# OCEANOGRAPHY

## HEARINGS

BEFORE THE

## SPECIAL SUBCOMMITTEE ON OCEANOGRAPHY

OF THE

## COMMITTEE ON MERCHANT MARINE AND FISHERIES HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

SECOND SESSION

ON

**H.R. 9361**

TO ADVANCE THE MARINE SCIENCES, TO ESTABLISH A COMPREHENSIVE 10-YEAR PROGRAM OF OCEANOGRAPHIC RESEARCH AND SURVEYS; TO PROMOTE COMMERCE AND NAVIGATION, TO SECURE THE NATIONAL DEFENSE; TO EXPAND OCEAN RESOURCES; TO AUTHORIZE THE CONSTRUCTION OF RESEARCH AND SURVEY SHIPS AND FACILITIES; TO ASSURE SYSTEMATIC STUDIES OF EFFECTS OF RADIOACTIVE MATERIALS IN MARINE ENVIRONMENTS; TO ENHANCE THE GENERAL WELFARE; AND FOR OTHER PURPOSES

**H.R. 10412**

TO ESTABLISH A PUBLIC POLICY WITH RESPECT TO OCEANOGRAPHIC SURVEYS, AND TO PROVIDE FOR COORDINATION OF THE EFFORTS OF FEDERAL AGENCIES WITH RESPECT TO OCEANOGRAPHIC SURVEYS

**H.R. 12018**

TO ESTABLISH WITHIN THE UNITED STATES COAST AND GEODETIC SURVEY A NATIONAL OCEANOGRAPHIC DATA CENTER AND A NATIONAL INSTRUMENTATION TEST AND CALIBRATION CENTER

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MAY 17, 19, 20, 24, AND 25, 1960

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Printed for the use of the Committee on Merchant Marine and Fisheries

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UNITED STATES
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55944 WASHINGTON : 1960

Norman T. Allen

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# OCEANOGRAPHY

**TUESDAY, MAY 17, 1960**

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON OCEANOGRAPHY OF THE
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
*Washington, D.C.*

The subcommittee met at 10 a.m., pursuant to notice, in room 219, Old House Office Building, Hon. George P. Miller (chairman of the subcommittee) presiding.

Present: Representatives Miller, Lennon, Oliver, Dorn, Pelly, and Curtin.

Staff members present: Paul S. Bauer, special consultant to the subcommittee, and Frances Still, assistant clerk.

Mr. MILLER. The committee will be in order.

For over a year our Special Subcommittee on Oceanography has been conducting an extensive study of oceanographic potential of the United States. The study has been carried out through public hearings, attendance at numerous meetings, and visits to oceanographic institutions. The subcommittee's work has centered around the splendid report of the Committee on Oceanography of the National Academy of Sciences-National Research Council.

I think it is fair to say to those who will appear before us that each and every member of this subcommittee is convinced of the importance of thorough study of the sea and all its attributes, and the urgency of proceeding with all reasonable speed toward the establishment of an effective, coordinated national oceanographic program.

In these hearings we are concerned with specific legislative proposals designed to foster such a program. We have before us a bill by Mr. Pelly which might be called an omnibus bill, passed upon the National Academy of Sciences recommendations. We also have bills introduced by myself and other members of the subcommittee, touching on individual aspects of the desired overall program.

The first consideration in the current hearings will be that part of oceanography concerned with surveys of the oceans of the world. In particular we shall start hearings this morning on H.R. 10412, which I have introduced, and the identical companion bills introduced by my colleague, Mr. Pelly, of Washington (H.R. 10581), and Mr. Oliver, of Maine (H.R. 10546).

(The bills follow:)

[H.R. 9361, 86th Cong., 2d sess.]

A BILL To advance the marine sciences, to establish a comprehensive 10-year program of oceanographic research and surveys; to promote commerce and navigation, to secure the national defense; to expand ocean resources; to authorize the construction of research and survey ships and facilities; to assure systematic studies of effects of radioactive materials in marine environments; to enhance the general welfare; and for other purposes

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

SHORT TITLE

SECTION 1. This Act may be cited as the "Marine Sciences and Research Act of 1959".

DECLARATION OF POLICY

SEC. 2. The Congress hereby declares that systematic, scientific studies and surveys of the oceans and ocean floor, the collection, preparation and dissemination of comprehensive data regarding the physics, biology, chemistry and geology of the seas, and the education and training of oceanographic scientists through a sustained and effective fellowship program is vital to defense against attack from the oceans and to the operation of our own surface and subsurface naval forces with maximum efficiency, to the rehabilitation of our commercial fisheries and utilization of other ocean resources, to the expansion of commerce and navigation, and to the development of scientific knowledge since many problems require an understanding of the waters which cover 71 per centum of the earth's surface, life within these waters, and the interchange of energy and matter between the sea and atmosphere.

The Congress further declares that sound national policy requires that the United States not be excelled in the fields of oceanographic research, basic, military or applied, by any nation which may presently or in the future threaten our general welfare, maritime commerce, security, access to and utilization of ocean fisheries, or the contamination of adjacent seas by the dumping of radioactive wastes or other harmful agents.

The Congress further declares that to meet the objectives outlined in the preceding paragraphs of this Act there must be a coordinated, long-range program of oceanographic research similar or identical to that recommended as a minimal program by the Committee on Oceanography of the National Academy of Sciences-National Research Council which requires but is not limited to the—

1. construction of modern, oceangoing ships for scientific research, surveys, fisheries exploration and marine development;

2. construction of laboratory and shore facilities adequate to service and supplement the research and survey fleets;

3. development and acquisition of new and improved research tools, devices, instruments, and techniques including but not limited to bathyscaphs and other manned submersibles, manned and unmanned deep ocean buoys, modified icebreakers, accoustical equipment and telemetering devices, current meters, direct density, turbulence and radioactivity measuring devices, biological sampling instruments, precision salinometers and echo sounders, magnetometers, and deep sea underwater cameras;

4. recruitment of prospective oceanographers from among undergradnate students of physics, chemistry, biology and geology and the facilitating of their advanced education in the marine sciences by a long-term fellowship program, where necessary, supported by or through the National Science Foundation or other appropriate agency of the Federal Government;

5. improvement of the economic and general welfare by obtaining more adequate information in the field of oceanography concerning the occurrence, behavior, and potential use of fish, shellfish, and other marine life, and thereby to enhance the development and utilization of living marine resources;

6. establishment of a national oceanographic records center to assemble, prepare and disseminate all scientific and technical oceanographic and closely related data, including but not limited to physical, biological, fisheries, hydrographic and coastal survey, meteorological and climatological data. All nonclassified data shall be made available for public use; and

7. development of formal international cooperation in the marine sciences on a reciprocal basis subject to approval by the President.

The Congress further declares that a coordinated, long-range program of oceanographic research requires establishment of a Division of Marine Sciences in the National Science Foundation, which shall include representation from Government agencies having duties or responsibilities connected with or related to the seas and oceans, and oceangraphic scientists associated with universities, institutions affiliated with universities, laboratories or foundations, and which Division shall be authorized and directed—

(a) to develop and encourage a continuing national policy and program for the promotion of oceanographic research, surveys and education in the marine sciences: *Provided*, That the long-range program for oceanographic research developed and projected by the Chief of Naval Research, Department of the Navy, and approved by the Chief of Naval Operations, known as project TENOC (Ten Years in Oceanography) be incorporated in the national program and policy;

(b) to recommend contracts, grants, loans or other forms of assistance for the development and operation of a comprehensive national program of oceanographic research and education in the marine sciences;

(c) to cooperate with and encourage the cooperation of the Office of Naval Research, the Hydrographic Office, the Bureau of Ships, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Atomic Energy Commission, the Maritime Administration, the United States Weather Bureau, the United States Coast Guard, the United States Geological Survey, the National Bureau of Standards, and other Government agencies dealing with problems related to the seas, and the National Academy of Sciences—National Research Council and administrators and scientists of all universities and institutions receiving assistance from Federal agencies for oceanographic or fisheries research or education in the marine sciences in the form of contracts, loans, grants, leases, donations, scholarships, fellowships or transfers of funds or property of the Federal Government;

(d) to foster the interchange of information among marine scientists in the United States and foreign nations within the security provisions and limitations of the National Science Foundation Act of 1950 (64 Stat. ch. 171); and

(e) to evaluate the scientific aspects of programs of oceanographic and fisheries research and surveys undertaken by agencies of the Federal Government, universities and institutions receiving assistance from the Federal Government for oceanographic and fisheries research and ocean surveys.

NATIONAL SCIENCE FOUNDATION, DIVISION OF MARINE SCIENCES

SEC. 3. (a) Section 7(a) of the National Science Foundation Act of 1950 is hereby amended by striking "and" after the semicolon in (3), redesignating (4) as (5) and inserting immediately after (3) the following new section:

"(4) Division of Marine Sciences; and".

(b) Section 8(b) of the National Science Foundation Act of 1950 is hereby amended by substituting a semicolon for the period after "Board" and inserting immediately thereafter the following new proviso: "*Provided*, That the Division of Marine Sciences shall include among its membership a representative from the Office of Naval Research, the Hydrographic Office, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Atomic Energy Commission, the Maritime Administration, and at least six scientists from the universities and institutions receiving assistance from the foregoing agencies."

SEC. 4. It is necessary in order to carry out the policies of S. Res. 136, Eighty-sixth Congress, and of this Act to have the National Science Foundation carry out, under laws, as amended, relating to such Foundation, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Foundation to carry out its duties under law. There is hereby authorized to be appropriated to the National Science Foundation, during the ten-year period beginning with July 1 of the first fiscal year following approval of this Act by the President, the following sums:

(a) The sum of $9,950,000 for the construction of oceanographic research ships;

(b) The sum of $12,440,000 for the operation of oceanographic research ships constructed under this Act;

(c) The sum of $8,250,000 for construction of shore facilities for oceanographic research;

(d) The sum of $37,200,000 for basic oceanographic research operations: *Provided, however*, That the expenditure under this subsection (d) shall not exceed $8,000,000 in any one year of the ten-year program.

(e) Such sums as may be adequate for specialized equipment for ocean exploration and research which may include bathyscaphs and other manned submersibles, manned and unmanned buoys, icebreakers and submarines converted for scientific use, acoustic telemetering devices, current meters, direct density measuring devices, cameras and underwater television, seismic equipment, turbulence measuring devices, biological sampling devices, precision salinometers, precision echo sounders, towed temperature recorders, magnetometers and other instruments and laboratory equipment: *Provided, however*, That expenditures under this subsection (e) shall not exceed $10,000,000 in any one year of the ten-year program.

(f) The sum of $3,000,000 for fellowships to graduate students training to become professional oceanographers: *Provided, however*, That annual costs of these fellowships shall not exceed $300,000.

BUREAU OF MINES AND BUREAU OF COMMERCIAL FISHERIES, DEPARTMENT OF THE INTERIOR

SEC. 5. The Secretary of the Interior is authorized and directed, with such funds as may be appropriated or otherwise made available to him, to undertake a ten-year program of study and research as part of the general program for the development of the marine sciences in the United States. In furtherance of the purposes of this Act, the Secretary is authorized and directed to carry out, in addition to programs now underway, the following activities:

(a) Make grants of funds to qualified scientists, research laboratories or institutions in furtherance of the purposes of this Act, such grants to be used for basic and applied research programs, the purchase of equipment, acquisition or improvement of facilities, and for other uses necessary to carry out the work hereunder.

(b) Initiate and carry out a program for the replacement, modernization and enlargement in the number of oceangoing ships being used for research, exploration, surveying and the development of marine resources.

(c) Construct and operate a sufficient number of shore facilities and laboratories to support effectively the vessels provided for under the preceding item (b).

(d) Cooperate with other departments and agencies in the conduct of ocean-wide surveys from which data relative to the study of ocean resources may be obtained.

(e) Conduct studies concerning the relation of marine life to radioactive elements, such studies to be directed toward determining the effect of distribution of radioactive elements in the sea on living marine organisms, and other such studies as the Secretary deems necessary to understand and evaluate the relation of radioactivity to the inhabitants of the marine environment.

(f) Conduct studies of the economic and legal aspects of commercial fisheries and the utilization of marine products.

(g) Request and obtain cooperation from other governmental agencies having an interest in the marine sciences, and cooperate with the several States, educational institutions, laboratories devoted to fishery research, marine science, oceanography, and with other public and private organizations and persons who may be of assistance.

(h) Determine the reserves of metals of industrial, commercial or monetary value in or beneath adjacent waters, and to ascertain techniques and probable costs of their recovery and extraction.

(i) Take such action and carry out other activities which he finds will accomplish the purposes of this Act.

SEC. 6. It is necessary in order to carry out the policies of S. Res. 136, Eighty-sixth Congress, and of this Act to have the Department of the Interior and its Bureaus and Offices carry out, under laws relating to such Department and its Bureaus and Offices, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department to carry out its duties under law. There is hereby authorized to be

appropriated to the Bureau of Mines and the Bureau of Commercial Fisheries, Department of the Interior, during the ten-year period beginning with July 1 of the first fiscal year following approval of this Act by the President, the following sums:

(a) Such sums as may be necessary for construction of new ships for fisheries exploration and research: *Provided, however*, That in the construction of these ships, modern fisheries exploration and research vessels of other nations shall be studied with respect to design and performance with a view to increasing the seaworthiness, range, and efficiency of the United States fisheries research fleet.

(b) Such sums as necessary for operation of new fisheries research and exploration ships: *Provided, however*, That operation costs for new research ships placed in operation by the Bureau of Commercial Fisheries not aggregate in excess of $2,000,000 per annum; *Provided further*, That in planning operations of the new research and exploration ships of the Bureau of Commercial Fisheries, the Secretary of the Interior shall give full consideration to the needs for such operation in the Gulf of Mexico, Bering Sea, other ocean areas of potential commercial importance, and the Great Lakes.

(c) Such sums as the departments deem adequate for capital expenditures in inaugurating, developing, or expanding new ocean resource studies and surveys, or constructing or procuring facilities for such studies including, but not limited to, unmanned buoys for automatic continuous oceanographic records, mesoscaphs for biological observations, automatic continuous plankton samplers, oceanaria and instrumentation for studies of marine life behavior, laboratories for research into marine survival, and establishment of an institute for research on diseases of fish, shellfish, and other marine life: *Provided, however*, That in constructing or procuring facilities for ocean resource studies, and in inaugurating such studies, full consideration be given to the fisheries resources of the Pacific and Atlantic Oceans north of 40 degrees north latitude, between 15 degrees and 40 degrees north latitude, the Gulf of Mexico, Bering Sea, other ocean areas of potential commercial value, and the Great Lakes, and that such facilities be located where they may provide maximum benefits to fishermen and other citizens residing in the United States.

(d) Such sums as are necessary for operations, excluding ship operations, of fisheries resource studies including, but not limited to, those stated above in (c) marine population sampling, biological surveys, ecological mapping, taxonomic development, genetics of marine organisms, pond fish culture and braking water farming, estaurine studies, transportations and nutrient increase research: *Provided, however*, That expenditures for operations of new resources studies by the Bureau of Commercial Fisheries of the Department of the Interior not exceed $10,000,000 per annum.

(e) The sum of $6,500,000 for continuing studies over a ten-year period of utilization of marine products for human consumption, animal feeds, industrial purposes, fertilizers and organic chemicals, and the development of new uses of marine products: *Provided, however*, That in directing these studies the Secretary of the Interior shall give full consideration to their being carried on in existing institutions through the issuance of grants to said institutions, for continuing studies over a ten-year period of the economics and law of commercial fisheries and for the investigation of the mineral deposits on the ocean floor and mineral resources in the sea.

DEPARTMENT OF COMMERCE

SEC. 7. The Secretary of Commerce is authorized and directed, with such funds as may be appropriated or otherwise made available to him, to undertake a ten-year program of study and research as part of the general program for the development of the marine sciences in the United States. In furtherance of the purposes of this Act, the Secretary is authorized and directed to carry out the following activities:

(a) Request and obtain cooperation from other Government agencies having an interest in the marine sciences and ocean surveys, and cooperate with educational institutions and laboratories devoted to the marine sciences and oceanography, and with other public and private organizations and persons who may be of assistance.

(b) Establish within the Department of Commerce a National Oceanographic Records Center, which records center shall collect from other agencies and departments of the Federal Government, agencies of the several States, oceano-

graphic institutions and laboratories and other sources, all oceanographic data, and prepare and disseminate such oceanographic data for public use.

(c) Initiate and carry out a program for the replacement, modernization and enlargement in the number of oceangoing ships for use in ocean and coastal surveys by the Coast and Geodetic Survey.

(d) Construct and operate a sufficient number of Coast and Geodetic Survey shore facilities to support effectively the vessels provided for under the preceding item (a), and provide instruments and equipment essential for efficient utilization of such shore facilities or survey ships.

(e) Inaugurate in the Weather Bureau a comprehensive ten-year study of the interchange of energy between the oceans and the atmosphere, and to prepare, based on such study, climatological maps illustrating the balance of incoming and outgoing radiation and heat exchange between the oceans and the atmosphere. The provisions of this subsection (e) may be carried out by means of contracts with public or private organizations, or by grants to scientific institutions carrying on such studies.

(f) Require that the Maritime Administration construct ships of approximately five hundred tons and one thousand two hundred to one thousand five hundred tons displacement specifically designed for basic oceanographic research with due attention given to suitable arrangement of laboratory space and living quarters for scientists, space and power for winches and other auxiliaries, sea keeping and handling qualities at low speeds, quiet operation, efficient and economical scientist-crew ratios, and operation in all kinds of weather, such ships, when completed, to be made available, at the discretion of the Secretary, to nonprofit oceanographic research centers, to other agencies of the Federal Government, or, pursuant to negotiated contracts or grants, to State institutions engaged to oceanographic research requiring oceangoing scientific ships, with preference given to such institutions which have engaged in such research prior to this Act.

SEC. 8. It is necessary in order to carry out the policies of S. Res. 136, Eighty-sixth Congress, and of this Act to have the Department of Commerce and its Bureaus and Offices carry out, under laws, as amended, relating to such Department or such Bureaus and Offices, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department to carry out its duties under law. There is hereby authorized to be appropriated to the Department of Commerce and its Bureaus and Offices, during the ten-year period beginning with July 1, of the first fiscal year following approval of this Act by the President, the following sums:

(a) The sum of $250,000 for capital outlay in the establishment of a National Oceanographic Records Center.

(b) Such sums as are necessary for operating expenses of a National Oceanographic Records Center: *Provided, however*, That expenses for this purpose during the first year not exceed $100,000, and that this amount shall not be increased more than 10 per centum per annum in each of the subsequent years of this program.

(c) Such sums as are necessary for construction by or for the Coast and Geodetic Survey of two survey ships of five hundred tons displacement, six survey ships of one thousand two hundred to one thousand five hundred tons displacement, and two survey ships of two thousand tons displacement or more.

(d) Such sums as are necessary for operations of new Coast and Geodetic Survey survey ships authorized under this Act during the ten-year life of this program—

for construction of new shore facilities for processing and evaluating Coast and Geodetic Survey data obtained through surveys and related research conducted from new oceangoing Coast and Geodetic Survey ships;

for expanded operations, excluding ship operations, of the Coast and Geodetic Survey during a ten-year period; and

for the establishment and operations of a ten-year study of the interchange of energy between the oceans and the atmosphere.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, OFFICE OF EDUCATION

SEC. 9. The Secretary of Health, Education, and Welfare is authorized and directed, with such funds as may be appropriated or otherwise made available to him, to undertake a ten-year program of obtaining new faculty in oceanography and marine sciences as part of the general program for the development

of the marine sciences in the United States. In furtherance of the purposes of this Act, the Secretary is authorized to provide assistance through the Office of Education in the form of teacher salaries and equipment.

SEC. 10. It is necessary in order to carry out the policies of S. Res. 136, Eighty-sixth Congress, and of this Act to have the Office of Education, Department of Health, Education, and Welfare carry out, under laws relating to such Department or Office, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department or Office to carry out its duties under law.

ATOMIC ENERGY COMMISSION

SEC. 11. In furtherance of the policies in S. Res. 136, Eighty-sixth Congress, and of this Act, and for the purpose of determining the effects of radioactive contamination upon the oceans and life within the oceans and their estuaries, and for regulating in the interests of public safety, health and welfare, the introduction of radioactive materials in the oceans, the Atomic Energy Commission is hereby authorized to conduct, in the marine environment, an intensive ten-year program of control and monitoring of radioactive waste disposal and studies including, but not limited to, circulation and mixing processes which affect the dispersion of introduced contaminants in coastal and estuarine environments and in the open ocean, inorganic transfer of radioactive elements from seawater to sediments, the effect of radioactive elements on living oragnisms in the oceans, coastal waters and estuaries and the genetic effects of radiation on such organisms. The Atomic Energy Commission is further authorized to carry out any of its duties or functions under this or other Acts, including the use of scientific ships and personnel, in cooperation with other agencies of the Federal Government, or through contracts with or grants to State institutions or independent scientific laboratories undretaking or equipped to undertake such programs: *Provided, however*, That those aspects of the program relating to regulating and monitoring the introduction of radioactive material in the ocean shall be carried out by the Coast and Geodetic Survey or the Public Health Service, or both, with funds made available by the Atomic Energy Commission.

SEC. 12. It is necessary in order to carry out the policies of S. Res. 136, Eighty-sixth Congress, and of this Act to have the Atomic Energy Commission carry out, under laws relating to such Commission, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Commission to carry out its duties under law. There is hereby authorized to be appropriated to the Atomic Energy Commission, during the ten-year period beginning with July 1, of the first fiscal year following approval of this Act by the President, the following sums as are necessary—

for engineering studies in connection with control and monitoring as authorized in section 11 of this Act: *Provided, however*, That expenditures for this purpose not exceed $370,000 in any one year of the ten-year program authorized by this Act;

for participating in international meetings of scientists and technical experts relating to international control and monitoring of radioactive waste disposal in the marine environment: *Provided, however*, That expenditures for this purpose not exceed $30,000 in any one year of the ten-year program;

for estuarine and coastal studies authorized in section 12 of this Act: *Provided, however*, That expenditures for this purpose not exceed $2,800,000 in any one year of the ten-year program of estuarine and coastal studies authorized by this Act;

for research to determine circulation and mixing processes which control the dispersion of radioactive wastes introduced in deep waters of the open ocean: *Provided, however*, That the expenditures for this purpose by the Atomic Energy Commission not exceed $1,400,000 per annum;

for studies of the inorganic transfer of radioactive elements from sea water to the sediments: *Provided, however*, That expenditures by the Atomic Energy Commission for this purpose not exceed $484,000 in the first year of the program or $299,000 in subsequent years of this ten-year period;

for studies of the effects of the biosphere on the distribution and circulation of radioisotopes in the ocean and its seas: *Provided, however*, That

expenditures by the Atomic Energy Commission for this purpose not exceed $938,000 per annum;

for studies of the genetic effects of atomic radiations on marine organisms: *Provided, however,* That expenditures by the Atomic Energy Commission for this purpose not exceed $100,000 per annum;

for field experiments in confined bodies of water utilizing radioisotopes: *Provided, however,* That expenditures by the Atomic Energy Commission for this purpose not exceed $100,000 per annum; and

for two major open-sea tests of radiological contamination at sea, its effects on marine life, and its potential effects on humanity.

DEPARTMENT OF THE NAVY

SEC. 13. In order to carry out the policies of S. Res. 136, Eighty-sixth Congress, of this Act and of the Navy's long-range program for oceanographic research known as TENOC, the Secretary of the Navy is authorized and directed to undertake a ten-year program of expanded basic oceanographic research and hydrographic surveys as a part of the general program for the development of the marine sciences in the United States. The Secretary is authorized and directed with such funds as may be appropriated or otherwise made available to him for purposes of this Act, to carry out the following activities:

(a) Make grants of funds to scientists, research laboratories, or institutions in furtherance of the purposes of this Act, such grants to be used for the purchase of equipment, acquisition or improvement of facilities, employment of scientists and personnel, and for other uses necessary to carry out the work hereunder.

(b) Initiate and carry out a ten-year program for the replacement, modernization, and enlargement in the number of ships for use in basic research and hydrographic surveys, and to supply, when available, ships designed for basic research to nonprofit scientific institutions: *Provided,* That when ships are supplied under this provision title to the ships shall remain with the United States Government and the ships shall be reassigned or returned to Federal operation upon termination of the grant or contract with the institution.

(c) Construct and operate a sufficient number of shore facilities and laboratories to support effectively the expanded program of basic oceanographic research and hydrographic surveys authorized for the Department of the Navy to undertake under this Act.

(d) Develop, construct, or acquire new or improved vehicles for ocean research and exploration, including but not limited to bathyscaphs and other manned submersibles, icebreakers and submarines converted for scientific use, seismic equipment, turbulence measuring devices, precision echo sounders, acoustic telemetering devices, and instruments for the study of the current structure of the ocean, oceanic temperatures, bottom topography, sediments, heat flow through the ocean bottom, sound transmission and velocities, ambient noise, biological activity and specimens, and water samples for salinities, phosphates, oxygen, nitrates, and other chemical or elemental components of the oceans.

(e) Continue and expand the Navy's support of civilian oceanographic laboratories as proposed in project TENOC approved by the Chief of Naval Operations, and substantially similar to the recommendations made in the report of the Committee on Oceanography of the National Academy of Sciences—National Research Council.

(f) Establish with the National Science Foundation or the National Academy of Sciences—National Research Council—a program of scholarships for selected students beginning at the senior level in undergraduate school, and carrying through with four years of graduate training and research in the marine sciences: *Provided,* That the Department of the Navy may recommend to the National Science Foundation the institutions qualified to participate in this program.

(g) Conduct a systematic and expanded program of three-dimensional ocean surveys including measurements or studies of depths, salinity, temperature, current velocity, wave motion, magnetism and biological activity.

(h) Continue a policy of expanding assistance and support to existing civilian laboratories and universities engaged in basic oceanographic research, foster the establishment and growth of new civilian laboratories for applied oceanographic research needed by the Navy. In the designation of new laboratories to receive Navy assistance consideration shall be given to geographic location with reference to the oceans, with the object of maintaining a balanced program of research in and adjacent to the seas and oceans bordering the United States.

(i) Request and obtain cooperation from other governmental departments and agencies having an interest in the marine sciences, and to cooperate with the several States, with educational institutions, laboratories, and other public and private organizations and persons who may be of assistance.

SEC. 14. It is necessary in order to carry out the policies of S. Res. 136, Eighty-sixth Congress, of this Act and of the Navy's long-range program for oceanographic research known at TENOC to have the Department of the Navy carry out, under laws relating to such Department, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department to carry out its duties under law. There is hereby authorized to be appropriated to the Department of the Navy, during the ten-year period beginning with July 1 of the first fiscal year following approval of this Act by the President, such sums as are necessary—

for the construction of nine one thousand two hundred to one thousand five hundred-ton displacement research ships: *Provided, however,* That not more than two of these ships shall be built the first year of the program; two in the second year; one in the third year; two in the fourth year, and one in succeeding years of the program;

for the construction of four two thousand to three thousand-ton displacement research ships: *Provided, however,* That not more than one such ship shall be built in any one year of the ten-year program;

for the construction of two survey ships of approximately five hundred-ton displacement;

for the construction of five survey ships of one thousand two hundred to one thousand five hundred-tons displacement: *Provided, however,* That not more than two of these survey ships shall be built in any one year;

for the construction of three survey ships of two thousand tons displacement;

for the construction of one research ship of three hundred-tons displacement;

for operations of basic research ships in excess of present operating costs for such ship operations: *Provided, however,* That the operating costs of new one thousand two hundred to one thousand five hundred-ton research ships not exceed $420,000 each per annun; that that of the two thousand to three thousand-ton ships not exceed $700,000 each per annum, and that of the five hundred-ton ships not exceed $250,000 each per annum;

for construction of new shore facilities for basic research;

for basic research operations other than ships;

for construction of new shore facilities for survey work;

for engineering needs for ocean exploration and research which may include bathyscaphs and other manned submersibles to be used for research, manned and unmanned buoys, icebreakers and submarines modified or converted for scientific use, acoustic telemetering devices, current meters, direct density measuring devices, cameras and underwater television, seismic equipment, turbulence measuring devices, biological sampling devices, precision salinometers, precision echo sounders, towed temperature recorders, magnetometers and other instruments and laboratory equipment for oceanographic research; and

for establishing a program of scholarships for selected students as authorized in section 13(f) of this Act: *Provided, however,* That costs to the Department of the Navy of these fellowships not exceed $300,000 per annum.

GENERAL

SEC. 15. (a) Nothing in this Act shall operate to limit, restrict, or otherwise interfere with carrying out any work programed prior to enactment.

(b) All appropriations authorized in this Act shall be in addition to other appropriations provided for the various departments, agencies, bureaus, and offices to carry out their duties under law.

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[H.R. 10412, 86th Cong., 2d sess.]

A BILL To establish a public policy with respect to oceanographic surveys, and to provide for coordination of the efforts of Federal agencies with respect to oceanographic surveys

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That Congress hereby finds that the needs of the United States in the fields of navigation, commerce, fisheries, and national defense require that continuing oceanographic surveys be made of the oceans and seas of the world. Congress further finds that although there is authority for conducting these oceanographic surveys, this authority has been granted to agencies of Government in the fields of their special interest and thus coordination of effort is necessary to most effectively carry out continuing oceanographic surveys.

SEC. 2. (a) There is hereby established the Coordinating Committee on Oceanographic Surveys (hereinafter referred to as the "Committee"). The Committee shall be composed of one representative from each of the following agencies:

(1) Office of Naval Research,
(2) the Hydrographic Office,
(3) the Coast and Geodetic Survey,
(4) the Maritime Administration,
(5) the United States Coast Guard,
(6) the United States Weather Bureau,
(7) the United States Fish and Wildlife Service.

(b) (1) The head of each agency represented on the Committee shall appoint the representative of that agency from among the officers and employees of the agency.

(2) The President may also appoint to the Committee a representative from any other agency of the United States dealing with problems related to the sea.

(c) The Committee shall elect a Chairman and a Vice Chairman from among its members.

(d) The Committee is authorized to obtain from the agencies represented on the Committee such facilities and personnel as the Committee determines necessary to carry out its duties under this Act. The head of each such agency shall furnish the Committee such facilities and personnel, from the facilities, officers, and employees of the agency, as the Committee shall request.

(e) The Committee is authorized and directed to coordinate the efforts of the represented agencies in carrying out their individual responsibilities with respect to the collection, preparation, and dissemination of knowledge of the oceans and their floors to the end that the United States can most effectively conduct continuing comprehensive oceanographic surveys.

(f) In carrying out its duties under subsection (e) of this section the Committee shall from time to time—

(1) assess and appraise the objectives of the United States in the field of oceanography, and

(2) consider policies on matters of common interest to the agencies of Government concerned with oceanography.

SEC. 3. The Committee shall, not later than January 31 of each year, submit to the President and to Congress an annual report of its activities under this Act, including recommendations for any legislation which it deems necessary to carry out this Act.

[H.R. 12018, 86th Cong., 2d sess.]

A BILL To establish within the United States Coast and Geodetic Survey a National Oceanographic Data Center and a National Instrumentation Test and Calibration Center

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That (a) the Secretary of Commerce is authorized to establish within the United States Coast and Geodetic Survey a National Oceanographic Data Center. The function of the National Oceanographic Data Center shall be to acquire, assemble, process, and disseminate all scientific and technological and oceanographic and related environmental data, including, but not limited to, physical, biological, fisheries, hydrographic and coastal survey, meterological, climatological, and geophysical data.

(b) There is hereby established an advisory board composed of one representative from each of the following agencies: (1) the Department of the Navy (2) the Bureau of Commercial Fisheries of the Department of the Interior, (3) the National Science Foundation, and (4) the Atomic Energy Commission. Such advisory board shall advise and consult with the Secretary of Commerce in the administration o fthe National Oceanographic Data Center.

(c) The National Oceanographic Data Center is authorized to conduct research and other projects within the fields of its activities for any department, agency, or instrumentality of the Government of the United States on a cost reimbursable basis.

(d) The Secretary of Commerce is authorized to exchange or sell, on a cost reimbursable basis, such data, publications, or other information of the National Oceanographic Data Center as he deems to be in the public interest. Such exchange or sale may be made with any governmetnal or nongovernmental department, agency, or institution or with any other person (including foreign governmental departments, agencies, and instrumentalities, and foreign persons).

SEC. 2. (a) The Secretary of Commerce is authorized to establish within the United States Coast and Geodetic Survey a National Instrumentation Test and Calibration Center. The function of the National Instrumentation Test and Calibration Center shall be to test, calibrate, and evaluate geographic and hydrographic instrumentation. Such testing, calibration, and evaluation shall be done on a cost reimbursable basis, and may be done for any governmental or nongovernmental department, agency, or institution or for any other person (including foreign governmental departments, agencies, and instrumentalities, and foreign persons).

Mr. MILLER. I want to particularly stress to all concerned that the subcommittee has no preconceived ideas. We are groping for the best that we can get.

It gives me great pleasure at this time to give the floor to the Honorable Thomas Pelly of Washington who, I understand, has a statement to make on H.R. 9361 and on H.R. 10581.

Mr. Pelly?

## STATEMENT OF HON. THOMAS M. PELLY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF WASHINGTON

Mr. PELLY. Thank you, Mr. Chairman. I appreciate the fact that we have some very important witnesses who will make a considerable contribution toward this testimony and the hearings and I will defer to them. If it would meet with your approval, instead I will insert in the record a statement which largely covers what is in the bill and invites some changes where necessary.

Let us just get on with the hearing, then, Mr. Chairman, and I will turn this statement in.

Mr. MILLER. Without objection, it will be made part of the record. (The statement follows:)

STATEMENT OF REPRESENTATIVE THOMAS M. PELLY IN SUPPORT OF H.R. 9361

Mr. Chairman, I appreciate this opportunity of testifying in connection with my bill, H.R. 9361, to provide for a 10-year program of oceanographic studies.

The objective of this measure is to accelerate research and thus advance the marine sciences. My bill would establish an expanded 10-year program in order to promote commerce and navigation and exploit valuable ocean resources as well as aid in increasing the important information so vital to the national defense.

Specifically, the bill would authorize construction of modern oceangoing ships for scientific research, surveys, fishing exploration, and marine development.

Likewise, in a coordinated, long-range program it recommends construction of laboratory and shore facilities and improved research tools and instruments. Along with this plan to obtain both surface and underwater survey devices, the bill seeks to encourage recruitment of prospective oceanographers and facilitate their advanced education in marine sciences by a fellowship program through the National Science Foundation or other appropriate Government agency.

A new division of marine sciences in the National Science Foundation, under this legislation, would be established and consist of representatives from the Office of Naval Research, the Hydrographic Office, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Atomic Energy Commission, and the Maritime Administration.

Also the membership would include at least six scientists from universities and institutions receiving assistance from the foregoing agencies.

The authorized expenditures under the act by my bill would be $9,950,000 for construction of research ships; $12,440,000 for operation of such ships; $8,250,000 for shore research facilities and $37,200,000 for basic research operations which would be limited to not to exceed $8 million in any one year of the 10-year program.

Authorization would also be given for not to exceed $10 million a year during the 10 years for special scientific equipment and instruments including bathyscaphs. Also $300,000 a year for fellowships.

H.R. 9361 would give broad authorization to the Department of the Interior and its bureaus and offices to carry out the policy of the bill, and additional appropriations for carrying out new duties under the law would be granted. For example, an aggregate of not in excess of $2 million per annum for operation of research ships is included for the Bureau of Fisheries and not in excess of $10 million per annum for fish studies. Also, a sum of $6,500,000 per annum for continuing studies for new uses of marine products.

Within the Department of Commerce, an Oceanographic Record Center would be set up at a cost of $250,000. Also, Coast and Geodetic Survey would obtain expanded ocean and shore facilities and equipment. The Weather Bureau would be given new responsibilities and the Department of Health, Education, and Welfare would be called upon for educational assistance.

An extremely important aspect of the bill is the study it calls for in determination of the effects of radioactive contamination of the oceans and marine life for public safety; $370,000 a year for the 10-year period would be authorized for this purpose and $30,000 per year in addition for international scientific and technical control discussions of radioactive waste. Also, $2,800,000 a year for coastal studies and $1,400,000 a year for research in deepwater disposal. Yearly sums are included for studies of inorganic transfer of radioactivity from sea water and also its genetic effects.

The Navy has developed a long-range oceanographic program known as TENOC which would be authorized and carried out under this bill. I understand the Navy is reviewing TENOC and its testimony may invite some changes in my bill.

Since the drafting of this legislation the role of the Coast Guard in many phases of the proposed program has been pointed up. I would favor appropriate recognition of its oceanographic responsibilities and for them to be expanded by a proper committee amendment to the bill.

In general I think it is obvious that H.R. 9361 is intended to be responsive to the recommendation contained in the report entitled "Oceanography 1960–70" of the National Academy of Sciences-National Research Council. The bill seeks to implement the report by activating all appropriate agencies of Government in a parallel coordinated long-term development of their maritime science programs.

As drafted, I am sure many technical changes may be desirable, but in general I believe legislation of this nature is necessary unless we are satisfied that the progress in this field is satisfactory and I have not found any qualified scientists who support status quo. On the contrary, many leaders in this field are emphatically dissatisfied.

One change recommended by a qualified fishery expert is that the Bureau of Commercial Fisheries responsibility as specified in my bill is not clear enough. Later witnesses will suggest supplements of this nature which I welcome. However, if properly amended I feel this legislation is constructive and will prevent the United States from being outclassed in the field of research and development of the marine sciences.

Meanwhile, I thank the committee for scheduling this hearing.

Mr. MILLER. I talked informally to you gentlemen yesterday and we will, if there is no objection, change the procedure in this hearing.

When we come to the questioning, I am going to ask Mr. Bauer to start off with the questioning because he is prepared. It is a technical subject that he knows.

After he gets through, then the members of the committee will take it up.

This is a procedure that is followed in many committees where technical subject matter comes before the committee.

Do you have any objection?

Mr. LENNON. I have no objection.

Mr. MILLER. Do you, Mr. Pelly?

Mr. PELLY. I thoroughly approve. I think it will save a lot of time, Mr. Chairman.

Mr. MILLER. Our first witness this morning is the Honorable James H. Wakelin, Jr., Assistant Secretary of the Navy for Research and Development and Chairman of the Interagency Committee on Oceanography of the Federal Council for Science and Technology.

Mr. Secretary, we are very happy to greet you here.

We will be very happy to hear you.

## STATEMENT OF HON. JAMES H. WAKELIN, JR., ASSISTANT SECRETARY OF THE NAVY FOR RESEARCH AND DEVELOPMENT AND CHAIRMAN OF THE INTERAGENCY COMMITTEE ON OCEANOGRAPHY OF THE FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Mr. WAKELIN. Mr. Chairman and gentlemen, I appreciate the opportunity to appear before you today. I have prepared a somewhat lengthy statement for the record. I would like, if it meets with your approval, Mr. Chairman, to summarize my statement briefly and then to discuss the broad aspects rather than the particulars of the bills on oceanography now under consideration by you.

Mr. MILLER. That is entirely agreeable.

(The statement follows:)

STATEMENT OF HON. JAMES H. WAKELIN, JR., ASSISTANT SECRETARY OF THE NAVY FOR RESEARCH AND DEVELOPMENT AND CHAIRMAN OF THE INTERAGENCY COMMITTEE ON OCEANOGRAPHY OF THE FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Mr. Chairman, gentlemen, the longstanding interest of this committee in oceanography has been most gratifying to me and to the members of other Federal agencies. I appreciate the opportunity of appearing before you today to discuss our long-range national plans and to comment on the bills on oceanography pending before this committee.

The comments I have to make to you will stem from two points of view. First, as Assistant Secretary of the Navy for Research and Development, I am concerned with the Navy's traditional interests in the oceans; oceanography affects every aspect of our operations from the Polaris fleet ballistic missile system to undersea warfare to amphibious and mine operations. Second, as Chairman of the Interagency Committee on Oceanography of the Federal Council for Science and Technology, I am concerned with increasing this Nation's knowledge of the oceans—their content, their boundaries—by substantially accelerating our efforts in an orderly program during the next 10 years.

Recognizing the seriousness of inadequate oceanographic information from the scientific, technical, and military points of view, the Federal Council for Science and Technology established a subcommittee last summer to prepare a coordinated national oceanographic program. This committee, now called the Interagency Committee on Oceanography, has recently been made a permanent instrument of the Federal Council with representation from the Departments of Defense, Commerce, Interior, Health, Education, and Welfare, the National Science Foundation, and the Atomic Energy Commission. The Interagency Committee carefully reviewed the report of the National Academy of Sciences-National Research Council's Committee on Oceanography. In this report the Academy recommended a minimal program for long-term growth at an achievable rate in training of scientific manpower, construction of adequate ships and laboratories, as well as a technical program for research and ocean surveys. The Interagency Commerce concurred generally with the National Academy and concluded that the report accurately stated the Nation's scientific needs in oceanography. The critical parameters are scientific manpower, funds, and time. Of course, I refer to a special kind of time—lead time for the construction of ships and shore laboratories and for the training of the additional scientists.

The Interagency Committee recommended to the Federal Council that the United States undertake a substantial and orderly expansion of activity in oceanography. The Committee stated that vigorous action must be taken to stimulate the growth of educational programs, that a permanent interagency committee should be established to review and coordinate the national effort and that international cooperation is essential to the research and survey program. These recommendations were accepted and endorsed by the Federal Council.

The Interagency Committee then developed by joint planning the budget for a 10-year national program to implement these general recommendations. The total funding requested in the President's budget for the oceanographic program in fiscal year 1961 totals about $56 million, an increase of almost 50 percent over the fiscal year 1960 level of $37 million. For the previous year, fiscal year 1959, funds for this work amounted to $24 million. I feel that this program provides for growth at a reasonable rate and that it satisfies the most critical initial needs of the departments and agencies in the field of oceanography.

What will a 10-year program require in terms of funds, facilities, and manpower? The National Academy of Sciences' report indicated that the program would cost $651 million in 1958 dollars over and above the rate at which the program was then being supported. This estimate is probably low when translated into 1961 dollars because the cost of doing business has increased. Also, we believe that the unit cost of construction of ships has been underestimated. Taking these factors into considerattion, the Interagency Committee has estimated that the total cost will approximate $1 billion during the 10-year program if our goal to double our present capability is to be realized. This is a modest goal when the level of our present knowledge is considered in relation to our needs. And I would like to say that doubling the present activity in oceanography will require more than doubling the rate of expenditures because of the capital investments required.

The United States currently operates about 52 ships, mostly of small size, for oceanographic research and surveys. About 30 of these will require replacement during the next 10 years because they will be overage. Construction of new research ships in preference to the conversion of existing hulls is considered essential for a number of reasons. The Navy is making a study of the efficiency and economy of new construction versus conversions for various applications, to point to the most feasible methods of providing the Navy with the required oceanographic ships in the next 10 years.

The most critical element in expanding our effort in this field is the shortage of scientific personnel to man the ships and carry out a creative program. Recently, we have compiled data from 10 major universities and institutions concerned with training of oceanographers as well as the conduct of research. This information is most encouraging and we must do everything possible to continue the trend. The number of professional oceanographers at the Ph.D., M.S., or equivalent level and the number of their graduate students for the past 3 years is summarized in the following table. These data show that there has been an increase of 28 percent in the professional level and of 80 percent in graduate students over the last 3 years.

| | 1958 | 1959 | 1960 |
|---|---|---|---|
| Professional level (Ph. D., M.S., or equivalent) | 253 | 290 | 327 |
| Graduate students | 137 | 176 | 246 |

Universities and institutions which supplied this data are: Columbia University, Johns Hopkins University, Oregon State College, Texas A. & M., University of Miami, University of Rhode Island, University of Southern California, University of Washington, Scripps Institution of Oceanography of the University of California, and Woods Hole Oceanographic Institution.

By 1970 I believe we can expect the annual cost of the program to level off at approximately $85 million. Here I would like to emphasize that beginning in fiscal year 1962 the annual cost of the program for several years may require funding in excess of $100 million to permit the construction of ships and shore laboratories necessary for expansion of the program. The training and educational program, however, will not be a large percentage of the total program cost. It has been estimated that approximately $15 million will provide the means whereby an adequate number of oceanographers can be trained in the next 10 years. This figure is a cost of education only, not the cost for facilities at educational institutions.

The Navy, by far the largest supporter of oceanographic research, contracts with universities and nonprofit institutions for about three-fourths of its basic research program; the remainder is conducted in Navy-operated laboratories. The funding for this research and for the construction of one research ship totals $22.9 million and constitutes the Navy portion of the national oceanographic program. In addition, the Navy Hydrographic Office conducts an extensive military survey program and the technical bureaus carry out many closely related military programs at universities, Government laboratories, and with industry. The cost of these efforts approximates $14 million for military surveys and about $10 million for military research. Because of the peculiarly military character of these programs, their funding is not included in the national oceanographic program.

The Navy's concern about the oceans today, as in the past, stems directly from military requirements. Here, the most pressing problem lies in the field of undersea warfare. To exploit fully the complex oceanic environment for offensive and defensive purposes, we must know and understand the characteristics of the oceans and we must know why and when these characteristics change. Other applications of oceanic knowledge include sea state and wave forecasts and ice condition forecasts, both of which have military and nonmilitary significance.

Aside from the military aspects of oceanography through a knowledge of the interaction between the atmosphere and the ocean, we may eventually learn to modify or even control storms, weather, and climate. We need to study the seas to determine the safety factors in radioactive waste disposal and to improve the safety and comfort of the centuries-old means of worldwide transportation. The potential resources of the sea, particularly the living resources, must ultimately play a larger role in the world's economy. A great deal of additional

research must be conducted to establish the whys and wherefores of these potentialities in order that we may exploit them.

The report of the National Academy of Sciences has focused national attention on the needs of oceanography. The Interagency Committee has demonstrated its effectiveness in a short time as a coordinating mechanism to meet these needs. In response to the tasks facing it, the Committee has established working panels for specific purposes. The function of one panel is to plan and coordinate our ocean survey program. A second panel has the responsibility for working out the details for establishing and the policies for operation of a national data center. Other panels are being considered.

Our next major task is to develop the budget for fiscal year 1962. Each agency's program and the national program as a whole will be reviewed critically by the Committee for balance and technical validity. The final result must be adequate to meet our most immediate needs, using the resources available, while emphasis must be placed on providing the tools we need on a long-term basis. We expect to seek endorsement of this program and budget from the Federal Council for Science and Technology and approval from the President before presenting it to Congress as a complete national program in oceanography.

Finally, I come to the contributions which the Congress and the members of this committee have made to oceanography. The several bills now being considered by you have already produced a salutary effect by attracting widespread interest in oceanography both inside and outside the Government. I believe this committee has received the specific comments of the Department of Defense and the other Federal agencies concerned with these bills. If not, I can provide you with copies of the Navy statements for the record. I intend to discuss the broad aspects of the bills now rather than the particulars.

H.R. 9361 is a bill of sweeping proportions to establish a comprehensive 10-year program of oceanographic research and surveys. It is patterned after the recommendations of the National Academy of Sciences Committee on Oceanography with which, I believe, we all find ourselves in general accord. It would appear, however, that much, if not practically all, of the authority contained in this bill is already provided for in the basic legislation of the various Federal agencies. Therefore, without detracting from the good intent of the Congress in this matter, enactment of H.R. 9361 is not considered necessary to achieve the national objectives. Section 15 of the bill would authorize funds for the oceanography program in addition to other appropriations provided for the various departments, bureaus, and offices to carry out their duties under law. Such a provision could have a very significant and beneficial effect on the programs of those agencies whose funds listed in the bill are large percentages of their entire departmental budgets.

H.R. 10412 is a bill to establish a public policy with respect to oceanographic surveys and to provide for coordination of the Federal agencies in these surveys and in oceanography generally by the establishment of a coordinating committee on oceanographic surveys. This proposes exactly what the Interagency Committee on Oceanography has been established to do. The secretaries of the departments and heads of the agencies represented on the Interagency Committee of the Federal Council have each indicated to me that they consider this Committee an effective means for achieving coordination and cooperation in our national oceanography program. I believe that this organization, assisted by working groups or panels comprised of representatives of the interested Federal agencies, will be responsive to the needs of this country. The establishment of a second committee as provided by this bill is not considered necessary.

H.R. 12018 proposes that the Secretary of Commerce establish a National Oceanographic Data Center and a National Instrumentation Test and Calibration Center within the U.S. Coast and Geodetic Survey. I think we all agree that such centers are needed. The Interagency Committee on Oceanography has recommended, and the Federal Council for Science and Technology has endorsed, that the National Oceanographic Data Center be established at the U.S. Navy Hydrographic Office. It is strongly urged that the Secretary of the Navy be authorized to establish these centers at the U.S. Navy Hydrographic Office and that funds be made available for them as a part of the national oceanographic program. I might add that the National Academy of Sciences Committee on Oceanography heartily endorses and encourages the establishment of the data center at the U.S. Navy Hydrographic Office.

Every branch of science is of importance to the Nation in some degree; it is difficult therefore to plan or determine priority in the usual sense of the term.

Furthermore, certain scientific areas call for enhanced support from the Federal agencies because of their intimate connection to national security and world leadership. Oceanography is one of these. What is necessary is to strive for balanced and broad programs for research support by the Federal Government. Therefore, it does not appear in the best interests of the sciences generally to single out one discipline for special organizational treatment.

In conclusion, the needs of oceanography have been recognized and are fully appreciated. An analysis of funding for the past few years reveals that the national effort in oceanography has begun to expand in an orderly fashion, currently at a rate of about 50 percent per year. Indeed, the future plans of the Federal agencies to promote a comprehensive 10-year program coincide closely in most respects with the proposals in the bills under consideration. We need, and indeed we seek, favorable consideration by you of the budget requests from the several departments and agencies cooperating in this program. I suggest that oceanography has a high probability of producing a greater return on the taxpayers' investment than some of the programs of equal magnitude which are currently fashionable.

Mr. WAKELIN. Thank you, sir.

I am, of course, concerned with oceanography from the viewpoint of the Navy as well as the viewpoint of the Nation's program as a whole.

The Navy's interest in oceanography is widely known and its needs are sufficiently self-evident as to require little justification. I think the same is true concerning the whole Nation's need for a coordinated program.

The purpose of the Interagency Committee on Oceanography is to develop and coordinate the national program. The consensus of the Federal agencies is that the Committee has already demonstrated its usefulness and that it will become more effective in the future.

Let me turn now to page 8 of my prepared statement for a discussion of the bills concerning oceanography:

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It is strongly urged that the Secretary of the Navy be authorized to establish these centers at the U.S. Navy Hydrographic Office and that funds be made available for them as a part of the national oceanographic program. I might add that the National Academy of Sciences Committee on Oceanography heartily endorses and encourages the establishment of the Data Center at the U.S. Navy Hydrographic Office and, in particular, approval of the funds for the construction of ship facilities and the training of scientific personnel.

Thank you, Mr. Chairman.

Mr. MILLER. Mr. Bauer?

Mr. BAUER. Mr. Secretary, would you give us for the record the composition of this Interagency Subcommittee on Oceanography?

Mr. WAKELIN. Yes, sir.

Mr. Bauer, for the Department of Defense, I am the Chairman representing the DOD and the Navy; Rear Adm. H. Arnold Karo, for the Department of Commerce; Mr. Donald L. McKernan, Director of the Bureau of Commercial Fisheries, for the Department of the Interior; Dr. I. E. Wallen, Division of Biology and Medicine, for the AEC; Dr. Randal M. Robertson, Director, Division of Mathematical, Physical, and Engineering Sciences, National Science Foundation; Dr. Homer D. Babbidge, Division of Higher Education of the Office of Education of the Department of Health, Education, and Welfare; and Mr. Wendall Pigman, as observer, representing the Bureau of the Budget.

As consultants to the Committee, we are privileged to have Dr. Britton Chance and Dr. Emanuel Piore of the Science Advisory Committee of the President.

Mr. BAUER. Now, I notice that you have a working group that is concerned with ocean surveys. Could you give for the record its composition?

Mr. WAKELIN. Yes. We have established a panel on surveys, Mr. Bauer. We have asked the various members of the Federal agencies and departments to nominate membership to this panel. We have not received their recommendations as yet.

Mr. BAUER. In other words, as far as being able to say that you can coordinate surveys, purely at a high executive level, you have no working groups as yet appointed, is that right?

Mr. WAKELIN. We would expect the members of the Panel to be working groups within their own departments.

Mr. BAUER. Have you considered the Coast Guard in your picture of ocean surveys?

Mr. WAKELIN. I am not sure that we have requested the Coast Guard for membership.

Might I go over with you the suggested membership without the names, Mr. Bauer?

On the Ocean Survey Advisory Panel, the Navy has representatives from the Office of the Chief of Naval Operations, the Office of Naval Research, and the Hydrographic Office; Commerce: the U.S. Coast and Geodetic Survey; the Weather Bureau; and an observer from the Maritime Administration; from Interior, the Bureau of Commercial Fisheries, the U.S. Geological Survey; from the Treasury we have a representative of the Coast Guard as a member; then two observers, one from the Science Foundation and one from the Atomic Energy Commission.

Mr. BAUER. How many of those groups are actively engaged in oceanographic survey work at the moment?

Mr. WAKELIN. Well, the Navy, certainly; the Department of Commerce, certainly; the Coast Guard and the Interior Department, of course, make use of the surveys provided by Commerce and by the Navy.

Mr. BAUER. Would you talk, Mr. Secretary, to the permanency of this Committee in view of the fact that it was created by executive desire and we have an election coming up shortly. My thought is, if ocean surveys are going to be planned for 10 years, the permanency feature of the Committee is certainly important. Do you agree?

Mr. WAKELIN. Yes. Actually, the Committee reports to the Federal Council for Science and Technology. This is a body representing the various agencies and departments of the Government interested in science and technology in their own departments.

I would believe that such a body would not necessarily have to change with the administration.

Mr. BAUER. I think that the permanency feature is the one thing that this bill tried to accomplish. However, I rather feel that perhaps at this time it might be well to put into the record, Mr. Chairman, a letter with respect to coordinating committees, signed by Rear Admiral Bennett which was sent to our counsel by the legislative liaison on the 19th of March 1959.

Admiral Bennett came to the conclusion, and I will quote from paragraph 2:

The conclusions given in enclosure (1)—

which I shall read shortly—

represent the results of the first meeting of Government agencies to consider the recommendations of the National Academy of Sciences. As an alternative to the formation of a new committee, as discussed in conclusion 3, it is proposed that the Coordinating Committee on Oceanography simply enlarge itself, and take over. It is likely that the CCO will act for, and report directly to, the newly established Federal Council on Science and Technology. In this case there would be no requirement for a new group.

Is that your thinking, sir?

Mr. WAKELIN. Well, yes. The CCO actually is an informal body, Mr. Bauer, as you know, which is not constituted by Executive action.

The ICO, of which we have just spoken, is formalized now as a part of the Federal Council and has been set up by virtue of Executive action.

Mr. BAUER. Has that been a matter of publication in the Federal Register?

Mr. WAKELIN. I do not believe so.

If I might complete the record in this regard, Mr. Bauer, the Interagency Committee on Oceanography evolved through an attempt by the Federal Council to review, from the agencies' and departments' points of view, the National Academy of Sciences-National Research Council reports on oceanography from the point of view of its adequacy in fulfilling the roles and missions of the agencies concerned with oceanography from a Federal point of view.

Mr. BAUER. In other words, the interdepartmental committee exists by virtue of the charter of the Federal Council, is that right?

Mr. WAKELIN. This is correct, sir.

Mr. BAUER. Conclusion 2 of this letter, which I will introduce, reads as follows:

In the discussion of the requirement for a formal interagency Committee on Oceanography, it developed that one was not required at this time. Committees of this type require an Executive order for their establishment, and are necessarily very high level. The experience has been that they are not very successful.

(The letter follows:)

OFFICE MEMORANDUM, U.S. GOVERNMENT

APRIL 3, 1960.

To: Mr. Drewry.
From: S. B. Freeborn, Commander, U.S. Navy,
Subject: List of Government organizations interested in oceanography.
Enclosure: (1) ONR ltr ONR: 416: GGL: lmg dtd March 19, 1959.

1. The enclosed letter of ONR's has, as its distribution list, a listing of the activities interested in oceanography and is forwarded for your use.

S. B. FREEBORN, *Commander, U.S. Navy.*

DEPARTMENT OF THE NAVY,
OFFICE OF NAVAL RESEARCH,
*Washington, D.C., March 1959.*

From: Chief of Naval Research.
To: Distribution list.
Subject: The interdepartmental meeting on oceanography.
Enclosure: (1) Conclusions of the interdepartmental meeting on oceanography.

1. The National Academy of Sciences has presented the Government with an unparalleled opportunity for collaboration on the development of our knowledge of the oceans. The Committee on Oceanography of the National Academy has prepared "A Summary Report on Oceanography" (ch. 1) which gives recommendations and budgets for the improvement of the position of the United States in its understanding and use of the ocean. The summary report will be followed by several detailed chapters in justification.

2. The conclusions given in enclosure (1) represent the results of the first meeting of Government agencies to consider the recommendations of the National Academy of Sciences. As an alternative to the formation of a new committee, as discussed in conclusion 3, it is proposed that the Coordinating Committee on Oceanography simply enlarge itself, and take over. It is likely that the CCO will act for, and report directly to, the newly established Federal Council on Science and Technology. In this case there would be no requirement for a new group.

3. It is requested that the addressees express their views on this alternative proposal, in writing, to the Chief of Naval Research. If enough agencies agree, the CCO will proceed informally to reorganize. It is expected that formal

recognition of the group will be forthcoming from the Federal Council on Science and Technology.

4. The Office of Naval Research will provide the clerical assistance for the CCO.

R. BENNETT.

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### CONCLUSIONS

The results of the meeting are as follows:

1. The agencies agree that the NAS–NRC Committee on Oceanography has issued a report of prime significance which must be carefully considered. Most agencies are not yet prepared to commit themselves on the budgets presented in "Chapter 1: Summary Report on Oceanography."

2. In the discussion of the requirement for a formal interagency Committee on Oceanography, it developed that one was not required at this time. Committees of this type require an Executive order for their establishment, and are necessarily very high level. The experience has been that they are not very successful.

3. It was concluded that the functioning interagency informal Coordinating Committee on Oceanography (CCO) should be enlarged, and retained. In addition, another committee should be formed at the next higher level of Government to include representatives who are involved with initial budget formulation. The new committee would meet once or twice a year to consider recommendations of the CCO.

4. It was agreed that the Department of the Navy would take the lead in requesting the establishment of the new committee. Accordingly, each agency was requested to suggest the names of possible members.

### DISTRIBUTION LIST

Department of Defense:
- J. M. Bridges, Office of Secretary of Defense (Research and Development).
- Benton Schaub, Office of Electronics.
- Willis B. Foster, Office of Science.

Department of Defense—Air Force:
- Lt. Col. Marshall V. Jamison, Geophysics Branch, AFDRD.
- Lt. Col. Lewis DeGoes, Chief, Terrestrial Science Laboratory, Geophysics Research Directorate, Cambridge, Mass.

Department of Defense—Army:
- Leonard S. Wilson, Geophysics Branch Army Research.
- Joseph Cloyd, transportation.
- Joseph Caldwell, Corps of Engineers, Beach Erosion Board.

Department of State:
- Wallace Brode, science adviser.
- Carl W. Flesher, Assistant Deputy Director for Technical Services.

Department of Interior:
- Thomas B. Nolan, Director, Geological Survey.
- Donald L. McKernan, Director, Bureau of Commercial Fisheries.
- Sydney Gottley, Bureau of Mines, head, technical program.

Department of Treasury:
- Capt. George Miller, U.S. Coast Guard.
- Lt. Comdr. Paul Lutz, U.S. Coast Guard.

Department of Commerce:
- D. C. Leavens, staff assistant, program coordinator for transportation.
- Rear Adm. Charles Pierce, Assistant Director, Coast and Geodetic Survey.
- Francis W. Reichelderfer, Chief, Weather Bureau.
- Charles Dennison, research coordinator, Maritime.
- Rear Adm. H. Arnold Karo, Director, Coast and Geodetic Survey.

Department of Health, Education, and Welfare:
- Harry G. Hanson, Assistant Surgeon General and Director, Robert A. Taft Sanitary Research Center, Public Health Service, Cincinnati, Ohio.
- Henry H. Armsby, Chief for Engineering Education.

Presidential Advisory Committee for Science and Technology:
- J. R. Killian, Jr., special assistant to the President.
- David Beckler, executive director.

Bureau of the Budget:
Elmer Staats, Assistant Director.
Hugh Loweth, budget examiner.
Wendall Tigman, Military Section.
Atomic Energy Commission:
A. Tammaro, Assistant General Manager for Research and Industrial Development.
I. Wallen, Division of Biology and Medicine, Environmental Sciences Branch.
J. Lieberman, Division Reactor Development.
National Science Foundation:
Randal Robertson, Director of Division of Physical Sciences and Engineering.
Robert W. Brode, Associate Director.
George Sprugel, program for environmental biology.
William Benson, earth sciences.
National Academy of Sciences:
John Coleman, executive secretary of Division of Physical Sciences.
Harrison Brown, Chairman, Committee on Oceanography.
Fritz Koczy, marine laboratory, University of Miami.
Sumner Pike, Lubec, Maine.
Milner B. Schaefer, Inter-American Tropical Tuna Commission.
Athelstan Spilhaus, Institute of Technology, University of Minnesota.
Richard Vetter, executive secretary, Committee on Oceanography.
Department of Defense—Navy:
Secretary, of the Navy: F. A. Bantz, Under Secretary of the Navy.
Office of the Chief of Naval Operations:
Capt. C. C. Cole, head, undersea warfare research and development OP–316.
Capt. J. W. Reed, replacement for Capt. C. C. Cole.
Rear Adm. H. C. Daniels, Hydrographic Office, OP–25.
Capt. H. G. Munson, deputy hydrographer, OP–25.
John Lyman, Director, Division of Oceanography.
Capt. W. P. Mack, OP–90.
Capt. R. Holden, OP–91.
Comdr. H. E. Walters, OP–91.
Office of Naval Research:
Rear Adm. Rawson Bennet, Chief.
Capt. Jacob C. Meyers, Assistant Chief for Research.
John N. Adkins, Director, Earth Sciences Division.
Gordon G. Lill, head, Geophysics Branch.
Arthur E. Maxwell, Oceanography Section.
Feenan D. Jennings, Oceanography Section.
Bureau of Ships:
Rear Adm. A. M. Morgan, code 300.
Capt. A. E. Krapf, code 310.
Comdr Patrick Lechey, code 370.
R. M. Sherwood, code 375.
Capt. A. J. Obermeyer, code 420.
B. K. Couper, code 688.
Capt. J. Adair, code 506.
Bureau of Ordnance:
Rear Adm. P. D. Stroop, Chief.
E. A. Ruckner, Assistant Chief for Research and Development.
J. E. Henderson, Director, Applied Physics Laboratory, Seattle, Wash.
Military Sea Transportation Service: Comdr. F. F. Penney.

Mr. BAUER. Whether he is right or wrong on that, this is germane, I think, to the question that we are considering and that is the permanency of this ocean survey development.

Now, with respect to the data center, I think we would appreciate it if, Mr. Secretary, you were the only one talking to the data center today because we realize that you are a very busy man.

With respect to the data center, how would that be set up?

Mr. WAKELIN. This would be set up, Mr. Bauer, as our plan at present is constituted, within the U.S. Navy Hydrographic Office and

would be supported by the Navy, the Department of Commerce, the Department of Interior, the National Science Foundation, and the Atomic Energy Commission, as a joint national enterprise for the collection of scientific data on oceanography.

Mr. BAUER. How many do you imagine would have the management control of this data center?

Mr. WAKELIN. This would have to be established through the Hydrographic Office under the direction of the Navy with a panel of these interested agencies and departments acting in an advisory capacity.

Mr. BAUER. Purely advisory?

Mr. WAKELIN. I would expect that the Hydrographic Office would provide the facilities and the housekeeping and that the advisory panel would help the hydrographer in determining how the data were to be analyzed, how they were going to be represented on cards or other means of storage and how they were going to be dispersed to interested parties on request.

Mr. BAUER. Would this data to be collected consist of geophysical as well as oceanographic data?

Mr. WAKELIN. Yes.

Mr. BAUER. You know that the Coast and Geodetic Survey are charged with being the national repository of geomagnetic data by statute. They are also the national repository of seismic data and are in the geodesy and cartographic business.

How would you marry the Coast annd Geodetic Survey and the Hydrographic Office?

Mr. WAKELIN. I think that would have to be worked out with the representatives of the Coast and Geodetic Survey who will be on this panel.

Mr. BAUER. That would require statutory action, would it not?

The Coast and Geodetic Survey are created as the repository by statute.

Let me ask you how would the Weather Bureau, which is under the Department of Commerce, phase itself into the data that is collected by oceanographers, and deposited in Asheville?

Mr. WAKELIN. Certainly, the meteorological data for which the Weather Breau acts as a repository in Asheville would have to be coordinated with the purely oceanographic data at the data center. I doubt that we would have to introduce a complete section of that magnitude here at the Hydrographic Office.

Mr. BAUER. Currently they are collecting at Asheville sea surface temperatures and a lot of other data for the publication of manuals.

Mr. WAKELIN. I think this is correct.

Mr. BAUER. In other words, what you have to come up with in the plan from this interagency committee on the question of a data center is how to marry those three various groups?

Mr. WAKELIN. That is entirely correct.

Mr. BAUER. Has such a plan occurred?

Mr. WAKELIN. Not as yet.

Mr. BAUER. Do you know when it is contemplated that this plan will come forth?

Mr. WAKELIN. We hope to have a start on this at our next meetings in June, during the first week in June. I do not know whether we will get to this particular point at that time, Mr. Bauer.

Mr. BAUER. How many meetings have you had of the Interagency Committee since it has been formed?

Mr. WAKELIN. Of the order of a half a dozen.

Mr. BAUER. Over a period of what time?

Mr. WAKELIN. Well, this counts the meetings we had as an ad hoc committee to review the National Academy of Sciences' report and the now constituted Interagency Committee on Oceanography of the Federal Council.

Mr. BAUER. I think the committee would like to know why there has been the delay in getting the show on the road if ocean surveys are supremely important, and we have testimony to that effect from everyone who has appeared.

Is there any technical holdup? Is it a fiscal holdup?

Mr. WAKELIN. The function that the ICO is now undertaking through the separate members is to construct the 1962 budget and program which we will review the first week in June for our recommendations to the various agencies.

Mr. BAUER. Well, that brings up another point which I am glad you mentioned, sir. That is, the budget cycle of 1962 is fairly well firmed up by departments as of right now, is it not?

Mr. WAKELIN. This is not true in the Navy, sir.

We are just starting to review the various budgets that have been presented by bureaus of the Navy Department in an integrated form.

This will go on probably through September.

Mr. BAUER. Then this Interagency Committee would be another review group to balance out.

Mr. WAKELIN. In the specific field of oceanography throughout the various agencies, including the Navy, concerned with oceanography.

Mr. BAUER. Could you talk to the amount of moneys that were spent in fiscal 1961, appropriated at the President's request, and what your thinking was?

Mr. WAKELIN. Yes. The program in oceanography in the President's budget, which was presented to Congress through the various agencies, totaled $55.7 million for fiscal year 1961.

Mr. BAUER. That includes strictly militarily motivated?

Mr. WAKELIN. It concerns no military research and no military surveys.

Mr. BAUER. $55.7 million for everything with the exclusion of military motivation.

How much was the military part?

Mr. WAKELIN. $24 million, sir.

Mr. BAUER. $24 million for military motivated research and development and $55.7 million for non-military-motivated research; is that correct?

Mr. WAKELIN. Yes, sir.

Mr. BAUER. I noticed that the recommendations of the NASCO Committee, which you have testified to before another committee, show comparative totals of $22.8 million; the recommendations of the Interdepartmental Coordinating Committee $120.2 million and the President's budget submission, $55.7 million.

Why was the reduction made in the budget?

Mr. WAKELIN. I can speak to that part, Mr. Bauer, which did not survive in the budget reviews. The subcommittee recommended of the order of $120 million for the national program in oceanography. In the difference between the two, I have a total of 119.1, but there is another million dollars which should be corrected in my estimate here. In the research area we were down by $9 million and in the ships area, which is ship construction, we were down $40.2 million, and in the facilities area we were down $10.2 million as a difference between the subcommittee's recommendations and the actual budget as submitted by the President.

Mr. BAUER. I am trying to bring out the question of how you feel now, sir, about the motivation for the expenditure of money for oceanography. Is it correct that the first motivation is national defense?

Mr. WAKELIN. On the Navy's part; yes.

Mr. BAUER. If there were a limited amount of dollars in the economy, would you not say that oceanography should have a first motivation nationally in order of priority?

Mr. WAKELIN. I am not sure that I would answer it that way. I think oceanography is one part of our total scientific effort. Certainly there are other important fields in which we must remain preeminent. There are fields in chemistry, there are fields in physics, there are fields in engineering which we must foster in the same way.

I would certainly think the high energy physics program should continue with the support it has had.

There are a great many problems in biology that should have basic research and applied research sponsorship.

I think perhaps in answer to your question, the reason this program here of $55.7 million is below the subcommittee's recommendation is that certainly in the Navy the ships for oceanographic research have to compete with military vessels of the line, and, in balancing out on a level budget between last year and this year, we have to apportion the priorities among those in the total Navy budget that we think should have the emphasis.

Mr. BAUER. Well, with respect to priority again, I hate to keep repeating myself, but it seems to me that one might consider this ratio of $24 million for military oceanography and $55.7 for nonmilitary oceanography as somewhat out of line in view of what we read in the newspapers.

Mr. WAKELIN. We are talking about the total program.

The Navy's program in oceanography in fiscal year 1961, apart from military surveys and research, is $22.9 million. Our military effort is $24 million.

Mr. BAUER. That is true, but on this integration of Commerce with the Coast and Geodetic Survey of $13 million, and the Department of Interior are in the ocean survey picture. All of that gives you military information, does it not?

Mr. WAKELIN. It gives us scientific information which certainly has military significance directly or indirectly, yes.

Mr. BAUER. What did you say the second motivation for an oceanographic survey program should be, perhaps fisheries?

Mr. WAKELIN. I think there are several other motivations, sir.

Mr. BAUER. I am just trying to get the priorities.

Mr. WAKELIN. Right.

With respect, first, to the military program, there has been a great deal of emphasis put on oceanographic surveys and research in augmentation of our fleet ballistic missile program.

Secondly, we are interested in knowing much more about the environment of the oceans apart from specific questions that we would like to have specific answers to now.

We would like to know more about the transmission of sound in the medium and the effect of temperature and density and salinity and variations thereof in such an environment.

These are questions of ultimate military significance but do not answer tomorrow a directly military question, so that we are interested in basic research that will lead to a better understanding of the ocean as an environment in which we have to live in the Navy in our submarine service.

Thirdly, which is not directly the Navy's concern but is a national concern, is the problem of the whole realm of fisheries and biology of the sea. This, we think, we should know much more about in terms of increasing the productivity of the oceans. Also the minerals and materials not only on the bottom but contained in the sea water itself are important raw materials for our use as a country.

Mr. BAUER. I have one further question, Mr. Chairman.

How about the instrumentation of oceanographic vessels? Is there any plan for standardizing the instrumentation that you know of as head of the departmental committee? We have been measuring certain areas of oceanographic information, if my information is correct, for some 20 years, and eventually came up with the Hydrographic Office capability of waves forcasting.

Now, certainly, we have an ASW problem. Have we explored to the fullest extent the question of instrumentation and are we properly budgeting and planning for it?

Mr. WAKELIN. I think this is a very good point, Mr. Bauer. We have not concerned ourselves as yet directly with the problem of instrumentation calibration and test but we believe this is a most important point and we are glad that it has been brought up.

Mr. BAUER. Thank you, sir.

Mr. MILLER. Mr. Secretary, I want to express my appreciation to you for the direct manner in which you have answered these questions. It shows that you certainly are cognizant of the subject.

I cannot go into the technical details that you or Mr. Bauer or the staff can talk about. We, sitting here, are not supposed to know too much about those. The thing that concerns me and to which I wish you would address yourself, and this is the only question I am going to ask, is, whereas this must be a continuing study over a long period of years, the fact is that if you compare it with the time that we have been using the ocean since before the dawn of written history, our knowledge of it is minuscule, I believe; is that correct?

Mr. WAKELIN. That is correct.

Mr. MILLER. Now we are trying to get this information. I appreciate the overriding interest of the Navy in the national defense picture but you touched on the other two fields, the biology of the ocean, the contents, the chemistry of the ocean, what is on the ocean floor. Of course, we had hoped up until last week that the meeting which is taking place now in Paris would be highly successful and I know we

all hoped that in the near future perhaps we could resolve some of these things internationally and then there will be a decrease in the emphasis on the defense phases in our national interest.

This, of course, will have to take place worldwide.

On the other hand, because of the things that the ocean has to give us, the interest in its more peaceful uses, this biology, this chemistry will, as the populations go up, increase; is that true?

Mr. WAKELIN. This is entirely true.

Mr. MILLER. Now then, if we tie our efforts to a department of Government, no matter how well established it is, that has no statutory base, with the pressures that will come in the future, may we not lose time in getting at the problem or in its continuing success?

That is the thing that concerns me. Do you understand what I mean?

Mr. WAKELIN. Yes, sir.

Mr. MILLER. In other words, it is not a question of who is going to be elected President next time and who is going to be elected after that and after that. This is a thing that we are starting.

We say a 10-year program and we know that at the end of 10 years it has to be continued for another 10 years.

Should we or should we not then set up some agency responsible to the Congress? After all, when, by order of the President, this is set up, it becomes administrative. What he can do today he can undo tomorrow. Yet it is a subject of such importance that the Congress of the United States should take cognizance of it and by fiat law set up some agency and designate that agency as the one that must be responsible for this work.

Then, of course, if we can answer that question, then the question of whether we should put it in the Hydrographic Office or in the Geodetic Survey is the second question and it has to be analyzed again.

How about the first question?

Mr. WAKELIN. This is a very good question to ask, Mr. Chairman. The purpose of my remark was not to counter suggestions of the Congress.

Mr. MILLER. I appreciate that. I want to congratulate you on the forthright manner in which you gave your statement.

Mr. WAKELIN. It was merely to present to you the opportunities that we feel we have through interagency cooperation of generating on our own an oceanographic program commensurate with the suggestion made by the National Academy. I think we all agree that the level of support and in general the distribution of that support in oceanography as recommended by the National Academy-National Research Council's committee is good.

On the question of permanency, sir, I do not feel that I am capable of answering in a long term sense, particularly the question about the dissolution of such a committee by executive order, by the same kind of executive order that established it.

The problem I think that we are all trying to solve, in the executive branch and in the Congress, is the problem of giving the proper balance to oceanography as a national program among all the other scientific efforts that desire sponsorship and require sponsorship.

I think that H.R. 9361 is an excellent vehicle to bring to the attention of the public and perhaps to provide a permanent mechanism

for an oceanographic program except that it is too definite with respect to agencies' responsibilities in the future.

I would prefer to suggest, if you want to set up an oceanographic committee responsible to the Congress, that you give it more general responsibilities and a general level of support that you would expect over the next 10 years than to recommend to you how they would apportion that and distribute that as the years go along.

The reason that I bring up this point is the following: that in our deliberations about the shipbuilding program which has vexed us greatly, the Department of Commerce and we in the Navy have very urgent need for research and survey ships. In order to fulfill the requirements of the National Academy's report, we have to spend what we consider a very large amount of money, about $400 million over the next 10 years, not only to replace some of the 52 ships that we have now but to augment that number to about 78. This will make great inroads as a program in our normal budgeting for ships within the Navy itself. These ships, then, of the survey and research type, are in competition with DE's, DD's, with carriers. These are immediate military requirements to fulfill the national and international commitments that the Navy has right now.

I think the interagency committee, except for the problem of appropriating for ships, can do the kind of a job that you would like to see done.

We intend to review the 1962 budget before it comes up to Congress, each of us, so that instead of having one congressional committee review the Navy's work and another the Department of Commerce, and another the National Science, and another the Department of Interior, each committee will have the whole national program in oceanography to look at. This interagency committee fulfills a great many of the requirements now. It does not constitute permanency in your context, I believe, sir.

Mr. MILLER. I may say that the bills I am interested in nevertheless were introduced a good deal with the idea of being retroactive, getting people to think on this subject. I do not think we are going to answer it now, but there are still wide areas that we can investigate and talk about.

Personally, I appreciate your being here and the only thing that worries me is that, in another committee in which I serve, we talk about $55 million as chicken feed. We do not even consider it. We talk of certain things that are going to cost $25 million a bang. We need them. We are going to get them.

If we could only get some of this thinking into this consideration, I am certain that we could make a little more progress.

I do thank you, sir.

Mr. Dorn?

Mr. DORN. I have no questions.

Mr. MILLER. Mr. Lennon?

Mr. LENNON. I have no questions.

Mr. MILLER. Mr. Pelly?

Mr. PELLY. Mr. Chairman, I would certainly want to join you in expressing the feeling that the Secretary has made a good contribution toward a subject which is going to require the opinions from all angles to help guide us in coming up with a policy which will be helpful in expanding the development and research work of oceanography.

Mr. Secretary, you brought up the subject of priorities and I am very conscious of the debt that actual science owes to the Navy because, as you said in your statement, you are the largest contributor toward research in the way of grants and other means of aiding the study of the marine sciences. It is that very thing that kind of concerns me because you have a responsibility for priority not only for the type of ships you construct, whether they should be for guided missiles or for basic research, but when you get down to your allotment of encouragement of oceanography, is there not a priority of the military needs and requirements as against the purely basic scientific needs of our country? I think that, if this program is controlled by the military, it is going to probably underemphasize basic scientific needs as against military needs.

Could you comment on that?

Mr. WAKELIN. Mr. Pelly, I would appreciate a chance to comment on that.

I think the Navy has been outstanding throughout the last 15 or 16 years in recognizing the importance of basic research. This has been a continuing effort within the Navy from the establishment of the Office of Research and Inventions in 1945 and then the establishment of the Office of Naval Research by congressional action in August of 1946 until now.

We were the only coordinated single Federal agency, following Dr. Bush's OSRD effort during the war, concerned with the support of basic research throughout the country as a federally sponsored program until the establishment in 1950 of the National Science Foundation.

I think the Navy has obtained so many marvelous results from this sponsorship of basic research in the Office of Naval Research that I would doubt if the Navy itself would deny basic research sponsorship a place on the priority listing of its efforts.

Mr. PELLY. I noticed that, for example, last year when we were hearing testimony on a bill to expand the limits in which the Coast and Geodetic Survey could work, that the Navy resisted it. In other words, I feel that possibly the military will not give the full encouragement to some of the other agencies of Government that have a vital interest in this same subject. I think that is something that we ought to consider at least, but I would be the first one, as I said before, to pay my tribute to the Navy for the work that has been done. Had it not been for that, I do not know where our country would be today.

Mr. WAKELIN. Could I comment just a moment on that?

We in the Navy are very happy that this restriction has been removed. I think the feeling now in the Navy is, and was prior to your action on the bill, that there was enough work in the survey field in the open ocean area for everybody.

Mr. PELLY. When you come to the location of a data center, I do not believe that, for instance, the scientists who are working in maybe the commercial fisheries field are going to be too happy to see it located in the Navy. I think they would feel more free if it could be in some more civilian type of Government department.

That is another aspect that we have to think about.

Mr. WAKELIN. The representatives of the agencies on the Interagency Committee have all agreed unanimously that the Hydrographic Office is the best place to locate the center.

Mr. PELLY. Well, we will probably get testimony from the actual scientists themselves.

I am thinking in terms of, for example, some of my own University of Washington professors who has a great deal of interest in this whole program. I am sure when they comment on the legislation they will express for themselves this feeling and I only am using guesswork when I say I think they will feel a little more free with some other department but they, in turn, are grateful to the Navy for what is done.

That is all, Mr. Chairman.

Mr. MILLER. Mr. Oliver?

Mr. OLIVER. Mr. Chairman, I do not want to take up too much time with the Secretary, but there are several points which I should like to raise if I may.

The first point, Mr. Secretary, is this: Have you any comments or observations to make with reference to what the Soviet program is in oceanography and particularly with reference to its fisheries program in terms of oceanographic or marine research?

Mr. WAKELIN. I have only general comments and I would like to submit them, if I may, for the record, Mr. Oliver.

The reason is that there is open and there is classified information and I would like to supply what you would like for the record.

(The following was furnished for the record:)

Information requested by Mr. Oliver, reference transcript page.

U.S.S.R. OCEANOGRAPHIC PROGRAM

Although receiving greater emphasis since World War II, oceanography has undergone a marked expansion in the Soviet Union since 1955, following the announcement of its plans to participate in the oceanography program of the International Geophysical Year (1957–58). Theretofore, Soviet oceanographic research was limited mostly to the regions bordering upon the U.S.S.R., and scientific relations with foreign scientists were essentially nonexistent. Since 1955, the U.S.S.R. has displayed a large, modern research fleet second to none, has announced the construction of new research facilities, has operated its research fleet throughout the oceans of the world, and has organized a sizable manpower force to conduct oceanographic research. The period from 1955 to 1960 definitely has been one of acquiring facilities, manpower, and scientific data.

The Soviet oceanography program has been a survey effort to collect oceanographic observations of all types over broad geographic areas. (See attached chart of the IGY cruise tracks of Soviet ships.) The present research fleet of the Soviet Union to support this type of effort is comprised of a large number and variety of ship types ranging from small fishing vessels to the *Mikhail Lomonosov* (5,960 tons). It also includes the research submarine *Severyanka*. New vessels have been acquired almost annually for this fleet. Since 1957, the *Mikhail Lomonosov* (5,969 tons), the *Severyanka* (1,050 tons), the *Voyeykov* (3,600 tons) and the *Shokal'skiy* (3,600 tons) have been added. The rate at which new ships are being acquired probably will continue for the next several years. Other converted submarines for research and underwater research vehicles, such as bathyspheres and bathyscaphs, also are expected to be acquired and supplement the surface research fleet within the next few years. Soviet plans to construct a bathyscaph were announced earlier this year and bathyspheres have been used for several years.

Shore-based facilities also have been expanded and constructed during the past several years, mostly located in the Moscow area. However, plans to construct scientific bases for two oceanographic institutes were announced in 1958 and a branch of the Marine Hydrophysics Institute was opened recently in Kalingrad

on the Baltic Sea. Considering the distance from Moscow, and the Soviet effort that has been expended in the Pacific Ocean and bordering seas, the expansion and construction of facilities should be expected in the Far East during the next several years.

The number of Soviet oceanographers, excluding marine biologists and fisheries researchers, is greater than 500. The total of their professional oceanographers is estimated as high as 800 to 900. The greatest expansion of manpower probably took place when the Soviet Union expanded its program to participate in the International Geophysical Year. Many of the oceanographers are young and lack experience, a partial explanation for the placing of the great numbers of scientific personnel on the large ocean research ships. However, the quality of these young scientists should improve from the experience being gained from present shipboard research and the analyses of data collected since the International Geophysical Year. It seems that quality rather than quantity of scientists is now needed in the Soviet Union.

The present research effort is oriented toward applications. Even the basic research conducted at the institutes of the Academy of Sciences tends to be directed towards ultimate applications. The institutes subordinate to ministries direct their research to support the efforts of the parent organizations. Polar and deep-sea oceanographic research are the strongest areas in the Soviet program. Continued and intensive scientific activity in arctic regions to develop the northern sea route has achieved a leading position in arctic oceanography for the Soviet Union; and the operations of the research fleet throughout the oceans of the world have shown an impressive ability to collect oceanographic data. High quality work also has been conducted in biology and fisheries research, marine geology, and seismology, particularly in conjunction with deep-sea research. The work in other areas of oceanographic research generally has not been of comparable quality. There is no information available concerning their military research efforts in oceanography. As the oceanographers gain experience, the quality of the research should generally improve within the next several years.

It is generally conceded that the present size and the rate of expansion of the Soviet manpower and ships for oceanographic research are considerably greater than those of the United States, and possibly of the entire free world. Their oceanographic research, rated as excellent in some fields of the science, is generally not as scientifically comprehensive as that of the United States. During the IGY their effort consisted of a well-rounded, exploratory-type program to collect basic information about the characteristics of the seas and oceans of the world. It did much to increase the stature of the U.S.S.R. among the world leaders in oceanography as well as to provide scientific support for the Soviet economic and political aspirations.

Mr. OLIVER. Is it not true that the Soviets have a very aggressive program, particularly in the fisheries area?

Mr. WAKELIN. They do, indeed.

Mr. OLIVER. Is it not true that this is perhaps adaptable to military information, and advantages are gained by reason of these many ships and activities that they are carrying on?

Mr. WAKELIN. Yes, they have, Mr. Oliver. They have over 100 ships engaged in oceanographic work and fisheries together. Of course, the major proportion of their efforts were apparent during the International Geophysical Year. This was the first chance we had to look at the magnitude of their program.

Mr. OLIVER. This is apparenty an expanding program on really an aggressive basis. I do not mean aggression. The program is expanding almost beyond any conception of what we may have.

Mr. WAKELIN. They are putting a lot of effort behind all aspects of oceanography, I would think not only in basic research and surveys but in biological and fisheries sides, too.

Mr. OLIVER. This brings me to this point: In the light of that and also in view of what our chairman has spoken about, another committee of Congress which is talking about multimillions of dollars for

programs in space exploration, for example, and let us be specific, for this program of oceanography, as the chairman has said, is only peanuts in comparison with that program. Are we pressing oceanography enough as far as our executive thinking is concerned?

Mr. WAKELIN. In order to get a quantitative fix on this problem, Mr. Oliver, the National Academy of Sciences recommended a 10-year program and, if I can translate that in 1961 dollars, I believe it was at a level of $949 million over 10 years.

The Interagency Committee on Oceanography recommended a program of about $50 million in excess of that for the 10-year period.

Our total effort this year was of the order of $80 million if you add the military research and the purely scientific and open, unclassified research.

The total level by which the Academy would like to see us approach is about $95 million on an average per year.

Mr. OLIVER. This, of course, we are not facing up to, are we? As I note your figures here, you talk about a fiscal 1961 program of $56 million and, in 1960, the level having been $37 million, and comparing that with 1959, where the level was $24 million, and draw the conclusion from this that we really are moving ahead here, I should expect, reasonably satisfactorily so far as you are concerned.

Is that a justified conclusion?

Mr. WAKELIN. In part, but may I answer in this way: I am not trying to equivocate but I would like to present all the facts to you.

The program of 1959 was about $25 million. In 1960 it was $37 million. In 1961 it is proposed at $56 million.

Now, the program in oceanography has essentially three parts and three problems: research, surveys, and ships.

I am trying to get up to the National Academy's recommendation, which is practically in H.R. 9361; the survey and research parts are in fairly good shape. We are down $40 million this year under our estimate. The reason that we are below our estimate is because of the amount that we have not put into new ship construction. We are using older ships longer. We are still getting work done on an accelerated basis but we are not facing the problem of replacing the overage ships and getting adequacy in 1970 that will be good in terms of usable ships.

Mr. MILLER. Will the gentleman yield?

Mr. OLIVER. Yes.

Mr. MILLER. Are we using old ships? Are we not falling behind when we do not appropriate money for ships because many of these ships that the National Academy recommended entirely new vessels and not replacements?

Mr. WAKELIN. Yes, some of them are new for replacement and some are new for augmentation.

Mr. MILLER. You just told us that the Russians have 100.

Mr. WAKELIN. This is the first year since 1931 that we will have built a ship for oceanographic research.

Mr. MILLER. If we were going to be up on this program and in keeping with the recommendations of the National Academy of Sciences, should we not have five ships on the ways right now?

Mr. WAKELIN. The total we have recommended, which is a variant on the Academy report in terms of size, is about 78, so that we should have 8 ships on the ways.

Might I show this graph to Mr. Oliver, sir, to show the magnitude of the problem?

Mr. MILLER. I want to say, if the gentleman will yield further, that no one is charging the Navy or charging you with this. We understand the pressure that is on you and pressure that is on the Navy, and other things, for money, and we would like to be the fulcrum of the lever that would sort of get you out of this hole, if possible.

Mr. WAKELIN. As I said, Mr. Chairman, again, and I hope that Admiral Hayward may speak to this because we face this problem of ship construction jointly in terms of priorities, the Navy has a problem in the next 10 years to supply that number of oceanographic ships sufficient to give us the NASCO recommended capability in competition with ships of the line.

Mr. MILLER. You see, Mr. Secretary, in the full Committee on Merchant Marine and Fisheries, this is the thing that confronts us. Our merchant fleet is becoming obsolescent and we are in exactly this same position here. We would like to build and certainly you would have no objection to building that atomic icebreaker up there [pointing].

Mr. WAKELIN. None at all.

Mr. MILLER. This is one of the things where the question is, Are we going to get an atomic icebreaker or probably put some of that money into another nuclear submarine? We also realize that we have to get some other things so that what we have to do is unify ourselves and perhaps we can make the fight to see if we can get some more loose money ends up for the whole program.

Mr. OLIVER. May I continue, Mr. Chairman?

Mr. MILLER. Yes.

Mr. OLIVER. Mr. Secretary, I appreciate very much your forthright statements and observations. However, it seems to me that your testimony this morning, at least, indicates that we are not moving ahead on the basis that I believe at least that we should be moving on. I do not mean a crash program but I am saying that I think there should be more stress and this thing should be dramatized more than is being done. The Inter-Agency Committee, of which you speak and which you support, is to me a constructive move. There is no question about that from what we had, which was not zero exactly but it was not too much.

I am wondering, and I have said this on several occasions before, if we do not need another mechanism that will place the proper stress on oceanography as a major function in this Government of ours, particularly in the face of what I read the Soviet program to be. I do not mean that we have to meet ship for ship and that sort of thing, but I feel that we are not moving ahead as fast as we should, and I feel that there should be some mechanism in the Government which would dramatize to the people in this country, far more than is being done, the need for this expanded program in order to get the expediting of it that I feel is essential and necessary, if we are going to meet this problem.

It seems to me that one of the fundamental ways to do that would be to say if a program is essential to the welfare of this Nation and perhaps even the survival of the Nation, why should it not receive more recognition than an interagency committee from an administra-

tive standpoint? Why should it not receive as much attention and have as much stress placed upon it perhaps as space exploration or similar programs that we have undertaken?

Why do we downgrade it in a sense by being satisfied with an interagency committee? How are we going to get to the Appropriations Committees? How are we going to get to the various departments of Government and have the heads of those departments feel that this is an essential and vital program unless somebody is there pounding away all the time asking and requiring more attention so far as appropriations are concerned and budgetary requests are concerned?

Is it not true that if we had a mechanism placing stress on this and this alone that it would be in a far better position to do the selling job that is necessary in order to get the results that I think most of us feel should be gotten and not wait and not be satisfied with just a moderate approach?

I do not know whether you want to comment on it, but this is my feeling on it from what exposure I have had in the last several months.

Mr. WAKELIN. I would like to comment on it, Mr. Oliver, to this degree.

Mr. OLIVER. I wish you would.

Mr. WAKELIN. I used to be a physicist when I was younger and, in looking at the support of science not only by the Government but by industry and academic institutions, I fear that you may be singling out oceanography as a special category for special attention when other fields of science and technology may deserve the same support and may not be as glamorous.

I know that oceanography has a military connotation. I know also that there are many fields of science that are just as important to this country's long-term survival as oceanography. I feel that you must decide how you want to treat the oceanography program in terms of all the other fields of science that come before you before you establish a mechanism for oceanography reporting directly to the Congress itself and a special vehicle by which additional funds are created for the program.

Mr. OLIVER. Thank you very much.

Mr. WAKELIN. I am not downgrading oceanography at all but I have these fears as a person.

Mr. OLIVER. I realize that, sir, and I want to express my appreciation to you for that statement.

I feel that that sums it up certainly far better than anything that I can say.

I feel that that is exactly the issue that confronts this committee and the Congress.

Mr. WAKELIN. Might I add one point which is germane to the whole program and is not a personal point.

In the 1962 budget coming up we have five ships in the program now. Two 1,300 oceanographic auxiliary research ships, 1,300 tons; two 500-ton AGOR's, and a survey ship of 1,300 tons. To put this in the proper context, we have one AGOR now in 1960 and one in 1961 which have survived.

There are five now going into the Navy fiscal year 1962 program and if other agencies contribute two or three more, we will be up to the eight.

There is an additional problem in training people. Oceanography is a peculiar field, Mr. Oliver, in that it is not a science. It is a group of sciences and technologies. It is not physics or chemistry or biology. It is a peculiar interweave of basic disciplines. We must interest young people in going into oceanography because without the people the ships are useless.

Mr. OLIVER. May I interject right there that this is something that I was going to bring up in my rather inadequate way as my next question that I wanted to pose to you: From the standpoint of educational training, I assume from what you have said here that it is the feeling that enough stress is being placed upon the training of graduate students and applicants for doctorates, and so forth.

Mr. WAKELIN. We feel that it is going along at a good rate.

Mr. OLIVER. The thing that I have been interested in myself, and I do not know whether it has been given consideration by your group, is what about the fact that we apparently have to have increasing numbers of people to handle instrumentation aboard ship? This does not take anybody who has a Ph. D. degree, does it? Is there anything being done as far as what you might call apprenticeship is concerned? I do not know whether that is the term to use but I was thinking of it in terms of perhaps people on merchant marine ships or people on fishing vessels or whatnot. It has to be reliable data.

I understand that, but is it not perfectly possible to have some kind of a program where technicians to do, what we might call the legwork is concerned, can be trained? Has there been any consideration as far as the Inter-Agency Committee is concerned along that line?

Mr. WAKELIN. Yes; there has been, Mr. Oliver. There are training programs at Woods Hole Oceanographic Institution, at the Lamont Geological Observatory in Columbia, and at the Scripps Institution of Oceanography of the University of California, among others, who are taking students, sometimes seniors in high school but preferably sophomores and juniors in college, and giving them summer training at all kinds of jobs either ashore or on oceanographic ships. They are taking as many as they have facilities for now.

We were talking about the Woods Hole people about 3 or 4 weeks ago. They have three or four times the applications than they have room for on ships or shore facilities. There is an interest by the young people in oceanography but there is still a lack of facilities to take care of them.

Mr. OLIVER. I am going to take the opportunity to put before you the availability of facilities which could take care of many, many students, perhaps, for this purpose of technical training and handling instrumentation, and so forth, and whether or not this sort of training is going to be recognized so far as grants are concerned to finance their training.

I expect that this may be already being done. Is that correct?

Mr. WAKELIN. It is being done.

Mr. OLIVER. Is it your feeling that perhaps the volume of technicians in this rather elementary training should be increased or do you think we are going along fast enough on this score now?

Mr. WAKELIN. I believe we are going along fast enough on the technician level.

Mr. OLIVER. In other words, do you not believe that we need to expand this phase of the program?

Mr. WAKELIN. Not greatly.

Mr. OLIVER. I think that is all I have, Mr. Chairman.

Mr. MILLER. Thank you very much, Mr. Secretary. We certainly appreciate your taking time out from your very busy schedule to come over here and discuss this with us.

We appreciate the very fine manner in which you have answered the questions.

May we put this in the record?

Mr. WAKELIN. Yes. Why do we not submit it to you, either way.

Mr. MILLER. You may submit it to us for the record, then, without objection.

(The following was furnished for insertion:)

THE ASSISTANT SECRETARY OF THE NAVY,
RESEARCH AND DEVELOPMENT,
*Washington, May 17, 1960.*

HON. GEORGE P. MILLER,
*Chairman, Subcommittee on Oceanography, Committee on Merchant Marine and Fisheries, House of Representatives, Washington, D.C.*

MY DEAR MR. MILLER: Again may I express my appreciation for being able to appear this morning before your Subcommittee on Oceanography of the House Committee on Merchant Marine and Fisheries. For the record, however, I would like to clear up two points contained in my answers to questions put to me by your committee. As they stand now these two items do not give the proper picture and I would like, by this letter, to set the record straight.

Firstly, in discussing the proposed data center and the participation therein by the Navy, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the National Science Foundation, and the atomic Energy Commission, the designation of their roles was termed "advisory." As envisioned by the Interagency Committee on Oceanography and the National Academy of Sciences Committee on Oceanography and concurred in by each of the agencies involved, the functions of this panel through these participating agencies would be jointly to finance, administer, and determine the operational policies of the center. These financial, administrative, and policymaking functions have been planned to insure the availability of the data for nonmilitary as well as military needs. The involvement of the panel is thus considerably more than might be construed from the use of the term "advisory," and I believe the clarification of this point will, in itself, answer numerous questions your committee might raise as to the advisability of physically locating this center at the Navy Hydrographic Office.

Secondly, to avoid possible confusion, the record should be clear as to the functions of the proposed oceanographic data center. The center would provide central storage, processing, and related services for only those data for which facilities do not already exist. These data consist of observations of the chemistry, physics, and biology of the oceans. Geophysical data such as gravity, seismic activity, and geomagnetism for which responsibility is already provided by law would not be included, nor would such related data as the marine meteorological information now available at the National Weather Records Center at Asheville, N.C., be included. Similarly, the detailed biological files of the U.S. National Museum would not be incorporated. However, certain biological measurements used together with other oceanographic data in productivity studies and which are adaptable to machine processing will be included. Other oceanographic data will be included when the need arises. The National Oceanographic Data Center would not duplicate any existing center but would keep apprised of such data collection of use to oceanographers and could relay requests for such information to the proper repository.

Attached hereto is an outline of the membership and the tasks proposed by the Interagency Committee for the Oceanographic Data Center Panel. Please note that in section 2f the panel is to recommend to the Interagency Committee legislation, if needed, to make the data center a valuable asset to the oceanographic community.

The Navy welcomes this opportunity, through the U.S. Navy Hydrographic Office's facilities, to participate in the national program for oceanography.

Sincerely yours,

JAMES H. WAKELIN, JR.

OCEANOGRAPHIC DATA CENTER PANEL

1. Membership has been requested from the following agencies:
Navy: U.S. Navy Hydrographic Office, Office of Naval Research.
Commerce: U.S. Coast and Geodetic Survey, Weather Bureau.
Interior: Bureau of Commercial Fisheries.
National Science Foundation.
Atomic Energy Commission.
Smithsonian Institution: Official observer.
National Academy of Sciences and National Research Council: Official observer.

2. Tasks outlined for the Data Center Panel:

(*a*) Prepare for consideration by the Interagency Committee on Oceanography a charter for the establishment of the National Oceanographic Data Center.

(*b*) Consult with the data center administrator (U.S. Navy Hydrographic Office) on matters concerning personnel and equipment requirements, organizational structure, fiscal requirements, and the like.

(*c*) Assist as appropriate in establishing procedures for handling and processing data within the center.

(*d*) Establish requirements for format of data submitted and criteria for accuracy of data. Determine what types of data should be collected by the center.

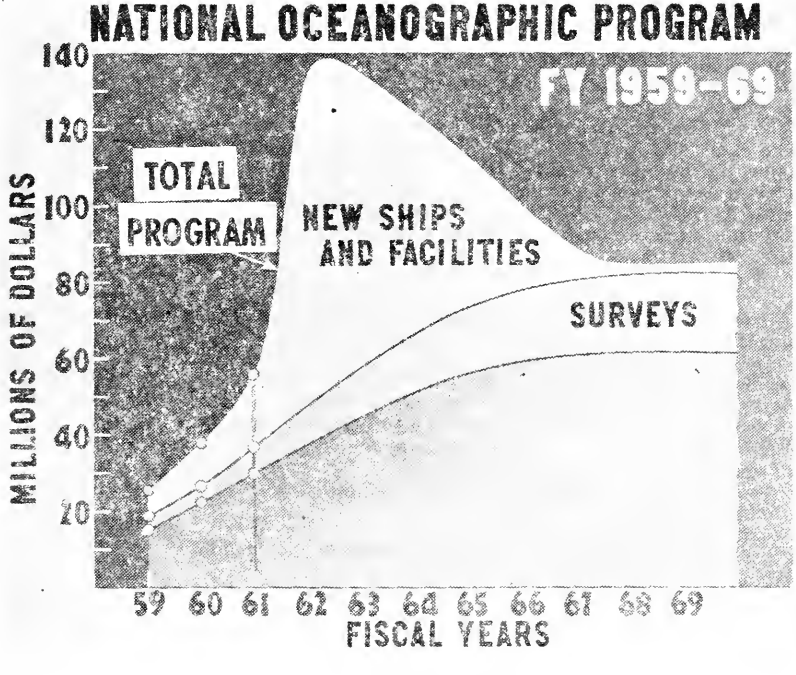
(*e*) Establish means to obtain maximum data from available sources, including civilian and international sources, on a reasonable time scale.

(*f*) Determine most reasonable means for individuals or activities to obtain data on request; establish uniform reimbursable cost basis. Such basis shall be in accordance with existing regulations. Review for adequacy existing Federal regulations pertaining to provision of data to non-Government activities. Recommend to Interagency Committee on Oceanography legislation, if needed, to make the data center a valuable asset to the oceanographic community.

(*g*) Consult with officially recognized and other scientific groups as may be appropriate in the interests of the National Oceanographic Data Center.

(*h*) Recommend to the oceanographic community deficiencies in types of data, area coverages, data collection techniques, etc.

ESTIMATE OF COST OF 10-YEAR NATIONAL PROGRAM IN OCEANOGRAPHY MADE BY INTERAGENCY COMMITTEE ON OCEANOGRAPHY



Thank you, Mr. Secretary.

Mr. WAKELIN. Thank you.

Mr. MILLER. The next man on the list is one whom we always welcome because he brings us refreshing points of view.

Admiral Hayward.

## STATEMENT OF VICE ADM. JOHN T. HAYWARD, U.S. NAVY, DEPUTY CHIEF OF NAVAL OPERATIONS (DEVELOPMENT)

Admiral HAYWARD. I have a statement, Mr. Chairman, and in the interest of time, I will submit it for the record unless you want me to read it.

Mr. MILLER. You may submit it for the record and then summarize it, if you care to.

(The statement follows:)

STATEMENT OF VICE ADM. JOHN T. HAYWARD, U.S. NAVY, DEPUTY CHIEF OF NAVAL OPERATIONS (DEVELOPMENT), ON THE NECESSITY FOR MAKING WORLD-WIDE OCEAN SURVEYS, AND THE POLICY OF THE DEPARTMENT OF THE NAVY WITH RESPECT TO OCEANOGRAPHIC SURVEYS

Mr. Chairman, it is a privilege to be able to address this committee on a matter of such importance to the country. I have prepared a written statement which I would like to present with your permission.

Less than 5 percent of the ocean area is adequately surveyed. The information that we have on the rest of the oceans is sparse and relatively inaccurate. We have considerable need in this country for a greatly increased ocean survey effort. These surveys should include continuous recording of bottom topography, gravity, and magnetic data while the ship is underway and obtaining of ocean water and bottom samples at intervals on the order of one station every 60 miles. From these surveys we hope to gain information which will be of great immediate interest to our country. These include:

1. Better navigational charts and other oceanographic information for use by our ships and submarines.
2. Improved knowledge of the oceans to assist our antisubmarine warfare efforts. For instance, ocean surveillance requires extensive knowledge of the shape and character of the ocean basins.
3. Indications of what oil and mineral resources would be available in the abyssal plains.
4. What effect bottom topography has on satellite orbits.
5. The exact size and shape of the earth through increased gravity data.
6. Improved knowledge of the effects of the earth's magnetic field on various extraterrestrial phenomena such as the Van Allen radiation belts which are so important to space flight.
7. A better understanding of ocean processes for location of fish and other foodstuffs.
8. Best routes for laying transocean cables.

But over and above the practical results we hope to attain through an increased ocean survey program, there are the as yet unknown results which will come from our improved knowledge of the oceans. The oceans cover 71 percent of our globe so that progress in many scientific areas is dependent on what we know of the oceans. For instance, theories connected with gravity, seismology, sedimentation, and magnetism will be able to expand enormously. We will be better able to attack such problems of basic research as the following:

1. Age of the oceans and the history of our planet.
2. Extent and origin of the abyssal plains.
3. How do oceanic trenches stay free of sedimentation? What processes form them?
4. Do rift valleys actually exist?
5. Where are fracture zones located and what is their origin?
6. What is the mixing process within the oceans?

To meet the needs of the United States as outlined above, the policy of the Navy Department is to give full support to a vigorous oceanographic survey program. We have at present 12 hydrographic-oceanographic survey ships des-

ignated to perform the bathymetric, oceanographic, and geophysical aspects of the program. In addition we frequently employ combatant ships for special tasks, for example, the nuclear submarines *Nautilus, Sargo,* and *Skate* in arctic research.

In recent years the urgent needs for precise surveys by new weapons systems under development have required a substantial diversion of survey ships to purely military projects. However, in addition to our survey efforts to satisfy the requirements of our military programs, the Hydrographic Office has been able to carry out substantial surveys in little known and hazardous waters that are of military and commercial importance to the United States and her allies.

The Navy has also contracted through the Office of Naval Research for the various oceanographic institutions to acquire survey information in conjunction with their basic research programs. This has been an excellent source of valuable oceanographic data. To obtain maximum information from all possible sources, the Hydrographic Office has requested our Navy and merchant ships to send in bathymetric and meteorological data which these ships collect as a matter of routine on their cruises. This is a major source of data for the charts used by our seamen. The Hydrographic Office's ship routing system is another effective program and results in a considerable saving of ship steaming time for ships routed by the system. With increased knowledge of the ocean processes from our survey efforts, we hope someday to be able to predict many oceanographic conditions on a synoptic basis. This would be of tremendous use to our fleet.

From the technical viewpoint the ocean survey program recommended by the National Academy of Science's Committee on Oceanography is feasible and realistic. The Navy is eager to support this effort within our capabilities. As a step in this direction we now are studying the level of support which we can afford to give to the Indian Ocean Expedition, an international group which is making a survey of the Indian Ocean in 1961–64.

As you can see from the above remarks the Navy is conscious of the needs for increased ocean surveys. We are now collecting as much data as possible and plan to continue an even more comprehensive effort as survey ships, personnel, and funds become available. Thank you.

Admiral HAYWARD. It is greatly to the point that only 5 percent of the ocean area is adequately surveyed and that the information we have is very sparse and inaccurate and we have a considerable need in this country for greatly increased ocean survey effort.

Now, these problems primarily are problems that we need to meet to meet the needs of the United States. This is going to cover quite an effort.

The Navy Department, of course, is going to give full support to a vigorous oceanographic survey program.

We would be very remiss if we did not.

We have at present 12 hydrographic oceanographic ships designated to perform recording of bottom topography, gravity, and magnetic data. We frequently employ combat ships such as the *Nautilus* and the *Skate* in the arctic region with which you are all familiar where they did considerable work. In discussing the program, I am sure your questions asked of the Secretary, particularly on priority, are very pertinent but over the years and particularly in recent years, the Navy has increased its effort and it has been in competition with quite a few other very important areas, as you know, Mr. Miller.

To give you some idea, and this is just the Navy's spending, since we started this in 1948 really, I have a total of our expenditures in the research areas and it does not include classified military research as we know it. It started off in 1948 with $160,000 and has gone to in fiscal 1961, $17,724,000. In the last 10 years, it has increased elevenfold. So that, I feel, just as the Secretary does, that if you went just all out on the oceanographic side some other part of the research and science program could suffer very much and that we have to be careful.

This must compete with the other sciences that we have and I feel that it has competed quite well in the budget and that Admiral Bennett's people have been quite a sparkplug in this whole program.

For instance, the Office of Naval Research has been very interested in the education and training program.

There are only 600 professional oceanographers in the country at the moment and we know that this is not adequate for what we need. ONR has taken the lead in getting some naval officers into the field. We have 4 of them at Mr. Pelly's university, and we have 76 at the Monterey postgraduate school and some of them are training in oceanography there.

We have also increased the graduate assistance program.

Mr. MILLER. I do not like to interrupt but do you have a formal course at the postgraduate school?

Admiral HAYWARD. Yes, sir. Under the postgraduate school in meteorology we have a training on oceanography. We have an elective course at the Naval Academy.

These are just general comments. That is not a summary of my statement but I thought it would be better to make some comments on the questions that you asked the Secretary, Mr. Miller.

Mr. MILLER. The reason I asked is that I get down toward Monterey when I am home quite frequently and I would like to drop in there some time.

Admiral HAYWARD. We would be delighted to have you there. I am sure that Adm. E. E. Yeomans would be delighted to give you some idea of what the graduate school does, particularly in meteorology and oceanography.

Mr. MILLER. You may proceed. Excuse me. I did not mean to interrupt.

Admiral HAYWARD. I have nothing further, Mr. Chairman, unless you have questions.

Mr. BAUER. Admiral, I have just a few things here.

This TENOC program which is directed from the Chief of Naval Operations to the distribution list of January 1, 1959, on page 31, and this has been used in our preceding hearings, points out the necessity of the Navy surveying certain areas, the Mediterranean, the Sea of Okhotsk, the Persian Gulf, the Arabian Sea, and the Arctic Ocean.

Admiral HAYWARD. Yes, sir.

Mr. BAUER. I assume there are military reasons why the North Atlantic and Pacific should be surveyed also, is that right?

Admiral HAYWARD. Yes, sir. These are specific areas on which we need information but the North Atlantic and North Pacific are in the same category, really.

Mr. BAUER. That is what I meant. That being the case, what is the Navy doing in financing, as I understand, the Indian Ocean joint survey. Is that a militarily important area?

Admiral HAYWARD. Yes, sir; it is.

Mr. BAUER. Who is going to run the survey, the Navy?

Admiral HAYWARD. Well, yes. It would be better if the Secretary answers that because he has been in on it.

Mr. WAKELIN. Most of the contracts which concern the oceanographic institutions which would be involved in this, Mr. Bauer, are out of the Office of Naval Research. This includes the Scripps Institution at La Jolla, the Woods Hole Institution and the Lamont Lab-

oratory at Columbia. While we may have military interest in the Indian Ocean, it was our considered opinion, on strong recommendation from civilian oceanographers and civilian scientists in this field and their willingness to go into a cooperative program with other countries, such as was done in the IGY, in the interest of promoting basic research without regard for military information that they would obtain for us, that we should support a program such as the Indian Ocean program over a 4-year period. It would amount to about 12 percent of our oceanographic research funds per years, we estimate.

Mr. BAUER. Thank you, Mr. Secretary.

At this time, I would like to put in the record the projects that are being financed by the Office of Naval Research in Oceanography.

Mr. MILLER. Without objection, so ordered.

(The document follows:)

DEPARTMENT OF THE NAVY,
OFFICE OF NAVAL RESEARCH,
*Washington, D.C., February 9, 1960.*

Mr. JOHN M. DREWRY,
*Chief Council, House of Representatives,*
*Committee on Merchant Marine and Fisheries, House Office Building,*
*Washington, D.C.*

DEAR MR. DREWRY: In response to your letter of January 4, 1960, in which you request fiscal information concerning the Office of Naval Research programs in oceanography and hydrobiology, we submit the attached material. The funding levels listed under the biology branch program represent only ONR money; that of the geophysics branch represents both ONR money and outside funds, but the latter have been indicated as such in the listing.

We hope this information will be of assistance to you. Please do not hesitate to request any additional information.

Sincerely yours,

R. BENNETT,
*Rear Admiral, USN, Chief of Naval Research.*

EXPLANATION OF THE OFFICE OF NAVAL RESEARCH OCEANOGRAPHIC RESEARCH PROGRAM AS SHOWN IN THE FOLLOWING TABLES

1. The first four institutions show contracts covering a 3-year period for each. This is made possible by the use of longevity funds which give these institutions a monetary buffer amounting to 10 to 20 percent of the total contract This is renewed each year.

2. In continuing type contracts, a single task description is presented to cover both 1959 and 1960. In some cases, there may be some slight difference between the 2 years in the emphasis placed on research work, but this would be minor and the task description reflects both the ability of the institution and the basic research requirements of the Navy.

3. There are a fair number of contracts that ONR has with institutions which are no fund extensions of previous tasks and equipment loan types. These have not been listed.

A SUMMARY OF ONR OCEANOGRAPHIC CONTRACT PROGRAM

I. Woods Hole Oceanographic Institution, Woods Hole, Mass. Nonr 2196(00)—Cost-type contract NR 083–004:

| | |
|---|---|
| Fiscal year 1959 (period: Sept. 1, 1958, to Dec. 31, 1961) | $800,000 |
| Fiscal year 1960 (period: Sept. 1, 1959, to Dec. 31, 1962) | 1,400,000 |

This task is defined in general terms to permit investigations of all phases of oceanography. Major emphasis is placed on: (1) description and explanation of general oceanic circulation, (2) geology and geophysics of marine areas, (3) development of oceanographic instruments, (4) wave and tide research, (5) oceanographic aspects of underwater acoustics and (6) studies from aircraft. The task represents a basic continuing study of the Atlantic Ocean, its adjacent waters and boundaries.

II. Scripps Institution of Oceanography, University of California, La Jolla, Calif. Nonr 2216(01)—Cost-type contract NR 083-005:

| | |
|---|---|
| Fiscal year 1959 (period: Nov. 1, 1958, to May 30, 1961) | $805,000 |
| Fiscal year 1960 (period: Nov. 1, 1959, to May 30, 1962) | 1,400,000 |

This task is defined in general terms to permit investigation of all phases of oceanography. Major emphasis is placed on: (1) waves, (2) descriptive oceanography, (3) deep anchored buoys, (4) military applications, (5) deep sea soundings, (6) shelled micro-organisms in sediments, (7), chemical oceanography, (8) geochemistry, (9) large pattern circulation systems, (10) sediment transport, (11) sediments in shallow water, (12) the geomagnetic field, (13) instrumentation, (14) general oceanography and (15) supporting activities. This task is representing the basic continuing study of the Pacific Ocean, its adjacent waters and boundaries. Past work supported by this contract has been of inestimable value to the Navy, both in ASW and amphibious operations.

III. University of Washington, Department of Oceanography, Seattle, Wash. Nonr 477(10)—Cost-type contract NR 083-012:

| | |
|---|---|
| Fiscal year 1959 (period: Oct 1, 1958, to Oct. 14, 1961) | $305,000 |
| Fiscal year 1960 (period: Oct. 1, 1959, to Oct. 14, 1962) | 400,000 |

This task supports research on inshore and coastal studies, open sea studies, physical oceanography which involves theoretical studies in this field (particular attention is being given to problems arising in the explanation and interpretation of data collected in the observational programs), chemical oceanography (attention is being given to geochemical implications as well as to improving analytical and field procedures and methods), biological oceanography, marine biology, model studies and instrumentation (attention is on salinity bridge recently developed under this contract and to automatic and semiautomatic devices for collecting water; measuring water properties and analyzing collected data.)

IV. Chesapeake Bay Institute, Johns Hopkins University, Baltimore, Md. Nonr 248(20)—Cost-type contract, NR 083-016:

| | |
|---|---|
| Fiscal year 1959 (period: Sept. 1, 1958, to Aug. 31, 1961) | $58,000 |
| Fiscal year 1960 (period: Sept. 1, 1959, to Aug. 31, 1962) | 166,800 |

This task conducts research to include studies of the kinematics and dynamics in coastal plain estuaries; chemical investigations of inshore and estuarine environments; study of extinction of light in estuarine waters; development and construction of instruments, and study of spectra of incipient and early stage gravity waves in inshore waters.

V. Texas Agricultural & Mechanics College, Department of Oceanography and Meteorology, College Station, Tex. Nonr 487(02)—Cost-type contract NR 083-036:

| | |
|---|---|
| Fiscal year 1959 (period: May 1, 1958) | $320,000 |
| Fiscal year 1960 (period: May 1, 1959, to Apr. 30, 1960) | 292,000 |

The oceanographic research being carried out under this task is part of a general project designed to furnish pertinent information concerning the various oceanic areas around our continent. Military applications of this task are mainly concerned with the buildup of a background of information of the general characteristics of the Gulf of Mexico. Part of the task has as its objective, an exhaustive study of the thermal structure of the upper layers of the oceanic water and the heat transfer processes operative between the ocean and atmosphere. The objective of this study is the development of an ability to forecast changes in the characteristics of the thermocline, with such thermocline forecast will come an ability to make realistic forecasts of sonar ranges.

VI. New York University, Department of Meteorology and Oceanography, New York, N.Y. NR 285(03)—Cost-type contract NR 083-046:

| | |
|---|---|
| Fiscal year 1959 (period: Sept. 1, 1958, to Aug. 31, 1959) | [1] $45,000 |
| Fiscal year 1960 (period: Sept. 1, 1959, to Aug. 31, 1960) | 55,000 |

[1] Plus $25,00, MARAD.

Work under this task is directed toward the further development of the theory of ocean currents and waves, and a study of the problems of anomalous fluctuations of the stratification of the upper water layers. Particular emphasis is placed on improvement of a complete statistical description of the properties of real ocean waves.

VII. Narragansett Marine Laboratory, University of Rhode Island, Kingston, R.I. Nonr 396(02)—Cost-type contract NR 083-054:
Fiscal year 1959 (period: Oct. 1, 1958, to Sept. 30, 1959)---------- $54,000
Fiscal year 1960 (period: Oct. 1, 1959, to Sept. 30, 1960)---------- 40,530

The problems investigated under this task are twofold in nature. The first concerns the study of the life cycle of zooplankton found in the open ocean. This is facilitated by the cooperation of the U.S. Coast Guard weather ship program permitting investigations at stations throughout the year. Secondly, this task includes an investigation and analysis of all noise producing fish in the New England area as well as a large number in the tropics. This includes a physical study of the noise producing mechanisms and a study of reasons for the noise.

VIII. Marine Laboratory, University of Miami, Miami, Fla. Nonr 840(01)—Cost-type contract NR 083-060:
Fiscal year 1959 (period: Oct. 15, 1958, to Oct. 14, 1959)---------- $186,800
Fiscal year 1960 (period: Oct. 15, 1959, to Oct. 14, 1960)---------- 295,600

The main emphasis in this task is to study the Florida Current, its fluctuations, associated phenomena. In this region of intense oceanic circulation, operation effectiveness of pro- and anti-submarine equipments vary widely from place to place and with time. It is the ultimate goal of this task to be able to explain and predict local changes in the oceanic environments caused by the Florida Current and other similar currents.

IX. Oregon State College, School of Science, Corvallis, Oreg. Nonr 1286(02)—Cost-type contract NR 083-102:
Fiscal year 1959 (period: Sept. 1, 1958, to Aug. 31, 1960)---------- $25,000
Fiscal year 1960 (period: Sept. 1, 1959, to Aug. 31, 1960)---------- 319,555

The primary objective of this task is to continue and expand the studies of descriptive oceanography of the nearshore waters of the Oregon coast. The temperature distribution along the coast will be studied by use of continuously recording thermometers along with the conventional bathythermograph and conductivity temperature indicator. The circulation and mixing patterns in Oregon coastal estuaries will be studied by mathematical and statistical methods plus enough fieldwork to evaluate the results. The microthermal structure will also be studied and possible other research with direct ASW potential.

This task also covers the construction and outfitting of a new research ship, designed specifically to meet the needs of Oceanography Department of Oregon State College.

X. Office of Naval Research Branch, Boston, Mass., Allot. 67003—Cost-type contract NR 083-122:
Fiscal year 1959 (period: July 1, 1958, to June 30, 1959)---------- $23,000
Fiscal year 1960 (period: July 1, 1959, to June 30, 1960)---------- 23,000

This allotment is intended to cover the cost of operating an R4D6R aircraft at Woods Hole Oceanographic Institution. The aircraft is on bailment contract from the Bureau of Aeronautics to Woods Hole. The funds will cover specifically fuel, oil, minor repairs, minor overhaul. Moreover, it will cover the cost of an initial overhaul which is necessary to put the aircraft in operable condition.

XI. Directorship, Committee for Oceanography, 6 Chemin des Sorbiers, Lausanne 12, Switzerland. Nonr 2976(00)—Cost-type contract NR 083-133:
Fiscal year 1959 (period: June 1, 1959 to, Nov. 30, 1960)---------- $25,000

This contract was designed to cover the personal services of M. J. Piccard in connection with the research and operation of the bathyscaph *Trieste*. Since the *Tricste* is at the Naval Electronic Laboratory in San Diego, Piccard will work in cooperation with the scientific and military personnel in planning the scientific program and in training U.S. naval officers in the operation of the *Trieste*.

XII. Directorship, Committee for Oceanography, 6 Chemin des Sorbiers, Lausanne, Switzerland. Nonr 2635(00)—Cost-type contract NR 083-133a:
Fiscal year 1959 (period: July 1, 1958, to June 30, 1959---------- $61,600
Fiscal year 1960---------- Not renewed

This task covers the construction of new deep-sea sphere capable of withstanding the pressures encountered at the greatest depths in the ocean. It will be interchangeable with the existing sphere on the bathyscaph, *Trieste*, thus permitting two scientists to explore the ocean trenches. This also includes the cost of additional inside equipment and construction of equipment for testing the new plexiglass windows.

XIII. Navy Purchasing Office, 8 Rathbone Place, London, England. Allotment 503—Cost-type contract NR 083–133b:
Fiscal year 1959 (period: June 9 to Aug. 31, 1958) _____
Fiscal year 1960 _____ Not renewed

This allotment is to cover the cost of crating, handling, and other miscellaneous charges that will arise in Germany in getting the new sphere shipped to the United States.

XIV. National Academy of Sciences, 2101 Constitution Ave., Washington, D.C. Nonr 2300(03)—Cost-type contract NR 083–136:
Fiscal year 1959 (period: Nov. 1, 1958, to Oct. 31, 1959) _____ [2] $65,500
Fiscal year 1960 (period: Nov. 1, 1959, to Oct. 31, 1960) _____ [3] 77,500

[2] $25,500, ONR; $20,000, AEC; $20,000, NSF.
[3] $27,500, ONR; $20,000, AEC; $20,000, NSF; $5,000, USFWS; $5,000, USC & GS.

This task provides a national center for oceanography in the United States where the diverse problems of the oceans may be brought to a focus. The Committee on Oceanography is supported jointly by several Government agencies. This group is to be called upon for advice on current oceanographic problems and, in addition, will provide counseling, planning, and coordination in long-range oceanographic research programs.

XV. Institute of Geophysics, University of Hawaii, Honolulu, Hawaii. Nonr 2590(00)—Cost-type contract NR 083–139:
Fiscal year (period: June 1, 1958, to May 31, 1959) _____ $8,160
Fiscal year 1960 _____ Not renewed

This task is to prepare an atlas of the oceanographic properties collected on the EQUAPAC Expedition of August–September 1956.

XVI. Commanding officer and Director, U.S. Navy Electronics Laboratory, San Diego, Calif. Allotment 953—Cost-typecontract NR 083–140:
Fiscal year 1959 (period: June 1, 1958, to May 31, 1959) _____ $308,500
Fiscal year 1960 (period: July 1, 1959 to June 30, 1960) _____ 500,000

This task is designed to cover research and operations with the bathyscaph, *Trieste*. The program includes the following areas of research: (*a*) Investigation of ambient noises and acoustic properties of the deep ocean; (*b*) visual examination of the bottom and selective photography; (*c*) determination of the natural distribution and conditions of bottom dwelling and other deep water organisms; (*d*) examination of bottom features which are too large to photograph and too small to observe on fathograms; (*e*) placing or inspecting equipment and instruments on the bottom; (*f*) direct reading of equipment in operation; (*g*) selecting samples for collection; (*h*) studying samples and background of cosmic radiation at great depths; (*i*) measuring physical and chemical properties of the water very close to the bottom; (*j*) study the formation and occurrence of bottom forming minerals such as manganese limonite, etc.; (*k*) planting instruments on the bottom where it is imperative to know the relative spacing and orientation of the instruments; (*l*) investigate the factors for submarine erosion and deposition and transportation of sediments; (*m*) investigate submarine canyons, structure of fans at the mouths of canyons, nature of deep submarine channels, fault scarps, sea mounts, trenches, basins, and other bottom features which may be discovered as a result of the use of the bathyscaph.

XV. American Association for the Advancement of Sciences, 1515 Massachusetts Ave., Washington, D.C. Nonr 2737(00)—Cost-type contract NR 083–140:
Fiscal year 1959 (period: July 1, 1958, to June 30, 1959) _____ $50,000
Fiscal year 1960 _____ Not renewed

The AAAS, together with the United Nations Educational, Scientific, and Cultural Organization, organized and helped sponsor an International Oceanographic Congress which was held at the United Nations Building in New York from August 30, to September 12, 1959. The Congress was designed to provide a common meeting ground for all scientists interested in the oceans and thus covered all possible aspects of oceanography.

XVI. Lamont Geological Observatory, Columbia University, Palisades, N.Y. Nonr 266(48)—Cost-type contract NR 083–142:

| | |
|---|---|
| Fiscal year 1959 (period: Jan. 1, to Dec. 31, 1958) | $570,000 |
| Fiscal year 1960 (period: Jan. 1, 1959, to Dec. 31, 1960) | 697,000 |

The objective of this task is to conduct a program of marine geophysical studies. Projects under this task include marine gravity investigations, marine magnetic measurements, marine seismic studies, oceanographic studies, and submarine geology and photography. These projects will be integrated for the purpose of obtaining a better understanding of the physical conditions and processes existing in the oceans and of the origin and structure of the oceanic basins.

XVII. Woods Hole Oceangrophic Institution, Woods Hole, Mass. Nonr 2734 (00)—Cost-type contract NR 083–143:

| | |
|---|---|
| Fiscal year 1959 (period: Oct. 1, 1958, to Sept. 30, 1959) | [4] $40,000 |
| Fiscal year 1960 (period: Oct. 1, 1959, to Sept. 30, 1960) | [4] 40,000 |

[4] One-half, DTMB.

This task is concerned with the measurement of both the one and two dimensional spectrum of natural wind generated waves at a wave tower facility in Buzzards Bay for a variety of wind velocities. Analyses of these records will be made and compared with the theoretical work of Neumann and others on spectrum analyses of wind generated waves. Further application of these results will be used in determining the ranges of applicability of the Pierson-St. Denis Theory of ship motions in irregular seas.

XVIII. Allan Hancock Foundation, University of Southern California, Los Angeles, Calif. Nonr 228(07)—Cost-type contract NR 083–144:

| | |
|---|---|
| Fiscal year 1959 (period: June 1, 1959, to Nov. 30, 1960) | $15,040 |
| Fiscal year 1960 | ------- |

This task involves a detailed study of the distribution of oxygen in the bottom waters of number of ocean basins off the coast of southern California. In addition to oxygen determinations, the temperature and salinity will be measured at each sampling point.

XIX. Global Marine Exploration Co., 650 South Grand Ave., suite 400, Los Angeles, Calif. Nonr 2891(00)—Cost plus fixed fee NR 083–145:

| | |
|---|---|
| Fiscal year 1959 (period: May 1 to Dec. 31, 1959) | $45,506 |
| Fiscal year 1960 | Not renewed |

The objective is to make an engineering study to improve present drilling techniques for very deep water application and to prove their feasibility.

XX. Hudson Laboratories, Columbia University, Dobbs Ferry, N.Y. Nonr 271(35)—Cost-type contract NR 281–001:

| | |
|---|---|
| Fiscal year 1959 (period: Sept. 1, 1958, to Aug. 31, 1959) | $547,000 |
| Fiscal year 1960 (period: Sept. 1, 1959, to Aug. 31, 1960) | 2,650,000 |

The immediate objectives include: (*a*) Research and sound propagation in the ocean to determine the characteristics of transmission of low frequencies of varying conditions of temperatures, dept bottom topography, and subbottom geology; (*b*) determination of the nature and distribution of ambient noise in the ocean and of exploitable characteristics of the noise output of submarines; (*c*) investigation of the physical and chemical properties of water to discover techniques for the detection of submarines by nonacoustic methods, including pressure and turbulence studies, as well as studying submarine wakes in detail; (*d*) investigation of such detection systems, communication systems, and signal processing techniques as are suggested by theoretical study and experimental results of (*a*), (*b*), and (*c*) above.

XXI. Woods Hole Oceanographic Institution, Woods Hole, Mass. Nonr 1367(00)—Cost-type contract NR 261–102:

| | |
|---|---|
| Fiscal year 1959 (period: Nov. 1, 1958, to Oct. 31, 1959) | $1,189,000 |
| Fiscal year 1960 (period: Nov. 1, 1959, to Sept. 30, 1960) | 1,150,000 |

The objective of this task is to continue the investigation of characteristics of the ocean as they pertain to acoustic transmission. These characteristics and effects are being studied as a function of location, season and weather conditions and the frequency, directivity, and power of the transmission signal. The study includes reverberations, transmission paths, signal sources, improved methods of data storage and analysis, and interrelation of salinity, temperature, density, and sound velocity and target effects on acoustic transmissions. Extension of the explosive echo ranging techniques through use of the directional characteristics and the signal composition are being studied. Data collection is conducted primarily from research vessels and is followed by the detailed analysis and correlation with previously obtained data and reporting of results.

XXII. Savannah Machine & Foundry, Savannah, Ga. (*Chain*); Mobile Ship Repair Co., Mobile, Ala. (*San Carlos*). Allotment 501 (MSTS)—Cost-type contract plus fixed fee NR 261–119:

| | |
|---|---|
| Fiscal year 1959 (period: July 1, 1958, to June 30, 1959) | $2,500,000 |
| Fiscal year 1960 (period: July 1, 1959, to June 30, 1960) | 1,400,000 |

In fiscal year 1959 this task provided funds to the Military Sea Transportation Service for activation, alteration, and operation of the U.S.S. *San Carlos* (AVP-51) and the U.S.S. *Chain* (ARS–20) for use as research ships for Hudson Laboratories of Columbia University and the Woods Hole Oceanographic Institution respectively. The *San Carlos* is now in service as the USNS *Josiah Willard Gibbs* T–AGOR–1) and the *Chain* has been leased to the Woods Hole Oceanographic Institution by the Bureau of Ships.

In fiscal year 1960 the funds cover the cost of operation by MSTS for the entire year for the *Gibbs* and to November for the *Chain*.

XXIII. Scripps Institution of Oceanography, University of California, La Jolla, Calif. Nonr 2216(65)/(10)—Cost-type contract NR 261–115/129:

| | |
|---|---|
| Fiscal year 1959 (period: Sept. 1, 1958) | $1,000,000 |
| Fiscal year 1960 (period: Oct. 1, 1959, to June 30, 1960) | 850,000 |

The Marine Physical Laboratory is conducting research on the generation, transmission, and detection of acoustic and electromagnetic energy in the ocean and the media bounding it. Their program also includes basic studies in geomagnetism, gravity, and other force fields or energy sources in the ocean. Indicated naval applications are investigated as they arise and the solution of Navy problems in these areas undertaken.

In addition, the research program at MPL has, for many years, included basic research in the field of sonar signal processing has led recently to the extended application of digital computer techniques to this problem. The objective of this task is to further research in this highly promising field and to validate theoretically demonstrated advantages of the concept through sea experiments.

## Biology Branch, Office of Naval Research

### No. 104.—*Hydrobiology program*

| Contractor | Contract | Type | Dates | Subject | Fiscal year 1959 | Fiscal year 1960 |
|---|---|---|---|---|---|---|
| Duke University | Nonr 1181(06) | Cost | July 1, 1950 | Metabolism of shell forming tissues in mollusca. | $6,575 | $12,000 |
| University of Minnesota | N8onr 662(08) | do | Jan. 1, 1951 | Studies of respiratory photoinhibition | 10,000 | 10,000 |
| Johns Hopkins University | Nonr 248(02) | do | Feb. 1, 1951 | Studies of coenzymes by means of biochemical mutants. | 10,720 | 10,720 |
| University of Rhode Island | Nonr 396(03) | do | Apr. 1, 1952 | Dynamics of biological productivity of plankton. | 98,200 | 0 |
| University of Maryland | Nonr 556(00) | Fixed price | July 1, 1951 | Limiting factors in mass culture of unicellular algae. | 0 | 15,000 |
| Yale University | Nonr 711(00) | do | Dec. 1, 1951 | Biological and oceanographic characteristics of Long Island Sound. | 11,400 | 0 |
| Marine Biological Laboratory, Woods Hole, Mass. | Nonr 097(02) | Cost | July 1, 1952 | Environmental factors influencing certain marine biological populations in the Woods Hole area. | 0 | 0 |
| Library of Congress | NAonr 186(54) | Government order | Jan. 1, 1952 | Marine borer bibliography | 7,725 | 0 |
| University of Washington | Nonr 477(05) | Cost, type A | Mar. 1, 1952 | Nutritional physiology of *Limnoria lignorum* | 0 | 23,000 |
| University of Iowa | Nonr 1020(00) | Fixed price | Jan. 1, 1953 | Hearing in amphibians | 0 | 0 |
| Duke University | Nonr 150(00) | Cost | Oct. 1, 1950 | Studies on growth of attached barnacles | 7,757 | 8,303 |
| Haskins Laboratories | Nonr 1111(01) | do | Jan. 1, 1953 | Factors determining growth in marine algae and protozoa. | 35,000 | 20,000 |
| Columbia University | Nonr 1762(00) | Equipment loan | Apr. 1, 1955 | Iodine utilization by marine organisms | 0 | 0 |
| Marine Biological Laboratory, Woods Hole, Mass. | Nonr 1497(00) | Cost | June 15, 1953 | Studies in marine biology | 0 | 30,000 |
| Princeton University | Nonr 1353(00) | Fixed price | Feb. 1, 1954 | Factors influencing the intensity of bioluminescence. | 0 | 0 |
| University of Miami | Nonr 840(03) | Cost | July 1, 1954 | General biology of marine borers | 7,000 | 7,000 |
| University of California | Nonr 035(03) | do | do | Immunology of marine animals | 11,841 | 0 |
| Do | Nonr 035(02) | do | Sept. 14, 1954 | Behavior and specificity in marine symbioses. | 9,907 | 0 |
| University of Delaware | Nonr 1506(00) | Fixed price | Sept. 1, 1954 | Energetics of ciliary motion | 0 | 6,850 |
| Bermuda Biological Station | Nonr 1135(02) | Cost | July 1, 1954 | Nutrition, feeding, and physiology of deep sea animals. | 0 | 6,300 |
| University of California | Nonr 233(31) | do | May 1, 1955 | Physical and biological causes of the deep scattering layer. | 15,000 | 21,000 |
| Do | Nonr 1842(01) | do | Oct. 15, 1955 | Mechanisms of ionic and osmotic regulations. | 0 | 0 |
| Johns Hopkins University | Nonr 248(46) | do | Aug. 15, 1955 | Estuarine ecology | 9,900 | 9,940 |
| Columbia University | Nonr 266(41) | do | Dec. 1, 1955 | Effect of temperature on marine borer growth. | 9,728 | 0 |
| Naples Zoological Station, Italy | Nonr 2100(00) | Fixed price | Jan. 1, 1956 | Marine biology of the Mediterranean | 30,000 | 25,000 |
| Marine Biological Laboratory, Woods Hole, Mass. | Nonr 097(01) | Cost | June 15, 1950 | Studies on isolated nerve fibers | 6,450 | 6,450 |

No. 104.—*Hydrobiology program*—Continued

| Contractor | Contract | Type | Dates | Subject | Fiscal year 1959 | Fiscal year 1960 |
|---|---|---|---|---|---|---|
| Pomona College | Nonr 2246(00) | Fixed price | Nov. 1, 1956 | Biological investigations of the SCUBA Zone. | $6,000 | $6,000 |
| Rockefeller Institute | Nonr 2317(01) | Cost type A | June 15, 1957 | Fundamental investigations in marine biology. | 0 | 11,110 |
| University of Oregon | Nonr 2762(00) | Fixed price | Nov. 1, 1958 | Meristic characters of fishes as indicators of coastal circulation. | 1,815 | 8,229 |
| Catholic University | Nonr 2249(01) | Cost | Nov. 1, 1956 | Effect of small organisms on ultrasonic waves. | 8,412 | 8,500 |
| Woods Hole Oceanographic Institute | Nonr 2232(00) | Cost and fixed fee | do | Silica deposition at the diatom surface | 6,500 | 6,720 |
| Florida State University | Nonr 988(06) | Cost | Nov. 15, 1956 | Hydrobiological aspects of mine countermeasures problems. | 30,440 | 20,000 |
| New York Zoological Society | Nonr 2306(00) | Pending | Jan. 1, 1957 | Coral reef investigations | (1) | 2,000 |
| Wm. F. Clapp Laboratories | Nonr 2318(00) | Cost | do | Studies in marine fouling and boring | 0 | 0 |
| Brandeis University | Nonr 1677(02) | do | Mar. 1, 1957 | Effects of polarized light on cellular development. | 9,000 | (1) |
| Chesapeake Biology Laboratory | Nonr 2299(00) | Fixed price | Feb. 1, 1957 | Hydrobiological characteristics of bottom sediments. | 3,000 | 3,000 |
| Drake University | Nonr 2345(00) | do | Jan. 1, 1957 | Cellular reorganization in relation to antigen-antibody reactions. | (1) | 0 |
| Stanford | Nonr 2506(00) | do | Sept. 15, 1957 | Marine biology in the Central Tropical Pacific. | (1) | 0 |
| University of Texas | Nonr 375(11) | Cost type A | Apr. 1, 1959 | Trophic structure and productivity of the hypersaline Laguna Madre. | 14,600 | 0 |
| Woods Hole Oceanographic Institute | Nonr 2421(00) | Cost type B | Nov. 1, 1957 | Geographical distribution of marine fouling organisms. | 0 | 0 |
| University of Hawaii | Nonr 2591(00) | Fixed price | May 1, 1958 | Marine phytoplankton productivity | 0 | 0 |
| University of Puerto Rico | Nonr 2468(00) | Fixed price C | Nov. 1, 1957 | Hydrobiological studies in the Caribbean | 0 | 0 |
| University of California | Nonr 035(04) | Cost type A | Sept. 1, 1958 | Population dynamic of barnacles | 0 | 5,200 |
| Cornell University | Nonr 401(33) | Cost type | June 1, 1958 | Physiology of elasmobranchs | 2,000 | 12,000 |
| Temple University | Nonr 2517(00) | Fixed price C | do | Biological effects of X-radiation on certain protozoa. | 0 | 3,200 |
| University of Maryland | Nonr 595(09) | Cost type A | July 1, 1958 | Biological problems in acoustics systems | 0 | 15,015 |
| University of Kansas | Nonr 2724(00) | Fixed price | Dec. 1, 1958 | Comparative biochemistry of proteins | (1) | 0 |
| Yale University | Nonr 2308(00) | do | Mar. 1, 1957 | Studies of tropical woods | 4,111 | 0 |
| University of Hawaii | Nonr 2756(00) | do | Dec. 1, 1958 | Factors affecting shark behavior | 2,600 | 0 |
| Virginia Polytechnic Institute | Nonr 2352(02) | Cost type A | do | Antibacterial activity of Antarctic plankton | 9,084 | 5,000 |
| Stanford | Nonr 25127 | Cost | Jan. 1, 1950 | Fluctuations in marine organisms correlated with fluctuations in hydrographic factors. | 800 | 0 |
| Bermuda Biological Station | Nonr 1135(04) | Cost type A | May 1, 1959 | Marine biology in the Bermuda area | 9,000 | 0 |
| University of Miami | Nonr 840(13) | do | Mar. 1, 1959 | Bioacoustics | 15,379 | 0 |
| Do | Nonr 840(12) | do | Feb. 15, 1959 | Behavior of plankton in relation to hydrographic factors. | 3,590 | 3,000 |
| Kaiser Foundation | Nonr 3015(00) | Fixed price C | Sept. 15, 1959 | Nitrogen fixation by marine algae | 0 | 4,901 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Laboratoire de Physiologie Acoustique | N6-2558-2226 | Special foreign contract. | Apr. 15, 1959 | Research on underwater sounds of biological origin. | 0, 000 | 0 |
| American Museum of Natural History | Nonr 552(07) | Cost | Jan. 1, 1959 | Biological sound | 40, 000 | 0 |
| Beaudette Foundation | Pending | Fixed price | Nov. 1, 1959 | Benthic sublittoral marine flora of Pacific, Baja, Calif., Mexico. | 0 | 4, 875 |
| Fish and Wildlife Service | NAonr 42-59 | Government order | Apr. 1, 1959 | Chemical analysis of shark repelling substances. | 8, 000 | 0 |
| American Museum of Natural History | Nonr 552(08) | Cost | do | Shark studies under field conditions | 27, 570 | 0 |
| Smithsonian Institution | Nonr 1351(07) | Cost type A | do | Distribution of sharks and shark attacks | 5, 000 | 5, 000 |
| Texas A. & M | Nonr 2119(03) | Pending | Jan. 15, 1960 | The production of lipids by plankton organisms. | 0 | 19, 373 |
| Smithsonian Institution | Nonr 1354(09) | Cost type A | July 15, 1959 | Systematics of marine fauna | 13, 128 | 0 |

[1] Equipment.

Mr. BAUER. Admiral, do you think that we are exerting enough effort in the ocean surveys from the point of view of the military?

Admiral HAYWARD. Well, my answer to that would be "No, sir." We should do more.

Mr. BAUER. How much more?

Admiral HAYWARD. Well, to give you an order of magnitude, I would say at least twice what we are doing now, but you must remember, sir, that, as I said, once again it has to compete with the rest of the tasks we have to do.

Mr. BAUER. True.

Admiral HAYWARD. And this amount of surveying which we are doing, which is, roughly, on the military side, $14 million, is what we felt was the best balance for the program.

Mr. BAUER. The question was leading to whether or not perhaps the Indian Ocean would dilute our military efforts.

Admiral HAYWARD. No, sir. Any information you get on these remote places in the world can aid and assist us from a military point of view. There is no question in our minds that your temperature, all of the rest of the information, has some spinoff to the military, particularly to our operations, weather, everything, so that it is pretty hard.

This is one of those areas where basic research may give us some very interesting indications about sonar conditions in the Indian Ocean which may help us tremendously, so that it is pretty hard to say that you are not doing it specifically from a military point of view.

We are going to get something out of it, I am sure, and I do not think it is going to dilute our efforts.

Mr. BAUER. That is all I have.

Mr. MILLER. There are some good reasons why the Indian Ocean should be investigated, are there not, as a place where we can look to try to solve some of the secrets of the weather and heat transference? That is rather important in the Pacific in time of war, is it not? Maybe Tiros will give it to us, but in the meantime we have to get it where we can.

Admiral HAYWARD. That is correct, Mr. Chairman. It can give us a lot of information. It is like a lot of research; you are going to increase your knowledge. And we need this.

Mr. MILLER. One of the things which has disturbed me is that when I was out to Scripps last year, with Mr. Pelly and Mr. Bauer, the very amiable director showed us a globe which brought out the areas of the ocean that were blank as far as any type of research is concerned, and if the oceans constitute 71 percent of the earth's areas, as I see the picture in my mind's eye, there is more than 60 percent of that 71 percent that we know nothing about.

Admiral HAYWARD. That is correct. Five percent has been surveyed.

Mr. MILLER. It has been inadequately surveyed, but this other great portion of it is just a blank. That is the thing that concerns me. Until we begin to scratch this can we resolve all of the problems that confront us in other parts of the world? I was impressed with the history of the Cromwell current, for instance, which was hit upon comparatively recently—I believe within the last decade.

There are a great many implications in that, both in defense and otherwise.

Are there currents in the vast reaches of the Pacific that could be pumping water with the same effect?

How can we get into these areas even if the data we are getting is not the refined type of thing that the idealistic scientists want? Is it not better to get some rough data on these rather than hold this thing back, Admiral?

Admiral HAYWARD. Any data is better than none.

Mr. MILLER. I was going to say that I quit engineering when I entered the Army in World War I, so that I hesitate to apply to myself the title of an old engineer but, as an old engineer, I remember some of the men who drove the Canadian Northern across the hills and I knew one of the men who made some of the preliminary reconnaissance on that and they did not even know what river basic they were going to hit on the other side.

Of course, today, you could fly over it and take some pictures and come back and most likely have laid out this railroad without half the effort.

Is this not what we are up against in these vast regions of the Pacific and the South Atlantic, that we do not know where the river basins and mountains are in the bottom of the ocean?

Admiral HAYWARD. All this is true, Mr. Chairman.

Mr. MILLER. How can we get at that? This is one of the provocative things.

We thought that we could, for instance, equip the *Savannah* with some instruments and let her, as she plies around the ocean, dig up some of these things, and that we could put some instruments on some ships that cross that occasionally which would not give us the bottom of the deeps by any degree of refinement but they certainly would have been able to tell us whether there is one there that is 20,000 feet deep as against 10,000 feet deep.

I think, as an old engineer, we would be very much interested in that but somehow or other some of our scientists did not think this was right, that we had to get this information with all its refinements the first time.

Admiral HAYWARD. We use a lot of this. All of our ships, as you know, report to the Hydrographic Office and we go to a lot of out-of-the-way places.

The depths, temperatures, weather are all processed. This data is better than none at all.

Mr. MILLER. Certainly.

Admiral HAYWARD. It is not the refined scientific work that you do but you do get weather information. You get a lot from it.

Mr. MILLER. It might give you a lead to know where to go out and look for the other things.

Admiral HAYWARD. That may very well be. It is amazing that even on some of the better traveled routes on the North Atlantic and Pacific there is a lack of information.

Mr. MILLER. Mr. Pelly?

Mr. PELLY. Admiral, I think the record would be helped if you would indicate your views as to whether we are doing enough in the field of controlling radiocative contamination and are working out a solution for the disposal of radioactive waste.

Admiral HAYWARD. From my knowledge at the moment, I think we are, Mr. Pelly. I think that with the Atomic Energy Commission, our

people, Admiral Rickover's people, that we are controlling it. It is a very long-term project, as you know. You just cannot say that you have everything in hand now. You do not know the problems 10 years from now but I think by being careful as to how you dispose of it now, what you do with it, will save you some real nasty problems in the future.

Mr. PELLY. If the Navy would be more or less in control of all research on oceanography or dominate it, I am wondering, for example, if we would do enough basic research in transfer of radioactivity from inorganic materials to the actual seawater and its effect on the genetics.

Admiral HAYWARD. Well, I feel that, with the Atomic Energy Commission as an observer in this particular committee and following it, we are very closely allied with those people on anything we do in this area, and I think, in the basic research side, they are primarily interested in some of this.

As you know, all the way back from the Bikini tests, we have done work on this particular subject and its effect on fish. You are familiar with some of those reports, I am sure. That is now 14 years ago, and we are beginning to get a pretty good record of just what the effects were.

Mr. PELLY. I noticed, for example, that in Mr. Miller's bill, H.R. 10412, to which other Members have introduced companion bills, that the Atomic Energy Commission is not listed as being one of the agencies that would have a representative on a coordinating committee on oceanography, and I notice they are mentioned on the Interagency Committee on Oceanography and I think possibly the record should indicate an opinion from you as to whether, if Congress does legislate in this matter and does establish a policy, would you not think that there should be added a permanent member from the Atomic Energy Commission?

Admiral HAYWARD. Yes, sir; very decidedly I do. They should have a representative.

Mr. PELLY. Well, I notice that in this particular bill and I think we should have it in mind.

Again, I would like to just conclude because time is short. In your opinion, are we moving in the direction of establishing a nationwide policy for the development of marine sciences as we are going now or would you think that maybe it could be better implemented by the permanent law and statutory organization?

Admiral HAYWARD. Well, in the 4 years that I have been here, we have taken tremendous steps and we have gotten good scientific people interested in this problem, and I think that we will come out with a national program that will be very excellent. I really do not feel that a specific law to this will assist it tremendously nor or is really necessary. The time may come when it will be but right at the moment, I feel, from the start of Admiral Bennett's letter, from the start when we came to Congress 3 or 4 years ago, that we have come a long way. We had a lot of opposition, as you remember, Mr. Pelly. We had to sell our own people in the Navy. We had to sell a lot of people in the Navy. We had to sell a lot of people on this. We have come a long way. We have gotten MIT interested in working with Woods Hole. We have increased the educational aspects. We have Dr. Henderson, the people out at Washington. We have gotten a lot of

interesting people and I am not sure that legislation is really required now.

Mr. PELLY. Well, I feel that in the infancy of this development, we do have a crusading spirit.

I do agree that we have some good men and I include the Secretary and yourself, but I am thinking in terms now of the long-range development, and it seems to me that now is the time to set the guidelines and establish a policy which will coordinate the program maybe on a permanent basis better than it would be under the present more or less flexible arrangement which probably works today but which might not work tomorrow.

Admiral HAYWARD. Mr. Pelly, I feel that by the mere fact that we are up here talking on this subject, we have come a long way. Four years ago, this would not have happened.

I think if the committee continues each year to go into the details of the program such as you are doing that you may come to the conclusion that you do need legislation. My personal opinion today, and it is my own opinion on it, is that we do not need it at the moment.

The committee, as I say, provides part of the spark to have the good people we have gotten.

Mr. Miller and the rest of you have helped this. I do not think that you need legislation now.

Mr. PELLY. I have the impression that some of the scientists in various fields feel that we are not making enough progress. They are dissatisfied and it is going to be necessary to come up with legislation in order to get the results that they would like to see.

Admiral HAYWARD. But, Mr. Pelly, we have a lot of people—and I am sure the Secretary will back me on this—that live in their own particular, let me say, discipline and do not have to balance the overall program. You may then wind up with legislation for not only oceanography but meteorology. There is no end to this, and at the moment there is a lot of confusion in the picture, too, in the fisheries side, the minerals side, a lot of the things, and just the pure research side, so that I do not think that you could really make a piece of legislation that would not require some changing and it might confuse the issue more than anything.

I do not agree that they need it to get the spark behind it because everybody that has been mixed up in it, Dr. Kistiakowsky, Dr. Wakelin, we have come a long way, as I say, in 4 years. Just look back 4 years and you will see it.

I know Mr. Miller knows this.

Mr. PELLY. Thank you.

Mr. MILLER. I know that this committee, beginning at the beginning of this session, knew nothing about oceanography. I do not know whether we know anything about it now. I think we are getting a liberal education.

Mr. Lennon, any questions?

Mr. LENNON. I was interested in the comment as to the opposition of those in the Navy which you have been able to overcome in the last 3 years. Why would anybody in Navy be opposed to the scientific study of the oceans? That is an oversimplified question.

Admiral HAYWARD. No, sir. For the same reason that the scientists come to Mr. Pelly to pass legislation on oceanography. The

man who is building the missile sees the money going to oceanography, and he says, "I want bullets in the locker." It is the same thing that we get in the field. He would be wrong if he did not push his program.

This is what you will always have, the way the program is put together and it is diverse. He would be wrong if he was not enthusiastic. It would be just as wrong if the oceanographer did not fight for his program.

Admiral Burke himself approved and went along with the TENOC program. To get that program approved by the Chief of Naval Operations was a tremendous step forward and Admiral Bennett deserves tremendous credit on that, and it was a long, hard pull for him, I know.

Mr. LENNON. I was thinking of the possibility that if the data center is lodged in a bureau of the Navy that you might still have the opposition of the Department of Defense to what it ultimately determined to be a purely civilian agency.

I was interested, too, in the Secretary's last statement that it always, and I quote, "is in competition with ships of the line."

Your statement to the effect that you had to overcome in the Navy itself an opposition to this type of program plus the Secretary's concluding remarks that always we have to consider in competition with ships of the line are the two most significant statements that have been made here today and lead me decidedly to the conclusion that seems to be in the mind of the gentleman from Washington, Mr. Pelly, that maybe we ought to consider very seriously the question of establishing this agency by an act of the Congress.

I do not suppose that the Department of Defense had too much enthusiasm about the establishment of the National Science and Astronautics Committee.

Most of the information that I had from members of the Department of Defense felt that it ought to be kept in the Army or Navy or Air Force but we finally did meet that issue, rightly or wrongly. We do not know.

That is all I have.

Admiral HAYWARD. Mr. Lennon, in answer to your question, first there were a lot of us that went right along with the committee and so testified, but the Hydrographic Office right today has 70 percent of all the data that you refer to. When I said "opposition," the Hydrographic Office is dependent in the Navy on everything that this outfit puts out. Actually, the way the research and development budget is made up, everything is in competition, and Mr. Wakelin mentioned the ships of the line. That is true, too, but I do not see how you can change this and you should not.

I think oceanography has done real well in my 4 years here and I will let the Secretary answer anything further on that particular phase.

Mr. LENNON. Well, the U.S. Coast and Geodetic Survey is charged with a statutory responsibility of compiling data in at least three categories that were mentioned a few minutes ago, is that not so, all of which would contribute to this overall picture? If that is done by statute, you would certainly have to amend that statute to transfer that authority over to the Hydrographic Office in the Navy Department. Would you not have to do that?

Admiral HAYWARD. Well, the statutory responsibilities you are referring to are the geology, the seismic, and the magnetic.

Mr. LENNON. Yes. Would that not be included in an overall picture of a data center at the Naval Hydrographic Office.

Admiral HAYWARD. I am no lawyer, but most of that would relate really to land measurements. We also understand the law gives the Navy basic responsibility for oceanography. For instance the magnetic fields and measurements in the far reaches of the ocean are all done by the Navy.

Mr. LENNON. That is statutory, likewise?

Admiral HAYWARD. That is what I believe; yes, sir.

Mr. LENNON. I do not know.

Admiral HAYWARD. As I say, I am not a lawyer.

Mr. LENNON. Thank you, Admiral.

Mr. MILLER. Mr. Curtin?

Mr. CURTIN. I have a question.

Admiral, I presume that there is some distinction between the publicity given the findings of, for example, the U.S. Coast and Geodetic Survey as against those made by the military, is there not? Yours are more classified than those made by the purely civilian agencies.

Admiral HAYWARD. Well, some of them are, not all of them. You can buy a card and get a lot of information. We have specific classified projects, though, where we want to find out about a certain place or area for specific information and this may be a classified project, yes.

Mr. CURTIN. Then there would be no problems if these were all put together in one committee?

Admiral HAYWARD. No, sir. There is no problem with this.

Mr. OLIVER. I have just one question, Mr. Chairman.

Admiral, I have been listening to your observations here with a great deal of interest and I think I have gained the impression from what you have said that you are satisfied with the progress which we are making in our grogram of oceanography, is that correct?

Admiral HAYWARD. Well, let me put it this way. I am pleased. I am never satisfied. If I ever get satisfied with a program my boss will probably fire me. But out of the balance of what we have had to put together in the research and development area, I think oceanography has made considerable progress and I am pleased with the amount of progress it has made.

Mr. OLIVER. I am sure that we all feel pleased about the progress you have made. However, I am wondering, in the face of this matter that I referred to when I was discussing with the Secretary, the Soviet activity in this field, do you, knowing what you do about what the Soviet program is, feel that time is running in our favor in this matter of oceanographic research and your program relating thereto?

Admiral HAYWARD. Well, my personal feeling, and I refer it to the whole research and development program, is that time is not in our favor, that while we stand today in a very good position the momentum of the Soviet program is such that if we do not do something and increase the rate, our position will change. The rate has increased but I am sure my previous testimony has made quite plain that I am not happy with it.

Mr. OLIVER. What I am concerned with, Admiral, is whether the rate of our momentum is fast enough in the face of what I consider to be an ever-increasing challenge and, therefore, I cannot feel too happy about moderate efforts. This is only a matter of my own observation.

You do not have to comment on it.

Mr. MILLER. Thank you very much, Admiral. We are always happy to see you here.

Thank you again, Mr. Secretary.

Mr. BAUER. With the Chairman's permission, I should like to insert in the record the various statistics of oceanographic ships funded by the Office of Naval Research and supplied at your staff's request.

Mr. MILLER. It is so ordered.

(The document follows:)

OCEANOGRAPHIC RESEARCH SHIPS OF INSTITUTIONS UNDER CONTRACT TO THE OFFICE OF NAVAL RESEARCH

The accompanying tables list the research ships of civilian institutions and present some facts and figures concerning each one.

The items concerning cost of operation and days at sea deserve a brief discussion:

The cost of operation is calculated from the annual cost divided by the number of days at sea. Although this yields a high daily operating cost because it includes cost of crews during time in port and all cost of maintenance, it is realistic in that it actually represents the cost charged to the contract for a day's operation at sea.

The number of days at sea is limited by maintenance periods, loading time, weather, and funds. Ships such as *Vema*, *Horizon*, and *Baird* are able to log more days at sea because they make long expeditions uninterrupted by loading time. As the size of the ship becomes smaller, it makes a wider variety shorter trips, using more days at the dock being reinstrumented, thereby giving less days at sea. Finally, with very small ships, the weather becomes a serious factor in determining the days at sea.

*Woods Hole Oceanographic Institution, Woods Hole, Mass.*

*Chain*—Converted ARS; constructed, 1944; length, 215 feet; beam, 41 feet; scientists, 28; crew, 33; displacement, 3,000 tons; range, 10,000 miles. Outfitted for all types of oceanographic research. In 1959, the *Chain* spent 210 days at sea. Operating cost was $2,000 per day, the Navy supported 100 percent of the 1959 cost of operation. Presently in a Boston shipyard for minor alterations, the ship leaves January 10 for 2 months' work in the Romanch Trench. This is owned by the Navy and leased to Woods Hole. Operational control is in the Office of Naval Research.

*Atlantis*—Ketch, specifically designed for research; constructed, 1931; length, 142 feet; beam, 28 feet; scientists, 9; crew, 19; displacement, 298 tons; range, 4,000 miles. Outfitted for all types of oceanographic research. In 1959, the *Atlantic* spent 256 days at sea. Operating cost was $1,000 per day, 50 percent Navy support. Presently operating in the Caribbean.

*Crawford*—Standard cutter; length, 125 feet; beam, 25 feet; scientists, 9; crew, 17; displacement, 280 tons; range, 6,000 miles. Outfitted to do most oceanographic research. In 1959, the *Crawford* spent 163 days at sea. Operating cost was $1,000 a day, 75 percent Navy support. Presently at Woods Hole, departs January 15 for 2 months' work in the vicinity of Virgin Islands.

*Bear*—Coastal freighter; constructed, 1941; length, 100 feet; beam, 22 feet; scientists, 10; crew, 14; displacement, 200 tons; range, 2,500 miles. Outfitted for oceanographic research along the coast with limited offshore capabilities. In 1959, the *Bear* spent 139 days at sea. Operating cost was $800 per day, 25 percent Navy support.

*Aries*—Yacht, given to Woods Hole by private donor, converted for limited oceanographic research at sea. In 1959, the *Aries* spent 211 days working out of Bermuda during which 130 days were spent at sea. No Navy support for operation.

*Scripps Institution of Oceanography, La Jolla, Calif.*

*Snatch*—Converted ARS; constructed, 1944; length, 215 feet; beam, 41 feet; scientists, 28; crew, 30; displacement, 2,000 tons; range, 10,000 miles. The *Snatch* is presently undergoing conversion to a research ship. Funds have been supplied by the Navy. Work should be complete by May 1 after which *Snatch* will make a 2-month shakedown and scientific expedition around the Hawaiian Islands. The ship will be Navy owned, leased to Scripps with operational control in the Office of Naval Research.

*Baird* and *Horizon*—Both are converted ATA's; constructed, 1944; length, 143 feet; beam, 33 feet; scientists, 18; crew, 17; displacement, 505 tons; *Baird* range, 18,000 miles; *Horizon* range, 15,000 miles. Both are outfitted to do all types of oceanographic research. The yearly average time spent at sea over the 3 fiscal years 1957–59 was 237 days for the *Baird*, and 238 for the *Horizon*. Operating cost is $1,600 per day per ship and Navy support was 50 percent for each ship in fiscal year 1959. Both ships are presently in port for regular maintenance. Both will be working out of San Diego on short cruises (1 week to 1 month) for the next several months.

*Paolina-T*—Purse seiner; constructed, 1948; length, 80 feet; beam, 22 feet; scientists, 5; crew, 7; displacement, 111 tons; range, 3,500 miles. Outfitted for most types of oceanographic research. The yearly average time spent at sea over the three fiscal years 1957–59 was 171 days. Operating cost is $500 per day, and 100 percent Navy support in 1959. This ship operates locally out of San Diego for MPL of Scripps. Title remains in the Navy, the ship is leased to Scripps.

*Orca*—USCG patrol vessel; length, 100 feet; scientists, 6; crew, 8; displacemesnt, 200 tons. Outfitted for most types oceanographic research. The yearly average time spent at sea during fiscal years 1957–59 was 175 days. Operating cost is $500 per day, 25 percent Navy support in 1959. For the most part this ship is used in the local marine life research program covering the oceans off the west coast between San Francisco and the middle of Baja California.

*Stranger*—A converted yacht; 300 displacement tons. The yearly average time at sea during fiscal years 1957–59 was 224 days. Operating cost is $800 per day. The *Stranger* has been in Thailand since September 1959. It will spend at least 2 years in that area as a part of a UNESCO marine assistance program.

*Lamont Geological Observatory, Palisades, N.Y.*

*Vema*—Auxiliary schooner; constructed, 1923; length, 202 feet; beam, 33 feet; scientists, 15; crew, 17; displacement, 533 tons; range, 4,000 miles. Outfitted for all types of oceanographic research. In 1959, the *Vema* spent 278 days at sea. Operating cost is $1,000 per day, 65 percent Navy support. At present, the ship is in the region of Australia on an expedition which will circle Antarctica.

*Agricultural & Mechanical College of Texas, College Station, Tex.*

*Hidalgo*—Converted PCS; constructed, 1944; length, 136 feet; beam, 28 feet; scientists, 8; crew, 12; gross, 245 tons; range, 2,000 miles. Outfitted for most types oceanographic research. In 1959, the *Hidalgo* spent 160 days at sea. Operating cost was $650 per day, 60 percent Navy support. The ship is presently in home port at Galveston, Tex. She operates primarily in the Gulf of Mexico on trips, exceeding 3 weeks.

*University of Washington, Seattle, Wash.*

*Brown Bear*—Converted FS; constructed, 1934; length, 114 feet; beam, 27 feet; scientists, 22; crew, 10; displacement, 270 tons; range, 2,600 miles. Outfitted for all types of oceanographic research. In 1959, the *Brown Bear* spent 131 days at sea. Operating cost was $700 per day, 53 percent Navy support. The ship performs research off the coast of Washington, in the Gulf of Alaska, and in the Bering Sea. Title to the ship is held by the Navy.

*Marine Laboratory, University of Miami, Miami, Fla.*

*Gerda*—North Sea trawler; constructed, 1949; length, 75 feet; beam, 21 feet; scientists, 7; crew, 4; displacement, 75 tons; range, 3,000 miles. Outfitted for biological studies along the Florida coast, physical oceanographic studies of the Florida current and some special studies in the West Indies. In 1959, the *Gerda* spent 210 days at sea. Operating cost was $500 per day, 65 percent Navy support. Presently, the ship is in Miami.

*Chesapeake Bay Institute, Johns Hopkins University, Baltimore, Md.*

*Maury*—Oceanographic research vessel; constructed, 1950; length, 58 feet; beam, 15 feet; scientists, 4; crew, 4; displacement, 34 tons; range, 300 miles. Outfitted for oceanographic research in bays and estuaries. In 1959, the *Maury* spent 133 days performing work in Chesapeake Bay. Operating cost is $250 per day, 50 percent Navy support.

*Narragansett Marine Laboratory, University of Rhode Island, Kingston, R.I.*

*Billy*—A small 40-foot boat used for limited research within Narragansett Bay. In 1959 the boat spent 152 days at work on the bay. In addition, personnel from the Narragansett Marine Laboratory spent 30 days, during 1959, performing oceanographic research from U.S. Navy destroyers in the open ocean.

*Hudson Laboratories, Columbia University, Dobbs Ferry, N.Y.*

*Josiah Gibbs*—Converted AVP; construction, World War II; length, 310 feet; beam, 41 feet; scientists, 30; crew, 48; displacement, 2,750 tons. Outfitted for all types of oceanographic research. In 1959, the *Gibbs* spent 212 days at sea. Operating costs were $2,150 per day, 100 percent Navy support.

Mr. MILLER. Admiral Pierce, you were next on the list. If you do not mind coming up on another day, maybe we can get through with a part of this thing and take all of your testimony at once.

Maj. Gen. W. K. Wilson, Jr., president of the Beach Erosion Board.

## STATEMENT OF MAJ. GEN. W. K. WILSON, JR., PRESIDENT, BEACH EROSION BOARD; ACCOMPANIED BY JOSEPH M. CALDWELL, CHIEF, RESEARCH DIVISION, BEACH EROSION BOARD, CORPS OF ENGINEERS, U.S. ARMY

General WILSON. Thank you, Mr. Chairman. I am a little outnumbered here this morning.

Mr. Chairman, I am Maj. Gen. W. K. Wilson, Jr. I am Deputy Chief of Engineers for Construction and in that position I am also president of our Beach Erosion Board.

I have with me, Mr. Caldwell, who is in the permanent staff of our Beach Erosion Board.

I feel somewhat like I am standing on the beach just getting my feet wet while these depths are being explored and, as a matter of fact, our whole problem could be called either a fringe problem or a fringe benefit.

Our basic concern is to bring into the program on oceanographic research the fact that the nearest shore is a portion of it and the basic scientific information on the nearest shore is almost in the same category as we have been hearing.

The amount of information we have is very limited.

I would like to point out just briefly why the Army, as such, is concerned. You no doubt are aware that the civil works mission of the Corps of Engineers consists of three major functions: the improvement and maintenance of navigable waterways, first authorized in 1924; flood control and related water resource development, authorized on a national basis in 1927; and beach erosion control measures in 1930. In addition to these three functions—that is, navigation, flood control, and beach erosion control—Congress in 1955 handed the Corps of Engineers responsibility for developing hurricane protection measures along our seacoast.

From the above, it is seen that the Corps of Engineers is vitally interested in inshore physical oceanography, as it furnishes the scientific basis of design of our navigation improvements at coastal inlets and

estuaries, our studies for the prevention of beach erosion, and our development of protection against hurricanes.

While for many years no funds or authority existed to extend our investigations beyond the immediate region of our costal engineering works we have consistently been aware of the need for oceanographic research and have endeavored to keep technically abreast of scientific progress in this field.

The classic work of Gaillard, first published in 1904 under the title "Wave Action in Relation to Engineering Structures," is a good example of the manner in which scientific knowledge currently available, plus a limited amount of experimental observation in nature, can be applied to practical engineering. Colonel Gaillard was a captain in the Corps of Engineers at that time and this publication was the standard treatise on shore structure design in this country for 30 years or more.

In Captain Gaillard's time, the improvement of navigation conditions at inlets and estuaries was the sole factor which directed the corps' attention to inshore shallow-water oceanography.

In the last 60 years, this phase of the corps' civil works program has become vastly more complex as the draft and tonnage of the vessels has greatly increased, thereby necessitating entrance channels up to 45 or 50 feet in depth, as opposed to 20 and 25 feet in 1900. Whereas 60 years ago many inlets and estuaries leading to our ports had natural depths over the bars and shoals which were sufficient to float our ocean vessels, today we find hardly a single one of our ports which does not require a costly, although economically justified, maintenance dredging program. We have had to upset nature's normal balance by creating navigation channels much deeper than the natural channel.

I will mention four of these channels serving our ocean ports.

*Average cost per year for past 10 years (new work and maintenance, 1949–58)*

| | |
|---|---|
| New York Harbor complex, 45 feet | $3,000,000 |
| Delaware River to Philadelphia, 40 feet | 5,400,000 |
| Savannah River to Savannah, 36 feet | 1,300,000 |
| Galveston Bay complex, 40 feet | 1,200,000 |

In these particular harbors we are spending annually $3 million on that part of the channel in New York; $5.4 million on the Delaware River; $1.3 million on the Savannah River; and $1.2 million on Galveston Bay.

These are just 4 of some 150 channels serving our larger ocean ports, plus another 100 channels serving our Great Lakes ports where the problems of shoaling are similar to those of our ocean ports.

The bad actors in these shoaling problems are the ocean waves, the tides and tidal currents, and the salt water currents that intrude into our estuaries due to the greater density of the ocean water.

Our interest in these ocean waves and currents was further increased by the addition of beach erosion control responsibilities and hurricane protection responsibilities.

We started research in this form of oceanography in 1946. Over the past 10 years we have been able to devote some $300,000 per year to research in shallow-water oceanography.

Although this enables such research to be carried out, it has not permitted extensive observations and studies in nature which are needed for long-range solutions.

Since the members of our staff acquainted your committee with the activities of our committee in February, I will not go into that, but we strongly support an accelerated program of nationally supported oceanographic research. We should like to see an appropriate proportion of the total effort applied in the physical field, and more particularly in the interaction of sea and land in the nearshore zone. We would hope to participate in such a program when and if it is undertaken, and to contribute to the extent of our technical resources to its successful accomplishment.

Once again, we are on very much of a fringe, however, in the major problem.

Mr. MILLER. Mr. Bauer?

Mr. BAUER. General, I understand that the Navy's position on the bill that Congressman Pelly put in, talking for DOD, is that, if Mr. Pelly's bill goes through, you would have an enlarged area of operations up to the 50-fathom curve in the tidal situation, and so on.

You are familiar with that position, are you?

General WILSON. Yes, sir; we are.

Mr. MILLER. Mr. Pelly?

Mr. PELLY. I have no questions.

Mr. MILLER. Mr. Lennon?

Mr. LENNON. Mr. Chairman, the gentleman may be on the fringe area but I had the pleasure last fall of going with him and other members of the Beach Erosion Board to visit some of our coastline in North Carolina and a particular inlet, Masonboro Inlet, General, you remember where there was a great deal of injury with respect to wave action along the shore causing the erosion particularly in that area of North Carolina that was hit by four hurricanes in the course of the 1 month. I know that he is cognizant and has a great knowledge of this problem.

I am delighted that he is here.

General WILSON. Thank you, Mr. Chairman.

Mr. MILLER. Mr. Curtin?

Mr. CURTIN. I have no questions.

Mr. MILLER. General, I feel that yours may be a fringe area but that most of the work we are doing in this field is sort of fringe work at the present time.

To me, it is quite important in the solution of many of these problems. Many of the facets of this work you are doing are going to be quite important.

General WILSON. Mr. Chairman, as we become more, shall I say, civilized and mature in the country, we have taken lots of steps which are serving to attack these beaches even more than has been done in the past.

One of them mentioned here is digging these channels. The sand moves along the beaches and across the inlets constantly. We open up and maintian a deep channel over the rough, outer bar by hopper dredge and dump the dredged sand at sea. Though in most cases this is the only effective method presently available to us, it removes the sand from the shore zone and, in effect, denies this sand to the beaches.

As you are aware, people in the United States are actually trucking sands from inland to put on their beaches because this is the first line of defense against storms, hurricanes, and things of that kind.

Now, for instance, in your own State, in order to reduce floods and erosion we are practically paving Los Angeles County and we are automatically, by so doing, stopping sand from reaching the beaches in that vicinity, and so we are building for ourselves a problem right there in the Los Angeles area.

We do not know enough now and did not have enough data to solve some of these things.

Mr. MILLER. I only wish to say, coming from another area of the State, that after we get east of the Rocky Mountains we are always very careful in discussing what takes place in California. We become superzealous of one another's position, you see.

General WILSON. Well, sir, you have some problems up in your area, too.

Mr. MILLER. I was going to say that if you could find some way of taking some of the silt that is clogging up part of San Francisco Bay and giving it to them in southern California, we would be very happy to make the transfer.

General WILSON. I might tell you that I got caught in studying that problem when I was a student at the University of California by Dean Emeritus O'Brien, who is now on our Board, and I remind him of how he got me into that thesis.

Mr. MILLER. I want to thank you for coming, General.

I want you to know that we on this committee realize that yours is the area in which the ocean and the land join physically and biologically and everything else this is a very important study.

General WILSON. Thank you, sir.

Mr. MILLER. I want to thank you for being here.

It is just about 12. We will be having a quorum call in a very few minutes so that, without objection, we will adjourn until 10 o'clock Thursday morning.

(Whereupon, at 12 noon, the committee adjourned, to reconvene at 10 a.m., Thursday, May 19, 1960.)

55944—60——5

# OCEANOGRAPHY

THURSDAY, MAY 19, 1960

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON OCEANOGRAPHY OF THE
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
*Washington, D.C.*

The subcommittee met at 10 a.m., pursuant to adjournment, in room 219, Old House Office Building. Hon. George P. Miller (chairman of the subcommittee) presiding.

Present: Representatives Miller, Dingell, Oliver, Flynn, Pelly and Curtin.

Staff members present: John H. Drewry, counsel; Paul S. Bauer, special consultant to subcommittee, and Frances Still, assistant clerk.

Mr. MILLER. The committee will come to order.

The first witness this morning will be Rear Adm. Charles Pierce.

Thank you, Admiral, for allowing me to bring you in this morning before the subcommittee.

Admiral Pierce is Assistant Director of the Coast and Geodetic Survey, and will be assisted by Dr. Harris B. Stewart, of the Survey, who is coauthor of the interesting recent paper on "Near Shore Ocean Currents off San Diego, Calif."

Admiral Pierce will be followed by Adm. James A. Hirshfield, Acting Commandant of the U.S. Coast Guard, and then we will hear from Dr. Preston E. Cloud, of the Geological Survey, and finally a presentation will be made by Mr. F. J. Agnich, vice president of the Geoscience and Instrumentation Division of Texas Instruments, Inc.

## STATEMENT OF REAR ADM. CHARLES PIERCE, ASSISTANT DIRECTOR, U.S. COAST AND GEODETIC SURVEY; ACCOMPANIED BY DR. HARRIS B. STEWART, JR., CHIEF OCEANOGRAPHER, U.S. COAST AND GEODETIC SURVEY

Admiral PIERCE. I have a brief statement on what activities we conducted recently plus what our plans are in the future.

Would you care to have me read it?

Mr. MILLER. I think it would be well to have you read it, Admiral.

Admiral PIERCE. Mr. Chairman and members of the subcommittee. I appreciate this opportunity to appear before you to testify regarding the bills you are considering for the purpose of developing a program in the field of oceanography and to tell you something of the role of the Coast and Geodetic Survey in contributing to increased understanding of the many unknowns still locked in the depths of our great oceans. Unfortunately, Admiral Karo, because of a conflicting

engagement, is unable to appear today. He asked me to express his regrets and to assure you of his desire to provide whatever information this committee might consider necessary to carry out its responsibilities.

With me is Dr. Harris B. Stewart, Jr., chief oceanographer of the Coast and Geodetic Survey. Dr. Stewart is in direct charge of our program in oceanography and has recently returned from the significant oceanographic voyage of the ocean survey ship *Explorer*. He is prepared to tell you of some of the important knowledge gained as a result of this voyage as well as other operations conducted in his area of responsibility.

Five bills are being considered by your subcommittee. The first of these, H.R. 9361, proposes a broad enactment to set up a comprehensive 10-year program of oceanographic research along the lines proposed by the Committee on Oceanography of the National Academy of Sciences. Three identical bills, H.R. 10412, H.R. 10581, and H.R. 10586, propose the creation of a committee to assure coordination of the efforts of the various agencies of the executive branch concerned with aspects of oceanographic surveys. The fifth bill, H.R. 12018 proposes that the Secretary of Commerce be authorized to establish within the Coast and Geodetic Survey a National Oceanographic Data Center and a National Instrumentation Test and Calibration Center.

Our views as to the advisability of the enactment of these bills and detailed comments on the specific bills have been included in reports which the Secretary of Commerce is transmitting to the committee. I ask that these reports be included in the record of these hearings when they are received.

Mr. MILLER. Without objection, that may be done.

(The reports follow:)

THE SECRETARY OF COMMERCE,
*Washington, D.C., May 17, 1960.*

Hon. HERBERT C. BONNER,
*Chairman, Committee on Merchant Marine and Fisheries,*
*House of Representatives, Washington, D.C.*

DEAR MR. CHAIRMAN: This is in reply to your request of February 18, 1960, for the views of the Department of Commerce with respect to H.R. 10412, a bill to establish a public policy with respect to oceanographic surveys, and to provide for coordination of the efforts of Federal agencies with respect to oceanographic surveys.

Although the Department is in agreement as to the principle enunciated in the bill, it does not recommend favorable consideration for the reasons hereinafter stated.

The bill would proclaim a public policy with respect to oceanographic surveys, and would establish, by statutory authority, a Coordinating Committee on Oceanographic Surveys composed of representatives from agencies of the various departments of the Federal Government which have a major interest in oceanographic surveys.

This committee would be authorized and directed to coordinate the efforts of the represented agencies in carrying out their individual responsibilities with respect to the collection, preparation, and dissemination of oceanographic data.

The bill also provides for an annual report to the President and Congress of the committee's activities during the year, including recommendations as to necessary legislation.

The Department recognizes that the oceanographic program necessary in the national interest is far too large and complex to be undertaken by any single agency. Coordination of the functions and operations of the interested agencies is essential to avoid duplication of effort and to plan the overall program so as to produce the maximum accomplishment.

However, a coordinating body already exists in the Federal Council for Science and Technology, and its recently established subcommittee is known as the "Interagency Committee on Oceanography."

The Federal Council for Science and Technology was established on March 13, 1959, by Executive Order 10807. The Council is composed of policy making officials of the various departments and agencies of the Federal Government having responsibilities in the field of science and technology.

The Council's principal function is to consider problems and developments in the fields of science and technology and related activities affecting more than one Federal agency or concerning the overall advancement of the Nation's science and technology, and to recommend policies and other measures (1) to provide more effective planning and administration of Federal scientific and technological programs, (2) to identify research needs including areas of research requiring additional emphasis, (3) to achieve more effective utilization of the scientific and technological resources and facilities of Federal agencies, including the elimination of unnecessary duplication, and (4) to further international cooperation in science and technology.

In keeping with this function, the Federal Council established on March 3, 1960, as a permanent subcommittee, the Interagency Committee on Oceanography. This Committee is composed of representatives of Federal agencies having a vital interest in the field of oceanography. The composition and general purpose of this subcommittee is, for all practical purposes, identical to that suggested in H.R. 10412.

It is the Department's view that the establishment of a coordinating body, as proposed in H.R. 10412, would be a duplication of an already existing and functioning committee and is not required, therefore, in the coordination of policies and programs in the important field of oceanographic science.

For the above reasons, the Department recommends against enactment of H.R. 10412.

We have been advised by the Bureau of the Budget that there would be no objection to the submission of this report to your committee.

Sincerely yours,

PHILIP A. RAY,
*Undersecretary of Commerce.*

Admiral PIERCE. We are in full accord with the purposes sought to be served by these legislative proposals. Oceanography requires the skill and knowledge of scientists trained in a variety of specialized disciplines. Our work in this field calls for the cordinated utilization of the organization and facilities of a number of Government agencies. In view of these needs, the Federal Council for Science and Technology, early this year, set up an Interagency Committee on Oceanography. Dr. Wakelin of the Navy Department is chairman and Admiral Karo represents the Department of Commerce on this Committee. Either Admiral Karo or I have attended each of the meetings held by the Committee to date.

It is our purpose, and the purpose of the other members of the Committee, to see to it that a well-coordinated program of research and systematic survey in oceanography to meet our national needs is carried out. This Committee operates at the highest levels among the agencies having an interest in the development of knowledge about the oceans and facilities for carrying out the work needed to be done to achieve this purpose. In the Interagency Committee on Oceanography we have a suitable apparatus for assuring the best utilization of Government facilities for research in oceanography and avoiding unneeded duplication of effort among the various Government agencies. This Committee has made some considerable progress along these lines and we expect that, as it continues to function, our oceanographic activities will be better directed toward achieving an expanded and balanced program of research and operations.

Until 1947, the various programs of the Coast and Geodetic Survey, including our work in oceanography, were conducted pursuant to authority contained in a number of legislative enactments and executive directives promulgated over the period of our 140 years of existence. Enactment of Public Law 373, 80th Congress, gave us a sound and comprehensive statutory basis for the performance of the many functions, including research in oceanography, for which we feel we have the facilities and technical skill. With the addition of Public Law 86–409 our legislative authority is adequate to assure authorization for any work we may be called upon to undertake in the field of oceanography.

Sections 7(b) and 8(a) of H.R. 9361 and H.R. 12018 provide for the establishment of an Oceanographic Data Center within the Department of Commerce. Since H.R. 12018 is more definitive in outlining the functions of the Center, our comments will be in reference to that bill rather than to the sections of H.R. 9361.

There is already in existence at the Hydrographic Office of the Navy Department a vast collection of oceanographic data which is tabulated on punchcards. In order to avoid a duplication of personnel and machines, we believe that the Oceanographic Data Center should be continued at the Hydrographic Office. If it is expanded as proposed, provision should be made for responsibility for its direction, operation, and financing to be shared with the civilian agencies interested in oceanography. We visualize that this joint operation would include assignment of personnel from the civilian agencies to the Data Center. In this way we will be able to assure that our civilian as well as military data needs will be adequately met.

Our relations with the Hydrographic Office have been most satisfactory and we believe that such an arrangement would work to the satisfaction of all concerned. However, we believe the functions that would be assigned to the center by H.R. 12018 are too broadly stated.

As now written, H.R. 12018 would relegate all participating agencies to the role of data gathering organizations and would apparently authorize the data center to perform activities in a wide range of scientific fields not all necessarily related to oceanography.

We believe that the activities of the center should be restricted to data which is definitely related to the field of oceanography. We feel that the center should not assume nor duplicate, except by mutual agreement, any of the functions which are assigned to or authorized to be conducted by any other agency.

Section 2 of H.R. 12018 would authorize the establishment of a national instrumentation test and calibration center. If such a center is established we believe there would be a definite advantage in having the testing center operated in conjunction with the data center in order that the results of the tests and calibrations would be readily available to those processing the data. This would assure uniformity in the reduction of records.

I have another statement here now on what we are doing and what we plan to do. Would you care for me to read this at this time, Mr. Chairman?

Mr. MILLER. Suppose we discuss this one now and then we will take the other one up after we get through.

I want to say to Mr. Dingell and Mr. Flynn that we have inaugurated the system of letting the counsel discuss these matters first and then we will follow up.

I discussed this with Mr. Dingell yesterday.

Mr. Bauer?

Mr. Bauer. Admiral Pierce, the question, of course, that concerns this committee is the statutory delegation of various data centers which have to do with data that concerns oceanography. For example, in title 33 of the United States Code, chapter 17, under section 883(c), you are made by statute the national repository of geomagnetic data and collection, and so on.

Section 883(d) gives you authority to indulge in research in geophysical sciences including geodesy, oceanography, seismology, and geomagnetism.

As far as the survey function, you have authority under section 883(a) to survey geomagnetic, seismological, gravity, and related geophysical measurements and investigations, and observations for the determination of variation in latitude and longitude.

This year, as you know, this committee endorsed legislation to remove any geographic restrictions upon your activities.

I believe that has passed the House and is on its way.

We also have the Weather Bureau at Asheville in the same Department as you are in, the Department of Commerce, which is collecting data from 1,800 ships at sea all over the world, 6 oceanic stations, 150 lightships, and, also, through the Hydrographic Office, observations from naval ships at sea as well as doing data processing and analysis of weather for the Coast and Geodetic Survey and the Hydrographic Office publications with respect to navigation on the water and in the air of the world.

Also, the Weather Bureau is engaging at Asheville on the analysis of climatic data for marine atlases.

I think it is of concern to this committee to see how these three data centers of these activties mentioned can be married without overlapping and whether any legislation is necessary.

So, first, I should like to ask you what is the oceanographic data that you contemplate would go to the Hydrographic Office directly?

Admiral Pierce. Well, I would say that all of the observations that are taken at sea, serial temperatures, salinities, biological data, that type of information, in fact the same type of information which is going there now would be sent to this National Oceanographic Data Center but I certainly believe that there is no reason to change the present situation where we are the repository for magnetic data, where we are the central office for determining earthquake epicenter locations, where we are perfectly able to take care of all of the nautical charting data, process it, apply it to our charts and produce the charts. There is no sense of sending that over.

We are perfectly capable of taking care of all of our tidal observations as we have for the last hundred years. There would be no sense in sending this over because it is being handled adequately at the present time.

I would say anything that affects oceanography, whether it is research or hydrographic or biological, that material should go in there. I see no sense in changing the present situation at all.

Mr. Bauer. Let me ask you further. Is geomagnetic data part of oceanographic data?

Admiral Pierce. It is applicable to oceanography and it is used, but I think there could be an interchange between the data center at the Hydrographic Office and the Coast and Geodetic Survey for magnetic data. For instance, we are today collaborating with the Hydrographic Office and we produce magnetic charts of the world, magnetic charts of the United States on a 5- and 10-year schedule, and we get data from the Hydrographic Office and from our observatories and our own ships, and these charts are compiled over there in collaboration with the Hydrographic Office and it has worked very well.

We have done the same thing for the lake survey. We prepared magnetic charts for them and have done the same thing for the Army Map Service in South and Central America. It seems to work very well.

I think there is no indicated change here at all.

Mr. Bauer. As far as the survey and the proposed data center, the two must be considered in view of your statement. How about gravity signatures and other geophysical information? Where would that information go?

Admiral Pierce. Gravity observations are specialized material. Most of your gravity observations obviously have been made on land because it is easy to do it. It is only in recent years that we have made observations at sea and they have progressed to the point where they are making them from the air now and also on surface-borne ships.

This material does affect oceanography and certainly involves geology, deflection of the vertical and this sort of thing.

The Coast and Geodetic Survey still maintains this data and I see no reason to change that data. In other words, I see no reason to assign gravity observations to this Oceanographic Data Center. I think we already have a vehicle that is handling it satisfactorily. I think it should be as the title says, an oceanographic data center.

Mr. Bauer. Well, how would you conceive of going about an ocean survey? Would there be an allocation of territorial interest, we shall say, by some coordinated mechanism or means within the Government or how would you do it to prevent duplication and the maximum use of our ship bottoms at sea?

Admiral Pierce. It is my understanding that this Interagency Committee of the Federal Council with their people from all agencies would consider this and allocate the areas because the people concerned are going to be right there so that this is one of the most vital things to be done at this time, to plan who is going to work where and to find out, which I think we do now, where these private institutions like Scripps and Woods Hole have worked.

This is going to have to be worked out in this Interagency Committee. I know it has to. There has been some progress along that line already.

Mr. Bauer. Admiral Pierce, with respect to the survey of the oceans, have you given any thought to employing industry to assist in this survey?

Admiral Pierce. I have thought about it but I do not think there has been anything done about it. It seems to me that your ships travel given routes and they would be repeating their observations if

they just travel those routes constantly and the areas where we need information on the depths, on the temperatures, on the type of bottom, and that sort of thing, the very places where we need this information is where the average commercial ship does not go.

Mr. BAUER. That is one form of industry, but I was thinking particularly of the geophysical exploration industry which has for many years conducted offshore oil surveys, seismic surveys, gravity, and so on.

Admiral PIERCE. Of course, they would have to build the ships and find the crews.

I am wondering whether the actual cost of this venture would be less or more than by the Government doing it.

Mr. BAUER. We shall hear from industry on that later this morning. I have one last question, sir. Do you have any idea of the cost of ship operation per mile of survey in round figures?

Admiral PIERCE. I have figures on the operation of survey vessels by what we call classes, by the size of the vessels.

We call our class I ship, ships that will run anywhere from 230 feet up to 300 feet. To keep that ship at sea for 9 months with 12 officers and 76 men—in that officer group you could include oceanographers—would be in the order of $750,000 a year. In other words, the annual cost would be $750,000 and the ship would be at sea 9 months.

Incidentally, the English have a very well-known oceanographic research vessel, the *Discovery II*. I noticed in one of their articles that they spoke very proudly of the fact that in the last 4 years that ship had been at sea half the time. In other words, it had worked 6 months out of the year at sea.

For the class II vessel, around 175 feet in length, carrying 11 officers and 58 men, the cost would be annually a little over $500,000 a year, and the class III vessel, which would have little ability to stay at sea, which is around 135 feet in length, carrying six officers, it costs annually $230,000.

These are figures based on Coast and Geodetic Survey's information. This is what it costs to operate ships each year.

Mr. BAUER. Thank you.

Mr. MILLER. Admiral, I was interested in an implication in part of your statement, starting at the bottom of page 3, where you say that:

> Until 1947, the various programs of the Coast and Geodetic Survey, including our work in oceanography, were conducted pursuant to authority contained in a number of legislative enactments and executive directives promulgated over the period of our 140 years of existence.

Then you state that the enactment of Public Law 373, 80th Congress, gave you a sound and comprehensive statutory basis to perform many of your programs.

Do we need additional law at this time in view of the importance of oceanography to further give you a sounder basis on which to operate, a firmer basis on which to operate?

This is the thing with which we are concerned. Most of the authority for oceanography is incidental to some other activity and this committee wants to find out whether there is sufficient legislation on the books or whether we should put more legislation on the books to establish this firmly and give it the type of foundation in consonance with its importance.

Admiral PIERCE. I do not believe the Coast and Geodetic Survey needs any additional legislation, sir. I was impressed with a remark yesterday where the Navy said that they had to consider the ships of the line along with other requirements like oceanography and other research programs.

The Coast and Geodetic Survey is in a similar position in that it is absolutely essential that we provide accurate and up-to-date charts of our waters, aeronautical charts, tide tables in advance, all of the products that people have to have and expect. It is essential that we produce these. Therefore, when we project an oceanographic program we certainly cannot neglect, for instance, areas where I know there were no surveys at all where we need them.

I would say that we should move into these areas and get the charts that will safeguard life and property before we start making scientific investigations. We have the same problem.

I do not believe we need any more legislative authority. I think we do have it. We can work worldwide if necessary.

As I said, we work very well with the Navy. There is no conflict. We discuss our problems. There is certainly no duplication of effort.

I feel again that it is a matter of decision as to which is the most important. If you have shipping coming into New York and Philadelphia there is no question that you have to produce adequate and accurate charts.

If an emergency comes up and an oil tanker runs aground in Cook Inlet because it has changed, the ice coming out in the spring has scoured and thrown up reefs and shoals, it is up to us to get there immediately and do that job.

These are the things we have to consider exactly as the Navy said yesterday along with the other requirements. We cannot sidestep that. These things we must do.

Mr. MILLER. I do not want to leave the impression that we feel that there is not coordination between the several branches of Government charged with responsibility in this field or that you are not doing the utmost, because I know you are. The thing that we are intrested in is how can we best further this in view of the importance now attached to it or the awareness of its importance that has come about as the result of the findings of the committee on the National Academy. They came out with a very fine report and it was rather shocking to many of us that this field had been so long neglected.

The thing we are striving for now is to see how we can implement and further this, realizing what we were told yesterday, what you have just said, that the competition for dollars is with us. All of us in Congress know that those agencies that have their own basic legislation, well established, stand the chance to do better than agencies that are within a major governmental organization where the demands are great and where the people who shoot the guns are generally in a position to grab most of the money. That is the thing that we are striving for.

I just wondered whether you had anything that you could do to help us in this mission.

Admiral PIERCE. I think what you have done so far is a terrific impetus to oceanography.

I was privileged to attend the final meetings of the National Academy of Sciences Committee on Oceanography and at that time

the big question before this committee was, "What is the next step to bring this alarming situation in the lack of oceanographic information to the attention of Congress and the people? What are we going to do about it? We have come up with this fine report. What is our next move?" The decision was to bring it to the attention of Congress and that is what has been done and I think you people have done a tremendous job on it. As a matter of fact, on a routine transfer of one of our ships from Seattle to Washington, as a result of your committee's work and the interest of the National Academy, we made this a cooperative program with other agencies and extended it up to practically a 3-month oceanographic investigation.

I think the committees of Congress and the National Academy promoted this.

This is the sort of thing we need.

How we are going to continue this emphasis, I do not know but I think that anything that can be done to point up the need is fine.

Mr. MILLER. I am glad to hear you say this. I do not know what part we played in it. I am certain that the work of the National Academy in pointing out the problem perhaps helped bring this about, but this is the problem with which we are confronted now and we have to turn to you people who are experts in this line to assist us in solving this problem. It is very easy to state the problem but sometimes getting the soluion is a little hard.

Admiral PIERCE. The fact that you let us appear before you and give you the information on what we are trying to do is encouraging to us, certainly, and on the policy level this has had considerable impact.

Mr. MILLER. You see, I have only been on this committee for about 6 years and, as far as I know, until this Academy report came out, we perfunctorily have had, for instance, the Coast and Geodetic Survey up before us for a hearing and I do not think that the committee, while interested, gave too much thought to your work.

I am very happy that, as the result of the Academy's work and the work that we have undertaken here, we are getting to know one another better.

I want you to know that this committee stands ready to help you in anyway that it can and we are still going to want the advice and knowledge that you have over the long haul in helping us get to the bottom of this.

Admiral PIERCE. Thank you.

Mr. MILLER. Mr. Curtin?

Mr. CURTIN. Yes, Mr. Chairman.

Do I understand, then, that you do not think that this bill is necessary?

Admiral PIERCE. I do not think that we need it to do whatever is necessary in the field of oceanography. We have plenty of legislative authority now.

Mr. CURTIN. You have sufficient authority now to do what needs to be done?

Admiral PIERCE. Yes, sir.

Mr. CURTIN. In the event that the bill should be enacted and become law, do you foresee that there would be any possibility of conflict between the civilian agencies and the military agencies as to the results of the surveys and the publicity that should be given to them?

Admiral PIERCE. This is in relation to the broad bill on oceanography?

Mr. CURTIN. Yes.

Admiral PIERCE. No, sir; I do not. From my past experience with the other agencies that are in this field I do not envision any trouble.

Mr. CURTIN. Thank you, sir.

That is all, Mr. Chairman.

Mr. MILLER. Mr. Oliver?

Mr. OLIVER. I am sorry that I was late in getting here, but I had another committee meeting that I had to attend, Mr. Chairman.

I was interested, however, in the line of questioning which you have already made and, to supplement that, Admiral, how much have your appropriations actually been increased if they have been increased for fiscal 1961 over 1960 for oceanographic purposes?

Admiral PIERCE. About $2 million in one item.

Mr. OLIVER. What does that represent in a percentage?

Admiral PIERCE. About a ninth of the Bureau's total appropriation.

Mr. OLIVER. I am not very sharp this morning on mathematics.

Mr. MILLER. That is about 11 percent.

Mr. OLIVER. Does this take care of your needs as you see them?

Admiral PIERCE. I also did not mention that we have authority to build two class III ships. That is another $4.7 million certainly in the field of oceanography.

Mr. OLIVER. This has been authorized and appropriations obtained for it?

Admiral PIERCE. Yes, sir.

Mr. OLIVER. This is for ship construction?

Admiral PIERCE. This is ship construction in 1961.

Mr. OLIVER. Of course, I expect that you can see a vast need for increase in your oceanographic activities.

Admiral PIERCE. In fact, we made a move last year. As the result of the same thing I am talking about, the interest of your committee and the interest of the National Academy, we actually put out instructions to all of our survey ships to spend a certain amount of their time on oceanography. Of course, there was less time spent on charting work.

Mr. OLIVER. If you could write the ticket yourself so far as dollars are concerned and talking from a reasonable standpoint, would you be in a position to use constructively more funds in oceanographic work?

Admiral PIERCE. We could use some more funds for instrumentation, yes, sir.

Mr. OLIVER. But not to any appreciable amount?

Admiral PIERCE. Not to an appreciable extent.

Mr. OLIVER. In other words, you are very happy about the whole situation.

Admiral PIERCE. Yes, I am. I think the rate is orderly and I am reasonably happy, but we could use more instrumentation. I still repeat that.

Mr. OLIVER. Do you think we have enough technicians, for example, in instrumentation work, to gather the data as rapidly as we should to keep up with the challenges coming to us from perhaps Soviet activities?

Admiral PIERCE. Well, in our particular service, all of our officers are graduate civil engineers and we are sending some of them for brief courses in oceanography. They happen to be going to the University of Washington.

I feel that a graduate civil engineer is in a position to pick up any of this type of work.

Mr. OLIVER. Could you use in your organization more personnel in perhaps the form of technicians who would not be these doctors and fellows and so forth in the higher echelons?

Admiral PIERCE. Yes, we could; but the problem is to find them. There do not seem to be too many boys today who are interested in going to sea.

Mr. OLIVER. Would they be, if they had some sort of an incentive, such as getting into this field of oceanographic technology?

Admiral PIERCE. I think so, and we do need that type of person, yes.

Mr. OLIVER. Would an educational program along this line be constructive in the interest of oceanography?

Admiral PIERCE. It sounds like an inservice program where you take these boys from high school and train them in your laboratories ships, or even in your central headquarters.

Mr. OLIVER. We had testimony yesterday that at Woods Hole there were more applications for admissions to the summer course than they could take care of.

Admiral PIERCE. The question that occurred to me at that time was how many of those boys do you get after they get out of school? They would like to get summer employment, but how many of these people we retain after they graduate is another question.

Mr. OLIVER. But it would be a constructive and salutary thing, would it not, if we had the incentive for these young juniors and seniors in high school, for example, so that they might enter the field of oceanographic research if they had encouragement along that line?

Admiral PIERCE. Yes, and we certainly could use them.

Mr. OLIVER. This perhaps would take some of the load off the more highly capable people so far as evaluation is concerned.

Admiral PIERCE. That is right, sir. It would.

Mr. OLIVER. I have one other question, Mr. Chairman, and that is all I have.

When your Bureau is asking for more funds do you find that, for example, with the Secretary of the Department, your requests are given all the consideration that you feel they should be given? I do not want to put you on the spot, Admiral, necessarily. I was wondering if the purpose of this legislation is not being perhaps downgraded a bit, because I am trying to think of it in terms of the mechanism that would put more emphasis on oceanographic needs.

Admiral PIERCE. Let me answer in this way, sir. Certainly the interest that these congressional committees have shown most importantly have increased the interest of our Department in oceanography in our appropriations. Let me put it that way.

Mr. OLIVER. Thank you. That is all.

Mr. MILLER. Mr. Flynn?

Mr. FLYNN. I have no questions.

Mr. MILLER. Admiral, thank you very much for this part of your statement. Now, will you go to the second section of it.

Admiral PIERCE. Well, sir, since I have held the floor for 40 minutes, I would like to have Dr. Stewart, here, read this and briefly describe what he has done on this cruise.

Dr. Stewart?

Dr. STEWART. This, Mr. Chairman, is in effect the line that our thinking is taking now as to where the Coast and Geodetic Survey could be going oceanographically. I will read this as I believe it is the easiest way to do it.

Mr. MILLER. Is it very long, Doctor? Could you hit the highlights of it? We will put the rest of it in the record because we are running a little short of time.

Dr. STEWART. All right, sir. I shall.

There is general thinking of increasing the oceanographic work of the Coast and Geodetic Survey within the present framework of our hydrographic surveys.

A sampling of the type of thing that would be involved is that oceanographic stations will be occupied over a grid in the area where normal charting activities are going on. Bottom samples will be taken in a grid in the same area. Tide and current observations which we need anyway for our nautical charting could be increased to provide specific oceanographic information in that particular area with geophysical observations with the magnetometer, for example.

The Bureau is receiving a magnetometer this spring, which, by towing it behind our ship as we did a borrowed magnetometer this spring behind our Explorer, adds tremendously. The expensive part is having the ship there. As long as the ship is there the Coast Survey feels that we should utilize this as much as possible to obtain the data.

One of these factors is merely the towing of a magnetometer which increases tremendously the value of routine surveys.

It is also hoped that we will be able to get into seaborne gravity meters and bottom photographs throughout the area. These can reveal a tremendous amount of information.

I have some of the bottom photographs obtained in this Explorer trip, obtained by the Navy Electronics Laboratory's deep sea camera which they put aboard our ship.

As an example of the way we are progressing, when the ship *Pioneer* reverts to Coast and Geodetic Survey control in early July we are tentatively planning that this ship will start work in the Aleutian Trench. The Aleutian Trench is one of the great features of the North Pacific. We still know very little about ocean trenches. Having the *Pioneer* work in this area would give us a very closely spaced bathymetric survey of this trench. Towing at the same time a magnetometer would give us the complete magnetic picture of the area and then, too, we would have a grid of oceanographic stations to sample the general oceanographic information in the area.

This statement goes on to summarize some of the personnel requirements, some of the ship requirements, some of the equipment requirements to carry out this type of work, also pointing out the fact that mere data collecting is not in fact oceanography. Put it this way: You cannot measure the amount of oceanography in number of track line miles, number of oxygen samples, number of sediment cores taken. The worth of any program is to be measured in the degree to which

knowledge is advanced, the degree to which man has learned more about the environment that he is working in.

That summarizes briefly the plans as we envision them, and we can present a copy of this to the reporter.

Mr. MILLER. If you do, we will put it in the record.

(Dr. Stewart's statement which he summarized follows:)

U.S. DEPARTMENT OF COMMERCE—COAST AND GEODETIC SURVEY

Ship time is the most expensive aspect of oceanographic surveys. The need for oceanographic data is great. Therefore, the addition of increased oceanographic programs to our ships' normal charting activities provides a most economic means of providing the necessary information. Oceanographic investigation will be conducted by Bureau survey ships to a degree that will still allow the Bureau to fulfill its regular charting requirements. To this extent each class I, class II, and class III ship will routinely carry out the following oceanographic activities in each area where it conducts hydrographic surveys:

(*a*) Oceanographic stations will be occupied over a grid in the area of operation. Observations will include BT and bottle casts for temperature, salinity, dissolved oxygen, and such other chemical parameters as may be required in specific areas.

(*b*) Bottom samples over a grid will be obtained, including sediment cores, rock dredge hauls, or surface samples as dictated by the bottom type. Analyses of these samples will be by other agencies or private institutions until the Bureau has the equipment and personnel to carry out such studies. Data will be used for the construction of sediment charts and for use in conjunction with geologic interpretation of hydrographic surveys.

(*c*) Tide and current observations will continue to be made in each area with tide gages and radio current meters. However, these will be planned to provide the maximum amount of useful oceanographic data in addition to data needed for charting and navigation. Drift bottle releases will be made at regular intervals.

(*d*) Geophysical observations will be made during runs to and from the working grounds and in the survey area consisting of continuous observations with towed magnetometer and, when the equipment is available, with shipborne gravity meter. This information coupled with well-controlled hydrographic data will be used to construct marine magnetic and gravity anomaly charts. The results from the few surveys of this type to date have been so rewarding that the importance of these additional observations cannot be overemphasized.

(*e*) Bottom photographs will be made on a planned grid in the working ground to study bottom sediment structures such as nodules and ripple marks, benthic animals, and evidence of bottom currents. At least one camera is to be available to the ships on each coast.

(*f*) Additional special observations will be made where needed. These include such projects as seismic reflection and refraction surveys, deep current studies in areas such as the Gulf Stream or the Aleutians with anchored bottom current meters, parachute drogues, or Swallow pingers; diving operations in areas such as Georges Bank where special bottom features require observation, and an enlarged program of any of the routine observations whenever such a program is necessary. For example, a seamount might be studied specifically with cores, dredges, bottom photography, and developed with hydrographic, magnetic, and gravimetric surveys.

As in the past, other governmental agencies and private institutions with oceanographic interests will be routinely informed of our planned activities at sea for the following field season. The Navy, Weather Bureau, Bureau of Commercial Fisheries, Woods Hole, Scripps, the University of Washington, and Oregon State College have worked with the Survey within the past year, and this type of oceanographic cooperation insures maximum efficient utilization of effort and time.

"PIONEER" PROGRAM

Upon the completion, July 1, of survey work for the Navy, the *Pioneer* will be utilized primarily as an oceanographic vessel. Following a period of outfitting with additional oceanographic equipment, the *Pioneer* is scheduled to commence operations in the area of the Aleutian Trench. This is a singularly prominent feature of the North Pacific Ocean and presents an opportunity for the acquisi-

tion of highly significant data in a scientifically critical area where accurate position control is possible. The survey will include 5-mile spacing of EPI-controlled lines across the trench to obtain continuous hydrographic, magnetic, and, if possible, gravimetric data to provide the most complete survey ever made of a major oceanic feature. General oceanographic observations will be included. Afterward similar surveys around the Hawaiian Islands are planned.

It is quite probable that by 1963 the *Pioneer* will be available for use in the proposed Indian Ocean surveys should Coast survey participation in this international effort be authorized. If the oceanwide survey program is by then underway, the *Pioneer* could be the first ship of this Bureau to engage in these surveys, and it would be joined in early 1964 by the first of the class I oceanographic ships.

"MARMER" PROGRAM

Starting with the proposed return of this 100-foot vessel to the Coast Survey in 1962, she will engage primarily in harbor and estuarine circulatory surveys commencing with Charleston, S.C. This vessel will also be utilized for some near-shore oceanographic operations where it would be impractical to operate one of the larger vessels.

The Coast and Geodetic Survey's present fleet is not yet adequate to carry out the proposed program. However, adherence to the Bureau's present programs of hydrographic and oceanographic ship construction ought to provide sufficient ships to pursue a vigorous oceanographic program.

The limited availability of trained personnel to man the ships at sea and to process the data ashore may well be the limiting factor determining the rate at which the planned program may proceed.

*Officer corps.*—As additional ships are built, it will be necessary to enlarge the size of the Coast Survey officer corps. The rate of increase will depend on the number of new ships actually built and the rate at which they are put into service.

Training of officers in oceanography must be continued until all junior officers with 2 or more years who are or will be assigned to the survey fleet will have had both courses now being given at the University of Washington, or comparable training. Officers stationed on the Seattle-based ships will continue to be sent to these courses at the rate of about 10 per year.

The assignment of at least one officer per year as a full-time student in oceanography at the University of Washington or a comparable institution will be continued until our ships are adequately staffed with qualified oceanographic officers.

*Civilian employees.*—There must be additional employment of professional oceanographers for the Washington office to plan the oceanographic programs of the Bureau, to direct and carry out the processing of the data collected by the ships, and to carry out research programs leading toward publication of results. Personnel with the necessary training are not now on the civil service roster in the lower pay grades, so the Bureau must hire from the higher grades (GS 9–15) in order to obtain competent oceanographers. In addition, we are now looking for a highly capable man, well known in his field and to the public, one who would carry out research in oceanography and publish his results and whose name associated with that of the Survey would add to the stature of both. It is questionable if a person of the necessary standing is available, but an attempt is being made to locate and approach him and funds should be appropriated for this position. Provisions will also be made for additional training of civilian personnel now in the Bureau.

Additional employees including marine geologists will be required by the Hydrographic Research Section of Nautical Charts to be used in the compilation and interpretation of closely contoured large-scale bathymetric charts of those areas adequately covered by continuously recording echo sounding surveys. These men will work with present Hydrographic Research personnel in the publishing of professional papers on the geologic interpretation of the hydrographic survey data. Civilian personnel must also be obtained as crewmen for the new ships and as technicians to maintain the additional equipment. Table IIb lists the additional civilian personnel needed to carry out these programs.

*Oceanographic equipment.*—We have prepared lists of the oceanographic equipment necessary on class I, II, and III ships to carry out oceanographic surveys in addition to their normal hydrographic activities. In addition, provisions must be made for the development of new equipment. Some is needed immediately and includes:

A vertical taut-wire gig with submerged float for radio current meter observations in the open sea.

An improved buoy-contained current recorder.

An improved current meter with digital printout.

Continuous recorder for physical and chemical properties of sea water.

Large-volume bottom-sediment and bottom-water samplers for adequate radiometric samples.

Three-component towed magnetometer to add magnetic data to other data now obtained.

Shipborne gravity meter of the general LaCoste-Romberg or Graf type.

Large-field underwater camera.

Subbottom acoustic probe for mapping subsurface discontinuities.

Improved fathometer.

Punch-type scanner and plotter for tide records.

*Oceanographic research.*—The data provided by the proposed oceanographic surveys will provide a body of information from which significant research contributions can be made. This is especially true when studies of some particular area or phenomenon are planned to provide data for a specific research problem. We must not concentrate solely on the collection of data but must utilize these data to further our understanding of the oceans. This means research both basic and applied. Bureau research oceanographers and Bureau research geophysicists should be the primary ones to work on Bureau-collected data. We must not deteriorate to become a data collector for other agencies and institutions. The end result of this expanded program must not be measured in miles of hydrography and magnetic data or total number of stations occupied, oxygens titrated, and cores collected. The end result must be measured in terms of the total scientific contribution made as a result of utilization of the collected data to extend man's knowledge and understanding of the ocean and the processes that act within it.

CONCLUSIONS

Given the required ships, the Coast and Geodetic Survey is in the singularly fortunate position of having the background and ability to provide the Nation with much of the oceanographic information which, as the recent report of the NAS–NRC Committee on Oceanography points out, is drastically needed to prevent "our being placed in a precarious position from the scientific, technological, and military points of view."

Mr. MILLER. Mr. Bauer?

Mr. BAUER. With respect to instrumentation of your ships, do you have enough in the way of instrumentation of your ships to permit you to do the oceanographic work that should be done while you are performing your hydrographic function?

Dr. STEWART. No, sir.

Mr. BAUER. Are there any plans for standardization of instrumentation in the Coast and Geodetic Survey that would be necessary to perform this oceanographic function?

Dr. STEWART. On our equipment at present, Mr. Bauer, we do some standardization ourselves. In other cases, some of our equipment is standardized by the Hydrographic Office. Other types of equipment, for example our current meters, we have had standardized at the Bureau of Standards, sometimes at the David Taylor Model Basin. We have had no trouble actually in getting our equipment standardized.

Mr. BAUER. In other words, to put it succinctly, you are handicapped in the operation that you could do with a ship at sea because you not have sufficient modern instrumentation. Is that a fair statement?

Dr. STEWART. Yes, sir. That is correct.

Mr. MILLER. Has any request been made to the Congress for funds to advance your instrumentation?

Dr. STEWART. Yes, there have, Mr. Chairman, and for 1961 we have obtained a substantial increase in the amount necessary for implementing the instrumentation for our ships. It is a considerable advance, but, as with many other things, the field of oceanographic instrumentation is constantly on the move.

As an example, we just this week are having delivered to the *Explorer* a salinity bridge for rapid determination of salinity of sea water samples at sea without having to bottle the samples and bring them back to shore. This will speed up operations tremendously. We have one. We hope eventually to have more.

These things are constantly changing.

This is almost a brandnew piece of equipment.

Mr. MILLER. This is a simple instrument to operate?

Dr. STEWART. This is amazingly simple to operate.

Mr. MILLER. In other words, previously you had to bottle this water and bring it back and determine its salinity. This, I believe, is an electrical method?

Dr. STEWART. It is. It works on the basic principle that the conductivity of a sea water sample is a function primarily of the salinity.

Mr. MILLER. That can be related to the salinity?

Dr. STEWART. Yes, sir.

Mr. MILLER. So that that is something that even I could be taught to operate?

Dr. STEWART. Oh, yes.

Mr. MILLER. If we had those on other ships, if the Navy had them on the ships of the line and on their MSTS ships crossing the ocean, could we pick up some valuable things? It may not be as refined as you want it.

Dr. STEWART. Anyone could with brief training with a piece of equipment like that determine the salinity of a sea water sample.

Mr. MILLER. As you go on, do you not think that you will simplify some of your other equipment?

Admiral PIERCE. Mr. Chairman, the ship has to stop to take these samples and put them into this instrument. You still have to stop your ship and get the samples, but it is a faster, more accurate method of getting the value.

Dr. STEWART. In order to get the sample this requires, at present, Nansen bottles and an oceanographic winch, some means of control to know where you are; and, once you are stopped, as long as you are getting water samples, you might as well get sediment samples and might as well make measurements of the velocity of sound in sea water and do everything that you can at one time.

I am inclined to think personally, Mr. Chairman, that oceanographic instrumentation as it becomes more sophisticated becomes more complicated.

Mr. MILLER. I think that is generally true.

Mr. OLIVER. Do you not think that that is true of society as a whole?

Mr. MILLER. We will leave that to the Committee on Ways and Means right now.

Mr. Curtin?

Mr. CURTIN. I have no questions.

Mr. MILLER. Mr. Oliver?

Mr. Oliver. I assume you have been aboard the Soviet research ships, *Vityaz* and *Lomonosov?*

Dr. Stewart. I have been briefly aboard the two of them.

Mr. Oliver. How does the instrumentation aboard the vessels of the Soviet compare with ours?

Dr. Stewart. Quite favorably, and I will speak specifically of the *Vityaz* that I visited for a week in San Francisco. Some of their equipment is inferior to ours. I am thinking specifically of echo-sounding equipment. Some of their equipment is considerably better than anything we have. I am thinking specifically of what they refer to as their hydro-optical program. They have some magnificent equipment for studying the optical properties of seawater that people with the visibility laboratory in San Diego have said is far superior to anything we have.

Generally, because of the wide exchange of information in the oceanographic community, their instruments, the greatest proportion of them were either identical with ours or a Russian counterpart of ours.

Mr. Oliver. I have one other question, Mr. Chairman.

Do they do quite a bit of evaluating aboard those research vessels?

Dr. Stewart. Yes, sir, they do.

Mr. Oliver. Do they do more than we in that particular area?

Dr. Stewart. I believe they do. I believe the main reason for this is that they have lots of space on these large ships not only for the laboratories for doing the analyses but also plotting rooms and conference rooms.

In San Francisco, they held a symposium during which they described the work they had been doing on that particular trip and I know the oceanographers that were aboard were quite impressed with the degree to which they had worked up their data at sea.

Mr. Oliver. I am not competent to evaluate, but aboard the *Lomonosov* last year in New York Harbor, it seemed to me that they had quite a plant, the ship and its instrumentation and what not.

Dr. Stewart. Yes.

Mr. Oliver. I take it that the scientists aboard were doing quite a bit of evaluating aboard ship while they were at sea?

Dr. Stewart. True.

Mr. Oliver. I was wondering how our efforts compare in this particular approach to the problem of oceanography.

Dr. Stewart. Most of our evaluation is done ashore.

Mr. Oliver. This takes time and costs more money.

Dr. Stewart. It takes a lot of time.

Mr. Miller. Mr. Flynn?

Mr. Flynn. I have no questions.

Mr. Miller. Admiral, I want to thank you and thank you, Dr. Stewart, for being here. It has been most enlightening.

I wish we had more time to go into a little more technical detail. There are more questions I would like to ask.

Thank you very much.

Admiral Pierce. Thank you, sir.

Mr. Miller. Rear Admiral James A. Hirshfield, Acting Commandant of the U.S. Coast Guard.

Admiral, we are very happy to have you with us, sir. Of course, the Committee on Merchant Marine and Fisheries is particularly

proud of the Coast and Geodetic Survey and the Coast Guard as part of its jurisdiction.

I meant to tell Admiral Pierce this.

I will make the general statement now that I am very happy to see you. We will be calling on you later for some favors but that is something that you and I will discuss.

They are going to have a graduation at the Academy and I think the Admiral with the proper amount of twisting of his right arm will manage to get some of us up there.

Mr. OLIVER. On the basis of being an old Coast Guard man of very few years' experience, I join with you in welcoming Admiral Hirshfield here.

## STATEMENT OF REAR ADM. JAMES A. HIRSHFIELD, ACTING COMMANDANT, U.S. COAST GUARD; ACCOMPANIED BY LT. COMDR. JOHN E. MURRAY, OCEANOGRAPHER, U.S. COAST GUARD

Admiral HIRSHFIELD. Thank you very much, Mr. Chairman. I feel that our feeling is well put by you.

Mr. MILLER. Have you a statement, Admiral?

Admiral HIRSHFIELD. No, sir. I have no statement, Mr. Chairman.

Our position on the two bills that we were asked to comment upon has been forwarded to the committee and I had sort of gathered I would come up and try to answer any questions which might be put to me.

Mr. MILLER. We will turn you over to our chief interrogator.

Mr. BAUER. Thank you, Mr. Chairman.

Admiral, for many years you have been conducting the ice survey in the Arctic and Greenland waters as well as running the weather ships on some of the oceans of the world, those that are responsible to our country.

Would you tell the committee just what you have done in the way of oceanography with respect to those areas wherever you have had those ships?

Admiral HIRSHFIELD. Mr. Bauer, may I correct just one part of that? We have had the International Ice Patrol for many, many years.

Mr. BAUER. That is correct.

Admiral HIRSHFIELD. I am sure that it is the area to which you refer.

Mr. BAUER. That is correct, sir.

Admiral HIRSHFIELD. We have conducted oceanographic surveys in the Grand Banks and the area in general which generates icebergs. We have had on occasion ships go up off the coast of Greenland.

These efforts were primarily in the area of ocean currents; in other words, to try to estimate the drifts of the bergs as they headed for the steamer lanes and also to estimate the number, the possible or probable number of icebergs which would come down and those which might menace the shipping lanes.

In Alaska, of course, years ago we did do some things for other departments. About 3 years ago, two of our ships circumnavigated the North American Continent, as you may recall, and those vessels were under a Navy task force but did some surveying in the waters on the top of the North American Continent.

As far as the weather ships are concerned we make routine Bathythermograph observations, and at one time did collect plankton samples on the Atlantic stations.

Mr. BAUER. Now, Admiral, with respect to your operations at that time, have you found it necessary to process the oceanographic data that you take on board the ship in order that you might be able to give an estimate of density currents available to the icebergs to cause them to flow this way and that way?

Admiral HIRSHFIELD. Mr. Bauer, we have each year, of course, had these observations taken. They were generally for the information of our own ice patrol commander who would then decide which track, refering to these international agreements on the steamer tracks, should be used. In other words, if the estimate was that the icebergs were going down to a certain latitude we would send our ships or planes out to locate them and then recommend moving the track accordingly.

Mr. BAUER. What I was getting at was, that there was a rapid evaluation of the data you obtained for useful purposes right then, essentially?

Admiral HIRSHFIELD. I think that is true. All oceanographic data is evaluated while being collected and completed evaluation is ready for distribution when the ship reaches port.

Mr. BAUER. Now, with respect to instrumentation, Admiral, are you lacking any instrumentation to enable you to carry out your oceanographic observations and analysis or do you have enough?

Admiral HIRSHFIELD. Well, my information is that we have adequate instrumentation, Mr. Bauer.

Mr. BAUER. You have positioning equipment enabling you to use the Decca chain?

Admiral HIRSHFIELD. No, sir, we do not. That, of course, is an electronic aid which is not used in the United States, as you know.

Mr. BAUER. That is true, but it does cover the waters of the International Ice Patrol, as I understand.

Admiral HIRSHFIELD. No, sir.

Mr. BAUER. Although you run the loran C network, do you have loran C receivers on your ships?

Admiral HIRSHFIELD. We have loran A receivers. The loran C East Coast Chain is experimental.

Mr. BAUER. That is the precise one.

Admiral HIRSHFIELD. The A is a pretty good one, too, and we do have stations, as you know, in the North Atlantic area.

Mr. BAUER. Do you have precision depth equipment?

Admiral HIRSHFIELD. Yes, sir.

Mr. BAUER. With respect to your oceanographic contributions, is it true that you were one of the first to utilize salinity bridges on your ships. I am talking of the Wenner-Soule bridge.

Admiral HIRSHFIELD. I would like to refer to my oceanographer to ask him to answer that, Lieutenant Commander Murray.

Commander MURRAY. Mr. Bauer, the Coast Guard has been using the Wenner-Soule salinity bridge for in excess of 25 years and it was the first one.

Mr. BAUER. Thank you, sir. I wanted to get that in the record because it shows that the Coast Guard is quite capable.

That is all I have, sir.

Mr. Miller. Mr. Curtin.

Mr. Curtin. I have no questions, Mr. Chairman.

Mr. Miller. Mr. Oliver?

Mr. Oliver. The Coast Guard is represented on this interagency committee?

Admiral Hirshfield. Mr. Oliver, I do not think we are. Let me put it this way. If we are it has not been brought to my attention.

Mr. Oliver. That surprises me. I thought that there was representation. When the committee was on an informal basis, I thought there was representation.

Admiral Hirshfield. When the committee was on an informal basis, my information, Mr. Oliver, is that we did sit in on those meetings.

Mr. Oliver. This is my understanding.

Admiral Hirshfield. Yes, sir.

Mr. Oliver. So that, on the relatively permanent committee, the Coast Guard is not represented?

Admiral Hirshfield. Not presently, no, sir.

Mr. Oliver. Do you feel that the Coast Guard should be represented on that committee?

Admiral Hirshfield. Well, I do not know whether it is necessary or not, very frankly.

Mr. Oliver. Could the Coast Guard make a greater contribution to oceanographic activities than it is making now, do you feel?

Admiral Hirshfield. Well, of course, you know we are a service organization, Mr. Oliver, and let me put it this way: The things which we do are in carrying out our statutory duties. If there is something required that we can do for some other agency, we would do it.

I think insofar as our own responsibilities are concerned that we are performing them.

Mr. Oliver. That is all I have, Mr. Chairman.

Mr. Miller. Mr. Flynn?

Mr. Flynn. I have no questions.

Mr. Miller. Admiral, I realize that you carry out fully your statutory duties but is this not a field to which your duties run very close so that, if we could get you money to increase your statutory duties and broaden them you could do a very fine job? Was not some of the first practical work in oceanography done by the Coast Guard?

Admiral Hirshfield. We have been in the business a long time. Mr. Chairman. As a matter of fact the Coast Guard was among the very first to make use of oceanography to assist in solving a practical problem, i.e., iceberg drift in connection with our duties on the International Ice Patrol.

Mr. Miller. And you have some people who are quite competent in this field.

Admiral Hirshfield. Well, we have presently on active duty, if my memory serves me, about eight officers who have gone either to Scripps or to one of the oceanographic schools.

Mr. Miller. In fact, historically, you had people who were highly competent in this field?

Admiral Hirshfield. The first one was Adm. "Iceberg" Ed Smith, who was in the late twenties, if my memory serves me.

Mr. MILLER. You have ships all over the Pacific and elsewhere. Do you not think we could make very good use of your ships if we gave you that money along with the authority? You would not dodge the opportunity, would you?

Admiral HIRSHFIELD. Well, we always try to do what we are told, Mr. Chairman.

Mr. MILLER. Well, I can understand your position. This is something that, frankly, our committee is very much concerned with.

I think we can get some things squared around up at this big school of yours. Here is a great potential in the field of oceanography.

Admiral HIRSHFIELD. Thank you, Mr. Chairman.

Mr. MILLER. We are still going to examine this.

Mr. Drewry?

Mr. DREWRY. No, thank you, Mr. Chairman.

Mr. MILLER. Thank you very much, Admiral.

Admiral HIRSHFIELD. Thank you, Mr. Chairman.

Mr. MILLER. Dr. Preston E. Cloud, Geological Survey.

Dr. Cloud, we would be very happy to hear from you. You have a prepared statement, I believe?

## STATEMENT OF DR. PRESTON E. CLOUD, JR., GEOLOGIST, GEOLOGICAL SURVEY

Mr. CLOUD. I have a prepared statement but, if it may go into the record without the formality of reading it, I would like briefly to summarize its main points.

Mr. MILLER. It is only a five page statement. I think we would have time. Suppose you give us your statement because I am very much interested in the Geological Survey. I almost joined it once.

Mr. CLOUD. I have been told that this statement is a little technical. It may bore you.

Mr. MILLER. Let us hear it. We are in the general field of science, I think.

Mr. CLOUD. The Geological Survey is the Federal agency responsible for exploring, evaluating, and interpreting the Nation's mineral resources, the geologic framework in which they occur, and the basic processes that affect both. During 80 years of research and survey experience in these fields it has held to the broad concept that geology is the science of the whole earth, including its internal and water-covered parts and the waters themselves. Our specific investigations, however, have moved from the frontiers of the expanding West to the frontiers of the mind, and particularly in recent years, to those of the continent itself.

Papers giving results of the Geological Survey's research on oceanic and estuarine processes, hydrography, sediments, and biology within the geographic areas appropriate to the Survey have been appearing in scientific journals and Goverment publications for the past 45 years. As a result of independent and collaborative activities by Geological Survey personnel, more than 60 reports on a wide variety of oceanographic problems have been issued during the past 10 years. During fiscal year 1960 the Geological Survey will have spent about $400,000 on research of an oceanographic nature, and in fiscal 1961 present plans call for increasing this to about $600,000. By reason of a long

tradition and wide experience in collaborating with and coordinating the activities of other people, institutions, and scientific disciplines, however, we are able to gain a large return from this relatively small investment.

I welcome the opportunity to tell you of some of the things we are doing and thinking about in some areas of our research program that impinge broadly on oceanography.

Coastal processes are being studied with special reference to the hydrodynamics of tidal and estuarine flow, the diffusion mechanics of impinging salt and fresh waters, and coastal erosion, deposition, and structure. This work, like most activities of the Geological Survey, is being carried out both in the laboratory and in the field. We are studying the principles and quantitative characteristics of tidal flow, fluid mixing, chemical hydrography, and particle movement and are applying the knowledge gained to the interpretation of existing natural environments, geologic structures and history, and the development of better instrumentation.

The geochemical balance of the hydrosphere is a subject whose theoretical and practical interest for geology and oceanography we have long appreciated, but in which we have only recently become active on a small but broad scale. Geological Survey personnel are now leading a worldwide study of the dissolved substances being carried to the ocean by rivers, with the objectives of explaining the dissolved load in the oceans and of detecting and explaining anomalies in the global geochemical balance. The problem of salt balance in closed basins is also being studied theoretically and empirically, with a view to explaining variations in the salt content and related physical properties of water bodies, including the ocean.

The marine geology and mineral resources of the continental shelves and shallower oceanic waters is a realm of oceanographic interest whose investigations the Geological Survey regards as a particularly logical and proper extension of its responsibilities on dry land.

We are mindful of the million square miles of unsurveyed ground below our shelf waters: of the potentially strategic insular and shoal waters belonging to or entrusted to the United States in the central Pacific; and of the new outlooks on sedimentary, biological, and geochemical processes that can result from imaginative research in these areas.

We have been actively working on the marine geology, sedimentation, hydrology, and geochemistry of parts of the Atlantic continental shelf, the insular Pacific, and the Arctic Ocean. We have conducted and published extensive scientific surveys of the mid-Pacific test sites and western Trust Territory of the Pacific Islands, have synthesized available records for the continental shelf areas of much of the world, have carried out a 2-year program of geophysical investigations of the Arctic basin from a floating ice island, and have discovered that marine bacteria over the Bahama Banks can separate the isotopes of hydrogen.

The dating, or geochronology, of events in oceanic history and the sedimentary and geochemical record of the ocean basins is basic to many other areas of oceanography. All geochronology depends on unidirectional processes such as the steady decay of radioactive elements and organic evolution, as revealed by the fossil record, and the Geological Survey employs a large proportion of the best qualified

people in these fields. The protactinium method, which fills an important part of the gap in radiogenic dating between the range of radiocarbon and other now conventional methods, was developed in our laboratroies by a Geological Survey scientist. We are uniquely qualified in the determination of hydrogen isotopes, whose characteristics can be used for tracing individual water masses. And, with suitable technical staff and operating funds, our radiocarbon and oxygen isotope facilities are capable of expanded efforts in biogeochemical, paleoecologic, and geochronologic research.

The needs to date for analysis of the fossil record in the marine sediments have been met successfully in our paleontological laboratories but any program of coring activities that called for additional biogeochronological or paleoecological research and service would require staff increase, particularly with regard to the microscopic plants and animals that drift in the upper waters of the sea and act as built-in geologic clocks and climatologic tracers in the oceanic sediments.

We have also maintained a continuing activity and interest in the facts and theory of the climatology, biogeography, and circulation of those ancient ocean systems which preceded and gave rise to the present one, but we have not as yet been in a position to expand this work to the degree needed or to supplement it by the model studies that could put it on a more quantitative basis. If we understood these subjects better, we could better evaluate the reality of postulated crustal shifts and the probable distribution of yet undiscovered resources long emerged from ancient seas.

Finally, our broad concern with major crustal features of the earth quite naturally takes in the continental margin, the ocean basins, and other modern marine features which might resemble those that formerly prevailed over the now continental reaches of the world. We have barely sampled these problems with aeromagnetic surveys of the western Atlantic basin, the California offshore basins, and some of the undersea mountains and trenches of the central and northern Pacific basin. More needs to be done, and this program could profitably be coordinated with geophysical inquiries being carried out from surface vessels and submarine devices by existing oceanographic institutions.

The importance of our oceanographic research is such that our best efforts should be devoted to obtaining basic scientific data from marine environments within the framework of a sound program of research on the geology of the earth as a whole. We are not equipped at this time to exert our full potential in oceanography, however; to fully complement this work, information would have to be obtained beyond the continental limits and territorial waters, which would require additions to our existing authorization.

I would like to close with the comment that, at this time, we feel that we can function most constructively in the field of oceanography, not by a separate marine facility, but by increasing the oceanographic activities in which we are already engaged; by expanding particularly the work on sedimentary and geochemical processes and mineral resources (including mineral fuels), crustal structure, and radiogenic isotopes; and by collaborating with existing oceanographic centers in the use of vessels, equipment, and personnel for marine geologic purposes.

Mr. MILLER. Mr. Bauer?

Mr. BAUER. Dr. Cloud, as I understand it, then, you do not desire to become a ship operator in any survey function?

Mr. CLOUD. This is correct. We feel that with the collaborative relationships that we have had with other Government agencies and the oceanographic institutions that we can borrow or charter the equipment that we need to carry out survey investigations offshore.

Mr. BAUER. Now, with respect to the survey of the oceans, where do you feel, from the point of view of a geologist, should the immediate attention be placed, on the supposition that you have only so many ships?

Mr. CLOUD. The logical extension of our activity is to the Continental Shelf area. Of course, this is a very big area, and we would have to make some selections about where to begin work there. In fact, we have begun work in the area around the Florida Peninsula and on the Bahaman platform offshore.

I would say that this would be a very good program to extend to work completely around the Florida Peninsula because we would encounter there a large variety of sedimentary situations that might have existed in the past.

Next to this, I would put the California offshore shelf and basin area where we know there are deposits of phosphate and possibly of manganese and other resources that could conceivably be exploitable at some time in the near future.

Mr. BAUER. Well, the reason I was asking that is this: Is is true that geology is really a science of the sea as far as sedimentation either on land or sea is concerned?

Mr. CLOUD. I am afraid that geologists are likely to be a little bit inclusive about their field of efforts. Since geology is defined as the study of the earth we consider that all parts of the earth properly fall within our realm of investigation. Much of what we deal with in the past is in the form of ancient marine deposits and for this reason we are particularly interested in the ocean and in the sedimentary and chemical processes that go on there.

Mr. BAUER. As I remember from my reading of Professor Knenen's book, the Gulf of Maine is one of the areas that needs a little attention, is it not?

Mr. CLOUD. Indeed so.

Mr. OLIVER. I am sure of that.

Mr. CLOUD. As a matter of fact, we had a collaborative project with the Fish and Wildlife Survey up on Sagadahoc Bay that ran for a number of years.

Mr. BAUER. Would you distinguish for the committee what your mission is as distinguished from that of the Bureau of Mines?

Mr. CLOUD. I would say, Mr. Bauer, that the Geological Survey had clear and primary responsibility for basic exploration and research, for interpretation and for evaluation including the computation of reserves on a regional and commodity basis. I would say that the Bureau of Mines had clear and primary responsibility for developing methods for getting the ore out of the ground, beneficiating it, and moving it to centers of distribution. In between these two rather clear responsibilities there is the twilight area of the exploration and evaluation of specific sites which may be done either by the Geological Survey or by the Bureau of Mines or by both working together.

Mr. Bauer. Now I have one more question. You mentioned in your statement that you would require authorization to enlarge your activities. Do you mean a removal of limitation similar to that was placed on the Coast and Geodetic Survey to work within the continental limits?

Mr. Cloud. A removal of the area limitation.

Mr. Bauer. Thank you. That is all.

Mr. Miller. Mr. Oliver?

I defer to you because the Gulf of Maine was mentioned here so that you have the floor.

Mr. Oliver. Thank you very much, Mr. Chairman. I appreciate that consideration. I am sure we could not say too much about the needs of the Gulf of Maine. Doctor, I hope that some day we can get together and talk about it and do something about some of the deficiencies that exist in the area.

I would like to ask this question, however. Is Geological Survey a member of this Interagency Committee?

Mr. Cloud. Yes.

Mr. Oliver. You were on the temporary committee also?

Mr. Cloud. We have representatives on the Federal Council and on the Committee on Oceanography of the Federal Council.

Mr. Oliver. What I refer to now is the Interagency Committee set up here under the Federal Council, I believe.

Mr. Cloud. I think they call that the Committee on Oceanography of the Federal Council, do they not?

Yes, we have a representative on that committee.

Mr. Oliver. Do you feel that this is a step in the right direction?

Mr. Cloud. I think this is very much a step in the right direction.

Mr. Oliver. Do you feel that it goes far enough?

Mr. Cloud. Yes, I feel that it goes far enough. I think that the work that this committee here has done and that the National Academy Committee on Oceanography has done in bringing to the attention of the bureaus and the departments the need for more activity in this area has encouraged all of us to look toward an expanded effort in oceanography and to ask for more money.

Mr. Oliver. I notice in your statement here that you talk about fiscal 1961, that present plans do call for increasing your research activities of an oceanographic nature to about $600,000.

Mr. Cloud. That is the shell of the peanut.

Mr. Oliver. Has that increase really been funded?

Mr. Cloud. No, the increase has not as yet been funded.

Mr. Oliver. But it is in the budget?

Mr. Cloud. It is in the budget.

Mr. Oliver. Did you ask through your budgetary control for more than that?

Mr. Cloud. I cannot answer that question. In 1958, when the Geological Survey supplemental appropriation bill came before the Congress with departmental approval we asked for $3 million in that bill. This was cut in half to a million and a half dollars. We had four oceanographic items in that proposal of which one has not been activated and two have been activated and continued at a very much reduced scale.

Mr. Oliver. Would you feel that if in the place of this Interagency Committee we had a mechanism which placed more stress upon ocean-

ography as a general activity of the Government that it might be helpful in meeting some of these objectives that you have been talking about?

Mr. CLOUD. No, I do not think so. I think the Interagency Committee is well constituted to do the job.

You have heard from a number of witnesses in the last few days that we have the authorization and we have the powers of coordination and we do work well together.

I think that the main thing that we need is the encouragement that you have given us to come to the Congress and to ask for more funds for basic research.

I think maybe we have been a little more timid about this than we should have been.

Mr. OLIVER. In other words, the wheel has not been squeaky enough in times gone by and you are getting some encouragement now to feel that perhaps there would be a little more sympathetic reception up here?

Mr. CLOUD. We have nothing to complain about.

Mr. OLIVER. Thank you. I notice that in your statement on page 4, you refer to the necessary staff increases if you were going into the area of more coring activities. Would this be a desirable thing?

Mr. CLOUD. I think so, yes.

Mr. OLIVER. Did you ask for it?

Mr. CLOUD. We do not anticipate, we have no reason to believe that coring activities will be abruptly accelerated. I think that your question puts the finger on one of the problems that all of us who work in basic science are a little bit afraid of. That is the problem of the crash program.

We are a little bit like a small boy who has faithfully eaten all of his spinach and is confronted with a large dish of ice cream. He knows if he eats it before it melts he is going to get a bellyache. Yet he hates to see it go to waste.

We are very much concerned that any funding of basic science activity, including oceanography take place at a pace such that we can keep up with it and assimilate it, get the best people, expand our efforts on a realistic basis, and complete and publish our researches as they are done.

Mr. OLIVER. What is your feeling with regard to the Soviet activities in a comparable area to which the Geological Survey is operating?

Mr. CLOUD. I think that probably in the Soviet they would not permit the amount of overlap that we have here. In other words, it is very unlikely that the Soviet geological survey is doing any oceanographic research. That would be the function of some other bureau.

Mr. OLIVER. Do you feel that maybe in general they are operating under a greater, more rapid momentum than we are?

Mr. CLOUD. They are certainly pouring a tremendous effort into all fields of scientific research. For instance, they have an enormous program of drilling core holes all over the country just to find out what is there.

Mr. OLIVER. Do you feel that our relatively lackadaisical attitude is good for the future of this country in terms of what they are doing?

Mr. CLOUD. Well, this is a difficult question to respond to because one always gets wound up in this business of scientific freedom. I do not think that the scientists of this country would stand still for a program whereby they were regimented and ordered about on the scale that the Soviet scientists are. This is one of the disadvantages of a democracy as far as attaining a military objective or a crash program is concerned.

Mr. OLIVER. I do not have that in mind, Doctor.

What I had in mind was that, for example, you are saying here that staff increases would be necessary for more coring activities and I assume that you really feel they should be increased.

Mr. CLOUD. That is right, and I had some experience in recruiting for this sort of thing over a period of 10 years in an administrative job, out of which I now happily am. To get the kind of people that we need to do this high level type of work is a very slow process. You must have your finger on the universities that are producing the personnel that are needed in this work, watch their students, have an opportunity to see what they can do and eventually hire them. It takes a long period of training to prepare a man for this type of work and recruitment is a very slow proposition.

If we should suddenly have as small a sum as $200,000 to go out and recruit for this work, we would have a hard time spending that sum wisely this year for new scientific personnel only, although we could easily and effectively spend much larger sums for equipment and facilities in anticipation of increased staffing.

I think one of our biggest problems in recruitment has been the lack of assurance of funds looking ahead to a future fiscal year whereby we could be in the market for the best people and offer them jobs when they graduate from school this year or next year because of the way in which we operate and on a year to year budget with only the assurances of tradition to give us the flexibility we need in making employment offers.

Mr. OLIVER. Have we any programs in effect now that would encourage people in either the later years of high school or in colleges to engage in this sort of a profession?

Mr. CLOUD. We do this individually.

Mr. OLIVER. But you have no funded program which would give us the result that you are speaking of?

Mr. CLOUD. Yes, we have a program. We have a staff geologist on the Geological Survey whose sole job is to keep in touch with promising students in the fields of science relating to geology, and he goes around to the annual meetings of the various societies, attends these meetings, and sets up an office where they interview prospective employees and discuss their qualifications and job opportunities on the Survey: but, of course, there never have been enough job opportunities on the Survey except in the immediate postwar crash program.

Mr. OLIVER. Mr. Chairman, I have just one other question.

Does Geological Survey engage at all in the so-called Mohole project?

Mr. CLOUD. A Geological Survey man, Dr. Harry Ladd, is the motive force behind this project.

Mr. OLIVER. This is being financed by private funds?

Mr. Cloud. There are people here who know more about it than I do. Perhaps Gordon Lill will respond to that. I think probably both ONR and NSF are putting money in it.

Mr. Oliver. I mention that to show the interest of just one member in this project. Even though a lot of people are inclined to ridicule it, I think that it is basic that that project be carried through.

Mr. Miller. Mr. Flynn?

Mr. Flynn. I have no questions.

Mr. Miller. Mr. Drewry?

Mr. Drewry. Dr. Cloud, I notice that you feel that you ought to have an addition to your existing authorization and, as I understood that, it was to enable you to go beyond the immediate closeby waters. I also notice that you have been active up in the Arctic Basin and the Bahama Banks. How did you manage that?

Mr. Cloud. Well, we operate to the Bahama Banks from Miami. The Arctic Basin work was some special arrangement with the Air Force whereby our men were stationed on one of those floating ice islands. It was off the coast of Alaska essentially, you might say, in the territorial waters of Alaska drifting along the Canadian Archipelago. We do have cooperative arrangements with agencies throughout the Government and at various times our personnel will be transferred to one of these agencies to perform a job outside of the territorial limits of the United States but we are not authorized in our own legislation to undertake this independently.

Mr. Drewry. Your problem, then, is somewhat similar to that of the Coast and Geodetic Survey, which was that they could participate in these programs but it took a little arranging to make it work out.

Mr. Cloud. Yes, that is correct.

Mr. Drewry. I noticed that you mentioned fiscal 1960 and 1961 and also that you had issued a number of reports over the past 10 years.

In the 10-year period, was there anything like the amount of money available that you have had since fiscal 1960?

Mr. Cloud. Yes, I think so. Actually, you know it is quite a problem to identify all of the things we do in oceanography. Frequently they are done for other purposes but they have an oceanographic bearing. We have always had a happy relation with the scientific community in general so that we are able to get them to do things for us and we play ball with one another and make our funds for research in this area go a long way.

I do not think that the amount of money that we have spent on oceanography anything like represents the cost of the actual operation in research.

Mr. Drewry. Of course, I think that it is important to realize that money is not everything in these respects.

That is all I have.

Mr. Miller. I take it, then, Doctor, from your answers to some of these questions, that crash programs in the field of science, this field or anything else are not the things that serve science the best.

Mr. Cloud. One of the worst things that can happen to basic science is to have a crash program.

Mr. Miller. I just wanted to get that into the record.

Now the Geological Survey, as its name implies, has to do with this but you also have a second branch that does cadastral surveying or topographical surveying?

Mr. CLOUD. This is the Topographic Division.

Mr. MILLER. How much of the area of the United States has now been mapped?

Mr. CLOUD. Topographically? I could only really guess at the answer to that question.

Actually, a very large part of the United States is covered by topographic maps of one sort or another but the quality of these maps over very large areas is simply inadequate for modern research purposes.

Mr. MILLER. You do not know what percentage is mapped?

Mr. CLOUD. I could only guess at that.

Mr. MILLER. Is it 75 percent?

Mr. CLOUD. I would say 75 or 80 percent of the country was covered by topographic maps of some quality, probably not more than 20 percent by means of good, first class quality, but I stress that these are simply wild guesses.

Mr. MILLER. The part where the maps are not entirely accurate at least gives us some idea of the country itself.

Mr. CLOUD. Yes, they do, and the topographic mapping program has been stepped up in recent years with particular emphasis on the coastal areas and the international boundaries. We have very fine maps for most of the coastal areas and the international boundaries with Canada and Mexico.

Mr. MILLER. If I remember rightly, this branch originally was part of the Army, was it not?

It started out as the topographical part of the Army away back around 1820 or some place in there.

Mr. CLOUD. No, the Survey was not organized until 1879.

Mr. MILLER. That is right, but the work that it did in topographical work of making maps of the country at that time was part of the Army's function that you inherited from them in 1878, is that right?

Mr. CLOUD. Well, this is a little more history than I can cope with. I recognize that both geology and topography were sort of appendages to military operations in the West before the organization of the Geological Survey.

Mr. MILLER. I have in mind a man who got his education in Europe, a fellow by the name of Fremont that started out west and among other things was instructed to look for routes on which to put a railroad. He was a topographical engineer.

The point I was making is that since at least 1878 we have been trying to map the United States on land and we have not done a very good job of it and yet there are vast areas of the Pacific which are many times the size of the United States on which we have practically no information.

Mr. CLOUD. I would to some extent defend the history of our mapping development and I would do it on this basis: that the complexity of your requirement is a function of your times. At the time of these early explorations when people were wandering around through the West in wagon trains and they would look and say, "That looks like

a low place over there, we will go through there," it was enough to have a map at a scale of 1 to 250,000 but most geologists nowadays would be lost on a 1 to 100,000 scale map and could hardly find their way around on it simply because we are looking for smaller things, and so we have to have larger scale maps to look for the small things on.

Mr. MILLER. I have no complaint and no quarrel with you on that at all. We have to have more progress. I say that if it were not for one of your early geographers, a man by the name of Marshall, we would not have the great Central Valley project in California because when he had nothing to do when he retired he put it together. That is how it got started. He lived in California and was a geographer of the West.

Thank you, Doctor, very much. I wanted to get in something for the West for the sake of my friend from Maine and now he has deserted me.

Mr. CLOUD. Thank you. It was a pleasure to be here.

Mr. MILLER. We will now hear from the Texas Instruments, Inc. Will you give your name and address to the reporter?

## STATEMENTS OF F. J. AGNICH, VICE PRESIDENT, GEOSCIENCES AND INSTRUMENTATION DIVISION, AND DAVE BARRY, OCEANOGRAPHER, TEXAS INSTRUMENTS, INC.

Mr. AGNICH. I am Fred J. Agnich. I am a vice president and director of Texas Instruments. I have been a geophysicist for about 23 years and I head up our Geoscience and Instrumentation Division in Dallas, Tex.

With me I have Mr. Dave Barry, who is particularly concerned with our oceanographic efforts, and I do have a prepared statement.

Mr. MILLER. Do you want to go ahead? I think you can summarize the statement. We have about 15 or 20 minutes.

(The statement follows:)

PREPARED STATEMENT OF TEXAS INSTRUMENTS

Mr. Chairman, members of the committee, thank you for the opportunity to appear before you today. My purpose in being here is to demonstrate an industrial capability which, I believe, can be used in support of enlarged oceanographic survey and research requirements. I will not burden my remarks with an accounting of the need for this program, since I feel that we are in agreement that a marine program is vital to the economic and military well-being of the country.

As a representative of Texas Instruments, an established leader in the field of exploration geophysics, I can say that we in the geophysical industry have followed with considerable interest the testimony which has been presented here. Certain phases of oceanography constitute an integral part of the industry's business. If I may repeat Admiral Karo's definition, presented in earlier testimony, "* * * oceanography may be divided into three branches—physical, geological, and biological * * *." The geophysical industry, then, is intimately concerned with the first two of these—physical and geological.

In the latter category, geological, the industry conducts what might aptly be called commercial oceanographic measurements, inasmuch as these measurements are directed toward determining the location of petroleum accumulations under shallow water. Using marine seismic reflection and refraction techniques, developed by industry, subbottom stratigraphic maps are constructed as an aid to locating oil. Marine gravity techniques, another important component of

marine geology, detect anomalies within the substructure and provide still another means of defining petroleum accumulations.

Interest in the physical characteristics of the oceans has been influenced by the industry's participation in the manufacture of instruments and systems for military applications. For work in the field of antisubmarine warfare, the industry's research and advanced studies groups are conducting investigations into acoustic propagation through water and the detection of submersibles by magnetic techniques.

At this point, I think it appropriate to specify how we in the geophysical industry feel that we can contribute to a program in oceanographic research and surveys. I will discuss, in some detail, industry's ability to conduct production marine surveys. To a lesser extent, I will comment on capabilities in the general areas of instrument design and data processing. It might be pointed out that it was only because of the economic need to find oil and other minerals that exploration geophysics enjoys the relatively high order of development it has attained.

MARINE SURVEY CAPABILITY

In reviewing the testimony as presented before this committee and the various documents which have been circulated pertaining to proposed programs in the marine region, it is industry's view that a definite need exists in the area of oceanic surveys. A common item of testimony has been the scarcity of qualified men and equipment to perform satisfactorily those operations required of a comprehensive oceanographic program. If I may again quote, a Committee on Oceanography publication remarks on "* * * routine survey tasks that are not the proper work of a research organization and contribute little to the laboratory except as a financial stopgap." While this remark is necessarily out of context, I believe that it effectively summarizes the relationship—at least as an operational arrangement—between research and surveys.

It is industry's belief that marine surveys can be accomplished more efficiently and with greater economy as surveys rather than as a part of research. The conduct of comprehensive oceanographic surveys, on a production basis, could relieve the universities and nonprofit institutions of an essentially routine operation and free valuable oceanographers for research.

Here, an industrial capability peculiar to the geophysical industry may provide a service in the conduct of the required surveys. The collection of earth sciences data, on a production basis, forms the major portion of the geophysical industry's business. In the last year, 180 geophysical exploration parties, both land and water, were dispatched by the industry to almost every free country in the world. Staffed from a total industrial personnel capability of over 5,000 geophysicists, these parties conducted seismic and gravimetric surveys in the search for petroleum.

In a highly competitive environment such as exists in the geophysical industry, close attention must be paid to cost and performance considerations. Production survey work must produce, both in quantity and in quality. For this reason, the industry's scientific exploration parties are organized to perform their activities in the most efficient, economical manner. Data gathering activities which can be accomplished by semiskilled or unskilled labor are performed by such labor, supervised, from a quality-control standpoint, by party scientists.

The amount of offshore marine survey work conducted by the industry is modest as compared to the total amount of work performed by nonindustrial agencies. However, the volume is a direct reflection of the need within the petroleum industry for such work. For example, in the peak year of marine exploration activity, 1954, there were some 28 ships and smaller vessels active. In 1959, this peak had been reduced by about 64 percent to a total of 10 vessels or less.

The marine surveys conducted by the geophysical industry required the use of specialized personnel, so a decline of 64 percent in the marine survey market should certainly have necessitated the wholesale discharge of such personnel. However, it has been the industry's pleasant experience to find that field personnel in the applied sciences—physicists, geophysicists, and the like—adapt readily to marine survey work. Therefore, since a falloff in the marine survey market was accompanied by an increase in land survey requirements, "marine" personnel were merely reassigned duties with exploration parties working on land.

The "environmental" versatility of applied scientific personnel has led the geophysical industry to the conclusion that general oceanographic surveys can

be accomplished by applied scientists supervising the activity of semiskilled labor. This would both reduce the cost of comprehensive marine surveys and, as stated previously, permit oceanographic researchers to spend more time on research.

The industry relies to a large extent on converted vessels, such as is shown in this first slide, for its marine survey operation. The vessel you see on the screen is Texas Instruments MV *Sonic*, a converted Navy LCS(L). Since its commission in 1954, the *Sonic* has surveyed in detail over 20,000 miles of line under contract to the petroleum industry. Its area of operations, as shown on the next slide, has been, for the most part, in the shallow offshore waters and bay areas. The vessel, however, is completely seaworthy. At one time, the *Sonic* successfully completed a seismic reflection profile in 16,000 feet of water in a project designed to determine the origin of the Bahamas Islands.

Industrywide statistics are, at best, characterized by large information gaps owing to the industry's tendency to classify as "company confidential" most work performance figures. However, I have attempted to gather pertinent data to indicate, at least in degree, the amount of marine survey work that has been accomplished. I wish to emphasize that these figures are estimates only. In the period 1944 to 1959, about 4,000 crew-months were expended on marine survey activity. From 1950 to 1959, an average of 20 crews engaged in marine survey activity each year. The total average number of seismic personnel on the water each year amounted to about 300. Of these, 100 were scientific and technical personnel. Shore-based data reduction and analysis personnel—all scientific—amounted to 200. The average total, then, in all categories averaged roughly 500 people engaged in marine survey activities per year.

An auxiliary function which is an important key to the successful execution of marine surveys is navigation. The navigation techniques employed by the industry aboard its vessels are the most advanced obtainable. The industry's navigators are skilled in the use of all commercially available navigation devices such as Loran A, Raydist, radar, and others. Additional, the industry is anticipating extensive use of the Transit satellite system when it becomes available.

### DATA PROCESSING CAPABILITY

The collection of oceanographic data on a worldwide basis requires automated processes for analysis of results. The need for automation is evident when one considers that an underway survey vessel, on a production survey, can accumulate an estimated 18 million discrete measurements in the course of 1 year.

In the area of data processing, a marine survey conducted as a separate production operation can use data collection and processing techniques which combine automated and semiautomated data recording with automated data handling. Our industry's geophysical data are handled in this manner in worldwide locations such as Texas Instruments data processing office in London, England. As a result, the industry has been able to employ more powerful mathematico-theoretical tools to the interpretation of measurement results.

### INSTRUMENTATION CAPABILITY

Oceanographic instrumentation, as pointed out in previous testimony, is inadequate. The geophysical industry faced a like situation in its infancy, and solved it by developing and manufacturing its own instrumentation. The market for geophysical equipment is relatively limited, and therefore provides little economic incentive for widespread manufacture of these items. For this reason, the geophysical instrument manufacturing capability is contained wholly within the industry.

This established instrument manufacturing capability is readily adaptable to the production of specialized oceanographic instruments. In fact, much of the equipment produced by the industry, either for commercial or military use, is designed specifically for marine environments. The AN/ASH–5 airborne bathythermograph shown in the next slide and the AN/ASQ–8 airborne magnetic anomaly detection system, supplied in production quantities to the Navy by Texas Instruments, typify marine instrumentation produced for military use.

In the area of commercial application, the LaCoste-Romberg submarine gravity meter, a Texas Instruments seismometer, and the SONIC marine system are but a few examples of instrumentation designed for shipboard operation or to withstand the corrosive effects of salt water. The instruments must also be designed to withstand extreme of operating conditions, from the cold of the Arctic to the heat of the Sahara.

Aside from the design and production of equipment to gather data, the industry also manufactures instrumentation specialized to reduce the data. Illustrative of this capability is Texas Instruments' seisMAC shown on the next slide. This equipment is an electronic analog computer which takes recorded seismic data and reduces them to a form suitable for direct plotting of subbottom stratigraphy. In addition, the quality of the data is improved via a process of signal enhancement.

While these remarks have been necessary brief, it is my hope that they have demonstrated the existence of a capability which, as a supplement to those in nonindustrial facilities, can aid in improving the current state of oceanography by providing production marine survey services, data reduction facilities, and instrument development.

Mr. AGNICH. I think I can summarize the statement, if you prefer.

I want to thank you, first, for the opportunity of being here today.

Our purpose in being here is to demonstrate an industrial capacity which I think can be used in an enlarged oceanographic survey in support of related research requirements.

I will not discuss the need for this program since I think we are all agreed that we need a greatly expanded effort.

We followed the testimony with a great deal of interest. I think everybody in our industry has, and we are concerned largely with the physical and geological branches of oceanography rather than the biological one.

Our industry conducts surveys which might be called commercial oceanographic measurements, used toward determining the location of petroleum accumulations under shallow seas.

We use, primarily, seismic reflection and refraction techniques, marine gravity techniques, and magnetometer work as a means of defining petroleum accumulations.

Our interest in the physical characteristics of the oceans has been influenced by our participation in the manufacture of instruments and systems for military applications, particularly in the field of antisubmarine warfare.

What I want to discuss here briefly is our ability to conduct production marine surveys and also to comment briefly on instrumentation design and data processing.

I think the common item of testimony before this committee, as I have read it, has been the scarcity of qualified men and equipment to perform the operations that would be required in an expanded and comprehensive oceanographic program, and I can quote the committee hearing which says that routine surveys, as being a floor to the proper work of a research organization, contribute little to the laboratory except as a financial stopgap. This is out of context, of course, but I think it effectively summarizes the relationship, at least as an operational arrangement, between research and surveys as such.

We believe in industry that marine surveys can be accomplished more efficiently and with greater economy as surveys rather than as part of research.

The conduct of such surveys would relieve the universities and nonprofit institutions of an essentially routine operation and free valuable oceanographers for research work.

The collection of earth sciences data, today on a production basis, forms a major portion of the geophysical industry's business.

Last year I think we had about 180 crews, both land and water, sent out by industry to all parts of the free world and staffed from a total industry personnel capability of over 5,000 geophysicists.

These are not technicians. These are professional geophysicists. This is a highly competitive field so we pay a great deal of attention to costs and performance considerations. This work must produce both in quality and quantity and therefore the crews are organized to perform their activities in the most efficient and economical manner.

The data gathering activities which can be accomplished by semi-skilled or unskilled labor are performed by such labor supervised from a quality control standpoint by party scientists.

The amount of offshore work actually done in the industry is modest, I think, compared to the total amount of work performed by non-industrial agencies.

In the peak year of our marine effort, 1954, I think there were some 28 ships and smaller vessels actively engaged and in 1959 this total had been reduced to 10 vessels or something of that nature.

These operations require the use of specialized personnel. You might think that this decline would be severe but you can readily transfer people from land to water in geophysics so that you simply pull them back to land operations which increased.

We in industry rely almost entirely on the use of converted vessels for marine survey operations.

In Texas Instruments, we have two, the motor vessel *Sonic*, which is a converted Navy LCS and the *Texin*, which we have just purchased.

Since 1954, the *Sonic* has surveyed in detail some 20,000 miles of seismic line under contract to the petroleum industry, primarily in shallow offshore waters and bay areas.

However, a few years ago, we successfully did a job in 16,000 feet of water in a project designed to determine the origin of the Bahamas Islands.

To give you some statistics, in the period 1944 to 1959, about 4,000 crew-months were expended on marine survey activity. From 1930 to 1959 there were about 20 crews engaged in marine survey activity each year and the number of personnel on the water each year amounted to about 300, of which 100 were scientific. On shore, in data reduction and analysis of the data, we had about 200 people, the average total being about 500 a year engaged in marine survey work.

We, incidentally, utilize all of the navigation techniques and we anticipate using the transit satellite system when it becomes available.

For analysis of results, the need for automation is evident if you consider that on a production survey an underway vessel can accumulate an estimated 18 million discrete measurements in the course of 1 year. Obviously, you must automate to be able to handle data on that volume.

We employ many of the more powerful mathematical and theoretical tools to use in the interpretation of this kind of result. Instrumentation, we feel and, as has been pointed out, is somewhat inadequate in this general area.

The geophysical industry faced a like situation in its infancy and solved it by developing and manufacturing its own instrumentation because the market for this equipment is relatively limited and it provides little economic incentive for widespread manufacture. For that reason, the capability is contained wholly within our own industry.

This instrument manufacturing capability is readily adaptable to the production or, indeed, the design of specialized oceanographic instruments.

Much of the equipment produced by the industry has been specifically designed for marine environments and here particularly in the ASW field for the detection of submersibles.

In the area of commercial production, I could refer to the LaCoste-Romberg submarine gravity meter, a Texas Instruments seismometer, and the sonic marine system, which are simply a few examples of the instruments designed for shipboard operation.

They must be designed to operate in any condition.

The industry also manufactures instrumentations specialized to reduce the data. These include Texas Instruments seisMAC. This equipment is an electronic analog computer which takes recorded seismic data and reduces them to a form suitable for direct plotting of subbottom stratigraphy. In addition, the quality of the data is improved via a process of signal enhancement.

I think that about summarizes the statement.

I would be glad to answer any questions you might have.

Mr. MILLER. Mr. Bauer?

Mr. BAUER. With respect to the data that you have obtained on your various surveys and so on, that is regarded as confidential to the various oil companies, is that correct?

Mr. AGNICH. It is very highly so.

Mr. BAUER. Have any of the oil companies, to your knowledge been approached by Federal agencies to get data that has been collected that belongs to them?

Mr. AGNICH. Mr. Barry?

Mr. BARRY. Actually the oil companies, most of them, have a working agreement where they supply this information for official use only to the Hydrographic Office and we have been partially instrumental in making arrangements for the oil companies to do this.

Mr. BAUER. I think it would be very interesting if you could describe briefly how you take your seismic sections. How often do you take them and do you have to stop the ship and have two ships and so on, as is often done by certain others?

Mr. AGNICH. No, we use one ship and the ship never stops. It proceeds at a rate of about 6 knots and we detonate an explosive charge in the water at about an average of one every 2 minutes and these are approximately a quarter of a mile apart and with these we measure the subsurface below the bottom of the ocean to a depth of, we will say, 20,000 feet in the earth.

One ship can under good going do as much as 100 miles of such surveying in a day.

Mr. BAUER. Do you know whether or not such equipment or techniques would be available for the Coast and Geodetic Survey?

Mr. AGNICH. If they wanted to utilize them, yes, sir.

Mr. BAUER. That is all I have, Mr. Chairman.

Mr. MILLER. Mr. Flynn?

Mr. FLYNN. I have no questions.

Mr. MILLER. Thank you very much. I appreciate your coming here.

I think that the testimony you have given us is most enlightening.

Perhaps out of it will come a better understanding that we have to do a lot more in this field. Of course, you have had an incentive for designing and developing instrumentation which they have not had in Government. We will have to get together.

Thank you.

Mr. AGNICH. Thank you.

(The following was furnished for insertion:)

TEXAS INSTRUMENTS, INC.,
GEOSCIENCES AND INSTRUMENTATION DIVISION,
GEOSCIENCES DEPARTMENT,
*Dallas, May 23, 1960.*

MR. PAUL BAUER,
*Consultant, House Committee on Merchant Marine & Fisheries,*
*U.S. House of Representatives, Washington, D.C.*

DEAR SIR: In response to your questions following our recent testimony before the committee we are pleased to submit the following information on oceanographic survey work:

A completely outfitted and manned survey vessel for conducting underway surveys including scientific personnel, amortization, data reduction, and all logistics would cost approximately $85,000 per month and would survey approximately 54,000 line nautical miles. Of course, this is employing a converted naval vessel and the ship operating cost is only about one-third of this figure, the balance being amortization of ship and equipment, scientific personnel salaries, and data processing costs.

The conversion costs of a naval vessel vary dependent upon the type vessel and measurements desired but would be well under $500,000 per vessel including instrumentation and purchasing the vessel at current surplus sale prices for any of the useable classes under about 1,000 tons displacement.

Conversion and outfitting time including supplying a trained scientific staff from the geophysical industry would not exceed 6 months per vessel.

Large-scale (oceanwide) survey costs would be directly dependent upon the number of miles and ship months of effort involved. To provide you with an example, to survey all the oceans of the world on a one degree line with 10 percent of the total line mileage devoted to crosslines for tying the survey together and including a proportionate number of time stations, the cost would be about $100 million. The survey would take 7 years to accomplish. This would include all oceanographic measurements and all costs.

If we can provide any additional information for you or the committee, please do not hesitate to call on us.

Sincerely,

DAVID T. BARRY.

Mr. MILLER. The committee will stand adjourned until Friday, at 10 o'clock.

(Whereupon, at 11:55 a.m., the committee adjourned, to reconvene at 10 a.m., Friday, May 20, 1960.)

# OCEANOGRAPHY

FRIDAY, MAY 20, 1960

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON OCEANOGRAPHY OF THE
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
*Washington, D.C.*

The subcommittee met at 10 a.m., pursuant to adjournament, in room 219, Old House Office Building, Hon. George P. Miller (chairman of the subcommittee) presiding.

Mr. MILLER. The committee will come to order. I understand, Mr. McKernan, you have a statement that you would like to make at this time. We welcome you, sir. We are always glad to see you.

## STATEMENT OF DONALD L. McKERNAN, DIRECTOR, BUREAU OF COMMERCIAL FISHERIES, FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR

Mr. MCKERNAN. Mr. Chairman, I have no prepared statement with me, but I am here to discuss with you the Department's reports on the three bills which are currently before this committee.

The chairman is aware that we in the Department appeared before this committee and presented extensive testimony with respect to the Department's and Bureau's efforts in the field of oceanography. I am sure the chairman would not like this material repeated again, since it is already in the record.

I would like to address myself to the bills that the chairman and the committee have before them. I think it rather important, Mr. Chairman, to indicate to the committee the importance which the Department places on your efforts in behalf of oceanography.

You have heard for the last several days of the importance of oceanography in the defense of our country. I am sure the chairman is well aware of the importance of the living resources of the sea. I personally am of the opinion that the biological research on the oceans has lagged behind and a great deal of practical research is needed in most fields of biological oceanography, as in fact in the physical and other aspects of oceanography.

We in the Bureau of Commercial Fisheries must use basic research in order to insure the maximum utilization of the living resources of the sea surrounding our country. We realize that we are pretty well scraping the bottom of the barrel in many respects and unless somehow we increase the level of research in the basic aspects of biological oceanography it appears we are not going to have information available to use by which we can make intelligent decisions concerning the rational use of the living resources of the sea.

Mr. MILLER. I am glad that you make that statement, Mr. McKernan. I think that I can speak for the committee when I say we recognize the importance of physical oceanography and the necessity of it in the field of defense, yet the biological features, the living resources of the sea, are of the utmost importance, and without detracting from the work that we do in the other area of physical oceanography we can certainly not afford to make secondary the biological features of this work.

If there is an excuse, or a reason necessary for oceanography, it is that we can develop the full resources of the sea, the biological resources of the sea. Today we do need to know all about the ocean and its effect as far as defense is concerned, but we hope that that is a passing and ephemeral necessity. Sooner or later peace will come to the world, and when it does come then again we must be prepared to start in on a thorough investigation of the biology of the sea. I am happy to hear you make the statement that you did.

Mr. MCKERNAN. I need not remind the chairman, who was on the spot in the recent discussions in Geneva on the law of the sea, the big issue facing the majority of the nations in the world is the matter of fisheries.

Mr. MILLER. The overriding consideration. They were trying to protect their own fisheries.

Mr. MCKERNAN. There were 80-some-odd nations in Geneva, and the fact that the Geneva discussions were not wholly successful probably rested squarely in the problem involved in fisheries jurisdiction in the sea surrounding the coasts, and adjacent to the coasts of the various countries of the world. So this matter of utilization of the living resources of the sea is certainly a very pertinent one and one that must be considered very important to our country today. Of course, our country has been a fishing nation since our foundation, and we are losing ground in this particular regard. Other nations—Japan, Canada, the U.S.S.R.—are going ahead at a much faster rate than we in many of the fields of study of the living resources of the sea.

Concerning the bills before your committee, Mr. Chairman, the Department has presented to the committee a report on H.R. 9361, to advance the marine sciences, to establish a comprehensive 10-year program of oceanographic research and surveys. The Department did a great deal of soul-searching with respect to this bill and we are very strongly in favor of the purposes for which this bill is designed. We feel that the recommendations of the National Academy of Science's excellent committee have been quite adequately covered with the exception of, in our opinion, some very minor changes that are necessary. But the Department has considered that it does have the authority within existing legislation to carry out the objectives of the bill and therefore we cannot see the necessity of this particular legislation at the present time. Nevertheless, the wide discussion that this particular bill has brought about within our own Department has to a considerable degree brought about a reemphasis of this particular problem and, I might add, an alignment of the thinking of the policy-making people within the Department of the Interior.

I should like to call to your attention that our own Department's budget was increased for fiscal year 1961, even though the National

Academy's report was quite late in being available to us. We still were allowed to provide over $2 million of increase in oceanography. A good share of this increase, it is true, is going into the construction of a major vessel in the New England area. This vessel will be of major use in studying the biology and fisheries resources of the New England area.

Mr. OLIVER. What are we going to name it, the *Albatross III*, or the *Albatross IV*?

Mr. MCKERNAN. No. I cannot give you any name right now. We will be glad to take any nomination you have, except it will not be *Albatross IV*.

Mr. MILLER. Off the record.

(Discussion off the record.)

Mr. MCKERNAN. Of course, the Department of the Interior is not only interested in the living resources. As you heard yesterday, the Department is also interested in the geology of the seas. We are interested in the mineral resources, and we believe that the increasing population in the United States is demanding, and is entitled to, a greater use of the seas resources for recreational purposes. We believe the reemphasis of the needs for additional studies on physical and biological oceanography is a very worthwhile thing, and this committee and the National Academy of Sciences is to be congratulated for their efforts in this particular regard.

My own views are that the Government in research in general has not kept up with the changing conditions and we are seriously behind the times. This in a sense is a repetition because the National Academy group of eminent scientists came up with this same decision and have said it far better than I. But I have felt for some time that our efforts, not only within our Government but within Government as a whole, were not well balanced with respect to research. I have felt further, Mr. Chairman, our efforts with respect to directed and basic research were even more out of line. In our own Bureau we have tried very hard, and we are continuing to try, and are meeting with considerable success because of the prominence this subject has had from discussions in this committee and elsewhere, and we are succeeding in reemphasizing the need for basic research which will provide this basic information needed for the ultimate utilization of the resources.

Mr. MILLER. We all agree that something must be done. How is it to be done? This reminds me of an experience that I had when I was first elected to the California Assembly. I was quite green. A man called me up and said that he was a thinker, a student. He knew all the answers. The trouble was the distribution of the wealth in the country. We should do something about that. Well, I said, "What do you suggest?" He said, "I am a dreamer, I am a thinker. We leave these solutions to the politicians."

So when we put in some bills we are trying to be a little provocative, and we are trying to carry out the recommendations of the thinkers.

Mr. MCKERNAN. Furthermore, I am personally aware that oftentimes implementation of programs in Government have come about through the passage of bills of this particular kind. In this instance, the National Academy's report has been reviewed by the Federal Council for Science and Technology, a policymaking group established in the latter part of 1958. This Federal Council, in my

opinion, Mr. Chairman, has been quite effective. It seems to me that it is quite essential that at least part of these matters be taken up through members of the administration who are in a position to act; who are in a position to set policy for the administration. These people are. They are at the secretarial level. They have also been wise enough to put underneath them a standing committee of top scientists in each department. I am fortunate enough to be an alternate on the standing committee for the Department of the Interior. The Director of the Geological Survey is the Interior Department representative, and I am sure that you will agree with me that he is a very eminent scientist in the field of geology. Other departments have made what I consider to be very excellent selections, so we have right underneath the political-executive policymaking level this council of top scientists in Government. And then there are several committees who are answering to the Federal Council directly. One of those is the Committee on Oceanography. I feel that they are answering to the Federal Council directly primarily because of the emphasis that has been put on oceanographic programs.

Dr. Wakelin of the Navy already testified before you and said he is the chairman of that particular committee, and on that committee I represent the Department of the Interior. We have attempted to coordinate the existing efforts in Government in oceanography, and we have made a stab in attempting to look at the future. We reviewed the National Academy of Science's report. By the way, it got a pretty clear bill of health from us also. From there it went on up to the Federal Council where it was adopted and is now Federal policy, which is tremendously important in the way our Government operates.

Now, the various Departments of Government are budgeting on the basis of this particular report, and you know that we are preparing our 1962 budgets, and these particular programs are being reviewed, not only within the departments themselves for the balance they must obtain, but also they are being reviewed by this interagency Committee on Oceanography, the Wakelin committee. Here the efforts of the various departments will be brought together. It is hoped we will be able to bring together a coordinated program. I would hope, of course, we would not attempt to be bureaucratic and stamp out all duplication of efforts. We will attempt to see that there is some review by people who are thinking about this problem to try to get the most for the taxpayer's dollar in the matter of oceanography.

We are also working very closely with this National Academy of Science's Coordinating Committee on Oceanography. We continue to attend their meetings and the council's interagency committee intends to ask the executive secretaries for the National Academy's oceanographic committee to attend the interagency meeting. So then this brings together the Government's efforts in oceanography with the thinking of non-Government experts in oceanography.

It seems to me that there is the possibility of considerable success. I say "possibility" because we are dealing with people, and I am not sure yet this is going to work perfectly. In my opinion it has not worked perfectly yet, but I am very hopeful with the proper stimulus, both from Congress and from the Government agencies, and from the scientific community outside of Government, that there will be enough stimulation of effort to bring about a coordination of

U.S. efforts in the field of oceanography and that there will be a considerable expansion in this particular field.

Mr. MILLER. We, too, accept this fine report by the committee of the National Academy. We think that it is a wonderful document. We are very happy they have adopted this policy in Government now. On the other hand we have the responsibility of seeing that this thing works. We cannot go beyond progress. Everything has to stop here and be sent back. So we are going to watch with great interest the operation of the Wakelin committee, the efforts it makes, with the sincere hope that it is successful. We are not going to leave all of the eggs in one basket. You will be coming back from time to time to give us suggestions how this research must go on for a long period of time. It is going to be stabilized in Government. It is not going to be dependent upon the thinking of successive administrations. I am certain that you would not want to see the Fish and Wildlife Service function without statutory law within the structure of the Government, would you?

Mr. MCKERNAN. No, I would not. I concur in your views in that regard. We certainly want to make all of our records and programs available for your critical review at any time.

Because of the setup within the Federal Council for review and coordination of the oceanographic effort, we believe that the objectives of House Resolution 10412 again are, so far as I am concerned, right down the line with respect to what they are attempting to do. We would like to see oceanographic surveys coordinated through the existing setup that has been organized within Government.

With respect to H.R. 12108, setting up a national oceanographic data center and a national instrumentation and calibration center, here we would prefer this in the Navy's Hydrographic Office, providing that the organization remains essentially in civilian control. We have reasons to believe the Navy intends to cooperate very closely with the civilian agencies and to work through, in a sense, a board of advisors of which we hope to be a member. This national data center, with the very expert and fine physical facilities that are available in the Navy at the present time, will be a wonderful way to bring together both physical and biological oceanographic data and make it more available for the scientists of our country and, in fact, the world.

Sometimes I am appalled by the amount of data and the complexity of data that is being assembled. Some of us have been giving thought to how we can make this data available. It is sometimes in a sense locked within agencies and not available, and there is no easy way to do this. I believe this is another field where considerable research is needed—to handle both biological and physical oceanographic data and put it in a form where you can retrieve it in some sort of sensible way so that it can be analyzed by our scientists, and so that it can free our scientists from sometimes overwhelming problems of attempting to manually tabulate and keep track of tremendous amount of data, which are accumulating at a tremendous rate in some fields.

So we are enthusiastic about this data center. We believe that the recommendations that have been made to put this within the Hydrographic Office with a group of civilian agencies advising the Hydrographic Office to make the data essentially civilian data unclassified and available to all concerned, is a good thing, and we believe with

the experts that the Navy has and with the physical facilities they have available, this perhaps is one of the wisest of moves.

I am of the opinion this could be done perhaps in other ways also. I believe that the Department of Commerce could very well accomplish it. They also have very highly trained and highly technical staffs. I suspect that the Smithsonian, by expanding and enlarging their current system, might possibly do it, though I am not quite so familiar in this instance. But it seems to me that the way recommended by a number of the research agencies recently, through the Hydrographic Office, perhaps is the one that we should give a trial.

Mr. Chairman, I am available for any questions now.

Mr. BAUER. Mr. McKernan, let us pay our attention first to the question of survey. What do you conceive would be an oceanwide survey in the sense of marine biology? How would you go about it?

Mr. MCKERNAN. In the first place, at the present time it seems to me our knowledge of the oceans is spotty. In some parts of the world it is not very worthwhile from the standpoint of assessing the living resources of the sea, or areas of productivity of the sea. What I would like to see is very close cooperation, not only on a national scale—which by the way we do not have perfectly at the present time—but on an international scale, and with systematic surveys drawn up that would survey not only the physical oceanography, but the biology in terms of the measures of productivity, in terms of the standing crop of organisms, the phytoplankton and the zooplankton, and quantitive measures of the standing crop of other organisms larger than plankton up to the mammals existing in these particular areas.

Mr. BAUER. With respect to how you go about it, let's do a little more thinking on that score.

Would you combine a biological survey with the same hull that you are using in physical or geological oceanography?

Mr. MCKERNAN. I believe we are talking about worldwide surveys, and, if I can use the term that is pretty well overworked, the basic surveys to find out what the oceans are like. I believe the biological and physical oceanographic surveys can probably be combined and can be handled by a single survey ship. Now this means that you are going to sacrifice something in measuring the standing crop of the larger organisms such as the fishes because this requires perhaps a specialized vessel, but in our efforts in the Central Pacific you will remember that we tried both ways of carrying out surveys of broad areas in the Central Pacific. We found in general the oceanographic surveys—and by that I mean the studying of the crop of smaller organisms plus the studies of the productivity in the area—could be done in one vessel, but the moment that we attempted to put experimental fishing gear on the boats we then tended to sacrifice considerably with respect to getting good physical and chemical oceanography. We could not cover enough space in a reasonable amount of time. So what we did in those instances was we attempted to find out where the rich pastures of the ocean might be, and then we came in later with experimental fishing boats and explored further these rich pasturages of the ocean to find out what kind of a crop of usable living resources were available there. This worked very successfully in the Central Pacific and I expect that it could work on a broader, worldwide basis.

Mr. BAUER. In other words, as far as your organization is concerned, you really need two types of survey operations, one devoted to the motivation of commercial fishes, or sport fishes, and the other with respect to the study of biology and ecology of the sea as it exists; is that right?

Mr. MCKERNAN. You could call a study of the concentrations of the living resources of the sea a survey if you like, but I would make a broad survey of the ecology and biology of the oceans along with the physical and chemical oceanography, and I would then follow this up in promising areas with more concentrated studies by perhaps smaller, or more specialized vessels which could carry two or three or four kinds of fishing gear including nets of various sorts. And that is the way that I would do it.

Mr. BAUER. In other words, the operation of the *Delaware* would not be of a survey nature but of an experimental fishing gear type of operation?

Mr. MCKERNAN. Right.

Mr. BAUER. Do we have any such vessels in the service of our country?

Mr. MCKERNAN. We do not have many good vessels. We have used vessels, both ourselves and a number of our oceanographic institutions, but I think we are pretty lean on good survey vessels with a good stable platform that can go to sea for a long period of time and cover a large area of the ocean. This is certainly essential to getting started in this direction. I believe that we are way behind. Our own efforts have been in very small, unsatisfactory vessels, sometimes risking life and limb actually.

Mr. BAUER. Are you currently conducting any surveys of pelagic fishes outside of tuna?

Mr. MCKERNAN. We are conducting such work in the Central Pacific and are doing some work on surveying this area for all species of fish, not only tuna.

Mr. BAUER. With respect to the data center, what would you have in mind as far as data that could be supplied, biological data, to a data center that would be established in the Hydrographic Office as you suggest, or the Coast and Geodetic Survey as the bill suggests?

Mr. MCKERNAN. All kinds of quantitative biological data, I believe, could be adjusted and put in an electronic data machine. I would be inclined to attempt to see whether or not such things as measurements of fish catches from surveys and from more intensive studies, such things as quantitative measures of plankton of various kinds, both quantity and quality of the living resources that we are taking in any kind of a quantitative way would fit themselves readily into such an electronic data center, or system.

Mr. BAUER. With respect to the survey, do you have any plan how this survey of the ocean should be made?

Mr. MCKERNAN. We have been giving it some thought. We do not have any specific plan but we would hope, of course, to work with the other countries, and, in fact, we are at the present time through both the North Atlantic Commission of 12 nations and also through the North Pacific Commission carrying on broad oceanographic investigations, oceanographic and fisheries investigations which would lend themselves very well to a survey type operation. In direct answer to your question I would say in some parts of the ocean we do have

plans for a survey type operation. We do not have proper vessels and good enough equipment at the present time to carry these out in the way that they should be carried out.

Mr. BAUER. How about this question of taxonomy that comes up? How do you feel about that?

Mr. MCKERNAN. We are doing some taxonomy at the present time. We have had two taxonomists here at the Smithsonian Institution, but we also supply large amounts of taxonomic material to taxonomists around the country. Here again, I come back to this matter of the need for basic research and a support for basic research, and I would say that we need to expand tremendously the work done by museums and universities along the taxonomic line. This has to be supported somehow by Government, and our own taxonomic efforts probably need expanding also. There has been some question as to whether or not these should be funded through our particular Bureau or somewhere else, and I do not have any particular strong feelings in this regard. We would be glad to do this, but on the other hand we are not asking for a thankless job particularly. I think that there has been some misunderstanding of our position in this regard.

Mr. BAUER. When do you contemplate you will have a plan for ocean surveys?

Mr. MCKERNAN. Whenever we see ocean surveys are getting underway we will be a part of a team. I would hope that it would be composed of Government and non-Government scientists interested in oceanography, and that we would participate in ascertaining what biological observations would be made on these particular surveys, so the answer to your question would be that we have to firm up just a little bit more the wherewithal to carry on broad ocean surveys before we get into detailed planning on an oceanwide basis.

Mr. MILLER. Thank you, Mr. McKernan. We always know that you are available.

Our next witness will be Dr. Milner B. Schaefer of the Inter-American Tropical Tuna Commission, La Jolla, Calif. We are very happy to welcome you here.

## STATEMENT OF DR. MILNER B. SCHAEFER, INTER-AMERICAN TROPICAL TUNA COMMISSION, LA JOLLA, CALIF.

Mr. SCHAEFER. Mr. Chairman, I want to speak this morning particularly about three of the subjects that are before your committee. First I want to speak on the matter of surveys, second on the data center, and third on the instrument calibration and test facility. I will be glad to discuss any other topics that you would like. I have a prepared statement here of about nine pages, and unless you wish me to read it I can summarize it.

Mr. MILLER. Suppose that you summarize it. We will insert your statement in the record at this point.

(The statement referred to follows:)

STATEMENT OF DR. MILNER B. SCHAEFER

I am Milner B. Schaefer, Director of Investigations of the Inter-American Tropical Tuna Commission, and research associate of the Scripps Institution of Oceanography of the University of California. I am a member of the Committee on Oceanography of the National Academy of Sciences-National Research Council. I am also a member of the NAS–NRC Committee on Effects of Atomic

Radiation on Oceanography and Fisheries. It is a privilege and a pleasure to have the opportunity to appear before your committee.

As you know, during the past 2½ years our Committee on Oceanography has reviewed in considerable detail the present status of oceanography, in its broadest sense, in the United States. We have estimated the needs and the requirements for additional national support in this field. We have made a number of recommendations for strengthening our national program in the marine sciences during the next 10 years. It is gratifying that the Congress is now considering ways and means of implementing these recommendations.

One of the important recommendations of the Committee on Oceanography is the need to make comprehensive surveys of the ocean, its boundaries, and its contents. Three-dimensional, oceanwide, ocean deep maps of such features as depth, salinity, temperature, current velocity, turbulence, wave motion, magnetism, and biological activity are urgently needed for immediate uses (for certain military problems, for the expansion and development of fisheries, for efficient routing of merchant ships, and for the disposal of industrial waste products) and to provide the comprehensive knowledge of the ocean and its contents needed for long-term basic research—research which will ultimately yield great benefits to the people of our Nation and the rest of the world. The task of making these surveys is large. It can and should be started on a planned, coordinated basis as soon as possible.

The oceanwide, ocean deep survey will involve many ships, technicians, and scientists from a variety of disciplines. Its efficient execution will require adequate cooperation and coordination among the several governmental agencies having interests and responsibilities in this aspect of oceanography. It will also require a high degree of international coordination since it is envisaged that the United States should undertake only about a third of the worldwide survey. The remainder of the survey would be done by other maritime nations on a cooperative basis. That this is possible is evidenced by the success of the International Geophysical Year, and by the plans now being formulated for an international study of the Indian Ocean.

Several means of providing the required interagency coordination within the United States have been proposed. H.R. 9361 and the companion Senate bill S. 2692 propose that a Division of Marine Sciences be established in the National Science Foundation. One possibility is to vest the responsibility for interagency coordination of the survey in this new office which would include in its membership representatives from the several Government agencies concerned (as well as representatives from universities and other nongovernmental institutions).

A second proposal, contained in H.R. 10412, 10546, and 10581, is to create a Coordinating Committee on Oceanographic Surveys with membership from the several Federal agencies dealing with oceanographic problems, reporting both to the President and to the Congress. It is noted that there is no provision for nongovernmental representatives on this Coordinating Committee. Since most of the oceanographic research of the United States and a good deal of survey work is being done and will doubtless continue to be done by universities and other nongovernmental institutions, it is my personal opinion that representation of such organizations would be desirable on any survey coordinating committee.

Recently a permanent Interagency Committee on Oceanography of the Federal Council on Science and Technology has been established. We understand that this Committee is planning to establish an Ocean Survey Advisory Panel in the immediate future. This Panel would have in its membership representatives from various Federal agencies concerned with this aspect of oceanography. Provision would be made for consultation with the scientific community. It seems to be highly possible that this may provide effective interagency coordination.

We are pleased to see that both the legislative and executive branches of our Government appreciate the need for broad oceanographic surveys and recognize the requirement for effective interagency coordination in their planning, financing, and execution. The particular kind of organization chosen to bring about this coordination is probably of lesser importance than the establishment of some organization.

Another aspect of the oceanographic requirements of the United States about which I would like to speak briefly is the need for a national oceanographic data center to serve adequately all public needs, particularly the civilian requirements of governmental agencies, scientific institutions, and individual scientists.

The need for such a center has become acute. A great volume of physical, chemical, and biological data is continually being collected in many areas by different groups for different purposes. Much of these data remain unpublished, stored in the files of both governmental and nongovernmental institutions. More is required, however, than simply a depository. A service facility is needed for central storage and readout. It is also necessary for the data center to undertake some degree of evaluation and quality control of the observations, preliminary processing, and summarization in convenient form for use by researchers, preparation of regular data summaries, catalogs, and atlases for those kinds of information widely used.

One small example is the use of sea-surface temperature information. Surface temperature data is taken by merchant vessels, research vessels, shore stations, and military craft. Several millions of such temperature observations are in the files of the Hydrographic Office and of the Weather Bureau's center at Asheville, N.C. In order to use these to study the variations in the temperature regime of the oceans, it is necessary first to do a careful job of editing the data to eliminate the "bad" observations. Then the data must be summarized and averaged by small intervals of space and time for each year. One of my colleagues is doing this, for the North Pacific Ocean. He has the original data for this area for the last couple of decades on punchcards. For over 2 years now, he (with several assistants), has been editing, summarizing, and charting surface temperatures by 2° squares for each month of the year. It will probably be yet several years before all the data are thus summarized. It is obviously inefficient to have several different groups doing this sort of thing, each for one piece of ocean. A central agency using the most modern data processing and computing equipment could do it much faster and cheaper, and also keep the processing up to date with the inflow of new data.

We must recognize that the collection and accumulation of oceanographic data will accelerate greatly. Increasing numbers of research and survey vessels will collect observations. Continuously recording instruments will turn out veritable floods of information which can only be processed in any reasonable time by modern data handling and computing equipment.

The Committee on Oceanography, having considered these problems, recommended in chapter 3 of its report "Ocean Resources":

"The most economical method for establishing the National Oceanographic Record Center would be to add it to an existing expandable facility in a Federal bureau concerned with technical and scientific matters, and with an interest in sea studies. Such a group should have both a tradition for performing public service and the competence and experience to handle large quantities of technical data.

"The U.S. Coast and Geodetic Survey and the U.S. Weather Bureau, both of which are in the Department of Commerce, most nearly meet these criteria. The former has the more direct interest in the sea; the latter has the greater facilities for mass processing of data. The U.S. Hydrographic Office also is concerned with technical and scientific matters; and it has even more widespread interest in oceanography, but it serves Navy needs primarily and civilian needs secondarily. All three collect, preserve, and disseminate certain types of oceanographic data. The panel considers that the National Oceanographic Records Center's function would be primarily to serve the public and that it should reside in a civilian agency in order to render this service effectively."

Quite recently, since the publication of that chapter of our report, we have been informed that a plan has been developed, under the auspices of the Interagency Committee on Oceanography, to set up an oceanographic data center at Suitland, Md., physically adjacent to the U.S. Hydrographic Office, but administered cooperatively by the Navy, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Atomic Energy Commission, and the National Science Foundation. In our opinion this would be a satisfactory way of meeting the requirements for a data center, providing that it is clearly stipulated that this center serve civilian and military needs adequately and on an equal priority basis. We recognize that certain classified military requirements are of very high priority. These should be handled by the Hydrographic Office essentially outside the National Oceanographic Data Center.

If the national data center were to be set up in the Coast and Geodetic Survey, as proposed in H.R. 12018, the center would tend to serve civilian needs on at least an equal-priority basis. However, the Hydrographic Office now has the world's largest collection of oceanographic data and the personnel experienced in the storage, processing, and interpretation of such data. If a new center is

located near the Hydrographic Office, much unnecessary duplication of facilities and data could be avoided.

H.R. 12018 also authorizes the establishment within the Coast and Geodetic Survey of a National Instrument Test and Calibration Center. This center would test, calibrate and evaluate geographic and hydrographic instruments, on a cost-reimbursable basis, for both governmental and nongovernmental agencies and persons, including foreign agencies and persons. I believe that the establishment of such a facility is of very great importance, especially in view of the plans for coordinated oceanwide research and surveys. These surveys will involve the efforts of many different groups within the United States and from other cooperating nations. The larger laboratories in the United States do most of their own instrument testing and calibration, but there is certainly a need for such services for smaller laboratories which cannot afford the necessary facilities. Even the larger laboratories might find that a national center would be able to provide the services at a lower cost. In the case of foreign laboratories, such as the small laboratories of some of our Latin-American neighbors, I know from personal experience that such a service would be very valuable to them, and could be an effective means of encouraging their development of marine sciences, as well as insuring that the data collected by them are accurate and comparable to those collected elsewhere.

I have no personal opinion as to whether such a test and calibration center should be located in the Coast and Geodetic Survey, the Hydrographic Office, the Bureau of Standards, or some other agency. I believe that any of the agencies I have just named could do the job competently.

Dr. SCHAEFER. With respect to the surveys, as you know, our committee has for some time reviewed this matter of the needs for surveys and we are extremely gratified to note that the Congress and the administration are both recognizing the necessity for these and are considering ways and means of accomplishing them.

The surveys, in our opinion, should be three dimensional, oceanwide. They should map such features as depth, salinity, temperature, current velocity, turbulence, wave motion, magnetism, and biological activity. These surveys are of value, both for immediate uses, for certain military problems, for the expansion and development of fisheries, for the efficient routing of merchant ships, and for the disposal of industrial waste products such as atomic waste, but they are also useful to provide a comprehensive background which will form a basis for scientists to orient basic research in particular subjects which will ultimately yield new kinds of benefits to our citizens and the rest of the world.

The task of making these surveys is very large. They will have to be made on a planned, coordinated basis, and in order to do it with any reasonable number of ships, and in any reasonable length of time, it will have to be done on an international basis. Our estimate is that the United States should undertake about a third of this worldwide survey and the remainder be done by other maritime nations on a cooperative basis. We believe that this procedure is feasible on the basis of the experience with the success of the International Geophysical Year, and the plans that are now being formulated for an international study of the Indian Ocean.

One aspect of these surveys, of course, which is important is the matter of the ship's position. It is particularly important with respect to the surveys of the bottom topography of the ocean. Precise positioning is needed for this. One of the interesting aspects of this problem is the navigational satellites which the space agency is just beginning to get up. I was talking to one of the scientists yesterday evening. It turns out that the technicians feel that they can make a shipboard instrument for using the navigational satellites which will

give the positions accurate to something like half a mile at a cost of something in the neighborhood of $10,000 or $20,000. The reason that I mention this specifically is because such a device would be not only important for the surveys, but in my opinion would be of very great value to our fishermen. Our tuna fishermen, for example in California, wish to locate a certain sea mount, because the tuna are attracted to these sea mounts and are more abundant there, and they sometimes spend a long time looking for it. If they had precise navigation they could go there much more directly and save on the running time. Similarly in the New England area on the Grand Banks there is a lot of rocky ground, and some flat ground, and the fisherman spends quite a little time looking for his particular 500 acres of flat ground. This precise navigational equipment will be of value, not only to the oceanographic surveyors, but also of great practical value to our fishermen.

Mr. MILLER. Why are the tuna attracted to the areas around the sea mounts?

Dr. SCHAEFER. I wish that I could give you a good clear answer to that. Unfortunately I cannot. It appears that there is a current going by the sea mounts which modify the circulation so that it brings up a greater amount of nutrients to the surface and supports a larger stock of forage fish. However, the mechanism by which this happens is pretty complex. We have been making some studies, in my own group, of this around one of the sea mounts and the mechanisms here look awfully complicated. We cannot give you a clear answer.

Mr. MILLER. This record will be read by laymen. I thought that this would be a good place to get that in the record.

Dr. SCHAEFER. With regard to the means of getting interagency coordination on these surveys there are several bills before the Congress. There is H.R. 9361 and the companion Senate bill, S. 2692, that propose that a Division of Marine Sciences be established in the National Science Foundation. There are a series of other bills, H.R. 10412, and two others of similar nature, to create a coordinating committee on oceanographic surveys with membership from the several Federal agencies dealing with oceanographic problems, reporting both to the President and to the Congress. With respect to those particular bills we note that there is no explicit provision for non-Government representatives on the coordinating committee. Since a lot of the oceanographic research of the United States and a good deal of the survey work is being done and will doubtless continue to be done by universities and other nongovermental institutions, I personally feel some representation of these nongovernmental people might well be provided for.

Mr. MILLER. If the bill were amended to provide for representation by these nongovermental agencies, with perhaps one or more representatives from the State agencies, do you think that would have some merit?

Dr. SCHAEFER. Yes; I think that it would have some merit. Actually, in regard to how this coordinating group is set up, I do not feel very strongly and I do not believe that my colleagues on the oceanographic committee feel very strongly. There are these various pieces of legislation that would provide this. At the same time, the interagency committee on oceanography of the Federal Council is planning to establish an ocean survey advisory panel consisting of

representatives of the various agencies, and in their prospectus on this panel they also propose to provide for consultation with the scientific community. In this particular area I think that our position is that the particular kind of organization chosen to bring about the coordination is of less importance than that there be established *some* organization. Which particular form is the most desirable I do not feel strongly about, and I do not think that my colleagues do.

Mr. MILLER. As far as I am concerned, being one of the authors of these bills, I can feel strongly about it. I want to do something to draw you fellows out.

Dr. SCHAEFER. I rather feel in that particular area that perhaps the Oceanographic Committee of the Federal Council may handle it quite adequately. However, the question of legislation on the subject gets into the matter of committees reporting both to the President and the Congress and this is an area we are not very experienced in. My personal feeling is this particular function probably could be handled by the Federal Council Committee. As I say, I would not urge any particular thing strongly. I would urge some mechanism be established fairly promptly.

Mr. MILLER. Getting back to the story that I told, I am just a thinker. I am trying to get you fellows to give a little guidance.

Dr. SCHAEFER. Turning now to the matter of the data center, we feel that there is a very great need for a national data center to serve adequately all the public needs, particularly the civilian requirements of governmental agencies, scientific institutions and individual scientists.

The need for such a center has become acute. An extremely large volume of physical, chemical, and biological data are continually being collected in many areas by different groups for different purposes. Much of these data remain unpublished, stored in the files of both governmental and nongovernmental institutions. I would like to emphasize that more is required, however, than simply a depository, that is, a service facility for central storage like a library. It is also necessary for a data center to undertake some degree of evaluation and quality control of the observations, preliminary processing, and summarization in convenient form for use by researchers, preparation of regular data summaries, catalogs, and atlases for those kinds of information widely used. A central agency, using the most modern data-processing and computing equipment, could do this preliminary processing job, summarizing job, much more efficiently, rapidly and more cheaply than different scientists working on different pieces of the ocean individually.

Mr. MILLER. You want something more than just an archives.

Dr. SCHAEFER. Something more than just an archives. The data needs to be put into a comparable form, to be edited to eliminate the "bad" observations. A good example of that is this: One of my colleagues at Stanford University, Dr. Sette, at the present time is working on the sea surface temperature data of the North Pacific Ocean. Now, he has obtained these data from the archives of the Hydrographic Office and the weather data center at Asheville, N.C., in the form of punchcards, the original observations, so he has quite a few million cards for all of the various sea-surface temperature observations made by merchant ships, research ships, and so on, over the last couple of decades. In order to put these in a form to in-

vestigate the short- and long-term variations in the distribution of sea-surface temperatures in the North Pacific, he has to first get these things averaged by 2° squares for each month of each year. He has been at this with several assistants for a couple of years and it will be some years yet before he has all of these charts completed. He has to go through these, edit out the bad observations, make the averages and plot them up and process them and so on. Although he is using punchcard equipment I think really modern data-processing equipment at a central data center could do this thing much more efficiently than having Dr. Sette at Stanford working on the North Pacific and someone else on the South Pacific.

Mr. MILLER. Here is where you have a lot of data that has never been analyzed and coordinated.

Dr. SCHAEFER. It has never been put in a form where scientists can get it out in the form they want to do their research on.

Mr. MILLER. Do you think besides in this field there are other fields where data is being collected that needs analysis?

Dr. SCHAEFER. This is only one example. It has been anticipated that we will have fairly shortly not only the survey vessels getting increasingly large quantities of data, but also we hope that we will have at various points in the ocean anchored buoys that are continuously recording various things. These are like the weather stations on land, where the network of weather stations get observations four times a day. With the survey vessels, and with these continuously recording instruments, we are going to have tremendous floods of data coming in. These data in this magnitude can only be processed in any reasonable amount of time by modern data-handling equipment and computing equipment. This is the sort of thing that the Texas Instrument people were referring to yesterday that they use to process their geophysical data. If you have 200 buoys, say, sitting out in the various oceans pouring out data continuously, you simply have to handle this by modern data-handling methods, you cannot do it with pencil and paper.

Now initially the Committee on Oceanography in considering this data center problem recommended that the most economical method for doing this would be to put into an expandable facility in a Federal bureau concerned with technical and scientific matters, and we further suggested that either the Coast and Geodetic Survey, or the U.S. Weather Bureau in the Department of Commerce would meet these criteria. We noted at that time that the U.S. Hydrographic Office is also concerned with technical and scientific matters, but it serves the Navy's needs primarily and civilian needs secondarily. Since that chapter of our report was written—in fact, quite recently—we have been informed that a plan has been devolved under the auspices of the Interagency Committee on Oceanography to set up a data center at Suitland, Md., physically adjacent to the U.S. Hydrographic Office but administered cooperatively by the Navy, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Atomic Energy Commission, and the National Science Foundation.

It is our opinion that this would be a satisfactory way of meeting the requirements for a data center provided it clearly stipulated that this center serves civilian and military needs adequately and on an equal priority basis.

Mr. MILLER. I think that is quite significant.

Dr. SCHAEFER. Yes.

Mr. MILLER. The only way I know of assuring that this is going to be done would be that.

Dr. SCHAEFER. This may very well be so. In fact, one point I did want to emphasize in amplification of my written statement here is that there needs to be a Board of Control consisting of representatives of these other agencies and perhaps of some non-Government scientists that acts in more than simply an advisory capacity. With an advisory board, you can take their advice or you can leave it alone. I think it is highly desirable at this data center, if it is located at the Hydrographic Office, to have a board of directors, determining its policy and the methods of operation, that is more than an advisory board, that actually runs it.

The third topic I would like to speak about briefly is the National Instrument Test and Calibration Center, a center to test, calibrate, and evaluate oceanographic and hydrographic instruments on a cost-reimbursable basis for both governmental and nongovernmental agencies, including foreign agencies and persons.

I believe the establishment of such facility is of very great importance, particularly in view of the plans for coordinated oceanwide survey and research programs. These surveys will involve the efforts of many different groups within the United States and from other cooperating nations.

At the present time the larger laboratories in the United States do most of their own instrument testing and calibration, but there is certainly a need for such services for smaller laboratories which cannot afford to have these facilities themselves, and even the large laboratories might very well find a national center would be able to provide these services at a lower cost than the cost for which we can provide the service ourselves.

I would also like to emphasize, in the case of foreign laboratories, such as the small laboratories of some of our Latin American neighbors, I know from personal experience such a service would be very valuable. This could be a very effective means of encouraging their development of marine sciences, and particularly in insuring that the data collected by them are accurate and comparable to those collected elsewhere.

Whether such a test and calibration center should be located in the Coast and Geodetic Survey, the Hydrographic Office, or the Bureau of Standards or some other agency I do not have any personal opinion. I think any of those agencies just named could do the job competently.

Mr. MILLER. There is a need for such a center?

Dr. SCHAEFER. Yes.

Mr. MILLER. Where we put it would be governed by other considerations.

Dr. SCHAEFER. Yes.

Mr. MILLER. Mr. Bauer.

Mr. BAUER. Let us talk on the data center bill by section (c) on page 2, the National Oceanographic Data Center is authorized to conduct research and other projects within the field of its activities for any department, agency, or instrumentality of the Government of the United States on a cost reimbursable basis.

The question is: Does that cover the need that you mentioned in the first instance when you were talking about a data center, getting the data information for us, or is it too narrow a statement?

Dr. SCHAEFER. I think this covers it.

Mr. BAUER. Regardless of where the data center is.

Dr. SCHAEFER. The thing we have in mind there is that there are certain things probably the data center would do for the Government agencies and the scientific community at large. For example, with respect to the sea surface temperatures, to put out atlases showing the monthly averages by 1° or 2° squares by each month of each year. It is the same thing the Coast and Geodetic Survey does now with tide level data. They reduce these and put out a publication each year showing average tide levels by months for each tide station. This is the sort of thing many scientists and Government agencies use. I would think the data center would do this sort of routine thing with its own appropriations, or the funds of the Navy and the various Government agencies.

However, a scientist, for instance, might want a particular kind of data gotten out of the files and averaged in a certain form that is not part of the general routine. In this case I want to be able to write in and say that these are the data I want. How much will it cost me to get them? When can you deliver them? They could give me an estimate and I could say to go ahead and do it.

Mr. BAUER. I was thinking it should be enlarged to include private and commercial institutions, both domestic and foreign, on a cost reimbursable basis.

Mr. MILLER. Plus the States.

Dr. SCHAEFER. It probably should include provisions for these services to institutions and individual scientists as well as Government agencies.

Mr. BAUER. Thank you.

Mr. MILLER. Mr. Flynn?

Mr. FLYNN. No questions.

Mr. MILLER. Mr. Drewry?

Mr. DREWRY. I came in late. I probably missed something. However, in connection with the proposal in H.R. 10412, the oceanographic survey, do you oppose that bill or are you just commenting that there are several approaches to it?

Dr. SCHAEFER. I do not necessarily oppose it. As far as I am concerned, and I think as far as the rest of the Academy Committee is concerned, we feel that the present Committee of the Federal Council may be quite adequate to handle this job. Doing it by legislation, with a group that reports both to the Congress and to the President, is another way of doing it. We feel that having some group for doing it is the important thing. The exact mechanism in this case I do not think is of particular interest to us.

We can see where a bill of this sort, where a group of representatives of the administrative departments, reporting both to the Congress and to the President, might involve some administrative problems. This is a subject we are really not very competent to deal with.

Mr. DREWRY. Just thinking back to when your committee first came to the Hill to tell us what had been going on, the immediate problem,

which I believe you felt and certainly we did, was: How do we make anything like a 10-year program stick? Appropriations are not handled on a long-term basis. Congresses come and go every 2 years. Presidential terms run every 4 years. In seeking a way to find some base to give the thing a hard core that would carry on on anything like a 10-year program, we tried what is represented by this bill as being something that, established by statute, it would have to stay in being. By putting it on the oceanography survey aspect of it, it would hit the real hard core, the initial effort that must be made.

By reporting to Congress under statute, the dangers of loss of interest on the executive side or just a change of viewpoint due to a change in the executive would be avoided.

I believe you mentioned here that it was your personal opinion that representation of the outside organizations would be desirable on any survey coordinating committee. Could not that be done effectively through means that are already in operation, despite the fact that there were a certain statutorily established oceanographic survey committee?

Dr. SCHAEFER. It could, sir, but there again you get into this same question that although authority already exists, when it is spelled out, it is sometimes more desirable than just having an understanding. Mr. Pelly's bill, which is similar to the Magnuson bill in the Senate, for example, provides that, with respect to this, they essentially are proposing to put this function and a number of other functions in a division of the National Science Foundation.

In the case of that bill, it specifically provides that the board of this new division would include, in addition to representatives of the Government agencies, several representatives from nongovernmental scientific institutions.

Rising to the chairman's challenge to quit being a thinker and be a politician for a moment—admitting I am in a field about which I know nothing—one thing I would like to say is that this business of authorization already existing comes up quite often. I think, as a matter of fact, even though authority already exists, when the Congress passes a bill making the authority again, it is sometimes much more effective than simply recognizing that the authority exists.

Mr. DREWRY. I think that is what we are both aiming for.

Dr. SCHAEFER. With respect to this particular bill, H.R. 10412, establishing a Committee on Oceanographic Surveys, I rather tend to think this is taking one facet of the oceanographic problem rather than the whole thing. The surveys are important, but so are the provisions for basic research and a great many other things.

I would think that if the Congress is passing authorizing legislation it might be desirable to do something more comprehensive along the lines of the Pelly-Magnuson bill rather than one item at a time. Here again I am talking about a subject in which I am by no means expert.

Mr. DREWRY. Thank you very much.

Mr. BAUER. Thank you, Dr. Schaefer. That was a very good statement.

Mr. Chairman, our next witness is Dr. Joel Hedgpeth, marine biologist, director, Pacific Marine Station, Dillon Beach, Calif.

## STATEMENT OF DR. JOEL W. HEDGPETH, MARINE BIOLOGIST; DIRECTOR, PACIFIC MARINE STATION, DILLON BEACH, CALIF.

Dr. HEDGPETH. Mr. Chairman, I have a short prepared statement here that, with your permission, I would prefer to simply summarize, and insert some remarks that occurred to me in listening to the other testimony.

(Dr. Hedgpeth's prepared statement follows:)

STATEMENT OF JOEL W. HEDGPETH CONCERNING H.R. 9361

My name is Joel W. Hedgpeth. I am director of Pacific Marine Station, a marine laboratory maintained by the College of the Pacific at Dillon Beach, Calif., about 55 miles north of San Francisco. In addition to administrative duties, I am also professor of zoology and devote part of my time to teaching zoology and directing graduate students. Today, however, I am appearing before this committee in response to an invitation from the Honorable George P. Miller, chairman, extended through the American Institute of Biological Sciences. There are almost 100,000 biologists in this country and Canada. A large number of these biologists, perhaps 10 percent or more, are directly concerned in one way or another with aquatic biology, with the phenomena of life and the action of living processes in the aquatic environment, whether fresh, brackish, or marine. Although marine bilogists in particular comprise a large group of scientists with diverse interests, ranging from such matters as the action of different types of chlorophyll found in various seaweeds to the energy budget of bottom-dwelling worms and clams, I am confident that I speak for all of them in saying that we are gratified by the consideration being given to the problems of oceanography and marine biology by the committee, that we are awaiting with interest the result of the committee's deliberations and that we are confident this committee will design a reasonable, imaginative and sound program to promote research in this important field of science.

We feel that this bill marks a distinct advance in the status of oceanography and marine biology on the national level, and earnestly hope that the objectives of the bill will be achieved. I think that I can best contribute to this end by presenting, for the benefit of this committee, a brief discussion of the present status of aquatic biology, how it fits into a general program for oceanography, and what the future needs and prospects for aquatic biology are. You will note that the term "aquatic biology" is used rather than "marine biology." We do this because it is not only difficult at times to distinguish between marine and fresh water biology because of the similar approaches, but also because some of the same people carry on studies involving situations in lakes and streams and in the oceans. I myself have published papers on fresh water shrimp, organisms found in desert brine pools, and on bottom animals from 2 miles beneath the surface of the sea. Furthermore, we prefer to consider marine and fresh water biology together because it is often necessary to work with physiological problems involving the transition from fresh to salt water, and because many marine biologists first learn their subject by starting in fresh water. However, for the most part we are concerned with marine biology because the oceans constitute by volume some two or three hundred times the living space available on land or in fresh water, and there is no part of the ocean without some life in it. Our point here is that we cannot always distinguish between marine and fresh water biology, and we hope that the ultimate version of this bill will recognize this problem by avoiding a too-rigid definition of the fields to be included.

Marine biology itself is not a simple subject but is simply the study of life in the sea. If it has any distinct characteristics from other types of biology, it is the concern with those processes involving living organisms in a three-dimensional environment that is also the medium by which most of the essential ingredients for those processes are carried about. Thus we have the hosts of organisms that live by sieving or accumulating finely suspended or dissolved materials from the medium. Indeed, without life in the ocean most of the problems involving the disposal of radioactive materials in the sea would not exist. In fact, without life in the ocean, most of the problems of physical oceanography would be of little interest to the average man. It is because there are fishes and strange creatures in the sea that we have so much popular interest in oceanography. Most scientists, I am sure, consider oceanography as a synthesis of what we study in the sea. As such, it embraces all sciences and

not the least of them is biology. To a biologist, oceanography without biology is a contradiction in terms.

As director of a comparatively small marine laboratory, I have been able to watch at close hand the growing interest these last few years in all things pertaining to the sea demonstrated by teachers, students, and the general public. This development of interest is undoubtedly due in part to the activities of the National Science Foundation in sponsoring summer institutes for teachers at marine stations in various parts of the United States. These teachers return to their schools and bring their students to visit nearby laboratories. On May 14, when a good low tide fell on a Saturday, several hundred students visited our laboratory. I talked to three such groups. It is evident that there will be no dearth of young people interested in marine biology, and we will have no difficulty recruiting people. Many universities are requiring their advanced students to spend a summer at the seashore, and we expect two from Kansas and several from Chicago this summer in our classes. This pattern of enrollment is typical of marine stations on all our coasts. Training facilities are also increasing: new laboratories are planned for various parts of the Pacific coast and curricula for marine biology and oceanography are being established at various institutions. What we must hope for is that there will be satisfactory opportunities for these young people once they have completed their training. The quality of their training will depend in part on present research opportunities and these in turn should lead to further opportunities. We hope that the proposed support of oceanography is implemented in such a way that there will not only be employment for young people who can do the things that need to be done, but for those who want to do things that do not have any apparent necessity for national defense, or to expand ocean resources, but simply to "enhance the general welfare."

Although we cannot define aquatic biology in any precise way, we should always remember that great deal of fundamental or basic work is being done without any direct concern for oceanography although the applications of such studies may profoundly influence the direction of oceanographic studies in the future. For example, there are people studying the problems of pure culture of micro-organisms in laboratories affiliated with hospitals and medical foundations; these studies promise to have direct bearing on the problem of utilization of trace materials found in the oceans, or the rate of increase of small poisonous micro-organisms. In general much more work in aquatic biology is being carried on in university laboratories and in small marine stations than in the large oceanographic institutions. The work we have in mind is that carried out, not in the spirit of "what is this good for" but in the spirit of "this is interesting and worth knowing for its own sake." With this in mind, we consider a diversified program involving several granting agencies to be a better way to stimulate significant research rather than to channel money through some new agency set up to embrace all of oceanography. We agree that the more strictly applied phases of aquatic biology, as carried out by the Bureau of Commercial Fisheries, require further support, but we also urge more generous support of the National Science Foundation, bearing in mind that a variety of boards and panels charged with supporting research in aquatic biology should insure a broader consideration of research proposals. On a purely administrative basis the number and diversity of proposals having some possible bearing on oceanography is too large for a single agency to handle effectively.

Systematic biology, the process of identifying organisms and studying changes in structure as related to genetic and environmental differences, whether natural or artificially induced (as by radiation), deserves particular consideration, since the program proposed will result in collections of material on a magnitude comparable with that of the survey program of the old Bureau of Fisheries late in the last century. Because the magnitude of the problem was not realized at that time, many collections from that former survey were never properly studied. Nevertheless, what was adequately treated now forms major parts of collections at the museums at Yale and Harvard as well as in the National Museum in Washington. Proper study of the material which will result from this program will require support of these and other museums having the background collections on which to base further studies. Knowledge of the organisms is one of our prime categories of data, and it cannot be obtained in a mechanical way or by beginning technicians, since recognition of species is essentially a process of mental computation, not of recognition by rote. Nevertheless, there is no scarcity of students offering themselves as prospective systematists, but we cannot encourage them to persist (as some will anyhow) until employment prospects are more encouraging. We need these people in our society, and will need

even more of them in the future. At the present time, studies of the possible effects of radioactive materials on organisms in the vicinity of waste disposal areas in the sea are inadequate because the supply of systematists is inadequate. There should be a place for a systematist in some group of organisms or another at every marine laboratory and oceanographic institution in the country.

Dr. HEDGPETH. I might say I am representing the general marine biological public. Nobody knows how many marine biologists there are. We tried to decide this. The American Institution of Biological Sciences has a nonduplicative directory of something like 100,000 biologists. As a wild guess, I think at least 10 percent of these people do something with marine organisms or work in or near the sea; so there are quite a lot of marine biologists. All of them I know and to whom I have spoken—of course, the National Academy report has been pretty well publicized—are greatly interested and they are greatly pleased as well that Congress has drawn up these bills and is taking this matter so seriously.

Of course, we feel this is, naturally, improving the status of marine biology as well as oceanography. In fact, oceanography without biology is somewhat of a contradiction in terms.

I was very glad to hear Chairman Miller make the remark that development of biology and physical oceanography should be on an equal basis.

I am director of a small marine station, and perhaps I am in somewhat closer contact with high school student groups and public groups than some of the other people. I might say I am out among the people. I talk to many of these groups. I have noticed the great interest of young people in learning about marine biology and expressing interest in going on and studying this in college.

Of course, as a professor of zoology I encourage some students to go on and, naturally, as every professor has to, I try to discourage some others. There is certainly no scarcity of people who want to be marine biologists of one kind or another.

One of our problems has been with people who want to become systematists or taxonomists. This problem has been mentioned. We have felt that we ought to discourage most of the students who want to become systematists, because there are so very few jobs for these people. This program should offer opportunities for systematists to carry on the necessary work that will accrue from this oceanographic program.

Being a systematist is a rather difficult art. It is a science as well. I am one myself. I have worked with rather large collections. What happens is essentially a process of human computation. You do not just memorize the shapes and forms of these animals and then slap names on them. You have to visualize sometimes a great deal more than that. We are going to need more of these people because so much work involving radioactive waste disposal is coming up. Here it will be perceptions of changes in form and structure, perhaps. We do not know.

At any rate, I view this bill as providing some opportunities for systematists, and I have already told one student that if these things materialize by the time he has gotten his Ph. D., there may well be a satisfactory job for him. At the present time they are limited, and museum budgets are pretty lean.

I think another problem not too thoroughly recognized with our museums is that they are public institutions and they have to help the

public, people who want things identified. They have to do a lot of routine work, and quite often this has to be done by the best man in the place.

There have been some discussions of who is to do which work and which committee should supervise the basic research programs, and so on. I think most of us on the outside of these things feel a little uncertain about prospects of any large monolithic agencies because marine biology or biology in the sea and/or aquatic biology as well—we should emphasize a lot of the work involved in fresh water is just about the same as that in marine work, the techniques are the same, philosophy is the same, and in the case of systematists they work all the way through the salinity range. I have published papers on fresh water and marine brines and the ocean myself.

At any rate, we should be talking of aquatic biology. There are so many diverse approaches involved in this that we think the support of present agencies such as the National Science Foundation and the Bureau of Commercial Fisheries is to be preferred to what some people have heard, perhaps mistakenly, of a more overall oceanographic direction of everything.

For example, some of the problems that have direct concern with these aspects of improving oceanic fisheries are going on in medical research laboratories, involving the attempts to raise certain microorganisms on only a single type of food.

Then there are other people who are doing studies on the physiology of worms as related to salinity. This may yield as valuable information on tolerances of species in different latitudes and the like.

A great deal of the material on marine biology at shore stations and university laboratories has direct bearing on the ocean. For this reason we hope that the various granting agencies or at least a diversity of them are retained.

Another problem, when too many grant applications come to one particular desk or division, everybody, including the panel and director, begin to get a little weary of the responsibility of deciding who should get the money. It is pretty heavy. All the people I know who are involved in this sort of work take it very seriously and spend sleepless nights over whether Professor A really deserves that much money, and so on.

There is another point that occurred to me in this discussion of a committee. That is, in addition to scientists or representatives of the Government agencies and universities involved in this work, there should be one or two members who have no special interest in it, at least in terms of getting money or carrying on a program. In other words, I think it is advantageous to have disinterested members on such broad committees, who can ask the questions from the layman's standpoint, so to speak.

I think this is the essence of my statement, sir.

Mr. MILLER. Doctor, I was not here when you took the stand. As a fellow Californian, I wanted to welcome you.

Dr. HEDGPETH. I used to live in Walnut Creek.

Mr. MILLER. I used to represent Walnut Creek. Mr. Bauer?

Mr. BAUER. Dr. Hedgpeth, some years ago the Congress passed a law permitting any agency of Government which had the authority to contract to also have the authority to grant. That was at the behest of the National Science Foundation.

Do you feel that the agencies which are now in the granting and the contracting business are doing the maximum they can do to encourage marine biology or aquatic biology?

Dr. HEDGPETH. I must say I do not have too much information on the whole process. I am familiar with the National Science Foundation primarily where I have reviewed many applications. I do not know, really, what percentage of these are actually granted. It has not been the custom, unless the people specifically ask it, for the ad hoc-ers, as they are known, to be informed of the fate of these. I think this has been changed.

Mr. BAUER. Is it a question of underfunding to get the maximum that is desired within the economy, or is it a question of something that is organizationally wrong?

Dr. HEDGPETH. Well, nothing in this world is perfect. I think underfunding is perhaps the most pressing problem, at least in my limited experience——

Mr. BAUER. Are you familiar with the National Science Foundation's program to encourage incentive to the development of personnel interested in aquatic biology?

Dr. HEDGPETH. Yes.

Mr. BAUER. Thank you.

Mr. MILLER. Mr. Flynn?

Mr. FLYNN. No questions.

Mr. MILLER. Thank you very much, Doctor. I notice you are accompanied by Dr. John Olive. Is he here?

Dr. HEDGPETH. Yes.

Mr. MILLER. Have you anything you would like to add?

Dr. OLIVE. No, sir; not today.

Mr. MILLER. Thank you very much, Doctor.

Dr. HEDGEPETH. Thank you.

Mr. MILLER. Mr. Robert Paul of the Sport Fishing Institute.

## STATEMENT OF ROBERT M. PAUL, EXECUTIVE SECRETARY, SPORT FISHING INSTITUTE

Mr. PAUL. Mr. Chairman, I have a rather long prepared statement which I would prefer to submit for the record and make a few brief remarks to supplement it.

Mr. MILLER. Without objection, it will be included in the record.

(Mr. Paul's prepared statement follows:)

STATEMENT OF ROBERT M. PAUL, EXECUTIVE SECRETARY, SPORT FISHING INSTITUTE, ON H.R. 10412 AND H.R. 9361

Mr. Chairman, I am Robert M. Paul, executive secretary of the Sport Fishing Institute, located in Washington, D.C. I am appearing before your committee on behalf of Sport Fishing Institute in order to join other witnesses in urging the early creation of an adequate national oceanographic research program. In addition, we would like to discuss briefly the implications of an expanded ocean research program for sport fishing and the need to emphasize the biological phases of the program, particularly as they relate to inshore and estuary areas.

The Sport Fishing Institute strongly supports the efforts to strengthen oceanographic research represented by the bills under consideration. H.R. 10412 to formalize coordination among the various Federal agencies concerned with oceanography seems to be the logical first step particularly when it is combined with the establishment of the National Oceanographic Data Center proposed by H.R. 12018. The major points of discussion, in our opinion, relate to specific details of the broad oceanographic program proposed in H.R. 9361.

The witnesses that you have invited to appear before your committee, the establishment of your Subcommittee on Oceanography, the various reports you have secured from committees of scientists, are all effective testimony to your committee's awareness of the need for expanding the Nation's oceanographic research program. We believe the need has been documented beyond question. The problem now is to plan and initiate a program that will adequately meet the national requirement.

Much of the initial interest and action on this problem was due to reports on oceanographic needs prepared by the Committee on Oceanography of the National Academy of Science-National Research Council. As you know, their recommendations have been largely incorporated onto H.R. 9361, which is one of the bills under consideration. We believe that the NAS–NRC Committee did an excellent job. The aggressive, thorough approach they took in attacking a most complex national problem is commendable.

A few months ago Dr. Harrison Brown, the Chairman of the NAS–NRC Committee, asked the Sport Fishing Institute for comments on the completed chapters of the report. The institute's comments were transmitted to Dr. Brown in a letter by our executive vice president, Richard H. Stroud. Those observations form the basis for discussing the bills under consideration. Dr. Brown asked six specific questions about chapter 1 (the "Introduction and Summary of Recommendations") :

1. Do you agree with the general recommendations contained in the report?
2. Do you agree with the need for an increased national program in the marine sciences?
3. Do you feel that the rate of increase outlined in the report is realistic?
4. What comments do you have concerning the detailed recommendations?
5. Do you feel that adequate attention has been given to a balance between the various aspects of the marine sciences?
6. What comments would you care to make concerning those aspects of the report which pertain to your particular interests?

On the first three questions we answered "Yes" with "No" qualifications whatsoever. Question 4 (the detailed recommendations in the report) had to be answered with some serious reservations about the proposals outlined for ocean resource research (sec. III, G. p. 22 of ch. 1 of the report).

We are extremely concerned about the apparent overemphasis on applied as opposed to basic research. We feel this is more than another argument over definitions. The wording and apparently the intent of the specific recommendations for ocean resources seems to contrast markedly with much of the Committee's chapter on basic research. The general recommendations of the Committee properly emphasize the accepted responsibility of the Federal Government for basic research. In our opinion, however, the details of the ocean resources recommendation of the report don't reflect this obligation.

The specific recommendations for ocean resources seem to reflect an overt, almost exclusive emphasis on commercially important fish stocks and on trade-oriented problem areas of the moment. We wonder if this is not an overly narrow, almost self-defeating focus on applied research which fails to recognize the long-range problems and potential of the marine resources.

What are some of the specific areas where the scope of proposed studies needed to be broadened?

Specifically, three major recommendations (Nos. 2, 11, and 14) propose to limit research to commercial or food fish. These recommendations overlook other species that are often more important, particularly the species used by sport fishermen. Moreover, this limitation to specific fishes might overlook the importance of other species as competing organisms or as important elements in food chains. The limiting of estuarine research to "food fish and shell fish" is clearly not justified.

Another recommendation (No. 3) would apparently limit behavior studies to the laboratory and exclude vitally important field studies. It is a well-known phenomenon that responses in the labortaory may differ decidedly from actions in nature. Both phases should be utilized; they are often mutually complementary aspects of research, both necessary to full understanding.

Recommendation 7 on the nature of the aggregation of organisms would be improved by expanding its scope in order to recognize and include broad-scale ecological studies and research on population dynamics of marine organisms. These are woefully weak areas of knowledge and hold vast potential to benefit mankind. Detailed life history studies are also badly needed. Among fishes alone, for example, less than 1 percent of the world's known total of about 25,000 species are biologically well known.

The promise for eventual deliberate farming of the sea depends on these particular areas of research. To omit these phases of the program is perhaps to deny the future. It seems to us that failure to include these phases is evidence of an unfavorable preponderance of emphasis on relatively narrow trade-oriented commercial fishery thinking. The result, in our view, is too much emphasis on applied as distinct from basic research. A greatly strengthened ecological approach needs to be injected to give better balance to this very important program.

The Committee's question No. 5 dealing with the balance between the various aspects of marine science brings up another point which we feel should be called to the attention of your committee.

There have been a number of expressions of concern about the relative lack of emphasis on the biological sciences in the NAS–NRC report. The American Fisheries Society, for instance, adopted the following resolution in September 1959:

"Whereas the National Academy of Sciences-National Research Council has recently published reports pointing out the Nation's critical need for an expanded oceanographic research program; and

"Whereas the U.S. Senate and the House of Representatives have each created a special committee to study oceanographic problems and recommend new legislation and programs to implement the National Academy of Sciences-National Research Council reports; and

"Whereas a careful study of these reports and publications indicated that the biological aspects of the proposed program are subordinated to other disciplines: Now, therefore, be it

"*Resolved*, That the society (1) commends the administration and the Congress for the interest they have expressed in expanding the national effort in oceanographic research; (2) expresses its concern that the vitally important biological aspects of the oceanographic research program be given more adequate recognition in the development and implementation of plans * * *."

This rather obvious neglect of the biological aspects of oceanography has been noted by other groups. For instance, the Department of the Interior's Advisory Committee on Fish and Wildlife made the following recommendation to the Secretary of the Interior on October 20, 1959:

"The 10-year oceanographic research program of the National Academy of Sciences is a vitally important undertaking which the Committee supports. The Committee is hopeful that greater emphasis will be given to the basic biological aspects, especially of the fishes. A preponderance of effort is now proposed on physical oceanography. We believe that added emphasis on biological research would strengthen the program and greatly increase its overall value."

To sum up our views, we question whether the proposed national oceanographic research program adequately meets the accepted Federal responsibility for basic research. We appreciate that the long-range national security benefits are implicit in efforts to increase food supplies—but this is not the entire problem. There should certainly be a more equitable balance between the biological and physical aspects of the program to enhance what are perhaps equally important long and short-range social and economic benefits to our Nation realizable from sport fishing. There should also be a better balance between inshore and estuary research and the deep sea research that has been most emphasized in previous testimony.

Obviously, we are concerned more with the details rather than with the basic structure of the report. This is because the implementing recommendations made thus far for detailed ocean resource studies that would follow seem to us to be somewhat more narrowly conceived and shortsighted than desirable for the overall public interest. Basic research is accorded secondary importance when it should be primary. There is an obvious lack of balance, not only in the overall report as between physical and biological research, but in the section on ocean resources as between basic biology and trade-oriented developmental research as well. There is an evident lack of appreciation for the underlying long-range importance of detailed life history and ecology studies, behavior in nature, and population dynamics of marine organisms, especially fishes.

We are concerned, too, as you might expect, over the overt restriction of research attention to commercial or food fishes. This indicates inadequate appreciation of the vast social and economic significance of marine fishery resources and the sport fishing industry. For example, in 1955, a detailed study of the State's marine sport fishery was made by the New Jersey Department of Con-

servation and Economic Development. It was discovered that 27 marine species were exploited jointly by sport and commercial fishermen. Of the total catch, 44 percent were harvested by sport fishermen. The five most important species to both groups were the same. This relationship is not much different in other areas of the country.

Economically, the marine sport fisheries are already at least one-half as valuable in terms of retail business generated as marine commercial products at retail level. All told, about 54 million Americans seek needed relaxation by going fishing in the ocean. Marine fish provide a total of some 70 million recreational days annually, a rapidly growing figure.

Last year Congress officially recognized the importance of salt water sport fishing for the first time. The bill directing the Secretary of Interior to initiate a saltwater sport fish research program was introduced by a member of this committee. The hearings held by your committee on Mr. Lennon's bill clearly showed that salt water sport fishing is an important and growing segment of the Nation's business and recreation. The number of salt water anglers is growing at a rapid rate. To ignore the importance of sport fishing in the development of the oceanographic program would seem to be neglectful of responsibilities. We strongly urge that the Department of Interior's participation in the program be broadened to include the Bureau of Sport Fisheries—not confined to the Bureau of Commercial Fisheries.

For your information, we estimate the current number of salt water anglers in the coastal States to be as follows:

*Total number of saltwater anglers*[1]

| Coastal States: | | Coastal States—Continued | |
|---|---|---|---|
| Alabama | 70,000 | New Jersey | 293,000 |
| California | 775,000 | New York | 608,000 |
| Connecticut | 103,000 | North Carolina | 328,000 |
| Delaware | 29,000 | Oregon | 190,000 |
| Florida | 487,000 | Rhode Island | 31,000 |
| Georgia | 239,000 | South Carolina | 180,000 |
| Louisiana | 209,000 | Texas | 748,000 |
| Maine | 70,000 | Virginia | 304,000 |
| Maryland | 148,000 | Washington | 198,000 |
| Massachusetts | 200,000 | | |
| Mississippi | 126,000 | Total | 5,391,000 |
| New Hampshire | 46,000 | | |

[1] Includes many anglers who also fish in fresh water.

We trust that our comments have been constructive. They are not intended as representing opposition to the objectives of the legislation under consideration. We urge the development of an adequate oceanographic research program as quickly as possible. For example, we strongly favor the part of H.R. 9361 that calls for the immediate strengthening of the marine biological research effort of the National Science Foundation. Implementation of the National Science Foundation program is probably the best way to get an early start on basic research problems and take advantage of the pool of talent available outside the Government agencies. There should be early emphasis on contractual and/or grant research because these are excellent ways to meet the need for more trained personnel in this field.

We appreciate the opportunity to present our views to your committee. Please be assured that we will be glad to assist further in any possible way.

Mr. PAUL. Mr. Chairman, I am Robert M. Paul, executive secretary of the Sport Fishing Institute in Washington. I am appearing before your committee on behalf of the Sport Fishing Institute in order to join other witnesses in urging the early creation of an adequate national oceanographic research program.

We would like to discuss briefly the implications of an expanded ocean research program for sport fishing and the need to emphasize the biological phases of the program, particularly as they relate to inshore and estuary areas.

I have been very pleased to hear the comments this morning about the need for emphasis on the biological phases of this program. I do not think they need to be repeated.

We strongly support any effort to strengthen the oceanographic research represented by the bills under consideration. The major points of discussion in our opinion relate not to the general overall tone of the bills but perhaps to specific details of broad programs such as those proposed in H.R. 9361.

I do not think there is any doubt but the witnesses who have appeared before your committee—in fact, the establishment of your own subcommittee, here, on oceanography and all of the testimony from outside people and organizations have made it clear that the need for a program has been documented beyond question. The problem now, as we see it, is to plan and initiate a program that will adequately meet the national requirements.

I would like to join with other witnesses in complimenting the NAS–NRC Committee or doing a fine job on their report. It is an aggressive and a thorough approach to the most complex national problem we have today.

You might be interested in knowing that we were asked to submit our comments by Dr. Harrison Brown to the committee. He put his letter in the form of questions. We were able to answer most of them with an unqualified yes, such as the things that deal with the general recommendations, needs for increased program, and the funding schedules that were proposed.

When it came to the detailed recommendations, however, we had some serious questions, particularly as they related to the balance between various aspects of marine science and the general tone of the recommendations in the ocean resources section of the report.

We really feel that there has been overemphasis on applied as against basic research in this section of the report. I think this is more than just an argument over definitions. We can argue definitions of basic as opposed to applied research all day. The only one I ever heard that makes sense is the scientist who said that basic research is what I do and applied research is what my competitors spend their time on.

This is more than that. We feel that there seems to be an almost self-defeating emphasis on commercially important fish stocks, which fails to recognize the long-range problems and the potential of the marine resources.

We think that the potential for deliberately farming the sea—which I think we are going to have to get into—depends upon a broad ecological approach to these problems. Specifically, we are concerned with some of the recommendations in section 3 of the report that limit research to commercial or food fish and limit behavior studies to laboratories. Other recommendations on the aggregation of organisms seem to be concerned only with how to get a net around them rather than the detailed life history studies that are so important. I think most of our questions are probably self-evident to biologists.

I do not think you would expect anyone concerned with sport fishing to be wholeheartedly in sympathy with any program that apparently limits participation of the Fish and Wildlife Service to the Bureau of Commercial Fisheries. This is admittedly a detail, we certainly have perfect confidence in Mr. McKernan and his staff, but

the orientation of the program probably tends to overlook the importance of inshore and estuarian areas which are so important to the tremendous number of people interested in sport fishing. We think the importance of sport fishing should be recognized at the time the program is adopted.

As to the balance between sciences, we think biology has been slighted. For the record, I submit two resolutions which deal with this subject, one from the American Fisheries Society, which expresses its concern that the vitally important biological aspects of the program be given more adequate recognition.

In another instance the Department of the Interior's Advisory Committee on Fish and Wildlife made the following recommendation to the Secretary of the Interior last fall:

> The 10-year oceanographic research program of the National Academy of Sciences is a vitally important undertaking which the Committee supports. The Committee is hopeful that greater emphasis will be given to the basic biological aspects, especially of the fishes. A preponderance of effort is now proposed on physical oceanography. We believe that added emphasis on biological research would strengthen the program and greatly increase its overall value.

I think this particular recommendation has had a very healthy effect upon the Department of the Interior, as Mr. McKernan mentioned this morning.

As to the balance between inshore and estuarian research and deep sea research, I think those of us who are concerned with what happens near the coasts have had our concern intensified by the obvious publicity and interest given to the deep sea phases of this program.

The importance of salt water commercial fishing is absolutely unquestioned. The importance of salt water sport fishing is something that just recently has come to the attention of Congress. Last year, as you recall, this committee held hearings and eventually passed a bill which resulted in Public Law 86–359 which directed the Secretary of the Interior to initiate a salt water sport fishing program for the first time. The hearings held by your committee on Mr. Lennon's bill clearly showed salt water sport fishing is an important and growing segment of the Nation's business and recreation. The number of salt water anglers is increasing rapidly, far faster than the total increase of the population as a whole.

The number of people concerned with salt water sport fishing is a major part of the population of our coastal States. As you know, this is an area which has not received much attention from the State fish and game agencies. Salt water sport fishing has certainly been neglected in the development of the Fish and Wildlife Service program.

We trust that our comments have been constructive. As I say, we are not arguing with the overall structure of the program but we are concerned with the details of specific proposals.

There are some portions of the bills I would like to comment on specifically. For example, we favor the immediate strengthening of the marine biological research program of the National Science Foundation. We think this is a very logical first step and perhaps the best way to take advantage of the large pool available biological talent in the academic institutions.

We think there should be an early emphasis on contractual or grant research in this field if for no other season than this is the best way to meet the need for more trained personnel.

Some other points again are details that should be considered now. Someone earlier this morning mentioned the need to strengthen work in museums on taxonomy and systematics. I think there is a very obvious need for a group such as the National Science Foundation to handle this phase of this program. Under the program that has been proposed earlier this is work that would be delegated to the Bureau of Commercial Fisheries. We have no particular argument with their ability to handle it, but we wonder if the scope might not be unnecessarily limited by their traditional emphasis on trade-oriented problems.

We appreciate the opportunity of presenting our views to your committee. We have no strong feelings on the establishment of the national data instrumentation test center other than to urge its early establishment. I think we favor the establishment of the center as it is proposed in the bill under a civilian agency or at least, as pointed out by Dr. Schaefer, in an agency whose authorizing legislation clearly points out that the civilian and military needs will both be met.

Mr. Chairman, that concludes my statement. I would be happy to answer any questions.

Mr. MILLER. Mr. Bauer?

Mr. BAUER. We have in the Department of the Interior a Bureau of Sport Fisheries, and from the very title it indicates that the motivation was concerned with sport fishing. We have the Bureau of Commercial Fisheries, and from the very title you would think the motivation would be commercial fisheries, although granted they do basic research in certain instances.

Have you any idea of what would be the problems presented if one were to propose that in addition to these one had in the Department of the Interior a Bureau of Aquatic Biology? I am saying this in view of the fact that the National Science Foundation is precluded from being operators by their charter. I would like to get your thoughts as to whether that would supply the manifest void that apparently exists, granted that the needs of sport fishing and commercial fishing are independent, you would have overlapping, let us say, in the Bureau of Aquatic Biology. However, as far as I know, such does not exist in the Government outside of the Smithsonian Institution's Barro-Colorado Island venture. Do you think there is anything to this suggestion?

Mr. PAUL. This is a very interesting question and one I think we should look at in terms of history. Originally, of course, the Department of the Interior's biological work was headed up and contained in a Bureau of Biological Survey. This name persisted until the reorganization of the Department of the Interior, I think, just before the war. I think it was proven back in the early days that it was certainly possible for the Federal Establishment to have an operating agency who was primarily concerned with basic biological information.

For a number of reasons this function has been split up. Until the reorganization of the Fish and Wildlife Service 4 years ago much of the basic aquatic biology was the responsibility of the Bureau of

Commercial Fisheries. The Division of Sport Fisheries is too new to evaluate. Because of funding problems their branch of research has not had a chance to develop too effectively. I think this was brought out quite clearly in the hearings on the Lennon bill last year by your committee.

As to the possible advantages of establishing yet another bureau directly concerned with basic biological studies within the Fish and Wildlife Service, my personal inclination is that this would tend to be self-limiting. Adequate funds would be hard to secure. I would rather see a strong program to take advantage of the pool of biological talent available outside the Federal Government. We have heard a lot of this discussion as far as basic research in missiles and rockets is concerned. It is equally true in biology.

I am more inclined to favor the approach of working for a strengthening of the marine biological section in the National Science Foundation with primarily emphasis on contractual research with academic institutions. If gaps appear as this program is strengthened, they should be filled in by strengthening the existing agencies within the Fish and Wildlife Service.

I do not see any real need or any advantage particularly in trying to establish a basic scientific unit within Interior.

Mr. BAUER. Thank you.

Mr. MILLER. Are there any further questioning? I want to thank you, Mr. Paul, for coming up. We always enjoy seeing you here.

I want to say in behalf of sports fishing that the economic result and value to the country, not directly but through collateral channels, is very great. Weighed against other interested facets of this work, I am certain in many cases it would be surprising if people got a good look at it. I think more money is expended by people seeking recreation in the field of fisheries, and increasingly so with the salt water fishing, than many of us stop to realize. Its impact on the economy is very great. I think it deserves every consideration. Thank you.

Mr. PAUL. Thank you, Mr. Chairman.

Mr. MILLER. Next is Dr. Columbus O'Donnell Iselin. We have got to get that "O'Donnell" in there because that is part of the Irish. We welcome you here, sir.

## STATEMENT OF DR. COLUMBUS O'DONNELL ISELIN, WOODS HOLE OCEANOGRAPHIC INSTITUTION, WOODS HOLE, MASS.

Dr. ISELIN. Mr. Chairman, at its last meeting the Academy Committee on Oceanography studied carefully the proposed Marine Science and Research Act of 1959. We read it carefully and made some comments. We found a few very minor inconsistencies. I believe that a copy of this piece of paper is already available to you. Therefore, it seems to me it would be more useful if I attempt this morning to make some general comments about the development of marine science in this country and about some of the difficulties that, as I see the situation, seem to lie ahead.

Oceanography, as we know it today, grew out of the interests of European naturalists during the latter part of the 19th century in the sea as the original environment for the development of life on this planet. In about 1900 physical oceanography hardly existed, but already by this time extensive collections of marine organisms had ac-

cumulated at the museums of the major maritime nations. As early as 1875 it was known that life existed at all depths in the ocean, but knowledge concerning the circulation of the ocean was still almost entirely two-dimensional and based on statistical summaries of surface observations.

During the first quarter of the present century interest in marine science was largely centered around problems associated with commercial fishing in coastal waters. During this period the basic tools of physical oceanography were developed and the first classical theoretical studies were published. Then beginning about 1925 there occurred both in Europe and in this country a revival of interest in deep sea oceanography. For the first time expeditions were equipped to study the physical and chemical properties of the whole water column rather than to make biological collections.

It became clear that in order to understand the distribution of life in the sea it was necessary to know about the movements of the water and their causes. I believe the cycle has gone around once again. We have more or less answered the basic questions which were put to me as a young physical oceanographer by my colleagues, my biological colleagues. We have developed methods and techniques for knowing how the water is moving the animals and plants around. It now becomes profitable once against to go back and look at the biology of the sea with the background that has been provided during the last 50 years, both theoretical and observational, on the physical environment.

In this country, beginning about 1930, three oceanographic laboratories were established with more or less adequate facilities for working in deep water. The necessary money was largely supplied by grants from the Rockefeller Foundation. These three laboratories became facilities that could be used by advanced students and university professors interested in some aspect of marine science. Until about 1940 they were mainly used during the summer vacation period and had only quite small permanent staffs.

However, in this way by the time World War II started there were perhaps a hundred people in this country who had done some work in deep sea oceanography and who had gained experience in making observations of many different kinds at sea. These people formed a nucleus for the very rapid expansion of marine science during the war years. This was, of course, financed by the Office of Scientific Research and Development. The studies carried out during the war period were largely in support of military applications. Oceanography was particularly helpful in the case of amphibious operations and in the case of submarine operations.

After the war the Navy continued this support of oceanography. At first the necessary funds were largely supplied by the Bureau of Ships. Later the Office of Naval Research became the largest contracting agency. Thus the existing laboratories came to have sizable, full-time staffs, and new laboratories developed during the postwar period. Also within the Navy laboratories and at the Hydrographic Office experienced oceanographic groups became established. We have indeed come a very long way in the last 20 years, as I look back on the situation. I believe we have shown quite clearly that we have the capacity and the ability to expand at some reasonable rate.

Another point I would like to make is that during this postwar period the Navy support of oceanography has been extremely wisely administered. The laboratories have been surprisingly free to work in areas of greatest interest to their staffs. We should try to keep it this way. Any good director of research knows that the one thing not to do if his laboratory is to be productive is to try to tell people what to think about.

Now as to some of the difficulties that we face in a continuing expansion of marine science, admittedly we have a training problem on our hands, but I doubt that this is a serious one. The students flock into fields where they see opportunities, and there are more opportunities for original research in oceanography than in a great many other fields. It is a lot easier to get a Ph. D. thesis written in oceanography than in physics, for example. There is still plenty of cream to be skimmed off and that is what students are looking for. If we have places for them to go and if they see opportunities for jobs, they will appear.

A more serious difficulty, which has become evident to us on the Academy Committee, is that through the obsolescence of the existing fleet of research and development ships we face a hump in the building curve. We have not built any ships for a long time. We have not converted many ships for a long time. If there is to be steady expansion, we have to start building some ships. This makes a budgetary hump. This is always a difficult thing to face.

Finally, I have a few general remarks that I would like to make about the benefits we can expect to come out of an accelerated oceanographic program. The first benefit that I believe we will receive, the one that is closest to reality, is more reliable and longer range weather forecasts. By marrying oceanographic research to the rapid developments in meteorology and by treating the whole system as one heat engine, which it indeed is, we will get long-range weather forecastings I believe rather quickly. Of course, this benefits everybody.

A second thing we will get and perhaps can get well within this 10-year period we are talking about is useful oceanographic forecasts, forecasts that will predict the goings and the comings of fish. There has been little emphasis in oceanography to date on forecasting. In fact, we have resisted this obligation. We were a little afraid that the forecasting would affect us as seriously as it has affected meteorology. I think we are now quite ready to begin with oceanographic forecasts. In fact, several types of forecasts are now being made on a continuing basis.

A third thing that I believe we are going to get out of all of this, perhaps a little more slowly, is the beginnings of efficient farming of the sea and the beginnings of environmental control in marine areas. This may take us 20 years or so because this is one you do not want to rush into until you are absolutely sure what effects you are going to have.

You might be interested in some thinking I have been doing of recent months about the situation in the Gulf of St. Lawrence. There it would be desirable to maintain an ice-free path up to the cities at the head of the Gulf of St. Lawrence. You could do this by running a pipeline down the deep channel, the drowned channel of the St. Lawrence River, and by pumping compressed air in it, allowing bubbles of compressed air to rise along this pipe, which would

bring heat up. There is a big reservoir of heat in the bottom of the Gulf of St. Lawrence. This is continually renewed and is an inexhaustible supply.

At the same time, you are also pumping up nutrients. There is a big supply of nutrients in the bottom of the Gulf of St. Lawrence. You would increase your fisheries.

This is the beginning of climatic control. Power requirements are not big. We are working in the fifth decimal place. Density of the water at the bottom of the Gulf of St. Lawrence is only very little more than the density at the surface. To plow the sea, which is all you need to do to make it produce more, is energywise much less than you need to plow the land. We have been doing this for years. It is much easier to turn over water than to turn over soil.

Finally, I think we are clearly facing a revolution in naval architecture. I believe lightweight, high-powered marine powerplants could be made available today within the existing technology, but it will probably take somewhat longer because these things are expensive to develop. However, once we have powerplants available for ships that are in the same class weightwise as powerplants available in airplanes today and do not need big crews to maintain them, then ships become an entirely different sort of thing than we know them today. The Navy will evolve extremely rapidly. These will be very high performance ships and it will become absolutely necessary in the design of the control mechanisms for these ships to know a great deal more about waves and turbulence than we know today. In a sense, in oceanography today we are trying to get the information together that we feel the designers are going to need once this technical breakthrough occurs.

Those were the thoughts I had prepared.

Mr. MILLER. Thank you very much, Doctor. We always like to see you come here. You bring us fresh thoughts, new thoughts, fresh information.

As to this matter of using bubbles, have not the Japanese used that?

Dr. ISELIN. They have made breakwaters this way.

Mr. MILLER. The Japanese used this around one of their shipbuilding plants, did they not?

Dr. ISELIN. We are using it on a small scale up in Greenland to keep ice away from the piers there.

Mr. MILLER. Are there any further questions? If not, thank you very much, Doctor, for coming here and waiting so patiently.

The committee will adjourn until 10 o'clock Tuesday morning.

(Whereupon, at 12 noon, the subcommittee recessed, to reconvene at 10 a.m., Tuesday, May 24, 1960.)

# OCEANOGRAPHY

TUESDAY, MAY 24, 1960

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON OCEANOGRAPHY OF THE
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
*Washington, D.C.*

The subcommittee met at 10 a.m., in room 217, Old House Office Building, Hon. John D. Dingell (acting chairman) presiding.

Mr. DINGELL. The committee will come to order.

The Special Subcommittee on Oceanography has been hearing H.R. 9361, H.R. 10412, and H.R. 12018.

This morning the committee will hear the testimony of Vice Adm. J. T. Hayward, Deputy Chief of Naval Operations for Development, on H.R. 12018.

## STATEMENT OF VICE ADM. JOHN T. HAYWARD, U.S. NAVY, DEPUTY CHIEF OF NAVAL OPERATIONS (DEVELOPMENT)—Resumed

Mr. DINGELL. Admiral Hayward, you are indeed welcome before the committee. We will be glad to hear from you.

Admiral HAYWARD. It is a pleasure to be here, sir.

Mr. Chairman, I would like to thank you for the opportunity to return again to address this committee on a subject connected with our oceanographic program. I have prepared a written statement which, with your permission, I would like to present.

On May 17, 1960, I appeared before this subcommittee to present the needs for making worldwide ocean surveys and the Navy's policy with regard to these surveys. At this time I indicated that the Navy supported a vigorous oceanographic survey program and that we planned to carry out increase survey efforts as ships, personnel, and funds become available.

Hand in hand with our need for ocean surveys is the need for a National Oceanographic Data Center to process and disseminate the information collected by our oceanographic ships. Since the Hydrographic Office has approximately 70 percent of the world's available oceanographic information on file, and is a recognized international authority in the field, the Interagency Committee on Oceanography (of which Assistant Secretary Wakelin is chairman) recommended that the data center be located at the Hydrographic Office. This recommendation has the general support of the entire oceanographic community, including the National Academy of Sciences Committee on Oceanography which originally recommended establishment of the center. The center will be operated by the Hydrographic Office but it

will be jointly funded by the Departments of Navy, Commerce, and Interior; the National Science Foundation; and the Atomic Energy Commission. The policies governing management, administration, and operation of the center will be determined by representatives from the sponsoring agencies mentioned above.

This data center would be a truly wonderful establishment for the scientific community. Whenever a scientist required information on any particular part of the oceans he could call or write to the center and the data would be furnished at a very nominal fee.

A few short comments are also in order on the need for a National Instrumentation Test and Calibration Center. Every scientific discipline requires a means for testing and calibrating its instruments. The problem is very complex with oceanography because of the unique nature of the oceans. The great pressures involved at depths, the variable conditions of salinity and density which affect the acoustic properties of sea water, and the difficulty of obtaining data from a moving platform have imposed a terrific burden on oceanographic instrumentation. This is an immediate need for a national center where oceanographers throughout the country can send their instruments for test and calibration. It is essential that all instruments be calibrated against a common standard so that under identical conditions each instrument will give the same readings.

Since the Hydrographic Office is acknowledged to have what is perhaps the world's largest collection of oceanic data, is the chief user of oceanographic data and instruments, and has important national and international responsibilities in this regard, it appears highly logical that the national data and calibration centers proposed by H.R.12018 be established at the U.S. Navy Hydrographic Office.

That completes my statement, Mr. Chairman.

Mr. BAUER. Admiral, we have heard testimony from several witnesses to the effect that they favored the Hydrographic Office having the data center, but they are somewhat concerned about the question of how the management of the data center would be run and how it would be conducted.

Would you talk a little more to just how you envision the management of this data center would operate?

Admiral HAYWARD. In my statement the sponsoring agency is Dr. Wakelin's group. They would review the proposals for the management of it.

From my own background I would say we would have a scientific director and he would be up in the same sort of box with a hydrographer and a deputy hydrographer. It would be definitely a technical problem. You would have to get a scientific director.

The management is such that we would manage it in the same way that many of these joint programs are managed. The actual policies would be determined by the representatives of these sponsoring agencies. The actual management of the funds and everything, after they had been budgeted, probably would be the job of the Department of the Navy.

Mr. BAUER. In other words, it would not be in the nature of a joint venture on the part of the civilian agencies and the Navy but it would be under the direct management and control of the Navy with some sort of advisory group, perhaps.

Admiral HAYWARD. Yes. The Department of the Navy, Commerce, Interior, and the National Science Foundation and the Atomic Energy Commission, their representatives would be the policy group for things to do with management. In other words, they would oversee the program very much in the way other joint programs go.

With the AEC and the Navy we have a joint physics program. In this particular case both bodies put up the money. The Navy is the management agency, however. The policy is run by the top people of the two agencies.

The amount that will be budgeted and the program is determined at that level.

Mr. BAUER. My thinking was whether the Secretary of the Navy would take kindly to anyone telling him how to run his shop. That is essentially what would happen.

Admiral HAYWARD. You must distinguish between actual management of the funds that are allocated. If each agency budgets and allocates certain sums they should have some say in the policy side of it. The direct management of the funds would be the responsibility of the Secretary of the Navy, the same as he is the direct manager of these other funds.

Mr. PELLY. I notice you stated there should be a central location for the calibration and adjustment of instruments. Is it necessary to bring all instruments into one central location to be sure they are all adjusted one equal with the other?

Admiral HAYWARD. As a physicist third class now I will put my hat on and say this: It is strange that this never has been done in oceanography, and we have some very strange answers.

In physics, whenever you measure the velocity of light or something, you do it under the same conditions. The oceanographic instrumentation business today, if I were to describe it, is pretty chaotic. You can get any answer on many things.

I will give you a good example. Take oxygen measurements in water by Woods Hole and British oceanographic ships; they are known to differ about 5 percent. I think if something is wrong by 5 percent you had better begin to look at the calibration of the instruments.

Mr. PELLY. I was thinking it would be simpler for Mohammed to go to the mountain in some cases than for somebody from Washington to go out and adjust them.

Admiral HAYWARD. I see. You would have a standard method of doing this, approaching the instrumentation problem. Like many other things you would be able to adjust them to this calibration in the field or at the various laboratories. You have to have some standard. It is really strange when you get so many different answers from these present organizations on everything from the speed of sound in water to the salinity.

Mr. PELLY. I am talking about something I know nothing about, but it seems to me that some of the instruments I have observed are rather large, and certainly it would be difficult to transport them. They may get out of adjustment in transport.

I thought you had an idea of sending back all of these instruments to be adjusted in one spot.

Admiral HAYWARD. No, sir. What we would intend to do in this field would be to require our contractors, at least, to use calibrated

instruments, techniques, and reporting systems meeting specifications which we would put out from the Hydrographic Office, which they have now under publication 607, for all oceanographic and research data we needed.

Mr. PELLY. This is beginning to take shape now and I see what you mean. In other words, the specifications would be sent out and standards established from one spot and in each locality the adjustments of the various instruments would meet those specifications?

Admiral HAYWARD. Yes, sir.

The Bureau of Standards does the same thing with many things. They do not send all the instruments into the Bureau of Standards but they have calibration methods and specifications to make measurements.

Mr. PELLY. So what you actually suggest is that rather than have the Department of Commerce send out specifications to the Coast and Geodetic Survey, that all agencies of Government centralize and have a consolidation of their specifications and everybody use the same ones?

Admiral HAYWARD. Yes; standardize measurements. That is actually what we would do.

Mr. PELLY. That is all, Mr. Chairman.

Mr. DINGELL. Thank you very much.

Does counsel have further questions?

Mr. DREWRY. Admiral, am I right that there is a standard maintained in Copenhagen from which salinity is measured? Are you familiar with that? I understood there is a certain quantity of water that is supposed to be the basic standard of purity against which salinity is measured.

Admiral HAYWARD. Yes, sir; there is a standard. The answer to that question, first, is "Yes." As the salinity varies people measure it, and that is the point I was making.

Mr. DREWRY. Are there standards in other things and are they scattered all over the world?

Admiral HAYWARD. There are other standards. The real difficulty has been in the measurements of these. You can set your standards and specifications, but if the man measures it, depending on what instruments, the results he gets can be way off, depending on where the measurements are taken. It is a problem of instrumentation rather than the setting of the standards.

Mr. DINGELL. I have been very much concerned throughout your testimony here this morning that possibly the Navy proposes to control this whole Data Center and to organize and operate it as an extension of the Hydrographic Office, and in effect use this as a device to increase the appropriations and the authority of the Hydrographic Office without achieving any real coordination or cooperation with the other agencies participating in it.

Is that a correct inference?

Admiral HAYWARD. No, sir; it is not. We are the greatest users of this information. We need this information. As an example, by putting computers in we are budgeting the appropriation before Congress now. There is money in our budget now for the computers.

It just made good sense to these other people that since we had 70 percent of the data there they would go along with us. There has not been any feeling we were trying to build up the appropriation.

We have put a considerable sum of money into oceanography and in the survey business. As I told Mr. Miller when I was here on the 17th, in the 4 years I have been on this job we have come a long way in oceanography. We started building up about 4 years ago. There is no intent on our part to just build up the appropriation of the Hydrographic Office.

We have definitely put more money into oceanography out of the Navy's budget, and we intend to.

It may solve any number of problems for us—the sonar prediction system coming out of some of the oceanographic work will help in finding convoys, and so on. With the deeper diving submarines we have to know more about the business.

We have to do this whether the Atomic Energy Commission or the other people went along with it or not. We would have to do something of this nature.

As a matter of fact, we feel it would come without this legislation, the scientific and technical community who are agreeing with us and going along with us would go along with making this the Data Center whether this legislation were enacted or not.

Mr. DINGELL. I want you to know I am not being critical of the Navy at this point. I want that very clear.

Admiral HAYWARD. Yes, sir.

Mr. DINGELL. I appreciate that perhaps your organization and the Office of Naval Research have been perhaps the two cornerstones of this entire operation of oceanography which has been conducted by the Federal Government and perhaps by the country as a whole.

I was getting around to a point which concerned me greatly, and that was this: Scientific information is good only if it is available to scientific communities for use. I am fearful there is a possibility that a great deal of this may receive a classified stamp and be locked away in vaults, and although we spent a substantial amount of funds on it, it will never, because of national defense needs and requirements, be disseminated to the various institutions which will require it.

Admiral HAYWARD. I feel the security classification has been resolved and does not pose a problem. We have declassified all data which really has no military significance. I am sure you speak to the man who decides whether it has military significance and this could keep the data out of the scientific community.

I do not feel this will happen. Of course, with these people who are participating as the policy group this is a policy question which would have to be posed to them. You get both sides of the fence on this.

You know Senator Bridges said we were doing too much in this field. We feel, however, that the classification problem has been resolved and should not pose any problem.

The military significance of some of these things is quite obvious and it would be clear cut.

In the gray area, where some decisions are to be made, it should be made by the policy group under Dr. Wakelin who has both responsibilities.

Mr. DINGELL. The reason I ask these questions is that it has been my experience it is not only the Department of Defense which is responsible for this sort of thing but the Atomic Energy Commission also has used the classified tag on information where I thought it

could have been made available to Congress and the public. Various Government agencies have also in the past used the Executive privilege and the classification system to cover up for mistakes and things of that sort.

I would even point out on one occasion the treatise on bows and arrows received a very high classified stamp.

On another occasion drainage of poison gas from a dump in the Rocky Mountain area received a classified tag from the Army after it was put in the ground.

The inference from that was the fact that water runs downhill might be secret information.

I hope if this program is carried out that the Navy Hydrographic Office would use every bit of good judgment possible to see to it that worthwhile information which is not properly classified is available in the proper way.

Admiral HAYWARD. I can assure you from my point of view that we will do as well as we can on the classification business. I only wish now that all the Russian oceanographic data were unclassified and I could get it.

You see, there are two sides to it, Mr. Chairman. If you have done a lot of work, sometimes you can get the information and start from where he left off, this helps you.

It is well known to us, for instance, that the Russians put at least a billion dollars in the equivalent of our money in doing nothing but translating and getting every bit of technical information from every technical publication that we have. This is a vast store of knowledge that saves them many man-hours and lots of work. I do not decry that, of course, because it has to be gotten around, but there is that side of it.

From the Hydrographic Office point of view I feel we can resolve the classification question. In these instances where the services have misused it, unfortunately you cannot get around some things like this because people are always involved, Mr. Chairman, and people make mistakes.

Mr. DINGELL. I want it clear on the record I am not being critical of you, your presentation, or the proposal. I am just hopeful that some of the devices we have seen in the past will be avoided here, at least an effort made.

Thank you very much, Admiral.

Further questions?

(No response.)

Mr. DINGELL. You have been very helpful and I thank you, Admiral.

Admiral HAYWARD. Thank you, sir.

Mr. DINGELL. The next witness is Dr. Alan T. Waterman, Director, National Science Foundation.

Do you have anyone with you that you would like to have identified?

Dr. WATERMAN. Dr. Robertson and Dr. Dees. Dr. Robertson is head of the Division of Mathematics, Physical and Engineering Sciences and Dr. Dees is head of the Division of Scientific Personnel and Education.

Mr. DINGELL. You are certainly welcome this morning. I have had the privilege of knowing Dr. Waterman for some time and I have noticed his appearance earlier in other committees of Congress.

Do you have a statement, Dr. Waterman?

Dr. WATERMAN. Yes.

Mr. DINGELL. Would you like to read the whole statement?

Dr. WATERMAN. I believe it expresses our position best if that is agreeable to you and the committee.

Mr. DINGELL. You may proceed as you wish.

## STATEMENT OF DR. ALAN T. WATERMAN, DIRECTOR, NATIONAL SCIENCE FOUNDATION, ACCOMPANIED BY DR. RANDAL M. ROBERTSON, ASSISTANT DIRECTOR FOR MATHEMATICAL, PHYSICAL, AND ENGINEERING SCIENCES, AND DR. BOWEN C. DEES, ASSISTANT DIRECTOR FOR SCIENTIFIC PERSONNEL AND EDUCATION

Dr. WATERMAN. Mr. Chairman and members of the subcommittee, the hearings which you are presently conducting are concerned with an extremely important area of scientific research, the significance of which is being increasingly recognized. The report of the Committee on Oceanography of the National Academy of Sciences, referred to in the declaration of policy contained in H.R. 9361, provides a framework for research activities in this field, and proposed future activities of the National Science Foundation with respect to the support of oceanographic research and the provision of facilities for such research, coincide closely with the Academy committee's report.

There are presently before your subcommittee for consideration five bills, three of which are identical. We have forwarded to you our comments on various of the bills being considered and it, therefore, does not seem desirable now to review in detail our views on them. I would, however, like to summarize briefly the Foundation's general views with respect to oceanographic research and education, as set forth in our comments on H.R. 9361, and I believe it would be appropriate, with your permission, Mr. Chairman, if our comments on H.R. 9361 could be entered into the record in full. We have available a number of copies of our letter of comment and will be happy to provide as many as you need.

(The letter follows:)

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
*Washington, D.C., March 18, 1960.*

Hon. HERBERT C. BONNER,
*Chairman, Committee on Merchant Marine and Fisheries, House of Representatives, Washington, D.C.*

MY DEAR MR. BONNER: This is in response to your request for the comments of the National Science Foundation with respect to H.R. 9361 relating to oceanography and the marine sciences.

We consider the objectives of H.R. 9361 to be extremely worthwhile. The recommendations of the Committee on Oceanography of the National Academy of Sciences-National Research Council, referred to in the bill's declaration of policy, have been given careful consideration by the various Government agencies concerned, and, in general, the objectives of the committee's report are considered worthy of endorsement. Proposed future activities of the National Science Foundation with respect to support of oceanographic research and the provision of facilities for such research coincide closely in many respects to the committee's report.

We are pleased to see the interest of the Congress in these matters which, of course, are important to the progress of oceanographic research. It would appear, however, that much of the authority contained in this bill is already provided for in the basic legislation of the various Federal agencies concerned. With respect to the National Science Foundation, the bill would not provide any addi-

tional legislative authority. Furthermore, the Foundation is engaged in the support of significant activities aimed at improving research and training in oceanography. For these reasons, we do not favor enactment of H.R. 9361. We would like to point out, however, that, while we believe that additional legislation is not necessary, it is important that certain areas of science which appear to require urgent assistance in the national interest, be supported more intensively. In recognition of the need for increased attention to the support of research in oceanography, we have added to our earth sciences program a full-time oceanographer. We are also encouraging the submission of proposals to the Foundation which will provide not only for the carrying on of research in the field of oceanography, but which also have a strong emphasis on the training of research workers in the field. Furthermore, the Foundation will consider support for programs of basic research covering a broad area or subarea of science within which support may be provided for graduate thesis research in such areas or subareas. In the field of oceanography, this type of research support would appear to be particularly appropriate. These and other methods being utilized by the Foundation in providing support for oceanographic research and training are discussed in greater detail in subsequent portions of the letter.

Our specific comments with respect to the bill are set forth below.

First, we note that subsection 4, appearing on pages 3 and 4 of the bill, proposes that the National Science Foundation, or other appropriate agency of the Federal Government, establish a long-term fellowship program for the recruitment of prospective oceanographers. Establishment of specialized fellowship programs for particular areas of science would tend to lessen the high-quality standards and the recognition which National Science Foundation fellowships now have. Furthermore, we believe that sufficient fellowship aid for high-quality students is available through various sources so as to enable financial assistance to be provided to persons interested in entering the field of oceanography. The problem is not so much that of making more fellowships available as it is of stimulating students to take an interest in becoming oceanographers. While the various disciplines that go to make up oceanography are referred to in our fellowship literature, it is planned, in the announcement of fellowship programs to operate in fiscal year 1961, to also specifically mention oceanography and meteorology as examples of areas, among others, in which fellowship support from the Foundation will be available to qualified persons.

Let us assure you that the National Science Foundation realizes the importance and need of increased support of teaching and research requirements in the field of oceanography. We are studying possible additional measures for the support of faculty and graduate students in existing or new departments at universities, covering critical areas of science, including oceanography. The objective here would include support, extending into the future as far as possible, of the research of faculty members who are engaged in such fields. As we are sure you recognize, such forms of support must be worked out carefully in terms of Government-university relationships in general, and especially with respect to considerations of balance and judicial treatment as among university departments and as among the various fields of science as noted above.

H.R. 9361 further proposes that there be established in the National Science Foundation a Division of Marine Sciences to develop and encourage a continuing national policy and program for the promotion of oceanographic research, surveys, and education in the marine sciences, to recommend contracts, grants, loans, or other forms of assistance for the development and operation of a comprehensive national program of oceanographic research and education in the marine sciences and to engage in other activities in the field. Oceanography includes, or is related to, many fields of science and thrives best in intimate contact with various scientific disciplines. We believe it more appropriate that marine biology, for example, remain associated with activities in the area of biological and medical sciences and that physical oceanography continue to be associated with the earth sciences. However, as we mentioned earlier, we have added a full-time oceanographer to our staff. We do not feel that the activities contemplated for the proposed Division of Marine Sciences necessitate the establishment of such a division but can more appropriately be carried out within the framework of the Foundation's existing organizational structure.

Section 4 of the bill would authorize appropriations, in addition to those otherwise authorized for the activities of the National Science Foundation, to provide funds for use in connection with specified oceanographic research activities. It appears to us that considerable care must be exercised so as to avoid creation of a general view that the provision of substantial additional

sums for particular areas of science will automatically greatly improve the research situation with respect to such areas. In the case of oceanography, while additional sums are being requested by various Federal agencies, the major problem is to obtain a sufficient number of well-qualified people able to utilize such additional funds in ways which will be of substantial benefit to oceanographic research. We believe that, in view of the particular interest which has been focused on the field of oceanography, more persons will become interested in entering the field. However, until a considerable number of additional persons are trained to do high-quality scientific research in oceanography, the provision of large sums for the support of oceanographic research will not of itself improve the research situation in the field. This is not to say that additional sums are not desirable but merely to provide a word of caution as to the ability of available oceanographers to utilize greatly increased amounts of research money in a useful manner. The National Science Foundation and other Federal agencies are seeking funds of a magnitude which they believe can presently appropriately be utilized for oceanographic research taking into account, of course, needs in other areas of science.

Subsection (b) of section 7 of this bill would establish within the Department of Commerce a National Oceanographic Records Center which would collect data on oceanography and disseminate it for public use. The desirability of such a center, and its location, if one is to be established, are currently under study within the executive branch and we believe it advisable to await these recommendations before any action is taken in this regard.

In connection with subsection (c) of section 7, we would like to point out that for the Coast and Geodetic Survey to operate beyond the limits of the Continental Shelf a change in its basic authority will be necessary. H.R. 8450, introduced in the first session of the 86th Congress, would provide such authority to the Survey.

Subsection (f) of section 7 would require the Maritime Administration to construct oceanographic research vessels to be made available to nonprofit research centers, to other agencies of the Federal Government, or to State institutions engaged in oceanographic research requiring oceangoing ships. We feel that it would be preferable if the Federal agencies concerned with oceanographic research budgeted for such ships when and as they are needed, either for their own use or for use by private institutions. We believe that more appropriate roles for the Maritime Administration in this connection would be to (1) serve as adviser on design studies, (2) undertake construction on the basis of a transfer of funds from the agency concerned, or (3) finance and undertake research and development for oceanographic ships of unusual or novel design on request of user agencies. Such an approach, we believe, would provide greater flexibility and yet permit utilization of the valuable services of the Maritime Administration in connection with the ship construction.

Section 9 of the bill would authorize the Secretary of Health, Education, and Welfare, through the Office of Education, to provide assistance, in the form of teachers' salaries and equipment, designed to obtain new faculty in oceanography and the marine sciences. Title IV of the National Defense Education Act authorizes the provision of funds by the Department of Health, Education, and Welfare which may be used by colleges and universities for faculty and equipment related to new or expanded fellowship programs undertaken by such institutions. It would appear that the combined authority existing in the National Science Foundation Act of 1950 and in title IV of the National Defense Education Act is fully adequate for the undertaking by executive agencies of providing all of the forms of support contemplated by section 9 of the bill.

With respect to section 11 of the bill, authorizing the Atomic Energy Commission to conduct an intensive 10-year program of control and monitoring of radioactive waste disposal and studies relating to the effects of radioactivity on the marine environment, we understand that the Commission is presently engaged in activities in this area. In addition, we would like to point out that, on August 14, 1959, President Eisenhower issued Executive Order 10831, establishing the Federal Radiation Council to advise him with respect to radiation standards and the provision of guidance to executive agencies for their use in developing operating rules and regulations for radiological health protection. This Council was given a statutory base by Public Law 86-373, approved September 2, 1959. It appears, therefore, that enactment of section 11 of the bill may be unnecessary.

Finally section 13(f) of H.R. 9361 would authorize and direct the Secretary of the Navy to establish, with the National Science Foundation, or the National

Academy of Sciences-National Research Council, a program of scholarships beginning at the senior level in undergraduate school and carrying through 4 years of graduate training and research in the marine sciences. Earlier in this letter we discussed the matter of providing special fellowships in the field of oceanography. With respect to undergraduate scholarships, it is our view that well qualified students in the various scientific fields are able to obtain financial assistance as needed and desired. We find substantial evidence that, with the scholarships presently available, students in at least the upper 10 percent of the classes graduating from the secondary schools, and planning to pursue studies in science, engineering, and mathematics, are generally able to obtain scholarship assistance if needed. Other financial assistance such as loans, is also available to them and to others with not so high an academic standing. Furthermore, it is our general view with respect to scholarship legislation, that, while science and engineering are exerting an increasing influence on our national life, a share of the highly talented youth should be available to other fields of endeavor. Therefore, if undergraduate scholarship legislation were enacted, we firmly believe that such a program should not be limited to a particular field of science or even to science and engineering generally.

There are four programs of the National Science Foundation that are of special interest in connection with motivating more young persons to undertake scientific careers. One of these is the program that we refer to as the undergraduate research participation program. In this activity the National Science Foundation provides grants which enable participating universities to offer special research-oriented training opportunities for undergraduates during the summer months and in some cases throughout the academic year. These training programs may be carried out on a university campus, at a field station, or at some other appropriate location. This program provides research opportunities, including financial assistance, which make it possible for undergraduates to work in close contact with scientists who are doing significant research. As it applies to the problem of increasing the number of students studying oceanography, the undergraduate research participation program offers the possibility of presenting to highly selected undergraduate students some of the specific techniques of research in oceanography. It is certain that this type of program can have the effect of exciting the interest of undergraduate students and turning their minds in the direction of graduate study in oceanography and, therefore, careers in this field. We are endeavoring to stimulate such activities in the field of oceanography during the coming year and stand ready to offer necessary support for them.

At a lower academic level, the National Science Foundation program of secondary school student training programs provides a variety of mechanisms by means of which carefully selected high school students can be shown the challenges of a particular scientific field and be given an explanation of the type of work that is actually carried out in that field. This past summer, for example, the American Meteorological Society sponsored a program along exactly these lines in an effort to arouse interest on the part of a selected group of high school students in possible careers in meteorology. Similar programs in oceanography could arouse the interest of a number of high school students and the Foundation is encouraging proposals for establishing and carrying out such programs.

College teachers in the various fields relevant to oceanography need to know more about oceanography so that they can broaden the outlook of their students. Summer institutes and conferences in oceanography, designed to meet the needs of these college teachers, could become an important phase of the effort to give oceanography a fuller degree of recognition, and college students a better idea of the rewards of careers in the field. We are presently attempting to stimulate interest in such activities in the field of oceanography and, here also, are prepared to provide necessary support.

The last of the National Science Foundation science education activities I shall mention is our program of visiting scientists. This program makes it possible for outstanding scientists to visit college campuses—and, to a limited extent, high schools, also—throughout the country, where they present to the students some of the latest findings in the visiting scientists' fields. Thus far the Foundation has supported programs in a number of fields, and experience has shown that this program is a powerful mechanism for stimulating undergraduate students to take an interest in graduate study and to think in terms of graduate study in the field of the visiting scientists. As a mechanism for bringing additional students into oceanography, therefore, this is a particularly useful possibility, and one of which we are encouraging oceanographers to make use.

The programs I have been discussing are all classified under the "Education in the Sciences" heading. The research-supporting operations of the National Science Foundation are also of major importance in connection with this problem. National Science Foundation research grants provide funds to enable individuals already trained in oceanography to carry out research in this field and in related areas of science. Grants made in support of oceanography (as in other fields) typically provide funds for the support of research assistants as do awards from other agencies supporting oceanographic research. The term "research assistants" is used to mean graduate students who are supported as a part of a research grant, either for a specific project or for a broad area of science. In many instances these students work on their dissertation problems in connection with a research grant which has been supported through the National Science Foundation's basic research program. With the additional funds being made available to the Foundation for the support of basic research in this area, more support will go into projects related to oceanography and, therefore, additional support will be provided for the training of graduate students in oceanography.

Another mechanism to which I referred briefly earlier in this letter is that of broad research grants in the area of oceanography to institutions having highly competent staffs and programs in the field of oceanography. Funds thus provided can be used for young scientists who, entering as graduate students in oceanography, participate in the research of these groups. The caliber of the men carrying on the research would be a substantial factor in helping to secure the interest of first-rate students in careers in oceanography. As a further comment with respect to the role that research grants can play in attracting more able young scientists into careers in oceanography, I would also place high on the list the provision of adequate facilities. This includes, of course, suitable vessels for carrying on oceanographic research. Various Government agencies, including the National Science Foundation, have programs to assure the provision of more facilities of this nature.

The Foundation stands ready to assist in all of these ways discussed above, and I believe that an attack on the problem with the many devices at the command of the Government and universities should result in an important strengthening of work in this field.

In summary, the primary problems in the area of oceanographic research and training appear to be the following:

(1) Motivation of more young persons to undertake careers in science and, at a later stage, to become interested in the field of oceanography. While financial assistance for highly capable persons interested in oceanography is, and should be, available, the problem is not primarily one of financial support, we believe, but more of encouraging oceanography as a career. As noted above, the National Science Foundation is undertaking efforts to achieve this objective.

(2) Coordination of Federal and private activities with respect to stimulating research and training activities in oceanography. Federal agencies concerned with matters of oceanographic research and with the marine sciences are working closely with one another and with non-Federal organizations to develop a comprehensive attack on the problem. In this connection, the Ford Foundation has recently announced the award of grants to several universities, designed to increase the number of advanced research scientists in the field of oceanography.

(3) Provision of funds to carry out needed programs in the field of oceanography and the marine sciences. The 1961 budget provides for substantial expansion of Federal support of oceanography through programs of the Foundation and a number of other agencies. We understand that total expenditures for oceanography exclusive of funds for certain military purposes will be $56 million in 1961 as contrasted with $38 million in 1960. As we mentioned earlier, care must be exercised, however, so as not to create too great an imbalance between oceanography and other areas of science. Another factor directly related to utilization of oceanographic research funds is that the number of oceanographers presently trained and capable of doing high quality research work is limited and until there is a significant increase in the number of such persons, additional funds alone will not achieve the desired result.

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Thank you for giving us the opportunity to comment on the bill.

The Bureau of the Budget has advised us it has no objection to the submission of this report.

Sincerely yours,

HARRY C. KELLY, *Acting Director.*

Dr. WATERMAN. As a general matter, it is our view that, while we concur with the objectives of all of these bills, which are aimed at promoting the progress of oceanographic research and training, sufficient legislative authority already exists within the executive branch to carry out the objectives of the bills without the need for additional legislation. We recognize the importance, however, of supporting more intensively those areas of science, such as oceanography, which appear to require urgent assistance in the national interest.

In this connection, you may be interested in the support which the Foundation is giving and plans to give to oceanographic research. In fiscal year 1958, the Foundation expended slightly over $1 million for the support of research in this area. In fiscal year 1959 our expenditures were approximately $2½ million. Our estimate for fiscal year 1960 is approximately $7½ million and the President's budget for 1961 has included approximately $9½ million for support of oceanographic research. This includes support under our programs in the mathematical, engineering, and physical sciences, support for biological oceanography, including facilities, and support for ship design and construction. As I mentioned earlier, the figures for fiscal year 1960 and 1961 coincide closely with the recommendations of the Committee on Oceanography of the National Academy of Sciences—National Research Council.

As we have pointed out previously, one of the major problems with respect to the promotion of increased research in oceanography lies in the production of more trained research workers in the field. Oceanography includes, or is related to, many fields of science, and thrives best in intimate contact with various scientific disciplines. There seems to be general agreement among the leaders in oceanographic work, therefore, as to the importance of securing people for oceanographic research from those well trained in other related fields, such as biology or chemistry. Provision of oceanographic research facilities, including ships, is, of course, highly necessary. Additional skilled researchers must be provided, however, in order that the expanded facilities can be utilized to their fullest extent. We do feel that the need for oceanographic research workers cannot be solved merely by the provision of more fellowships or by the furnishing of additional scholarship aid. Moreover, on this point we believe that sufficient fellowship aid for high-quality students is presently available through various sources so as to enable financial assistance to be provided to persons interested in entering the field. As you know, the National Science Foundation presently awards fellowships in the various sciences, including oceanography and related fields, and, in fact, we specifically mention oceanography in our fellowship brochure; but we think there would be risk of lowering the high-quality standards and the recognition which NSF fellowships now have if the Foundation were to establish specialized fellowship programs for particular areas of science without some overriding justification.

With respect to undergraduate scholarships, it is also our view that well-qualified students in the various scientific fields are able to ob-

tain financial assistance as needed and desired. We find substantial evidence that, with the scholarships presently available, students in at least the upper 10 percent of the classes graduated from the secondary schools and planning to pursue studies in science, engineering, and mathematics are generally able to obtain scholarship assistance if needed. Other financial assistance, such as loans, is also available to them and others with not quite so high scholastic standing.

As we see it, the problem is more one of motivation, and, if sufficient young persons of high capability can be interested in entering upon careers in oceanography, we believe that necessary financial aid can be obtained.

In this connection, the support which the Foundation is providing for research in oceanography and related areas of science is an extremely valuable training mechanism. By means of Foundation research grants, graduate students can receive support for their participation in the research while, in many cases, working on their dissertation problems in connection with the research. In addition to the support we provide for meritorious proposals requesting assistance for particular research, we are in a position to encourage requests for support for research which has a strong emphasis on the training of research workers.

This is especially good because it provides training at the centers where the standards for oceanographic work are high. Furthermore, we consider support for programs of basic research covering a broad area or subarea of science within which support may be provided for graduate thesis research. Both of these types of support appear particularly appropriate for oceanography.

In our comments on H.R. 9361, we discussed in detail those programs of the National Science Foundation which are of special interest in connection with motivating more young persons to undertake science careers, and which can be of particular assistance with respect to encouraging careers in oceanography. These programs are as follows:

(1) The undergraduate research participation program, whereby support is provided to universities for special research-oriented training opportunities for undergraduates during the summer and, in some cases, throughout the academic year. Under this program, undergraduates may receive financial assistance and an opportunity to work in close contact with scientists who are doing significant research. With particular reference to oceanography, the Foundation has awarded grants for support of four undergraduate research activities of this nature which are taking place at the Virginia Fisheries Laboratory, Oregon State College, the Scripps Institution of Oceanography, and Humboldt State College.

(2) At a lower academic level, the Foundation supports summer programs related to secondary school training by means of which selected high school students can be shown the challenges of a particular scientific field. Two such programs in oceanography are now underway at the Scripps Institution of Oceanography and at Louisiana State University in a effort to encourage interest in possible careers in this field. We anticipate expanding our activities in this area including those which relate to oceanography.

(3) Summer institutes and conferences for college teachers. We hope that, through this type of program, college teachers in fields

related to oceanography will learn enough about oceanography to be able to broaden the outlook of their students. We are presently supporting one such summer institute at Oregon State University. In addition, we are attempting to stimulate further interest in such activities and are prepared to provide necessary support for them.

(4) Program for visiting scientists. This program makes it possible for outstanding scientists to visit college campuses and, to a limited extent, high schools throughout the country, where they present to the students some of their latest findings. We have found this to be a very useful mechanism for stimulating undergraduate students to take an interest in graduate studies in the fields of the visiting scientists and we are encouraging interest in a program of this nature in oceanography.

In addition, we are supporting special training programs in marine biology for high school teachers at the Hopkins Marine Station and at the Texas A. & M. Marine Station, and have supported conferences aimed at the development of plans for specialized field institutes in scientific areas directly related to oceanography. An example of the kind of conference which I have just mentioned is one which was supported through a grant to the American Society of Limnology and Oceanography for the preparation of a report on the status of education in oceanography in the United States. We also are providing aid for a summer institute for graduate students in marine science at the University of Texas Marine Station. At a higher level we are supporting a summer program at Woods Hole Oceanographic Institution in geophysical fluid dynamics.

In all these ways, we are developing our programs for assistance to training in the oceanography and related sciences. We are prepared to expand this support as rapidly as we can, taking into account the quality of the programs for which support is requested and availability of funds, keeping in mind, of course, needs in other areas of science.

I have discussed these matters at some length, Mr. Chairman, because I wish to make several things clear: First, that we realize the importance of providing particular support for research and training activities in the field of oceanography and in related scientific fields. Second, that we believe our present legislative authority is sufficient to authorize those activities we believe are, or may become, necessary to encourage such research and training; and third, that we are presently engaged in providing support for such activities and in developing interest in them among the educational community.

I would like to make several other observations with respect to the legislation at hand. Subsection (f) of section 7 of H.R. 9361 would require the Maritime Administration to construct oceanographic research vessels to be made available to nonprofit research centers, to other agencies of the Federal Government, or to State institutions engaged in oceanographic research requiring oceangoing ships. As we have previously pointed out, we believe that flexibility in this area is highly important and that it would be preferable if the Federal agencies concerned with oceanographic research budget for such ship when and as they are needed, either for their own use or for use by private institutions, calling on the Maritime Administration for appropriate advice and assistance.

With respect to the coordinating committee proposed in H.R. 10412, as you know, the Inter-Agency Committee on Oceanography has been established under the auspices of the Federal Council for Science and Technology, with representation from agencies having a concern with oceanographic activities, to act as a coordinating mechanism with respect to Federal activities in oceanography. We feel that this committee will be an effective means for promoting coordination of the national program. Under these circumstances, it appears that the committee proposed in H.R. 10412 would unnecessarily duplicate the activities of the Inter-Agency Committee.

We are in agreement with the objectives of H.R. 12018, which would establish a National Oceanographic Data Center and a National Instrumentation Test and Calibration Center. Both of these proposed centers are needed and their location within the executive branch is presently being determined.

We are mindful, as I mentioned earlier, of the great importance of oceanographic research and stand ready to provide such assistance and support as we can to promote its progress. I would like to express a word of caution, however. We must be careful to make sure that various needy areas of science, of which there are a number, receive the support and assistance necessary for their continued advancement. New scientific frontiers are constantly opening up and we must be certain that all needy scientific areas receive the maximum support feasible. The possibility of overemphasizing one field to the detriment of others is a constant danger which must be avoided. Flexibility in this regard is highly important, and too rigid organizational arrangements aimed at a particular scientific field can be detrimental to the interests of science generally. Advancements in a particular field of science, which appear to have no direct relationship to other scientific fields often, at some later date, prove to have an important connection and, in many cases, provide the approach for a scientific breakthrough along completely unanticipated lines. That is why support of science across a broad base is so vital.

This concludes my statement, Mr. Chairman. We will be happy to answer any questions you may have.

I have also with me Dr. John Wilson, head of our Division of Biological and Medical Sciences, who can speak to our participation in that.

Mr. DINGELL. Thank you very much.

Mr. BAUER. With respect to your charter established by the National Science Foundation Act, section 1862 authorizes you and directs you to develop a national policy for the promotion of basic research and education in the sciences.

You are also directed to initiate and support basic scientific research.

With that in your charter, why do we have to have a Federal Council of Science and Technology?

Dr. WATERMAN. The most important reason, I think, is that we in our charter are concerned with basic research and not at all with development. Our charter states in ordinary broad terms we are expected to provide support for basic scientific research, and for programs to strengthen scientific research potential, which includes our education in the sciences programs.

Whereas we do have the function of making surveys and analyses of what is going on in the country in research and development generally,

we have no authority to support development, and I early took the position in the Foundation that if we have no authority to deal with it in that sense it would be a mistake for us to try to impose our authority on other agencies. I think this would be, therefore, out of order.

This was cleared up in Executive Order 10512 in 1954 which specified responsibilities of agencies of the Government in research and development, and here it was pointed out other agencies should be held responsible for developmental work, and in fact be encouraged to support basic research closely related to their missions.

As I say—I am making a long story of it—it is essential if we are to have proper coordination within the Government to have a body such as the Federal Council with responsible representatives of the agencies mostly concerned with research and development, in order that they may handle matters of coordination in areas which include not only basic research but applied research and development as needed.

Oceanography is a subject of that sort. While a great deal of basic research is needed, as you know very well, one of the important aspects of oceanography is the practical result which can come out of it which leads one right away into applied research.

Mr. BAUER. Do you initiate programs in basic scientific research?

Dr. WATERMAN. Yes, sir. We do this in a way which research scientists fully understand and it has their complete approval; namely, first of all we encourage them to send us applications or proposals for what they feel they are competent to do and would like to do, and an estimate of how much this would cost. Then there is a system for reviewing this, and then when necessary this is reviewed further by advisory committees to talk about the general plan we have, and then our program consists of making a selection of the applications which come to us.

In the process of that selection there is a planning operation, so in this way we select the work which the scientists of the country feel is most important to do from their standpoint. This is a great source of strength to the country. Without this technique they would not have that power.

Superposed on this general support, what the scientists would like to do, we can sense from discussion with scientists and other agencies areas which at the moment deserve more attention. In that case there are various techniques one can use to encourage the field.

But I must add, as I stated in my statement here, that if one is dealing with basic research, one has to be very careful not to force the issue with people. A basic research person, you see, by definition is a person trying to find something new. He knows best what he can do to find something original. If someone else tells him to work on something else because he happens to be a qualified person, this can be done to a limited degree but only where the work has a very high priority. If you do too much of that, you take off our best research workers from the field which they themselves think they can do best and put them on something else just because they are asked.

This gets pretty close to dictation and one should not do this in science. Therefore, one has to deal with this matter of handling of what you might call critical areas of science with a great deal of caution. That is not true, of course, on the applied and development

areas. There you have to find the people to do the work the Government needs.

Mr. BAUER. Do you regard ocean surveys as basic research?

Dr. WATERMAN. Fundamentally, they are. That is a very important aspect. They can be applied if one knows what he is looking for from the survey. The Navy's interests from the standpoint of a military agency I would call applied research. They have an end in view. They are trying to find certain things that are useful to the Navy.

An oceanographer, who, shall I say, is a pure oceanographer, wants to know what he can find—for example what the ocean bottom is like. His job is to find out what is there. He is really an explorer. In that sense, these surveys in oceanography are basic. One can always being in the other point of view, depending on the particular program one has in mind. They are both involved in oceanography.

Mr. BAUER. If you make a grant to an institution and give the institution a sum of money to build a ship, would that ship be required to do nothing but basic research?

Dr. WATERMAN. From our standpoint, yes. As you know, we are already engaged in plans for construction of one and another one the coming year. These ships would be for basic research. That would be our object.

Of course, in this we are in close touch with the Navy planning because the vessels they have for oceanographic research would also be doing basic research, but also the research of special interest to the Navy. That gives them a special slant, a special aspect, in what they are going to do.

Since that is not the whole aspect we, of course, take the general side which would be basic. That would cover the physical sciences and be quite impartial about the whole thing.

Mr. BAUER. Supposing one of your grantees decides to use a ship for applied research or development. What would you do with the ship? Would you take it back?

Dr. WATERMAN. I do not suppose that question would arise. It could arise, of course, and would arise in the case of war or near war where one could assign a vessel to do this. Certainly, we would have no intention of refusing.

I believe one would best say this about it. Our ships are intended for basic research. When they get going then if they see something to do which has a practical side, that can still be basic, you understand, in the sense you are trying to find out what the facts are. In that case you are turning the research into a particular practical direction.

This line is very hard to draw. I do not really see any occasion where a vessel turned over to an oceanographic institute, that one would worry too much about it. I do not think we would because, as I say, the line is very hard to draw. After all, we are providing the vessel as a research tool and leaving the research, depending on the terms of how the funds were provided, to the agency itself. We would have done our duty in providing the vessel for basic research purposes.

Mr. BAUER. That is all, Mr. Chairman.

Mr. DINGELL. Thank you very much. Mr. Drewry?

Mr. DREWRY. I think not, Mr. Chairman.

Mr. DINGELL. Mr. Pelly.

Mr. PELLY. Dr. Waterman, I find it rather novel to listen to testimony where money is not necessarily the solution for all problems. You say that in our need for additional research workers that more money and fellowships will not solve it. That is very unusual here in Washington to hear that. I thought all we had to do was add a million dollars here or there and solve all problems.

Dr. WATERMAN. We tend to fall in that box because of shortness of money. As a matter of fact, in all these things it is the people who count. In order for the people to work, they need money and equipment.

Mr. PELLY. In the scientific field and the need for engineers, I should not become quite convinced that a friend of mine was correct when he said that our problem there was to take the best students we already had; that we had plenty of them in our higher educational institutions; we did not need more enrollment. We encourage everybody to try to become engineers, but we had enough if we could hold them to go on with their higher education. There was the need for additional and more liberal fellowships so that the brains, you might say, would not be tempted away by private industry and could be held. But apparently that is not true, in your opinion, in this field.

Dr. WATERMAN. I do not want to give the impression of being too dogmatic about it. I would say this. If one is interested in building up oceanography as a subject in the Nation's interest, in the long run what you have to do is make the career in oceanography attractive. That is what appeals to Americans. They do not care how many inducements you put in the way if they cannot see ahead of them a good and promising career where they can do the things they want to and be adequately provided with what it takes to raise their families, and so on. That is the thing one has to focus on. That has the biggest appeal in this country of anything, a promising career.

What do we do to stimulate that? First of all, provide support to research and activities in oceanography so there are plenty of jobs, and these jobs ought to be good paying jobs where constructive work is being done. There should be vessels where oceanographers can go, there should be reports of what they find, they should be incorporated in the Government agencies' capacity to lead into applied work so that everybody in the industry can see what is being done.

As for encouraging people going into graduate work or specializing, there are two techniques. One is by fellowships, or making it possible for people to do it individually, and the other by supporting research in these same institutions.

Mr. PELLY. You say the fellowships available now and the finances are adequate, really?

Dr. WATERMAN. They can be. You see, we have a broad fellowship program, and oceanography is listed as one of the areas. If the oceanographers feel it is very important to have graduate students get fellowships, all they have to do is look around and persuade competent undergradnates to apply for them. This has happened in fields like mathematics.

We find, for example, among both our applications and awards of fellowships that mathematics is way ahead of the others in the proportionate number that go in as compared to the number in the field. This is just because the mathematicians all over the country have realized it is important to get more people in the field, and they have

encouraged people to go ahead. The same thing can take place in oceanography. Our program is flexible in that respect.

What I particularly want to say is the other side, that if you back research projects which are rather general in scope, you provide training facilities and provide opportunities for graduate students to be employed on those, and you do it at the best centers. This can be deliberately done. Research is encouraged and, at the same time, the training of the graduate students. I think that is a very sound policy.

Mr. PELLY. How about the international exchange of information and projects of that nature? Would you elaborate a little? It is in the omnibus bill.

Dr. WATERMAN. At the present time, as I believe you gentlemen know, the foundation has responsibility, centered in our Office of Scientific information Service for taking the lead in the science information field among the Federal agencies. This does not mean we do all the scientific information exchange activities: each agency plays its part, but we take the lead in this both with private and public institutions dealing with scientific information exchange. One important aspect of this is contact with the sciences abroad.

For example, at the moment one of the major items in our scientific program is the translation of foreign languages into English, especially Russian, where we are translating now something like 50 Russian periodicals into English and seeing that those get distributed. This feature in our Office of Scientific Information is one which would enable us to exchange information abroad.

Mr. PELLY. Do we have fellowships abroad like the Guggenheim fellowships in music and those fields?

Dr. WATERMAN. In the Foundation until this year we have had no authority to provide fellowships to other than U.S. citizens, but a fair proportion of our fellows who are American citizens that we appoint go abroad to study.

Mr. PELLY. That is what I meant.

Dr. WATERMAN. In addition, we send a considerable number of people to international conferences, including oceanography, each year.

Mr. PELLY. Thank you.

Mr. DINGELL. I would like to turn to your discussion of these ships. You mentioned you were going to spend about $7.5 million in fiscal year 1960, and in 1961 about $9.5 million in support of oceanographic research. About how much of that is going into ship construction?

Dr. WATERMAN. Dr. Robertson can answer this in detail. I believe in the first $7.5 million we had one ship to cost $3 million, and in the next year, because it would follow somewhat the same design, it would cost slightly less. Am I right?

Dr. ROBERTSON. Yes. I think in 1961 it is planned to spend $2.75 million for another new ship, and I believe about $1.5 million in converting a ship for research in the Antarctic.

Mr. DINGELL. Who is going to have title to these vessels?

Dr. WATERMAN. At the present time what the Government is doing, is to provide for the cost of construction and necessary maintenance, to begin with. Then we have the authority to give these to the agency if the Government has no use for them. They have not been built. We have not faced that question yet.

Mr. DINGELL. The original National Science Foundation Act provided, as I recall, that grants of equipment, and so forth, to private institutions would remain the property of the United States. Am I correct in my understanding of that?

Dr. WATERMAN. Not quite, sir. We have authority to give them to the institution if the Government has no need.

Mr. DINGELL. As of when do you have that authority? When that bill was passed during the last Congress?

Dr. WATERMAN. This was in the original act, as Mr. Hoff, our General Counsel, can confirm. We have always had this authority.

Mr. DINGELL. You have always had that authority?

Mr. HOFF. Yes, we have always had that authority, we feel.

Mr. DINGELL. Do you propose to give these ships to private institutions or do you intend to avail them to or lease them to private institutions?

Dr. WATERMAN. Since they have not been built, we have not had that arise explicitly as yet.

Dr. ROBERTSON. The grant we made this year to the Woods Hole Oceanographic Institution for $3 million contemplates that they will have the ship designed and built and that they will have title to the ship after it is built.

Mr. DINGELL. As a taxpayer, do you not think that is a rather extraordinary procedure, to give title to a $3.5 million ship?

Dr. ROBERTSON. I think it is very similar to our giving money to an institution to build a nuclear accelerator, for example. We regard this ship as a scientific tool that can best be designed and constructed and operated by one of our leading scientific institutions in the same way that another institution might design, build and utilize a nuclear accelerator.

We feel it is simpler and probably cheaper in the long run for them to own and to be responsible for this ship. We specified that in the event of a national emergency title could revert to the Government.

In constructing the ship we have specified a number of check points where approval of the National Science Foundation is required. In carrying out that portion we have assembled a committee, an advisory committee, consisting of members named by the Department of the Interior, the Maritime Commission, and the Navy, to help us in approving the design and inspecting the construction of the ship.

Dr. WATERMAN. Mr. Chairman, it seems to me a very reasonable position and one of great strength in the support of oceanographic work to have ships provided and used both by the Government and by private institutions. Within the Government, of course, the Navy's vessels would be Government-owned and Government-operated, and similarly with other vessels which would be under Government agency authority.

This provides for the Government's interest in this. The Government's interests are always tinged with the idea of some application. That is important and should be maintained. On the other hand, when these are used by private institutions, there is a great advantage in having them for pure basic research, such as these private centers do. This makes them more flexible in what they do, more comprehensive in what they find. I believe it is to the country's interest to see to it that private agencies have these facilities available, too, particularly where we have such very strong centers as we really have at Woods Hole and

Scripps and other places. I believe this adds to the strength of the country's effort.

Mr. DINGELL. I have no objection to assisting these private institutions, even by assistance in ship construction, but the question concerning me is this. In the event this vessel were to be used or sold as a fishing trawler or the institution for one reason or another were to close its doors, what would happen to the vessel then?

Dr. WATERMAN. As Dr. Robertson said, we do require in our contract for this that the institution check with us as to the purposes for which the vessel is to be used from time to time.

Mr. DINGELL. Once you give them title to the vessel how do you recapture it if they do not use it as you dictate?

Dr. WATERMAN. I forget the terms of the grant. Do you remember those?

Dr. ROBERTSON. Not on that point.

Mr. DINGELL. Do you have any control over this? I am very interested in this point. I would like to see this vessel afloat, but at the same time I would like to know whether or not it is going to serve the purposes you indicated.

Dr. ROBERTSON. We made a grant essentially to Woods Hole to build a ship which we can regard as a scientific instrument, to use for their research purposes.

Mr. DINGELL. I understand. What happens if they do not follow that? I assume it is a farfetched possibility, but in the event they should not use it as indicated, what would the National Science Foundation do?

Dr. ROBERTSON. We have the same problem, in a sense, in all our grants. We make grants for basic research and research equipment.

Mr. DINGELL. I understand, excepting the cyclotron can only be used as a cyclotron, or a particle accelerator as a particle accelerator.

Dr. WATERMAN. That is not exactly correct, sir. You can use a cyclotron or a particle accelerator for the making of isotopes.

Mr. DINGELL. But it is limited in its uses, whereas, the ship has a widespread series of purposes for which it may be used.

Dr. WATERMAN. This would be a legal point requiring attention, I would think, but the purpose in the grant was spelled out that these ships were to be used for basic research in oceanography. If they should not be used for that purpose, I should think the Government should have some say in the matter, though I am not a lawyer.

Mr. DINGELL. The question I am directing to you, since you are the officer to speak on behalf of the National Science Foundation, I would like to know: (1) What would the National Science Foundation propose to do, and (2) what could it do under its contract?

I would like to have some explanation of that. Perhaps your counsel would like to give his name for the record and explain it to us.

Dr. WATERMAN. We could give this some thought and submit something for the record unless Counsel would like to speak now.

Mr. HOFF. I am William Hoff, General Counsel of the Foundation.

It seems to me the chief sanction of all these things is that the ship is given to them for certain purposes, specified in the grant, for basic research. We have continuing relations with these institutions. The institutions are for the purpose dedicated to basic research.

If they misused anything which had been given to them under the grant, it would be very difficult for them to get further support on

which they rely rather heavily. I think that is about the main sanction developed.

Mr. DINGELL. What power do you have to recapture the vessel?

Mr. HOFF. Only in the event of emergency, I believe. I would like to check that against the actual grant.

Mr. DINGELL. Would you submit to us that information?

Mr. HOFF. Yes; if that is wrong, we will correct it.

Mr. DINGELL. What have you done to standardize these oceanographic research vessels?

Dr. WATERMAN. We have none this big. This is a matter of starting from scratch.

Mr. DINGELL. Have you held any discussions with Maritime Commission about standardization?

Dr. WATERMAN. Yes; they are our chief advisers in this whole problem.

Mr. DINGELL. Is there being some effort made to standardize these vessels?

Dr. WATERMAN. Dr. Robertson, can you answer that? Of course, we have the design of a completely up-to-date vessel now going. Then we have a second to follow. The construction of the first one is standardization in a sense. For this class of vessel we will then know how best to build one and how best to build the second.

Dr. ROBERTSON. My comment would be that it is not really plain that this type vessel should be standardized. Perhaps certain features can be standardized, but the different requirements of research and different kinds of research that people carry out using this vessel may dictate changes or differences in design in order that that particular kind of research can best be done. We feel that a good deal of leeway should be allowed in this kind of design.

Mr. DINGELL. You are, of course, familiar that hull designs are hull designs and the compartmentation is a very simple matter with each ship. The engines again are a very simple matter on which you can standardize. Have you made any effort to standardize such things as hull design or perhaps dimensions or perhaps engines as a matter of economy?

Dr. WATERMAN. The standardization of vessels—I am not expert in this, but I have talked enough with people to understand what the problem is for oceanographic purposes. It is to take into account both the design of the vessel for its speed and seaworthiness—which is the general hull design and compartmentation, and so forth—and, of course, provision for the necessary activities that have to take place on board so that those have to be adapted to each other.

One, naturally, cannot build an oceanographic vessel and at the same time make it the fastest vessel afloat, for example. This is a matter of getting together with what the research people feel they must do, what space they need for it, what special gear they need for it, and get them together with authorities on building ships in general.

The oceanographic people have had years of experience in the kinds of things they need to do, and the types of vessels that can do it, and the Maritime Commission, of course, has great experience in ships of all kinds and experience in this particular area also.

Mr. DINGELL. Have there been discussions with Maritime on these possibilities of standardization?

Dr. Waterman. Yes; that is one of the chief points about this contract we made to get the vessel built. We have corresponded with them on that subject and they are happy to do it.

Mr. Dingell. One last question about this. You did not give this vessel to the private institutions on the basis of the statute passed out of Interstate and Foreign Commerce last year, giving you authority to give title——

Dr. Waterman. We have always had the authority.

Mr. Hoff. May I perhaps enlarge my remarks on that?

Mr. Dingell. Yes.

Mr. Hoff. We have always had the authority to make grants for support of basic research. The language was changed a little, but that is basically it. The grant being made for the construction of the ship would be a facility for conducting research, as any other facility which we have given. Last year we did clarify our language a little by including in the section on powers, I believe we added the words "grant of any personal or real property," but this was merely a clarification of what we thought was the meaning of the section all along.

It also, in my mind, relates more to giving property over which we had title at the time rather than a gift for the construction or acquisition of something.

Mr. Dingell. Thank you very much.

Mr. Hoff. One further thing. Last year, of course, there was the other bill giving grant authority to agencies which had contractual authority to support basic research. This legislation was sponsored by the Foundation, did not affect us. This was merely to try to get other agencies supporting basic research under contractual authority only the same authority in many areas to give grants that we had.

Dr. Waterman. One other point is this. Under this same legislation other agencies were permitted to give equipment in case of grants for basic research to the institutions to which the grant was made. Both these were things sponsored by the National Science Foundation.

Mr. Dingell. I just wanted to be sure you had not been given the ship under the section which provides for grants for small pieces of equipment to private agencies. It would be a rather large piece of small equipment. Mr. Drewry?

Mr. Drewry. Dr. Waterman, I believe you said that you could not say whether the title to the ship would be given to the grantee because it had not been built. Is not the grantee the one who will make the contracting arrangements?

Dr. Waterman. I was wrong in that. Dr. Robertson corrected me. It is a provision in our grant that they may take title except under the restrictions mentioned.

Mr. Drewry. In fact, from the very time they get the money and they proceed to use the money and make the contract with the naval architect and shipyard, and so on——

Dr. Waterman. Yes.

Mr. Drewry. In other words, the title begins to attach just as soon as they start working on the ship.

Dr. Waterman. I believe that would be right.

Mr. Hoff. Yes.

Mr. Drewry. Thank you.

Mr. DINGELL. Do you think it would be wise to have title remain in the hands of the Federal Government until such time as work on the vessel were completed?

Dr. WATERMAN. I should not think it would matter, Mr. Chairman. It is intended for the work done by this group and for the reason I said earlier I believe it is important that private groups have the equipment they need, the installations and research instruments they need to do their work free of encumbrance. This is a source of strength in the general picture.

Mr. DINGELL. This could be done with the Federal Government having nominal title to the vessel.

Dr. WATERMAN. Yes, it could be.

Mr. DINGELL. Would you explore that? This vessel grant is something that concerns me. I am happy to see you have all the money you want to do what you want and what the public interest requires. I sincerely mean that. I have the feeling in my own mind that possibly this could be scrutinized in your own agency with an eye to tightening up some things you are doing. After all, you are not giving out a small technical instrument. You are giving out a very large and a very valuable public asset. I hope you are doing it with the greatest degree of care possible.

Dr. WATERMAN. We made a great deal of study on this whole matter over a period of 2 years before deciding to go into it. We will be very glad to.

Mr. DINGELL. As you are aware, even the Maritime Commission comes a cropper on some programs from time to time, and they have had a great deal of experience in these matters.

Are there further questions? Thank you very much, Doctor.

Dr. WATERMAN. Thank you, sir.

Mr. BAUER. Mr. Chairman, with your permission, I would like to introduce for the record a letter from Dr. Waterman addressed to Dr. Paul M. Fye, Director of the Woods Hole Oceanographic Institution, Woods Hole, Mass., pertaining to a research grant of $3 million by the National Science Foundation to Woods Hole Oceanographic Institution. The letter is dated November 23, 1959.

Mr. DINGELL. Without objection, it will be placed in the record at this point.

(The letter referred to follows:)

Re Research Grant NSF–G10337.

Dr. PAUL M. FYE,
*Director, Woods Hole Oceanographic Institution,*
*Woods Hole, Mass.*

DEAR DR. FYE: I am pleased to inform you that the sum of $3 million is hereby granted by the National Science Foundation to Woods Hole Oceanographic Institution, for the support of design and construction of an oceanographic research vessel, under your direction, for a period of approximately 2 years.

An initial payment in the amount of $100,000 will be made on or about 2 weeks from date of this letter. Subsequent periodic payments shall be determined by mutual agreement based upon the anticipated needs for expenditure, as they occur, upon provision of satisfactory documentation to the Foundation by the grantee.

It is a condition of this grant that it may be revoked in whole or in part by the Foundation after consultation with the grantee, except that a revocation shall not affect any commitment which, in the judgment of the Foundation and the grantee, had become firm prior to the effective date of the revocation; and that funds not committed by the grantee prior to the conclusion of the work contemplated under this grant shall be returned to the Foundation.

It is a further condition of this grant that disposition of patent and other rights in any inventions or discoveries made or conceived during the research shall be the responsibility of the grantee; that the grantee shall give the Foundation reasonable notice of application by the grantee or other person or institution for a foreign or domestic patent on any such invention or discovery; and that upon issue of any patent on any such invention or discovery, the patentee shall grant the Government an irrevocable, royalty-free, nonexclusive license for use of such invention or discovery for governmental purposes.

Special supplemental conditions of this grant are:

(*a*) The grantee will submit detailed construction plans, drawings and specifications, together with detailed cost estimates based thereon, for Foundation approval prior to solicitation of bids. It will also submit for Foundation concurrence plans for: (1) The solicitation of bids, (2) award of the contract, and (3) inspection and supervision of construction.

(*b*) The Foundation reserves the right to make periodic review of the progress of the work, including inspection.

(*c*) The grantee will, within the reasonable limits of its funds, operate and properly maintain the completed vessel.

(*d*) During a period of national emergency declared by the President or the Congress, the grantee will, should the cognizant Federal Government executive agency decide that the interests of national defense require it, convey to the Government, title and ownership of the vessel without further cost to the Government except for such equipment and improvements as may have been added by the grantee and such other costs as may, in the judgment of the cognizant agency, be deemed equitable.

The Foundation desires that this grant be administered in general accordance with the Foundation's policies for research grants as stated in "Grants for Scientific Research," April 1955, and in conformity with the other understandings reached between the Foundation and the grantee relating to this grant.

Please acknowledge receipt of this grant letter and agreement with its conditions at your earliest convenience.

Sincerely yours,

ALAN T. WATERMAN, *Director.*

Mr. DINGELL. Dr. Dixy Lee Ray, Department of Zoology, University of Washington. Under the circumstances, the Chair will recognize Mr. Pelly briefly.

Mr. PELLY. I already personally told Dr. Ray I was proud and pleased that she is going to appear before this subcommittee. I would like the record, however, to show that it was the intention of the chairman, Mr. Miller, to have the subcommittee visit the University of Washington and I hoped, too, the Friday Harbor Oceanographic Laboratory last fall, but we were prevented from doing so.

While I think Mr. Bauer was able to get to the campus of the University of Washington, the rest of us were not. I hope we may put on our itinerary for the months ahead such a visit because I know that the University of Washington and the scholars and scientists connected with it are well known and recognized by this committee in the oceanographic field.

Again, I am very delighted to welcome you here, Dr. Ray, and hope to return your call in the near future.

Dr. RAY. Thank you very much.

## STATEMENT OF DR. DIXY LEE RAY, DEPARTMENT OF ZOOLOGY, UNIVERSITY OF WASHINGTON

Mr. DINGELL. It is a privilege to have you with us. Do you have a prepared statement?

Dr. RAY. Yes, I do. It is rather a long statement and, if it is satisfactory to you, I will briefly summarize the main points, unless you would like me to read it in its entirety.

Mr. DINGELL. Feel free to summarize it, and we will insert your entire statement in the record.

(Dr. Ray's biographical sketch and prepared statement follow:)

BIOGRAPHICAL SKETCH, DIXY LEE RAY

Address: Department of Zoology, University of Washington, Seattle, Wash.
Major field of interest: Marine biology.
Born: Tacoma, Wash., September 3, 1914.
Degrees: B.A., Mills College, 1937; M.A., 1938; Ph. D. (Biology) Stanford University, 1945.
Professional career: Instructor zoology, University of Washington, 1945–47; assistant professor, 1947–57; associate professor, 1957—. Member staff, Friday Harbor Laboratories, 1947—; executive committee 1958—.
Awards: Guggenheim Fellow, 1952–53.
Member: American Association for the Advancement of Science, American Institute of Biological Science, Western Society Naturalists.
Scientific contributions in: Microbiology; fish morphology; marine invertebrates; cellulolytic activity of marine wood-boring animals.

STATEMENT OF DIXY LEE RAY

My statement today is concerned with marine biology. I would like first of all to emphasize that when I use the phrase "marine biology" I mean it with the broadest possible connotation, and with reference to all manner of biological studies on aquatic organisms whether they live inshore, on the high seas, in surface waters or at the ocean depths. The term "hydrobiology" or perhaps "aquatic biology" would even be preferable for we recognize that it is water itself that mainly characterizes the environment; water is the primary feature of aquatic life. In the ocean, size and salt content modify and enlarge many of the problems, and indeed, introduce some highly significant new ones but many of the features that affect floating, swimming, and submerged organisms are the same for fresh water as for marine creatures. Therefore studies in estuaries, lakes and streams contribute importantly to an understanding of biological phenomena in the sea and the reciprocal is also true. Traditionally fresh water biologists are called limnologists (like the Pacific salmon many are anadromous) but the problems studied are basically similar and a matter of terminology should not obscure the essential unity in aquatic biology.

Another point needs to be understood, I believe, in order to view the role of biological studies in the sea in proper perspective. And that is what oceanography really encompasses. Oceanography is a very special kind of science; it is the study of an environment. This environment is a vast, interacting and dynamic system. It occupies a very large portion of our globe and presents many unique features not encountered on land. Description, analysis and ultimate understanding of all its properties requires the cooperative effort of scientists from every discipline.

In order to study the sea in a comprehensive fashion the problems that must be resolved are big; many of them demand extensive and expensive facilities and instrumentation, and they are interdependent. This interdependence I want also to stress. That oceanography draws upon the special knowledge and skills of all branches of the traditional sciences can readily be illustrated. To cite a few examples:

(1) Knowledge of current patterns and of water circulation helps to explain the distribution of some aquatic organisms and conversely, recognition of certain species may identify a body of water from a particular region or one that remains isolated within the larger mass (something like a cloud in a clear sky). These water cells are often not distinguishable by ordinary physical or chemical methods and are known only by biological indicator organisms.

(2) Some unusual elements, e.g. arsenic and vanadium, are known to occur in the ocean only because they are accumulated in the bodies of marine animals or plants. Certain tunicates (commonly known as sea squirts) are capable of concentrating vanadium 280,000 times over the level present in the water.

(3) Study of benthic forms provides information about the nature of the ocean floor, and studies in submarine geology reveal much about the bottom living animals to whom the substratum is an important aspect of their ecology.

(4) The whole energy budget, the productivity of the sea, depends for its understanding upon detailed and exacting studies on the interplay between the physical environment and its contained, living organisms.

Such examples could be multiplied manyfold, but these few serve to emphasize the interdependence of the physical and biological sciences in the study of the oceans. Pursuit of oceanographic research exclusively or predominantly from either a physical or a biological point of view would most certainly be self-defeating and would not lead to that synthesis of knowledge that a full understanding of the ocean demands.

Having thus emphasized the necessary unity in a study of the oceans, I want now to call attention to some of the special problems and requirements of marine biological research. To do this I would like to outline briefly a few of the broad areas of biological interest and responsibility in marine research and then to consider the problems that confront biology in its efforts to fulfill its role in relation to other marine sciences. For convenience I propose to consider the biological interests, many of them discussed at NASCO under three broad headings: (1) food, (2) pollution, and (3) greater understanding of the living world.

(1) Food: We have heard a great deal about the ocean as a reservoir of potential food for an increasing human population; of determining the productivity of the sea; of developing a marine agriculture to exploit the sea's living resources. Before these exciting possibilities can be realized a truly formidable amount of study and research is needed. We must know not only what kinds of plants and animals live in the sea—in spite of extensive biological explorations in the past much remains to be learned about what forms are present, how they are distributed not only in space but also from the surface to the bottom and how their populations fluctuate in time. The breeding, life cycle, and survival of young are known for only a pitiful few marine organisms. It is essential also to determine the food and feeding habits of marine animals with far greater precision.

Recent work has made it clear that to determine the productivity of the sea it is not enough to measure chlorophyll or the total growth of phytoplankton. The composition in species of phytoplankton is critical, and chlorophyll data as an index of the quantity of phytoplankton mean little if not complemented with taxonomic data. The nutritional specificity of crustacea, especially those forms important in the zooplankton, is very precise and of enormous ecological importance. It may be comfortable to assume that in many food chain studies there is no obligation to identify the constituent species, but this assumption is unwarranted. For each member of the zooplankton only certain species of algae will be ingested and of these only some are capable of supporting the growth and metabolism of the animal. The complexities of selective feeding can be ignored at the price of only a dim notion of reality.

Of an importance second only to careful species identification is a more thorough knowledge of the physiological state of the algal species in the phytoplankton. It is known for some species (e.g. chlorella) that as this alga passes the peak of its growth phase the contained starch granules are converted in large part to oil droplets. This may explain why these forms, when aged, become toxic to some crustacea.

Bacteria too contribute to the food chain in as yet undetermined ways: these microorganisms merit extensive study if ever we are to understand the cycle of life and energy transfer in the oceans.

I mention these examples merely to illustrate how great is our need for more thorough knowledge before we are in any position to exploit the vast marine resources.

(2) Pollution: the disposal of industrial, domestic and radioactive wastes: Rational answers to the question of waste disposal can be formulated only on the basis of information for which further research is essential. When confronted with this problem the biologist quickly recognizes the serious lack of basic and fundamental knowledge concerning the distribution and rate of growth of marine organisms and their populations, and concerning the interrelationships between various organisms and the elements or substances that might be expected in their environment as contaminants. Studies of these problems, especially with respect to radioactivity are being conducted, but they are far too few and the rate of progress is slow indeed when compared to the rate at which information is required. Moreover controlled laboratory experiments

have shown that the problem of uptake of radioactive isotopes in aquatic organisms is complicated by the fact that these elements are accumulated by various means other than ingestion, that some are concentrated, some are transported by vertical or horizontal migrations, and that there appears to be no correlation between uptake and concentration of single isotopes.

Although mass mortality or gross somatic damage to marine organisms has not so far been observed, no one knows what may be the eventual effect of prolonged exposure to small amounts of added radiation. Whether the assumption that levels not demonstrably harmful to man are safe for "lower forms of life" remains to be established so far as most marine organisms are concerned. Life history, morphological, physiological, and genetic studies are obviously needed. These require laboratory facilities especially designed for rearing marine forms, and few indeed are the places where such work is possible.

Another problem causes concern to the biologist, this is the procedure of measuring activity from an entire collection of bottom forms or planktonic organisms. The importance of determining the accumulation of various elements by different species of plankton cannot be overemphasized, for it is known that for every element there is some species that will especially concentrate it. Finally, I would like to emphasize that if it were not for the living organisms in the sea we would have far less concern for its use as a receptacle for wastes of all kinds.

(3) The third category to illustrate the role of biology in an expanded program of marine research, I have called simply greater understanding of the living world. Of the 28 or so well recognized phyla of animals, only a scant half dozen have succeeded in colonizing the land. This means that the great majority of different kinds of animals live in the sea. The diversity of body forms, the myriad adaptations to different habits and habitats, but withal the underlying unity of living processes have profoundly influenced our conception of the origin and evolution of life. I need only to mention the theory of organic evolution to illustrate the impact of significant ideas upon the mind of man.

Study of marine organisms has contributed greatly to further understanding of many biological phenomena. Much of the basic knowledge of the function of nerve tissue has come from studies on the giant nerves and ganglia of the squid, of the inhibitory fibers in the lobster, of neurosecretion in worms and crustacea. The field of immunology and serology got its start in studies of the sting of jellyfish and sea anemones. Investigation of animal toxins from various fish, sea cucumbers and mollusks is an active field in pharmacology. Examination of the minute, submicroscopic structure of the diverse kinds of muscle cells from coelenterates and other lower invertebrate animals helps to clarify our knowledge of the origin and differentiation of muscular tissues. Most important contributions to understanding the phenomena associated with fertilization and activation of eggs has come from studies on the lowly sea urchin. These and the eggs of other marine animals have provided material for greater insight into the process of cell division and its control.

Whereas considerable progress has been made toward understanding bacterial diseases of some fish, e.g., the Pacific salmon, that no marine invertebrate suffers from cancer is a mystery not yet explored.

Paramount among the contemporary research interests in aquatic biology are problems concerned with the forming of aggregations of organisms, of population structure and dynamics, of interactions between species, of the phenomena of light production, underwater sound, communication, and navigation. On some of these topics I am sure you will hear in more detail from Dr. Galler.

This brief résumé of the interests and kinds of research in marine biology is meant to highlight the range and diversity of studies directed toward greater understanding of life and living processes. Such a wide variety of investigation requires a very large number of scientists and they represent all sections of our country. As I emphasized earlier many problems of aquatic organisms can best be studied in bodies of fresh water where environmental variables may be more subject to control. Biologists have long had the habit of going to the shores of the sea to carry out their research and the institution known as the marine laboratory has played an important role in fostering and making possible the advances in hydrobiological knowledge.

Continuing and increasing research in aquatic biology depends in the last analysis upon three things: (1) facilities, (2) support, (3) manpower.

The studies of life cycles, physiological activities, and genetics of marine organisms, so sorely needed to solve pressing problems in waste disposal, productivity, etc., can be carried out only where laboratories exist that are able

to provide flowing unpolluted sea water in reasonably equipped working quarters. Most of the existing marine laboratories are university-associated; their maintenance is expensive, the costs of expansion almost prohibitive. Yet the requests for working space continue to exceed by far what is available. If it is in the national interest to increase the kinds of biological studies we have been discussing, then more marine and fresh water laboratories are urgently needed, increased and continuing support for those already in existence is imperative.

This need most emphatically includes museums, where the major taxonomic studies are carried out. Accurate identity of the plants and animals that constitute study and experimental material is an essential so basic that without it much biological research is useless. There are no shortcuts to identifying species, no handy tests to guide the novice to accurate judgments.

Although there is recent evidence of a sincere desire to reverse the trend of the past few years, the plight of our museums is at present a national disgrace. Natural history museums, besides providing the leadership in research in systematics, serves for the biologist as the major data center. This simple fact must not be overlooked in planning for other data centers designed to receive the kind of material that can be fed through a computer. Biological data, in very large part, can be processed only by the most complicated computer yet invented, the human brain.

Another kind of facility for biological research that is presently beyond the financial capacity of most university laboratories, is a research vessel designed and built for biological studies so that it is essentially a floating laboratory. Many problems with respect to plankton and epipelagic and open ocean organisms cannot be studied except by taking the laboratory to the location and staying there while all possible features of the environment are intensively studied. In any case, provision for a greater amount of more varied biological investigations of phenomena in the sea must include expanded facilities both ashore and afloat.

Provision of physical plant is no less important than its maintenance and operating costs. Here again the requirements are beyond the capacity of individual scientists or institutions. Regional cooperation is a promising solution to effective utilization of specialized facilites but the continuing support of programs appears to offer the best solution to the serious financial problems confronting the biologist interested in undertaking long-range research studies.

Continuing support should mean not only funding for the glamorous aspects of collecting the field data or specimens, but also for their sober study and interpretation through to the publication of the treatises, monographs and research papers that represent the "processed data" or "data reduction" of the biologist. Many results from previous biological surveys and expeditions are not available through failure to provide for the study and publication costs.

Finally we come to the question of manpower—who will do all this work if expansion of research in hydrobiology is encouraged. In spite of the fact that the Civil Service Commission still fails to include biologists along with other scientists and engineers in its recommendations for salary increases (see p. 1428 in Science, vol. 131, for May 13, 1960) the biologists of this country are a large and active group and many young people are choosing this branch of science as their profession. I agree with Dr. Hedgpeth that there is no dearth of talent and interest. A major difficulty is the relatively small number of professional opportunities, for aside from the academic world and Government service, employment for biologists is limited.

May I say in closing that it is a privilege to be here and to speak in behalf of hydrobiology, its role, its interests and its problems. This committee has the thanks and gratitude of the entire scientific community for its genuine interest in science and for the concern it has shown to encourage the thoughtful development of our knowledge of the sea.

Dr. RAY. Before starting on my statement, I would like to thank Mr. Pelly especially for his kind word of welcome. If it is not stepping too far out of line, I would like to extend on behalf of the University of Washington a very cordial invitation to the committee and any of its members. We would be most happy to see you visit our institution and, if it should be possible to serve in the capacity of guide, I would be delighted to show you all of our facilities and the work that is going on.

It is a privilege to be here this morning to speak about biology. More specifically, I am a marine biologist myself, and the area of my interest is one that I have been asked to summarize briefly. There are several points I should like to make, the first being that when I use the term "marine biology," I use it a bit out of habit, but I should like to emphasize that we recognize that all organisms which live in the water share many properties and face many of the same problems.

For that reason, we often use the term "hydrobiology" or perhaps even "aquatic biology" to point up the fact that in the study of living organisms in water that water itself is the key factor. So far as the ocean itself is concerned, the size of the body of water, the salt content, often introduces significant problems. However, basically, the study of organisms, whether they be marine or fresh water, present many problems in common and we recognize no strong or sharp distinction between the fresh water and marine aspects of our discipline.

The second point that I need to underscore is that oceanography is a study of environment. It is a very special area of science and not quite comparable to the traditional scientific disciplines. It calls upon the knowledge and the skills of all the basic disciplines for the development of the knowledge of the sea. We must have the cooperative activity of all branches of science, including all of the physical and biological phases.

It is also important in recognizing this to see that the approach to a knowledge of the sea or any other body of water requires cooperation among scientists of different disciplines because the information is interdependent, the phenomena are interdependent.

To use one or two examples, knowledge of currents and movement of water helps to explain and to understand better something about the distribution of the various species of animals and plants. In the same way one recognizes certain species of animals or plants as characterizing bodies of water that are somewhat isolated from the mass of water around, it is something like a cloud in a clear sky. These masses of water are otherwise not identifiable by physical or chemical means, but can be identified by the biological species that inhabit the particular water mass. From a chemical point of view, there are organisms that select certain levels.

Some unusual elements, such as arsenic and vanadium, are known to occur in the ocean only because they are accumulated in the bodies of marine animals or plants. Yet in certain animals vanadium is concentrated as much as 280,000 times over the level that is present in ordinary sea water.

The study of the productivity of the sea, which is certainly one of the big problems we need to know a great deal more about, is utterly dependent upon information from both the physical and biological sciences.

While emphasizing that biology recognizes the unity of problems both in fresh water and sea water, while recognizing the interdependence of the physical and biological sciences, if we are ever to attain a thorough knowledge of the sea, we must also point out that biological research and interest covers certain specific areas. Particularly, there are responsibilities for biological information from the sea and there are special problems involved in biological work.

Touching upon these briefly, I think I would like to mention three main aspects of biological studies that are important for oceanographic

work that have been mentioned many times in these hearings and, of course, have received considerable consideration on the part of the National Academy of Science Committee. These are the areas of food, pollution, and of expanding knowledge.

We heard a great deal about the possibilities of developing the resources of the sea, of developing a marine agriculture, of farming the oceans, and so on. I feel it is essential to point out that before these exciting possibilities can be realized we have to have a very great deal more basic information about the kinds of animals and plants that are present in the sea—what they do, how they live, their life cycles, how they are distributed, and what their properties are in terms of the contribution they make to the balance of life in the sea.

It is not enough simply to measure the overall total quantity or volume of, let us say, phytoplankton: it is not enough to take a chlorophyll measurement as an index of productivity unless we know the composition of all these organisms in terms of the species involved.

One of the reasons for this is that the animals that feed upon plant material in the open sea are themselves highly selective in their feeding. They do not swim through the water simply scooping up everything that may be the right size, but have the capacity to select out certain features just as an animal on land on an acre of woodlot, for example, will eat certain plants but not others. So also in the sea the minute crustacea, upon which larger fishes depend for their food, are highly selective in their feeding. It is highly essential to study this species composition. If this is not done, then we will ignore one of the most important of the biological variables and come to have only a very dim notion of reality.

The role of bacteria, which has been for the most part overlooked in the sea, is also significant. Recent studies have shown the presence of various kinds of bacteria in sea water and in fresh water determines whether or not the other living organisms are able to utilize material for their nutrition.

For example, certain species of algae—and Chlorella is one of them—can support the metabolism, can support nutrition, can support the reproductive life cycle of certain species of crustacea only if it is accompanied by bacteria because Chlorella alone does not have all the nutritional properties necessary to support the reproductive life cycle.

This area, so far so little developed and so little investigated, must be looked into if we are really going to take advantage of the resources of the sea and to harvest them in the way in which we hope to be able to do.

The problems of pollution, of course, are enormous. Rational answers to the questions of what can be introduced into the sea without affecting the economy of the living organisms depend entirely upon greater amounts of research in the knowledge of what organisms are present and what they are doing.

At the present time we have only a broad overall information that it is possible that certain levels of various kinds of wastes, including radioactive wastes, do not appear to cause gross damage. But until we know for sure just what the levels of tolerance are for the many organisms, from microscopic organisms through the bottom-living marine invertebrates, the various fishes, we may be doing something

for the sea for which, as Dr. Spilhaus said, future generations are going to blame us.

When it comes to the introduction of polluting matters into the sea, we must remember that if it were not for the living organisms of the sea, we would have far less concern about utilization of the ocean as a receptacle for wastes of all kinds.

Finally, in terms of contributions to knowledge, most biological work in the sea, even those things related to the greater utilization of fool resources and in trying to solve problems concerning disposal of wastes, most of the work relates to the general area which we call basic research. In this area I think it is particularly important to recognize that not only are things that show no practical application at all important but also many things that appear at the present time not to have any practical utilization may add considerably to our knowledge in a practical fashion.

On the first point I have only to mention the theory of organic evolution to mention one area of knowledge that has had a terrific impact upon the mind of man, with little practical application; hardly any industrial utilization has been made from this idea, which has probably had the most significant impact of any.

In terms of increase of knowledge of the way in which living things behave and the way in which the living world is organized, I would like to mention just two or three specific examples. Much of our knowledge of the behavior of nervous tissue has been gained from studies of the squid and studies of the lobster because these organisms have nervous systems that are organized somewhat differently from ours and provide experimental material much easier to work with and give us clues that help us to underscore the essential unity and processes of living things. The field of immunology and serology got its start in studies of the sting of jellyfish and sea anemones. At the present time investigation of animal toxins from mollusks, crustaceans, poisonous fishes, et cetera, is an active area in research in pharmacology.

There are many studies on the minute structure of cells. Many of the eggs of jellyfishes, for example, are so clear and so transparent that their microscopic study is infinitely easier than that where the structures are more opaque.

One of the areas of activity with implications for many other areas is the field of animal behavior, navigation, production of underwater sound, underwater light, and so utilization of these activities on the part of marine animals for communication and for navigation.

This very brief and quick superficial touching upon these areas I wanted to do so as to point out that in biological work in the sea and other bodies of water we are dealing with a tremendously diverse body of information, we are dealing with a subject matter which has a level of complexity that is very great, indeed.

For this reason biologists as a whole are not concentrated into two or three or a half-dozen large centers of investigation, but rather are scattered throughout our entire country and represent institutions large and small, State and private and governmental. It has been long the habit of biologists, university-associated biologists, to utilize their time during Easter and summer vacations, so-called, to migrate to the seashore and to work there on problems of their own basic research interests.

It is from investigations so conducted that great contributions have been made to our knowledge of biological activities in the sea. This has led to the rise of marine laboratories, and these laboratories have served an important function in advancing our knowledge of biological activities in the sea.

Many marine laboratories exist today and in terms of looking toward the expansion and improvement of biological work related to oceanography, and we must expect these marine laboratories to continue and expand their activities. This, of course, requires greater financial support than has been previously available to them.

There are many problems in connection with particularly the food resources of the sea and the biological activities in the open ocean not possibly to study unless the biologists are able to get out to the sea to work in those areas. This requires essentially a floating laboratory, a biological research ship, because the needs of biological work in the open ocean require often that a ship or a floating laboratory shall stay in one place for a very long period of time in order that all of the essential areas of environment can be intensively studied.

Biological work at sea is less meaningful unless it is accompanied by physical data taken at the same time. Of course, it is important to have access to records of temperatures and salinity and oxygen concentrations taken in the past and over long periods of time. But very often to solve a particular biological problem one must know these physical and chemical factors taken at the same time as the biological investigations are going on.

I agree very firmly with what Dr. Hedgpeth said last Friday and with some of the testimony this morning that one of the needs in the field of biological work in the oceans as well as others is the problem of manpower. But I also agree that there is no dearth of interested young people at the present time, that support for young people coming into this field is at a high level, and that those of us in universities are, if anything, flooded with students.

One of the pressing problems, however, is: What is the student going to do when he finishes with his technical training and has completed his professional training and comes to the point where he is ready to take a career position? So far as biological work is concerned, one of the areas I shall use as an example, where the most crying need for workers exists, provides the fewest positions, that is the field of taxonomy. In this particular field, which underlies and underscores work in all other biological disciplines and specialties, there are very, very few professional positions open to persons when they get their training in this field.

The plight of our museums, both national, public, and private, is almost a national disgrace. The amount of work that is needed, if we are going to solve problems such as how are we going to utilize resources from the sea, how are we going to determine what is safe to put into the sea, in terms of waste materials, depends in the last analysis on the basis of knowing for sure the kinds of animals, kinds of plants that are there and how these things are going to affect them.

To do this, we have to have people who are capable of determining the species. These are taxonomists, and for these people there is little career employment at the present time. There is no way to have a shortcut to the species identification. There is no more important

aspect of biology now or at any time. The only way in which species can be identified is through the long study and concerted judgment of the person who has become thoroughly familiar with the particular organisms with which he is concerned.

There is no computer, no electronic brain that can take care of these data. The only way they can be handled is by utilization of the most complicated computer known and that is the human brain. For this we need a great many more of them in this line.

I have touched briefly of some of the points I mentioned in my prepared statement. If there are any questions, I should be glad to try to answer them.

Mr. Dingell. Your statement has been most helpful to the committee this morning.

Mr. Bauer. As a biologist, Dr. Ray, are you concerned with the disposal of atomic wastes in the Columbia River where I understand 2,500 curies a day are going into the river at Hanford and 1,000 curies a day coming out of the mouth of the river? Would you talk to that?

Dr. Ray. Speaking as a biologist, we cannot help but have concern; that is true. I think anyone who knows that any amount of radiation, especially at these levels, enters the ocean or any body of water at any point, must be concerned for what the effect of these substances may be on the living organisms in the vicinity.

I have no direct contact with the production or the dispersal of these materials. I have no personal knowledge of the situation as it exists in the Columbia River. I can only say as an interested biologist in the general area that to the best of my knowledge we do not have the amount of information that we ought to have to determine what is going on in terms of the effect of the thousand curies a day, let us say, coming out of the mouth of the Columbia River. There may be studies in progress that have not come to our attention at the university and it may be that the people at Hanford or others working through the Atomic Energy Commission are carrying on studies that are not public knowledge, but to the best of my information there is not the kind of daily or continuing study monitoring what substances are entering the ocean and what is happening to them that I feel as a biologist should be going on.

Mr. Bauer. Are you familiar with the work of Dr. Erling Ordal?

Dr. Ray. Yes.

Mr. Bauer. Would you tell us a little bit about his observations of mutations of *Chondrococcus columnaris?*

Dr. Ray. *Chondrococcus columnaris* is a bacterium belonging to the general group of myxobacteria which are present in many bodies of water, both marine and fresh.

It is an organism that has been seen on a few occasions in the past in certain rivers in the United States. I believe it was first identified in some branches of the Mississippi River. At any rate, during the summer of 1942 Dr. Ordal was interested in the fact that the salmon in the Columbia River, many of them became violently ill and a very large death resulted, a mass mortality of the salmon in the river. This was repeated at a number of intervals of time and he became more interested in the phenomenon in the early 1950's and began to look at it rather carefully. As a microbiologist with a broad biological background, he was interested in the causative agent and was the first one able to identify and to isolate the bacterium that caused the disease, to

grow it in pure culture and to reinfect fish with it so as to prove that the death of the salmon was due to a particular bacterium, which was found in the lesions, in the skin. He has been interested in pursuing this work over several years' time and as a result has come to the conclusion, with quite a bit of supporting data, that the columnaris organism is present at all times, that there are many strains of this bacterium. Some of them are lethal and some are quite harmless.

When the water temperature in a river system or a stream rises above a certain critical point, and this may differ for different species or different strains, but for the particular strain in the Columbia River I believe the temperature is 18° C.—I could be wrong on that—at any rate, when the water temperature rises above that particular point, there is a mutation that takes place and the organisms become virulent. When they become virulent, they are capable and have caused a mortality in the fish as high as 98 to 100 percent.

There are two possibilities for the explanation for the virulence. One is that it is a temperature effect and there are warm-water pockets, building of dams slows the water down, and the appearance of the virulent attacks on the fish have been correlated very closely with the increase in water temperature.

A second factor enters here; that is that the introduction of radioactive waste from the plant at Hanford not only increases the water temperature itself, but also increases the radioactive isotopes and it is also a possibility that the presence of the radioactive materials may themselves be responsible for inducing mutations in the bacterium, which in turn becomes then virulent to the fish so that one must keep an open mind, let us say, about the effects of radiation.

If one studies just the fish alone and finds that the fish are dying from a bacterium disease and experience shows there is no direct effect on the fish from the radiation itself, one must still not rule out the possibility that there may be an effect which is due to another factor, in this case the possibility of mutation of bacteria which then become virulent, and we come back down to the contribution of the polluting radioactive materials.

I think this is a case where it is reasonable to look more closely into the entire ecology of the river itself and to the entire picture of what has caused the virulence of the virulent strains to appear and result in the last analysis in the mortality of the fishes.

Mr. Bauer. It is still within the realm of possibility, Doctor, is it not, that there might be a resistant group of salmon that could carry this disease and effect the entire salmon crop in the Pacific? Is that not a possibility?

Dr. Ray. I do not know whether any work has been done to follow along the lines of that possibility. The fact that we know that the bacteria are present at all times and only become virulent under certain conditions and we know for sure, I should not say for sure but it seems reasonable that the main cause of virulence should be the increased temperature, the radioactivity or both, and making a comparison from other studies with streptococcus, for example, it is shown that many different environmental and biological factors can cause a change from a non-pathogenic to a pathogenic strain. It means that the carrying of the non-pathogenic strain from one body of water to another, let us say, if in the second body of water the conditions

existed that would cause the mutation to the pathogenic strain, then this could be a possibility.

Mr. BAUER. Now, not to change the subject very much, but have you any feeling about where a data center for oceanographic information of a biological nature should be placed?

Dr. RAY. I would like to say first of all a data center for biological information to a biologist means a museum.

I recognize, of course, that the physical data, the chemical data, are essential to gather into one place and to be made available and on such information a biologist would often wish to call, but when it comes to the knowledge of the biological features in the sea for the most part, let us say one of the most important aspects of the collection of information is the collection of specimens and their proper identification.

This means that the animals, the plants, the micro-organisms, must be available for study and as reference collections for comparative studies throughout time and this, of course, means the U.S. National Museum which has this function already directed to it under its statutory existence as an independent branch of the Government.

I think that in terms of thinking about data centers for oceanographic work one must keep in mind the needs of biology in this respect and include the U.S. National Museum and possibly other museums as well as a repository of the basic biological information in terms of collections.

Mr. BAUER. Thank you.

Mr. DINGELL. Mr. Pelly?

Mr. PELLY. Dr. Ray, where is the American National Museum that you referred to?

Dr. RAY. The U.S. National Museum is a part of the Smithsonian Institution.

Mr. PELLY. I understand now. I did not quite know it by that name.

In other words, you feel that for want of funds, the Museum has not been able to keep up and give the student and the scientist sufficient material for their work?

Dr. RAY. I think there are a number of factors here. The museum staff in terms at least of the people who are active in the curating, identification, description of materials from marine collections, are among our leading taxonomists in this country. They have, however, been expected or have had the responsibility to do far more than is possible for anyone or small group of individuals to do. One of the difficulties has been that in biological surveys and expeditions of the past there has been plenty of financial, or at least enough financial support so that the work has been done to collect, to preserve, and to bring to shore the specimens that represent the areas that have been visited, but there has never been adequate provision for paying for the personnel, to study these materials afterward and to bring the results of the study to publication.

I understand from Dr. Waldo Schmidt, who has retired, but he was the curator of the marine invertebrates, there was 10 years' work simply to study the collections of the past, with the present personnel and amount of money available and still after studies are made, there is insufficient provision within the budget to publish the work after

it is done because the publication of biological treaties and monographs is very expensive indeed, and requires a special subsidy.

The work is unavailable to other scientists until it has been published.

I think one of the most important things in terms of being able to increase our knowledge in the biology of the sea is far greater support for the U.S. National Museum and other university and private museums, not only in terms of the facility itself, but in terms of the provision for professional personnel to do their work, technical assistance for them, and provision for publication of the work.

The U.S. National Museum serves the entire country and all of the scientists and yet those of us in universities must think twice let us say, then be a bit hesitant about going there to work on some particular group we may be especially interested in because we know if we do some one of the already overburdened staff must take time off from his work, show us where the collections are and help us get bottles off the shelf. There is not sufficient technical personnel even to replace the preservatives properly, store the specimens back on the shelf and keep collections in order, et cetera.

The routine work of maintaining a good museum which is available and useful to biologists has not been sufficiently supported.

I think this is a very crying need.

Mr. PELLY. I think the members of this committee are very much interested in your statement and I think that I can speak for all of us, that we would be very glad to help in some way to encourage the Smithsonian and its U.S. Museum get adequate help to catch up and help the scientists.

I was very much interested in the reference to the Columbia River and the salmon because, of course, in commercial life that means a lot of money. It is always easier for one to justify to the taxpayer some adequate return.

I wonder, where have the funds come from for the research that has been going on all this time on the Columbia River and its changes in temperature by Dr. Ordal? Do you know who was financing his research work?

Dr. RAY. The particular work on Columnaris and other diseases in the salmon was financed through the Fish and Wildlife Service by transfer of a grant of money from the Corps of Engineers. I understand the development of information in river basins, et cetera, comes under the Corps of Engineers. This particular work at any rate was financed in this way: by a transfer of funds from the Engineers to the Fish and Wildlife Service and administered through Fish and Wildlife.

Mr. PELLY. I have heard the development of a fish farm, in order to try to replace maybe some of the stream's supply that has been eliminated as far as fish spawning is concerned, has resulted in some evidence to the effect that maybe the fish are not as healthy when they are raised that way and also they are subject to some diseases. I think by feeding some particular food to the fish in one place they did get a virus which spread and maybe in its natural environment salmon does a lot better. Is that true?

Dr. RAY. I think it generally is true in biological work that when an animal is confined you have a harder time keeping it healthy as when it is in its natural state.

The only work I know of specifically along that line in connection with developing the salmon in hatcheries, et cetera, was a serious situation with respect to their contracting TB and this developed, in part, through feeding, and it became a very serious disease until the cause was found and corrective measures were taken. The salmon are quite subject to TB.

This is present in the natural population, but the ones that are bred and developed naturally seem to have quite a bit more resistance to the disease than those reared in the fish hatcheries.

Mr. PELLY. Doctor, I noticed, in going through the book which you edited of the symposia held at Friday Harbor Laboratories on Marine Borers, that the estimated commerical loss each year is about half a billion dollars through the activity of these organisms; and again, I think it points up to the business and the taxpayer the potential savings that can be made through basic research.

Dr. RAY. That is right.

Mr. PELLY. I want to again mention this book, "Marine Boring and Fouling Organisms," which you edited. It is a very technical book and has illustrations which certainly would be more intellectually absorbed by one of your colleagues in the field, but I can see obviously that it is a considerable contribution to the science.

I again say when I come out there—I think maybe you can explain to me a little more easily in layman's language than I could learn by trying to absorb all that is in this book.

Dr. RAY. I would be very happy to have the opportunity.

Mr. PELLY. I hope the opportunity will come.

Dr. RAY. I hope so, too. I would like to add anyone who works in a field like that cannot help but become impressed by the fact that you cannot draw a sharp line between what is basic research and what is applied and whether one is looking for the answer to a problem that is an important economic one or whether one is looking for additional ways to exploit food resources, or whatever, the approach through basic research is in the long run the only one that will provide the kind of fundamental information on which the intelligent decisions for control or for exploitation must depend and it is very difficult to undertake a piece of work and say this is useless, or this is for the particular purpose of solving this particular problem.

The flexibility and freedom to attack a problem and to be able to follow along any line which seems to be promising I think is one of the most important things that must be continued and maintained and guarded in terms of support of science.

Mr. PELLY. Some of us have been a little disturbed at the lack of research funds in the fisheries field, particularly, as the great new State of Alaska is dependent on this for its principal industry, which is salmon.

There is about $80 million a year of income dependent on that research. Private industry has been doing it before, but I believe now they are just finding themselves in the position of not being able to carry on some of their work. We did succeed this year in getting all that we would have liked in the way of research, but it is easier to talk than to get down to the basic research. You cannot appeal to the taxpayer.

Dr. RAY. That is true.

Mr. PELLY. I am glad you mentioned that point, as to the importance of the basic research. I am sure that this statement that you have given us here today will build a record which eventually will be quite important in the report that this committee makes on any legislation that might be necessary in this field.

Thank you.

Mr. DINGELL. Doctor, we certainly want to thank you for a very splendid statement this morning. You have been most helpful to the committee and on behalf of the committee I would like to extend to you our collective thanks for your very fine assistance this morning.

I would be remiss if I did not tell you how valuable our member of this committee, the Congressman from Washington, Mr. Pelly, is. We are very grateful for your assistance.

Dr. RAY. Thank you. It is a very great privilege to be here.

Mr. DINGELL. The next witness will be Dr. Sidney Galler, biologist, Office of Naval Research.

Dr. GALLER. My colleague, Mrs. Helen Hayes.

Mr. DINGELL. Doctor, I believe you have a prepared statement?

Dr. GALLER. Yes, sir; I have a prepared statement, Mr. Chairman.

Mr. DINGELL. Do you want to read it or summarize it?

Dr. GALLER. I will submit it for the record, if you don't mind, and summarize it briefly.

Mr. DINGELL. There is absolutely no objection on the part of the committee. We appreciate that very much.

(The statement follows:)

STATEMENT BY DR. SIDNEY R. GALLER, HEAD, BIOLOGY BRANCH, OFFICE OF NAVAL RESEARCH

Mr. Chairmen, gentlemen, it is a privilege for me to be asked to appear before you today to discuss the Navy's research program in hydrobiology and its relationship to the national plans for oceanography and the bills on oceanography pending before this committee.

My brief statement will be presented in three stages. First, the U.S. Navy's interests and objectives in developing and sponsoring a research program in the field of hydrobiology. Secondly, I wish to present before this subcommittee a résumé of the basic scientific disciplines which contribute hydrobiological information of interest not only to the Navy but to many other public and private agencies. Finally, I hope to review for you some of the problems confronting hydrobiologists in the United States today which inhibit an optimum utilization of our national scientific resources in this field.

Hydrobiology, like the closely related field of oceanography, is not a single scientific discipline. It may be defined as a multidisciplinary effort to identify and characterize the biological constituents of marine, estuarine, and freshwater environments as well as to elucidate the interrelationships of the biological with the physical, chemical, geological, and other features of these environments.

The Navy programatic interests in this field are of long standing and may be categorized generally as follows:

(1) Research aimed at the control of organisms which may interfere with the efficient performance of materials, components, equipments, and personnel in the conduct of naval operations;

(2) Research aimed at the utilization of organisms and/or the products of organisms in the furtherance of naval operations; and

(3) Research aimed at examining biological systems as a basis for the possible improvement of manmade systems with performance capabilities that would enhance naval operations.

Permit me to refer to the exhibit before you which consists of an artist's conception of examples of the Navy's interests in hydrobiological research. I should state that, although the basic research making up the Navy's hydrobiology program is almost entirely unclassified, a number of our objectives and

uses of information derived from this program are applied and classified. I would be pleased to present the classified aspects of our program to this subcommittee should it so desire. This presentation, however, will be unclassified.

As you can see from the exhibit, the Navy has a continuing need for basic research information leading to the development of new and improved materials, techniques, and equipments for the prevention of marine biological deterioration and fouling. The Navy, since World War II, has been successful in developing a number of improved protective agents for reducing marine biological deterioration and fouling. However, continuing technological developments of high performance equipments and vehicles required in naval operations present new deterioration and fouling problems which can best be met by encouraging basic hydrobiological research aimed at obtaining a better understanding of the behavior of marine animals and plants, and thereby yielding scientific information which ultimately will be useful in controlling them.

The next illustration indicates how a wide variety of marine animals ranging from very small forms up through the largest marine mammals can interfere with the transmission and reception of acoustic energies under water. This is an important hydrobiological problem in the fields of submarine and antisubmarine warfare, mine countermeasures, etc. It is considered essential that we obtain more information regarding those animals which either actively or passively can interfere with the propagation of acoustic energies. Not only must we identify these organisms, but we must have sufficient basic information regarding their behavior and population distribution throughout the year in all geographic areas of interest to the Navy so that we may be in a better position to predict the types and degree of biological interference with underwater acoustics which the Navy may expect to encounter in a specific locality at any given time.

The next picture illustrates another complex of problems of continuing concern to the Navy—namely, the protection of naval personnel against poisonous, venomous, and carnivorous marine animals. This involves not only our obvious and continuing concern with the protection of survivors at sea against attacks from sharks, but also it includes the necessity for building up a body of basic information which can be used to protect the underwater swimmer against sharks, barracuda, moray eels, poisonous sea urchins, and corals, and a whole host of other dangerous marine animals which increase the operational hazards of the underwater swimmer. Closely related is the problem of protecting naval personnel as well as civilian populations residing in geographic areas that are under the administrative jurisdiction of the Navy against ichthyotoxism, or so-called fish poisoning. I am not speaking about the toxological effects of ingesting rancid or decayed food products. This problem is concerned with the fact that many species of edible fish may, at certain times of the year and in a manner not yet understood, become toxic, producing serious physiological upsets and sometimes resulting in the death of a person who may eat the fish. This was a very serious problem in the Pacific theater of operations during World War II when the military and civilian populations attempted to augment the food supply from local sources. It still is an oft-recurring problem.

Marine bioluminescence is also of interest to the Navy, as you can see from the next illustration. Frequently, populations of marine organisms will emit light when disturbed mechanically as, for example, by a submarine at periscope depth, the movement of a surface ship, or the action of underwater swimmers. The result is that our movements can be detected by enemy aircraft flying overhead.

The Navy supports basic hydrobiological research in an effort to utilize certain marine organisms or their products. A number of the applications in this category are classified. However, as you can see from the next illustration, we are making an effort to obtain basic hydrobiological data, specifically on the seasonal and geographic distribution of various marine animals and plants that can be utilized to sustain naval personnel under emergency survival conditions at sea. Similarly, the Navy is supporting marine microbiological research including investigations of marine and fresh-water algae in an effort to determine the feasibility of developing photosynthetic gas exchangers suitable for maintaining viable atmospheres in submarines. In addition, data resulting from the hydrobiology program has led to the discovery of a new antibiotic which was derived from marine algae. This antibiotic in laboratory tests appears to be a very potent substance against a broad spectrum of pathogenic bacteria, including the staphylococcus organisms.

The third phase of the Navy's interests in hydrobiology is depicted in the next illustration. As you know, many marine animals as well as land animals

are able to select and identify targets from great distances. Further, these organisms are able to "navigate" with great accuracy toward these targets in a manner presently not understood by man. It is noteworthy that many of these animals are relatively small, weighing only a few pounds. Nevertheless, they encompass exceedingly complex mechanisms for information reception, integration, and transmission. In other words, these microminiaturized natural systems are capable of performing at levels of efficiency that man, with his most sophisticated equipment which may weigh upward of hundreds of pounds, is unable to duplicate at present. Thus, the investigation of biological systems could well lead to the development of new concepts for the construction of mechanical and electronic analogs of considerable usefulness to the Navy. There are a number of classified aspects to this phase of the program which I would be happy to present to the subcommittee if it so desires. Continuing along unclassified lines, however, it should be noted that in addition to efficient navigational mechanisms many marine animals possess highly developed communication systems, silent propulsion systems, and hydrodynamic characteristics which, frankly speaking, we envy and would like to duplicate.

I have presented in this statement a number of examples of the Navy's interests and activities in the field of hydrobiology. There are other items in this area which I could present except for the limitations of time. However, they all have one common frame of reference. Simply stated, all of our objectives and interests are predicated upon a continued and extended support of a broad spectrum of scientific disciplines which make up the field that we call hydrobiology. The motivating philosophy behind ONR's hydrobiology program is that before we can successfully control, utilize, or emulate living organisms, or certain properties of living organisms, we must first establish a body of basic information regarding the vital processes, the behavioral patterns, the population dynamics, and the geographic and seasonal distribution of the organisms as well as their interrelationships with the other factors of their environments. In order to obtain this body of basic information which must serve as the foundation for further research and development, there is an urgent requirement to support adequately marine microbiology, systematics, ecology, physiology, biochemistry, genetics, and other specialties which comprise what we call hydrobiology. As you can see, therefore, the hydrobiological sciences not only impinge upon and extend into oceanography but cover a much broader and more diffuse collection of research specialties in the biological sciences. In this connection it is important to note that, although a number of very competent biological scientists are located at oceanographic institutions, the great preponderance of hydrobiologists reside outside of oceanographic institutions and are located in departments of biology throughout the United States and abroad. Many of these departments of biology are associated with marine, estuarine, or fresh-water laboratories, where most of the hydrobiological field studies are being conducted.

Very few marine or fresh-water laboratories in the United States associated with academic institutions have the financial resources or the facilities needed to support to the limits of their capabilities the outstanding biological scientists on their staff. As a result, we are left with important gaps in our knowledge. For example, taxonomy, which includes the identification of species of marine animals and plants, is greatly undersupported to the point that the Navy and other agencies requiring taxonomic identification of organisms of direct concern to their activities are unable to obtain this information or, at best, must wait for many months and even years before the data is made available. The relatively small number of marine taxonomists located in such institutions as the U.S. National Museum are greatly overburdened with a backlog of biological collections and requests for identification. The fact that very few promising young graduates choose taxonomy for their scientific careers accentuates the problem. Although various agencies, including the National Science Foundation and the Office of Naval Research, are attempting to alleviate the situation within the limits of their resources, support for this essential scientific discipline is still grossly inadequate.

This committee may wish to note that very few marine biological laboratories and departments have access to oceangoing research ships. As a consequence, the necessity for careful and sustained study of marine animals and plants in their oceanic environments is not being fulfilled. The result is that for the most part we must rely upon preserved collections of biological material or try to maintain living organisms in the laboratory. Both of these, while of great importance in their own right, are inadequate substitutes for many types of biological investigations under field conditions. There exists an urgent need to provide

marine biological organizations with adequate research ships designed to permit continuing studies in the field, not only of individual animals and plants, but also of populations of organisms.

The committee may wish to know also that departments of limnology, i.e., fresh-water biology, have produced many outstanding young scientists who later became eminent in the fields of hydrobiology and oceanography. As a matter of fact, these departments and fresh-water field stations represent, in my opinion, an outstanding but poorly supported resource for the education and training of young men and women who will later become interested in the investigation of the marine environment.

This subcommittee deserves the respect and full support of the scientific community in the United States in its efforts to encourage additional research in the marine sciences. I trust that my statement with regard to the role of the hydrobiologists in contributing to the fulfillment of the needs of the Navy, as well as the great importance of recognizing the contributions of the biologists to our knowledge of the oceans, will be of some assistance to you. Again I extend my sincere thanks for the privilege of appearing before this subcommittee.

## STATEMENT OF DR. SIDNEY GALLER, HEAD, BIOLOGY BRANCH, OFFICE OF NAVAL RESEARCH; ACCOMPANIED BY MRS. HELEN HAYES, ASSISTANT TO DR. GALLER

Dr. GALLER. Mr. Chairman, gentlemen, it is a real privilege for me to appear before you today to discuss the Navy's program in hydrobiology and its relationship to the national plans for oceanography and the bills on oceanography pending before this committee.

Hydrobiology, like oceanography, is not a single discipline. Rather, it consists of multidisciplinary investigations of the biological constituents of marine, estuarine, and fresh-water environments; in an effort to characterize the biological factors in relation to the physical and the chemical factors of these environments.

I should say at the outset that the Navy's hydrobiology program is a basic research program, consisting of research projects as basic as those supported by the National Science Foundation. It is an unclassified program. However, the objectives are applied and in some cases classified.

Incidentally, I am delighted to say that a previous witness, Dr. Dixy Lee Ray, is representative of the competence of the scientists that the Office of Naval Research has the privilege of supporting in its hydrobiology program.

My very brief statement may be divided into three general headings: No. 1, why is the Navy interested in supporting a basic research program in this field? No. 2, a very brief résumé of the many biological disciplines which comprise what we call hydrobiology; and No. 3, a brief survey of some of the problems confronting biologists in the United States that limit their capabilities in basic research of interest to the Navy.

Generally, the Navy's interest in hydrobiology consist of three objectives: No. 1, the control of marine organisms, both plant and animal, which may interfere with the efficient utilization of materials, components, equipment, and the performance of naval personnel in the conduct of naval operations. The prevention of marine biological deterioration and fouling is one example of a control problem; No. 2, the utilization of marine animals and plants and their products in ways designed to enhance naval operations; and No. 3, investigations of biological systems in an effort to duplicate some of the biological phenomena of particular interest in the Navy.

With your permission, gentlemen, I would like to exhibit a chart that will save many words.

Essentially this is an artist's depiction of some of the Navy's interests in the field of hydrobiology. First, under the objective of control of marine plants and animals that interfere with efficient naval operations: Marine biological deterioration and fouling includes not only the classic problems of deterioration of waterfront structures, the fouling of ships' bottoms, and the breakdown of cordage, but also some of the more specialized problems, such as the fouling of moored mine cables, the deterioration of bottom mines and the fouling of tranducer domes and hydrophones.

Another aspect of our interest in control is related to the problem of biological interference with underwater detection and communication by acoustic means.

Very frequently, organisms ranging in size from a few millimeters to many feet may interfere with the propagation of acoustic energies under water. They may show up as false acoustic targets quite similar in appearance to targets of operational significance. This has been and continues to be a problem of concern to submariners as well as to those groups concerned with antisubmarine warfare.

Also, many types of marine animals are sound producers. Their sounds may obscure sounds of operational significance or frequently these sounds may be confused with sounds of propellers, engines, or other types of equipment. This is a continuing problem.

False targets are a special type of biological interference. Large marine animals such as whales or porpoises or sharks may be confused by the sonar man, unless he is very skilled, with sonar signals from submarines or other types of ships.

Another problem of control in the field of hydrobiology deals with the protection of underwater swimmers and other personnel against poisonous, venomous, and carniverous marine animals. There is also the need to protect the underwater swimmer against marine bacteria and fungi, some of which cause acute infections in swimmers. Control includes, of course, the continuing problem of personnel protection against sharks and some of the other carniverous animals. A small but significant part of the hydrobiology program is devoted to research leading to the development of more effective shark repellents.

Closely associated is the problem of ichthyotoxism. Many fishes of commercial as well as sports interest ordinarily considered edible, sometimes, in certain parts of the world, become toxic to man. This is a basic ecological and biochemical problem that still needs to be solved. It has been and still is of concern to the Navy. For example, during World War II in the Pacific theater of operations, Navy personnel as well as other service personnel and civilian populations were in part dependent upon local fishery resources to sustain themselves. They found that some of the fishes which were considered to be edible, at certain times of the year became toxic.

I wish to say parenthetically at this time that what I am presenting now is completely unclassified but there are a number of classified aspects to this program and at your pleasure I would be happy to present them to you.

Another problem in control of hydrobiological pests, is concerned with the problem of marine bioluminescence.

Certain marine organisms, when disturbed mechanically, tend to luminescence, or produce light, so that the wake of a submarine proceeding at periscope depth or a surface ship or an underwater swimmer, becomes illuminated. An enemy aircraft overhead at night could easily detect the wake.

The second objective concerns the utilization of marine organisms in ways that tend to enhance naval operations. Here we have a number of classified implications that I will present at your pleasure. However, among the unclassified aspects is the continuing problem of sustaining a survivor under emergency conditions at sea until he can be rescued.

This means in terms of basic research the necessity for ecological as well as taxonomic studies to determine the edible flora and fauna of the oceans, both in terms of seasonal and geographic distribution and to provide the survivor with enough know-how so that he can avail himself of these local edible resources in order to sustain himself at sea.

Now the third general objective concerns our desire to study marine animals as well as other living organisms, both plant and animal, because of their ability to accomplish complex tasks of direct interest to the Navy.

For example, as you well know, many marine fishes are able to migrate or "home" over great distances, sometimes intercontinentally. This involves abilities of target identification, target selection, and "navigation" over great distances with a high degree of accuracy.

The interesting part here is that fish and other marine organisms are able to carry out these tasks without sextants and the other paraphernalia that man requires. They are able to do this with biological "equipment" which frequently weighs only a few pounds and may weigh as little a couple of grams. Man, with hundreds of pounds of highly sophisticated electronic and mechanical gear is not able to perform similar tasks in as efficient a manner as these organisms. Obviousy, we are interested in studying these animals as biological models.

This illustration presents a rather stylized comparison of the abilities of fishes and birds to perform in ways which our missile men are quite interested in duplicating. It also points up another closely related problem, the problem of communication among underwater swimmers and submarines. The problem of being able to communicate with one another under water in a secure fashion is becoming acute. Yet I am sure you have all seen schools of fishes execute to-the-right flank, or to-the-left flank, or to-the-rear movements with military precision. They do this in ways that we certainly do not understand, but they are obviously communicating and we are interested in discovering the mechanisms involved.

Closely related is the aspect of silent propulsion in marine organisms, their hydrodynamic characteristics and boundary layer control mechanisms.

This is a bird's-eye view of some of the unclassified interests of the Navy in this basic research field of hydrobiology.

Now, what do we mean by hydrobiology? As I mentioned earlier, it is really a diffuse collection of basic biological disciplines associated very closely with physics and chemistry attempting in concert to obtain more knowledge of the oceans as well as of estuarine and freshwater areas of our planet.

The program itself consists of basic research. It comes about through the support by the Office of Naval Research of unsolicited projects from scientists who are interested in pursuing basic research of primary concern to themselves so that essentially the Navy here buys into the "brain power" of the scientist without in any way orienting his interests. The scientist is happy in being able to pursue the basic research, the Navy is happy in getting another bit of knowledge to fit into a meaningful mosaic of programmatic information that will further naval operations.

Now, gentlemen, this particular program is confronted with a number of practical handicaps. The handicaps are the ones that confront the basic researchers working in the fields of interest to the Navy. Taxonomy, as presented earlier, is one of considerable importance in hydrobiology. The necessity for identifying and classifying marine animals and plants of peculiar concern to the Navy is an important one and yet we find that all too frequently we are not able to get the information required from the limited number of systematists located at such institutions as the American Museum of Natural History in New York, the U.S. National Museum in Washington, D.C., or the relatively few other taxonomic centers in the United States of America. These men are terribly overburdened. Sometimes we have to wait for months or even years to get the information we require.

They have a backlog of collections that will take years to work up.

The situation is accentuated by the fact that relatively few young men and women are willing to come into the field of taxonomy because there are few jobs waiting for them.

Finally, the matter of ships for biological research: I think it is important that we recognize that although the institutions of oceanography in this country possess some of the most competent biologists that are available in the United States, the great preponderance of competent biologists contributing to our program reside outside of oceanographic institutions.

Nevertheless, they need field and laboratory tools similar to the oceanographers. These they are not able to get because very few marine or fresh water laboratories associated with universities have the financial means to provide the scientists with sufficient equipment to realize their maximum capabilities.

On the matter of research ships, for example, the biologist very frequently has a special need for research ships which is quite different from the need of the oceanographer. There is a necessity for the biologist to get out into the oceans for a long enough period of time to study the animals and plants in their natural environments in order to determine in a coordinated way the seasonal and geographic distribution of these animals and plants. Right now it is very difficult for them to do this because they do not have the research ships.

As a result, they have to rely on preserved collections and the culturing of organisms in the laboratory. It is not possible to rear many marine animals, especially deep sea forms, in the laboratory.

Both of these facets are quite important in their own right but they do not offer a suitable substitute for field research.

I will be very happy, gentlemen, to answer any questions that you may have.

Mr. DINGELL. Thank you very much, Doctor.

Mr. Bauer?

Mr. BAUER. Dr. Galler, you mentioned oceangoing research ships for biologists. How would you run such a ship? Would it be part and parcel of the Bureau of Commercial Fisheries, would you say, or should it be handled by the Smithsonian Institution?

Dr. GALLER. Obviously, each Government agency with interests in marine research must be concerned with the problem of obtaining the use of oceangoing research platforms. However, I say, in addition there we need to provide academic institutions with research ships, possibly on a regional basis. We must bring together the biologists located in coastal areas with biologists located in inland universities and on a cooperative basis provide them with the research ships required in the national welfare.

Also, I should say at this point that the limnologists, that is, the fresh water biologists, and the institutions and departments of limnology in the United States constitute a very important but unrecognized resource for education and training of young men and women who may later wish to go into the marine sciences.

Mr. BAUER. Are there any moves afoot that you know of supplying this lack of oceanographic or oceangoing ships for biologists?

Dr. GALLER. I am sure I am not qualified to give you an authoritative answer on this, Mr. Bauer. I have understood that the National Science Foundation is making an effort to provide certain oceanographic institutions with funds that would permit the biologists there to make use of the oceangoing research ships.

However, I am not aware of any similar effort to provide marine biologists in other research institutions with ships.

Mr. BAUER. Does estuarine research need a little bit of help at the present time, do you think?

Dr. GALLER. Yes, sir; very definitely.

Mr. BAUER. Do you concur with the thinking of the previous witness, Professor Ray, that the National Museum would be the logical place for the establishment of a biological data center?

Dr. GALLER. I concur completely with Dr. Ray in the sense that the U.S. National Museum already is the principal center for marine biological collections in the United States. In my opinion, there is a necessity for any group that is going to establish a data center to process the data in a manner that would be collated with the biological collections at the Smithsonian.

Mr. BAUER. With respect to ocean surveys, Dr. Galler, do you think it possible to make a biological survey simultaneously with a survey of physical oceanography on the same ship or the same operation, or are the requirements different?

Dr. GALLER. I do not mean to beg the question, but quite frankly I am not sure what is meant by the term "survey." This is one of the terms that appears to mean all things to all people.

If by a biological survey we mean the routine collection of biological material coordinated with the collection of physical and chemical oceanographic data, I say yes, this is possible, provided we appreciate the great limitations from the biologist's point of view of synoptic sampling; that is, sampling, skipping, sampling, skipping, and so forth—material which may of interest. It does not answer two great needs:

No. 1, the need for what we call a standard biological station; that is, putting a research ship into a given area for a long enough period

of time to study population fluctuations in that area throughout the year.

No. 2, the need for a research platform that will enable the biologist to study individual organisms in their natural environments for a relatively long period of time.

This would not be met by a survey as I presently understand the term.

Mr. DINGELL. The committee is certainly grateful to you for your appearance this morning.

We have heard throughout the testimony this morning the problems faced by the Smithsonian Institution in doing a proper job with the collections. I wonder if it would be helpful to the program as a whole and also to the Smithsonian if we were to include them as one of the cooperating agencies under H.R. 12018?

Dr. GALLER. In my opinion this would be a step in the right direction.

Mr. DINGELL. You think it would be helpful to the data center?

Dr. GALLER. Yes, sir.

Mr. DINGELL. You feel it also would be helpful to the Smithsonian?

Dr. GALLER. Yes, sir; that is my personal opinion.

Mr. DINGELL. The committee is grateful to you for your kindness in appearing this morning. Your pictorial presentation was extremely impressive.

Dr. GALLER. Thank you, sir.

Mr. DIGELL. We will stand adjourned until 10 o'clock tomorrow.

# OCEANOGRAPHY

WEDNESDAY, MAY 25, 1960

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON OCEANOGRAPHY OF THE
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
*Washington, D.C.*

The subcommittee met at 10 a.m., pursuant to adjournment, in room 219, Old House Office Building, Hon. George P. Miller (chairman of the subcommittee) presiding.

Present: Representatives Miller, Dingell, Flynn, Dorn, Pelly, and Curtin.

Staff members present: John H. Drewry, counsel; Paul S. Bauer, special consultant to subcommittee; and Frances Still, assistant clerk.

Mr. MILLER. The committee will be in order.

Capt. R. A. Earle, Chief of Geophysics Division, Coast and Geodetic Survey, is the first witness.

Captain Earle.

## STATEMENT OF CAPT. ROBERT A. EARLE, CHIEF, GEOPHYSICS DIVISION, U.S. COAST AND GEODETIC SURVEY

Mr. MILLER. Captain, I know that you are going to tell us something about earthquakes and the tsunami that they create. Perhaps give us the history of what is taking place now in the Pacific and tell us what we should further do to get early warning on these things. I do not know that we can do very much.

Do you know of any way we can stop earthquakes?

Captain EARLE. I do not think that there is any way we can stop earthquakes, Mr. Chairman.

Mr. MILLER. We along the Hayward Fault in my district of California would be very much interested if there was.

Captain EARLE. We certainly hope science comes up with some method in the future whereby we can give warning of earthquakes.

Mr. MILLER. I assume that you know where Hayward Fault is.

Captain EARLE. That is a very active seismic zone out there.

Mr. Chairman and members of the subcommittee, I appreciate this opportunity to appear before you to tell you about the seismic seawave warning system which is operated by the Coast and Geodetic Survey.

As a background for this information, it is stated that after a disastrous tsunami or seismic seawave hit the Hawaiian Islands on April 1, 1946, killing 173 people and causing damage in excess of $25 million, the Coast and Geodetic Survey set up a warning system. Seismographs around the Pacific area were equipped with warning bells to provide 24-hour monitoring of major earthquakes; selected tide sta-

tions were equipped with special pressure gages to record long-period seismic seawaves; and priority communication systems were organized by which all data could be forwarded to the nerve center of this system at the Honolulu Magnetic Observatory of the Coast and Geodetic Survey.

Constant vigil is maintained at the major seismological stations comprising this net and, on the average, 20 earthquakes occurring at various places around the world are recorded each day. Most of these are small in magnitude and of interest only to seismologists and geophysicists; however, occasionally this quiet is shattered by violent activity when some adjustment deep within the earth releases vast amounts of energy. Within minutes after an earthquate occurs, depending on the distance from the focal point, seismographs will begin wild oscillations which can last for hours.

Now, Mr. Chairman, I would like at this stage to show you the seismogram from the seismograph in our Washington area which is in the Commerce Building. It shows you how these waves are recorded. We have indicated time on the gram. It takes the seismogram 1 hour to go across here and thus 3 or 4 days' records can be recorded on this seismogram.

This is Greenwich civil time at 1900 and this would be zero hour each day.

This is where the record for May 22 starts. This is the first earthquake that came in from Peru and, incidentally, the gain was set way down because otherwise instrument would hit the stops and oscillate back and forth too much.

As you look down 2 or 3 days later, this oscillator indicates another quake and this point indicates the time when your major tsunami came in. In this case it was hitting the stops, vibrating back and forth very strongly.

That is the record we get at various seismographs.

I might state that different types of waves come in. There is a P wave and S wave and, because we know how fast those waves travel through the earth, we can determine how far an earthquake is from a particular seismograph.

This is just a copy of the record.

Mr. Miller. How long does it take these to be transported through the earth? This thing took place in Chile, say, at zero hour. How long was it before you got it up here?

Captain Earle. Before we got word of that?

Mr. Miller. No. How long was it before it showed up on your seismograph?

Captain Earle. Those waves travel between 5 and 20 kilometers per second, very fast. In other words, in 12 to 20 minutes it reached all the seismographs around the Pacific. We knew that a major earthquake occurred. We did not know whether it created a tsunami but we knew there was a major earthquake.

As soon as the tide stations sent their records to Honolulu, they knew there was a major tsunami.

Mr. Miller. The vibration of the earth set up by this great release of energy in Chile runs through the earth much more quickly than the speed of sound in water.

Captain EARLE. It is just like a vast explosion and goes out in all directions. They are elastic waves traveling in all directions out from the center. They go through the earth and around the earth.

The first two waves, known as the primary and secondary waves, are waves that cut through the earth to the seismograph. For example, I have another map that I will show you later.

I think it takes 10 minutes for those waves to reach Tucson, and so forth.

Mr. MILLER. Where is your institution in Hawaii actually located?

Captain EARLE. It is out near Ewa, right past the Ewa Air Field. We are moving that institution and we are dedicating a new observatory on the 23d of June. That was necessary because the old observatory had been surrounded by many Standard Oil buildings. They were also building a refinery near by. It did not affect seismology as much as it affected our magnetic work at this observatory. Great masses of steel and also pipelines disrupted the study of magnetism so that we had to move the observatory.

The Navy supplied us with an area of 177 acres and we received money to move the observatory.

Mr. MILLER. Admiral Karo was kind enough to send us invitations to attend this dedication and, if we could get time out and he would furnish transportation, the committee would be glad to go.

Captain EARLE. I hope the committee will be able to see one of our observatories.

Mr. MILLER. You may proceed.

Captain EARLE. To continue, when a major shock wave reaches a specific installation, a buzzer warns the seismologists that a major earthquake has occurred. They will analyze their records to determine the arrival times of the ground waves and the estimated distance to the epicenter. This information is dispatched to the central station at Honolulu by the quickest means available. The communication channels have been previously established and are kept open at all times so that immediate transmission is accomplished.

Within a few minutes after the earthquake occurrence, the staff at Honolulu, previously alerted by its own seismograph, begins to plot the location of the earthquake, using data coming in from the network. If the epicenter is in a Pacific Ocean area, an advisory is issued, warning of a possible tsunami.

The tsunami travels at speeds up to 500 miles per hour, much slower than the ground waves of the earthquake itself. The tsunami wave is but a few feet high and hundreds of miles long, but when it strikes a coast it may gain great height and become very destructive.

Positive identification of an actual tsunami is necessary. Two points make the decision difficult. First, few earthquakes produce tsunamis, and, second, tsunami waves are impossible to recognize at sea because of their low height. Identification is made through the tide stations of the network at which observers scan their tide gage records for a period when the wave might be expected.

Upon receipt of a positive report from a tide station, a warning is issued. This is usually completed in less than 3 hours after the earthquake, giving time for evacuation and other precautions at distances of 1,500 miles or more from the quake. Coastal areas at remote places thus have warnings, sometimes of several hours.

Both the advisory and the warning are given to a group of action agencies, as follows:

(1) Commander in chief, Pacific—by telephone.

(2) Duty forecaster, Kunia Forecast Center—by telephone.

(3) Chief of Police, Honolulu, Hawaii—by telephone. In other words, the observer in charge telephones them immediately of both the warning and alert.

(4) The CAA Supervisor, Honolulu, Hawaii—by telephone, and confirmation by teletype, and this is confirmed, too, so that there are no slips.

(5) Weather Bureau duty forecaster (information for broadcast to public) by telephone and confirmation by teletype (warning only).

(6) Honolulu district officer, Coast and Geodetic Survey—by telephone.

(7) San Francisco district officer (warning only).

(8) Federal Civil Defense Administration, region 7.

(9) Director, Coast and Geodetic Survey.

Participating seismological and tide stations are:

The Honolulu Center (control station of the warning system).

Seismological stations:

College (Fairbanks) Alaska.
Sitka, Alaska.
Berkeley, Calif.
Pasadena, Calif.
Tucson, Ariz.
Huancayo, Peru.
Guam, Mariana Islands.
Manila Observatory, Baguio, Philippine Islands.
Japan Meteorological Agency, Tokyo, Japan.

Tide stations—these are not all the stations in the net. These are the active ones on which we count:

Attu (Murder Point), Alaska.
Adak (Sweeper Cove), Alaska.
Unalaska, Unalaska Island, Alaska.
Kodiak, Alaska.
Sitka, Alaska.
Crescent City, Calif.
San Pedro, Calif.
La Jolla, Calif.
Balboa, C.Z.
Pago Pago, Tutuila, American Samoa.
Canton Island, Phoenix Islands.
Hilo, Hawaii.
Johnston Island, Pacific Ocean.
Midway Island, Pacific Ocean.
Wake Island, Pacific Ocean.
Kwajalein, Marshall Islands.
Guam, Mariana Islands.
Christmas Island, Line Islands.
Suva, Fiji.
Valparaiso, Chile.
Scripps Institution of Oceanography Tide Stations.
Nauru, Pacific Ocean.

The network has functioned with precision and saved many lives and millions of dollars. The seismologists and tide observers of the network are proud of the fact that they have not misssed a warning or given a false alarm during their 14 years of operation.

In that regard, we say we did not give a false alarm. We have called alarms or warnings when we knew a tsunami was coming but the wave may have been only a few feet in height. We have no way of predicting this.

Thus at times even though they evacuated waterfront areas, the waves were just high enough to slap into the docks.

I think the reason for the loss of life this time was because the two previous tsunamis did not generate large waves, and, as this was at midnight, I feel that the people did not get out even though the warning sounded in these areas.

I have one other thing which I would like to show you gentlemen, if I may. This is a travel-time chart. On this chart we have plotted the location of the epicenter. When that earthquake occurred, it sent seismic waves through the ground and, as you can see, it took 12 minutes to Tucson, 15 minutes 10 seconds to Fairbanks, 13 minutes to Honolulu, and so forth.

The minute these stations recorded an arrival of a major earthquake, a bell rang in their observatories, the seismologists awakened and immediately scanned their seismogram and found out how far this earthquake was from their actual location. They wired this information to Honolulu. Honolulu knew that the earthquake was say 6,000 miles from Fairbanks. They swing distance arcs on a globe and the intersection of those arcs must be the epicenter or focal point of the earthquake.

The next point is to determine whether or not this earthquake, which occurred under the sea, was generating a tsunami. That is very difficult. Nobody knows exactly why most of them do not generate tsunamis and a few of them do. I have heard the reasoning that if an earthquake occurs right where the water and land join, it would create a tsunami because all this pressure would be released into the water.

On the other hand, if it is a mile down, it might not create a tsunami. That is just a theory.

Honolulu will immediately wire these different tide stations and tell the observers to read their gages and note whether this long period wave, whose period is anywhere between 15 minutes and a half hour, has been recorded. They can tell how long it will take that wave to travel between the epicenter and an individual station.

The minute they receive a positive report that is definite, they will issue a warning.

The other day they put out the actual warning, not the advisory, 5½ hours before the wave hit. I think they waited to be sure that Tahiti still recorded a wave. When they found that there was a big wave at Tahiti, they put out the warning.

The reason for checking this is that you do not want to put out unnecessary warnings. If you do people will not get out of their homes but will just brush them off.

Mr. MILLER. Was there not a great deal of damage done in Tokyo?

Captain EARLE. Yes, sir: there was. That wave traveled through here. I have noted articles that said the Japanese were not warned

and yet, there was a note in the paper that admitted they had been warned but, because they did not know that the wave did a lot of damage in Honolulu, they did not take it too seriously. That, to me, is a lot of hooey, because the Japanese have a very capable group of seismologists in their country who study earthquakes. They had complete warning and somebody muffed, in my estimation.

Furthermore, our military and CAA and Weather Bureau send these notices to the islands. Certainly the military notified the military in Japan, because we have ships over there.

Mr. MILLER. Mr. Bauer.

Mr. BAUER. Captain Earle, would you mind distinguishing for the committee and the record the difference between a catastrophe of this type and the seiche that occurred with no warning at Lituya Bay and created the loss of the three ships?

Captain EARLE. Yes. You see, Lituya Bay was close to the focal point of that earthquake. In other words, the earthquake was in southeast Alaska, thus there was no time for any warning.

There are various ideas on how that wave occurred. We know there was a glacier and a huge cliff at one end of that bay and we know that many thousand tons of material dropped into this small, narrow bay. This probably created the seiche that surged down the bay and swept those fishing vessels over the bar. This did not create a tsunami or tidal wave. This wave was caused when a vast amount of material dropped from the heights of the glacier into the bay.

Mr. BAUER. In other words, any warning method that you have available must of necessity be somewhat remote from the epicenter?

Captain EARLE. Absolutely, sir. There would be no warning of this event because it did not create a tsunami. That was just a seiche and it dissipated in the sea. Any earthquake in ocean areas could create a tsunami but few of them do. We cannot put out too many warnings because it is crying "wolf." However, we have never missed on a warning.

Mr. MILLER. What do you have in the Atlantic? Have you ever had any tsunamis in the Atlantic? You have had some powerful earthquakes over here.

Captain EARLE. We have had powerful earthquakes years ago but, as far as I know, there were no tsunamis in the Atlantic. Of course, the one in Charleston, S.C., in the 1800's, was a major earthquake but whether it was near enough to the coast to create any surge at sea, I cannot answer.

Mr. MILLER. Do the Azores ever shake?

Captain EARLE. There are quite a few earthquakes in the Azores. That is a seismic belt. However, the most active seismic belt in the world is that rim of the Pacific and most tsunamis occur there.

Right from South America, you go through the State of California to the Aleutians and Japan and on down through the East Indies. It is a very active seismic zone.

Mr. MILLER. This is the zone that is surrounded by a group of volcanoes.

Captain EARLE. Yes, sir. Of course, there is some connection. We do not think there is a connection in this case but an earthquake can be started by volcanic action.

Mr. MILLER. As far as you know, now, how was the comparison of damage done at Hilo by this one and the one in 1946? I happened to

be in Honolulu 2 days afterward. We flew down and took a look at Hilo. It was pretty well laid low.

Captain EARLE. Well, the only thing I have on that—and we have no direct report, Mr. Chairman—is that possibly it was as large. The newspaper reports are the only thing I know. In 1952 a major tsunami hit Hilo with no loss of life but there was damage on the waterfront.

Mr. MILLER. They still want to build right on the water.

Captain EARLE. You see, gentlemen, this tsunami is a pressure wave just pushing forward. In deep water it may create a wave of only a foot in height. Hilo is on a funnel-like trough so that, as this pressure pushes, it pushes the water up this funnel. The sloping shelf and contour of the land make Hilo very vulnerable.

Mr. MILLER. Mr. Dorn?

Mr. DORN. I have no questions.

Mr. MILLER. Mr. Pelly?

Mr. PELLY. You do not have any information as to the effect that this particular wave had on southern California—for example, Long Beach? I know that there has been a sinking there and I have always heard that a large wave might cause a lot of damage to our naval installations there at Long Beach.

I wondered if they had anything like that.

Captain EARLE. No, sir. I have seen reports that they did have something like a 6-foot wave hit along the California coast as a result of this earthquake. It was a seismic sea wave that hit through there but I think it only broke the moorings of small boats and disrupted things a little bit without causing appreciable damage.

Mr. PELLY. I am thinking of the flooding of a low area which is protected, as I understand, by a dike. That could be quite serious.

Captain EARLE. It could, sir, but I do not think the height of the wave that hit there would be comparable to waves from some of the major storms that came up the coast.

Mr. MILLER. Would the gentleman yield?

Mr. PELLY. Yes.

Mr. MILLER. Of course, if this tsunami came along at a high tide, it would do a lot more damage than if it hit at a low tide. If it hit at a low tide along that coast a 6-foot wave would not be very high but the damage at a high tide would be much more.

Captain EARLE. When you have your spring tides your water level is so much higher that the force of a tsunami would push water further inland. I guess you gentlemen are all acquainted with the wave of 1946 which was over 100 feet in height and wiped out Scotch Cap Light which was, I think, 86 feet above sea level. I think it occurred at a high tide. Of course, the earthquake that generated that tsunami occurred very close to the area of the light.

Mr. MILLER. Mr. Curtin?

Mr. CURTIN. Thank you, Mr. Chairman.

Do these tidal waves always proceed at relatively the same speed, or are they influenced by the severity of the earthquake?

Captain EARLE. They always proceed at the same speed. However, the speed of a tidal wave is related to the depth of the water. At great depths, it is 400 to 500 miles per hour. The chart which I gave you, which is a travel time curve, is figured on the basis of depth

because a wave proceeds at different speeds in different depths of water.

Mr. CURTIN. That is all, Mr. Chairman.

Mr. MILLER. What is the cost of maintaining the network?

Captain EARLE. Sir, we get about $21,000 a year but, of course, we absorb most of the cost in our seismic and magnetic station costs. Specifically allotted for the seismic seawave warning system is around $21,500 a year.

Mr. MILLER. There are a lot of these stations. I assume the one at Scripps would be maintained by the Scripps Institution?

Captain EARLE. That is correct, sir. At the stations in our magnetic and seismological nets, most of the cost of maintaining the seismic seawave warning system is borne by the other functions.

Mr. MILLER. Nearly every big university has a seismographic center.

Captain EARLE. That is right, and we depend on our own, and particularly the seismographs at CalTech and the University of California. Dr. Byerly and Dr. Press are very loyal in seeing that their reports are forwarded immediately. Those are the ones we can depend on in California.

Mr. MILLER. Is that not true around the world?

Captain EARLE. The Japanese are very prompt in forwarding reports from Tokyo University. At other universities we have cooperative arrangements. Of course, this does not affect the seismic seawave warning system. We sometimes pay an assistant professor on a contract up to $100 a month to tend the instrument, read the records, and send us a report once a month. This is for our epicenter location work.

In some universities we supply the instrumentation and they do the rest, but some will not do it that way and we want better records.

Mr. MILLER. Is there any progress being made in predicting earthquakes?

Captain EARLE. I would say at the present time, no. There are all kinds of studies being made relative to strain gages which we put in deep holes and various other things but it is all in the line of research and I do not think they have come up with anything that gives us any hope of predicting earthquakes as yet.

Mr. MILLER. I remember that many years ago somebody came out and make statements that the next major earthquake on the Pacific coast would take place in the Los Angeles area and people down there were up in arms because it affected some real estate deals and one thing and another.

I guess maybe the next one was down in that part of the country. I come from Alameda County and we get our share of them.

Captain EARLE. With regard to that point, in our office here, we continually get letters from people who are predicting earthquakes. Two of them are very persistent—one in this country, and one in France who does it by astrology. We just file them away and possibly compare data when we have a major event.

Mr. MILLER. Of course, you always have those people who say, "This is earthquake weather."

Captain EARLE. That is right. I have heard that, too, sir.

Mr. MILLER. Then the rumblings that precede them are spoken of. I have been in a lot of earthquakes and the greatest rumbling you get is when a chandelier starts to shake.

Thank you very much, Captain. I want to congratulate the Service. I think this is one of the fields that has enhanced the great reputation that the Coast and Geodetic Survey now has.

Captain EARLE. I certainly appreciate the opportunity of speaking before you, gentlemen, and telling you a little about these things.

Thank you very much, sir.

Mr. MILLER. Dr. Fenner A. Chace, Curator of Marine Invertebrates, Museum of Natural History at Smithsonian.

Doctor, we welcome you here.

I do not know that I can speak for my colleagues but I am always amazed at the amount of work that is done at the Smithsonian Institution. Then all of a sudden you come up with some new phases of work that you do there and it makes me a little ashamed that I am not more familiar with it and have not taken time to acquaint myself with it. I am just speaking for myself.

## STATEMENT OF DR. FENNER A. CHACE, JR., CURATOR OF MARINE INVERTEBRATES, MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION

Mr. CHACE. Mr. Chairman and members of the committee, I feel that I am not a very good witness for the Smithsonian. I have not been able to contact many of our administration in the last few days. Most of them seem to be away so that I am afraid I will have to speak largely for myself rather than for the Smithsonian.

Mr. MILLER. We will be very happy to have you speak for yourself.

Mr. CHACE. I have no statement. I will be glad to answer any questions that any of you may have.

Mr. MILLER. I will turn you over to Mr. Bauer because he speaks your language. I know that I do not.

Mr. CHACE. I realize that.

Mr. BAUER. Dr. Chace, yesterday we heard from some of the biologists—Professor Ray from the University of Washington and Dr. Galler—and we have heard, in response to various questions that have been asked, the thinking that the tie-in with taxonomy and systematics that you are so capable of doing, should be enlarged to perhaps consider biological data obtained in the surveys of the sea with respect to H.R. 10412 and its companion bills and also Mr. Pelly's bill, H.R. 9361, and the companion bill on the data center.

What is your feeling? Should the Smithsonian Institution enlarge its scope to get a closer marriage, we will say, between the collection of biological remains and data that is evolved by study of biology in the open ocean?

Mr. CHACE. I would like to speak as a biologist and not as a witness for the Smithsonian.

Mr. BAUER. I realize that you cannot commit the Smithsonian.

Mr. CHACE. Yes, sir, I think there is great need for more basic knowledge in systematic biology in relation to oceanography and many other fields of science and I do feel that the Smithsonian with its facilities is the place to base those studies.

Mr. Bauer. Now, it was mentioned yesterday in our hearings that one of the difficulties with biological research is the fact that we do not possess adequate platforms to study the various marine invertebrates and vertebrates in situ but must depend upon their being brought back to a laboratory.

Now, do you feel, as a systematic biologist, that it would be of any assistance to have ships constructed for biological research in the ocean or the estuaries and be run on some sort of a national program and made available, we shall say, for universities of the east coast and the west coast and the central coast, and so on? Would that kind of a program be of any benefit?

Mr. Chace. It is a subject I have thought about a little bit. I am not a field man myself, so that my reaction may be a little biased. I think that most of the collecting of marine organisms can be done without participation by the specialist concerned; but, of course, a great deal can be added to our knowledge by knowing the colors of these organisms and what they look like when they come out of the water. To a limited extent, I think it is desirable for the specialist to go to sea and see some of these things alive.

Mr. Bauer. You certainly would say, I should think, that the ecology would have to be studied at sea, would you not?

Mr. Chace. Well, I was thinking particularly of deep water where we at this moment can not go easily. Of course, a great deal of ecological data can be gained from the collections in museums: associations, and so forth.

Mr. Bauer. I realize, of course, that you cannot commit the Smithsonian. Would it be of any value to have a joint study looking to the provision of adequate platforms for research for biology undertaken by the Smithsonian and the National Science Foundation and come up with recommendations as to a program of how universities could be integrated into the picture—various State governments, the various people that are interested in estuarine studies, and so on? Would that be of any value?

Mr. Chace. It seems to me that the biological work that can be done at sea gets into the experimental field to a considerable extent and I do not think that the Smithsonian is competent to enter that field. We have had very little experience in that field, and I think that it could be more properly handled by some other agency or by private institutions.

Mr. Bauer. I was thinking particularly of the fact that you do operate something of that nature in Barro Colorado Island at the moment.

Mr. Chace. That is right. That is a shore station.

Mr. Bauer. I was thinking that you are operators really when you look at your Astrophysical Observatory and Barro Colorado Island. In other words, you maintain facilities as well as a staff of able scientists.

Mr. Chace. That is right.

Mr. Bauer. That is all, Mr. Chairman.

Mr. Miller. Mr. Pelly?

Mr. Pelly. Dr. Chace, yesterday Dr. Dixy Lee Ray, testifying before this committee, indicated that we should do a little more for the U.S. National Museum. She said she hated to bother the staff be-

cause they were so overtaxed with work and it was difficult for a researcher to really get the information that was wanted.

Is there anything that we should do in order to increase appropriations along that line, in your opinion?

Mr. CHACE. I would have to answer that as an individual again.

Mr. PELLY. Answer it personally, yes.

Mr. CHACE. I think that you have done a great deal already. I think that, of course, our great need at the moment is space. We cannot do very much without it and I understand that we have a fairly good chance of getting the wings on our present building now. If we get those, we can move ahead. Without additional space, we are pretty well stymied.

Mr. PELLY. I think that the members of this committee are very much interested in writing a report on legislation which will contribute to science generally and that what you have said personally, although not in behalf of the Smithsonian, can be very helpful when we come up with some sort of what may be piecemeal legislation.

I appreciate that this is one opportunity that you will have when the Bureau of the Budget or even the administration of the Smithsonian Institution does not have you under wraps. I think this is your chance, if you can speak up now and tell us any way that we can be helpful in writing legislation; that is what the committee wants.

Mr. CHACE. I do not think there is anything that I can add.

I do want to stress that we cannot produce miracles in a short time and until we get the additional space we are pretty well stymied.

Mr. PELLY. When is that building supposed to be completed?

Mr. CHACE. I do not know. Well, of course, we can prepare for the expanded facilities in advance, but even so, we are going to have difficulty in obtaining an adequate staff. Systematic marine biologists are few and far between.

Mr. PELLY. Thank you.

Mr. MILLER. Mr. Dingell?

Mr. DINGELL. Unfortunately, I did not have an opportunity to hear all of your testimony, sir, but I was particularly interested in receiving the answer to one question. You are familiar, of course, with H.R. 12018, and specifically, insofar as it would establish a data center?

Mr. CHACE. Yes.

Mr. DINGELL. Do you feel it would be helpful to the data center to have the Smithsonian Institution included therein as one of the consultants and one of the participating Government agencies?

Mr. CHACE. I have never been able to decide just how marine biological data is to be handled in a data center. I think that if it is included we certainly could contribute, because we have a mass of raw data.

Mr. DINGELL. Then you do feel that it would be helpful to have the Smithsonian included as one of the participating Government agencies?

Mr. CHACE. I think so.

Mr. DINGELL. Do you think that it would be helpful to the Smithsonian to participate in something of this sort?

Mr. CHACE. I do not think so.

Mr. DINGELL. Would you want to elucidate on that?

Mr. CHACE. Yes. I have thought about the possibility of machine carding much of our data and I do not think it would be of any value to us. At present we use typed reference cards in two files, systematic and geographic. For our needs, that is adequate. To have to feed cards into a machine every time we wanted our information would slow up our activities.

Mr. DINGELL. Thank you very much, Mr. Chairman.

Mr. MILLER. A clearinghouse for marine biological data would be highly desirable, would it not?

Mr. CHACE. I think it would be for the other disciplines, yes.

Mr. MILLER. For the other disciplines. The Smithsonian might gain something from it, though. Any time that you have any great amount of information available, you can always gain.

Mr. CHACE. Any cooperation is useful, yes.

Mr. MILLER. I have no further questions.

Are there any further questions?

Thank you very much, Doctor. We appreciate your coming.

Mr. CHACE. Thank you very much, Mr. Chairman.

Mr. MILLER. Dr. W. M. Chapman of the American Tuna Boat Association.

We always welcome you, sir.

## STATEMENT OF DR. W. M. CHAPMAN, THE RESOURCES COMMITTEE

Mr. CHAPMAN. Thank you, Mr. Chairman.

Mr. MILLER. I know that Mr. Pelly and I were very happy to see you go to Geneva.

Mr. CHAPMAN. Thank you. We were very happy to see you there, also, to give us a little added suport that we needed at the time.

Mr. MILLER. I do not know that it added quite enough because we were not too successful.

Mr. CHAPMAN. We are not through with that problem just yet. We will have it before us for the next several years.

Mr. MILLER. I think that you are right, and I think that the fact that Members of Congress did take time enough to go over there has taught us that this is something that we just cannot take for granted and Congress has to be much more concerned about it.

In that respect, I think our visits over there were very worthwhile.

Mr. CHAPMAN. That is correct. As I told you Members of Congress who did show up at the Law of the Sea Conference in Geneva—we, in the fishing industry, in particular, were most grateful for you taking off that period of time in the midst of your busy duties to do so, because this matter of the jurisdiction which the coastal States have over the fisheries in the adjacent high seas, tied in as it is with the adjacent territorial sea and therefore with the great military as well as mercantile interests which you have as your particular responsibility here in this committee, is going to make it necessary for all of us to pay much more attention to this subject in the years immediately before us.

Mr. PELLY. Mr. Chairman.

I think at this point I would just like to comment that the community of interest that all nations have in conservation certainly must sometime, through basic research, bring us together completely so that

we can arrive at a satisfactory territorial sea; but until we get more in the way of research and common understanding, I think it is going to be very difficult.

Mr. CHAPMAN. Quite so, and that is particularly pertinent to these particular hearings in two respects, sir: not only in respect of the problem of overfishing and conservation which must advance on the basis of additional knowledge, but also on the basis of straight survey oceanography.

If I may divert a little bit to comment on what came up in the Law of the Sea Conference in its terminal days and affected the voting materially, there was a position taken by Chile, Ecuador, and Peru, primarily, which was based on their concept that the ocean adjacent to their coast is a unique thing—that it requires to be treated uniquely from the standpoint of jurisdiction. Their political decision which was registered there by votes adverse to the United States was based almost entirely on a lack of oceanographic knowledge in that area of the world and this lack of knowledge there will, by a lack of having decision at Geneva, affect materially your salmon and trawl operations in the Gulf of Alaska, Bristol Bay, and the Bering Sea.

It is peculiar how these various problems around the world affecting the law of the sea are all interwoven. A decision taken in one of them will affect all of the rest of them also.

One of the things we are very much interested in in our area of the world is pushing forward the oceanographic investigations along the Chile-Ecuador-Peru area not because we anticipate making any money out of the oceanographic results that will be forthcoming therefrom, but in their application to the diplomatic efforts of the United States in respect of the law of the sea; and this is just as important to us as if they were showing us where to catch tuna.

Mr. PELLY. If I might inject at this point, Mr. Chairman—I just want to say that the fishing interests of the Pacific Northwest agree with you 100 percent in our area. We want to push basic research and hope through that channel to achieve conservation and understanding and political unity.

Mr. CHAPMAN. Yes. I might mention for the committee's benefit, one such project that is being carried forward now by the Bureau of Commercial Fisheries at the joint request of all of the fishing industries of the Pacific coast from San Diego to Juneau. That is the work being carried forward by Dr. Sette and his group at the Stanford Laboratory of the Bureau of Commercial Fisheries which has as its primary objective the analysis of two sorts of data—sea surface temperatures and barometic pressures that have been accumulating for many years by ship captains sending them in to the Weather Bureau.

The work that has gone forward in that Laboratory so far is aimed at providing a mechanism for predicting from the weather and surface temperature records the success of fishing throughout the whole of the eastern Pacific.

This illustrates very well the problem which the committee here is up against.

The first lot of data that came to this Laboratory consisted of 5 million separate cards with information on them. I think this is one of the places from which generated this desire by all hands involved to have a national data center for oceanographic information because

we had there on our hands so much data that it was impossible for a human mind to comprehend it and get a grasp of it and yet in that mass of data was the information which perhaps governed the success of all of our fisheries on the Pacific coast.

Putting this information through the newly developed electrical collating machines is bringing it into some degree of order now. And from this is already proceeding very useful results which we are beginning already to put into practice by informing our fishermen of predictable changes in surface temperatures which will affect their ability to catch a load of tuna quicker and, therefore, more cheaply; but we are most anxious to have this work proceed more rapidly and we have been petitioning the Bureau of Commercial Fisheries and the Congress for more funds to boost up this Laboratory upon which all of our other fisheries laboratories from Juneau to San Diego depend for their results.

This is one example where what is called basic research appears to have great economic as well as basic significance.

Mr. MILLER. Before we leave entirely the law of the sea, the way I look at it—heretofore the 3-mile limit was based on certain historic principles and 40 years ago it was unthinkable that fishing vessels should cross the Pacific, cross an ocean in the pursuit of fish. This is not confined to the Pacific. I think the implications in the Atlantic are just as great and as these new nations come into being, it will become greater among the Asian-African bloc. So it is universal. It was unthinkable that you would cross the ocean, and some of us are never quite conscious of the fact that in this field like others, time and distance has disappeared and we have to bring the law of the sea into new perspective.

We have been a little slow, perhaps, in doing it and the particular phase that you point up to me is bringing out, developing biological data and the biology of the sea, and being able to bring it on into an international concept and we are merely in the beginning of it.

Perhaps a good many of us do not quite grasp its significance and its importance, but if this committee can touch this off in Congress, I think we can take pride in saying that we were the first in Congress to touch on this particular phase of it and we are making a contribution. And I am very happy to know that you recognize it.

Mr. CHAPMAN. I fully agree with your remarks, sir, and I would like to illustrate them with an example or two.

From your long acquaintance with the California fisheries, you will realize that prior to the war we were not very far-ranging fishermen. We fished mostly the California coast and down along the Mexican coast and to some degree south of that.

The industry at the present time in California operates vessels steadily from southern British Columbia on the north in the Albacore fishery in which your fishermen participate to northern Chile where, I might say, your fishermen participate from time to time.

Mr. PELLY. You have been shot at a few times, I know.

Mr. CHAPMAN. We have been under great effort to prevent your people from being shot at just like ourselves in the area.

Now we operate down off northern Chile, I say, about 3,800 or 3,500 miles from San Diego. If you draw a 3,000-mile radius out into the Pacific based on San Diego, you encompass the whole of the Marquesas to Tuamotu, and the Hawaiian Islands and, as a matter

of fact, our vessels are quite able to range out that far and we have been prevented from doing so heretofore by our dependence upon bait fishing which kept us within 200 or 300 miles of the shore.

Now, however, we are changing over to purse seining, which liberates us from the coast, if you may use that term, and we are once more taking a close look at the far reaches of the Pacific which are within our mechanical range, if we can get them within our economic range, which we think we might be able to do. You cannot go out hunting for tuna generally on the ocean. You have to have a place where tuna are going to aggregate in commercial volume in order to cut down your cost of production where you can practically get the tuna on the table at the price the housewife will pay.

Not only are we engaging in exploratory expeditions in this broad area of the Pacific from time to time, but we have vessels at the present time fishing along the coast of west Africa from Mauritania on the north to Angola on the south.

One of our companies has exploration contracts with both the Government of Ghana and the Government of Nigeria. Another of our companies is establishing a cold storage facility at Sierra Leone in west Africa.

I say all of this to illustrate your point that the interests of our area are becoming substantially global. We are no longer interested primarily in our fishery relations with Mexico or the oceanographic data directly off Mexico. We are interested in the subtropical, tropical, and temperate oceans of the world and all of the political connections that go with that.

This is so in other countries. This committee has had before it, of course, the enormous expansion that is taking place in the Russian fisheries, which is bound to affect most of the fishery jurisdiction problems in the world. They plan to increase the take of fish of all nations on the high seas of the world by, let us say, 25 percent, within the period of the next 7 or 8 years and they are proceeding very efficiently and effectively in this program of doing so.

Sir, I had a very important statement to begin with and I have skipped around through it a good deal already, so that, if I may pick out some highlights from it and perhaps give for the record at a later time a more comprehensive and consistent statement, I would appreciate it.

Mr. MILLER. That would be fine, sir.

(The statement follows:)

STATEMENT OF W. M. CHAPMAN, DIRECTOR, THE RESOURCES COMMITTEE, SAN DIEGO, CALIF.

My name is W. M. Chapman. I am director of the Resources Committee with offices at the American Tunaboat Association, 1 Tuna Lane, San Diego, Calif. The Resources Committee is an organization whose primary purpose is to represent the common interests of canners, boatowners, and fishermen in the southern California fishing industry in respect of the law of the sea, ocean research, conservation, and like problems relating to the abundance and availability of the ocean resources we harvest.

We principally harvest tuna. Tunas are preeminently creatures of the open sea. Their eggs are extruded into the open sea and float freely in it prior to hatching. The young drift freely in the open sea until large enough to control their movements, and then spend the rest of their lives as pelagic migrants in the open sea. The relationship of tuna to land masses, while important to us fishermen, is casual to the tuna and is mainly related to the fact that the rub-

bing of currents against sea mounts, islands, and the continents creates conditions that result in increased production of tuna food.

The same sort of thing is found to a greater or less extent in the open sea a thousand or more miles from shore at the interfaces between any two currents. This produces turbulence, this turbulence results in greater production of food tuna like, where there is food tuna aggregate, and where tuna aggregate we fishermen try to be. Tuna are found in more or less commercial quantities in all seas of the world where the temperature is right irregardless of distance from land. This is generally from the thermocline to the surface in those seas commonly called temperate, subtropical and tropical.

The consumption of tuna has been increasing very sharply in the United States since the war, having tripled since 1947. Approximately the same thing has been going on in the other two principal tuna markets of the world (Japan and Europe). In the last few years tuna markets of consequential size have opened up and expanded in perhaps 20 other countries around the world. There does not appear at present any limit to this expansion on a worldwide basis. Large stocks of tuna which are yet untapped or barely tapped by commercial fisheries are known; the worldwide need for more low-cost high-protein food is so well known as to require no further elaboration.

Thus the trend in the tuna fishery of the world has been one of rapid expansion since the war and this will likely be the trend for some years into the future. The expansion of market has brought equivalent expansion in fishing areas both along the coast and on out to sea. From the experience of this expansion the big, expensive, highly mechanized long-range vessel has developed to be much the cheaper and more efficient in terms of cost per ton of production than the smaller coastal boat, despite the large initial capital cost of the former. This larger vessel has made distance from port or type of sea less important to the tuna fishermen than it used to be; fishing trips extending over several months and ranging 10,000 miles or more are not unusual.

The Japanese, having had the economic advantage over us in the past 10 years, have expanded most rapidly both geographically and productionwise. They now fish customarily in all suitable waters of the Pacific Ocean, Indian Ocean, and Atlantic Ocean. Their tuna fishery in the mid-Atlantic is only 4 years old but will produce about 85,000 tons of tuna this year. To illustrate how little distance means to tuna fishermen any more, some Japanese fisherman go to the Atlantic tuna grounds by crossing the Pacific from home and using the Panama Canal; others, with equal facility, go by way of Singapore, the Indian Ocean and Cape of Good Hope, and they may deliver a load of tuna in Italy and return home by way of the Mediterranean and the Suez Canal, fishing in the Indian Ocean on their return trip. The central Atlantic appears to the modern tuna fishermen to be rather a small enclosed sea. Once the long journey to get there is completed he moves back and forth across it in fishing with not much less trouble than the small coastal boats in a big bay.

By reason of extreme Japanese competition in our own markets we American tuna fishermen have been slowed and hampered in our similar geographic and production expansion. Nevertheless, we customarily fish the eastern Pacific Ocean from southern British Colombia to northern Chile, and in recent years our vessels have engaged in exploratory trips to the Juan Fernandez, Society, Tuomotu, Marquesas, Line, Phoenix, and Hawaiian Islands in the Pacific, throughout the Caribbean, and across the Atlantic to the west coast of Africa from Mauretania on the north to Angola on the south. Quite recent very sharp technological advances in our fishing methods have so lowered our cost per ton of production that we are not at all sure but what our rate of geographic and production expansion in the next 10 years may not begin to approach that which has been enjoyed by the Japanese tuna fishermen over the last 10 years.

These introductory comments have been made to illustrate that our interest in the study of the ocean is as broad as the ocean and practically as broad as the subject of oceanography. The whole trick in our business is to deliver tuna at a price which the housewife will pay against competing protein foods and to keep our cost of doing this with enough margin to pay our capital and operating costs and leave a reasonable margin of profit to the boatowners and earnings to the fishermen. More intensive study of the ocean may well contribute to our ability to do this on an increasing scale by giving us the knowledge needed to prevent us from overfishing any stocks of tuna we work (which would raise our cost per ton of production), enable us to locate and catch a load of tuna quicker (which would cut our cost per ton of production), and prevent foreign governments from harassing our vessels while normally plying their trade on the high seas (which would raise our cost per ton of production).

If you think that our view on ocean research is too dollar conscious we can only reply that this is our place in the scheme of things. Millions of tons of the finest protein food goes to waste each year in this protein hungry world by dieing, decaying, and returning to the food cycle of the sea unharvested and unused by man. It is the function of the commercial fisherman to get that food from the ocean onto the consumer's plate. This has to be done at a price the consumer will pay. It is a highly competitive, and a high-risk business. Thus the distant water commercial fisherman bends his every thought to costs. Ocean studies have the possibility of reducing his cost; if they do he can perform his function more fully and more efficiently. Therefore the commercial fisherman looks at ocean research from the standpoint of how it will reduce his costs most effectively and quickly.

CONSERVATION AND OVERFISHING

The general laws of population dynamics which govern and define conservation and overfishing have been worked out over the past 50 years. They are well known. In fact they were agreed upon by 82 nations at the First Geneva Conference on the Law of the Sea in 1958 and incorporated by them as the base of the Convention on High Seas Fishing and the Conservation of the Living Resources of the Sea. Advice and consent to the ratification of this treaty by the U.S. Government was given by the U.S. Senate this session of the Congress. It will provide the international charter for the management of the high seas fisheries of the world for our generation.

Generally speaking a stock of fish in the ocean is most abundant, and the average size of the individuals in it is largest, in a state of nature before any fishery starts upon it. Also it is at its most wasteful level then because none of it is being used by man. Natural mortality is killing off enough of the stock each year to keep its level in balance with the rest of the living environment associated with it. This natural mortality returns the excess population to the food chain of the ocean in which it circulates ad infinitum without serving any purpose for mankind.

As the fishery on this stock of fish begins two key things begin to happen: (*a*) The total abundance of fish in the stock begins to decrease; and (*b*) the average size of the individual fish in it decreases (because the average age of fish in the stock is decreasing). The third thing that is happening at the same time is that the stock of fish is becoming useful to mankind and the useful productivity of the stock increases as its abundance and average individual fish size decreases. One of the principal reasons for this is that some of the fish the fishery takes would have died naturally and been lost had they not been caught. Also the lowered abundance of the population makes more food left for the rest, which enhances their chance of survival and also it lessens the natural losses to predators, etc. The net effect of this is that as the fishery takes more fish from the stock, the stock continually increases its useful productivity, and also its resiliency to natural factors.

The relationships described above work only up to a certain point. Beyond this point the fishing mortality plus the remaining natural mortality begins to exceed the total productivity of the stock. At this point, and beyond it, the more the stock is fished the more the abundance continues to fall but so does the useful product, or catch. Thus the more you fish beyond this point of maximum sustainable productivity the less your catch comes to, the more your cost per ton of fishing increases, and the profit of the enterprise rapidly fades.

This is the point at which the nations are agreed that restrictive regulations shall be placed upon the fishery for that stock of fish—the point at which the stock of fish is producing its maximum sustainable annual crop of food or other product useful to man. It is the task of the marine fishery scientist to determine this point and for the conservationist to frame regulations which will prevent the fishery from exceeding that level of intensity.

All of this sounds straight forward and simple, but it is anything but that. To begin with there is no direct way of telling how many individual fish are in the stock of fish, like there is of counting cows in a pasture. The albacore tuna of the North Pacific (for instance) migrate widely and perhaps regularly across the entirety of that ocean. Albacore that are tagged off Mexico and southern California are caught off southern Japan. Other albacore that are tagged north of Hawaii are recaught both off southern Japan and southern California. They are impossible to count; the pasture is too large.

Since you cannot count the stock under your charge you have to estimate the count by indirection. One of the most useful tools to do this with is to tag a population of a certain size, turn those loose in the area and see what percentage of these get caught by the fishery. Another way is to compare the percentage of each year class present in the population. This will give an estimate of the total mortality. This will be related to both the fishery mortality and the natural mortality in a manner which you have to discover by other means. Another way is to assume that the catch per unit of effort bears a constant relationship to the size of the population, then by keeping track of the amount of fishing effort being used you can calculate the changes in the relative abundance of the fish stock and relate this to the amount of fishing effort and determine when the fishing is exceeding the point of maximum sustainable yield.

The trouble with all of these indirect methods of determining the size of your fish stock and the effect of the fishery upon it is that they are dependent upon a mathematical treatment of data derived from fish catches. The fish catch is dependent, however, on two different factors (leaving aside the skill of the fisherman and hoping that this is taken care of by averaging all the fishermen together). These two factors are the actual abundance of the fish in the stock and the availability of those fish to the fisherman.

In some kinds of fish, like the Pacific halibut, the availability factor does not change sharply from year to year and the scientist and conservationist is a lucky fellow. He can predict and regulate with some precision. In the tropical tunas, and a good many other kinds of fish, however, slight changes in the ocean currents, surface temperatures, etc. cause wide seasonal and yearly differences in the availability of fish to the fisherman that may be quite independent from the actual abundance of the fish in the stock. The scientist has to measure this factor too and be able to evaluate it in his abundance calculations. To do this he must become an oceanographer as well as a biologist.

This, incidentally, was the very way Dr. Schaefer, Director of the Inter-American Tropical Tuna Commission, who testified before you last week became such an eminent oceanographer. He and his staff are hired to find out the relation between our fishery and the stocks of yellowfin and skipjack tuna we fish, to determine these points of maximum sustainable catch, and see that we do not exceed that in our fishing. Very early in the game he found that availability related to changes in ocean climate was such a large factor in the catch rate for tropical tunas by the methods we used that he had to put in as much effort and time in evaluating what the ocean was doing as he did in evaluating changes in the fish abundance and the fishing activity.

All of this applies only to a homogeneous stock. Fish (as well as other animals and plants) have a tendency to break up into separate interbreeding stocks which inhabit adjacent geographic areas but do not mix much with each other. Each of these stocks present a separate problem of the kind noted above. As an example the Pacific halibut north and west of Cape Spencer, Alaska, mix very sparsely, if at all, with those south of that point along the coast of southeast Alaska, British Columbia, Washington, and Oregon. Yet the same fleets of fishing vessels fish both of these areas. It would do no good to regulate in one of these areas alone because the fleet would just shift to the other area and overfish the other quite independent stock.

The differentiation of these separate stocks within a fishery is never easy, has always taken a number of years to accomplish, and to the great discouragement of the scientists a sharp change in ocean climate for a few years may cause the stocks to intermingle for that period of years in a most confusing manner, and then separate out again in a subsequent climate cycle.

This highly oversimplified picture of the task of the fishery scientist and conservationist in the ocean fisheries has described the very simplest case, where the fishery operates on a single species of fish (or nearly so). Such cases are the menhaden fishery of the east and gulf coasts the halibut fishery of the northeast Pacific, or the pilchard fishery of South Africa. Unfortunately, however, many very important marine fisheries depend upon catching several species of fish at the same time in a mixed fishery.

Our fishery for tropical tunas is the simplest example of this sort of mixed fishery. We fish for yellowfin tuna and for skipjack tuna and for a number of years they were about equally important in our catches. Individual boatloads composed roughly half and half of the two species were more common than not (we catch a third species occasionally, too, the big-eye tuna but this is not sufficiently abundant in our fishing to be a problem to Dr. Schaefer). It

did not take Dr. Schaefer and his staff very long in this research to find out that the yellowfin and skipjack stocks were reacting in quite different ways to our fishery.

The yellowfin tended, in the size classes we caught, to school at the surface in some loose relationship with land masses either around islands, near sea mounts, or adjacent to the continent where upwelled water occurred. They tended to migrate north and south along the continents seasonally in a fairly regular manner. When they had been in our fishery for 2 or 3 years they settle down out of the upper layers of the ocean to just above the thermocline where they spent the rest of their years and were available for catch no longer by the bait boats that we used but by long lines like the Japanese used. Most importantly he had a long enough historical record of total catches and fishing effort to be able to plot with some assurance the affect of the fishery upon the abundance of the yellowfin stocks. He was able to demonstrate with some confidence that we were not overfishing yellowfin, had not been overfishing them, and even more important he was able to hazard a shrewd guess at the level of fishing intensity we could reach in the future without overfishing these stocks.

With skipjack he found each of these factors, as well as others, to be different from yellowfin. Skipjack tended to be the more open ocean fish with less tendency to congregate in relationship to land masses. They appeared to migrate to the fishery along the coast from the open Pacific to the west. They stayed in the area of our fishery for about 2 years also, mostly as juveniles, but moved in and off shore rather than up and down the coast. When as adults they disappeared from our fishery they did not settle down in the ocean to the thermocline where they could be caught by long lines. They just disappeared to the westward out into the open Pacific and were traced from this time on mostly by their numerous eggs and larvae that are to be found widely in the surface waters of the tropics at most seasons. Schaefer had as long a series of historical data for skipjack as for yellowfin catches emanating from the catch records of the same identical vessels. The catch per unit of effort for skipjack, however, did not change in any determinable way over this period of years although the catch had increased as it had for yellowfin. From this it could be said only that the stock of skipjack was so large in relation to the catch that the factor of natural variability was so much larger than the effect of the fishery on the abundance of the fish stock that it quite masked it.

Thus Schaefer with a two-species fishery had one species that would require regulation if the fishing intensity increased by about 50 percent and the other species was so abundant in relation to the amount being caught that he had not even any tentative guidelines as to how big catches it would stand. While it caused the financial ruin of many fishermen, the economic recession we had was a godsend to Schaefer and his staff. It gave them 10 years time to determine these factors before our fishery again began to expand.

There are other fisheries that are much more complicated than this, such as the trawl fisheries of the Pacific Northwest, of the New England area, and of the North Sea, which may have one or more principal species in them and several to a dozen or more quite important species, each of which react as differently to the fishery and the ocean climate as our yellowfin and skipjack do in our fishery. The scientific and conservation problems in such mixed fisheries become incredibly complex.

There are other important fisheries to which these rules and theories simply do not quite apply. An example is the shrimp fisheries of the South Atlantic States and the Gulf of Mexico. The principal species only live for about 15 months and can be considered annuals like a field of wheat. Also like a field of wheat what is left over and above that needed for seed at the end of the year simply dies and goes to waste. Here the problem of the ocean scientist and the conservationist is to determine the rate of growth and rate of mortality over the short life span to see at what point in the rapid growth curve the maximum weight of shrimp is available for the harvest.

Another class of fish problem is illustrated by the enormous fisheries for the herring, anchovy, sardine, pilchard, and similar fishes where long range cyclic changes in the climate of the ocean appear to have such enormous effects on the survival of successive year classes as to quite mask the effect of even quite huge fisheries upon the abundance of the stocks. Where the fish stock is so large as to not be affected by the fishery for a decade or two or three, subtle changes in the ocean climate which are not yet well understood although they have been studied elaborately for a long while, may so reduce the abundance of the stock of fish that after a few years it will hardly support a commercial fishery of

any sort for a decade, or two, or three. In the herring fishery of the Norwegian Sea (for instance), one of the most productive fisheries in the world, statistics are available going back to the 13th century illustrating that such long cyclic fluctuations have happened repeatedly and with some degree of regularity in that fishery.

This discourse has in every point vastly oversimplified the difficulty of solving the problems faced by the ocean fishery scientist and conservationist in the fisheries of the high seas, and even such an oversimplified discussion may lead you to believe that the problems are so complicated as to be incapable of solution.

And yet they must be solved, for amity among the family of nations depends upon their solution in a very real sense. Wars between the nations have been started over the yield of the marine fisheries in the past. Examples are the "herring" wars between the Dutch and English in the late Middle Ages. American colonial participation in the French-Indian wars drew New England support from the New England desire to establish themselves closer to the bank fisheries of the Nova Scotia coast.

It is hardly conceivable that war between nations could be started over the yield of sea fisheries today and yet this is one of the most active sources of discord among nations all around the world now, and this seems likely to increase as time goes forward.

One of the strongest strains in the NATO relationships has been the controversy that has raged for years between Iceland and England over the fisheries of the Icelandic Continental Shelf. A primary strain among our allies in the Far East is the apparently irreconcilable controversy over fisheries between Japan and Korea. In the Mediterranean area our allies Greece and Turkey quarrel continually over the fisheries of the eastern Aegean and northeast Mediterranean. In the Adriatic Sea the squabble over fisheries is a principal factor in keeping the diplomatic relations between Yugoslavia and Italy strained. In the Indian Ocean Ceylon and India have important high seas fishery rights in dispute. In southeast Asia our allies Thailand and Cambodia quarrel over the yield of the sea fisheries.

The adverse effects of fishery disputes upon the diplomatic relations of the United States is not confined to keeping peace among its allies, although I have only touched lightly upon these problems in the paragraph above. We have fishery diplomatic troubles of a serious nature of our own with Canada, with Mexico, with Chile, Ecuador and Peru, and with Japan.

All of these problems are intensifying by the months as the sea fisheries of the world are being expanded rapidly by the old fishing nations, and are being entered by one after another of the nations which never had a high sea fishery before. This is going on with great rapidity. Ten years ago Peru was not considered to be a fishing country. Today its fish catch is among the top five of the countries in the world. In that 10 years the fishery of Panama has come from nothing to being one of that country's principal sources of exports. In that 10-year period the yield of the tuna fisheries of the world has approximately doubled.

The magnitude of these great changes that are going forward in the high seas fisheries of the world is epitomized by the enormous expansion being made in the fisheries of Russia. Russia has already become either the second or third largest fish producer in the world. Her plans for the next 7 years envision her increasing the total fish production of the high seas of the world by 20 to 25 percent by her own efforts, and there is no reason to expect that she will not reach that goal. She is already conceded 20 percent of the Antarctic whale fishery. Her vessels have become important factors in the North Sea, Norwegian Sea, and Iceland fisheries. She has 200 big trawlers at work off the Grand Banks and in that vicinity. Her fleets now fish off Liberia, Ghana, and Nigeria in West Africa. A Russian gill netter trying the menhaden fishery recently off loaded a sick seaman for medical care at one of our eastern ports. Her trawling fleets are working off the coast of Alaska in eastern Bering Sea and her exploratory vessels have been seen in the Gulf of Alaska. Her tuna fishermen have been seen in the Trust Territories of the western tropical Pacific.

The upshot of all of these expansions in the high seas fisheries of the world is that one after another of these fisheries is going to become "mature," as we call fisheries that have reached the point of maximum sustainable yield. When this happens another problem arises. How is the quota which can be produced from each of these mature fisheries annually going to be divided among the fishermen not only who fish them now, but of those hungry nations who will want to fish them in the future? The resources of the high seas are not like

those of the land. They do not belong to anyone or to any country. They are the common property of all mankind. The only property rule which applies is that they belong to him who first reduces them to his possession.

The nations of the world have earnestly tried for 13 years to reach some general worldwide settlement of this problem. The International Law Commission has devoted a major part of seven of its annual sessions to this problem since 1947. The General Assembly of the United Nations has debated and considered it at several sessions during that time. It has been from time to time a major topic in meetings of NATO, which is supposed to be primarily an organization for mutual defense. It has long been a topic for discussion in the Organization of American States. A 45 nation conference under United Nations auspices was held on the subject in Rome in 1955; an 82 nation conference considered it in Geneva in 1958; an 88 nation conference considered it fruitlessly in Geneva in 1960.

The inevitable conclusion to be reached from these broad, very active and intensive international diplomatic efforts is that there is no general conclusion to this problem that can be reached by the international community at this time.

The problem is composed of two parts: (1) Shall the living resources of the sea be protected from overfishing so that each of them can produce its maximum sustainable harvest each year into the future, and (2) how shall this be done?

The first part of this problem was settled at the Rome Conference and confirmed at the First Geneva Conference. All nations were able to agree on the necessity and desirability for conservation, define it, and accept responsibility to see that their fishermen did not overfish these resources. A very good mechanism for insuring what should be done was adopted by a big majority at the First Geneva Conference.

The second part of the problem, how should the fish be divided among the nations, proved incapable of solution. This failed primarily because of ignorance. The fishing countries did not know enough about the ocean and the fish, and the relationship between the two and the fishing effort to give any broad assurance to the nonfishing countries that they knew how to frame proper conservation regulations, except in a few instances, such as our tuna fishery, the Pacific halibut, etc. Given this state of knowledge, the nonfishing countries in order to protect their joint ownership interests in the high seas resources wished to be able to extend their jurisdiction unilaterally out over the fisheries in the adjacent high seas at their will. Their contention was that only they could insure the protection of the fish resources from the rapacity of the foreign fishermen.

The fishing nations could not accept this solution on these main grounds:

(*a*) They needed the fish, too, to feed their populations and to protect their economies. Good examples of this among small countries were Greece, Portugal, Belgium, and the Netherlands. Good examples among big industrial nations were Japan, England, and Russia (for Russia has adamantly been against any controls by the coastal state over fisheries more than 12 miles from its coast except those necessary for conservation and jointly developed and agreed to by the fishing country and the coastal state).

(*b*) Granting preferential controls over high seas fisheries to the coastal state would give no assurance of proper conservation and might tend to defeat that objective because, by and large, what have come to be known as the coastal states have little or no scientific establishments competent to ferret out the facts required to undertake adequate conservation regulations in high seas fisheries. Good examples of this are the emergent nations of Africa, the new nations of southeast Asia, and almost all of the older nations of Latin America.

(*c*) For the coastal state to have the right to block off foreign fishermen from high seas resources that were not fully fished would merely increase the wastage of ocean resources and decrease the supply of protein food in the world.

(*d*) The principal problem in increasing the flow of food from the ocean up to this time at any rate has not been the prevention of overfishing, but decreasing the cost per ton of production (as noted below) so that consumers could afford to buy the product. Splitting up the ocean into spheres of influence or ownership by the nations would simply increase the cost of fish production by the most efficient producers, the large distant water vessels.

(*e*) As noted below, there seems to be no possibility of agreeing on a system of ownership of high seas resources that does no involve ownership of the ocean, and this would so interfere with the free use of the sea by vessels of all kind as to be quite inconsistent with the best interests of mankind or of even a simple majority of nations.

(*f*) There seems to be no general rule that can be adopted by the nations for the division of the resources of the sea on economic grounds because the economic needs and the economic systems of the several nations, and the groups of nations, at this time so diverse and distinctive that no agreeable common ground can be found.

Thus conservation of the living resources of the sea is a problem that can affect the ability of the resource to produce at its maximum sustainable level and that can and does bring discord among the nations. It can be solved only through scientific investigation. The research is expensive in terms of money, equipment, and highly trained personnel. Nevertheless 30-odd years of experience with International Fisheries Commissions properly staffed and funded show that these problems can be worked out one by one on the basis of research even though they cannot be solved in a general fashion by voting of a large group of sovereign nations.

What is needed is money for the research.

### DECREASING COSTS OF PRODUCTION

The world ocean is full of living resources which are going to waste for lack of harvesting. Enormous resources are untapped. For instance one of the main resources of our Pacific coast waters is hake, which is not fished steadily at all. One of the main resources of the North Atlantic is the ocean redfish, and this is sparsely fished.

Prior to the war it was generally stated that the main high seas resources were in the Northern Hemisphere and that the tropical seas were mostly barren. Events of the past 15 years show this to have been ignorance compounded by economic difficulties. Since then the great fisheries of South Africa have developed and the enormously expanded tuna fisheries of the tropical seas have only been exposing to view additional untapped food resources in those seas. In the brief period of 4 years the anchovy fishery of Peru has expanded from an annual production of practically nothing to over 2 million tons with a reasonable prediction that it can be doubled again without danger to the stock. Southeast Asia presents the classical example of people starving in the midst of plenty. The crowding populations of human rice and fish eaters go hungry surrounded by seas that pullulate with the fish they want and need.

While there are a lot of complex reasons why this is so the primary one is economic. If there are a group of consumers ashore who will eat fish (and a large share of the world's population are fisheaters by preference), and the ocean is full of fish, the problem is to get the fish out of the ocean at a cost that will put the product on a consumer's plate at a price he will and can pay and leave the fisherman enough pay so that he can buy the boat and equipment he needs and make better wages going to sea than he can by staying ashore. Hardly any man is fool enough to take the punishment of the sea life if he can make as good a living at home ashore with his family.

The picture of the small fisherman in a southwester going to sea in his dory waving goodby to his family standing at the door of their shack on the beach has become as old fashioned and outdated as the picture of a dirt farmer scratching his field with a steel tipped wood pole drawn by oxen. There are still millions of such dirt farmers in the world but each one of them does not produce much more food in a year than his family can eat. The big food producer is the farmer with the barn full of expensive machinery and three or four hired hands who are more mechanics than they are farmers. The reason for this revolution in land food production was the enormous expenditures for agricultural research in this century. Where this research has thrived and its results been applied food production has soared much faster than population and there is plenty; where this has not happened there is poverty, squalor and famine.

In the ocean fisheries the same thing is going forward but more slowly because the research base has not been built. But even now, although there are still millions of dory and canoe fishermen in the world, who, like the dirt farmers, can scarcely feed their own families by their efforts, the big food producers of the sea are the skippers whose vessels cost half a million to a million and a half apiece, who have modern electronic navigational and fish locating devices, whose powerplants are modern and efficient, and who can follow the fish rather than wait for them to come to him. These are the men who produce in volume at the cheapest cost per ton of product, and by doing so lower mankind's food bill.

These modern fishermen must be businessmen as well as seamen and to run their business their capital equipment must be harvesting fish every day. It cannot lay in harbor for weeks waiting for the weather to moderate; it cannot wait in the bay for the run of fish to come to it; it cannot scout the far reaches of the ocean for days or weeks looking for concentrations of fish. The skipper must know the place to which to run where he can load up his vessel the quickest, get back to port fastest, and repeat the process again with assurance. His cost per day goes on whether he is catching fish or not; these are so high that he must keep catching.

Fish are not spread evenly over the ocean. They concentrate in certain places at certain times, whether for food, to propagate, or to migrate between spawning and feeding places (which may be some hundred or thousands of miles apart). By and large these congregations, both as to place and time, are governed by the changing internal climate of the ocean and this in turn is related to the changing climate of the atmosphere above it.

If you would put the corn farmer of Iowa in the same place as the tuna fisherman of San Diego, his corn crop would ripen at one time in Alberta, at another time in Louisiana and at quite another time in northern Brazil. The appearance of the corn crop in these places would not only rotate among them seasonally but change from year to year in unfathomed ways. We have had the experience of having $10 million worth of tuna vessels churning the seas off Peru for a month fruitlessly awaiting the expected tuna crop that, it turned out, was showing up a thousand miles to the north.

Prior to the war we had a most generalized picture of the Pacific Ocean's circulation which was not much changed from that developed in the sailing boat days of the last century. There was a big clockwise movement of water in the North Pacific, an equally (and opposed) counterclockwise current in the South Pacific, both of which flowed easterly in the upper temperate zone, and westerly in the lower tropical zone. In between them, above the equator was a strong easterly flowing, narrower equatorial current.

Through the Office of Naval Research the Navy expanded its ocean research activities sharply in the postwar period, utilizing for this purpose in our area the Scripps Institution of Oceanography of the University of California (and latterly other organizations). We tuna people got on the bandwagon in and about 1950 by seeking the establishment of the Pacific Ocean fishery investigations of the Bureau of Commercial Fisheries centered on Honolulu, and the Inter American Tropical Tuna Commission centered on the eastern tropical and subtropical Pacific. Just previous to this we Californians had got established the California cooperative oceanic fisheries investigations centered on the sardine fishery of our temperate water latitudes; and a little later the salmon people instigated large ocean research activities in the North Pacific centered on the Asiatic and North American salmon runs.

By 1953 already we had a very unusual year in our tuna fishery off Peru and Ecuador. In that area of the world this condition occurred with enough regularity that it had been given a name. It was an "El Nino" year. But at the same time the POFI research boats working south across the equator found that the normally strong equatorial current had almost stopped flowing. Off California there was unusually dry weather, the ocean had warmed, and sardine production had gone from bad to worse. The year class of salmon that went to sea that year did not return to these northern streams 3 years later in the abundance that was expected from past history. The rather newly discovered jet stream of the high atmosphere layers, that Pan-American Airways was trying to learn to ride from Tokyo to Honolulu, disappeared for awhile.

From this assorted information the suspicion existed that the variations in ocean climate and circulation of the whole North Pacific and adjacent South Pacific were different aspects of one interdigitating whole and that all of the fisheries of the eastern Pacific were affected simultaneously by these changes. To investigate these things the Bureau of Commercial Fisheries established its Stanford Laboratory under Dr. Sette, who had been Chief at POFI in Honolulu.

Dr. Sette had only two sets of oceanwide data with which to work. These were the sea-surface temperatures and barometric pressures which cooperative ships at sea had been furnishing the Weather Bureau over the years. While the data were only of two sorts their quantity was staggering. The first shipment from the Weather Bureau consisted of 5 million separate observations. This has been followed by other shipments of a million or so observations. The task of making anything out of this welter of data 10 years ago would have been superhuman. Even today with the so-called electronic "brains" the task of

getting these data edited, programed for the machine, and put into shape to study has been formidable and time consuming.

This program had hardly gotten underway, however, before it began to profoundly affect the design and practice of fishery oceanography on this coast. These numerous data proved conclusively that what this science needed was time-space data; that is continuous or repeated observations of what was going on at one point in the ocean repeated simultaneously at numerous key points in the ocean.

This sort of thing could not be done from research boats at sea. In the first place getting enough data to be intelligible by this means would be prohibitively expensive. In the second place the research boat could not take observations at the same time at widely separated points in the ocean. During the time it took to stream from one point to another the mobile, flowing, ever-changing ocean was different. Tide gage stations and thermographs at points along shore were fine sources of such time series data, but there was so much upwelling along shore, and other parochial changes created by the friction of the ocean against the land, that the shore station didn't measure very well what was happening 20 miles (or 200 miles) at sea.

Accordingly, development was started on moored buoys that could be anchored far at sea in 2,500 fathoms of water and which would automatically and continually record a variety of oceanographic measurements, be reasonable in cost, and capable of being recovered, monitored, or read at monthly or 6-month intervals.

Such moored buoys have not had all the bugs worked out of them yet, but production models are obviously not too far away. This prospect has terrified the oceanographers almost more than the absence of data. When a dozen research ships bring in more data from the sea than can be assimilated in a year or two what will happen when 50 of these moored monsters begin turning out hourly readings of temperatures at 5 depths around the clock, 365 days a year, besides such other parameters as salinity, current, wind pressure, wind velocity, etc.?

It was the prospect of this in the near future which led to the oceanographer's requesting a national "memory" bank for oceanographic data of this sort, into which all such data can be fed automatically as it arrives, and from which an individual scientist can obtain a "read-out" of all data available on the point he is investigating and that he can, in turn, program through his electronic machines and manipulate so as to wring information out of them.

While this all may sound as if it is a good distance away from tuna fishing it is not. Sette had hardly gotten set up with his first 5 million cards before his successor at POFI, Murphy, who had been given the job of investigating the whereabouts of albacore tuna in the North Pacific after they left the seasonal fishing grounds, conceived the idea of doing this by comparing the geographic appearance of albacore as found by sightings and catches with sea surface temperatures. He began doing this by taking the daily observations for the whole north Pacific off the Weather Bureau's pipeline in Honolulu and plotting them up into monthly charts of isotherms.

This was, as far as he was concerned, simply a research tool and he was not too particular about how fast he got his monthly charts compiled but, as has become customary in Pacific Ocean research, when he did get a chart completed he sent copies of it around to all his colleagues. Very quickly two things became plain: (1) The ocean surface temperature had a pattern to it which was related to the appearance and aggregation of albacore, and (2) this ocean temperature pattern changed slowly so that one could predict reasonably well from the pattern of last month's isotherms, what their pattern would be next month, or even the month after, and thus have another tool with which to locate fish.

This research tool looked to have useful connotations for us fishermen. In the meantime other researchers had ascertained that about 90 percent of all albacore catches were made where the sea surface temperatures were between 58° and 69° F., with the median at 62° at the beginning of the season and sloping off to nearer 58° at the end of the season. I may say that similar studies indicate small skipjack catches in waters warmer than 83° F. and the same for yellowfin in waters warmer than 85° F.

Accordingly, we industry people asked the Bureau of Commercial Fisheries to develop this research tool into a fishing tool. Starting at the first of this year, its San Diego Laboratory began publishing these surface temperature charts for the northeast Pacific at each month end and distributing them to the trade. Now, additionally, they are publishing 2-week charts covering the albacore

grounds, albacore fishermen are using them, and albacore are appearing in the fishery on the proper isotherm.

Without belaboring this sea surface temperature thing too much I only wish to point out some timing. The Tuna Commission and POFI got underway in 1950; by 1953 it was noted that phenomena in the North Pacific were occurring in a connected manner; by 1955 surface temperatures looked like a useful research tool to help explain these happenings; by 1957 monthly surface isotherm charts for the North Pacific had been developed into a useful research tool; and in the spring of 1960 biweekly isotherm charts were already being used by the albacore fishermen in their business at sea.

One other example of the fast transition from basic science to applied science in our area concerns bottom topography. Marine geologists are enormously interested in the contours of the ocean bottom for a variety of reasons associated with how the earth was put together. With the increasing perfection of electronic gear, it became possible to draw continuously on a paper as the ship sailed a quite exact picture of the sea bottom underneath it and to accurately enough position the ship so as to have the component data for bottom topographer charts. From 1950 on, as ocean research vessels plying south of California became so equipped and their voyages more frequent, patterns of submarine valleys, mountain ranges, plateaus, scarps, sharp sea mounts, and all the other descriptive adjectives of the land began to appear.

What is a sea mount to a marine geologist is very apt to be a tuna bank to a tuna fisherman, if the temperature of the water and the ocean current in the area is right. This became sharply apparent in 1956 when one of these research vessels discovered a sea mount 100-odd miles west of our normal fishing area, a tuna biologist aboard (Belle Shimada) relayed this word by radio to the fleet, and one of our vessels (the *Notre Dame*) made a round trip to it bringing back a full load of tuna in 11 days out of port, a thing almost unheard of at that time (since that time this tiny point in the far open Pacific has yielded more than $15 million worth of tuna).

This happenstance threw us and the marine geologists together quickly. Dr. Menard, the geologist at Scripps, found that our skippers had a lot of tuna banks in the Eastern Pacific that he didn't know about and were sea mounts to him, he had a lot of sea mounts and ridges that we didn't know about and might be tuna banks to us. The trouble was that the whole business was in the line of being trade secrets. Our data were the trade secrets of the skipper that had it; his data were the trade secrets of the Navy which didn't want strange submarines to have submerged navigation points to navigate from without surfacing or sea mounts they could hide in the shadow of.

We got together some money for Dr. Menard to hire a cartographer with which to put all of this bottom data—classified or not—on charts. We wanted a series of 24 charts to cover the whole sea bottom from California to Chile and 1,000 miles to sea. If he would attend to getting the charts put together we would take the chance of being able to declassify the data on them from our skippers and the Navy.

The skippers gave in first and were willing to pool their data; the Navy came a little slower. In the meantime we ran out of money, but by this time the Bureau of Commercial Fisheries was able to pick up the cost of the cartographer. This spring the Navy got its classification problem squared away and could release the charts which contained its data. As a consequence the first two of these bottom topography (sea mount or tuna bank) charts have been published and distributed to the fleet, and we can expect one a month until the whole series is completed.

Thus within 6 years of the date that Shimada Bank was discovered we should have on each tuna vessel a reasonably complete set of charts of the bottom from Point Conception, Calif., to Iqueque, Chile, and a thousand miles to sea. In the meantime more research vessels with precise equipment are continuing to map the valleys and mountains of the Pacific floor, and we can expect to have these charts ready for revision in 3 or 4 years, together with charts of similar nature extending further to sea if we are then fishing there, which now becomes likely.

While there has been a very considerable increase in knowledge of the Eastern Pacific Ocean in the past 10 years, which have been illustrated by the above two examples of sea surface temperature and bottom topography and could be illustrated by other examples dealing with the production of basic food in the area, the intensive study of particular areas such as around a sea mount, around an oceanic island, or an area of seasonal upwelling such as in the Gulf of Tehuan-

tepec, the progress of these 10 years has really been in the nature of a reconnaisance, which has given us a better understanding of what we need to study. Despite the excellent work which is being done by the scientists of several institutions and agencies in a very well coordinated way and on a scale which 10 years ago would have looked large, we are only on the threshold of unlocking the secrets of the ocean which we can use to lower the cost per ton of catching tuna. Some of the problems ahead of us are these:

*1. Skipjack*

As noted above, skipjack are far the most abundant tuna not only in our area of ocean but probably in the world ocean. Yet they move out of the area of our fishery into the open Pacific when, or before, they are the most desirable size for canning. Where they go to is not known except that it is probably somewhere in the area between 5° and 30° N. latitude, and between the mainland and the Hawaiian Islands.

In this area, as big as the United States, they must congregate in catchable schools in relation to some oceanographic features such as along ocean "fronts," or at the interface between currents. But the detailed oceanography of the region is so poorly known that for a fisherman to sail blindly around in the area looking for concentrations of skipjack simply is not economically feasible. Yet within 10 years, certainly, the U.S. market will be requiring more tuna than the limited yellowfin resource will provide on a sustained yield basis.

*2. Bluefin*

Bluefin tuna occur even closer to home than do skipjack, and we know even less about them than we do about skipjack. In season they come in close to land in the area between Guadalupe Island (off northern Mexico) and the Channel Islands (off southern California). In some years considerable catches are made a stone's throw outside the coastal kelp beds.

Where they come from or to where they return no one knows. There is no reasonably accurate estimate of the size of the stock. That they do not spawn in the adjacent ocean is known from the very extensive plankton hauls the California cooperative fishery investigation has made over the past 10 years in the area of the fishery and far to sea both north, south, and west of that area. All we really know is that they show up and catches of 2,000 to 15,000 tons are made during the season, which may be short or stretch over several months.

*3. Ocean "fronts"*

Ocean "fronts" or "tide rips" are known to occur widely through the whole area of our fishery and far out to sea beyond that. In some places they occur with more frequency and consistency than others. One might say that some areas of the ocean are more "prone" to fronts than others.

Fronts are areas where there is sharp turbulence and temperature change across a narrow line that may be short or run unbroken over the horizon. The front may last minutes, or hours, or perhaps much longer. Along the turbulent front sealife gathers, the plankton brought in involuntarily by the currents and the larger animals, including tuna, congregate because of this; that is their food.

Fronts may very well be the secret of where the skipjack in our area congregate far out to sea. But as little is known about the occurrence and location of fronts as about the habits or whereabouts of the skipjack.

*4. Relation of tuna to water masses*

The Hawaiian Islands are at the edge of the normal mixing areas of two large water masses of somewhat different origin. There is a large gyral that swings down in clockwise manner from the western North Pacific extension of the Kuroshiwo. The rest of that current goes on across the ocean to hit the continent and then swing down south and out to sea again north of the equator as a broad slow-moving mass where it is known as the California current extension. When it reaches the longitude of the Hawaiian Islands its water is somewhat less saline than that of the western Pacific gyral, but not much. Also there are subtle but detectable differences in the temperatures of the two water masses.

The measurements that we use to tell these two water masses apart are so small and subtle that it scarcely is credible that the skipjack should be responding to those differences. Yet the big oceanic skipjack are mostly in the water mass of the California current extension and in years when that current is strong and comes into the Hawaiian Islands broadly the summer season skip-

jack fishing will be good and comprised substantially of the large oceanic skipjack. And when, contrarily, the western Pacific gyral is strong and presses the California current extension water away from the islands the summer skipjack catch will be small and composed largely of the juvenile-sized fish that we catch near the mainland.

Obviously much is to be learned about what it is in the water that the fish are measuring. We are not at all sure that we are measuring the same characteristics of the water that they are. We are averaging our measurements over broad areas of the ocean because we have so few. Obviously the fish are responding to the changes in the environment directly around it, not miles away, and they obviously are not responding to averages.

*5. Basic versus applied research*

It used to be that the basic researcher and his work was a thing apart from the fellow who was doing applied or engineering research. This was general in science. For instance, Faraday discovered the basic laws of motor and generator behavior early in the 1800's, but it was not until near the turn of the century that Edison made a practical application of these laws and built a central station to generate power for his electric lights. Contrarily the lagtime between basic and applied research in our time has become so short that 5 years after the Bell Telephone Laboratories discovered the amplification effect of semiconductor materials the application of transistors to communications circuits had become big business.

It is the same with the ocean sciences. We fishermen can hardly decide which is the most important to us, the study that is just framed to find out something about the ocean or the study that is designed to give us a useful tool in working on the ocean. As noted in the discussion of sea surface temperatures and bottom topography above, the time lag between discovery and application of ocean information has shrunk like a $10 suit in the rain. We are inclined to watch the ivory tower basic researcher more closely now than we do the applied researcher on the pretty well founded assumption that what the basic researcher is doing to satisfy his own curiosity today may very well revolutionize our industry 5 years from now.

And we feel, without exactly knowing how to prove it, that more emphasis should be put into this basic research on just how the ocean is put together and how it works. Our applied researchers and fishermen seem to be using up the reservoir of acquired knowledge of the ocean more rapidly than it is now being gathered, and basic ocean research is not expanding rapidly enough.

All in all, what is needed is money with which to do the research.

## STRATEGIC IMPLICATIONS OF OCEAN RESEARCH

There are a number of strategic implications of ocean research that top policymakers in the United States seem to have great difficulty in recognizing. Among these are:

*1. Law of the sea*

In two universal conferences at Geneva in 1958 and 1960 the basic position of the United States was to protect a narrow territorial sea preferably of 3 miles, certainly if no more than 6 in width. The basis of the U.S. position was defense. To give one of many excellent reasons for this position, the cost of maintaining naval control in the Bay of Bengal from our advance base at Guam under a 3-mile limit is some hundreds of millions of dollars cheaper than a 12-mile limit which would close the more direct straits through the Indonesian islands. It is perhaps a billion or two cheaper than if the Indonesian Archipelago theory is applied in international law thus requiring the creation and operation of an 8th U.S. Fleet in the Indian Ocean.

The arguments for a narrow territorial sea both for military and mercantile reasons are persuasive and overwhelmingly beneficial to the whole free world. Yet the United States has not been able to get this concept adopted into international law and the reason in each case has been the defection at voting time of firm allies which in some cases depend for their very national existence upon the naval power which their adverse vote was putting into jeopardy.

The reason for the adverse votes has been fish. While the countries know that the United States will defend them some way or another to protect itself they are not sure it will feed them and they need the fish to eat. It has been hard,

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so far in fact impossible, for our top diplomats to comprehend that the vote on such overpowering policy matters depends upon the fish vote.

It has been even more difficult to get across the point that these votes arise in large part from ignorance of ocean conditions. A perfect example is posed by the votes of Chile, Ecuador, and Peru that defeated us at Geneva in 1960. These countries do not know the status of the fish populations off their coast or the relations of variations in oceanic circulation to them. They do not have research establishments of their own to find these things out. Accordingly they feel that the safest way to safeguard their future food supply is to claim sovereignty over all the seas to a minimum distance of 200 miles from their coasts. Then with ownership of the resources they can protect them.

Yet to get the appropriations, modest though they are, with which to fund an adequate ocean research program in that area of ocean to dispel this ignorance and by so doing to ease this fear is quite impossible. The biggest factor leading to amity in the area has been the ocean research of the Inter-American Tropical Tuna Commission. Yet the same Department of State that is wringing its hands at the defeat in this spring's law of the sea conference (which was lost by the last minute defection of Ecuador) denied an increase of $14,000 in the 1961 budget for the Inter-American Tropical Tuna Commission which the Commission wanted to establish some research in Ecuador of the type Ecuador wanted for the resolution of this problem.

This is only one example out of very many. Each of these fish problems among our allies which has made it impossible to get the needed votes for a narrow territorial sea is based on fear for future food supply, a fear that can only be resolved or mitigated by ocean research to find out the facts.

*2. World food supply*

The press for protein food in the world is great, and will continue to increase. In Latin America and in southeast Asia it is already critical in areas of the world where high seas fishery resources are known to be large and efficient fisheries sparse.

Our foreign aid program in agriculture goes forward very effectively in a wide variety of countries; our foreign aid program in high seas fisheries is generally ineffective. One cannot help but feel that this is connected with the millions of dollars per year that this country has spent on agricultural research in this century, which has so revolutionized food production from the land, and the parsimonious appropriations for ocean food research—a condition that obtains to this date. The agriculturist from this country has something to teach the dirt farmer of India to increase the yield of his work. The fishery scientist does not have very much.

Yet every step taken in the United States to put ocean fishery research on a footing comparable with U.S. worldwide responsibilities has been opposed by the executive branch of the Government irregardless of the party in control. In recent years the original Saltonstall-Kennedy bill was opposed by the Executive. The reorganization of the U.S. Fish and Wildlife Service was opposed by the Executive. Because under these two acts money for ocean reseach had been slipped through the Bureau of the Budget's guard, it has since held down firmly an expansion of the Bureau of Commercial Fishery's regular budget needed to meet modern research conditions.

*3. U.S. food supply*

With the agricultural surpluses that plague the Government it is quite incomprehensible to the executive branch of the Government that the country's source of food from the sea is in any danger or that this should be any source of concern. Yet for the past 10 years one after the other of our major sea fisheries has gone downhill and the fish part of our national diet has become increasingly dependent upon the product of foreign fishermen. In the years 1955 through 1959 the value of edible fish imports increased from $208 million to $311 million whereas the export of such products only increase from $20,823,00 to $21,646,000. This movement is increasing. In 1959 the imports were about 15 percent higher in value than in 1958.

While the U.S. high seas fisheries have been permitted to molder and retrogress the other principal fishing countries of the world have bent every effort to increase the yield of their high seas fisheries. Examples are Japan, England, West Germany, and Russia among the highly industrialized countries. It seems a safe assumption that what is good for our friends and enemies alike might very well be good for us.

In another connection above I have mentioned the vast increase in the Russian high seas fisheries and their even greater plans for increasing those yields in the immediate future. Their ocean research is expanding hand-in-hand with their ocean food production in a way that is being matched by no other country in the world, including the United States. Their big ocean research vessels roam the world. They are doing more ocean research in the Indian Ocean than we are; they know more about the Canadian Continental Shelf in the Arctic than the Canadians do. Their fleets of vessels are accompanied by research vessels; their big independent trawlers, much larger than any U.S. fishing vessel, carry scientists along not only to do research but to advise in the fishing operation.

It would seem that sooner or later we should learn that the Russians in their scientific activities do not make many false moves, and that we could do worse than keep abreast of them. Khrushchev boasts about bringing his pork and beef production up to match that of the United States in a few years but he has spent millions upon millions in the last few years on ocean research and expansion of his high seas fisheries. In consequence he has already caught up with the United States as the second largest fishing nation of the world, and as our fisheries continue to decline his continue to advance steadily ahead at a rapid rate.

### NEED FOR GENERAL LEGISLATION

Most if not all of the Government witnesses that have come before you have said that there is no need for general legislation dealing with oceanography because their present enabling legislation is broad enough to enable them to do the things that the general legislation would authorize.

This is both true and untrue, but is a directed statement authorized to all hands by the Bureau of the Budget. It is true that the agencies have most of the authority to do the research authorized by the general oceanography legislation before your committee, but they do not have the money with which to initiate or carry forward the expanded ocean research programs called for by it. Furthermore they are unlikely to get those funds unless some such general legislation is enacted which clearly shows the present interest of the present Congress.

The great benefit of the National Academy of Sciences-National Research Council Committee on Oceanography grew out of the fact that its reports did not have to be cleared by the Bureau of the Budget. Accordingly a competent group of scientists well versed in the ocean needs of the United States and its worldwide responsibilities were able to put together a rational program of research which would attend to those responsibilities. Moreover, they were able to include cost estimates for each phase of the expanded research program and for the total.

In the executive agencies this is legally possible also, but in practice the Bureau of the Budget does not permit such a thing to happen. I know of quite good ocean research planning which has been done in the Government agencies, some of whom you have chided for their dereliction in not doing adequate forward planning. Before these plans emerge into the public eye the corners have been so rounded off by the Budget officers that the plans are generalized platitudes and the cost estimates have been eliminated. In consequence the Congress rails at the bureaucrats for not doing their work properly, the bureaucrats go back whipped to have another go at the budget officers, and the ocean research does not get started or done.

The plans of the NASCO Committee, and their cost estimates, were so competently done that they have already had a considerable effect upon the budget officers. So many people in the Congress, in the interested electorate, and in the executive agencies themselves have been impressed by the ability and general cohesion of this set of plans that the budget officers have loosened the purse strings this year without general legislation being passed. Each of the affected agencies except the Bureau of Commercial Fisheries has been given a substantial increase for their ocean research budgets for fiscal 1961.

This is another normal stratagem of budget officers. Rather than have authorization legislation passed that carries cost estimates that will be binding upon them as the will of Congress, they will loosen the purse strings enough to let the pressure behind the legislation escape. Once the pressure goes down they again tighten the purse strings. Having spent 10 disheartening years seeking to get an adequate ocean research program going in the eastern Pacific we have been through this process several times.

The costs of research at sea appear to landsmen to be extraordinarily high when compared with the same sort of research done ashore on land problems. This is true and inescapable. It costs the ocean scientist approximately $1,000 per day more than the land scientist just to have a platform (the ship) to stand

on to do his work. On top of this come all the comparable equipment, personnel and time costs that the land scientist has. But what happens is that the ocean scientist's appropriations go up on the same scale as those of the land scientist. Thus if he uses his money for ship time at sea he has no money left for laboratory work at home.

We run vessels of comparable size in comparable waters and are prepared to testify that ocean research vessels operating in this region operate at as good efficiency as can be wanted. If you want to learn about the sea you have to get out on it, and that costs money.

This country has the needs, the competent scientists, the able executive agencies, and a high degree of coordination in its ocean research planning and execution to enable it to do what is wanted on the sea. What is needed to get our ocean research on an adequate basis is money, and some time. We believe that the enactment of general oceanography legislation such as the committee has before it will expedite getting the money and this will cut down the time required to expand the country's present ocean research program.

While we do not wish in any way to deprecate space research we believe that mankind and the United States may be well served by having a good look at the bottom of the ocean before examining in detail the back side of the moon. We note that the Russians seem to think so, too. So far as we know they are the only country in the world whose fishery agency has a research submarine at sea working on commercial fishery problems.

Mr. CHAPMAN. I am, of course, W. M. Chapman of San Diego, Calif., director of The Resources Committee.

The people in our industry live by and on and from the ocean and are interested in all aspects of the medium in which we make our living. It is our responsibility under international law and practice not to overfish any of the resources that we work upon because these are the property of the international community and are in the public domain. This was where our first interest in ocean research really came to us—by the difficulties we had in ascertaining whether or not we were overfishing the resources on which we were working.

Directly after the war, several of the Latin American countries adopted a policy of a breadth of territorial sea extending to a minimum distance of 200 miles from their coast. They did so on the basis that the U.S. fishermen were overfishing the resources off their coast and endangering the future fishery resources of their countries. We were the fishermen they were talking about because we were the only U.S. fishermen in the area.

The United States could not tolerate a breadth of territorial sea like this because of its military and mercantile operations. Yet it could not tolerate being accused by its neighboring States of overfishing resources which were jointly owned.

The upshot of this was the establishment of the Inter-American Tropical Tuna Commission, whose director testified before you here last week.

While the situation which brought this about is an international political one, the problem had to be settled by scientific investigation, and Dr. Schaefer and his group of young scientists at the Inter-American Tropical Tuna Commission have done this. They have a sufficient understanding of the populations of tuna in the eastern Pacific and the effect of our fishing effort upon them to be able to state in a manner that is agreed to by all of the countries involved that there is no overfishing. Is the mechanism in the treaty establishing the Commission sufficient and adequate to prevent any overfishing when there is danger of that occurring in the future.

So that particular objective for which the Commission was established has been fulfilled and is being fulfilled.

Mr. MILLER. Doctor, could you, just for the record, tell us how the Commission is established? who sits on it? how many members are chosen?

Mr. CHAPMAN. The Commission is established under a convention between Costa Rica, Panama, and the United States. This is an open end convention to which any other country interested in the fishery can adhere upon notification to the signatory governments and their agreement.

My understanding is that Ecuador is now in the process of adhering to that treaty. Mexico, El Salvador, and Peru have shown a great deal of interest in adhering to it; and my guess is that in a year or two or three they probably will, because the benefits that have come from the research work of the Commission are becoming apparent to these other governments, also. And I think this is the thing that Mr. Pelly brought out that sometimes you cannot solve international political problems just by voting. You have to proceed on the basis of the acquisition of new knowledge to eliminate the subsidy problems with which you are dealing before you can have really something to vote sensibly upon in these international forums.

Here is a case where we could not and have not solved that international political problem, but it is being solved in spite of us by the generation of scientific information and the countries are getting together on a practical basis even though at Geneva they talked very bitterly against each other.

The work that Dr. Schaefer has done has led us over into many directions. To learn about the variations in the populations of fish which he was studying, he had to know more about the movements of ocean currents: he did not have appropriations or facilities sufficient to do this, so that this has led him to cooperate extensively with the Scripps Institution of Oceanography. The Office of Naval Research in particular, which does contract work with the Scripps Institution, had many of the same interests with regard to ocean circulation in that area of the world as did Dr. Schaefer in his specialized problems, so that they have joined in almost a cohesive program of work in the eastern Pacific Ocean which has been lately joined in by the Bureau of Commercial Fisheries in its specialized work on the tuna resources there.

There started off rather accidentally another organization which has contributed materially to our whole knowledge of Pacific oceanography. We in 1947–48, you will remember, were expanding very rapidly. The tuna market was expanding very rapidly and the Japanese production of tuna had not yet hit this market, so that our whole tuna industry along the coast was looking for possible new resources of tuna within their geographic reach. Therefore, your people in Washington and Oregon and California joined with those in Hawaii to seek through the Congress the establishment of the Pacific Oceanic Fisheries Commission of the Bureau of Commercial Fisheries based in Hawaii.

The results of this investigation again were quite unexpected and not along the line that we were seeking originally. They have not established any new fisheries out there although I would not say that their work would not in the future lead in that direction; but what they have found under Dr. Sette and various other administrators since is a great deal of knowledge about the manner in which

the upper 200 fathoms of the ocean in particular circulates. Whole new currents as big as major rivers have been discovered. The effects of these upon the total ocean circulation are still in the process of being elucidated. I believe, however, that, as major a contribution as this program has made to us has been not only the scientific information, the new concepts which were developed there, but the men who were trained there.

Dr. Sette and Mr. McKernan, Dr. Schaefer, Dr. Kask of Canada, and Mr. Murphy of the California Cooperative Sardine Investigation are all graduates of that school, you might say. They were trained while they were learning. Through that mechanism we have obtained a fine group of scientist administrators which we did not have 10 years ago and who are leaders in this field now.

The information which was brought forward by the investigations was not directly useful to us but it lead to the establishment of Dr. Sette's laboratory that I mentioned before at Stanford to further explore and elucidate the relationship between the weather, ocean, and fish production.

This has proceeded so very well. Ten years ago we did not have very much scientific knowledge about the eastern Pacific. We did not have trained people adequate to investigate the intricate problems involved. We did not have the ships or the institutions to sponsor and support and be used by these men. Now we have and our problem in these last few years has been budgetary as much as anything else—getting the funds with which to enable these scientists and institutions to properly engage in their work.

We ran into great difficulty in the Department of the Interior on this in 1954 and 1955, which all of you people will remember, and as a consequence, we joined with all the other fishing interests in the country in recommending to the Congress a reorganization of the way in which the Department of the Interior handled its fisheries responsibilities. This led to you people adopting the Fish and Wildlife Act of 1956, which reorganized completely this administration of commercial fisheries work and has been attended with great benefit as far as we are concerned.

The Bureau of Commercial Fisheries which was established under that legislation has gone forward in its work in a very fruitful, able, and effective manner so far as we are concerned, and I think that feeling is rather general around the fishing communities of the country.

The first thing that was done in our area was the establishment of a program in the Scripps Institution of Oceanography by contract with the Bureau of Commercial Fisheries on tuna research which was a broad basic study and a longrange one to determine what was the effect specifically in our fishing areas of the changes in ocean climate, you might call it, upon the biological productivity of the area—the productivity of the tuna, in particular, of the area—and the times and places at which the tuna would aggregate in maximum concentrations.

The aim of the work specifically was to result in lower cost per ton of production and, therefore, lower the cost of tuna to the consumer in the United States.

This work has been proceeding very effectively.

As the Bureau of Commercial Fisheries continued its reorganization, it established a project office in California and has now established last year a biological laboratory in San Diego which will serve as the focal point of the direction of its investigations in the whole eastern Pacific area, California and south.

What is needed now is money. The scientists in our area work very closely together. All of the organizations work very closely together. We have what is called the Eastern Pacific Oceanic Conference each year to which the oceanographers and tuna biologists from not only all of our institutions in this country but also the ones in the southern countries and through discussions and very informal activities, relate their programs together for the coming year and report upon what has been accomplished in the last year.

This is a very strong correlating mechanism. We have no duplication of effort as a result of that in that whole broad area of ocean from Peru north to British Columbia, and including the Japanese.

We find out through these yearly discussions not only what each other is doing, so that there will not be duplication, but also what loopholes of investigation are being left so that what spare money can be drummed up can be used to investigate these loopholes of investigation which nobody is gathering.

The Bureau of Commercial Fisheries in itself has developed a 10-year program of research which encompasses our research activities as well as those of the whole country. You people have not seen it yet but I am informed that it will be in your hands before the end of this session of Congress. I have had some contact with it and have reviewed it from time to time as it progressed and think that their program is a very well conceived one. But, here again, we are talking really in terms of getting more money to put flesh and blood on the skeleton organization which we have formed.

Our industry in itself has formed this Resources Committee that I mentioned a little while ago for the purpose of having all canners, all labor unions, and all boatowners associations connected with our industry have a focal point where they can aid in these programs of research.

Mr. Miller. Has labor joined with you?

Mr. Chapman. Yes. In fact, in my present guise today, I am representing the labor unions down in our area, also, insofar as these oceanographic programs of research are concerned.

The Resources Committee is intended really as a point where all of the people in the industry—the canners, boatowners, and labor—can lay aside our differences and come here and talk about our problems that we have in common; and these research problems are all of common interest to us.

Mr. Miller. I want to particularly bring that out because I am not unfamiliar with it and I think that the fishing industry has shown the way for cooperation between labor and management in trying to protect and advance the industry the benefit of all of them.

I know that they do have their very bitter squabbles, but when they are through they put these aside and then get down and do that which is good for the industry.

I think this has been carried on for some time, has it not?

Mr. CHAPMAN. Yes. We are very fortunate in having a very able leadership in our unions in California, our maritime unions, who have broad views. They will fight like dogs with us about the negotiation of a split in share between the fisherman and a boat-owner on a vessel or the price to be paid for the product by the canners. We have some of the liveliest fights, I think, of any place around the country; and then again, when this is all done, we can get together in another room and discuss in a very broadminded way all of these international law things, for instance, which plague us all jointly and equally, and all of these research matters which benefit us all equally and jointly.

Now, I think, sir, that that is about all I will bother you with this morning.

If I could have the privilege of giving a more coherent written statement for the record, and answer any questions there may be at the present time, I would appreciate it.

Mr. MILLER. Without objection, that will be ordered.

Mr. Bauer?

Mr. BAUER. With respect to the ocean survey and the resulting data center, Dr. Chapman, could you tell us how and with what accuracy one of your tuna vessels must be at a particular spot in the ocean?

Mr. CHAPMAN. Well, as an example, the Navigator Bank off the coast of Colombia is, I would judge, 200 miles from any point of land and I would judge a third of a mile across. This takes pretty precise navigation to find that and you do not want to waste your ship's time coasting around looking for it. This I only cite as an example. We have banks 200 miles north and also northwest of the Galapagos Islands that we go to customarily and the people head out from Panama and go to that bank. It is a thousand miles away. The navigational requirements are much more precise than apply to the normal merchant marine traffic.

Mr. BAUER. Has the classification of bathymetric data injured your industry in any fashion?

Mr. CHAPMAN. This perhaps is not the right way to express it. Perhaps it would be better to express it in terms that had we had the information which was classified, it would have strongly benefited us.

Let me give you an example of this. There is a professor at Scripps Institution who is a marine geologist who has been gathering bathymetric material for the whole of the eastern Pacific and doing some excellent research on the basis of it. We found out what he was doing because he was asking our tuna skippers for information on the location of their secret banks. When we found out what was going on, we undertook to get all the skippers on a confidential basis to release their information to this gentleman.

As a consequence of this, we found out that he had an awful lot of information also from naval records which we did not have and that he had been trying to get declassified for some period of years.

We cooperated with him fully in giving him all our data and then we could not even get that back because it was mixed up with classified data, and those of us who did not have adequate security clearance were not permitted to see it. I happened to have it. We set about getting this whole bathymetric material put together in chart form. We actually provided him with money to hire a cartographer

so that he could have the whole eastern Pacific charted bathymetrically, and we are going to extend this up the coast up to your area, Mr. Pelly.

We began going into the tropical area. We got the material all put on charts. We could not get the charts released because it contained some classified material and, furthermore, nobody knew what material was classified and what was not.

The lines of classification were not clear to anybody. In fact, we industry people took this up with Admiral Burke personally, and as a result of this and several other lines of activity, this information was released here about 3 months ago and the charts will start coming out in about a month, I am informed. This is only one example where classification of scientific information hampers the advancement of science and the industry dependent upon it.

Mr. BAUER. Under the present policies expressed in OPNAV Instruction 3160.6A of January 20, 1960—and may I put this in the record at this time?

Mr. MILLER. Without objection, so ordered.

(The document follows:)

DEPARTMENT OF THE NAVY

OFFICE OF THE CHIEF OF NAVAL OPERATIONS

WASHINGTON 25, D.C.

OPNAV INSTRUCTION 3160.6A

From: Chief of Naval Operations.

To: Distribution list.

Subject: Security Classification of Oceanic Soundings.

Ref: (*a*) OPNAVINST 3160.2B of 26 December 1957.
(*b*) U.S. Navy Regulations, article 0755.

1. *Purpose.* To promulgate policy concerning the security classification and release of oceanic soundings.

2. *Cancellation.* This instruction cancels OPNAVIST 3160.6 of 28 April 1959.

3. *Background.* A proper balance is required beetween the need to deny information to a potential enemy and the equally important need to make available the data required to insure our own scientific and technological advance. This instruction delineates which sounding information shall be classified.

4. *Policy.* The necessity of security classification for the collection and dissemination of oceanic sounding information shall be determined in accordance with the below criteria.

(*a*) Classification shall be as follows:

(1) All charts and collection sheets containing sounding information from ships where positioning was by LORAN C, or similarly precise electronic positioning systems, at line spacing less than 10 nautical miles shall be classified as directed by the Chief of Naval Operations (Op–03). All sounding information positioned by such a system shall be forwarded directly to the Hydrographer for plotting on master collection sheets. The Hydrographer will release as unclassified a sanitized collection sheet obtained from such parts of the above data as will not present fine grain information of less than 10-mile spacing between tracks.

(2) All sounding information collected at the direction of the Chief of Naval Operations by ships during surveys or other operations where the geographical position of ships or installations are classified shall be classified as specified by the Chief of Naval Operations (Op–03). Charts and collection sheets based on such information shall be classified accordingly.

(3) All Hydrographic Office charts reproduced from foreign charts with permission of that foreign government shall be classified in accordance with the wishes of the government concerned.

b. All other sounding information, charts, collection sheets, and other means of portraying ocean depths not specifically classified in paragraph 4a, above shall be unclassified. This includes but is not limited to sounding records, echo-

grams, collection sheets, small scale chartlets prepared for inclusion in scientific or technical papers, and similar sounding information where the method of position is by conventional navigational means such as piloting, navigation radar, celestial, LORAN A, or dead reckoning.

c. Sounding information, as well as visual observations and sonar contacts, indicating uncharted features which are dangers to navigation shall be unclassified. Reports of such features shall be sent to the Hydrographic Office by message and verified by mail. The verifying correspondence shall contain recorded sounding, plotted ship tracks and any additional information that will assist in positioning and evaluating the danger. The necessity of security classification for such correspondence will be determined in accordance with the preceding criteria.

5. *Action.* Commanding Officers of all Navy ships collecting information in accordance with directives issued by the Fleet and Force Commanders in response to reference (a), and all Navy Bureaus and Officers whose contractors obtain oceanic soundings will be governed by the foregoing policy. The Hydrographer will implement the necessary action to declassify data pursuant to paragraph 4.b. above. Upon request the unclassified information shall be made available to individuals and/or organizations. The expense involved in reproducing the data must be borne by the requestor.

WALLACE M. BEAKLEY,
*Deputy Chief of Naval Operations*
(Fleet Operations and Readiness).

Authenticated:

D. A. PAOLUCCI,
*Commander, U.S. Navy.*

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Mr. BAUER. Classification shall be as follows:

(1) All charts and collection sheets containing sounding information from ships where positioning was by Loran C, or similarly precise electronic positioning systems, at line spacing less than 10 nautical miles shall be classified as directed by the Chief of Naval Operations.

Can you live with this 10-nautical-mile grid?

Mr. CHAPMAN. It is better than we have. It is not as close as we need. We have to know where things are with much more preciseness than that, sir.

Mr. BAUER. Thank you, sir.

That is all I have.

Mr. MILLER. Mr. Pelly?

Mr. PELLY. I have no questions.

Mr. MILLER. Doctor, I want to thank you for coming here. We look forward to reading your more formal statement in the record and discussing not only the problems of your own industry but the effect that a broad picture of oceanography has upon not only this country but the world.

Mr. CHAPMAN. I appreciate being here, sir, and appreciate the tremendous activity this committee and subcommittee is undertaking in this respect.

You will remember the great economic travail we have been in here in the last 8 or 10 years in our industry.

We are getting in a good deal better health now and are likely not to be bothering you folks quite so much if things keep going as they are. One of the reasons for this is the research work that is going on in our area by this Scripps Institution, the Bureau of Commercial Fisheries, the Inter-American Tropical Tuna Commission, the Office of Naval Research, and so forth. We think that besides getting out from under our international problems by elucidation of these problems, we are very likely to get our costs per ton of production down to a level where we can compete with any fishermen in the world in this market and this, I will point out to you, results in a lower cost food to the American housewife.

Mr. MILLER. Thank you very much, Doctor.

Mr. Drewry, did you have any questions?

Mr. DREWRY. No.

Mr. BAUER. Before you adjourn, Mr. Chairman, the staff requests permission to insert in the record certain documents received during the hearing.

Mr. MILLER. Thank you.

So ordered.

(The documents follow:)

SHIPBUILDERS COUNCIL OF AMERICA,
*New York, N.Y., May 19, 1960.*

Hon. HERBERT C. BONNER,
*Chairman Committee on Merchant Marine and Fisheries,*
*House Office Building, Washington, D.C.*

DEAR CONGRESSMAN BONNER: It is understood that hearings are being held by the committee of which you are chairman, on H.R. 9361 entitled "To advance the marine sciences, to establish a comprehensive 10-year program of oceanographic research and surveys."

Early in 1959, before this bill was introduced, the council sent letters to several legislators including Congressman Miller, chairman of a special Subcommittee on Oceanography, Committee on Merchant Marine and Fisheries, endorsing the need for increased oceanographic research and study.

The council desires to go on record at this time as strongly supporting H.R. 9361.

It is noted that section 14 of H.R. 9361 covers authorizations for appropriations to the Department of the Navy for a 10-year program for a total of 24 ships of varying types as listed in section 14. It is suggested that the Navy be directed to have these ships constructed in private shipyards of the United States.

The incorporation of this letter in the record of the hearing will be greatly appreciated.

Sincerely yours,

L. R. SANFORD, *President.*

ATOMIC ENERGY COMMISSION,
*Washington, D.C., May 23, 1960.*

HON. HERBERT C. BONNER,
*Chairman Committee on Merchant Marine and Fisheries,*
*House of Representatives.*

DEAR MR. BONNER: By letter of May 13, 1960, there were forwarded to your committee the Atomic Energy Commission's comments on H.R. 9361 and H.R. 12018 in connection with current hearings on oceanographic research. I am attaching, herewith, further comments by the commission on the subject of these bills with the request that the enclosure, as well as our previous comments, be made a part of the hearing record.

Thank you for the opportunity to express our views.

Sincerely yours,

DWIGHT A. INK, *General Manager.*

STATEMENT OF THE U.S. ATOMIC ENERGY COMMISSION BEFORE THE HOUSE COMMITTEE ON MERCHANT MARINE AND FISHERIES ON H.R. 9361 AND H.R. 12018

I am pleased to be here today on behalf of the Atomic Energy Commission and for the opportunity to testify on H.R. 9361 and H.R. 12018. The Commission, as you know, has a deep interest in oceanography. The Atomic Energy Commission is one of four Federal agencies (the others are Navy, Interior, and NSF) that asked the National Academy of Sciences-National Research Council to establish a Committee on Oceanography to advise and assist these Government agencies with respect to their activities and interests in this field. We have established a close and valuable relationship with the Committee, and since its inception members of the Commission's staff have participated in development of certain aspects of the 10-year program recommended by the Committee. During the course of this working relationship, the AEC has implemented certain suggestions by the Academy Committee as they were developed.

In accordance with the Academy Committee's recommendation, the Commission is continuing its interest in those aspects of oceanography which are concerned with radioactivity. Research is underway to describe the immediate and ultimate fate of radioactive materials that may be intentionally disposed of or accidentally lost in the ocean. The projects now being supported include studies of (1) vertical and horizontal movements of oceanic, coastal, and estuarine waters as a distributive mechanism for radioactivity, (2) uptake by living organisms and cycling of radioactive elements through marine food webs, (3) rates of sinking and permanency of sedimentation of radionuclides, (4) mechanisms for estimation of residence time of abyssal waters as related to the physical decay of radioactive isotopes, (5) the direct and indirect effects of radioactivity on marine organisms, (6) mechanisms for reduction or dilution of possible centers of radioactivity in the ocean, and (7) other oceanographic factors related to the behavior of radioactive materials in the marine environment.

During the present fiscal year, the Commission's expenditures in oceanography will be approximately $1.8 million. In fiscal year 1961 we anticipate an increase in expenditures to about $2.2 million.

The programmatic requirements of anticipated developments in the utilization of atomic energy lead directly to a requirement for further information about the oceans. As the uses of nuclear energy expand in the ship propulsion field, in space vehicles, in nuclear aircraft and in the development of special energy sources, the demand for careful research to determine their relationship to world oceanic resources also increases. For example, in the development and testing of space vehicles which might include nuclear components, there will be a requirement to examine in some detail specific oceanic environments that would be involved in such programs.

The committee is, I am sure, already aware of the care with which the Commission has approached the problems of safety of operation of nuclear submarines, nuclear surface vessels, and the production of nuclear materials. In this regard I would like to refer to a report of the National Academy of Sciences/National Research Council entitled, "The Biological Effects of Atomic Radiation, Summary Reports 1960." On page 59 the report states, "to date, radioactive waste management operations have not resulted in any significant effect on the public, its environment or its natural resources." The Commission recognizes, as is reported by the NAS/NRC, that continuing monitoring programs must be maintained to assure that concentrations of radioactive material released to the environment do not become excessive.

In the same report, on page 62, we note the following statement. "The safety of these operations (that is, the disposal of solid packaged wastes into the ocean) has been supported by (1) the views of experts in the marine sciences and other related fields to whom the problem has been referred, (2) the actual operating experience of the British in disposing of considerably greater quantities of liquid radioactive wastes to the Irish Sea, and (3) the preliminary but direct information from actual field studies made in both Atlantic and Pacific Ocean disposal areas."

The Commission's comments on H.R. 9361 have been sent to this committee and we would suggest, for the committee's consideration, insertion of that letter into the record of this hearing. I would like to confirm the position taken in our letter, that although we believe that greater emphasis will be placed on oceanography in the AEC, we do not require statutory authority beyond the Atomic Energy Act of 1954 as revised to increase our effort in this field.

If, however, it is felt that legislation should be enacted, we are providing certain comments on that portion of the bill which has special application to the Commission's program. With respect to section 11 as a whole, we believe that it should be deleted since it grants no new authority to the Commission. We should like to note, however, that the Commission has particular concern with the proviso in section 11 because the language could be read as placing in the Coast and Geodetic Survey, the U.S. Public Health Service, or both, responsibility for regulating and monitoring the introduction of radioactive materials in the ocean. Under the Atomic Energy Act of 1954 the Commission already administers an extensive regulatory program covering the use and disposal of source, special nuclear and byproduct materials, including the disposal of such materials in the ocean. The language in the proviso therefore is inconsistent with the Commission's present authority and might result in an implied repeal of certain provisions of the Atomic Energy Act.

Monitoring activities are essential to the effective administration of the Commission's regulatory program. While we do not object, of course, to the Coast and Geodetic Survey and the U.S. Public Health Service continuing to conduct such monitoring activities as may be necessary to perform their responsibilities, it is of utmost importance to our regulatory program that the Commission's authority to monitor not be impaired. The fact is that the Commission has heretofore effectively cooperated with the Coast and Geodetic Survey and the U.S. Public Health Service in performing ocean studies, and we expect this relationship to continue.

In view of the foregoing we are recommending that section 11 of the bill be deleted entirely. If it should be concluded, however, that even though the authority provided by this bill merely duplicates that already conferred by the Atomic Energy Act, the Commission's role under the bill should be defined, we strongly recommend that the proviso clause of section 11 be eliminated.

With regard to the second bill, H.R. 12018, the Commission has participated in many discussions concerning the establishment of a National Oceanographic Data Center. We feel that there is need for such a center to provide access to and more efficient utilization of the large quantities of data being gathered by oceanographers under governmental and private funding arrangements. We feel that such a center should have an operating board to assist in meeting the data requirments of various private and public agencies. We are presently, however, a participating member of a planning committee of governmental agencies that feel that the Navy Hydrographic Office has the basic authority and expertese to carry out the activities involved, and that the data center should be established in that office. We would expect to assist in its operation and to have ready access to the data.

Again to repeat our written comments, we support the establishment of a National Oceanographic Data Center but feel that it might properly be established as an extension of the U.S. Navy Hydrographic Office.

Mr. MILLER. The subcommittee will adjourn, subject to the call of the Chair.

(Whereupon, at 11:30 a.m., the subcommittee adjourned, subject to the call of the chair.)

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