A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

NOAA Technical Report NMFS CIRC-355

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

CIRCULAR

Saltwater Recirculation System and Laboratory at the Exploratory Fishing and Gear Research Base, Pascagoula, Miss.

DONALD A. WICKHAM

SEATTLE, WA.
July 1971

National Marine Fisheries Service, Circulars

The major responsibilities of the National Marine Fisheries Service (NMFS) are to monitor and assess the abundance and geographic distribution of fishery resources, to understand and predict fluctuations in the quantity and distribution of these resources, and to establish levels for optimum use of the resources. NMFS is also charged with the development and implementation of policies for managing national fishing grounds, development and enforcement of domestic fisheries regulations, surveillance of foreign fishing off United States coastal waters, and the development and enforcement of international fishery agreements and policies. NMFS also assists the fishing industry through marketing service and economic analysis programs, and mortgage insurance and vessel construction subsidies. It collects, analyses, and publishes statistics on various phases of the industry.

The NOAA Technical Report NMFS CIRC series continues a series that has been in existence since 1941. The Circulars are technical publications of general interest intended to aid conservation and management. Publications that review in considerable detail and at a high technical level certain broad areas of research appear in this series. Technical papers originating in economics studies and from management investigations appear in the Circular series.

NOAA Technical Reports NMFS CIRC are available free in limited numbers to governmental agencies, both Federal and State. They are also available in exchange for other scientific and technical publications in the marine sciences. Individual copies may be obtained (unless otherwise noted) from NOAA Publications Section, Rockville, Md. 20852. Recent Circulars are:

315. Synopsis of biological data on the chum salmon, *Oncorhynchus keta* (Walbaum) 1792. By Richard G. Bakkala. March 1970, iii + 89 pp., 15 figs., 51 tables.

319. Bureau of Commercial Fisheries Great Lakes Fishery Laboratory, Ann Arbor, Michigan. By Bureau of Commercial Fisheries. March 1970, 8 pp., 7 figs.

330. EASTROPAC Atlas: Vols. 4, 2. Catalog No. I 49.4:330/(vol.) 11 vols. ($4.75 each). Available from the Superintendent of Documents, Washington, D.C. 20402.

331. Guidelines for the processing of hot-smoked chub. By H. L. Seagran, J. T. Graikoski, and J. A. Emerson. January 1970, iv + 23 pp., 8 figs., 2 tables.

332. Pacific hake. (12 articles by 20 authors.) March 1970, iii + 152 pp., 72 figs., 47 tables.

333. Recommended practices for vessel sanitation and fish handling. By Edgar W. Bowman and Alfred Larsen. March 1970, iv + 27 pp., 6 figs.

335. Progress report of the Bureau of Commercial Fisheries Center for Estuarine and Menhaden Research, Pesticide Field Station, Gulf Breeze, Fla., fiscal year 1969. By the Laboratory staff. August 1970, iii + 33 pp., 29 figs., 12 tables.

336. The northern fur seal. By Ralph C. Baker, Ford Wilke, and C. Howard Baltzo. April 1970, iii + 19 pp., 13 figs.

337. Program of Division of Economic Research, Bureau of Commerecial Fisheries, fiscal year 1969. By Division of Economic Research. April 1970, iii + 29 pp., 12 figs., 7 tables.

338. Bureau of Commercial Fisheries Biological Laboratory, Auke Bay, Alaska. By Bureau of Commercial Fisheries. June 1970, 8 pp., 6 figs.

339. Salmon research at Ice Harbor Dam. By Wesley J. Ebel. April 1970, 6 pp., 4 figs.

340. Bureau of Commercial Fisheries Technological Laboratory, Gloucester, Massachusetts. By Bureau of Commercial Fisheries. June 1970, 8 pp., 8 figs.

341. Report of the Bureau of Commercial Fisheries Biological Laboratory, Beaufort, N.C., for the fiscal year ending June 30, 1968. By the Laboratory staff. August 1970, iii + 24 pp., 11 figs., 16 tables.

342. Report of the Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida, fiscal year 1969. By the Laboratory staff. August 1970, iii + 22 pp., 20 figs., 8 tables.

343. Report of the Bureau of Commercial Fisheries Biological Laboratory, Galveston, Texas, fiscal year 1969. By the Laboratory staff. August 1970, iii + 39 pp., 28 figs., 9 tables.

344. Bureau of Commercial Fisheries Tropical Atlantic Biological Laboratory progress in research 1965-69, Miami, Florida. By Ann Weeks. October 1970, iv + 65 pp., 53 figs.

346. Sportsman's guide to handling, smoking, and preserving Great Lakes coho salmon. By Shearon Dudley, J. T. Graikoski, H. L. Seagran, and Paul M. Earl. September 1970, iii + 28 pp., 15 figs.

347. Synopsis of biological data on Pacific ocean perch, *Sebastodes alutus*. By Richard L. Major and Herbert H. Shippen. December 1970, iii + 38 pp., 31 figs., 11 tables.

Continued on inside back cover.

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator
NATIONAL MARINE FISHERIES SERVICE
Philip M. Roedel, Director

NOAA Technical Report NMFS CIRC-355

Saltwater Recirculation System and Laboratory at the Exploratory Fishing and Gear Research Base, Pascagoula, Miss.

DONALD A. WICKHAM

SEATTLE, WA.
July 1971

Saltwater Recirculation System and Laboratory at the Exploratory Fishing and Gear Research Base Pascagoula, Mississippi[1]

By

DONALD A. WICKHAM, Fishery Biologist
National Marine Fisheries Service
Exploratory Fishing and Gear Research Base
Pascagoula, Mississippi 39567

ABSTRACT

An approximately 10,000-gal capacity saltwater recirculation system and laboratory were built to conduct controlled behavioral studies of the responses of fish to harvesting gear. This facility consists of an 18-ft diameter by 4½-ft deep pool, a 4-ft deep by 15-ft long rectangular tank, and several water tables. Design compromises resulting from space limitations and construction of the laboratory in an existing one-story structure are discussed. Techniques using a commercial swimming pool diatomaceous-earth filter for removing iron precipitate from the subsurface salt water and particulate matter from the high salinity wedge river water used to supply the system are described. The system's components and operation are also briefly described.

A saltwater recirculation system and a laboratory were built at the National Marine Fisheries Service (NMFS) Exploratory Fishing and Gear Research Base, Pascagoula, Miss., in 1969. These facilities were erected to study controlled behavioral responses of fish to harvesting gear. This system and laboratory are described because the medium size (about 10,000 gal), moderate cost, and the approach to problems in design and operation may be of value to others.

Guidelines for the design were taken from Marvin and Wheeler (1961), Clark and Clark (1964), and Marvin and Proctor (1964).

The saltwater system and laboratory were built within a one-story concrete block structure adjacent to the net-storage shed at the Base's dock site on the Pascagoula River (Figure 1). Construction of a saltwater laboratory in the 800 ft^2 of floor space available required considerable design compromises. Space limitations prohibited the construction of large storage tanks used in most recirculation systems. Maximum utilization of available space was possible by designing a dual-capacity system — combining experimental pool and water reservoir.

Construction of the recirculation system on an existing ground level concrete slab prevented placing a sump below the experimental tanks; therefore, a modified sump was incorporated to permit isolation of the pool-reservoir during experiments. This sump was

[1] Contribution No. 213.

Figure 1.—Concrete block structure housing the seawater recirculation system and laboratory at the Exploratory Fishing and Gear Research Base's dock site on the Pascagoula River. One of the elevated filter boxes can be seen at the end of the building. The saltwater well is located beneath the filter box.

designed to function in hydrostatic pressure balance with the pool, and water flowed from the pool into the sump whenever a hydrostatic pressure imbalance was created by pumping water out of the sump.

A gravity-flow water delivery system was selected for use in the recirculation system. A head of hydrostatic pressure with sufficient water volume is essential to provide a continuous water flow for an effective gravity flow system. This condition was met by using elevated filter boxes which provided hydrostatic pressure and water volume with sufficient fall to ensure an acceptable gravity flow delivery. Filtration of the water, immediately preceding its return to the experimental tanks, was also considered advantageous.

Before the construction of the recirculation system, clean water from the Gulf of Mexico, for use in experimental tanks, was transported to the laboratory by the research vessel *George M. Bowers*. The complexity and cost of this operation prevented its continued use. Consequently, two alternate water sources, a saltwater well and a high-salinity wedge in the Pascagoula River, were used to supply the recirculation system.

Consultation with the U.S. Geological Survey led to the drilling of a well adjacent to the laboratory, and salt water was reached at a depth of about 90 ft. A polyvinyl chloride (PVC) casing and strainer were set in the drill hole, and a 2-hp stainless-steel impeller pump was used to raise the water.

Salt water from the well looked clear and suitable for use following initial flushing; however, after the water was exposed to air, a reddish-brown precipitate formed. Further testing revealed that the well water contained 15 ppm of iron, apparently in the form of soluble ferrous hydroxide, $Fe(OH)_2$, which, upon contact with the air, oxidized into insoluble ferric hydroxide, $Fe(OH)_3$.

Iron precipitate was successfully removed from the subsurface salt water by continuous aeration as it was recirculated through a commercial swimming-pool diatomaceous-earth filter. This filter contains seven 18- by 26½-inch filter grids of polypropylene and stainless steel with a total filtering surface of about 46 ft^2. The filter material was commercial grade diatomate. In less than 6 hr of recirculation, the filter reduced the iron content of 500 gal of salt water from 15 ppm to below 1 ppm. Removal of the iron precipitate reduced the hydrometer determined salinity from 29.7 ‰, its original value, to about 23.0 ‰. The diotomaceous-earth filter grids required cleaning after they had filtered three or four 500-gal batches of well water.

A wedge of high-salinity water (30 ‰ plus) was found to intrude along the bottom of the 40-ft deep Pascagoula River channel at the location of the saltwater laboratory. This source was also used to fill the recirculation system. A suction hose lowered into the wedge conveys this water into the laboratory where it is recirculated through the diatomaceous earth filter before the water enters the system's reservoir.

Figure 2 shows the floor plan of the laboratory. The combination experimental pool-water reservoir, at the center of the laboratory, is 18 ft in diameter and 4½ ft deep, and holds about 7,000 to 8,000 gal (the completely filled system contains about 10,000 gal). The side of the pool is of steel-reinforced concrete block filled with poured concrete, and the bottom of the pool is of poured concrete. A drain was constructed in the center of the pool floor for cleaning purposes. The pool was coated with "Damtite", a concrete sealer, to ensure a water-tight structure.

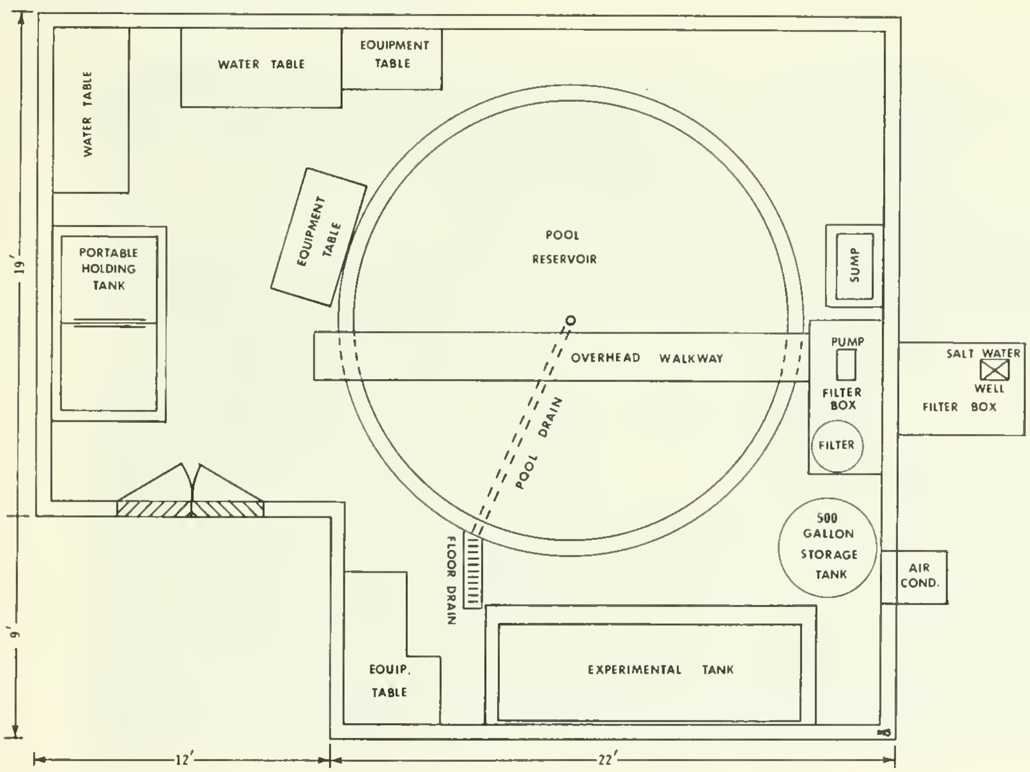

Figure 2.—Floor plan of the seawater laboratory at the Exploratory Fishing and Gear Research Base, Pascagoula, Miss.

A movable catwalk above the pool permits biologists to observe the behavior of fish in the pool and engineers to install or service apparatus mounted above the pool (Figure 3). The center of the acoustic tile ceiling was modified to provide head room above the catwalk.

The west wall is occupied by a rectangular experimental tank and equipment table (Figure 4). The tank is 4 ft wide, 4 ft deep, and 15 ft long. This tank was constructed of 1-inch plywood reinforced with polyester-resin bonded fiber glass and supported by external bracing.

The north section of the laboratory is occupied by two water tables used for aquariums and small experimental tanks (Figure 5). A 700-gal portable fiber glass tank is often placed in this area for holding live specimens.

The south wall of the laboratory is occupied by the recirculation system (Figure 6). Basic components of the recirculation system, the combination pool-reservoir (previously described), sump, filter boxes, pump and delivery systems, and various auxiliary components are illustrated schematically in Figure 7. The sump, constructed of poured concrete, is 2 by 3 ft and 4½ ft deep. Twin elevated filter boxes (one inside and the other outside the laboratory) were constructed of 1-inch thick plywood and are 3 ft wide, 2 ft deep, and 5 ft long.

A continuous duty 2-hp self-priming pump of 30 lb. working pressure is the heart of the recirculation system. This pump functions during the water cleaning with the diatomaceous-earth filter and the recirculating of water in the filled system. A standby pump is available for emergency.

Most parts in the recirculation system are either made of or coated with plastic to minimize maintenance and toxic materials.

The 2-inch piping and valves used throughout the recirculation system are polyvinyl chloride. Leaching of toxic materials into the recirculated water was inhibited by coating the pool, sump, and twin filter boxes with polyester resin. Pigmented polyester resin provided background colors used in the experimental pool (commercial pool paints should be avoided because most of them leach chemicals that are toxic to aquatic animals). The steel diatomaceous-earth filter is sealed inside by a heavy

Figure 3.—Movable catwalk above the experimental pool. The ceiling above the catwalk has been modified to provide head room. An elevated filter box is located at the far end of the catwalk.

Figure 4.—Experimental tank and equipment table at the west wall of the laboratory.

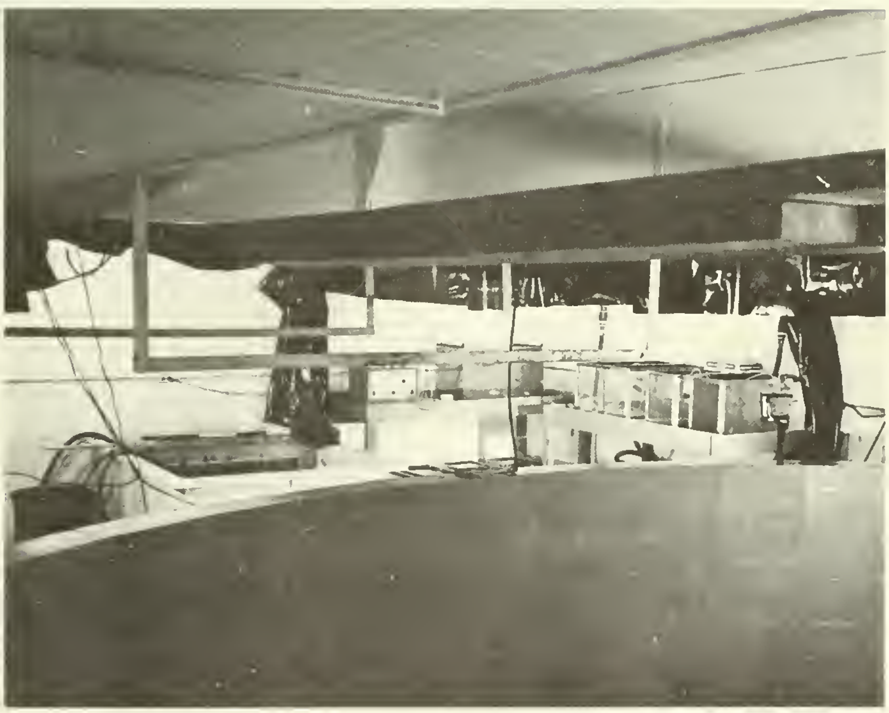

Figure 5.—Water tables for aquarium and a 700-gal fiber glass tank at the north section of the laboratory. The experimental pool and catwalk are in the foreground.

Figure 6.—A portion of the recirculation system occupying the south wall of the laboratory. The experimental pool, sump, pump, diatomaceous-earth filter, and 500-gal fiber glass tank are shown from left to right.

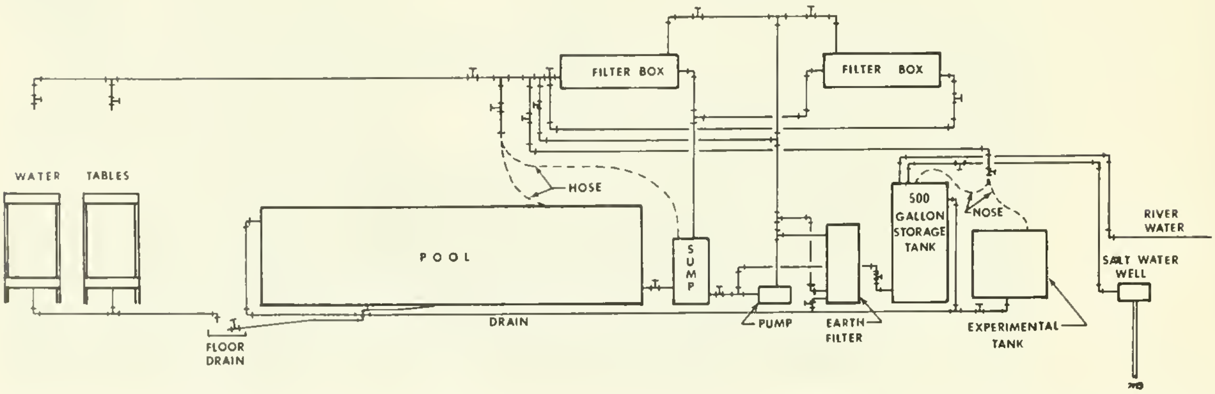

Figure 7.—Schematic illustration of the recirculation system. The pool-reservoir, sump, pump, filter boxes, and delivery system form the basic system. Auxiliary components are the diatomaceous-earth filter, 500-gal storage tank, water tables, experimental tank, and saltwater well.

layer of vinyl. The 500-gal storage tank is constructed of spun fiber glass.

An open floor drain, leading from the laboratory into a storm drain, is used for disposing water from the experimental tanks and water tables, and for emptying the pool-reservoir.

During experiments the pool and water tables are enclosed by opaque curtains that run on ceiling-mounted tracks.

Numerous grounded electrical outlets are located about the laboratory and along the raised ceiling above the catwalk. Fluorescent lights are mounted above the water tables and the rectangular experimental tank.

A reverse-cycle air-conditioning unit is used to maintain the laboratory and the recirculated water at a constant temperature.

Operation of the recirculation system can best be understood by following the water flow through its various components.

Water from either the saltwater well or from the high-salinity wedge is aereated by splashing into the 500-gal storage tank. When the tank is full, water is then pumped from the storage tank through the diatomaceous-earth filter and splashed back into the storage tank.

Upon completion of the cleaning procedure, each 500-gal batch of water is pumped up to a filter box from where it enters the pool- reservoir. Cleaning is repeated until the recirculation system is full. At that time, the storage tank and diatomaceous-earth filter are isolated from the basic recirculation system.

Water in the recirculation system flows from the pool into the sump as the hydrostatic pressure balance between these two components is disrupted following the pumping of water out of the sump. Water from the sump is pumped up to an elevated filter box (only one filter box is used at a time) where it is aereated by splashing onto the oyster-shell filter material. Crushed oyster shells were used for reconditioning the salt water. A concise discussion of water reconditioning and the function of oyster shells is given by Burrows and Combs (1968). Water percolating through the crushed shells is collected by perforated pipes, in the bottom of the filter box, which lead into the distribution system. The water is then returned to the pool-reservoir, or directed to the experimental tanks, or to the water tables. During experiments the pool can be isolated from the recirculation system by directing water into the sump and closing the connecting line between pool and sump.

The delivery rate of the gravity flow system was limited primarily by the percolation rate through the filter. A maximum flow rate, estimated at about 20 gal/min, was obtained when full hydrostatic pressure in the filter boxes was maintained by continuous overflowing excess water back into the sump.

The recirculation system described has functioned satisfactorily, within its limitations, and has proved adequate for maintaining a modest saltwater experimental facility.

ACKNOWLEDGMENTS

Brandy Siebenaler (Gulfarium, Ft. Walton Beach, Fl.) helped solve some of the problems encountered in the design and operation of the system. Kenneth Marvin (NMFS Biological Laboratory, Galveston, Texas) suggested the use of crushed oyster shells as a filter medium. Personnel of the NMFS Technological Laboratory, Pascagoula, Miss., tested water samples from the recirculation system and saltwater well. Special thanks are due Edward F. Klima (NMFS Exploratory Fishing and Gear Research Base, Pascagoula, Miss.) for his encouragement and assistance during construction of the saltwater laboratory.

LITERATURE CITED

BURROWS, R. E., and B. D. COMBS.
1968. Controlled environments for salmon propagation. Progr. Fish-Cult., 30: 123-136.

CLARK, J. R., and L. CLARK (Editors).
1964. Sea-water systems for experimental aquariums. A collection of papers. U.S. Fish Wildl. Serv., Res. Rep. 63, 192 p.

MARVIN, K. T., and R. R. PROCTOR, JR.
1965. Description of salt-water laboratories. *In* Biological Laboratory, Galveston, Texas, fishery research for the year ending June 30, 1964. U.S. Fish Wildl. Serv., Circ. 230, p. 94-102.

MARVIN, K. T., and R. S. WHEELER.
1961. Sea-water system. *In* Galveston Biological Laboratory, fishery research for the year ending June 30, 1961. U.S. Fish Wildl. Serv., Circ. 129, p. 68-71.

GPO 998-779

349. Use of abstracts and summaries as communication devices in technical articles. By F. Bruce Sanford. February 1971, iii + 11 pp., 1 fig.

350. Research in fiscal year 1969 at the Bureau of Commercial Fisheries Biological Laboratory, Beaufort, N.C. By the Laboratory staff. November 1970, ii + 49 pp., 21 figs., 17 tables.

351. Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base, Pascagoula, Mississippi, July 1, 1967 to June 30, 1969. By Harvey R. Bullis, Jr., and John R. Thompson. November 1970, iv + 29 pp., 29 figs., 1 table.

352. Upstream passage of anadromous fish through navigation locks and use of the stream for spawning and nursery habitat, Cape Fear River, N.C., 1962-66. By Paul R. Nichols and Darrell E. Louder. October 1970, iv + 12 pp., 9 figs., 4 tables.

356. Floating laboratory for study of aquatic organisms and their environment. By George R. Snyder, Theodore H. Blahm, and Robert J. McConnell. May 1971, iii + 16 pp., 11 figs.

361. Regional and other related aspects of shellfish consumption — some preliminary findings from the 1969 Consumer Panel Survey. By Morton M. Miller and Darrel A. Nash. June 1971, iv + 18 pp., 19 figs., 3 tables, 10 apps.

UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SCIENTIFIC PUBLICATIONS STAFF
BLDG. 67, NAVAL SUPPORT ACTIVITY
SEATTLE, WASHINGTON 98115

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE

U.S.MAIL

PERIODICALS LIBRARIAN C
MARINE BIOLOGY LABORATORY
LIBRARY
WOODS HOLE, MA 02543