A UNITED STATES
DEPARTMENT OF
COMMERCE
PUBLICATION

NOAA Technical Report NMFS SSRF-654

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

An Electric Detector System for Recovering Internally Tagged Menhaden, Genus *Brevoortia*

R. O. PARKER, JR.

SEATTLE, WA
February 1972

NOAA TECHNICAL REPORTS

National Marine Fisheries Service, Special Scientific Report--Fisheries Series

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, analyzes, and publishes statistics on various phases of the industry.

The Special Scientific Report—Fisheries series was established in 1949. The series carries reports on scientific investigations that document long-term continuing programs of NMFS, or intensive scientific reports on studies of restricted scope. The reports may deal with applied fishery problems. The series is also used as a medium for the publication of bibliographies of a specialized scientific nature.

NOAA Technical Reports NMFS SSRF 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 SSRF's are:

604. The flora and fauna of a basin in central Florida Bay. By J. Harold Hudson, Donald M. Allen, and T. J. Costello. May 1970, iii + 14 pp., 2 figs., 1 table.

605. Contributions to the life histories of several penaeid shrimps (Penaeidae) along the south Atlantic Coast of the United States. By William W. Anderson. May 1970, iii + 24 pp., 15 figs., 12 tables.

606. Annotated references on the Pacific saury, *Cololabis saira*. By Steven E. Hughes. June 1970, iii + 12 pp.

607. Studies on continuous transmission frequency modulated sonar. Edited by Frank J. Hester. June 1970, iii + 26 pp. 1st paper, Sonar target classification experiments with a continuous-transmission Doppler sonar, by Frank J. Hester, pp. 1-20, 14 figs., 4 tables; 2d paper, Acoustic target strength of several species of fish, by H. W. Volberg, pp. 21-26, 10 figs.

608. Preliminary designs of traveling screens to collect juvenile fish. July 1970, v + 15 pp. 1st paper, Traveling screens for collection of juvenile salmon (models I and II), by Daniel W. Bates and John G. Vanderwalker, pp. 1-5, 6 figs., 1 table; 2d paper, Design and operation of a cantilevered traveling fish screen (model V), by Daniel W. Bates, Ernest W. Murphey, and Earl F. Prentice, 10 figs., 1 table.

609. Annotated bibliography of zooplankton sampling devices. By Jack W. Jossi. July 1970, iii + 90 pp.

610. Limnological study of lower Columbia River, 1967-68. By Shirley M. Clark and George R. Snyder. July 1970, iii + 14 pp., 15 figs., 11 tables.

611. Laboratory tests of an electrical barrier for controlling predation by northern squawfish. By Galen H. Maxfield, Robert H. Lander, and Charles D. Volz. July 1970, iii + 8 pp., 4 figs., 5 tables.

612. The Trade Wind Zone Oceanography Pilot Study. Part VIII: Sea-level meteorological properties and heat exchange processes, July 1963 to June 1965. By Gunter R. Seckel. June 1970, iv + 129 pp., 6 figs., 8 tables.

613. Sea-bottom photographs and macrobenthos collections from the Continental Shelf off Massachusetts. By Roland L. Wigley and Roger B. Theroux. August 1970, iii + 12 pp., 8 figs., 2 tables.

614. A sled-mounted suction sampler for benthic organisms. By Donald M. Allen and J. Harold Hudson. August 1970, iii + 5 pp., 5 figs., 1 table.

615. Distribution of fishing effort and catches of skipjack tuna, *Katsuwonus pelamis*, in Hawaiian waters, by quarters of the year, 1948-65. By Richard N. Uchida. June 1970, iv + 37 pp., 6 figs., 22 tables.

616. Effect of quality of the spawning bed on growth and development of pink salmon embryos and alevins. By Ralph A. Wells and William J. McNeil. August 1970, iii + 6 pp., 4 tables.

617. Fur seal investigations, 1968. By NMFS, Marine Mammal Biological Laboratory. December 1970, iii + 69 pp., 68 tables.

618. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River Basin - past and present. By Leonard A. Fulton. December 1970, iii + 37 pp., 6 figs., 11 maps, 9 tables.

619. Macrozooplankton and small nekton in the coastal waters off Vancouver Island (Canada) and Washington, spring and fall of 1963. By Donald S. Day, January 1971, iii + 94 pp., 19 figs., 13 tables.

620. The Trade Wind Zone Oceanography Pilot Study. Part IX: The sea-level wind field and wind stress values, July 1963 to June 1965. By Gunter R. Seckel. June 1970, iii + 66 pp., 5 figs.

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 SSRF-654

An Electric Detector System for Recovering Internally Tagged Menhaden, Genus *Brevoortia*

R. O. PARKER, JR.

SEATTLE, WA.
February 1972

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price 25 cents

CONTENTS

An Electronic Detector System for Recovering Internally Tagged Menhaden, Genus *Brevoortia*

By

R. O. PARKER, JR., Fishery Biologist
National Marine Fisheries Service
Atlantic Estuarine Fisheries Center
Beaufort, North Carolina 28516

ABSTRACT

Operation and results are described of an electronic detector-recovery system for fish with internal ferromagnetic tags. The system does not interfere with the operation of fish reduction plants. Date and location of recapture can be obtained since tagged fish are detected and recovered as they are landed. Growth rates of 3.1 and 7.2 mm per month were obtained for two menhaden out 130 and 483 days. Scale analyses supported annulus formation assumption. The best location for tag injection in adult menhaden appears to be about 13 mm above and just forward of the origin of the pelvic fin. Tag incisions were healed in 85% of the fish recaptured after 10 days.

INTRODUCTION

In most fish tagging studies the recovery of the tagged fish is desirable. Tags recovered by magnets in scrap conveyors in all menhaden reduction plants along the Atlantic and Gulf coasts of the United States are providing adequate information on migration patterns and mortality rates (Dryfoos, Cheek, and Kroger[1]). Tagged fish recoveries, however, in addition to providing the above information, permit the determination of: growth rates, validity of aging techniques, best tag injection location, and time for tag incisions to heal.

The isolation of tagged fish from millions of fish being processed has presented difficulties to many investigators. Mechanical means of catching, handling, and processing large quantities of menhaden and other industrial fish makes visual detection and recovery of marked fish impractical. Photoelectric detection of marked menhaden was unsuccessfully attempted by Reintjes (1963). Dahlgren (1936) was the first to develop a successful detector-recovery system for fish with metal body cavity tags. The system was improved by Hart and Tester (1937).

Our detector-recovery system was developed to recover menhaden tagged with a 14-mm internal ferromagnetic tag or the 1-mm Bergman-Jefferts[2] microwire tag (Jefferts, Bergman, and Fiscus, 1963). The microwire tag could not be detected at menhaden plants because of the interference of machinery. These tags, unlike our larger tags, cannot be easily distinguished from the other metal recovered on magnets. Consequently, attempts to use the microwire tag for menhaden were discontinued.

---

[1] Dryfoos, R. L., R. P. Cheek, and R. L. Kroger. Atlantic menhaden tagging studies, 1966-1969. Unpublished manuscript. National Marine Fisheries Service, Atlantic Estuarine Fisheries Center, Beaufort, N.C. 28516.

[2] The mention of trade names in this publication does not imply endorsement by the National Marine Fisheries Service.

DESCRIPTION OF THE SYSTEM

The electronic detector-recovery system is installed between the dock and processing plant (Fig. 1). Fish being unloaded are transferred from boat to plant by a dragline or screw conveyor. In the conveyor of a small menhaden reduction plant in Beaufort, N.C., we have installed a trap door which when open allows fish to slide down a transfer chute onto a conveyor belt. The belt is made of 8 mm rubber, 41 cm wide and 8.2 m long, and runs at a rate of 2.1 m/sec through a magnetic shield which houses a detector head. The shield, 107 × 56 × 41 cm, is made of iron-nickel alloy which reduces extraneous magnetic fields that interfere with the operation of the detector. The Jefferts detector senses minute currents created by the magnetic fields of stainless steel tags, 14 × 3 × 0.5 mm, in fish. The electronic unit has a sensitivity adjustment that can be set for different sizes of magnetic tags (Fig. 1E). When a tag is detected, an audio and electrical impulse is produced. The impulse triggers an interphase unit which activates a pneumatic gate on the side of the belt conveyor system. Time delay adjustments for closing and opening the gate are built into the interphase unit (Fig. 1F). The gate is hinged to close across the belt at an angle, forcing the marked fish off the belt into a tub (Fig. 2). If the gate is not activated, unmarked fish are carried by the belt into a screw conveyor and back to the plant's conveyor system. The detector-recovery system does not interfere with the plant's operation. Since some unmarked fish are collected with the marked ones, it is necessary to recycle the collected fish individually to isolate the tagged fish. The proportion of unmarked fish that must be recycled has been considerably reduced in our two-phase electronic detector-recovery system built at a larger menhaden reduction plant. This system consists of two sequential detector-recovery operations in which the second phase thins out most of the untagged fish (Fig. 3). Since one-half of this system is used only when a tagged fish is detected, recoveries can be recycled through this half during the actual recovery operation. The double system costs less than $14,000 including conveyors, compressor, construction, and electronics; this is about twice the cost of the single system (Appendix). However, it searches nearly twice the number of fish per hour and is nearly twice as efficient in recovering tagged fish. Thus, a cost analysis favors the double system.

OPERATIONAL PROBLEMS

Several problems were encountered when we began using the electronic detector-recovery system. False detections caused by moving metal equipment and vibrations were eliminated by shielding and isolating the detector head. Small tagged fish sometimes wedge under the closing gate and unless they are quickly removed, they are lost to the screw conveyor. This loss was reduced in our later detector-recovery system by changing the type of belt lacing from a thick diagonal splice to a thin horizontal splice and by using a one-piece metallic gate assembly insert. These changes permitted a close level sweep of the gate over the conveyor belt. Another problem, overloading belts or screw conveyors, and thus stopping the units, was resolved by using higher amperage fuses.

Tests indicate that the efficiency of recovering tagged fish of the single detector-recovery installation is 36% and that of the double installation is 60%. The single installation can convey all of the catch at a small processing plant or 13 tons per hour. The double installation can convey a fourth of the catch at a conventional menhaden plant or about 22 tons per hour. Most of the losses of tagged fish in our system occur after large quantities of menhaden enter our conveyor: detection occurs and the gate closes for an instant, but as the fish are about to be deflected, a pileup occurs. This often holds back the tagged fish or causes it to flip over the gate. In both instances it is not recovered. Although up to 64% of the tagged fish entering our detector installations are missed, most of the tags are eventually recovered on magnets in the plants.

The electronic detector-recovery system was to play an additional role on the Gulf coast to that on the Atlantic coast because methods of fishing are not the same. Atlantic menhaden fishermen normally return to port daily after fishing over a small geographical area, and their catch is usually processed immediately. Thus, thousands of tags recovered by magnets are providing reliable data for estimating population parameters in the Atlantic. Gulf of Mexico

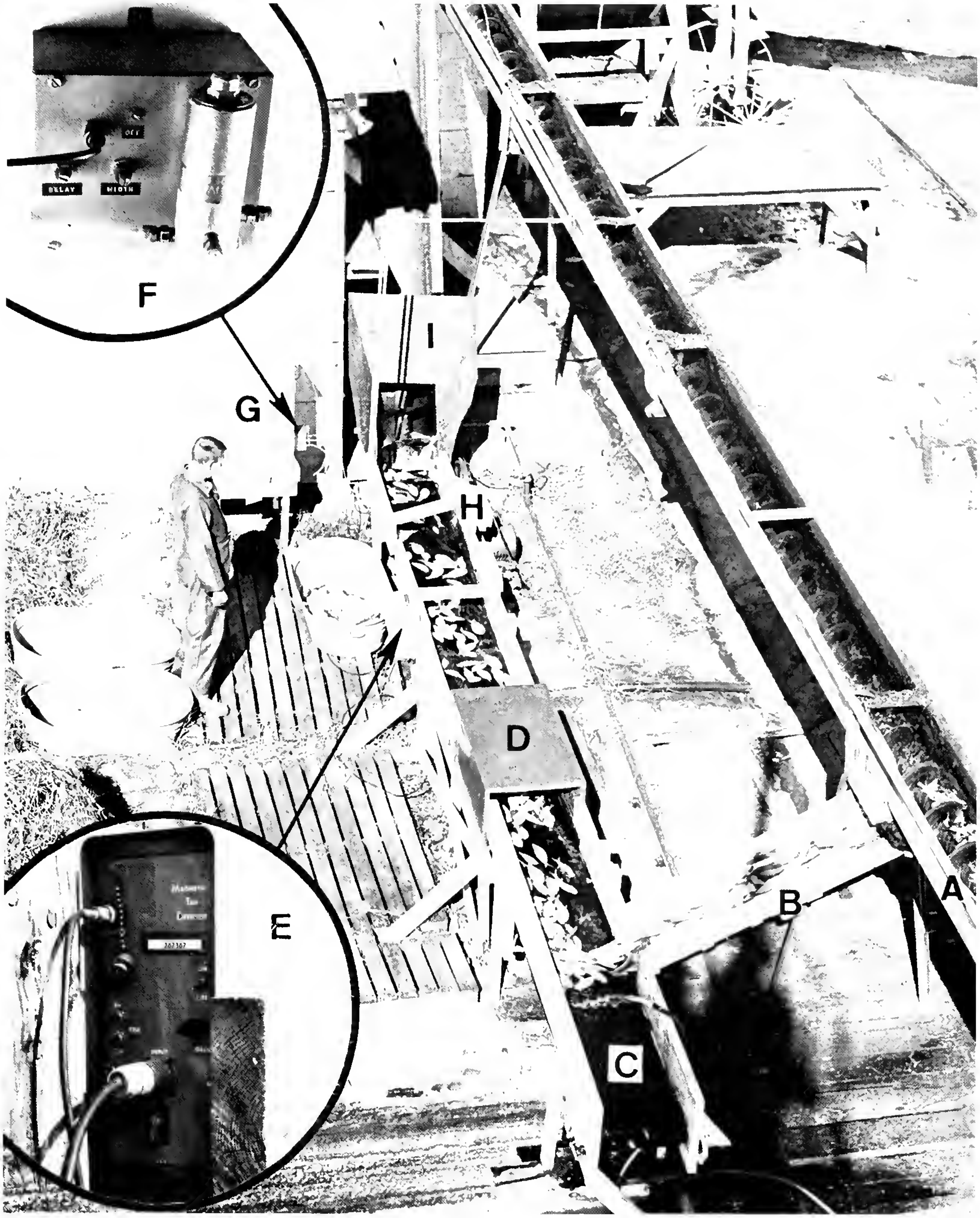

Figure 1.—Overhead view of our single electronic detector-recovery system. Shown are the plant's screw conveyor (A), transfer chute (B), belt conveyor (C), magnetic shield and detector head (D), electronic controls (E), interphase unit (F), compressor (G), gate (H), and return screw conveyor (I).

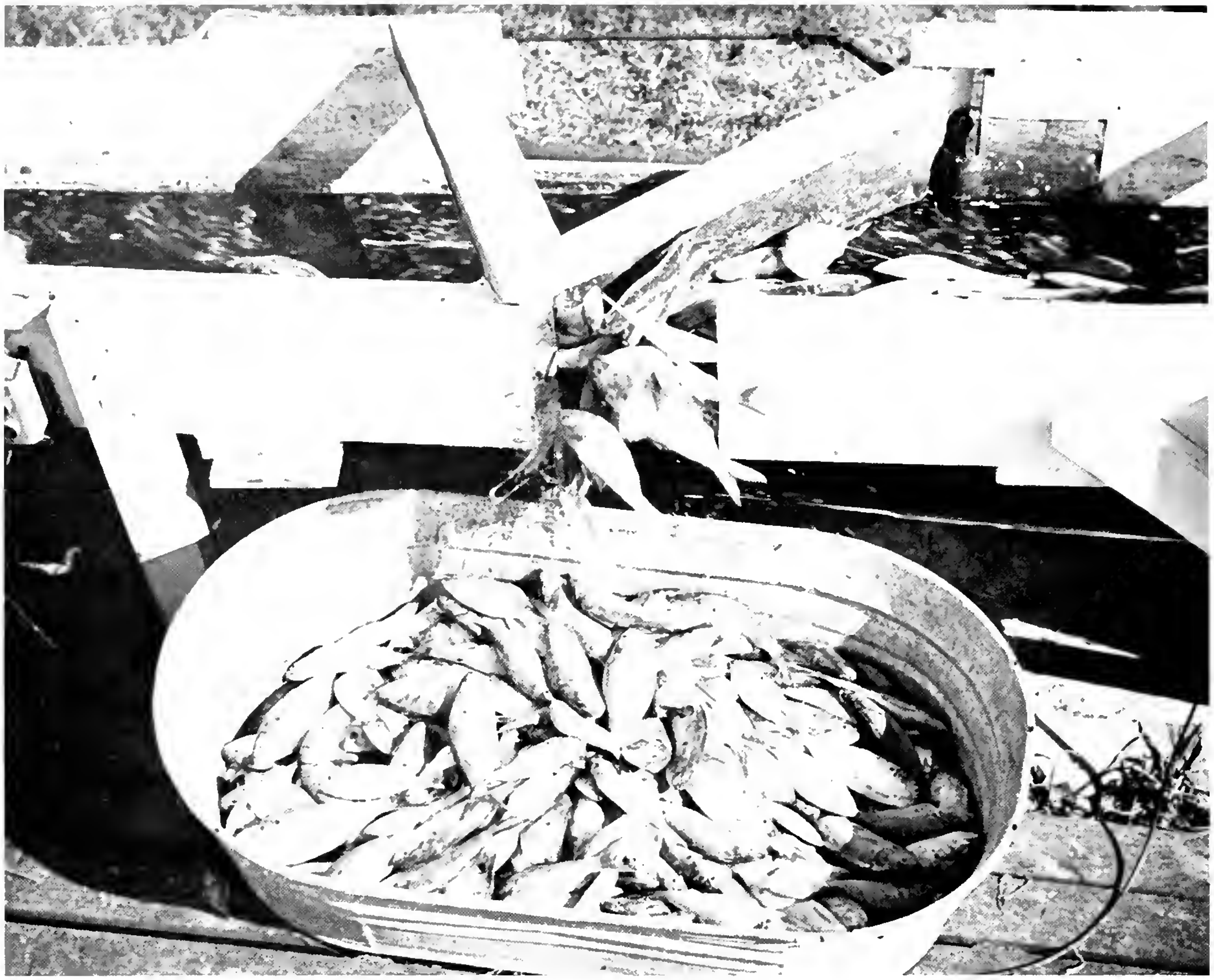

Figure 2.—Closed gate forcing fish off conveyor belt into a tub.

menhaden fishermen, however, often remain at sea for several days fishing over a wide geographical area. Hence, our electronic detector-recovery system adapted for operation aboard fishing vessels was thought to be the best means of obtaining reliable menhaden migration data in the Gulf. We have not yet resolved the technical problems of application of this system to use on vessels. The major problem is not detection of tagged fish as they are pumped aboard, but retrieval of the fish once it has been detected. Results from tags recovered by magnets in the Gulf now indicate that reliable estimates of the interchange of fish between fishing areas, growth and mortality rates, and the importance of certain estuaries in the production of menhaden may be obtained from these data. Thus, it may not now be necessary to adapt the detector-recovery system for operation aboard fishing vessels.

RECOVERIES

Since we began using the detector-recovery system in the summer of 1967, we have recaptured 231 fish. Only 34 recaptures had been out 4 months or longer and just two of these, both females, had been measured and scale sampled when released. One female, out 130 days, moved from Chesapeake Bay to North Carolina during the fall spawning migration. She grew 13 mm, 290 to 303 mm (fork length), or an average of 3.1 mm per month. The other female was released and recaptured in North Carolina waters. She had been out 483 days, from the

Figure 3.--Overhead view of double electronic detector-recovery system.

beginning of one fall through the following fall, and grew 114 mm, 183 to 297 mm or an average of 7.2 mm per month. These growth rates are considerably faster than those estimated by Richards (1968), using the Von Bertalanffy (1938) growth equation. He found that females 292 to 312 mm grew an average of 1.6 mm per month, and those 131 to 292 mm grew an average of 4.5 mm per month. Our growth rates were somewhat slower than the 7.5 mm per month for fish in Chesapeake Bay during the first 3 years of life (McHugh, 1967).

Recoveries of fish that had been scale-sampled when released can be used to validate aging techniques described by June and Roithmayr (1960). Scales from the females out 130 and 483 days revealed no and one new annulus, which supports our aging methods.

The best location for tag injection and time required for tag incisions to heal can also be determined from these recoveries. Of three locations selected for tag injection in adult menhaden, the best appears to be about 13 mm above and just forward of the origin of the pelvic fin. This was inferred from sharp decreases in recoveries after 9 days of fish tagged in the other locations. Tagging as little as 13 mm anteriorly or posteriorly of this spot can puncture the liver or spleen. Returns from two field tests designed to test these three locations verified the above conclusion. Returns were 11 to 50% better for menhaden tagged above the pelvic fin. Tag incisions were healed in 85% of the 67 fish recaptured within 10 days. The tagging scar was absent in three fish recaptured within 10 days, but it was still visible in one menhaden out 463 days.

The information obtained from these recoveries has been worthwhile and unobtainable from other techniques. However, because the cost of the detector-recovery system is greater than the magnet recovery system and because adequately precise data for population parameter estimates are being obtained from tags recovered on magnets, we are not expanding the use of the electronic detector-recovery system.

LITERATURE CITED

BERTALANFFY, L. VON.
1938. A quantitative theory of organic growth. II. Inquiries on growth laws. Hum. Biol. 10: 181-213.

DAHLGREN, E. H.
1936. Further developments in the tagging of the Pacific herring, *Clupea pallasii*. J. Cons. 11: 229-247.

HART, J. L., and A. L. TESTER.
1937. The tagging of herring (*Clupea pallasii*) in British Columbia: methods, apparatus, insertions, and recoveries during 1936-37. Br. Columbia Prov. Fish. Dep., Report for the year ended December 31st, 1936, p. R55-R67.

JEFFERTS, K. B., P. K. BERGMAN, and H. F. FISCUS.
1963. A coded wire identification system for macro-organisms. Nature 198: 460-462.

JUNE, F. C., and C. M. ROITHMAYR.
1960. Determining age of Atlantic menhaden from their scales. U.S. Fish Wildl. Serv., Fish Bull. 60: 323-342.

McHUGH, J. L.
1967. Estuarine nekton. *In* G. H. Lauff (editor), Estuaries, p. 581-620. Amer. Assoc. Adv. Sci., Washington.

REINTJES, J. W.
1963. An initial inquiry into a photoelectric device to detect menhaden marked with fluorescent pigments. Int. Comm. Northwest Atl. Fish., Spec. Publ. 4: 362-368.

RICHARDS, C. E.
1968. Analog computer techniques for age-growth studies of fish. Proc. Southeast Assoc. Game Fish Comm., 21st Annu. Conf. 1967: 273-275.

APPENDIX

Suppliers and cost of equipment for the double detector-recovery system.

Item	Supplier	Cost
Belt conveyor components	Dillon Supply Co. Raleigh, N.C. 27602	$2,092
Screw conveyor components	P&M Steel Co. Raleigh, N.C. 27607	1,400
Assembly and construction	Local contractor	2,689
Air compressor	Sears Roebuck & Co. Greensboro, N.C. 27402	125
Electronic packages (2)	K. B. Jefferts, Ph. D. Consultant in Physics Summit, N.J. 07901	2,400
Detector heads (2)	K. B. Jefferts, Ph. D. Consultant in Physics Summit, N.J. 07901	1,000
Magnetic shields (2)	K. B. Jefferts, Ph. D. Consultant in Physics Summit, N.J. 07901	3,400
Interphase units (2)	K. B. Jefferts, Ph. D. Consultant in Physics Summit, N.J. 07901	600
Total		$13,706

GPO 999-920

621. Predation by sculpins on fall chinook salmon, *Oncorhynchus tshawytscha*, fry of hatchery origin. By Benjamin G. Patten. February 1971, iii + 14 pp., 6 figs., 9 tables.

622. Number and lengths, by season, of fishes caught with an otter trawl near Woods Hole, Massachusetts, September 1961 to December 1962. By F. E. Lux and F. E. Nichy. February 1971, iii + 15 pp., 3 figs., 19 tables.

623. Apparent abundance, distribution, and migrations of albacore, *Thunnus alalunga*, on the North Pacific longline grounds. By Brian J. Rothschild and Marian Y. Y. Yong. September 1970, v + 37 pp., 19 figs., 5 tables.

624. Influence of mechanical processing on the quality and yield of bay scallop meats. By N. B. Webb and F. B. Thomas. April 1971, iii + 11 pp., 9 figs., 3 tables.

625. Distribution of salmon and related oceanographic features in the North Pacific Ocean, spring 1968. By Robert R. French, Richard G. Bakkala, Masanao Osako, and Jun Ito. March 1971, iii + 22 pp., 19 figs., 3 tables.

626. Commercial fishery and biology of the freshwater shrimp, *Macrobrachium*, in the Lower St. Paul River, Liberia, 1952-53. By George C. Miller. February 1971, iii + 13 pp., 8 figs., 7 tables.

627. Calico scallops of the Southeastern United States, 1959-69. By Robert Cummins, Jr. June 1971, iii + 22 pp., 23 figs., 3 tables.

628. Fur Seal Investigations, 1969. By NMFS, Marine Mammal Biological Laboratory. August 1971, 82 pp., 20 figs., 44 tables, 23 appendix A tables, 10 appendix B tables.

629. Analysis of the operations of seven Hawaiian skipjack tuna fishing vessels, June-August 1967. By Richard N. Uchida and Ray F. Sumida. March 1971, v + 25 pp., 14 figs., 21 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - 35 cents.

630. Blue crab meat. I. Preservation by freezing. July 1971, iii + 13 pp., 5 figs., 2 tables. II. Effect of chemical treatments on acceptability. By Jurgen H. Strasser, Jean S. Lennon, and Frederick J. King. July 1971, iii + 12 pp., 1 fig., 9 tables.

631. Occurrence of thiaminase in some common aquatic animals of the United States and Canada. By R. A. Greig and R. H. Gnaedinger. July 1971, iii + 7 pp., 2 tables.

632. An annotated bibliography of attempts to rear the larvae of marine fishes in the laboratory. By Robert C. May. August 1971, iii + 24 pp., 1 appendix I table, 1 appendix II table. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - 35 cents.

633. Blueing of processed crab meat. II. Identification of some factors involved in the blue discoloration of canned crab meat *Callinectes sapidus*. By Melvin E. Waters. May 1971, iii + 7 pp., 1 fig., 3 tables.

634. Age composition, weight, length, and sex of herring, *Clupea pallasii*, used for reduction in Alaska, 1929-66. By Gerald M. Reid. July 1971, iii + 25 pp., 4 figs., 18 tables.

635. A bibliography of the blackfin tuna, *Thunnus atlanticus* (Lesson). By Grant L. Beardsley and David C. Simmons. August 1971, 10 pp. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - 25 cents.

636. Oil pollution on Wake Island from the tanker *R. C. Stoner*. By Reginald M. Gooding. May 1971, iii + 12 pp., 8 figs., 2 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 25 cents.

637. Occurrence of larval, juvenile, and mature crabs in the vicinity of Beaufort Inlet, North Carolina. By Donnie L. Dudley and Mayo H. Judy. August 1971, iii + 10 pp., 1 fig., 5 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 25 cents.

638. Length-weight relations of haddock from commercial landings in New England, 1931-55. By Bradford E. Brown and Richard C. Hennemuth. August 1971, v + 13 pp., 16 fig., 6 tables, 10 appendix A tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 25 cents.

639. A hydrographic survey of the Galveston Bay system, Texas 1963-66. By E. J. Pullen, W. L. Trent, and G. B. Adams. October 1971, v + 13 pp., 15 figs., 12 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 30 cents.

640. Annotated bibliography on the fishing industry and biology of the blue crab, *Callinectes sapidus*. By Marlin E. Tagatz and Ann Bowman Hall. August 1971, 94 pp. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price $1.00.

641. Use of threadfin shad, *Dorosoma petenense*, as live bait during experimental pole-and-line fishing for skipjack tuna, *Katsuwonus pelamis*, in Hawaii. By Robert T. B. Iversen. August 1971, iii + 10 pp., 3 figs., 7 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 25 cents.

642. Atlantic menhaden *Brevoortia tyrannus* resource and fishery—analysis of decline. By Kenneth A. Henry. August 1971, v + 32 pp., 40 figs., 5 appendix figs., 3 tables, 2 appendix tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 15 cents.

646. Dissolved nitrogen concentrations in the Columbia and Snake Rivers in 1970 and their effect on chinook salmon and steelhead trout. By Wesley J. Ebel. August 1971, iii + 7 pp., 2 figs., 6 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 20 cents.

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