THE POTOMAC ESTUARY

biological resources

trends and options

Edited by
William T. Mason
Kevin C. Flynn

Commission on the Potomac River Basin / Maryland Power Plant Siting Program

THE POTOMAC ESTUARY
biological resources
trends and options

Proceedings of a Symposium
Alexandria, Virginia
June 4-6, 1975

Edited by
WILLIAM T. MASON
KEVIN C. FLYNN

Editorial Assistants
EVA M. DELP
SANDY SAYERS
V. JAMES RASIN

Program Coordinators
MARY ELLEN WEBSTER
GAIL GREEN

Sponsored by
INTERSTATE COMMISSION ON THE POTOMAC RIVER BASIN
4350 East West Highway
Bethesda, Maryland 20014

MARYLAND POWER PLANT SITING PROGRAM
Department of Natural Resources
Tawes State Office Building
Annapolis, Maryland 20160

April 1976

Anadromous Fishes of the Potomac Estuary

John V. Merriner

Anadromous fishes* have been and continue to be important members of the ichthyofauna within the tidal waters of the Potomac River and other tributaries of Chesapeake Bay in the ecological, commercial, recreational and aesthetic sense. Attributes of the Potomac River basin and its waters have been described in several earlier presentations and shall be cited herein only as they apply to anadromous fishes.

Environmental stresses of either natural or man-made origin are particularly critical to a group of finfishes dependent upon the tidal waters for spawning and nursery grounds (Odum, 1970). In the Potomac River the area utilized by various anadromous fishes extends from the river mouth to Great Falls: approximately 100 nautical miles (185 km) of mainstream habitat plus numerous tributary streams (Davis, *et al.*, 1970; Lippson and Moran, 1974; O'Dell and Boone, personal communication). The life cycle of anadromous species thus indicates the importance of habitat and water quality to the continued existence of these fishes (Massmann, 1971, and Talbot, 1966). Anadromous fishes spawn in the springtime. The total available spawning and nursery grounds within the tidal portion of the estuary are partitioned in an ecological sense among the several anadromous species. Fishes being considered include striped bass, *Morone saxatilis*; American shad, *Alosa sapidissima*; hickory shad, *A. mediocris*; Atlantic sturgeon, *Acipenser oxyrhynchus*; shortnose sturgeon, *A. brevirostrum*; and sea lamprey, *Petromyzon marinus* (Wass, *et al.*, 1972). My comments are centered upon striped bass and the several alosine species in the Potomac River.

Striped bass migrate into the Chesapeake Bay from the ocean, ascend the Potomac and spawn in tidal freshwater. Mainstream spawning in the area from Hallowing Point to Sandy Point is the general rule (Lippson and Moran, 1974) though some fish travel all the way to the fall line. Larvae and juveniles disperse throughout the tidal waters during spring and early summer and are most abundant in the saline portion of the estuary. Young striped bass spend 2 to 3 years in the estuary before migrating seaward.

Alosine fishes (American shad, hickory shad, alewife, and blueback herring) utilize that reach of the Potomac extending from Ragged Point to the fall line near Washington, D.C. (Warinner, *et al.*, 1970; Lippson and Moran, 1974). The primary spawning grounds of alosine fishes include mainstream and tributaries from Mathias Point to the fall line. River herring (alewife and blueback) also utilize the freshwater portions of downriver tributary streams in Maryland and Virginia between river mile 60 and 30 as spawning sites (Davis, *et al.*, 1970; O'Dell, personal communication). American and hickory shad primarily use mainstream waters for spawning sites. The larvae and juveniles spread throughout the tidal freshwater portion of the estuary (Warinner, *et al.*, 1970) and remain there until water temperatures drop in the fall; at that time they proceed seaward.

Data available to assess the anadromous fish stocks in the Potomac include: 1) commercial landings and gear use as compiled by the Bureau of Commercial Fisheries and National Marine Fisheries Service; 2) commercial fishery statistics compiled for the Potomac River Fishery Commission (Maryland and Virginia); 3) published accounts of commercial and recreational fishing; 4) recently completed and on-going research programs of the Maryland Department of Natural Resources (fisheries administration and power plant studies group) and the Virginia Institute of Marine Science; and 5) manuscript reports prepared under contract for several industries in the tidal portion of the river basin.

Striped Bass

Striped bass stocks of the Chesapeake Bay system are significant contributors to the East Coast population (Koo, 1970). The recreational and commercial fisheries for this species are intensive and extensive (Richards, 1962; Deuel and Clark, 1968; Deuel, 1973; Merriner and Hoagman, 1973; and Ridgley and Deuel, 1975). Marine recreational harvest of striped bass in the United States as estimated by Deuel is several times greater than the commercial landings published by NMFS. Eggs, larvae, and juveniles of striped bass fluctuate in abundance on a year to year basis (Koo, 1970; Dovel, 1971; Dovel and Edmunds, 1971; Merriner and Hoagman, 1973; and Johnson and Koo, 1975). The natural variability in striped bass abundance (Fig. 1) and year class strength tend to confound efforts to describe cause and effect relationships between abundance and environmental stresses. Using commercial fishing data, Koo (1970) postulated a 6-year cycle for striped bass abundance. The last strong year class of striped bass in Chesapeake Bay

*Anadromous fishes are those in which adults migrate from marine waters into freshwater for spawning. The young spend a variable portion of their early life history, depending upon species, in tidal waters before returning to sea. The young fish spend 2 to 4 years at sea and then return to the estuary as mature fish to complete their life cycle.

John V. Merriner, Ph.D. is a Senior Marine Scientist and head of the Ichthyology Department at the Virginia Institute of Marine Science, Gloucester Point, Virginia 23062. This paper is Contribution No. 696, VIMS.

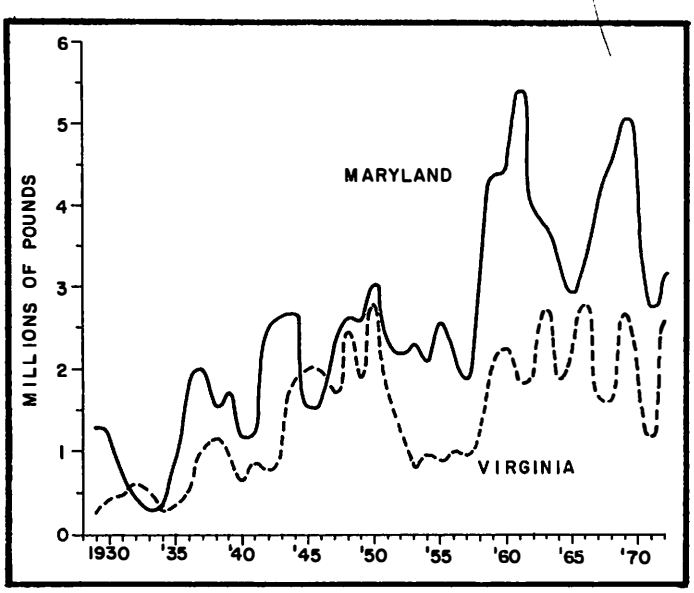

FIGURE 1. Landings of Striped Bass by Virginia and Maryland Commercial Fisheries, 1929-72

waters occurred in 1970. Subsequent year classes were average to low in year class strength (Merriner and Hoagman, 1973; Boone, personal communication).

What is the impact of low year class strength in one or more spawning streams upon the local fishery, Chesapeake Bay fishery or Atlantic coast fishery? Can we define and quantify the component elements of the Atlantic coast striped bass population in a hierarchical scheme? Answers to these questions are needed as a foundation for policy and management strategies pertaining to striped bass and other biological resources.

Field and laboratory studies of the various life stages of striped bass (see bibliography by Rogers and Westin, 1975) have produced several viable hypotheses regarding fluctuations in year class strength and stock size. Talbot (1966) reviewed a number of factors. Yet, a synthesis of the available data and design of a research program to simultaneously address the topic of year class fluctuations in the laboratory and the estuary has not been accomplished. The Potomac River Fisheries Study (PRFS) represents a significant step in the right direction. However, the development of a reliable data matrix such as the PRFS for rational resource management decisions is costly (see Richkus, this symposium).

American Shad

The fishery for American shad in Chesapeake Bay and its tributary rivers was at its peak in the late 1800's to early 1900's (Fig. 2). Throughout its history the shad fishery has experienced fluctuations in landings, but the recent data suggest depressed stock abundance (Hoagman, *et al.*, 1973). Landings in the Potomac River over the last 7 years have ranged from 80,000 lbs. (36,320 kg) in 1974 to 420,000 lbs. (190,680 kg) in 1972. Mansueti and Kolb (1953) and Walburg and Nichols (1967) reviewed the shad fishery of the United States and provide a wealth of historical as well as analytical comment.

Shad continue to sustain a spring fishery in the Potomac River. The peak of spawning season for American shad in the Potomac River is mid to late April when the water

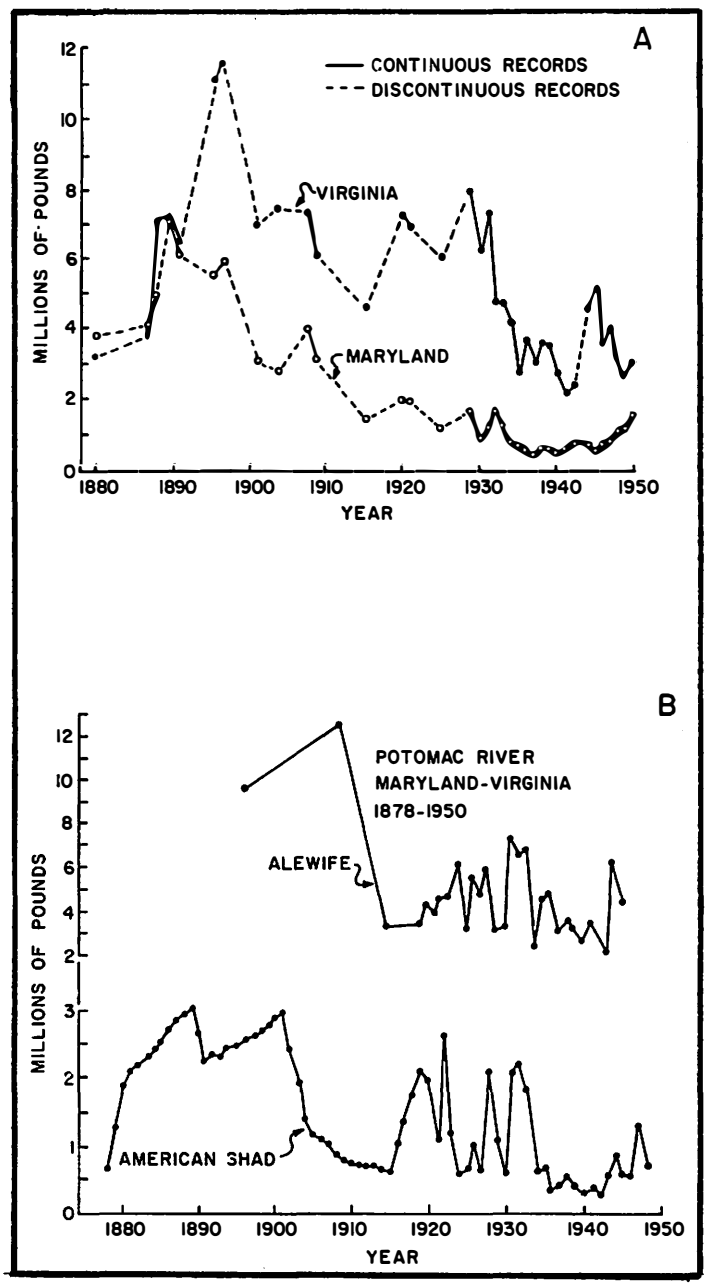

FIGURE 2. Commercial Catch of Alosine Fishes — A: Maryland and Virginia American Shad Fisheries 1880-1950 and B: Potomac River American Shad and Alewife Fisheries 1878-1950

temperatures have risen to approximately 18°C (Table 1). Leggett and Whitney (1972) summarized the migratory pattern of adult and juvenile American shad along the Atlantic coast and concluded that temperature was the key triggering mechanism for the species. However, interactions of natural and man-induced stresses relative to reproductive success remain to be tested.

Alewife and Blueback Herring

River herring landings have closely paralleled the shad fishery historically. Landings are primarily derived from pound nets and tend to peak during April and May (Table 1). The recent history (1967-1974) of the river herring fishery in the Potomac River reveals a severe reduction in catch (Fig. 3). Hoagman, *et al.* (1975), concluded that the decline in river herring catch, on a catch per unit effort basis, represented

true reduction in stock size. Similar trends have been observed in the North Carolina fishery (Street, *et al.*, 1975).

Foreign fishing off the middle Atlantic coast of the United States began in 1967-68 and domestic catch (VA. and N.C.) subsequently declined as foreign landings became appreciable (Fig. 4). The reported foreign fleet landings plus Virginia landings between 1969 and 1971 exceed the 1965-1968 Virginia annual landings. Since Virginia landings are typical, in trend, for the domestic fishery before and after inception of the offshore activity, it is evident that stocks of river herring were overfished between 1969 and 1971. Continued fishing on the offshore stocks resulted in a very low catch by the United States fishermen.

Management strategies are difficult to implement since the inshore (i.e., domestic) catch is made up of spawning fish and the offshore catch is made up of both immature and mature fish. Furthermore, the offshore fishery takes place in international waters. Also, catch quotas formulated by ICNAF or stipulated in bilateral agreements affect only signatory parties and not all nations engaged in the Middle Atlantic Bight fishery are signatory parties in the existing agreements.

A preliminary assessment of a spawner-recruit model for alosine fishes revealed no strong relationship between adult stock size (catch per unit effort) and production of juveniles in the James, York, Rappahannock and Potomac Rivers (Hoagman, *et al.*, 1975). Year class strength of juvenile alosine fishes has been depressed since 1970, thus short-term (3-4 years) forecasts for the United States fishery do not point toward higher landings. Fluctuations in juvenile abundance reflect early life stage responses to both natural and man-induced stress. We have yet to define the role of these stresses in determining year class strength.

Conclusions

Anadromous fishes of the Potomac estuary and Chesapeake Bay are significant in the ecology of the system, and in the recreational and commercial fisheries. Their perpetuation involves social, political, economic, and aesthetic forces which must be considered in development of effective management strategies.

The dependence of anadromous fishes upon the tidal portion of the Potomac River as a spawning and nursery ground emphasizes the need to maintain or improve the quality of the habitats utilized. In this instance, the entire tidal portion of main river and tributary streams must be considered. Organic and thermal loading as well as physical habitat alteration have been considered by several other speakers; the potential response of anadromous fishes must be recognized by planners and resource managers whose actions might modify the environment.

Striped bass year classes have been below average since 1970 and the fisheries have been less productive as a result. The cyclical nature of this resource was postulated by Koo (1970) on the basis of commercial landings, but the growth of the recreational fishery in Chesapeake Bay and other coastal waters may have a damping effect upon population pulses. The critical topics to be assessed include definition of the impact of man-induced stresses upon the population, the impact of natural stresses upon the population, the population size of the several major spawning stocks and their contribution to the total Atlantic coastal population, and the natural plus fishing mortality for the estuarine and migratory components of the coastal populations.

Perpetuation of the fisheries for river herring and shad will require firm control of harvest through existing and future

Month	American Shad				Hickory Shad	River Herring	
	Stake Gillnet		Pound Net		Stake Gillnet	Pound Net	
	Female	Male	Female	Male		Alewife	Blueback
January	0	230	0	0	0	0	0
February	5	12	0	0	0	153	0
March	1,195	3,505	334	909	35	38,832	0
April	33,850	12,676	4,907	4,015	8	411,742	874,952
May	6,955	2,396	1,721	4,881	16	194,479	1,966,395
June	0	0	25	1,633	0	3,129	31,637
Total	42,005	18,819	6,987	11,438	59	648,335	2,872,984
Total	60,824		18,425			3,521,319	
Total	79,249						

TABLE 1. Commercial Catch of *Alosa* by Stake Gillnets and Pount Nets in the Potomac River During 1974 (in pounds)

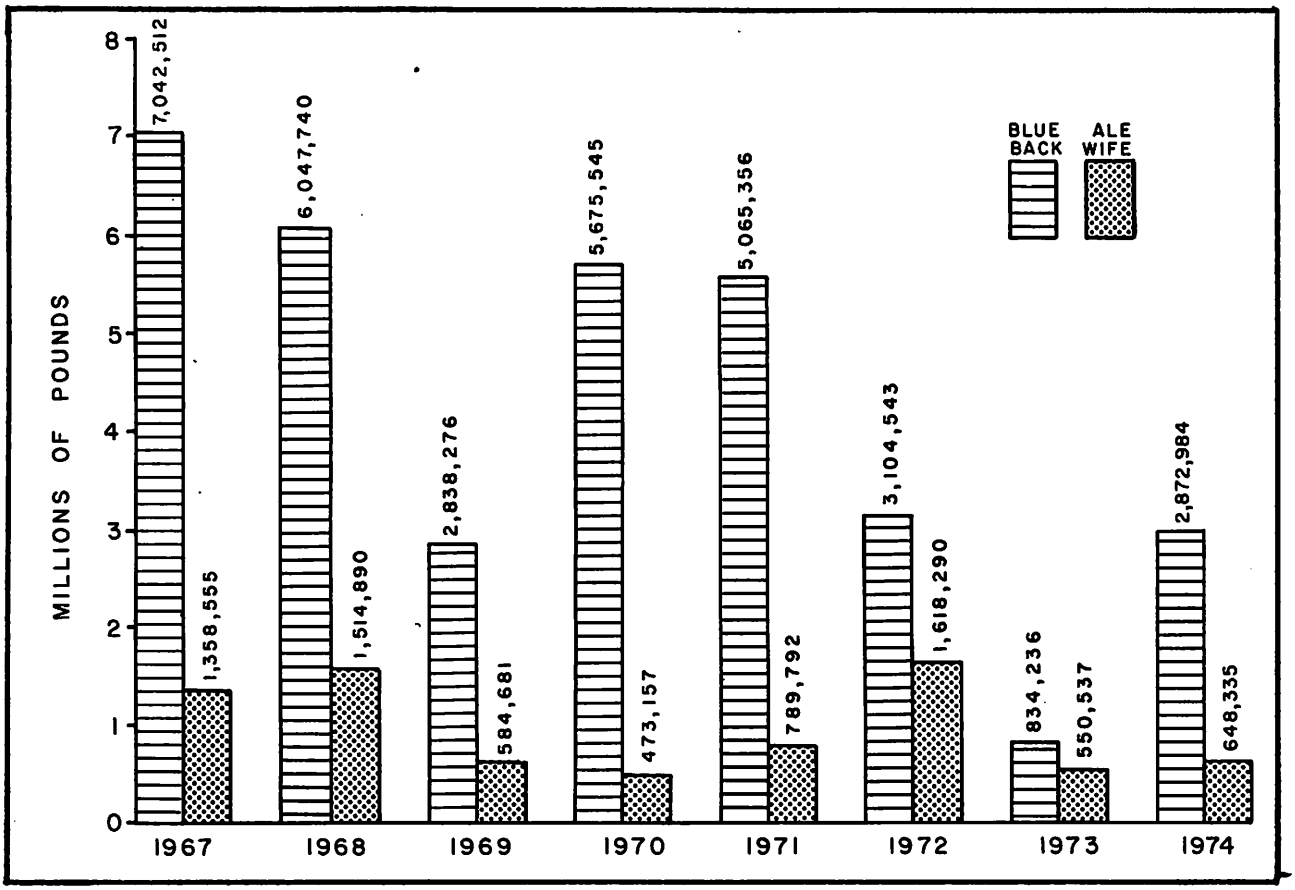

FIGURE 3. Landings of River Herring in the Potomac River, 1967-74

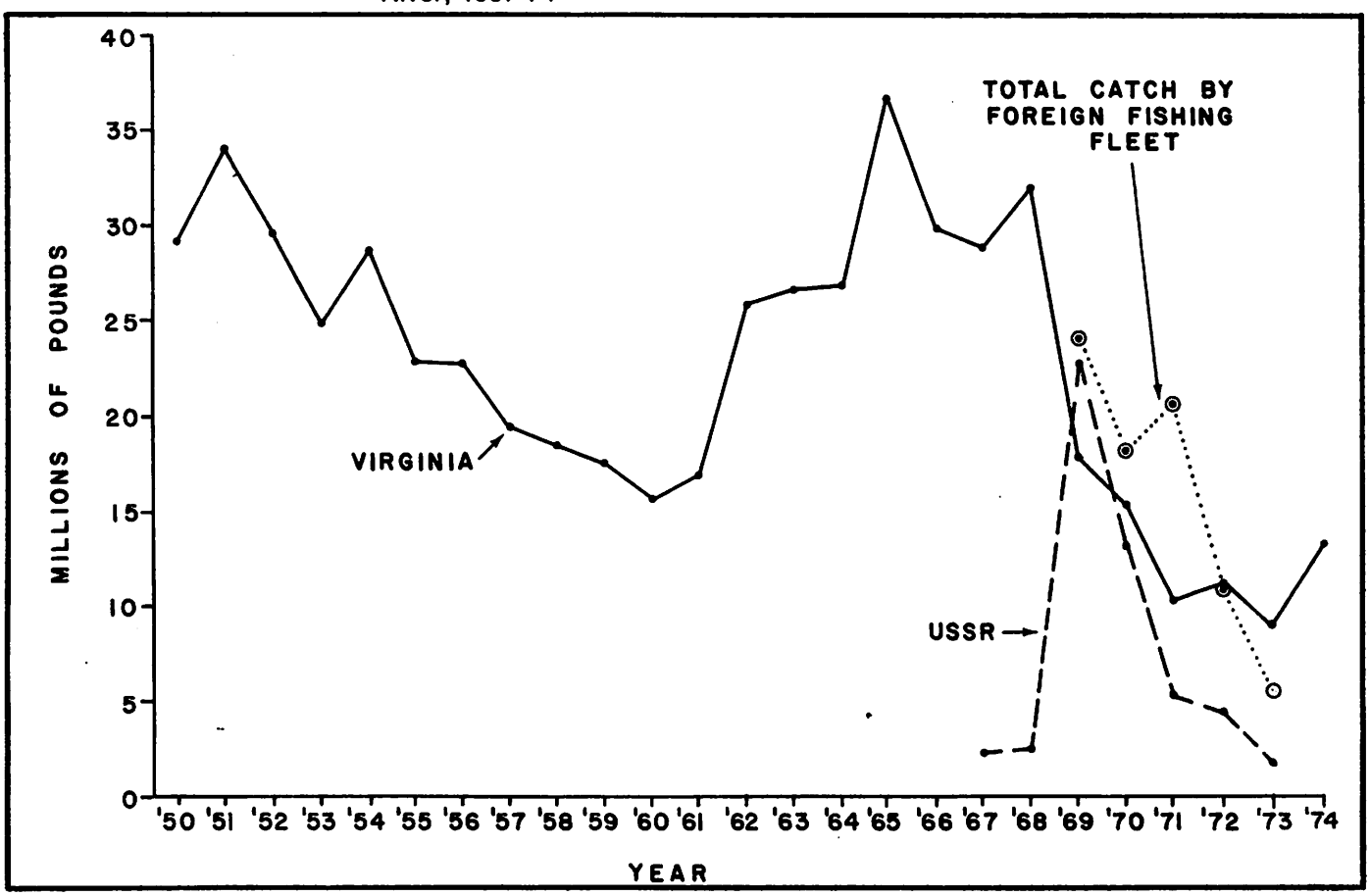

FIGURE 4. Landings of River Herring (Alewife and Blueback Combined) in Virginia from Lower Chesapeake Bay and Tributaries, Total Foreign Fleet Catch and USSR Catch in the Middle Atlantic Bight

bilateral and multilateral agreements or establishment of an extended jurisdiction zone for economic resources. Harvest control will probably include the two-tier catch quota system of the International Commission for the Northwest Atlantic Fisheries (ICnNAF) but necessitates a more relibable definition of the by-catch (i.e., incidental catch) in the offshore fishery.

An adequate data base for estimation of alosine stock size must be developed. Given realistic knowledge of stock size, the proportionate contribution of the several estuarine nursery grounds to the recruitment stock should be defined. Management strategies could then be formulated on a predictive basis given year class strength in the several nurseries, natural mortality, desired fishing mortality and condition of the mature population.

References

1. Davis, W. J., J. P. Miller, and W. L. Wilson. 1970. Biology and utilization of anadromous alosides. Phase 3. Location of spawning sites and nurseries. *In:* Completion Rep. Anadromous Fish Project. Va. Va. Inst. Mar. Sci. Gloucester Point, Va. 25 pp.
2. Deuel, G. G. 1973. 1970 salt-water angling survey. Current Fishery Statistics 6200. NOAA, NMFS, Rockville, Md. 54 pp.
3. Deuel, G. G., and J. R. Clark. 1968. The 1965 salt-water angling survey. Resources Publ. 67. U.S. Dept. of Interior, Bur. Sport Fish. and Wildl. 51 pp.
4. Dovel, W. L. 1971. Fish eggs and larvae of the upper Chesapeake Bay. Spec. Rept. 4. Nat. Res. Inst., Chesapeake Biol. Lab. Solomons, Md. 71 pp.
5. Dovel, W. L., and J. R. Edmunds. 1971. Recent changes in striped bass (*Morone saxatilis*) spawning sites and commercial fishing areas in upper Chesapeake Bay; possible influencing factors. Chesapeake Sci. 12: 33-39.
6. Hoagman, W. J., J. V. Merriner, R. St. Pierre, and W. L. Wilson. 1973. Biology and management of river herring and shad in Virginia. Completion Rep. Anadromous Fish Project, Va. AFC-7 Va. Inst. Mar. Sci., Gloucester Point, Va. 210 pp.
7. Hoagman, W. J., J. V. Merriner, W. H. Kriete and Wilson. 1975. Ibid. Ann. Progress Rep. Anadromous Fish Project, Va. AFC8-1. Va. Inst. Mar. Sci., Gloucester Point, Va. 76 pp.
8. Johnson, R. K., and T. S. Y. Koo. 1975. Production and distribution of striped bas (*Morone saxatilis*) eggs in the Chesapeake and Delaware canals. Chesapeake Sci. 16: 39-55.
9. Koo, T. S. Y. 1970. The stiped bass fishery in the Atlantic states. Chesapeake Sci. 11: 73-93.
10. Leggett, W. C., and R. R. Whitney. 1972. Water temperature and the migrations of American shad. Fishery Bull. 70: 659-670.
11. Lippson, A. J., and R. L. Moran. 1974. Manual for identification of early development stages of fishes of the Potomac River estuary. Publ. PPSP-MP-13. Power Plant Siting Program of the Md. Dept. Nat. Resources. Annapolis, Md. 282 pp.
12. Mansueti, R., and H. Kolb. 1953. A historical review of the shad fisheries of North America. Publ. 97. Md. Bd. Nat. Resources Dept., Res. Educ., Publ. 97. Chesapeake Biol. Lab., Solomons, Md. 293 pp.
13. Massmann, W. H. 1971. The significance of an estuary on the biology of aquatic organisms of the middle Atlantic region. pp. 96-109. *In:* A symposium on the biological significance of estuaries. Sport Fishing Inst., Washington, D.C. 111 pp.
14. Merriner, J. V., and W. J. Hoagman. 1973. Feasibility of increasing striped bass populations by stocking of underutilized nursery grounds. Completion Rept. Project AFS 6, Anadromous Fish Project. Va. Inst. Mar. Sci., Gloucester Point, Va. 197 pp.
15. Odum, W. E. 1970. Insidious alteration of the estuarine environment. Trans. Amer. Fish. Soc. 99: 836-847.
16. Richards, C. E. 1962. A survey of salt-water sport fishing in Virginia, 1955-1960. Chesapeake Sci. 3: 223-235.
17. Ridgley, J. E., and D. G. Deuel. 1975. Participation in marine recreational fishing Northeastern United States 1973-74. Current Fisheries Statistics 6236. NOAA, NMFS, Rockville, Md. 7 pp.
18. Rogers, G. A., and D. T. Westin. 1975. A bibliography on the biology of the striped bass, *Morone saxatilis* (Walbaum). Marine Tech. Rept. 37. Univ. Rhode Isl., Providence. 134 pp.
19. Street, M. W., P. P. Pate, Jr., B. F. Holland, Jr., and A. B. Powell. 1975. Anadromous fisheries research program, northern coastal region. Completion Rept. Project AFCS 8, N.C. Dept. Nat. and Economic Resources, Morehead City. 262 pp.
20. Talbot, G. B. 1966. Estuarine environmental requirements and limiting factors for striped bass. pp. 37-39. *In:* A symposium on estuarine fisheries. Spec. Publ. 3. Amer. Fish. Soc. 154 pp.
21. Walburg, C. H., and P. R. Nichols. 1967. Biology and management of the American shad and status of the fisheries, Atlantic coast of the United States, 1960. Spec. Rept. — Fish. 550. U.S. Fish and Wildl. Serv., Washington, D.C. 105 pp.
22. Warinner, E. J., J. P. Miller, and W. J. Davis. 1970. Distribution of juvenile river herring in the Potomac River. Proc. 23rd Ann. Conf. Southeastern Assoc. Game and Fish Com. 384-387.
23. Wass, M. L., *et al.* 1972. A checklist of the biota of lower Chesapeake Bay. Spec. Sci. Rept. 65, Va. Inst. Mar. Sci., Gloucester Point, Va. 290 pp.