LITERATURE CITED

Eschmeyer, R. W. 1942. The Catch, Abundance, and Migration of Game Fishes in Norris Reservoir, Tennessee, 1940. Jour. Tenn. Acad. Sci., Vol. 17(1): 90-115.

————————. 1943. The Effect of Impoundment on Fishing Intensity in Several TVA Waters. Trans .Am. Fish. Soc., Vol. 72(1942): 103-107.

————————, D. E. Manges, and O. F. Haslbauer. 1946. Spring Fishing on Several TVA Reservoirs, 1945. Jour. Tenn. Acad. Sci., Vol. 21(1): 78-88.

————————, D. E. Manges, and O. F. Haslbauer. 1947. Trends in Fishing on TVA Storage Waters. Jour. Tenn. Acad. Sci., Vol. 22(1): 45-56.

————————and Clarence M. Tarzwell. 1941. An Analysis of Fishing in the TVA Impoundments During 1939. Jour. Wild. Mgt., Vol. 5(1): 15-41.

Tarzwell, Clarence M. 1941. A Second Season of Creel Census on Four Tennessee Valley Authority Reservoirs. Trans. Sixth N. Am. Wild. Conf., pp. 202-221.

———————— and Lawrence F. Miller. 1943. The Measurement of Fishing Intensity on the Lower TVA Reservoirs. Trans. Am. Fish. Soc., Vol. 72(1942): 246-256.

Tennessee Valley Authority and Tennessee Game and Fish Commission. 1964. Norris Lake Fishing. 8-page brochure.

White, C. E., Jr., and Ben Jaco. 1961. Commercial and Sport Fishing on Guntersville Lake During the Period of March 15-June 13, 1960. Proc. 15th Ann. Conf. Southeast Assoc. Game and Fish Comm. October 22-25, 1961: 411-419.

Presented at the Eighteenth annual conference of Southeastern Game and Fish Commissioners, Clearwater, Florida, October 19-21, 1964.

Presented at the Southern Division, American Fisheries Society Clearwater, Florida, October 19-21, 1964

A POSITIVE APPROACH TO COASTAL SPORT FISHERY PROBLEMS

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Adequate habitat is an absolute necessity for coastal marine and estuarine fishes. The importance of estuarine and coastal nursery areas for weakfish, flounders, tautog, striped bass, scup, American shad, spot, bluefish, Atlantic croaker, seatrout, black drum, and menhaden has been adequately demonstrated. The American Fisheries Advisory Committee of the Department of Interior at their June 1963 meeting in Washington concluded that protection of estuaries is essential. The need for positive action concerning fish habitat was emphasized by Assistant Director James T. McBroom of the Bureau of Sport Fisheries and Wildlife in an address at the 1964 Annual Meeting of the Western Association of Game and Fish Commissioners.

Protection of some vital coastal and estuarine habitat is being afforded by creation of state and national parks, wildlife refuges, private preserves and recreation areas. The State of Massachusetts has

taken the lead in protecting vital marsh habitat in private ownership defining, locating, and evaluating these critical areas and protecting them through legislative action. Such efforts are to be commended and should be continued with all possible vigor. It will be absolutely impossible to protect the entire coastline, however.

The damage to some estuarine and coastal habitat is being repaired by strong anti-pollution measures, but stronger action is needed especially in control of toxic wastes and pesticides. The creation of fish ladders over previously impassable dams is now providing access to productive spawning and nursery areas that have long been unavailable. All these efforts are not only desirable, they are essential. Further efforts are needed if our fisheries are to be maintained in the face of the ever increasing inroads of civilization on vital fish habitat.

Habitat improvement, long an effective tool of freshwater fishery biologists for improving streams and lakes has been almost completely ignored by marine fishery workers. Because the sea is so vast, the problems so great, and the basic facts are so few, the possibilities of improving estuarine and coastal habitat have received only limited consideration.

The most notable achievement in coastal fishery habitat improvement has been the development of marine fishing reefs—long advocatd by the Sport Fishing Institute as a useful tool in improving marine sport fisheries. Probably the first artificial marine fishing reef in this country was "McAllister Grounds" created off Long Island, New York in 1950 (Stroud, 1961). Since then California fishery biologists have seized upon this important new tool and completed a series of studies which demonstrate not only the value of reefs in attracting fishes but the best materials, form, and location for such reefs as well (Carlisle, et. al. 1964). These studies have demonstrated in California, that such reefs must be located at least one-half mile from existing reefs, that quarry rock, which costs about $6,000 for a 1,000-ton reef is the best reef material, and that reefs should be constructed in the form of an open circle or square with a central opening not more than 50 or 60 feet across (Turner, 1964). Oyster shell reefs have been extensively used in Texas. Evaluation of oyster reefs for improvement of fishing in Maryland suggested that while such reefs had limited value in the St. Mary's River (Elser, 1960), Arve, (1960) showed that such reefs significantly increased the numbers of fish in a limited area of Chincoteague Bay. Reefs have also been constructed on a limited scale in coastal waters of New Jersey, North Carolina, Virginia, Florida and Alabama.

The success of fishing in the vicinity of offshore oil rigs off the Texas and California coasts indicates the value of pilings offshore while, inshore, bridges and piers are obviously helpful in attracting fishes. Many estuaries have bottoms too soft to support conventional fishing reefs. Pilings or poles driven into the bottom would appear to offer considerable promise as substitute reefs in such areas. Net stakes, when not actually in use, supporting nets, are known to be excellent fishing areas for striped bass, weakfish, scup, tautog, spadefish, and other popular sport fishes. Such stands especially constructed in suitable areas not obstructing navigation channels would appear to merit consideration. However, the value of such devices would need thorough testing and evaluation.

Fish collecting rafts anchored offshore by the Japanese—"tsuke rafts"— have been proven effective in concentrating pelagic fishes. Such devices could be useful in improving our coastal sport fisheries. Japanese biologists are planning to release 300 man-made planks to assess their value in concentrating tuna and other pelagic fishes. Logs and planks in coastal waters are well known as favorite fishing locations. Although such objects constitute a hazard for small boats, strips of bouyant plastic sheeting or other light, cheap material might be equally effective.

The disposal of acid wastes offshore from the New Jersey coast, once feared as destructive of fish in that area has instead probably improved fishing, in the opinion of Rutgers University professor Dr. James Westman. The record 95,000 pound haul of bluefish in late August by tuna seiners was made at the edge of the "acid grounds." Westman believes that increased turbidity of water at the acid grounds is the most probable reason for the improved fishing. If true, this suggests new possibilities for the use of dyes or other materials to create patches of turbid water in clear offshore areas.

Natural estuaries have long been assmued to be ideal spawning and nursery areas for estuarine and coastal fishes, but are they? In Chesapeake Bay, for example, some estuaries are better fish producers than others. For example, the York River produces greater numbers of small shad than the Chickahominy, but the reverse is true for juvenile river herring (Massmann, 1953). Also sections of estuaries are far more productive of young fishes than other sections. A 20-mile river stretch in the York River, characterized by salinities ranging from 1 to 15 parts per thousand and higher turbidities than either freshwater upriver or saltwater downriver, included greater numbers of young croakers, weakfish, spot and other fishes than other sections of the estuary (Massmann, 1963).

What are the important features of estuarine habitat that make them such crucial areas in relation to fishes? The presence of brackish water is one distinctive characteristic of estuaries that differentiates them from both the marine and freshwater habitats. The presence of freshwater at the upper end of estuaries is essential as spawning and nursery areas for Atlantic shad, river herring, striped bass, white perch and other anadromous fishes. These fishes can reproduce only in freshwater.

However, freshwater may not be essential for some other species usually regarded as typical estuarine species. For example, the brackish water zone of estuaries whose salinities range from 5 to 15 parts per thousand is extensively utilized by young menhaden, croaker, spot, weakfish, drums, and flounders which move to these inshore nursery areas from ocean spawning grounds. However, recent experiments with larval menhaden according to U. S. Fish and Wildlife Service biologist John Reintjes of Beaufort, North Carolina, have shown that larval menhaden may transform in waters of higher salinity as readily as in brackish water. The growth of young summer flounders is more rapid in high salinity water than in water of low salinity (Deubler and White, 1962). It seems possible, for these species at least, that low salinity itself may not be essential; instead other factors associated with low salinity provide the essential conditions.

The second distinctive feature of estuaries is that they are semi-enclosed waters. In coastal areas where tides are present, this configuration produces tidal currents. Current appears to be a vital aspect of most estuaries as they relate to fishes. Seaward currents of freshwater are necessary in directing migrating fish to freshwater spawning areas. Such currents are also credited with supplying nutrient rich water from inland areas to the estuaries. In Georgia estuaries, however, Odum (1963) states that inflow of river water dilutes rich estuaries with poor water, mud, and clay. Subsurface currents of ocean water that move into the estuaries from the sea as the salt wedge are believed to carry larval fishes into and up the estuaries from oceanic spawning areas.

Tidal and wind induced flows provide the dynamic force that sets up the complex estuarine current systems, constantly mixes the waters, and brings the large amounts of decomposed vegetation and other detritus from marshes into the estuaries. According to Kelley (1964), todal action probably has more influence on Delta fish populations than any other physical force.

Fertility of estuaries has probably received more attention than any other biological factor. While it is true that in terms of *biomass* estuaries probably outproduce any other comparable area, much of this production is diverted or tied up in forms other than fishes or potential fish food organisms. Substantial amounts of this production are probably never utilized, by economically important fishes at least.

In a thought-provoking paper Mansueti (1961), pointed out the possibility that increased pollution in the Chesapeake Bay may be responsible for the upward trend in striped bass population in recent years.

These factors and others of possibly lesser but yet unknown importance all contribute to make the estuary the vital habitat for marine and coastal fishes that it now is. With the exception of those areas wisely being preserved, however, vast changes are being wrought in the estuarine habitat, and far greater changes are in store for the future. It is necessary to do more than measure the effects of such changes when they occur, or predict the effects of estuarine destruction that will occur. It is necessary to understand the fishes and their environment so well that estuaries can be improved for fish production, to compensate for lost habitat and integrate positive plans for fishery improvement with engineering projects now contemplated.

Construction of an experimental estuary or series of small estuaries would be helpful in determining how different environmental factors could be manipulated to the advantage of fish populations. Such estuaries could be altered experimentally and changes measured. On the basis of such experiments damage to estuaries could be minimized. or prevented and existing estuaries might even be improved.

LITERATURE CITED

Arve, John. 1960. Preliminary report on attracting fish by oyster shell plantings in Chincoteague Bay, Maryland. Ches. Sci. 1(1): 58-65.

Carlisle, J. G., C. H. Turner, E. E. Ebert, 1964. Artificial habitat in the marine environment. Calif. Dept. of Fish and Game, Fish. Bull. (124: 1-93).

Deubler, E. E. and J. C. White, Jr. 1962. Influence of salinity on growth of postlarvae of the summer flounder, *Paralichthys dentatus*. Copeia 1962 (2): 468-9.

Elser, H. J. 1961. A test of an artificial oyster shell fishing reef, Maryland Dept. of Res. and Educ. Ref. 61-16.

Kelley, D. W. 1964. The effect of water development on the Delta environment. Ann. Rept. (1963-64). Delta Fish and Wildl. Protection Study. Calif. Res. Agency: 1-34.

Odum, E. P. 1963. The role of marshes in estuarine production. Part I. New Jersey Outdoors 14(1): 9-15.

Mansueti, R. J. 1961. Effects of civilization on striped bass and other estuarine biota of Chesapeake Bay. Proc. Gulf and Carib. Fish. Inst. 110-36.

Massmann, W. H. 1953. Relative abundance of young fishes in Virginia estuaries. Trans. 18 N. Amer. Wildl. Conf.: 439-49.

Massmann, W. H. 1963. The critical zone of estuaries. SFI BULLETIN 141., August, 1963: 1-2.

Stroud, R. H. 1961. Artificial saltwater fishing reefs. SFI BULLETIN 121, December, 1961: 1-3.

Turner, C. H. 1964. California's artificial reef research program presented at 5th Ann. Conf. Underwater Society, Mexico City, Mexico, June, 1964. 9 pp.