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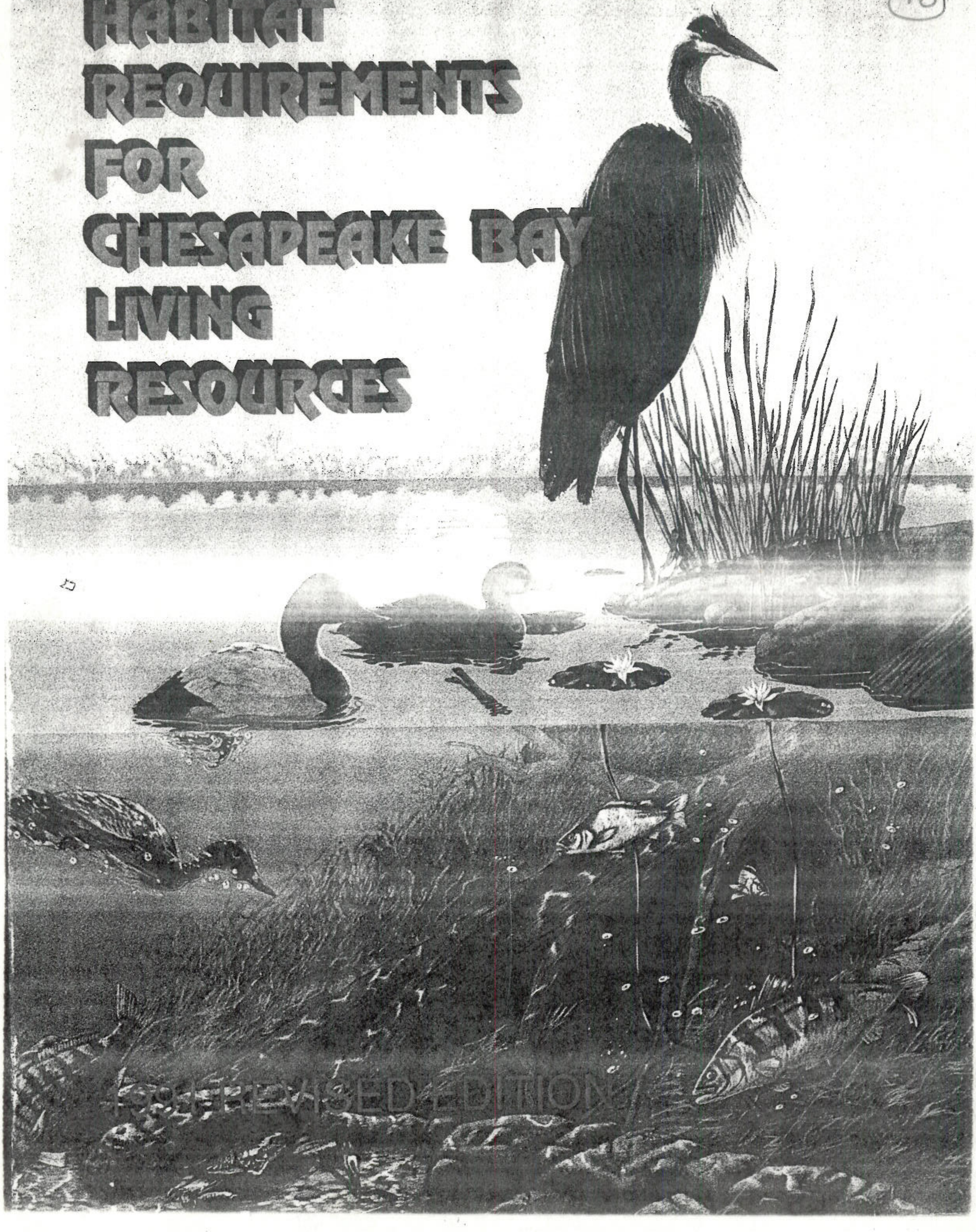
HABITAT REQUIREMENTS FOR CHESAPEAKE BAY LIVING RESOURCES



1991 REVISED EDITION

YELLOW PERCH
Perca flavescens

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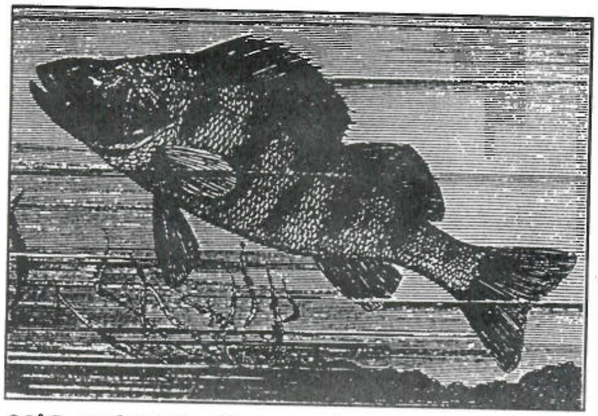

Yellow perch stocks in Chesapeake Bay have declined since the mid-1960's. The cause for the decline has not been identified precisely, but several environmental factors undoubtedly hinder stock recovery. They include sedimentation from improper land use, decreased spawning habitat caused by stream blockages, and the interaction of metals and acid rain. Eutrophication caused by excessive nutrient loading may adversely affect yellow perch by decreasing dissolved oxygen, which reduces the forage base for yellow perch.

Suitable habitat for yellow perch includes dissolved oxygen greater than 5.0 mgL^{-1}, summer water temperatures below 30°C, and gradually warming water temperatures during egg and larval development (March through May). Yellow perch populations appear able to sustain reproducing populations at pH 5.0, but pH 4.0 has been documented after rain events. Salinities above 2.0 ppt reduce hatchability of yellow perch eggs. Adults and juveniles tolerate salinities of 13.0 ppt.

Restoration of yellow perch to historic abundance levels may be accomplished by reducing sedimentation and eutrophication in the Bay. Toxic inputs also must be reduced, and suitable yellow perch spawning habitat must be restored by reducing stream blockage. Stock recovery also will require reduced mortality which can be accomplished primarily by proper management of the yellow perch fishery.

INTRODUCTION

Yellow perch is one of the most important fish species in the Chesapeake Bay. Yellow perch make their spawning run in late winter, thereby providing the earliest opportunity for sportfishermen to get into the field. The early spawning run has become an important tradition for many sportsmen. This late-winter spawn is equally important for commercial fishermen. Yellow perch are the first catchable commercial fish species of the year. The importance of yellow perch to commercial fishermen has been amplified in light of the moratoria on shad and striped bass harvest.

Chesapeake Bay once sustained a vigorous yellow perch fishery. Commercial fishermen harvested over one million pounds annually at the turn of the century.[8] Since then yellow perch landings have fluctuated, but by 1965, the commercial catch was only 278,000 pounds. Annual catches from 1967 to 1970 stabilized at about 110,000 pounds. Yellow perch catches declined precipitously from 1973 through 1986. Recently, annual catches have exceeded 40,000 pounds (Table 1). This increase in landings is attributed to increased fishing effort, not to a population increase. Since the early 1980's, most of the commercial fishing effort has been centered in the upper Chesapeake Bay.

Yellow perch have become a more important catch for commercial fishermen since moratoria have been imposed on striped bass and shad fishing in Maryland. Prices for yellow perch, adjusted for inflation, were stable at \$0.11 per pound in the mid-1970's, but increased to \$0.15 per pound in the mid-1980's.[66] Unadjusted prices for yellow perch were approximately $1.00 per live pound in 1988, 1989, and 1990.

Total 1990 February income for Maryland yellow perch commercial fishermen was $20,000 (unpublished data: Maryland Department of Natural Resources). The February catch represents less than one-half of the total annual commercial catch of yellow perch, which is estimated at $60,000.

The value of the recreational fishery is extremely hard to determine. The economic value has been reported as the marginal willingness to pay: the amount of money that a fisherman would pay to catch one yellow perch. In 1983, the marginal willingness to pay for yellow perch was $0.50 in Maryland.[66] The authors multiplied this figure by the estimated sportfishing harvest during the non-spawning season, and estimated the yearly value of the Maryland yellow perch sportfishing industry at $120,000.

BACKGROUND

The yellow perch is a member of the family Percidae. The family contains 121 species, of which approximately 100 are found in North America. Percids are found throughout the northern hemisphere excluding Alaska, the western United States, extreme northeast Canada, Greenland, and Iceland.[1] In the U.S., the percids are represented by the yellow perch, sauger, walleye, and darters.

Yellow perch range from South Carolina north to Nova Scotia, west through the southern Hudson Bay region and Saskatchewan, and south to the northern half of the Mississippi drainage.[66] In Maryland, yellow perch historically have been reported in all tributaries to Chesapeake Bay (Map Appendix) and the Youghiogheny River system (Ohio River drainage). There has been an absence of spawning in several lower western shore Chesapeake Bay tributaries over the past several years.[57]

Available data suggest that yellow perch populations are declining, although the rate of decline varies in different parts of the Chesapeake Bay. Spawning occurs in upstream reaches of most rivers that hold adult yellow perch (Map Appendix). Small spawning runs of yellow perch were found in these western shore rivers: North River, Magothy Run, and Severn Run.[37] No spawning yellow perch were captured in Stockett's Run (Patuxent River drainage) nor in Bacon Ridge Branch (South River drainage), and only nine adult yellow perch were collected during the spawning run in the North River.[23] The coordinated juvenile survey collected only five juvenile yellow perch in Mattawoman Creek, and none in the South or Severn Rivers.

A similar study found few spawning yellow perch on two Chester River tributaries: Granny Finley Branch and Three Bridges Branch.[31] Juvenile yellow perch have been collected in the Potomac River system from Washington, D.C. downstream to Breton Bay in St. Mary's County, Maryland. Absences of yellow perch were noted in the Rhode River and the lower West River.[57] Conversely, yellow perch are more prevalent in the upper Bay. All upper Bay tributaries have been found to hold juvenile yellow perch; the Bush, Sassafras, Northeast, Back, and Middle Rivers produce the majority of the landings for the fishery in the upper Bay.[57]

LIFE HISTORY

Migration and spawning

Adult yellow perch migrate from downstream stretches of tidal waters to spawning areas in less saline upper reaches in mid-February through March. Males tend to reach the spawning areas first.[66,77] Spawning takes place generally in mid-March, but the actual spawning date is influenced greatly by water temperatures. Optimal spawning temperatures were reported as 7.8-12.2°C.[32] Yellow perch spawning was documented at 2.0°C in the Severn River, but peak yellow perch spawning occurred in the Patuxent River at surface temperatures of 8.0-10.0°C.[77] Eggs are partially extruded and dragged through expelled milt. Fertilization may be accomplished by multiple males. As many as 25 males have been observed to fertilize a single egg strand.[77]

Eggs

Eggs and larvae are sensitive to several environmental factors including temperature,[28] pH and aluminum interactions,[75] sedimentation,[2] and loss of habitat. Therefore, the Chesapeake Bay Living Resources Task Force identified eggs and larvae as the critical life stages for yellow perch in Chesapeake Bay.[10]

Individual eggs are semi-demersal and clear amber. The average diameter of eggs before water hardening is 1.76 mm; post-fertilized eggs have a mean diameter of 2.26 mm.[46] The single oil droplet averages 0.4 mm.[1]

Eggs are laid in a conspicuous gelatinous strand from 0.6 to 2.0 m long.[1] Egg deposition occurs in upstream areas generally in places with large amounts of organic debris.[66] Riparian litter may serve as attachment sites for the adhesive egg strands. Despite the distinctiveness of the egg strand, there appears to be no predation on developing eggs. Either egg masses are unpalatable or predators do not recognize the egg strands as a food source.[56]

Development

Egg development stages were broadly defined by Mansueti.[46] Yolk completely filled the perivitelline space prior to fertilization. The oil droplet was displaced to the periphery, and germinal tissue formed around the droplet 14 minutes after fertilization. The two-cell stage was evident five hours after fertilization. Gastrulation occurred 21 hours after fertilization; at this stage, germinal ring covered one-third of the yolk. The author identified "early embryonic stages" at three to six days after fertilization. These stages were terminated by the separation of the tail from the yolk. Pectoral buds, auditory vesicles, and caudal finfolds were present after 6-11 days. Myotomes were fully present and the vent was visible by day 16. Eyes formed and the heart was functional during the period from 16-25 days. Hatching occurred 25-27 days after fertilization.

Larvae

Yellow perch are considered prolarvae from hatching until the yolksac is completely resorbed. Yellow perch hatch at 5-8 mm.[1] There are 32-42 myomeres (body segments). The prolarvae remain near cover. Swim bladder inflation, which is crucial for normal development, occurred at 7 mm.[46] Swim bladder inflation also was reported at the swim-up stage at 13.0°C.[33] Yolksac is completely resorbed at 8-10 mm and bones begin to ossify. At 11-15 mm, fin rays are evident. Larval yellow perch in Lake Itasca migrated offshore for their larval existence to reduce risks from littoral predators.[81] My observations in the Wye River and at hatchery ponds seem to verify offshore existence for larval yellow perch in Chesapeake Bay as well.

Juveniles

Fish are considered juveniles when all finfolds are developed. Essentially, juveniles are identical to adults except in size. Yellow perch are considered juvenile at about 20-40 mm total length (TL). Scales appear at 20-22 mm TL. In general, juvenile yellow perch migrate from the limnetic zone to the littoral zone.[81] This behavior evolved to enable juvenile yellow perch to feed on the comparably richer near-shore food sources. At this stage, predator avoidance should be sufficiently developed to reduce predation risks.

Adults

Analysis of age distributions of yellow perch shows that the age structure of the spawning population has changed over the past three decades. Yellow perch collected from the Severn River in the early 1960's showed that ages II through X were equally represented.[53] Recent studies demonstrate that only a few year classes are represented in the commercial catch (Table 2).[17,18] The major implication of the absence of older fish is decreased reproductive output per spawning fish.

The age when fish first mature depends proximally on growth rate and ultimately on variables such as forage base and competition. Females matured by age III in the Severn River, and some males matured at age I. All male perch were mature by age III.[53]

Fecundity, or the amount of eggs that a female produces, varies with body length and weight. This is a fundamental parameter that is important in projecting production estimates. Unfortunately, the only estimates of fecundity relationships for Chesapeake Bay stocks of yellow perch are 20-30 years old, and changes in forage base and growth rate may have made these equations obsolete.

The fecundity of Patuxent River yellow perch was best described by the equation:

$$\text{fecundity} = 150.56(\text{weight in g}) - 1424.1.$$

Fecundities of yellow perch were 5,266-75,715 eggs per female in the Patuxent River[74] and 5,900-109,000 eggs per female in the Severn River.[53]

Sex ratios of yellow perch may deviate drastically from the expected 1:1 (M:F) ratio. Sex ratios have been reported from several Chesapeake Bay tributaries (Table 3). Deviations from a 1:1 sex ratio may be caused by the different migration patterns of the sexes. Male yellow perch reach the spawning areas before females and do not migrate downstream until the females leave the spawning areas.[77]

Growth characteristics

Comparisons of growth rates of yellow perch in Chesapeake Bay (Tables 4 and 5) and in impoundments, the Great Lakes, and other freshwater systems[19,21,55,78] indicate that in both freshwater and Bay populations, females were consistently larger than males at any given age, and that Chesapeake Bay growth rates were similar to those reported from the Great Lakes.[66]

Several studies have found a variety of factors that affect growth rates. Some studies showed that yellow perch growth rates were density dependent in the upper Great Lakes,[29,39,78] but not in western Lake Erie.[26] Other studies showed that inter-basin differences in Lake Erie's forage base accounted for differential growth rates,[27] that different diets may alter growth by as much as 300%,[13] and that lake morphology, or the shape and contour of a lake, played the most important role in determining growth rates in Lake Itasca, where growth rates varied directly with the amount of littoral zone.[81] Physiologically, temperature is one of the most important physical variables for fish, but there did not appear to be a correlation between rising temperatures and yellow perch growth in South Bay, Lake Huron.[29]

Migrations

Adult yellow perch remain in their natal river systems. In a two-year study, yellow perch from the Severn and Chester Rivers were captured, tagged, and released in the Severn River. Tag returns showed that all of the native Severn River yellow perch were recaptured within the Severn River system, whereas the stocked yellow perch from the Chester River were recaptured throughout Chesapeake Bay.[47]

The only migration evident besides adult spawning migration is the downstream dispersal of juvenile yellow perch. Neither the timing nor the extent of this migration has been studied, but one study indicated that juveniles do not disperse downstream synchronously.[18] Some juvenile yellow perch were collected in early June in the brackish waters of the Wye East River in Maryland where maximum water depths were four feet (1.2 m) and salinity was 12.2 ppt, whereas other juveniles were collected further upstream in late September.

ECOLOGICAL ROLE

Although the feeding habits of yellow perch have been studied extensively in freshwater systems, little information has been found on the diets of estuarine yellow perch. Freshwater stocks of yellow perch change prey selection as they develop. In a Lake Itasca study, post-yolksac larvae fed on limnetic zooplankton.[81] First foods for these fish (9 mm TL) were copepods and cladocerans. Ghost midges were eaten as the larvae grew. Newly metamorphosed juveniles continued to feed on pelagic plankton but quickly shifted to benthic invertebrates. Cannabalism may account for 25% of the juvenile yellow perch diet.[59] Cannabalism of juvenile yellow perch in hatchery ponds also has been documented.[18]

Adult yellow perch in Chesapeake Bay fed primarily on anchovies, killifish, and silversides.[30] Susquehanna River yellow perch consumed scuds, caddisfly larvae, and midge larvae.[79] A study in the Gunpowder River determined that midge larvae were the preferred food for adult yellow perch.[66] Differences among these studies probably were due to different forage bases rather than different behavioral responses of yellow perch.

Yellow perch are eaten by top predators. Predators on yellow perch in Chesapeake Bay have not been thoroughly documented,[66] but during Maryland Department of Natural Resources (DNR) yellow perch collections, striped bass, largemouth bass, chain pickerel, catfish species, white perch, and bluefish were found in the same areas as yellow perch. Yellow perch larvae are important prey for alewives in Lake Ontario,[5] which also could be true in the Chesapeake Bay region, because yellow perch hatching dates in the Bay coincide with alewife and blueback herring upstream spawning migrations. Piscivorous birds, including ospreys, bald eagles, several species of gulls, terns, herons, and egrets have been noted at many yellow perch sampling stations.

HABITAT REQUIREMENTS

Water Quality

Water quality factors that affect Chesapeake Bay stocks of yellow perch are discussed in the following sections. Table 6 lists the most important characteristics and tolerance limits for each life history stage.

Temperature

Temperature is the most important environmental factor for poikilothermic (cold-blooded) animals. It controls metabolic rate, growth, and reproduction. Many studies ? show how temperature directly affects yellow perch and how temperature changes may cause behavioral changes which ultimately could induce mortality.

Gradual warming (0.9°C d^{-1}) is important to maintain constant and normal development of eggs.[28] Hatching times are greatly influenced by temperature: eggs reared at 5.4°C incubated in 51 days with 50% mortality,[34] compared to 27 days at 8.3°C[25] and 8-11 days at 18°C.[69] The last value is most typical of water temperatures at hatching dates in the Chesapeake Bay region.

After hatching, larvae have a temperature tolerance range of 10-30°C.[28,33] Significant larval mortality occurred when temperatures were increased 15°C for larvae acclimated at 13.5-17°C. Four-hour exposure of larvae to temperatures from 19-24.5°C produced no significant effects.[61] The acclimation temperatures are applicable to Bay area larvae, which were most frequently captured in water of 8-17°C.[15]

The temperature tolerance of juveniles is similar to that of larvae. Several studies have found that juveniles selected a temperature range of 19-24°C.[9,34,50,54,80] Two studies determined that juveniles demonstrate a diel or semi-daily temperature preference: 16.7°C just before dawn and 23.8°C at dusk.[4,65] Young of the year yellow perch grew optimally at constant temperatures between 26-30°C, did not grow at 8°C, and died at 34°C.[51]

Adults have thermal preferences similar to juveniles,[3,52] with 24.7°C apparently the physiologically optimal temperature.[34] Two studies conducted in Lake Erie found that adults tolerated a temperature range of 12-16°C during the winter and 16-22°C from June through September.[20,64]

Sublethal and behavioral responses of juvenile fish to temperature are probably very important in determining suitable habitat, but few studies have addressed sublethal effects or attempted to correlate the implications of suboptimal temperature with actual field observations. Thermal avoidance may cause larval and juvenile perch to emigrate from areas that provide cover from predators, or it may exclude young perch from foraging in areas with high prey densities. Also, should ambient temperatures decrease growth rates, the chances of being preyed upon would be considerably greater.

Dissolved Oxygen

Molecular oxygen is required for respiration by all higher animals. Fish extract oxygen that is dissolved in water. Dissolved oxygen (DO) passes across the gills and is extracted from the water by simple diffusion. The minimum suitable DO concentration for all life stages of yellow perch is 5 mgL^{-1}.[38] However, each life history stage has different oxygen requirements, and seasonal oxygen requirements may not always be equivalent.

Seasonal lethal DO for adults is 0.2 mgL^{-1} in winter and 1.5 mgL^{-1} in summer.[76] Yellow perch require less oxygen in winter because they are poikilothermic, that is, their metabolism is determined by ambient temperature. Yellow perch are much less active in low winter temperatures and consequently they need less oxygen.

The lethal DO for larvae at 23°C was 0.84 mgL^{-1}, but water temperatures are generally lower than 23°C during larval stages. A dissolved oxygen concentration of 0.84 mgL^{-1} was not lethal for young of the year at 15.1°C.[59] Dissolved oxygen less than 7 mgL^{-1} was lethal to juveniles in Lake Erie.[76] Growth of juveniles is not significantly affected when mean DO concentrations are more than 3.5 mgL^{-1}, but is reduced significantly when DO concentrations are greater than 2.0 mgL^{-1}.[7]

Suboptimal DO may have many acute implications. If DO in a preferred habitat is below optimum, fish may leave the area, which could subject them to predation. Similarly, if growth is retarded, especially in the juvenile stage, survivability is reduced. For these reasons DO is one of the most important environmental requirements. A DO of 5 mgL^{-1} is viewed as the lowest average concentration that sustains normal development and activity.

Salinity

Many Chesapeake Bay stocks of yellow perch are subjected to some degree of salinity in one or more life history stages. Yellow perch spawn in areas with 0-2.5 ppt salinity.[53] The optimal salinity range for yellow perch reproduction is 0-2.0 ppt.[25,38] An inverse relationship exists between hatching and salinities above 3.0 ppt. Larval mortality was lower in 3.0 ppt water than in 6.0 ppt water; however, mortality was 100% in 12 and 24 ppt water.[69] This relationship suggests that there is an optimum salinity for developing yellow perch, but growth efficiencies in different salinities have not been determined.

Juveniles exhibit a salinity tolerance range of 0-13 ppt.[38] Juveniles collected in the Miles and Severn Rivers were most abundant in 5-7 ppt.[17,53] Those collected in the Wye River system were most often found in salinities of 6-8 ppt.[18] Adult salinity tolerance is similar to that of juveniles, although preferences have not been determined in the laboratory. Most field and literature review surveys list salinity tolerances from 0-13 ppt[386] or from 0-10.3 ppt.[16,53]

pH

Acidity, represented by low pH, has severe effects on aquatic ecosystems. Acidic conditions may cause reproductive failure in fish populations, or if severe enough, the death of individuals. Acidic conditions sometimes occur naturally, and sometimes are associated with mine drainage. In the Chesapeake Bay region, acid rain is the largest source of acidic input.

Many of the Bay's tributaries are poorly buffered,[14] which exposes them to acidic runoff associated with atmospheric deposition. In a recent study of the combined effects of acidity and dissolved aluminum in flow-through bioassays with four pH levels and five aluminum concentrations, mortality rates were significantly greater in the lowest pH treatment (pH 5.0). Changes in aluminum concentration did not increase mortality.[37]

Newly hatched yellow perch appear to be slightly more sensitive to acidity than older fish. Klauda *et al.*[42] found that larvae could survive exposure to pH 5.0 for 24 h, but pre-feeding larvae were less sensitive than older larvae. Another study found that newly hatched yellow perch exhibited statistically significant differences in mortality when subjected to pH levels of 5.0.[14] Addition of 100 μgL^{-1} aluminum at pH 5.0 also significantly increased larval yellow perch mortality.[75]

Based on these studies, critical acidic conditions for egg and larval yellow perch occur at pH 4.5-5.5 with monomeric aluminum concentrations of 50-150 μgL^{-1}.[41] Yellow perch are assumed to be able to support reproducing populations when mean pH is 5.0.

Suspended sediments

Sediment loading may affect yellow perch reproduction. If sediment adheres to eggs, oxygen transport across the membrane may be reduced. Waterfront development and other human activities such as road construction cause increased sediment loads in spawning streams. Fine-grained suspended sediment in concentrations ≤ 500 mgL^{-1} had no effect on yellow perch hatching success, but hatching time was delayed 6-12 h.[71] Other tests determined that a 1000 mgL^{-1} suspension significantly reduced hatching success of yellow perch eggs,[70] although a similar study found no decrease in hatching success.[2]

Minimal information exists concerning the effects of suspended solids on larvae. The mechanisms of reducing larval survival are the same as with eggs. Fine-grained sediment may critically damage sensitive structures such as the gills and gill membranes. Survival was reduced significantly when larvae were exposed for 96 h to concentrations of suspended solids ≥ 500 mgL^{-1}.[2]

Structural habitat

Habitat Structure

Larvae inhabit the littoral zone immediately after hatching, but soon migrate to the limnetic zone and become pelagic.[81] They are photopositive and migrate vertically through the water column.[76] Juveniles (25 mm) migrate back to the littoral zone[81] and exhibit photonegative behavior.[76] Areas with > 20% cover were preferred by juvenile yellow perch.[66] Adults inhabit slow-moving, nearshore water with moderate cover.

Stream Velocity

Yellow perch fry generally inhabit currents less than 2.5 cm s^{-1}.[66] Adults prefer stream velocities > 5 cm s^{-1}. Currents in excess of 25 cm s^{-1} shear egg strands.

SPECIAL PROBLEMS

Eutrophication

Eutrophication - the effect of excess nutrients on an aquatic system - affects fish populations by altering the physical properties of the water (e.g., increased water temperature and decreased DO) and by altering predator and prey community structures. Hypereutrophy in Lake Erie's western basin caused decreased yellow perch growth rates.[27] Yellow perch populations in the mildly eutrophic central basin showed increased growth rates. The authors attributed these differences to a shift in available benthic prey size. Hypereutrophy decreased benthic prey size in the western basin, whereas mild eutrophication in the central basin increased prey size. This shift was hypothesized to affect growth rates of larger yellow perch, eventually causing stunting.

Another study reported similar effects. In general, as eutrophication increased, prey sizes decreased, parasitism increased, and percid growth increased to a threshold level where further eutrophication decreased growth rates. Low dissolved oxygen concentrations due to eutrophication also caused shifts in percid distributions.[43]

Acid Rain

Yellow perch are designated as acid tolerant; however, dissolved aluminum and depressed pH adversely affect larval yellow perch survival.[75] Spring pH levels below 5.0 have been documented in yellow perch spawning streams following rain events.[57] Acid deposition may not be the ultimate cause of declines of anadromous fish stocks, but it may inhibit recovery of fish populations.[23] Several ongoing studies are attempting to monitor the impact of acid deposition on spawning anadromous fish species. Passive and mechanical liming of spawning streams is being evaluated as a possible solution to the acidification problem.

Overharvest

Yellow perch congregate in upstream stretches of spawning streams during a contracted time period, a period when they feed aggressively. This spatial and temporal distribution of spawning behavior makes yellow perch more vulnerable to overharvesting by sportfishermen.

Commercial fishing for yellow perch is similarly affected by the contracted spawning runs. Fyke nets, the most common gear used in the commercial fishery, are very efficient in capturing migrating yellow perch. The ban on shad and striped bass fishing in Maryland has made yellow perch fishing more popular, which has led to increased landings in the upper Bay area.

Yellow perch populations should be able to sustain a healthy fishery but natural reproduction must be monitored carefully.

Contaminants

Acute toxicity tests of a number of inorganic and organic compounds have been conducted on yellow perch larvae and juveniles. Apparently no information is available on the toxicity of metals and metalloid elements to yellow perch, except for the studies of aluminum toxicity summarized above under **pH**.

Chlorine (total residual) is lethal to yellow perch larvae at moderately low concentrations (0.55 mgL^{-1} and greater). Its toxicity increases with temperature, with exposure time, and with salinity.[61,72] Effects of total residual chlorine on juveniles were similar; 24 h LC_{50} ranged from 8 mgL^{-1} at 10°C to 0.7 mgL^{-1} at 30°C.[6]

Hydrogen sulfide is toxic to larvae and juveniles at very low concentrations, with 96 h LC_{50} ranging from < 2 μgL^{-1} for larvae at 20°C to 36 μgL^{-1} for juveniles at 10°C.[22]

The 96 h LC_{50} for juvenile yellow perch exposed to hydrogen cyanide was 90.4 μgL^{-1} at 15°C and 108 μgL^{-1} at 21°C. Sensitivity to HCN increased with decreasing DO concentration.[74]

Organic compounds for which toxicity information is available include a selection of pesticides and industrial chemicals (Table 7). It is difficult to generalize the relative toxicities of these compounds, except to comment that some insecticides (e.g., DDT, endrin, toxaphene, azinphos-methyl) are lethal at extremely low concentrations. Among Chesapeake Bay species, yellow perch may be particularly susceptible to chemical spills and contaminated runoff during the spawning and larval development periods, because of their concentration in relatively small streams.

Yellow perch exposed to ambient levels of a polychlorinated biphenyl (PCB; Arochlor 1016) in the Hudson

River accumulated tissue concentrations 10,400 times those in the river water.[73] Accumulation of PCB and other persistent organic compounds either directly or through the food chain could be a matter of concern for Chesapeake Bay yellow perch.

Stream Blockages

One cause of decreased suitable yellow perch spawning habitat is stream blockages. Many of the Bay's tributaries are impounded by gauging stations, highway culverts, small-scale dams, and hydroelectric facilities. A regional Chesapeake Bay effort is underway to mitigate the blockages by removing them or by installating fish passageways and diversions. The increase in available spawning and nursery habitat should serve to further rehabilitation of the stock.

Stream blockages are being breeched in the Patapsco River drainage (6 blockages), the Susquehanna River (Conowingo Dam), the Elk River (one dam), the Bush river (two dams), and the Potomac River drainage (five dams). Other catalogued impoundments are in the Sassafras River drainage, Tuckahoe Creek, and the Chester River system.[11] Similarly, Virginia has developed a database of stream blockages. Embry dam on the Rappahanock River, five dams on the James River, and four dams on the Appamatox River are considered priority blockages (Map Appendix).[11]

RECOMMENDATIONS

Nutrient inputs and other allochthonous and xenobiotic inputs that cause decreased DO levels in the Bay should be reduced.

Implementation and enforcement of programs to reduce both sediment and nutrient inputs into the Chesapeake system should be carried out to enable yellow perch stocks to expand in both range and abundance. Shoreline development and activities causing erosion and nonpoint source nutrient loading should be limited throughout the Chesapeake Bay drainage.

Harvest by sportfishermen and commercial fishermen must be monitored and managed, ideally by river system. Spawning stock characteristics such as age and growth rates must be determined to ensure that harvest levels are allowing sufficient reproduction to increase stock abundance. Size limits should be set to allow increased natural reproduction in the river systems open to yellow perch fishing through greater spawning contribution of older age class fish.

Stream blockages that impede upstream spawning migrations must be removed or made passable to yellow perch.

Relatively little is known about yellow perch environmental preferences and tolerances in the Chesapeake Bay. This report draws largely from research literature on freshwater stocks of yellow perch. There is an urgent need for more research on estuarine stocks of yellow perch. This is especially true for larval and juvenile yellow perch habits and habitats.

The potential threat to yellow perch spawning runs and early life stages from improper use, disposal, and storage of pesticides and other toxic chemicals should be recognized.

Aggressive research must be continued on acid deposition. Mitigation efforts are also important through reduced sulfur emissions from industry and automotive exhaust. Evaluation of stream liming programs to make more areas suitable for spawning should be studied.

CONCLUSIONS

The ultimate, historical cause of the yellow perch population decline in the Chesapeake Bay has not been identified. Many environmental factors are acting to preclude yellow perch stock recovery. Loss of spawning habitat caused by stream blockages and sedimentation also undoubtedly are acting against yellow perch stock recovery, as are the synergistic effects of acid deposition and dissolved metals.

ACKNOWLEDGEMENTS

Steven A. Fisher, Lenwood Hall, Jr., and John Sullivan compiled and sumarized the information in Table 6. Dr. Stephen Jordan (Maryland Department of Natural Resources) contributed the discussion on contaminants. Drs. Roman Jesien (University of Maryland) and Bryan Henderson (Ontario Ministry of Natural Resources) provided technical reviews which significantly added to the value of this chapter. In addition, Harley Speir and R. Steve Early (Maryland Department of Natural Resources) critically reviewed the document and provided information on yellow perch distribution. Don Cosden (Maryland Department of Natural Resources) also provided some information on juvenile yellow perch distribution.

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