

Final Report to the Hudson River Foundation

Grant Contract 001/92B

“Determinants of Habitat Quality for Estuarine Dependent Fishes”

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OBJECTIVES:

The overall objectives of this research program was to determine the factors affecting recruitment of estuarine-dependent fishes in New Jersey estuaries. This project was a multi-institutional effort focused on resource species of economic importance to commercial and recreational fisheries of the region. We planned to determine, for a stressed and unstressed estuary 1) the quantitative habitat-specific densities for juvenile fishes, 2) habitat-specific growth rates, and 3) movement patterns within and among habitats. This approach let us evaluate several habitats and their associated nursery communities simultaneously.

METHODOLOGY:

We attempted to determine the importance of habitats to the growth and survival of juvenile fishes based on comparison of habitats in a relatively unaltered, unstressed system (Great Bay - Mullica River Estuary) versus a heavily altered and stressed system (Hudson/Raritan Estuary). More specifically, for juveniles of economically important species, we addressed the following tasks: 1) comparison of seasonal, diel and ontogenetic patterns of habitat use, 2) determination of movement patterns within and between habitats to further evaluate habitat use patterns for selected species, and 3) determination of growth and survival of selected estuarine-dependent species. Thus, the intent was that comparisons between these estuarine systems will eventually provide a ranking of habitat quality among habitats under different levels of stress.

RATIONALE:

Habitat degradation and destruction are ongoing problems in New Jersey estuarine waters as well as along every coast of the U.S. These problems are likely to continue because estuarine habitats are coming under mounting pressure due to continued human population growth around our major estuaries. Currently, we lack the knowledge to confidently identify the habitats and the patterns of habitat productivity that are critical to the numerous commercially and recreational important finfishes that have estuarine dependent life histories. The proposed research addressed the relationship between habitat and fisheries production and the means for managing habitats for multiple uses.

PROJECT RESULTS:

Specific results of the individual tasks are as follows:

Task 1: Preliminary analysis suggests there may be estuarine-specific responses in the juvenile fish fauna. We are still investigating whether these are the result of the lower habitat quality or differences in larval recruitment to different estuaries. Analysis of throw trap, experimental trap and beam trawl samples to date show a generally similar fauna between Great Bay and Sandy Hook bays, but the abundance of certain habitat types (eelgrass, sea lettuce) differs dramatically. (Publications 4, 9, 11, 12, 13; Technical Reports 1, 2; Presentations 1-5, 7, 12, 14, 16). We have expanded these studies, and provided a new research direction, by adding the heavily impacted Hudson River and Long Island Sound in projects funded by the NOAA Coastal Ocean Program.

Other publications, manuscripts, technical reports and presentations that contributed to the overall project objectives are included below.

Task 2: We have determined habitat-specific growth rates for black sea bass (Publ. 5, 7, 14). We are also assembling a long-term data set on the latitudinal variation in growth rates of recently settled winter flounder based on earlier studies. In a continuing attempt to understand habitat use patterns we have investigated predation affects, particularly on recently settled winter flounder (Publ. 6). Other studies have determined the role of habitat parameters such as dissolved oxygen on growth for black sea bass (Publ. 5). Numerous presentations at national meetings have addressed this same issue (Presentations 4, 5, 7, 12, 13, 14, 16, 17)

Task 3: Patterns of juvenile fish movement are better understood based on our use of small honeybee tags. With these, we have intensively followed the movements of juvenile black sea bass, tautog and cunner in the estuary over long periods of time (up to 100 days), and have found that all three species are highly localized, and thus habitat-specific studies of growth may be especially appropriate (see Publications 14, 15). Other studies have documented the occurrence of a settlement area where winter flounder from approximately 9-25 mm appear to be resident, then at larger sizes they disperse throughout the estuary based on intensive sampling. Direct studies of the movements of juvenile winter flounder have proven somewhat problematic. Intensive mark-recapture experiments in the settlement area resulted in relatively few recaptures and none outside the settlement area. Our intensive sampling program in artificial eelgrass has determined the diel patterns of movement (Publ. 3). Several syntheses have helped determine the degree of estuarine use by several species, including black sea bass (Publ. 7, 10, 14), summer flounder (Publ. 1, 4), underutilized searobins (Publ. 2), and descriptions of the general fish fauna (Publ. 3, 9, 11, 13). These results have also been included in numerous oral communications (Presentations 3, 5, 7, 11, 12, 16, 17, 21).

PUBLICATIONS:

1. Keefe, M. and K.W. Able. 1994. Contributions of abiotic and biotic factors on settlement in summer flounder, (Paralichthys dentatus). *Copeia* 1994(2):458-465.
2. McBride, R.S. and K.W. Able. 1994. Reproductive seasonality, distribution and abundance of Prionotus carolinus and P. evolans (Pisces: Triglidae) in the New York Bight. *Est. Coast. Shelf Sci.*38:173-188.
3. Sogard, S.M. and K.W. Able. 1994. Diel variation in immigration of fishes and decapod crustaceans to artificial seagrass habitat. *Estuaries*. 17(3):622-630.
4. K.W. Able and S.C. Kaiser. 1994. Synthesis of summer flounder habitat parameters. NOAA, Coastal Ocean Program, Decision Analysis Series.
5. Hales, L.S. Jr., and K.W. Able. 1995. Effects of oxygen concentration on somatic and otolith growth rates of juvenile black sea bass, Centropristis striata. pp. 135-153 *In:* Recent Developments in Fish Otolith Research, D.H. Secor et al. (eds.), Belle W. Baruch Marine Science Laboratory, University of South Carolina Press.

6. Witting, D.A. and K.W. Able. 1995. Predation by sevenspine bay shrimp, Crangon septemspinosus, on winter flounder, Pleuronectes americanus, during settlement: laboratory observations. *Mar. Ecol. Prog. Ser.* 123:23-31.
7. Able, K.W., M.P. Fahay and G.P. Shepherd. 1995. Early life history of black sea bass Centropristis striata in the Mid-Atlantic Bight and a New Jersey estuary. *Fish. Bull.* 93:429-445.
8. Morse, W.W. and K.W. Able. 1995. Distribution and life history of windowpane, Scophthalmus aquosus, off the northwestern Atlantic. *Fish. Bull.* 93: 674-692.
9. Szedlmayer, S.T. and K.W. Able. 1996. Patterns of seasonal availability and habitat use by fishes and decapod crustaceans in a southern New Jersey estuary. *Estuaries* 19(3): 697-707.
10. Hales, L.S. Jr. and K.W. Able. (In press). Overwinter mortality, growth and behavior of young-of-the-year of four coastal marine fishes in New Jersey (USA) waters. *Marine Biology*.
11. Able, K.W., D.A. Witting, R.S. McBride, R.A. Rountree and K.J. Smith. 1996. Fishes of polyhaline estuarine shores in Great Bay - Little Egg Harbor, New Jersey: a case study of seasonal and habitat influences, pp. 335-353 In: Nordstrom, K.F. and C.T. Roman (eds.) *Estuarine Shores: Evolution, Environments and Human Alterations*. John Wiley & Sons, Chichester, England.
12. Smith, K.J. and K.W. Able. (In review). Role of vegetation in salt marsh surface pools: patterns of faunal composition, abundance and growth.
13. Wilson, K.A., K.W. Able and K.L. Heck Jr. (in review). Distribution and abundance of fishes and decapod crustaceans: Habitat comparisons in southern New Jersey estuaries. *Estuaries*.
14. Able, K.W. and L.S. Hales, Jr. (In press) Habitat fidelity, movement and growth rates of juvenile black sea bass, Centropristis striata, in a southern New Jersey estuary. *J. Exp. Mar. Biol. Ecol.*
15. Hales, L.S. Jr. and K.W. Able. (In prep.) Habitat-specific growth and mortality of two young-of-the-year estuarine temperate wrasses (Labridae).
16. Able, K.W. and M.P. Fahay. (In press). *The First Year in the Life of Estuarine Fishes in the Middle Atlantic Bight*. Rutgers University Press.

ANCILLARY PROJECTS

1. Duval, E.J. and K.W. Able. (In review). Life history of the seaboard goby, Gobiosoma ginsburgi, in New Jersey waters. Estuaries.
2. McBride, R.S. and K.W. Able. (In press) Ecology and fate of butterflyfishes, Chaetodon spp., in the temperate, northwestern Atlantic. Bull. Mar. Sci.
3. Campbell, B.C. and K.W. Able. (In press). Aspects of the life history of the northern pipefish, Syngnathus fuscus in New Jersey waters. Estuaries
4. McBride, R.S., J.B. O'Gorman and K.W. Able. (In review) Variations in abundance and size structure of two Prionotus (Pisces: Triglidae) in the Mid-Atlantic Bight.

TECHNICAL REPORTS:

1. Goldberg, R., A.L. Studholme, A. Calabrese and K.W. Able. 1993. Functional significance of estuaries in the Northeast--Comparing habitat utilization and quality. Proceedings of Coastal Zone '93, July 1993, New Orleans.
2. Able, K.W. and S.C. Kaiser. 1995. New Jersey estuaries finfish resource assessment, phase I: Literature Summary. IMCS Technical Report 95-01.
3. Able, K.W., R. Lathrop and M.P. De Luca. 1996. Background for research and monitoring in the Mullica River - Great Bay Estuary. IMCS Technical Report 96-07.

PRESENTATIONS:

1. Able, K.W. Habitat changes: A 20-year perspective. Fisheries of New Jersey Round Table 1994. Toms River, NJ, March 1994.
2. Able, K.W. Current research activities at the Rutgers University Marine Field Station. Tuckerton, New Jersey. New Jersey Marine Educators' Association, May 1994.
3. Able, K.W. The natural history of summer flounder in southern New Jersey. Barnegat Bay Decoy and Baymen's Museum, Tuckerton, September 1994.
4. Able, K.W. Implications of natural history for flatfish aquaculture. Flatfish Culture Workshop, New York Sea Grant Institute and the National Coastal Resources Research and Development Institute, October 10-11, 1994, Ronkonkoma, NY.
5. Able, K.W. Fish recruitment in the coastal zone. Mid-Atlantic Chapter of the American Fisheries Society, November 15, 1994, New Brunswick, NJ.
6. Psuty, N.P., M. P. De Luca, R. Lathrop, K.W. Able, S. Whitney and J.F. Grassle. The Mullica River - Great Bay National Estuarine Reserve: a unique opportunity for research

- preservation and management. 8th Symposium on Coastal and Ocean Management, New Orleans, July 1993.
7. Able, K.W., A.L. Studholme and J.P. Manderson. Fish habitat quality in shallow estuarine waters: an approach to evaluation of impacted and unimpacted systems. Marine and Estuarine Shallow Water Science and Management in the Mid-Atlantic Region, EPA, Atlantic City, NJ, March 1994.
 8. Hoppe, M.A., K.J. Smith and K.W. Able. Species and size composition of larval and juvenile fishes in southern New Jersey salt marsh pools. 39th Annual Meeting of the New Jersey Academy of Science. Monmouth College, April 1994.
 9. Neuman, M.J. and K.W. Able. Spatial and temporal patterns of abundance of larval and juvenile windowpane flounder (*Scophthalmus aquosus*), in an estuarine/inner continental shelf system. NOAA/NMFS Flatfish Biology Workshop, Mystic, CT, December 1994.
 10. Witting, D.A. and K.W. Able. Predator-prey interactions between benthic crustaceans and recently settled winter flounder: field observations. NOAA/NMFS Flatfish Biology Workshop, Mystic, CT, December 1994.
 11. Curran, M.C. and K.W. Able. Settlement areas for winter flounder: patterns in the use of coves near inlets. NOAA/NMFS Flatfish Biology Workshop, Mystic, CT, December 1994.
 12. Studholme, A.L., A. Calabrese, K.W. Able and S.C. Wainright. Fish recruitment in the northeastern United States: the role of estuarine habitats. NOAA/NMFS Flatfish Biology Workshop, Mystic, CT, December 1994.
 13. Hagan, S., R. Hoden and K.W. Able. Habitat-specific patterns for distribution and growth of young-of-the-year winter flounder in a relatively unimpacted southern New Jersey estuary. NOAA/NMFS Flatfish Biology Workshop, Mystic, CT, December 1994.
 14. Manderson, J.P., A.L. Studholme, K.W. Able and D. Packer. Habitat use and growth of young-of-the-year winter flounder, *Pleuronectes americanus*, in the lower Hudson River. NOAA/NMFS Flatfish Biology Workshop, Mystic, CT, December 1994.
 15. Curran, M.C. and K.W. Able. Evaluation of fish tethering as a technique to assess predation. Benthic Ecology Meeting, New Brunswick, New Jersey, March 1995.
 16. Able, K.W., A.L. Studholme, and J.P. Manderson. Juvenile fish habitat quality: comparisons between impacted and relatively unimpacted estuaries. American Fisheries Society Annual Meeting, Habitat Utilization and Recruitment of Estuarine Dependent Fishes symposium, Tampa, FL, August 1995.
 17. Fish habitat quality in impacted and relatively unimpacted estuaries. Chesapeake Biological Laboratory, Solomons, Md, October 1995.

18. Natural history of black sea bass. Barnegat Bay Decoy and Baymen's Museum, Tuckerton, NJ. April 1996.
19. Neuman, M.J., Curran, M.C. and K.W. Able. Overwintering mortality in temperate, young-of-the-year fishes. American Society of Ichthyologists and Herpetologists, June 1996, New Orleans
20. Neuman, M. and K.W. Able. Patterns of habitat use by early life history stages of windowpane flounder, Scophthalmus aquosus. American Society of Ichthyologists and Herpetologists, June 1996, New Orleans.
21. Able, K.W. and M.P. Fahay. Middle Atlantic Bight estuarine fishes: natural history patterns during the first year--a progress report. American Society of Ichthyologists and Herpetologists, June 1996, New Orleans.

DEGREES GRANTED

Richard S. McBride, Ph.D., 1994. Comparative ecology and life history of two temperate, northwestern Atlantic searobins, Prionotus carolinus and P. evolans (Pisces: Triglidae).

David A. Witting, Ph.D. 1995. Influence of invertebrate predators on survival and growth of juvenile winter flounder

Other results are in preparation as the result of student research in the Hudson/Raritan estuary by Beth Phelan (Ph.D., Ecology and Evolution Graduate Program, Rutgers University)

ACCOMPLISHMENTS:

As a result of these studies, we have more completely defined the role of estuaries as nurseries for a variety of species. These include commercially or recreationally important species such as black sea bass, tautog, winter flounder, windowpane and summer flounder, as well as the underutilized searobins. These intensive studies emphasized the need for further evaluation of geographical variation in estuarine nursery function and have resulted in collaborative efforts with other NOAA agencies, including COP and NMFS. In addition, this research has improved our understanding of the importance of salt marsh creeks as nursery habitat. The best examples are for summer flounder and black sea bass, as well as a broad assemblage of forage species. The above-mentioned studies have also provided important insights into the early life history of the same species. More specifically, they have identified how to sample these critical stages, and what estuarine habitats appear most important based on density, growth and degree of habitat fidelity. The general sampling and experimental studies have also helped further characterize estuarine fish faunas and thus help to interpret their role in estuarine ecosystems. As a result of this and other grants, we have prepared a book on the first year in the life of estuarine fishes in the Middle Atlantic Bight (Able and Fahay, in press). It includes the analysis of specific data from the Hudson/Raritan estuary.