Habitat Hotline Atlantic
Issues of Concern for Atlantic Marine Fish Habitat
December 2000, Volume VII, Number 3

Salt Marshes in the Gulf of Maine

How are fish utilizing this important habitat?

Michele Dionne, Wells National Estuarine Research Reserve
Frederick T. Short, University of New Hampshire
David M. Burdick, University of New Hampshire

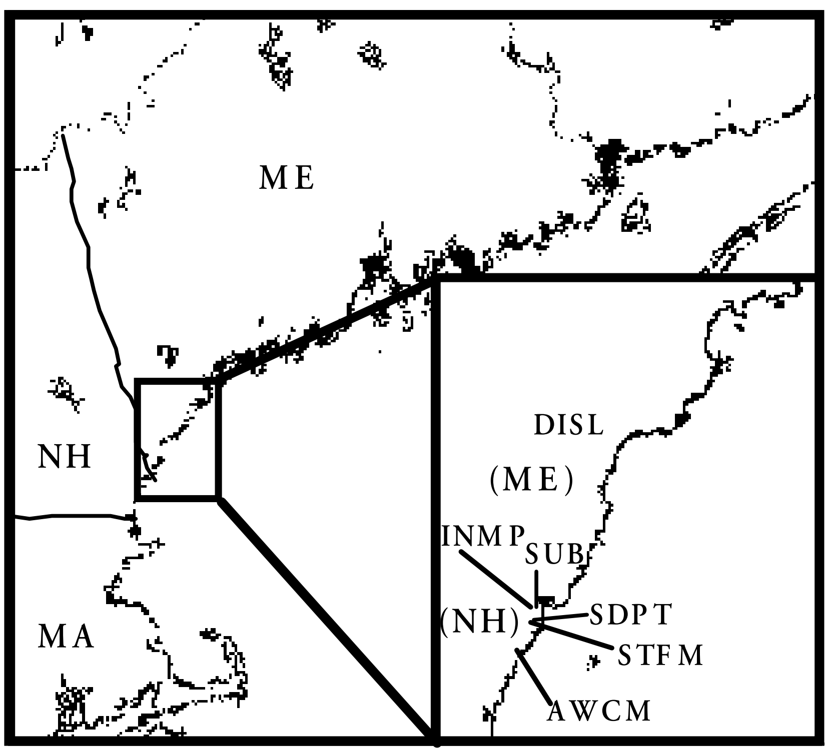

Figure 1. Map of study sites. Abbreviations for sites: INMP= Inner North Mill Pond, NH; SUB=Inner Cutts Cove, NH; OCC (not shown)=Outer Cutts Cove, NH; DISL=Drakes Island Marsh, Webhannet River, ME; STFM=Stuart Farm Marsh, Squamscott River, NH; AWCM=Awcomin Marsh, NH; SDPT=Sandy Point Great Bay, NH.

Salt marsh habitat losses since colonial times range from 84% lost in the Bay of Fundy to 25-50% lost in Massachusetts, New Hampshire, and Maine, based on recent estimates of areal coverage of this vulnerable ecosystem throughout the Gulf of Maine. Given its important place in the coastal landscape, it is surprising how little is known about the role of salt marsh ecosystems in supporting the Gulf of Maine fish communities. Studies of fish present in salt marsh estuaries are limited (Cartwright 1997) and even fewer investigations have been done in marshes on fish diets and food webs (Deegan and Garritt 1997).

This study assessed how fish along the central Gulf of Maine coastline (Figure 1) utilized both newly created salt marshes as well as restored salt marshes. The marshes were restored either by removal of tide gates from culverts or construction of tidal channels through berms. The study focussed on vegetated marsh as opposed to intertidal or subtidal creeks or open estuarine waters. The researchers posed three questions: (1) How does the fish assemblage of the manipulated marsh compare with that of an appropriate reference marsh? (2) How does the difference between the fish assemblage of the

(continued on page 2)

(continued from page 1)

Table 1. Fish species and crustacean occurrences at all salt marsh study sites. Fish assemblages between manipulated and associated reference marshes were assessed to determine possible differences in fish utilization between these marshes. Specifically, comparisons of fish species occurrences between a manipulated marsh and its paired reference marsh revealed few significant differences in species number. Stuart Farm and Sandy Point study sites had the largest differences in the number of species, where Stuart Farm had more species in the restored marsh and Sandy Point had more species in the reference marsh. The designations "created, " "culvert," and "berm" refer to types of restoration or creation projects. Abbreviations for Habit: R=marsh resident; T=marine transient; M=migratory (c=catadromous; a=anadromous); F=freshwater. OCC is an additional reference site. Res=Restoration or Creation, ref=Reference. Data are pooled across all samples (n=35 for reference sites; n=27 for restoration or creation sites).

		SALT MARSH STUDY SITES												
		Restored/Created					Culvert				Berm			
FISH SPECIES	Habit	**INMP** Inner North Mill Pond, NH		**SUB** Inner Cutts Cove, NH		**OCC** Outer Cutts Cove, NH	**DISL** Drakes Island Marsh, ME		**STFM** Stuart Farm Marsh, NH		**AWCM** Awcomin Marsh, NH		**SDPT** Sandy PointGreat Bay, NH	
		Res	ref	Res	ref	ref	Res	ref	Res	ref	Res	ref	Res	ref
Mummichog	R	*	*	*	*	*	*	*	*	*	*	*	*	*
American Eel	R or M (c)	*	*	*	*	*		*	*	*		*	*	*
Atlantic Silverside	R	*	*				*	*	*	*	*	*		*
Striped Killifish	R									*			*	*
Two-spined Stickleback	R						*	*						*
Three-spined Stickleback	R						*	*						*
Four-spined Stickleback	R						*							
Nine-spined Stickleback	R								*			*		
Atlantic Tomcod	T		*	*	*	*			*					
Winter Flounder	T					*			*					
Atlantic Herring	T					*								
Stiped Bass	M (a)					*								
White Perch	M (a)								*					
American Shad	M (a)	*												
Sunfish sp.	F								*					
15 Species Total		4	4	3	3	6	5	5	8	4	2	4	3	6
CRUSTACEANS														
Green Crab		*	*	*	*	*	*	*	*	*	*	*	*	*
Shore Shrimp		*		*	*	*			*	*	*	*	*	*
Sand Shrimp							*	*	*	*	*	*	*	*
American Lobster					*									
4 Species Total		2	1	2	3	2	2	2	3	3	3	3	3	3

manipulated marsh and the reference marsh change over time? and (3) How do fishes respond to different types of marsh restoration?

Methods and Results

The six study sites along the New Hampshire and southern Maine coast had both manipulated and reference marshes (Figure 1). A *manipulated* marsh was either a newly created or restored marsh. For each manipulated marsh, an adjacent undisturbed area was selected to serve as a paired *reference* marsh. Both types of marshes were sampled simultaneously to ensure that they were flooded by the same tide, and as much as possible, at similar points during the cycle of tidal inundation.

Fish were collected with adapted fyke nets as they left the marsh during evening spring tides. During the course of the study, researchers collected a total of 3,275 fish from 62 samples. This figure excludes a school of Atlantic Herring because their extremely high density represented an outlier. The area of marsh sampled ranged from 8.7 to 870 m^2, with a mean of 317 m^2.

Researchers collected fifteen fish and four crustacean

(continued from page 2)

species from the thirteen area marshes sampled. Seven of these fish species were marsh residents, four were diadromous, three were transients, and one was an accidental freshwater visitor. The number of species in each marsh area sampled ranged from two to eight (Table 1), with Mummichog present in all of the marshes. American eel was in all of the reference marshes and two thirds of the manipulated marshes. Atlantic silversides occurred in 71% of the reference and 67% of the manipulated marshes. Winter flounder, three-spined stickleback, nine-spined stickleback, striped killfish, and Atlantic tomcod were all seen less frequently in both types of marshes. Four-spined stickleback, American shad, and white perch occurred only in manipulated marshes.

The Stuart Farm and Sandy Point study sites had the largest differences in the number of species between the manipulated and reference marshes with more species in the restored marsh at Stuart Farm and more in the reference marsh at Sandy Point (Table 1). Comparisons of fish occurrence between manipulated and reference marshes at the six study sites revealed few significant differences in density, total length, or species number.

This study used a simplified version of fish life history habits, collapsing seven categories, found in the classification by McHugh (1967) as described in Ayvazian et al. (1992), into three categories: resident, migratory (catadromous), and transient. Estuarine *residents* are species that spawn and then spend a significant part of their life in the estuary. *Migratory* fish have an anadromous or catadromous life history. Finally, the *transient* fish are both the spawners (marine species that spawn in ocean waters but use the estuary as a nursery), and marine (marine fish that visit the estuary as adults) classifications.

Other results not presented here include analyses of mummichog densities and lengths, large fish densities, and the relative effects of culverts and berms on mummichog density.

Disscussion

In this study, researchers monitored both manipulated and reference marshes at six locations in a small geographic area along the coast from Drakes Island Marsh in Wells Maine to Awcomin Marsh in New Hampshire. The fish populations were sampled for one to three years within a post-restoration period. This is an early phase of the marsh creation or restoration. Mummichog dominated the fish assemblage and comprised 93% of the mean total fish density. Of the fourteen marine and estuarine species identified, more than half were marsh residents, followed by transients, and then migratory species. This assemblage represents about a fourth of the 48 fishes know to occur in Gulf of Maine salt marsh dominated estuaries (Cartwright 1997), including most of the marsh resident species. Marsh residents along other areas of the Atlantic Coast are known to use the vegetated marsh surface to a much greater degree than other groups of fish that occur in salt marsh estuaries (Kneib 1997).

This study provides the first density estimates for fishes in vegetated salt marsh habitat in the Gulf of Maine. Most prior studies of fish distribution and abundance in this area relied on measures of relative abundance and were restricted to sampling within intertidal and subtidal waters (Cartwright 1997). Mean total fish density in the present study ranged from 0.05 to 0.67 m^{-2}. The highest mean densities overlap with some of the lower mean densities measured for vegetated marsh in southern coastal areas in Virginia (Varnell and Havens 1995), Georgia (Kneib and Wagner 1994), Louisiana (Baltz et al., 1993; Rozas and Reed 1994), and Texas (Minello et al., 1994). These southern tidal wetlands are low marsh dominated by *Spartina alterniflora.* The greatest fish densities in the present study occurred in the reference sites at Inner North Mill Pond and Sandy Point, areas consisting of fringing *S. alterniflora* low marsh as opposed to the *S. patens* dominated high marsh of the Drakes Island, Stuart Farm and Awcomin Marsh reference areas. This study suggests a difference in fish utilization between low and high marsh zones that merits further investigation, given that both of these marsh types are important habitat in the Gulf of Maine. Most opportunities for marsh restoration in the Northeast occur in marsh systems containing both high and low marsh with low marsh comprising only 10-20% of the total marsh area.

Often people consider one criterion for the success of a salt marsh to be the use of marshes by nekton (Mattews and Minello 1994). This study indicates that fish will readily visit restored and created marshes in assemblages similar to those found in references marshes. This result is not surprising given the mobility of fish and the general tendency of many littoral fishes to investigate physical structures such as plant stems. However, they are subject to the influence of differences in tidal regime, access to marsh habitat, and possibly density of vegetation found in restored marshes.

While visitation is necessary, it is not sufficient evidence that a restored or created marsh is valuable fish habitat. This study did not establish a comparison between fish growth and survival in the manipulated marshes to that in natural marshes. Studies comparing the benthic invertebrate fauna of manipulated and reference marshes indicate that invertebrate prey can be significantly less in created marshes during the first ten to twenty years (Posey et al, 1997). One study reported lower fish densities but increased feeding in a created marsh, due to the increased abundance of polychaetes that were more accessible to fish than the oligochaetes in the reference marsh (Moy and Levin 1991). *From the differing results of many studies, it appears that variation in prey availability is an important factor in determining the value of created and restored salt marshes for fish.*

At Stuart Farm, the restored marsh area was undergoing a process of colonization and succession by salt marsh plants after salt water from the tidal restoration killed the fresh marsh

(continued on page 4)

(continued from page 3)

vegetation. At Drakes Island the entire restored marsh was dominated by *Spartina alterniflora* creating an expanse of contiguous low marsh unusual in New England. For marsh resident fishes, prolonged inundation of emergent vegetation can create optimal conditions for feeding, growth, and survival. Other aspects of marsh restoration are critical for fish survival such as the dimensions and placement of culverts that influence the movement of fish to and from the restored marshes. At Drakes Island, the small diameter and long traverse of the culvert pipe likely negatively influenced fish movement. *Physical and behavioral barriers to fish passage should be considered in the design of marsh restoration and creations projects.*

For most instances, dam removal and other hydrologic restoration of tidally restricted marshes will improve a much greater area of fish habitat per unit cost than creation of a new marsh and will not be subject to many of the constraints that limit the function of created marshes (Zedler 1996). In these tidal restoration projects, the primary consideration is not necessarily the cost of construction, but instead the social, economic and political issues surrounding the project. Often, these areas are located in highly developed coastal areas and local residents may perceive the restoration of tidal flow as a threat, even when flood hazard studies show that no such threat exists. *In spite of this caution, thousands of hectares of coastal fish habitat could be improved through a program to restore the hydrology of tidally restricted marshes in the Gulf of Maine (Dionne et al., 1998).*

Acknowledgements

Material for this article was printed with permission of the American Fisheries Society. The complete paper appears in their 1999 publication *Fish Habitat: Essential Fish Habitat and Rehabilitation*, Lee Benaka editor.

References

Ayvazian, S.G., L.A. Deegan, and J.T. Finn. 1992. Comparison of habitat use by estuarine fish assemblages in the Acadian and Virginian zoogeographic provinces. Estuaries 15:368-383.

Baltz, D. M., Rakocinski, C. and Fleeger, J.W. 1993. Microhabitat use by marsh-edge fishes in a Louisiana estuary. Environmental Biology of Fishes 36:109-26.

Cartwright, M.A. 1997. Dietary habits of benthic-feeding fishes in a Southern Maine salt marsh: evaluation of prey availability and feeding selectivity. Ph.D. Thesis, University of Maine. 135 pp.

Deegan, L. A. and R. H. Garritt. 1997. Evidence for spatial variability in estuarine food webs. Marine Ecology Progress Series 147:31-47.

Dionne, M., D. Burdick, R. Cook, R. Buchsbaum and S. Fuller. 1998. Physical alterations to water flow and salt marshes: protecting and restoring flow and habitat in Gulf of Maine salt marshes and watersheds. Final draft of working paper for Secretariat of the Commission for Environmental Cooperation. Montreal, Canada. 68 pp.

Kneib, R.T. 1997. The role of tidal marshes in the ecology of estuarine nekton. Oceanography and Marine Biology 35:163-220.

Kneib, R. T. and Wagner, S. L. 1994. Nekton use of vegetated marsh habitats at different stages of tidal inundation. Marine Ecology Progress Series 106:227-38.

Matthews, G.A. and T.J. Minello. 1994. Technology and success in restoration, creation, and enhancement of *Spartina alterniflora* marshes in the United States. Decision analysis series. No. 2. US Department of Commerce, National Oceanic and Atmospheric Administration, Coastal Ocean Office. Washington, D.C.

McHugh, J.L. 1967. Estuarine nekton, pp. 581-691. In G. H. Laurff (ed.), Estuaries. American Association for the Advancement of Science, Special Publication 83.

Minello, T.J., R. J. Zimmerman and R. Medina. 1994. The importance of edge for natant macrofauna in a created marsh. Wetlands 14:184-198.

Moy, L.D. and Levin. 1991. Are *Spartina* marshes a replaceable resource? A functional approach to evaluation of marsh creation efforts. Estuaries 14:1-16.

Posey, M. H., T. D. Alphin, and C. M. Powell. 1997. Plant and Infaunal communities associated with a created marsh. Estuaries 20:42-47.

Rozas, L. P. and D. J. Reed. 1994. Comparing nekton assemblages of subtidal habitats in pipeline canals traversing brackish and saline marshes in coastal Louisiana. Wetlands 14:262-275.

Varnell, L. M., and K. J. Havens. 1995. A comparison of dimension-adjusted catch data methods for assessment of fish and crab abundance in intertidal salt marshes. Estuaries 18:319-325.

Zedler, J. B. 1996. Ecological issues in wetland mitigation: an introduction to the forum. Ecological Applications 6:33-37.

For more information contact Michele Dionne at (207) 646-1555 or dionne@wellsnerrcec.lib.me.us

Habitat Committee Moves Forward on SAV and Gear Impacts Report

The ASMFC Habitat Committee met in October at the Annual Meeting to discuss several issues including project review, marine protected areas, and the Commission's Action Plan. One key agenda item at this meeting was how to implement the report: "Evaluating Fishing Gear Impacts to Submerged Aquatic Vegetation and Determining Mitigation Strategies." In June, the Committee discussed ten different implementation options including such actions as SAV mapping, SAV state plans, and an education effort.

This summer the ASMFC asked for public comment on these implementation options through a survey sent to various groups and notices in Fisheries Focus, Habitat Hotline, and on the ASMFC website. The Commission received considerable feedback from a variety of sources including recreational and commercial fishermen, fishery and habitat managers, as well as our Commissioners. In general, there was strong support for the recommendations and people felt the Commission should be moving forward with this process.

The Habitat Committee discussed the survey results focussing much of their attention on the "State Plans" recommendation. State plans would give the states maximum flexibility in addressing issues in their state while taking into account their current regulations, mapping and education efforts. Each state could decide how they could best increase protection of SAV given their fishing efforts and needs. Many of the other ten recommendations could be included in these state plans.

The Habitat Committee will be meeting in the first half of next year to discuss in greater detail what would be included in these State plans and develop a recommendation for future Commission action. For more information, contact Carrie Selberg, Habitat Specialist, at the ASMFC office (cselberg@asmfc.org or 202-289-6400).

National Oceans Commission Created

On August 7, 2000, President Clinton signed into law the Oceans Act of 2000. The Act creates a 16-member national Oceans Commission to make recommendations for a coordinated and comprehensive ocean policy that will promote several objectives, including the protection of life and property against natural and manmade hazards, responsible stewardship of fishery resources and other ocean and coastal resources, protection of the marine environment and prevention of marine pollution, the enhancement of marine-related commerce and transportation, and the expansion of human knowledge of the marine environment.

Members will be appointed by the President, with 12 members coming from congressional leadership nominations: the Majority Leader of the Senate (4 members), Speaker of the House of Representatives (4 members), Minority Leader of the Senate (2 members), and Minority Leader of the House of Representatives (2 members); and the remaining 4 members being selected by the President. Membership is to be drawn from representatives of state and local government, ocean-related industries, academic and technical institutions, and public interest organizations involved with scientific, regulatory, economic, and environmental ocean and coastal activities.

The Act requires the Commission to hold regional public hearings, providing opportunities for public input. Furthermore, when a draft report is available for public review, the Commission is required to publish a notice in the Federal Register.

Beginning January 20, 2001,when the Act takes effect, the Commission will have 18 months to develop recommendations for a long-term strategy to protect the oceans to present to the President and Congress. Previously in the mid-1960s, the Stratton Commission undertook a comprehensive review of U.S. ocean policy and recommended the establishment of the National Oceanic and Atmospheric Administration, the Coastal Zone Management Act and the National Estuarine Research Reserve system.

In addition to the Oceans Act of 2000, two other marine coastal bills have recently become law. The Beach Act was signed into law by President Clinton on October 10, 2000. This legislation amends the Clean Water Act to require ocean, bay, and Great Lakes states to adopt minimum, health-based criteria for water quality, comprehensively test recreational beach waters for pathogens, and notify the public when contamination levels make beach water unsafe for swimming, surfing, and other activities. The bill authorizes $30 million annually in federal grants to help coastal states develop and implement effective water quality monitoring and public notification programs.

The Estuary Restoration Act of 2000 was signed into law by President Clinton on November 7, 2000 to encourage the restoration of estuary habitat through more efficient project financing and enhanced coordination of Federal and non-Federal restoration programs. The Act authorizes $275 million over five years to restore coastal habitat.

Sources: Coastlines*, October 2000 Issue 10.5 and Clean Water Network's November/December 2000 Status Report*

CA Chemical Companies To Pay for DDT Clean Up & Wildlife Restoration

On Tuesday, December 19, 2000 the Department of Justice, on behalf of the National Oceanic and Atmospheric Administration, filed a settlement agreement in federal court requiring that chemical companies pay for environmental clean up and restoration of wildlife contaminated by the largest known deposit of DDT. After years of research and litigation, Montrose Chemical and three related companies have agreed to pay $73 million to the United States and the state of California. The Montrose Chemical factory located in Torrance, California, near Los Angeles, was one of the world's largest manufacturers of the pesticide DDT until 1972, when it was banned in the United States. The factory discharged its wastes into the ocean contaminating 17 square miles of sediments near the sewer outfall. Today, the impact is still seen in the area's contaminated fish and bald eagles eggs with shells too weak to incubate and hatch.

Approximately $30 million of the settlement will be spent to restore natural resources harmed by the DDT, including fish, bald eagles, peregrine falcons and other birds in the area. The rest of the settlement, about $43 million, will be available to clean up the contamination. One option being considered is that of capping the contaminated sediment by burying it with clean sediment. In addition, under the terms of the settlement, up to $10 million of the cleanup funds could also be used for more restoration projects, depending on the remedy selected by the U.S. Environmental Protection Agency. The restoration portion of the settlement is the biggest payment for natural resource damages since the Exxon Valdez oil spill.

Source: NOAA press release

Atlantic States Marine Fisheries Commission
1444 Eye Street, N.W., 6th Floor
Washington D.C. 20005

Return Service Requested

Habitat Hotline Atlantic

Robin L. Peuser
Carrie D. Selberg
Editors

Funded by