

INVENTORY OF INTERTIDAL AND ESTUARINE FISHES OF ACADIA NATIONAL PARK

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INTRODUCTION

Acadia National Park is part of the Northeast Temperate Network, and inventory and monitoring activities are becoming increasingly important to the long-term management goals of the Park. Summaries of past studies of freshwater fish resources of Acadia National Park have been issued (Bowes et al. 1999) and more detailed inventories (with relative abundance assessments) are undergoing final reviews (Moring et al. 2001). However, detailed inventories of fishes of estuaries and intertidal areas adjacent to Park lands are very limited.

Fishes inhabiting these mixing areas between the land and ocean are extremely important components of ecosystems (Edwards et al. 1982), and can be categorized in one of three groups.

Intertidal fishes are those utilizing the intertidal zone, either during flood or ebb tides.

Typically, they forage in the area between the low and high tide marks during the flood tide, then often depart with the receding tide. **Tidepool fishes** are found in isolated, trapped tidepools at low tide. Tidepool fishes are also intertidal fishes, but not all intertidal fishes are tidepool fishes.

Tidepool fishes include (1) those species that spend their entire life cycle (or much of it) living in tidepools and the intertidal zone, (2) juvenile stages of subtidal fishes that use tidepools as refuges from predators during the first or second year of life, and (3) occasional, rare visitors--

typically intertidal species that become trapped in pools with a rapidly receding tide. **Estuarine fishes** are those found in the transition zones between river mouths and the ocean, and in salt marshes. Often, the species list for such areas depends on the salinity at a given location, although many estuarine fish species are euryhaline, and are able to live in a variety of salinities.

These intertidal and estuarine areas are particularly susceptible to oil spills, sewage, chemical pollutants released into coastal areas, and coastal development (Moring 1983). Not only do such spills tend to concentrate along the shores (Boesch et al. 1974), but intertidal and estuarine fishes have strong habitat and food requirements in these locales. Even if fishes are able to physically move from an impacted area, marine algae and many forms of sessile invertebrates can not leave. Thus, fishes can be adversely affected, even in an indirect way because of the strong habitat requirements and associations (Boesch and Turner 1984; Rozas and Odum 1988; Sogard and Able 1991). Estuaries are typically the most productive regions of coastal waters and tidepools serve important nursery and refuge functions for many commercially-important species of marine fishes in Maine waters, such as juvenile pollock (*Pollachius virens*), Atlantic herring (*Clupea harengus*), winter flounder (*Pleuronectes americanus*), and lumpfish (*Cyclopterus lumpus*). As a consequence, future Park management may rely heavily on baseline inventories of species presence and their relative abundance.

Doering et al. (1995) completed an analysis of the Bass Harbor Marsh system near Bass Harbor, and this included some sampling of fishes. However, the emphasis of those investigations was water quality and other physical/chemical features. Fish collections were made at several stations within the estuary, periodically between the months of April and October.

Some limited work on the Northeast Creek estuary has targeted single fish species (e.g., mummichog, *Fundulus heteroclitus*). The species present and relative abundance of fishes in other estuaries have been little studied, if at all. Thus, fish species presence and absence and positions related to salinity and season need to be documented for principal estuaries.

Proctor's (1933) biological examination of Mount Desert Island examined intertidal and inshore marine fishes, but the collections were not made temporally, nor were they quantitative. Rather, Proctor only documented some species that were collected in the 1920s and 1930s. Moring (1990b) has examined fish species of tidepools along Schoodic Peninsula (a detached portion of Acadia National Park near Winter Harbor) since 1979 and has provided check lists and relative abundance data for Maine tidepool fishes (Moring 1993a). Moring also has conducted more detailed investigations of individual intertidal and inshore fishes (e.g., rock gunnel, *Pholis gunnellus* (Moring 1993b), lumpfish (Moring 1989; Moring and Moring 1991), and sculpins, *Myoxocephalus* spp. (Moring 2001), among others. But, intertidal fish populations adjacent to Park lands on Mount Desert Island have not been examined on a broad or even a local scale.

OBJECTIVES:

The objectives of this research are to (1) inventory fish species found in tidepools at locations adjacent to Park lands on Mount Desert Island and Schoodic Peninsula, and (2) conduct more detailed inventories of estuarine fishes at Northeast Creek, Frazer Creek, Bass Harbor Marsh, and 10 other locations over different seasons and estuarine locations.

METHODS:

Fishes will be inventoried during two field seasons, 2001 and 2002. This is strictly an inventory process and is not intended to be a long-term monitoring protocol. Thus, quantitative sampling procedures will not be utilized that will allow for repetitive comparisons in future years. Rather, the objective is to sample as many diverse habitats as possible in the intertidal and estuarine zones to maximize the resultant species lists. Intertidal sampling and estuarine sampling can not be placed within a convenient experimental sampling design because dates and times of sampling must, to a large extent, be based on tidal cycles. The Bay of Fundy and waters adjacent to Acadia National Park have some of the highest tidal ranges in the world. Some locations and their inhabitants are only accessible during -0.0 m tides, while much estuarine sampling will be conducted during flood tides. In addition, many suitable tides occur at night, which limits sampling because of visibility and safety concerns, and inclement weather conditions adversely affect visibility for intertidal sampling.

Because of this, there only will be a finite number of sampling days available each year to accomplish this inventory, and these do not occur on a regular sampling basis. Two seasons of sampling will be necessary to adequately document the fish populations.

All data regarding fauna and location will be entered by the investigators into the National Park Service NPSpecies Database, with guidance from the Park biologists (Wildlife) and data management technicians. The Park has requested that one to three specimens of each species be collected for the Park's reference collection. The Principal Investigator will confer with the Park's museum curator concerning preservation, labeling, and cataloging specimens for the NPS Collections Management program.

Intertidal Sampling

Tidepool fish presence in the rocky intertidal zone is seasonal in nature (Moring 1990b, 1993a). Winter water temperatures can reach slightly below 0°C and almost all fish species depart for subtidal waters in winter. It has been documented that fishes are generally absent from tidepools from about November through April (Moring 1990b), with the exception of the occasional presence of sculpins (*Myoxocephalus* spp.). Therefore, sampling in tidepools along the rocky shores will occur from May through October.

On these trips, fishes will be collected at low tides using long-handled dip nets, small seines, small hand nets, (occasionally) small, baited minnow traps, and small trawls. These techniques have been efficient and productive in previous investigations (Chenoweth 1973; Moring et al. 1980; Moring 1990a). Each captured fish will be anesthetized using MS-222 (tricaine methanesulfonate), identified, measured to total length, and then returned to the tidepool where collected. Except for the smallest fishes, measuring can induce stress in fishes, thus anesthesia is appropriate. In addition, the Institutional Animal Care and Use Committee recommends the use of anesthetics to avoid stress and pain when handling fishes.

Between one and two sampling locations can be inventoried on each appropriate low tide period, as the sampling window exists only from about 1.5 hours prior to low tide to 1.5 hours after low tide. The objective will be to sample each such intertidal location at least once during spring, summer, and fall over the two field seasons. It is anticipated that a minimum of 12 general intertidal sections, each with multiple pools, as well as other areas with single pools, will be visited for this inventory.

In addition, small trap nets and minnow traps may be anchored in pools to assess

intertidal visitors during flood tides when direct sampling is difficult. Larger-scale sampling using staked gill nets in the intertidal zone has been employed by Ojeda and Dearborn (1989, 1991), but the procedures are extremely labor-intensive, difficult to employ, and dangerous to implement on a broad scale, and would be cost-prohibitive for these investigations.

Date, time, water temperature, pool height (which can then be related to tidal height), approximate algal cover, and salinity will be recorded at each location for each sampling date. All intertidal sampling locations will be recorded using a GPS unit so that GPS location and related fish species and numbers can be used by others in GIS applications. Tidepool surface area will be measured at least once during the inventory using digital measuring devices. Approval will be obtained from the University of Maine's Institutional Animal Care and Use Committee for the fish collecting and handling procedures, but fishes will be released. Mortality associated with capture is expected to be minimal except for specimens that will be preserved and held by Acadia National Park, at the request of Resource Management staff. Invertebrates collected during trapping will be noted and counted, but no attempt will be made to make quantitative or qualitative assessments of community species.

Estuarine Sampling

A maximum of 13 estuaries will be examined for fish inhabitants, each of which borders Acadia National Park lands: Bass Harbor Marsh, Northeast Creek, Frazer Creek, Breakneck Brook/Hulls Cove, Schooner Head, Otter Cove/Otter Creek, Hunters Brook, Ship Harbor, Pretty Harsh, Stanley Brook./Seal Harbor, Whalesback/Northeast Somes Sound, and Man of War Brook/Acadia Mountain. Some of these estuaries are quite limited in size, and may not be

functional estuaries during all seasons. At each estuary, a series of stations will be established where water temperature, depth, and salinity will be recorded. Depending on the location, fishes will be collected using beach seines, gill nets, trap nets, and baited minnow traps. Catch effort (time) will be recorded for use in providing catch-per-unit-effort data for relative abundance estimates. Such sampling will be conducted at low tides and high tides to assess tidal differences in species and species numbers. These sampling stations will be accessible by boat and from shore. Thus, a complete sampling trip to an estuary will take from three to five days to complete. Each estuary will be visited in spring, summer, and fall over the course of the entire two seasons, 2001 and 2002, depending on tides and weather conditions. Handling procedures and GPS coordination will be similar to those techniques used in collecting and processing intertidal fish specimens. Invertebrates encountered while trapping will be noted and counted, but the objective is to make inventories of fishes rather than invertebrates. Submerged cover and bottom type will be recorded.

Statistical Notes

The intertidal sampling can not be designed to fit a normal sampling approach because tidepools are only exposed during limited periods each day and the times and height of the low tides vary each day. The objectives of this inventory is to determine presence or absence of species and estimate, based on catch and effort, relative abundance. Along Mount Desert Island and Schoodic Peninsula, rocky intertidal areas containing tidepools are scattered, so a thorough search of each pool or series of pools can be accomplished on a single trip. For example, although the intertidal zone of Schoodic Peninsula stretches for many miles, there are actually

only six principal rocky tidepool sections that contain fishes at low tide, each with only one or two pools. Thus, instead of randomized sampling points, each such section can be thoroughly examined. Within a single pool, it is not valid to create subsampling locations because a tidepool may contain several distinct microhabitat types. Since the purpose is to maximize encounters with as many fish species as possible, the objective will be to sample a variety of habitats.

For estuaries, a modified random design can sometimes be employed, except that species distribution and abundance is largely a factor of salinity and cover. Certain species will be found higher in the system, in waters with low salinities, while other species are confined to lower reaches, where salinities are higher.. Thus, sampling site selection must maximize possible fish encounters across salinity and habitat gradients, which are fluid--changing with tidal cycle. In both environments, the overall objective is to thoroughly sample as many habitats and seasons as possible.

For both intertidal and estuarine sampling, species richness and diversity indices will be calculated (Richness, Shannon-Weaver, Dominance, etc.) and compared in relation to location, water temperature, surface area, and salinity. Species lists will be presented by estuarine area and by general intertidal location in relation to Park lands.

Safety Concerns

For the intertidal zone, access is often across slippery, algae-covered rocks; thus, unstable footing is a major concern. During implement weather, working in the turbulent intertidal zone can be dangerous because of water turbulence, waves, and wet rocks. As a consequence, sampling trips during poor weather will be avoided, partly because visibility of pools is impaired.

Flood tides advance quite rapidly and samplers and equipment can be isolated and trapped--thus the time windows of sampling are only broad guidelines.

For estuarine sampling, boats may be required. All operators of motorized boats will complete a Department of the Interior Motorboat Operators Course prior to using outboard motors. Safety equipment for boats, including personal flotation jackets, safety lights, first aid kits, and fire extinguishers will be placed on boats. We do not anticipate sampling at night, so night safety concerns may not be an issue. However, working in boats in rapidly changing tidal conditions is recognized as a potentially dangerous situation. No personnel will work alone in the field,

PRODUCTS PRODUCED:

Progress reports will be submitted annually using the National Park Service=s Investigator=s Annual Report (IAR) reporting system, which is a web-based summary. These annual; summaries will be a product of annual meetings between Park officials and the investigators. A Final Report will be submitted before June 30, 2003. The report will include sampling locations recorded by GPS, according to ANP-NPS GIS standards. It is anticipated that a scientific paper or papers will be submitted to journals, based on the results of these inventories. At least one oral presentation will be made at a scientific meeting. At least two informal seminars are anticipated, one presented to Park staff and the other presented to the general public.

The investigators will prepare and label all collections and will catalog specimens according to NPS Collection Management guidelines. Originals of all photographs or slides

(labeled), field notes, and written descriptions of field or laboratory techniques will accompany the Final Report. No equipment is specified in the Budget that is to be purchased with NPS funds, so property ownership is a moot point.

SPECIAL ATTRIBUTES:

The Maine Cooperative Fish and Wildlife Research Unit owns some sampling equipment and computer hardware and software needed to conduct these investigations, including nets, computer hardware and software, and field GPS units. The project will purchase trap nets, minnow traps, and gill nets will be needed because of the extensive sampling in estuaries. The Unit is not requesting salary for the Principal Investigator, but he will be committing 2 person-months of time each year to this project. The Unit will be most cost-effective in conducting this work, using undergraduate students to conduct most field sampling, thus negating the need to budget for professional salaries and benefits.

Unit personnel work closely with biologists with the Maine Departments of Marine Resources and Inland Fisheries and Wildlife, and have a good working relationship with National Park Service personnel in Maine. The Unit comes to this investigation with over 37 years of experience conducting fisheries investigations in Maine waters, and the Principal Investigator has over 33 years of experience conducting intertidal and estuary research.

TIME TABLE:

May 1, 2001 - November 1, 2001	Field collections, Year 1 in estuarine and intertidal areas
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December 31, 2001	Progress report for Year 1
April 1, 2002 - November 1, 2002	Field collections, Year 2, in estuarine and intertidal areas
December 31, 2002	Progress report for Year 2
June 30, 2003	Final report for project.

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<u>BUDGET:</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>TOTAL</u>
1. <u>Wages/Salaries</u>				
(One undergraduate crew leader--\$8.20/hr X 8 months; one undergraduate field assistants--\$7.20/hr X 8 months)	5,773	5,773	0	11,546
	5,069	5,069	0	10,138
2. <u>Supplies</u>				
(Trap nets, minnow traps, gill nets, notebooks)	2,300	200	581	3,081
3. <u>Photocopying</u>	100	100	500	700
4. <u>Computer Services</u>	150	150	150	450
5. <u>Equipment Purchase/Maintenance</u>	2,500	2,000	500	5,000
6. <u>Report Preparation</u>	50	50	400	500
7. <u>Collections</u>	270	270	80	620
(Specimen preservation @ NPS rate of \$3.00/specimen)				
8. <u>Travel and Housing</u>	9,100	9,100	148	18,348
(Mileage, commercial housing, food)				
9. <u>Safety Equipment</u>	1,000	100	100	1,200
TOTAL DIRECT COSTS	26,312	22,812	2,459	51,583
INDIRECT COSTS (23.5 % NPS coop. agmt. rate)	5,831	5,008	578	11,417
<u>TOTAL PROJECT COSTS</u>	32,143	27,820	3,037	63,000
<u>Project Contributions:</u>				
National Park Service	32,143	27,820	3,037	63,000
University of Maine	5,831	5,008	578	578
			11,417	
(Cost sharing, 23.5%)				
U.S. Geological Survey	14,591	14,927	15,270	44,788
(Value of salary for time commitment of PI)				