Annual Report

Ecological Role of Adult and Juvenile Anadromous Forage Fish in Downeast Maine Estuaries: Sea-Run Alewife and Groundfish Predators

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Submitted by

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Project objectives and scientific hypotheses

Our original objectives were to compare the diets of potential predators in one high alewife estuary to one low alewife estuary per summer, with a total of four estuaries in the experimental design. After near zero catches of potential alewife predators in Denny's Bay in 2006 and no available means to count alewives in the Denny's River, in 2007 we added two midcoast Maine estuaries with larger, monitored alewife runs and larger potential predator populations. This effectively increased the chance of observing alewife predation in the nearshore marine environment and we have maintained this sample regime for 2008 (Table 1).

Table 1: Changes in sampling design

	High alewife numbers	**Low alewife numbers**
2006	Denny's Bay	Gleason Cove
2007 (using remaining funds from 2006)	Damariscotta Estuary, St. George Estuary	Gleason Cove/mouth of Passamaquoddy Bay
2008 (no cost extension from 2007)	Damariscotta Estuary, St. George Estuary	Gleason Cove/mouth of Passamaquoddy Bay

Work completed to date

- **Sampling of the St. George, Damariscotta and Little River (Passamaquoddy Bay) estuaries in August 2007, October 2007, and May 2008.**

  We expanded our sampling in 2007 to include two midcoast estuaries, as suggested in the original proposal reviews, with the hopes of catching more cod and other commercially viable groundfish. Two additional fishermen, both currently lobstermen, and a tuna fisherman were contracted to work in the waters in and around the St. George and Damariscotta River Estuaries in 2007. We initiated the use of baited tub trawls to augment

our catch, but found that in the midcoast region most hooks were stripped of bait within the 3-hour soak period by small non-target fish and crustaceans. We also shifted our sampling dates to later in the summer and into the fall to better capture out-migrating young-of-year (YOY) alewives. This shift in timing was highly successful in the midcoast estuaries.

- **Assessing alewife spawning run abundance through the:**
  - Successful installation of video counting equipment at the Damariscotta Mills fish ladder, summer 2007.
    - When combined with harvest data from 2007, these data give a relatively complete account of how many alewives reached the harvest point at Damariscotta Mills, and therefore traversed the estuary during their migration.
  - Construction and installation of experimental weir at Sennebec Pond, St. George River, as well as video assessment equipment.
    - The majority of adult alewife data from the St. George River will come from harvest records from 2007. However, we did make a first step towards establishing harvest-independent counts in 2007 and 2008 in conjunction with a NOAA-funded effort to assess alewife movement over a rehabilitated dam site at the base of Sennebec Pond (7 miles upstream). The site where the harvest independent count occurred receives a small proportion of the total run, but will give us a relative sense of the run size in 2007 and 2008.
    - Dr. Willis designed and installed the weir for the Sennebec Pond project using funds from a separate grant. That effort, though not focused on needs relevant to this project, did address the problem of qualifying estuaries as high and low alewife. The weir used in the Sennebec Pond Project was an attempt to field test counting weir designs appropriate for mainstem coastal rivers without fishways, as a way to address the need for harvest-independent counts of alewife runs. The design used in 2007 and 2008, a floating panel weir, was sound and should be able to withstand the higher flows in the lower portion of the river.
- **Completed processing diets sampled during the 2007 season.**

Results

Diets We caught approximately 989 fish in 2007 (Table 2), most of which were sampled for diets. All diets from 2007 have been processed, with diet items identified to lowest taxonomic level possible, counted and weighted (wet weight). Data is currently being proofed, entered and analyzed.

Table 2: 2007 catches from Damariscotta, Passamaquoddy Bay (Little River, Perry) and St. George Estuaries.

Count of Species		**Month**						
Location	**Species**	**5**	**6**	**7**	**8**	**9**	**10**	**Grand Total**
Damariscotta	alewife						137	137
	cod	3		22			31	56
	cunner	7	1	4			10	22
	cusk		3					3
	longhorn sculpin	2		4			13	19
	mackerel			14			79	93
	pollock			29			60	89
	redfish		2	15			4	21
	shorthorn sculpin			10			5	15
Damariscotta Total		*12*	*6*	*98*			*339*	*455*
Passamaquoddy Bay	cod				1	1	13	15
	dogfish				1		1	2
	hake				1	1		2
	herring				4			4
	longhorn sculpin				34	1	16	51
	mackerel				63	21	59	143
	pollock				1	1	3	5
	sea raven				7	1		8
	shorthorn sculpin				35	6	13	54
	smelt				1			1
P. Bay Total					*148*	*32*	*105*	*285*
St. George	alewife						9	9
	cod		1	17			18	36
	cunner			5			7	12
	hake						1	1
	herring			1				1
	longhorn sculpin		1	6			3	10
	mackerel			40			79	119
	pollock			13			20	33
	redfish			11			6	17
	sea raven			1			1	2
	shorthorn sculpin		1	6			2	9
St. George Total			*3*	*100*			*146*	*249*
Grand Total		**12**	**9**	**208**	**148**	**32**	**590**	**989**

Alewife in diets September 2007 was a dry period, ending in early October with heavy rains on the 12th (Figure 1). This coincided with the appearance of YOY alewives in the diets we sampled (Figure 2), as well as in sightings of schools of alewives in harbors and along the coast. The presence of YOY alewives correlated with above-water (gulls) and below-water (pollock, cod and mackerel) feeding events. Alewives in these schools ranged from 54 – 94 mm (Figure 3).The fisherman we were working with at this time reported seeing schools of alewives up to two weeks before this time period as well. Alewives were not present in diets at other times of the year.

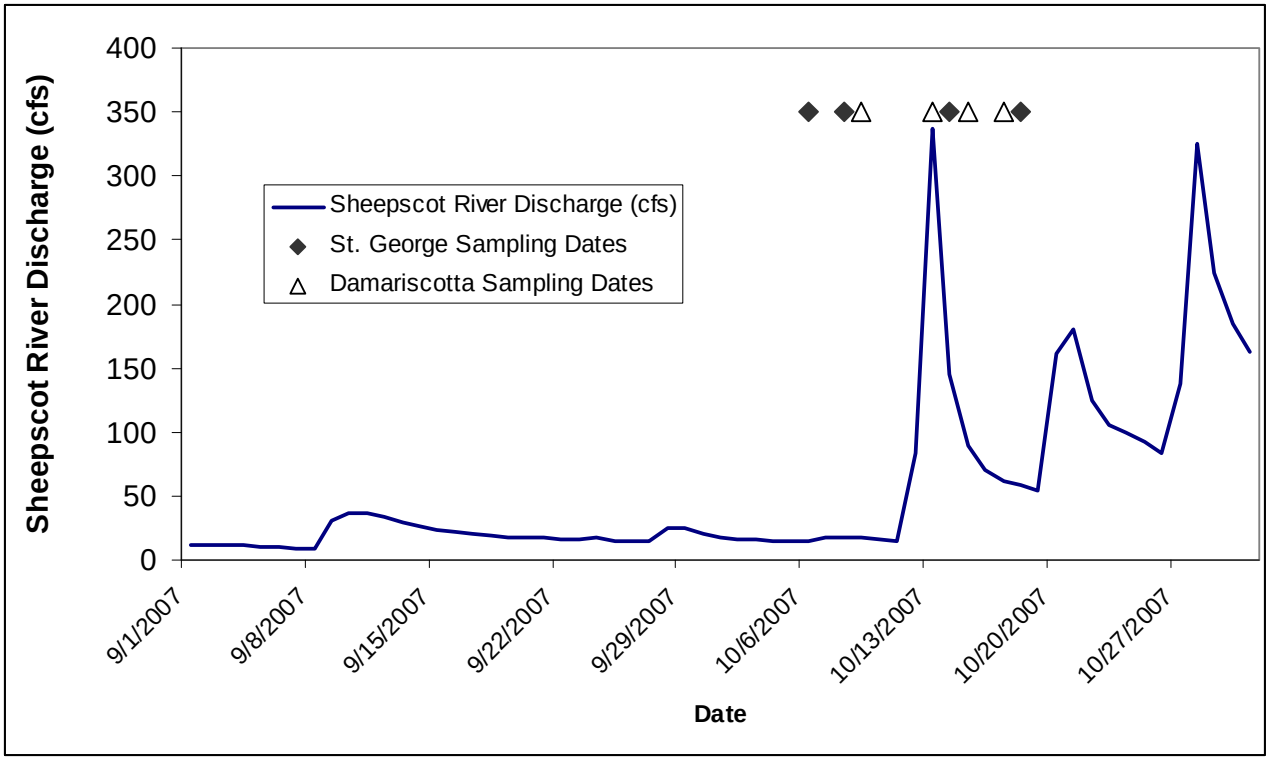

Figure 1. Sheepscot River discharge in cubic feet per second (cfs). Sampling dates for the St. George and Damariscotta estuaries are indicated. We first observed schools of YOY alewives on the 13th of October, one day after heavy rains. Discharge data from USGS.

Figure 2. Fresh YOY alewives in the diet of a mackerel caught off the mouth of the Damariscotta River. October 2007.

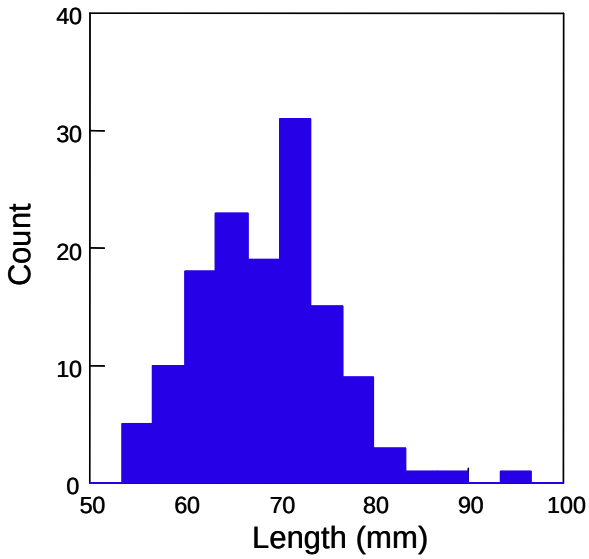

Figure 3. Length distribution of YOY alewives caught in Damariscotta River, October, 2007.

Alewife counts for estuaries Counts for the Little River (Passamaquoddy Bay) alewife run were unavailable for 2007 and 2008, but were very small as compared to the midcoast estuaries (Table 3).

Table 3. Alewife escapement and harvest numbers.

System	**Spawning fish**			**Harvested fish**		
	2006	*2007*	*2008*	*2006*	*2007*	*2008*
Dennys[A]	Unknown	Unknown	~ 70,000	None	None	None
Little[B]	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
St. George[C]	Unknown	7332 at Sennebec	47,109 at Sennebec	90,000	300,000	not yet available
Damariscotta[D]	79,230	80,142	not yet available	54,360	95,640	not yet available

[A] *Dennys River Estuary was only sampled in 2006. In 2008, the MeDMR began counting alewives for the first time at their salmon counting weir in Dennysville. The Dennys River run is currently not harvested.*

[B] *The Little River fish ladder was likely nearly impassable before 2007 due to incorrect operation of the fish ladder at Boyden Dam.*

[C] *In the St. George River, estimates of spawning alewives are for those fish that moved above the rock ramp at the outlet of Sennebec Pond only. There is considerable spawning habitat downstream of Sennebec Pond.*

[D] *Damariscotta River alewives were assessed by hand counts in 2006, hand counts and video in 2007, and hand counts in 2008.*

Damariscotta River Alewife counts (2007) As part of a small, separate project, Dr. Willis secured funds to test a video counting system at the Damariscotta River fish ladder at Damariscotta Mills. Again, although the Damariscotta River project was not expressly meant to provide alewife counts for this project, it did provide useful data to that end. In the process of seeking permission to install the video equipment Dr. Willis was made aware of the harvest independent count that already occurs at Damariscotta Mills, sponsored by Ridgewood Power and the Newcastle-Nobleboro fish committee. Consequently, count data from Damariscotta Mills will be available for 2008.

The two systems were run side by side in 2007. Using video, we evaluated efficacy of the 10-minutes-on-the-hour counting technique that has been used historically at the Damariscotta Mills fish ladder to assess spawning escapement since 1987. Video footage from the 2007 camera install was posted on YouTube in cooperation with the Gulf of Maine Research Institute (Table 4).

Table 4. Video footage from Damariscotta Mills fish ladder activity.

Video subject	Link
"Alewives in the Damariscotta Mills"	http://youtube.com/watch?v=PTkxoYtxkuM
"Largemouth bass eating alewives"	http://youtube.com/watch?v=VdtKc2LQ0Pg
"Cormorant eating alewives"	http://youtube.com/watch?v=EibZRfGfwjo

Baited Video Observing In 2007 we tried to increase our catch rates in all of the sampling areas by using baited tub trawls. We found that by the end of the 3-hour set time all bait had stripped from the hooks and catch rates were extremely low. In most cases, less than 10% of the hooks still had bait when retrieved. For August and October 2007 we added a Baited Video Observation Station (BVOS) to our sampling efforts. A low-cost system was constructed using the underwater video camera purchased in 2006 for conducting alewife video counts. We assessed bait retention on the hooks and identified if bait was being lost to demersal scavengers, groundfish that were not being hooked, or if the bait was simply falling off the hooks. In the midcoast we found that a baited hook was often denuded of bait within 15 minutes by lobster, crabs, or, more likely, swarms of small cunner (*Tautogolabrus adspersus*) (Table 5). We abandoned tub trawls in light of what we saw on the video.

Table 5. Video footage of baited hooks from drop camera.

Video subject	Link
"Cunners and pollock"	http://youtube.com/watch?v=J47YXs8xyGA
"Lobster on drop camera"	http://youtube.com/watch?v=kPqH9DxvKSg

Methods and work plans – 2007 and 2008

1. **Lack of large fish predators.** Despite considerable fishing effort (Table 6), and adding sampling sites in midcoast estuaries, we encountered relatively few predatory groundfish in our spring 2007 sampling session. However, catches of target species increased significantly in the summer and fall sampling periods, suggesting that groundfish are rare inshore in the spring, and that groundfish large enough to prey upon spawning alewife (such as legal sized cod) are absent in nearshore waters. Our observations and inquiries lead us to conclude that birds, marine mammals, and humans are the major predators of spawning alewife. However, October samples demonstrated the fact that, in the right place at the right time, juvenile alewives are a preferred diet item for groundfish in the nearshore region.

Table 6: Fishing effort expended in the St. George and Damariscotta River Estuaries in May 2007. Catch rates were very low.

Damariscotta Estuary May 2007		
Gear	**Total set time (hours)**	**Effort per fish (hours)**
Handlines	149.88	21.41
Groundlines	1911.88	637.29
Traps	75.00	9.38
St. George Estuary May 2007		
Handlines	122.43	no fish caught
Groundlines	1419.87	1419.87
Traps	69.37	34.69

2. **Inability to replicate May/June sampling in Passamaquoddy Bay.** Insurance policy changes at the University of Southern Maine concerning liability insurance on fishing boats used for collaborative research and financial difficulties on the part of the fisherman (i.e., engine troubles after a mishap in the fall) meant that no sampling occurred in Passamaquoddy Bay in May/June 2007. By early August these issues were resolved and we were able to conduct our August and late September sampling as planned. We sampled in Passamaquoddy Bay in Spring 2008.

Steps/tasks for next 6 months

- Analyze diets collected in 2007.
- Process and analyze diets collected in 2008.
- Sample Damariscotta, St. George, and Passamaquoddy Bay sites again in August, September and October 2008.

Impacts and applications

Thus far, our largest impact on the fishing community is one of raising awareness of alewife runs and their potential impact on marine fisheries resources. The process of arranging to count alewife runs has brought us, as scientists, in contact with many members of the local community. We have worked with and conferred with fish committees from local towns, harvesters licensed by the towns to harvest and sell alewives, and local lobstermen who buy alewives for early spring bait. The alewife river fishery has proven to be a foray into a politically charged fishery with many competing interests.

Alewives were thrust into the spotlight with the declaration of Species of Concern status in 2006 by National Marine Fisheries Commission, and the introduction of Amendment 2 to the Shad and River Herring Fisheries Management Plan by the Atlantic States Marine Fisheries Commission in January 2008. The possible action of closure of all directed fisheries took towns and harvesters by surprise.

In March, 2008, we (K. Wilson, T. Willis) organized a Maine Fisherman's Forum symposium on the Amendment 2 plan, which included a presentation by a representative of

ASMFC. At this forum the four proposed management options were discussed (see pg 19, ASMFC Shad and River Herring Public Information Document for Amendment 2, http://www.asmfc.org/), as well as two new management options, one of which was a proposal for river specific management requiring documentation of spawning escapement as well as harvest. Video and weir techniques developed and field tested in association with this project will be useful for towns interested in assessing alewife numbers in the rivers to which they have licensing rights.

The work we have been doing through this NEC project has lead to additional opportunities to work with the alewife fishery. For example, Dr. Willis is the *de facto* scientific advisor for the newly formed Alewife Harvesters of Maine. AHoM is bringing a new industry voice to alewife issues in Maine, including feedback on the proposed changes to the Shad and River Herring Management Plan and other issues, such as the St. Croix River fishway closures.

Our second largest impact would be with the fishermen we work with directly. During the June sampling both boat captains and their crew members recounted stories of fishing in the areas where we were working and catching fish. They were surprised that as far out as 6 miles from the mainland they could not catch any fish, let alone a cod or other large predator. In these same areas a decade earlier a 24 hr. tub trawl/groundline would have caught at least some desirable species.

We have also created opportunities for collaboration with municipalities in Nobleboro, Newcastle, Warren, and Waldoboro, and community groups with a resource focus (e.g., Quebec Labrador Foundation/Atlantic Center for the Environment, Trout Unlimited, Georges River Land Trust, Damariscotta River Association).

Partnerships with fishermen

Although our collaborating fishermen were not involved with the initial design of this project, they contribute greatly to the day to day operations, helping us find historical fishing areas and imparting invaluable local knowledge. When your livelihood depends on catching fish, it is rare to have the 'luxury' of catching zeros (e.g., spring sampling for groundfish), which has spawned some interesting conversations with the captains, particularly in the spring.

Related projects

Work on counting alewives in the St. George River was funded through a Gulf of Maine Council/NOAA habitat restoration partnership grant to Dr. Willis. Work on counting alewives in the Damariscotta River was funded through a Davis Conservation Grant to Dr. Willis. Alewife spawning run counts in the Little River (Gleason Cove, Passamaquoddy Bay site) were attempted in spring 2007 by collaborators associated with the Passamaquoddy Tribe with advice based on our experiences in the summer of 2006.

Presentations

K.A. Wilson and Theodore Willis. Alewives as Groundfish Forage in Maine Estuaries. Northeast Consortium Participants Meeting, Dec 2007. (Invited)

Workshop presentation: River Herring Management & Biology. Maine Fisherman's Forum, March 2008. Organizers: K. Wilson and T. Willis.

K. Wilson and T. Willis. River Herring in the Gulf of Maine: challenges for management and research. Invited talk as part of the Gulf of Maine Research Institute's Sea State 3.1 Public Lecture Series. April 2008.

T. Willis. River Herring in the Gulf of Maine: challenges for management and research. St. George River Land Trust. May 2008. (Invited)

K. Wilson, T. Willis and K. Robbins. Freshwater-marine linkages: the role of small coastal Maine rivers as spawning habitat for a marine forage fish. 9th Biannual River Management Society Symposium, Portland, Maine. May 2008.

K. Wilson and T. Willis. River Herring in Maine: Challenges for Management and Research. Sheepscot River Watershed Council. June 2008. (Invited)

Student participation

Four undergraduate students from the University of Southern Maine and University of Maine have assisted in diet analyses and fieldwork during 2006-2008. All students have an interest in marine biology, an interest in fisheries issues, and some association with the commercial fishing industry.

Signature and date

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Karen A. Wilson Date

Attachments: Many photos available by request.