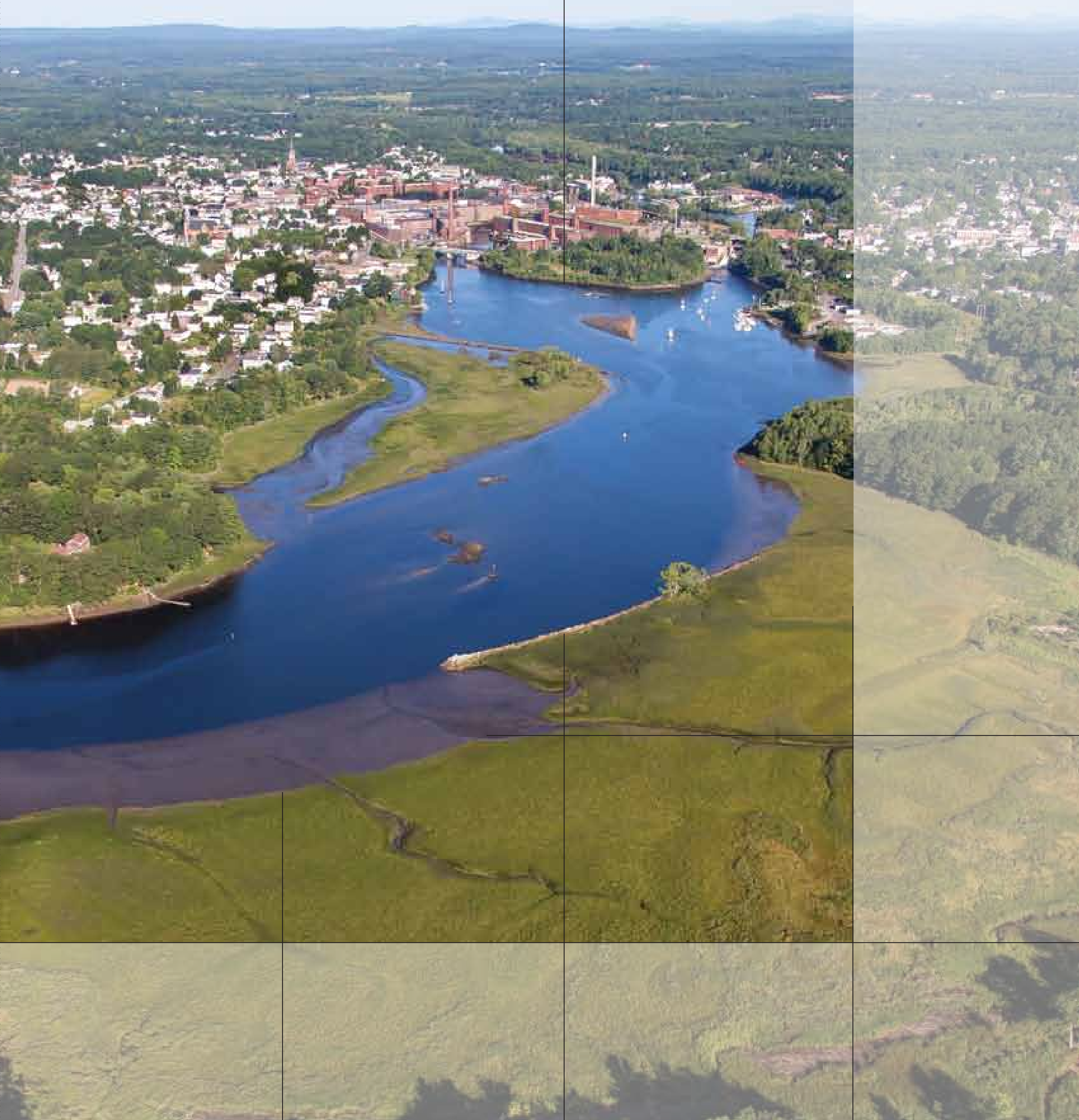
Sustaining the Saco
e s t u a r y

final report 2015



Sustaining the Saco
estuary

final report 2015

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Saco River Corridor Commission **Biddeford-Saco Chamber of Commerce and Industry**

Town of Biddeford: Planning Board, Open Space Committee, Conservation Commission, Shellfish Conservation Committee

About the Stewardship Network

Many people care for the Saco Estuary. Together they form a Stewardship Network protecting water, wildlife and habitats. Residents, visitors and businesses benefit from the efforts of the Stewardship Network. The surprisingly diverse collection of plants, birds and fish discovered by UNE and Wells Reserve researchers is a consequence of the cumulative actions taken by these people to sustain the Saco Estuary and the values most important to the people who live work and play in the region.

360 Acres of Tidal Marsh

Three types of tidal marshes --salt, brackish, and freshwater-- occur here. These marshes improve water quality and provide habitat for many kinds of wildlife.

10 Rare Plants

A surprising diversity of plants live in these marshes, including ten species that are rare in Maine and/or nationally.

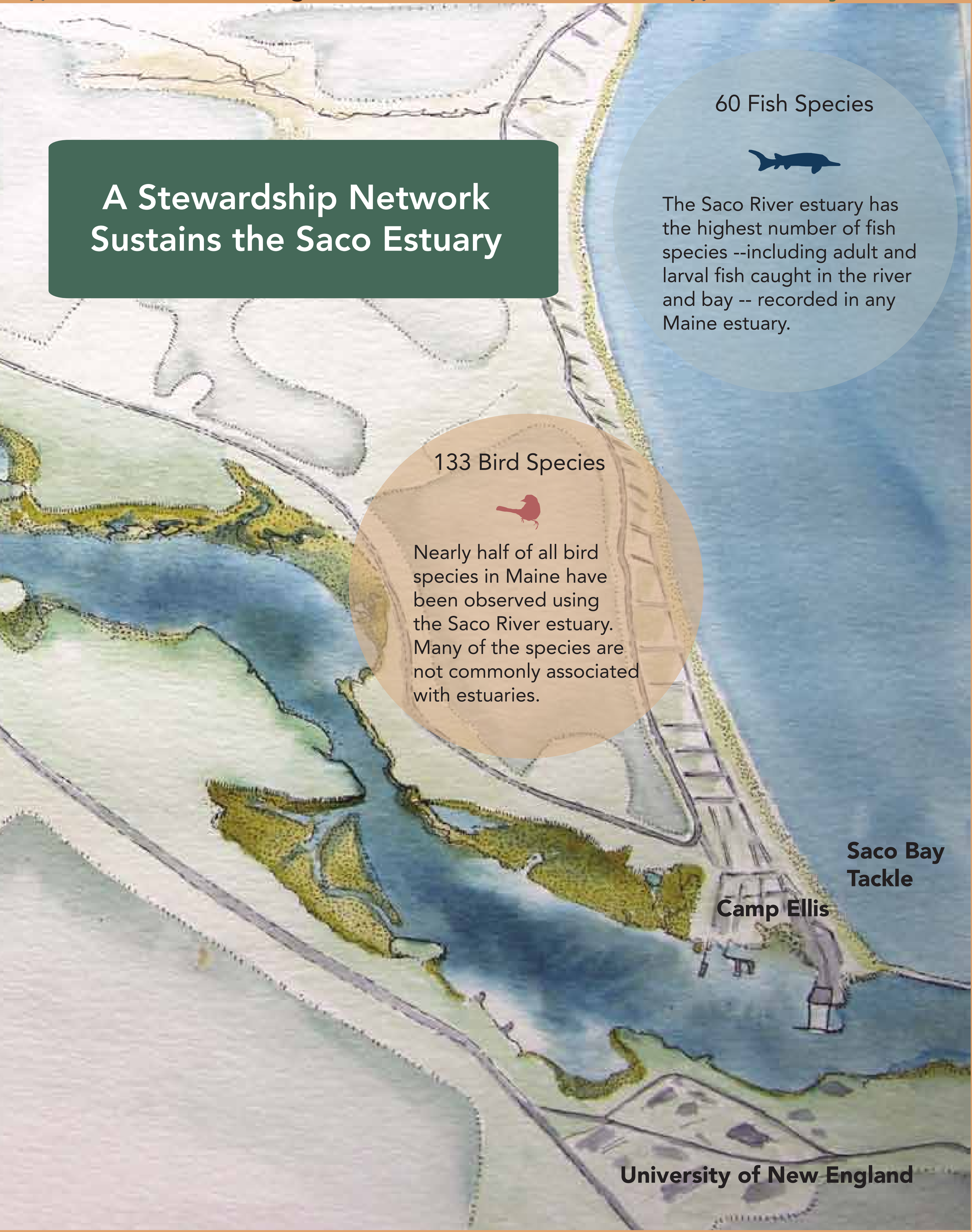
This research is part of Maine's Sustainability Solutions Initiative, a program of the Senator George J. Mitchell Center, which is supported by National Science Foundation award EPS-0904155 to Maine EPSCoR at the University of Maine.

MollyMaps 2014

State of Maine: DEP, DMR, DIFW **Wells National Estuarine Research Reserve**

Town of Saco: Planning Board, Conservation Commission
Saco Valley Land Trust

A Stewardship Network Sustains the Saco Estuary



60 Fish Species

The Saco River estuary has the highest number of fish species --including adult and larval fish caught in the river and bay -- recorded in any Maine estuary.

133 Bird Species

Nearly half of all bird species in Maine have been observed using the Saco River estuary. Many of the species are not commonly associated with estuaries.

Saco River Salmon Club
Biddeford Saco Water
Coastal Waters Commission
Biddeford Pool Land Trust

Rachel Carson National Wildlife Refuge
Friends of Wood Island Lighthouse

CHAPTER 5

FISH OF THE SACO ESTUARY

RIVER CHANNEL AND TIDAL MARSHES

BY KAYLA SMITH, KRISTIN WILSON, JAMES SULIKOWSKI, and JACOB AMAN

INTRODUCTION

Before the current study, what did we know about the fish using the Saco estuary?

A report published 30 years ago documented 18 fish species and a variety of crustaceans, echinoderms, and mollusks using the estuary (Reynolds and Casterlin 1985). A two-year survey conducted by UNE scientists in 2007 and 2008 using plankton tow nets, a seine net, and otter and beam trawls found 31 fish species in the estuary and in Saco Bay, just outside the river (Furey and Sulikowski 2011; Wargo et al. 2009). Nearly all of the species were observed at juvenile lengths (10 larval and 21 juvenile fishes), characterizing the system as a nursery ground.

The incidental capture of two Atlantic sturgeon by Furey and Sulikowski (2011) spurred an ongoing investigation into the ecology and movement of this important and threatened species in the estuary. Little et al. (2013) suggested that the Saco estuary is a foraging stopover site for migratory fishes such as the endangered shortnose sturgeon and the threatened Atlantic sturgeon (Figure 1).

These previous studies were limited to sampling fish just offshore in Saco Bay and close to the mouth of the river in the river channel. For the current study, fishing efforts in the river channel were extended up river to Cataract Dam and also included fishing on the surfaces of tidal marshes at high tide.

STUDY OBJECTIVES—FISH

The objectives of this study were to answer several questions about the fish in the estuary:

1. What additional fish species use the Saco estuary upriver from the mouth of the river?
2. Do the fish communities change as one moves from the mouth of the river up to Cataract Dam?

FIGURE 1 James Sulikowski, left, and student researchers pose with an Atlantic sturgeon measuring seven feet and one inch long before releasing it back into the Saco River.

3. Is there a difference in the types of fish using the river channel and the tidal marshes?
4. What commercially and recreationally important fish use the estuary?
5. Which species listed as threatened or endangered, or as species of concern, are found in the estuary?

RESEARCH DESIGN AND METHODS

We used four methods of sampling fish species in the Saco estuary to collect data on species composition, distribution, and abundance. Over four field seasons (2010–2013), we conducted beach seining near the river mouth, gillnetting and plankton tows (for larval fish) in the mid channel, and fyke netting on the marsh surface.

River Channel Sampling

Sampling using beach seines occurred at the mouth of the Saco River (at Freddy Beach) two or three times per week from March to November. Weekly gillnet surveys were conducted from June to September at three distinct locations: close to the river mouth, in the middle of the estuary, and below Cataract Dam. Gillnets are a passive

Species of Concern are those species about which NOAA's National Marine Fisheries Service (NMFS) has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act (ESA). "Species of concern" status does not carry any procedural or substantive protections under the ESA. *Source: NOAA.*

FIGURE 2 Map of river channel sampling sites from 2010–2013. Upper, middle, and lower are sites where gillnets were set. Beach seining was conducted at Freddy Beach.

gear type, meaning only fish actively swimming in the water column will be caught. Beach seine nets are an active gear type, catching mostly juvenile fish resting on or in sediments as well as in the water column. Sampling was performed during summer months when the estuarine fish community is the most representative of its composition and when the greatest contrast would be observed between sampling locations. Fish metrics recorded for samples from the seine and gillnets included total length for all species. In addition, we used a fish measuring board, tape measure, or calipers to measure fork length, head length, interorbital width, and mouth width of sturgeon species. Length measurements were recorded for the first 30 individuals of each species, with bulk counts recorded for all remaining individuals. For individuals captured during each sampling event, catch-per-unit-effort was calculated, and these values were then used to determine the percent of catch.

Surface plankton tows were also performed to collect larval fish (i.e., ichthyoplankton) at multiple locations within the estuary, between the upper and lower gillnet sampling sites. In 2010 and 2011, ichthyoplankton tows were performed biweekly in June through August. In 2012 and 2013, tows were conducted weekly in June through August, increasing sampling effort. A plankton net was towed with the UNE research vessel *Llyr* at a speed of approximately 2.0 knots for 10 minutes (Figure 4). Following

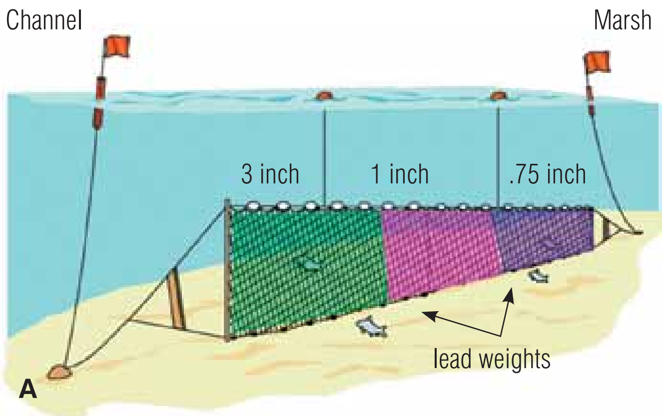


FIGURE 3 (A) Diagram of the multi-mesh gillnets used for sampling the river channel. *Image courtesy of Michigan Sea Grant.* (B) Beach seine used to sample the river channel along Freddy Beach.

FIGURE 4 Plankton tow net used to collect larval fish at multiple locations within the Saco estuary.

collection, the plankton net was washed down to ensure that all specimens were in the cod end, and samples were preserved. Ichthyoplankton samples were sorted by hand using a dissecting microscope. Larval fish were measured, and key morphological characteristics were noted, including pigmentation patterns and fin ray and myomere counts for identification purposes.

Tidal Marsh Sampling

Many fish move onto the marsh surface at high tide, seeking food, shelter, and protection from predators. To sample under these conditions, fyke nets are used to sample fish species on the marsh surface when it is flooded by high tides (Figure 5). The nets also catch crustaceans such as crabs and shrimp. The fish and crustaceans caught are referred to as nekton.

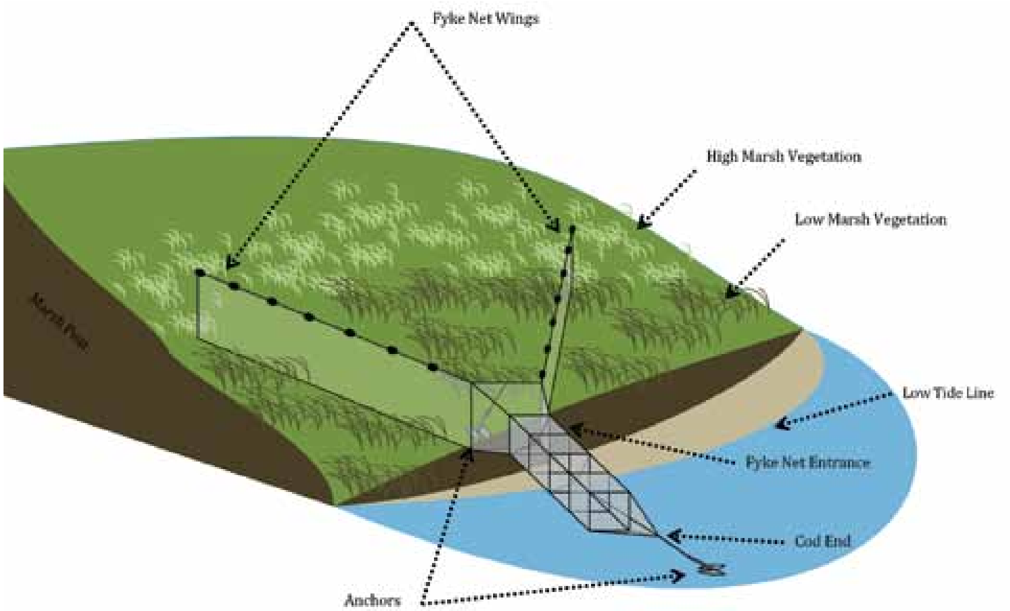


FIGURE 5 Fyke net deployment for sampling in tidal fringing marshes.

Eight of the 16 tidal marsh study sites were chosen for fish sampling (Figure 6). These eight were selected based on several criteria, including proximity to large areas of tidal marsh vegetation and suitability for use of fyke nets. We also selected sites so they were distributed from Cataract Dam to the river mouth, and so they reflected a range of development intensity in the adjacent upland. Some adjustments were made to the sites fished between 2010 and 2011 due to steep slopes and other issues that made sampling with fyke nets challenging. Sites were fished during one daytime and one nighttime high tide in August 2011, 2012, and 2013. In 2010, the sampling effort was greater, as each site was fished in both June and at the end of July.

Fish and crustaceans were identified to the species level, weighed, and measured. Bulk count and weight were recorded for all remaining individuals after the first 30 of each species. The distance between the fyke net and the flagged high tide line was measured so that the area fished could be calculated, allowing us to quantify the density of fish using the marsh surface.

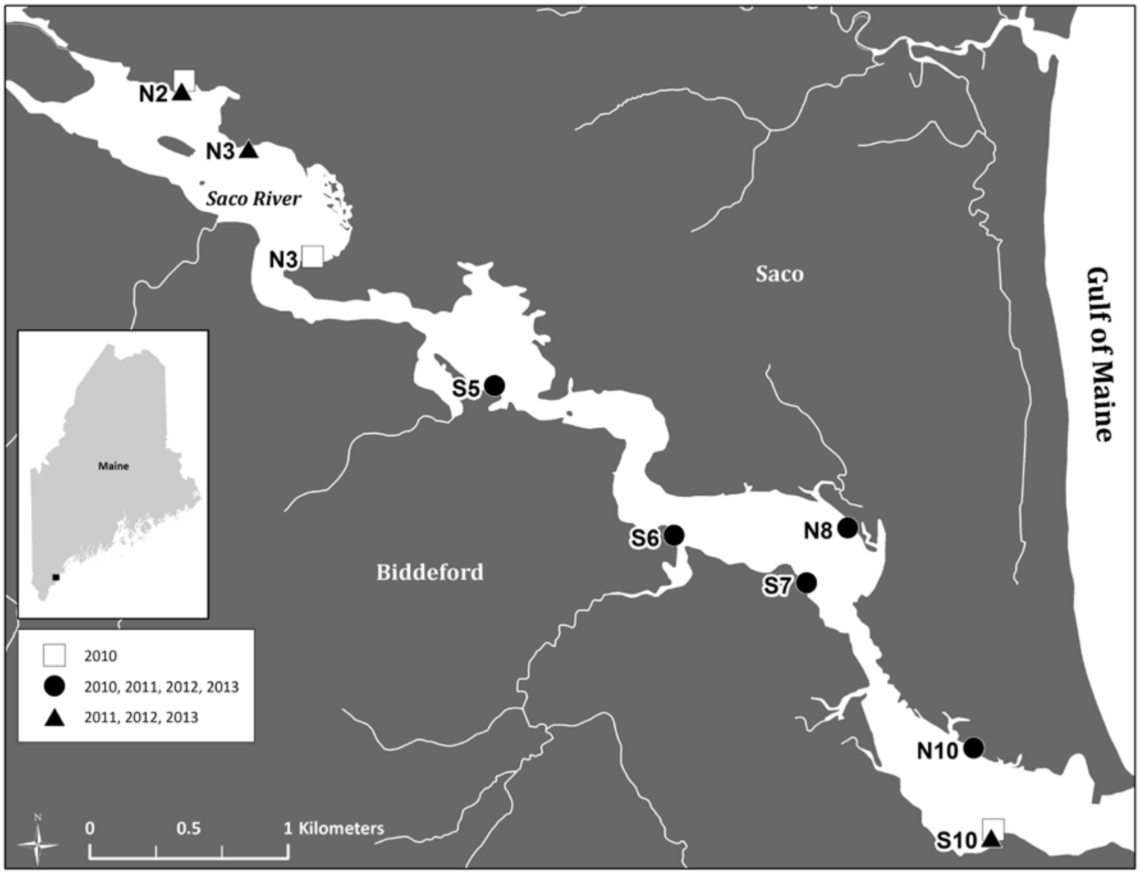


FIGURE 6 Map of tidal marsh fyke net sampling sites from 2010–2013.

RESULTS AND DISCUSSION

What did we learn about the fish of the Saco estuary?

There are more kinds of fish using the estuary than previously recorded.

This study resulted in the addition of 15 new species of juvenile and adult fish recorded for the Saco estuary, compared to the 24 species reported by Furey and Sulikowski (2011), the most comprehensive study until now. The 15 newly recorded species are bluegill, chain pickerel, golden shiner, lake chub, pollock, white sucker, American shad, Atlantic menhaden, longhorn sculpin, shortnose sturgeon, smallmouth bass, spottail shiner, striped bass, striped killifish, summer flounder, and white perch. Many of these new species recordings are of freshwater species using fringing marshes in the upper reaches of the estuary.

The Saco estuary has more fish than any other estuary documented in the State of Maine.

In this four-year study, 39 species were identified using the river channel and the tidal marshes (Table 1). Combined with previous studies, the total number of fish species using the estuary stands at 41. Adding those species caught in nearby Saco Bay (29) gives us a total of 64 species of fish documented using the estuary and the waters outside the river mouth.

Most of the same fish species use the river channel and the tidal marshes.

TABLE 1 The 39 fish species of the Saco estuary caught in the river channel and the marsh surface from 2010-2013 with sampling method and life history. Life history categories include: d = diadromous, m = marine, e = estuarine, f = freshwater (from FishBase v. 04/2014).

Scientific Name	Common Name	Life History Classification	River Channel Sampling		Tidal Marsh Sampling
			Beach Seine	Gill net	Fyke net
Alosa pseudoharengus	alewife	d	X	X	X
Anguilla rostrata	American eel	d	X	X	X
Ammodytes americanus	American sand lance	m	X		
Alosa sapidissima	American shad	d		X	
Clupea harengus	Atlantic herring	m	X	X	X
Brevarotia tryanous	Atlantic menhaden	m	X	X	
Menidia menidia	Atlantic silverside	m	X		X
Acipenser oxyrinchus	Atlantic sturgeon	d		X	
Microgadus tomcod	Atlantic tomcod	d	X	X	X
Fundulus diaphanus	banded killifish	e	X		X
Alosa aestivalis	blueback herring	d	X	X	X
Pomatomus saltatrix	bluefish	m	X	X	X
Lepomis macrochirus	bluegill	f			X
Esox niger	chain pickerel	f			X
Apeltes quadracus	fourspine stickleback	f	X		X
Notemigonus crysoleucas	golden shiner	f			X
Couesius plumbeus	lake chub	f			X
Micropterus salmoides	largemouth bass	f	X		X
Fundulus heteroclitus	mummichog	e	X		X
Pungitius pungitius	ninespine stickleback	e	X		
Syngnathus fuscus	northern pipefish	m	X		X
Pollachius virens	pollock	m			X
Lepomis gibbosus	pumpkinseed	f	X		X
Osmersus mordax	rainbow smelt	f	X		X
Urophycis chuss	red hake	m	X		X
Myoxocephalus octodecimspinosus	longhorn sculpin	m	X		
Acipenser brevirostrum	shortnose sturgeon	d		X	
Micropterus dolomieu	smallmouth bass	f	X		
Notropis hudsonius	spottail shiner	f	X	X	X
Morone saxatilis	striped bass	d	X	X	
Fundulus majalis	striped killifish	e	X		X
Mugil cephalus	striped mullet	m	X		
Paralichthys dentatus	summer flounder	m	X		
Gasterosteus aculeatus	threespine stickleback	e	X		X
Morone americana	white perch	f		X	X
Catostomus commersonii	white sucker	f			X
Scophthalmus aquosus	windowpane flounder	m	X		
Psuedopleuronectes americanus	winter flounder	m	X		X
Perca flavescens	yellow perch	f			X
Totals for sampling methods			28	13	27

Different gear types are needed to fully sample the range of fish diversity.

The gear types used were complementary, each yielding different information about fish communities in the estuary. Specifically, beach seining sampled eight species that were sampled by no other method (American sand lance, ninespine stickleback, longhorn sculpin, smallmouth bass, striped mullet, summer flounder, threespine stickleback, and windowpane flounder). Gill netting sampled three species that were sampled by no other method (American shad, Atlantic sturgeon, and shortnose sturgeon). Finally, fyke netting of fringing marshes revealed seven species that were sampled by no other method (bluegill, chain pickerel, golden shiner, lake chub, pollock, white sucker, and yellow perch). With the exception of pollock, all of these additional species sampled by fyke netting are freshwater species.

The fish species that are most common differ between the river channel and the tidal marshes.

River Channel Sampling

In the river channel, 32 fish and five crustacean species were caught between April 2010 and November 2013. Near the river mouth, American sand lance and Atlantic herring were among the most abundant species collected using the beach seine (Figure 7). Atlantic herring is a schooling marine transient species that was observed in high abundance entering the estuary in both 2011 and 2012.

Tidal Marsh Sampling

Fyke netting of the marshes from 2010-2013 captured 27 fish species and two crustacean species. The total number of individuals caught varied greatly across years and sites. Eight species (American eel, blueback herring, European green crab, largemouth bass, mummichog, sand shrimp, striped killifish, and white perch) were caught in all four sampling years.

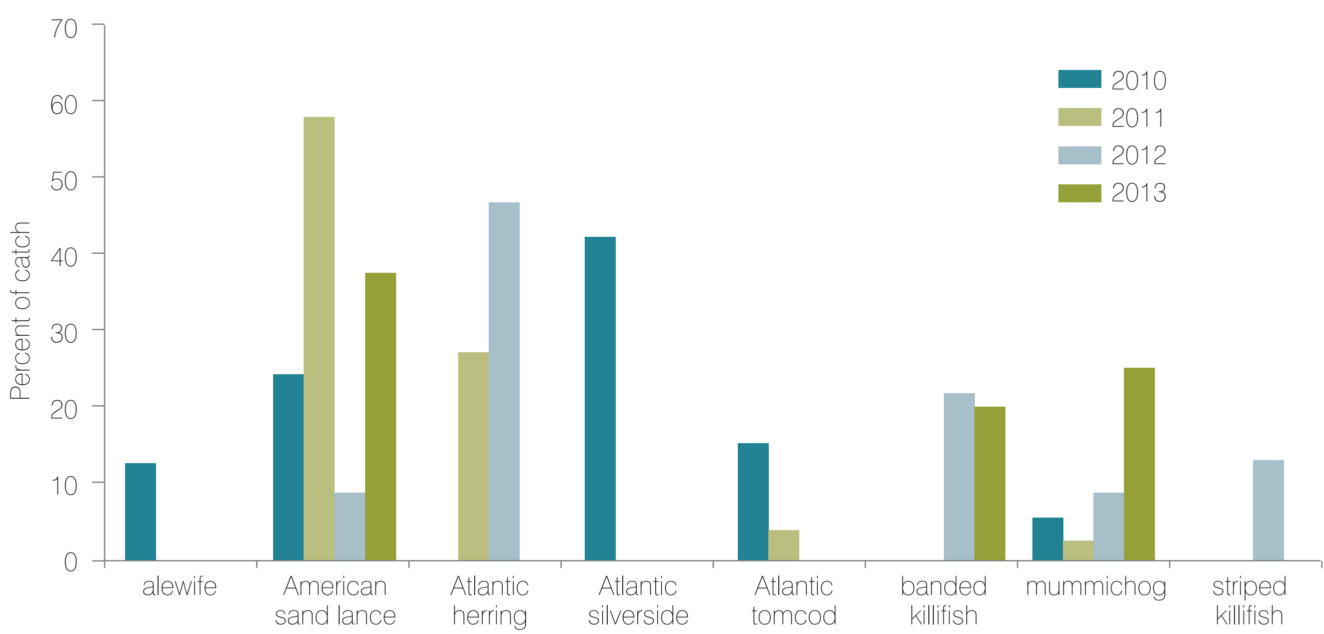


FIGURE 7 Most abundant fish species collected near the river mouth in beach seines.

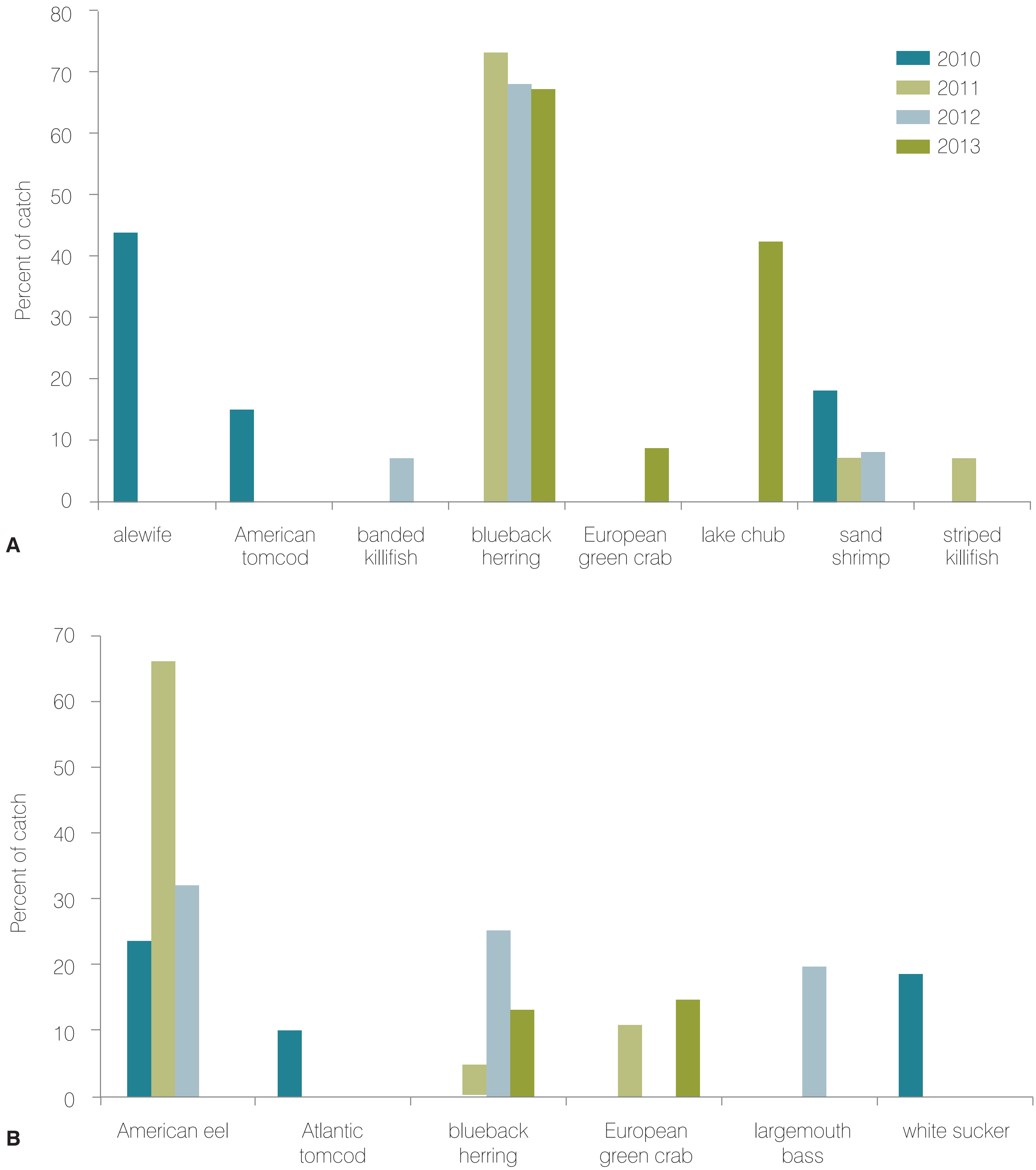


FIGURE 8 Fish and crustaceans using the tidal marshes. Shown are the top three species caught in fyke nets each year. (A) Most abundant species numerically. (B) Species sorted by biomass..

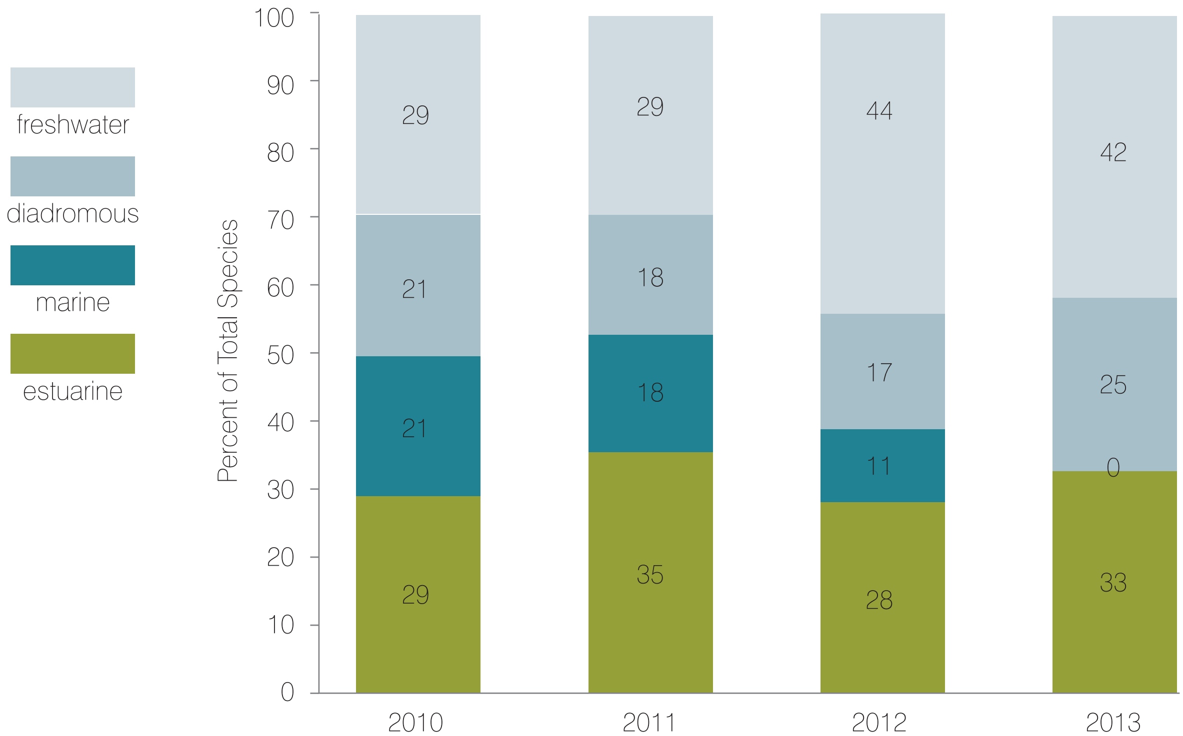


FIGURE 9 Percent of species caught fyke netting that represent each life history designation as categorized by Dionne et al. (1999) and FishBase v. 04/2014. Marsh resident species and freshwater species represented most of the total catch in every year sampled.

Blueback herring were caught in the greatest numbers in three of the four years (Figure 8). American eels were not as numerous, but due to their large size they comprised the greatest proportion of biomass every year. Other species numbers and biomass were more variable over time.

Also, most of the species using the tidal marshes were either marsh resident species or freshwater species (Figure 9). However year-round sampling would be needed to determine actual residency in the Saco River marshes.

Commercially and recreationally valuable species as well as federally listed endangered species, threatened species, and species of concern use the river channel and the tidal marshes.

Four fish species of recreational importance were caught. These species were largemouth bass, pumpkinseed, and bluefish (found in both the river channel and the tidal marshes) and the striped bass (caught in the river channel).

Three commercially valuable species were caught in the river channel and in the marshes (Atlantic herring, winter flounder, and red hake).

Two species listed under the Endangered Species Act were discovered using the estuary: the threatened Atlantic sturgeon and the endangered shortnose sturgeon (both found in the river channel). Also found were the alewife, blueback herring, and rainbow smelt, which are considered Species of Concern by NOAA's National Marine Fisheries Service. These species were caught in both the river channel and the tidal marshes.

Fish communities differ as one moves from the river mouth up to Cataract Dam.

Salinity gradients caused by freshwater runoff and tidal flushing were found to affect the distribution and abundance of fish species in the Saco estuary. The regulation of freshwater discharge by various hydroelectric dams along the river may also affect the movement of fish species within the estuary.

River Channel Sampling

The water at the bottom of the river channel was saltiest at the lower sampling site (17.1 ± 2.4 ppt), decreasing upriver at the middle (6.2 ± 1.9 ppt) and upper sites (5.7 ± 1.9 ppt). More marine fishes, such as the Atlantic herring and red hake, were caught at the sampling sites closest to the mouth of the river. Freshwater fishes, such as the spottail shiner and white perch, were more common at the two upper sampling sites.

The diversity of fish species as measured by species richness (S) and the Shannon-Wiener diversity index (H) varied across the river channel sites and with the method of sampling. Looking first at the sites sampled using gillnets, the number of species caught increased as we sampled farther upriver (3 at the lower sample site, 10 at the middle site, and 12 at the upper). Diversity as measured by the Shannon-Wiener Index (H) was greatest at the middle site (H=1.82), followed by the upper (H=1.23) and lower (H=1.03) sites. Sampling using the beach seine caught by far the greatest number of species (S=28; H=1.82).

Also, at the beach seine site near the mouth of the river, the salinity of the water during sampling affected the types of fish caught. Most of the catch contained freshwater species when the water was fresh to oligohaline (0–5 ppt). When the water was saltier, or mesohaline (5–18 ppt), more than half of the species caught were marine. Estuarine fish species were equally present in fresh and oligohaline as well as mesohaline water (Figure 10).

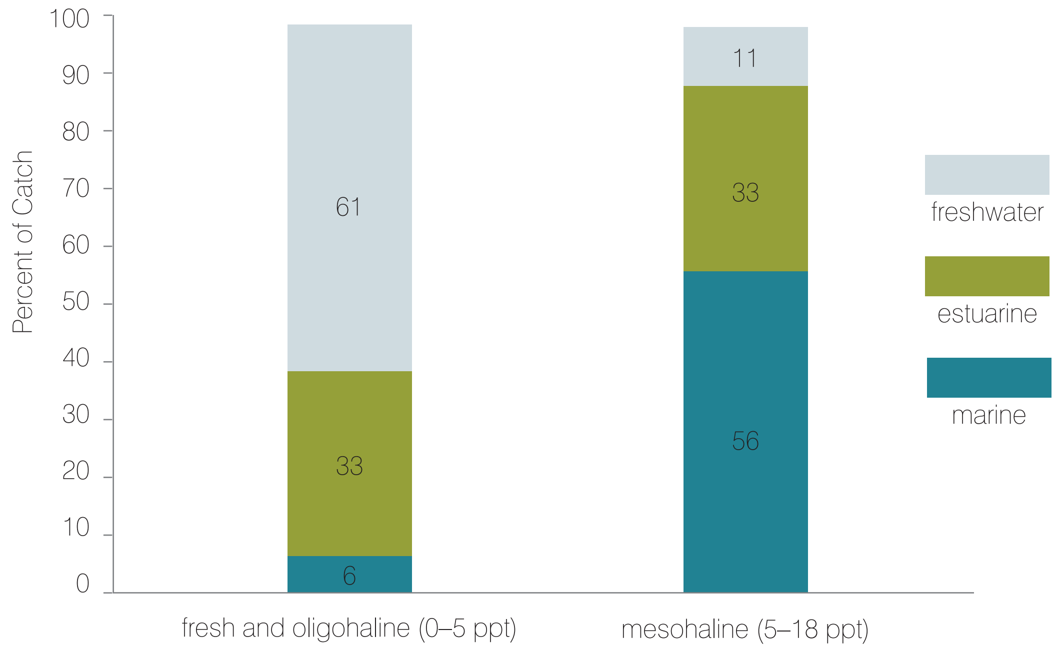


FIGURE 10 Distributions of freshwater, estuarine, and marine fish species between fresh and oligohaline (0–5 ppt) water and mesohaline (5–18 ppt) water during 2013 beach seine sampling. As only 4% of total catch in seines were diadromous (catadromous or anadromous), fish were put into marine or freshwater categories according to where they spend the majority of their lives (catadromous were considered freshwater and anadromous were considered marine). Fish species life history classifications categorized by Dionne et al. (1999) and FishBase v. 04/2014.

Tidal Marsh Sampling

Similar to the pattern observed in the river channel, the number of different species using the marsh surface increased with distance from the mouth of the river, due to more freshwater fish being caught upriver. This reflects the salinity gradient we observed from sampling the water on the marsh surface during fishing events (Figure 11) and agrees with other published studies (e.g., Fitzgerald et al. 2002). In contrast to the increase in species richness, we found that the total number of fish using the marshes decreased at the upper river sites.

In all years but one, site N2, which was located the farthest upriver, was the most diverse site as measured by the Shannon-Wiener diversity index (H) (Table 2).

Percent species composition by number of individuals and biomass reveals considerable variation across sites and across years for any one site (Figure 12). A shift in species composition seems to occur near site S5, with greater relative abundance of freshwater species occurring at that site and sites upriver (N3 and N2). The variability in species composition across sites and years demonstrates that multiple sampling efforts are needed to fully characterize fish communities using fringing marshes of the Saco estuary.

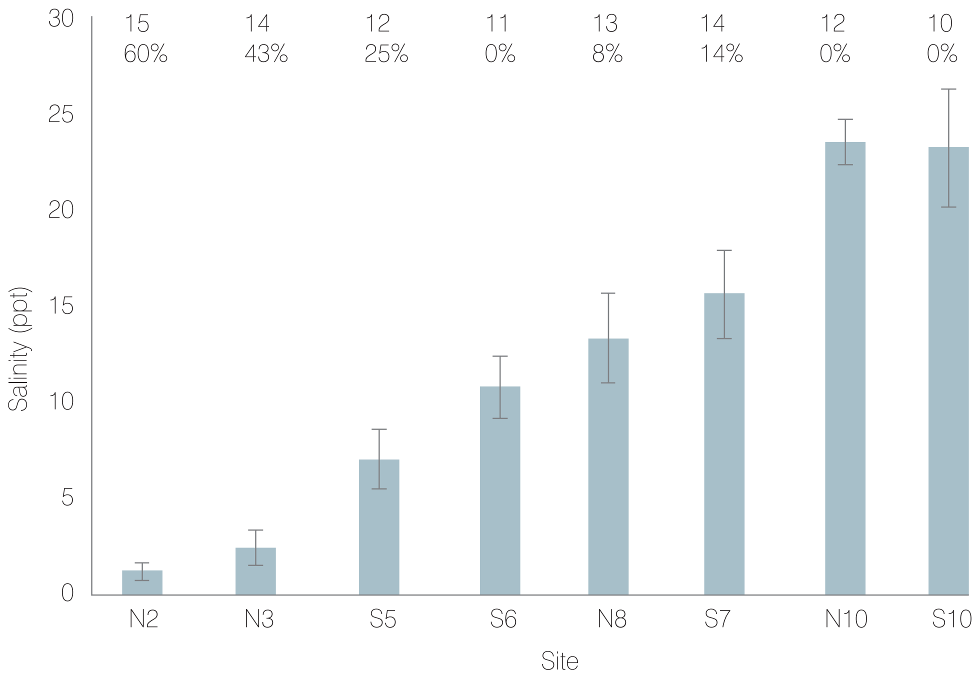


FIGURE 11 Average marsh surface water salinity (ppt) ± standard error, all years combined (2010–2013) from fyke net sampling. The number of fish species caught at each site and the percent of those that are freshwater species are given above each bar.

TABLE 2 Shannon-Wiener diversity index (H) by site and across years. The site with the greatest diversity each year is highlighted in red. Sites with the least diversity in a given year, indicated in blue, were more variable.

	Year			
Site	2010	2011	2012	2013
S10	1.13	1.29	0.00	1.05
N10	1.42	1.32	1.44	0.73
S7	1.20	1.62	0.52	1.29
N8	1.48	1.24	0.14	0.62
S6	1.32	1.03	0.64	0.59
S5	1.51	1.15	1.04	0.97
N3	1.46	0.46	1.29	1.17
N2	2.03	1.51	1.45	1.62

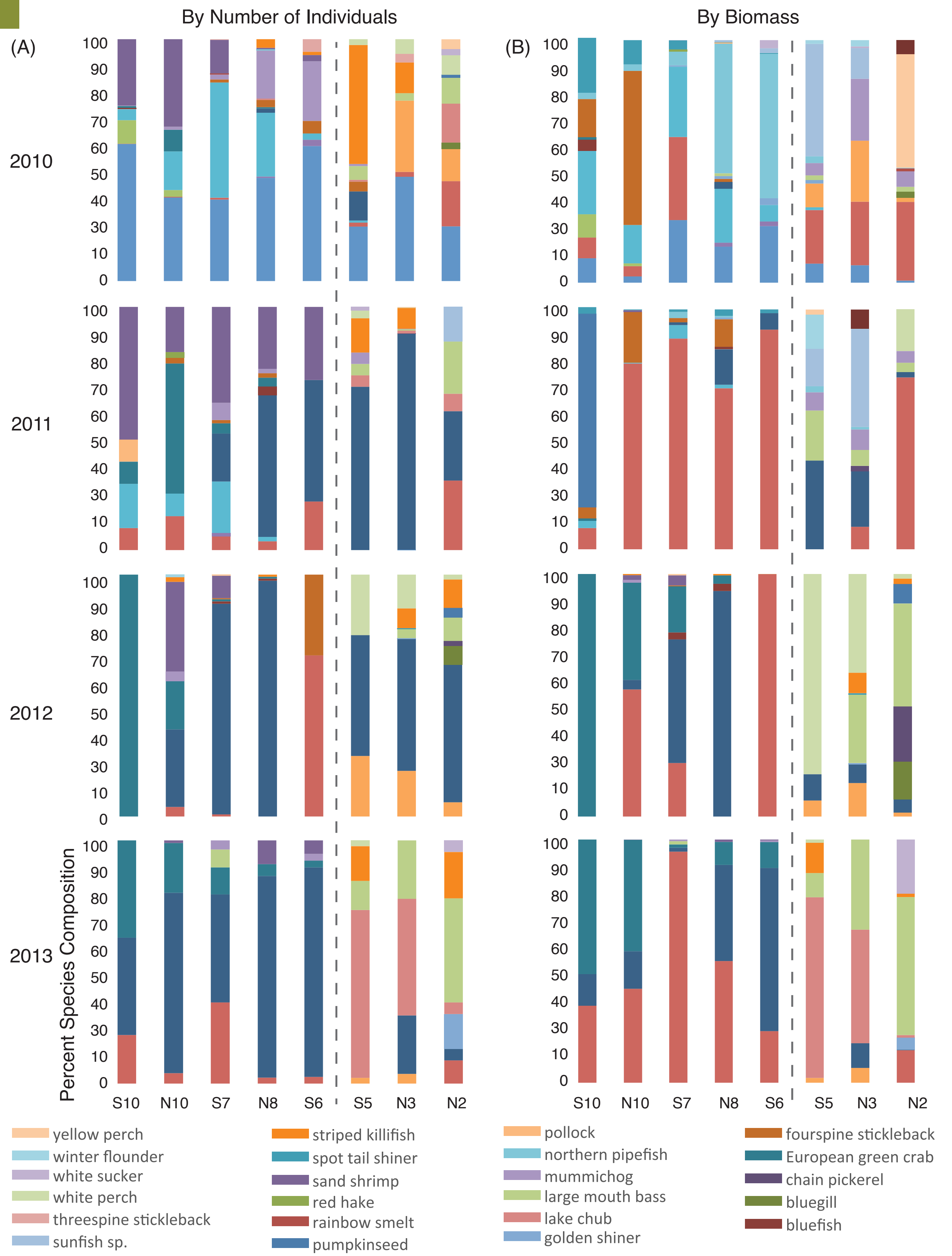


FIGURE 12 Percent species composition by site and year as determined by (A) number of individuals and (B) biomass.

The estuary is an important nursery ground for larval fish.

From the 64 ichthyoplankton tows conducted during this study, 586 larval fish representing at least 13 species were identified (Table 3). The overall abundance and total number of larval fish observed is considerably lower than in tows conducted in Saco Bay (Wargo et al. 2009; JA Sulikowski, unpublished data). Species diversity is difficult to characterize because 20% of the total catch is still unidentified. These larvae are presumably of freshwater taxa, which will require additional resources to positively identify. Approximately 75% of identified larvae were marine species. Of those larvae, northern pipefish and Atlantic herring were the most abundant species, representing approximately 65% of the total catch. Before this study, fourbeard rockling, mummichog, and spottail shiner larvae had not been observed in the Saco estuary. The collection of new larval fish species provides an impetus for further study of the estuary as a fish nursery ground.

TABLE 3 Compiled ichthyoplankton species list and total number of individuals collected from plankton tow sampling from 2010-2013 (all sites combined). Life history categories include: d = diadromous, m = marine, e = estuarine, f = freshwater (from FishBase v. 04/2014).

Scientific Name	Common Name	Life History Classification	% of Total Catch
Syngnathus fuscus	northern pipefish	m	45.6
Clupea harengus	Atlantic herring	m	19.8
Scophthalmus aquosus	windowpane flounder	m	7.7
Perca flavescens	yellow perch	f	1.7
Apeltes quadracus	fourspine stickleback	e	1.0
Tautogolabrus adspersus	cunner	m	0.9
Ammodytes americanus	American sandlance	m	0.7
Enchelyopus cimbrius	fourbeard rockling	m	0.3
Fundulus heteroclitus	mummichog	e	0.3
Notropis hudsonius	spottail shiner	f	0.3
Psuedopleuronectes americanus	winter flounder	m	0.2
Moronidae spp.	striped bass and white perch	e, d	10.1
Cluepeidae spp.	alewife, American shad or blueback herring	d	8.5
Unidentified			2.9

CONCLUSIONS

We make the following conclusions from our study of fishes in the river channel and tidal marshes of the Saco estuary.

- A surprising result was that both the Saco River channel and its fringing marshes are important habitats for many federally listed species of concern as well as commercially and recreationally important fish species. In addition, the Saco estuary supports the greatest fish diversity of any estuary within the Gulf of Maine with associated research that has been published in the peer-reviewed literature to date.
- Within the Saco estuary, we have now observed all but three of the 12 diadromous fish species known to occur in the Gulf of Maine. Diadromous fishes provide important links between rivers and the sea, migrating through estuarine systems as part of their life cycle. These fishes have served as economically valuable and culturally important resources for historical and present-day coastal communities in Maine. However, diadromous fish populations are at record low levels because access to spawning habitats has been impeded by dams and the commercial harvest was previously unregulated. Currently, little is known of these fish assemblages within small coastal rivers in Maine. Establishing a current diadromous fish population baseline within the estuary is essential for future conservation of these important fishes and associated marine resources.
- The results of this study suggest that fish communities of the Saco estuary are structured, in part, by the salinity gradient from the river mouth to Cataract Dam. Changing climatic conditions and land-use decisions may affect this gradient. Rising sea level, increased frequency and/or intensity of extreme precipitation and flooding events, and increased amounts of impervious surface within the shoreland zone and surrounding watersheds are all factors that will likely influence the structure of fish community assemblages in the Saco estuary spatially and temporally. Data collected during this study may provide one baseline by which future studies may compare fish community data.

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