

## Chapter 1

# OVERVIEW OF THE KENNEBEC ESTUARY



Diverse natural communities and human resource uses converge as tidal freshwater marshes abut Abagadasset Point farmlands. Photo: Slade Moore and John Sowles.

Representing a link between Gulf of Maine waters and those draining nearly 8,000 square miles of uplands in Maine and New Hampshire, the Kennebec Estuary is at once a unique assemblage of ecological attributes, a resource of economic, cultural, and social value, and a region of historical significance. The complex interactions among the many components of this system—including those linking people with the environmental goods and services they have historically desired, expected, and needed—have made successful stewardship of the estuary especially challenging.

## Introduction

Although it represents only part of a much larger system, the influence of the Kennebec Estuary features prominently in the region's cultural and environmental history. The complex, shifting interactions between the estuary's natural systems and its people have shaped a legacy of social expectations and ecosystem response that still marks the region. At its worst, the lower Kennebec functioned more as an overburdened repository for the combined noxious effluent of the watershed, rather than as a healthy, biologically diverse interface between riverine and nearshore ecosystems. In some cases, ecological improvements since the nadir of the estuary's health were dramatic and rapid once corrective measures were implemented, but mounting evidence indicates that the consequences of historical and contemporary alterations of this system continue to hinder recovery.

This project was designed to explore restoration opportunities and challenges for the Kennebec Estuary. We did so by developing a synthesis of existing data and knowledge in order to identify ecological issues warranting heightened awareness and, where necessary, further investigation or intervention by ecological researchers, natural resource managers, and policy makers. Because restoration and management goals often seem to reflect only partial appreciation of a system's potential before dramatic environmental change, we attempted to examine degraded or lost ecological capacity in the context of historical conditions. We assessed the ecological relevance of each issue by investigating its possible consequences on ecosystem function and delivery of goods and services. By "function" we mean the many diverse, self-supporting processes of the estuary (e.g., nutrient recycling, primary productivity) that help maintain its metabolism and largely define its character. Ecosystem goods and services are the foundations of human well-being and include clean water, nourishing food, economic security, spiritual sustenance, and recreational opportunities, among many others. We were also interested in factors that promoted or eroded the integrity or wholeness of the estuary ecosystem and the estuary's resilience—its ability to accommodate disturbance pressure without changing significantly in structure or function.

One constraint that often narrowed the extent of our focus on particular subject areas was the shortage of available information. Despite the Kennebec Estuary's notoriety during the early phases of nationwide efforts to address centuries of water pollution, relatively few data were available even for issues that were once prominent in the public's perception. In some cases, limited raw data were accessible but required analysis or context, which we have provided. We relied heavily on historical documents and, where possible, interviews with local experts, to compare the present state of the estuary with its historical condition. The use of such alternative knowledge systems is crucial for providing ecological reference points that are not well-documented or are largely lost from memory and, as a result, are often not adequately represented in management systems.

A lack of knowledge regarding the ecology of adjacent sub-estuaries and their interactions with the Kennebec tended to force an artificial restriction of this effort's geographic scope. Likewise, estuarine influences on the landscapes of which they are a part, such as nutrient and energy flow, have been less well studied than land-use influences on estuarine condition. Where it is relevant and available, we discuss knowledge of the interactions between the estuary and the greater system, but the main focus of our investigations is on the estuary proper. However, we acknowledge that integration of land conservation and estuarine restoration efforts represents an important next step. Until a better understanding is achieved of how aquatic systems contribute to terrestrial systems, full integration of land and water restoration efforts will be incomplete.

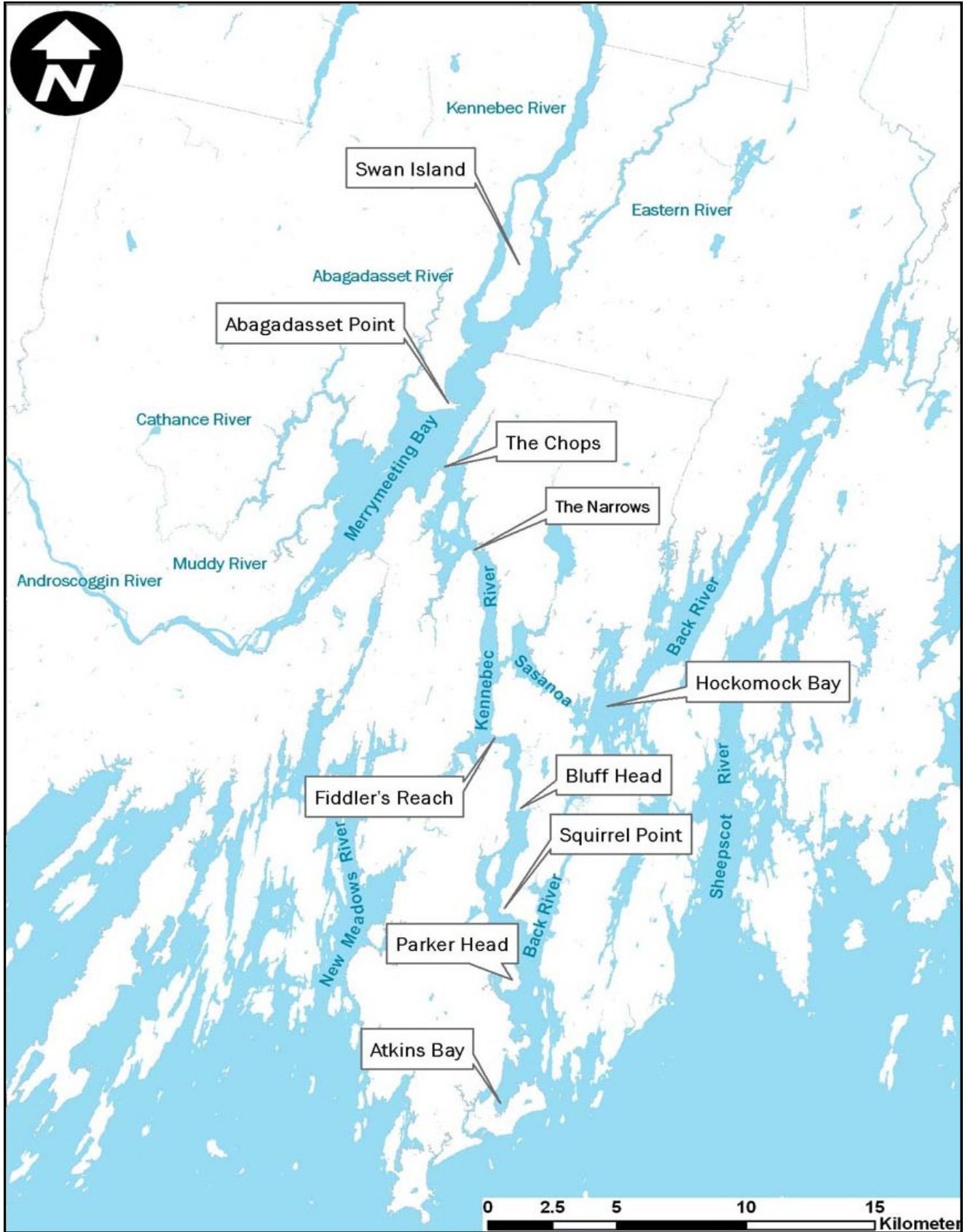
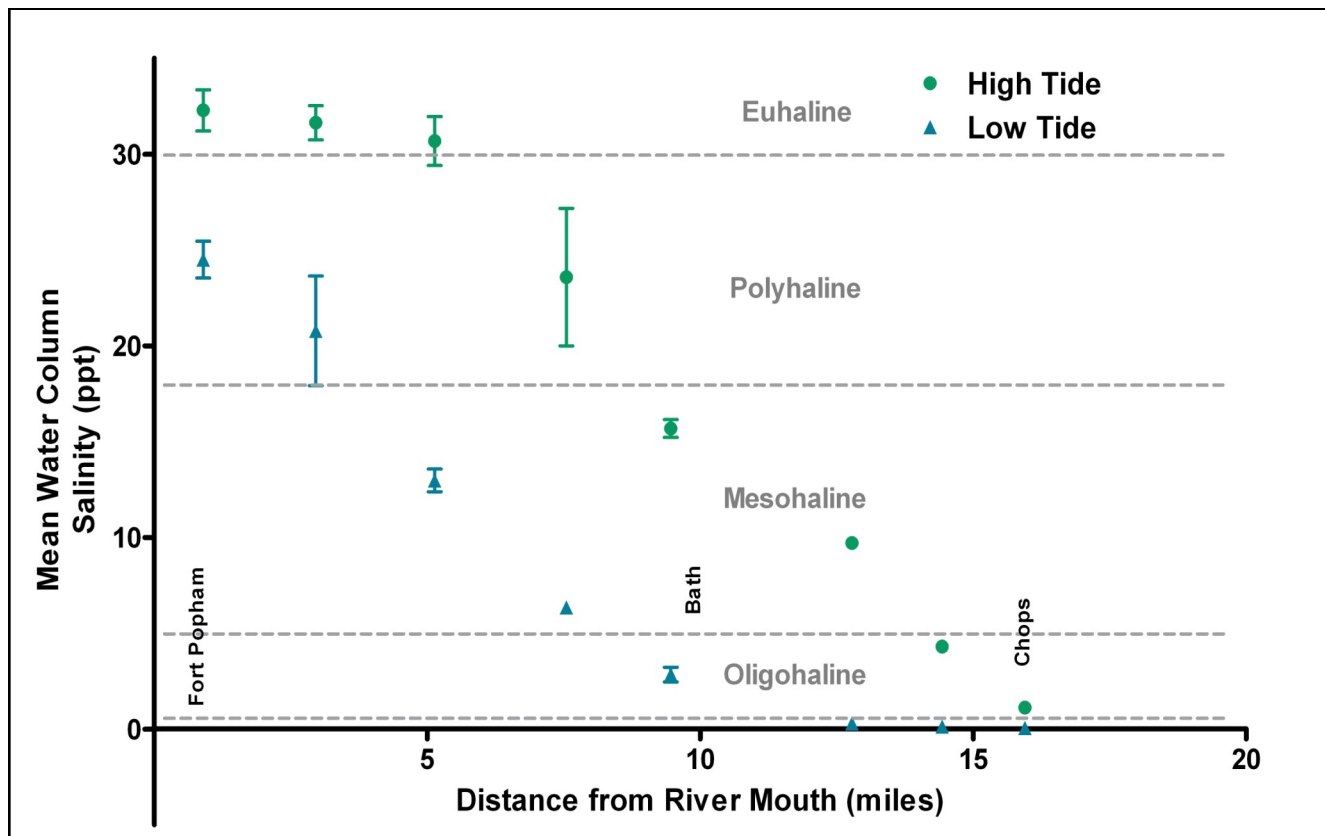


Figure 1-1. Map of the Lower Kennebec Region

## Physical Overview

The Kennebec Estuary is one of the primary sources of freshwater to the Gulf of Maine with a discharge that ranges between  $100 \text{ m}^3/\text{s}^1$  and  $4,000 \text{ m}^3/\text{s}^1$  (annual mean =  $425 \text{ m}^3/\text{s}^1$ ) (Kistner and Pettigrew 2001). At Merrymeeting Bay, the upper Kennebec Estuary receives waters from six different drainages of note (Fig. 1-1). The two largest of these, the Kennebec and Androscoggin, are the second and third largest rivers in Maine. From its source at Moosehead Lake to the open ocean, the Kennebec River is approximately 225 km (140 mi) long and has a drainage area of approximately  $14,775 \text{ km}^2$  ( $5,704 \text{ mi}^2$ ) (Fenster and Fitzgerald 1996). The Androscoggin River, whose source is Umbagog Lake in New Hampshire, is about 213 km (132 mi) long and drains  $8,500 \text{ km}^2$  ( $3,282 \text{ mi}^2$ ) (Fenster and Fitzgerald 1996). Collectively, these two rivers drain roughly a third of the land area of Maine and a portion of the state of New Hampshire (Lichter et al. 2006). The four remaining rivers (the Eastern, Cathance, Muddy, and Abagadasset) are much smaller and collectively drain less than  $520 \text{ km}^2$  ( $200 \text{ mi}^2$ ) (D'Andrea et al. 1975).

The waters of Merrymeeting Bay exit into the lower, saline portion of the Kennebec Estuary through a narrow ( $\sim 245 \text{ m}$  [805 ft]) bedrock constriction known as the Chops, located approximately 27 km (16 mi) upstream of the river's mouth. Downstream of the Chops, waters of the estuary sluice through a series of additional constrictions before reaching the open ocean. On the way, the Sasanoa River joins the estuary on the bank opposite Bath, connecting the Kennebec Estuary with the Sheepscot River Estuary. Further down in the estuary, the Back River again provides another link with the Sheepscot system.



**Figure 1-2.** Mean water column salinities ( $\pm 1 \text{ SD}$ ) in the Kennebec Estuary at or near low and high tide during the fall of 2007. Boundaries between salinity zones are delineated according to Odum (1988). Adapted from J. Reblin and J. Lichter (unpublished data).

Substrates in the channel of the Kennebec Estuary are largely composed of sand and bedrock, though finer materials dominate in lower-energy coves and margins of the estuary (Fenster and Fitzgerald 1996). Main channel depths at low tide typically range from 17 m (58 ft) near the mouth to less than 10 m (33 ft) in the Kennebec River above Merrymeeting Bay. South of the Chops there are several points in the main channel where depths exceed 25 m (82 ft). When freshwater flows in the river are low, strong flood tide currents issuing through the Chops redirect downriver sediment transport, replenishing the sandy intertidal delta at the mouth of the Abagadasset River (Fenster et al. 2005) known locally as “the Sands.”

The Kennebec is classified as a mesotidal estuary (FitzGerald et al. 2000); the daily tidal range at its mouth averages 2.6 m (8.5 ft) (NOAA 2008a), though during spring tides the range can be as large as 3.5 m (11.5 ft) (Fenster et al. 2005). Flood tide duration decreases as distance from the mouth increases, which dampens tidal amplitude (Fenster et al. 2005). At Bath, the tidal range averages 2.1 m (6.8 ft) (NOAA 2008a); farther up the estuary in Merrymeeting Bay, tidal range typically varies from 1.6–2.7 m (5.2–8.9 ft) (P. Lea, Bowdoin College, unpublished data).

The Kennebec’s tidal prism—the amount of seawater flowing in and out of the estuary on each tide—is relatively large ( $1.0 \times 10^8 \text{ m}^3$  or 130,795,061 yards<sup>3</sup>) (Fitzgerald et al. 2000). One study found that the change in the lower estuary’s water volume associated with tides was 1,600% greater than the average freshwater discharge of the Kennebec and Androscoggin Rivers combined during the same time period (Fitzgerald et al. 2000). However, flow in the estuary is typically ebb-dominated, especially during the late winter and early spring when downstream current velocities are greatest below Merrymeeting Bay (Fenster et al. 2005; Fitzgerald et al. 2000). During extremely high discharge events such as the 1987 flood, flows can be entirely ebb-oriented, with freshwater from the Kennebec and Androscoggin watersheds displacing the entire tidal prism of the estuary (Stumpf and Goldschmidt 1992; Fenster et al. 2005).

Tidal waters in the estuary extend northward to Augusta on the Kennebec and to the dammed series of falls separating Brunswick and Topsham on the Androscoggin River (Wheeler and Wheeler 1878). However, fluctuating bathymetry and complex channel geometry help limit the migration of marine waters up the estuary during flood tides (Fenster and Fitzgerald 1996). As a result, seawater in the estuary is largely restricted to areas below Merrymeeting Bay (Mayer et al. 1996; Wong and Townsend 1999; Fenster et al. 2005; Souther 2005). At the Chops, surface water salinities (Fig. 1-2) are typically below the 5.0 parts per thousand (ppt) threshold (Odum 1988) that distinguishes oligohaline from mesohaline systems (J. Reblin and J. Lichter, Bowdoin College, unpublished data; Mayer et al. 1996; Wong and Townsend 1999; Souther 2005), although bottom salinities can remain elevated upstream of the Chops (B. Vickery, The Nature Conservancy, personal communication) owing to the greater density of saline waters. Below the Chops the differences between water salinities at high and low tide are typically greater (Fig. 1-2), with the estuary becoming more saline at high tide (J. Reblin and J. Lichter, unpublished data; Mayer et al. 1996).

During periods of low flow, the lower estuary’s water column is typically more stratified, with higher salinity marine waters being found both deeper in the river channel and further up the estuary (Fenster and Fitzgerald 1996). However, during periods of high discharge, downstream freshwater flows can significantly dilute marine waters in the estuary, greatly reducing water salinities (Kistner and Pettigrew 2001; Fenster and Fitzgerald 1996). Depending on the river flows and the strength of the tide, marine waters typically penetrate up the estuary between 5 and 35 km (3–22 mi) from the Kennebec’s mouth (Kistner and Pettigrew 2001).

The origins of the Kennebec Estuary’s bedrock valley can be traced to the Tertiary Period (~65–1.8 million years before present or BP), during which massive fluvially induced erosion of metasedimentary rock gave the valley its initial shape (Fenster et al. 2005). During the Pleistocene (1.8 million–10,000 years BP), glacial action deepened the bedrock channel (Fenster et al. 2005; Roman et al. 2000), and by 14,000 BP, the local ice sheet covering Maine may have been over 1,000 m (3,300 ft) thick and may have extended

as far seaward as the continental shelf (worldwide sea level at that time was about 110 m below present levels) (Kelley et al. 2005; Hooke et al. 2006).

The immense mass of this ice sheet bowed the earth's crust sufficiently to put Maine's present coastline below local sea level at that time. As the glaciers retreated, isostatic rebound of the land commenced, but at a rate insufficient to keep ocean waters from flooding the still-depressed earth's crust and creating a vast inland sea extending up to 100 km (62 mi) inland. Evidence of this landward transgression of the sea is found in Maine's vast deposits of glaciomarine clay (e.g., the Presumpscot Formation) and fossils of ocean life located far inland (Hooke et al. 2006).

With time, isostatic rebound outpaced global sea level rise, causing Maine's coastline to move seaward relative to its current position (Kelley et al. 2005). As the rate of rebound waned, sea level rise became the dominant factor affecting the coastline. By approximately 11,000 years BP, the local coastline was near its current position at the mouth of the Kennebec River (Belknap et al. 2002). However, over the next ~500 years, larger-scale rebound processes were probably responsible for sea levels falling to almost 60 m (~200 ft) below current levels (Belknap et al. 2002). During that period, large sandy deltas and other artifacts of erosional and depositional processes formed at the mouth of the Kennebec River and at more seaward locations (Kelley et al. 2003). Over the last 10,000 years, the modern Kennebec Estuary was formed by the drowning of the bedrock river valley (Fenster and Fitzgerald 1996), and since 5,000 BP sea levels have apparently continued an overall increasing trend (Kelley et al. 2005).

## Ecological Overview

### Communities and Ecosystem Function

Extending from tidal freshwaters to exposed coastline, the Kennebec Estuary supports a diverse ecological milieu. As elsewhere, plants and animals of the estuary exist within the limits of environmental tolerances that determine the conditions necessary for survival (Hutchinson 1958). Where the tolerance ranges of different organisms overlap, assemblages of species co-occur in patterns that are, to varying extents, repeatable. Despite the continuous variation within these collections of organisms, attempts have been made to classify them as distinct community types (Krebs 1985). Certain types of estuarine communities are particularly notable for their resilience to wide swings in salinity and exposure to air, among other conditions. However, if conditions at a given location shift so much that the tolerances of resident organisms is exceeded, the community will be replaced by a plant and animal assemblage that is more suited to the new environmental regime.

Factors that influence the development of distinct aquatic communities are often grouped into chemical, physical, and biological categories. Among chemical factors, the osmoregulatory challenges associated with salinity are particularly influential in the development of aquatic communities. Tidal action, which creates areas within the estuary that are regularly exposed to air (intertidal) or are always covered by water (subtidal), is a physical factor that has considerable effect in determining community membership (Hummel et al. 1988). Besides salinity and tides, many other factors shape communities, including those attributed to conditions and processes that are physical (e.g., substrate grain size, current or wave energy, light limitation) and those that are biological (e.g., competition, predation, herbivory, disturbance) (Dayton 1971; Connell 1983; Leigh et al. 1987; Ojeda and Dearborn 1991; Steneck et al. 1991; Sanford et al. 1994; Lalli and Parsons 1997).

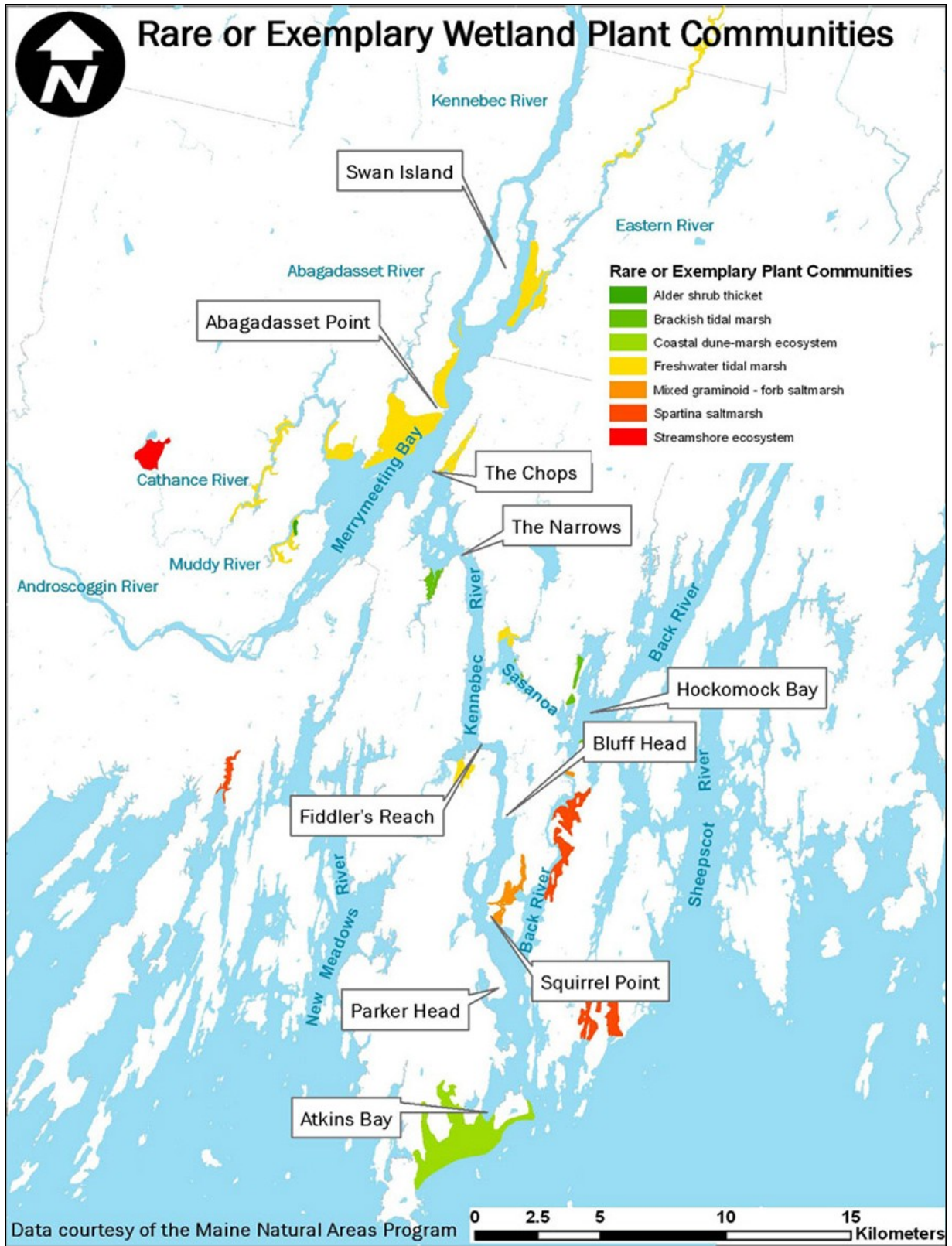
The classification of ecological communities has its origins in plant ecology; consequently terrestrial community types are often named according to dominant plant associations at a given site. In estuarine and marine benthic environments, plants are not often the most apparent components of the system. As a result, in classifying these communities, a geomorphological nomenclature that denotes the habitat rather than the dominant species (e.g., sand beach) is often used.

Seaward of the estuary’s mouth, but well within its influence, benthic communities are primarily associated with sandy and gravelly substrates (Barnhardt et al. 1996) with occasional submerged ledge and rocky islands that offer a foothold for dense, fleshy macroalgae communities to develop. At the estuary’s mouth, moderate and high-energy sand beaches and ebb deltas represent features that support distinct communities and that, along with dune systems, provide a bulwark against the forces of open-ocean wind and waves. Landward of these areas lower-energy intertidal communities are represented by saltmarshes and mudflats that fringe the Kennebec channel.

Moving north in the estuary, as salinities decline, freshwater and brackish tidal marshes become more common at about 16 km (10 mi) from the river’s mouth, supplanting saltmarshes as the dominant intertidal community. North of the Chops, Merrymeeting Bay owes much of its character to expansive tidal

Marine and estuarine community types	Ecosystem functions and services						Managed animal species					
	Primary production	Recycles nutrients	Accumulates-exports nutrients	Human food provisioning	Sequesters contaminants	Mediates wave/flood damage	Recreation opportunities	Invertebrates	Fish	Birds	Mammals	Rare species
<i>Intertidal</i>												
Mudflat	X	X		X	X			X		X		
High energy sand beach	X	X		X		X	X	X		X		X
Sand flats	X	X		X	X		X	X	X	X		X
Unvegetated gravel and ledge				X		X	X	X		X	X	X
Vegetated gravel and ledge	X	X	X	X		X	X	X	X	X	X	X
Marsh	X	X	X		X	X	X		X	X	X	X
Scrub and forested wetland	X	X	X		X	X				X	X	
<i>Shallow Subtidal</i>												
Mudflat	X	X	X	X	X		X	X		X		X
Unvegetated sand							X	X	X			X
Submerged aquatic vegetation	X	X	X	X	X	X	X	X	X	X		X
Unvegetated gravel and ledge				X		X	X	X	X	X		X
Vegetated gravel and ledge	X	X	X	X		X	X	X	X	X		X
Pelagic/water column	X	X	X	X			X		X	X	X	X

**Table 1-1.** Generalized examples of Kennebec Estuary community types and associated ecosystem roles. Partially adapted from Ward (1999).



**Figure 1-3.** Maine Natural Areas Program mapped communities of heightened management interest. Not noted in this map are communities at the southern "Foot" of Swan Island and those associated with submerged aquatic vegetation.



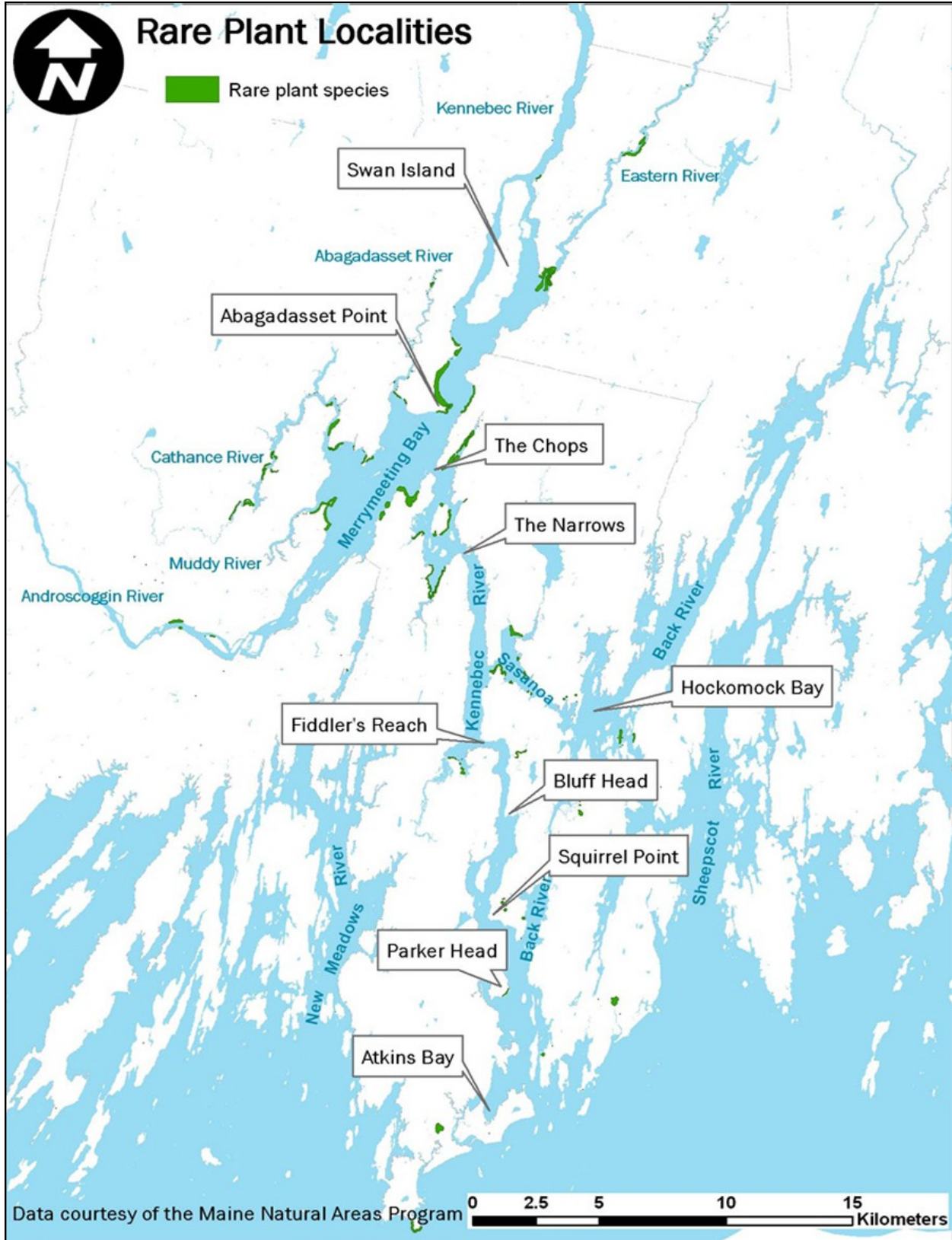


Figure 1-4. Maine Natural Areas Program mapped locations of rare plant species.

freshwater marshes and also to the sand deltas that form in mid-bay as a result of opposing currents. Freshwater submerged aquatic plant communities add to the distinctive character of the upper estuary. Nowhere else in Maine is there such an extensive tidal freshwater system as the one represented by the upper Kennebec Estuary, and Merrymeeting Bay in particular.

In different ways and to varying extents, distinct community types such as those discussed above contribute to ecosystem function, the self-supporting processes that maintain system metabolism and give each system its unique character. Optimal delivery of ecosystem goods and services—the foundations of human life and well-being—occurs as a result of healthy ecosystem functioning. In modern societies the fundamental dependency on ecosystem function and services has often been poorly recognized to the extent that ecosystem degradation is more the norm than the exception (Corvalan et al. 2005). Table 1-1 provides a matrix of generalized benthic community types occurring in the Kennebec Estuary and examples of associated ecosystem functions and services those communities would be expected to provide. To some extent, most of the community types listed contribute to most of the functions and services listed, but our intent is to draw attention only to the ecosystem roles supported in an exemplary or otherwise notable manner for a given community type.

## Communities and Species of Management Interest

Mounting evidence shows that certain kinds of ecosystem change, such as declines in species richness and shifts in community structure away from a “historical” or “native” condition, can reduce an ecosystem’s capacity to provide ecosystem services that are expected and valued (Duarte 2000; Lotze et al. 2006; Worm

Common name	Scientific name	General location		Status
		Mid-estuary	Upper estuary	
Beaked spike rush	<i>Eleocharis rostellata</i>	X		Special Concern
Eaton's bur-marigold	<i>Bidens eatonii</i>		X	Threatened
Estuary bur-marigold	<i>Bidens hyperborea</i>		X	Special Concern
Estuary monkeyflower	<i>Mimulus ringens var colpophilus</i>		X	Special Concern
Horned pondweed	<i>Zannichellia palustris</i>	X		Special Concern
Lilaeopsis	<i>Lilaeopsis chinensis</i>	X		Threatened
Long's bitter-cress	<i>Cardamine longii</i>	X	X	Threatened
Marsh bulrush <sup>b</sup>	<i>Bolboschoenus novae-angliae</i>	X		Special Concern
Mudwort	<i>Limosella australis</i>	X	X	Special Concern
Parker's pipewort	<i>Eriocaulon parkeri</i>	X	X	Special Concern
Pygmyweed	<i>Crassula aquatica</i>		X	Special Concern
Saltmarsh false foxglove	<i>Agalinis maritima</i>	X		Special Concern
Spongy arrowhead	<i>Sagittaria calycina</i>	X	X	Special Concern
Stiff arrowhead	<i>Sagittaria rigida</i>		X	Threatened
Water pimpernel	<i>Samolus valerandi</i>	X	X	Special Concern
Yellow pond lily	<i>Nuphar advena</i>		X	Special Concern

<sup>a</sup> Mid-Estuary = Fiddlers Reach to the Narrows, Upper Estuary = Upstream of the Narrows.  
<sup>b</sup> Only documented location in Maine

**Table 1-2.** Rare plant species documented in the Kennebec Estuary by the Maine Natural Areas Program.

et al. 2006). Given the potentially high costs associated with declining ecosystem integrity and resilience, which include ecological, economic, social and cultural impoverishment, well-informed natural resource management efforts must understand patterns of distribution, abundance, structure, trends, and both inter-community and intra-community interactions, as well as the vulnerabilities of distinct ecological elements.

The Maine Natural Areas Program (MNAP) has identified a number of rare or exemplary wetland plant communities and plant locations throughout the estuary (Figs. 1-3 and 1-4; Table 1-2) as part of a larger effort to prioritize conservation needs. These wetland communities are relatively accessible which facilitates observation by ecologists. Subtidal communities are less accessible. Efficient identification and characterization of these communities often requires the use of specialized, dedicated technologies (e.g., acoustic seabed classification systems, underwater video). The costs associated with identifying and mapping subtidal communities areas have largely impeded our understanding of their distributions and, as a result, management of these areas.

Efforts to document and track vertebrate populations within the estuary have benefited from the work of the Maine Department of Marine Resources (MDMR), which since 1979 has conducted summer–fall biweekly beach seine surveys in the Kennebec Estuary primarily to monitor restoration of striped bass (*Morone saxatilis*) and juvenile alosids (members of the herring family). These sampling efforts have identified over 60 species of fish that use the estuary for one or more phases of their life history (G. Wippelhauser, MDMR, unpublished data). Included among them are the anadromous species that historically had large runs in the Kennebec Estuary but are now represented by dramatically less biomass. For sampling deeper subtidal areas such as those at the mouth of the Kennebec, use of commercial trawl gear is a more suitable collection method. Use of that method resulted in documentation of particularly important Atlantic sturgeon (*Acipenser oxyrinchus*) habitat at the mouth of the Kennebec (S. Sherman, Maine DMR, unpublished data).

The Kennebec is also known to support 9 of 10 fish species designated as Trust Species by the U.S. Fish and Wildlife Service (USFWS). Several key species of management interest, including the anadromous blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), and to some extent striped bass, are largely perceived as fish of the water column community, although they can have important interactions with benthic communities.

Large assemblages of vertebrate and invertebrate species have close affinities with particular substrate types that more or less define benthic communities. Eelgrass (*Zostera marina*) supports one of the most diverse of these benthic communities in North Atlantic waters, although the Kennebec Estuary supports relatively little growth of this submerged aquatic vegetation (SAV) type. However, environments in the upper estuary, particularly Merrymeeting Bay, support the growth of expansive SAV beds that provide escape, nesting, and nursery cover for a variety of fish species, provide food for invertebrates and wildlife, and probably represent an important component of a detritally based food web.

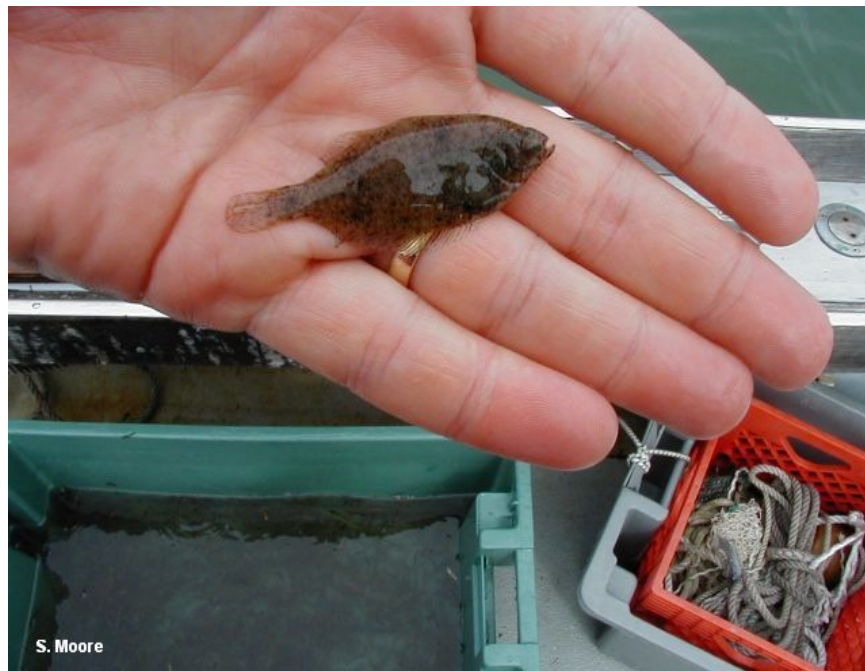
In addition to anadromous species, fish and invertebrate taxa that warrant heightened management interest due to low population numbers or limited distributions are also found in the estuary. These include redfin pickerel (*Esox americanus americanus*), for which the only documented occurrence in Maine is a tributary of the upper Kennebec River Estuary (Kircheis 1994). The tidewater mucket (*Leptodea ochracea*), a freshwater “mussel” designated as Threatened in Maine, is also known to occur in Merrymeeting Bay and the Kennebec River above Swan Island (Nedeau et al. 2000).

The Kennebec Estuary has long been recognized for its value as important waterbird habitat. Much of the recent knowledge regarding abundance and distributions of waterbirds and waterbird habitat is available through the use of spatial data prepared by the Maine Department of Inland Fisheries and Wildlife (MDIFW). The extensive tidal marsh communities that traditionally made Merrymeeting Bay a focal point

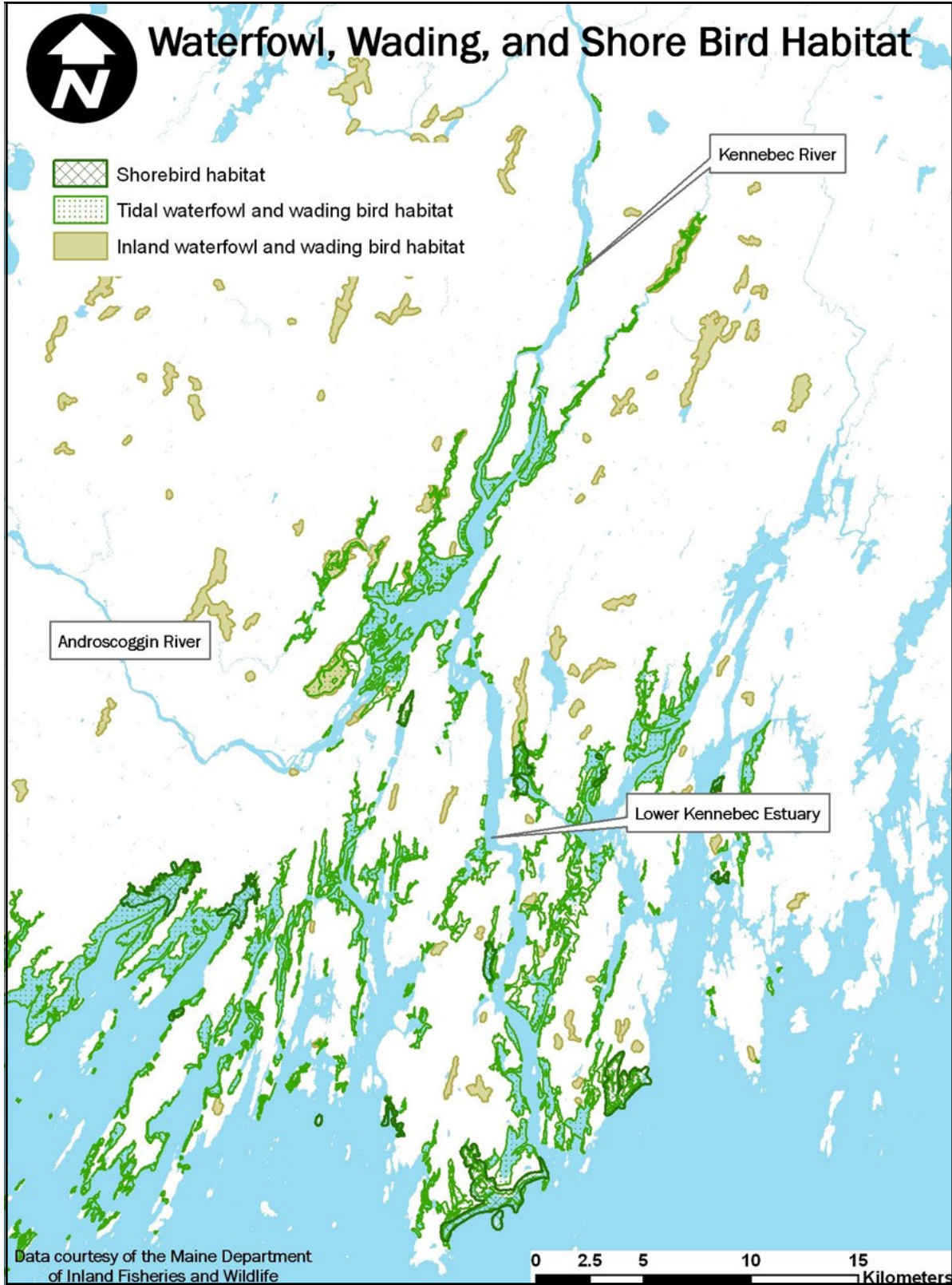
for waterfowl hunters still provide regionally important habitat for ducks, geese, wading birds and bald eagles (*Haliaeetus leucocephalus*) (Fig. 1-5). Likewise, mud and sand intertidal communities in and adjacent to the Kennebec Estuary offer feeding and roosting habitat for shorebirds. They also support local shellfish harvesting, which in 2007 removed over 150,000 kg (330,700 lbs) of commercial clams (H. Bray, Maine DMR, unpublished data). Species of interest using saltmarshes include the saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus*), designated a Special Concern species in Maine, which breeds in several marshes of the lower estuary.

At the Kennebec's mouth, the piping plover (*Charadrius melodus*) and least tern (*Sterna antillarum*), both of which have been designated as Endangered Species by the state of Maine, use the sand beach–dune systems for nesting and use the nearby sandy intertidal and shallow subtidal areas for feeding. In these same waters of the extreme nearshore and up into the mouth of the Kennebec, state-endangered roseate terns (*Sterna dougallii*), designated an Endangered Species by the state of Maine, and Arctic terns (*Sterna paradisaea*), designated a Threatened Species, feed on pelagic juvenile-stage fish forms and nest on islands that also support the nesting requirements of common eider (*Somateria mollissima*), common tern (*Sterna hirundo*), and Leach's storm petrel (*Oceanodromo leucorhoa*), among other species.

Outside the Kennebec's mouth, expansive sand and sandy gravel seabed classes historically provided habitat for abundant groundfish such as Atlantic cod (*Gadus morhua*) until stocks were depleted in the early 1990s (S. Sherman, Maine DMR, personal communication). Likewise, rocky subtidal communities supported urchin harvesting until stocks were depleted to commercial extinction in the late 1990s (M. Hunter, Maine DMR, personal communication).



High quality nursery habitat is key to the conservation of exploited fish species, such as this months-old winter flounder (*Pseudopleuronectes americanus*). A U.S. Fish and Wildlife Service Trust Species, winter flounder typically associate with benthic communities having fine or mixed gravel substrates. Photo: Slade Moore.



**Figure 1-5.** Waterfowl, wading, and shorebird habitat documented and mapped in the Kennebec Estuary by the Maine Department of Inland Fisheries and Wildlife.

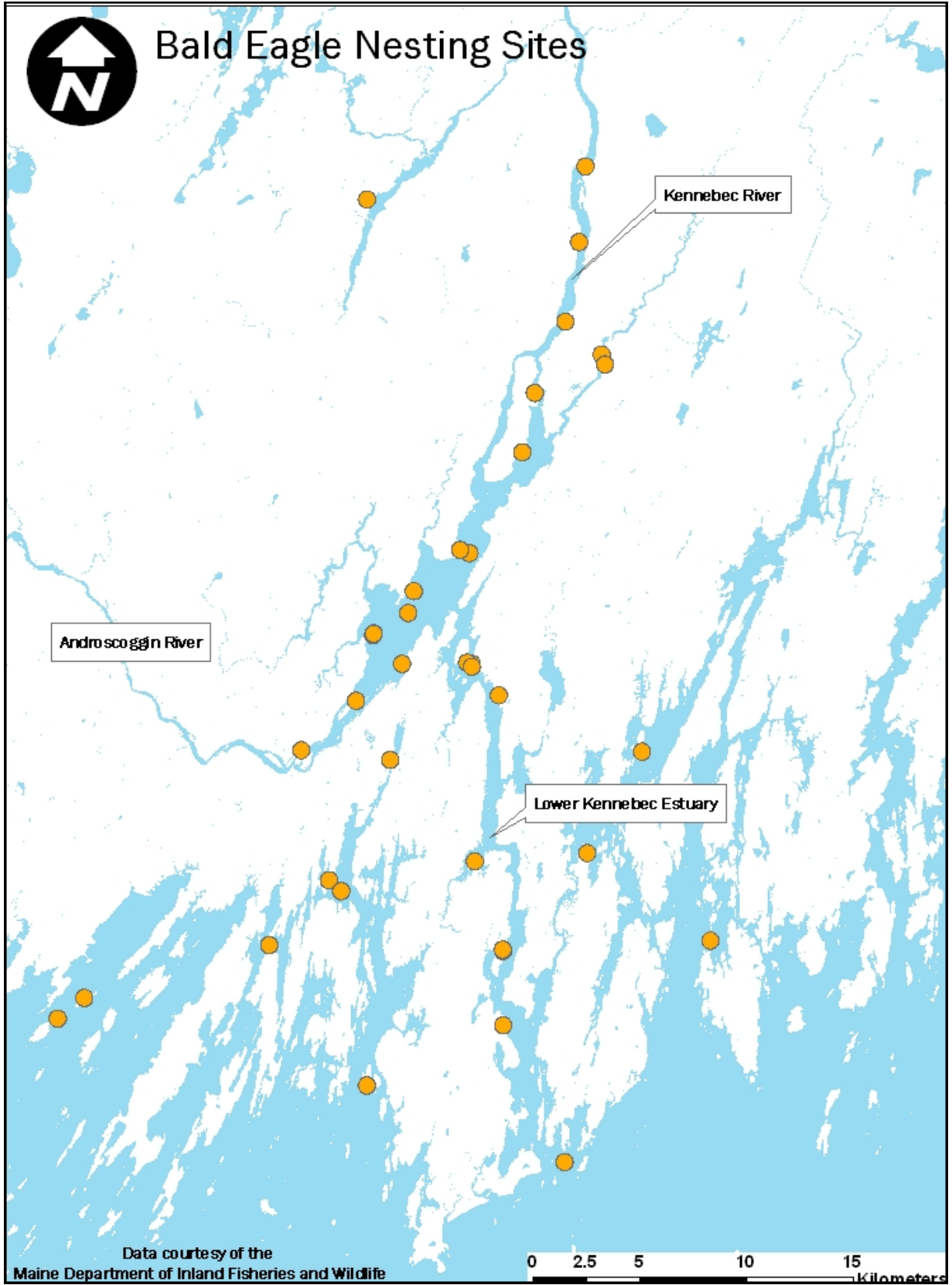


Figure 1-6. Bald Eagle nest sites documented in the Kennebec Estuary by the Maine Department of Inland Fisheries and Wildlife.