INTERSECTING HISTORIES IN THE KENNEBEC RIVER, MAINE: MIGRATORY FISH AND EDWARDS DAM

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This dissertation is the first concerted analysis of the removal of Edwards Dam from the Kennebec River, Maine. Its method is chiefly historical. Its historical materials – pre- and post-Edwards – are supplemented by newspaper reportage, documents from state and federal agencies and environmental health organizations, and personal interviews with relevant stakeholders. Among the dissertations findings are that, despite its many shortcomings, the Lower Kennebec River Comprehensive Hydropower Settlement Accord (1998) changed the facilitation of dam removal in the United States. It secured the Federal Energy Regulatory Commission's authority to deny an application for the renewal of a hydropower project and to order a dam be removed at the expense of its owner were it to determine that this was in the public interest. In so doing, it restructured the relationships among hydropower project licensees, state and federal natural resource agencies, environmental health organizations, Indian Tribes, and other stakeholders. The Settlement Accord allowed for Edwards to be removed from the Kennebec promptly and without public funds. It also provided unobstructed access to seventeen miles of spawning and rearing habitat for some native migratory fish species. Water quality, wildlife, and recreation were also enhanced. During the relicensing process, stakeholders were able to express their concerns and recommendations. This open consultation encouraged – if not demanded – public involvement that, through debate and discussion, would eventually help address and resolve various ongoing and potential issues early in the relicensing process.

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ABBREVIATIONS AND ACRONYMS

ASF – Atlantic Salmon Federation

BIW – Bath Iron Works

CBA – Cost-Benefit Analysis

CMP – Central Maine Power

CWA – Clean Water Act

DEIS – Draft Environmental Impact Statement

ECPA – Electric Consumers Protection Act

EIS – Environmental Impact Statement

ESA – Endangered Species Act

FEIS – Final Environmental Impact Statement

FERC – Federal Energy Regulatory Commission

FOMB – Friends of Merrymeeting Bay

FPA – Federal Power Act

FPC – Federal Power Commission

KC – Kennebec Coalition

KHDG – Kennebec Hydro Developers Group

KRAC – Kennebec River Angler's Coalition

MBEP – Maine Board of Environmental Protection

MDEP – Maine Department of Environmental Protection

MDMR – Maine Department of Marine Resources

NEPA – National Environmental Policy Act

NMFS – National Marine Fisheries Service

NPDES – National Pollutant Discharge Elimination System

NRCM – Natural Resources Council of Maine

PRRP – Penobscot River Restoration Project

PRRT – Penobscot River Restoration Trust

TU – Trout Unlimited

USACE – United States Army Corps of Engineers

USFWS – United States Fish and Wildlife Service

USDOI – United States Department of the Interior

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INTRODUCTION

Most rivers in the state of Maine (U.S.) once supported naturally reproducing, self-sustaining populations of 12 species of native migratory fish. Also known as diadromous fish, these species were considerably more abundant and widely distributed than in the past 200 years. That migratory fish co-evolved over thousands of years with themselves and other aquatic organisms native to rivers in the state suggests that the long-term community stability and productivity of riverine ecosystems throughout Maine will depend on sustaining interspecies relationships, individual species function, and the complexity and connectivity of their habitats.

In the early 1800s, all populations of native diadromous fish species in Maine began to decline due to the impacts of overfishing, water quality degradation, and physical impediments to migration. Restoration attempts did occur mid-century, but were futile due to, in large part, the ubiquity of dams in Maine rivers like the Penobscot, Kennebec, and Androscoggin. Since then, availability and accessibility to spawning and rearing habitat has either continued to deteriorate or been lost.

While dams provide important functions to society, they do so in a manner that wreaks havoc to riverine, estuarine, and marine environments. As dams alter the flow of water, sediment, nutrients, energy, and biota, they, in turn, disrupt and change most of the central ecological processes of a river. For migratory fish, the most severe effects of dams are the elimination and degradation of spawning and rearing habitat, together with the loss of the complexity and connectivity of this habitat.

Most dams in the U.S. are federally regulated under a relicensing process that issues licenses to operate under the status quo for terms of 30 to 50 years. Only in a few cases – and only more recently – have ameliorative efforts been mandated via this federal relicensing process, while any such voluntary actions on the part of the dam licensee are not common. These mitigation attempts include: enhancing up- and downriver fish passage facilities, upgrading water flow and quality standards, fish stocking programs, habitat protection agreements, and, of course, dam removal.

Formally arriving at a decision of whether to remove a dam is a complex, contentious, and laborious process. Having said that, it is also coming to be seen as a practical, comprehensive, and successful alternative to more *ad hoc* attempts made to restore the health of a river, including its migratory fish populations. When a dam is removed, water quality improves, species diversity increases, and ecosystem function overall is enhanced. For diadromous fish, access to spawning and rearing habitat can be augmented.

That so many dams across the country are aging, together with the costs of keeping them operational, all but guarantees that considerations for dam removals will become more vigorous in the impending decades. And, while still in its infancy, a consensus is expanding in individual and institutional communities alike that look to such removals as a way to promote both environmental and socioeconomic health.

Edwards Dam was built in the Kennebec River in 1837, where it remained for more than 160 years to obstruct upriver passage for 12 species of diadromous fish native to the river. Within just a few years – not decades – populations of migratory fish in the river and its tributaries were evanescent.

Much, much later, in the 1980s, Edwards had become a lingering hydropower project that employed only three people and produced a very small amount of electricity – so insignificant, in fact, that its 3.5 megawatts of electricity accounted for merely one tenth of 1% of the entire power supply for the state.

Issued by the Federal Energy Regulatory Commission (FERC), the license to operate Edwards expired in 1993, and its licensee, Edwards Manufacturing Co., applied for renewal. Notably, in December 1994, as a component of a separate policy-making process, FERC concluded that it has the authority to deny an application for the relicensing of a (nonfederal) hydropower project and order a dam be removed at the expense of its owner were it to determine that this was in the public interest.

Various stakeholders began to foster public awareness about how the potential environmental and socioeconomic benefits from the removal of Edwards would outweigh the hydropower benefits from its continuance. While public support for removal increased, the likelihood that it would actually happen was very uncertain. The removal of Edwards appeared to be both complicated and momentous.

Knowledge of dam removal is increasingly important to the restoration of migratory fish. The following analysis of the removal of Edwards Dam from the Kennebec River attempts to emphasize that while the consideration of dam removal is novel and difficult, it is also a viable option for when long-term restorative measures are needed. To date, no such analysis exists in academic, empirical, or any other related literature.

SOME BACKGROUND ON MIGRATORY FISH IN MAINE

Ecological Importance

The ecological milieu wherein migratory fish native to Maine evolved is a stark contrast to what exists nowadays. The environmental changes that have transpired in only the past few hundred years are omnipresent and extend widely over spatial and temporal scales. Many are still ongoing, while others are underway and being discovered frequently. Before the European invasion of the New World, rivers in Maine supported naturally reproducing, self-sustaining populations of at least 12 species of native diadromous fish (i.e., fish that migrate between fresh- and saltwater) (see Figure 1, p. 81), including: alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), Atlantic salmon (*Salmo salar*), brook trout (*Salvelinus fontinalis*), American eel, (*Anguilla rostrata*), Atlantic sturgeon (*Acipenser oxyrinchus*), shortnose sturgeon (*Acipenser brevirostrum*), Atlantic tomcod (*Microgadus tomcod*), rainbow smelt (*Osmerus mordax*), sea lamprey (*Petromyzon marinus*), and striped bass (*Morone saxatilis*).

The life histories of these migratory fish species are complex and quite variable (see Figures 2 and 3, p. 82-83). Each requires unobstructed access to riverine, estuarine, and marine habitats, and each has distinguishable stages in its life history that involve changes in behavior, physiology, and habitat necessity. Among diadromous fish, *anadromous* fish spend much of their life at sea, but spawn in rivers, while *catadromous* fish do the opposite. Of the abovementioned diadromous species native to Maine, only the American eel is catadromous, all others are anadromous.

Migratory fish co-evolved over time with themselves and other aquatic organisms native to rivers in Maine, which suggests that the long-term community stability and productivity of these riverine ecosystems will depend on sustaining interspecies relationships, individual species function, and connectivity between riparian zones, lakes, ponds, wetlands, estuaries, and the ocean (Fay et al. 2006, p. 17). As important sources of carbon, nitrogen, phosphorous, and other nutrients vital to benthic communities in rivers, billions of juvenile migratory fish were also essential forage for groundfish in the Gulf of Maine (Goode 2006, p. 23; 25). River herring (i.e., alewife, blueback herring, and American shad), as well as American eel, Atlantic tomcod, and rainbow smelt, were once a significant part of the forage base of coastal Atlantic cod and other groundfish.

A consensus has been growing among scientists who posit that one reason why groundfish populations remain precarious in the Gulf of Maine is that their forage base is diminished (Goode 2006, p. 25). For instance, the research of Ted Ames, Vice-Chair and Hatchery Director for Penobscot East Resource Center in Stonington and 2005 MacArthur Fellow, indicates that Atlantic cod began to wane together with river herring in the early 1900s:

> "The disappearance of local anadromous forage stocks and the disappearance of nearby Atlantic cod spawning components was a coincidence that occurred in several areas, suggesting that the traditional movement patterns and arrival times of Atlantic cod may have been disrupted at their inner spawning grounds when the forage stock disappeared. If so, the restoration of coastal populations of Atlantic herring, alewives, and river herring may also be important to restoration of coastal Atlantic cod fisheries." (Ames 2004, p. 19)

As this knowledge advances, it could be employed in efforts to improve migratory fish habitat availability and accessibility and, in so doing, perhaps also provide the floundering commercial groundfisheries throughout the Gulf of Maine with a much-needed boost.

Historical Abundance And Distribution

Records of historical abundance and distribution of native migratory fish in Maine rivers are incomplete. The majority of what is documented pertains to the three largest rivers in the state (i.e., the Penobscot, Kennebec, and Androscoggin), as well as Atlantic salmon. Commissioners of Fisheries for Maine in the late 1800s, C.G. Atkins and N.W. Foster, provide many of these initial historical accounts, although their descriptions mainly refer to the fisheries of certain species. As formal surveys and quantitative estimation techniques had not yet been developed, these estimates of historical abundance and distribution must thus be treated with caution (Saunders et al. 2006, p. 538).

Native Americans fished for American shad and sturgeon in the Penobscot near Old Town at least 6,000 and 3,000 years ago, respectively (Goode 2006, p. 23). Accounts of "explorers'" that date from the sixteenth century depict diverse and plentiful populations of anadromous fish - widespread in the Gulf of Maine - and, in particular, Atlantic salmon, river herring, sturgeon, and striped bass (Goode 2006, p. 23).

Evidence suggests that Atlantic salmon were indeed abundant in large and small rivers alike during these earlier periods, while before the construction of dams in the beginning of the nineteenth century, upriver spawning migrations extended a very long reach into the headwaters of the Penobscot, Kennebec, Androscoggin, and other large rivers in Maine - except for where natural barriers existed (See Figure 4, p. 84) (Saunders et al. 2006, p. 540).

Historically, populations of alewife, blueback herring, American shad, and rainbow smelt were vast in Maine rivers, while the fisheries they enabled in the 1800s were economically significant and often quite lucrative (see Figures 5 and 6, p. 85-86) (Saunders et al. 2006, p. 540-541).

Reports of the historical abundance and distribution of sea lamprey in Maine rivers are virtually absent (Saunders et al. 2006, p. 541). And, until no earlier than the nineteenth century, this is also the case for reliable figures on other diadromous species, i.e., American eel, Atlantic tomcod, brook trout, and striped bass. In total, however, limited historical information does indicate all native migratory fish species in Maine existed for 12,000 years as naturally reproducing, self-sustaining populations throughout the majority of rivers in the state. During this period, they were considerably more abundant and widely distributed than in the past 200 years, while they were also able to migrate much farther upriver to spawning and rearing habitats.

Historic Decline

Towards the beginning of the nineteenth century, populations of 12 species of migratory fish native to Maine began to tumble. While a host of factors spanning many generations has contributed to the present-day status of their abundance and distribution, the earliest causes of decline were the impacts of overfishing, water quality degradation, and physical impediments to migration, the latter two of which emerged via waste disposal activities and hydropower development associated with the Industrial Revolution in New England during the early 1800s. Restoration attempts did occur mid-century, but were futile due to, in part, the ubiquity of dams (Fay et al. 2006, p. 23).

The total adult run of Atlantic salmon in rivers in the U.S. declined from hundreds of thousands of fish in the early nineteenth century to a likely range of 500 to 2,000 fish by the middle of the twentieth century – the majority of which inhabited rivers in eastern Maine (Fay et al. 2006, p. 23). Nowadays, fewer than half of these 34 historic "salmon rivers" have Atlantic salmon returning to them (Saunders et al. 2006, p. 541). According to the Maine Department of Marine Resources (MDMR), current abundance of Atlantic salmon in the Gulf of Maine is indeed significantly lower than historical figures, and less than 1,500 adults have returned to spawn each year since 1998 (MDMR 2009). To date, and primarily because of dams, more than 90% of historic spawning habitat of Atlantic salmon in the Gulf of Maine has been lost (Goode 2006, p. 24). And, based on population size and corresponding growth rate, the likelihood of their extinction ranges from 19% to 75% within the next 100 years – this even with the continuation of ongoing levels of hatchery supplementation (Fay et al. 2006, p. 5).

In 2000, Atlantic salmon from the Gulf of Maine Distinct Population Segment were listed as endangered under the Endangered Species Act (ESA) in eight small eastern Maine Rivers. In 2005, a petition was filed to list native populations of Atlantic salmon in the Kennebec as endangered. The petitioners, (brothers) Timothy and Douglas Watts, Friends of Merrymeeting Bay (FOMB), and the Maine Toxics Action Coalition, requested that the U.S. Department of the Interior (USDOI) declare the Kennebec population of Atlantic salmon as endangered based on supporting evidence, including: (1) DNA analysis of tissue samples indicated conclusively that wild Kennebec salmon are genetically distinct from other wild and hatchery populations in Maine, including the Penobscot and (2) wild Kennebec salmon remain alive in the river to this day (Watts et al. 2005, p. 1-2). On June 15, 2009, partly as a result of the petitioners' efforts, the U.S. Fish and Wildlife Service (USFWS) extended this protection under the ESA to include Atlantic salmon in the Penobscot, Kennebec, Androscoggin, and their tributaries.

As a long-lived fish, American eel may survive in riverine habitats for 30 to 50 years and grow to be five feet in length before migrating out into the Gulf of Maine en route to spawn in the Sargasso Sea. It is because of their size, in part, that sexually mature American eels suffer a very high mortality rate when they attempt to migrate downriver and must pass through respective turbines in a multiplicity of dams. Because these eel populations have plummeted, the Watts brothers petitioned USDOI in 2004 to list the American eel as endangered under ESA (Watts & Watts, 2004). To date, however, USFWS has not deemed the status of American eel warrants listing.

In 2005, FOMB petitioned the Maine Board of Environmental Protection (MBEP) "to revoke, modify, or suspend the Maine Hydropower Permits and Water Quality Certificates" at four dams in the Kennebec and six dams in the Androscoggin and, in so doing, "to provide for and require the immediate safe downstream and upstream passage of American eel" (FOMB 2005, p. 1). FOMB provided MBEP with supporting evidence indicating that the absence of safe and effective passage for eels at these 10 dams violated at least four sections of Maine law, as well as the federal Clean Water Act (CWA). In addition, FOMB provided evidence indicating that the Androscoggin and its tributaries were in non-attainment of the State's water quality standards. MBEP held an adjudicated hearing to consider the Kennebec claim, but they refused to conduct one for the Androscoggin. Despite subsequent petitions to MBEP and appeals to both Maine Superior and Supreme Courts, the petitioners received no satisfaction and the courts never heard the merits of the cases.

Populations of 10 other species of diadromous fish native to Maine are either at or near historic lows. Shortnose sturgeon has been listed as endangered throughout its range since 1967. Numbers of Atlantic sturgeon have dropped precipitously (Goode 2006, p. 24) and they are, together with rainbow smelt, listed as species of concern by the National Marine Fisheries Service (NMFS). Though not listed as endangered or threatened, blueback herring and alewife both remain far below historical levels (Saunders et al. 2006, p. 542). Anadromous brook trout are found only in a few rivers and streams in the Gulf of Maine; native populations of sea lamprey have been extirpated from many of the larger rivers (Goode 2006, p. 23); and American shad now inhabit less than a dozen rivers in Maine (Saunders et al. 2006, p. 542). Populations of striped bass and Atlantic tomcod, which have perhaps undergone the least declines, remain very much hindered in production potential *vis-à-vis* historical conditions (Goode 2006, p. 23).

In merely a few centuries, anthropogenic activities have severely disrupted symbiotic complexity and connectivity between riverine, estuarine, and marine ecosystems. Consequently, historical populations of native migratory fish species in rivers all over Maine have been decimated. Availability and accessibility to spawning and rearing habitat has either deteriorated or been lost. In a very similar way, current land- and water-use practices – which, just as before, involve agriculture, flood control, forestry, urbanization, water pollution, water withdrawal, and, of course, dams – continue to diminish the quantity and quality of diadromous fish habitat in Maine (Fay et al. 2006, p. 74).

Some Background On Anthropogenic Dams

As such endeavors were rampant throughout New England during the late eighteenth century, more sizeable – and therein more consequential – dams were first built in Maine at this time in rivers spread widely across the state. Exploitations in the Penobscot, Kennebec, and Androscoggin were later augmented to generate the power necessary to meet the swelling demands of various local businesses and industries, such as sawmills, tanneries, and textile factories. Yet, given that these earlier dams were built well before the implementation of environmental laws, there was no governmental consideration of their adverse impacts on entire ecosystems, let alone on diadromous fish.

To be fair, dams have indeed provided helpful services to society. Among other functions, they have afforded flood control, irrigation, power generation, navigation, recreation, and water supply. While dams continue to facilitate these important functions, they do so in a manner that has always wreaked havoc to the environment. Empirical research and understanding of the effects of dams is exhaustive and consensual – simply put, dams alter the flow of water, sediment, nutrients, energy, and biota, and thereby disrupt and change most of the central ecological processes of a river (Ligon et al. 1995, p. 183). As Poff and Hart (2002) have aptly summarized:

> "Both individually and cumulatively, dams fundamentally transform river ecosystems in several ways: (a) They alter the downstream flux of water and sediment, which modifies biogeochemical cycles as well as the structure and dynamics of aquatic and riparian habitats. (b) They change water temperatures, which influences organismal bioenergetics and vital rates. (c) And they create barriers to upstream-downstream movement of organisms and nutrients, which hinders biotic exchange. These fundamental alterations have significant ecological ramifications at a range of spatial and temporal scales." (Poff & Hart 2002, p. 660)

For migratory fish, the most severe effects of dams are the elimination and degradation of spawning and rearing habitat and the loss of the complexity and connectivity of this habitat.

According to the Natural Resources Council of Maine (NRCM), the number of dams in the 31,000 miles of rivers and streams in Maine is not known, although it has been estimated to be at least 1,000, with more than 750 of those registered with the State over two feet in height, and of which 111 produce hydropower (NRCM 2002, p. 4, 6, 20). The National Inventory of Dams Program lists 639 dams over four feet in height in Maine (see Figure 7, p. 87) (Fay et al. 2006, p. 75), with the largest hydropower projects occupying the rivers within the distribution of native diadromous fish located in the Penobscot, Kennebec, Androscoggin, Presumpscot, and Saco. In the Kennebec and its tributaries, for instance, there are at least 73 dams, 26 of which are licensed hydropower and storage projects (see Figures 8 and 9, p. 88-89) (Fay et al. 2006, p. 78).

Electricity generated in Maine is transferred into a regional grid of about 500 generating facilities and 8,000 miles of transmission line, which service around 6 million customers in six states (NRCM 2002, p. 20). Most dams in Maine do not generate hydropower, but the 24 largest dams generate 76% the state's total hydropower (see Figure 10, p. 90) (NRCM 2002, p. 20). Most of these hydropower dams are small facilities – with 78% generating a capacity of less than 10 megawatts (NRCM 2002, p. 21). By comparison, the electricity generated by just two natural gas power plants built in Maine recently exceeds the total production of all the operating hydropower dams built in Maine over the past 200 years (NRCM 2002, p. 20).

Upriver fish passage facilities have been installed in several dams in the Penobscot, while only the three lowermost dams in the Androscoggin contain such passage. Downriver facilities exist in most dams in the Penobscot and its tributaries, but many of these are informal, interim, and do not meet current USFWS or NMFS fish passage prescriptions (Fay et al. p. 95). No *safe and effective* downriver facilities are available for species like American eel and Atlantic salmon at any hydropower project in the Penobscot, Kennebec, or Androscoggin. Furthermore, as Goode (2006) has explained, the intention of fish passage does not necessarily come to fruition:

> "The impacts of dams differ with each species. For species such as sturgeon, striped bass and rainbow smelt, there is no proven technology to pass these fish over dams. For skittish species such as American shad, fish elevators are required since they are reluctant to use fish ladders. Even with a fish lift, it is rare to find a self-sustaining shad run above two or more dams. For Atlantic salmon, it is virtually impossible to find a self-sustaining run of salmon above three or more dams in North America or Europe. As mentioned earlier, the downstream impacts may be as detrimental or, in the case of the American eel, worse to fish populations. A good example of the cumulative impacts of dams can be seen on the Penobscot River, the largest river in the Gulf of Maine. With the possible exception of the American eel, the river is not capable of supporting any self-sustaining population of migratory fish above the first dam. In this particular river, a gauntlet of three dams close to the ocean continue to retard the meaningful restoration of Atlantic salmon, despite decades of efforts and millions of dollars." (Goode 2006, p. 24)

So, without a doubt, as Larinier (2000) has emphasized, one "must never lose sight of the limits to the effectiveness of fish passes" (Larinier 2000, p. iii).

Since diadromous fish often must pass through turbines during downriver migration, they experience an assortment of stress (e.g., shocking, rapid acceleration and deceleration, and sudden changes in pressure and cavitation) likely to induce high mortality (Larinier 2000, p. 3). The mortality rate in adult eels, for example, may reach a minimum of 10% to 20% in large low-head turbines, and more than 50% in smaller turbines found in most small-scale hydropower projects (Larinier 2000, p. 3). This means that both direct and delayed mortality will only increase as downriver migration is attempted in rivers with multiple hydropower projects. If, for example, 100 adult eels must travel through six separate dams on their way to spawn in the Sargasso Sea, then even with a conservative, *direct* mortality rate of 20% – at each dam – only 26 will survive downriver migration. This is an all too typical scenario faced by migratory species of fish. Despite the multiplicity of downriver fish passage devices that attempt to prevent fish from being flushed into turbines, only recently have such devices been utilized that are safe and effective, practical to install and operate, and widely acceptable.

As migratory fish often must pass through spillways, they undergo injury and mortality both directly (e.g., abrasion, impact, shearing, turbulence, and abrupt variations in velocity and pressure) and indirectly (e.g., increased vulnerability to predation via disorientation and shocking) (Larinier 2000, p. 3). This predation is also augmented by hydropower projects since unnatural (i.e., higher) concentrations of diadromous fish will school immediately above and below dams (Larinier 2000, p. 5-6).

Most hydropower projects in the U.S. could operate under conditions that would lessen their current damage to riverine environments (American Rivers et al. 1999, p. xii). However, as the overwhelming majority of these projects are federally regulated under a relicensing process that issues licenses to operate for terms of 30 to 50 years, only in a few cases - and only more recently - have such ameliorative efforts been mandated (and voluntary actions on the part of the project licensee are not common) via the federal relicensing process. Mitigation attempts include: the installation or retrofitting of enhanced fish passage, changes in water flow and upgrades in water quality standards (e.g., initiated or increased minimum flows and periodic high flows), fish stocking programs (e.g., hatchery supplementation), and habitat protection agreements.

The lifetime of a dam is finite. Typically, as inefficiencies, structural failures, safety hazards, and the costs of maintenance, repairs, and upgrades all tend to increase as a dam ages, so too will a dam owner's financial burdens and liabilities. So, for these, and other socioeconomic and environmental concerns, older dams - whether abandoned, inefficient, obsolete, unproductive, and/or unsafe - are occasionally removed. Research by American Rivers et al. (1999) has identified at least 465 dams that have been removed in the U.S. since 1912, and that number is likely higher (American Rivers et al. 1999, p. viii). By comparison, however, the number of dams not removed in the U.S. is estimated to be somewhere between 76,000 to 2.5 million (American Rivers & International Rivers Network 2004, p. 7). In Maine, recently, several smaller hydropower dams that were uneconomical have been removed (NRCM 2002, p. 21).

While formally considering and possibly deciding to remove a dam is a complex, contentious, and laborious process, it is also coming to be seen as a practical, comprehensive, and successful alternative to more *ad hoc* attempts made to repair the health of a river as an ecosystem. The long-term, advantageous environmental effects of dam removal are varied, yet correlative. For example, as Bednarek (2001) has stated:

> "Restoration of an unregulated flow regime has resulted in increased biotic diversity through the enhancement of preferred spawning grounds or other habitat. By returning riverine conditions and sediment transport to formerly impounded areas, riffle/pool sequences, gravel, and cobble have reappeared, along with increases in biotic diversity. Fish passage has been another benefit of dam removal." (Bednarek 2001, p. 803)

Indeed, when a dam is removed, water quality improves, species diversity increases, and ecosystem function overall is enhanced. And, most favorable for diadromous fish, access to spawning and rearing habitat can be augmented. It is crucial to understand, however, that with reference to rivers subject to multiple hydropower projects, the removal of one dam may be biologically fruitless if the cumulative presence of other dams (usually, those downriver of removal) continues to obstruct fish migration.

That so many dams across the U.S. are aging, together with the costs of keeping them operational, all but guarantees that considerations for dam removals will become more vigorous in the impending decades (Poff & Hart 2002, p. 667). And, while still in its infancy, a consensus is expanding in local, institutional, and governmental communities that look to such removals as a way to promote environmental health. As stated by the Natural Resources Council of Maine, the "goal of dam removal projects in Maine is to secure a new balance of economic, environmental, and quality of life factors – a balance that is in line with the priorities and realities of our times" (NRCM 2002, p. 3).

AN ACCOUNT OF THE KENNEBEC RIVER AND EDWARDS DAM

A Historical Sketch Of The Kennebec River, Maine

As the second largest river in the state of Maine, in the far northeastern corner of the United States, the Kennebec River flows south from its source in Moosehead Lake near Greenville for just under 152 miles before it reaches its mouth in Phippsburg and then empties into the Gulf of Maine in the Atlantic Ocean. Covering a very generous drainage basin of almost 6,000 square miles, and hence flowing amid scores of aquatic, riparian, and terrestrial environments, the Kennebec and its tributaries have provided sustenance to an untold number of resident and migrant species since its formation at the end of the last ice age, some 12,000 years ago.

At least 12 species of diadromous fish native to Maine (i.e., alewife, American shad, blueback herring, Atlantic salmon, brook trout, American eel, Atlantic sturgeon, shortnose sturgeon, Atlantic tomcod, rainbow smelt, sea lamprey, and striped bass), for example, have at one and the same time existed as naturally reproducing, self-sustaining populations in the Kennebec's collective riverine, estuarine, and marine environments. With its excellent, extensive upriver spawning and rearing habitat at the time, the river enabled local Native American peoples to maintain sustainable fisheries for roughly 7,000 years. And, before it was first dammed in the former half of the nineteenth century, the Kennebec was briefly strong enough to be the site of prolific, although arguably wanton, commercial fisheries.

Despite the aid of archaeological evidence, a more exact description of the lives of prehistoric indigenes in this region of Maine has, sadly, not yet been determined. The "deep human past of this vicinity," as local author and English professor Franklin Burroughs has eloquently and empathetically chronicled, likely begins with:

> "… the Paleo-Indians, who were replaced or mutated into the Red Paint people, who three thousand years ago, at about the time King David was ascending to the throne of

Israel, themselves gave way to or became the Ceramic people. These last were the nations—Micmac, Abenaki, Passamaquoddy, and so forth—that the first Europeans found here. We therefore have some account of their lives and customs, although that account is always inflected by the fear, longing, greed, self-justification, ideological convenience, theological conviction, guilt, and nostalgia of the Euro-Americans who pushed them violently into the deep, inaccessible vault of the past." (Burroughs 2006, p. 16)

This onetime insidious and possibly only temporary presence of European Americans in the Kennebec valley soon shifted to that of an inevitably permanent settlement, in part, because commercial fisheries for river herring, Atlantic salmon, rainbow smelt, striped bass, and sturgeon began to thrive in the Kennebec during the eighteenth century. The Englishman George Weymouth was one of the first Europeans to explore and comment on the area after he landed at Monhegan Island and sailed up the Kennebec in 1605 (Reed & Sage 1975, p. 2-4). Weymouth's acclaim for the River's bountiful fish and opportune harbors, as well as Maine's vastly forested landscapes, convinced Sir John Popham to found a colony at the mouth of the Kennebec in 1607 (Reed & Sage 1975, p. 2-4).

As indicated by the Kennebec Coalition (KC), according to a personal account included in a letter written in 1723 by a French priest in Norridgewock, diadromous fish ascended the Kennebec "in such numbers that a person could fill 50,000 barrels in a day, if he could endure the labor" (KC 1999, p. 5). Driftnet fishers recurrently landed thousands of these migratory fish in just one evening in the river (NRCM 2002, p. 12), while more specific records (also from the late eighteenth and early nineteenth centuries) recount: 6,400 American shad caught by four fishers in one day; 1,000 striped bass taken in a single weir in a single tide; and 500 Atlantic salmon landed by an individual fisher in one season (KC 1999, p. 5).

Atlantic salmon were indeed so plentiful that some European Americans famously grumbled at the high proportion of the fish in their diet – one laborer, in particular, actually insisted on introducing a contractual stipulation with his employer (a hay farmer) which explicitly stressed that these salmon were not to be served more than once each day (Meadows 2001, p. 33).

At this time, striped bass afforded between $5,000 to as much as $25,000 per year to local fishers, who would even pay their bills at general stores with fish; it seems that one pound of fish traded equally for a pint and a half of an "all-important frontier commodity, NewEngland [*sic*] rum" (Judd 1990, p. 28).

By the early nineteenth century, populations of diadromous fish in the Kennebec had indubitably become mainstays in the local economy.

The Onset Of Edwards Dam, Augusta

Edwards Dam was built in the Kennebec in Augusta in 1837 by and for its original owner-operator, Kennebec River Dam Co. (which would soon become Kennebec Locks & Canal Co.). As a rock-filled, timber crib structure 24 feet tall and 917 feet wide, equipped with locks for boat passage and a (very short-lived) fish ladder, the dam initially supplied mechanical power to various mills, while it also facilitated upriver navigation, such as passage for barges. (In short: from 1842 until 1846, Edwards powered seven sawmills, one gristmill, and one machine shop; one of those sawmills and the gristmill were razed by fire in 1868; after a major breach in 1870, the dam was rebuilt to the configuration it would then have for more than a century; its ownership was transferred to Edwards Manufacturing Co. in 1882, while a large textile mill that eventually employed more than 700 people was built along the west bank of the river; in 1903, eight water wheels began to supply power via a system of belts, pulleys, and shafts; electrical generators were first installed in 1913; and, in 1973, the owner at that time, Bates Manufacturing, sold Edwards Manufacturing Co. to Miller Industries in a transaction that kept 800 jobs in the Augusta area, as well as retaining the "Edwards Manufacturing Co." company name (NRCM 2000, p. 1).)

To the assorted Maine citizens who were likely to become the recipients of gainful employment and other local and regional economic opportunities that stood to be available via the dam and its partnered industries, the construction of Edwards was greatly appreciated. However, to the many other members of the same Maine communities who were very concerned about the impacts that the dam could quite possibly have on migratory fish populations and commercial fisheries in the Kennebec, construction was resisted when it was first proposed in legislative authorization in 1834. While during its heyday of generating power for various mills, Edwards intermittently employed as many as 800 workers, it always remained a grave impediment to the vital movements of populations of native diadromous fish.

Still within a tidal reach of the Kennebec in Augusta, approximately 40 miles above the mouth of the river in Phippsburg, Edwards was an outright, unremitting, physical obstruction as faced in the river by populations of 11 species of anadromous fish, which had historically spawned above the site of the dam, and a population of 1 species of catadromous fish (i.e., American eel), which had historically migrated from above to below the site of the dam, with the latter movement having been en route to spawn in the Sargasso Sea. As stated by the Maine Department of Marine Resources, Edwards "blocked upstream passage of *all* migratory fish species since the mid 1800s" (MDMR 2004, p. 1, emphasis in original).

The existence of a fish ladder was both mandated and provided for in the original construction of Edwards in 1837, but the ladder was destroyed by spring flooding the next year. In disregard of the Commonwealth's "Fishway Act" (1797) that required every dam in the Kennebec to have such a ladder, Kennebec Locks & Canal Co. patently refused to install another one and, incredibly, every subsequent owner of Edwards, spanning a duration of more than 160 years, was seemingly allowed to – and actually did – repeat this recalcitrant neglect.

How could this mandate be ignored for so long? Well, as Nate Gray, a scientist who works with diadromous fish species and habitat for MDMR, has expanded:

> "Nothing new here. There are gobs of very thoughtful laws on the books that are ignored at worst or given minimal status at best. The 'fishway act' came with heavy fines

for every day that passage was unavailable. None were levied and the protests of the public went not unheard but un-acted upon. There was no way to enforce them. No one was willing or able to make the laws stick. Too much was at stake monetarily for the owners. Jobs would be lost. Entire municipalities that existed on the back of the river could potentially collapse. That most of them did anyway makes no difference. They made their money and… split." (Gray 2009)

Even while Edwards would never again include fish passage, its biological intention would not have been achieved for 4 of at least 12 species of native migratory fish in the Kennebec. Rainbow smelt, mature striped bass, and both Atlantic and shortnose sturgeon do not use fish passage (MDMR 2004, p. 3; 6) and are not known to have ever passed through any such facility at any dam (American Rivers et al. 1999, p. 60).

Concomitantly – and equally as deleterious – had any diadromous fish actually been able to pass above Edwards, it is very unlikely that respective spawning would have transpired, given that the dam created a reservoir in the river that inundated 17 miles of prime upriver spawning and rearing habitat between Edwards and the next dam up, in Waterville. Indeed, immediately after its construction in 1837, all 17 miles of this ideal habitat was lost (Robbins & Lewis 2008, p. 1489). As a dam, Edwards flooded more than 1,000 acres in and along the Kennebec and rendered this impoundment an "aquatic wasteland" – far too stagnant and too deep to be a healthy river – which thereby killed many of the invertebrates that were crucial to the ambient food chain and, at the same time, created a habitat much better suited for invasive species, such as smallmouth bass (Meadows 2001, p. 33).

It is surely not a happenstance, but rather, there is a clear causal relationship between overfishing, impassable dams, and declining water quality that engendered a severe disruption of symbiosis and the decline of once abundant populations of migratory fish in the Kennebec and its tributaries after Edwards was built in 1837 (MDMR 2006, p. 1; Reed & Sage 1975, p. 3-28). In a mere two years, in fact, populations began to plunge (Robbins & Lewis 2008, p. 1489), while, within a decade, landings of river herring, Atlantic salmon, and sturgeon plummeted to a tiny fraction of their historical, pre-Edwards numbers. According to the *Maine Department of Commissioners of Fisheries, 1st Report (1867- 1917)*:

- John Holbrook of Newport reported that as early as 1839, the spring alewife migration in the Sebasticook River (i.e., a tributary of the Kennebec above Edwards) had fallen off, and several years after had disappeared (KC 1999, p. 5).
- A seine that had reportedly taken 700 American shad in the Kennebec in Augusta during a day in 1822 caught only 3,000 such shad during the entire season in 1857, and by 1867, just 30 years after Edwards was built, the American shad fishery in Augusta had collapsed (KC 1999, p. 6).

Foster and Atkins (1867) estimated that a minimum of 68,000 and as many as 216,000 Atlantic salmon returned to the Kennebec annually before 1820 (Foster and Atkins 1867, as cited by Saunders et al. 2006, p. 540). Soon after Edwards was built, however, Foster and Atkins (1869) had a much different account of Atlantic salmon populations in the Kennebec:

> "At Augusta, Mr. William Kennedy estimates the number of salmon taken in 1820 at 4000. There were twelve drift nets engaged in the fishery. The year that the Augusta dam was built, Mr. K. caught more than usual, namely 500; but from that time the fish immediately fell away, and very soon the yield was only twelve per year. In 1866, fishing with a seine, he took only two salmon." (Foster & Atkins 1869, as cited in Lichter et al. 2006, p. 166)

Similarly, a drift netter, Charles Hume, landed Atlantic salmon right below Ticonic Falls in Waterville (i.e., at the time, the first natural barrier to upriver migration in the Kennebec) and from 1830 until 1837 he averaged 150 salmon caught per season and estimated the annual catch in that reach to be 2,000 (Burroughs 2006, p. 49-50). Yet, once Edwards was constructed, the numbers of these Atlantic salmon tumbled:

> "... Hume moved his operation downriver and had himself a banner year, landing between 300 and 400 of the suddenly dispossessed and disoriented salmon that milled around below the dam. But that was just about the end of it. He kept at it—it is the nature of fisherman to keep at it—but by 1850 he was catching no more than four or five salmon a year, and in some years none at all." (Burroughs 2006, p. 50)

As described by the *Fisheries and Fishery Industries of the United States, U.S. Senate, 47th Congress (1881-82)*, sturgeon fisheries in the lower Kennebec (see Figure 11, p. 91) comprised just 12 fishers by 1880, and their catch had dwindled to 12,000 pounds per year - as opposed to the 320,000 pounds per year they had landed in the beginning of the nineteenth century (KC 1999, p. 6). And, according Lichter et al. (2006), the sturgeon fisheries had actually collapsed by 1851 (Lichter et al. 2006, p. 170).

A century later, during the late 1970s, several large adult Atlantic sturgeon began reappearing in the Kennebec and the State was quick to permit them to be harvested commercially: 32 adult fish were landed in the first season in 1980; none the next season; then none the season after that; and only 3 were caught in 1983, after which MDMR reestablished the ban on harvesting them (Burroughs 2006, p. 22).

The widespread onslaught of human influence on natural environments in Maine at this time, beginning in the late eighteenth century with deforestation (which increased sedimentation in rivers like the Kennebec), overfishing, and the construction of impassable dams, eventually culminated in the twentieth century as acute pollution stemming from industrial, municipal, and residential emitters intensified the damage.

More And More Anthropogenic Damage Strikes The Kennebec

Together, the vitality of migratory fish populations and the viability of more active commercial fisheries in the Kennebec began to decrease rapidly in the middle of the nineteenth century, while the levels of an assortment of pollutants entering its riverine, estuarine, and marine environments soon became exponential, and would continue as such well into the twentieth century. As local, state, and federal authorities lacked any sort of regulatory mechanisms that even remotely pertained to the mitigation of these numerous anthropogenic sources of pollution, the Kennebec was viewed – and treated – by some people in Maine as a versatile, virtual deadzone, to be used solely for the convenient removal of industrial, municipal, and residential wastes.

Various riverside industries' effluents – many of which contained an increasing and/or already dangerous amount of chemicals – were perpetually disposed of in the Kennebec (KC 1999, p. 6). The several sawmills and one textile mill that Edwards powered in the latter half of the nineteenth century dumped their wastes, which included immense quantities of acids, dyes, fibers, and sawdust, directly into the river (Lichter et al. 2006, p. 161). Built during the 1880s and 1890s, the most damaging point sources of water pollution affecting the Kennebec were perhaps the sulphite pulp mills:

> "... by 1931, six [such] mills were in operation on the Kennebec. The sulphite pulp process involved heating a mixture of wood chips and sulphurous acid for 20 to 30 hours, after which the waste liquor, which contained fibrous and dissolved organic matter and was quite acidic (i.e., lignosulphonic acid, pH $\approx$ 2), was discharged directly into the river. The tremendous inputs of organic matter stimulated microbial growth and respiration, which, in turn, depleted dissolved oxygen in the river water." (Lichter et al. 2006, p. 161-162)

By no later than the middle of the century, these and other wastes from untreated sewage, for instance, and log drives, which strangled the river with massive volumes of wood and debris, had entirely transformed the Kennebec into what many Maine citizens commonly referred to and regarded as "an open sewer" (NRCM 2002, p. 12).

It is remarkable. The Kennebec once provided sanitary ice that was renowned across the country and the world for its refrigeration uses. This tidewater ice (also known at the time as "white gold") afforded an extraordinary opportunity, given that as much as 3 million tons were harvested - and some was exported as far away as the East Indies - each winter in the nineteenth century. As for the Kennebec of the 1950s, however, commercial fishers abandoned it as a lost cause, recreational boaters found its stench intolerable (even the windows of the State House in Augusta often remained closed during the summer months because of the foul odors), swimmers considered swimming as life-threatening, and, all the while, vast quantities of raw sewage consumed its oxygen levels resulting in immense fish kills as reported in 1947, 1957, 1963, and 1965 (KC 1999, p. 5-6; Lichter et al. 2006, p. 162). In 1966, in fact, the Maine Environmental Improvement Commission reported, "although the Kennebec River has been highly polluted for a number of years, the present day pollution has never been paralleled in its severity" (KC 1999, p. 6). And, while fecal coliform counts had historically been infrequent, data obtained in the 1970s indicated that very large inputs of raw sewage were present in the Kennebec (Lichter et al. 2006, p. 162).

With the cumulative, omnipresent impacts of deforestation, overfishing, the construction of Edwards, and anthropogenic pollution, the once prodigious populations of 12 species of migratory fish native to the Kennebec appeared doomed:

> "Never before had fish species been harvested to local extinction nor had dams altered the flow regime of rivers and prevented anadromous fish from reaching their spawning habitat. Never before had so many chemicals, many not previously occurring in nature, been discharged directly into waterways and the atmosphere." (Lichter 20006, p. 154)

The Outset Of Some Change For The Better

It was no later than when Edwards was built in 1837 (and perhaps much earlier, as Maine's commercial fisheries during that time may well have been grossly unsustainable) that populations of diadromous fish in the Kennebec – which had historically existed in symbiosis with countless other species via both the apposite health and wealth of the river and its tributaries as an ecosystem – first began to suffer from the abysmal realities of the anthropogenic activities so often made in the name of development and progress. Yet, more than 130 years later, the Kennebec finally seemed to be headed towards some sort of recovery, however late in coming, and however incomplete.

In an attempt to address and begin to reduce the awful levels of air and water pollution that were so pervasive in the U.S. at the time, more than a dozen pieces of federal environmental legislation – much of it having been championed by then Maine Senator Edmund Muskie – were passed in the 1970s, which inevitably deterred both log drives and the dumping of untreated wastes in the Kennebec, making such actions illegal. That these unprecedented efforts to mitigate pollution in the country were actually not prompted by an altogether earnest concern for environmental health does not negate their importance. As Ted Steinberg, History and Law professor at Case Western Reserve University, has explained:

> "In the tumultuous political atmosphere of the 1960s, it was far safer for establishment politicians to support the environment as opposed to the more threatening antiwar agenda being served up by campus radicals... Discussion of major federal undertakings, whether it was building a dam or constructing a highway, would no longer take place behind closed doors, but in public where everyone from environmental activists to corporations could debate the potential ecological fallout... The massive legislative arsenal read like a gigantic handbook on how to counter the ills of modern, consumption-oriented society. It dealt with everything from industrial pollutants to protecting endan-

gered species to cleaning up the synthetic detergent problem. Although none of the legislation interfered, to any major extent, with corporate America's hold over the environment, the gains were real nonetheless." (Steinberg 2002, p. 250-251)

This boom in environmental legislation created significant improvements in the water quality of rivers and their tributaries nationwide (Lichter et al. 2006, p. 155). Perhaps most germane to the plight of the Kennebec was the Water Pollution Control Act of 1972 (when amended in 1977, it became commonly known as the Clean Water Act (CWA)), which mandated permits for all businesses discharging pollutants, as well as waste treatment facilities for all industries and municipalities. To do this, the concept of a shared administration of water pollution control measures between state and federal governments was seen as fundamental to CWA (Meltz & Copeland 2006, p. 4). Congress thereby established two specific, yet complementary, legal avenues:

(1) Federally promulgated effluent reduction limitations, which target the discharge of pollutants and are administered via the permits from the National Pollutant Discharge Elimination System (NPDES) (Meltz & Copeland 2006, p. 4).

(2) State water quality standards – that consist of criteria to both limit ambient concentrations of certain pollutants and designate particular beneficial uses (e.g., recreation and water supply) – and respective enforcement, which together aim to regulate water pollution in a more general manner (Meltz & Copeland 2006, p. 4).

As is frequently the case with environmental legislation, however, these endeavors to improve water quality throughout Maine were not infallible, and would take some time. Until 1976, the Scott Mill in Winslow, for example, continued to dump into the Kennebec a volume of mostly raw wastes equal to that of a city of roughly 2 million people – i.e., double the population of the entire state of Maine at the time (KC 1999, p. 6).

At around the same period that this lawmaking emerged, fisheries biologists and others began to campaign for the removal of Edwards, namely because more than 90% of spawning habitat of anadromous fish native to New England waters was by then considered to be destroyed (Meadows 2001, p. 33). Lewis N. Flagg, for instance, then of the onetime Maine Department of Sea and Shore Fisheries, first suggested his own scheme in 1972 whereby he proposed that Edwards be removed to allow migratory fish access to habitat all the way up the Kennebec to the next dam, in Waterville (Reed & Sage 1975, p. 3-29). Flagg reckoned that with Edwards gone, the extent of sturgeon spawning habitat would double and populations would thereby increase (KC 1999, p. 8). It had also been estimated that populations of alewife, American shad, and striped bass would likely burgeon as a result of having access to this 17-mile reach that was once ideal spawning and rearing habitat (Anon. 1998, p. 2). And, for the very same reasons, fisheries experts again sought dam removal after a flood washed away 150 feet of Edwards in 1974; nevertheless, the dam was rebuilt the next year (NRCM 2000, p. 1).

It was not until the early 1980s that the State of Maine implemented what would become the first of several *ad hoc* strategies for the restoration of a few species of anadromous fish. As written in the *State of Maine Statewide River Fisheries Management Plan* (1982), with respect to the Kennebec, the State's goal was: "To restore striped bass, rainbow smelt, Atlantic sturgeon, shortnose sturgeon, American shad and alewives to their historic range in the mainstem of the Kennebec River" (*State of Maine Statewide River Fisheries Management Plan* 1982, as cited in MDMR 2004, p. 2). The plan included three main objectives: (1) "Determine the status of anadromous fish stocks and their potential for expansion"; (2) "Identify, maintain, and enhance anadromous fish habitat essential to the viability of the resource"; and (3) "Provide, maintain, and enhance access of anadromous fish to and from suitable spawning areas" (MDMR 2004, p. 2).

Three years later, MDMR developed *The Strategic Plan for the Restoration of Shad and Alewives to the Kennebec River Above Augusta* (1985), which detailed its goal to "restore the alewife and shad resources to their historical range in the Kennebec River System" (*The Strategic Plan for the Restoration of Shad and Alewives to the Kennebec River Above Au-*

gusta 1985, as cited in MDMR 2004, p. 2). It had two main objectives: (1) "To achieve an annual production of 6 million alewives above Augusta" and (2) "To achieve an annual production of 725,000 American shad above Augusta" (MDMR 2004, p. 2).

It is important to understand that six species of migratory fish native to Maine (i.e., American eel, Atlantic salmon, brook trout, Atlantic tomcod, blueback herring, and sea lamprey) were excluded in the *Management Plan* (1982), while all migratory species save alewife and American shad were excluded in the *Strategic Plan* (1985). When asked why 6 and 10 species, respectively, were disregarded in the *Plans*, Nate Gray clarified:

> "They were not ignored really. Just not much of a mention. This had to do with what we were capable of accomplishing as much as anything. Perfect? Not by a long shot" (Gray 2009).

Gray did note, however, that these efforts certainly improved the situation overall for anadromous fish in the Kennebec.

With the advent of CWA and its associated mandates for the primary treatment of industrial and municipal wastes, many riverine ecosystems throughout the U.S. were enhanced considerably (Lichter 2006 et al., p. 153). This was the case with Maine's rivers and streams – although diminished water quality continues to affect them to this day (Fay et al. 2006, p. 99). Along these lines, water quality in the Kennebec also rebounded and indications began to emerge that both the State's *Management Plan* (1982) and MDMR's *Strategic Plan* (1985) – which strove for partial migratory fish restoration – could actually achieve some sort of remedial outcome. In 1986, a juvenile striped bass was observed for the first time via an annual anadromous fish survey that was initiated in 1979 (Lichter et al. 2006, p. 170). Striped bass were soon caught not far below Edwards for the first time in decades (KC 1999, p. 6). In addition, small spawning populations of striped bass and American shad increased in the lower Kennebec (American Rivers et al. 1999, p. 59), while alewife that had been "trapped and trucked" above the dam began to spawn in several respective lakes (KC 1999, p. 6).

Around the same time that MDMR's *Strategic Plan* (1985) was developed, an assemblage of owners of seven dams located in the Kennebec above Edwards – i.e., the Kennebec Hydro Developers Group (KHDG) – was formed. As the first "Agreement" between KHDG and MDMR, the *Operational Plan for the Restoration of Shad and Alewives to the Kennebec River* was instituted the next year in 1986 (MDMR 2004, p. 3). Although its goals and objectives were the same as the *Strategic Plan*, the *Operational Plan* (1986) permitted KHDG to postpone the installation of fish passage as *quid pro quo* for providing funds for a "trap, truck, and release program" to transport adult alewife and American shad into upriver spawning and rearing habitat (MDMR 2004, p. 3).

Whether KHDG was actually earnest in its voluntary efforts towards partial remedial action is not the only difficulty with the *Operational Plan*. Given that nonmember Edwards Manufacturing Co. blatantly refused to participate in any such restoration attempts, for instance, had KHDG done as promised and installed fish passage, such actions would not have produced the intended biological benefits simply because all migratory fish populations in the Kennebec still remained unable to pass above Edwards, which was then the first and only dam these fish would encounter. And, while Edwards Manufacturing Co. (perhaps to reconcile its public image) installed an "experimental fish pump" in 1988, it proved useless (MDMR 2004, p. 4).

While the overall environmental health of Maine was much better by the 1980s, this was not the case for populations of native diadromous fish still utterly incapable of passing themselves above dams located in critical reaches of every major river in the state. This was especially evident in the case of the Kennebec wherein Edwards blocked 12 species from reaching 17 miles of formerly prime spawning and rearing habitat above Augusta. So, given that the very long-standing federal license required to operate Edwards was soon due to undergo the relicensing process, it was becoming more apparent to some that in order to mount a realistic effort to restore populations of native migratory fish in the Kennebec, a timely, concerted, and public intervention aimed at this relicensing process would be imperative.

It was in the early 1980s that members of Trout Unlimited (TU) – i.e., a nonprofit organization that advocates for the conservation, protection, and restoration of cold-water fisheries and watersheds in North America – such as Peter Thompson (then its Maine Council President) and John McLeod (then its Kennebec Valley Chapter President) began to campaign for the removal of Edwards. Before long, TU Maine Council encouraged the University of Maine Cooperative Extension (i.e., a part of the nationwide Cooperative Extension System, which works with land-grant universities to conduct research on various issues, such as those involving natural resources, as well as socioeconomic development) to play an active role in certain Edwards-related public policy forums. The Council's persuasion sparked two publications: first, a catalog of fisheries in the Kennebec and, second, a summation of the primary issues needing to be resolved in order to have Edwards removed (TU 2000, p. 1). Thompson, McLeod, and other fishing enthusiasts then formed the Kennebec River Angler's Coalition (KRAC), which was determined to restore migratory fish populations in the Kennebec by literally (though legally) "KRAC-ing" a hole in Edwards (NRCM 2000, p. 2; TU 2000, p. 1).

Together, TU, KRAC, the two ensuing publications, and the increasing amount of public awareness, understanding, and concern *vis-à-vis* the issues encompassing the removal of Edwards they helped foster, would all lead, in part, to the founding of the Kennebec Coalition (KC) in 1989. A collaboration of four environmental health organizations (American Rivers, the Atlantic Salmon Federation, NRCM, and TU – including its Kennebec Valley Chapter) KC was launched "for the exclusive purpose of securing removal of the Edwards Dam and restoration of the Kennebec River" (KC 1999, p. 11).

For part of its role, the Kennebec Valley Chapter pledged (and honored its commitment) to donate $2,000 to KC each year "until the dam is removed" – a big contribution for such a small chapter, and one that was indicative of its dedication (TU 2000, p. 1).

With the 30-year federal license to operate Edwards set to expire in 1993 and the dam's owner planning to apply to the Federal Energy Regulatory Commission (FERC) for license renewal, KC began to organize, strategize, and publicize its concerted efforts to advocate for the restoration of native diadromous fish species in the Kennebec, intervene in this relicensing process, and, ultimately, have Edwards removed.

An Analysis Of FERC And Hydropower Project (Re)licensing And Removal

The decision of whether to remove a dam in the U.S. is neither centralized nor reached by any one particular entity; rather, it is arrived at by a private dam owner and/or state and/or federal agencies, and will depend on the dam's ownership, the services it provides, and the scope of its impacts (Bowman 2002, p. 739). While there is no separate or single abiding, extensive, or static national policy for the removal of a dam, or any specific federal regulations or policies that govern such a removal in its entirety, the federal government does, however, perform various roles within a larger legal context of dam removal (Heinz Center 2002, p. 60-61).

When not a voluntary undertaking, the decision to remove a dam is normally the consequence of a legal process – either a formal outcome of that process or a negotiated settlement from that process. If the decision reached is for a dam to be removed, then several federal agencies can exercise their respective jurisdiction, including: the U.S. Army Corps of Engineers (USACE), the U.S. Department of the Interior (USDOI), the U.S. Department of Commerce, and, as in the case of Edwards, the Federal Energy Regulatory Commission (FERC). In addition, some federal statutes and programs pertinent to the construction, maintenance, and operation of a dam can also be applicable to its removal, most notably: the Federal Power Act (FPA) of 1920, the Electric Consumers Protection Act (ECPA) of 1986, CWA, the National Environmental Policy Act (NEPA), and the Endangered Species Act (ESA) (Heinz Center 2002, p. 61).

As the independent agency responsible for the regulation of the interstate transmission of electricity, natural gas, and oil (Robbins & Lewis 2008, p. 1489), FERC is also the same agency that inspects, reviews, and (re)licenses all private, municipal, and state hydropower projects (as opposed to federal hydropower projects, which are authorized by Congress, subject to the requirements of NEPA, and built by either USACE, the U.S. Bureau of Reclamation, or the Tennessee Valley Authority) (Heinz Center 2002, p. 61).

To be clear, according to the Maine Department of Environmental Protection (MDEP), hydropower projects as such include all water-powered electrical and mechanical generating projects, as well as all water storage projects (MDEP b., p. 1). In a general sense, and perhaps above all else in this (re)licensing process, FERC is charged with determining whether the issuance of a new license for a nonfederal hydropower project is in the public interest by giving equal deliberation to hydropower values (e.g., electricity) and nonhydropower values - such as fish and other wildlife, recreation, and water quality.

After the Federal Power Commission (FPC) was abolished in 1977, a subsequent Act of Congress that same year established FERC, and the agency would from thereon assume the majority of the responsibilities that had been originally granted to FPC under FPA (Heinz Center 2002, p. 61). As an enactment from 1920, and since amended, FPA ensures "a broad federal role in the development and licensing of hydropower" and mandates a FERC-issued license for the construction, maintenance, and operation of all nonfederal hydropower projects located in the U.S. (FPA, as cited in Meltz & Copeland 2006, p. 2). Specifically, FPA gives FERC the authority to (re)license the operation of all nonfederal hydropower projects located in navigable waters in the U.S., which is a Congressional grant of authority that extends to all such projects located "across, along, from, or in any of the streams or other bodies of water over which Congress has jurisdiction under its authority to regulate commerce with foreign nations and among the several States" (FPA, as cited in Becker 2006, p. 821, n. 58).

As amended, FPA instituted several processes intended to protect and restore anadromous fish affected by hydropower projects regulated by FPC and, later, FERC (Fay et al. 2006, p. 152). A part of these processes may involve, for example, consultation with state agencies that can, in turn, recommend that certain (re)license terms and conditions be imposed in order, for instance, to preserve or improve migratory fish populations, renewable energy production, and other public interests (MDEP a., p. 1). It is important to be aware, however, that while FPA authorizes - ever since 1920 - the same agencies that are responsible for the protection of fish and other wildlife (e.g., USFWS and NMFS) to recommend (re)license terms and conditions to protect such species, FPC, FERC, and the respective statutes that each agency administered did not undertake or contemplate serious deliberation on the environmental impacts of dams for some 60 years; instead, the Commissions focused almost entirely on hydropower production and associated economic implications (Becker 2006, p. 821).

It was not until the mid-1980s – more than a half century after the creation of FPA – that Congress and the courts first began to seemingly attempt to ensure that FERC balance equally both hydropower values and nonhydropower values in all of its project (re)licensing decisions. As an amendment to FPA, ECPA of 1986 bolstered the position of fish and other wildlife agencies by requiring FERC to include (re)license conditions to "protect, mitigate damages to, and enhance, fish and wildlife" resources affected by hydropower projects (ECPA of 1986, as cited in Becker 2006, p. 822, n. 63). These conditions are to be based, in part, on recommendations from USDOI's U.S. Fish and Wildlife Service (USFWS), the U.S. Department of Commerce's National Marine Fisheries Service (NMFS), and other state and federal natural resource agencies, as well as from Indian Tribes.

On the other hand, FPA, ECPA, and other amendments, also gave FERC the discretion to dismiss any such recommendations if it deemed them inconsistent with FPA provisions. Fay et al. (2006) have described the inadequacy of these regulatory mechanisms:

> "Section 18 of Act [i.e., ECPA] assigns to the Commission a responsibility to require hydroelectric licensees to construct, maintain, and operate at their expense fishways prescribed by the Secretaries of Interior or Commerce; however, the resultant changes to sections 10(a) and 10(j) of the Federal Power Act are largely discretionary and not mandatory… FERC is responsible for assessing the power and 'non-power' values associated with these different alternatives to determine which option would give the greatest benefit to the public; however, the non-power benefits of licensing alternatives are rarely quantified or incorporated in net benefit estimates." (Fay et al. 2006, p. 152)

While these Acts of Congress may appear to ensure that migratory fish and other wildlife, for instance, are safeguarded via FERC's hydropower project (re)licensing process, in the end, "FERC has failed to *fully* embrace environmental protection where the FPA allows it discretion over license conditions" (Becker 2006, p. 822, emphasis added).

To be fair, ECPA at least offers opportunities for state and federal natural resource agencies, Indian Tribes, environmental health organizations, members of the public, and other such stakeholders to participate in FERC's (re)licensing process, given that, under ECPA, they are all permitted to consider the adverse environmental effects of hydropower projects that are up for renewal, and suggest potential approaches to mitigate any such impacts (Heinz Center 2002, p. 62; NRCM 2002, p. 21).

FERC currently regulates 1,600 hydropower projects encompassing more than 2,000 dams nationwide (Meltz & Copeland 2006, p. 5). It is slated to process applications for license renewal for about two thirds of these dams in the next 15 years (Meltz & Copeland 2006, p. 5) – nearly 300 by 2018 alone (Becker 2006, p. 823). Therefore, as a consequence of ECPA, the aforementioned stakeholders who are serious about helping to ensure the defense of riverine, estuarine, and marine ecosystems are now able to wield a greater degree of participatory influence as they seek to avoid, minimize, and reverse the detrimental effects of dams.

The duration of FERC's (re)licensing process is often four or more years (Meltz & Copeland 2006, p. 5). Shockingly though, a licensee of a nonfederal hydropower project is required to apply to FERC to renew its operating license just once every 30 to 50 years, and hence *a license to operate a nonfederal hydropower project is issued for terms of 30 to 50 years*. The length of such a license seems nonsensical given that it permits a (most often) private licensee to generate hydropower – and, in turn, what is frequently a substantial profit – via the invasive exploitation of a very historic, very dynamic, and very public resource… namely, a river.

Why are FERC's license terms so long? What are the ramifications of such lengthy terms? Such questions are perhaps uncommon, as explorations into possible answers are scarce and virtually absent from academic, empirical, or any other related literature.

For Doug Watts, founder and president of Friends of the Kennebec Salmon in Augusta, however, these questions are indeed familiar, and their answers are evident:

> "The terms of FERC licenses were established in the FPA, when federal environmental laws did not exist, to create financial and regulatory incentives to encourage private investors to construct hydroelectric dams on U.S. waterways. The purpose for the long license terms was to ensure that the dam owner/builder had sufficient time to amortize the initial cost of construction and to be able to secure financing. Obviously, if a license was up for renewal every five years, and could possibly be revoked, many banks would be very unwilling to loan the dam owner the money for the initial construction costs. The FPA exempted hydro dams from any existing state fish passage laws and 'federalized' the permitting and construction of hydro dams, which removed any regulatory authority states might have had. So, in essence, the license terms were made very long to encourage dam construction and to encourage banks to loan money to build dams with the sole goal of maximizing the generating potential of the site regardless of environmental impacts." (Watts 2009)

When FPA was enacted in the 1920s, knowledge of the effects of hydropower projects on ecosystems was, at best, limited. Indeed, the promotion of such projects was viewed as an opportunity to provide jobs, rural electrification, and "cheap power" – all by simply "putting the river to work" and at a time when it was already choked with industrial, municipal, and residential wastes (Watts 2009). As for the ramifications:

> "By the 1980s, when the CWA had finally reduced water pollution in rivers to where fish could actually live in them, federal and state natural resource agencies began to consider the possibility of restoring the lost fish populations and fish runs and began to scrutinize the effects of dams on these runs. Because the various dams on a river (like the Kennebec) all have different licenses with different expiration dates (often years or decades apart), the long license terms in the FPA made it exceedingly difficult for natural resource agencies to develop effective, coordinated and timely fisheries restoration programs for a watershed. Today, these license terms are inappropriate for dams that have

long been built and paid for, which comprise nearly all private hydro dams in the U.S., and actively prevent achievement of the goals of the nation's federal and state water quality protection and fisheries restoration laws." (Watts 2009)

Under CWA, NPDES' permit program controls water pollution by regulating point source discharges into water bodies (Fay et al. 2006, p. 153). The practical advantage of this five-year NPDES permit term is that if a legally-licensed discharge is known to be degrading water quality, it can be addressed promptly (Watts 2009). The fatal error in FERC's (re)licensing process for a hydropower project is that 30 to 50 year terms can render moot every state and federal law intended to protect, mitigate damages to, and enhance fish, other wildlife, and water quality, since once a project has been (re)licensed, it is all but impossible to address the adverse – and possibly even illegal – impacts of that project if they are not identified during the (re)licensing process because, of course, "you have to wait thirty to fifty years" (Watts 2009).

Furthermore, as Nate Gray has explained, the historical and contemporary influence of institutions and politics on hydropower projects extends to the intent behind the length of these terms:

"The terms are long because it is a protection of interests on the part of the site developer. They want a guarantee that they can operate for the terms of the license without undue interference from the public. That being said, the terms seem extraordinarily long. The resource being utilized belongs to the people. The energy lobby is quite powerful. The currying of favor is nothing new in halls of power. Once a FERC license is issued, it is very difficult to modify the terms of the license both in terms of money (legal costs) and time." (Gray 2009)

Given FERC's license terms, state and federal natural resource agencies, Indian Tribes, and other concerned parties must be diligent in their attempts to identify and address as many environmental issues as possible when a hydropower project undergoes (re)licensing (Meltz & Copeland 2006, p. 5). To lessen this predicament, the Maine

Department of Environmental Protection (or the Land Use Regulation Commission in the State's unorganized areas) has been granted independent authority under section 401 of CWA to issue water certification to ensure that any such hydropower project will meet State water quality requirements (MDEP a., p. 1). If (or when) FERC issues a license for renewal, the terms and conditions set forth in the State of Maine's water quality certifications become part of that federal license (MDEP a., p. 1).

Separate from CWA, FPA, and ECPA, NEPA of 1969 requires that federal agencies confer with each other and employ systematic and interdisciplinary techniques in decision-making (Fay et al. 2006, p. 154). In addition, as Rogers et al. (2008) have described:

> "The NEPA could be considered a Magna Carta for the environmental movement in the US and later in many other countries. It gave citizens and citizens' groups legal standing on a host of environmental issues that they did not previously have. Under the NEPA the citizenry could participate in the decision-making process, which formerly had been reserved for government agencies operating without the need for consultation... The idea was to help improve the performance of government and introduce more democratic participation in decision making." (Rogers et al. 2008, p. 140; 146)

FERC, for example, is required under NEPA to perform and publish an Environmental Impact Statement (EIS) to be utilized as part of the decision-making process for hydropower project (re)licensing, as this statement can highlight adverse environmental effects – as well as remedial actions and potential alternatives – *vis-à-vis* hydropower projects (Robbins & Lewis 2008, p. 1489). Typically, an EIS from FERC should be a detailed statement on: (1) the environmental impact of the project; (2) any unavoidable adverse impacts should the project be (re)licensed; (3) alternatives to the proposed action; (4) the relationship between short- and long-term uses and productivity; and (5) any irreversible and irretrievable commitments of pertinent resources (Fay et al. 2006, p. 154).

Congress amended the (re)licensing process in 1992 to allow applicants for hydropower project licenses to fund EISs (also known as "third-party contracting") and, additionally, to authorize FERC to assess these licensees for the costs incurred by natural resource agencies for any relevant studies required under Part I of FPA (Heinz 2002, p. 62-63). In December 1994, as a component of a separate policy-making process, a new and certainly most noteworthy policy was issued and adopted, which concluded that *FERC has the authority to deny an application for the relicensing of a nonfederal hydropower project and order a dam be removed at the expense of the owner were it to determine that such a removal is in the public interest* (American Rivers et al. 1999, p. 60; Bowman 2002, p. 740; Heinz Center 2002, p. 61).

Some Preliminary Considerations Of The Removal Of Edwards

As soon as apposite rail transportation became readily available throughout Maine during the mid-nineteenth century, barging in the Kennebec and other large rivers in the state was abandoned. At this same time, as industries along the river increasingly relied on alternative and novel sources of power, which thereby rendered Edwards obsolete, the mills powered via the dam slowly but steadily began to shut down. Each of the two original, primary functions of Edwards, therefore, had become redundant and eventually went on to be superseded.

When most of the textile industries in Maine had all but faded away in the early 1980s - some from bankruptcy, while others from competition from overseas - Edwards Manufacturing Co. was quick to realize that it stood to earn more money by solely generating hydropower than it did by continuing to produce cloth (Clark 2004, p. 27). It was at some point in the beginning of that decade that the last operational mill powered by Edwards (a textile mill) was finally closed forever, and all its employees were laid off. The company subsequently signed a lucrative 15-year contract in 1984 to sell hydropower - and at roughly four times the market price - to Central Maine Power (CMP), the largest utility in Maine.

This lingering hydropower project employed only three people and produced a very small amount of electricity (NRCM 2002, p. 13). The amount was so insignificant, in fact, that its 3.5 megawatts of electricity accounted for merely one tenth of 1% of the entire power supply for the state (American Rivers et al. 1999, p. 60). (For reference, according to the 2000 U.S. Census, Maine has an estimated 518,200 households (NRCM 2002, p. 21).) Despite how utterly unproductive it was, Edwards still remained and blocked 12 species of native migratory fish in the Kennebec from passing above and below the dam, just as it had for more than 160 years.

A massive fire destroyed the closed textile mill in 1989, the vestiges of which were subsequently demolished. However, the respective hydropower generation facilities were rebuilt soon afterwards in order for Edwards to continue to sell electricity to CMP. Then, a few years later, given that its 30-year license to operate was set to expire in 1993, and that any such application had to be filed two years in advance, Edwards Manufacturing Co. submitted an application in 1991 to FERC for license renewal. The company was also required to notify state and federal natural resource agencies of its hydropower project proposal (Meadows 2001, p. 33), which, as was detailed in the application, sought to expand both the terms of its operating license (i.e., from 30 years to that of 50 years) and its generating capacity (i.e., from 3.5 megawatts to 11.5 megawatts).

As it had anticipated that Edwards Manufacturing Co. would seek license renewal, KC began to boost its efforts to foster awareness, understanding, and concern in various Maine communities about the issues surrounding Edwards and, ultimately, to convince FERC to deny relicensing and thereby order the dam removed.

While public support for removing Edwards was clearly mounting throughout the state, the likelihood that such a removal would actually happen was very uncertain. And, as its objective to have Edwards removed – which was unprecedented for a dam of its size in the U.S. – appeared to be both complicated and momentous, KC was initially uneasy about what lay ahead. The Coalition did indeed recognize that its goals might be difficult to attain: "Back then, no one else wanted to touch dam removal", former KC Project Manager Steve Brooke noted (Meadows 2001, p. 33).

To be sure, not everyone was in favor of the removal of Edwards. Riverfront land-owners both above and below the dam, for example, were convinced that their property would be devalued if water levels dropped, while they and others were worried that a shallower, faster-flowing Kennebec would expose the unsightly debris left on the river bottom from the last of the log drives during the late 1970s (NRCM 2002, p. 14). Other critics cautioned that removing the dam would lower the river at least 10 feet and would therefore induce erosion, stir up old, settled pollutants, and basically render the Kennebec as little more than a thin dribble as it passed through malodorous mudflats (Clark 2004, p. 27). There were also Mainers who were justifiably skeptical that the Kennebec - either with or without the presence of Edwards - could ever become what it once was. After all, this was a river all but destroyed by centuries of deforestation, over-fishing, impassable dams, and severe pollution.

It was soon evident, however, that KC would garner the support of some very public - and very influential - bureaucrats, as well as state and federal natural resource agencies. In his response to the application Edwards Manufacturing Co. had submitted to FERC, then Maine Governor John McKernan, for instance, declared that he strongly opposed the renewal of Edwards and instead recommended the dam be removed. In addition, both the State legislature and USFWS adopted a similar resolve that called for the removal of Edwards. As Gordon Russel, then of USFWS in Old Town, explained: "From the beginning, we favored dam removal because a number of species don't use fishways — they can work for salmon because they're attracted to flowing water but sturgeon migrate along the bottom" (Meadows 2001, p. 34).

During this time in the early 1990s, Edwards Manufacturing Co. was but a small, privately held company that existed only to generate a relatively minuscule - though very costly - amount of electricity in the state, and that employed just a few individuals. So, would the continuance of this hydropower project actually be worthwhile? Perhaps the opposing sentiments were longstanding, or perhaps by having Edwards up for re-newal they were roused (by, for instance, the public endeavors of KC). Either way, it was becoming obvious to a growing number of people in Maine that keeping Edwards

Dam in the Kennebec River would not be good for anyone – fingered, finned, feathered, or four-legged alike:

> "At the same time, residents along the Kennebec became increasingly aware of how vital the recreation economy is to our state – and what the environmental and economic benefits might be if the Edwards Dam were removed. People began envisioning a different future for the river – a future in which fish and wildlife in and along the Kennebec flourished, and economic activity was generated due to the absence of the dam. They imagined people traveling to the Kennebec from around the country to go fly fishing for striped bass or shad. They imagined people from throughout Maine spending the day canoeing or kayaking a new stretch of Class II rapids created upstream from Augusta after the dam was removed, and then dining on the deck of a riverside café. They imagined watching increased populations of osprey, bald eagles and kingfishers who themselves were dining along the Kennebec – on the resurgent fish populations spurred by the dam's removal." (KC 1999, p. 1)

Just as appreciation and concern for natural environments and resources, outdoor recreation, animals other than humans, and the restoration of rivers and associated fisheries and watersheds seemed to be expanding throughout the country, more and more of many sorts of people in Maine also began to arrive at the realization that the very minor hydropower benefits from the continuance of Edwards would be far less significant than the environmental and socioeconomic benefits from its removal.

The Edwards Relicensing Process And Removal Decision

Although Edwards Manufacturing Co. applied to renew its hydropower project license in 1991, the formal relicensing process in which FERC would ultimately decide whether Edwards would continue to generate hydropower, or even remain to stand as a dam at all, did not actually begin until 1995. During this interim, Maine's capital city, Augusta, became a co-licensee of Edwards in 1992 after it signed an agreement stipulating that 3% of the gross revenues from Edwards Manufacturing Co. were to be provided to the City. Despite the fact that the license to operate Edwards had expired in 1993, the co-licensees were allowed to operate the dam just the same by means of an annual permitting process with FERC, while the decision on the application for license renewal was pending. Then, in 1994, when FERC established its new policy that authorized it to deny an application for relicensing and order a dam to be removed at the expense of the owner, both Edwards Manufacturing Co. and the City of Augusta objected. Not coincidently, they soon withdrew the proposed megawatt expansion and amended the application to maintain the same 3.5-megawatt hydropower capacity.

In 1993, the Natural Resources Policy Division of the Maine State Planning Office established its *Kennebec River Resource Management Plan: Balancing Hydropower Generation and Other Uses*. Its goal for anadromous fish restoration in the Kennebec River did not stray from what the *Management Plan* targeted in 1982 – in fact, it was included verbatim. This *Kennebec Plan* (1993) stated its objective for (again, only) the six anadromous species; it was "to restore or enhance populations in the segment of the Kennebec River from Edwards Dam in Augusta to the Milstar Dam in Waterville" (MDMR 2004, p. 3). While the *Kennebec Plan* (1993) contained an identical goal, its approach to restore four of the targeted species was definitely not:

> "Since mature striped bass, rainbow smelt, and Atlantic and shortnose sturgeon will not utilize passage facilities, the strategy for the restoration of these species was to *remove the Edwards Dam*. Its removal would also enhance the ongoing shad and alewife restoration program by reducing the cumulative impacts of dams on out-migrating juvenile alosids." (MDMR 2004, p. 3, emphasis added)

For part of its role in the Edwards relicening process, FERC was required to consider this *Kennebec Plan*. In addition, the Commission had to assess the overall impact of the hydropower project on the environment (which would necessitate preparing and publishing an EIS) and to also collect and review any comments submitted by natural resource agencies, environmental health organizations, and other such concerned parties.

A Draft EIS (DEIS) was prepared by FERC and released in January 1996. It included a (partial) cost-benefit analysis (CBA) of the hydropower project (Robbins & Lewis 2008, p. 1489) whereby the Commission recommended renewing the license, but with the stipulation that the owners install fish passage (as specified by USFWS), which would cost $9 million to install (in 1997 dollars). Under the Fish and Wildlife Coordination Act, as a component of FERC's (re)licensing process, both USFWS and NMFS possess the authority to recommend conditions for license renewal. While these two agencies may submit any such recommendations for FERC to consider, however, they only have the authority to impose mandatory conditions for the construction of fish passage, and they cannot mandate that a dam be removed – even if such a removal is the only way possible to achieve fish passage (Bowman 2002, p. 745). So, in the case of Edwards, both USFWS and NMFS "concluded that fishways would not be effective at passing the target fish species, and that dam removal was the only way the target fish species could be restored. Nevertheless, the only action they could mandate to provide fish passage at the dam was construction of fishways. Thus the agencies *recommended* dam removal, but *ordered* construction of fishways" (Bowman 2002, p. 745, emphasis in original).

It is important to understand that, as previously mentioned, FERC's DEIS contained, in fact, only a partial CBA because it excluded any consideration of nonhydropower values that would result from the removal of Edwards (Robbins & Lewis 2008, p. 1490). In a timely attempt to counteract this gross deficiency, Freeman (1996) submitted a report to FERC that emphasized the essential need to include relevant nonhydropower values if any such CBA of the Edwards hydropower project were to be accurate and useful. This sort of an omission within the overall cost-benefit context of FERC's DEIS was, as Freeman has stated, "a fatal methodological flaw" that rendered it "impossible for the dam removal alternative to ever show a net economic benefit to society" (Freeman 1996, as cited in Robbins & Lewis 2008, p. 1490).

As a very common method of attempting to incorporate both socioeconomic and environmental circumstances and goals into the process of choosing between certain alternative courses of action involving a range of policies and activities (Beder 2006, p. 129), CBA has become fundamental to the manner in which the majority of economists now approach environmental decision-making (Dresner 2008, p. 115). Simply put, CBA offers decision-makers and stakeholders helpful information on an array of potential socioeconomic consequences of policy decisions (Whitelaw & MacMullan 2002, p. 730). CBA can, for instance, be used to determine what particular environmental goods are worth to people in monetary terms – e.g., a rough gauge of what people would pay to exploit and/or preserve a quality of the environment (Dresner 2008, p. 115). In order for costs and benefits to be calculated equally, CBA usually seeks to attach a monetary value to exploitation and preservation, with the value of each expressed in the same numeric units (Beder 2006, p. 130). Whichever course of action (e.g., exploitation or preservation) generates the larger monetary value is thus considered to be the better of the two options (Dresner 2008, p. 115).

A good deal has been written about assorted methods of such nonmarket valuation, as it has about the problems associated with CBA (Robbins & Lewis 2008, p. 1491). Some critics insist, "environmental value is highly subjective" (Beder 2006, p. 132). As Rogers et al. (2008) have expressed, in practice, CBA is "costly, requires highly skilled practitioners, and is ultimately arbitrary with regard to the estimation of social prices" (Rogers et al. 2008, p. 287). Indeed, it is undeniably difficult to assign fitting monetary terms to many costs and benefits (Beder 2006, p. 131) and calculating the values that people place on the environment is very tricky, if not impossible (Beder 2006, p. 135). Some environmentalists assert, for example, that nature has an intrinsic value that extends beyond the scope of any such value that people may attach to it (Dresner 2008, p. 115) and that is entirely separate from the service of simple utilitarian ends (Dresner 2008, p. 127).

More recently, as economists have begun to place increasing emphasis on determining the socioeconomic values associated with preservation in particular, they have developed "shadow prices" by the means of questionnaires that aim to tabulate what people would be prepared to pay for the preservation of an environmental good (Dresner 2008, p. 115). In the case of this "willingness-to-pay" (or "contingent valuation") survey, however, which its proponents claim is impartial in the way it reflects values of a given population, economists do, in fact, exercise their own value judgments about which answers are to be included in their analysis (Beder 2006, p. 132).

To the mainstream economist, in contrast, the environment actually can be priced because all such values can be translated into the preferences of individual people (Beder 2006, p. 135). Another justification for the usefulness of this environmental pricing is that monetary value is the primary language of big business and government treasuries, and hence it is only appropriate to address environmental issues in the same terms that these influential entities understand and under which they operate (Middleton 2008, p. 47). Additionally, supporters of CBA believe that it stands to offer a notably apt coherence:

> "It has been argued that CBA should be applied to all private as well as public projects as a way of ensuring that environmental and social costs and benefits, as well as profit potential, are included in all project decisions... Economists and business people are now arguing that it should be used more often as a way of deciding which way to proceed towards sustainable development. ... proponents of CBA see it as helping to make the decision-making process more objective and rational. They argue that it is rational to choose a course of action in which the gains outweigh the losses and that, by putting the gains and losses in numeric terms, it is easier to be objective, consistent and rational in the assessment." (Beder 2006, p. 130-131)

While the use of CBA continues to gain momentum, few such analyses have attempted to calculate the total nonmarket value of dam removal (Robbins & Lewis 2008, p. 1491). Dams can provide certain economic goods and services (e.g., hydropower, flood control, and water supply); they also, however, pose severe threats and damages to ecosystems existing in riverine, estuarine, and marine environments. For that reason, it is imperative to understand both the enviornmental and socioeconomic costs and benefits of rehabilitating and restoring rivers via dam modification and removal (Whitelaw & MacMullan 2002, p. 724). CBA is seen as a tool, even if a limited one, to help achieve that knowledge.

In addition to its DEIS, FERC's recommendations and conditions for the renewal of the Edwards hydropower project included reference to a report written by Boyle et al. (1991), which inferred that fish passage at Edwards would yield recreational fishing benefits similar to those that would result from the removal of Edwards (Robbins & Lewis 2008, p. 1490). The rejoinder Freeman (1996) submitted to FERC was based on the results of the mail survey conducted by Boyle et al., which utilized a combination of willingness-to-pay questions (including willingness to pay a travel cost) that were sent to a sample of recreational fishing license holders in Maine (Robbins & Lewis 2008, p. 1491). In his analysis, Freeman was critical of the sampling methods used by Boyle et al., as he stressed that they "served to underestimate - potentially significantly - the non-power recreational fishing value for dam removal" (Freeman 1996, as cited in Robbins & Lewis 2008, p. 1491).

Accordingly, Freeman employed data from the 1991 study undertaken by Boyle et al. to calculate that the present value of benefits to recreational anglers alone would be at least $36.2 - $48.2 million (in 1995 dollars) (Robbins & Lewis 2008, p. 1490). (For reference, fishing in all inland waters in Maine provided an estimated $293 million in annual revenues in 1996 (NRCM 2002, p. 3).) These figures certainly represent the lower range of any such estimate, given that they do not include other potential recreational or socioeconomic benefits resulting from removal (Robbins & Lewis 2008, p. 1490-91).

Since Edwards blocked the passage of canoes and kayaks, moreover, whitewater paddling and other such recreational opportunities, as well as river-based tourism, were expected to increase with the removal of the dam (Robbins & Lewis 2008, p. 1491). And, according to a survey of the Kennebec conducted in 1824 by the onetime U.S. Department of War, the 17-mile reach between Augusta and Waterville contained at that time (before Edwards was built in 1837) more than five miles of Class I and Class II rapids (KC 1999, p. 4). It was believed that with the reappearance of such whitewater, this stretch of the river would become a bigger attraction to paddlers and would thereby provide a boost to local economic activity in a number of different ways (e.g., the sale of: food, lodging, and paddling boats and respective equipment) (KC 1999, p. 4).

Furthermore, there were other nonhydropower benefits, such as riparian habitat enhancements and water quality improvements, which were not estimated by Boyle et al. (Robbins & Lewis 2008, p. 1491). Overall water quality in the Kennebec, for instance, suffered significantly since the dam slowed the flow of the river, which consequently reduced oxygenation and also natural flushing of pollutants and silt (NRCM 2002, p. 14). With Edwards removed, as Freeman attempted to demonstrate, these adverse effects and others would likely be alleviated, and an array of nonhydropower benefits would likely be gained.

The involved parties, who were in favor of a more comprehensive CBA, as well as dam removal, could only hope that the limited Boyle et al. CBA would not sway FERC, and that, instead, the points from Freeman's study would in some way take hold. In response to the DEIS and its associated implications, as well as to FERC's recommendations and stipulations for renewal, KC, together with several state and federal resource agencies, put forward extensive filings (i.e., a 7,000-page response (TU 2000, p. 1)), which – in stark contrast with what FERC had initially addressed – sought to stress and tackle as many of the diverse problems surrounding the relicensing of the Edwards hydropower project as possible, whereby pertinent engineering, legal, philosophical, political, and socioeconomic concerns were considered collectively: "It was not a one-sided analysis... We carefully examined the pros and cons, documented the benefits, and addressed the negative issues to convince others that removal was the best option even in the worst-case scenario," as KC member Margaret Bowman, of American Rivers in Washington, D.C., has explained (Meadows 2001, p. 34).

With respect to the biological and socioeconomic issues encompassing fish passage and dam removal, for instance, these comprehensive comments from KC and the resource agencies demonstrated that: (1) up to that point, four species of diadromous fish native to the Kennebec (i.e., rainbow smelt, mature striped bass, and both Atlantic and shortnose sturgeon) were not known to have ever successfully utilized any such upriver fish passage; (2) regardless of the species, had the intent of fish passage actually come to fruition, the dam would, however, continue to inundate – and thereby impair – 17 miles of vital spawning and rearing habitat in the Kennebec, which was at one and the same time used by populations of 12 migratory species; and (3) the USFWS- mandated fish passage would pass only 3 of the 12 species, and its installation would have cost much more than actually removing Edwards in its entirety. And, as for this last point, specifically, CBA concluded that fish passage (and necessary structural repairs) would cost 1.7 times the cost of dam removal (Whitelaw & MacMullan 2002, p. 724).

Then, in July of 1997, following a decade in which the civic ambience of much of Maine – and especially those communities having long been tied with the Kennebec – could be described as one of mounting, sequentially coalesced awareness, understanding, concern, debate, and discourse *vis-à-vis* the fate of Edwards, something extraordinary occurred. After a reassessment of its own DEIS and the estimated cost of respective dam removal – as well as, to a large degree, a consideration of the validity of the numerous public comments submitted in response to the DEIS (e.g., KC's response and Freeman's report) – FERC released its Final EIS (FEIS) for the Edwards hydropower project, which essentially reversed its preliminary DEIS. FERC recommended: (1) denial of the request for license renewal filed by Edwards Manufacturing Co.; (2) decommissioning and removal of Edwards; and (3) requiring Edwards Manufacturing Co. fund the cost of removal in its entirety.

Unmistakably, FERC's final recommendations were a clear indication that it no longer believed that the economic benefits of the continuance of the Edwards hydropower project would exceed that of the socioeconomic and environmental benefits of outright dam removal. Rather, FERC had publicly come to acknowledge exactly what TU, KRAC, KC, USFWS, NMFS, MDMR, the State Planning Office and legislature, Governor McKernan, and others had collectively put forth: (1) the cost of removing Edwards would be far less than installing the mandated fish passage – which itself would be biologically effective for only three of the target species and 2) with Edwards removed, (a) 17 miles of prime, upriver spawning and rearing habitat would once again be accessible to 12 diadromous fish species native to the Kennebec, and (b) recreational opportunities (e.g., birding, boating, fishing, paddling, and swimming) would be increased, thereby stimulating the local economy, and (c) the overall health of the riverine, estuarine, and marine environments in the Kennebec would be improved.

A Voluntary Settlement Agreement Is Reached

On November 25, 1997, FERC commissioners officially voted to deny the application submitted by Edwards Manufacturing Co. to renew its license to operate the Edwards hydropower project and – for the first time ever – ordered that a dam be removed against the wishes of its owner (Bowman 2002, p. 740). FERC also ordered the company to develop a strategy and schedule for removal, by November 1998, which was required to include a plan to fund the removal (American Rivers et al. 1999, p. 61).

Given their anticipated loss of revenue, Edwards Manufacturing Co. and the City of Augusta were obviously not pleased with FERC's FEIS and its relicense decision. It is obvious, though, that regardless of which way FERC had leaned – i.e., towards its DEIS or its FEIS – its ultimate decision would still have led to a momentous change for the co-licensees. On the one hand, had FERC ruled to renew the license, Edwards Manufacturing Co. would still be required to pay $9 million for the installation of the USFWS-mandated fish passage, and would inevitably earn less from the sale of electricity once its contract with CMP expired in 1998. On the other hand, as became the case, a denial of renewal meant the company would be responsible and liable for dam removal.

Not surprisingly, after FERC's November 1997 decision was delivered, Edwards Manufacturing Co. and the City of Augusta entered into a formal appeal process in late December (NRCM 2000, p. 2). And, despite the fact that FERC had concluded that Edwards Manufacturing Co. needed to plan to fund the removal of Edwards, this undertaking of an appeal of FERC's decision left unresolved the inevitable issues of exactly when Edwards would be removed and who would pay for its removal. At this juncture, it appeared this increasingly contentious situation was likely headed for a multi-year legal wrangle. As it would turn out, however, a potentially lengthy and volatile legal dispute was quickly avoided:

> "To try to keep the dam owners and the City of Augusta from going to court and holding up restoration for who knows how long, the Kennebec Coalition approached the State Planning Office and asked if the State would play an active role in arriving at a settlement. The new governor, Angus King, agreed, and State Planning Office director Evan Richert and the Coalition led negotiations for the State. 'We needed to find a way where no one party was unduly injured,' says Richert. For its part, the State of Maine offered to take ownership of Edwards Dam, as well as both the responsibility and liability for removing it... The next step was to build trust among the negotiating parties. 'The Governor talked to the dam owners and the City to gain their confidence. He built rapport with the dam owners and even went to an Augusta City Council meeting,' says Richert... But trust only goes so far, and in the end it all came down to money. Funding was a stumbling block until the Kennebec Coalition found a creative solution. Extending their focus beyond the 17-mile stretch impounded by Edwards Dam, the coalition cut deals with stakeholders both up and down the river." (Meadows 2001, p. 34)

To avoid the protracted litigation that seemed imminent, members of KHDG, officials representing state and federal agencies, as well as those with the City of Augusta, and the owners of both Edwards Manufacturing Co. and one other such commercial operation along the Kennebec, all entered voluntarily into exacting negotiations led, in part, by KC members. These negotiations promptly resulted in the formulation of a mutually beneficial settlement that led to the withdrawal of the appeal and expedited the removal of Edwards – and without the use of any public funds. And so, on May 26, 1998, the *Lower Kennebec River Comprehensive Hydropower Settlement Accord* was reached. As it was written, the *Settlement Accord* (1998) yielded the following:

"(1) a charitable donation of the Edwards Dam from Edwards Manufacturing Company to the State of Maine; (2) the removal of the Edwards Dam on the Kennebec River by the State of Maine in 1999; (3) contribution of $7.25 million towards Edwards Dam removal and related activities, and towards other Kennebec River anadromous and catadromous fish restoration efforts, by Bath Iron Works Corporation and Kennebec Hydro Developers Group members; and (4) amendment of certain fish passage obligations at seven dams on the Kennebec and Sebasticook Rivers owned by Kennebec Hydro Developers Group members upstream of the Edwards Dam." (Federal Energy Regulatory Commission 1998, p. 6)

A total of $7.25 million was contributed by KHDG and Bath Iron Works (BIW, a large shipyard along the Kennebec in Bath that builds mainly U.S. Navy vessels), which was deposited into the Kennebec River Restoration Fund and managed by the National Fish and Wildlife Foundation. KHDG and BIW funded $4.75 million and $2.5 million, respectively, all of which was used for dam removal and associated restoration efforts.

For the purpose of removing Edwards, the State of Maine accepted the transfer of ownership of the entire hydropower project site as a gift from Edwards Manufacturing Co. on January 1, 1999. As the new dam owner, the State became responsible and liable for the removal. All costs, however, were provided by the funds committed by KHDG and BIW, which meant neither state nor federal funds were required. In the end, just under $3 million was needed to remove Edwards – i.e., $800,000 for engineering and permitting and $2.1 million for deconstruction (American Rivers et al. 1999, p. 60-61).

The remaining funds were utilized for attempts to restore certain populations of native *anadromous* fish in the Kennebec. According to MDMR (2004), "because an additional 17 miles of riverine habitat would be available to alewives and American shad when the Augusta dam was removed", the *Settlement Accord* "included a new timetable for fishways at the KHDG dams" and necessitated trap-and-truck operations until this obliged passage was built (MDMR 2004, p. 14-15). Put another way, even though all associated costs of construction and operation of fish passage would remain the responsibility of KHDG dam owners (MDMR 2004, p. 15), the *Settlement Accord* permitted the owners of these seven KHDG dams to postpone their obligations to install fish passage in exchange for the funds they provided for both the Edwards removal and the stocking program. The understanding was that the timing of fish passage installation in KHDG dams would depend on biological schedules or triggers – i.e., as particular anadromous species returned, only then would respective fish passage be constructed.

Besides the *Settlement Accord*, the second Agreement (the first being the *Operational Plan* from 1986), i.e., *The Agreement Between Members of the Kennebec Hydro Developers Group (KHDG), The Kennebec Coalition, The National Marine Fisheries Service, The State of Maine, and The US Fish and Wildlife Service*, was also implemented on May 26, 1998. Under it, MDMR would continue to be responsible for implementing a trap-and-truck program for alewife and American shad, as well as for ensuring that the specific goals and objectives established for the Kennebec in the *Management Plan* (1982) were achieved via monitoring and assessment of the River's anadromous species of fish (MDMR 2004, p. 4). In addition, MDMR, KHDG, and USFWS would together provide funding for the continuation of the State fishery agencies' fishery management plan (MDMR 2004, p. 4).

In exchange for its contribution under the *Settlement Accord*, BIW was permitted to build a 17-acre expansion of its shipyard operations in the Kennebec, the construction of which, before the implementation of the *Settlement Accord*, had been awaiting an environmental mitigation plan required by state and federal agencies.

Lastly, given that it was a co-licensee of Edwards, the City of Augusta stood to lose revenue with the dam removed. Augusta City Manager William Bridgeo stated that the City received about $250,000 in revenue from Edwards annually, half of which was from property tax, the rest from the sale of electricity (Edwards 2009, p. 2). So, as a provision of the *Settlement Accord*, the State Planning Office would take responsibility of the 14-acre site of Edwards (which had become a contaminated brownfield), restore it, and then transfer its ownership to the City, free of charge. In addition, a new working partnership between the State of Maine and the City of Augusta was to be developed in order to facilitate collaborative efforts to develop and achieve substantial Kennebec waterfront improvements in Augusta, which would also deliver socioeconomic and recreational benefits to the City.

Edwards Removed And An Initial Boost To The Kennebec

In the summer of 1998, an engineering firm was hired to develop plans to remove Edwards and prepare applications for the necessary permits to do so; those permits were obtained later that year from USACE, MDEP, and the City of Augusta. Ownership of the entire hydropower project was transferred to the State of Maine on January 1, 1999 and all electricity generation ceased. The hydropower equipment went on to be sold at a public auction in February of that year.

A contractor began to mobilize for the removal towards the end of May; construction of a temporary, gravel cofferdam was underway on June 16. Placed immediately above Edwards on the western side of the Kennebec, the cofferdam enabled a 70-foot section of the dam to be removed. At this point, because spring spawning migrations of alewife and American shad were ongoing, and removal had only just begun, trap-and-truck operations continued to ensure that fish that were blocked below Edwards would still be able to spawn upriver.

Finally, on July 1, 1999, after more than 160 years of serving as an impassable presence to populations of 12 species of migratory fish native to the Kennebec River, Edwards Dam was breached. As the river rushed through the 70-foot hole in the dam, the historical moment was acknowledged with a ceremonial bell-ringing. "For the many of us who have crusaded for removal of the Edwards Dam for the past decade," said Everett "Brownie" Carson, long-time Executive Director of NRCM, "we never knew if this day would come -- but here we are and it's a fantastic day for celebration" (Anon. 1998, p. 1). Amongst the thousands in attendance were Governor Angus King (who served as master of ceremonies), former Governor John McKernan, Interior Secretary

Bruce Babbitt, Augusta Mayor John Bridge, Maine's entire congressional delegation, and even one of the owners of Edwards Manufacturing Co.

There was still much work to be done after this first breach, but it went well:

> "... construction moved to the east side of the river where another temporary gravel cofferdam was built... and approximately 200 feet of the dam was removed. This cofferdam was breached on August 12th and the river was re-diverted through this larger gap... The remainder of the dam was removed with heavy construction equipment, working from east to west. The demolition debris was used to fill the power canal on the west bank and to fill other locations in order to restore the site for final use by the City of Augusta. Full removal of the dam was completed on October 12, 1999, a full month ahead of schedule and approximately $300,000 under budget." (American Rivers et al. 1999, p. 62)

By the fall of 1999, after multiple breaches and then full deconstruction, Edwards became the first major dam to be removed in Maine (Robbins & Lewis 2008, p. 1498).

Water quality and wildlife, recreation, and populations of migratory fish native to the Kennebec were all augmented as a result of the removal of Edwards. The renovated 17-mile reach between Augusta and Waterville improved both water quality and the habitats of fish and other wildlife, while it returned various rapids and riffles to the Kennebec, which afforded new and renewed recreational opportunity. The removal also made this stretch above Edwards accessible to all diadromous populations, some of which were thereby enabled to access prime, historical spawning and rearing habitat.

Edwards had created an impoundment above it that turned the Augusta-to-Waterville reach in the Kennebec into a sluggish, oxygen-deprived, inhospitable stretch. According to Dave Courtemanch, director of environmental assessments for MDEP, after removal the "water quality improved almost immediately" (Courtemanch as quoted in Edwards 2009, p. 3). MDEP operates a program that designates four water quality classifications for freshwater rivers and streams in Maine (Classes AA, A, B, and C), and by early as January 2000, the water quality in the Kennebec had recovered enough to receive a higher rating – i.e., Class B. As clear evidence of enhanced water quality, sediment samples indicated an enormous growth in both the number and diversity of organisms in and around the river, especially those occupying benthic communities, such as caddis, may, and stone fly larvae. MDEP estimated numbers increased from about 50 to nearly 2,000 per sample, while diversity doubled from roughly 6 to 12 species per sample (Meadows 2001, p. 35).

Furthermore, and in connection with this improved water quality, other outcomes were quick to emerge that indicated this stretch of the Kennebec was on the mend. First, sightings of wildlife increased as the amelioration of the river was welcomed by numerous birds such as bald eagles, cormorants, great blue herons, hawks, killdeer, kingfishers, ospreys, and sandpipers. These species were less common along the reach above the dam, but with Edwards removed, they were then seen flying overhead and feeding in the river much more often (American Rivers et al. 1999, p. 62). Sightings of mammals like fox, otter, beaver, and even the occasional harbor seal also increased. Second, the concern about the possibility of malodorous, unsightly mudflats becoming exposed as a result of both the removal and the decision not to manually reseed the riverfront (American Rivers et al. 1999, p. 62) was allayed; within weeks of removal, grasses, wildflowers, and other self-seeding vegetation took hold along the Kennebec, while cleanup crews carried away any ambient debris and a few old pulp logs that the lower water levels revealed (Clark 2004, p. 24). This reestablished riparian vegetation created new and diverse habitats for native plants, as well as birds, insects, and other animals.

Even before Edwards was fully deconstructed in the fall of 1999, striped bass 40 inches long were landed by recreational anglers in Waterville, while barely three months later large schools were seen feeding on alewife well above Augusta (American Rivers et al. 1999, p. 62). A year later, Bob Dionne, owner of Aardvark Outfitters in Farmington, was frequently guiding his clientele of fishing enthusiasts in driftboat trips down the Kennebec. As Dionne explained: "We thought it would be good for the river, but we thought it would take at least a couple years. The fishing is unbelievable… the river was waiting for the right moment. In terms of just sheer economic development, the river's recovery is going to bring incredible results" (Dionne as quoted in NRCM 2002, p. 15).

In addition to increased angling opportunities, the removal of Edwards restored rapids, riffles, and gravel bars in the reach from Augusta to Waterville. Six sets of rapids, in particular, once inundated by the dam's impoundment, were soon revealed (American Rivers et al. 1999, p. 62). As a result, canoeing and kayaking outings both increased, while the emergence of more natural water levels and flows provided not only enhanced aesthetic value, but also habitat for fish and other wildlife.

The existence of Edwards stood to be a principal impediment to the numerous concerted efforts to mend populations of migratory fish native to the river. And so it is with the removal of this dam, coupled with the dewatering of the large impoundment it created upriver, that a "natural restoration of the Kennebec" (MDMR 2004, p. 6) of sorts has occured above Augusta. With Edwards gone, 12 anadromous species began to return to the 17-mile reach upriver of its former site (Robbins & Lewis 2008, p. 1498). For the first time since the construction of the dam in 1837, not only were striped bass soon observed as far up as Waterville, but nearly 2 million alewife arrived at the base of the Ft. Halifax Dam in the mouth of the Sebasticook River in Winslow the following spring (NRCM 2002, p. 13-14). Within a year, American shad, Atlantic salmon, and sturgeon were found moving upriver of Augusta (Meadows 2001, p. 35).

Recovery rates of migratory fish populations depend on the life history of the species, a plethora of familiar threats and damages (e.g., air and water quality, forest loss, global warming, invasive species, overfishing, predation, sprawl, water supply, and, of course, hydropower projects and respective (re)licensing processes), and the overall scope of concern for and understanding of the health of diadromous fish and associated restoration efforts and funding. It was assumed from the beginning that with removal, none of the migratory fish populations would be repaired or restored immediately, but that a steady increase in the coming decades was anticipated for some species, while others were at the mercy of additional restorative actions.

The first Agreement between MDMR and KHDG, the *Operational Plan* (1986) (which focused on alewife and American shad restoration in the Kennebec) evolved into what today is referred to by MDMR as the "Kennebec River Diadromous Fish Restoration Project", the goal of which is "to restore Maine's native diadromous fishes to their historic range and abundance in the watershed" (MDMR 2006, p. 1); the Project seeks to address all Maine's diadromous fish populations. With Edwards removed, access to historical spawning and rearing habitat has been made available to species like rainbow smelt and both Atlantic and shortnose sturgeon, however, that is not the case for other species, such as Atlantic salmon and river herring - including American shad, all of which once migrated much further up the Kennebec (MDMR 2006, p. 1). Much has changed for the better since Edwards was removed, but there is so much more yet to be done.

INCONCLUSION

According to MDMR promulgations from 2004, the "restoration of anadromous fish to the Kennebec River and its tributaries is proceeding on schedule" (MDMR 2004, p. 1). With Edwards Dam removed, the Lockwood Dam would become (in 2008) and remains the lowermost hydropower project in the mainstem of the Kennebec. 63 miles above the River's mouth, Lockwood is located in Waterville where it spans the Kennebec near the former site of Ticonic Falls. Under the *Settlement Accord* (1998), permanent upriver fish passage is required at Lockwood no *earlier* than 2010, and its installation is scheduled or triggered only when 8,000 American shad have been passed via the hydroproject's interim trap-lift-and-sort facility (MDMR 2004, p. 19). This system did not become operational until 2006, a year in which, according to the Atlantic Salmon Federation (ASF), 4,094 river herring and 15 Atlantic salmon were trapped then trucked into the upper reaches of the Kennebec (ASF 2009, p. 3). In 2007, it trapped 3,448 herring, including 18 American shad, and 15 salmon; then, in 2008, 93,775 herring - no shad - and 22 salmon (ASF 2009, p. 3). As of mid-June 2009, the interim facility trapped 45,495 river herring - again, no shad - nine Atlantic salmon, 28 American eel, and five striped bass (Edwards 2009, p. 1).

Before 2008, but only after the removal of Edwards in 1999, the Fort Halifax Dam in Winslow was the lowermost hydropower project in the Kennebec. A fish pump installed at Fort Halifax provided passage in 2000 for 125,586 river herring that were pumped and trucked to upriver habitat (ASF 2009, p. 3). Pursuant to the *Settlement Accord*, as well as the hydroproject's FERC license, permanent upriver fish passage was required by May 1, 2003 *or* the dam was to be breached that same year (MDMR 2004, p. 20). Despite that the licensee of Fort Halifax actually proposed to decommission and breach the dam, FERC did not approve this application to surrender the license and breach Fort Halifax until January 2004 - more than a year later (MDMR 2004, p. 20). And, even then, due to processing delays and other setbacks, the breaching would not occur for four more years. In the meantime, the fish pump passed 461,412 river herring in 2007 and then 401,331 river herring in 2008, its final year of operation (ASF 2009, p. 3). On July 17, 2008, Fort Halifax was finally breached and subsequently removed, more than five years after the *Settlement Accord* had mandated either passage or breach. Since then, the removal has provided fish passage at the mouth of the Sebasticook, while roughly 90% of alewife passing through the former site are now a step closer to their natal spawning habitat in the River's 946-mile drainage basin.

The Sebasticook is the largest tributary of the Kennebec, which it joins in Waterville. With both the removal of Edwards and the continuation of trap-and-truck operations, MDMR estimated the annual migration run of alewife in the early 2000s to be between 1 and 2 million in the Sebasticook alone, which, at the time, made it the largest alewife run in Maine and perhaps the largest in New England (MDMR 2004, p. 8-9). Most recently, in regards to this distinction *vis-à-vis* the entire country, Nate Gray said, "it's probably close, if not the largest… We're looking at something in the order of nearly two million fish" (Gray as quoted in Grard 2009, p. 1).

After Fort Halifax was removed in 2008, Benton Falls Dam and Burnham Dam became the lowermost and second lowermost hydropower projects in the Sebasticook, respectively. Under the *Settlement Accord*, both Benton and Burnham were required to provide upriver fish passage (as designed only for Atlantic salmon and river herring, including American shad) within one year of the installation of permanent upriver fish passage at four nonhydropower projects located above the Sebastiook (i.e., fishways for Pleasant Pond Dam in Stetson, Plymouth Pond Dam in Plymouth, and Sebasticook Lake Outlet Dam in Newport, as well as the removal of Guilford Dam in Newport) (MDMR 2004, p. 21). All four passage installations were completed in June 2003, which triggered passage at Benton and Burnham be completed by June 2004. Just like Fort Halifax, however, the terms of this requirement pursuant to the *Settlement Accord* were not met. First, the licensee of Benton delayed its designs for fish passage, and then the licensees of both hydropower projects indicated that they would simply (and were permitted to) await FERC's decision on the Fort Halifax situation before submitting their own revised plans. In the end, installation of fish passage at Benton and Burnham did not transpire until April 2006. Since the licensee of Fort Halifax was still wrangling in court at this juncture, the full biological benefits of fish passage constructed at Benton and Burnham – which are located upriver – would not come to fruition for a few more years.

In May 2009, the towns of Benton and Vassalboro reestablished municipally managed commercial harvests of river herring (except shad) in the Sebasticook – for the first time since Edwards was built in 1837. These river herring are preferred bait for lobster fishers, and there is also a market for human consumption. With the protracted removal of Fort Halifax and construction of fish passage, 593,465 such herring eventually passed through and upriver of the fish lift at Benton in the first week of May; a total of 1,287,630 had done so by mid-June (ASF 2009, p. 3). While the majority passed above Benton to spawn, more than 350,000 were netted (roughly, 100 tons), a harvest that provided the town of Benton, for example, with more than $15,000 in revenue, as it receives one third of the proceeds from each catch (Grard 2009, p. 1). River herring were also harvested in Vassalboro's Webber Pond for the first time since the early 1800s.

With the removal of Fort Halifax, restoration of American shad in the Kennebec-Sebasticook system is also "proceeding according to schedule", as MDMR estimated more than 2,000 adults returned in 2003 from the previous years' stocking efforts (MDMR 2004, p. 1). While it is certain more shad currently migrate here, exact figures are difficult to come by, given that the fish generally do not use fish passage. As Nate Gray has explained about such calculations and operations at Benton, "We've seen them… We're reconfiguring it [fish passage] to specifically try to target them at the tail end of the herring run. It's a steep learning curve, though, because they're so difficult to catch -- and we're not dealing with great numbers, so the opportunities are few" (Barrett 2009, p. 2). The size of the population is not "great" by any means, but the fact that shad are returning in increasing numbers, however gradually, is a very good omen. Gray, again:

"That's really, really important. It's good for our inland river systems, as well as for the greater good of the Gulf of Maine… They're an overall health indicator of the river system, as well as a grand fishing opportunity. We've come a long, long way, from where we were twenty years ago... We're seeing something here that hasn't been seen in two hundred years. It's pretty damn humbling." (Gray as quoted in Barrett 2009, p. 1-2)

This fishing opportunity, whether for American shad, striped bass, or a few other anadromous species native to the Kennebec, has indeed continued to improve in the decade since Edwards was removed. Robbins and Lewis (2008), who conducted an *ex post* survey of recreational anglers *vis-à-vis* the Kennebec, determined that fishing has indeed expanded:

> "We find significant benefits have accrued to anglers using the restored fishery. Specifically, anglers are spending more to visit the fishery, a direct indication of the increased value anglers place on the improved fishery. Anglers are also willing to pay for increased angling opportunities on the river. These findings have policy implications for other privately owned dams that are currently undergoing relicensing and/or dam removal considerations. Our findings may also hold implications for fisheries that have deteriorated due to historic dam construction." (Robbins & Lewis 2008, p. 1488)

To the extent possible, Robbins and Lewis developed their survey and analysis of *ex post* economic impacts along the same lines as that of the original *ex ante* survey and analysis conducted by Boyle et al. (1991) in order to incorporate similar recreational benefits. Like the *ex ante* angler survey, the *ex post* survey contained both willingness-to-pay and travel-cost questions so that data on fishing activity and economic benefits that ensued from the use of the lower Kennebec fishery could be obtained. Robbins and Lewis estimated the total annual economic impact resulting from recreational use of the Kennebec between Augusta and Waterville to be $27,575,200 (Robbins & Lewis 2008, p. 1495). This estimated economic impact is substantially larger than the estimate before Edwards was removed, which influenced the decision FERC would ultimately reach. Had Boyle et al. used the same methodology and assumptions Robbins and Lewis did to calculate this total economic impact, they would have found it to be $8,355,019 (Robbins & Lewis 2008, p. 1495). So, as it turns out, Freeman (1996) was correct when he posited to FERC that Boyle et al. had actually underestimated the potential economic impact from the removal of Edwards.

In June 2004, the Penobscot River Restoration Trust (PRRT) signed the *Lower Penobscot River Multi-Party Settlement Agreement*. PRRT (whose Members are the Penobscot Indian Nation, The Nature Conservancy, American Rivers, Maine Audubon, NRCM, ASF, and TU) is a not-for-profit corporation founded for the purpose of implementing the primary components of the Penobscot River Restoration Project (PRRP). PRRP is the result of many years of negotiations among its key partners, including: Pennsylvania Power and Light; USDOI's Bureau of Indian Affairs, the National Park Service, and USFWS; the National Oceanic and Atmospheric Administration; the State of Maine's Department of Natural Resources, Department of Inland Fisheries and Wildlife, and the State Planning Office; the Penobscot Indian Nation; and PRRT and its Members.

According to Goode (2006), as it seeks to address the restoration of both native migratory fish populations in the Penobscot and connections between the river and the Gulf of Maine, PRRP "may be the most innovative, far reaching river restoration project in the country today" (Goode 2006, p. 26-27). If implemented, PRRP would lead to: (1) the removal of the two lowermost mainstem dams in the Penobscot, i.e., Veazie and Great Works Dams; (2) the installation of a fish bypass, as determined by state and federal natural resource agencies, around a third dam, i.e., Howland Dam; and (3) the improvement of current fish passage, with the approval of USFWS, at four other hydropower projects. Unlike the Edwards removal process, the design of PRRP was based on a holistic, integrated analysis of the entire watershed in an attempt to determine how many dams would need to be removed in order to allow for viable populations of diadromous fish species to recover and maintain themselves without the need for hatchery supplementation or other anthropogenic interventions (Watts 2009).

PRRP would greatly improve habitat accessibility for native migratory species (Fay et al. 2006, p. 152), making – provided many more nonhydropower projects are removed or fitted with effective passage – 1,000 river miles available, while also maintaining 90% of the hydropower generation in the Penobscot. With a drainage basin of more than 8,500 square miles, the Penobscot is the largest river in Maine; it continues to produce the most annual adult Atlantic salmon returns in the state, i.e., about 1,000 each year (Saunders et al. 2006, p. 541). Also, if PRRP is implemented, the potential exists for an immense annual American shad run. Goode also says estimates place the historical run well over 2 million shad, while, "Under the scenario of removing Veazie and Great Works and putting a fish lift in at Milford, biologists think we could get back a run of a million to a million and a half shad over time" (Goode as quoted in Holyoke 2009, p. 1). Additionally, these potential benefits of PRRP would have very important – and different – implications for the Penobscot Indian Nation. For many decades, the Penobscot have been unable to exercise their federally-recognized subsistence fishery rights simply because migratory fish are incapable of reaching their reservation; but if the restoration of such species were to transpire, then the Penobscot Indian Nation would likely be provided with a clean source of food, while also imparting a sense of meaning to their fishery rights (Goode 2006, p. 25).

* * *

Numerous state and federal regulations and statutes have been established in one way or another to address ongoing and potential environmental threats and damages. Many of these remedial mechanisms have also attempted to repair and protect the overall health of native migratory fish in Maine. Nevertheless, far too often they have lacked effectiveness. While neither a complete list nor an exhaustive analysis, a few examples of this ineffectiveness have been discussed earlier herein. They include:

- The Commonwealth's "Fishway Act" was implemented in 1797, but throughout the duration of Edwards – that is, more than 160 years – no fines were ever levied because there was no way, or simply no will, to enforce them.
- Despite the provisions of the Federal Power Act of 1920, and for some 60 years, FPC

and later FERC, as well as the respective statutes each administered, never gave serious attention to the various environmental impacts of dams.

• The Water Pollution Control Act was instituted nationwide in 1972, yet the Scott Mill in Winslow, for example, continued to dump raw wastes in the Kennebec until 1976.

• The Electric Consumers Protection Act of 1986, together with FPA and associated amendments, actually gave FERC discretion to dismiss any recommendations (from USFWS, NMFS, other state and federal natural resource agencies, and Indian Tribes) to protect, mitigate damages to, and enhance fish and other wildlife.

• The *State of Maine Statewide River Fisheries Management Plan* (1982) made no mention of 6 of at least 12 species of diadromous fish native to Maine. Clearly, *The Strategic Plan for the Restoration of Shad and Alewives to the Kennebec River Above Augusta* (1985) and the *Operational Plan for the Restoration of Shad and Alewives to the Kennebec River* (1986) made no such mention, either.

• Lastly, and perhaps most importantly, FERC's license terms of 30 to 50 years promoted the construction of hydropower projects across the country in order to maximize the generating potential of a site, regardless of the environmental impacts. With such lengthy terms, it is exceedingly difficult for state and federal natural resource agencies to develop effective, coordinated, and timely fish restoration efforts. Additionally, these long-lasting terms can render moot every state and federal law intended to protect, mitigate damages to, and enhance fish and other wildlife.

The abundance and the very survival of populations of diadromous fish in Maine will largely depend on existing state and federal regulations and statutes. Those remedial mechanisms that are not sufficient to deal with damages and threats to such fish, together with those which may be adequate as written, but are neither applied nor enforced, will continue to pose a serious hindrance to the community of individuals and institutions alike that endeavors to mend and defend populations of migratory fish. Plainly, both implementation and enforcement need to be strengthened.

The *Lower Kennebec River Comprehensive Hydropower Settlement Accord* (1998) allowed for Edwards to be removed promptly and without public funds, while it also provided unobstructed access to 17 miles of prime spawning and rearing habitat for some *anadromous* species. As a result, water quality, wildlife, and recreation, as well as populations of some migratory fish species native to the Kennebec, were enhanced. Quite unlike the more recent PRRP negotiations referenced above, however, the *Settlement Accord* was reached only when members of KHDG were again permitted to postpone required fish passage - for roughly 5 to 15 years - in exchange for fully funding the removal of the dam and temporarily funding the continuation of short-term stocking and trap-and-truck efforts, targeted mainly at Atlantic salmon and river herring, including American shad.

Even though water quality, wildlife, and recreation have all improved since removal, consumption of fish caught in the Kennebec is still restricted because of the presence of polychlorinated biphenyls (PCBs) and dioxins from various industrial point sources along the river, while combined sewer overflows in the reach from Skowhegan to Gardiner and Randolph produce elevated levels of bacteria (Fay et al. 2996, p. 101-102). The Sebasticook is contaminated with PCBs and other hazardous materials, and approximately 208 miles of the Kennebec and its tributaries are listed as impaired by MDEP (Fay et al. 2006, p. 102). Similarly, fish consumption advisories are located along much of the Penobscot and its tributaries due to the levels of dioxins, PCBs, furans, and mercury found in certain fish species as tested, like American eel (Goode 2006, p. 25). Obviously, damages and threats to water quality only serve to hinder benefits to wildlife and recreation gained by dam removal.

Remarkably, even postponed postponements can, again, be postponed. Pursuant to the *Settlement Accord*: (1) either permanent upriver fish passage or breach was required at Fort Halifax Dam by 2003, but did not occur until 2008; (2) Benton and Burnham Dams were required to contain such passage by 2004, but did not until 2006. And only time will tell what will happen at Lockwood Dam, as it is not required to have permanent upriver fish passage until no earlier than 2010 - and only as scheduled or triggered by the passage of *8,000* passage-averse American shad.

The temporary funding provided by KHDG under the *Settlement Accord* is a particular concern for Nate Gray (2009), "There were no provisions for the long-term restoration efforts. We run out of money in 2011-2012. Then what? Who will continue to do restoration activities?" Worse, one may wonder just how effective fish passage and short-term stocking and trap-and truck-attempts will be – even assuming adherence to future requirements and funding beyond 2012. As Goode (2006) has explained:

> "Public agencies now have 130 years of field experience in the Gulf of Maine to understand that fish ladders, lifts, and hatcheries cannot overcome the impacts of multiple dams on a river. Yet tens of millions of public dollars continue to be spent perpetuating the myths of these technologies. While these technologies can play a limited role, such as a hatchery being used to keep a species from going extinct, they should not be considered lasting solutions." (Goode 2006, p. 26)

As for continued funding, perhaps innovative legislation is needed. Gray has offered a possible, partial solution that basically sees some fraction of every cent per kilowatt-hour generated being dedicated to a fund for the restoration of native species and habitats. Regardless of where the hydropower project is located in Maine, it would be based on generation efficiency – the bigger the project, the more it dedicates to the fund (Gray 2009).

Populations of migratory fish species native to the Kennebec were certainly afforded some help when the removal of Edwards made 17 more miles of river accessible. The cumulative impacts of hydropower projects still in the Kennebec and its tributaries, however, continue to thwart any serious restorative measures. On average, the major rivers in Maine contain more than five mainstem dams, while current regulatory mechanisms (and their regulators) assess these hydropower projects on a case-by-case basis. In stark contrast to the recent PRRP, as Doug Watts has elaborated, the *Settlement Accord* and ultimate removal of Edwards were not underpinned by any quantitative, iterative analysis that could possibly address the multiplicity of dams in the Kennebec:

"It was scientifically rigorous but was solely focused on the Edwards Dam. There was no watershed-wide, basin-wide analysis of the type and scope undertaken on the Penobscot. This is because the Penobscot project was wholly based upon the lessons learned from the Kennebec project. The process was not effective because it was not holistic and did not ask the primary question: what will it take to make this river work again? In contrast, for the analytic process on the Penobscot, we examined every permutation of dam removals and dam retentions and tried to come up with the combination that would ensure fisheries restoration to the entire drainage while minimizing the loss of installed hydro capacity. Under the status quo conditions of dams on the Kennebec, it is fundamentally impossible to restore healthy, functioning, self-sustaining populations of native migratory fish above its first dam in Waterville. I base this conclusion on the analytic process we used on the Penobscot, i.e., you cannot restore salmon, shad and river herring runs in habitat blocked by more than three mainstem dams. So in a sense, the Kennebec is like the dad who gave up his music career and took a steady, paying job so that his kid, the Penobscot, could get into Julliard." (Watts 2009)

Attempts to restore these Atlantic salmon, for example, are severely challenged in the Kennebec because only one mainstem dam to date contains upriver fish passage (i.e., Lockwood), which is an interim trap-lift-and-sort facility. While some Atlantic salmon rearing habitat is indeed accessible in the restored reach between Augusta and Waterville, the overwhelming majority – roughly 90% – of their habitat in the Kennebec and its tributaries is located above Lockwood (see Figure 12, p. 92) (Fay et al. 2006, p. 90). And, even after (or, one wonders, if) permanent upriver fish passage is constructed at Lockwood pursuant to the *Settlement Accord*, Atlantic salmon will still need to pass above no less than six mainstem dams (i.e., Lockwood, Hydro-Kennebec, Shawmut, Weston, Abenaki, and Anson) in order to access 50% of available rearing habitat.

If populations of migratory fish are ever to regain their historical abundance and distribution, then state and federal regulations and statutes, as well as any other remedial mechanisms, must certainly be founded on the principle of sustaining interspecies relationships, individual species function, and connectivity between riparian zones, lakes, ponds, wetlands, estuaries, and the ocean. A holistic approach that addresses, implements, applies, and enforces effective, long-term restorative measures based on ecological processes and relationships among riverine, estuarine, and marine environments will be needed.

* * *

As Nate Gray recollects, "You have to remember that the original prize was the removal of Edwards. That was the goal and it has been achieved" (Gray 2009). Indeed, despite having been based on limited analytic methodology and either (at best) questionable or (at worst) inexcusable compromise, the removal of Edwards from the Kennebec in 1999 forever changed the facilitation of dam removal in the United States. It marked the first time FERC had ever decided to: (1) deny an application to renew a hydropower project; and (2) order a dam to be removed notwithstanding the objections of its owner. Together, these two firsts firmly secured FERC's then relatively new (1994) authority to deny an application for the renewal of a hydropower project and to order a dam be removed at the expense of its owner were it to determine that this was in the public interest.

FERC's decision to remove Edwards against the will of its owner has restructured the relationships among hydropower project licensees, state and federal natural resource agencies, environmental health organizations, Indian Tribes, and other stakeholders. FERC concluded that the nonhydropower values resulting from removal (e.g., improved water quality, recreation, and access for migratory fish) outweighed the hydropower value of its continued operation (i.e., the generation of one tenth of 1% of electricity in Maine). In so doing, FERC changed the idea of dam removal – which until then was typically seen as a long shot of a campaign, waged by foolhardy radicals – into a feasible and potentially lasting solution to the plight of numerous riverine ecosystems throughout the country.

Two months after the *Settlement Accord* was signed, Bruce Babbitt (1998), former USDOI Secretary, delivered an address to the Ecological Society of America in which he heralded the change that was afoot in the way the nation would perceive dam removal:

> "I believe that huge public interest reflects a deep, widespread understanding that America overshot the mark in our dam building frenzy. Dams that were clearly justified for their economic value gradually gave way to projects built with excessive taxpayer subsidies, then justified by dubious cost-benefit projections. We in America have been slow to recognize the ecological costs of dams. And slower still to envision watershed restoration through dam removal. The public is now learning that we have paid a steadily accumulating price for these projects. Rivers are always on the move and their inhabitants know no boundaries; salmon and shad do not read maps, only streams. The coming age of restoration requires the active involvement of the citizens who live on the entire watershed. Most of all it requires a creative act; we must see not only what is, but envision what can be. It requires us to reach back into our history in order to grasp the future in which we might live." (Babbitt 1998)

This reach backwards to gain historical insight – when coupled with holistic and applied research – can help identify past, present, and potential damages and threats to riverine environments within the context of overall ecosystem health. With respect to the restoration of mutually beneficial relationships between a fully functioning river and naturally reproducing, self-sustaining populations of native migratory fish, this insight and research has increasingly shown that the consideration of dam removal is a viable option for when long-term restorative measures are called for. As the Edwards case has shown, and what Babbitt speaks to, however, is that dam removal necessitates public participation since, as an initiative for river restoration, it still remains very much in its infancy and inevitably raises issues that demand public debate and discussion.

With a greater understanding of both what the Kennebec River once, but no longer is, and what it could become in the absence of Edwards Dam, public support for its removal grew. The dam came to be seen less as a charming local monument of sorts, and more as a relic of generations passed, a finite utility that supplied very little electricity and suffocated a public resource in so doing. The notion of returning to a healthier, more freely flowing 17-mile reach in the Kennebec began to be appreciated for the host of environmental and socioeconomic benefits it would eventually provide. By recognizing the once-in-a-lifetime opportunity to intervene in the relicensing process and thereby test FERC's newly established authority, and by building awareness of how removal could serve the various interests at stake, the participating parties succeeded in effecting an unprecedented solution.

Much of this increase in public awareness can be attributed to those who lent credibility to the novel idea of removing Edwards. Perhaps it began with Lewis N. Flagg and other concerned fisheries biologists who, in the early 1970s, were among the first to base their recommendations for this removal on empirical research. Then, a decade later, environmental health organizations like the Kennebec River Angler's Coalition, the Natural Resources Council of Maine, Trout Unlimited, and, especially, the Kennebec Coalition, began to lead grassroots advocacy efforts and, in so doing, pressured many policy makers to consider the removal of Edwards in earnest. In time, several state and federal resource agencies, such as the Maine Department of Marine Resources, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the Maine State Planning Office, would also recognize some common interest and play a key role. Together, communication and cooperation among these organizations, agencies, and members of numerous local communities would gain momentum. When the Federal Energy Regulatory Commission released its Draft Environmental Impact Statement in 1996, these stakeholders were able to express both their concerns and recommendations. This open consultation process encouraged – if not demanded – public involvement that, through debate and discussion, would eventually help address and resolve various ongoing and potential issues early in the relicensing process. Public participation was a key influence on FERC's decision.

As Doug Watts advises, "It's important to remember that the political, social and scientific support for river restoration via dam removal is extremely new and is growing exponentially. What is considered commonplace now was not even considered possible in 1990. Hopefully, the same will hold true twenty years from now" (Watts 2009). Riverside communities are increasingly contemplating, if not advocating, dam removal as a feasible course to be taken at a particular juncture in the lifetime of a particular dam. This stirred, exciting discussion is indeed a watershed in the societal perception of dams. At the very least, the removal of Edwards Dam from the Kennebec River has advanced consideration of both why dam removals are viable solutions and how they can be facilitated. Edwards is gone, but its legacy of holistic participatory solutions remains to guide the efforts to be mounted to secure the full restoration of migratory fish in Maine to their historical abundance and distribution, as well as, in turn, their environmental and socioeconomic significance.

APPENDIX

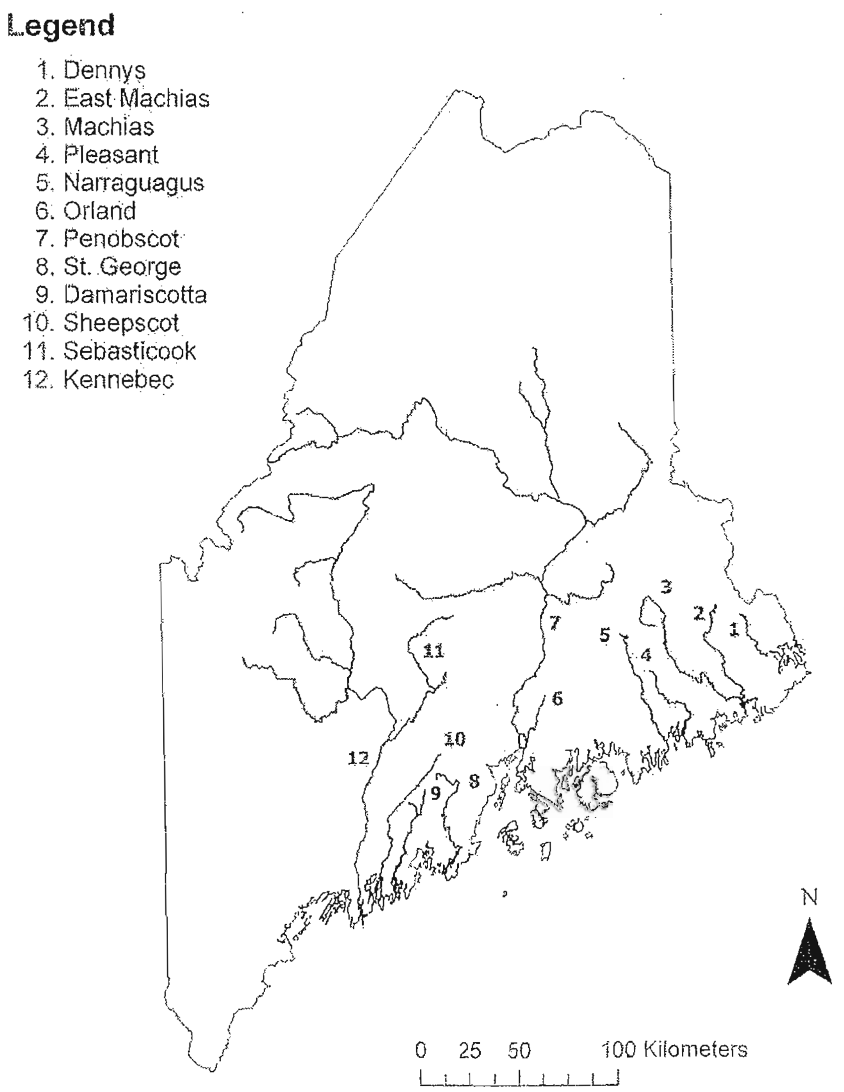

Figure 1. Selected Rivers in Maine With Important Diadromous Fisheries.

(Saunders et al. 2006, p. 540)

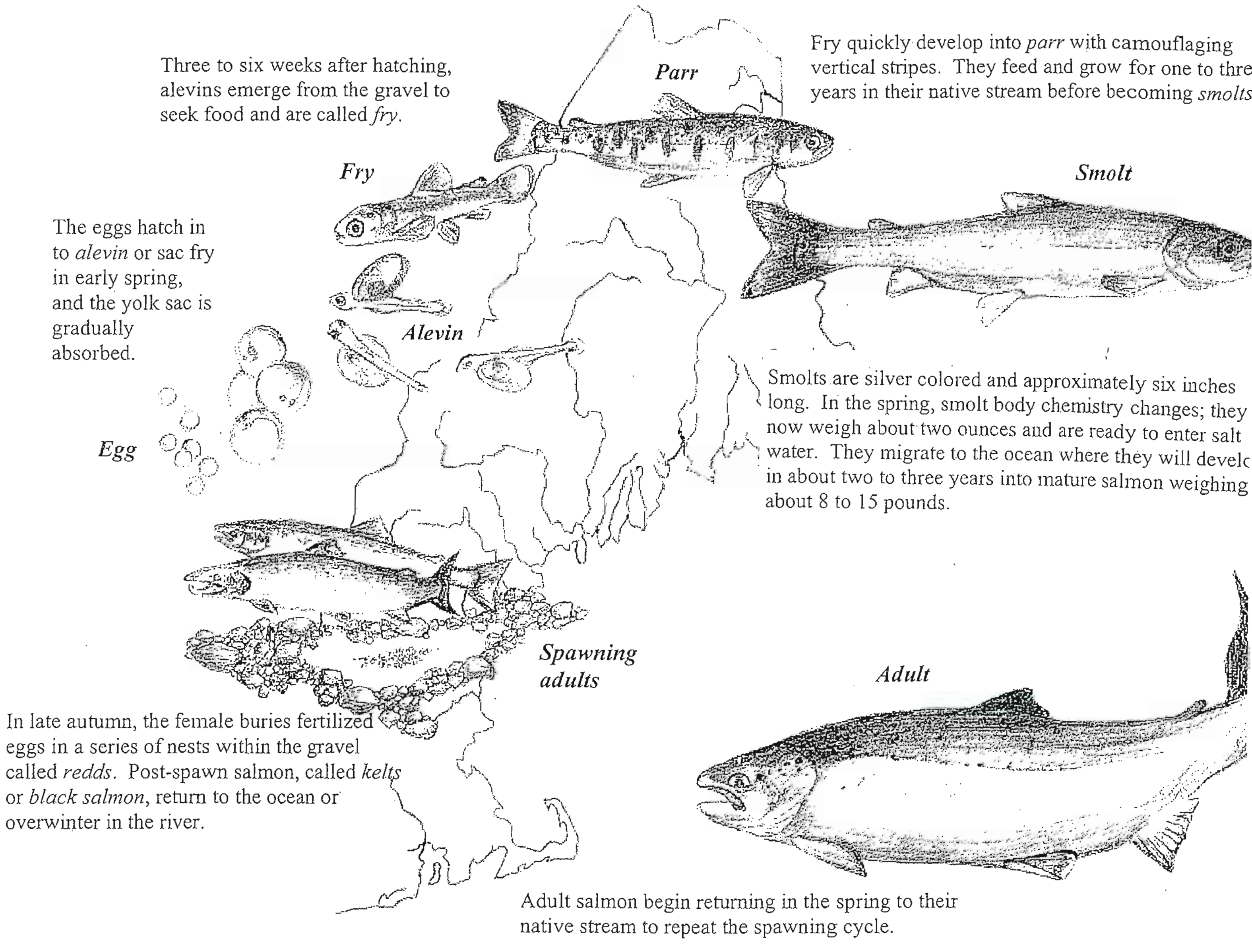

Figure 2. Life Cycle of the Atlantic Salmon.

(courtesy of Katrina Mueller, as cited in Fay et al. 2006, p. 10)

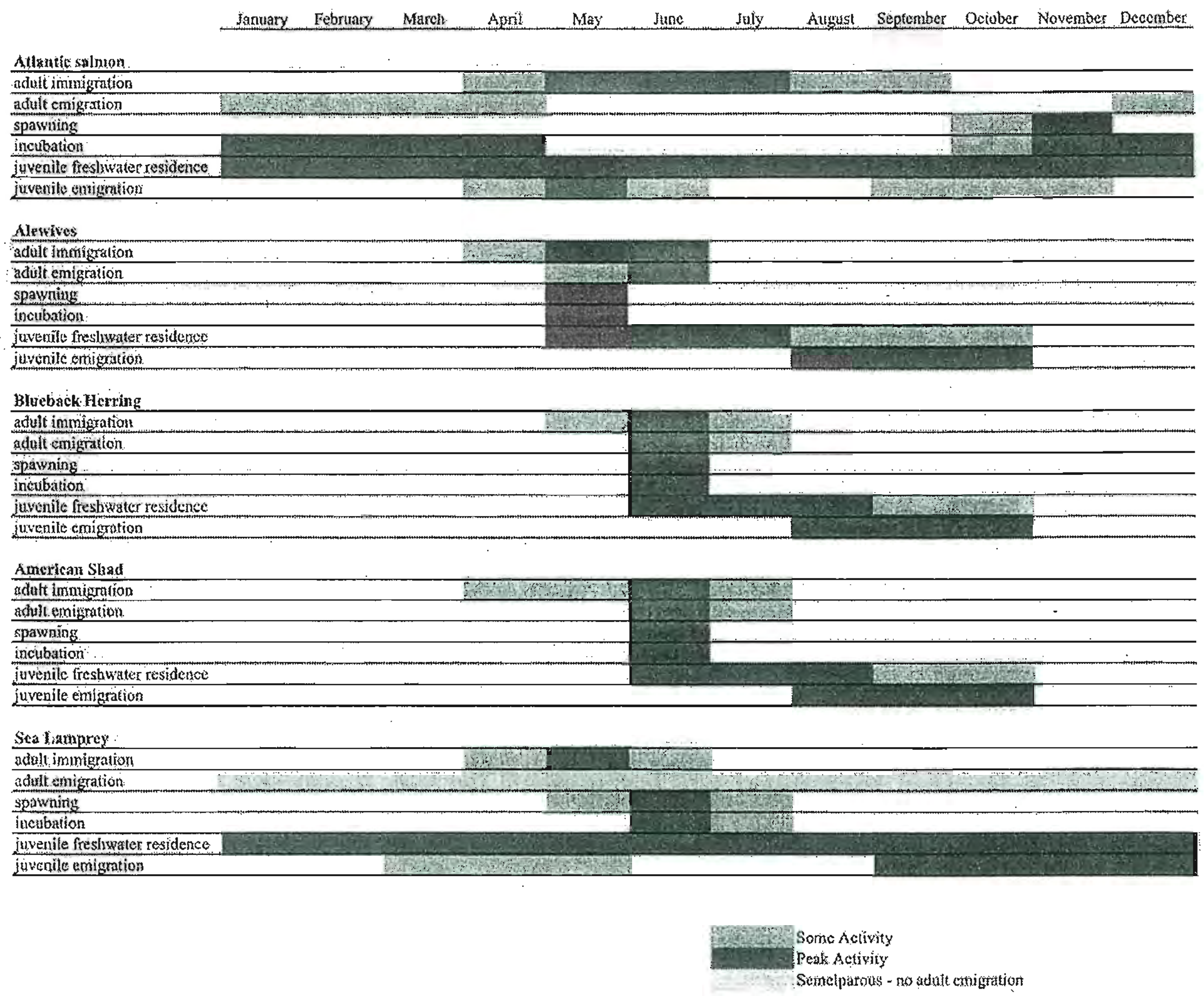

Figure 3. Generalized Life History of Several Anadromous Fish in Maine.

(Saunders et al. 2006, p. 539)

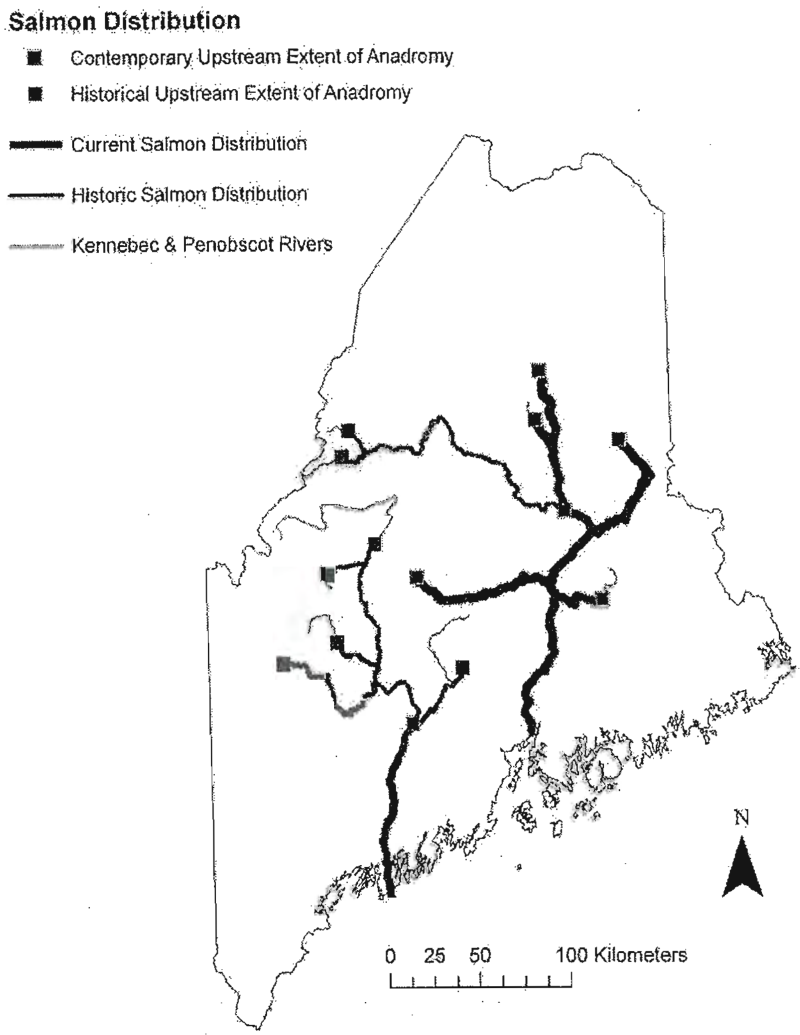

Figure 4. Historical and Current Distribution of Atlantic Salmon in the Penobscot and Kennebec Rivers.

(Saunders et al. 2006, p. 541)

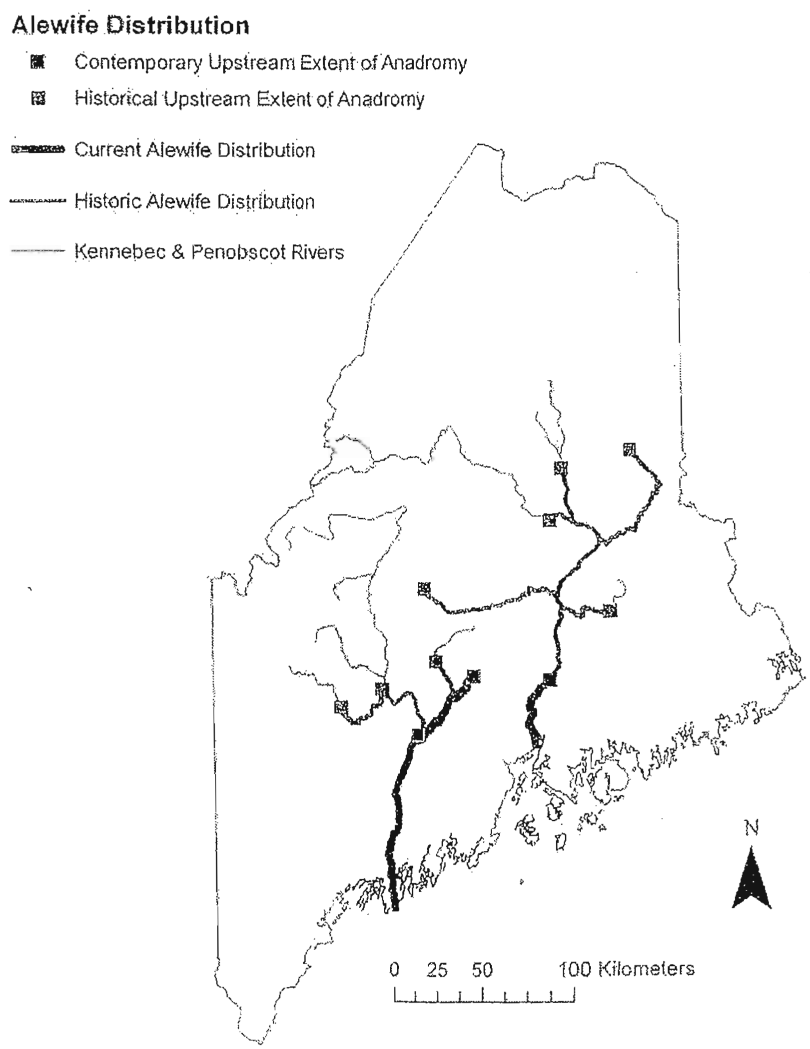

Figure 5. Historical and Current Distribution of Alewife in the Penobscot and Kennebec Rivers. (Saunders et al. 2006, p. 542)

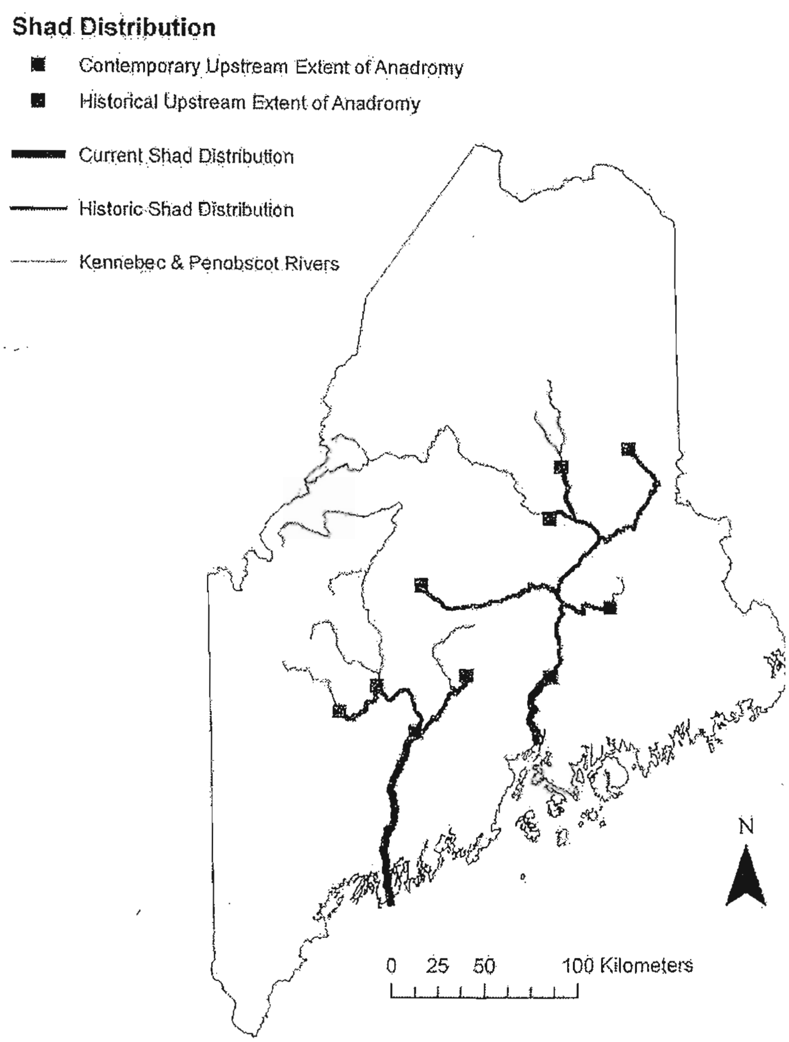

Figure 6. Historical and Current Distribution of American Shad in the Penobscot and Kennebec Rivers.

(Saunders et al. 2006, p. 543)

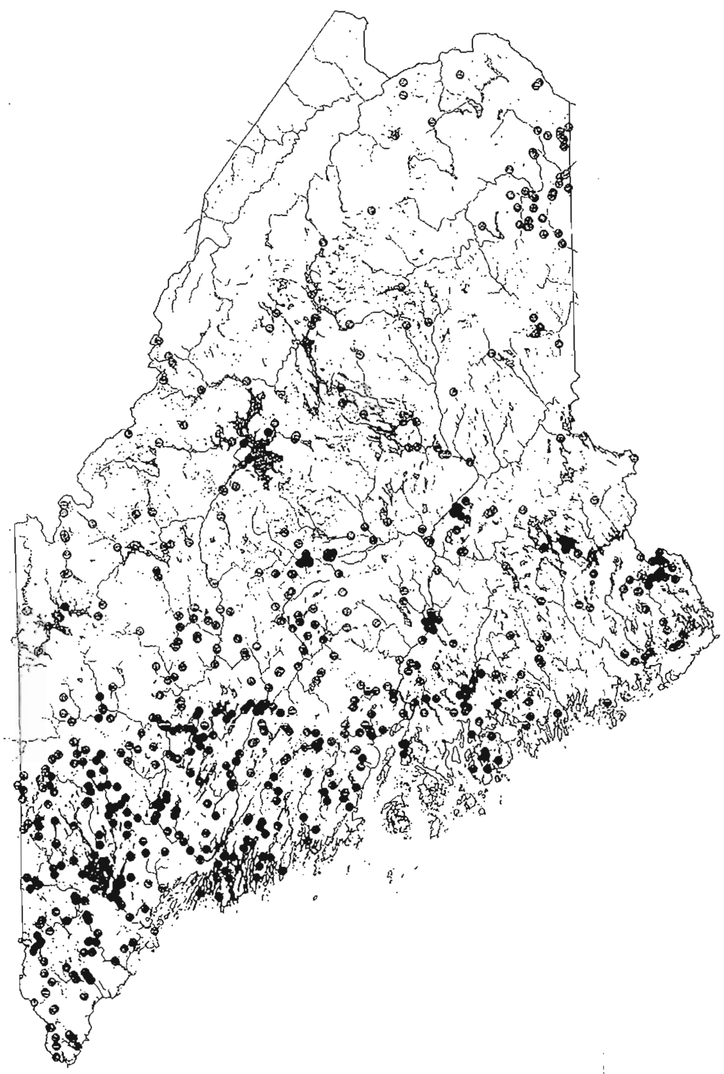

Figure 7. The 639 Dams Over Four Feet in Height in Maine
as Listed by the National Inventory of Dams Program.
(NRCM 2002, inside cover)

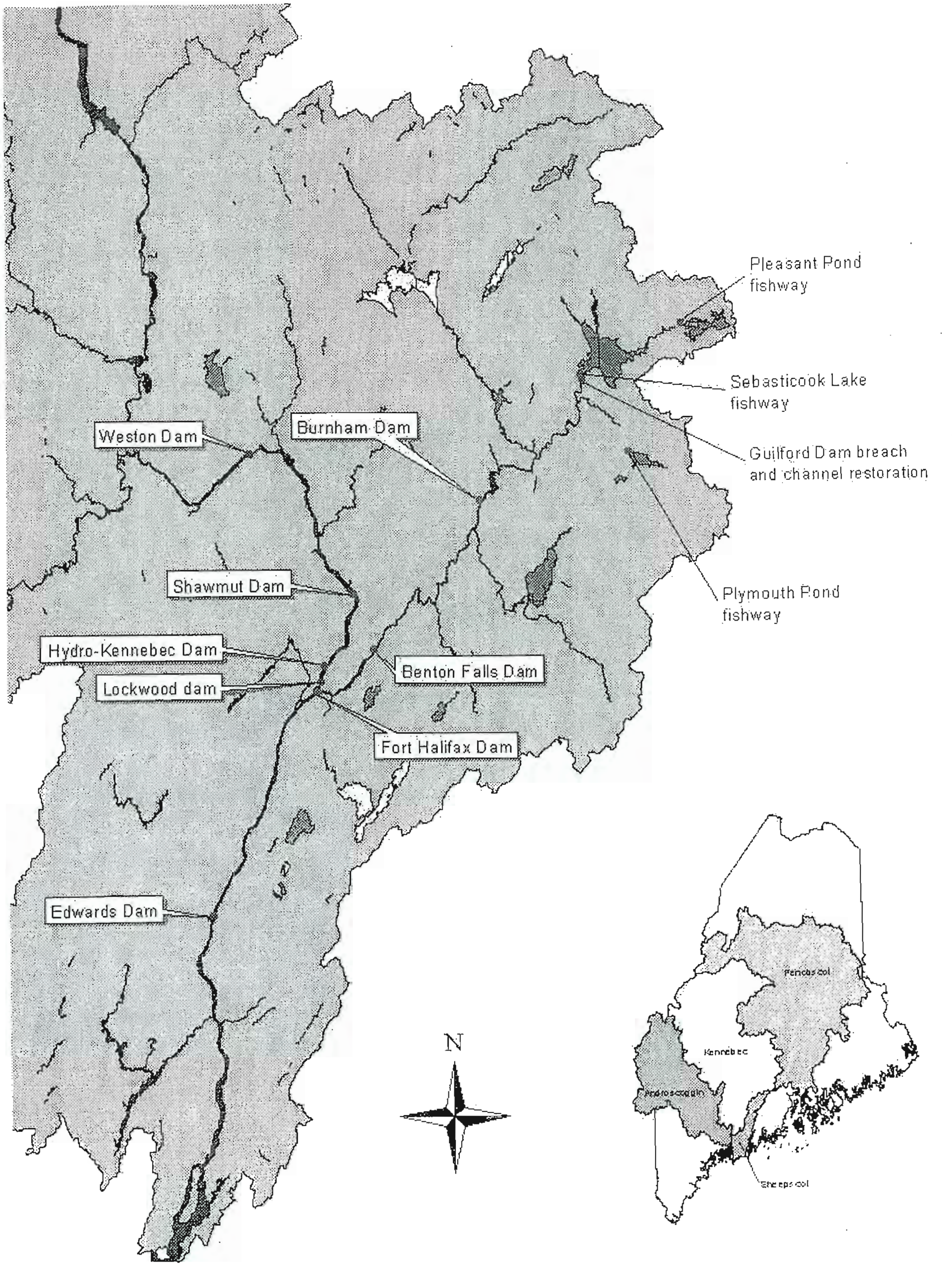

Figure 8. Lower Kennebec River Watershed.

(http://www.maine.gov/dmr/searunfish/kennebec/map.htm)

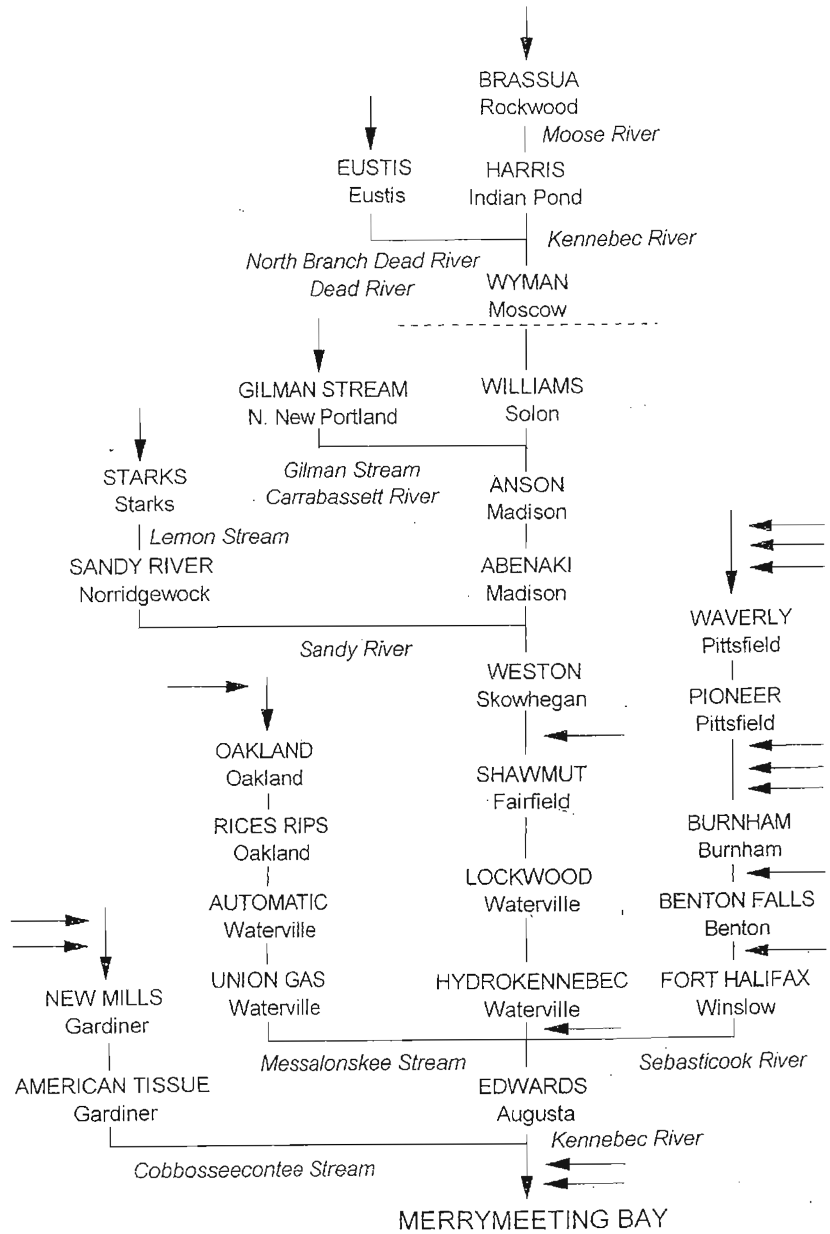

Figure 9. Schematic Diagram of the Kennebec River Basin Above Merrymeeting Bay, Showing Hydropower Projects (all capitals), the Closest Municipality to the Project, and the Names of Streams on Which the Projects Are Located (in italics). (McCleave 2001, p. 595)

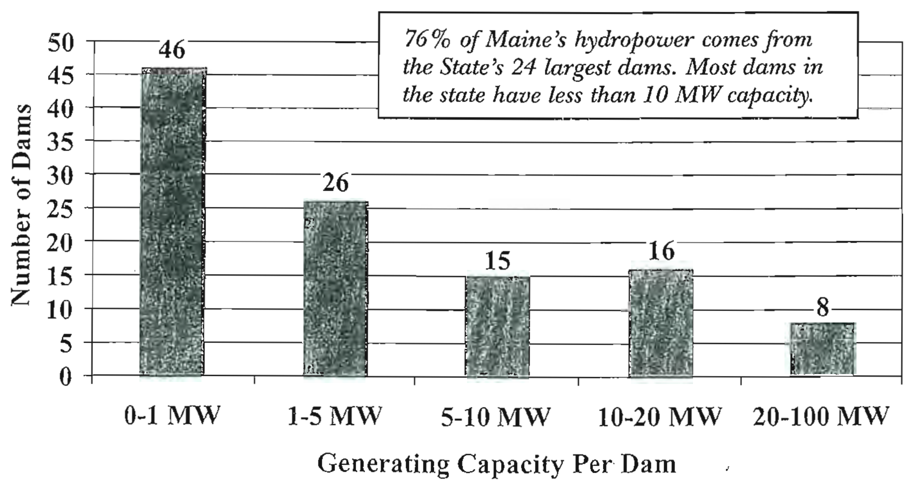

Figure 10. Hydropower Capacity (in megawatts) of Dams in Maine.

(NRCM 2002, p. 20)

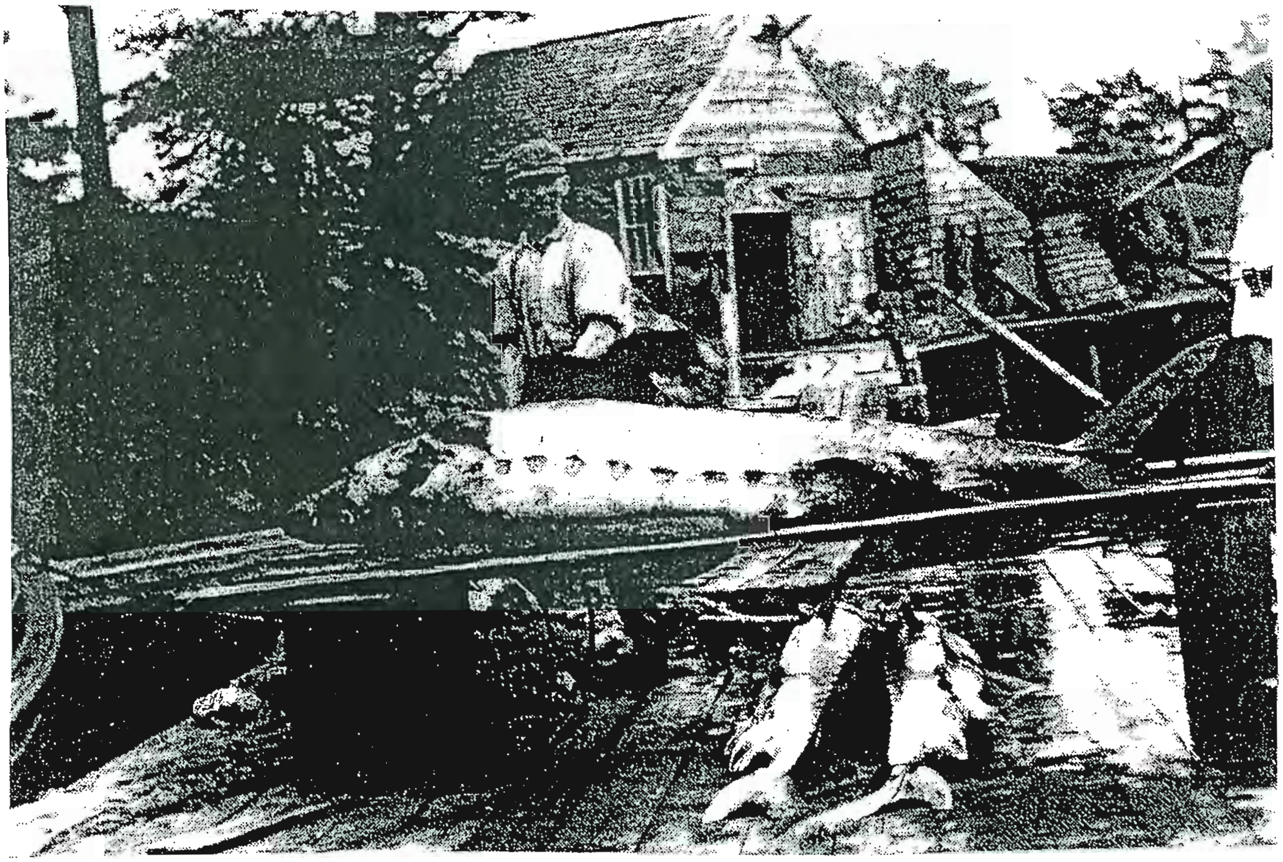

Figure 11. Kenneth Edgecomb Processing an Atlantic Sturgeon on Sturgeon Island, Merrymeeting Bay, c. 1900.
(courtesy of the Maine Maritime Museum, as cited in Koulouris et al. 1990, p. 55)

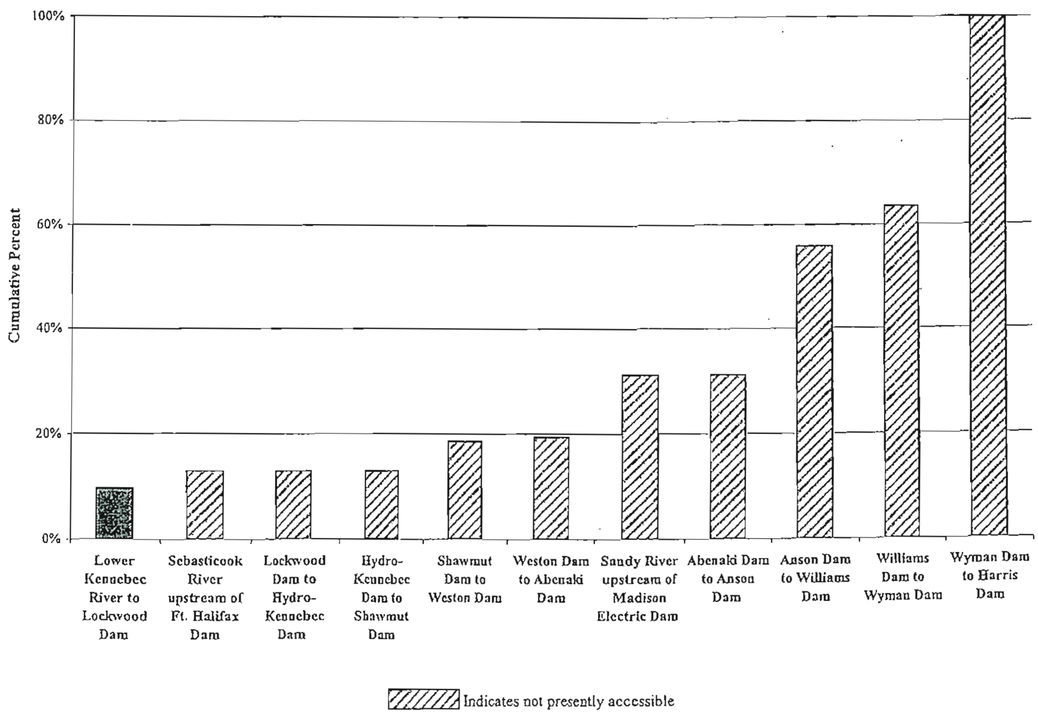

Figure 12. Cumulative Percentage of Atlantic Salmon Rearing Habitat Within Selected Reaches of the Kennebec River Watershed.

(Note: reaches delineated by hydropower dams;

as of spring 2006, trap and truck passage above Lockwood.)

(Fay et al. 2006, p. 93)

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