Commonwealth of Massachusetts

Final In-Lieu Fee Program Instrument

The MA Department of Fish and Game

Program Sponsor

Table of Contents

List of Figures

List of Tables

I. Introduction

This Instrument establishes an In-Lieu Program ("ILFP" or "ILF Program") for the Commonwealth of Massachusetts to be sponsored and administered by the Department of Fish and Game ("DFG") in accordance with the Final Rule issued by the Army Corps of Engineers ("ACOE", or "Corps") and the United States Environmental Protection Agency ("EPA") in 2008 at 33 C.F.R. Part 332 (the "Mitigation Rule"). The Mitigation Rule governs in-lieu fee compensatory mitigation associated with ACOE permits under §404 of the Clean Water Act and/or §§9 or 10 of the Rivers and Harbors Act of 1899.

By way of background, the Corps, DFG and its Division of Marine Fisheries ("DMF") entered into a Memorandum of Understanding ("MOU") in June 2008, authorizing DMF to be the program sponsor for an ILFP established to provide compensatory mitigation for impacts to aquatic habitats of marine and diadromous fish species in Massachusetts. That MOU, however, was limited to providing compensatory mitigation associated with in-lieu fee projects that meet the criteria for coverage under the MA General Permit ("GP") issued by the ACOE pursuant to the 2008 rule. DMF's ILFP expired in June 2013, and as described herein, is being incorporated as a component of DFG's state-wide ILFP established by this Instrument.

As discussed below, both DFG and the Corps recognize the need and value in establishing a state-wide ILFP for Massachusetts. To that end, DFG submitted a Prospectus for a proposed state-wide ILFP in accordance with the 2008 rule to the Corps on September 26, 2012. DFG's Prospectus underwent a 30 day public comment period that ended on November 1, 2012. On November 28, 2012, the Corps determined, based on its review of the Prospectus and the public comments, that DFG's proposed ILFP has the potential to provide compensatory mitigation for activities authorized by the Corps, as required by 33 CFR 332.8(d)(5), as well as other related actions. Accordingly, the Corps authorized DFG to proceed with the development of a draft ILF Instrument. This Instrument is consistent with the ILFP described in DFG's Prospectus. This Instrument is not a contract and does not give rise to claims for money damages; rather this Instrument is an agreement regarding regulatory requirements of the Corps associated with mitigation for activities permitted by the Corps.

With the approval of the Final Instrument by the Corps, DFG will be the program sponsor of In-Lieu Fee Program for the Commonwealth of Massachusetts.

II. Need for an In-Lieu Fee Program

The need for an effective, state-wide compensatory mitigation program is evident in Massachusetts, given the historic loss of and continuing threat to aquatic resources across the state. The Compensation Planning Framework in this Instrument provides a summary of the scope and magnitude of historic and current threats to both coastal and inland aquatic resources, which is consistent with the trend nationwide. The nature and scale of this problem supports the need for an alternative to ACOE permittee-responsible, on-site compensatory mitigation that will result in additional high quality mitigation.

In order to achieve these objectives, the ILFP will supplement state-required mitigation and encompass all Corps permit actions affecting Massachusetts waters and wetlands. DFG's own experience with compensatory mitigation and land protection shows that the most effective approach takes into account the larger landscape/watershed context, including assessing the extent to which a mitigation project contributes to the sustainability of an ecosystem. As highlighted in the Prospectus, DFG and its divisions have the expertise, capacity and compensatory mitigation framework to develop and administer an innovative and effective ILFP. These qualifications are briefly summarized below.

III. Qualifications of the Program Sponsor

The Department of Fish and Game ("DFG"), an agency of the Commonwealth established pursuant to M.G.L. c. 21A, §8, is uniquely qualified to be the sponsor of the In-lieu Fee Program in Massachusetts. DFG is responsible for the management and protection of the Commonwealth's wildlife, including marine fisheries, as well as the habitats that support the state's wildlife. DFG's three divisions, in turn, have specific authority and responsibilities associated with the core components of DFG's overall mission, which often overlap in complimentary fashion:

The Division of Marine Fisheries ("DMF") has the authority and responsibility under M.G.L. c. 130, §17 for the development and stewardship of marine fisheries resources, habitat, and harvest as authorized under G.L. c.130, §17. DMF's fisheries management activities are performed through a long-standing strategic partnership with the NMFS and extensive involvement with the New England and Mid-Atlantic Regional Fishery Management Councils ("NEFMC" and" MAFMC"), the Atlantic States Marine Fisheries Commission ("ASMFC"), and the Massachusetts Marine Fisheries Advisory Commission ("MFAC").

DMF is an experienced administrator of compensatory mitigation projects, including for authorized impacts to aquatic resources, in particular Essential Fish Habitat ("EFH") and aquatic habitats of managed diadromous fish and marine finfish and shellfish species in Massachusetts' waters, as well for authorized impacts to aquatic fish and shellfish habitat in Massachusetts. Prior to the promulgation of the Mitigation Rule, DMF was the program sponsor of a Corps-approved ILFP associated with providing compensatory mitigation for impacts to aquatic habitats of marine and diadromous fish species until the expiration of the program in June 2013. Thus, DMF has the demonstrated experience and capacity to provide compensatory mitigation for the marine and diadromous fisheries component of DFG's state-wide ILFP.

The Division of Ecological Restoration ("DER") was created in July of 2009 with the merger of the DFG's existing Riverways Program and the Wetlands Restoration Program previously housed within the state's Coastal Zone Management ("CZM") Office. DER coordinates ecological restoration to improve habitat for fish and wildlife and to restore important ecosystem services that benefit the quality of life for all Massachusetts citizens. The Riverways Program has been maintained within the DER and continues to coordinate outreach and technical assistance to support river conservation and protection.

DER and its municipal and NGO partners facilitate capital-based projects, including but not limited to, dam removal and culvert replacement with the goal of restoring aquatic habitats and ecosystems across the state. In addition to restoring valuable aquatic resources, DER-sponsored projects support commercial and recreational fisheries and provide many other ecological and public benefits such as reduced flooding, improved water quality, and the replacement of aging infrastructure. As discussed below, DER already has an established, substantial portfolio of active physical restoration projects that have the potential to serve as compensatory mitigation projects under a DFG ILFP.

The Division of Fisheries and Wildlife ("DFW") is responsible under M.G.L. c. 131 for the conservation, restoration, protection and management of the inland fish and wildlife resources of the Commonwealth. DFW's mission also includes conserving and protecting endangered, threatened and species of special concern pursuant to the Massachusetts Endangered Species Act, M.G.L. c. 131A ("MESA"), and the MESA regulations promulgated thereunder at 321 CMR 10.00. As discussed below, in its role as regulator under MESA, DFW has developed extensive expertise and experience developing, approving and overseeing the implementation of compensatory mitigation projects, with a particular focus on preserving the habitats of state-listed species. This type of compensatory mitigation approach and experience will complement and strengthen the preservation of the aquatic resources component of DFG's proposed ILFP.

Finally, the *DFG habitat protection program*, a joint partnership between DFG and DFW, identifies and protects the most ecologically important habitats throughout Massachusetts, including the high value fish and wildlife habitats and natural communities. More specifically, the goals of the DFG habitat protection program are to protect and perpetuate functioning ecosystems that contain significant fish and wildlife resources, to conserve biological diversity, and to provide adequate routes for public access to the lands and waters of the Commonwealth. The program targets river corridors, wetlands, various types of forested upland, habitat of state-listed species, and other types of high quality habitats. Current holdings stretch from Berkshire County to Cape Cod and the Islands and total more than 190,000 acres. DFW manages over 160,000 acres as Wildlife Management Areas for conservation and outdoor recreation.
In short, DFG's habitat protection program, together with DFW's compensatory mitigation initiatives under MESA, provides a sound foundation for the preservation component of the Massachusetts ILFP.

IV. Legal Responsibility for Compensatory Mitigation

Acceptance of an ILF payment into the ILFP established by this Instrument is an acknowledgement by DFG that it assumes all legal responsibility for satisfying the mitigation requirements of the Corps (i.e., the implementation, performance, and long-term management and monitoring of the compensatory mitigation project(s) approved under this Instrument and subsequent Compensatory Mitigation Plans).

This transfer of legal responsibility is established by: 1) the approval of this In-Lieu Fee Instrument; 2) receipt by the district engineer of a Notice of Credit Sale and Transfer of Legal Responsibility to DFG that is signed by the DFG and the permittee and dated; and 3)

the transfer of fees from the permittee to DFG. DFG may use grantees, subcontractors and agents in the performance of its obligations as described herein, provided DFG shall nevertheless remain responsible for all such obligations.

V. Compensation Planning Framework

A. *Overview of the Compensation Planning Framework*

Consistent with the Mitigation Rule, the compensation planning framework for DFG's ILFP is composed of 11 elements that guide how DFG as the program sponsor will identify, prioritize and implement compensatory mitigation within each of the geographic service areas established by this program, while taking into account the historic and current aquatic resources of Massachusetts.

DFG's wide ranging experience in habitat protection and compensatory mitigation shows that the most effective approach takes into account the larger landscape/watershed context, including assessing the extent to which mitigation projects contribute to the sustainability of an ecosystem. The compensation planning framework describes the historic context, the prioritization criteria, and the tools that will be used to identify and place potential mitigation projects within this landscape/watershed context.

Consistent with DFG's Prospectus and as summarized below, the compensation planning framework for this Instrument prioritizes the use of land preservation (or to use DFG's preferred term "habitat protection") as the most effective, long-term form of compensatory mitigation for addressing impacts to inland aquatic resources. In some cases, habitat protection may also be an effective form of mitigation of impacts to coastal aquatic resources (e.g., permanently protecting on-shore embayment areas to prevent water quality degradation to marine waters). However, as discussed in Section IX.B. of this Instrument ("The Restoration Components of DFG's ILFP"), DFG expects that most of the mitigation in the coastal/open ocean environment will be in the form of restoration and enhancement.

"Preservation" is defined in the Mitigation Rule as the removal of a threat to, or preventing the decline of, aquatic resources by an action in or near the aquatic resources and includes the protection and maintenance of such resources through appropriate physical and legal mechanisms. The permanent protection of habitat that contains or buffers aquatic resources through land preservation is no longer considered a last resort option and is expressly allowed under the Mitigation Rule when all of the following five criteria are met:

(i) The resources to be preserved provide important physical, chemical, or biological functions for the watershed;

(ii) The resources to be preserved contribute significantly to the ecological sustainability of the watershed. In determining the contribution of those resources to the ecological sustainability of the watershed, the district engineer must use appropriate quantitative assessment tools, where available;

(iii) Preservation is determined by the district engineer to be appropriate and practicable;

(iv) The resources are under threat of destruction or adverse modifications; and

(v) The preserved site will be permanently protected through an appropriate real estate or other legal instrument (e.g., easement, title transfer to state resource agency or land trust).

The Corps' criteria expressly recognize that permanently protecting resources that are under threat of destruction or adverse modification is an appropriate form of compensatory mitigation. Indeed, the Mitigation Guidance issued by the Corps' New England District makes the point that "[d]ue to wetlands laws in all of the New England states that reduce development pressure on wetlands, New England District encourages upland preservation that protects aquatic functions over wetlands-only preservation" (p.8).

As the third most densely populated state in the nation (852.1 people per square mile), Massachusetts is the subject of widespread development that impacts or threatens our already limited aquatic resources. As documented in the 4th edition of *MassAudubon's Losing Ground* series back in 2009, 54% of the state was located within the "Sprawl Frontier Zone" or the "Sprawl Danger Zone" (DeNormandie et al., 2009). These two zones represent areas within Massachusetts where dispersed residential development is having documented impacts on the ecological integrity and function of both aquatic and upland systems. In the four years since the above report was issued, more ground has been lost in Massachusetts. As discussed in more detail below, this new research arose out of the Commonwealth's Sustainable Water Management Initiative, which, in turn, will inform DEP's more protective approach to regulating water withdrawals in Massachusetts.

The importance of permanently protecting aquatic resources/habitats and buffers in Massachusetts is underscored by the conclusions of two recent USGS reports (Armstrong et al. 2011, Weiskel et al. 2010). These USGS reports document how the capacity of our rivers and streams to support fisheries is directly threatened by the construction of impervious surfaces, and water withdrawals in riparian and upland areas. Both reports use fish communities as indicators of the overall health of the aquatic resources in which they reside, and quantify the relationship between the composition of such fish communities and the degree of development and withdrawals impacting them.

Similarly, recent research looking at the biotic integrity of fish assemblages in the Etowah basin (4,800 sq km) in Georgia found that "[m]ost fish assemblage variables were related to percent forest and percent urban land cover, with the *strongest relations at the largest spatial extent* of land cover (catchment), followed by riparian land cover in the 1-km and 200-m reach, respectively" (Roy et al., 2007). The research conclude that "catchment land cover is an important driver of fish assemblages in urbanizing catchments, and riparian forests are important but not sufficient for protecting stream ecosystems from the impacts of high levels of urbanization" (Roy et al., 2007).

Several peer-reviewed studies have also established the link between percent impervious cover and degradation in aquatic systems. Moreover, as this research into this area has matured, the threshold at which degradation of some sort is detected has moved lower: from 8-12% (Booth and Jackson, 1997) to between 1 and 14%, with an emphasis on the low end for protection (Walsh et al., 2005). More recently, changes in composition of fish communities were detected in numerous taxa between 0.5 and 2% cover (King and Baker, 2010).

The above research support DFG's view that mitigation in the form of the permanent protection of aquatic resources/habitats and buffers at the catchment/watershed scale is the most effective to maintain the long-term biotic integrity of stream and river systems.

Climate change represents yet another long-term threat to the aquatic resources of Massachusetts that will have dispersed landscape-level impacts upon aquatic resources. Many emerging strategies, collectively being called *Climate Change Adaptation*, are designed to identify ecosystems and populations that maintain resistance and resilience despite the adverse impacts of climate change. This approach to conservation planning values habitats, natural communities, and ecosystems that are of sufficient size, support ecological processes, have high connectivity to other habitats and ecosystems, and minimize non-climate stresses to species and ecosystems (BioMap2, 2010). The *BioMap2* project selected areas within Massachusetts that are the most important for the protection of biological diversity. The permanent protection of these *BioMap2* areas will contribute to the ecological sustainability of the watersheds and their aquatic resources. DFG has a range of assessment and planning tools, such as BioMap2, that will be used to identify areas that provide the essential physical, chemical, and biological conditions necessary to maintain the ecological sustainability of the watershed.

B. *The ILFP Service Areas*

A service area is defined in the Mitigation Rule as the watershed, ecoregion, physiographic province and/or other geographic area within which the in-lieu fee program is authorized to provide compensatory mitigation required by Corps permits. DFG's ILFP has the following four service areas, each of which corresponds to a major bioregion:

(1) *The Berkshire/Taconic Service Area*;

(2) *The Connecticut River Service Area*;

(3) *The Quabbin/Worcester Plateau Service Area*; and

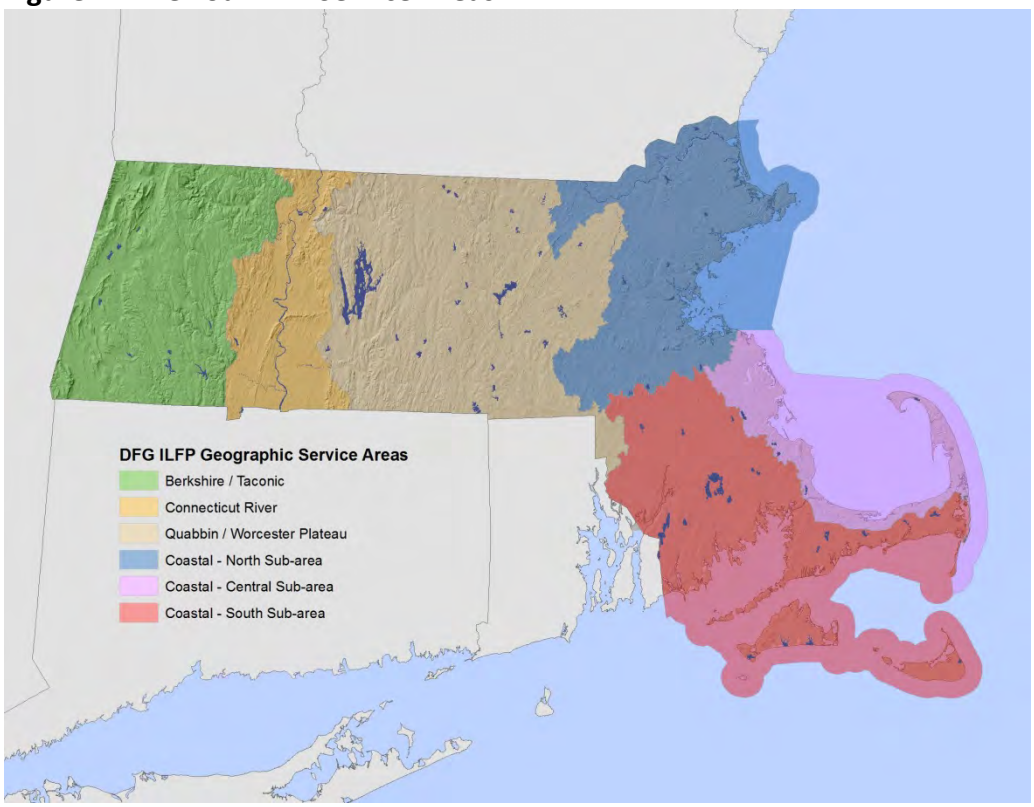
(4) *The Coastal Service Area*.

These four service areas, which are depicted together in **Figure 1**, represent geographically distinct and administratively manageable units. A larger scale map of each service area is contained in **Appendix B.** While Massachusetts eco-regions are defined in different ways depending upon refinements of scale, the four main service areas are separated by differences in underlying geology, soils, vegetation, land-use and geography.

In developing these service areas, DFG consulted EPA's Level IV eco-regions as well as the eco-regions in *BioMap2*, which was jointly produced by DFG and The Nature Conservancy. DFG delineated the internal boundaries of the service areas using the USGS HUC 8 watershed boundaries, which closely coincide with the ecoregion boundaries in each region. The use of watershed boundaries will facilitate organization and identification of aquatic resource projects. The exception was the Connecticut River service area, for the reasons discussed below.

DFG's larger, but geographically distinct, service areas will not only offer a greater array of potential mitigation opportunities, but will allow DFG to identify habitat protection, restoration, establishment, and enhancement projects that are most closely associated with impacts to specific habitat types. This approach helps ensure that resource-specific impacts are mitigated most effectively without artificial constraints.

Figure 1. The Four ILFP Service Areas



The *Berkshire/Taconic* Service Area is dominated by unfragmented, mixed hardwood forests of the Taconic Mountains and the Berkshire Plateau and associated wetlands and calcareous fens. The Housatonic, Farmington and Hoosic Rivers are the major watersheds within the service area and are part of the Western New England Marble Valley Ecoregion. There are significant floodplain forests along the Housatonic River and its tributaries and an abundance of high gradient, cold water streams that support an array of fluvial dependent species such as Eastern brook trout. Natural lakes and ponds are abundant, especially in the lower Berkshire Hills.

Goals and Objectives Specific to the Berkshire / Taconic Service Area:

- Protect DFG-identified "focus areas" that are located within this Service Area, which have been selected based on their character as high quality, riparian, palustrine habitats, as diverse natural communities, and/or as habitats of wildlife species, including state-listed species protected under MESA (which incorporates federally-listed species);

- Support efforts that increase fish passage in rivers that drain directly to high quality coldwater streams;

- Restore habitat continuity in high quality stream reaches by removing dams and replacing culverts with those that meet MassDEP stream standards;

- Protect high quality wetlands and land around those wetlands, including but not limited to calcareous fens and riverine wetlands such as oxbows and remnant channels; and

- Restore degraded wetlands that are adjacent to high quality wetlands.

The *Connecticut River Service Area* encompasses the entire Massachusetts portion of the 410-mile-long Connecticut River, New England's longest river. Within Massachusetts there are 65 miles of mainstem river habitat that run almost due north/south. The mainstem river habitats are characterized by wide, low gradient streambeds meandering through broad river valleys with extensive flood plains. Soils are rich from a long history of periodic inundation, these floodplains contain a mix of wetlands and uplands, the wide floodplains are utilized primarily for agriculture.
Significant aquatic species include the Dwarf Wedgemussel, Yellow Lampmussel, and Eastern Silvery Minnow.

DFG modified the boundary of the Connecticut River Service Area from the one proposed in the Prospectus to include the lower portions of the Green, Deerfield, Millers, Westfield, and Chicopee watersheds that fall within the Connecticut River Valley ecoregion. These four additional areas, as shown in **Figure 2** below, are distinct from the higher elevations of each of these watersheds. They and the aquatic resources contained within them are more similar to the rest of the Connecticut River Valley, both in flora and fauna.

Goals and Objectives Specific to the Connecticut Service Area

- Protect DFG-identified "focus areas" that are located within this Service Area, which have been selected based on their character as high quality, riparian, palustrine habitats, as diverse natural communities, and/or as habitats of wildlife species, including state-listed species protected under MESA (which incorporates federally-listed species);

- Support efforts that increase fish passage in rivers that drain directly to high quality coldwater streams;

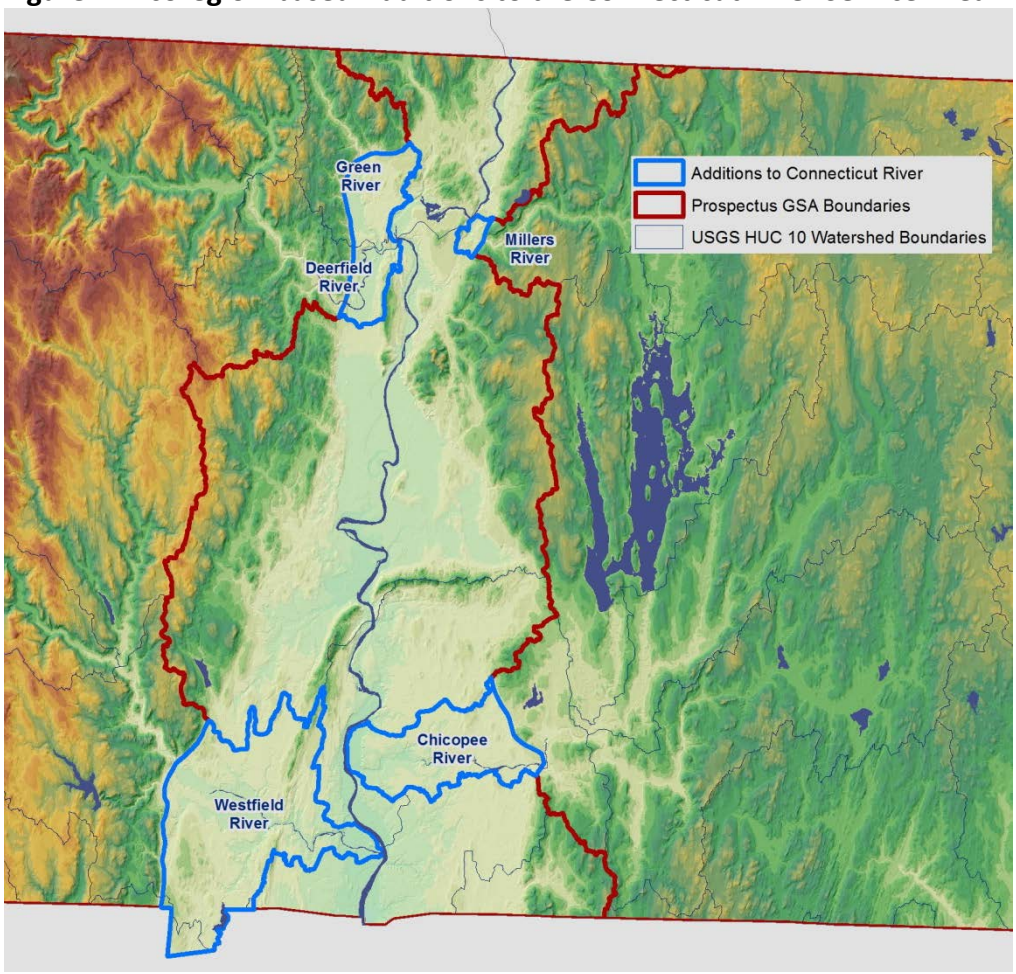
- Restore habitat continuity in high quality stream reaches by removing dams and replacing culverts with those that meet MassDEP stream standards;

- Protect high quality wetlands and land around those wetlands;

- Restore degraded wetlands that are adjacent to high quality wetlands; and

- Restore riparian vegetated buffers in active agricultural lands.

Figure 2. Ecoregion-based Additions to the Connecticut River Service Area



The *Quabbin/Worcester Plateau* Service Area contains the largest freshwater body in Massachusetts, the Quabbin reservoir. The water surface of the reservoir is approximately 25,000 acres, and is surrounded by 81,000 acres of primarily forested watershed lands. Major watersheds in this service area include the Quinebaug, Chicopee, Millers, French, Nashua, Sudbury, Assabet, Concord and Blackstone Rivers. These rivers are fairly flat and support a diversity of warmwater species. Wetland plant communities include shallow beaver ponds, naturally acidic ponds and wet meadows.

The Worcester Plateau sub area is comprised primarily of gently rolling hills with occasional high monadnocks. Forests are transitional hardwoods with some northern hardwoods. Forested wetlands, such as Red Maple Swamps are common. Surface waters are primarily acidic.

Goals and Objectives specific to the Quabbin/Worcester Plateau Service Area

- Protect DFG-identified "focus areas" that are located within this Service Area, which have been selected based on their character as high quality, riparian, palustrine habitats, as diverse natural communities, and/or as habitats of wildlife species, including state-listed species protected under MESA (which incorporates federally-listed species);

- Support efforts that increase fish passage in rivers that drain directly to high quality coldwater streams;

- Restore habitat continuity in high quality stream reaches by removing dams and replacing culverts with those that meet MassDEP stream standards;

- Protect high quality wetlands and the land around those wetlands;

- Restore degraded wetlands that are adjacent to high quality wetlands; and

- Restore riparian vegetated buffers in active agricultural lands.

The *Coastal* Service Area extends three miles seaward from the shore to the Massachusetts jurisdictional limit, and is divided into three subareas based on distinct differences in watershed types, climates, and ocean circulation patterns. Cape Cod acts as a divide between two biogeographic regions, the Gulf of Maine, and the Southern New England – New York Bight systems. The geophysical range of aquatic habitats for managed diadromous fish and marine finfish and shellfish species includes 16 watersheds with direct hydrographic connections to the coast.

The distinct ocean circulation patterns in the above subareas influence water temperature, water chemistry, and climate on a regional scale. Other factors influencing these subareas include coastal hydrology, bathymetry, and tidal fluctuations. Each subarea contains an array of diverse marine, estuarine, and riverine habitat types including salt marshes, barrier beaches, mudflats, riffles, eddy pools, eelgrass beds, estuaries, salt ponds, embayments, and rocky shores. There are measurable differences in the ecological functions of habitats within each subarea, including variations in species assemblages, and in the timing and duration of different life history stages of many species.

The North Coastal service subarea extends from the coastal boundary at the New Hampshire border to Cohasset and includes Plum Island Sound (includes the Great Marsh), Cape Ann, Salem Sound, and Boston Harbor. The entire region is within the Gulf of Maine

watershed. All or parts of the Merrimack, Parker, Ipswich, Shawsheen, North Coast, Concord, Mystic, Charles, Neponset, and Weir watersheds are located in this region.

The Central Coastal service subarea is comprised of the south shore, Cape Cod Bay, and the easternmost extent of Cape Cod. The majority of this region also lies in the Gulf of Maine, except for the eastern extent of Cape Cod. This region contains the entire South Coastal watershed and the northern extent of the Cape Cod watershed that drains into the Gulf of Maine. The boundary between the North and Central service subareas divides two distinct Major Watersheds: the Weir and the South Coastal. These and other Major Watersheds, in turn, were defined by USGS' Water Resources Division and the Massachusetts Water Resources Commission. Consistent with the Mitigation Rule, DFG used the Major Watersheds as a basis for defining its service areas. The exception to this approach was the Cape Cod Major Watershed, which DFG divided based on drainage. DFG decided against dividing the South Coast Major Watershed and instead established the boundary of its North and Central service subareas between the Weir and South Coast Major Watersheds.

The South Coastal service subarea extends from the Massachusetts/Rhode Island coastal boundary east to Monomoy Island and includes Mount Hope Bay, Buzzards Bay, Nantucket and Vineyard Sounds, the Elizabeth Islands, and the south facing coast of Cape Cod, east to Pleasant Bay. The entire subarea is located within the Southern New England - New York Bight system. All or parts of the Buzzards Bay, Taunton, Mount Hope Bay, Narragansett Bay, and Islands (Martha's Vineyard and Nantucket) watersheds are located within this subarea. This subarea also contains the southern portion of the Cape Cod watershed that drains exclusively into the Southern New England – New York Bight region.

Goals and Objectives Specific to the Coastal Service Area:
Located in the most populous region of the state, the MA ILFP Coastal Service Area is the largest of the service areas and includes 16 watersheds with direct hydrographic connections to the coast.

The specific ILFP goals and objectives for the Coastal Service Area objectives are as follows:

- To identify and pursue opportunities to restore priority coastal resources and habitats;

- Support restoration projects in coastal areas that facilitate coastal wetland migration to adapt to climate change and sea level rise;

- Support efforts that increase fish passage in rivers that drain directly to the ocean and in high quality coldwater streams;

- Support coastal habitat connectivity;

- Support protection, restoration or enhancement opportunities near high quality habitats that improve coastal aquatic resource functions and values;

- Address point sources (e.g., culvert replacements) and nonpoint sources (e.g., low impact development techniques) that reduce nitrogen loading to coastal waters;

- Acquire land and conservation easements to preserve important coastal habitats and coldwater streams;

- Protect high quality wetlands and land around those wetlands; and

- Restore degraded wetlands that are adjacent to high quality wetlands

C. *Description of Threats*

For the purposes of the Instrument, the term "threats" is broadly defined as a range of direct and indirect adverse effects that alter or modify physical, chemical, or biological environments. There is a wide range of threats to the aquatic resources of Massachusetts, including but not limited to:

- loss or alteration of wetland resource areas;

- loss of adjacent upland buffers;

- loss, degradation, and/or fragmentation of aquatic and wildlife habitats;

- stormwater discharges and low flow conditions that adversely affect water quality and fisheries resources in estuaries, rivers and streams;

- road, rail crossings, dams and other structures that block flow or impede fish and wildlife passage resulting in temporal shifts/losses in community structure;

- agricultural impacts from nonpoint source runoff, pesticides, soil degradation, sedimentation and erosion; and

- climate change related impacts including sea-level rise, ocean acidification, shifting habitats, biodiversity loss, and frequency and intensity of extreme weather events.

Threats to aquatic resources are inherently complex because of the longitudinal (up and downstream) and lateral (to their floodplains and adjacent uplands) connections of aquatic systems. In addition these systems are impacted by subsurface flows (Massachusetts Comprehensive Wildlife Conservation Strategy, 2006).

DFG's ILFP will assess and prioritize the impacts from various types of anthropogenic threats to coastal and inland aquatic resources within a particular service area. These impacts will be addressed through a compensatory mitigation strategy that is directed at effectively remediating the threats and/or protecting the aquatic resource and the

surrounding landscape from future threats to their ecological sustainability. The threats to coastal and inland resources are more specifically set forth below.

D. *Coastal Resources*

In the coastal/marine environment, threats to aquatic resources can range from temporary disturbances of resident marine life to permanent alterations of benthic habitats. Alterations to coastal habitats can be exacerbated by human impacts occurring at different times and scales. Impacts from these threats can take decades to be fully understood. For example, studies of Cape Cod salt marshes have found that mosquito ditching activities that occurred in the 1930's has interacted synergistically with increasing shoreline development and recreational fishing pressure to deplete low salt marsh habitat, inhibiting marsh persistence and expansion (Coverdale et al. 2013). Many aquatic resource threats have been identified for both the terrestrial and marine environments. Threats specific to the coastal resource realm in Massachusetts, including coastal development, habitat loss and fragmentation, altered hydrologic regimes, pollution, climate change, and sea level rise are described here in further detail.

Coastal Development:

Population rates in coastal service areas continue to increase. Coastal counties in Massachusetts have seen more than a 30% increase in population since 1960. Population densities for Massachusetts' coastline counties rank third highest in the nation, behind only New York and New Jersey (US Census Bureau, 2008). Coastal development contributes to aquatic habitat degradation by infringing upon coastal wetlands and buffers, accelerating coastal erosion, and hardening of shorelines. As coastal populations increase, accelerated threats to coastal habitats from commercial and recreational uses of coastal resources are also expected to continue. In response to these increases, resource agencies responsible for coastal development will need to balance the environmental and economic importance of aquatic habitats with the pressures of coastal development. This will require new and innovative solutions for preserving, restoring, and enhancing coastal habitats.

Habitat Loss and Fragmentation:

Land use conversion from natural habitats into residential and commercial subdivisions, roads, and other uses reduce both aquatic habitat quantity and quality. Activities that contribute to habitat loss and fragmentation include dock and pier construction, dredging and dredge material disposal, obstruction of water bodies and streams, pipe and cable installations, shore protection (beach fill, sea walls, groins, and bulkheads), water extraction, and sewage disposal. Historically, habitat loss and fragmentation resulting from common nearshore and in-water development of coastal aquatic habitats in Massachusetts have resulted in:

- Habitat alterations (removal, burial, replacement with structures, shading, habitat conversions) of aquatic habitats;
- Changes in water flow and sediment transport;
- Changes in water quality;
- Direct mortality of aquatic habitat types and the species that rely upon them;
- Disruption of feeding and/or respiration;

- Disruption of passage or aggregation;
- Disruption of important life history stages of important aquatic species
- Entrainment of larvae;
- Sediment and contaminant resuspension;
- Establishment and spread of invasive species
- Water table drawdown

Altered Hydrologic Regimes:
Increasing impervious surfaces, increasing water withdrawals, wastewater discharges, and impediments to river and stream flow (i.e. dams and culverts) created during land development and use can alter hydrologic regimes and impede or sever aquatic habitat connectivity. Many hydrologic changes that also impact flow rates, temperature, and water clarity are discussed in more detail below under Inland Resource threats section. However, there are some noteworthy threats relative to the coastal service area that will be addressed in this section.

The Cape Cod aquifer is the principal source of drinking water for Cape Cod. According to a study by the United States Geological Survey, continuous water withdrawal from the aquifer at the average year-round rate and average summer rate decreases the freshwater discharge to the wetland and ocean along the northeastern boundary of the aquifer. (LeBlanc, 1982). This, in conjunction with climate change and sea level rise, has the potential to threaten the aquatic resources critical to the sensitive coastal ecosystems of the region. The Cape Cod aquifer is also highly susceptible to contamination from sewage and other contaminants (i.e. heavy metals and nitrates) which could create a significant public health hazard according to the US EPA. Approximately 85% Cape Cod's wastewater originates from on-site septic systems. Properly functioning septic systems reduce the release of solid waste, however, chemical contaminants such as nitrogen, passes readily from the septic leach fields into the ground. These contaminants eventually enter the groundwater and discharge into coastal embayments, threatening water quality.

Water Pollution:
Riverine discharges of nitrogen to coastal waters are reported to have increased 5-20 times since pre-industrial times due primarily to increased human population and atmospheric deposition (Carpenter et al. 1997). Elevated nutrient levels (nutrient loading) can result in excessive algal growth (causing harmful algal blooms), decreased light penetration, low concentrations of dissolved oxygen, and loss of desirable flora and fauna. Municipal waste from urbanized coastal areas in MA are significant nutrient sources to the marine environment.

Climate Change:
Climate change impacts are predicted to have profound effects on the economy, public health, water resources, infrastructure, coastal resources, and natural features in Massachusetts. Predicted climate related impacts include alterations to aquatic species distributions, migration patterns, and productivity, changes to weather patterns and ocean current circulations, shoreline change and near-shore habitat loss resulting from sea level rise, ocean acidification and impacts on important shellfish populations, changes in the

frequency and intensity of storm events across the region, and exacerbation and facilitation of invasive species colonization and dispersal.

Sea Level Rise:
Sea level rise is projected to rise by several feet along the coast by the end of the century, leading to increases in the extent and frequency of coastal flooding and erosion. Many areas where inland coastal habitat migration might take place are blocked by existing dense coastal development. *BioMap2* estimates that only 34,500 acres remain of low-lying undeveloped coastal upland that lies directly adjacent to existing salt marsh and dune ecosystems (BioMap2, 2010, DFG/TNC).

While the habitat threats resulting from climate change and sea level rise impacts are not fully understood, DFG continues to work with EEA and other state environmental agencies on strategies to address climate change. In 2008, the Massachusetts Legislature passed The Global Warming Solutions Act, directed the Secretary of Energy and Environmental Affairs (EEA) to convene an advisory committee to develop a report, analyzing strategies for adapting to the predicted changes in climate. This report is available online at: *http://www.mass.gov/eea/air-water-climate-change/climate-change/climate-change-adaptation-report.html*

E. *Inland Resources*

Land use in the Commonwealth, from intensive agriculture in the post-colonial period, to heavy industrialization, to today's continued, sprawling suburbanization, has negatively impacted the great majority of Massachusetts freshwater ecosystems.

More specifically, in examining the indicators of stream and freshwater habitat degradation the above referenced 2010 USGS report discussed the historic impacts to and stressors on our state's aquatic resources:

> "Massachusetts streams and stream basins have been subjected to a wide variety of human alterations since colonial times. These alterations include water withdrawals, treated wastewater discharges, construction of onsite septic systems and dams, forest clearing, and urbanization—all of which have the potential to affect streamflow regimes, water quality, and habitat integrity for fish and other aquatic biota" (Weiskel et al., 2010).

The report identifies impervious cover, water withdrawals, and dams and other barriers as major stressors to freshwater ecosystems. The report also highlighted the widespread character of these impacts, noting that "about 18 percent of Massachusetts sub-basins and contributing areas are highly developed, with a local impervious cover greater than 16 percent" (Weiskel et al., 2010).

More recent USGS reports found both water withdrawals and impervious cover to be tightly correlated with stream degradation as measured by fish diversity and fish type. A 2011 USGS report found that "as percent impervious cover and an indicator of percent

alteration of August median flow from groundwater withdrawals increase, the relative abundance and species richness of fluvial fish decrease" (Armstrong et al., 2011).

This body of research supported the efforts of the Sustainable Water Management Initiative ("SWMI"), created by the Massachusetts Executive Office of Energy and Environmental Affairs ("EEA") in 2010, with the participation of DFG, the Department of Environmental Protection ("DEP"), the Department of Conservation and Recreation ("DCR") and a wide range of other stakeholders. The primary goals of SWMI are to develop a sustainable approach to managing the Commonwealth's water resources that properly balance ecological and human needs. This sustainable water management approach, in turn, will inform DEP's implementation of M.G.L. c. 21G, the Water Management Act, which regulates water withdrawals in Massachusetts.

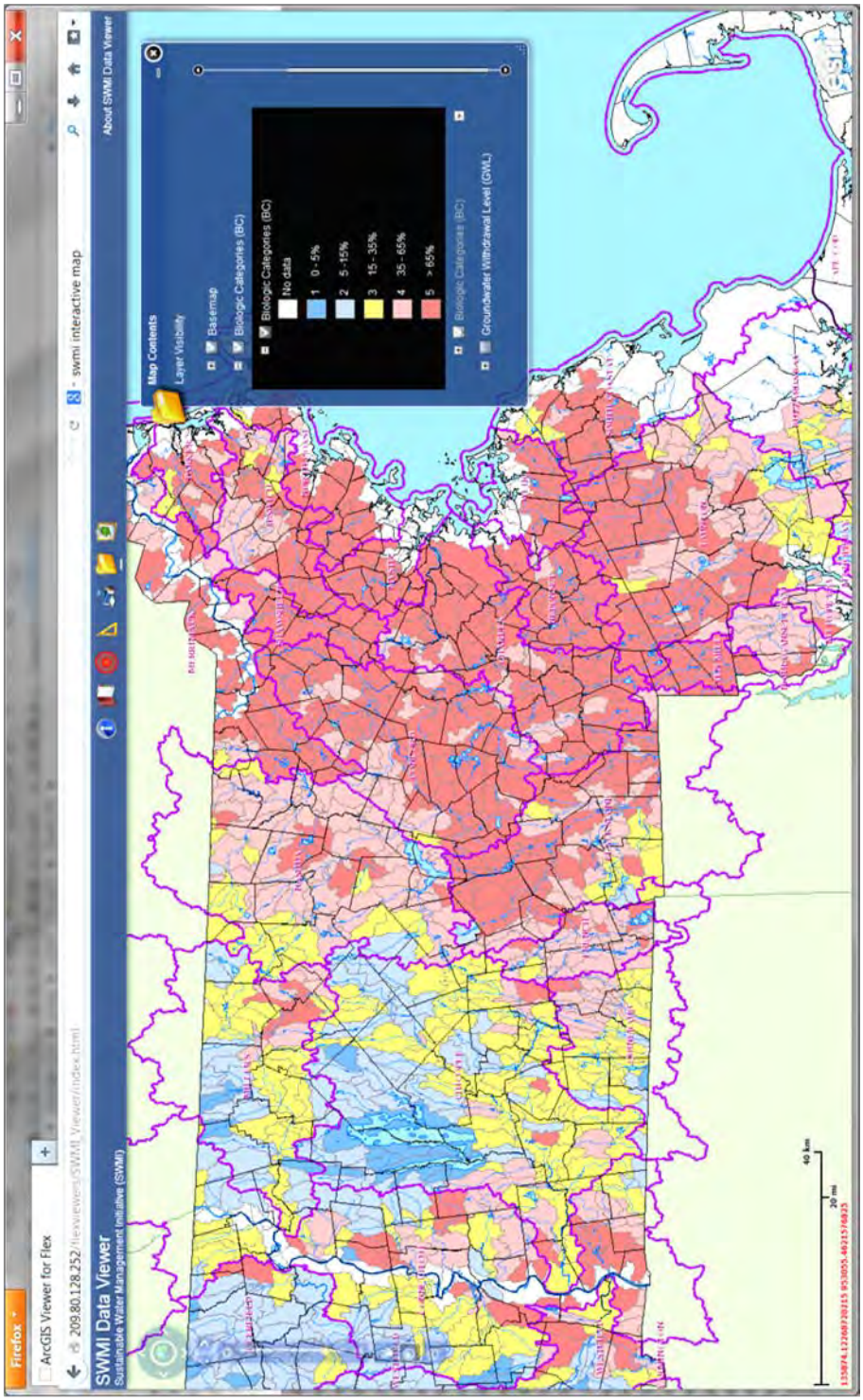
A key work product of SWMI was the November, 2012 publication of the *Final Framework Summary for the Massachusetts Sustainable Water Management Initiative*, which provides recommendations on the development of a regulatory approach that includes a classification of the ecological health of water sources and streamflow criteria to maintain the magnitude and timing of the natural flow regime seasonally and at a subbasin scale to protect aquatic habitats. SWMI also developed tools that allow mapping of the distribution of threats to aquatic systems and the species that reside in them. Specifically, the online SWMI interactive map tool (http://www.mass.gov/dep/water/resources/swmi.htm) categorizes the state's sub-basins into five Biological Categories that fall along a continuum of impact from human alteration. Biological Category 1 represents high quality aquatic habitats that are relatively unaffected by human alteration, while Category 5 represents highly altered aquatic habitats, as evidenced by fish communities that have undergone severe changes to their structure and function. This viewer also identifies the coldwater fisheries resources present in Massachusetts.

A screen shot of the online SWMI viewer depicting the Biological Categories of the state's sub-basins is shown in **Figure 3** below.

The extent of the state that is within Biological Category 3 (yellow), Biological Category 4 (pink), and Biological Category 5 (red) is alarming. Watersheds in Biological Category 3 likely contain fish communities that have exhibited considerable change in the structure of the fish community. Sensitive species may still be maintaining populations but at considerably reduced abundances. As noted above, watersheds in Biological Categories 4 and 5 are even more severely degraded. This tool underscores the need for a mitigation approach that prioritizes the permanent protection of aquatic habitats that are under serious threat from a variety of environmental stressors.

In terms of the implementation of the ILFP, the data and tools developed as part of SWMI will allow the spatial delineation of threats to aquatic resources and habitats to be identified and integrated into the mitigation project prioritization strategy, as discussed in more detail below.

Figure 3. The SWMI Interactive Map Tool Depicting the Biological Categories by Sub-basin



Another measure of threats to freshwater ecosystems is the statewide water quality sampling results. The USGS' review of DEP's stream assessments found that in 2002, "more than 50 percent of the assessed stream miles were considered impaired" (Weiskel et al., 2010). These impairments to streams are due to a wide range of threats, many of which are attributable to non-point source pollution, which itself is exacerbated by loss of buffer zones, increased impervious effective area, and development of sensitive lands such as headwaters and riparian corridors.

Aquatic ecosystem barriers such as dams, culverts, and dikes also fragment these habitats and interrupt essential ecosystems processes such as the transfer of nutrients and passage of aquatic species. The scope of the problem is evidenced by the approximately 3,000 dams and 30,000 culverts located in Massachusetts. Most, if not all, of these dams present a barrier to uninterrupted fish and other aquatic organism passage, degrade water quality, and alter native communities. Moreover, inventories conducted by DER and its partners determined that at least 50% of the 30,000 culverts are undersized and found to be a significant barrier to aquatic species passage.

The effects of climate change will continue to degrade both coastal and inland habitats through altered hydrologic regimes, increased temperatures, and incursions of new invasive species. More specifically:

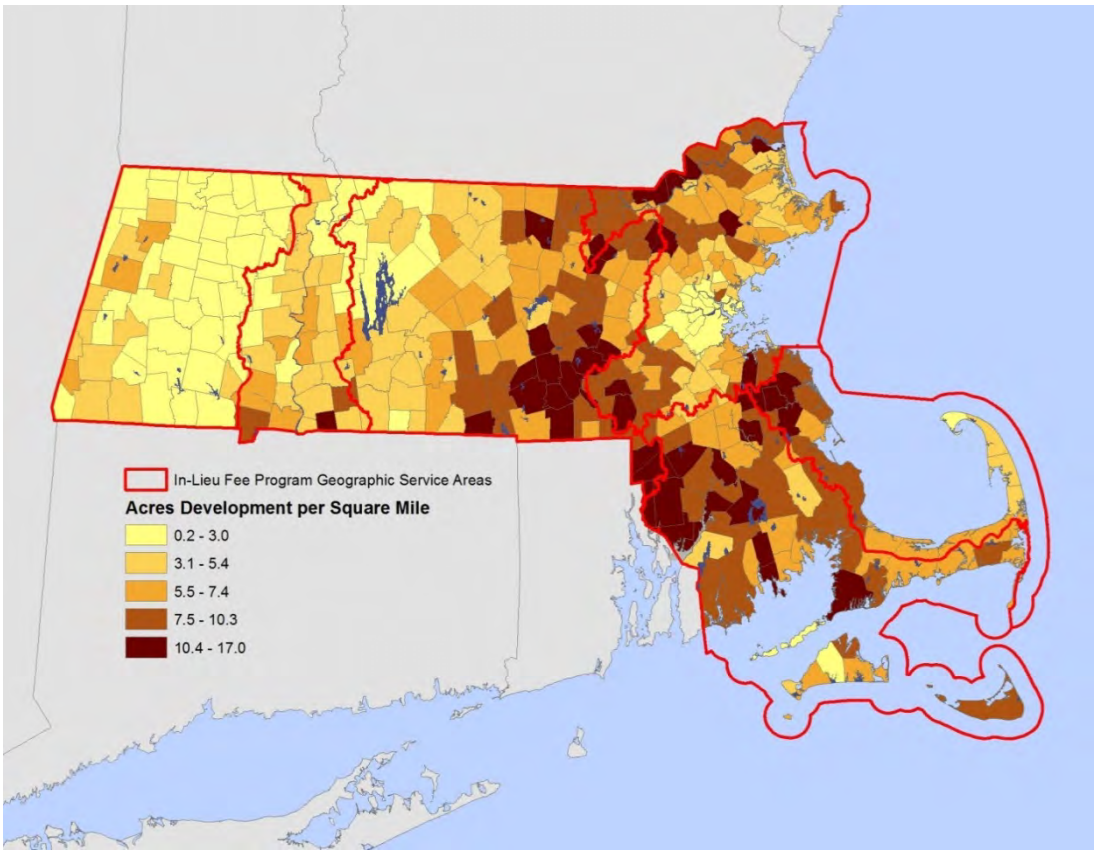
- Average temperatures across the Northeast have risen more than 1.5 degrees F since 1970, with winters changing most rapidly, warming 4 degrees F between 1970 and 2000. Temperatures in Massachusetts may rise between 6 -14 degrees F by the end of the 21st century (BioMap2, 2010, DFG/TNC).

- Heavy rainfall events have also increased measurably in recent decades across the Northeast. The frequency and severity of such events are expected to rise further, resulting in more frequent flooding. Winter precipitation is predicted to increase by 20 to 30 percent, with more of that falling as rain than has been historically the case. During the summer months, increased frequencies of short term droughts are expected (BioMap2, 2010, DFG/TNC).

- Climate scientists expect that warmer and wetter conditions in the Northeast will cause more high-flow events (flooding) in winter, earlier peak flows in spring, and more prolonged low-flow periods in summer. These changes, combined with an increase in water temperatures, are expected to diminish cold-water refugia critical to species such as brook trout (Frumhoff et al., 2007).

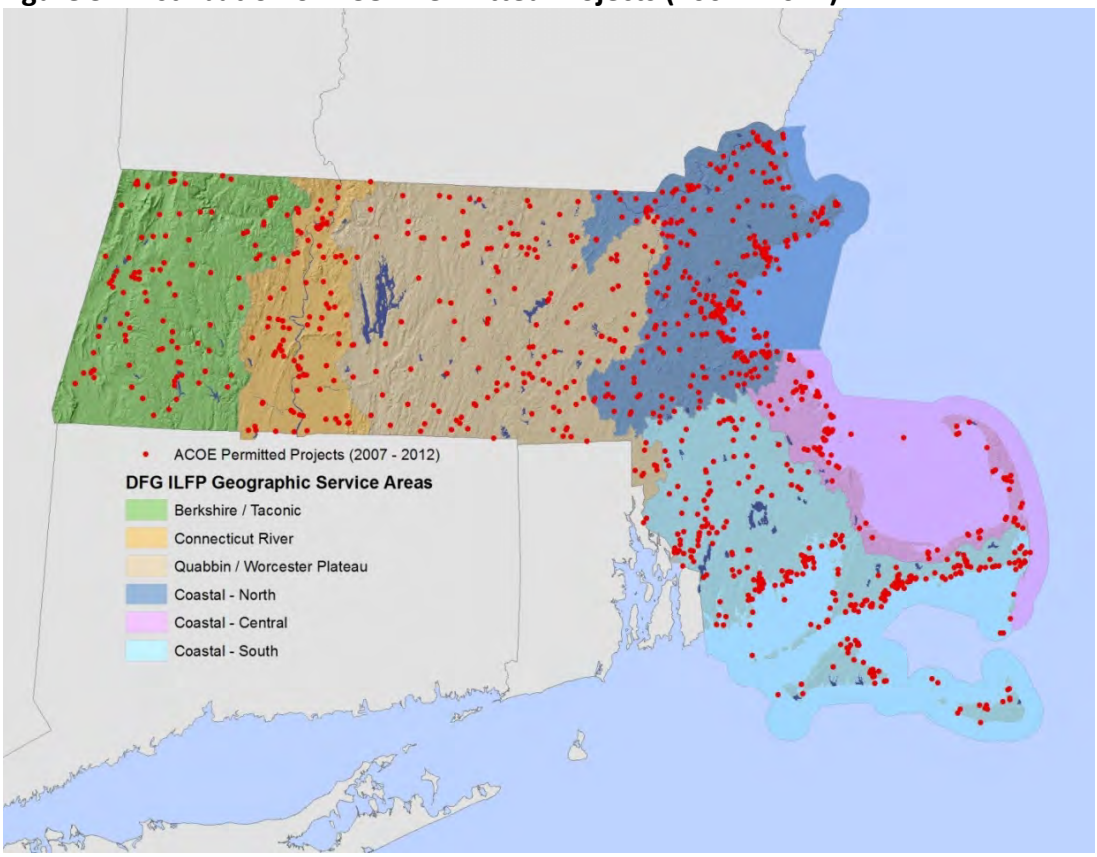
In short, as Massachusetts continues to be developed, with accelerated growth concentrated in areas such as the southeast coast and metro-west (portions of the Coastal and Worcester plateau bio-regions), we will continue to see habitat loss and stream degradation. Climate-associated threats will likely magnify current impacts, further stressing Massachusetts' freshwater, marine and estuarine ecosystems.

Figure 4. Acreage of Land Conversion Per Square Mile in Massachusetts Municipalities Between 1999 and 2005



While impervious cover and flow alteration tends to be greatest in areas with long-standing development, another threat exists in those less developed areas where residential construction is taking place at the highest rates. As referenced earlier, the widening "sprawl frontier," identified in the 4th edition of Mass Audubon's *Losing Ground Series* (DeNormandie et al., 2009) tends to be in the less developed areas of Massachusetts. To illustrate this threat, **Figure 4** above shows the rate of conversion from natural to built land uses in the towns of Massachusetts from the *Losing Ground Series*. Note that municipalities in the Greater Boston Harbor area are already heavily developed and therefore have lower amounts of *conversion* of natural to built land uses, which accounts for lower number of acres of *new* development in these densely populated areas.

Figure 5. Distribution of ACOE Permitted Projects (2007 - 2012)



Finally, **Figure 5** above depicts the location of projects permitted by the Corps from 2007 to 2012, which further illustrates the broad geographic distribution and density of threats to the aquatic resources across Massachusetts. See also **Table 1** below. This distribution of ACOE-permitted impacts by service area was also the basis for determining the amount of Advance Credits under this ILFP.

VI. Analysis of Historic Loss and Degradation of Resources

Since the European settlement began nearly four centuries ago, the Massachusetts landscape has experienced a series of changes caused by human activities that have eliminated, altered or threatened the existence or quality of inland and coastal aquatic resources in the state. As highlighted above, depending on the time in history and the geographic area, aquatic resources across the state have been, to differing degrees, used, impacted or otherwise affected by agricultural activities, industrialization, the development of infrastructure (such as roads and highways, dams, bridges and culverts), and sprawl caused by the establishment of cities, towns and suburban residential and commercial development. These activities have caused habitat loss and fragmentation, alterations to hydrologic resources, degradation of water quality from point and non-point sources of pollution, including nutrient enrichment, and the spread of invasive species and plants – all of which negatively impact aquatic resources, and functioning, directly and indirectly.

More specifically, one-third of wetlands in Massachusetts have been lost to filling and alteration. Thousands of acres of coastal marshes are impacted by road and rail crossings that block flow of ocean tides or impede fish and wildlife passage. As underscored by SWMI, a growing number of rivers and streams, especially in eastern Massachusetts are impacted by low flow. Urban sprawl and development pose a continued and growing threat to river and wetland health, as illustrated in **Figure 4** above. Over 3,000 dams fragment and degrade our rivers and there are an estimated 30,000 culverts statewide. Finally, climate change is expected to further stress the ecological integrity and health of the Commonwealth's aquatic resources.

To understand the scope of impacts underlying the distribution of ACOE-permitted projects depicted in **Figure 5** above, between 2007 and 2012 there were over 15 million square feet of impacts to aquatic resources and roughly 276,000 linear feet of impacts to rivers/streams from these projects. **Table 1** below further breaks down the impacts by resource type and geographic service area.

Table 1. Corps Permitted Project Impacts (2007 - 2012)

Acres of resource impacted by permitted projects (2007-2010) by service area or sub-area

Resource Type	Berkshire Taconic	Connecticut River	Quabbin/Worcester Plateau	Coastal – North Sub-Area	Coastal – Central Sub-Area	Coastal – South Sub-Area	Coastal	
Harbor/Ocean				3.6	1.6	11.2	16.4	16.4
Lake	0.5	2.7	1.3	0.0		0.1	0.1	4.6
Non-Tidal Wetland	19.8	11.8	20.7	26.1	0.5	15.9	42.5	94.9
Other		0.1	0.1	20.4	15.0	10.0	45.4	45.6
Pond	5.3	7.7	9.2	9.2		0.8	10	32.1
River/Stream	1.6	5.5	2.9	6.3	0.6	3.7	10.6	20.6
Stream/River/Ocean	2.7	8.3	2.8	12.4	2.5	100.6	115.5	129.1
Tidal Wetland	0.0		-	2.4	0.5	1.7	4.6	4.7

Linear feet of resource impacted by permitted projects (2007 - 2012) by service area

Resource Type	Berkshire Taconic	Connecticut River	Quabbin/Worcester Plateau	Coastal – North Sub-Area	Coastal – Central Sub-Area	Coastal – South Sub-Area	Coastal	
Harbor/Ocean				9.8	-	67,000.1	67009.9	67,010.0
Lake	-	-	-	-		-	0	-
Non-Tidal Wetland	-	-	4,260.0	19,685.0	-	3,600.0	23285	27,545.0
Other		-	198.0	-	-	11,407.7	11407.7	11,605.7
Pond	650.0	-	-	-		-	0	650.0
River/Stream	4,297.3	272.0	321.0	153,981.4	-	-	153981.4	158,871.8
Stream/River/Ocean	1,443.0	60.0	481.0	130.0	8,057.0	650.0	8837	10,821.0
Tidal Wetland	-		-	-	-	-	0	-

DEP's Wetlands Conservancy Program is an additional source of information on wetlands change in the Commonwealth. Originally derived from aerial, digital orthophotographs taken throughout the 1990s, DEP's Wetlands Change datalayers capture changes to the wetlands in Massachusetts. DEP mapped the wetlands changes detected in this succession of aerial photographs and assessed the driver of the changes to the wetlands. DEP

subsequently updated these datalayers in 2001-2003, 2005, and 2008-2009. DEP determined that over 1,700 acres of changes were detected to the original wetlands. **Table 2** below summarizes the probable range of activities that caused the changes to the wetlands.

Table 2. Activities Resulting in Wetlands Change (1990s to 2000s)

Photo-interpreted Change Type	Acres
Residential Development	417
Cranberry Bog Activity	299
Commercial Development	226
Other	189
Clearing Unknown Reason	146
Agriculture	132
Gravel Operation	105
New Road	78
Transportation Infrastructure	50
Logging/Clearing	47
Filling Unknown Reason	14
Driveway	1
Flooding	1
Dock or Pier	1

As shown above, residential and commercial developments are the drivers of almost 40% of these wetland changes. Cranberry bog activity accounts for an additional 18% of the wetland changes. A range of other activities, such as road/transportation construction, agriculture (other than cranberry bogs), and gravel operations, account for another 25% of these changes. Finally, 20% of the changes are due to unknown and other reasons.

DEP's "Wetlands Update 2011" is based on a re-mapping of all the wetlands in Massachusetts using 2011 imagery and documents the change in wetlands between the 1990s and 2011 imagery. While this latest update is not reflected in Table 1, it is expected to show there has been additional loss or changes to wetlands between the two time-steps.

In addition to assessing wetland habitat impacts, DEP began an Eelgrass Mapping and Monitoring Program in 1994 to define the areal extent of the eelgrass resource statewide. DEP completed the following five phases of mapping efforts in this area:

1. 1995 – The entire Massachusetts coastline;

2. 2001 – The entire Massachusetts coastline, except for Billingsgate Shoals and the Elizabeth Islands;

3. 2006 - Selected Embayments on Cape Cod, Buzzards Bay and Martha's Vineyard;

4. 2010 - Selected Embayments on Cape Cod and Buzzards Bay; and

5. 2012 – The New Hampshire border south along the North Shore, Boston Harbor, and South Shore around to Provincetown

Following the 2006 mapping effort, DEP determined that only three embayments exhibited increases in eelgrass coverage while 30 of the original 46 embayments showed some indication of decline (Costello and Kenworthy, 2011). Waquoit Bay lost all of its seagrass during the mapping period (Costello and Kenworthy, 2011).

Research since the late 1980s has established a direct link between land-derived nitrogen loading through groundwater and sources such as septic tanks and the growth of macroalgae and the decline of *Z. marina* (Eelgrass) (Valiela and Costa 1988; Costa et al. 1992; Valiela et al. 1992; Hauxwell et al., 2003; McGlathery 2001; Fox et al. 2008). These studies also suggest that eelgrass can serve as an indicator of coastal environmental change associated with natural and anthropogenic disturbances.

The changes detected in the extent of eelgrass beds between 1995 and 2012 will be one of the considerations used by DFG to identify priority watersheds targeted for development of water quality remediation plans and formulation of conservation and restoration plans for eelgrass in impacted areas (Costello and Kenworthy, 2011).

Changes to coastal Massachusetts wetlands are representative of a growing national threat. According to a 2011 US Fish and Wildlife report (Dahl, 2011), collectively, marine and estuarine intertidal wetlands declined by an estimated 1.4 percent between 2004 and 2009. The majority of these losses (73 percent) were to deepwater bay bottoms or open-ocean. In addition, Dahl's report also identified noteworthy trends to other coastal aquatic habitat types. For example, from 2004 through 2009, intertidal emergent wetlands experienced a habitat loss rate more than three times higher than the previous rate loss calculated for the period between 1998 and 2004.

In short, the range and extent of historic aquatic resource loss in Massachusetts underscores the added value that a state-wide ILFP will provide toward achieving the goals and objectives for slowing or reversing the cumulative loss of aquatic resources in the state, as identified below.

VII. Analysis of Current Aquatic Resource Conditions

A key of the Comprehensive Planning Framework for DFG's ILFP is to identify which areas of the state are currently most likely capable of supporting aquatic resource functions and habitats, as well as buffers and upland necessary to protect aquatic resources from degradation. This assessment of current aquatic resource conditions will, in turn, provide the scientific basis for priority setting for appropriate mitigation projects in each service area.

In term of the state's current aquatic resource conditions, there are:

- 27 major river basins in Massachusetts;
- Nearly 10,000 miles of perennial rivers and streams and an additional 3,800 miles of intermittent streams;
- Approximately 3,200 lakes and ponds with a combined area of 151,000 acres.
- Approximately 460,000 acres of wetlands (palustrine, riverine, and lacustrine).

Along the coast of Massachusetts, there are:

- Approximately 223 square miles of harbors and estuaries;
- More than 1,500 miles of coastline (MassDEP, Massachusetts Year 2012 Integrated List of Waters);
- Approximately 82,000 acres of estuarine wetlands (salt marsh, tidal flats, beaches, rocky intertidal shores); and
- An additional 43,000 acres of estuarine and marine open water systems (MassDEP, Massachusetts Year 2012 Integrated List of Waters).

Finally, the portion of the Coastal Service Area that extends off of the coast includes slightly more than 2,500 square miles of marine resources and open water systems (~1.6 million acres).

Another important source of information about the current aquatic resource conditions, is DEP's *Massachusetts Year 2012 Integrated List of Impaired Waters*, which identifies streams and surface water bodies that do not meet one or more of the designated uses (habitat for fish, other aquatic life and wildlife, and recreation). These listed impaired waters are monitored for physical, chemical and biological parameters and may have a total maximum daily load ("TMDL") for pollutants assigned to them by DEP. It is important to note, however, that DEP's list is not complete because there are water bodies in the state that have not been assessed or not fully assessed as to their compliance with all of the applicable water quality criteria. One clear finding from the above assessment process is that nonpoint source pollutants derived from stormwater runoff plays a major role in degrading water quality and preventing surface waters from attaining the designated use goals.

In terms of existing wetland resources in Massachusetts, DEP's data shows that are slightly more than 80,000 acres of estuarine habitat, 230,000 acres of lacustrine/riverine habitat, and slightly more than 460,000 acres of freshwater wetlands in Massachusetts. Estuarine resources contain a mix of important habitats including salt marshes, tidal flats, coastal salt

ponds, dune habitats, and beaches. **Table 3** below summarizes the acreage of wetlands by type and their location in the ILFP service areas.

Table 3. Wetlands and SAV Acreage by Resource Type in Each Service Area or Sub-Service Area

Resource Type	Berkshire / Taconic	Connecticut River	Quabbin / Worcester Plateau	Coastal North Sub-Area	Coastal Central Sub-Area	Coastal South Sub-Area	Coastal TOTAL	Statewide TOTAL
Submerged Aquatic Vegetation				162	989	2681	3832	**3832**
Estuarine, Intertidal, Emergent *				19,987	15,089	10,257	45,333	**45,333**
Estuarine, Intertidal, Rocky Shore				582	151	458	1,191	**1,192**
Estuarine, Intertidal, Unconsolidated Shore **				9,384	15,216	11,039	35,639	**35,638**
Lacustrine, Riverine (freshwater and estuarine not distinguished in DEP wetland data set)	18,633	14,573	71,614	35,825	12,448	74,964	123,237	**228,058**
Palustrine, Emergent	12,419	6,356	30,075	20,654	6,308	26,171	53,133	**101,982**
Palustrine, Forested	27,107	20,443	78,086	59,913	16,390	83,393	159,696	**285,332**
Palustrine, Shrub Swamp	14,445	6,005	23,020	14,382	4,593	14,697	33,672	**77,143**
Upland ***				2,566	5,626	5,657	13,849	**13,850**
	72,604	**47,376**	**202,795**	**163,455**	**76,810**	**229,318**	**469,583**	**792,360**

Massachusetts has nearly 9,000 miles of perennial streams and more than 3,500 miles of intermittent streams and rivers. Many of the state's smaller streams are located in the Berkshire/Taconic Service Area, while the larger Connecticut and Merrimack rivers flow through the Connecticut River Service Area and the Coastal-North Sub-area, respectively. The relatively flat, low-lying Coastal-South Sub-area contains the low-gradient Taunton River as well as associated large wetland complexes. **Table 4** below shows the number of miles of intermittent and perennial streams in each of the ILFP service areas.

Table 4. Distribution of Streams by Service Area or Sub-Area (from 1:25K hydrography layer)

	Stream Type	
Geographic Service Area	Perennial	Intermittent
Berkshire / Taconic	1,609	830
Connecticut River	970	344
Quabbin / Worcester Plateau	2,683	1,475
Coastal – North Sub-area	1,511	672
Coastal – Central Sub-area	448	52
Coastal - South Sub-area	1,337	409
Coastal	3,296	1,133
TOTAL	**8,557**	**3,781**

Vernal pools are ephemeral wetlands that fill annually, mainly in the spring, from precipitation, runoff, and rising groundwater. Most vernal pools become completely dry later in the season, losing their water to evaporation and transpiration over the summer.

This wet-dry cycle prevents fish from becoming established permanently and presents an important fish-free, if temporary, breeding habitat for many species. Vernal pools are found in all of the ILFP service areas, with a total of almost 29,000 statewide, 5,500 of which have been certified by DFW's Natural Heritage and Endangered Species Program. **Table 5** below shows the distribution of certified and potential vernal pools within the ILFP service areas.

Table 5. Distribution of Vernal Pools by Service Area or Sub-area

Geographic Service Area	Certified Vernal Pools	Potential Vernal Pools
Berkshire / Taconic	368	2088
Connecticut River	318	2028
Quabbin / Worcester Plateau	1867	9859
Coastal - North Sub-area	1817	6049
Coastal - Central Sub-area	306	1193
Coastal - South Sub-area	846	7648
Coastal	2969	14890
TOTAL	**5,522**	**28,865**

There are roughly 2900 known dams in the state, most privately owned and operated. Almost 1350 of them are not subject to state dam safety regulation due to their size, design, and ownership. Of the remaining dams that are subject to regulation (1545), 304 are classified by DCR as "high hazard", 727 as "significant hazard" and 514 as "low hazard" (Massachusetts Climate Change Adaptation Report, 2011). **Table 6** below shows the number of dams and river/stream crossings in each of the ILFP service areas.

Table 6. Number of Stream Dams/Crossings by Service Area or Sub-area

Service Area	Number of Dams	Number of River/Stream Crossings
Berkshire / Taconic	372	3006
Connecticut River	270	2342
Quabbin / Worcester Plateau	1164	7456
Coastal - North Sub-area	499	4803
Coastal - Central Sub-area	160	599
Coastal - South Sub-area	436	2761
Coastal	1095	8163
TOTAL	**2,901**	**20,967**

DFW has compiled a coldwater stream overlay that identifies coldwater stream resources throughout the state. It was delineated using the 1:100,000 National Hydrology Dataset available from USGS and therefore will not identify all coldwater stream resources. However, since it was consistently delineated statewide, it is useful when screening to identify coldwater resources that overlap other aquatic resources of interest. Identification and preservation of coldwater stream habitat is an important adaptation strategy identified in the Massachusetts Climate Change Adaptation Report (2011). **Table 7** below shows the number of coldwater streams in each of the ILFP service areas.

Table 7. Miles of Coldwater Streams Identified in Each Service Area

Geographic Service Area	Miles of coldwater streams
Berkshire / Taconic	1330
Connecticut River	474
Quabbin / Worcester Plateau	840
Coastal	175
TOTAL	**2819**

A. *Prioritization Tools Available to Assess Current Aquatic Resource Conditions*

Set forth below is a sampling of some of the GIS tools and models that are currently available for DFG's use when identifying and prioritizing aquatic resources in Massachusetts that are the most suitable for compensatory mitigation. It is not, however, intended to be a fixed or exclusive list of tools, models and data that will be used to prioritize and select compensatory mitigation projects. As a general operating principle, DFG will avail itself of the most updated or new tools, models, and information available when prioritizing aquatic resources for compensatory mitigation.

B. *BioMap 2*

BioMap2, published in 2010, is designed to guide strategies for biodiversity conservation in Massachusetts over the next decade. It focuses on the protection of and stewardship on those geographic areas that are most critical for ensuring the long-term persistence of rare and other native species, their habitats, exemplary natural communities, and a diversity of ecosystem types. The information in and analyses associated with BioMap2 will help set priorities within the statewide extent of aquatic resources types, identifying a more manageable subset of resources that are most critical to protect, manage, and/or restore. **Table 8** below shows the acreage of the range of BioMap2 resources by ILFP service area.

Table 8. Acreage of BioMap2 Resources by Service Area

	Berkshire / Taconic	Connecticut River	Quabbin / Worcester Plateau	Coastal – North Sub-area	Coastal - Central Sub-area	Coastal - South Sub-area	Coastal	TOTAL
BioMap2 Core Habitat	277,964	152,077	282,970	154,208	119,109	296,757	570,074	**1,283,085**
BioMap2 Wetlands	16,283	6,750	24,571	14,907	6,412	41,536	62,855	**110,459**
BioMap2 Upland buffers to wetlands	25,031	9,083	36,814	13,287	6,449	35,949	55,685	**126,613**
BioMap2 Aquatic Core	40,149	21,986	56,577	42,848	13,052	44,472	100,372	**219,086**
BioMap2 Upland buffers to aquatic cores	49,144	21,193	41,510	13,005	5,580	25,875	44,460	**156,306**
Coastal Adaptation Analysis	0	0	0	5,287	8,464	20,156	**33,907**	**33,907**

C. *DER Restoration Potential Model*

The DER Restoration Potential Model identifies dams that have a high impact on the environment but are located on otherwise healthy streams. Consequently, the removal of such dams would have an enhanced beneficial impact to the up and downstream segments. The model identifies the watersheds and sub-watersheds for each dam, and those watershed polygons were used to calculate indicators of the dam's impact on the environment. The factors considered in the DER Restoration Priority Model include:

- Connectivity (i.e., the extent of upstream and downstream miles surrounding the dam); Ecological integrity of the resources in question, which also involves consideration of data from BioMap2, the DFW Coldwater fisheries resources layer, watershed percent imperviousness, and August flow alteration); and

- Watershed position (i.e., the number of downstream dams, head of tide, and headwaters).

DER ran the model for approximately 2500 dams in Massachusetts and, based on the above considerations, produced a score associated with the dams. **Table 9** below identifies the distribution of the model-run dam scores by ILFP service areas.

Table 9. Distribution of Dam Scores in the DER Restoration Potential Model by ILFP Service Area

	Berkshire / Taconic	Connecticut River	Quabbin / Worcester Plateau	Coastal - North Sub-area	Coastal - Central Sub-area	Coastal - South Sub-area	Coastal	TOTAL
Lowest quintile	4	206	39	152	30	109	291	**540**
Second quintile	22	241	29	93	56	110	259	**551**
Third quintile	39	250	40	81	33	78	192	**521**
Fourth quintile	126	188	65	42	18	53	113	**492**
Top quintile	142	131	61	25	11	30	66	**400**

Note that in those ILFP service areas with less development, the dam scores are skewed towards the top quintiles, while the opposite is true in the more heavily developed in the Coastal Service Area/subareas. This model will help DFG prioritize those potential dam removal mitigation projects that will have the greatest restoration benefits for impacted aquatic resources.

D. *Habitat Protection Focus Areas*

At highlighted in the section on DFG's qualifications to be the program sponsor of an ILFP, DFG, in partnership with its DFW, has protected over 190,000 acres of land in Massachusetts, adding approximately 6,000 acres in 2010 alone. The primary goal of DFG's habitat protection strategy is to permanently protect land that contains larger ecosystems

with significant fish and wildlife resources. This focus, in turn, protects biological diversity of the state.

To that end, DFG's Lands Committee has identified specific "focus areas" within each of DFW's management districts, which are selected based on the consideration of the following land conservation objectives:

- To protect a diversity of the state's native species by protecting the habitats of species of management concern, including state-listed species, harvested species, and species associated with inter-jurisdictional initiatives (e.g., neotropical birds).

- To protect outstanding natural communities and a diversity of natural community types (e.g., limestone wetlands, floodplain forests, old growth forests, and vernal pools).

- To protect high-quality riparian, palustrine, and estuarine habitats (e.g., cold-water streams, major rivers, emergent marshes, and other wetlands).

Within each focus area, parcel-level information and the extent of existing protected land are taken into consideration, which allows for the identification of "core parcels" of interest that are prioritized for protection. DFG does not publicly identify these focus areas so it can undertake acquisitions in a manner that is protective of the Commonwealth's financial interests. **Table 10** below identifies the acreage of focus areas present in each of the ILFP Service Areas.

Table 10. Acres of DFG Focus Areas Present Within Each Service Area

Geographic Service Area	Acres
Berkshire / Taconic	236,923
Connecticut River	77,991
Quabbin / Worcester Plateau	125,030
Coastal – North Sub-area	36,493
Coastal – Central Sub-area	8,352
Coastal – South Sub-area	107,201
Coastal	152,046
TOTAL	**591,990**

E. *Critical Linkages Project*

The Critical Linkages project at UMass Amherst provides another useful tool to prioritize among the approximately 30,000 locations where aquatic resources are intersected by roads. Each crossing is given a score based on the improvement in the ecological integrity that would result if the crossing were replaced. This tool provides a way to prioritize among the thousands of potential projects by identifying those that would result in the greatest improvement of aquatic connectedness if a culvert/crossing were replaced. As with the dams, **Table 11** below shows that a high percentage of crossings with high

potential ecological benefits are located in low population ILFP service areas. These scores can then be used to compare crossing projects for their ecological benefits within a particular ILFP service area.

Table 11. Distribution of Scores in the Critical Linkages Aquatic Model by Service Area

	Berkshire / Taconic	Connecticut River	Quabbin / Worcester Plateau	Coastal - North Sub-area	Coastal - Central Sub-area	Coastal - South Sub-area	Coastal	TOTAL
Lowest quintile	649	434	1443	835	144	687	1666	**4195**
Second quintile	354	462	1436	1040	172	731	1943	**4195**
Third quintile	404	462	1546	1074	119	590	1783	**4195**
Fourth quintile	526	505	1539	1127	85	413	1625	**4195**
Top quintile	1073	479	1492	727	79	340	1146	**4190**
TOTAL	**3006**	**2342**	**7456**	**4803**	**599**	**2761**	**8163**	**20,970**

F. *Wetlands Assessment and Monitoring Program*

The Wetlands Assessment and Monitoring Program is a long-term partnership between DEP, CZM, and EPA. The program is developing cost-effective tools and techniques for assessment and monitoring of wetland and aquatic systems in Massachusetts. EPA advocates a three level approach to wetlands assessment and monitoring: 1) landscape level assessments, 2) rapid assessment methodologies, and 3) intensive site assessments. The partnership is initially focusing on the landscape and site level assessments.

The ***Conservation and Assessment Prioritization System ("CAPS")*** model is being used for the above referenced landscape level assessments. The CAPS landscape level assessment of aquatic systems is available statewide, integrating specific metrics for coastal and inland aquatic resource types. ***Site level assessment methods ("SLAMs")*** are being developed at the site-specific level. The program has also developed methods to produce ***Indices of Biological Integrity ("IBIs")*** for salt marshes, forested wetlands, and wade-able streams. Field efforts to validate these models have yielded information on at least 600 road-stream crossings and over 400 coastal and inland wetlands.

Information from the above projects has also been used to assist EPA in developing its ***Recovery Potential Assessment Tool***, which identifies impaired waters in Massachusetts with the greatest potential for ecological recovery.

VIII. Goals and Objectives

The overall goals and objectives of Massachusetts ILFP are summarized as follows:

- To address a real need in Massachusetts for an alternative to ACOE permittee-responsible, compensatory mitigation (whether on-site or off) that will result in a broad range of enhanced coastal and inland aquatic resource restoration,

preservation, establishment, and enhancement projects across the state. The goal of this ILFP is to substantially increase the scope and quality of restoration and protection of aquatic resources and their related buffers and uplands;

- To implement a compensatory mitigation strategy of prioritizing the permanent protection of priority areas containing high quality inland and in some cases coastal aquatic resources under threat of loss or adverse modification;

- To broaden the availability of the in-lieu fee mitigation option beyond the small-sized projects regulated under the ACOE's MA GP to cover the Individual Permits ("IPs") required for major projects by the ACOE;

- To establish an ILFP that utilizes and benefits from the existing technical expertise, the analytical tools and programmatic experience of DFG's three divisions, and its habitat protection and restoration programs;

- To expand the geographic reach and effectiveness of ILFP compensatory mitigation projects;

- To implement a comprehensive compensatory mitigation strategy within each service area and for all resource types that is based on a detailed analysis of the loss of and threats to specific aquatic resources with consideration of other watershed-scale stressors, the identification of land preservation focus areas and ecological restoration, establishment, and enhancement priorities ;

- To establish and administer a single expendable trust account in accordance with the Office of the State Comptroller regulations that will hold and track the in-lieu fees accepted and disbursed by Massachusetts ILFP in a manner that will meet the objectives and requirements of the Mitigation Rule; and

- To reduce the extent of cumulative adverse impacts to aquatic resources in Massachusetts.

IX. Establishment and Operation of the In-Lieu Fee Program

As noted at the outset of this Instrument, a state-wide ILFP will be administered by DFG as the Corps-approved program sponsor in accordance with this Instrument, which reflects the Corps' concurrence with the compensation planning framework set forth herein. Based on its application of this compensation planning framework, DFG will propose compensatory mitigation projects for approval by the Corps. ILFP compensatory mitigation projects will also be reviewed by an Interagency Review Team ("IRT") composed of representatives from the U.S. Environmental Protection Agency ("EPA"), the U.S. Fish and Wildlife Service ("USFWS"), the National Marine Fisheries Service ("NMFS"), the Massachusetts Department of Environmental Protection ("DEP") and the Massachusetts Office of Coastal Zone Management ("CZM"). The IRT will make a recommendation to the

Corps, as the final decision-maker, to approve or not approve each proposed mitigation project.

Through DMF's experience of administering the prior coastal ILFP, DFG understands and appreciates the consultative role of the IRT in providing input to the Corps and DFG on mitigation projects selected by DFG consistent with the compensation planning framework in this Instrument. DFG and its Divisions expect to have a proactive "seat at the table" to share their technical expertise and regional knowledge with the Corps and the IRT during the implementation of the ILFP authorized by this Instrument.

DFG has demonstrated experience in both permanently protecting and restoring aquatic resources in a range of contexts. This section summarizes the inland and coastal components of DFG's ILFP, which are based on established and successful programs of the relevant Division(s) and program(s). As discussed below, DFG's ILFP has the benefit of building on the existing mitigation expertise and experience in DFG/DFW's jointly administered land protection program, DMF's preceding coastal ILFP, and DER's portfolio of inland and coastal restoration projects

A. *The Habitat Protection Component of DFG's ILFP*

As highlighted in the overview of the compensation planning framework, the permanent protection of geographic areas containing aquatic resources, habitats and related buffers that are threatened or already adversely impacted will constitute the predominate form of inland compensatory mitigation under DFG's ILFP. As also noted in the above overview, habitat protection is also a potentially effective form of mitigation of impacts to coastal aquatic resources, but would not be used by DFG as mitigation on Commonwealth tidelands because such aquatic resources are already under the ownership of the Commonwealth.

DFG has a proven record of habitat preservation, as evidenced by the over 190,000 acres that it and DFW have permanently protected state-wide, including 6,000 acres in 2010 alone. The foundation for our success in this area includes a demonstrated ability to leverage additional land protection funds through long-standing partnerships with land trusts and other nongovernmental organizations. DFG already has a well established land acquisition process to identify potential parcels, including focus areas, employing the best available science and mapping technology, consideration of the larger landscape context, the long-term management requirements and comparison of the relative value of parcels. This process was specifically developed to be flexible and responsive to changing land protection priorities and needs (e.g., climate change adaptation), and is readily adaptable to the ILFP focus on protecting aquatic resources and buffer areas. Indeed, this preexisting, complementary framework will result in a more efficient and cost-effective use of the ILFP staff resources and funds.

Apart from its land protection activities, DFW in DFG has years of experience in evaluating and overseeing compensatory mitigation under the Massachusetts Endangered Species Act ("MESA"). Mitigation provided pursuant to MESA is for the purpose of offsetting impacts

of projects and activities that occur in priority habitat of state-listed species, including in wetland resource areas that serve as habitat for such species (i.e., estimated habitat, a subset of priority habitat). To that end, DFW utilizes mapping tools that delineate MESA-regulated habitats on a species-by-species basis, which has the following conservation planning benefits:

1. helps land protection plans focus on the actual habitat of rare species;

2. enables a more accurate assessment of the levels and kinds of protection that already exist for state-listed species habitats; and

3. helps identify which species are most in need of further habitat protection.

When DFW determines that a project or activity will cause a "take" of a state-listed species (which can result from the alteration of priority habitat), it can only be authorized under the MESA through the issuance of a conservation and management permit that provides for compensatory mitigation that results in a long term net benefit to state-listed species as a whole. A common means of providing the required net benefit mitigation is through the permanent protection of land that serves as habitat for the affected state-listed species. Under certain circumstances, MESA permittees are allowed to make a funding contribution to meet the net benefit mitigation standard, and subject to DFW's oversight, these funds are used to permanently protect off-site habitat for the affected state-listed species. In short, DFW's compensatory mitigation approach and implementation experience under MESA is readily transferrable to the ILFP framework and objectives.

DFG will draw on its in-house expertise and the key features of its established habitat protection programs when identifying, prioritizing and selecting proposed ILFP mitigation projects. DFG will also seek to integrate ILFP mitigation projects in this area with ongoing DFG habitat protection objectives and priorities in order to expand and maximize the resulting long-term benefit to aquatic resources. DFG has long-standing experience using a range of land protection mechanisms that satisfy ILFP mitigation requirements (e.g., fee acquisition by DFG, conservation restrictions held by DFG or a qualified third party). This habitat protection approach will complement and enhance the reach and beneficial effect of both DFG's ILFP and our ongoing habitat protection initiatives.

B. *The Restoration Components of DFG's ILFP*

While the above described habitat protection approach will be the predominant form of inland mitigation under the ILFP, DFG also intends to implement a significant amount of mitigation in the form of restoring inland and coastal aquatic resources. This will especially be the case for the marine/coastal component of the ILFP where the acquisition of a fee or property interest in coastal property is comparatively expensive, and in the case of Commonwealth tidelands, unnecessary because it is already held in trust for the public.

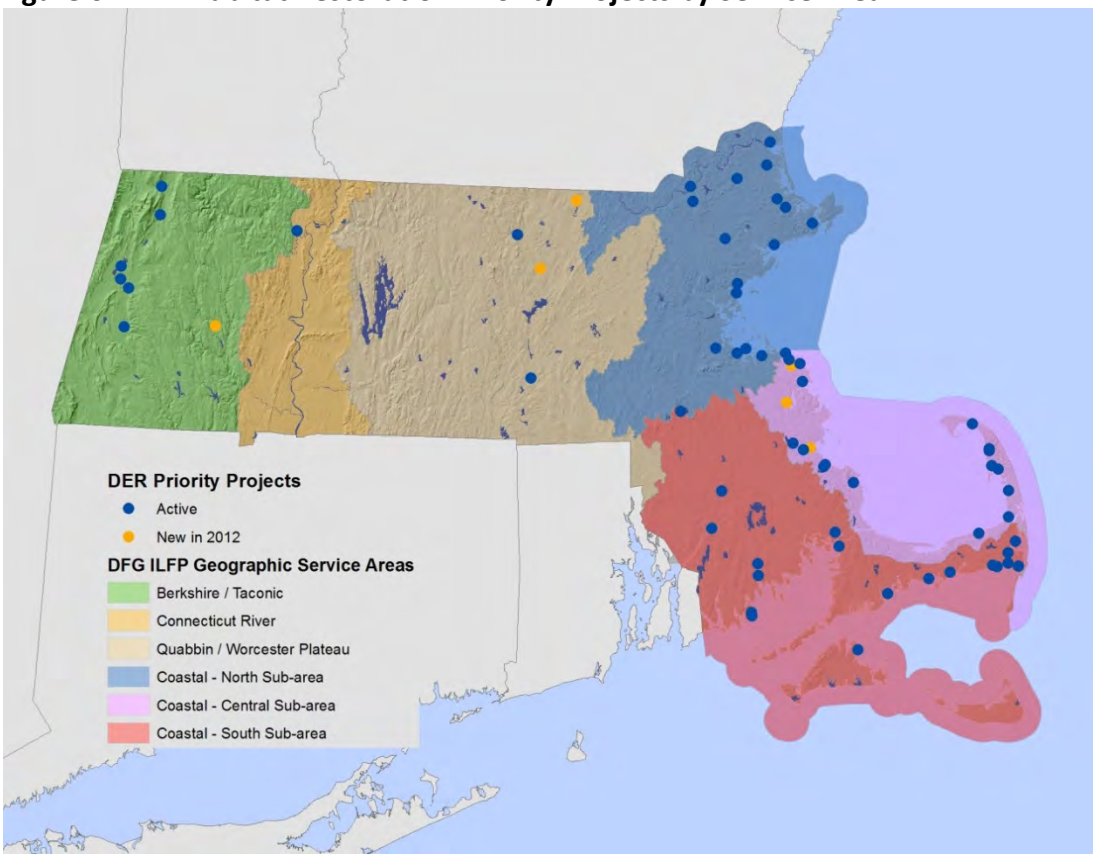
C. *The Inland Restoration Component of the ILFP*

DFG's Division of Ecological Restoration (DER) will play the lead role in implementing the inland restoration component of the ILFP, drawing on the complementary expertise in

DMF, DFW, and DEP as needed. DER has an existing portfolio of 70+ physical restoration projects, some of which may be appropriate as ILFP mitigation projects. DFG's Division of Fisheries and Wildlife (DFW) also implements a smaller number of inland waters restoration projects. **Figure 6** below identifies the location of DER's active and new restoration projects in Massachusetts.

DER and its range of established project partners have existing watershed-based restoration plans as well as state-wide planning tools such as the GIS Restoration Potential Model at their disposal. As noted earlier in this Instrument, DER will also make use of the UMass Amherst / MassDEP / Coastal Zone Management Wetland Monitoring and Assessment method, which includes CAPS and Site Level Assessments, as well as DEP's Recovery Potential Screening Tool.

Figure 6. DER Habitat Restoration Priority Projects by Service Area



In recognition of DER's extensive experience and project portfolio, DFG will give active restoration projects by DER or DFW first priority for funding under the ILFP for associated inland impacts. If there were no suitable DFG projects that furthered the restoration goals and prioritization strategy within a particular service area, DFG would solicit aquatic habitat restoration project proposals through a competitive RFP process. Consistent with the ILFP project selection criteria described below in this Instrument, DFG will consider both on-site and watershed-scale ecological impairments and beneficial effects achieved through restoration and prioritize degraded and former aquatic habitats that, after project implementation will result in significant ecological improvements.

All DFG inland mitigation projects – whether they are proposed to be implemented by DER or DFW or identified and implemented by a third party through a Request for Responses (RFR) process - would be subject to review by the IRT and approval by the ACOE.

DFG acknowledges that the funds for a particular mitigation project must be obligated within three (3) years of receipt of the corresponding in-lieu fees, unless the Corps grants an extension of time.

D. *The Coastal Restoration Component of the ILFP*

As noted under the Qualifications section of this Instrument, from June 2008 through June 9, 2013 DMF was the Corps-approved program sponsor for a more limited ILFP that addressed impacts to aquatic habitats for managed diadromous fish and marine finfish and shellfish species in Massachusetts. DMF's ILFP provided compensatory mitigation for Corps-permitted projects that impacted less than one acre of aquatic habitat and met the criteria for authorization under the MA GP issued by the Corps. It tracked project impacts by location (i.e., their latitude and longitude; whether they occur in the north, central or south sub regions of the Coastal service area, and by the type of aquatic habitat impacted. The categories that defined impacted habitats eligible under the coastal/marine component of DFG's ILFP included:

- Open water (water column and subtidal impacts);
- Salt marsh;
- Submerged Aquatic Vegetation;
- Streams (diadromous passage and spawning); and
- Mud flat (intertidal impacts).

This tracking approach was important in determining the most effective use of the in-lieu fees for addressing impacts to coastal aquatic habitats. In 2012, DMF developed a project ranking tool through a grant from the Massachusetts Bays Program ("MBP") to select projects from proposals received through a Request for Responses ("RFR") seeking coastal restoration projects to be funded from $194,000.00 in fees collected between 2009 and 2012. The proposed restoration projects received through the RFR process included *Phragmites* control, dam removal, and other restoration projects. The applicant pool included state and town agencies, universities and non-profits. Three projects with the highest overall scores were chosen through this process, resulting in the funding of restoration projects in two coastal service sub-areas.

DMF will continue to play the lead role in implementing the coastal/marine component of DFG's ILFP, with the involvement of DER who also implements a significant number of restoration projects in a coastal environment.

DMF has extensive experience designing and implementing mitigation and pro-active restoration projects in Massachusetts coastal watersheds and marine environments. DER also has extensive experience restoring streams and tidal wetlands within coastal watersheds across the state. For this reason, DMF and DER will have the first option of

implementing a mitigation project to meet the identified restoration priorities and objectives, when fees are directed towards restoration, establishment and enhancement. Alternatively, DMF and DER may use a competitive RFP process as a means of identifying, prioritizing, and selecting coastal restoration projects to be funded by the program. DMF has experience with this mitigation project selection process, having successfully used this approach to identify and select three mitigation projects that were approved by the Corp under DMF's existing ILF Program. DER also has extensive experience in restoration planning and a longstanding priority project program that has defined criteria for project selection based on a suite of factors that improve project implementation success. These models use an RFP process as a means of soliciting input on habitat restoration priorities and projects in a given area. The resulting proposals are then reviewed and graded by a review panel for their ability to effectively achieve the identified restoration priorities and objectives. Both Divisions have demonstrated success using this approach, and consistent with DMF's prior ILFP, it will be employed for DFG's expanded coastal ILFP component.

All DFG coastal restoration mitigation projects – whether they are proposed to be implemented by DMF or DER or identified and implemented by a third party through an RFR process - would be subject to review by the IRT and approval by the ACOE.

E. *Monitoring of Mitigation Projects*

Each mitigation project approved under this ILFP will contain performance standards to be used to assess whether the project is achieving its objectives (e.g., developing into the desired aquatic resource type; providing the expected ecological functions; resulting in the preservation of the required acreage of land). To that end, the mitigation project plan will also have a monitoring period that is sufficient to demonstrate that the project has met the identified performance standards. Consistent with the Mitigation Rule, projects will be monitored for a minimum of five years (ten years for forested wetlands), unless DFG, with approval the Corps in consultation with the IRT, reduces or waives the remaining monitoring period based upon its determination that the project has met its performance standards. Conversely, DFG may extend the monitoring based upon its determination that the project has not met or is not on track to meet its performance standards. In such cases, DFG may implement or require an approved third party to implement adaptive management activities and/or corrective actions deemed necessary by DFG to meet the performance standards in accordance with a revised timeframe.

X. Prioritization Strategy for Selecting Compensatory Mitigation Projects

The overarching goal of DFG's ILFP prioritization strategy is to identify mitigation projects that will have the greatest beneficial impact on the most valuable and/or most impacted aquatic resources using a watershed planning framework. To that end, DFG has developed a set of criteria to analyze the merits of potential mitigation projects, consistent with the compensation planning framework in this Instrument. The criteria is also predicated on the use of the best available ecological science and GIS tools to identify and prioritize aquatic resources and the potential mitigation projects. DFG's intent is that as the science

and analytical tools get updated or change, our ILFP prioritization strategy will be refined and modified accordingly.

A. *The Goals of DFG's ILFP Prioritization Strategy*

The goals of DFG's prioritization strategy dovetail with the larger goals underlying our ILFP and are further specified through the criteria we will use to identify, prioritize and select mitigation projects. Underlying the latter, more specific project criteria are the following ILFP prioritization strategy goals:

- The ILFP is based on and consistent with a DFG-wide conservation strategy that values the big picture, holistic conservation priorities and goals that are critical to the long-term protection of aquatic resources in Massachusetts;

- The ILFP evaluates potential mitigation projects within a landscape/watershed context, including assessing the extent to which a project contributes to the ecological sustainability of a watershed;

- The ILFP Identifies quality habitat protection projects that have clearly defined objectives consistent with all five criteria in the Mitigation Rule applicable to land preservation as an authorized form of compensatory mitigation (e.g., identifying resources that contribute significantly to the ecological sustainability of a watershed and are under threat of destruction or degradation such as high quality riparian areas, specific natural communities, areas of biological diversity, etc.);

- The ILFP applies sound and proven criteria using the best scientific evidence and analysis available to evaluate specific mitigation locations/parcels;

- The ILFP's project selection criteria and process is transparent to and informed by input from the Corps and the IRT and other relevant stakeholders.

- ILFP fosters and strengthens the partnerships with highly qualified land conservation/habitat restoration entities and other experienced NGOs.

B. *The 5 Prioritization Criteria*

Consistent with the Prospectus, DFG will use the following five criteria to identify, prioritize and select mitigation projects, discussed in more detail below:

1. *The Project's Ability to Achieve Multiple Mitigation Objectives;*

2. *The Project's Support of or Compatibility with Broader Conservation or Management Initiatives and Surrounding Landscape;*

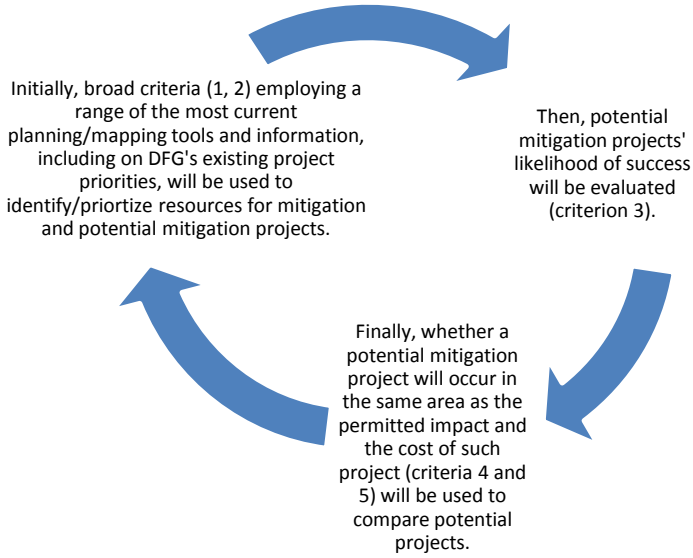
3. *The Project's Likelihood of Success;*

4. *Whether the Project will Result in Mitigation in the same Service Area; and*

5. *Cost of Implementing and Maintaining the Project*

Figure 7 below is a graphic depiction showing the sequential nature of DFG's application of the prioritization criteria.

Figure 7. Sequential Application of the ILFP Prioritization Criteria



As shown above, DFG's identification and evaluation of potential projects under criteria 1 and 2 will focus on the extent to which their implementation would result in multiple mitigation benefits and fit into broader DFG or state conservation/management initiatives that are compatible with the purposes of the ILFP. In applying these two criteria, DFG expects to employ the array of planning/mapping tools and data discussed in this Instrument (e.g., BioMap 2, CAPs, etc.), which will also be used to identify and prioritize a broad range of potential mitigation needs and projects within each service area. In applying these first two broader criteria, DFG will also consider potential projects suitable for ILFP mitigation purposes that have already been identified within existing DFG habitat protection programs and project portfolios.

Table 12 below provides a summary of the current ecological datasets and GIS mapping tools/models that are available for use by DFG in applying its prioritization criteria. Note that the subcriteria referenced in Table 12 are set forth in the Application of the Prioritization Criteria section below.

Table 12. Ecological Datasets and GIS Mapping Tools/Models Currently Available to Support Prioritization Criteria

	Prioritization Criteria											
	1a	1b	1c	2a	2b	2c	2d	2e	2f	2g	4a	4c
BioMap2	X	X		X			X		X		X	X
NHESP Databases	X		X	X	X					X		
DEP Site-level assessments	X			X								
CZM Salt Marsh Index of Biological Integrity	X										X	
DER Dam Restoration Potential Model				X					X	X	X	
DER Potential Restoration Sites									X	X		
Sustainable Water Management Initiative								X				
CAPS Models / Critical Linkages						X	X		X	X	X	
DFW Coldwater Resources Overlay									X	X		

The above Table 12 list of datasets and tools/models will change over time as they get updated and/or as new information, tools/models become available to DFG.

After evaluating whether a potential mitigation project would result in multiple mitigation benefits and/or fit into broader DFG or state conservation/management initiatives (criteria 1 and 2), DFG would then evaluate the project's likelihood of success (criterion 3), whether it will be implemented in the same service area as the permitted impact (criterion 4) and the cost of implementing and maintaining the project (criterion 5). Final project selection will always represent a balancing of priority projects with funds available and types of aquatic resource impacts for which mitigation is to be provided.

In summary, DFG's prioritization criteria approach focuses first on identifying and prioritizing mitigation needs and projects that best contribute to the long-term ecological sustainability of the watershed or other larger aquatic habitat landscape, and then paring that universe down based on implementation considerations such as the cost and likelihood of success.

C. *Application of ILFP Prioritization Criteria*

Set forth below is a more detailed description of the five ILFP prioritization criteria, which includes *examples* of the considerations underlying the application of each criterion to a particular mitigation project proposal:

1. *The Project's Ability to Achieve Multiple Mitigation Objectives,* including consideration of whether the proposed project:

    a. Restores or improves more than one ecological function or system;

    b. Protects high quality resources/habitats for state-listed species protected under MESA;

c. Protects important wildlife habitats identified by MassDEP's or other entities important habitat maps;

d. Targets a high quality riparian habitat area(s);

e. Targets resources that are under threat of destruction or degradation; and/or

f. Furthers the habitat protection climate change adaptation strategies described in the 2011 Massachusetts Climate Change Adaptation Report such as:

   i. Protection of vulnerable intermittent headwater streams as well as their upland buffer areas;
   ii. Protecting areas that are upgradient from coastal wetlands to allow wetland migration; and
   iii. Protecting resilient wetland ecosystems as well as the buffer zones surrounding these systems.

g. Falls within one or more management and restoration climate change adaptation strategies such as:

   i. Identify and protection remaining coldwater fish habitat areas and reconnect high quality habitats by removing in-stream barriers and re-establishing stream flows;
   ii. Identify and implement strategies for detection and removal of invasive exotic plants in streams, rivers, lakes, and ponds;
   iii. Identify, assess, and mitigate barriers to inland migration of coastal wetlands;
   iv. Identify and assess potential restoration of coastal wetlands; and
   v. Manage the spread of invasive species and support efforts to reduce nutrient loading of waterways and waterbodies.

2. *The Project's Support of or Compatibility with Broader Conservation or Management Initiatives and the surrounding Landscape, including consideration of whether the proposed project:*

   a. Location, scope, and objectives are compatible with broader conservation or management initiatives of DFG, the ACOE, one or more members of the IRT, or other natural resource conservation or management entities that work with DFG will be prioritized.

   b. Furthers one or more broader DFG or state conservation or management initiatives such as:

i. The Commonwealth's Sustainable Water Management Initiative (SWMI);
ii. DFG/DFW joint habitat protection program;
iii. DFW's State Wildlife Action Plan;
iv. MESA-related conservation programs for state-listed species;
v. DER's priority inland and coastal restoration projects;
vi. DMF's coastal and ocean resource restoration and protection programs; and
vii. DEP's Recovery Potential Model associated with the recovery and delisting of impaired inland waters in MA.

c. Fits into other landscape-level effect considerations, which may include:

i. Reduction of habitat fragmentation, and establishment of riparian and other wildlife corridors and buffers that prevent degradation of aquatic resources;
ii. The extent to which their location provides a buffer from incompatible adjacent land uses; and
iii. Enhancement of the ecological functions of existing natural resources.

3. *The Project's Likelihood of Success*, including consideration of whether the proposed project:

a. Demonstrates a high likelihood of success; this standard is met in the case of projects which result in permanent protection of aquatic resources/habitat and/or their upland buffers.

b. In the case of restoration, establishment, and enhancement projects, the extent of available site-specific information on hydrology, soils, flora, fauna, and climate change (where applicable).

c. Results in restoration of aquatic resources on already protected conservation land, thereby maximizing the ecological benefits and improving the project's likelihood of success.

d. Is able to manage any threats from or the presence of invasive species.

4. *Whether the Project will Result in Mitigation in the same Service Area:*

Given the geographic extent of the ILFP service areas, DFG's expectation is that a potential mitigation project will be implemented in the same ILFP service area as the permitted aquatic resource impact(s). In cases where a mitigation project will be implemented in a different service area, DFG acknowledges that it must first obtain the approval of the Corps, made in consultation with the IRT.

5. *Cost of Implementing and Maintaining the Project:*

   The cost of implementing and maintaining a mitigation project will be evaluated, taking into account any cost differences arising out of the project's geographic location, as well as the higher costs associated with constructing and maintaining restoration, establishment, and enhancement projects. DFG will weigh the costs against the predicted ecological benefits, including magnitude, quality and duration of such benefits.

D. *Selection and Submission of Proposed Mitigation Projects to the Corps and the IRT*

DFG will apply its ILFP prioritization criteria to prioritize and select proposed mitigation projects. DFG's proposed mitigation project will be submitted for approval by the Corps in consultation with the IRT, and will provide the following project selection information:

- A description of the proposed mitigation project, including its purpose, location in the relevant service area, acreage, relevant natural resources, and the mitigation objectives and outcomes to be achieved through the implementation of the project;

- A description of how DFG applied its ILFP prioritization criteria to the proposed mitigation project, including an explanation as to why it was selected as the proposed project;

- A description of any other potential mitigation project(s) identified and reviewed by DFG, including an explanation as to how such other proposals were evaluated under the ILFP prioritization criteria and compared with other proposed mitigation project(s).

In addition to providing the above scope of project selection information, DFG will respond to any follow-up questions or requests for information from the Corps or the IRT regarding its proposed mitigation project(s). DFG's goal is to ensure that the Corps and the IRT have a thorough understanding of and level of comfort on how and why DFG selected a particular mitigation project in accordance with the ILFP prioritization criteria described in this Instrument.

XI. Ownership Arrangements and Long-Term Management of Mitigation Projects

The Mitigation Rule provides that the Instrument must include the following information:

1. Identify the party responsible for ownership and all long-term protection and management of the mitigation projects;

2. Include a description of long-term management needs, annual cost estimates for these needs, and identify the funding mechanism that will be used to meet those needs; and

3. Specify what long-term financing mechanisms will be used, such as "non-wasting endowments," trusts, contractual arrangements with future responsible parties, and other appropriate financial instruments.

DFG will prepare, or require of a third-party, a long-term protection and management plan to be implemented for each compensatory mitigation project. Mitigation project sites will be managed in accordance with an approved Mitigation Plan, which shall include a long-term management plan and be subject to Corps approval.

As discussed under the habitat protection component of this ILFP, DFG will utilize a range of land protection mechanisms that satisfy ILFP requirements (e.g., fee acquisition by DFG, conservation restrictions held by DFG or a qualified third party) that will result in the permanent protection of these mitigation sites. These land protection mechanisms may also be appropriate for use in other coastal or inland restoration projects implemented under this ILFP. With the approval of the Corps, DFG may also transfer ownership or long-term management responsibilities associated with certain mitigation projects to an appropriate non-profit conservation organization, land trust, local government, or other qualified third party entities. In such cases, the long-term management entity would be required to use the related long-term management funds in accordance with terms of the management plan and/or any applicable real estate or other legal instrument.

XII. Description of Stakeholder Involvement

DFG will have ongoing interactions with the Corps and the IRT during the implementation of this ILFP. In addition, DFG and its Divisions have a range of existing partnerships or working relationships with federal and state agencies, non-profit natural resource management organizations, and municipalities in several areas and contexts that are germane to ILFP objectives and activities.

DFG intends to optimize the success of its ILFP by strengthening its existing partnerships and working relationships. This effort will include proactively reaching out to relevant public and private stakeholders for their input on the framework for and implementation of the ILFP, and/or because such stakeholders may have an interest in participating in the ILFP, either as a source of regular projects that require ACOE permits and are suitable for in-lieu fee mitigation, or because of their experience and resources in identifying and providing comment or other assistance on potential mitigation projects.

XIII. Strategy for Periodic Evaluation and Reporting

The Mitigation Rule requires the Instrument to include reporting protocols addressing the following four areas:

1. Monitoring reports, on a schedule and for a period determined by the project-specific mitigation plan;

2. Notification to the ACOE of credit transactions;

3. An annual program report summarizing activity from the program account, addressing both financial and credit accounting; and

4. An annual financial assurances and long-term management funding report.

DFG will submit the annual program report to the Corps and to the IRT, which will include an accounting, on a statewide and service area basis, of all income, disbursements and interest earned by DFG's ILFP, and the balance of such funds. The annual report will also provide the following information:

Every five years, DFG will produce, in consultation with the Corps and the IRT, a status and trends report summarizing the activities and accomplishments of its ILFP during the preceding five years. The report will include an assessment of the extent to which DFG has achieved the goals established in this Instrument for the inland and coastal mitigation components of its ILFP, and discuss how the mitigation projects implemented under each component during this period helped achieve or made progress toward achieving the ILFP goals.

Every ten years or as funds allow, DFG will assess, in consultation with the ACOE, the IRT and other ILFP stakeholders, the effectiveness of the compensation planning framework established in the program instrument.

XIV. Default

In the event that the Corps determines that DFG is in material default of any provision of this Instrument or an approved Compensatory Mitigation Plan, the Corps shall provide DFG with written notice of such material default. If DFG fails to remedy such default within ninety (90) days after receipt of such notice (or if such default cannot reasonably be cured within such ninety (90) day period, upon DFG's failure to commence and diligently pursue remediation of such default, the Corps may upon written notice to DFG, declare DFG to be in breach and take appropriate action, including but not limited to, suspending credit sales, adaptive management, decreasing available credits, directing of funds to alternative locations, taking enforcement actions, calling bonds or any other financial assurance(s) in place, or terminating this Instrument as provided below.

XV. Termination and Closure

The Corps or DFG may terminate this Instrument by giving ninety (90) days written notice to the other party. At least 30 days prior to termination, DFG shall deliver to the Corps an accounting of funds held in the DFG ILF Program Account which shall include an identification of the ongoing expenses of all Corps approved mitigation projects. Upon

termination, after payment of all outstanding obligations, any remaining amounts in the Program Account shall be paid to entities as specified by the Corps.

In the event of termination of the Instrument: (i) DFG shall cancel as many outstanding obligations as possible, but DFG shall be entitled to payment for all non-cancelable costs incurred through the date of termination, and (ii) DFG shall be responsible for fulfilling any remaining mitigation obligations, unless the obligation is specifically transferred to another entity as agreed upon by the Corps and DFG.

XVI. Force Majeure

DFG will not be liable, and nothing herein shall constitute a default or breach, for any delay, damage, or failure to comply with the terms of this Instrument or any project specific Compensatory Mitigation Plan attributed to circumstance beyond DFG's reasonable control which materially adversely affects its ability to perform, including, but not limited to, natural catastrophes such as earthquake, fire, flood, storm, drought, disease or infestation; war or civil disturbance; strike or labor dispute; or condemnation or other taking by a governmental body. DFG will coordinate any force majeure occurrence with the Corps and IRT, as appropriate.

XVII. Accounting Procedures

DFG will establish and maintain a system for tracking in-lieu fee payments received from Corps permittees, the generation of advance credits and the sale of credits. These transactions will be tracked on both a permit-specific basis and for the overall ILFP (e.g., by the number of available credits for the entire program by service area). Set forth below is a more specific description of DFG's ILFP accounting procedures, including the method for determining ILFP credits generally, the basis for the number of advance credits by service area, the fees to be charge for credits, and the ILFP Program Account.

A. Introduction

Under the Mitigation Rule, once the Corps has determined that a permit applicant has *avoided* impacts to aquatic resources to the extent practicable, and minimized to the extent appropriate and practicable, then the remaining impacts caused by the permitted activity must be offset or compensated for to the extent appropriate and practicable." The amount and type(s) of compensatory mitigation measures required by the Corps are set forth in its permits and authorizations.

There are four basic types of compensatory mitigation allowed by the Corps under the 2008 rule:

1. The *preservation* (i.e., permanent protection) of aquatic resources and/or habitats and buffers protecting aquatic resources, referred to in this Instrument as habitat protection;
2. The *restoration* (or re-establishment) of what had historically been an aquatic resource to its former state so there is a gain in aquatic resource acreage;

3. The *establishment* (creation) of an aquatic resource at a site where there is no evidence that it was previously an aquatic resource; and
4. The *enhancement* (or rehabilitation) of an aquatic resource by restoring degraded functions of an existing wetland, which does not result in a gain in aquatic resource acreage.

In lieu of providing one or more of the types of compensatory mitigation directly, a Corps permittee has the option of purchasing mitigation credits in the amount specified by the Corps from DFG's ILFP. Mitigation credits are defined in the Mitigation Rule as:

> "a unit of measure (i.e., a functional or areal measure or other suitable metric) representing the accrual or attainment of aquatic functions at a compensatory mitigation site. The measure of aquatic functions is based on the resources restored, preserved, established, or enhanced" 33 C.F.R. 332.2.

Once a Corps permittee purchases credits from DFG's ILFP, DFG as the ILFP Sponsor becomes legally responsible for fulfilling the mitigation requirements associated with those credits. This transfer of legal responsibility is memorialized in a Transfer of Legal Responsibility Certificate ("Certificate") signed by DFG and the Corps permittee, and is delivered to the Corps upon DFG's receipt of the in-lieu fee payment from the permittee. The Certificate will identify the Corps permit number, the name of the permittee name, and number of credits that have been sold to the permittee. The Certificate will also list the resource types and the amount of each resource that is directly or indirectly impacted by the project. DFG will retain a copy of each Certificate in the administrative and accounting records for its ILFP program instrument. Credit and debits will be reflected in DFG's annual accounting reports.

B. *Advance Credits*

Following the approval of this Instrument by the Corps, DFG shall be permitted to sell advance credits in each service area in the amounts identified in **Table 13** below. The number of advance credits is based on the total of impacts to aquatic resources permitted by the Corps from 2008 – 2012 in each service area. These amounts were rounded up to the nearest whole number. DFG also established the following minimum credit amounts in those service areas that had limited permit activity over the five year time period:

> 50 advance credits per service area for aquatic resources denominated in acres; and
>
> 2,500 advance credits per service area for aquatic resources denominated in linear feet (e.g., shoreline of rivers, streams and ocean).

The purpose of these minimum advance credit amounts is to ensure that each service area has an adequate number of advance credits at the outset of the ILFP.

Table 13. Number of Advance Credits per Service Area

Measure	Berkshire /Taconic	Connecticut River	Quabbin/ Worcester Plateau	Coastal	TOTAL
Acreage	50	50	52	130	282
Linear feet	5,741	2,500	2,500	162,819	173,560

As mitigation projects are implemented by DFG in a particular service area, advance credits will be converted to released credits. For example, in the case of habitat protection projects, advance credits will be released when the mitigation parcel has been permanently restricted as conservation land and documented by means of (1) a . recorded legal instrument and (2) a management plan approved by the Corps. Whenever advance credits are converted to released credits, an equivalent number of advanced credits will be made available for use in the applicable service area.

C. *Method for Determining Credit Fees and Initial Fee Schedule*

When a Corps permittee chooses to purchase credit(s) from DFG's ILFP in lieu of being responsible for implementing the otherwise required mitigation, the Corps will specify the corresponding number of credit(s) in the permit. The Corps will generally require a 1:1 mitigation ratio at the permitting stage, meaning that if the permitted activity impacts 1 acre of wetland, a permittee opting to use the ILFP would be required to make an in-lieu payment that equals the cost of purchasing a 1 acre credit from DFG.

As discussed in more detail below, the fees established by DFG for its ILFP credits are based on the full cost of restoring a unit of aquatic resource, which is expressed in terms of a cost per square foot or cost per linear foot, depending on the resource type. The "full cost accounting" approach underlying the credit fees factors in the following categories of mitigation costs, adjusted by service area:

1. The costs of purchasing suitable land to serve as the mitigation site, including legal fees and other due diligence costs associated with such acquisition;

2. The costs of the planning, design, permitting, and construction of the project;

3. The costs of monitoring and maintaining the project until its performance standards have been met;

4. The separate cost of long-term monitoring, which will extend beyond the project's achievement of its performance standards, to protect the project from encroachment and conversion;

5. Administrative overhead costs; and

6. A contingency amount, to ensure that there are funds available for any corrective actions.

The initial fee schedule for DFG ILFP credits by service area is set forth in **Table 14** below. DFG intends to develop an ILFP Fact Sheet that provides more information and guidance on the credit fees. DFG will also periodically review the fees to determine whether any adjustments are appropriate to account for the full cost of administering the ILFP.

Table 14. Initial Fee Schedule

Service Area	$/square foot	$/linear foot
Berkshire	$13.68	$100.00
Connecticut	$13.70	$100.00
Worcester	$13.73	$100.00
Coastal	$14.26	$200.00
Statewide Average	$13.84	$125.00

D. *Determining the Appropriate Amount of Mitigation for Projects Implemented by DFG under the ILFP*

The Corps' New England District Mitigation Guidance ("Mitigation Guidance") provides a range of information and general and project-specific guidance related to providing compensatory mitigation as a condition of Corps permits. Like many Corps districts around the country, the Corps' New England District has developed standard compensatory mitigation ratios that are included in the Mitigation Guidance. **Table 15** below is a version of the mitigation ratios tables contained in the 2010 Mitigation Guidance, as modified by DFG to identify a more detailed range of resource categories and resource types that is consistent with DFG's experience and ILFP approach.

In its Mitigation Guidance, the Corps states that "[w]hile the ratios are the starting point for developing appropriate compensatory mitigation, *there continues to be flexibility on a project-by-project basis in order to achieve the most appropriate mitigation for a specific project* and, based on the facts of a particular situation, permit decisions may result in different requirements than the ratios set forth in this [Mitigation Guidance]." (Emphasis in the original, p.12). The Mitigation Guidance (p.12) lists some of the factors to be considered in developing project-specific compensation, including the likelihood that the compensatory mitigation project will attain performance goals, and notes that proven mitigation methods and confidence that a mitigation plan substantially reduces the risks inherent in wetland construction may also be considered in determining the appropriate ratios for a specific project. In summary, the Corps makes clear that the flexibility referenced in the Mitigation Guidance may lead to compensatory mitigation deemed adequate and appropriate which is at different ratios than the ones included in its Guidance.

Table 15. New England District Standard Mitigation Ratios (as modified by DFG)

Resource Category*	Resource Type*	Restoration	Creation	Enhancement	Preservation
Palustrine	Includes emergent, shrub-scrub, fresh water, and forested wetlands.	2:1 to 3:1	2:1 to 4:1	3:1 to 10:1	15:1
Vernal Pools	Vernal Pools	2:1	N/A	project specific	project specific
Estuarine	Includes salt marsh, submerged aquatic vegetation, mudflats	2:1 to 5:1	project specific	project specific	project specific
Riverine	River, Streams & Brooks	2:1	N/A	3:1 to 5:1	10:1 to 15:1
Marine	Includes sub-tidal, inter-tidal, open water.	1:1	1:1	project specific	project specific
Upland	Upland	≥10:1	N/A	project specific	15:1

*Note: DFG has further specified the resource categories and types from those identified in the Corps' 2010 Mitigation Guidance.

As explained above, the Corps will generally require a 1:1 mitigation ratio at the permitting stage, while the standard mitigation ratios in the Mitigation Guidance range from 1:1 to 15:1, depending on the form of mitigation, as well as "project-specific" for certain categories. Consistent with the flexibility contained in the Mitigation Guidance and in recognition that of the fact that the Corps will generally apply a 1:1 mitigation ratio at the permitting stage, the Corps and DFG agree that the mitigation ratios applicable to DFG when implementing mitigation projects in its role as the ILFP sponsor, will be determined by the Corps on a project-specific basis, in consultation with the IRT and DFG.

E. *The Release of Credits*

Every mitigation project implemented by DFG will have a Compensatory Mitigation Plan (the "Compensatory Mitigation Plan", or "CMP") that will include project mitigation objectives or performance standards, as well as a schedule for achieving these milestones. Every CMP is also subject to the approval of the Corps, in consultation with the IRT. As the established project mitigation milestones are achieved, a percentage of the credits, as

specified in the CMP approved by the Corps, are released back to the ILFP. DFG must document the achievement of a particular milestone before the Corps will approve the release of the corresponding percentage credit.

DFG will track the actual number of credits available under the ILFP at any given point through the Corps' *Regulatory In lieu fee and Bank Information Tracking System* (RIBITS).

F. *The In-Lieu Fee Program Account*

The Mitigation Rule requires the establishment of an in-lieu program account and the implementation of related accounting procedures.

The Commonwealth of Massachusetts, Department of Fish and Game, Environmental Expendable Trust ("DFG Environmental Mitigation Expendable Trust"), established pursuant to State Office of Comptroller's ("OSC") regulations at 801 CMR 50.00 on April 8, 2013, will serve as DFG's In-Lieu Fee Program Account. An expendable trust is a dedicated account of the Commonwealth, established on the Massachusetts Management Accounting and Reporting System ("MMARS") and with the State Treasurer, into which are deposited monies held by the Commonwealth or a state agency such as DFG. The monies deposited therein may be expended only in accordance with the terms of the expendable trust. The financial accounting and reporting procedures associated with expendable trusts are governed by generally accepted accounting principles as promulgated for governments by the Governmental Accounting Standards Board.

The establishment of DFG's Environmental Mitigation Expendable Trust will allow the in-lieu fee payments made by Corps permittees to DFG to be deposited and held in an account of state government that is separate from the Commonwealth's general fund and not subject to appropriation by the state legislature. The administration of the expendable trust is subject to generally accepted governmental accounting procedures, and OSC's requirements are flexible enough to allow DFG to use any interest accrued in the expendable trust for ILFP purposes. DFG and its divisions have the capacity to segregate, track and account for the use of the in-lieu fee payments as required by the Mitigation Rule. DFG and its divisions shall ensure that all in-lieu fee payments deposited into DFG's Environmental Mitigation Expendable Trust are used solely for the purposes authorized by DFG's ILFP Instrument and the Mitigation Rule.

G. *Administrative Overhead Set-aside*

Consistent with the Mitigation Rule, DFG has established an administrative overhead set-aside in the amount of 17.5%, which shall be deducted from all in-lieu fee payments to cover DFG's costs of administering the ILFP. DFG's administrative costs to be funded from this set-aside may include, but is not limited to, supplies, equipment, salaries, and fringe benefits and indirect costs that may assessed the DFG Environmental Mitigation Expendable Trust under state law.

XVIII. Reporting Protocols

As required under the Mitigation Rule, DFG will provide the following reports to the Corps:

1. monitoring reports, on a schedule and for a period determined by each project-specific Compensatory Mitigation Plan;

2. notification to the Corps of credit transactions and the related transfer of legal responsibility for mitigation to DFG in the form of Certificates (see **Appendix A**);

3. an Annual Program Report summarizing activity from the program account, addressing both financial and credit accounting; and including a report detailing the financial assurances and long-term management for all projects subject to this ILFP.

A. *The Annual Program Report*

DFG will submit the annual program report and ledger ("Annual Report") to the Corps and to the IRT, which will include an accounting, on a statewide and service area basis, of all income, disbursements and interest earned by DFG's ILFP, and the balance of such funds. The Annual Report will also provide the following information:

1. The Annual Report will include the following information on each project paying into the ILFP:

    a. the ACOE permit number;

    b. the name of the permittee;

    c. the date the permit was issued;

    d. the town(s) where the permitted activity occurred;

    e. a description of the impacts to aquatic resources authorized by the permit, including the amount of the impact;

    f. the amount of the in-lieu fee required by the permit;

    g. the date that DFG received the in-lieu fee from the permittee;

    h. Information on each ongoing mitigation project:

        i. A brief history of the mitigation project;

ii. An accounting of the expenditures for each ongoing mitigation project;
iii. monitoring reports for each ongoing mitigation project; And
iv. An evaluation of any ongoing mitigation project that DFG and/or the IRT determines is not meeting its mitigation objectives or performance standards, and a corrective action or an adaptive management plan, if needed.

2. The balance of credits advanced and released at the end of the annual reporting period for each service area and for each component of DFG's ILFP (coastal/marine aquatic resources; inland aquatic resources; land preservation), and any changes in the availability of credits (including any additional credits advanced or released). The status of these credits will also be tracked in RIBITS.

3. An annual financial assurances and long-term management funding report.

4. Any other changes to the program (changes to administrative fees, Program Instrument updates, etc.) that occur within the reporting period.

XIX. Transfer of Long-Term Management Responsibilities

Consistent with the Mitigation Rule, each Compensatory Mitigation Plan (CMP) will include a "Long-Term Protection and Management Plan" that describes how the compensatory mitigation project will be managed after performance standards have been achieved to ensure the long-term sustainability of the resource, including long-term financing mechanisms and the party responsible for long-term management.

Each Long-Term Protection and Management Plan will address the following issues:

1. Responsible Party. As a general rule, DFG will be the party responsible for ownership and all long-term protection and management of the mitigation projects; however, it may from time to time assign ownership to, or contract for, long-term protection and management with non-governmental organizations.

2. Long-Term Management Costs. A description of long-term management needs, with annual cost estimates for these needs, and the funding mechanisms that will be used to meet those needs.

3. Long-Term Financing. Funding mechanisms, such as "non-wasting endowments," trusts, contractual arrangements with future responsible parties, and other appropriate financial instruments will be specified. In general, DFG will retain Long Term Management responsibility for implementing the CMP, which will funded from the ILFP fees established by DFG pursuant to Section XVII.C. of this Instrument.

As discussed earlier in Instrument, DFG's habitat protection program currently utilizes a range of land protection mechanisms (e.g., fee acquisition by DFG, conservation restrictions held by DFG or a qualified third party) that satisfy ILFP requirements and result

in the permanent protection of land and water resources. These land protection mechanisms will be modified as appropriate for use in DFG's ILFP.

With the Corps' approval, DFG may also transfer ownership or long-term management responsibilities associated with certain mitigation projects to an appropriate non-profit conservation organization, land trust, local government, or other qualified third party entities. In such cases, the long-term management entity would be required to use the related long-term management funds in accordance with terms of the management plan and/or any applicable real estate or other legal instrument.

XX. Financial Arrangements for Long-Term Management

As described in this Instrument's Compensation Planning Framework, DFG is responsible for funding the long term protection and management strategies for activities conducted under this ILFP. Each Compensatory Mitigation Plan will identify the funds dedicated to long term protection and management for that particular project.

If the protection and/or management of a mitigation site is to be transferred to a qualified third party, those funds will be transferred to the third party to be held in one or more dedicated funds to ensure that the funds will be available to support the annual long-term management needs of the compensatory mitigation project(s). The transfer of responsibility will be effectuated by a written contract assigning the rights and delegating the responsibilities to the steward, and shall include as consideration the transfer of funds dedicated for long term protection and management. Signatories will be DFG and the qualified third party. The Corps must review and approve the transfer of responsibility document.

XXI. Periodic Evaluation of the ILFP

Five years after the establishment of this ILFP (dated from the Corps approval of the Final Instrument) and every five years thereafter, DFG will produce, in consultation with the ACOE and the IRT, a status and trends report summarizing the activities and accomplishments of its ILFP during the preceding five year periods. The report will include an assessment of the extent to which DFG has achieved the goals established in the program instrument for the inland and coastal restoration and land preservation components of its ILFP, and discuss how the mitigation projects implemented under each component during this period helped achieve or made progress toward achieving the ILFP goals.

Every ten years or as funds allow, DFG will assess, in consultation with the ACOE, the IRT and other ILFP stakeholders, the effectiveness of the compensation planning framework established in the program instrument.

XXII. Modifications to this Instrument

This Instrument may be modified with the written agreement of DFG and the Corps using the streamlined review process described in 33 CFR 332.8(g)(2), provided that the changes

are related to adaptive management, credit releases, and other changes the Corps' New England District deems not significant. Any proposed changes to this Instrument will be coordinated with the IRT.

XXIII. Notice

Any notice required or permitted hereunder shall be deemed to have been given when any of the following occur: (i) when notice is delivered by hand, or (ii) three (3) days have passed following the date deposited in the United States Mail, Postage Prepaid, by Registered or Certified Mail, Return Receipt Requested, and a copy of the return receipt with date is available upon request, or (iii) when notice is sent by Federal Express or similar Next Day Nationwide Delivery System, addressed as follows (or addressed in such other manner as the party being notified shall have requested by written notice to the other party):

If to the Corps:

U.S. Army Corps of Engineers
Regulatory Division
696 Virginia Road
Concord, MA 01742-2751
Attention: Chief, Policy Analysis and Technical Support Branch

If to the DFG:

Department of Fish and Game
251 Causeway Street, Suite 400
Boston, MA 02114
Attention: General Counsel

Other Documents:

Annual Reports, Monitoring reports, and similar documents may be e-mailed to the New England District Corps of Engineers ILF Program Manager who will acknowledge receipt for DFG's records.

XXIV. Signatures

IN WITNESS WHEREOF, the parties hereto have executed this In-Lieu Fee Program Instrument this 23 day of May, 2014.

Sponsor: The Massachusetts Department of Fish and Game

By _____ Date: May 23, 2014
Mary B. Griffin, Commissioner

U.S. Army Corps of Engineers, New England District:

By _____ Date: 23 May 14
Charles P. Samaris, District Engineer

Appendix A – *Sample Notice of Credit Sale and Transfer of Legal Responsibility to DFG*

Date
PERMITTEE NAME
ADDRESS

Re: Notice of Sale of ## [Wetland and/or Stream] Mitigation Credits for Corps Permit No. NAE-xxxx-xxxxx

Dear (Name):

The Massachusetts Department of Fish and Game (DFG) and the U.S. Army Corps of Engineers, New England District (Corps) have established an In-Lieu Fee Program (ILFP) in Massachusetts pursuant to an ILFP Instrument between DFG and the Corps. Pursuant to the Instrument, DFG is the Corps-approved Sponsor of the ILFP for Massachusetts.

This letter confirms the sale of ## credits to compensate for ## [acres/linear feet] of impact to **RESOURCE TYPE(s)** in the **NAME** Service Area as authorized by the above Corps permit.

By selling these credits, the legal responsibility for implementing compensatory mitigation associated with this purchase of credits has been transferred to DFG.

Sincerely,

_____
Name and Title [Authorized DFG signatory]

Cf:
U.S. Army Corps of Engineers
New England District, Regulatory Division
Attn: Chief, Policy Analysis and Technical Support Branch
696 Virginia Road
Concord, MA 01742-2751

_____
[Permittee]

Appendix B. – *ILFP Service Areas*

Figure 8. Berkshire / Taconic Service Area

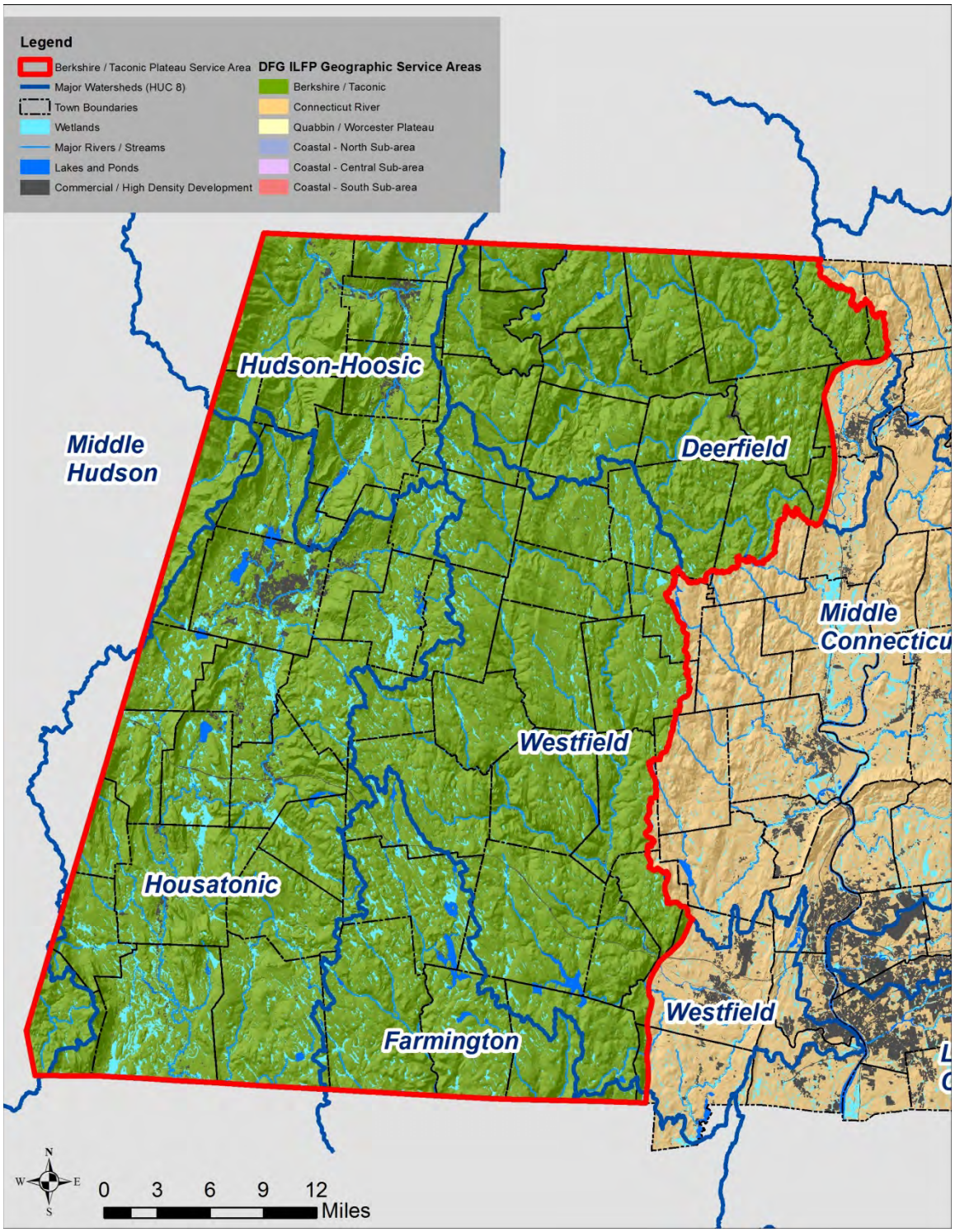


Figure 9. Connecticut River Service Area

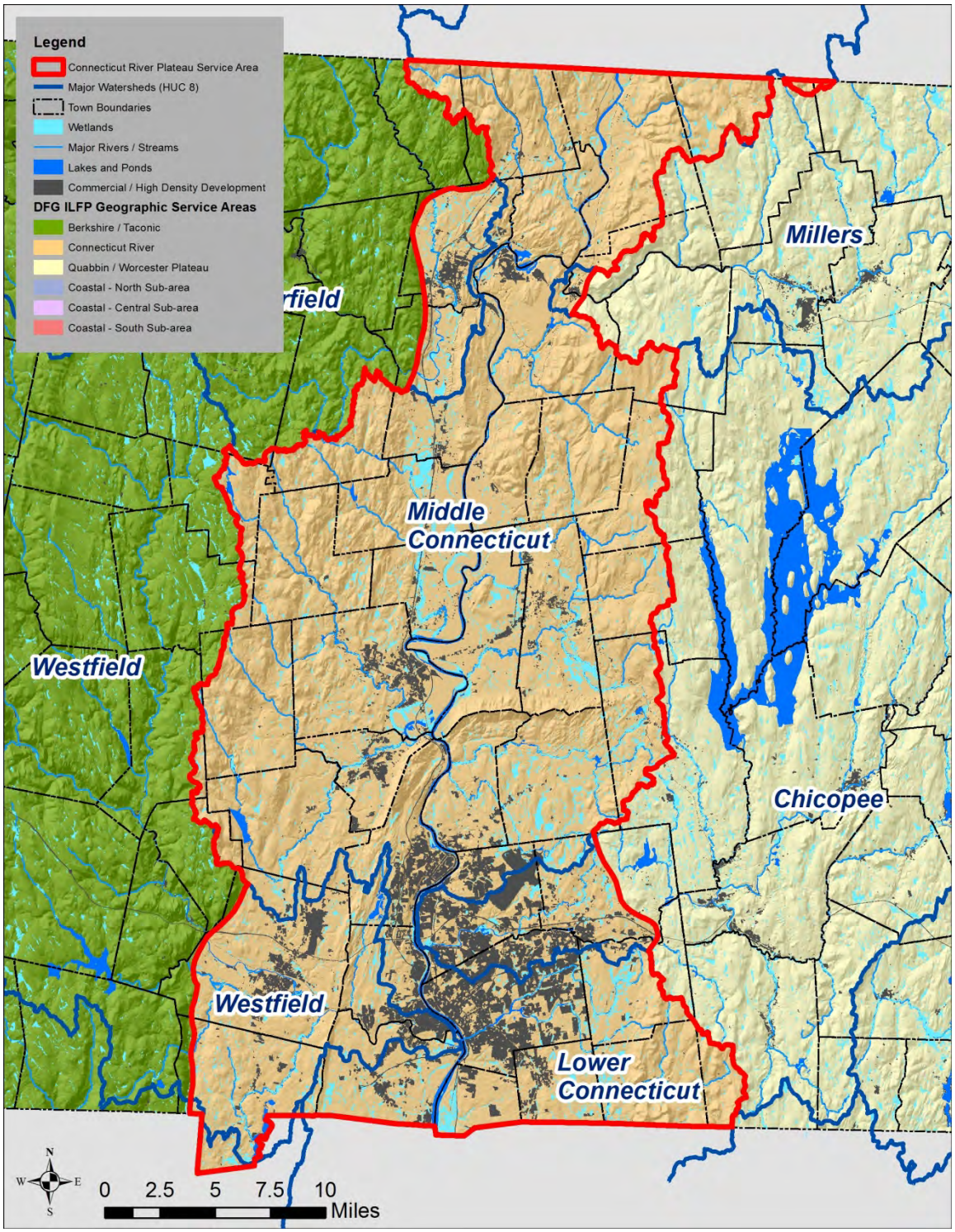


Figure 10. Quabbin / Worcester Plateau Service Area

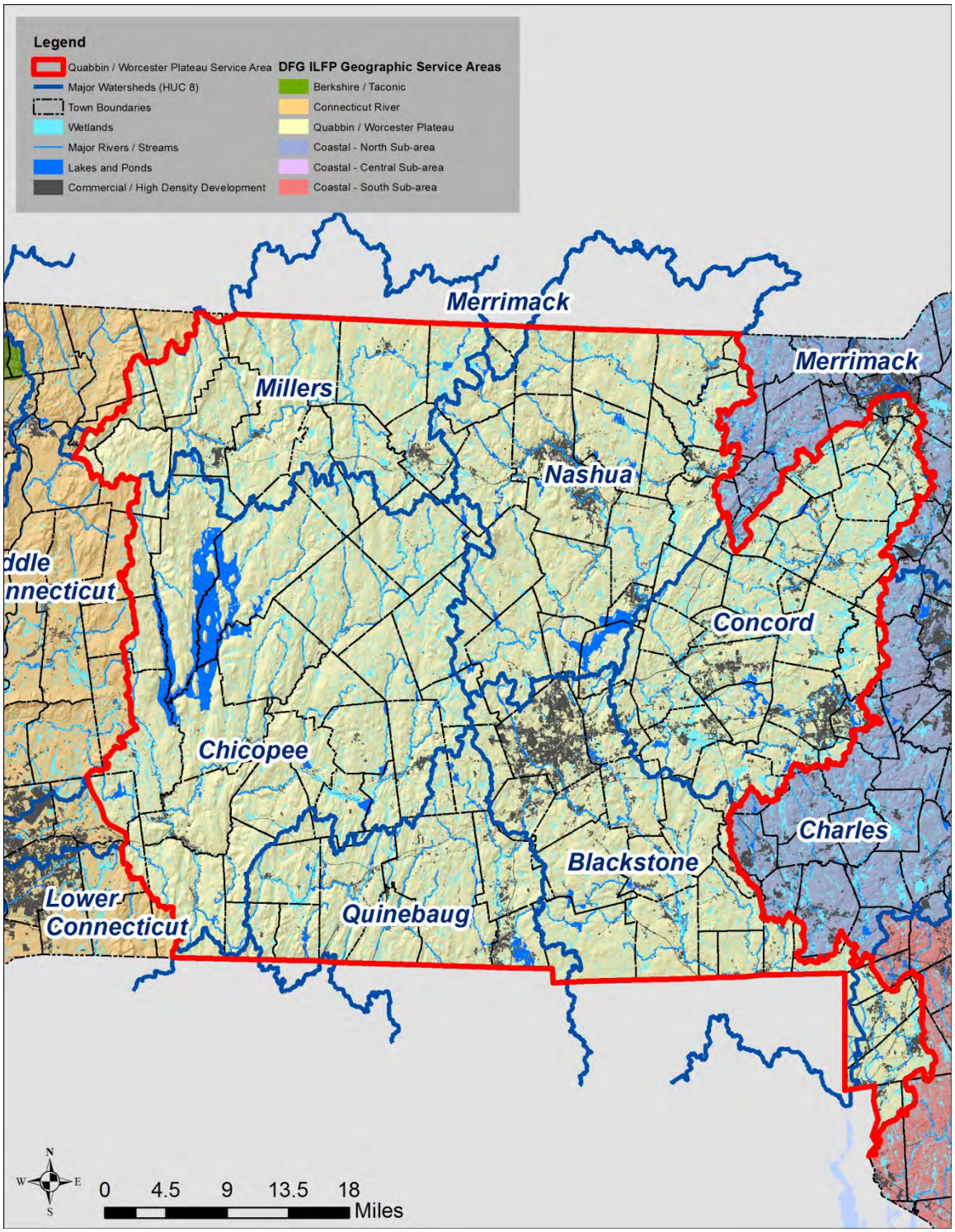
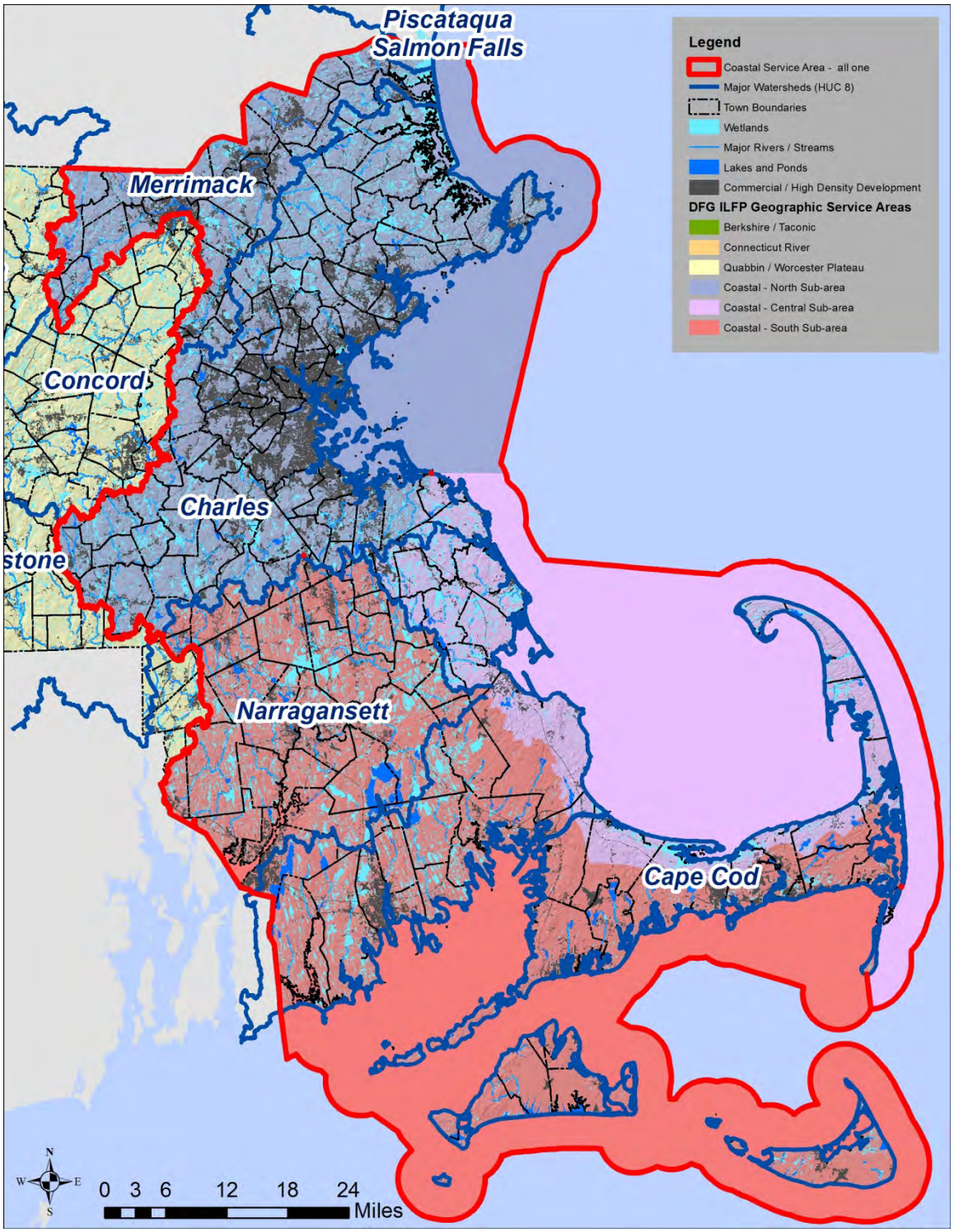


Figure 11. Coastal Service Area



Appendix C. - *Watershed and Restoration Planning Information*

Planning tools to assist in ILFP implementation

The Division of Ecological Restoration has a range of statewide restoration planning models and tools as well as more geographic specific restoration plans that will be incorporated into DFG's ILFP. The DFG ILFP may utilize additional modeling tools or updated versions of existing tools as new information and/or techniques applicable to the MA ILFP become available.

Statewide Planning Models and Tools

DER's Restoration Potential Model

A GIS-based analytical framework that assesses the environmental impact of dams on aquatic resources from their contributions to environmental degradation.
http://www.openmass.org/dfwele/der/freshwater/riverrestore/riverrestore.htm

USGS, Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins
http://pubs.usgs.gov/sir/2009/5272/

UMass and partners: CAPS: Conservation Assessment and Prioritization System
http://www.umass.edu/landeco/research/caps/caps.html

EPA and DEP's Recovery Potential Screening, *Tools for Comparing Impaired Waters Restorability* http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/recovery/index.cfm

Watershed & Restoration Plans

Great Marsh Tidal Crossing Inventory and Assessment
• Produced by the Parker River Clean Water Association with funding provided by the Mass Bays Program and MA CZM, completed: 1996 (with 1997 addendum)
This project identified 147 tidal crossings within the Great Marsh coastal region from Cape Ann to New Hampshire and assessed the impact of restrictions on tidal flows. The document provides one-page summaries for 25 sites that were deemed to be most restrictive. A 1997 addendum identifies an additional 22 sites in the study area. Several sites in the inventory have been restored and others are currently being studied for project feasibility.

Gloucester River and Stream Habitat Restoration Report
• Produced by the Massachusetts Audubon Society with funding provided by the Massachusetts Riverways Programs, completed: 2002
Staff from the MAS North Shore region worked with Gloucester officials and residents to identify, assess, and prioritize degraded aquatic resources within the city limits. 225 sites

were identified. Potential restoration actions include fill removal, dam removal, buffer enhancement, stream daylighting, invasive species control, and stormwater treatment. The report provides detailed maps, sketches, photos, and descriptions of all identified restoration opportunities

North Shore Atlas of Tidally Restricted Marshes

• Produced by the Massachusetts Wetlands Restoration Program with partial funding provided by the Massachusetts Bays Program, completed: 1996

This study was WRP's first restoration planning project and covers the North Shore coastal region from New Hampshire to Boston. The atlas contains maps of tidal wetland habitats with various classifications and shows locations of potential tidal restrictions and tidally-restricted coastal wetlands. 190 sites were identified.

Shawsheen River Watershed Wetlands Restoration Plan

• Produced by the Massachusetts Wetlands Restoration Program with funding provided by the MA Dept. of Environmental Protection, completed: 2002

This plan identifies, characterizes, and prioritizes freshwater 63 wetland restoration opportunities in the Shawsheen River Watershed. The majority of sites identified are historically filled wetlands that appear to offer practical, physical restoration options. Other restoration opportunities include ditched/drained and diked/impounded wetlands. These sites may be particularly useful to officials and others looking for good opportunities to compensate for wetland alterations or other environmental impacts caused by construction.

Rumney Marshes ACEC Salt Marsh Restoration Plan

• Produced by the Massachusetts Wetlands Restoration Program and the Massachusetts Areas of Critical Environmental Concern Program, completed: 2002

The Rumney Marshes Restoration Plan provides an inventory of 14 completed and 16 potential salt marsh restoration opportunities within the boundary of the Rumney Marsh ACEC. Summary descriptions with maps and photos are provided for both completed and potential restoration projects. The Plan identifies 5 projects that are recommended as priorities for implementation. Several sites in the plan are now in various stages of project development.

Maynard-Assabet Wetlands Restoration Inventory Project

• Produced by Epsilon Associates, Inc., a private consulting firm, as a donation under the Massachusetts Corporate Wetlands Restoration Partnership, completed: 2001

This inventory project covers three sub-watersheds of the Assabet River in the towns of Maynard, Acton, Stow, and Sudbury. 40 potential restoration sites were identified using GIS analysis and local input, were evaluated in the field, and were then prioritized based on their restoration potential. Restoration opportunities address various impacts including fill, degraded water quality, and altered hydrology. The plan provides conceptual restoration designs for the top 5 sites.

Blackstone River Watershed Wetlands Restoration Plan

• Produced by the Massachusetts Wetlands Restoration Program and Worcester County Conservation District with funding provided by the MA Dept. of Environmental Protection, completed: 2003

This plan identifies, characterizes, and prioritizes 71 freshwater wetland restoration opportunities in the Upper Blackstone River Watershed. The majority of sites identified are historically filled wetlands that appear to offer practical, physical options for restoring wetland structure and function. Other restoration opportunities include ditched/drained and diked/impounded wetlands. Identified sites may provide good opportunities for wetland mitigation.

Neponset River Watershed Wetlands Restoration Plan

• Produced by the Massachusetts Wetlands Restoration Program with assistance provided by the U.S. Army Corps of Engineers New England District, completed: 2000

This restoration plan identifies, characterizes, and prioritizes both tidal and non-tidal potential wetland restoration sites (171) in the study area. Restoration opportunities include fill removal, restoration of tidal hydrology, and enhancement of wildlife habitat. The Plan identifies 7 restoration goals developed with planning partners and 65 sites as priorities for restoration based on their potential to address those goals.

South Shore Tidal Restriction Atlas

• Produced by the Metropolitan Area Planning Council with funding provided by the Massachusetts Wetlands Restoration Program, completed: 2001

The South Shore Atlas provides an inventory of potential tidal restrictions and affected wetlands along the Massachusetts coast between Weymouth and Plymouth. Twenty-five high priority sites are detailed in one-page summaries with maps, photos, and descriptions of site features. The Atlas recommends a variety of potential restoration actions that focus primarily on the removal of tidal restrictions, but also address potential stormwater problems. 121 potential restoration sites were identified.

Mount Hope Bay Tidal Restriction Atlas

• Produced by the U.S. Army Corps of Engineers New England District in partnership with the Massachusetts Wetlands Restoration Program, completed: 2003

The Mount Hope Bay Atlas provides maps, photos, and detailed descriptions of 25 tidal restrictions in the study area. Sites were identified based on GIS analysis, field work, and input from local officials. WRP is now working with the Army Corps of Engineers to conduct follow-up technical assessments on several of the most promising sites. The goal is to prepare several sites for conceptual restoration design work and funding applications.

Buzzards Bay Tidal Restriction Atlas

• Produced by the Buzzards Bay Project with funding provided by the Massachusetts Wetlands Restoration Program, Massachusetts Department of Environmental Protection, and Massachusetts Environmental Trust, completed: 2002

The Buzzards Bay Atlas inventories and prioritizes 257 potential tidal restrictions along the coastline of the Buzzards Bay watershed. Sites are ranked based on several factors

including estimated construction costs and size of restricted wetland. The document provides site profile pages with maps and photos for the 30 highest ranking sites.

Buzzards Bay Selected Inventory of Restoration Sites

• Produced by the Buzzards Bay Project with funding provided by the Massachusetts Office of Coastal Zone Management, completed: 2005

This selected inventory identifies 204 fresh and saltwater wetlands that have been physically altered (mostly filled) on public lands, private conservation areas, and within abandoned cranberry bogs. Sites were included if they offer practical opportunities for restoration. The inventory covers the entire Buzzards Bay watershed in two phases: Phase I - Southern; Phase II - Northern & Eastern. Maps, aerial images, and summary descriptions are provided for all sites.

New Bedford Harbor Wetlands Restoration Plan

• Produced by the Massachusetts Wetlands Restoration Program with funding provided by the New Bedford Harbor Trustee Council, completed: 2003

This plan was prepared at the request of the New Bedford Harbor Trustee Council to identify high-value fresh and tidal wetland restoration opportunities where funds can be spent to produce significant environmental benefits. The plan provides maps, aerial photos, and summary descriptions for 69 potential restoration sites that include filled wetlands, tidal restrictions, and other impacts. The Council and the NOAA Restoration Center are now pursuing some of the highest value sites identified in the plan.

Cape Cod Tidal Restriction Atlas

•Produced by the Cape Cod Commission with funding provided by the Massachusetts Wetlands Restoration Program and Massachusetts Bays Program, completed: 2001

The Cape Cod Tidal Restriction Atlas identifies and describes 114 tidal restrictions based on GIS analysis of the study area, extensive field work, and input from local officials. Maps, photos, and summary descriptions are provided for all sites. Several sites in the atlas have now been restored or are nearing construction, and many more are being studied for project feasibility. The Cape Cod region contains some of the largest restoration opportunities in the Commonwealth.

Cape Cod Water Resources Restoration Plan

http://www.capecodcd.org/Cape_Cod_Water_Resources.pdf

HubLine Pipeline Mitigation and Restoration Program

The Massachusetts Division of Marine Fisheries (MarineFisheries) was designated as the lead agency with the responsibility to provide effective mitigation and/or restoration of aquatic resources and habitat in response to potential HubLine construction impacts.

A Marine Fisheries internal steering committee was chosen to provide initial guidance to the HubLine mitigation and restoration program and a public process was implemented by November 2003 to solicit input on mitigation/restoration project ideas. We designed the public process to include a public announcement and comment period during October 28-

November 28, 2003 and the creation of an Inter-Agency Steering Committee to seek input from interested stakeholders and relevant state and federal agencies

Additional information can be found in the HubLine Impact Assessment, Mitigation, and Restoration Completion Report.
http://www.mass.gov/dfwele/dmf/programsandprojects/hubline/hubline_5yr_assessment_report.pdf

References:

Armstrong, D.S., Richards, T.A., and Levin, S.B., 2011, Factors influencing riverine fish assemblages in Massachusetts: U.S. Geological Survey Scientific-Investigations Report 2011–5193, 58p.

Booth, D.B. and Jackson, C.R. 1997. Urbanization of aquatic systems: Degradation thresholds, stormwater detection, and the limits of mitigation. Journal of the American Water Resources Association. Vol 33, No 5, Pgs 1077 – 1090.

Carpenter, S.R., N. F. Caraco, D.L. Correll, R.W. Howarth, A.N. Sharpley, and V.H. Smith. 1997. Nonpoint pollution of surface watershed with phosphorus and nitrogen. Ecological Applications 8: 559-568.

Costa, J.E., B.L. Howes, A.E. Giblin, and I. Valiela. 1992. Monitoring nitrogen and indicators of nitrogen loading to support management action in Buzzards Bay. In Ecological indicators vol. 1, ed. D.H. McKenzie, D.E. Hyatt, and V.J. McDonald, 499–531. Research Triangle Park: Elsevier Applied Science.

Costello, C.T. and Kenworthy, W.J. Twelve-Year Mapping and Change Analysis of Eelgrass (Zostera marina) Areal Abundance in Massachusetts (USA) Identifies Statewide Declines. Estuaries and Coasts, January, 2011.

Coverdale, Tyler C., N.C Herrmann, A.H. Altieri and M.D. Bertness. 2013. Latent impacts: the role of historical human activity in coastal habitat loss. Frontiers in Ecology and the Environment 11: 69–74. http://dx.doi.org/10.1890/120130.

Dahl, T.E. 2011. Status and trends of wetlands in the conterminous United States 2004 to 2009. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C., 108 pp.

DeNormandie, J., Corcoran, C., and Clarke, J. May 2009. Losing Ground (4th edition), Beyond the Footprint, Patterns of development and their impact on the nature of Massachusetts. Mass Audubon.

Environmental Law Institute and Land Trust Alliance. 2012. Wetland and Stream Mitigation: A Handbook for Land Trusts.

Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee. September, 2011. Massachusetts Climate Change Adaptation Report.

Executive Office of Energy and Environmental Affairs. November, 2012. Massachusetts Sustainable Water Management Initiative, Framework Summary.

Executive Office of Environmental Affairs, Massachusetts Division of Fisheries and Wildlife, Department of Fish and Game. September, 2006. Commonwealth of Massachusetts Comprehensive Wildlife Conservation Strategy.

Fox, S.E., E. Stieve, I. Valiela, J. Hauxwell, and J. McClelland. 2008. Macrophyte abundance in Waquoit Bay: effects of land-derived nitrogen loads on seasonal abundance and multi-year biomass patterns. Estuaries and Coasts 31: 532–541.
Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

Hauxwell, J., J. Cebrian, and I. Valiela. 2003. Eelgrass Zostera marina loss in temperate estuaries: relationship to land-derived nitrogen loads and effect of light limitation imposed by algae. Marine Ecology Progress Series 247: 59–73.

King, R.S. and Baker, M.E. 2010. Considerations for analyzing ecological community thresholds in response to anthropogenic environmental gradients. Journal of the North American Benthological Society. 29(3): 998-1008.

LeBlanc, Denis R. 1982. Potential hydrologic impacts of ground-water withdrawal from the Cape Cod National Seashore, Truro, Massachusetts. United States Geological Survey. Open-File Report 82-438.

McGlathery, K.J. 2001. Macroalgal blooms contribute to the decline of seagrass in nutrient-enriched coastal waters. Journal of Phycology 37: 453–456.

Roy, A., Freeman, B.J., and Freeman, M.C. 2007. Riparian influences on stream fish assemblage structure in urbanizing systems. Landscape Ecology 22:385-402.

U.S. Army Corps of Engineers. 7-20-2010. New England District Compensatory Mitigation Guidance.

U.S. Census Bureau. 2008. Decennial Census of Population and Housing: 1960 to 2000; Population Estimates Program.

Valiela, I., and J.E. Costa. 1988. Eutrophication of Buttermilk Bay: a Cape Cod coastal embayment: concentrations of nutrients and watershed nutrient budgets. Environmental Management 12: 539–553.

Valiela, I., K. Foreman, M. LaMontague, D. Hersh, J. Costa, P. Peckol, B. DeMeo-Anderson, C. D'Avanzo, M. Babione, C.H. Sham, J. Brawley, and K. Lajth. 1992. Coupling of watersheds and coastal waters: sources and consequences of nutrient enrichment in Waquoit Bay, Massachusetts. Estuaries 15: 443– 457.

Walsh, C.J., Fletcher, T.D., and Ladson, A.R. 2005. Stream restoration in urban catchments through redesigning stormwater systems: looking to the catchment to save the stream. Journal of the North American Benthological Society. 24(3):690–705.

Weiskel, P.K., Brandt, S.L., DeSimone, L.A., Ostiguy, L.J., and Archfield, S.A., 2010, Indicators of streamflow alteration, habitat fragmentation, impervious cover, and water quality for Massachusetts stream basins: U.S. Geological Survey Scientific Investigations Report 2009–5272, 70 p., plus CD–ROM.

Woolsey, H., A. Finton, J. DeNormandie. 2010. BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World. MA Department of Fish and Game/Natural Heritage & Endangered Species Program and The Nature Conservancy/Massachusetts Program.