7 Effectiveness Monitoring and Adaptive Management

The previous chapters in this SWAP have discussed in detail the Massachusetts Species of Greatest Conservation Need, their habitats, threats to those species and habitats, and proposed conservation actions targeting those species in their habitats and on a state-wide basis. However, without monitoring the implementation of conservation actions and measuring the effectiveness of those actions at accomplishing conservation goals, it is impossible to know if the considerable resources targeting biodiversity conservation in Massachusetts are being used appropriately. This chapter discusses effectiveness monitoring and adaptive management for SGCN and their habitats.

A. Regional Coordination of Monitoring and Adaptive Management

Regional guidance for appropriate monitoring methodologies has been set forth in the Terwilliger Consulting and the Northeast Fish and Wildlife Diversity Technical Committee report of 2013, Taking Action Together: Northeast Regional Synthesis for State Wildlife Action Plans, as it describes the regional structure and cooperation Massachusetts intends to follow.

The Northeast Association of Fish and Wildlife Agencies (NEAFWA) Monitoring and Performance Reporting Framework (NEAFWA 2008) is intended to help each Northeastern state meet the expectations set by Congress and the USFWS for the State Wildlife Action Plans and the State Wildlife Grants (SWG) programs. The goal of this framework is to assess the status and trends of SGCN and their habitats across the Northeast states, and to evaluate the effectiveness of activities intended to conserve species and habitats across the Northeast. For more information and to review project reports, see http://rcngrants.org/content/regional-monitoring-and-performance-framework.

The monitoring framework identified eight conservation targets (defined as species, landscape features, or vegetation communities important to fish and wildlife): forests, freshwater streams and river systems, freshwater wetlands, highly migratory species, lakes and ponds, managed grasslands and shrublands, regionally significant SGCN, and unique habitats in the Northeast. Each of these targets is discussed above under the appropriate chapter for species and habitats. For each target, key threats were identified, along with conservation actions that could help alleviate or eliminate the effects of that particular stressor. Indicators were proposed for tracking status and trends of each of the targets, and data sources were identified for each of the indicators (NEAFWA 2008). Table 5.1 from NEAFWA (2008), reproduced here as Table 7-1, lists the indicators and threats that were selected by workshop participants for each of the eight conservation targets.

Table 7-1. List of Conservation Targets and Proposed Indicators.

From Table 5.1, NEAFWA 2008.

Targets	Proposed Indicators
1. Forests	1a. Forest area – by forest type 1b. Forest area – by reserve status 2. Forest composition and structure – by seral stage 3. Forest fragmentation index 4. Forest bird population trends 5. Acid deposition index
2. Freshwater streams and river systems	1. % impervious surface 2. Distribution and population status of native Eastern Brook Trout 3. Stream connectivity (length of open river) and number of blockages 4. Index of biotic integrity 5. Distribution and population status of non-indigenous aquatic species
3. Freshwater wetlands	1. Size/area of freshwater wetlands 2. % impervious surface flow 3. Buffer area and condition (buffer index) 4a. Hydrology – upstream surface water retention 4b. Hydrology – high and low stream 5. Wetland bird population trends 6. Road density
4. Highly migratory species	1. Migratory raptor population index 2. Shorebird abundance 3. Bat population trends 4. Abundance of diadromous fish (indicator still under development) 5. Presence of Monarch Butterfly
5. Lakes and ponds	1. % impervious surface/landscape integrity 2. % shoreline developed (shoreline integrity) 3. Overall productivity of Common Loons
6. Managed grasslands and shrublands	To be developed

Targets	Proposed Indicators
7. Regionally significant SGCN	1. Population trends and reproductive productivity of federally listed species 2. State-listed status and Heritage rank of highly imperiled wildlife 3. Population trends of endemic species
8. Unique habitats in the Northeast	1. Proximity to human activity/roads 2. Wildlife presence/absence 3. Wildlife population trends 4. Land use/land cover changes

Conservation Status of Northeast Fish, Wildlife, and Natural Habitats

Using the indicators developed at the regional level, NEAFWA supported The Nature Conservancy to assess the current condition of species and habitats in the Northeast through the Conservation Status Project. This project used a GIS analysis to examine the relationship between species and habitat condition and land ownership and conservation management status. The original assessment project merged with another RCN-funded project, titled *Regional Indicators and Measures: Beyond Conservation Land* (Anderson and Olivero Sheldon 2011), which measured approximately 30 indicators of habitat condition and species and ecosystem health in the northeastern states. Together these projects, completed in September 2011, implemented approximately 75% of the Northeast Regional Monitoring and Performance Measures Framework (NEAFWA 2008), previously funded by the NFWF and the RCN Grant Program. Please see: *http://www.rcngrants.org/sites/default/files/final_reports/Conservation-Status-of-Fish-Wildlife-and-Natural-Habitats.pdf*.

State Wildlife Grants Effectiveness Measures Project

Building on the success of the Northeastern Regional Monitoring and Performance Measures Framework (NEAFWA 2008), the Association of Fish and Wildlife Agencies led an effort to develop an approach for measuring the effectiveness of wildlife conservation activities funded under the USFWS's SWG program. In September 2009, AFWA's Teaming with Wildlife Committee formed the Effectiveness Measures Working Group. This working group included representatives from state fish and wildlife agencies as well as private, academic, and non-governmental conservation partners with expertise in wildlife conservation and performance management.

In April 2011, the working group released a final report that outlines a comprehensive approach to measure the effectiveness of the activities funded under the SWG program. The report builds on the monitoring framework that was originally developed in the northeastern states and recommends a set of common indicators for measuring status, trends, and/or effectiveness of thirteen general types of conservation actions that are commonly supported by SWG. These actions include direct management of natural resources, species restoration, creation of new habitat, acquisition/easement/lease, conservation area designation, environmental review, management planning, land use planning, training and technical assistance, data collection and analysis, education, conservation incentives, and stakeholder involvement. The report includes sample templates and forms that could be used for reporting the results of conservation activities, as well as a discussion of the specific methods by which these reporting methods could be incorporated into in the USFWS's grants management database. For more information and to review the project final report, please visit: *http://www.fishwildlife.org/files/Effectiveness-Measures-Report_2011.pdf*.

Wildlife TRACS Database

The State Wildlife Grants Effectiveness Measures Project has informed the development of *Wildlife TRACS*, a database designed by the USFWS to record information about conservation activities funded through the Wildlife and Sport Fish Restoration Program, including SWG. When fully functional, *Wildlife TRACS* is intended to track and report project outputs, effectiveness measures, and species and habitat outcomes. *Wildlife TRACS* has the potential to track long-term outcomes for species and habitats, above and beyond the types of short-term output measures commonly tracked by funding agencies (e.g., number of publications, number of workshops, number of people contacted). Because it is being designed to be responsive to the needs of the state agencies receiving SWG funding, *Wildlife TRACS* includes its own customized classifications of conservation actions and

threats. These classifications are based, at least in part, on the classifications developed jointly by the IUCN and the Conservation Measures Partnership (CMP, see Salafsky et al. 2008). For more information about the development of *Wildlife TRACS*, please visit: http://wsfrprograms.fws.gov/Subpages/TRACS/TRACS.html.

Northeast Lexicon for Common Planning and State Wildlife Action Plan Database

Wildlife conservation planners in the Northeast have long recognized a potential ambiguity in many of the terms that are used to describe fish and wildlife conservation activities. For example, a "target" may refer to a number, an area, a specific site, a species, a group or guild of species, a vegetation community, or an ecosystem type. There is an acute need to develop a standard lexicon that provides conservationists with a uniform terminology that accurately and adequately describes the work of state fish and wildlife agencies. Although lexicons have been developed by the IUCN and the CMP, they are designed primarily for international conservation and sustainable development projects, activities that differ in many important ways from fish and wildlife conservation activities in the northeastern states. Thus, the Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC) is developing a regional conservation lexicon that can be used by state wildlife agencies and partners to describe their conservation projects (Crisfield and NEFWDTC 2013).

The *Northeast SWAP Database* is a data management tool developed by Kevin Kalasz, Karen Terwilliger, and Jonathan Mawdsley that provides a basic structure for storing and querying data collected by the individual states as part of their SWAP revisions. The database includes full support for results chains as well as indicators and the AFWA SWG Effectiveness Measures.

Region-wide Taxa-specific Surveys and Monitoring

There are numerous taxa-specific surveys, inventory, or monitoring programs that have been developed and implemented with NEAFWA's support and through other regional collaborations. With RCN funding, surveys and assessments have been conducted or are in the process of being conducted for Wood Turtle, Eastern Black Rail, odonates (dragonflies and damselflies), New England Cottontail (Fuller and Tur 2012), shrubland birds (McDowell 2011), aquatic habitats (Gawler 2008), and frogs. Detailed avian indicators have also been developed for assessing the magnitude of threats and the effectiveness of conservation measures (Northeast Coordinated Bird Monitoring Partnership 2007). An online database of museum specimen records for SGCN invertebrates in the Northeast was developed by Fetzner (2011). More in-depth reports describing the methods and results of these surveys and associated data products are available at the RCN website: http://www.rcngrants.org.

Regional Monitoring Protocols and Databases

Northeast states have also developed monitoring protocols and databases through regional multi-state collaborative efforts. With funding from the RCN Grant Program, monitoring protocols have been developed, reviewed, or revised for several species of regional conservation interest, including New England Cottontail (Fuller and Tur 2012), shrubland-dependent birds (McDowell 2011), freshwater aquatic habitats (Gawler 2008), and frogs. Ongoing RCN projects are also developing monitoring protocols for Wood Turtle, Eastern Black Rail, and odonates (dragonflies and damselflies). The consistent and widespread use of common monitoring methodologies and survey protocols will help support regional assessments of the status and trends of SGCN and their habitats. In addition, NEAFWA has also funded development of a database for regional invertebrate species of greatest conservation need through a partnership with the Carnegie Museum of Natural History in Pittsburgh (Fetzner 2012). A more comprehensive database has been proposed that would include data on all species, habitats, actions, and threats from the individual SWAPs in the Northeast; for introductory information and a lexicon of terms that would be used in such a database see Crisfield and NEFWDTC 2013. Links to monitoring plans and tools developed through the RCN Grant Program are available on the web site.

B. Effectiveness Monitoring of SGCN and Their Habitats in Massachusetts

Numerous agencies, organizations, and individuals in Massachusetts have been tracking, gathering data, and monitoring the SGCN, their habitats, threats, and ecological processes and indicators for decades now, with every expectation of continuing most such efforts. See Table 7-2 for a compilation of many such monitoring efforts. Despite all these efforts, there are still data gaps. Some of the most notable gaps are listed in Chapter 6, Table 6-2, Species Needing Systematic Surveys and Research Efforts.

Table 7-2: Monitoring Programs in Massachusetts

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
Fish	Rivers and streams	DFW/Fisheries Section	Annually	All-species surveys, targeting especially coldwater streams, unsurveyed waters, and sites with older surveys. About 4,700 sites have been sampled state-wide since 1998.
	Lakes and ponds	DFW/Fisheries Section	Annually	All-species surveys, targeting especially unsurveyed waters and sites with older surveys. About 330 sites have been sampled state-wide since 1998.
	Stream Flow Monitoring Project	DFW/Fisheries Section; Massachusetts Cooperative Fish and Wildlife Research Unit	Annually	Sampling of fish communities in unaltered streams, streams downstream of water supply impoundments, and streams downstream of unregulated dams
	Fish Kill Investigations	DFW/Fisheries Section	Annually	All reported fish kills are investigated to determine causes; these kills sometimes include SWAP fishes.
	Anadromous fish - Blueback Herring, Alewife, American Shad, American Eel, Sea Lamprey	DFW/Fisheries Section; USFWS	Annually	Fish passage facilities at the on the Connecticut, Westfield, and Merrimack Rivers are monitored annually to determine numbers of anadromous fish passing the dams. Blueback Herring are also sampled below dams by USFWS, as they do not use fishways consistently.
	Coldwater Fisheries Streams Temperatures	DFW/Fisheries Section	Annually	Two streams currently, in Sturbridge and Sutton.
	Connecticut River Fish Assemblages	First Light/DFW Fisheries Section	2015-2016	Component of FERC relicensing of Turners Falls Dam and Northfield Mountain Pumped Storage Facility

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
	Dam Removals	DFW/Fisheries Section/TNC	Varies	Fish assemblage surveys as needed; currently for Nissitissit River
Amphibians	North American Amphibian Monitoring Program	UMass Cooperative Extension Program	Annually	Surveys of 25 set routes for calling anurans; MA website and protocols
	Eastern Spadefoot	DFW/NHESP, Kestrel Land Trust, Grassroots Wildlife, Mass Audubon	Currently monthly	Surveys of constructed pools for spadefoots in Sunderland and Barnstable
	Eastern Spadefoot	National Park Service	Annually	Surveys on Cape Cod National Seashore
	Marbled Salamander	DFW/NHESP	Annually	Population monitoring; distribution surveys
	Blue-spotted and Jefferson Salamanders	DFW/NHESP, cooperators	Annually	Population monitoring; distribution surveys
	Anuran Call Survey	USFWS/Assabet, Great Meadows, Oxbow National Wildlife Refuges	Annually	Inventory
Reptiles	Northern Red-bellied Cooter	DFW/NHESP, USFWS, UMass, various cooperators	Annually, through at least 2016; longer intervals after that	Monitor nesting; assess success of previous headstarting efforts
	Northern Red-bellied Cooter	USFWS/Massasoit National Wildlife Refuge	Annually	Monitoring to inform management
	Northern Diamond-backed Terrapin	Mass Audubon and cooperators	Annually	Nest locations, threats, and population size
	Bog Turtle	DFW/NHESP, various cooperators	Annually	Population monitoring
	Blanding's Turtle	DFW/NHESP, various cooperators	Every 3-5 years	Population monitoring; distribution surveys
	Blanding's Turtle	USFWS/Assabet, Great Meadows, Oxbow National Wildlife Refuges; Grassroots Wildlife Conservation	Annually	Baseline monitoring; monitoring to inform management
	Wood Turtle	DFW/NHESP, various cooperators	Every 3-5 years	Population monitoring; distribution surveys
	Eastern Box Turtle	DFW/NHESP, various cooperators	Every five years	Population monitoring; distribution surveys
	Eastern Box Turtle	National Park Service	Annually	Surveys on Cape Cod National Seashore
	Spotted Turtle	DFW/NHESP, various cooperators	Every five years	Population monitoring; distribution surveys

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
	Eastern Hog-nosed Snake	National Park Service	Annually	Surveys on Cape Cod National Seashore
	Coverboard Surveys (Snakes)	USFWS/Parker River National Wildlife Refuge	Annually	Inventory
Birds	Breeding Bird Survey	US Geological Survey Patuxent Wildlife Research Center	Annually	Point counts along 24 routes in MA, assessing long-term breeding bird population trends
	Christmas Bird Count	National Audubon	Annually	Species and numbers surveys in 34 circles in MA, assessing long-term wintering population trends
	Federally listed birds breeding in MA – Piping Plover, Roseate Tern	DFW/NHESP, USFWS, with numerous cooperators	Annually	Intensive monitoring of every pair, including productivity, threats
	MESA-listed birds state-wide	DFW/NHESP	Varies depending on species	Population size, threats
	Ruffed Grouse	DFW/Wildlife Section	Annually	Roadside drumming surveys state-wide
	USFWS American Woodcock Singing Ground Surveys	DFW/Wildlife Section	Annually	Roadside singing surveys state-wide
	American Black Duck	DFW/Wildlife Section	Annually	Post-breeding season banding to determine survival rates; midwinter coastal surveys' waterfowl breeding surveys
	Common Eider	DFW/Wildlife Section	Annually	Midwinter coastal surveys
	Long-tailed Duck	DFW/Wildlife Section	Annually	Midwinter coastal surveys
	American Kestrel	DFW/Wildlife Section and NHESP, Mass Audubon, numerous other cooperators	Annually	Monitoring of kestrel nesting boxes; banding to determine wintering areas and migratory pathways
	Coastal waterbirds - Common, Arctic, and Least Terns; Laughing Gulls; American Oystercatcher	DFW/NHESP, USFWS, numerous cooperators	Annually	Nest locations and success rates; staging locations and counts; disturbances
	Common Loon	DFW, Dept. of Conservation and Recreation	Annually	Nest locations and productivity
	Bald Eagle	DFW, various cooperators	Annually	Nest locations and productivity
	Bald Eagle Mid-winter Survey	USFWS/Assabet National Wildlife Refuge	Annually	Baseline monitoring
	Peregrine Falcon	DFW, various cooperators	Annually	Nest locations and productivity
	American Woodcock and Eastern Whip-poor-will	USFWS/Assabet, Great Meadows, Parker River National Wildlife Refuges	Annually	Monitoring to inform management
	Saltmarsh Sparrow Surveys	USFWS/Monomoy, Parker River National Wildlife Refuges	Annually	Inventory; baseline monitoring

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
	Breeding Landbirds and Habitat	USFWS/Assabet, Great Meadows, Oxbow, Parker River National Wildlife Refuges	Annually	Monitoring to inform management; baseline monitoring
	Migrating Landbirds and Habitat	USFWS/Assabet, Monomoy, Nomans Land Island, Oxbow National Wildlife Refuges	Annually	Monitoring to inform management
	Migrating Common Nighthawks	USFWS/Great Meadows National Wildlife Refuge	Annually	Inventory
	Migrating Raptors	USFWS/Assabet, Nomans Land Island National Wildlife Refuge	Annually	Inventory
	Migrating Shorebirds	USFWS/Monomoy, Nantucket, Nomans Land Island National Wildlife Refuge	Annually	Baseline monitoring
	Shorebird Disturbance Study	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
	Migrating Waterfowl	USFWS/Assabet, Great Meadows, Oxbow National Wildlife Refuges	Annually	Inventory
	Secretive Marshbird Survey	USFWS/Assabet, Great Meadows, Nomans Land Island, Oxbow National Wildlife Refuges	Annually	Baseline monitoring
	Impoundment Waterbird Monitoring	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
	Impoundment Marsh and Wading Bird Monitoring	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
	Integrated Waterbird management and Monitoring (IWMM) Vegetation Survey	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
	Wading Bird Census	USFWS/Monomoy National Wildlife Refuge	Annually	Baseline Monitoring
	Vegetative and Bird Response to Water Level Management	USFWS/Great Meadows National Wildlife Refuge	Annually	Monitoring to inform management
	Baseline Bird Surveys	USFWS/Mashpee National Wildlife Refuge	Annually	Inventory
	Shrub Bird Area Searches and Shrub Bird Activity Budgets	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
	Landbird Point Count	USFWS/Massasoit, Nomans Land Island National Wildlife Refuge	Annually	Monitoring to inform management
	Sparrow Productivity Survey (Hg Levels)	USFWS/Parker River National Wildlife Refuge	Annually	Baseline Monitoring

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
	Bird Banding	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
	Avian Influenza Surveillance	USFWS/Monomoy National Wildlife Refuge	Annually	Baseline Monitoring
	Wind Turbine Pre- and Post-Construction Monitoring	USFWS/Monomoy National Wildlife Refuge	Annually	Baseline Monitoring
Mammals	New England Cottontail	DFW/Wildlife Section, numerous cooperators	Annually	Road-kill, hunter harvest, and winter pellet surveys, targeted at and near known or suspected locations of New England Cottontail
	New England Cottontail Habitat Suitability and Species Presence	USFWS/Assabet, Great Meadows, Mashpee, Massasoit, Nomans Land Island, Oxbow National Wildlife Refuges	Annually	Monitoring to inform management
	Vegetation Composition and Structure (New England Cottontail and habitat)	USFWS/Mashpee National Wildlife Refuge	Annually	Monitoring to inform management
	Black Bear	DFW/Wildlife Section, Massachusetts Cooperative Fish and Wildlife Research Unit	Annually	Mortality and distribution data (hunting and non-hunting); radio-tracking of female bears with cubs; surveys of people re attitudes towards bears; to inform a population model and develop a comprehensive Black Bear management plan
	Bobcat	DFW/Wildlife Section	Annually	Mortality and distribution data (hunting and non-hunting)
	Moose	DFW/Wildlife Section	Annually	Mortality and distribution data (hunting and non-hunting)
	Bat Monitoring	USFWS/Assabet, Great Meadows, Oxbow, Parker River National Wildlife Refuges	Annually	Inventory
	Resident Bat Inventory	USFWS/Assabet, Great Meadows, Mashpee, Oxbow, Parker River, Silvio O. Conte, Thacher Island National Wildlife Refuges	Annually	Inventory
	Resident and Migrating Bat Inventory/Monitoring	USFWS/Massasoit National Wildlife Refuges	Annually	Baseline Monitoring
Misc. Invertebrates	No systematic monitoring			
Snails	No systematic monitoring			

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
Freshwater Mussels	SWAP mussels state-wide	DFW/NHESP	Rotating 5-year schedule	Updates of older surveys, de novo surveys, population monitoring, threats
Crustaceans	SWAP crustaceans state-wide	DFW/NHESP	Rotating 5-year schedule	Updates of older surveys, de novo surveys, population monitoring, threats
Odonates	SWAP odonates state-wide	DFW/NHESP	Rotating 5-year schedule	Updates of older surveys, de novo surveys, population monitoring, threats
	Bee and Dragonfly Inventory	USFWS/Parker River National Wildlife Refuge	Annually	Inventory
Beetles	Northeastern Beach Tiger Beetle	USFWS, DFW, cooperators	Annually	Population monitoring
	Puritan Tiger Beetle	USFWS?	Annually	Population monitoring
Lepidoptera	MESA-listed moths and butterflies state-wide	DFW/NHESP	Annually	Updates of older surveys, de novo surveys, population monitoring
Bees	State-wide Fauna	Michael Veit, Joan Milam, cooperators	2010-2015	Creation of list of all bee species in MA, including county lists
	Pollinator Surveys	USFWS/Nomans Land Island National Wildlife Refuge	Proposed	Baseline monitoring
	Bee and Dragonfly Inventory	USFWS/Parker River National Wildlife Refuge	Annually	Inventory
Plants	Federally listed plants – Sandplain Gerardia, Small Whorled Pogonia, Northeastern Bulrush	DFW/NHESP	Annually	Population size, landscape context, nearby invasive species, other threats
	Federally listed plant – Seabeach Amaranth	USFWS, DFW/NHESP	Proposed	Do novo surveys; monitoring of planned reintroduction
	Regionally rare plants	New England Wild Flower Society, including NEPCoP and PCVs	Varies depending on species	Population size, landscape context, nearby invasive species, other threats; seed banking
	Regional seed bank	New England Wild Flower Society	Varies depending on species	Includes species from across New England
	MESA-listed plants state-wide	DFW/NHESP	Varies depending on species	Population size, landscape context, nearby invasive species, other threats; includes regular updates for known sites and de novo surveys
	MESA-listed plants on The Trustees of Reservations (TTOR) properties	TTOR	Varies depending on species	Population size, landscape context, nearby invasive species, other threats
	MESA-listed species on The Nature Conservancy (TNC) Massachusetts properties	TNC	Varies depending on species	Population size, landscape context, nearby invasive species, other threats
	MESA-listed species on Sheriff's Meadow Foundation properties, Martha's Vineyard	Sheriff's Meadow Foundation	Varies depending on species	Population size, landscape context, nearby invasive species, other threats

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
	MESA-listed species on Nantucket Conservation Foundation properties, Nantucket	Nantucket Conservation Foundation	Varies depending on species	Population size, landscape context, nearby invasive species, other threats
	Rare Plants and Natural Communities	USFWS/Assabet, Great Meadows, Oxbow National Wildlife Refuges	Annually	Coop monitoring to inform management
	Franklin County Flora	Franklin County Flora group – Robert Bertin, Matt Hickler, Glenn Motzkin, Karen Searcy, cooperators	2010 to probably 2017	Inventorying all plant species for a county flora, including town-by-town lists
	Hampshire County Flora	Laurie Sanders, cooperators	2015 to probably 2020	Inventorying all plant species for a county flora, including town-by-town lists
	Flora of Myles Standish State Forest and vicinity	Irena Kadis, Alexey Zinovjev	2010-2016	Concentration on inventorying plants in Myles Standish State Forest and nearby areas; to be expanded eventually to a flora of Plymouth County
	Plant Inventory and Herbarium	USFWS/Parker River National Wildlife Refuge	Annually	Inventory
	Occasional surveys	Framingham State College students with Bryan Connolly Bridgewater State College students with Don Padgett Smith College students with Jesse Bellemere	Varies	May include population size, landscape context, nearby invasive species, other threats
Upland Forest	Forest Cutting Operations on DFW conservation easement holdings	DFW/Wildlife Section	As needed	Balance of current and desired conditions, overall landscape context, wetland crossings, invasives, impacts to wildlife habitat, BMPs
Young Forests and Shrublands	Early successional areas on DFW Wildlife Management Areas	DFW/Wildlife Section and NHESP	As needed	Pre- and post-treatment monitoring of birds, butterflies, rare plants, invasive plants, and tree species to determine efficacy of early succession area creation efforts
	Post-Burn Monitoring	USFWS/Assabet, Mashpee, Massasoit, Monomoy National Wildlife Refuge	Annually	Monitoring to inform management
	Shrubland Adaptive Management Project	USFWS/Great Meadows National Wildlife, Parker River Refuges	Annually	Monitoring to inform management
	Shrubland Vegetative Composition and Structure	USFWS/Nomans Land Island National Wildlife Refuge	Annually	Monitoring to inform management

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
	Shrubland Adaptive Management Project Berry Survey	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
Rivers and Streams	Stream Continuity	MA Dept. of Environmental Protection, TNC	Annually	Surveys for impediments to upstream animal movements (dams, under-sized culverts, etc.)
Freshwater Marshes	Open Marsh Water Management	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
Salt Marshes	Salt Marsh Integrity Assessment	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
	Salt Marsh Process Monitoring (Ice Rafts and Pool Evolution)	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
	Surface Elevation and Accretion Monitoring	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
Vernal Pools	Vernal Pool Certification	DFW/NHESP	As needed	Species present, size, location, and condition of functioning vernal pools
	Obligate Vernal Pool Breeders	USFWS/Assabet, Great Meadows, Oxbow National Wildlife Refuges	Annually	Baseline monitoring
General Vegetation	Vegetation Cover Type Map Development	USFWS/Assabet, Great Meadows, Mashpee, Massasoit, Monomoy, Nomans Land Island, Oxbow National Wildlife Refuges	Annually	Inventory
	Native and Nonnative Vegetation	USFWS/Monomoy National Wildlife Refuge	Annually	Monitoring to inform management
	Impoundment Vegetation Survey	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
Ecological Processes	Harvard Forest Long Term Ecological Research Program	Harvard University	Annually	Effects of wind and fire, past climate change, land-use and landcover dynamics, atmospheric pollution, global temperature changes, land management, land policy and conservation
	Plum Island Ecosystem Long Term Ecological Research Program	Woods Hole Marine Biological Laboratory	Annually	Coastal processes, including meteorological data, sea level changes, salt marsh carbon balance
Open Water and Wetlands	Water Quality Monitoring	MA Dept. of Environmental Protection	Varies	Sediment load, dissolved oxygen, water chemistry, fish community, aquatic macroinvertebrate community, other measures of water quality

Target Species/ Habitat	Monitoring Program	Survey Organizations	Frequency	Comments
	Watershed/Lake/Beach Water Quality Assessments	MA Dept. of Environmental Protection	Multi-year	Sediment load, dissolved oxygen, water chemistry, fish community, aquatic macroinvertebrate community, other measures of water quality
	Acid Rain Monitoring Project	University of Massachusetts Water Resources Research Center	Annually	pH, alkalinity, total phosphorus, major cations and anions, in lakes, ponds, and streams
Invasive Species	Hardy Kiwi (exotic invasive vine; *Actinidia arguta*)	Mass Audubon/Town of Lenox/DFW/NHESP	Currently annually	Surveys to determine extent of infestation in Town of Lenox
	Invasive Species Mapping	USFWS/Assabet, Great Meadows, Mashpee, Massasoit, Nomans Land Island, Oxbow, Parker River National Wildlife Refuges	Annually	Monitoring to inform management
	Hemlock Woolly Adelgid	USF7WS/Great Meadows National Wildlife Refuge	Annually	Monitoring to inform management
	Perennial Pepperweed Monitoring	USFWS/Parker River National Wildlife Refuge	Annually	Monitoring to inform management
Predators	Predator Presence and Impacts	USFWS/Monomoy National Wildlife Refuge	Annually	Monitoring to inform management
Miscellaneous	Insect Inventory and Herbarium	USFWS/Parker River National Wildlife Refuge	Annually	Inventory

C. Effectiveness of Conservation Actions

Massachusetts is committed to an adaptive management approach to the conservation of SWAP species and habitats. As part of this approach, the effectiveness of conservation actions must be appropriately monitored, and changes made as needed to the conservation actions over time.

The effectiveness of conservation actions described in this Plan will be measured using a set of standard effectiveness measures that have been developed by the Association of Fish and Wildlife Agencies (AFWA 2011). The USFWS *Wildlife TRACS* database (see Section A, above) will be used to compile the resulting values and to compare the values over time, as conservation actions are undertaken.

The complexities of natural systems often make it difficult to assess if conservation actions are indeed effective. Simplified models called results chains (Margoluis and Salafsky 1998; Foundations of Success 2009) can be constructed to clarify the links among an initial population or habitat, conservation actions targeting the resource, and the desired outcome. Figure 7-1 is an example of a results chain for one conservation action targeting Northern Red-bellied Cooter.

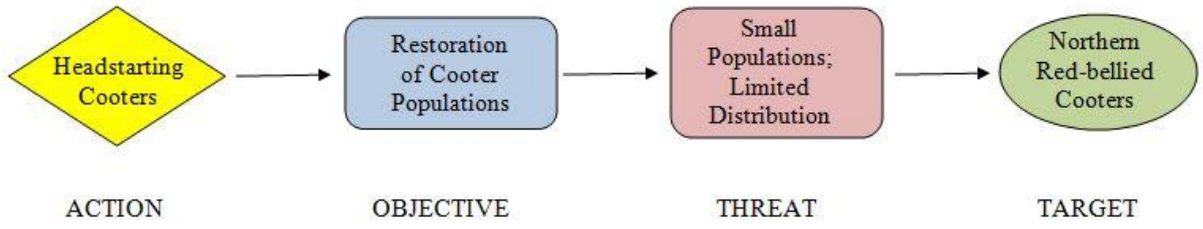

Figure 7-1: Example of a Results Chain

In this case, measuring the change in condition and distribution of cooter populations over time, after headstarting, will measure the effectiveness of the conservation action. In fact, recent assessments of cooter populations in Massachusetts have demonstrated that headstarted cooters did survive to adulthood, thus increasing the population, and have spread to other waterbodies.

Not all natural situations are as easily described as is cooter headstarted. Many SWAP species in Massachusetts are found only or primarily in coastal plain ponds. These ponds are thought to be threatened by nonpoint source pollution from shoreline development, destruction of shoreline habitat by beaches and docks, and by drinking water withdrawal from nearby wells, among other threats. One species emblematic of coastal plain pondshores is the plant Plymouth Gentian; in Figure 7-2, a set of parallel conservation actions, we use the condition of Plymouth Gentian populations as the indicator target for the health of coastal plain ponds overall.

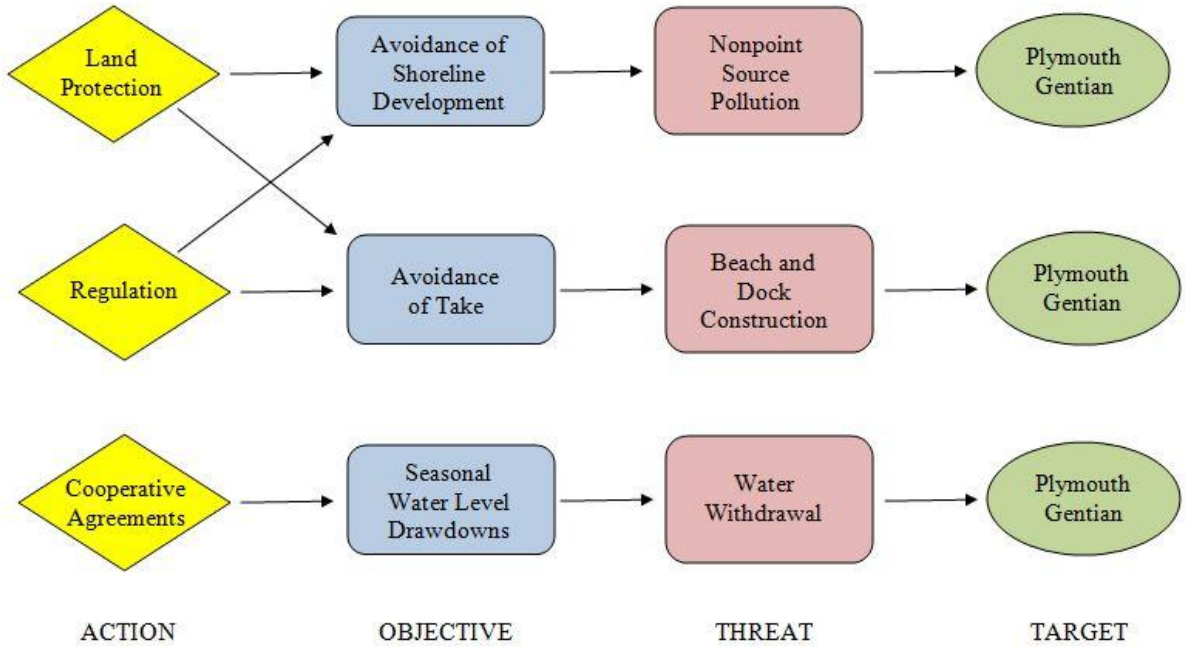

Figure 7-2: Example of a Multi-Action Results Chain

It is likely that not all three potential conservation actions could be implemented everywhere there are or could be Plymouth Gentian populations. Comparison of the effectiveness of these actions may reveal, for example, that ponds completely protected all around their shoreline still do not support robust Plymouth Gentian populations because water levels remain too high throughout the season to allow the plant to grow along the shoreline (in fact, the water levels in many Massachusetts coastal plain ponds has remained too high in recent years to allow the successful growth and flowering of coastal plain pondshore specialists). Thus, it may be necessary to develop cooperative agreements with municipal water departments to ensure that enough groundwater is pumped out that pondshores emerge towards the end of the summer, a regime coastal plain pond plants are adapted to. Land protection and regulation may be insufficient to conserve Plymouth Gentian and the pondshore habitat; constructing and using results chains like those in Figure 7-2 can illuminate these complexities in effecting conservation.