Rhode Island Wildlife Action Plan

2015

Chapter 3

Threats to Rhode Island's SGCN and Key Habitats

The Nature Conservancy
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State of Rhode Island Department of Environmental Management

The University of Rhode Island

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Introduction

Rhode Island's SGCN and their key habitats face numerous problems or threats that may adversely affect them and compromise their status in the state. Some of these threats are global or national in scale, while others may be regional, statewide, or local. Identifying the threats to Rhode Island's SGCN and key habitats is an important component in developing effective conservation actions for this SWAP. Once identified, threats can be addressed through actions that RI DEM DFW and its partners have developed throughout this SWAP process, and implemented for long-term conservation of SGCN and key habitats as resources and opportunities allow. The previous two chapters identified Rhode Island's SGCN (Element 1) and key habitats (Element 2); this chapter addresses the threats affecting these important conservation targets (Element 3).

SWAPs are required to identify the "problems which may adversely affect species of conservation need and their habitats." These "problems" include threats that stress wildlife species and habitats, as well as management challenges such as deficiencies in data or resources for particular species or habitats. Human activities and natural processes that affect wildlife species and habitats in negative or detrimental ways are threats, while the effects of these threats on particular wildlife species or habitats are known as stress responses or stressors. Threats may be species-specific, affecting a species by a direct action or through indirect impacts by limitation of a particular habitat condition, or limiting factor. Although terms are often used interchangeably, the word "threat" is used in this document as an umbrella term referring to all aspects of the process by which human actions or natural events may jeopardize fish and wildlife species and their habitats. This RI WAP uses the IUCN categories of threats (Salafsky et al. 2008) to describe and present them in a consistent way, as recommended by the Northeast Lexicon and Synthesis (Crisfield and NEFWDTC 2013; Terwilliger and NEFWDTC 2013).

All species have likely been impacted by human activities. Some have taken advantage of the conditions found in developed areas; alien and invasive species such as European Starling, Rock Pigeon, Tree-of-heaven, and many others have thrived. A few native species have found a surrogate habitat in urban areas as natural habitats have diminished. Some examples of these opportunists in Rhode Island include the Common Nighthawk, Chimney Swift, and Peregrine Falcon. The majority of Rhode Island's wildlife populations are vulnerable to multiple threats associated with human activities, and the SGCN list identifies the most vulnerable. Following this chapter (Chapter 4), threats are targeted and addressed by the actions to implement long-term conservation of SGCN and key habitats.

Threats in the Northeast Region

There is no comprehensive assessment of threats across the northeastern region. However, numerous threats to fish, wildlife, and their habitats have been identified by the northeastern states as part of their individual SWAPs. After the completion of the 2005 CWCSs, a survey was conducted to identify common threats listed by states (AFWA 2011) and the predominant threats are listed in Table 3-1 in descending order. The 13 northeastern states and the District of Columbia identified 37 common, recurring threats to SGCN or their habitats (AFWA unpublished and 2011). The most frequently mentioned threats included invasive species (mentioned by 100% of northeastern states) and industrial effluents (pollution); commercial and industrial areas; housing and urban development; and agricultural and forestry effluents (all of which were mentioned by at least 83% of northeastern states). Other important challenges mentioned by 50% or more of the northeastern states included: dams and water management; habitat shifting and alteration; recreational activities; roads and railroads; storms and flooding; temperature extremes; logging and wood harvesting; problematic native species; harvest or collection of animals; lack of information or data gaps; and droughts. In addition to the specific threats mentioned in the 2005 CWCSs, recent work by the northeastern states has emphasized the importance of additional, emerging threats such as climate change, exurban developments, new invasive species, and disease. The following table fails to convey the fact that climate change can exacerbate other threats, as previously discussed in Chapter 1 within taxonomic group discussions. A few examples of exacerbated effects from climate change: heavier rains are more effective at transporting nutrients and pollutants to water bodies than light rains (negatively impacting water quality), heavy rains cause worse erosion, and invasives thrive in warmer temperatures (M. Staudinger, NECSC pers. comm. 2015).

Table 3-1. Key Threats Identified by Northeastern States in Their Wildlife Action Plans

Key Threats Identified by Northeastern States in their Wildlife Action Plans (in descending order of listing recurrences)
Invasive & Other Problematic Species & Genes: Invasive non-native/alien species
Pollution: Household sewage & urban waste water
Pollution: Industrial & military effluents
Pollution: Agricultural & forestry effluents
Residential & Commercial Development: Housing & urban areas
Residential & Commercial Development: Commercial & industrial areas
Human Intrusions & Disturbance: Recreational activities
Natural System Modifications: Dams & water management/use
Climate Change & Severe Weather: Habitat shifting & alteration
Climate Change & Severe Weather: Storms & flooding
Climate Change & Severe Weather: Temperature extremes
Barriers/Needs: Lack of biological information/data gaps
Climate Change & Severe Weather: Droughts
Transportation & Service Corridors: Roads & railroads
Biological Resource Use: Harvesting/collecting terrestrial animals
Biological Resource Use: Logging & wood harvesting
Natural System Modifications: Other ecosystem modifications
Invasive & Other Problematic Species & Genes: Problematic native species
Biological Resource Use: Harvesting aquatic resources
Pollution: Air-borne pollutants
Barriers/Needs: Natural Resource Barriers: Low population levels, insufficient habitat requirements, etc.
Pollution: Garbage & solid waste
Agriculture & Aquaculture: Wood & pulp plantations
Pollution: Excess energy

Key Threats Identified by Northeastern States in their Wildlife Action Plans (in descending order of listing recurrences)
Barriers/Needs: Lack of capacity/funding for conservation actions
Barriers/Needs: Lack of education/outreach with public and other stakeholders
Natural System Modifications: Fire & fire suppression
Agriculture & Aquaculture: Non-timber crops
Residential & Commercial Development: Tourism & recreation areas
Barriers/Needs: Lack of monitoring capacity/infrastructure
Barriers/Needs: Lack of capacity/infrastructure for data management
Barriers/Needs: Administrative/political barriers
Transportation & Service Corridors: Shipping lanes
Biological Resource Use: Gathering terrestrial plants
Energy Production & Mining: Renewable energy
Energy Production & Mining: Mining & quarrying

To provide consistency in identifying threats to SGCN and key habitats, the IUCN standard lexicon of threats (and actions, described in Chapter 4) was adopted for use in SWAPs (Salafsky et al. 2008). "Threats" are defined as, "the proximate human activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets." The RI WAP technical committees applied this lexicon when identifying the specific threats to Rhode Island SGCN and key habitats, the results of which are outlined in Table 3-2 and 3-3.

Identifying Threats to Species of Greatest Conservation Need and Key Habitats in RI

The IUCN threat classification system was also used in RI to report threats at the state level, the taxa level, the habitat level and the species level. The Northeast Lexicon was used to assess degree of threat. The RI WAP Technical and Scientific Teams reviewed and reevaluated the threats listed in the 2005 CWCS as well as additional updated threat information according to these standardized protocols. Climate change and emerging diseases are examples of threats where more updated information was incorporated into the threats determination, assessment and ranking process.

Over 100 existing conservation programs and plans were identified through a literature search and were used as a foundation from which to develop the list of threats in this chapter, the WAP, its Profiles and the companion document. Key citations are listed at the end of this chapter on threats to SGCN and their habitats, and additional threats were compiled from current local, state and regional, national and international conservation plans listed in Appendix 1a. Appendix 3 represents threat classification system used by the many partners to identify and rank threats for the RI WAP.

Through a series of workshops, teams of experts, partners and stakeholders identified and ranked the 2005 and additional updated information on threats to SGCN. Teams then grouped and condensed these threats, where similar, for species suites, habitat associations, or broader taxa applicability. A similar process was conducted for identifying and updating threats to each key habitat. Habitat threats were also grouped and condensed to higher tier habitat groupings whenever possible to reduce redundancy and highlight common threats. Table 2-3 presented the best available assessment (by the Technical and Habitat Teams) of degree of threat to each key habitat and its relative condition.

To highlight the link from threats and actions, priority actions presented in this document are linked to the threat addressed. Threats are coupled with actions and are listed for each hierarchical level (from general statewide to specific species) in Chapter 4, and are listed in Appendix 4 and the species and habitat profiles. Appendix 3 outlines threats at the statewide, taxa, and habitat levels.

The following tables and figures depict the key threats identified to Rhode Island fish and wildlife. Figure 3-1 depicts the ranked threats to the SGCN. The ranking for this table was produced using a rank coefficient for each threat and the number of times that the threat is given for each of these. Should a threat be listed first (revealing a rank of 1), the Rank Coefficient if 10; should a threat be listed second (revealing a rank of 2), the Rank Coefficient is 3.1623, should a threat be listed third (revealing a rank of 3) the Rank Coefficient is 1.7783, and so on with an exponential decrease (decrease by square root) in Rank Coefficient, with a place of seventh the Rank Coefficient is only 1.0366. The purpose of this simple method is to give greater weight to initial levels, focusing on making the primary level the priority. Table 3-2 depicts the threats to SGCN taxa and Table 3-3 depicts the threats to Rhode Island's key habitats.

It is clear that residential and commercial development pose the greatest threat overall to SGCN. Natural systems modifications, pollution, biological resource use, and invasive species are other top threats to species. In comparison, invasive species are listed as a top threat to Rhode Island's key habitats followed by pollution and development.

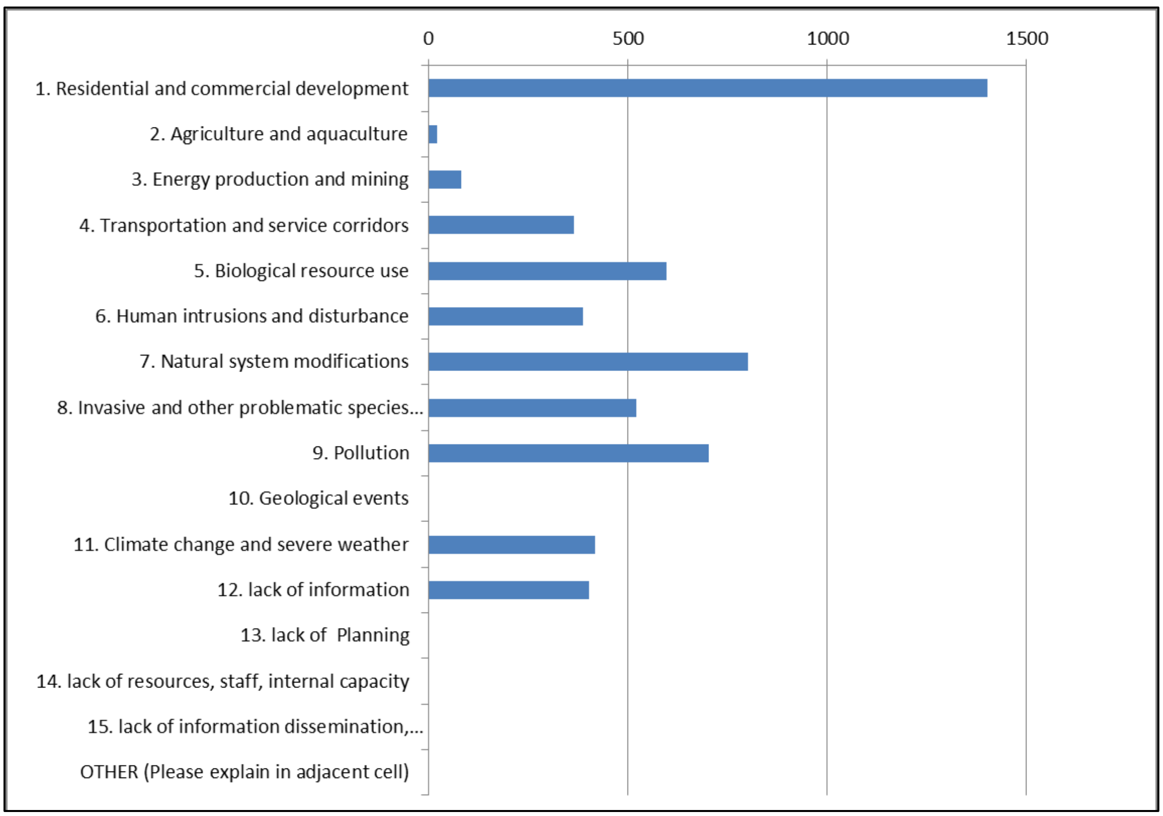

Figure 3-1 General Species Threats and Total Ranked Score

Table 3-2. General Threats and Percent of SGCN Affected

IUCN Threat Code	BIRD	MAM	FISH	HERP	INV	ALL[reg]	ALL[norm]
1. Residential and commercial development	50%	52%	18%	70%	59%	53%	50%
2. Agriculture and aquaculture	2%	19%	0%	4%	0%	2%	5%
3. Energy production and mining	14%	14%	0%	0%	0%	4%	6%
4. Transportation and service corridors	2%	24%	2%	78%	11%	12%	24%
5. Biological resource use	15%	48%	53%	48%	22%	26%	37%
6. Human intrusions and disturbance	46%	43%	0%	39%	14%	24%	28%
7. Natural system modifications	49%	14%	20%	61%	20%	30%	33%
8. Invasive and other problematic species and genes	37%	33%	24%	78%	19%	28%	38%
9. Pollution	31%	38%	53%	48%	51%	45%	44%
10. Geological events	0%	0%	0%	0%	0%	0%	0%
11. Climate change and severe weather	41%	5%	29%	70%	27%	32%	34%
12. Lack of information	20%	19%	9%	22%	8%	12%	15%

Table 3-3. Key Threats to Rhode Island Key Habitats

Threat	Primary	Secondary	Tertiary	Overall
Invasive and Other Problematic Species	16%	50%	31%	97%
Residential and Commercial Development	47%	2%	3%	52%
Climate Change and Severe Weather	14%	22%	5%	41%
Natural System Modifications	9%	21%	3%	33%
Transportation and Service Corridors	--	16%	16%	31%
Pollution	3%	10%	16%	29%
Human Intrusion and Disturbance	16%	3%	3%	22%
Biological Resource Use	--	--	2%	2%
Energy Production and Mining	--	2%	--	2%

Residential and Commercial Development

A primary threat to Rhode Island's fish, wildlife, and their habitats is conversion of land by human development for housing, urban areas, commercial, industrial, and recreational uses. Since its colonization 400 years ago, southern New England continues to be one of the most densely populated regions in the country. Rhode Island is the second most densely populated state, with 1,052,567 residents (US Census 2010) occupying roughly 1,045 square miles. This figure is only about 0.4% higher than the population reported in the 2000 Census, and is the lowest rate of population growth of the New England states, which averaged 3.8% for the region (US Census 2010).

Although Rhode Island's population has not grown appreciably there has been a continuing trend of population declines in cities and towns within the urbanized corridor, and population increases in rural communities (Table 3-4). For example, the town of West Greenwich, one of the more rural communities in the western part of the state, experienced the highest growth rate at 20.6%, an increase of approximately 1,050 new residents. The town of South Kingstown added more than 2,700 new residents for a growth rate of 9.7% (US Census 2010). Increases in rural populations tend to be accompanied by a rise in new homes. For example, in West Greenwich during the seven year period of 2006-2012 there was a 23% increase in the number of housing units.

Table 3-4. Population Growth Rates in Rhode Island Municipalities 2000 – 2010

Urban Communities*		Suburban Communities		Rural Communities	
City/Town	GR	City/Town	GR	City/Town	GR
Providence	+2.5	Cumberland	+5.2	W. Greenwich	+20.6
Central Falls	+2.4	Smithfield	+4.0	N. Smithfield	+12.7
Cranston	+1.4	Bristol	+2.2	S. Kingstown	+9.7
N. Providence	- 1.0	Johnston	+2.0	Foster	+7.8
W. Warwick	- 1.3	E. Greenwich	+1.5	Richmond	+6.7
Pawtucket	- 2.5	Portsmouth	+1.4	Exeter	+6.3
E. Providence	- 3.4	Lincoln	+1.0	Hopkinton	+4.5
Warwick	- 3.7	N. Kingstown	+0.6	Block Island	+4.1
Woonsocket	- 4.7	Westerly	- 0.8	Coventry	+4.0
Newport	- 6.8	Barrington	- 3.0	Tiverton	+3.4
		Narragansett	- 3.0	Burrillville	+1.0
		Jamestown	- 3.9	Scituate	0
		Warren	- 6.6	Charlestown	- 0.4
		Middletown	- 6.8	Glocester	- 2.0
				Lit. Compton	- 2.8
Overall GR	**- 0.8**	**Overall GR**	**+0.3**	**Overall GR**	**+5.2**

Source: US Census, GR=Growth Rate
* Communities assigned to Urban, Suburban, and Rural categories based on designations provided by GrowSmart RI (2000).

Commercial and industrial development inevitably accompanies housing, and recent trends in commercial development have been spacious "big box" developments, superstores, shopping villages, and regional distribution facilities that consume large acreages of habitat.

Increases in residential and commercial development in rural areas accounts for much of the reported losses in wildlife habitat and other natural resources. The 2008 forest survey of Rhode Island conducted by the USFS reported a total of 348,400 acres of forest in the state which is a reduction of more than 11% from the 393,000 acres reported in 1998 (RI DEM DFE 2014, Butler 2014). Figure 3-2 provides one illustration of a recent "big box" development in the town of North Smithfield, Rhode Island that has consumed more than 175 acres of deciduous forest habitat.

Figure 3-2. Aerial Photographs from 2008 and 2011 Showing the Development of a "Big Box" Complex (Dowling Village) in the Town of North Smithfield, RI

According to the NRCS, widespread development has resulted in a significant loss of prime farmland in Rhode Island with approximately 50,000 acres (25%) converted to non-farmland uses during the 23-year period from 1981-2004 (NRCS 2014) (Figure 3-3).

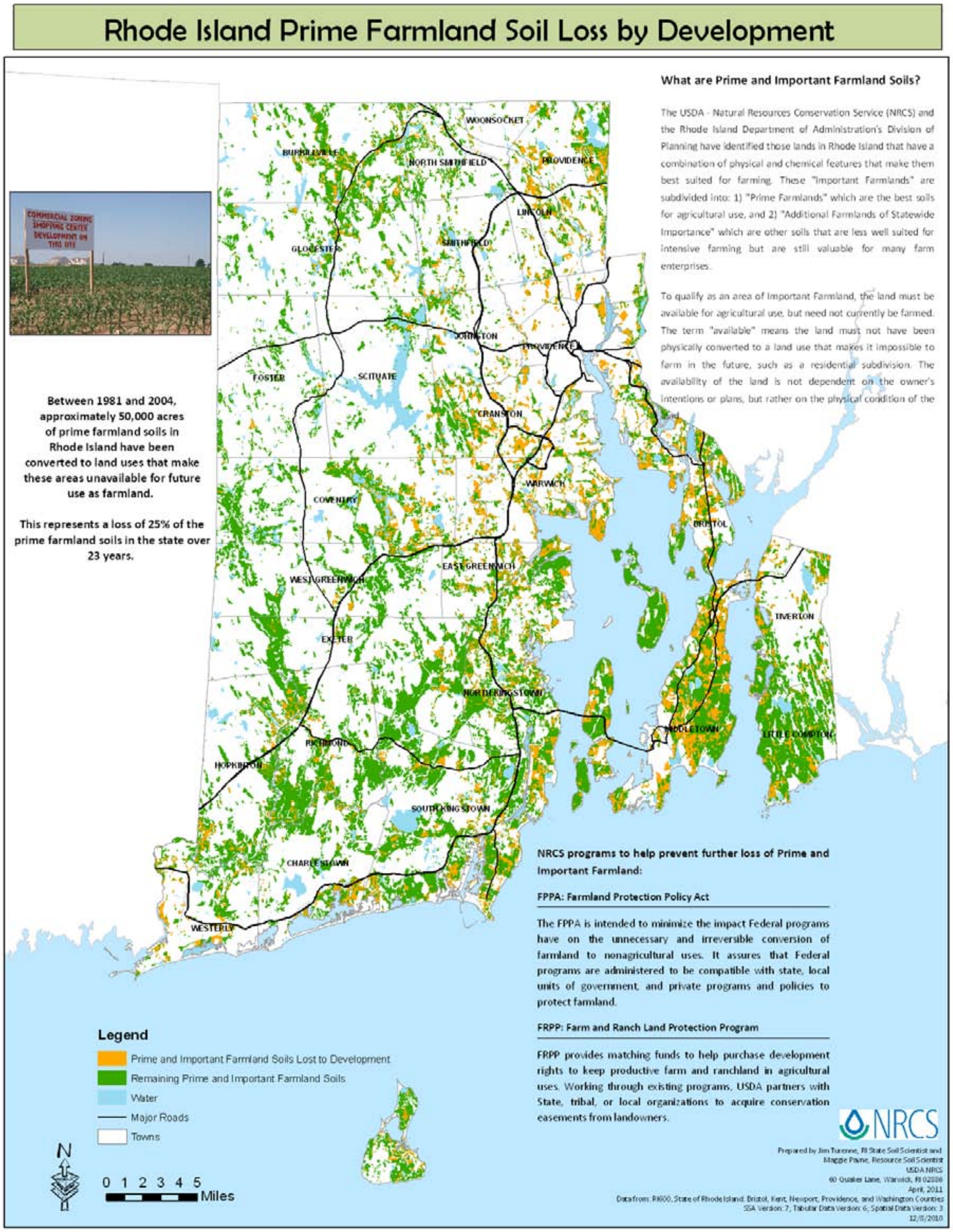

Figure 3-3. Rhode Island Prime Farmland Soil Loss by Development. Source: NRCS 2014

Transportation infrastructure that accompanies development compounds impacts by further fragmenting habitats and interrupting wildlife travel corridors to breeding, spawning, and wintering habitats. Table 3-5 provides an indication of the increase in miles of public roads in Rhode Island.

Results of the Geospatial Condition Analyses (Anderson et al. 2013) shed additional light on the extent of these threats in the Northeast. In general, high density development of natural habitats can change local hydrology, increase recreation pressure, introduce invasive species either by design or by accident with the introduction of vehicles, and bring significant disturbance to the area. Urbanization and forest fragmentation are inextricably linked to the effects of climate change, because the dispersal and migration of forest plants and animals are disrupted by development and roads.

Fragmentation subdivides large contiguous areas of natural land into smaller patches, resulting in each patch having more edge habitat and less interior. Because edge habitat contrasts strongly with interior the surrounding edge habitat tends to isolate the interior region and contribute to its degradation. Thus fragmentation can lead to an overall deterioration of ecological quality and integrity, and a shift in associated species from interior specialists to edge generalists.

Table 3-5. Total Miles of Public Roads in Rhode Island. Source: US DOT 2013

Road Type	1995	2000	2012
Urban	4572	4720	5256
Rural	1321	1333	1224*
Total	**5893**	**6053**	**6480**

* 2012 figure for rural roads reflects a reclassification of previously designated "rural" areas to "urban" areas, rather than a decline in the number of rural road miles.

In Figure 3-4, Westerly Airport is at the top, the Atlantic Ocean on the bottom. The 1988 photo clearly shows the complex of vernal ponds in this area, with housing development beginning to encroach from the west.

Figure 3-4. Aerial Photograph from 1988 of a Portion of the Westerly Moraine

The 2008 photo (Figure 3-5) shows the amount of development that occurred in 20 years and how the ponds have been isolated and amphibian movement corridors compromised.

Figure 3-5. Aerial Photograph from 2008 of a Portion of the Westerly Moraine

Development patterns in Rhode Island have been described in the single word, "sprawl." Grow Smart Rhode Island (2000) described sprawl as, land development trends and patterns that are more wasteful, impact larger amounts of natural resources, require redundant capital investments (public facilities and infrastructures), and impact considerable human resources requiring longer commute distances. In recognition of this development pattern, the Rhode Island Division of Planning has published *Land Use 2025 State Land Use Policies and Plan* as the major State Guide Plan for conservation and development in the 21st Century. This plan envisions Rhode Island as a constellation of community centers connected by infrastructure corridors and framed by greenspace (see Figure 3-6).

Coordination with ongoing planning efforts will be important. This includes RhodeMap RI, a coordinated effort by the state intended to make Rhode Island a better place to live and work by mobilizing state and community assets in a new way. RhodeMap RI, offers a possibility to strengthen the economy, meet current and future housing needs, and plan for future growth through the development of an integrated plan that will also include strategies for transportation, land use, and environmental protection. RhodeMap RI is funded with a Sustainable Communities Initiative Grant, one of several offered through the Federal Partnership for Sustainable Communities, a collaboration of the U.S. Department of Housing and Urban Development, EPA, and the U.S. Department of Transportation (US DOT). The Sustainable Communities Regional Planning Grant Program supports metropolitan and multi-jurisdictional planning efforts that integrate housing, land use, economic and workforce development, transportation, and infrastructure investments in a manner that empowers jurisdictions to consider the interdependent challenges of: (1) economic competitiveness and revitalization; (2) social equity, inclusion, and access to opportunity; (3) energy use and climate change; and, (4) public health and environmental impact. For more information about RhodeMap RI, see**:** *http://rhodemapri.org/*.

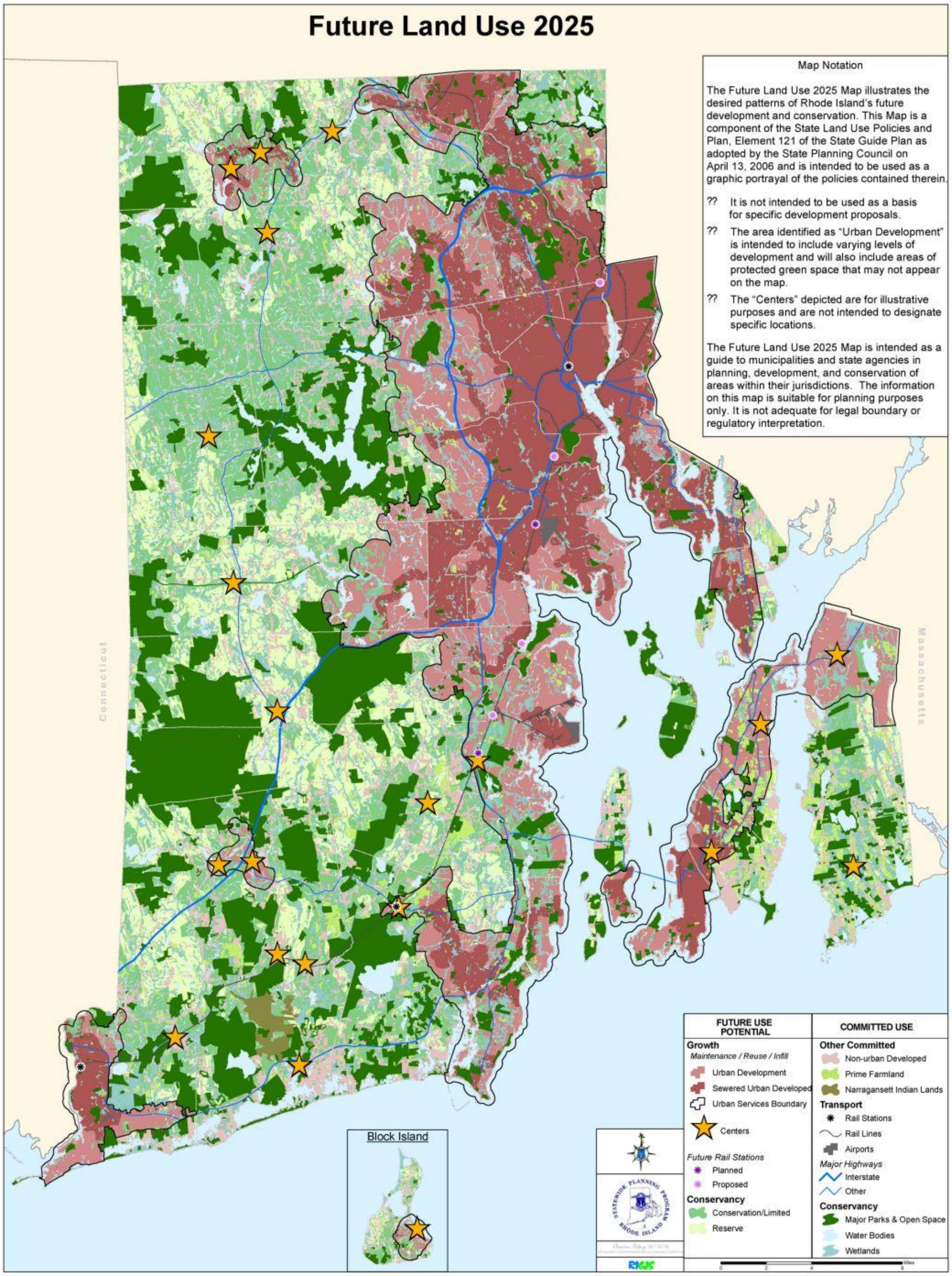

Figure 3-6. Projected Future Land Use in Rhode Island 2025. Source: RI Division of Planning 2014

The RI DEM Land Conservation Program, operating through the Division of Planning and Development (DPD), works to preserve the state's natural areas, to guarantee their permanent protection, and to ensure proper management of land having high intrinsic resource value. With an emphasis on the following critical elements - working farms, forests, drinking water protection, recreation, and natural heritage/biodiversity - RI DEM works to ensure that these resources remain available for future generations. The Program prioritizes parcels of land whose resource value, size, location, and relationship to existing conservation land make them significant to the state's welfare.

RIDEM's DPD manages and supports statewide land conservation programs, coordinates land conservation activities with other state, federal and non-profit programs, and works to preserve land consistent with state plans and state regulations. The DPD conducts land protection in Rhode Island through three programs. The State Land Conservation Program is administered by the RI DEM Land Acquisition Committee (LAC), which makes recommendations regarding real estate transactions that will enhance RI DEM's Management Areas, Parks, and Forest Lands. Funding for these real estate acquisitions is provided by State Open Space bonds, with contributions from municipalities and land trusts, from local partners such as The Nature Conservancy and the Champlin Foundations, and from various federal programs including the USFS Forest Legacy program, USFWS, NOAA, Federal Highway Administration, and the National Park Service's (NPS's) Land and Water Conservation Fund (LWCF). In addition, this program combines its funding with the Local Open Space Grants Program and the Agricultural Land Preservation Program to complement its conservation projects.

The Local Open Space Grant Program supports cities and towns, land trusts, and non-profit organizations in their protection and acquisition of natural areas that are deemed priorities at the municipal level. This critical partnership works to leverage funds from municipal, non-profit, and federal agencies for the protection of Rhode Island's resources with RI DEM providing up to 50% funding to successful applicants and adding a layer of protection to the conserved parcels to ensure they remain undeveloped in perpetuity. All grant applications are reviewed and scored by the Rhode Island Natural Heritage Preservation Commission Advisory Committee according to the following criteria: habitat protection, presence of rare species and communities, greenway or regional linkage, planning consistency, resource protection, water resource protection, and multi-community partnerships. Final awards are determined by the Natural Heritage Commission with the State's share of funding provided by State Open Space Bonds.

The Agricultural Land Preservation Program, which is administered by the Agricultural Land Preservation Commission (ALPC) and staffed by RI DEM, preserves agricultural lands through the purchase of farmland development rights (PDR) which enables farmers to retain ownership of their property while protecting their lands for agricultural use. At the same time, it provides farmers with a financially competitive alternative to development and helps to ensure that farming remains viable in the state. Applications for PDR are reviewed and scored by the ALPC according to parcel size; soil quality; agricultural operation and viability; protection of water supplies and quality; open space, cultural and scenic features; flood protection; relative development pressure; and consistency with state and local plans. Funding for this program is obtained through Open Space Bonds, The Nature Conservancy, the Champlin Foundations, the USDA Farm and Ranch Lands Protection Program, and through the leveraging of land trust and municipal funds.

During the 10-year period of 2002-2012, funding provided through these three land conservation programs protected 15,502 acres with a land value of $171.5 million, and 73% of this value provided by federal and local contributions. When added to land already protected, more than 20% of the state has been preserved as open space, for recreation, and for agricultural use (Figure 3-7) (RI DEM DPD 2012).

RI DEM announced a new Open Space Grants totaling $5 million, with funding provided from the 2008 and 2012 Open Space Bond Authorizations. Moreover, an additional Clean Water, Open Space and Healthy Communities bond included on the November 2014 ballot was passed (RI DEM press release, March 11, 2014).

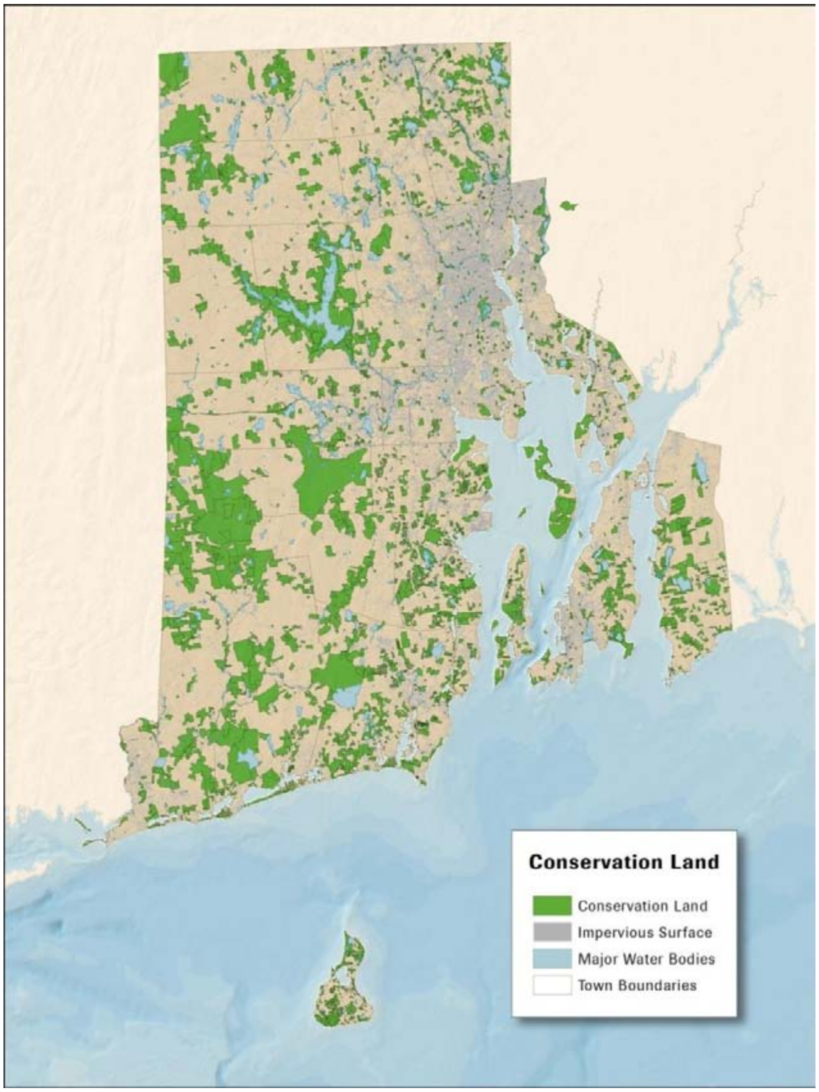

Figure 3-7. Conserved Land in Rhode Island. Source RI GIS 2014

Invasive and Other Problematic Species

The spread of exotic invasive species poses a significant threat to SGCN throughout the Northeast. Invasive species go by many names – exotics, aliens, pests, or weeds, but all are introduced, non-indigenous organisms that can aggressively usurp populations of native species and devastate natural habitats. With NEAFWA funding through the RCN Grant Program, Klopfer (2012) identified 238 invasive species from 12 groups with a potential to adversely affect SGCN, while at the same time acknowledging that this is not a complete list of invasive species for the Northeast. The majority of species identified are plants (68%), and the majority of these (58%) occurred in seven or more states. There were 71 (30%) invasive species common to all states in the Northeast. The habitat identified with the greatest number of invasive species was classed as "forest edge" with 115 species (48%), followed by pasture and grassland with 94 and 86 species respectively (39% and 36%).

The RI WAP Habitat Technical Committee has determined that nearly all (97%) of the key habitats in Rhode Island are threatened by invasive species. Focusing on freshwater wetland habitats, the RI DEM OWR and the RINHS (2014) concluded that invasive species were present in 48% of all surveyed wetlands (n = 281) and 60% of wetlands excluding the relatively undisturbed vernal pools and cedar swamps, bogs and fens. In particular, open emergent marshes were found to be vulnerable to the spread of invasive species with 90% of surveyed sites impacted, especially by plants such as Common Reed (*Phragmites australis)*, European Bittersweet (*Celastrus orbiculatus*), and Purple Loosestrife (*Lythrum salicaria*) (Figure 3-8; RI DEM OWR and RINHS 2014)

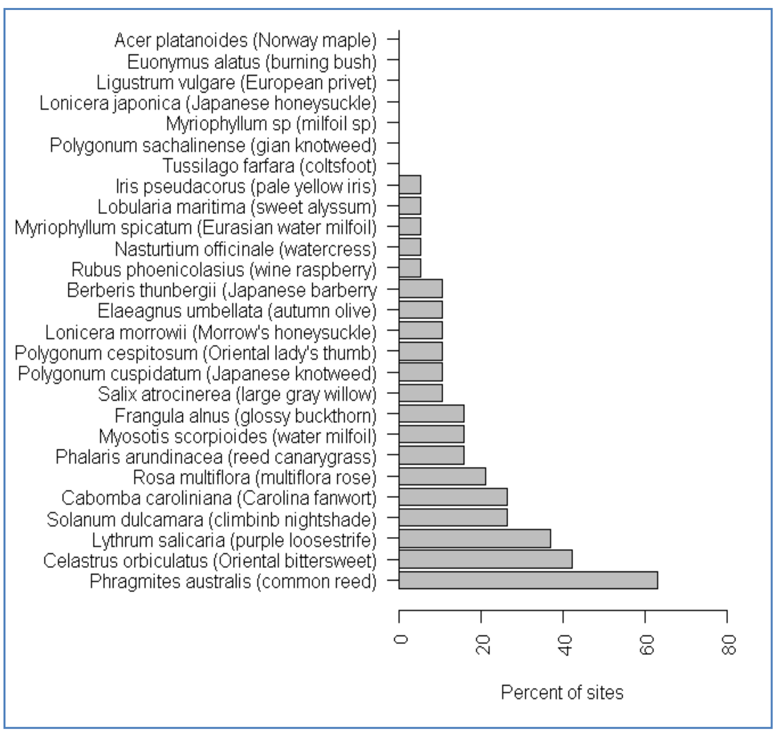

Figure 3-8. Frequency of Invasive Plants in Surveyed Rhode Island Emergent Marshes. Source: DEM OWR and RINHS 2014

In 2007, the RI DEM OWR Surface Water Monitoring Program began to survey Rhode Island's freshwater rivers and lakes to map the statewide distribution of Aquatic Invasive Species (AIS) (Figure 3-9). Monitoring allows RI DEM personnel to determine the presence and location of the species in Rhode Island and to track their spread. RI DEM uses this information to prioritize where to direct future monitoring efforts in order to detect new invasions, and to inform stakeholders about infestations in their lakes and the surrounding watershed.

RI DEM coordinated with the Coastal Resources Management Council (CRMC) and other partners to form the Rhode Island AIS Working Group in 2007. The group grew out of the process of developing the Rhode Island AIS Management Plan, which outlines recommended actions for managing invasives and provides a framework for coordinating state and federal management efforts. The AIS Working Group, co-chaired by RI DEM and CRMC, facilitates the implementation of the Rhode Island AIS Management Plan which was approved by the federal Aquatic Nuisance Task Force in November 2007. A copy of the plan is available at: *http://www.anstaskforce.gov/State%20Plans/RI_SMP_Draft.pdf*.

K. Proft

Phragmites invading tidewaters

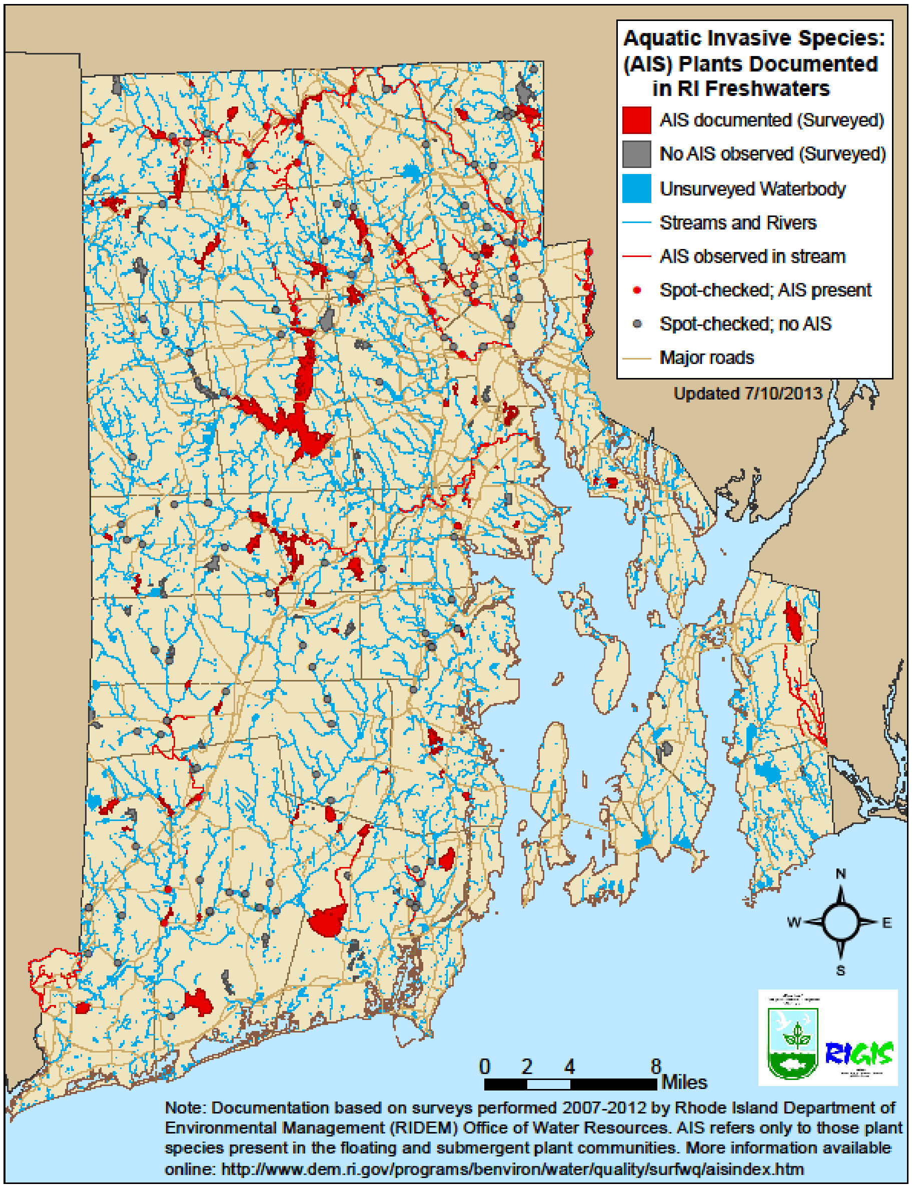

Figure 3-9. Distribution of Aquatic Invasive Species in Rhode Island Freshwaters Based on Surveys Performed 2007-2012. Source RI DEM OWR 2013 AIS refers to invasive plant species present in floating and submergent plant communities

Several aquatic invasive animals have also been documented in Rhode Island waters. Although aquatic invasive animals are often harder to find than large invasive plant populations, invasive animals can have devastating effects on freshwater ecosystems. Most invasive animals are small and larvae or adults can be transported in bilge water, bait buckets, or attached to boats. Others are used as live bait with extras discarded into the water, and some species intentionally stocked. Regardless of the means of introduction, the spread of invasive animals constitutes a serious threat facing river and lake habitats. Ecologically, aquatic invasive animals may cause the local extirpation of native aquatic species, degrade habitats, alter food webs, and degrade water quality. Moreover, aquatic invasive animals may reduce the numbers of sport fish by competing for food and destroying habitats, and invasive shellfish can foul boats and motors. Currently, two important aquatic invasive animals species found in Rhode Island to date include the Asian

Clam and several species of carp. The Zebra Clam which is a particularly damaging species has yet to be found in Rhode Island (RI DEM OWR 2013).

In 2010, a cooperative effort between the Rhode Island CRMC and the URI Outreach Center developed the Invasive Plant Management Certification Program (IPMCP) to train green industry professionals and other interested individuals working in the coastal zone to provide sustainable invasive plant management services to clients, and to facilitate restoration of degraded coastal habitats. Professionals completing a two-day certification training program are recognized as Coastal Invasives Managers by the CRMC. For more information about this program refer to: *http://www.uri.edu/cels/ceoc/LR_IPMCP.html*.

The marine environment is not immune to the incidence of invasive species as many alien plants and animals are transported to Rhode Island estuaries in the ballast of container ships and other vessels. In 2000, CRMC, the Narragansett Bay Estuary Program, and others, organized the first surveys of marine aquatic invasive species in the state. Marine aquatic invaders that have become established in Rhode Island include the European Green Crab (*Carcinus maenas*), Asian Shore Crab (*Hemigrapsus sanguineus*), Lace Bryozoan (*Membranipora membranacea*), Codium (*Codium fragile*), the Red Macroalgae (*Grateloupia turuturu*), and various species of sea squirts and shellfish pathogens (CRMC 2014).

Most SGCN are indirectly impacted by the spread of invasive plants. The changes most evident in an invaded community are declines in native plant diversity and a consequent restructuring of the community that in many situations can negatively alter habitats of SGCN. However, some invasions may be considered beneficial, such as the patches of primarily invasive shrubs in old fields near the coast that serve as habitat for early successional species and migratory songbirds. Table 3-6 identifies key habitats most impacted by invasive species in Rhode Island.

Table 3-6. Key Habitats in Rhode Island Negatively Impacted by Invasive Species with Representative Species of Greatest Conservation Need

Key Habitat	Invasive species	SGCN
Beaches, beach strand, dunes	Japanese Sand Sedge	Tiger beetles, Piping Plover
Coastal shrublands	Multiflora Rose, Autumn Olive,	Early successional birds
Ruderal forest	Many trees and shrubs	Migratory birds
Pasture (selective grazing)	Woody shrubs; Black	Grassland birds
Emergent marsh, wet meadow	Purple Loosestrife, *Phragmites*	Marsh Wren, rails
Salt/brackish marsh	*Phragmites*	Saltmarsh Sparrow, rails
Impoundment	*Phragmites,* Purple Loosestrife,	Waterfowl
Graminoid fen, sea level fen	*Phragmites*	Dragonflies
Coastal salt pond	*Phragmites*	Marsh birds
Lakes and ponds	Water Chestnut, other aquatic	
Forests	Woody shrubs, Japanese Stilt	Forest interior birds

Source: WAP Habitat Team

The proliferation of invasive plants is principally abetted by anthropogenic disturbances. While disturbance is a normal part of natural ecosystem dynamics, in many systems the alteration of disturbance regimes and the introduction of novel disturbances produce increased opportunities for invasion (Hobbs 2000). The fragmentation of forest habitats by residential development and land management practices create patches of disturbed land and opportunities for invasion, and the linear openings formed by roads and utility rights-of-way serve as the pathways for spread of invasives. Invasive woody shrubs (e.g., Multiflora Rose, Autumn Olive, and European Bittersweet) typically appear in forest openings because they produce abundant fruit and seeds carried long distances by birds. Other species produce abundant seeds or propagate by root fragments that are transported on vehicle tires or the soles of hiking shoes.

Woody shrubs are also typical invaders in grassland habitats, especially old fields where mowing and other management mechanisms have been curtailed. In pastures, invasive shrubs with abundant thorns (e.g., Japanese Barberry and Multiflora Rose) are mostly avoided by grazing animals and may eventually overrun some fields. The USFWS has identified invasive shrubs as a major concern on several Rhode Island wildlife refuges and has conducted periodic burning and other control measures to restore invaded habitats to benefit grassland birds (USFWS 2013).

Palustrine and estuarine wetlands are highly vulnerable to the spread of invasive species that take advantage of situations where these habitats have been altered by filling, dredging, increased sedimentation, and other flood and tide control operations. Maritime beaches and dune systems have typically not been habitats favored by invasive plants as these dynamic habitats are normally sparsely vegetated by the relatively few plants capable of withstanding the extreme conditions. However, an exception is the appearance of Japanese Sand Sedge (*Carex kobomugi*) at several Rhode Island beaches (Enser 2006). This invasive plant crowds out native plants, creating densely vegetated patches that can limit available habitat for some listed animals. In the mid-Atlantic there have been documented impacts on federally listed species, including Piping Plover and Northeastern Beach Tiger Beetle (Wootten 2006). There is also concern that Japanese Sand Sedge may change beach profiles, making dunes lower because the plant is smaller and cannot catch as much sand as larger native plants. Lowering of dunes could significantly impact the ability of these barriers to ameliorate storm surge (Wootten 2006).

In 2009, RINHS, in close partnership with the RI DEM, was awarded a $673,000 grant through the USFS to establish the Forest Health Works Project (FHWP). The primary purpose of this grant was to control non-native invasive plants that threatened priority forests in Rhode Island by training "green industry" professionals such as landscapers and arborists. Other aspects of forest health were incorporated into the project, including wildlife management, native plant propagation and marketing, recreational use, and environmental education (Barnes 2012). Intensive field work resulted in the most comprehensive inventory of invasive plants ever conducted in Rhode Island, and most likely southern New England. Efforts were concentrated in the western part of the state, based on stakeholder input and innovative GIS analysis. As a result, a total of 2,228 acres of invasive plants were mapped and over 166 acres treated for invasives across 41 sites. In addition, a pilot Rhode Island Youth Conservation League (YCL) project was run under the auspices of FHWP in which deer exclosures were built to demonstrate over time the relationship between invasives, deer, and forest health (Barnes 2012).

The final report (Barnes 2012) offered the following recommendations for continuing efforts to reduce the threat of invasive species in Rhode Island:

1. Reconvene the Rhode Island Invasive Species Council which has been defunct since 2005 due to lack of funding. In its absence there has not been a clear set of statewide policies for invasive species.

2. Develop closer coordination between conservation organizations on invasives and forest health because in a period of declining financial resources, but increasing environmental challenges, cooperation and partnership between stakeholders (inter- and intra-state) is critical for success.
3. Dedicate resources to follow-up treatment on FHWP-treated sites and others across the state because invasive plant control is a long-term management activity that requires follow-up.
4. Monitor and manage deer to improve forest health as deer densities have surpassed levels for sustainable forest regeneration in many areas of the state, which promotes many invasive plants, Lyme disease, and other issues.
5. Permanently establish the Rhode Island YCL to meet three goals: cost-effective natural area maintenance, environmental opportunities for youth in a state that has few, and improved public image of conservation.
6. Expand and promote Rhody Native which has proven to be a great potential as a unique conservation agency/nursery industry partnership and should be prioritized in plant restoration and consumer outreach efforts.
7. Continue Green Industry Workforce Development to train a cohort of landscapers, arborists, nurserymen and others.
8. Analyze the FHWP GIS dataset which has generated an extremely comprehensive geodatabase which should be used for research and management purposes.

Although not invasive, under various circumstances native species may become overabundant and problematic. White-tailed Deer are overabundant in much of the U.S. due to a lack of natural predators, an increase in human altered, and fragmented landscapes, and changing social values about hunting. In suburban areas, where landscaping provides excellent forage for deer and hunting is not allowed, growth of the herd is unimpeded. Unmanaged deer populations can lead to over population and potentially threaten native species and habitats (Tefft 2011).

Recognizing the detrimental impacts of an overabundant deer population, the RI DEM DFW reviewed and revised its deer management strategy in 2010. A new approach was based on an analysis of habitat, deer harvest demographics, and deer-auto collision data. The resulting town-by-town profile of harvest versus road kill enabled a logical division of deer management zones to begin the process of reducing deer overabundance and increasing sustainability (Tefft 2011).

Climate Change and Severe Weather

The changing climate is now recognized as a potential major threat to fish and wildlife habitats, populations, and communities. Indeed, there is evidence that climate change may already be affecting ecosystems as distributions of animals and plants change, ecological phenologies are disrupted, and community compositions and structures are altered. Species and populations likely to have greater vulnerabilities to climate change include those with highly specialized habitat requirements, native species already near temperature limits or having other narrow environmental tolerances, currently isolated, rare, or declining populations with poor dispersal abilities, and groups especially sensitive to pathogens. Species with these traits will be even more vulnerable if they have a small population, a low reproductive rate, long generation times, low genetic diversity, or are threatened by other factors (NFWPCAP 2014).

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as three distinct components: 1) exposure: magnitude and rate of climate change a resource is likely to experience, 2) sensitivity: characteristics that mediate tolerance to climate change of a particular resource, and 3) adaptive capacity: the inherent ability of the target to moderate the impacts of climate change (IPCC 2007, Glick et al. 2011). The Northeast Climate Science Center (NECSC) is currently developing a synthesis of regional information on Climate Change (USGS in progress; http://necsc.umass.edu/). Once developed this will be applied over the next decade through implementation of the 2015 RI WAP.

Climate modeling analyses for the northeastern region of the U.S. have projected major changes over the rest of this century, although the magnitudes of these changes are likely to vary spatially across the region. Using recent modeling studies the Manomet Center for Conservation Sciences (MCCS) projected the following changes in the climate of the Northeast by 2070-2099 (NWF and MCCS 2014).

- The annual average air temperature across the region will increase by 2-5 °C (3.6- 9.0 °F) depending on the emissions scenario.
- The annual average temperature increase will have seasonal and geographical components, being greatest in the winter months and at higher latitudes.
- An annual increase in precipitation levels by about 7-15%, most falling as rain during the winter months, with longer dry streaks between events (particularly in the summer).
- The number of extreme heat days per year (>50 °C, 90 °F) will increase from the current 10 to 20-40 days depending on the emissions scenario.
- The length of the plant growing season (days between last and first killing frosts) will extend by 30-50 days, depending on the emissions scenario, and the plant hardiness zones will advance north.
- Soil moisture content (percent saturation) may decrease, particularly during the summer months (by about 1-2%), due to longer dry streaks between precipitation events.
- Winter and spring floods of shorter duration but higher intensity and more frequent.
- Ice formation occurring later in the year and melting earlier and many lower elevation lakes and rivers might no longer have sustained ice cover.

Accelerating rising sea levels are another manifestation of the changing climate. Under rising global temperatures, sea water is undergoing spatial expansion, and ice caps and glaciers are melting and contributing to rising sea levels. Sea level rise (SLR) poses significant threats to coastal ecosystems that may become inundated, resulting in habitat changes and losses, and adverse impacts to species or communities that depend on these habitats. Indeed, it is generally considered by climate scientists that coastal ecological resources are likely to be among the most vulnerable to the changing climate, and that the climate change impacts to ecosystems over the next few decades will be most marked in the coastal zones (Frumhoff et al. 2007; Karl et al. 2009, IPCC 2007).

Future SLR projections have evolved over the last decade. One estimate (IPCC 2007) was that global mean sea level would rise over the course of this century by between 18 and 59 centimeters (cm), depending on the emissions scenario. However, more recent studies that include measurements of Arctic and Antarctic ice melt have produced larger SLR estimates between 0.5 meter (m) and 2.0 m., depending on the emissions scenario. Furthermore, storms are likely to become more destructive in the future as SLR contributes to higher storm surges and erosion (Anthes et al. 2006). Tebaldi et al. (2012) projected future change in frequency of today's 100-year flooding event through the year 2050 and estimated return frequencies of every 5 years for Portland, ME, a 30-year return frequency for Boston, MA and a 10-year return frequency for Providence, RI.

Recently, a cooperative effort between The Nature Conservancy, Rhode Island Sea Grant, URI, Rhode Island Coastal Resources Center, and CRMC have applied SLAMM modeling to project the likely paths for salt marsh migration in Rhode Island coastal communities due to SLR. A pilot project (Ruddock 2011) was conducted in the town of North Kingstown and an example of the mapping derived for this community is shown in Figure 3-10. Mapping for all Rhode Island coastal communities has recently been completed and can be viewed at: *http://www.crmc.ri.gov/maps/maps_slamm.html*.

The newest modeling tools go beyond the abilities of SLAMM models and are starting to be able to estimate coastline's dynamic versus static response to SLR. Dr. Robert Thieler and colleagues at USGS (Nathaniel Plant and Dean Gesch) and Columbia University (Radley Horton), recently completed their study evaluating sea-level rise impacts in the northeastern U.S. The project developed a new method to distinguish coastal areas in the northeastern U.S. (Virginia-Maine) that will likely experience a predominantly inundation (e.g., flooding) response to sea-level rise (SLR) from those that will likely respond dynamically by moving or changing (e.g., landforms such as barrier islands and marshes). They found that areas likely to inundate include urban regions of intense development and/or coastal engineering, as well as bedrock coasts. Alternatively, areas likely to respond dynamically include beaches, unconsolidated cliffs, barrier islands, and wetlands (M. Staudinger, NECSC pers. comm. 2015). *https://necsc.umass.edu/projects/research-and-decision-support-framework-evaluate-sea-level-rise-impacts-northeastern-us*

Figure 3-10. Map of Calf Pasture Point Area in North Kingstown, Rhode Island Showing Marsh Migration Patterns Based on Projected Sea Level Rise. Source: Ruddock 2011

The projected changes posed by climate change and SLR pose significant threats to SGCN and key habitats. Given many uncertainties, from the amount of global warming to the impacts on ecosystems, it is difficult to determine how individual species will respond. For example, we are certain that it is warming, but less so about how much, and for planners this means that it is important to prepare for full range of scenarios instead of some mean value. There are a variety of vulnerability assessments that have been conducted to better understand the magnitude of these threats. All of these studies include some combination of specifying likely climate impacts, estimating exposure to these impacts, and accounting for non-climate stressors.

Examples of non-climate stressors include invertebrate pests, over-abundant White-tailed Deer, pollution, land use change, and invasive exotic plants that may already be threatening some communities. While climate change may increasingly exert adverse effects on these habitats, the current stressors will also continue to be important, conceivably more important as these interactions may exacerbate the impacts of the changing climate. The most obvious examples concern the "beneficial" effects that climate change may have on the life cycles of pest species. There is already evidence that some forest pests are benefiting from a warming climate, for example Hemlock Wooly Adelgid has spread north and impacted hemlock stands that were previously not vulnerable to this temperature-limited pest (NFWPCAP 2014).

Understanding ecological vulnerabilities provides valuable information that may be used to better inform existing decision processes and may also suggest new policies or adaptation strategies to reduce future impacts. Several studies have been reviewed to develop an assessment of the vulnerability of Rhode Island SGCN and key habitats. These include an assessment of the likely impacts of climate change on Northeast habitats and SGCN conducted through a collaborative effort of the NEAFWA, MCCS, and the National Wildlife Federation (NWF; NWF and MCCS 2014), and a series of assessments previously conducted by MCCS for the Massachusetts Division of Fish and Wildlife (MADFW; MCCS and MADFW 2010).

Vulnerability of Rhode Island Habitats to Climate Change

Table 3-7 provides a summary of the vulnerability of key Rhode Island habitats to the impacts of climate change as determined by the SWAP Habitat Technical Team. The habitats of highest vulnerability are estuarine wetlands and other coastal habitats, primarily due to the combined impacts of SLR and increases in storm frequency and intensity. Much of Rhode Island's coastline is recognized as being of ecological and conservation importance and is protected in local, state, and federal reserves. This protection mosaic has successfully conserved important populations of plants and animals and their habitats. Many of the reserves are recognized as "showcase" sites that demonstrate that ecological resources can be conserved despite growing human pressures. However, this reserve system was established during a time when the challenge of climate change and resulting shifting coastlines and habitats was not fully appreciated. As a result of climate change, the boundaries of reserve systems may not continue to contain the environmental features to support the fish and wildlife for which they were originally designed to offer protection.

It is also important for local conservation organizations, such as land trusts and watershed associations, to consider the impacts of a changing climate. A 2013 report prepared by Rhode Island Sea Grant and Coastal Resources Center (Rubinoff et al. 2013), as a pilot study for the South Kingstown Land Trust, outlined a five-step approach for assessing vulnerability and monitoring both adaptation actions and habitat changes. These changes create a new set of challenges and opportunities that have the potential to greatly affect the conservation strategies of land trusts and other conservation organizations. For example, preserved forest areas should be relatively large to function effectively as resilient reserves, and some larger organizations or partnerships of various groups are capable of assembling such acquisitions.

Critical habitats – areas in which targeted species can persist and/or relocate over time – may provide a refuge from climate change impacts and become high-priority candidates for acquisition and enhanced conservation efforts. Land trusts involved with agricultural operations can promote innovative pest management, monitoring, irrigation methods, and other farming practices designed to address climate change. Research can be conducted to identify structurally diverse and species-rich habitats as well as important movement corridors. Monitoring for new invasive plants, insects and other pests may be implemented. Cool water streams and cold water fish habitat can be incorporated into a land trust's or watershed association's buffer strategy in order to conserve connected water bodies and protect vegetative canopies over streams to help reduce impacts of warming temperatures. Local conservation groups have the ability and knowledge to take the lead in habitat and buffer restoration utilizing diverse native species, thereby increasing the resiliency of habitats to the stresses of climate change and shifting environmental condition.

Table 3-7. Vulnerability of Key Rhode Island Habitats to the Impacts of Climate Change Determined by the Wildlife Action Plan Habitat Technical Team

Degree of Vulnerability	Habitat Type
Highly Vulnerable	Brackish marshes Tidal flats
Vulnerable	Maritime beaches/dunes Northern hardwood forests Hemlock forests Cold water streams Cold water ponds Shrub swamps/wet meadows Emergent marshes Vernal pools Hardwood (Red Maple) swamps Atlantic White Cedar swamps Floodplain forests Salt marshes
Less Vulnerable	Pitch Pine woodlands/barrens Oak-Pine forests Warm water rivers and ponds

Highly Vulnerable Habitats

Brackish Marshes, Tidal Flats and Salt Marshes

SLAMM modeling conducted at several coastal Massachusetts USFWS wildlife refuges has determined that the habitat types likely to suffer the greatest reductions in extent under most SLR scenarios are brackish marsh and tidal flats, with likely reductions in area on the order of 50%-99% (NWF and MCCS 2014). In contrast, the extent of salt marsh and estuarine open water is projected to increase greatly at each of these two sites. These results can be explained by postulating that as sea level rises land that is currently intertidal will become subtidal (hence, the increase in open water and loss of tidal flats), while salt marsh will extend further up gradient as the inundation and salinity changes, at the expense of the brackish marshes, which it will replace (NWF and MCCS 2014). A projected global rise of only 0.39m (the most optimistic of current estimates) is sufficient to result in major habitat changes, particularly losses in brackish marsh and tidal flats and gains in salt marsh. These changes generally become more marked as the SLR scenario is increased.

The recently completed SLAMM modeling in Rhode Island (Boyd and Rubinoff 2014) is projecting significant changes in the extent of salt marsh, depending on the SLR scenario applied. As shown in Table 3-8, the acreage of salt marsh is predicted to increase initially with the inland migration of this habitat type, at the expense of brackish marshes and tidal flats, as was shown in the Massachusetts SLAMM modeling cited above. However, the opportunities for salt marsh migration begin to lessen with further increases in sea level, with a net loss of this habitat type of more than 1000 acres predicted under the 5-foot SLR scenario (Boyd and Rubinoff 2014). There are also indications that sea level rise could result in a conversion of salt marsh to open water where rising sea level rapidly alters marsh drainage patterns and the rate of sea level rise outpaces marsh accretion rates.

Table 3-8. Losses and gains in Rhode Island salt marsh habitat predicted by SLAMM modeling for three Sea Level Rise Scenarios.

	Sea Level Rise Scenarios		
	1-foot SLR	**3-foot SLR**	**5-foot SLR**
Salt Marsh Losses	450 acres	1895 acres	3189 acres
Salt Marsh Gains	1057 acres	1148 acres	2151 acres
Net Loss/Gain	+ 607 acres	- 747 acres	- 1038 acres

Source: CRMC 2014

In addition, there are predicted to be sizable losses in the extent of freshwater marsh along the coast as these wetlands are inundated by salt water. Under the three scenarios (1, 3, and 5-foot SLR) there is projected to be losses of 204, 635, and 1059 acres of freshwater marsh respectfully.

Freshwater tidal marshes, the rarest subtype, will likely be completely lost as estuaries move upstream and salinity increases, and because there is a lack of suitable adjoining areas to accommodate upland migration. Reduction in extent and complexity of these highly productive interfaces between land and water will have impacts on ecological function (e.g., storm buffering, flood storage, fish nurseries, and water filtering) and biodiversity within the state. An example of the impact of SLR on habitats is shown in Figure 3-11.

Figure 3-11. View of Twin Ponds in Narragansett, RI

These ponds include large portions of brackish emergent marsh dominated by cattails. Rising sea level and increased storms will likely breach the barriers of these ponds converting them to salt marsh.

Vulnerable Habitats

Maritime Beaches/Beach Strand

Sims (2012) modeled the consequences of SLR over the next 100 years for Piping Plover nesting habitat in Rhode Island focusing on five mainland beaches that are currently used by the birds as breeding sites. The SLR predictions used in the study were increases of 0.5, 1.0 and 1.5m, and three future scenarios were modeled. First, that rapid SLR would disrupt the inland migration of the sites (the "stationary model"); second, that the pace of SLR would allow the inland migration of the coastal system (the "migration without development model"); and third, that the pace of SLR would allow the inland migration of the sites but that current development would prevent that to some extent (the "migration with development model"). The model was based on one previously developed by Seavey et al. (2011) for barrier islands in New York.

Under the stationary model the area of habitat available to Piping Plovers would decrease by different extents at all five sites and the amount of reduction would be a function of the degree of SLR, with greater SLR resulting in more habitat loss. Without considering current development as a blockage to habitat migration all sites showed large increases in beach habitat, and four of them continued to show an increase at the 1.5m SLR scenario. If, however, current development blocks beach migration the results were mixed, with three sites continuing to show habitat increases even at the 1.5m SLR scenario and the other two sites showing habitat decreases or little change at the higher SLR scenarios.

Results from the Sims (2012) and Seavey et al. (2011) analyses suggest that the implications of SLR for nesting habitat of Piping Plovers in the Northeast may be complicated. The studies agree that if sites or habitats are constrained in their ability to move inland or upslope the result is likely to be habitat loss, and the losses will increase with increasing SLR. However, if the sites or habitats are able to migrate under SLR, then new habitat would be created and the total area of Piping Plover nesting habitat might be expanded (this assumption is based on there being enough sand in the system). However, if more intense or frequent coastal storms and surges accompany SLR, nesting habitat could be significantly reduced.

Palustrine Wetlands

Freshwater wetlands (emergent marshes, shrub swamps, wet meadows, vernal pools, hardwood and coniferous swamps) are likely to be affected by climate change similarly due to changes in hydrology. Although modeling suggests that under both the lower and higher emissions scenarios precipitation levels in the Northeast will increase by about 10%, much of this increase will occur during winter months, with more precipitation falling as rain than snow and reduced snowpack that leads to changes in spring seasonal flows and floods. Summer months will be characterized by rising temperatures, greater evapotranspiration rates, and little or no increase in precipitation or perhaps even precipitation reductions (in terms of summer average amounts) due to more consecutive dry days. These circumstances would lead to seasonal drying out of wetland soils and more protracted and severe droughts. Hayhoe et al. (2007) project that, under the higher emissions scenario, summer droughts lasting 1-3 months in duration may occur each year, rather than once every 2-3 years as at present, and that medium-term droughts (lasting 3-6 months) will become more frequent. These changes will likely result in loss of wetland habitat as upper areas dry out during the summer and the vegetation is eventually replaced by mesophytic or xeric upland species. As such, marshes and swamps will contract inward toward currently deeper or more reliable water sources, and smaller, less well-watered marshes could be entirely replaced by upland vegetation. Larger marshes could become fragmented and reduced in area (MCCS and MADFW 2010).

An additional stressor in wetland communities will be the further spread of invasive plant species, especially Purple Loosestrife and *Phragmites*, two species highly tolerant of seasonal soil drying and drought – more so than most native species that have more restrictive hydrological requirements. Seasonal drying of marsh soils and drought is likely to increase the competitive advantage of these species and result in further loss of native habitat.

In general, emergent marshes are considered more vulnerable to climate change than other freshwater wetlands because of their limited extent in the state. However, more widespread types (shrub swamps and forested swamps) are similarly vulnerable to projected changes in hydrology. Shrub swamps could suffer a net loss of habitat; however, in some areas the effect could be that the shrub swamp will contract inland toward more saturated soils and areas where the water table is currently closer to the surface. If the shrub swamps surround open water habitat or emergent marshes they could move inward, replacing those habitats as the overall wetland dries. In such cases there may be relatively little shrub swamp habitat loss; indeed, it is feasible that there could be a net gain (MCCS and MADFW 2010).

Forested swamps may also suffer a net loss due to changes in hydrology, and rising temperatures could be accompanied by the increase in additional stressors such as increased risk of fire and insect attack. Due to its apparent ability to exist in areas with markedly higher temperatures (e.g., Florida and the Gulf Coast), it is unlikely that Atlantic White Cedar would be adversely affected by increasing temperature. Indeed, it is possible that rising temperatures could be beneficial, but it is more likely that the most important climatic factors that might affect the distribution of this habitat type will be those that have adverse impacts on site hydrology (MCCS and MADFW 2010).

In dry, warm springs vernal pools may dry out earlier in the summer and amphibian breeding seasons may become truncated, with resulting low productivity and possibly complete failure in many pools (Brooks et al. 2004). Thus, the earlier drying out projected under climate change, particularly under the higher emissions scenario could have adverse consequences for vernal pools, particularly smaller pools.

Cold Water Streams and Associated Riparian Zones

The limited distribution and quantity of these habitats in Rhode Island makes them particularly fragile and susceptible to projected changes in climate. As air temperatures increase, the suitability of cold water streams for critical species such as Brook Trout will decline. In many locations the critical water temperature threshold is already being exceeded, particularly during the late summer months in shallow reaches. This has important ramifications on the abundance of not only top predators like Brook Trout, but also on many important aquatic organisms that support a dynamic food web within streams and adjoining terrestrial ecosystems (MCCS and MADFW 2010).

Northern Hardwood Forests

Northern hardwood forests will likely be reduced through the attrition of several dominant trees due to increase in average annual temperature. Sugar Maple is projected to retract its range northward, and Eastern Hemlock will also be reduced because higher temperatures are more favorable to the spread of Hemlock Wooly Adelgid. In addition, several herbaceous plants with northern affinities that typify the understory layer of northern hardwood forests will likely be reduced and eventually eliminated from the Rhode Island flora (MCCS and MADFW 2010).

Less Vulnerable Habitats

Upland forests

With the exception of the northern hardwood type, upland forests that typify much of the Rhode Island landscape will likely be less affected by climate change. In fact, the overall oak-dominated types that typify areas south of Rhode Island may benefit from a warming climate, with oaks expanding their range to include areas currently occupied by northern hardwood forests (MCCS and MADFW 2010).

Pitch Pine occurs in significantly warmer climates to the south of Rhode Island in New Jersey and Maryland. If the only determinant of its distribution were climate it would be likely that its distribution in Rhode Island would expand under a warming climate; however, non-climatic factors, mainly the distribution of sandy, nutrient-poor soils, fire frequency, and development are also important factors and are likely to more important determinants in the future extent of Pitch Pine barrens (MCCS and MADFW 2010).

Ecological Land Units

A changing climate poses a significant challenge for conservationists: how can they protect habitats for plants and animals when the composition of the ecological communities will be rapidly changing over the next century. The identification and protection of ecological land units (ELUs) , a concept developed by The Nature Conservancy, may help the conservation community assess the potential value of "the stage" to ensure the maintenance of rich communities of native plants and animals as climate change effects manifest themselves (Anderson et al. 2010). As explained by Mark Anderson, regional scientist for The Nature Conservancy, it is difficult to protect the specific "actors" (i.e., the plants and animals) because we do not know who they will be as climate change effects occur, but we can protect the "stage" (i.e., the physical habitat) on which they will thrive. Landscapes with high biodiversity tend to be more resilient to disturbances and are able to continue delivering important ecosystem services. Other criteria also inform conservation decisions, such as the size and connectedness of protected lands and the mission and goals of individual land trusts and conservation organizations, but the number and diversity of ELUs found in a candidate site is an additional important factor to consider.

ELUs areas on the landscape with unique physical properties based on soil characteristics and topography. ELUs provide an ecological setting for plant communities. Areas with many different ELUs often have diverse plant and animal communities and show high levels of biodiversity. Therefore, ELUs help identify landscapes that will support high future biodiversity as plant communities shift in response to climate change. Many factors determine which species of plants and animals live in an area. For animals, the variety and species of plants in an area are important components of "habitat." For plants, the physical properties of a site frequently determine the suitability of the area for supporting specific species. Critical physical properties are elevation, slope, aspect, geology, soils, and hydrology; information that is already available to conservationists and the general public through the RI GIS website. For example, some species of plants such as Pitch Pine thrive in gravelly, well-drained soils, in dry landscapes whereas other species, such as Red Maple, prefer moist, highly organic soils in poorly-drained locations. The land use and disturbance history of a site are also very important and can, in some cases, be the most important factors in determining the richness of biodiversity. This is particularly true when land use destroys habitat, alters hydrology, or replaces natural vegetation with impervious surfaces.

Research by many scientists confirms that there is a strong positive relationship between the diversity of physical characteristics on the landscape and the variety of plants that may be found in a particular location. This relationship occurs at site-level scales (five acre study plots) and larger landscape scales that may contain tens and hundreds of acres and even whole states (Anderson et al. 2010).

The relationship between physical diversity and ecological diversity has important relevance to the conservation community – protected lands that are highly variable with respect to physical properties will likely support diverse communities of plants and animals as the climate changes. Therefore, the identification of areas on the landscape that are physically diverse may be important targets for conservationists because they are likely to support high biodiversity in the future as climactic conditions change. Figures 3-12 and 3-13 illustrate how ELUs have been defined and identified in Rhode Island and the level of diversity among those ELUs (Rubinoff et al. 2013). More detailed information about ELUs can be found on the ELU website hosted by the Environmental Data Center at URI. This interactive web site contains maps, data, and on-line mapping tools for using ELUs in conservation planning: *www.edc.uri.edu/elu/*.

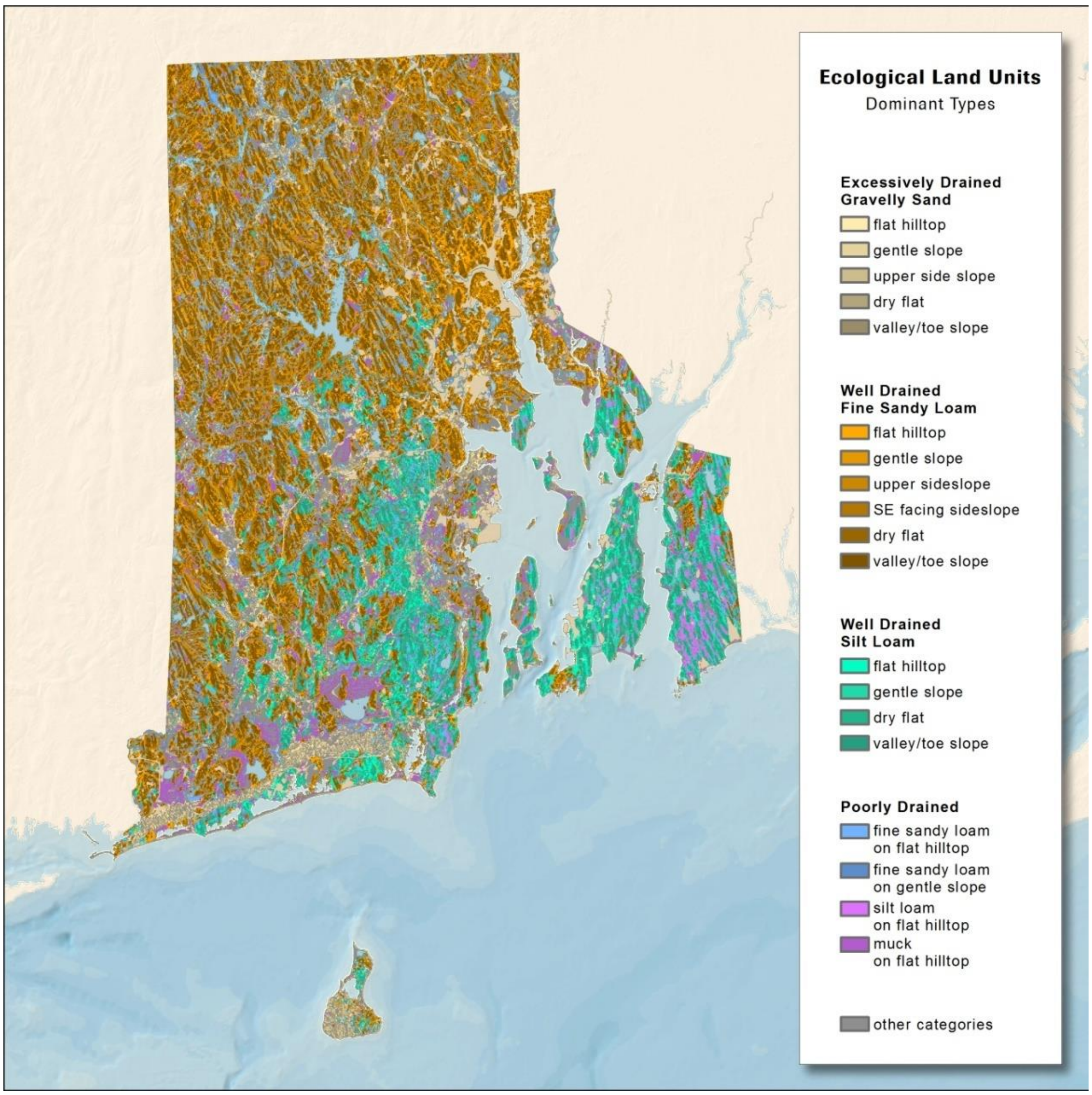

Figure 3-12. Dominant Ecological Land Units. Source: Rubinoff et al. 2013

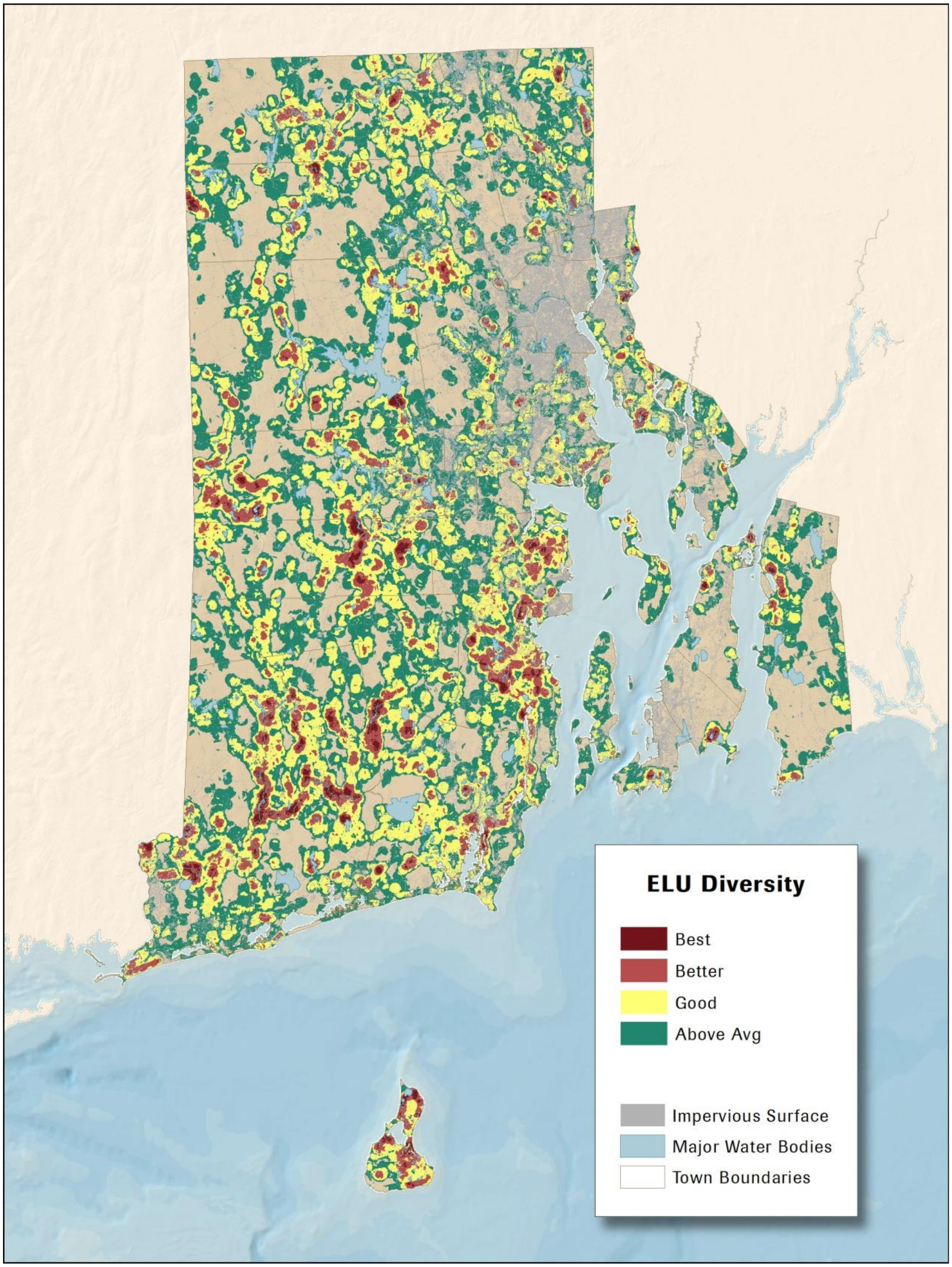

Figure 3-13. Ecological Land Units Diversity. Source: Rubinoff et al. 2013

Natural System Modifications

Natural system modifications are defined as threats from actions that convert or degrade habitat in service of "managing" natural or seminatural systems, often to improve human welfare (Salafsky et al. 2008). In general, identified modifications tend to be associated with natural disturbances that if allowed to occur under normal frequencies and intensities could result in damage to property and/or loss of life; however, management of natural disturbance often results in the minimization or elimination of processes essential to the maintenance of natural communities.

One example of a natural system modification is the suppression of fire. Natural, lightning-caused fire is a dominant force in the western and Midwestern portions of the U.S. that naturally perpetuates several community types, most notably prairies and savannahs. However, in the Northeast and especially in southern New England, lightning-strike fires are rare events. Instead, historical fire disturbance in this region was primarily the result of Native Americans employing fire as a land management tool. Across the region White-tailed Deer represent the most abundant faunal remains in archaeological sites, and management of forest understory habitat and structure to promote larger deer populations was consistent with the hunter-gatherer subsistence pattern that characterized Native American populations in the region (Foster and Motzkin 2003). Although there is little evidence that fire was purposely used to generate sizable areas of open habitat (Foster and Motzkin 2002) it is apparent that the selective burning employed by Native Americans helped create and maintain fire-dependent habitats in southern New England, especially Pitch Pine barrens.

Following European colonization and up to the mid-1900s the use of fire as a management tool was abandoned because of the threat posed to human settlements; however, wild fires caused by accident or in some cases by arson continued to maintain fire-dependent communities in some areas. For example, Tucker (1979) documented the occurrence of fire in the Kingston Pine Barrens of Rhode Island, finding that the area had severely burned twice in 1905 and 1910, and smaller portions had burned between 1930 and 1968, the year of the last recorded fire.

Lack of fire in Pitch Pine barrens results in succession of these communities with increase in hardwoods and reduction in Scrub Oak understories that support the unique assemblage of plants and animals characteristic of barrens habitats. Recognition of this consequence of fire suppression has spurred conservation organizations and agencies throughout the Northeast to conduct controlled burns to manage Pitch Pine barrens and other fire dependent habitats (Simmons 2006).

In Rhode Island the use of controlled burns to manage Pitch Pine barrens is complicated by the residential development within and adjacent to these habitats. Figures 3-14 and 3-15 illustrate the level of development that has taken place since 1981 at the Kingston Pine Barrens in South Kingston. At several Pitch Pine sites in Rhode Island the selective cutting of trees has been employed as an alternative to fire management in order to stimulate understory growth. However, many species of barrens' plants and animals depend on fire to reduce competition from fire-intolerant species or to stimulate a physiological response, such as the high temperatures needed to release the seeds from Pitch Pine cones.

Figure 3-14. Aerial View of Kingston Pine Barrens in South Kingston in 1981. Source: RIGIS 2014

Figure 3-15. Aerial view of the Kingston Pine Barrens, South Kingstown in 2011. Source: RIGIS 2014

The Pitch Pine dominated barrens appear as a broad band running southwest from the northeastern corner. The comparison illustrates how residential development has inhibited the use of fire to maintain the Pitch Pine community.

Another natural system modification identified as a threat to many wetland habitats is water management, a broad category that includes dam construction, surface water diversion, withdrawals from surface and groundwater sources, and other operations that alter water flow patterns from their natural range of variation either deliberately or as a result of other activities.

As the birthplace of the American Industrial Revolution, Rhode Island has a long history of water management. In 1789, Slater Mill on the Blackstone River was established, beginning an era that would result in the formation of mill villages along all of the state's major rivers and tributaries, each operation constructing dams to guarantee a steady supply of water. In the 1900s larger dams were built to create reservoirs of drinking water, culminating with the construction of a 3,200-foot dam to create the 5.3 square miles Scituate Reservoir that supplies water to nearly half the state's population. Today, there are 43 reservoirs in Rhode Island that supply drinking water to about 75% of the state's residents (RI DEM OWR 2014) and 668 inventoried dams (RI DEM OCI 2012).

Of particular concern to fish and wildlife resources is the construction of dams on major rivers that has prevented the migration of anadromous fish to inland breeding locations (see Chapter 1), and have also impeded the inland flow of tidal waters resulting in the nearly total loss of the unique Freshwater Tidal Marsh community described in Chapter 2.

A natural system modification that has been identified as a threat to forest ecosystems is management conducted to retard natural succession. This circumstance is particularly relevant in Rhode Island where nearly all of the original forest was historically removed. Although large portions of the original forest had regenerated by the 1960s, tracts of forest have continued to be cut for timber, firewood, and wildlife management purposes. Even in undisturbed forests it may take centuries for native forest plants to recolonize former agricultural sites (Flinn and Velland 2005), but re-colonization is prevented from occurring in areas where patches of trees are continually being removed. Moreover, the creation of forest openings provides the disturbed conditions that benefit the spread and establishment of invasive species.

Pollution

Compared to other regions, the Northeast consists of some of the smallest geographically sized states and highest population densities. The combination of large metropolitan areas, bustling towns, and thriving industries generates significant amounts of waste in the form of household sewage, solid waste, and industrial effluents. Pollutants from these sources impair key riparian, aquatic, and terrestrial habitats throughout the region. Changes in water quality and quantity now pose serious threats to all northeastern aquatic systems.

Climate change can exacerbate the impacts of other stressors, like pollution. Inputs of contaminators and nutrients will increase with projected increases in precipitation and extreme events, effecting the health, structure and function of downstream ecosystems including coastal areas. Rising temperatures are also expected to increase methylation rates of mercury. It is also possible that increased temps will increase the trophic transfer and biomagnification rates of some contaminants (Pinkney et al. 2015).

The Northeast is not only the most populated area of the country but its buildings and infrastructure reflect its older character and often contain out-of-date septic and wastewater systems. Household sewage, garbage, solid waste, storm run-off, and other types of urban waste generated by the many northeastern cities and towns leach residual contaminants into ground waters and riparian areas. Garbage and solid waste in particular are a major concern, and throughout the region many landfills are closing and seeking ways to turn trash into energy.

Industries are generally located near populated areas with essential water and transport, so the problem of industrial pollution is magnified in the densely populated Northeast, resulting in additional impairment of aquatic and terrestrial habitat throughout the region. Storm water runoff further degrades water quality through erosion, and the ever-increasing amount of impervious surfaces in drainage areas poses a major threat to small streams and the aquatic communities they support. Roadway runoff, acid mine drainage, siltation/sedimentation, and even acid deposition and mercury originating in the industrial Midwest, cause soil chemistry degradation here.

Indications of the degree of potential sources of pollution to wetland habitats is provided by analyses performed during the first six years of the Rhode Island Wetland Monitoring and Assessment program (DEM OWR and RINHS 2014, Figure 3-16). The most common stressors within 500-foot buffers of 245 assessed wetlands were raised road beds and unsewered residential development (Table 3-9); and, the most common in-wetland stressors for 164 assessed wetlands were anthropogenic fluvial inputs, and filling and dumping (Table 3-10). Anthropogenic fluvial inputs included nutrients, sediments, toxins, and salts.

Table 3-9. Types of Stressors within the 500' Buffers of 245 Assessed Wetlands

	All	WAU	Restoration Units	Vernal Pools	Cedar Swamps, Bogs and Fens
Raised road beds	168	113	9	20	26
Unsewered residential development	106	77	5	11	13
Footpaths / trails	95	69	1	16	9
Commercial or industrial development	47	38	6	2	1
Row crops, turf, or nursery plants	38	27	1	8	2
Sewered residential development	36	26	3	5	2
Golf course / recreational development	31	26	1	4	0
Other*	23	16	1	2	4
Orchards, hay fields or pasture	19	14	1	1	3
Channelized streams or ditches	18	9	6	0	3
New construction	13	10	1	2	0
Sand and gravel operations	8	4	1	1	2
Landfill or waste disposal	3	1	2	0	0
Piers, docks or boat ramps	2	2	0	0	0
Poultry or livestock operations	1	0	0	1	0
Total	**546**	**378**	**37**	**65**	**66**

Source: DEM OWR and RINHS 2014
Wetland assessment units (WAU) defined on the basis of hydrologic discontinuity (n=146); Restoration Units defined by the extent of restoration activities (n=10); Vernal Pools defined based on vegetative community (n=36); and Cedar Swamps, Bogs and Fens defined based on vegetation community (n=53).

Table 3-10. Prevalence of In-Wetland Stresses in 164 Assessed Wetlands

	All	WAU	Cedar Swamps, Bogs, and Fens	Restoration Units
Anthropogenic fluvial inputs	107	76	21	10
Filling and dumping	99	79	12	8
Invasive species	94	76	8	10
Impoundment	73	54	17	2
Excavation and other substrate disturbances	51	39	8	4
Draining or diversion of water	48	37	6	5
Vegetation and detritus removal	28	24	2	2
Total	**500**	**385**	**74**	**41**

Source: DEM OWR and RINHS 2014
Wetland Assessment Units (WAU, n=101) defined on the basis of hydrologic discontinuity; Restoration Units (n=10) defined by the extent of restoration activities; and Cedar Swamps, Bogs and Fens (n=53) defined based on vegetation community.

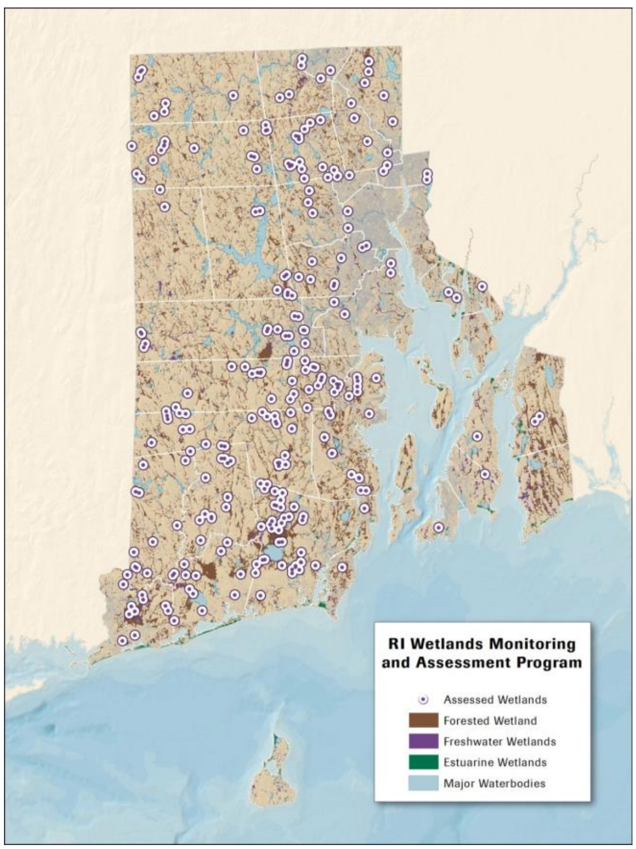

Figure 3-16. Locations of 281 Wetlands Assessed by the RI Wetlands Monitoring and Assessment Program 2006-2011.
Source DEM OWR and RINHS 2014

Trends in water quality and aquatic life of rivers and streams have been monitored through the cooperative efforts of RI DEM, individual Watershed Councils, URI and other partners. Changes in water quality have been well-documented, as important aquatic systems and habitats continue to degrade and become unsuitable as fish and wildlife habitat. Three families of benthic macroinvertebrates, Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), have been monitored as indicators of water quality and degraded aquatic conditions. RI DEM routinely monitors and maps trends in water quality, aquatic life support and sources of impairment for the state's rivers, streams, lakes, ponds, estuaries and marine waters (RI DEM 2006). The Wood River has served as a reference site for detailed monitoring since 1993 (RI DEM 2006), and the Wood-Pawcatuck Watershed Association (WPWA) conducts detailed monitoring of several stream reaches in the Pawcatuck River watershed (Burgess 2002, Saila et al. 2004). RI DEM's Narragansett Bay Estuary Program continues to identify degraded aquatic habitats for restoration. The Environmental Data Center at URI also has a variety of digital resources related to aquatic habitats such as aquifer protection, drainage basin, discharges, and water quality classification maps: *http://www.edc.uri.edu/riatlas/*.

The Nature Conservancy has recently initiated an assessment of the streams and rivers throughout the Lower New England / Northern Piedmont ecoregion, determining which are the most intact and functional for each river and stream type. Assessment parameters include ecological land type (elevation, geology, slope, etc.), fish species, road crossings, road density, developed land, natural cover, number of dams, and other characteristics.

The EPA has also conducted a threats assessment – the Index of Watershed Indicators (IWIs) – on the watersheds of North America (U.S. EPA 2002). Based on data obtained primarily in the 1990s and using 8-digit Hydrologic Unit Code (HUC) for watersheds, the IWIs assessed the health and threats to each watershed for 18 or more indicators. Indicators include water quality parameters, the loss of wetlands, urban and agricultural runoff potential, atmospheric deposition, contaminated sediments, and other variables that affect the health of aquatic ecosystems. Table 3-4 highlights the threats assessment for the four, 8-digit HUC watersheds in Rhode Island – Blackstone, Narragansett, Pawcatuck-Wood, and Quinebaug. For their period of assessment (the late 1990s), all four watersheds were found to have less serious water quality problems. The Narragansett watershed was the only one of the four found to have a high vulnerability to problems threatening its aquatic ecosystem, with contaminated sediments, urban runoff, ambient water quality indicators, hydrologic modification due to dams, and estuarine pollution found to be significant problems (U.S. EPA 2002). This threats assessment is outdated, so it is unknown whether these watershed characterizations and threat classifications are reflective of current conditions in Rhode Island. An updated assessment of these aquatic indicators has been identified as a SWAP research need in order to determine if the state's watersheds are improving or degrading over time.

Pesticides by their nature, as substances that in many cases are designed to kill pests, can pose risks to humans and the environment. The EPA works to reduce those risks in several ways. The Office of Pesticide Program's Conventional Reduced Risk Pesticide Program expedites the review and regulatory decision-making process of conventional pesticides that pose less risk to human health and the environment than existing conventional alternatives. The goal of this program is to quickly register commercially viable alternatives to riskier conventional pesticides such as neurotoxins, carcinogens, reproductive and developmental toxicants, and groundwater contaminants.

EPA gives priority in its registration program for conventional chemical pesticides to pesticides that meet reduced risk criteria including low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management (IPM).

Recently, a draft memorandum of understanding (MOU) was developed between the EPA Office of Pesticide Programs (OPP) and the USFWS to protect migratory birds. The purpose of this MOU is to promote the conservation of migratory bird populations through enhanced collaboration between EPA's OPP and USFWS on actions carried out by OPP. Migratory birds are an important component of biological diversity, and as such, conserving them and their habitats supports ecological integrity, contributes to public conservation education, and enhances the growing interest in outdoor recreation opportunities (U.S. EPA 2014). For more information on this MOU between EPA and USFWS see: *http://www.epa.gov/oppfead1/cb/csb_page/updates/2014/birdtreaty.html*.

Use of chemical pesticides for agricultural purposes has been partially curtailed in recent years with the wider development of organic farms. Organic food is produced by farmers who emphasize the use of renewable resources and the conservation of soil and water to enhance environmental quality for future generations. Organic food is produced without using most conventional pesticides, fertilizers made with synthetic ingredients, or sewage sludge, bioengineering or ionizing radiation. On organic farms, soil fertility is maintained with compost, cover crops, rock mineral powders and other natural fertilizers. Pests and diseases are controlled by crop rotation and biological control and by applying non-synthetic materials. Weeds are managed by practices such as cultivation, mulches and flaming (NOFA 2014). Farms may be certified "organic" by agents accredited by the USDA; in Rhode Island the RI DEM Division of Agriculture has administered the state's Organic Certification Program since 2002. In 2010, 26 farms in Rhode Island were certified organic.

Additional Threats to Species of Greatest Conservation Need and Species Groups

In addition to the primary threats to key habitats identified by the SWAP Habitat Technical Team, the individual taxa teams have identified threats that impact individual SGCN or groups of species.

In addition to the direct loss of habitat by conversion of land to residential and commercial development, there are incidental impacts and causes of mortality to some species of wildlife that are associated with development. For example, building collisions cause high bird mortality with a recent assessment by Loss et al. (2014) estimating that between 365 and 988 million birds are killed by building collisions annually in the U.S. A breakdown of these numbers indicates that roughly 56% of this mortality is at low-rise buildings, 44% at residences, and <1% at high-rises. Moreover, it appears that several species are disproportionately vulnerable to collisions at all building types, including Canada Warbler, Wood Thrush and Worm-eating Warbler, three SGCN in Rhode Island (Loss et al. 2014).

Furthermore, it is estimated that free-ranging domestic cats are the single greatest source of anthropogenic mortality for birds and mammals in the U.S. Findings by Loss et al. (2013) indicate that 1.3–4.0 billion birds and 6.3–22.3 billion mammals are killed annually in the U.S., mostly by feral cats as opposed to owned pets. The conservation strategy for the New England Cottontail has suggested that, although there is little direct evidence regarding the role of domestic cats in influencing New England Cottontail populations, given the high human population and housing densities throughout most of their range, domestic cats may be important predators of this species (Fuller and Tur 2012).

Biological Resource Use

This category includes threats from the consumptive use of biological resources including deliberate and unintentional harvesting, as well as the persecution or control of specific species (Salafsky et al. 2008). This threat has been identified as an issue for 46% of SGCN reptiles and amphibians primarily due to the collection of animals for the pet trade.

Several SGCN birds and mammals are game species and therefore subject to "deliberate harvesting." For instance, cottontail rabbits are considered small game animals and are legally hunted in four of the six states inhabited by New England Cottontail. States have the jurisdictional authority to regulate Eastern Cottontail and New England Cottontail harvest and may adopt regulations to maintain healthy populations according to local circumstances.

Maine (where only the New England Cottontail is found) recently closed its cottontail hunting season, and New Hampshire has prohibited taking cottontail rabbits in parts of the state where New England Cottontail are known to live. Massachusetts, Connecticut, Rhode Island, and New York permit taking both species during regulated hunting seasons, but because hunting pressure is low relative to the overall abundance of cottontails and not considered significant compared to other mortality factors, its impact on the New England Cottontail population is believed to be minimal (Fuller and Tur 2012). However, the recent rediscovery of New England Cottontail at three sites in Rhode Island (Tefft 2013) suggests that limitations on the take of New England Cottontail in the state should be reconsidered since the size of their populations is currently unknown.

Human Intrusion and Disturbance

This category includes threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources (Salafsky et al. 2008). In a state with a high population density, the threat of human disturbance to many fish and wildlife species and their habitats can be considerable, and some species are particularly vulnerable to this threat.

Maritime beaches and the unique suite of species they support are vulnerable because of the extreme use of these habitats for human recreation. Beach-nesting birds, including Piping Plover and Least Tern, are particularly vulnerable because human disturbance often curtails breeding success. Foot and vehicular traffic may crush nests or young and excessive disturbance may cause the parents to desert the nest, exposing eggs or chicks to the summer sun and predators. Interruption of feeding may stress juvenile birds during critical periods in their development. In addition pets, especially dogs, may harass the birds, and developments near beaches provide food that attracts increased numbers of predators such as raccoons, skunks, and foxes. Domestic and feral cats are also very efficient predators of small mammals and birds, including the Piping Plover.

The USFWS assists partners with management at 16 nesting sites from Westerly to Middletown, including Block Island. Since management efforts in 1992, the population in southern Rhode Island has increased 690% from 10 nesting pairs in 1992 to 69 nesting pairs in 2009.

Wildlife Diseases

Wildlife diseases have the potential to impact a broad range of wildlife. An emerging disease that has received particular attention in the Northeast is White-nosed Syndrome (WNS) in bats. The RCN Grant Program has funded two projects to begin research and to address the threat of WNS that has killed more than 5.7 million hibernating bats in the northeastern states. The disease is named for its causative agent, a white fungus (*Geomyces destructans*) that invades the skin of hibernating or otherwise torpid bats. Research has demonstrated that bats affected by WNS arouse from hibernation significantly more often than healthy bats. The severity of cutaneous fungal infection correlates with the number of arousal episodes from torpor during hibernation. The increased frequency of arousal from torpor likely contributes to WNS-associated mortality, but the question of how fungal infection induces increased arousals remains unanswered. Other research has focused on the development of methodologies to combat WNS in bats to test potential treatments against cultured *Geomyces destructans* under laboratory conditions, test potential treatments for safety in healthy bats, and test potential treatments for efficacy against *G. destructans* in hibernating bats. In Rhode Island, RI DEM DFW has implemented comprehensive surveys of all bats to understand the implications of WNS in the state – to date the disease has not been documented in Rhode Island (Brown pers. comm., 2014).

Since 2009, Timber Rattlesnakes from separate populations in eastern, central and western Massachusetts have been found to have a significant disease identified as fungal dermatitis. Fungal dermatitis has been previously documented as a cause of morbidity and mortality in both captive and free-ranging Viperidae snakes (Cheatwood et al. 2003). With funding from the RCN Grant Program, researchers are actively trying to understand the spread of this disease and factors that contribute to its virulence in rattlesnake populations.

New Energy Developments

There are many potential impacts of new energy development on wildlife in the northeastern states, ranging from effects of hydraulic fracturing and off shore drilling on aquatic systems, the development of biomass and consequent forest harvesting, and the direct mortality of birds and bats from wind turbines along mountain and coastal flyways.

A Risk Assessment of Marine Birds in the Northwest Atlantic Ocean is under way through NALCC and partners to develop a series of maps depicting the distribution, abundance and relative risk to marine birds from offshore activities (e.g., off shore drilling and wind energy development) in the northwestern Atlantic Ocean. The goal is to develop and demonstrate techniques to document and predict areas of frequent use and aggregations of birds and the relative risk to marine birds within these areas. This NALCC project is supporting several components of map and technique development by leveraging several large, ongoing projects funded by the Bureau of Ocean Energy Management (BOEM), Department of Energy (DOE), USGS, and NOAA and involving research groups at the Biodiversity Research Institute, North Caroline State University, City University of New York-Staten Island, the USGS Patuxent Wildlife Research Center, and the NOAA National Centers for Coastal Ocean Science-Biogeography Branch.

On September 5, 2014, Deepwater Wind received the final federal approval needed to build the Block Island Wind Farm, the nation's first offshore wind farm. The 30-megawatt wind farm, consisting of five turbines, will be located three miles off the coast of Block Island entirely within Rhode Island state waters. Offshore construction is expected to begin during the summer of 2015 with the wind farm in-service in 2016. BOEM is still reviewing the permit for the transmission line from Block Island to the mainland, but it is expected that approval will be received.

Wind turbines pose a potential threat to birds, although compared to other sources of fatality (e.g., collisions with buildings and communication towers and predation by cats) wind turbines, at the current rate of development, appear to be a relatively minor source of mortality; however, these fatalities are cumulative and may become more pronounced over time. As turbine size increases and development expands into new areas with higher densities of birds, risk to birds could increase (The Wildlife Society 2007).

Lack of Information, Planning and Outreach

Although not a direct threats each of these are considered action drivers or needs that call for important actions to address conservation of SGCN and key habitats. Lack of information on the distribution, status, and ecology of SGCN and key habitats is considered here because of the importance of having accurate information to respond appropriately and meaningfully to identified threats. A threat identified in the 2005 CWCS as an Overarching Statewide Conservation Action was, "Lack of GCN species and key habitat data incorporated into comprehensive strategy" (RI DEM 2005). These needs for information and planning call for the continuing processes of planning and gathering of additional information that has been identified and prioritized. However, primarily due to budgetary constraints, there has been little accomplished in regard to the acquisition and management of data to complete conservation actions identified in the CWCS. The same is true with the need for outreach and need for dissemination of these data.

A 2005 action to "Identify all critical habitats" has been partially completed through the Photoscience project described in Chapter 2 for mapping RI ecological communities, although Phase 2 of this project, which would enhance the coverage with more detailed mapping of rare communities, remains to be done. Some additional actions to "assess threats to species and habitats" by research and monitoring have occurred since 2005, but the goal of this work, "to recognize or create de facto wildlife "preserves", or conservation areas, has not been completed. The Conservation Opportunity Area maps in Chapter 4 provide some of the natural resource information needed to designating these areas, but a finer scale delineation of focal areas (a key ingredient of the COA process) is not yet possible without more site-specific information on SGCN and Key Habitats. Some of this information is available in disparate databases, much of it remains to be gathered, all of it should be incorporated into a central database to insure accuracy and consistency.

Threats to Plants

Threats to plants are essentially the same as those that face animals, especially the loss of habitat by conversion to development. Individual plant species are projected to face additional pressures from the effects of climate change, as detailed in the climate change section above. Some plants are especially prone to the threat of over-browsing by animals, especially White-tailed Deer. Several families of plants, including the orchids (Orchidaceae), and lilies (Liliaceae) are prone to deer browsing, and species within these families have undergone declines and extirpations during the past 25 years (Enser in prep.). Plants are also affected by subtle changes in soil chemistry, losses of symbiotic mycorrhizal fungi, species-specific alien pests, and introduced animals (earthworms).

Many plants are also the targets of collectors for various purposes. Although all plants and animals are prohibited from collection on state properties without a permit, this regulation is rarely enforced. However, only a handful of plants are threatened by collection. A recent example is the loss of the last population of Walking Fern (*Asplenium rhizophyllum*).

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