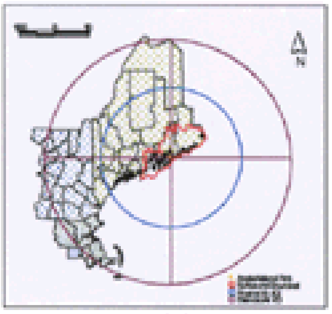
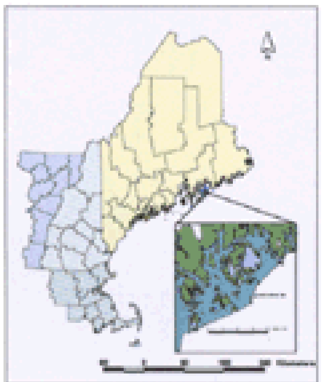
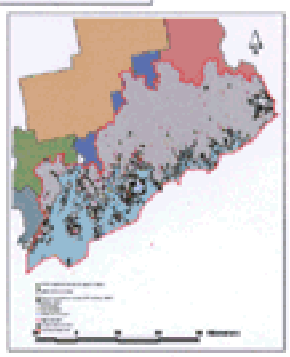
An Assessment of Contaminant Threats at Acadia National Park







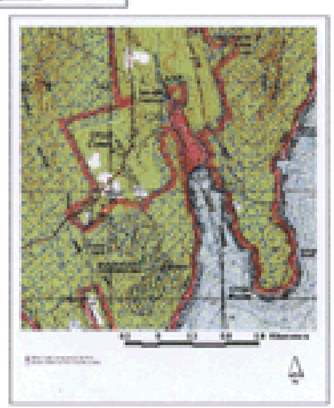


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Table of Contents

List of Tables

List of Figures

1.0 Introduction

The U.S. Geological Survey (USGS) Biomonitoring of Environmental Status and Trends (BEST) program seeks to identify and understand the effects of environmental contaminants on lands and biological resources managed by the Department of the Interior (DOI). The primary goals of the BEST program are: (1) determine the status and trends of environmental contaminants and their effects on biological resources, (2) identify, assess, and predict the effects of contaminants on ecosystems and biological populations, and (3) provide summary information to managers and the public for guiding conservation efforts. One of the tools used to reach these goals is the Contaminant Assessment Process (CAP).

In 1998, the retrospective analysis portion of CAP was initiated at Acadia National Park (ANP). The retrospective analysis identified contaminant sources and transport pathways to ANP. The contaminant sources and types were identified, prioritized, and areas of potential contamination within the park were delineated. This report summarizes these sources and areas of potential contamination. Spatial and tabular information were incorporated into the CAP and were managed by using a geographic information system (GIS). Data were collected from federal and state databases, University of Maine, College of the Atlantic, local harbormasters, U.S. Coast Guard, and park personnel (Table 1). The products of this assessment include this report summarizing the findings and recommendations, and the GIS application that incorporates all of the information collected during this study.

Table 1. Contaminant data sources used for the Acadia National Park CAP

Transport Mechanism	Contaminant Source Type	Data Source
Air	Stationary Criteria Pollutant Sources	U.S. Environmental Protection Agency (USEPA) Aerometric Information Retrieval System
	TRI Facilities	USEPA Toxic Release Inventory System
	Power plants and Incinerators	USEPA Aerometric Information Retrieval System
	Fugitive Emission Sources	USEPA Toxic Release Inventory System
	Land-farmed Sludge	Maine Department of Environmental Protection (MDEP), Bureau of Land and Water Quality (BLWQ), Water Resources Regulation Division (WRRD)
Surface Water (fresh water)	RCRA Facilities	USEPA Resource Conservation and Recovery Information System
	CERCLA Sites	USEPA Comprehensive Environmental Response, Compensation, and Liability Information System
	TRI Facilities	USEPA Toxic Release Inventory System
	PCS Facilities	USEPA Permit Compliance System
	Mines	MAS/MILS
	Uncontrolled Spill Sites	MDEP, Division of Remediation, Bureau of Remediation and Waste Management
	Transmission Line Pesticides	Bangor Hydroelectric Company
Surface Water (salt water)	Oil and Hazardous Material Spills 1995-1999	USEPA Emergency Response Notification System
	Bulk Oil Storage	USCG Maine and New Hampshire Area Contingency Plan
	Bulk Hazardous Materials Storage	USCG Maine and New Hampshire Area Contingency Plan
	Harbor use on Mount Desert Island 1998	Harbormasters: Ed Monat, Tim Butler, Mike Johnson, Gene Thurston
	Boat Traffic 1996-1998	USCG Bucksport Field Office
	Boat Traffic Lanes	Ed Monat and NOAA
	Maine Aquaculture Lease Sites	Maine Department of Marine Resources
	County Pesticide Use	NOAA Gulf of Maine Project
Ground Water	Underground Storage Tanks	MDEP records
	Landfills	MDEP, Division of Remediation, Bureau of Remediation and Waste Management
	Injection Wells	MDEP BLWQ WRRD
	Road Sand/Salt Storage Sites	MDEP BLWQ WRRD

1.1 CAP Overview

1.1.1 General

The CAP is a systematic approach for determining if contaminants pose risks to habitats or biota managed by the DOI, including national wildlife refuges and parks. The CAP is divided into two parts, retrospective analysis, and if necessary, field sampling. In the retrospective analysis ecological characteristics, management goals, and local habitats of importance for the park are reviewed. The spatial extent of the analysis is determined, and environmental pathways by which contaminants may be transported to the park are identified. Contaminant sources (including point and nonpoint), and potentially sensitive species are documented.

Areas of likely contamination located in the park are identified and ranked. Areas potentially susceptible to accidental spills of hazardous materials are also identified. In the second part of the process, field-sampling plans are developed to confirm the presence of the suspected contaminants or document prespill conditions on park lands

1.1.2 Contaminant Transport Mechanisms

Contaminants enter the environment as solids, liquids, aerosols, gases, or mixtures. Once released, they interact chemically with biotic and abiotic media. Physical movement of contaminant-laden air and water controls most long- and short- range transport of contaminants. An underlying assumption of the CAP is that air and waterborne contaminants tend to move along, more or less, predictable routes. The CAP approach generally evaluates three major contaminant transport mechanisms: surface water, ground water, and air, and one less typical transport mechanism, biotic transport.

1.1.3 Areas of Interest

Areas of interest (AOIs) refer to the spatial extent surrounding the park that is evaluated for each contaminant transport mechanism. The AOI is used to focus the assessment on those areas which might contain sites of contaminant releases that are likely to reach the park in sufficient concentration to have an adverse effect on habitats or biota. Contaminants released outside of the AOI are not likely to impact park resources.

1.1.3.1 Ground and surface water AOIs

Contaminants enter surface and ground water from point sources or nonpoint sources. Point sources refer to locations where contaminants are released to the environment via discrete structures, such as pipes, sloughs, or troughs. Nonpoint sources refer to areas where contaminants associated with the vegetation or soil are carried into surface or groundwater bodies by rainfall, snowmelt, or irrigation The AOIs for surface water and ground water typically correspond to the boundary defined by the 8-digit hydrologic unit classification (HUC) in which the park is located. The HUC system is a hierarchical, nationally uniform, hydrological mapping framework developed by the USGS to map watershed boundaries. The AOI for surface and ground water used in the Acadia assessment was the Maine Coastal Watershed (HUC #01050002) and was also used to account for tidal transport of contaminants.

1.1.3.2 Air AOI

Airborne contaminants are released from point sources (i.e., stacks, chimneys or vents) or as fugitive emissions (i.e. diffuse, non collected sources). Point source emissions are typically released at a fixed height, from a specific opening, and frequently at elevated temperatures. Fugitive emissions are typically released at or near ground level, over a diffuse area at ambient temperature. Because of the different characteristics of point vs. fugitive airborne emission sources, different AOIs were used each source type. The typical AOI used in CAP for airborne contaminants released from point sources is a 160-km buffer extending from the boundary of the unit. This distance is based on the assumption that wind could reasonably be assumed to blow persistently for 5 hours from one direction. The highest wind speed assumed in the USEPA models is about 24 miles / hour. Therefore, for the purpose of establishing an AOI for air, it was assumed that if the wind blew at about 20 mph for 5 hours, contaminants could be transported about 100 miles (~160 km). This default distance was extended in the Acadia assessment to 200 km to include potential sources from the Boston metropolitan area. A second AOI for airborne sources extended to 300 km of the park boundary to take into account regional emissions sources from power producing facilities. Canadian air pollutant sources within the extended airshed were not taken into account as part of this assessment.

A third AOI was established to account for airborne contaminants released from fugitive emission sources, due to their different dispersion characteristics. The extent of the AOI for fugitive airborne contaminants was discussed during a meeting between NPS Air Quality Division and BEST staff in May 1998. Fugitive emissions are likely to impact and absorb onto biotic (plants, vegetation canopy) or abiotic media (soil, water) within a relatively short distance from their release. The consensus reached during the meeting was to establish a 30 km AOI for fugitive emissions. This AOI was considered to be sufficiently conservative to account for the majority of fugitive emissions that might reach a park.

1.1.3.3 Biological AOIs

In some cases, contaminants are transported to a park in the tissues of living animals.This biotic transport of contaminants includes instances of migrating organisms which may carry remotely bioaccumulated pesticides or industrial contaminants. While biotic transport of contaminants should be considered as part of the CAP, this mechanism is not necessarily applicable for all situations. When appropriate, the assessment of biotic transport should be limited to those species/ assemblages that are likely to carry bioaccumulated contaminants, in sufficient concentrations, to affect the park or its biota. Although biotic transport was evaluated as part of the Acadia project, it was not deemed to be a significant vector of contaminants to the park.

1.1.4 Contaminant Transport Pathways

Once the AOIs are established, individual transport pathways are identified for each transport mechanism. Contaminant transport pathways are identifiable avenues through which the bulk of contaminants move. For example, contaminant transport pathways for surface water might include specific streams, canals, rivers, lakes, or tides; for ground water, aquifers or springs; and for air, predominant local surface wind directions.

1.1.5 Ranking Contaminant Sources and Types.

After transport pathways are identified, contaminant sources associated with each pathway are reviewed and the types of contaminants that they release are cataloged, assessed, and ranked. Contaminant sources were ranked differently according to exposure pathway. Airborne pollutant sources were ranked by volume of pollutant emitted, proximity to park, and direction from park. Surface water pollutant sources were ranked according to proximity to the park, proximity to park water bodies, and quantity of waste produced, or severity of known contamination. Ground water pollutant sources were ranked according to toxicity of the pollutant, the source's geographic location to the park (both proximity and up-gradient/ down-gradient status) and proximity to a water body. Contaminants that potentially pose higher risks than others are designated as contaminants of concern (COC).

1.1.6 Identifying Biological Receptors

Biological receptors (i.e., organisms) within the park are identified for each COC. Criteria for selecting receptors include susceptibility and their potential exposure. The range of the receptor and the boundary of the particular transport mechanism carrying the COC to the park must overlap. Areas where contaminant transport pathways and receptors overlap are designated as potentially contaminated areas (PCA). Because PCAs are located along the dispersion path of known contaminant sources, they are likely to contain elevated concentrations of contaminants, and; consequently, sampling at these areas will permit earlier detection of contaminant presence or contaminant-related effects as compared to randomly selected sites in the park.

In some situations, NPS-managed habitats and biota may be not be threatened by contaminants released into specific pathways but rather, may be vulnerable to spills of hazardous materials carried along nearby highways, railroads, or navigation channels. To address these concerns, baseline sampling areas (BSAs) are also identified as part of the CAP. These areas would typically be located were the presence of spilled contaminants or their effects could be observed soon after the material reached the park, or at vulnerable, high-value habitats along the transportation corridor. Field-sampling conducted at PCAs in the second part of CAP is intended to confirm the presence of suspected contaminants and sampling at BSAs is intended to document site conditions before a spill. Data collected at BSAs can provide valuable information in support natural resource damage assessments.

1.2 Park Overview

Acadia National Park is the only national park in the northeastern United States. Located on the coast of Maine (Figure 2), the park is situated within a day's drive from many large cities within the region, and is visited by more than three million people annually. With more than 16,000 hectares in Hancock and Knox counties, it is one of the largest publicly owned and protected natural areas in the region.

The park was originally established as Sieur de Monts National Monument by Presidential Proclamation (#1339) in 1916. The park endured boundary and name changes (including the 1929 change to Acadia National Park) until, in 1986, the park's legislative boundary was established by Public Law 99-420. The park's mission is to "…protect and conserve outstanding scenic, natural, and cultural resources for present and future generations. These resources include a glaciated coastal and island landscape, biological diversity, clean air and water, and a rich cultural history."(Acadia National Park 1998).

The park consists of land on Mount Desert Island (MDI), plus portions of, and in some cases, the entire extent of outlying smaller islands, a portion of Isle au Haut (IAH) to the southwest of MDI, and the tip of Schoodic Peninsula, located on the mainland to the east of MDI. In addition, the park holds over 150 conservation easements in the Penobscot Bay and

Frenchman Bay areas. The park is located in the broad transition zone between northern coniferous forest and temperate deciduous forest, which has resulted in a rich and diverse flora of approximately 1200 species, and more than 330 bird and 50 mammal species (Acadia National Park 1998).

The park is home to one federally-listed endangered bird species, one federally-listed threatened bird species, seven state-listed endangered bird species, and four state-listed threatened bird species (Table 2). Within the park there are also 183 species of vascular plants that are either state-listed or designated as locally rare (Greene 1990).

Figure 1. Areas of interest (AOIs) for air and water transport mechanisms

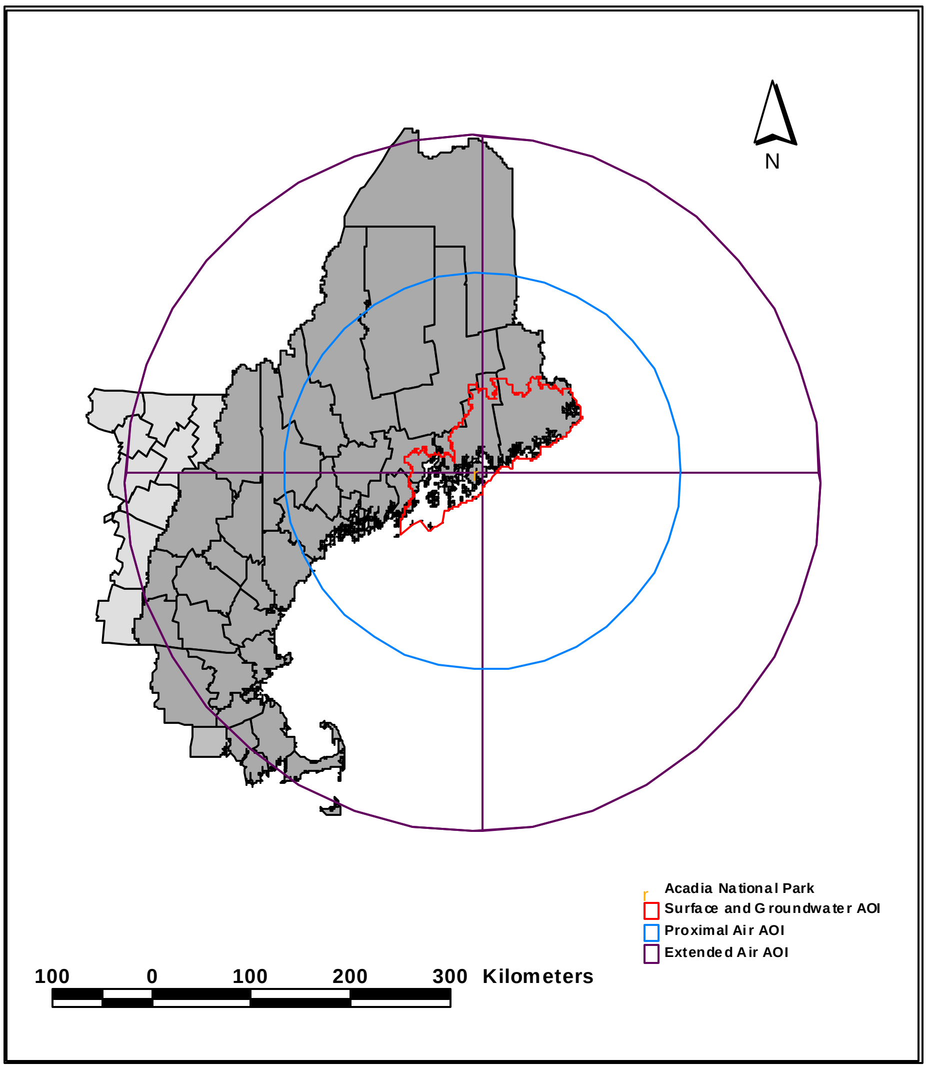


Figure 2. Map showing location of Acadia National Park

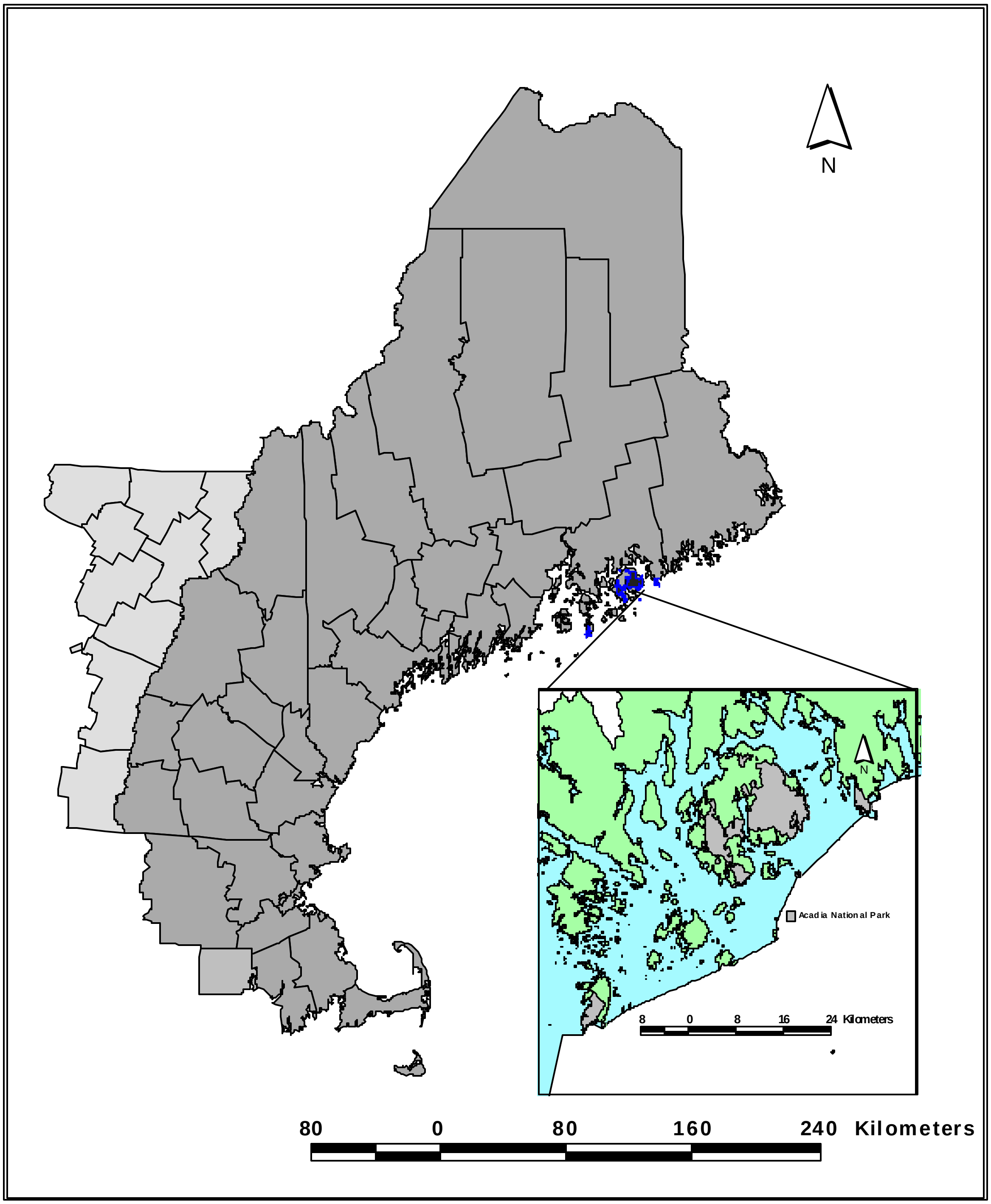


Table 2. Endangered and threatened birds of Acadia National Park

Status	Species	Common Name
Federally endangered	*Sterna dougallii*	Roseate Tern
Federally threatened	*Haliaeetus leucocephalus*	Bald Eagle*
State endangered	*Ammodramus savannarum*	Grasshopper Sparrow
	Sterna albifrons	Least Tern
	Chlidonias niger	Black Tern
	Aquila chrysaetos	Golden Eagle
	Cistothorus platensis	Sedge Wren
	Anthus spinoletta	American Pipit
	Ammodramus savannarum	Grasshopper Sparrow
State threatened	*Alca torda*	Razorbill
	Fratercula arctica	Atlantic Puffin
	Histrionicus histrionicus	Harlequin Duck
	Bartramia longicauda	Upland Sandpiper

* Proposed for delisting July 1999

Park watersheds are relatively free of point-source pollutants. However, the park is uniquely located downwind of major air pollution sources, and as a result the watersheds receive some of the highest levels of air pollutants (ozone, sulfur dioxide, mercury) in the northeastern United States. In addition, urban plumes transported over the Gulf of Maine are brought ashore by sea breezes, thus compounding the problem (Ray *et al*. 1996). Currently, air pollution has caused the most significant pollutant-related damage in the park, including ozone-induced foliar damage on sensitive plant species (Kohut *et al*. 1997) and high levels of mercury in park fish (Stafford and Haines 1997).

1.2.1 Current Monitoring at the Park

1.2.1.1 Air monitoring

The park, in conjunction with State and Federal agencies, maintains an Air Monitoring Program and is involved in the joint U.S. Environmental Protection Agency (USEPA)-NPS Park Research and Intensive Monitoring of Ecosystems Network (PRIMENet)[1]. Air monitoring data are collected at two sites located on on MDI: Cadillac Mountain and McFarland Hill (Table 3). The McFarland Hill station was moved approximately ¼ mile north and up-slope from its original location and has been named the McFarland Hill Air Research Site (MARS). In addition to collecting various chemical data, park personnel also monitor ozone-induced foliar damage on bigleaf aster (*Aster macrophyllum*) and spreading dogbane (*Apocynum androseamifolium*) at 18 sites within the park.

[1] Before December 1998 PRIMENet was known as the Demonstration Intensive Site Project (DISPro)

1.2.1.2 Water Monitoring

In 1997 the park began long-term freshwater monitoring at ten of the park's 22 named lakes (Table 4). Additionally, in 1997 the park began stream macroinvertebrate sampling at single sites on four of the park's streams- Duck Brook, Stanley Brook, Hunter's Brook and Cannon Brook[2].

1.2.1.3 Biological Monitoring

The park populations of Peregrine falcons *(Falco peregrinus)*, bald eagles *(Haliaeetus leucocephalus)*, Harlequin ducks *(Histrionicus histrionicus)*, and beavers (*Castor canadensis*) are monitored. Additionally, the park serves as a site for the annual National Audubon Society-sponsored Christmas Bird Count.

2.0 Contaminant Assessment Rationale, by Pathway

2.1 Air Pathway

2.1.1 Summary

The air transport of pollutants is the primary mechanism by which Acadia receives the majority of its pollutant load. The significance of the mechanism lies not in a multitude of large nearby pollutant sources, but rather in the park's location downwind of many major pollutant sources in the eastern United States. The park also projects into the Atlantic Ocean to receive any pollutants that are concentrated and circulated back ashore by onshore breezes.

[2] In 1999 stream macroinvertebrate sampling was also conducted at single sites on two additional streams - Heath Brook Stream and Lurvey Spring Brook.

Table 3. Air monitoring at Acadia National Park

Monitoring Type	Monitoring Program	Site	Parameters	Collection Frequency	Year Start	Year End
Atmospheric Deposition	National Atmospheric Deposition Program (NADP)	M	pH, sulfate, nitrate, ammonia, chloride, base cations	Weekly	1980	On-going
	Mercury Deposition Network (MDN)	M	Wet and dry deposition of mercury	Weekly	1995	On-going
Photochemical Assessment Monitoring (PAMS)	Gaseous Pollutant Monitoring	M, C	Ozone	Continuous	1982	On-going
		C	NO_x	Continuous	1991, 1993, 1995-	On-going
		C	SO_2	Continuous	1988	1990
		C	VOC	Event and continuous	1991, 1993, 1995-	On-going
Meteorlogical Monitoring		M, C	Wind speed, wind direction, temperature, dew point	Continuous	1993	On-going
		M	Precipitation, temperature	Continuous	1926	On-going
Visibility Monitoring	Fine particulate monitoring (IMPROVE)	M	Particulate size & mass, nitrate, sulfate, organic & elemental carbon	2 24-hr periods/wk	1987	On-going
	Optical Monitoring	M	Standard visual range	Continuous	1987	On-going
	Scene monitoring	C	Qualitative characterization of visibility	Daily	1980	1995
PRIMENet		M	UV-B, total column ozone	Continuous	1998	On-going

M= MARS, C= Cadillac Mountain

Table 4. Current lake monitoring at Acadia National Park

Lake	Parameters			
	Dissolved Oxygen	Temperature and Secchi transparency	Eutrophication analytes	Acidification analytes
Bubble Pond	X	X		X
Eagle Lake	X	X		
Echo Pond	X	X	X	
Jordan Pond	X	X	X	X
Long Pond	X	X		
Sargent Mountain Pond		X		X
Seal Cove Pond	X	X	X	
The Bowl		X		X
Upper Hadlock Pond	X	X	X	
Witch Hole Pond	X	X	X	X

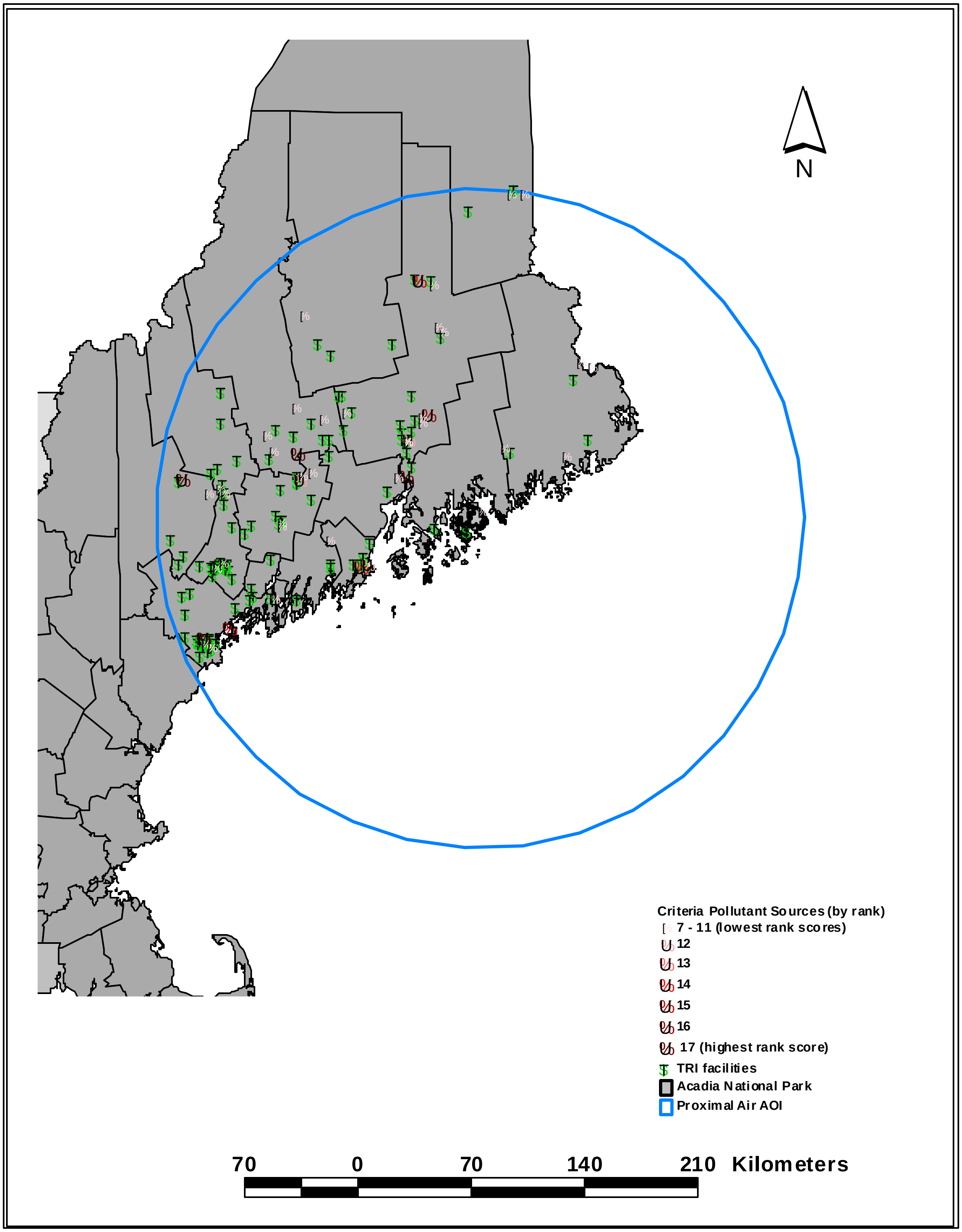
Eutrophication analytes include: field temperature, Secchi transparency, pH (closed cell), specific conductance, true color, dissolved organic carbon, total phosphorus, total nitrogen, chlorophyll *a*, lake stage, dissolved oxygen/temperature profile. Acidification analytes include: field temperature, Secchi transparency, pH (closed cell), pH (equilibrated), acid neutralizing capacity, specific conductance, true color, dissolved organic carbon, dissolved inorganic carbon, calcium, magnesium, potassium, sodium, ammonia (NH_4), silica, SO_4, Cl, NO_3, aluminum (total dissolved), total nitrogen, lake stage. (Gawley and Breen 1998)

region encompassing all emissions that have any influence on the park, then the airshed for the park would have to be hemispheric or global. To catalog all the emissions sources within such an area and then to calculate their relative pollutant effect on the park would be impossible. For this assessment, two air-pathway AOIs were delineated that extend up to 350 km from the park. Although this region may contain significant sources of many pollutants that reach the park, some pollutants (e.g., sulfur oxides, nitrogen oxides, mercury) are known to be transported much longer distances. It is beyond the scope of this assessment to address long-range transport and deposition of air pollutants.

Within 200 km of the park, we cataloged and ranked point sources emitting criteria pollutants and air toxics (Figure 3). Criteria pollutants are air pollutants for which the USEPA has established "primary" standards to protect public health, and "secondary" standards to protect other aspects of public welfare, such as preventing materials damage, preventing crop and vegetation damage, or assuring visibility (Appendix A). These standards are the National Ambient Air Quality Standards (NAAQS). Carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), particulate matter (PM_{10} or PT), and sulfur dioxide (SO_2) are criteria pollutants.

Air toxics, also known as hazardous air pollutants (HAPs), include pollutants that are known or suspected to cause cancer and/or other serious health effects, such as birth defects or

Figure 3. Stationary criteria pollutant sources and TRI facilities within 200 km of the park



reproductive effects. The USEPA lists 189 air toxics. Stack or point air emissions are releases that occur through stacks, vents, ducts, pipes, or other confined air streams, as well as storage tank emissions and air releases from air pollution control equipment. In evaluating airborne contaminant risks, the CAP tends to emphasize toxic compounds over criteria pollutants.

Within 30 km of the park, we considered fugitive emissions of air toxics, and volatization from land-farmed sludge from municipal waste facilities, and paper and pulp mills (Figure 4). Fugitive or Non-Point Air Emissions are those not released through stacks, vents, ducts, pipes, or any other confined air stream. Included in this category are equipment leaks from valves, pump seals, flanges, compressors, sampling connections, open ended lines, etc; evaporative losses from surface impoundments and spills; releases from building ventilation systems; and any other fugitive or non-point air emissions. Sludge may be a significant source of trace metals to soils where it is applied (McBride *et al*. 1999), but volatile elements such as mercury may not remain in the soil. High concentrations of mercury have been detected in the air over contaminated soils (Lindberg *et al*. 1995), indicating that land-farmed sludge may be a source of mercury to the atmosphere.

To capture pollutant input from major emitters within the industrialized area around Boston, Massachusetts (the closest major metropolitan area), we cataloged and ranked incinerators and power plants (SIC codes 4953 and 4911) within 350 km of the park (Figure 5).). Major emitters as defined in Section 112 of the Clean Air Act include stationary sources within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants.

2.1.3 Prevailing Wind Direction

Wind speed and direction are measured at two NPS Gaseous Air Pollutant Monitoring Stations within the park: Cadillac Mountain and McFarland Hill. The predominant wind direction recorded in 1996 at the stations was from the southwest (Figure 6). Ozone levels and mercury deposition are highest when the wind is out of the southwest (Figure 7). Therefore pollutant sources to the southwest are likely to contribute significant amounts gaseous pollutants to the park. However, it should be noted that at the Cadillac Mountain meteorological station the wind direction recorded is frequently out of the northwest, and pollutant sources to the northwest of the park should not be overlooked. Further, pollutants transported long distances by meteorological phenomena will reach the park, but are not considered in this analysis.

2.1.4 Ranking Scheme

Sources within 30 km of the park are summarized but not ranked. For criteria pollutant sources within the 200 km and 350 km AOIs, numerical ranking was based on volume of pollutant emitted, proximity to park, and direction from park (Tables 5 and 6). Specific air toxics were ranked by volume, distance, and direction from the park[3]. Sources with the highest numerical rank were considered the sources of highest concern[4].

[3] Note that the air toxics are ranked as individual chemicals as we are interested in the cumulative effects of these toxics to park resources.

[4] The numerical ranks ranged from seven to 17. There were 12 sites with a rank value of 12 or higher, which were considered the sources of highest concern.

Figure 4. Fugitive emission sources within 30 km of the Park

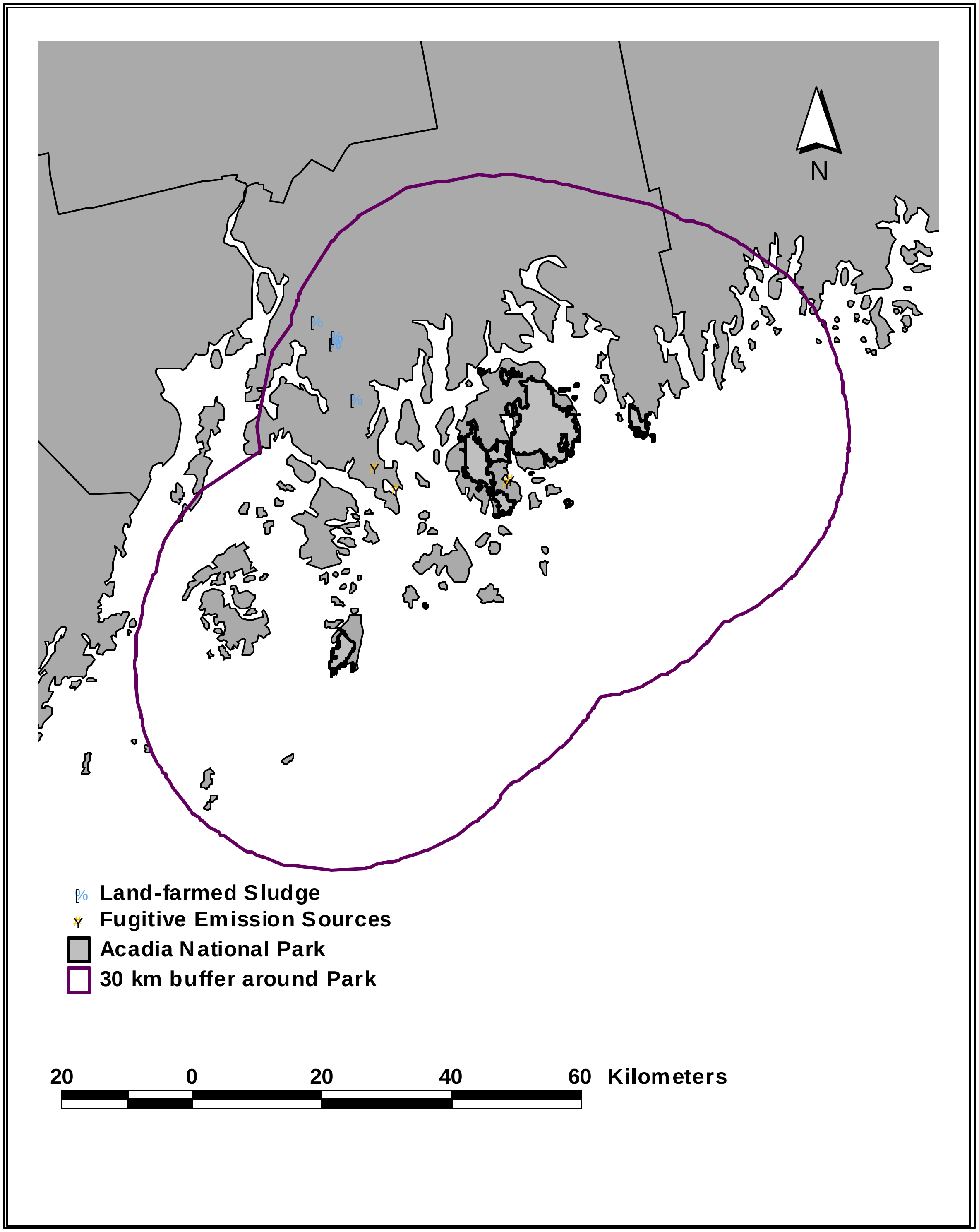
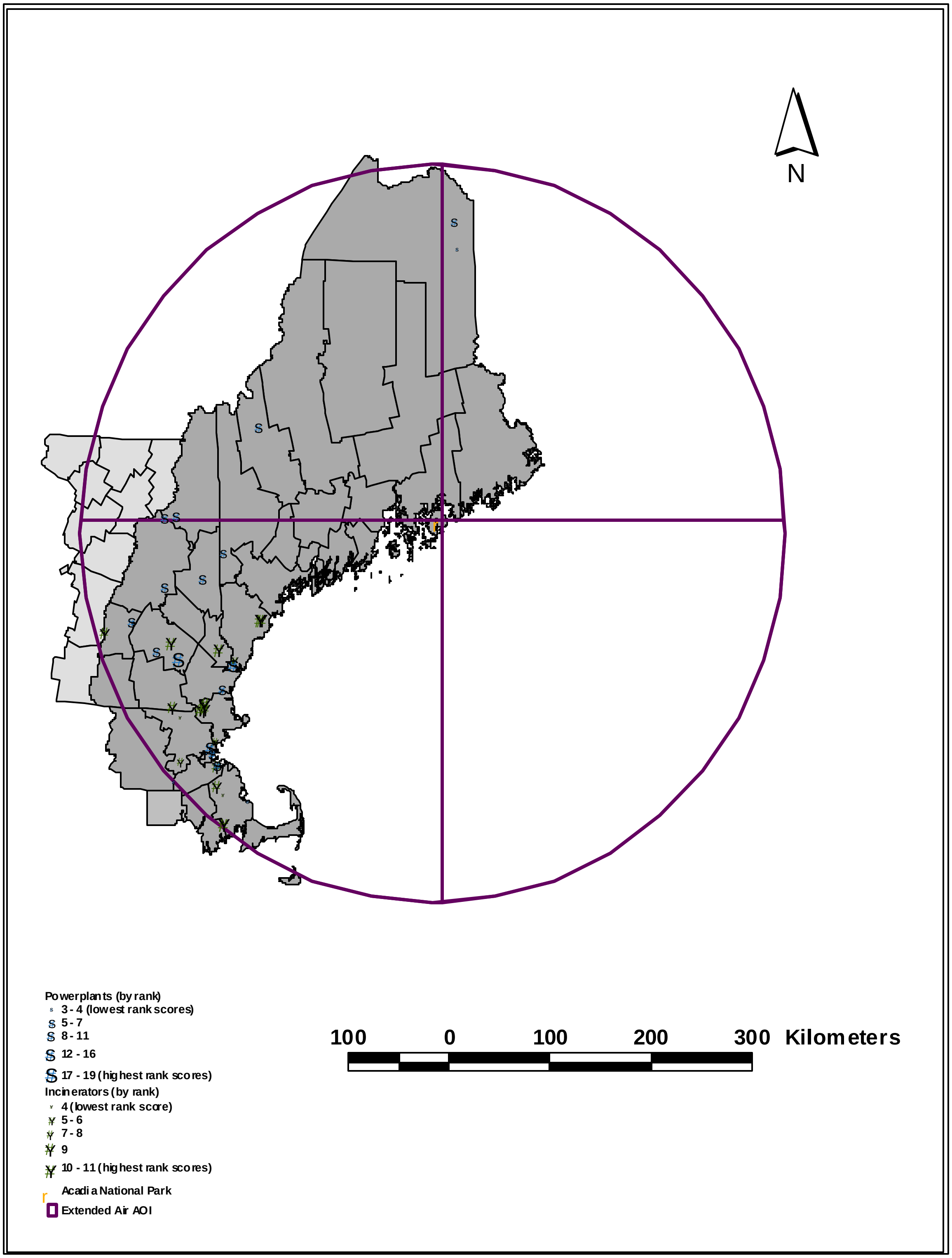
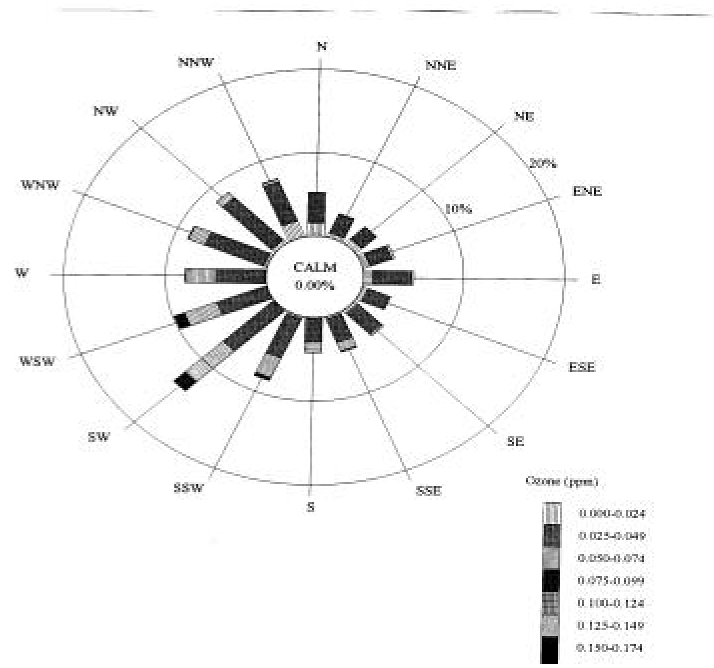


Figure 5. Incinerators and power plants between 200 and 350 km of the park



fFigure 6. Wind speed and direction at Cadillac Mountain and McFarland Hill, 1996

Cadillac Mountain



McFarland Hill

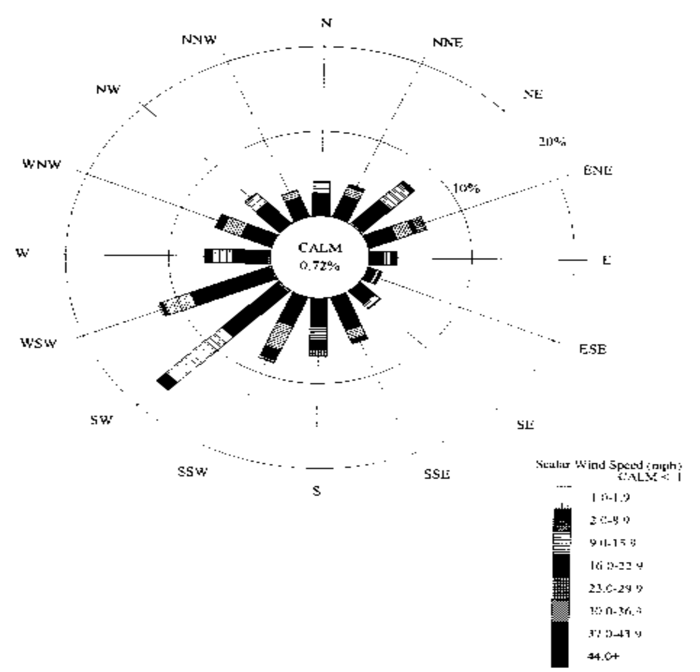
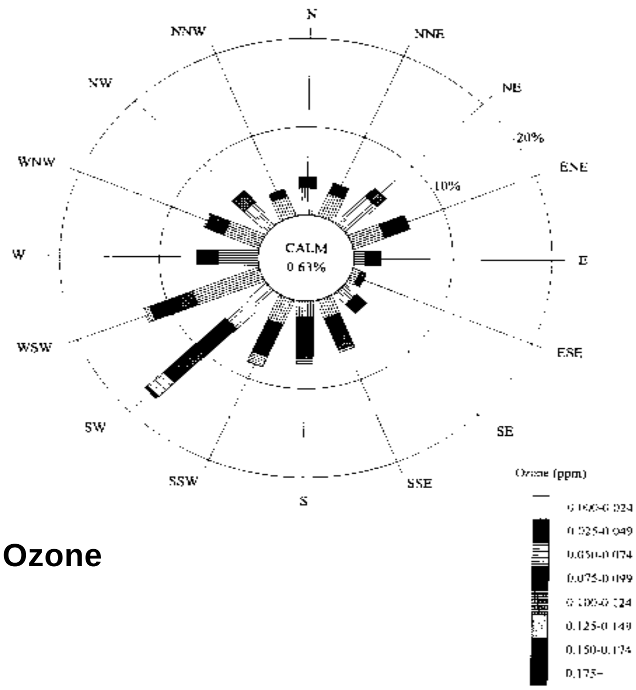
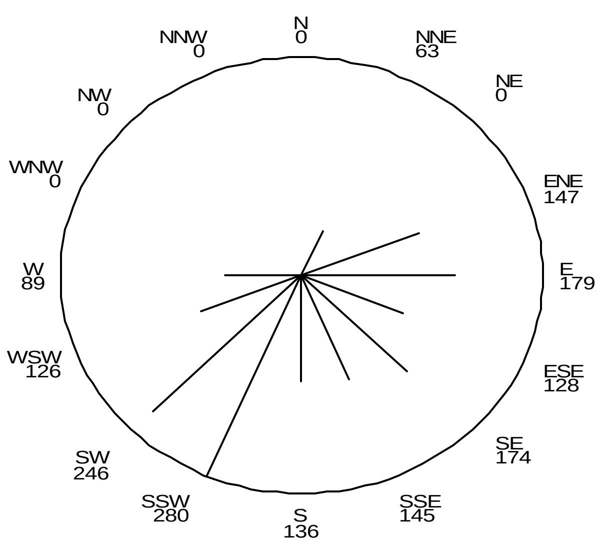


Figure 7. Ozone concentration and mercury deposition at McFarland Hill, 1996



Ozone



Mercury deposition

Table 5 . Ranking scheme for criteria pollutant sources within 200 km of the park

Volume	Rank	Distance	Rank	Direction	Rank
5-10 K tpy	5	<50 Km	4	SW	3
2-5 K tpy	4	51-100 Km	3	NW	2
1-2 K tpy	3	101-150 Km	2	NE	1
0.5-1 K tpy	2	151-200 Km	1		
<0.5 K tpy	1				

Volume units (K tpy) are thousands of tons per year

Table 6. Ranking scheme for incinerators and power plants between 200 and 350 km of the park

Volume	Rank	Distance	Rank	Direction	Rank
>30 K tpy	6	200-250 Km	3	SW	3
20-30 K tpy	5	251-300 Km	2	NW	2
10-20 K tpy	4	301-350 Km	1	NE	1
5-10 K tpy	3				
1-5 K tpy	2				
<1 K tpy	1				

Volume units (K tpy) are thousands of tons per year

2.2 Surface Water Pathway

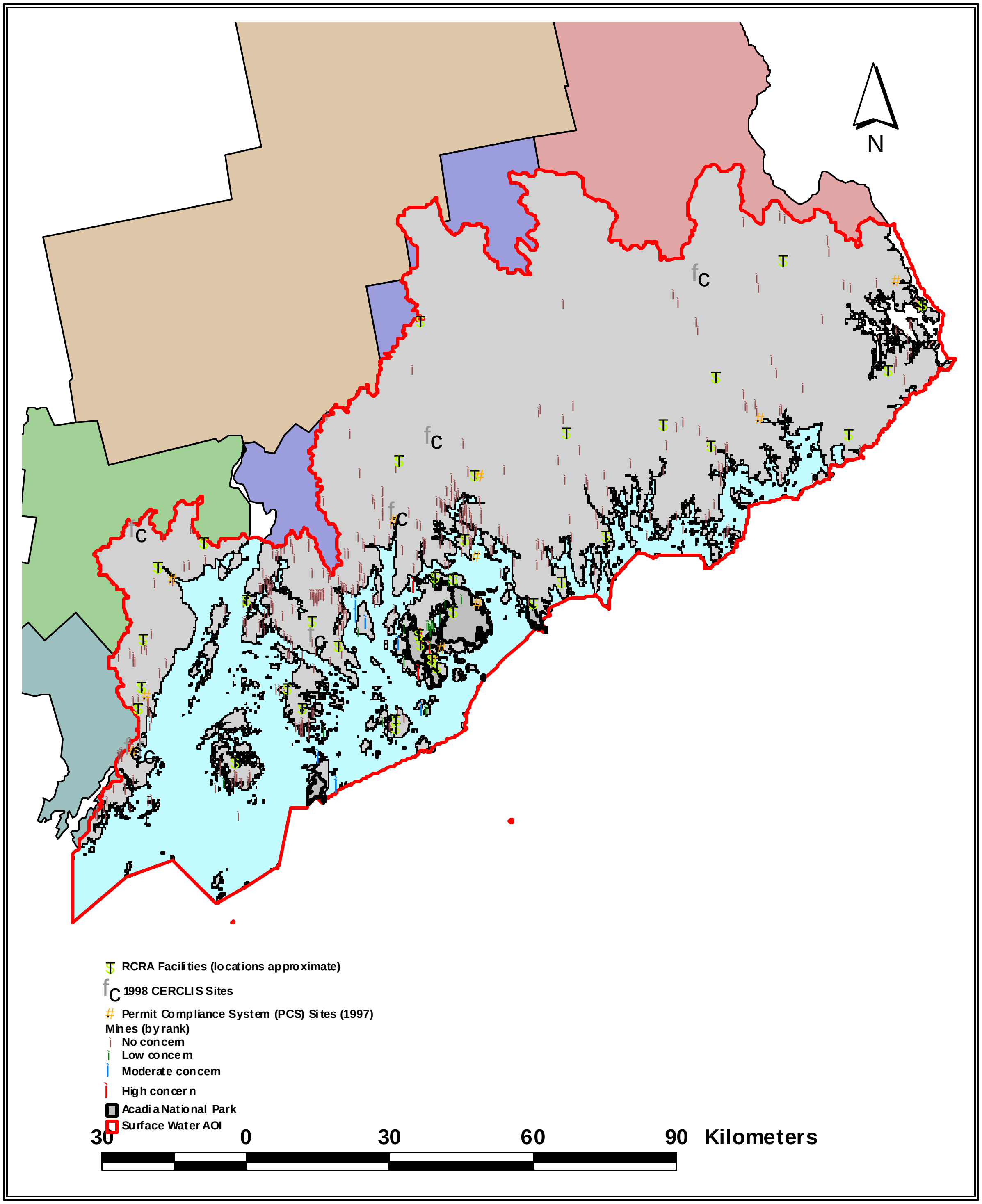
2.2.1 Summary

The major land holdings of the park are on MDI, Schoodic Peninsula, and IAH. The island nature of the park limits the contaminants that may be borne on river systems. However, the park is highly vulnerable to any oil or hazardous material spills that might occur within the watershed. Thus, ocean surface water pathway has the greatest potential to deliver contaminants to coastal regions of the park. The freshwater component of the surface water pathway will be discussed first, followed by the saltwater component.

2.2.2 Contaminant Sources (freshwater)

The surface water AOI boundary is the Maine Coastal watershed. Within the Maine Coastal watershed we cataloged federal RCRA, CERCLA, TRI, PCS, and mining sites (Figure 8). RCRA (Resource Conservation and Recovery Act, 1976) sites are those facilities that are permitted to generate, transfer, treat, store or dispose of hazardous waste (as defined by federal hazardous waste codes). CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act, 1980) sites are sites with known hazardous waste contamination- these are sites listed on the National Priorities (Superfund) List (NPL), or sites that have been considered for listing. TRI (Toxic Release Inventory, as mandated by the Emergency Planning and Community-Right-to-Know Act, 1986) sites are facilities that release or transfer any of 650 toxic chemicals and compounds to the water. PCS (Permit Compliance System, as mandated by the Clean Water Act, 1977) sites are those facilities holding permits (National Pollutant Discharge Elimination System, NPDES permits) to discharge effluent into navigable waters.

Figure 8. Federally-listed sites within the surface water Area of Interest (AOI)



At the state level, local pesticide use, and uncontrolled hazardous substance sites were cataloged (Figure 9). Uncontrolled hazardous substance sites are areas or locations (licensed or unlicensed) where hazardous substances are, or were handled, or otherwise came to be located. Hazardous substances include those materials identified by the State of Maine, or the United States Comprehensive Environmental Response, Compensation and Liability Act of 1980, Federal Water Pollution Control Act, Clean Air Act, Toxic Substances Control Act.

2.2.3 Surface Water Flow Direction

Many of the streams within the park are small and lie, in their entirety, within the park. Additionally, the park owns the headwater lands of most of the park streams and water bodies. In general, surface water flow is away from park lands. However, in some cases, because of the irregular nature of the park boundary, a stream may flow out of the park, into a more urbanized area, and then farther downstream flow back into the park. For example, Marshall Brook flows out of park land, receives leachate from a private landfill, then flows back onto park land.

2.2.4 Ranking Scheme

Sites were ranked according to proximity to the park, proximity to park water bodies, and quantity of waste produced, or severity of known contamination. Mining sites were ranked with respect to proximity to park lands, type of mining, and proximity to a waterbody (Table 7). Mines included in the analysis were described in source databases as “producers” or “unknowns.” Available databases provide limited information regarding the duration or scale of mineral production at permitted mining sites. In some cases, mining operations at permitted sites were limited or even non-existent. The ranking scheme used in the analysis assumed that mineral production took place at the permitted sites. Sources with the highest numerical rank were considered the sources of highest concern.

Table 7. Mining sites ranking scheme

Parameter	Criteria	Rank
Location	>1 km from park	0
	<1 km from park	1
Type of Mining	Non-metal Producer (sand and gravel, stone, coal)	0
	Metal producer	1
Proximity to water	>500 m from water	0
	<500 m from water	1

2.2.5 Contaminant Sources (saltwater)

The ocean surface water AOI boundary is the coastal water within the Maine Coastal Watershed. Within this AOI we catalogued oil and hazardous materials spills from 1995 to March 1999, bulk oil and hazardous material storage facilities, aquaculture lease plots, boat traffic, and boat lanes (Figure 10).

2.2.6 Ocean Currents

Little work has been conducted on the tidal or current flow in the region of Eastport to Monhegan Island (the approximate coastal boundaries of the Maine Coastal watershed). Neal Pettigrew (University of Maine, Orono) has collected current information from one drogue set off Stonington. The current was recorded at approximately 15 cm/sec toward the southwest. These measurements are made several meters down in the water column. An oil spill may be more influenced by surface currents. Surface wind and heat, freshwater fluxes, river discharge, and tidal and sub tidal inflow from the open ocean affect near-shore surface currents. Using the Princeton model as a base, Huijie Xue, (University of Maine, Orono) has modeled near-shore currents for Penobscot Bay. The geographic range of this model includes IAH and the western half of MDI. When surface winds are out of the northeast, surface flow tends toward the southwest (Figure 11). When surface winds are out of the southwest surface flow tends toward the east-southeast (Figure 12). As mentioned earlier, wind direction recorded McFarland Hill and at the top of Cadillac Mountain is predominantly out of the southwest. Tidal currents around MDI tend to flood northward and ebb southward.

Figure 9. Maine Department of Environmental Protection uncontrolled hazardous substance sites and electric utility company pesticide usage on Mount Desert Island

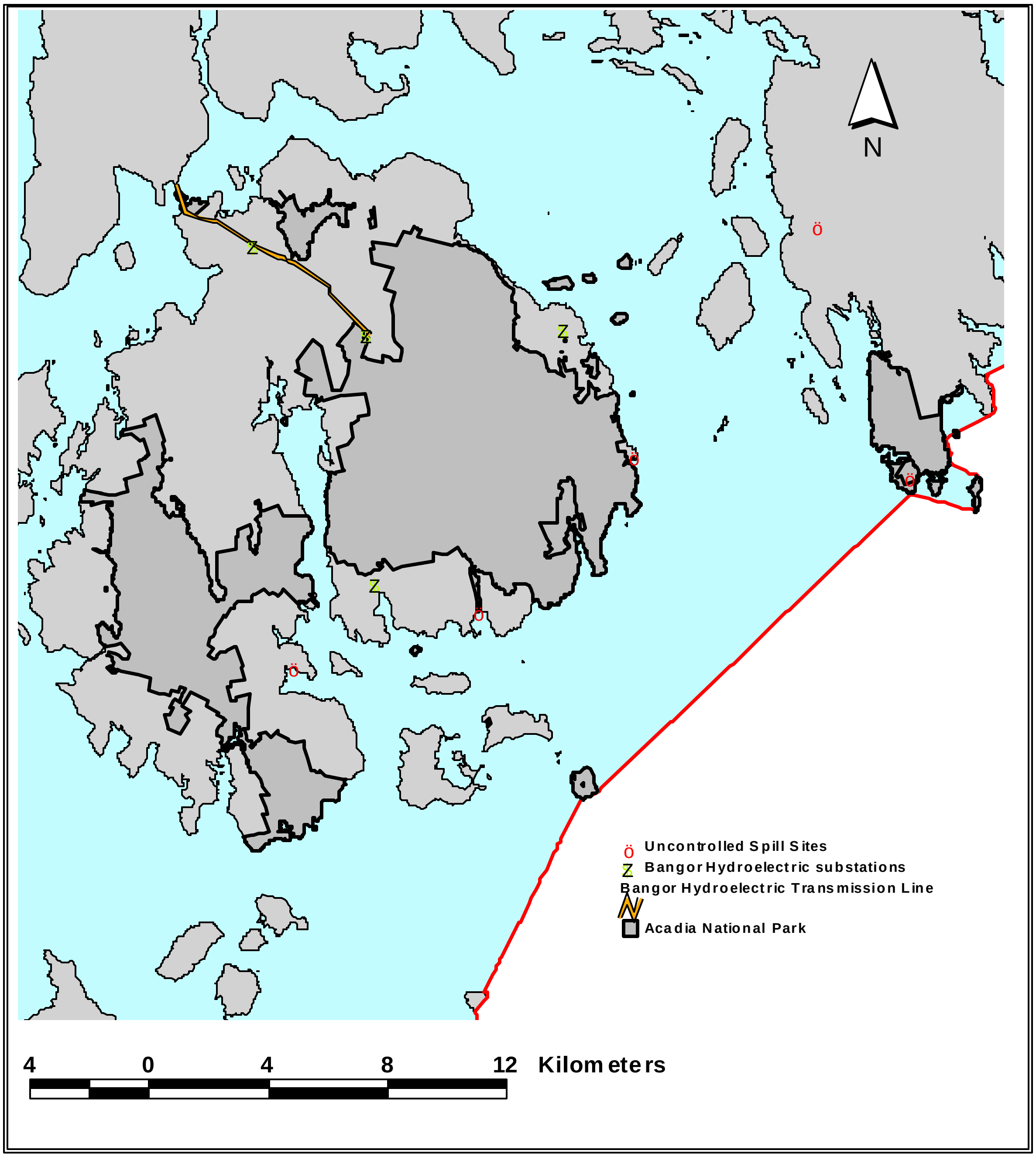
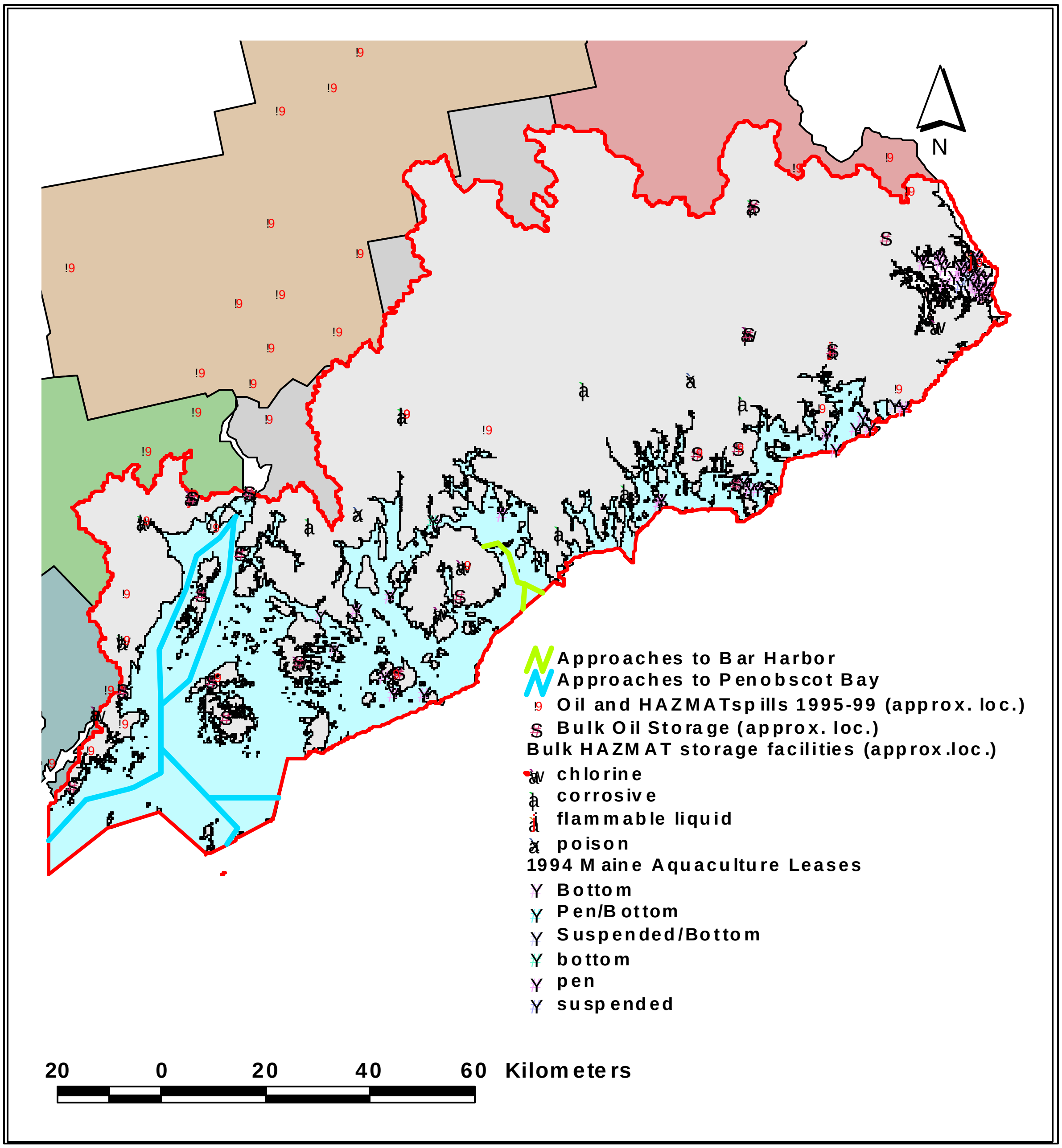


Figure 10. Ocean pathway potential sources of pollutant inputs



2.3 Ground Water Pathway

2.3.1 Contaminant Sources

The ground water AOI boundary is the Maine Coastal Watershed. However, we confined most of our research to MDI, the Schoodic Peninsula, and IAH. For these areas we cataloged landfills, storage facilities for road salt and sand, underground storage tanks (USTs), and shallow well injection points (Figure 13; note: the figure does not include USTs).

2.3.2 Ground Water Flow

As with the surface water, the park owns most of the up-gradient land, which is in relatively pristine condition. This suggests that few contaminants will reach park resources through groundwater flow.

2.3.3 Ranking Scheme

Landfills were reviewed on an individual basis. Road salt and sand storage facilities were ranked by their geographic location to the park (both proximity and up-gradient/ down-gradient status) and their proximity to a water body. Underground storage tanks were ranked by age, volume, substance held, and proximity to the park. Shallow well injection points were ranked by facility process and proximity to the park.

3.0 Contaminant Assessment Findings, by Pathway

3.1 Air Pathway

3.1.1 Pollutant Sources of Highest Concern

The park occupies a unique geographic location in that it is located downwind of most industrialized areas in the eastern United States. Although the sources listed below are the sources of highest concern for this CAP, air pollutants reaching the park may have been generated at facilities well beyond the 350 km boundary of the extended AOI. Therefore, the sources listed below may contribute only a small fraction of any given chemical to the park.

3.1.1.1 30 km

Six sludge-application sites are located within 30 km of the park. According to 1996 TRI data, three facilities are also located within 30 km of the park that report air emissions of acetone, lead and lead compounds, and styrene. While near the park, releases from the TRI sites are low (Table 8) and, therefore pose minimal risks to the park. Because mercury is not measured in either municipal or paper and pulp mill sludge, the amount of mercury volatizing from land-farmed sludge is unknown. Compared to other regional sources, mercury released from these sites is probably of low concern.

Figure 11. Surface ocean currents when prevailing wind is from the northeast

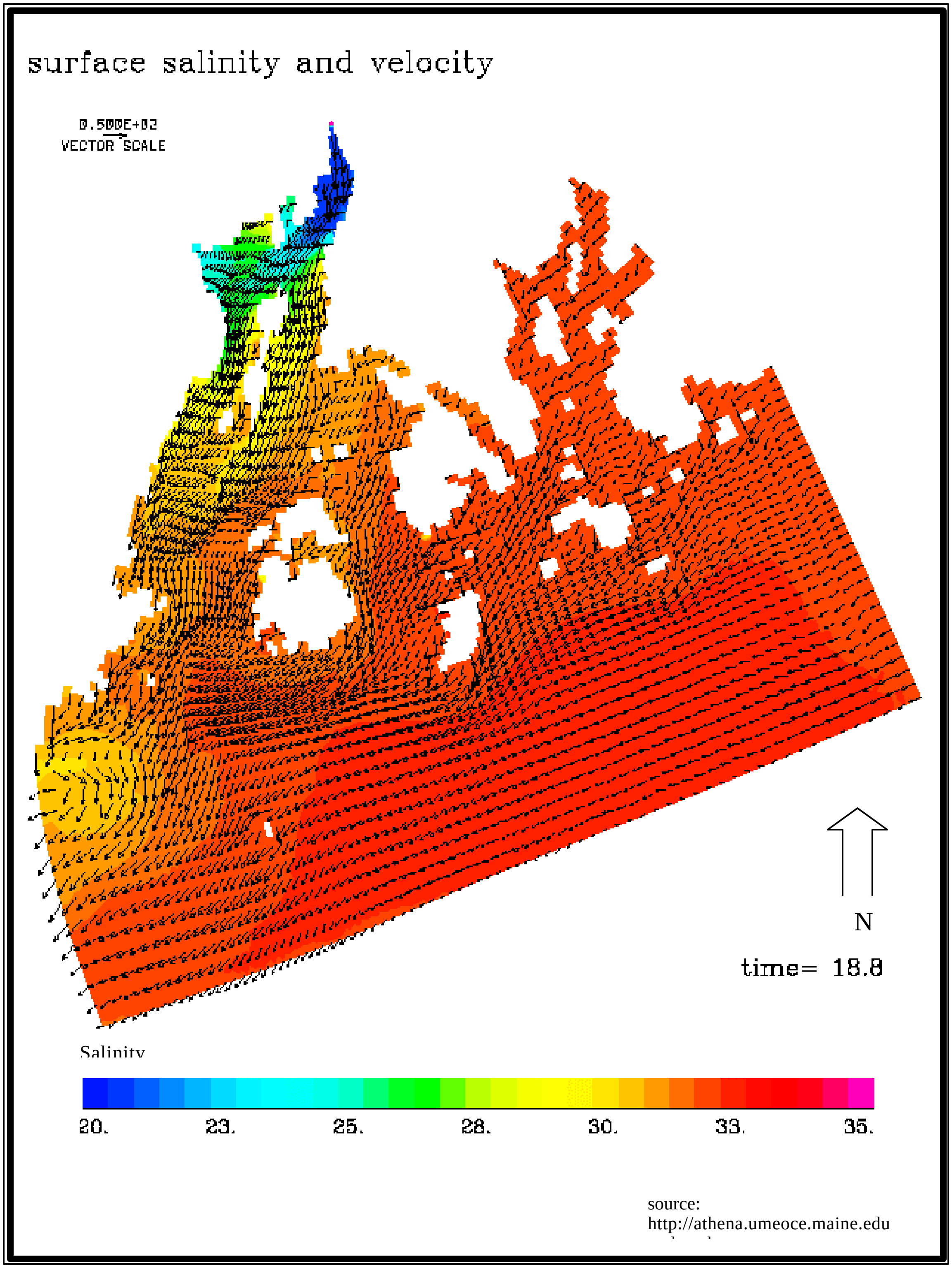


Figure 12. Surface ocean currents when prevailing wind is from the southwest

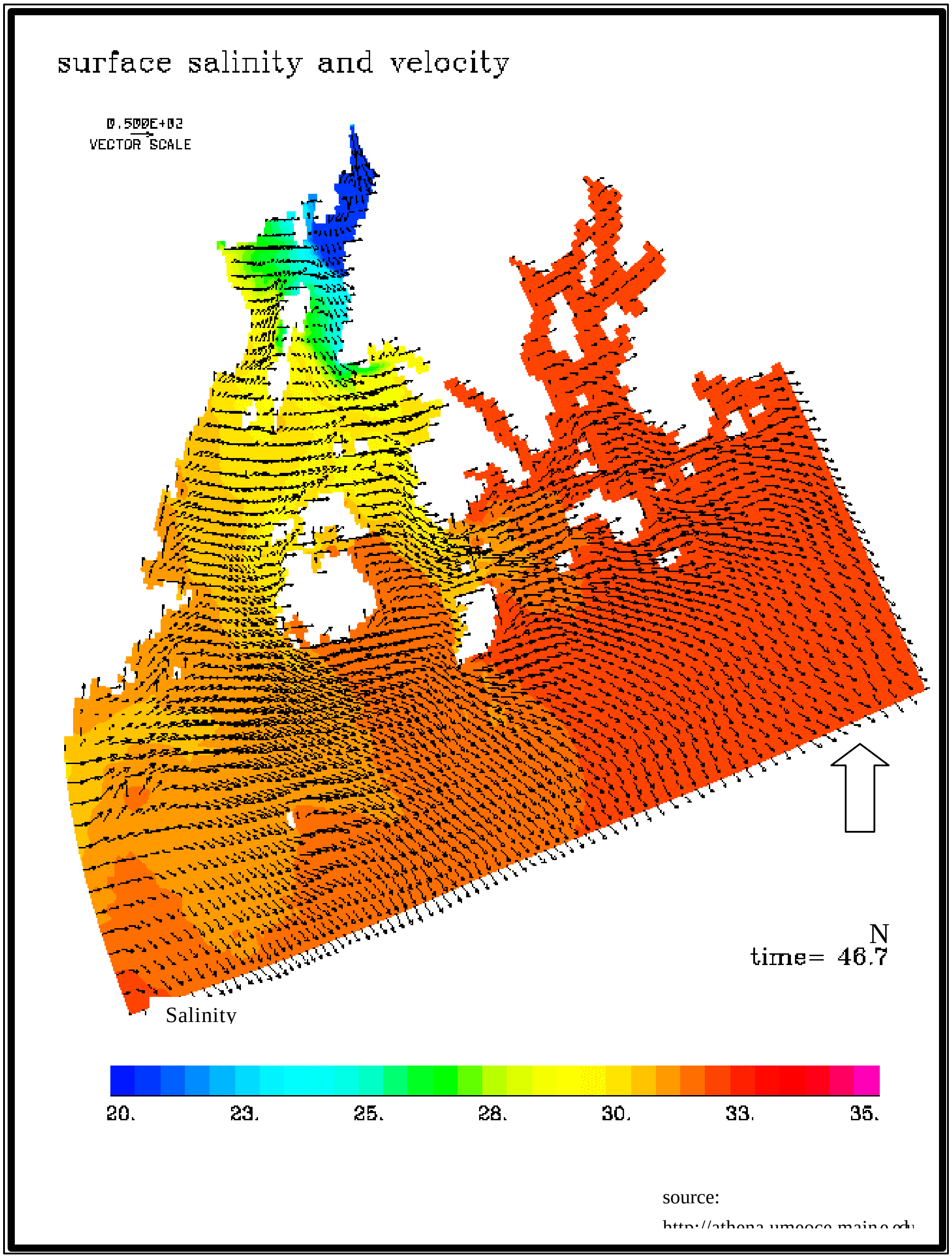


Figure 13. Groundwater Area of Interest (AOI) contaminant sources of concern

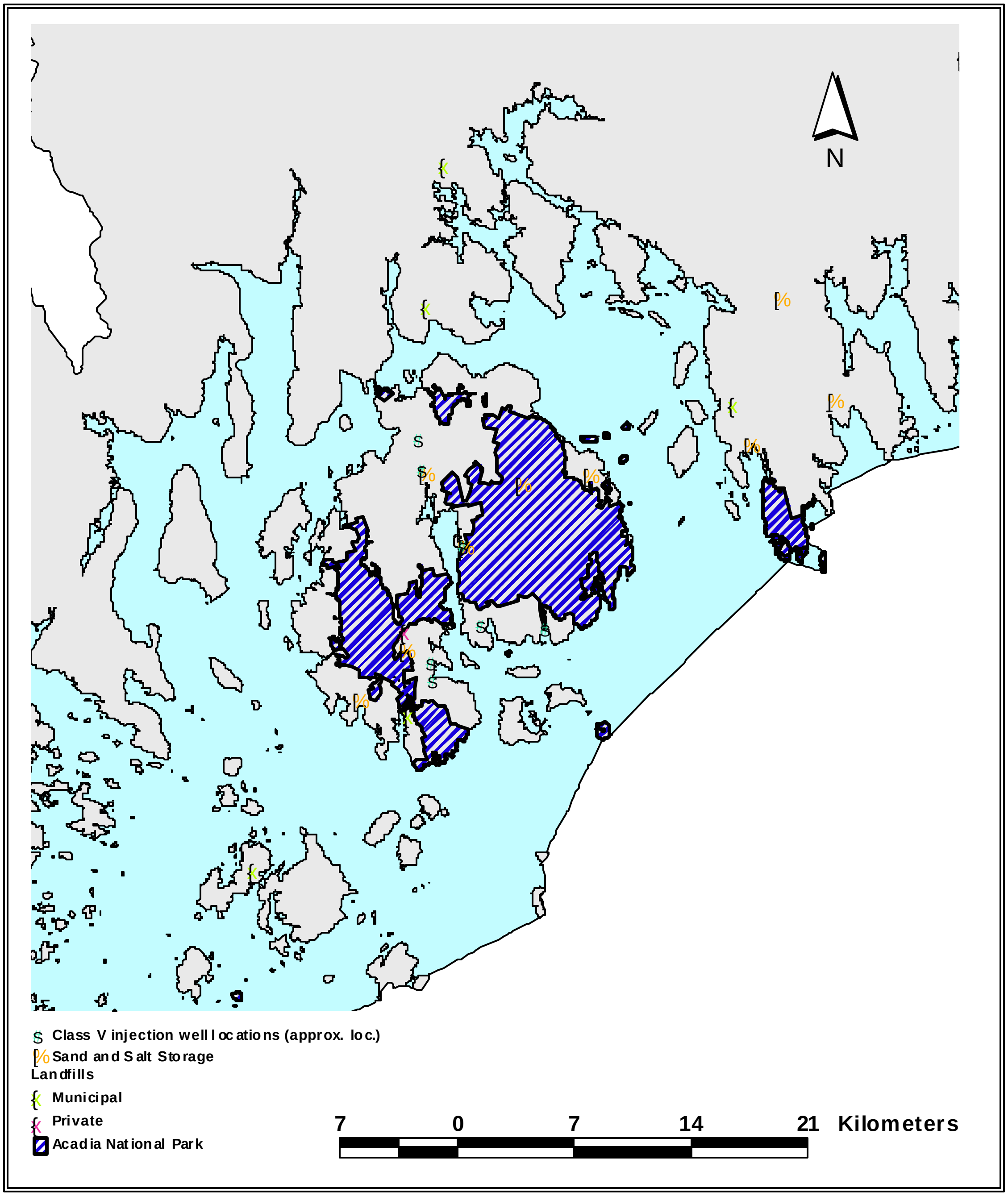


Table 8. TRI fugitive air toxics emissions within 30 km of the park

Chemical	Fugitive volume release (lb/y)	Companies
Acetone	8550	Atlantic Boat, Hinckley Co.
Lead and lead compounds	8150	Morris Yacht
Styrene	11160	Atlantic Boat, Hinckley Co., Morris Yacht

3.1.1.2 200 km

There are 49 facilities within 200 km of the park reporting emissions of criteria pollutants, and 130 facilities reporting emissions of air toxics. Based on 1996 data, SO_2 is the primary criteria pollutant emitted (Table 9).

Table 9. Summary of criteria pollutants emitted within 200 km of the park

Direction	CO		NO_2		Pb		PM_{10}		PT		SO_2		VOC	
Southwest	2909	13	5377	13	21	2	1611	12	324	2	9730	13	2468	14
Northwest	7630	28	13353	28	--		4356	28	1157	9	26534	28	2919	28
Northeast	2715	7	1691	7	--		857	7	--		649	7	882	7
Total	13254		20421		21		6824		1481		36913		6269	

Volume, in tons per year, followed by the number of facilities reporting
-: no emissions reported

Of the air toxics methanol, sulfuric acid, and hydrochloric acid constitute the largest release volumes (Table 10). The greatest volume of criteria pollutants and air toxics are generated northwest of the park. Because the wind direction is primarily from the southwest at the park it is uncertain how much of the pollutants reaching the park come from northwesterly sources. The largest single source of air toxics to the southwest is Sappi Paper, Westbrook, located approximately 185 km from the park. This source contributes the majority of the n-hexane and xylene coming from the southwest. The highly volatile nature of these organic solvents makes it unlikely that they would affect the park in their original form. The threat of air toxics contamination from single point sources to the park, although not nonexistent, is low.

3.1.1.3 350 km

While Canadian air pollution sources were not taken into account as part of this assessment, USEPA data indicates that there are 20 incinerators and 19 power plants located between 200 and 350 km of the park. There are three power plants located northwest of the park. The rest of the facilities are to the southwest of the park. These facilities emit a total of 71,210 tons per year (tpy) SO_2, 34,806 tpy NO_2, 633 tpy CO, 2,716 tpy VOCs, and 5,407 tpy PM_{10}.

3.1.2 Summary of Contaminants of Concern, Air

Facilities to the southwest of the park (the direction of the prevailing winds) within both the proximal and extended AOIs emit 3,542 tpy CO, 40,183 tpy NO_2, 7,018 tpy PM_{10}, 80,940 tpy SO_2, and 5,184 tpy VOCs. Facilities to the southwest emit only 11.3 percent of the

Table 10. Summary of high volume air toxics emitted within 200 km of the park

Chemical	Volume emitted (pounds per year)			
	Southwest	Northwest	Northeast	Total
Methanol	284,120	2,082,541	140,000	2,506,661
Sulfuric Acid	115,614	1,452,259	None	1,567,873
Hydrochloric Acid	240,000	979,360	None	1,219,360
Ammonia	5258	680,605	8,300	694,163
Chloroform	57,000	206,000	None	263,000
Toluene	168,707	42,174	None	210,881
n-Hexane	160,000	11,729	None	171,729
Acetaldehyde	10,000	137,528	None	147,528
Formaldehyde	55,072	None	70,875	125,947
Xylene (mixed isomers)	53,884	21,982	None	75,866

methanol, 7.4 percent of the sulfuric acid, and only 19.7 percent of the hydrochloric acid within the proximal AOI. No emitted criteria pollutants have exceeded their national standards at the park within the last five years. However, ozone, a non-emitted criteria air pollutant, has occasionally exceeded the national standard (ANP 1998) at the park. Additionally, atmospherically deposited mercury is high in park fish species. This suggests that other atmospheric pollutants deposited by the same mechanism as mercury, such as dioxins, PCBs, and aerially-applied pesticides, may also be present in elevated concentrations.

3.1.2.1 Ozone

Ozone is considered a secondary atmospheric pollutant because it is formed from photochemical reactions of NOx (including NO_2) and VOCs. In 1995 ozone levels at the park exceeded the national standard (1-hour average concentration of 0.12 ppm) twice (Table 11).

Table 11. Ozone exceedances at the park

Year	First exceedance (ppm)	Second exceedance (ppm)
1995	0.134	0.128
1997	0.126	--
1998	0.135	0.125

The federal standard for ozone was exceeded once in 1997 and twice 1998. Although the point sources of NO_2 within the AOI have been cataloged and ranked, in the United States in 1995 automobile emissions accounted for 49 percent of NO_2 emissions (USEPA 1995). This potentially-significant source is not addressed by CAP. Sources located outside the 350 km AOI are also not addressed. It is not possible to isolate and rank individual point sources of ozone precursors. Ozone is, however, a contaminant of concern (COC). Several species of plants native to the park are sensitive to injury by ambient levels of ozone, including: black cherry, quaking aspen, white ash, bigleaf aster, and spreading dogbane (Kohut *et al*. 1997). Foliar damage has been documented on broad-leaf aster and spreading dogbane plants within the park. Ozone-related foliar damage to sensitive species was monitored at 30 random and non-random locations within the park from 1992-1997 (Eckert et al 1999; Figure 14).

3.1.2.2 Acid Rain

In 1997 the park received 115 cm of rain with an average pH of 4.6 (ANP 1998). Acid rain is a secondary atmospheric pollutant, forming when atmospheric SO_2 is oxidized to form H_2SO_4, and is then washed out of the atmosphere in rain, snow, or fog. No one point source can be attributed to the acidification of rain reaching the park or other areas in North America. However, the CAP indicates that over one million pounds of acid is being released within 200 km of the park. Acid rain affects plant growth. The effects of acid rain and fog on the declining population of red spruce (*Picea rubens*) in the park is well documented (Jagels 1986, Jagels *et al*. 1988, Jagels *et al*. 1989). A more wide-spread effect of acid rain is the release of metals from soils with low buffering potential (soils low in base cations). These metals, specifically aluminum, are toxic to fish, particularly salmonids, and other aquatic life. The effects of acid rain are expected to be the highest in lakes with low buffering potential and high altitude lakes. A survey of 18 lakes and 23 streams in ANP (Kahl *et al*. 1985) found that the mean base flow pH was 6.39 for lakes, 6.48 for second-order streams, and 5.93 for first-order streams. The only acidic water was Sargent Mountain Pond, with a mean pH of 4.58. This lake is devoid of fish, and they would not be expected to survive under these conditions. The first-order streams were episodically acidified during spring runoff, with the mean pH being depressed to 5.43. Total aluminum concentrations were generally low (<100 µg/L), suggesting that damage to fish populations was unlikely.

3.1.2.3 Mercury

Mercury is atmospherically deposited in regions remote to its origin. Once deposited, mercury is washed into waterbodies, methylated, and then biomagnifies through aquatic food chain. Methylmercury, at elevated concentrations, adversely affects the nervous and reproductive systems of all animals. Fish from lakes were sampled in 1994 as part of the USEPA's Regional Environmental Assessment Program (REMAP) effort. Smallmouth bass from Hodgdon Pond had some of the highest mercury levels in the state, with fillet concentrations up to 3.41 µg/g Hg, wet weight (Burgess, 1997). As a result of the finding of these elevated levels, a survey was conducted of 11 MDI lakes (Table 12). Seal Cove Pond and Lower Hadlock Pond were added to the list of lakes with fish mercury concentrations above 1.0 µg/g. The State mercury consumption advisory recommends that the sensitive human population not eat fish containing greater than .27 µg/g mercury. All 11 lakes had at least one fish sample for which the fillet mercury concentration exceeded the advisory.

3.1.2.4 Organochlorines

PCBs, dioxins, and organochlorine pesticides are atmospherically transported and deposited in areas remote to their origin. PCBs, dioxins and some pesticides are very stable in the environment and do not readily breakdown. These organic compounds have high liposolubility and biomagnify within a food chain. These contaminants, similar to mercury, may be atmospherically transported and deposited in the park. However, the state-wide survey of contaminants in fish, conducted in 1993-94, did not detect appreciable quantities of PCBs or pesticides in fish from park freshwater lakes (DiFranco *et al*. 1995). Although high concentrations of PCBs and DDE have been measured in nestling bald eagles

Figure 14. Ozone damage monitoring plots at Acadia National Park

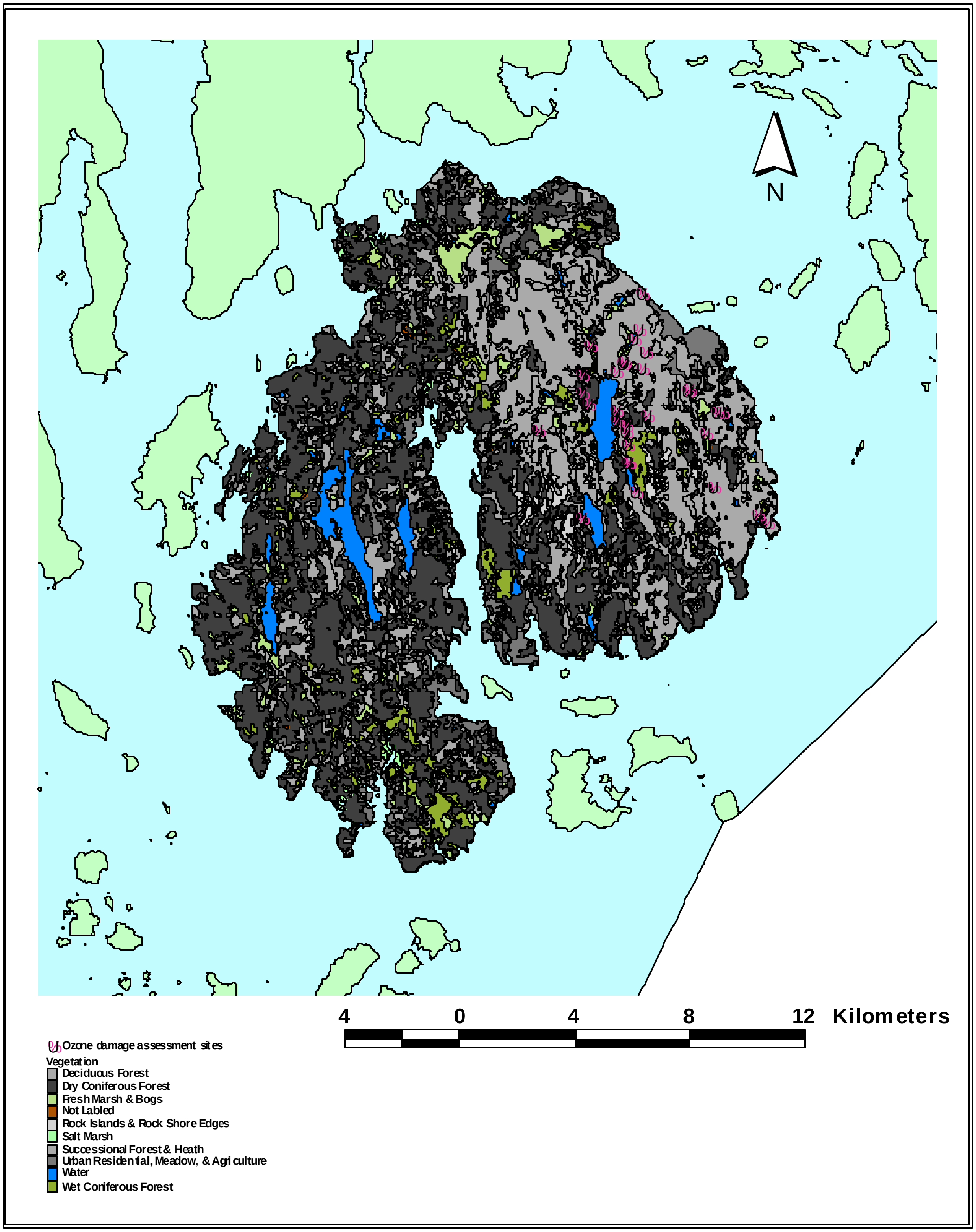


Table 12. Lakes with known fish mercury information

Lake	Collection Year	Maximum Hg concentration (mg/g, fillet)
Bubble	1994	0.20
Eagle	1995	0.32*
Echo	1995	0.40*
Hamilton	1995	0.79*
Hodgdon	1994	3.41*
Jordan	1995	0.37*
Long (MDI)	1995	0.54*
Long (IAH)	1995	0.49*
Lower Hadlock	1995	1.03*
Round	1995	0.56*
Seal Cove	1995	1.16*
Somes	1995	0.45*

* Exceeds State of Maine mercury consumption advisory for the sensitive population (0.27 μg/g)

from nests located within and near the park (Welch 1994), these chemicals most probably originated from marine organisms in the diet and may result from point-source discharges in Frenchman Bay. The concentrations reported are high enough to damage park resources, having been correlated with eggshell thinning in bald eagles (Wiemeyer *et al*. 1984), as well as a decline in semen concentration and altered courtship in American kestrels (Bird *et al*. 1983), and a reduction in eggshell thickness in Peregrine falcons (Nygard 1983). Exposure to PCBs, dioxin, and certain pesticides can cause reproductive failure, birth defects, and liver disorders, and all three groups of contaminants are thought to be endocrine disruptors. The effects of these contaminants are most likely to be expressed by aquatic organisms and their predators.

3.1.3 Potentially Contaminated Areas, Airborne Contaminants

3.1.3.1 Potentially Contaminated Area for Ozone

Ozone is an atmospherically deposited pollutant and ozone levels at the park are typically the highest within the coastal corridor (Ray *et al*. 1996). The PCA for ozone should include the entire park. There may be some regions in the park that might receive higher exposure to ozone than other areas. Air mass flow over the park comes out of the southwest, and the mountains and hills on MDI trend north to south. Therefore, ozone injury could be greatest on the southwest faces of the mountains. However, the 18 ozone damage monitoring sites are all located on the eastern and northeastern side of MDI. Ozone damage to plants on the southern side of MDI remains largely unstudied. The present bioindicator species, bigleaf aster and spreading dogbane, are found in fields and deciduous forest edges. The inclusion of sampling sites on the southern side of MDI for foliar damage of these plant species would help elucidate the extent of ozone effect in the park.

3.1.3.2 Potentially Contaminated Area for Acid Rain

The entire park receives acid rain. No park lands are more than 5 km from the ocean; therefore it is unlikely that there would be gradational fog deposition (although higher elevations might receive slightly more acid fog). Acid rain is well studied at the park. Currently, a paired watershed study is being conducted that will assess watershed-based factors influencing the effects of acid rain. Although many other programs are addressing certain aspects of acid rain effects to park resources, the effects of acid deposition on park amphibians has not been addressed. Spring peepers, bull frogs, and spotted salamanders are all present in the park, leopard frogs are suspected to be present in the park and are all highly susceptible to low pH levels (ANP 1998). General abundances of these species were recorded in 1987 (Coman 1987). Stream surveys of salamanders were conducted in 1998 on Great Brook, Breakneck Stream, Bubble Pond Brook, and Hadlock Brook. Sampling of stream pH and its effects (egg mortality or other pH-dependent endpoint) on resident salamander or frog species should be conducted during the spring freshets. If possible, sampling should be conducted along the entire length of the above-mentioned streams.

3.1.3.3 Potentially Contaminated Area for Mercury

The entire park is a PCA for mercury. However, fish and avian species using park freshwater habitats are most susceptible to the effects of mercury poisoning. Inasmuch as mercury biomagnifies through food chains, longer food chains will yield higher mercury burdens in the top predators. Fish from only 11 of the 33 named waterbodies within the park have been sampled for mercury. Warm water predatory fish species (smallmouth bass, chain pickerel, and white perch) and resident fish-eating birds (bald eagles, osprey, loons, and kingfishers) will probably have the highest mercury burdens and therefore may be the most susceptible to the effects of mercury poisoning. Mercury has been shown to contribute to reduced breeding success of common loons in Nova Scotia, Canada (Nocera and Taylor 1998), and elsewhere in Maine (Evers *et al*. 1999). Therefore bodies of water supporting these species should receive the most attention (Table 13). Factors such as watershed-to-lake area ratio and watershed percent coniferous cover will affect mercury input to a particular waterbody and should be considered when selecting sampling locations within the PCA. Water quality parameters such as high lake color and low specific conductance are good indicators that mercury levels will be high in a particular lake. In considering trophic complexity, the watershed factors, and water quality values mentioned above, the fish and fish-eating prey of Hodgdon, Little Round, Round, and Witch Hole ponds may be the most at risk to mercury contamination. Mercury concentrations are already known for fish in Hodgdon and Round Ponds. Fish mercury concentrations are unknown in Witch Hole Pond and therefore, fish sampling should be conducted there (Little Round Pond is not within the park boundaries). Loon sampling should be conducted on all ponds. Additionally, to date no fish from the 39 named streams in the park have been sampled for mercury. A survey should be conducted of the fish from named streams associated with the 11 lakes that have had fish samples collected and analyzed for mercury and from the streams associated with Witch Hole pond. Streams sampling should include Bubble Pond Brook, Duck Pond Brook, Great Brook, Hadlock Brook, Hodgdon Brook, Jordan Stream, Steward Brook, and Stony Brook (Figure 15).

Figure 15. Recommended water bodies to be sampled for mercury in fish

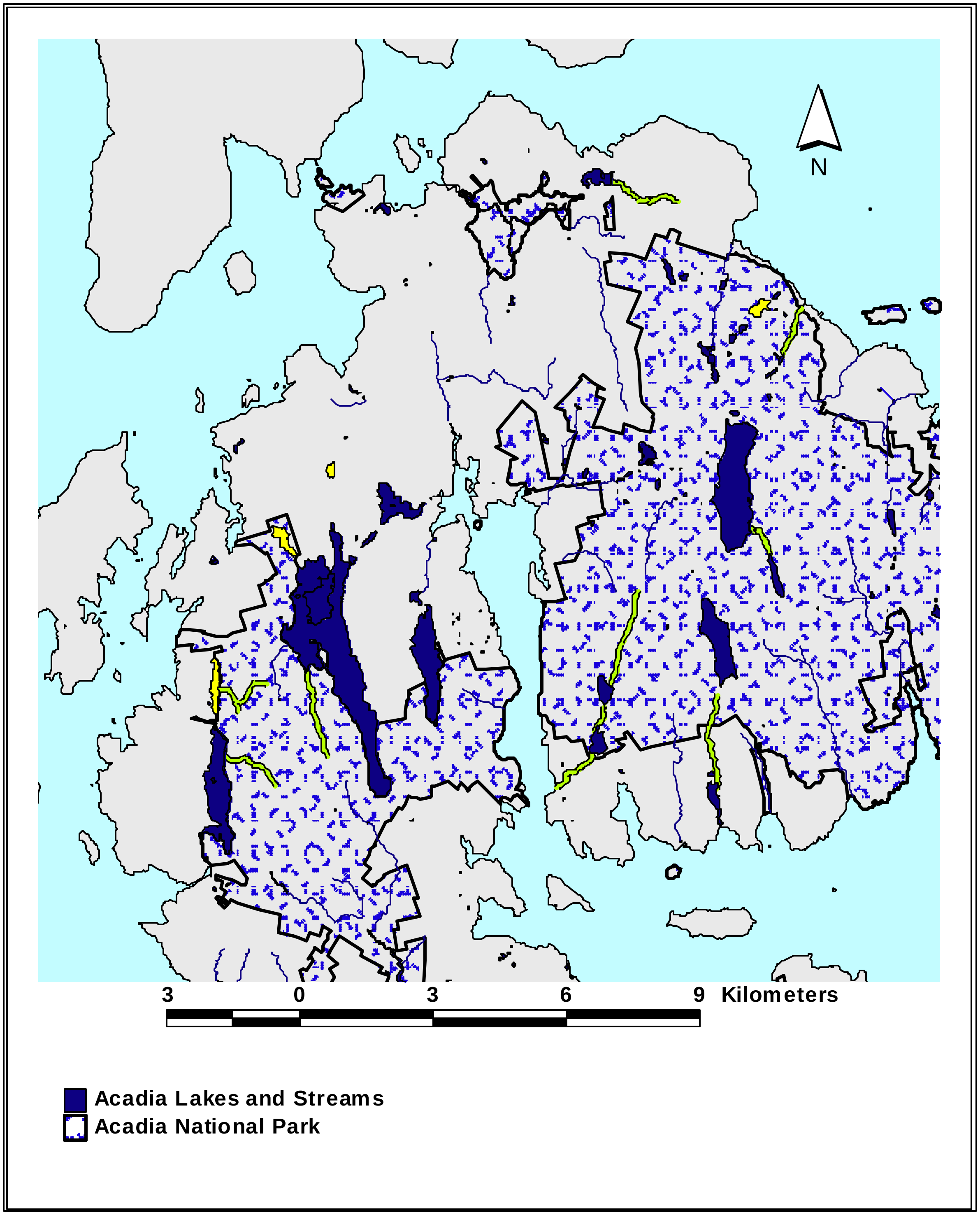


Table 13. Lakes that support warm water fish populations and breeding pairs of loons that have physical indicators of high mercury contamination

Warm water fish present?	Breeding loons present?	Water Quality or Watershed Parameter	Color (highest values)	Specific Cond. (lowest values)	Watershed: lake area (highest ratios)	Percent conifer cover (highest percents)
Hodgdon	Hodgdon		Sewall	Little Long	Sewall	Little Round
Long	Long		Hamilton	Lake Wood	Halfmoon	Sargent Mtn.
Lower Breakneck	Echo		Witch Hole	Halfmoon	Hamilton	Fawn
Round	Round		Beaver Dam	Witch Hole	Little Round	Hodgdon
Seal Cove	Seal Cove		The Bowl	Upper Hadlock	Little Long	Upper Hadlock
Somes	Somes		Upper Hadlock	Sargent Mtn.	Aunt Betty	Little Long
Lower Hadlock	Witch Hole		Hodgdon	Eagle	Upper Hadlock	Round
Little Round			Aunt Betty's	Jordan	Little Echo	Sewall

3.1.3.4 Potentially Contaminated Area for Organochlorines

The entire park is a PCA for organochlorines. The most sensitive species would be those consuming a high percentage of fish in their diets and having naturally low reproductive rates. Based on their position at the top of the aquatic food chain, resident fish-eating birds- e.g., loons and kingfishers - could be considered high-risk species. The nature and extent of PCBs, dioxin, and pesticide contamination at the park is unknown and must be examined. Sampling of fish (species of the type and size eaten by fish-eating birds) and birds should be conducted to determine the presence or absence of organochlorine contamination.

3.2 Surface Water Pathway

3.2.1 Pollutant Sources of Highest Concern (freshwater)

3.2.1.1 RCRA Facilities

RCRA facilities have the potential to cause environmental damage by an accidental release of any hazardous waste handled. They are potential sources of contamination, but not necessarily current sources. There are 13 RCRA facilities on MDI, none on IAH, and one on Schoodic Peninsula. None of these 13 facilities are large quantity generators (generating over 1000 kg hazardous materials per month), and none have been issued Notices of Violation in the last five years. There are four large quantity generators within the Maine Coastal watershed (Table 14).

The threat of contamination from local small-quantity generators is small due to the downstream nature of their locations relative to park lands. The threat of contamination from the four large-quantity generators to park-owned lands is small due to the fact that they are very distant from park lands.

3.2.1.2 CERCLA Sites

CERCLA sites are usually sites of gross environmental damage, affecting not only surface water habitat but usually also ground water resources. There are 19 CERCLA sites within the Maine Coastal watershed. Ten of these sites are listed on the National Priorities List (NPL), however, none of these ten sites are proximal to the park and the threat of released contaminants reaching the park is low. Within the watershed there are nine sites that were considered for CERCLA action and clean-up, but were not listed on the NPL (Table 15). These sites are not listed on the NPL because they fail to meet certain federal requirements for listing. That does not necessarily mean that they are less of a threat than are NPL sites. Of these nine sites, two- the Winter Harbor Town Landfill and the Naval Security Group Activity, also in Winter Harbor - are of high concern as contaminants sources to the park. These sites are discussed in the "Landfills" and "Uncontrolled Hazardous Substance Sites" sections of this report, respectively.

3.2.1.3 TRI Facilities

TRI facilities release known quantities of chemicals into the environment, the potential exists for more chemical to be released than is reported. There are no TRI facilities on MDI, Schoodic Peninsula, or IAH. The threat of contamination from TRI facilities to the park is low.

3.2.1.4 PCS Facilities

Each PCS facility permit is based on the allowable discharge load for specific constituents and the flushing rate of the receiving water. Maximum allowable load will differ with different flushing rates. The permit does not take into account other PCS facilities also discharging into the same body of water. There are three PCS sites on MDI - all municipal wastewater treatment plants and all considered major facilities. Although there are only three permitted facilities, one facility has three discharge points and one facility has four discharge points (Table 16), and these points are unmapped. None of these facilities are permitted to receive or discharge heavy metals or organic compounds. One discharge point of the Town of Mount Desert, the Otter Creek discharge point, is permitted to discharge to the ocean, but does so only at high tide. Heavy metals have been found in effluent from this outfall, and the Otter Creek discharge permit is currently being reviewed by the MDEP and the USEPA; additional testing of effluent is underway (Bob Breen, ANP, personal communication). The presence of heavy metals and the variability in flushing of the receiving water elevates this to a contaminant source of concern.

3.2.1.5 Mining Sites

Environmental consequences of mining may include acidification and sedimentation of local water bodies, elevated levels of heavy metals, and accidental releases of process chemicals such as cyanide. There are 459 mine sites reported in the AOI, but many of these may be "sham" mines that never operated. Of the 459 sites, only one is a concern to the park- the copper mine located approximately 500 meters from an unnamed stream draining into Long

Pond. Based on available information, including its designation as a metal-producing mine, and its proximity to the stream, this copper mine was initially assigned a high risk value. However, an inspection of the site revealed no evidence of mining activity. If a title search confirms that no mining activity has occurred at this site, it should be ignored as a significant contaminant source.

Table 14. RCRA small-quantity generators on MDI and Schoodic Peninsula, and large-quantity generators within the watershed

Name	Street	Town	Generator Status
The Jackson Laboratory	600 Main St	Bar Harbor	Small Quantity Generator
MDI Hospital	Wayman Ln	Bar Harbor	Small Quantity Generator
Mount Desert Cleaners	Neighborhood Rd	Northeast Harbor	Small Quantity Generator
Hinckley Co.	Shore Rd	Southwest Harbor	Small Quantity Generator
Wilbur Industries	Main St	Southwest Harbor	Small Quantity Generator
John M. Williams Co.	Hall Quarry	Mount Desert	Small Quantity Generator
MDI Biological Laboratory	Rte 3	Salsbury Cove	Small Quantity Generator
New England Telephone Office	N E Harbor Rd	Mount Desert	Small Quantity Generator
New England Telephone	Somesville Rd	Somesville	Small Quantity Generator
Morang Robinson Automobile Co.	269 Main St	Bar Harbor	Small Quantity Generator
Town of Southwest Harbor	Town Manager	Southwest Harbor	Small Quantity Generator
USCG Guard Base, Southwest Harbor	End Of Checkpiont Rd	Southwest Harbor	Small Quantity Generator
US Naval Security Group Activity	Schoodic Pt	Winter Harbor	Small Quantity Generator
Malcolm Pettigrew Inc.	Seal Cove Rd	Southwest Harbor	Small Quantity Generator
Maine Photographic Workshop	2 Central St	Rockport	Large Quantity Generator
US Defense Fuel Support Pt	Trundy Rd	Searsport	Large Quantity Generator
Champion International Corp	Main St	Bucksport	Large Quantity Generator
F M C Corp Food Ingredients Div	Crocketts Pt	Rockland	Large Quantity Generator

Table 15. CERCLA sites not listed on the NPL

Site	Town	Federal Action	CERCLA number
Belfast-Moosehead Railroad	Belfast	NFRAP, 3/28/89	0101950
Rumford National Graphics	Belfast	NFRAP, 7/12/93	0102113
Naval Communication Unit	Cutler	NFRAP 3/28/94	0101829
Green Hill Quarry	Meddybemps	NFRAP 1/9/95	0101029
Seal Island (NWR-DOI)	Middlebridge	NFRAP	0101069
Old Cannery Site	Robbinston	NFRAP 12/1/93	0101655
Defense Fuel Support Point	Searsport	NFRAP 6/1/84	0101070
Naval Security Group Activity	Winter Harbor	NFRAP 6/23/88	0101783
Winter Harbor Town Dump	Winter Harbor	NFRAP 6/1/84	0101017

NFRAP: No Further Remedial Action Planned

Table 16. Outfalls for individual PCS permitted sites

PCS permitted facility	NPDES Permit	Discharge points
Town of Bar Harbor	ME0101214	Ledgelawn
		Degregoire
		Hulls Cove
Town Of Mount Desert	ME0101346	Northeast Harbor
		Somesville
		Seal Harbor
		Otter Creek
Town of Southwest Harbor	ME0100641	Southwest Harbor

3.2.1.6 Local Pesticide Use

Direct runoff from pesticide application or drifting pesticides may cause injury to non-target species. Pesticide drift is of concern when the application of pesticides is aerial. There is no aerial spraying of pesticides on MDI, Schoodic Peninsula, or IAH. The closest spraying occurs on blueberry fields in the town of Sedgwick. According to Maine Pesticide Control Board personnel, pesticides from Sedgwick are unlikely to drift onto park-owned land or affect park resources. Bangor Hydroelectric Company, the local power company, uses a non-motorized application system to apply Garlon-4 along transmission lines and at substations on MDI. This spraying is done no more than once every two years. Garlon-4 is the trade name for Triclopyr. Triclopyr, a pyridine, is a selective systemic herbicide used for control of woody and broadleaf plants along rights-of-way. It is slightly to practically nontoxic to birds, practically nontoxic to fish and nontoxic to bees (Table 17).

Table 17. Toxicological profile of Clorpyr (trade name: Garlon-4)

Organism		Chemical type	Endpoint	Concentration	Exposure route
Birds	Mallard	Parent compound	LD_{50}	1698 mg/kg	Food borne
	Bobwhite quail	Parent compound	LC_{50}	2935 mg/kg	Food borne
	Japanese quail	Parent compound	LC_{50}	3278 mg/kg	Food borne
Fish	Rainbow trout	Amine salt	LC_{50} (96-hour)	117 mg/L	Waterborne
	Rainbow trout	Ester formulation	LC_{50} (96-hour)	0.74 mg/L	Waterborne
	Bluegill sunfish	Amine salt	LC_{50} (96-hour)	148 mg/L	Waterborne
	Bluegill sunfish	Ester formulation	LC_{50} (96-hour)	0.87 mg/L	Waterborne
Invertebrates	Daphnia	Amine salt	LC_{50} (96-hour)	1170 mg/L	Waterborne

Source: The Extension Toxicology Network, http://ace.orst.edu/info/extoxnet/

The spraying of Garlon-4 by Bangor Hydroelectric is not likely to affect park resources. None of the towns on MDI are permitted by the State to apply pesticides to the roadsides, and the State Department of Transportation (DOT) uses non-chemical methods to control weed growth along State roads on MDI (Bob LaRoche, MeDOT Environmental Services, personal communication). The DOT uses a one percent solution of Garlon-4 once a year on the roadsides on Schoodic peninsula. There are three golf courses on the island. The volume of pesticides used at the golf courses is unknown. However, all three golf courses are down-gradient of the park, and any pesticides applied are not likely to degrade park resources.

3.2.1.7 Uncontrolled Hazardous Substance Sites

The MDEP's Uncontrolled Hazardous Substance Site Program (USP) monitors spills and areas were the storage or handling of hazardous substances might negatively affect the surrounding environment but may not be large enough to warrant federal attention. There are 38 USP-designated sites in the Maine Coastal watershed. There are six sites within five km of the park (Table 18). Of these six sites the Naval Security Group in Winter Harbor is of high concern, because of poor historic PCB and fuel storage protocols, proximity to the Schoodic Peninsula parcel of the park, and because the land will revert to park ownership in 2002. The Winter Harbor Town Dump is also of high concern and is discussed in the landfill section of the groundwater transport pathway.

3.2.1.8 Roadways and Parking Lots

Parking areas at the most popular areas within ANP- the Visitor Center, Eagle Lake, Echo Lake, Sand Beach and Thunder Hole - are crowded during the summer tourist season. Various contaminants may occur in runoff from the parking lots, including petroleum products and other organic chemicals, such as ethylene glycol, from vehicles, wear products from tires and brake linings, exhaust residue, breakdown products from paving materials, chemicals from wet and dry atmospheric deposition, deicing compounds, fertilizers, pesticides, and herbicides from maintenance of adjacent areas, accidental spills, and littering

Table 18. Hazardous substance sites within 5 km of the park

Site	Risk to Park	Brief Narrative
Jackson Laboratory	Low	On January 28, 1984, 5326 gallons of #5 fuel oil was spilled. Clean-up was conducted immediately follow-up soil sampling revealed no contamination.
Abel Fox Marine	Low	Abel Fox Marine operated as a boat building facility from 1980 to 1989. Leaking drums and poor waste management lead to soils contaminated with waste oil, VOCs, and lead. In 1995 the site was remediated, with the removal of contaminated soil, to the satisfaction of the Maine DEP. Waste oil and VOC contamination may still exist under the northeast corner of the building on site. This site is located down-gradient of park land.
Schooner Head Battery	Low	Formerly Utilized Defense Site: Hazardous substance contamination as a result of military use is not likely. A Spanish-American war battery of an 8" rifle gun mount was located on the site. Gun removed in 1943.
Stanley Brook	Moderate	A leaking underground storage tank was discovered at the water treatment plant located approximately 50 m east of Stanley Brook. Tank and contaminated soil was removed. Sampling conducted by Goff-Chem in 1994 found elevated levels of PAHs and heavy metals. However, neither appeared to be migrating towards Stanley Brook.
Winter Harbor Landfill	High	Chlorinated hydrocarbons (TCE, Perc, DCE) found in local drinking water wells, and in sediments and surface waters to the southwest and northeast of the landfill. 1993 sampling revealed 81 ppb TCE in surface waters to the northeast of landfill. 7.92 mg/kg Aroclor 1260 found in sediments to the southeast of the landfill in 1998 sampling.
Naval Security Group, Winter Harbor	High	In 1981, PCBs were found to have leaked though cracks in floor of building 41. 205 rusted capacitors stored outside (each with 3.1 gal PCB oil). Facility has had at least 47 USTs- oldest installed in 1935. Facility is about to be given back to the park.

(Thomson *et al*. 1997). The type and quantity of contaminants produced is dependent on rainfall characteristics (amount, duration, season, etc.), traffic density, maintenance practices, drainage design, and atmospheric deposition (Marsalek *et al*. 1999). Contaminants in the runoff can affect terrestrial and aquatic plant and animal species within and near these sites. Because of their proximity to streams or wetlands, runoff from parking lots at the Visitor Center, Eagle Lake, Echo Lake, and Sand Beach are of high concern.

Salt runoff from roadway deicing operations has been shown to affect the composition of some wetland plant and invertebrate communities. Existing flora may be replaced by more salt-tolerant species (Panno et. al.1999, Isabelle et al. 1987), and invertebrates such as cladocerans and copepods are replaced by oligochaetes, Tipulidae, and Ceratopogonidae (Williams et.al. 1997, Saerkkae et. al. 1997).

3.2.2 Summary of Contaminants of Concern (freshwater)

The highest risk of contamination via the surface water pathway comes from the Town of Mount Desert's sewage outfall at Otter Creek and the Naval Security Group on Schoodic Peninsula.

3.2.2.1 Town of Mount Desert Sewage Outfall

The Otter Creek treatment plant is one of four treatment plants in the Town of Mount Desert. The treatment plant is permitted to discharge into the ocean. The treated effluent from the plant is currently discharged into Otter Cove, a shallow estuary that is exposed for several hours during low tide cycles.

Maine DEP and EPA notified the park in 1997 that the outfall from the Otter Creek treatment plant is exposed at low tide, periodically eliminating seawater dilution of the effluent. Chemical analysis revealed that undiluted effluent from the treatment plan contained copper, zinc, and cyanide concentrations that exceeded maximum regulatory limits (total Cu in effluent =112 ug/L, EPA standard= 2.9 ug/L; total Zn in effluent = 165 ug/L, EPA standard= 95 ug/L; and total cyanide in effluent =6.5 ug/L, EPA standard=1.0 ug/L). The sources of copper, zinc and cyanide inputs to the treatment plant are unknown but may be related to leaching of these metals from copper and galvanized pipes and solder connections associated with residential plumbing systems and private wells.

3.2.2.2 Naval Security Group, Winter Harbor

In 1935 the Naval Security Group (NSG) moved from Otter Cliffs on MDI to six acres on Schoodic Peninsula. By 1947, the size of the NSG facility had grown to 100 acres. Schoodic Peninsula was originally added to the park in 1929 and in 2002, the park will resume ownership of the NSG land and the approximately 50 buildings onsite. The two primary contaminants of concern at the NSG are PCBs and leaking oil from underground storage tanks (USTs), some of which were in place from 1935 until the early 1990's (Maine DEP UST database).

In 1981, the NSG was found in violation of 40 CFR 761.42- PCB Storage and Handling Procedures. The NSG had approximately 222 PCB capacitors, each containing 1.406 kg of PCB fluid. Two hundred and five of these capacitors had been stored outside and had rusted and were no longer useable. The other 17 capacitors had ruptured or leaked while in-service and were awaiting disposal. The 222 capacitors were stored in a building with cracked concrete floors. The capacitors were removed from the NSG; their exact removal date is unknown.

The NSG has had on its property 47 USTs, of which 17 are currently in service (Table 19). The tanks currently in use are less than 8 years old. However, as late as 1985 the NSG was using two tanks installed in 1935, seven tanks installed in the 1950s, and seven tanks installed in the 1960s. As USTs age the potential exists for the tank material to degrade and for leaks to develop. Spills and overfills are also common. Prior to December 22, 1998, tank owners were not required to maintain leak detection, corrosion protection, or overfill/spill protection. Prior to the 1998 regulations (40 CFR Part 280: Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks) it

Table 19. Summary of underground storage tanks at the Naval Security Group, Winter Harbor

Product	Total gallons stored	Total number of USTs	Number still in service
Fuel Oil	96,750	34	10
Unleaded gasoline	19,000	4	2
Premium unleaded gasoline	11,000	2	1
Unleaded plus gasoline	10,000	2	1
Diesel	9500	3	3
Regular gasoline	8000	1	0
Waste Oil/Used Motor Oil	500	1	0

Source: MDEP, Master Underground Storage Tank List, 9/3/98

was possible for leaks to go undetected for years. The leaked fuels could contaminate groundwater or migrate to surface water bodies. Because of the age of the tanks at NSG (the older tanks were removed in the early 1990s, exact dates are unknown) there is a high likelihood that some leaked. Whether any confirmatory soil testing was conducted when the older tanks were removed is unknown.

3.2.3 Potentially Contaminated Areas, Surface Water-borne Contaminants (freshwater)

3.2.3.1 Potentially Contaminated Area for Sewage Effluent

The PCS database does not contain exact longitude/latitude (or UTM coordinates) for each outfall within a permit. To address this data gap, all outfalls on MDI should be mapped. Site visits and discussions with park staff indicate that discharge pipe for the Otter Creek outfall extends approximately 565 feet into the cove. The PCA for the Otter Creek Treatment Plant includes the inner Otter Cove (Figure 16). The inner cove has been exposed to undiluted sewage. Additionally it may have a lower overall flushing rate than the cove as a whole because it is blocked at its mouth by causeway (tidal water is exchanged through the culverts in the causeway). The park owns most of the land surrounding the inner Otter Cove (except for a small parcel on the northeast shoreline). It is unclear whether the park boundary extends into the cove to the low tide mark or to the high tide mark. The abundance and diversity of intertidal fauna at the Otter Creek outfall should be compared to the species composition in the Cammen and Larsen (1992) benchmark study for Otter Creek. Because the effluent may have had elevated levels of copper, zinc, and cyanide even before the 1992 study was conducted it may be wise to also compare the intertidal species composition to that in another similar cove on the island that does not have effluent coming into it. Bivalves *Mya arenaria* or *Macoma balthica* or the polychaete *Nereis virens* should be collected and analyzed for copper, zinc, and cyanide.

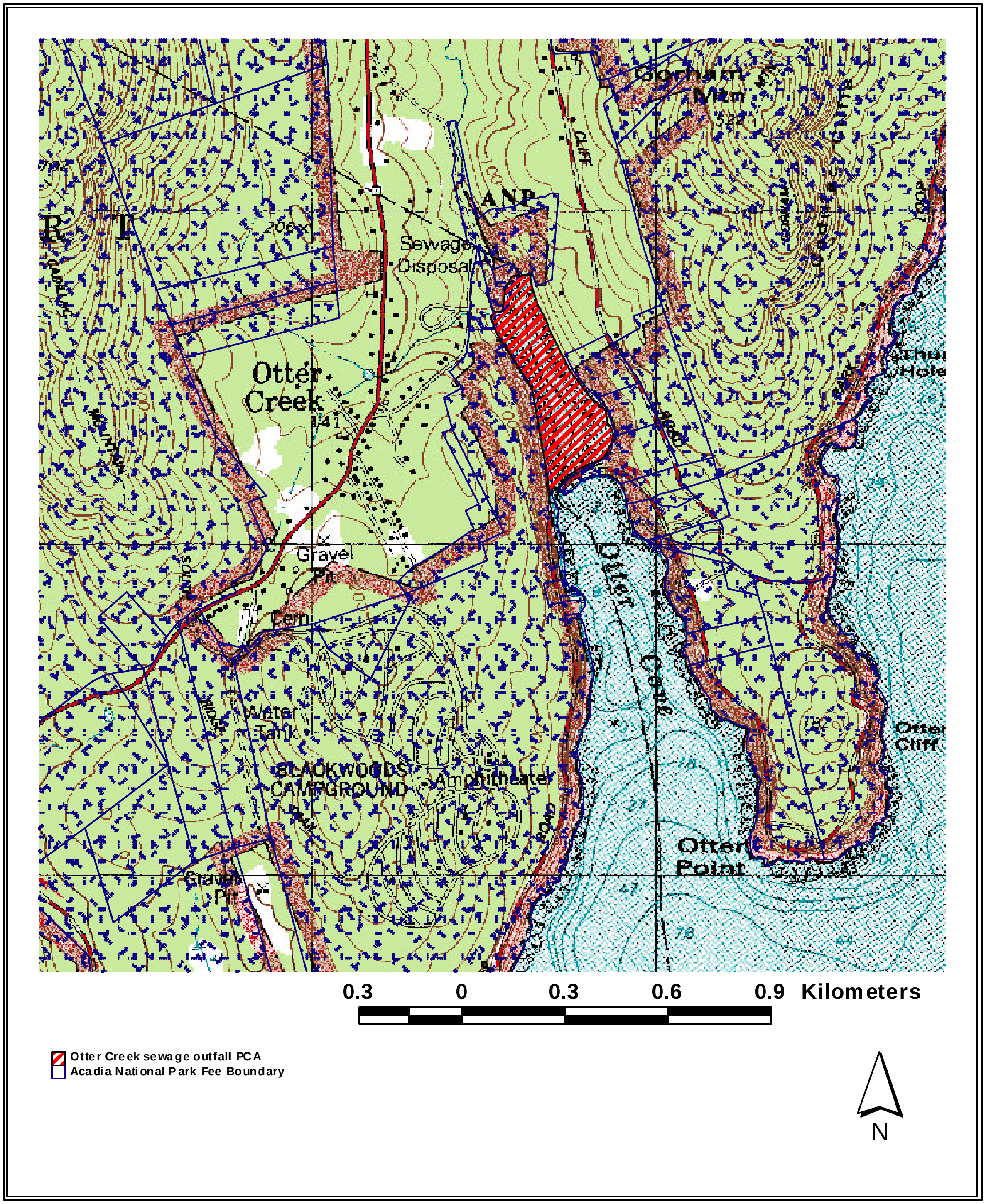
3.2.3.2 Potentially Contaminated Area for PCBs from the Naval Security Group

Without knowledge of where the rusted capacitors were stored outside, or where the in-service capacitors were when they ruptured, the park land parcel located down-gradient of the entire naval facility should be considered a PCA. A detailed review of naval records should be conducted to pinpoint the locations of the capacitors. Although PCBs tend to bind to particulate matter and may be bound to the soils around these locations, they are highly stable and are likely to persist today. Some PCBs may have been transported to the three unnamed ponds within 200 m of the NSG, or to Arey Cove (less than 500 m from the NSG). Any sampling plan to determine the nature and extent of any PCB contamination should include sediment sampling in inner Arey Cove.

3.2.3.3 Potentially Contaminated Area for oil from older USTs at the Naval Security Group

A detailed review of tank removals should be conducted to determine the condition of the tanks when they were removed and to catalog the results of any soil sampling that was conducted. This will help delineate the extent of any soil contamination and potential for contaminant movement to open water. A thin strip of park land lies down-gradient of the NSG, between the NSG and Arey Cove. There are several small streams and three unnamed ponds down-gradient of the NSG. The waters likely to be affected by leaking oil would be these streams and ponds as well as Arey Cove. The PCA would extend from the park land located between the NSG and the ocean into Arey Cove (Figure 17). Arey Cove is rocky, with high wave action. Petroleum products transported to the cove would likely be dispersed by the high wave action upon entry to the cove. Primary focus therefore should be on the freshwater resources near the NSG. The park, during its pre-acquisition assessment, should address the extent of PCB contamination and contamination threats from USTs within the NSG.

Figure 16. Potentially Contaminated Area (PCA) for the Otter Creek sewage outfall



3.2.3.4 Potentially Contaminated Areas for Parking Lot Runoff

Parking lots that are within 50 meters of streams, wetlands, ponds, or lakes are of highest concern. These include parking lots at the Visitor Center, Eagle Lake, Echo Lake, and Sand Beach (Figure 18). Sediment sampling should be conducted both upstream and downstream from these parking lots to determine whether this is a contaminant issue. Sediments should be analyzed for heavy metals, and water should be analyzed for total dissolved solids, total organic carbon, trace metals, and nutrients.

3.2.4 Pollutant Sources of Highest Concern (saltwater)

A review of historic oil spills, marine navigation patterns, bulk oil and hazardous materials storage facilities, and aquaculture indicate that ocean pathways are not routinely transporting substantial contaminant loads to the park. Spills of hazardous materials in nearby navigation channels pose unpredictable but potentially serious risks to park-managed habitats and species

3.2.4.1 Historic Oil Spills

Within the past 5 years two oil spills on MDI have been reported to the USEPA's Environmental Response Notification System (ERNS). In both instances the material and volume spilled were not reported. One spill involved the leaking UST near Stanley Brook (see Table 19), and the other spill was reported off the Bar Harbor town pier. The spill near Stanley Brook is considered a moderate concern, the spill in Bar Harbor, by itself, is of low concern.

3.2.4.2 Boat Traffic and Boat Lanes

Bar Harbor is the busiest harbor within the AOI. In 1998 Bar Harbor was visited 43 times by 13 different cruise ships. The harbor can accommodate three QE 2 class vessels or two QE 2 and two 750' class vessels at one time. The harbor is home to 13 seasonal tour boats and 35 year-round commercial fishing vessels. The harbor currently has one daily high-speed ferry- the 900-passenger Bar Harbor-to-Yarmouth, Nova Scotia, ferry. The harbormaster estimates that there is at least one oil spill greater than 5 gallons per week.

Northeast Harbor is one of the three busiest cruising harbors on the Maine coast. According to former harbormaster, Mike Johnson, approximately 2800 sailboats and pleasure motor boats visit the harbor every summer. The boats range in size from 30' to 115' with the majority between 40' and 50'. The only oil spill in recent history was in the fall of 1997 (this spill was not reported to ERNS). A fishing boat sank, discharging an unknown amount of diesel fuel to the water. The Coast Guard was called and they determined that the discharge did not need to be boomed.

Figure 17. Potentially Contaminated Area (PCA) for the Naval Security Group Activity, for both PCBs and underground storage tanks

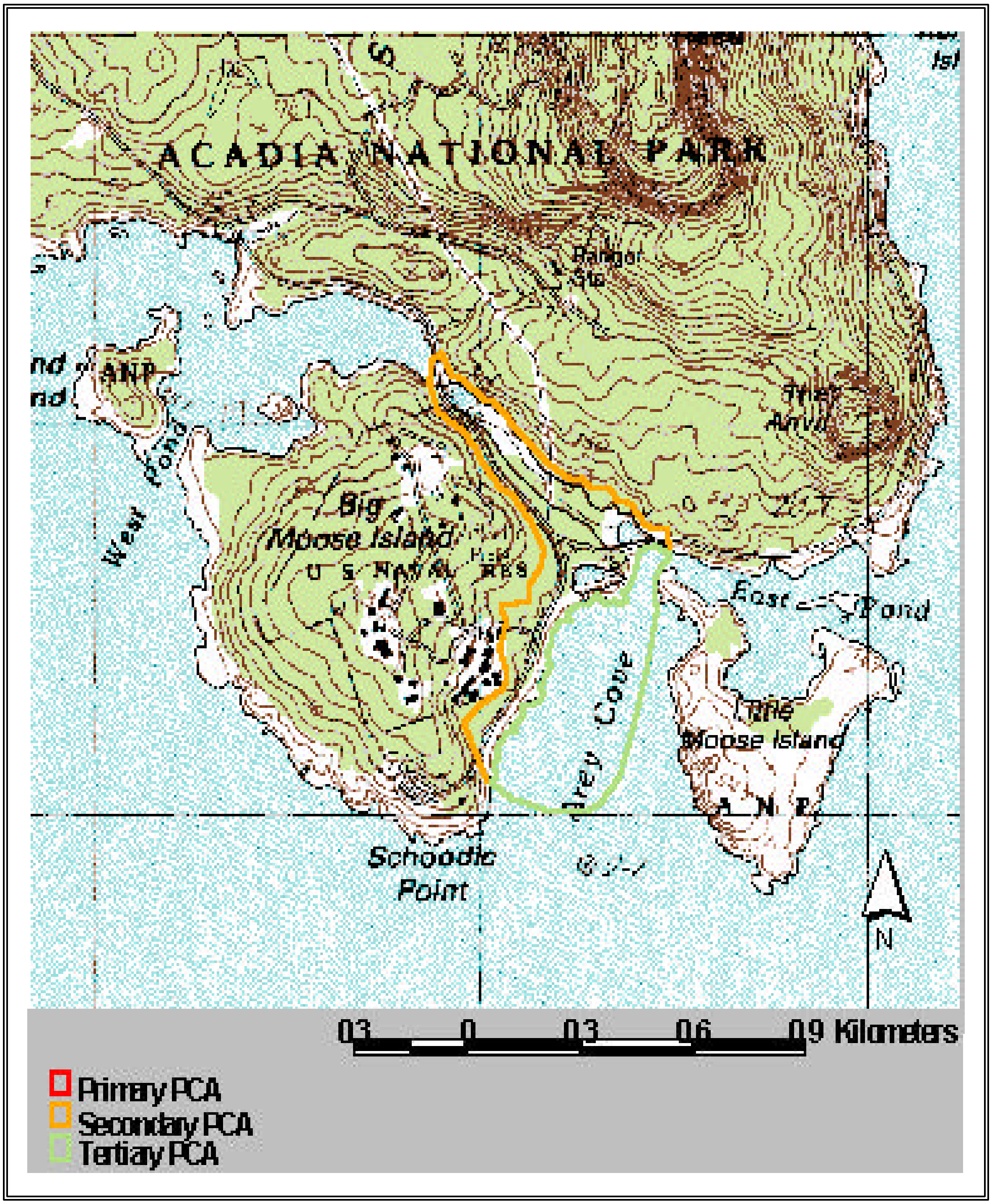
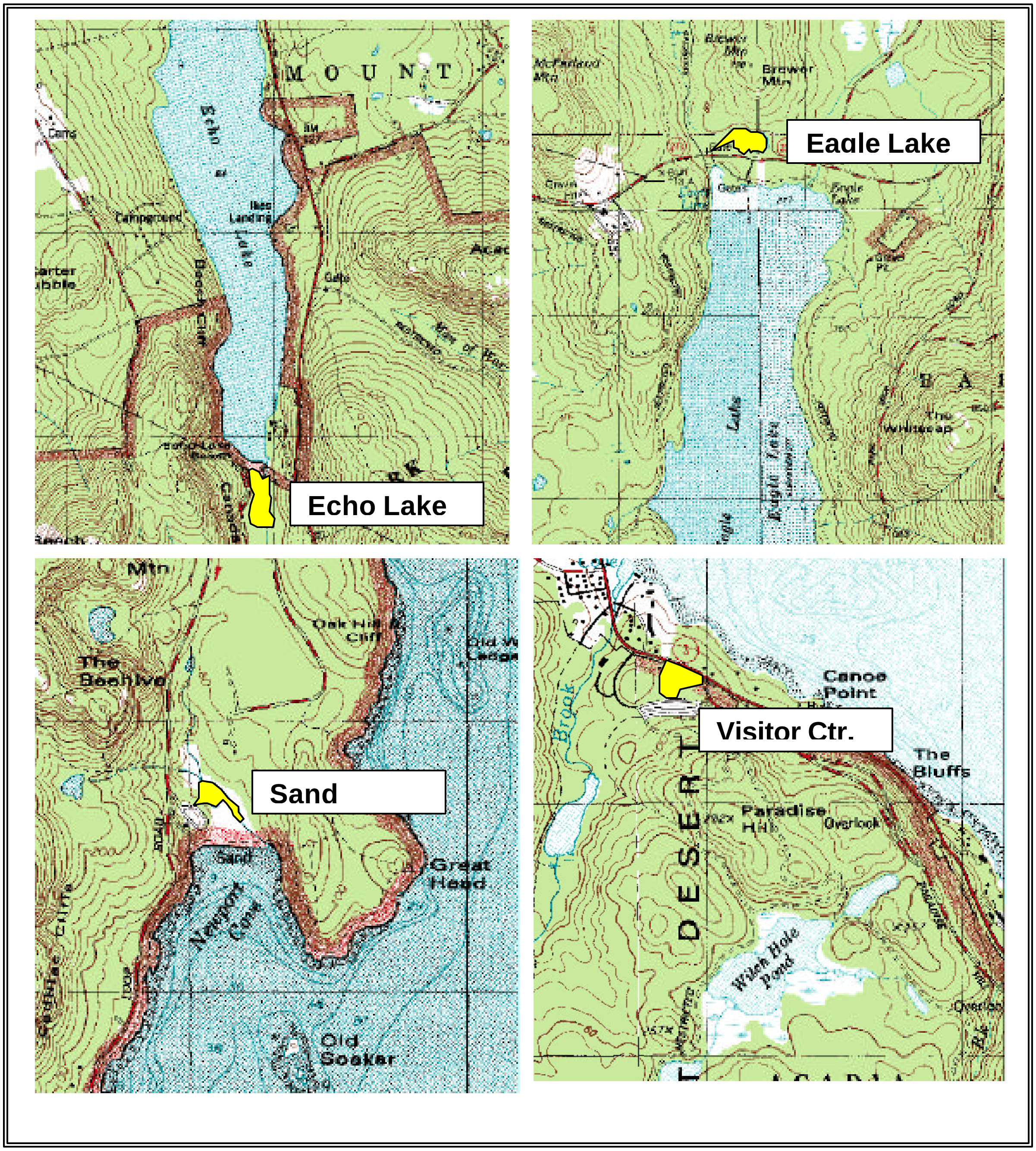


Figure 18. Potentially Contaminated Areas (PCAs) for parking lot runoff



Neither the Southwest Harbor harbormaster nor the Tremont harbormaster had any record of oil spills. Bass Harbor and Manset Harbor fall under the control of the Southwest Harbor harbormaster. Two State of Maine ferries use Bass Harbor on a daily basis- the Swans Island Ferry and the Long Island Ferry.

3.2.4.3 Merchant Transport within the area of Penobscot Bay to Eastport

Between 200 and 300 freighters and tank vessels enter the AOI every year. The USCG does not keep numbers on tank barges, nor does it keep numbers on vessels departing the area. These numbers include vessels going to Eastport, Searsport, Bucksport, and up the Penobscot River to Bangor and Brewer (as well as to smaller ports), but do not include tankers going to the Irving Oil Refinery in Saint John, New Brunswick.

3.2.4.4 Bulk Oil and Hazardous Materials Storage Facilities

There are 41 facilities receiving, storing, and using hazardous materials in the region. The largest storage facilities are in Searsport (Delta Chemical) and in Woodland (Georgia-Pacific), and for all storage facilities the primary chemical class stored is caustics. The only hazardous substance transported in bulk by vessels is caustic soda imported at Searsport. On Mount Desert Island there are four bulk hazardous material storage facilities, all of which store chlorine (Table 20).

There are 33 facilities storing petroleum products in the region. The largest facilities are the Irving Oil tank farm in Searsport (1,370,500 bbl) and the Mobil Oil tank farm in Bangor (1,224,000 bbl). There are no bulk petroleum storage facilities on MDI or Schoodic Peninsula.

Table 20. Facilities on MDI that store bulk chlorine

Facility Name	Address	Phone Number	Product	Volume Stored (lbs)
Bar Harbor WWTP Ledgelawn and Cromwell	P.O. Box 337 Bar Harbor, ME 04609	207-288-3555	Chlorine	2,500
Bar Harbor WWTP Hulls Cove	Beaver Dam Road 93 Cottage St. Bar Harbor, ME 04609	207-288-3555	Chlorine	300
Southwest Harbor WWTP	Apple Lane Southwest Harbor, ME 04679	207-244-7919	Chlorine	1,500
Southwest Harbor Water	Long Pond P.O. Box 745 Southwest Harbor, ME 04679	207-244-3948	Chlorine	300

3.2.4.5 Aquaculture

Aquaculture may contribute to an overall decline in water quality around MDI, IAH, and Schoodic peninsula. However, high tidal flux in the areas of aquaculture leases minimize this risk. There are three fin-fish leases and five shellfish leases near MDI, Schoodic

Peninsula, and IAH. The Maine Department of Marine Resources requires all finfish leases to submit results of dissolved oxygen tests once a year (usually in the fall, and reporting is not required of shellfish leases). There have been no dissolved oxygen reports of concern from aquaculture sites near park lands. Pesticides are only approved for use in fin-fish culture. Cypermethrin (brand name: Excis) is used in pen cultures to treat fish for sea lice. Non-target organism research has been conducted with cypermethrin and lobsters. If used correctly there are no adverse effects on lobsters, however, an overdose will kill juvenile lobsters within 100' of the pen. There are no aquaculture lease plots within 2 km of park-owned lands. The closest finfish culture is the Trumpet Island Salmon Farm, Inc. lease plot on the eastern side of Trumpet Island (an island for which the park owns the conservation easement).

3.2.5 Summary of Contaminant Concerns (saltwater)

The primary concern to park resources is the threat of an oil spill. The threat of damages to park resources arises from the accumulated affects of small spills, and possibly from larger spills from oil transport or storage.

Small spills occur on a regular basis in all of the harbors of MDI. These spills are likely to go unreported but their cumulative effect is the overall degradation of the benthic environment within the harbors. Spills are most likely to have the greatest degenerative effect in Bar Harbor (which has the greatest overall volume of boat traffic) and the harbors of Tremont (which has the greatest number of fishing vessels). Due to their proximity, park resources most likely affected by the years of small oil spills in the harbors would be the park's offshore land holdings near MDI and park-owned coastline between Bass Harbor and Sewall Pond (Figure 19). Sentinel resident bivalves, *Mya arenaria* or *Macoma balthica,* or annelids, *Nereis virens or Capitella capitata*, should be collected from these areas and analyzed for polyaromatic hydrocarbons and their metabolites.

Information about ocean currents and tidal currents around MDI is limited. It is unclear what affect a large oil spill in Penobscot Bay or involving a tanker headed for the refinery in Saint John, New Brunswick would have on park resources. Baseline assessments should be conducted in high value habitats (Table 21 and Figure 20). Not all of these areas fall completely within the park's jurisdiction. However, any oil spill impact felt by the resources in these areas would probably affect the park. Each one of the above mentioned locations should be considered a baseline sampling areas (BSAs). Data collected should provide some baseline information to support a natural resource damage assessment in the event that a future spill injures park resources.

3.3 Ground Water Pathway

3.3.1 Pollutant Sources of Highest Concern

3.3.1.1 Landfills

Leachate from active landfills or landfills that have not been properly closed may contain a variety of toxic chemicals that will affect nearby water bodies and the biota therein. There are 63 municipal landfills in the AOI, all of which are closed. There are four municipal landfills within five km of park land- Lamoine, Swan Island, Tremont, and Winter Harbor. These landfills were closed with interim caps and grades (ICAG). Although this is not a full closure procedure, the cap does include an impermeable layer (clay), which may limit the potential for leaching. The Lamoine landfill is of slight concern as a contaminant source due to the presence of iron, manganese, and some arsenic in residential wells nearby. However, Eastern Bay separates the landfill from the park, and contaminants originating from the landfill are likely to be flushed away by the tides. Winter Harbor is of high concern due to the presence of PCBs and other hydrocarbons (Table 22) in surface and ground water samples taken around the landfill, and its proximity to the Porcupine Islands, Bar Island, and The Hop. In addition to the municipal landfills, there are also private landfills on MDI. The Worcester landfill is an inactive landfill in Southwest Harbor. The landfill operated from the 1930's until the early 1990's. Leachate from the landfill contains high concentrations of unionized ammonia and has affected water quality in Marshall Brook. Downstream from the leachate input, and upstream from the confluence of Lurvey Brook, the benthic invertebrates have low diversity indices. This is reflected in small numbers of different taxa present, and large numbers of individuals of one taxon (specifically *Diptera chironomidae,* Boyle *et al*.1987). Marshall Brook once had the finest sea-run brook trout fishery in the area (Hansen 1980). Four-spined sticklebacks have now replaced the brook trout and American eels. This is a contaminant source of high concern. However, the park and other interested parties have conducted sampling to determine the extent of the effects of the landfill (Appendix B).

Figure 19. Sampling locations for in-harbor oil or hazardous material spills

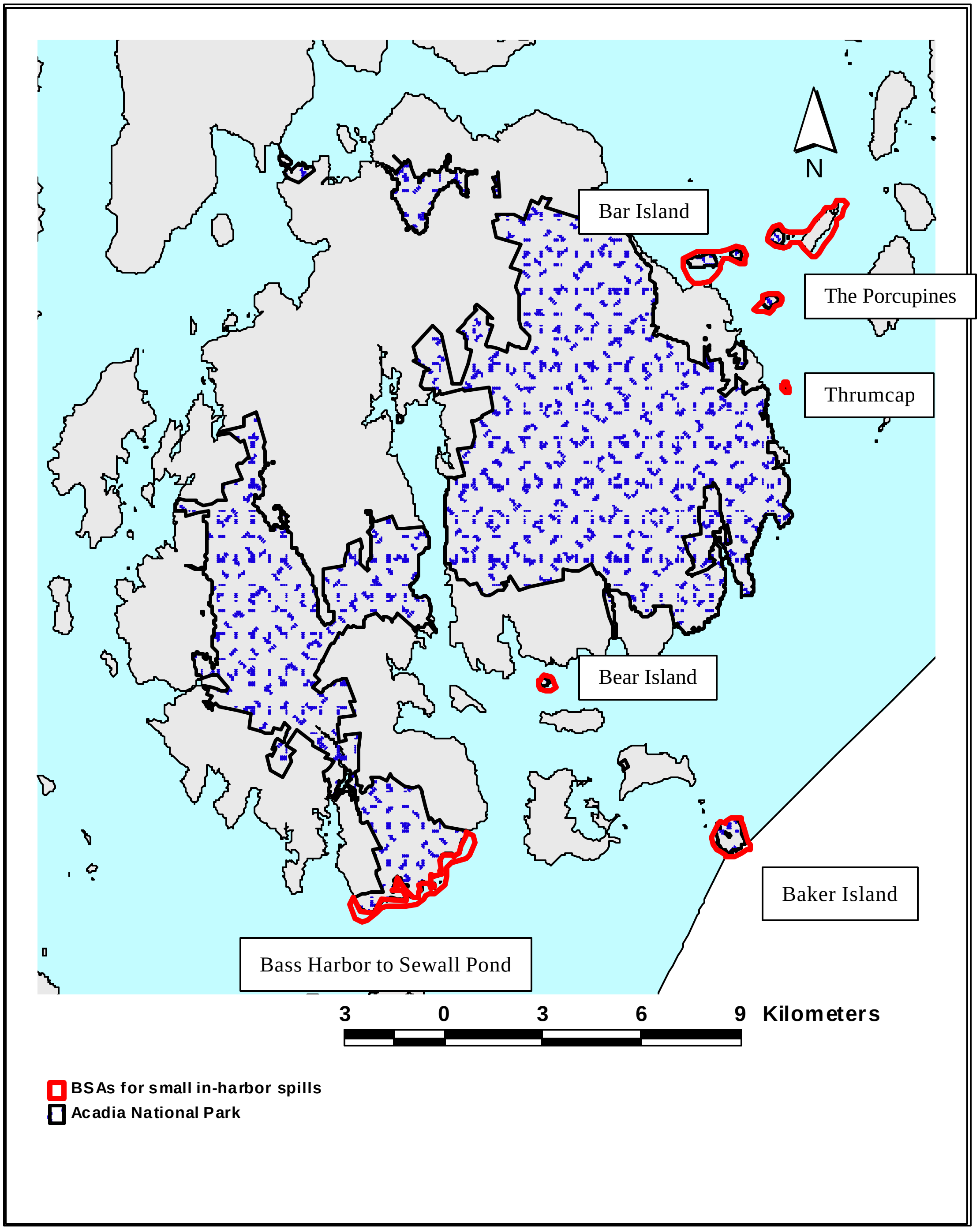


Figure 20. Primary baseline sampling areas for oil or hazardous material spills

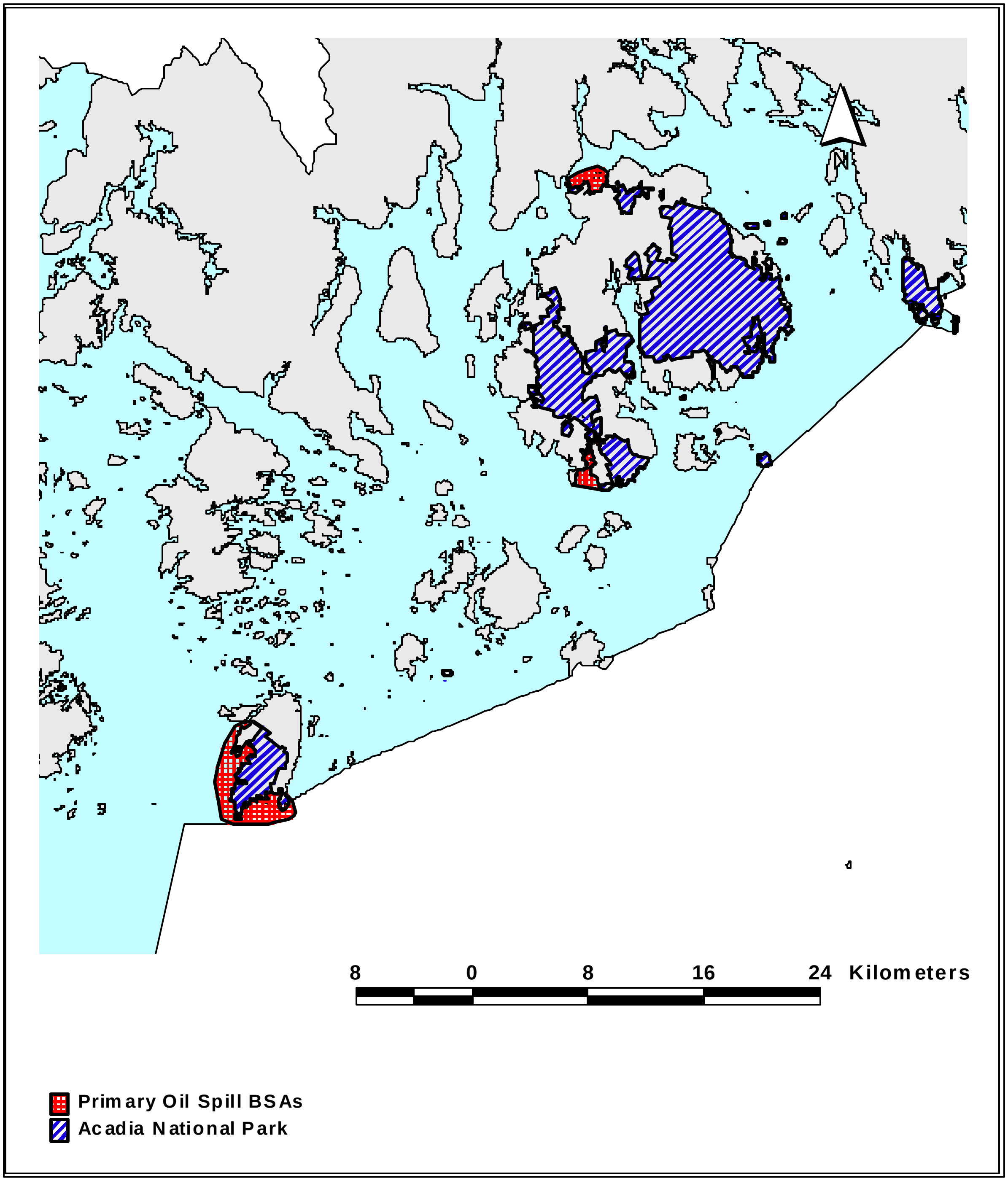


Table 21. Recommended baseline assessment sampling areas

Assessment importance	Location	Habitat of interest	Sampling scheme
Primary	Isle au Haut	Winter habitat for Harlequin duck, a State-listed threatened species	Population assessment
	Thompson Island, Thomas Island, Northeast Creek	Waterfowl wetlands, tidal flats, marshlands, herring nursery	Abundance and diversity of benthos and waterfowl
	Bass Harbor Marsh	Supports juvenile finfish of commercial importance and waterfowl	Abundance and diversity of fish and waterfowl
Secondary	Anemone Cave	Sea cave	Abundance and diversity flora and fauna of the cave
	Marshall Brook, Hunter Brook, Stanley Brook	Sea-run brook trout streams	Population assessment
	Denning, Marshall, Breakneck, and Duck Brooks. Bass Harbor, Seal Cove, and Bracy Harbor.	Important runs for American eel	Population assessment
	Otter, Clark, and Northwest Coves. Hunters Beach and Northeast Harbor.	Smelt and alewife runs	Population assessment
	Bar, Trumpet, Thrumcap, and Ship Islands	Important for bird nesting	Population assessments

Table 22. Summary of contaminants found at and near the Winter Harbor landfill

Chemical	Conc.	Units	Media	Location	Year	Compare to:	Ref.
Aroclor 1260	7.92	µg/g	soil	Northwest of landfill, in a drainage swale	1998	1.3 µg/g	CCME-HH[1]
	0.33	µg /g	soil	Northwest of landfill, in a drainage swale	1998		
	0.266	µg /g	soil	Southern side of landfill	1983		
Tetrachloro-ethene	1.89 1.38 3.16	µg /L	ground water	Residential wells 200-800 m southwest of landfill	1994	5.0 µg /L	EPA[2]
	81,000	µg/L	surface water	Southern side of landfill	1994	840 µg /L	MDEP[3]
cis 1,2-Dichloro-ethylene	13	µg /L	surface water	Southern side of landfill	1994	NA[4]	MDEP
	0.71	µg /g	soil	Southern side of landfill	1994	NA	CCME-HH
Trichloro-Ethane	1.81	µg /g	soil	Southern side of landfill	1994	NA	CCME-AL[5]
Fluor-anthene	2.548	µg/g	soil	Southern side of landfill	1983	2.355 µg/g	CCME-AL
Benzo(a)-anthracene	1.08	µg /g	soil	Southern side of landfill	1983	0.385 µg/g	CCME-AL
Benzo(a)-Pyrene	1.52	µg /g	soil	Southern side of landfill	1983	0.782 µg /g	CCME-HH
Phen-anthrene	0.723	µg /g	soil	Southern side of landfill	1983	0.515	CCME-AL
Pyrene	2.15	µg /g	soil	Southern side of landfill	1983	0.875	CCME-AL

[1]CCME-HH: Canadian Council of Ministers of the Environment's "Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health". Values for residential and park lands.
[2]EPA: USEPA's maximum contaminant level as promulgated under the Safe Drinking Water Act.
[3]MDEP: Ambient Water Quality Criteria, pollutant limits set by the EPA and adopted by the State of Maine to protect aquatic life. Values are criterion continuous concentration (chronic criterion).
[4]NA: Soil, sediment or water quality criteria, not available.
[5]CCME-AL: Canadian Council of Ministers of the Environment's "Canadian Sediment Quality Guidelines for the Protection of Aquatic Life". Values are the Probable Effects Levels.

3.3.1.2 Road Salt and Sand

Salt, used to de-ice roads in the winter, is stored in piles that are usually uncovered. Sodium and chloride can leach from the piles and affect local water quality. There are six storage piles on MDI and, three on Schoodic Peninsula. Only one pile is both up-gradient of park land and near a water body- the Town of Southwest Harbor salt pile. The pile lies less than 20 m from Marshall Brook and about 50 m upstream from the park. Because of its proximity to both the brook and the park, it is a contaminant source of high concern. The salt pile is downstream from the above-mentioned Worcester landfill, so it may be difficult to discern salt pile effect versus landfill leachate effect. This area has been negatively affected by the Worcester landfill. Because of the compromised state of resources in the area, monitoring and sampling of the effects of the salt pile on park resources is not recommended.

3.3.1.3 Underground Storage Tanks

As USTs age the potential exists for the tank material to degrade and for leaks to develop. Spills and overfills are also common. Prior to December 22, 1998 tank owners were not required to maintain leak detection, corrosion protection or overfill/spill protection. Prior to the 1998 regulations it was possible for leaks to go undetected for years. The leaked fuels can contaminate groundwater and migrate to the nearest surface water body. There are approximately 80 USTs in ground and active on MDI and 19 USTs on Schoodic Peninsula (Table 23). No tanks have been in service for more than 20 years and most, 69 percent, of the tanks on MDI have been installed in the last ten years. All of the tanks on Schoodic Peninsula are less than 10 years old. Products stored include kerosene, #2 fuel oil, #5 fuel oil, unleaded and leaded gasoline, and diesel. Tanks in the ground prior to December 22, 1998 and still in service have been retrofitted with leak detection, corrosion protection or overfill/spill protection and therefore are of low concern to the park. In 1985 the state has required that all USTs be registered. Since that time approximately 369 USTs have been removed from MDI and 41 removed from Schoodic Peninsula. Closure reports for these tanks were not reviewed. Most of the tanks on MDI are located in the villages of the island and are therefore down-gradient from park resources. There do not appear to be any sand and gravel aquifers on MDI (Figure 21), and therefore the risk of groundwater contamination and migration of any product to surface waters is low. If leaking USTs were removed, local soil contamination is likely. The USTs, both in service and removed, on MDI and Schoodic should be mapped to have a better grasp on where soil contamination may be a problem.

3.3.1.4 Shallow Well Injection

There are five categories of injection wells (Table 24). Only Class V shallow well injection occurs in Maine. Shallow well injection involves disposal of hazardous and non-hazardous substances to the ground and ground water through septic systems and floor drains. Industrial and commercial wastes discharged via shallow injection wells include petroleum products, cleaning solvents and degreasers, industrial and agricultural chemicals, and a variety of other wastes. The state has focused on eliminating automobile service station and manufacturing facility floor drains due to their high groundwater contamination potential. There are seven facilities with a total of 16 shallow injection wells on MDI (the state has no record of any on Schoodic Peninsula, Table 25). Five of the facilities with shallow injection wells are garages, one is a funeral parlor, and one is a dry cleaner. There are no park lands near the Fernald Funeral Parlor or Hillside Garage. The remainder of the sites are down-gradient from the nearest park land and are a low contaminant risk to park resources.

3.3.2 Summary of Contaminants of Concern

The highest risk of contamination via the ground water pathway comes from the Town of Winter Harbor's landfill.

3.3.2.1 Town of Winter Harbor Landfill

Winter Harbor's two-acre landfill was operated as a municipal landfill from 1971 until 1992. The site sits about 850 m from Myrick Cove and about 1.3 km from Mill Stream, which drains into Henry's Cove (Figure 22). Surface water flows away from the site in both a southerly direction from the south end of the site and in a northwesterly direction from the western edge of the site. From 1971 through 1977 the NSG disposed of electrical components containing small quantities of PCBs with an estimated total of 40.91 kg PCBs disposed. It is likely that the electrical components corroded and that the PCBs are unconfined.

NUS Corporation collected soil samples in 1983 for the USEPA. Soils to the southeast of the landfill contained 0.266 µg/g Aroclor-1260 and five polycyclic aromatic hydrocarbons (PAHs- fluoranthene, 2.538 µg/g; benzo(a)anthracene, 1.078 µg/g; benzo(a)pyrene, 1.522 µg/g; and phenanthrene, 0.723 µg/g). In 1994, Woodard and Curran Consulting Engineers collected surface water and soil samples for the Town of Winter Harbor. Tetrachloroethene (a chlorinated hydrocarbon used in dry cleaning and metal degreasing) was found in one surface water sample (81 mg/L). It was also found in residential wells to the southeast of the landfill (concentrations ranging from 1.38 to 3.16 µg/L, note the order of magnitude difference between surface and groundwater samples). In 1998 the state collected surface water and soil samples for PCB analysis. Aroclor 1260 was found in two soil samples (0.33 and 7.92 µg/g). Both samples were from the northwest of the landfill. In February 1999 the state contracted GZA, an environmental consulting firm, to perform a complete assessment of the site, for PCBs and other chlorinated and nonchlorinated hydrocarbons and for all media- surface water, groundwater, and soil. The extent of contamination at this site is unknown.

In 1989 sediment samples were collected in Frenchman Bay as part of the National Oceanic and Atmospheric Administration (NOAA) Status and Trend's Benthic Survey program (NOAA, 1994). Samples were collected from four sampling stations and PCB congeners were found at three of the four sites (Table 26).

There is no straightforward relationship between Aroclors and PCB congeners. Aroclor is the trade name by which PCBs were sold. The Aroclors were identified by a four digit numbering code (e.g., 1260) in which the last two digits indicate the chlorine content by weight. An Aroclor is a mixture of differently chlorinated PCB congeners (of which there are 209). Congeners differ in their rates of biodegradation, bioaccumulation, and photodegradation; they also differ in water solubility, vapor pressure, K_{ow} values, and Henry's Law constants. It would be impossible to infer that the PCBs in the sediments of Frenchman Bay originated at the Winter Harbor town landfill. However, the landfill did receive PCBs, and PCBs have been found in the soils. Run-off from the landfill does drain into Frenchman Bay. These facts do suggest that the landfill may be one source of PCBs in the Bay.

Figure 21. Sand and gravel aquifers in the ground water Area of Interest (AOI)

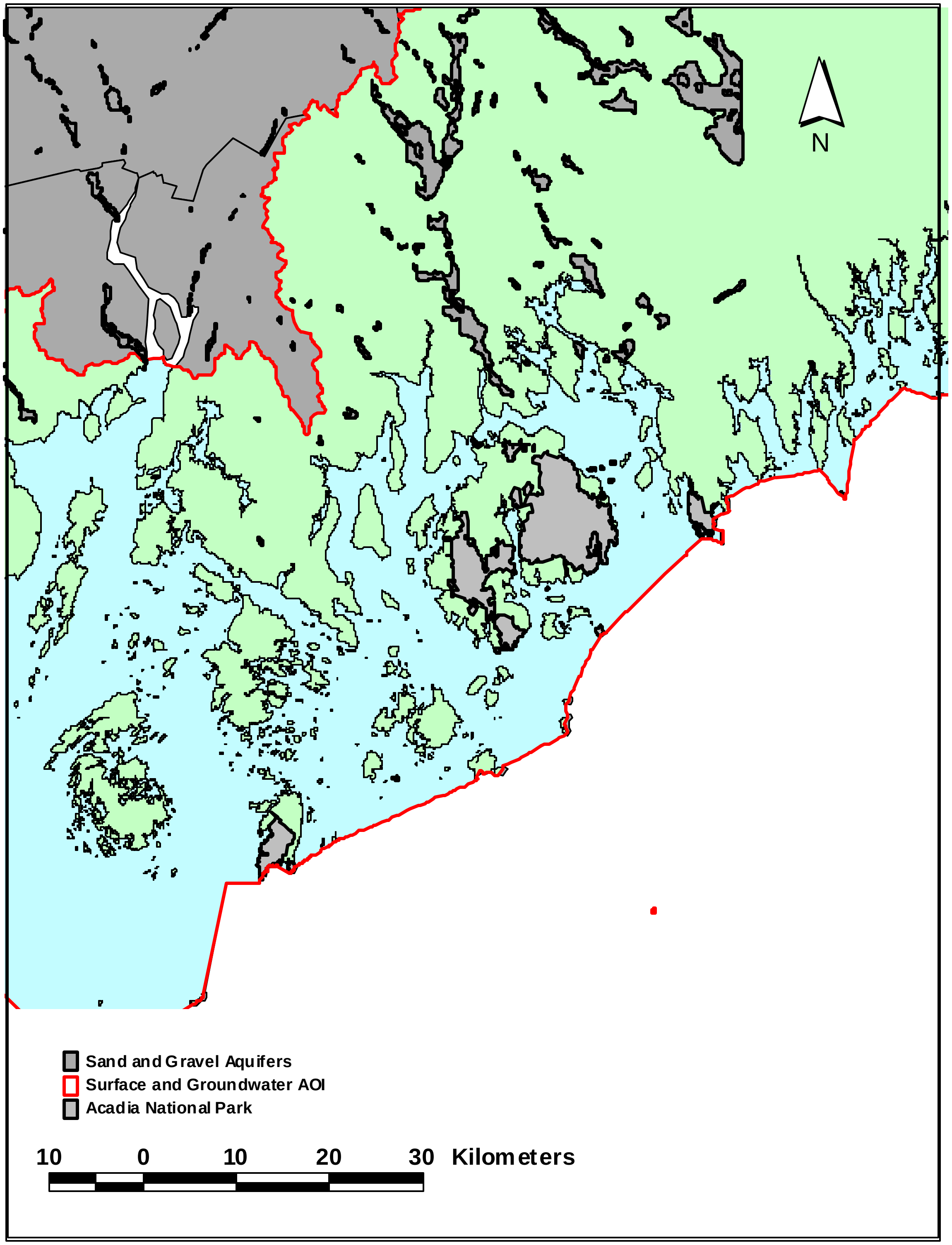


Figure 22. Winter Harbor landfill

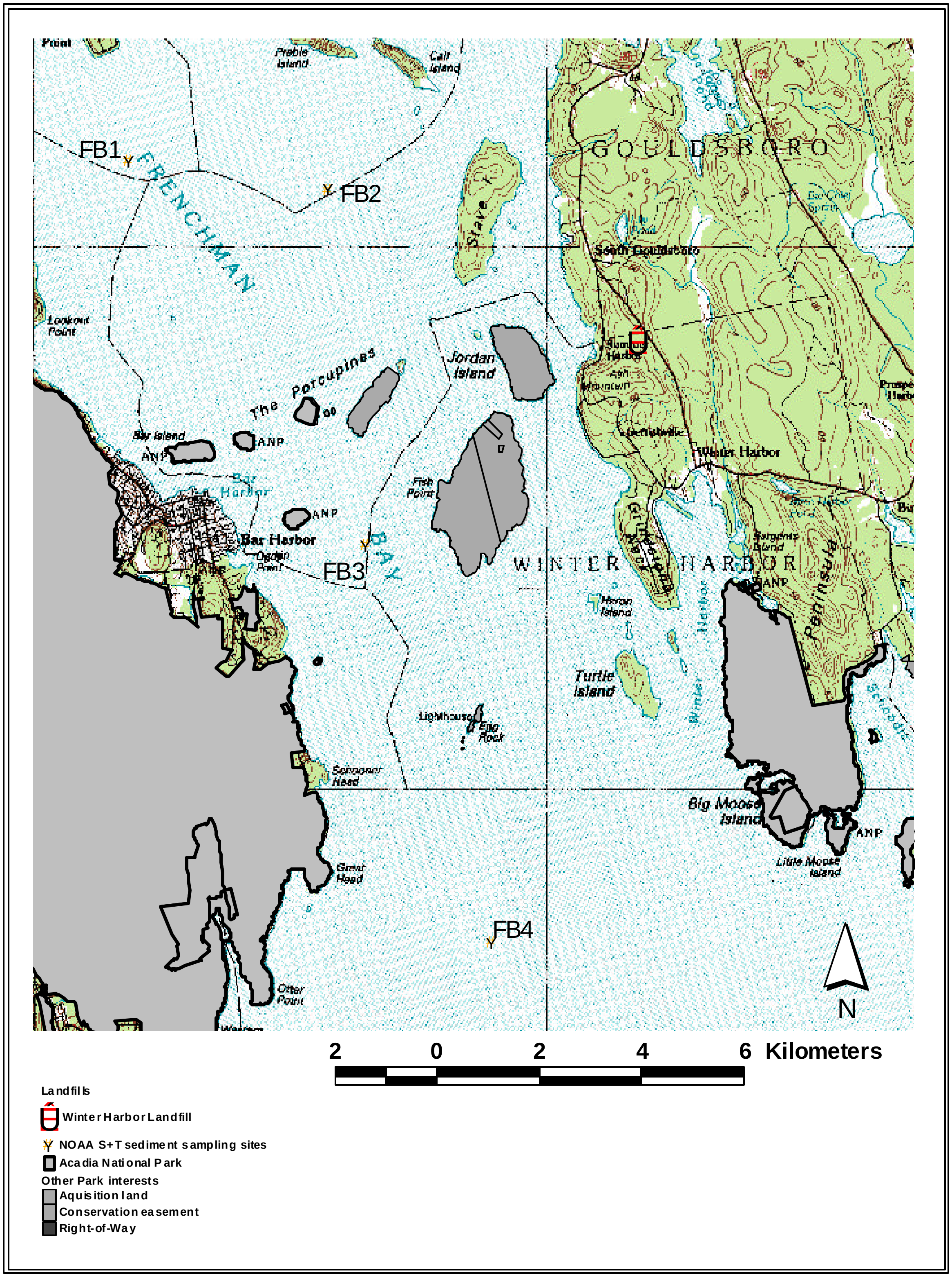


Table 23. Underground storage tanks

Location	Town	Product	# of Tanks	Total volume (gallons)
Mount Desert Island	Bar Harbor	#2 Fuel Oil	23	84,750
		Unleaded Gasoline	9	57,000
		Premium Unleaded Gasoline	8	33,000
		Diesel	5	33,000
		Unleaded Plus Gasoline	4	21,000
		#5 Fuel Oil	1	10,000
		Regular Gasoline	1	550
		Waste Oil/Used Motor Oil	1	550
	Bass Harbor	Unleaded Gasoline	1	3000
		Premium Unleaded Gasoline	1	4000
		Diesel	1	8000
	Mount Desert	#2 Fuel Oil	6	10,600
		Unleaded Gasoline	3	21,000
		Premium Unleaded Gasoline	2	10,000
		Diesel	2	14,000
		Unleaded Plus Gasoline	1	6000
Mount Desert Island (cont.)	Seal Harbor	Unleaded Gasoline	1	8000
		Premium Unleaded Gasoline	2	5000
	Southwest Harbor	#2 Fuel Oil	2	6500
		Unleaded Gasoline	2	20,000
		Premium Unleaded Gasoline	3	20,000
		Diesel	2	16,000
		Kerosene	1	500
Schoodic Peninsula	Winter Harbor	Unleaded Gasoline	1	4000
		Leaded Gasoline	1	8000
	Naval Security Group	See Table 19 for summary of the 47 USTs at the Naval Security Group		

Table 24. Shallow injection well categories

Category	Description	Status in Maine
Class I	A well used to inject hazardous wastes beneath an aquifer	Not present
Class II	A well used to inject fluids associated with oil and natural gas production	Not present
Class III	A well used to inject fluids associated with mineral extraction	Not present
Class IV	A well used to inject hazardous or radioactive waste into or above an aquifer	Prohibited
Class V	Septic systems, floor drains, drainage wells. Class V wells typically inject non-hazardous and hazardous fluids into or above an aquifer.	Common

Table 25. Shallow injection wells on Mount Desert Island

Business name	Business type	Town	# of drains	Discharge point
Hillside Garage, Town Hill	Garage	Bar Harbor	1	Pipe to storm drain
A. C. Fernald Sons, Inc.	Funeral home	Mount Desert	3	Directly to soil
Greenrock Co., Seal Harbor	unk.	Mount Desert	1	Pipe to stream
Mount Desert Cleaners, Inc., Northeast Harbor	Dry cleaner	Mount Desert	3	Directly to soil
Mount Desert Hwy. Garage	Garage	Mount Desert	8	Pipe to stream

Table 26. Concentrations of PCB congeners, in ng/g, found in sediments in Frenchman Bay

Congener	Location			
	FB-1	FB-2	FB-3	FB-4
PCB 8	12.233	10.269	6.891	nd
PCB 66	5.808	2.622	nd	nd
PCB 105	0.438	0.291	nd	nd
PCB 209	nd	0.390	nd	nd

nd: not detected

PCBs are hydrophobic and most commonly are bound to soils. The entrained PCBs can be washed into the nearest waterbody and enter the food chain. Any park fauna consuming prey from Frenchman Bay may consume PCBs. PCBs have high potential for bioaccumulation and chronic exposure can lead to disrupted hormone balances, reproductive failures, teratomas or carcinomas.

3.3.3 Potentially Contaminated Areas, Ground Water-borne Contaminants

3.3.3.1 Potentially Contaminated Area for PCBs from the Winter Harbor Landfill

The park owns all or part of four islands in Frenchman Bay within 10 km of the Winter Harbor Landfill- The Hop, Bald Porcupine, Sheep Porcupine, and Bar Island. The PCA covers these islands (Figure 23)[5]. There are many bird species that use this area, including plovers, sandpipers, Ruddy Turnstones, and Greater Yellowlegs. In the winter a large number of ducks feed in the vicinity. Most of these birds, however, are not fish-eating birds and the highest PCB concentrations in birds are measured in fish-eaters. Fish eating birds- cormorants, osprey, kingfishers, swallows, loons and bald eagles - have been seen in the vicinity of the islands. Bald eagles from MDI have some of the highest PCB burdens ever recorded, up to 12.13 µg/g (Welch 1994).

PCB contamination in avian species may contribute to eggshell thinning. For most birds, a reduction in eggshell thickness of 15 to 20 percent may be the critical limit beyond which population numbers will decline (Nygard 1983). Eggshell thinning and population declines have been recorded for Bald Eagles, Black-crowned Night Herons, and peregrine falcons (Eisler 1986). Many bird species with high PCB concentrations also have high concentrations of other chlorinated organics, such as DDE and dieldrin. These contaminant burdens confound the relationship between PCBs and eggshell thinning.

Prey species from the waters off the above mentioned islands should be collected and analyzed for PCB congeners. The diet of the coastal bald eagles in Maine consists mostly (76 percent) of other bird species (Welch 1994). However, this is not the case for the other fish-eating birds hunting near the islands in Frenchman Bay. Collecting and analyzing sediments, resident fish (*Fundulus heteroclitus*) and invertebrates (annelid- *Nereis virens*, bivalves- *Mytilus edulis* or *Mya arenaria*) should clarify which prey items are contaminated with PCBs. If the prey have significant PCB burdens it may be prudent to collect and analyze birds for PCB contamination. This sampling will confirm whether consumption of marine invertebrates from the waters adjacent to the park acts as a route of exposure for PCBs to park animals.

4.0 Summary

Airborne contaminants dominate the pollutants affecting park resources. Ozone, acid rain, and mercury are well studied within the park. The extent of airborne organochlorines

[5] Although this is a large PCA it best captures the area of concern and is within the definition of a PCA as an area where a contaminant transport pathway and park lands bisect.

reaching the park is unknown but is not likely to be significant. A sampling scheme should be developed to assess the nature and extent of organochlorine contamination in the park.

There are several contaminant sources of smaller scale that should also be addressed with confirmatory sampling. Among them are:

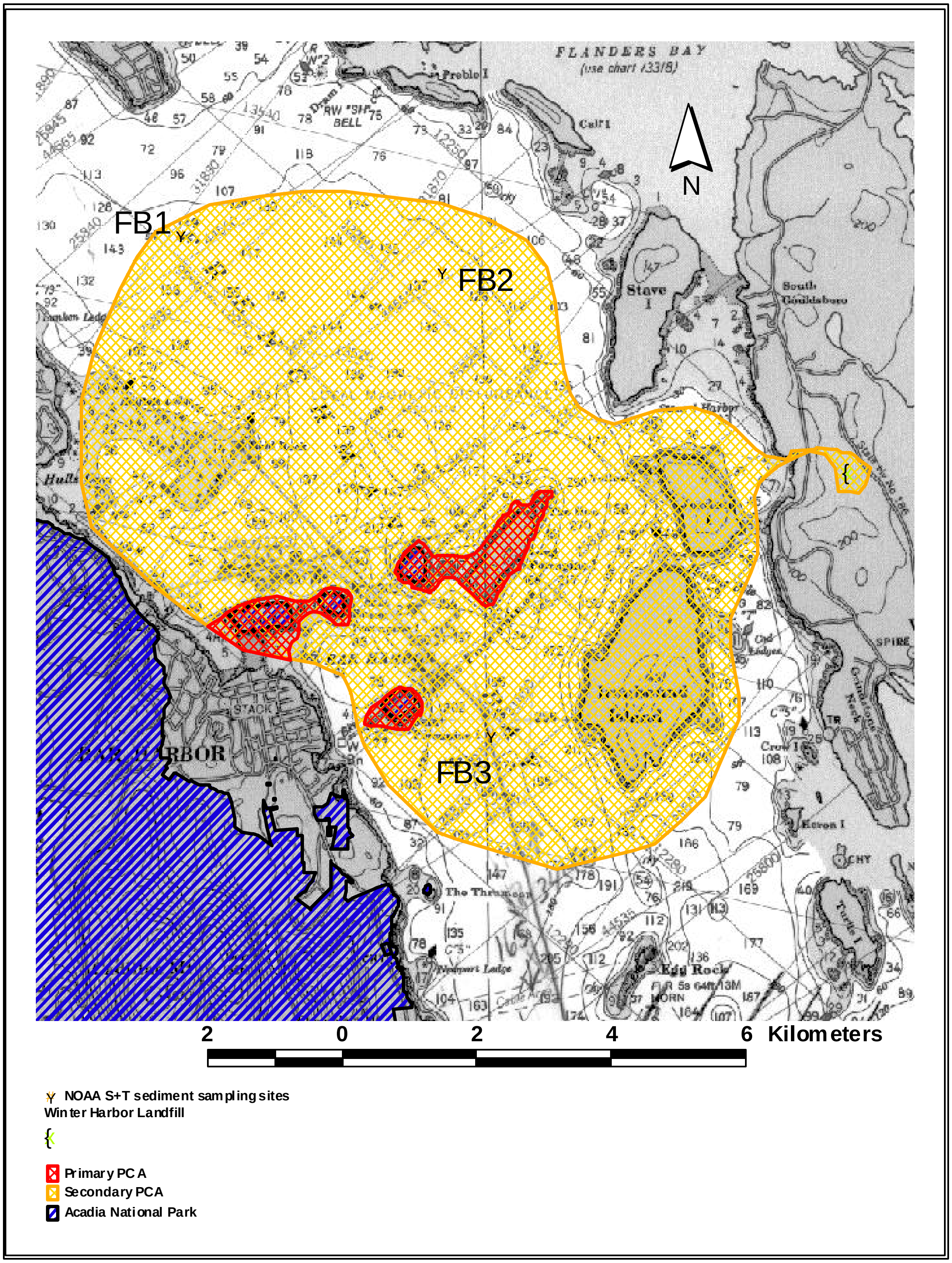
- Possible heavy metals in sewage effluent in Otter Cove,
- Cumulative effects of multiple small oil spills on sentinel benthic species, and
- PCB contamination of Frenchman Bay as a result of PCB disposal at the Town of Winter Harbor municipal landfill.

Sampling efforts to confirm these contaminant threats should be undertaken at the parks discretion. Potential sampling strategies are summarized in Table 27. In addition to confirmatory sampling, baseline assessments should be considered in the more sensitive coastal areas of the park to support natural resource damage assessment activities in the event of an oil spill. Potential sampling strategies for BSA sampling were summarized in Table 21.

Several other areas of contaminant concerns were identified that also should be addressed (Table 28). These concerns are more research and monitoring in nature and are not within the scope of CAP sampling and should be pursued through other avenues by the park.

In addition, we recommend that the park pursue mapping underground storage tanks and sewage outfalls on MDI.

Figure 23. Potentially Contaminated Area (PCA) for the Town of Winter Harbor landfill



5.0 Limitations of CAP

The BEST CAP procedure is a straightforward stepwise process. Using a geographic information system-based decision support system (DSS) is the best way to assess the spatial nature of contaminants, exposure pathways and potentially contaminated areas. However, the present CAP has some limitations that should be addressed such as:

- Over-reliance on federal databases and limits to their accuracy
- Lack of air transport models
- Lack of ocean current models
- Inclusion of the contaminant exposure and effect data for terrestrial vertebrates (CEE-TV) database.

Federal databases maintained by the USEPA are excellent clearinghouses for broad-scale contaminant information. However, for managing data on the scale of an area of interest (e.g., a watershed) the federal databases are incomplete. Often, information such as exact location is incomplete (a street is given but no number listed) or missing (exact locations of sewage outfalls). Source information is incorrect (mines that do not exist) and in some instances sources are not listed at all (e.g., the CERCLIS NFRAP sites, two of which are of high concern to Acadia National Park). Such omissions would not have been discovered for this CAP had it not been for a thorough review of contaminant sources listed in the DSS by the principal investigators and park personnel; a review of State records; and a working knowledge of the area around the park. For future CAPs, it is recommended that more emphasis be given to collecting contaminant information at the state level. Most data used in federal databases are supplied by the states, but the data often are incomplete. Although collecting information from individual states requires more time and is a departure from the cookie-cutter approach to contaminant assessments, the end result will be a more thorough assessment.

Table 27. Potential strategies for confirmatory sampling (page 1 of 2)

Contaminant	Location	Sample Matrix or Species	Sampling Scheme	Rationale
Organochlorines	Hodgdon, Seal Cove, Long, and Lower Hadlock Ponds	Resident fish-eating birds: Loons, tree swallows, or kingfishers	Collection of whole resident tree swallows or the blood of loons or kingfishers from at least three of the five lakes listed for analysis of a suite of PCBs, organochlorine pesticides, and dioxin- and furan-like compounds[1].	Airborne organochlorine contamination of park animals is suspected to be high. Fish-eating birds should have the highest concentrations of organochlorines due to their position in the food chain.
Heavy metals	Inner Otter Cove	Sediments and resident sentinel bivalves or annelids: *Mya arenaria* or *Nereis virens*	Sediments and whole invertebrates collected at least three sites from the inner cove and analyzed for the 13 priority pollutant heavy metals[2].	Sewage effluent from the Town of Mount Desert's Otter Creek outfall may contain heavy metals that may affect the benthic environment within Otter Cove.
	Upstream and downstream of Visitor Center, Eagle Lake, Echo Lake, and Sand Beach parking lots	Sediments	Collection of sediments at one site upstream and on site downstream of each parking lot. Sediments to be analyzed for heavy metals.	Runoff from parking lots may contain heavy metals and may be affecting habitat quality in waterbodies.

Table 27: Potential strategies for confirmatory sampling (page 2 of 2)

Contaminant	Location	Sample Matrix or Species	Sampling Scheme	Rationale
Polyaromatic hydrocarbons (PAHs)	Bass Harbor, Bar Island, The Porcupine Islands	Sediments and resident sentinel bivalves or annelids: *Mya arenaria* or *Nereis virens*	Collection of sediments and animals from at least two sites and analysis for a suite of PAHs or PAH metabolites (could be done in conjunction with PCB sampling)[3].	Chronic small oil spills may have affected the benthic habitat near the harbors. This sampling will confirm whether there is a problem.
	Upstream and downstream of Visitor Center, Eagle Lake, Echo Lake, and Sand Beach parking lots	Sediments	Collection of sediments at one site upstream and on site downstream of each parking lot. Sediments to be analyzed for heavy metals.	Runoff from parking lots may contain heavy metals and may be affecting habitat quality in waterbodies.
PCBs	The Hop, Bald Porcupine, Sheep Porcupine, and Bar Islands	Sediments and resident sentinel fish, bivalves or annelids: *Fundulus heteroclites*, *Mya arenaria* or *Nereis virens*	Collection of sediments and animals from at least three sites around the four islands and analysis for PCB congeners (could be done in conjunction with PAH sampling)[4].	PCBs are high in sediments from Frenchman Bay. This sampling is to confirm whether food items found offshore of park lands have elevated levels of PCBs that would affect park resident animals.

[1] Including but no limited to: p,p'-DDE, p,p'-DDD, p,p'-DDT, dieldrin, heptachlor epoxide, chlordane, toxaphene, hexachlorobenzene, endrin, mirex, PCB congeners.

[2] The priority pollutant metals were selected because they are a standard analytical suite of metals including: Aluminum, antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc.

[3] Including, but not limited to: naphthalene, anthracene, acenaphthene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene.

[4] The standard analytical suite of PCB congeners 66, 77, 81, 105, 114, 118, 126, 128, 138. 153, 170, 180, 187, 195, 206, and 209.

Table 28. Other recommended sampling not pursuant to CAP

Contaminant	Location	Species	Sampling Scheme	Rationale
Ozone	Southwestern side of MDI	Ozone-sensitive plant species-spreading dogbane and bigleaf aster	Placement of new ozone damage monitoring plots and observations of ozone damage	To increase geographic knowledge of ozone-damage on MDI. Presently ozone damage plots are located on the eastern side of MDI
Mercury	Island streams feeding lakes containing fish with known mercury concentrations	Fish species common to all streams	Collection of fish and analysis to total mercury concentration	Mercury contamination is known for fish from 11 of the lakes on MDI but unknown in any of the streams
Acid rain	Great Brook, Breakneck Stream, Bubble Pond Brook, and Hadlock Brook	Resident salamander or frog species-spotted salamanders, spring peepers, leopard frog, bullfrog	Sampling of stream pH and pH-sensitive endpoint, such as egg mortality, conducted during the spring freshets or during sensitive life-stages of amphibians or frogs	Although acid rain/snow at park has been documented, the effects of acid rain on sensitive park residents is unknown

Assessing the effect of upstream sources on downstream receptors is straightforward. Assessing the effects of individual airborne pollutant emitters to any DOI land unit resources is far less simple. The inclusion of air movement and contaminant trajectory models would enhance the capabilities of CAP. With the use of models, a more relevant air pathway area of interest can be developed, and relative contributions of individual facilities or regions may be easier to discern. Models should be used that is compatible with the GIS software being used, and should also be compatible with the models used by the particular DOI bureau (National Park Service, Fish and Wildlife Service, etc.).

A thorough understanding of ocean currents is needed to assess ocean-borne contaminant threats to DOI land units abutting the ocean. For most such units complete near shore current information is unknown. Current models are available and should be used for future CAPs. The models should be consistent with those used by National Marine Sanctuaries.

Contaminant issues at Acadia National Park are relatively well studied. This is not the case for all Park Service lands. The inclusion of the CEE-TV into future decision support systems for future CAPs will provide a useful on-hand wildlife toxicity reference. Although the CAP may be a screening level tool, without addressing the above mentioned limitations future CAPs may be incomplete and possibly erroneous in their conclusions.

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Appendix A

National Ambient Air Quality Standards (NAAQS)

Pollutant	Standard
Carbon Monoxide	1-hour average concentration of 335 ppm 8- hour average concentration of 9 ppm
Nitrogen Dioxide	Annual average concentration of 0.053 ppm
Sulfur Dioxide	3-hour average concentration of 0.5 ppm (This level may not be exceeded on more than one day per year) 24- hour average concentration of 0.14 ppm (This level may not be exceeded on more than one day per year) Annual average concentration of 0.03 ppm
Ozone	1-hour average concentration of 0.12 ppm (This level may not be exceeded on more than one day per year) 8-hour average concentration of 0.08 ppm
Particulate Matter smaller than 10 microns	24-hour average concentration of 150 $\mu g/m^3$ Annual average concentration of 50 $\mu g/m^3$
Lead	Quarterly average concentration of 1.5 $\mu g/m^3$

Appendix B

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