Spatial Distribution of Non-point Contaminants in Alaskan National Park Ecosystems

Final summary of Geo-database and associated EndNote library

Leora Nanus, July 30, 2014

1. Study Region

The study region is shown in Figure 1 and includes National Parks and Wilderness in Alaska and the Aleutian Islands. A literature review was conducted to evaluate past and present Agency and University based non-point contaminant research and monitoring that has implications for Alaskan National Park Ecosystems.

Multiple agencies including the National Park Service (NPS), US Fish and Wildlife Service, US Geological Survey, Alaska Department of Fish and Game, National Oceanic and Atmospheric Administration, US Environmental Protection Agency, and others as well as many University based researches are investigating non-point contaminants in Alaskan ecosystems. 140 references on non-point contaminants including air toxics and mercury (Hg) relevant to Alaskan Park Ecosystems from 1978-2012 were compiled into an EndNote library. This includes the Western Airborne Contaminant Assessment Project (WACAP) and associated publications that have shown Alaskan ecosystems are receptors of pollutants transported long distances, with contaminant detections in remote parts of Alaska for chemicals that have not been used in the US for decades (3.16). Spatial data on non-point contaminants in many ecosystem indicators including fish, marine mammals, predatory birds, polar bears, vegetation, snow, surface water, air, and sediment were extracted from relevant literature on Alaska. National Parks with

available data include Denali National Park and Preserve (DENA), Gates of the Arctic (GAAR), Glacier Bay National Park and Preserve (GLBA), Katmai National Park & Preserve (KATM), Klondike Gold Rush National Historic Park (KLGO), Lake Clark National Park and Preserve (LACL), Noatak National Preserve (NOAT), Stikine-LeConte Wilderness (STLE), Wrangell-St. Elias National Park & Preserve (WRST).

An ArcGIS geodatabase was developed by extracting and compiling information on sampling locations in Alaska and sample types with air toxics and mercury data from relevant

literature (n=84) (3.1-3.22, 4.1-4.3, 5.1-5.12, 6.1-6.15, 7.1-7.10, 8.1-8.4 9.1-9.21).

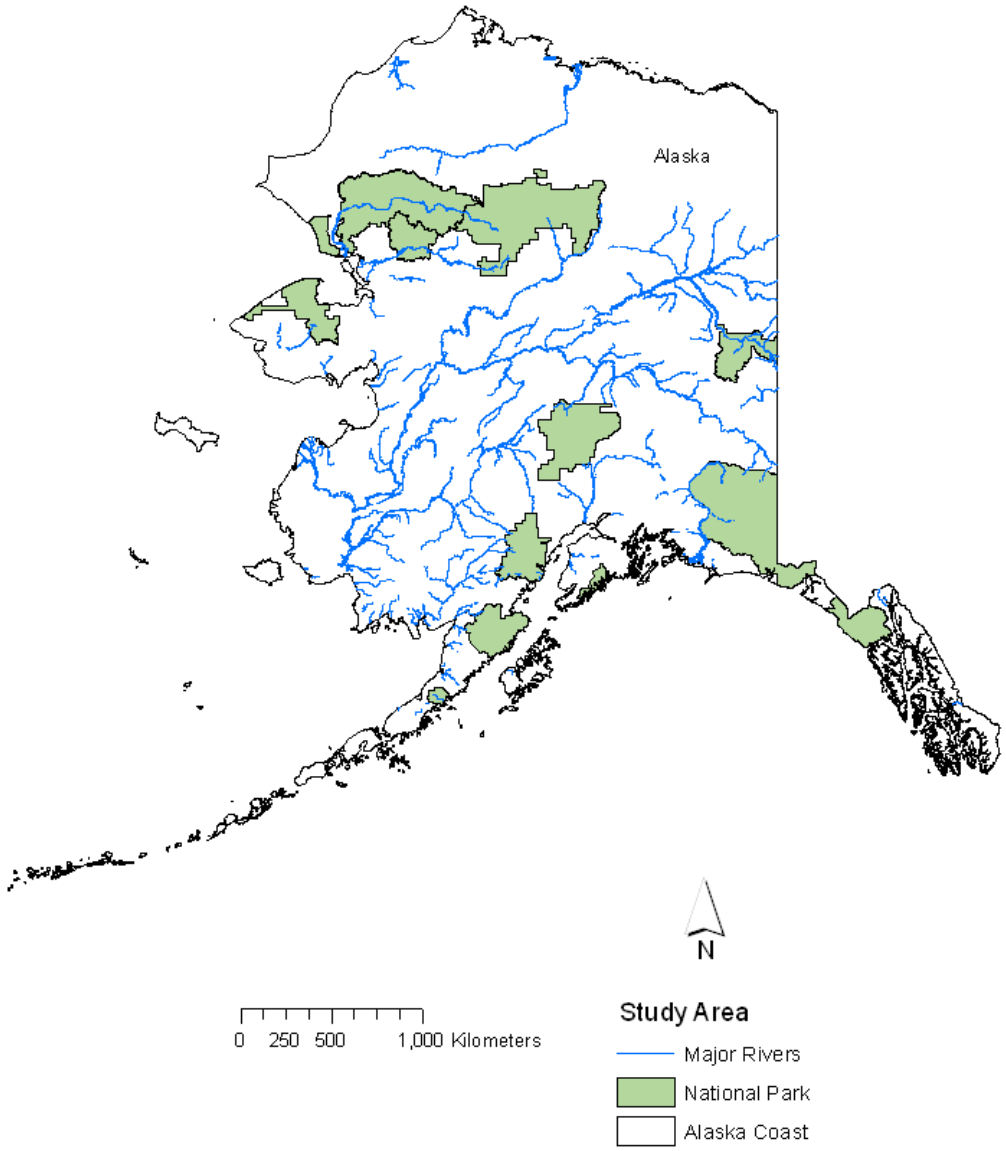

Figure 1. Map of Study Area with National Park Service boundaries.
[Data Source: National Park Service, 2014]

2. Spatial Distribution of Non-Point Contaminants

The spatial extent of sites sampled over the past three decades (1978-2012) with available data on air toxics and Hg in fish (n=179), surface water (n=27), air and sediment (n=108), avian (n=45), vegetation (n=90), wildlife (n=48), and snow (n=59) are show in Figure 2

(3.1-3.22, 4.1-4.3, 5.1-5.12, 6.1-6.15, 7.1-7.10, 8.1-8.4 9.1-9.21). When all ecosystem indicators are combined there is widespread spatial coverage of air toxics data across Alaska and the Aleutian Islands (Figure 2), particularly for NPS lands. The ecosystem indicator with the greatest spatial coverage in Alaska is fish (n=179) (Figure2). To further assess the spatial distribution of sampling locations with available air toxics data in Alaska, an ArcGIS geodatabase was created and used to develop maps for each ecosystem indicator (Figures 3-9). The geodatabase was created by extracting and compiling available data on non-point contaminants in Alaskan ecosystems from past and recent published literature. Each ecosystem indicator (media sampled) in the geodatabase has a unique shapefile containing information on site name, latitude(DD), longitude(DD), analyte, media sampled, start and end date, National Park, and literature reference. This information can be used to identify sampling, analyte, or other data gaps in existing and future research and monitoring for Alaskan park ecosystems.

The spatial distribution of non-point contaminants, including air toxics and Hg, in Alaska is dependent upon: 1) variation in atmospheric concentrations and deposition, and 2) variation in air toxics accumulation in different ecosystems (Simonich and Nanus, 2012). Ecosystem indicators that are directly linked to the atmosphere, such as air and precipitation, may be used to evaluate spatial variation in air toxics atmospheric concentrations and deposition (Simonich and Nanus, 2012). Whereas, ecosystem indicators such as annual snowpack, biota, and sediments may be used to evaluate the spatial variation in the combined effects of variation in air toxics atmospheric concentrations and deposition and the accumulation in aquatic and terrestrial ecosystems (Simonich and Nanus, 2012). However, when evaluating the spatial distribution of air toxics, it is best to minimize variation by comparing the same ecosystem

indicator (including species if applicable), collected at the same time at different sites, and air toxics measurements analyzed, preferably, in the same laboratory (Simonich and Nanus, 2012). Concentration data for non-point contaminants in Alaska is not included in Figures 2-9 but can be accessed from the associated reference included in each shapefile [3.1-3.22, 4.1-4.3, 5.1-5.12, 6.1-6.15, 7.1-7.10, 8.1-8.4 9.1-9.21].

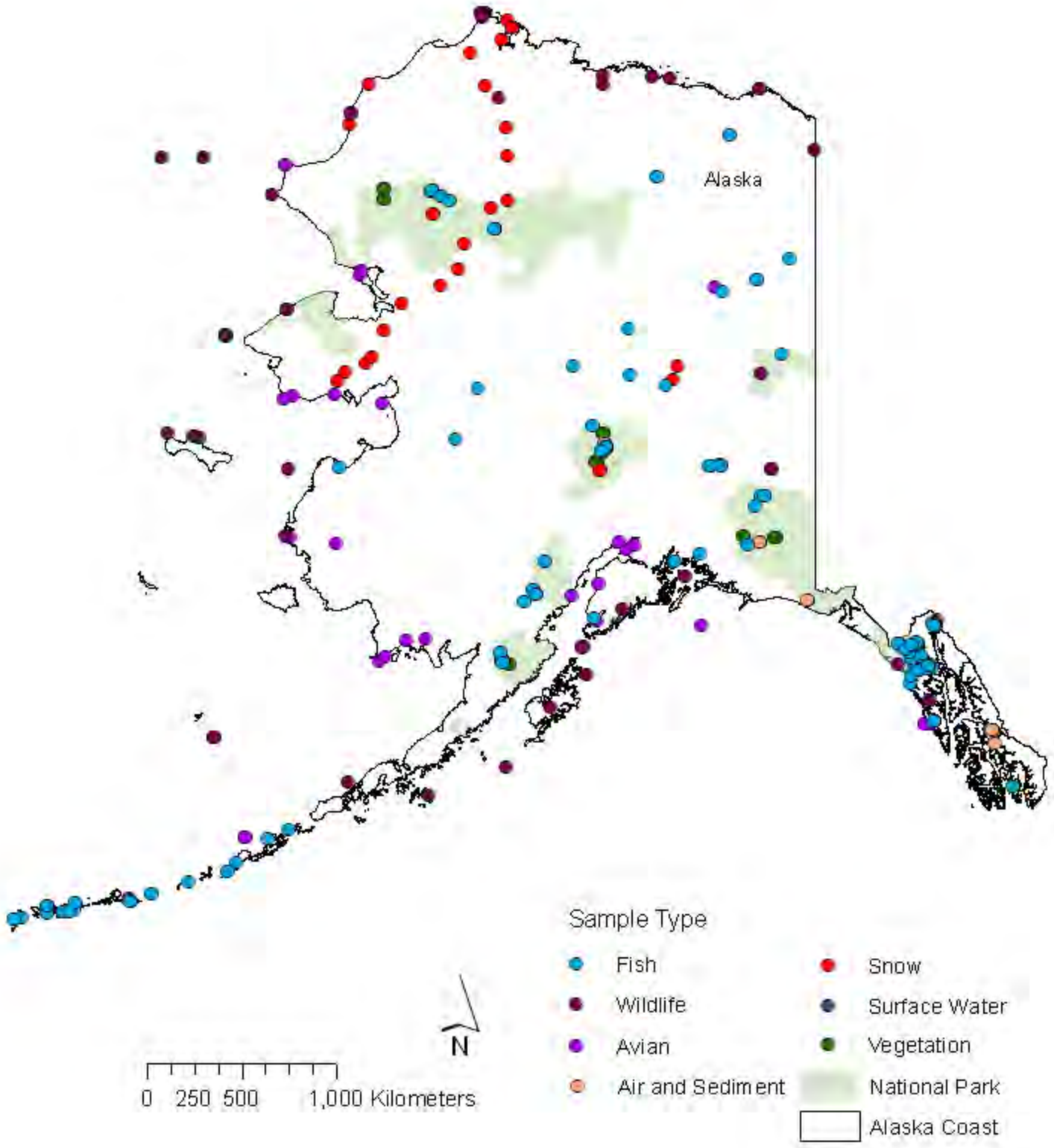

Figure 2. Sample locations and sample type for toxic air contaminants and mercury in Alaska (1978-2012) [Ref. 3.1-3.22, 4.1-4.3, 5.1-5.12, 6.1-6.15, 7.1-7.10, 8.1-8.4 9.1-9.21].

3. Fish

Non-point contaminants in Alaskan fish represent the largest number of different sampling locations (n=179) compared with other ecosystem indicators, including sites located within and outside of National Park boundaries and in the Aleutian Islands. The spatial distribution of sampling locations across Alaska on non-point contaminants in fish is relatively good due to past and on-going assessments from Federal Agencies (NPS and US Fish and Wildlife Service), State Agencies, and University researchers that contribute to the available data [3.1-3.22]. National Parks where fish were sampled include DENA, NOAT, KATM, Lake Clark, GAAR, WRST, GLBA, KLGO. The different types of marine and freshwater fish sampled in Alaska from 1992 to 2012 include Sockeye Salmon, Chinook Salmon, Grayling, Lake Trout, Pacific Cod, as well as Marine Mussels. Fish samples were analyzed for Current Use Pesticides (CUPs), Historic Use Pesticides (HUPs), Total Mercury (Hg), Polychlorinated Biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs), Dichlorodiphenyltrichloroethane (DDT), Polychlorinated dibenzofurans (PCDFs), Polychlorinated dibenzodioxins (PCDDs), combustion byproduct, metals, and emerging contaminants [3.1-3.22].

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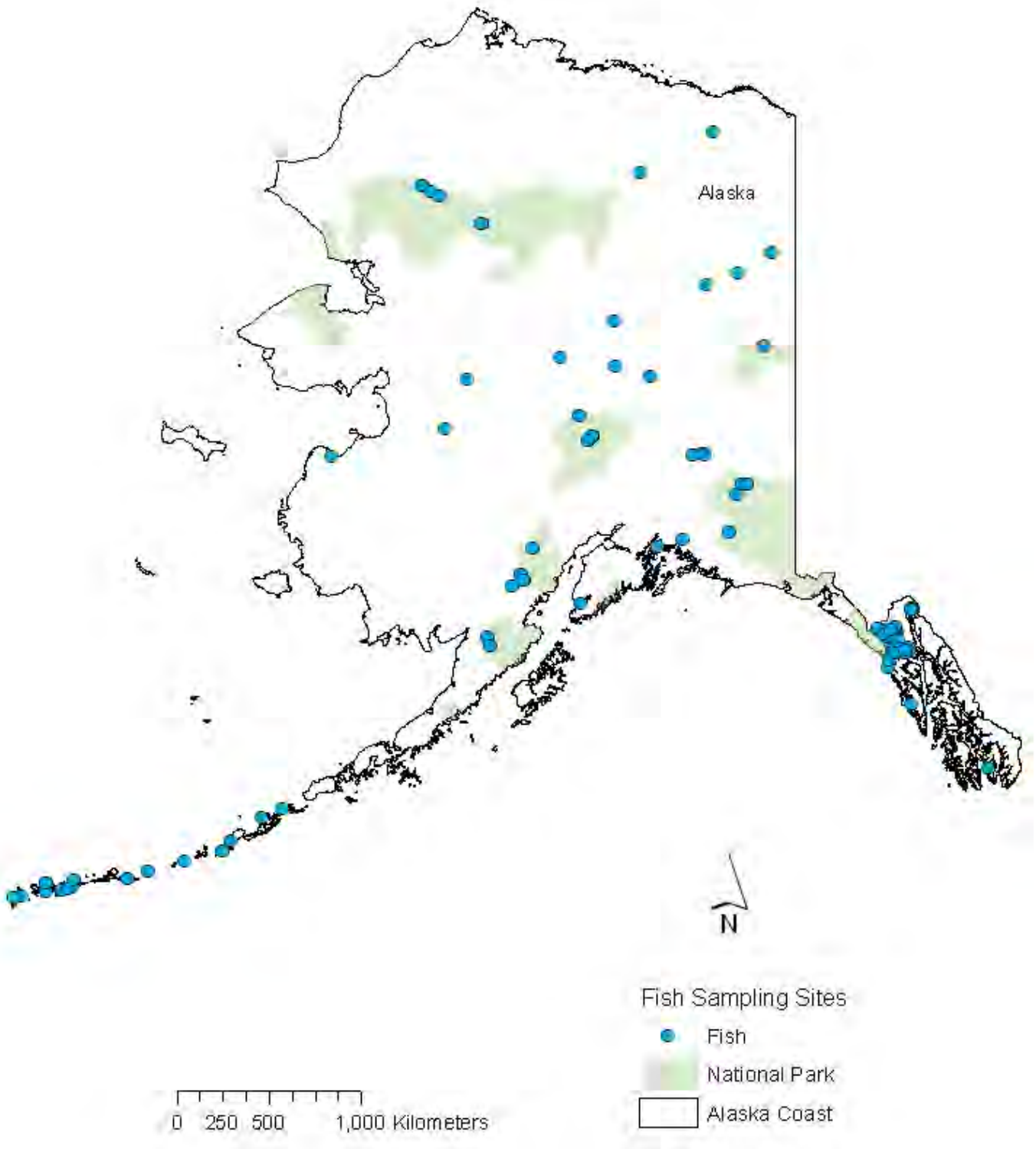

Figure 3. Fish sampling sites in Alaska (n=179) (1992-2009) [Ref 3.1 – 3.22].

4. Surface Water

Surface water assessments for non-point contaminants, including air toxics and mercury, are rare in Alaska. Surface water sampling locations with available air toxics are primarily located within National Parks (n=27), and samples were collected between 2002 and 2007 (Figure 4) (4.1-4.3). Over 75% of the 27 surface water sampling sites are located in DENA, NOAT, GAAR, GLBA (Figure 4). Surface water data collected at these sites were analyzed for airborne contaminants including CUPs, HUPs, combustion byproduct, metals, and Hg (4.1-4.3). Measuring air toxics in surface waters of Alaska has not been a priority because of low concentrations due to low water solubility and temporal variability, as well as high detection limits (Simonich and Nanus, 2012).

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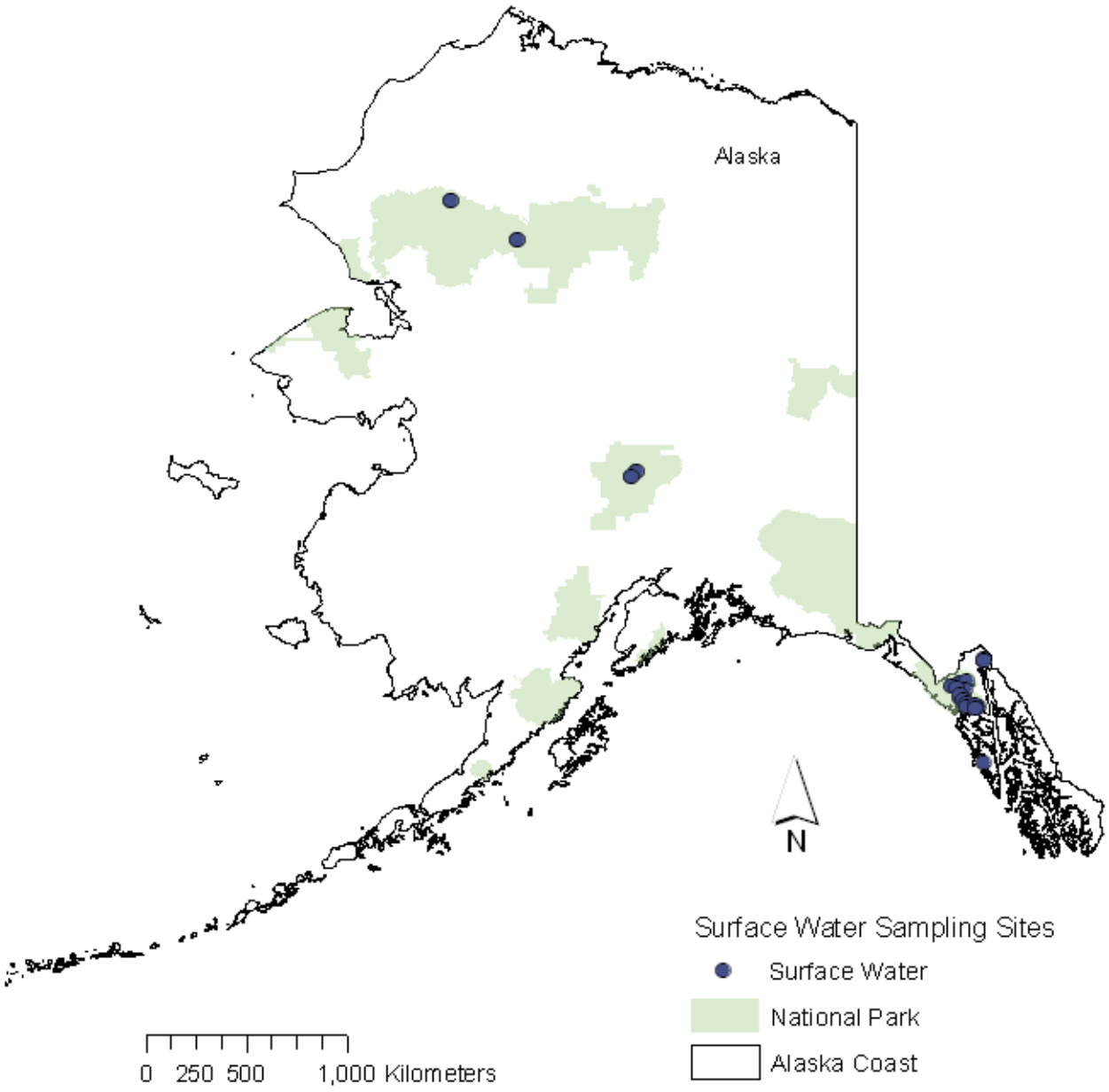

Figure 4. Surface Water Sampling Sites in Alaska (n=27) (2002-2007) [Ref. 4.1-4.3].

5. Snow

Available data on air toxics in snow from 1979 to 2007 includes NPS sites in DENA, GAAR, NOAT and additional sampling locations in Northern and Northwestern Alaska (Figure 5) [5.1- 5.12]. Historical data show that snow samples were collected and analyzed for toxic contaminants including SOCs-CUPs, HUPs, PCBs, DDT, PAHs, combustion byproducts, metals, and Hg [5.1-5.12]. Northwestern Alaska has a relatively good spatial distribution of sampling locations for airborne contaminants in snow, but sites are not well distributed in Southern and Central Alaska likely due to winter and spring access issues.

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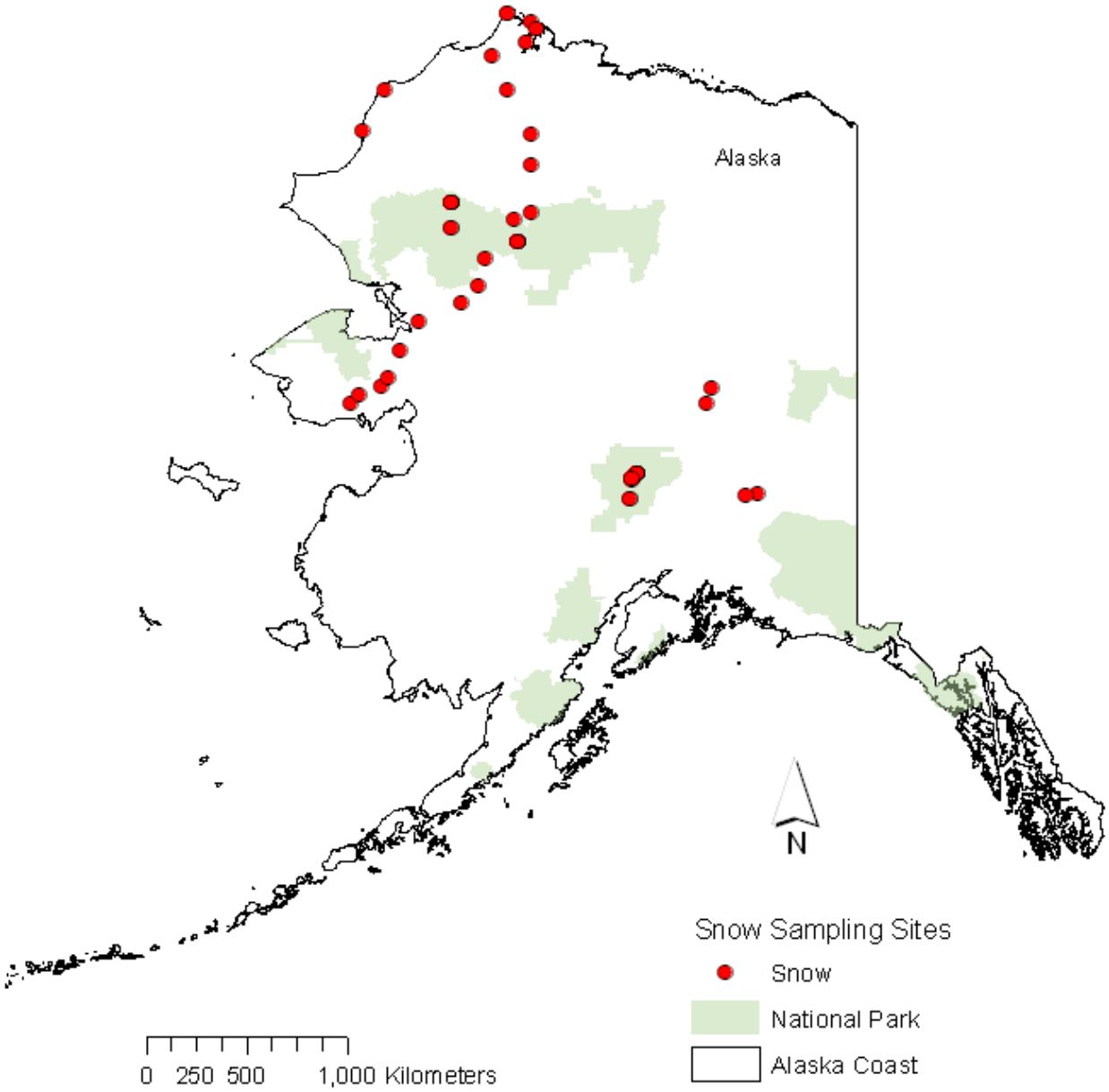

Figure 5. Snow Sampling Sites in Alaska (n=59) (1979-2007) [Ref. 5.1-5.12].

6. Air and Sediment

Over 70% of the sites sampled for non-point contaminants in air and sediments (n=108) from 1990-2008 are located within National Park boundaries, including GLBA, DENA, NOAT, GAAR, WRST, KATM, SITK, and KLGO (Figure 6) (6.1-6.15). Toxic contaminants and Hg sampled in air in Alaska were collected from active and passive air monitoring sites. Eight air assessments and nine sediment assessments that have available data on airborne contaminants were conducted in Alaska over the past 3 decades, with a larger number of sampling locations in Southern Alaska (Figure 6). Air and sediment samples were analyzed for multiple contaminants including CUPs, HUPs, PCBs, DDT, PAHs, combustion byproduct, metals, and Hg.

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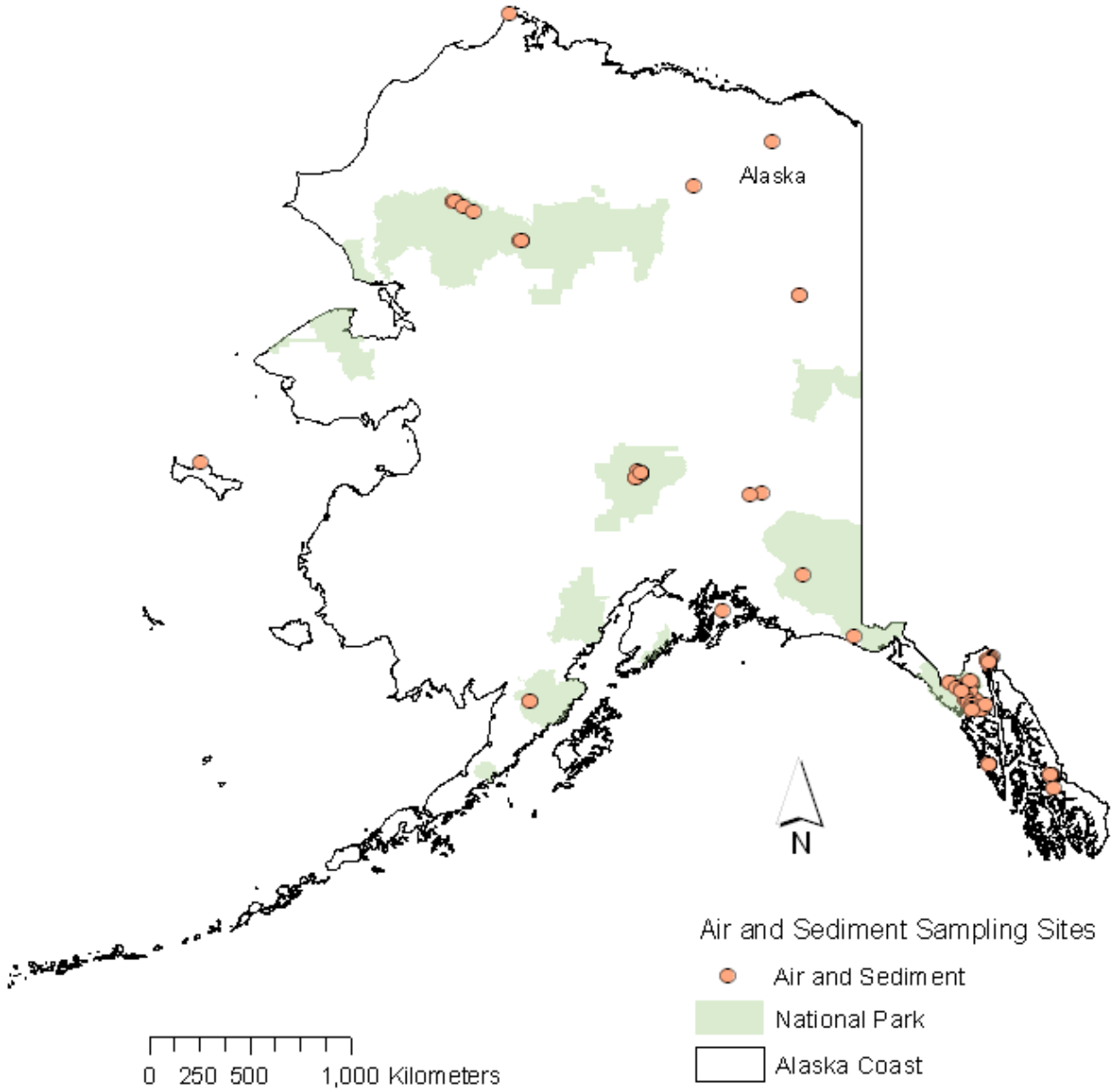

Figure 6. Air and Sediment Sampling Sites in Alaska (n=108) (1991-2005) [Ref. 6.1-6.15].

7. Avian

Available data on predatory birds and other avian indicators in Alaska represent a widespread spatial distribution of sampling locations, particularly along the coast and the Aleutian islands (Figure 7, n=45). The types of eggs sampled for airborne contaminants during past studies include Murre eggs, Seabird Eggs, Thick-Billed Murre Eggs, Glaucous-Winged Gull Eggs, and Bald Eagle Eggs. Other avian species sampled include birds, seabirds, Eider Species, Lesser Scaup, Bald Eagles, and Glaucous-Winged Gull. Avian samples were collected in past assessments conducted between 1991 and 2005, and were analyzed for airborne contaminants including PCBs, DDT, PCDDs, PCDFs, HCBs, DDE, Hg, and heavy metals.

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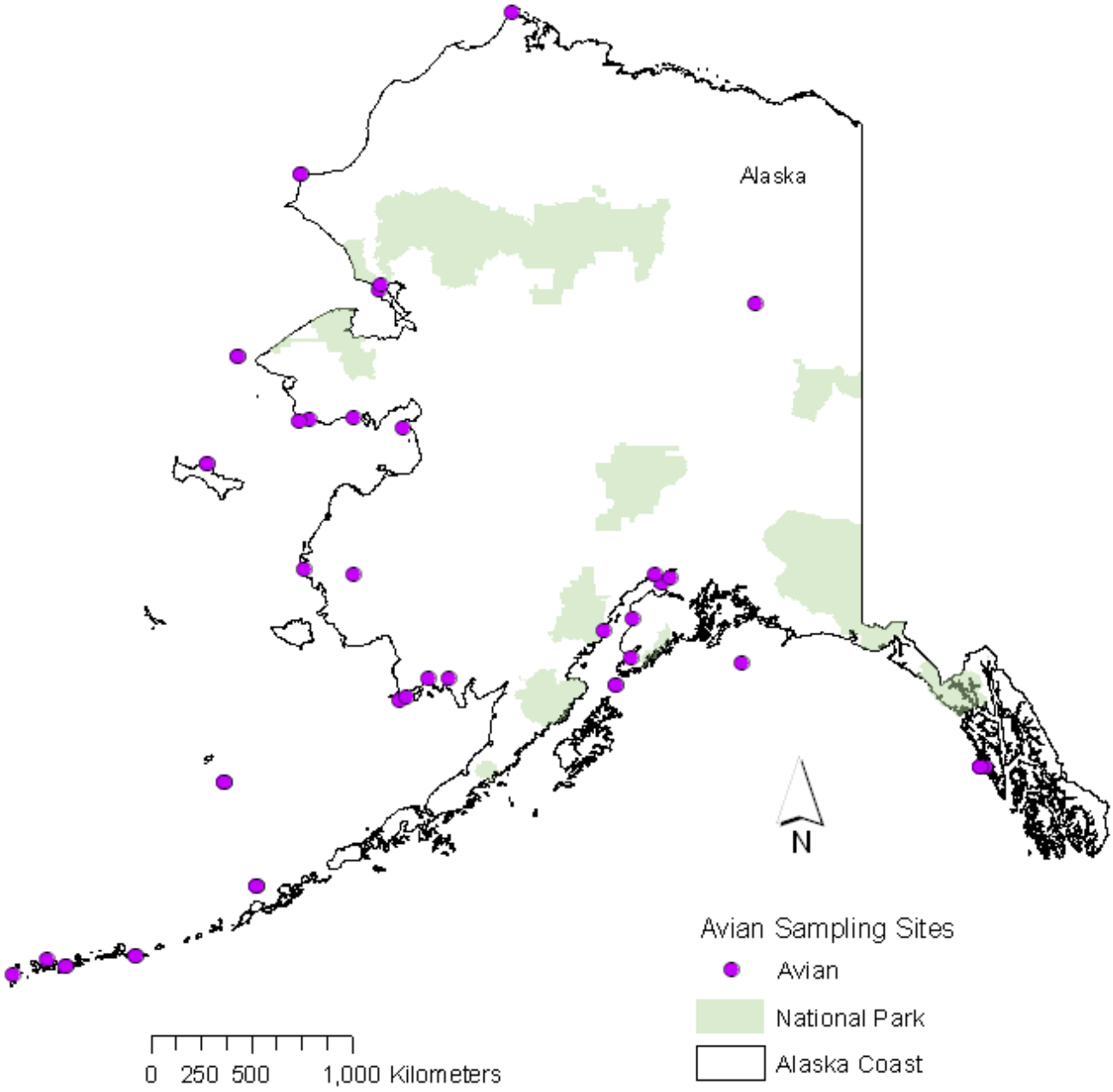

Figure 7. Avian Sampling Sites in Alaska (n=45) (1991-2005) [7.1-7.10].

8. Vegetation

The spatial distribution of air toxics and total Hg sampled in vegetation in Alaska is shown in Figure 8. Lichen and conifer needle samples were collected during the Western Airborne Contaminant Assessment Project (WACAP) and other past studies conducted between 2002 and 2007 in Alaskan National Parks including DENA, GAAR, KATM, NOAT, STLE, WRST [8.1-8.4], with several sites located outside of Park boundaries in Southern Alaska. Historical data on lichen and conifer needles are available for CUPs, HUPs, PAHs, IUCs, combustion byproduct, and metals [8.1-8.4].

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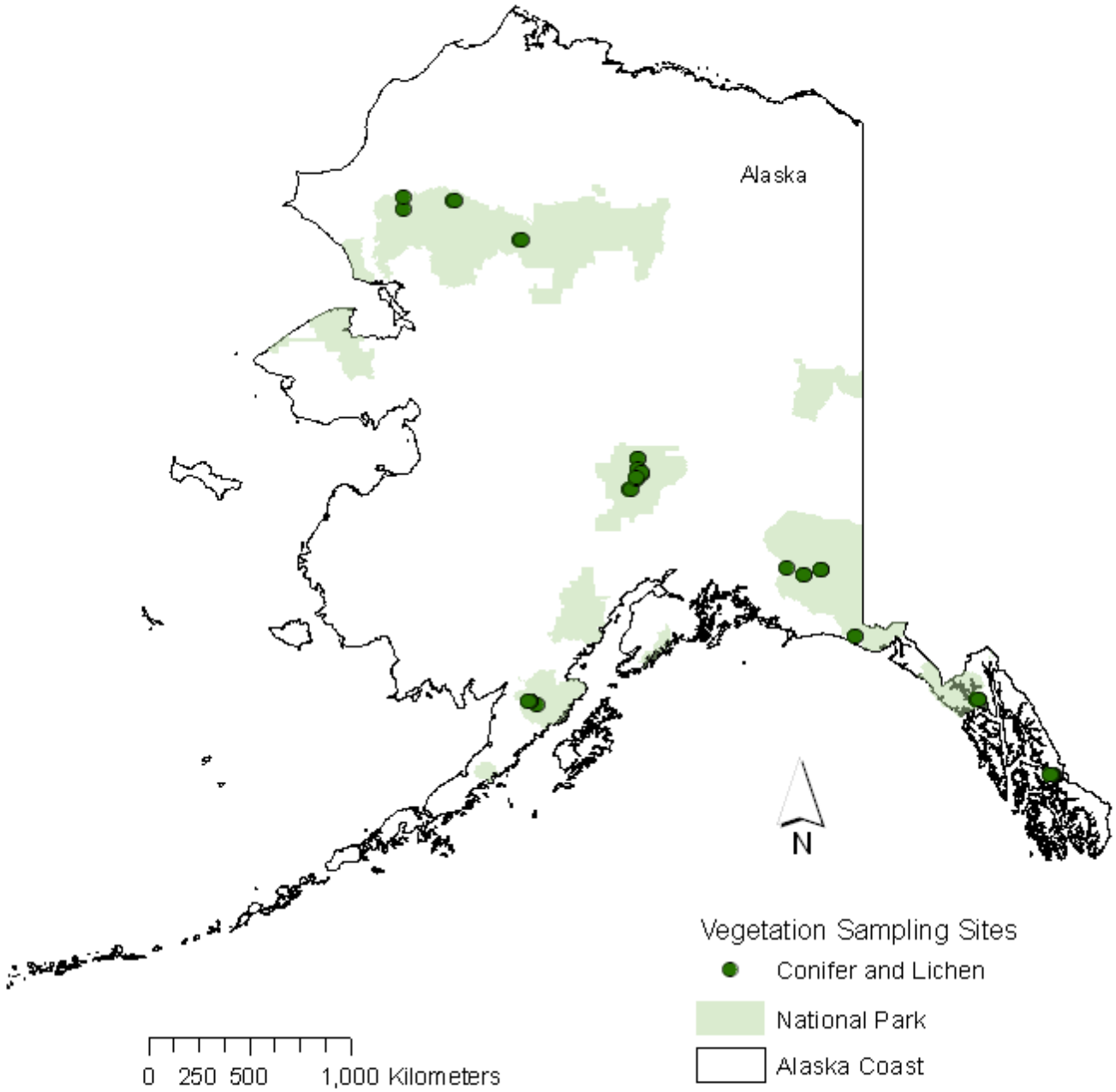

Figure 8. Vegetation Sampling Sites in Alaska (n=90) (2002-2007) [Ref. 8.1–8.4].

9. Wildlife

Spatial data was extracted from the relevant literature on non-point contaminants in different wildlife and is shown in Figure 9 [9.1-9.21]. There is a widespread spatial distribution of wildlife sampling locations including National Parks, Aleutian Islands, Alaskan coast and other locations. Ecosystem indicators include artic fox, seals, whales, moose, polar bears, sea otters, sled dogs, and sea lions [9.1-9.21]. Samples were collected from 1976 to 2008 and were analyzed for a range of air toxic contaminants including organochlorine contaminants, PCBs, PBDEs, PCDDs, DDT, PFOS, Flame retardents, Hg, and metals [9.1-9.21].

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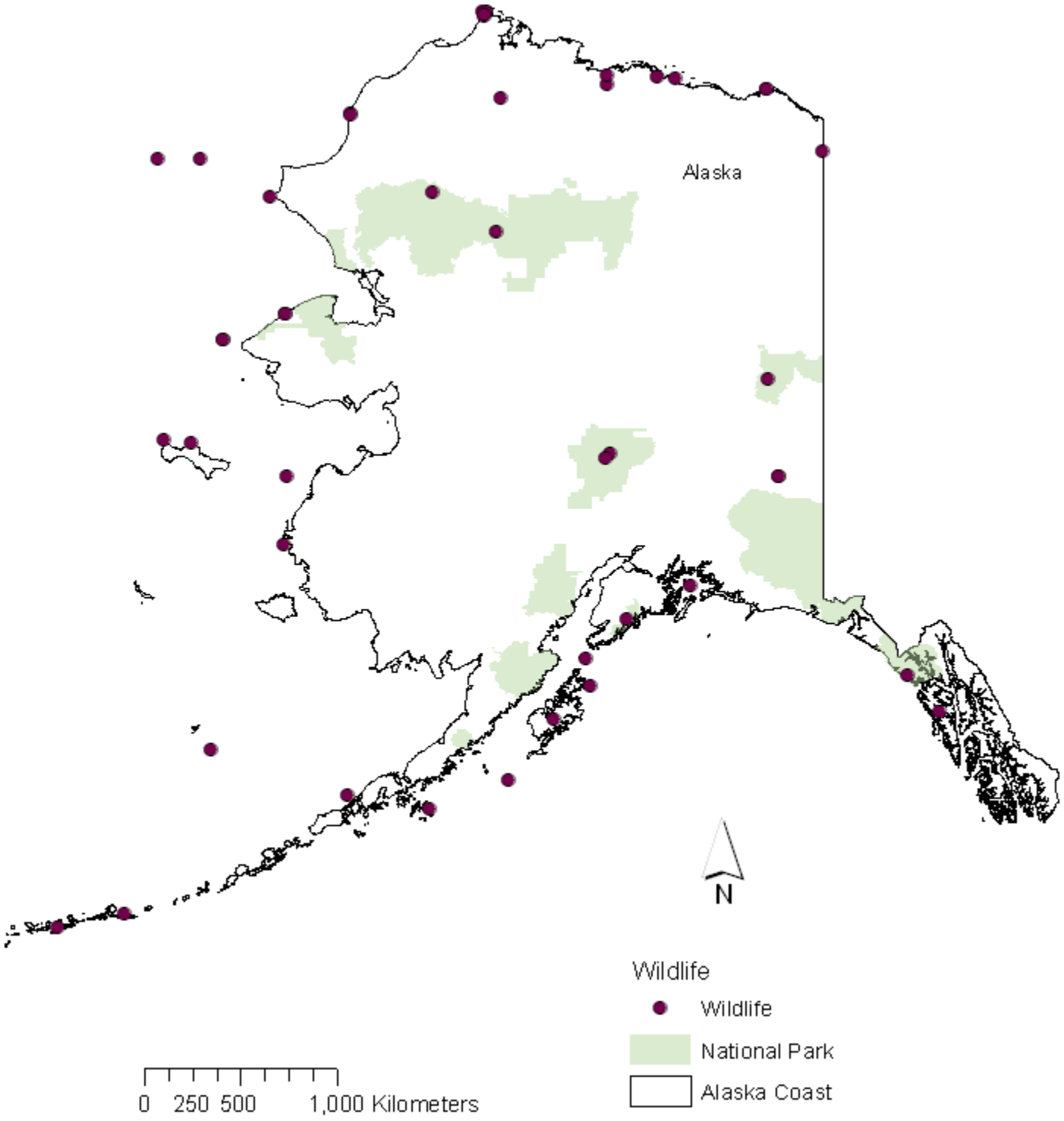

Figure 9. Wildlife Sampling Sites in Alaska (n=48) (1976-2008) [Ref. 9.1-9.21].

Additional References

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