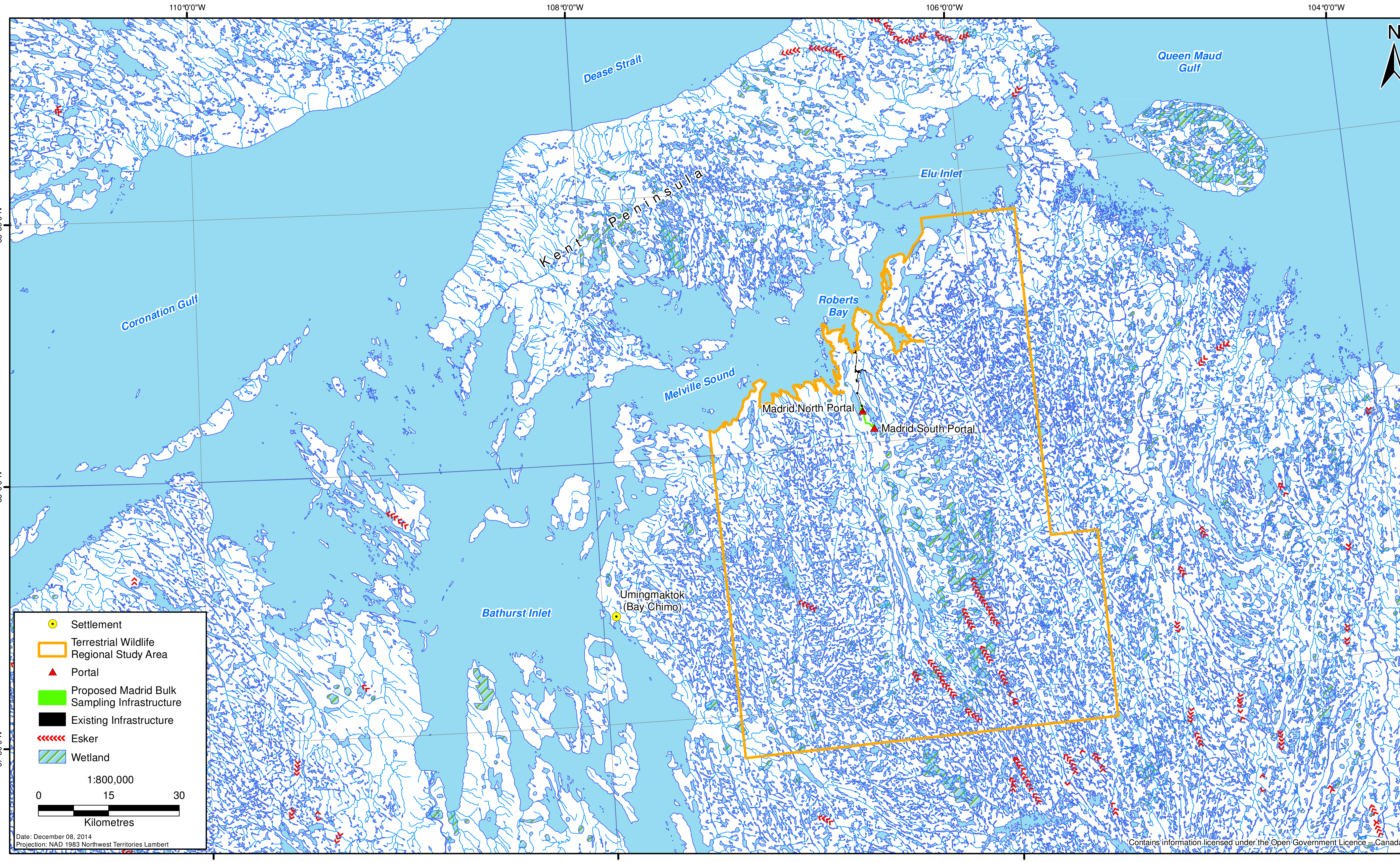
Figure 3.2-1
Wildlife Mitigation and Monitoring Program Area



Baseline bird information has also been collected in the Hope Bay Belt area from 1995 to 2013. As with other wildlife species, annual monitoring of birds has been conducted since 2006 as part of the WMMP. Surveys conducted for bird species have included point counts and prism plots for terrestrial breeding birds (shorebirds, passerines, and game birds); aerial surveys for raptors, waterbirds (waterfowl, gulls), and seabirds; as well as ground nesting surveys for seabirds.

Inuit Traditional Knowledge is also available for the general region from the following sources: Thorpe et al. (2002), Keith et al. (2005).

3.2.1 Ungulates

Results from the baseline studies and WMMP monitoring have identified two ungulate species in the RSA: Barren Ground Caribou (Ahiak and Dolphin-Union herds) and Muskoxen.

3.2.1.1 Barren Ground Caribou

Barren ground Caribou (a species of Special Concern) is a keystone species in the Arctic, both biologically and culturally (COSEWIC 2007, 2014). Caribou are a main prey item of Grizzly bears, wolves, Wolverines and foxes, and can alter the landscape. Historically, the Inuit have relied on Caribou for food and clothing. Three herds have historically been identified in the Hope Bay Belt area, notably the Bathurst, Ahiak, and Dolphin-Union herds.

Survey results during the period of 1996 to 2011 suggest that Ahiak Caribou used portions of the RSA for calving and post-calving during the late 1990's, reducing their use of the area by 2003. Collar data suggest that the calving range of the Ahiak herd has moved east and out of the RSA during this period. During the late 1990's, when spring (northern) and winter surveys were conducted, Caribou were found to use the RSA, likely Dolphin-Union Caribou. These spring and winter surveys were discontinued in the early 2000's. Spring surveys were again conducted between 2008 to 2010, and 2011 and Caribou use of the area during this period appears consistent with that observed in the late 1990's. A re-analysis of the post-calving Caribou data from 1996 and 2005 was conducted in 2010 to determine whether a zone of influence (ZOI) could be detected with either count or presence-absence data. No consistent ZOI was found, and it was determined that Caribou numbers from recent years (2006 to 2012) are too low to detect a ZOI during the post-calving period, if one exists. As a result, 2011 was the last year of aerial surveys for Caribou. In their place, TMAC plans to contribute to Government of the Northwest Territories Department of Environment (GN-DOE) regional Caribou monitoring programs and utilize wildlife cameras to monitor wildlife movements near Hope Bay operations, including the proposed Madrid Advanced Exploration Program bulk sample sites.

3.2.1.2 Muskoxen

Muskoxen are observed in the RSA throughout the year, but numbers between years and seasons are highly variable. Based on historical surveys and incidental observations, muskoxen appear to be more common in the RSA during summer than during winter. Muskox are not a VEC, but were counted during aerial transect surveys for Caribou. In most years, both the proportion of groups with calves and the calf:adult ratio is low. The cause of this low calf:adult ratio is unknown. In 2012, however, a group of 20 young was recorded in a herd of approximately 50 animals. As with Caribou, 2011 was the last year of aerial surveys for Muskox. Moving forward, TMAC will utilize wildlife cameras to monitor wildlife movements near Hope Bay operations, including the proposed Madrid Advanced Exploration Program bulk sample sites.

3.2.2 Carnivores

Results from the baseline studies and WMMP monitoring have identified five carnivore species in the RSA: Grizzly Bear, Wolverine, Wolf (*Canis lupus*), Arctic Fox (*Vulpes lagopus*), and Red Fox (*Vulpes vulpes*).

3.2.2.1 Grizzly Bears

Grizzly bears are a species of Special Concern (COSEWIC 2002) and are classified as Sensitive in Nunavut (COSEWIC 2005). Approximately 800 grizzly bears are found in the West Kitikmeot region at low densities (COSEWIC 2002). Grizzly bears are vulnerable to decline from increased adult mortality (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Boutin 2003; McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003; Meteorological Services of Canada (MSC) 2004). They also have low ecological resiliency, are sensitive to human activity, and are frequently displaced by industrial developments (Weaver, Paquet, and Ruggiero 1996; Ross 2002). Grizzly bears are regularly observed throughout the Hope Bay Belt area, and in 2009 at least eight individual Grizzly bears were identified in the northern Belt. Between 2005 and 2008, habitat use by Grizzly bears at various distances from the Project footprint was quantified as the proportion of riparian vegetation plots which had been used by Grizzly bears in each year. This study was discontinued due to safety concerns and replaced in 2010 with a more intensive one year-long assessment of Grizzly Bear population and distribution using a DNA hair capture study. Grizzly Bear DNA studies confirmed that this coastal system in northern Nunavut is highly productive for grizzly bears. Although it was not possible to estimate Grizzly Bear density because the study area does not represent a geographically closed population, results suggest that approximately 8 to 11 individual grizzly bears may be detected for every 1,000 km^2. Densities in western Nunavut are approximately 7 bears/1,000 km^2 (M. Dumond, GN-DOE, pers. comm.).

3.2.2.2 Wolverine

Wolverine populations in the central Arctic are stable (COSEWIC 2003) and classified as Secure in Nunavut (CESCC 2005), while the western Canadian population (which includes parts of Nunavut) is listed as a species of Special Concern (COSEWIC 2003). Wolverines use large home ranges and populations are generally of low density in the central Arctic (Mulders 2000). Wolverines use reproductive dens from February through April (Magoun and Copeland 1998). Food availability is the driving factor influencing movement patterns and home range selection by Wolverines (Banci 1994).

Wolverines have been observed in the HB Belt area during aerial surveys and incidental observations. Between 2005 and 2008, Wolverine use of the Hope Bay Belt area was examined through a study of snow tracks across the study area. Wolverine DNA studies conducted in 2010 and 2011 detected a total of eight males and three females in the Hope Bay Belt area. Sample sizes and recapture rates were too small to conduct any population level analyses.

3.2.2.3 Wolves and Foxes

Wolves and foxes are classified as Secure in Nunavut (CESCC 2005); they are found throughout the Hope Bay Belt area and den in the area. Satellite-collar data indicate that wolves in the central Arctic migrate over large areas in the fall, winter and early spring, following the migratory Caribou herds (Walton et al. 2001). Wolves occupy smaller home ranges around the den during parturition and pup rearing (May to September; Walton et al. 2001). Wolf and fox dens are preferentially located in eskers, which can be limiting (McLoughlin et al. 2004). Carnivore den surveys located three wolf dens in the Hope Bay Belt area, with only one den that was active in 2009. Productivity of this den was not determined.

3.2.3 Birds

A number of bird species, including upland breeding birds, waterbirds, and raptors, have been identified in the Hope Bay Project area through baseline and Wildlife Mitigation and Monitoring Program WMMP studies, as well as incidental sightings. Results from previous baseline and monitoring studies have identified 25 species of upland breeding bird, 28 species of waterbirds, and 9 species of raptors to be present in the RSA (Table 3.2-1).

Table 3.2-1. Incidental Observations of Birds in the Hope Bay Belt Area, 1996 to 2013

Species	Type	Total	Species	Type	Total	Species	Type	Total
Canada Goose	V	>1,522	Long-tailed Duck	V	>100	Savannah Sparrow	V	>75
	N	9		N	>2		N	1
Snow Goose	V	>787	Gadwall	V	10	American Tree Sparrow	V	>32
Greater White-fronted Goose	V	>705	Glaucous Gull	V	>55		N	2
Brant Goose	V	1	Herring Gull	V	>17	White-crowned Sparrow	V	>30
Tundra Swan	V	>200	Common Raven	V	>99	Horned Lark	N	2
	N	1		N	2	Snow Bunting	V	>9
Sandhill Crane	V	>151	Rough-legged Hawk	V	>69	Horned Lark	V	>15
	N	>1		N	1	American Pipit	N	2
Pacific Loon	V	>253	Northern Harrier	V	2	Common Redpoll	V	>15
Common Loon	V	6	Golden Eagle	V	>65	American Pipit	V	>5
	N	1	Bald Eagle	V	3	Hoary Redpoll	V	58
Red-throated Loon	V	>29	Peregrine Falcon	V	>29	Lapland Longspur	V	>42
	N	3	Gyrfalcon	V	7		N	2
Yellow-billed Loon	V	4	Short-eared Owl	V	44	Gray-cheeked Thrush	V	yes
King Eider	V	>8	Snowy Owl	V	7	Semipalmated Sandpiper	V	>6
Common Eider	V	5		N	1	American Golden Plover	V	5
Red-breasted Merganser	V	>65	Arctic Tern	V	>9	Least Sandpiper	V	>11
Common Merganser	V	1	Parasitic Jaeger	V	>4	Baird's Sandpiper	V	2
Greater Scaup	V	98	Long-tailed Jaeger	V	>1	Pectoral Sandpiper	V	2
Lesser Scaup	V	9	Willow Ptarmigan	V	>98	Wilson's Snipe	V	12
American Green-winged Teal	V	16	Rock Ptarmigan	V	13	Red-necked Phalarope	V	>9
Northern Pintail	V	>210	Harris' Sparrow	V	1	Semipalmated Plover	V	2

Notes:
V = Visual observation
N = Nest observation
Sightings noted as "yes" were recorded as being "several".

Birds in Nunavut are protected under various forms of federal and territorial legislation. All upland breeding birds and waterbirds identified at Hope Bay through baseline and monitoring studies, with the exception of ptarmigan species, are considered "migratory birds" and are protected under the *Migratory Bird Convention Act* (1994). Raptors and Common Raven are not considered migratory birds under *the Migratory Bird Convention Act*. However, all bird species, including raptors, are protected under the Nunavut *Wildlife Act* (2003).

Several species encountered during baseline and monitoring studies in the Hope Bay Belt are of conservation concern at the federal and territorial level. Of the 62 species identified, two are listed under the federal *Species at Risk Act* (SARA; 2002). Peregrine Falcon and Short-eared Owl are listed as species of Special Concern under Schedule 1 of SARA. Several others are listed as Sensitive in Nunavut by the Canadian Endangered Species Conservation Council (CESCC 2010), including American Golden-plover, American Pipit, American Tree Sparrow, Arctic Tern, Common Eider, Glaucous Gull, Golden Eagle, Gyrfalcon, Harris' Sparrow, Hoary Redpoll, King Eider, Least Sandpiper, Long-tailed Duck, Red-necked Phalarope, and Rough-legged Hawk, Semipalmated Sandpiper, Snow Bunting, and White-crowned Sparrow.

3.2.3.1 Upland Breeding Birds

Upland breeding birds were surveyed in 2012 using the PRISM method, and the same six ubiquitous passerine species accounted for over 86% of detections. Shorebirds and ptarmigan were detected significantly less often than songbirds. When averaged across plots, results (numbers of species, adults, breeding territories, and nests detected) were similar for plots located within 1 km of Hope Bay Belt infrastructure and those farther away in both 2011 and 2012. Compared to upland habitats, lowland and mixed habitats supported on average one more species of upland breeding birds, and about four more breeding territories per 12 hectares of tundra. Active or recently active nests indicate breeding success is occurring within 1 km of Hope Bay Belt infrastructure.

3.2.3.2 Raptors

Raptors are relatively common in the northern Hope Bay Belt. Nest productivity and success, the number of eggs per occupied nest, and the proportion of occupied nests that successfully raised chicks, is highly variable between years. Results from 2012 indicate that raptor breeding success across the northern Hope Bay Belt was low for rough-legged hawks, but within the normal range for all species combined. There were four occupied raptor nests within 1 km of Doris North facilities in 2012, two of which were successful. In 2011, only one of ten occupied raptor nests within 1 km of Hope Bay Belt facilities was successful.

3.3 AQUATIC ECOSYSTEMS

Aquatic systems comprise organisms from multiple trophic levels, and include periphyton, phytoplankton, zooplankton, benthic macroinvertebrates (also known as benthos), and fish (highest trophic level). Periphyton, algae that grows on the surfaces of rocks or larger plants (along with bacteria and protozoa that live with the algae), are an important food item for many benthic invertebrates, which are in turn the main food source for fish in streams and rivers. Due to their short life cycles, periphyton are among the first organisms to respond to environmental stressors, and tend to exhibit taxon-specific changes to stressors, making them good indicators of current environmental conditions. Phytoplankton (free-floating autotrophic algae) also play an important role in many aquatic systems as primary producers and prey for higher trophic levels. Phytoplankton biomass and taxonomic composition can be affected by environmental changes and have been widely used to examine effects of nutrient and metal pollution. Zooplankton, the heterotrophic component of aquatic plankton, provide an important link to the aquatic foodweb, consuming phytoplankton and providing food for may fish species. Zooplankton can be sensitive to changes in water quality and have short life-cycles, rendering them good indicators of environmental change. Benthos (greater than 0.5 mm in size) are also good indicators of environmental change because these organisms are in close contact with the sediments and feed on algae, bacteria, and detritus. Benthos also tends to be less mobile than fish, making them good indicators of local conditions. In addition to their potential use as indicator species, benthic organisms are important food sources for fish, particularly in streams. These various components have been studied in the Madrid Area and are described in the sections that follow.

3.3.1 Plankton and Periphyton

Comprehensive phytoplankton, zooplankton, and periphyton baseline sampling programs were conducted in the Madrid Area in 2009 (Rescan 2010f, 2011g). Additional baseline data are available for some lakes from 1996, 1997, 2007, and 2010 and for some streams from 1996 and 1997 (Table 1.1-1; Figure 2.5-7).

3.3.1.1 Phytoplankton

In 2009, lake phytoplankton biomass (as indexed by the concentration of chlorophyl *a* in ug chl *a*/L) and density (number of cells/mL) varied among lakes in the Madrid Area. Biomass levels ranged from 0.3 to 5.6 µg chl *a*/L, and density ranged from 69 to 4,980 cells/mL. Biomass and density tended to be highest in Ogama Lake and lowest in Windy, P.O., and Patch lakes.

During the summer, lakes with the highest levels of phytoplankton biomass and density were dominated by cyanobacteria (blue-green algae). Cyanobacteria, largely the nitrogen-fixing species *Aphanizomenon flosaquae*, made up 84% of the phytoplankton assemblage in Ogama Lake. In lakes with low phytoplankton biomass and density, diatoms, chlorophytes (green algae), and cryptophytes were abundant, and cyanobacteria generally made up much smaller fractions of the phytoplankton assemblages. Phytoplankton richness ranged from 11 to 20 taxa/sample, and Simpson’s diversity index ranged from 0.4 to 0.87 across all sites, seasons, and years. Phytoplankton diversity was lowest in the cyanobacteria-dominated Ogama Lake. Phytoplankton diversity and richness generally followed similar trends.

Patterns in phytoplankton density and community composition were consistent with those observed in previous years.

3.3.1.2 Zooplankton

In 2009, mean zooplankton density was highly variable among lakes in the Madrid area. Imniagut Lake had the highest zooplankton density of the lakes surveyed (255,000 organisms/m^3). The lowest density was observed at Windy Lake (2,210 organisms/m^3). Lake zooplankton assemblages were composed mainly of rotifers, copepods, and cladocerans. Common zooplankton species encountered in the area included the rotifers *Kellicottia longispina* and *Keratella quadrata* and the cladoceran *Bosmina longirostris*. Zooplankton genera richness ranged from 3 genera/sample in Windy and Glenn lakes to 12 genera/sample in Lake Wolverine. Simpson’s diversity indices ranged from 0.14 in Glenn Lake to 0.72 in Patch Lake.

Patterns in zooplankton density and community composition were consistent with those observed in previous years.

3.3.1.3 Periphyton

In 2009, periphyton biomass (as chlorophyll *a*) in the Madrid area ranged from 251 µg chl *a*/m^2 in Patch Outflow to 2,500 µg chl *a*/m^2 in Ogama Outflow. Periphyton density ranged from 70,200 cells/m^2 in P.O. Outflow to 427,000 cells/cm^2 in Ogama Outflow. Stream periphyton assemblages were almost exclusively