Protocol Development Summary

Protocol: Coastal Lagoon Communities and Ecosystems [short name: Lagoons]

Parks Where Protocol will be Implemented:
Cape Krusenstern National Monument (CAKR)

Justification/Issues being addressed:
The total shoreline in the ARCN, including bay and barrier island ecosystems, is approximately 450 km (250 miles). This is the third largest block of coastline that the NPS manages. Cape Krusenstern National Monument, located along this coastline, contains five coastal lagoons, Akulaaq, Imik, Kotlik, Krusenstern, and Sisualik. These lagoons are likely to be essential fish nurseries, over-wintering habitats, and major feeding locations along coastal bird migration routes (ARRT 2001). The lagoons provide critical habitat for subsistence resources, mainly whitefish (Uhl and Uhl 1977, Georgette and Shiedt 2005). Residents from nearby Kivalina, Noatak, and Kotzebue utilize the Monument for subsistence activities, one of which is harvesting whitefish from the lagoons (Reynolds *et al.* 2005). One of the overarching objectives of the ARCN is to better understand the interaction between subsistence activities and ecosystem dynamics. To capture this interaction, we will incorporate the simultaneous collection of both social science and natural science data. These data will allow for a comparative and more comprehensive understanding of CAKR lagoon ecosystems. Little data exist on the five coastal lagoons in CAKR which makes management of these lagoons difficult, at best. Key reasons for monitoring the coastal lagoons in CAKR include: (1) provide habitat for subsistence resources, (2) minimal baseline data exist for the lagoons, (3) identified in the Alaska Coastal Management Program, (4) identified in the General Management Plan for CAKR as a management objective, (5) increase understanding of shallow, arctic, coastal lagoons and provide information about these under-studied systems, and (6) provide insight into climate change in the Arctic.

Specific Monitoring Questions and Monitoring Objectives to be Addressed by the Protocol:
Some of the specific monitoring questions that will be addressed by this protocol include:

- What is the temporal variability of water quality parameters in the lagoons? Is there a relationship between water quality parameters and wind speed and direction?
- What is the temporal variability in the water level of each lagoon? Is there a relationship between water level and wind speed and direction?
- What is the annual variability of snow depth and ice thickness in the lagoons?
- What are the nutrient levels in the lagoons?
- What is the surface area of each lagoon and is it changing over time?
- What are the levels of contaminants (i.e. metals) in the sediments?
- What are the levels of contaminants (i.e. metals) found in whitefish (*Coregonus* sp.)?
- What is the species richness and relative abundance of biota in the lagoons?

- What is the annual variability of subsistence activities in the lagoons and is it changing over time? Is there a relationship between subsistence activities and ecosystem health (measured as water quality and the relative abundance of species)?

The specific monitoring objectives of the Lagoons Vital Sign are to:

1. Determine the temporal variability in water quality parameters on a semiannual basis. *Justification: These lagoons are known to provide habitat for subsistence fisheries and water quality (e.g. salinity and dissolved oxygen) can have an impact on the presence or absence of a species within the lagoons.*
2. Measure the water level, wind speed, and direction in each lagoon on a semiannual basis. *Justification: These lagoons are located along the coast which is subject to strong, westerly storms. These storms push seawater into the lagoons, which influences the water quality. Knowing how water levels change throughout the year and whether there is a correlation between water level, wind speed, and direction will provide information about water quality. These data will also provide insight about the species inhabiting the lagoons.*
3. Measure the snow depth and ice thickness in each lagoon on an annual basis. *Justification: The amount of snow covering the lagoons impacts the amount of light penetrating into the underlying water column, which influences the growth of primary production. Knowing whether or not these lagoons freeze to the bottom will give insight as to the availability of overwintering habitats.*
4. Determine nutrient levels. *Justification: Understanding the types of nutrients entering the lagoons will provide insight into the health of these systems.*
5. Measure the surface area of each lagoon. *Justification: These lagoons are located next to the shoreline so changes in their size will provide information about the coastline and how it is changing over time. These data will help evaluate the influence of global climate change on Arctic ecosystems.*
6. Identify and quantify contaminant levels in the sediment. *Justification: Knowing the levels of contaminants in the sediment will provide information about the habitat in which subsistence species are living.*
7. Identify and quantify contaminant levels in *Coregonus* sp. *Justification: The primary subsistence fishery in the lagoons is whitefish; identifying contaminants and monitoring levels throughout time will provide valuable information about the health of this subsistence fishery.*
8. Determine the species richness and measure the relative abundance of biota in the lagoons. *Justification: Understanding the types of species that inhabit these lagoons as well as how many of each species exist will allow park management decisions to be made with current, local data. Species-specific trends can also be monitored as a result of these data.*
9. Identify subsistence activity in the lagoons on an annual basis. *Justification: Changes in subsistence activity may indicate changes in the presence or absence of a species. Monitoring the importance of these lagoons in terms of subsistence activity will prove useful to the Park when making management decisions.*

Basic Approach:
There will be a three tiered approach to monitoring the coastal lagoons in CAKR. Tier 1 samples will be collected on a semiannual basis, once during ice-covered conditions and once during open water conditions. The samples collected will include: water quality parameters (temperature, dissolved oxygen, salinity, conductivity, and pH), meteorological parameters (air temperature, wind speed, and wind direction), ice thickness, and snow depth. Continuous data loggers will be deployed into the water column after ice break-up and will be retrieved at the onset of ice formation in the lagoons. Existing weather stations (Kivalina, Red Dog Mine, and Kotzebue) will be utilized to collect continuous meteorological data. Traditional Ecological Knowledge (TEK) interviews will be conducted annually during the open water sampling period as well as on an opportunistic basis. We will work collaboratively with other agencies and organizations (i.e. ADF&G, Maniilaq) during their harvest surveys if lagoon resources are part of the surveys. During the first year of sampling, TEK interviews will be open-ended and semi-directed. Structured interviews will then be conducted based on the information collected from the open-ended and semi-directed interviews. These structured interviews will then be conducted on an annual basis. Tier 2 samples will be collected every 5 years and will include: species richness and abundance, zooplankton, phytoplankton, and nutrients. Tier 3 samples will be collected every 10 years and will include: aerial photos, surface area, sediment contaminants, contaminant testing of subsistence fisheries, and genetic testing of subsistence fisheries.

All aforementioned samples in Tier 1, Tier 2, and Tier 3 will be collected during the first year that monitoring begins. This will establish a baseline and allow comparative changes to be documented throughout time. These data will provide Park managers with information to help make informed management decisions.

Existing protocols (e.g. USGS-NAWQA, EPA – EMAP, USFWS, AMAP) will be utilized to collect natural resource data, but modifications will be made to accommodate for site-specific challenges (e.g. logistics, weather, types of sampling gear, etc.). Many of these challenges have been identified (Reynolds *et al.* 2005) so exploratory research will not be needed for protocol development.

Existing protocols (e.g. EPA, ADF&G, Romney *et al.* 1986, Weller and Romney 1988, D'Andrade 1989, Johnson 1990, and Johnson and Griffith 1998) will be utilized to collect and analyze social science data. Modifications will be made to accommodate for site-specific challenges. Exploratory research will not be required for protocol development.

Principal Investigators and NPS Lead:
Principal Investigators will be Melinda Reynolds and Terry Reynolds, both East Carolina University Ph.D. Candidates. NPS Lead: Amy Larsen and Greta Burkart, both of ARCN.

Development Schedule, Budget, and Expected Interim Products:

The P.I.'s will produce a draft protocol ready for external peer review by September 30, 2008. After peer review, revision, and approval, we hope to implement the protocol in Spring 2009. We have budgeted $24,000 for protocol development in FY 2008.

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