Protocol Development Summary

Protocol: Coastal Erosion/Sedimentation/Deposition [Short Name: Coastal erosion]

Parks Where Protocol will be Implemented: BELA, CAKR

Justification/Issues being addressed:
The total shoreline in 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. Nearshore coastal waters and shoreline habitats include subtidal zones, sandy shores, barrier spits and islands, lagoons, bays and inlets, tundra bluffs, dune systems, rocky bluffs, deltas, and wetlands. These habitats are critical for bird nesting, seal haul-outs, potential denning sites, freshwater and anadromous fish, and migratory stopover sites for marine mammals and birds. As a result, the coastal zone has a long history of and is still very important for subsistence fishing, egg gathering, and hunting of waterfowl and marine mammals. Many hunting and fishing camps and travel routes associated with subsistence activities are in the coastal zone of BELA and CAKR.

Coastal change consists primarily of coastal erosion and bluff retreat, as well as less common beach accretion, deposition of sediments during extreme storms, and modification to inlets and lagoons. A particular concern is that coastal ecosystems are changing rapidly with arctic warming and other environmental stressors (Arctic Climate Impact Assessment 2005). Coastal and nearshore environments in BELA and CAKR are experiencing dramatic changes (Manley et al. 2007), with impacts on a variety of nearshore marine, terrestrial, and freshwater habitats. Coastal erosion directly impacts beach geomorphology and nearshore ecosystems. Bluff erosion causes loss of terrestrial habitat. Changes in sediment erosion and deposition can lead to capture of thaw-lake basins, migration of barrier inlets, flooding or closure of inlets, and other modifications to freshwater habitats. Release of sediment and organic carbon alters nutrient fluxes in nearshore marine and lagoon ecosystems (Jorgenson and Brown 2005). Protected by sea ice for several months each year, the fragile coastal zone may change rapidly with Arctic warming, permafrost melting, sea-level rise, lengthening of the summer sea-ice free season, and changes to storm frequency and severity (Arctic Climate Impact Assessment 2005, Rachold et al. 2005). Coastal change is one of the most observable and sensitive indicators of environmental change for the Arctic. The Coastal Erosion protocol will be linked to other protocols including Climate and Weather, Snow and Ice, Point Source Human Effects, Terrestrial Vegetation and Soils, Bird Assemblages, Stream Communities and Ecosystems, Lake Communities and Ecosystems, Lagoon Communities and Ecosystems, Surface Water Dynamics and Distribution, and Sea Ice.

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

1. What is the rate of beach erosion and deposition in CAKR and BELA?

2. What are the long term effects of coastal erosion and deposition on lagoon formation, stability, and persistence?
3. What is the effect of ice cover change and open ocean season on rates of coastal erosion and deposition?
4. Will tundra coasts experience accelerated erosion due to thermokarst formation and permafrost thawing?

Monitoring Objectives:

1. Determine long-term trends and variation of coastline accretion, erosion, and bluff retreat.
2. Detect changes in area, volume, or mass fluxes at long-term monitoring sites along the coastline.
3. Detect changes in nearshore vegetation and landcover.
4. Link coastline monitoring sites and methods with those for the sea ice, permafrost, and lagoons protocols.

Basic Approach:

Coastal erosion/accretion will be assessed primarily through remote sensing of the coastline coupled with field mapping and measurements at long-term monitoring sites along the BELA and CAKR coasts. Remote sensing methods will involve repeated acquisition (approximately every 5-10 years) of orthorectified, high-resolution base imagery and Digital Elevation Models (DEM's). High-resolution imagery (IFSAR radar imagery, Ikonos or QuickBird satellite imagery, or orthorectified aerial photography) is required for the quantification of erosion at rates of typically 0.1 to 10 m/yr. High-resolution DEM's (from IFSAR or LIDAR) are required to calculate volumetric loss or gain, as well as sediment and carbon fluxes to nearshore marine ecosystems. Standard GIS and remote sensing packages are then used to digitize the base imagery and quantify vector and raster algorithms to show erosion rates, change in erosion rate through time, areas lost and gained, volumes lost and gained, and fluxes. Spatial and temporal patterns can be related to land cover classes and other environmental variables as well as to ground surveys at repeat-measurement sites. Coastal change should be quantified approximately every five years, with additional observations during or after large storm events.

Principal Investigators and NPS Lead:

The current NPS contact for the coastal erosion protocol is Scott Miller, ARCN data manager. The principal investigators is William Manley (University of Colorado) with collaborators Leanne Lestak and Eric Parrish (University of Colorado).

Development Schedule, Budget, and Expected Interim Products:

The protocol will be developed on the following schedule:

- Fall 2005 – Fall 2008: Protocol development and baseline imagery acquired for the years…
- Fall 2008: Baseline analysis of changes in coastal erosion and accretion for the periods 1950-1980, 1980-2003, 19 -20xxxxxx completed.
- December 2008: Draft protocol ready for peer review.

- Fall 2009: Protocol finalized and implement. Estimated annual operating costs, based on protocol development is $ once every 5 years. Acquisition of new imagery is scheduled for 20xx.

Literature Cited:

Arctic Climate Impact Assessment. 2005. Impacts of a warming Arctic – Arctic climate impact Assessment Report, Cambridge University Press, New York.

Jorgenson. M.T. and J. Brown. 2005. Classification of the Alaskan Beaufort Sea Coast and estimation of carbon and sediments inputs from coastal erosion. Geo-Marine Letters (**25**): 69-80.

Manley, W.F., O.K. Mason, J.W. Jordan, D.M. Sanzone, E.G. Parrish, and L.R. Lestak. 2007. Coastal change since 1950 in the southeast Chukchi Sea, Alaska, based on GIS and field measurements: Arctic Coastal Zones at Risk, Scientific Workshop on the Impact of Global Climate Change on the Arctic Coastal Zones, Tromsø, Norway, Oct. 2007.

Rachold, R., E. A. Feliks, D. E. Atkinson, G. Cherkashov, and S. M. Solomon. 2005. Arctic Coastal Dynamics (ACD): an introduction. Geo-Marine Letters (**25**): 63-68.