Alaska Center for Climate Assessment and Policy
Project Report

Current Coastal Change Projects and Priority Information Needs in Western Alaska

By

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Photos: NOAA (left), US Fish and Wildlife Service (center), AP Tyler Rhodes (right)

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Current Coastal Change Projects and Priority Information Needs in Western Alaska

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Abstract

Research and management studies on coastal change in Western Alaska has increased rapidly in recent years, making it challenging to track existing projects, understand their cumulative insights, gauge remaining information gaps, and prioritize future projects. The goal of this effort is to identify current coastal research and management projects that are taking place in Western Alaska and to synthesize information into a report that documents the 'project landscape' for communities facing change, decision-makers navigating change, researchers pursuing projects, as well as funding agencies trying to prioritize where to allocate resources. To identify coastal change projects, we first conducted an extensive Internet search utilizing existing databases and online resources. We then contacted 130 stakeholders from a diverse range of university, state, federal, native and local institutions to review and comment on additional projects. We summarized the list of projects into key disciplines and topic areas. We than compared our list of current coastal projects to a list of key recommended needs identified from the 2012 Coastal Hazards Workshop. We found that the majority (38%) of current coastal change projects in Western Alaska is focused on biological system projects (e.g. fish, bird, habitat and marine mammal species). Human system projects (subsistence, local knowledge and coastal change adaptation) comprised 26% of the total number of projects occurring in the region. Landscape/Geophysical system projects (e.g. research that is related to geophysical processes along the coastline or nearshore stretches of land) represented 20% of the total number of current efforts. And oceanographic system projects (projects related to ocean currents, waves, biochemical fluxes) had the fewest number of current projects (16%). Of the total number of projects, only 32% were categorized as a "recommended need" based on knowledge gaps identified in a 2012 Coastal Hazards Workshop. Our final report provides a synthesis of current project efforts in Western Alaska that may help to (1) to foster better coordination about coastal studies in Western Alaska, (2) help practitioners and scholars learn from one another, and (3) identify information gaps that need to be addressed.

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BACKGROUND AND PRIOR WORK

Research and management studies on coastal change in Western Alaska has increased rapidly in recent years, making it challenging to track existing projects, understand their cumulative insights, gauge remaining information gaps, and prioritize future studies. This project identifies existing coastal change studies in Western Alaska and synthesizes each project's focus, approach, and the individuals/organizations involved. This report documents the research and management studies landscape for communities facing change, decision-makers navigating change, researchers pursuing projects, as well as funding agencies trying to prioritize where to allocate resources.

Coastal resources and communities in Western Alaska have experienced and will increasingly experience the tangible impacts of climate change due to rising sea level, loss of sea ice, and changes to coastal storm patterns (Markon et al. 2012). Ecosystem impacts include saltwater intrusion and changes to shore-fast ice, which lead to habitat degradation of wildlife and fish species, while social impacts include damage to infrastructure, impacts to drinking water supplies, and changes to traditional subsistence patterns (Burkett & Davidson 2012). Alaska has more than 44,000 miles of shoreline (ACMP 2005) and over ¾ of Alaskans live in coastal regions, which support more than 80% of the economy (USFWS 2006). Prior research has highlighted a range of potential climate change impacts to coastal regions (Scavia et al. 2002), as well as linked social-ecological coastal vulnerabilities (Boruff et al. 2005), but they have not focused specifically on the Alaskan region.

Communities, the state government, agencies, non-profits and research institutions have all highlighted coastal change research needs (Cochran 2004, ADFG 2006, Hopcroft et al. 2008, State of Alaska 2008, Kinner 2009, State of Alaska 2009, Brubaker 2011, Golder Associates 2011, NOAA 2011). The 2012 Coastal Hazards Workshop jointly hosted by the Western Alaska Landscape Conservation Cooperative (Western Alaska LCC), the Alaska Ocean Observing System (AOOS), and the Alaska Climate Science Center (CSC) recently identified some of the region's priority information needs. Many of these assessments agree that there is a need for more baseline data, including coastal mapping, wave and wind monitoring, and tidal benchmarks. Other common research needs include better understanding severe storms, ice conditions, coastal modeling for Western Alaska, community observations, and interactions between chemical, physical and biological parameters.

Multiple simultaneous coastal change projects, funded by groups such as Western Alaska LCC, National Oceanic and Atmospheric Administration (NOAA), National Science Foundation (NSF), U.S. Geological Survey (USGS), US Fish and Wildlife Service (USFWS), and others, exist in the Western Alaska LCC region. While significant progress has been made addressing research questions, an overall synthesis of coastal change projects in Western Alaska has not been produced. This report will help decision makers and community members better understand the current range of coastal change projects in the Western Alaska LCC region and its implications for their local area. It will also help researchers network, learn from, and collaborate with others exploring similar topics in the region. Finally, it provides funders, specifically the Western Alaska LCC, with a compendium of current studies and analysis of the extent to which these studies address identified regional needs. The goals of this report are to:

- *Short term:* to create an accessible report that compiles current coastal projects occurring in Western Alaska.

- *Long term:* (1) to foster better coordination about coastal change projects in Western Alaska, (2) help practitioners and scholars learn from one another, and (3) identify information gaps that need to be addressed.

Objectives: The specific steps we used to reach these goals include: (1) identify current coastal projects through existing databases and web-searches, (2) expand this list through conversations with individuals knowledgeable about research and studies in the region, (3) confirm the list with help from key experts in the region, (4) compile information on each project, (5) synthesize information in a readable and useful resource, (6) compare current efforts with stakeholder-identified needs, (7) disseminate the results of this project, and (8) evaluate the project.

DESCRIPTION OF METHODS

Coastal Project Definition: Before we began our project search, we first defined the geographic bounds for projects in Western Alaska. We used the approximate boundary for the Western Alaska LCC as the geographic bounds for our project search. We also included projects that occurred in the northern stretches of coastline in Kotzebue Sound to the Aleutian chain as well as several islands off the Western Coast of Alaska (e.g. St. Lawrence Island). Communities, research sites and stations along this coastline made up the majority of coastal change projects. However, we extended our search to projects inland only if they were directly related to coastal change (e.g. estuary projects). We also included projects that occurred along the Aleutian chain as well as several islands off the Western Coast of Alaska.

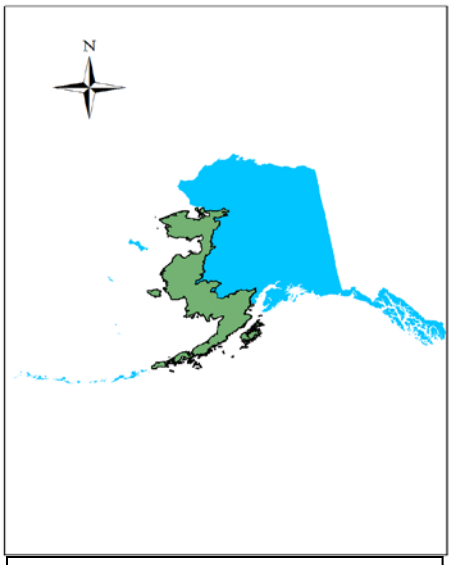

Figure 1. Geographic scope of Western Alaska projects.

Next, we defined "coastal projects" with help from Western Alaska LCC staff, as those that have at least one of the following criteria:

- Focus on coastal drivers (storms, erosion, sea level rise, nearshore sea ice)
- Projects in communities on or near the coast in the LCC geography that are looking at coastal change
- Shoreline projects (e.g. mapping, stabilization surveys)
- Coastal habitat or species response projects (including estuaries and delta habitats)
- Nearshore projects (lagoons, eel grass communities).
- Estuary projects
- Marine mammal projects as they relate to their land or nearshore habitats
- Subsistence species projects that include marine mammals or coastal bird species/populations
- Fish projects at coastal sites

Finally, we were interested in identifying existing or current projects, so we also bounded our search by projects that have been started in the past 4 years (since 2010), are currently ongoing, or projects that are projected to begin by 2015.

Identify Existing Projects: We began our search by utilizing available online resources including the Western AK LCC website, AOOS website, AOV website, and those documented in the NSF Arctic Science database (Jonet Johnson per comm). We also searched the web for research and studies related to coastal change in Western Alaska. We searched for combinations of terms including: coastal change, coastal research, coastal processes, climate change, Western Alaska, erosion, coastal storms. We added additional projects to our database as they were identified.

A range of stakeholders may be conducting coastal assessments, not all of which are documented in databases or websites. In order to connect with key coastal decision-makers we also identified, with the help of Western Alaska LCC staff, a list of Western Alaska LCC stakeholders and other interested regional partners. This list was composed of contacts with knowledge of the region from research institutions, local organizations, agencies, tribal councils and town governments. This list was augmented using web searches, existing databases, and discussions with colleagues, funders, and long-term residents. This list was also expanded through "word-of-mouth" and online requests for information on the AOOS, ACCAP, and Western Alaska LCC websites. During this phase, we confirmed the drafted list of current coastal change projects through confirmation by key experts who are familiar with the region and existing projects. We identified key experts through existing ACCAP and Western Alaska LCC networks and by speaking with researchers and funding agencies working in the region. We then emailed a draft project list to this group to receive confirmation of its completeness and suggestions of other projects.

In total, we contacted 130 individuals via email and provided a project description, call for information and our contact information (Appendix A). Initially, we contacted every individual on our email list and received a 35% response rate (46 individuals). If we did not receive confirmation from our stakeholder contacts within 3 weeks, we sent a second follow-up email. Several of the respondents (n=9) were no longer working in Western AK and could not provide information on our list of projects. Of those stakeholder contacts that responded, our drafted list of projects was reviewed by 37 individuals representing a diverse range of university, state, federal, native and local organizations (Appendix B).

Gather information about projects: For each project that met our criteria, we collected information on the principle investigator(s), project name, collaborator(s), geographic scope, project duration, abstract/project description, internet link, funding source, and contact information. If this information was not available online or through existing databases, we tried contacting the principle investigators to collect this information.

Summarize existing projects: Once the information was collected from each project, we

summarized projects into key topic areas. Key topic areas included human systems, biological systems, landscape/geophysical systems, and oceanographic systems. These topic areas are broad in scope; however, the topic areas are meant to facilitate a quick search by future users when utilizing the database. We summarized the total number of projects in each topic area which allowed us a relative comparison of current projects in Western AK.

Keywords for each topic area were given as a descriptor or term that identifies the primary focus or discipline for each project. It is important to note that interdisciplinary or cross disciplinary projects will often have more than one focus. Thus, we assigned projects a primary keyword and a secondary keyword if necessary. Disciplinary projects that have one focus will only have one keyword. For example, a study tracking wave patterns via buoys will only be given the keyword WAVE/CURRENT. Another project tracking wave patterns via buoys and citizen observations will be given two keywords, WAVE/CURRENT and LOCAL OBSERVATION. We then totaled the number of project keywords to compare more specific research and studies across disciplines (Fig. 3-6). We created an Excel database that organized each topic area into a spreadsheet. For those interested in learning more about particular projects the complete database is available at the ACCAP website. The database provides a structure from which users can search projects by keywords, project names, location, etc.

Additionally, we created a Mapbox website showing the distribution of projects across the Western Alaska landscape. We used online information, existing databases, and discussions with project PI's to obtain the geographic location for each project including the latitude and longitude and the name of the geographic location (e.g. village name). If this information was unavailable, we tried to place projects in a general region (e.g. Bering Strait). Spatial points represent the locations of coastal change projects. Unique color markers were used to identify topic areas (human systems, biological systems, landscape/geophysical systems, and oceanographic systems). Users can click on the location on the interactive Mapbox website and the project name and description is pulled up. This format allows users to identify projects in their region. To differentiate large-scale projects that represent broad geographic regions, we used larger shaped markers to indicate the greater

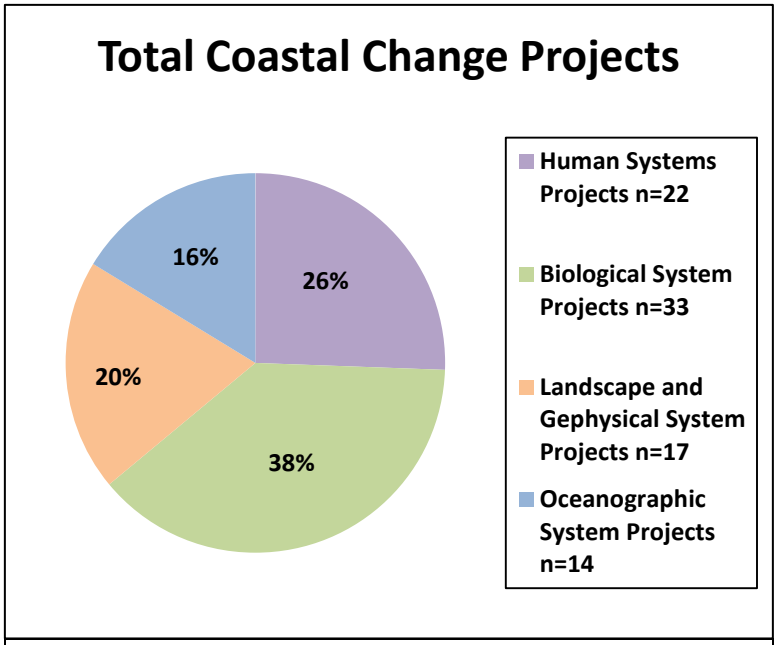

Figure 2. Pie chart representing the total number of projects by topic area (n=86).

size. For more information (i.e. funding source, site link, abstract), users should reference the project database on the ACCAP website.

PROJECT SUMMARIES

In total, we recorded information on 86 current coastal research and management projects in Western Alaska. Over 38% of those projects were defined as biological systems projects. Human systems projects came next with 26% of the current research efforts, followed by Landscape and Geophysical projects 20%, and Oceanographic projects 16% (Fig. 2). It should be noted that the keyword results in the following sections represent the total number of both primary and secondary keywords. For example, the marine mammal keyword (n=9) represents the total number of projects that have a primary or secondary focus on marine mammals species.

Biological System Projects:

This topic area includes projects associated with coastal and nearshore habitats, species and biological processes. These projects were organized into 6 keywords including: 1) bird, 2) marine mammal, 3) fish, 4) vegetation, 5) coastal habitat and 6) nearshore habitat projects. In total, we collected information of 33 current projects that are related to biological systems in Western Alaska. Most of the current studies in this topic area focused on projects related to sea or shore birds (n=13) and marine mammals (n=9). Projects focusing on wildlife or fish habitat were also common (i.e. coastal habitat n=7; and nearshore habitat n=5). Fish-related projects have seven ongoing efforts. Vegetation studies have the fewest current projects (N=4, See Fig. 3, Table 1).

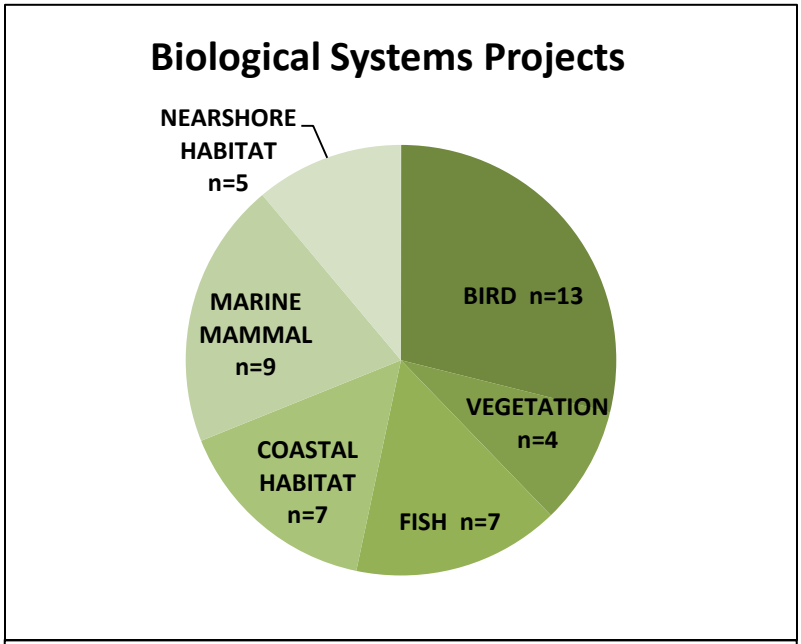

Figure 3. Pie chart representing the total number of primary and secondary project keywords.

Coastal and Nearshore Habitat Projects: We define coastal habitat as an area along the coastline at the interface of land and sea (e.g. estuaries and deltas). Coastal habitat projects were often associated with shore or sea bird projects (**B2, B6, B7, B8, B9, B15)** due to their role in several species' annual cycle, particularly during the nonbreeding period. Nearshore habitat, or the region of sea or seabed relatively close to shore, is critical to populations of biologic and economic value, including

shellfish, salmon, seabirds, eelgrass, and marine mammals. For example, eelgrass is a species of seagrass that serves a vital role as habitat shelter for fish and a variety of invertebrates and provides physical substrate for invertebrates and algae (**B19, B32**). Several fish and invertebrate species (e.g. clam and mussels) live in nearshore communities and are important food resources for coastal communities (**B17**).

Bird Projects: Bird projects were those that focused on sea, shore or water birds populations in coastal areas of Western Alaska. Several of these projects focused on the abundance and distribution of bird species (**B1, B5, B6, B8, B15, B21**). The USGS, USFWS, and National Park Service conduct annual bird surveys for several species including: Emperor geese (*Chen canagica*), Steller's eider (*Polysticta stelleri*), Arctic geese (*Chen caerulescens)* and Black oystercatchers (*Haematopus bachmani*). These projects provide valuable information on population trends, migration routes, and the temporal and spatial distribution of important life history sites (e.g. nesting sites). A few projects, focused on the effects of changing coastal conditions, such as increased storm frequency, on the distribution and survival of bird populations (e.g. **B2**).

Marine Mammal Projects*:* Marine mammals are important constituents of marine ecosystems and are sensitive to variation in coastal conditions. We focused our search on marine mammals that used coastal or nearshore habitat during some phase of their life history. For example, Pacific walrus (*Odobenus rosmarus divergent*) haul out by the thousands in coastal areas throughout Western Alaska and are one of many marine mammals affected by recent environmental change in the Arctic. Several studies focused on the effects of sea ice loss on the use of coastal haul outs by Pacific walrus (**B12, B13, B16).** Sea otters (*Enhydra lutris kenyoni*) occupy nearshore habitat from sheltered bays, estuaries, and fjords to exposed rocky coastlines. They are widely regarded as a "keystone" species in coastal marine ecosystems. However, we found only two studies currently being conducted in the Western Alaska study region related to sea otter abundance and their prey (**B20, B18)**. Other coastal marine mammals projects were focused on bearded seals (**B27**, *Erignathus barbatus*), Steller sea lions (**B23,** *Eumetopias jubatus*), and beluga whales (**B28**, *Delphinapterus leuca*).

Fish Projects: We defined fish projects as those that occurred in coastal areas (e.g. river deltas or estuaries). Of the seven fish projects, most of the research was on changing water temperature or thermal regimes on fish species. For example, the "Pilgrim River Watershed Temperature and Spawning Success of Salmon" project focused on the effects of higher river temperatures on the energetic demands on sockeye salmon (**B10**). Another project focused on the extent continued changes in thermal regimes would affect fish growth, food web structure, and bioaccumulation of mercury (**B11**). Several fish projects are also listed under the human systems topic area (**H4, H14, H15,** and **H17**).

***Vegetation Projects*:** Vegetation project focused on coastal (e.g. bluegrasses) and nearshore plant species (e.g. sea grasses). One long-term project has been working in coastal areas throughout

the state on re-vegetation and erosion control (**B3**1). This project offers a comprehensive implementation guide for land managers and owners starting re-vegetation projects. Other vegetation projects investigated characteristics, such as primary productivity and nutritional quality, of vegetation for coastal and marine species (**B14**).

Human System Projects:

This topic area includes projects whose focus is on Western Alaskan communities, organizations or individuals being affected by coastal change. Keywords for human system projects included: 1) subsistence, 2) local observation, and 3) coastal change adaptation. In total, we found 22 current projects that are related to human systems in Western Alaska. Of those projects, 13 investigated aspects of subsistence activities, seven focused on climate change adaptation, and 10 focused on local observation (See Fig.4, Table 2). Additionally, several projects included keywords from the biological systems group (e.g. fish) and oceanographic systems group (e.g. wave/current and sea ice).

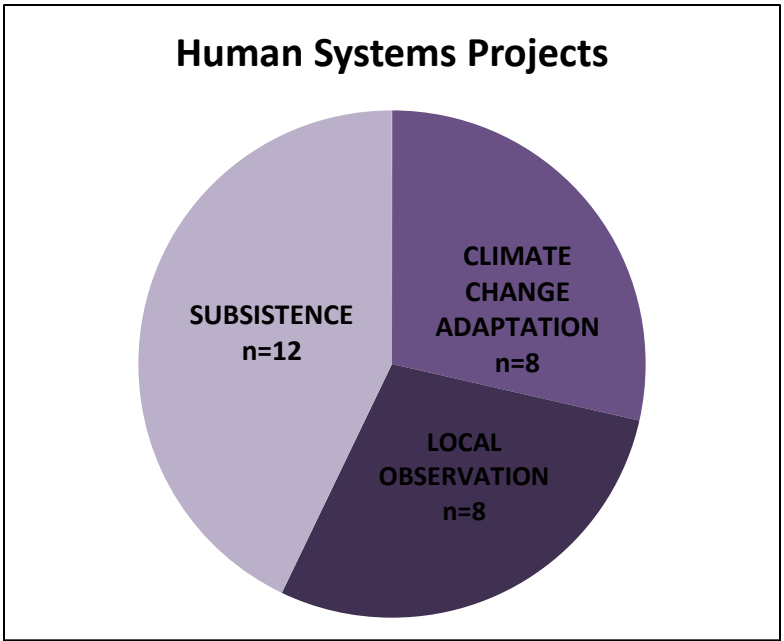

Figure 4. Pie chart representing the total number of primary and secondary project keywords.

Subsistence Projects: Subsistence projects concentrate on the harvest and processing of wild resources for food, raw materials, and other traditional uses. Several projects were especially concerned with climate change effects on coastal subsistence resources and food security. For example, one project titled "Salmon Harvests in Arctic Communities: Local Institutions, Risk, and Resilience" is currently investigating the effects of rapid climatic warming on subsistence salmon fishing in local communities in the Kuskokwim Region (**H4**). This interdisciplinary project utilizes both ethnographic and economic methods to document how local economies based on salmon harvest will perform and adapt to greater risk and uncertainty under changing climate conditions. Several projects, are utilizing local observers to keep track of the distribution of valuable subsistence species across the landscape in an effort to monitor potential changes in species distribution and properties of ecologically significant species such as marine mammals (**H3, H22),** salmon (**H4, H15, H17, H19**), and whitefish (**H14**). Several of

these projects were given both subsistence and local observation (**H19, H22**) keywords. This type of information will be vital as communities are learning how best to adapt to changing resource conditions.

Local Observations Projects: Local observation projects utilized both historic and current knowledge of community members to catalog, track and compare changing coastal conditions. Several projects employed community meetings, semi-directive interviews, and workshops gathering information from traditional knowledge holders. Projects like the Community Observation Network is tracking subsistence species through local observations (**H22**). Other local observation projects are tracking environmental conditions (e.g. snow and ice conditions) providing important, real-time observational data. Input from local communities can inform researchers building models that forecast change to coastal systems. For example, The Bering Strait Ocean Observing System supports a comprehensive observationally-based measurement plan for communities along the Bering Strait (**H5**). This project combines local in situ observations with traditional knowledge resulting in a 4km resolution ice-ocean model, ECCO2 (Estimating the Circulation and Climate of the Ocean phase II).

Coastal Change Adaptation Projects*:* Coastal change adaptation projects are those that examine how individuals, families and coastal communities might adapt to changing resource and environmental conditions. For example, changing storm patterns, ice conditions, and marine wave and current activity can introduce various environmental conditions that adversely affect human activity and infrastructure in coastal areas. Projects like the Yup'ik Environmental Knowledge Project: Natural and Cultural History of the Bering Sea Coast (**H6**), Climate Change Health Assessments for Three Coastal, Riverine and Lake System Communities (**H1**) and Community Observation and Vulnerability Assessments (**H2**) provide essential information on how local communities and researchers can work together to document the past and better prepare for the future.

Landscape/Geophysical System Projects:

This topic area includes projects that are related to geophysical processes along the coastline or nearshore stretches of land. This topic area includes projects related to: 1) coastal erosion, 2) shoreline mapping, 3) bathymetry, and 4) hydrologic projects. We collected information on 16 different projects focused on landscape and geophysical systems. Most of the work in this area is on coastal erosion (n=8) and shoreline dynamics projects (n=9). We found very few nearshore bathymetry (n=2) and hydrology (n=3) projects (See Fig. 5, Table 3).

Coastal Erosion Projects:

Coastal erosion is a serious concern for communities throughout Western Alaska and the primary focus for Landscape/Geophysical Project. Several projects have been implemented near towns and communities that are currently being affected by coastal erosion (**LG-8, LG-12, LG-13**).

One project, "Coastal Geohazard Evaluation and Geologic Mapping in the Vicinity of Wales, Alaska" is documenting the rate of erosion to predict which areas might be impacted in the future (**L-G 6**). This project is generating coastal geohazard maps through a series of measured coastal profiles, nearshore bathymetry and coastline characterizations. These projects can provide valuable information when making decisions about where to install hard coastal structures (**L-G8**), implement dune stabilization (**L-G7**), and build evacuation roads and shelters (**LG-8**).

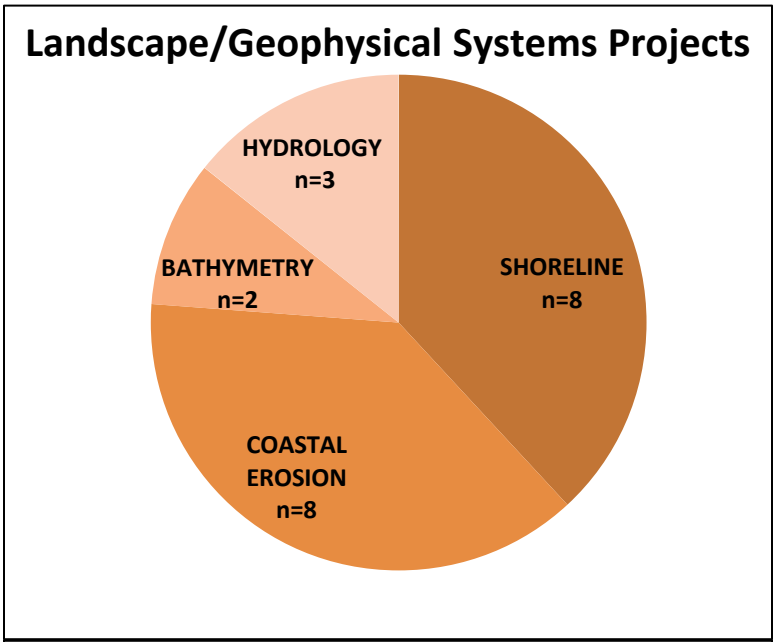

Figure 5. Pie chart representing the total number of primary and secondary project keywords.

Shoreline Mapping and Stabilization Projects:

Mapping the shoreline of Western Alaska is an important step in understanding coastal processes and measuring changes in coastal storm characteristics and impacts. Digital shoreline maps that meet the National Hydrographic Dataset standards have been developed from Cape Espenberg to Cape Prince of Wales (**L-G1**). ShoreZone maps are recently completed or currently being made for Kotzebue Sound and northern Seward Peninsula (**L-G2**), Bristol Bay (**L-G3**), and southeastern Alaska Peninsula (**L-G5**). The ShoreZone project provides a comprehensive inventory of the biological and geographical resources for Western Alaska. These projects are also publically available (http://alaskafisheries.noaa.gov/shorezone/) and provide an excellent resource for oil spill and emergency planning and response, community planning, habitat management, and invasive species detection.

Bathymetry Projects:

Bathymetry projects measured the depth of nearshore areas off the coast of several communities in Western Alaska. The "Coastal Geohazard Evaluation and Geologic Mapping in the Vicinity of Wales, Alaska" project is measuring nearshore bathymetry as one of several parameters being used to establish a baseline record of dominant coastal processes in and around selected communities (**LG-6**). Nearshore bathymetry measurements are also being utilized as a parameter in storm surge models that are necessary for coastal residents making coastal change management decisions (e.g. potential re-location sites for infrastructure) (**LG-10**). In the 2012 Coastal Hazards Workshop, bathymetry, detailed coastal topography and terrestrial benchmarks

tied to water level measurements were the three key components for linking ocean, near-shore and coastal processes.

Oceanographic System Projects:

This topic area is devoted to projects on ocean currents, waves, biochemical fluxes, and physical properties that occur within the oceans and coastal environments in our Western Alaska focal area (e.g. Bering Sea, Southeast Chukchi Sea and Gulf of Alaska). The five keywords for this topic area include: 1) biophysical, 2) storm patterns, 3) wave/currents, 4) tidal projects, and 5) sea ice. This topic area had the fewest total projects (n=15). Most of the work in this area is being conducted on wave and current (n=6). Biophysical and storm pattern projects both have four current studies. Tidal benchmarks only have two projects (See Fig. 6, Table 4).

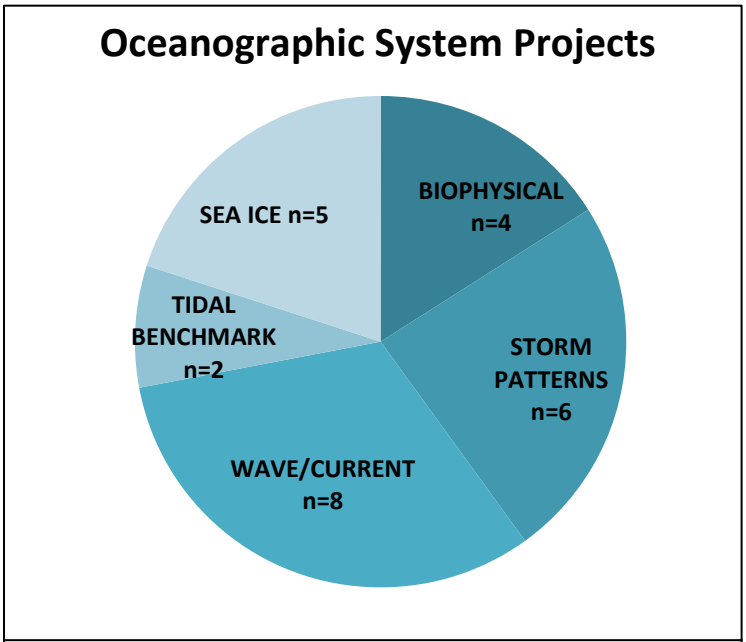

Figure 6. Pie chart representing the total number of primary and secondary project keywords.

Wave and Current Projects: Wave and current projects typically measure the volume, frequency, and timing of water moving in or away from shore. Projects utilizing wave buoys data can collect real-time information about the volume and direction of water movement (**O3, O5,** and **O11**). The Wave Information Study for Western Alaska uses data from wave buoys as well as the best available input for wind fields, to predict past and current wave conditions (**O7**). Ocean currents are being measured by both satellite markers (**O13**) and high-frequency radar (**O12**). Local experts also have provided knowledge about the location and characteristics of ocean currents including descriptions of how currents have traditionally been used for hunting and travel, how currents currently interact with other environmental variables, and how ocean currents are changing around their communities (**H13**).

Biophysical Projects: Biophysical projects measure both biotic and abiotic processes in the marine environment. These projects provide importation information on nutrient cycling, water temperature and for marine systems. One comprehensive project has been measuring temperature, salinity, water velocity, ice thickness and motion, nutrients, fluorescence, and transmissivity with subsurface oceanographic moorings in the Bering Strait Region (**O4**). The Alaska Ocean Acidification project is studying the processes that control the role of oceans in the global carbon cycle and how climate change can affect the chemistry of the oceans (**O6**).

Storm Pattern and Sea Ice Projects: The coastline of Alaska is vulnerable to coastal storms, which can cause coastal erosion and flooding affecting both human communities and wildlife habitat. Storm pattern projects document areas that are vulnerable to coastal storms e.g. Yukon-Kuskokwim Delta (**O2**) and St. Lawrence Island (**O8**). Changing storm patterns can interact with sea ice conditions producing environmental conditions that can adversely affect human activity. One project titled, "The role of sea ice berm formation to alter environmental marine forcing in West Alaska coastal communities" uses local observational data from Shishmaref, Shaktoolik, and Gambell to develop a model describing slush ice berm formation (**H8**). Another project is investigating the role of the reduction of sea ice on storm surge pattern **(O1).** This relationship is important because the reduction of ice coverage could potentially increase the frequency and extent of coastal flooding and erosion.

Tidal Benchmark Projects*:* Measurements of coastal uplift coupled with water levels are important pieces to understand sea level rise in coastal areas of Western Alaska. We found only two projects working to establish tidal benchmarks in our study region. One project, "Reconnaissance static occupation of Tidal Benchmarks in Western Alaska" has re-visited 32 established tidal benchmarks along the Western Alaska coastline resulting in a vertical velocity model (**O14**). The other project is compiling a dataset that includes a digital shoreline map of mean water height for a strip of a coastal shoreline extending from Cape Prince of Wales to Cape Espenberg.

Figure 7. Screenshot of the Western Alaska LCC coastal project Mapbox site. Unique colors represent human (purple), biological (green), landscape-geographic (orange), and oceanographic (blue) system projects. Click here for the Mapbox website.

Spatial Distribution of Projects:

The Western Alaska LCC extends from Kotzebue through Unimak Island off of the Alaska Peninsula, and includes Kodiak Island. We used the approximate boundary for the Western Alaska LCC as the geographic bounds for our project search. We also included projects that occurred in the northern stretches of coastline in Kotzebue Sound all the way to the south central Aleutian chain as well as several islands off the Western Coast of Alaska (e.g. St. Lawrence Island). To examine the distribution of projects across the Western Alaska LCC landscape, we placed projects into the northern coastal region (area between Kotzebue Sound and Norton Sound including St. Lawrence Island), the central coastal region (area south of Norton Sound to Cape

Constantine including Nunivak Island), and the southern coastal region (Bristol Bay to Alaska Peninsula including Kodiak Island).

In total, we collected information on 210 project sites throughout our study area (Fig 7). There were seven projects that had sites across large portions of Western Alaska and extended beyond a particular geographic region (e.g. coastline mapping projects). Large-sized markers in the Mapbox site represent these wide-ranging projects. We also included all Western Alaskan communities that submitted observations with the Local Environmental Observer Network (36 total project sites **H12**).

We found that the majority of project sites were distributed throughout the northern region (99 project sites). Most of these sites were from human systems projects (50 sites), followed by biological systems projects (22 sites), landscape-geophysical system projects (14 sites) and oceanographic system projects (13 sites). The central region encompassed the second-most number of project sites (60 sites). Most of the project sites in this region were human system projects (25 sites), followed by biological system projects (21 sites), oceanographic system projects (9 sites), and landscape-geophysical system projects (5 sites). The southern region had the fewest total number of project sites (51 sites). The majority of which were biological system projects (20 sites), followed by human system projects (18 sites), oceanographic system projects (7 sites), and landscape-geophysical sites (6 sites).

DISCUSSION

Summary of Findings: The majority of coastal projects that are occurring in Western Alaska were defined as Biological System projects (n=33, 38% of total projects). These efforts were focused on fish, marine mammal, bird, vegetation, and habitat projects. Shorebird and sea bird projects make up the majority of biological system projects and have the highest number of total primary/secondary keywords compared to the other keywords. Subsistence, local observations and coastal change adaptation under human systems comprise 26% of the total number of projects occurring in Western Alaska (n=22). Landscape/Geophysical systems projects represented 20% of the total number of current projects (n=17). Oceanographic System projects had the fewest number of current projects (n=14), representing 16% of the total number of projects. We were especially surprised to see low representation of projects related to several keywords that are highly important to aspects of coastal change in Western Alaska as defined in the 2012 Coastal Hazards Workshop. In particular, we found few projects focused on nearshore bathymetry and tidal benchmarks and most of these were initiated in response to the workshop's recommendations (See Table 5).

While we had an adequate response rate, it is likely that there are more current projects underway than are not captured in this report. For instance, citizen science projects, such as those tracking coastal erosion rates through student observations and measurements, were not captured in our assessment. A mechanism to update or add information to this report and database can be found on a Google form at the ACCAP website.

Identifying Information Gaps: In 2012, AOOS, Western Alaska LCC, and the USGS's Alaska CSC hosted a Coastal Hazards Workshop. Workshop participants included a broad array of stakeholders including residents, local, state and federal managers, and university researchers. This group reviewed the current state of the coast, discussed stakeholder information needs and developed the framework for a conceptual model focused on natural-human system impacts due to coastal erosion and inundation. Key recommendations and needs came from the discussions surrounding nearshore conditions, ocean to shore conditions, and the linkages and feedbacks between these conditions. A list of key recommendations was made available after the workshop (See Appendix C). Workshop participants identified three categories under key recommendation and needs: 1) ocean to shore processes, 2) nearshore processes, and 3) bathymetry.

While summarizing information, we tracked whether the current projects met a Coastal Change Workshop's Recommended Need(s). We found that 30 out of the 86 (~33%) current projects would meet at least one of the recommended priority needs listed by workshop participants. Most of the projects that were identified as a recommended need fell under the ocean to shore process category (n=23). We found five projects that could be defined as a nearshore processes recommended need project. And only two projects were defined as a bathymetry recommended need (Table 5).

The low number of "recommended need" projects is due to the fact that most of the key recommendations fell under oceanographic or landscape/geophysical projects. For example, both bathymetry and tidal benchmark projects were identified as key data needs. As mentioned above, there were few projects related to those disciplines. These results are striking in that workshop participants have accurately identified key needs that are also projects that have low representation compared to the total number of projects, and that new projects have been established following the workshop to help fill these gaps. This finding would also suggest that there is a remaining information gap for both nearshore processes and bathymetry projects.

In addition, the distribution of project sites suggests that the majority of coastal projects are occurring in the northern stretches of Western Alaska. Most of sites in this region were focused on human system projects. This result may be due to the concentration of communities between Norton and Kotzebue Sound (e.g. Kotzebue, Wales, Shishmaref, Nome). Both the central and southern regions also include several important community hubs (e.g. Kodiak, Hopper Bay, Emmonak). However, there seems to be a high density of human systems projects occurring in the northern region. The majority of project sites within the southern region were biological system projects. These regions encompass several national parks, wildlife refuges, and marine reserves (e.g. Izembek National Wildlife Refuge, Katmai National Park, Yukon Delta National Wildlife Refuge), which is likely affecting the concentration of biological system projects.

Although it was difficult to collect specific geographic information for some oceanographic systems projects due to their broad geographic scope, it is important to note the low number landscape/geophysical projects within both the central and southern regions. Another apparent gap in project distribution was the low number of total sites along the central

coast (coastline between St. Michael and Dillingham) and Alaska Peninsula. The geographic gap in projects could be due to several factors including lack of infrastructure for project support (e.g. number of airstrips, roads), location priorities based on project funding, and the persistence of stakeholders in others coastal regions. Nonetheless, the geographic distribution provides important information regarding the types of projects occurring across coastal regions in Western Alaska and whether some communities may be targeted for projects more than others. This information should be considered as agencies continue to prioritize future work.

Utility for Coordination and Learning: This report provides a synthesis of current research and management studies in Western Alaska that may help to (1) to foster better coordination about coastal change in Western Alaska, (2) help practitioners and scholars learn from one another, and (3) identify information gaps that need to be addressed. The online database is a resource that allows communities and researchers to better understand and coordinate around current research efforts. This may lead to learning between projects and communities, both related to research outcomes as well as the methods that have worked in related projects. In several topical areas, we have identified similar projects as well as projects that could be complementary to one another. We disseminated an executive summary to all of the lead PI's working in this region as well as our identified network of knowledgeable persons in order to facilitate the process of coordination and learning.

Recommendations: While it is difficult to resolve the factors influencing research gaps in coastal change in Western Alaska, this type of document highlights geographic regions and project disciplines that would benefit from prioritization of resources. In particular, we found that several key recommendations (e.g. bathymetric and tidal benchmark data) were underrepresented in the final database. However, we also found several key recommendations that are currently funded and collecting information (e.g. utilizing community observations for storm surge), which highlights both the coordination and funding effort of agencies to meet stakeholder needs. Additionally, the geographic distribution of projects across the landscape emphasizes regions that would benefit from more research (e.g. central coastline). It has become a goal to continue this information sharing effort into the future, and we encourage stakeholders to update our website as new projects are developed. We highly recommend this type of synthesis for stakeholders in other coastal regions throughout Alaska or abroad as they navigate the difficult decisions associated with changing coastal conditions.

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Table 1: Biological System Projects for Western Alaska. The full database includes project abstract, collaborators, funding sources, internet links, and contact information and can be found at ACCAP website.

Project ID:	Keyword:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
B1	birds[1], subsistence[2]	Aerial Survey OF Emperor Geese and Other Water birds in Southwestern Alaska	Christian Dau (U.S. Fish and Wildlife Service)	Yukon-Kuskokwim Delta, Alaska Peninsula	1981-Ongoing
B2	birds[1], coastal habitat[2]	The impacts of storm surges on breeding water birds on the Yukon-Kuskokwim Delta, Alaska: past effects and future projected impacts	Sarah Saalfeld (Manomet Center for Conservation Sciences)	Yukon-Kuskokwim Delta	2012-2014
B3	birds[1], hydrology[2]	Expanding environmental monitoring instrumentation on Kigigak Island	Melissa Gabrielson (U.S. Fish & Wildlife Service)	Kigigak Island	2013-2015
B4	marine mammals[1], wave/currents[2]	Arctic Whale Ecology Study 2014	Nancy Friday (National Oceanic and Atmospheric Association)	Chukchi Sea	2014-2015
B5	birds	Spring Steller's Eider Surveys in Southwestern Alaska	William Larned (U. S. Fish and Wildlife Service)	Coast of southwestern Alaska, from the Yukon-Kuskokwim Delta (Y-K Delta) to the west end of the Alaska Peninsula.	1992-2012
B6	birds[1], coastal habitat[2]	Population Structure of Pacific Common Eiders Breeding in Alaska	Margaret Petersen (U.S. Geological Survey)	Aleutian Islands, Saint Lawrence Island, Seward Peninsula, Yukon Delta National Wildlife Refuge	2005-2013
B7	birds[1], coastal habitat[2]	Changing Arctic Ecosystems: Forecasting Effects of Climate Change on the Distribution and Abundance of Bird Populations across the Boreal-Arctic Transition Zone	Colleen Handel (U.S. Geological Survey)	Seward Peninsula	2010-2014

Table 1 Continued

Project ID:	Keyword:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
B8	birds[1], coastal habitat[2]	Population Status and Ecology of North Pacific Shorebirds	Colleen Handel (U.S. Geological Survey)	Seward Peninsula, Yukon Delta National Wildlife Refuge	2001-2015
B9	birds[1], coastal habitat[2]	Migration Ecology of Arctic Geese	Jerry Hupp (U.S. Geological Survey)	Izembek National Wildlife Refuge, Yukon Delta National Wildlife Refuge	2001-2015
B10	fish	Pilgrim River watershed (Nome)--Temperature and Spawning Success of Salmon	Michael Carey (U.S. Geological Survey)	Pilgrim River, Seward Peninsula	2013-2016
B11	fish	Biological Response to Increasing Water Temperatures in Arctic Coastal Plain Lakes	Christian Zimmerman (U.S. Geological Survey)	Nome	2014-2016
B12	marine mammals	Changing Arctic Ecosystems: Enhancing forecasts of polar bear and walrus population response to a rapidly changing Arctic ecosystem (Modeling walrus population dynamics and bioenergetics)	Mark Udevitz (U.S. Geological Survey)	Chukchi Sea	2010-2015
B13	marine mammals	Walrus Adaptability and Long-term Responses; Using multi-proxy data to project sustainability	Nicole Misarti (University of Alaska Fairbanks)	Little Diomede Island	2014-2016
B14	bird[1], vegetation[2]	Asynchrony in the timing of goose-vegetation interactions: implications for biogeochemical cycling in wet sedge tundra	Jeffrey Welker (University of Alaska Anchorage)	Chevak	2014-2016
B15	birds[1], coastal habitat[2]	Shorebird distribution and abundance on the Yukon Delta National Wildlife Refuge	Richard Lanctot (US Fish and Wildlife Service)	Yukon Delta National Wildlife Refuge	2015-2016
B16	marine mammals	Pacific walrus terrestrial haul out attendance and disturbance	Lori Polasek (Alaska SeaLife Center)	Bristol Bay	2011-2015
B17	nearshore habitat[1], subsistence[2]	Intertidal Invertebrates and Algae Sampling	Heather Coletti (National Park Service)	Aniakchak National Monument & Preserve, Katmai National Park and Preserve, Lake Clark National Park	2008-2014

Table 1 Continued

Project ID:	Keyword:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
B18	nearshore habitat	Mussel Bed Sampling	Heather Coletti (National Park Service)	Katmai National Park and Preserve	2008-2014
B19	vegetation[1], nearshore habitat[2]	Eelgrass Bed Sampling	Heather Coletti (National Park Service)	Katmai National Park and Preserve	2010-2014
B20	marine mammals[1], nearshore habitat[2]	Sea Otter Surveys	Heather Coletti (National Park Service)	Katmai National Park and Preserve, Aniakchak National Monument and Preserve	2006-2014
B21	birds	Marine Bird Surveys	Heather Coletti (National Park Service)	Katmai National Park and Preserve	20062014
B22	birds	Increasing Variability of Ecological Response by Beringian Endemic Seabirds to Rapid Environmental Change	Douglas Causey (University of Alaska Anchorage)	Aleutian Islands, Saint Lawrence Island, Seward Peninsula, Yukon Delta National Wildlife Refuge	2009-2014
B23	marine mammals	Diving Behaviors and Habitat Use of Adult Female Steller Sea Lions (*Eumetopias jubatus*)	Michelle Lander (National Oceanic and Atmospheric Administration)	Western Bering Sea	2011-2014
B24	birds	Population status and spatial distribution of breeding and post-breeding waterbirds	Peter Neitlich (National Park Service)	NA	NA
B25	fish	Assess Kotzebue Sound Whitefish Ecology and Seasonal Dynamics	Peter Neitlich (National Park Service)	NA	NA
B26	marine mammals	Using Acoustics to study ambient noise levels and seal vocalizations in Kotzebue Sound	Alex Whiting (Native Village Kotzebue)	Kotzebue Sound	2014-2015
B27	marine mammals	Live capture of bearded seals for hearing research	Alex Whiting (Native Village Kotzebue)	Kotzebue Sound	2014-2015
B28	marine mammals	Using Acoustics to study Kotzebue Sound Beluga	Alex Whiting (Native Village Kotzebue)	Kotzebue Sound	2014-2015
B29	nearshore habitat	Geological substrate and potential habitat map for deep sea corals and sponges in the Gulf of Alaska margin and the Aleutian shelf and slope regions	Jennifer Reynolds (University of Alaska Fairbanks)	Gulf of Alaska margin and the Aleutian shelf and slope regions	2012-2014

Table 1 Continued

Project ID:	Keyword:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
B30	coastal habitat[1], hydrology[2]	Thermal Response of Western Alaska Lakes and Lagoons to Past, Present, and Future Changes in Climate	Benjamin Jones (U.S. Geological Survey)	Across several lakes in Western Alaska LCC, Kotzebue	2009-2013
B31	vegetation[1], coastal erosion[2]	Alaska Coastal Revegetation & Erosion Control Guide	Stoney Wright (Department of Natural Resources)	Western AK coastline	1994-Ongoing
B32	vegetation[1], nearshore habitat[2]	Establishing a Baseline for Regional Scale Monitoring of Eelgrass (*Zostera marina*) Habitat on the Lower Alaska Peninsula	Kyle Hogrefe (US Geological Survey)	Izembek National Wildlife Refuge	2010-2014
B33	hydrology[1], fish[2]	Strategy Development for Establishment of a Voluntary Water Temperature Monitoring Network in the Kodiak Archipelago, Alaska	Bill Pyle (US Fish and Wildlife Service)	Kodiak Island	2014-2015

Table 2: Human System Projects for Western Alaska.

Project ID:	Keywords:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
H1	coastal change adpatation[1], subsistence[2]	Climate Change Health Assessments for Three Coastal, Riverine and Lake System Communities	Sue Flensburg (Bristol Bay Native Association)	Nondalton, Levelock, and Pilot Point	2011-2014
H2	local observation[1], storm patterns[2]	Community Observation and Vulnerability Assessment	Michael Brubaker (Alaska Native Tribal Health Consortium)	Nome, Shaktoolik, Shishmaref, Solomon, Stebbins, St. Michael, Teller, Unalakeet, Wales, White Mountain	2012-2014
H3	subsistence[1], coastal change adaptation[2]	Bering Sea Sub Network: A Distributed Human Sensor Array to Detect Arctic Environmental Change	Lillian Alessa (University of Alaska Anchorage)	Togiak	2009-2014
H4	subsistence[1], fish[2]	Salmon Harvests in Arctic Communities: Local Institutions, Risk, and Resilience	Lance Howe (University of Alaska Anchorage)	Kuskokwim River	2010-2013
H5	local observation[1], sea ice[2]	A Bering Strait Ocean Observing System for the Pacific Inflow to the Arctic- a fundamental part of the Arctic Observing Network	Rebecca Woodgate (University of Washington)	Shishmaref, Nome, Diomede, Wales	2014-2018
H6	local observations[1], sea ice[2]	Yup'ik Environmental Knowledge Project: Natural and Cultural History of the Bering Sea Coast	Ann Fienup-Riordan (Calista Elders Council)	Kotlik	2011-2014
H7	coastal change adaptation[1], subsistence[2]	The Vulnerable North? Risk and Resilience in Alaskan Coastal Communities	Karen Hebert (Yale University)	Dillingham	2013-2014
H8	local observations[1], sea ice[2]	The role of sea ice berm formation to alter environmental marine forcing in West Alaska coastal communities	David Atkinson (University of Victoria)	Shishmaref, Shaktoolik, Gambell	2012-2014
H9	subsistence	Commercial Shipping Vulnerability Analysis	Douglas Burn (U S Fish and Wildlife Service)	Aleutian Islands	2013
H10	subsistence	An Inventory of Coastal Wildlife Resources Most at Risk from Marine Vessel Incidents and Oil Spills	Douglas Burn (U S Fish and Wildlife Service)	Aleutian Islands	2013-Ongoing

Table 2 Continued

Project ID:	Keywords:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
H11	coastal change adaptation	Community Health Assessment for Climate Change	Michael Brubaker (Alaska Native Tribal Health Consortium)	Levelock, Nondalton, Pilot Point, Selawik	NA
H12	coastal change adaptation[1], local observations[2]	Local Environmental Observer Network	Michael Brubaker (Alaska Native Tribal Health Consortium)	Western AK Coastline	2012-Ongoing
H13	local observations[1], wave/current[2]	Indigenous Knowledge and Use of Ocean Currents in the Bering Strait Region (Alaska)	Julie Raymond-Yakoubian (Kawerak, Inc.)	Shishmaref, Wales	2010-2013
H14	subsistence[1], fish[2]	When the fish come, we go fishing: Local Ecological Knowledge of Non-Salmon Fish used for Subsistence in the Bering Strait Region	Julie Raymond-Yakoubian (Kawerak, Inc.)	Bering Strait Region	2010-2014
H15	subsistence[1], fish[2]	Climate-Ocean Effects on Chinook Salmon: Local Traditional Knowledge Component	Julie Raymond-Yakoubian (Kawerak, Inc.)	Brevig Mission, Golovin, and Unalakeet	2010-2013
H16	subsistence	How to Assess Food Security from an Inuit Perspective: Building a Conceptual Framework on How to Assess Food Security in the Alaskan Arctic	Carolina Behe (Inuit Circumpolar Council)	Wales, Stebbins, Emmonak	2013-2014
H17	subsistence[1], fish[2]	How People of the Yukon River Value Salmon: A case study in the lower, middle, and upper Yukon River	Catherine Moncrieff (Yukon River Drainage Fisheries Association)	Russian Mission	2014-2016
H18	coastal change adaptation[1], local observation[2]	Sustainable Futures North	Phillip Loring (University of Saskatchewan)	Bristol Bay and Kotzebue Sound	2014-2017
H19	Subsistence[1], local observation[2]	Yukon River In-Season Teleconference and Harvest Interviews	Catherine Moncrieff (Yukon River Drainage Fisheries Association)	Alakanuk, Marshall	2004-Ongoing

Table 2 Continued

Project ID:	Keywords:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
H20	coastal change adaptation	Planning and Land Management Alaska Community Coastal Protection Project	Sally Russell Cox (Alaska Department of Commerce, Community, and Economic Development)	Shaktoolik and Shishmaref	NA
H21	local observation	Creating Common Understanding - Multi-Partner Pilot to Communicate Coastal Storm Hazards	Aimee Fish (National Weather Service)	NA	2014-Ongoing
H22	local observation[1], subsistence[2]	Community Observation Network for Arctic Livelihoods and Subsistence (CONALS)	Lillian Alessa (University of Idaho)	Gambell, Savoonga, Togiak, St. George, and Sand Point in Alaska	2010-2015

Table 3: Landscape and Geophysical System Projects for Western Alaska.

Project ID:	Keywords:	Title:	PI First Name:	PI Last Name:	Institution:
L-G1	Shoreline[1], tidal benchmark[2]	Compilation of NHD Compliant shoreline from Cape Prince of Wales to Cape Espenberg using NOAA extracted vector shoreline	Andrew Robertson (Saint Mary's University)	Kotzebue Sound to Seward Peninsula	2012-2013
L-G2	shoreline	ShoreZone Mapping in Kotzebue Sound	Cindy Hartmann Moore (National Oceanic and Atmospheric Administration)	Coastline between Wales and Kotzebue	2012-2014
L-G3	shoreline	ShoreZone Mapping in Bristol Bay	Cindy Hartmann Moore (National Oceanic and Atmospheric Administration)	Bristol Bay Region	2012-2015
L-G4	shoreline[1], coastal habitat[2]	Extensive mapping of Bering Sea and Gulf of Alaska coastal change by Landsat time series trend analysis, 1985-2012	Matthew Macander (ABR, Inc.)	Kodiak Archipelago, Kotzebue, Alaska Peninsula	2013-2014
L-G5	shoreline	ShoreZone mapping on the southern Alaska Peninsula	Cindy Hartmann Moore (National Oceanic and Atmospheric) Administration)	Cold Bay to Balboa Bay	2013-2015
L-G6	shoreline[1], bathymetry[2]	Coastal Geohazard Evaluation and Geologic Mapping in the Vicinity of Wales, Alaska	Nicole Kinsman (Alaska Department of Natural Resources)	Wales	2012-Ongoing
L-G7	coastal erosion	Use of Beach Wildrye to Stabilize Coastal Berms	Harvey Smith (Alaska Department of Transportation)	Shaktoolik	2010-2014
L-G8	coastal erosion	Monitoring Storm Surge in Western Alaska	Harvey Smith (Alaska Department of Transportation)	Hooper Bay, Kivalina, Unalakleet, Point Hope, Shishmaref, Mertarvik, Shaktoolik and Kotzebue	2010-2014

Table 3 Continued

Project ID:	Keywords:	Title:	PI First Name:	PI Last Name:	Institution:
L-G9	hydrology	Collaborative Research: IPY: Arctic Great Rivers Observatory (Arctic-GRO)	Robert Spencer (Woods Hole Research Center)	Yukon River	2008-2016
L-G10	bathymetry	Nearshore bathymetric data collection in the vicinity of Western Alaska Communities	Nicole Kinsman (Alaska Department of Natural Resources)	Western AK coastline	2012-2014
L-G11	coastal erosion	Alaska Coastal Profile Tool	DGGS Staff Alaska Division of Geological & Geophysical Surveys	Western AK coastline	2014-Ongoing
L-G12	coastal erosion	Contemporary Shoreline Retreat Rates at Meshik in Port Heiden, Alaska	Nicole Kinsman (Alaska Department of Natural Resources)	Meshik	2013-2014
L-G13	coastal erosion	Preliminary Evaluation Of Coastal Geomorphology and Geohazards on 'KIGIQTAM IGLUA', an Island	Nicole Kinsman (Alaska Department of Natural Resources)	Shishmaref	2012-2013
L-G14	NA	Landscape Classification and Mapping for the Yukon-Kuskokwim Delta, Alaska	Torre Jorgenson (ABR Inc. Environmental Research Services)	NA	NA
L-G15	NA	Landscape Changes in Coastal Ecosystems, Yukon-Kuskokwim Delta	Torre Jorgenson (ABR Inc. Environmental Research Services)	Yukon-Kuskokwim Delta	NA

Table 4: Oceanographic System Projects for Western Alaska.

Project ID:	Keywords:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
O1	storm patterns[1], coastal erosion[2]	High-resolution model coupling effects of sea ice, tide, wind-driven wave dynamics, and currents in the formation of Storm Surges in Western Alaska	Robert Grumbine (National Oceanic and Atmospheric Administration)	Western AK coastline	2012-2013
O2	storm patterns, birds[2]	Storm surge impacts on biological resources in the Yukon Kuskokwim Delta	Thomas Ravens (University of Alaska Anchorage)	Yukon-Kuskokwim Delta	2012-2014
O3	wave/current	Leveraging opportunity for wave buoy data collection	Molly McCammon (Alaska Ocean Observing System)	Western AK coastline	2012-2014
O4	biophysical	Russian-American Long-term Census of the Arctic (RUSALCA)	National Oceanic and Atmospheric Administration, Russian Academy of Sciences	Chukchi Sea	2004-2014
O5	biophysical[1], wave/current[2]	Observing turbulent fluxes in the upper Arctic Ocean	Jennifer MacKinnon (University of California, San Diego)	Nome	2015
O6	biophysical	Alaska Ocean Acidification Network	Jeremy Mathis (National Oceanic and Atmospheric Administration)	SE Bering Sea	2013-2014
O7	wave/current	The Wave Information Study, Western Alaska Wave Hindcast (1985 - 2013)	Robert Jensen (Army Corps of Engineers)	Western AK coastline	1985-2015

Table 4 Continued

Project ID:	Keywords:	Title:	Principle Investigator:	Geographic Scope:	Project Duration:
O8	storm patterns	Assessment of Storm-induced water levels for St. Lawrence Island and the greater Bering Strait Region, Alaska	Li Erikson (U.S. Geological Survey)	St. Lawrence Island and greater Bering Strait Region	2007-2014
O9	biophysical	Synthesis of Arctic Research (SOAR): An ocean acidification sensitivity index for the Pacific Arctic Region	Tom Weingartner (University of Alaska Fairbanks)	Northern Bering Sea, Bering Strait	2012-2013
O10	storm patterns	Towards a 90-day monthly storm outlook for Alaska, North Pacific, and Hawaii	John Walsh (University of Alaska Fairbanks)	Coastal AK	2012-2013
O11	wave/current	Northern Bering Sea improved hazard monitoring in the marine and coastal environments	David Atkinson (University of Victoria)	Northern Bering Sea, Bering Strait	2010-2012
O12	wave/current	Optimization of the High-frequency Radar Sites in the Bering Strait Region	Gleb Panteleev (University of Alaska Fairbanks)	Bering Strait Region	2009-2014
O13	wave/current	Mapping surface currents of Kotzebue Sound using satellite drifters	Alex Whiting (Native Village Kotzebue)	Kotzebue Sound	2014-2015
O14	tidal benchmark	Reconnaissance static occupation of Tidal Benchmarks in Western Alaska	Nicole Kinsman (Alaska Department of Natural Resources)	Western Alaskan coastline	2013-2014

Table 5: Coastal projects that meet a key recommended need from the 2012 Coastal Process Workshop. Asterisks represent projects that began the same year or soon after the workshop.

Project ID:	Title:	Recommendation Categories:	Coastal Process Workshop Key Recommendation:
B2***	The impacts of storm surges on breeding water birds on the Yukon-Kuskokwim Delta, Alaska: past effects and future projected impacts	ocean to shore	Better understand the relationship between storm surge, wave generation and ice condition.
H2***	Community Observation and Vulnerability Assessment	ocean to shore	Utilize community observation for storm surge and tide height, nearshore and shore-fast ice impacts on surge, etc.
H5***	A Bering Strait Ocean Observing System for the Pacific Inflow to the Arctic- a fundamental part of the Arctic Observing Network	ocean to shore	Utilize community observation for storm surge and tide height, nearshore and shore-fast ice impacts on surge, etc.
H8***	The role of sea ice berm formation to alter environmental marine forcing in West Alaska coastal communities	ocean to shore	Utilize community observation for storm surge and tide height, nearshore and shore-fast ice impacts on surge, etc.
H12***	Local Environmental Observer Network	ocean to shore	Utilize community observation for storm surge and tide height, nearshore and shore-fast ice impacts on surge, etc.
H13	Indigenous Knowledge and Use of Ocean Currents in the Bering Strait Region (Alaska)	ocean to shore	Utilize community observation for storm surge and tide height, nearshore and shore-fast ice impacts on surge, etc.
H22	Community Observation Network for Arctic Livelihoods and Subsistence (CONALS)	ocean to shore	Utilize community observation for storm surge and tide height, nearshore and shore-fast ice impacts on surge, etc.

Table 5 Continued

Project ID:	Title:	Recommendation Categories:	Coastal Process Workshop Key Recommendation:
L-G1***	Compilation of NHD Compliant shoreline from Cape Prince of Wales to Cape Espenberg using NOAA extracted vector shoreline	ocean to shore	Identified a fundamental need to collect vertical data tied to tidal benchmarks
L-G2***	ShoreZone Mapping in Kotzebue Sound	ocean to shore	Identified a fundamental need to collect vertical data tied to tidal benchmarks
L-G3***	ShoreZone Mapping in Bristol Bay	ocean to shore	Identified a fundamental need to collect vertical data tied to tidal benchmarks
L-G5***	ShoreZone mapping on the southern Alaska Peninsula	ocean to shore	Identified a fundamental need to collect vertical data tied to tidal benchmarks
O1***	High-resolution model coupling effects of sea ice, tide, wind-driven wave dynamics, and currents in the formation of Storm Surges in Western Alaska	ocean to shore	Better understand the relationship between storm surge, wave generation and ice condition
O2***	Storm surge impacts on biological resources in the Yukon Kuskokwim Delta	ocean to shore	Better understand the relationship between storm surge wave generation and ice surge.
O3***	Leveraging opportunity for wave buoy data collection	ocean to shore	Increase wave measurement devices (wave spectra; use of buoys).
O4	Russian-American Long-term Census of the Arctic (RUSALCA)	ocean to shore	Better understand the relationship between storm surge wave generation and ice surge.
O5***	Observing turbulent fluxes in the upper Arctic Ocean	ocean to shore	Increase wave measurement devices (wave spectra; use of buoys)
O6***	Alaska Ocean Acidification Network	ocean to shore	Increase wave measurement devices (wave spectra; use of buoys)
O7	The Wave Information Study, Western Alaska Wave Hindcast (1985 - 2013).	ocean to shore	Increase wave measurement devices (wave spectra; use of buoys)
O8	Assessment of Storm-induced water levels for St. Lawrence Island and the greater Bering Strait Region, Alaska	ocean to shore	Identified a fundamental need to collect vertical data tied to tidal benchmarks
O10***	Towards a 90-day monthly storm outlook for Alaska, North Pacific, and Hawaii	ocean to shore	Better understand the relationship between storm surge, wave generation and ice condition

Table 5 Continued

Project ID:	Title:	Recommendation Categories:	Coastal Process Workshop Key Recommendation:
O11	Northern Bering Sea improved hazard monitoring in the marine and coastal environments	ocean to shore	Increase number of wave measurement devices
O13***	Mapping surface currents of Kotzebue Sound using satellite drifters	ocean to shore	Increase wave measurement devices (wave spectra; use of buoys).
O14***	Reconnaissance static occupation of Tidal Benchmarks in Western Alaska	ocean to shore	Identified a fundamental need to collect vertical data tied to tidal benchmarks
B17	Intertidal Invertebrates and Algae Sampling	nearshore	Establish Sentinel Sites to gather critical parameters including chemical, physical, and biological measurements of these systems
B19	Eelgrass Bed Sampling	nearshore	Establish Sentinel Sites to gather critical parameters including chemical, physical, and biological measurements of these systems
B32	Establishing a Baseline for Regional Scale Monitoring of Eelgrass (Zostera marina) Habitat on the Lower Alaska Peninsula	nearshore	Establish Sentinel Sites to gather critical parameters including chemical, physical, and biological measurements of these systems
B34	Inventory and Monitoring of Eelgrass, Seaweeds, and other marine organisms in Southwest Alas	nearshore	Establish Sentinel Sites to gather critical parameters including chemical, physical, and biological measurements of these systems
O9***	Synthesis of Arctic Research (SOAR): An ocean acidification sensitivity index for the Pacific Arctic Region	nearshore	Evaluate existing models of the nearshore, including relationships between physical, chemical and biological components
L-G6***	Coastal Geohazard Evaluation and Geologic Mapping in the Vicinity of Wales, Alaska	bathymetry	Bathymetry – an underlying need for nearshore bathymetry identified throughout workshop
L-G10***	Nearshore bathymetric data collection in the vicinity of Western Alaska Communities	bathymetry	Bathymetry – an underlying need for nearshore bathymetry identified throughout workshop

APPENDIX A:

To: Western AK Coastal Project Contact
From: Casey Brown

Date: August 13, 2014

Subject: Request for information regarding coastal projects in western Alaska

My name is Casey Brown and I am graduate student at the University of Alaska Fairbanks working in collaboration with the Western Alaska LCC and ACCAP on the project **Current Coastal Change Research/Management Projects and Priority Information Needs in Western Alaska.**

The goal of this effort is to identify current coastal research and management projects that are taking place in Western Alaska and to synthesize information into a report that documents the 'project landscape' for communities facing change, decision-makers navigating change, researchers pursuing projects, as well as funding agencies trying to prioritize where to allocate resources.

Currently, I am compiling a list of coastal projects taking place in Western Alaska. I hope to expand this list through conversations with key researcher and stakeholder groups that have been active in the region. You have been identified as an important contact through the Western Alaska LCC. We are asking our contacts to take a few minutes to review a list of projects in their field. Specifically, we would like to know of other coastal projects that are underway in western Alaska. If you are involved in a project not on this list please contact me and I will add the project information to the database. If you know of other projects, please send me the contact information so we can get in touch with the appropriate people and include their information in the database.

We are defining "coastal projects" as those that have at least one of the following criteria:

- focus on coastal drivers (storms, erosion, sea level rise, nearshore sea ice)
- projects in communities on or near the coast in the LCC geography that are looking at coastal change
- shoreline projects (e.g. mapping, stabilization surveys)
- coastal habitat or species response projects (including estuaries and delta habitats)
- nearshore projects (lagoons, eel grass communities)
- estuary projects
- marine mammal projects as they relate to their land or nearshore habitats
- Subsistence species projects that include marine mammals or coastal bird species/populations
- Fish projects at coastal sites.

I can be reached at: clbrown12@alaska.edu

Sincerely,

Casey

APPENDIX B.

List of Coastal Contact Institutions

- National Park Service (NPS)
- Environmental Protection Agency (EPA)
- National Oceanic and Atmospheric Administration (NOAA)
- ABR, Inc.
- U.S. Fish and Wildlife Service
- Norton Sound Economic Development Corporation
- U.S. Bureau of Indian Affairs
- Alaska Department of Transportation
- University of Alaska Anchorage
- University of Alaska Fairbanks
- University of Alaska Anchorage
- Bureau of Ocean Energy Management
- U.S. Geological Survey (USGS)
- U.S. Army Corps of Engineers
- Kawerak, Inc.
- Aleutian Pribilof Island Association
- Alaska Department of Fish and Game
- Alaska Native Tribal Health Consortium
- University of Victoria
- Alaska Department of Natural Resources
- Manomet Center for Conservation Science
- Yukon River Drainage Fisheries Association
- Alaska Ocean Observing System
- University of Saskatchewan
- Alaska SeaLife Center
- Alaska Department of Environmental Conservation
- Aleut International Association
- Native Village of Kotzebue

APPENDIX C.

Key Recommendation and Needs:

Document drafted at the 2012 Coastal Hazards Workshop. For a complete report, visit: http://www.aoos.org/workshops-and-reports/

Ocean to Shore

- o Identified a fundamental need to collect vertical data tied to tidal benchmarks
  - Linkage is critical to connect topography and bathymetry, and thus link hydrodynamic models to surge impact models.
  - This 'ocean to shore' connection was described as a "Rosetta Stone" for understanding related processes and impacts.
- o Increase tidal gauges (3 month duration is the minimum time needed to measure cycle); to be complete, 25 hours (gets us started on the 1-4 cycles per day tides), 29.53 days (1 synodic month, gives us the spring/neap cycles), 1 year (annual and semi-annual tides, and splitting of the daily and monthly tides), and 19 years (the gold standard, includes the lunar node and perigee variations at 8.85 and 18.6 years)
- o Utilize community observation for storm surge and tide height, nearshore and shore-fast ice impacts on surge, etc.
- o Discover and synthesize existing information (e.g., nearshore data listed earlier, etc.)
- o Increase number of wave measurement devices (wave spectra)
- o Better understand the relationship between storm surge, wave generation and ice condition (both offshore ice presence and shore-fast ice presence)

Nearshore

- o Evaluate existing models of the nearshore, including relationships between physical, chemical, and biological components, for applicability to Western Alaska oceans. Include review and synthesis of existing sources of relevant data for this region.
- o Establish Sentinel Sites to gather critical parameters including chemical, physical, and biological measurements of these systems
  - Example of Bristol Bay pilot program (Nushagak Bay Diversity Project, UAF Bristol Bay Campus, Environmental Science Laboratory) as a mechanism for site establishment that employs scientists, students and local residents to conduct baseline studies and long-term monitoring of physical parameters.
  - Eelgrass beds may provide key strata of sites.
- o Comments emphasized the need to develop and maintain data discovery and access.

Bathymetry – an underlying need for nearshore bathymetry identified throughout workshop