A Conservation Action Plan for Estuarine Ecosystems of Southeastern Alaska

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Figures

Conservation Action Plan Summary

The mission of The Nature Conservancy (TNC) is to conserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. The estuarine ecosystems of the southeastern Gulf of Alaska are globally significant as intact ecosystems with high levels of productivity for people and wildlife.

This report is a conservation action plan (CAP), forming the foundation of TNC's marine conservation strategies in this region. The CAP defines the project scope, the ecosystems and species conservation targets, the risk factors to those targets, and initial conservation strategies to implement in Southeastern Alaska over a 5 year planning horizon. This report builds upon the decision support tools that TNC and Audubon Alaska developed in the terrestrial ecoregional assessment for Southeastern Alaska and the State of Alaska Comprehensive Wildlife Conservation Strategy (CWCS) (ADF&G 2006; Schoen 2007). The ecoregional assessment developed recommendations for TNC's conservation design for watersheds. While the assessment referenced estuarine systems as an important feature of the region, they were not central to the overall conservation design. This document provides the context for developing a marine conservation design which reflects the ecological connections between coastal forest watersheds and the marine ecosystems of the region.

Southeastern Alaska's nearshore marine and estuarine ecosystems (referred to in this document as the estuarine ecosystem complex) are defined by the intersection between the temperate rainforests, rivers, and the Alaska Coastal Current. Estuaries are described generally as partially enclosed bodies of water along coastlines where freshwater and saltwater meet.[1] The massive amount of freshwater flows converges with saltwater and provides numerous ecological services to fish, wildlife and people.[2]

Anadromous fish utilize the transitional habitat for adapting to either saltwater or freshwater during their migration. This region provides spawning and nursery areas for plankton, invertebrates and marine fish; food and habitat for whales, migratory waterfowl, sea birds, Stellar sea lions (*Eumetopias jubatus*), sea otters (*Enhydra lutris nereis*), and harbor seals (*Phoca vitulina*). This land-sea interface also is important for terrestrial mammals such as brown and black bears (*Ursas arctos* and *americanas*), Alexander Archipelago wolves (*Canis lupus ligoni),* mustelids, and Sitka black-tailed deer (O*docoileus hemoinus sitchensis*). In turn, the salmon and other animals bring marine derived nutrients back into the forested watersheds (Ben-David 1998; Fellman 2008; Helfield 2001; Janetski 2009; Kline 1990; Quinn 2009).

Thirty coastal communities, with a population of approximately 69,000 people, depend upon intact estuaries and nearshore marine ecosystems for economic activities, traditional food resources, cultural traditions, and recreation. The management of these places includes a ban on bottom trawling (except for the scallop fisheries of Yakutat) and finfish farming. Fisheries are managed with the intent of sustained yield with limited entry fisheries used as a management tool. The relatively clean water quality of the region supports shellfish growing activities while

[1] The current definition of an estuary is "a narrow, semi-enclosed coastal body of water which has a free connection with the open sea at least intermittently and within which the salinity of the water is measurably different from the salinity in the open ocean Tomczak, Matthias. 2000. Definition of estuaries; Empirical estuary classification. Page 14."

[2] Most of Southeastern Alaska is semi-enclosed by land with a freshwater flow regime coming into the region at about 25,500 cubic meters per second or nearly 1 million cubic feet per second. This freshwater markedly dilutes the ocean water of the Gulf of Alaska. Thus by definition, the entire archipelago is considered one large estuarine complex.

the protected inlets and bays of the region host thousands of tourists and recreation seekers each year.

Due to the predominantly steep and rocky topography of the region, some of the most productive habitats are often preferred areas for housing, barge, ferry and cruise ship transportation, energy infrastructure, roads, and airports. With coastal development being a practical necessity, communities are faced with the challenge of protecting the ecological integrity of Southeastern Alaska's estuarine ecosystems– while sustaining local economies.

Chapter 1. The Nature Conservancy's Planning Methods

1.1 Overview

The Nature Conservancy achieves conservation results by designing and implementing conservation projects at multiple scales, using a framework known as Conservation by Design. The three planning tiers include the global habitat assessment, the ecoregional assessment, and the conservation action plan. The Nature Conservancy has identified the North Pacific Marine region as a global conservation priority, spanning from the warm waters of Baja, Mexico up to the temperate coasts of the Pacific Northwest, extending north to the Beaufort Sea. While vast in area, these waters are interconnected by coastlines, migrating species, and currents that bring waters from the ocean floor to the surface to provide nutrients and food to an immense web of life, on the sea and the land.

At the ecoregional level, TNC refines scientific analysis to consider finer-scale data on the distribution and status of biodiversity, habitat condition, current and future threats and socio-political conditions. The SEAK Ecoregional Assessment provides an overview of the biogeographic provinces, major habitats, fish and wildlife resources, human uses, an assessment of risk to those resources, and a conceptual conservation strategy focused on watersheds (Schoen 2007). Watershed geomorphology, environmental conditions, and freshwater inflow directly affect the characteristics and productivity of the estuarine and nearshore marine ecosystems. Thus, the next phase is to characterize the physical characteristics, ecological functions, and conservation status of estuaries, tidelands, nearshore marine waters, and biota of Southeastern Alaska. Additionally, Alaska's Comprehensive Wildlife Conservation Strategy (CWCS) used elements of Conservation by Design and the development of an ecological framework for conservation actions specific to ecosystems and habitats in Southeastern Alaska is designed to address these recommendations.

Information on the distribution of past and current human activities needs to be compiled in order to characterize the ecological integrity of specific estuary sites in relation to societal goals for the management of these resources. The combined assessment of ecosystem diversity, biological and human use values and management status will help inform conservation priorities for The Nature Conservancy and others in the region.

1.2 Conservation Action Planning

TNC has developed an integrated process for planning, implementing, and measuring conservation success for conservation projects, referred to as "Conservation Action Planning (CAP)", see Figure 1.

Figure 1. The Nature Conservancy's Conservation Action Planning Process

The basic steps of the CAP are illustrated below in Figure 2. One of the most important aspects of the CAP is to identify the focal conservation targets, such as ecosystems, communities or species, which, if conserved over time, will protect the biodiversity of the project area. Once the targets are identified, the next step is to document the status of target health or viability, then document the stresses and sources of stress, i.e. threats, to the health of the target. CAP results in developing strategies that are directly related to the health of focal conservation targets.

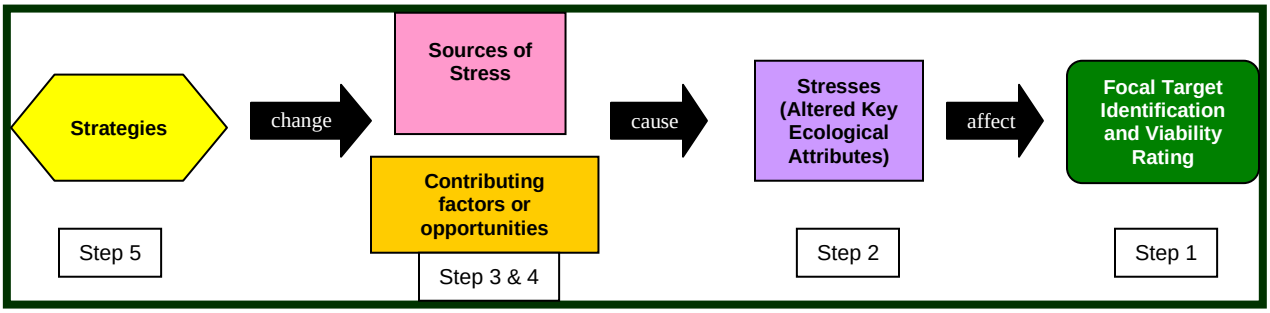

Figure 2. Conservation Action Plan steps

Two primary CAP tools were used in the development of this report:
1) The CAP Workbook, an Excel-based program in which users input ecological information i.e. conservation targets and ecological attributes, viability ratings of targets, percentages of targets needed for conservation goals, threats and stresses to those targets, rankings of the threats, monitoring plans, and strategy development based on the highest ranked threats. The end products result in summary tables that are useful for evaluating and setting priorities.
2) Miradi project management software, which helps conservation project managers illustrate, track and monitor their strategies.
These planning tools can be found at The Nature Conservancy's Conserveonline Website for CAP resources: http://conserveonline.org/workspaces/cbdgateway/cap/resources/index_html.

Because CAP is an iterative process that emphasizes adaptive management throughout

the life of a project, we will initially address the estuarine complex of Southeastern Alaska at a regional scale. This CAP provides the foundation for proceeding with an ecoregional assessment, with the goal of establishing priorities among important nearshore marine areas and estuaries. The ecoregional assessment involves the compilation of scientific information on ecosystem functions and values defined from existing coastal plans, scientific expertise, stakeholders and TNC's scientific "toolbox" under development e.g. ShoreZone Mapping, see Appendix I, and a hierarchical estuarine classification system, see Section 2.

1.3 Project Partners

As part of the initial CAP process, TNC has identified a significant number of opportunities to work with partners with an interest in maintaining or improving nearshore marine and estuarine ecosystems, habitats, and the diverse array of species that inhabit them. We will engage stakeholders in this project, including the coastal communities, watershed councils, the tourism industry, fishing and mariculture industries, government agencies, scientists, and landowners. These are the partners who manage, research, monitor, and use these dynamic systems every day:

- Skaggs Foundation
- The Gordon and Betty Moore Foundation
- The Leighty Foundation
- NOAA National Marine Fisheries Service and the Alaska Science Center
- Alaska Dept. of Natural Resources
- Alaska Dept. of Fish and Game
- U.S. Fish and Wildlife Service
- U.S.D.A. Forest Service
- University of Alaska Southeast
- The Ocean Fund, Royal Caribbean Cruise Lines Inc.
- Coastal and Ocean Resources Inc.
- Archipelago Marine Research Ltd.
- Southeast Alaska Petroleum Resources Organization
- Coastwise Services

Chapter 2. Southeastern Alaska: An Estuarine Ecosystem Complex

2.1 A Dynamic and Productive Region

2.11 Geomorphology of the Coast

The planning area in Southeastern Alaska extends from Cape Suckling north of Yakutat to Dixon Entrance at the southern end of Prince of Wales Island consisting mostly of a narrow 193 km (120 mi) strip of mainland mountains and with over 1,000 offshore islands (O'Clair 1997). Because the region includes deepwater fjord-type basins, all of the estuarine and nearshore marine waters within the confines of the shoreline regardless of depth are considered part of this area. For the purposes of the conservation framework, the subtidal boundary of those shorelines on the outermost islands and the coast from Cape Suckling to Yakutat bordering the State of Alaska's three-mile zone extending from the shoreline seaward to the thirty meter isobath will be included in the scope of this project (Madden 2005).

Southeastern Alaska's habitats and biological resources are the result of extremely dynamic geological processes and large scale meteorological and oceanographic systems of the Gulf of Alaska. The bathymetric complexity of the region reflects the diverse tectonic and glacial processes that have operated over the region for millions of years (Weingartner et al 2008). This region is dominated by water – marine, freshwater, and a maritime climate characterized by cool temperatures and heavy precipitation. Year-round precipitation is responsible for the formation of vast ice fields, numerous streams, and temperate rain forests.

Because the oceanographic circulation of the Gulf of Alaska's (GOA) current is northward on average, this provides a connection between marine ecosystems of British Columbia and Southeastern Alaska. This linkage may be critical in maintaining the current biological structure of Southeastern Alaska and the northern GOA and in governing or impacting the future evolution of these marine ecosystems (Weingartner 2008).

The GOA covers the convergent Pacific and North American lithosphere plates and thus is one of the more tectonically active zones on earth (Jacob 1987). The plate convergence and related seismic, tectonic, and volcanic activities are responsible for many of the geo-morphological characteristics of this region. Scientists have measured the rise of land in this dynamic landscape and have found the fastest rates of land uplift in the world in Southeastern Alaska at Glacier Bay (1.18 in/yr) and Yakutat Icefield (1.26 in/yr) (Motyka 2007). The uplift pattern measured was shown to span an area of over 100,000 square km. The greatest amount of sea level change also occurred at these sites where the greatest uplift occurs.

2.12 Characterizing Estuaries

Estuarine systems in this region can be characterized based on physical parameters derived from the marine realm (e.g., depth, exposure, sea surface temperature, tidal range, salinity, etc.), freshwater realm (runoff, glacial influence, velocity, sediment regime, nutrient inputs, etc.), and terrestrial realm (geology, landform, gradient, watershed condition, etc.), Fig. 3. The combination and interaction of all of these factors will determine the functions, habitat and species assemblages using these estuaries.

The tidal regime is the one common denominator among the habitats in the estuarine ecosystem complex. The shorelines are subject to mixed semidiurnal tides with two high and two low tides daily, each differing in amplitude. Tidal heights and times differ based on the characteristics of the shoreline, offshore islands and basins, and weather. The tidal range in this

region is between 3.5 to 8.2 meters and directly affects the strength of currents and tidal prisms in all locales.

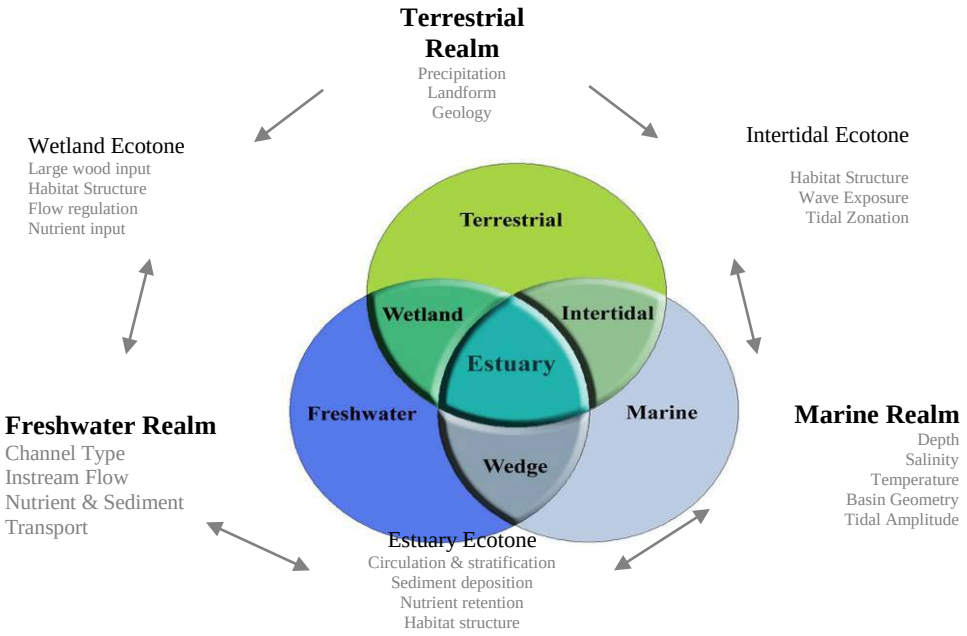

Figure 3. Key ecological processes in the terrestrial, freshwater and marine realms provide the contextual framework for characterization of a wide range of species and ecological systems. Adapted from (Fastie & Derr 2007; MacKenzie 2004).

The plant and animal species living in this estuarine complex reflect their adaptation to tides, salinity, geomorphology, current, and wave exposure. Wave and fluvial energy that control deposition and transport of sediments, as well as the local substrate, are the primary determinants of habitat associations and biotic composition within a shoreline unit (Ricketts 1985). Shorelines throughout Southeastern Alaska have the full range of exposure, from highly exposed on the outer coast with salinities up to thirty-three percent, to protected bays with relatively low salinities of fifteen percent or less. Also, the distribution of organisms in space and time exhibit regular and predictable patterns of zonation based on the tidal height, wave energy and substrate conditions, a phenomenon known as biobanding (Harney 2008).

One of the reasons for the diversity and abundance of animal life in estuaries is their high primary productivity. Tidal marshes or salt marshes (*Puccinellia sp*. and other salt tolerant herb grasses), in particular, produce a prodigious amount of plant material that serves as food for direct consumers of organic detritus. Dead plant material is recycled in the marsh or transported into the estuarine waters. Microbes break down this detritus, which is transported throughout the estuary by tides and becomes the foundation of life in estuarine ecosystems (Brophy 2007). Salt marshes provide carbon in the form of detritus as a source of energy to the estuarine complex and ocean. They also provide important food sources for brown and black bear, waterfowl and shorebirds, salmonids, and marine fish species. Salt marshes are a rare habitat in this region and make up less than 0.2 % of the emergent vegetated wetlands.

Eelgrass is one of the most important habitats of estuarine ecosystems, supporting more than fifty species of marine fish, commercially utilized invertebrates, invertebrates as food

sources for fish, and food for waterfowl (Johnson et al.2003). Some of the most abundant marine species found in eelgrass beds include walleye pollock (*Theragra chalcogramma*), Pacific sand lance (*Ammodytes hexapterus*), shiner perch (*Cymatogaster aggregate*), juvenile rockfish (*Sebastes* spp.) and Pacific cod (*Gadus macrocephalus*). Eelgrass may occur in both the intertidal and subtidal areas, depending on location and conditions. Eelgrass is sensitive to disturbance, turbidity and eutrophication and has been designated as a critical habitat by the US Fish and Wildlife Service, NOAA National Marine Fisheries Service, and the Alaska Dept. of Natural Resources.

Macro-algal communities found on rock substrate within the estuarine ecosystem complex include canopy and understory kelp communities. Canopy kelps are shallow subtidal communities dominated by large brown algae forming surface cover. Canopy kelps are among the most productive marine communities in temperate waters and provide habitat for juvenile marine fish, forage fish, sea urchins, and sea otters. The three canopy kelp species that occur in Southeastern Alaska include the Alaska giant kelp (*Macrocsystis integrifolia*), bull kelp (*Nereocystis luetkeana*) and dragon kelp (*Alaria fistulos*a).

2.13 Ecological Functions of Estuaries

Estuaries support a diverse array of fish and wildlife species because of the important biological and physical functions that they serve, see Table 1. Estuaries function as transitional waters for anadromous fish adapting to either saltwater or freshwater during their migration. In addition to fish, many species of land and marine mammals depend on estuaries for food and breeding areas. Migratory birds use estuaries as stopover points for resting and feeding before continuing their migration.

Table 1. A list of ecological functions provided by estuarine habitats.

Biological Functions	Hydrology and Circulation
Contributes to primary production	Sediment and organics transport
Breeding grounds for marine mammals and birds	Alter turbidity
Nursery habitat for juvenile shellfish, pelagic fish, groundfish and anadromous fish	Modify water temperature
Refuge habitat for fish, marine mammals and birds	Freshwater and saltwater retention
Provides substrate for habitats	Erosion reduction
Migration corridor	Wave energy reduction
Supports complex marine and terrestrial food web interface	Maintains water quality through filtration
	Modifies chemical water quality i.e. salinity, dissolved oxygen

Estuaries are important to the health of the oceans by serving as a buffer between the ocean and the land. They filter sediment and pollutants from freshwater before it enters the oceans. Excess nutrients are remediated in bordering salt marshes, resulting in improved water quality for people and marine organisms. Estuaries decrease the impact of flooding and storm surges, thus reducing impact on human activities and property.

2.14 Nurseries of the Sea

Estuaries have been called "nurseries of the sea" because they provide the protected environment, nutrient exchanges, and abundant food sources for fish and shellfish reproduction. About seventy-five percent of all fish caught by the commercial fisheries in Alaska utilize estuaries and salt marshes during some part of their life history (Chambers 1992). Over one hundred and sixty species of marine fish have been collected from Glacier Bay alone (Arimitsu et al. 2003) and the total number of species utilizing estuaries in this region is much larger.

Forage fish provide an essential food supply for nearly all species found in the estuarine complex. Their importance to the well-being of many species is often overlooked and relatively little information is available on their habitats or distribution. The principal forage fish of interest include Pacific herring, eulachon, Pacific sand lance, and capelin. Forage fish life cycles include specific habitat requirements for spawning, rearing, and feeding patterns. The viability of forage fish are of concern, due to their shear importance in the nearshore marine and estuarine ecosystems.

There is little information known about trends in eulachon populations, sand lance and capelin populations. There is a commercial fishery open for herring and a personal use and subsistence fishery exists for eulachon. The life cycles of forage fish are poorly understood. In turn, impacts resulting from environmental, predation and anthropogenic activities such as overfishing, pollution, habitat degradation, competition with hatchery fish are poorly understood.

Pacific halibut, sablefish, Pacific cod, and rockfish species all spend a portion of their life cycles in the estuarine ecosystem complex. Seasonal ocean circulation and stratification patterns, health of species (levels of contaminants, size and weight), population numbers, and food quality all contribute to fish population levels. Sablefish is fished commercially in the protected waters of the region. Juvenile sablefish are consistently found in only a few isolated estuaries, making those sites extremely important habitats. Pacific halibut are common inhabitants of shallow estuarine waters. Most spawning takes place off the edge of the continental shelf in deep waters; although there may be small localized spawning populations in deep waters such as in Chatham Straight. Because the eggs and larvae are free-floating and there is subsequent mixing of juvenile halibut throughout the Gulf of Alaska, there is only one known genetic stock of halibut in the northern Pacific. Halibut has become one of the most important commercial, recreational, and subsistence fisheries in Southeast. Overall, marine fish viability is assessed to be good, although this rating is species dependent.

2.2 A Hierarchy of Estuaries in Southeastern Alaska

from (Albert 2008)

The Alexander Archipelago, or the North American Pacific Fjordlands ecoregion, is located within the southeastern Gulf of Alaska. This area extends southwest from Icy Point (including Yakutat Bay) to Dixon Entrance south of Ketchikan (Spalding 2007). Nearshore marine and estuarine systems are characterized by supratidal, intertidal, and subtidal zones defined by elevation, tidal inundation, wave exposure, salinity, geomorphology, and watershed conditions. Within this ecoregion, primary distinctions are drawn among ecological systems directly influenced by the Pacific Ocean (high salinity) and between northern (colder, low salinity) and southern (warmer, low salinity) inside waters (O'Clair 1996; O'Clair 1998).

The boundary between northern and southern inside waters occurs at the Kuiu-Kupreanof-Mitkof island group, with only 3 narrow connections at Rocky Pass, Wrangell Narrows and Dry Strait. The northern inside zone is the complex drainage of Chatham Strait, including Lynn Canal, Glacier Bay, Icy Strait, Stephens Passage (which includes the Taku River) and Frederick Sound. The southern inside zone is dominated by the freshwater effluent of the Stikine River into both Sumner and Clarence Straits, with Dixon Entrance as the southern boundary of this zone. Thus, the Alexander Archipelago can be understood as a complex estuarine system with deep-water connectivity of large, main-land rivers to the Pacific Ocean at Chatham Strait and Dixon Entrance, and more constrained connectivity at Cross Sound, Salisbury Sound and Sumner Strait (Albert 2008; Nowacki 2001; Weingartner 2008)

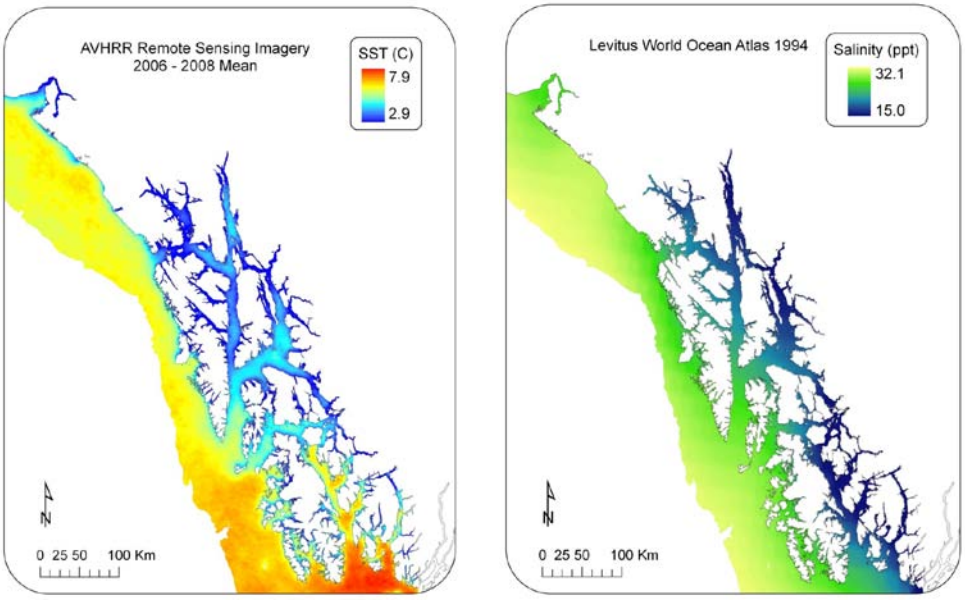

Figure 4. Relatively coarse scale salinity values were obtained from the NODC (Levitus) World Ocean Atlas Data 1994 and sea surface temperatures were from all available Advanced Very High Resolution Radiometer (AVHRR) data between 2006 - 2008.

Coastal basins can be further divided into sub-basins representing sets of adjacent watersheds with similar coastal morphology, glacial and marine influence, and a common salt water basin. This scale of the hierarchy is analogous to, and was informed by, ecological subsections based primarily on geology and glacial history and sub-basins among freshwater systems (Maxwell 1995; Nowacki 2001). Characteristic examples of sub-basins in Southeastern Alaska include Tenakee Inlet, Sitka Sound, Tracy / Endicott Arm, Sea Otter Sound and Kasaan Bay.

A preliminary database has been developed in which an estuary is located at each point where a freshwater stream meets salt water. Based on this database, approximately 12,000 estuaries exist in Southeastern Alaska, see Figure 5. By imposing a minimum basin size of 100 ha, the number is reduced to 2,944 estuaries (Schoen 2007). Because there are thousands of estuaries in Southeastern Alaska exhibiting a variety of estuarine features and functions, scientists' ability to predict or generalize the consequences of anthropogenic or global change on these estuaries is marginal. Currently, there are many different classification systems for estuarine and nearshore marine habitats across the country, but no uniform standard (Vander Schaaf 2006). Likewise, there is no adequate classification system for the Southeastern Alaska estuarine complex.

TNC is working with partners to develop two baseline data tools for inventorying and classifying coastal resources in Southeastern Alaska. The first tool is the habitat mapping and

inventory of the protocol known as ShoreZone (see Appendix I). Some of the basic ecological information applied in this CAP is based on the Alaska ShoreZone Habitat Mapping and Inventory Project (Baker 2011).

The second tool is a data-driven classification framework to improve the scientific basis of representing biological diversity and productivity. This preliminary framework, *Coastal Ecological Systems in Southeastern Alaska, A Preliminary Classification of Coastal Ecological Units: A Hierarchical Framework and Exploratory Analysis*, is in development and available for review. This classification framework is a data-driven analysis, using physical, climatic and hydrological variables to identify the locations and differences of water bodies in the region. Other methods of classification systems, such as descriptive classifications provided in the Coastal and Marine Ecological Classification Standard (CMECS) will help inform the classification framework in Southeastern Alaska by providing reference narrative descriptions of different classes of water bodies (Madden 2005).

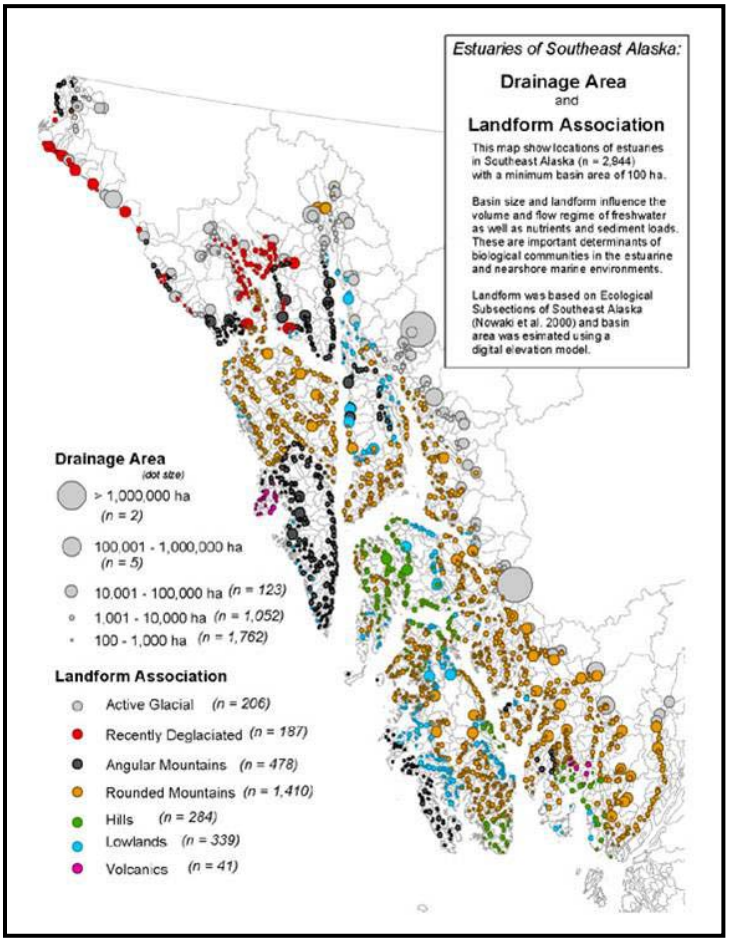

Figure 5. This map shows locations of estuaries in Southeastern Alaska (n-2944) with a minimum basin area of 100 hectares. Basin size and landform influence the volume and flow regime of freshwater, nutrients and sediment loads. These are important determinants of biological communities in the estuarine and nearshore marine environment.

Classification systems help to define how specific functions are associated with specific components of the estuarine system. An example is the relation of retention time of water in a basin to rearing habitat for juvenile salmonids or marine fish. A classification system will help determine which estuaries and habitats are most sensitive to stresses and threats. For example, a classification system using physical and hydrologic attributes to estimate the susceptibility of estuaries to pollutants has been developed (Engle 2007).

The goal is to be able to derive measures of habitat quality and productivity for a suite of species and ecological systems. When such measures are combined in a systematic manner, we will be able to distill relatively simple indices of combined biological value that will be very useful for systematic planning of conservation strategies, see Figure 6 for this conceptual model (Edgar 1999). Ultimately, TNC plans to apply the Classification Framework, in conjunction with the model in Figure 6 to evaluate places for conservation priorities based on the relative biological value, conservation significance, and human use values of specific estuaries.

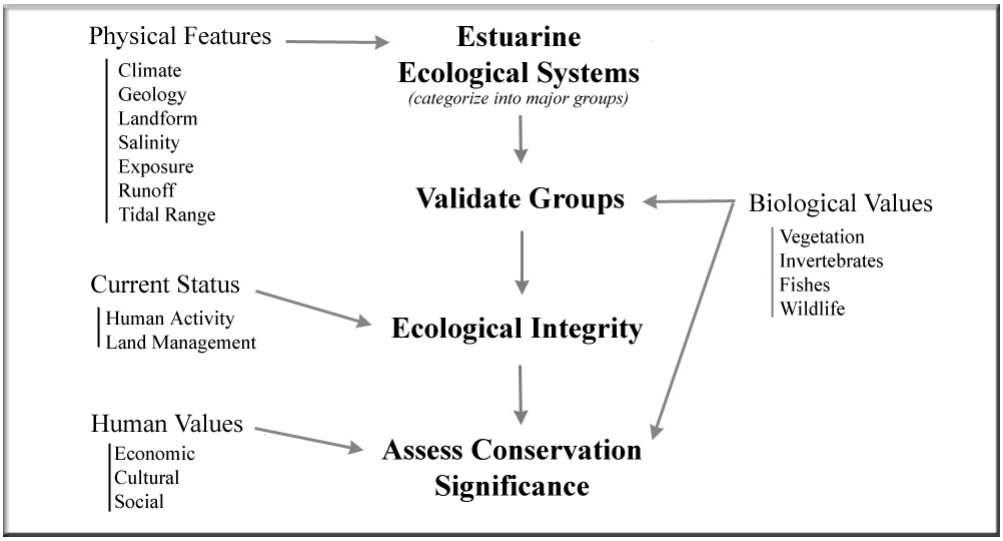

Figure 6. A conceptual model for ecological classification of estuaries and assessment of their conservation significance (adapted from (Edgar 1999).

Chapter 3. Focal Conservation Targets and Key Ecological Attributes

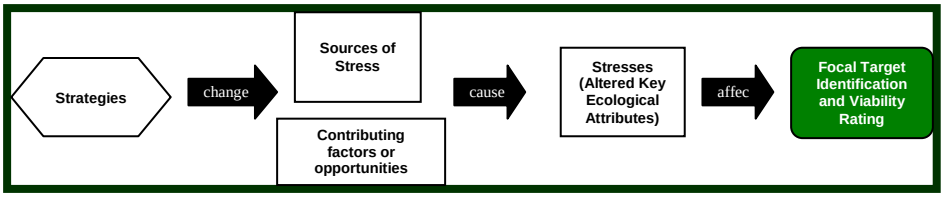

Figure 7. Focal target identification and viability rating section.

For the purposes of the CAP, focal conservation targets are defined at a regional scale and are a representative suite of ecological systems, habitats and species which, if adequately conserved over time, would ensure conservation of the biodiversity of the planning area. Figure 7 above shows a conceptual model of how planning begins with the identification of conservation targets. The targets for this CAP include: 1) Estuarine Ecosystem Complex, 2) Freshwater Ecosystems, 3) Anadromous Fish, 4) Marine Mammals, and 5) Migratory Birds.

The next step in the CAP process is to define the key ecological attributes of the conservation targets, or those factors which the conservation targets need to remain healthy. The key ecological attributes (KEA) provided in this paper are to be applied as a template for assessing target health or viability, see Appendix C. TNC plans to further evaluate the viability of key ecological attributes with a geospatial analysis on the current condition and trends to inform more detailed conservation strategies.

A list of preliminary indicators for the key ecological attributes has also been developed, see Appendix C. Indicators are specific parameters that can be monitored over time in order to ascertain target health and the level of impacts from risks factors. There are a number of monitoring plans with indicators for nearshore marine areas across the Gulf of Alaska. However, there is no ecosystem based, long term, regional monitoring plan - an important step in implementing a conservation plan.

3.1 Estuarine Ecosystem Complex

Southeastern Alaska is a fjordland ecoregion with heavy rainfall, high tidal variation, wind, and terrain driven mixing. These physical processes drive the productivity of Southeastern Alaska's nearshore marine and estuarine environment. The estuarine ecosystem complex includes estuaries, rocky shore communities, and specific species as nested targets. This is a regional scale target intended to help characterize large scale processes. The key ecological attributes include oceanographic circulation and sedimentation, water quality, and habitat structure.

There are a number of stresses to the attributes described above that have never been quantified region-wide, including climate change impacts. Upland and coastal development such as logging and urbanization have impacted the condition of numerous watersheds and the quantity and quality of freshwater inflow and sedimentation processes to estuaries. Preliminary indicators for measuring impacts to estuarine ecosystems are listed in Appendix C.

While no quantitative measure of stresses to estuarine ecosystems in the region exists, the ShoreZone habitat inventory and the classification system will provide a baseline dataset of locations of coastal habitats. Once this inventory is complete, the health and condition of those habitats can be assessed in relation to the stresses listed above.

3.2 Freshwater Ecosystems

Freshwater ecosystems include all of the sources of freshwater flow such as streams, wetlands, groundwater, and lakes, which contribute inflow to the estuarine complex. The key ecological attributes of freshwater ecosystems include the freshwater hydrologic and sedimentation regime, habitat structure and connectivity, the condition of riparian, wetlands, and in-stream habitats, and water quality. Freshwater flow directly affects the structure and function of the estuarine complex through its influence on salinity, sediment delivery, circulation and the conveyance of watershed materials such as small and large wood detritus, pollutants, and other watershed-derived materials.

Historic logging across Southeastern Alaska has impacted a portion of freshwater stream ecosystems, as well as roading, urbanization, mining, and contaminated sites. Preliminary indicators for measuring impacts to freshwater ecosystems across the region are listed in Appendix C.

3.3 Anadromous Fish

Anadromous fish represent the need to conserve habitat connectivity between the watersheds, estuaries, shorelines, and open ocean. This target covers the five species of Pacific salmon: chinook (*Oncorhynchus tshawytsch*a), sockeye, (*O. nerka*), coho (*O. kisutch*), chum (*O. keta*), and pink (*O. gorbuscha*), the steelhead trout (*O. mykiss*), the cutthroat trout (*O.clarki*), and the Dolly Varden char (S*alvelinus malma*) that make up the native wild anadromous fish in Southeastern Alaska. The key ecological attributes identified for salmonids include connectivity for fish between freshwater systems, estuaries, and nearshore marine habitats; condition of spawning and rearing habitats; and water quality.

General risks to salmonids include barriers within streams and along shorelines, degraded habitat for spawning and rearing, point and non-point source pollution, and fisheries management issues. Indicators for assessing salmonid viability are listed in Appendix C.

The estuarine ecosystem complex is critical to many species, but particularly to salmon. Sustaining viable populations of all salmon species and other estuarine-dependent wildlife is dependent on maintaining all of the ecological attributes at healthy levels in these coastal waters. The condition of the watersheds as reflected by the stream hydrograph, the sediment delivery regime, and the integrity of the riparian vegetation are principal components of the habitat that salmonids have adapted to over thousands of years. Estuaries play a critical role in the early life history of these fish and the abundance of a year class most likely depends upon their initial growth and survival in this environment.

The overall abundance of the salmon species is monitored by the Alaska Dept. of Fish and Game through catch statistics and escapements. The current abundance of salmon in Alaska and this region is above historical numbers and most populations are currently stable (Clark 2006 ; Halupka 2000). About 13,750 miles of anadromous habitat has been identified in this region with coho salmon being the most widely distributed. Based on the estimated freshwater distribution of salmon and steelhead among the twenty-two biogeographic provinces in Southeastern Alaska, North Prince of Wales Island contained the most anadromous salmonid habitat (Schoen and Dovichin 2007).

3.4 Marine Mammals

Marine mammals are identified as a conservation target due to their susceptibility to human disturbance and climate change. This target includes several species of marine mammals that belong to two separate classification orders. The order Cetacea includes whales, dolphins, and porpoises. The order Carnivora includes sea otters (*Enhydra lutris*), harbor seals (*Phoca vitulina*), and the eastern stock of Stellar's sea lions (*Eumetopias jubatus*). Steep, expansive rocky shore areas are prime locations for Stellar's sea lion and harbor seal haul-outs.

The humpback whale is a pelagic and coastal species often feeding in very shallow waters. Its prey is primarily euphausids and forage fish. Between April and November, humpback whales feed in the rich fjords of southeast, Alaska, fattening for migration to overwinter in Hawaii. The populations of humpback whales are increasing in this region from lows of several hundred after the ban on whaling to between three and five thousand whales today (Calambokidis 2008). Humpback whales are managed as endangered species under the Endangered Species Act. Risks, such as boat strikes, entanglement, harassment, Navy sonar testing, pollution, and changes in forage composition and availability are present in Southeastern Alaska.

The presence of sea otters in Southeastern Alaska are the result of a translocation of four hundred and twelve animals from Prince William Sound and Amchitka in the late 1960s (USFWS 2002). Prior to the translocation, they had been absent from these habitats since the beginning of the 20th century. The population estimate calculated for Southeastern Alaska in 1994 is for slightly more than 12,000 animals (USFWS 2002). Although some threats exist, such as fishery interactions, mortality and illegal take, they are considered to be insignificant in Southeastern Alaska (Golden 2008a; USFWS 2002). However, as sea otters re-populate areas that have not had a species filling this ecological niche in many decades, there are local concerns that the otters' voracious eating habitats are impacting peoples' ability to harvest certain shellfish species. Under the Marine Mammal Protection Act, only Alaska Natives are allowed to hunt sea otters in specified areas and under certian conditions (USC 1971).

The Steller sea lion is listed as an endangered species in western Alaska, west of Cape Suckling and as a threatened species throughout Southeastern Alaska. All populations are listed as depleted under the Marine Mammal Protection Act. It is understood that there is exchange of animals between these populations. While these complex relationships surpass the scope of this report, this may be of great importance in developing a conservation design for marine areas in the region. The number of rookeries and haul-outs used by the Steller sea lion may be an indicator of their overall condition and there has been a documented increase in use of these places in Southeastern Alaska (Jemison 2009).

The harbor seal is an important apex predator and one of the more numerous mammals in the region, though its population trends differ among areas in Southeastern Alaska. Little is actually known about its life history, foraging ecology, movements, or health status. Harbor seals eat squid, shrimp, and fish, especially Pollock and capelin. They feed often in estuaries and consume more sand lance and eulachon than do sea lions. They may give birth on rocky shores, but favor the iceberg-strewn waters near tidewater glaciers that are relatively free of terrestrial predators such as bears. Their behavior of hauling out in groups of a few to thousands may be a good indicator of their overall health (Wynne 2007). Tourism operations can have an effect on harbor seals, especially when the operations disturb the animals during the spring pupping season at the front of tidewater glaciers.

3.5 Migratory Birds

Migratory birds have been identified as a target in order to represent the importance of migratory stopovers in Southeastern Alaska in addition to other stopover sites in other regions. General attributes of shorebirds and migratory waterfowl include nesting habitat quality, weather regime, abundance and composition of food resources, and predation regime. Migratory bird species have varied ecological attributes for habitat use during molting, staging, and breeding life stages. Threats to shorebirds include a decline in critical habitat across their migratory range, changes in forage species composition and availability, contaminants and oil pollution, and changes in ocean conditions.

Chapter 4. Human Activities and Climate Change: Potential Stresses to Conservation Targets

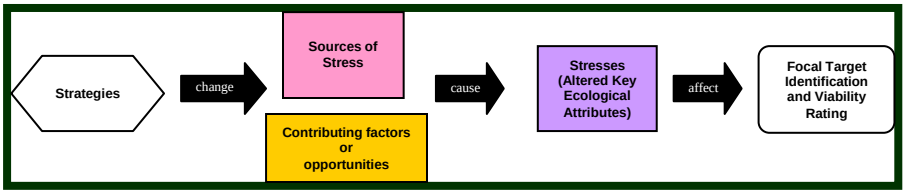

Figure 8. This section gives an overview of stresses to key ecological attributes of the targets and risk factors or contributing factors to stress.

A Summary of National and Regional Stresses

For Southeastern Alaska, four general categories of threats have been identified. These include global climate change and ocean acidification, point and nonpoint source pollution, coastal development, and depletion and impacts to food web interactions.

Reports prepared by the Pew Oceans Commission (2003) and the U.S. Commission on Ocean Policy (2004) highlight the poor and declining state of ocean and coastal ecosystems in the U.S. Both reports found that the health of the ocean ecosystem was declining at an alarming rate and made recommendations to reverse the trend. Not surprisingly, the major issues and risks to our oceans identified by the commissions, outlined in Table 2, are consistent with the issues presented within this preliminary CAP.

Major risks faced by ocean and coastal ecosystems
Coastal Water Pollution
Nonpoint Source Pollution
Point Source Pollution
Managing Sediment and Shorelines
Invasive Species
Aquaculture
Coastal Development
Population Growth and Tourism
Offshore Energy and Mineral Development
Habitat Alteration
Unsustainable Fisheries
Bycatch
Climate Change
Marine Transportation
Marine Debris
Health of Marine Mammals and People

Table 2. A summary of major issues faced by coastal and ocean ecosystems, compiled by the Pew Oceans Commission and the U.S. Oceans Commission.

Though these issues exist in this region, certain progressive resource management actions in Alaska including trawl closures, timber harvest best management practices, banning of finfish farming, and upland wilderness designations have significantly curtailed impacts on the region's estuarine resources. Conversely, due to the remote nature of the region, many activities that may

affect ecosystem and habitat functions, such as coastal development, point and non-point source pollution, and marine transportation have not been quantified. Additionally, proposals of significant scale for mining and hydro-energy export are of concern within the next ten years.

Due to a lack of baseline data for the region, such as a basic inventory of coastal resources or a classification system, the cumulative effects of multiple stresses throughout the region have not been quantified and the status of the region's estuarine and nearshore marine resources is largely unknown. Developing an index to begin to quantify these information gaps will allow The Nature Conservancy to develop feasible conservation strategies with partners. This preliminary CAP takes a region-wide approach for describing stresses to targets and key ecological attributes. Each stress has a brief description that includes:

- Impacts, i.e. stresses, to key ecological attributes of targets;
- Description of management approaches;
- Potential gaps in information, research, or management; and
- Preliminary list of indicators for measuring impacts to targets, see Appendix C.

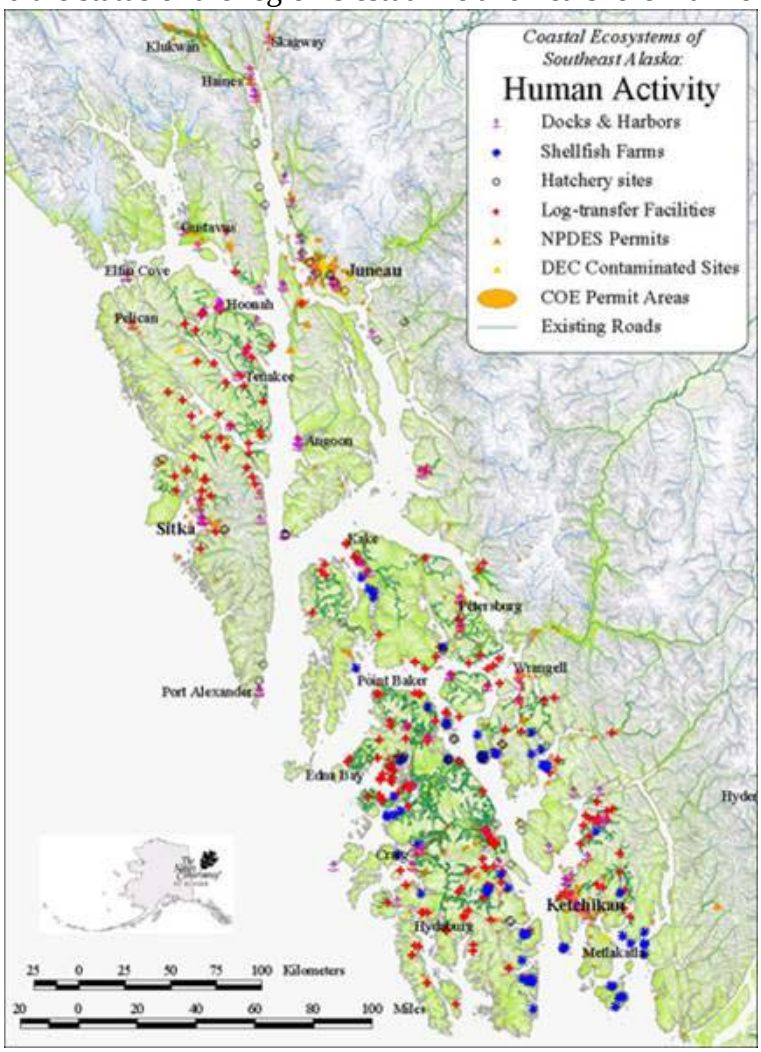

Figure 9. A map which illustrates some activities in nearshore marine and estuarine systems, including docks and harbors, shellfish farms, hatchery sites, log transfer facilities, NPDES permits contaminated sites and Army Corps of Engineers permits as of 2003.

Due to the complexities of the marine and estuarine ecosystems, combined with the differing levels of stressors associated with each of the targets, it is difficult to understand the cumulative effects happening within this region. For example, water quality is a key ecological attribute of each conservation target, yet the sources of pollution are extensive and varied and there is no systematic water quality monitoring program across the region. One of the next steps in the ecoregional assessment process is to analyze these stresses comprehensively, at both local and regional spatial scales in relation to the conservation targets and indicators of viability for those targets, see Appendix C. A map that shows a coarse level of detail on human activities across the region

is provided as Figure 9. It may be necessary to implement a water quality monitoring program across the region, due to the importance of this issue in relation to conservation target viability.

It is important to note that each of the communities and watersheds across the region have localized stressors not representative of the entire region. Ranking and developing conservation strategies is made difficult by the size of the region and differences in geography, ecology, community activities, and land ownership. Historic impacts to several of the targets will be evaluated in relation to the expected time of recovery of the natural processes. For example, logging practices common before the Tongass Timber Reform Act caused significant changes to watershed processes and fish and wildlife habitat. Some of the ecological processes that were impacted may continue to affect target viability for decades or even centuries regardless of ongoing activities (Murphy 1989)

4.1 Global Climate Change and Ocean Acidification

Climate change effects are expected to have significant impacts on the ecology and biodiversity of species and habitats around the world and may be one of the most important drivers of landscape change in Southeastern Alaska (Fastie 2007). Substantial changes in the climate of Southeastern Alaska during this century are expected, notably, increases in rainfall and ambient temperatures, and increases in frequency and intensity of coastal storms (Kelly 2007).

The potential ecological responses to global climate change include species migrations due to temperature regime shifts, changes in species composition, availability and timing of food sources such as plankton and krill, alterations of upwelling sites, and increases in storm frequency (Walther 2002). Estuaries are particularly vulnerable to many of these changes because they are positioned at the interface of the riverine, terrestrial, and marine realms (see Fig. 6). However, estuaries are considered to be “enduring features” of the landscape as there will always be an area where the land and saltwater meet. The impacts on salmonids through potential changes in snowmelt and groundwater may be adverse to growth and survival and affect distribution (Meisner 1988). However, more information is needed on understanding the impacts to other coastal species. For example, the distribution of kelp species is based on temperature, salinity, and wave exposure. Through the ShoreZone mapping project, these species are being inventoried and we now know the distribution of the three species of canopy kelp in the region. Changes in these climactic factors could affect distribution of kelp species.

Global sea levels are expected to rise an average of 0.1-0.9 meters during the next one hundred years with coastal waters potentially rising an additional 0.2 m (Hengeveld 2000 ; Snover 2005). The Pacific Northwest is expected to experience 1.7 0C higher annual average temperatures and slight increases (0-10%) in winter and annual precipitation by mid-Twenty First century (Snover 2005). These meteorological changes may result in changes to freshwater inflow and sediment delivery to the tidal ecosystems in Southeastern Alaska. Changes to tidal ecosystems could impact scarce resources, such as salt marsh habitat, a coastal habitat that makes up about 0.2% of wetland acreage. One unknown factor in parts of this region is the mitigating affects of isostatic rebound caused by retreating glaciers in parts of the region. For example, in Juneau, the rate of isostatic rebound is expected to occur faster than the projected rate of global sea level rise over the next one hundred years, and Juneau is expected to see a drop in sea level rise (Kelly 2007).

The Alaska Marine Conservation Council characterizes ocean acidification as a “sister problem” to climate change because the same processes that have caused climate change from

the emissions of CO_2 are causing other impacts to ecosystem processes. Approximately thirty to fifty percent of global anthropogenic CO_2 emissions are absorbed by the world's oceans (Sabine 2004). The effects of increased absorption of CO_2 are a major reduction in ocean pH. It is hypothesized that effects of ocean acidification may be more apparent in coastal waters that are glacially influenced because glacial waters decrease the buffering capacity of sea water. (Mathis, Communication, 2010).

Marine organisms that form shells depend on minerals in seawater to build their support structures. A more acidic ocean decreases the availability of these minerals to corals, clams, crabs, and pteropods, a main food source for salmon (AMCC 2008). Marine life in colder waters will be affected first because calcium carbonate is less stable in cold water. A study published by U.S. and international scientists stated that some polar and sub-polar waters will not have enough calcium carbonate available for organisms to build strong shells within the next 50 years (Orr 2005).

More information is needed in order to understand the specific impacts of climate change and ocean acidification to tidal ecosystems and marine resources in Southeastern Alaska. The ecoregional assessment process will include climate change as a factor in planning for conservation of resilient ecosystems and species. Multiple climate modeling efforts are underway. The Nature Conservancy's Washington Chapter plans to develop climate change models for estuaries in Puget Sound, while other partners are working to develop climate change models and scenarios in Southeastern Alaska including NOAA, University of Alaska Fairbanks Scenarios Network for Alaska Planning, and the Pacific Northwest Research Station (SNAP 2008).

4.2 Coastal Development

4.21 Shoreline Dredge and Fill Activities

Shoreline dredge and fill activities include Army Corps of Engineers permitted activities such as breakwaters, docks, harbors, marinas, bulkheads, dikes, airports, and roads. Dredge and fill operations in Southeastern Alaska's communities generally involve physically altering some aspects of estuarine or rocky shore communities. Historically, wetlands and salt marshes have been filled or altered for harbors, airports, and other activities because flat land for building is scarce in the region.

Road construction, maintenance, and runoff are chronic risks to estuarine ecosystems. Roads and culverts that are improperly built or maintained can disrupt habitat connectivity. Roadway runoff contributes heavy loads of sediment and pollutants such as heavy metals to freshwater and marine systems. Over 5,000 miles of roads have been built on the Tongass National Forest and many of these roads need continued maintenance to prevent impacts to the streams and estuaries. One of the conclusions reached from a USDA Forest Service analysis is that the greatest risk of degradation to fish habitat is from sediment input to streams caused by poorly maintained roads (Swanston 1996). The Forest Service does develop Access and Transportation Management Plans for each Ranger District in order to manage the road infrastructure. Management of permits for wetland fill, including intertidal areas, is overseen by the Army Corps of Engineers and the Dept. of Natural Resources through the Alaska Coastal Management Program (see the discussion in Section 8 on Alaska's Coastal Management Framework).

4.22 Urban Development

Urban and coastal development encompasses housing, businesses, transportation infrastructure, streets and parking lots, domestic wastewater effluent, floating structures and mixing zones.[3] Coastal development is one of the highest sources of nonpoint source pollution in Southeastern Alaska (ADEC 2008b). Coastal development not only displaces organisms that once used a particular site but also indirectly affects a much broader area through non-point source and point source pollution. Of primary concern is the influence on the sedimentation regime, freshwater inflow, water quality, degraded forage fish spawning habitat, and the loss of essential fish habitat through the filling of salt marsh and eelgrass beds (see Table 5).

Development activity in Southeastern Alaska has directly impacted salt marsh and eelgrass habitat, uplands, and freshwater systems that influence nearshore marine waters. For example, Juneau lost about forty percent of their surrounding wetlands to residential and commercial development from 1948 to 1984 (Adamus 1987). Most of the sites on the State of Alaska's 303(d) List of Impaired Waterbodies are impaired by some aspect of urban development, resulting in alterations of freshwater flow, heavy metal accumulation, pesticide or chemical accumulation, sedimentation, toxic spills, or changes in biotic interactions (ADEC 2008b).

Effluents to marine waters from coastal communities, individuals, and businesses are either permitted by the recently approved Alaska Pollutant Discharge Elimination System (APDES) or the EPA's National Pollutant Discharge Elimination System (NPDES) permits, depending on the type of entity discharging waste. Eight communities in Southeastern Alaska have NPDES permits with a Clean Water Act §301 (h) waiver, which means that these communities can have less then secondary treatment for their sewage systems (ADEC 2008c; Wanstall 2009). All individuals and business discharging waste have to meet Alaska's water quality standards, although some exemptions are being made through mixing zone regulations[4].

4.23 Timber Management

Timber management includes historical and new timber harvest activities and mill operations. Large-scale industrial logging began at Hollis in Southeastern Alaska in the 1950's with a one square-mile clear-cut in the Maybeso Creek Watershed. To date, over seven hundred and fifty thousand acres of forest have been logged on public and private lands in southeast (Schoen and Dovichin 2007). Logging has occurred disproportionately among Southeastern Alaska's biogeographic provinces in comparison to the availability of productive forest lands. For example, North Prince of Wales Island originally contained fourteen percent of productive forest lands in the region but has incurred thirty-eight percent of all timber harvest.

From the mid 1950s to the late 1980s, clear-cut logging was conducted without requirements for riparian buffers. An estimated twenty percent of the approximately five hundred thousand acres of flood plain forests that encompass most of the riparian forest next to

[3] The impacts of dredge and fill operations have been separated out specifically, and are discussed in the following section 5.4.

[4] Under the Alaska Administrative Code 18 AAC 70, mixing zones are defined as areas in "which the water quality criteria and any limit set by or under this chapter may be exceeded ADEC. 2006. 18 AAC 70 WATER QUALITY STANDARDS MIXING ZONE REGULATION CHANGES.." In 2006, the Alaska Department of Environmental Conservation (ADEC) amended Alaska's prohibition on mixing zones in freshwater ecosystems where anadromous fish and select resident fish spawn. Under the revised regulations, some exemptions are allowed for mixing zones.

salmon streams have been logged. Highest proportion of logging of flood plain forests occurred on Baranof Island, North Prince of Wales, the Chilkat River, and east Chichagof Island (Schoen and Dovichin 2007).

Impacts of logging on anadromous fish in the region are well documented (Gibbons 1987; Hall 2004; Murphy 1986). Logging and associated activities can have multiple affects on salmonid habitat because their habitat is a product of the interactions among the stream, floodplain, riparian habitat, and uplands. Changes in habitat affects their life history stages including migration, spawning, and rearing and often results in reduced growth, survival and carrying capacity. Because estuaries are the ecotone between marine and freshwater realms, alterations of freshwater inflow, changes in sediment load, changes in riparian vegetation, or discharge of xenobiotics upstream can degrade estuarine and nearshore marine habitats (Northcote 2004).

Even though there has been extensive watershed development from logging activities, there has been little research in estuaries to document changes or impacts. The historic timber harvest activities were intensive and consequently, recovery of the natural processes in many of the watersheds may take decades to centuries. For example, Murphy and Koski (1989) estimated that it would take 200 years before trees would grow large enough to naturally replenish large woody debris in streams.

The current USDA Forest Service timber management policy in Southeastern Alaska emphasizes development of value-added forest products, tourism opportunities, and restoring fish and wildlife habitats (Forest 2008). Tongass land managers and partners are engaging in a host of forest and freshwater restoration efforts, including forest thinning, culvert replacement and freshwater stream restoration. The potential impact of timber management activities within tidal ecosystems is most likely to be minimal under the current Tongass land management conservation strategy and the present economic scenarios for the industry.

4.24 Hydroelectric Power and Tidal Energy

Hydroelectric power and tidal (hydrokinetic) energy development could pose risks to freshwater ecosystems, tidal ecosystems, fish species, and marine mammals in Southeastern Alaska, depending on citing, design and regulatory factors. Impacts of hydropower operations can alter freshwater inflow and tidal circulation patterns. Depending on the type and location of hydropower operations, hydropower infrastructure has the potential to impact salmonid populations. Southeastern Alaska's extensive shoreline of over 33,600 km and fiord topography also provides an opportunity to harvest energy from the ocean using tidal or wave energy and marine turbines. The impacts of tidal energy sources depend on the use, design and scale of this energy source which thus far, are largely unknown.

Hydroelectric power is currently Alaska's largest source of renewable energy. Southeastern Alaska's mountainous terrain, high precipitation, and numerous streams present opportunities for development of this resource. Twenty-two hydro and community intertie projects are in operation or scheduled for development in this region (Walker 2009). Hydropower in Southeastern Alaska is currently produced by impounding water in a reservoir behind a dam or a lake and then discharging water through a powerhouse near sea level such as Snettisham near Juneau and Blue Lake near Sitka. Due to citing procedures, hydropower operations do not currently adversely impact salmonid resources (Walker 2009).

Alaska has one of the best wave resources in the world, with parts of its southcentral and southeast coastlines averaging sixty kW per meter of wave front (Polagye 2006). There are five

tidal energy proposals in Southeastern Alaska (Walker 2009). Tidal energy development is a risk because of the potential impacts to salmonids, marine mammals, and marine fish from contact and entanglement with infrastructure, primarily turbines. Other concerns include acoustic effects (Luxton 2007). For example, fish passage studies at the Bay of Fundy have shown a turbine-related mortality of 20-80% of fish per passage depending on species, size, and efficiency of operation. These study results are a cause for concern as tidal turbines could cause widespread impact on marine biota (Dadswell 1994)

Increased demand for renewable energy will increase pressure to develop energy projects (Hatch 2007). Development of the region's renewable water resources has potential to impact estuarine and nearshore habitats; management strategies must anticipate problems and implement solutions early in the development process, such as statewide instream flow minimum requirements and strict citing regulations for anadromous streams.

4.3 Point and Non-point Source Pollution

4.31 Catastrophic Events

Catastrophic events include large oil spills, toxic waste spills and ship grounding. Marine-related petroleum products pose an everyday risk of spill and possible pollution to a largely pristine environment (RRT 2005). Following the *Exxon Valdez* oil spill in 1989, concerns have been raised about the impacts of catastrophic events on nearshore marine resources. Impacts to all life cycles of marine resources are of concern, specifically Pacific herring and other forage fish, salmonids, marine mammals, sea birds, shorebirds and waterfowl.

Extensive studies on the toxicity of oil to herring following the *Exxon Valdez* oil spill were conducted by scientists at the NMFS Auke Bay Laboratory (Carls 2000; Carls 1999). In a review of this research, is was determined that 1 µg L^{-1} (part per billion) aqueous total polynuclear (or polycyclic) aromatic hydrocarbons (TPAH) can cause herring embryo abnormalities and mortality (Carls 2002).[5] As a result of their research, scientists recommend that safety standards for dissolved PAH should be revised to reflect a toxicity threshold of < 1 µg L^{-1} TPAH to adequately protect aquatic organisms and aquatic habitat.

Twenty-two PAHs have been listed with the Environmental Protection Agency as " the most deadly fraction of crude oil, as persistent, bioaccumulative, toxic pollutants (ACAT 2009)." The links between PAH and health issues have been made by medical specialists. Some of these health problems include endocrine disruption, suppression of the immune system, problems with reproduction, and affects on the central nervous system (ACAT 2009).

The West Coast Offshore Vessel Traffic Risk Management Project concluded that incidents involving mechanical and equipment failures occur off the West Coast of the United States regularly. With an average of twelve times per year, this would justify a concern that such incidents could result in drift groundings and the release of oil and other hazardous materials into the environment (Cameron 2003). The primary concerns outlined by Robert Mattson, Alaska Dept. of Environmental Conservation's (ADEC) Spill Response Coordinator, are:

- Large cruise ships carrying intermediate fuel oil;
- Bulk freighters transporting log or ore which carry intermediate fuel or bunker oil, specifically log freighters around Prince of Wales Island and freighters carrying ore from Greens Creek mine, Skagway, and Stuart; and

[5] In Prince William Sound oil from the *Exxon Valdez* was detrimental to twenty-five to thirty-two percent of the spawned biomass of herring eggs.

- Increased numbers of bulk container ships transiting through the Dixon Entrance to Prince Rupert's container port scheduled for further capacity increases (Mattson 2009).

According to the Alaska DEC Summary of Oil and Hazardous Substance Spills by Subarea report, spanning 1995-2005, Southeastern Alaska experienced an average of three hundred and eighty nine reported spills per year with an average of forty thousand gallons spilled per year. The average spill size is approximately one hundred and three gallons. The large number of spills indicates the vulnerability of marine resources to contamination events, although there are few reports on impacts available.

The ADEC acts as the coordinating agency for spill response, prevention, and industry preparedness along with the US Coast Guard, and the Southeastern Alaska Petroleum Resources Organization (SEAPRO). A number of gaps in the response community's technological capacity in a response situation have been flagged by response managers, including lack of geospatial information systems (GIS) analytical capacity for applying spatially explicit information to response planning. Also, improved weather reporting is one strategy that resulted from the Traffic Management Project Report. While there is more flight transportation in Alaska than in other states and a greater reliance on vessel traffic, there is relatively less infrastructure for reporting weather. Of one hundred and sixty-eight weather radars in the country, only seven are in Alaska – an area one-fifth the size of the rest of the United States (RRT 2005).

4.32 Large Vessel Waste Discharge

Marine vessels such as cruise ships are a significant source of pollutants that are discharged into marine waters. In 2008, over one million passengers cruised through Southeastern Alaska's waters. Approximately twenty large commercial passenger vessels were registered to discharge waste into Alaska's water, representing approximately 570,000 passengers (ADEC 2008a). According to an advisory science panel report written in 2002 for ADEC's Commercial Passenger Vessel Environmental Compliance Program, *Impacts of Cruiseship Wastewater Discharge on Alaska Waters*, no significant harm to marine species is expected from cruise ship effluent. The panel did recommend increasing monitoring of mussels along Alaska's coast, including Southeastern Alaska, in the summer during the highest cruise ship traffic season.

In 2006, a citizen's initiative in Alaska was passed to impose stringent water quality standards on large commercial passenger ships, i.e. cruise ships. A feasibility study performed in 2008 concluded that wastewater discharge technology on cruise ships was not adequate to consistently meet standards at the point of discharge (ADEC 2009). ADEC is currently reviewing the feasibility of cruise ships to adopt technology that will meet Alaska's standards. Meanwhile, during the 2009 cruise season, ships are being allowed to discharge amounts of ammonia, copper, nickel, and zinc, greater then what is allowed in Alaska Statutes.

4.33 Contaminated Sites

This category encompasses point source pollution resulting from industrial sites (localized), seafood processors, formerly used defense sites and other military facilities, shipyards, log transfer facilities, and non-point source pollution from industrial sources in Asia. Closed or abandoned mine sites and active mine sites are covered in section 6.3 under the topic of mining. Contamination ranges from accumulation of organic debris such as bark and seafood waste, to nuclear waste, heavy metals, dioxins, and other persistent organic pollutants. These

pollutants alter water quality in tidal and freshwater ecosystems across the region and can degrade habitats impacting resident and migratory birds, salmonids, forage fish, marine fish, and drinking water. While the majority of point and non-point source pollution issues are site specific, the cumulative effects of hundreds of sites across the region are unknown and need additional analysis. Region-wide, one of the primary sources of contamination to nearshore marine waters and freshwater systems is the deposition of atmospheric contaminants, primarily from Asia (Tallmon 2009). Impacts of this pollution source need to be assessed in conjunction with other pollution sources.

In Southeastern Alaska, a list of several hundred hazardous waste, chemical, exposure or federal toxic waste sites exist. This list includes ADEC's list of impaired (or polluted) waterbodies, i.e. water bodies that do not meet water quality standards. Twenty-seven "notable" contaminated sites for which ADEC is performing clean-up actions across the region are listed on ADEC website (ADEC 2008d). Contaminated sites have been documented in several intertidal areas by NOAA's Office of Response and Restoration, including high concentrations of heavy metals in shellfish, see Figure 10.

Figure 10. A map from NOAA's Office of Response and Restoration of contaminated sites affecting NOAA trust resources: 5. Klag Bay Mine Site; 6. Alaska Pulp Corp. – Sitka, ; 7. Ketchikan Pulp Co. – Ward Cove Ketchikan; 8. Metlakatla Indian Community (Brownfield Site) (NOAAORR 2003)

In addition to notable contaminated sites, coastal communities in Southeastern Alaska generally have a shipyard or marina where many vessels including fishing boats, recreational boats, tugboats, and passenger ships, are maintained or prepared for operation. These areas absorb contaminants such as anti-fouling paints containing copper or tributyltin or zincs to inhibit electrolysis, affecting intertidal species. These are site specific issues and impacts to marine species appear to decline sharply with distance from the affected site (Tallmon 2009).

Another type of contaminated site impacting marine fish habitat and bird populations is fish waste from seafood processors. Seafood waste discharge affects the feeding patterns of birds and marine fish, depending on the size of waste products. The seafood waste can smother benthic habitats and create anaerobic conditions. Seafood processors have Environmental Protection Agency (EPA) waste discharge permits issued through the National Pollutant Discharge Elimination System (NPDES), and more recently, the Alaska Pollutant Discharge Elimination System. Permits address size of waste particles and the maximum area for the zone of deposition of waste (Region 10 Dive Team 2009). Even though permits are in place,

problems remain in relation to the enforcement of permit specifications, including zones of deposits and particle size (Pederson 2009).

Log transfer facilities (LTFs) are places where logs are transferred between the land and marine waters. The building of LTFs involved filling small acreages of uplands and intertidal areas for sorting logs and transportation. At some LTF's, logs were stored in the water. This log storage became a source of organic pollution from bark falling onto benthic habitats. In 1982 there were ninety log transfer facilities with an average bottom coverage of 1.96 acres for a total area impacted of one hundred seventy-six acres or about 0.02 % of their estimated estuarine area less than sixty feet deep (Faris 1985). The detrimental effects of bark accumulation on the benthic resources include reduced abundance of benthic infauna, reduced diversity of benthic epifauna and macroalgae, reduced fitness and survival of bivalves, and reduced fecundity and increased egg mortality in Dungeness crab (Freese 1988; O'Clair 1988; Pease 1974). Bark has also been shown to significantly impact the benthic habitat in deep water areas and significantly reduce species richness (Kirkpatrick 1998). Schultz and Berg (1976) and Freese et al. (1988) found that accumulations of bark and wood persisted up to 26 years in Southeastern Alaska.

Current federal and state permits for operating LTF's require monitoring for bark accumulation to a depth of about 20 m (Kirkpatrick 1998). Monitoring bark accumulation is being applied as a surrogate for monitoring species recovery, as measuring biomass is costly and more time-consuming. It is unclear how effective the current bark accumulation measurements are in defining impacts and recovery of sites. Data gathered on LTF sites from the timber industry was submitted to the Alaska Department of Natural Resources, but it is unknown if this information was recorded and analyzed. This would be useful in developing a current analysis of sites and impacts. An incidental impact of log transfer is the loss of logs from rafts by storms, human error, or failure of log booms. Large numbers of logs lost from rafts or barges become "drift logs" and can cause severe damage to intertidal habitats and organisms from their pounding by waves (O'Clair and O'Clair 1998).

The Clean Water Act and Alaska 18 AAC Water Quality Standards are the primary tools applied by the EPA and ADEC. ADEC identifies impaired water bodies by reviewing available information and publicly soliciting nominations for impaired water bodies (DEC 2008). However, ADEC is not equipped to develop or implement a statistically valid testing methodology to identify sites. This may be an information gap that needs to be addressed. The Alaska Dept. of Environmental Conservation (ADEC) houses a Contaminated Sites Program to clean up soils and groundwater on federal, state, and local lands in Alaska. ADEC works with the Department of Defense to clean up formerly used defense sites. The NOAA Office of Response and Restoration also addresses site clean-up of areas that affect NOAA trust resources (NOAAORR 2003). For a list of management agencies and authorities, refer to Appendix B.

4.34 Mining Activities

This topic covers closed and abandoned mine sites, exploration and current mining activities, associated development, and closing and reclamation of sites. Southeastern Alaska has a long history of mining, including sand and gravel mining, dating back to the discovery of gold along the Stikine River in 1861. A wide variety of valuable mineral resources exist within the region, including gold, silver, platinum, uranium and other precious metals as well as copper, zinc, and lead deposits. Stressors to conservation targets from pollutants of closed, abandoned, or current mining sites are degraded water quality for fish, wildlife and people from heavy metals and sedimentation. Low levels of contaminants have been shown to affect reproductive success

of marine fish, forage fish, and salmonids and impact human health depending on levels of consumption of contaminated fish.

While ADEC's contaminated sites database includes some of the most problematic sources of contamination from mining, it is understood that numerous mines have yet to be recorded or assessed for contamination levels (Golden 2008b). Numerous mining sites are known pollution sources across the region. According to a 1998 Toxics Release Inventory by the Environmental Protection Agency, Greens Creek mine on Admiralty Island, one of America's largest silver mines, was the second largest producer of toxic waste in Alaska (Golden 2008b). Bokan Mountain, the site of the Ross-Adams uranium mine on southern Prince of Wales Island has elevated levels of arsenic, lead and uranium in the waste rock and tailings on site. This area is being explored for mining potential by Landmark Alaska Limited Partnership, an American subsidiary of the Canadian UCore Uranium, Inc (USDA FS, 2008). While the Ross-Adams mine area is closed to human use, eighteen salmon streams are in the vicinity of the area. Klag Bay on Chichagof Island is a known site contaminated with metals, mercury, arsenic, and other minerals (see Figure 19). The Tulsequah Chief Mine is leaching approximately fifteen tons of contaminants into the Tulsequah River each year from previous mining activities and clean-up actions are a requirement of re-opening the mine (Bluemink, 2008).

There are other mining exploration activities happening in Southeastern Alaska, or watersheds draining into Southeastern Alaska. Coeur Alaska is developing the Kensington Gold Mine north of Juneau and the Bureau of Land Management is proposing to open some of the Yakutat Forelands for mining. A company called Geohedral LLC has staked approximately 49,000 acres for exploratory drilling. Also, Galore Creek mine, in Northwestern British Columbia, is a large gold and silver hard-rock mine in the development process. Galore Creek flows into Scud Creek, which flows into the Stikine River.

To adequately conserve freshwater and coastal conservation targets, The Nature Conservancy must assess mining risks and impacts in relation to all other listed risks. While some of the most problematic sites have been identified, clean-up or remediation of these areas is slow and expensive (DEC, website 2009). Costs such as long term monitoring, clean-up, and remediation activities should be taken into consideration when new mines are being opened. Additionally, both the Taku and the Stikine River are transboundary rivers crossing from British Columbia into Alaska. The Galore Creek Mine and Tulsequah Chief Mine are located in British Columbia and impacts from these mines are challenging to address and mitigate due to the geopolitical nature of the risks.

4.35 Marine Debris and Entanglement

Marine debris, including abandoned fishing gear and massive amounts of plastics, are two major concerns for marine mammals, birds, and fish in the ocean. Plastics are a significant concern to marine fish and birds on a global scale. Problems associated with marine debris include direct ingestion of plastics leading to starvation or drowning; ingestion of microscopic size particles still in polymer form leading to bioaccumulation of toxins through the food chain, causing reduction in reproductive health and fitness (Barnes 2009; Gregory 2009; Moore 2003; Teuten 2009). While marine debris is a widespread problem, further investigation is needed as to the level of impacts to ecosystem and species in Southeastern Alaska.

Scar analysis performed on humpback whales in northern Southeastern Alaska revealed that a maximum of seventy-eight percent of the whales had scars, indicating recent entanglement. Entanglements can cause drowning of small cetaceans such as porpoises,

pinnipeds, seals, and sea lions. Drowning of large whales is less common due to their ability to swim to the surface, although impacts can range from starvation to infections to reduction in reproductive success (Network 2008). In Southeastern Alaska, there is a Stranding Network that is set up to respond to entangled animals that are reported.

4.4 Depletion and Impacts to Food Web Interactions

4.41 Ship Strikes, Harassment, and Sonar Testing on Marine Mammals

Ship strikes are one source of whale mortality, although the documentation of strikes are challenging (Gabriele 2008). Due to the remote areas of Alaska and little systematic data on ship strikes to large whales, it is difficult to document the rates of occurrence and the extent and types of vessels involved. Other challenges of documenting whale strikes include collisions going undetected and avoidance of reporting by vessel operators for lack of knowledge or fear of consequences, difficulty in assessing the condition of whales after a collision happens, and assessing whether a stranded whale was dead or alive when it was struck (Gabriele 2007).

The Alaska Marine Mammal Stranding Database has been set up by the NOAA Fisheries Alaska Protected Resources Division to track and characterize strikes to whales. This data shows that reported strikes have primarily been located in Southeastern Alaska and have occurred on humpback whales. This study suggests that this is a function of the large number of humpback whales in the region, the high vessel traffic, the accessibility of authors to localized areas, and the increase in vessel traffic due to the growth in whale watching and tourism activities. The authors suggest that a statewide survey be performed to increase information about ship strikes and increasing the number of necropsies in order to understand how ship strikes affect whales.

The number of charter and tour operators that participate in wildlife viewing has grown considerably in recent years in Southeastern Alaska. Concerns have been raised to NOAA Protected Resources Division about whale watching and sea lion watching practices that violate the Marine Mammal Protection Act (Jensen 2008). These practices include: “leapfrogging” (a practice where marine vessels transit in front of a whale thereby cutting them off and forcing them to dive and show their tale), motoring after whales for long periods of time, maneuvering closer than one-hundred yards, and approaching sea lions near rookeries or haul-outs causing disturbance to the animals (Johnson 2006). To address these concerns in Alaska, NOAA’s Protected Resources Division implemented a one-hundred yard minimum approach distance from humpback whales along with “slow, safe speed” regulations (with some exemptions under the Marine Mammals Protection Act (MMPA) and the Endangered Species Act) (Oliver 2001). Also, Glacier Bay National Park has implemented more strict regulations in waters with high concentrations of whales known as “whale waters” (NPS 2008).

Enforcing the regulations is one of the most challenging actions for the Protected Resources Division for NOAA. For eight years, there was no enforcement presence on the waters to enforce the one-hundred yard rule and the “no take” regulations of the MMPA (Jensen 2008). In 2008, an enforcement officer was hired to monitor both fisheries and marine mammal issues of concern to NOAA in northern Southeastern Alaska. Also, some guiding companies have recently shown an interest in developing their own self-policing network (Jensen 2008).

Sonar testing by the Navy is also an issue that may affect marine mammals in Southeastern Alaska. While the testing activities are happening within the northern Gulf of

Alaska, they may have an effect on migratory whales in the southern Gulf of Alaska (Radio 2009).

4.42 Fishing

Fisheries are the backbone of local and regional economies in Alaska. The principal commercial fisheries include all salmon species, halibut, Pacific herring, blackcod, king crab, tanner crab, and Dungeness crab, and other invertebrates including shrimp, scallops, geoducks, sea cucumbers, and red sea urchins. Commercial fish landings at the major ports (Yakutat, Juneau, Sitka, Wrangell, Petersburg, and Ketchikan) amounted to over one hundred thousand tons in the year 2000 and were comprised mainly of salmon. Salmon fishermen alone poured more than $87 million into the regional economy in 2006. Sport fishermen come from all over Alaska, Canada, the contiguous U.S., and around the world to fish in this region's productive estuarine and nearshore waters. The primary sport fish species include all species of salmon, steelhead, char, Pacific Halibut, lingcod, and rockfish. In 2000, more than 100,000 sport fishing licenses were sold in Southeastern Alaska. Most communities also participate to some degree in subsistence and personal use fishing. Additionally, those communities with a higher proportion of Alaska Native residents rely more heavily on subsistence and their annual consumption may exceed four hundred pounds per capita.

While fisheries are an important economic driver for this region, fishing has the potential to affect multiple trophic levels within the marine ecosystems. Overfishing of target species, by-catch of non-targeted species, reduction of biomass from the ecosystem, and affects on seabirds through incidental take or capture are generalized potential impacts. One of the primary risks to benthic habitat around the world is bottom trawling, which was banned in the majority of Southeastern Alaska's waters in 1989. Some dive fisheries have been closed for commercial harvest due to over-harvest in past decades, including the pinto abalone (*Haliotis kamtschatkana*) (http://seafood.ucdavis.edu/pubs/abalone.htm). There is some limited trawling for shrimp near Wrangell and dredging for scallops near Yakutat that could affect the benthic habitats in those locales.

Effective fisheries management is imperative in maintaining ecosystem health and sustainable stock rates. It is beyond the scope of this paper to review all fisheries management and trends, though we will highlight three examples of important trends including the Pacific Halibut, salmon and Pacific herring fisheries. The Pacific halibut fishery is in a state of change due to the need to re-evaluate the management and regulatory framework of the sport and charter catch rates in the region. As of 2007, the NOAA National Marine Fisheries Service (NMFS) has been developing new regulations for the charter fishing industry.

In Alaska, management of salmon populations for ecosystem health was assessed to be adequate (Piccolo 2009). Currently, all Alaska salmon stocks and related salmon fisheries are certified by the Marine Stewardship Council as sustainable and well managed. Management issues that develop around salmon tend to be habitat related whereas forage fish management issues are likely to be related to stock dynamics and abundance.

A recent petition to list the Lynn Canal population of Pacific herring as threatened or endangered resulted in a finding that the Lynn Canal Pacific herring stock is part of a larger, regional Southeastern Alaska distinct population segment (DPS). Because the Lynn Canal population was considered to be part of the larger DPS, NOAA deferred listing the species as endangered, until a determination could be made on the status of the larger DPS. NOAA considers this DPS to be a candidate species under the Endangered Species Act (ESA). A status

review for herring analyzed extinction risk, an assessment of the factors listed under section 4 (a) (1) of the ESA, and an evaluation of conservation efforts for the DPS as a whole (Rauch 2008). This review found that "listing Lynn Canal pacific herring as threatened or endangered under the ESA is not warranted"(Service 2008).

4.43 Invasive Species

Invasive species are plant or animal species that are both non-native to a particular ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Williams 2008). Successful invasive species tend to be those that are abundant over a large range in their native region, have broad feeding and habitat preferences, wide physiological tolerances, short generation times, and high genetic variability (Mac 1998). For example, farmed Atlantic salmon are known to be carriers of exotic diseases and parasites, having had devastating impacts on fish populations in Europe and infestations of sea lice to wild fish populations near net pens in British Columbia. Some pathways for invasive species in Alaska include finfish farms in British Columbia, species introductions associated with fisheries, large ships traffic patterns and ballast water release (Fay 2002).

Relatively few invasive aquatic species have been introduced and become established in Alaska compared to other states. This is due in part to factors such as Alaska's strict plant and animal transportation legislation, relatively isolated geography, and northern temperate climate (Fay 2002). Invasive species impacts to Alaska are currently low, but because of the state's extensive aquatic ecosystems many potential opportunities for invasive species exist. Several species are considered nuisance or invasive species in Southeastern Alaska include tunicates (*Botrylloides violaceus),* Atlantic salmon (*Salmo salar*), salt marsh cordgrass (*Spartina sp*), and Reed Canary Grass *(Phalaris arundinacea*) (Fay 2002).

One species of high concern for Southeastern Alaska is the Atlantic salmon. In the last fifteen years, more than one million Atlantic salmon have escaped from Washington and British Columbia farms (Bisson 2006) They have been caught in troll fisheries in Southeast and have been found in streams near Cordova, Ketchikan, Yakutat, and the Bering Sea (Fay 2002; Wing 1992). Natural reproduction of escaped Atlantic salmon is documented from streams in British Columbia. This indicates that spawning could occur in similar habitat in Southeastern Alaska. Atlantic salmon habitat requirements are similar to those of steelhead and cutthroat trout, Dolly Varden and coho salmon, but the number of streams to monitor is daunting (Volpe 2001). The ecological consequences of these feral Atlantic salmon populations have not been fully addressed because established populations are still rare and limited to small areas (Bisson 2006).

The threat posed by invasive species in coastal estuaries and nearshore habitats could increase, as indicated by climate change trends. However, there are many gaps in the science and the management of invasive species (Williams 2008). It is important to understand and monitor temperature changes in this region to assess how changes in temperature could support or enhance invasive species ability to persist. Several recommendations for monitoring and management of invasive species include:

- Development of a ballast water law in Alaska consistent with the other West Coast states (Fay 2002);
- Implement statistically valid sampling designs into monitoring programs for high risk invasive species (Bisson 2006)

In addition to Alaska Department of Fish Game, NOAA and local watershed organizations are addressing invasive species through habitat modeling, educational efforts, and regulatory mechanisms.

4.44 Hatcheries and Mariculture

Salmon hatcheries in Southeastern Alaska provide economic values to the region and mariculture is of increasing importance. Currently, there is a dirth of science to help decision-makers understand the levels of stress that hatcheries impose on the ocean ecosystems and wild salmon. It is believed by some that Alaska salmon hatcheries have the potential to jeopardize the fitness and health of wild populations of salmon and other species that use these same ecosystems (ENRI 2001). Others point to the state salmon management program as robust, including a comprehensive genetics policy that minimizes hatchery and wild stock interaction (Smoker 2007). The issues surrounding Alaska salmon hatcheries are complex and include genetics, straying, ecological interactions between wild and hatchery stocks, fish-culture practices, mixed-stock fisheries, and ecosystem alterations.

Currently there are about twenty hatcheries operating in Southeastern Alaska (White 2008). Chum, coho, chinook, and sockeye salmon accounted for approximately 73%, 22%, 18%, and 3% of the commercial harvest respectively (White 2008). In 2005, hatcheries released about 516 million juvenile salmon composed of (in descending order of magnitude) chum, pink, coho, sockeye, and chinook (Eggers 2006). Concern is sometimes voiced that this large number of juvenile fish released into the marine waters could create increased competition, transmit disease, or increase predation on the wild stocks of salmon.

In general salmon hatcheries on the Pacific Coast were conceived as a method of replacing salmon lost to overfishing and degraded habitat. Development of the hatchery program in Alaska was based on a different set of circumstances than that of other hatchery programs in the Pacific Northwest: (1) populations of wild salmon, though diminishing, were relatively healthy, (2) spawning and rearing habitats were still pristine with no dams on major rivers and minimal habitat loss from developments, and (3) there was a growing awareness over the performance of hatchery fish compared to wild fish in other hatchery programs in the Northwest. Based on these conditions, the state implemented a more conservative approach to avoid past mistakes common to other hatchery programs.

In 1974 legislation was passed that enabled private non-profit organizations to build and operate hatcheries to provide salmon for the common property fisheries. While the main hatcheries in the region were owned and operated by the state until 1990, two regional aquaculture associations were formed. The Southern Southeast Alaska Regional Aquaculture Association located in Ketchikan and the Northern Southeast Alaska Regional Aquaculture Association located in Sitka, comprise representatives of commercial, subsistence, and sport fishermen, processors, and local communities. These associations have been active in implementing salmon enhancement projects as well as operating six major production hatcheries in the region. Additionally, several federal experimental hatcheries, the Bureau of Indian Affairs hatchery on the Annette Island Indian Reservation and ten non-association private hatcheries produce salmon in the region including Douglas Island Pink and Chum, Inc. (DIPAC).

Alaska appears to have been successful in managing salmon harvest over the past forty years, but in accomplishing this, the question of whether salmon biodiversity has been adequately protected for the future is still unanswered. Protection of biodiversity is the best insurance policy for survival of Pacific salmon, especially in the event of significant future

environmental change. Given the lack of knowledge about the effects of hatchery fish on wild salmon and estuarine ecosystems as a whole, and the effects of a changing climate, it is prudent that Alaska 's salmon hatcheries be operated conservatively with strict application of the Alaska Dept. of Fish and Game's genetics policy (ENRI 2001).

Mariculture is the practice of growing organisms in saltwater to maturation (ADF&G, 2008) http://www.cf.adfg.state.ak.us/geninfo/enhance/aquaculturehome.php. On June 21, 2002, House Bill 208 was signed into law authorizing the Department of Natural Resources to identify and offer for lease a minimum of ninety sites suitable for aquatic farming. The three primary state resource management agencies in Alaska, ADNR, ADF&G, and ADEC, identified a total of 158 sites for these activities. By the end of 2003, a total of fifty-eight aquatic farmers were permitted to culture Pacific oysters (*Crassostrea gigas*), blue mussels (*Mytilus trossulus*), weathervane scallops (*Patinopecten caurinus)*, Pacific littleneck clams (*Protothaca staminea*), Pacific geoduck clams (*Panopea abrupta*), bull kelp, and Porphyra, a red algae, on 237 acres of tide and submerged lands leased by the ADNR.

The potential stressors to conservation targets include introduction of invasive species, reduced foraging opportunities for fish because of intensive filtering of plankton, sedimentation from harvesting, and introduction of pathogens to wild stocks. Regulations addressing the stressors to ecosystems are in three sets of regulations and a permitting review process, through the Alaska Coastal Management Program, the ADF&G aquatic farming regulations, and ADNR tideland leasing regulations.

For example, to address pathogen control, the regulations require the seed sources be disease-free. There is one non-native species being commercially grown in the region, the Pacific oyster. Because oysters do not spawn in the relatively cold waters of Southeastern Alaska, their production is not expected to be problematic unless abiotic factors change in their favor. Monitoring of invasive species, water temperature, and water quality are important aspects of the mariculture industry. Informed shellfish farmers can make observations of species they observe in the nets or gear and work with a specialist if they notice unfamiliar species. Because clean water quality and certain water temperatures are important attributes for growing shellfish, farmers across the region could be a part of a water quality monitoring network.

4.45 Finfish Farming

Fish farming is a way to help feed people worldwide while easing the pressure on declining populations of wild ocean fish. However, finfish farming raises concerns surrounding genetics, introduction of invasive species, pathogens, increased exposure of wild stocks to diseases, and economic competition of farmed fish with wild fisheries. Currently, Alaska prohibits fish farms in state waters. However, under pending federal legislation, floating pens and fish farms could be allowed in federal waters.

The National Offshore Aquaculture Act of 2007 (H. 2010) would allow the US Secretary of Commerce to issue permits for fish farms in federal waters, up to 200 miles offshore, although states would have an option to decline to participate in these activities. This bill would provide a defined permitting process and allow long-term leases. There is also an exemption to the Magnuson-Stevens Fishery Conservation and Management Act, changing current laws so foreign corporations can own fish farms in U.S. waters. The Gulf of Mexico Fishery Management Council voted 11-to-5 in favor of allowing the farming to begin starting January, 2009. The Gulf of Mexico will be the first federal waters off of the U.S. to allow fish farming and few details are available.

4.46 Impacts from Boat Wakes

There is a little knowledge about the potential effects resulting from commercial and recreational boats on eelgrass beds, salt marshes, nearshore marine habitats, freshwater stream systems, and species. Propeller wash and boat wakes can disturb shallow benthic habitat, uproot eelgrass, re-suspend sediment and chemical contaminants, accelerate shoreline erosion, and disturb marine and terrestrial species. The magnitude of waves generated by a boat depends on many different factors including the boat's speed, its size, passenger and cargo loading, shape of the hull, distance from shore and water depth.

It has been suggested that in shallow or enclosed regions such as harbors, estuaries, bays, and deltas, the waves produced by low-wash vessels can have a sizeable impact on infaunal assemblages and that wave-induced erosion may be enhanced by the impact of wakes to the natural wave field (Bishop 2008; Hughes 2007; Osborne 1999; Parnell 2001). Additionally, ship wakes produced by deep-draft vessels transiting the lower Columbia River have been observed to cause stranding of juvenile salmon Pearson et al. (2006). Pearson et al.'s study suggest that under certain conditions, deep-draft vessels (but not small vessels) can produce wakes that strand juvenile salmon because of fish presence close to the shore, properties of the nearshore waves, and characteristics of the beach. Juvenile salmon migrating from streams to the ocean typically migrate close to shore until they grow to a large enough size to avoid predators in deeper water (Celewycz et al. 1994). While there are significant numbers of ships in Southeastern Alaska's waterways, especially in the summer, no studies have addressed this issue. Further investigation of this issue may be appropriate.

Chapter 5. Coastal Management in Southeastern Alaska

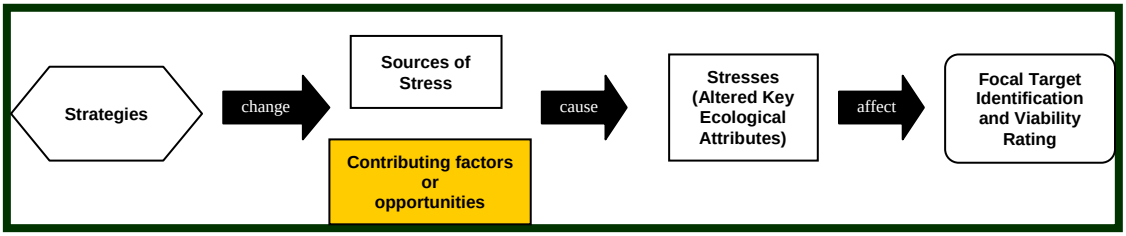

Figure 11. Step 3 in the CAP process – defining the contributing factors, management, and opportunities related to risk factors.

The conservation targets and associated human activities are managed by a combination of federal, state and municipal agencies, authorized by a complex network of state constitutional provisions, federal and state laws, management plans and conservation strategies (see Figure 12).

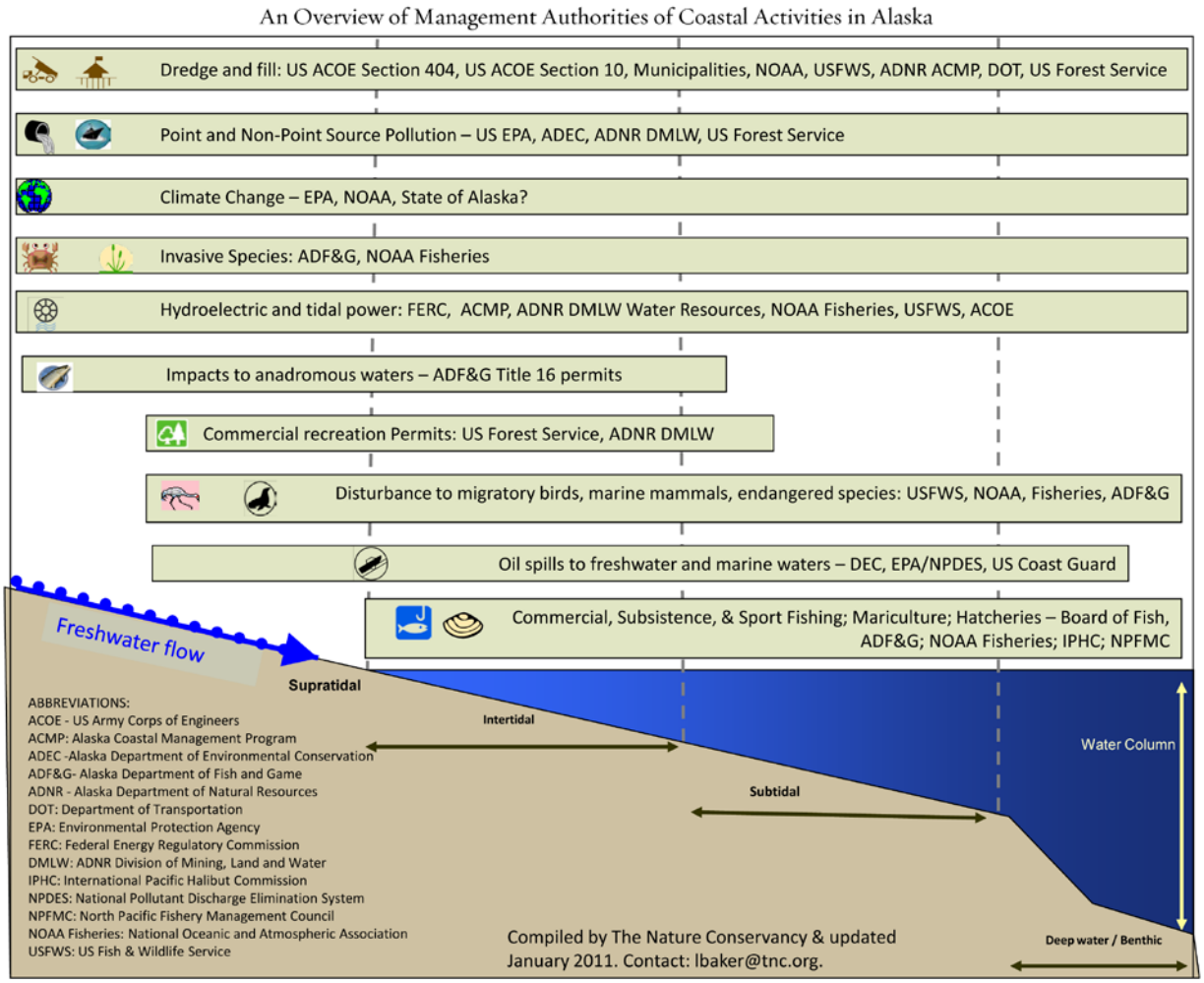

Figure 12. A summarized view of the complex management of resources along Alaska's coast.

An outline of the primary coastal resource management agencies, respective laws authorizing management activities, and the activity or scope of authority of those agencies relevant to Southeastern Alaska is provided in Appendix B. The importance of the management matrix cannot be overstated, as each of the eight conservation targets and the many risk factors are managed by different agencies. While this matrix of management is not unusual, complicated jurisdictions and authorities make it difficult to assess conservation values being maintained at any scale. A brief description of the management framework of coastal resources is provided in the next section.

5.1 Alaska's Coastal Management Approach

Title to unoccupied and undeveloped tidal and submerged lands was given to the State of Alaska in 1959 through the Submerged Land Act of 1953. Alaska has retained the majority of these lands estimated at 65 million acres of tidelands, shorelands and submerged lands with over 34,000 miles of coastline and only a small percentage of these lands are owned by non-state entities i.e. federal, municipal and private ownership (ADNR 2008) .

In a white paper published by The Nature Conservancy in 2006 titled "An analysis of Alaska's tidal and submerged land leasing laws, policy and conservation potential" author Judy

Harvey explains that the key provisions contained within the Submerged Lands Act of 1953, the Public Trust Doctrine and the Alaska State Constitution are the groundwork for understanding conservation opportunities of state-owned tidal and submerged lands and resources (Harvey 2006).

The State of Alaska Constitution provides the foundation of managing state-owned resource and authorizes the legislature to "provide for the utilization, development and conservation of all natural resources belonging to the state, including land and waters, for the maximum benefit of its people." Furthermore, the Constitution contains a Sustained Yield article which states that "Fish, forests, wildlife, grasslands and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle." Other provisions in the Constitution prohibit the state from unreasonably restricting use of fish and game where they occur to the public, known as the "common use" clause; while Sections 3, 15 and 17 of the Constitution prohibit exclusive or special privileges to take fish and wildlife, known as the "equal access clauses (Harrison 2002)."

Because of the common use and equal access clauses, arguments have been made that the state should regulate fish and game use as little as possible, while conservationists have argued that when analyzed holistically, provisions of the Constitution, including the "common use" clause and the "sustained yield" clause place the state in a position of conserving natural resources for future uses (Cook 1993).

One important application of the common use clause is the use of limiting entry into fisheries (comm. Rue, former Commissioner of ADF&G, 2009). A constitutional amendment provided the Limited Entry Fisheries Amendment, which is now found in Alaska Statutes (AS) 16.43. The statute serves three functions, to conserve fishery resources, to maintain economical and efficient fisheries, and to avoid economic hardships of people engaged in fisheries (Legislature 1972). AS 16.43 created the Commercial Fisheries Entry Commission that "…helps to conserve and maintain the economic health of Alaska's commercial fisheries by limiting the number of participating fishers." (CFEC 2009)

5.2 Coastal Management Agencies and Plans

Alaska Department of Natural Resources

The state legislature has directed the Alaska Department of Natural Resources (ADNR) to manage state-owned tidal and submerged lands. The ADNR has eight divisions to carry out duties: Agriculture, Ocean and Coastal Management, Forestry, Geological and Geophysical Surveys, Mining Land and Water, Oil and Gas, Parks and Outdoor Recreation.

The Alaska Coastal Management Plan

The Alaska Dept. of Natural Resources (DNR) administers several sets of plans. The Division of Coastal and Ocean Management administers the Alaska Coastal Management Program (ACMP), which contains statewide *standards* for defined coastal zone areas. In addition, the Division of Mining Land and Water administers Area Plans and Management Plans which provide guidelines for adjudicators to follow when administering permits both through the Alaska Coastal Management Plan consistency review process and non- ACMP adjudication and permitting processes.

The federal Coastal Zone Management Act of 1972 and the Alaska Coastal Management Act of 1977 provided the basis for the Alaska Coastal Management Program (ACMP) in Alaska,

developed to encourage cooperation and coordination among a networked program of state agencies. The mission of the ACMP is to provide "stewardship for Alaska's rich and diverse coastal resources to ensure a healthy and vibrant Alaskan coast that efficiently sustains long-term economic and environmental productivity."

The ACMP provides the following statutes and regulations for permitting development activities:

- **Statewide Standards for Coastal Development**;
- **General guidance on how to avoid, minimize, or mitigate** activities that can impact coastal resources and habitats;
- **Defines Coastal Boundaries**
- **Sets up a Consistency Review Process:** ACMP implementation occurs through project reviews for consistency with enforceable policies of the program and local enforceable policies contained within approved coastal district plans (Gray, 2008). Coordination of coastal project consistency reviews is required if:
  - The project is a federal activity;
  - The project requires a federal government approval; or
  - The project requires permits from more than one State agency.
  - Proposed usage and development of resources in the coastal zone require proponents to participate in the review process for consistency with the enforceable policies of the ACMP: see Coastal Project Questionnaire http://www.alaskacoast.state.ak.us/Clawhome/ABClist/Final/ABC_List_CPQ_Evaluation.pdf
- **Authorized to designate Special Area Management Plans, Special Management Areas and/or Areas Meriting Special Attention,** which have enforceable policies, may be authorized through administrative action and are similar to Special Land Use Designations in the DNR area plans based on importance to subsistence, scientific importance, or potential for designation as an estuarine or marine sanctuary.
- **Development of District Coastal Management Programs**: ACMP presents an opportunity for local governments to interact with state agencies in developing policies that create "an effective forum for responsible development and resolving local issues under ACMP Chapter 1.1 and 11 AAC114;

The Alaska Coastal Management Plan houses key statewide provisions, such as the Habitat Standards, Areas Meriting Special Attention, subsistence use areas, and enforceable policies, which has the potential to provide significant conservation opportunities of coastal ecosystems. In 2003 and 2005, a host of far-reaching changes were made to the ACMP through bills passed in the Legislature and through regulations and interpretations of the regulations.

In 2006, changes to the statewide habitat standards and requirements for the development of district-level enforceable policies significantly weakened the conservation intent of the Alaska Coastal Management Program. Understanding that the ACMP is both historically and potentially one of the most important conservation tools in the region, TNC asserts that significant improvements to the ACMP are needed if Alaska is to maintain the balance of developing its coastal resources and communities while maintaining the biologically and economically significant ecological functions of a healthy coastal environment. TNC supports the following:

- Changes to strengthen the statewide habitat standards.
- Giving coastal districts greater authority to implement enforceable policies for significant habitats in their districts that are not adequately addressed by the statewide habitat standards; and
- A more inclusive decision-making process that enables ADEC and coastal districts to work closely with DNR, ADF&G, and applicants to achieve the goals of the ACMP.

ADNR Area Plans and Management Plans

The DNR Dept. of Mining Land and Water (DMLW), Resource Development and Assessment Section is responsible for planning and managing state lands to meet statutory and public needs. These duties include:

- Preparation of land use plans and easement atlases;
- Land classification;
- Leasing and permitting of state lands;
- Sale of state lands and conveyances to municipalities;
- Management of Public Use and Recreational River Systems; and
- All mineral programs that pertain to the 96 million acres of state lands available for such activites.

DMLW prepares *area plans* and *management plans* that establish goals, policies, and guidelines for the use of state lands, and seeks public input in the process. Thus far, the Area Plans and Management Plans under the DNR DMLW are generally more site specific then the ACMP, although the City and Borough of Juneau's Coastal District Management Plan is the same plan that is incorporated into DNR's Area Plan. These plans are used by DMLW department permit reviewers when issuing recommendations and decisions on permit applications for tideland or submerged land development to the ACMP Consistency Project review process.

For the Special Land Use Designation, only the state legislature has the authority to close an area which is 640 acres or greater to multiple uses, or limit mining and associated mineral activities. The commissioner of the DNR has the ability to designate special use areas for smaller parcels through administrative authority. The Resources Section is charged with managing Public Use Areas or special use lands which provide protection of scenic, historic, archeological, scientific, or biological resource values warranting additional protections.

State land is managed based on parcel units and the management action is driven by a resource and use inventory, existing and potential needs, existing authorization, existing plans, and public participation. Chapter 2 in the Area Plans also includes general goals that can be designated for state lands, such as economic development, public use, settlement and sustained yield. According to 11 AAC 55.040, state lands are to be managed with the following intent:

1. State lands are managed to allow for multiple uses unless they are legislatively designated or have been withdrawn from the general lands designation, as in the case of state park lands.
2. State lands will be managed to protect access and public resources.
3. State land will remain open to mineral entry unless specifically closed.
4. Activities and authorizations in units identified as *primary designated uses* take precedence over other activities. If DNR determines that a conflict exists and that the

proposed use is incompatible with the primary use, the proposed use shall not be authorized or it shall be modified so that the incompatibility no longer exists.
5. Land is designated into categories that are generally consistent with current use patterns and most significant resources of the area.

Alaska Department of Fish and Game

The Alaska Department of Fish and Game (ADF&G) manages fish and wildlife resources on state-owned lands and waters, including salmonids, crab species, and Pacific herring. ADF&G fisheries regulations are set by the Alaska Board of Fisheries and ADF&G carries out the management of those regulations. ADF&G divisions include: Sport Fisheries; Commercial Fisheries, which oversees subsistence/personal use fisheries management, mariculture and aquatic farming, salmon enhancement and hatcheries; and Wildlife Conservation, which oversees research, hunting and trapping regulations, refuges and sanctuaries, non-game management, and other wildlife. ADF&G Wildlife Conservation works closely with the US Fish and Wildlife Service (USFWS) and NMFS on marine mammals, waterfowl, endangered species, and species of special concern.

Alaska Department of Environmental Conservation

The Alaska Department of Environmental Conservation (ADEC) is charged with regulating air and water quality. ADEC's mission is "To conserve, improve, and protect its natural resources and environment and control water, land, and air pollution, in order to enhance the health, safety, and welfare of the people of the state and their overall economic and social well being." ADEC has implemented primacy over the EPA National Pollutant Discharge Elimination System process, now under the Alaska Pollutant Discharge Elimination System permitting process.

5.3 State refuges, sanctuaries, range areas, or fish and game critical habitat areas

Under Alaska Statutes 38.05.300, the state legislature can implement Special Use Areas for fish and game over six hundred and forty acres in size including state refuges, sanctuaries, range areas, or fish and game critical habitat areas. These areas have the strictest land use designations under ADF&G management. These places are designated because of their exceptional fish and wildlife values and the land use priority and management intent by ADF&G is for conservation and protection of those values.

5.4 Federal management of coastal resources in Southeastern Alaska

Federal agencies play a significant role in managing coastal resources in Southeastern Alaska (see Appendix B for a list of agencies, management authorities, regulations, and scope). The US Fish and Wildlife Service, in partnership with Alaska native people, manage sea otters and migratory birds. The International Pacific Halibut Commission sets regulations for Pacific halibut and the NMFS carries out the IPHC's regulation. NMFS manages most marine mammals and marine fish species under the Marine Mammal Protection Act, the Magnuson-Stevens Fishery Conservation and Management Act, and the Endangered Species Act. NMFS carries out

research on nearshore marine and estuarine environments for identifying and increasing understanding of essential fish habitat. Federal agencies are authorized to make recommendations during the permit review process for development activities that may impact species over which those agencies have the authority to manage.

Two significant federal managers in the region include the National Park Service (including Glacier Bay National Park, Klondike Gold Rush National Historic Park, and the Sitka National Historic Park) and the USDA Forest Service. The land, marine waters, and species within Glacier Bay National Park are managed holistically. The majority of the uplands in Southeastern Alaska are federally owned and managed by the Tongass National Forest, directed by the Tongass Land Management Plan, 2008 (USDAFS 2008).

5.5 Effectiveness of Coastal Management in Southeastern Alaska

This paper serves to point out that there is a need to further understand the viability of conservation targets in relation to human activities and the complexities of the management structure of Alaska's coastal resources. We recommend that a management gap analysis be done to identify which coastal resources are being effectively conserved and managed and which need further conservation actions. For example, increasing direct protection of important habitats and strengthening statewide habitat standards are two strategies that would greatly benefit estuarine systems.

Chapter 6. Summary of Conservation Strategies

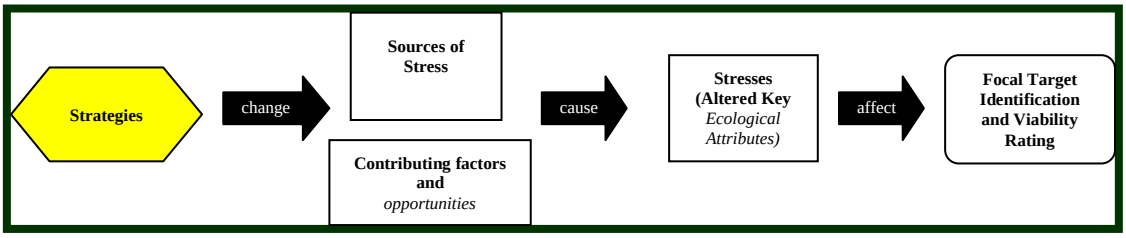

Figure 13. Developing strategies for conservation actions.

It is important that conservation strategies protect processes and functions of ecosystems i.e. the ecological attributes, while meeting conservation goals and objectives for species and human impacts. Also, strategies should be integrated into a comprehensive coastal management plan (Kelleher 1992; Roberts 2003). Based on the wide ranging and complex nature of both conservation targets, stressors, and management opportunities presented in this conservation action plan, below is an outline of proposed conservation objectives and next steps.

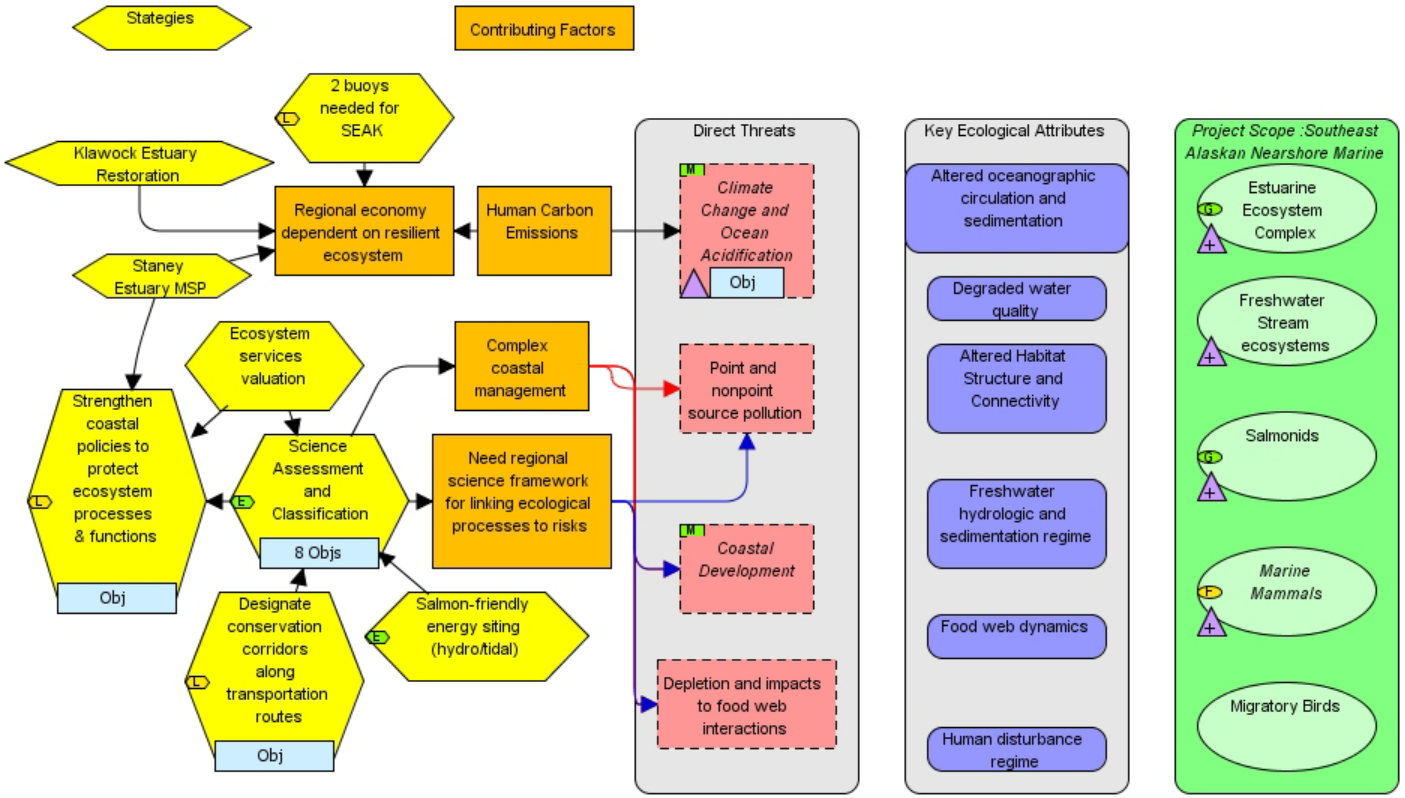

Figure 14. Reading from right to left, this diagram illustrates the connections among the focal conservation targets, key ecological attributes, threats, contributing factors and conservation strategies.

Objective 1. Advancing Scientific Knowledge of Marine Systems in Southeastern Alaska

This objective is a multi-site strategy to provide important scientific information to increase the conservation capacity of the network of coastal management professionals in the region.

Priority Actions

- Develop state of the art nearshore marine and estuarine database equivalent of terrestrial assessment.
- Refine classification framework for Southeastern Alaska's nearshore marine and estuarine ecosystems.
- Complete ShoreZone habitat mapping and inventory system (See Appendix A)
- Assess conservation target status, trends, and threats.
- Perform management gap analysis
- Prioritize high value places based on ecological and human use values through Marxan Analysis
- Identify a network of priority estuarine and nearshore marine areas for conservation actions at multiple scales through an ecoregional assessment.
- Increase capacity of oil spill response officials to avoid or minimize impacts of catastrophic events e.g. oil spills and ship grounding

Objective 2. Work with partners to maintain or improve current health of the conservation targets.

Priority Actions

- Work at the local level in a specified watershed and coastal basin e.g. Staney Creek estuary drainage into Sea Otter Sound, to develop a marine spatial planning model for multiple objectives including identifying aquaculture areas, marine monitoring for ocean acidification issues, etc.
- Ensure Southeastern Alaska remains a salmon-friendly region in relation to increasing energy infrastructure development. Specifically, TNC will map out potential ecological impacts of freshwater hydro-power scenarios for the region in order to engage with FERC, Tongass National Forest, conservation groups and communities.
- Engage in the revision of the Alaska Coastal Management Program to maintain and protect salt marsh and eelgrass bed habitats.
- Support forest and estuarine restoration through Tongass and private lands forest and rivers restoration actions e.g.re-opening of Klawock Causeway
- Federal Offshore Fish Farming Policies: Evaluate TNC's involvement in the national bill for implementing very strict standards through a systematic approach.
- Improve statewide salmon policies to address mining, hydrologic changes, and other water quality issues through instream flow legislation, Anadromous Waters Catalog, and water quality standards.

Objective 3. Develop strategies to address monitoring of water quality and other indicators for conservation targets

Priority Actions

- Organize experts to develop an index for assessing cumulative effects of multiple stresses (Three cumulative impact studies have been done in Alaska on the Kenai, North Slope, Sitka Coastal Zone). Potentially apply the Total Maximum Daily Load (TMDL) approach as an established mechanism and adopt process for defining thresholds for areas where cumulative effects are taking place.
- Understand ADEC's priority projects and primary strategies: copper, total dissolved solids; mixing zones; cruise ship discharge.
- Designate outstanding water quality through the anti-degradation policy process.
- Review water quality monitoring efforts across Southeastern Alaska and assess the need for a regional water quality monitoring approach.
- Follow up on Cook Inlet Keeper's Stream Temperature Monitoring Network: Water Temperature Data Logger Protocol for Cook Inlet Salmon Streams and the Citizen's Environmental Monitoring Program.
- Assess potential partnerships with ADEC's Environmental Monitoring and Assessment Program and NOAA's Southeast Alaska Coastal Monitoring program.
- Collaborate with the University of Alaska Fairbanks Marine Advisory Program on their monitoring data.
- Review the National Park Service Southeast Alaska Monitoring Network (Fig. 15).

Figure 15. National Park Service Southeast Alaska Monitoring Network Indicators

TNC will to work with partners to refine and implement the strategies outlined above. An example of a significant conservation strategy that was developed to protect salmon and watersheds in Southeastern Alaska and on the Tongass National Forest was the requirement for buffer zones on all anadromous streams mandated by the Tongass Timber Reform Act in 1990 (USDA 1995) and the Alaska Forest Resources and Practices Act in 1990 (ADNR 2003). This concept of a zone to protect the natural functioning of streams and salmon habitat is somewhat analogous to the concept of marine reserves that is defined as "areas of the ocean that are completely protected from all extractive and destructive activities" (Lubchenco 2003).

A network of estuarine and nearshore conservation areas could protect ecosystem processes and functions that support multiple objectives, i.e. juvenile fish recruitment, human use activities, and ecosystem linkages (Roberts 2003). Marine reserves or protected areas cannot alleviate all problems such as pollution, climate change, or overfishing that originate outside of reserve boundaries. However, marine reserves are a tool that should be complemented by other approaches (Lubchenco 2003).

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Appendix A. The Alaska ShoreZone Inventory and Habitat Mapping Project

Background

In 2001, an effort unprecedented in size and scope, was launched to photograph, map and inventory all 34,000 miles of Alaska's coast through a project known as ShoreZone – from Southeastern Alaska, through the length of the Aleutian Islands, and north to the Beaufort and Chukchi seas. A web-based mapper, tutorials, supporting documentation, and metadata are available at www.shorezone.org. The Nature Conservancy (TNC) is supporting this project because of the need to identify and conserve the most productive areas of Alaska's coastline, which cannot be completed until there is a full inventory of the coastal resources.

Over thirty agencies and non-profits across the State of Alaska, British Columbia, and Washington have partnered to implement the ShoreZone inventory and mapping effort across the North Pacific region. A complete region-wide database of nearshore features (biology and geomorphology) will provide baseline data to coastal community managers, scientists and the public, so we can make informed decisions when managing resources and planning development.

ShoreZone Habitat Mapping and Inventory Description

ShoreZone is a habitat mapping and inventory system which relies on the collection and interpretation of aerial imagery of the intertidal zone and estuarine environment. The digital imagery is then made public through www.shorezone.org. Because of its scale and complexity, an inventory of the region's coastal habitats has only been feasible with recent developments in mapping technologies.

ShoreZone inventory of a designated shoreline is conducted in two phases. The first phase involves collecting oblique low-altitude aerial video and digital still imagery of the coastal zone during summer low tides (zero tide level or lower) from a helicopter flying at <100 m altitude. Video and still imagery are georeferenced. Video imagery is accompanied by continuous, simultaneous commentary by a geologist and a biologist aboard the aircraft. The imagery and commentary are later used in the definition of discrete along-shore coastal habitat units and the "mapping" of observed physical, geomorphic, sedimentary, and biological features in those units. Units are digitized as shoreline segments in ArcView or ArcGIS, and then integrated with the along-shore and across-shore geological and biological data housed in a relational database. Mapped habitat features include degree of wave exposure, substrate type and morphology, sediment texture, intertidal biota, and some nearshore subtidal biota.

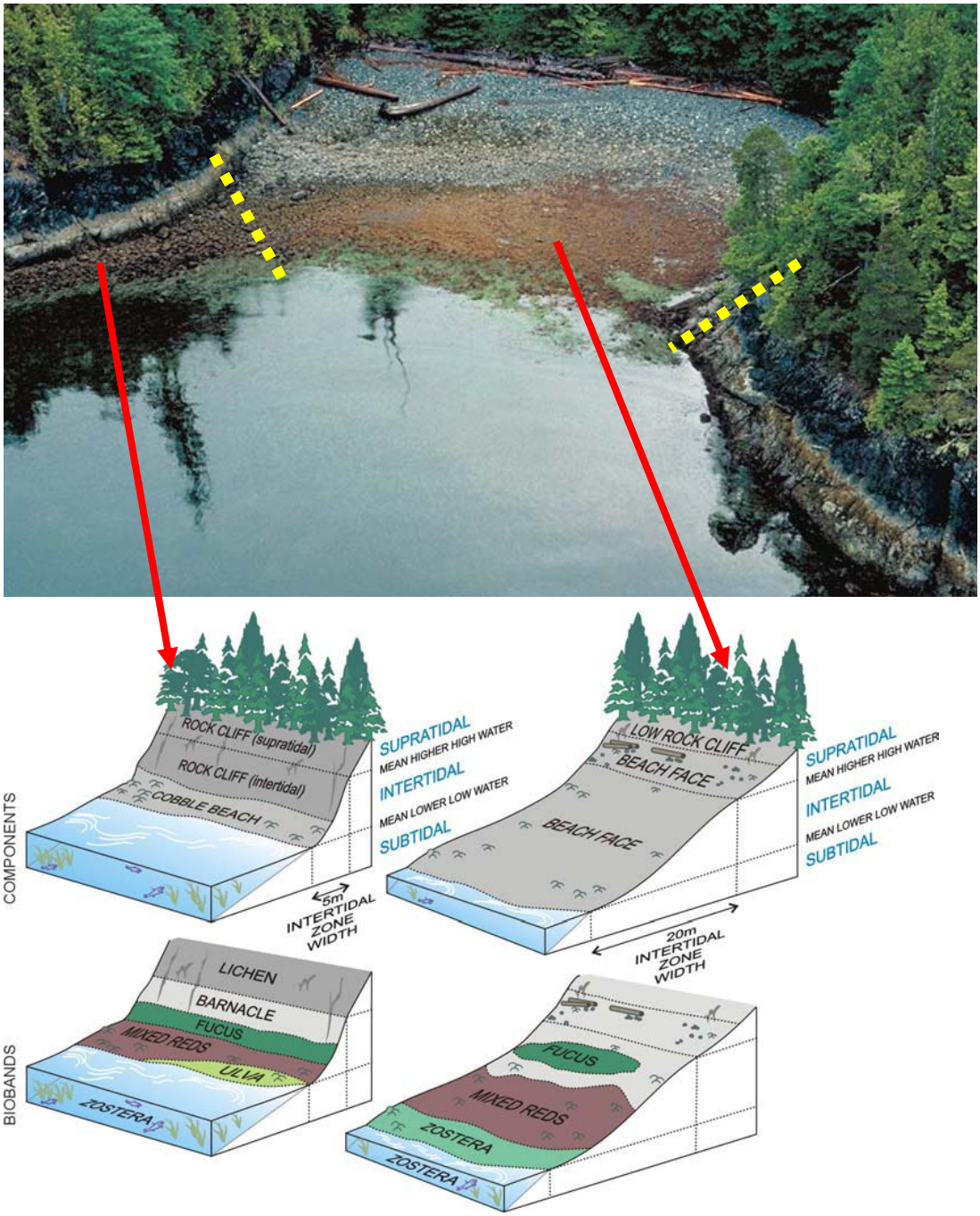

Figure 1. Oblique aerial photo (A) illustrating the delineation of an alongshore unit. Each unit is sub-divided into several across-shore zones (B) according to tidal elevation (supratidal, intertidal, subtidal), in which the geomorphic and sedimentary components (e.g. rock cliff, cobble beach) and biobands (e.g. lichen, barnacle, *Fucus*, red and green algae, and eelgrass) are mapped (from Harney et al, 2008 SZ Protocol).

Appendix B. A Matrix of Alaska's Coastal Resource Management Entities

Agency/Division	Authority		Activity/ Scope of Authority
	Federal	State Legislation	
Alaska State Legislature		**State Constitution: Article VIII Natural Resources** §1. Statement of Policy It is the policy of the State to encourage the settlement of its land and the development of its resources by making them available for maximum use consistent with the public interest. § 2. General Authority The legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State, including land and waters, for the maximum benefit of its people. § 4. Sustained Yield Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses. For full description of Article VIII, see http://ltgov.state.ak.us/constitution.php?section=8	Public Lands Public Resources Fish and Game Environmental Conservation
Municipalities		Local zoning authority; Coastal District Areas; Coastal Resource Service Areas	Upland and tideland management; enforceable zoning policies
Native Corporations	Alaska Native Claims Settlement Act	Alaska Forest Resources and Practices Act	Upland and tideland management: roading, logging, mining, tourism, and recreation; land selection processes underway for coastal zone recreation and tourism development by Sealaska; Sacred sites management;
Alaska Dept. of Natural Resources (ADNR) Div. of Mining Land and Water (DMLW)		Under AS 38 Public Lands, DMLW develops and administers state land use authorizations for activities occurring on state owned lands.	**DMLW is responsible for the preparation of** land use plans, easement atlases; land classification; leasing and permitting of state lands, sale of state lands and conveyances to municipalities, management of Public Use and Recreational River Systems, and all mineral programs that pertain to the 96 million acres of available state lands. **Area plans** and management plans establish goals, policies, and guidelines for use of state lands. Chapter two of each Area Plan outlines land use designations: General Use; Aquatic Farming; Fish and Wildlife Habitat Harvest Areas; Habitat and Crucial Habitat Areas; Forestry; Material Sites; Shorelines, Stream Corridors, and Coastal Areas; Special Use Lands 2. **Public Use Areas or special use lands** provide protection of scenic, historic, archeological, scientific, or biological resource values warranting additional protections.
DMLW Water Resources		Planning and permitting of water rights and regulations.	Instream flow reservations; protection of fish and wildlife habitat, migration, etc; Recreation and Parks; Navigation and transportation; Sanitation and water quality

Agency/Division	Authority		Activity/ Scope of Authority
	Federal	State	
DNR Division of Coastal and Ocean Management (DCOM): Alaska Coastal Management Program (ACMP)	Coastal Zone Management Act of 1972 (CZMA) provides guidance for states to develop coastal management programs.	1. The Alaska Coastal Management Act of 1977 provided the basis of the Alaska Coastal Management Program. 2. AS 46.39.040 authorizes the development of **statewide standards** for the ACMP and criteria for the preparation and approval of district coastal management plans. 3. Designation of Special Area Management Plans (SAMPs), Special Management Areas (SMAs) and/or Areas Meriting Special Attention (AMSAs) are area or site specific, have enforceable policies, may be authorized through administrative action, similar to Special Land Use Designations (SLUD) in DNR area plans based on importance to subsistence, scientific importance, or potential for designation as an estuarine or marine sanctuary.	**Major uses or activities subject to the ACMP program;** coastal development, natural hazards areas, coastal access, energy facilities, utility routes and facilities, timber harvest and processing, sand and gravel extraction, subsistence, and transportation routes and facilities. **Proposed usage and development of resources in the coastal zone require** proponents to participate in the review process for consistency with the enforceable policies of the ACMP: see Coastal Project Questionnaire http://www.alaskacoast.state.ak.us/Clawhome/ABClist/Final/ABC_List_CPQ_Evaluation.pdf **ACMP requires coordination** of coastal project consistency reviews: a. The project is a federal activity; b. The project requires a federal government approval; or c. The project requires permits from more than one State agency.
Division of Coastal and Ocean Management		1. Administration of Coastal Impact Assistance Program (CIAP); 2. Mitigation of damage to fish, wildlife or natural resources.	CIAP includes projects and activities related to conservation, protection, or restoration of coastal areas, including wetlands. http://www.dnr.state.ak.us/coastal/CIAP/ciap.htm
Office of Project Management and Permitting (OPMP)		Coordinates the review of large projects on state lands	1. Oil and gas leasing 2. Mining operations 3. ANILCA Coordination 4. Federal agency jurisdiction overlap
Div. of Support Services, Land Records Information Section			Provides Land Administration System (LAS), the Geographic Information System, and produces and maintains the state's land status maps
Division of Parks and Outdoor Recreation		Alaska Statute AS 41.21: Planning and administration of legislatively designated parks.	Park Unit Types: State Parks, State Marine Parks, State Historic Parks, State Historic Site, State Recreation Area, State Recreation Site, Special Management Area, State Trail [State Recreational River], State [Scientific, Ecological, Educational] Preserve
Division of Forestry		Alaska Statutes 41.17.200-230: Administers the **Alaska Forest Resources and Practices Act** governs how timber harvesting, reforestation, and timber access occur on state, private, and municipal land.	Forest plans are managed for multiple uses and sustained yield, incorporated into DNR area plans, accompanied by a five year Schedule of Timber Sales; accompanied by Forest Land Use Plans.

Agency/Division	Authority	Activity/ Scope of Authority
	State	
Board of Fisheries	**State Legislation: Title 16**	Conserves and develops the fishery resources of the state; board is charged with making allocative decisions, and the ADF&G is responsible for management based on those decisions.
Alaska Department of Fish and Game (ADF&G)	**State Legislation: Title 16**	Responsible for the management of fish, game and aquatic plant resources of the state.
Habitat Division	Alaska Executive Order 114; **Alaska Statute 16.05.841 (Fishway Act)** requires that authorization is obtained for activities within or across a stream used by fish if Habitat determines that such uses or activities could represent an impediment to the efficient passage of fish. **Alaska Statute 16.05.871 (Anadromous Fish Act)** requires that an individual or government agency provide prior notification and obtain permit approval from the Habitat "to construct a hydraulic project or use, divert, obstruct, pollute, or change the natural flow or bed" of a specified waterbody (Quoted portions from AS 16.05.871 (b)). Law does not apply until it is in the catalogue (criminal statute).	Mission: Preserve the state's fish and wildlife resources by protecting the areas they need to complete their life cycles. Includes management and permitting of Critical Habitat Areas, Refuges, Sanctuaries. • Fishways Act can address culvert installation; water withdrawals; stream realignment or diversion; dams; low-water crossings; and construction, placement, deposition, or removal of any material or structure below ordinary high water all require approval from Habitat. • Habitat Div also performs non-regulatory functions: coordination of ADF&G comments • Minor role in administration of Shellfish act
Division of Wildlife Conservation	**01. Subsistence Finfish Fishing (5 AAC 01.001 – 5 AAC 01.750)** **02. Subsistence Shellfish Fishery (5 AAC 02.001 – 5 AAC 02.625)** **77. Personal Use Fishery (5 AAC 77.001 – 5 AAC 77.695)** **96. Local Fish and Game Advisory Committees and Regional Fish and Game Councils (5 AAC 96.010 – 5 AAC 96.920)**	Manages wildlife populations and habitat, develops public information, and facilitates interactions between state, federal, and communities. State subsistence hunting and trapping is managed by the Division of Wildlife Conservation.
Sportfish Division	Title 05 Permanent Regulations	Oversight and management of Alaska's sport and personal use fisheries
Commercial Fisheries (including mariculture)	Title 05 Permanent Regulations	Manage, protect, rehabilitate, enhance, and develop fisheries and aquatic plant resources in the interest of the economy and general well-being of the state, consistent with the sustained yield principle and subject to allocations established through public regulatory processes.

Agency	Authority		Activity/ Scope of Authority
	Federal	**State**	
Alaska Dept. of Environmental Conservation (ADEC) Division of Water: Water quality programs - NonPoint Source Water Pollution Control Program; Water Quality Standards Assessment & Restoration; Wetland Program; Wastewater Discharge Authorization; Village Safe Water Program)	1. Section 301(a) of the Clean Water Act (CWA) provides that the discharge of pollutants to surface waters of the United States is unlawful except in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. 2. CWA section 305(b) and 303 (d) reporting 3. Alaska Performance Partnership Agreement (National Environmental Performance Partnership System)	18 AAC: Chapter 70. Water Quality Standards. Chapter 72. Wastewater Disposal. Chapter 73. Construction Grants. Chapter 74. Water and Wastewater Operator Certification and Training. Chapter 77. State-Funded Clean Water Account. Chapter 78. Underground Storage Tanks. Chapter 80. Drinking Water. Chapter 90. Pesticide Control. Chapter 95. Administrative Enforcement.	**Mission:** Improve and protect water quality; Establishes standards for water cleanliness; Regulates discharges to waters and wetlands; Financial assistance for water and wastewater facility construction, and waterbody assessment and remediation; monitors and reports on water quality. **Scope:** Domestic Wastewater, Septic Systems, Industrial Wastewater (including seafood processing), Temporary Camps, Stormwater, Log Transfer Facilities **Other activities:** Non-point source pollution prevention; Watershed management, planning, and restoration; Id state water quality priorities; Schedule for developing recovery plans on impaired water bodies; Providing pass-through funding and technical assistance groups involved in water quality projects.
Division of Spill Prevention & Response: Contaminated Sites Program; Industry Preparedness Program; Coordinates with Dept. of Defense; NOAA Office and Response and Restoration; NOAA's Coastal Protection and Restoration Division;	Defense Environmental Restoration Act; Comprehensive Environmental Response Compensation and Liability Act (CERCLA) 1980 which include the National Priority List or "Superfund" sites; Resource Conservation and Recovery Act of 1984	Chapter 75. Oil and Hazardous Substances Pollution Control. 1. Oil Pollution Prevention Requirements. (18 AAC 75.005 - 18 AAC 75.090)	Oil and chemcial spill prevention; Contaminated Sites clean-up; Industrial spill preparedness; Leaking underground tanks; Prevention and Emergency Response (of oil and hazardous substances) http://www.dec.state.ak.us/spar/csp/federal.htm
Municipal Grants & Loans		Chapter 76. Alaska Clean Water Fund. (18 AAC 76.005 - 18 AAC 76.100)	Provides loans and engineering support for drinking water, wastewater (sewer), solid waste and non-point source pollution projects
National Pollutant Discharge Elimination System Primacy	ADEC must certify the NPDES general permits under section 401 of the Clean Water Act (CWA) Certification	State Legislative Authority: Senate Bill 110; AS 46.03.100; House Bill 149	• NPDES Primacy Regulations development/ amendment • Program policy and procedures • Planning
Compliance and Enforcement		State Legislative Authority: Senate Bill 110; AS 46.03.100; House Bill 150	Assuring compliance with APDES permit and program requirements
Cruise Ship Program		Cruise Ship Wastewater Statues AS 46.03.460-490; Regulations 18 AAC; Ballot Measure 2;	Ensures that cruise ships and State ferries comply with wastewater effluent and visible emission standards and conducts scientific research to assess the impact of cruise ship wastewater on Alaska's environment.
Alaska Clean Water Actions (ACWA)		ACWA was created through Administrative Order 200.	**Directs resource agencies to work together to characterize Alaska's waters in a holistic manner;** sharing data, expertise and other information. ACWA's database of priority waters and identified stewardship actions; DEC, ADFG, DNR conducts annual joint matched-solicitation for water quality projects using federal funds.

Agency	Authority	Activity/ Scope of Authority
	Federal	
North Pacific Fisheries Management Council	1. The Magnuson-Stevens Fishery Conservation and Management Act,(Public Law 104-267)	With jurisdiction over the 900,000 square mile Exclusive Economic Zone (EEZ) off Alaska, the Council has primary responsibility for groundfish management in the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI), including cod, pollock, flatfish, mackerel, sablefish, and rockfish species harvested mainly by trawlers, hook and line longliners and pot fishermen. The Council implements halibut regulations set out by the IPHC. The Council determines how to allocate the area-specific catch allowance among all the competing interests: commercial, subsistence, sport, research, bycatch. http://www.fakr.noaa.gov/npfmc/about.htm
NOAA Fisheries	1. The Magnuson-Stevens Fishery Conservation and Management Act,(Public Law 104-267) (Source: http://www.fakr.noaa.gov/habitat/faq.htm#authorized) 2. Endangered Species Act 3. Marine Mammal Protection Act - The harvest of seals, sea lions and some whales is co-managed by the NMFS and Alaska Natives under the MMPA 4. Rivers and Harbors Act: requires the ACOE to consult with NMFS on Clean Water Act Section 404 and Section 10 permits; 5. Halibut Act	NOAA Fisheries performs project reviews and provides recommendations on essential fish habitat protections and climate change impacts to the ACOE, FERC, USFS, and other agencies on federal projects. Essential Fish Habitat are those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity. Under the Halibut Act, NMFS receives data and limit determinations from the International Pacific Halibut Commission or the North Pacific Fisheries Management Council, then carries out regulations and limits. NMFS Office of Protected Resources also manages human impacts including: Figheries Interactions - the incidental capture of marine mammals; Ocean Sound Acoustics; Ship Stirkes; Viewing Wildlife; and Safely Deterring Marine Mammals. http://www.nmfs.noaa.gov/pr/impacts.htm
NOAA Office of Restoration and Response		National Oceanic and Atmospheric Administration (NOAA) acts for the Secretary of Commerce as a federal trustee under the Superfund Act to protect and restore natural resources in coastal and marine areas. NOAA trust resources in Alaska include walleye, pollock, Pacific salmon, cod, and halibut, steelhead, rockfish, Dungeness, king, and snow crab, razor clams, and dozens of other species and their supporting habitats (e.g., tidal wetlands). http://response.restoration.noaa.gov/book_shelf/464_crc_state_AK.pdf
US Fish and Wildlife Service	1. Migratory BIrd Treat Act 2. Marine Mammal Protection Act 3. Endangered Species Act: Manages habitat for endangered species (Stellar's sea lions, sea otter in Southeastern Alaska) 4. Rivers and Harbors Act: requires the ACOE to consult with USFWS on Section 404 and Section 10 permits; 5. Fish and Wildlife Coordination Act 6. National Environmental Policy Act	Fish and Wildlife Coordination Act allows USFWS to comment on major federal activities. USFWS provides recommendations to other agencies, including the US Forest Service, ACOE, and state agencies on federal projects. The harvest of waterfowl and other migratory birds is co-managed by the U.S. Fish and Wildlife Service and Alaska Natives http://alaska.fws.gov/mbsp/mbm/index.htm. The harvest of sea otters is co-managed by the U.S. Fish and Wildlife Service and Alaska Natives under the Marine Mammal Protection Act. http://alaska.fws.gov/fisheries/mmm/index.htm The NOAA Fisheries Office of International Affairs
USDA Forest Service	Tongass Land Management Plan; Tongass Timber Reform Act	US Forest Service is primary upland owner and manager in Southeastern Alaska. Management decisions, including logging, road building, special use permitting, tourism operations affect riparian and stream health, beach buffers, impact nearshore and estuarine areas. Special Use Permits are issued by District level.
Federal Energy Regulatory Commission	Federal Power Act	Small hydropower is an important and increasing energy source in Southeastern Alaska (Falls Creek, Lake Dorothy, Blind Slough, Whitman Lake, Cascade Creek, etc) http://www.ferc.gov/for-citizens/projectsearch/SearchProjects.aspx?Region=Northwest

Agency	Authority	Activity/ Scope of Authority
	Federal	
US Environmental Protection Agency (USEPA)	For all laws and regulations see: http://www.epa.gov/owow/wetlands/laws/ and http://www.epa.gov/owow/wetlands/regs/index.html Pertinent laws include: 1. Clean Water Act; 2. Rivers and Harbors Act 3. National Environmental Policy Act of 1969 (NEPA) 4. Rivers & Harbors Appropriation Act of 1899 • Section 10 - establishes a program to regulate activities affecting navigation in United States waters, including wetlands • Army Corps of Engineers, Section 10 Program 5. Endangered Species Act (ESA) The ESA provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. 6. Coastal Wetlands Planning, Protection & Restoration Act (CWPPRA) 7. North American Wetlands Conservation Act (NAWCA)	The Clean Water Act sets the basic structure for regulating discharges of pollutants to waters of the United States including dredged and fill material, Ocean Discharge Criteria, National Pollutant Discharge Elimination System. EPA permits wetland and tideland activities, conservation, and project review.
USEPA	Responsible for the management of fish, game and aquatic plant resources of the state.	Spill Prevention, Control, and Countermeasure (SPCC) Plan: Facilities subject to the rule must prepare and implement a plan to prevent any discharge of oil into or upon navigable waters of the United States or ad-joining shorelines.
USEPA	Special Aquatic Sites (ftp://ftp-fc.sc.egov.usda.gov/OR/Planning_Worksheets/OREVT1SAS.doc) Section 404 b.(I) guidelines (Federal Register 1980	Special Aquatic Sites possess special ecological characteristics of productivity, habitat, wildlife protection or other important and easily disrupted ecological values. Special Aquatic Sites include fish and wildlife sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and riffles and pool complexes.
U.S. Army Corps of Engineers (ACOE)	1. Rivers & Harbors Appropriation Act of 1899 • Section 10 (33 U.S.C. 403) covers construction, excavation, or deposition of materials in, over, or under such waters, or any work which would affect the course, location, condition, or capacity of those waters • Section 404 authority (33 U.S.C.1344) for the discharge of dredged or fill material into waters of the United States at specified disposal sites. Section 404 includes rules regarding Compensatory Mitigation for loss of Aquatic Habitat.	Under Section 10 and Section 404, ACOE must consult with NOAA NMFS, USFWS, EPA for recommendations on habitat protections. • Placement of fill material. • Ditching activities when the excavated material is sidecast. • Levee and dike construction. • Mechanized land clearing. • Land leveling. • Most road construction. • Dam construction.

Agency/Treaty	Authority	Activity/ Scope of Authority
	International	
International Pacific Halibut Commission	International Treaty: Convention between the United States and Canada for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea.	The IPHC collects the data and determines the limits each year for the entire stock, and on an area-by-area basis. http://www.iphc.washington.edu/halcom/default.htm
Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean	Implementing Legislation: The North Pacific Anadromous Stocks Act of 1992 (Title VIII of Public Law 102-567).(Senate Treaty Document 102-30, 102d Congress, 2d Session). Member Nations: Canada, Japan, the Republic of Korea, the Russian Federation, and the United States. http://www.nmfs.noaa.gov/ia/docs/2008_International_Agreements.pdf	The NPAFC serves as a forum for promoting the conservation of anadromous stocks and ecologically-related species, including marine mammals, sea birds, and non-anadromous fish, in the high seas area of the North Pacific Ocean.
Treaty Between the Government of the United States of America and the Government of Canada Concerning Pacific Salmon, 1985.	Pacific Salmon Treaty Act of 1985 (16 U.S.C. 3631). http://www.nmfs.noaa.gov/ia/docs/2008_International_Agreements.pdf	The PSC's mission is to serve as a forum for cooperation between the United States and Canada in the establishment of general fishery management regimes for the international conservation and harvest sharing of intermingling North Pacific salmon stocks. Implementation of the principles of the Pacific Salmon Treaty should enable the two countries, through better conservation and enhancement, to "prevent overfishing and provide for optimum production; and provide for each Party to receive benefits equivalent to the production of salmon originating in its waters."

Appendix C. Matrix of CAP Targets, Ecological Attributes, and Indicators

Target	Key Ecological Attribute	Risk Factors	Indicators
Estuarine Ecosystems	• Freshwater flow and Sedimentation Regime	• Hydropower; urban development; mining, climate change	• Freshwater flow regime
	• Eelgrass, salt marsh, kelp beds or tidal flats	• Dredge and fill; climate change	• Condition of eelgrass, salt marsh, kelp beds and tidal flats; Army Corps of Engineers Fill permits
	• Water quality	• Dredge and fill; road runoff; climate change; urban development	• Large and small vessel wastewater discharge; Effluent permits; historic oil spills and ship groundings
Freshwater Ecosystems	• Freshwater flow regime	• Hydropower; urban development; Historic logging effects	• % of watersheds with specific development criteria (urban, roads, mining, logging)
	• Condition of riparian habitat	• Timber harvest activities (primarily historical)	• Acres of young growth in wood dependent channels
	• Water quality condition	• Contaminated sites; atmospheric deposition of pollutants	• State water quality criteria measurements; distribution and status of impaired water bodies
Anadromous Fish	• Connectivity: Fish passage between stream, estuarine, and nearshore habitats	• Roads, culverts; dredge and fill; urban development	• # obstructions within watershed (i.e. culverts) or # marine facilities per mile shoreline
	• Quality of rearing habitat	• Historic logging practices; urban development;	• # pools or amount of large woody debris per km of stream; abundance of juvenile salmon in estuaries; Annual catch rates of species
	• Water quality	• Contaminated sites; Marine vessel waste discharge; urban development; mining; climate change; catastrophic events	• Salinity range, temperature range, DO, contaminants
Marine Mammals	• Health of species	• Marine vessel transportation; fishing gear; marine debris; poaching; catastrophic events; climate change	• # of boat strikes, strandings, entanglements, of humpback whales;
	• Human disturbance regime (harbor seal pupping sites at tidewater glaciers; haul-outs and rookeries; concentrated feeding areas of whales)	• Marine vessel transportation associated with tourism	• # of violations or complaints on encounters; Marine traffic patterns in relation to known marine mammal congregations

	• Quantity and quality of food	• Fisheries management; climate change; dredge and fill of forage fish habitat;	• Annual herring biomass estimate
Migratory Birds	• Habitat quality	• Urban development; Historic logging practices; Contaminated sites	• % loss of critical habitat for migratory species; % use of known sea bird colonies (terns, cormorants, puffins, murres)
	• Abundance of food resources	• Climate change; Urban Development; Dredge and Fill; Fisheries mgmt.	• Tern colony hatching success
	• Bird populations	• Migratory species management; Dredge and fill; Contaminated sites	• Species distribution of waterfowl by USFWS