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Alaska Coastal Wetlands Survey

by

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Cooperative Report

Department of the Interior
U.S. Fish and Wildlife Service
National Wetlands Inventory
Washington, D.C. 20240

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National Oceanic and Atmospheric Administration
National Ocean Service
National Marine Pollution Program Office
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CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
meters (m)	0.5468	fathoms
kilometers (km)	0.6214	statute miles
kilometers (km)	0.5396	nautical miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters (m^3)	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons (t)	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees (°C)	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
statute miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
square miles (mi^2)	2.590	square kilometers
acres	0.4047	hectares
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28350.0	milligrams
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
pounds (lb)	.00045	metric tons
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees (°F)	0.5556 (°F - 32)	Celsius degrees

ALASKA COASTAL WETLANDS SURVEY

INTRODUCTION

In 1984, the U.S. Fish and Wildlife Service (Service) initiated a study designed to determine the current acreage of wetland and deepwater habitat types in Alaska. Statistical information on the extent and distribution of wetlands is important for the development or alteration of federal, state, and local wetland management programs and policies. Accurate wetland acreage data reduces conflicts by permitting more efficient planning and resource allocation. Resource managers are making decisions affecting coastal and other wetland types in Alaska without information on the extent of the resource.

Data on the current status and trends of coastal and inland wetlands in the contiguous United States were developed by the Service in 1983 (Frayer et al. 1983). Following completion of this analysis, the Service initiated the Alaska survey in order to fill a sizable data gap. Wetland acreage statistics that were truly national in scope would not be available until an accurate measurement of Alaska's wetland resources was made.

The State of Alaska was not included in the earlier study for two reasons. First, suitable aerial photography needed to conduct the statistical sampling study was not available for large areas in Alaska. Secondly, wetland losses relative to the state's total wetland acreage have not been great. It would not have been practical to include Alaska in a study that was initiated primarily in response to the need for accurate information on wetland losses

that were known to have occurred in the lower 48 states over the past 20 years. The Alaska study was designed to assess only current wetland acreage. Coastal and inland wetland acreage data for Hawaii, the only other area not sampled in the original statistical analysis, were developed by the Service and the University of Massachusetts in 1987 (Griffin et al. 1987).

It was predicted that the contribution of Alaska acreage to the national total would be significant for both coastal and inland wetlands. The 34,000-mile shoreline of Alaska (U.S. National Oceanic and Atmospheric Administration 1975) represents approximately 38 percent of the total length of the U.S. coast. Some of the Nation's most extensive complexes of intertidal wetlands occur along this northern land/water interface. It was anticipated that the acreage of inland wetlands in Alaska would be considerably more than the wetland acreage in the other states combined.

The Alaska wetland acreage study is designed to be completed in two phases: (1) the analysis of coastal wetlands; and (2) the analysis of inland wetlands. This report presents the results of phase 1 of the statewide study. The coastal survey is restricted to marine and estuarine wetlands as defined by the classification of Cowardin et al. (1979). Ocean derived salinity in these wetlands must be greater than 0.5 ppt at some time during the year in all years. Phase 2 of the statewide analysis will measure the extent of Alaska's freshwater wetlands. This includes coastal wetlands that are influenced by tidal water with salinities less than 0.5 ppt. Completion of this phase will depend on the availability of cooperative funding. The coastal wetlands survey is funded jointly by the Service and the National Oceanic and Atmospheric Administrations's National Marine Pollution Program Office.

SURVEY AREA DESCRIPTION

PHYSICAL ENVIRONMENT

Alaska's 34,000-mile coastline crosses an extensive range of both latitude and longitude. The latitudinal variation extends from 51°16'N on Amatignak Island in the Aleutians to 71°23'N at Point Barrow (Figure 1). Longitude ranges from 130°00'W at Camp Point in southeast Alaska to 172°28'E on Attu Island (Orth 1967). With these distances, there is tremendous variability of climatic, geologic, and tidal conditions along the coast of Alaska. The dynamic aspects of the state's coastal environment have a significant effect on the distribution, structure, and function of coastal wetland habitats.

Marine waters boardering Alaska include the Beaufort, Chukchi, and Bering Seas, and the Gulf of Alaska (Pacific Ocean). Mean tidal amplitudes vary from 30.3 ft at Turnagain Arm in southcentral Alaska to 0.3 ft at Point Barrow on the Beaufort Sea coast (U.S. National Oceanic and Atmospheric Administration 1988). The mean range in Turnagain Arm is the highest along the entire west coast of North and South America. In general, the tide along the coast of Alaska consists of semidiurnal and diurnal components. The semidiurnal portion occurs approximately every 12 hours while the diurnal component occurs at about 25-hour intervals. These phenomena result in two high tides of unequal amplitude diurnal cycle.

Variations of solar radiation (e.g., angle of incidence, intensity, diurnal and seasonal duration) across Alaska's 20° latitudinal span result in markedly different climates. Temperature extremes range from approximately -60°F on

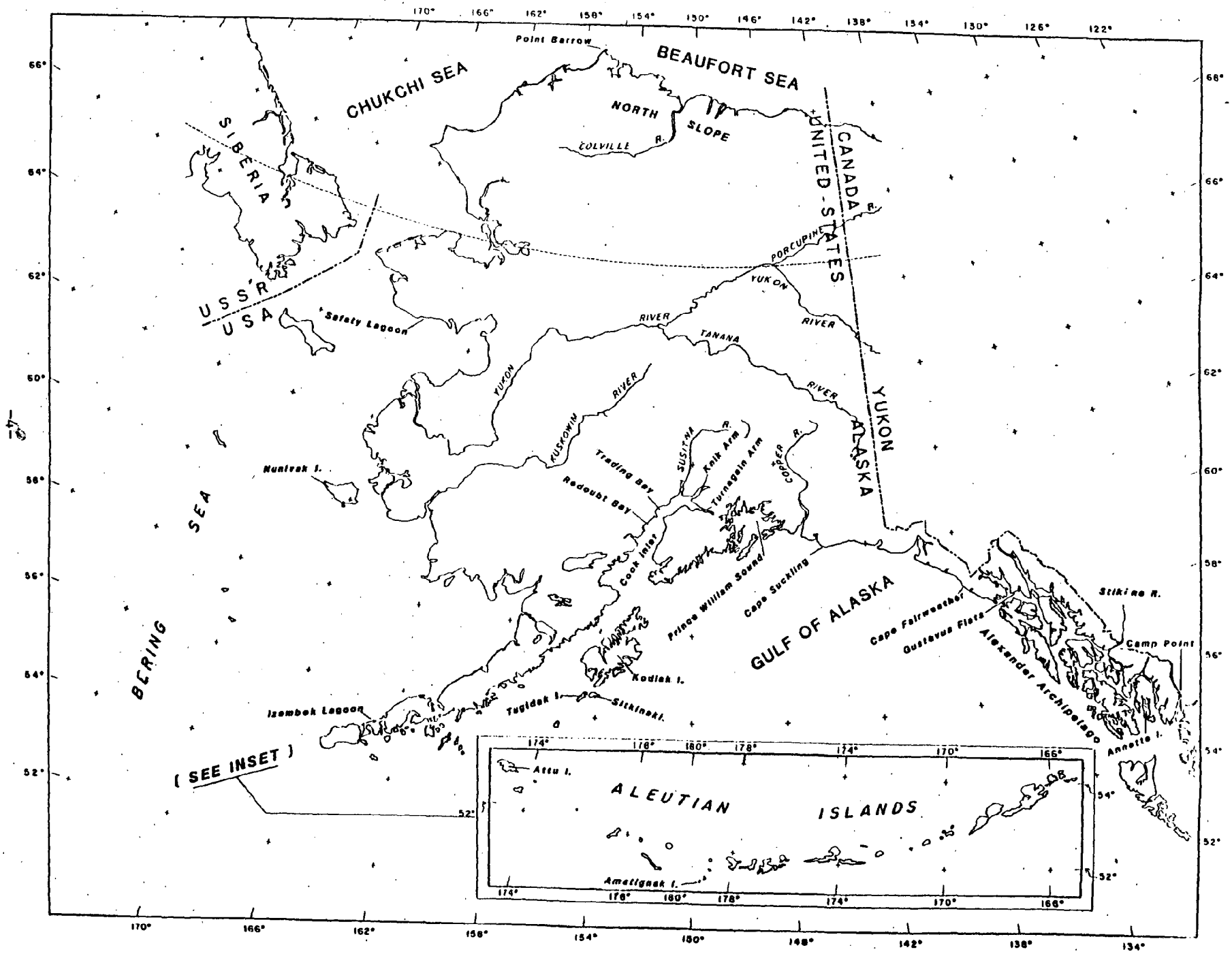

Figure 1. Map of Alaska showing locations of areas and features discussed in text.

the coastal plain of the North Slope to greater than 90°F in the southcentral and southeast regions. Mean annual precipitation in coastal areas of Alaska vary from less than 5 inches on the Arctic coast to more than 200 inches in several locations in southeast Alaska. Table 1 compares climatic data from three coastal locations representing the northern, central, and southern latitudes.

Sea ice in the Beaufort, Chuckchi and Bering Seas is conspicuous evidence of the extremely low temperature regimes in the northern latitudes. The seasonal presence of ice is an important variable that influences coastal habitats in Alaska (Batten and Murray 1982). The scouring effects of ice on substrates in intertidal and shallow subtidal areas limits the establishment of vegetation. Ice cover also reduces phytoplankton production due to reduced light transmission and low temperatures (Redburn 1976). Figure 2 shows the southern extent of sea ice in the Bering Sea from May data obtained over a 29 year period, 1953 through 1981 (Webster 1981).

Coastal morphology is another element of the physical environment in Alaska that is extremely diverse. Major coastal landforms include glacier-formed fjords, large deltas, barrier islands, rocky headlands, lagoons, bays, and inlets. Intricate shorelines in some regions, particularly the Alexander Archipelago (southeast Alaska), account for the extraordinarily high coastline length for the state. Approximately 63 percent of the tidal shoreline is in the southeast region where the coast is a labyrinth of fjords, islands, and bays. (U.S. Army Corps of Engineers 1971).

Table 1. Comparison of climatic data from three coastal locations in Alaska (data from Selkregg 1974).

Climatic Data Category	Location: Northern Alaska Barrow (71°17'N, 156°45'W)	Central Alaska Nunivak Is. (60°23'N, 166°13'W)	Southern Alaska Annette Is. (55°03'N, 131°33'W)
Temperature			
Mean low winter temp.	-25°F	4°F	30°F
Mean high winter temp.	- 6°F	28°F	40°F
Mean low summer temp.	29°F	38°F	48°F
Mean high summer temp.	44°F	54°F	64°F
Precipitation			
Annual precip. total	5"	15"	118"
Annual snowfall	29"	58"	43"

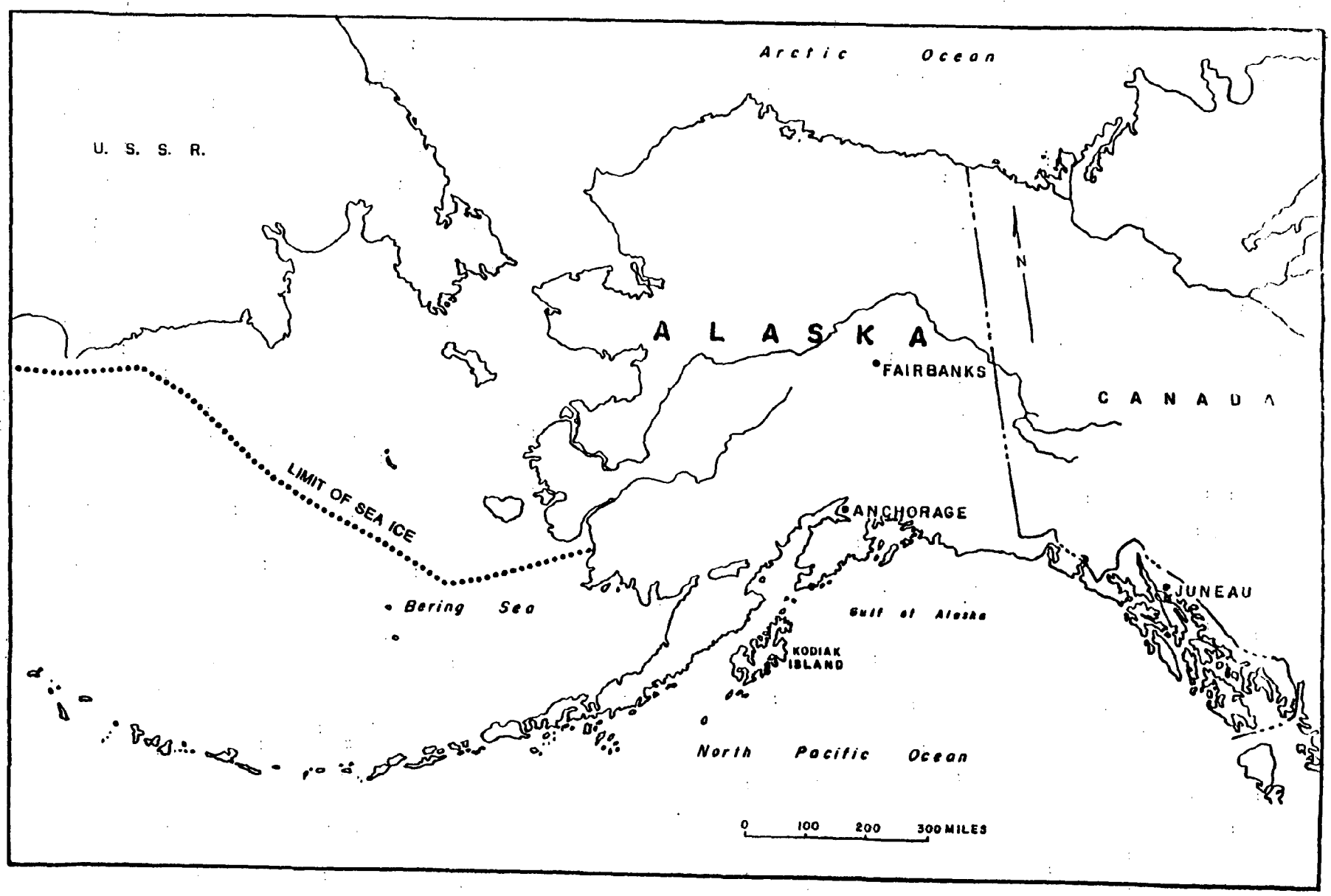

Figure 2. Average maximum extent of sea ice on May 1, 1954-1980 (adapted from Webster 1981).

COASTAL WETLANDS

Coastal wetlands in Alaska are represented by two major types: (1) estuarine emergent wetland (salt marshes) and (2) intertidal flats. Other coastal wetlands include beaches, rocky shores, forested wetlands and scrub-shrub wetlands. In some regions, long stretches of shoreline consist primarily of just one of the above wetland classes. For example, sand and gravel beaches characterize most of the 250-mile coastline between Cape Suckling and Cape Fairweather in the northern Gulf of Alaska. Bedrock and boulder rocky shores account for most of the intertidal zone in the Aleutian Island chain (Redburn 1976). Areas such as the sheltered portions of the Alexander Archipelago and lower Cook Inlet have a greater diversity of coastal wetland types. Emergent marshes, unconsolidated shores, and rocky shores often alternate over short distances in these regions.

Estuarine Emergent Wetlands

Estuarine emergent wetlands are dominated by erect herbaceous vegetation such as sedges and grasses. These areas are commonly called "salt marshes" and "brackish tidal marshes." Salt marshes are characteristically on or near low-energy, nearly level shores close to the mouths of rivers or behind barrier islands and beaches. Estuarine water generally moves in and out of the salt marshes by way of tidal creeks. The plant zonation in coastal marshes is largely a result of the pattern of tidal inundation. The role of inundation is complex and may involve a combination of factors including soil salinity, moisture, aeration and nutrient status (Seliskar and Gallagher 1983).

Vegetational zonation and species composition in salt marshes of southeast Alaska are similar to coastal emergent wetlands along the northwest coast of the conterminous United States. Species that are abundant in both areas include Carex lyngbyei and Triglochin maritimum in lower positions of the intertidal zone, and Potentilla egedii and Elymus arenarius in higher marsh areas. Due to the prevalence of steep, rocky shorelines, salt marsh sites in the southeast region are generally more limited in distribution and size than in other coastal areas of Alaska. Coastal wetlands in the region are often a major component of stream/estuary ecotones. These ecological interfaces serve as important habitat to salmonid fish species (Merrell and Koski 1978) and migratory waterfowl. A typical zonation sequence for an estuarine emergent wetland in southeast Alaska is shown in Figure 3.

Several large coastal emergent wetland complexes, thousands of acres in size, occur in the central latitude region of Alaska's coastal zone. The Copper River Delta, just east of Prince William Sound, exhibits a large scale physiographic zonation consisting of offshore sandy barrier islands, estuarine tide flats, salt marsh, freshwater marsh, and glacial outwash plains. Zonation of estuarine emergent wetlands on the delta was significantly altered as a result of uplift from a 1964 earthquake of Richter magnitude 8.5. The entire river delta was uplifted 6.2 - 13.1 ft (Thilenius 1986). Tidally influenced, sedge dominated marsh has extended seaward as much as .9 miles across tidal flats. Pre-earthquake salt marsh areas have converted to freshwater systems dominated by shrubs and emergents. The Copper River Delta is important as the sole nesting area for the dusky Canada goose, as a major nesting area for trumpeter swans, and as a staging area for numerous species of waterfowl and shorebirds.

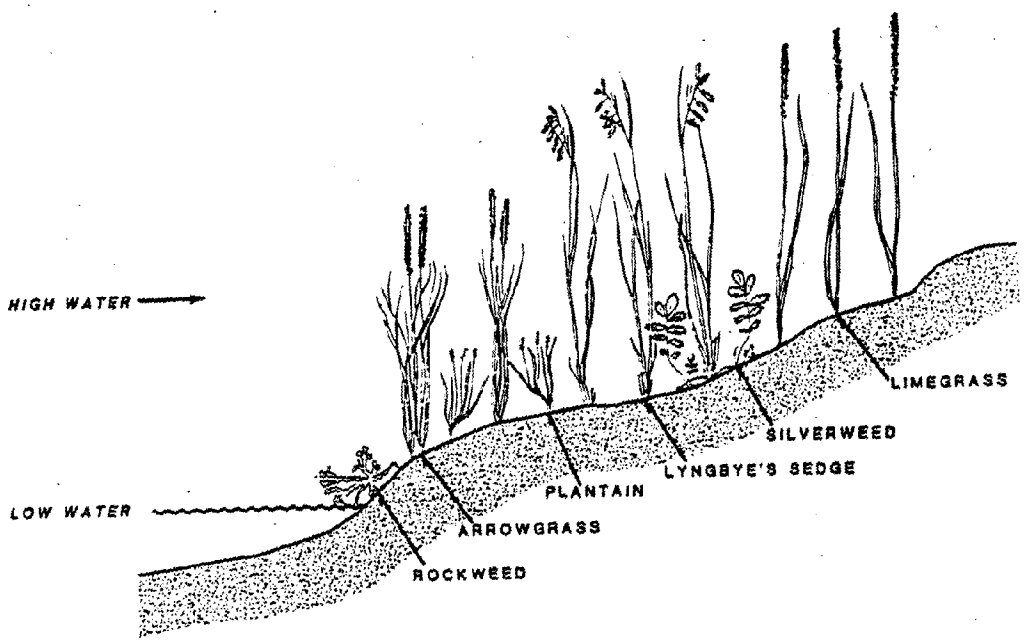

Figure 3. Generalized profile of a southeast Alaska salt marsh.

In the upper Cook Inlet area, estuarine intertidal wetland environments consisting of expansive mud flats and wide estuarine emergent zones are located in Trading Bay, Redoubt Bay, Turnagain Arm, Knik Arm, and near the mouth of the Susitna River. The Goose Bay salt marshes on the north side of Knik Arm are typical. Areas regularly inundated by brackish tidal water at this site are dominated by Puccinellia spp., Salicornia europaea, and Glaux maritima. Common species in zones above ordinary high tide include Carex lyngbyei, Triglochin maritimum, Plantago maritima, and Potentilla egedii (Hanson 1951). The upper Cook Inlet wetlands are one of seven wetland complexes in Alaska designated by the Service as waterfowl habitat areas of major concern.

Brackish tidal marshes occur extensively along the 500-mile shoreline of the Yukon-Kuskokwim Delta -- one of the largest river deltas in the world. In general, these marshes are more expansive in the southern half where tidal amplitudes are larger. Extremely low elevations in portions of the coastal plain result in wide zones of estuarine emergent wetland. In addition to the intrusion of brackish water from lunar/solar tidal influences, storm surges push seawater inland over the relatively flat terrain for considerable distances. The zone of flooding may be extensive, extending 10 miles inland along much of the Bering Sea coast (Dupre 1978).

The coastal plain of the Yukon-Kuskokwim Delta is one of the most productive wildlife areas in Alaska. Coastal zones support very high densities of waterfowl and shorebirds. In some areas during late summer and fall, as many as 20 species of shorebirds use the intertidal zone in densities exceeding 6 birds per acre. Coastal estuaries and rivers are particularly important to

large flocks of molting birds and broods of brant, emperor, cackling, and white-fronted geese (U.S. Fish and Wildlife Service 1988).

Salt marshes along Alaska's northernmost coastline differ significantly from those in southern regions of the state. The emergent vegetation in Beaufort Sea estuarine areas frequently forms a low reddish mat. The mat is composed primarily of two species, Carex subspathacea and Puccinellia phryganodes (Taylor 1981). Due to small tidal ranges (0.3-0.5 ft) in this region, tidal creeks are poorly developed or nonexistent in most coastal marsh areas. Polygonal ground patterns, formed by intensive frost action (Gabriel and Talbot 1984), occur in some of the intertidal marshes. A common pattern consists of polygons with 16-40 ft diameters bordered by ridges that are 1-2 ft higher than the surface of the central basin. Brackish water remains in the closed basins following periods of tidal flooding.

Intertidal Flats

Intertidal flats occur extensively in most coastal regions of Alaska. They often lie seaward of salt marsh areas, at river mouths and deltas, along rocky coasts, or in lagoons. Tidal flats appear at low tide largely as unvegetated expanses of mud or sand, although a rich layer of microscopic plants like diatoms and dinoflagellates may blanket the sediments to several centimeters in depth (Redburn 1976). Macroscopic algae and vascular aquatic plants such as eelgrass (Zostera marina) commonly dominate these flats. Intertidal flats are often intricately mixed with areas of estuarine emergent wetlands or rocky shores.

Many of the largest intertidal flats along Alaska's coastline are associated with major river deltas. The most expansive tidal flat complex in the southeast region occurs as an outer zone of the Stikine River Delta. In southcentral Alaska, the Copper River Delta includes large areas of unvegetated flats protected from the high-energy marine system by a series of barrier islands. On the Beaufort Sea coast, over 20,000 acres of this wetland type are found along the seaward edge of the Colville River Delta (Meehan and Jennings 1988). The intertidal sand and mud flats bordering the Yukon-Kuskokwim Delta exceed a width of 6 miles in several locations and cover approximately 130,000 acres (U.S. Fish and Wildlife Service 1988). Examples of extensive intertidal flats that are not associated with major deltaic formations include the Gustavus Flats in southeast Alaska, the intertidal lagoons of Tugidak Island and Sitkinak Island in the Kodiak Archipelago, and the vast mud flats in upper Cook Inlet.

Intertidal flats vegetated with macroalgae are more prevalent in the southern areas of Alaska's coastal zone than in the northern regions. This algal flora is limited in arctic regions due to the extreme ice scouring stresses imposed on the nearshore environment, thus making the intertidal substrate largely unsuitable for attached algae. Intertidal flats that include substantial amounts of rocky material in the Aleutian Islands, the western Gulf of Alaska, and southeast Alaska provide ideal habitats for the successful growth of algal communities. Rockweed (Fucus spp.) is the most common algae in these intertidal environments. Other common species include Enteromorpha spp., Ulva spp., and Halosaccion glandiforme.

Eelgrass dominated intertidal flats range from the protected bays and inlets of southeast Alaska to the lagoons of the Bering and Chukchi Seas (McRoy 1970). Eelgrass favors the soft sediments of shallow, protected lagoons and is excluded from large river deltas, glacial fjords, and most arctic environments. Large areas of this wetland habitat include Izembek Lagoon on the Alaska Peninsula, Safety Lagoon on the Seward Peninsula, and Tugidak Lagoon on Tugidak Island in the Trinity Island group. The Izembek Lagoon contains one of the largest eelgrass beds in the world: over 84,000 acres in size (U.S. Fish and Wildlife Service 1985). This area was identified as a crucial wetland habitat by the Convention on Wetlands of International Importance. Most of the world's emperor geese and nearly all of the brant in the Pacific Flyway use the lagoon during spring and fall migration.

SURVEY PROCEDURE

The objective of the study is to develop acreage estimates for categories of coastal wetlands and deepwater habitats in Alaska. The coastal survey is a component of a larger effort to produce statistics for all wetlands in Alaska. The statewide survey is designed to develop statistics that will, on the average, have a probability of 90 percent that estimated totals are within 10 percent of the true totals, by category. The statistical methodologies used in the Alaska study are the same as those used by the Service in the study on the status and trends of wetlands and deepwater habitats of the 48 conterminous states (Frayer et al. 1983).

Aerial photography was the data source used for the Alaska coastal wetlands survey. The mean year of the photography is 1980, with over 90 percent of the

photo coverage acquired within three years of the mean year. Most of the photography was 1:60,000 scale, color-infrared imagery flown by the National Aeronautical and Space Administration for the Alaska High-Altitude Aerial Photography Program (AHAP). Black-and-white and true-color imagery of scales between 1:16,800 and 1:76,000 was used for coastal areas not covered by the AHAP program.

A random sample within Alaska's estuarine and marine intertidal areas was used to develop the acreage statistics. Estuarine areas were delimited and measured on all coastal 1:250,000 scale U.S. Geological Survey (USGS) maps. The estuarine boundaries were drawn using the estuarine system definition in the U.S. Fish and Wildlife Service's "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin et al. 1979). In general, the estuarine system consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

In order to determine the total number of plots needed to develop statistics with the desired level of precision, 101 coastal zone plots were sampled in a pilot study. After analysis of the pilot study plots, it was determined that 899 more plots would have to be randomly selected. The total sample size for the coastal zone stratum is 999 plots.

Each sample unit in the coastal wetlands survey consists of a four-square mile plot, two miles on each side (Figure 4). The photointerpretation of the wetland types was performed stereoscopically using a 6 power magnification

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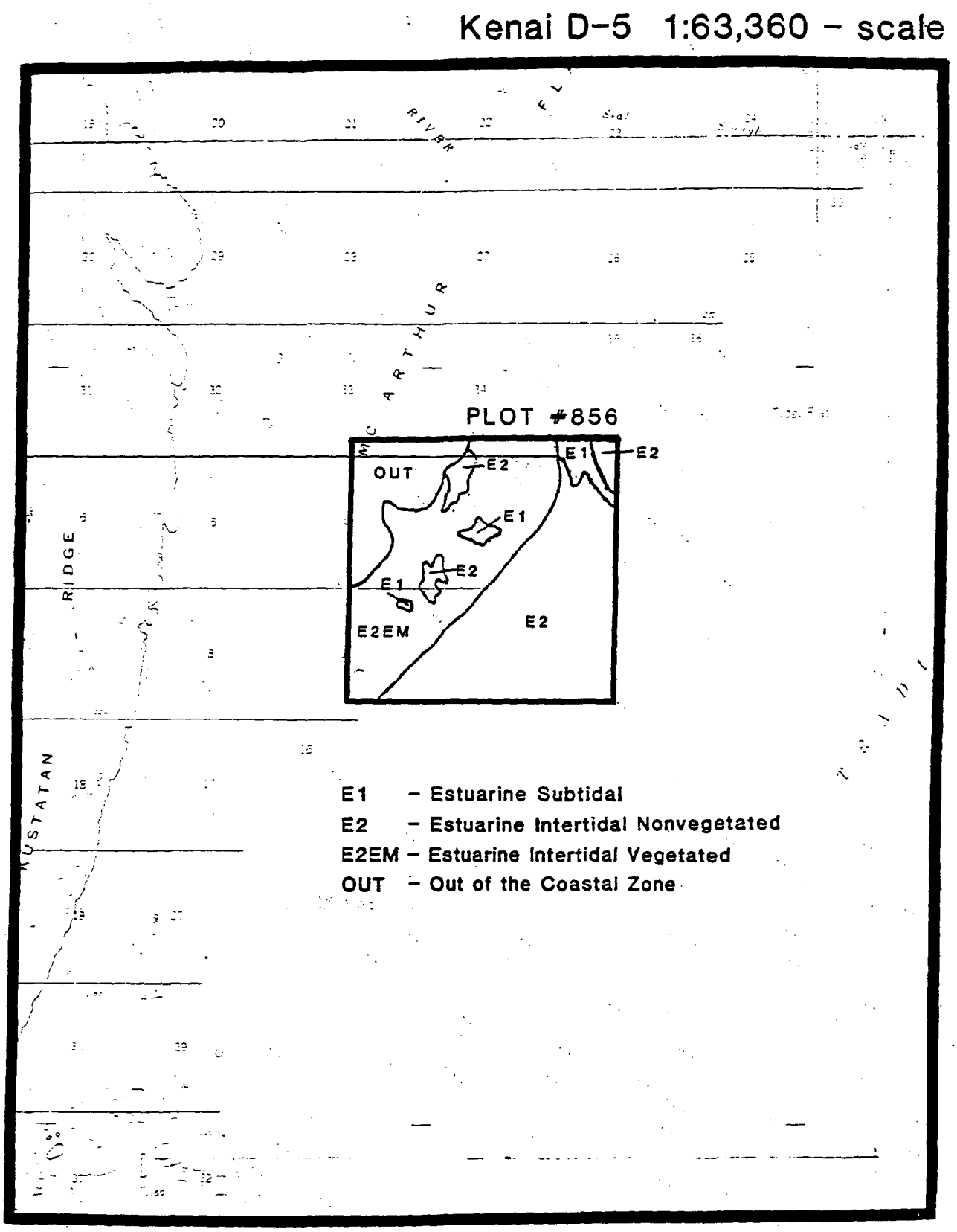


Figure 4. Example of sample plot in Cook Inlet, Alaska (Kenai D-5 USGS quadrangle).

stereoscope. The smallest wetlands delineated and classified were approximately 1 acre in size. The interpreted information was transferred from the photos to overlays on the 1:63,360 scale base maps. Measurements of the wetlands on the overlays were made using a video area measurement system.

In addition to the development of statewide coastal wetland statistics, the sample plot data were analyzed on a regional basis. This analysis was conducted to identify variations in the distribution of the wetland classes along Alaska's extensive coastline. Four coastal regions (Figure 5) were identified based on morphological and climatic factors. A listing of the number of sample plots by coastal zone region is shown in Table 2.

The wetland and deepwater habitat categories analyzed in the Alaska coastal survey are the same as the coastal classes used in the study on the status and trends of wetlands and deepwater habitats of the 48 conterminous states. Identical types were selected to facilitate direct comparison of results and to determine national totals. An additional ten categories will be analyzed for the inland portion of the statewide wetland acreage survey (Table 3). The following section describes the four classes used in the coastal stratum. The classes are listed under definitions of the two ecological systems represented in the study.

Marine System

The Marine System consists of the open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the hydrologic characteristics are

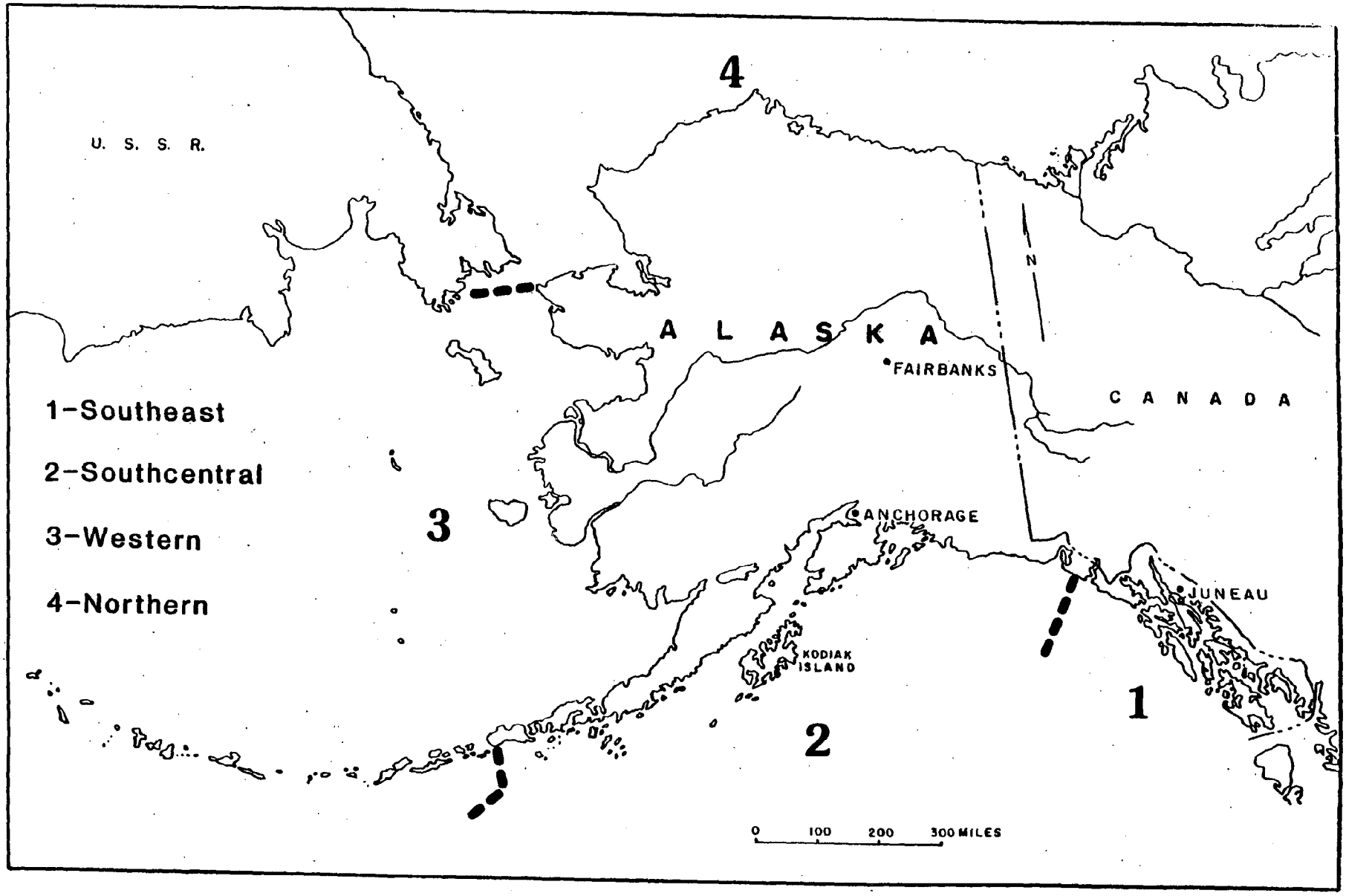


Figure 5. Coastal regions of Alaska used in the regional analysis of sample plot data.

Table 2. Number of samples taken within each coastal zone region.

Region	Number of Plots
Southeast	342
Southcentral	314
Western	170
Northern	173

Table 3. Wetland and deepwater habitat classes used in Alaska wetland acreage study.

Class
Marine Intertidal*
Estuarine Subtidal*
Estuarine Intertidal Nonvegetated*
Estuarine Intertidal Vegetated*
Palustrine Unconsolidated Shore
Palustrine Open Water
Palustrine Aquatic Bed
Palustrine Emergent - Saturated
Palustrine Emergent - Flooded
Palustrine Forested - Satuarted
Palustrine Forested - Flooded
Lacustrine

*Categories used in the coastal portion of the statewide study.

determined primarily by the ebb and flow of oceanic tides. Salinities generally exceed 30 ppt, with little or no dilution except outside the mouths of estuaries. Shallow coastal indentations or bays without appreciable freshwater inflow, and coasts with exposed rocky islands that provide the mainland with little or no shelter from wind and waves, are also considered part of the Marine System because they generally support typical marine biota.

MARINE INTERTIDAL. This category includes all areas in which the substrate is exposed and flooded by tides, including the associated splash zone. Marine Intertidal habitats consist of rocky shores and unconsolidated shores (beaches, bars and flats). The substrates may be unvegetated or vegetated with aquatic beds such as Fucus and Halosaccion.

Estuarine System

The Estuarine System consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean. The ocean water is at least occasionally diluted by freshwater runoff from the land. The salinity may be periodically increased above that of the open ocean by evaporation. Along some low-energy coastlines there is appreciable dilution of sea water.

ESTUARINE SUBTIDAL. All estuarine areas in which the substrate is continuously submerged.

ESTUARINE INTERTIDAL NONVEGETATED. All estuarine areas where: (1) the substrate is exposed and flooded by tides; and (2) vegetation in the form

of emergents, shrubs, or trees is nonexistent or negligible. This category is used to estimate the extent of Alaska's estuarine mudflats. Estuarine rocky shores, beaches, and bars are also included, but the areal extent of these habitat types is small in comparison to mudflats. The substrates may be vegetated with algal aquatic beds such as Fucus or vascular aquatic beds such as Zostera.

ESTUARINE INTERTIDAL VEGETATED. This category includes all estuarine areas where: (1) the substrate is exposed and flooded by tides, and (2) vegetation in the form of emergents, shrubs, or trees is evident. This type is used to estimate the extent of areas commonly called "salt marshes" and "brackish tidal marshes." Forested estuarine wetlands are uncommon in Alaska and usually consist of a cover of dead trees over an emergent marsh layer. Estuarine wetlands dominated by shrubs are also a very small component of this category.

The land ownership/management status of Alaska's wetlands also was determined for the coastal wetland acreage survey. This information is expected to be particularly useful for individual agency management planning. The following eight land ownership/management categories were used in the study:

- Bureau of Land Management
- U.S. Fish and Wildlife Service
- National Park Service
- U.S. Forest Service
- Other Federal

- Native
- State
- Other

The Other Federal category refers primarily to military ownership. However, federal agencies managing relatively small areas such as the Federal Aviation Administration are also included. The Native land status category is used to classify land that has been conveyed to regional or village native corporations through the Alaska Native Claims Settlement Act of 1971 and its amendments. All private land not obtained through this legislation is included in the Other category.

The precision of the estimates for each ownership/management category will vary depending on the size of the landholdings, as well as the distribution of wetlands in the property owned or managed by each group. The wetland ownership statistics are most precise on a statewide basis. The results are less meaningful for some categories on a stratum basis, such as for the coastal stratum. The ownership/management of the sample plots was determined primarily by examining land status records maintained by the Bureau of Land Management in Anchorage, Alaska. Records held by other agencies such as the Minerals Management Service and the U.S. Forest Service were also examined.

RESULTS AND DISCUSSION

Statewide acreage for the four wetland categories analyzed in the coastal zone stratum are shown in Table 4. These data represent the extent of the wetland classes in 1980, the mean year of the aerial photography used in the study.

Table 4. Acreage of coastal wetland and deepwater habitat classes in Alaska, 1980.

Class	Acreage	SE%	% of Total
Marine Intertidal	46,436	29.2	0.2
Estuarine Subtidal	18,866,822	0.7	90.0
Estuarine Intertidal Nonvegetated	1,702,918	7.6	8.1
Estuarine Intertidal Vegetated	345,390	14.1	1.7
Total	20,961,566		100.0

The standard error for each entry is expressed as a percentage of the entry (SE%). In general, the smaller the SE%, the higher the reliability of the estimate. Reliability can be stated at the 68 percent confidence level as the estimate plus or minus the SE%/100 times the estimate. For example, if an entry is one million acres and the SE% is 20, then there is 68 percent confidence that the true value is between eight hundred thousand and 1.2 million acres. An equivalent statement for 95 percent confidence can be made by adding and subtracting twice the amount to and from the entry.

By excluding the acreage for the Marine Intertidal class shown in Table 4, the total extent of estuarine habitat in Alaska was determined to be 20,915,130 acres. This figure is slightly larger than the 20,217,947 acre estuarine total for the 48 conterminous United States and Hawaii (Frayer et al. 1983; Griffin et al. 1987). Combining the data from all areas of the United States reveals a national total for estuaries of 41,133,077 acres (Table 5).

The relative abundance and acreage of estuarine habitats in Alaska and the combined data for all other coastal regions of the United States are compared in Figure 6. One of the most significant differences between the two data sets is the extent of Estuarine Intertidal Vegetated habitat. In Alaska, this wetland class comprises 345,390 acres, or 1.7 percent of the state's estuarine total. The same class totals 4,497,171 acres in the coastal areas of the conterminous United States and Hawaii, or 22.2 percent of the estuarine system. The acreage of Estuarine Intertidal Vegetated wetland in Alaska is 7.1 percent of the national total for this class. Interestingly, Estuarine Intertidal Nonvegetated wetlands (flats, beaches, and bars) are more extensive in Alaska than in the remainder of the United States. Alaska's 1,702,918 acres

Table 5. Acreage of estuarine habitats for the United States, including Alaska.

Class	Acreage	% of Total
Estuarine Subtidal	33,840,880	82.3
Estuarine Intertidal Nonvegetated	2,449,636	6.0
Estuarine Intertidal Vegetated	4,842,561	11.7
Total	41,133,077	100.0

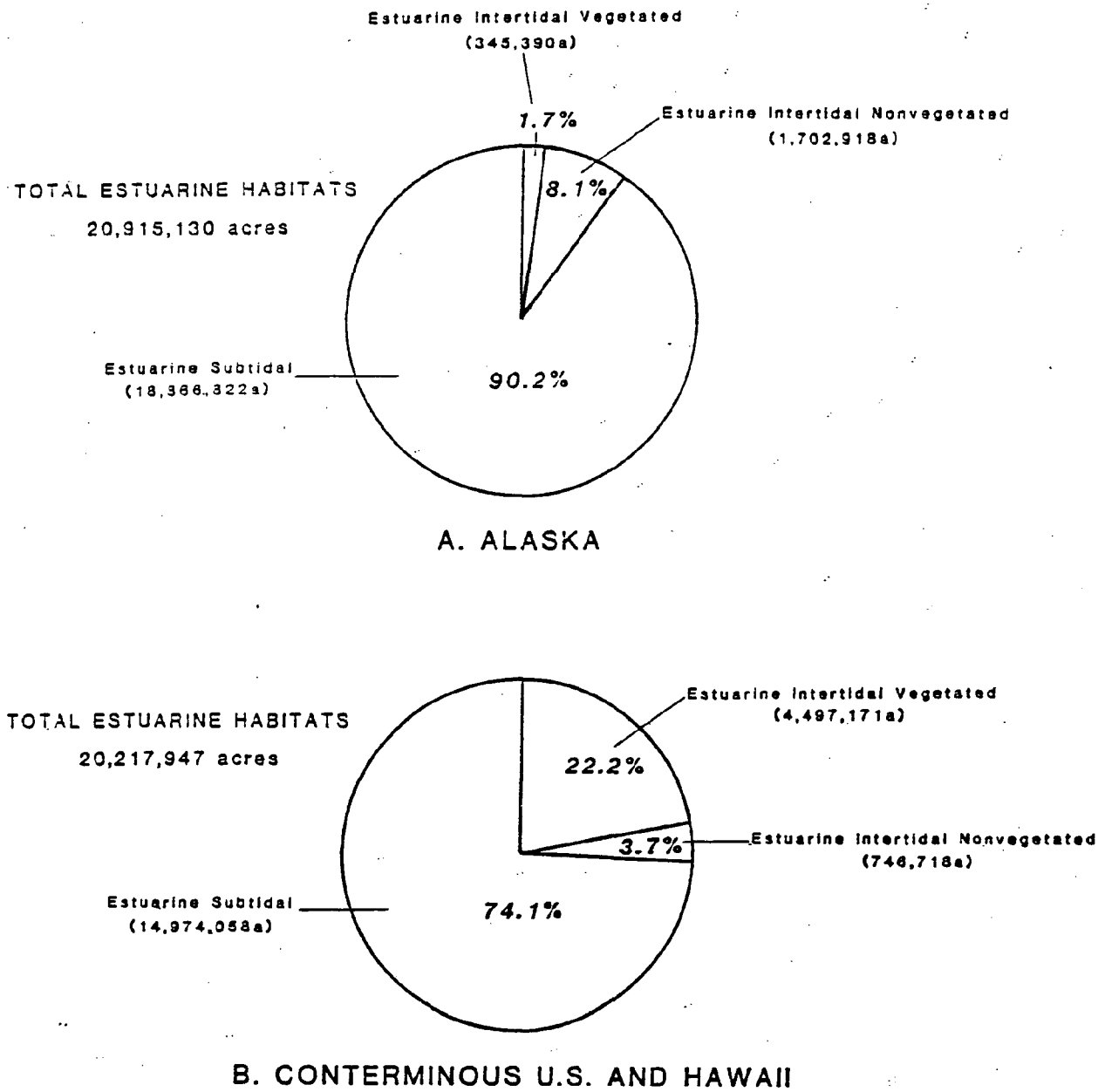


Figure 6. Relative abundance and acreage of estuarine habitat classes in (A) Alaska, and (B) the conterminous United States and Hawaii.

of this wetland class is more than twice the amount (746,718 acres) found along the shoreline of the 23 other coastal states. The acreage in Alaska accounts for nearly 70 per cent of the national total.

Tables 6-9 present the acreage data for the southeast, southcentral, western, and northern coastal regions of Alaska. The Marine Intertidal class was excluded from the regional tables due to high standard errors for this limited category. Figure 7 shows the acreage contributions from each coastal area toward the statewide totals for the three estuarine habitat types.

In all regions of Alaska, the Estuarine Subtidal class comprises most of the estuarine acreage. The coverage of this deepwater habitat category ranges from 70.9 percent of the total acreage in western Alaska to 96.9 percent in the southeast coastal region. The areal extent of Estuarine Subtidal habitat was greatest in the southeast where about 7.5 million acres were measured. This accounts for about 40 percent of the total acreage of this type in Alaska.

The Estuarine Intertidal Nonvegetated wetland class was most abundant in the western coastal region where 874,453 acres of this habitat type occurred. The presence of vast acreages of mudflats along the shoreline of the Yukon/Kuskokwim Delta greatly contributed to this amount. Over 51 percent of the state's total acreage of Estuarine Intertidal Nonvegetated wetland was found in the western coastal area.

Table 6. Acreage of estuarine habitats in the southeast coastal region of Alaska.

Class	Acreage	SE%	% of Total
Estuarine Subtidal	7,467,560	0.5	96.9
Estuarine Intertidal Nonvegetated	220,178	18.8	2.9
Estuarine Intertidal Vegetated	18,764	26.6	0.2
Total	7,706,502		100.0

Table 7. Acreage of estuarine habitats in the southcentral coastal region of Alaska.

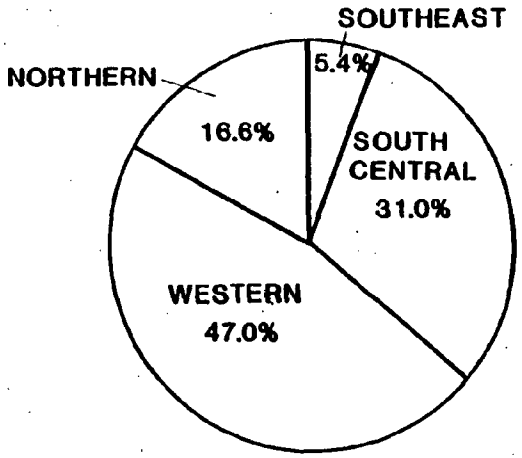
Class	Acreage	SE%	% of Total
Estuarine Subtidal	5,488,059	1.6	89.7
Estuarine Intertidal Nonvegetated	525,440	14.2	8.6
Estuarine Intertidal Vegetated	107,190	26.7	1.7
Total	6,120,689		100.0

Table 8. Acreage of estuarine habitats in the western coastal region of Alaska.

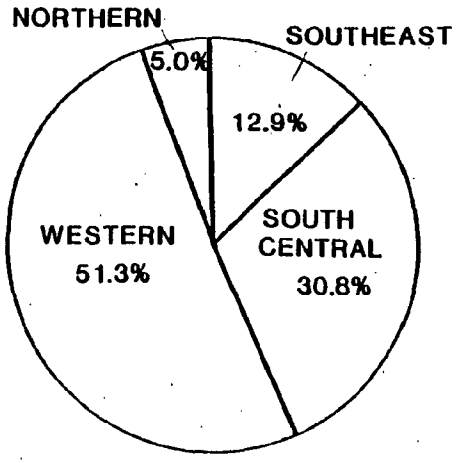
Class	Acreage	SE%	% of Total
Estuarine Subtidal	2,526,926	4.0	70.9
Estuarine Intertidal Nonvegetated	874,453	10.8	24.5
Estuarine Intertidal Vegetated	162,159	22.7	4.6
Total	3,563,538		100.0

Table 9. Acreage of estuarine habitats in the northern coastal region of Alaska.

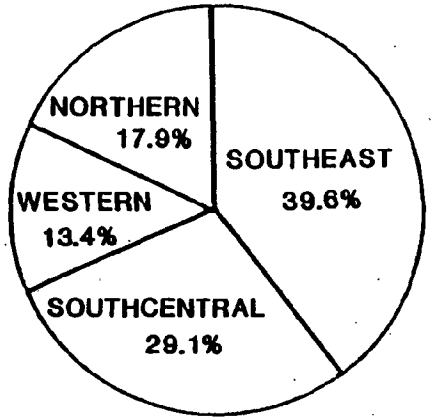
Class	Acreage	SE%	% of Total
Estuarine Subtidal	3,384,276	0.8	96.0
Estuarine Intertidal Nonvegetated	84,847	21.6	2.4
Estuarine Intertidal Vegetated	57,277	23.6	1.6
Total	3,526,400		100.0



Estuarine Intertidal Vegetated
Alaska Total – 345,390 acres



Estuarine Intertidal Nonvegetated
Alaska Total – 1,702,918 acres



Estuarine Subtidal
Alaska Total – 18,866,822 acres

Figure 7. Regional distribution of the three estuarine habitat classes in Alaska.

The Estuarine Intertidal Nonvegetated category was least extensive in the northern region. This coastal stretch had 84,847 acres of flats, beaches, and bars representing 2.4 percent of the total regional estuarine area. Only about 5 percent of the statewide acreage of this wetland class is located in the northern area. Acreages for the southeast and southcentral coastal regions were 220,178 acres and 525,440 acres, respectively.

The Estuarine Intertidal Vegetated class, representing brackish or salt marsh habitat, was unevenly distributed among the four coastal areas. The greatest extent of this type occurred in the western region. The coastal marsh type totaled 162,159 acres in this zone, or about 47 percent of the total for the entire state. The second highest acreage for the vegetated category was found in the southcentral region, where 107,190 acres were recorded. This represents 31 percent of the state's total. The extensive salt marshes in Cook Inlet account for a significant portion of this acreage.

The southeast region ranked last in coverage of Estuarine Intertidal Vegetated wetland. Although this area has the largest estuarine acreage and a shoreline that comprises about 63 percent of the state's total, the coastal marsh class covered only 18,764 acres. This amount comprised 5.4 percent of Alaska's total for the vegetated category. The steep, rocky shorelines that are typical throughout the southeast region preclude development of large coastal marsh areas.

Even in the northern coastal region, the extent of Estuarine Intertidal Vegetated wetland is significantly greater than in southeast Alaska. The northern zone's 57,277 acres is nearly three times the amount found in the

southeast region. Approximately 17 percent of the total estuarine marsh acreage in the state occurs in the northernmost sample area.

The wetland acreage data for the eight land ownership management categories showed high standard errors for most of the ownership classes. The unreliability of the data was anticipated for the coastal zone stratum. Many of the government agencies and groups (e.g. National Park Service and Native) were known to manage or own relatively small portions of Alaska's estuarine and marine intertidal areas. There was an insufficient number of sample plots needed to obtain reliable estimates of these limited acreages. The documentation of wetland ownership/management is intended for statewide analysis once both the coastal and inland portions of the wetland acreage study are completed.

SUMMARY

The results reported are based on a statistically designed study of the current status of wetlands and deepwater habitats of Alaska. The coastal wetlands survey represents the first phase of the investigation of wetland extent for the entire state. The second phase will produce acreage estimates for the inland wetland types.

Data on the status of coastal and inland wetlands in the conterminous United States and Hawaii have been available for several years. Statistics that are truly national in scope required completion of an analysis of wetland acreage in Alaska. The Alaska coastal wetlands survey filled the data gap that existed for the marine and estuarine categories.

The analysis of 999 sample plots shows that nearly 21 million acres of estuarine habitat occur along the coastline of Alaska. This comprises about 51 percent of the nations's estuarine acreage. Alaska's 1.7 million acres of Estuarine Intertidal Nonvegetated wetlands (flats, beaches and bars) account for 70% of the national total for this category. The Estuarine Intertidal Vegetated wetland class (brackish marsh and salt marsh) has much less coverage. Approximately 345,000 acres, or 7.1 percent of the U.S. total for vegetated estuarine wetlands, was measured by the Alaska coastal wetlands survey.

The data on regional wetland distribution show wide variation in the amount of coastal habitat types along Alaska's extensive coastline. Although the southeast region contains 63 percent of the state's shoreline, only 5.4 percent of the Estuarine Intertidal Vegetated wetland class occurs in that coastal area. The western region has the greatest coverage for the three intertidal categories. The Estuarine Subtidal class is most extensive in the southeast area.

It is anticipated that the results of this survey and the planned inland wetland acreage study for Alaska will serve as baseline data for measuring future wetlands trends. While 10-year updates for measuring wetlands losses and gains are scheduled for the contiguous part of the United States, intervals of 20 years are probably sufficient for monitoring changes in Alaska's wetlands. Increased emphasis will be placed on conducting regional or local wetland trends studies in developing areas where wetland resources are most threatened.

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