STATUS AND TRENDS OF WETLANDS IN THE LOWER KENAI RIVER AREA, ALASKA (1950 to 1996)

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Cover photo: Low shrub and emergent fen, Soldotna, Alaska

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INTRODUCTION

The U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) project has produced large-scale wetlands maps for approximately 90 percent of the conterminous United States and 35 percent of Alaska. The Clean Water Act of 1977 and the Emergency Wetlands Resources Act of 1986 mandate this mapping by the NWI program. In addition to developing hard copy and digital wetland map products, the NWI produces local, regional, and national data on the status and trends of wetlands. The information on losses and gains of wetlands is important for reviewing the effectiveness of government programs and policies designed to protect wetlands.

In 1994, the NWI published data on the current status of wetlands in Alaska (Hall 1994). This report showed that 43.3 percent, or 174.7 million acres, of Alaska's surface area is classified as wetland. In comparison, wetlands only occupy 5.5 percent of the land surface of the lower 48 states (Dahl 2000). Alaska contains 63 percent of the nation's wetlands.

Although there is no statistically reliable data on statewide wetland losses, the USFWS estimates that Alaska had lost 200,000 acres, or less than one percent of the state's original wetland acreage (Dahl 1990). A 1989 report on the effects of petroleum operations in Alaska wetlands prepared by Senner (1989) for ARCO Alaska estimated cumulative wetland losses from human activity at 80,000 acres since the time of territorial accession in 1867. The report indicated that the loss estimates would be substantially higher if a complete and more accurate inventory was conducted. In most states, the destruction of wetlands through draining and filling has been much more dramatic. More than 80 percent of the wetlands have disappeared in California, Illinois, Indiana, Iowa, Kentucky, Missouri, and Ohio. As a whole, the conterminous United States have lost an estimated 53 percent of their original wetland acreage.

While total wetland losses relative to Alaska's vast wetland acreage have been small compared to other areas of the country, the loss of wetlands has been significant in specific areas. The rapid growth of urban centers and the expanding development of oil, gas, mineral, agricultural and timber resources have impacted wetlands in many locations.

Urban development and construction of transportation systems account for the greatest loss of wetlands in Alaska. The state's three largest cities (Anchorage, Fairbanks, and Juneau) are located in areas where wetland density is high. Many towns and villages in northern and western Alaska are built almost entirely on land classified as wetlands. In 1982, the potential for urban expansion to impact remaining wetlands in Anchorage led to the establishment of a local comprehensive wetland management plan. The NWI program conducted an analysis of the losses of wetlands in the Anchorage Bowl. In 1950 the Bowl contained 18,903 acres of wetland. By 1990, 52.7 percent (9,958 acres) of the 1950 wetland base was lost from draining and filling activities (U.S. Fish and Wildlife Service 1993).

The USFWS completed a wetlands trends analysis for the Juneau area in 1986 and included the data as part of the 1987 Juneau Wetland Management Plan (Adamus 1988). The 15,606-acre study area represented most of the developable land in Juneau and vicinity. Wetlands in 1948 comprised 59 percent, or 9,208 acres, of the study area. Based on the analysis of aerial photography, a total of 1,162 acres were filled between 1948 and 1984, representing a loss of about 13 percent of the wetland acreage present in 1948.

Rapid growth of residential and commercial development in the Kenai, Soldotna and Sterling area of Alaska led the Environmental Protection Agency to fund the analysis of wetland trends presented in this report. These communities are located in the Kenai River watershed. This area supports internationally known fish and wildlife resources that are used by sport and commercial fishers, hunters, trappers, wildlife viewers, and subsistence users. Most of the fish and wildlife species in the area are dependent on wetland habitats for some or nearly all of their life requirements. The NWI project utilized the same standard procedures and methods that were used to conduct the local wetland trends studies in Anchorage, Juneau and other locations throughout the U.S.

STUDY AREA

The boundaries of the study area (Figure 1) were selected to include most the developed areas bordering the lower Kenai River in the vicinity of Kenai, Soldotna and Sterling. The study area has a land surface of 233.5 square miles, or 149,459 acres. The study area includes portions of the Kenai B-2, B-3, B-4, C-2, C-3, and C-4 USGS quads (1:63,360 scale).

The project area is in the Kenai Lowlands that falls within the Cook Inlet-Susitna Lowland physiographic region. This region also includes Talkeetna, Anchorage, Palmer, Wasilla and Homer. This area is a long narrow basin between the Kenai, Chugach, and Talkeetna Mountains to the east and the Aleutian and Alaska Ranges to the west (Rieger et al. 1979). Hall (1994) determined that 28.0 percent of the land surface in the Cook Inlet-Susitna Lowland region is classified as wetland.

Today's landscape on the Kenai Lowlands is a result of multiple glaciations over the past 200,000 years. Glaciers would advance from the north and from the Kenai Mountains to the east, and coalesce into broad lobes or ice sheets that scoured the underlying bedrock and deposited glacial sediments. When the climate warmed, the glaciers would recede back to the mountains until the next ice advance cycle.

In the study area, the Moosehorn and Killey Stades of the Naptowne glaciation created most of the modern landforms. The complex glacial features such as proglacial lakes, outwash streams, fan deltas, and moraines originated between 25,000 and 12,000 years ago (Reger and Pinney 1997). The Kenai River channel evolved near the end of the Moosehorn advance, with glacial meltwater flows and outburst flood flows much higher than those of today, resulting in a channel and valley that are substantially larger than the present river that flows within it.

The Kenai Peninsula lies in the transitional climate zone of Southcentral Alaska. Weather conditions in the Kenai Lowlands average between the neighboring maritime and continental zones: temperature extremes are greater than those of marine climates, and precipitation is greater than typical locations in interior Alaska, but less than coastal areas. The mean annual air temperature at the Kenai Airport is 33.7°F and the mean annual precipitation is 19.2 inches. Seasonal snowfall at the Kenai Airport averages 61 in., amounting to approximately 60% of the average annual precipitation for the area.

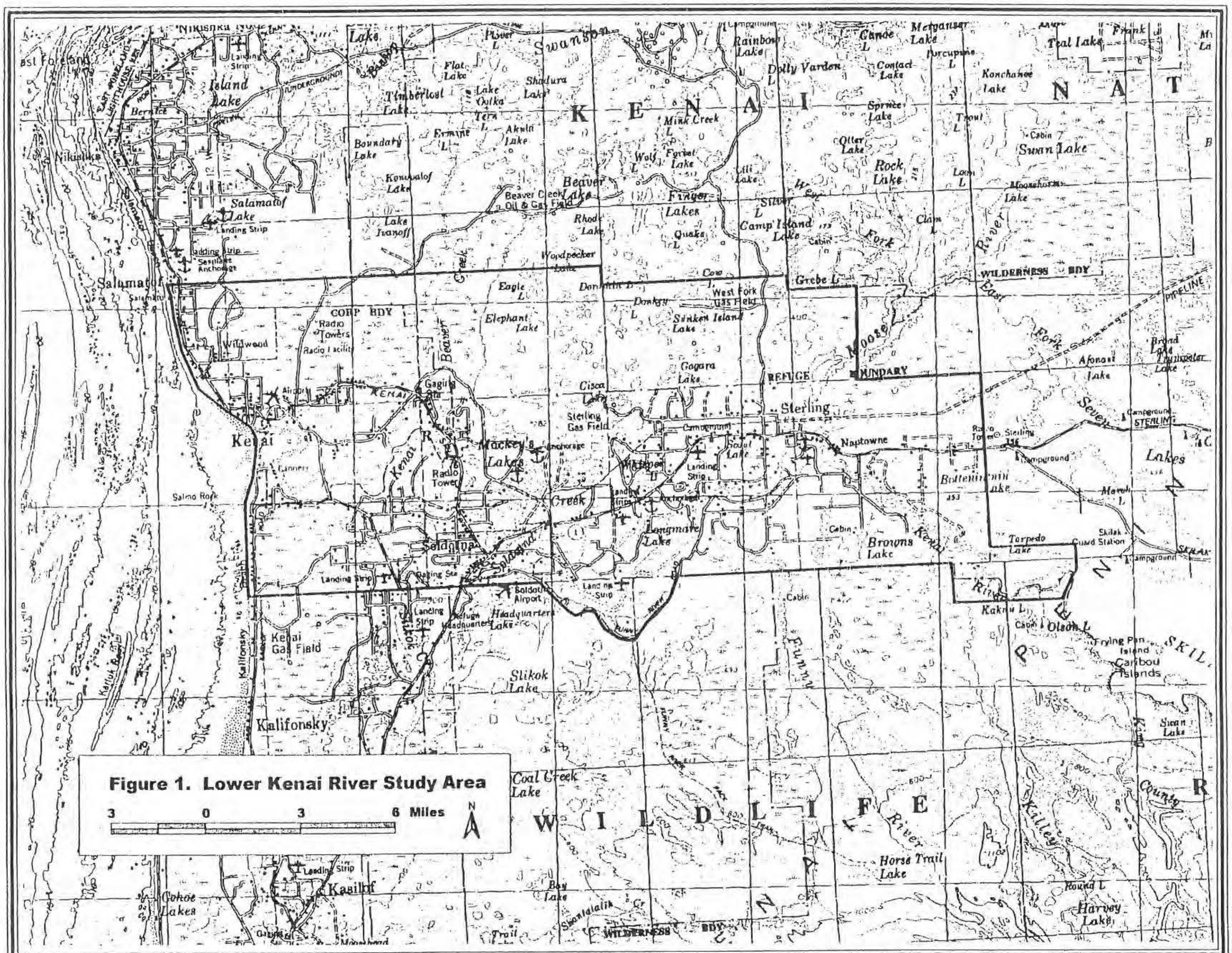

Figure 1. Lower Kenai River Study Area

3 0 3 6 Miles

The Kenai Lowlands area is predominantly forested with an interspersion of many ponds, lakes, and peatlands. Most of the non-wetland areas support a mixed evergreen-deciduous forest composed of white spruce, black spruce, paper birch, aspen and balsam poplar. More poorly drained sites are characterized by an increase in the occurrence of black spruce. A forest type containing white spruce and balsam poplar commonly occurs in floodplain areas.

Fire has had a substantial effect on the species composition of the lowland forests on the Kenai Peninsula. Large areas that have been burned in the past 60 years consist of dense thickets of aspen, alder, willow, and paper birch. These deciduous species represent transitional stages toward the climax forests dominated by white spruce on well-drained sites and peatlands on poorly drained sites.

METHODS

Wetland trends analysis involves detecting changes in the extent of wetlands by comparing aerial photography from at least two time periods for a given area. For the present study, aerial photographs from 1950, 1977 and 1996 were used to determine the extent of wetland losses and gains.

National Wetlands Inventory (NWI) maps covering the study area were published in 1981. These maps were based on the photo interpretation of 1977 color infrared (CIR) aerial photographs at a scale of 1:120,000. The digital file of the original NWI map data served as the starting point for the wetland trends study. Corrections were made to the 1977 base data if it was determined that the original mapping personnel made errors when interpreting the photos. Most of the corrections involved adding wetlands that were overlooked by the original interpreters. Other corrections included refinement of wetland boundaries and adjustments to wetland classifications.

The documentation of wetland trends between 1977 and 1996 was done on-screen at a computer work station. The corrected digital data from 1977 was displayed over digital, ortho-rectified panchromatic imagery acquired in 1996 (1:24,000 scale). Since the on-screen interpretation was done monoscopically, the analyst often verified interpretations by viewing hard-copy prints of the aerial photography with a 5X power stereoscope. Wetland losses and gains were delineated and attributed on-screen.

Wetland losses and gains between 1950 and 1977 were identified by comparing the 1950 imagery (black & white, 1;40,000 scale) with the 1977 photography and digital NWI map file. The 1997 digital data was printed out on acetate overlays that matched the scale of the 1950 photography. Wetland changes were annotated and labeled by a photo-interpreter on the acetate sheets. The photo-interpretation was performed stereoscopically using a 5X power stereoscope. The 1950 and 1977 photos were also viewed simultaneously using a Bausch & Lomb Zoom Transfer Scope. This was done to verify changes and to assign attributes for the causes of the change. The acetate sheets were digitized in order to produce acreage data for the 1950 – 1979 wetland losses and gains.

Wetlands and deepwater habitats were classified using the Classification of Wetlands and Deepwater Habitats of the U.S. (Cowardin et al. 1979). All changes identified during the study were assigned a code according to the type of activity that caused the change. The categories

used are listed below. Complete definitions of the wetland loss/gain categories are included in Appendix A.

1. Residential development
2. Commercial development.
3. Industrial development
4. Public facilities
5. Road construction
6. Agriculture
7. Other development
8. Natural

RESULTS

Status: 1996

In 1996, the study area contained 40,893.29 acres of wetlands, or 27.4% of the total land surface (Figure 2). Deepwater habitats (lakes, river channels, and marine and estuarine subtidal areas) encompass 7,093.61 acres, or 4.7% of the project area. Approximately 67.9% of the lands in and around the Sterling/Soldotna/Kenai area are classified as non-wetland (uplands).

Most of the wetland/deepwater habitat acreage in the study area is in the **palustrine** ecological system (Table 1). All five ecological systems described by Cowardin et al. (1979) are represented in the project area. The **estuarine** and **marine** habitats are restricted to areas near the mouth of the Kenai River.

Forty-four wetland and deepwater habitat categories (Cowardin et al. 1979) were identified during the photo interpretation phase of the wetlands trends study (Appendix B). For data presentation purposes, these types were combined into 11 general classes. Descriptions of the classes follow:

Wetlands

Estuarine Mud Flat: Intertidal mud flats that are usually unvegetated and composed of silt and sand-sized particles. Some mud flat areas may be covered with sparse algae. This category is restricted to areas near the mouth of the Kenai River (Kenai River Flats).

Estuarine Salt Marsh: Intertidal marsh that is alternately flooded and exposed by brackish tidal water. This class includes low marsh areas flooded daily by tidal water and high marsh zones that may only be flooded a few times each month. Common species include *Carex lyngbyei, Carex ramenskii, Triglochin maritimum, Plantago maritima, Potentilla anserina,* and *Elymus arenarius.*

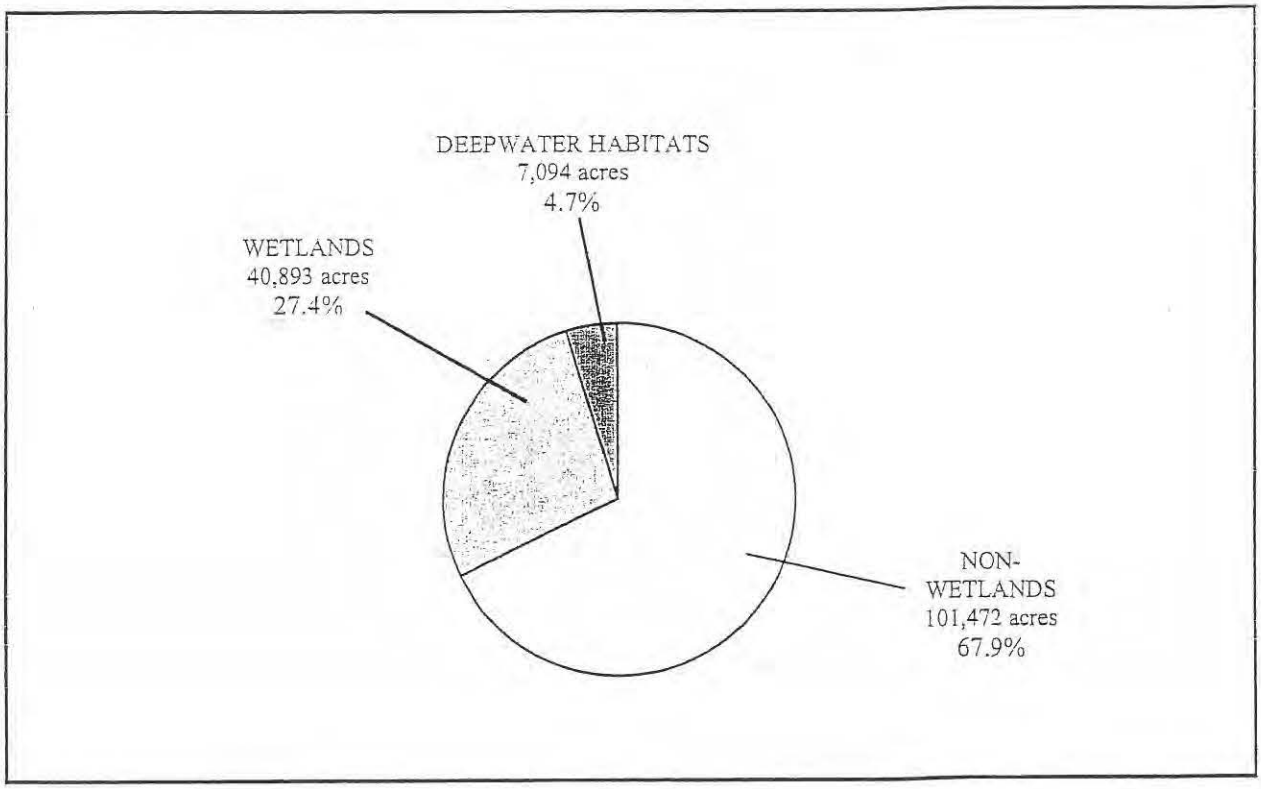

Figure 2. Distribution of wetlands, deepwater habitats and non-wetland areas in the lower Kenai River study area – 1996.

Table 1. Classification of wetlands and deepwater habitats by ecological system in the lower Kenai River study area – 1996

Ecological System *	Acres	Percent
Palustrine	37,676.48	78.5
Lacustrine	3,368.44	7.0
Riverine	2,732.64	5.7
Estuarine	2,597.90	5.4
Marine	1,611.44	3.4
Totals	47,986.90	100.0

* Ecological systems are described in the Classification of Wetlands and Deepwater Habitats of the U.S. (Cowardin et al. 1979).

Marine Beach/Bar: Unvegetated beaches and bars exposed to high-energy wave action along the shoreline of Cook Inlet.

Palustrine Open Water: Small open water bodies (ponds). This class also includes: (1) ponds that may be vegetated with aquatic beds (e.g., *Nymphaea tetragona* and *Potamogeton* sp.), and (2) small basins that may only contain water on a seasonal basis. Some of the wetlands in this class are excavated basins in developed areas.

Palustrine Emergent: Wetlands dominated by herbaceous vegetation including sedges, grasses, and forbs. Includes wetlands commonly referred to as marshes and wet meadows. Common emergent species in the lower Kenai River watershed include *Calamagrostis canadensis*, *Potentilla palustris*, *Carex sitchensis*, *C. rostrata*, *C. aquatilis*, *Menyanthes trifoliata*, and *Equisetum arvense*.

Palustrine Scrub/Shrub: Wetlands dominated by woody vegetation less than 6 m (20 feet) tall. This category includes true shrubs such as willow (*Salix* spp.), young trees, and trees that may be stunted because of environmental conditions (e.g., *Picea mariana* in wet bogs). Other common species dominating scrub/shrub wetlands include *Vaccinium uliginosum, Betula nana, Empetrum nigrum, Potentilla fruticosa*, and *Alnus crispa.*

Palustrine Forested: Wetlands dominated by woody vegetation greater than 6 m (20 feet) tall. *Picea mariana* dominates most of the forested wetlands in the study area. In some sites the black spruce is mixed with *Betula papyrifera* and *Picea glauca*. Forested wetlands dominated by *Populus trichocarpa* are found along rivers and streams.

Deepwater Habitats

Estuarine Subtidal: Subtidal, low-energy brackish open water. This category is limited to channels and tidal creeks in the Kenai River Flats area.

Marine Subtidal: Subtidal, high-energy open water of Cook Inlet. This class is restricted to a small area near the mouth of the Kenai River.

Lacustrine: This class includes all bodies of water greater than 20 acres in size. Examples of this class include Elephant Lake, Browns Lake and Whisper Lake.

Riverine Channel: Permanently flooded channels of rivers and streams.

The acreage for each of the generalized wetland types in 1996 is presented in Table 2. Palustrine scrub/shrub wetlands predominate, accounting for over 80% (32,850.85 acres) of the total wetland acreage in the study area. The next two most extensive wetland classes are palustrine emergent wetlands and marine beach/bars, with 3,560 acres (8.7%) and 1,562 acres (3.8%), respectively. Many wetland areas dominated by black spruce are recorded in the palustrine scrub/shrub category. In accordance with Cowardin et al. (1979), the height of woody vegetation must exceed 20 ft. to be classified as forested. Many sites in the study area are dominated by black spruce with heights just under 20 ft.

Most of the deepwater habitat acreage in 1996 consisted of lacustrine and riverine channel areas (Table 3). These two categories accounted for 86.0% of all deepwater habitat acreage. Estuarine subtidal and marine subtidal areas covered 943.09 acres (13.3%) and 49.44 acres (0.7%), respectively.

Table 2. Acreage of wetland types in the lower Kenai River study area: 1996		
Wetland Type	Acres	Percent
Estuarine Mud Flat	163.53	0.4
Estuarine Salt Marsh	1,491.28	3.7
Marine Beach/Bar	1,562.00	3.8
Palustrine Open Water	723.09	1.8
Palustrine Emergent	3,560.30	8.7
Palustrine Scrub/Shrub	32,850.85	80.3
Palustrine Forested	542.24	1.3
Total Wetlands	**40,893.29**	**100.0**

Table 3. Acreage of deepwater habitat types in the lower Kenai River study area: 1996		
Deepwater Habitat Type	Acres	Percent
Estuarine Subtidal	943.09	13.3
Marine Subtidal	49.44	0.7
Lacustrine	3,368.44	47.5
Riverine Channel	2,732.64	38.5
Total Deepwater Habitats	**7,093.61**	**100.0**

Trends

Wetland Losses: 1950 to 1977

Between 1950 and 1977, 497.30 acres of wetland in the study area were filled or drained by development activities (Table 4). Palustrine scrub/shrub wetlands were the most adversely impacted type with over 423 acres lost. In descending order of acreage lost, this is followed by 37.19 acres of palustrine emergent wetland and 28.84 acres of estuarine salt marsh. It appears, however, that no wetland type showed a significant disproportionate loss when compared to the original extent of the category in 1950. For example, 85.1% of the wetland losses were in palustrine scrub/shrub wetlands. This wetland class accounted for 80.3% of the wetlands at the beginning of the study period.

A total of 233 development actions resulting in wetland loss between 1950 and 1977 were identified during the analysis of the aerial photography (Table 5). Definitions of the development types are shown in Appendix A. Road construction, with 80 locations identified, was the most common action resulting in wetland loss. The average loss per road construction activity was 1.01 acres. Although agricultural development resulted in wetland loss in fewer cases (25), the average loss per action was much higher (6.30 acres). A total of 157.46 acres of wetland was drained or filled for agricultural development.

Table 4. Losses of wetlands (by class) due to development activities in the lower Kenai River study area: 1950 – 1977		
Wetland Type	Acres	Percent
Estuarine Mud Flat	0.38	0.1
Estuarine Salt Marsh	28.84	5.8
Marine Beach/Bar	0.00	0.0
Palustrine Open Water	0.00	0.0
Palustrine Emergent	37.19	7.4
Palustrine Scrub/Shrub	423.11	85.1
Palustrine Forested	7.78	1.6
Total	**497.30**	**100.0**

Development related to commercial activities and construction of public facilities resulted in the smallest wetland losses, with 7.22 acres and 0.72 acres lost, respectively. The "Other" category was used where initial development had occurred (e.g., placement of a fill pad), but eventual use of the area could not be determined. This category also includes miscellaneous uses that do not fit into the other main categories (e.g., golf courses).

The photo interpreters did not identify any natural wetland losses between 1950 and 1977.

Table 5. Losses of wetlands (by development category) in the lower Kenai River study area: 1950 - 1977				
Development Type	Frequency	Percent of Total Development Actions	Acres Filled/Drained	Average Loss Per Action (acres)
Residential	44	18.9	85.29	1.94
Commercial	4	1.7	7.22	1.81
Industrial	48	20.6	111.31	2.32
Public Facilities	1	0.4	0.72	0.72
Road Construction	80	34.3	80.43	1.01
Agriculture	25	10.7	157.46	6.30
Other	31	13.4	54.87	1.77
Total	**233**	**100**	**497.30**	**2.13**

Wetland Gains: 1950 to 1977

Human development activities resulted in some gains of wetland habitat. A total of 16.34 acres of wetland was created from 14 development actions during the 1950-1977 study period. Palustrine open water wetlands accounted for all of the gains. Most of the gain (10.42 acres) was the result of industrial development (e.g., excavated ponds in gravel pits). The remaining gain of palustrine open water was caused by residential development (2.74 acres) and other

development (3.18 acres). No natural wetland gains between 1950 and 1977 were identified during the study.

Deepwater Habitat Losses & Gains: 1950 to 1977

There was only one change in deepwater habitats identified during the 1950-1977 trend period. A single residential development action resulted in a loss of 1.2 acres of lacustrine habitat.

Wetland Losses: 1977 to 1996

Between 1977 and 1996, 235.71 acres of wetland in the study area were filled or drained by development activities (Table 6). Palustrine scrub/shrub wetlands were the most adversely impacted type with over 187 acres lost. In descending order of acreage lost, this is followed by 26.78 acres of palustrine emergent wetland, 16.23 acres of palustrine open water, and 5.07 acres of estuarine salt marsh. There were no acreage losses for the estuarine mud flat, marine beach/bar and forested wetland types.

Table 6. Losses of wetlands (by class) due to development activities in the lower Kenai River study area: 1977 – 1996

Wetland Type	Acres	Percent
Estuarine Mud Flat	0.00	0.0
Estuarine Salt Marsh	5.07	2.2
Marine Beach/Bar	0.00	0.0
Palustrine Open Water	16.23	6.9
Palustrine Emergent	26.78	11.3
Palustrine Scrub/Shrub	187.63	79.6
Palustrine Forested	0.00	0.0
Total	**235.71**	**100.0**

A total of 219 development actions resulting in wetland loss between 1977 and 1996 were identified during the analysis of the aerial photography (Table 7). Residential development, with 107 separate actions identified, was the most common development type resulting in wetland loss. The average loss per residential development action was 0.64 acres. Five of the six other development types showed a higher average loss per action. For example, the average loss resulting from industrial development (51 cases) was 1.80 acres.

Development related to commercial activities and construction of public facilities resulted in the smallest wetland losses, with 8.76 acres and 4.58 acres lost, respectively. The photo interpreters did not identify any natural wetland losses between 1950 and 1977.

Wetland Gains: 1977 to 1996

Human development activities resulted in small gains of wetland habitat. A total of 9.75 acres of wetland was created from 14 development actions between 1977 and 1996. Palustrine open water wetlands accounted for all of the gains. Most of the gain (9.58 acres) was the result of industrial development (e.g., excavated ponds in gravel pits). The remaining gain (0.17 acres)

of palustrine open water was caused by a single commercial development action. No natural wetland gains were identified during the 1977-1996 trend period.

Table 7. Losses of wetlands (by development category) in the lower Kenai River study area: 1977 - 1996

Development Type	Frequency	Percent of Total Development Actions	Acres Filled/Drained	Average Loss Per Action (acres)
Residential	107	48.9	68.78	0.64
Commercial	7	3.2	8.76	1.25
Industrial	51	23.3	91.76	1.80
Public Facilities	4	1.8	4.58	1.14
Road Construction	24	11.0	12.73	0.53
Agriculture	13	5.9	38.58	2.97
Other	13	5.9	10.52	0.81
Total	**219**	**100**	**235.71**	**1.08**

Deepwater Habitat Losses & Gains: 1977 to 1996

There was only one change in deepwater habitats identified during the 1977-1996 trend period. A single industrial development action resulted in a gain of 1.59 acres of lacustrine habitat.

Net Changes: 1950 to 1996

Table 8 shows the acreage of wetland and deepwater habitat classes in 1950, 1977 and 1996. The data represents net losses and gains. For example, the palustrine open water class decreased in coverage from 729.57 acres in 1977 to 723.09 acres in 1996. This net loss of 6.48 acres is derived from:

- Loss of 16.23 acres: palustrine open water to non-wetland due to development (see Table 6).
- Gain of 9.75 acres: non-wetland to palustrine open water due to development (see text in Wetland Gains: 1977 to 1996 section)

There was a net loss of 706.92 acres of wetland during the 46-year study period. Between 1950 and 1977, total wetland acreage decreased by 480.96 acres. The average annual net loss of wetlands during this 27-year time frame was 17.81 acres. Between 1977 and 1996, total wetland acreage decreased by 225.96 acres. The average annual net loss of wetlands during this later time period was 11.89 acres.

The palustrine open water category was the only wetland class that showed a net gain. This wetland type increased by 9.86 acres during the study period. Palustrine scrub/shrub wetlands lost the most acreage: 610.74 acres between 1950 and 1996. The coverage of deepwater habitats remained stable. The lacustrine class was the only deepwater habitat category that showed a net change between 1950 and 1996 (.39 acre gain).

Table 8. Net acreage changes for wetland and deepwater habitat classes in the lower Kenai River study area: 1950 - 1996							
Class	**Acres 1950**	**Acres 1977**	**Change in Acres 1950 - 1977**	**Acres 1996**	**Change in Acres 1977 - 1996**	**Change in Acres 1950 - 1996**	**% Change in Acres 1950 - 1996**
Estuarine Mud Flat	163.91	163.53	-0.38	163.53	0.00	-0.38	-0.2
Estuarine Salt Marsh	1,525.19	1,496.35	-28.84	1,491.28	-5.07	-33.91	-2.2
Marine Beach/Bar	1,562.00	1,562.00	0.00	1,562.00	0.00	0.00	0.0
Palustrine Open Water	713.23	729.57	+16.34	723.09	-6.48	+9.86	+1.4
Palustrine Emergent	3,624.27	3,587.08	-37.19	3,560.30	-26.78	-63.97	-1.8
Palustrine Scrub/Shrub	33,461.59	33,038.48	-423.11	32,850.85	-187.63	-610.74	-1.8
Palustrine Forested	550.02	542.24	-7.78	542.24	0.00	-7.78	-1.4
TOTAL WETLANDS	**41,600.21**	**41,119.25**	**-480.96**	**40,893.29**	**-225.96**	**-706.92**	**-1.7**
Estuarine Subtidal	943.09	943.09	0.00	943.09	0.00	0.00	0.0
Marine Subtidal	49.44	49.44	0.00	49.44	0.00	0.00	0.0
Lacustrine	3,368.05	3,366.85	-1.20	3,368.44	+1.59	+0.39	+0.01
Riverine Channel	2,732.64	2,732.64	0.00	2,732.64	0.00	0.00	0.0
TOTAL DEEPWATER HABITATS	**7,093.22**	**7,092.02**	**-1.20**	**7,093.61**	**+1.59**	**+0.39**	**+0.01**
TOTAL WETLANDS & DEEPW. HABITATS	**48,693.43**	**48,211.27**	**-482.16**	**47,986.90**	**-224.37**	**-706.53**	**-1.5**

SUMMARY

In 1996, the 235 square-mile study area had 27.4% of its land surface covered by wetlands. An additional 4.7% consisted of deepwater habitats. Palustrine scrub/shrub wetlands accounted for 80.3% of the total wetland acreage.

In 1950, the lower Kenai River study area contained 41,600.21 acres of wetland. Between 1950 and 1977, the area lost 497.30 acres of wetland from development activities. There were 233 development sites that contributed to this loss. Over 34% of these sites were recorded as road construction. Industrial development accounted for 20.6% of the development actions.

Between 1977 and 1996, an additional 235.71 acres of wetland were lost as a result of 219 separate development actions. Residential development was identified as the primary activity in 107 cases (48.9% of the total actions).

Wetland acreage in the project area decreased by 1.7% during the 46-year study period. The loss of 733.01 acres during this period was slightly offset by a gain of 26.09 acres.

The 1996 end-date of the study was used because more recent aerial photography was not available. Significant growth in the Kenai, Soldotna and Sterling areas has continued from 1996 to the present. It is anticipated that the National Wetland Inventory program will update the trends study when more recent imagery covering the entire project area is acquired.

While this report documents recent trends in the project area, it does not address changes in the quality of the remaining wetlands. As development increases, the quality of wetlands and the functions they provide can be expected to deteriorate. This deterioration comes from increased runoff from commercial and residential developments, increased sedimentation, fragmentation of wetland systems, and modification to natural hydrologic regimes. It is probable that many of the road construction activities that caused wetland losses also affected fish passage in small streams.

REFERENCES CITED

Adamus, P.R. 1988. Juneau wetlands: functions and values. Adamus Resource Assessment, Inc. *For* City and Borough of Juneau, Alaska. 285 pp.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, FWS/OBS-79-31. Washington, D.C. 103 pp.

Dahl, T.E. 1990. Wetlands losses in the United States 1780s to 1980s. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 21pp.

Dahl, T.E. 2000. Status and trends of wetlands in the conterminous United States 1986 to 1997. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 82pp.

Hall, J.V., W.E. Frayer, and B.O. Wilen. 1994. Status of Alaska wetlands. U.S. Department of the Interior, Fish and Wildlife Service, Anchorage, AK. 33pp.

Reger, R.D., and D.S. Pinney. 1997. Last major glaciation of the Kenai lowlands. *In:* Alaska Geological Society 1997 guide to the geology of the Kenai Peninsula. Alaska. pp. 54-67.

Rieger, S., D.B. Schoephorster and C.E. Furbush. 1979. Exploratory soil survey of Alaska. U.S. Dept. of Agriculture, Soil Conservation Service, Washington, D.C. 213pp.

Senner, Robert G.B. 1989. Effects of petroleum operations in Alaskan wetlands. Robert Senner and Company, Anchorage, Alaska. *For* ARCO Alaska, Inc. and BP Exploration (Alaska) Inc., Anchorage, AK. 138 pp.

U.S. Fish and Wildlife Service. 1993. Anchorage wetlands trends study (1950 to 1990). U.S. Department of the Interior, Fish and Wildlife Service, Anchorage, Alaska. 62 pp.

U.S. Fish and Wildlife Service. 1995. Photointerpretation conventions for the National Wetlands Inventory. U.S. Department of the Interior, Fish and Wildlife Service, St. Petersburg, Florida. 60 pp.

APPENDIX A

Wetland Loss/Gain Categories
Palmer/Wasilla Study Area

Residential Development: Construction of single-family homes, condominiums, apartment buildings, etc. This category includes the roads and driveways associated with the residential development.

Commercial Development: Construction of buildings, fill pads, and access roads associated with the development of commercial establishments such as retail stores, restaurants, motels and private office buildings.

Industrial Development: Construction of light industrial facilities including warehouses and heavy equipment/large vehicle storage yards. This category also includes oil and gas development, airport/airstrip development, construction of airport related facilities (e.g., air cargo businesses), fish processing facilities, boat harbors and related structures, and gravel mining.

Public Facilities: Schools, public recreation (e.g., playgrounds and ball fields), sewage treatment facilities and government buildings (federal, state and local). The category also includes the roads, driveways and parking lots built specifically for the public facilities.

Road Construction: Public roads not specifically built for one of the development types listed above.

Agriculture: Cropland, pasture, nurseries and other related land uses. The category includes associated development such as farm roads, farm ponds and buildings (e.g., barns).

Other Development: This category is used where initial development had occurred (e.g., placement of a fill pad), but eventual use of the area could not be determined. The category also includes miscellaneous uses that do not fit into the other main categories (e.g., golf courses and recreational vehicle parks).

Natural: Changes caused by natural phenomena such as meandering river channels and beaver activity.

APPENDIX B

List of NWI Map Codes Identified During Photo Interpretation
from
Photo Interpretation Conventions (U.S. Fish and Wildlife Service 1995)

Palustrine System	Marine System
PEM1Ax	M1UBL
PEM1B	M2USN
PEM1C	M2USP
PEM1F	
PEM1H	**Estuarine System**
PEM1R	
PEM1/SS1B	E1UBL
PEM1/UBH	E2EM1N
PFO4B	E2EM1P
PFO4/EM1B	E2EM1/USN
PFO4/EM1C	E2USN
PFO4/SS1B	
PFO4/SS1C	**Lacustrine System**
PSS1B	
PSS1C	L1UBH
PSS4B	L2AB3H
PSS4C	L2UBHx
PSS1/4B	
PSS1/4C	**Riverine System**
PSS4/1B	
PSS4/1C	R1UBV
PSS1/EM1B	R2UBH
PSS1/EM1C	R3UBH
PSS1/EM1F	
PSS1/EM1R	**Upland**
PSS4/EM1B	
PSS4/EM1C	U
PUBFx	
PUBH	
PUBHx	