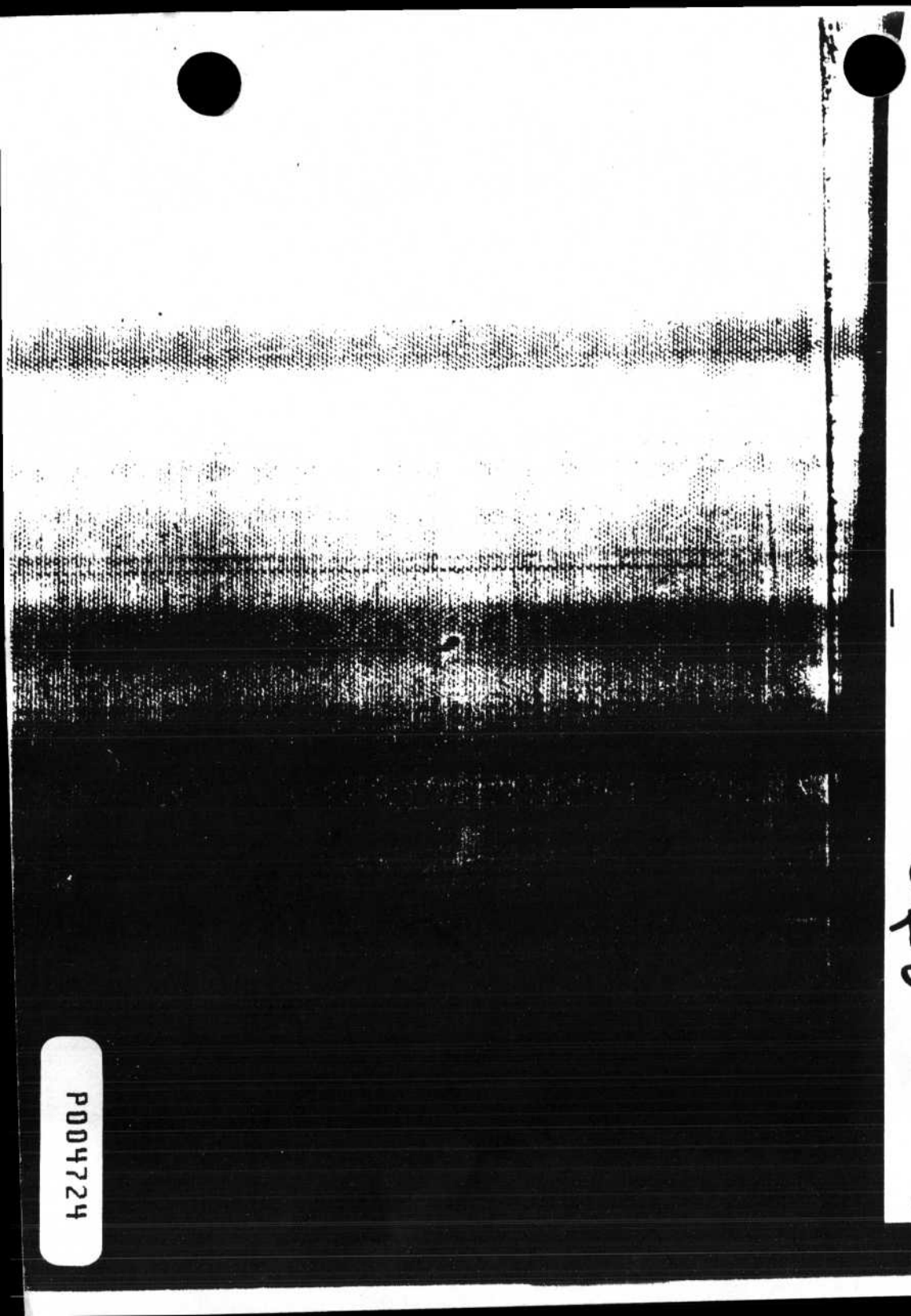

P0047Z4

ROUTING AND TRANSMITTAL SLIP Date 21 Oct. 78

TO: (Name, office symbol, room number, building, Agency/Post)	Initials	Date
1. Forest Brooks, RP		
2. RICN JESSE - file		
3. ERS Wetlands Contract		
4.		
5.		

	Action		File		Note and Return
	Approval		For Clearance		Per Conversation
	As Requested		For Correction		Prepare Reply
	Circulate		For Your Information		See Me
	Comment		Investigate		Signature
	Coordination		Justify		

REMARKS

Attached is a copy of the draft report received from the contractor for the Skagit Wetland Inventory. Sample of maps is available at my desk. If you have any comments, please let me know this week. Comments go back to the contractor on 30 Oct. 78.

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

FROM: (Name, org. symbol, Agency/Post)	Room No.—Bldg.
Karen Mettling	ERS
	Phone No. 3624

5041-102

OPTIONAL FORM 41 (Rev. 7-76)
Prescribed by GSA
FPMR (41 CFR) 101-11.206

SAI SHAPIRO & ASSOCIATES, INC.

October 20, 1978

Dr. Stephen Dice
Seattle District
Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Dr. Dice:

The joint venture of Shapiro & Associates, Inc./Parametrix/Daniel P. Cheney (SAI/PMX/DC) is pleased to present this draft report, Inventory of Skagit Valley Wetlands, for your review and comment. (Please note the complete bibliography is being typed and will be submitted at a later date.)

We feel the wetland mapping effort conducted as part of this study provides the most up-to-date and comprehensive coverage of wetlands in the Lower Skagit Basin. We also feel it important to note that the level of detail we were able to achieve within the time frame of the study was only possible with the assistance of the Washington Department of Game. The unpublished field studies of Skagit Flat vegetation they provided to us allowed both interpretation of inaccessible areas and verification of our own field efforts. Additionally, we feel the aerial reconnaissance provided an important overview of the study area as well as numerous useful oblique photographs.

Frost: I looked thru MARC's slides. Not bad.. and have borrowed them to make duplica for use at [illegible] workshop

We hope this report fulfills your requirements for the Skagit River Channel Maintenance EIS. We look forward to receiving your comments on this study in the near future.

Sincerely,

SHAPIRO & ASSOCIATES, INC.

Marc E. Boulé

Marc Boulé, for the joint
venture SAI/PMX/DC

MB:pg
Enclosure

Do we have a project yet?

P004725

DRAFT

INVENTORY OF WETLANDS

LOWER SKAGIT RIVER

Prepared for

U.S. Army Corps of Engineers
Seattle, Washington

Prepared by

Shapiro & Associates, Inc.
812 Smith Tower
Seattle, Washington 98104
(206) 624-9190

October 1978

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INTRODUCTION

1. The Seattle District, U.S. Army Corps of Engineers is planning a Skagit River Levee and Channel Improvement Project. The proposed project extends from Sedro Woolley, Washington, downstream to the mouth of the Skagit River, along both the north and south forks. Much of this area has been recognized as wetland, and as such is an important natural resource.

2. The purpose of this study is threefold: (1) to identify, classify, and map those wetlands lying within the proposed project area; (2) to evaluate the relative biological importance of those wetland habitats; and (3) to recommend a priority rating of the various wetland habitat types with respect to their fish and wildlife value. This report describes both the previous work in the area and the work performed during this project. Accompanying this report is a set of fifteen 1:24000 black and white aerial photographs with the various wetland types delineated.

Previous Research in the Project Area

3. Classification and evaluation of wetlands in the United States began in earnest with the work of Shaw and Fredine (1954). This study, popularly referred to as Circular 39, describes 20 basic wetlands types and discusses their use by various species of wildlife. In addition, the results of state-by-state wetland inventories were presented. In Washington the wetland inventory summarized in Circular 39 was completed on a county-by-county basis by the U.S. Fish and Wildlife Service (1954). Those data are presented in Table 1, in the Results section of this report.

4. More recently, the University of Washington College of Forest Resources has conducted a study of wetlands in Skagit County (Raedeke, et al., 1976). A survey of present wetlands in Skagit County and a comparison of that information to data developed by U.S. Fish and Wildlife Service (1954) was a major objective of this project. The study also discussed the historic changes in the wetlands of Skagit Bay as a function of deltaic processes.

5. The Washington State Department of Game investigated the vegetation along the Skagit flats to assess the growth of the wetland habitat. The field work for this study consisted of approximately 150 vegetation transects extending from the dike into Skagit Bay between the north fork Skagit River and the Stillaguamish River. Although as yet unpublished, field reports for this study were graciously made available to us by the Department.

6. Skagit delta wetlands are considered in the "Wetlands Survey of Northwestern Washington" (Jeffrey, et al., 1977). This work identifies 10,435 acres of wetlands in the area between the dike and mean

lower low water, and notes high use of the habitat by ducks, geese, raptors, gulls and salmonids. According to criteria for evaluation of the wildlife resources and human use, this area is the most valuable of those considered.

7. The Washington Department of Game recently completed an environmental impact statement (EIS) for a proposed wildlife interpretation center in the Skagit River south fork delta. The EIS summarizes much of the information that is known about wildlife in the area. It also provides lists of vegetation and wildlife found in the delta and a general description of the function of the estuarine ecosystem.

8. The Coastal Zone Atlas for Skagit County (Washington DOE, 1978) includes maps of coastal habitats in the Skagit flats area and up the south fork to Conway. Habitats identified include brackish marshes and riparian woodlands. In addition, critical biological areas for various wildlife species are identified.

METHODOLOGY

9. The first phase of the present study was to review previous studies performed in the area to determine their applicability to the proposed work. Of particular interest was any wetlands mapping which had been completed as a part of the prevous studies, and the desire to equate previously used classification systems to the National Wetland Inventory (NWI) classification system (Cowardin, et al., 1977). The studies evaluated were:

- U.S. Fish and Wildlife Service, 1954; Inventory of Washington Wetlands
- Raedeke, et al, 1976; Wetlands of Skagit County
- Jeffrey, et al., 1977 (unpublished); Wetlands Survey, Northwestern Washington
- Jeffrey, et al., (unpublished); Skagit Flats Vegetation Study
- Washington State Department of Ecology, 1978; Coastal Zone Atlas

10. The USFWS (1954) inventory noted approximately 4,400 acres of wetlands in Skagit County (not including sounds and bays), but there was no discussion of distribution. As a result, the study provided us only with an historical perspective.

11. We were fortunate enough to acquire copies of the original 1:24000 scale base maps generated by Raedeke, et al. (1976). In all, approximately 40 wetlands were identified by that report within our study area. Unfortunately, we had difficulty in equating the classification system used by Raedeke with the NWI. Nonetheless, this study did indicate the location of known wetlands within the study area.

12. The wetlands survey completed by the Washington Department of Game (Jeffrey, et al., 1977) does not map specific wetlands within the study area. It does, however, identify much of the wildlife which utilizes Skagit flats. In contrast, the unpublished vegetation transects completed by the Department of Game (R. Jeffrey, personal communication) provide a great deal of detail about the plant communities in Skagit flats.

13. Evaluation of the Skagit County Coastal Zone Atlas (Washington DOE, 1978) showed it to be the most comprehensive mapping of Skagit flats available, and it was also at a scale of 1:24000. Unfortunately, the mapping did not extend upriver beyond Conway, thus much of the area to be considered in this study was not included. We were, however, able to equate the classification used in the Atlas to the NWI classification.

14. With the review of literature completed, it was possible to begin field investigations to identify and classify wetland types which were discernible on the photographs. Initial field investigations included a reconnaissance of the south fork delta by boat and an aerial survey of the entire study area. These were followed by five days of mapping by car or boat throughout the study area. During these trips results were plotted on a set of 1:24000 photographs.

15. Upon completion of the field mapping, the results were transferred to a new set of photographs for inclusion with this report. In addition, the various wetland habitat types were described and their areal extent determined. These data are included as a part of this report.

RESULTS

16. Wetland habitats in the Skagit River are classified and mapped using the system developed by the U.S. Fish and Wildlife Service (Cowardin, et al., 1977). This system identifies wetlands as marine, estuarine, riverine, lacustrine or palustrine. (See Appendix A for a description of this classification.) Of these, only estuarine, riverine and palustrine wetlands are present within the Skagit River study area. In addition, certain upland habitat types, such as urban, agriculture, and dikes, have been mapped where they are located immediately adjacent to the river.

17. This discussion will first describe the various habitats which have been identified within the study area. Although vegetation and inundation are the principal characteristics considered, water salinity and substrate type are also discussed to the degree which they are known.

18. Following the description of habitats is a discussion of the functional characteristics of each habitat type. Fish and wildlife habitat, areal extent and primary productivity are important aspects of this discussion. A matrix summarizing the functional characteristics is included.

Habitat Type Description

Estuarine

19. As defined in the FWS classification (Cowardin, et al., 1977), estuarine wetlands are found in semi-enclosed waters where the salinity may vary from 0.5 to 30 ppt*. No known salinity studies of the river have been conducted to determine the upstream limits of saline intrusion. However, low surface salinities in Skagit Bay during most years (c.f. Collias, et al., 1973), high freshwater runoff, and very low conductivity measuresments at Conway (WDG, 1977), suggest the saline intrusion does not extend far upstream. For this reason, estuarine wetlands have been identified only along the Skagit flats area and at the river mouths.

20. Estuarine habitat types identified within the study area include:

- Regularly flooded, unvegetated flats
- Regularly flooded, persistent, emergent wetlands
- Regularly flooded, non-persistent, emergent wetlands
- Irregularly flooded, persistent, emergent wetlands
- Irregularly flooded, non-persistent, emergent wetlands

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* ppt = parts per thousand

21. Regularly flooded unvegetated flats are located landward of the main channel and seaward of the vegetated flats adjacent to Fir Island. These flats vary in elevation from subtidal to above mean tide level. The substrate is often sand, with some silt or clay in places. Shellfish, such as Macoma sp. and Mya arenaria are found scattered throughout the area. High populations of other invertebrate organisms such as annelid worms, polycheates, and isopods are also found. These latter organisms are an important food source for juvenile salmon beginning seaward migration.

22. Regularly flooded persistent emergent wetlands are the deepest or outermost vegetation community along the Skagit Flats area. This habitat type can be divided into two zones in most of the study area. Scirpus americanus dominates in the lowest reaches of this habitat, either in dense monospecific stands or in conjunction with Cotula coronopifolia. At higher elevations S. maritimus may co-dominate with S. americanus, but higher still S. validus is found. In some areas, hummocks covered with Carex lyngbyei may be found scattered within the S. americanus. These communities are in the high intertidal and are probably inundated at least once a day. Sand, silt, clay and organic material make up much of the substrate.

23. Regularly flooded non-persistent emergent wetlands consist of a wide variety of species but are most often dominated by Carex lyngbyei. Agrostis alba, Triglochin maritimum, and Scirpus validus may be present in varying amounts. Most of these species are broken up through the winter, and few remain standing by spring. Regular tidal inundation carries much of this detritus into the tidal channels or onto the unvegetated flats where it may be consumed by the invertebrates living there.

24. Irregularly flooded non-peristent emergent wetlands constitute a diverse community consisting of Potentilla pacifica, Deschampsia caespitosa, Aster subspicatus, and Agrostis alba. Carex lyngbyei may be present, but rarely dominates. Distichlis spicata, Atriplex patula and Juncus balticus may also occur, either scattered or in small but dense stands.

25. Irregularly flooded persistent emergent wetlands may be characterized as dense, monospecific stands of Typha latifolia. Located in the upper portion of the intertidal area, this habitat is probably inundated less than once a day. The presence of Typha is probably indicative of extremely low salinities in high intertidal areas adjacent to the bay. This diverse habitat is often the uppermost tidal wetland and may form a transition zone with upland species, especially riparian shrubs or ruderal annuals. Substrate may vary with these wetlands, but it is often firm, suggesting sand rather than clay.

Riverine

26. According to the FWS classification, all riverine wetlands consist of non-persistant vegetation. However, certain tidal wetlands, containing persistant vegetation appear to be best characterized as riverine, and for the purposes of this report, they have been so identified. These wetlands are tidal (perhaps regularly) and often located at the mouth of the river adjacent to the bay. Although the location actually suggests an estuarine situation, the la lack of any discernible saline water and the presence of numerous freshwater marsh species implies a riverine designation. As a result, two riverine habitat types are described:

- Non-persistent tidal emergent wetlands
- Persistent tidal emergent wetlands

27. Non-persistent tidal emergent wetlands are dominated by Phalaris arundinaceae, a prolific inhabitant of riverine and adjacent upland habitats. Juncus effusus, Epilobium sp., Lotus corniculatus, Scirpus fluviatile and Typha latifolia are all distributed widely in this habitat, but rarely do they dominate.

28. Persistent tidal emergent wetlands are similar to those just described except Typha latifolia is the dominant over most of the area. Potentilla palustris, Scirpus validus, Carex vesicaria, Equisetum fluviatile and Bidens cernua may also be found in this habitat type, often in small monospecific patterns, rather than randomly distributed.

Palustrine

29. The remainder of the wetlands identified in the study area are classified as palustrine. That is, they are either isolated habitat types of less than 20 acres, or they are adjacent to the river but function more as floodplain habitats, rather than riverine habitats.

30. Palustrine wetlands in the study area include:

- Permanent open water
- Floating leaved aquatic bed
- Persistent, semi-permanently flooded, emergent wetlands
- Non-persistent, seasonally flooded, emergent wetlands
- Non-persistent, temporarily flooded, emergent wetlands (farm)
- Non-persistent, tidal, emergent wetland (farm)
- Broad-leaved deciduous, tidal, scrub/shrub wetland
- Broad-leaved deciduous, seasonally flooded, scrub/shrub wetland
- Broad-leaved deciduous, intermittantly flooded forest

31. Permanent open water describes a variety of ponds or slow-moving streams in the area. These areas may vary in depth from only a few inches to several feet. The bottom substrate is usually silty, with high concentrations of organic material, especially where Nuphate or Typha are found along the borders.

32. Floating leaved aquatic beds consist entirely of Nuphar polysepalum. Common in shallow, slow-moving water, this community is found in many ponds and old backsloughs in the area. An extremely silty substrate is usually found in these small ponds.

33. Persistent, semi-permanently flooded, emergent wetlands are Typha latifolia communities, usually located in isolated ponds or old sloughs. Juncus effusus, Sparganium spp. and Polygonum spp. may also be present. Frequently, these wetlands will be located between open water or aquatic beds and the shore of the pond. Silty or sandy substrates are most commonly associated with this wetland type.

34. Non-persistent, seasonally flooded, emergent wetlands are usually dominated by Phalaris arundinaceae, and are located between the river and the dike. Often a small creek or backslough runs through these communities or borders them adjacent to the dike. Juncus effusus, Equisetum fluviatile, Polygonum spp. and Sparganium spp. may also be found in scattered locations. This habitat may be used for occasional grazing, but not on a regular basis.

35. As noted, non-persistent, temporarily flooded, emergent wetlands are frequently utilized as grazing land. P. arundinaceae may be present, however, pasture grasses, ruderal species and Juncus effusus are more common. Slightly higher in elevation than the seasonally flooded wetlands just described, and controlled by agricultural practices, these areas show little resemblance to that habitat type.

36. One example of a non-persistent tidal emergent wetland was identified in the study area. Heavy grazing has resulted in a major alteration of this site. Sparganium sp., Equisetum arvense, Lysichtum americanum, Scirpus microcarpus, Veronica sp. and Ranunculus sp. are scattered about the area along with numerous old logs and stumps.

37. The broad-leaved deciduous, tidal, scrub/shrub wetland is a diverse community of shrubs and small trees. Spiraea douglasii, Lonicera involucrata, Pyrus fusca, and Salix spp. are all found here. The community is found in the high intertidal, often between the dike and a natural berm adjacent to the river. This habitat type usually represents a successional stage between persistant Typha wetlands and forested wetlands dominated by Populus or Picea; therefore, species from these other communities will often be found scattered throughout. Inundation is usually irregular tidal.

38. A non-tidal equivalent of the previous habitat type is the broad-leaved deciduous, seasonally flooded, shrub/scrub wetland. These wetlands are dominated by Salix lasiandra, S. hookeriana, and S. scoulerii, and often have dense stands of Phalaris arundinaceae in the understory. These stands are extremely common on gravel bars, point bars, and cut-off islands where they may be inundated from three to nine months of the year. Salix wetlands appear to represent a successional stage preceeding Populus forests, and thus some Populus specimens are usually present. The substrate may vary from silt to mixed sand and cobbles, but there is usually little or no indication of a soil horizon.

39. The broad-leaved deciduous, intermittantly flooded, forested wetlands consist predominantly of stands of Populus trichocarpa. Alnus rubra, Salix spp., Picea sitchensis and Thuja plicata may also be found scattered throughout this habitat type. The substrate is usually a sandy loam in which a soil horizon has begun to form.

Upland

40. Several upland habitat types have been identified and mapped within the study area. In general, they are located immediately adjacent to the river or adjacent wetlands. These habitat types include:

- Dike
- Agriculture
- Urban

41. Dikes, or levees, are artificial structures intended to control the river when it exceeds its capacity. They generally parallel the natural river course, often immediately adjacent to the river and occasionally several hundred meters away. Dikes are constructed of soil often with a rock (riprap) face on the river side to minimize erosion. In order to ease maintenance, vegetation along dikes is usually limited to grasses and annuals; this may be done by mowing, herbicides or grazing. In the Skagit River, grazing is common along dikes and on the non-persistent, temporarily flooded, emergent wetlands adjacent to them.

42. Agricultural lands adjacent to the Skagit River include both grazing and crop lands. Dairy pasture is the most common land use, however, planted crops such as corn, carrots, beets and other vegetables are also present.

43. Urban activities in the study area are primarily residential and associated commercial and industrial activities. Mt. Vernon, Burlington, Sedro Woolley and Conway are all urban centers located on the river.

Habitat Type Functional Characteristics

44. Functional characteristics of wetlands have been identified in Corps regulations (33 CFR 320.4) and further described in other Corps documents (c.f. USACE, Institute for Water Resources, 1977; USACE, 1978). Those characteristics include:

- Biologic Functions
  - Productivity
  - Vegetation Density
  - Plant and Animal Diversity
  - Threatened/Endangered Habitats
- Ecosystem Support
  - Hydrologic Periodicity
  - Location or Elevation
  - Areal Extent
  - Ecological Importance
- Physical Functions
  - Physical Protection
  - Storm and Floodwater Storage
  - Groundwater Recharge
  - Water Purification

Detailed descriptions of these functions may be found in the Snohomish Estuary Wetlands Study (USACE, 1978) and are appended to this report (Appendix B).

45. In the following discussion, each habitat type is considered as to how well it performs these various functions. This is followed by a table which lists the areal extent of each wetland type.

Estuarine

46. Unvegetated flats adjacent to vegetated wetlands often exhibit a high secondary productivity, but a low primary productivity. Primary production is limited to diatoms and other microscopic algae; secondary production is based on detritus exported from adjacent wetlands. Smith (1977) has shown that mudflats at the mouth of the Snohomish support dense populations of benthic invertebrates, and it is suspected that the same is true of Skagit Bay mudflats (J. Congleton, personal communication). Recent work indicates that these invertebrates are second only to marsh insects as a food source for seaward migrating juvenile salmon (Congleton, unpubl). These invertebrates are also an important food source for a wide variety of shorebirds. Finally, harbor seals have often been observed to haul out on the Skagit flats.

47. The Skagit Flats are located in the low intertidal zone and are inundated daily by high tides, thus providing a constant water

exchange with its associated dissolved oxygen and detritus food sources. The flats are extensive, covering some 7,000 acres between the north and south forks of the river.

48. The regularly flooded persistent emergent wetlands are dominated by Scirpus spp. In Nehalem Bay, Oregon, Eilers (1975) determined a mean Scirpus productivity of approximately 600 g/m^2/yr. While this is higher than most world agricultural crops (c.f. Odum, 1972), it is relatively low compared to most marsh communities. S. maritimus is the only species common to both Nehalem and Skagit Bay. The other Scirpus species which appear in the Skagit are both larger and denser than those in Oregon, suggesting a productivity that is somewhat higher than that measured by Eilers.

49. These regularly flooded wetlands are inundated at least once a day, thus exporting detritus and allowing juvenile salmon to feed on marsh insects (J. Congleton, personal communication, 12 September 1978). This habitat is also an important feeding area for Snow Geese, which graze heavily on shoots and rhizomes of Scirpus americanus. Scirpus maritimus has also been noted as a popular food source for waterfowl (Monroe, 1973).

50. Regularly flooded non-persistent emergent wetlands are more diverse, and probably more productive than other regularly flooded estuarine wetlands. A similar community in Oregon was noted as having a mean annual productivity of approximately 1,700 g/m^2/yr, a relatively high figure for wetlands production (Eilers, 1975).

51. These are densely vegetated wetlands which provide food and shelter for a wide range of fauna. Both Carex and Triglochin have been noted as food sources for pintail and mallard ducks (USACE and WDG, 1976). In addition, some rodents probably use the densely vegetated habitat for feeding.

52. As a regularly flooded wetland this habitat is inundated at least once a day, providing a major path for the export of detritus to the unvegetated flats. The habitat extends in a narrow band from the north fork to the south fork covering a total of approximately
acres.

53. Irregularly flooded persistent emergent wetlands are dense monospecific stands of Typha. Productivity of Typha has been reported as varying from 684 g/m^2/yr to 1,506 g/m^2/yr (Eilers, 1975; Wetzel, et al., 1977), with an average of about 1,200 g/m^2/yr. Typha stands provide important feeding and nesting habitat for a wide range of mammal and avian fauna. Muskrats and other rodents feed on Typha and also use it as nesting material. Bitterns, rails and redwing blackbirds also nest and feed in this habitat type.

54. Irregularly flooded wetlands are not inundated at every tide, so export of detrital material is limited to periods of extremely high tides. Typha wetlands are very extensive, expecially in the delta of the south fork, and encompass some acres within the Skagit Bay area.

55. The irregularly flooded non-persistent emergent wetlands are the most diverse habitat type within the study area, and may also be the most productive. Eilers (1975) recorded values of 1,756 $g/m^2/yr$ and 1,936 $g/m^2/yr$ for communities with a similar composition. Vegetation is extremely dense in this wetland and probably provides important feeding and nesting habitat for small rodents, which in turn are prey for raptors and carnivorous mammals such as mink.

56. As with other estuarine wetlands, this habitat type extends as a narrow band from the north fork to the south fork, covering approximately acres. Although only irregularly inundated, the non-persistent character of the vegetation suggests much of it is exported seaward during very high tides.

Riverine

57. The tidal non-persistent emergent wetlands are dominated by a single species, Phalaris, but also include a wide range of other freshwater wetland species. Although it is a prolific and extensive species, there are no known studies of Phalaris productivity. The habitat type is densely vegetated and undoubtedly provides habitat for a wide variety of marsh birds and small mammals. These in turn would be prey for raptors and carnivorous mammals. Evidence of beaver and deer have been observed on dry ground immediately adjacent to the habitat.

58. This habitat type is found at one location in the study area, and occupies approximately acres. The area is tidal, however, the frequency of inundation is not known. Nonetheless, export of detrital material probably occurs both during high tides and high river stages.

59. Tidal, persistent, emergent wetlands are dominated by Typha, but may also contain populations of a diversity of other species. As mentioned above, the high productivity of Typha has been reported, as have many of the wildlife habitat values (see irregularly flooded persistent emergent wetlands). This habitat type varies primarily in its complete lack of a salinity intrusion, and the introduction of several other freshwater marsh species.

Palustrine

60. Permanent open water describes a number of small ponds within the study area. These ponds often consist of several habitat

types, which together form a complete ecosystem. The open water provides a feeding and resting area for waterfowl, and these may then nest in adjacent habitats within the pond ecosystem. In larger ponds the open water may also support a population of small fish. Frogs and other amphibians require open water as rearing habitat for juveniles. All of these open water species may become food for herons, waterfowl, raccoons or other carnivores from neighboring habitat types.

61. Floating leaved aquatic beds probably exhibit a low primary productivity, although there are no known studies of the subject. Located in slow-moving waters or ponds, often with high runoff from adjacent uplands, these communities trap organic sediments and nutrient materials creating both a rich substrate and a nutrient source for adjacent deeper waters in the pond. The habitat supports a wide variety of insect fauna and benthic invertebrates. These in turn support small fish, amphibians and snakes which are prey to herons, raptors, raccoons and weasels. These carnivores often nest in adjacent wooded or shrub habitat and visit the pond to feed.

62. Although ponds may be numerous, they are often small and represent a very small total area. Nonetheless, in conjunction with the adjacent open water, cattails, scrub/shrub and forested wetlands, the aquatic beds are an important feeding and nesting area for a wide variety of wildlife and waterfowl. In addition, these ponds may also serve in floodwater storage.

63. Persistent semi-permanent emergent wetlands often constitute one community in a pond habitat. Typha is a highly productive species which will contribute a significant amount of detritus to the pond ecosystem. Dense Typha stands also provide nesting areas for marsh wrens, redwing blackbirds and various other small song birds. Muskrats and small rodents feed on Typha and may also nest in or near the stands. The diverse community of small birds and mammals provides a food source for a wide range of carnivores, including weasels, raccoons and raptors, which may not nest in the area but often feed there.

64. Non-persistent, seasonally flooded wetlands are usually monospecific populations of Phalaris. As mentioned earlier, little is known of the productivity of this prolific grass. The habitat type usually supports a diverse insect fauna, and swallows are often associated with these areas. Some evidence of muskrats has also been noted, but their use of the habitat type is not known. Sometimes these grasslands are used as pasture, thus minimizing their wildlife habitat value.

65. The exception to the above discussion of non-persistent seasonally flooded wetlands is the approximately 350 acres of crops managed by the Washington Department of Game. Each fall these grain

fields are flooded to provide feeding and resting habitat for migra-ing ting waterfowl.

66. Non-persistent, temporarily flooded, emergent wetlands are primarily grazing lands, and therefore provide little primary production or wildlife habitat to the river ecosystem. Some detrital material does enter the river from these communities during times of flood waters.

67. The only non-persistent tidal emergent wetlands noted in the study area is also heavily grazed. As mentioned above, grazing usually limits both the primary productivity and the wildlife habitat value of a wetland.

68. Broad-leaved deciduous, tidal, scrub/shrub wetlands are extremely diverse and dense communities of shrub vegetation. There are no known productivity studies of these wetlands; however, Eilers (1975) has estimated the productivity of a similar, though less diverse, habitat at approximately 1,700 $g/m^2/yr$. Peat formation in similar wetlands in the Snohomish River, suggests that much of this primary productivity remains on site rather than being exported as detritus.

69. Shrub/scrub wetlands provide important nesting and feeding habitats for song birds and small rodents. These in turn are preyed upon by raptors and carnivorous mammals.

70. Broad-leaved deciduous, seasonally flooded, shrub/scrub wetlands are similar to the previous wetland, although usually not as diverse. These wetlands do not appear to develop the highly organic substrate common in their tidal counterparts, suggesting that perhaps a greater amount of production is exported during seasonal floods.

71. The shrub/scrub wetlands are extensive, but widely scattered along the river's edge. In this riparian location they act as an important buffer between upland agricultural activities and the riverine ecosystem. They also provide nesting and feeding habitat for numerous species, many of which also use the adjacent areas. Song birds and rodents will nest in the wetland and feed in the pasture. Raptors, weasels and raccoons will do the same. Beaver feed on young Salix, while river otters prey on fish in the river and nest in shrub/scrub or forested wetlands.

72. Broad-leaved deciduous, intermittantly flooded, forested wetlands might be best described as riparian woodlands. As such they provide nesting and feeding habitats similar to that described for the shrub/scrub wetlands. In addition, the tall trees are important nesting sites for raptors. Where large forested wetlands are found, such as on Hart Island, deer may also be an important inhabitant.

Table 2

FUNCTIONAL CHARACTERISTICS
OF SKAGIT RIVER WETLANDS

	Habitat Type	NWI Designation	Productivity	Vegetation Density	Plant and Animal Diversity	Threatened/ Endangered Species	Hydrologic Periodicity	Location	Areal Extent	Ecological Importance	Storm and Floodwater Storage
ESTUARINE	Regularly flooded unvegetated flats	E2F12	Med.				High	X	X	X	
	Regularly flooded persistent emergent	E2em5(N3)	Med.	X			High	X	X	X	
	Regularly flooded non-persistent emergent	E2em3(N3)	High	X	X		High	X	X	X	
	Irregularly flooded non-persistent emergent	E2em3(P3)	High	X	X		Med.		X		
	Irregularly flooded persistent emergent	E2em5(P3)	High	X			Med.		X	X	
RIVE	Non-persistent tidal emergent	Rlem3(NØ)	Med.	X			High				
	Persistent tidal emergent	Rlem5(PØ)	High	X			Med.			X	
PALUSTRINE	Permanent open water	Pow(HØ)	Low		X			X		X	X
	Floating leaved aquatic bed	Pab4(HØ)	Low		X			X		X	X
	Persistent, semi-permanently flooded emergent	Pem5(FØ)	High	X				X		X	X
	Non-persistent, seasonally flooded emergent	Pem3(CØ)	Med.	X							X
	Non-persistent temporarily flooded emergent (farms)	Pem3(AØf)	Low								X
	Non-persistent, tidal emergent	Pem3(RØf)	Low				Med.				
	Broad-leaved deciduous tidal scrub/shrub	Pssl(RØ)	High	X	X		Med.			X	
	Broad-leaved deciduous seasonally flooded scrub/shrub	Pssl(CØ)	High	X	X				X	X	X
	Broad-leaved deciduous intermittantly flooded forest	Pfol(JØ)	High	X					X	X	X

Major Wetland Areas

73. To this point the discussion has focused on the individual wetland types and their functional characteristics without regard to their distribution within the study area. Several major wetland areas have been identified within the overall project area. These are:

- Skagit Flats
- South Fork Skagit River Delta
- Fir Island and Upriver Cutoff Sloughs
- Hart Island
- DeBays Slough
- Skagit River

Each of these areas will be discussed here individually as a part of the overall lower Skagit River ecosystem.

Skagit Flats

74. Skagit Flats is a broad expanse of wetland habitats extending from the mouth of the north fork to the mouth of the south fork near Stanwood. The flats extend from the dike on Fir Island to the east side of the Skagit Bay channel. From the dike there are several zones of vegetated wetland averaging 2,000-3,000 feet in width. Bayward of this is about 10,000 feet of unvegetated intertidal flats.

75. The Flats are an extremely important resting and wintering area along the Pacific flyway (WDG, 1978). In particular, large populations of Snow Geese winter here every year, grazing on the roots and culms of Scirpus americanus. A wide variety of waterfowl, including mallard, pintail, widgeon and teal feed on Carex lyngbyei and Scirpus maritimus. Bald eagles, roosting on nearby islands, feed on returning salmon which must navigate the flats to reach the Skagit River (Jeffrey, et al., 1977). Harbor seals haul out on the flats at low tide, and probably also feed on the migrating salmon.

76. Skagit Flats is thus a large and diverse habitat which provides important feeding, breeding and resting areas for a wide variety of wildlife. This is due in part to its size, its diversity of habitat types, and its undisturbed character.

South Fork Skagit River Delta

77. At the mouth of the Skagit River south fork is a delta consisting of about islands, separated by different slouths. The delta totals approximately 3,000 acres of forested and emergent wetlands, open and closed sloughs and agricultural land. Most of the agricultural land belongs to the Washington Department of Game, and is managed to encourage waterfowl usage. Cereal crops are planted and then the fields are flooded through the winter, thus providing food and resting area for migrating waterfowl. In the summer, water-

fowl prefer to nest adjacent to the quiet water of closed sloughs, rather than the moving river waters (R. Jeffrey, personal communication).

78. Open river channels are important routes for salmon migrating upriver. Equally important is the use of these sloughs by seaward migrating juvenile salmon. Forested wetlands overhanging the slough edges provide shape and protection from predation for the young salmon. These fry also feed extensively on insects in the emergent wetlands at the mouths of the delta (J. Congleton, personal communication).

79. Scrub/shrub and forested wetland habitat types along the sloughs and in the upper end of the delta provide valuable feeding and nesting areas for large mammals and furbearers. Deer, raccoon, muskrat, beaver, otter, and weasel have all been noted in delta wetlands. Many of these require both the wooded areas and the river to survive.

80. The south fork Skagit delta consists of a variety of freshwater tidal wetland types which are exploited by a variety of fish, waterfowl, and mammals. Woodlands adjacent to both marsh and river result in numerous transition zones which are advantageous to many species.

Fir Island and Upriver Cutoff Sloughs

81. Fir Island, located between the north and south forks of the Skagit River, is bisected by several sloughs which no longer carry running water except in times of flood. Upriver are several similar areas, in particular Britt and Gages Sloughs. Each slough is a complex pattern of open water ponds, Phalaris dominated dry beds, and wooded channels. These various units are connected by culverts beneath roads and driveways which are often too high to allow year-round water flow.

82. Open water ponds may vary from one to several acres, and often have aquatic beds and Typha stands around the edges, with scrub/shrub and forested wetlands surrounding the area. Secluded and often surrounded by agricultural lands these ponds are almost self-contained ecosystems. Waterfowl are common, feeding on shallow vegetation and aquatic insects, and nesting in the scrub/shrub along the shores. Herons and kingfishers may visit to feed on small fish. Raptors, weasels and mink will nest in the forested wetlands and feed on rodents from the pond ecosystem or from adjacent fields.

83. Phalaris dominated dry slough beds often support large populations of rodents or small song birds. These small animals may become prey to raptors or weasels, especially if there is a nearby scrub/shrub or foreseted area to support these predators. Along some portions of slough channels the substrate is nearly saturated

but rarely inundated. Small groves of scrub/shrub Salix are common here, supporting small populations of rodents, weasels, raccoons and small birds.

84. Pond ecosystems along cutoff sloughs are important habitats to the large populations of waterfowl located in the lower Skagit Basin. These systems are often extremely diverse and provide food and shelter for numerous birds and mammals. The slough channels are also important for draining adjacent uplands during flood conditions.

Hart Island

85. Hart Island is a large (1,126 acres), heavily wooded oxbow island which was probably cut off from the river long ago. This dense forest of Salix and Populus is interrupted only by a few small, wet patches of Phalaris. It probably houses extensive populations of deer, raccoon, mink, weasel, muskrat, coyote, and rodents. Song birds are prolific on the island as are insects. Although not a diverse habitat, this large uninterrupted unit of forested wetland is nonetheless an important habitat to upland game mammals and furbearers.

86. DeBays Slough is a combination of open water, emergent wetlands and surrounding forested wetland. The open water and emergent wetlands cover approximately 80 acres, and are surrounded by about 232 acres of forested woodland.

87. As with other open water and emergent wetland sloughs this area is feeding and breeding habitat for waterfowl; small populations of mallards and widgeons have been noted here. Herons and trumpeter swans have also been reported feeding in this slough (Jeffrey, et al., 1977). Raptors, deer, and small mammals such as raccoon, weasel, and mink are probably common in the adjacent forested wetland.

Skagit River

88. The Skagit is a major river basin in the Puget Sound region. In the study area it is the link between all the wetlands described. It is an important salmon spawning river, waterfowl wintering ground and human recreation area. Bald eagles nesting in the upper reaches depend on migrating salmon for food. Juvenile salmon depend on emergent wetlands and productive mudflats at the river's mouth for feeding and shaded river banks for protection. Benthic invertebrates in the mudflats require detritus from nearby emergent wetlands. Waterfowl nest in cutoff sloughs, but feed in tidal wetlands along Skagit Flats. Visiting harbor seals and Snow Geese depend on food sources available in the estuary and along the flats. All the wetland types interrelate and the river is the connecting link. In any evaluation or comparison of habitat value, this interconnection must be considered.

SUMMARY

Wetlands within the Skagit River study area encompass approximately acres (not including unvegetated flats or riverine and estuarine open water). These may be divided as follows: acres estuarine, riverine, and palustrine. A detailed breakout of areal extent is included in Table 1.

In addition to areal extent, each wetland type has been described in terms of the functional characteristics elucidated in 33 CFR 320.4. Table 2 summarizes the functional characteristics of the various wetland types. Analysis of this matrix allows an evaluation of the habitat values of the various wetland types.

With the evaluation of the wetland habitat types, it is possible to identify them as wetland types of importance, wetland types of concern, or other wetlands. These designations are not meant to be absolute statements of the value of each wetland type, but rather an indication of their significance to the Skagit Basin. The habitats and their designations are:

Wetland Types of Importance

- Estuarine regularly flooded persistent emergent wetlands
- Estuarine regularly flooded non-persistent emergent wetlands
- Palustrine broad-leaved, deciduous, seasonally flooded scrub/shrub

Wetland Types of Concern

- Estuarine regularly flooded unvegetated flats
- Estuarine irregularly flooded non-persistent emergent wetlands
- Estuarine irregularly flooded persistent emergent wetlands
- Palustrine open water
- Palustrine floating leaved aquatic bed
- Palustrine semi-permanently flooded persistent emergent
- Palustrine broad-leaved deciduous tidal scrub/shrub
- Palustrine broad-leaved deciduous intermittantly flooded forest

Appendix A

NATIONAL WETLANDS INVENTORY

WETLANDS CLASSIFICATION SYSTEM

Appendix A

NATIONAL WETLANDS INVENTORY
WETLANDS CLASSIFICATION SYSTEM
(from Cowardin, et al., 1977)

System

Marine System-High energy, constant sea strength, halinity (30-40 ppt). Coasts with offshore island formations and "Bays without appreciable freshwater inflow" should be mapped as Marine if salinity and biota information indicate Marine conditions.

Estuarine System - Low energy, variable halinity influenced and often semi-enclosed by land system. The system can thus extend off shore to seaward limit of occasionally diluted seawater (30 ppt). In absence of halinity data, an alternating dashed and dotted line should be drawn across mouth of a bay, river or sound. The primary data to be used in identifying Estuarine Systems is the halinity and the plant and animal communities inhabiting the areas. Lagoons which are hyperhaline are also included in Estuarine System.

If mouth of an Estuarine River has been extended into the Marine System by parallel breakwaters, the seaward limit of breakwaters forms the Estuarine-Marine break.

The seaward limit of the Estuarine System is defined by limit of wetland emergents, shrubs or trees.

The landward limit of Estuarine System extends inland to limit of ocean derived halinity (0.5 ppt) at average annual low flow of diluting stream or river. It is, thus, the maximum annual intrusion of haline water.

Riverine System - Contained in natural or artificial channel periodically or continuously containing flowing water. The channel bank is the active bank exposed above the average annual high water flow. Paustrine emergents, trees, shrubs, lacustrine areas, or upland landforms may be included within the Riverine System.

Where a river enters a lake, the extension of the Lacustrine shoreline across the mouth of the river forms the Riverine - Lacustrine Division.

Oxbow lakes are places in Palustrine or in Lacustrine System unless they are connected to a Riverine System by an open channel. Water bodies (lakes) in a river floodplain which

annually contain flowing water as a result of flooding from the adjacent river are considered to be in Riverine System. Some water bodies may have flowing water for a portion of the year, but may still be considered to be Lacustrine if they better fit the criteria for a lake system. All channels connecting two Lacustrine bodies of standing water are Riverine.

Lacustrine System - Natural or artificial basin or catchment containing non-flowing water, lacking persistent emergents, trees, and shrubs with aerial coverage greater than 30% and greater than 20 acres in size. Basins or catchments less than 20 acres in size are included if a wave formed or bedrock feature forms all or part of shorline boundary or if average water depth in deepest part of basin is greater than 2m. Lacustrine System formed by damning a river channel is mapped according to the contour approximating normal spillway elevation or normal or summer pool elevation if wide pool fluctuations do not occur. This corresponds with USGS Mapping conventions for producing 1:24,000 scale topographic maps. Navigation canals and rivers with dams and associated locks are considered lakes upstream to elevation of water surface at dam. Oxbow lakes are placed in Lacustrine or Palustrine System if they appear to be cut off from river and, thus, do not on an annual basis contain flowing water. In the typical situation where a river enters a lake through a constricted, well defined opening into a much wider lake, the extension of the lake shoreline across the river

mouth forms the Lacustrine-River boundary. The lakeward extent of a delta and its associated chennels exposed at average annual low water is included in the Lacustrine System.

Palustrine - Includes all wetlands which are non tidal or if tidal, where salinity due to ocean-derived salts is less than 0.5 ppt. and are dominated by trees, shrubs, persistent emergents, and nonaquatic mosses or lichens. Wetlands lacking such vegetation are also included if they:

1) are less than 8 hectares (20 acres)
2) do not have an active wave formed or bedrock shoreline feature;
3) have at low water a depth less than 2m. in deepest part of basin;
4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

A wetland smaller than 20 acres created behind a dam or a stream is by convention Palustrine unless a wave formed or bedrock shoreline feature can be seen.

Subsystem

Marine and Estuarine.

Subtidal - Continuously submerged substrate, thus, below extreme low spring water. The division between intertidal and subtidal should be made by reference to NOS charts or, as a

last resort, the tide stage at the instant of photography. The subtidal portions are found by subtracting the correct amount from mean low water to calculate extreme low water of the subtidal boundary.

Intertidal - This defined as the area from extreme low spring water to extreme high spring water and associated splash zone. The NOS charts display the Intertidal zone (from mean low to mean high) by a light green coloration. The intertidal zone delineated on photo overlays will thus contain the green colored intertidal areas of NOS charts plus area included to extreme low water as that depth is subtracted from mean low water line. The upland limit of intertidal zone is drawn based upon maximum extent of salt tolerant vegetation or surrounding shoreline features.

Riverine

Tidal - This reach of river extends from upper boundary of Estaurine System to extreme upper limit of tidal fluctuation. The tidal reach terminates downstream where the concentration of ocean-derived slats in water exceeds o.5 ppt during period of annual average low flow.

Lower Perennial - This reach contains permanent slow flowing water, low gradient, stream bed consists of sand, silt, and clay, oxygen deficits may occur; and contains well developed flood plain.

Upper Perennial - This reach contains permanent, fast flowing water - the presence of rapids on the photos is often a good indicator of this reach. The bottom has a high gradient and is composed of rocks, cobbles, and gravel.

Intermittent - This reach contains channels that contain water only part of the year, but may contain isolated permanent pools when the flow stops. This reach thus applies to tidal fresh streambeds (creeks) which flow only part of the year. Intermittent streams are only delineated if streambed and/or surrounding shoreline maintains enough moisture to support growth of hydrophytic vegetation of flows annually.

All streams containing flowing water at the instance of photography should be delineated where flowing water can be seen and is as wide as the penline on the photograph. The channel should be approximated from USGS TOPO quads when it is obscured by an overhanging canopy.

This means that an interpretor should make the greatest attempt to connect disjunct sections of riverine channel so that a unified stream system id delineated. The obscured channel of a riverine system should not be approximated beyond the last open stretch of water or streambed going upstream visible on the photography.

Lacustrine

Littoral - Extends from shoreward boundary to 2m. below annual low water or to maximum extent of non-persistent emergents. Water bodies less than 8 hectares (20 acres) in size are considered to be in the Palustrine system unless detailed depth information is available or an active wave formed or bedrock shoreline forms all or part of the boundary. Individual water bodies and their associated shorelines (such as flats) will have to total 20 acres of potentially contiguous water area to be typed as Lacustrine. Dense aquatic beds of submergent vegetation are considered to be in littoral subsystem unless detailed depth information is available.

Limnetic- Includes all deep-water habitats within Lacustrine System. All water bodies greater than 8 hectares (20 acres) in size should be considered to be in limnetic subsystem unless detailed depth information is available.

Class

Classes can be mixed on the photo overlay. The first (major) coverage shown will be the tallest layer of vegetation having 30% or more aerial canopy coverage. The second layer of vegetation identified will be a lower level of vegetation, water or upland, which comprises at least 30% or more of area mapped unit. Mixed classes are separated by a slash, eg. PEM/OW.

Vegetated - The aerial canopy coverage of vegetation must be at least 30% of the unit delineated.

Dominance - Classes are distinguished on basis of vegetative life-form which constitutes the upper most layer of vegetation and possesses an aerial coverage greater than 30% of the unit delineated

Vegetated classes should take precedence over unvegetated classes if a choice has to be made, as especially in linear wetlands. Thus, a narrow emergent wetland should be mapped rather than the stream which flows through the emergents.

Open Water/Unknown Bottom - This class was created to allow the mapping of all nonvegetated water areas visible on the photos where the permanence of water and of substrate is unknown. Open water bodies greater than 8 hectares (20 acres) in size are considered to be in Lacustrine limnetic subsystem unless detailed collateral data exists. Open water bodies less than 8 hectares in size are considered to be Palustrine unless they meet criteria detailed under the Lacustrine System.

Rock and Unconsolidated Bottom - Includes all deep-water (subtidal) habitats and all wetlands and deep-water habitats in non-saline inland areas with permanently flooded, intermitently exposed, and semi-permanently flooded water regimes which have rock substrates. These classes are used only when detailed collateral data is available on bottom composition.

Aquatic Bed - Represents wetlands and deepwater habitats dominated by submergents, floating-leaved, or floating plants for the majority of the growing season in most years. Aquatic beds are considered to be in water less than 2m. deep and are thus placed in littoral subsystem (if in a Lacustrine System) unless detailed depth information is available.

Reef - Ridge or mound elevated above the substrate which interferes with normal wave flow found in wetland and deep-water habitats and formed by the colorization and growth of sedentary invertebrates. This class is only used when supported by detailed collateral data.

Flat - Irregularly shaped, nearly level unconsolidated sediments sheltered from strong currents and wave action. A dendritic drainage pattern is often present on flat if it is exposed.

Streambed - This class refers to intertidal or seasonally flooded or drier portions of the Riverine and Estuarine System. The class specifically refers to tidal creeks that are dewatered at low tide and the channel of streams which periodically dry up during the course of a year. The streambed class can also be used in the Estuarine and Riverine System as a generalized lumper if a shoreline feature is seen on the photography and is not clearly definable as a flat or a beach/bar. The class also allows a field or photo observer to classify an exposed shoreline which is a complex of flat, beach/bar, and rocky shore and is either too small too confusing to separate into its individual entities.

Rocky Shore - High energy shoreline where stable bedrock or large rock fragments lie exposed as a result of erosion are not moved by wave action.

Beach/Bar - Consists of unvegetated and sloping landforms generated by waves and currents and composed predominately of coarse unconsolidated substrates. Beaches are generally continuous with the shore and extend landward to toe of foredune, cliff or bank. Bars are elongate ridges, banks, or mounds bordered by water on at least two sides.

Moss/Lichen - Areas where mosses or lichens cover the substatee. This class will probably only be delineated based upon detailed field or collateral data.

Emergent - Characterized by erect, rooted, herbaceous hydrophytes. All emergents visible on photos will be considered to be perisstent emergents and thus mapped as Palustrine unless field or detailed collateral information is available. Prostrate mats or clumps of grass-like vegetation or emergents simply overtopped by spring flood waters should be typed as persistent emergents. Non-persistent emergents are dominated (greater than 50%) by emergent plants which are killed by frost and essentially dissolve so that there is no trace of the vegetation by the beginning of the next growing season.

Scrub/Shrub - Woody vegetation less than 6m. (20 ft.) tall.

Dead - Aerial canopy coverage is determined from the extent of area covered by dead branches.

Forested - Woody vegetation greater than 6m. (20 ft.) tall.

Appendix B

FUNCTIONAL CHARACTERISTICS OF WETLANDS

Appendix B

FUNCTIONAL CHARACTERISTICS OF WETLANDS

(from Snohomish Estuary Wetlands Study,
U.S. Army Corps of Engineers, 1978)

A. Natural Biological Functions

1a) Primary Productivity. Wetlands which have high natural rates of net primary productivity are considered highly valuable. This net primary productivity is the basic energy source for the entire food web in the estuary. Areas with high rates of productivity can support large and diverse populations of organisms. Highly productive areas include algal beds, salt marshes, brackish/freshwater marshes and swamps. This criterion should not be used alone, however. It is still a qualitative measure in the Snohomish estuary since no productivity measurements are available for the study area. The estimated level of aquatic interaction (see below) should be considered along with estimated net productivity. The combination of the two better describes the potential for a given area to be a source of energy for the major food webs in the estuary.

1b) Secondary Productivity. Aquatic lands with dense populations of benthic organisms have high secondary productivity. Benthic fauna store energy extracted from detritus, thus reintroducing it to the food chain.

2) Vegetation Density. Dense vegetation provides protective cover for a wide variety of animals. This is particularly important to small mammals, molting waterfowl, or other relatively defenseless animals. Dense vegetation also functions to slow water flow through the area, thus enhancing sedimentation of suspended solids and their associated nutrients and pollutants. Cattail, bulrush and mixed cattail/bulrush marshes are prime examples of dense vegetation.

3) Plant and Animal Diversity. The more diverse plant communities tend to support more diverse animal communities. More diverse animal communities in turn exploit the available energy resources more efficiently. Thus, in areas with more diverse animal populations, less of the energy stored as plant ma-

terial is lost. In addition, diverse populations are considered to be more resistant to changes in environmental conditions. Elimination of a single species does not result in the collapse of the community. Finally, the presence of diverse populations within a single trophic level results in interspecific competition and co-evolution, thus strengthening the genetic character of the species involved (Ricklefs, 1973).

4) Threatened or Endangered Animal Species Habitats. Wetlands where there have been observations of a threatened or endangered or otherwise rare or unique animal species are considered important. Habitats containing locally vanishing or restricted species are also included here.

B. Natural Physical Functions

a. Ecosystem Support

This criterion refers to those areas the destruction or alteration of which would detrimentally affect natural drainage characteristics, sedimentation patterns, saninity distribution, flushing characteristics, current patterns or other environmental characteristics. For example, filling the mudflats in front of Maulsby Swamp might severely impact the flushing and hydraulic characteristics of that area.

1) Hydrologic Periodicity. The frequency and duration of inundation due to tides, river flow or runoff is a measure of the interaction between habitat types within an ecosystem. Subtidal algal and eelgrass habitat types exhibit continuous inundation, and therefore very high interaction with adjacent aquatic areas. Salt marshes and intertidal brackish/freshwater marshes and swamps are usually inundated twice daily providing high aquatic interaction. Non-tidal marshes and swamps such as those behind dikes are inundated only by flooding and therefore have lower aquatic interaction with the estuarine ecosystem.

2) Location or Elevation. The location of a habitat is an important part of its contribution to the ecosystem. Proximity to the open water system is important when evaluating aquatic interaction. In addition, a wetland which is adjacent to other wetland areas contributes to a larger and more diverse wetland habitat.

Isolated habitats, surrounded by urban or agricultural areas, may not contribute as much to the total estuarine ecosystem, although they may be productive units in themselves. Elevation of a wetland is important in evaluating the extent of the aquatic interaction between the wetland and the open water ecosystem. Hydrologic linkages deteriorate as the depth of flooding decreases.

3) Areal Extent. The size value of an area can be very important either by itself or in combination with contiguous related areas. A large unit provides cover and protection for wildlife. It may also provide a functionally intact system, relatively free from outside disturbances. A large unit made up of a variety of habitat types provides a diverse habitat. The shape of a habitat can also be very important in increasing the wildlife value of an area. For example, swamps and riparian habitats possess high wildlife values in different configurations. A swamp serves identical productivity functions whether it be compact or linear. However, wildlife values to swamp species are greatly enhanced by a compact shape. The protection and security provided by the interior of a swamp are necessary for the survival of many animals which are very wary of, or cannot tolerate, human activity. In contrast, a riparian woodland has more value in a linear shape. The vegetation functions to support wildlife, provide shade for the stream or slough (maintenance of cool water temperature is important to fish habitat), provide a source of primary production to stream detritus feeders (through vegetation falling into the stream followed by decomposition), and provide habitat for insects, many of which become food for fish, or small birds. Also, dense stream or dike bank vegetation provides erosion protection.

4) Ecological Importance. This criterion refers to the characteristics of an area that make it valuable for resting, breeding or feeding. The characteristics required for each species are different, and include specialized nesting or spawning sites, security from predators, availability of nest sites and materials, and food sources. As knowledge of individual species requirements is refined, this criterion will become more valuable. For example, the use of the wetlands by browsing and foraging herbivores is well known. Also, the spawning and nesting of some spe-

cies are known to occur in the estuary, and identification and protection of these specific habitats is important to maintain the populations.

b. Physical Protection

Wetlands included here are those that are significant in shielding other areas from wave action, erosion, or storm damage. Good examples are Jetty Island and the Tulalip spit.

c. Storm and Floodwater Storage

Wetlands are valuable if they are able to store storm or floodwaters and thereby protect upland areas from erosion and safe private property from destruction. This function is particularly critical for major floods such as occur in the Snohomish Basin every few years.

d. Natural Groundwater Recharge

Wetlands which serve as prime groundwater recharge areas are important. These areas help maintain the general groundwater table. There are no major groundwater recharge areas in the Snohomish estuary.

e. Water Filtration and Purification

Wetlands included here are those that serve to purify water through natural filtration processes. Suspended solids and associated contaminants are trapped in wetland sediments and may be released slowly through incorporation by wetland organisms. Recent studies have indicated that particular plant species and communities have the ability to concentrate or decompose contaminants, such as excess nitrogen and phosphorus compounds, heavy metals, and various hydrocarbons. For example, the cattail (Typha latifolia) has been shown to concentrate nitrogen, phosphorus and manganese by removing them from the sediment (Lee, et al, 1976). The wetland plant community thus incorporates free nutrients and releases them slowly as detritus.