AN ABSTRACT OF THE THESIS OF

John L. Marshall for the degree of Master of Science in Geography presented on October 31, 1985. Title: Value Assessment of Jackson-Frazier Wetland, Benton County Oregon: A Case Study

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A growing realization that wetlands are potentially valuable resources has recently stimulated efforts towards their protection. While a foundation for wetland management exists, decision makers still lack adequate tools for addressing issues of wetland preservation vs. development. Wetland preservation values are often neglected in traditional market analyses and in the decision making process. This research uses a wetlands assessment methodology that addresses non-market wetland values in the Willamette Valley, Oregon.

The Jackson-Frazier Wetland, north of the Corvallis city limits, is used as a case study for assessment. The Larson Model, a tested assessment model for eastern Massachusetts wetlands, is applied to the Jackson-Frazier Wetland. The model is modified to increase its reproducibility in wetlands classification, accommodate regional differences in the study area, and account for recent information on

wetland classification and value assessment.

The Jackson-Frazier Wetland qualifies as a high priority site for further assessment under four of eleven criteria: 1. rare plants, 2. visually prominent plants, 3. availability of information, and 4. rare habitat types. The wetland received an adjusted wildlife habitat score of 89 percent (good to excellent) and an adjusted visual-cultural score of 66 percent (moderately good). The wildlife habitat score reflects a complex habitat mosaic spread over a sizable area supporting a diverse and relatively abundant fauna. The visual-cultural score reflects a visually complex landscape dominated by vegetation. The diversity of wetland types, the complex interspersion of wetland classes and subclasses, and the proximity of the wetland to educational institutions combine to offer a variety of visual, educational, and passive recreational opportunities. However, the lack of navigable water bodies, the lack of nearby visually prominent landforms, urban noise, and urban encroachment limit the number and quality of visual-cultural opportunities.

The wetland was assessed for its downstream flood mitigation capability under two models with two respective adjusted flood mitigation scores of 96% and 69%. The second score is judged to be more consistent with findings of the Corvallis Drainage Master Plan suggesting the Jackson-Frazier site mitigates floods associated with "common" storm events (e.g., 12% return frequency). Neither flood assessment addresses flooding from the Willamette River during a

100 year flood. In a separate economic analysis, publicly acquired nonwetland wildlife habitat and visual-cultural areas are used as gauge sites to provide a minimum monetary estimate of preservation values of the Jackson-Frazier Wetland. The derived figure of $ 2,022/acre is compared with several appraised market values of the wetland using preservation value/alternative use value ratios. Ratios greater than one indicate preservation values are greater than alternative use values. Borderline ratios are weighted towards preservation values due to the non-wetland character of the gauge sites.

The greatest utility of the applied model is to display traditionally intangible wetland preservation values. This display of values should be considered by resource managers and decision makers in conjunction with a variety of other decision making tools. The validity of a given assessment is directly related to the assumptions and subsequent criteria used. Perceptions of validity are highly influenced by the degree of societal acceptance and use.

Value Assessment of Jackson-Frazier Wetland, Benton County, Oregon: A Case Study

by

John L. Marshall

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Cont.)

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VALUE ASSESSMENT OF JACKSON-FRAZIER WETLAND, BENTON COUNTY, OREGON: A CASE STUDY

Introduction

Since 1955, concepts of wetlands in the United States have changed dramatically. Prior to 1950, wholesale destruction and subsequent development of millions of acres of wetlands occurred under the belief that wetlands were essentially worthless (Shaw and Fredine 1956). The realization that wetlands are potentially valuable resources has recently spurred efforts towards their preservation. Several federal laws, enacted in the 1960's and early 1970's, serve to formalize a legal basis for efficacious management of natural resource areas such as wetlands, e.g., the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, and Section 404 of the 1972 Water Pollution Control Act (amended in 1977 and now called the Clean Water Act). These legislative tools were joined by a number of administrative directives and recently passed state laws to set the foundation for informed wetland management (McCormick 1978).

Review of Wetland Politics

Section 404 of the 1977 Clean Water Act is perhaps one of the most important legislative actions related to wetlands. While the original intent of the Act was to regulate water quality in navigable waters, a subsequent broader interpretation has been made by the courts to include all waters of the United States (U.S. Congress, Office of Technology Assessment 1984).

The federal agency with jurisdiction over Section 404 is the U.S. Army Corps of Engineers, which in 1982, set regulations that defined permit jurisdiction under Section 404 to include:

> all navigable waters, tributaries to navigable waters, and wetlands adjacent to navigable waters including lakes and any other waters of the United States.

During the permit review process, the Corps sends all permit applications to relevant state and federal agencies, private individuals, and other interested parties. This is part of a public review to determine if permit issuance is in the best public interest. The Corps must also determine that discharge complies with U.S. Environmental Protection Agency (EPA) guidelines stipulated in Section 404 (b) (1) of the Clean Water Act. Additional comment is solicited from federal and state fish and wildlife agencies to comply with stipulations of the Fish and Wildlife Coordination Act (Shipley 1974). The Corps must also obtain a water quality certification statement from the state water quality management agency and, if the permit application is from a coastal area, an approval from the coastal zone management agency (Blumm 1978).

In 1967, the State of Oregon established the Division of State Lands (DSL). The DSL has a close working relationship with the Corps of Engineers regarding the review of permit applications for projects that have potential impacts on Oregon's waters. As a state agency, the DSL serves as a liaison between the Corps and other state and local agencies in matters concerning removal and fill operations. The DSL circulates federal permit applications for state and local agency review and consolidates the state's comments in a letter from the Governor to the District Engineer.

In addition to its role in the 404 permit process, the DSL is responsible for permit approval for dredge and fill operations at the state level. While Oregon's removal-fill law emerged from a concern for anadromous fisheries in 1967, it has since been expanded to deal with estuarine resource issues, navigation, and public recreation. In 1981, Oregon's removal-fill law was amended to stipulate mitigation requirements for lost habitats due to dredge and fill operations. In 1984, the DSL adopted new rules expanding their authority beyond nonforested wetlands.

The Director of the DSL is required to provide the local planning departments with applications for fill and removal for areas within their respective jurisdictions. The planning department must then determine whether the proposed activity is compatible with the local comprehensive plan and ordinances (including floodplain regulations). Under state compliance and compatibility rules (OAR 660-31-005 to 660-31-040), the DSL is also required to be in compliance with the Statewide Planning Goals. However, the Director of the DSL may issue a permit which conflicts with the statewide planning goals if "findings" substantially support permit issuance (Zajonc 1984).

Wetland management in the state of Oregon is directly linked to the statewide land use planning program. The agency responsible for overseeing this program is the Land Conservation and Development Commission (LCDC).

Under the authority of LCDC, each county and municipality in Oregon is required to develop comprehensive plans regarding future development in their jurisdiction. The LCDC has adopted 19 statewide planning goals regarding land use in Oregon. County and municipal comprehensive plans are required to comply with each of these goals (Oregon LCDC 1975).

Wetland management issues, outside of the coastal zone, are addressed under Statewide Planning Goal 5: "To conserve open space and protect natural and scenic resources". Under Goal 5 and the administrative rule governing the goal (OAR-660-16-et seq.), wetlands and other resources must be inventoried with respect to their location, quality, and quantity. The inventory is completed at the local level. Inventory data is collected from as many sources as possible, i.e., experts in the field, local citizens, land owners, etc.

Conflicting uses must also be identified for inventoried nonprotected resources. If no conflicting uses are identified for a particular resource, it is managed to preserve its original character. However, if conflicting uses are identified, the local planning jurisdiction must develop a document determining the economic, social, environmental, and energy (ESEE) consequences of the conflicting uses

(Appendix A). The ESEE analysis is used to develop a planning program to achieve the goal (Oregon LCDC 1975).

Research Problem and Goals

While a framework for wetland identification and protection has been established in Oregon, local resource planners and decision makers still lack sufficient knowledge and specific tools to adequately address issues of wetland preservation vs. development. These tools are critical for wetland issues prevalent in the densely populated Willamette Valley. Reconstructions of Willamette Valley vegetation coincident with early settlement (Habeck 1961 and Johannessen 1971) indicate a substantial area of seasonally wet prairie. Conservative estimates of a once common residual wet prairie grass (tufted hairgrass) community in the Valley (Baker 1981) indicate that about 200 acres (80 hectares) of an estimated 125,000 acres (50,600 hectares) remains. Much of this is in fragmented parcels. Frenkel (1985) estimates approximately 1000 acres (400 hectares) of wet prairie currently exists in the Willamette Valley in parcels greater than 10 acres (4 hectares).

Often decisions on wetlands focus on the potential benefits society accrues through their development, i.e., housing, jobs, etc. Amenity values tend to be overshadowed during considerations of more traditional utilitarian benefits. This research proposes to present resource planners and decision makers with a tool for dealing with the disparity between wetland development and wetland preservation considerations. A case study of the Jackson-Frazier Wetland will illustrate the use of this tool.

Specific goals of my research are to:

- Review pertinent wetland evaluation methods.
- Select a model for wetland evaluation to be applied to the Jackson-Frazier Wetland.
- Implement a case study to assess the wetland values of the Jackson-Frazier Wetland.
- Apply an economic model to assess the preservation value of the Jackson-Frazier Wetland.

Wetland Value Assessment Models

Development of wetland value assessment methods began in the mid to late 1970's. In 1981, the Water Resource Council (WRC) published a review of prior methods for assessment of wetland values. The review was conducted by a research team at the Environmental Laboratory of the U.S. Army Engineer Waterways Experiment Station (WES) in Vicksburg, Mississippi. The WES review analyzed the effectiveness of a variety of techniques for assessing wetland values. A general consensus was that each methodology had its merits and limitations and that resource planners should choose the method most suitable to his or her particular objectives. It also pointed out that wetland assessment models were best developed for wildlife habitat functions. Methods for addressing hydrologic functions were regarded as poorly developed. The WES study team recommended that research programs in this area be given high priority (Lonard 1981).

The WES assessment was stimulated by mandates assigned to the WRC Floodplain Management Task Force. These mandates included: overseeing recommendations of a report entitled, "A United National Program for Floodplain Management"; implementing the Council's responsibilities under Section 5 of the Floodplain Management Executive Order (E.O. 11988); and improving coordination and integration of wetland and floodplain management. The latter mandate was most responsible for the analysis and comparison of wetland assessment methodologies by the WES research team (Lonard 1981).

The study was organized into five tasks: identification of methods currently used or under development to assess wetland functional values; preparation of criteria for a comprehensive analysis of selected assessment methods; examination of the merits and limitations of each method and to select methods that warrant detailed study; identification of specific areas where methods are lacking or are of limited use for assessment of functional values; and preparation of recommendations for the improvement of constancy of wetland assessment methods.

Forty-two documents were identified and evaluated by the WES research team. The research team used a screening process eliminating all but 20 of the 42 documents. A series of tables listing the components of each selected method are listed in Appendix B.

The most recent wetland assessment method is in an unpublished technical report prepared in 1982 for the Federal Highway Administration (FHWA) entitled "A Method for Wetland Functional Assessment" by Paul R. Adamus and L.T. Stockwell. In the two volume report, Volume I provides a critical review of wetland functions and wetland assessment concepts; Volume II presents a wetland assessment method (Adamus and Stockwell 1983, Adamus 1983). Much of Adamus and Stockwell's report was based on the WES analysis of methodologies for assessing wetland values. A major goal of the document was to improve the state of the art of wetland assessment methods.

Definition and Philosophy of Models

A wetland assessment model, as defined in this paper, is a method that assesses functional wetland values and serves as an example for emulation. The evaluating criteria used in the models discussed here are based on assumptions founded in the phenomenological school of thought. That is, "resources are not; they become" based on societies perceptions of the social, political, economic, technological, and environmental milieu (Mitchell 1979). It is very difficult to develop a model representing the values and subsequent perceptions of a pluralistic society. The authors of models reviewed here have simplified the problem by addressing a particular segment of society. This segment is characterized by people who value wetlands in their unaltered state. Recognition of this fact becomes important in a practical sense when the models are applied to wetlands and when resource managers and decision makers evaluate the conclusions derived from their application. Any conscientious use or critical review of these models should recognize that there is a decided bias towards wetland preservation in the fundamental assumptions and subsequent conclusions.

Rationale for Use of Models

The question ultimately arises, why use assessment models? Traditionally, land use decisions in the United States primarily have been based on market criteria. These criteria, under neoclassical economic theory, reflect a marriage between utilitarianism and human preferences as motivators in economic behavior (Victor 1979). Land values can be defined under this system using four economic factors (American Institute of Real Estate Appraisers 1983):

- Utility - the ability of a parcel of land to satisfy a human desire.
- Scarcity - the present or anticipated supply of a given type of land in relation to the demand for it.
- Desire - human wants beyond basic life support needs.
- Effective Purchasing Power - the ability of individuals or groups to participate in the market transactions relevant to a given parcel of land.

The market system strives to achieve "efficiency" in allocation of land resources. An "efficient" land transaction would allow consumer demands to be satisfied with the lowest possible cost to society. Efficiency also means that land resources are being drawn towards their highest and best use (as measured by consumer willingness to pay) through the market system. An optimum efficiency, under neoclassical economic theory, would occur if no further exchanges could be made with a parcel of land in which at least one person would be made better off without leaving anyone else worse off. This optimum efficiency is known as Pareto Optimality (Huffman and Plantico 1979).

Economists, recognize that there are certain "costs" and "benefits" involved in resource management decisions that are characteristically intangible when measured by the market. These kinds of costs and benefits are called negative and positive externalities. Externalities are often inadvertent costs and benefits that accrue to individuals or groups in society as a result of activities designed to produce effects other than those inadvertently accrued. An example of two negative externalities would be the loss of wildlife habitat and scenic values due to a housing subdivision. The costs are inadvertent in the sense that the goal of the developer is not to eliminate scenery and wildlife habitat but to provide housing. The costs are intangible in the sense they are not readily measurable in monetary terms.

These kinds of externalities are often not adequately considered in issues requiring wetland preservation vs. development decisions. The models discussed here were designed to aid resource managers and decision makers in considering wetland wildlife habitat, scenic, cultural, and hydrologic values in their decision criteria. The models propose to do this by providing a framework for display of wetland values; both in monetary and nonmonetary terms.

Model Selection

A specific set of criteria was established for selecting a wetland assessment model to apply to the Jackson-Frazier Wetland:

o The model must provide a method to identify outstanding wetlands.

- o The model must provide a system for the relative ranking of wetlands.
- o The model must address intangible values associated with wetlands, i.e., wildlife habitat, scenic quality, and cultural values.
- o The methods used in the model must provide reproducible results by an independent value assessment of the same wetland.
- o The model must be useable by persons with a general background in resource management.
- o The model must be applicable to freshwater wetlands in the Willamette Valley, Oregon.
- o The data required to satisfy the model must be obtainable without extensive specialized research.

After reviewing the 20 models evaluated by the WES study team (summarized in Appendix B) and the Adamus and Stockwell report, the Larson Model (Larson 1976) was selected for application to the Jackson-Frazier Wetland. This decision was based on the criteria listed above.

The Larson Model

The development of the Larson Model was an interdisciplinary effort funded and supported by the United States Department of Interior, Office of Water Resources Research (Larson 1976). The interdisciplinary team included a number of scholars at the University of Massachusetts, Amherst. The model was applied to nine wetlands in Massachusetts. The Larson Model consists of four submodels within the infrastructure of a single, three level eliminative model (Figure 1). The first three submodels attempt a relative ranking of wetland wildlife habitat, visual-cultural values, and ground water potential (a case study of flood mitigation potential for wetlands in the Charles River Basin is included briefly in the third submodel). The fourth submodel attempts to convert the combined output of the first three submodels into a monetary value. This is done through an economic assessment that uses a "willingness to pay" approach.

As an eliminative model, the Larson model screens a given wetland through the following levels of assessment:

1. Outstanding wetland attributes
2. Numeric analysis of wildlife habitat, visual-cultural, and ground water potential.
3. Conversion of the numeric scores derived in level 2 to dollar values.

Under this system, wetlands satisfying one or more of the outstanding criteria of the first level of assessment were automatically recommended for preservation. If the wetland did not exhibit outstanding attributes, it was subsequently evaluated at the second and third levels.

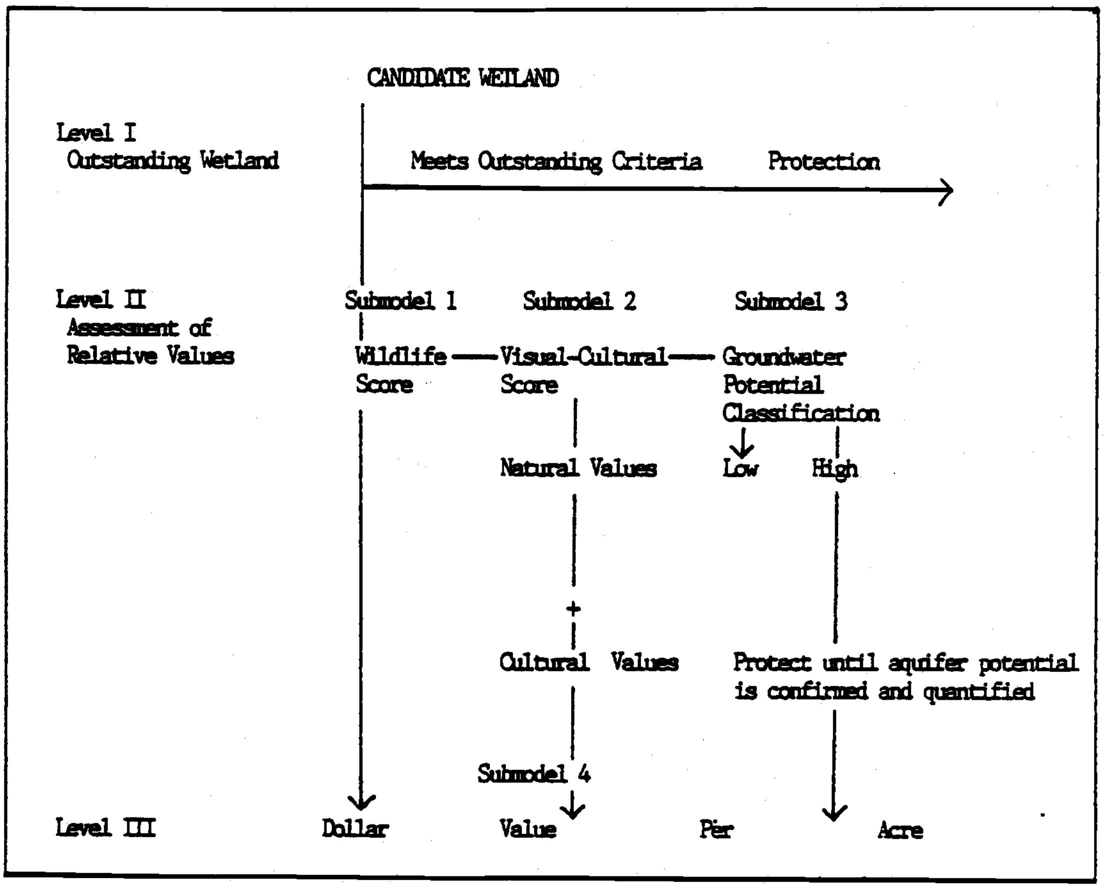


Figure 1. General outline of the Larson Model (Larson 1976).

Modification of the Larson Model

In applying the Larson Model to the Jackson-Frazier Wetland, certain modifications of its structure and content were made (Figure 2). The most pronounced difference between the two approaches is the organization and philosophy of assessment. The modified Larson model is not an eliminative model. Under this system wetlands are assessed in three separate stages. While preservation and alternative use values are compared in the economic assessment stage of the model, the display of values demonstrated during each stage of assessment is considered the most important function of the model. The model is intended to be used by decision makers and resource managers in conjunction with a variety of other tools for making preservation vs. development decisions.

The classification system used in the original Larson Model was made more reproducible by developing a numeric classification based on structural characteristics of vegetation and the hydrologic character of the site. In addition, modifications were made for sections of the model that were based on values pertinent primarily to northeastern wetlands. For example, no attempt was made to assess ground water potential in the modified version of the model due to regional differences in aquifer types. Also, the flood mitigation section of the original model, based on a study in the Charles River Basin, does not give procedures for applying the assessment to other wetlands. Therefore, flood

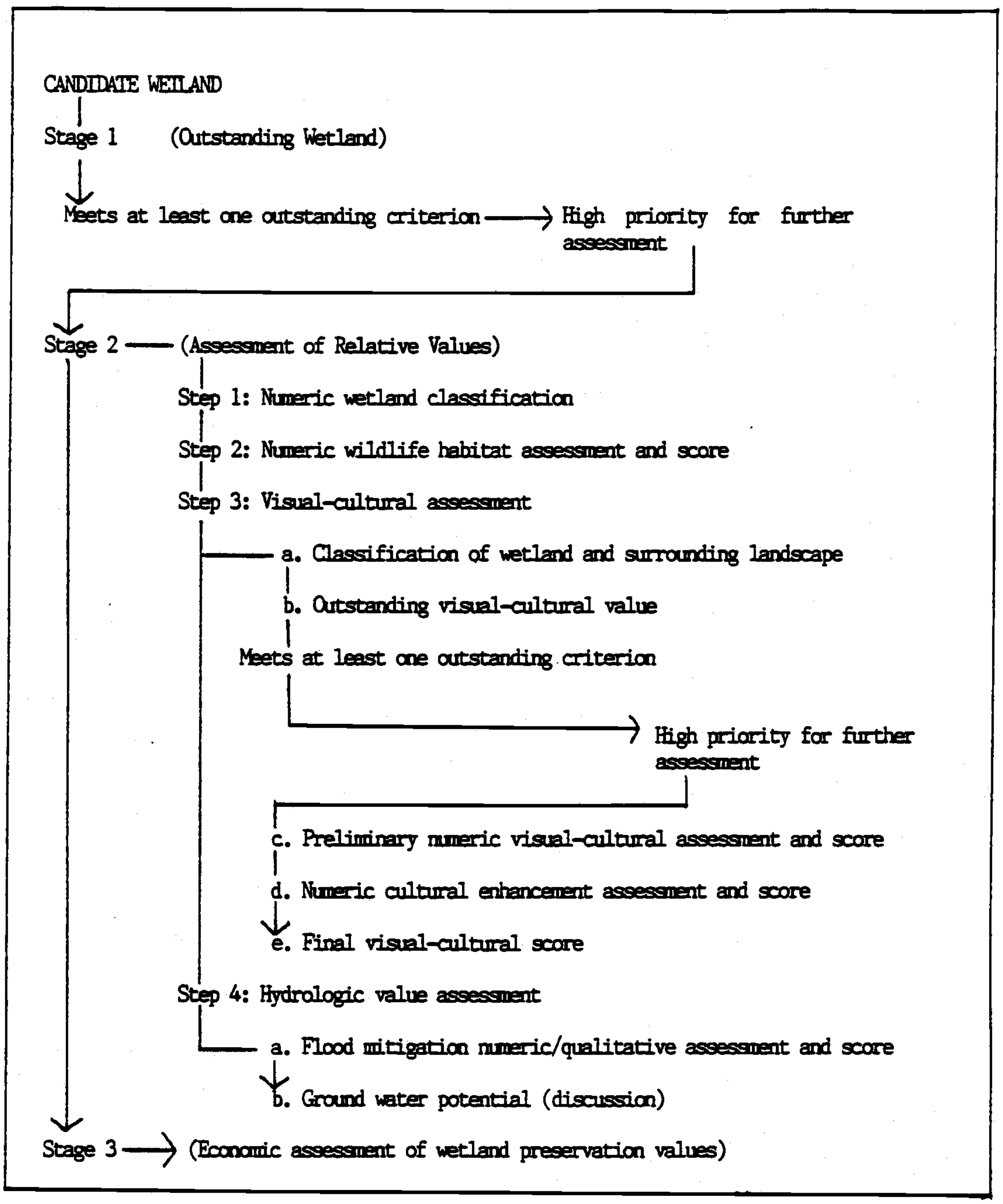


Figure 2. General outline of the modified Larson Model applied to the Jackson-Frazier Wetland.

mitigation values were addressed using sources outside of the original model.

The visual-cultural assessment was done in five steps in both the original and modified Larson model. They include: visual-cultural classification, qualitative visual-cultural assessment, numeric visual-cultural assessment, cultural enhancement assessment, and final calculation of a visual-cultural score. However, where the original model gives the choice of considering each assessment score separately or adding the two scores for a final score, the modified version of the model averages the scores.

Finally, the economic submodel used in the original model was modified and applied to the Jackson-Frazier Wetland. The original model employed numeric scores derived in the previous submodels as weights against politically established gauge sites to determine preservation value of wetland amenities (e.g., wildlife habitat and visual-cultural values). The modified economic assessment separates from the other stages of assessment. Politically established gauge sites are used directly to infer minimum preservation value (measured in dollars) of the Jackson-Frazier Wetland. Also, whereas the original model assumes no overlap between preservation values, the modified version assumes overlap exists and recognizes it in the assessment methodology.

Jackson-Frazier Wetland Background Information

Location and Size

The Jackson-Frazier Wetland is located within the Willamette Valley physiographic province. It borders the northern city limits and urban growth boundary (UGB) of Corvallis (Figure 3). The wetland encompasses approximately 159 acres (64 hectares).

The southern border of the wetland is bounded by vacant urban land; however, a mobile home park, multiple and single family housing units, and a junior high school are nearby. The remainder of the wetland is bordered by agricultural land.

Rationale for Site Selection

The Jackson-Frazier Wetland was selected as a study area for the following reasons:

- The site is in close proximity to an urban area allowing relatively easy access.
- The site has been frequently visited by scientists and a large body of information about the site has been documented.
- There is a need for information pertaining to the Jackson-Frazier Wetland values to aid officials in deciding whether the wetland should be protected, partially protected, or unprotected.
- The Jackson-Frazier Wetland contains typical wetland classes found within the Willamette Valley physiographic province.
- The Jackson-Frazier Wetland is relatively undisturbed by human activities.

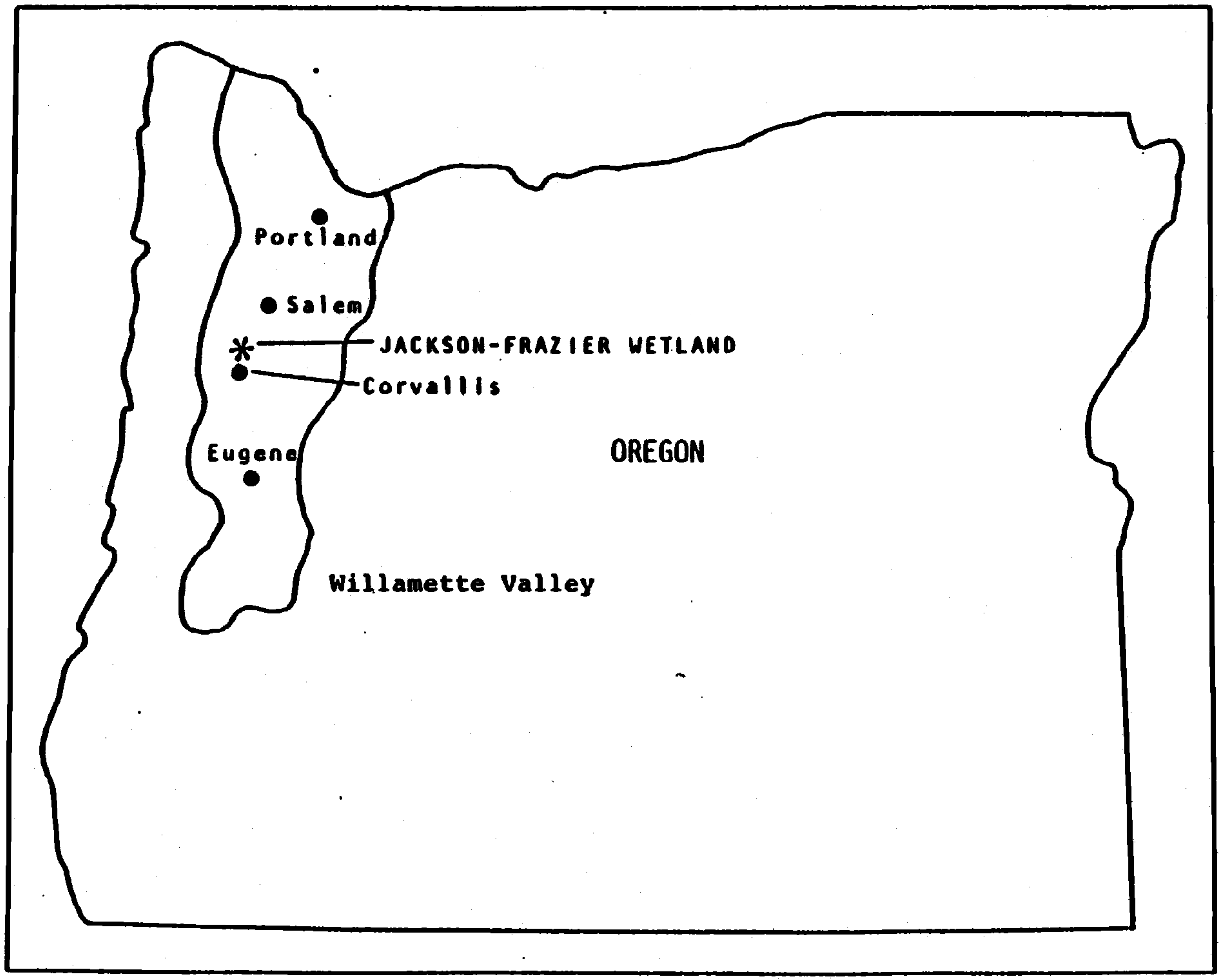


Figure 3. General location of the Jackson-Frazier Wetland.

Physiography

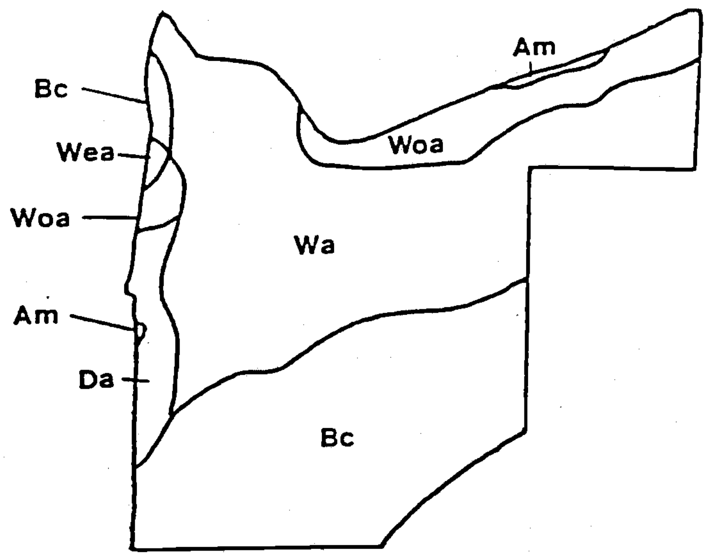
The northeasterly trending depression, the topographic feature largely responsible for water retention at the Jackson-Frazier site, was probably formed from scouring associated with mid to late Pleistocene flood events. This assumption is based on the estimated time of deposition of Willamette silt underlying the depression. These silt deposits were estimated to have occurred between 22,000 and 12,000 years ago (Norgren 1984).

Climate

The Jackson-Frazier Wetland is characterized by a relatively moderate maritime climate. The mean annual precipitation in the Corvallis area, for the years 1951-1980, is about 43 inches. Over seventy percent of the annual precipitation falls from November through March. About five percent falls from June through August. Summers are relatively warm and moderately dry. The winters are cool and wet (Murphy et al. 1983). The annual precipitation is adequate to saturate soils and recharge the deep water table (Stearns and Kierluff 1975).

Soils

The Jackson-Frazier wetland soils (Figure 4) are comprised of six soil types (Knezevich 1975). The wetland soils are dominated by Waldo silty clay and Bashaw clay, both of which have extreme shrink-swell characteristics. These soil types and other associated types are listed in Table 1.



Abbr.	Soil Name	SCS Land Capability Class
Am	Amity silt loam	II
Bc	Bashaw clay	IV
Da	Dayton silt loam	IV
Wa	Waldo silty clay loam	III
Wea	Willamette silt loam	I
Woa	Woodburn silt loam	II

Figure 4. Jackson-Frazier Wetland soils (ESEE Analysis, Benton County Planning Dept., p.6).

Table 1. Jackson-Frazier Wetland Soils.

Soil Series	Percent Wetland Area	Acres
Waldo silty clay loam	47.0	74.0
Bashaw clay	37.0	59.1
Woodburn silt loam	10.0	15.7
Dayton silt loam	4.5	7.2
Amity silt loam	1.1	1.8
Willamette silt loam	0.4	0.8
Total	100.0	158.6

Source: Economic, Social, Environmental, and Energy Analysis of the Jackson-Frazier Wetland (Starker Tract) 1984, Benton County Planning Department, p. 6,7.

These soils are generally classified as hydric due to such characteristics as mottled or gleyed horizons, hardpans, and high content of montmorillinite clays with shrink swell properties (Knezevich 1975).

Vegetation

The Jackson-Frazier Wetland is located in the Willamette Valley portion of the "Interior Valleys of Western Oregon" (Franklin and Dyrness 1973). The vegetation is dominated primarily by hydrophytes and has been phytosociologically classified (Appendix C) into 14 vegetation communities (Figure 5). The plant communities are also defined within the context of the U.S. Fish and Wildlife wetland classification (Appendix D) system (Cowardin et al. 1979).

Surface Hydrology

The Jackson-Frazier Wetland receives surface water from

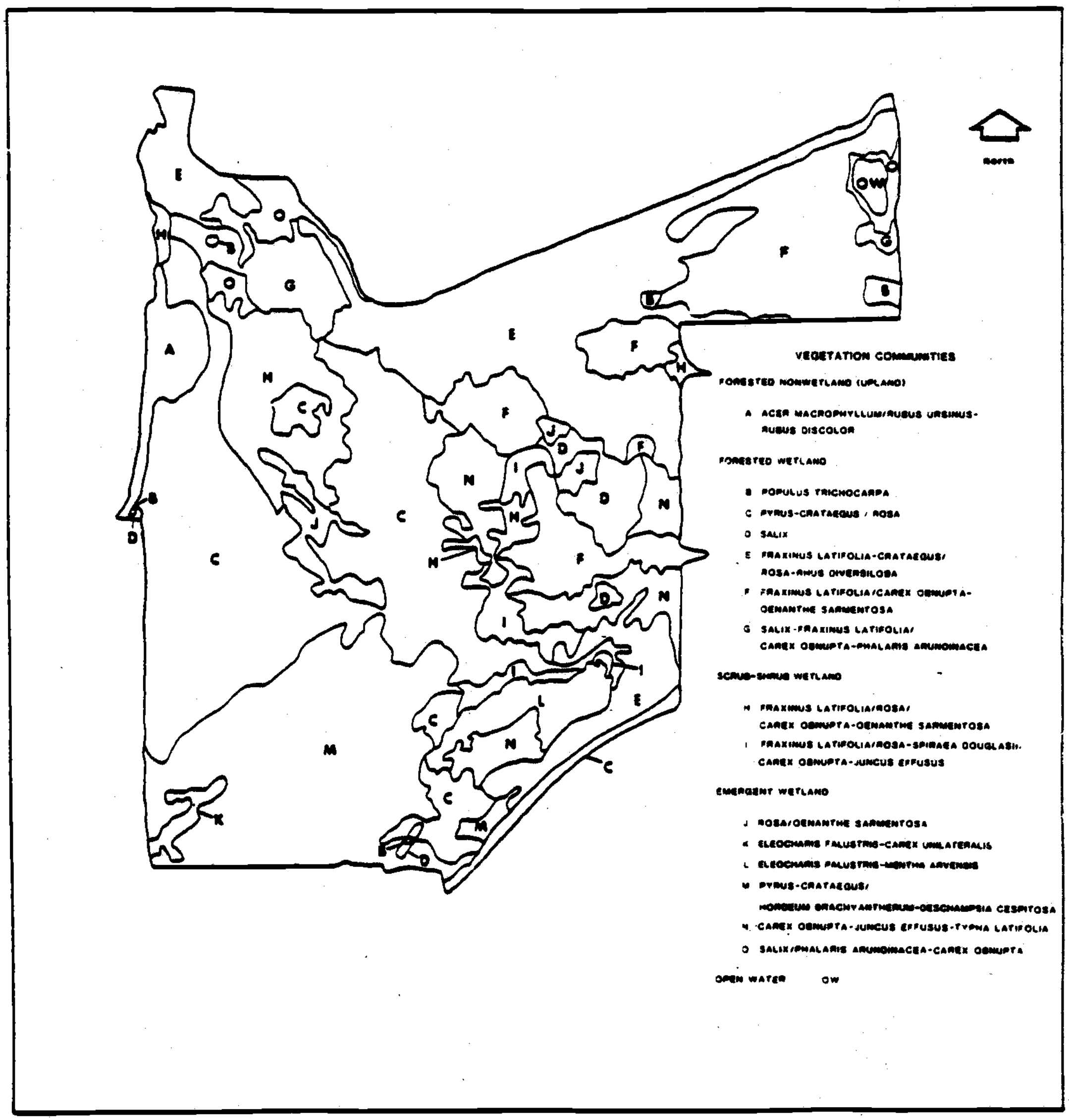


Figure 5. Jackson-Frazier Wetland vegetation.

four stream channels that enter the wetland at various points along the northwestern and western borders (Figure 6). Most of the water enters the wetland through the Frazier Creek channel, below the confluence of the Jackson and Frazier creeks, at the northwest corner of the wetland. The drainage basin feeding the Jackson and Frazier Creeks encorporates about 3680 acres (1490 hectares) and is characterized by pasture, woodlots, forest, and rural residential housing. Another unnamed stream enters the wetland approximately 560 feet (170 meters) southeast of the confluence of Jackson and Frazier Creeks. There are several small streams entering Jackson Creek just north of the confluence of Jackson and Frazier Creek. The combination of these drainages, in close proximity, form a complex drainage pattern near the northwest corner of the wetland.

A combination of a broad shallow depression, low relief, impermeable soils, dense vegetation, microtopographic variation, and beaver dams, cause many of the channels to become braided and obscure in the wetland interior. There are, however, several interior channels that are deep enough to limit overflow to peak storm events and spring freshets. Some of these channels have been excavated in the past.

Frazier Creek, above the confluence with Jackson Creek, flows in a southeasterly direction about 760 feet (230 meters) into the wetland before it turns due east. It flows east for about 650 feet (200 meters) where it forks. The north fork flows about 65 degrees northeast until it drains into a man-constructed duck pond at the northeastern corner of the wetland. The south fork continues to flow due east but apparently turns southeast just prior to leaving the wetland boundary.

There are three main channels releasing water from the wetland. Two of these exit from the eastern border, eventually converging to form Frazier Creek Ditch which flows about 10.5 miles (16.8 kilometers) northeast where it joins Beaver Slough before draining into the Willamette River. The remaining drainage, Stewart Slough, receives water from a vernal pond near the southeastern border of the wetland. Water from the pond area reaches Stewart Slough (the main outlet of the wetland) both directly, where the ditch enters the pond area, and indirectly via a ditch that flows into a larger ditch (Village Green Ditch) which flows into Stewart Slough. The Village Green Ditch is a drainage ditch excavated by the City of Corvallis in 1981 to minimize overflow hazards to adjacent urbanized land. Stewart Slough flows southwest about 0.6 miles (1 kilometer), turns due east about 1 mile (1.6 kilometers), and flows northeast about 4 miles (7 kilometers) until it drains into the Willamette River.

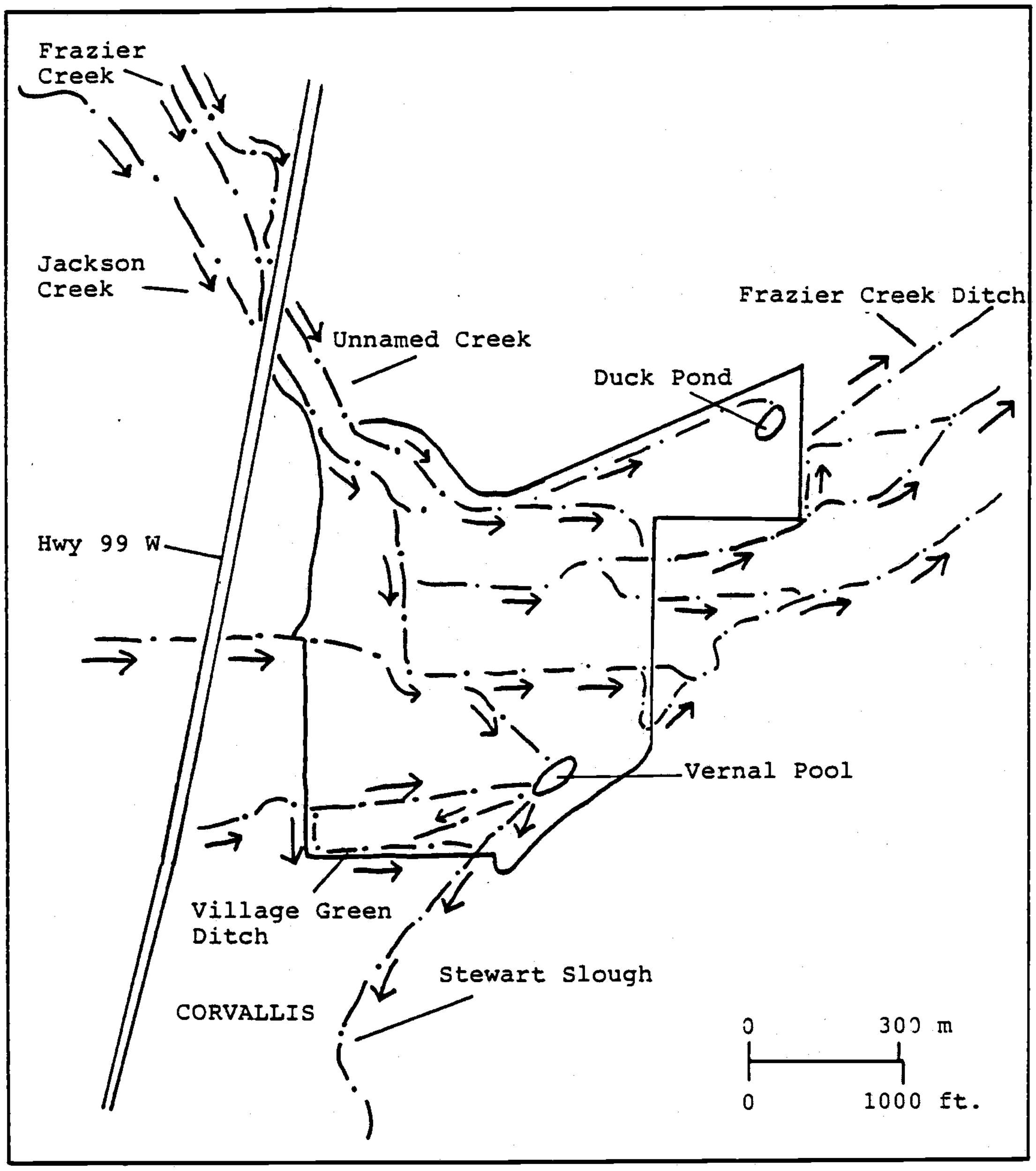


Figure 6. Jackson-Frazier Wetland surface water flow.

Outstanding Attributes of Jackson-Frazier Wetland (Stage 1)

The first stage of assessment identifies outstanding wetland attributes under eleven criteria. This portion of the model is qualitative in principle. It was the consensus of the Larson research team that some wetland attributes should not be assessed numerically and that wetlands displaying these attributes should be preserved in their unaltered state. Under the guidelines of the Larson Model (Larson 1976), wetlands displaying characteristics outlined in the eleven criteria were automatically considered high priority sites for protection. This "red flag" approach was criticized by Lonard (1981) who concluded that "red flag" criteria were useful as identifiers of potential outstanding sites but not as blanket statements for protection. Lonard's recommendation was adopted in the assessment of the Jackson-Frazier Wetland. Criteria used to determine outstanding wetland attributes of Jackson-Frazier Wetland, however, were based on Larson (1976):

1. Presence of rare, restricted, endemic or relict flora and/or fauna.

   Outstanding Wetland Status: Yes

   The site contains populations of a candidate endangered plant (<u>Lomatium bradshawii</u>) species (Hohn 1979).

2. The presence of flora of unusually high visual quality and infrequent occurrence.

   Outstanding Wetland Status: Yes

The site contains small populations of _Brodiaea_ _hycinthia_, _Clarkia_ _amoena_ spp. _lindleyi_, and _Dowingia_ _yina_ (Halse and Chambers 1980).

3. The presence of flora or fauna at, or very near, the limits of their range.

   Outstanding Wetland Status: No

4. The juxtaposition, in sequence, of several stages of hydrarch succession.

   Outstanding Wetland Status: No

   While autogenic succession processes are very clearly occurring throughout the Jackson-Frazier site (determined through a comparison between 1936 and 1956 air photos with present conditions), there is little evidence of classical hydrarch succession.

5. High production of native waterfowl species.

   Outstanding Wetland Status: No

6. Used by great numbers of migrating waterfowl.

   Outstanding Wetland Status: No

7. The presence of outstanding or uncommon geomorphological features in, or associated with the wetland.

   Outstanding Wetland Status: No

8. The availability of reliable scientific information concerning the geological, biological, or archeological history of the wetland.

   Outstanding Wetland Status: Yes

   While, there has been a significant amount of scientific investigation at the Jackson-Frazier site, there has been no published account of the work. However, a large data base has been generated. Aerial photographs of the area for 1936, 1956, and 1981 offer researchers the opportunity to document and measure vegetation change at the site. Detailed vegetation studies by the Environmental Protection Agency (EPA) offer data on vegetation diversity, productivity, and hydrological association (Boss 1979). An extensive bird list (Jarvis 1978) and plant list (Halse and Chambers 1980) are available.

9. The known presence of outstanding archeological evidence in the wetland.

   Outstanding Wetland Status: No

10. Wetlands that are relatively scarce in a physiographic region or that provide distinct visual contrast.

    Outstanding Wetland Status: Yes

    Given that the Willamette Valley constitutes a physiographic region which originally contained extensive palustrine wetlands, the Jackson-Frazier site contains remnant wetland types (e.g., Deschampsia wet prairie and a vernal pool) that are threatened by prevailing land uses (Baker 1981 and Margolis 1982).

11. Wetlands that are integral links in a system of waterways or are so large that they dominate the landscape of the region.

    Outstanding Wetland Status: No

While the Lonard (1981) research team concluded these criteria should not be used as blanket statements for wetland protection, wetlands possessing these characteristics should certainly be examined carefully in the decision process. Several salient points should be considered:

1. Rare species indicate rare habitat types. The Bradshaw desert parsley (Lomatium bradshawii) and its associated Deschampsia wet prairie are a prime example at the Jackson-Frazier site. This should indicate to decision makers that the wet prairie is a severely diminished resource in the Willamette Valley.

2. Island biogeographic research indicates that species with small restricted populations are often among the first to become endangered. As remnant populations are restricted to fewer and more isolated islands of habitat, opportunities for dispersal are diminished (Ripley and Lovejoy 1978). Given the Jackson-Frazier Wetland is an ecological island surrounded by agricultural and urbanized land and that the Lomatium bradshawii population is atypical there in abundance (Chambers 1982), protection would seem warranted if extinction of this species is a concern.

3. There is a growing concern in the scientific community regarding our "lack of knowledge" concerning wetlands; with special emphasis on inland freshwater wetlands (Frenkel 1985). This lack of information is alarming considering the amount of lost opportunities for study due to wholesale wetland destruction and development. A significant amount of research and subsequent data have already been generated regarding the Jackson-Frazier Wetland. This established data, in conjunction with the convenient location of the site with respect to research institutions, offers a unique opportunity for a long term monitoring and research program that would broaden our understanding of wetland functions and values.

The Jackson-Frazier Wetland qualifies as an outstanding wetland with high priority for further study under four of the eleven criteria listed. The assessment was continued at the next stage.

Numeric Assessment of Jackson-Frazier Wetland Preservation Values (Stage 2)

The second stage of the evaluation numerically assesses wetland preservation values. It provides decision makers and resource managers with an itemization and display of intangible preservation values that are often overshadowed in the more traditional market analyses.

This stage of the evaluation can be divided into four steps:

1. Numeric wetland classification
2. Numeric wetland wildlife habitat evaluation
3. Visual-cultural wetland evaluation (qualitative and numeric)
4. Numeric/qualitative evaluation of hydrologic related values

Numeric Wetland Classification (Step 1)

The wetland classification method presented here is a modification of Larson's (1976) classification. Larson's classification is descriptive and requires subjective decisions for implementation. One measure of the utility of a model is the reproducibility of results derived from its application. Techniques that give reproducible results were common in the Larson Model except for the wetland classification. The wetland classification system developed in this paper attempts to facilitate reproducibility.

Modified Wetland Classification

While the modified classification employs many components of the Larson Model, it embodies five major modifications:

1. An importance index based on percent cover and height of plant taxa was used to classify the structural components of the plant communities.

2. An importance index based on percent cover and arbitrarily selected significance coefficients were used to classify hydrologic traits.

3. Vegetation and hydrologic traits were hierarchically classified.

4. Larson's "Wooded Wetland", "Seasonally Flooded Meadow", and "Shallow Marsh" wetland classes were respectively renamed "Forested Wetland", "Infrequently Emergent Wetland", and "Frequently Emergent Wetland". His "Deep Marsh" and "Open Water Wetland" classes roughly correspond to my "Shallow Open Water" and "Deep Open Water" wetland classes.

5. Water regime modifiers were adopted from the Cowardin et al. (1979) wetland classification.

A multi-step process was employed to classify the wetland. First, wetland type boundaries were provisionally delineated on an aerial photo of the site. The original black and white imagery (WAC-82H-1-112) was at a scale of 1:65,000. The photo was subsequently enlarged to a scale of approximately 1:3,200. Since the Jackson-Frazier site was near the center of the original photo, the enlarged photo was judged to have negligible distortion and was found acceptable for mapping and classification purposes. Boundaries were drawn around discernible vegetation and water units (referred to here as image units) on clear acetate overlaying the photo. Characteristics used to determine boundaries included image: density, texture, tone, and shape.

Each delineated image unit was sampled in the field.

Data collected at each sample included a list of species, an estimate of species percent cover by cover class, mean species height class (trees were measured with a clinometer), and an estimate of percent cover of water bodies and their depth at the time of the survey. Identified taxa were also placed in one of three moisture tolerance classes and classified by life form:

Species Moisture Tolerance	Life Form
obligate hydrophyte (h)	Tree /1
faculative hydrophyte (h/m)	Shrub
mesophyte (m)	Emergent

The number of samples were roughly proportional to the areal extent of the image units. Sixty-five units were delineated on the photo and 75 samples were taken.

The percent vegetation cover class and height class data (Table 2) were recorded using the structural categories of Küchler (1966).

Sampling was done in the late fall and early winter. This made identification of some plants to the species level impossible. Genera were used when species could not be determined.

Importance Index

After the data were compiled for each sample, an importance index was calculated and used to organize the data and

/1 Trees constitute predominantly woody (nonbushy) plants greater than 2 meters in height.

Table 2. Vegetation Height and Cover Class Parameters (after Küchler (1966).

Height	Height Class	Percent Cover	Cover Class	Mid Point (Percent)
35-45m	8	75-100	5	88
20-35m	7	50-75	4	63
10-20m	6	25-50	3	38
5-10m	5	5-25	2	15
2- 5m	4	< 5	1	3
.5- 2m	3			
.1-.5m	2			
< .1m	1			

classify the wetland. The importance index represents the degree a particular life form or hydrologic trait dominates the character of a given image unit. The classification is based on structural characteristics of vegetation and hydrological traits of associated water bodies. Both vegetation and water bodies are assumed to affect wildlife habitat and scenic-cultural values. The importance index is determined by running the data from each sample through six steps:

1. Group species by life form.
2. Sum percent cover class mid-points for each life form and hydrologic trait.
3. Determine a height class index for each life form and a significance coefficient for each hydrologic trait. This is done by finding the average height class number for each life form and the appropriate significance coefficient for each hydrologic trait. /2

/2 The hydrologic traits of "Shallow" and "Deep Open Water" were given significance coefficients of 4 and 5 respectively. Significance coefficients for hydrologic traits serve the same function as height class numbers for life forms. That is, they weight the importance value of their respective habitat characteristics. Relatively high significance coefficients were selected on the premise that deep and open water regimes heavily influ-

4. Determine an importance value for each life form by multiplying the sum of the life form cover mid-points by its height class index. The importance value for hydrologic traits is derived by multiplying their cover class mid-point by their corresponding significance coefficient.

5. Determine sum of importance values for all life forms and hydrologic traits.

6. Determine a relative importance value for each life form and hydrologic trait by dividing a given life form or hydrologic trait value by the sum of all importance values. This is the importance index number.

The process by which importance indexes were derived can be followed on Form 1 (Figure 7). Data from sample 74, image unit 62, is displayed to allow the reader to follow the procedure. This form was used for each sample.

The subsequent task of defining the relative importance of various wetland classes in each sample was accomplished using Form 2 (Figure 8). The importance index derived for each wetland component on Form 1 was transferred to the respective life form or hydrologic trait on Form 2. A "dominant threshold index", within a range of 0 to 1, was selected to categorize the dominant wetland class. Any life form or hydrologic trait that obtained an importance index greater than or equal to the threshold was considered a dominant wetland class. The threshold was 0.38. A "subordinate threshold index" of 0.14 was selected to delineate subdominant wetland classes. The selection of the dominant threshold index was based on the lowest importance index

/2 (Cont.) ence the physical and biological character of the sites they occupy.

(Step 1) Wetland: Jackson-Frazier Unit:62 Sample:74 Date:12-01-83

Plant Species	Plant Moisture Tolerance h	h/m	m	Hydrologic Trait (HT)	Cover Class and Cover Class Mid-Points (Percent): Life Form (LF): Trees	Shrubs	Emergents	Hydrologic Trait (HT): Shallow Open Water .1-2 m (SO)	Deep Open Water >2 m (DO)	Life Form Height Class (HC): T	S	E	Hydrologic Trait Sig. Coeff. (SC): SO	DO
CAOB	X						3 38					3		
PHAR		X					3 38					3,4		
TYLA	X						2 15					3,4		
MECI	X						1 03					2		
ROSA SP.		X				1 03					4			
SALIX SP.	X				2 15					4				
FRLA	X				2 15					4,5				
				SO				4 63					4	

	Trees	Shrubs	Emergents	Shallow Open Water	Deep Open Water
(Step 2) Sum the percent cover mid-point number for each LF and each HT.	30	03	94	63	

(Step 3) HEIGHT CLASS/SIG. COEFF. INDEX
Find the mean HC for each respective LF and the SC for each respective HT.

HC/SC INDEX				
T	S	E	SO	DO
4.3	4.0	3.2	4.0	

	T	S	E	SO	DO
(Step 4) IMPORTANCE VALUE For each LF and HT, multiply the sums of cover class mid-points by their respective HC and SC indexes.	129	12	300.8	252	
(Step 6) IMPORTANCE INDEX Divide each importance value by the sum of importance values.	.19	.02	.43	.36	

(Step 5) Sum the importance values.
693.8

* The shallow and deep open water hydrologic traits were arbitrarily assigned the numerical significance coefficients of 4 and 5 respectively. This is done on the premise that these traits significantly affect the physical and biological character of wetlands.

Figure 7. Importance index (Form 1).

Wetland: Jackson-Frazier Unit:62 Sample:74 Date:12-01-83

Wetland System: Palustrine	Life Form Criteria				Hydrologic Trait Criteria		
	Trees (T) >2 m	Shrubs (S)	Emergents (E)		Open Water Wetland		Water Regime Modifiers
			≥60% h/m	≥60% h	Shallow ≤2 m	Deep ≥2 m	
Descriptors:	a.moist decid. b.moist evergr. c.dead d.water regime (2-7)	a.moist decid. b.moist evergr. c.dead d.sapling <2 m e.short bushy < 2 m f.tall bushy > 2 m g.lianas h.water regime (2-7)	a.short narrow leaf < 2 m b.tall narrow leaf > 2 m c.robust d.persist e.nonpersitent f.water regime (3-7)	a.short narrow leaf < 2 m b.tall narrow leaf > 2 m c.robust d.persist e.nonpersistent f.floating broad leaf g.water regime (1-3),7	a.algal b.aquatic moss c.rooted vasc. d.floating broad leaf e.cobble f.gravel g.sand h.mud i.organic j.water regime (1-3,7)	a.algal b.aquatic moss c.rooted vasc. d.floating broad leaf e.cobble f.gravel g.sand h.mud i.organic j.water regime (1,7)	1.Permanently Flooded 2.Semipermanently Flooded 3.Seasonally Flooded 4.Saturated 5.Temporarily Flooded 6.Intermittently Flooded 7.Artificially Flooded
Dominant Import. Ind.				.43			
Subordinate Import. Ind.	.19				.36		
Wetland Classification (Mod. Larson)	A Forested Wetland	B Shrub Wetland	C Infrequent Emergent Wetland	D Frequent Emergent Wetland	E Shallow Open Water Wetland	F Deep Open Water Wetland	Code: D/E-A or Dg(3)b/ Ej(2)c-Ad(3)a
Wetland Classification (Cowardin)	Forested Wetland Scrub Shrub Wetland	Scrub Shrub	Emergent Wetland	Emergent Wetland	Aquatic Bed	Aquatic Bed Unconsolidated Bottom	

Figure 8. Wetland classification (Form 2).

found in all the samples that was dominant in a single sample. The subordinate importance index threshold selection was based on a subjective interpretation of field observations.

If two or more samples were taken within a given image unit, the derived importance indexes for the corresponding life forms and hydrologic traits in each sample were averaged.

Using the data in sample 74 (Figures 7,8), the Frequently Emergent Wetland class has an importance index of .43; qualifying it for dominant class status. The "Shallow Open Water Wetland" (importance index .36) and the "Forested Wetland" (importance index .19) areas qualify as subordinate wetland classes in the area sampled. Selection of the Frequently Emergent Wetland class was based on findings indicating that more than 60% of the emergent vegetation in sample 74 was dominated by obligate hydrophytes (plants that are found almost exclusively in hydric soils). Had the emergents in the sample been more than 60% faculative hydrophytes (plants that tolerate hydric and mesic soil conditions), the area would have been classified as an Infrequently Emergent Wetland.

An upper case letter code (A-F) was used to define the wetland classes in each sample. Wetland classes are represented fractionally in the code with increasing importance to the left. A slash is used to separate the dominant classes from the subordinate. A dash is used to represent co-dominant or cosubordinate classes. The code for sample 74 is:

D / E - A

D = Frequently Emergent Wetland
E = Shallow Open Water Wetland
A = Forested Wetland

Following Larson (1976) and Cowardin et al. (1979) each class and subclass is modified by descriptive components of the chief vegetative or hydrologic characters of the site, i.e., narrow leaf emergents, broad leaf emergents, bushy shrubs, etc. Descriptors are represented by a lower case letter code and are listed in order of decreasing importance to the right of the class or subclass they describe. They are listed in sample 74 under the following letter code:

Dg(3)b/Ej(2)c-Ad(3)a

D
g = water regime (3)
b = tall narrow leaf emergents

E
j = water regime (2)
c = rooted vascular

A
d = water regime (3)
a = moist deciduous

The "water regime" descriptor is always assumed to be the most important descriptor of the wetland class or subclass. It is divided into seven modifiers (Cowardin et al. 1979):

1. Permanently Flooded

   Water that covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes.

2. Semipermanently Flooded

   Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

3. Seasonally Flooded

   Surface water is present for extended periods early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface.

4. Saturated

   The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present.

5. Temporarily Flooded

   Surface Water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plants that grow both in uplands and wetlands are characteristic of the temporarily flooded regime.

6. Intermittently Flooded

   The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation. The dominant plant communities under this regime may change as soil moisture conditions change. Some areas exhibiting this regime do not fall within the Cowardin (1979) definition of wetland because they do not have hydric soils or support hydrophytes.

7. Artificially Flooded

   The amount and duration of flooding is controlled by means of pumps or siphons in combination with dikes or dams. The vegetation growing on these areas cannot be

> considered a reliable indicator of water regime. Examples of artificially flooded wetlands are some agricultural lands managed under a rice-soybean rotation, and wildlife management areas where forests, crops, or pioneer plants may be flooded or dewatered to attract wetland wildlife. Neither wetlands within or resulting from leakage from man-made impoundments, nor irrigated pasture lands supplied by diversion ditches or artesian wells are included in this modifier.

The classification of each unit, without descriptors and modifiers, is recorded in Appendix E. Figure 9 shows the distribution of wetland classes and subclasses in the Jackson-Frazier tract. It is important to recognize that the classification is based on data collected in the fall and winter.

The next step in the classification was to consider the wetland classification map in Figure 9 in relation to two other sets of wetland type maps. In the first case, wetland cover types (Larson 1976) were subdivided into eight categories (Figure 10). The Jackson-Frazier site was judged to best fit wetland cover type 3. In the second case, wetland vegetation interspersion types (Larson 1976) were subdivided into three categories (Figure 11). The Jackson-Frazier site was judged to best match wetland interspersion type 3.

Comparison Between the Modified Larson Wetland Classification and the Cowardin Wetland Classification

The U.S Fish and Wildlife Service is currently conducting a nationwide wetland inventory based on the "Classification of Wetlands and Deep Water Habitats of the United

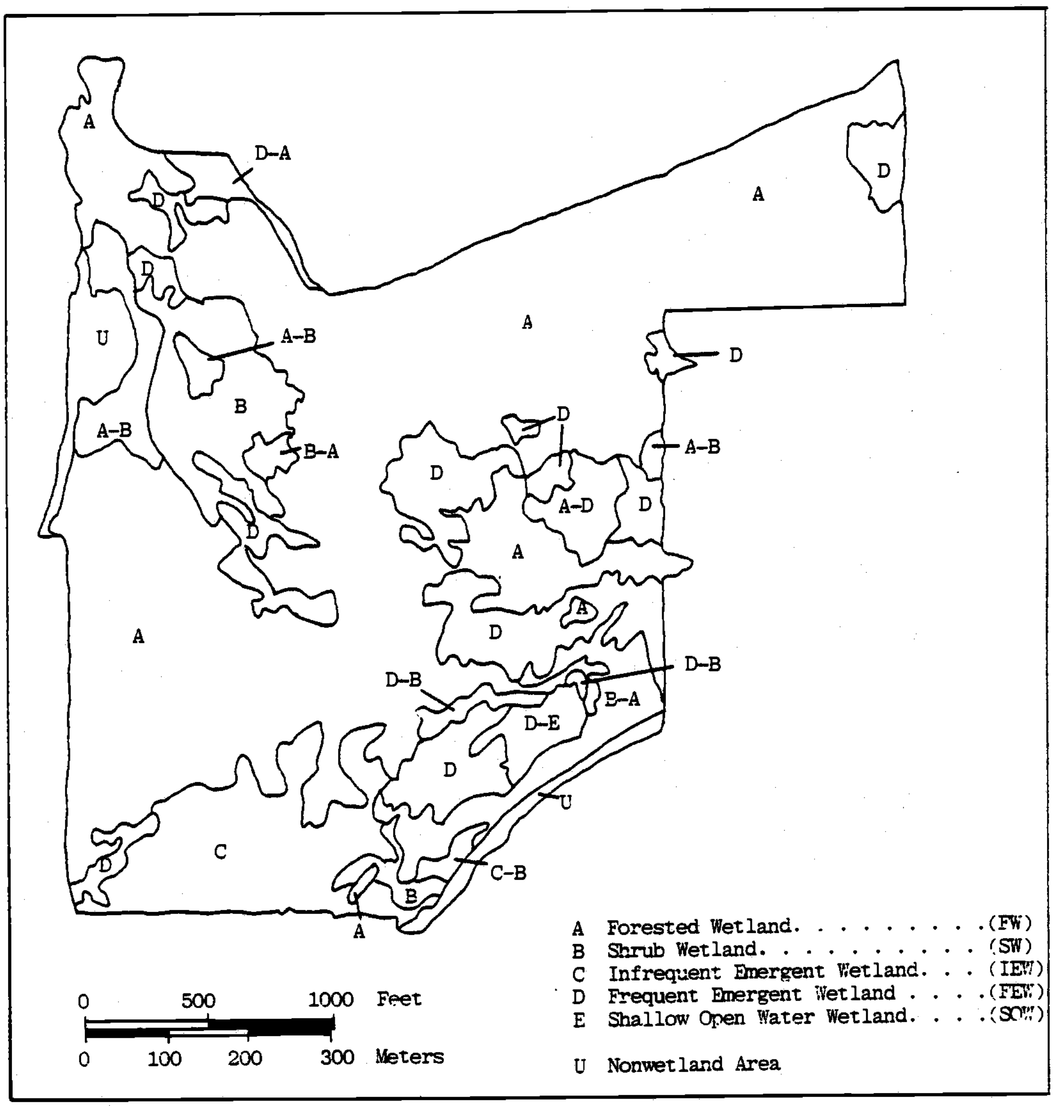


Figure 9. Wetland classification of the Jackson-Frazier tract (descriptors, modifiers, and subclasses are not included).

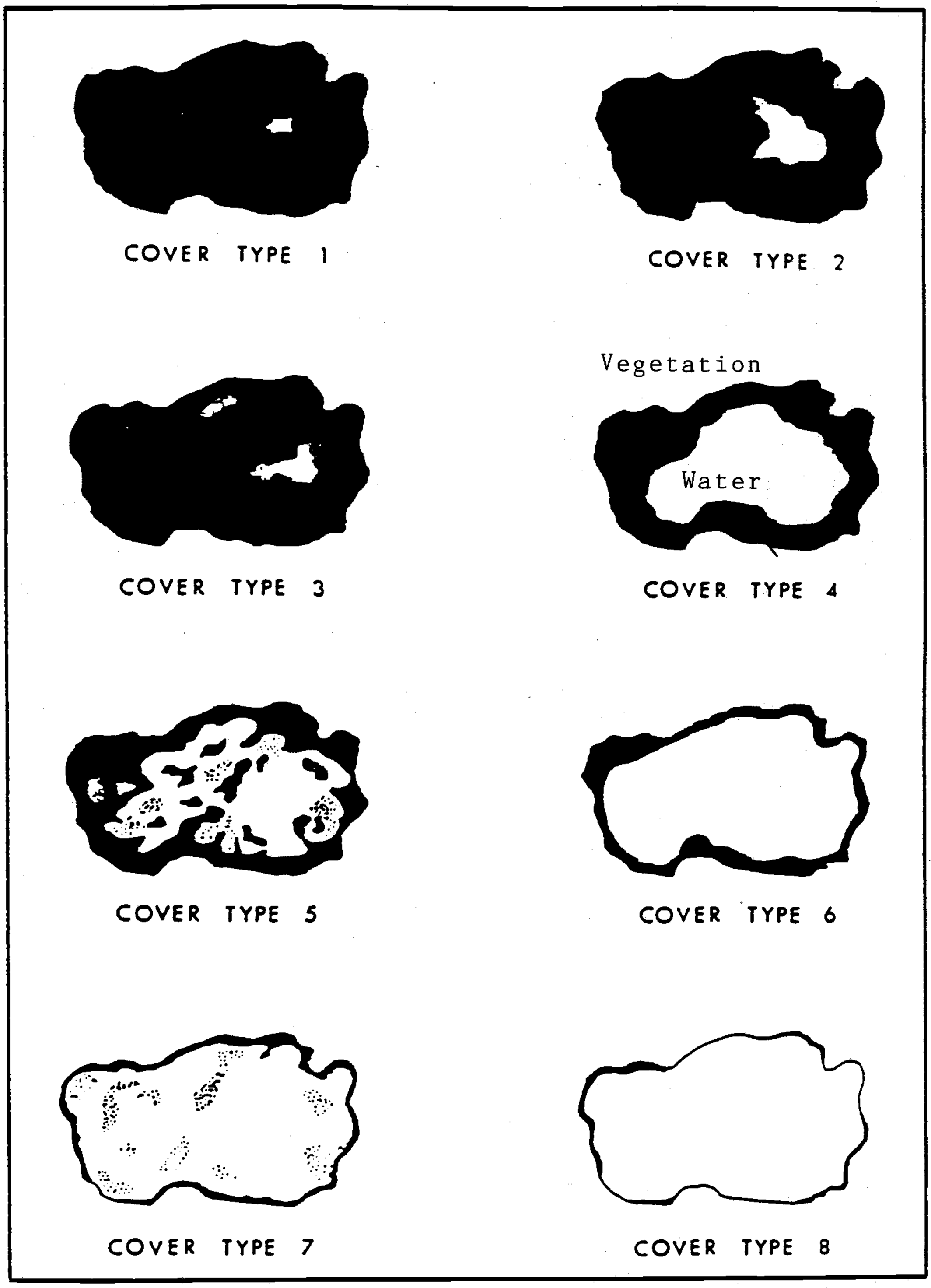


Figure 10. Wetland cover types(Larson 1976).

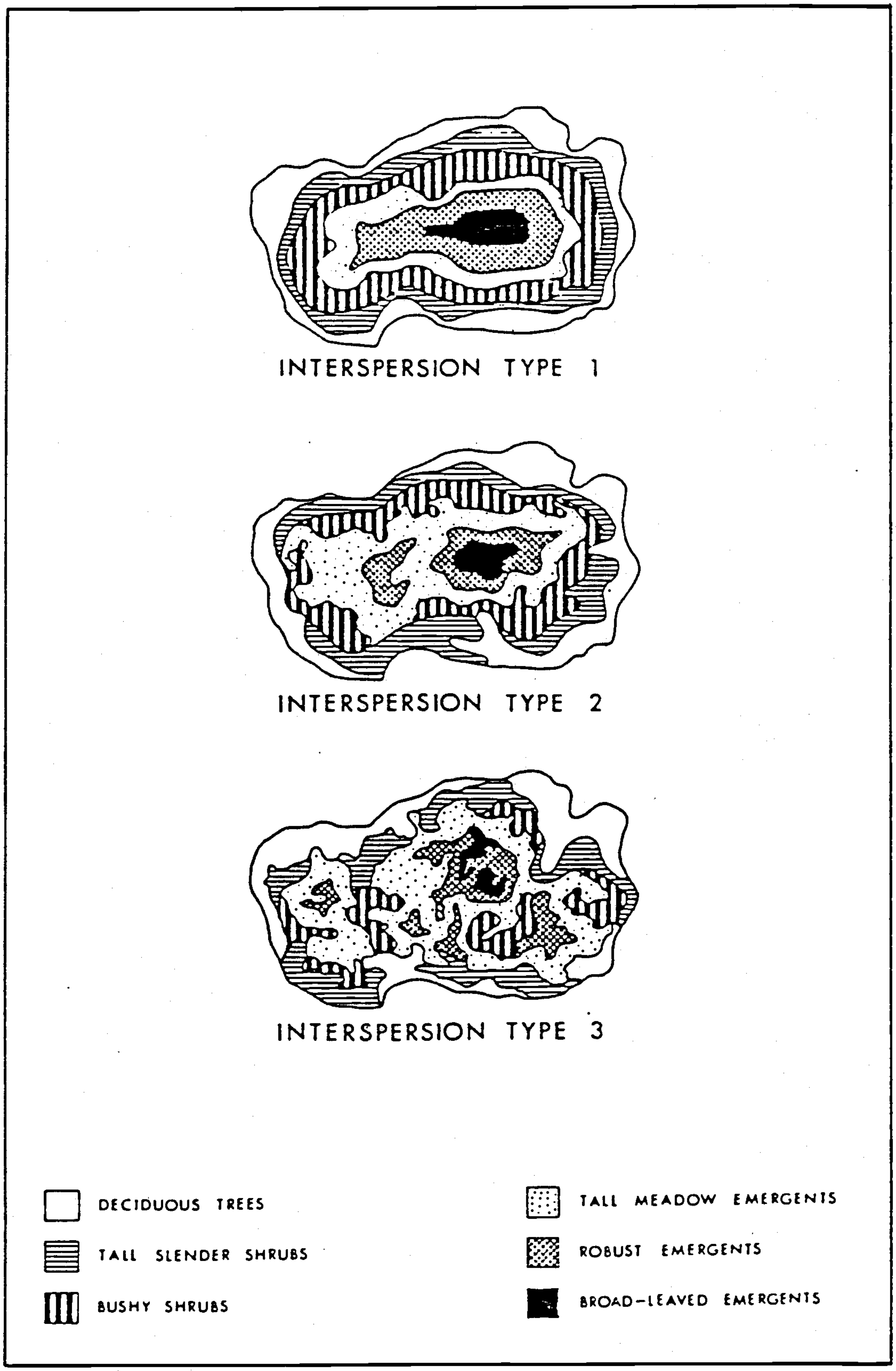


Figure 11. Wetland vegetation interspersion types (Larson 1976).

States" (Cowardin et al. 1979). This system is expected to become the standard wetland classification in the United States. Table 3 compares the modified Larson classification developed in this paper with the Cowardin Classification.

While the modified Larson classification adopts the Cowardin criteria for wetland classification at the "system" level (Cowardin et al. 1979), there are distinct differences at the class and subclass levels. /3 Comparison between the two methods must be made with the realization that the modified Larson method allows class components (e.g., Forested Wetland, Shrub Wetland, etc.) to also serve as subclasses. The descriptors in the modified Larson method compare with both subclass and modifier components in the Cowardin classification. Also, the modified Larson classification, as applied to the Jackson-Frazier Wetland, is displayed in more detail than the Cowardin classification system as applied in the National Wetland Inventory. A more detailed classification was judged necessary to adequately complete the assessment.

/3 The Jackson-Frazier Wetland is classified as a "Palustrine Wetland System" under both the Cowardin et al. (1979) and the modified Larson classifications.

Table 3. Comparison of the Modified Larson Classification and the U.S. Fish and Wildlife Classification (Cowardin et al. 1979).

Modified Larson Classification (this research)	Cowardin et al. (1979)		
System: (see Appendix D)	System: (see Appendix D)		
Classes/Subclasses and Descriptors	Classes/Subclasses	Water Regime	Water Chemistry
A. Forested Wetland a. moist deciduous b. moist evergreen c. dead d. water regime (2-7)	Forested Wetland 1. needle leaf evergreen 2. broad leaf evergreen 3. needle leaf deciduous 4. broad leaf deciduous 5. dead	All non-tidal regimes except permanently flooded	Fresh
B. Shrub Wetland a. moist deciduous b. moist evergreen c. dead d. sapling < 2 m e. short bushy < 2 m f. tall bushy > 2 m g. lianas h. water regime (2-7)	Scrub-Shrub 1. needle leaf evergreen 2. broad leaf evergreen 3. needle leaf deciduous 4. broad leaf deciduous 5. dead	All non-tidal regimes except permanently flooded	Fresh
C. Infrequent Emergent Wetland (> 60% faculative hydrophytes) a. short narrow leaf < 2 m b. tall narrow leaf > 2 m c. robust d. persistent e. nonpersistent f. water regime (3-7)	Emergent Wetland 1. persistent 2. nonpersistent	Saturated	Fresh Mixosaline
D. Frequent Emergent Wetland (> 60% obligate hydrophytes) a. short narrow leaf < 2 m b. tall narrow leaf > 2 m c. robust d. persistent e. nonpersistent f. floating broad leaf g. water regime (1-3)	Emergent Wetland 1. persistent 2. nonpersistent	Semipermanently Flooded, Seasonally Flooded	Fresh Mixosaline

Table 3. (Continued) Comparison of the Modified Larson Classification and the U.S. Fish and Wildlife Classification (Cowardin et al. 1979).

Modified Larson Classification (this research)	Cowardin et al. (1979)		
System: (see Appendix D)	System: (see Appendix D)		
Classes/Subclasses and Descriptors	Classes/Subclasses	Water Regime	Water Chemistry
E. Shallow Open Water Wetland (< 2m) a. algal b. aquatic moss c. rooted vascular d. floating broad leaf e. cobble f. gravel g. sand h. mud i. organic j. water regime (1-3,7)	Emergent Wetland 1. persistent 2. nonpersistent Aquatic Bed 1. algal 2. aquatic moss 3. rooted vascular 4. floating	Semi-permanently Flooded, Intermittently exposed, Permanently Flooded	Fresh Mixosaline
F. Deep Open Water Wetland (>2 m) a. algal b. aquatic moss c. rooted vascular d. floating broad leaf e. cobble f. gravel g. sand h. mud i. organic j. water regime (1,7)	Aquatic Bed 1. algal 2. aquatic moss 3. rooted vascular 4. floating Unconsolidated Bottom 1. cobble-gravel 2. sand 3. mud 4. organic	Permanently Flooded, Intermittently Exposed	Fresh Mixosaline

Numeric Wetland Wildlife Habitat Evaluation (Step 2)

Wildlife habitat was judged with regard to ten habitat criteria. Each criterion was assigned a significance coefficient based on its estimated importance in terms of habitat character. Significance coefficients were assigned numerical values from 1-5 with 1 being the least important.

In addition, a series of ratings (1.0, 1.5, 2.0, 2.5, 3.0) are listed for each criterion. In many cases these ratings are developed from a classification of a given wildlife habitat criterion. For example, the criterion of wetland size is divided into five categories with the highest rating (3.0) assigned to the largest size. The assumption made here is that large wetlands are more valuable to wildlife than small wetlands.

Wildlife Habitat Evaluation Criteria

The Jackson-Frazier Wetland was evaluated under the ten criteria in Tables 4 and 5. This section of the paper will discuss the assumptions behind each criterion and the rationale used to rate the wetland using those criteria.

Number of wetland classes. The assumption made under this criterion is that a diverse habitat will support a diverse fauna and such diversity will increase the value of a wetland. The number of wetland classes was derived using the modified Larson classification of the wetland. To be counted, at least 5 acres (about 2 hectares) of the wetland had to have been covered by a given wetland class. The

Jackson-Frazier site contained five wetland classes (Fig. 9), thereby qualifying it for the highest possible rating (3.0).

Dominant wetland class. It is recognized that certain wetland classes support a greater number of species than others. In addition, certain wetland classes support species that provide traditional utilitarian uses, i.e., sport and commercial harvest. These classes are given higher ratings in the model. Wetland classes supporting waterfowl (Infrequently Emergent Wetland, Frequently Emergent Wetland, and Shallow Open Water Wetland) were assigned the highest significance coefficient and rating. A wetland area that is predominantly comprised of one or more of these classes receives a high rating under the model.

The Jackson-Frazier Wetland is predominantly composed of the Forested Wetland class, which does not support large numbers of waterfowl. However, Infrequently Emergent, Frequently Emergent and Shallow Open Water areas are interspersed throughout the wetland. Therefore, the Jackson-Frazier site obtains a medium rating (2.0) for this criterion.

Wetland size. It is assumed that large wetlands are more valuable to wildlife than small wetlands. The concept of a positive correlation between land area and species diversity finds strong support from island biogeographic research (Diamond 1975). The Jackson-Frazier Wetland is an ecological island separated from similar ecological islands by a "sea" of agricultural and urbanized land. Some factors that may contribute to the correlation between wetland size and species diversity are: large wetlands are likely to have a large variety of habitat types or wetland classes, large wetlands serve as barriers to human impacts to their interiors, and large wetlands tend to be more hydrologically stable than small wetlands because large size is often associated with a permanent high water table (Larson 1976). The Jackson-Frazier wetland covers approximately 160 acres, thereby placing it the 101-500 acre category in the model. Wetlands in this category were asigned a medium high rating (2.5).

Number of wetland subclasses. This criterion is based on the same assumption as the criterion of the number of wetland classes, i.e., the more types of habitat available, the more opportunity for species diversity. Classes containing subclasses contribute to habitat variation.

Five wetland subclasses were determined for the Jackson-Frazier Wetland during the wetland classification (Appendix E). This qualifies the Jackson-Frazier tract for the highest possible rating (3.0).

Site type. Under this criterion, bottomland wetlands are considered to have higher value than nonbottomland wetlands. This is based on the assumption that bottomlands have more fertile soils and less fluctuation of surface water levels.

A sustained surface water level contributes to the longevity of the wetland. It is also assumed that wetlands associated with significantly large bodies of open water are more valuable to wetland wildlife than wetlands that are isolated from open water.

The Jackson-Frazier site is bottomland wetland isolated from any bodies of open water of significant size and is therefore, assigned an intermediate rating (2.0).

Surrounding habitat types. The assumption made under this criterion is that wetlands adjacent to undeveloped lands are more valuable to wildlife than wetlands adjacent to developed lands. An additional assumption is that diverse habitat types associated with adjacent lands contribute to the wildlife diversity of the wetland.

The Jackson-Frazier site is surrounded by agricultural and vacant open space along 90% of its border. The south edge of the wetland is adjacent to the Corvallis Urban Growth Boundary where a small tract of vacant land separates the wetland from a housing development and trailer park. While the agricultural area surrounding the Jackson-Frazier Wetland is relatively undeveloped, it is not very diverse. Therefore, under this criterion in the model, the Jackson-Frazier site is rated intermediate (2.0).

Cover type. This criterion assumes that an ideal wetland for wildlife habitat would have a vegetation cover/open water ratio of about 1:1. It further assumes that a spatially complex pattern of cover and water is desirable as wildlife habitat.

The Jackson-Frazier site was compared to a series of idealized cover types (Figure 10) and judged most closely to resemble type 3. This type is relatively lacking in open water bodies. For this reason, the site received an intermediate (2.0) rating.

Vegetation interspersion. This criterion is based on the edge effect concept in wildlife management; that is, areas where plant communities or structural differences in vegetation meet, ecotones or edges, are thought to be richer in faunal species than the adjoining communities or structural types (Maser et al. 1979). The model utilizes this concept by assigning a higher rating to wetlands that display large numbers and complex interspersion of wetland subclasses. The Jackson-Frazier site was compared to a series of idealized vegetation interspersion types (Figure 11) and found to correspond best to type 3. This type is characterized by a diverse set of wetland classes interspersed to create an abundance of edge habitat. Therefore, the Jackson-Frazier site was rated high (3.0) under this criterion.

Wetland juxtaposition. The assumption here is that species diversity and populations will be enhanced if wetlands in a region are spatially proximate. This is thought to be especially true if the neighboring wetlands consist of different classes or subclasses. Connecting stream and riparian corridors are assumed to further enhance wildlife diversity by providing relatively safe migration routes for animals.

The juxtaposition of the Jackson-Frazier site with respect to other wetlands was determined, using an aerial photo (WAC-82H-1-112) and field reconnaissance. The site is hydrologically connected, by the Jackson and Frazier Creeks, to a predominantly forested wetland 1/4 mile from its northwest boundary. However, the stream corridor is partially interrupted by Highway 99 and the Southern Pacific Railroad right of way. For this reason, the site was given an intermediate wetland juxtaposition rating (2.0) for an otherwise highly rated characteristic.

Water chemistry. The assumption made under this criterion is that water chemistry can be used as an indicator of potential wildlife productivity. It is recognized that chemical properties of water influence the type, abundance, and distribution of plankton species. Plankton are important components in the food web supporting animals in open water wetland communities.

However, primary productivity at the Jackson-Frazier site occurs mainly in the aquatic emergents. While water chemistry may influence the productivity of these plants, the degree of effect and the ideal chemical parameters for optimum productivity are unknown. Consequently, this criterion is probably of little use in the evaluation of the Jackson-Frazier site. In addition, the chemical properties listed in the original model (pH and total alkalinity) were adopted in lieu of more specific data collected in the eastern United States. These properties and the respective parameters set by the model may not apply to Willamette Valley wetlands.

Therefore, while water samples were collected and colorimetrically tested (the pH was confirmed with a mini-pH meter), the results were not used in the model for rating wildlife habitat. The derived intermediate rating (2.0) was considered speculative at best.

Wildlife Habitat Score for the Jackson-Frazier Wetland

The criteria used in the wildlife habitat evaluation submodel for the Jackson-Frazier site are listed with their respective numerical values (significance coefficients and ratings) and are displayed in Tables 4 and 5. Once the wetland was rated under the wildlife habitat evaluation submodel (Table 4), each rating was multiplied by its respective significance coefficient to derive a subscore. The sum of the subscores for each criterion was derived to give a total wildlife habitat score for the Jackson-Frazier Wetland (Table 5).

The total score for wildlife habitat for Jackson-Frazier Wetland was derived based on the following assumptions:

- o All criteria in the model are relevant except for water chemistry.
- o It is unreasonable to assume even the "best" wildlife habitat in the Willamette Valley will meet all the criteria in the model at the highest level possible.

- 90 percent of the total possible points under the model (105 x .90 = 94.5) is a realistic gauge of the minimum numerical score for a wetland with the "best" wildlife habitat in the Willamette Valley.

The Jackson-Frazier Wetland total numeric score is 84.5. Using 90 percent of the total points possible (94.5) as a reasonable gauge, leaves a final score for the wetland of 89% with respect to the "best" wildlife habitat (84.5 is 89% of 94.5).

Several conclusions are interpreted from the wildlife habitat assessment. First, the Jackson-Frazier Wetland contains a complex habitat mosaic spread over a sizable area, offering a variety of habitat types for use by a diverse and relatively abundant fauna (e.g., mammals, passerine birds, raptors, etc.) Second, while waterfowl habitat is limited, significant Emergent and Shallow Open Water Wetland units are interspersed throughout the wetland (waterfowl were commonly observed using these habitats). A relatively undeveloped area surrounding the wetland, in combination with a vegetated stream corridor connecting the area with a nearby forested wetland, provides in and outward migration opportunities for wildlife. The agricultural fields surrounding the wetland provide feeding areas for waterfowl and raptors (Red-tailed hawks were observed perching in isolated cottonwood stands located in portions of the wetland adjacent to the fields and numerous waterfowl were observed using ponded water in the fields during winter). In summary, opportunities for a diverse and relatively abundant fauna and interspersed areas for waterfowl (enhanced by adjacent undeveloped land) are the primary contributors to the wildlife habitat value of the Jackson-Frazier Wetland.

Table 4. Wildlife Habitat Ratings for the Jackson-Frazier Wetland.

Habitat Criteria	Rating 3	2.5	2.0	1.5	1
1. Number of wetland classes	> 5	4	3	2	1
2. Dominant wetland class	IEW FEW SO		FW SW	DO	U
3. Size Class	> 500 ac.	101 - 500 ac.	51 - 100 ac.	10 - 50 ac.	< 10 ac.
4. Number of Wetland Subclasses	> 5	4	3	2	1
5. Site Type	bottomland lakeside, bottomland deltaic, bottomland stream-side		bottomland isolated, upland lakeside		upland isolated
6. Surrounding Habitat Type	> 2 of the following habitat types constitute > 90% of the surrounding habitat: 1. forest land 2. agricultural or open land		> 1 of the following habitat types constitute 50 - 90% of the surrounding habitat: 1. forest land 2. agricultural or open land or 1 of preceding constitutes > 90% of the surrounding habitat		> 1 of the following habitat types constitute < 50% of of the surrounding habitat: 1. forest land 2. agricultural or
7. Cover Type	Type 5	Type 4	Type 3,7	Type 1,2	Type 8

IEW = Infrequently Emergent Wetland
FEW = Frequently Emergent Wetland
SO = Shallow Open Water Wetland
FW = Forested Wetland
SW = Shrub Wetland
DO = Deep Open Water Wetland
U = Nonwetland

Table 4. (Continued) Wildlife Habitat Ratings for the Jackson-Frazier Wetland.

Habitat Criteria	Rating				
	3	2.5	2.0	1.5	1
8. Vegetation Interspersion Type	Type 3		Type 2		Type 1
9. Wetland Juxtaposition	Hydrologically connected to other wetlands (different dominant class) or open water bodies within 1 mile or hydrologically connected to other wetlands (same dominant class within 1/4 mile) or wetland > 500 acres with 3 or more wetland classes, including Frequent Emergent and Shallow Open Water Wetland		Hydrologically connected to other wetlands (different dominant class) or open water bodies from 1-3 miles or hydrologically connected to other wetlands (same dominant class) from 1/4-1 mile away or within 1/2 mile of other wetlands (different dominant class) or open water bodies but not hydrologically connected		All other possibilities
10. Water Chemistry	Total alkalinity > 69 ppm CO_3 pH > 7.5		Total alkalinity 23-69 ppm CO_3 pH 6.5-7.5		Total alkalinity < 23 ppm CO_3 pH < 6.5

Table 5. Numeric Wildlife Habitat Score for the Jackson-Frazier Wetland.

Habitat Criteria	Significance Coefficient	Rating	Subscore
1. Number of Wetland Classes	5	3	15
2. Dominant Wetland Class	5	2	10
3. Wetland Size	5	2.5	12.5
4. Number of Wetland Subclasses	4	3	12
5. Site Type	4	2	8
6. Surrounding Habitat Type	4	2	8
7. Cover Type	3	2	6
8. Vegetation Inter-spersion Type	3	3	9
9. Wetland Juxta-position	2	2	4
		Score:	84.5

84.5/(105 x .9) x 100 = 89%
(see page 55)

Visual-Cultural Values (Step 3)

The visual-cultural value assessment of the Jackson-Frazier site consists of five parts: a. classification of wetland and surrounding landscape, b. evaluation of outstanding visual-cultural resources, c. preliminary numeric visual-cultural evaluation, d. numeric cultural enhancement evaluation, and e. a final visual-cultural score.

Classification of Wetland (Part a)

Classification of the Jackson-Frazier site for assessment of visual-cultural values was administered in two sections: classification of interior wetland types and classification of surrounding landscape types. Classification of interior wetland types was accomplished in the initial wetland classification. Five wetland classes were identified (Figure 9). Classification of surrounding landscape types is based on the assumption that the visual-cultural values of a wetland are intimately related to the surrounding landscape. The surrounding landscape was classified under two categories, land use and landforms. A large scale (1:3200) aerial photograph (WAC-82H-1-112) of the wetland and surrounding area, a soils map/orthophotograph in the Benton County Soil Survey Report (Knezevich 1975), and field reconnaissance were used to determine surrounding land uses. Landform types on and around the Jackson-Frazier site were determined using USGS 7 1/2 minute maps (Riverside and

Corvallis quadrangles), the large scale aerial photograph (WAC-82H-1-112), and field reconnaissance.

Ten landscape characteristics (Table 6) were identified. Each characteristic was rated for its contribution to the visual-cultural value of the wetland (Table 8).

Table 6. Definitions of Landscape Characteristics.

1. Landform Diversity

   The variety of shape and/or mode of origin of landforms surrounding, adjacent to, or part of a wetland.

2. Wetland Edge Complexity

   The degree of irregularity of the physical boundary of the wetland where it meets a landform or nonwetland vegetated edge.

3. Associated Water Body Size

   The area of any lake, pond, or reservoir, or the length of a river or stream that borders, goes through, or is part of a wetland.

4. Landform Contrast

   The amount of visual edge manifested in the form of object dominance or spatial enclosure of the wetland in reference to a given landform.

5. Diversity of Associated Water Bodies

   The number of different types of water features surrounding or comprising a given wetland.

6. Surrounding Land Use Contrast

   The amount of contrast generated by the difference in vegetative and structural height and texture between the wetland and the adjacent land use or uses.

7. Surrounding Land Use Diversity

   The amount of contrast generated by the different vegetative and compatible land uses bordering a wetland.

Table 6. (Cont.) Definitions of Landscape Characteristics.

8. Wetland-type Diversity

   The number of various wetland types or micro-landscapes within the wetland itself.

9. Internal Wetland Contrast

   The amount of contrast generated within a wetland by differences in vegetation height, water body size, and texture.

10. Wetland Size

    The size of the continuous wetland area.

<u>Outstanding Visual-Cultural Attributes</u> (Part b)

Certain wetland characteristics are deemed exceptional or outstanding by the model. Under the Larson model, a wetland that meets one or more of the exceptional visual-cultural criteria is automatically recommended for preservation. However, this "red flag" system for protecting wetlands was rejected again at this stage of the evaluation due to the recommendations of the Water Resource Council (Lonard 1981) to utilize "red flag" criteria only as identifiers of potential outstanding wetlands but not as blanket judgements for protection. The criteria are:

1. Outstanding Wetland Natural Areas
   a. Rare and/or endangered species or habitat

2. General Landscape Values

   a. A scarce wetland type within a physiographic region.

b. Outstanding visual contrast (e.g. forested and/or open space against the backdrop of an urbanized landscape.

3. Wetland Systems Value

   a. Wetlands connected to other wetlands by a river or stream of at least 15 miles (24 kilometers) of navigable length.

   b. Wetlands connected to another wetland by a lake, pond, or reservoir over 200 acres (81 hectares) in area.

   c. The wetland constitutes an area of at least 1,000 acres (about 400 hectares).

The Jackson-Frazier Wetland qualifies under criterion number 1a., rare and endangered species or habitat, due to the tufted hairgrass (Deschampsia cespitosa) wet prairie community located near the southern border of the wetland (Baker 1981) and its associated population of the candidate rare and endangered plant species (Hohn 1979), Bradshaw's desert parsley (Lomatium bradshawii). In addition, it qualifies under criterion 2a., a scarce wetland type within a physiographic region due to the vernal pool (Margolis 1982) associated with the wetland (see discussion on page 29).

Air photo and ground surveillance reveal a sharp contrast between the Jackson-Frazier Wetland and the surrounding agricultural land. This visual contrast qualifies the wetland as a potential outstanding scenic resource under criterion 2b.

Preliminary Numeric Visual-Cultural Evaluation (Part c)

This part of the visual-cultural evaluation is developed on the premise that wetlands provide visual, recreational and educational benefits. These benefits may be incurred during such activities as hiking, photography, canoeing, boating, field study, and research.

Two visual quality variables and two recreation/education quality variables are used in the Larson model to derive a preliminary visual-cultural score for wetlands (a cultural enhancement assessment was factored in with the initial visual-cultural score to derive a final visual-cultural score). The visual quality variables are contrast and diversity. The recreation/education quality variables are carrying capacity and opportunity diversity (Table 7). Wetland visual-cultural values are considered to be dependent on these variables. The variables are judged to be manifestations of the ten landscape characteristics identified in the classification.

Each landscape characteristic is rated for its visual-cultural contribution on a scale of 1 to 5 with 5 as the highest. The model rating system (Table 8) was based on research by behavioral scientists (Smardon and Fabos 1983 and Smardon 1983).

The rating system was weighted to account for "mutability" and overlapping values. The greater the "immutability" of a landscape variable, the more resistant to natural or human perturbations, the greater the weight applied to its rating. "Mutability" was weighted on a scale of 1 to 3 with 3 representing immutability (e.g. a landform). Also, over-

Table 7. Visual-Cultural Quality Variables and Associated Landscape Characteristics.

Visual Quality Variables	Landscape Characteristics
1. Visual Contrast	a. landform contrast b. water body size or length c. surrounding land use contrast d. internal wetland contrast
2. Visual Diversity	a. landform diversity b. wetland edge complexity c. wetland type diversity
Recreational/ Educational Quality Variables	**Landscape Characteristics**
1. Recreational Carrying Capacity	a. landform diversity b. wetland edge complexity c. water body size or length d. wetland size
2. Opportunity for Recreational and Educational Diversity	a. landform diversity b. water body diversity c. surrounding land use diversity d. wetland edge complexity e. wetland type diversity f. wetland size

lapping or multiple value weights were applied to landscape characteristics providing more than one potential value. For example, the landscape characteristic of wetland type diversity may contribute to visual, recreational, and educational values. It is, therefore, given a weight of 3 where as a landscape characteristic contributing only to one value receives a weight of 1. The final weight or significance coefficient was derived by multiplying the mutability score by the number of values affected by the landscape characteristic. This number was then multiplied by the rating derived for the associated landscape characteristic. The product represents the numeric score for the landscape characteristic (Table 9).

Table 8. Visual-Cultural Ratings for the Jackson-Frazier Wetland.

1. <u>Landform Contrast</u>

   A. Landscape Dimensions: relative relief/average wetland width

      a. relative relief (difference between wetland elevation and adjacent landform height) = 100 ft.

      source: U.S.G.S. Riverside and Corvallis 7.5 minute Quadrangles

      b. average wetland width = 2517 ft.

      source: air photo (WAC-82H-1-112)

      c. landscape dimensions: 100 ft. / 2517 ft. = .04

   B. Rating Procedure

      a. multiply derived ratio by 3 (arbitrary multiplier) .04 x 3 = .12

      b. assign adjacent landform rating:

Adjacent landform height	Rating
800 - 1000 ft.	5
600 - 800 ft.	4
400 - 600 ft.	3
200 - 400 ft.	2
0 - 200 ft.	1 *

      c. average the two ratings .12 + 1.0 / 2 = .56

      d. Rating = .56

2. <u>Landform Diversity</u>

   A. Landscape Dimensions: number of landform types

      a. number of landform types = 3

         1. foothills near western border of wetland

         2. stream channels draining into, through, and away from the wetland boundaries

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

<u>Landform Diversity</u> (Continued)

source: field reconnaissance and air photo (WAC-82H-1-112)

3. Willamette Valley flood plain

source: U.S.G.S. Riverside and Corvallis 7.5 minute Quadrangle

B. Rating Procedure

a. rate landform diversity using the following scale:

Landform Diversity Rating

Number of Landform Types	Rating
6	5
5	4
4	3
3	2 *
2	1
1	0

b. Rating = 2

3. <u>Wetland Edge Complexity</u>

A. Landscape Dimensions: wetland edge configuration

a. distance along perimeter of wetland (S) = 14,380 ft.

source: a map measurer was used to determine the wetland perimeter on a large scale air photo of the wetland (WAC-82H-1-112).

b. total area of wetland (A) = 158.6 acres or ca. 6,908,600 sq. ft.

source: a planimeter was used in conjunction with the Riverside 7.5 minute Quadrangle to determine wetland area.

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

Wetland Edge Complexity (Cont.)

B. Rating Procedure

a. $S / 2\sqrt{\pi A} = 14{,}380 / 9{,}318 = 1.54$

b. compare wetland edge complexity score with the following scale:

Wetland Edge Complexity	Rating
> 5	5
4 - 5	4
3 - 4	3
2 - 3	2
1 - 2	1 *

c. Rating = 1

4. Associated Water Body Size

A. Landscape Dimensions: navigable length of stream by canoe or acreage of pond or lake

a. navigable length of streams flowing through the Jackson-Frazier site = < 1 mile

b. number of acres of pond or lake = less than 9 acres

source: field reconnaissance and air photo (WAC-82H-1-112)

B. Rating Procedure

a. compare findings with the following scales:

Navigable Miles (canoe)	Acres (pond or lake)	Rating
12 - 15	> 100	5
9 - 12	50 - 100	4
6 - 9	20 - 50	3
3 - 6	9 - 20	2
< 3	< 9	1 *

b. Rating = 1

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

5. Associated Water Body Diversity

A. Landscape Dimensions: number of water bodies in or adjacent to wetland

a. number of water bodies in or adjacent to wetland

1. vernal pool (seasonal)
2. numerous streams and flooded ditches (seasonal)
3. Stewart Slough
4. duck pond (seasonal)

source: field reconnaissance and air photo (WAC-82H-1-112)

B. Rating Procedure

a. use the following table to determine a rating for associated water body diversity:

Number of Water Bodies	Rating
5	5
4	4 *
3	3
2	2
1	1

b. Rating = 4

6. Surrounding Land Use Contrast

A. Landscape Dimensions: the difference between the average height of the wetland vegetation and average height of surrounding land use

a. average height class (see part a. of rating procedure for "surrounding land use contrast") of wetland vegetation

1. The north, east, and west boundaries of the wetland have an average vegetation height class of 5

2. The average vegetation height class at the southern boundary is 3. However, since this portion of the wetland border occupies approximately 10% of the total perimeter and the other 90% of the border has

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

Surrounding Land Use Contrast (Continued)

an average vegetation height class of 5, the wetland was assigned a height class using a weighted average:

10% of border:	1 x 3 = 3
90% of border:	9 x 5 = 45

45 + 3 = 48
48 / 10 = 4.8 (weighted height class)

3. The average height class of the surrounding land use (agriculture) is 2.

source: field reconnaissance

B. Rating Procedure

a. Compare and determine the height class with the following rating procedure (after Smardon 1983):

Average Vegetation Height (feet)	Height Class	Height Class Combinations	Rating
0	1	1/5	5
0 - 2	2	2/5, 1/4	4 *
2 - 4	3	1/3, 2/4, 3/5	3
4 - 15	4	1/2, 2/3, 3/4, 4/5	2
> 15	5	same height	1

b. Rating = 4

7. Surrounding Land Use Diversity

A. Landscape Dimensions: number of height classes and wildlife habitat classes bordering the wetland

a. The number of wildlife habitat classes and their height classes bordering the wetland.

1. There are four wildlife habitat classes (Smardon 1983) surrounding the wetland border. They are as follows:

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

Surrounding Land Use Diversity (Continued)

Wildlife Habitat Classes Surrounding the Wetland	Height Class
a. grass	2
b. cultivation	2
c. water (seasonal)	1
d. forest	5

source: Air photo (WAC-82H-1-112) and field reconnaissance

B. Rating Procedure

a. Compare the number of wildlife habitat classes with the number of height classes surrounding the wetland and average the two numbers.

No. Wildlife Habitat Classes	No. Height Classes	Average
4	3	3.5

b. Rating = 3.5

8. Wetland Type Diversity

A. Landscape Dimensions: The number of wetland classes.

a. The number of wetland classes within the wetland boundary.

1. There are five wetland classes. They are as follows:

Forested Wetland (FW)
Shrub Wetland (SW)
Infrequent Emergent Wetland (IEW)
Frequent Emergent Wetland (FEW)
Shallow Open Water Wetland (SO)

source: field reconnaissance and air photo (WAC-82H-1-112)

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

Wetland Type Diversity (Continued)

B. Rating Procedure:

a. Compare the number of wetland classes with the rating scale below:

Number of Wetland Classes	Rating
5	5 *
4	4
3	3
2	2
1	1

b. Rating = 5

9. Internal Wetland Contrast

A. Landscape Dimensions: The contrast between heights of different wetland classes

a. Determine adjacent wetland classes and their respective height class ratios and use the rating system under criterion number 6 (Surrounding Land Use Contrast) to derive ratings for the various height class combinations.

Adjacent Wetland Classes and Associated Height Classes (See 8 for full names)	Rating
IEW / FW 1 / 4 2 / 5	4
IEW / SW 1 / 3 2 / 4	3
IEW / FEW same height	1
IEW / FW, IEW, SW 1 / 3 2 / 4 3 / 5	3

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

<u>Internal</u> <u>Wetland</u> <u>Contrast</u> (Continued)

Adjacent Wetland Classes and Associated Height Classes	Rating
FEW / SW	3
1 / 3	
2 / 4	
FEW / FW	4
2 / 5	
FEW / FW-IEW-SW	3
1 / 3	
2 / 4	
3 / 5	
FEW / FW	4
2 / 5	
1 / 4	
SO / FEW	2
1 / 2	
2 / 3	
3 / 4	

source: Height classes and wetland classes were derived during the wetland classification using both field work and air photo interpretation (WAC-82H-1-112).

b. Determine the percent of the total edge, exclusive of perimeter, occupied by each set of height class combinations listed above.

Height Class Combination	Percent Total Edge
1. 2 / 5, 1 / 4	4.30
2. 1 / 3, 2 / 4, 3 / 5	5.50
3. same height	3.50
4. 1 / 3, 2 / 4, 3 / 5	10.30
5. 1 / 3, 2 / 4, 3 / 5	7.60
6. 2 / 5, 1 / 4	67.20
7. 1 / 3, 2 / 4, 3 / 5	.48
8. 2 / 5, 1 / 4	1.90
9. 1 / 2, 2 / 3, 3 / 4, 4 / 5	2.40

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

Internal Wetland Contrast (Continued)

source: The percent total edge of each height class combination was derived using a map measurer to trace wetland class boundaries delineated on the Jackson-Frazier classification map.

B. Rating Procedure

a. Multiply the percent of the total edge for each height class combination by its respective rating. Determine the sum of the products.

Percent Total Edge	Rating	Product
1. 4.30	4	.172
2. 5.50	3	.165
3. 3.50	1	.035
4. 10.30	3	.309
5. 7.60	3	.228
6. 67.20	4	2.688
7. .48	3	.014
8. 1.90	4	.076
9. 2.40	2	.048
	Total	3.735

b. Rating = 3.7

10. Wetland Size

A. Landscape Dimensions: Size of wetland (area)

a. Measure wetland area.

1. The Jackson-Frazier Wetland encompasses 158.6 acres.

source: A planimeter and an air photo (WAC-82H-1-112) was used to determine area.

B. Rating Procedure

a. Compare wetland acreage with the scale listed below:

Table 8. (Continued) Visual-Cultural Ratings for the Jackson-Frazier Wetland.

<u>Wetland</u> <u>Size</u> (Continued)

Wetland Area	Rating
501 - 1000 acres	5
251 - 500 acres	4
101 - 250 acres	3 *
51 - 100 acres	2
10 - 50 acres	1

b. Rating = 3

The preliminary visual-cultural score. The preliminary visual-cultural score for the Jackson-Frazier Wetland is 75.4 (Table 9). The highest possible score is 140. While the original model (Larson 1976) assumes a gauge score of 120 for high ranking wetlands, the approach used here was to use a gauge score equal to 90% of the total possible points (126). This was done to maintain consistency in the scoring procedures used in the various sections of the model. Using this approach, the Jackson-Frazier Wetland preliminary visual-cultural percent score was determined to be 59.8% (75.4/126 x 100 = 59.8%).

Each landscape characteristic criterion is displayed in Table 10 under its respective visual-cultural quality variable. This display allows comparison of wetland landscape characteristic ratings in relation to their respective variables. A comparison is useful in interpreting the preliminary visual-cultural score.

The preliminary visual-cultural score is based on the premise that the greater the diversity and contrast exhibited by wetland associated landscape characteristics, the larger the wetland, and the more area of navigable water, the greater the opportunity for quality visual, recreational, and educational experiences. If these landscape characteristics are relatively permanent (immutable) and are presumed to affect more than one visual-cultural value, the wetland values are heightened.

While the Jackson-Frazier Wetland exhibits a great deal

Table 9. Preliminary Visual-Cultural Score for the Jackson-Frazier Wetland.

Landscape Characteristic	Immutability Number			No. of Visual-Cultural Values			Sig. Coeff.	Rating	Score	Maximum Score Possible
	Landform 3	Water 2	Vegetation 1	Visual 1	Recreation 1	Education 1				
1. Landform Contrast	X			X			3	.56	1.7	15.0
2. Landform Diversity	X				X	X	6	2.0	12.0	30.0
3. Wetland Edge Complexity /a			X	X	X	X	3	1.0	3.0	15.0
4. Associated Water Body Size		X			X		2	1.0	2.0	10.0
5. Associated Water Body Diversity		X		X	X	X	6	4.0	24.0	30.0
6. Surrounding Land Use Contrast			X	X			1	4.0	4.0	5.0
7. Surrounding Land Use Diversity			X	X	X		2	3.5	7.0	10.0
8. Wetland Type Diversity			X	X	X	X	3	5.0	15.0	15.0
9. Internal Wetland Contrast			X	X			1	3.7	3.7	5.0
10. Wetland Size			X		X		1	3.0	3.0	5.0
								Total:	75.4	140.0

75.4/(140 x .9) x 100 = 59.8%
(see page 77)

/a The original Larson Model (1976) gives this landscape characteristic an immutability number of 3 on the premise that wetland edges are defined by differences in landform. While this is true in many cases, the area surrounding the Jackson-Frazier site occupies the same landform as the wetland, Willamette Valley floodplain. The wetland boundary, in this case, is defined by cultural influences, i.e., agricultural and urban development. For this reason, the Jackson-Frazier site was assigned an immutability number of 1 for this landscape characteristic.

of diversity and contrast with regards to vegetation and a moderate diversity of water bodies, it is relatively lacking in proximate landform contrast, landform diversity, navigable water bodies, and is only moderate in size. Given that vegetation is highly mutable, the result is a modest preliminary visual-cultural percent score for the wetland. However, the Jackson-Frazier site should not be construed to offer medium to low quality opportunities for visual, recreational, and educational experiences. Within the visual quality display (Table 10), surrounding land use contrast, internal wetland contrast, and wetland type diversity score is in the medium-high to high range. These scores suggest a visually complex and interesting landscape. Within the recreation/education quality display, the Jackson-Frazier site receives moderate scores under wetland size and surrounding land use diversity and high scores under water body diversity and wetland type diversity. These scores suggest a definite but limited set of opportunities for recreational and educational experiences for limited numbers of people.

In summary, the Jackson-Frazier Wetland should be considered a complex highly sensitive wetland offering limited opportunities for visual, recreational and educational experiences for limited numbers of people. Low impact uses (e.g., bird watching, plant identification, outdoor education, unintrusive research practices, etc.) should be considered due to the wetland sensitivity and limited carrying

Table 10. Visual-Cultural Quality Variable Scores for the Jackson-Frazier Wetland.

Visual Quality Variables	Landscape Characteristics	Rating	Maximum Rating Possible	Percent of Possible Rating
1. Visual Contrast	a. landform contrast	.56	5.0	11
	b. water body size	1.0	5.0	20
	c. surrounding land use contrast	4.0	5.0	80
	d. internal wetland contrast	3.7	5.0	74
			Score: 1.1 x (46.25) = 51 *	
2. Visual Diversity	a. landform diversity	2.0	5.0	40
	b. wetland edge complexity	1.0	5.0	20
	c. wetland type diversity	5.0	5.0	100
			Score: 1.1 x (53.33) = 57 *	

Recreation/ Education Quality Variables	Landscape Characteristics	Rating	Maximum Rating Possible	Percent of Possible Rating
1. Recreational Carrying Capacity	a. landform diversity	2.0	5.0	40
	b. wetland edge complexity	1.0	5.0	20
	c. water body size or length	1.0	5.0	20
	d. wetland size	3.0	5.0	60
			Score: 1.1 x (35.0) = 39 *	

* These scores are treated independently in this research and are displayed here to demonstrate individual contributions of landscape characteristics to the visual-cultural variables (values) of the Jackson-Frazier Wetland. The scores were weighted on the premise that it is unreasonable to expect any wetland to score 100% under the model and that a wetland scoring at least 90% should be considered an excellent wetland in terms of visual-cultural values. In effect, the weight used compares the scores derived for the Jackson-Frazier Wetland with a hypothetical wetland receiving 90% of the possible score.

Table 10. (Cont.) Visual-Cultural Quality Variable Scores for the Jackson-Frazier Wetland.

Recreation/ Education Quality Variables (Cont.)	Landscape Characteristics	Rating	Maximum Rating Possible	Percent of Possible Rating
2. Opportunity for Recreational and Educational Diversity	a. landform diversity	2.0	5.0	40
	b. water body diversity	4.0	5.0	80
	c. surrounding land use diversity	3.5	5.0	70
	d. wetland edge complexity	1.0	5.0	20
	e. wetland type diversity	5.0	5.0	100
	f. wetland size	3.0	5.0	60
			Score: 1.1 x (61.66) = 68 *	

* These scores are treated independently in this research and are displayed here to demonstrate individual contributions of landscape characteristics to the visual-cultural variables (values) of the Jackson-Frazier Wetland. The scores were weighted on the premise that it is unreasonable to expect any wetland to score 100% under the model and that a wetland scoring at least 90% should be considered an excellent wetland in terms of visual-cultural values. In effect, the weight used compares the scores derived for the Jackson-Frazier Wetland with a hypothetical wetland receiving 90% of the possible score.

capacity.

The numbers generated here are most meaningful when used ordinally with numbers generated for other wetlands in the same phisiographic province under the same model. For example, proximate landform contrast, as measured in the model, is probably insignificant for most wetlands in the Willamette Valley. Therefore, most Willamette Valley wetlands will probably score low under the landform contrast criterion. Application of the model to a variety of Willamette Valley wetlands would allow a range of scores to be established for this criterion. The criterion could then be judged as invalid and eliminated or manipulations of the scale of measure could be made to reflect the range of scores possible in the Willamette Valley. Criterion elimination and manipulations of measurement scales were considerd for this research but judged to be premature due to the absence of comparison sites.

<u>Numeric Cultural Enhancement Evaluation</u> (Part d)

The purpose of this section of the visual-cultural evaluation is to address cultural attributes, both positive and negative, of the Jackson-Frazier Wetland. A cultural attribute or variable represents the effects of human activity on the values of the wetland. For example, a wetland's value may be enhanced by increased accessibility or diminished by the pressure of an adjacent housing development. The cultural variables used in this stage of the application of the

Larson (1976) Model are defined as follows:

1. Educational Proximity

   The proximity of elementary schools, high schools, and colleges.

2. Physical Accessibility

   The accessibility to the wetland by trail or road and accessibility within the wetland by boat, trail, or road.

3. Ambient Quality

   The physical condition of the wetland as indicated by lack of water pollution, air pollution, high noise level, and visual misfits or visually noncompatible land uses.

The Jackson-Frazier Wetland was rated under each of the cultural enhancement variables described above. A rating scale from 1 to 5 was used with 5 as the highest rating (Table 11).

Table 11. Rating Cultural Enhancement Variables for the Jackson-Frazier Wetland.

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1. Educational Proximity

   A. Landscape Dimensions: The proximity of elementary schools, high schools, and colleges to the Jackson-Frazier site.

      a. Locate all the elementary schools and high schools within a 10 mile radius of the wetland.

         1. Cheldelin Junior High School
         2. WCTU Childrens Home
         3. Mountain View School
         4. Wilson School
         5. Fairplay School
         6. Hoover School
         7. Highland View School
         8. Garfield School
         9. Jefferson School
         10. Franklin School
         11. Washington School
         12. Harding School
         13. Zion School
         14. Roosevelt School
         15. Adams School
         16. Corvallis High School
         17. Crescent Valley High School

         source: Knezevich, C. A., 1970, Soil Survey of Benton County , Oregon, Sheet 17, 11, 22, and 21.

      b. Locate all colleges within a 50 mile radius of the wetland.

         1. Oregon State University
         2. Linn-Benton Community College
         3. Willamette University
         4. University of Oregon
         5. Western Oregon State College
         6. Lane Community College
         7. Chemeketa Community College

      source: telephone directories and state highway map

      c. Measure the distance of the closest elementary school along existing roads.

Table 11. (Continued) Rating Cultural Enhancement Variables for the Jackson-Frazier Wetland.

Educational Proximity (Continued)

1. Cheldelin Junior High School is approximately 3/4 of a mile from the wetland border along existing roads.

source: Knezevich, C. A., 1970, Benton County Soil Survey Report, Benton County, Oregon, Sheet 17.

d. Measure the distance to the closest college along existing roads.

1. Oregon State University is approximately 4 miles from the southern border of the Jackson-Frazier Wetland.

source: City map of Corvallis.

B. Rating Procedure

a. compare the derived distances with the following scale to determine a rating for educational proximity:

Distance Zones (Elementary and/or High Schools)	Rating	Distance Zones (Colleges and Universities)	Rating
0-1 m	5 *	0-10 m	5 *
1-5 m	4	10-20 m	4
5-10 m	3	20-30 m	3
10-15 m	2	30-50 m	2
> 15 m		> 50 m	1

b. Average the two ratings:
5 + 5 = 10   10 / 2 = 5

c. Rating = 5

2. Physical Accessibility

A. Landscape Dimensions: The number of access types.

Table 11. (Continued) Rating Cultural Enhancement Variables for the Jackson-Frazier Wetland.

<u>Physical Accessibility</u> (Continued)

a. Check wetland and surrounding area for different types of access to and on the wetland and record the number of access types found.

1. Trails on wetland
2. Trails to wetland
3. Roads to wetland

source: Field reconnaissance and air photo (WAC-82H-1-112).

B. Rating Procedure

a. Compare access types listed above with the following table to determine the physical accessibility rating.

Number of Access Types	Rating
5	5
4	4
3	3 *
2	2
1	1

b. Rating = 3

3. <u>Ambient Quality</u>

A. Landscape Dimension: The number of environmental quality problems on or near the wetland.

a. List all environmental quality problems at the wetland site using a cursory survey without the aid of environmental testing equipment.

1. Due to the close proximity of the Jackson-Frazier site to major road and railroad access routes to the city of Corvallis, considerable noise from automobiles and trains is discernible from the wetland interior.

Table 11. (Continued) Rating Cultural Enhancement Variables for the Jackson-Frazier Wetland.

Ambient Quality (Continued)

2. The wetland vegetation provides a visual buffer between most of the interior wetland areas and the outside areas. However, due to the relatively open character of vegetation near the southern border, an urban multi-unit housing tract and trailer park are visible to people walking in that area. This urbanized land use does not blend in with the overall visual character of the wetland site. In addition, the Corvallis Hospital is visible from certain portions of the wetland interior.

source: field reconnaissance and air photo (WAC-82H-1-112).

B. Rating Procedure

a. Use the following schedule to determine the rating for the ambient (environmental) quality of the wetland site.

Number of Problems	Rating
0	5
1	4
2	3 *
3	2
4	1

b. Rating = 3

Cultural enhancement score. The cultural enhancement score (Table 12) was derived using essentially the same system used in determining the preliminary visual-cultural score. The only difference was in the method used to determine the significance coefficient. The mutability criteria used in determining the preliminary visual-cultural score were irrelevant in the cultural enhancement evaluation.

Table 12. The Numeric Cultural Enhancement Score for the Jackson-Frazier Wetland.

Cultural Resource Variable	No. of Visual-Cultural Values			Signif. Coeff.	Rating	Score	Maximum Score Possible
	Visual	Recreational	Educational				
Educational Proximity			X	1	5	5	5
Physical Accessibility	X	X	X	3	3	9	15
Ambient Quality	X	X	X	3	3	9	15
					Total:	23	35

$23/(35 \times .9) \times 100 = 73\%$
(see page 89)

Therefore, the significance coefficient was determined solely by the number of values a particular cultural variable affects. Once the significance coefficients were determined, they were multiplied by their respective ratings as determined in Table 11. Each of the products were then summed to derive a total cultural enhancement score of 23. There are 35 total points possible in the cultural enhancement section of the model. Using the 90% factor (.90 x 35 = 31.5), the final score for the cultural enhancement variables is 73% (23 = 73% of 31.5).

Final Visual-Cultural Score (Part e)

The original model (Larson 1976) gives the option of using the visual-cultural evaluation by itself in the final assessment or the option of adding the cultural enhancement score and the visual-cultural score to derive a total visual-cultural score. Neither of those options were used in the Jackson-Frazier site analysis. Instead, the percent scores derived from the visual-cultural and cultural enhancement assessments were averaged to obtain a final visual-cultural score for the wetland. This approach was judged to be a more meaningful representation of the effect of the cultural enhancement variables on the the visual-cultural values of the Jackson-Frazier site. The final visual-cultural percent score is 66% (59.8% + 73% / 2).

The cultural enhancement section of the model reflects the effects of man's activities on the visual-cultural values of the wetland, both positive and negative. The close proximity of the wetland to education centers and available access routes to the wetland are counterbalanced by infiltration of urban noise and urban encroachment at the southern border. The average of the preliminary visual-cultural score and the cultural enhancement score reflects the effect cultural influences have on the visual, recreational, and educational experiences offered by the wetland. The final percent score should be interpreted as an indication of a valuable visual-cultural site that offers a limited but definite set of high quality visual-cultural experiences, is highly sensitive to perturbations and that is indeed experiencing the effects of urban encroachment.

Hydrologic Value Assessment (Step 4)

Two alternative methods are used to assess hydrologic values associated with the Jackson-Frazier Wetland. The first method is comprised of two sections; flood mitigation capabilities and ground water potential. The second method addresses flood mitigation and desynchronization potential.

Method Number 1

Flood Mitigation Capability. The ability of wetlands to desynchronize and mitigate flooding is well documented in the literature (Reppert et al. 1977). A wetland's ability to modify downstream flooding is largely dependent upon the following factors: size of the wetland, associated stream order, magnitude of the flood, degree of urban encroachment, alternative retention sites near potential damage areas, and proximity of the wetland from potential downstream flood problem areas (Ogawa 1982).

While the Larson Model presents an assessment of flood mitigation values for wetlands in the Charles River Basin and their subsequent estimated dollar value, it does not outline procedures for applying the assessment to other wetlands. Therefore, the methods required to complete this section of the assessment were adopted from other sources.

To gain an understanding of the flood storage effectiveness of the Jackson-Frazier site, the Adamus (1982) model for functional wetland assessment was used in conjunction with the research of Ogawa (1982) and the Corvallis Drainage Master Plan (City of Corvallis 1981) to develop and implement a numeric flood mitigation assessment. Six criteria, identified by Ogawa (1982), were used in the the assessment: /4

1. Size of wetland

   The larger the wetland the greater its potential for water detention.

2. Stream order association /5

   "Upstream wetlands" (associated with 1st - 3rd order streams) are more effective in reducing immediate downstream flooding than "downstream wetlands" (associated with 5 th order streams).

3. Degree of urban encroachment

   The areal extent to which a given wetland has been filled and developed.

4. Magnitude of flood: /6

   Flood magnitude means frequency and degree of bank overflow as measured by the statistical correlate of the 100 year flood. This criterion is heavily influenced by the

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/4 The rationale used to establish these criteria were based on the results of computer simulations applied to wetlands in the Charles River Basin, Massachusetts (Ogawa 1982).

/5 The results of computer model simulations indicate that downstream mainstem wetlands are more effective at downstream flood mitigation than upstream wetlands (Ogawa 1982). These findings appear to be in conflict with the Adamus Model criterion "Location in Watershed". Adamus assumes the lower a wetland is in the overall watershed, the lower its ability to retain a significant portion of the inflow (Adamus 1982). A case study (Strahler and Strahler 1974) in the Savannah River Basin indicates that flood discharge increases downstream due to the increased watershed. For this research, this criterion reflects the reasoning of the Adamus Model.

/6 This criterion was incorporated into the model under the encroachment criterion. A 100 year flood was considered under varying degrees of encroachment.

degree of urban encroachment. Relatively heavy encroachment (up to 50%) does not significantly alter peak flow of an 8 year flood. However, the peak flow of a 100 year flood would significantly increase with the same degree of encroachment.

5. Proximity of other storage areas upstream of potential damage sites:

   The effectiveness of a particular wetland to mitigate floods decreases with an increase in the number of alternative storage areas upstream (within 1-2 miles) of the potential damage sites.

6. Proximity of the wetland to potential damage sites:

   The further downstream a potential damage site (e.g. an urbanized area) from a given wetland, the less effective the wetland is at modifying the effects of flooding on the site.

These criteria were placed in a format similar to that used in the Adamus Model (Table 13). The assessment was modified by respectively substituting the qualitative values of high, medium, and low, proposed in the Adamus (1982) Model, by the ratings 3, 2, and 1 to facilitate a numerical interpretation of wetland flood mitigation potential. The ratings determined for the Jackson-Frazier Wetland were summed to determine a final numeric score. This score was then converted to a percent score based on 90% of the maximum number of points possible in the rating system used. The results were compared with the findings outlined in the Corvallis Drainage Master Plan.

Table 13. Flood Mitigation Rating and Score for the Jackson-Frazier Wetland (Method 1).

Criteria	Rating Value: High (3)	Rating Value: Medium (2)	Rating Value: Low (1)	Rating	Maximum Rating Possible
Wetland Size	> 200 acres	100-200 acres	< 100 acres	2	3
Stream Order Association	1st and 2nd order	3rd and 4th order	> 5th order	2	3
Degree of Encroachment	less than 25%	25-50%	50-100%	3	3
Alternative Flood Storage	no alternatives upstream of the urbanized area	1 medium (100-200 acres) alternative immediately upstream of potential problem areas or 1-3 100-200 acre alternatives < 2 miles upstream of the potential damage areas	1 large alternative (>200 acre) immediately upstream of potential problem areas or > 3 alternatives > 200 acres in size within 2 miles upstream of the potential damage areas	3	3
Proximity of Wetland to Potential Damage Sites	0 - 1 mile	1 - 2 miles	> 2 miles	3	3
			Numeric Score:	13	15

Percent Score: 13/(15 x .9) x 100 = 96% /a (see page 95)

/a It is unreasonable to expect any wetland in the Willamette Valley would achieve all the points possible in the model. Therefore, in effect, this score compares the Jackson-Frazier Wetland with a hypothetical "best" wetland achieving 90% of the possible points.

The Jackson-Frazier Wetland achieved a flood mitigation score of 13. This was divided by 90% of the maximum score possible (13.5) and multiplied by 100 to derive a final percent score of 96. This score suggests a high potential for downstream flood mitigation for areas within one mile of the wetland. These findings are somewhat inconsistent with the findings in the Corvallis Drainage Master Plan (City of Corvallis 1981) that the Jackson-Frazier Wetland area only serves as a ponding area for low flows associated with "common" storm events. The inconsistency in findings may be attributed with several factors. First, relatively few criteria are used in the assessment. One of those criteria gives the wetland points for being the only detention site in the area. While this may increase the wetlands responsibility for flood reduction, it also increases potential flow volumes which detract from the wetland's storage capability. Also, this assessment identifies the flood mitigation potential of the wetland relative to downstream development based on upstream drainage. However, under major flood conditions (one percent flood return probability) flooding also occurs downstream of the wetland due to Willamette River waters (City of Corvallis 1981).

The model should be viewed as a general means of identifying some key factors that may be helpful in estimating a wetland's ability to mitigate flooding (e.g., size, stream order, degree of encroachment, and proximity to damage sites). It cannot predict the antecedent moisture conditions relative to a given storm which clearly affects the wet land's ability to retain water (Ogawa 1982). In addition, the model cannot quantitatively predict the total flood reduction downstream of the wetland for a given storm event or over a projected time frame.

For the reasons cited above, no attempt was made to attach a dollar value to the flood mitigation benefits provided by the wetland. However, such attempts have been made in other studies. They are included here to give a perspective of potential dollar benefits accrued through flood mitigation by wetlands.

The Larson (1976) Model uses a Corps of Engineers study to derive a capitalized value for flood control benefits of wetlands in the Charles River Basin of $1,488 per acre (5.375% capitalization rate). A subsequent study by the Corps of Engineers in the Charles River Basin was used by Ostro and Thibodeau (1979) to derive a capitalized value for flood mitigation of $ 33,000 an acre (6% capitalization rate).

Potential Ground Water. A 1:62,500 map (Bela 1978) of the stream and terrace deposits underlying the Jackson-Frazier Wetland indicates ground water potential to be good to high for much of the site. This is supported by the Corvallis Drainage Master Plan (1981) and an unpublished paper (Norgren 1984); however, the fact that the area is underlain by ground water-bearing deposits does not mean that the wetland represents a ground water recharge area. The surface clay deposits, with impeded drainage, suggest that the wetland does not have direct connection with the ground water resource.

There is, at this time, no method available for confirmation of ground water capabilities other than test drilling. For this reason, and the fact that water supply is not a major concern for the general area, an assessment of ground water potential was considered unnecessary and beyond the scope of this research.

Method Number 2

Flood Mitigation Capability. This assessment emulates and modifies the flood storage section of the Adamus (1982) Model and applies it to the Jackson-Frazier Wetland. Fourteen criteria were used to define the wetland's ability to store flood waters and desynchronize flows:

1. Degree of outlet constriction
2. Shape of wetland channels
3. Amount of wetland surface area
4. Wetland area/subwatershed (drainage basin feeding wetland) ratio
5. Location in watershed
6. Gradient of wetland
7. Gradient of wetland edge
8. Vegetation (form)
9. Substrate type

10. Landcover of subwatershed
11. Mean water depth (measured over time)
12. Flow blockage
13. Vegetation (density)
14. Sheet flow vs. channel flow

Each criterion is considered a predictor of the degree of a wetland's effectiveness in flood mitigation and is rated using three probability ratings; low, medium and high (they are assigned the numbers 1, 2, 3 respectively). However, no one predictor should be considered in an absolute sense. Although the predictors are considered to be correlated with wetland flood mitigation capability, the associated probability ratings cannot be considered statistical correlates. Therefore, the rating of any given predictor may be tenuous if considered in isolation of the associated predictors.

Each predictor is rationalized and gauged under three modifiers. The modifiers are also rated low, medium, and high. However, modifiers are not assigned numbers. There is no attempt to incorporate them into the numeric rating system. They are presented here to aid users of the system in judging the relative validity of the criteria used. The rationale and modifiers are defined below:

Rationale:

This describes the principle for the rating of the associated predictor.

A. Certainty of Validity:

This is a subjective statement concerning the author's (Adamus 1982) confidence in the accuracy and general applicability of the ratings and philosophy associated with the rationale.

B. Potential Importance to Process:

A subjective and relative statement of the magnitude of potential importance a predictor has with respect to the considered function.

C. Soundness of Measure:

The soundness of measure varies according to the directness of measure, i.e., a measurement of the degree of slope for a stream channel can be directly measured but the degree of outlet constriction is more of a subjective estimate (these decisions were based on this authors' opinions).

Predictor Analysis

1. Constriction

Rationale:

Constricted outlets hold back flood waters and increase storage area of a basin.

A. Certainty of Validity: High

B. Potential Importance to Process: Moderate

C. Soundness of Measure: Low (estimated during ground survey)

2. Shape of Wetland Stream Channels

Rationale:

Channels with irregular shorelines slow passage of flood waters through actual physical resistance. Straighter stream channels have higher peak flows and higher mean velocities at flood stage.

A. Certainty of Validity: High

B. Potential Importance to Process: Low

C. Soundness of Measure: Moderate (estimated and mapped [Figure 6] with aid of air photo [WAC-82H-1-112] during ground survey)

3. Amount of Wetland Surface Area

Rationale:

The larger the wetland the larger its functional value for water storage. However, the value does not always increase proportionally with size. Other factors may alter the influence of size on flood retention capability.

A. Certainty of Validity: Unknown

B. Potential Importance to Process: Unknown

C. Soundness of Measure: High (a planimeter was used to estimate the area on USGS Riverside Quadrangle)

4. Wetland Area/Subwatershed Ratio

Rationale:

A wetland with a relatively small watershed may more effectively buffer stream runoff than the same size wetland with a significantly larger watershed.

A. Certainty of Validity: Moderate

B. Potential Importance to Process: High

C. Soundness of Measure: High (Figure 6.6 in the Corvallis Drainage Master Plan and USGS Riverside Quadrangle were used to outline drainage basin boundary and wetland boundary with a planimeter. The respective areas were compared in a ratio)

5. Location in Watershed

Rationale:

The storage capacity is less likely to be overwhelmed if inflows are moderate as occurs high in watersheds.

A. Certainty of Validity: Moderate

B. Potential Importance to Process: Moderate

C. Soundness of Measure: High (Figure 6.6 in the Corvallis Drainage Master Plan, USGS Riverside and USGS Corvallis Quadrangles were consulted for this information)

6. Gradient of Wetland

   Rationale:

   Lower gradients have slower drainage rates and therefore increase retention times of flood waters in a wetland.

   A. Certainty of Validity: Moderate

   B. Potential Importance to Process: Moderate

   C. Soundness of Measure: Moderate (USGS Riverside Quadrangle used to make rise over run calculation)

7. Gradient of Wetland Edge

   Rationale:

   Flat to gentle slopes permit flood waters to spread out, providing temporary storage and loss via evapotranspiration without a severe increase in stage height (adjacent lands receive flow that would otherwise flood downstream areas)

   A. Certainty of Validity: High

   B. Potential Importance to Process: High

   C. Soundness of Measure: High (Estimated with a clinometer during field visits)

8. Vegetation Form

   Rationale:

   Vegetation helps desynchronize flows by increasing channel roughness. However, vegetation resistance rapidly decreases as water depth exceeds vegetation height.

   A. Certainty of Validity: High

   B. Potential Importance to Process: Moderate

   C. Soundness of Measure: Moderate (Estimated during wetland classification field visits)

9. Substrate Type

   Rationale:

   Functional resistance decreases with decreasing particle size of sediment. Coarser sediments have faster drainage rates and are less likely to be saturated during peak flooding. Therefore, they are considered more capable of storing additional inputs and controlling peak flows.

A. Certainty of Validity: Moderate

B. Potential Importance to Process: Low

C. Soundness of Measure: High (Soil samples were examined in the field)

10. Landcover of Subwatershed

Rationale:

Urban development increases runoff because impervious surfaces and hydraulically effective drainage systems result in higher outflow peaks. Cropland also increases runoff efficiency and decreases actual physical resistance to flood waters.

A. Certainty of Validity: High

B. Potential Importance to Process: High

C. Soundness of Measure: Low (Estimate based on personal observations while traveling in the area)

11. Mean Water Depth (measured seasonally)

Rationale:

Storage per unit area becomes proportionally less the shallower the depth.

A. Certainty of Validity: High

B. Potential Importance to Process: High

C. Soundness of Measure: Moderate (Estimated from field visits made in the late summer and fall (low runoff) and spring (high runoff)

12. Flow Blockage

Rationale:

Channel roughness, flood water velocity, and desynchronization potential increase directly with the number of obstructions.

A. Certainty of Validity: High

B. Potential Importance to Process: Moderate

C. Soundness of Measure: Low (Estimated during field visits)

13. Vegetation Density

Rationale:

Friction of flood water flow is positively correlated with vegetation density. Also, nonsubmerged vegetation increases evapotranspiration potential.

A. Certainty of Validity: Low / Moderate

B. Potential Importance to Process: Low / Moderate

C. Soundness of Measure: Moderate (Estimated during wetland classification field visits)

14. Sheet Flow vs. Channel Flow

Rationale:

Frictional resistance and thus potential for desynchronization is greater where flow is mostly sheet flow.

A. Certainty of Validity: Moderate

B. Potential Importance to Process: Moderate

C. Soundness of Measure: Low (Estimated during field visits)

Table 14. Flood Mitigation Rating and Score for the Jackson-Frazier Wetland (Method 2).

Criteria	Modifiers	Rating /a			Score/ Possible Score
		High (3)	Medium (2)	Low (1)	
Degree of Outlet Constriction	H,M,L	Highly Constricted	Moderately Constricted	Unconstricted	1/3
Shape of Channels	H,L,M	Irregular/Sinuous	Moderately Irregular	Straight	2/3
Wetland Surface Area	U,U,H	> 200 acres	100-200 acres	< 200 acres	2/3
Wetland Area/ Subwatershed Area	M,H,H	> .20	.05-.20	< .05	1/3
Location in Watershed	M,M,H	Upper 1/3	Middle 1/3	Lower 1/3	1/3
Gradient of Wetland	M,M,M	Gentle	Moderately Steep	Steep	3/3
Gradient of Wetland Edge	H,H,H	Gentle	Moderately Steep	Steep	3/3
Vegetation Form	H,M,M	Forested	Shrub	Emergent	3/3
Substrate Type	M,L,H	Rubble > 3in.	Cobble-Gravel/ Sand .1-3 in.	Organic/Mud < .1 in.	1/3
Landcover of Sub-Watershed	H,H,M	Forested	Non-forested Natural Vegetation	Developed	2/3

/a In many cases the Jackson-Frazier site fit under more than one rating classification depending on the location in the wetland. In those cases, the predominant feature was used in the rating procedure.

Modifiers

1st place = Certainty of Validity
2nd place = Potential Importance to Process
3rd place = Soundness of Measure

H = High
M = Moderate
L = Low

Table 14. (Cont.) Flood Mitigation Rating and Score for the Jackson-Frazier Wetland (Method 2).

Criteria	Modifiers	Rating /a			Score/ Possible Score
		High (3)	Medium (2)	Low (1)	
Mean Water Depth	H,H,M	> 2 meters	1 - 2 meters	< 1 meter	1/3
Flow Blockage	H,M,L	Much Debris or Bathymetric Irregularity	Moderate Debris or Bathymetric Irregularity	Little Debris or Bathymetric Irregularity	2/3
Vegetation Density	L/M,L/M, M	Dense	Semi-Dense	Scattered	3/3
Sheet Flow vs. Channel Flow	M,M,L	Mostly Sheet Flow	50% Sheet/50% Channel	Mostly Channel	1/3
					26/42

Percent Score: 26/(42 x .9) x 100 = 69% /b (see page 106)

/a In many cases the Jackson-Frazier site fit under more than one rating classification depending on the location in the wetland. In those cases, the predominant feature was used in the rating procedure.

/b It is unreasonable to expect any wetland in the Willamette Valley would achieve all the points possible in the model. Therefore, in effect, this score compares the Jackson-Frazier Wetland with a hypothetical "best" wetland achieving 90% of the possible points.

Modifiers

1st place = Certainty of Validity
2nd place = Potential Importance to Process
3rd place = Soundness of Measure

H = High
M = Moderate
L = Low

The Jackson-Frazier Wetland scores 26 points out of a possible 42 points under this model (Table 14). Using a 90% factor (42 x .9 = 37.8) the wetland achieves a percent score of 69 (26 is 69% of 37.8). This score would indicate the wetland has moderate flood storage and desynchronization capabilities. The results of this assessment are more consistent with the findings of the Corvallis (1981) Drainage Master Plan (that the Jackson-Frazier Wetland is only capable of storing floods with an approximate 12% return frequency) than the previous flood mitigation assessment used in this research. A more detailed list of assessment criteria may improve the validity of the assessment (this is, apparently, a major assumption under the Adamus [1982] model). Limitations associated with the previous flood mitigation assessment regarding antecedent moisture conditions and downstream flooding from the Willamette River also apply to this assessment. Hydrologic research data generated by a long term monitoring program is needed to test results of flood assessment models. At this stage, they should only be used as guidelines for determining flood mitigation potential.

In general, we can interpret from the model that the Jackson-Frazier site has certain features that are conducive to flood desynchronization and storage (e.g., gentle gradient, gentle edge, moderately irregular stream channels, moderate surface area, a moderately developed drainage basin, and high dense vegetation). However, the wetland's surface area is less than 5% of the surface area of the area draining into it, is too shallow to contain large volumes of water, has a substrate relatively impervious too surface drainage, and drains most of its water through unconstricted channels.

Economic Assessment of Jackson-Frazier Wetland Preservation Value (Stage 3)

Wetland preservation values are presumably anthropic concepts based on societie's perceptions of their desirability which are generated by perceptions of their utility (relative to alternative uses) and scarcity. The measure of value is distinguished from the concept of value. This section of the Jackson-Frazier Wetland value assessment emulates the Larson (1976) model in using the number of public dollars used to purchase lands for preserving wildlife habitat and visual-cultural values as the measure of preservation value expressed as a "price". Prices were established for wildlife habitat and visual-cultural sites in the Willamette Valley and used as gauges to estimate the preservation value of the Jackson-Frazier Wetland.

Wildlife Habitat Values

Data were collected on acquisition prices for areas purchased in the Willamette Valley by the Oregon Department of Fish and Wildlife (ODFW) and the U.S. Fish and Wildlife Service (USFWS). Each area was acquired with public monies for its wildlife habitat value and is currently designated as a wildlife refuge. The refuges acquired are listed below with their respective governing agency:

1. William Finley (USFWS)
2. Baskett Slough (USFWS)
3. Ankeny (USFWS)
4. Sauvie Island (ODFW)

Since, these refuges were acquired and are currently maintained with federal and state dollars, they are judged to be adequate indicators of societies' "willingness to pay", or the economic rent, for wildlife habitat in the Willamette Valley. However, since most of the land acquired at these sites is nonwetland, this research acknowledges the sites may underestimate the monetary value of wildlife habitat for wetlands in the Willamette Valley. /7

A major problem associated with this approach is that land acquisitions for these refuges occurred at various periods in time and under different political and economic conditions than today. A means of adjusting past dollar values to present dollar values had to be determined. The problem of different times of acquisition was addressed using two methods to update the dollar values of past refuge land acquisitions:

Value Adjustment Method Number 1

Every five years, all federal wildlife refuges in Oregon are required to complete an appraisal of their lands for revenue sharing with their respective counties. Appraisals for William L. Finley, Baskett Slough, and Ankeny Refuges were completed in 1982 (Kistner 1982). Since these appraisals provide estimates of fair market value, they were used in the assessment. This leaves the problem of updating the

/7 These sites were not acquired as unaltered wetlands, although significant unaltered wetland sites occur on two of the refuges (Finley and Sauvie Island), the predominant character of most of the parcels acquired was that of abandoned or active farmland.

1982 prices for the federal refuges and updating all the acquisition prices (46 land acquisitions were considered) for two Sauvie Island state refuges. This was accomplished using method number 2.

Value Adjustment Method Number 2

Most non-urbanized land in the Willamette Valley is in agricultural use. Each of the selected refuges is surrounded by agricultural land zoned Exclusive Farm Use (EFU). It is, therefore, reasonable to assume that were it not for their protected status, they would have likely continued in farm use.

Under this assumption, a farm real estate value index (Table 15) was used to convert past acquisition prices to 1983 dollars (this method was used by federal refuges prior to the implementation of their current appraisal system). The acquisition prices per acre for each refuge were estimated and listed in Table 16.

The highest and lowest priced refuges, Baskett Slough and Wiliam L. Finley, respectively, were selected to define the range of prices society is "willing to pay" for wildlife habitat in the Willamette Valley.

Visual-Cultural Values

The method used to attach monetary value to visual-cultural values of Willamette Valley wetlands is similar in technique and philosophical premise to the method used in the wildlife habitat assessment. Two publicly acquired

Table 15. Farm Real Estate Value Index (1947-1983).

1977 = 100

Year	Index No.	Year	Index No.
1947	13	1966	36
1948	14	1967	39
1949	13	1968	43
1950	13	1969	49
1951	15	1970	54
1952	16	1971	61
1953	16	1972	67
1954	16	1973	75
1955	17	1974	84
1956	17	1975	90
1957	18	1976	95
1958	18	1977	100
1959	19	1978	109
1960	21	1979	120
1961	24	1980	132
1962	26	1981	144
1963	29	1982	145
1964	32	1983	138
1965	35		

$$\text{Present Value} = \frac{\text{Present Index Number}}{\text{Past Index Number}} \times \text{Known Value}$$

Source: Farm Real Estate and Market development Outlook and Situation CD-88. U.S.D.A., Economic Research Services, August, 1983.

Table 16. Adjusted 1983 Acquisition Prices for Publicly Established Wildlife Habitat in the Willamette Valley (dollars/acre).

Wildlife Refuge	Acquisition Prices /a
William L. Finley (USFWS)	1,083.00
Baskett Slough (USFWS)	1,407.00
Ankeny (USFWS)	1,249.00
Sauvie Island (ODFW)	1,127.00

/a Capitalized operations and maintenance costs are not included due to uncertainty regarding whether those costs will be associated with the Jackson-Frazier Wetland and to maintain the conservative approach used in the assessment.

visual-cultural sites were selected. The sites were acquired by Oregon State Parks (Department of Transportation) as part of an effort to protect land along the Willamette River Greenway (a statutory greenbelt established along the banks of the Willamette River from Dorena Reservoir to its mouth). The criteria for site selection were:

- o The sites must exhibit wetland characteristics over a portion of their interiors.
- o The sites must be acquired by public dollars specifically for their value as recreation and scenic areas.
- o The sites must be relatively close to urban areas.
- o The sites must have been zoned as Exclusive Farm Use (EFU) prior to their acquisition.

Table 15 was used to adjust their acquisition prices to 1983 prices. They are listed (Table 17) by the name of the former property owner and by river mile.

Table 17. Adjusted 1983 Acquisition Prices for Publicly Established Visual-Cultural Sites in the Willamette Valley (dollars/acre).

Property	River Mile	Acres	Adjusted Acquisition Prices /a
Pilcher	110	224.5	1,077.00
Cloverdale Farms	119	105.0	1,560.00

/a Capitalized operations and maintenance costs are not included due to uncertainty regarding whether those costs will be associated with the Jackson-Frazier Wetland and to maintain the conservative approach used in the assessment.

These sites were used to define the range of prices society is "willing to pay" for land with visual-cultural value in the Willamette Valley. /8

Preservation Value Determination for the Jackson-Frazier Wetland

The next task was to determine a range of gauge prices for Willamette Valley wetland preservation values. /9 This

/8 This "range" should be viewed critically in lieu of the limited number of gauge sites.

/9 While the literature (Gupta and Foster 1976 and Hufschmidt et al. 1983) suggests adding wildlife and visual-cultural values, this research recognizes an overlap. Since the degree of overlap is difficult to determine, a range of values was established. The upper limit assumes no overlap and the lower limit assumes the lowest preservation value subsumes the highest value.

was done in several steps:

1. First, the minimum per acre wildlife habitat acquisition price (Finley Refuge) and the minimum per acre visual-cultural acquisition price (Pilcher) were compared. The lower of the two figures (Pilcher) was considered the lower limit of the preservation value range:

   $ 1,077.00

2. Next, the maximum per acre wildlife habitat acquisition price (Baskett Slough) and the maximum per acre visual-cultural acquisition price (Cloverdale) were summed. This figure represents the upper limit of the preservation value range:

   $ 1,407.00 + $ 1,560.00 = $ 2,967.00.

3. Finally, a "best estimate" of per acre preservation value of Willamette Valley wetland was derived by averaging the lower and upper limits of the preservation value range:

   $ 1,077.00 + $ 2,967.00 / 2 = $ 2,022.00

The Jackson-Frazier Wetland per acre preservation value is assumed to be equal to or greater than the figure displayed since the figure was derived from acquisitions that were predominantly nonwetland in character. Therefore, a minimum estimate of the preservation value of the Jackson-Frazier Wetland is derived by multiplying the total wetland acreage by the estimated per acre preservation value:

158.6 acres x $2,022.00 = $ 320,689.20

Wetland Preservation vs. Alternative Uses

Preservation value assessments have been used to provide decision makers with a means of making informed choices regarding wetland preservation vs. alternative uses. The original model (Larson 1976) proposes that the best measure of this decision is the difference between the "rate of return" on preservation benefits and the "opportunity cost of the fixed investment". If the number is equal to or greater than zero, alternative uses would be denied. If the number were negative, alternative uses would be granted. This rationale was modified for the preservation value assessment of the Jackson-Frazier Wetland. Fair market value land appraisals of the wetland were judged to be representative of the capitalized value of benefits obtainable from alternative uses and therefore measures of societies' "opportunity cost for preservation". Politically established preservation values were judged to represent capitalized preservation values. Four separate land appraisals for the Jackson-Frazier Wetland were used: $ 4,000 (appraisal by Benton County), $ 2,073.00 (adjusted Benton County Assessors estimate of market value), $ 1,750 (an appraisal by The Nature Conservancy), and $ 500 (price paid for property by present owner). Each appraisal comparison (Table 18) is displayed in a preservation/alternative use ratio. If the ratio is greater than 1 the model suggests the wetland preservation values are greater than alternative use values. If the ratio is less than one the model suggests alternative use values are greater.

Table 18. Preservation / Alternative Use Comparison for the Jackson-Frazier Wetland /a

Preservation Value (dollars/acre)	Alternative Use Value (dollars/acre)	Ratio
2,022.00 /b	4,000.00	.51:1
	2,073.00	.98:1
	1,750.00	1.16:1
	500.00	4.04:1

/a Potential economic benefits from flood mitigation and ground water are not included in the ratio.

/b This figure represents the minimum preservation value for wetlands in the Willamette Valley under EFU zoning.

The model would recommend the wetland be acquired for preservation purposes under the 1,750, and the 500 dollar per acre appraisals. It would recommend alternative uses be allowed in the wetland under the 4,000 and 2,073 dollars per acre appraisals. However, borderline ratios should be weighted towards preservation benefits since the gauge figure used is regarded as a minimum estimate of Willamette Valley wetland preservation values.

Users of this method should realize that all gauge sites must be under the same zoning regulations as the wetland under consideration. For example, if urban wetlands are evaluated using gauge sites zoned as EFU, the preservation value side of the ratio will be very meager compared to the alternative use side of the ratio. Another approach may be to use gauge sites in any zone but weight the ratio to eliminate the disparity between land values created by zoning (other factors contributing to land value may have to be factored in as well). /10 The former approach is recommended as it more closely addresses the "willingness to pay" philosophy of the model.

The preservation value/alternative use value ratio represents the monetary equivalent of preservation value of the Jackson-Frazier Wetland compared to the monetary value of alternative uses. This information gives us a conservative estimate (measured in dollars) of societies' potential loss if the wetland were developed and several estimates of what someone in society may lose if the wetland is preserved.

Examination of this method and the philosophical basis supporting it raises a host of interesting questions. First, How valid is the "willingness to pay" concept? Benton County or The Nature Conservancy may or may not be willing to pay as much for wildlife habitat as the USFWS or the ODFW. The monies used by these agencies for habitat acquisition was largely generated through hunters fees. Were the habitat types and rare plants found at Jackson-Frazier Wetland in the thoughts of these hunters when they purchased their hunting licenses and duck stamps? Do past acquisitions of farmland reflect, even at a minimum level, the true value of increasingly scarce wetlands? Should we compare alternative use values with preservation values given the former are

/10 For a discussion on variables that affect land values, see Beaton (1982).

more directly realized by individuals and the latter are more directly realized by society? Who benefits from preservation values? Do all members of society perceive these values equally? Are there multiplier effects generated by alternative uses that are not accounted for in the ratio? Could developers argue that fair market value is a minimum estimate of alternative use value? Will different perceptions of value bias estimates of preservation and alternative use values? It is evident that this assessment does not resolve the wetland resource preservation issue. It does, however, focus preservation values in more traditional terms, i.e., money. While the validity of this may be argued, it is this authors opinion that the base assumptions and methods used here are as valid as those used in any real estate appraisal. The only difference lies in the fact that the latter system is widely accepted and used and the former system is not. The value comparisons made for the Jackson-Frazier Wetland are not presented as a model for decision making but as information to be viewed and integrated into the decision process.

Summary and Conclusion

Values of Jackson-Frazier Wetland north of Corvallis, are addressed using a modification of the Larson (1976) model for wetland value assessment. The model employs three stages, a preliminary assessment of outstanding wetland values to determine priority for further assessment, a detailed independent assessment of three sub-values: wildlife habitat, visual-cultural, and flood mitigation, and an independent economic assessment of the Jackson-Frazier Wetland. These approaches present information which should help decision makers in making choices with respect to preservation or development of a wetland.

Preliminary Assessment

In the first stage of the modified model, the Jackson-Frazier Wetland qualifies as a high priority wetland for further assessment under four of eleven criteria: 1. Presence of rare flora (*Lomatium bradshawii*); 2. The presence of flora of unusually high visual quality and infrequent occurrence (*Brodiaea hycinthia*, *Clarkia amoena* spp. *lindleyi*, and *Dowingia yina*); 3. The availability of reliable scientific information concerning the biological history of the wetland; and 4. Wetlands that are relatively scarce in a physiographic region or that provide distinct visual contrast between the wetland and its surroundings.

Wildlife Habitat Values

Wildlife habitat values are assessed numerically following a modification of Larson's (1976) procedures. Habitat values are expressed as a percentage relative to a maximum possible wildlife habitat score. The assessment can stand alone or be used comparatively. Wildlife habitat is judged with regard to ten criteria. The wetland is rated under each criterion. The final adjusted wildlife habitat score for the Jackson-Frazier Wetland is 89%, which means that the wetland has good to excellent wildlife habitat values.

A major conclusion is that the Jackson-Frazier Wetland contains a complex habitat mosaic spread over a sizable area and offers a variety of habitat types for use by a diverse and relatively abundant fauna including, mammals, passerine birds, waterfowl, and raptors.

Visual-Cultural Values

Visual-Cultural values are judged with respect to ten landscape characteristics so as to assess visual, recreational, and educational opportunities. This assessment was done in two steps: a preliminary visual-cultural score was determined from measured landscape characteristics followed by consideration of cultural values which either enhance or diminish the values of the wetland.

The adjusted preliminary visual-cultural score for the Jackson-Frazier Wetland is 59.8%. This score is based on the premise that the greater the diversity and contrast exhibited by wetland-associated landscape characteristics, the greater will be the opportunity for quality visual, recreational, and educational experiences. The Jackson-Frazier Wetland has much vegetational and hydrological diversity and contrast. The landforms lack diversity and contrast and the wetland area is rated moderate in size. The result is a modest preliminary visual-cultural percent score; however, the Jackson-Frazier site should not be construed to offer low quality opportunities for visual, recreational, and educational experiences, but as a complex, highly sensitive wetland (based on the vulnerability of vegetation) offering limited opportunities for such experiences as bird watching, nature study, outdoor education, research, as well as, opportunities for solitude and scenic views.

Visual-cultural values are further refined by individually rating three cultural enhancement variables: educational proximity, physical accessibility, and ambient quality. In this section, the model reflects both positive and negative effects of man on visual-cultural values. For example, the area is enhanced by proximity to educational facilities and is impacted by traffic noise and urban encroachment. The Jackson-Frazier Wetland has an adjusted enhancement score of 73%. This score is averaged with the adjusted preliminary visual-cultural percent score (59.8%) to determine a final adjusted visual-cultural score for Jackson-Frazier Wetland of 66%. The wetland is judged as having moderately good visual-cultural qualities.

Flood Mitigation Values

Flood mitigation capability of the wetland is assessed by two alternative methods. The first, is based on Ogawa's (1982) computer simulation model which determines six independent criteria affecting flooding. The simulation was done using data derived for the Charles River Basin, Massachusetts. Following this method, the Jackson-Frazier Wetland has a final score of 96 percent. This score suggests the wetland has an excellent potential for downstream flood mitigation, a finding which is inconsistent with the results of the Corvallis Drainage Master Plan (City of Corvallis 1981). In the Plan, the wetland was identified as a ponding area for "common" storm events (it is capable of storing floods with an approximate 12% return frequency). The inconsistency in findings may be attributed to too few (six) criteria being considered and the inapplicability of certain criteria. Furthermore, this assessment assumes the wetland will mitigate downstream flooding, but it is known that under major regional flood conditions, downstream flooding is caused by the Willamette River (City of Corvallis 1981). This first method should be viewed as a general means of identifying some key factors related to flood mitigation.

The second flood mitigation assessment uses a modification of the Adamus (1982) model in which fourteen criteria define the wetland's ability to store flood waters and desynchronize flows. Under this method, the Jackson-Frazier Wetland has a score of 69%, indicating moderate to good flood storage and desynchronization capabilities. These results are more consistent with the findings of the Corvallis Drainage Master Plan (1981) than those based on Ogawa's (1981) computer model summarized above.

In general, the Jackson-Frazier Wetland has features that desynchronize and store water of low return frequency floods. However, the wetland occupies less than 5% of the surface area of the drainage basin, is too shallow to contain large volumes of water, has impervious clay soil, and rapidly loses its flood mitigation function under higher or more frequent levels of flooding.

Geologic maps indicate potential for ground water in deposits underlying the wetland. Confirmation can only be made through on-site drilling; however, it is improbable that the Jackson-Frazier site is a ground water recharge site due to the impervious clay soils.

Economic Assessment

As an alternative approach to wetland assessment, a modified economic assessment of the Jackson-Frazier Wetland is presented. The assessment is based on a modification of Larson's (1976) model and uses publicly acquired wildlife habitat and recreational sites in the Willamette Valley as gauge sites for the economic value of the wetland. Three federal and two state wildlife refuges are used in conjunction with two Willamette River Greenway acquisitions as economic gauges of societies' willingness to pay for preservation values. A "best estimate" of $ 2,022 per acre is established as the minimum capitalized value of protected wetlands in the Willamette Valley.

The price established for preservation value is compared to several fair market value land appraisals of the Jackson-Frazier Wetland. These estimates were judged to be representative of the capitalized value of benefits obtainable from alternative uses and therefore measures of societies' "opportunity cost for preservation". Four separate per acre appraisals are used: $ 4,000 (appraisal by Benton County), $ 2,073 (adjusted Benton County Assessor's estimate of market value), $ 1,750 (an appraisal by The Nature Conservancy), and $ 500 (price paid for the property by present owner). Each appraisal is compared with the estimated preservation value of $ 2,022/acre.

Based on these simple economic values, the model recommends the wetland be acquired for preservation purposes under the $ 1,750, and the $ 500 per acre appraisals. It would recommend alternative uses be allowed in the wetland under the $ 4,000 per acre appraisal. The appraisal of $ 2,073 per acre is a borderline situation, but should be weighted towards preservation because of the non-wetland character of the gauge sites.

The preservation value/alternative use value ratio represents the monetary equivalent of preservation value of the Jackson-Frazier Wetland compared to the monetary value of alternative uses. This information gives us a conservative estimate (measured in dollars) of societies' potential loss if the wetland were developed and several estimates of what someone in society may lose if the wetland is preserved.

Each assessment method presented should be viewed critically with regards to its assumptions and subsequent criteria. Users of the numeric models should realize the models offer displays of wetland preservation values. These values are often neglected in wetland preservation vs. alternative use decisions. The economic model is treated separately as an alternative means of viewing wetland value. None of the models propose a specific decision but should be regarded as sources of information to be reviewed and integrated into the decision process.

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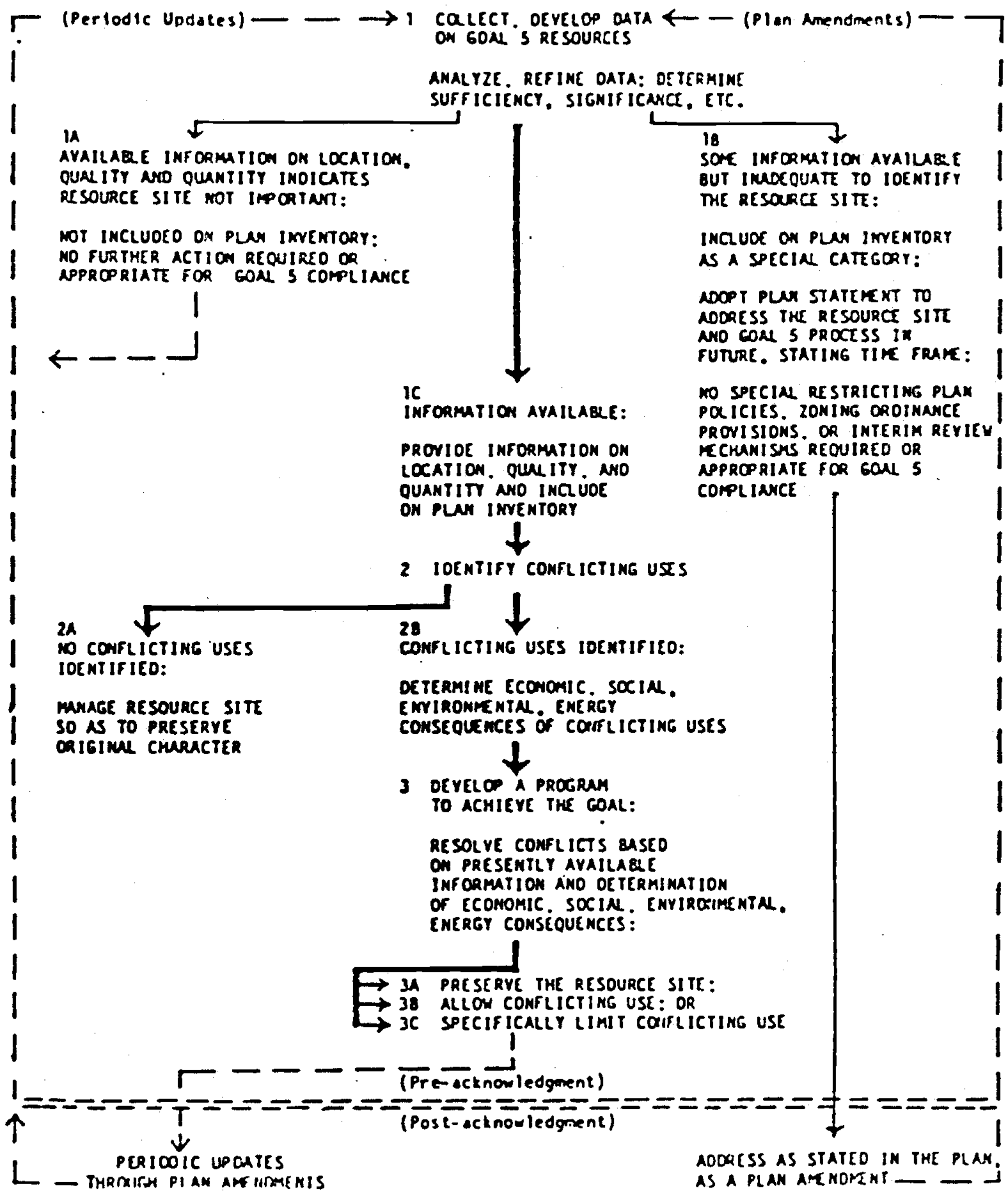
APPENDICES

APPENDIX A

Outline of the Procedure to be Used in Addressing Resources Under Statewide Planning Goal 5 (OAR-660-16-000 et seq.)



APPENDIX B

Summary of the Data Requirements of 20 Wetland Evaluation Procedures

Methodology Number	Citation	Types of Data Required	Measurement Techniques	Limitations Imposed on Data Collection	Implications Relative to User Needs
1	Brown, A., et al. 1974.	Aerial photographs, topographic maps, surficial geology maps, pertinent literature, and field reconnaissance	Value judgments and quantitative information	None	Resource manager should consult specialists for the interpretation of critical data
2	Dee, N., et al. 1973.	Obtained from historical records or from several different measurements that are related; topographic maps, wildlife lists, plant species lists, cultural, historical, and educational/scientific information	Interdisciplinary team assigns points to parameters. Parameter weights are assigned by quantifying research team's subjective value judgments	None stated, but seasonal limitations may be imposed on the collection of some data	Disagreements may occur over the relative values of the parameters
3	Fried, E. 1974	Aerial photographs, maps, alkalinity determinations, species lists, vegetative interspersion, vegetation classes, and vegetative cover	Value judgments and quantitative information	None stated, but possibly seasonal limitations	A resource manager may be necessary to edit results obtained by field workers
4	Galloway, G. E. 1978	Extensive data requirements dependent upon the type of parameters chosen to evaluate; preliminary data include maps and detailed species lists	Interdisciplinary team utilizes value judgments and quantitative data. A team of laymen is required to weigh parameter values	None	The procedure is time-consuming and requires extensive coordination between and among the team of scientists and laymen

APPENDIX B (Cont.)

Methodology Number	Citation	Types of Data Required	Measurement Techniques	Limitations Imposed on Data Collection	Implications Relative to User Needs
5	Golet, F. C. 1973.	Aerial photographs, topographic maps, surficial geology maps; full reconnaissance to obtain wetland subclasses, vegetative interspersion, and water chemistry data	Value judgments and quantitative data	None	Resource manager must be familiar with vegetation and have a good background in wildlife management
6	Gupta, T. R., and Foster, J. H. 1973.	Maps and aerial photographs, limited field data	Value judgments are converted into numerical values	None	The procedure may be too superficial for general use
7	Kibby, H. V. 1978.	Determination of wetland size, periodicity of water exchanges, work review, net primary productivity data	Primarily value judgments, but some quantitative data	None	The procedure may be too superficial for general use
8	Larson, J. S., et al. 1976.	Extensive data requirements; maps, aerial photographs, transmissivity, water storage, and water quality data	Value judgments and quantitative data	None	Procedure results should be monitored carefully for assessment of red flag features
9	Reppert, R. T., et al. 1979.	Maps, charts, aerial photographs, plant and animal species lists, basic hydrology data	Value judgments and quantitative data	None	Additional personnel are likely needed to collect and interpret data

APPENDIX B (Cont.)

Methodology Number	Citation	Types of Data Required	Measurement Techniques	Limitations Imposed on Data Collection	Implications Relative to User Needs
10	Schuldiner, P. W., et al. 1979	Extensive data requirements, plant and animal lists, primary and secondary productivity, basic hydrology data, determination of potential impacts	Value judgments and quantitative data	Basic hydrology data must be collected periodically for at least one year	The user must be willing to commit large amounts of time and resources to an evaluation
11	Stearns, Conrad, and Schmidt - Consulting Engineers. 1979	Extensive hydrology related data requirements, annual water budgets, evapotranspiration rates, mass loadings, etc.	Value judgments based primarily on qualitative data	Hydrology data must be collected on a seasonal basis for at least one year	Extensive amounts of field and laboratory equipment are necessary to implement the procedure
12	Smardon, R. C. 1972	Topographic maps, aerial photogrammetric land use information, cover maps, surficial and bedrock, geology maps, and data obtained from field inspections	Primarily value judgments	None	The user may need training in general principles before the procedure is applied
13	Solomon, R. C., et al. 1977	Interdisciplinary team must decide data requirements	Value judgments and quantitative data	None	The procedure requires large amounts of time, resources, and coordination for implementation
14	State of Maryland. Department of Natural Resources.	Maps, aerial photographs, and field vegetative data	Value judgments and quantitative data	None, but seasonal limitations may be placed on the identification of plant species	The resource manager must be familiar with vegetation and wildlife food value of various plants

APPENDIX B (Cont.)

Methodology Number	Citation	Types of Data Required	Measurement Techniques	Limitations Imposed on Data Collection	Implications Relative to User Needs
15	U. S. Army Engineer Division, Lower Miss. Valley (HES). 1980	Extensive amounts of habitat data; species lists, plant cover, vegetation sampling, data maps, etc.*	Focus on quantitative data; value judgments placed on habitat value	None stated; but seasonal limitations are imposed for some parameters**	Personnel should be trained and certified before attempting to utilize the procedure†
16	U. S. Army Engineer Division, New England. 1972.	Extensive date requirements, wildlife resources, hydrology, hydraulics, geology, demography, archeology, etc.	Value judgments based primarily on floodwater storage capacity of wetlands	Seasonal and possibly other limitations	The Charles River project required extensive citizen participation; the project had extensive time and cost requirements
17	U. S. Department of Agriculture. 1978.	Maps, field analysis, forest management practices, flood control information, species lists, rare and endangered species lists	Value judgments and quantitative information; primarily value judgments	None	The procedure may be too superficial for certain uses. Only a generalized evaluation is possible
18	U. S. Fish and Wildlife Service (HEP). 1980.	Aerial photographs, determination of plant cover types, species lists, topographic maps, photogrammetric information, and water gauging station records	Focus on quantitative data; value judgments placed on habitat value	None	Personnel must be trained and certified before the procedure can be used successfully

APPENDIX B (Cont.)

Methodology Number	Citation	Types of Data Required	Measurement Techniques	Limitations Imposed on Data Collection	Implications Relative to User Needs
19	Virginia Institute of Marine Science. Undated	Reports, maps, aerial photographs, onsite inspections	Value judgments and quantitative data	None	Procedure is limited to applications only in coastal tidal marshes that are flooded daily
20	Winchester, B. H., and Harris, L. D. 1979	Aerial photgraphs, plant and animal species lists, data concerning vegetative structural diversity	Primarily value judgments	None	Results obtained may be too superficial and generalized for some purposes. A rapid evaluation is possible from limited amounts of data

APPENDIX C

Classification of Jackson-Frazier Wetland Vegetation

Phase 1 (Data Collection)

The field data collected for the wetland classification was also used to determine and map wetland plant communities at the Jackson-Frazier site. Image boundaries of vegetation were delineated on a sheet of acetate overlying a 1:3200 scale air photo (WAC-82H-1-112). Boundaries were determined by image tone, texture, density, and shape.

Each of 63 "image units" delineated on the photo was sampled at least once in the field. A total of 75 samples were taken (larger units contained more than one sample). For plant community classification, a sample consisted of a list of the predominant plant species, and a rough estimate of percent cover for each. Sample size varied.

Phase 2 (Data Analysis)

Two multivariate computer programs, TABORD and CLUSTER, were used to analyze community composition. The program, TABORD, is a clustering procedure based on sample similarity. The final product of a TABORD analysis is a phytosociological table derived by clustering like samples according to a selected similarity index. The index used in this research was based on species similarity between samples (Van der Maarel et al. 1978):

$$S_{x,y} = \frac{\sum x_i \sum y_i}{\sum x_i^2 + \sum y_i^2 - \sum x_i y_i} \quad (i = 1, \ldots, n)$$

Initially, samples were arbitrarily assigned to clusters to reduce bias. Samples were relocated, by TABORD, into new clusters based on the statistical similarity of each sample to the initial clusters. As new clusters were formed, the program continued through several iterations until the clusters were "stable". The "stability" of the clusters was dependent on parameters arbitrarily defined prior to the relocation routine, i.e., a 'frequency limit' of .80 (to screen out ubiquitous species and thus highlight diagnostic species), a 'fusion level' of .65 (the level of similarity between clusters required before fusion can occur), and a 'threshold value' of .40 (a means of screening out aberrant samples and thus protecting the integrity of clusters). Parameters were also imposed on the number of iterations, minimum and maximum number of clusters, and minimum cluster size. Various values of these parameters were experimented with. The final association table printed by TABORD is shown as Figure C-1.

The CLUSTER program, a hierarchical agglomerative classification system , groups entities on the basis of (dis)similarity. CLUSTER was used to progressively cluster samples to a single cluster. Each cluster cycle united the least (dis)similar pair of samples based on the Bray-Curtis dissimilarity measure:

$$D_{jk} = \frac{\sum_{i=1}^{n} | x_{ij} - x_{ik} |}{\sum_{i=1}^{n} (x_{ij} + x_{ik})}$$

n = number of species
x_{ij} = value of species i of sample j

A flexible fusion strategy (Boesch 1979), using a beta parameter of - 0.25, was used in conjunction with the dissimilarity measure described above to cluster samples. The final product of CLUSTER was a dendogram displaying the relative dissimilarity of samples within the entire population of samples (Figure C-2).

The table from TABORD (Figure C-1) and the dendogram generated from CLUSTER (Figure C-2) were both used to identify plant communities for the Jackson-Frazier Wetland. Fourteen wetland plant communities were identified. They are displayed in Table C-1 within the context of the wetland types identified in the Cowardin (1979) wetland classification.

```
FREQUENCY PERCENTAGE LIMIT  80.0
                                                SAMPLE NUMBERS

                                 2233445566671223356662344445556667777111122233410011133344570000001225501156
                                 1546276867848463771247556890190350123127902308145834512903251246790893533649

                                   D  |  O  |   N    |     E & F     |    J     |     C      |  M  |  A |L|
     CLUSTER NUMBER              1111119999992222222223333333333333336666666666577777777777755555544444000


     SPECIES

   SALIX SPP.                    555552433142-13-1-2-1-43-----------3--1--21-22-------3---------------------13-
   PHALARIS ARUNDINACEA          ------243525--2---1--------1---1----------------------------------------------
   ROSA SPP.                     ------33231124242533223 3--2131-421-2155334323245555544355433333343-131-2-32
   CAREX OBNUPTA                 3--4323342334 3555-2425523144422131444112-32412---1--22------1-------1----2--
   FRAXINUS LATIFOLIA            1--1-131223232131515254555555555355333 4-12-11223-----2233232 1-----1-----1--
   CRATAEGUS SPP.                -1------3---131313-12-3--232---24443----1---1----14323242333 21-33133342 1--
   JUNCUS EFFUSUS                ---1---4222-354224334---------------1--1--111133-2---1----------------1-----1--
   OENANTHE SARMENTOSA           3--335------1-2--2---4-2243-1-231-15112--134435534---43--113--11---------------
   PYRUS SPP.                    -------------------------------------1-----1--33333553312--21212-343-3---------
   HORDEUM BRACHYANTHERUM        -------------1---1-----------------1--12---2-----------1----2--54433------2----
   DESCHAMPSIA CESPITOSA         -------------1---1--------------------------------------------331214-----2----
   POLYSTICHUM MUNITUM           ------------------------11-1-------------------------------1--- 1------12-11----
   RUBUS DISCOLOR                --1-1--------1------------2-2----2-----------------------------2 1------1223---2
   RUBUS URSINUS                 ----------------------------2-1------2--------------------------------1323---3-
   JUNCUS TENUIS                 -------------------------------------------------------------2-----------------
   CAREX UNILATERALIS            -----------------------------------------------------------------------------4--
   JUNCUS BALTICUS               ----------------------------------------------------------------1----------2---
   AMELANCHIER ALNIFOLIA         -------------------------------------------------------------2------------------
   POPULUS TRICHOCARPA           -22---------1-----------------------4-------------------------------------------4
   BERBERIS AQUIFOLIUM           --------------------------------------------------------------------------------
   PRUNUS SPP.                   ----------------------------------------------------------------------1---------
   LEMNA  MINOR                  ------111----1---------------1-----------------1------1-------------------------
   VERONICA AMERICANA            ------1231----1--------------------------------1------12---------------3------1--
   BECKMANNIA SYZIGACHNE         -----------------------------------1-----------------------------------------2--
   GRINDELIA INTEGRIFOLIA        -----------------------------------------------------------------------------1--
   DACTYLIS GLOMERATA            --------------------------------------------------------------------------------
   EPILOBIUM WATSONII            ---------------------------------------3---------------------------1------------
   ATHYRIUMUM FILIX-FEMINA       --------------------1-----------------------------------------------------------
   CORNUS STOLONIFERA            ----------1---------1----------------2------------------------------------------
   PTERIDIUM AQUILINUM           --------------------------------------------------------------------------------
   CIRSIUM VULGARE               --------------11---------------------2--------------------1------------1--1-1-----
   PRUNELLA VULGARIS             ------------------------------1---------------------------1-2----------------------
   RHAMNUS PURSHIANA             -------------------------------------------------------------------122-------4--
   ACER MACROPHYLLUM             -------------------------------------------------------------------------34-----
   RHUS DIVERSILOBA              ---------------------2-----21---22-------------------------23-11--------2--2------
   SYMPHORICARPOS ALBUS          ------------------------------------------------------------------------3--------
   RUMEX SPP.                    ---------------------------------------------------------------11-1-1-----------
   MENTHA CITRATA                -------------------1-----1----1------2-----23-----------------------------------
   MENTHA ARVENSIS               ---------------------------------------2---1--------------------------------22--
   SOLANUM DULCAMARA             ------3--------2-3-----22-------------------1----------3------------------------
   SPIRAEA DOUGLASII             -1-----2--21-22222--1122---------2-----221212----2----12--------------3---------
   ELEOCHARIS PALUSTRIS          ------------1--------------------------4------------------------------------34--
   TYPHA LATIFOLIA               ------2--22-23---------------------------2---1--2--------------------------11-
   JUNCUS SPP.                   ------2----------------------111--122-------------------1--------------------2-
   CAREX SPP.                    -------------------------------2---------------------------------------------5---
   ALNUS RUBRA                   --------------------1-----------------------------------------------------------
```

Figure C-1. Plant association table based on TABORD.

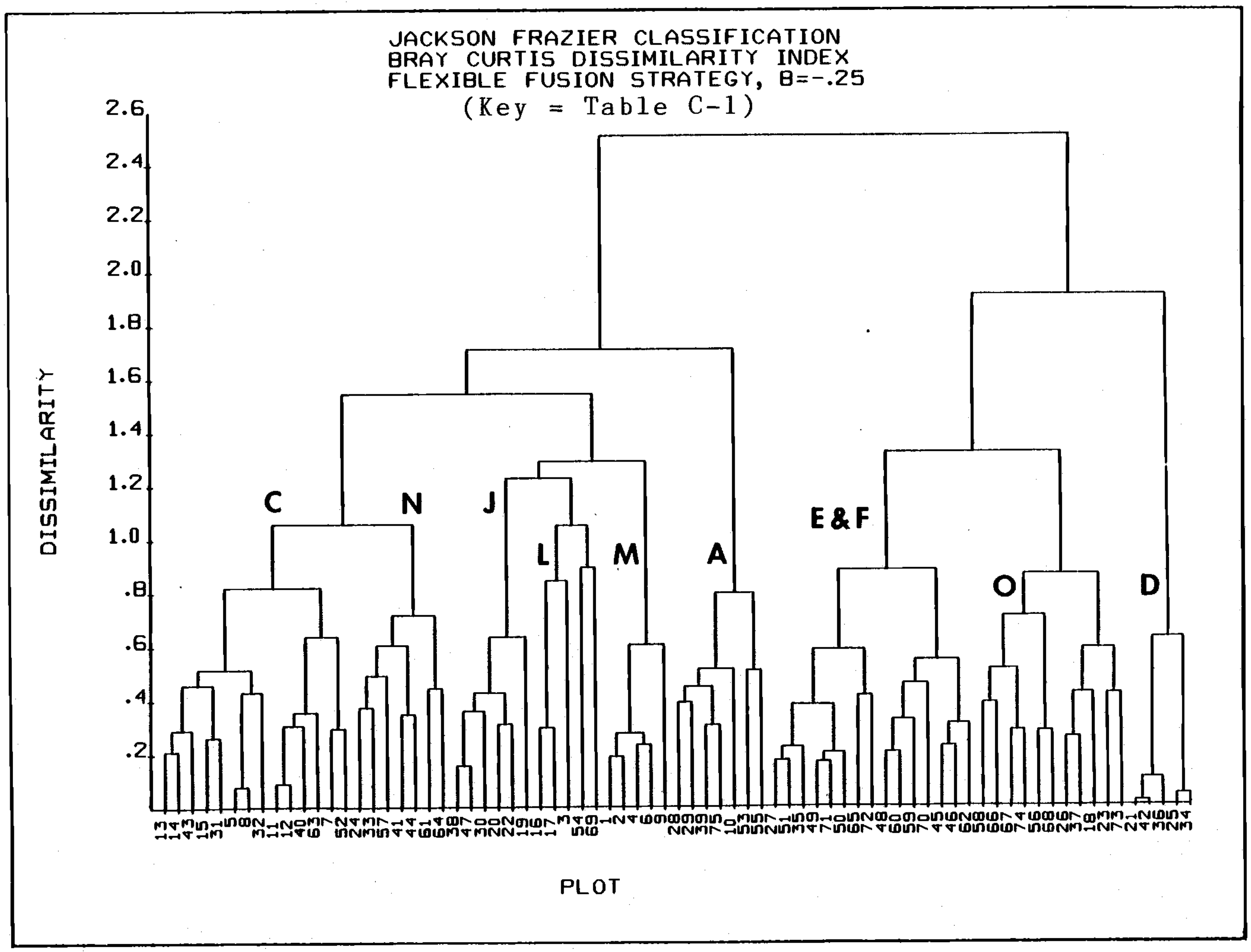


Figure C-2. Jackson-Frazier wetland cluster dendogram based on sample dissimilarity.

Table C-1. Jackson-Frazier Wetland Plant Communities and Associated Wetland Classes. /a

Forested Nonwetland (Upland)

A *Acer macrophylum*/*Rubus ursinus*-*Rubus discolor*
(bigleaf maple/Pacific blackberry-Himalayan berry)

Forested Wetland

B *Populus trichocarpa*
(black cottonwood)

C *Pyrus*-*Crataegus*/*Rosa*
(pear and apple-hawthorne/rose)

D *Salix*
(willow)

E *Fraxinus latifolia*-*Crataegus*/*Rosa*-*Rhus diversiloba*
(Oregon ash-hawthorne/rose-poison oak)

F *Fraxinus latifolia*/*Carex obnupta*-*Oenanthe sarmentosa*
(Oregon ash/slough sedge-water parsley)

G *Salix*-*Fraxinus latifolia*/*Carex obnupta*-*Phalaris arundinacea*
(willow - Oregon ash/slough sedge-reed canary grass)

Scrub-Shrub Wetland

H *Fraxinus latifolia*/*Rosa*/*Carex obnupta*-*Oenanthe sarmentosa*
(Oregon ash/rose/slough sedge-water parsley)

I *Fraxinus latifolia*/*Rosa*-*Spiraea douglassii*/*Carex obnupta*-*Juncus effusus*
(Oregon ash/rose/hardhack/slough sedge-rush)

Emergent Wetland

J *Rosa*/*Oenanthe sarmentosa*
(rose/water parsley)

/a The TABORD and CLUSTER computer programs were used in conjunction with field observations to determine plant communities. The disparity in number results largely from an inadequate number of samples. Image units that qualified as distinct communities were often inadequately represented in the programs and their samples contributed to a reduction in the integrity of clusters.

Table C-1. (Continued) Jackson-Frazier Wetland Plant Communities and Associated Wetland Classes.

Emergent Wetland (Continued)

K Eleocharis palustris-Carex unilateralis
(spike rush-one sided sedge)

L Eleocharis palustris-Mentha arvensis
(spike rush-mint)

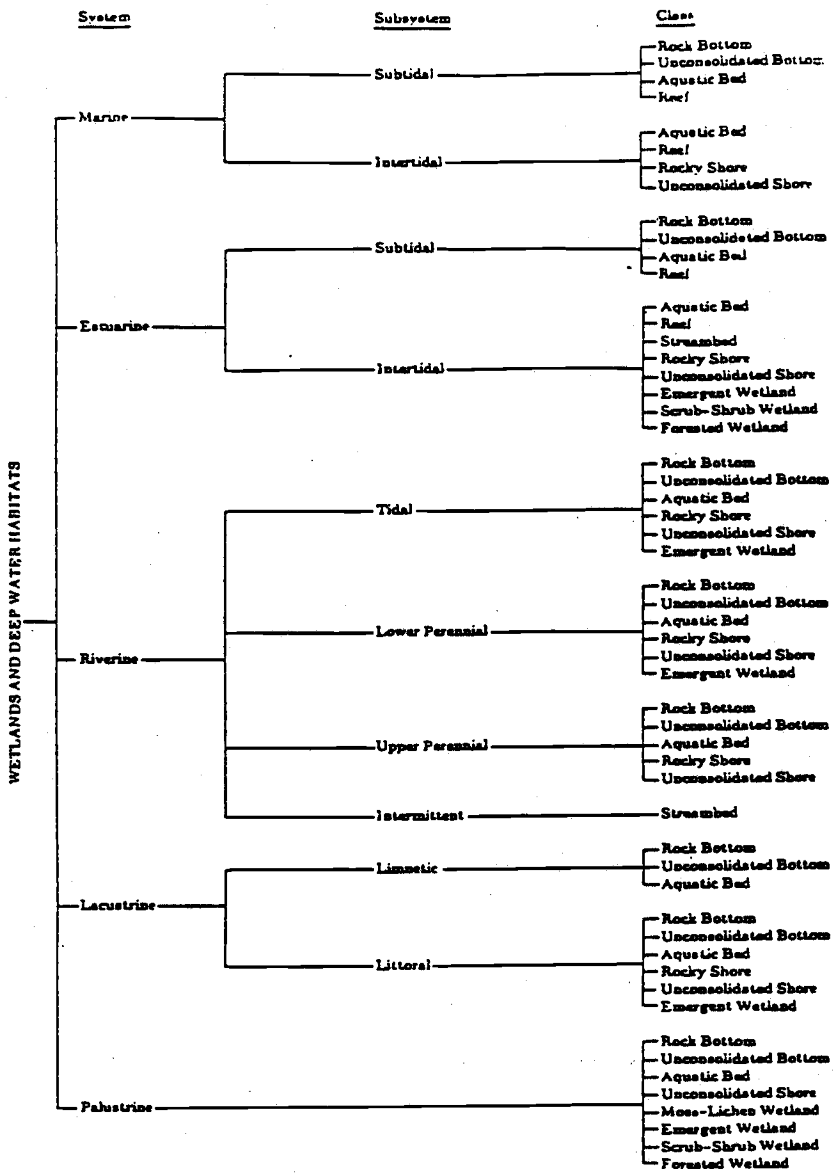
M Pyrus-Crataegus/Hordeum brachyantherum-Deschampsia cespitosa
(pear and apple-hawthorne/meadow barley-tufted hair-grass)

N Carex obnupta-Juncus effusus-Typha latifolia
(slough sedge-rush-cattail)

O Salix/Phalaris arundinacea-Carex obnupta
(Willow/reed canary grass-slough sedge)

APPENDIX D

Classification Hierarchy of Wetlands and Deep Water Habitats Showing Systems, Subsystems, and Classes (Cowardin et al. 1979)



APPENDIX E

Jackson-Frazier Wetland Unit Classification

Table E-1. Jackson-Frazier Wetland Unit Classification.

Sample /a	Unit /b	Class /c	Subclass /d
1,2	1a	IEW	SW-FW
3	1b	FEW	
4,5	2	SW	FW-IEW
6,7	3	FW	IEW-SW
8	4	SW-FW	
9	5	IEW-SW	
10	6	FN	SN
11,12	7	SW-FW	
13,14	8	FW	SW
15	9	FW	SW
16	10	FEW-SOW	
17	11	FEW	SW
18	12	FEW	FW
19	13	FEW-SW	
20	14	FEW-SW	FW
21	15	FW	FEW
22,23	16	FEW	SW
24	17	FEW	SW-FW
25	18	FW	SOW
26	19	FEW	
27	20	FW	FEW
28	21	FW	
29	22	FW	SW-HN
30	23	FEW	SW
31,32	24	FW	SW
33	25	FW	SW-FEW
34	26	FW	
35	27	FW	FEW-SW
36	28	FW-FEW	
37	29	FEW	SW
38	30	FEW	FW
39,40	31	FW-SW	
41	32	SW	FEW-FW
42	33	FW	FEW
43	34	SW	FW
44	35	SW-FW	
45	37 /e	FW	SW
46	38	FW	FEW

/a Samples consist of "in field" estimates of vegetation and water cover class and vegetation height measurements in an immediate undefined area within a predesignated "image unit" defined from air photo recognizance. Larger image units had more samples.

Table E-1. (Cont.) Jackson-Frazier Wetland Unit Classification.

Sample /a	Unit /b	Class /c	Subclass /d
47	39	FEW	FW
48,49,50	40	FW	FEW
51	41	FW	FEW-SW
52	42	FW-SW	
53	43a	FN	SN
54	43b	FW	SW
55	44	FN	SN
56	45	FW	SW-FEW
57	46	FW-SW	FEW
58	47	FEW	FW
59	48	FW	FEW
60	49	FW	
61	50	FEW	SW
62	51	FW	FEW-SW
63,64	52	FW	SW-FEW
65	53	FW	FEW-SW
66	54	FEW-FW	
67	55	FEW	SW
68	56	FW	SW-FEW
69	57	FW	SW
70	58	FW	FEW
71	59	FW	FEW
72	60	FW	FEW
73	61	FW	FEW
74	62	FEW	SOW/FW
75	63	FW	SW

/b Units are image units defined on an air photo based on image tone, texture, size, and shape.

/c Classes are artificial categories numerically defining the predominate vegetation life form(s) and hydrologic trait(s) characterizing a unit.

/d Subclasses are artificial categories numerically defining the subordinate vegetation life form(s) and hydrologic trait(s) characterizing a unit.

/e Unit 36 was combined with unit 37 in the field.

FW = Forest Wetland
SW = Shrub Wetland
FEW = Frequent Emergent Wetland
IEW = Infrequent Emergent Wetland
SOW = Shallow Open Water Wetland

FN = Forested Nonwetland
SN = Shrub Nonwetland
HN = Herbaceous Nonwetland

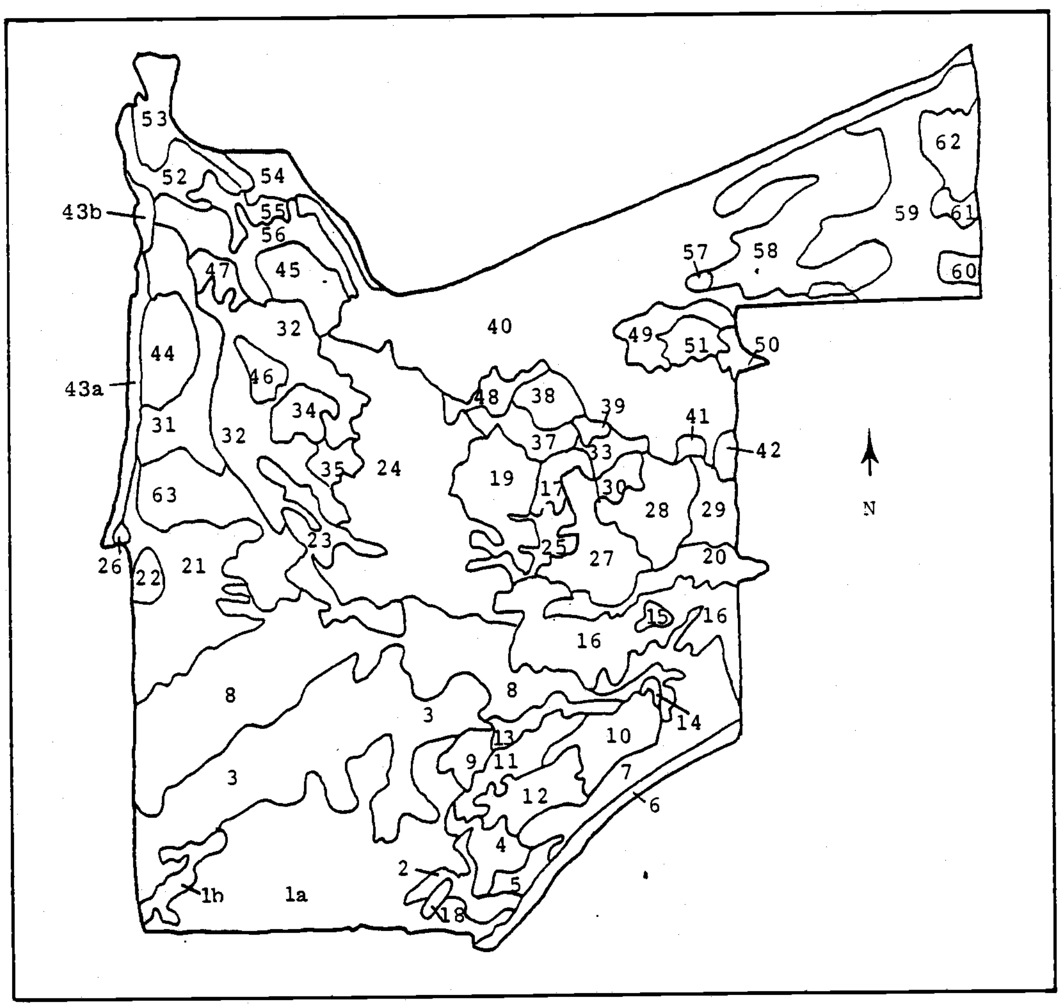


Figure E-1. Jackson-Frazier Wetland image units.