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RESEARCH TECHNICAL COMPLETION REPORT
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AQUATIC RESEARCH NATURAL AREAS IN IDAHO

by

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and

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John S. Gladwell, Director

Proposed Mill Lake Natural Area, Lemhi Range, Lemhi National Forest - A. alpine cirque lake, B. subalpine ponds, C. wet meadow, D. meandering stream, E. whitebark pine, F. mixed subalpine fir-Engelmann spruce forest, G. heather meadows.

ACKNOWLEDGEMENTS

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SUMMARY

1. Personal interviews were held with Forest Service, Bureau of Land Management, National Park Service, Fish and Wildlife Service and State Departments of Lands, Parks, and Fish and Game representatives to inform them of the natural areas project and elicit their recommendations for aquatic natural areas within their districts. A nomination form was developed and distributed to these and other interested parties in the state.

2. As a result of these interviews and correspondence, over 200 sites were nominated. A cross-section of these areas representing all ecosystem types and geomorphic provinces was visited in order to develop classification and evaluation systems and to confirm the natural area potential of the areas.

3. A lake classification system is proposed which would include one or more of the following approaches: lake origin, thermal stratification, biotic composition and production potential. Ponds are listed only as temporary or permanent.

4. Wetland classification includes marshes, bogs and fens. Marshes are characterized by water depths ranging from saturated soil to five feet and include zones of emergent and submergent vegetation. Subtypes of fresh and brackish are defined by specific conductivity levels. Bog ponds and ground surface bogs occur where there is growth and accumulation of sphagnum peat in acidic waters. Fens are areas of sedge peat accumulation in alkaline waters.

5. Thermal waters are described by geologic unit generating the heat source including the granitic batholith, Tertiary volcanics, and fault zones in pre-Tertiary sediments. Each reflect different ionic compositions.

6. Physical, chemical and biological factors were analyzed during reconaissance surveys of 32 northern Idaho streams to identify characteristics suitable for stream classification criteria.

7. Three major stream types among first to fourth order streams are characterized by flow, gradient and substrate differences. These are: type 1 - low gradient, meandering glide; type 2 - moderate gradient, riffle-pool; and type 3 - steep gradient, torrential. Ephemeral streams and those with a major spring source are also recognized.

8. Instream features identified as aquatic subtypes include beaver ponds, waterfalls, springs, and deltas. Streams and rivers exceeding fourth order designation are excluded from further classification.

9. Qualitative collections of aquatic biota included plants, invertebrates, fishes and amphibians. Rare and uncommon species are identified, distribution tables constructed, species correlations with stream type recorded, and preliminary plant-invertebrate associations identified.

10. Water chemistry parameters which may affect biological productivity were measured (specific conductivity, alkalinity, temperature, pH, Ca, Mg, Na, K).

11. A methodology for selection of potential aquatic natural areas is proposed using as example the streams inventoried for classification purposes. Information from a Site Characteristic Sheet is summarized on a Site Profile and Evaluation Form. Non-weighted points are assigned to 20 physical, chemical, and biological features for both aquatic and terrestrial components of the drainage basin. Sites which score highest are given a high priority rating for selection.

12. Socio-economic or management factors involving site selection are identified. These include ownership, size, accessibility, alternate uses, threat and situation redundancy.

13. A procedural flow chart for selection of aquatic natural areas is presented.

14. A methodology for a baseline description of aquatic natural areas is proposed using as an example Bottle Lake, a bog lake in northern Idaho. Information presented includes physical description of the area with maps and photographs, specific reasons for recommendation (or establishment), basic water chemistry data and lists of aquatic biota and terrestrial flora and fauna.

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INTRODUCTION

"It is desirable that some large and easily accessible region of American soil should remain, as far as possible, in its primitive condition, at once a museum for the instruction of the student, a garden for the recreation of the lover of nature, and an asylum where indigenous tree . . . plant . . . beast, may dwell and perpetuate their kind."

George Perkins Marsh (1874)

There has been a concerted effort by federal, state and private conservation organizations to protect areas of outstanding natural value including State and National Parks, Wilderness areas, Wildlife Refuges, National Monuments, Botanical Areas, Nature Reserves and Research Natural Areas. The existing network of natural areas includes sites of botanical, geological and aquatic interest, and uses range from intensive recreation to non-destructive scientific research.

The Idaho natural area program is patterned after the federal Research Natural Area (RNA) program. A Research Natural Area is "an area where natural processes are allowed to pre-dominate and which is preserved for the primary purposes of research and education." (Federal Committee on Research Natural Areas, 1968). RNAs are established:

1. to provide baseline areas against which the effects of human activities in similar environments can be measured.

2. to serve as gene pools and preserves for ordinary as well as rare and endangered species of plants and animals.

3. to provide educational research areas for scientists to study the ecology, successional trends, and other aspects of the natural environment.

Selection of a representative system of natural areas for Idaho should be based on needs identified through a classification scheme which includes all ecosystem types. Presently, forest and grassland-shrubland natural areas are identified by application of the SAF Cover Type or Daubenmire's (1968) Habitat Type classification systems with emphasis on old growth stands.

This project was initiated in recognition of the need for a study of the range of aquatic ecosystem types present in the state, and development of a classification system from which aquatic natural area needs could be identified. As most aquatic types are represented at numerous places, a selection system based on numerical ranking of sites was also developed. Specific project objectives were:

1. to locate unique and/or representative aquatic habitats throughout the state suitable for designation as aquatic natural areas,

2. to develop a classification of aquatic types with emphasis on small stream systems in northern Idaho,

3. to develop a methodology for selecting potential aquatic natural areas with emphasis on northern Idaho streams.

BACKGROUND - THE NATURAL AREA PROGRAM

History

In 1926 the Ecological Society of America published Shelford's A Naturalist's Guide to the Americas, an inventory of the preserved and preservable sites in the country. Out of this work grew both The Nature Conservancy, an organization which acquires outstanding natural areas located on private lands, and the Federal Research Natural Area Program. The U.S. Forest Service was the first federal agency to establish Research Natural Areas and in 1936 established the Tepee Creek RNA in northern Idaho. Presently, there are nine RNAs on Forest Service lands in Idaho.

Recently The Nature Conservancy (1975) prepared an excellent report on natural diversity together with an assimilation of ideas and aspirations dealing with the identification and protection of natural areas. Besides numerous land acquisitions which have been deeded over to the Forest Service, two Conservancy natural areas are present in Idaho. These are Idler's Rest in Latah County containing ponderosa pine, Douglas fir and western red cedar forests, and Dautrich Memorial in Canyon County containing horsebrush, shadscale and big sage communities.

The International Biological Program (IBP) of the 1960s aroused worldwide interest in the establishment of natural areas. In Great Britain a network of data collecting centers and national organizations was established to collect information on Britain's changing flora and fauna. Methods developed in the British Isles are now being adopted by other European countries and several projects to map the flora and fauna on a continental scale are underway (Heath, 1975).

In 1966 the U.S. Department of Interior established the Federal Committee on Research Natural Areas whose purpose was to help develop a system of natural areas in this country and contribute to a world-wide natural area system. Included on this committee were representatives of all government agencies which administered federal lands on which natural science research potential existed. The directory of RNAs published by this group is an important source of information on established natural areas throughout the country (op. cit.). The Federal Committee on Ecological Reserves is continuing this work.

Many states have active natural area programs. Vermont, Indiana, Ohio and California are outstanding examples of states with natural area programs where extensive private lands are involved. In the Rocky Mountain states and Pacific Northwest much of the unaltered lands are administered by the Forest Service and Bureau of Land Management. Natural area programs initiated by Forest Service personnel have been organized in Washington-Oregon (Dyrness et al., 1975), Montana (Schmidt and Dufour, 1975) and Idaho (Wellner and Johnson, 1974).

The Idaho Natural Areas Organization

The Idaho Natural Areas Organization (INAO) was founded in 1973 by Charles A. Wellner (Forest Service, retired) and Fred W. Johnson of the College of Forestry, Wildlife and Range Sciences at the University of Idaho. Organization membership is made up primarily of federal and state agency and university personnel. Annual workshops are held each spring. The organization chart is shown on page 5.

This organization has been working toward a natural areas system for Idaho by cataloging and classifying natural diversity within the state, by developing a system of natural areas to preserve this diversity, and by working very closely with land management agencies, to recognize, select and establish suitable natural areas. The ideal situation is close cooperation between the Idaho Coordinating Committee and the agencies, especially the planning teams, as they allocate uses within each planning unit. Our work on aquatic natural areas has been conducted within the context of the INAO.

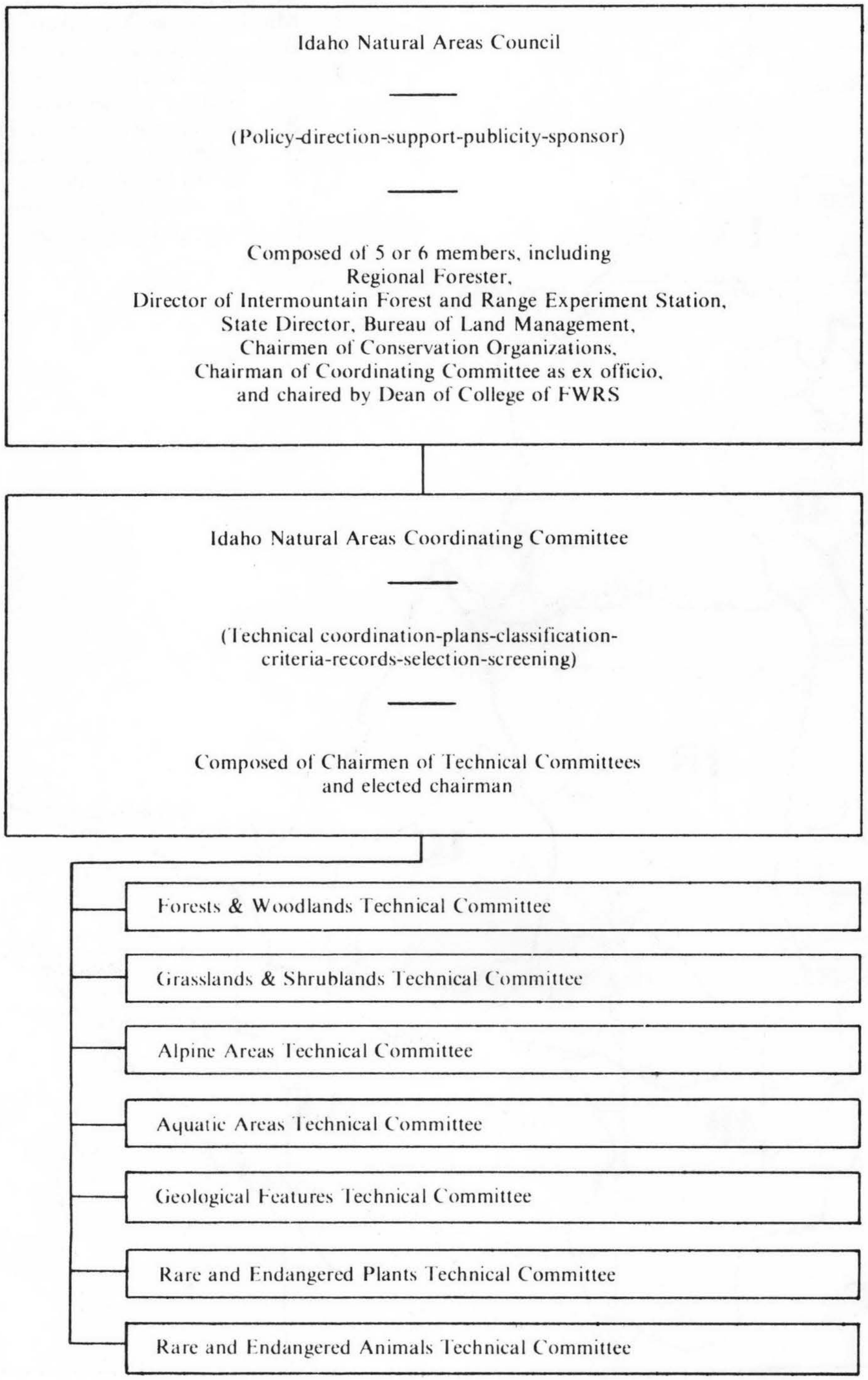
Natural Area Cells

As ecologic research identifies discrete ecosystems, communities, associations, habitats or endangered species, these entities become candidates for inclusion in a natural area system. Each basic ecologic unit (single organism, lake, plant, association of geologic features) becomes a cell in the natural areas system. Natural areas comprise an aggregation of cells, and natural area needs identify which cells need representation within the system (Dyrness, et al., 1975).

The Geomorphic Provinces

The geomorphic provinces originally delineated by Fenneman (1931) have been adopted, with minor modifications, as representing natural subdivisions which reflect the range of topographic, lithologic, edaphic, and climatic differences which exist in Idaho (Figure 1). Identification of natural areas by province and section ensures the inclusion of sites which typify ecosystem conditions within a fairly homogenous region. Province and section descriptions, derived in large part from Ross and Savage (1967), are presented in Appendix A.

IDAHO NATURAL AREAS
ORGANIZATION CHART



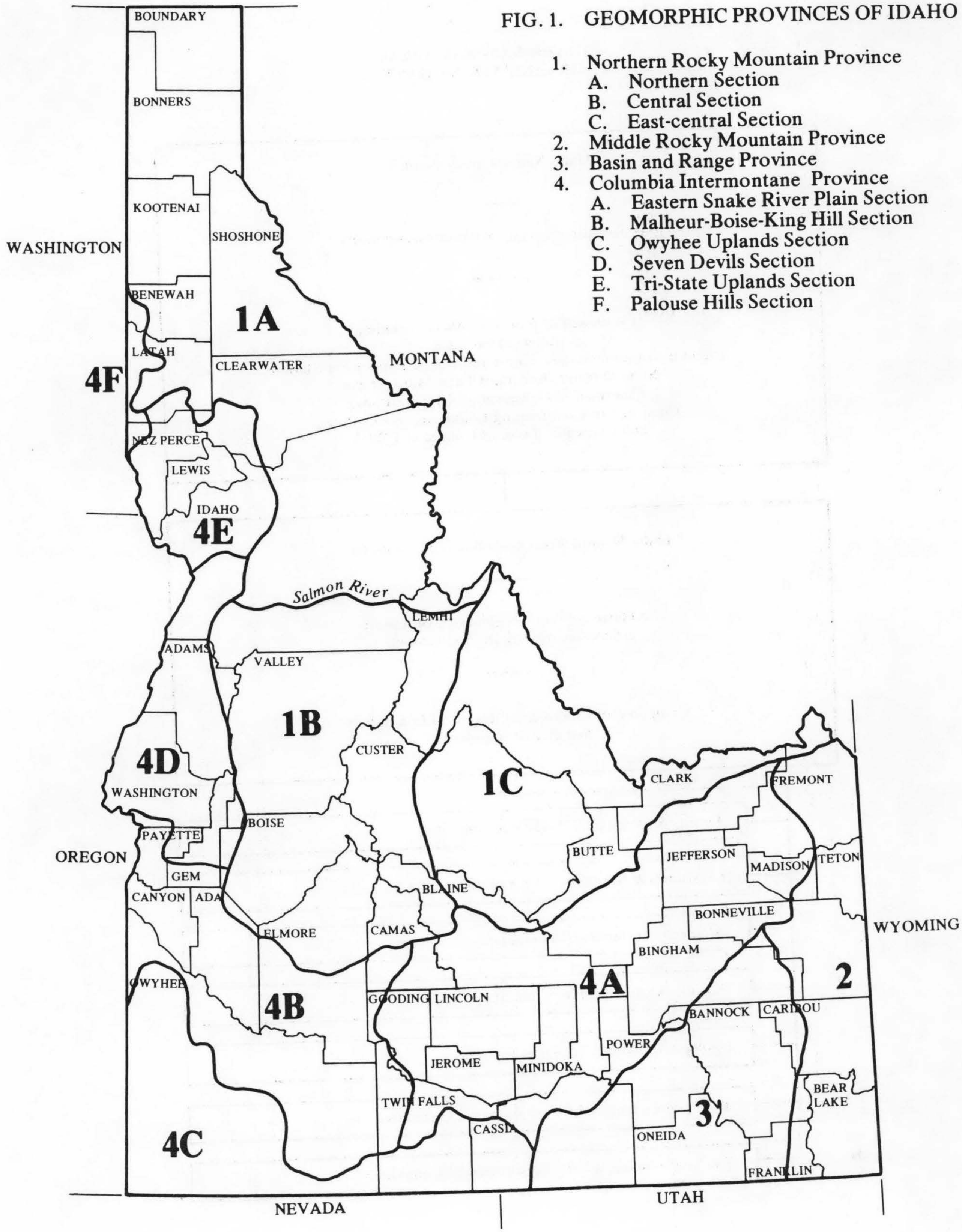


FIG. 1. GEOMORPHIC PROVINCES OF IDAHO

1. Northern Rocky Mountain Province
   - A. Northern Section
   - B. Central Section
   - C. East-central Section
2. Middle Rocky Mountain Province
3. Basin and Range Province
4. Columbia Intermontane Province
   - A. Eastern Snake River Plain Section
   - B. Malheur-Boise-King Hill Section
   - C. Owyhee Uplands Section
   - D. Seven Devils Section
   - E. Tri-State Uplands Section
   - F. Palouse Hills Section

PROBLEM - THE NEED FOR ACTION

The need to select and to establish natural areas in Idaho is extremely urgent today. According to the Idaho Environmental Overview (1975) approximately 15% of Idaho is in a relatively undisturbed condition, much of which is the finest concentration of pristine environments in the country outside of Alaska. However, movement of people and industry to the Pacific Northwest in ever increasing numbers is placing increased demands on its total resource base including aquatic areas. Most of the flat land already has been disturbed by man and only remnants are left of several undisturbed grassland types.

We have the opportunity in Idaho, if we act promptly, to exercise some choice in selecting and establishing natural areas. But these opportunities are disappearing rapidly as uses of land and water resources accelerate. Trends point to continued degradation of aquatic habitats and accelerated rates of land use change resulting in deterioration of environmental resources in many parts of the state.

Development of a natural areas system in Idaho is largely dependent on federal lands because they encompass two-thirds of the state and the bulk of undisturbed land and water. Various recent federal laws require detailed land use planning. As a result, federal land management agencies are presently engaged in this program throughout Idaho. It is critically urgent that needs for natural areas be recognized in the planning for each unit.

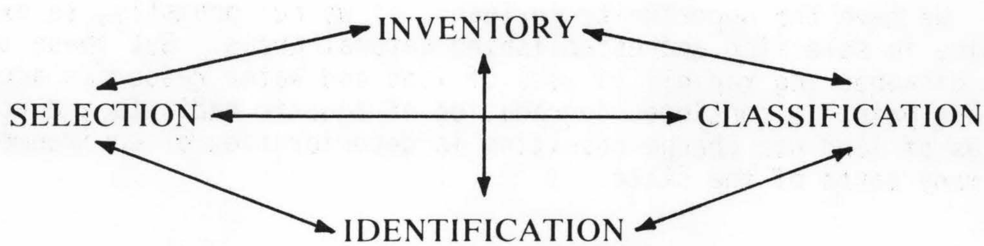
We have established close working relations with land managers in Idaho while studying aquatic sites. A number of these areas have been recommended for establishment as natural areas. We cannot emphasize too strongly the importance and urgency of getting natural area needs into the land use planning process. This must be done now or opportunities to do so will become difficult or, in many instances, lost.

RESEARCH APPROACH

Usually, the selection of natural areas is preceded by a thorough inventory of ecosystem types, development of a classification system on which to base identification of natural area needs, and identification of potential areas.

INVENTORY → CLASSIFICATION → IDENTIFICATION → SELECTION

However, because of the urgency dictated by the ongoing land planning process, this systematic procedure was modified in favor of an approach which addresses all steps simultaneously.



Thus, in order to forward our objectives as rapidly as possible, we first developed a preliminary classification system based on literature review and general knowledge, then contacted land management agency personnel for identification of potential aquatic natural areas within their districts. This initial contact also served to inform the agencies of the project. A natural area nomination form was developed (Table 1) and distributed to these people and to other interested individuals throughout the state. The agencies and offices contacted included:

<u>U.S. Forest Service</u>

Kaniksu N.F. at Bonners Ferry, Priest River and Sandpoint
Coeur d'Alene N.F. at Coeur d'Alene
St. Joe N.F. at St. Maries
Clearwater N.F. at Orofino
Nez Perce N.F. at Grangeville
Payette N.F. at McCall
Boise N.F. at Boise
Sawtooth N.F. at Twin Falls
Caribou N.F. at Pocatello
Targhee N.F. at St. Anthony
(Salmon and Challis National Forests were contacted by correspondence only)

Table 1

AQUATIC RESEARCH NATURAL AREAS - PROPOSAL FORM

Name of site: ____________________ Elevation: __________
Location: Twp. __________ Rge. __________ Sec. __________
Ownership: ____________________

Description of site: Please check aquatic cells present at site and give brief description of cell such as size, outstanding features.

- Hot spring ☐ ____________________
- Cold spring ☐ ____________________
- 1st to 4th order stream ☐ ____________________
  - Intermittent flow ☐ ____________________
  - Permanent flow ☐ ____________________
  - Steep gradient ☐ ____________________
  - Moderate gradient ☐ ____________________
  - Low gradient ☐ ____________________
- 5th order stream or river ☐ ____________________
- Delta ☐ ____________________
- Waterfall ☐ ____________________
- Beaver pond ☐ ____________________
- Seasonally flooded flats ☐ ____________________
- Wet meadow ☐ ____________________
- Marsh ☐ ____________________
- Bog ☐ ____________________
- Pond or pothole ☐ ____________________
  - Permanent ☐ ____________________
  - Vernal ☐ ____________________
- Lake ☐ ____________________
- Other ☐ ____________________

Aquatic fauna: Waterfowl: __________ Amphibians: __________
fish populations (specify natural or planted): __________
____

Terrestrial habitat: Geology. ____________________
____________________ Land type: __________
Cover type: ____________________
Wildlife: ____________________

History of use and disturbance at site: ____________________
____

Natural area values or other reasons why this site should be preserved as a RNA: ____________________
____

Name of nominating party ____________________ Phone: __________
Address: ____________________

Bureau of Land Management

Coeur d'Alene
Cottonwood
Boise
Burley
Idaho Falls

State Lands Department

Coolin
Boise
McCall
Idaho Falls

Idaho Fish and Game Department

Coeur d'Alene
Lewiston
McCall
Boise
Jerome
Pocatello
Salmon

National Parks

Craters of the Moon

State Parks

Ponderosa State Park at McCall
Bruneau Sand Dunes State Park
Harriman Railroad Ranch State Park

As a result of these interviews and correspondence, a list of approximately 220 sites with aquatic natural area potential was available to us for further evaluation.

During the summer and fall of 1975, we visited a cross-section of these sites statewide (about 50 sites) in order to evaluate their natural area potential, identify aquatic types present, and collect physical, chemical and biological data. Five sites among these, which appeared to have outstanding natural area values, were studied in greater detail and have been approved by the INAO and recommended to the agency. These were Bottle Lake, Steep Lake, Lily Marsh, Box Canyon and Vinyard Lake.

The first year of work provided us with an overview of the aquatic natural area potential within the state. This knowledge of the range of existing conditions enabled us to begin work on a general classification system that covered lakes, wetlands, streams and hot springs.

During the second year, we concentrated our efforts on a classification of low order streams. This work was done on 32 established and recommended natural areas north of the Salmon River to the Canadian border. Most of the sites were within the Kaniksu, Coeur d'Alene, St. Joe, Clearwater and Nez Perce National Forests. Observations, measurements and collections were made in the field and additional information was gained from maps. This data included:

Basin Characteristics	Stream Characteristics		
	Physical	Chemical	Biological
Elevation	Width	Alkalinity	Algae (macroscopic)
Directional aspect	Depth	pH	Liverworts
Stream orders	Substrate size	Specific Conductivity	Mosses
Rock type	Flow characteristics	Ca, Mg, Na and K ions	Vascular plants
Land types	Temperature		Invertebrates
Habitat and cover types	Gradient		Amphibians
Aquatic habitats			Fishes

Following the inventory and classification of these streams we developed a methodology for selection of aquatic natural areas based on numerical ranking of sites. This involved a site profile and evaluation where points were allotted to 20 site features which relate to natural diversity and uncommon occurrence. A systematic selection procedure summarized in a flow chart was developed which summarizes all steps from nomination to site selection.

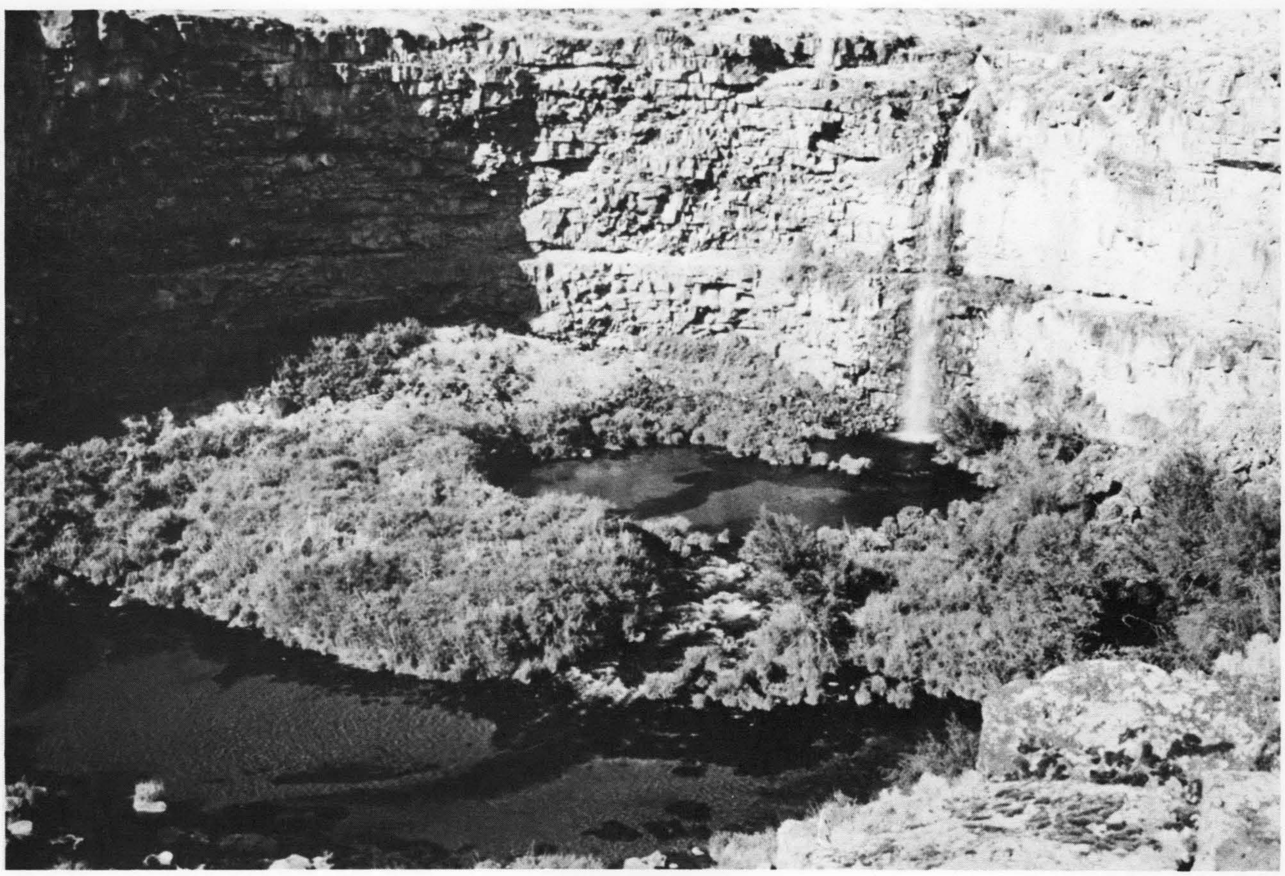
PART II

RESEARCH RESULTS

Objective 1: Identification of Aquatic Natural Areas

Objective 2: The Classification of Aquatic Ecosystems

Objective 3: Selection Methodology



RESEARCH RESULTS

Objective 1: Identification of Aquatic Natural Areas

About 220 potential natural area sites were nominated by state and federal agency personnel and other individuals during the early months of this project. These sites are listed in Appendix B, Table 1.

A summary of this information showing the distribution of sites by aquatic type, land ownership and geomorphic province is presented in Appendix B, Table 2. First to fourth order streams occurred most frequently, followed by lakes. Seventy-four percent of areas nominated were on Forest Service lands. The number of areas by province reflected climatic conditions with most areas occurring in the wetter sections of the northern Rocky Mountain province (1A and 1B). To some extent past and present land use also influenced location. The extensive agricultural development in sections 4E and 4F, and the heavy grazing in 1C, 2 and 3 have altered the natural conditions of many streams and wetlands in these sections.

Presently established natural areas in Idaho are described in Appendix B, Table 3 including the aquatic features contained in these areas. While most of the 13 established areas contain small streams, there are no lakes or wetlands, with the exception of one bog pond, within any of these areas.

Those areas which are in an early stage of the establishment process are listed in Table 4. This list changes annually as new areas are approved by the Idaho Natural Areas Coordinating Committee and as recommended areas become established.

General location of areas in Tables 3 and 4 are indicated on Figure 1, Appendix B.

Objective 2. The Classification of Aquatic Ecosystems

Identification of unusual and representative aquatic ecosystem types involves the difficult process of classification. Much effort over the years has gone into the attempt to place the infinite variety of continually changing surface water features into distinct and meaningful categories. Nearly every physical, chemical and biological aspect of water has been considered at some time as well as the social aspect of specific, multiple, or optimum use. Most limnologists and resource managers have concluded that any single system would be too restrictive even if it received general acceptance, a very unlikely occurrence.

Resource Use Classification

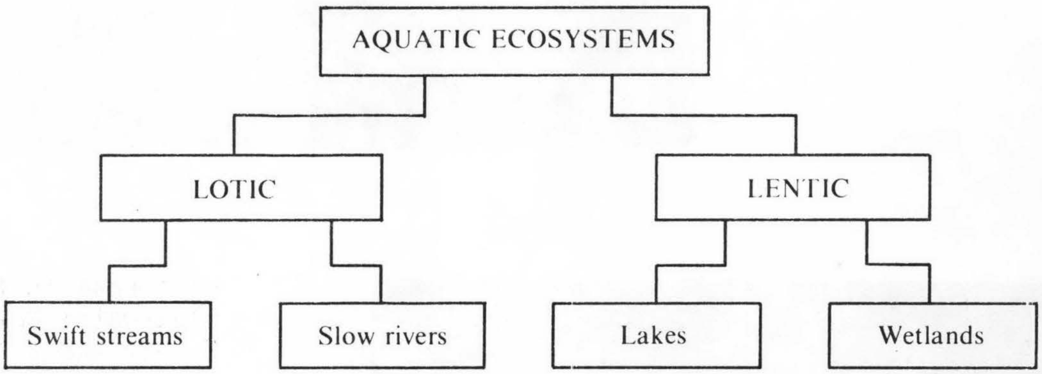
From the social or resource management approach, surface waters can be classified easily by specific use since a well-defined set of parameters can be identified to describe and categorize a water body. For example, streams in Idaho have been classified by the Idaho Fish and Game Department on the basis of general fishery value. Parameters measured included accessibility, fishing pressure, game fish population level and habitat condition (IFG, 1968). Leopold (1969), comparing aesthetic factors among Idaho rivers, ranked them by uniqueness ratio based on physical, biologic, water quality, human use and interest factors. Milligan and Warnick (1973) developed a factor profile to describe and classify Idaho lakes and reservoirs on the basis of recreation resource management. Sixteen parameters deemed important in describing reservoir attributes were discussed.

Washington and several other states have classified streams by type of use on the basis of water quality condition as determined by coliform levels (Washington State Pollution Control Commission, 1970). Another specific use system is the classification of rivers for potential inclusion in the Wild and Scenic Rivers System. Classes are based on the degree of manmade alterations to the river and adjacent lands (PL 90-542).

Aukerman (1971), attempting to develop an optimum use classification for surface waters, rejects "pre-set" systems such as those just described and evaluates a "post-set" system where classification is the end product of a systematic decision making process based on thorough physical and socioeconomic studies of a drainage. He selected the system developed by the U.S. Bureau of Land Management as the most complete and reliable optimum use classification method available.

Scientific Classification

From the scientific approach, classification of surface water features has proven much more complex. It is, however, fundamental to establishment of a system of representative aquatic Natural Areas. Two basic categories of surface water perhaps can be agreed upon, and these are lotic systems (running water) and lentic systems (standing water). Lentic systems are immediately divided into lakes and wetlands, based primarily on water depth and lotic systems into fast and slow moving water. These basic categories have been established because they contain distinctly different communities and because they are obvious to the observer and no further investigation is necessary to categorize. Some other parameters that are commonly used to subdivide aquatic types are temperature, salinity, size and associated vegetation - parameters which have a pronounced effect on the nature of the aquatic community.



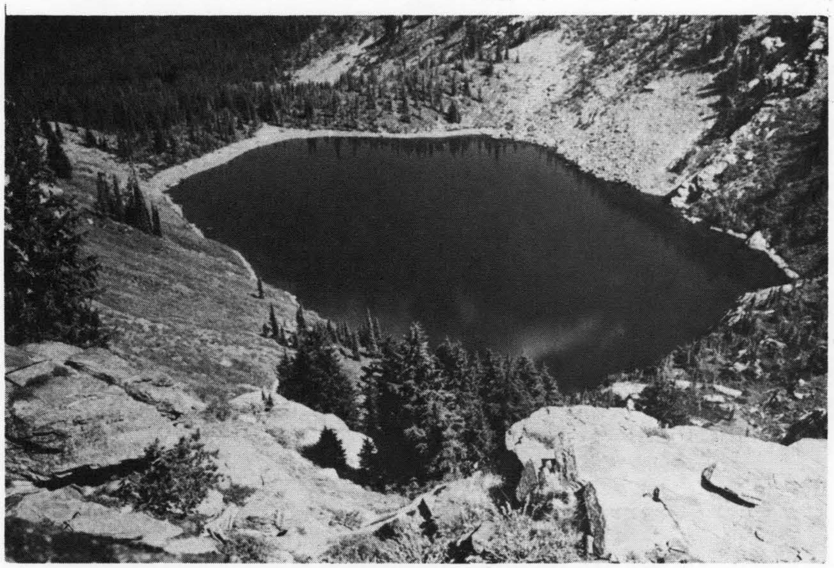
General classification systems in present use by a number of entities involved with natural ecosystems are shown in Table 2. These are low information systems with wide applicability. More specific, high information systems usually emphasize either the physical, chemical or biological components of the aquatic feature and are frequently applicable only on a regional basis. A number of these systems have relevance to aquatic ecosystem classification in Idaho and will be discussed in the succeeding sections.

Classification of Idaho Lakes and Ponds

Idaho contains over 2000 lakes and reservoirs ranging from small ponds to Pend Oreille Lake with a surface area of 148 square miles. The majority of natural lakes occur in the central mountainous part of the state in montane to subalpine zones.

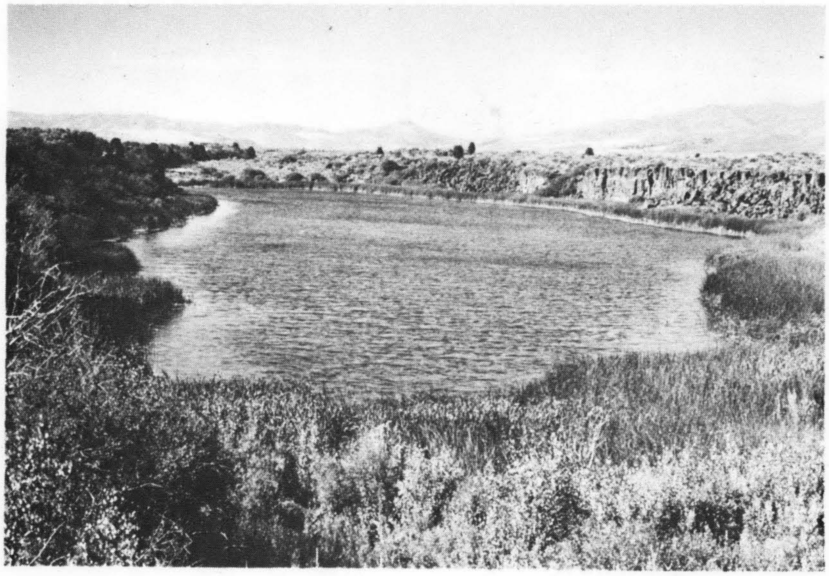
Lakes in the alpine zone are not as common as those found in the subalpine. Areas of known alpine and probable alpine habitats based on vascular plant distribution have been identified by Henderson (Wellner and Johnson, 1974). For example, an unnamed alpine lake is located in a cirque basin on the east flank of Borah Peak at an elevation of 10,400 feet (Henderson, personal communication). The upper shore of Upper Mill Lake in the Salmon

Upper Steep Lake and Pond in the Clearwater National Forest have a high production potential indicated by an abundance of freshwater shrimp and high alkalinity



Halo Lake in the Clearwater National Forest Forest has a low production potential indicated by the boulder substrate and low alkalinity

Theriaut Lake in the St. Joe National Forest is a shallow cirque lake surrounded by marsh and old growth Western Hemlock forest.



McCammon Pond is a lava sink near Pocatello exemplifying hydric-mesic-xeric plant succession.

This pond, located on the West Fork of West Fork of Smith Creek in the Kaniksu National Forest, is surrounded by wet meadow and subalpine fir forest.

Table 2. Aquatic ecosystem classification systems

RNA Directory and National Parks and Landmarks
(National Park Service, 1969)

A. Aquatic types

1-10. Marine ecosystems
11. Estuaries
12. Rapidly flowing rivers and streams
13. Slow meandering rivers and streams
14. Deltas
15. Springs
16. Thermal waters
17. Underground waters with distinct animal life
18. Large deep lakes
19. Large shallow lakes
20. Lakes of complex shapes
21. Crater lakes
22. Kettle lakes and potholes
23. Oxbow lakes
24. Dune lakes
25. Sphagnum bog lakes
26. Saline lakes
27. Lakes fed by thermal streams
28. Tundra lakes and ponds
29. Swamps and marshy areas
30. Sinkhole lakes
31. Unusually productive lakes
32. Lakes of low productivity and high clarity
33. Habitats of freshwater aquatic species of special interest
34. Lake shorelines

Washington-Oregon RNA System
(Dyrness, et al., 1975)

(Lowland, subalpine, alpine)
Lakes
Permanent ponds
Vernal ponds
Streams
Cold springs
Hot springs
Swamps
Marshes
Bogs

Montana RNA System
(Schmidt and Dufour, 1975)

(Lowland, upland-montane, alpine)
Lakes
Streams
Springs
Bogs and marshes

IBP Handbook No. 4
(Peterken, 1967)

Standing water (permanent, intermittent, unproductive, productive)
- Swamps
- Lakes
- Ponds

Running water (permanent, intermittent)
- Cold springs
- Hotsprings
- Streams
- Rivers

Special features
- Geysers
- Waterfalls
- Rapids
- Underground rivers
- Seasonally inundated land
- Bogs

Experimental Ecological Reserves Project

Shallow water environments
- Ponds
- Wet meadows
- Marshes
- Swamps

Flowing water environments
- Small streams and springs
- Intermittent streams
- Medium-sized rivers
- Large rivers
- Large springs
- Unique features
  - waterfalls
  - thermal streams
  - underground or cave streams
  - saline streams
  - acid streams
  - tailwaters of reservoirs

Limnetic environments
- Highly saline lakes
- Moderately saline lakes
- Eutrophic lakes
- Mesotrophic lakes
- Oligotrophic lakes
- Dystrophic lakes
- Special lake types
  - meromictic
  - volcanic
  - meteorite craters
  - marl lakes
  - solution
  - thaw
  - ice dam
  - cirque
  - coastal barrier ponds
  - caves
  - dunes
  - Carolina Bay lakes
  - permanent ice cover

Impoundments
- Riverine
- Limnetic

National Forest is also above timberline (9,800 feet elevation) with alpine plants at the edge of the lake. We expect to find additional alpine lakes and ponds in the Lost River Range, White Clouds, and Pioneer Mountains in Central Idaho

It is proposed that the selection of lakes as natural areas be based on the following criteria:

1) Stratification. Lakes should be identified which differ in thermal stratification properties. Idaho lies between 42° and 49° north latitude and ranges from 740 to 12,662 feet in elevation. Most lakes in Idaho are either dimictic (spring and fall circulation periods) or holomictic (unstratified). According to Hutchinson and Loffler (1956), other possible lake types at these latitudes and elevations are amictic lakes (surface layer is permanently frozen), cold monomictic (water temperatures never exceed 4°C with one period of circulation occurring in the summer), and warm monomictic lakes where temperature is always greater than 4°C and water circulation takes place in the winter and stratification in the summer. Identification of these types would be of great interest to limnologists.

2) Lake origin (after Hutchinson, 1957). The origin of most Idaho lakes is associated with mountain-valley type glacial activity. Cirque lakes or tarns (occupying cirque basins at the head of former glaciers) comprise most of the high mountain lakes in the state. Examples are Hurst, Deer and Oregon Butte Lakes in the Buffalo Hump area (Nez Perce National Forest), and Upper and Lower Steep Lakes in the Bitterroot Range. Moraine lakes (formed behind terminal and lateral moraines left by glaciers) include Fish Lake in the Buffalo Hump area and several lakes in the Sawtooth Mountains.

Paternoster lakes (series of lakes below a glacial scoured basin) include the Brandon Lake complex in the Nez Perce National Forest and Terrace Lakes in the Salmon National Forest. Kettle lakes (small lakes formed by melting of isolated ice blocks) are quite common in the northern part of the state. Many of them, such as Kelso Lake between Sandpoint and Coeur d'Alene, have been developed and can no longer be considered natural. Bottle Lake and Hager Pond were originally kettle lakes but are now classed as bog lakes as a result of the accumulation of Sphagnum in the basins. Bog lakes are included as part of the wetlands classification.

Fault-block lakes are represented by Black Lake in the Payette National Forest, landslide lakes by Palisades Lakes in the Targhee National Forest and Roosevelt Lake in the Payette National Forest, and volcanic lakes by McCammon Pond owned by Idaho State University. A number of lakes and ponds formed by higher organisms (reservoirs and beaver ponds) occur in the state.

These lakes can be further classified as drainage and semidrainage lakes. Drainage lakes have permanent inlets and outlets, moderate to rich plankton populations, moderate to large quantities of dissolved materials and low transparencies. Pennak (1969) describes semidrainage lakes in Colorado as being small in size with shallow depths, no surface outlet, high nitrate content, high organic content and high water transparencies.

3) Vertebrate and invertebrate composition. Some lakes support what are considered unusual or uncommon vertebrate populations. Lower Steep Lake in the North Fork of the Clearwater drainage, for example, is the only lake north of the Salmon River which contains breeding population of golden trout (*Salmo aquabonita* Jordan).

The Born Lakes in the White Clouds (Sawtooth National Recreation Area) contain possibly a unique strain of cutthroat trout (Don Corley, personal communication). According to Corley, these fish are similar in coloration to golden trout but no records exist of any golden plants in the lake.

There is a need to set aside lakes that contain populations of *Ambystoma macrodactylum* (long tailed salamander). According to Dick Wallace (personal communication) little is known about this salamander together with the fact that these amphibians cannot coexist with fish populations in the same lake. Twin Lakes, located in the headwater region of John's Creek in the Nez Perce National Forest, are reported to contain long tailed salamanders.

Selection of ponds and lakes without fish populations is also important as far as invertebrate populations are concerned. Before stocking, zooplankton populations often consist of large species. After size selective predation by the fish, the zooplankton populations might suddenly change to smaller forms. Rabe (1968) observed in the Uinta Mountains of Utah that before fish were stocked in several high lakes there occurred large red calanoid copepods together with dysticid beetles and Trichoptera larvae in abundance. These forms all virtually disappeared once fish were introduced.

4) Production potential. Classification by trophic status stresses biological productivity of a lake. Direct measurement of productivity most commonly involves estimates of phytoplankton measured by the C^{14} or chlorophyll-a methods or by plankton standing crop (biomass). Phytoplankton species composition and succession (Rawson, 1960; Stockner and Northcote, 1974), zooplankton composition and structure (Anderson, 1968; Patalas, 1971; Schindler and Noven, 1977) and zoobenthos composition (Thienemann, 1925; Schmitz, 1958; Rawson, 1960; Hamilton, 1971) have also been correlated with trophic status. Fish production has been measured especially where studies have been directed toward a fishery management goal (Reimers et al., 1955; Rabe, 1963; Johnston, 1973; Stockner and Northcote, 1974).

Uttormark and Wall (1975) reviewed a number of systems designed to rank lakes by trophic status. All methods were judged to achieve a realistic ranking of regional lakes relative to each other although no two systems used the same set of indicator parameters. The most frequently used parameters were hypolimnetic dissolved oxygen, nitrogen, phosphorus, and secchi transparency followed by chlorophyll-a, conductivity and alkalinity.

An effective way to rank a large number of lakes as to productivity is to simplify the methodology so that ordinary survey methods involving rather a basic knowledge of limnology is adequate. In this manner technicians would be able to collect and in some cases analyze much of the data.

We decided to modify a procedure outlined by Johnston (1973) who surveyed over a hundred high lakes in the Cascade Mountains of Washington. He predicted the carrying capacity of lakes for trout populations where environmental factors differed. We would apply a number of these parameters to the lakes in Idaho together with some additional ones we thought were important in assessing the potential production of a lakes, especially those not containing fish. Physical factors would include exposure direction, elevation, water fluctuation, alkalinity, hardness, extent of shallows zone, substrate composition and rock type. Biological factors would be the presence of absence of freshwater shrimp (Gammarus lacustris), large zooplankton such as Daphnia and some Diaptomus species and whether or not higher aquatic plants (macrophytes) exist in the lake and in what concentrations.

Most of these parameters are relatively easy to measure and their sum would provide us with a means to class them as having POOR, AVERAGE, or HIGH productivity potential (Table 3).

Many high lakes in Idaho are located in drainage basins composed of inert rock types such as granite or quartzite where low quantities of nutrient salts are carried into lake waters. These are infertile and biologically they are considered unproductive. On the other hand, some lakes are found in drainage basins such as limestone or argillaceous shales made up of easily weathered rock which yields relatively large quantities of nutrients into the water. We hope to include examples of as many of these different rock basins as possible.

Surveys of high lakes in Idaho include those of Platts (1972) who studied lakes in the White Clouds, Boulder and Pioneer Mountains with emphasis on the fishery potential. Espinosa et al. (1977) surveyed a number of lakes in the Buffalo Hump Region and Parr et al. (1968) made observations of a number of lakes in the Five Lakes Butte area of the Clearwater National Forest. Some of the data on these surveys can eventually be applied to the above ranking system in order to begin the evaluation of some of these waters as natural areas.

Studies were completed for two very different lakes. Upper and Lower Steep Lakes are subalpine cirque lakes on the west slope of the Bitterroot Range in the Clearwater National Forest at elevations of 6,600 and 6,100 ft.

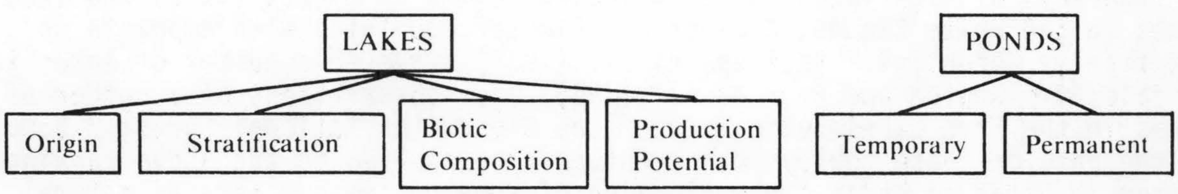
Table 3. Association of some physical, chemical and biological parameters and productivity rates in high lakes*

Environmental Parameters	Production Potential		
	Low	Average	High
Exposure Direction	N	N-NW, NE-E	SW-S-SE
Elevation (ft)	6,000	4,000-6,000	4,000
Water level fluctuation (ft)	10	8-10	0-2
Alkalinity (mg/l)	14	15-29	30+
Hardness (mg/l)	4	5-17	18+
Gammarus Abundance	None	Incidental	Abundant
Daphnia or large calanoid copepods	None	Incidental	Abundant
Aquatic macrophytes	None	Scattered	Large beds
Percent acreage less than 10' deep	15	15-35	35
Littoral zone bottom composition (water depth less than 10' deep)	Bedrock of boulders	Other compositions	Rubble and/ or gravel
Rock types	Granite, quartzite	metamorphic rocks	Limestone

*Modified from Johnston, 1973

Vinyard Lake is a spring formed canyon in the Snake River basalt flow near Twin Falls (elevation 3,600 ft). These sites have been formally proposed for natural area status.

McCammon Ponds, a lava sink south of Pocatello is on property owned by Idaho State University. It has been studied by Moellmer (1966) and Chase (1974) and has been identified as a natural area.



Classification of Idaho Wetlands

Wetlands are areas where the water table is near, at or above the land surface long enough each year to create a habitat typified by hydric soils

Kaniksu Marsh - showing zones of emergent and submergent vegetation located in a former meander scar in the lower Priest River Valley

Hager Pond is a bog and fen occupying a glacial kettle west of Priest Lake.

Lily Marsh is located in Ponderosa State Park A peripheral zone of submergent vegetation and pond lilies surrounds a shallow central zone dominated by sedges.

Elk Valley is a 300 acre montane marsh in the Caribou National Forest, fed by springs issuing from the sagebrush-grass covered foothills and drained by a meandering stream.

and the growth of hydrophytic plants (Sather, 1976). There is a continuous gradient from wet conditions to dry land (aquatic-hydric-mesic-xeric) associated with most surface water features. Wetlands, by definition, are usually bounded on the land or upper edge by a change from hydric to mesic vegetation and on the water or lower edge by the limit of submerged and rooted, floating leaved vegetation (about five feet deep). Because of the emphasis on vegetation as a diagnostic feature, wetlands are as much or more in the realm of the botanist than the aquatic biologist.

The classification system adopted by the Fish and Wildlife Service (Shaw and Fredine, 1956) as a basis for a federal inventory of wetlands has received wide usage. Water depth and vegetation were the principal descriptive characteristics. Wetland types for inland fresh waters were: seasonally flooded flats, wet meadows, shallow and deep marshes, open water, shrub and wooded swamps, and bogs. These types were designated with the focus on management of wetlands as waterfowl habitat.

Golet and Larson (1974) refined the system of Shaw and Fredine for the glaciated Northeast focusing on structure of the vegetation (life-form), rather than species, and total wildlife production and diversity. This approach would appear to be more meaningful for determination of wetland values and as a basis for identifying Natural Areas than the more restricted waterfowl habitat approach.

Many wetland classification systems have arisen in the Prairie Pothole Region of the northcentral United States. Stewart and Kantrud (1971) stressed permanence and salinity of surface water in this poorly drained region while vegetation was a function of these characteristics. This system also realistically combined lake and wetland types. In many naturally occurring lentic ecosystems a central deep water zone (profundal) grades peripherally into a series of wetland types (littoral) each with characteristic vegetation.

The recently revised Fish and Wildlife Service classification (Sather, 1976) has incorporated many of the changes recommended by the above authors and others. In this revision, wetlands are classified on a national scale, first Province (e.g. Cedar-hemlock-Douglas fir province), then by Ecological system (e.g. riverine, lacustrine), Habitat class (e.g. life-form of vegetation), Subclass and Order, and lastly by Habitat type where modifiers such as salinity, pH, Ca concentration, etc. are added. Terms such as "marsh", "swamp", and "bog" are purposely avoided in this version.

After evaluating these systems in terms of aquatic Natural Areas in Idaho, we decided to emphasize the aquatic aspect by limiting our definition of wetlands to those areas where shallow standing water or saturated soil is present during most of the summer season. We have tentatively excluded from

classification "wet meadows" which are more terrestrial than aquatic and "seasonally flooded flats" which occur briefly in the spring adjacent to most low to moderate gradient streams. We did not observe any true swamps where water tolerant tree and shrub species occur in a standing water environment.

We examined thirteen wetland sites in Idaho which are described in Table 4 where we recognized the following basic wetland types:

MARSH including emergent zone and submergent zone

Fresh - specific conductivity <800 umhos @ 25°C

Circumneutral - pH 6.0 - 8.4

Alkaline - pH > 8.4

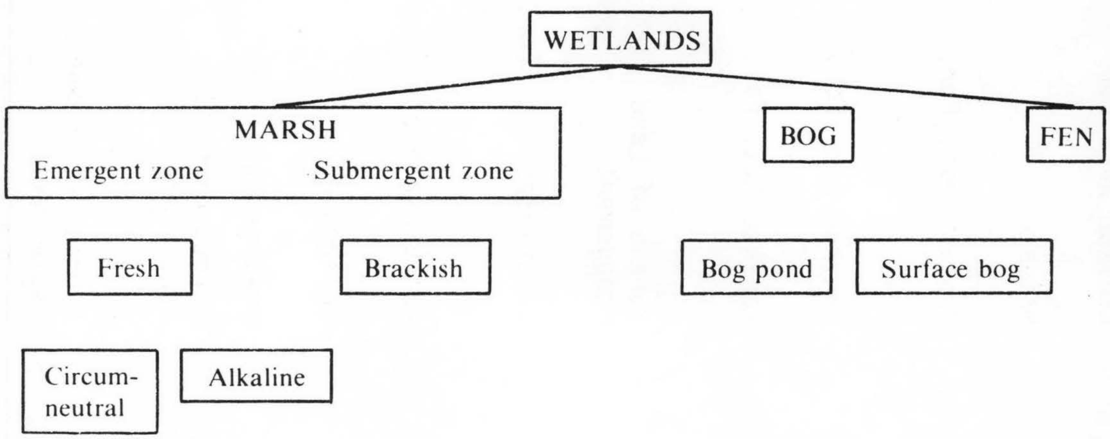
Brackish - specific conductivity >800 umhos @ 25°C

BOG typified by accumulation of *Sphagnum* peat

Bog pond - peripheral and floating mat of vegetation

Surface bog - water table at soil surface supports sphagnum accumulation

FEN typified by accumulation of sedge peat



The marsh emergent zone is characterized by saturated soil or shallow water (one or two feet in depth) supporting grass-like plants such as sedges (Cyperaceae), rushes (Juncaceae), reeds and grasses (Gramineae) and cattails (Typhaceae). The submergent zone contains rooted, floating-leaved plants such as the pond lilies (Nymphaceae) and submergents including coontails (*Ceratophyllum* sp.), pondweeds (*potamogeton* sp.), and bladderworts

Table 4. Characteristics of thirteen wetland sites in Idaho

	Province	Ownership	Aquatic Features	pH	Alk. ppm	Spec. Cond. umhos @25^{o}C
Bottle Lake	1A	Kaniksu Nat. For.	Deep spring and stream fed bog pond with beaver	6.7	10	29
Hager Pond	1A	Private	Bog pond and *Carex-Spirea* fen	-	-	-
Potholes	1A	Kaniksu Nat. For.	Headwater marshy area with beaver ponds and low gradient stream, bog ponds	-	-	-
Kaniksu Marsh	1A	Kaniksu Nat. For.	Large emergent and submergent marsh with beaver	-	-	-
West Fork of West Fork Smith Creek	1A	Kaniksu Nat. For.	Subalpine mountain meadow with bog ponds, marsh, low gradient stream	6.7	9	12
Pinchot Marsh	1A	Bureau of Land Management	High mountain meadow with springs, stream, ponds and marsh	6.4	14	45
Sneakfoot Meadows	1A	Clearwater Nat. For.	Mountain meadow containing stream, surface bog, marsh and small ponds	6.8	11	37
Lily Lake	1B	Ponderosa State Park	Emergent and submergent marsh with good successional stages	6.8	20	34
Elk Valley	2	Caribou Nat. For.	Large mountain marsh with ponds, meandering stream	7.0	16	-
Iron Creek Bog	1C	Challis Nat. For.	Bog pond	-	-	-
Summit Creek Pond	1C	Bureau of Land Management	Marsh	7.6	225	-
Thousand Springs	1C	Private	Marsh, ponds, stream	8.4	300	-
Bruneau Marsh	4B	Bruneau Sand Dunes State Park	Brackish marsh	8.3	160	6000

(*Utrichularia* sp.). Non-rooted plants including algae and duckweeds are also common in these quiet, shallow water situations.

A fen is the mesotrophic, alkaline equivalent of the oligotrophic, a acidic bog (Daubenmire, 1968). Whereas sphagnum moss and associated flora dominate and characterize a bog, sedges are the floristic dominant in a fen. Shrubs such as *Spirea* and *Salix* are frequently associated with fens but rarely when standing water is present. Hager Pond near Priest Lake contains an example of a bog pond and late succession fen (Rumely, 1956).

According to the Idaho Water Resources Inventory (1968), no natural saline waters exist in the state (specific conductivity >800 umhos). However, brackish ponds and a marsh occur within Bruneau Sand Dunes State Park. These water bodies were formed in natural depressions among the dunes by the artificially raised water table resulting from the impoundment of the Bruneau River in the 1950s. They are permanent and have a well-developed natural flora and fauna representative of brackish waters. As such they are good candidates for Natural Area status in lieu of naturally occurring saline waters.

The majority of natural wetlands in the state occur in high mountain meadows or valleys associated with streams, lakes or seep areas. In most situations several wetland types occur together and along with associated lentic or lotic features comprise a diverse aquatic ecosystem. More detailed studies of Idaho wetlands should be undertaken in order to identify the range of wetland types present in the state.

Two wetland sites were studied in considerable detail during the course of this project. These were Bottle Lake, a Sphagnum bog pond on the west wide of Priest Lake (see Appendix D for description of area), and Lily Lake, a large marsh within Ponderosa State Park at McCall. These sites are administered by the Kaniksu National Forest and Idaho State Parks Department respectively and have been formally proposed to the INACC as natural areas.

Two additional wetland sites are briefly described here which appear to have exceptional natural area potential. Elk Valley is a large marsh (ca 300 acres) containing ponds and a meandering stream located in the Gannet Hills section of Caribou County at an elevation of 7,500 feet. No other mountain marsh of this size exists in southeastern Idaho or western Wyoming. Springs and streams issuing from the sagebrush covered valley slopes maintain perennial wet conditions in the marsh which forms the headwaters of a tributary draining into the Salt River. It is an outstanding waterfowl nesting and moulting area and has been protected by the Caribou National Forest from development or alteration. Adjacent land uses include grazing and oil drilling which have had little or no effect on the marsh itself to date. This area has been formally proposed as a natural area.

Kaniksu Marsh is located in what is probably an old river meander near Chipmunk Rapids on the lower Priest River at an elevation of about 2100 feet. It exceeds 200 acres in size and contains zones of emergent and submergent vegetation. There are at least three active beaver lodges in the open water area and several beaver ponds within the drier portions of the marsh. A limited amount of timber removal has taken place on the adjacent forested slopes with no noticeable effect on the marsh. This area is administered by the Kaniksu National Forest, Priest Lake Ranger District.

Classification of Idaho's Thermal Waters

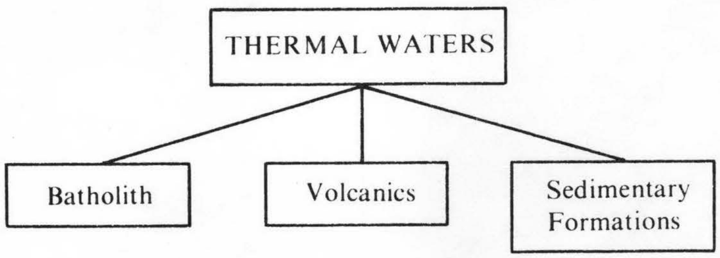
There are over 200 thermal springs in Idaho with temperatures ranging from about 30° to 90°C (Ross, 1971). The pools and streams associated with these springs contain an interesting, specialized flora and fauna and as such are excellent candidates for aquatic natural areas. Hot springs are popular recreational areas, however, and unaltered springs are rapidly disappearing as more back country areas become accessible.

The energy source for most springs is probably related to residual heat of deep-seated Cenozoic rock bodies. About half of Idaho hot springs emerge from the borders of the Idaho batholith or associated silicic volcanic rocks in Provinces 1A, 1B and 4D. Other geologic units which produce thermal anomalies are Tertiary volcanic rocks (east-central and eastern Idaho), Tertiary and Quaternary volcanic or sediment filled basins (Snake River plain), and faults in pre-Tertiary sedimentary rocks (southeastern and east-central Idaho). No hot springs are present in the panhandle (northern) counties.

There is considerable chemical variation in Idaho hot springs but some general groupings can be made. Specific conductivity of water from springs in granitic rocks averages between 300 and 400 umhos/cm @ 25°C while water from volcanic rocks is somewhat higher at 500-600 umhos. Water from southeastern Idaho has specific conductivities as high as 18,000 umhos reflecting the presence of limestone in that area. Sodium and bicarbonate are the dominant ions in most springs with Ca and Mg exceeding Na in southeastern Idaho. Sulfate and Cl ion concentrations are also exceptionally high in this area. Silicon levels are generally high and fluoride concentrations range up to 26 ppm proving fatal to deer and elk that utilize these springs in the winter.

Vulcan Hot Spring located along the South Fork of the Salmon River in Valley County near Warm Lake has been identified as a potential Natural Area. There has been little development of this spring and the chemistry and biology have been studied by University of Idaho graduate students in entomology.

Vulcan Hot Spring is located in the batholith. Additional thermal natural area sites should reflect the different chemistries represented by springs in the volcanic and sedimentary units in the state. Springs with unusual chemical or biological features would also make excellent candidates.



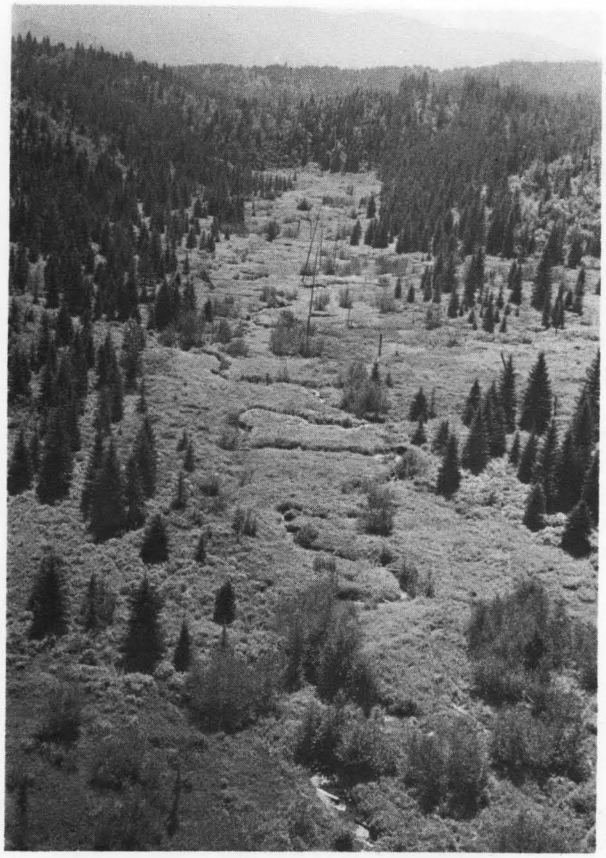
Classification of Idaho's Streams

As is true for most aquatic ecosystems, the extreme variability in landforms, climate, latitude and fauna has hindered the development of any single stream classification system with worldwide applicability. Much research, however, has gone into the attempt to classify streams, primarily for fishery management purposes, and the utility of such a classification is generally recognized.

In Idaho, streams have been classified by fishery potential by the Idaho Fish and Game Department (1968). Platts (1974) attempted to correlate fishery potential with physical and chemical stream characteristics and to integrate these with the landform classification system used by the Forest Service.

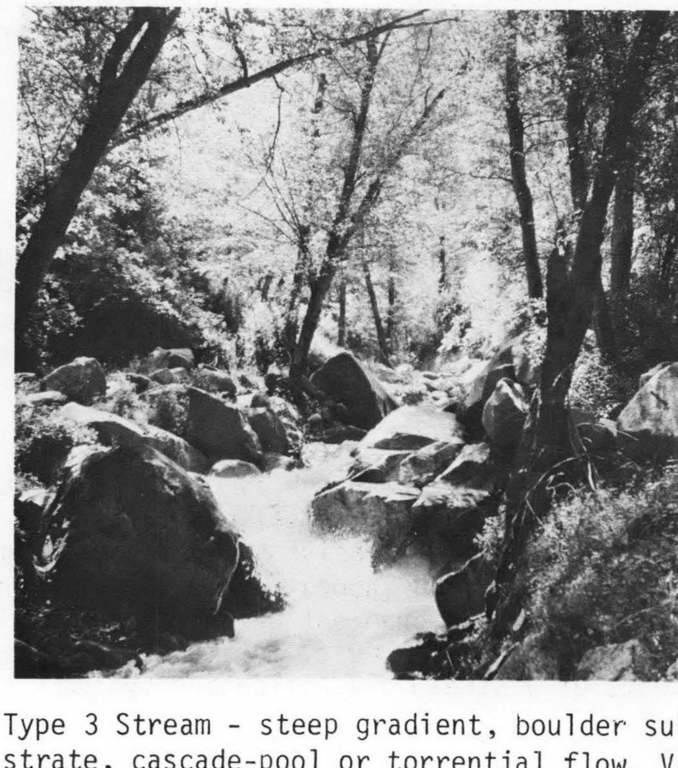
Collotzi (1976) designed a study to integrate landtypes with lotic habitats in the Bridger-Teton National Forest of Wyoming. Valley bottom type (V-shaped, narrow-open, wide) was correlated with stream gradient, substrate and other stream habitat characteristics as well as soil-vegetation associations and landtypes. Management capabilities for each stream type were then defined. This ecosystem approach to stream classification is desirable from a land management as well as a natural area viewpoint.

Potential classification criteria such as mean annual temperature, average discharge or current velocity, biological community structure, indicator organisms or productivity require extensive analysis over time either because of seasonal fluctuation or detailed laboratory analysis. Non-variable physical characteristics such as order and gradient which can be easily determined by observation of map interpretation must, for the sake of expediency, provide the basic elements of a stream classification system.



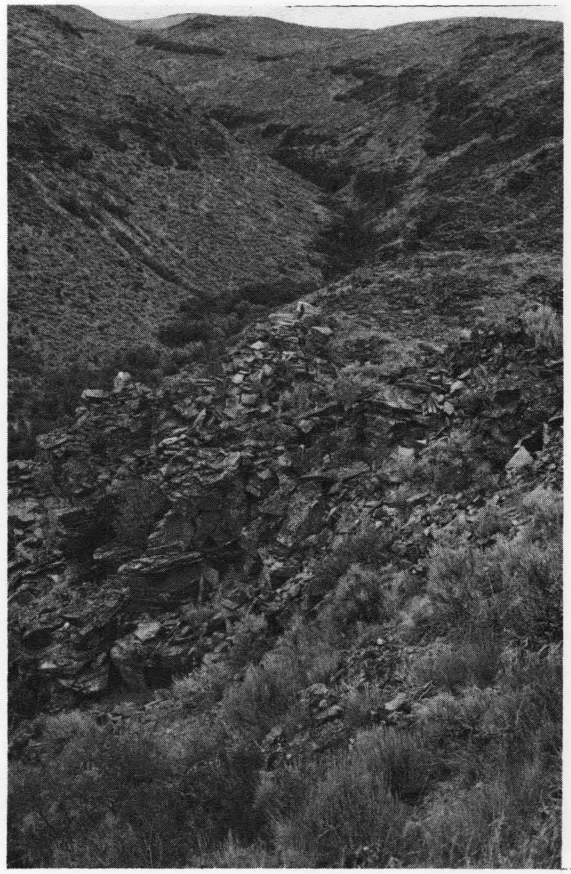
Type 1 Stream - high sinuosity, low gradient, soft substrate, wide valley (Sneakfoot Meadows, Clearwater National Forest).

Type 2 stream - moderate gradient, riffle-pool flow, cobble-gravel substrate, narrow-open valley (Montford Creek, St. Joe National Forest).

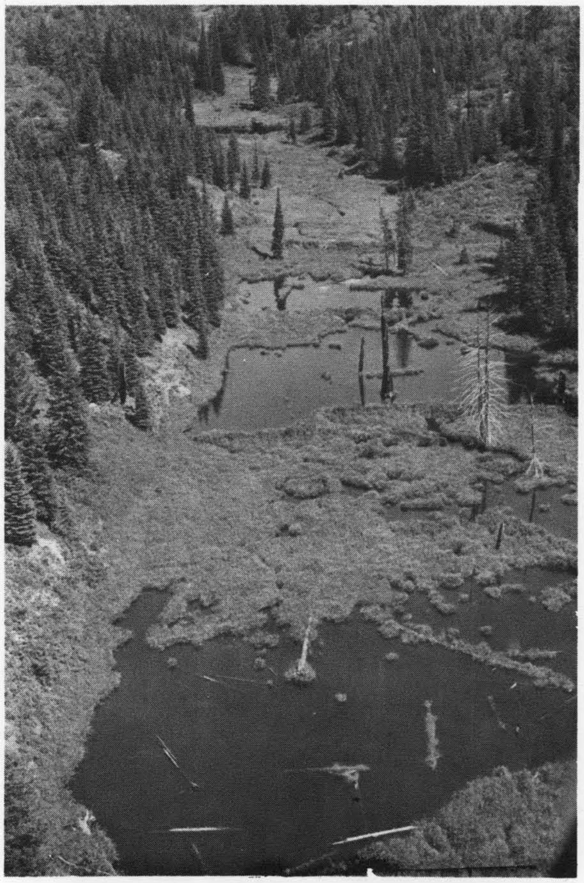


Type 3 Stream - steep gradient, boulder substrate, cascade-pool or torrential flow, V-shaped valley (O'Hara Cr. drainage, Nez Perce National Forest).

Ephemeral Stream - channel contains water only during periods of high runoff (Dry Creek, Shoshone District, Bureau of Land Management).



Spring Stream - springs (right side of photograph), rather than runoff, are primary source of water resulting in equitable seasonal discharge and temperature conditions. (Vinyard Canyon, Shoshone District, Bureau of Land Management).

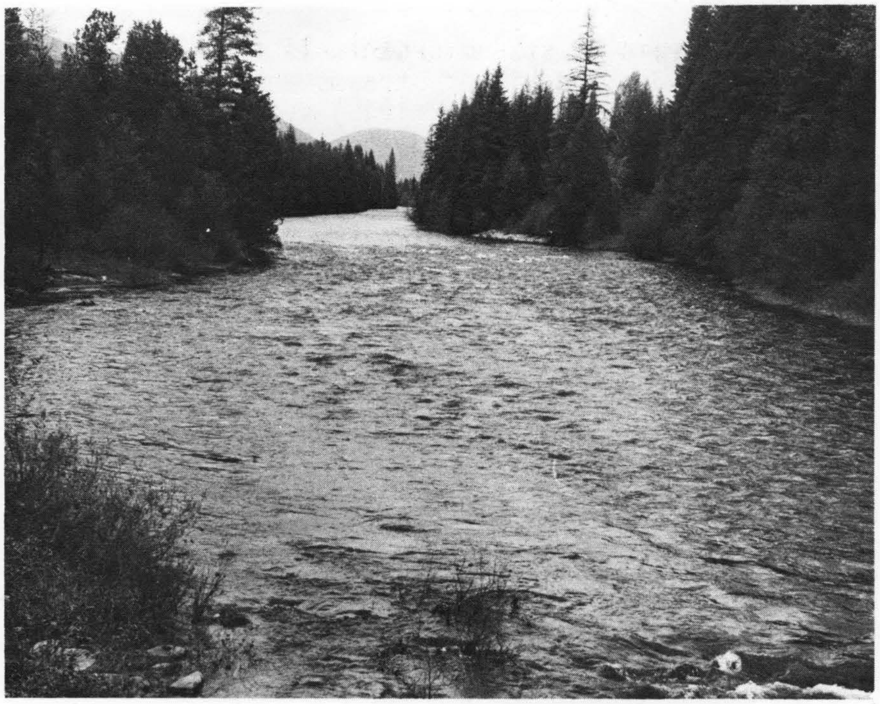


A

B

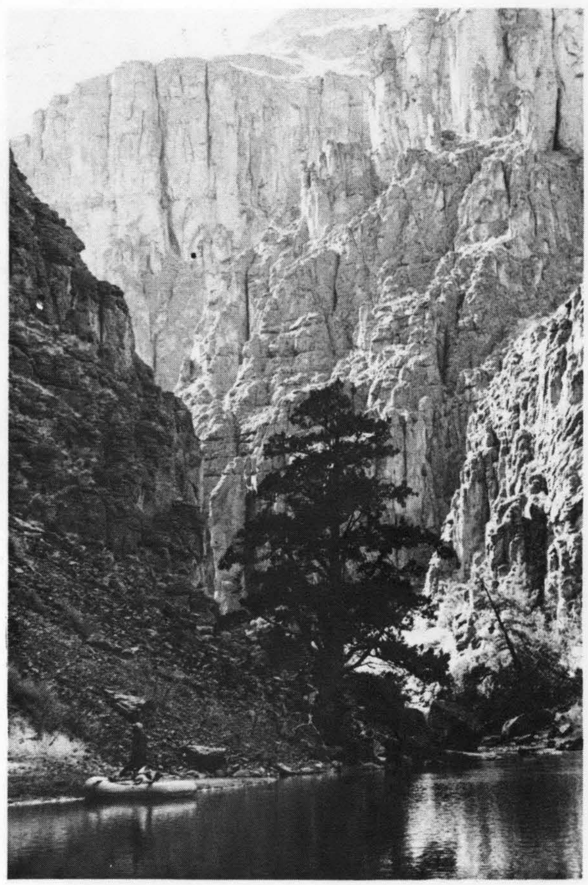
C

Special Aquatic Features - Beaver ponds (A), waterfalls (B), and small springs (C) comprise subtypes within the stream classification system. These features provide specialized habitats within the stream system.



A

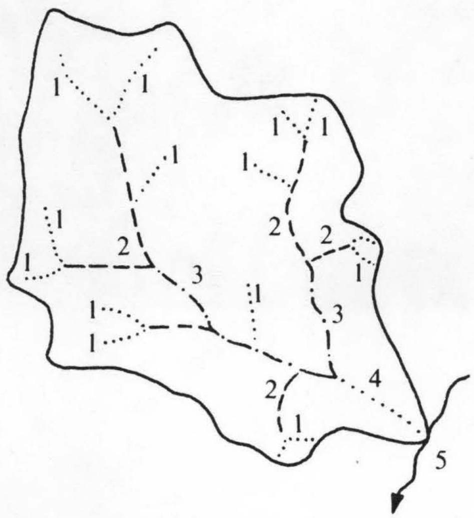
B



Rivers in northern and southern Idaho, illustrated here by the Moyie (A) and the Bruneau (B), differ considerably in valley type, riparian vegetation, discharge, aquatic biota, water chemistry and water temperature.

Classification by Physical Characteristics

We first categorized streams by stream order: 1) first through fourth order streams, and 2) fifth order and higher streams and rivers. We used Strahler's (1957) modification of the Horton (1945) system of ordination. First order (1^o) streams are the smallest headwater branches which have distinct channels. Two 1^o streams join to form a 2^o stream, two 2^o streams join to form a 3^o stream, etc. Stream order does not increase if a stream of a lower order joins one of a higher order, but only when two streams of equal order come together. Stream order can usually be determined accurately $\pm$ one order from large scale topographic or Forest Service maps.



Studies which have associated stream order with longitudinal physical and biological changes have generally found good correlations (Kuehne, 1962; Harrel et al., 1967; Harrel and Davis, 1968; Leopold et al., 1964; Morisawa, 1971). In a study in the Horse Creek drainage in central Idaho, Newlon (1977) found fairly good correlation of invertebrate species diversity and biomass with stream order but with a high variability streams of the same order.

Carrying our classification a step further, we recognized five stream subtypes among 1^o-4^o streams based on observable differences in flow and gradient. These include ephemeral streams which contain water only during brief periods of high flow, streams with a major spring source, and three types among all other streams distinguished by nature of flow, substrate and gradient (Table 5).

Other aquatic subtypes within the stream ecosystem are beaver ponds, waterfalls, small springs and deltas. These features directly influence the stream regimen as well as the composition of the biotope.

Table 5. General stream types within low order streams in Northern Idaho

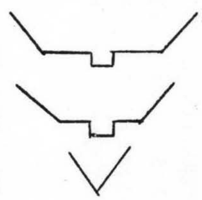
Stream Type	Flow Characteristics	Gradient	Substrate	Valley Type*
1	Meandering glide	<1%	Soft - fine inorganic and organic sediments	Wide valley; mountain meadow
2	Riffle-glide-pool	1-9%	Coarse - cobble, gravel sand	
A	Meandering glide	1%	↓	Wide valley; mountain meadow
B	Riffle-pool	2-5%	increasing size	Narrow-open valley
C	Riffle-pool	5-9%	↓	Narrow-open to V-shaped valley
3	Cascade-pool or torrential	>9%	Very coarse - bedrock boulder, cobble, log debris	V-shaped valley

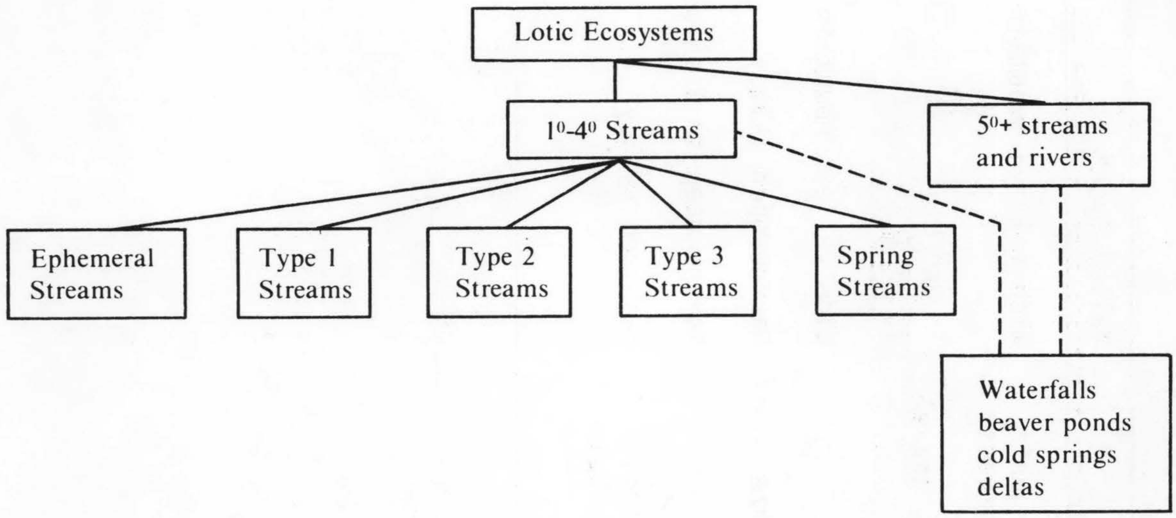
*After Collotzi (1976)

Wide:

Narrow-open:

V-shaped:





Towards Classification by Biological Characteristics

Ultimately it would be desirable to refine the stream classification system further on the basis of biological community characteristics similar to the climax community or habitat type employed in classification of terrestrial ecosystems. This is based on the assumption that distinguishable differences in aquatic communities, expressed by indicator species or associations, indeed exist within these low order streams.

Historically, fish species has been the main biologic criteria for identifying river zones. Ricker (1934) described "swift trout streams" and "slow trout streams" in Ontario while Huet (1954) identified trout, grayling, barbel and bream zones in European rivers. Carpenter (1928) delineated head streams, trout becks, and minnow reaches among upland streams in Britain. Many low order streams in Idaho do not contain adequate flow to maintain a fishery and those that do constitute the upper limits of the "trout zone". Therefore, other components of the aquatic community will necessarily have to provide the biologic factors used in classification.

We collected macroscopic algae, liverworts, mosses, vascular plants, invertebrates, amphibians, and some fishes at 43 stations on 32 streams in northern Idaho (Appendix C). Although these collections are incomplete for each stream, they indicate certain patterns of distribution and association. Distribution of plant and invertebrate species by stream station as well as frequency of occurrence and comparative rarity (based on the expert knowledge of the specialists cited) is presented in Table 6.

Table 6. Distribution of plant and invertebrate biota among northern Idaho streams

Taxon	Round Prairie	Floss	Crater	Sneakfoot	E.F. Bimerick	W.F. Bimerick	Binarch Sta. 1	Binarch Sta. 2	Binarch Sta. 3	Square Mtn. inlet	Square Mtn. outlet	Upper Jackknife	Lower Jackknife	WF of WF of Smith	Moose Meadows	Noble	Twentymile Meadows	Upper Tepee	Lower Tepee	Lower Beaver	Middle Beaver	Upper Beaver	Bad Bear	Fly	Lower Mosquito	Upper Mosquito	Clear	Brett	Eagle	Hobo	Lower Canyon	Upper Canyon	Montford	Fishhook	Lund	Shoshone	Lower O'Hara	E.F. O'Hara	Trib. O'Hara	E.F. Horse	M.F. Horse	Little Granite	No Business	Frequency of occurrence
RHODOPHYTA																																												
Batrachospermum sp.		X												X																														2
CHRYSOPHYTA																																												
*(r) Chrysostephanosphaera sp.																													X															1
Tribonema sp.				X															X																									2
CYANOPHYTA																																												
Nostoc sp.										X					X												X																	3
Oscillatoria sp.																																				X								1
CHLOROPHYTA																																												
Draparnaldia sp.		X										X				X				X			X	X	X																			7
Prasiola sp.							X													X			X													X	X			X				6
Vaucheria sp.							X																																					1
Ulothrix zonata			X											X														X																3
Spirogyra sp.																											X																	1
Zygnema sp.										X																	X																	2
Tetraspora sp.			X																																									1
Microspora willeana																X																												1
Oedogonium sp.	X																																											1
BRYOPHYTA																																												
Marchantia polymorpha							X			X						X												X									X						X	6
Aplozia sphaerocarpum				X													X		X																X									4
Pleocolea obovata												X															X																	2
Scapania undulata														X										X					X							X								4
S. uliginosa																								X																				1
S. oakesii																X																												1
Plaziochila asplenoides																																					X							1
Sphagnum squaveosum				X								X																																2
S. russowii														X																														1
S. teres				X																																								1
Fontinalis neo-mexicana	X	X	X	X	X	X	X	X			X				X	X	X	X	X									X	X					X										17
F. antipyretic var. oreg.								X											X															X										3
Scoularia aquatica															X	X																			X									3
S. agnatica								X																																				1
Cinclidium stygium																								X							X	X											X	4
Rhizomium glabrescens																			X																									1
Pohlia sp.														X																														1
Bartramia pomiformis																								X																				1
Eurhynchium praelongum																		X											X					X	X	X		X					X	7
Brachythecium frigidum																												X			X	X												3
B. hylotopetum										X																																		1
B. aspeninum																		X																										1
Scleropodium obtisifolium																																											X	1
Homalothecium megaptilum								X																																				1
Amblystegium tenax																																	X											1
A. polyganum																																					X							1
Hygrohypnum ochraceum															X																													1
H. dilatalum																				X											X													2
Drepanocladus uncinatus										X									X					X																				3
Hypnum circinale																															X	X												2
Isopterygium palihellum																									X						X	X												3
Plagiomnium venustrum																																											X	1
PTERIDOPHYTA																																												
Equisetum arvensi							X									X																												2
E. palustre		X																																										1
Equisetum sp.	X																						X		X																			3
SPERMATOPHYTA																																												
Juncus sp.	X																																											1
Scirpus sp.					X	X																																						2
Sparganium sp.							X																																					1
Carex vesicaria	X																																											1
C. aquatilus				X																																								1
C. rostrata								X																																				1
Carex sp.		X					X																																					2
Rannunculus aquatilus	X			X			X																																					3
Mentha arvensis							X																																					1
Galium sp.							X																																					1
Mimulus sp.							X											X																										2
Veronica sp.		X																													X													2
Rorrippa nasturtium-aq.		X		X																																								2
(r) Vallisneria americana	X																																											1
Nuphar sp.	X																																											1
Myriophyllum sp.	X																																											1
(u) Alternanthera sp.	X																																											1
Utricularia vulgaris	X			X																																								2
Potomogeton natans	X																																											1
Solidago extraria					X																																							1
Dryopteris felixmas					X																																							1
Epilobium sp.																															X													1
Cerastium sp.																															X													1
Montia sp.																															X													1
Asarum caudatum																		X																										1
Cinna lattifolia																X																												1
Puccinellia pavciflora															X																													1

* (r) rare, (u) uncommon

	Round Prairie	Floss	Crater	Sneakfoot	E.F. Bimerick	W.F. Bimerick	Binarch Sta. 1	Binarch Sta. 2	Binarch Sta. 3	Square Mtn. inlet	Square Mtn. outlet	Upper Jackknife	Lower Jackknife	WF of WF of Smith	Moose Meadows	Noble	Twentymile Meadows	Upper Tepee	Lower Tepee	Lower Beaver	Middle Beaver	Upper Beaver	Bad Bear	Fly	Lower Mosquito	Upper Mosquito	Clear	Brett	Eagle	Hobo	Lower Canyon	Upper Canyon	Montford	Fishhook	Lund	Shoshone	Lower O'Hara	E.F. O'Hara	Trib. O'Hara	E.F. Horse	M.F. Horse	Little Granite	No Business	Frequency of occurrence
EPHEMEROPTERA																																												
* (u) Cinygma sp.																	X																X	X										3
Cinygmula sp.																	X			X		X	X	X	X	X		X	X		X		X			X		X	X	X	X	X	X	18
(u) Heptegenia sp.										X						X																X												3
Rhithrogena robusta																														X				X	X	X			X			X		6
Epeorus grandis																											X	X	X		X		X	X	X	X						X		9
(r) E. flavipennis																		X																								X		2
E. longimanus																												X	X								X							3
E. albertae																				X				X	X						X		X		X	X								7
(r) E. nitidus																			X																									1
(u) E. deceptivus																												X						X		X							X	4
Baetis tricaudatus						X	X	X									X			X																				X				5
B. bicaudatus												X											X	X	X	X		X	X		X	X				X	X	X	X	X	X	X		16
B. parvus					X		X		X																X																			4
B. intermedius																																								X				1
(u) Callibaetis sp.									X																																			1
Centroptilum sp.				X		X						X		X											X															X	X			7
(u) Ephemerella spinifera								X				X				X	X								X												X	X		X		X		9
E. coloradensis																																								X	X			2
E. tibialis							X	X				X					X			X	X		X	X	X				X								X							11
E. flavilinea							X	X													X		X	X				X	X				X			X	X	X	X					12
E. doddsi																					X		X	X				X	X	X					X	X			X			X		10
E. inermis-infrequens												X				X									X								X				X		X					6
(u) E. hystrix												X								X			X	X	X													X				X		7
(u) E. edmundsi																X																												1
(u) E. aurivillii	X																																											1
E. grandis	X					X									X	X																												4
Ephemerella sp.																		X				X																		X				3
(u) Paraleptophlebia heteronea															X	X	X																X	X										5
(u) P. debilis	X			X																																								2
(u) P. bicornuta	X																																											1
(u) Paraleptophlebia sp.					X	X																																						2
(u) Ameletus connectus																		X															X			X								3
A. cooki												X	X								X	X	X	X		X											X	X						9
Ameletus sp.			X					X	X	X					X																X	X								X	X			9
Siphlonurus columbianus	X			X		X	X																																					4
Siphlonurus sp.								X																																				1
PLECOPTERA																																												
Peltoperla sp.			X							X	X	X			X	X	X			X		X	X			X		X		X	X	X	X	X	X	X		X	X	X	X		X	24
(u) Pteronarcella sp.																X	X																											2
Pteronarcys californica																																					X							1
(u) Leuctra sp.												X						X	X					X						X										X	X		X	8
Nemoura sp.					X		X	X		X	X		X	X	X	X										X			X	X	X	X		X	X	X			X				X	19
Acroneuria californica						X									X		X			X		X	X		X			X					X							X	X			11
A. pacifica																																					X							1
Claasenia sabulosa																																										X		1
Arcynopteryx sp.					X						X	X			X		X		X		X	X	X			X			X	X	X	X	X	X	X	X	X		X				X	21
Isogenus sp.	X		X	X		X		X			X	X	X		X	X		X	X									X					X	X			X		X				X	18
(u) Isoperla sp.																		X																		X								2
Alloperla sp.						X		X		X		X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X		X	X	X		X	X	X						X	26
Paraperla sp.																											X													X	X			2
TRICHOPTERA																																												
Microsema sp.			X			X		X			X	X			X	X	X		X						X													X	X					12
Brachycentrus sp.						X															X	X	X	X	X																			6
Glossosoma sp.																	X							X													X		X		X		X	6
Rhyacophila acropodes		X				X				X	X					X	X			X			X		X			X		X			X				X			X	X	X		16
R. vagrita										X			X		X	X		X										X		X					X	X								9
(r) R. tucula																																					X							1
(u) R. verrula																			X							X		X					X			X	X	X	X					8
R. vaccua			X									X				X				X				X			X	X	X				X	X	X				X					12
(u) R. hyalinata																																			X									1
R. venulsa								X				X										X																						3
Limnephilus sp.									X																																			1
Neothremma sp.			X							X					X											X				X	X	X		X	X	X		X	X				X	13
Drusinus sp.		X	X				X		X	X	X		X			X						X		X			X	X			X	X	X	X	X	X	X							19
Psychoglypha sp.		X									X										X	X			X												X							6
(u) Oligophlebodes sp.																																						X	X	X	X			4
(u) Neophylax sp.																X								X													X		X					4
Dicosmoecus sp.																									X			X						X			X							4
(r) Genus A										X																X																		2
(r) Genus D																															X	X												2
Lepidostoma sp.		X		X			X	X	X	X		X						X						X		X									X					X	X	X		14
Parapsyche elsis						X		X			X				X				X		X		X					X	X				X	X	X				X				X	14
Hydropsyche sp.																																					X							1
Arctopsyche grandis																									X		X													X				3
Wormaldia sp.									X			X			X				X							X		X			X	X	X		X	X				X				12
Sortosa sp.																	X																											1
Hydroptila sp.							X	X																																				2

Taxon	Round Prairie	Floss	Crater	Sneakfoot	E.F. Bimerick	W.F. Bimerick	Binarch Sta. 1	Binarch Sta. 2	Binarch Sta. 3	Square Mtn. inlet	Square Mtn. outlet	Upper Jackknife	Lower Jackknife	WF of WF of Smith	Moose Meadows	Noble	Twentymile Meadows	Upper Tepee	Lower Tepee	Lower Beaver	Middle Beaver	Upper Beaver	Bad Bear	Fly	Lower Mosquito	Upper Mosquito	Clear	Brett	Eagle	Hobo	Lower Canyon	Upper Canyon	Montford	Fishhook	Lund	Shoshone	Lower O'Hara	E.F. O'Hara	Trib. O'Hara	E.F. Horse	M.F. Horse	Little Granite	No Business	Frequency of occurrence
(u) Phryganea sp.	X																																											1
ODONATA																																												
(r) Cordulegaster dorsalis					X	X																																						2
(u) Cordulia sp.				X																																								1
Aeshna sp.	X					X																																						2
HEMIPTERA																																												
Gerris nyatalis					X																			X																				2
G. remigis		X																																										1
G. buenoi				X																																								1
Gerris sp.	X						X		X																												X							4
MEGALOPTERA																																												
Sialis sp.			X						X		X																																	3
COLEOPTERA																																												
Heterlimnius corpulentus						X					X	X				X	X						X	X	X	X				X				X				X					X	13
Heterlimnius sp.																																					X							1
Cleptelmis subornata																																						X	X	X				3
Narpus concolor						X						X													X												X						X	5
(u) Lara avara																																					X				X			2
Zaitzevia parvula						X										X				X																								3
Optioservus seriatus						X						X													X																			3
(u) Ametor latus							X											X																										2
(u) Hydrobius sp.													X																															1
(u) Hydrophilidae Sp.													X																										X					1
Hydroporous sp.			X					X																X													X							4
Agabus sp.								X																																				1
Dytiscidae Sp.		X					X			X																																		3
(r) Dioptopsis sp.																																									X			1
Staphylinidae Sp.							X																																					1
(u) Brychius pacificus	X																																											1
Haliplus sp.	X																																											1
Amphizoa insolens																																							X	X				2
DIPTERA																																												
(u) Rhabdomastix sp.																				X				X	X																			3
Hexatoma sp.						X				X	X					X	X	X						X		X	X	X		X						X								12
(r) Prionocera sp.																																X												1
(u) Pedicia sp.										X								X													X													3
Antocha sp.																											X										X			X				3
Tipula sp.																														X					X						X			2
Holorusia sp.																X																												1
Dicronota sp.					X		X		X			X																																4
Simulium sp.	X	X			X	X	X		X						X	X		X	X					X						X	X	X	X			X		X					X	18
Prosimulium sp.																									X															X				2
Chironomidae	X	X	X	X	X	X		X		X				X	X	X				X			X	X	X	X	X	X	X			X		X	X				X					23
(u) Palpomyia sp.	X													X													X																	3
(u) Weidemannia sp.																X																												1
(u) Hemerodromia sp.																						X																						1
(r) Empididae Sp.				X																							X								X	X	X							5
(u) Muscidae Sp.																								X																				1
(u) Dixa sp.																															X													1
(u) Psychodidae Sp.																															X													1
Tabanidae Sp.						X																																						1
Atherix variegata																				X						X																		2
MOLLUSCA																																												
Gastropoda	X	X							X																															X				3
Pelecypoda	X		X							X						X																												4
ANNELIDA																																												
Oligochaeta								X																X																				2
Hyrudinea																																												
Helobdella stagnalis				X																																								1
Erpobdellidae Sp.	X						X																																					2
Glossiphonidae Sp.	X																																											1
PORIFERA	X																			X																								1
PLATYHELMINTHES																																												
Planarians							X								X	X				X	X	X									X	X												8
CRUSTACEA																																												
Hyatella azteca	X						X																																					2

Among the algae, Chrysostephanosphaera sp. is generally uncommon and of rare occurrence in northern Idaho (McMullen, personal communication). It was found only in Eagle Creek (Settlers Grove of Ancient Cedars). Several of the bryophytes (liverworts and mosses) are unrecorded species for Idaho reflecting the small size of herbarium collections of this taxonomic group (Anderegg, personal communication). Fifteen of these species of bryophytes were single occurrences. Among the vascular plants, Alternanthera sp. is uncommon and Vallisneria americana may be a new state record (Naskali, personal communication). Both were collected only in Round Prairie Creek.

Nine rare and numerous uncommon aquatic insects were identified (Biggam, personal communication). Five of these insects were from streams in already established Research Natural Areas. Rare species and their locations are:

Location	Species	Status
Tepee Creek RNA	Epeorus flavipennis (Ephemeroptera)	Rare
	Epeorus nitidus	Rare
	Rhyacophila tucula (Trichoptera)	Rare
Canyon Creek RNA	Prionocera (Diptera)	Rare
	Genus D (Trichoptera:Limnephilidae)	Undescribed biology, rare.
O'Hara Creek	Rhyacophila tucula	Rare
East and West Forks Bimerick Creek	Cordulegaster dorsalis	Common in SW, Rare in Idaho
Little Granite Creek	Dioptopsis sp. (Diptera: Blepharodiridae)	Rare, limited to torrential streams.
Square Mtn. and Upper Mosquite Creeks	Genus A (Trichoptera:Limnephilidae)	Undescribed biology, adult unknown, larva rare
Sneakfoot Meadows	Empididae species (Diptera)	No key to genus, rare

The many plant and insect species among our collections which are uncommon, rare or unrecorded indicates, in part, a lack of knowledge of the biotic diversity within the state. There is a great need to locate and record this diversity while unaltered ecosystems are still intact.

Associations of plants and insects which commonly occur together were derived through computer analysis of the distribution data in Table 6. The phytosociological tables described by Mueller-Dumbois and Ellenberg (1974) which were developed to show mutually associated species provided the methodology for this treatment of biotic relationships. Most groups correlated fairly well with stream type but not with other physical or chemical factors (Table 7).

Table 7. Bioassociations in northern Idaho streams

Group No.	Association	No. of Streams	Stream Types
1	Draparnaldia sp. Ephemerella hystrix	5	1, 2A, B
2	Cinygmula sp. Baetis bicaudatus	9	2B, C, 3
3	Peltoperla sp. Arcynopteryx sp.	15	1, 2, 3
4	Ameletus connectus Isoperla sp.	2	2
5	Bertramia pomiformis Zygnema sp.	2	2
6	Hirudinea Paraleptophlebia debilis Utrichularia vulgaris	2	1

The distribution of aquatic biota within and between stream types is listed in Table 8. Most vascular plants were limited to low to moderate gradient stream reaches in stream types 1 and 2. Rooted vascular plants were confined almost entirely to the soft substrate, type 1 streams.

Among the aquatic insects, approximately 17% were cosmopolitan, being widely distributed in all stream types. Odonata (dragon flies), Hemiptera (water striders) and Sialis sp. (alderfly) were found only in stream types 1 and 2A. This was also true of other aquatic invertebrates such as leeches and molluscs. The greatest number of insect species (30%) were restricted to the moderate gradient, riffle-pool habitat present in type 2 streams. Only 16% of the total number of insect species occurred in the steeper gradient streams (Type 2B and 3). However, relatively more of these were rare or uncommon species.

Invertebrate and plant diversities (species richness) are summarized in Table 9. Upper Binarch Creek with 34 species of invertebrates and 16 aquatic plants had the highest total biological diversity. The highest number of invertebrate species alone was in O'Hara Creek (43 species), Mosquito Creek (35 species), Binarch Creek (34 species) and Beaver Creek (32 species). Round Prairie Creek contained the greatest number of vascular plants (10 species).

Table 8. Plant and invertebrate species within and between stream types in 32 northern Idaho streams

	Type 1*	Types 1 and 2	Type 2	Types 2 and 3	Type 3	All Stream Types
Algae	(s) Vaucheria sp. (s) Tetraspora sp. (s) Oedogonium sp.	Draparnaldia sp. Prasiola sp. Ulothrix zonata Bratracheospernum sp. Tribonema sp.	(s) Spirogyra sp. Zygnemia sp. Nostoc sp. (r,s) Chrysostephanosphaera sp. (s) Micropora willeana (s) Oscillatoria sp.			
Liverworts		Marchantia polymorpha Aplozia sphaerocarpum Pleocolea obovata	Scapania undulata S. uliginosa (s) S. oakesii (s) Plaziochila asplenoides			
Mosses	Sphagnum secundum	Fontinalis neo-mexicana Drepanocladus uncinatus	(s) Sphagnum warnstorfii Fontinalis antipyretica var. oregonensis Scoularia aquatica (s) S. agnatica (s) Rhizomium glabrescens (s) Pohlia sp. (s) Bartramia pomiformis Brachythecium frigidum (s) B. hylotopetum (s) B. aspeninum (s) Homalothecium megaptilum (s) Amblystegium tenax (s) A. polyganum (s) Hygrohypnum ochraceum (s) H. dilatalum (s) Hypnum circinale Isopterygium palihellum	Cinclidium stygium Eurhynchium praelongum	(s) Scleropodium obtusifolium (s) Plagiomnium venustrum	
Vascular plants	Juncus sp. (s) Sparganium sp. (s) Carex vesicaria (s) C. aquatilus C. sp. (s) Menthe arvensis (s) Galeum sp. (s) Rorrippa nasturtium aquat. (s) Vallisneria americana (s) Nuphar sp. (s) Myriophyllum sp. (s) Alternanthera sp. Utrichularia vulgaris (s) Potamogeton natans (s) Asarum caudatum	Scirpus sp. Equisetum arvensi E. palustre E. sp. Tannunculus aquatilus Mimulus sp.	Salidago extraria (s) Dryopteris felixmas (s) Epilobium sp. (s) Cerastium sp. (s) Montia sp. (s) Veronica sp.			
Insects						
Ephemeroptera	(su)Ephemerella aurivillii (u) Paraleptophlebia debilis (us)P. bicornuta	(u) Cyngma sp. Baetis tricaudatus B. parvus Centroptilum sp. Ephemerella tibialis E. grandis (u) Paraleptophlebia sp. Ameletus sp. Siphlonurus columbianus	(u) Heptegenia sp. Epeorus longimanus E. albertae (r,s) E. nitidus (u,s) Callibaetis sp. (u,s) E. sp. (u) Paraleptophlebia heterogena (u) Ameletus connectus (s) Siphlonurus sp.	Cinygmula sp. Rhithrogena robusta Epeorus grandis (r) E. flavipennis (u) E. deceptivus Ephemerella doddsi		Baetis bicaudatus Ephemerella spinifera E. flavilinea E. inermis-infrequens E. hystrix Ameletus cooki
Plecoptera			(u) Pteronarcella sp. (s) Pteronarcys californica Acroneuria californica (s) A. pacifica	(u) Isoperla sp.		Peltoperla sp. Leuctra sp. Nemoura sp. Arcynopteryx sp. Isogenus sp. Alloperla sp.
Odonata	(u) Cordulia sp.	(r) Cordulegaster dorsalis Aeshna sp.				
Hemiptera	Gerris remigis G. Buenoi	Gerris nytalis Gerris sp.				
Megaloptera		Sialis sp.				
Trichoptera	(u) Phryganea sp.	Microsema sp. Rhyacophila vepulsa Drusinus sp. Psychoglypha sp.	Brachycentrus sp. Rhyacophila vigrita (s,u) R. hyalinata Dicosmoecus sp. (s,r) Limnephilidae Genus A (s) Hydropsyche sp. (s) Arctopsyche grandis (s) Sortosa sp. Hydroptila sp.	Glossosoma sp. Rhyacophila verrula (u) Oligophlebodes sp. (u) Neophylax sp. (r) Limnephilidae Genus D Parapsyche elsis		Rhyacophila acropodes R. vaccua Lepidostoma sp. Wormaldia sp.
Coleoptera	(s) Staphylinidae sp. (s,u) Brychius pacificus (s) Haliplus sp.	Heterlimnius corpulentis Optioservus seriatus (u) Ametor latus Hydroporous sp. Dytiscidae sp.	(s) Heterlimnius sp. Zaitzevia parvula (s,u) Hydrobius sp. Hydrophilidae sp.	(u) Lara avara	(s,u) Cleptelmis subornata (s,r) Dioptopsis sp.	(u) Narpus concolor
Diptera	(s) Tabanidae sp.	Dicronota sp. (u) Palpomyia sp.	(u) Rhabdomastix sp. (u) Pedicia sp. (s) Antocha sp. (s) Holorusia sp. (s) Prosimulium sp. (s,u) Weidemannia sp. (s,u) Hemerodromia sp. (s,u) Muscidae sp. (s) Atherix variegata	Hexatoma sp. (r) Empididae sp.		Simulium sp. Chironomidae
Other invertebrates						
Gammaridae	Hyatella azteca					
Hyrudinea	(s) Helobdella stagnalis (s) Erphobdellidae sp. (s) Glossiphonidae sp.					
Mollusca		Gastropoda Pelecypoda				
Porifera		Porifera				
Oligochaeta			Oligochaeta			
Planaria						Planaria

Table 9. Species richness (diversity) of aquatic plants and invertebrates in 32 northern Idaho streams

Taxonomic Group	Round Prairie***	Floss	Crater	Sneakfoot	E.F. Bimerick	W.F. Bimerick	Binarch	Square Mtn.	Jackknife	W.F. Smith	Moose	Noble	Twentymile	Tepee	Beaver	Bad Bear	Fly	Mosquito	Clear	Brett	Eagle	Hobo	Canyon	Montford	Fishhook	Lund	Shoshone	O'Hara	E.F. Horse	W.F. Horse	Little Granite	No Business
Algae*	1	2	2	1		1	2	2	1	2	1	2		1	2	2	1	1	3	1	1						2	1	1		1	
Bryophyta	1	1	1	4	1		5	4	2	3	3	4	2	6	1		4	1	1	3	3		5	1	3	3	2	4				6
Vascular plants**	10	4		4	1	3	9			1		3	1	2		1		1					4									
Total number of plant species	12	7	3	9	2	4	16	6	3	6	4	9	3	9	3	3	5	3	4	4	4		9	1	3	3	4	5	1		1	6
Ephemeroptera	5		1	3	2	5	10	2	6	1	2	6	6	4	9	7	7	11	1	7	7	2	5	8	5	4	9	11	9	5	8	2
Plecoptera	1		2	1	2	3	2	5	5	2	6	5	5	5	4	4	2	5	1	4	3	4	4	5	4	4	5	6	6	6	1	6
Trichoptera	1	4	4	1		3	8	9	7	1	5	6	4	5	10	3	6	10	3	8	2	4	6	6	5	8	5	14	4	4	2	3
Odonata	1			1	1	2																										
Hemiptera		1		1	1		1										1															
Megaloptera			1					1																				1				
Coleoptera	2	1	1			4	5	2	5			2	1	1	1	2	1	3				1			1			6	2	2	2	2
Diptera	3	2	1	2	3	3	4	3	1	2	3	5	1	2	4	2	4	5	5	3	2	2	7	2		1	4	5	2	2	1	1
Other inverts.	4	1	1	1			4	1			1	2		1	4			1					1	1					1	2		
Total number of invertebrate species	17	9	11	10	9	20	34	23	24	6	17	26	17	18	32	18	21	35	10	22	14	13	23	22	15	20	27	43	24	21	14	14

* Rhodophyta, Chrysophyta, Cyanophyta, Chlorophyta

** Pteridophyta, Spermatophyta

*** Streams are arranged in order of increasing gradient

Occurrence of fish and amphibian species is presented in Table 10. Fishes were collected by angling in some streams. Additional fish distribution information was provided by the Idaho Fish and Game Department, Forest Service, or was derived from the literature (Maughn, 1976; Mauser, 1970). The westslope cutthroat trout (*Salmo clarki lewisi*) is endemic to mountain streams mainly west of the continental divide in the northern Rocky Mountains. This subspecies has hybridized with introduced trout species to varying degrees in most of this region. However, Binarch and Brett Creeks contain nearly pure strain populations of this native trout (Wallace, personal communication).

Amphibians (frogs and salamanders) were identified in a number of the streams. Of the amphibians, the Pacific giant salamander (*Dicamptodon ensatus*) was observed only in the O'Hara Creek drainage. This species is limited in its range to Valley County on the south and Benewah and Shoshone Counties on the north (Fichter and Linder, 1964). The spotted frog (*Rana pretiosa*) was observed primarily in low gradient mountain streams while the tailed frog (*Ascaphus truei*) occupied moderate to steep gradient stream habitats.

Water Chemistry

Ion concentrations, especially Ca and HCO_3 levels, affect some plants and not others (Hynes, 1970). Generally, high levels are conducive to greater plant productivity and thus indirectly influence animal productivity. Temperature has an important effect on the aquatic community both indirectly through influence on dissolved oxygen levels and directly through physiological effects on animals including life cycles, growth rates, migration and occurrence. These parameters have potential for classification criteria.

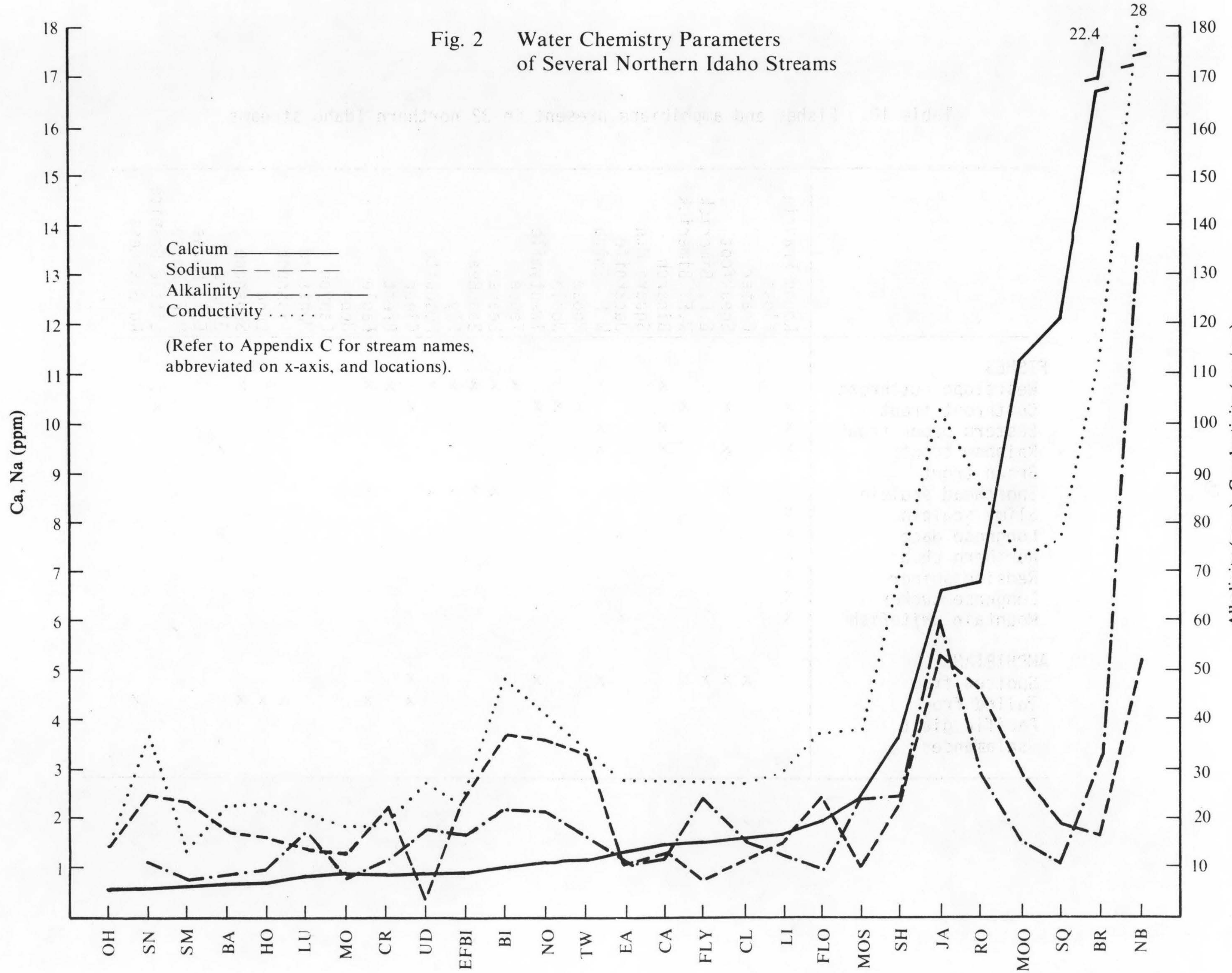
Water chemistry data was collected on 27 northern Idaho streams. Water temperature varied from $5^{o}C$ - $19^{o}C$. However, some of this variation was due to difference in sampling date so no correlations were attempted. Alkalinity, specific conductivity, Ca and Na levels are presented in Figure 2. Streams are listed in order of increasing Ca concentrations.

Sodium exceeds Ca in most streams draining batholithic granites. It is not known what effect this somewhat uncommon characteristic has on the biological community. Calcium concentrations were highest in No Business Creek (28 ppm) draining Tertiary limestones in the Slate Creek drainage and Brett Creek (22 ppm) in the Precambrian Belt rocks of the Coeur d'Alene River drainage. Alkalinity and specific conductivity were also highest in No Business Creek. No unusual biological features were noted in this type 3 stream which could be attributable to these high levels; however, primary productivity was not measured. Newlon (1977) found that alkalinity was positively correlated with invertebrate biomass in an analysis of environmental variables affecting the invertebrate community in the Horse Creek drainage.

Table 10. Fishes and amphibians present in 32 northern Idaho streams

	Round Prairie	Floss	Crater	Sneakfoot	E.F. Bimerick	W.F. Bimerick	Binarch	Square Mtn.	Jackknife	W.F. Smith	Moose	Noble	Twentymile	Tepee	Beaver	Bad Bear	Fly	Mosquito	Clear	Brett	Eagle	Hobo	Canyon	Montford	Fishhook	Lund	Shoshone	O'Hara	E.F. Horse	M.F. Horse	Little Granite	No Business
FISHES																																
Westslope cutthroat							X			X				X	X	X	X	X		X	X						X					
Cutthroat trout	X			X		X					X	X	X						X												X	
Eastern brook trout	X						X			X																						
Rainbow trout	X			X			X			X																		X				
Brown trout							X																									
Shorthead sculpin				X											X	X	X	X			X											
Slimy sculpin	X																															
Longnose dace	X								X																			X				
Northern chub	X																															
Redside shiner	X																															
Longnose sucker	X																															
Mountain whitefish	X								X																							
AMPHIBIANS																																
Spotted frog			X	X	X	X				X			X						X													
Tailed frog																			X		X				X	X	X					X
Pacific giant salamander																												X				

Fig. 2 Water Chemistry Parameters of Several Northern Idaho Streams



Classification Summary for All Aquatic Types

The classification system for aquatic features in Idaho is summarized in Table 11. This rather general classification is subject to change as future inventory work identifies distinctive aquatic subtypes.

Streams are classified according to easily observable physical characteristics which influence the nature of the plant and animal community in the stream. "Special features" associated with streams (waterfalls, beaver ponds, and cold springs) also are reflected by specialized biota. No chemical classification was developed for the chemically homogenous set of streams studied in northern Idaho; however, this factor may enter into a statewide classification.

No real classification system exists for Idaho lakes. The subtypes listed indicate possible classification categories. Probably no one category will be satisfactory for all lakes. Ideally, further inventory may result in enough information to list each lake in all four classification categories.

Ponds are usually "small" and "shallow" but no quantitative size limit has been suggested as to lake or pond designation for a body of water, as any area or depth parameters would be arbitrary. Physical circumstances and popular usage are two contributing factors to such a designation.

At present, classification of wetlands is based on water chemistry. A complete survey of wetlands in Idaho may reveal subtypes based on floristic dominants of associations. The "fen" requires further investigation as to origin and succession.

Hot springs may also be further subtyped by more exact chemical constituents or temperature ranges.

Table 11. Aquatic ecosystem classification for Idaho natural areas

Aquatic Class	Symbol	Aquatic Types and Subtypes	Characteristics	Special Features
LOTIC	1	1^{o}-4^{o} streams		
	A	Ephemeral	Contains water only during brief periods	a. waterfall
	B	Type 1	Meandering glide; <1% gradient, soft substrate	b. beaver pond
	C	Type 2	Riffle-pool; 1-9% gradient; cobble substrate	c. cold spring
	D	Type 3	Cascade-pool or torrential; >9% gradient; boulder	
	E	Spring stream	Major spring source; low gradient, high flow	
	2	5^{o}+ streams & rivers		d. delta
LENTIC	3	Lakes	(These categories are defined in the text. Subtype designation indicates feature of primary interest).	
	A	Origin		
	B	Stratification		
	C	Productivity		
	D	Special biota		
	4	Ponds		
	A	Temporary		
	B	Permanent		
	5	Marsh	Includes emergent and submergent zones	
	A	Fresh	Specific conductivity <800 umhos	
	a	Circumneutral	pH = 6.0 - 8.4	
	b	Alkaline	pH > 8.4	
	B	Brackish	Specific conductivity >800 umhos	
	6	Bog	Sphagnum peat accumulation, oligotrophic, pH <7.0	
	A	Pond	Peripheral and floating mat encroaching on pond	
	B	Surface	Ground surface feature	
	7	Fen	Sedge peat accumulation, mesotrophic, pH $\geq$7.0	
THERMAL	8	Hot springs		
	A	Batholith	specific conductivity moderate ~ 400 um/cm	
	B	Volcanic	Specific conductivity moderate ~ 500 um/cm	
	C	Sedimentary	Specific conductivity high ~ 1500 um/cm	

Objective 3. A Methodology for the Selection of Aquatic Natural Areas

Natural areas can be selected either on the basis of unique, outstanding or extremely unusual features (relatively few) or on the basis of representative ecosystem types which typify the natural diversity of a region (the majority of sites). Identification and selection of potential aquatic natural areas representative of basic aquatic ecosystem types requires knowledge of the natural diversity based on an extensive inventory of the state, province or region. This is tied in closely with a classification system which delineates aquatic types.

Recent nationwide interest in the inclusion of natural areas in regional land use plans has led to the development of objective evaluation methods for priority selection of potential natural area sites. Most methods involve a numerical ranking of sites based on values assigned to natural features and to socioeconomic or management factors (Smith, 1975; Gehlbach, 1975; Sargent and Brande, 1976). All authors emphasize that relative score is intended to indicate priority only and does not exclude low-scoring sites from later consideration. Ranking is simply a tool for objective comparison and evaluation of a large number of sites so that selection of natural areas is based on clearly defined criteria. A ranking system is of greatest value where like situations are being compared in order to select the best area to represent a given situation.

One cannot assume that ranking systems are the final answer in terms of decision making involving resource values. It is almost impossible to survey all of the characteristics of any natural area and the dangers of overlooking positive or negative values are very great (Ehrenfeld, 1976). There is also an inherent danger in judging or comparing one area against another. Instead the selection of a site should probably be made independently of the need to conserve another. However, unless there is some attempt to call attention to the physical features of these ecosystems together with the community structure in terms of diversity and uncommon species then this information will go unnoticed and the option of preservation will be less in a state where economic growth is proceeding at a rapid rate.

An objective of the present project was to develop a methodology for selection of aquatic natural areas in Idaho which would be useful to the Idaho Natural Areas Coordinating Committee as well as resource managers in evaluating a site as to natural area potential. The methodology discussed here is directed toward the selection of lotic ecosystems using as examples the data accumulated on 32 northern Idaho drainages (primarily in province 1A) which were discussed in the section on stream classification and community structure. Those streams are described in Appendix C. This system can easily be adapted, with minor modifications, to selection of lake or wetland areas. It is best applied where a large number of unaltered drainages are being compared for greatest cell representation within each potential natural area.

Although the project was directed toward identification of aquatic natural areas, it is impossible to divorce the terrestrial features of a site from the aquatic, especially where lotic ecosystems are concerned. If feasible, aquatic natural area boundaries are drawn to include an entire watershed in order to protect the stream from alterations derived from adjacent land uses. In order to satisfy the maximum number of cell needs in the minimum number of natural areas, both terrestrial and aquatic cells should be filled in the same sites wherever possible. In evaluating a site, then, both aquatic and terrestrial components should be studied.

The Selection Process*

Step 1: Nominations for potential natural areas were acquired through interviews and correspondence with federal and state land management agency personnel. Most of the 220 site nominations came from this source. A nomination form (see Part I, Table 1) was also developed and distributed to schools and universities, agencies and wildlife and conservation organizations.

Step 2: Two requirements are fundamental to the identification and selection of a potential natural area:

1) "Natural" condition of site. Undisturbed or unaltered areas have the greatest natural area values. This criterion has been modified in occasional situations, however, where the site is the best available to represent certain features.

2) No immediate use conflict. Sites which are included in a timber sale or receive heavy recreational use, for example, present use conflicts which are difficult to surmount. Only the discovery of extraordinary natural area values would justify pursuing selection of such sites.

Step 3: Once it is determined that a nominated area satisfies these criteria, a reconnaissance survey of the site should be conducted by individuals qualified in aquatic and terrestrial sciences. Physical, biological and water quality characteristics should be determined and recorded on Site Characteristic Sheets (Table 12) or comparable forms (e.g the INAO Field Examination Form). Aquatic and terrestrial cells present should be identified and compared with a list of cell needs for the province (Wellner and Johnson, 1974).

Step 4: A Site Profile and Evaluate Form was designed which summarizes the information recorded on the Site Characteristic Sheets in such a manner

*Summarized in flow chart (Figure 3) on following page.

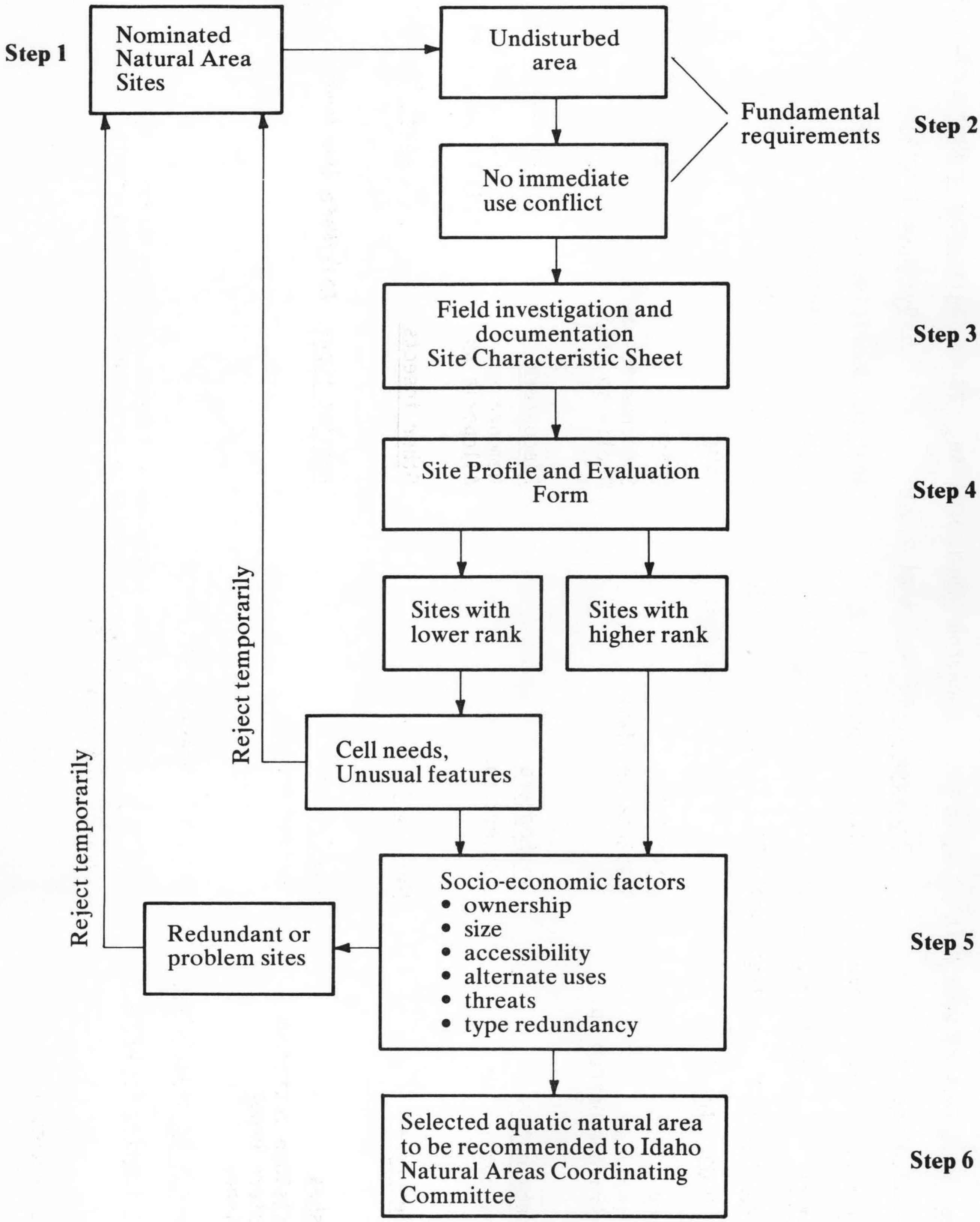

Step 1
Nominated Natural Area Sites
Undisturbed area
No immediate use conflict
Fundamental requirements
Step 2
Field investigation and documentation Site Characteristic Sheet
Step 3
Site Profile and Evaluation Form
Step 4
Sites with lower rank
Sites with higher rank
Reject temporarily
Cell needs, Unusual features
Reject temporarily
Redundant or problem sites
Socio-economic factors
• ownership
• size
• accessibility
• alternate uses
• threats
• type redundancy
Step 5
Selected aquatic natural area to be recommended to Idaho Natural Areas Coordinating Committee
Step 6

Table 12. Site Characteristic Sheet for W.F.W.F. Smith Creek

Site West Fork of West Fork of Smith Cr. Location T64N, R3W, Sec. 29 Agency/Owner Kaniksu Nat. For.

Elevation ca 5000' Drainage basin Kootenai River Drainage Direction E

Rock type Kaniksu batholith Stream order(s) 1, 2 Landtype Subalpine mtn. meadow, steep outlet

Station Sampling date 8/23/76 Gradient 1% Substrate cobble-grave-sand-fine organic

Stream width 8' Stream depth 2' Temp. Alkalinity 8 ppm Conductivity 12.8

Ca 0.63 Mg 1.25 Na 2.30 K 0.39 Other ions 0.5 ppm SO_4 pH 6.7

Algae	Liverworts	Mosses	Vascular plants
Ulothrix sp. Bratracheospernum sp.	Scapania undulata	Sphagnum rossowii Pholia sp.	

Ephemeroptera	Trichoptera	Plecoptera	Diptera
Centroptilum sp.	Drusinus sp.	Nemoura sp. Alloperla sp.	Chironomidae *(U) Palpomyia sp.

Coleoptera	Hemiptera	Other insects	Other invertebrates

Fishes	Amphibians	Habitat types
westslope cutthroat eastern brook rainbow	spotted frog	Abla/Mefe (Rhodendron), Abla/Xete

Associated aquatic features Bog pond, beaver pond, marsh

Outstanding features of site Several aquatic cells, westslope cutthroat, caribou range, unusual density of Ulothrix in streams. Subalpine fir climax with old growth Engelman spruce and Douglas fir.

*(U) uncommon
(R) rare

that the natural area values of nominated sites in a region can be directly compared (Tables 13-17).

The form includes the following categories:

Aquatic features - These include stream types, instream features and other aquatic situations present in the drainage basin which were identified during the classification process as aquatic types or subtypes (Table 11).

Terrestrial features - Habitat types are the basic vegetational subdivisions of the landscape. Each one has a potential as to sere and climax and is recognized by a distinctive overstory and understory at maturity (Daubenmire, 1968). Each habitat type is a cell and the total number of habitat types indicates the vegetational diversity of the drainage.

Outstanding features - These are situations which are unusual relative to other sites in the forest, province or region and which have natural area value.

Water chemistry - Included in this category are unusual water chemistry characteristics such as extremes in water hardness of specific ion concentrations (refer to Figure 2).

Algae, bryophytes, vascular plants, invertebrates - Outstanding situations involving these aquatic biota include unusually high species diversities, presence of rare species, or unusual abundance of a species or group (refer to Tables 6, 9 and 10).

Climax communities - Where a climax forest or grassland community is present, cover type and habitat types are equivalent and constitute an important natural area situation.

Species of special concern - Plants and animals which are rare or endangered of whose habitat is threatened, or whose range is limited constitute "species of special concern" for Idaho. These species have been listed for vertebrates (Johnson and Trost, 1976) and plants (Steele, 1976; Wellner and Johnson, 1974).

Those sites with a high number of cells represent areas of greatest natural diversity and may be assigned highest priority for consideration as natural areas. For example, the range of numbers of aquatic cells is 1-7. Sites with five or more aquatic cells include Floss, Binarch and Smith Creeks (Table 13), Fly and Mosquito Creeks (Table 15) and Square Mountain and O'Hara Creeks (Table 16). These would be the best candidates for aquatic natural areas in the northern Idaho forest on the basis of aquatic cell diversity.

The range in terrestrial cell numbers is 1-19. Shoshone Creek with nine habitat types, O'Hara Creek with 10 and Little Granite Creek with 19 scorehighest among all drainages. These are some of the largest areas and also score well on aquatic diversity.

Table 13. Site Profile and Evaluation Form

Kaniksu Forest Site	Aquatic Features													Terrestrial Features	Outstanding Features						
	Ephemeral streams	Type 1 streams	Type 2 streams	Type 3 streams	Spring streams	Waterfalls	Beaver ponds	Cold springs	Lakes or ponds	Marshes	Bogs or fens	Hot springs	TOTAL AQUATIC CELLS	HABITAT TYPES	Water Chemistry	Algae	Bryophytes	Vascular plants	Invertebrates	Climax communities	Species of special concern
Tepee Cr. (E)	1		1					1			1		4	4					3	2	
Canyon Cr. (E)	1		1					1					3	7			1		2	2	
Binarch Cr.	1	1	1				1		1	1			6	1				1	1		1
WF Smith Cr.	1	1	1	1					1	1	1		7	2		1				1	2
Floss Cr.	1	1					1		1	1			5	2							
Round Prairie Cr.		1											1	1				2	1		
Total	5	4	4	1	0	0	2	2	3	3	2	0									

(E) - established Natural Areas

Table 14. Site Profile and Evaluation Form

Coeur d'Alene Forest Site	Aquatic Features													Terrestrial Features	Outstanding Features						
	Ephemeral streams	Type 1 streams	Type 2 streams	Type 3 streams	Spring streams	Waterfalls	Beaver ponds	Cold springs	Lakes or ponds	Marshes	Bogs or fens	Hot springs	TOTAL AQUATIC CELLS	HABITAT TYPES	Water Chemistry	Algae	Bryophytes	Vascular plants	Invertebrates	Climax communities	Species of special concern
Montford Cr. (E)	1		1	1									3	2						1	
Eagle Cr. (E)			1					1					2	3		1				1	
Shoshone Cr.			1	1		1		1					4	10	1				1	3	
Brett Cr.	1		1										2	3	1					1	1
Total	2	0	4	2	0	1	0	2	0	0	0	0									

Table 15. Site Profile and Evaluation Form

St. Joe Forest Site	Aquatic Features													Terrestrial Features	Outstanding Features						
	Ephemeral streams	Type 1 streams	Type 2 streams	Type 3 streams	Spring streams	Waterfalls	Beaver ponds	Cold springs	Lakes or ponds	Marshes	Bogs or fens	Hot springs	TOTAL AQUATIC CELLS	HABITAT TYPES	Water Chemistry	Algae	Bryophytes	Vascular plants	Invertebrates	Climax communities	Species of special concern
Fishhook Cr. (E)	1	1	1										3	2						1	
Hobo Cr. (E)	1		1										2	2						1	
Bad Bear Cr.	1		1										2	4							
Beaver Cr.	1		1				1						3	5							
Fly Cr.	1		1	1				1	1				5	5							
Mosquito Cr.	1		1	1		1			1				5	5					2		
Clear Cr.	1		1						1	1			4	1							
Lund Cr.	1		1										2	6						1	
Total	8	1	8	2	0	1	1	1	3	1	0	0									

Table 16. Site Profile and Evaluate Form

Clearwater Forest Site	Aquatic Features													Terrestrial Features	Outstanding Features						
	Ephemeral streams	Type 1 streams	Type 2 streams	Type 3 streams	Spring streams	Waterfalls	Beaver ponds	Cold springs	Lakes or ponds	Marshes	Bogs or fens	Hot springs	TOTAL AQUATIC CELLS	HABITAT TYPES	Water Chemistry	Algae	Bryophytes	Vascular plants	Invertebrates	Climax communities	Species of special concern
Crater Meadows		1						1					2	3							
Sneakfoot Mead.		1								1	1		3	1							
E.F. Bimerick		1					1						2	4							
W.F. Bimerick			1			1	1						3	4					1		
Jackknife Cr.	1	1	1								1		4	4							
Total	1	4	2	0	0	1	2	1	0	1	2	0									

Table 17. Site Profile and Evaluation Form

Nez Perce Forest Site	Aquatic Features													Terrestrial Features	Outstanding Features						
	Ephemeral streams	type 1 streams	type 2 streams	type 3 streams	Spring streams	Waterfalls	Beaver ponds	Cold springs	Lakes or ponds	Marshes	Bogs or fens	Hot springs	TOTAL AQUATIC CELLS		Water chemistry	Algae	Bryophytes	Vascular plants	Invertebrates	Climax communities	Species of special concern
Square Mtn.		1	1	1					1	1	1		6	2					1		
Moose Meadows			1								1		2	5							
Noble Cr.			1										1	4							
Twentymile Mead.			1										1	1							
O'Hara Cr.	1		1	1		1	1			1			5	9						1	1
E.F. Horse Cr.			1										1	1							
M.F. Horse Cr.				1									1	1							
No Business Cr.				1									1	4	1					1	
Little Granite				1					1				2	13					1	9	
Total	1	1	6	5	0	1	1	0	2	2	2	0									

Vertical totals among aquatic cells indicate those cells that are well or poorly represented in each forest. For example, the Smith Creek area contains the only type 3 stream in the Kaniksu region (Table 13), enhancing the value of this area. In the Coeur d'Alene region (Table 14), Shoshone Creek is the only site containing a type 3 stream and waterfall, while in the St. Joe region (Table 15) beaver ponds occur only on Beaver Creek. Assuming the cell is present, a need is apparent if a certain cell is not filled among established natural areas.

Outstanding features include rare or unique situations that should be considered individually. Some of these features represent situations which would warrant natural area establishment on the basis of a single situation. For example, the western red cedar climax communities in Settler's Grove of Ancient Cedars (Eagle Creek) and Hobo Cedar Grove (Hobo Creek) formed the basis for establishment of these National Forest Botanical Areas although total cell count is relatively low for these sites. The occurrence of pure strain westslope cutthroat trout on Binarch Creek or rare aquatic insects on West Fork of Bimerick or Mosquito Creeks would add weight to the selection of these areas.

Step 5: Once it is determined that a site has significant natural area values, other "socio-economic" or management factors need to be considered. These include:

Ownership - While federal agencies (Forest Service, Bureau of Land Management and National Park Service) have established policies for designation of natural areas, this is not true for state lands or private parties. In the latter cases, designation or acquisition of significant areas may be complicated or expensive and involve special negotiations.

Size - Size should be large enough to protect features of interest and include a buffer zone. However, too large an area may produce undesirable conflicts with other interests.

Accessibility - In order to be of usefulness to scientists and educators an area should be reasonably accessible. Inaccessible areas might best serve as baseline study areas.

Alternate uses - What degree of recreation, resource values, etc. occur on the site:

Threat - Will immediate establishment be necessary to protect natural values of site or is indefinite protection ensured by some other designation (e.g. Wilderness Area)?

Type redundancy - Do the aquatic or habitat types present on the site fill cell needs or do they closely duplicate cells already filled in established natural areas?

Where serious problems occur involving one or more of these factors, a site may be temporarily rejected, in the interests of earlier establishment, in favor of a site with comparable cells and fewer socio-economic obstacles.

Step 6: The selection process concludes with the formal recommendation of a site to the appropriate entity with the authority to take steps toward natural area establishment (Idaho Natural Areas Coordinating Committee, Forest Service Natural Areas Committee). During all phases of the selection process the land management agency involved should be consulted and informed as to interest in the site as a potential natural area.

PART III

DISCUSSION

BIBLIOGRAPHY

DISCUSSION

The roles of water as a modifier of the earth and a supporter of life are best understood by comparing undisturbed ecosystems with those altered by man. Small watersheds, bogs, marshes and high lakes have been largely neglected during land use planning, yet their aggregate value is immense. Because this value has not been generally recognized, these features are under continuous threat of being altered to some degree.

A system of natural areas designed to include the range of aquatic and vegetational diversity present in the state is a land use alternative of outstanding non-economic value. It is important that we weight non-economic values as well as economic values in land use planning and recommend land use alternatives which protect examples of natural diversity (Ehrenfeld, 1976).

A thorough survey of the natural diversity of the state and development of a classification system identifying discrete ecosystem types is essential to a natural areas system. This information is lacking for aquatic sites in Idaho yet the necessity for this basic knowledge is finally being recognized by agencies involved in resource planning. "Idaho's Water: A Vulnerable Resource" (1976) speaks of the need for well documented baseline data from which we can decide whether a certain use is altering the environment. Rice et al. (1977) identify research needs pertaining to characterization of small undisturbed streams in order to better evaluate forest practice impacts. A well documented collection of plants and animals present through time is one of the best ways of monitoring the effects of pollution.

This project addressed these needs by cataloging the biota occupying unaltered streams, lakes and wetlands throughout Idaho together with chemical and physical characteristics. Our proposed classification system identifies aquatic types and subtypes primarily on the basis of physical characteristics, especially among streams. This system will have broad applicability within the state; however, we feel that a more meaningful classification system for natural areas will involve biological characteristics such as community structure or productivity. The research begun by Newlon (1977) in the Horse Creek drainage and Platts (1974) in the central Idaho batholith as well as ' by the present project should be extended to include the biologic component in the classification system.

Additional studies will be required to accumulate an adequate data base for a more refined classification of lakes and wetlands. However, the methodology developed for selection of streams should be applicable to lake and wetland ecosystems.

To ensure the integrity of natural conditions, management of natural areas prohibits destructive uses such as road construction, logging, grazing and mining; limits manipulative practices such as physical improvements, disease or insect control or reforestation; and discourages public use. A more versatile management system for Idaho natural areas might involve two levels of use:

1) Baseline and research areas - no manipulation.

2) Education areas - nature trails, general use.

Baseline natural areas provide controls against which the effects of landscape manipulation can be measured. Jenkins and Bedford (1973) believe that these baseline areas should be located in remote areas far from human activities and that there should be several in each district. Both biotic and abiotic parameters can be measured and these measurements continued indefinitely on a regular schedule. Biesecker and Leifeste (1975) describe the hydrologic benchmark program in the United States. Stations located on major river across the country are continually monitored for changes in water quality. Only two such sites are located in Idaho. One of these is on Wickahoney Creek near Bruneau and the other is on Hayden Creek, parts of which have been roaded and logged. There is a great need for more undisturbed aquatic sites to monitor both biological and chemical conditions which could be provided by the establishment of additional natural areas in the state.

Hundreds of species of plants and animals are now known to be close to extinction. In Idaho 53 vertebrate animals have been identified as "species of special concern" (Johnson and Trost, 1976). Destruction of habitat is the main reason for the imminent loss of these animals. The Endangered Species Act of 1973 (PL 93-205) recognized the importance of conservation measures to protect endangered and threatened species. Federal law also requires the preparation of an Environmental Impact Statement when alteration of habitat of a rare or endangered species is projected. Natural Areas act to some extent as preserves for many of these species as well as other plant and animal associations.

Perhaps the most notable use of natural areas is for non-destructive scientific research and ecological education. Fosberg et al. (1963) discuss the opportunities for research and teaching on a wildlife sanctuary at Bowling Green State University in Ohio. Hoffman (1963) describes research in wetland reserves and Norris (1968) explains teaching activities within the California land and water reserve system. Franklin and Hall (1972) provide an excellent guidebook for scientists and educators of RNAs in Oregon and Washington.

In Idaho, established natural areas have been used for ecological research and proposed natural areas have provided sites for graduate thesis projects. These include studies by Rumely (1956) on Hager Ponds, a bog pond and fen near Priest Lake; Moellmer (1966) on McCammon Pond, a lava sink near Pocatello; and Newlon (1977) on Horse Creek, a low order stream system in north-central Idaho.

Natural area boundaries should, when possible, be drawn around entire watersheds in order to protect the aquatic ecosystem from upstream alterations. However, this is not always feasible, so fragments of watersheds should be identified when the alternative is to lose a significant example of a biotic community of physical feature (Tuocott, 1972). Also, some replicate areas should be identified in case of loss due to accidental destruction or to provide areas for various levels of use. It would be desirable to have as many representatives of different kinds of communities as possible. However, since species intergrade continuously, there is little chance of duplicating precisely identical communities.

Where possible, sites are selected which satisfy numerous cell needs. For example, the proposed Little Granite Creek natural area in the Seven Devil-Hells Canyon area includes eleven forest cells, nine grassland-shrubland cells, and four aquatic cells. Divide Lake in the Cabinet Mountains contains aquatic, geologic, forest and alpine cells. This approach reduces the number of natural areas needed to encompass the range of natural diversity while increasing the value of each site.

Decisions as to numbers, size and location of natural areas are continually being addressed by the Idaho Natural Areas Coordinating Committee in conjunction with the Forest Service and other land management agencies. Because of the efforts of this group, recommended natural areas are increasingly being included in federal land planning statements as land use alternatives. It is critically urgent that potential natural areas sites are included in all unit planning prior to the completion of the final environmental impact statement. Because of the public involvement process, reallocation of lands to natural area status at a later date may be very difficult.

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PART IV

APPENDICES

APPENDIX A

THE GEOMORPHIC PROVINCES OF IDAHO

Northern Rocky Mountain Province (1)

Northern Idaho Section (1A)

Section 1A, bounded on the south by the Salmon River, is characterized by the heavily forested slopes and deep, narrow valleys of the Selkirk, Cabinet, Coeur d'Alene, Bitterroot and Clearwater Mountains. Mountain tops throughout this section and in the Salmon Mountains of Section 1B tend to rise to an accordant level at 6500-7500 feet reflecting a middle Tertiary plateau or mature erosion level (Peneplain). Subsequent uplift and erosion has resulted in massive mountain ridges with benchlands and wet mountain meadows containing low gradient streams at upper elevations and deeply incised valleys below. In the northern portion of the section, continental glaciation has shaped the topography resulting in more U-shaped valleys. Bog ponds formed from glacial kettles are found in this area. Minor alpine glacial activity has modified upper elevation ridges and valleys throughout this section forming many small cirque lakes.

The predominant rock types are metasediments of the Pre-Cambrian Belt Supergroup and granitic rocks of the Idaho batholith. The basic soil type is subhumid to humid forest soils. Mean annual precipitation ranges from 24-40 inches, much of it falling as snow during the months of November through March.

Central Idaho Section (1B)

The northern portion of this section contains the massive 7000-8000 foot highly dissected Salmon River Mountains drained by the South and Middle Forks of the Salmon River. Further south, the more linear and intensely glaciated Sawtooth, White Cloud and Boulder Mountains rise to 10,000 to 12,000 feet in elevation. Most of this section is underlain by the granodiorites, quartz monzonites and quartz diorites of the Idaho batholith with some Paleozoic sediments occurring in the Boulder and White Cloud Mountains. Aquatic features include numerous cirque and moraine lakes and an extensive network of streams. Hot springs are common throughout the Idaho Batholith (Ross, 1971).

With a mean annual precipitation of 16-40 inches, this area, although also heavily forested, is somewhat drier than section 1A. Subhumid to humid forest soils predominate.

Eastcentral Idaho Section (1C)

This section is in many ways more similar to the Basin and Range Province than to the Northern Rocky Mountain Province. Parallel NW-SE trending fault block ridges forming the Beaverhead, Lemhi, Lost River and Pioneer Mountains are separated by broad down-faulted valley floors. Peaks commonly reach 10,000-11,000 feet in elevation and Mt. Borah, the highest peak in Idaho at 12,655 feet, is located in the Lost River Range. Glacial cirque lakes are common at upper elevations. Perennial streams draining the ridges become intermittent when they reach the alluvium filled valleys. The mature, meandering, south-flowing rivers in turn disappear into the porous basalts of the Snake River plain. The south-flowing Little Lost, Birch, Medicine Lodge and Beaver Creeks were pirated from the north-flowing Pahsimeroi drainage during late Tertiary geologic uplift which formed the low drainage divide which now bisects the section. Large marshy areas occur in these low gradient valleys.

Folded and faulted Paleozoic sedimentary rocks form the major ridges while rocks of the PreCambrian Belt Supergroup and Challis volcanics occur in the north and west portions of the section. Arid to semiarid grassland soils with sagebrush-grass vegetation occur in the valleys and on the lower slopes while grassland-forest transition soils are present on the upper slopes. Mean annual precipitation is approximately 16 inches with a range of 7-32 inches.

Middle Rocky Mountain Province (2)

Paleozoic and mesozoic sedimentary rocks, folded and thrust-faulted into distinct, NW-SE trending ridges and valleys comprise the major portion of this province. Elevation of the peaks ranges from 7000-9000 feet in the Bear River, Aspen and Caribou Ranges and the valley floors are generally more than 5000 feet above sea level. The western rim of the heavily forested Yellowstone Plateau and the eastern portion of the Snake River basalt flows occupy the northern portion of the province. Extensive glaciation occurred in the Yellowstone Plateau and Teton Range immediately east of the Idaho border and in the Bear River Range. Few high elevation lakes occur in this province but many streams of moderate gradient together with abundant aspen groves provide excellent beaver habitat. Low gradient streams and wetlands occupy the mountain valleys.

Soil types within the province include grassland, transition and forest soils with climatic conditions ranging from arid to subhumid. Mean annual precipitation ranges from 16-40 inches.

Basin and Range Province (3)

This province is characterized by sub-parallel, block-faulted mountains separated by broad, open valleys which are down-faulted blocks. Because of tilting during faulting, the block mountains tend to be asymmetrical with one face steeper than the other. Ranges in this province include the Cotterell, Deep Creek, Sublett, Bannock, Portneuf and Wasatch Mountains which rise to 7000-9000 feet above sea level. Valley floors are generally about 4500 feet. The ridges are Paleozoic and early Mesozoic sedimentary rocks which may be somewhat metamorphosed. Some of the basins contain basalt flows and all are filled with alluvial materials from erosive processes. Although much of the Great Basin has internal drainage, the portion in Idaho drains northward into the Snake River. Most streams are intermittent. An enclosed basin occurs in the Pocatello Valley. The outlet of glacial Lake Bonneville in Utah was north through the Cache Valley and Red Rock Pass to the Snake River. The Bonneville flood deposited much allüvial material and altered the topography along its path. Hot springs are common in this province.

Arid to semiarid sagebrush and grassland soils predominate with some transition soils present on forested upper slopes. Mean annual precipitation ranges from 10-20 inches.

Columbia Intermontane Province (4)

Eastern Snake River Plain Section (4A)

This section is characterized by several thousand feet of horizontal basalt flows which have filled a structural and topographic basin. The flat surface of the plain rises from about 3,000 feet near Bliss, Idaho to about 6,000 feet at the eastern extremity. The surface is a youthful (Quaternary) lava plateau, partially covered with a thin wind-blown soil. Relief is provided by low (200-400 ft) shield volcanos, cinder cones and squeeze up lava ridges. Lava tubes forming ice caves occur throughout the section. Craters-of-the Moon National Park is located in this section. The Snake River flows in a deep gorge near the southeastern margin of the section. Little surface water exists on the plain but an extensive underground aquifer is present, formed by the waters of the Big Lost and Little Lost Rivers, among others, which disappear into the porous basalt and reappear as large springs along the Snake River gorge. Arid sagebrush-grass soils are present and annual precipitation is less than 10 inches, most of it falling as snow during the winter months.

Malheur-Boise-King Hill Section (4B)

This section is slightly lower in elevation than section 4A and is characterized by thick lacustrine and fluviatile sediments that are extensively interbedded with thick, horizontal basalt flows of Miocene age. Soils and precipitation are much like that of Section 4A. The section includes low ridges adjacent to the plain, most of the Bruneau River basin and the lower portions of the Boise and Payette River Basins. Many hot springs occur in this section.

Owyhee Uplands Section (4C)

This section is an uplifted area consisting of a core of granitic rock overlain by silicic rhyolites and welded tuffs older in age than the Snake River basalt flows flanking the section. Much of the area is at an elevation of 4000-5000 feet, but a few peaks rise to 8000 feet. These uplands are more deeply dissected than Sections 4A and 4B because of age and elevation. Most of the section is drained by the Owyhee River which flows in a deep gorge typical of the province. Soils are arid to semiarid sagebrush and grassland and transition soils. Annual precipitation is approximately 14 inches with a range of 8-32 inches.

Wallowa-Seven Devils Section (4D)

This section is characterized by rugged, deeply dissected mountain masses reflecting block faulting and glaciation. The southern part of the section consists of tilted blocks of Columbia River basalt while greenstones (metamorphosed lavas and sediments), Mesozoic limestones and granitics related to the Idaho batholith form the scenic Seven Devils to the north. The highest peak in the Seven Devils (9,393) rises almost 8,000 feet above the Snake River in Hells Canyon. Most of the section is forested, although semiarid sagebrush and grasslands prevail in the southern portion. Cirque lakes and steep gradient streams drain the mountain slopes. Precipitation ranges from 16-40 inches per year.

Tri-State Uplands Section (4E)

This section is an undulating plateau of 3000 to 5000 feet elevation, underlain by Columbia River basalt flows. Warping and faulting have occurred resulting in Craig Mountain to the south and the Uniontown plateau to the north with the Lewiston basin forming a structural and topographic low between. The Clearwater and Lower Salmon Rivers drain the area. Prairies predominate in this section with forests occurring in the eastern portion. Soils are semiarid through transition to subhumid forest soils. Precipitation ranges from 16-24 inches per year.

Palouse Hills Section (4F)

This small section is characterized by dunes of windblown loess overlying thick basalt flows. Stream deposited alluvium fills the broad valleys separating the loessial hills. Occasional higher hills of Belt metasediments or granitic rocks stand out reflecting a pre-basalt topography. Grassland soils predominate and mean annual precipitation is about 16 inches. The Potlatch and Palouse Rivers drain most of this section.

APPENDIX B

Table 1. Preliminary list of potential aquatic natural areas

	Aquatic Type												Land Ownership						
	1^o-4^o stream	5^o+ stream	delta	waterfall	beaver pond	cold spring	wet meadow	marsh	bog	pond	lake	hot spring	Forest Service	BLM	State Lands	State Parks	Private	AEC	National Parks
PROVINCE 1, SECTION A																			
Upper Priest River		X	X										X				X		
Tepee Creek (E)	X					X			X				X						
Bottle Lake									X				X						
Canyon Cr. (E)	X					X							X						
Hughes Meadows	X						X						X						
Armstrong Meadows							X						X						
Potholes	X						X	X		X			X						
Hager Pond									X								X		
Upper Binarch Cr.	X				X			X		X			X						
WF of WF Smith Cr.	X						X	X	X				X						
Long Canyon Cr.	X												X						
Round Prairie Cr.	X												X				X		
Copper Falls	X			X									X						
Moyie River		X											X				X		
Floss Cr.	X				X		X	X		X					X				
Kent Lake											X						X		
Hunt Lake											X				X				
S.F. Gold Cr.	X												X						
Divide Lake								X			X		X						
Fisher Lake											X		X						
Sand Cr. marsh	X							X					X						
Kaniksu marsh					X			X					X						
Kilroy Lake									X				X						
Mineral Springs						X							X						
Kirby Cr. marsh	X					X		X					X						
Still Lake											X		X						
Caboose Lake											X		X						
Scotchman Peak Lake											X		X						
Moose Lake								X			X		X						
Shoshone Cr.	X			X									X						
Montford Cr. (E)	X												X						
Cinnamon Cr. pond										X			X						
Brett Cr.	X												X						
Settlers Grove (E)	X												X						
Pond Lake											X		X						
French Lake	X							X			X		X						
Stevens Lake	X										X		X						
Lone Lake	X										X		X						
Revett Lake	X							X			X		X						

	Aquatic Type												Land Ownership						
	10-40 stream	50 stream	delta	waterfall	beaver pond	cold spring	wet meadow	marsh	bog	pond	lake	hot spring	Forest Service	BLM	State Lands	State Parks	Private	AEC	National Parks
Gold Lake	X							X			X		X						
Hidden Lake								X	X	X					X		X		
Clark Fork Delta		X	X														X		
St. Joe Delta		X	X												X		X		
Upper Fishhook Dr. (E)	X												X						
Lund Creek	X													X					
Pinchot Marsh	X					X		X						X					
Beaver Creek	X				X								X				X		
Mosquito Cr., Twin L.	X										X		X				X		
Dam Creek	X				X		X						X						
Clear Creek	X						X						X						
Theriault Lake								X			X		X						
Daveggio Meadows	X						X						X						
White Pine Gulch	X												X						
Elk Creek Falls		X		X									X						
Five Lakes Butte											X		X						
Bacon Peak Lakes	X							X			X		X						
Skyland Lake	X							X			X		X						
Lower Sawtooth Creek	X												X						
Foehl Creek	X												X						
No-see-um Lake								X				X	X						
Up.N. Fk. Clrwtr R.	X												X						
Jackknife Creek	X							X					X						
Weitas Creek	X												X						
Lower Lochsa		X											X						
Aquarius		X				X							X						
Upper Steep Lake	X										X		X						
Lily Lake								X			X		X						
Bimerick Creek	X				X		X						X						
Colt Lakes											X		X						
Grimes Lake											X		X						
White Sands Creek													X						
Pete Ott, Ice Lakes											X		X						
Boulder Creek													X						
Rudd, Moore Lakes	X						X				X		X						
Sneakfoot Meadows	X												X						
Weir Cr. Hot Spring												X	X						
Marion Meadows	X						X						X						
Crater Meadows	X						X						X						
Kooskooskia Meadows	X						X			X			X						
Tenmile Creek	X						X						X						
Johns Creek	X												X						

	Aquatic Type												Land Ownership						
	1^o-4^o stream	5^o stream	delta	waterfall	beaver pond	cold spring	wet meadow	marsh	bog	pond	lake	hot spring	Forest Service	BLM	State Lands	State Parks	Private	AEC	National Parks
Horse Creek	X												X						
O'Hara Creek	X			X	X								X						
Big Mallard Cr.	X												X						
Noble Creek	X						X						X						
Upper Borgamin Cr.	X												X						
Upper Selway		X											X						
Up. Moose Meadows	X						X						X						
Low. Twentymile Mead	X						X						X						
Fish Lake	X							X			X		X						
Dry Saddle Ridge L.											X		X						
Schwar Creek	X												X						
Lick Creek	X							X					X						
Buffalo Hump Lakes	X							X			X		X						
Up. Big Cr. Meadow	X						X						X						
Bear Creek	X												X						
Lake Creek	X												X						
Sheep Creek	X												X						
Salmon Mtn.	X										X		X						
PROVINCE 1, SECTION B																			
Lily Lake	X							X								X			
Rush Creek	X												X						
Black Lake											X		X						
Lodgepole Creek	X						X						X						
Blackmare Creek	X												X						
Jacobs Ladder Cr.	X										X		X						
Porphyry Creek	X												X						
Curtis Lake											X				X				
W. Fk. Chamberlain Cr.	X												X						
Enos Lake											X		X						
Caton Lake											X		X						
Cave Creek	X				X								X						
Spangle Lakes area											X		X						
Trinity Lakes											X		X						
Bannock Creek (E)	X												X						
Bear Creek (E)	X												X						
Lowman Creek (E)	X												X						
Sacajawea Hot Spring												X	X						
Vulcan Hot Spring												X	X						
Pistol Creek	X												X						
Bull Creek	X						X						X						

	Aquatic Type													Land Ownership						
	10-40 stream	50+ stream	dealta	waterfall	beaver pond	cold spring	wet meadow	marsh	bog	pond	lake	hot spring		Forest Service	BLM	State Lands	State Parks	Private	AEC	National Parks
Forge Creek	X			X								X		X						
Terrace Lakes	X										X			X						
Ketchum Warm Springs												X		X						
Warfield Hot Spring												X		X						
Bench Lake											X			X						
Born Lakes											X			X						
Up. Little Wood R.	X													X						
N.Fk. Big Wood R.	X													X						
Trail Cr. Meadows	X						X							X						
Elk Creek	X													X						
N.Fk. Boise River	X													X						
Chamberlain Cr.	X													X						
Wickiup Creek	X													X						
W.Fk.E.Fk. Salmon R.	X													X						
Martin Creek	X													X						
White Clouds Lakes	X										X			X						
Gammarus Lake											X			X						
Bowery Creek	X													X						
East Pass Creek	X													X						
PROVINCE 1, SECTION C																				
Thousand Springs	X						X		X									X		
Angel Lake	X			X						X				X						
Iron Creek Bog								X						X						
Summit Creek	X										X				X					
N.Fk. Big Creek	X														X					
Mill Lake	X									X					X					
Bear Valley Creek	X														X					
Merriam, Pass Lakes										X					X					
Mill Lake Cr.	X						X				X			X						
Dry Creek	X													X						
Swauger Lake											X			X						
Webber Creek	X				X						X			X						
Divide Creek	X				X	X								X						
PROVINCE 2																				
Palisades Cr. Lakes	X										X			X						
Spring Creek	X					X												X		
Montpelier Creek	X				X									X						
Henrys Fork		X		X										X		X				
Silver Lake	X							X			X						X			

	Aquatic Type													Land Ownership						
	10–40 stream	50+ stream	delta	waterfall	beaver pond	cold spring	wet meadow	marsh	bog	pond	lake	hot spring		Forest Service	BLM	State Lands	State Parks	Private	AEC	National Parks
Buffalo River	X	X												X						
Snowslide Creek	X													X						
Icehouse Creek	X				X	X								X						
Bear Creek	X													X						
Preuss Creek	X				X									X						
Elk Valley	X					X		X		X				X						
Diamond Creek	X													X						
Falls River	X													X						
Big Burns Canyon	X													X						
N.Fk. Teton River	X																			
Bloomington Lake											X			X						
Bitch Cr.	X													X						
Moose Cr.	X					X								X						
Robinson Cr.	X					X								X						
Partridge Cr.	X				X	X								X						
Upper Goose Lake											X			X						
PROVINCE 3																				
Slug Creek	X														X					
Hanzel Mountain	X														X					
Petticoat Peak	X														X					
W.Fk. Mink Creek (E)	X					X								X						
Jim Sage Mtn.	X														X					
McCammon Pond*										X						X				
Gibson Jack Cr.	X													X						
Independence Lakes											X			X						
PROVINCE 4, SECTION A																				
Camas Prairie Potholes										X					X					
Fort Hall Springs						X												X		
Vinyard Lake	X			X		X					X				X					
Box Canyon	X			X		X									X			X		
Blue Springs						X				X					X					
Devils Lake											X				X					
Silver Creek	X															X		X		
Sonners Reservoir											X					X				
Big Wood River		X														X				
Camas Creek	X															X				
Little Wood River		X																X		
Crystal Ice Caves																X				

*Idaho State University

	Aquatic Type												Land Ownership						
	10-40 stream	50+ stream	delta	waterfall	beaver pond	cold spring	wet meadow	marsh	bog	pond	lake	hot spring	Forest Service	BLM	State Lands	State Parks	Private	AEC	National Parks
Craters Caves																			X
Craters Potholes										X									X
Big Lost River		X												X				X	
PROVINCE 4, SECTION B																			
Band Lake											X			X					
Halvorsen Lakes											X			X					
Bruneau Sand Dunes L.								X			X				X	X			
Bruneau R.		X												X					
Birds of Prey		X												X					
Jarbidge R.		X												X					
Hill City Marsh	X							X						X			X		
PROVINCE 4, SECTION C																			
Jarbidge R.		X												X					
Salmon Falls Cr.		X												X					
Big Cottonwood Cr.	X				X								X						
Upper Goose Creek	X												X						
Owyhee Canyon		X												X					
Jacks Cr.	X													X					
PROVINCE 4, SECTION D																			
Little Granite Cr.	X					X							X						
Baldy Lakes											X		X						
Rapid River	X	X											X						
Redfish Cave													X						
PROVINCE 4, SECTION E																			
Lower Salmon River		X												X					

(E) = Established Natural Area

Appendix B

Table 2. Summary of potential aquatic Natural Areas

Province	Aquatic Type*												Land Ownership						
	10-40 streams	50+ streams	deltas	waterfalls	beaver ponds	cold springs	wet meadows	marshes	bogs	ponds	lakes	hot springs	Forest Service	BLM	State Lands	State Parks	Private	AEC	National Parks
1A	64	8	3	4	7	6	18	23	6	6	30	1	90	2	4	-	10	-	-
1B	27	3	-	1	1	1	2	1	-	-	12	5	38	-	1	1	-	-	-
1C	10	-	-	1	2	1	1	1	1	1	6	1	7	5	-	-	1	-	-
2	18	-	-	1	4	6	-	2	-	1	4	-	18	-	1	1	1	-	-
3	6	-	-	-	-	1	-	-	-	1	-	-	2	4	1	-	-	-	-
4A	4	3	-	2	-	4	-	-	-	3	3	-	-	10	-	1	1	1	2
4B	-	3	-	-	-	-	-	-	-	-	3	-	-	6	-	1	1	-	-
4C	3	3	-	-	1	-	-	-	-	-	1	-	3	4	-	-	-	-	-
4D	2	1	-	-	-	-	-	-	-	-	1	-	4	-	-	-	-	-	-
4E	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
4F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	134	22	3	9	15	20	21	27	7	12	60	7	162	31	7	4	13	1	2

*Many areas contain more than one aquatic type.

APPENDIX B

Table 3. Established natural areas in Idaho[1]

Name	Province	Administering Agency	Principal Features	Aquatic Features
Bannock (BA)	1B	Boise N.F.	Ponderosa pine and Douglas fir forests	Small streams
Bear (BE_1)	1B	Boise N.F.	Sagebrush-grass	Small streams
Canyon Cr. (CA)	1A	Kaniksu N.F.	Western hemlock white pine and subalpine fir	Steep, spring streams
Dautrich Memorial (DA)	4B	The Nature Conservancy	Horsebrush, shadscale, big sage, dunes	
Hobo Cedar Grove (HO)	1A	St. Joe N.F.	Western red cedar forest	small streams
Gunbarrel Cr. (GU)	1A	Salmon N.F.	Ponderosa pine and Douglas fir forests - burned and unburned portions	Low order streams in four watersheds
Idler's Rest (ID)	1A	The Nature Conservancy	Ponderosa pine, Douglas fir, larch and cedar	Small stream, springs
Kipuka (KI)	4A	National Park Service	Sagebrush-fescue	
Lowman (LO_1)	1B	Boise NF	Ponderosa pine and Douglas fir forests	Small streams
Montford Cr. (MO)	1A	Coeur d'Alene N.F.	White pine, western hemlock, grand fir, Douglas fir, larch forests	Small steep streams, springs

(1) Modified from Wellner and Johnson (1974)

Name	Province	Administering Agency	Principal Features	Aquatic Features
Settler's Grove of Ancient Cedars (SE)	1A	Coeur d'Alene N.F.	Western red cedar forest	Streams, springs
Tepee Cr. (TE)	1A	Kaniksu N.F.	White pine, western hemlock, cedar, larch, Douglas fir, larch forests	Springs, streams, bog ponds
Upper Fishhook Cr. (UP_1)	1A	St. Joe N.F.	Western red cedar and white pine forests	Small streams, marshy areas
West Fork Mink Cr. (WE)	3	Caribou N.F.	Douglas fir, aspen forests, sagebrush-grass	Springs, streams, beaver ponds
Areas which were listed in the RNA Directory (1968) but are not officially established				
Bruneau River (BR)	4B	BLM	Endangered birds of prey	Canyon river
China Cup Butte (CH)	4A	BLM	Cinder cone	
Crater Rings (CR)	4B	BLM	Volcanos and lava flows	
Jarbidge River (JA)	4B	BLM	Unique canyon walls - 800 ft high	Canyon river
Salmon Falls Canyon (SA)	4B	BLM	Endangered birds of prey	Canyon river
Snake River Birds of Prey (SN)	4B	BLM	Endangered birds of prey	Canyon river
St. Anthony Sand Dunes (ST)	4A	BLM	Sand dunes	
Volcanic Cone-Big Southern Butte	4A	BLM	Ancient volcano cone, grasslands	

APPENDIX B - Table 4

Natural areas for which establishment action is underway by agency

Name	Province	Administering Agency	Aquatic Features
Bottle Lake (BO_1)	1A	Kaniksu N.F.	Bog pond, streams
O'Hara Cr. (OH)	1A	Nez Perce N.F.	Steep to moderate gradient streams, beaver ponds, waterfall

Proposed natural areas approved by Idaho Natural Areas Coordinating Committee

Name	Province	Administering Agency	Aquatic Features
Aquarius (AQ)	1A	Clearwater N.F.	
Bear Valley Cr. (BE_2)	1C	Lemhi N.F.	Streams
Box Canyon (BO)	4A	BLM, private	Springs, stream, waterfall
ERDA Park (ER)	4A	ERDA	
Lily Marsh (LI_1)	1B	State Parks	Marsh, streams
Little Granite Cr. (LI_2)	4D	Nez Perce N.F.	Lakes, streams, springs
Lund Cr. (LU)	1A	BLM	Streams, marsh
Meadow Canyon (ME)	1C	Lemhi N.F.	
Mill Lake (MI)	1C	Lemhi N.F.	Streams, lakes
Sheep Mtn (SH_1)	1C	Lemhi N.F.	

GEOMORPHIC PROVINCES OF IDAHO

1. Northern Rocky Mountain Province
   - A. Northern Section
   - B. Central Section
   - C. East-central Section
2. Middle Rocky Mountain Province
3. Basin and Range Province
4. Columbia Intermontane Province
   - A. Eastern Snake River Plain Section
   - B. Malheur-Boise-King Hill Section
   - C. Owyhee Uplands Section
   - D. Seven Devils Section
   - E. Tri-State Uplands Section
   - F. Palouse Hills Section

(TE) Established natural areas
[BO] Areas for which establishment action is underway
EL Proposed natural areas approved by INACC

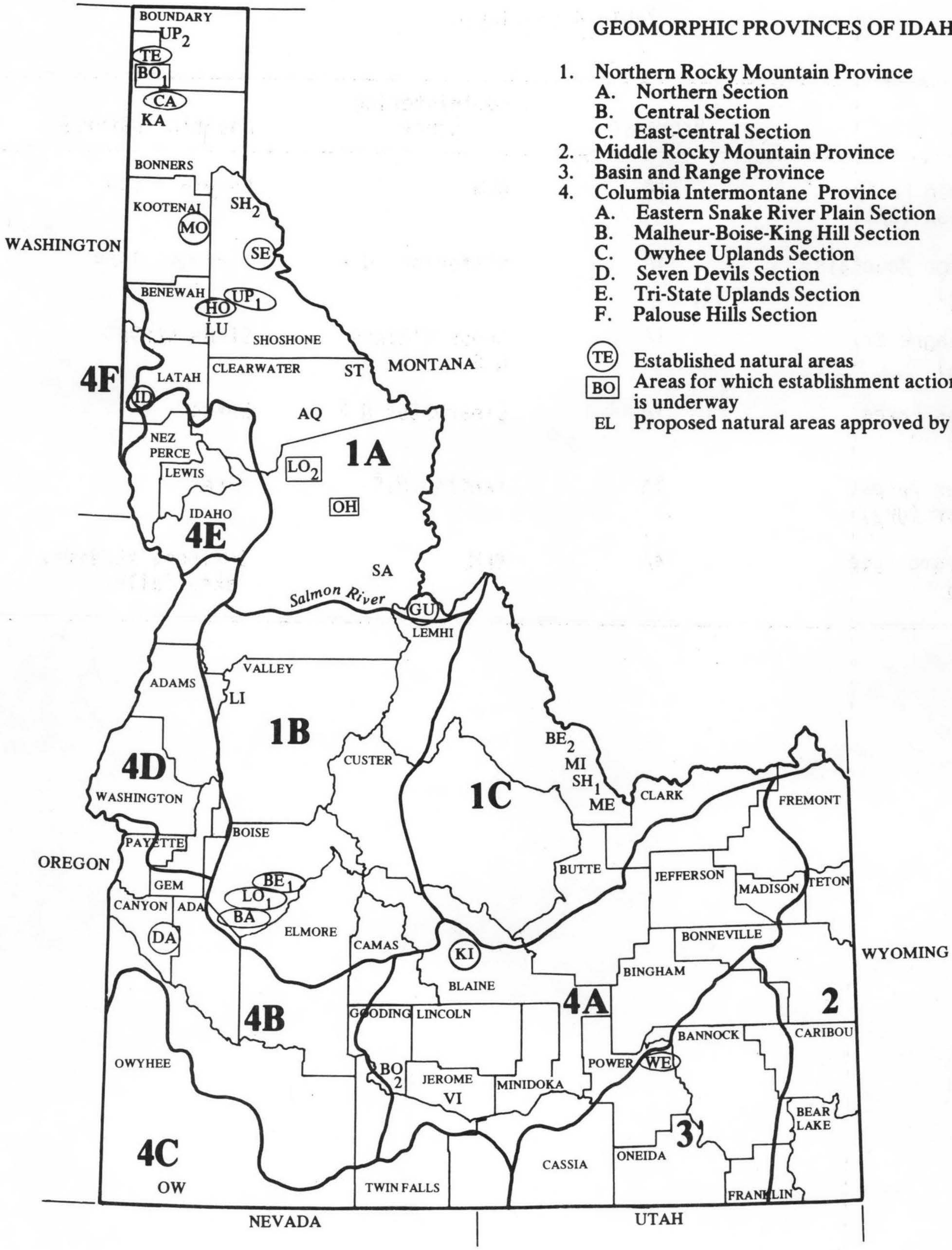

Table 4 continued

Name	Province	Administering Agency	Aquatic Features
Salmon Falls Canyon (SA_1)	1A	BLM	Canyon river
Salmon Mountain (SA_2)	1A	Bitterroot N.F.	Streams, lake
Shoshone Cr. (SH_2)	1A	Coeur d'Alene N.F.	Steep stream
Steep Lakes (ST)	1A	Clearwater N.F.	Lakes
Upper Priest River (UP_2)	1A	Kaniksu N.F.	River
Vinyard Lake (VI)	4A	BLM	Springs, streams, lake, falls

Appendix C. Northern Idaho streams used in developing the stream classification system and selection methodology

Name	Location	Ownership	Elevation	Gradient	Substrate	Aquatic Features
Bad Bear Cr. (BA)	Shoshone Co. T32N, R8E	St. Joe N.F. & private	3966-5200'	3%+	Cobble-gravel	Ephemeral and type 2 streams
Beaver Cr. (BE)	Shoshone Co. T43N, R8E	St. Joe N.F. & private	3618-4300'	1-6%+	Cobble-gravel	Ephemeral and type 2 streams
E.F. Bimerick Cr. (EFBI)	Clearwater Co. T34N, R8E	Clearwater N.F.	4300'	1%	Silt, detritus	beaver ponds and type 1 stream
W.F. Bimerick Cr. (WFBI)	Clearwater Co. T34N, R8E	Clearwater N.F.	4300'	2.3%	Cobble-gravel	type 2 stream, beaver ponds, waterfall
Upper Binarch Cr. (BI)	Bonner Co. T59N, R5W, S5 T60N, R5W, S32	Kaniksu N.F.	4300'	1%	Cobble-gravel; Silt-detritus	Ephemeral, type 1 and type 2 streams, beaver ponds, marsh, temporary pond
Brett Cr. (BR)	Shoshone Co. T52N, R2, 3E	Coeur d'Alene N.F.	2745-4600'	3.8%	Cobble-gravel	Ephemeral and type 2 streams
Canyon Cr.	Bonner Co. T58N, R3W S. 20,28,29	Kaniksu N.F.	4400-5614'	9%	Boulder-gravel	Ephemeral and type 2 streams and spring
Clear Cr. (CL)	Shoshone Co. T46N, R6E	St. Joe N.F.	3342-5200'	4.5%	Boulder-cobble	Ephemeral and type 2 streams, marshes, ponds
Crater Meadows (CR)	Clearwater Co. T37N, R9E, S.11	Clearwater N.F.	6000'	1%	Silt-detritus	Type 1 stream, springs
Eagle Cr. (EA)	Shoshone Co. T50N, R5E, S.4 T51N, R5E, S.33,34	Coeur d'Alene N.F.	3200-3600'	5%	Cobble-gravel	Type 2 stream, spring
Upper Fishhook Cr. (UP)	Shoshone Co. T44N, R5E, N½S.32	St. Joe N.F.	5000'	1-7.5%	Silt-detritus Boulder-cobble	Ephemeral, type 1 and type 2 streams
Floss Cr. (FLO)	Bonner Co. T63N, R4W, S.16,17,21	State Lands	3000'	1%	Sand-detritus	Ephemeral and type 1 streams, marsh, beaver ponds, temporary pond
Fly Cr. (FLY)	Shoshone Co. T43N, R8E	St. Joe N.F. and private	3560-5700'	3.8%	Cobble-gravel	Ephemeral, type 2 and type 3 streams, lake, spring
Hobo Cr. (HO)	Shoshone Co. T43N,R3E, S.7	St. Joe N.F.	3800-4400'	3%	Cobble-gravel	Ephemeral and type 2 streams.

Outstanding Features	Other Comments
	One of the few remaining uncut and unaltered tributary drainages in the St. Joe River Basin
	Spawning stream for westslope cutthroat. No cutting but road alters water quality.
	Sequence of beaver ponds, moose habitat.
Rare species of dragon-fly.	Grazing and recreation pressures.
High diversity of aquatic plants and invertebrates, pure westslope cutthroat	Great blue heron sighted.
Pure westslope cutthroat, high Ca level, hemlock climax	Upstream barrier maintained by Fish and Game Department to protect trout.
High diversity of bryophytes, several rare and uncommon invertebrates, climax hemlock and subalpine fir forests.	This is an established Research Natural Area within the Priest River Experimental Forest.
	Upper elevation wet meadow, light grazing
Uncommon species of alga (Chrysostephanosphaera) and cedar climax forest	This is Settler's Grove of Ancient Cedars Botanical Area
Climax cedar forest	This is an established Research Natural Area
	Large, active beaver ponds, moose and waterfowl habitat
	Uncut and unaltered tributary to St. Joe River
Cedar climax forest	This is Hobo Cedar Grove Botanical Area.

Name	Location	Ownership	Elevation	Gradient	Substrate	Aquatic Features
E.F. Horse Cr. (EFHO)	Idaho Co. T31N, R9E	Nez Perce N.F.	4100'	5.5%	Cobble-gravel	Type 2 stream
M.F. Horse Cr. (MFHO)	Idaho Co. T31N, R9E	Nez Perce N.F.	4200'	18%	Cobble-gravel	Type 3 stream
Jackknife Meadow (JA)	Clearwater Co. T39N, R8E, S.34	Clearwater N.F.	4800'	1%	Silt-detritus	Type 1 stream, surface bog
Little Granite Cr. (LI)	Idaho Co. T23N, R2W	Nez Perce N.F.	1600-7800'	33%	Boulder-cobble	Type 3 stream, lakes
Lund Cr. (LU)	Shoshone Co. T43N, R4E	BLM	5000-6200'	7%	Boulder-cobble	Ephemeral and type 2 streams
Montford Cr. (MO)	Kootenai Co. T51N, R1W, S.30 31	Coeur d'Alene N.F.	3040-4000'	7-17%	Cobble-gravel	Ephemeral, type 2 and 3 streams
Moose Meadows (MOO)	Idaho Co. T27N, R8E	Nez Perce N.F.	6000'	1%	Cobble-gravel	Type 2 stream, surface bogs
Mosquito Cr. (MOS)	Shoshone Co. T43,44N, R8E	St. Joe N.F. and private	3200-6000'	3-30%	Boulder-cobble	Ephemeral, type 2 and 3 streams, lake, waterfall
Noble Cr. (NO)	Idaho Co. T26N, R9E	Nez Perce N.F.	5100'	1%	Cobble-gravel	Type 2 stream
No Business Cr. (NB)	Idaho Co. T26N, R2,3E	Nez Perce N.F.	3000-7000'	30%	Boulder-gravel	Type 3 stream
O'Hara Cr. (OH)	Idaho Co. T31N, R7, 8E	Nez Perce N.F.	2000-5000'	8%	Boulder-cobble	Ephemeral, type 2 and 3 streams, beaver ponds, waterfall, marshy areas
Round Prairie Cr. (RO)	Boundary Co. T65N, R2E, S.28,29	Kaniksu N.F.	2600'	1%	Silt-detritus	Type 1 stream
Shoshone Cr. (SH)	Shoshone Co. T53N, R4E	Coeur d'Alene N.F.	3560-5600'	8-17%	Boulder-dobble	Type 2 and 3 streams, springs, waterfall
W.F.W.F. Smith Cr. (SM)	Boundary Co. T64N, R3W, S.20	Kaniksu N.F.	5000'	1-10%	Silt-detritus, boulder	Ephemeral, type 1, 2 and 3 streams, bog pond, beaver pond, marsh

Outstanding Features	Other Comments
	Unaltered drainage adjacent to Horse Creek experimental watershed
	Control stream in Horse Creek experimental watershed.
	Some recreation, upper elevation wet meadow, gyrfalcon observed
A rare aquatic insect, nine climas grass and forest types	This area is within the Hells Canyon National Recreation Area
Subalpine fir climas forest	
Western hemlock climax forest	This is an established Research Natural Area within the Nells Canyon National Recreation Area
	Ungrazed wet mountain meadow with extensive surface bogs and other interesting flora.
One rare and two uncommon aquatic insects	Uncut tributary to St. Joe River
	Relatively unaltered meadow and stream falls off steeply into Big Mallard Cr.
High Ca water, hemlock climax forest	.
Climax cedar forest	Large unaltered drainage with moderate to steep gradient streams, falls
Both an abundance and diversity of aquatic plants, several uncommon aquatic insects	Short reach of this stream is on Forest Service land, res on private, affected by agriculture.
High Zn level for natural waters, climax forests of mtn. hemlock, western hemlock subalpine fir, several uncommon insects	A headwater tributary to Shoshone Cr. containing ten habitat types, steep stream and falls.
Uncommon presence of alga Ulothrix, subalpine fir climax, westslope cutthroat and caribou range	Numerous aquatic cells in this subalpine mountain meadow

Name	Location	Ownership	Elevation	Gradient	Substrate	Aquatic Features
Sneakfoot Meadows (SN)	Clearwater Co. T36N, R14E, S.24	Clearwater N.F.	6000'	1%	Silt-detritus	Type 1 stream, surface bog, marsh
Square Mtn. Cr. (SQ)	Idaho Co. T26N, R5E, S.8	Nez Perce N.F.	6600-7600'	1-5%	Silt-detritus Dobble-gravel	Type 1, 2 and 3 streams, lake, marsh, surface bog
Tepee Cr. (TE)	Bonner Co. T63N, R4W, S.30	Kaniksu N.F.	2450-3200'	2-9%	Cobble-gravel	Ephemeral and type 2 streams, bog pond, spring
Twentymile Mead (TW)	Idaho Co. T28N, R6E	Nez Perce N.F.	3300'	1%	Cobble-gravel	Type 2 stream

Outstanding Features	Other Comments
	Relatively unaltered mountain meadow with several aquatic cells, moose habitat.
Rare species of aquatic insect.	Cirque lake and numerous other aquatic features. Some fishing and hunting
Several rare and uncommon aquatic insects, climax cedar and hemlock	This is an established Research Natural Area.
	Relatively undisturbed mountain meadow.

APPENDIX D

PROPOSED BOTTLE LAKE NATURAL AREA

Preface

Information presented here includes a general description of the area including maps and photographs, specific reasons for recommending it as a natural area, and some observations of the physical, chemical and biological characteristics of the site. In addition to basic water chemistry data, there is a list of aquatic invertebrates, terrestrial plants, and mammals and birds.

This write-up is intended to serve as a model for the kind of descriptive report which should be prepared for natural areas.

We are recommending the Bottle Lake addition to Tepee Creek Natural Area for the following reasons:

1) The lake exhibits many of the chemical and biological characteristics of a typical bog lake in northern Idaho.

2) Protected by Natural Area status, this area will provide excellent opportunities for studying bog history, plant succession and invertebrates.

Location

Bottle Lake is located on the eastern edge of the Okanogan Highlands Section of the Northern Rocky Mountain Province (15). It is in Bonner County, Idaho in Township 62 North, Range 4 West, Boise Meridian (Figure 1). The bog lake is in the NE 1/4 Section 20 with the remainder of the site extending into parts of Sections 16, 17 and 21. The elevation of the lake is 2,860 feet. The low elevation of the site is 2,820 feet on Bottle Creek below the outlet. High elevations are 3,280 feet on the east and 3,368 feet on the west boundary. The tract includes approximately 260 acres and is immediately south of and adjacent to the Tepee Creek Research Natural Area which was established on June 27, 1935. With this addition, the total natural area would be about 920 acres.

Both the Bottle Lake and Tepee Creek tracts are on U.S. Geological Survey 7 1/2 minute topographic quadrangles, Priest Lake NE and Priest Lake NW issued in 1967. The sites are administered by the U.S. Forest Service and are in the Priest Lake Ranger District of the Kaniksu National Forest. Recent Forest Service maps of the area are also available.

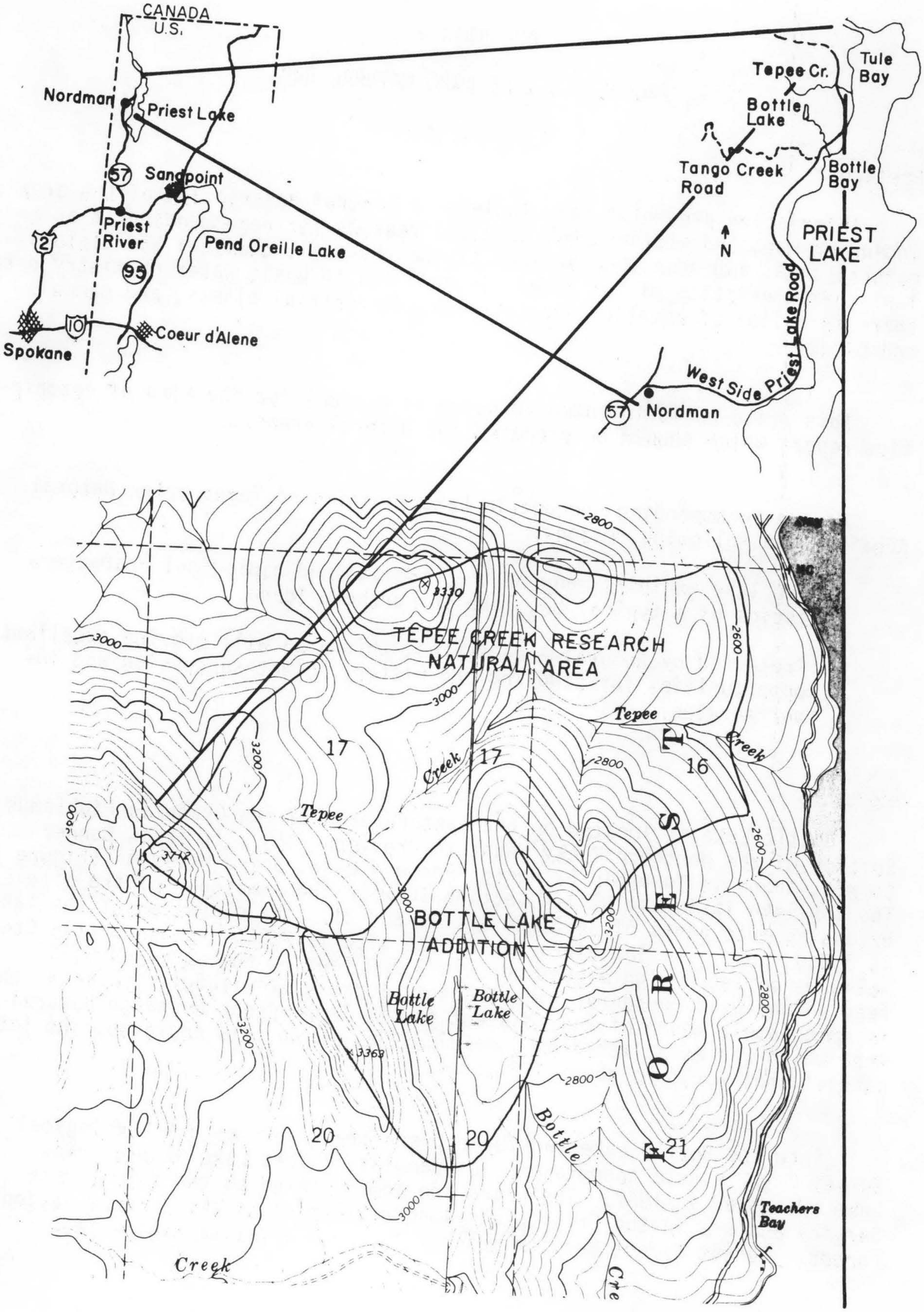

Fig. 1 Location maps. Bottle Lake Natural Area.

Physical Environment

Bottle Lake and the adjacent slopes which comprise the natural area form the headwater catchment of Bottle Creek which flows in a southeasterly direction for 1 1/2 miles and enters Priest Lake at Bottle Bay. Bottle Lake is slightly more than 400 feet higher than Priest Lake.

The site is underlain by silicic granitic rocks of the Kaniksu batholith. The batholithic rock is greyish to pinkish, white and black, granodiorite, quartz monzonite and monzonite with locally some gneissic and schistose characteristics and cut by dikes and stringers. This intrusive complex was formed during the Nevadan-Laramide diastrophism of middle Cretaceous to early Tertiary age. The main body of the batholith forms the Selkirk Mountains to the east of Priest Lake which reach elevations of 7,300 feet.

The topography of the area was modified during the Pleistocene by repeated episodes of continental glaciation, the latest being the Lake Wisconsin Pinedale Subage (1). Most of glaciated northern Idaho is well drained by V-shaped valleys except locally where glaciers have left flat-bottomed valleys and high elevation flat meadows. Small sphagnum bogs are widely scattered throughout this terrain (6,7,8). Bottle Lake probably originated as a kettle lake formed late in the period of post-Wisconsinan alpine glaciation which prevailed in the mountainous areas of northern Idaho.

Deep, productive soils of glacial origin mantle the lower slopes at the Bottle Lake site while soils of the steep upper slopes are shallow and rocky, derived from the underlying granite. A veneer of loess covers much of the area. The general soil type is dark to light brown, subhumid to humid forest soils (2,3). The soil deposits are poorly drained and there is evidence that the lake is extensively spring fed.

The climate of northern Idaho is a continental type modified by the oceanic influence brought by south-westerly winds resulting in a summer dry period. Temperatures are not extreme but there is considerable variation due to topography, and frost can occur any day of the year due to cold air drainage from higher elevations. Most of the precipitation falls during the period from October through March and heavy snows blanket the area during much of this time. Summers are temperate and occasional thundershowers occur.

The climatic data on the following page was recorded at the U.S. Weather Bureau Station located at the Priest River Experiment Station which is about 25 miles south of Bottle Lake at an elevation of 2,380 feet.

Temperature and precipitation data, 1948-1974

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (inches)													
Mean monthly	4.90	3.22	2.98	1.94	2.29	2.38	0.90	1.14	1.55	2.80	4.53	4.95	
Mean annual													33.58
Temperature (^{o}F.)													
Mean monthly	23.40	29.20	34.05	42.50	52.25	58.75	64.30	63.15	55.05	44.15	33.10	27.00	
Mean annual													43.85
Mean Jan Min.	17.20												
Mean Jul max.							82.50						

Terrestrial Biota

Flora

The Bottle Lake area is heavily forested with a rich mixture of mesophytic trees, shrubs, grasses and forbs. Old growth cedar, western hemlock, and white pine are co-dominants along with grand fir and Douglas fir in the overstory. Estimated acreages of Daubenmire's habitat types (4) are as follows:

Tsuga heterophylla/Pachistima myrsinites	224
Abies grandis/Pachistima myrsinites	10
Pseudotsuga menziesii/Physocarpus malvaceus	10

Estimated acreages of cover types are listed below:

SAF 215	Western white pine	184
SAF 227	Western redcedar-western hemlock	40
SAF 213	Grand fir-larch-Douglas fir	10
SAF 210	Interior Douglas fir	10

No detailed study has been made of flora in the area, however, the following species have been observed (5):

Trees
- Abies grandis
- Betula papayrifera
- Larix occidentalis
- Picea engelmanni
- Pinus monticola
- Populus tremuloides
- Populus trichocarpa
- Pseudotsuga menziesii
- Taxes brevifolia
- Thuja plicata
- Tsuga heterophylla

Tall shrubs
- Acer glabrum
- Amelanchier aonifolia
- Alnus incana
- Cornus stalonifera
- Holodiscus discolor
- Philadelphus lewisii
- Salix sp.
- Sambucus sp.
- Sorbus scopulina

Medium shrubs
- Berberis aquifolium
- Ceanothus velutinus
- Clematis columbiana
- Lonicera ciliosa
- Lonicera utahensis
- Oplapanox horridum
- Pachistima myrsinites
- Physocarpus malvaceus
- Ribes lacustre
- Rosa gymnocarpa
- Rubus parviflorus parviflorus
- Spiraea betufolia lucida
- Symphoricarpos albus
- Vaccinium membranaceum
- Vaccinium ovaliforium

Low shrubs
- Arctostaphylos uva-ursi
- Berberis repens
- Chimaphila umbellata
- Gaultheria ovatifolia
- Linnaea borealis longiflora
- Lycopodium sp.
- Pyrola asarifolia
- Pyrola secunda
- Pyrola uniflora
- Xerophllum tenax

Perennial Graminoids
- Bromus vulgaris
- Calamagrostic rubescens

Perennial Forbs

Schillae millifolium lanulosa
Actae rubra
Adenocaulon bicolor
Anemone piperi
Aquilegia sp.
Aralia nudicaulis
Arnica cordifolia
Asarum caudatum
Athryium filixfemina
Calypse bulbosa
Companula sp.
Clintonia uniflora
Coptis occidentalis
Corallorrhiza mertensiana
Cornus canadensis
Disporum oreganum
Epilogium angustifolium
Erythronium grandiflorum
Fragaria sp.
Balium triflorum
Goodyera oblogifolia
Hieracium albiflorum
Hydrophyllum capitatum capitatum
Mitella stauropetala
Monotropa uniflora
Polystrichum munitum
Pteridium aquilinum
Pterospora andromedea
Rananculus sp.
Smilacina stellata
Streptopus amplexifolium
Thalictrum accidentale
Tiarella unifoliata
Trillium ovatum
Urtica dioica gracilis
Viola glabells
Viola orbiculata

Fauna

The area provides some browse for deer during the summer. Winter range occurs about 200 feet lower in elevation along the shoreline of Priest Lake. Beaver are active in Bottle Lake and have had a major influence on the lake level. There are two lodges in the lake at the present time. Tentative lists of mammals and birds have been developed for the area based on range maps, records of occurrence and habitat affinities, as well as trapping records and field observations (Table 1). Information was drawn from a number of sources (10, 11, 12, 13, 14).

Lake Description

Bottle Lake is a sphagnum bog lake about 15 acres in size (Figure 2). It is 450 feet long and ranges in width from 40 to 140 feet. It is uniformly 19 feet deep and is surrounded by a mat of sphagnum 20 to 60 feet wide. On the land side of the mat is a littoral zone occupied by dead trees, some of which occur as snags in the water. Northwest of the main lake is a one-acre surface bog that through succession has already passed the open water stage.

The normal hydrarch succession leading to the eventual filling in of the lake has been reversed by impoundment of the area by beavers. An aerial photograph taken by the Forest Service in 1932 indicates well advanced succession with a reduced volume of open water and the encroachment of pioneer tree species on the sphagnum mat. Photographs of Bottle Lake taken in 1956 and 1974 illustrate the flooding that occurred since that time.

Apparently beavers have occupied the site periodically at which times they have rebuilt dams, raised the lake level, utilized and exhausted the food supply and then abandoned the area. In time, water has cut through the dams and lowered the lake level permitting alder and cottonwood to reestablish on the drained lake margin followed by a reinvasion by the beaver. At present, there are two beaver lodges within the lake and two dams at the outlet which are completely overgrown with grasses. Beavers still occupy the lake but they have consumed all easily available food and are not felling coniferous trees for food as far away as 200 feet from the waters edge. Presumably abandonment of the area will occur in the near future.

Oxygen is limiting below 2M in the lake (Table 2). Temperature differences were observed over the summer with overturn of the lake waters being noted in October. Surface water chemical data collected August 25, 1974 and expressed as mg/l was as follows.

SO_4	Ca	Mg	Na	K	Fe	Alkalinity
1	2	0.3	2	0.4	0.05	10

The substrate surface in the shallow littoral zone of the lake was littered with a coarse matrix of limbs, twigs, bark and needles from coniferous trees as well as dead plant tissue from aquatic macrophytes. This material will eventually form a "wood peat".

Substrate samples collected from the open water zone consisted of a fine, dark organic muck streaked with bands of white and with no recognizable plant parts. The open water sediments in a bog lake typically exhibit a higher degree of organic decay than substrate beneath the sphagnum mat or edge zone and form a "limnetic peat" grading into a muck.

The elemental analysis of the open water substrate is shown below and compared with a sedge marsh located in central Idaho. Quantities are expressed in mg/l.

	Zn	Mn	Cu	Fe	Ca	Mg	K	Na
Bottle Lake	48	620	24	4800	3200	160	414	460
Lily Marsh	41	800	10	7200	5200	760	484	207

Aquatic Biota

The following is a list of aquatic macrophytes which appeared on the sphagnum mat. *Carex sheldonii* and *Sparganium chlorocarpum* are dominant. Collections were made during the summer of 1974-75.

Carex sheldonii
Carex canescens
Sparganium chlorocarpum
Eriophorum gracile
Drosera rotundifolia
Sphagnum sp.

The following emergents and submergents were observed in the littoral zone.

Eleocharis palustris
Dulichium arundinaceum
Scirpus microcarpus
Utricularia vulgans
Nuphar variegatum
Brasenia schreberi
Equisetum palustre
Potentilla palustris
Galium sp.
Potogmogeton amplifolius
Fontinalis sp.

Nuphar variegatum was also present in the open water zone.

Macroinvertebrates were collected from the edge of the sphagnum mat, in the open water zone and from the shallow littoral zone. A true benthic fauna was non-existent due to the nature of the bottom substrate and lack of oxygen.

Many adult dragonflies and damselflies were observed in the area of the bog whereas numphal forms predominated in the littoral zone. The water bug (Notonecta sp.) was also very abundant. The paucity of herbiverous species may be due to the large number of carnivores present in the lake, especially during the early part of the year. Mayflies occurred in large numbers during the October sampling period.

Two species of insects with limited distribution were a dragonfly (Leucorrhina hudsonica) restricted to sphagnum bogs and an aquatic beetle (Gallerucella sp.) which has a narrow habitat preference for yellow pond lillies. A complete list of macroinvertebrates is presented in Table 3.

Only two species of cladocera and one copepod were collected. A definite temporal change in the zooplankton was noted over four months of observation. Holopedium gibberum was most common during the early months of the summer whereas Diaptomus leptopus was most common during the October sampling period. Daphnia rosea increased slightly in numbers over the season.

The Spotted Frog (<u>Rana pretiosa</u>) was present in and around the margins of the lake. Fish were not observed. Due to irregularities and barriers in the outlet stream fish are not presently able to migrate up from Priest Lake. The presence of trout was noted in the lake from a survey conducted in 1929.

Table 1. Tentative List of Mammals - Bottle Lake Area

Order	Scientific Name	Common Name
Insectivora	*Sorex cinereus	Masked shrew
	Sorex obscurus	Dusky shrew
	Sorex vagrans	Vagrant shrew
Chiroptera	Eptesicus fuscus	Big brown bat
	Lasionycteris noctivagans	Silver-hairdd bat
	Lasiurus cinereus	Hoary bat
	Myotis lucifugus	Little brown myotis
	Myotis volans	Long-legged myotis
	Myotis yumanensis	Yuma myotis
	Plecotus townsendii	Townsend's big-eared bat
Lagomorpha	**Lepus americanus	Snowshoe rabbit
Rodentia	**Castor canadensis	Beaver
	*Clethrionomys gapperi	Gapper's red-backed mouse
	Erethizon dorsatum	Porcupine
	*Eutamius ruficaudus	Red-tailed chipmunk
	Glaucomys sabrinus	Northern flying squirrel
	Marmota monax	Woodchuck
	*Microtus longicaudus	Long-tailed vole
	Microtus pennsylvanicus	Meadow vole
	Microtus richardsoni	Water vole
	Neotoma cinerea	Bushy-tailed wood rat
	*Peromyscus maniculatus	Deer mouse
	Phenacomys intermedius	Heather vole
	**Tamiasciurus hudsonicus	Red squirrel
	**Thomomys talpoides	Northern pocket gopher
	Zapus princeps	Western jumping mouse
Carnivora	**Canis laptrans	Coyote
	Canis lupus	Gray wolf
	**Felis concolor	Mountain lion
	Bulo luscus	Wolverine
	Lynx canadensis	Lynx
	Lynx rufus	Bobcat
	Martes americana	Marten
	**Mephitis mephitis	Striped skunk
	Mustela erminea	Short-tailed weasel
	Mustela frenata	Long-tailed weasel
	Procyon lotor	Raccoon
	**Ursus americanus	Black bear
	Ursus arctos	Grizzly bear
	Vulpes fulva	Red fox

(*) indicates direct evidence - trap records
(**) indicates direct evidence (observation) or indirect evidence (tracks, scats, etc.)

Order	Scientific Name	Common Name
Artiodactyla	Alces alces	Moose
	**Cervus canadensis	Elk
	Odocoileus hemonius	Mule deer
	**Odocoileus virginianus	White-tailed deer
	Rangifer tarandus	Caribou

Tentative List of Birds - Bottle Lake Area

Family Ardeidae	herons
*Anatidae	ducks, geese
*Accipitridae	hawks
Tetraonidae	grouse
Scolopacidae	sandpipers
*Strigidae	owls
*Trochilidae	hummingbirds
*Picidae	woodpeckers
Tyrannidae	flycatchers
Hirundinidae	swallows
*Corvidae	jays, crows, ravens
*Paridae	chickadees
*Sittidae	nuthatches
*Certhiidae	creepers
*Turdidae	thrushes
Sylviidae	kinglets
Parulidae	wood warblers
*Fringillidae	sparrows

(*) indicates members of this family were observed.

Table 2. Physical and chemical characteristics of Bottle Lake, 1974.

	July 18		Aug. 1		Aug. 25		Oct. 26	
Secchi Transparency (ft.)	7.0		6.5		6.0		6.0	
			Temp (°C) - Oxygen (mg/l)					
Depth (ft)								
surface	19	1	23	8	20	9	4	2
3	17	-	21	7	17	6	3	1
6	15	-	16	1	15	0.6	2	1
9	13	-	13	2	12	0	2	1
12	9	-	9	0.5	9	0	2	1
15	8	-	7	0	7	0	2	1
18	7	-	6	0	6	0	2	0
pH								
surface	6.8		6.6		6.6		6.2	
middle	---		6.6		6.2		6.0	
bottom	---		6.2		5.9		6.3	
Alkalinity (mg/l)								
surface	10		10		10		8	
middle	--		10		11		--	
bottom	--		16		12		10	

Table 3. Aquatic invertebrate fauna

Taxa	8/1/74	8/25/74	10/26/74	7/12/75
Odanata				
Anisoptera				
Aeshnidae				
Aeshna interrupta	6	6	-	X
Aeshna umbrosa	-	-	-	X
Libellulidae				
Leucorrhina hudsonica	8	40	1	X
Zygoptera				
Lestidae				
Lestes dryas	3	-	-	X
Coenagrionidae				
Ischnura perparva	15	32	7	X
Coleoptera				
Dytiscidae				
Graphoderus liberus	31	5	-	X
Haliplidae				
Haliplus sp.	1	-	-	X
Gyrinidae				
Gyrinus sp.	1	-	-	-
Chrysomelidae				
Gallerucella sp.	3	-	-	X
Trichoptera				
Limnephilidae	-	4	-	X
Psychomyiidae	-	-	2	-
Hemiptera				
Belostomatidae				
Lethocerus americanus	4	-	-	X
Notonectidae				
Notonecta sp.	55	12	54	X
Gerridae				
Gerris buenoi	7	2	5	X
Ephemeroptera				
Baetidae				
Centroptilum sp.	1	2	65	-
Diptera				
Chironomidae	-	-	5	X
Culicidae (Chaoborinae)				
Eucorethra underwoodii	-	-	25	-
Hirudinea				
Erpobdella punctata	X	X	-	-
Pelecypoda				
Sphaeriidae	X	X	X	X
Gastropoda				
Planorbidae (*Gyraulus* sp.)	-	-	X	-

X = species collected but not counted.

A

B

Aerial photographs of Bottle Lake, A. 1932, B. 1956

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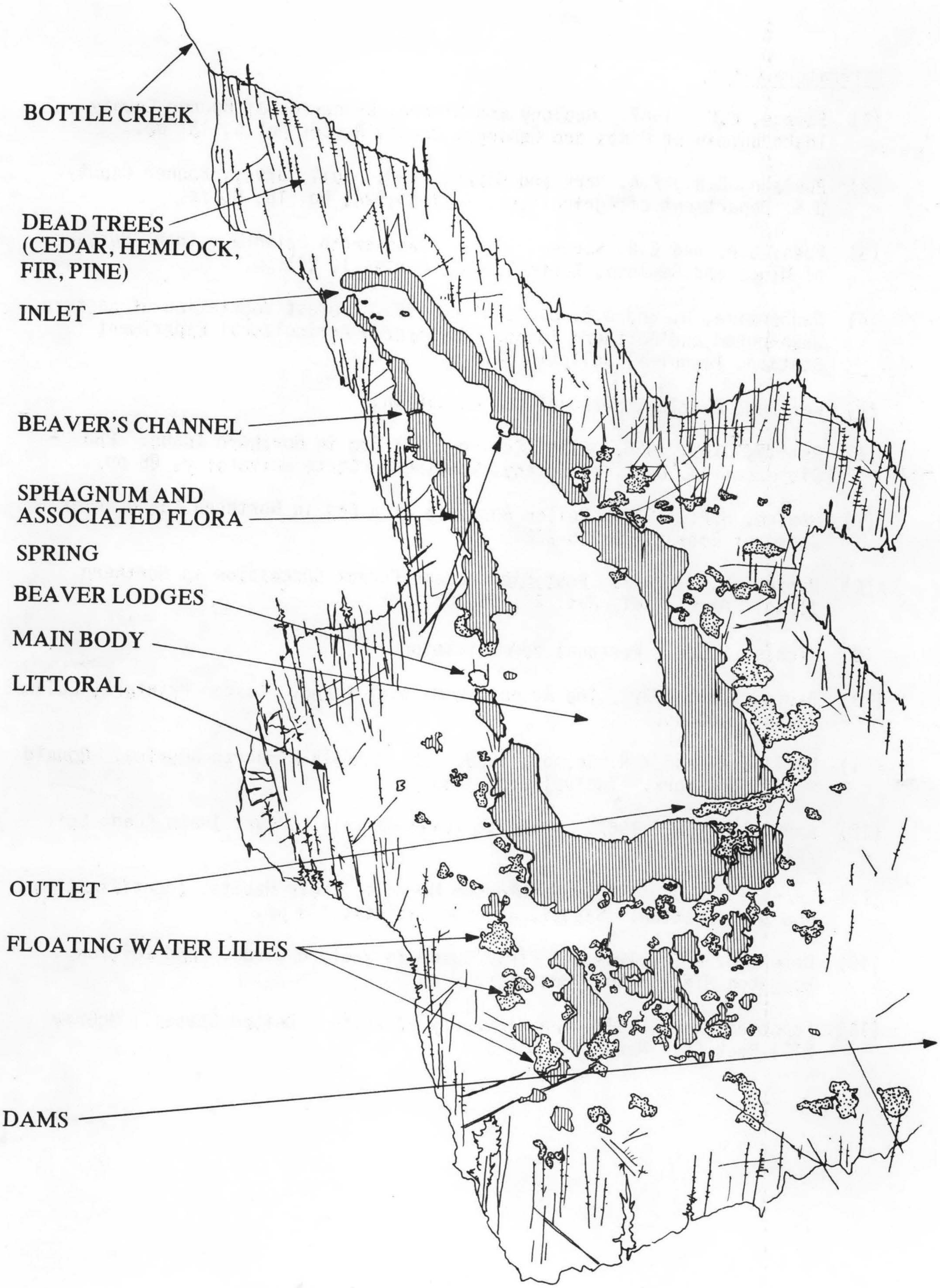

Fig. 2 Map of Bottle Lake (1974)