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AN EXPANDING ROLE FOR SUBARCTIC WATERSHED RESEARCH[1]

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ABSTRACT. It is increasingly recognized that natural resources research should in many cases be broadened in scope and oriented toward more general "environmental" problems. Locales with a history of "watershed" research can be eminently suited for development of comprehensive, environmental research programs. This is recognized in many research efforts of the International Biological Program (IBP), where watershed research sites have been successfully utilized for intensive investigations of process and function of selected ecosystems or ecosystem components. In the North American Subarctic there is almost no history of "watershed" studies. Basic data on hydrometeorologic parameters such as precipitation amounts and areal and seasonal distribution of runoff are scarce; the data framework within which environmental understanding can be structured is exceedingly sketchy. Opportunity exists in the discontinuous-permafrost settings of central Alaska to begin rectifying this situation. A basic program of multi-agency, multi-discipline research and data acquisition for the most significant hydrologic subregions is being developed, based around several existing environmental research areas (chiefly the Bonanza Creek Experimental Forest, the Caribou-Poker Creeks Research Watershed, the Wickersham Dome Fire Study Area, and a series of outlying sites).
(KEY TERMS: hydrology; watershed; environmental research; subarctic)

INTRODUCTION

Watershed management might simply be defined as "management of land for the optimum production of high-quality water, regulation of yields, and for maximum soil stability along with other products of the land" (Dils, unpublished notes, 1963). While water is the primary concern and unifying medium for this discipline, full regard for the complexity of "other products", from recreation to wood fiber, is increasingly necessary and accepted. A wide scope of resource management activities necessarily bears on rational watershed management. It follows that watershed research encompasses a similarly broad field. Some aspects of research into almost all facets of wildlands and natural resources, from forest pathology to logging engineering to wildland recreation, have direct bearing on hydrologic functioning of natural landscape units. The quality,

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quantity, or timing of water yield, and the on-site or off-site benefits de[illegible]n the watershed, also have often complex interrelationships with the larger p[illegible]imal community, including man. Water quality and hydrologic regimen are [illegible]liable indicators of the overall environmental "health" of a landscape.

At least two aspects of watershed research have become noteworthy in [illegible]years. First, "classical" experimental watershed research has come under criticis[illegible]arily because of the long time periods required for pretreatment calibration and p[illegible]ment assessment of results in paired watershed studies, for alleged lack of [illegible]e for results of landscape manipulation trials, and for sometimes high [illegible]. Such criticism has been effectively fielded by Hewlett, Lull, and Reinhart (1969). Well-planned watershed research remains the basis for much of our current hydrologic understanding of natural landscapes.

A second development is that, in this era of environmental consciousness, research is concerned to an increasing extent with soil, air, water, plant, and animal systems – ecosystems. There is emerging acknowledgment that natural resources research is more effective when conducted on an interdisciplinary basis, and concomitantly, complete watersheds often present the most appropriate land units for interdisciplinary environmental research and management. This is reflected in recent reports from programs of the International Biological Program (IBP) (e.g., Huff, 1970, 1971; Franklin, Dempster, and Waring, 1972), as well as in the writings of such workers as Johnson and Swank (1973), McHarg (1969) and Likens, *et al* (1970).

Our points so far are: (1) Watershed research concerns a broad spectrum of topics; (2) There has been, and will continue to be, critical evaluation of the watershed approach to research, hopefully serving to improve the work which is undertaken in the name of "Watershed Research"; and (3) There is a rational basis for considering watershed research *per se* and discrete watershed study units as fundamental components of comprehensive, interdisciplinary, environmental study.

SUBARCTIC INFORMATION NEEDS

The North American Subarctic may be simply defined as the region of discontinuous permafrost (figure 1). There has been little study of hydrologic parameters and processes in this region, and even less on a watershed basis. Dingman's (1966, 1971) work on a 0.7-mi^2 catchment near Fairbanks was the first "watershed" study in subarctic Alaska. Much, perhaps most, subarctic environmental research has in the past been conducted along narrow disciplinary lines.

At the same time, basic hydrologic and environmental data are sparse in subarctic Alaska (Feulner, *et al.* 1971; Johnson and Hartman, 1969); this was discussed in a companion paper in this meeting (Slaughter, Freeman, and Audsley, 1973), and is similarly attested to by Canadian work (i.e., Hare, 1971). Among the reasons for the lack of even basic information such as precipitation and runoff data for upland areas, could be cited the low population of the Subarctic, the logistical problems of data gathering, the high cost of all operations in remote and often severe environments, and until very recently, a lack of *obvious* (to much of the "temperate zone" populace, including governmental agencies) need for information on this "remote, inhospitable" part of the continent.

It is safe to say that the need for environmental data, including water resources information, is now increasingly apparent. The continuing debate over the proposed

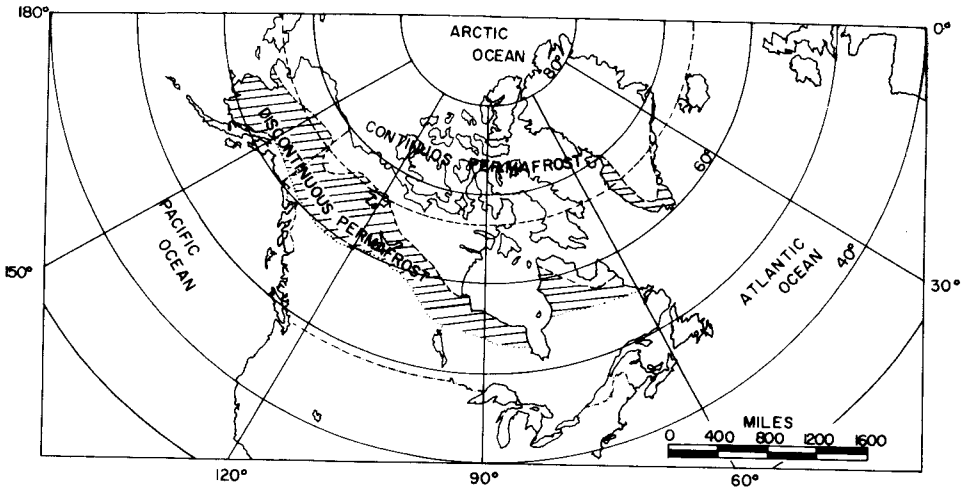

Figure 1. Permafrost distribution in North America

trans-Alaska oil pipeline, with the lack of knowledge about lands to be traversed compounding the problem of predicting environmental consequences of construction and operation, has done much to emphasize the "information gap" in the Subarctic. A major shift in land control is currently taking place with settlement of the Alaska Native Land Claims. A Federal-State Land Use Planning Commission is developing recommendations for disposition and utilization of most of Alaska. Some 40 million acres can be expected to change hands in Alaska within the next several years; at least fifteen new national forests, parks, wildlife refuges, wild and scenic rivers, and ecological reserves have been proposed for Alaska's Subarctic.

These developments presage changes in resource management alternatives and needs. All accentuate the need for both baseline environmental data and, perhaps ultimately more significant, for developing an operational capability for assessing immediate and long-term environmental consequences of land management practices.

Existing information needs notwithstanding, much has been accomplished. Existing environmental and hydrologic data have been summarized on a statewide basis by Johnson and Hartman (1970) and Feulner, *et al* (1971). Forest environment research in interior Alaska was initiated at the Institute of Northern Forestry (USDA Forest Service) in 1957; as in the other 49 states, the University of Alaska's Institute of Water Resources is building a statewide hydrologic resource program. First-caliber natural resources-oriented research projects have been executed by University, State, and Federal personnel. Federal hydrologic programs have also been recently accelerated in some sectors (e.g., Brice, 1971; Childers, 1972; Childers, Sloan, and Meckel, 1973).

THE OPPORTUNITY

In the 1960's the State of Alaska and the U. S. Forest Service collaborated in establishment of Bonanza Creek Experimental Forest, about 40 miles west of Fairbanks. Much research of the Institute of Northern Forestry has since been centered at Bonanza Creek. In 1970 the Forest Service instituted a "multi-functional" research program in

central Alaska, conceived as embracing research in Bonanza Creeks Experiment Forest and the Caribou-Poker Creeks Research Watershed (see below) as complementary research environments within the extensive Alaskan Taiga (figure 2).

Actions leading toward a coordinated, multi-disciplinary watershed-based research effort were also begun in the late 1960's. Twelve State, Federal, and University units joined to establish the Caribou-Poker Creeks Research Watershed, 30 miles north of Fairbanks, Alaska (Slaughter, 1971). The 40-square-mile catchment includes both

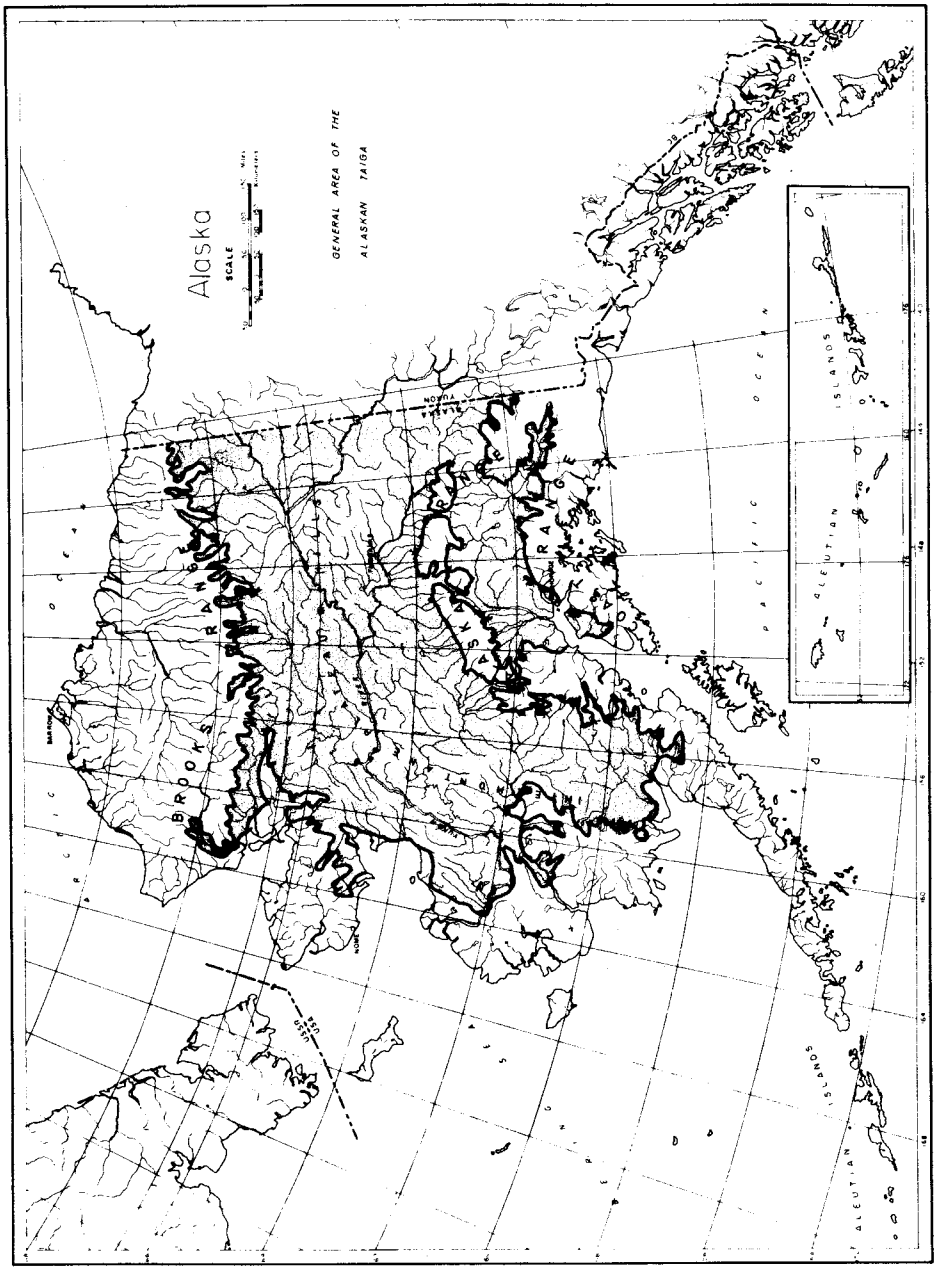

Figure 2. General area of the Alaskan taiga

"representative" and "experimental" basins, according to the criteria of Toebes and Ouryvaev (1970). While not formally defined, substantial encouragement for a multi-discipline Subarctic research effort was given during this period by the Tundra Biome, U. S. IBP, whose own research was concentrated in the wet tundra ecosystem at Barrow, Alaska.

In 1971 Forest Service researchers capitalized on the accessibility of a major forest fire near Wickersham Dome, only eight miles from Caribou-Poker Creeks and accessible by highway, to establish the Wickersham Dome Fire Study Area. Landscape recovery following fire and fire control activities is being monitored along with study of several related phenomena, including small mammal populations and permafrost thaw.

These activities, coupled with the developing information needs, have resulted in a perhaps unprecendented opportunity for cooperative watershed-based research in Alaska's Subarctic. Helmers and Cushwa (1973) have summarized the dimensions of research need, and called for early implementation of a cooperative taiga research program. A base now exists on which a coordinated interdisciplinary taiga research effort may be developed.

We would propose, in brief, that a "Taiga Environment and Resources Research Center" (the name is not a critical point) be established to provide overall direction and coordination for cooperative work in the three research areas mentioned above, and for such additional sites as should be required. Participants would likely include many or most of the Federal, State, and University entities currently linked through the Inter-Agency Technical Committee for Alaska (Slaughter, *et al.* 1973). Already-established directions of research effort support a general plan to (1) concentrate conifer silvicultural work and related process study at Bonanza Creek Experimental Forest; (2) concentrate fire effects research at the Wickersham Dome Fire Study Area; and (3) utilize the Caribou-Poker Creeks Research Watershed as a locale for baseline and process hydrometeorologic and environmental studies, and as a site for watershed-scale experimentation (manipulation) designed to validate predictive techniques developed from results of research at the complementary sites and in other taiga environments, as applicable.

JUSTIFICATION

Since it is patently impossible to investigate *all* aspects of the Subarctic taiga, initial concentration on the forested Yukon-Tanana Uplands (Wahrhaftig, 1965) is appropriate. Of all Subarctic Alaska, this physiographic unit is considered most susceptible to severe pressures of development and population growth over the next several decades. Highway access to the area is (for Alaska) well developed. Fairbanks, second largest city in the State, is situated on the southern margin of the region, and serves as a cultural, educational, transportation, and communications hub for most of interior Alaska. In contrast to more remote areas, sufficient amenities exist in a reasonable climate to allow family living generally along the patterns developed in more southerly areas. At the same time the region possesses scenic, wildlife, forest, and mineral resources which are already under pressure from both local and out-of-state interests. Further, this region is considered reasonably representative of much of the Alaskan (and much of the Canadian) taiga.

In this same locale, an active effort is underway to determine what information or answers resource managers need *now*, as well as to forecast future information needs. This

effort on the part of public resource management and research personnel is fundamental to ensuring that study programs yield operationally useful answers at the earliest possible stage.

With acceptance of the premise that the taiga of the Yukon-Tanana Uplands should receive priority in research, it is logical to meld to the fullest extent possible existing environmental research capabilities at a few selected locations, reasonably representative of major regional environments, to gain the greatest good from the total research effort. Given a low total availability of resident research staff and resources in Alaska's Subarctic, and similarly given restrictive budgets and logistical capabilities, close cooperation in environmental studies make eminent sense.

The three study areas mentioned previously, considered together, comprise a logical "environmental study complex" (figure 3). They are sites formally dedicated to research;

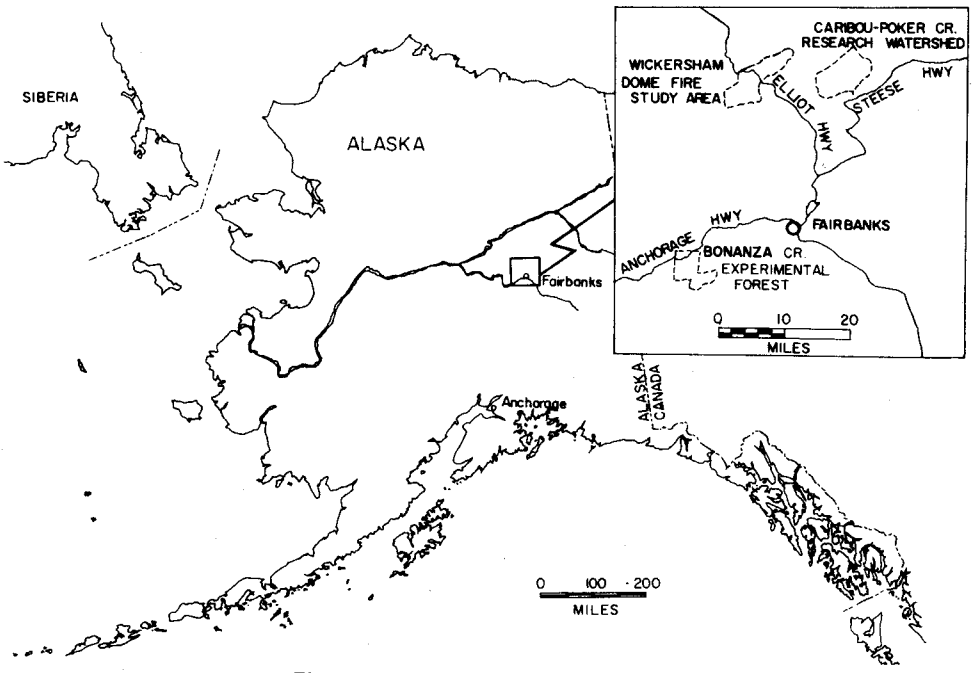

Figure 3. Complementary Environmental Research Sites in Subarctic Alaska

information about each exists in greater or lesser amounts; they encompass most local terrain and vegetation types found in the Yukon-Tanana Uplands, from the river flood plains to the altitudinal treeline. Similarly, the major vegetation communities are included; riparian shrubs and hardwoods, permafrost-underlain black spruce/tamarack stands, nearly pure aspen-birch stands, and mature ("commercial") white spruce forests. Only three major environmental types are *not* included in these areas: alpine, extensive wetlands, and lakes. Satellite study areas have already been tentatively identified which do include such types.

Sufficient area is available now to allow conduct of both "baseline" studies and active landscape perturbation and rehabilitation experimentation, on a scale approaching that of actual land management operations.

PREREQUISITES

Given the need, appropriate study areas, and a willingness on the part of local agencies and personnel to cooperate in a mutual research endeavor, two factors are still lacking; adequate funding, and appropriate administrative arrangements for effecting coordination, control, and fiscal administration. These factors seem to be intertwined; we feel that agreement on administrative arrangements is a prerequisite to development of adequate financial support.

Cooperative research efforts to date in central Alaska have been reasonably successful. However, each participant has retained full control over its research objectives, approaches, and priorities; only a very open attitude and a willingness to actively work together on a day-to-day basis have permitted this fairly loose organizational mode to be successful. An expanded program such as that proposed herein will require more formal definitions, guidelines, and commitments by the participants.

It is possible to look to other existing arrangements for guidance here; two examples are the Tundra Biome Center, International Biological Program, (TBC), at the University of Alaska, and the Pinchot Institute in Upper Darby, Pennsylvania (The Pinchot Institute, 1973). In both cases a separate administrative unit was established (the TBC under the Vice-President for Research, University of Alaska, and the latter as a non-profit Institute housed at the U. S. Forest Service Northeast Forest Experiment Station); each administrative unit is empowered to receive and disburse funds, to establish broad research directions and goals, to review and approve or disapprove individual study proposals, and to coordinate major data acquisition and dissemination activities. Our experience to date suggests that some such administrative entity (e.g., a Taiga Environment and Resources Research Center) will be required for effective research coordination.

A NOTE ON RELEVANCE

Much current criticism of natural resources research revolves around the question of relevance – is the researcher answering questions or providing information which is relevant to resources management decisions and techniques? In the Subarctic this is especially apparent. As pointed out previously, much land is changing hands and new landholders are already laying plans for development, management, or otherwise using or exploiting available natural resources. Decisions will often be made with only the sketchiest information on available resources, interacting ("multiple") uses, or immediate and long-term consequences of specified courses of action.

This argues convincingly for a program of problem-oriented studies – short-term, applied research – designed to give operationally useful information within the shortest possible time frame. Such "research" may be simply data gathering and inventory work, with appropriate analysis and interpretation. A coordinated environmental research effort should very clearly include and design for these immediately relevant studies, in close collaboration with the users. This means obtaining active involvement of the State and Federal resource managers, native regional corporations, and other land controllers, preferably at all stages of research planning.

Examples of questions which might be anticipated could be, for a native corporation which has obtained control of a forested catchment:

What is the forest resource – how much timber do we have?

Is there a market if we harvest the standing crop?

What is a feasible sustained yield?

Will timber harvesting affect wildlife availability? (Subsistence hunting remains a fact of life in Alaska)

Will timber cutting affect water quality, either surface or groundwater?

How can the necessary roads be built at least cost and with minimum adverse effect, i.e., siltation?

What fire control standards are appropriate for the area?

Two examples of immediately useful products in this vein are "Environmental Guidelines for Road Construction in Alaska" (Lotspeich, 1971) and "Permafrost and the Environment in Alaska" (Lotspeich, 1973).

While accepting and endorsing the necessity of an applied research effort immediately responsive to management needs, it is equally important that soundly-designed longer-term research programs be initiated simultaneously. Developing the requisite data base and process knowledge requires sustained multi-disciplinary research. With the personnel and budgetary constraints mentioned earlier, this means that cooperative, coordinated, multi-agency and multi-disciplinary research programs must be implemented at a relatively few sites. In many cases, concentration of effort will effect economies in equipment, transportation, and field efforts, allowing execution of short-term "applied" research while contributing toward in-depth understanding.

Ultimately, the most rational management decisions can be developed only with reliable predictions of consequences of alternative management courses, set in a perspective of adequate environmental data and with understanding of the many interactive biotic and abiotic processes operative in the "real world". The unifying concepts of watershed research provide a framework for this study and application in the Subarctic.

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