REPORT

TO THE PRESIDENT OF THE UNIVERSITY OF ALASKA

BY THE

COMMITTEE FOR THE STUDY OF THE FEASIBILITY OF THE ESTABLISHMENT OF AN INSTITUTE OF ARCTIC BIOLOGY AT THE UNIVERSITY OF ALASKA

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SUPPORTED BY

GRANT NO. G-15386

FROM THE

NATIONAL SCIENCE FOUNDATION

AUGUST 1962

WASHINGTON STATE UNIVERSITY
PULLMAN, WASHINGTON

DEPARTMENT OF ZOOLOGY

Laboratories of Zoophysiology
6 August 1962

President William R. Wood
University of Alaska
College, Alaska

My dear President Wood:

It is my privilege to transmit herewith the report of the Committee for Study of the Feasibility of the Establishment of an Institute of Arctic Biology at the University of Alaska. This study was supported by a grant (G-15386) from the National Science Foundation to the University of Alaska.

The members of the Committee, as appointed by you, were Dr. Arthur D. Hasler, Professor of Zoology, University of Wisconsin; Dr. Richard H. McBee, Professor of Bacteriology, Montana State College; Dr. Frank A. Pitelka, Professor of Zoology, University of California, Berkeley; Dr. C. Ladd Prosser, Professor of Physiology and Head of the Department, University of Illinois; Dr. Dixy Lee Ray, Associate Professor of Zoology, University of Washington, on leave as special assistant to the Assistant Director, Biological and Medical Sciences, National Science Foundation; Dr. P. F. Scholander, Professor of Physiology, Scripps Institute of Oceanography, University of California; Dr. William C. Steere, Director, The New York Botanical Garden; and Donald S. Farner, Professor of Zoophysiology and Dean of the Graduate School, Washington State University, Chairman of the Committee. The Committee convened twice at the University of Alaska, on 11 - 15 February 1962 and 9 - 11 June 1962. Site visits were made by the entire Committee, or by individual members, at the Arctic Research Laboratory, Barrow; Umiat; Arctic Aeromedical Laboratory, Fairbanks; Alaska Agriculture Experiment Station, Palmer; Arctic Health Research Center, Anchorage; Douglas Marine Station; the Biological Laboratory of the Bureau of Commercial Fisheries, Auke Bay; the facilities of the Bureau of Commercial Fisheries and Alaska Department of Fish and Game on Kodiak Island; and Homer, Seldovia and the Kachemak Bay area.

The Committee was able to draw extensively on the previous experience of some of its members in Alaska and elsewhere in the Arctic. It drew widely, by correspondence, conversation, and conference, from the experience and advice of many Alaskan biologists and many other biologists with experience in Alaska. It has examined the role of universities in arctic biology in the United States and in other countries. Finally, the University of Alaska itself, because of its possible role as the host University for an institute of arctic biology, has been the object of careful study with particular attention to its resources and potential development.

On behalf of the Committee, I wish to express sincere appreciation for the assistance and many courtesies extended to us by you and by members of the faculty and staff of the University of Alaska.

Sincerely yours,

Donald S. Farner

Donald S. Farner
Chairman of the Committee

DSF/ds

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ABSTRACT

Modern transportation, expanding populations, increased pressures on natural resources, considerations of national security and international relations, and, not the least, the curiosity of man concerning his universe have enhanced conspicuously the importance of the Arctic. The State of Alaska encompasses vast areas of land and water which lie within the Arctic. Research on biological problems of these cold regions will certainly contribute extensively to the knowledge which will permit man to live more successfully in the arctic environment and to use its resources with greater wisdom. Moreover, the commonness of these problems will almost certainly lead the northern countries of Eurasia and North America to greater cooperation in research thus providing an avenue for improvement of international understanding.

Although numerous organizations are engaged in arctic biological research, there is need for coordination and continuous sponsorship of projects and programs of long-term duration. There is therefore need for an Alaska-based national research facility, an Institute of Arctic Biology, as an integral part of a university.

Included in this report is a representative selection from the plethora of areas of arctic biology with important unsolved, or partially solved, problems. Although it is to be emphasized that basic biological knowledge of the Arctic has intrinsic value quite apart from immediately apparent applications, it is also obvious that many of the problems have obviously important economic ramifications. Thus the extremes of day length and temperature in the Arctic are responsible for numerous biological adaptations of fundamental interest; but basic information derived from investigations of these adaptations will have very extensive applications in the management of crops, forests, and wildlife.

Specific examples of problems with important economic ramifications are a series with important relationship to Alaskan fisheries. Thus there is a pressing need for more investigation of the freshwater environments used by the rapidly dwindling salmon stocks. Further, the growing king-crab, shrimp, and clam industries are based on abundant populations whose resiliences are inadequately known. The life histories, adaptational physiology, ecology, and population dynamics of these species need much more investigation. Another group of problems is associated with the vast areas of frozen forest whose ecology and physiology are poorly understood. Other problems have a close relationship to Alaskan agriculture which needs additional basic knowledge of photoperiodism, thermoperiodism, winter hardiness, and genetics of arctic strains.

Additional subjects for research, equally challenging and important, are cited for many fields of biology and related sciences, such as anthropology and soil science.

Cognizance should be given to the frequent usefulness of parallel studies with temperate and tropical species and conditions.

The University of Alaska is uniquely situated and organized to serve as the parent organization for an institute of arctic biology. It is the unanimous conclusion of the Committee that it is both feasible and desirable that the University undertake the establishment of such an institute. The Committee recommends that the University procure sufficient funds, from sources within and outside the State, to provide an essential nucleus of personnel and to construct a laboratory of a minimum of 20,000 net square feet, at an estimated cost of $1,500,000, as the first phase in the development of the physical plant.

As early as possible the University should appoint a resourceful and prestigeful director who will formulate a program, plan the physical plant, begin the recruitment of staff, and organize an advisory committee and an advisory council.

The Institute should cooperate with existing units of the University, including the departments of biological sciences, the Institute of Marine Science, the Alaska Agricultural Experiment Station, and the Geophysical Institute. It should establish and maintain logistics for itself, and cooperating organizations, for the conduct of research in the far-flung areas and varied habitats of the Arctic and Subarctic. Existing facilities of federal and state agencies offer significant opportunities for the development of collaborative research. In addition to the Institute's base in Fairbanks, auxiliary semi-permanent and mobile units should be established in appropriate areas. An adequate system of communications should be a part of this development. The Institute should strive to develop the effective balance between laboratory and field investigations so essential for successful research programs. In this respect emphasis must be placed on the provision of extensive controlled-environment facilities.

The Institute should encourage research further by sponsorship of graduate students, visiting scientists, and lecturers as collaborators. It should nurture the international nature of arctic biology.

Provision should be made to utilize the staff of the new Institute to strengthen appropriate academic departments of the University through joint appointments which will extend and improve the graduate program. Similarly, the effectiveness of the Institute can be enhanced by appropriate part-time appointments in the Institute for members of the academic departments. For the recruitment of staff, attention should be directed to fringe benefits and socio-economic needs.

The Committee is of the opinion that, in the hands of a capable director and a corps of dedicated investigators, the Institute can maximize the substantial intrinsic advantages of the proposed position as an integral part of the University of Alaska and that its endeavors in basic biological research will contribute significantly to the wise utilization of the abundant renewable resources of Alaska. The Committee is further of the opinion that in such hands the Institute can acquire great significance as both a national and international center for arctic biological research.

Man, because of his mental capabilities, and through his technology, is endowed with tremendous power over his environment. But, noblesse oblige, and the possession of this power, demand of man that he preserve and utilize rationally all natural resources. We have become aware that sovereignty over land carries the moral obligation of wise utilization so that future generations will not accuse us of irreparable damage of our and their heritage. This is particularly important in the case of new and insufficiently known environments, such as the Arctic, which man conquers with his technology. Even though an almost explosive increase in interest in the Arctic has developed during the past quarter century, there is still a great lack of understanding of its biology in comparison with our understanding of the biology of temperate environments.

The increase in interest in the Arctic is ultimately a reflection of the pressure of increasing population and the tendency of mankind, and particularly Western Civilization, to inhabit as much liveable area as possible and to maximize exploitation of renewable and non-renewable resources wherever they may be. It is also a manifestation of basic human curiosity, the major motivation in exploration and scientific inquiry. Interest has been facilitated and catalyzed by improved transportation which now makes the Arctic readily accessible. The Arctic is now traversed by air routes which interconnect the principle western countries. The sharply enhanced military interest and activity, which had its origin during World War II, is now based primarily on the strategic position of the Arctic with respect to these air routes. This expanding general interest in the Arctic has been accompanied by a corresponding crescendo of interest in arctic biology. Such is both natural and essential. The arctic and antarctic environments impose extremely rigid conditions on the existence of man; successful existence can come only with a thorough comprehension of the environment in both its physical and biological aspects.

Our country has a history of good biological investigations in the Arctic. That this record of accomplishment is being continued is evident from Appendix A which lists selected examples of current activity in arctic research by biologists of the United States. It is nevertheless correct to observe that our arctic biology, viewed collectively, remains both skimpy and fragmentary. Meteorology has informed us concerning the gross physical nature of this environment but we know relatively little of its significance to organisms from micro-organisms to trees, and to animals including man. Yet basic information on the impact of this arctic environment on organisms is essential to the best management of the renewable natural resources of the Arctic as well as to the purely intellectual urge to understand the Arctic which occupies such a significant fraction of the land surface of the earth.

Whereas under extreme arctic conditions, in which the land is covered with ice and snow for most of the year, productivity is very low, fundamentally the high insolation during summer should permit

high rates of photosynthesis. Therefore, it should be possible to establish principles by which photosynthesis and growth during the short polar summer could be maximized so that an enormous increment of energy could be tapped. This is demonstrated by the excellent growth of some species of trees after forest fire has lowered the depth of permafrost until tree cover itself again raises the permafrost level.

There are three major areas of the earth in which it is potentially possible to increase productivity: (1) the tropical oceans which are at present of low productivity because of low concentrations of nutrients; (2) the deserts which contain little vegetation because of a shortage of water; (3) the arctic regions which are of very low productivity because of a lack of heat. Consequently basic information on low-temperature performance of plants, physiology under snow cover, and problems associated with roots and permafrost will be essential in improving productivity in a major area of low productivity. Other very important general problems which can best be studied in the arctic environment are those of cold resistance, frost damage, freezing and thawing of cells, reduction of sexual reproduction under cold conditions, and pathogens in plants under cold conditions. These are important in temperate and alpine environments also and therefore their study would aid biology and agriculture in temperate regions as well.

In the Arctic man lives intimately with his environment. This enhances the importance of a thorough comprehension of the roles of cold, snow, ice, long summer days, and long winter nights in the evolution and existence of the entire arctic biota. It is only through a thoroughly comprehensive arctic biology that it will become possible to utilize the Arctic and Subarctic wisely and to avoid irreparable damage to their renewable natural resources. Nowhere can ignorance of an environment become more tragic than in the Arctic!

Within the State of Alaska lie our only truly arctic and subarctic areas. The rapid development of arctic biological research in Alaska, as carried forward by many universities, including the University of Alaska; the Alaska Agricultural Experiment Station; the U. S. Public Health Service; the U. S. Fish and Wildlife Service; and the military services constitute ample evidence of recognition of its importance. (See Appendix B for a list of biological research installations within Alaska.) Viewed as a whole, however, our research effort in arctic biology has been largely a kaleidoscopic venture lacking in cohesion and integration.

Whereas it is true that good research programs can only be guided rather than directed, there is nevertheless a substantial element of advantageous integration and consequent enhancement of progress which could be attained through the development of an outstanding university-affiliated research institute with its own vigorous research program, facilities for guest investigators, a program of conferences and symposia, and an effective scheme of publications.

There can be no doubt of the desirability, and indeed of the essentiality, of the establishment at this time of an Institute of Arctic Biology and the formulation of plans for its eventual development into an institute of a sweeping general nature with the role of a national and international center for research in arctic biology.

THE JUSTIFICATIONS AND ADVANTAGES OF UNIVERSITY AFFILIATION FOR AN INSTITUTE OF ARCTIC BIOLOGY

Having reached the conclusion of the desirability and urgency for the establishment of an Institute of Arctic Biology, sponsorship and affiliation should now be considered. Because of the original charge to the Committee, and recognizing that basic biological research traditionally has been pursued most successfully in university laboratories, the Committee has directed its attention to an analysis of the advantages of a university affiliation and sponsorship.

Prominent among the basic justifications for such a relationship is the association of the Institute and its staff within a community of scholars of diverse disciplines. An environment with stimulating influences of interdisciplinary relationships is of fundamental importance. This is particularly pertinent with respect to the challenging problems in arctic biology.

A further justification for association with a university is the availability of certain facilities ordinarily found in universities. Among the most important, of course, are library facilities and collections. The library requirements of an Institute of Arctic Biology are extensive and by no means restricted to the field of biology. Another clearly important facility is a reference collection of plants and animals to assure proper identification of species and to provide information on their distribution. Other facilities of a university which would be advantageous to an Institute of Arctic Biology include shops, transportation facilities, procurement systems for supplies and equipment, and general maintenance facilities. It is imperative that the Director of the Institute be freed from the routine housekeeping chores of maintenance, procurement, and logistics.

The most important justification for an institute within a university is that of educating graduate students who will continue research in arctic biology. The lack of a university institute proximate to the Arctic, and oriented primarily toward research and graduate study in arctic biology, is perhaps the most serious single defect in arctic biology in this country today. The Committee recognizes and emphasizes that there is no clear-cut dichotomy between undergraduate education and graduate study in biology. It therefore envisions that the fullest benefits of the affiliation of an institute of arctic biology within a university can be realized only if there is a close relationship between the Institute and the academic teaching departments with a substantial number of individuals holding joint appointments between the Institute and an appropriate academic department.

In thinking of an Institute of Arctic Biology within a university, the Committee envisages the Institute as a cluster of research laboratories and programs, with common facilities, including field stations,

wherever possible. Development would be primarily by increments of additional laboratories and/or programs. It envisions the director as the principal scientist of one of the research programs for it is only through an established investigator with administrative ability that the Institute can acquire a capable staff and establish effective rapport with the scientific community at large. The Committee has no firm recommendations either with respect to specific research areas and functions of the individual laboratories, or with respect to the order in which they would be added. The quality and success of research is so highly dependent on the talent of the principal investigators that the availability of competent scientists must be the prime determining factor in the functions of the laboratories, their areas of research, and the order in which they are added. Rather it is more appropriate for the Committee to outline, as it has done in a subsequent section of this report, a broad spectrum of important areas of research which are unique or important to the Arctic and the Subarctic.

THE FEASIBILITY OF THE ESTABLISHMENT OF AN INSTITUTE OF ARCTIC BIOLOGY AT THE UNIVERSITY OF ALASKA

Although there is little doubt of the desirability of a university affiliation for an Institute of Arctic Biology, it is nevertheless clear that the advantages to be derived thereby are direct functions of the nature of the university, the quality of its faculty, its facilities, its personnel policies, and its organization. To evaluate the University of Alaska as the potential host university for an Institute of Arctic Biology is not a simple task. The University is young and, although it is generously supported by the State, its immediate resources are nevertheless limited. This limitation becomes very conspicuous when related to the size of the State and the projected increases in population. Because of its unique course of development, it is patently impossible to compare the University of Alaska directly with other state-supported universities in the United States. This distinctive course of development is imposed by a combination of circumstances, including the nature of the State of Alaska itself, the extensive interest of the Federal Government in Alaska, and the impact of the logarithmic increase in federal support of higher education at an early stage in the development of the University. The Committee, therefore, of necessity, recognizes the inapplicability of many of the familiar comparisons which would be useful for other state-supported universities; on the other hand, it has attempted to apply sensibly the long-established principles which nurture and promote the development of basic scientific research in universities. The Committee recognizes that much of the eventual support of an Institute of Arctic Biology at the University of Alaska could be derived logically and justifiably from federal and other external sources. To place itself in a position in which it can attract and justify responsibly research funds from external sources, it is necessary that the University of Alaska first provide certain basic assurances concerning its contribution to such an establishment. These assurances involve fiscal support for facilities and positions as well as measures to establish the conditions necessary to attract and retain the kind of research biologists necessary for the success of such an institute.

The Committee holds that the feasibility of the establishment of an Institute of Arctic Biology at the University of Alaska depends first on the establishment by the University itself of a modest, but significant, corps of scientific and supporting personnel. It strongly urges that the University from its own resources provide funds immediately for a director, and when facilities become available, for an assistant director, and four additional positions. The director and assistant director should be prominent scientists who will develop their own research programs. The nature of the other four positions should be determined by the director. It is anticipated that they would be clerical and technical.

The Committee feels that the establishment of the Institute will require the University to provide a substantial block of funds for construction of laboratories. The Committee emphasizes that the quality of the director, and his program, must be of the highest order. Under these circumstances, the probability of success in obtaining matching funds from federal sources should be very good. The Institute necessarily must develop gradually with appropriate additions to its physical plant. It is suggested that the initial unit include a minimum of 20,000 net sq. ft., or about 30,000 gross sq. ft., of floor area. At current costs of construction and equipment, this would probably represent a total expenditure of about $1,500,000.

An essential component of the physical plant of the Institute is an adequately equipped and staffed shop which can perform a variety of machine work, woodwork, welding, glass blowing, work with plastics, and work with at least simple electrical and electronic apparatus. It would be highly desirable, in addition, to develop the necessary arrangements with the Geophysical Institute for more complex electronic and instrument work.

In planning space and facilities for the Institute of Arctic Biology, it must be borne in mind that such an institute should become both a national and international center and that provision must be made for visiting investigators. The Committee urges that a part of the philosophy of the operation of the Institute include the organization of concentrated short-term programs devoted to relatively circumscribed areas of research in which a body of visiting investigators would participate. Possible examples are a "frozen-lake program," a "glacier-biology program," a "frozen-forest program," etc. This type of potentially productive activity can become possible only with careful initial planning to provide the necessary facilities for substantial numbers of visiting investigators.

Paramount among the facilities essential for an Institute of Arctic Biology are extensive controlled-environment facilities. It can be anticipated that the generic type of research operation will involve primary identification of problems in the field followed by the formation of hypotheses which must be tested under controlled conditions. Experiments under controlled conditions lead to modified hypotheses which frequently must be subjected to field observations and further modified and again subjected to experiments under controlled conditions in the laboratory. Thus it is anticipated that many or most of the investigations of the Institute will alternate between field and laboratory and that a very substantial fraction of the work in the laboratory will require rigidly controlled conditions including a substantial number of laboratories, animal rooms, and plant rooms which can be maintained at temperatures well below 0° C. A complement of aquarium rooms will also be required.

As the functions of the Institute are envisioned, its operations would be widespread geographically. This necessitates careful attention to a system of outlying stations, a matter of substantial importance since Fairbanks is not within the Arctic Zone. Of fundamental importance then will be the relationship of the Institute to the Arctic Research Laboratory at Point Barrow and to its outlying stations. In time other stations will be required. Attention should be directed, therefore, to such requirements of the Institute in relation to those of other research units of the University which require field stations at substantial distances from Fairbanks, such as the Geophysical Institute, the Institute of Marine Science, the Alaska Agricultural Experiment Station, and individual academic departments.

The Committee recommends that the University establish as early as feasible a multipurpose marine station in the Kachemac Bay area. This station could be used for undergraduate and graduate instruction and in the research programs of the Institute of Marine Science and the Institute of Arctic Biology.

Effort should be extended by the Institute to establish cooperative arrangements which would permit the use of biological research installations of federal and state agencies within Alaska. Emphasis must be placed on the development of a system of adequate logistic support including an adequate system of communication with outlying operations. Early consideration should be given to the establishment of a motor-vehicle pool and to an adequate system of air transport, including helicopter. Attention also must be directed to the development of mobile laboratory units.

A major justification for the development of such an institute as a part of a university should be that of the availability of a university library. Here much remains to be done. The collection of books and periodicals in the Library of the University of Alaska in the various fields of biology is small and spotty. Although there is some recognition of the problem, the Committee is not convinced that there is an understanding of its true importance and magnitude and is strongly of the opinion that an acceleration of the development of its library collection in the biological sciences is mandatory. It recommends that any plan for the development of an Institute of Arctic Biology incorporate substantial mechanisms for supplementing the collection of the Library of the University. The importance of this is magnified by the relative isolation of the University. The Library's collection will be an important factor in attracting and retaining high-calibre biologists, both in the Institute and in the academic departments. Attention must be directed to a system for rapid procurement of photocopies of materials from other libraries. The Library should follow closely the developing schemes for facsimile transmission, microcard storage, and retrieval systems.

As early as feasible the Institute should consider the establishment of an international journal of arctic biology. This journal could then be used on an exchange basis as a means of improving the pertinent collections of the Library.

The Committee recognizes clearly the importance of adequately curated representative collections of Alaskan animals and plants as an essential adjunct to an Institute of Arctic Biology. It is felt that these collections should not be a part of the Institute itself but should constitute an important and well-supported function of the University. It is not anticipated that any of the sustained programs of the Institute would be primarily taxonomic, although the facilities of the Institute would be available for visiting scientists who are concerned with taxonomic and biogeographic problems. The importance of the collections of plants and animals lies in the proper identification and information on the distribution of the species involved in the investigations of the Institute.

In looking toward the establishment of the Institute of Arctic Biology, the University must assume the leadership in setting aside important areas for biological research in the future. It should be fully cognizant of the great handicaps experienced by most universities and most states by the failure to initiate appropriate, vigorous programs of this kind at a sufficiently early time. In moving to set aside such areas for maintenance in untouched condition, the University should have in mind not only the preservation of areas unique to the Arctic and Subarctic but also certain areas in which Alaska represents the last untouched frontier even though these areas are not characteristically arctic or subarctic. It is recommended that the University seek the establishment of such a system as early as possible and that it provide the mechanisms necessary for maximum wisdom and imagination in the selection and preservation of such areas.

The mechanism should include a highly knowledgeable board drawn from a variety of areas of biology and other natural sciences. Its functions should be executive as well as advisory. It is to be emphasized that such reservations should be for research purposes and, therefore, quite distinct from state parks, game reserves, and the like. Areas incorporated therein should include all types of ecologic areas, adequate coastal strips of different characteristics, islands, glaciers, glacial moraines, entire lakes, entire streams including their drainage basins, and other areas of potential value for research in the future. The sizes of such areas would vary enormously, with some approaching the size of the Arctic Wildlife Range. The Committee recommends that careful attention be given to the highly successful State Board for the Preservation of Scientific Areas in Wisconsin. The extensive transfer of federal lands to the State, now being effected, re-emphasizes the desirability that the University undertake the establishment of this program at the earliest feasible date.

The Committee has given extensive thought to the relationship between the Institute of Marine Science and the proposed Institute of Arctic Biology. There are numerous reasons for such considerations. Certainly there are many areas of research interest which would be common to the two institutes. This requires an integration

of planning which can be best effected if the two are closely coordinated. Beyond this, such matters as common shop facilities, common store facilities, common field stations, common means for transportation and communication should be considered. The Committee urges that the University give extremely careful attention to the matter of administrative devices which will assure the greatest possible ease in coordination and cooperation of these two institutes.

The Committee has also considered the possible relationship between the presently proposed Laboratory of Zoophysiology and the proposed Institute of Arctic Biology. It seems logical that the Laboratory of Zoophysiology should become one of the components of the Institute.

There are many areas of research in the functions of the Institute of Arctic Biology and the Alaska Agricultural Experiment Station which are potentially complementary. Adequate provision for liaison should be established, a possible mechanism being through the Advisory Committee of the Institute. (See Appendix D). The possibility of joint appointments between the Institute and the Alaska Agricultural Experiment Station should be explored in cases where basic research is involved and where the controlled-environment facilities of the Institute would be of use. It is the opinion of the Committee that, with adequate liaison and understanding, the programs of the Experiment Station and the Institute can only result in mutual stimulation and in an acceleration of progress in arctic biological research.

The Institute, at a very early stage in its development, should explore the possibility of an arrangement with the U. S. Department of Agriculture whereby the Agricultural Research Service might station a corps of investigators at the Institute.

The Committee recognizes potential relationships of mutual benefit between the Institute of Arctic Biology and the Geophysical Institute. There are many possibilities for such productive interaction. Among these are the possible biological effects of atmospheric forces, magnetism, atmospheric ions, and studies of solar radiation. Also there are many possible bases of collaboration in instrumentation and data processing.

The Committee anticipates that the campus of the University of Alaska will become the site of several federally supported laboratories engaged in biological research. It anticipates that these will contribute substantially to the establishment of a community of investigators and that the Institute and the University will profit extensively thereby. Such a relationship can maximize the beneficial interactions of basic and applied research. In order to maximize the beneficial interactions between the Institute and such laboratories, including the existing Arctic Aeromedical Laboratory, the Committee recommends that there be careful planning to assure optimum proximity among these laboratories and the Institute. It suggests that the

University explore the possibilities of direct contributions from such laboratories to the development of the collection of the university library.

The operation of the Institute of Arctic Biology must also provide adequate liaison with other extra-university programs and laboratories involved in biological research in Alaska, including those of the Arctic Aeromedical Laboratory, the Arctic Health Research Center, the Alaska Department of Fish and Game, the U. S. Fish and Wildlife Service and the Bureau of Forests.

It is important here to re-emphasize the significance of effective working arrangements with the Arctic Research Laboratory at Point Barrow. Its extensive system of stations throughout the Alaskan Arctic and its effectively organized system of transportation and logistics can be of inestimable value in the functions of the Institute of Arctic Biology.

As noted above, it is the opinion of the Committee that the single most important justification for the development of an Institute of Arctic Biology within a university is that it would provide the means for graduate study and production of new young scholars dedicated to the type of investigations for which the Institute is founded. The Committee recognizes and emphasizes that there is no clear-cut dichotomy between undergraduate education and graduate study in biology. It is, therefore, concerned about the ultimate relationships between the proposed Institute of Arctic Biology and the academic departments of biological sciences. It urges that joint appointments between the Institute and the appropriate academic departments be facilitated for those members of the Institute who desire them. It recommends that all instruction be handled through the academic departments and that members of the Institute who direct graduate study do so as part-time members of the appropriate academic departments even though the research itself may be done within the Institute. It is recommended also that the degrees be granted through the appropriate academic departments. In order to assure the most favorable mutualistic relationship between the Institute and the academic departments of biological sciences, the Committee recommends that the University carefully consider the organization of the biological sciences per se and their position in the general organization of the University with careful consideration of the matter of the number of departments of biological sciences. The Committee recommends the development of a policy of procurement of personnel in the biological sciences in which the selection of new personnel for the academic departments will be made in light of their potential for effective part-time appointments in the Institute.

The Institute, as a part of its function as a center for visiting investigators, should develop a scheme which would enable graduate students from other universities to conduct their research at the Institute. Such a scheme must involve adequate arrangements for supervision and for defrayal of costs.

Although it is anticipated that much of the research conducted at the Institute will be done by visiting investigators, the success of the Institute nevertheless will depend to a great extent on a permanent corps of highly capable biologists. It is the opinion of the Committee that in order to procure and retain a corps of outstanding investigators, the University must address itself to the development of schemes of tenure, insurance, and retirement benefits similar to those now characteristic of the major universities of the United States. It will need to continue the development of its housing program. It is particularly important also that attention be given to the provision of funds for attending at least one national or international meeting per year, and to the development of a system of periodic annual or semester leaves. All of these matters inevitably will have a direct bearing on the quality of permanent staff.

Manpower is indeed the most critical problem in the development of research and graduate education. Therefore, every effort should be made to (1) attract the right type of scientists to form a nucleus around which groups can grow, and (2) attract the attention of government agencies which are stationing research workers in different parts of the country. Thus, as noted above, U. S. Department of Agriculture should be approached concerning the possibility of stationing plant physiologists at the Institute to utilize the unique arctic conditions for the study of photoperiodism, cold resistance, and other general problems. Possibly the Weather Bureau might station climatologists at the Institute. The possibility of similar collaboration with U. S. Geological Survey in investigations in such areas as soil genesis and glacial biology should be explored.

The Committee recognizes that, in relation to the present incomes of the University of Alaska and of the State of Alaska, these recommendations involve very substantial commitments. The Committee, however, re-emphasizes the critical importance of the renewable resources of the State and that wise exploitation of them can come only with a much more thorough knowledge of arctic and subarctic biology. The annual income from agriculture in Alaska is now in excess of $5,000,000; the income from fisheries and fisheries products exceeds $90,000,000. Lumber and forest products contribute approximately $40,000,000 annually. The tourist industry, including sport fishing and hunting, has become a significant element in the income (estimated at $30,000,000 per year) of the State and will increase in importance for many decades to come. The fur industry contributes about $4,000,000 per year. The value of fish and game taken in "subsistence hunting and fishing" is of the order of $3,700,000 per year. The economic value of these renewable biological resources is particularly impressive when it is noted that the annual value of the products of mineral extraction is less than $50,000,000. Obviously, then, the State does have an enormous stake in the development of arctic and subarctic biology if it is to manage its renewable resources wisely. Whereas the proposed Institute of Arctic Biology would not be involved

directly in applied research and development, it would be the source of much of the fundamental knowledge of arctic and subarctic biology which is essential for effective applied research and development.

THE RELATIONSHIP OF STATE AND NATIONAL INTERESTS IN AN INSTITUTE OF ARCTIC BIOLOGY

Arctic biological research obviously involves many relationships and interactions between state and national interests. Such relationships will be even more extensive in an Institute of Arctic Biology in a university. National interest is involved first in the growing philosophy of federal support of higher education and, more specifically, federal support of research in universities. Beyond this, the federal government doubtless will continue to have other important functions in Alaska, many of these having a direct bearing on the renewable natural resources. It is anticipated that the Institute of Arctic Biology will have close relationships to these functions and that students from the Institute will eventually assume many positions of importance therein. Arctic Alaska will be an area of strategic military importance throughout the foreseeable future. It is inevitable that this will continue to provide an impetus to research in the Arctic. Graduate education has become firmly established as an instrument of foreign policy, a concept which universities have readily accepted; the implications therein for an Institute of Arctic Biology, with a vigorous program in graduate education and research, are obvious. For this and other reasons, it must be recognized that an Institute of Arctic Biology at the University of Alaska will present a unique opportunity in international relations. Among the universities of the world, only the new University of Oulu in Finland shares with the University of Alaska the advantages of a highly favorable location with respect to the Arctic and Subarctic. Bearing in mind that cooperation and understanding develop readily, and without regard to nationality, within a community of investigators in a university, and further that there is a great commonness in all of the Arctic, it becomes apparent that the development of such an institute could be powerful in furthering international understanding. The establishment of such an institute at the University of Alaska represents an opportunity for the University, the State, and the Nation to exert genuine and effective international leadership in arctic biological research. Whereas the efforts of Canada, the USSR, Finland, and the Scandinavian countries in arctic biological research are extensive, our best information indicates that no country as yet has taken the important unifying step of establishing an institute of arctic biology in an advantageously located university. Thus the national interest in the development of such an institute is both extensive and diverse.

The importance of such an institute to the State of Alaska is equally great. The potential role in providing the knowledge and understanding necessary for an intelligent exploitation of its renewable resources has been presented adequately above. Increasing population will require an enhancement of the efficiency and extent of its agriculture and fisheries. It must be emphasized also that such an institute can contribute substantially to the stature of the University of Alaska and to higher education in Alaska.

These interrelationships suggest that the Institute of Arctic Biology should be developed according to the normal patterns of cooperation between universities and the federal government. The Committee, therefore, re-emphasizes its position that the University of Alaska should provide initially a corps of positions for the Institute and a substantial block of funds for construction of the first phase of the physical plant. With this initial fiscal step, with the appointment of a director of accomplishment and imagination, and with development of sound research programs, there can be no doubt that, through many channels, the federal government and other external organizations, will become willing and extensive partners in the Institute.

POTENTIAL AREAS OF INVESTIGATION

Even a brief visit in Alaska is sufficient to cause a biologist to realise that there is in the Arctic and Subarctic an amazing number of problems which are as yet unsolved. Pure intellectual curiosity will drive him to seek their solution. But there are also economic reasons why these problems should be solved. Instead of penetrating by the brute force of technology into the inhospitable environment of the Arctic, it is possible to spy on nature and discover how the polar bear, the husky, and the hare have adapted themselves to this environment which holds no terrors for them. And by the same reasoning, it should be possible to discover the differences between the native plant which can survive the long and intensely cold winter and the introduced and tender cultivated plant and then apply this knowledge to the practical problems of agriculture.

The significance of this basic approach to arctic biological problems is perhaps best demonstrated by visiting Kodiak after Anchorage and Fairbanks. In the latter two places several kinds of spruce, birch and poplar grow well up to 2,000-3,000 feet in the mountains. On Kodiak, further south and with an apparently milder climate, only one spruce and one poplar grow, not ascending more than 500 feet on the slopes of the mountains, whereas still further south on the Aleutian islands there are no trees at all. If we knew what limits tree growth in the Arctic and Subarctic, these differences should be explainable, and it might be possible to grow trees where they do not grow at present.

Obviously, there is no difficulty in compiling a list of highly interesting areas of investigation, concerned with phenomena typical of, or unique to, the Arctic or Subarctic, which are very important to basic biological science and to an enlightened exploitation of our Arctic. The Committee offers these suggestions not only as a justification for the development of an Institute for Arctic Biology but also as a guide for the planning of such an institute.

The Committee does not wish to designate areas of primary importance nor to recommend orders of priorities for development and support. It declines this role for several reasons. It recognizes that the most imaginative and novel investigations can develop only with freedom of choice of problems, species, and methods. It recognizes further the frequent impossibility of contemporary assessment of the ultimate value of a given investigation. Finally it recognizes that success of research is primarily a function of the quality of the investigator and that greater progress can be made by permitting the temporal sequence of investigations to be established by sequence in availability of gifted investigators than by attempting to fit less-gifted investigators to a predetermined sequence of investigations.

The suggestions presented below are to be construed primarily as <u>selected examples</u> of areas in which research is highly desirable. As a body they necessarily constitute only a partial inventory of the potential areas of research in which the Institute could operate.

Photosynthesis and Related Phenomena

Of very fundamental interest and importance is a cluster of problems related to photosynthesis in the Arctic. The potential ramifications of such are almost innumerable. Of substantial interest, for example, would be studies of photosynthetic activity during the long summer photoperiod with special attention to the factors, other than available light energy, which are rate-limiting. Of interest here also, as in many other aspects of the biological effects of light, are problems incident to the long periods of twilight. Photosynthetic activity beneath the ice is of great interest. Long-term studies of variations in solar radiation and their relationship to productivity should be made. These should be extended to studies on the relationships to animal populations. Of great interest also would be the investigation of other autotrophic activities in the Arctic by means of combined field and laboratory studies. (See also Limnology, Ecology.)

Biology of Snow, Glaciers, and Permafrost

Of paramount importance in arctic biology is the permafrost and its extensively pervasive effects on the arctic vegetation and the associated fauna. Investigations are needed with respect to the growth and distribution of plants, the regrowth of forests, and community development (ecological succession) in general. Extensive attention can be directed profitably toward the microbiology of permafrost, elemental cycles, and the age and nature of the deposits.

The biology of glaciers offers a most exciting and fruitful field for investigation. Such investigations should also extend beyond the macroflora and macrofauna to include studies of the microbiota and elemental cycles. Attention should also be given to the biological effects of run-off from glaciers and to invasion by plants, soil genesis, and successions in the new habitats made available by recession of the glaciers. Another closely related field of investigation, which is certain to be fruitful, is the study of organisms associated with floating ice, including the adaptations of such involved. The role of ice islands in promoting the well-known holarctic distribution of many species of plants and animals needs thorough attention.

Also requiring extensive attention is research on snow as an ecological factor, and the biology and microbiology of snow. It must be borne in mind that snow exists in a great variety of physical forms.

Biology of Sub-freezing Temperatures

Although the existence of living material in sub-freezing temperatures is by no means unique to the Arctic, it does provide important and unique opportunities for the investigation of this interesting phenomenon. Such studies should provide extremely important

information not only on the nature of life at these temperatures but also on the role of water as a component of living systems in general. The Arctic is replete with examples of life in sub-freezing temperatures for which our present knowledge fails to offer adequate rationalization. Such studies should be of substantial importance to applied as well as to basic and theoretical biology. For example, much needs to be learned concerning the basic mechanisms of winter hardening, and the physiology of survival in a frozen state. A closely related battery of problems are those associated with life at the temperature of freezing under both snow and ice; attention should be directed to the properties of the enzyme systems involved, to the properties of proteins, and to the genetic bases of the induced differences.

Latitudinal Variation

An area of investigation of very great potential importance both to basic and applied biology is that of latitudinal differences within species and among closely related species of both plants and animals with attention to the basic nature of such adaptations. Attention should be given both to the intrinsic range of adaptations characteristic of a genotype and the genetically fixed spectrum of adaptations among genotypes as developed in evolution. Many of these problems have obviously important implications for agriculture; they represent an area of potential cooperation between the Institute and the Alaska Agricultural Experiment Station. Investigation of the adaptive aspects of annual cycles in molt, reproduction, metabolism, and behavior among vertebrates should be most fruitful. Equally important are studies of the mechanisms by which extremes in environmental conditions bring about variations in organisms. (See also Microbiology, Entomology, Ecology, Life Cycles, Biological Rhythms.)

Microbiology

There are many microbiological problems of great fundamental interest and importance in the Arctic. Some are noted elsewhere in this report as aspects of ecological problems. Among the microbiological problems are the natures of the carbon, nitrogen, sulphur, and phosphorous cycles in soils and lakes which are frozen for a substantial portion of the year. Investigations thereon should include the nature of the changes, the rates, magnitudes, and the micro-organisms involved. Of great interest and importance is the problem of selection or adaptation of bacterial species or types according to climate. Our present state of knowledge concerning this is extremely poor. Of importance also is the problem of prolonged survival of micro-organisms in the frozen state. The theoretical and potential practical ramifications of this are extremely extensive. For example, what is the basis for the different thermal optima of some arctic organisms? Much attention needs to be given also to the importance of microclimate in the activities of the micro-organisms of soil. Productive microbiological research in the Arctic can profitably absorb the efforts of many talented investigators for many years to come.

An adaptation which has permitted a number of species of birds and mammals, and perhaps species of other groups, to survive throughout the year in the Arctic, is the development of schemes for utilization of cellulose and other ordinarily indigestible natural polymers. These adaptations involve the use of microbial flora and fauna somewhere in the digestive system to perform the necessary breakdown of these large molecules into molecules usable in the metabolism of the host organism. This type of adaptation, of course, is not unique to the Arctic. Yet, the Arctic may offer some of the most spectacular examples of this type of adaptation. Investigations of them would certainly be most fruitful. Physiologic adaptations of the host species for use of microbial products constitute a potential area of investigation. (See also Ecology; Latitudinal Variation; Biology of Snow, Glaciers, and Permafrost; Biology of Sub-freezing Temperatures; Diseases.)

Life Cycles

Much remains to be learned concerning life cycles of important terrestrial, fresh-water, and marine animals and plants of the Arctic and the adaptive aspects of these cycles. For example, the life cycle of the king crab, now the basis of an important industry, is incompletely known. The same is true for several important species of fish. The life cycles of many important species of insects and mites remain completely unknown. Similarly much remains to be done on the life cycles of many species of arctic and subarctic plants. Finally the mechanisms involved in the control of such cycles would also be productive subjects for investigation. (See also Ecology; Limnology; Biological Rhythms; Hibernation, Migration, and Related Phenomena; Entomology.)

Limnology

In the field of limnology there are extensive and important untouched areas of research which are uniquely arctic and subarctic. The long, cold winter bestows on arctic lakes physical and biological properties distinctly different from those of other latitudes. Detailed studies of various physical types of lakes in the Arctic should contribute significantly to our general knowledge of limnology. Attention should be given to studies of heat budget, the effect of ice over such a substantial fraction of the year, circulation patterns under the ice, algal blooms beneath the ice, the annual population cycles of all organisms, microbiology, and elemental cycles. Of great interest will be studies of photosynthetic activity beneath the ice, photosynthetic activity and limitations thereon in continuous light, and general productivity during twilight periods. Much attention can be directed fruitfully toward the study of the life history of aquatic organisms, including fish, in the lakes and streams of the Arctic for little is known of the adaptations of these organisms to arctic conditions. The phenomenon of adaptive summer growth requires much additional attention.

The breeding grounds of salmon and other commercially important fish are in fresh water. A better knowledge of fresh-water biology is essential if fish which migrate to and from the sea are to contribute significantly to the economy of Alaska.

In conjunction with investigations of fresh-water biology in the Arctic it must also be recognized that the problems of pollution of streams and lakes are vastly different in the Arctic than in the temperate zones. It is consequently desirable to understand thoroughly the physical, and biological aspects of arctic lakes and streams in order to be in a position to deal effectively with the problems of pollution which are certain to come with the development of the State. It is significant to note that the U. S. Public Health Service plans to establish a water pollution control laboratory at the University. Potentially then this laboratory and the Institute will share an area of mutual interest with the possibility of complementary and cooperative projects. (See also Photosynthesis; Life Cycles; Biology of Snow, Glaciers, and Permafrost; Population Dynamics.)

Ecology

In its broadest aspect, ecologic research must constitute one of the major efforts of the proposed Institute of Arctic Biology for it is the relatively severe environment of the Arctic that is basic to many of the biological problems of the Arctic. Many of these problems are included elsewhere in this section (Biology of Snow, Glaciers, and Permafrost; Biology of Sub-freezing Temperatures; Latitudinal Variations; Microbiology; Limnology; Population Dynamics). In addition to the ecological problems listed elsewhere are those associated with the development of homeostatic (climax) communities in the Arctic. It is obvious that many concepts, as derived from investigations at lower latitudes, cannot be applied without modification in the Arctic. Of interest will be studies on total productivity including studies of photosynthetic activity at low temperature and in twilight.

Attention should be given to the general field and concepts of microclimates and niches in the distribution and survival of animals and plants during the arctic winter. As research has developed in this area it becomes increasingly evident that an extremely important aspect of survival in the Arctic winter is that of exploiting the most favorable microclimates. Much important research remains to be done in this area. It must be borne in mind that man also survives in the Arctic primarily through maintenance of favorable microclimates.

Much of theoretical and practical interest can be learned from the study of plants from other climates under arctic conditions. Attention also should be directed toward the domestication of native species of potential value as sources of food or fiber. Properly executed, such investigations may yield results of extensive theoretical and practical significance. Efforts in this direction should be

coordinated with investigations at the Alaska Agricultural Experiment Station. Consideration should be given to the establishment of a botanical garden with primary emphasis on arctic and subarctic plants.

There are numerous interesting and important fields of investigation with respect to biological aspects of the atmosphere. Many of these require close cooperation with meteorologists. Of interest in this category are studies on the volatilization of organic matter from forests into the air, air-borne pollen, spores, and micro-organisms; fall-out and air pollution. Additional important investigations can be made in the related field of climatology, particularly in reference to long-term climatic changes and their effect on the fauna and flora, and on biotic communities.

Population Dynamics

The Arctic, with its relatively untouched populations subjected to extremely rigorous environmental conditions, offers many opportunities for studies of population dynamics and the factors which control the sizes of populations. The role of predation, nutrition, parasites, and other factors can be evaluated in relatively yet untouched populations. Also the evolution of population-limiting mechanisms within species can be studied advantageously among some Arctic species. Collaboration with related programs now in existence at the University of Alaska, the Arctic Health Research Center, and elsewhere in Alaska, including the extensive studies in lemmings at the Arctic Research Laboratory, should be developed. In such studies the population dynamics of the original Eskimo populations must not be overlooked. (See also Limnology, Ecology, Entomology, Biological Rhythms, and Anthropology.)

Entomology

Many important areas of potential investigation in the Arctic lie within the field of entomology. Some are mentioned elsewhere in conjunction with more general ecologic problems. Surprisingly little is known about the life cycles of most arctic species. A thorough understanding of these life cycles would contribute much to entomology as a science and likewise would contribute extensively to problems in applied entomology which are certainly to arise with more extensive utilization of the Arctic. The behavior of viruses and rickettsiae in insects, mites, and ticks, requires much additional investigation as a basis for an intelligent epidemiology and epizoology of the Arctic. Taxonomic entomology needs many investigations with modern genetic approaches in order to understand adequately the Arctic insect fauna. As in so many other groups of animals, studies in winter hardiness are highly desirable. As agriculture becomes more extensive it is certain that the importance of entomological research will become still greater. Research programs in entomology, of course, must be coordinated with research in this field at the Arctic Health Research Center, Alaska Agricultural

Experiment Station, and the Arctic Aeromedical Laboratory. (See also Life Cycles, Frozen State, Diseases, Biological Rhythms, Ecology.)

Hibernation, Migration, and Related Phenomena

Reduction of metabolic rate and activity is a common adaptation to cold. Although the physiology and ecology of hibernation have received extensive attention during the past three decades, much remains to be learned. Research on hibernation produces information of importance far beyond explanations concerning the species involved; it has extensive ramifications in intermediary metabolism and regulatory mechanisms. Investigations on hibernation, of course, cannot be divorced from investigations of other mechanisms which facilitate survival of homoiothermal animals in the Arctic. These aspects also have received extensive attention during the last three decades. But here also much remains undone. For example, further studies are highly desirable in the field of physical thermoregulation in the cold aquatic environment. The relationships of research on hibernation and other adaptations to arctic climates to man and domestic animals are obvious. Of great theoretical interest, and possibly of equal applied interest, is the study of natural hypothermia in parts (particularly extremities) of the bodies of certain species. Associated with this are the problems of integration and the operation of receptors, nerves, and circulation during extreme hypothermia. Another aspect of winter survival by homiotherms is that of behavioral thermoregulation, including aggregation, seeking favorable microclimates, covering of body areas with high heat loss, etc. More detailed investigation of this type of adaptation is needed.

A common scheme of adaptation to the Arctic is that of migration, a phenomenon which has evolved many times in many groups of animals. Although the gross aspects of migration are now well understood empirically, at least, for birds, mammals, and some fish, much remains to be done to understand completely the control and timing mechanisms, the energetics involved, mechanisms for orientation, and the relative roles of inheritance and learning.

Biological Rhythms

The Arctic provides interesting and critical conditions for the study of circadian rhythms. Certainly much can be learned concerning the role of the daily photoperiod, and its change from 0 to 24 hours per day in the Arctic, in the phasing of circadian rhythms. In a similar manner the Arctic should provide important species for the study of circadian rhythms and photoperiodic controls in plants and animals. In cold-blooded animals and in plants it should provide interesting material for the interaction of photoperiodic and thermoperiodic controls. It should also provide the species and conditions necessary for fruitful investigations of annual or quasi-annual intrinsic periodicities, if such exist, and the thermoperiodic and photoperiodic phasing thereof. The Arctic should also provide conditions

and material for studying the role of other possible timing and phasing forces such as changes in intensity of the magnetic field.

In conjunction with the study of annual cycles, attention should also be given to invertebrate species, both fresh-water and marine, and particularly to the non-annual cycles which are known to occur in at least some marine species. (See also Latitudinal Variation; Life Cycles; Entomology; Ecology; Hibernation, Migration, and Related Phenomena.)

Diseases

Much remains to be learned concerning the ecology of diseases of man and animals in the Arctic despite rapid strides which have been made in this field by investigations supported by the Public Health Service and by the military services. Such investigations are of importance not only because of their very substantial direct importance but also as contributions to a general understanding of the ecology of disease. The problems are extremely diverse. They involve the nature of the infectious organisms, hosts, reservoirs, vectors, their life cycles and their ecologic relationships. Many of the problems are unique to the Arctic. But beyond this many important investigations can still be performed in Alaska because of the relatively untouched areas still remaining. The results of investigations conducted by the Arctic Health Research Center emphasize the fruitfulness of the broad ecologic and biologic approach in the study of diseases of man and animals. Investigations undertaken by the Institute should be planned in light of the program of the Arctic Health Research Center.

In a somewhat analogous manner, much research is still needed on the etiology and ecology of disease plants in the Arctic and Subarctic. Such investigations must be correlated with those of the Alaska Agricultural Experiment Station.

Inventory of Biota of Alaska

The activities of the Institute should be such as to facilitate an inventory of the fauna and flora of Alaska. These activities should be integrated with the activities of the natural history museum of the University and with the investigations of visiting scientists with interests in systematics and biogeography.

Anthropology

Anthropology can provide important dimensions to several research areas discussed earlier herein and to others of a similar kind not listed. It can provide a time-depth dimension through archaeological research. By uncovering faunal (conchological and osteological) and floral (especially palynological) remains, earlier soil horizons, and the like, and by dating them accurately in terms of the rapidly

developing cultural and post-Pleistocene geological chronologies, archaeologists can work cooperatively with the biological sciences to reveal climatic changes, coastline fluctuations, modifications through time in local floral and faunal assemblages, and so on. Through the recovery and dating of human skeletal material and the determination of its cultural context, archaeologists can secure material which may be studied pathologically to contribute an important time-depth dimension to medical research. Anthropological studies can also provide an indigenous cultural dimension through archaeological and ethnographic-linguistic research. It is important to learn in detail the nature of Eskimo and Indian awareness of their coastal, riverine, and interior forest environments, and of their cultural adaptations to them. This would involve among others comparative ethnobotanical and ethnozoological studies, studies of culturally established microenvironments, ecological analyses in depth, and research on diurnal and annual activity rhythms. Attention must be devoted not only to historically recent adaptations but also to changes in adaptation through time, as revealed in the archaeological record. A further anthropological contribution is a human population dimension, identifying native groups culturally and physically, and providing important data on their size, migrations, intra-breeding and inter-breeding patterns, physical changes through time, and similar questions bearing upon processes of microevolution in the Arctic. These data also are of basic importance to the broad spectrum of human biological and medical research. A further dimension is a human psycho-cultural dimension in which would be investigated the biological, psychological, cultural (including dietary), and physical environmental factors which possibly underlie well-known abnormal psychological manifestations among Eskimo and Indian populations. Anthropological investigations of the Institute of Arctic Biology should be planned in light of investigation being conducted at present by the University of Alaska and other universities.

APPENDIX A

A SELECTED LIST OF CURRENT OR RECENT BIOLOGICAL INVESTIGATIONS IN THE ARCTIC AND SUBARCTIC OF ALASKA

This list has been compiled as an indicator of the pattern of current biological research activity in the Arctic and Subarctic of Alaska. It is emphasized that it is by no means a complete list of research projects and is not so intended.

Investigation of the phosphorus and nitrogen cycles of arctic and subarctic lakes. R. C. Dugdale, University of Pittsburg; University of Alaska.

Limnology of Peters and Schrader Lakes and life-cycle adaptation of arctic Cladocera. David G. Frey, University of Indiana.

Role of sorption on clays and ion exchange in modifying the marine environment in regions where fresh and salt water mix. K. M. Rae, J. E. Noakes, and L. I. Knowles, University of Alaska.

Dynamics of the nitrogen cycle in the Sargasso Sea compared to that in arctic waters. R. C. Dugdale and J. J. Goering, University of Alaska.

Effect of temperature stress on marine bacteria. H. L. Scotten, University of Alaska.

Functional morphology of marine mollusks. J. L. Gonor, University of Alaska.

Further studies of the desmids of Alaska. H. T. Croasdale, Dartmouth College.

An ecological study of the flora and fauna of the Cape Thompson-Ogotoruk Creek region, Alaska. Brina Kessel, William O. Pruitt, Albert W. Johnson, L. G. Swartz, University of Alaska.

A cytological study of the vascular flora of the Cape Thompson-Ogotoruk Creek region. Albert W. Johnson and John Packer, University of Alaska.

Parasites of sea-cliff birds. L. G. Swartz, University of Alaska.

Temperature regulation in the Gray Jay. James H. Veghte, University of Alaska and Arctic Aeromedical Laboratory.

Composition, structure and interrelationships of forest and muskeg in southeastern Alaska. Bonita J. Neiland, University of Alaska.

Investigation on grizzly bear in interior and Arctic Alaska. F. C. Dean, University of Alaska.

Ecology of white fox in western and northern Alaska. David L. Chesemore, University of Alaska.

Taxonomy and ecology of Alaskan mammals. Robert Rausch, Arctic Health Research Center, Anchorage.

Distribution of birds of the Cook Inlet area. L. J. Peyton, Arctic Health Research Center, Anchorage.

Productivity and nutrient cycles in soil-vegetation-animal system of arctic tundra. A. M. Schultz, University of California.

Comparative ecology of lemmings and other microtines in northern Alaska. Frank A. Pitelka, University of California.

Field studies of certain groups in the arctic flora. Eric Hultén, Riksmuseum, Stockholm.

Studies on grass and legume species adapted to the extreme climate of Alaska. Allan Mick, John Koranda, L. J. Klebesadel, Roscoe Taylor, H. J. Hodgson, Alaska Agricultural Experiment Station.

Determination of chromosome numbers of vascular plants from Arctic North America. Olov Hedberg and Brita Rufelt, University of Uppsala.

Arctic relatives of the so-called marine glacial relicts, Friday Harbor, Washington, and Barrow, Alaska. Charlotte M. Holmquist and Ulf Lettevall, Riksmuseum, Stockholm and Limnologiska Institutonen.

Fish populations of certain Alaskan river systems. James E. Morrow, University of Alaska.

An ichthyological survey of the Aleutian Islands. Norman J. Wilimovsky, University of British Columbia.

Arctic Basin Marine Biology--Arlis II. John L. Mohr, University of Southern California.

Arctic mosses. William C. Steere, New York Botanical Garden.

Experimental taxonomic studies of arctic ecotypes of Alaskan grasses and legumes and an analysis of their variability. John Koranda, H. J. Hodgson, L. J. Klebesadel, Alaska Agricultural Experiment Station, Palmer.

Skeletal analysis of arctic fish. Melvin I. Moss, Columbia University.

Biology of the right, gray, and white whales in arctic Alaskan waters. John L. Mohr, University of Southern California.

Echinococcus infections. Robert Rausch, Arctic Health Research Center, Anchorage.

Diphyllobothrium spp. and other fish-born helminths. Robert Rausch, Arctic Health Research Center, Anchorage.

Rabies, brucellosis, trichinosis, and helminthological surveys. Robert Rausch, Arctic Health Research Center, Anchorage.

Taxonomy, bionomics, and distribution of adult and immature Alaskan snipe flies. Rhagionidae: Symphoromyia. K. M. Sommerman, Arctic Health Research Center, Anchorage.

Photoperiod and conception rate in domestic mammals in Alaska. W. J. Sweetman, Alaska Agricultural Experiment Station, Palmer.

Studies of hematological enzyme systems in Alaskan native populations. E. M. Scott, Arctic Health Research Center, Anchorage.

Reactions to cold of men, women and children of various racial groups. Laurence Irving and Keith Miller, Arctic Health Research Center.

Studies of conduction and excitation in nerves in heterothermal tissues. Laurence Irving and Keith Miller, Arctic Health Research Center.

Physiologic effects of acute exposure to the arctic environment. Arctic Aeromedical Laboratory and contractors.

Physiologic effects of chronic exposure to an arctic environment. Arctic Aeromedical Laboratory and contractors.

Archeological investigation of the arctic slope of northern Alaska. John M. Campbell, George Washington University.

Archeological investigation of Howard Pass, Alaska. C. C. Chard, W. N. Irving, Thomas Hamilton, University of Wisconsin.

Archeological survey of Seward Peninsula. F. Hadleigh-West, University of Alaska.

Beach-ridge dating. J. L. Giddings, Brown University.

Archeology and ecology of northeastern Alaska. Ralph S. Solecki et al., Columbia University.

Cretaceous floras of Kuk River, Alaska. Charles J. Smiley, Macalaster College.

Pleistocene environment of the Bering-Chukchi land bridge. D. A. Livingstone and P. A. Colinvaux, Duke University.

Taxonomy, bionomics, and distribution of adult and immature Alaskan black flies. Simuliidae. K. M. Sommerman, Arctic Health Research Center, Anchorage.

Dietary studies of Alaskan native populations. E. M. Scott, Arctic Health Research Center, Anchorage.

APPENDIX B

A SELECTED LIST OF LABORATORIES IN ALASKA

WITH FACILITIES FOR BIOLOGICAL RESEARCH

This list includes laboratories which, because of their location and/or facilities, represent potential opportunities for collaboration, in investigations or in use of facilities, with the proposed Institute of Arctic Biology. Facilities and laboratories on the main campus of the University of Alaska at College are not included in this list.

Arctic Research Laboratory, Point Barrow, Alaska. Max C. Brewer, Director. The Arctic Research Laboratory is operated by the University of Alaska under contract with the Office of Naval Research. It now has an expanding system of outlying stations including facilities at Peters Lake, Camp Putu (mouth of Colville River), Meade River Village (Apkasuk), Umiat, Anaktuvuk Pass, and two ice islands (Arlis II, T III). In the period 1957-1962 ARL has expended about $750,000 in logistic support of biological research.

Alaska Agricultural Experiment Station, Palmer. Allan H. Mick, Director.

Alaska Agricultural Experiment Station, Petersburg Fur Farm, Petersburg. Allan H. Mick, Palmer, Director.

Douglas Marine Station, University of Alaska, Douglas. Present Officer in Charge, L. I. Knowles.

Arctic Aeromedical Laboratory, Fort Wainwright, Fairbanks. Horace F. Drury, Director of Research.

Arctic Health Research Center. U. S. Public Health Service, Anchorage. A. Colyar, Director.

Biological Laboratory, Auke Bay. Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service. George Y. Harry, Director. The Laboratory operates facilities also at Karluk Lake (Kodiak Island), Ugashik, Port Walter, Naknek, Brooks Lake and River, Wood River, Homer, and elsewhere.

Alaska Department of Fish and Game, Juneau. Walter Kirkness, Director; Howard Tait, Director, Division of Biological Research; James W. Brooks, Director, Division of Game; Alex H. McRea, Director, Division of Sport Fisheries; Stanley D. Swanson, Director, Division of Commercial Fisheries. The Division of Biological Research has facilities at Kitai Bay, Petersburg, and Juneau; the Department has other facilities at Kodiak, Petersburg, Juneau, and College.

Fisheries Products Research Laboratory, Ketchikan, Alaska Department of Fish and Game and U. S. Fish and Wildlife Service. Jeff Collins, Acting Director.

Northern Forest Experiment Station, U. S. Forest Service, Juneau. Richard Hurd, Director. The station also has facilities at Hollis and Fairbanks.

Cape Thompson Site, Project Chariot, U. S. Atomic Energy Commission, Kotzebue. Limited facilities of uncertain future.

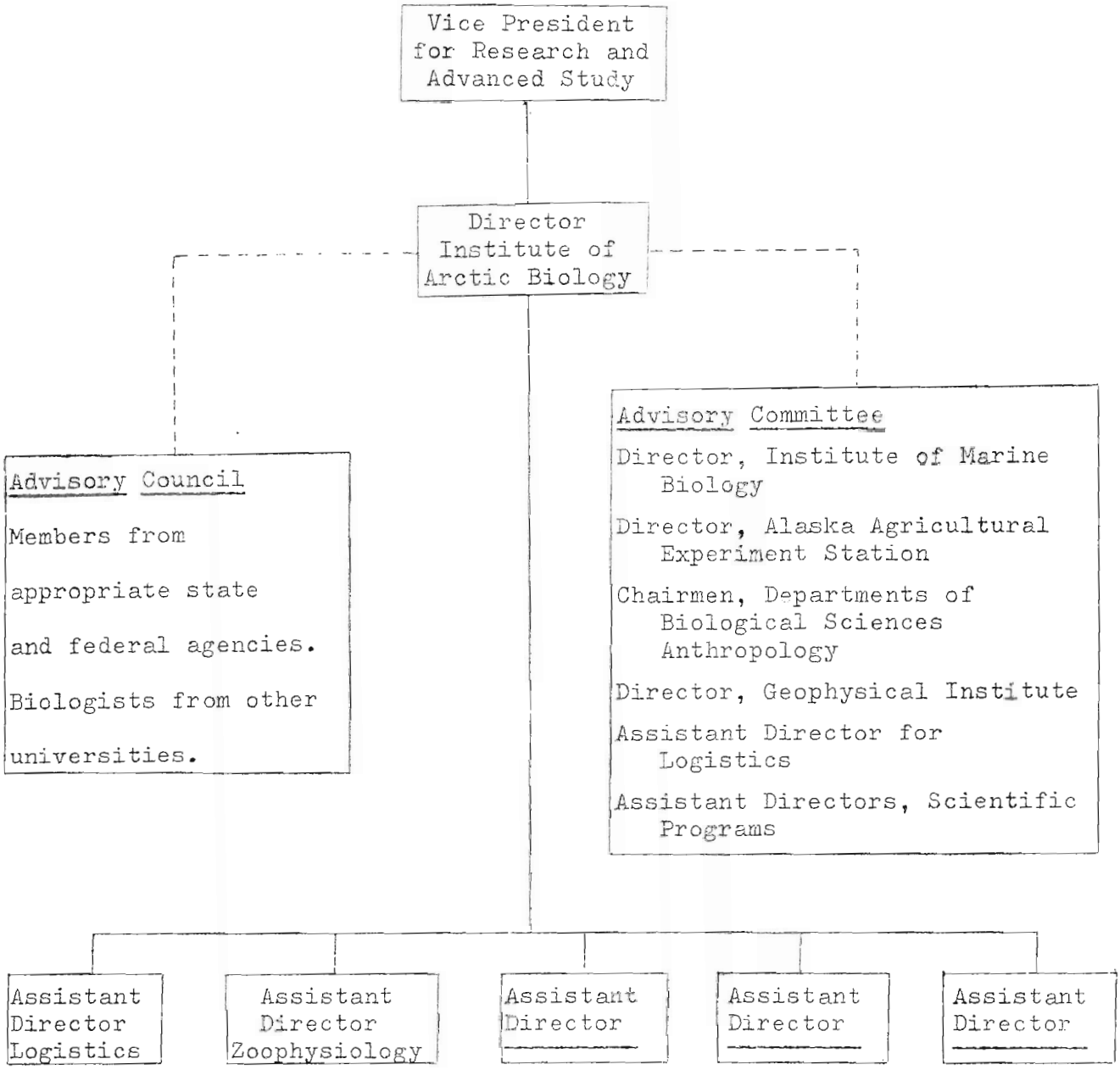
Various hospitals, federal and state refuges and National Park Services areas offer possibilities for limited facilities for short periods.

APPENDIX C

A SUGGESTED FUNCTIONAL CHART FOR

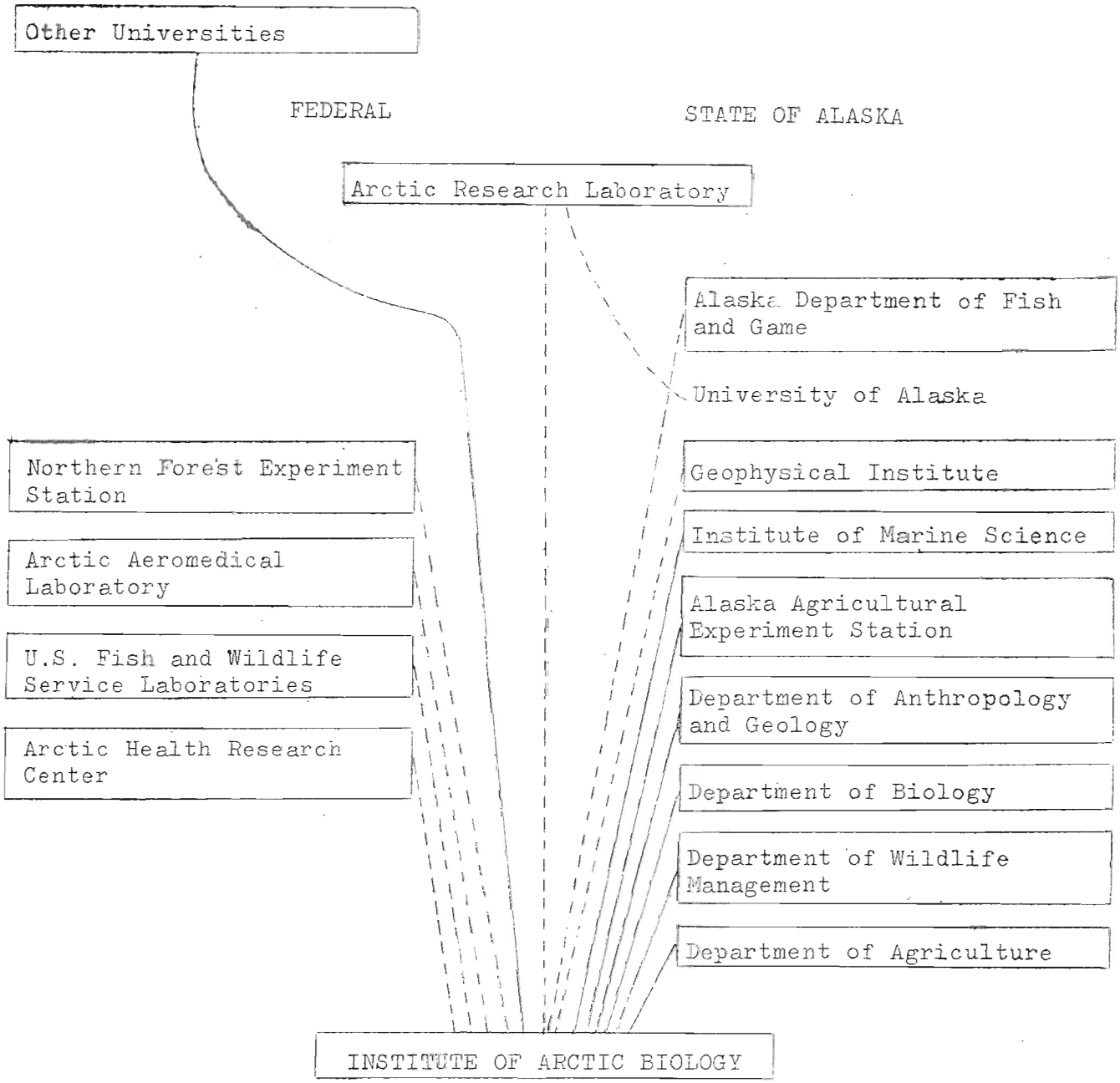
THE PROPOSED INSTITUTE OF ARCTIC BIOLOGY

AT THE UNIVERSITY OF ALASKA



APPENDIX D

POSSIBLE RELATIONSHIPS OF PROPOSED INSTITUTE OF ARCTIC BIOLOGY TO OTHER DEPARTMENTS OF THE UNIVERSITY AND TO OTHER BIOLOGICAL RESEARCH ORGANIZATIONS IN ALASKA



------- Possible collaboration in research or facilities

_____ Possible joint appointments and collaboration in research facilities and graduate programs