

NOTES ON THE INVENTORY AND MONITORING OF SPECIES
IN ACADIA NATIONAL PARK

ACADIA NATIONAL PARK
1987



National Park Service
1987
AKI Copy

UNIVERSITY OF MAINE

COLLEGE OF FOREST RESOURCES

Department of Wildlife
240 Nutting Hall
Orono, Maine 04469-0125
207/581-2862

December 3, 1987

Mr. Michael Soukup
National Park Service
Regional Office
15 State Street
Boston, MA 02109

ACADIA NATIONAL PARK
RESOURCE MANAGEMENT DIVISION

Dear Mike:

Sorry to be so long in getting back to you, but I've just been swamped. The enclosed materials come in all formats but, I hope, provide some guidelines.

Raymond O'Connor did the bird work and, as you can see, feels the job is too complicated to make firm recommendations without further information. He is one of the best in the country in bird survey methods and I suggest that if you wish to pursue this area that you plan to meet directly with him. He is a new staff member in our Wildlife Department.

I didn't go into detail on the deer-vegetation work as you have a proposal for that already in hand. For many aspects of inventory and monitoring, park personnel and students could be used depending on their availability, expertise and interest. For example, we would plan to do that for much of the snow tracking.

Finally, both you and Carroll mentioned some interest in studying furbearers on the island. I mentioned this to our new staff member, Dan Harrison, and he was very interested. He worked five years on interactions of coyotes, foxes and bobcat in eastern Maine prior to moving to Connecticut to head up their non-game and furbearer programs. Dan mentioned that MDI is the last place in eastern NA to study the impact of coyotes on the variety of predators indigenous to this area. Coyotes have just gotten onto MDI and a study initiated quickly could provide some fascinating information. Dan arrives January 1 and would love to discuss this with you.

Best of luck.

Sincerely,

Ray B. Owen, Jr.
Ray B. Owen, Jr., Chairman
Department of Wildlife

P.S. A reference being used by Glacier NP in their inventory work is:
Kessell, S.R. 1979. Glacier N.P. Guide. Gradient modeling: resource and fine management. Springer-Verlag, NY. 432pp.

1 October 1987

TO: Steve Kahl

FR: Chris Cronan

RE: Acadia Resource/Monitoring/Inventory

Thanks for the opportunity to pitch some ideas for the Acadia inventory and monitoring program. Here is a recap. . . .

- 1) Alan White (Assoc. Prof. of Forest Biology) and I would be interested to look at "disturbance and recovery of forest vegetation at Acadia: influence of species strategies, competition, and site physical-chemical properties in determining forest recovery".
- 2) I might like to look at patterns of nitrogen cycling and watershed nitrogen loss in forests exposed to acidic deposition on Acadia.
- 3) It would be interesting to look at patterns of alkalinity generation as a function of landscape characteristics at Acadia.

A PROPOSAL TO MONITOR AND MODEL THE RESPONSE OF NON-BEACH ENVIRONMENTS TO SEA LEVEL
RISE IN ACADIA NATIONAL PARK

KELLEY, Joseph T., Maine Geological Survey, and Dept. of Geological
Sciences, University of Maine, Orono, ME 04469; BELKNAP, Daniel
F., Dept. of Geological Sciences, University of Maine, Orono, ME
04469

Sea level is rising more rapidly in Maine than in most other locations (Anderson et al., 1984). The rate of sea level rise is uneven along the Maine coast, however, with eastern (Eastport) areas drowning at 3 times the rate of western (Kittery) regions (Belknap et al., in press). Although there is a tide gauge station in Bar Harbor, to date the record from central Maine has not been integrated into the regional picture of sea level rise.

The response of unconsolidated bluffs to sea level rise is to erode over the long term, but the short-term response is more complex (Kelley, Belknap and Smith, 1986). The problems associated with bluff erosion in Acadia National Park range from acute at Pretty Marsh to modest at Thompson Island, where an unsuccessful and illegal attempt has been made to rip-rap part of the shoreline. The response of salt marshes, which are frequently adjacent to eroding bluffs, is to accumulate sediment and keep pace with rising sea level. Where the supply of sediment is cut off, or is otherwise less than the rise of the sea, the marshes themselves erode. This is occurring at numerous locations where construction locally has cut off the supply of mud from eroding bluffs. To properly manage coastal environments during a period of rapid sea-level rise it is essential to accurately know the local rate of sea-level rise, the rate of bluff erosion, and the sediment accumulation rate of marshes. In this proposal we plan to collect that data at the Park, integrate it into a larger data base begun by Kelley and Belknap with Sea Grant Funds (Kelley, et al., 1986), and project shoreline change all along the "soft" coast of Acadia National Park.

Bluff erosion rates will be evaluated by the emplacing monuments near eroding bluffs throughout the Park. The rate of bluff retreat may be directly measured with these just as the long-term rate of retreat may be measured by digitizing air photos on the State's Geographic Information System. Sediment accumulation rates in marshes will be measured by emplacing layers of brick dust in marshes and monitoring the build up of mud over them. Each of the measured parameters will be correlated with the Bar Harbor tide gauge and a model which relates sea-level rise to shoreline retreat will be constructed by regression techniques. The long-term change in the Park shoreline may then be projected on the basis of future scenarios of sea-level rise (Barth and Titus, 1984).

Anderson, W.A., Kelley, J.T., Thompson, W.B., Borns, H., Sanger, D., Smith, D., Tyler, D.A., Anderson, R.S., Bridges, A., Crossen, K., Lapp, J., Anderson, B., and Lee, F., 1984. Crustal warping in coastal Maine: *Geology*, v. 12, p. 677-680.

Barth, M.C. and Titus, J.G., eds., 1984, Greenhouse effect and sea level rise: A challenge for this generation, Van Nostrand Reinhold, Co., New York, 325 pp.

Belknap, D.F., Andersen, B.G., Anderson, R.S., Anderson, W.A., Borns, H.W., Jr., Jacobson, G.L., Jr., Kelley, J.T., Shipp, R.C., Smith, D.C., Stuckenrath, R., Jr., Thompson, W.B., and Tyler, D.A., In Press, Late Quaternary sea level changes in Maine; in Nummedal, D., Pilkey, O.H., Jr. and Howard, D. (eds.) *Sea Level Change and Coastal Depositional Systems*, SEPM Special Publication.

Kelley, J.T., Belknap, D.F., Smith, Rebecca, 1986, Coastal retreat mechanisms involving bluffs of the Presumpscot Formation, In Andrews, D.W., Thompson, W.B., Sandford, T.C. and Novak, I.D., *Geologic and Geotechnical Characteristics of the Presumpscot Formation: Maine's Glaciomarine Clay*.

A PROPOSAL TO EVALUATE THE SEDIMENT DYNAMICS OF SAND BEACH, ACADIA NATIONAL PARK, MAINE

KELLEY, Joseph T., Maine Geological Survey, and Dept. of Geological Sciences, Univ. of Maine, Orono, ME 04469; Belknap, Daniel F., Dept. of Geological Sciences, Univ. of Maine, Orono, ME 04469.

Sand Beach is one of the most popular spots in Acadia National Park, Maine, and one of only 2 large carbonate beaches known from the northeastern U.S. (Leonard, 1981). Like all other beaches experiencing rapid sea-level rise in Maine, Sand Beach is probably slowly moving landward (Belknap et al., in press). The future of Sand Beach will depend on a continuous re-supply of shell material (or clastic sediment), or it will erode. Despite its uniqueness and importance to the National Park, no research on its sediment budget has ever been published, nor have any studies evaluated its ultimate origin or speculated on its future. This proposal briefly describes a project to evaluate the recent geological history of Sand Beach with emphasis on its carbonate budget.

The geological history of Sand Beach will be evaluated by obtaining radiocarbon dates from cores of the marsh landward of the beach (Belknap et al., in press). Historical changes in the beach will be monitored by digitizing time-series maps and photos of the beach on the State's Geographic Information System. The carbonate budget will be constructed by measuring the volume and composition of shell material in subaerial and submarine parts of the beach. Surveying and coring will occur on land, while side scan sonar, seismic reflection profiles and cores will be gathered offshore. Vertical changes in carbonate composition and abundance will be compared to the present composition of the beach, as well as to seasonal surveys, to monitor changes in sediment supply. We will also undertake Quantitative ROV and SCUBA collection of submarine fauna for comparison to carbonate sand constituents. In addition, temporal variability of carbonate on a nearby clastic beach will be compared to Sand Beach to determine the importance of contemporary offshore activity.

Products from this research will include: 1) an understanding of the time of formation of Sand Beach, 2) an evaluation of shoreline change in response to contemporary sea-level rise, 3) a model of beach dynamics which integrates offshore and terrestrial observations and incorporates measurements of changing sediment volume and shell composition over time. Data will be stored on the Maine Department of Conservation Geographic Information System which may be accessed in a variety of ways. Park Service personnel could easily be trained to assist in the collection of the time-series data. An understanding of the formation and continuing dynamics of the beach will provide a rational basis for managing this valuable resource as sea-level rises in the future (Barth and Titus, 1984).

Leonard, J., 1981, Origin of a high latitude carbonate beach: *Northeastern Geology* 3:178-183.

Barth, M.C. and Titus, J.G., eds., 1984, Greenhouse effect and sea level rise: A challenge for this generation, Van Nostrand Reinhold Co., New York, 325 pp.

Belknap, D.F., Andersen, B.G., Anderson, R.S., Anderson, W.A., Borns, H.W., Jr., Jacobson, G.L., Jr., Kelley, J.T., Shipp, R.C., Smith, D.C., Stuckenrath, R., Jr., Thompson, W.B., and Tyler, D.A., In Press, Late Quaternary sea level changes in Maine; in Nummedal, D., Pilkey, O.H., Jr. and Howard, D. (eds.) *Sea Level Change and Coastal Depositional Systems*, SEPM Special Publications.

Name: Ivan J. Fernandez
Title: Associate Professor of Soil Science and Cooperating
Associate Professor of Forest Resources
Affiliation: University of Maine, Department of Plant and Soil Sciences
and Department of Forest Biology

SUMMARY OF PROPOSED RESEARCH LONG-TERM MONITORING IN ACADIA NATIONAL PARK

A long-term research effort designed to evaluate ecosystem level processes in a stream watershed at Acadia National Park can be critical to our understanding of ecosystem response to natural and anthropogenic influences for years to come. Much of our inability to understand and predict ecosystem response in environmental and management issues is the result of a lack of long-term studies and data over time periods that truly encompass natural variability and mechanisms of change. Proposed here are three objectives, in priority order, based on my scientific interests and perceived data important to the understanding of ecosystem function. These proposed activities assume that (1) stream chemistry will be monitored, (2) precipitation will be monitored, and (3) plant communities will be mapped and characterized in the watershed by other investigators with more scientific interest in those efforts. With this as background, I propose the following:

- 1- Basic to understanding the influences of watershed characteristics on stream chemical and physical properties is an inventory of soil types and their distribution in the watershed. If a soil map of the study watershed is not already available, then the watershed should be mapped according to standard Soil Conservation Service procedures and nomenclature and a soil map of the watershed should be prepared as a 2nd Order survey or perhaps at an even higher intensity if feasible. This information, in combination with the plant community inventory, is a basic ingredient to any effort describing processes in the soil-plant-air continuum.
- 2- It should be possible from a research effort such as the one described in this proposal to develop a material budget for the system. Should an energy budget also be of interest, appropriate temperature measurements could be added to accomplish this goal. Budget development has been clearly identified, within scientific debates on issues such as atmospheric deposition and global climate change, as critical information to define ecosystem response. Therefore, throughfall should be monitored within the study watershed on both a periodic and episodic basis. Major chemical constituents would be measured as well as volumes. Collector numbers will be governed by vegetation patterns and throughfall variability. The influence of vegetation characteristics on total atmospheric inputs, particularly when fog events are frequent, is essential to this research effort. Standard funnel-type collectors, with associated rain gauges, will be employed.
- 3- The final area of work will include soil sampling and chemical characterization to determine the potential influences of soil properties on stream chemistry, with special attention in soil sampling to morphological characteristics of the soil materials in the field and to vertical gradients in soil profiles. Soil solution collections would significantly assist in this area of study, however, such an effort would require significantly more resources than required to carry out the other work proposed here.

With this information, in combination with other research carried out at the site, it should be possible to define and predict, over time, the movement of materials into and through the ecosystem. This information also provides the foundation for other research efforts which would hopefully evolve at the long-term monitoring site.

Summary of Submissions from Cooperators

McCrimmen

1. Bio-monitoring environmental pollutants of ANP using cellular physiological techniques with freshwater and marine fish.
2 years \$64,075

Patterson

1. Recommends monitoring ecosystem disturbances such as fire, air pollution on vegetation development.

What is the nature of vegetation/air pollution interactions in the context of "normal" vegetation change and development?

To what extent has fire, both in prehistoric and historic times, been a factor in "normal" development?

Craig Greene

1. Endangered, threatened and rare plant monitoring

Ray Owen - University of Maine/Orono

1. Distribution and relative abundance of medium to large mammals in Acadia NP
\$34,720 (2 yrs)
2. Distribution of wetlands, beaver, mink and otter on Acadia NP
\$9300 (1 yr)
3. Influence of fire and browsing on vegetation at Acadia NP
\$8400 (1 yr)
4. Survey and Monitor terrestrial insects
\$57,816 (2 yrs)
5. Inventory and monitoring of aquatic macroinvertebrates
\$28,667 (4 yrs)
6. Inventory and monitoring of the breeding birds
7. Periodic survey of endangered, threatented and rare species

APPENDIX II

SUMMARY BUDGET PROPSAL: I&M

FY88

PARK:

ITEM

	1
	1 FUNDS REQUESTED
	1
	1
1. Personnel	1
	1
2. Travel	1
	1
3. Equipment (List item and dollar amount for each item exceeding \$1,000).	1
	1
	1
	1
	1
	1
	1
	1
4. Contracts	1
	1
5. Interagenu transfers	1
	1
6. Other (List items.)	1
	1

INFLUENCE OF FIRE AND BROWSING ON VEGETATION AT
ACADIA NATIONAL PARK

This proposal has already been submitted with documentation. We propose that the vegetative studies be conducted every 10 years, that the exclosures be evaluated at a 5 year interval but checked yearly for any needed repair and that the winter tracking occur on a 5 year rotation in concert with the other winter track studies.

Personnel and Budget:

Please see original proposal for the initial study. Thereafter time commitments should approximate:

(a) Vegetation analysis of exclosures - 10 days	\$1,000
Travel	300
(b) Winter tracking - 90 days	5,000
Travel and lodging	1,200
Add approximately 12% overhead	

DISTRIBUTION AND RELATIVE ABUNDANCE OF MEDIUM TO LARGE MAMMALS IN ACADIA NATIONAL PARK

A. Objectives:

- (1) To determine the distribution of medium and large mammals in ANP.
- (2) To provide an index of population size of medium and large mammals in ANP.
- (3) To relate the distribution of medium and large mammals in ANP to major habitat types.

B. Previous Work:

Distribution of deer after the 1947 fire was studied by McLaughlin (1968) in 1965 to 1967 and by Gilbert and Harrison (1982) from 1980 to 1981. Dubuc (1987) related the distribution of otter to fire history and beaver created wetlands between 1985 and 1987. Little work has been done on canids (fox and coyotes), felids (bobcat), sciurids (red and gray squirrels), or other mustelids (mink, weasel, fisher or marten). Coyotes have just reached ANP and probably will have a significant impact on both bobcat and fox.

C. Methods:

- (1) The area of major habitats of ANP will be measured from aerial photographs and sampling stratified based on the area of each type. Adjustments in sampling intensity may be made to obtain reliable data on rarer species occurring in isolated habitats.
- (2) Approximately 870, 100 m permanently marked transects will be divided among the habitat types. Investigators will walk these transects 2-5 days after a snowstorm and record all tracks. These censuses will be conducted in conjunction with the white-tailed deer-snowshoe hare study.
- (3) Analyses will provide information on species relative abundance in each of the major habitats in ANP.
- (4) More specific information on the vegetation characteristics of the habitats in ANP will come from the 600 plots measured in the deer/hare vegetation study.

D. Duration, Personnel and Budget:

(1) Duration

(a) Inventory phase - 2 years

Personnel - 1 graduate student for 2 years

Stipend \$15,000

Tuition 2,000

Technician (3 months each winter) 8,000

Support

Supplies 1,000

Travel 3,000

Lodging 2,000

Direct Costs \$31,000

Add approximately 12% overhead

(b) Monitoring phase - <u>once every 5 years</u>	
Personnel - 2 technicians (3 months)	\$8,000
Support	
Travel	2,000
Lodging	1,000
Direct Costs	<u>\$11,000</u>

Literature Cited:

Gilbert, J.A., and J.R. Harrison. 1982. Influence of white-tailed deer on vegetation of Mt. Desert Island, Acadia National Park. Report to National Park Service.

McLaughlin, F.L. 1968. Ecological relationships of white-tailed deer and vegetation at Acadia National Park. M.S. Thesis, Univ. of Maine, Orono. 106pp.

Long Term Monitoring of the Surface Waters of Acadia National Park

J.S. Kahl and S.A. Norton

Maine Dept. of Environmental Protection and University of Maine

As part of an monitoring program for surface water quality which also includes a calibrated watershed at Upper Hadlock Pond, Acadia National Park, we propose a modest sampling program for Acadia lakes and streams. This effort should include potential effects from acidic deposition, as well as other man induced changes to which surface water quality may be susceptible, in view of increasing developmental pressures on Mount Desert Island.

The suggested program would be an integral part of the calibrated watershed study, for cost efficiency, and data consistency. Sample sites would include the major lakes on MDI, as well as The Bowl, Sargent Mountain Pond, and several of the larger streams. Sampling frequency would range from monthly or less for the streams, to yearly for the lakes. Sample sites would be located to include both 'pristine' sites, and those potentially impacted from human development. Sites such as Long Pond, or Cromwell and Marshall Brooks might be sampled at increased frequency if data suggested a need (for example, if phosphorus concentrations appeared to be elevated, seasonally). Data collected would include standard chemical parameters for total inorganic chemical characterization (see e.g. Kahl et al., 1985), plus at least DOC, DIC, and total P. Sampling and analysis for anthropogenic hydrocarbons could also be included where appropriate. All standard analyses would be performed at the Geochemistry Laboratories at the University of Maine, utilizing State-of-the-Art equipment and methods. Analysis of complex organic compounds would be performed at an outside laboratory.

This proposed program will complement monitoring studies to be implemented by the US EPA in late 1988 or early 1989, and by the State of Maine to start in 1988, state-wide. We hope that a program such as we are proposing, after modification based on discussion with NPS staff, will assure Acadia National Park, and Mount Desert Island, of being able to document deterioration or improvement in water quality as a result of anthropogenic perturbations.

*Hayward
O'Connor*

The Acadia Project's requirements in respect of birds necessitate separate consideration of the inventory and monitoring issues. An initial inventory is desirable to define baseline distributions over the area as a whole and needs to be based on methods yielding density estimates or absolute counts. The monitoring protocol for most species, however, can be based on index methods, with rare species requiring special treatment. Distributions within the breeding season and outside the breeding season also require separate methods.

Breeding Season

Inventory

Three procedures suggest themselves in respect of the initial breeding season inventory, namely spot-mapping, area-based point counts, and atlassing. Combination of these techniques in the interests of cost-effectiveness is possible.

Spot-mapping has been widely used to assess absolute densities of birds. Several visits, typically eight to twelve, are paid to a selected census plot and all evidence suggesting territorial behavior by the birds encountered is plotted on a large scale map of the plot. Subsequent collation of these data by species yields clusters of registrations that closely approximate the territorial locations of pairs of birds on the plot. The technique is very robust because of the spatial integration afforded by the mapping procedure, can be tied to particular habitats or locations, and can be effective in registering encounters with scarce and not instantly recognized species (because the observer is free to move closer to the contact to identify it). Nevertheless, the mapping method suffers significant drawbacks. First, it is time-consuming, requiring at least an hour of fieldwork per hectare surveyed, with higher figures in complex habitats. Second, even after this investment of time, not all species will have been well censused, with secretive species particularly problematical. Thirdly, assessing the relationship between clusters recorded and territories estimated requires considerable skill on the part of the analyst, skill generally acquired only after significant training, and analysts with this level of skill are not routinely available in the U.S. Finally, problems arise here with data gathered in ecotonal plots.

An alternative is to use one of the area-based point count methods, such as the variable circular plot method. With these methods the observer positions himself at pre-defined positions (often grid-based) within the census area and estimates distance and direction of all vocalizations occurring within a specified time span (typically 5-20 minutes). These procedures are substantially cheaper in manpower than mapping, allowing greater spatial coverage per unit of field time, and can be located precisely by habitat or location. The principal difficulties involved are the dependence on the observer's registration of avian vocalizations and on distance estimation during field work, requiring high field skills on the part of the observer. These can however be acquired with less training than needed for spot-mapping

analysis. As with mapping, secretive species and edge habitats are particularly problematical with this method.

Some data based on a less rigorous variant of the point count technique are already available for Acadia, in the form of information from Breeding Bird Survey routes that fall within the Park boundaries. In some cases these data might be converted to absolute densities by calibration of ongoing data collection against a rigorous density estimation method.

A third approach to consider is that of atlassing, whereby the entire area is surveyed on a fine grid basis. The smallest grid used in such work elsewhere has been the 1 km square, with tetrads (2km x 2km) more widely used. In Acadia the smaller unit would give maybe 130-150 points (allowing for partial squares). Within each square an observer would search for evidence of breeding by target species, irrespective of the amount of effort needed for any given species. The resulting map displays the distribution of each species over the Park, more reliably for common than for scarce species. Reasonable coverage would be attained with about 10 hours of fieldwork per square. Advantages of this technique are that observers of moderate skill can undertake the fieldwork, for target species missed can be made the subject of increased effort within the square, and that the results obtained provide a systematic assessment of distribution. Disadvantages are that mapping is only on a presence/absence basis and that the effects of local "hot spots" in habitat or topography, etc., are not resolved. Moreover, the influence of any habitat gradients present may not be well discriminated (depending on the relative scales of the atlas unit and the gradient slope). In principle the technique could be modified to encompass density estimation on a relative scale e.g. by incorporating point counts or line transect procedures within the surveys of individual squares - but at the cost of increasing the effort and rigor demanded of the observers. In practice, interpolation of data gathered by other methods would be more cost-effective.

A modified atlas technique that has recently been made good use of in Wisconsin and in Ontario is the analysis of checklists made by observers visiting restricted localities within the survey area. Although gathered on an ad hoc basis, such data build up to provide an overview with many of the qualities of the standardized atlas approach. The technique has the useful property that lists can be recorded by date and by individual sites within a square, so that the site identity and date information is not lost as in the regular atlas record. This technique can also be used to integrate data gathered e.g. by point counts - with those obtained by less rigorous methods.

Conclusion re inventory

The standardized mapping of the atlas approach produces an end result that is in many ways ideal for the overall inventory objective but has the problems of scale and of absence of density estimates already noted. However, the idea of obtaining absolute density estimates for the whole of the Park on a fine resolution grid is probably impractical. Nor does the idea of censusing in fine detail a relatively small number of census

plots e.g. by spot-mapping or variable circular plot methods and subsequently interpolating between these points - promise a solution, given the habitat diversity of the Park. I am driven to the conclusion that the most effective protocol for the inventory of bird populations in the park must be an amalgam of these approaches. Moreover, because bird distributions show a broad correlation with topography and vegetation, these features require consideration in specifying the inventory protocol.

The following might be a viable "top-down" approach to a minimum cost inventory of the breeding birds of the Park:

1. Define the level of spatial resolution needed for management purposes within the Park, without regard to avian mobility and the variation in territory size between species.
2. Prepare a grid map based on this resolution. Each grid point will then constitute a recording cell for management purposes. Overlay this grid on topographical and vegetation maps of the Park, so that each cell can be assigned a topographic and vegetation attribute.
3. Review all existing datasets for breeding birds within the Park and assign the numerical information (at whatever level) to each cell with which it coincides. Assign a further attribute to retain the nature of the data source. This procedure will allow the incorporation of absolute counts e.g. locations of Bald Eagle nests, counts of colonial shorebirds, etc. - be incorporated with less quantitative information e.g. Breeding Bird Survey results - and with more qualitative (presence/absence) data such as species lists for sites of special interest.
4. At this level simple maps of the known instances of each species within the Park can be mapped, with extension to relative abundance where e.g. BBS data - are sufficiently abundant.
5. These data can be extended by plotting both types (presence/absence and quantitative) against topographic categories and vegetation categories and against their co-occurrence. A proportion of species will show good predictability against these variables and this result can now be used to extrapolate the distributions of these species into grid cells for which no empirical data are available. This extrapolation will probably prove possible for numerically abundant species and for a smaller subset with specialized habitat requirements.
6. These revised maps can now be used to identify regions of the Park for which the existing bird information is inadequate and to identify those bird species which need to be targeted for intensive fieldwork.
7. Until this stage of the inventory is completed I find it impossible to assess how much fieldwork will be needed. On

completion of 1-6 above, key areas for total survey will be known. Such areas can be targeted for variable circular plot survey, with the sampling regime stratified to take account of the relative areas of distinct habitats to be surveyed (though some regard may be needed for the expected densities of birds within each type - there is little point in intensively surveying a habitat type that is a priori very poor in birds). In addition, a list of anticipated (or historically recorded) species with inadequate information available will have been identified. These species will almost certainly be either very scarce or be species for which specialist census techniques will be required e.g. nocturnal owls.

8. At this stage some review of the quality of information available from BBS routes will be needed. The possibility of using calibration procedures, with a professional census worker simultaneously surveying a sample of the stop-points on routes being run by BBS participants, could be a fruitful route to integrating absolute counts coming from the previously unsurveyed areas of the Park and extant relative abundance data.
9. After completion of items 7-8 above the new data should be recycled through the procedure in 4-6 above for review of any outstanding fieldwork needs.

Subsequent monitoring

A widespread assumption about monitoring bird populations is that annual fieldwork for all targeted species is essential. This is, in general, not true. Bird populations can vary in numbers between seasons by a factor of six or more (depending on species, habitat, weather, etc.) and determination of the resulting variations in numbers may contribute little to management information. Moreover, because many species are relatively abundant quite crude estimates of their numbers may suffice.

Rare breeding species require the greatest monitoring effort (per pair). With large conspicuous species e.g. eagles - annual survey of all traditional nest sites within the Park is probably the only viable option. With smaller and more elusive rarities, annual visitations to known sites will provide early warning of the need for more intensive survey should numbers decline, though on occasion breeding pairs may simply have moved from surveyed to unsurveyed sites. In addition, survey only of existing sites may overlook a population expansion elsewhere within the Park, but as such an event, if significant, would be likely to be noticed incidentally to other activities this is not a point of major concern. Species with limited habitat distribution within the Park form a third group that may also need annual survey but the fieldwork required is, by definition, limited in space. However, where the previous species categories require counting, this third category could be monitored with some form of density-assessing technique. Variable circular plots or spot-mapping would both be suitable here, given the restricted distributions postulated. Alternatively, a number of non-density index methods could be deployed, since what is required is detection of relative changes in numbers. Point count methods would most likely be

cost-effective for this purpose. The choice of year-on-year analysis method is critical here, given the sensitivity needed for an early alert. The Mountford Common Birds Census analysis offers the most highly sensitive technique currently available for this purpose.

Three monitoring strategies are available in respect of the more abundant species in the Park. The first is to maintain a rolling program of habitat-based censusing or survey, with a proportion of the habitats present surveyed in any given year. With a three or four year cycle, the species breeding in each major habitat group would be reviewed every three or four years, at a cost in fieldwork of only 25-33 per cent of a full annual review. Provided the data are subjected to thorough analysis and review each year, there is no reason why a reduced fieldwork schedule should not meet management needs. The fieldwork methods used could be either absolute or relative (index-based), with some case for the former given the reduced volume of fieldwork needed.

A second monitoring strategy would be to develop the use of BBS routes within the Park. The BBS data probably have a bias in their concentration along the Park roads but might nevertheless cover many major habitats adequately. The suitability of the technique for use by volunteer cooperators could keep overall costs down, allowing the available financial resources be concentrated on scarce habitats and species. Again, if the BBS methods are to be adopted in this way, improved methods of annual analysis will be needed. The current US Fish and Wildlife Service procedures are suited only to the detection of long-term linear trends in national populations, features not well-suited to Acadia's needs.

A third strategy, and one which again is open to cost reduction by the use of cooperators' efforts, is a development of the Wisconsin-Ontario fieldlist system already mentioned. By setting up a system for the inputting of data from observers' field sheets from anywhere within the Park, it would be possible to map distribution and numbers of commoner species by integrating "chance" data from different sites over several years. In practice some sites, by virtue of their popularity, will be covered annually by cooperators whilst others may not be surveyed for several years unless effort is directed there. This approach would again put responsibility on management for timely review of each year's data and for addressing effort (either volunteer or professional) to covering developing gaps the following year.

I find it difficult to take these ideas further forward without quantitative information about the Park and its habitats, the datasets currently available, and the resources likely to be deployed to the monitoring program.

Non-breeding Season Surveys

Inventory and monitoring work on birds in the Park outside the breeding season is needed only to the extent that the Park offers these birds resources significant to their successful onwards migrations or to their overwintering survival. Of these, the over-wintering position is easiest to review.

The Christmas Bird Counts scheme has (I understand) been well supported within Acadia and therefore offers a ready source of broad-brush information with which to plan the Park's longer-term data needs. As an initial approach I would suggest the available data be reviewed using SYMAP or other interpolating distribution program to map the mid-winter patterns of bird use of the Park. This technique would exploit the quantitative data of the Christmas Bird Counts and identify the areas of greatest ornithological significance within the Park. Based on UK experience, these are likely to be restricted to certain habitats, though individual species may well find optimal conditions elsewhere. The CBC counts do not offer high spatial resolution and it will be necessary to supplement them, at least in respect of restricted habitat, with directed field effort. Simple counts of birds seen whilst searching the habitat over known time periods probably provide adequate indexing of numbers involved. I have no experience of what winter conditions are like in Acadia to judge what might be involved in implementing such a program.

For an initial inventory of the Park's birds in winter the possibility of using bird lists gathered by volunteer observers whilst birding within the Park's boundaries could again be considered. This approach has been used in Ontario in establishing winter bird distributions there.

Any seasonal variation in numbers of birds present in winter e.g. of waterfowl on wetland areas - will need preliminary data to determine the counting protocol to be adopted. First, seasonal variation needs documentation lest a mid-winter count period be located at a seasonal low, so that numbers using the site are under-estimated. Secondly, if there is rapid seasonal change at certain times of year, small variations in the timing of this changes could greatly alter the outcome of a count scheduled about that time, even if there was no underlying change in bird numbers. Preliminary data for this purpose may already be available for some groups e.g. waterfowl or shorebird counts.

Inventory of migratory birds poses special problems, given the annual variability in timing and volumes of birds moving. Absolute counts of birds passing a given count provide a relative measure of numbers but may be heavily biased as measures of the total volumes of birds passing. Where the count is of birds visibly on passage it obviously provides a minimum estimate of the birds present. Where the counts are of birds on the ground but thought to be on migration, questions of population turnover arise: do two successive counts of, say, 1000 birds mean that 1000 birds used the site concerned for two days or do they mean that 2000 separate individuals used the site but each for one day only? The latter has quite different implications for the biological significance of the site from the former. The turnover question can be addressed with terrestrial birds by trapping and color-marking, with the persistence of color-marked birds an indicator of the transience of the birds recorded in a given count. Catching is probably impractical for seabirds and for raptors, though the latter are possibly also more likely to be counted whilst visibly on passage. If counts of raptors are made at resting sites, however, the turnover question again arises. The important point here is that the significance of any count regime adopted cannot be

assessed without some preliminary data as to the scale and frequency of turnover.

Conclusion re non-breeding season work

Conditions during migration and winter are too labile to permit prescription of counting protocols without review of preliminary data. An overview of midwinter distributions may be obtainable from a review of the Christmas Bird Count data taken in previous years but will need supplementation by more detailed survey based on timed counts. Before a monitoring program can be established preliminary information on seasonal variation in numbers and in population turnover rates at key sites will need investigation.



UNIVERSITY OF MASSACHUSETTS
AT AMHERST

Department of Forestry and Wildlife Management

Holdsworth Hall
Amherst, MA 01003

November 28, 1987

Dr. Michael Soukup
USDI - NPS, NARO
15 State Street
Boston, MA 02109-3572

Dear Mike:

I am responding to your October 7th letter regarding the Inventory and Monitoring Initiative for Acadia. Sorry to be so long in getting back to you. I am afraid it has been one step forward and two steps back for me all fall. I'm hoping to hang on until intersession! In the mean time, I'm afraid I am not going to be able to provide as much information/advice as you might reasonably expect from me. With this letter, I will try to do what I can with the limited time I have.

I'd first like to call your attention to a paper published a little over a year ago by the Institute of Ecosystem Studies. It has much sound and practical advice for those who would set up a long-term monitoring program. The paper is too long for me to conveniently copy, but I've included the title page and summary.

As for your specific request. I assume you are primarily interested in my thoughts on fire/vegetation interactions.

In general I think there are two primary concerns with respect to Acadia's terrestrial vegetation:

1. What is the nature of vegetation/air pollution interactions in the context of "normal" vegetation change and development?
2. To what extent has fire, both in prehistoric and historic times, been a factor in "normal" development?

I can't really deal with question #1. That's not my area of expertise. Question #2 has been of interest to me, and a subject of my research, for quite some time, however. I am inclined to think that question #1 (or at least the "in the context..." part) can't be addressed without first making progress on #2. I believe that we have established that fire during the historic period played an important role in influencing the nature of the current vegetation. I concede that the question of the importance (chiefly in terms of frequency) of fire during the prehistoric period is as yet unknown. We do not know if the dominant role that fire has played during the past 200+ years is an aberration of European settlement or a continuation of a fire regime that has been established for several millenia. Thus I would argue for placing a high priority on detailed analyses of one or (preferably) more "long" cores that can be used to document fire occurrence and effects for at least the past 5,000 years. This sort of work is costly and time consuming and would probably take three years and \$20,000 to \$30,000 (using grad students as the cheapest if not the quickest source of data!) I do believe there is a fundamental need for this sort of information, however.

Beyond the above-indicated "inventory" work, there is a need for long-term monitoring of vegetation succession, both in the presence and absence of fire. If only such a program had been proposed in 1948! But of course it is difficult to predict when and where future fires will occur (and setting fires - even prescribed ones - doesn't seem to be an option at Acadia). I can only suggest that long-term monitoring plots be established in stands representing a variety of age classes within the five or ten most important (either aerially or as unique habitats) vegetation types. Plots should be large enough (400 or so m²) so that they will continue through time to represent mature vegetation of the dominant tree species, with variables [including: size, growth rate, reproduction and mortality of individuals; species composition, biomass and necromass (i.e. fuel) for the community as a whole; etc.] monitored at periodic (~5-year) intervals. Some parameters or species groups (e.g. herbs, lichens, etc.) have to be inventoried more frequently - annually or even more than once during the growing season.

I am realistic enough to know that you will get a long list of parameters to sample, and that the ideal sampling protocol would require funds that would far exceed any that you might hope to have available. Thus, in closing, I would like to try to make a case for what to me is by far the most important consideration here. If you can not guarantee some way to institutionalize the continued monitoring of whatever parameters you select as most important, you will probably be wasting time and money setting up a program that will have an all-too-short life. This is why I suggested at the September meeting that highest priority be placed on seeing that Park administrators make a long-term (whatever that is!) commitment to dedicating someone like the resource management specialist to the task of maintaining the program. It would be a disaster to try to let it out to us university types! You would never be able to satisfy our insatiable appetite for money (!), and I'm afraid that our interest would wain as did the funding. At least in the area of vegetation dynamics, no program will be useful until it spans several decades, so the program must be made permanent within the Park as an institution if it is to be successful.

I don't know that I have answered the questions you posed, or even provided anything that you can use, but please don't hesitate to call me if you think I might be able to add something to the development of your proposal. I have long thought that this type of activity is of great importance, and I am excited to think that NPS may make an effort to develop a program based on a comprehensive inventory of park resources and long-term monitoring.

Sincerely,

Bill

William A. Patterson III
Associate Professor of Forestry

Encl.

SURVEY OF ENDANGERED, THREATENED AND RARE SPECIES AT
ACADIA NATIONAL PARK

I suggest that ANP initiate a periodic survey of all species that occur on the federal or state lists of species of special concern. Some of these plants and animals (e.g., eagles) are currently being monitored, but others should be checked. Perhaps the best way to accomplish this is to provide a small contract to someone to do a literature search on the past status of these species, survey current status, and provide suggestions for a monitoring regime.

Proposal for Biological Inventory and Monitoring at Acadia
Park: Terrestrial Insects

An inventory of terrestrial insects can build on the earlier surveys of Proctor of the 1930s and 40s. However, that work was, for the most part, general collecting and identification of insect species. There was little attempt to associate species with particular habitats and to identify their niche in communities; and there was no indication of relative abundance of species. These latter considerations should be emphasized in a new effort.

Some considerations are:

1. We should concentrate on insects (and perhaps other arthropods) associated with particular plant species or species groups.
2. The target plant species should be common and should be dominant or relatively stable in terms of ecological succession. Forest trees could be selected; however, their size makes them difficult to sample. The shrub-type plants of heaths and barrens would be a better choice. Where several plant species are abundant on a heath, several can be studied. Emphasis could shift to tree species and to insect assemblages not directly associated with plants at a later time if the program enlarges.
3. The plant species would be sampled using one or more of several standard techniques at regular, frequent intervals through the growing season. After two seasons of this effort, one will be able to describe the insect species

regularly associated with the plants, their baseline relative abundances, their trophic relationships with the plant and with each other, and their basic life cycles.

4. Once the initial inventory is done, it should be possible to identify time periods and sampling procedures where much less intensive sampling can be done into the future in a monitoring mode. If unusual shifts in community structure occur, there should be provision for special studies to determine the cause.

The approach identified above is general. It is impossible to select the specific plants and study locations without an initial reconnaissance on the ground. We have not had the opportunity to do that this fall.

John B. Dimond

Professor

Entomology Dept.

BUDGET

Inventory phase - two years

Personnel - two graduate students for two years

Stipend	\$28,000
Tuition	3,200
Two summer student labor	4,800

Support

Supplies	1,000
Motor pool	3,000
Lodging	4,000

(Note: The two costs immediately above are poor estimates. We have not yet determined the relative costs of commuting from Orono versus residing near the study area. It may be possible to arrange inexpensive living arrangements with organizations such as College of the Atlantic or similar groups.)

Monitoring phase - years 3 and 5

Personnel - two summer students, two years	5,800
Support - travel and lodging	2,000
Supplies	1,000

(Note: Monitoring interval after first five years should be decided at that time.)

Direct costs: -----	\$52,800
Indirect costs (46%) -----	\$24,288
Subtotal -----	\$77,088
Less University contribution (25%) _____	\$19,272
Total _____	\$57,816

THE MOUNT DESERT ISLAND *Biological Laboratory*

SALSBURY COVE, MAINE 04672

(207) 288-3605

November 30, 1987

Dr. Michael Soukup
Chief, Office of Scientific Studies
National Park Service
North Atlantic Region
15 State Street
Boston, MA 02109-3572

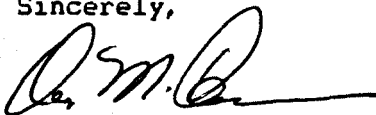
Dear Mike:

Enclosed is a proposal from the Mount Desert Island Biological Laboratory for the monitoring of environmental pollutants in Acadia National Park using the tissues of freshwater and marine fish. We believe the approach suggested is innovative, offering an important opportunity for the Park Service and the Laboratory to collaborate in the development of a significant new monitoring tool.

There are other inventory and monitoring projects that we would welcome an opportunity to propose in the future. For example, we are in a good position to either lead or participate in surveys or censuses of certain fish populations in the marine waters surrounding Acadia National Park. During the summer, our biologists are significant consumers of species such as dogfish sharks, winter flounder, and little skates. In the past, we have found that adequate information on the distribution and abundance of these and other vertebrate species in the waters of Frenchman Bay, Somes Sound, the MDI region of the Gulf of Maine, and Blue Hill Bay is difficult, if not often impossible, to obtain. For budgets of between \$15,000 and \$20,000 per year, we could make a substantial contribution to adding to the base of population information for such species.

For the present, however, we are limiting our formal proposals to the one enclosed, thinking that it represents a particularly appropriate focus in exploring cooperative agreements between the Laboratory and the Service. Thank you very much for the opportunity to bring our ideas to your attention.

Sincerely,



Donald A. McCrimmon
Associate Director

encl.

Bio-monitoring environmental pollutants of Acadia National Park using
cellular physiological techniques with freshwater and marine fish

Donald A. McCrimmon
Mount Desert Island Biological Laboratory
Salsbury Cove, Maine 04672

Exposure to toxicants frequently results in direct physiological responses as organisms attempt to biologically modify the chemicals affecting them (Stegeman and Kloepper-Sams, 1987). The study of xenobiotic metabolism has significant ecological implications. An understanding of the molecular events during the metabolism of pollutants may permit comparative determination of the susceptibility of individuals or populations to pollutants and may be useful in monitoring the concentrations of these compounds in the ambient environment (Kleinow et al., 1987).

Oxidative metabolism of xenobiotics is often a first biochemical event as chemicals are transformed to types less harmful. Currently, there is intense interest among toxicologists in describing the functional mechanisms of the dominant cellular catalyst for the oxidative transformation, the cytochrome P-450 system. This family of enzymes is of particular importance in the liver and kidney. Research now indicates that hepatic microsomal monooxygenase activity can be increased in fish by exposure to low levels of polychlorinated biphenyls (PCB's) or polynuclear aromatic hydrocarbons (PAH's) (Stegeman and Kloepper-Sams, 1987). These chemicals are the basis of a broad class of pollutants including pesticides and petroleum derivatives. Since induction of cytochrome P-450 activity is in response to environmental stimulation, a particularly sensitive measure of pollution might be increased amounts of messenger-RNA coding for ribosomal production of cytochrome P-450 enzymatic

proteins. Appropriate analytic techniques are currently being developed which might permit determination of graded responses to varying pollution levels.

Acadia National Park contains many important freshwater and marine biological communities. These have commonly been perceived to be pristine or, at least, significantly less polluted than ecosystem components found elsewhere in the northern and eastern United States. Nonetheless, today there is a growing realization that the environment of Acadia National Park is more subject to external contamination than was previously believed. Monitoring the levels of contaminants with an emphasis on early detection of changes is fundamental to the long-term management of the natural aquatic systems of Acadia and contiguous regions.

The Mount Desert Island Biological Laboratory is a world-renowned center for the study of comparative marine molecular physiology. For decades, prominent physiologists in the areas of membrane and transport physiology have worked at MDIBL during the summer. Recently, a Marine and Freshwater Biological Sciences Specialized Center of Research for the study of cellular effects of heavy metals and other toxicants was established under a grant from the National Institutes of Health, marking the entry of the Laboratory into the area of environmental toxicology. The Laboratory is in a unique position to develop and refine biomonitoring procedures for PCB and PAH contamination which may be of significance to the stewardship of Acadia National Park.

METHODS

Our initial request is for a seasonal (3-month) operation for two years in order to develop the techniques described and determine the feasibility of those procedures in the setting of Acadia National Park. At the end of that time, if results warrant, the project may be expanded to a year-round operation.

We propose sampling populations of three freshwater fish species (Brook

Trout, Lake Trout and Land-locked Salmon) which are found in four important freshwater habitats in Acadia National Park: Eagle Lake, Echo Lake, Jordan Pond and Long Pond. One suggested experimental protocol is to electrofish or capture by other suitable means 12 male fish of each species at each location, hold half in cages in waters at the study site, and take the remainder to the Laboratory where they will be housed in tanks and supplied with a continuous supply of charcoal-filtered fresh water to remove toxicants and xenobiotics. At the end of thirty days, half of these laboratory-housed fish will be killed and appropriate m-RNA or isozyme analyses conducted for comparison with half of the field-housed fish.

Tissue samples for liver and kidney will be prepared to determine cytochrome P-450 levels directly, as well as microsomal monooxygenase activity (e.g., 7-ethoxyresorufin-O-deethylase as per Melancon et al. 1987). At the same time, we will develop analytic techniques for the measurement of m-RNA based on Northern blots which should be helpful in assessing graded cellular responses leading to the induction of the cytochrome P-450 enzyme system by specific messenger-RNA's. Our hypothesis is that detection of the genetic message for the elaboration of the P-450 enzyme will prove to be a more sensitive as well as a more practicable index of early exposure to toxins disposed of by this system in the livers of fish than measurement of the P-450 enzyme itself. There are, however, additional immunological methods which have been employed recently for cytochrome P-450 isozyme determinations (Kleinow, personal communication). These can be utilized during the development of more time-related or sensitive analytic techniques and can be drawn upon while others are being developed. While these immunological techniques can be graded and quantitative, they may be more suitable for the detection of impacted environments rather than for concentrations of

pollutants.

The lab-housed freshwater fish not killed at the end of the first thirty-day period will be returned to the field to be held for an additional thirty days, at which time all field-held fish will be killed and assayed. Such a design allows for the determination of time-based and graded responses to pollutants as well as simple detection.

To study the marine environment, we propose sampling populations of Little Skate, Yellowtail Flounder and Winter Flounder in the waters of Somes Sound and Frenchman Bay in a manner comparable to that proposed for the freshwater species. Laboratory-housed marine fish will be kept in tanks continuously supplied with charcoal-filtered sea water and sacrificed according to the design outlined above.

BUDGETS

Two budgets are proposed, a budget for two years of initial operations and a separate budget for one-time equipment costs:

Two-year Operating Costs

Laboratory associate (Ph.D. or equiv.)	\$16,000
Consultant's fees	10,000
Marine specimen collection 24 days @ 240.00/day	5,760
Consumable supplies	3,000
Sub-total two-year operations	\$34,760

One-time Costs

Electroshock equipment for freshwater fish	\$ 2,000
Electrophoretic equipment	3,000

One-time Costs (continued)

Refrigerated tanks for laboratory-housed fish	10,000
Materials for field cages	1,500
Sub-total one-time costs	\$16,500
Total Budget	
Two-year and one-time totals	\$51,260
Indirect costs @ 25%	12,815
Total	\$64,075

PERSONNEL

To accomplish the work proposed, we will collaborate with a number of toxicologists and physiologists associated with the Laboratory. Dr. John J. Lech of the Medical College of Wisconsin and Dr. Kevin Kleinow of the School of Veterinary Medicine at Louisiana State University are leading experts in the area of inductive biotransformation who have agreed to collaborate. Dr. Kleinow spent the summer of 1987 at MDIBL as a research fellow sponsored by the Markey Charitable Trust. Additional collaboration will be provided by Dr. Franklin H. Epstein, Professor of Medicine at Harvard University; Dr. Leon Goldstein, Professor of Physiology at Brown University; and Dr. David H. Evans, Director of MDIBL's Center for Membrane Toxicity Studies and Professor of Zoology at the University of Florida. Administrative coordination will be provided by Dr. Donald A. McCrimmon, Associate Director of MDIBL.

LITERATURE CITED

Kleinow, K. M., M. J. Melancon and J. J. Lech. 1987. Biotransformation and induction: Implications for toxicity, bioaccumulation and monitoring of environmental xenobiotics in fish. Environmental Health Perspectives 71: 105-119.

Melancon, M. J., S. E. Yeo and J. J. Lech. 1987. Induction of hepatic microsomal monooxygenase activity in fish by exposure to river water. *Environmental Toxicology and Chemistry* 6: 127-135.

Stegeman, J. J. and P. J. Kloepper-Sams. 1987. Cytochrome P-450 isozymes and monooxygenase activity in aquatic animals. *Environmental Health Perspectives* 71: 87-95.

Title: Inventory and monitoring of aquatic macroinvertebrates in Acadia National Park.

Principal Investigator: K. Elizabeth Gibbs, Department of Entomology, University of Maine, Orono, Maine 04469. Tel. 207-581-2965.

Objectives:

1. To determine the species of aquatic macroinvertebrates present in Acadia National Park and to associate them with particular aquatic habitats.
2. To establish sampling sites and procedures which will provide baseline information on macroinvertebrate community structure within the Park and to form a base from which future changes in this community can be measured.

Previous Work:

Aquatic macroinvertebrates are generally defined as those invertebrates large enough to be seen without magnification and which spend a significant part of their lives in freshwater habitats. This group is made up mainly of the aquatic insects (mayflies, stoneflies, caddisflies, dragonflies, and aquatic beetles, bugs and flies) but also includes amphipods, isopods, snails and clams. Their ability to reflect current and past history of water quality of lakes, ponds and streams is well known. When associated with appropriate physical and chemical parameters, measures of benthic community structure provide a means of estimating the type and degree of stress on aquatic environments. Since these organisms are fundamental to the functioning of aquatic ecosystems and their status is a good indication of the quality of life the system can support.

Current knowledge of the species composition of the fauna of Acadia National Park comes from the publications of biologists who have collected in this area for almost a century. However, the only comprehensive survey is

that of Proctor (1938). This survey was conducted over a number of years and the leading specialists of the time were involved in either making the collections or the identifications. Records of the location and dates of collections are included. Most collections were of terrestrially occurring adult forms. The dragonflies appear to have been the most intensively collected group. Borror (1944) provides an annotated list of the Odonata of Maine in which he cited published records of collections from Mt. Desert Island made since the late 1800's. A further search of the literature may reveal that other groups have been collected in Acadia. Some of the specimens collected during the Proctor (1938) survey are in the collection of the University of Massachusetts and further search may reveal others in other collections. Currently a comprehensive survey of the mayflies of Acadia National Park is underway which includes both collections of aquatic nymphs and terrestrial adults. This survey is funded by the National Park System and is being carried out by Ronald Mack. It is only this mayfly study which stresses the occurrence of organisms in the aquatic habitat. Incidental to the mayfly collecting, other forms are currently being collected but this is not a comprehensive effort. Specimens from this collection will be housed in a special section of the Department of Entomology, University of Maine collection.

Conversation with personnel of the Maine Inland Fisheries and Wildlife Division indicate that an extensive fish stocking program has been in place for a number of years in Acadia and that eight to ten years ago the isopod Asellus racovitzae was transferred from Echo Lake to a number of other lakes in an effort to increase its availability as fish food. Also, limited information on the occurrence of benthic organisms in Echo lake is available from studies on the gut content of fishes (Gatley 1978).

The only quantitative data available on community structure of lakes

that I am aware of come from samples taken by the Maine Department of Environmental Protection. These samples were taken from the deeper areas of Bubble Pond (at one location in 1984), Eagle Lake (two locations in 1972, 1973 and 1974) and Jordan Pond (one location in 1987). These data are available with associated water quality data and could be used as the basis for long term monitoring in these lakes. Quantitative data on community structure of streams comes from the study of the impact of a landfill on the Marshall Brook ecosystem funded and conducted in cooperation with the National Park Service. These data are available and voucher specimens from the collection are in the Department of Entomology, University of Maine collection.

Two recent publications have addressed long term monitoring of benthic macroinvertebrate communities and the ability of these communities to reflect changes in water quality. Townsend et al. (1987) studied the persistence of stream communities in southern England over an eight year period in relation to environmental variables and Nalepa (1987) looked at changes in the fauna of southern Lake Michigan where many sites had been sampled for twenty years and some as long as fifty years.

Methods:

A continuing effort in this project will be the collection and identification of both the aquatic and terrestrial forms of aquatic macroinvertebrates. In addition, the literature will be surveyed for records from Mt. Desert. Annotated species lists will be prepared for the Plecoptera, Trichoptera, Odonata, aquatic Coleoptera, aquatic Diptera, aquatic Hemiptera and aquatic Lepidoptera as well as the Amphipoda, Isopoda and Mollusca. A special area of the Department of Entomology Collection will be allocated as a reference collection for this fauna.

A series of permanent sampling sites in lakes, ponds and streams will

be identified. Our objective would be to include bodies of water which are subject to human influence and those which are not. Also, sites in lakes and streams previously sampled would be included because of the historic significance of these records and their associated water quality data. Which bodies of water are finally selected will depend on time available and the perceived needs of the National Park Service.

Preliminary list: Duck Brook (lower reaches)

Breakneck Stream (lower reaches)

Stanley Brook

Hadlock Brook

Marshall Brook

Bubble Pond

Eagle Lake

Echo Lake

Sargent Pond

Sampling Methods:

The choice of sampling methods has been made on the basis that they lend themselves to being objectively replicated ; that the resulting samples are appropriate for statistical manipulation; that they have the ability to demonstrate either persistence or change in the community over time.

Five Ekman grab samples will be taken in the deeper areas of lakes. Standardized sweep net samples will be taken in areas of emergent vegetation at the periphery of lakes or ponds. Streams will be sampled with artificial substrate "rock bags" consisting of 2 kg rocks having a maximum diameter of 5-6 cm. Appropriate measures of physical and chemical parameters of habitat characteristics and water quality will be measured associated with the invertebrate sampling and will include measurements of stream discharge, pH,

conductivity. For one day of each month emergence traps will be placed at each site to collect emerging adult insects to aid in species identification.

Results will be analysed both on the basis of community persistence and abundance. Townsend et al. (1987) addresses measurements of community persistence in samples of this type and Elliott(1977) and others address abundance measurements.

An appropriate computerized system will be selected for data storage and retrieval.

Schedule:

I propose that the first four years of the project be devoted to identifying the permanent monitoring sites, assessing the proposed sampling methods and establishing baseline information on the identity of the organisms at the sites. Concurrently faunal collections will continue throughout the park and the permanent collection of park fauna at the University will be added to. I suggest that monitoring on the streams and lakes be carried out once every five years. Stream sampling will take place in April or May and lake sampling in mid summer.

Literature Cited:

- Borrer, J. 1944. An annotated list of the Odonata of Maine. Canad. Entomol. LXXVI:134-150.
- Elliott, J. M. 1977. Some methods for the statistical analysis of samples of benthic invertebrates. Freshwater Biological Association Scientific Publication 25, Titus Wilson and Son Ltd. Kendal, England.
- Gatley, G. F. 1978. Competition for food between landlocked smelt (Osmerus mordax) and landlocked alwives (Alosa pseudoharengus) in Echo Lake, Maine. M.S. thesis, Department of Zoology, University of Maine.
- Nalepa, T. F. Long-term changes in the macrobenthos of southern Lake Michigan. Can. J. Fish. Aquat. Sci. 44:515-524.
- Proctor, W. 1938. Biological survey of the Mount Desert region. Part VI. The insect fauna. Wistar Inst. Anat. & Biol.:1-495.
- Townsend, C. R., A. G. Hildrew and K. Schofield. 1987. Persistence of stream invertebrate communities in relation to environmental variability. J. Animal. Ecol. 56:597-613.

Budget: Annual budget for the first four years of the project: (Completing the faunal survey and establishing the permanent monitoring sites and procedures).

Salaries and wages:

Two graduate assistantships @ 9,000.....\$18,000

Hourly wages (assist with procuring and sorting samples)
480 hours @ \$6.00 per hour.....2,880

Equipment:

Storage facilities for collection.....500

Other.....500

Materials:

Vials, alcohol and misc. supplies.....500

Travel and maintenance:

Travel to Acadia National Park @ 150 miles per trip.....1,800
(two trips per week for 20 weeks - 6,000 miles @ \$0.30)

\$100 per week for 20 weeks.....2,000

Direct costs: 26,180

Indirect costs: (.46%).....12,042

Subtotal: \$38,222

Less University contribution (25%)..... - 9,555

Total:\$28,667



UNIVERSITY OF MAINE

Department of Geological Sciences

110 Boardman Hall
Orono, Maine 04469
207 581 2152

January 4, 1987

Dr. Michael Soukup
National Park Service
North Atlantic Region
15 State Street
Boston, MA 02109

Dear Mike:

Mary Foley has conveyed to me that the watershed program that I proposed for Acadia may be funded beginning in FY88. There are two items pertaining to the project administration that are of early importance, should monies be approved.

The first involves the funding mechanism. I believe the last proposal I sent to you correctly listed the Maine Department of Environmental Protection as lead Maine agency. However, I expect to leave DEP and return to the University in the near future. I do not believe that anyone else there has either the expertise or the interest in continuing such a project. Thus, I suggest that any funding arrangements be made with the University of Maine.

Secondly, the sooner details are known, the sooner I can begin activities in order to be in the field in the spring. I'd like to sample spring snowmelt if possible, and have the site completely instrumented by mid-summer. Buying equipment, hiring a technician, and meeting with Park and COA staff will take time. Of course, I realize the problems involved with dealing with Federal budgets.

As always, if I can be of assistance with this, or with the I&M initiative, do not hesitate to contact me.

Regards,

Jeffrey S. Kahl

Co-operating Research Scientist

cc: Mary Foley