

Research Opportunities Catalog

March 9 Scoping Workshop

Freshwater Resources

Introductory Remarks - Jim McKenna

Jim introduced the workshop by introducing the dual mission of SERC. One mission is to support and improve science-based research in the park system. The second mission is to accelerate transfer of scientific information, including transfer to the non-scientific public. Jim also described the opportunities that SERC provides to researchers in the area. Working in concert with Acadia Partners for Science and Learning, SERC provides logistics support for research, lodging, and cooperation in park related research topics. Another example of support for research is the LL Bean Research Fellowship program, which provides support for researchers working in the park. The fellowships are \$5,000 a year--the program will run for five years.

There are two objectives for today's session. One is to identify research needs for the park. The other is to identify ways that the park can support researchers. The product emerging from these sessions and from other work will be a research opportunities catalog -- both in printed form and as a living document on the web--that will identify research opportunities in Acadia National Park.

David Manski -- Research Opportunities Catalog Scoping Workshop -- Introduction

Why are we interested in science at Acadia and how does it relate to our mission?

David began with a quotation from the Park's Organic act, focusing on conservation and on keeping park resources unimpaired. To do this, the park needs to know what is here that is to be protected and needs to understand what causes impairment. This also works the other way, in that the park provides support for science and scientific education.

The park owns 35,000 acres and holds another 12,000 acres in conservation easements. These lands represent a variety of ecosystems--most of them island ecosystems--that see a variety of human uses.

David notes that, as he lists issues and concerns, the researchers will notice a focus on tactical issues. This is not to shortchange the importance of strategic, longer-term research. But it recognizes that the NPS has issues staring it in the face that require knowledge to support decisions in the short term.

Key Issues:

- Lack of Baseline Data. We actually do not really know what species are here. This is a priority for the NPS. Vascular plants and vertebrates are covered--but there is much less knowledge about the populations of other life forms, let alone how these populations are changing.
 - Need to inventories of species
 - Need to develop protocols for monitoring
- Visitor experience and Impacts
 - Acadia has the highest number of visits per acre of all parks in the system.
 - What constitutes a positive visitor experience?
 - What are the impacts of visitor use?
 - How can we help the public use the park in an appropriate way?
- Ecological Restoration
 - How do we propagate some of these native materials?
 - How does one do restoration in harsh environments
- Changing Land use Adjacent to the Park
 - Increasing development pressure
 - What is the impact of ecosystem fragmentation? What does the mean for plant and animal systems?
 - What is impact of increased number of septic systems and wells?
 - What are the trends and changes in the estuary systems?
 - What is impact on groundwater and groundwater dependent resources

- Invasive Exotic Species
 - About 1/4 of the vascular plants in the park are non-native. Which of these must be managed? How do we manage?
 - Similarly, which exotic animals represent threats? If they are a threat, how do we manage them?
- Air Pollution
 - We know that we have high levels of acidification and high levels of mercury
 - Where we need help is on understanding the impacts?
 - We need to know more about what else is coming from these emission sources that could matter
- Rare Species Conservation
 - We have about 1000 vascular species -- it appears that there are 240 species that are no longer here. We do not know why.
- Management of Native Animals
 - Management of raccoons in campgrounds, for example. Can we change behavior?
 - Beavers -- cause flooding and damage
 - Deer -- communities on the Island are interested in establishing a hunt. This in spite of evidence that shows that population could be declining. We need to be as informed as possible.
 - Young eels bring \$500 a pound. The harvest is intense and heavy. What is the impact of this? What are the options?
 - What is the effect of worming in intertidal areas? Is there an effect on shorebirds? How is the harvest managed?
 - Fisheries management. We know very little about what is going on here. We do not know how populations are changing and about relationships between fishing and the broader ecosystem..
- Data and Information Management
 - How do we ensure that data is accessible and useful over the long term?

Introductions:

Jim McKenna -- Ph.D. in oceanography. New to the park service. Directs SERC at Acadia. Research was on carbon and nitrogen cycling in estuarine systems.

Kathy Tonnessen -- workshop moderator and Research Coordinator for the National Park Service. Kathy is compiling the research catalog that will emerge from these workshops. She has a long history of association with NPS research at regional levels, and has also spent time working at Acadia.

Alan Ellsworth -- regional hydrologist for NPS -- based in Troy, NY. Has been involved in looking at long term water quality data in this park.

Bill Zoellick -- Development Director at Acadia Partners for Science and Learning, the organization that manages the facilities at SERC and which also provides support for scientific research at the Park.

Peter Vaux -- University of Maine. Focuses on broad patterns of freshwater biodiversity. This also involves conservation planning in cooperation with the Nature Conservancy. Has developed a database to help rank quality of water resources.

Bruce Connery -- wildlife resource manager for the Park.

Deb Wade -- Chief Interpreter -- in charge of interpretive activities at Acadia National Park.

Aria Amirbahman --University of Maine -- civil and environmental engineering-- aquatic chemistry and contaminant transport. Has worked on the mercury studies in the park, as well as on phosphorus dynamics. Looks at questions of how mercury is retained and released. Interested in using techniques developed in other settings to study mercury and phosphorous dynamics in estuaries.

Bill Gawley -- focuses on air and water issues in the Park. Sees increased focus on stream monitoring and groundwater studies. Feels that we are at a point where there is enough data to begin making assessments.

Martha Nielsen - hydrologist and USGS focusing on groundwater and wetlands hydrology. Has looked at stream nitrogen budgets (Northeast Creek), questions of housing density and groundwater quality, marsh systems in Bass Harbor, wetland classification, development of wetland monitoring protocols

Steve Kahl -- Director of Center for the Environment at Plymouth State University. Began work at Acadia in 1982 --

baseline water chemistry. Moved on to acid rain monitoring and research. Developed a pilot calibrated watershed project in 1990. Has developed a record of deposition over time. Has directed much of the watershed research around the park, much of this through research by graduate students.

Charley Roman -- NPS -- Coastal Ecologist working at the regional level.

Adria Elskus -- USGS and University of Maine -- aquatic toxicologist --really a fish toxicologist. Studies fish response to pollutants -- looking at effects and tolerance. Development of genetic resistance. Goal is to look at biochemical indicators and tie that to performance parameters -- how well does the animal do? This should enable predictions and modeling about chemical effects. Would also like to develop a bio-assessment mechanism for larger systems, such as Acadia National Park

Leon Tsomides -- Maine Dept of Environmental Protection -- biological monitoring unit. Focus is now shifting to wetlands. Since mid 90s the department has increased focus on non-point source problems. Has, over 10 years, built up substantial collection of data for areas around the park.

Andy Reeve -- hydrogeologist at U Maine -- wetlands hydrology and fractured field hydrology. Recently looking at Sieur de Mont springs, which is going eutrophic, showing evidence of algal blooms. Possible sources and causes are septic systems and soils.

Questions:

- Adria asked about the timeframe and focus of the product from these workshops. Jim estimated that there would be a finished catalog by the end of next summer. In the short term, he would like to share the notes from the workshops. David said that one end goal is a document that the Park can use to direct research strategically and to solicit new research. It will also be a way to enable scientists to tap into the bibliography to establish the need and importance of research when preparing proposals.
- Steve Kahl asked about funds for research. David summarized the NPS funding process. Bill Zoellick explained about Acadia Partners' focus on developing private sources of support, which starts more with the science and the researcher and moves out to engage the individual donor. Finally Jim McKenna spoke to the support that SERC can provide. David also spoke briefly to the vital signs monitoring program, some of which is kicking off at Acadia this summer. This effort should create a dataset that can support additional research
- Martha asked about the form of the catalog and the other workshop topics. Jim answered that the catalog will be both print and web based. He also identified the other workshop topics.

The Park's Current Research Needs

What Information Does Acadia Need -- What Stressors Have We Missed?

Martha: The NPS has inadequate geologic mapping. It needs detailed GIS information that is appropriate for use as a research tool, at a site specific level. Steve Kahl added to this by providing specific examples. What is needed is a combination of geologic data and aggregation of existing data. Maine Geological Survey does provide this kind of information, but has not focused on the MDI area. Providing support to help MGS do this work could be a starting point.

Alan Ellsworth -- Is this research effort just MDI-centric? Do we need to focus on areas beyond MDI? Would it make sense to look at areas like Isle au Haut as a way to look at differences between heavily used and lightly used areas?

Adria: Are there GIS data that can help provide a big picture overview of toxic issues and distribution? For example, a map of sediment loadings? In particular, are there tools or data that could help in the selection of control sites?

Peter Vaux: the Park needs information about temporal variance. A first step would be to pull together what we know about temporal variances. We need a sense of the natural variability in various communities, as a way to set benchmark data.

Alan Ellsworth: related to Peter's remark, we need a sense of the needs of key species. With regard to fish, for example, we would need to know about the needs of, say brook trout, to understand predation and so on.

Peter: most of the data that we have is presence/absence -- checkmark data. So, what would be helpful would be abundance data and trophic data.

Adria: the trophic data should be hypothesis based.

Leon: It would be useful to monitor an entire watershed, from the wetland on down. Bill Gawley noted that in some cases we already have good stream data, so we could focus on building up from that.

Martha: What about climate change? Everyone agreed that this is a large instance of Peter's point about needing to understand normal variability.

Steve Kahl: it would be useful to focus on indicator data -- and indicator species.

Andy Reeve: how do fluctuations in water levels, water resources, availability, and use of these resources affect ecosystems?

Kathy asked Aria where we need to go with the mercury research. Aria answered that there is a disconnect between the chemistry and the biology. We understand the mercury cycle, but have less understanding of how this affected by the biota. So, it would be useful to set up some studies that focus on mechanisms at the system level. The total amount of mercury in a system is nearly irrelevant. The question is what will be released. So, the interesting questions are related to what could cause release --- what conditions will trigger release. Steve Kahl noted that this is fundamental to management.

Steve Kahl: Acid rain and nitrogen still need to be on the list. Also pathogens in the ecosystem -- focused on beaches, for example.

Steve: Better information exchange is a critical requirement. In particular, we need to have web-based data portals such as PEARL that serve data and methods and results in a geospatial format. This is much more than information exchange among scientists—it is public data access for anyone and everyone—teachers to managers to policy makers to students.

Leon: it is important to understand to understand what the mosquito population is.

Peter: monitor development and its impacts.

Martha: we don't know a lot about wetland water budgets. The park should be an ideal place to do research on this. MDI provides an array of different wetlands with different levels of disturbance.

Adria: what about vehicle impacts? vehicle emissions, tire materials, and soon. David answered that there is already some work underway. Road salt is a potential stressor. There have been state level policy changes in terms of salt application and use -- what are the effects of this?

Steve Kahl: one reality check is that there is already a high sodium chloride loading in the area, due to its proximity to the ocean. On the other hand, the sand from winter road treatment does increase phosphorus loading.

Alan (from an email communication after the workshop) -- The vehicle impact study mentioned by David Manski was: The Impact of Vehicle Traffic on Water Quality in Acadia National Park by Peckenham, Kahl, and Amirbahman. While Kahl indicated high salts associated with oceanic inputs, discussion with Gawley suggested salts in freshwater quickly drops off according to available stream data. It seems that describing where this separation occurs and promoting salt analyses in areas that can be separated by road and ocean inputs would be valuable.

Alan (email communication) -- As with salts, general promotion of using available historic water data should be encouraged.

Martha: it would be useful to expand the number of water quality parameters that we could look at.

Peter: direct physical impacts of visitors on aquatic systems -- stream banks, for example.

Alan (email communication) -- Recovery of this area from decreasing sulfur loads associated with Clean Air Act improvements is a topic of interest for study.

Adria: common data formats and data accessibility. Get the data out and make it available to the researchers who

need it.

Steve Kahl: it is important to include social science data in the research list.

Alan (email communication) -- Endocrine disruption in fish species due to wastewater treatment plant inputs is a current issue in the science field. USGS - NY Pat Phillips has been working on this issue and it has piqued interest in Biscayne Bay outside of Miami, FL.

Alan (email communication) -- Causal relationships associated with herp populations.

Alan (email communication) -- Shippensburg University is working on a growth model for both Upper Delaware "Park" and the urban DC area. Might be worth pursuing this model for use in ACAD.

Emerging Issues

What does Acadia need to prepare for? What should we be learning now, thinking ahead to changes later?

Adria: Multiple stressors. This is the circumstance where there is no one overwhelming threat. For example, tree frogs with low levels of cadmium exposure, when exposed to predators, turned out to have increased sensitivity to cadmium. She tied to this is an emphasis on looking at behavioral endpoints.

Steve Kahl: changing interactions among stressors. Part of this is the importance of monitoring data. Without monitoring data, you have got no basis for research.

Adria: Yes, but the monitoring must be hypothesis based, not just monitoring for the sake of filling data gaps, hoping that something will emerge.

Andy: Saltwater intrusions

Karen asked the group to think about effects of climate change.

Martha: one example of an effect would be changes in transpiration.

There was a discussion as to whether water availability would be an issue. Martha felt that this would not be a big problem in this area. Water quality is always an issue, but this is tied to human use, not to climate change.

Steve: Eutrophication should be on the list of things to watch as an emerging issue. He noted that this is also tied to climate change, since when lakes are ice free for longer periods, eutrophication increases.

Aria substantiated this on the basis of his research, looking at phosphorus release.

Karen -- what about snow vs. rain? Is there reason to believe that this makes a difference? The collective sense was that this is probably not a big issue for Acadia, since it typically gets a lot of both rain and snow.

Charley: Is there research that could be done at Acadia--on inland lakes--that would be unique because it is coastal? Steve noted that, in this sense, Acadia could serve as control to inland areas.

Martha: one outcome of her study of the effects of rural development in Bar Harbor is the question of the effects of increased septic tank construction.

Karen -- what about pesticides?

Alan suggested that increases of this sort of change could be tied to development. Peter and Adria noted that this is the kind of thing that could tie into multiple stressor monitoring.

Example of multiple stressors: combination of pesticides with temperature changes and acidity changes. Bruce noted that another example is the emergence of amphibian diseases -- developmental changes that cannot be reversed --

which seems to tie into multiple stressors. There are also examples with eagle population -- there is evidence that as eagles age, and build up toxins, they become less fit as breeding adults. Another observation -- this work on multiple stressors requires long term monitoring.

Steve observed, listening to this, that one effect of climate change is changes in timing and quantity of vernal pools.

Leon said that we should also be looking at changes in the extent of impervious surfaces. The increase in impervious surfaces has a powerful, detrimental effect on water quality. David Manski noted that we are not keeping track of the increase in impervious surfaces and that it might make sense to do so.

Andy: are there ways that we can mitigate these impacts? Leon: Yes. Andy: Is this something that the park should be looking at?

Steve Kahl: we need to look beyond incremental, linear extrapolation. Is it possible for us to be thinking about potentially large changes and sudden shifts?

Peter: This is related to question of how and what we monitor over the long term. Hypothesis based monitoring, for example, works only on current assumptions and does not collect data that will necessarily be useful when we have a changed situation or a changed set of hypotheses.

Bill Gawley: this speaks to the importance of, for example, of keeping the paired watershed monitoring moving forward.

Peter Vaux: will the vital signs monitoring result in data that can somehow be related to data collected from other locations? David and Alan: this is an important question, and the answer varies, depending on what you are looking at. We should bring this up with Brian Mitchell when he is here next week.

Karen: looking into your crystal ball, do you see invasives coming into the area that we should be tracking? Keep in mind that sometimes the sequence can be complicated.

Martha: Milfoil should be on the list.

David: the Asian Crab and Green Crab are examples of invasives that we should be looking at.

Adria: Evolution happens. Invasives would get here even if there were not humans here. How do you make this judgment? David provided the park perspective, which focuses on whether the species is introduced by humans. Bill Zoellick noted that knowledge does not imply management action--part of our focus here is on acquiring knowledge of conditions where we see a likelihood of change over the next few years -- to create a baseline.

Peter Vaux tied this to the idea of "reference conditions." Does it make sense to think of Acadia as a source of reference sites? It seems useful to study systems that are "in pretty good shape" -- and characterizing such systems.

Karen -- is there research that we could/should do with regard to beaver populations? David: his concern is not so much what happens when a beaver builds a dam, but instead what happens when a dam is breached. When a dam is removed it can release a huge sediment load.

Bruce provided a brief overview of the beaver issue, which is made worse by the human activity such as road building.

Role of Acadia in the Research Landscape

How is Acadia National Park useful to researchers in your area of study? If you had the support to do work here, what kind of work would you like to do? What are the important research opportunities at Acadia, apart from the Park's management concerns?

Karen: What kinds of research might YOU want to do in the park, setting aside park management concerns. What do you want to see in the research catalog to support your own interests?

Adria: The ability of animals to become resistant to stressors. There is an emergent technique, toxicogenomics --

where you look at genes in a comparative sampling that includes pristine environments and ones with known toxin loadings-- and see what kind of genetic markers you might see that could be related to the presences of toxins. Looking at this with regard to mercury would be attractive.

Another idea: a GIS approach that maps actual impairment against predicted impairment -- toward construction of a GIS bio-assessment model. This is work currently being done by a graduate student, published in an environmental toxicology journal. It might be very interesting to expand on this work with research at Acadia.

Andy: understanding fractured bedrock systems--mapping fractures and looking at groundwater flow. This is a good environment because there is not a lot of overburden -- it is a relatively simple system to map. Another possibility is research into wetlands/groundwater interaction. Finally, carbon cycling research in wetlands.

Martha: groundwater recharge research -- research on discharge into estuaries. Again, this environment, with bedrock near the surface, works well for this.

Leon: Biological variability in first and second order streams. Also, impact of long-term fire history.

Peter: Integration of Acadia into a network of stream sampling sites.

Steve: Air pollution research as part of a national research network looking at mercury.

Martha: groundwater discharge to estuaries. Thermal imaging work is the first stage, now she needs volume estimates.

Martha: Denitrification in freshwater wetlands.

Aria: Phosphorus mobilization, focusing on Acadia streams and brooks. Work is already underway on Hadlock brook and Bear Brook. The study would look at phosphorus movement from streams into the lakes.

Bruce: It would be nice to create an evaluation scale of temporary pool wetland conditions using invertebrates as a measure of health.

Bruce: It would be good to look a lead effects -- shot and sinkers used in fishing. What is the mortality in the bird population? This is still an active topic.

Bruce: Impediments and blockages of small streams and their effect on anadromous fishes. Adria noted that historical records would be important here. Charley added that the effects to be studied go beyond fisheries to vegetation and, in truth, an entire micro-ecosystem. The study could look at the responses of the ecosystem to roads as a hydrologic alteration, as well as at restoration alternatives.

Kathy: noted that in general, it would be useful and interesting to study restoration alternatives.

Steve: the declining leaching and availability of calcium and base cations. It would be good to take a regional approach.

Alan: Making sure that we are working with other places and tying to other sites with some of the same issues -- comparing results and making sure that we are not working in isolation.

Peter: Genetics. Genetic issues and structures.

Wrap Up

What can SERC do to facilitate research?

Steve: electronic versions of the research catalog. Electronic connection among researchers.

Alan (in an email communication after the close of the workshop): This is a general statement of personal concern. I think NPS should promote low impact research whenever possible. The Learning Center should promote peer review

of proposals and discourage proposals that involve environmental manipulation. The park provides an opportunity to examine natural change, manipulative experiments can be performed elsewhere.

Peter: SERC should be a major partner in disseminating information -- synthesized and available.

David: dissemination not just to scientists, but also the general public

Adria: How about a seminar series at SERC. Given the distance, perhaps a conference?

Jim: how much of a challenge is the distance? Adria: not bad for a day if the full day is useful.

Adria and Steve: how about web based research summaries and abstracts? Science programs for the general public. Interactions between graduate students and board members. Translating research so that the general public can understand it.

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Research Catalog Meeting

March 10: Marine & Estuarine Resources

Introductory Remarks - Jim McKenna

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David Manski -- Research Opportunities Catalog Scoping Workshop -- Introduction

David characterized the purpose of the workshop as one of providing a strategic approach to research at the Park. He began with the question of "Why are we interested in science at Acadia and how does it relate to our mission?"

David began with a quotation from the Park's Organic act, focusing on conservation and on keeping park resources unimpaired. To do this, the park needs to know what is here that is to be protected, and it needs to understand what causes impairment. David's shorthand for this is "Science for Parks." This also works the other way, in that the park provides support for science and scientific education. This is "Parks for Science" and, more, a mandate to share scientific knowledge with the broader community.

The park owns 35,000 acres and holds another 12,000 acres in conservation easements. This lands represent a variety of ecosystems--most of them island ecosystems--that see a variety of human uses.

David noted that researchers will notice a focus on tactical issues in his list of key issues. This is not to shortchange the importance of strategic, longer-term research. But it recognizes that the NPS has issues staring it in the face that require knowledge to support decisions in the short term.

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 - Beavers -- cause flooding and damage
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 - Young eels bring \$500 a pound. The harvest is intense and heavy. What is the impact of this? What are the options?
 - What is the effect of worming in intertidal areas? Is there an effect on shorebirds? How is the harvest managed? What interactions between the worms and other benthic life and the rest of the park ecosystem?
 - Fisheries management. We know very little about what is going on here. Sea run brook trout are of interest, but we do not know how populations are changing and about relationships between fishing and the broader ecosystem.
- Data and Information Management
 - How do we ensure that data is accessible and useful over the long term?

David closed by thanking the attendees for coming. He noted that this list misapplied research -- and that we are also interested in broader research, originating from scientific research coming from outside the park's immediate concerns.

Introductions

Jim McKenna -- Ph.D. in oceanography. New to the park service. Directs Secret Acadia. Research was on carbon and nitrogen cycling in estuarine systems. Prior to coming to the NPS he was on the faculty at Williams College, doing research focused on the fringe between freshwater and estuarine systems, looking for indicators that would point at good denitrification systems.

Kathy Tonnessen -- workshop moderator and Research Coordinator for the National Park Service. Kathy is compiling the research catalog that will emerge from these workshops. She has a long history of association with NPS research at regional levels, and has also spent time working at Acadia.

Charlie Culberston -- USGS -- Microbial Ecologist; focus has been on nutrient transport to estuaries via surface waters and shallow ground water. Has looked at impacts of residential development on tributaries and estuarine systems in the Park. Recent work has focused on establishing baseline water quality conditions (nutrients, major ions, trace metals) in bedrock monitoring wells in Northeast Creek and Bass Harbor Marsh watersheds, and identifying shallow ground water seeps in NE Creek and BH Marsh using aerial thermal imaging. Co-PI on a pending proposal to look at the fate of nitrate-nitrogen in estuarine wetlands at Acadia.

Hilary Neckles -- USGS -- estuarine and wetland ecologist, focused on stressors and responses. In particular, she has looked at land use, associated nitrogen loads, and seagrass response. Also works on developing indicators for wetland ecosystems, and on predictors for ecosystem recovery, again, with a focus on seagrass.

Bill Zoellick -- Development Director at Acadia Partners for Science and Learning, the organization that manages the facilities at SERC and which also provides support for scientific research at the Park.

Charley Roman -- NPS -- Coastal Ecologist, heading up one of the Cooperative Ecosystem Studies Units (CESU). Charley's specialty is saltmarsh research, looking at questions such the impacts of reintroduced tidal flow to restricted systems. Has also looked at nutrient loading in marsh systems, including Bass Harbor marsh. At Boston

Harbor Islands he has been involved in an effort to map, classify, and inventory rocky intertidal areas. Charley is also involved in the vital signs effort, focusing on shallow estuarine systems.

Karen Anderson -- Acadia NP GIS specialist. She serves as generalist with regard to support for numerous scientific applications of GIS..

Peter Vaux -- Mitchell Center, U Maine. Background is more in freshwater ecology, so is here as an observer today. His recent work has looked at prioritizing watersheds and lakes, with an eye toward potential conservation. Also involved heavily in PEARL -- an online forum for sharing environmental data. He is just now substantially increasing the number of datasets available on PEARL.

Sean Denniston -- NPS, GIS Specialist. Does technical training with regard to GIS, remote sensing, and so on. Will be working at Acadia on the Isle au Haut visitor/resource management assessment.

Bill Gawley -- focuses on air and water issues in the Park. Sees increased focus on stream monitoring and groundwater studies. Feels that we are at a point where there is enough data to begin making assessments.

Marc Neidig -- Acadia NPS -- Interpretive staff. Is involved with transfer of scientific information to the general public.

Steve Fegley -- MMA -- has worked with marine invertebrates over abroad spectrum. Recent work has focused on bivalves: Oysters and soft-shell clams. He has also begun working with historical data, to understand populations and use patterns. He has also worked with Brian Beal and others on Acadia looking at intertidal populations in and around Anemone Cave. Questions included at whether the species in the caves were unique and whether there were impacts from pedestrian traffic in and out of the cave.

Natalie Springuel -- ME Sea Grant -- she is not a researcher, and is here to learn more about the research at Acadia. She expressed interest in sponsoring research at Acadia. Natalie also coordinates an island monitoring program looking at use impacts on islands.

Linda Mercer -- Maine DMR -- her focus is mostly on monitoring and inventorying of marine resources, with a focus on impacts and changes. Maine DMR has sampling sites in the vicinity of the park for lobsters and sea urchins. DMR also monitors and maps eel grass, and has sponsored research in Taunton Bay on bay management and health. Taunton Bay is also the focus of horseshoe crab research. Other surveys focus on scallops and sea cucumbers, inshore trawl survey of marine resources, and water quality and biotoxin monitoring. Has also done work looking at juvenile finfish habitat. DMR has also been doing elver studies and monitoring, though not necessarily right in this area. DMR conducts periodic assessments of seaweed abundance and marine worm abundance.

Blaine Kopp -- USGS -- background in biological oceanography, looking in particular at responses of seagrass systems to stressors. Has also worked on spatial models for seagrass sites. Work in the park has focused on seagrass responses to nutrient enrichment -- some of this work is tied to the vital signs monitoring program. Has also looked at Sommes sound, which he considers to be a special kind of estuarine system.

Questions:

Steve Fegley -- could you provide a list of projects already underway? David provided a printed list of research topics that were underway as of last year. He also spoke in particular to Susan Brawley's research looking at the relatively pristine intertidal zones on Schoodic, characterizing this area and collecting baseline data. Another one of Susan's students is looking at near shore circulation systems using oranges.

Blaine -- what about jurisdiction? Does the park have jurisdiction over worming? What kind of authority does the park have? Linda of Maine DMR answered that there could be some jurisdiction over seaweed, but with regard to worming, the State has jurisdiction. David noted that this is a legal issue, not a scientific one, and is also not settled. He is less concerned about jurisdiction than getting an understanding of potential impacts. The situation is the same with freshwater fisheries management -- the park has not focused on jurisdiction, but on collecting accurate information.

Linda noted that Mussel dragging is a hot topic -- not in the park jurisdiction -- but one where cooperative work to gain understanding could be useful. The impacts of mussel dragging on habitat and other organisms, particularly in the intertidal are of concern and need for research.

Charley Roman -- are the lands that are not owned by the park service, but managed under easements -- are these lands managed to NPS standards? David replied that there is precedent for this with regard to air pollution, but he also noted that each easement is separately negotiated -- and so each easement can be a little different.

Natlie -- she noted that, with regard to intertidal jurisdiction, the pressure on the park areas will only increase, due to restrictions being placed on other shoreland areas.

The Park's Current Research Needs

What Information Does Acadia Need -- What Stressors Have We Missed?

Hilary -- What about climate change in general? David responded that this is a very appropriate topic

Steve -- The park has a number of unique habitats which could suddenly be gone or changed with even a small sea level change. So, he suggested a sensitivity analysis in which the Park would identify which areas that will be changed or affected given a certain amount of sea level change.

Hilary -- the other factor, apart from sea level change, is temperature change. Acadia is currently at the dividing line between northern and mid-Atlantic natural systems -- it seems likely that that dividing line will shift over the next 25 years. It would be useful for the park to anticipate that change with appropriate research in advance of the shift.

Steve -- yes -- it does seem likely that the park might see changes on land more quickly than changes in water systems, where the changes could happen more slowly.

Karen -- the mapping and boundary line question is important, not only to ecosystems, but also as jurisdiction. As water level rises, what is owned can change in a variety of ways.

Blaine -- if we see major changes in climate we would probably also see major changes in storm patterns and the frequency of large storm events, which would have effects on intertidal zones.

Jim -- does climate change result in changes to nitrogen cycling?

Hilary -- it depends on which scenario develops ... will the area be wetter or drier?

Hilary -- we have only taken the tip off the iceberg in understanding how changes in land use will change the estuarine environment. To the south, entities understand flow patterns, flow times and other critical factors that determine how changes in land use affect nitrogen transport and delivery. We don't know how input of nitrogen relates to residence time in the Acadia area. Models are location specific because embayments have different residence times. We should develop good models for Acadia.

Blaine -- what sorts of denitrification rates can we expect? Do we have areas that are more vulnerable to enrichment because they have less capacity for denitrification?

Steve -- Studying the currents is not only important to understand where the nitrogen will go, but also to understanding how communities in the archipelagic system will change as storm patterns change. Part of understanding what is happening in intertidal communities will depend on understanding their ability to recover, which in turn depends on understanding the currents. Steve noted that getting this understanding can happen in concert with understanding the nitrogen issues.

Blaine -- the park has good information about wet deposition -- it might be useful to understand the relationship between wet deposition and dry deposition.

Kathy -- what about the effect as this deposition comes down to the ocean?

Blaine -- yes, that is what I was getting at.

Kathy -- what about phosphorous mobility?

Hilary -- we have focused our research on nitrogen because there is indication that the systems are usually nitrogen

limited -- but, yes, phosphorous is something for which we have very little understanding -- and, clearly, there are times when the systems are phosphorous limited.

Charley -- We should get better understanding of the thresholds of ecosystem response to nutrient loading. An appropriate research question would be "At what levels of nutrient loading do we begin to detect significant changes in coastal ecosystem structure and/or function?" For seagrass systems, this question is being addressed in USGS research in Northeast Creek; however, we need to address this question for estuarine mudflat habitats, rocky intertidal/subtidal algal habitats in enclosed basins (e.g., Sommes Sound), and other coastal habitats. Measured responses would include primary producers, as well as consumers and higher trophic levels.

Hilary -- yes -- it would be useful to understand more about impacts at higher trophic levels.

Steve -- we need to be very careful about we try to take a look at. At Maine Maritime, the students get used to looking at the habitats around Castine -- to show them diversity, we bring them over here, where there is much greater diversity. In Steve's view, the difference in diversity is probably due to greater abuse of the Penobscot system over time. His point is that you have to be careful about what you measure if you want to see the fuller picture. Students coming from Castine and conducting the same research over here could be busily engaged in collecting data while missing the bigger picture fact that there is a difference in the level of diversity in the systems.

Hilary -- we do not have a great understanding of the quantitative relationships between land use and load.

Bill -- what about multiple stressors?

Hilary -- yes, this is something that we, as researchers think about. We can reasonably assume, for example, that response to nitrogen load changes as you also change climate and temperature. It is work that needs to be done.

Charley -- Thermal imaging is a remote sensing technique that can detected areas where groundwater is discharging into shoreline habitats at focused areas or seeps. It has been especially successful around salt marsh systems and other shallow estuarine habitats. Once these groundwater seep areas are identified, follow-up field studies can be used to determine the concentration and loading of nutrients discharging from these seeps, thus determining if they are a significant source of nutrients to the system. .

Charlie C -- yes, we did some of this at Northeast Creek and Bass Harbor Marsh, and it was very useful; more effective in BHM as more of the marsh is exposed at low tide allowing for easier detection of seepage zones associated with thermal anomalies.

Charlie C --- getting back to Jim's question on the potential impacts of climate change on nitrogen cycling, some recent studies in the Arabian Sea have linked certain indicators of climate change, specifically lack of snow cover (hence earlier and more intense heating of the landmass), to increased coastal upwelling (resulting from changing wind and ocean circulation patterns). Net effect: dramatic increases in surface water nitrate and chlorophyll (> 350%) concentrations over the last decade. Other potentially related ecological effects: increased threat of hypoxic events resulting in fish kills and marine mammal beachings; increased flux of N₂O to the atmosphere as conditions for denitrification become more favorable. Might the Gulf of Maine be susceptible to the same cascade of events? (See <http://earthobservatory.nasa.gov/Study/Monsoon/printall.php> and Goes et al., 2005. Science 22 v.308, p545-547.)

Linda -- what about the impact of cruise ships?

David -- Bar Harbor now receives upwards of 80 cruise ships a year. We have not been involved with looking at that, but, yes, it is a good issue.

Hilary -- cruise ships are a kind of point source issue. Another is salmon net pens -- it seems likely that this will have an impact on the estuarine systems. Permit requests are tending toward sites that get less flushing-- this has the risk of becoming the next pig farms.

Steve -- Cruise ships -- and sailboats coming up from the south -- also tie into species introduction. What is on the hulls is often the organisms that end up in the rocky intertidal areas. How do you detect early signs of, say, an invasive sponge? Further, what is the management strategy?

Linda -- one invasive that has gotten a lot of coverage is didemum -- there's some evidence that it is growing on aquaculture sites.

Linda -- there have been a couple rapid assessments of marine invasives (Casco Bay and Cobscook Bay). There is also some directed monitoring for the Asian shore crab and for green crabs -- it would be useful to do some rapid assessments here, and perhaps more of them, looking at different invasives.

Blaine -- invasives are a regional issue -- not just MDI centric. This means participating in the larger context. It would be good for the Park to join in some of these regional efforts.

Linda -- speaking to that point, there is a state marine invasives working group. There is a regional task force -- Northeast Aquatic Nuisance Species -- that deals with marine, freshwater and terrestrial invasives. The U.S. Fish and Wildlife Service provides funding for research and management. DMR and DEP have submitted a report to the state legislature looking at ballast water and marine invasives.

Steve -- one interesting question is whether communities are more or less susceptible to invasion depending on whether or not they are disturbed. Given this information, that could guide management activity.

Charley -- he wanted to reiterate what Linda said about rapid assessments. He would like to see rapid assessment teams active at Acadia. Given such teams, we might find out there is more change, and more invasion, than we know about.

Peter -- is it possible to do sensitivity analysis, as people do in freshwater, to identify areas that are more susceptible to impact?

Steve -- this is hard. The knowledge base is not there and, besides the systems are much more open.

Jim -- what about changing land use?

Blaine -- one thing that I wonder about is how development might change flow patterns and the hydrology of an estuary.

Steve -- There is often a disconnect in research between what is going on in the upland -- mercury for example -- and the marine environment. A general direction might be to look at how the different systems relate to each other.

Peter -- what do we know about temporal variance?

Steve -- quite a bit. But not necessarily right around here.

Hilary -- when we talk about temporal variation, we know more about shorter term variations -- over the course of a research study. We know much less on the decadal scale. If these systems come and go on decadal scale, should they even be protected? This is something that Acadia could be very well positioned to do-- taking a longer term perspective made possible by its status as a protected area.

Steve -- we also lack knowledge about what is going on in winter -- which is when the kelp is really growing. So, it would be good to fill in the base of knowledge with regard to the winter months.

Charley -- I would like to have better information regarding harvesting. For all species harvests that are occurring in the intertidal and shallow subtidal zone (macroalgae, worms, shellfish, elvers, etc.) it would be good to understand where the harvesting occurs, when the harvesting occurs, and what is the intensity of harvesting. Also, experimental studies could be designed to evaluate the impact of harvesting on intertidal communities, namely species composition, species abundance, and perhaps some key ecosystem processes

Blaine -- possible effects could include changes in geophysical structure and chemistry.

David -- and on seabirds -- trophic linkages.

Kathy -- what about shellfish toxins?

Linda -- this is definitely a research question. We have excellent data on the red tides. Data goes back to the 1970s. There is work underway looking at correlations -- but the basic questions about causes still exist.

Charlie C. -- what about human and animal borne pathogens?

David -- Linda -- could you summarize elver research?

Linda -- we are looking at recruitment each year -- but only at one site. We are also looking at what eels need to move upstream. We do have harvest data. But we have no idea of the impact on the total population.

Karen-- are the harvest data tied to geographic source -- where the eels are being taken from?

Linda -- probably not at the level to enable useful GIS presentation.

Charley -- it would be good to do some of that monitoring on Acadia.

Linda -- do you have good data on anadromous fish at Acadia?

David -- we have a good inventory of adult eels. We know some things about sea run brook trout. My concern is on the role of eels in the larger ecosystem -- they clearly have a lot of value.

David -- what kinds of research opportunities -- such as research into circulation patterns -- could help us in planning a response to and oil spill?

Blaine -- some of this monitoring of circulation and movement in the water column could serve double duty as monitoring for invasives.

Blaine -- another question -- what about the impact of historic structures --dams, docks, roads -- on the marine ecosystem?

Emerging Issues

What does Acadia need to prepare for? What should we be learning now, thinking ahead to changes later?

Hilary -- Like aquaculture, there are other uses that could have substantial impacts. LNG, for one. Alternative energy, such as tidal power, is another example. We should be working to understand potential impacts. This involves both knowing what is already in place -- what is there to be impacted -- and also about what is involved in the energy development work. What are the potential sources of disturbance?

Jim -- power cables are another example.

Kathy -- what about marine mammal issues?

David -- there is already work under way studying harbor seals. College of the Atlantic and the Allied Whale group deals with a different class of marine mammal issues.

Marc -- what about diving for urchins?

Linda -- what about seabirds. Kayaking, for example, and the impact on nesting?

Charlie C -- what about other contaminants, such as pesticides? A recent USGS pub detected at least one pesticide in virtually every stream studied throughout the U.S. (n = ~200); pesticides were detected throughout most of the year in streams in watersheds from the following land-use types: Agricultural (97% of the time); Urban (97%); Mixed land-use (94%); and Undeveloped areas (65%). (See Gilliom et al., 2006. The Quality of Our Nation's Waters -- Pesticides in the Nation's Streams and Ground Water, 1992-2001. USGS Circular 1291, 172p. The fact Sheet and Circular are available free of charge at: <http://water.usgs.gov/nawqa>)

Kathy -- yes, this would tie into marine mammals, since this is where you would see higher concentrations.

Blaine -- in general, you should be looking at resource extraction. The elver fishing and sea cucumber harvesting, for

example are relatively new fisheries where impacts are not well understood.

Steve -- diseases of marine organisms is another emerging topic. Diseases both as management issues and as indicators.

Steve -- We have all been strongly influenced by bio-geography theory --looking at organisms as living in islands, at some level of meaning of this term. But I am not so sure that we understand the scale issues. What is the meaningful size of a management unit? This has to do with currents, flows and other things for which we have little understanding. More generally, it would be good to understand more about the life cycles of species so that you could know what you could reasonably control and manage, given limited resources.

Steve -- give consideration to potential spatial autocorrelation effects --are near neighbors affected? The impact is that you might often find that you do not really have truly independent variables when you do tests. The two issues are that you could miss signals in the system that are really there-- and that you get spurious differences that look significant, but which are not when you consider the lack of independence.

Steve -- we should also pay attention to bio-prospecting -- as happened with the horseshoe crab.

Kathy -- what about rare marine species?

Linda -- there is some baseline information, but the information for marine species is sketchier when you get away from things like sturgeon and whales. As far as Linda knows, there is no tracking mechanism to know what algae and other lower marine species are at risk.

Charley -- this goes back to the basic need for good inventories. We simply do not have intertidal inventories. We need to map the biota in our intertidal habitats.

Kathy -- what about sedimentation?

Charley -- my perception is that this is not a big issue for this part of Maine.

Karen -- coastal erosion could change as sea level changes.

Hilary -- disappearance of marshes due to sea level rising.

Charley -- particularly as the rate of rise seems to be increasing. We should perhaps establish SETs -- Surface Elevation Tables -- for this area. There are a number of areas where marshes are drowning because they are not able to accumulate sediment at the rate that the sea level is rising.

Hilary -- we have no data that we could use to predict what the marshes will do at Acadia.

Steve -- We know that winters are different than they used to be. We can assume that habitats are changing. We should be trying to record current conditions. Note also that this means that longer term studies are not necessarily applicable to current conditions.

David -- What about marine debris? Is there something we could learn from the debris?

Steve -- given the high number of lobster traps, what are the impacts? What're the larger impacts of lobster fishing?

Bill -- are there impacts that we might anticipate from development of the Union River watershed? And ways that, if we anticipate these changes, we want to set up monitoring?

Linda -- shellfish sampling for contaminants could be an indicator.

Bill -- I would be interested in hearing more about how the marine environment and terrestrial environment interact. Could we focus on that for a bit?

Steve -- a few years back there was some concern about pesticides from blueberry farming. People talk about Acadia sitting at the exhaust pipe of the Midwest, in terms of air currents. But in terms of water currents the flow is down

the coast. So, in terms of water borne pollutants, the sources are up in the Bay of Fundy and along Washington County.

Role of Acadia in the Research Landscape

How is Acadia National Park useful to researchers in your area of study? If you had the support to do work here, what kind of work would you like to do? What are the important research opportunities at Acadia, apart from the Park's management concerns?

Hilary -- Here we have a protected, relatively pristine environment. It provides the opportunity to characterize habitats in coastal environments along any number of critical variables.

Steve -- It would be nice to repeat some of the classic studies, done in sites that were once undisturbed, in the pristine environment in Acadia.

Steve -- note that there is also concern among scientists that they cannot get useful work done in National Parks. That there would be a lot of administrative oversight and so on.

David -- it is true that we are more conservative than other entities, due to our mission. But note that we have done studies where there were modifications to systems for experimental purposes. We also, in bio-blitzes, do let researchers take specimens. This reflects an increased level of scientific sophistication on the part of the park. But also, it is true that we approach this through a permit process.

Linda -- note that you are located a place where you are in a colder water stream than in places further west. That is something to build on.

Steve -- I can corroborate that -- we have done studies up in Washington County and in southern Maine, and they are dramatically different systems.

Charlie C -- this would be a great location for a GoMoos buoy that could do real time sampling: currents, wind, nutrients, chlorophyll, water temp, turbidity and so on. This would be an inshore - nearshore buoy. Just to clarify, GOMOOS already maintains a deep water (~100 m) buoy off Mt. Desert.

Linda -- the Gulf of Maine Ocean Data Partnership is a group of organizations with relatively large stores of data that is seeking ways to share data. It would be good for Acadia to be a member.

Steve -- If SERC is looking to have marine work done out of here, you need a place to put boats in and to moor boats. In short, the package needs to include mooring and launching capability. To make SERC an attractive research destination, you need to take seriously all the small details that make research easier and more productive at one place than another.

Natalie -- do you have a wet lab here?

Jim -- this year we are starting with a field station lab -- we will want to develop that into a wet lab.

Steve -- Here is some context. There is a statewide effort to get the entire state recognized as a Marine research site. So, if SERC wants to be part of that, you should tie now into MMRC.

Charley. -- I think that there could be more work done on the nursery role of our shallow marine systems in this part of Maine. Salt marshes, seagrass beds, macroalgal beds, and tidal flats all serve an essential function as habitat for juvenile marine species. There is extensive research on this nursery role at more southern latitudes, but only a few studies have been conducted/published for Downeast Maine marine habitats. It would be useful to understand the role of estuaries and sea grass beds as nurseries.

Steve -- Biodiversity is a good focus, and one that does not require a lot of equipment or sophisticated facilities. It might be mutually beneficial for researchers and SERC if SERC focused on describing all the lower marine species.

Linda -- The Sloan foundation is funding a biodiversity effort. The Census of Marine Life Gulf of Maine Program (<http://www.usm.maine.edu/gulfofmaine-census/>) is collecting information on biodiversity and ecological processes

in the Gulf of Maine.

Jim -- Acadia seems like a great place for long term baseline monitoring -- to be compared to other places that are not developed now but which may be in the future.

Steve -- Washington County is one of the last places for such research. Now is the time.

Peter -- does the presence of mountains along the coast make the area more interesting for research?

Steve -- this environment is more like the Maritimes. So, it does present a distinct research area.

Hilary -- this reminds her that there are exciting marine programs going on in Canada that could be worth tying into.

Steve -- the strength of having a place, such as this, that is a different kind of system from what we have south of here is that it allows you to test the generality of your hypotheses.

Blaine -- what SERC needs is critical mass. Give the space away in order to get that.

What Can SERC Do For You?

How can we make SERC useful for you?

Steve-- make it easy for people from out of state to bring a group of graduate students here for a few days or a week. In detail, what you need is to have the food taken care of, lodging taken care of, bench top space reserved for the group, and transportation. On top of that it would be nice to have microscopes and other basic instruments available.

Jim -- much of this is in place. How do we publicize it?

Steve -- meetings. Professional organizations. Newsletters of these organizations. And the focus should be out of state.

Hilary -- internship programs are another component of this kind of program. The key is to get the interns developing their own research here, so that their graduate program is here.

Steve -- also, it is helpful to provide support for families, so that the researcher can bring a family along. In his own experience, Steve has found that the question of whether there is a place for his family to stay--and things for them to do--can be a make or break decision in terms of going to a place for research.

Steve -- rather than thinking in terms of a scientist in residence, start out with a "scientist nearby." Steve felt that he could serve in this role himself. To be interested in this, Steve would like some office space and lab space here that he could count on.

Charley -- this is a good idea. The research opportunities catalog should list local experts for the key areas of investigation identified in the catalog.

Natalie -- connect volun-tourism with your mission as a research center, as away to bring in volunteers, revenue, and to create broader public interest. Kathy suggested tying this into alumni groups.

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Research Catalog Meeting

March 13: Wildlife

Introductory Remarks - Jim McKenna

Jim introduced the workshop by introducing the dual mission of SERC. One mission is to support and improve science-based research in the park system. The second mission is to accelerate transfer of scientific information, including transfer to the non-scientific public. Jim also described the opportunities that SERC provides to researchers in the area. Working in concert with Acadia Partners for Science and Learning, SERC provides logistics support for research, lodging, and cooperation in park related research topics. Another example of support for research is the LL Bean Research Fellowship program, which provides support for researchers working in the park. The fellowships are \$5,000 a year--the program will run for five years.

There are two objectives for today's session. One is to identify research needs for the park. The other is to identify ways that the park can support researchers. The product emerging from these sessions and from other work will be a research opportunities catalog -- both in printed form and as a living document on the web--that will identify research opportunities in Acadia National Park.

David Manski -- Research Opportunities Catalog Scoping Workshop -- Introduction

David characterized the purpose of the workshop as one of providing a strategic approach to research at the Park. He began with the question of "Why are we interested in science at Acadia and how does it relate to our mission?"

David began with a quotation from the Park's Organic act, focusing on conservation and on keeping park resources unimpaired. To do this, the park needs to know what is here that is to be protected, and it needs to understand what causes impairment. David's shorthand for this is "Science for Parks." This also works the other way, in that the park provides support for science and scientific education. This is "Parks for Science" and, more, a mandate to share scientific knowledge with the broader community.

The park owns 35,000 acres and holds another 12,000 acres in conservation easements. This lands represent a variety of ecosystems--most of them island ecosystems--that see a variety of human uses.

David noted that researchers will notice a focus on tactical issues in his list of key issues. This is not to shortchange the importance of strategic, longer-term research. But it recognizes that the NPS has issues staring it in the face that require knowledge to support decisions in the short term.

Key Issues:

- Lack of Baseline Data. We actually do not really know what species are here. This is a priority for the NPS. Vascular plants and vertebrates are covered--but there is much less knowledge about the populations of other life forms--invertebrates and non-vascular flora--let alone how these populations are changing.
 - Need to inventories of species
 - Need to develop protocols for monitoring
- Visitor experience and Impacts
 - Acadia has the highest number of visits per acre of all parks in the system except for urban parks -- with over 60 visitors per acre per year.
 - What constitutes a positive visitor experience?
 - What are the impacts of visitor use?
 - How can we help the public use the park in an appropriate way?
- Ecological Restoration
 - How do we propagate some of these native materials?
 - How does one do restoration in harsh environments?
- Shoreline Erosion
 - Threats to cultural and archeological issues
- Changing Land use Adjacent to the Park
 - Increasing development pressure
 - What is the impact of ecosystem fragmentation? What does the mean for plant and animal systems?

- How do we preserve quietude and dark night skies as development increases?
- What is impact of increased number of septic systems and wells?
- What are the trends and changes in the estuary systems?
- What is impact on groundwater and groundwater dependent resources?
- Invasive Exotic Species
 - About 1/4 of the vascular plants in the park are non-native. Which of these must be managed? How do we manage?
 - Similarly, which exotic animals represent threats? If they are a threat, how do we manage them?
- Air Pollution
 - We know that we have high levels of acidification and high levels of mercury--we have good basic data on air pollution, extending back in time.
 - Where we need help is on understanding the impacts.
 - We need to know more about what else is coming from these emission sources that could matter.
- Rare Species Conservation
 - We have about 1000 vascular species -- it appears that there are 240 species that are no longer here. We do not know why.
- Management of Native Animals
 - Management of raccoons in campgrounds, for example. Can we change behavior?
 - Beavers -- population is increasing -- they can cause flooding and damage
 - Amphibians -- need better understanding of diseases and population changes
 - Deer -- communities on the Island are interested in establishing a hunt. This in spite of evidence that shows that population could be declining. We need to be as well-informed as possible.
 - Young eels bring \$500 a pound. The harvest is intense and heavy. What is the impact of this? What are the options?
 - What is the effect of worming in intertidal areas? Is there an effect on shorebirds? How is the harvest managed? What interactions between the worms and other benthic life and the rest of the park ecosystem?
 - Fisheries management. We know very little about what is going on here. Sea run brook trout are of interest, but we do not know how populations are changing and about relationships between fishing and the broader ecosystem.
- Data and Information Management
 - How do we ensure that data is accessible and useful over the long term?

David closed by thanking the attendees for coming. He noted that this list is applied research -- and that we are also interested in broader research, originating from scientific research coming from outside the park's immediate concerns.

Introductions

Jim McKenna -- Ph.D. in oceanography. New to the park service. Directs SERC at Acadia. Research was on carbon and nitrogen cycling in estuarine systems. Prior to coming to the NPS he was on the faculty at Williams College, doing research focused on the fringe between freshwater and estuarine systems, looking for indicators that would point at good denitrification systems.

Kathy Tonnessen -- workshop moderator and Research Coordinator for the National Park Service. Kathy is compiling the research catalog that will emerge from these workshops. She has a long history of association with NPS research at regional levels, and has also spent time working at Acadia.

Greg Burr -- Maine IFW -- fisheries biologist -- responsible for Washington and Hancock Counties. Work has been primarily from a management perspective, with a focus on game species. Sea-run brook trout are a particular area of interest -- we do not know where these fish are coming from and whether they return to natal streams or someplace else. This relates to questions of how to protect the species.

Merry Gallagher -- Maine IFW -- working on the research side. Currently working on effects of invasive species (Northern Pike) and also looking at fish habitat relations in streams.

Sean Denniston -- NPS, GIS Specialist. Does technical training with regard to GIS, remote sensing, and so on. Will be working at Acadia on the Isle au Haut visitor/resource management assessment.

Cyndy Loftin -- USGS and U Maine -- has had students working on amphibian research. Michael Bank, who did mercury work in the park, was one of Cyndy's students. She is now looking at the effects of fish introductions on invertebrate populations.

Sarah Nelson -- Mitchell Center, U Maine -- has worked on paired watershed research, looking at mercury deposition. Is here primarily as an observer.

Megan Gahl -- U Maine -- working on dissertation on amphibian diseases.

Mark McCollough -- Endangered species biologist with US FWS. Looking at resurrecting shorebird work. Past work has look at Penobscot Meadow Hole -- work with harlequin ducks. Has also worked with freshwater mussels as well as dragon flies and maiden flies, and also with amphibian monitoring.

Linda Welch -- US FWS-- Biologist with Maine Coastal Islands Refuge. Started with work on contaminants in bald eagles. Focus is on restoring colonial nesting habitats for shorebirds. With habitats established, she is now looking at broader issues such as food sources as affected by land use patterns and human recreation on islands. Also interested in doing baseline inventories and monitoring techniques.

Dan Harrison -- U Maine -- Professor of wildlife ecology. Has done baseline surveys of terrestrial mammals -- looking at the question of whether there were viable populations of higher level predators. Has also done surveys of woody vegetation looking at interactions between deer, hare, and native plants. Some of this helps track forest succession after the 47 fire. Also has worked with coyotes, coyote/deer interactions.

Bruce Connery -- Acadia NPS -- wildlife resource manager for the Park.

Kate Petrie -- Acadia NPS -- director of fall programs for educating grade school students.

Brian Mitchell -- NPS -- Director of I&M program. Studied coyote/wolf communication. Has also looked at bird and amphibian populations. Planning on monitoring bird populations in the park Starting next year, will work to develop a research protocol for the rocky intertidal zone.

Wing Goodale - Biodiversity Research Institute. Has an eagle web/cam project underway in coastal Hancock County. The goal is to engage the public in the research. Another park project focuses on seabird mercury on Little Duck island. Also has looked at loons and loon mercury levels -- has found the the mercury levels in loons in the park are relatively low relative to other populations in the state -- but has also found that reproductive activity for this population is low. Seeking funding for songbird mercury levels higher up in the watershed. Is finding that mercury is a problem in terrestrial systems as well as fresh water aquatic systems.

Eleanor Groden - U Maine -- Insect ecologist and chair of the biological sciences department. Has been working on the invasive ant problem -- both trying to understand the explosive growth and understand whether there are management options. Has found that the ants are well adapted to this climate, and also has found that the ants are truly invasive, driving out other ant populations. It also appears that the ants are affecting small mammals and, since the ants farm aphids, are having the effect of increasing the aphid population, which, in turn, has impacts on plant disease transmission. Eleanor has a particular interest in insect diseases, and is looking at whether there might be some associated management options. Is also looking at multiple stressor relationships as management tools. Has found that the short season here might place some limits on natural constraints.

Charlie Todd - Maine IFW -- wildlife researcher working on resource assessment. Has worked on colonial seabirds. He is a raptor specialist, with a long term involvement in bald eagle research. He notes that eagle populations have been monitored for 40 years. By the late 70s, local population was down to 5 nesting pairs in the boundaries of the park -- that is now back up to 50 pairs. Has looked a lot at the effect of toxics, which was the cause of much of the population decline. He notes that we have learned a lot from looking at the lifecycle of a top predator. He notes that eagles have changed their food sources over time. With regard to peregrines, focus has been mostly on management -- numbers have been too small for research to date -- but that is just now beginning to change.

The Park's Current Research Needs

What Information Does Acadia Need -- What Stressors Have We Missed?

Dan -- We have had recent extinctions in the park -- fisher, bobcat, and bear. These should tell us that something is happening that we need to pay attention to. Looking at the road traffic in the park, it is mind-boggling. We have evidence of changes affecting the herbivore population. Coyotes moved into the park in 1981 -- they pushed the fox out of its status as dominant predator -- and it is now unusual to see a deer in park. I am concerned about the population of otters, given the increase in road traffic. We also are finding that porcupines have a limited distribution in the park -- they are highly susceptible to risk from roadkill threats. All of this points to changes in the

plant/herbivore interaction. This, in turn, leads to a conclusion that monitoring is incredibly important. Spruce grouse is another one that interests me, and one where I would be concerned about it blinking out.

Kathy -- so, you are looking at indicator species here? What would you pick? Porcupines? Otter?

Dan -- yes, those, among others.

Wing -- Loons are another species that we should be looking at, focusing on the low reproduction rates. They are particularly good bioindicators of mercury.

Merry -- Anadromous brook trout. We have very poor information on saltier brook trout. MDI is one of the few Maine locations where we still get consistent reports of their presence. We need to know where fish still are.

Megan -- We do not have good data on terrestrial amphibians and reptiles. Also, no one has done much work on pond breeding amphibians and how they move into the terrestrial zones.

Mark -- MDI is like Mt Agamenticus -- where we have a very dense concentration of vernal pools. This leads to the question of whether the park has a good mapping of vernal pools?

David -- no, we don't

Mark -- that would be an important thing to do.

Megan -- we are doing that with Bar Harbor this year. We will do that with Mt. Desert next year.

David -- this is a case where the towns will have more data than the park does.

Megan -- Just a note ... I have found that everyone doing this research uses a different naming scheme for the wetlands. It makes comparing the results really difficult. So, one suggestion would be that we establish a common naming system for the pools.

Wing -- Students at COA and elsewhere are always looking for projects. Mapping vernal pools and developing a common naming system would be a great project.

Mark -- U of Maine would be another resource.

Dan -- Given that some of the critters that have disappeared in the park are wide ranging animals, it suggests that we don't know what it takes to keep wide ranging animals around. Given the disappearance of the coniferous forests, we should be careful not to think of Acadia in isolation from other areas. We need to be looking at this at a larger scale.

Dan -- I would also think we want to look at community composition -- looking at trends, and comparing the areas in the park with other areas.

Greg -- Towns do not need permits to replace culverts. When they do replace a culvert, it may be inadequate with regard to fish needs or mammal needs. We need to look at specific spots where it might make sense to get money to help a town replace a culvert with a different kind of structure that was more supportive of wildlife movement under roads.

Linda -- we need to better understand the affect of harvesting -- rockweed harvesting for example -- on ecosystems.

Linda -- also, there has been, in recent years, massive starvation of seabird chicks -- due to disappearance of hake and other food stocks.

Eleanor -- freshwater invertebrates is an area that I wonder about. Does the park have good data there?

David -- we do have data about freshwater invertebrate communities

Bruce -- but these data look only at communities around a single station. We do not have good data about how the population varies up and down a whole stream. And we have virtually no information about freshwater lakes.

Cyndy -- Jean DeFranco is trying to incorporate wetlands into the stream research. It would be worth looking at what she is doing.

Kathy -- What is your assessment with regard to fire? Is this a research issue?

Mark -- Early successional habitats are an issue in the Service at this time. We have a number of birds that use grasslands and shrublands that are becoming rare. But, for the Park, this is probably not a big management theme.

David -- we are generally not managing habitat to keep it in early successional stages.

Bill -- Dan seems to be speaking to a need for monitoring that is not necessarily hypothesis based -- that looks for emergent, large changes.-- indicators of more work to be done in new areas.

Dan -- Yes. The work with deer and coyotes back at the start of the 1980s is a good example of seeing a complex interaction -- where the coyotes were perhaps applying a natural level of pressure, but, when combined with effects of increased roadkills and pressure on the habitat, it became a level of pressure that the deer could not withstand.

Merry -- Water quality. We need to understand more about the effects of very soft waters--low calcium waters--and potential impacts on fish health. Sea run brook trout and eels would be species that might be most sensitive to that. Acadia seems like an ideal place to study this and learn more about it.

Wing -- we are having similar concerns related to low calcium levels in birds ... in some cases perhaps relating to their ability to reproduce. I would agree that Acadia would be a good place to do this work

Mark -- fire retardant chemicals (PDBE chemicals) are something we should be monitoring.

Charlie -- they bioaccumulate and may have effects on eagles and other raptors

Wing -- this is still very much an emerging issue. It is truly a synthetic chemical, and is showing up everywhere, so it is out there, is something our bodies have no idea of how to deal with, and the scary part is that we don't really know what it is doing.

Eleanor -- what is the impact of temperature change? As it effects, for example, susceptibility to disease?

Merry -- the role of wood in streams, as habitat on macro-invertebrates and fish. There is some talk about it as a calcium store. This should include small woody debris.

Linda -- the increase of use of coastal islands is something we need to monitor. There are many more sea kayakers out there than ten years ago.

Mark -- we don't have enough information about spiders in the state. There are issues related to contaminants, as well as with changes in population. We might use spiders as a kind of indicator species -- looking at contaminant effects there, at a lower trophic level.

Linda -- the invasive spiders do not have the same role in the ecosystem as the native spiders -- controlling spruce budworm, for example. So, as the invasives displace the natives, there is a cascade of other effects.

Wing -- speaking to the matter of contaminant loading in spiders, we are seeing very high concentrations of mercury in a number of songbirds -- so, this does suggest that we have an emerging problem here.

Emerging Issues

What does Acadia need to prepare for? What should we be learning now, thinking ahead to changes later?

Mark -- we are dealing a lot with wind power. Issues include placement, effects on migratory species, and creation of appropriate policies. Effects on peregrine falcons and other coastal migrants could be substantial. Be aware that in some cases these projects are on a fast track -- where they don't even want to be thinking in terms of preliminary siting studies. Acadia should be proactive in this regard, gathering data in advance of decisions to begin siting things here.

Brian -- bats are another species affected by wind energy.

Mark -- in particular, we need baseline information about pelagic birds. We don't know much about their populations.

Kathy -- what about tidal power.

Mark -- right. Underwater turbines. There would be an effect on salmon, for sure.

Linda -- There was talk about an LNG terminal in Gouldsboro.

Mark -- We are reviewing 3 LNG projects that would almost be in sight of the St. Croix unit. There would be a lot of ship traffic. These are very productive, upwelling waters -- so there would be questions about the effect of ship traffic on these systems.

Wing -- Does the park have a plan with regard to oil spills?

Bruce -- We are not the lead agency, but we are involved in the response, and, yes, there is a plan.

Kathy -- What are the research issues related to this? Mostly monitoring issues?

Linda -- There is a lot of need for that. We don't know what the traditional uses are of these offshore resources.

Mark -- That is so valuable. It would be very helpful for the park to have baseline data for these areas that could be affected.

Bruce -- Yes. We need pretty specific numbers if we would hope to receive payment in the event of an emergency. Another potential problem is the increase in cruise ship traffic.

Kathy -- At one of the other workshops, when we talked about this, the stressor was dumping. Are there other stressors?

Brian -- What about exotics?

Bill -- Air pollution.

Brian -- what about air traffic?

David -- there is increasing air tour activity, including use of a B-17 last summer.

Kathy -- so, does this lead to research questions?

Charlie -- overflights of seabird islands would be wide open to abuse.

Linda -- We see a lot of that. We see planes buzzing the ground, causing the birds to panic. There are regulations saying you can't do that -- we are trying to figure out how to enforce them. So, this is not so much a research question as a management question.

Kathy -- what about diseases?

Merry -- Infectious salmon anemia would be one. We don't understand much about this. It appears to be something carried by other species. We don't know how it affects them.

Megan -- There is an education issue with regard to diseases in wetlands.

Linda -- Obviously, this year there is a big push on getting samples with regard to bird flu.

Kathy -- are there management plans or research related to this?

Linda -- I am getting trained on this later this week.

Wing -- There is a strain of lyme that is emerging and could spread to seabirds. They can complete their entire lifecycle on birds. If this transfers to passerines, this could be a major human healthy issues.

Brian -- It would be good to develop baseline data with regard to blood samples.

Kathy -- With regard to restoration, are there research questions that you can think of that we should be pursuing in order to do restoration?

Dan -- Risk assessment with regard to roads would be useful for a host of species. It would be good to understand the patterns of road traffic and how they relate to mortality.

Kathy -- Is there research we should be doing with respect to specific mitigation issues, relative to roads?

Mark -- There is funding out there for management -- for example, with regard to turtle populations -- if you can make your case.

Megan -- For amphibians, it would be easy to do road closures in specific areas, at specific times, to address the problems.

Merry -- Sediment influx into small streams from sanding of roads in winter.

Megan -- Salt, too. There is really high salt concentration in some of the smaller streams.

Eleanor -- Work to detect and manage invasives. How do you identify sensitive areas that you want to protect? How do you protect those areas?

Kathy -- are there wildlife species that we can be expecting to move into the area

Merry -- Northern Pike

Eleanor -- Hemlock wooly adelgid

Wing -- Cowbirds

Bruce -- We need to do modeling to understand the levels at which these things become problems. So, the idea of risk assessment is really important. The same thing applies to vernal pools. At what point does the loss of vernal pools, serving as connectors between water sources, become large enough that it creates fragmentation?

Kathy -- what stressors are associated with climate change?

Brian -- the intensity and frequency of storms is an issue that is related to climate change

Linda -- the rise in sea level can result in loss of wetlands, given armoring of the coast.

Sarah -- Changes in precipitation will change the amount of mercury deposition.

Dan -- we could take the build out scenarios that David showed us earlier, and then overlay some of what we know about the viability of populations, to anticipate some of the potential changes. For example, the ability to have a viable moose population is affected by this build out and by the associated fragmentation.

Eleanor -- are there comparable parks? Ones that have such minimal buffer areas? Is there comparative analysis work that we could do?

Megan -- We might look at the Canadian parks for examples -- in the Bay of Fundy.

Bruce -- there might be some coastal parks -- Sleeping Bear Dunes, for example -- that could serve as good comparisons for risk assessment.

Bruce -- I would like to get a better understanding of what people are willing to live with. We need a better understanding of what the communities of users care about. Such an understanding would help us explain and get support for management policies.

Mark -- documenting the genetic biodiversity of the various parts of the park, reflecting the fact that it is a collection of islands. You might have some unique genetic resources that you should be strategizing to conserve.

Dan -- We talked about species that used to be here that are not here anymore. It would be nice to see some information about the viability of restoration -- of both plants and animals.

Bruce -- Aquaculture. It is not really emerging, but we could use a better understanding of what is going on in the ecosystem where there are aquaculture sites.

Linda -- a related issue is placement of aquaculture systems. We think of finfish aquaculture -- but in some cases mussel aquaculture is an even larger operation and issue. In some bays in Canada mussel aquaculture covers 80% of the bay surface. In the larger operations, people use propane canons or drive around the bay at high speed to harass and scare off wildlife.

Megan -- loss of herring from midwater trawlers is an emerging issue.

Role of Acadia in the Research Landscape

How can Acadia be a platform for research that interests you or your agency, apart from the Park's management concerns?

Merry -- Identifying the sources of mortality of eels.

Wing -- Acadia lends itself nicely to contaminants work because the watersheds are smaller and tend to be self-contained.

Charlie -- Atmospheric contaminant research. There is a nice existing data set.

Dan -- Fire ecology and plant succession -- with Sommes Sound splitting the Island and fire on one side.

Sarah -- What will happen on Schoodic, now that the use has changed?

David -- We do not intend for there to be heavy use on Schoodic, but, yes, getting baseline data here is important.

Kathy -- Are there any institutes, research groups, reference watersheds, and so on where we should be partnering with others?

Bruce -- Both Linda and Megan have pointed us in the direction of working more closely with the Canadians.

Bruce -- There is also some potential for doing work looking at harbor seals, which could lead to work with other species.

Mark -- Are there breeding bird survey routes in the Park? Or efforts to link to other surveys?

Bruce -- not at the moment, but it is something that we could reestablish.

Charlie -- the array of easements managed by the park is huge. It would be useful to have a survey and comparison of the easement areas.

Mark -- What is the relationship between SERC and Eagle Hill?

Jim -- Yes. We have met with Eagle Hill. I think that we started out being a little concerned about being competitive, but, after talking George, it is clear that we are more likely to be complementary than competitive. It is definitely a great resource to have in the area.

Dan -- Lyme disease arrived here about the same time that the deer population crashed. Monitoring of lyme disease and ticks should be ongoing work.

Megan -- Note that, since this is federal property, we can use the National Wildlife Health Center in Madison, WI. to help identify any diseases in dead animals.

Greg -- It would be good to map critical fish habitats.

Merry (this was a thought that Merry had while driving home, after the workshop, which she subsequently communicated by e-mail): -- Acadia may be a good place for some intensive eel population monitoring and study for many reasons. If the species is declining worldwide like many believe, then Acadia may be a good place for studying the effects of the loss of a historically abundant fish resource on other community members and trophic relationships (small eels are probably an important food resource for many birds, other fishes, and possibly some mammals and turtles). Eels should be quite abundant in waters with close proximity and access to the coast (like Acadia) and their loss may dramatically affect or contribute to current stresses on the community. Also, this species needs a greater effort toward public education and outreach. Most people are too grossed out by them or simply don't care about eels when they are an incredibly important component of the fish community where they occur.

What Can SERC Do For You?

How can we make SERC useful for you? How can we make it an attractive place for you to do research?

Megan -- the hardest thing on the Island is housing. Living over here would be difficult. We are already putting in 10 hour days -- adding a two hour commute would be very difficult.

Eleanor -- I think that the parks have an undeserved reputation for making research work difficult. I have not found that to be true at all, but the reputation is there.

Jim -- What about support? We have the LL Bean fellowships now, at \$5,000 -- is that workable?

Megan -- For a graduate student, \$5,000 is a perfect amount.

Eleanor -- It would be more interesting if you could commit to a multiple year grant. Having two years in the bag would make it more attractive.

Cyndy -- It would also be interesting to have a second source that was a little larger. It costs about \$60,000 to keep a Master's student in place for 3 years -- so, \$25,000 a year would allow me to put a student in place.

Wing -- The toxic sampling work is very expensive. \$5,000 wouldn't go very far -- it would cover sampling costs for, like, 2 days. And, since we are working on the islands, having sleeping arrangements here is not particularly useful.

Jim -- what about our ability to tie into the interpretive staff?

Cyndy and Merry -- yes, this is useful, and is showing up as a funding requirement with increasing frequency.

Dan -- it would be good to build that connection to interpretation into the project from the start. It is not something that we, as researchers, are set up to do. So, being able to work with people who are paid and trained to do this work could be very useful.

Jim -- Are there other kinds of academic programs that we should be running here?

Greg -- What about an enviro-thon?

Jim -- We had a regional event of that sort last year, and I would like to do more.

Greg -- What if we wanted to host an event here -- an Inland Fisheries conference or something of that nature? How do we find out fees and so on?

Jim -- Go to the Acadia Partners website ... www.acadiapartners.org . And, call Denny O'Brien at Acadia Partners, since it is often possible to put together some kind of package arrangement on pricing.

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Research Catalog Meeting

March 14: Physical Sciences

Introductory Remarks - Jim McKenna

Jim introduced the workshop by introducing the dual mission of SERC. One mission is to support and improve science-based research in the park system. The second mission is to accelerate transfer of scientific information, including transfer to the non-scientific public. Jim also described the opportunities that SERC provides to researchers in the area. Working in concert with Acadia Partners for Science and Learning, SERC provides logistics support for research, lodging, and cooperation in park related research topics. Another example of support for research is the LL Bean Research Fellowship program, which provides support for researchers working in the park. The fellowships are \$5,000 a year--the program will run for five years.

There are two objectives for today's session. One is to identify research needs for the park. The other is to identify ways that the park can support researchers. The product emerging from these sessions and from other work will be a research opportunities catalog -- both in printed form and as a living document on the web--that will identify research opportunities in Acadia National Park.

Research Opportunities Catalog Scoping Workshop -- Introduction

Jim characterized the purpose of the workshop as one of providing a strategic approach to research at the Park. He began with the question of "Why are we interested in science at Acadia and how does it relate to our mission?"

Jim began with a quotation from the Park's Organic act, focusing on conservation and on keeping park resources unimpaired. To do this, the park needs to know what is here that is to be protected, and it needs to understand what causes impairment. Jim's shorthand for this is "Science for Parks." This also works the other way, in that the park provides support for science and scientific education. This is "Parks for Science" and, more, a mandate to share scientific knowledge with the broader community.

The park owns 35,000 acres and holds another 12,000 acres in conservation easements. This lands represent a variety of ecosystems--most of them island ecosystems--that see a variety of human uses. In addition to the islands around MDI, the Park manages St. Croix island and an associated site on the main land near Calais.

Jim noted that researchers will notice a focus on tactical issues in his list of key issues. This is not to shortchange the importance of strategic, longer-term research. But it recognizes that the NPS has issues staring it in the face that require knowledge to support decisions in the short term.

Key Issues:

- Lack of Baseline Data. We actually do not really know what species are here. This is a priority for the NPS. Vascular plants and vertebrates are covered--but there is much less knowledge about the populations of other life forms--invertebrates and non-vascular flora--let alone how these populations are changing.
 - Need to inventories of species
 - Need to develop protocols for monitoring
- Visitor experience and Impacts
 - Acadia has the highest number of visits per acre of all parks in the system except for urban parks -- with over 60 visitors per acre per year.
 - What constitutes a positive visitor experience?
 - What are the impacts of visitor use?
 - How can we help the public use the park in an appropriate way?
- Ecological Restoration
 - How do we propagate some of these native materials?
 - How does one do restoration in harsh environments?
- Shoreline Erosion
 - Threats to cultural and archeological issues
- Changing Land use Adjacent to the Park
 - Increasing development pressure
 - What is the impact of ecosystem fragmentation? What does the mean for plant and animal systems?

- How do we preserve quietude and dark night skies as development increases?
- What is impact of increased number of septic systems and wells?
- What are the trends and changes in the estuary systems?
- What is impact on groundwater and groundwater dependent resources?
- Invasive Exotic Species
 - About 1/4 of the vascular plants in the park are non-native. Which of these must be managed? How do we manage?
 - Similarly, which exotic animals represent threats? If they are a threat, how do we manage them?
- Air Pollution
 - We know that we have high levels of acidification and high levels of mercury--we have good basic data on air pollution, extending back in time.
 - Where we need help is on understanding the impacts.
 - We need to know more about what else is coming from these emission sources that could matter.
- Rare Species Conservation
 - We have about 1000 vascular species -- it appears that there are 240 species that are no longer here. We do not know why.
- Management of Native Animals
 - Management of raccoons in campgrounds, for example. Can we change behavior?
 - Beavers -- population is increasing -- they can cause flooding and damage
 - Amphibians -- need better understanding of diseases and population changes
 - Deer -- communities on the Island are interested in establishing a hunt. This in spite of evidence that shows that population could be declining. We need to be as well-informed as possible.
 - Young eels bring \$500 a pound. The harvest is intense and heavy. What is the impact of this? What are the options?
 - What is the effect of worming in intertidal areas? Is there an effect on shorebirds? How is the harvest managed? What interactions between the worms and other benthic life and the rest of the park ecosystem?
 - Fisheries management. We know very little about what is going on here. Sea run brook trout are of interest, but we do not know how populations are changing and about relationships between fishing and the broader ecosystem.
- Data and Information Management
 - How do we ensure that data is accessible and useful over the long term?

Jim closed by thanking the attendees for coming. He noted that this list is applied research -- and that we are also interested in broader research, originating from scientific research coming from outside the park's immediate concerns.

Introductions

Jim McKenna -- Ph.D. in oceanography. New to the park service. Directs SERC at Acadia. Research was on carbon and nitrogen cycling in estuarine systems. Prior to coming to the NPS he was on the faculty at Williams College, doing research focused on the fringe between freshwater and estuarine systems, looking for indicators that would point at good denitrification systems.

Kathy Tonnessen -- workshop moderator and Research Coordinator for the National Park Service. Kathy is compiling the research catalog that will emerge from these workshops. She has a long history of association with NPS research at regional levels, and has also spent time working at Acadia.

Sean Denniston -- NPS - Capitol Region -- GIS specialist, also in a management training program. Does technical training with regard to GIS, remote sensing, and so on. Will be working at Acadia on the Isle au Haut visitor/resource management assessment.

Harold Borns -- U Maine -- Professor of Geology, retired. Primary field of interest is glacial records as a proxy record of climate change. The work in Maine has turned out to be the most interesting. The last work was done in the 1920s. This work left open questions about dating. His work looked at the coastal zone, starting with a mapping, from easternmost Maine to Penobscot Bay. They discovered that the land rose as the ice receded. One outcome was a mapping of the geology of Acadia NP. They mapped the bedrock geology of the Park and then mapped the glacial geology of the Park. The unique thing about Acadia is that it is high. It was the only place in the state where the land was above the glacial sea level. The reorganization of the Atlantic basin as it moved into and out of the ice age are recorded in the geology -- here, as well as in the geology of Sweden, Norway, and Denmark. More recently Borns has been involved in communicating these findings to the public. The outcome is a map titled "Maine's ice-age trails Downeast." It is a map showing a trail with 40 stops showing places of interest. The map starts on top of Cadillac, in Acadia. The map will initially be distributed to the public, free of charge. This will be ready for use this summer.

Upcoming research projects include a mapping of the slope of the ice sheet from Katahdin to Cadillac. He also has interest in tying some of this research to Indian artifacts.

Holly Ewing -- Bates College -- trained in geology and ecology. Work at Acadia is just beginning, looking at soils with regard to metal load. She is interested in what happens in soils, and looks at how soils act as filters for chemicals. She is also interested in larger, system-wide effects.

Kate Petrie -- Acadia NP -- Works in interpretation in the park. Primary work to date has been with middle school children. Future plans include training for high school students and senior college students.

Ginny Reams -- Acadia NP -- Writer and web coordinator at Acadia. Writes park science-based articles for FOA journal, among other things. Is working with Jim McKenna and David Manski to share information with the public about park research activity and results.

Marshall Chapman -- Morehead State Univ -- Professor of Geoscience. Did his Master's and Ph.D. on Isle au Haut. Did work on an outcrop called Eastern Head -- that shows what happens to a lava chamber that gets invaded periodically by basaltic lava. He said that this site is an absolute geological jewel. This is now attracting international attention. Is interested in doing surficial geology and also, with more funding, groundwater flows.

Brian Mitchell -- NPS NETN -- With the Park Services inventory and monitoring program at the regional level. His group is doing data gathering on deposition as well as forest monitoring that involves taking soil samples. Sampling will look at carbon, nitrogen, and exchangeable cations. Will also work on water quality and quantity monitoring. Is also interesting in monitoring shoreline changes, including rocky intertidal monitoring.

Joseph Kelly -- U Maine -- Coastal geologist at U Maine -- has had students working on Sand Beach, which is mostly shells. Students have looked at sources of shells as well as at how the shells dissolve. Also interested in sea level change, looking at more recent history. Recent focus has been on the effects of rising sea level in the park. Also interested in looking at a transect of lakes -- raised shorelines and drowned shorelines for inland lakes. As a marine geologist, a lot of his work is marginal to the park. Interesting work includes looking at coastal zone craters in areas such as Sommes Sound, which contained methane from biodecomposition.

Tom Huntington -- USGS -- Water division. By training is a soils scientist, now working as a research hydrologist. Has recently done work on hydrologic responses to climate change in Maine -- timing of lake ice-out, spring flows, changes in runoff and trends of that nature. Looking 100 years out, what are the potential changes, given different emission scenarios? He has studied the transport of dissolved carbon in the Penobscot River basin and delivery to the Gulf of Maine. Also looking at nitrogen loading. Has also looked at calcium in Maine forest soils, using datasets from ANP. Is seeking funding to look at denitrification in the Park. The basic question is what is the Park's capacity to continue to filter out nitrogen.

Kathie Weathers -- Institute for Ecosystem Studies -- Milbrook NY. A biogeochemist. Started at Acadia looking at fog chemistry. Has done atmospheric deposition work. Right now is looking at the interface between deposition and soils, with effects on animals. Has also worked in Great Smoky Mountain NP. Has a parallel interest in Chile, looking comparatively at areas there and here. Is also interested in the interface between management and policy.

Sarah Nelson -- U Maine -- has worked on paired watersheds in Acadia. Focus has been on atmospheric deposition, particularly mercury, but also sulphur and sea-salt. Most recently has been looking at deposition through snow. Has also looked at ways to integrate and collect data.

Bill Zoellick -- Acadia Partners -- Development Director for Acadia Partners, the non-profit organization that manages facilities at SERC and that seeks private support for research.

Tonnie Maniero -- NPS-NER--Air Quality Specialist working with the parks. Worked on an earlier assessment that was, in some ways, a precursor to this research catalog effort. Focus has been on effects of the pollutants, in addition to measuring presence of pollutants.

The Park's Current Research Needs

What Information Does Acadia Need -- What Stressors Have We Missed?

Joe -- Create a sand budget for Sand Beach. Look at whether the beach is growing or shrinking. Is the source of

carbonate something that will be depleted over time?

Joe -- I am also looking at bluff erosion at Frazer point, Fernald Point, and on Thompson Island. Also, I would note that there are non-conforming structures, particularly the road around Otter Cove. The research questions have to do with how to manage this going forward. Do we keep the infrastructure?

Tom -- Is there marsh loss related to sea level rise? If there is net marsh loss, what will be the fate of carbon stored in those sediments?

Kathie -- Is sea level rise the primary driver for marsh loss?

Tom -- I would think that it is the primary one. But there are other factors.

Joe -- Sea level is rising so fast that some marshes cannot keep up. When that happens, the marsh changes -- it becomes a different kind of marsh.

Marshall -- Isle au Haut is an interesting contained experiment, all of its own. The geographical area is contained. One interesting project that we began involved going around to all the island wells in off season to record water height in the wells. The result was a dog's breakfast -- results varied widely. It was clear that there was a lot of complex fracturing. But, what would be neat, if this research continued, would be that the results could be really useful to people on the island, helping them anticipate salt water intrusion, among other things. Putting the picture together requires merging a lot of different projects. It also involves serious money.

Kathie -- If a well study is done, it would be important to think about what other information you might obtain at the same time.

Harold -- there is a developing history of lake levels in the state, which reflect groundwater. Today's lake levels are much higher in the past. We have evidence of a historically lower level of precipitation.

Holly -- As development continues, it is clear that there will be impacts on both water quality and quantity.

Joe -- Another factor is looking at presence of petrochemicals. Tenants Harbor had to rebuild its whole water infrastructure, and it was not because of an oil spill. It was just cars, cars -- runoff from parking lots, running into fractured bedrock.

Kathie -- Could we organize the research topics in terms of human drivers. What are the categories of human impacts? What questions would be associated with that.

Kathy -- for example, we could look just at land use changes?

Kathie -- yes, and other things.

Harold -- I have a comment that goes back to strait geology. The mountains of Acadia provide us with a way of measuring the thickness of the ice sheet. That then bears on problems such as the ones that Joe is addressing, such as how the crust responds to de-glaciation. It also helps us reconstruct the history of the park.

Harold -- Another point is that we are losing archeological sites as sea level rises. Isle au Haut has, for example, the only lithic quarry site.

Kathy -- Let's go back to land use change, and associated research questions.

Kathie -- We can start with pollutants associated with car use.

Holly -- Eutrophication

Tom -- Increase in impervious surfaces.

Tonnie -- How do changes in wetland size affect methylation of mercury.

Marshall -- increased taxing on freshwater aquifers. Increased pumping from increased human activities, coupled with sea level rise, results in increased salt water intrusion.

Kathie -- Increased erosion from increased human use?

Sarah -- Land cover change. The forest over by Cadillac has changed a lot in the last ten years -- how does this change deposition?

Holly -- Changes in soils due to changes in cover changes, and effects on deposition processes.

Holly -- Effects of increased energy use and increased waste disposal

Harold -- Let's turn this around. What is the effect of the Park on surrounding areas? When you rebuilt a trail, you bring in the gravel from Lamoine, and in the process are contributing the the destruction of that aquifer.

Tom -- As development happens, and land comes out of agricultural use, does this have effects, positive or negative, on water systems.

Kathie -- Ammonium nitrate travels a long ways, and could be carried in the air masses coming over the park. So, this could be a monitoring issue.

Kathie -- Continued research into the impact of fogs.

Sarah -- there is evidence of mercury in fog.

Tom -- I would expect that you would see higher levels of ground level ozone from increased human activity.

David -- There has been some work on this ... it did not turn up a lot of evidence of impacts. But, it does provide a baseline for future work.

Joe -- Methane is being released in high quantities in Sommes Sound. It is affected by human activity -- someone drops an anchor and the methane bubbles up.

David -- There are a number of lakes in Acadia that are public water supply. There has historically been concern that beavers cause giardia. We have not found scientific evidence that beavers are a significant source of giardia.

Kathie -- are there regional changes in air pollution that would help us think in terms of emerging air quality issues?

Tonnie -- we have found it hard to anticipate what problems will show up.

Brian -- What about cobble beaches? Are there degradation concerns there?

Joe -- They are pretty resistant.

David -- But we may have a security issue -- when security was increased at the Bar Harbor airport, the screeners began seeing all these rounded shapes in luggage.

Emerging Issues

What does Acadia need to prepare for? What should we be learning now, thinking ahead to changes later?

Joe -- How will sea level rise change the shoreline?

Marshall -- How will sea level rise change aquifers?

Kathie -- How will extreme events change sediment loading?

Tom -- Note that there is not much agreement as to whether climate change would increase the frequency of extreme events. It is consistent with the theory -- but it is not yet evident in the record.

Holly -- We need to look at changes in variance as well as in changes in the mean. This is possible through paleoecology, but it takes more work.

Tom -- So, to make sure I understand -- the goal would be to look at the effects of increased variability.

Holly -- right.

Tom -- One area that is wide open is getting a better understanding of vernal pool ecology, and then connecting that to the timing of snow melt and so on.

Marshall -- has there been climate change research at Acadia?

David -- to my knowledge, there have been a number of proposals, but I do not know of any research. I think that Acadia could potentially be a good place to work because of its sitting on the boundaries of climate ranges.

Harold -- you can go through the lakes here in the park to look at paleoecology -- understanding how we got to the present situation. One question we could ask is what would happen if the Labrador current stopped running. It could be possible to get evidence that could help build that scenario by looking at cores.

Tom -- People have documented the ebb and flow of spruce in this region. It gives you a sense of just how rapidly the forest could change, given small changes in climate.

Kathie -- Another thing to look for is changes in pests and pathogens as climate changes and as species composition changes.

Holly -- I have done a little exotic earthworm research in NY -- they can dramatically change the forest floor structure. In the places where they become extensive they make extensive changes. When you are looking at research to try to understand this problem, keep in mind that the forests in Minnesota are more similar to the forest here than are the forests in the Northeast, to the south -- that is where I would look for relevant research. Questions would include looking into relevant controls as well as impacts.

Sarah -- Looking at the snow to rain ratio -- and at possible changes in that, could be important.

Holly -- One effect is on the freezing of surface soil.

Tom -- Less snow could result into deep freezing.

Harold -- From the Greenland ice core goes back 250,000 years. We can see from these data that the transition from a cold climate to a warm climate can take place in 3 to 5 years. This is a transition from full glacial conditions to conditions like today in just a few years. There was an abrupt change around 1890 from a growing season of less than 100 days to one of more than 200 days in about a decade. My point is that the record shows that these changes can come relatively quickly.

Holly -- the research question is how the ecosystem responds. We don't have any idea about the impacts of such changes at the system level. It is a great research question.

Harold -- But, does it matter? The change happens, and you have a different system. You are not going to preserve the older one.

Jim -- The goal is to be able to pick up the signal in a way that allows you to distinguish anthropogenic changes from larger scale changes.

David -- For example, we have lost over 200 species over the past 100 years or so. It would be great to know which of these changes are anthropogenic.

Holly -- we are currently doing some modeling work looking at the relationship between climate changes and

deposition changes.

Tonnie -- That's interesting, since we are doing a lot of deposition analysis. We would want to make sure to include those change factors in that assessment.

Holly -- Yes, that is part of what the modeling work is trying to explain. But, it should be coupled with empirical work.

Tom -- It might be important to note here that no one that I know of is looking seriously at severe climate change over the very short run -- over a 3 to 5 year period -- in the next 100 years. What is expected is a more gradual change -- 3 to 4 degrees of sea level warming over the full 100 years.

Kathy -- lets look beyond climate change. What else do you see that we should be looking at?

Sarah -- changes in the makeup of the air masses moving toward the park, in terms of chemical makeup.

Harold -- has anyone looked at changes in the number of visitors due to changes in gasoline prices and so on?

Joe -- How about the impacts of windfarms, or aquaculture?

Joe -- there are also regulatory issues to consider. What about roads along the shore that are not consistent with regulations?

Tom -- What about LNG?

Kathie -- Increased marine traffic in the St. Croix area has air pollution effects.

Kathie -- another thing to think through is the effect of emission trading with regard to other pollutants.

Tonnie -- this ties to a general question of setting up air pollution regulations, and setting them correctly.

Kathie -- or, to look at it another way, thresholds.

Holly -- We need to get beyond simple thresholds to understanding system responses.

Sarah -- We might look at watersheds that cross park boundaries. Looking at what sort of stressors are there, collecting baseline data

Kathy -- what about toxics?

Tonnie -- flame retardants

Kathie -- endocrine stimulants. Also PM 2.5

Bill G -- Aeroleine

Kathie -- fish viruses.

Holly -- we might also look at genetically modified organisms. Salmon farming is one place where there is use of GMOs. Also, look at genetically engineered herbicide resistant plants.

Holly -- In general, there are huge ramifications from aquaculture -- I don't know if that is something that you want to look at.

Kathie -- what about rusty crayfish and other filter feeders that mow down aquatic vegetation. Think of this as an instance of a class of organisms.

Tom -- I am still concerned about whether forest growth is sustainable, given the levels of deposition and their

effects on calcium

Kathie -- this is likely to show up first on the animal side.

Tom -- what about natural levels of arsenic and radon?

Holly -- arsenic issues can turn up where there is a lot of oxygen demand. It is naturally occurring, but can get released through redox reactions.

Harold -- the Gulf of Maine is warming. Is there any research of the effects on the biota along the shore?

Tom -- shellfish diseases increase as water warms

Kathie -- it would be useful to make comparisons between changes in coastal temperatures and temperatures more inland.

Role of Acadia in the Research Landscape

How can Acadia be a platform for research that interests you or your agency, apart from the Park's management concerns

Joe -- This will be one of the first places in the US that sea level changes have been studied in depth. The geology tells you so much about what is going on here structurally. This is a world class place for glacial geology -- it would be good to communicate that to the public.

Harold -- This place is so high and abrupt -- there are complete shorelines, with duplicates of the present shoreline, but 250 feet above sea-level.

Kate -- Remember that when you are writing a grant, there is an opportunity to tie all of these things that you are talking about into park interpretation -- this can be win-win -- where you end up with a stronger proposal and kids and others can learn more about the things that you are finding.

Marshall -- Over the last 25 years the story of Maine granites has been retold, from a new viewpoint.. This is true on Isle au Haut especially, but also is true on MDI. Some of these places are emerging as world-class geographic sites. We want to protect them as well as make people aware of them. With regard to Isle au Haut there is a great deal of important research out there to do: isotopes have not been done, dating of the top of the pile has not been done, studies of the fracture pattern has not been done. It is a great case study for undergraduate institutions. One problem is what the park service has for lodging. To get from here to Isle au Haut, by car, is ... well, a long time.

Kathie -- ANP has world class geology, but also has world class air pollution. You can get really significantly different study environments all in a compressed area. That is really valuable from a research perspective

Sarah -- With the intermodal transportation center coming, it would be good to do a pre-post study of vehicle emissions to see if you can pull out the local signal.

Kathy -- What research might you do on Schoodic?

Kathie -- anything that is regional -- and that does not need to be done specifically on MDI.

Marshall -- there is the dike system at the end of Schoodic point.

Holly -- Are there places here to do paleoecology core sampling?

Marshall -- what about oral histories and family histories?

David -- we have just completed an ethnographic study of this general area.

Marshall -- I am thinking in terms of more recent stories. Getting stories before people die.

Kathie -- If there is an open area that is not downwind of some road, there might be possibilities for air sampling here. That is the kind of thing that might be done here on Schoodic.

Brian -- I was just thinking that if you did a comparison between here and MDI, you might be able to pull out some of the local factors.

Kathy -- what about comparisons between conditions here and in Canada?

Joe -- Sea level changes at Fundy National Park are interesting.

Holly -- Most any comparison of soil conditions could be useful.

Tom -- What about the eel research? What was that slide about in Jim's presentation? There seem to be some really interesting questions there.

David -- Yes. The increase in eel prices has driven some heavy harvesting. That is why we would like to get a better understanding of their movement between freshwater and saltwater.

Kathy -- what about the paired, calibrated watershed data?

Sarah -- there have been comparisons of soil chemistry and deposition. We know a lot about nitrogen chemistry, fire history and a range of other factors.

Bill Z. -- Yes. This is something I would like to follow up on. It seems that we have a foundation for a lot of other research. Is this something that we can build new research on?

Kathie -- How feasible is it to add a weir -- or gauging station -- to a park watershed?

David -- We would be willing to look at a proposal to do that. We would want to understand the effects, on the ground.

Holly -- Back on the watersheds ... there is a lot that we could learn by looking at soils as well as water.

Holly -- On another thought, it strikes me that Acadia is an excellent place to do research that does not always look at humans as separate from the ecosystem. Putting my educator's hat on, I can say that it would be very useful for students to look at places as a whole system, including the social science dimensions as well as the natural sciences. Acadia offers some unique opportunities to do that kind of work and teaching.

What Can SERC Do For You?

How can we make SERC useful for you? How can we make it an attractive place for you to do research?

Marshall -- you have a repository of samples?

David -- we have a collection of about 1.5 million items. Including the Proctor collection, which includes field notes and collections for about 6000 insect species.

Marshall -- I have samples that I collected here, and my field notes. What would you want from me? For a geologist, the field notes are the collection. Do you want the notes/ A copy?

David -- A copy of the notes is all we are looking for. As for samples, we are just looking for a representative sample of what has been collected.

Jim -- We have guidelines that can help. We don't want to make the guidelines a burden. But, on the other hand, if you are open to suggestion, it is easier for us if things come in a more standard form.

Kathie -- Two things help. One is humans. The park staff is an important resource. The other is housing.

Jim -- We have plenty of housing here. But it is an hour to MDI, if that is where the research is. So, thinking about doing research on Schoodic is attractive. The other thing to remember is that housing is more available in the off season.

Joe -- You could require people to produce a web page. That helps make the research more broadly accessible, particularly if it is written with that audience in mind.

Harold -- "SERC" strikes me as a name that tells me nothing about what the center is about. There is no reference to Acadia in the title, and "SERC" loses

Harold -- There ought to a research budget for the Park. NSF research has to be cutting edge. A lot of what we are talking about here is important, but not cutting edge. Why don't you guys establish a research budget? What would be useful would be to establish a budget that would allow a PI to get some research started, and once that is done, go on to other places to get funding. Why can't you guys make a stronger argument for a budget? What happens, for example, if you ask the USGS to come in and do some work?

Jim -- we have to pay for it, in some cases quite a bit.

Harold -- You guys can ask for NSF funds, so long as you don't apply for salaries. Have you thought through the opportunities to take overhead for researchers submitting for NSF funds, but submitting through the park?

Tom -- It would be useful if your webpage would provide a clearinghouse for research opportunities that could be done in the Park.

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Research Catalog Meeting

March 15: Terrestrial Resources

Introductory Remarks - Jim McKenna

Jim introduced the workshop by introducing the dual mission of SERC. One mission is to support and improve science-based research in the park system. The second mission is to accelerate transfer of scientific information, including transfer to the non-scientific public. Jim also described the opportunities that SERC provides to researchers in the area. Working in concert with Acadia Partners for Science and Learning, SERC provides logistics support for research, lodging, and cooperation in park related research topics. Another example of support for research is the LL Bean Research Fellowship program, which provides support for researchers working in the park. The fellowships are \$5,000 a year--the program will run for five years.

There are two objectives for today's session. One is to identify research needs for the park. The other is to identify ways that the park can support researchers. The product emerging from these sessions and from other work will be a research opportunities catalog -- both in printed form and as a living document on the web--that will identify research opportunities in Acadia National Park.

David Manski -- Research Opportunities Catalog Scoping Workshop -- Introduction

David characterized the purpose of the workshop as one of providing a strategic approach to research at the Park. He began with the question of "Why are we interested in science at Acadia and how does it relate to our mission?"

David began with a quotation from the Park's Organic act, focusing on conservation and on keeping park resources unimpaired. To do this, the park needs to know what is here that is to be protected, and it needs to understand what causes impairment. David's shorthand for this is "Science for Parks." This also works the other way, in that the park provides support for science and scientific education. This is "Parks for Science" and, more, a mandate to share scientific knowledge with the broader community.

The park owns 35,000 acres and holds another 12,000 acres in conservation easements. This lands represent a variety of ecosystems--most of them island ecosystems--that see a variety of human uses. The Park's responsibilities are not only for MDI and the surrounding islands and peninsula, but also for Saint Croix Island park on the border between Maine and New Brunswick.

David noted that researchers will notice a focus on tactical issues in his list of key issues. This is not to shortchange the importance of strategic, longer-term research. But it recognizes that the NPS has issues staring it in the face that require knowledge to support decisions in the short term.

Key Issues:

- Lack of Baseline Data. We actually do not really know what species are here. This is a priority for the NPS. Vascular plants and vertebrates are covered--but there is much less knowledge about the populations of other life forms--invertebrates and non-vascular flora--let alone how these populations are changing.
 - Need to inventories of species
 - Need to develop protocols for monitoring
- Visitor experience and Impacts
 - Acadia has the highest number of visits per acre of all parks in the system except for urban parks -- with over 60 visitors per acre per year.
 - What constitutes a positive visitor experience?
 - What are the impacts of visitor use?
 - How can we help the public use the park in an appropriate way?
- Ecological Restoration
 - How do we propagate some of these native materials?
 - How does one do restoration in harsh environments?
- Shoreline Erosion
 - Threats to cultural and archeological issues
- Changing Land use Adjacent to the Park

- Increasing development pressure
 - What is the impact of ecosystem fragmentation? What does the mean for plant and animal systems?
 - How do we preserve quietude and dark night skies as development increases?
 - What is impact of increased number of septic systems and wells?
 - What are the trends and changes in the estuary systems?
 - What is impact on groundwater and groundwater dependent resources?
- Invasive Exotic Species
 - About 1/4 of the vascular plants in the park are non-native. Which of these must be managed? How do we manage?
 - Similarly, which exotic animals represent threats? If they are a threat, how do we manage them?
- Air Pollution
 - We know that we have high levels of acidification and high levels of mercury--we have good basic data on air pollution, extending back in time.
 - Where we need help is on understanding the impacts. For example, what is the impact of high mercury levels in fish tissue? What are the impacts of high ozone levels?
 - We need to know more about what else is coming from these emission sources that could matter.
- Rare Species Conservation
 - We have about 1000 vascular species -- it appears that there are 240 species that are no longer here. We do not know why.
- Management of Native Animals
 - Management of raccoons in campgrounds, for example. They have habituated to humans as a food source? Can we change behavior? Of animals? Of the people?
 - Beavers -- population is increasing -- they can cause flooding and damage
 - Amphibians -- need better understanding of diseases and population changes
 - Deer -- communities on the Island are interested in establishing a hunt. This in spite of evidence that shows that population could be declining. We need to be as well-informed as possible.
 - Young eels bring \$500 a pound. The harvest is intense and heavy. What is the impact of this? What are the options?
 - What is the effect of worming in intertidal areas? Is there an effect on shorebirds? How is the harvest managed? What interactions between the worms and other benthic life and the rest of the park ecosystem?
 - Fisheries management. We know very little about what is going on here. Sea run brook trout are of interest, but we do not know how populations are changing and about relationships between fishing and the broader ecosystem.
- Data and Information Management
 - How do we ensure that data is accessible and useful over the long term?

David closed by thanking the attendees for coming. He noted that this list is applied research -- and that we are also interested in broader research, originating from scientific research coming from outside the park's immediate concerns.

Introductions

Jim McKenna -- Ph.D. in oceanography. New to the park service. Directs SERC at Acadia. His research was on carbon and nitrogen cycling in estuarine systems. Prior to coming to the NPS he was on the faculty at Williams College, doing research focused on the fringe between freshwater and estuarine systems, looking for indicators that would point at good denitrification systems.

Kathy Tonnessen -- workshop moderator and Research Coordinator for the National Park Service. Kathy is compiling the research catalog that will emerge from these workshops. She has a long history of association with NPS research at regional levels, and has also spent time working at Acadia.

Mary Foley -- NPS - NERO -- Regional Chief Scientist. A paleoecologist and paleoclimatologist. Has done work on plant communities in the park -- now is primarily a science program administrator. Now a generalist with a good overview of the issues and research in the Park.

Richard Hildreth -- retired -- Works as a naturalist. Has participated in bio-blitzes in the park. Much of his work has been on Petit Manan -- involved in damselfly and maiden fly surveys. He has worked with US FWS as well. His main interest has been insect migration. The State of Maine is starting a butterfly atlas -- he is working on the planning on that. Also studying the biodiversity on his own property in Steuben.

Glenn Guntenspergen -- USGS -- interested in the impacts of climate change on ecological processes. Worked with

colleagues on the pre-settlement biology in Wisconsin. In Acadia, has been involved in decision support systems to assess impacts of land use change on the Northeast Creek system. Also looking at stressors on a watershed catchment level.

Ivan Fernandez -- U Maine -- works with soils at the U Maine. In the Park he has been involved in the paired watershed study. He has also been involved with metals work in the park. Also involved in research in Greenville. Ivan is also tied into graduate student projects looking at issues related to plants and soils. Statewide he is involved with a number of other watershed studies, including the Bear Brook study. Most of his research looks at acid deposition, climate change, and impacts of perturbation.

Sarah Nelson -- U Maine -- Sarah Nelson -- U Maine -- has worked on paired watersheds in Acadia. Focus has been on atmospheric deposition, particularly mercury, but also sulphur and sea-salt. Most recently has been looking at deposition through snow. Has also looked at ways to integrate and collect data. She is currently working on a watershed condition assessment in the park.

Chris Cronan -- U Maine -- Biology department. Some years ago he did a resource inventory at St. Croix. Has also taught field ecology classes at COA, with a focus on intertidal biodiversity. Feels like he has chipped away at a lot of issues in the park -- things that should be fleshed out. He has looked at nitrogen export budgets in a number of river basins in Maine.

Alison Dibble -- Stewards, LLC -- Lives near the park. Is interested in the question of how visitors can be engaged in conservation. Studied shrub in Duck Brook for her doctoral work. Has a lot of interest in bees and their associations. Conducted research in this park and others to characterize fuels in relation to invasive plants. Currently serves as a cooperating research ecologist for the USFS. Recently has been looking at the effect of acid rain on lichen and bryophyte populations.

Bill Livingston - U Maine -- main background is on forest ecology -- looking at causes when large numbers of trees die. Has looked, for example, at viability of populations of jack pine. Looked at white spruce die off on Monhegan. It looks like regeneration is possible there, but is limited by Japanese barberry as an invasive species. Other studies include looking at adelgid as a limiter of fir. Looking toward the future, he is looking at hemlock woolly adelgid as it comes up the coast. Has also looked at mortality of native beech, due to an invasive disease. There could be impacts here.

Karen Anderson -- Acadia NP -- GIS specialist. She does a lot of work with terrestrial data.-- she helps the staff so that they can work with and interpret data. She is here today as an observer.

Jill Weber -- Consulting botanist -- has worked on numerous projects in the park. Has developed rare plant monitoring plans. Acadia was ahead of the curve with regard to inventories -- the next questions have to do with management. Has worked on the Acadia vegetation map, which is a great research resource. One part of that work was characterizing over 50 different community types in the park. Also worked on invasive plants in the park -- quantifying the problem and identifying problematic species. This was tied into Karen's GIS work, resulting in maps that identify hot spots. Developed a program called partners for plants, in association with Garden Clubs of America, to find whether volunteers could be useful with regard to rare plant monitoring. Could minimally trained people be useful? The answer was that they could produce repeatable, useful data. She just finished an update of "Flora of Acadia National Park" -- based on new field work.

Betty Lyle -- Acadia NP -- interpretation division. Interested in getting the word out to people that this is a dynamic place. She runs the Hulls Cove visitors center. Her challenge is taking this information and getting it to the staff in a way that can be transferred to visitors in short engagements.

Geneva Langley -- Acadia NP -- botanist. Work involves more monitoring than research -- working with invasive plants

Nishi Rajakaruna -- COA -- Worked in the park as a student. An evolutionary biologist interested in plants that grow in extreme environments as a way of better understanding evolution. Has looked at plants that grow in the midst of bird droppings, plants that grow in heavy metal environments, and other environments that are inhospitable. Has been doing work looking at metal uptake. One of the things that he is interested in doing in Acadia is getting a better understanding of rarity -- what is it that limits these species -- looking both at above ground and below ground ecology. Interested in serpentine soils.

Tom Rawinski -- USFS -- Botanist. Looking at invasive plant problems as they effect forest health. Deals more with State forests. Has studied purple loosestrife -- worked with the Nature Conservancy. Worked with Mass Audubon --

got experience in managing conserved lands. Has moved around the northeast enough to have gotten a good overview of the botany of the whole area.

Bill Zoellick -- Development Director, Acadia Partners -- Acadia Partners manages the facilities at SERC and also seeks to provide new sources of support for scientific research in the Park, looking in particular at private sources of support.

Roger Cox -- Canadian Forest Service -- His group looks toward Acadia as a way get insight into problems that are heading their way. It also works the other way -- with problems showing up first in Canadian parks and heading south. So, maintains a close relationship with Acadia. His own interests include the effects of acid fog on birch populations, as well as effects of summer ozone levels on the ability of birches to resist the freeze-thaw cycle. Also interested in fog deposition with regard to mercury. Recent work has looked at edge effects, such as the increased mixing of mercury from fog due to winds coming off the bluff. Also project leader for a group of scientists studying the effects of global climate change. They are pushing for more engagement in urban forestry.

Sean Denniston -- NPS - Capitol Region -- GIS specialist, also in a management training program. Does technical training with regard to GIS, remote sensing, and so on. Will be working at Acadia on the Isle au Haut visitor/resource management assessment.

The Park's Current Research Needs

What Information Does Acadia Need -- What Stressors Have We Missed?

Chris -- moisture stress, stress from lack of snow -- all of these as individual components of the larger effects from climate change.

Bill L. -- when you are looking at things like trees, with long life spans, be aware that things that are happening now can have impacts in the future. Also, you should be looking at forest stands. For example, I would expect that you are about to see significant changes in the stand that grew back after the 47 fire. Another question relates to adelgid issues -- this is a management issue -- but it is one that you can expect to come your way.

Kathy -- what about blow downs? Is there a management issue?

Roger -- Remember that the forest in the park is not managed in the same way as a production forest. If you are managing to avoid fire, then you create other impacts. With regard to blow downs, one would expect to see more of this as storm intensity increases.

Kathy -- Are we, in fact, seeing more extremes?

Roger -- There is certainly enormous variation over time. But we are seeing some evidence of increasing frequency of winter thaws.

Bill L. -- The examples of extreme events that are most relevant for Maine, perhaps ironically, are droughts. They can result in forest die-offs. This, again, is related to the stage of the forest -- and is why you need to be thinking in terms of the age and stage of particular stands.

Richard -- The climate here makes generalization very difficult. In the spring, you can move around just on the Steuben peninsula at any time in May and move from dead of winter vegetation to spring bloom. So, people studying things here need to be aware of the steep climate gradient as you move inland.

Alison -- Sea level rise should be a concern for the park. there are two kinds of mollusks that should be monitored. One is a European periwinkle --

Littorina littorea -- it is very present here and can be impacting other species. The other one is non-native slugs -- something that is made worse by the cool, wet springs -- it can have effects on plant diversity and fungal diversity. Another thing to keep an eye on is the coyote population and the possible introduction of opossum.

Nishi -- How much is known about atmospheric nitrogen deposition?

Ivan -- I am sure that most of the major issues have been raised ... but, one of the questions to the Park is what is the framework of the physical and chemical environment for these changes taking place in the Park? What is the

suite of measurement networks? Speaking to nitrogen deposition, we know a lot about it from a national perspective. What do we really know about input/output budgets in the Park? ... that's a good question. Everything needs to be built upon a foundation of appropriate inventorying and monitoring.

Kathy -- Right. So, people should feel free to identify the parameters that are most important for us to be monitoring here.

Nishi -- The reason that I brought it up is that there is evidence coming out of California is that nitrogen deposition is behind changes that make plant communities more susceptible to invasives -- it appears that growth of the invasives had previously been nitrogen limited.

Roger -- There is a consequence to nitrogen deposition, particularly at the edges of stands, where you are also getting acid deposition. You can begin to get movement of grasses in, replacing forest. This is an area where monitoring of change could be useful.

Alison -- Automobile pollution might have an impact on road corridors.

Roger -- DOCs (Dissolved Organic Carbons) account for up to 7% of the carbon produced into the atmosphere in Europe. Getting an understanding of biogenic DOCs is important.

Chris -- Is there research into patterns of lyme and West Nile disease?

David -- There has been survey work looking at movement lyme disease. We have probably not done anything specific with West Nile.

Chris -- With regard to the visitor experience, the Park might want to have some understanding of the spread and prevalence of the problem.

Richard -- we did studies some years back of ticks on dead birds and mammals

Roger -- the ticks attach themselves to birds?

David -- Yes -- and there is some evidence that there might be a new strain of the disease coming in on seabirds.

Mary -- One question is whether the Park should be doing research into these areas, dealing with the spread of disease?

Chris -- Well, you want people to come to the parks ...

David -- With lyme disease, we are not managing it. Just as with rabies, all we do is education. We tell people how to protect themselves.

Chris -- Back to what Ivan said, I think that dealing with this reductionist approach is complicated. We need a higher level framework, so that we can detect larger changes.

Mary -- Note that we are very process focused -- we are interested in identifying the processes that are not well understood, as opposed to worrying about the number of deer or of some other species. We focus on removing the human influences, rather than mucking around with the populations, per se.

Chris -- You can approach this from two directions -- and one is that you need to have a way to know whether something is changing.

Mary -- But what we really need to understand is the underlying processes.

Glenn -- The research question is what do you need to know in order to know what to measure.

Alison -- One source of nitrogen is dog feces. We don't know all the interactions between dogs and wildlife around the park. As population around the park increases, we would expect this problem to get worse.

Nishi -- We recently had a number of old Norway spruce removed from campus due to a disease. Is there species cross-over?

Kathy -- there are parks in the Rockies where they will be spraying for forest pests, for reasons of fire control.

David -- we have not even started monitoring for forest pests. You are already at the level of management ...we don't even know what is going on.

Bill L. -- This relates to what I was saying about stand dynamics. The problems with pests are related to the age of the stand. At some point, a disturbance will come through and explode. You need to anticipate which stands are vulnerable. Talking about indicator species, the biggest questions have to do with what is under those stands. What is going to regenerate? If you have invasives in there, you're going to have a big problem. If there aren't invasives, then you would have natural regeneration.

Tom -- You need to focus on the community, not just on the species. You need to set up plots where you can look at an increase or decrease and relate it to something.

Kathy -- In some parks they are putting in forest health monitoring plot. Is that going on?

David -- There are a couple in the park.

Tom -- But they are not sensitive enough to pick up the kinds of things we need to know.

David -- Right.

Ivan -- We need, again, to be thinking in terms of the framework. We need to think about the relationships between the different indicators -- and then ask whether there is an adequate network of monitoring. For example, with the beech disease that Bill mentioned, the question is what are the drivers? Are we making the measurements that we need in order to be able to watch the indicators of change? My pitch is, "What is the strategy approach that you need?"

Nishi -- if you want to ask some of these questions, the critical thing is to push for permanent monitoring.

David -- The Park is initiating a monitoring program that will include protocols to monitor forest health. If you are interested in looking at those protocols, we can get them to you.

Nishi -- It is important that we can look at those protocols across different plots. There needs to be enough standardization to permit comparison.

Roger -- It would be good if the Canadian parks could use these and make comparisons too.

Bill Z. -- We should note that, over the past few days, numerous people have made the point that the relevant points of comparison for Acadia would often look more toward Canada, rather than to the south.

Alison -- To my knowledge, the inventory of fungi in the park is incomplete. The same is true of lichens, bryophytes, and other less studied organisms.

Richard -- a fungi blitz in the fall would be very feasible. We have a good number of experts who could be brought in.

Alison -- in addition to the blitz approach, there should be a more systematic sampling efforts.

Mary -- What do we need to know about invasions?

Tom -- The understanding of communities that I was talking about is part of that.

Nishi -- It is true that there are underrepresented groups, but I think that we actually have a reasonable understanding of many populations. What is missing is an understanding of the ecology. There are very few studies that have come out of Acadia that

have looked at species in communities.

Glenn -- Mary raises a good point. We have understanding a lot of the factors that can affect invasions. What is needed at Acadia is an understanding of the anticipated changes, which we know are coming, and these other factors, so that we can anticipate some of probable invasive issues.

Emerging Issues

What does Acadia need to prepare for? What should we be learning now, thinking ahead to changes later?

Alison -- As we develop data about plant populations and locations, how widely available should we make this, in view of potential plant collecting for personal or commercial purposes? There are potential consequences to making this information publicly available.

Nishi -- The focus here would be on species that are rare or that have commercial value.

Chris -- For the US, enrichment of the environment with regard to nitrogen will be an issue.

Alison -- Invasive plants are known to have an interesting phenomenon, which is that currently benign non-native plants can begin to spread rapidly. The park should be aware that invasive plants of the future can look like they behaving well now. The park should develop a relation with APHIS, (Animal and Plant Health Inspection Service) to understand how it might respond when there is a need for bio-control.

Nishi -- A related thought is that sometimes a non-native species can be very effective at cleaning up problems.

Geneva -- Summit restoration. We have no very good idea as to how to restore natural vegetation on summits that receive a lot of use.

Tom -- You might look at research to understand the man-made environment around buildings at SERC, to know what is here and whether there are potential management issues, including the potential for spread of invasives from this site.

David -- We need help with practical means for soil sterilization for soils that we bring into the park.

Alison -- What about "monumentation" of research plots. What is an acceptable set of markers for a plot? Perhaps some valuable plots need some kind of change over.

Mary -- What is going on in Canada that might have an effect on us?

Roger -- Well, we assume that most migration is heading north. But, seriously, one thing we are looking at is the European Brown Longhorned beetle, which affects red spruce. It is probably already here. The question is when it will become a problem.

Mary -- Are there changes in energy use that could effect the park?

Roger -- We are dead against the LNG development in St. Andrews -- but there is another one being built in St. John, so, we can't scream too much. Having big ships angling around in the approaches to the Western Passage is a dangerous business.

Mary -- I am concerned that we are headed toward using coal again. Are we anticipating the effects of sulfur emissions?

Roger -- A related question is emissions from cruise ships. That is slated to get better, with new regulations.

Kathy -- what about pollution from fires in the boreal zone?

Roger -- We have been impacted by burns in Quebec, as well as ones from the south. I am not sure that there is

much that we can do about it.

Ivan -- One question with regard to fire -- Is it true that there are well defined guidelines as to how fire management is to be approached? With alterations to the landscape -- pathogens and climate change -- resulting in large amounts of woody fuel in the park, are there management policies dealing with this?

David -- Because of the high level development around Acadia we are not using fire as a management tool. If there was a fire here, it would be put out as quickly as possible.

Ivan -- So, my question is that in an environment with more woody fuel, would you consider changing policies?

Bill L -- Put simply, if you end up with a whole lot of dead trees, what are you going to do about it? For example, with the lack of snow cover this year, if we have a dry summer, we are looking at a real risk. Is there something you should do about it?

Mary -- You raise an interesting question, but the Park has a policy of total fire suppression.

Bill L -- The question is one of mechanical thinning. Salvage operations on the dead trees.

Roger -- We do have fires in boreal forests. The cycle is very long, but when we have them they can be very big fires.

Glenn -- This leads into the topic of whether there are things we can do with modeling. Not only to guide research questions, but also to guide management policies.

Alison -- Landfire.org is a site that deals with models of presettlement conditions. This could be a valuable resource. But ... given the no cutting policy in the park, you should certainly be looking at evacuation plans.

Kathy -- This connects to changes in land use. I would like to look at this question of what research we would need to be prepared for a build- out of the island.

Chris -- As you get to 5, 10, 15% impervious surface thresholds, you begin to run into real problems. You might find that you have some hotspots on the island that need attention.

Mary -- We have found that spruce grouse are in many case outside the park, rather than in the park. It would be useful to know the impacts of development on spruce grouse.

Ivan -- Light pollution is one example of a class of issues related to the interface between the park and its boundaries. This is a class of general issue that is an area of research.

Alison -- If the park could find ways to protect unique and unusual bedrock types, such as the gabbro-diorite on the west side of the park.

Roger -- This leads to the broader question of being able to extend your monitoring activities outside the park boundaries, along with extending your influence.

Bill L -- You get to a question of whether you really have a natural system anymore, and then what level of management you should have, given that. At some point you begin managing to provide a nice visitor experience, rather than conservation of the ecosystem.

Roger -- This becomes a philosophical question, as well as a research question. But it is an important question. It is a question that tends to be in the background -- what are the aims of protecting a dynamic system -- but at some point it comes into the forefront.

Mary -- again, we are more process oriented -- trying to manage to exclude anthropogenetic influences

Tom -- but you have to balance that with the fact that there will be many more people on the Island, which dramatically increases the probability that you will have a fire in the future. Given that, you have a management question, whether you want to face it or not is another question. As an example, in the Pine Barrens, they have

decided to have intentional removal of timber as a way to manage fires.

Jill -- In doing some boundary work, I found huge slash piles on the park boundary. In one case I saw a water line that was drawing water from the park. I have seen houses butted up right against the NPS markers, along with their septic fields. I have a sense at Acadia that we need to look out at the boundaries.

Alison -- I wanted to suggest idea toward the future desired conditions. Key components would include the idea that native ecosystems are desired. There would also be a diversity of forest age classes. Exemplary habitats might include the fact that some of these areas must be unpeopled. A triage approach might focus on things that are likely to disappear sooner rather than later -- shell middens as an example. Another would be summit restoration. And, finally, fire management issues as we are discussing.

Kathy -- What about management of easements?

Roger -- it depends on the rights.

David -- The easements differ. The negotiations reflect different management objectives.

Jill -- They are extremely variable. Some of them are sloping lawns that establish a view shed. Others are whole islands.

Roger -- Are you, for example, concerned with conserving the present nature of the islands? Why not think in term of studying a developing area? My thinking is in using the easements as a way to get some diversity, as a way to study impacts.

Bill L -- One of the advantages of islands is that you have less human pressure, which gives you a way to study impacts by comparison.

Jill -- A couple of small picture things. Last year park staff asked about revegetation using bryophytes. That could be a useful research question. Another is questions about how to amplify populations of rare species.

Nishi -- Looking at the contributions or plants to global warming is a potentially fundable research project. Some recent work shows that plants are a significant source of methane.

Nishi -- Lead is another potential research issue.

Chris -- Maybe something along the social science area -- you have this expanding ecological footprint -- how do you get people around the park so that they are not antagonistic to the goals of the park.

Tom -- we can expect that there might be pressure to use the parks as an energy resource.

Alison -- I visited Great Smokey Mountains last spring for the wildflower pilgrimage. One thing to think about is that if you lost the shade from the eastern hemlocks, that changes the nature of the stream. Another question is how to you bring large numbers of people to the park without having them trample everything. Some answers: the trails are very well marked, are limited in scope, and much more pleasant to be on than it is to be off the trails.

Role of Acadia in the Research Landscape

How can Acadia be a platform for research that interests you or your agency, apart from the Park's management concerns?

Richard -- Given this island archipelago concept, one of the big events that goes on here is that this is an migration corridor. This is certainly true for birds, and for bats, but is also true for insects. And it involves much more than Monarch butterflies. There are other butterflies, moths, and dragon flies that are also migrating species. The migrations tend to be concentrated on coasts. These peninsulas sticking out in the ocean are great study sites. How to study it is a more difficult question. Good study can require numbers of people with substantial expertise.

Richard -- I also want to point out that spring raptor migration is not studied. The focus has always been on fall migrations. The feeling has been that the spring migration is diffuse, and that volunteers don't want to sit all day and

not seeing anything. But, as I have been watching this more closely -- a couple of years ago I saw 42 eagles come in over a period of a couple of hours. So, it may be that this is a nice migration issue that should get more research.

Nishi -- How am I going to sell this park as an exciting research opportunity? Maybe it has to do with giving out research scholarships ... One thing to do is to identify specific research areas of interest and make them well known, coupled with funding. When I see that most of the projects in the past have been regional, it makes me think that there has not been enough publicity.

Roger -- you can provide space for researchers and graduate students.

Alison -- I would suggest a brand new program focused on vendors of high tech field equipment that is based around research questions of interest to the park. This could be a big deal, if well endowed companies could be involved.

Nishi -- In a related idea, set up a research lab. This is something that we don't have at COA -- and if there were facilities here, that would be very interesting.

Chris -- NEON -- National Environmental Observatory Network -- perhaps we could make a pitch to develop an observatory at Acadia that could be plugged as a module into the larger network, but keeping in mind that the way to do something with NEON is to get started on your own.

Jim -- Are the gauged watersheds an initial component that could be part of the kind of offer you are talking about?

Chris -- Well, yes, but they also have a high tech vision. The university has some real expertise with sensing technologies, so that we could become the people who they are looking to as they get this going. That is the idea, get started and become the model to emulate.

Kathy -- there is also a question of how much infrastructure is involved. Being a satellite site could be attractive, but being a main site could present more conflicts with other objectives.

Glenn -- the heavy focus on infrastructure and technology grows out of the fact that the funding comes out of the NSF infrastructure pot.

Jim -- can we talk about remote sensing in general?

Chris -- Here is an example. We are looking at electronically sensed fluorescence in algae as a way to monitor lake ecosystems.

Ivan -- The precipitation network is an example of a high quality site where you can easily get access to excellent data.

Kathy -- Are there good remote sensing research topics that could be done at Acadia?

Ivan -- air pollution stress on trees.

Nishi -- If you can get NASA interested -- such as looking at research on topics that would be potentially relevant to interplanetary research. This ties into the questions of instrumentation, high technology, and remote sensing.

Bill Z -- In your case, Nishi, with your focus on evolution in extreme environments, that is a reasonable connection, isn't it?

Nishi -- The same thing could apply to, say, methane research.

Ivan -- I am currently involved in NSF grants. They are very competitive, and one of the factors that weighs heavily is the public component. If this facility had a prepackaged way to do that, it could make working with this facility much more attractive. The alternative is our having to put that together all the time.

Glenn -- and what the panels are looking at is an operational plan. So that you can identify outcomes and measure them.

David -- Let's be sure to follow up on this -- pulling together researchers and park staff to look at ways to explore this kind of cooperative effort.

Alison -- Serving underrepresented groups is part of the requirement as well -- we should give thought to who these groups are.

Alison -- When I have looked on the web for a published bibliography of research at Acadia, I have had difficulty finding that. It should be more visible.

Glenn -- Particularly as the vital signs monitoring program gets underway, you will be collecting data that will make it easier to see trends. That, in itself, should make it attractive to do research in the park -- you are starting with a foundation of data that you can use to put research in context.

Nishi -- another thing to think about is getting high school students involved in research.

Nishi -- Having a really nice greenhouse facility would stimulate biological research.

What Can SERC Do For You?

How can we make SERC useful for you? How can we make it an attractive place for you to do research?

Roger -- One area is restoration. To put some demonstrations in would attract people from the urban environment who are dealing with similar environments.

Geneva -- We already give staff to other parks, such as trail crews, to teach what they have learned. It would be useful to turn that around.

Tom -- Have you visited other institutions -- Harvard Forest, Woods Hole -- to see what makes them tick? How do they attract professors, students, and funding?

Roger -- Have you considered extending the park underwater?

Jim -- There are some jurisdictional challenges ...

Roger -- The opportunity is to extend the range of research ...

Jim -- Exactly. And the research issues are there, regardless of jurisdiction.

Jill -- this is a lovely facility, but a lot of the research takes place on MDI. Have you considered a boat?

Jim -- There are some logistical issues, particularly in winter. You need a car on the other side to get around. And ... it can take as long by boat as by car. But, SERC is more than just a place, and it extends over the whole park. I am just as interested in research on MDI, too, even if it does not involve this facility.

Chris -- Will you have site licenses for GIS?

Jim -- Yes. Which brings up other technical infrastructure issues, such as connectivity, that we are working on.

Tom -- Do you have biological collections? Are you wanting to increase those? Do you do curation?

David -- We have a collection with about 1.5 million objects. Most are cultural -- but the natural items are growing. We would like to have representative samples of all species. We also have the specimens and field notes from the William Procter collection.

Tom -- I would encourage you to keep at it, and don't underestimate the cost of continuing to manage a growing collection.

