Island Monitoring Task Force
Three-year Pilot Project 2004-2006

Final Report

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Sea Grant
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FINAL REPORT

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*Please refer to each island's separate hard-copy binders and digital files for all field and GIS data, maps, and photos.

** Please refer to the separate document, *Methods Manual: Monitoring Recreation Impact on Islands*, for a complete overview of all field and GIS methods (including blank data sheets, step by step descriptions of field methods, and how to construct an island's GIS database and companion maps).

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Introduction

a) Report Content

This report and its companion documents, *Methods Manual: Monitoring Recreation Impact on Islands* and seven island-specific reports, collectively document three years of work for the environmental monitoring pilot phase (2004-2006) of the Island Monitoring Task Force. The intent is to ensure that all aspects of the project, from goals to field methods to data, are all documented in a format available for future reference and use by the Maine Island Trail Association, the Maine Bureau of Parks and Lands, Maine Sea Grant, Task Force members, volunteers, and future monitoring staff.

The physical format of the report includes three components:

1. **Island Monitoring Task Force Final Report** (This document which includes history and background information about the project and its goals, an overview of the protocol used and why, and a series of recommendations and lessons learned to help set priorities for the future.
2. **Methods Manual: Monitoring Recreation Impact on Islands** (including blank data sheets, step by step descriptions of field methods, and how to construct an island's GIS database and companion maps).
3. **Seven island-specific hard-copy binders and companion DVD's** (including each island's complete field data, GIS database, selected printed maps, and photos).

b) Project Background

Project History

In December 2003, the Bureau of Parks and Lands of the Maine Department of Conservation (BPL) and the Maine Island Trail Association (MITA) published the *Recreation Management Plan for the Public Islands on the Maine Island Trail, 2004-2014* (The Plan). The Goal of The Plan is "to provide an opportunity for visitors to discover and enjoy a coastal water trail in a manner that conserves the outstanding natural and cultural values of the state-owned islands on the Maine Island Trail (piii)." The Plan states that "monitoring island conditions and social impacts is necessary to provide relevant information for ongoing recreational use management decisions (p.35)." While MITA had been monitoring island changes in an informal way for years (a process well documented by MITA and not the subject of this report), The Plan's concept was to enhance this approach with science-based methodologies providing quantifiable data that island managers can use to guide island use. Specifically, The Plan recommended the following (p. 35):

- Set up a Monitoring Task Force to develop a long term monitoring plan for the public islands;
- Identify the social and environmental indicators for visitor experience and use area conditions;
- Define standards for the level of acceptable change;
- Determine field research methods to monitor conditions and experience against established standards;
- Enhance existing monitoring programs and data collection techniques to align with new monitoring goals.

The "Summary of Major Recommendations" (p. 48) states:

- Set up a Monitoring Task Force to develop a long term monitoring plan to track environmental and social changes against established indicators and standards.
- Enhance volunteer monitoring programs and data collection techniques to align with new monitoring initiatives

The Bureau of Parks and Lands and MITA established a precedent by identifying the need to monitor islands with a specific goal of providing data to inform management decisions. In direct response to the above recommendations, the Island Monitoring Task Force officially formed in January of 2004 for a three-year pilot phase. Recognizing that an effective long term monitoring plan ultimately should balance the management needs of island environments, social perceptions and use number, the Task Force decided that the pilot phase should focus first on developing effective environmental monitoring methods. Simultaneously, and more recently, MITA and partners have begun tackling a social perceptions assessment and more formally tracking use numbers with the help of a University of Maine Ph.D. student. While all three measures are needed to effectively inform management, this report focuses specifically on the methods and results of environmental monitoring only.

The three year environmental pilot phase was coordinated by Maine Sea Grant with a Task Force that included governmental, academic, and non-profit representation. Another recommendation of The Plan was to make use of existing collaborations and increase partnership opportunities in the implementation of the Plan. The project was a good fit for a Maine Sea Grant partnership with MITA and BPL. Maine Sea Grant's mission is to provide science-based information, research and outreach about the marine environment and facilitate decision-making in complex coastal problems; island monitoring case studies were identified as a priority in Maine Sea Grant's Implementation Plan for 2003-2005.

The diverse Task Force membership strove to highlight expertise in island management, recreation ecology, science, and stewardship. The role of the Task Force was to advise the project as it moved forward, make sure the work was relevant and effective, link the project to opportunities and resources, and serve as a sounding board for the project's working group and staff. Additional experts and advisors were called in as needed making Task Force membership somewhat fluid. A smaller and more consistent Task Force working group led both the on-the-ground work, as well as setting the goals and objectives of the project (For a complete list of people involved, please see Appendix A). In addition, over the course of the three year pilot phase, the Task Force benefited from more than a dozen field volunteers, as well as two graduate-level and two undergraduate-level interns working both in the field collecting data and in the lab mapping results into a GIS database.

It soon became apparent to the Task Force that The Plan provided the impetus to develop island-monitoring methods that could be applied to a wider scope of coastal Maine's recreational islands, and that this project could have broad appeal to diverse island managers/owners throughout Maine's coast, public or private, on the Maine Island Trail or not. An effort was made throughout the process to keep other island managers informed and involved in the project, which in return, benefited from their advice.

Early on, the Task Force also identified the advantage of island users becoming actively involved in monitoring the islands they love to visit. The long term intent (beyond the three-year pilot) was to engage island users in producing quality-assured, science-based observations, and enhancing existing volunteer monitoring programs. Though the pilot project engaged a number of volunteers, much work remains to develop a volunteer plan. (More on this in recommendations section.)

Ultimately, baseline studies are effective only when follow-up monitoring identifies change, and data are used to guide management decisions. The intent of this three-year baseline project was to develop the foundations of a long-range island-monitoring plan. This report documents the process and results so far in the hopes of informing future monitoring objectives.

Goals and Objectives

The charge outlined in The Plan provided a starting point for the Task Force. The next task was to develop a vision, goals, and objectives specifically addressing this three-year environmental monitoring pilot project. Early in 2004, the Task Force working group agreed to the following:

VISION: Management decisions about recreational use of Maine islands will be informed by monitoring that tracks changes occurring as a result of recreational use patterns.

GOAL: To develop recreational use management information and techniques that island owners and managers can use to achieve their resource and recreation management objectives.

MONITORING OBJECTIVES

- Conduct inventory of present natural resource and social conditions on representative subset of islands.
- Identify natural resource and social indicators of recreation impact and define their associated standards.
- Develop monitoring protocols that identify and monitor change caused by recreational use, for comparison to established standards.

PROJECT OBJECTIVES

- Develop a monitoring toolbox for the range of island and intertidal conditions and uses that can be applied by a diversity of island owners and managers, volunteers, and students.
- Develop a plan to institutionalize the monitoring program to ensure its longevity.

When the Task Force needed a shorter statement, the following was used as a **summary goal statement:**

> *The goal of the Task Force is to develop methods for assessing recreational impacts on islands and to provide managers/island owners with the kinds of impact-information needed to make decisions about island use.*

Why Collect Data? (Rationale)

Repeatedly throughout the three years, members of the Task Force asked "Why are we doing this?" The group felt this question crucial in keeping the work focused on the needs at hand. Maine's coast is speckled with hundreds of islands that are used for recreational purposes by thousands of tourists each year. Coastal tourism provides more economic return to the state than fisheries and aquaculture combined. Nature-based tourism opportunities are important to the state's tourism economy and that of many small coastal towns. Sea kayakers, pleasure-boaters, sailors, row-boaters, and schooner passengers journey to the islands each year to get a taste of paradise. MITA reports that between 1996 and 2002, the use of Maine's public islands increased by 50%. As interest in recreational opportunities on Maine's public and private islands continues to grow (or remains steady according to recent informal MITA observations), recreation management will increasingly depend on information about the relationship between island use and island conditions. Careful management of this use can mitigate ecological impact, but effective recreational management is dependent on science-based information.

Sid Quarrier, a long time MITA volunteer and active member of the working group on the Task Force, has long advised MITA and BPL on site-specific management decisions. Sid's years of experience visiting islands and working with MITA gives him a great perspective to answer the questions "why monitor islands?" or "Why collect data?" Sid states, "To make management decisions, a process that goes on continually, we need to know what is here, how it works, how it is changing, why it is changing, and what is the role of recreational use in the change. For the different use areas (tent sites, paths, intertidal and shore access areas, etc.), what are the conditions, what are the ongoing changes in character and rate, and what are the overall changes on the islands that are occurring outside the specific use areas as a result of recreational use? What are the different impacts from use on different types of ground conditions: rock, sand, forest, meadow, organic soil, mineral soil, etc.? How are the kinds and rates of change related to the levels and kinds of recreational use? In some instances these changes raise island management issues and the need for deciding whether or not to manage and if so what kind or amount of management." These are the questions that an effective environmental monitoring plan can help address.

For the purposes of the three year pilot, the Task Force identified the following informational needs that environmental monitoring could address:

- The cause and effect of impacts at specific sites.
- The relationships between use numbers and impact.
- The effects of resource management efforts (e.g., soil compaction as a result of tent platforms on Hells Half Acre).
- Site specific resource impacts.
- Prioritization of management needs.
- Quality science to help future funding needs.
- Periodic comparisons of conditions to standards of acceptable change.
- Information gaps needed to create sound recreation management plans for coastal islands in Maine.

Research Context

Though this report is not a literature review, it is worth describing the research context for this project. Recreation ecology is a growing field of study that examines, assesses, and monitors visitor impacts to natural areas. Recreation ecology is a step beyond traditional "carrying capacity" research which looks at the relationship between the amount of use and the intensity of impact. Recreation ecology recognizes that the use/impact relationship is complex and situational and depends on a diversity of social and ecological factors. Recreation ecologists encourage looking at a suite of impact indicators (such as soil compaction, campsite size, and trail condition), then comparing those indicators to their established standards of acceptable change. This indicators and standards approach is the context within which this project functioned.

For a complete bibliography of resources and literature used, please refer to Appendix C.

c) Project Implementation Timeline

Over the course of two field seasons (2004 and 2005), baseline assessments were conducted on a total of seven islands. Non-field seasons in those first two years were dedicated to defining project goals and objectives, identifying islands for pilot monitoring, researching appropriate methods and monitoring protocols, preparation for field work, volunteer and field staff recruitment, and data management using GIS mapping software produced by ESRI and other computer application. In the first field season, three islands had preliminary data collected with various methodologies that were tested and assessed for their practicality and usefulness in this project. Some methods were discarded while others were subsequently refined. In the second field season, the original three islands were re-assessed for data completion, and baseline data was also collected on four additional islands. The third year, 2006, was dedicated to completing all GIS-based data management, refining methods, and compiling this report.

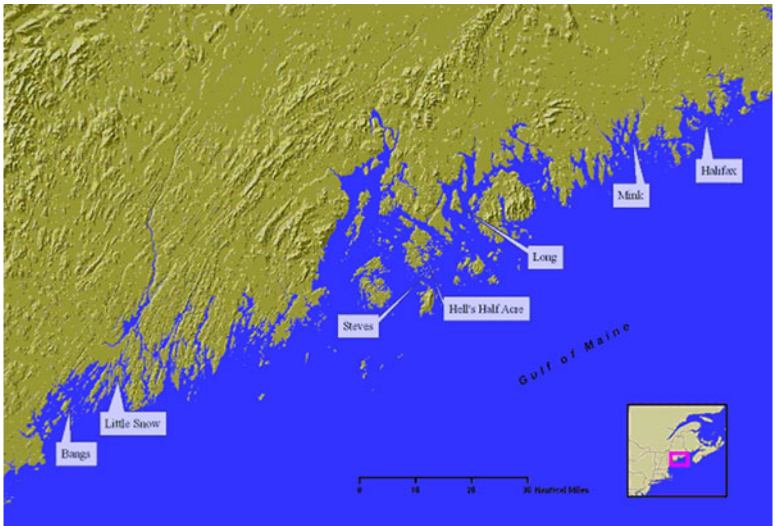
d) The Seven Pilot Islands

*The field and GIS data, maps, and photos for each island are available in separate island-specific hard-copy binders and digital files. The information below serves as an overview of these islands.

Seven islands were specifically chosen for baseline monitoring because they were representative of the suite of island types on the Maine Island Trail with respect to:

- Proximity from the mainland, population centers, and launch areas
- Use levels and trends
- Condition and number of campsites and use areas
- Vegetation condition
- Conditions at landing areas and in the intertidal zone
- Overall geology and island morphology

The islands are introduced here geographically from west to east. Note: Each island's specific impact indicators, field methods, and complete monitoring data can be found in the island's individual report.



Locator map of seven pilot islands. Map produced by Jodi Jacobs.

Bangs Island
Bangs Island in Casco Bay is a public island with a history of local use though it was only added to the Maine Island Trail and listed in MITA's *Handbook* in 2004. It was the only island in the group that was new to the Trail, thus making it a good candidate for establishing a baseline.

Little Snow Island
Little Snow Island, in the very protected Quahog Bay, is one of the more frequented public islands on the Trail. It is a popular spot for day and overnight users and has long been known for hosting an osprey nest located right above one of the three campsites. Little Snow has scattered high marsh areas on some of its shores.

Steve's Island
Steve's Island, in popular Merchant Row off of Stonington, has seen an increasing amount of use and impact in the last decade, including an expanding number of campsites that managers have needed to cull. It is a small wooded island with a network of trails meandering between the island's five (four as of 2005) designated campsites.

Hell's Half Acre
Hell's Half Acre, also in the Merchant Row region, is among the most visited public islands on the Trail, and is within very close proximity to a popular boat launching area. It has been the subject of careful observation by MITA for years, and was chosen as the location of MITA's first installation of tent platforms intended to combat soil compaction and campsite sprawl. Managers were interested in tracing the effects of management decisions.

Long Island
Long Island, in Blue Hill Bay, is the only island not on the Trail. Acadia National Park holds a conservation easement on this privately owned island and manages all aspects of its use. A popular local use island, Long Island is large (about five miles long), and has up to five camping area scattered along the eastern shore.

Mink Island
Mink Island, the smallest and least-used island in the group, is located Downeast where recreational boat traffic is just beginning to increase. Mink's lone campsite, located up a short forested trail, receives little use, giving the island a remote feeling despite its location in a protected bay.

Halifax Island
Halifax Island, also Downeast, is owned by the Maine Coastal Islands National Wildlife Refuge, and is open for MITA members to camp with permission. A gravel bar connects two portions of the island, the larger of which is closed to all use for habitat protection. Halifax is the group's least protected island with typical offshore conditions (few trees, shrubby vegetation, gravel shores, beach pea…)

Methodology

This section of the final report is an overview and discussion of the methodology used in this project. For step by step descriptions of field methods, and how to construct an island's GIS database and companion maps, please refer to the accompanying document: *Methods Manual: Monitoring Recreation Impact on Islands.*

a) Baseline Inventories and Impact Indicators in Island Environments

An effective environmental monitoring plan starts with a baseline inventory or an initial assessment of island conditions that describes key indicators of impact and describes, maps, and photographs the island's use area, location, development, and condition. This, in simple terms, is the function of the baseline inventories conducted on the seven pilot islands. Results of future monitoring can be compared to these initial assessments to determine any changes in island conditions

We relied heavily on existing recreation impact monitoring methods (see bibliography in Appendix C). However, islands present a unique recreational environment. Unlike large wilderness areas, for example, where use tends to be concentrated specifically on trails and at campsites, people visiting islands move freely through three environmental zones: terrestrial, shoreline, and intertidal. Thus, methods for baseline assessments needed to be developed for each of the three zones and their specific impact indicators.

This image of Bangs Island shows the three island zones.

The **terrestrial (or upland) zone** is the area of the island above any risk of salt water flooding (except in extreme tide and weather conditions.) Terrestrial zones are usually composed of soil and land-based vegetation, and are the site of camping activity. On some islands, the "terrestrial" zone may be soil-less and composed of rock, shingle or sand (such as the cobble bar on Halifax Island).

The impact indicators in the terrestrial zone that this project focused on include:

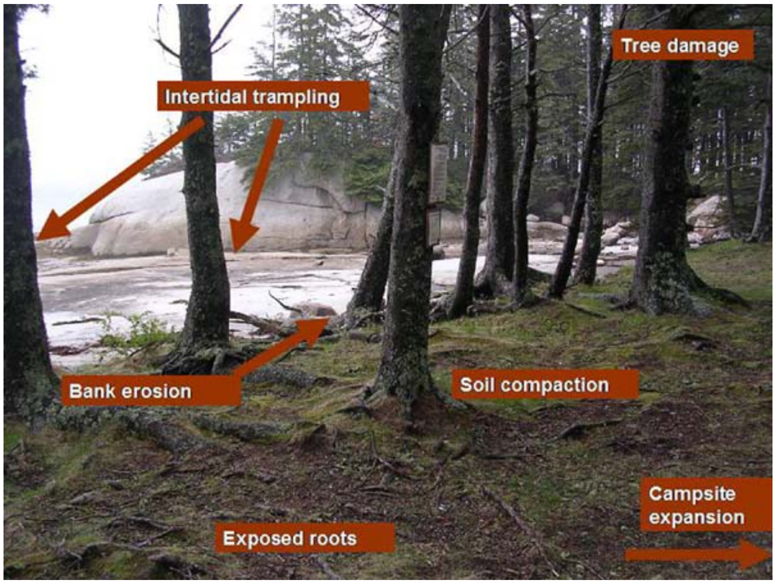
- Overall campsite condition class
- Campsite size

- Potential for un-managed site expansion
- Vegetation ground cover
- Exposed soil
- Tree damage
- Root exposure
- Fire rings
- Trails entering and exiting site, and length and condition of other interior trails
- Litter
- Human waste/toilet paper
- Other areas of special concern

The **shoreline zone** is the transition area above the mean high tide line and below the terrestrial zone. It is often considered the "bank" area. Because the shoreline zone is the transition between the two other island zones, it is often difficult to determine exactly where it begins and ends, and it might include characteristics of both the intertidal and the land. Vegetation in the shoreline zone is salt tolerant.

The impact indicators in the shoreline zone that this project focused on include:

- Overall shoreline condition class
- Substrate of shoreline at landing area
- Width of shoreline disturbance
- Vegetation trampling
- Bank erosion
- Tree damage
- Root exposure
- Fire sites
- The number and condition of access trails through the shoreline
- Human waste and litter



Multiple impact indicators are visible in the main meadow campsite of Hell's Half Acre and its adjoining shoreline and intertidal zone.

The **intertidal zone** is the area below mean high water and above mean low water. It is the region where all life forms have adapted to salt water flooding for multiple and varying hours of the day/night. In the absence of docks and piers, as is the case on all the pilot islands, the intertidal zone is, by necessity, the zone where all boats accessing the island land and launch.

The impact indicators in the intertidal zone that this project focused on include:

- Abundance of dominant space occupiers
- Species diversity in low tide zone
- presence/absence of barnacle hummocks
- Age of *Ascophyllum nodosum* (Knotted Wrack)

Delineating three island zones and their associated impact indicators helps define the kinds of methodologies needed to assess island impact and conditions, but there still remains a tremendous amount of variability from one island to the next. How much use does the island get? What is its proximity to launching areas? What is its dominant vegetation? Are there any trees? What is the underlying geology? How big or small is it? Arguably, the diversity of Maine's islands is one thing that makes them so compelling to visitors. It also creates challenges for standardizing monitoring methods.

No two islands are the same, and no two islands will require the same suite of methods. It is important to acknowledge that decisions on **when to use which inventory protocol** on an island are based on a variety of factors including:

- The island's description in the Public Island Management Plan, if applicable;
- Information and management goals provided by the island's managers/owners;
- Use numbers and patterns;
- Island type and environment (wooded or shrubby, granite ledge or sand bar, etc.);
- Location (inshore/offshore, proximity to launch area, etc);
- Presence or absence of various impact indicators on the island;
- Condition of island at time of monitoring trip;
- Environmental constraints such as tide and weather;
- Human constraints such as staff time for fieldwork, level of experience/expertise, and funding availability;
- Prioritizing and decision-making by field staff while in the field;
- Equipment and data availability while in the field; and
- How the data will be processed or maintained (paper files, GIS databases, etc.)

b) Field Methods Overview

Though each island has a unique combination of data collection methods, the Island Monitoring Task Force settled on seven standard protocols from which to choose for each island's baseline inventory. The protocols are briefly introduced below but for step by step descriptions of field methods, please refer to the accompanying document: *Methods Manual: Monitoring Recreation Impact on Islands.*

- **Field Mapping and GPS:** Sketch maps (prepared ahead of time and used in the field) are an important component of every method outlined below. In addition, some line and point data can be collected with GPS, such as high and low tide lines (though accuracy will depend primarily on the GPS unit used).
- **Survey checklist:** This is an initial island-wide description of perimeter and shoreline attributes obtained by circumnavigating the island (or the extended use area if the island is too big, such as Long Island). Using a map, changes in the islands characteristics are noted as sections. Each section is categorized for a series of attributes such as landability, substrate/habitat type, dominant species, areas of concern, etc. Back in the lab, this data is incorporated into the GIS.
- **Campsite Monitoring:** This methodology has been adapted from (and heavily relies on) Jeff Marion's *Developing a Natural Resource Inventory and Monitoring Program for Visitor Impacts on Recreation Sites: a Procedural Manual."* Monitoring parameters include: measuring/mapping campsite boundary (radial transect method), fixed-point photography, areas of special concern, inventory indicators, and impact indicators including condition class, vegetative ground cover, exposed soil, tree canopy cover, tree damage, and root exposure.
- **Trails Monitoring:** Adapted in part from Acadia National Park's use of trail-based condition classes, and modified for the purpose of monitoring island trails, including mapping trail location and function, assigning a condition class to trails where they intersect with the high tide line (access points) and "in to three meters," and in some cases, interior trails as well.
- **Shoreline Monitoring:** With the mapping method initially adapted from Canada's Department of Fisheries and Oceans *Shorekeepers Guide*, this includes using a shoreline transect to

systematically photograph and map shoreline use areas. Additionally, indicators such as root exposure and vegetation trampling, and condition class are also used.

- **Intertidal Monitoring:** Adapted from several sources including: Canada's Department of Fisheries and Oceans *Shorekeepers Guide,* Brosnan and Crumine's Intertidal Trampling studies, and Murray et al.'s *Methods for Performing Monitoring, Impact, and Ecological Studies on Rocky Shores*,, and other resources including recommendations by Maine-based and other intertidal experts. Focusing on use area, this method includes intertidal transects to systematically inventory percent cover of abundant species, rapid low-tide searches, assessing/mapping barnacle hummocks, and aging ascophyllum.
- **Photo Transect Method:** This method is used when there is simply a need for fixed-point photography as the only method for documenting an island's particular area or features. Though these photo points can be mapped, mapping and measuring are not specific objectives of this methodology.

c) A Note on Condition Classes

In a condition class evaluation, verbal descriptions are rated on a scale that standardizes level of impact ranging from least to most. Assigning use areas a "condition class" was a system used within three of the above methodologies (campsite, shoreline and trails monitoring). Though details will be covered within the discussion of each of the seven methods, all three condition classes are listed here because they have captured significant attention from the Task Force with the hopes of standardizing them for use by volunteers.

Campsite Condition class	**Trail condition class**	**Shoreline condition class**
This is general assessments of campsite condition. This system and the rest of our campsite monitoring methodology is based on Jeff Marion's "Developing a Natural Resource Inventory and Monitoring Program for Visitor Impacts on Recreation Sites: A Procedural Manual."	This rating to be used specifically when monitoring trails that enter an island's terrestrial zone from the shore. Two conditions are assessed using this same rating. The first is where the trail intersects the island perimeter (or "high tide line" on our maps). The second is three meters in from that point. The actual ratings were based on a system used by Acadia National Park.	This condition class rating was designed by field workers after extensive discussion about which shoreline indicators best help track impact issues. In this case, the condition class is assigned to the whole length of shoreline area as defined by the transect-based method.
Condition Class 1: Recreation site barely distinguishable; slight loss of vegetation cover and /or minimal disturbance of organic litter. **Condition Class 2:** Recreation site obvious; vegetation cover lost and/or organic litter pulverized in primary use areas. **Condition Class 3:** Vegetation cover lost and/or organic litter pulverized on much of the site, some bare soil exposed in primary use areas.	**Condition Class 0:** Trail barely distinguishable; no or minimal disturbance of vegetation or organic litter (typically applied to the undistinguishable sections of discontinuous trails). **Condition Class 1:** Trail distinguishable; slight loss of vegetative cover and/or minimal disturbance of organic litter. Includes shrubby overgrown trails with obvious tread of bare soil that can no longer be seen because the shrub cover has	**Condition Class 0:** No apparent impact **Condition Class 1:** slight shoreline and bank vegetation trampling but not apparently permanently damaged **Condition Class 2:** Some erosion areas and/or some exposed roots and/or some damaged vegetation **Condition Class 3:** 25% erosion and/or 25% exposed roots and/or 25% damaged vegetation **Condition Class 4:**50% erosion

Condition Class 4: Nearly complete or total loss of vegetation cover and organic litter, bare soil widespread. **Condition Class 5:** Soil erosion obvious, as indicated by exposed tree roots and rocks and/or gullying.	overgrown the trail. **Condition Class 2:** Trail obvious; vegetative cover lost or disturbed **Condition Class 3:** Vegetative cover and organic litter lost in nearly all places, but little or no erosion. **Condition Class 4: Soil** erosion or compaction in tread is beginning in some places. **Condition Class 5**: Soil erosion or compaction is common; tread is obviously below ground surface.	and/or 50% exposed roots and/or 50% damaged vegetation **Condition Class 5:**more than 50% of shoreline/bank erosion, and/or exposed roots, and/or damaged vegetation.
[NOTE: Before future use, the condition classes should be streamlined to each contain the same number of categories.]		

The advantage of using a "Condition Class" rating is that it provides a rapid survey method that standardizes the language used to describe impact. Monitors are limited to the language provided in the rating, so one person's designation of a trail as a "2" will, by definition, be the same as another's. There is certainly some subjectivity inherent in the system, however. For example, one trail that looks like a "2" to one person may look like a "3" or a "1" to another. For this reason, it is always a good idea to have two people working together to determine a condition class rating to make sure that consensus keeps subjectivity to a minimum.

If over two monitoring seasons a trail or campsite changes by just one condition class, then managers might assume that subjectivity is at play. However, if the trail or campsite changes by two or more condition classes over two monitoring seasons, then it is safe to assume that there is a significant enough change occurring in the condition of the indicator and managers should take note.

Note: See the recommendations section about the need for a photo manual to complement the verbal condition class descriptions. This work was begun by graduate intern Jodi Jacobs and the draft is included in Appendix D.

d) GIS Mapping and Data Management Methods

The three-year pilot project made extensive use of Geographic Information Systems mapping and database management technology. Thus, our methodologies pre-supposed access to GIS technology and know-how, and in many cases, were dependent on GIS as a tool for managing and presenting data collected in the field. Two College of the Atlantic graduate students were hired as GIS technicians to implement the entire project's mapping needs and keep track of all mapping protocols. The *Methods Manual* provides extensive instructions on all aspects of GIS use that should help ensure consistency in any future GIS applications (including detailed GIS how-to steps and extensive notes on all actions taken for each island's complete digital files).

There are opportunities and challenges inherent in utilizing GIS technology and mapping capabilities for the purpose of monitoring recreational impact on islands. One of the graduate students involved in this project, Jodi Jacobs, conducted her graduate thesis on this topic. While analyzing the potential and pitfalls of mapping in general, she specifically analyzed the GIS-related work of the Island Monitoring Task Force as her primary case-study. This student was involved in the project from field to lab. Thus, anyone who undertakes the use of GIS for monitoring islands should refer to her thesis because it provides an extensive analysis that is grounded in active project implementation. Her work stands alone as a valuable evaluation of the use of GIS in this project. Her final thesis was sent to MITA in 2006 and is also available from Natalie Springuel at Maine Sea Grant.

Conclusion and Recommendations

The Conclusions and Recommendations section is organized into two parts:

- **Where Goals and Objectives Met?** This first part revisits the original goals and objectives of the Island Monitoring Task Force and comments both concretely and philosophically on the status of each.
- **Recommendations.** The second section presents a series of recommendations for next steps that would contribute significantly to the future of the project, beyond the three year pilot phase. These recommendations attempt to summarize in one place all the suggestions and ideas generated by various members of the Task Force. These ideas are organized into four important areas (a summary of recommendations can be found on page 17):
  I. Recommendations on Developing a Long Term Monitoring Plan
  II. Recommendations for Island Managers
  III. Recommendations for to Enhance Future Field Work
  IV. Recommendations Specific to Each Method

Were Goals and Objectives Met?

The Island Monitoring Task Force began meeting in January 2004 as a result of recommendations made in the *Recreation Management Plan for the Public Islands on the Maine Island Trail, 2004-2014*. As mentioned earlier, the Task Force tackled their charge by developing a long term vision and a series of goals and objectives specific to the three year pilot project. Before launching into recommendations for the future, it is valuable to restate these goals and objectives with some commentary on successes so far.

VISION: Management decisions about recreational use of Maine islands will be informed by monitoring that tracks changes occurring as a result of recreational use patterns.

This was a three-year baseline project to develop environmental monitoring methods and baseline inventories on seven pilot islands, both of which would help build the foundations of a long-range island-monitoring plan. Ultimately, baseline inventories are effective only when follow-up monitoring identifies change and that data are used to guide management. The success of this vision will be measured in the years to come, when (and if) a future monitoring plan is developed and implemented. (More on this in the recommendations).

GOAL: To develop recreational use management information and techniques that island owners and managers can use to achieve their resource and recreation management objectives.

This overarching goal was about developing methods for monitoring impact and this goal has, by and large, been successfully achieved. Two years in the field followed by extensive time in the GIS lab has netted a series of methodologies that are valid and replicable. There are certainly some decisions that remain to be made before any future monitoring should occur, and these will be covered more extensively in the recommendations section. But we now have, in our hands, the parts necessary to replicate island monitoring. The document *Methods Manual: Monitoring Recreation Impact on Islands,* a companion document to this final report, provides in-depth instructions for future monitors about how to go about replicating field work. And the individual reports for each of the seven pilot islands provide the baseline data needed to effectively track change when future monitoring data are collected.

The indicators monitored in each of the methodologies where chosen specifically because they addressed a management concern. How the data will be used by managers in achieving their resource and recreation objectives will emerge in the future. It is important to note, however, that management objectives for each island may differ depending on the landowner. Thus, the project sought to identify a broad array of impact indicators and field methods that would meet a diversity of potential landowner needs.

MONITORING OBJECTIVES

- *Conduct inventory of present natural resource and social conditions on representative subset of islands*.

Seven islands were specifically chosen to be representative of the suite of island types on the Maine Island Trail, with respect to distance from the mainland and launch areas, use level and type, vegetative condition, and overall shape and size. Natural resource conditions, specifically related to recreational impact, were successfully inventoried on all seven islands. The hope is that, as subsequent years of monitoring data comes in on these seven islands, the changes observed can be considered representative of the kinds of changes that might be occurring on islands with similar conditions.

Though our objectives included inventorying social conditions, the Task Force concluded to focus the three year pilot project on environmental conditions only. In the last year, however, the social monitoring component has taken a giant leap forward as Andrea Ednie, a Ph.D. candidate in the University of Maine's Parks, Recreation and Tourism Department (working under Professor John Daigle) has focused her thesis research on social perceptions of the islands in the Stonington region. Multiple members of the Task Force steering group have been working closely with Ednie and her work will be presented to MITA, the Bureau of Parks and Lands, and the Task Force in Spring 2007.

- *Identify natural resource and social indicators of recreation impact and define their associated standards.*

Indicators of recreation impact on island natural resources were successfully identified in all three island zones (terrestrial, shoreline and intertidal), and baseline data was successfully collected for multiple indicators on the seven pilot islands.

Standards of acceptable change for each natural resource indicator, however, were not clearly identified through this work. The primary reason is that the Task Force concluded their role was to focus on methods and baseline data rather than management decisions. Defining standards is a management decision that needs to be informed by both environmental and social data, the later of which is not yet in. And ultimately, landowners and managers need to decide what indicators best reflect their management objectives for each island, and THEN determine appropriate standards.

Though in general terms, the islands' present conditions loosely serve as the standard by which they should be (and often are) managed, island managers might do well to decide how to address the questions of specific standards of acceptable change for individual indicators. It was the intent of the Task Force that the development of field methods and the collection of baseline data would inform this discussion, and certainly, multiple island managers have actively participated in the Task Force's work, helping ensure that indicators and methods would indeed be relevant.

As for the other part of this objective, the social indicators of recreation impact, the Task Force again focused exclusively on natural resources rather than social indicators, but Ednie's thesis will likely address this.

- *Develop monitoring protocols that identify and monitor change caused by recreational use, for comparison to established standards*.

Monitoring protocols have successfully been developed for all three island zones (terrestrial, shoreline and intertidal). This objective has occupied the majority of the Task Force's work over the last three years and this report provides the results in their entirety. While all of the monitoring protocols described in the methodology section of this report are ready to be applied in the future, three years of experience enables us to see that there are some protocol modifications that might make the process a bit easier. These are covered in the methods recommendations.

As for the future comparison to established standards, see the objective above.

PROJECT OBJECTIVES

- *Develop a monitoring toolbox for the range of island and intertidal conditions and uses that can be applied by a diversity if island owners and managers, volunteers, and students.*

The document entitled *Methods Manual: Monitoring Recreation Impact on Islands* achieves this objective. The methods are presented in a format that is ready to be used in the field, with a step by step guide and blank data sheets. The recommendations in the following pages list some modifications that might yet improve the methods and these should be considered before the next round of monitoring gets underway. These methods are in no way tied to island ownership or management jurisdiction and are available for use by any manager or owner.

Volunteers and students have been actively involved in this project from the beginning (a full list can be found in the acknowledgements section). Partnering volunteers and students with field staff was a formula that worked quite well in this pilot phase. Though there were hopes early on that the three year pilot phase would lead to a new volunteer monitoring program, the methods, as they stand now, do require that experienced field staff lead the charge. The Task Force and managers have begun to explore how the methods might be streamlined to enable volunteers and students to independently gather credible data. The recommendations section goes into this in more detail.

- *Develop a plan to institutionalize the monitoring program to ensure its longevity.*

No concrete plan exists as of now, other than informal discussions among Task Force members and Maine Sea Grant, about future monitoring options and needs. However, this objective is crucial to the successful long term outcome of this three year pilot phase. See recommendations for more on this topic.

Recommendations

The Task Force settled on a series of methods that seemingly would meet our goals and objectives and would work for our purposes over the three year pilot phase. There was much trial and error, methods were utilized and either discarded or amended, and decisions were made with the best available information. Yet there is never one exact and only way to monitor natural resources. The process of monitoring can always be improved. For this reason, the last section of this report is dedicated to recommendations for how to improve monitoring methods and for where to go with a monitoring plan in the future. In addition, each island's individual report includes specific monitoring and management recommendations (not contained here).

These recommendations attempt to summarize suggestions and comments made by various Task Force members throughout the project, though it should be said that they were written by the project coordinator, from the perspective and hindsight afforded by three years and hundreds of hours in the field and GIS lab.

These recommendations are predicated on the assumptions that environmental monitoring is a valuable exercise for helping island managers make informed decisions about island use, that impact monitoring is in the best interest of the islands, and that island monitoring should indeed occur in the future.

The recommendations are summarized in the box on the next page. In depth discussion related to each recommendation can be found following the box.

Summary of Recommendations

I. Recommendations on Developing a Long Term Monitoring Plan

Recommendation Ia: MITA and BPL should commit to a continued Island Monitoring Task Force that strives to meet the monitoring goals outlined in the 10 year *Recreation Management Plan for the Public Islands on the Maine Island Trail, 2004-2014 (The Plan)*, and define the role of that Task Force, including designating a new Task Force coordinator.

Recommendation Ib: Identify when the need is for baseline data collection vs. monitoring, and distinguish between the two.

Recommendation Ic: Distinguish between methods that can be effectively collected by volunteers and those that require staff expertise.

Recommendation Id: Develop and implement a plan that takes advantage of volunteer power to collect quality-assured island data.

II. Recommendations for Island Managers

Recommendation IIa: Develop standards of acceptable change for key impact indicators using both environmental and social monitoring data.

Recommendation IIb: Develop a protocol for how to interpret condition class data (for campsite, trails and shoreline).

Recommendation IIc: Update maps in the MITA *Handbook* to more accurately represent location of landing areas, campsites and trails on islands**.**

III. Recommendations to Enhance Future Field Work

Recommendation IIIa: Determine how many islands are sufficient to form a representative subset of all Maine public islands.

Recommendation IIIb: Monitor the seven pilot islands again in three to five years, so that by 2014, the end date of *The Plan*, each island will have had two to three rounds of monitoring.

Recommendation IIIc: When conducting future baseline inventories, include a full natural resource inventory of island flora and fauna to the list of baseline inventory methodology.

Recommendation IIId: Schedule all future monitoring as close as possible to the same dates as when the original baseline data were collected.

Recommendation IIIe: Finalize a photographic manual that shows images of representative condition classes and impact indicators, for use in the field.

Recommendation IIIf: Review and update the three condition class ratings (campsite, trails and shoreline) so that they contain the same number of classes.

IV) Recommendations Specific to Each Method

Field Mapping and GPS Recommendation: Secure the use of a high end sub-meter accuracy GPS unit when this level of accuracy is deemed a priority.

Campsite Monitoring Recommendations:

- **Campsite Recommendation 1:** Finalize campsite methodology by reviewing changes suggested by Ednie, Daigle and Quarrier (Fall 2006) and comparing to methods listed in this report.
- **Campsite Recommendation 2:** Eliminate the first three inventory indicators having to do with the shoreline, as this topic is best covered in the shoreline monitoring protocol.
- **Campsite Recommendation 3:** Eliminate the impact indicator looking at root exposure per tree (keep root exposure for full campsite).
- **Campsite Recommendation 4:** Develop a photo manual to facilitate campsite monitoring

Shoreline Monitoring Recommendations:

- **Shoreline Recommendation 1:** Clarify the first impact indicator to more specifically address shoreline.
- **Shoreline Recommendation 2:** Eliminate the impact indicator about root exposure as this is more adequately covered in the shoreline condition class.
- **Shoreline Recommendation 3:** Develop a photo manual to facilitate shoreline monitoring

Intertidal Monitoring Recommendation: Conduct localized study to determine cause of blue green algae scarring.

I. Recommendations on developing a long term monitoring plan

<u>Recommendation Ia</u>: MITA and BPL should commit to a continued Island Monitoring Task Force that strives to meet the monitoring goals outlined in the 10 year *Recreation Management Plan for the Public Islands on the Maine Island Trail, 2004-2014 (The Plan)*, and define the role of that Task Force, including designating a new Task Force coordinator.

The importance of this recommendation cannot be emphasized enough! Without a designated body dedicated to guiding the work, the project runs the very real risk of disintegrating. Maine Sea Grant had committed to coordinating the Island Monitoring Task Force in an initial three-year pilot project. This report captures that work and provides a road map for future monitoring. Ultimately however, it is up to MITA and BPL to decide on the future of the Island Monitoring Task Force and the implementation of the recommendations in this report. The Task Force has come a long way since its inception three years ago; now is the time to ensure its long term success. There are still seven years left to achieve the goals outlined in *The Plan* and the three-year pilot has successfully laid the foundation for effective and credible long term monitoring. In a parallel effort, the social monitoring survey is also being conducted. However, without a directed plan and commitment on the part of managers, there is a risk of these parallel efforts (environmental and social monitoring) falling through the cracks with little direct impact on management decision-making. In addition, without this dedicated and explicit commitment, MITA and BPL run the risk of having wasted three year's time and money, and failing to achieve the 10-year goals outlined in their own *Plan.*

MITA and BPL should designate a new Island Monitoring Task Force coordinator to ensure that the efforts of the three -ear pilot and soon-to-be published social monitoring results are both put to good use and that the monitoring goals laid out in *The Plan* are ultimately achieved.

Continuing this work is crucial for the baseline to be of any worth, however this is not without any financial cost. A plan must be made to identify funding sources to carry out this work. The total budget for the three-year pilot project was just under $140,000, with nearly 80% of this total covered by Maine Sea Grant (See Appendix F for full budget). Clearly, future monitoring budgets will never reach these numbers again, however, making a commitment to monitoring also means making a commitment to finding funding for its implementation. MITA and BPL must reconvene the Island Monitoring Task Force to define affordable and realistic priorities for the future. Hopefully, the following series of recommendations will help in this work.

<u>Recommendation Ib</u>: Identify when the need is for baseline data collection vs. monitoring, and distinguish between the two.

The methods outlined in this report can be used for collecting baseline as well as for subsequent monitoring. However, subsequent monitoring on the seven pilot islands need not be as comprehensive as that conducted in the pilot phase. In the event that new islands are proposed for long range monitoring, it might be wise to conduct this level of comprehensive baseline data collection, to ensure that all indicators are covered. But for the actual monitoring years, when the data collected is compared to a baseline, then specific field work can be much more tightly targeted. The methods could be down-sized to meet specific management objectives. Likewise, they could be downsized to meet limitations posed by staffing or funding. These decisions should be made before venturing out for future seasons of field work and should take into consideration **who** is actually going to conduct the field work. See next recommendation for more on that.

<u>Recommendation Ic</u>: Distinguish between methods that can be effectively collected by volunteers and those that require staff expertise.

It might be useful to think of three levels of expertise needed for field work. The first level, baseline data collection like that collected in the pilot phase, clearly requires experienced staff. The second level, monitoring to make detailed comparisons to the baseline data, is likely comprehensive enough that it also needs some level of staff expertise, or an extremely skilled volunteer. In both these cases, volunteers can and should be actively engaged but they likely will not have the skills needed to take the lead role. Instead, they should be partnered with staff or trained monitoring interns/leaders.

The third level of monitoring is that which can be carried out specifically by volunteers, independently of staff. The Task Force has already begun discussing what a volunteer field protocol might look like, including things like a streamlined condition class assessment for trails, campsites and shorelines. Such data can serve as a complement to more rigorous monitoring and can, in some cases, replace or contribute to aspects of field work that would otherwise need to be conducted by skilled staff. More on volunteer potential in the next recommendation.

<u>Recommendation Id</u>: Develop and implement a plan that takes advantage of volunteer power to collect quality-assured island data.

Tapping into the huge interest in island stewardship among both private and commercial island users and new and existing volunteers is a sure way to protect islands and build a workforce. Globally, there is a growing interest among travelers and recreationists to contribute to the protection of the places they love to visit. Examples include the growing popularity of travel options modeled on Earthwatch where participants pay to be involved in meaningful research. There is great potential in joining the goals of long range island monitoring with meaningful travel options for recreational boaters and island visitors. Many existing volunteer monitoring networks can serve as models. Maine Sea Grant has long been a central coordinator of the Maine Shore Stewards program and has a history of managing volunteer efforts in phytoplankton, water quality, and beach profile monitoring. These programs have established systems for quality assurance and control that are recognized by scientists as effective and credible. MITA is also seasoned at recruiting, managing, and retaining volunteers and serves as a model nationwide for other water trail organizations that rely heavily on volunteerism.

As mentioned above, the Task Force has begun exploring streamlined methods that can effectively be carried out by volunteers and island users themselves. Given limited staffing, well-trained volunteers can gather useful information that contributes to long term goals. At the most basic level, existing MITA volunteer programs can be enhanced so that current MITA volunteers also collect additional monitoring data on their existing runs. But the volunteer potential can be much greater than that. For example boaters, kayakers, sailors, guides, island owners, tourists and others can be supplied with simple field checklists to document indicators of impact (e.g. litter and tree damage) as they travel to their favorite island destinations. For more in depth data collection, sea kayak guides, schooner tour operators, camp leaders, teachers and professors can all be trained to engage their passengers, customers, and students in quality data collection as an exciting feature of their programs. For example, activities could include taking photo transects of a particular shoreline, or assigning condition classes to a series of access trails.

In the interest of simplicity and short-term implementation, getting such a volunteer program started could be as simple as current Task Force staff and members using this report to train a few leaders and educators in basic monitoring methods and encouraging them to undertake a few pilot runs during a summer season. Potential organizations who have already expressed interest in participating with their customers or students include: Chewonki Foundation, Gulf of Maine Expedition Institute, Ardea EcoAdventures, and MDI Water Quality Coalition. Maine Sea Grant and MITA could train the leaders and provide materials needed for the field. [NOTE: the recommendations contained in the methods section below will also highlight how some methods could be improved to make them volunteer friendly and still produce quality data.]

II. Recommendations for island managers

<u>Recommendation IIa</u>: Develop standards of acceptable change for key impact indicators using both environmental and social monitoring data.

Defining standards of acceptable change is a management decision that needs to be informed by both environmental and social data and is entirely reliant on management objectives for a particular site or island. Island visitors have a threshold of tolerance for environmental impact and other social indicators such as crowding. For the purpose of decisions about recreational use, this social threshold is just as important for management decisions as ecological change caused by humans. Both parameters need to play into decisions about future island management.

With the pilot environmental monitoring phase coming to a close and the parallel social monitoring survey being conducted by PhD. candidate Ednie, the timing will soon be right for island managers (and a future iteration of the Island Monitoring Task Force, should it continue to exist) to explore the question of standards. As mentioned previously, the islands' present conditions loosely serve as the standard by which they should be (and often are) managed. But island managers might do well to decide how to address the questions of specific standards of acceptable change for individual indicators, both social and environmental. As monitoring data is collected in the years to come, managers will need a decision-making protocol to help them address environmental changes and social perceptions that are highlighted by incoming data. With standards in place, management decisions can more easily be implemented. [Note: See bibliography for sources of information on how to establish standards of acceptable change.]

Below is the list of indicators covered by the pilot methods, each of which is followed with suggestions for how the affiliated indicators might be expressed. This list simply recommends possible ways to note when a standard has been reached. It does NOT propose to suggest what the proposed management action might then be.

Terrestrial zone indicators

- <u>Overall campsite condition class</u> – Management action should be considered if condition class changes by at least two ratings (i.e. from a 1 to 3, or 2 to 5).
- <u>Campsite size</u> – The standard established for campsite size should consider site capacity limits as established by BPL and MITA and type/amount of use. Managers should determine what percentage of campsite growth (either by area or perimeter) is considered unacceptable (for example: not to exceed X hundred square feet; or not to increase more than Y%). This might need to be a site specific standard, or could be specific to vegetation type (all grassy sites, or all wooded sites). For islands with multiple sites, a collective standard could also be applied.
- <u>Potential for un-managed site expansion</u> – same as Campsite size.
- <u>Vegetation ground cover</u> – Management action should be considered if percent ground cover decreases by at least two percentage ratings (i.e. from 76-95% to 25-50%).
- <u>Exposed soil</u> – Management action should be considered if percent exposed soil increases by at least two percentage ratings (i.e. from 25-50% to 76-95%).
- <u>Tree damage</u> – At the site level, managers should determine what is an acceptable increase in numbers of trees that have either "moderate" or "severe" damage.
- <u>Root exposure</u> – At the site level, managers should determine what is an acceptable increase in numbers of trees that have roots with either "moderate" or "severe" exposure. Managers should consider management action if the whole campsite has "severe" root exposure.
- <u>Fire sites</u> – Given that island LNT practices recommend limited use of fire, and that only with a permit and in the intertidal zone or in a designated fire ring, the existing management protocol of dismantling un-designated fire rings seems logical to continue.

- Trails entering and exiting site – Managers should decide if the existing number of trails entering and exiting the site is appropriate and then monitor any increase in that number. If any trail's condition class changes by at least two ratings (i.e. from a 1 to 3, or 2 to 5), management action should be considered. For length and condition of other interior trails, managers should consider if the total length and location is appropriate. Changes in trail condition class should be considered the same way as for trails entering and exiting site.
- Litter – Given that island LNT practices recommend not littering, the existing management protocol of picking up any waste seems logical to continue.
- Human waste/toilet paper – Given that island LNT practices recommend packing out human waste, the existing management protocol of cleaning up any waste seems logical to continue.
- Other areas of special concern – Standards to be determined on a case by case basis

Shoreline zone indicators

- Overall shoreline condition class – Management action should be considered if condition class changes by at least two ratings (i.e. from a 1 to 3, or 2 to 5).
- Substrate of shoreline at landing area – Management action should be considered if this area exhibits a change (for example, it turns to mud from overuse, or become severely eroded)
- Width of shoreline disturbance – Managers should decide if the existing level of shoreline disturbance is acceptable, and at what level it becomes unacceptable (for example, if an access trail has grown twice as wide and eroded significantly, managers might consider hardening with steps)
- Vegetation trampling – Managers should determine if an "moderate" or "severe" rating of vegetation trampling along this shoreline is acceptable, and consider management action if not.
- Bank erosion – Managers should determine if an "moderate" or "severe" rating of bank erosion along this shoreline is acceptable, whether trampling is acceptable, and consider management action if not.
- Tree damage – Managers should determine what is an acceptable increase in numbers of trees that have either "moderate" or "severe" damage.
- Root exposure **--** Managers should determine what is an acceptable increase in numbers of trees that have roots with either "Moderate" or "Severe" exposure.
- Fire sites – Given that island LNT practices recommend limited use of fire, and only with a permit and in the intertidal zone or in a designated fire ring, the existing management protocol of dismantling un-designated fire rings seems logical to continue.
- The number and condition of access trails through the shoreline – Managers should decide if the existing number of trails entering and exiting the island through the shoreline is appropriate and then monitor any increase in that number. If any trail's condition class changes by at least two ratings (i.e. from a 1 to 3, or 2 to 5), management action should be considered.
- Litter – Given that island LNT practices recommend not littering, the existing management protocol of picking up any waste seems logical to continue.
- Human waste/toilet paper – Given that island LNT practices recommend packing out human waste, the existing management protocol of cleaning up any waste seems logical to continue.

Intertidal zone indicators

[Note: additional research should be conducted on how to express standards in the intertidal zone.]

- Abundance of dominant space occupiers – Managers should consider action when dominant species abundance has changed, either up or down, by at least two percentage ratings (i.e., from 50-75% to a rating of less than 5%; or the other way around).
- Species diversity in low tide zone – Managers should consider action if there is a change in the presence or absence of invertebrate species, or a significant decrease in low tide species diversity.

- Presence or absence of barnacle hummocks – Managers should consider action if barnacle hummocks are decreasing or disappearing.
- Age of *Ascophyllum nodosum* (Knotted Wrack) – managers should consider action when the age of *Ascophyllum* is on the decline.

Note on the use of photos in assessing indicators

Photos are used extensively in assessing many of the indicators outlined above. When managers compare the status of indicators with their established standards, photos can certainly be used to supplement the data, but it is important to note that photos and measurements are not interchangeable. Because of the power of a picture, there may be a tendency to rely on them for decision-making. Managers need to determine what role photos play for each indicator, alongside the measurement.

Recommendation IIb: Develop a protocol for how to interpret condition class data (for campsite, trails and shoreline).

Managers need to decide what level of change in condition class should trigger their attention. This is similar to the recommendation above suggesting the need for developing standards of acceptable change. For example, from one monitoring season to the next, a rating change of one level may not be a significant concern for managers, but a rating change of two levels may be the red flag that managers need to consider options.

There is also a concern with how to interpret a map that depicts condition classes using color. This is a particular question with trails data. Thanks to the use of GIS mapping, the total number of access trails into an island and their condition class can be viewed on one map. This makes it easy to note the percentage of total trails at each condition class rating. However, managers need to decide how to make use of this information. For example, just because a trail's condition class color implies high impact, that impact may be perfectly appropriate if the trail is a primary, designated access trail. If, on the other hand, the trail is an undesignated trail whose function is questionable, then managers may decide the appropriate action is to close that trail down.

Managers need to decide what parameters are important in weighing data results. Developing data interpretation protocols and standards will facilitate management decisions for condition class ratings specifically, but the same holds true for many of the monitored indicators.

Recommendation IIc: Update maps in the MITA *Handbook* to more accurately represent location of landing areas, campsites and trails on islands.

The maps provided in the MITA *Handbook* are island users' first source of information on landing areas, campsites and trails. Though Trail managers have asserted that the features on these maps should not be considered official designated use areas, island users tend to follow the maps that MITA provides them. In a few cases, where the map information is dated or inaccurate, this may contribute to additional impact on island ecosystems. For example, the *Handbook* map for Little Snow Island shows a trail running through the center of the island. Careful searching on Little Snow reveals that this trail does not exist. Yet baseline monitoring on the island revealed that there are numerous small trail spurs that go nowhere throughout the interior of that island, perhaps a sign that island users are looking for the trail listed in the *Handbook.*

III. Recommendations for future field work

Recommendation IIIa: Determine how many islands are sufficient to form a representative subset of all Maine public islands.

The seven pilot islands were selected for this project based on their characteristics as being a representative subset of the Maine public islands. Are these seven islands enough, or should baseline data be collected on more or all of the islands? The experience and knowledge gained from this study should be used to re-evaluate to what degree the islands are representative of all Maine public islands, and whether this subset should be enlarged to give more detail representative of all islands along the coast.

Recommendation IIIb: Monitor the seven pilot islands again in three to five years, so that by 2014, the end date of *The Plan*, each island will have had two to three rounds of monitoring.

Until subsequent field seasons of monitoring have occurred, the baseline data remain of little use in terms of tracking human-caused changes. Two to three rounds of monitoring over ten years on the seven pilot islands would provide managers enough information spaced over enough time to begin to quantitatively assess changes and make corresponding management decisions.

Recommendation IIIc: When conducting future baseline inventories, include a full natural resource inventory of island flora and fauna to the list of baseline inventory methodology.

Currently, methods are focused almost exclusively on documenting change in the islands' use area. As a result, there is a significant risk that other important impacts on an island's flora and fauna might be missed. For example, is a trail's location affecting songbird breeding in the forest interior? Is there a unique plant species on the island that needs special consideration? Natural resource inventories in all three of the island's zones can provide information that is crucial to the management plan of that island. Such inventories should be conducted on all of the seven pilot islands, perhaps when these are scheduled for monitoring again, and any new island added to the list for baseline.

Recommendation IIId: Schedule all future monitoring as close as possible to the same dates as when the original baseline data were collected.

As mentioned above, monitoring should be replicated at three to five year intervals. In any given monitoring year, schedule the field work to occur in the same timeframe as the original work. The idea is to strive to capture the site after it has experienced a similar level of use and in similar ecological condition, given the season. Avoid, for example, collecting data in mid-August when the original data were collected in mid-July as this will lead to inaccurate comparisons. In mid-July, island use has been high for only a week or two, whereas in mid-August, islands will have experienced a good month of so of higher use. Conditions will be different regardless of long term impact. Monitoring at wide time intervals detracts from the accuracy of the changes that might be highlighted by data results and photos.

Recommendation IIIe: Finalize a photographic manual that shows images of representative condition classes and impact indicators, for use in the field.

Many of the methods contained in this report would benefit from a photo manual to illustrate condition class ratings and impact indicator scales (such as root exposure and tree damage). Such a manual was started by Jodi Jacobs, the COA graduate student who worked extensively on this project, and needs to be completed. The draft photo manual is included in Appendix D.

Jacobs identified that such a manual could improve both field work and management. It would decrease subjectivity in the field and ensure greater consistency in how data are quantified by giving field workers visual examples of conditions and ratings. A photo manual would be a tool that volunteers could easily learn how to use, thereby contributing to the quality of volunteer data. And a photo manual would also give managers concrete examples of conditions plus the visual tool for making comparisons over time.

The indicators that could be tracked with the help of a photo manual might include: campsite, shoreline and trail condition class, root exposure, tree damage, soil compaction, potential site expansion, erosion, scarring in the blue green algae, and barnacle hummocks.

<u>Recommendation IIIf</u>: Review and update the three condition class ratings (campsite, trails and shoreline) so that they contain the same number of classes.

As mentioned above, volunteers could easily be tasked with collecting condition class ratings, particularly if they are armed with photo manuals to help them in their data collecting. This would be further facilitated if all three ratings had the same number of classes. Currently, the campsite rating contains five classes (1-5), while the trails and shoreline each contain six (0-5).

This was overlooked during the pilot phase, until a spring 2006 meeting of MITA volunteers who were surveyed for their opinion about the feasibility of this approach. Among the recommendations they made was the need to streamline the ratings to contain the same number of classes. The quality of the data, regardless of who collects it, would be improved with standardized methods.

[Note: the MITA volunteers also agreed that the photo manual would facilitate their participation and standardize their responses.]

IV. Recommendations specific to each method

The recommendations below suggest a few ways to improve the methods and should be considered before any future monitoring is conducted. The methods write-up themselves cover the specifics about how to conduct each methodology and provide background on how and why.

<u>Field Mapping and GPS Recommendations</u>: Secure the use of a high end sub-meter accuracy GPS unit when this level of accuracy is deemed a priority.

This method's write-up details the limitations of a hand-held, internal antenna, recreation-grade GPS. Monitoring could be greatly enhanced with a high end external antenna sub-meter accuracy GPS unit that could be counted on to collect point, line and polygon data. Such a device would greatly save time in the field and at the data processing level.

There are also several electronic field mapping units on the market now that would greatly facilitate future monitoring, such as a sub-meter accuracy GPS that loads coordinates directly into a hand held personal digital assistant equipped with GIS software. Such a unit would greatly enhance accuracy and efficiency at all steps of the way.

<u>Campsite Monitoring Recommendations</u>:

Campsite Recommendation 1: Finalize campsite methodology by reviewing changes suggested by Ednie, Daigle and Quarrier (Fall 2006) and comparing to methods listed in this report.

Ednie and Quarrier began updating the campsite methodology to make it more user friendly and better address managers' questions. Though both the new approach and the approach outlined in this report are very similar, there are enough differences (such as the radial transect approach, for example, is slightly different) the two should be reviewed for the purpose of choosing the final best protocol. The following campsite recommendations offer suggestions for how to improve the campsite method covered in this report.

Campsite Recommendation 2: Eliminate the first three inventory indicators having to do with the shoreline, as this topic is best covered in the shoreline monitoring protocol.

The campsite monitoring form includes a list of inventory indicators intended to get an overall sense of the campsite. The first three inventory indicators are shoreline specific (including substrate of shoreline, composition at access, width of disturbance). While the intent is to get this information within the context of the campsite, the way they are phrased is not clear and these indicators are best assessed as the overall shoreline is monitored. In fact, this parameter (with slightly different language) is asked again in the shoreline data sheet which presents confusion at the data analysis phase (which data should be used?).

Campsite Recommendation 3: Eliminate the impact indicator looking at root exposure per tree (keep root exposure for full campsite).

Root exposure occurs naturally and regularly on islands due to the islands' thin layer of top soil. While root exposure is a reasonable indicator of soil compaction as a result of human use, it is difficult to specifically determine which roots belong to which tree, as there are often simply too many. Rather, it makes more sense to get an overall assessment of root exposure throughout a campsite. If root exposure through the campsite is fairly high, then campers may look outside the site for more even ground.

Campsite Recommendation 4: Develop a photo manual to facilitate campsite monitoring (see recommendation IIIe).

<u>**Shoreline Monitoring Recommendations**</u>:

Shoreline Recommendation 1: Clarify the first impact indicator to more specifically address shoreline.

The first impact indicator asks about substrate at the landing area. This question is adequately covered in both the intertidal method and the survey checklist. Replace this with "Composition of shoreline at access onto island's terrestrial zone B=Bedrock, C=Cobble, Sh=Shell, S=Sand, M=Mud)." This question is currently located in the campsite inventory indicators but (as recommended above) is better covered here as part of the shoreline methodology.

Shoreline Recommendation 2: Eliminate the impact indicator about root exposure as this is more adequately covered in the shoreline condition class.

As mentioned in the campsite recommendations, it is difficult to identify which trees specific roots grow from. An overall assessment of root exposure is included in the shoreline condition class and should suffice.

Shoreline Recommendation 3: Develop a photo manual to facilitate shoreline monitoring (see recommendation IIIe).

<u>**Intertidal Monitoring Recommendations**</u>**:**

Intertidal Recommendation 1: Conduct a localized study to determine cause of blue green algae scarring.

The current theory that scars in blue green algae are caused by the dumping of kitchen waste such as boiling pasta water has not been tested. A simple experiment should be conducted to help determine if this is in fact the cause. Conducting such as experiment would help managers evaluate if any changes need to be made to the existing Leave No Trace message. Permission should be secured by island owner before such an experiment is undertaken.

Appendix A

Acknowledgements

This three-year pilot project benefited tremendously from the time, skills and expertise of dozens of individuals. Participants in the Island Monitoring Task Force ranged from active working group members, organizational staff, regular and occasional advisors, students, and volunteers. Task Force participation was deliberately open to anyone interested, based on the assumption that diverse perspectives would benefit the overall project. The list below is a best effort at listing all people who somehow contributed to this project, either in the field, in the lab, in a meeting, or simply on the receiving end of a phone call seeking their expert advice. Everyone on this list receives our sincerest thanks!

Note: Task Force Working Group members are in bold and include all who, at some point over the three year pilot, dedicated a significant amount of time and expertise to the project.

Sarah Boucher, College of the Atlantic graduate student and project GIS technician
Dr. John Daigle, UMaine Department Parks, Recreation and Tourism
Andrea Ednie, Ph.D. Candidate, UMaine Parks, Recreation and Tourism
Tracy Hart, Maine Sea Grant and project intertidal coordinator
Jodi Jacobs, College of the Atlantic graduate student, project intern and GIS technician
Charlie Jacobi, Acadia National Park
Amy Kersteen, Maine Island Trail Association
Gordon Longsworth, College of the Atlantic GIS Lab Director
Brian Marcaurelle, Maine Island Trail Association
Pat Mahoney and Ben Martens, Bowdoin College 2004 Island Monitoring interns
Dave Mention, Maine Island Trail Association
Sid Quarrier, Maine Island Trail Association volunteer
Steve Spencer, Bureau of Parks and Lands, Department of Conservation
Natalie Springuel, Maine Sea Grant and Task Force Coordinator
Linda Welch, Maine Coastal Islands National Wildlife Refuge
John Anderson, College of the Atlantic
Jane Arbuckle, Maine Coast Heritage Trust
Dr. Susan Brawley, UMaine School of Marine Science
Chebeague Island students and Historical Society
Melissa Coleman, UMaine School for Marine Sciences
Lee Dogget, Department of Environmental Protection
Bob Earnest, Chebeague Island resident
Steve Fegley, Maine Maritime Academy
Scott Hall, Audubon and Friends of Maine Sea Bird Nesting Islands
Anne Henshaw, Bowdoin College Coastal Studies Center
Helen Hess, College of the Atlantic
Tora Johnson, College of the Atlantic
Darren Kelly, Ardea EcoAdventures
Sarah Kirn, Gulf of Maine Research Institute
David Kleinpeter, Acadia National Park summer staff
Susan Kynast, Maine Island Kayak Company
Vinny Marotta, Maine Island Trail Association
Rich MacDonald, Gulf of Maine Expedition Institute
Jeff Marion, Patuxent Wildlife Research Center
Peter Maguire, Island Heritage Trust Intern

Annette Naegel, George's River Land Trust
Rachel Nixon, George's River Land Trust
Ellie Pepper, Bowdoin College
Chris Peterson, College of the Atlantic
Marney Pratt, Bowdoin College
Maine Sea Grant staff
Pete Raimondi, University of California at Santa Cruz
Greg Shute, Chewonki Foundation
Esperanza Stancioff, Maine Sea Grant/Cooperative Extension
Elizabeth Stephenson and intern Elizabeth Roberts, UMaine Darling Marine Center
Karen Stimpson, Maine Island Trail Association
Shey Veditz, Island Institute
Lindsay Whitlow, Bowdoin College
Karen Young, Casco Bay Estuary Project

Appendix B

Three Year Project Budget

Island Monitoring Task Force 3 Year Budget (2004-2006)	Quantity	Total cost per item	Maine Sea Grant	Bowdoin College	MITA/BPL	College of the Atlantic (in kind)	Island Mon. Task Force In Kind (time	Total
Staff and Interns								
Staff (N.Springuel), 1/3 FTE for three years including salary, fringe and indirect			$80,000.00					$80,000.00
Staff (T. Hart), 1/3 FTE for one year including salary, fringe and indirect			$25,000.00					$25,000.00
Interns (2), summer 2004, salary	2	$1,500.00		$3,000.00				$3,000.00
GIS technician Winter/Spring 2005, salary			$1,800.00					$1,800.00
Graduate Intern, Summer 2005, salary					$3,000.00			$3,000.00
Support for Summer 2005 Intern (work space, travel, food etc)			$1,000.00					$1,000.00
GIS technicians Fall 2005 and Winter/Spring/Summer 2006, salary			$3,700.00		$1,000.00			$4,700.00
Support for GIS technicians			$1,000.00					$1,000.00
College of the Atlantic GIS lab and computer use and GIS support, 2005-2006						$2,000.00		$2,000.00
Island Monitoring Task Force in kind time, 2004-2006 (3-5 meetings/year, field visits etc)							$5,000.00	$5,000.00
Staff and Interns totals			**$112,500.00**	**$3,000.00**	**$4,000.00**	**$2,000.00**	**$5,000.00**	**$126,500.00**
Transportation								
Road mileage by Sea Grant 2004-2006 (others included in TF In kind above)			$5,000.00					$5,000.00
Motor boat use and gas (boats used include Sea Grant, MITA, BPL and Personal so only the estimated totals provided here)			$1,000.00				$4,000.00	$5,000.00
Transportation total			**$6,000.00**				**$4,000.00**	**$10,000.00**
Field insturments and/or electronics								
GPS	1	$250.00	$250.00					
Cables to connect GPS and PC	1	$90.00	$90.00					
Digital camera	1	$300.00	$300.00					
Wateproof case for camera	1	$150.00	$150.00					
Field insturments and/or electronics total			**$790.00**					**$790.00**
Other Field Equipment								
Peep Hole compass	1	$130.00	$130.00					
Card Compass	2	$15.00	$30.00					
150 meters line	1	$45.00	$45.00					
Flagging rolls	6	$5.00	$30.00					
Measuring wheel	1	$10.00	$10.00					
Surveyors tape	2	$15.00	$30.00					
Rite in the Rain© reams of 81/2x11 paper	4	$40.00	$160.00					
Rite in the Rain© notebooks	2	$12.50	$25.00					
Rite in the Rain© grid sheets (50 per pack)	4	$15.00	$60.00					
Rite in the Rain© field desk (closable clipboard)	1	$20.00	$20.00					
Field guides: intertidal zone	3	$15.00	$45.00					
Pencils	10	$0.50	$5.00					
Engineer's ruler	1	$20.00	$20.00					
Trowel	1	$2.00	$2.00					
Wire strainer	1	$3.00	$3.00					
Reference stakes and nails	20	$2.00	$40.00					
Nautical charts	4	$19.00	$76.00					
Field equipment total			**$731.00**					**$731.00**
Total			**$120,021.00**	**$3,000.00**	**$4,000.00**	**$2,000.00**	**$9,000.00**	**$138,021.00**

Appendix C

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Intertidal and Marine Environments

NOTE: Tracy Hart, while an employee of Maine Sea Grant, led the early designing of the Island Monitoring Task Force's intertidal methodology. To that end, she conducted an extensive literature review on intertidal monitoring. In addition to the following references, Hart summarized a series of case studies for the Island Monitoring Task Force to refer to in defining intertidal monitoring methods. That case study summary is included in the appendices.

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Tree Damage

NONE/SLIGHT = BRANCHES REMOVED

Campsite LSI_ C
Photo 106
June 30, 2005

Campsite LSI_ C
Photo 107
June 30, 2005

Tree Damage

MODERATE = MORE BRANCHES REMOVED AND SCARRING

Far Right Corner: Campsite LSI_C

Photo 108, June 30, 2005

Below: Campsite LSI_C

Photo 103, June 30, 2005

Above: Campsite LSI_C

Photo 109, June 30, 2005

Right: Campsite LSI_C

Photo 110, June 30, 2005

Tree Damage

HEAVY = BRANCHES REMOVED, SCARRING, AND GIRDLING

Above: Campsite LSI_C

Photo 104, June 30, 2005

Above:Campsite LSI_C

Photo 105, June 30, 2005

Above: Campsite LSI_C

Photo 111, June 30, 2005

ROOT EXPOSURE

None/Slight

Campsite LSI_C, Photo 112, June 30, 2005

ROOT EXPOSURE

MODERATE

Campsite LSI_C, Photo 113, June 30, 2005

Campsite LSI_C, Photo 114, June 30, 2005

ROOT EXPOSURE

SEVERE

Campsite LSI_C, Photo 115, June 30, 2005

Appendix E
Intertidal Case Studies

Intertidal Monitoring Goals and Protocols: A Review of Several U.S. and Canadian Programs
(compiled by Tracy Hart, Maine Sea Grant, 2004)

1. Rocky Intertidal Monitoring Handbook--Channel Island National Park, CA Fish and Game, CI National Marine Sanctuary, Minerals Management Service, and Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) (Dan Richards)

The Program:
Goals: Overarching: Collect long-term data on a variety of indicator organisms (indicator organisms=those dominating particular zones or biotic assemblages). Specific: Monitor trends in populations of indicator organisms; determine normal variation of indicator organisms; discover abnormal conditions (invasives, oil spills, etc.); ID issues and communicate to park management and collaborators; measure effectiveness of management actions; Minerals Management Service interested in this monitoring for pre and post oil spill assessment; monitor seasonal and annual variation in populations of rocky intertidal organisms.
One of park's purposes is to protect the undisturbed tide pools providing species diversity unique to the eastern Pacific coast.
Methods/Protocols:
Overview: Semi-annually (spring and fall). One site worked per day. Program requires 40-45 fieldwork days per year. 4 person field crews. Sept-Jan; Mar-June Fixed plots assess amount of cover and abundance of intertidal organisms.

A. Field Log: Field Logs to record general info about site, weather, observers, etc. and habitat overview photos. Tide, water temp, max # of mammals, humans, birds seen at any point, pollution, general conditions of core species: abundance, condition of population, recruitment
B. Fixed Photoplots. Size=50 x 75 cm . Five photoplots per zone/core species. There are 9 core species for which photoplots have been established, although info is collected for other species. Target species=several barnacle sp., several red algae sp., several rockweed, mussels, persistent tar areas (from oil spill). Determine percent cover at each plot using Random Point Contact method. Score target species occurring at 100-point intersections on a grid. Score the top-most visible layer that is ATTACHED to the substrate (unless top layer is a weedy species such as ulva, enteromorpha, porphyra).
C. Mapping: aerial photos and differential GPS units have been used to create maps of the individual plots and site features
D. Area Photos: Visual record of overall site appearance. Locate reference bolts and stand over bolts to shoot photos. Photograph anything unusual
E. Motile Invert Counts: Determine relative abundance of mobile species on the fixed photoplots by searching plot and counting species. (Can move macrophytes aside). Measure length of first ten of several snail species. Subsample snails and limpets when numerous using a 20 x 20 cm frame.
F. Abalone Counts 30-minute search within a defined area at the site. Measure shell.
G. Surfgrass Transects: 3 ten-meter transects established in dense surfgrass areas. Score at 100 pts along transect distributed at 10 cm intervals. Each point scored as one of 22 categories of core species, higher taxa, or substrates. Only record topmost layer that is attached to the substrate.
H. Species Richness: Species and relative abundance. Search entire tidal range within site boundaries and note all species found. Look under rocks, in pools, etc. Create species list. For each species mark abundant, common, present, rare, absent. Note dominant species. or noticeable changes.
I. Temperature Loggers: readings once an hour.
J. Comprehensive Surveys: Transects to place fixed plots into perspective within the intertidal area. Maps can be made of the info.
K. Comprehensive Surveys: Baseline transect parallel with shore and vertical transects from baseline to mean low tide placed every 3 meters along baseline. 100 points recorded along each vertical transect. Motile inverts counted in quadrats. Seastars and abalone in transect 1 m to either side of vertical transects. Topography along each transect mapped with laser.
L. Station Summary Sheet. Metadata for survey. Observers, number of plots, envir. conditions, etc.

Overview of taxa-specific protocols: Changes in sessile inverts and algae in dominant zones using fixed photoplots. Dominant zones = mussels, various species of barnacles, rockweeds, red alga. Size and density of abalone in irregular

fixed plots. Size and density of a limpet in one-meter fixed circular plots. Pisaster seastars counted in timed searches and fixed transects. Surfgrass monitored in point intercept transects.
Self-Assessment/Critique/Their Suggestions to Us: Phone conversation with Dan Richards. There are enough models out there for intertidal monitoring and enough people have done it that it is now pretty straightforward. Easy to expand. The biggest issue in using citizen volunteers is consistency in the data. They represent such a vast array of expertises and experience. The REEF Program (reef.org) is one to look at for volunteer monitoring (fish counts). They have an elaborate checking system for quality control. They currently have a scan tron data sheet but are moving toward an online data entry program. They flag questionable items and call volunteers back. Suggests we call Greg Shriver-Marsh Billings National Park in Woodstock, VT. Call and ask for manual. He is the MARINE network coordinator (also see overview of MARINE below).
Reference: Richards, Daniel V. and Gary E. Davis. 1988. Rocky Intertidal Monitoring Handbook, Channel Islands National Park, Ventura, California. 62 pp.

2. Sustainable Ecosystem Institute: Temperate Shores

The Program: From their website: "Shorelines are coming under increasing human pressure, and SEI has been a leader in monitoring human impacts and in finding ways to minimize effects and still allow for enjoyment. The groundbreaking research of SEI President Dr. Deborah Brosnan on trampling and intertidal marine parks, formed the backbone of the Oregon Territorial Sea Plan and her efforts and research have been incorporated into coastal plans on the west coast and internationally. Keith Bernhardt now takes up the torch, with an exciting and active volunteer-based intertidal monitoring program. Centered around Yaquina Head in Oregon, this program excels in combining sophisticated science and easy, direct monitoring." http://www.sei.org/coast.html
SEI scientists went on to develop ways to monitor and minimize these impacts. SEI has ongoing projects in three states Washington, Oregon, and California. We have developed monitoring programs for State Parks, Federal Reserves in Oregon and Washington. At Yaquina Head Marine Gardens in the central Oregon coast we work closely with the Bureau of Land Management to protect the rocky shore habitats. Part of our original work on human impact on shores was carried out at this headland, and current management regulations are a direct result of this study.
Goals: Identify the nature and extent of visitor impacts. Detect human impact, and distinguish it from natural variability in species abundance.

GUIDELINES FOR MONITORING AND DETECTING VISITOR IMPACTS

- Set overall goals and establish a team to help develop a strategy;
- Gather baseline information identify plant and animal species present, including rare or threatened species; identify potential indicator species (those most vulnerable to impact); identify key species and ecological interactions; identify main habitat types; identify other areas e.g. historical sites define concerns e.g. trampling, diver impacts etc.
- Refine goals in light of information gathered.
- Design Monitoring Plan. Monitoring will include: visitor numbers and activities, key species, sensitive species, indicator species, habitat area. Include volunteer, visitor, and community monitoring programs in addition to staff activities.
- Set up monitoring sites in control and impacted areas (include representatives of main habitats).
- Etc. (data management, adaptive management approach, *)

THE MONITORING PROGRAM:
The basic biological information, and types of use allowed in the park will form the framework of the monitoring plan. Key points to include in the plan are:
a. Monitor impacted (open to public use) and control areas (off limits). Control areas need to be large enough that they will not be affected by impacts elsewhere. Sometimes this can be difficult, for example feeding wildlife can impact all areas of the park by changing the behavior and numbers of animals. Ensure an adequate number of controls for each area, at least two are recommended (see Underwood, 1994).
b. Pay particular attention to key species, sensitive species and rare species
c. Include representative of all important habitats in control and impacted sites
d. Monitor the probable causes of impacts. For instance, fishing effort, numbers of visitors etc. It is important to be able to correlate changes in human activity with impacts on the biology. e. Set up a monitoring program that is based on sound sampling techniques, and that is consistent.

Methods/Protocols: Sessile (attached) species such as plants, and corals are often monitored by "quadrat sampling" Quadrats consist of defined areas that are monitored consistently over time. The size of the quadrat will vary depending on the ecosystem. For instance, in marine rocky shore studies, quadrats often measure 0.5m by O.5m. These are either permanently marked areas, or random areas within study sites (e.g. within control or impacted plots (see Brosnan and Crumrine 1994)). In studies on reef-fish, quadrats are often larger and can be at least 5m x 5m. They are often permanently positioned (i.e. the exact same area within a study site is continually monitored). At each sampling period, data are collected from many quadrats within control and impacted sites. Numbers of individuals in the quadrat, or percent cover occupied by a species are ways in which abundance is estimated. For mobile species (e.g. fish, deer, or starfish,) counting numbers in quadrats is one method. Transects are another commonly used method (See Box 2). For some species it may be important to note size, age, Juveniles or adults), and gender. This will provide additional information on species health. If a species is thriving, then it should also be reproducing and there will be juveniles and adults present. However, if individuals are in poor health or stressed, then reproduction often fails. Because adults remain in the population for some time, you may not record a decline until it is too late (e.g. the decline of the marbled murrelet in the U.S.). The number of quadrats used in the monitoring program will depend on the habitat and size of the quadrat (1 0-20 are frequently used). Monitoring may need to be done seasonally, or even monthly. This will be determined by the types of species present, whether the ecosystem is degraded and recovery is in progress (more frequently), or whether the ecosystem is relatively stable (less frequent monitoring). Photographic and video records are always valuable, and should be encouraged as monitoring tools. When designing a program the following factors should be considered: (For reviews and suggestions on statistical design and analysis for detecting human impacts see, Osenberg et al 1994; Underwood 1994; and Thrush et al 1994).
Controls and impact areas. Ensure that controls are adequate, i.e. that they are comparable to impacted sites, and that there are sufficient control sites. Good controls help to eliminate alternative explanations of changes in abundance.
Statistical rigor: Is there enough replication (among all habitats and species) to detect changes, and to relate these changes to anthropogenic factors? Have important factors been identified and isolated?
Spatial and temporal considerations. Ensure that studies are carried out over sufficiently large spatial scales. Be able to recognize changes at a local level (individual sampling areas), and larger scale (e.g. entire habitat area or park). Initially, it will be difficult to interpret temporal trends in abundances, because many patterns will only become obvious with time. Ensure that monitoring programs are set up for long-term studies.

Set thresholds for action: Success and sustainability are not easy. How can we define successful management? We need to define success in biological terms. If good background information has been used to set up a monitoring program, then defining success and points of concern will be easier. One way to define a healthy ecosystem is by species composition and abundance, presence of key interactions, and habitat persistence. Changes are a way of life, in ecological systems. But it is important to distinguish between natural changes, and effects of human impact, and to understand how these two types of changes interact to affect ecosystem health. Use historical records and biological information to set initial thresholds for action. For example, it may be natural for some species to show seasonal fluctuations in numbers, and these may tend to fall within certain limits. If numbers start to drop below natural limits, then this is probably cause for concern, and often indicates that some remedial action is necessary.

For each habitat, keystone species, or sensitive species (as applicable), set a threshold level for action. Thresholds may include, a certain percent loss in cover of key coral, or tree species; reproductive failure of fish or bird species. Thresholds can be more effective if set conservatively. It is often the case that habitats have been much reduced (e.g. development) and this can limit a species ability to recover. Under these conditions, it may be prudent to set the threshold level within natural lower limits of abundance.
CASESTUDY OF VISITOR IMPACTS: The shore at Yaquina Head Outstanding Natural Area in Oregon USA, was once considered one of the most biologically rich areas, and was consequently much visited by schools and colleges as well as tourists. This trend has continued. More than 400,000 users visit the shore annually, and often over 700 people can be on the shore at one time. (Note that visitors can only visit the shore during low tide and so this concentrates the effect.) The shore is managed by the Bureau of Land Management (BLM). BLM was concerned with the biological state of the shore, a concern echoed by many others. In 1992 a study was set up (Brosnan and Crumrine 1992) to investigate the effects of human impact, primarily trampling, on the shore. The study was set up in conjunction with studies in nearby pristine" areas. A human exclusion zone was set-up for six months, and changes in species composition and abundance monitored. Results of the study showed that the shore at Yaquina Head was lower in diversity compared to nearby "pristine areas". In addition key components of the ecosystem were missing- these included mussels (shellfish), and the large foliose seaweed species. Instead the area was dominated by low-growing seaweed "turf". When humans were excluded, many of the large foliose seaweeds returned, and diversity increased. However, mussels did not recruit; they will need many years to recover. Experimental studies in pristine areas showed that large foliose seaweeds and mussels are highly susceptible to trampling (Brosnan and Crumrine 1994). Mussels provide a habitat for over 300 associated species, and so the loss of mussels

severely affects diversity and ecosystem health. Foliose seaweeds provide food and habitat for many other species, which are also lost. Similar impacts occur on shores in parts of Southern California (Elliott, Quon, and Brosnan; Zedier 1976). Mussels, foliose algae and algal turf are all potentially useful indicator species (see Brosnan 1993 for details on monitoring using the indicator species concept). In areas where trampling has little effect, mussels and foliose algae will thrive. However, when trampling is intense, diversity will be lower, mussels and foliose species are absent, and algal turf is the main species present. In these areas, an ecosystem dominated by algal turf is not a healthy ecosystem. Personnel with little biological background can be trained to monitor changes in these three types of indicator species. This technique can form the basis of a monitoring strategy. Monitoring and protection strategies are being used, and continually refined at Yaquina head.

3. Multi-Agency Rocky Intertidal Network (MARINe)- http://www.marine.gov

(My contact: Pete Raimondi, UCSB. Other primary contacts: Jack Engle UCSB; Gary Davis, NPS; Mary Elaine Dunaway, Minerals Management Service; and others)
The Program: Scientists from Federal, State, and local government agencies, universities, and private and volunteer organizations have formed a Multi-Agency Rocky Intertidal Network (MARINe) to monitor important shoreline resources. This network consists of 69 sites ranging from San Diego, CA to San Luis Obispo County and includes offshore Channel Islands (now also includes sites up to Washington state). The network is supported by 23 organizations. The MARINE program started in 1991. The network was initiated by the Department of the Interior in response to the Exxon oil spill recognizing the need for a baseline inventory of intertidal resources in California. Received a contract from DOI Minerals Management Service. Key rocky intertidal habitats and species are sampled every fall and spring using a variety of methods. Mussels, seastars, abalone, surfgrass, acorn and goose barnacles, and several algal species, such as rockweed and turfweed, are among the key species and habitat types studied.

Goals: One of the objectives of this network is to establish consistent monitoring methodologies so that spatial and temporal comparisons can be made in the future. The MARINE program targets certain species/taxa assemblages to see if change occurs (barnacles, mussels, mobile species, giant limpet). The information generated by monitoring is used by the various agencies and organizations to assess environmental effects, manage natural resources and aid coastal planning efforts. Continuous monitoring provides resource managers with early warnings of abnormal conditions, allowing for the possibility of reduction of environmental effects. One of MARINe's goals is to develop a data management system so all members have easy access to this long-term dataset and more comprehensive evaluations can be made.
Methods/Protocols: (From the website)
(1) Band Transect/Irregular Plot Protocol: The number and size of seastars (primarily ochre seastars Pisaster ochraceus) and black abalone (Haliotis cracherodii) are monitored along band transects or within irregularly-shaped plots, depending on site topography. Seastar transects are typically 2 x 5 m; abalone transects are typically 1 x 10 m. Transects are marked at both ends (and often in the center) by notched bolts. Irregular plots are marked by four "corner" bolts. All black abalone and ochre seastars in transects or irregular plots are counted and measured (abalone: shell length; seastars: from center to tip of longest ray).
(2) Timed Searches: Site-wide timed searches have been employed at locations where abalone and seastars exist in too few numbers to monitor within a limited area. One person spends 30 min (or 2 persons 15 min each) searching crevices and pools along the low intertidal zone haphazardly throughout the site for possible occurrences of ochre seastars or black abalone. Numbers encountered and size measurements (at some sites) are recorded.
(3) Owl Limpet Counts and Size Frequencies: The number and size distribution of owl limpets (Lottia gigantea) are monitored each spring and fall to follow population dynamics within 5 permanent circular plots per site at most intertidal sites with sufficient scorable individuals (generally > 20 individuals/plot). Plots were established in areas of high density to obtain as many measurements as possible, preferably > 100 per site. Plots are marked with a center bolt, notched to indicate the plot number. Limpets are measured within a circle (typically 1 m radius, 3.14 m2 area) around each bolt. A 1m length of line or tape is attached to the bolt and arced around to form the circle. Owl limpets found within that circle (including those touched by the 1 m mark) are measured with calipers to the nearest millimeter, then marked with a crayon to avoid scoring duplication. Limpets are never removed from the rock.
(4) Photoplots: The cover of target species as well as other core and optional species/taxa/substrates is sampled by photographing 5 (at most sites) permanent 50 x 75 cm plots per target species, then scoring point contact occurrences on the photo image. Plots were established in areas of high target species density wherever possible. Photoplots typically are scored from the photographs in the laboratory, supplemented when possible by field plot sketches and notes. For film photographs, each slide is projected onto a grid of one hundred evenly-spaced points (10 x 10). Individual taxa beneath the points are identified and recorded. When scoring digital images, a grid is created on an LCD computer monitor (using Adobe Photoshop) of one hundred evenly-spaced points (10 x 10), and placed on a separate layer. Layering is not scored separately using either procedure, so the total percent cover is constrained to 100%. The top-most layer that is attached to

the substrate (i.e., not an obvious epibiont) is always scored regardless of the type of target or core species involved. Limpets, chitons, abalone, and seastars are scored "as is." For other motile invertebrates, whatever lies beneath the mobile species is scored if possible; otherwise, the point is scored as "unidentified". Data are entered into a Microsoft Access database for analysis.

(5) Transects: The cover of surfgrass (Phyllospadix spp) is sampled by point-intercepts along 10 m long permanent transects. Transects were established in areas of high surfgrass density wherever possible. Most sites have 3 replicate transects. Transects may run end to end or be separated widely, depending on the shape and expanse of the surfgrass bed. Each transect is divided into 100 points distributed at 10 cm intervals. The top-layer target, core, or optional species/taxon/substrate is scored under each point. In addition, surfgrass is separately scored if it occurs beneath another species. In the latter situation, total transect cover can be greater than 100%.

Additional Information from Pete Raimondi: Decided to base the intertidal surveys on existing programs so that the data was compatible. Adopted protocols developed by the Channel Islands National Park Service (see above), who had been conducting intertidal community surveys of sites on the Channel Islands since 1983/4. The protocols were modified to make use of the greater amount of funding available for MARINE than had been available for the CI surveys.

All 69 sites use the same core set of protocol to monitor rocky intertidal areas. They hold workshops once/year to ensure sampling compatibility and that all partners are employing the protocol as intended. The workshops also allow them to respond to unforeseen changes in the environment. Ex. This year they added protocols for a sea star in response to a boom in the population this year.

They do allow some site-specific protocols to be added on to the core set to address issues specific to a site or to monitor species that only occur in a given area. Still, 90% of protocols are identical at each site. Partners are always welcome to do any additional monitoring that they would like as long as they do the core set also. They also allow region-specific protocols for things that don't occur everywhere. For example-abalone only occurs in the north.

When they started the program, there were programs that had been going on for years, which were very different from each other and site or issue specific. Couldn't compare their data. They felt this compromised the usability of the data. They argued to funders that standardization of protocols was needed and hadn't been done.

Enforce the protocols through money. They have grants that they provide to their monitoring partners which force them to follow the protocol. If you don't have money as a forcer, could encourage compliance through a database service. Even if programs are funded separately, people will tend to adhere to the protocols if you offer to manage, house, and analyze the data. Many site-specific programs don't have the resources to manage their own database.

Conducted a pilot to determine protocols-1st held a series of workshops to determine objectives. The objectives provide you with spatial and temporal scope for the project. You need to be very clear on the questions you are asking before developing protocols. Your questions will help you determine what species to monitor, how many quadrats, and site selection. These questions will define your protocols. They asked:

· Can we detect change in intertidal species/community abundance and if so over what spatial scales? This question then required that they look at common and conspicuous species because it is in these populations that you are most likely to be able to detect change. They also thought rare species would be good indicators

· Can we differentiate change from natural variability/natural fluctuation? They decided they wanted protocols that would enable them to detect a 20% change in species abundance in the species they were monitoring. Need to set a goal for % change you would like to be able to detect and then you can statistically determine from there how many quadrats will be necessary to accomplish this. In 1997 they had an oil spill where they could test what level of change their methods allowed them to detect. They found that while their goal was 20%, they actually were able to detect changes in species abundance as low as 10% (because communities are relatively stable over time and they did extensive sampling!).

· What scale can we expect natural processes to act on? Spatial extent. Are there regional differences?

Species selection: Because their objectives were to look for changes in species abundance, they looked at conspicuous space occupiers (here this might be ascophyllum, fucus, mussels, barnacles, etc.). Also chose species important for ecological reasons. For example, large owl limpets because they are long-lived, have slow recruitment, and people eat them. Also sea stars because they are key stone species and because people target them for collecting. They chose species that were of special interest such as the abalone because it is protected and invasive species. Lastly, they chose species that are the best indicators of the health of the system-simply by looking at the size structure of these species you can tell if the area is heavily visited, e.g. limpets. Also need to make a decision about the level of taxonomic expertise you need. The thing that compromises data the most is if you are asking for identification levels that exceed the skills of the identifiers. This leads to mis-identifications and unusable data. There are examples where monitoring at very basic taxonomic scales yields important data (see The Limpet Program, below)

He felt that our questions and objectives are specific enough to develop protocols from. For us, our question might be, which species are most likely to be impacted by recreational use?

One of the queries they have done has looked at how community structure and abundance varies with proximity to a parking lot. This has been more useful to them in predicting impact than collecting visitor numbers.

The sites they chose are similar to each other in topographic complexity. They don't do monitoring on boulder fields, only on the predominant rocky benches. The sites are spaced to ensure coverage of important ecological drivers-some calmer sites, some with ocean exposure, salinity regimes, etc.

Coordinated central database. They have metadata catalogs. All partners can query the data. Online entry. Data is available online. Password protected. There is one data master. This is the only person who can change the data after the fact.

Once per year they do a data review. They are in the testing phase now for the database and the data review has allowed them to catch mistakes. The database development process has been very slow. They thought it would all be in place three years ago. Still working on it.

They have found that it becomes easier to fund the project over time as it becomes used in management and useful to management. The start up budget was fairly large as they were bolting sites and using theodolites. But now two technicians work for him and coordinate all the sites sampling each twice per year. Now they use volunteers to assist the monitoring partners (record data). Cost of sampling is now about $50,000 per year for sampling half of California.

Why do monitoring versus research/exclusion studies of impacts? There is enough variability in communities that a targeted study won't give you a large enough scale. Both research and monitoring are important, but what's not done normally is the work to understand the ecological context of experiments. Research tells you what might be a problem, but cannot tell you whether the result is unique in space or time or applicable to the whole range. Research is often too site-specific or too short-term to provide necessary context over a large enough scale. Monitoring gives you spatial and temporal context. Experiments normally don't provide inference over the whole area of management interest.

Synopsis of the Interagency Rocky Intertidal Monitoring Network Workshop Final Report at
http://www.coastalresearchcenter.ucsb.edu/scei/Files/1997-0012.pdf

Excerpts from the report: Table 5. Potential Ways of Modifying the Current Rocky Intertidal Monitoring Programs.

- Add or drop key species based on appropriate rationale. A high priority should be placed on analyzing existing data for species' suitability in achieving monitoring goals. There is a need to improve taxonomic skills or consistent identifications. Supra-species categories may be considered for monitoring if they provide ecologically meaningful information. There was a consensus that as many key species as possible be monitored at each site. Also, participants recommended collecting biodiversity data, even if only one time per site.
- Characterize/monitor the physical environment at each site. Parameters to be measured could include degree and direction of wave exposure, substrate angle/aspect, substrate type, sand influence, temperature, salinity, chlorophyll, and nutrients. Some of these would be measured only once to characterize the sites, while others would be measured frequently.
- Evaluate feasibility of extending at least a portion of the sampling to include other population parameters such as recruitment, growth, size-structure, fecundity, or mortality. Participants particularly emphasized the value of size-structure data (which currently are collected for two key species).
- Conduct region-wide mapping to put the existing monitoring sites in the context of available resources in the entire region. Start by compiling historical information, then consider aerial surveys in combination with ground truth visits. Consider use of MMS helicopter in tri-county area. Consider characterizing rocky shores according to differing types of physical conditions, key species, and access, for possible stratification of monitoring or research sites.

4. Shorekeepers' Guide-Department of Fisheries and Oceans Canada, British Columbia (Glen Jamieson)

www.keepersweb.org/Shorekeepers

The program: An intertidal monitoring guide for professionals and non-professionals. Training program and technical support services.

Goals: long-term provision of usable data. (Created in response to Oceans Act requiring ecosystem-based approach to management-"requires collecting data not just on managed species but on a variety of species within a habitat connected ecologically to the managed species." Also developed in response to growing concern about human impacts on marine life in BC-runoff, sewage, foot traffic, etc.

Methods/Protocols: Methods based on approach described in DFO Coastal and Estuarine Fish Habitat Description and Assessment Manual, 1993. Differs in that uses physical substrate and biological features to define habitats.

3 field testings from 1996 to 1998

Mapping and Surveying (2 days per year; 5-6 people/team; 4-6 hours per intertidal survey)

I. Defining Study Area Boundaries: Recommend study area 50-500 m in length.

A. Set up a baseline running parallel to the water and marked every 2 m.

B. Identify habitats within the study area choosing from 10 IZ habitat types provided (rock habitat; cobble/shell habitat; sand; mud; rockweed; sea lettuce; kelp; mixed; eelgrass; tidal marsh). Ex. Kelp habitat: "Regardless of substrate, at least 50% of area covered by broad-bladed large kelp sp." To count as a habitat type must be at least 25 sq. meters.
C. ID Habitat substrates-more detail about the habitat base material, e.g. bedrock, boulder, cobble, pebble, sand.

II. Mapping the Study Area: map borders of the study area, habitats, IZ border with backshore, water's edge, and markers.

A. Describe baseline end points by triangulating and distance measurements to permanent features.
B. Map all the borders by measuring from baseline perpendicular to the feature you're mapping (habitat edge; upper end of the intertidal, low tide mark, etc.). Repeat every 2 m. along the baseline.
C. Take bearings from baseline end points to permanent features and mark with GPS waypoints.

III. Documenting Physical Features of Each Habitat: Record habitat characteristics (area; slope; elevation)

IV. Documenting Plants and Animals in Each Habitat-Sample 6-15 quadrats per habitat type-more in areas with many organisms. Soft sediment use 25 sq. cm. Quadrat and dig into substrate. Hard substrate: use 50 sq. cm. Quadrat. Size of quadrat and number of samples must be consistent for all sampling within the same habitat type. Within each habitat type, lay out 3 equidistant transect lines running perpendicular to the shore. Space quadrats equally along the transects. ID each different species at the surface, beneath movable objects, and within the substrate to 10 cm. Estimate percent cover for live plants or attached animals. Count mobile animals.
V. Surveying the Backshore Zone

Self-Assessment/Critique/Their Suggestions to Us: Phone conversation with Glen Jamieson (jamiesong@pac.dfo/mpo/gc.ca). The program was five years in the development and included a lot of field-testing. The monitoring has provided time series data. The program included 60-70 sites with different substrate characteristics-hard beaches, soft beaches, etc. These were not the most polluted environments. They hired displaced fishermen to participate in the monitoring.
Problems: They didn't have their questions defined ahead of time. They thought of protocol first, but didn't think of management. For species identification, they had trained biologists who conducted training on using the keys. But still mis-identifications. They had to do an audit of the data. They also had to make sure that the terminology that data collectors used when they found species that were not on the list of common species was consistent. But he is loathe to limit the survey to just the 30-40 most common species because you want to have information about rare exotics. They do have a Junior Shorekeeper program where they restrict the number of species to ID. This program is strictly an educational tool. Make sure to have enough replicates! They found significant annual variability between sites and natural fluctuations in abundances. Because their sites are randomly chosen, it isn't clear what the replicates are. Difficult to compare fluctuations from year to year. The pattern is not clear.
The program is losing resources. They have lost funding for their data technician and are now finding it difficult to get data back to the volunteers in a timely manner (for stewardship reasons).
Currently, they still have training programs and conduct monitoring for baseline data and educational purposes. They are looking now at sites that are not impacted and sites to assess impacts of aquaculture and overfishing.
Glen's description of their Sampling Regime: Define sites on the basis of habitat and physical features. Do an initial habitat mapping. Minimum of six quadrats per habitat type. They define habitat types at each site through by group consensus. Does this lead to consistency in defining habitat? The % cover categories look at big differences in coverage (0-20% cover, 20-50%, etc.). These are big enough ranges that there is consistency. They sample the same time every year especially for annual plants. A lead volunteer sends in the data.
Results: There was movement detected over time. The substrates changed over time. Eelgrass beds moved. Detected shifts in dominant species over time.

5. UMCE Proposed Coastal Rocky Intertidal Pilot Project for Casco Bay (Esperanza Stancioff) Status: Proposed, not implemented.

Goals: To provide data to the Maine Oil Spill Advisory Committee for use with oil spill damage assessment procedures; develop sustainable long-term intertidal baseline database; develop a collaborative monitoring effort; develop a working model; stimulate expanded community involvement in local science and stewardship.
Project aimed to answer the following questions:

Do the abundance of collected species change over time? Are there shifts in distribution among the species at each site? Are there differences in species dynamics from one end of Casco Bay to the other?
Methods: (Methods chosen were based on the Channel Island National Park Inventory and Monitoring Program protocols and data from the Multi-Agency Rocky Intertidal Network (see below).
1 day per year. Collect data at 10-15 rocky intertidal sites. Record species counts and percent cover from low tide mark to high tide mark. Includes citizen volunteers.

A. Site selection: choose representative sites that are bedrock or boulder substrate; have a slope of less than 40 degrees; have an abundance of "index" species; are safe and permanent study sites. Will have sites that are: exposed, semi-exposed, protected; impacted, semi-impacted, non-impacted; marine and estuarine.
B. Marking: Mark location on map and GPS. Determine a spot 2-5 m above the barnacle zone to serve a permanent mark and where you will lay down the transect line.
C. Lay transect line perpendicular to waterline from top of barnacle zone to waterline. Measure distance. Divide transect evenly by three to establish high, mid, and low intertidal zones. Measure vertical height of the transect area and slope.
D. Quadrat Placement: .25 sq. meter quadrats. Throw 10 rocks from waterline along transect to randomly determine where to do quadrats in lower IZ. Measure perpendicular distance from rock to transect line. Measure quadrat location along the transect length. Repeat at mid and high zones.
E. Data Collection: percent cover of algae and clustered species; lower a plumb bob and record the canopy species that it intersects; record species at 25 grid intersections on the quadrat; biota counts-count and record all individuals of each species in the quadrat for all holdfast species and all mobile species for which there are 10 or fewer within the quadrat. Photographs.

6. Shoreline Inventory of Intertidal Resources of San Luis Obispo and Northern Santa Barbara Counties, Principal Investigator: Pete Raimondi University of California, Santa Cruz, http://www.coastalresearchcenter.ucsb.edu/cmi/inventory.html

Goals/objectives:

The purpose of the Shoreline Inventory Project is to provide baseline information on the rocky intertidal plants and animals along the central and southern California coast. Information on coastal biota in these areas would be essential in the event of an oil spill or other major impact. In addition, the monitoring studies yield important data on population dynamics on a local and regional scale which can be utilized for more effective resource management as well as provide fundamental ecological knowledge about the dynamics of the systems.
Methods/Protocols: 23 semi-annual samples for Northern Santa Barbara sites, and 16 semi-annual samples for San Luis Obispo sites. The sampling protocol focuses on target species or assemblages. Permanent photoplots are established in assemblages such as barnacles, mussels, anemones, turfweed, and rockweed. Cover of the major taxa is determined by point-contact photographic analysis for all plots except barnacles, which are scored in the field to allow samplers to distinguish Chthamalus spp. from Balanus glandula. Counts of mobile invertebrates occurring within the barnacle, mussel, Endocladia, Mastocarpus, Silvetia, and Hesperophycus photoplots are also done in the field. Additional permanent plots are established for large motile species such as owl limpets, black abalone, and sea stars. Line transects are used to estimate the cover of surfgrass. Photographic overviews and field notes are used to describe general conditions at the site and to document the distribution and abundance of organisms not found within the photoplots.
Over the past year, we have completed efforts to fully standardize our sampling methods with all groups in MARINE (Multi-Agency Rocky Intertidal Network). One of MARINE's goals is to develop a database for all of the intertidal groups to use for data entry. This goal is nearly complete, and we hope to begin using the newly constructed MARINE database sometime this summer.
They also conduct one volunteer program, which is administered through the high schools. The LIMPET program (Long-term Monitoring Program & Experiential Training for Students, http://limptes.noaa.gov/monitoring/rockIntertidal/procedures.html). Here students look at broad taxonomic categories. At this scale, you can detect large changes. You might not be able to see small changes or to detect invasive species, but the data is still useful. More useful than asking these students to identify species to a level they are trained for.
Pete also works on Biodiversity Comprehensive Surveys. A group out of UC Santa Cruz coordinates this work . This program is designed to complement the MARINE program because they realized that they weren't doing a good job of biodiversity assessment. This program employs standardized biodiversity surveys from Glacier Bay Alaska to Mexico. Looks at how biodiversity changes as a function of latitude and aims to define biodiversity hotspots. They are also tracing how species ranges are changing. They have found some of the predictable biogeographic breaks in biodiversity, but also some that no one had known about before.

Trained a core group of people to do the surveys and trained them extensively to know every species that occurs. Same group does the surveys year after year so data consistency. Set out a spatial grid and are developing 3-D maps of intertidal species/community distributions.
The results are spatially explicit. Each species has a coordinate attached to it.
Finding that the most biodiverse areas and areas with greatest number, size, and diversity of long-lived species are at military bases and private restricted ranches, which have been restricted since the 1800s. [Similar to findings here for Schoodic Point]. Providing new perception of biodiversity baseline and pristine condition, because completely different communities at these sites than found elsewhere, even than found in state intertidal MPAs. State MPAs are often managed by the California Coastal Commission, which has both conservation and public access responsibilities. These are not necessarily compatible. The result is that many of the intertidal MPAs have parking lots associated with them, ensuring visitor use. MPAs encourage visitation. For intertidal diversity, perhaps an MPA is the worst thing that can happen to an area. Attracts public attention to it and often leads to access.
Has sparked a large debate there about whether managers should diffuse access or whether to concentrate access and "sacrifice" certain areas. Looking at the diversity at these ranches and bases, he leans toward concentrating use in order to restrict use in certain areas. These sites suggest that small amounts of use can have big changes if you are talking about long-lived species with low recruitment. Balance needed-people's access and conservation.
Small-scale impacts have been seen as important on land for a long time, but only now are small-scale consistent impacts seen as important to marine systems. Casual use impacts.
This data can help to identify areas of special biological significance, which can influence management of these areas.

7. Santa Monica Bay Restoration Commission: http://www.santamonicabay.org/site/problems/layout/hRockyIntertidal.jsp

Goal: The SMBRC is supporting research to survey rocky intertidal habitat in the Bay and determine visitor impacts to intertidal communities.
Historically, impacts from wastewater discharges had a large impact on rocky intertidal areas in Southern California. One study (Dawson 1959, 1965) noted reductions of 50 to 70% in algal species diversity between 1895-1912 and 1956-59 at sites near the Joint Water Pollution Control Plant sewage outfalls at Whites Point. Later studies showed similar declines.
A continuing threat to rocky intertidal habitats and the associated biological communities is direct human disturbance in the form of trampling, rock turning, and collecting by the many visitors to these areas. Two protected areas have been established on the Palos Verdes Peninsula to help save rocky intertidal habitat from these visitor impacts. The two areas, one at Abalone Cove and the other at Point Fermin, are designated as Ecological Reserves by the California Department of Fish and Game. Restrictions in these areas include: no taking or disturbing of any plant or animal; no commercial fishing; no pets without a leash; and no fires. However, without active enforcement, the protection afforded by these areas is limited.

8. Cabrillo Tidepool Study-- Gary E. Davis, Principal Investigator

In 1990 the National Park Service commissioned the National Biological Service to study the Cabrillo National Monument intertidal zone. The purpose of the study is to measure the impact of public visitation and other human activities in the San Diego metropolitan area. Every spring and fall the scientists collect information from the tidepools. Among the 13 key species being monitored semi-annually are:
California Mussel (Mytilus californianus)
Common Rockweed (Pelvetia fastigiata)
Owl Limpet (Lottia gigantea)
Acorn Barnacle (Chthamalus spp.)
Goose Barnacle (Pollicipes polymerus)
Thatched Barnacle (Tetraclita rubescens)

9. Bowdoin College Intertidal Lab (Amy Johnson)

Goal: Education-Lab 1: To familiarize the student with the organisms that inhabit the rocky intertidal (habitat, behavior, tolerance, trophic niche). Lab 2: calculating species richness and species diversity of algal species at comparable heights along two transects

Methods: Lab 1: 3 quadrats. Estimate % cover of 20+ species/taxa. Lab 2: 1 tide @ four transect lines historically established. Each group establishes sampling stations along a transect; ID and quantify organisms within the transects. Determine location of the zones (blue-green algae, barnacle, mussel, rockweeds, etc.)

10. Invertebrate Abundance on Ocean Coasts-GLOBE Special Measurement Protocol. Website: http://eebweb.arizona.edu/faculty/mangin/globecoastal/protocolschoice.html

Goal: The data will create a baseline for densities of common invertebrates on coastal shores worldwide. Monitor the health of coastal ecosystems by providing us with data to track changes in densities of these common organisms over time and across multiple sties.
The program has recently developed specific protocols for rocky coasts and sandy bays, as well as general IZ monitoring protocols
Overview of Protocols for Rocky Intertidal: Students will estimate the densities of certain broad categories of animals, common on many coastal shores worldwide. They will count numbers of invertebrates in quadrats 25 cm on a side in areas where each category is common. They will also count the number they can find in ten-minute searches. The categories for counts in quadrats are snails, barnacles, mussels, oysters, and anemones. Snails are counted both near the water's edge and near the shore. The categories for timed counts are sea stars, sea urchins, sea cucumbers, snails, crabs, chitons, limpets and an open category. Each school chooses four categories to count for the quadrat counts, and three categories for the timed counts.
Can enter data online and data is accessible online.

11. Kachemack Bay Intertidal (& Subtidal) Mapping/Trampling Effects/Intertidal Baseline Characterization:

www.habitat.adfg.state.ak.us/geninfo/kbrr/coolkbayinfo/kbec_cd

Mapping
Goals/Objectives: Overall: Determine rates and extents of ecological change. Map and distinguish changes due to changing environmental conditions vs. large natural fluctuations of biological populations in space and time. Specific: Map neashore habitats in Kachemak Bay and quantify the physical attributes that force spatial variation in biodiversity of algal and invertebrate populations from characteristic habitat types; measure temporal variation of nearshore biodiversity among similar but spatially independent habitat types; test how well the Shoreline Classification and Landscape Extrapolation model predicts benthic community structure.

Methods: 2001 to 2002
(A) Collect salinity, temp using physical mooring arrays;

B. Use low altitude videography to do large scale partitioning of the shoreline based on physical and biological characteristics;
C. Oblique photography and California's GIS protocols for kelp bed mapping to determine aerial extent of kelp bed coverage;
D. Field map the shoreline to partition shoreline into geophysically homogenous segments, quantifying the geophysical attributes known to force biological communities;
E. Develop GIS database of physical habitat features for intertidal and subtidal lands and analyze distribution of characteristic habitat types

Trampling: Objectives of the Monitoring the Potential Effects of Trampling in the Intertidal Zone of Peterson Bay, Alaska: A Pilot Project (Center for Alaskan Coastal Studies, Marilyn Sigman, email: cacs@xyz.net). To recognize the importance of monitoring and understanding the impacts of concentrated use of the intertidal zone. To quantify the effects of educational programs conducted by the center in the intertidal areas that attract ~1500 visitors each year. To develop a strategy for a long-term program to monitor the impacts of trampling in the intertidal zone. CACS will modify their educational program to minimize the impacts to intertidal diversity.

Methods: Data collected since 1998. Permanent transects between the upper and lower intertidal zones at two sampling sites. People are excluded from one transect. The other is in the area where CACS conducts programs. Measure species richness and percent cover in quadrats evenly spaced along each transect. Summer months, low tides.

Intertidal Baseline Characterization

The characterization calls for long-term monitoring to develop baseline data for oil spill assessment and for assessment of long-term community change. Local residents were noting changes over the last two decades==decreases in intertidal species such as chitons, sea stars, etc. Methods: Compared intertidal surveys from 1974-1976 and 1996. Found no major shifts in species dominance or community health outside range of natural variability and that changes observed were not necessarily due to human impacts.

12. Coast Walkers, Glacier Bay National Park-Mapping Glacier Bay's Coast

www.nps.gov/glba/learn/preserve/projects/coastal (Lewis Sharman)
Two person teams walk the shore during low tide and delineate habitat polygons (habitat areas) based on areas of similar beach surface substrate. Field crews map the coast by delineating polygons on aerial photos. For each polygon, the following field data is collected:

1. Surface substrate characterization
2. Four-minute timed biological inventory of key intertidal flora and fauna
3. A transect from the water's edge to the woody vegetation to document vertical zonation patterns.
4. Stream inventory to capture major stream characteristics (streams running through the intertidal area)
5. Three documenting photos
6. Presence/absence of special interest resource attributes-archeological sites, offshore reefs, kelp beds, clam habitat, urchin recruitment areas, tide pools, wildlife aggregation areas.
7. GPS points to assist georeferencing.

Info about intertidal biota, beach substrate, vertical zonation, animal haul-outs, etc. instantly available on GIS to resource managers and decision-makers on park's network. They can "walk the beach" segment by segment on the computer. Developing a web-based version so the public will be able to view the information via the internet.

13. Maine's Coastal Wetlands: Recommended Functional Assessment Guidelines (Alison Ward, DEP, 1999).The Program: Produced for DEP to help guide assessment of intertidal coastal wetlands and impacts of various activities. Provides intertidal sampling guidelines by impact and activity type (e.g. pilings, dams, bridges, shoreline stabilization, etc.), and habitat type (sand beach, boulder beach, salt marsh, mud flat, etc.).

Goals/Objectives: to help standardize functional assessments in coastal wetlands. To assess the most critical functions and values of coastal habitats and identify vulnerable environments and resources with the least amount of sampling effort possible to make informed decisions to prevent loss or degradation of coastal wetlands. (Specifically targeted to professional consultants for assessing projects impacting 500 sq. feet or more of coastal wetlands).
Methods/Protocols:
All habitat types:

1. Complete a Maine DEP survey checklist including location, tide, size of project's impact, depth of sediment impact, slope, exposure, freshwater sources, salinity range, signs of erosion, sediment characteristics, depth to anoxic layer, recreational activity, fisheries, pollution, development, other impacts. Also record dimensions and percent cover of major habitat types within the area of disturbance (eelgrass, algae, marsh, kelp, boulder, etc.), geological description (sediment grain size and geologic features such as bluffs, beach nourishment, deposition sources), habitat description for each intertidal zone (epifauna and epiflora, worm & clam holes, worm tubes, fecal mounds, tide pool samples, and habitat condition based on species diversity, abundance, and functional groups). Species List from qualitative assessments (see below). Historical information (what impacts and when). Impact assessment.
2. Photos: taken on negative tide, date, time, tidal height, compass direction. Indicate area of development. Close-up photos of undisturbed surface sediment and marine life in the site. Unusual features (polluted sediments, deformed animals).
3. Habitat Map: Hand drawing with hand measured dimensions. GPS measurements not required. Terrestrial and marine features with habitat dimensions in sq. feet for mussel beds, eelgrass, salt marsh, oyster bars, kelp, rockweed, commercially important areas, areas with lobsters, areas with cucumbers or urchins, Irish moss.

Location of mean high and mean low water, scale, compass direction, location of point sources, lobsters, road and boat access, area of impact, other features.

See field card data sheets pg. 55-75. Includes species lists and habitat types for all habitat types (mixed course and fine sediment, mud flat, sand flat, sand beach, ledge, boulder beach) and general species list.

Soft Sediment Habitats:

a. Qualitative Survey: note location and measure all habitat types. Create a draft Habitat Map. Take photos. Do a qualitative epifauna survey by turning over rocks, wood, boulders, etc. and looking in eelgrass, algae, and marsh. Record species present on surface. Conduct infauna survey by raking through sediments and identifying species and estimating relative abundance.
b. Quantitative Benthic Infauna Survey: In high, mid, and low intertidal zones, take cores (number varies by size of project area-1-3 cores/zone/acre). 1- cm core at randomly chosen sites. Lab analysis of the sample using a 1.0 mm sieve. ID and count all animals that were alive before preservation of the sample. Bryozoans, nematodes, and oligocheates not id'd to species.

(Same or similar protocol for mixed sediments, ledge, and saltmarsh. Can use a shovel or grab within the quadrat to sample down to 10 cm. in harder sediments.)

Boulder Sampling:

a. Randomly choose a specified number of moveable boulders from each intertidal zone. 9 boulders per acre, 7 per 0.5-1 acre site, 5 per site less than 0.5 acre.
b. Before disturbing boulder describe epifauna and flora on top and sides of boulder. Over-turn boulders and ID and enumerate species. Include animals on or under rocks under the boulder.
c. Create reference collection of unusual or unidentified animals
d. Record location of boulders on habitat map.

14. REEF Program -reef.org
15. Citizen Shoreline Inventory-pugetsound.org/csi/main.html

Additional Notes/References:

** Dan Dauer out of Old Dominian-developed an ABC method for monitoring benthic habitats (source: Sarah Lindsay, UMaine)

**from Channel Is. Document: "A good review of Rocky intertidal ecological study design and alternative methodology can be found in Murray et al. 2002.

** Intertidal monitoring protocol examples listed in "Maine's Coastal Wetlands" Alison Ward:

Baker 1987; US Army Corps 1995; Admus et. al 1987; Larsen & Doggett 1981; Bryan et. al 1987; Diaz 1982; Bowen & Small 1992; LaSalle & Ray 1992; ME DMR 1998; Nelson 1987; Puget Sound Estuary Program 1991