ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Section 1. Contacts

1. Date submitted March 20, 2008	2. Region 5	3. Regional Biologist Jan Taylor
4. Refuge Supervisor Janet Kennedy	5. Refuge/Station Name Maine Coastal Island NWR	6. Station Project Leader Brian Benedict, Acting Refuge Manager Signature:
7. Contact person Linda Welch and Sara Williams	8. Contact phone number (207) 546-2124 extensions 11 and 13	9. Brief title Vegetation Management on Seabird Nesting Islands

10. Biological Monitoring Team Contacts

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Section 2. Synopsis of adaptive management workshop

11. Date & location of workshop: November 27 and 28, 2007

12. Workshop Participants, including Refuge staff.

Participants	**Agency**	**E-mail / phone number / notes**
Charlie Blair	FWS-Maine Coastal Islands	Charles_Blair@fws.gov, 207-236-6970
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Julie Ellis	Tufts University	Julie.ellis@tufts.edu, 508-887-4933
Glen Mittelhauser	Maine Natural History Observatory	glenm@acadia.net, 207-963-2012
Scott Hall	National Audubon	SHall@audubon.org, 207-210-3569

13. Brief problem description.

Maine Coastal Islands NWR (Refuge) administers six of the ten islands that support over 94% of breeding Arctic and common terns, laughing gulls, and Atlantic puffins in Maine. The Refuge and the National Audubon Society ensure the success and perpetuation of these colonies by maintaining predator free nesting sites, documenting population and breeding productivity trends, facilitating research, and on some islands, annually managing habitat. In order to further advance seabird restoration in Maine, vegetation monitoring protocols need to be standardized and the most effective and efficient methods for creating and maintaining tern habitat need to be determined.

For common and Arctic terns, colony managers in Maine have tried techniques (such as mowing, burning, grazing, herbicide, and landscape fabric) to maintain low sparse vegetation. The results of these treatments may be difficult to predict because the influence of the season which the treatment is applied, island topography, available moisture (rain and fog) during the growing season, storm events, soil type and soil depth are often unknown. Seasonal limitations imposed by the seabird nesting season and severe weather increase the complexity and uncertainty of managing vegetation on these remote islands. Several published studies describe the effect marine birds have on habitat, but few published seabird habitat management studies exist. A standardized habitat monitoring protocol is needed, but more importantly, we need to determine the best management practices for enhancing tern habitat. A model that predicts the effect a vegetation management technique may have on islands with peat or non-peat soils during wet or dry growing seasons would greatly advance the scientific communities understanding of island ecosystems and hopefully lead to improved efficiency.

In order to reach the Refuge's seabird conservation objectives (identified in the 2005 CCP), 4 additional islands will be restored and managed over the next 15 years. The Refuge annually implements mowing, prescribed fire, grazing, and occasionally experimental treatments on three islands. The model developed by this Adaptive Management study will enable the Refuge to improve the efficacy and efficiency of habitat management and increase our capacity to manage multiple islands. This information will be used by our conservation partners to help manage other seabird islands in the Northeast.

14. Objectives.

An adaptive management study is needed to identify vegetation management techniques that create the most suitable habitat for Arctic, common, and roseate terns and determine if islands respond uniquely to treatments. In addition to enhancing Arctic and common tern habitat, we will decrease the amount of suitable breeding habitat for laughing gulls, direct competitors and predators of terns. The Refuge would like to convert habitat into a self sustaining low structure that does not need annual maintenance. Seabird objectives for each island were developed for this project by Refuge staff and modeled after broader regional and Refuge Habitat Management Plan objectives. Although reaching population objectives may not be possible, population objectives provide context for habitat objectives. Supporting breeding eider and Leach's storm-petrels are part of the Refuge's broader mission, but are not the focus of this adaptive management study.

Tern Objectives:

- Target number of breeding pairs (see 5 year-average below)
- Productivity of 1 chick/pair (area is free of gulls, predators are controlled, human disturbance is limited)
- Common and Arctic tern habitat: <0.5m vegetation height with 10-25% overhead cover. Nests are evenly distributed across area; reduce the density of terns nesting on the perimeter where they are at greater risk of depredation and storm events. Vegetation < 0.5m feet in height will also deter laughing gull nesting
- Roseate tern habitat: 0.5m to 1.0m vegetation height, >70% overhead cover (including debris and boxes)
- Roseate tern nests located in historical subcolonies (within ARTE/COTE habitat)

Island Name	Population Goals		Habitat Acreage
	Common/Arctic Terns	Roseate Terns	
Petit Manan	2,000 pairs	60 pairs	8.1 acres
Seal	2,000 pairs		11 acres
Matinicus Rock	1,200 pairs		11 .4 acres
Metinic	1,000 pairs		23.4 acres
Pond	500 pairs	20 pairs	4.8 acres
Eastern Brothers	300 pairs		4.7 acres

Laughing Gull Objectives

- target number of breeding pairs (see 5 year-average below)
- Reduce gull population over the next 5 years to decrease predation on tern eggs and chicks and competition for nesting habitat
- Productivity of <1.0 chicks/pair
- 1.0-2m vegetation height. (Low vegetation height also allows the Refuge to be more efficient in nest control efforts)

Island Name	Population Goals	Habitat Acreage	Annual Population Reduction
Petit Manan	500 pairs	3.7 acres	18% pop. reduction
Matinicus Rock	350 pairs	1 acre	12% pop. reduction

15. Management alternatives & expected response of the resource. Who makes decisions about what management actions to implement? When & how often are these decisions made?

The Refuge annually manages against rank vegetation on three islands to support breeding Arctic and common terns using the traditional techniques of mowing, prescribed fire, and grazing. After visually assessing habitat throughout the spring and summer and considering tern distribution and success, habitat management decisions are typically made in the fall and implemented in the fall or spring. The table below describes the treatments to be tested during this adaptive management study for the first 3 year timeframe. The time of year a treatment is conducted has the potential to change treatment results. The Refuge is currently constrained to conducting treatment in the late spring or fall because of the breeding phenology of the birds and adverse weather conditions during winter and early spring. Small scale experiments may be conducted to determine the efficacy of other techniques (i.e. landscape fabric or herbicide) and in areas where birds currently aren't nesting, the effect of conducting treatment throughout the growing/breeding season. Although only six islands in Maine support the majority of nesting seabirds, we would consider implementing summer treatments on new restoration islands for several years if it would reduce the need to conduct annual treatments.

Treatment	**Petit Manan Isl.**	**Metinic Is.**	**Eastern Brothers Isl.**	**Pond Isl.**
Prescribed Burn	✓			
Mow	✓	✓		
Graze		✓	✓	
No action (experimental plots)	✓	✓	✓	✓
Experimental plot treatments		herbicide	herbicide	herbicide

Table 1. Proposed treatments to test for the Adaptive Management Study.

We expect the results of management actions to be unique for each island. To account for these differences, we will analyze soil properties (including pH and soil depth). A brief summary of past actions and expected results for each island are described below. To account for the seasonal effects of weather on plant growth, we will collect temperature, windspeed, rainfall, and the number of days of fog for each growing season. These additional datasets should help explain why treatments are unique to each islands.

- **Petit Manan Island:** Prescribed fire has been conducted annually on Petit Manan since 2002 and will be continued for the duration of this study. In addition, several 30m plots will be mowed in the fall and the entire island will be burned in the spring. Managers have experimented with vegetation management at Petit Manan since 1984. Techniques utilized include: the application of lime, aluminum sulfate, herbicide, and rock salt; placement of landscape fabric, plywood, and sheetrock; mechanical actions of tilling, mowing, and prescribed burns; and no action. Not all techniques worked well, but prescribed burning resulted in an overall shift in tern distribution from the colony edge to the interior of the island and the initiation of laughing gull control efforts to limit depredation on terns. Annual prescribed fire has reduced the height of Canada bluejoint (habitat preferred by laughing gulls) from >6 feet to <3 feet and has improved the efficiency of laughing gull nest control (destruction and egg poking). The number of laughing gulls has increased dramatically at Petit Manan since 1997 but these increases are not a result of habitat conditions on the island.) Although prescribed fire releases nitrogen into the soil and may enhance vegetation growth, burning in the fall damages Canada bluejoint growth shoots and limits growth the following season. Because Petit Manan island soils are dominated by peat, fires are conducted in the spring when soils are saturated. As a result, only the top surface of soil and vegetation are burned. Underground peat fires could burn extensively and threaten historical structures and nest initiation by terns and alcids. We anticipate that a combination of mowing and burning will be most effective in maintaining low habitat and that Canada bluejoint will not be eliminated, but reduced in height.
- **Metinic Island:** The Refuge owns 140 of 330 acres on Metinic Island where sheep grazing is a historical use. Since the tern restoration effort began in 1998 and through 2006, an average of 120 sheep have been allowed to graze the entire island from August through April, and are then excluded from a portion of the tern nesting area (1.5 acres on the northeast point) from April through mid August. Grazing on Metinic Island appears to encourage the dominance of grasses and has minimized expansion of raspberry and shrubs in the tern restoration area. In 2007, the Refuge further restricted sheep grazing by closing the entire northern half of Metinic to grazing (rather than just 1.5 acres). We observed robust raspberry growth and the expansion of undesirable thistle. In the fall of 2008, the Refuge applied herbicide to raspberry, sprayed and cut seed heads of invasive thistle plants, and mowed the northern peninsula to encourage the sheep to graze in this area throughout the winter and spring. We expect that herbicide and mowing will most effectively control raspberry, and that low meadows that are mowed and later grazed will stay low throughout the season.

- **Eastern Brothers Island:** Sheep grazed this island for over 100 years until the mid 1990's. The Refuge acquired the island in 1997 and initiated a seabird restoration project in 2007. To reduce the density of grasses and thatch in the tern restoration area, a prescribed burn was conducted on the entire island in 2007. Eastern Brothers Island has peat soils, similar to Petit Manan Island but the vegetation communities are much different. We did not observe any significant change in habitat structure or type as a result of the burn, but the height of standing dead grass during tern arrival was significantly reduced. We anticipate that grazing will reduce the height and density of grasses and will experiment with seasonal and year-round grazing treatments.
- **Pond Island:** No habitat management actions have bee conducted on Pond Island in recent years. Poison ivy will be sprayed with glyphosate in 2008 but significant treatments are not planned this year. We will collect vegetation data on Pond Island in 2008.

16. Competing models & key uncertainties.

Complex transportation logistics create uncertainty in whether or not treatments can be accomplished. Some treatments such as herbicide application or prescribed fire must be conducted during favorable weather conditions. Sea conditions, storms, and the seabird nesting season also limit number of days management can be conducted. The effectiveness of managing in the fall or the spring is also unknown for many treatments, and unpredictable stochastic events of fog and rain during the growing season compound uncertainty. Treatment results on individual islands may not be representative of all Maine seabird islands for many reasons including but not limited to soils, geomorphology, or distance from mainland. Currently, the positive effects of management actions on vegetation height and density are short lived and the cumulative effects of treatments over multiple years are not known.

The model for this Adaptive Management Study focuses on the effect management actions will have on three vegetation types: low meadow, high meadow, and shrub. We anticipate that the proposed actions will either maintain or reduce the height and density of these habitat types, but to different degrees. We are currently in the process of making predictions for how the three vegetation communities will respond to treatments on each island based on the Refuge's collective observations of prior treatments. No competing models have been identified for the results of any one treatment. Any competing models suggested during future discussions with our consultation team and partners will be incorporated.

17. Decision support & modeling tools.

A model was developed to determine response during three time intervals of three vegetation types of shrub, low meadow, and high meadow to different treatments. Refuge will meet with ecologists and botanists to more accurately describe community types and ensure the types identified can be differentiated. The description of these broad community types may differ in species composition between islands. The distribution of terns and laughing gulls may help identify the location of these community types on each island. The general community types utilized were described by Julie Ellis in "The vascular flora of five seabird breeding islands in the Gulf of Maine, USA," a currently unpublished report. The information generated by this project may be useful to refine National Vegetation Classification System for Maine islands but NVCS classification will not be used for identifying changes in vegetation communities.

Sampling intervals correlate to tern nesting phenology: May (tern arrival), June (peak of tern incubation), and July (chick fledging). The goal of treatments is to create low vegetation communities that stay low during the tern breeding season. For each treatment and each island, Refuge staff assigned probabilities that the height of the three vegetation communities will increase, decrease, or stay the same between each sampling interval. The definition of "low and high" vegetation height may be different for each time interval. A limitation of this model is that it doesn't capture if a vegetation community type changes to another community type but separate data analysis will produce this information. To reduce the complexity of the model and because we are not certain vegetation communities will change within a three year time frame, we'll determine shifts in community types separately by collecting data on dominant species, densities, and height within vegetation plots. If trends are observed after several years of data collection, we may consider adding predictions for changes in community types into the model. We will work with local botanists and experts to ensure monitoring protocols can capture structural and species composition changes within each community type.

Data from each island will be analyzed independently but the same model structure (spreadsheet) will be used for each. We think this is appropriate because we assume that islands would have different vegetation communities if management was not conducted. Each island will be studied independently, but data will be compared to determine if vegetation response to treatments is similar among all islands. A consequences table (see example below) will be used to identify the best treatment option. After data collection, results will be imputed into the consequence table and objectives will be weighted. A single utility index will be calculated for each treatment that includes actual treatment results and a cost/benefit analysis.

The scale of the model was developed for a 30m grid square but values will be multiplied by the total island area to calculate overall island response. We will also monitor and include in our data analysis soil type, soil depth, topographical features, and precipitation levels to help account for differences in treatment results among islands. These data will be useful when selecting islands for restoration and predicting treatment results on islands with similar characteristics (i.e. peat or non-peat soils).

Consequences Table example				
Objectives	**Treatments**			
	Spring Burn	Mow and Burn	Grazing	No Treatment
Habitat (proportion of plot that is good habitat for terns)				
Arctic and Common Terns (pairs)				
ARTE/COTE Tern Productivity (chicks per pair)				
Roseate Tern pairs				
ROST Productivity (chicks per pair)				
Proportion of exp plots with ARTE/COTE nests				
Proportion of exp plots with ROST nests				
Gull (pairs/nests per 30m pix)				
cost per 30m				
Number of people needed per 30m				
Number of people needed per 30m				
Petrels				
Eiders				
Bird diversity (richness of desirables)				
Number of suitable days available to conduct treatment				
Utility Index				

18. Monitoring metrics.

- Habitat (proportion of plot that is good habitat for terns): % cover, height and density of dominant species, vegetation type/community, depth of peat/soil, soil pH, presence or absence of invasive plants
- Number and distribution of Arctic and common tern nests/pairs (GOMSWG Census: islands wide nest count)
- Arctic and common tern productivity (chicks per pair)
- Number of roseate tern pairs
- Roseate tern productivity (chicks per pair)
- Proportion of exp plots with ARTE/COTE nests
- Proportion of exp plots with ROST nests
- Number and distribution of laughing gull nests/pairs
- Treatment cost
- Hours of staff time needed to conduct treatment
- Presence or absence of nesting Petrels and Eiders; Bird diversity (richness of desirables)
- Other: weather

19. Time step for updating models.

Treatment results may not be significant in the first year but would require several years of repeated treatments and monitoring. The group agreed on a three year time period during which we would replicate a single treatment in the same way each year.

20. Briefly, how will this project improve management at your station & elsewhere?

This adaptive management study will help the Refuge increase management flexibility and weigh the associated benefits, costs and risks of treatments. The four islands selected for this study will serve as representative seabird islands in Maine and will help managers prioritize and develop management strategies for new restoration projects. Most importantly, this study will allow the Refuge to increase the number of islands managed in a given year. Of the 49 Refuge owned islands, 33 currently or could potentially support nesting seabirds.

Section 3. Implementation Plan

21. Monitoring Partners (all Refuge stations and others who will be implementing the plan).

Partner	**Agency**	**E-mail / phone number / notes**
Maine Coastal Islands NWR	Rockport and Milbridge offices	
Scott Hall (project coordinator) Juliette Lamb (graduate student)	National Audubon University of Massachusetts, Amherst	shall@audubon.org Control plots and experimental replicates for landscape fabric and planting grasses.
Jane Arbuckle	Maine Coast Heritage Trust	stewardship@mcht.org Permission to sample on Nash Island, an additional replicate for sheep grazing (100+ years)

22. Timeline for implementation. Estimate when assistance will be needed from modeler, database expert, BMT, or Regional Biologist.

Approx. Date	Task	Responsible Person
November 2007	Finalize management alternatives	Consultation Team
February 2008	Draft decision support spreadsheet Make predictions	Eric Lonsdorf Refuge staff
May-Aug 2008	Test monitoring protocols, begin data collection	Refuge staff and seasonal technician
Sept. 2008	Implement fall management actions	Refuge staff
Oct 08-March 09	Create monitoring database	Todd Sutherland
Oct 08-Feb 09	Finalize decision support spreadsheet Update spreadsheet	Eric Lonsdorf Refuge staff
April 2009	Implement spring management actions	Refuge staff
2009, 2010	Continue treatments and monitoring. Study findings will dictate if the project continues beyond 2010.	

23. Budget.

Total request from Regional Office: $

Station(s) proposed to receive the funds (if multiple stations indicate the budget breakdown by station).

If grants or other funding sources are being used for the project, indicate the sources & amounts (add a column).

Item (Examples)	Hours	Station $$	Regional Office $$	Total $$
Staffing				$21,907
Refuge Staff (GS11 $26.11/hr) 15 days project planning and 4d data analysis/reporting, 19 days habitat management (9d PMI Burn, 2d Brothers, 8d Metinic)	300	$7,833		
Seasonal employee (GS9) Island vegetation mapping, vegetation plot location selection and construction, testing monitoring techniques, data collection, tern census, tern productivity, data entry, camp closures	640		$14,074	
Operations				$5,868
Boat Transportation Average hourly cost including operator, maintenance, etc for 18, 2 hour trips		$5,868		
Equipment/supplies				$3,617
Stream Gauges modified to measure veg. height + wooden poles		$1,200		
Electric Fence for Metinic		$500		
Meter Sticks (6)		$162		
Control plots for grazing		$50		
Field Soil pH Test Kit		$100		
Lab Analysis for Soil Samples (120 samples)		$1,080		
Sheep grazing on E. Brothers		$500		
Herbicide		$25		
Total		$17,318	$14,074	$31,392

Section 4. Attachments

A. November 24, 2007 Adaptive Management Consultation Minutes
B. February 2008 Maine Coastal Islands NWR Adaptive Management Project Update
C. Review of Vegetation Management Techniques Used on Maine Seabird Islands
D. Strategy Table

Section 5. Instructions

25. After your adaptive management workshop, the workshop recorder will summarize the minutes of the workshop and distribute to all interested persons (participants, partners, managers). The planning team will meet to finalize any items not completed during the workshop. These include refining the descriptions of the alternative management actions and defining the monitoring metrics and how they will be interpreted. The planning team or representatives will meet with the modeler to work out details of drafting a decision support tool (spreadsheet). The planning team also needs to estimate when they need help creating a project database to hold the monitoring data. If the services of a contractor are needed (specialized expertise or reviews), solicit needed contracts.

The planning team will draft this Implementation Plan & discuss the plan with the Project Leaders (PL) at each station proposing to implement. The Team Leader will finalize the Implementation Plan and forward to the Regional Biologist (RB), with cc to the PL. The PL will e-mail the RB to indicate their concurrence with the Plan. (Alternatively, send a hard copy with PL signature to the RB; the RB still needs the digital file.) The Regional Office will determine whether or not additional funds are available to support implementation of the project. A revised plan with updated budget should be submitted on or before 1 March each year that the project is operational if Regional Office funding is desired. Projects should be designed to be feasible with or without this funding.