Guemes Island
Rapid Shoreline Inventory

Prepared for the Skagit County Marine Resources Committee

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Volunteer Ivar Dolph quality checks Anne Passarelli's, and Howard Pellett's data form.

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Executive Summary

During the summer of 2005, People For Puget Sound staff and volunteers conducted a Rapid Shoreline Inventory (RSI) on select marine shorelines of Guemes Island. Working under contract and in partnership with the Skagit County Marine Resources Committee, the Northwest Straits Commission, and the Guemes Island Planning Advisory Committee (GIPAC), a detailed set of physical and biological data for six-and-a-half miles of shoreline on the Island were compiled.

People For Puget Sound designed the Rapid Shoreline Inventory to gather information about the relationships between shoreline land use and indicators of beach health. By looking closely at these relationships, areas can be identified that may be appropriate for voluntary conservation and restoration actions. RSI participants — volunteers who help collect RSI data and property owners who grant permission — gain a better understanding of shoreline habitat and how it functions, and therefore are better able to protect and restore the shoreline.

The Skagit County Marine Resources Committee (MRC) and the Northwest Straits Commission funded and assisted with the 2005 Guemes Island Rapid Shoreline Inventory in order to:

1) Assess nearshore habitats on Guemes Island;

2) Assist habitat conservation efforts by individual property owners, community groups, and resource managers, and;

3) Identify opportunities for voluntary conservation and restoration activities in the area.

By comparing their beach to more "natural" beaches, property owners can determine what sorts of landscaping activities they can undertake to improve the habitat qualities of their shoreline. Property owners who own large stretches of beach or who join

together a group of neighbors might qualify for permanent habitat protection by way of a conservation easement. Property owners who are interested in voluntarily protecting or restoring habitat on their property are encouraged to contact the MRC or People For Puget Sound.

<u>Key Findings of the Rapid Shoreline Inventory</u>

In the 6.45 miles of shoreline inventoried in 150-foot sections, 71% of those 227 sections contained at least one patch of potential forage fish spawning gravel, 93% had a backshore, 85% contained bluffs or banks, 34% contained invasive plant species, 18% were predominantly undeveloped, and 81% contained no manmade structures on the shoreline. However, 59% of land use was not visible from the beach. Fifty five outfalls were observed. Erosion was noted at 32% of the outfalls, associated algae growth at 32%, and darkened sediment at 11%.

The most common wildlife sighted were barnacles, clams, shore crabs, snails, gulls, sea anemone, whelks, crabs, sea stars and segmented worms (Appendix B). The most common aquatic vegetation observed were eelgrass, kelp, sea lettuce (Ulva fenestrata), rock weed, and Enteromorpha spp., while the most common terrestrial species were grass, ocean spray, roses, Douglas fir, and willows (Appendix B).

The RSI data was analyzed by feeding it into five semi-quantitative, multi-factor, causal models developed by King County and People For Puget Sound. These models describe the relationship between habitat features and indicators of habitat quality. The models are an attempt to define how various measurable characteristics of nearshore habitat affect habitat quality with respect to target biological communities or physical processes.

With the results of the analyses and general knowledge of Guemes Island we identified three conservation areas and four restoration areas. Combining those results we identified five focus areas in Map 7:

1. Starfish Rock: 900 ft of high scoring conservation sites.
2. North Beach: High bluff areas of North Beach scored high in conservation. High scoring restoration sites were found in lowland where there is a higher density of residents.
3. West Beach: Mostly high bluff conservation area with some restoration sites in the south.
4. Young's Park: A small residential area that scored high for restoration.
5. Seaway Hollow: A small residential area that scored high for restoration.

Areas prioritized for conservation provide quality habitat for a broad range of species with few or no features that impact habitat negatively. Restoration areas have high quality habitat with features that could negatively impact that habitats health. North Beach and West Beach are two areas with great habitat and high conservation scores, but they also have some areas where improvements could be made (high restoration scores).

In addition to the five focus areas which are based on the analysis, four other potential projects have been identified:

- Further Spartina surveys;
- South Shore feeder bluff conservation and restoration;
- Cooks Cove Marsh restoration; and
- Removal of derelict creosote pilings in Peach Preserve and Kelly's Point.

These recommendations are based on the inventory findings and the interests expressed by the community during the survey.

<u>Recommendations</u>

Further ground investigation of the focus areas (Figure 1 and Map 7) is recommended to assess their potential for voluntary conservation and restoration actions. Continued outreach and education would also benefit the entire community. This survey was not designed to produce the final word on specific site selection. These focus areas have not been ranked in order of priority. When considering projects for habitat conservation it is customary to consider some factors that are not included in this study. These factors include size, adjacency to conserved areas, threat of habitat destruction, price, and landowner willingness.

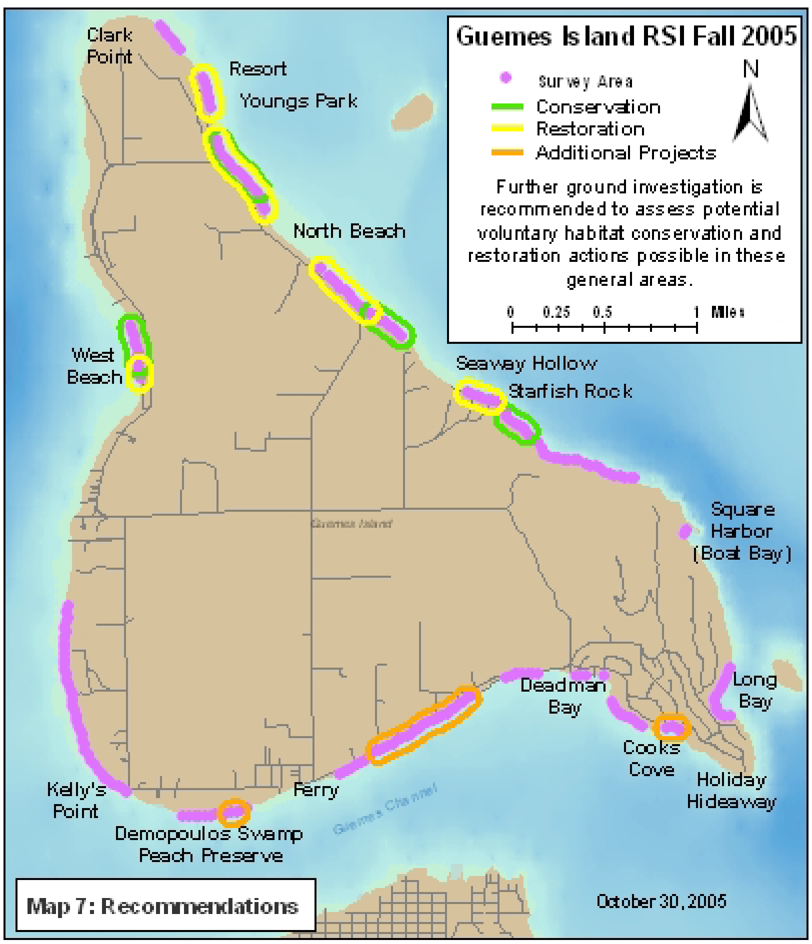


Figure 1: Recommended focus areas and project areas.

About the Rapid Shoreline Inventory

In 1995, following a report by marine scientists from Washington State and British Columbia, People For Puget Sound recognized the need for more detailed information about marine “nearshore,” habitats — from the eelgrass and kelp beds to the adjacent uplands (Figure 2). Working with many partners and experts, People For Puget Sound began to develop what would become the Rapid Shoreline Inventory. As of this publication, inventories have been completed in San Juan, Kitsap, Whatcom, Skagit, and King Counties, for a total of 37 miles of data.

The Rapid Shoreline Inventory is designed to gather information about the relationships between shoreline land use and indicators of beach health. By looking closely at these relationships, areas can be identified that may be appropriate for voluntary habitat conservation and restoration actions. RSI also contains a strong educational component. RSI participants — volunteers who help collect RSI data and property owners who grant permission for the survey — better understand nearshore habitat and how it functions, and are therefore better able to steward and restore the shoreline.

<u>The primary objectives of the Rapid Shoreline Inventory are to:</u>

- Educate and involve local citizens by training volunteers to collect accurate data;
- Identify relationships between nearshore habitat conditions and adjacent land uses;
- Develop an inventory of high-quality data useful for assessing the health of nearshore habitats in Puget Sound;

- Present data that can be used by property owners and public agencies to make informed decisions about conservation and restoration of nearshore habitat;
- Further develop the concept of "shoreline ecosystems" and the importance of nearshore habitat;
- Refine models that identify areas of high resource value and high restoration potential, and;
- Assure agreement and compatibility with existing coarse-grain data sets such as Washington State Department of Natural Resources' *ShoreZone*.

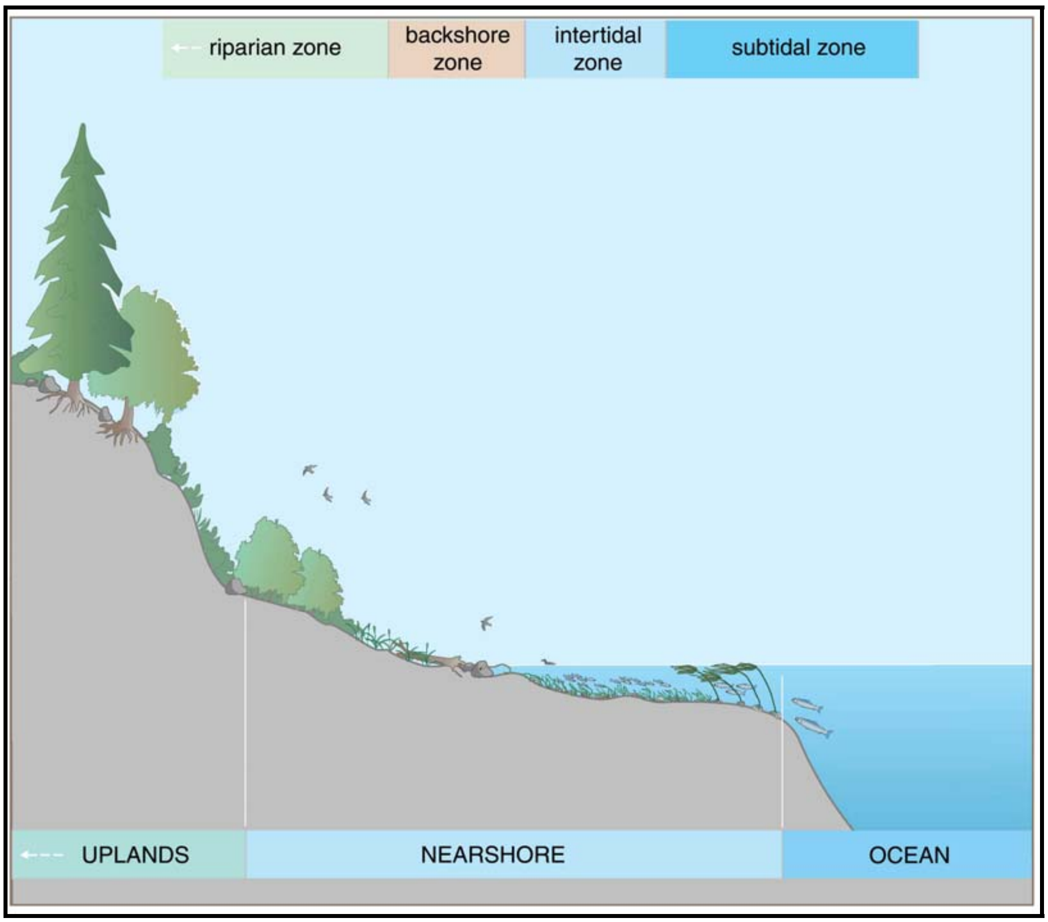


Figure 2: Nearshore habitat extends from the deeper water of the ocean into the adjacent uplands. The nearshore represents a transitional area that integrates characteristics of both environments. (Image courtesy of King County DNR.)

Guemes Island Rapid Shoreline Inventory 2005

RSI's in Skagit County

In 2001, People For Puget Sound conducted a Rapid Shoreline Inventory on March's Point for the Skagit County Marine Resources Committee (MRC). In 2002, People For Puget Sound conducted the Samish Island RSI funded by the MRC, Northwest Straits Commission, and the Packard Foundation. The results of those RSI's are available on the internet at http://pugetsound.org/index/pubs. In 2005, People For Puget Sound was awarded a contract by the MRC, with funding coming from the Northwest Straits Commission, to conduct the Guemes Island Rapid Shoreline Inventory for Skagit County. This report represents the result of that effort.

Founded in 1998, the Skagit County Marine Resources Committee is citizen-based, with representatives appointed by the county commissioners from local government, the tribal government co-managers, and the scientific, economic, recreational, and conservation communities. Members of the Skagit County MRC are working to restore nearshore, intertidal, and estuarine habitats, improve shellfish harvest areas, and support bottom-fish recovery.

Site Selection

In order to complete an update of the shoreline master plan, the local citizen's group, GIPAC, wanted to have more baseline data, and to engage community members on Guemes Island. They requested this assistance from People For Puget Sound and the Skagit MRC added their interest in continuing the Bays Blueprint already begun in Skagit County. The RSI portion of the project was conducted during the summer of 2005, and will be followed by a blueprint analysis of the shoreline of Guemes Island, and be incorporated into the Skagit Bays Blueprint in February of 2006.

Figure 3: The survey area for this project was the marine shoreline of Guemes Island.

Methodology Overview

Each RSI employs a well-trained and highly supervised team of volunteers to survey shorelines by foot, in 150-foot sections during extreme low daytime tides, taking observations but no samples. The data is carefully entered and compiled in a Microsoft Access database and then transferred to an ESRI ArcMap 9 Geographic Information System (GIS), which displays the data on maps. (Each dot on each map represents a specific, geo-referenced, 150-foot beach section.) The GIS is then used to assign values to the data to produce priority areas for voluntary conservation and restoration actions.

Property Owner Permission

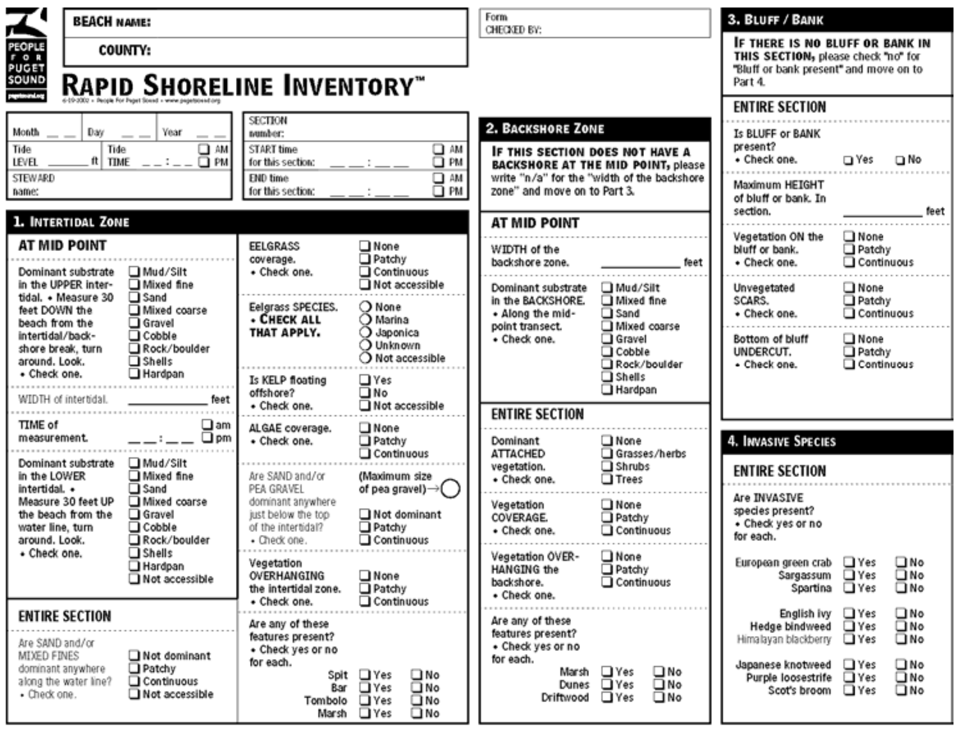
In the summer of 2005, postcards were mailed to 250 shoreline property owners in this study area to request permission to conduct the inventory on their beaches. Addresses were collected by GIPAC from the Skagit County Assessors office. Responses to this mailing were tracked in the People For Puget Sound office, and some follow up was done by knocking on doors and with a few targeted phone calls. GIPAC and volunteers also contacted some owners personally to obtain their permission. Because of the multiple means we used to contact owners and the possibility that some of the addresses were outdated, the number of land owners contacted was approximately 250. By the end of this effort we had 93 owners that had granted their permission, and 43 declining to be a part of the study. Focus areas were created by concentrating on stretches of beach where the most contiguous permissions existed — thus, some who had agreed to participate did not have their beach surveyed.

<u>Volunteer Training and Data Collection</u>

For this RSI, 30 volunteer stewards attended two training sessions for a total of Seven hours of training (One three-hour session in the classroom and one four-hour session in the field) before they were ready to begin field data collection. A second method of training was developed for volunteers who did not make the first trainings. A new volunteer would receive a training packet to read and pair up with an already trained volunteer until they were ready to work on there own. A GIS/flagging team was given additional on the beach training. They prepared the beach for the inventory by placing temporary flags delineating each 150-foot section and recording the coordinates of each section with a Trimble GeoExplorer 3 Geographic Positioning System (GPS). The data was taken during extreme low tides on July 20 through August 20, 2005. Stewards recorded information for each 150-foot shoreline section including:

1. Section number, volunteer's name, time of day
2. Characteristics of intertidal zone
3. Characteristics of backshore zone
4. Bluff/bank characteristics
5. Invasive species
6. Adjacent land use
7. Streams, outfalls, and other freshwater discharges
8. Artificial shoreline structures
9. Wildlife
10. Vegetation

Volunteers used a detailed data form, which placed data into clear, discrete categories, to collect this information (Figure 4). The data form limits errors and makes the data as consistent as possible.


PEOPLE FOR PUGET SOUND

BEACH NAME:

COUNTY:

RAPID SHORELINE INVENTORY™

Form CHECKED BY:

Month __ __ Day __ __ Year __ __

Tide LEVEL ______ ft | Tide TIME __ __ : __ __ ☐ AM ☐ PM

STEWARD name:

SECTION number:

START time for this section: __ __ : __ __ ☐ AM ☐ PM

END time for this section: __ __ : __ __ ☐ AM ☐ PM

1. INTERTIDAL ZONE

AT MID POINT

Dominant substrate in the UPPER intertidal. • Measure 30 feet DOWN the beach from the intertidal/backshore break, turn around. Look. • Check one. ☐ Mud/Silt ☐ Mixed fine ☐ Sand ☐ Mixed coarse ☐ Gravel ☐ Cobble ☐ Rock/boulder ☐ Shells ☐ Hardpan

WIDTH of intertidal. ________ feet

TIME of measurement. __ __ : __ __ ☐ am ☐ pm

Dominant substrate in the LOWER intertidal. • Measure 30 feet UP the beach from the water line, turn around. Look. • Check one. ☐ Mud/Silt ☐ Mixed fine ☐ Sand ☐ Mixed coarse ☐ Gravel ☐ Cobble ☐ Rock/boulder ☐ Shells ☐ Hardpan ☐ Not accessible

ENTIRE SECTION

Are SAND and/or MIXED FINES dominant anywhere along the water line? • Check one. ☐ Not dominant ☐ Patchy ☐ Continuous ☐ Not accessible

EELGRASS coverage. • Check one. ☐ None ☐ Patchy ☐ Continuous ☐ Not accessible

Eelgrass SPECIES. • CHECK ALL THAT APPLY. ○ None ○ Marina ○ Japonica ○ Unknown ○ Not accessible

Is KELP floating offshore? • Check one. ☐ Yes ☐ No ☐ Not accessible

ALGAE coverage. • Check one. ☐ None ☐ Patchy ☐ Continuous

Are SAND and/or PEA GRAVEL dominant anywhere just below the top of the intertidal? • Check one. (Maximum size of pea gravel)→○ ☐ Not dominant ☐ Patchy ☐ Continuous

Vegetation OVERHANGING the intertidal zone. • Check one. ☐ None ☐ Patchy ☐ Continuous

Are any of these features present? • Check yes or no for each.
Spit ☐ Yes ☐ No
Bar ☐ Yes ☐ No
Tombolo ☐ Yes ☐ No
Marsh ☐ Yes ☐ No

2. BACKSHORE ZONE

IF THIS SECTION DOES NOT HAVE A BACKSHORE AT THE MID POINT, please write "n/a" for the "width of the backshore zone" and move on to Part 3.

AT MID POINT

WIDTH of the backshore zone. ________ feet

Dominant substrate in the BACKSHORE. • Along the mid-point transect. • Check one. ☐ Mud/Silt ☐ Mixed fine ☐ Sand ☐ Mixed coarse ☐ Gravel ☐ Cobble ☐ Rock/boulder ☐ Shells ☐ Hardpan

ENTIRE SECTION

Dominant ATTACHED vegetation. • Check one. ☐ None ☐ Grasses/herbs ☐ Shrubs ☐ Trees

Vegetation COVERAGE. • Check one. ☐ None ☐ Patchy ☐ Continuous

Vegetation OVERHANGING the backshore. • Check one. ☐ None ☐ Patchy ☐ Continuous

Are any of these features present? • Check yes or no for each.
Marsh ☐ Yes ☐ No
Dunes ☐ Yes ☐ No
Driftwood ☐ Yes ☐ No

3. BLUFF / BANK

IF THERE IS NO BLUFF OR BANK IN THIS SECTION, please check "no" for "Bluff or bank present" and move on to Part 4.

ENTIRE SECTION

Is BLUFF or BANK present? • Check one. ☐ Yes ☐ No

Maximum HEIGHT of bluff or bank. In section. ________ feet

Vegetation ON the bluff or bank. • Check one. ☐ None ☐ Patchy ☐ Continuous

Unvegetated SCARS. • Check one. ☐ None ☐ Patchy ☐ Continuous

Bottom of bluff UNDERCUT. • Check one. ☐ None ☐ Patchy ☐ Continuous

4. INVASIVE SPECIES

ENTIRE SECTION

Are INVASIVE species present? • Check yes or no for each.
European green crab ☐ Yes ☐ No
Sargassum ☐ Yes ☐ No
Spartina ☐ Yes ☐ No
English ivy ☐ Yes ☐ No
Hedge bindweed ☐ Yes ☐ No
Himalayan blackberry ☐ Yes ☐ No
Japanese knotweed ☐ Yes ☐ No
Purple loosestrife ☐ Yes ☐ No
Scot's broom ☐ Yes ☐ No

Figure 4: The Rapid Shoreline Inventory data collection form is divided into discreet categories and provides reminders about data collection standards. This two-sided form is provided in Appendix D, Rapid Shoreline Inventory Data Form.

The volunteers were instructed to gather this data in very specific ways (Appendix C, RSI Protocol). Volunteers were deployed in teams of five or less, led by a highly experienced staff person or volunteer (team leader). The team leaders were available at all times while the volunteers were gathering data to answer questions about methodology and data standards. The team leaders checked each data form for accuracy and completeness on-site within the 150-foot section of beach represented by that data form, with the volunteer standing by to clarify any outstanding issues.

In the People For Puget Sound office, the information from the two-sided forms was carefully entered into a Microsoft Access database, by the data entry volunteer. The data was checked and corrected in table form, and transferred to a Geographic Information System (GIS). During analysis and map building the data was quality checked a third time. In some cases sites were compared with oblique aerial photos to confirm data findings. All components of the RSI protocol have been peer reviewed.

The data is displayed on13 analysis maps and 37 feature maps (Appendix A) that can be viewed at http://pugetsound.org/index/pubs , where one can also find a sampling protocol for the Rapid Shoreline Inventory (Appendix C).

Data Uses

The data are intrinsically valuable as indications of beach types and as baselines of physical and biological information. For instance, in the case of an oil spill, restoration goals could be set using RSI data gathered prior to any damage. The data can also show simple correlations between upland and intertidal land use and ecosystem health indicators on the adjoining beach.

People For Puget Sound staff, working with nearshore habitat experts, created a system to analyze RSI data in a way that enhances its value. Different “scores” are assigned to different pieces of datum in order to prioritize areas that are appropriate for voluntary habitat conservation and restoration actions (see Rapid Shoreline Inventory Data Analysis, below).

Data Limitations

Replicate site data is not collected due to the urgency to gather the information during extreme low tide conditions. Daylight low tides occurred during 4 periods in the summer months, and volunteers were on the beach during all of these hours. Time restrictions and manpower do not make it feasible to collect replicate data. However, the quality of the data is protected through rigorous quality checking.

The features observed are limited by the height of the tides at the time of the survey, and some characteristics, such as presence of eel grass, and Sargassum, are underrepresented during higher tides.

Beaches under high bluff areas have a tendency to be owned by state agencies. Since state agencies permitted us to survey their land, state owned beaches and High bluff beaches are overrepresented in this study.

The data describing physical shoreline features (data form parts one through eight) are the most specific, as they represent physical characteristics of the nearshore that can be seen and measured. The biological data (data form parts nine and ten) are more generalized. Plants and animals are sometimes identified to the species level, but often are only identified to the level of genus, family, or order. While the RSI training contains an overview of key species of interest, it is not possible to fully train volunteers on complicated taxonomic distinctions in the allotted time. As a result, the species lists represent only a general view of what was found on the beach on a particular day by volunteers with various skill levels. Further more, few species are targeted in the survey, and little time is given to record non-target species, so targeted species such as eelgrass will be consistently looked for while the non-target species will be underrepresented. Since the survey counts species only at the transect some species could be missed entirely. However, these species lists are often the first ever compiled for many of the beaches inventoried and provide a good base from which to build.

Results and Discussion

Description of Study Area

Guemes Island has a rich diversity of habitat types. Substrates vary from the sandy mud flats of North Beach to the rocky cliffs of Holiday Hideaway. The shoreline supports rich eelgrass beds and kelp forests, which in turn supports a variety of bird and invertebrate life. The island is an attractive spot for retirees, and weekend vacationers. It supports a variety of recreational activities such as beach walking, birding, fishing, clamming, and crabbing.

Guemes Island has both private and State owned property. Since the public lands were easiest to obtain permission to survey, and often occurs where there are less desirable building sites, bluff areas are overrepresented in the RSI.

Characteristics of the Intertidal Zone

The intertidal zone, the shoreline between the low and high tide lines, is home to a wide range of flora and fauna — many of which spend their entire lives there, or are dependent on the intertidal for some critical stage of their lives. The Rapid Shoreline Inventory captures detailed information at the low tide line, where such things as eelgrass and geoducks can be observed (Figure 5), and near the high tide line where several species of forage fish spawn. Two of Puget Sound's three primary forage fish, surf smelt and sand lance, need specific sizes of substrate at or near the top of the intertidal zone in which to lay their eggs: namely, from sand to very small gravel below 4 mm in diameter[1] (Bargmann, 1998). Pacific herring, the third of these three forage fish, attach their eggs to eelgrass and kelp (Bargmann, 1998).

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[1] Surface substrate size in the intertidal zone is subject to seasonal fluctuations. RSI data is gathered during daytime low tides, which restricts the data to late spring and summer observations. In most cases, RSI data is gathered only once in any one location.

Figure 5: Beds of eelgrass that occur in the lower intertidal and subtidal zones are critical nursery habitat for a variety of species (image courtesy of NOAA).

Seventy-one percent of the beaches had at least one patch[2] of potential spawning gravel at the upper edge of the intertidal zone, with 50% having continuous coverage along the 150 foot sections. Despite this high occurrence of sand and/or small gravel at the high tide mark, most of the upper-intertidal samples (the top 30 feet at the mid-point) were dominated by gravel (33%) or larger cobble (26%). Along the water line at low tide, 54% of the sections had substrate that would support eelgrass (sand or sandy mud, but not just mud) in whole or in part (Koch, 2001). Eelgrass was observed in 59% of sections, however 11% of this was observed in the water or out on the mud flat and therefore not accessible.

[2] It is not known how small of a "patch" of sand/gravel can be located and used by forage fish for spawning. The Rapid Shoreline Inventory located only "potential" forage fish spawning areas — the right size sand in the right part of the beach in patches or continuous stretches along the length of the section. The RSI protocol defines "patch" as anything that dominates your view from a standing position looking straight down at the beach.

Vegetation that hangs over the intertidal zone is important to shade forage fish spawn (to keep the eggs from drying out), and as a source of insects that drop into the water thus providing food for juvenile salmon[3]. A majority of sections, 59%, contained at least some vegetation overhanging the intertidal zone. Only 15% of those sections had continuous coverage.

Figure 6: Backshore habitat can include driftwood, salt-tolerant vegetation, salt marshes, and sand dunes.

Characteristics of Backshore Zone

The backshore is a "splash zone," often a flat area at the top of the beach that collects driftwood and where most of the plants can tolerate occasional salt spray (Figure 6). The driftwood and plants in the backshore provide habitat for small invertebrates, which in turn provide food for migrating juvenile salmon (King County Department of Natural Resource, 2001). This zone is often reduced or eliminated when bulkheads are

[3] Jeff Cordell and others at the University of Washington have been doing research on this issue for several years. By trapping insects as they fall into the water and comparing those insects to those found in the stomachs of juvenile salmon, they have been able to prove that overhanging and riparian vegetation provide food for juvenile salmon both in restored estuarine marshes and along marine shorelines (Cordell et al., 2001). Jim Brennan at King County has been adding to this pool of research by seining and pumping the stomachs of juvenile salmonids on marine shorelines.

built. High energy beaches with high bluffs may naturally have no backshore present at all.

Ninety-two percent of the sections surveyed had backshores at the mid-point of the section. This is a very large number, especially when considering 85% of the sites had bluffs and banks**.** The average width of the backshore, where present, was 18.0 feet. Driftwood was present on 93% of the sites, and 74%, had overhanging vegetation.

Figure 7: Large and small feeder bluffs are critical sources of sediment for Puget Sound shorelines.

Bluff/Bank Characteristics

Bluffs and banks just shoreward of the beach (Figure 7) provide a variety of unique habitat niches. Two birds found in marine environments, the kingfisher and the pigeon guillemot, are known to nest in holes in sandy bluffs (Alsop, 2001). Fourteen kingfisher sightings were recorded during this RSI. Pigeon guillemots and their nests were seen but not recorded because they did not cross the transects of the survey. Most importantly, sand and gravel slide from bluffs and banks to re-supply fine substrates to the intertidal zone, maintaining the structure and profile typical of beaches from Anderson Island north to Samish Island. Bluffs of banks that provide a steady source of sediment to the shoreline are commonly called "feeder bluffs".

Bluffs or banks, either natural or armored, were present on 85% of sections, with the average height being 54.3 feet. Eighty-five of these sections had at least some vegetation coverage, 41% was continuous and 44% was patchy. Un-vegetated scars[4], usually an indication of a recent slide and potential supply of sand to the beach, were continuous for 11% of sections, while 50% had patchy scars. Forty-nine percent of all sections had at least some undercutting at the base of the bluff or bank.

Invasive Species

Plants and animals that are introduced from other parts of the country or the world, whether intentionally or accidentally, can sometimes present a threat to native flora and fauna. "Invasive species" are those that aggressively crowd out, out-compete, or consume native species. They often spread rapidly and can completely cover the landscape. Perhaps the worst current threat to Puget Sound nearshore habitats is *Spartina*, an invasive aquatic cordgrass that can completely cover mid to upper intertidal mud flats. While the impacts of *Spartina* infestations on fish and wildlife are little studied, it is reasonable to assume that the loss of mudflats in Puget Sound would have a detrimental effect on the shellfish that live there and the salmon and shorebirds that depend on mudflats as important forage areas (Feist, 2002). A patch of spartina was found on South Beach and removed during the survey (Figure 8). The patch covered a square yard, and was approximately three years old. Since the RSI had a limited survey area, additional investigation of the existence of *Spartina* on Guemes Island is recommended.

[4] RSI records "scars" as any area that lacks vegetation. Volunteers are not asked to attempt to differentiate between natural erosion and that which is caused by human activity.

Figure 8: Volunteers removing *Spartina anglica*, otherwise known as European cord grass.

Thirty four percent of the records had invasive species. Himalayan blackberry was the most prevalent invasive identified in 20% of the sites, followed by Scots broom at 10%, the algae *Sargassum* at 6%, and English ivy in 2% of the sites. A single site of hedge bindweed (morning glory) was identified. No occurrences of European green crab, Japanese knotweed, or purple loosestrife, were identified. Dwarf eelgrass (*Zostera Japonica*) was found in 7% of sections, while native eelgrass was identified in 46% of the sites. It should be noted that the level of threat posed by *Sargassum* and dwarf eelgrass has not yet been established.

<u>Adjacent Land Use</u>

The ways that land owners build on and maintain the land adjacent to the shoreline[5] can directly impact the quality of nearshore habitat (Figure 9). Vegetated riparian buffers act as natural filters, absorbing water from flood events and filtering out toxins

[5] The RSI records information on adjacent land use by noting features which are dominant for that 150-foot segment, immediately adjacent the high tide line, and can be seen from the beach.

and excess nutrients. Clearing trees and shrubs to create views removes shade and food sources on which many species rely (King County Department of Natural Resources, 2001), and lawn and garden fertilizers and pesticides can be washed into the water. Unmanaged access points can cause erosion and trampling of shoreline vegetation. Roads and parking lots along the water can increase the runoff of oil, gas, and antifreeze. Agricultural and industrial runoff is not always filtered or treated.

Figure 9: Land use adjacent to the shoreline has an impact on many characteristics of the nearshore environment, including riparian vegetation, aquatic vegetation, erosion, pollutants, and wildlife habitat use.

Due to the prevalence of high bluff areas in our survey, 59% of the immediately adjacent upland was predominantly not visible. Eleven percent of the sites were observed to be predominately residential. Most of these occurrences were in low lying areas, and half of these residences had bulkheads. Only one commercial site on the shoreline was recorded and no industrial sites were recorded. Two percent of the sites were observed to be dominated by lawn, 2% unpaved road, and 1% paved road. South Shore Road runs along much of the high bluff areas of South Beach. Only four percent of the sites had trail access.

Streams, Outfalls and Other Freshwater Outflows

In many cases, fresh water flowing onto the beach can be an important part of the nearshore ecosystem. Streams and creeks can create deltas or marshes, and can allow fish to move upstream to spawn. But water can also bring pollutants and garbage onto the beach (Figure 10). The Rapid Shoreline Inventory counts the numbers and types of discharges (which include rivers, creeks, ditches, pipes, and seeps), looks for potential signs of pollution (i.e. darkened sediment, excessive algal growth, etc.), and records whether or not the discharge is flowing. No water samples were taken or tested.

Figure 10: Freshwater discharges entering the nearshore environment can carry excess nutrients or toxic pollutants onto the beach.

There was potential concern with discharges in the study area, however only 4% of sections surveyed contained one or more discharge. A total of 55 discharges were recorded, with 58% being seeps, 38% pipes, and 4% creeks. No ditches or rivers were observed. Sections that contained outfalls had an average of 1.3 per section. Erosion was noted at 32% of the outfalls, associated algae growth at 32%, and darkened sediment at 11%. Guemes Island has a relatively large amount of freshwater seeping, especially on north Kelly's Point where we found some continuous seeps for over 150 feet.

The survey area in general showed a relatively high occurrence of algae (continuous or patchy on 95% of sections, with sea lettuce identified on 88% and *Enteromorpha* on 14%) This suggests that Padilla Bay, the Guemes Channel, and the Bellingham Channel are nutrient rich in general.

Shoreline Structures

The Rapid Shoreline Inventory looks for structures built on the shoreline such as bulkheads, docks, ramps, jetties, and levees. Shoreline structures can serve many purposes, from helping protect upland areas from erosion to providing a place to dock or launch boats (Figure 11). Some may be unnecessary or in disrepair, with owners that may be unaware of their potential impacts on nearshore habitat. Bulkheads and jetties can block the flow of sand onto and along the beach, and can force juvenile salmon into deep water, exposing them to predators (Williams and Thom, 2001). Many structures can amplify the energy of waves, which in turn can scour sand from the top of the beach or increase erosion on adjacent or neighboring properties (Shipman, 1995). Failing structures, especially rip-rap bulkheads, can litter the beach with large materials that cover habitat for clams and other sand-dwelling invertebrates (People For Puget Sound, 2001).

Figure 11: Structures are often intended to prevent erosion or to provide people with access to the shoreline. Both types of structures can negatively impact nearshore habitat, especially as the structures begin to fail.

The volunteers described 76 structures for this inventory. Only 9% of the 150-foot sections contained structures. Of those sections, the average number of structures was 1.3. The majority of structures, 41%, were bulkheads or seawalls, 22% stairs, and 7% each for the category launches or ramps. No jetties, groins, dikes, or levees were observed. Thirty-three derelict creosote pilings were observed at Peach Preserve from an old dock. Kelly's Point also had creosote pilings in the intertidal, near the trail head. The combined length of these structures was 1,855 feet – 5% of the distance surveyed.

Sixty-two percent of the structures were in good or excellent condition, meaning that they were serving their intended purpose. Thirty-three percent were in poor condition, meaning that they were in some stage of obvious failure.

Wildlife and Vegetation

Volunteers for this inventory were not explicitly trained nor expected to identify wildlife and vegetation beyond a few common species. However, many of them already had extensive experience with species identification, and all volunteers at all times had access to "team leaders" for assistance with identification. This inventory was not designed to produce an exhaustive or quantitative assessment of species on the beach, but it does indicate the presence and distribution of species in the survey area, and it often provides the first species list compiled for an area. Since RSI data is usually taken only once, it does not reveal the use of the nearshore by species over time.

The most common intertidal wildlife sightings were barnacles at 87% of sections, clams at 26% (Figure 12), shore crabs at 23%, snails at 22%, gull at 21%, and both whelk and sea anemone observations at 20%. Only seven percent of sites had mussels (horse or unidentified), which are sometimes as common as barnacles in other areas.

The most common algal sightings were sea lettuce at 88%, kelp at 58%, rockweed at 23%, and *Enteromorpha spp*. at 14%. The most common vascular plant sightings were native eelgrass (*Zostera marina*) at 46%, dwarf eelgrass at 4%, grass at 30%, ocean spray at 27%, Himalayan blackberry at 20%, roses at 20%, Douglas fir at 15%, and willows at 15%. Trees and in particular Douglas fir, suggest a relatively healthy and mature shoreline plant community. Another sign of relative health is the fact invasive species did not dominate the landscape. A complete list of the flora and fauna identified in this inventory is provided in Appendix B.

Figure 12: Wildlife found in the intertidal can provide indications of ecosystem health. In this picture are two ocher sea stars, rockweed, and sea lettuce.

Rapid Shoreline Inventory Data Analysis

While habitat inventories contain significant intrinsic value, descriptions of habitat can be most valuable to inform habitat conservation decisions when used to build and populate geospatial models that define and describe habitat quality. Working with King County Department of Natural Resources in Washington State, People For Puget Sound developed five semi-quantitative, multi-factor, causal models[6] using the data collected during Rapid Shoreline Inventories. These models describe the relationships amongst habitat features, measured during the RSI for each 150-foot section of shoreline, and indicators of habitat quality. The models assign values for each 150 ft. shoreline section relative to the number of shoreline features present that either support the habitat requirements of specific species groups or provide habitat forming/maintaining processes. The models are an attempt to define how various measurable characteristics of nearshore habitat affect habitat quality with respect to target biological communities or physical processes (model targets).

This methodology is based on the best available science for the relationship between marine nearshore habitats and key ecosystem processes and nearshore-dependent species in Puget Sound. However, scientific study in this area is not abundant. Moreover, the scoring system presented below represents value judgments made by staff scientists based on the scientific literature and other unpublished scoring schemes. These values can be adjusted to reflect other priorities and emerging research.

[6] A causal model is based on the knowledge that certain physical attributes create or "cause" features that provide habitat for fish and wildlife.

<u>Data Analysis Models</u>

The five models characterize nearshore habitat for:

- Forage fish spawning (species group)
- Nearshore juvenile salmonid use (species group)
- Aquatic vegetation (species group/ecosystem process)
- Feeder bluffs and nearshore sediment dynamics (ecosystem process)
- Shoreline-dependent terrestrial wildlife, with a focus on birds (species group).

These five models were chosen because they represent key elements of a functioning nearshore ecosystem typical of much of Puget Sound.

Due to the inexact state of scientific knowledge about nearshore processes and the interaction between shoreline development and biological community health, these models serve several purposes. First, the models allow one to compare and contrast large amounts of geospatially-referenced species and habitat data. Secondly, they force one to develop formal hypotheses about species-habitat connections that can be tested through restoration actions followed by monitoring and adaptive management.

The models are designed to assess each site for both the current condition of the site (conservation opportunities) and for the potential condition of the site (restoration opportunities). Each model employs two series of "habitat attributes." One series of attributes is valued positively for perceived benefits or indications of benefits to habitat quality. These we call "habitat function." The second series of attributes, which we call "habitat impacts," is assigned negative values for impacts on ecosystem processes, indications of physical disturbance, or direct impact on the model's focal species group.

Habitat Conservation Opportunities

To locate conservation opportunities, the models are used to rate individual 150-foot sections of shoreline on a scale of -100 to 100 with higher scores reflecting higher quality habitat. Positive scores were assigned to positive habitat functions such as riparian vegetation or feeder bluffs. Negative scores were assigned to habitat impacts such as bulkheads or signs of pollution. The conservation score is then simply the sum of the positive and negative values accrued for any 150 ft. section.

This analysis is helpful for identifying areas of highly functional habitat as well as those places that are not being directly or indirectly impacted by habitat altering processes related to invasive organisms or anthropogenic development. While scores vary linearly on this scale, it is important to recognize that this is a semi-quantitative model that provides a relative indication of site conservation value (sites scoring higher will generally be more favorable) for areas included in this study. The precise scores achieved may have little meaning taken outside the context of this specific cross-site analysis.

Habitat Restoration Opportunities

Ranking sites for restoration potential is complex and must account for both existing habitat conditions and potential future conditions should the site be restored. Since no system currently exists for evaluating nearshore restoration potential, the creation of a new scoring scheme was required. For the restoration ranking scheme, the ultimate goal was to target high value sites with restoration actions that produce the largest reduction in impacts. This scheme is designed to achieve the overall objective of identifying those sites with a high level of current ecosystem function or potential, and a significant degree of impairment.

The restoration analysis was based on the same scientific literature and data-driven, semi-quantitative rankings of site characteristics used in the conservation model. The specific objective was to develop the most appropriate restoration model that would accentuate those sites scoring high in both the habitat function and habitat impact categories while giving relatively little value to sites that score low in either category. This objective was achieved by multiplying the habitat function score and the habitat impact score, and then taking the absolute value of the product of the two numbers. Thus the restoration scores vary from zero – those sites that have either no current habitat function or no obvious habitat impacts, to 10,000 – those sites that have both the maximum score in habitat functions and impacts present. A site with high restoration potential might have multiple positive habitat functions such as pea gravel, a spit, eelgrass, and riparian vegetation, but also habitat impacts such as intertidal structures, a boat ramp, and several outfalls.

As with any model, the interpretation of scores requires care and consideration. It is recommended that scores for this model be interpreted on a logarithmic scale. Since the model is semi-quantitative, the direction of scores (higher being more favorable than lower) is more important than the specific score or precise difference between scores.

One way to visualize the analyses is to plot conservation and restoration scores versus habitat function and impact values (the independent variables used to calculate the scores). Table 1 shows a series of idealized habitat function and impact values and the corresponding conservation and restoration scores. These values are plotted on Figures 13a-d. Notice that when conservation scores are plotted along lines of constant habitat function or habitat impact values, scores increase linearly with *improvements* in both habitat function and impact (i.e. less impact). *The point of the conservation scoring system is to identify sites that have the greatest existing habitat value and the fewest negative impacts*.

Function	Impact	Conservation	Restoration
100	-100	0	10000
100	-50	50	5000
100	0	100	0
50	-100	-50	5000
50	-50	0	2500
50	0	50	0
0	-100	-100	0
0	-50	-50	0
0	0	0	0

Table 1: Idealized habitat function and impact values for corresponding conservation and restoration scores. For demonstration purposes only -- see Figure 13a-d.

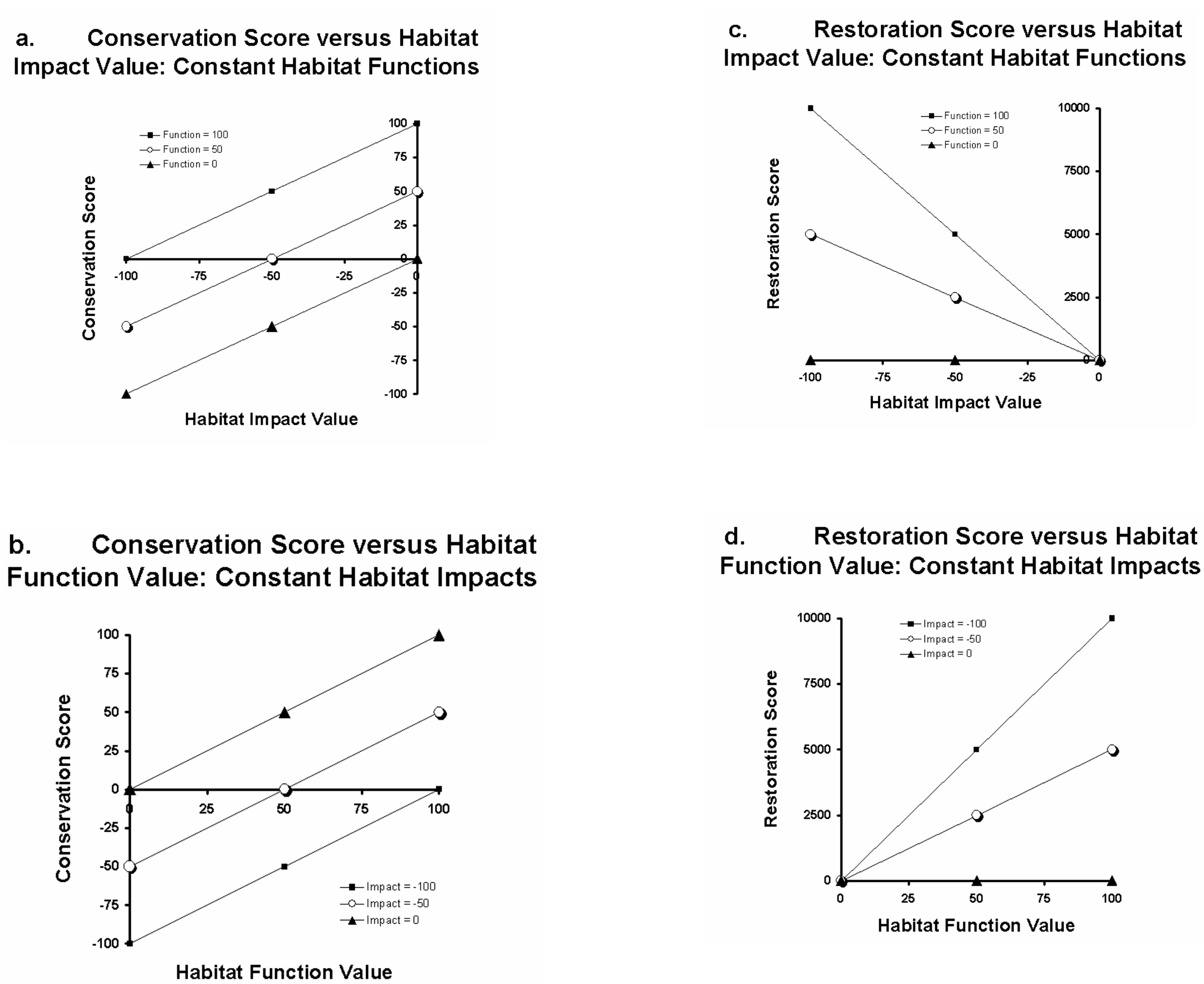


Figure 13a-d: Relationship between conservation and restoration scores and habitat function and impact values. Idealized for presentation -- see Table 1.

For the restoration analyses, the scores increase along with increasing habitat function and increasing *intensity* of impact (more impact equals a larger negative number). This results because the impact and function values are multiplied instead of added. *The implications of this model are that sites with very low habitat function or very low habitat impact are not prime targets for restoration, whereas sites that still have substantial remaining or intrinsic habitat value, but also have significant impairment, represent the best opportunity to make significant gains for the ecosystem through restoration.*

This ranking system reveals those restoration opportunities that would provide the highest value to the living resources — not merely those that are the cheapest or most convenient. While sites identified using this tool are likely to provide ecosystem benefits if they are protected and restored, this ranking scheme should only serve as a guide and pre-ranking tool for further detailed site inspections and analysis of site-specific circumstances.

Because the precise meaning of each individual score is uncertain, it is best to compare sites within a given physical sampling area. In the specific examples presented later, the sites are ranked according to their scores and display those ranks rather than the raw scores. Those sites scoring in the highest decile (top 10%) are likely the most noteworthy sites and should be reviewed for potential conservation or restoration. Depending on the sampling area, sites in lower quantiles (the next 20%) may also be of interest for review. Overall conservation and restoration values were calculated by averaging the rank order (between 1 and 277 [the number of samples] with 277 being the highest scoring site) for the five models described here.

This conservation and restoration ranking scheme does not take into account the quality of immediately adjacent 150 ft. sections, or groups of adjacent sections. In this sense, the study and analysis does not explicitly account for habitat continuity along the shoreline. For example, multiple continuous sections of good to moderate quality habitat might be more important for conservation than one cell of excellent quality habitat in the middle of a larger area of very low quality habitat. While scores for individual sections do not reflect this larger spatial context, viewing groupings of scores on the display maps can help identify important habitat "clusters", and at this point, the summary maps probably represent the appropriate tool for such integrative ranking of spatial relationships.

On site by site analysis it has been discovered that some habitat impact features can be naturally occurring features. For example, in outfalls, finding algae around a seep draining a marsh is probably natural nutrients cycling. This should be considered while looking at individual sites. Habitat "clusters" are likely to be more accurate signs of health than individual sites.

<u>Forage Fish Spawning Habitat Analysis</u>

Forage fish, including populations of Pacific herring (*Clupea harengus*), surf smelt (*Hypomesus pretiosus*), and Pacific sand lance (*Ammodytes hexapterus*), are an essential component of the Puget Sound food web. Though phylogenetically unrelated, these three species comprise an essential trophic link within the nearshore environment, and are a major component of the diet of many predatory species including salmonids (Bargmann 1998). While relatively little is known about adult life stages of forage fish (e.g. Figure 14), spawning preferences and requirements are generally understood. This analysis is an important extension of surveys that identify forage fish spawn, because this model focuses on both current and potential spawning habitat. While forage fish may use the same sites for spawning over long periods of time (Penttila 1995), a site may be abandoned for no apparent reason only to become used again at some point in the future (Robards et al. 1999).

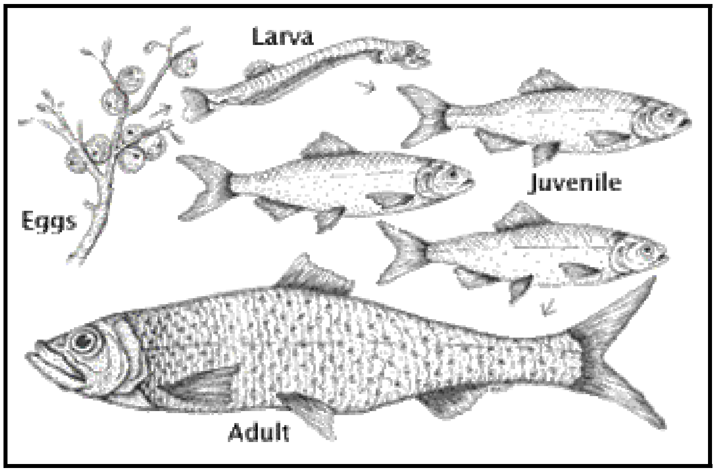


Figure 14: Life stages of Pacific herring (Courtesy of USGS).

Shoreline surveys to identify spawning beaches have been conducted by the Washington State Department of Fish & Wildlife (formerly the Department of Fisheries) since 1972. Based on information obtained during these surveys, surf smelt and sand lance are thought to spawn selectively on shorelines that have deposits of either sand or pea-gravel sized sediment in the upper intertidal zone (Bargmann 1998). In addition to substrate preferences and requirements, forage fish eggs tend to have lower mortality when there is riparian vegetation adjacent to the shoreline that can shade the shoreline and moderate temperatures (Robards et al. 1999). Pacific herring vary slightly from smelt and sand lance in that herring spawn primarily in the lower intertidal and shallow subtidal zones, attaching their eggs to vegetation such as eelgrass or kelp (Penttila, personal communication 2001).

The forage fish analysis focuses on identifying those beaches with conditions that would seem to favor forage fish spawning and spawn survival. Positive functions for shorelines include appropriate sediment found in the upper intertidal, overhanging vegetation, as well as aquatic vegetation that might be used for spawning.

Negative components of this model are primarily those that interrupt or disturb potential spawning areas or the processes that form potential spawning areas. These include artificial outfalls which might supply excess nutrients or toxic chemicals to the shoreline, bulkheads which alter nearshore hydrography, or piers that shade subtidal vegetation (Figure 15).

Figure 15: Examples of Development that can impact nearshore forage fish habitat.

The causal model and scoring for this model are described in Figure 16 and Table 2, respectively.

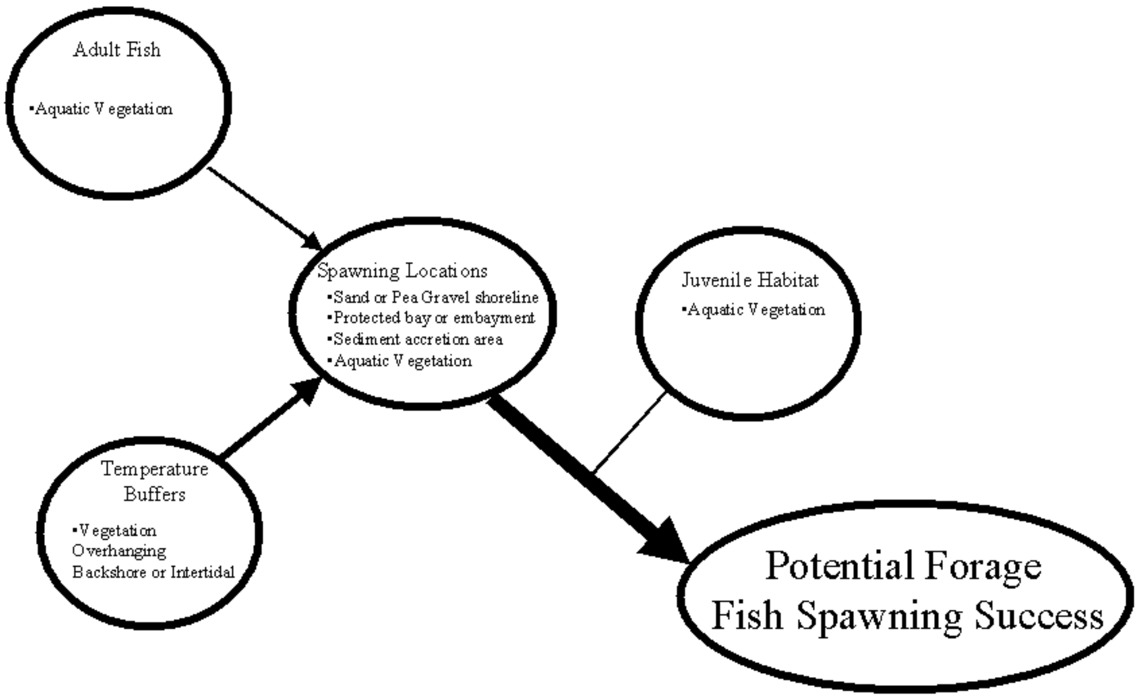


Figure 16: Causal model describing the relationship between shoreline characteristics and forage fish spawning success. Weight of arrows reflects assumed relative importance of those functions for "success" in this particular model.

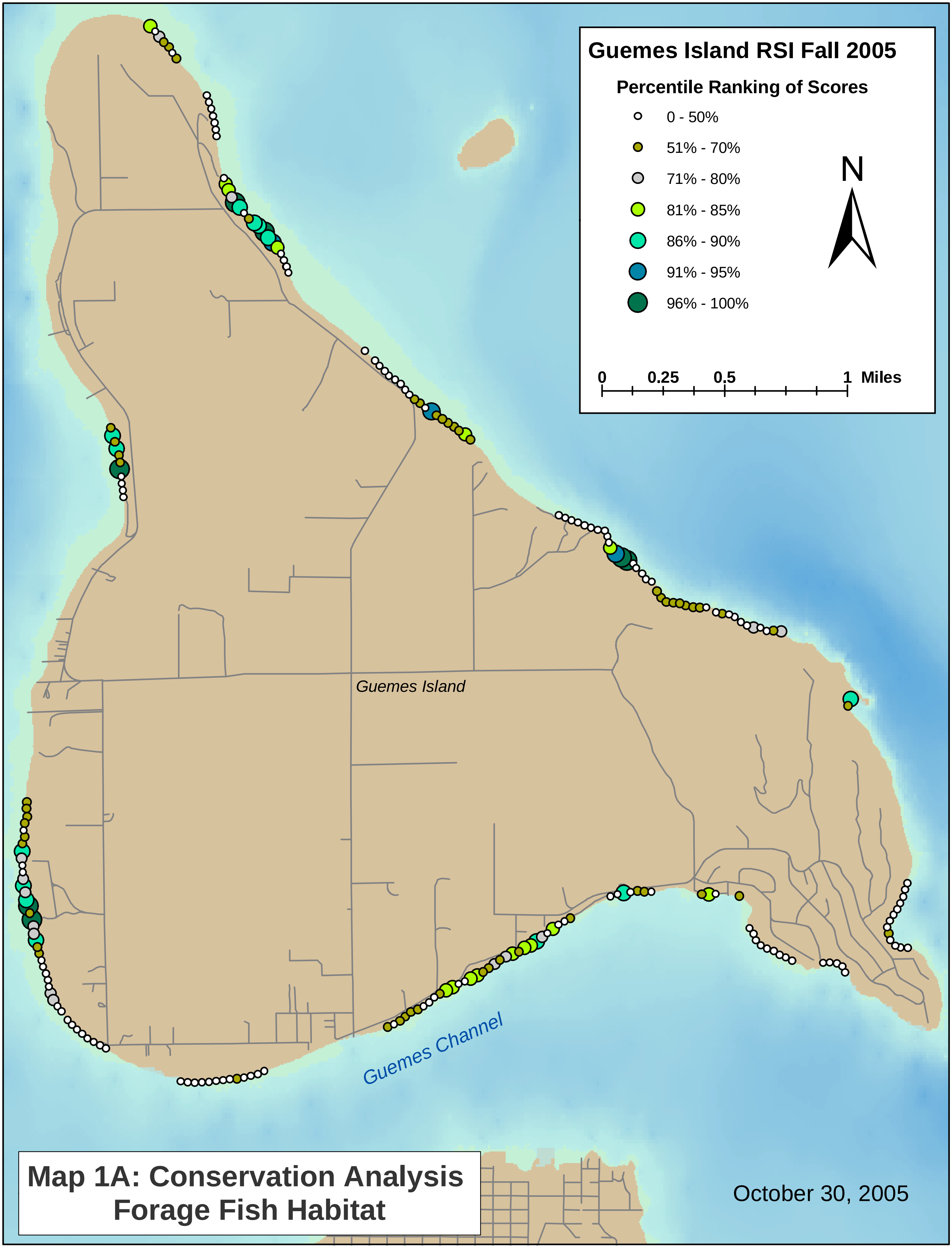
Habitat Function	Habitat Quality Value	Score Justification
Geophysical Characteristics		
Upper Intertidal Substrate	5	Appropriate substrate size in appropriate location
Sand/Pea Gravel Bed	20	Spawning bed of adequate size
Spit, Bar, or Tombolo	10	Substrate source present in area
Seep	5	Moderates substrate temperatures
Bluff Size	5	Substrate source present in area
Vegetation Characteristics		
Eelgrass (*Z. marina*)	10	Spawning medium
Kelp and intertidal algae	10	Spawning medium
Overhanging Vegetation	5 to 15	Shades spawn
Marsh	5	Provides prey resource
Anthropomorphic Group		
Undeveloped/Natural Adjacent Land use	5	Natural habitat with less disturbance
No intertidal structures	10	Signals nearshore hydrography is likely intact
Habitat Impact	**Habitat Quality Value**	**Score Justification**
Intertidal Structures	-10 to -30	Intertidal structures impact nearshore hydrography and sediment transport
Upland Land use	-10	Potential or actual impacts to shoreline
Boat Ramp	-20	Potential for continuing damage through use and potentially altered nearshore hydrography
Potentially Polluted Outfalls	-10	Signs of pollutants and/or excess nutrients to nearshore

Table 2: Description of model scores and justification for forage fish spawning model.

This analysis is biased toward upper intertidal sand lance and surf smelt spawning habitat, as the Rapid Shoreline Inventory only partially accounts for subtidal herring spawning areas. This can be corrected, however, by comparing this analysis to documented spawning areas for the three species.

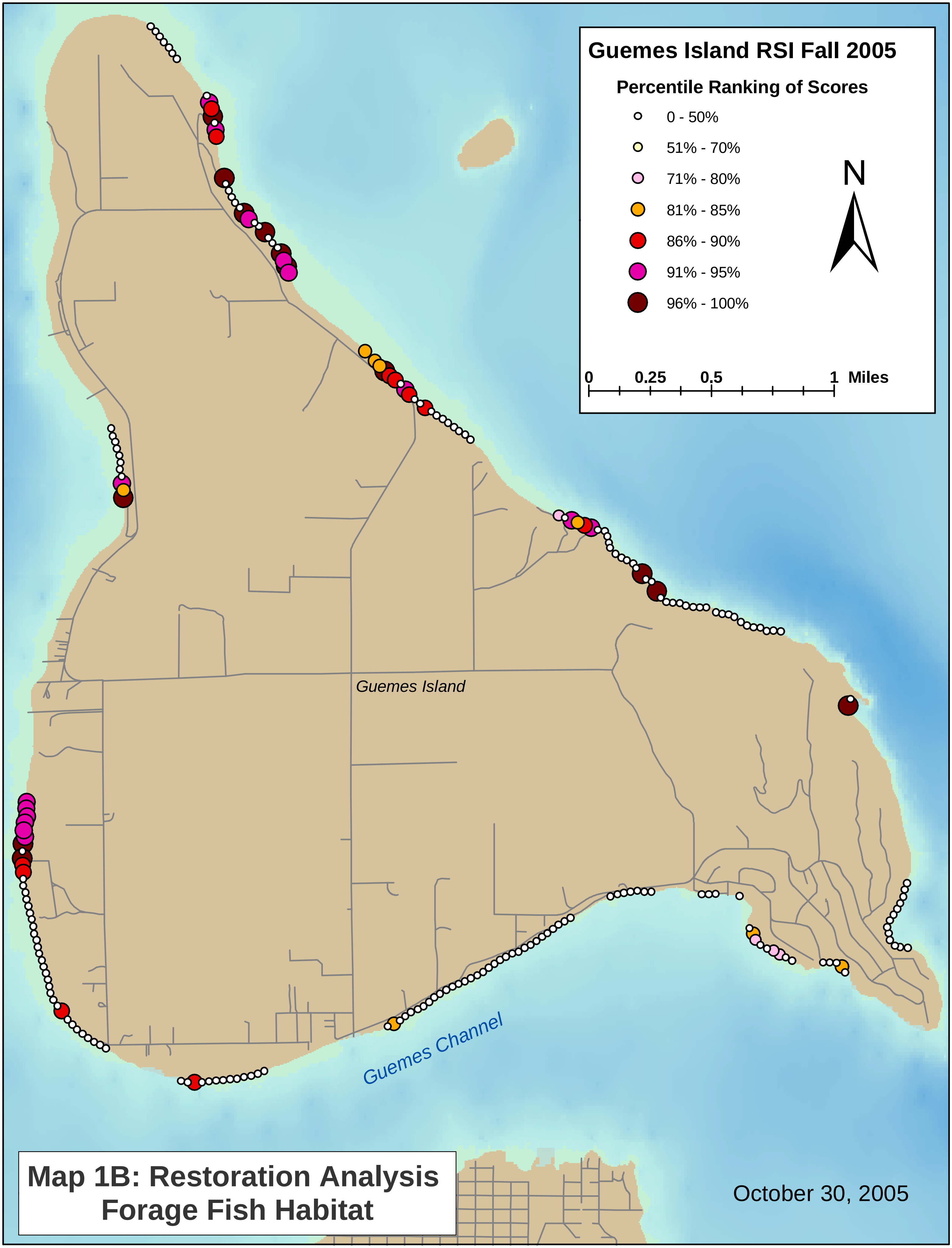
The conservation analysis reveals forage fish conservation priorities on the beach south of Starfish Rock, the high bluff areas on the northern side of North Beach and the center of Kelly’s Point (Map 1A). West Beach and southern North beach each had a single site in the top decile.

The restoration analysis reveals forage fish restoration priorities on the high bluff areas on either side of North Beach, the northern stretch of Kelly’s Point, Young’s Park, south West Beach, one site in Square Harbor, and several points south of Starfish Rock (Map 1B). Habitat impacts that affected these scores included structures such as bulkheads and groins, and outfall features that could be signs of pollution. Kelly's Point, the sites south of Starfish Rock and Square harbor were most affected by outfall features such as algae, discolored sediment, and erosion. While algae could be a sign of pollution it could also be a sign of normal nutrients cycling. This is the likely case in Square Harbor. The beaches most affected by structures are North Beach, Young’s Park, and southern West Beach.



Map 1A: Conservation Analysis
Forage Fish Habitat

October 30, 2005



Map 1B: Restoration Analysis
Forage Fish Habitat

October 30, 2005

<u>Nearshore Juvenile Salmonid Habitat Analysis</u>

The salmon habitat analysis relies on the assumption that nearshore habitats provide key functions for juvenile salmon development and survival. Nearshore marine habitat may serve as migration corridors, feeding areas, physiological transition zones, refuge from predators, or refuge from high energy wave dynamics (Mason 1970; MacDonald et al. 1987, Thorpe 1994; Levings 1994; Spence et al. 1996). All juvenile salmon utilize the shallow waters of estuaries and nearshore areas as migration corridors to move from their natal streams through Puget Sound to the ocean (Willliams and Thom 2001). Estuarine environments provide a gradual transition area for juvenile salmon to adjust physiologically to salt water (Simenstad et al. 1982). With declines in aquatic vegetation that formerly served as feeding grounds and refugia for juvenile salmonids, it is likely that juvenile salmon have shifted their distributions and now utilize shallow water as an alternate refuge habitat (Ruiz et al. 1993).

This model focuses on valuing individual sites for their capacity to serve as feeding areas, refugia, or migration corridors. Emergent vegetation (*Carex lyngbyei*, *Scirpus spp*., etc.) and riparian shrubs and trees have been identified as vital components that provide detritus and habitat for chinook food organisms (Levings et al. 1991, Cordell et al. 2001), and were therefore scored appropriately.

Habitat impacts are those features that are known or believed to displace habitat or impede habitat forming processes. These include structures that reduce shallow water nearshore refuge and habitat or adjacent land uses that may impact vegetation and upland food sources. The causal model and scoring for this model are described in Figure 17 and Table 3, respectively.

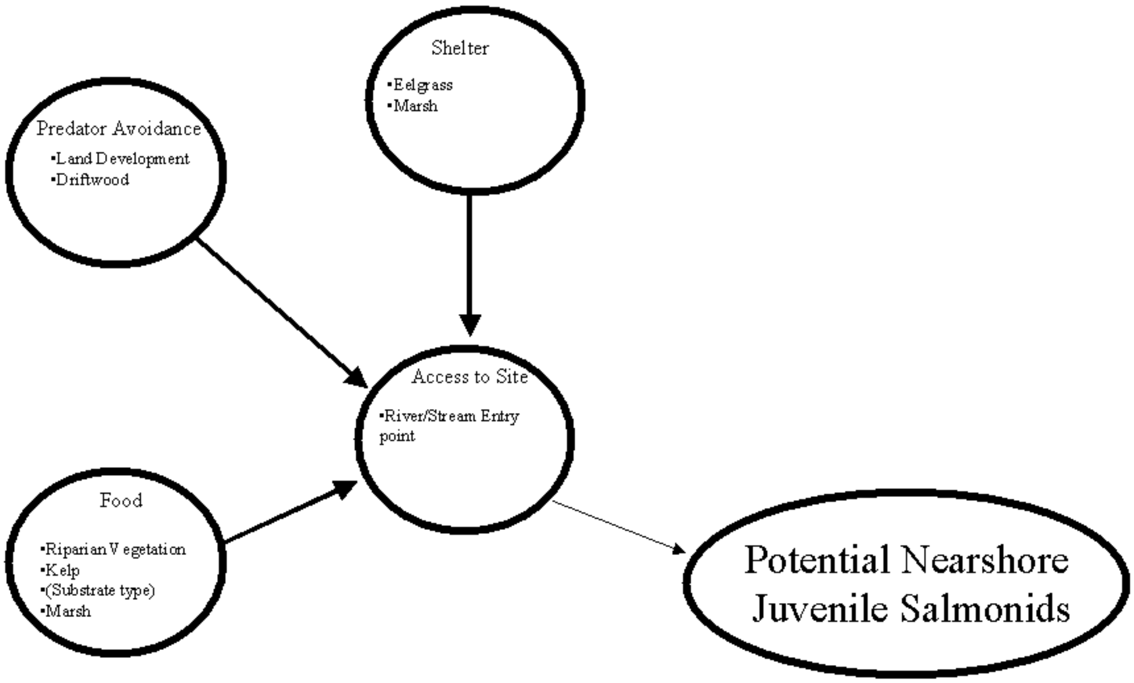


Figure 17: Causal model describing the relationship between shoreline characteristics and nearshore juvenile salmonid success. Weight of arrows reflects assumed relative importance of those functions for "success" in this particular model.

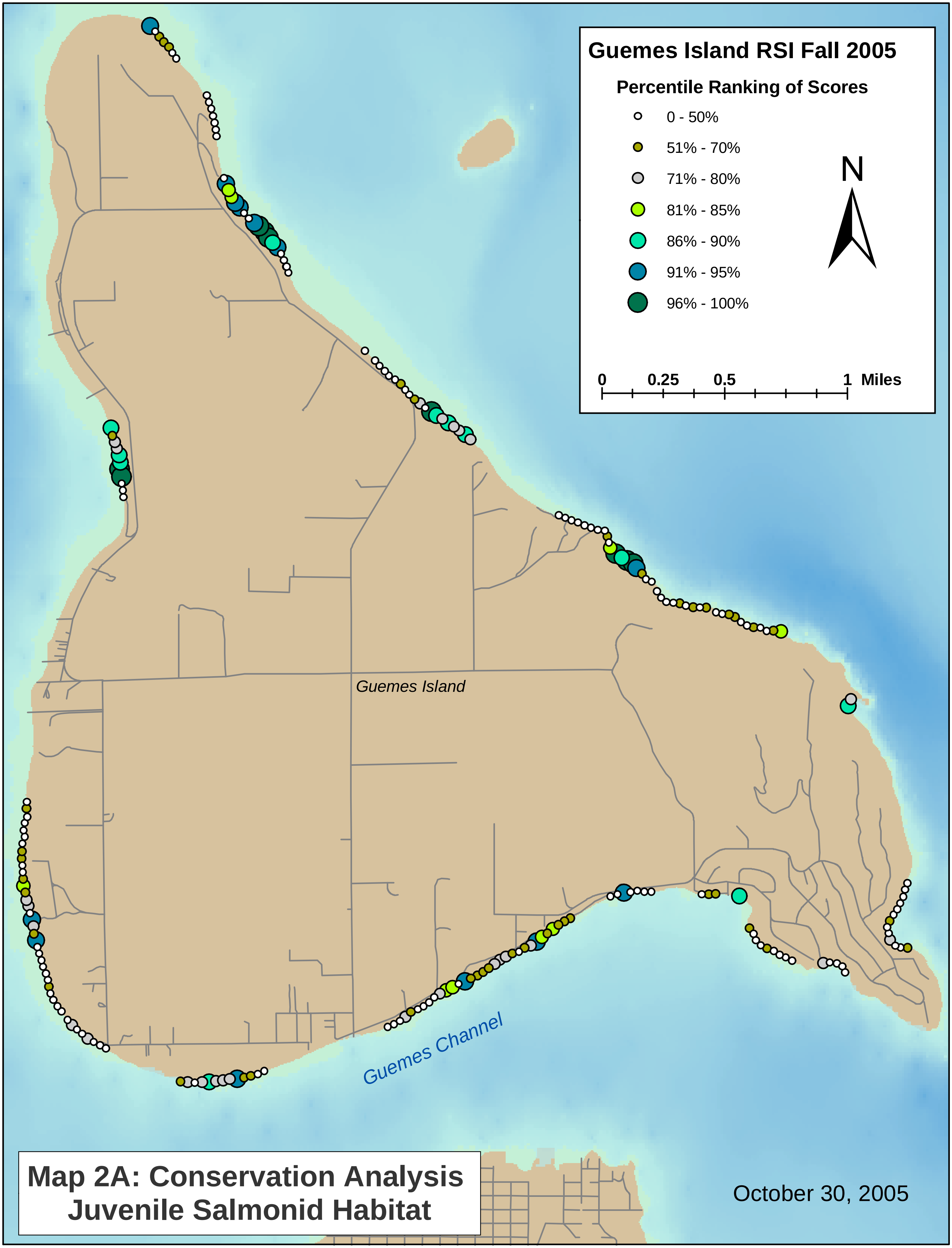
Habitat Function	Habitat Quality Value	Score Justification
Geophysical Characteristics		
Intertidal Substrate	10 to 15	Habitat for prey resource
Driftwood Presence	5	Habitat for prey resource Refugia
Creek or River Mouth	5	Habitat for prey resource Migration corridor Physiological transition zone
Vegetation Characteristics		
Eelgrass (*Z. marina*)	15	Habitat for prey resource Refugia
Kelp	5	Habitat for prey resource Refugia
Riparian Vegetation	10 to 30	Habitat for prey resource Refugia
Marsh	15	Habitat for prey resource Refugia
Bluff/Bank Vegetation	3 to 5	Habitat for prey resource
Anthropogenic Group		
Undeveloped/Natural Adjacent Land use	5	Undeveloped areas represent areas that lack disturbance and are more likely to have native flora.
Habitat Impact	**Habitat Quality Value**	**Score Justification**
Structures		
Intertidal Structure	-30	Removes refugia Removes prey resource
Shoreline Armoring	-10 to -30	Removes refugia Removes prey resource
Upland Land use	-10 to -30	Adverse land uses increase disturbance, reduce habitat and introduce pollutants
Potentially polluted Outfalls	-10	Pollutants entering the system can reduce dissolved oxygen content and act as stressors.

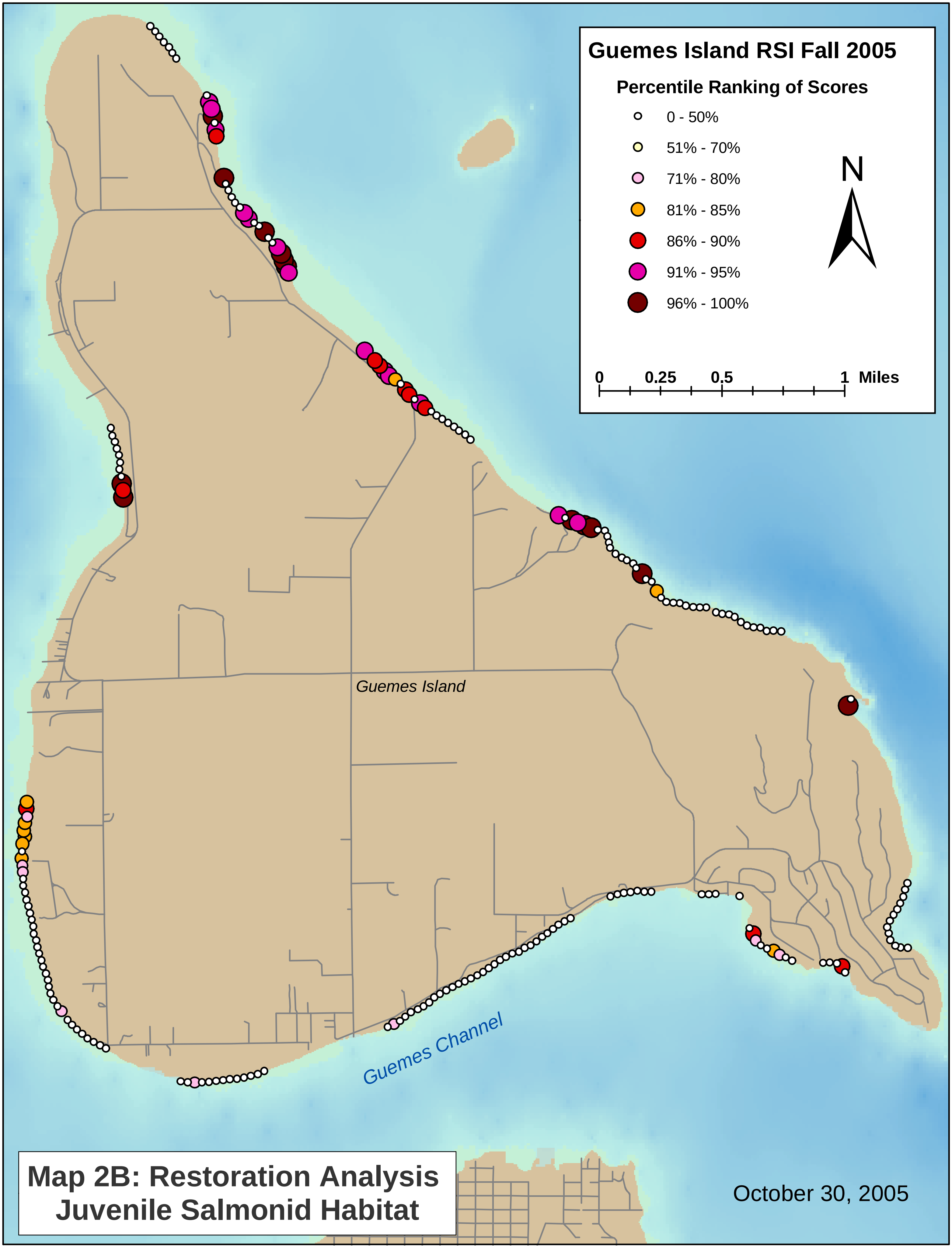
Table 3: Description of model scores and justification for nearshore juvenile salmonid habitat model.

Another criterion for juvenile salmon habitat conservation might be the area's proximity to large, chinook-bearing rivers. Recent research in the Skagit River suggests that juvenile chinook can be prematurely forced out of estuaries and into marine shorelines (Beamer et al., in preparation), although this has yet to be documented for other sub-estuaries of Puget Sound. Juvenile salmon also use the beach as a migration corridor; the continuity of good habitat is an issue not addressed by this report.

The conservation analysis reveals juvenile salmonid conservation priorities on the beach south of Starfish Rock, the high bluff areas on the northern side of North Beach, and West Beach (Map 2A). Southern North Beach, West Clarks Point, Peach Preserve, the center of Kelly's Point, and South Beach had several isolated sites scoring in the highest decile.

The restoration analysis reveals juvenile salmonid restoration priorities on the high bluff areas on either side of North Beach, Seaway Hollow, Young's Park, and south West Beach (Map 2B). Habitat impacts that affected these scores included structures such as bulkheads and groins, and outfall features that could be signs of pollution. The beaches most affected by structures are North Beach, Seaway Hollow, Young's Park, and southern West Beach.


Guemes Island RSI Fall 2005
Percentile Ranking of Scores
0 - 50%
51% - 70%
71% - 80%
81% - 85%
86% - 90%
91% - 95%
96% - 100%
N
0
0.25
0.5
1 Miles
Guemes Island
Guemes Channel
Map 2A: Conservation Analysis
Juvenile Salmonid Habitat
October 30, 2005


Guemes Island RSI Fall 2005
Percentile Ranking of Scores
0 - 50%
51% - 70%
71% - 80%
81% - 85%
86% - 90%
91% - 95%
96% - 100%
N
0
0.25
0.5
1
Miles
Guemes Island
Guemes Channel
Map 2B: Restoration Analysis
Juvenile Salmonid Habitat
October 30, 2005

Aquatic Vegetation Analysis

Primary production forms the base of any food web, and in Puget Sound the primary producers are seaweeds, sea grasses, benthic microalgae, kelps, marsh macrophytes, and phytoplankton. In Puget Sound, areas of increased algae and seagrass density, or biomass, contain more species and a greater abundance of epibenthic invertebrates than do areas of lower vegetative cover or structure (Cheney et al. 1994). With the exception of estuary marsh vegetation, which was formerly widespread in and around the major bays and deltas of Puget Sound (Bortelson 1980), primary production is limited to a relatively narrow band of habitat as a result of the steep fjord-like character of Puget Sound's nearshore habitat. Any attempt to determine the suitability of a certain area as habitat for submersed aquatic vegetation (SAV) must take into consideration light and parameters that modify light (epiphytes, total suspended solids, chlorophyll concentration, nutrients) (Koch 2001). Anthropogenic nitrogen loads to shallow coastal waters have been linked to shifts from seagrass to algae-dominated communities in many regions of the world (McClelland and Valiela 1998). Propagules of most types of aquatic vegetation are generally found to be ubiquitous, so the absence of aquatic vegetation is generally a result of either inappropriate habitat for colonization and survival or displacement by another type of aquatic vegetation (Moore et al. 1996).

The focus of this analysis is on direct observations of aquatic vegetation with individual types of aquatic vegetation valued primarily for their ecological "services." Implicit in the scoring of this model is the underlying assumption that each type of aquatic vegetation typically occupies a particular zone in the nearshore environment, from the subtidal to the upper intertidal. Species and multi-species assemblage scores are largely based on the ecological services they provide and the number of zones they occupy. Factors affecting light availability and nutrient loading as well as non-native competitors are assessed as detractors in this model. The causal model and scoring for this model are described in Figure 18 and Table 4 respectively.

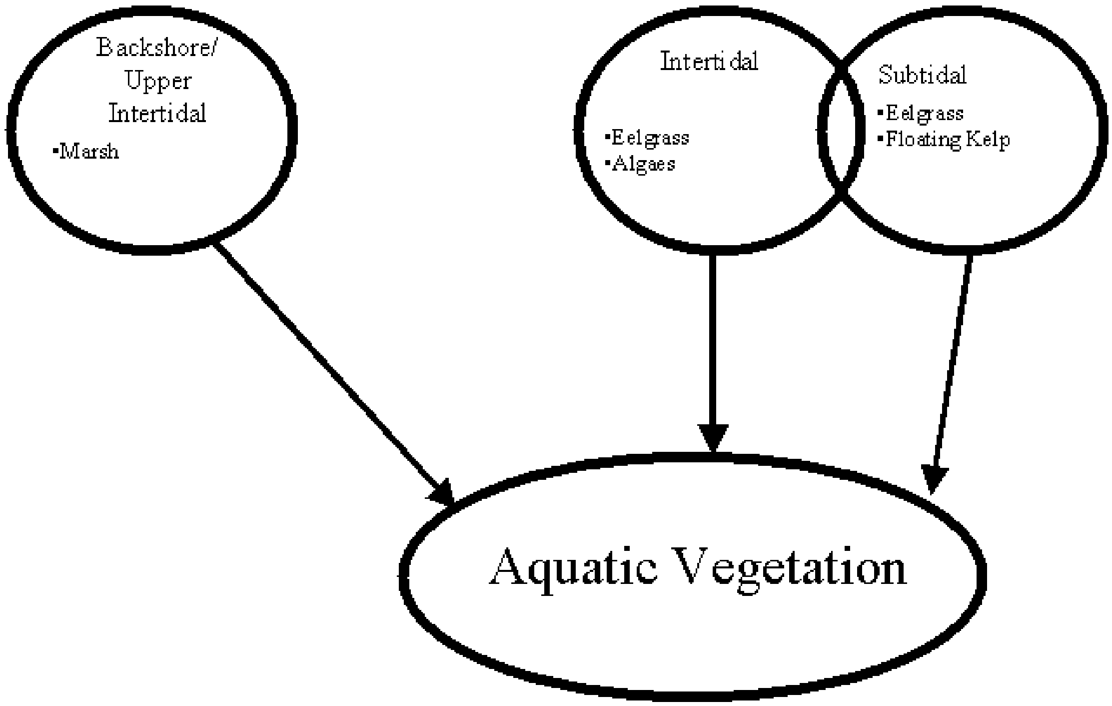


Figure 18: Causal model describing the relationship between shoreline characteristics and aquatic vegetation. Weight of arrows reflects assumed relative importance of those functions for "success" in this particular model.

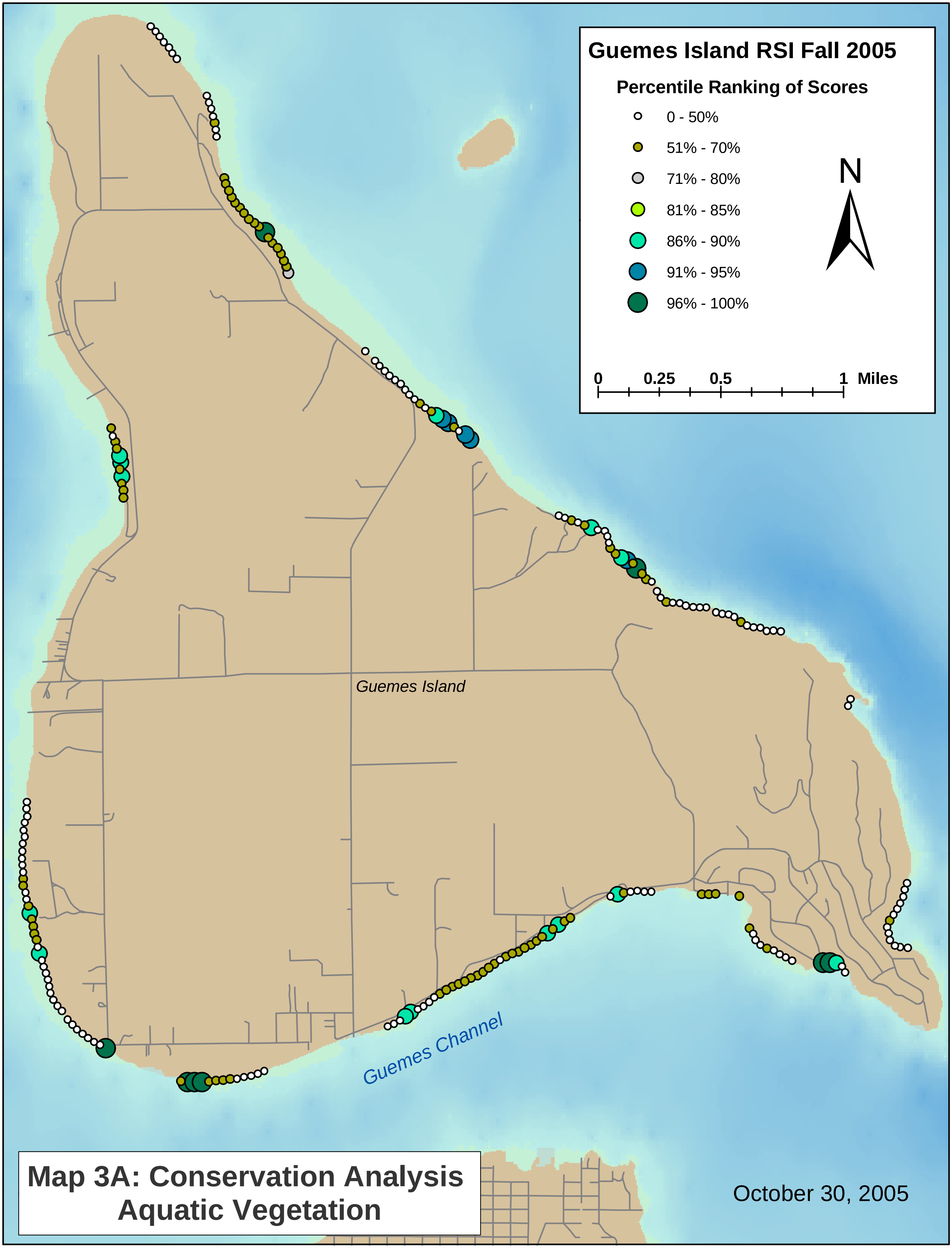
Eelgrass	Kelp	Brown Algae and Ulvoids	Marsh	Score
X	x	X	x	100
X	x		x	90
X		X	x	90
X			x	85
	x	X	x	70
	x		x	60
		X	x	60
X	x			50
X		X		50
X	x	X		60
			x	40
X				40
	x	X		30
	x			20
		X		20
				0

Habitat Impact	Habitat Quality Value	Score Justification
Invasive Plants		
Spartina	-30	Alters habitat Competes with native vegetation
Purple Loosestrife	-20	Competes with native vegetation
Sargassum	-10	Impacts of competition with native vegetation are unknown
Pollution/Nutrient Inputs		
Potentially Polluted Outfalls	-10	Altered nutrient supply impacts community composition Source of potential chemical contaminants
Structures		
Intertidal Structures	-20	Shades nearshore vegetation Affects nearshore hydrography
Shoreline Armoring	-10	Affect nearshore hydrography, occupies habitat

Table 4: Description of model scores and justification for aquatic vegetation model.

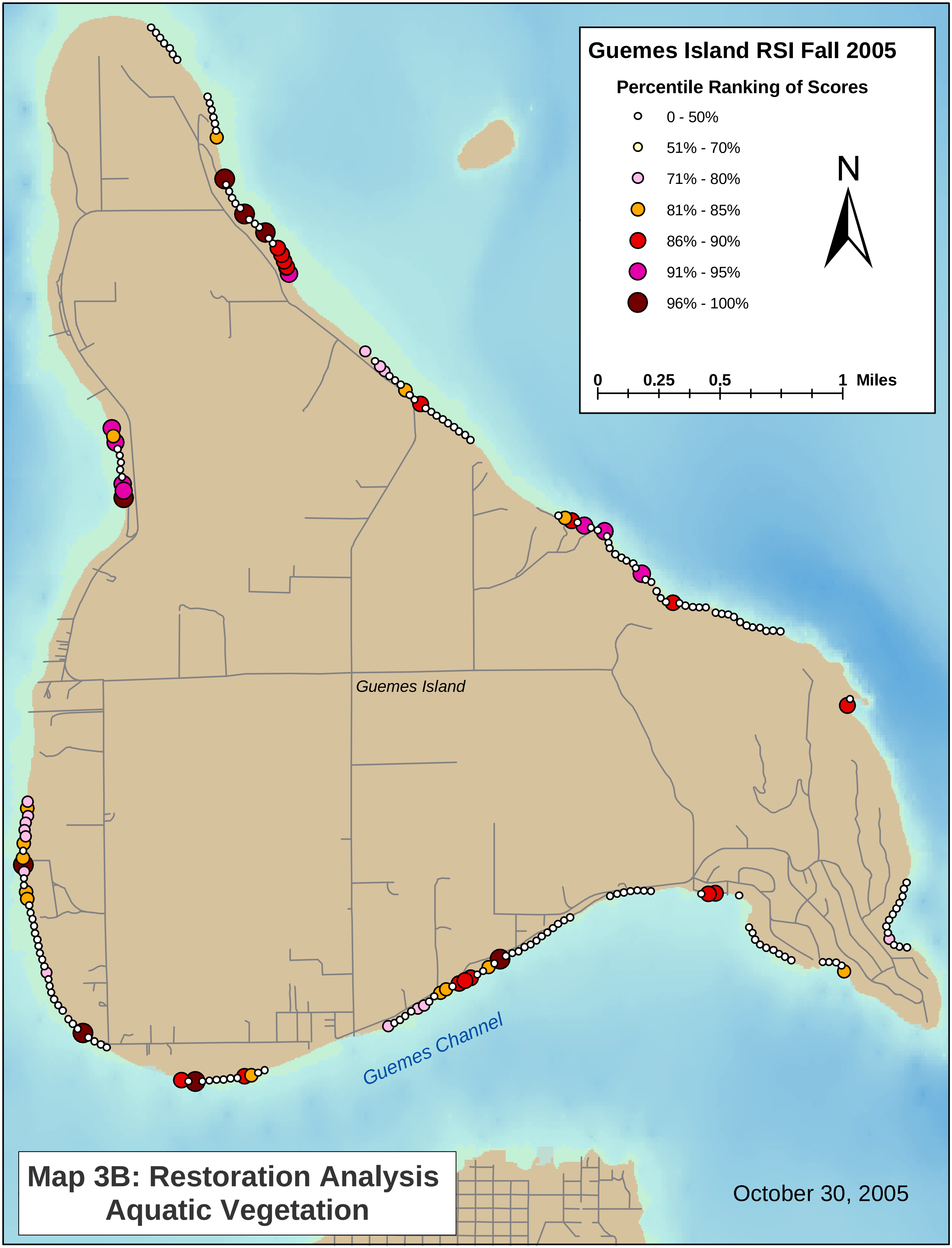
The conservation analysis reveals aquatic vegetation conservation priorities on Peach Preserve, Cooks Cove, sites south of Starfish Rock, and southern North Beach (Map 3A). Isolated sites were also found on northern North Beach and Kelly's Point. Peach Preserve and Cooks Cove scored the highest due to their backshore marshes.

The restoration analysis reveals aquatic vegetation restoration priorities on the high bluff areas on North Beach, West Beach, and Seaway Hollow (Map 3B). Dispersed sites were also found south of Starfish Rock, South Beach, Peach Preserve, and Kelly's Point. These sites were affected by invasive species, structures, and potentially polluted outfalls. The highest scoring site in the center of south beach was where the spartina was identified and removed.



Map 3A: Conservation Analysis Aquatic Vegetation

October 30, 2005



Map 3B: Restoration Analysis Aquatic Vegetation

October 30, 2005

Feeder Bluffs and Nearshore Hydrography Analysis

Puget Sound's shorelines are composed of hundreds of littoral cells that redistribute sediment along the shoreline. In the relatively protected waters of Puget Sound, the primary sources of sediment to the shoreline are alongshore and onshore transport, bluff erosion, and beach nourishment. Sediment is lost from the beach as a result of erosion and longshore transport or deposition on spits (Downing 1983). Shoreline development and armoring actively impact Puget Sound beaches by altering sediment supply and transport processes on shorelines and by directly modifying and occupying critical habitats (Shipman and Canning 1993, Shipman 1995).

In developing a causal model to assess the local functionality of the nearshore sediment budget, the results of other models that focus on the impacts of human activity on shoreline erosion were adapted (e.g. Lawrence 1994). The focus of this analysis is on identifying signs that the sediment budget is being filled by looking for evidence of active erosion, in particular along bluff faces, and areas of deposition that are found at the end of drift cells such as tombolos and spits. The causal model and scoring for this model are described in Figure 19 and Table 5 respectively.

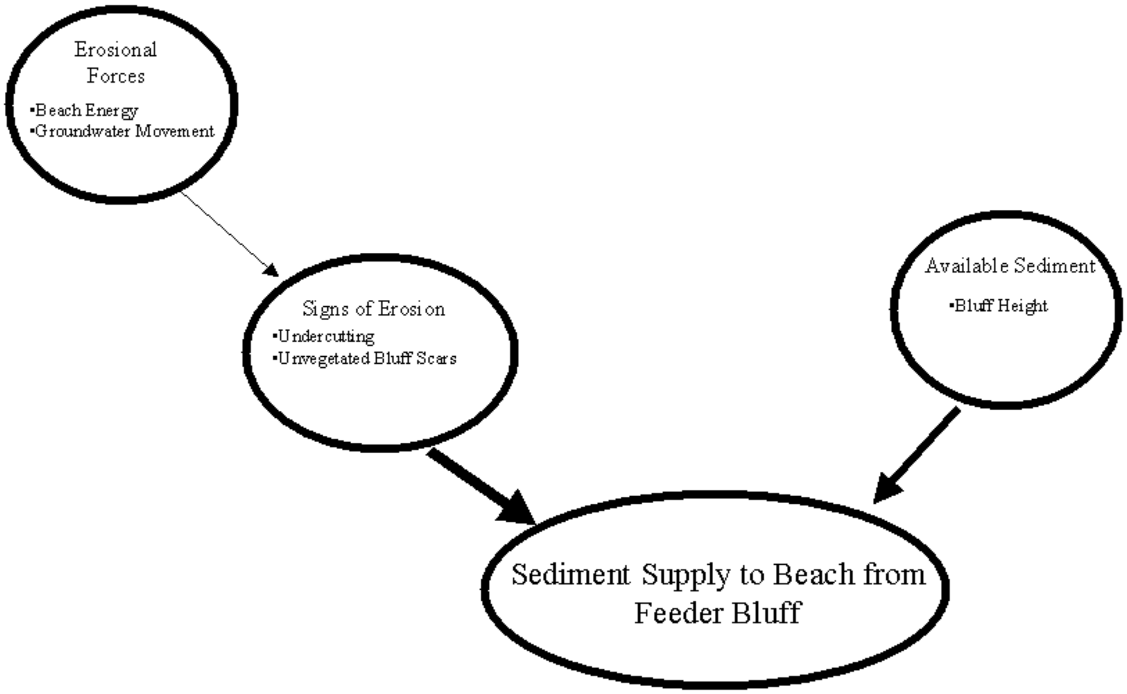


Figure 19: Causal model describing the relationship between shoreline characteristics and functional nearshore hydrography and feeder bluffs. Weight of arrows reflects assumed relative importance of those functions for "success" in this particular model.

Habitat Function	Habitat Quality Value	Score Justification
Signs of Erosion		
Bluff Scars	10 to 15	Sign of active erosion
Bluff Undercutting	10 to 15	Sign of high beach energy and erosion potential
High Beach Energy	10	Cause of erosion
Sediment Supply		
Bluff Height	10 to 50	Sediment source potential
Stream or River	10	Sediment source potential
Sediment Deposition		
Tombolo, Spit, or Bar	10	Sediment Deposition Zone
Habitat Detractor	**Habitat Quality Value**	**Score Justification**
Shoreline Development		
Proportion of Shoreline Armored	-10 to -40	Shoreline armoring both exacerbates nearshore sediment loss and prevents sediment supply to the beach
Adverse Adjacent Land use	-20	Adjacent land use may act as a source of pollutants and developed land uses are likely to reduce sediment budget

Table 5: Description of model scores and justification for functional nearshore hydrography and feeder bluff model.

The conservation analysis reveals isolated nearshore hydrography and feeder bluff conservation priorities on the beach south of Starfish Rock, the high bluff areas of North Beach, Kelly's Point, and South Beach (Map 4A). The beaches south of Starfish Rock to Deadman Bay are bedrock outcroppings; therefore they are probably not appropriate priorities. No section of beach scored consistently within the 90th percentile. However, within the 80th percentile South Beach would be the best place to consider conservation projects. South Shore Road runs along South Beach and undercutting has been a large problem in that area. This must be considered while planning conservation projects.

The restoration analysis reveals nearshore hydrography and feeder bluff restoration priorities on the high bluff areas of North Beach, southern West Beach, and a single site on South Beach (Map 4B). Deadman Bay and Cooks Cove are Rocky bluffs and therefore are probably not appropriate priorities. These sites were mostly affected by structures and adjacent land use.

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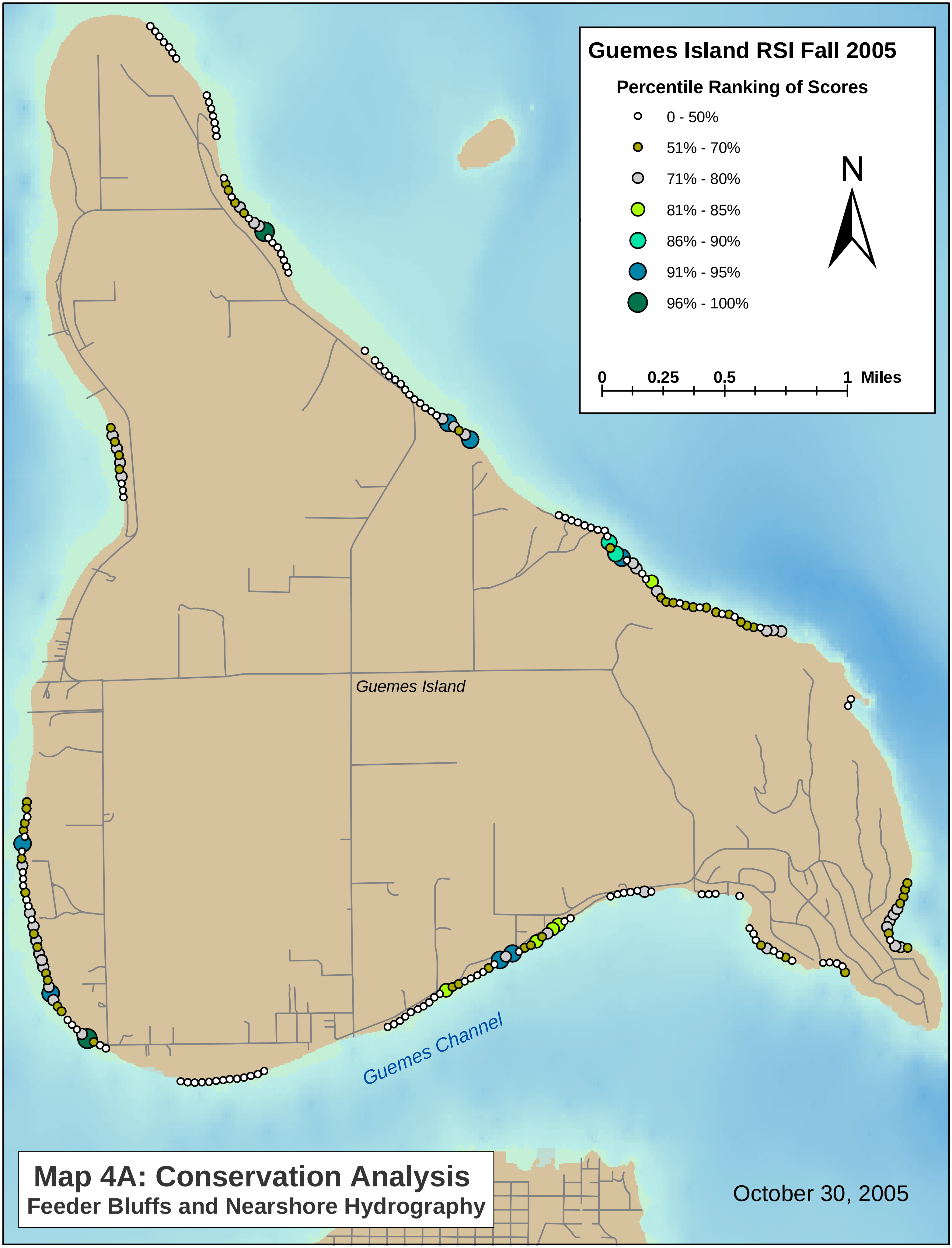
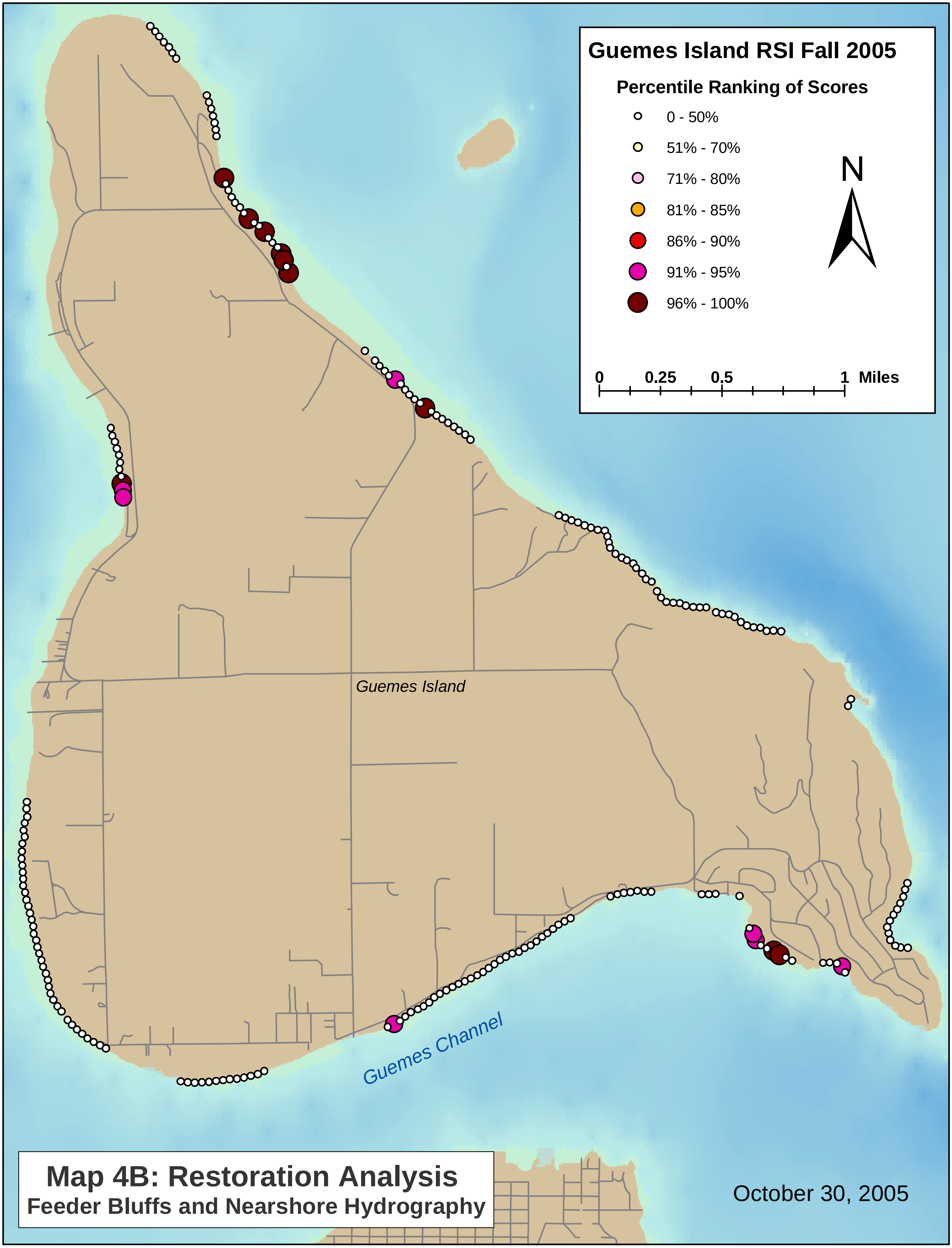

Guemes Island RSI Fall 2005
Percentile Ranking of Scores
0 - 50%
51% - 70%
71% - 80%
81% - 85%
86% - 90%
91% - 95%
96% - 100%
N
0
0.25
0.5
1 Miles
Guemes Island
Guemes Channel
Map 4A: Conservation Analysis
Feeder Bluffs and Nearshore Hydrography
October 30, 2005



Map 4B: Restoration Analysis

Feeder Bluffs and Nearshore Hydrography

October 30, 2005

Marine Birds and Wildlife Habitat Analysis

Varieties of terrestrial animals spend part or all of their lives within the nearshore environment and have a great impact on the composition and functioning of the nearshore ecosystem. An essential component of the nearshore ecosystem are marine birds. Marine birds are often the dominant predators along rocky as well as sandy beaches (Hori and Noda 2001). In addition to being a dominant consumer of animals, most birds are omnivores and therefore play a critical role in structuring assemblages of animals as well as vegetation in the nearshore ecosystem.

This analysis focuses on habitat components that contribute to the feeding, rearing, and resting of shoreline-dependent wildlife. This analysis looks at a variety of shoreline features that are beneficial for a variety of birds that depend on marine shorelines. It awards points for fine sediments where shorebirds forage, niche habitats where rivers and creeks meet salt water, and dunes where some shorebirds nest. It awards points for a variety of vegetation directly beneficial to marine waterfowl (such as brants) and indirectly beneficial to fish-eating birds (such as great blue herons and kingfishers). The causal model and scoring for this model are described in Figure 20 and Table 6 respectively.

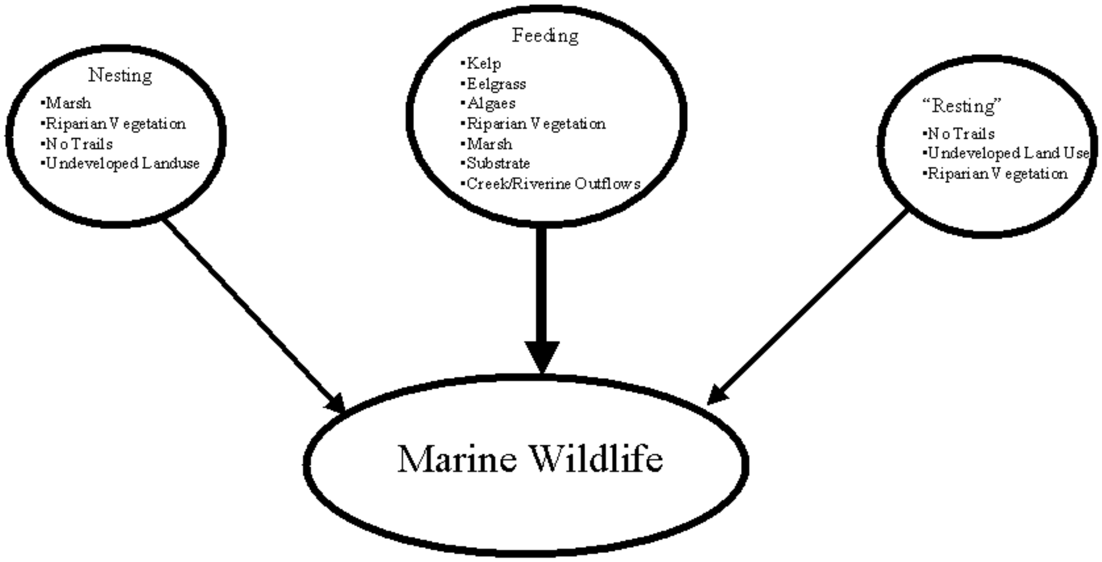


Figure 20: Causal model describing the relationship between shoreline characteristics and marine wildlife habitat. Weight of arrows reflects assumed relative importance of those functions for "success" in this particular model.

Habitat Functions	Habitat Quality Value	Score Justification
Geophysical Characteristic		
Intertidal Substrate	10 to 20	Shorebird habitat
Creek or River	5	Migration corridor Prey resource
Dune	15	Unique niche
Vegetation Characteristic		
Eelgrass (*Z. marina*)	10	Trophic productivity
Kelp	5	Trophic productivity
Marsh	10	Trophic productivity
Riparian Vegetation	5 to 25	Trophic productivity Resting/nesting
Bluff/Bank Vegetation	3 to 5	Trophic productivity Refuge/resting/nesting
Upland Land use		
Undeveloped Natural	5	Less Disturbance
Habitat Detractor	**Habitat Quality Value**	**Score Justification**
Upland Land use		
Developed Land use	-10 to –30	Potential pollutants Loss of habitat structure (refuge/resting/nesting)
Trail Access to Shoreline	-10 to –20	Disturbance
Structure		
Intertidal Structure	-30	Loss of habitat structure (refuge/resting/nesting)
Shoreline Armoring	-10 to –20	

Table 6: Description of model scores and justification for marine wildlife habitat.

The conservation analysis reveals marine bird conservation priorities on the beach south of Starfish Rock, northern North Beach, and West Beach (Map 5A). Isolated sites were also found on southern North Beach, Peach Preserve, Clark Point, Kelly's Point, and South Beach.

The restoration analysis reveals marine bird restoration priorities on North Beach, Seaway Hollow, Young's Park, and southern West Beach (Map 5B). Single sites were found on Kelly's Point and Square Harbor. These sites were mostly affected by structures. Square Harbor had a habitat impact score of -10, because of a trail head. It scored high for restoration due to its high habitat score and the relatively low restoration scores within the entire data-set. The Square Harbor trail is fairly remote and probably does not get the level of use that Kelly's Point or North beach does, and therefore is not an appropriate restoration site.

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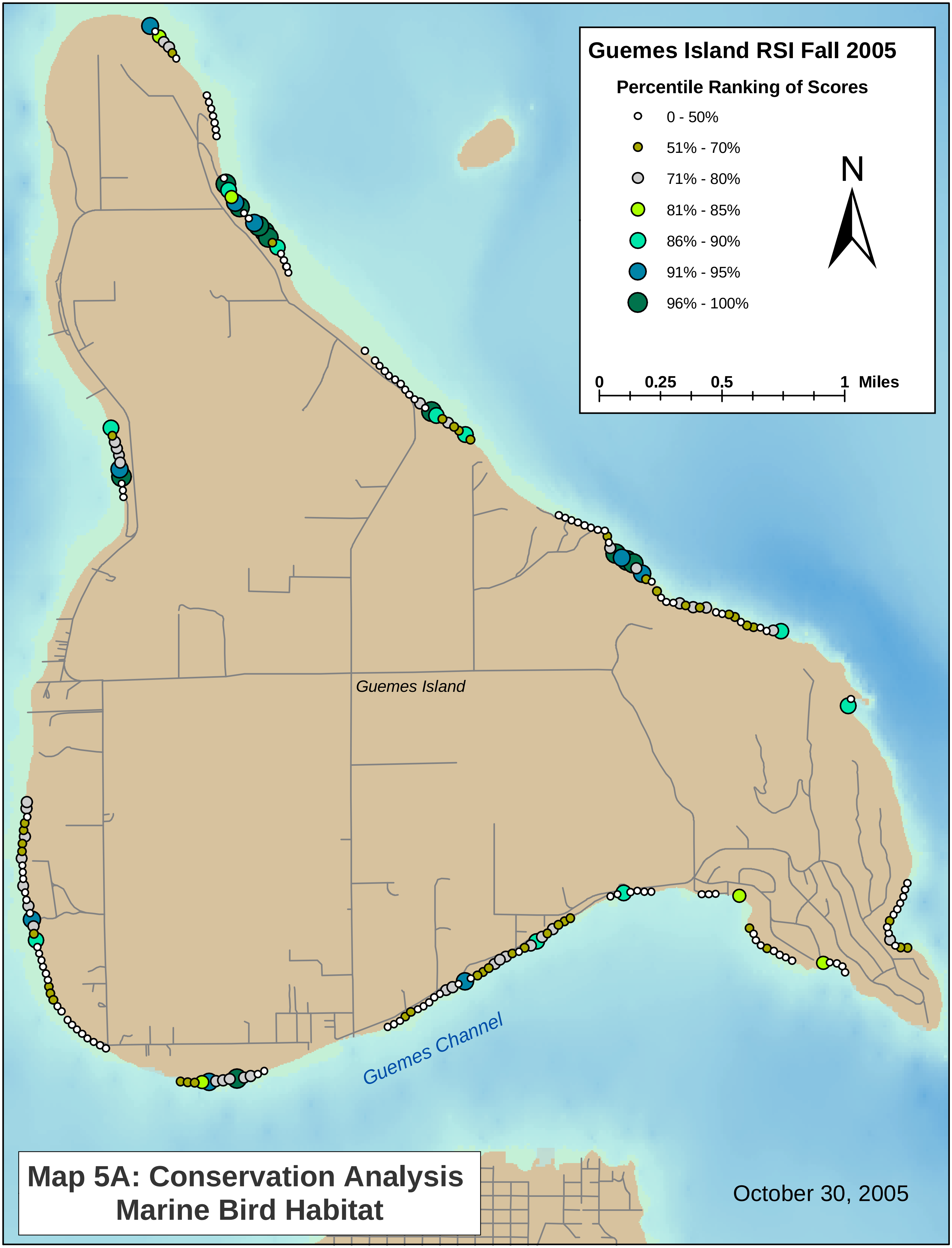
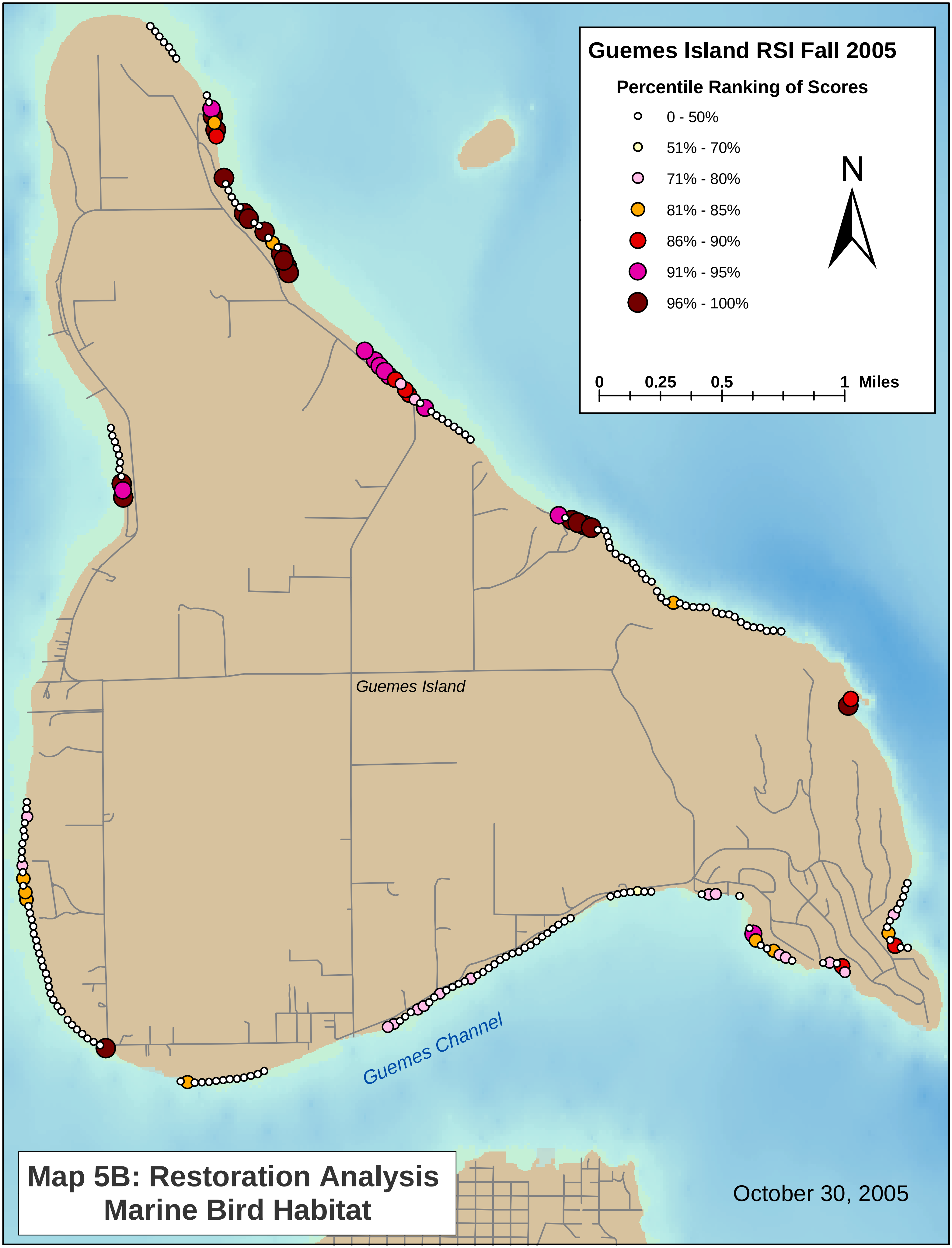

Guemes Island RSI Fall 2005
Percentile Ranking of Scores
0 - 50%
51% - 70%
71% - 80%
81% - 85%
86% - 90%
91% - 95%
96% - 100%
N
0
0.25
0.5
1
Miles
Guemes Island
Guemes Channel
Map 5A: Conservation Analysis
Marine Bird Habitat
October 30, 2005


Guemes Island RSI Fall 2005
Percentile Ranking of Scores
0 - 50%
51% - 70%
71% - 80%
81% - 85%
86% - 90%
91% - 95%
96% - 100%
N
0
0.25
0.5
1 Miles
Guemes Island
Guemes Channel
Map 5B: Restoration Analysis
Marine Bird Habitat
October 30, 2005

Conservation Focus Areas

The conservation scores from the five models were summed to create the overall conservation scores displayed in Map 6A. The areas that scored highest for overall conservation were the stretch of beach south of Starfish Rock, the high bluff areas of North Beach, and West Beach. South Beach, Kelly's Point, and southern North Beach had stretches of shoreline that scored well in the 80th Percentile. An isolated site in Cooks Cove also scored high in conservation. Based on this analysis and general knowledge of Guemes Island three general areas are recommended as focus areas:

1) The Starfish Rock area;
2) The North Beach area; and
3) The West Beach area.

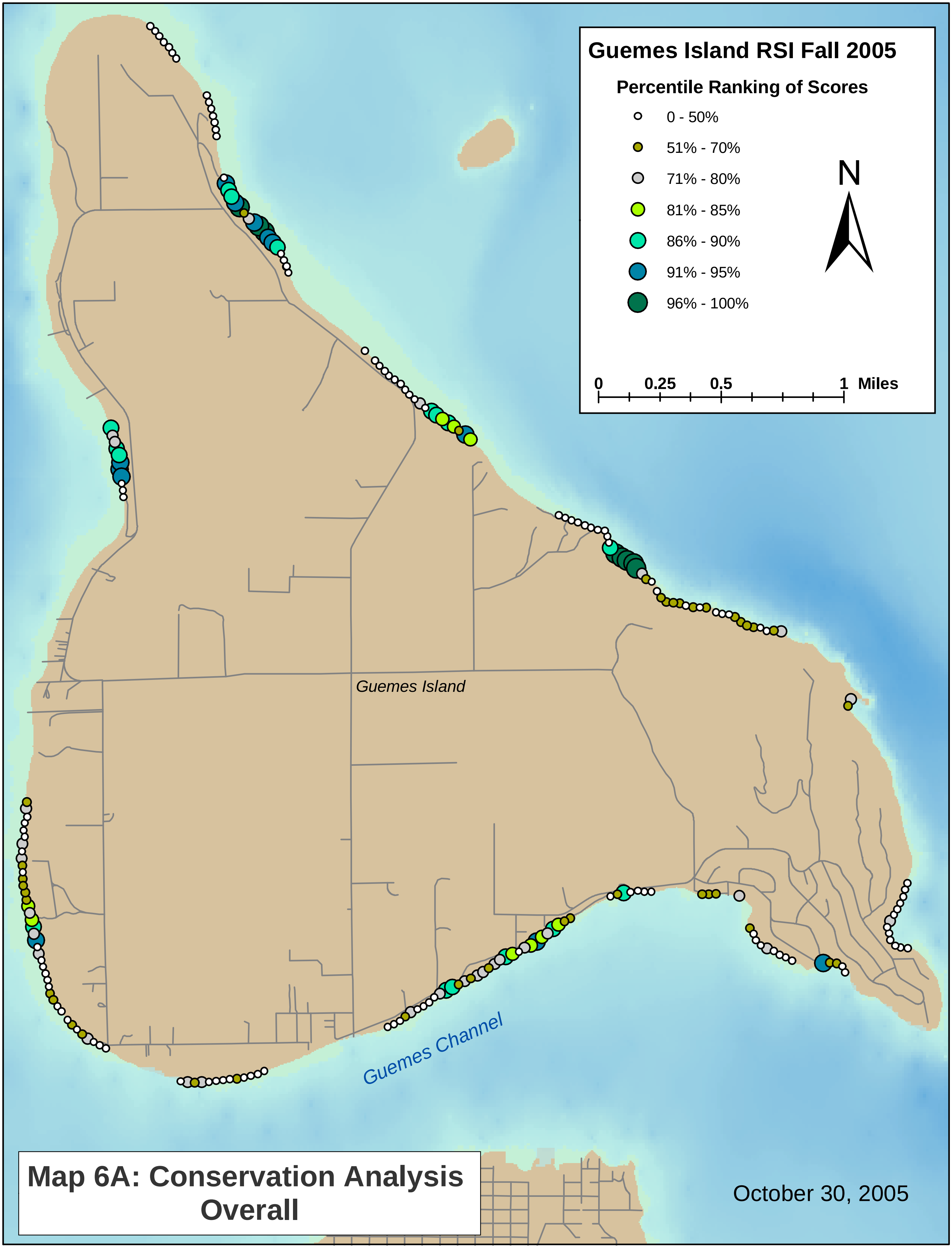
The beach south of Starfish Rock scored high on all five sub-analyses. The northern North Beach sites scored in the top decile on forage fish, salmon, and marine bird analysis. It also scored within the 80th percentile for vegetation. There are a series of sites in the southern high bluff area that scored in the 80th percentile for overall conservation. West Beach scored in the top decile on salmon and marine bird analysis, and had isolated high scoring sites for forage fish. It also scored in the 80th percentile for vegetation. These general areas had multiple sites scoring in the top decile in this combined analysis. Therefore these would be the most logical areas to start consideration for conservation projects.

Restoration Focus Areas

The restoration scores from the five models were summed to create the overall restoration scores displayed in Map 6B. High scoring areas included northern North Beach, Young's Park, Seaway Hollow, and southern West Beach. Isolated high scoring sites were identified on southern North Beach, South Beach, south of Starfish Rock, and Square Harbor. Based on this analysis and general knowledge of Guemes island four areas are recommended as focus areas:

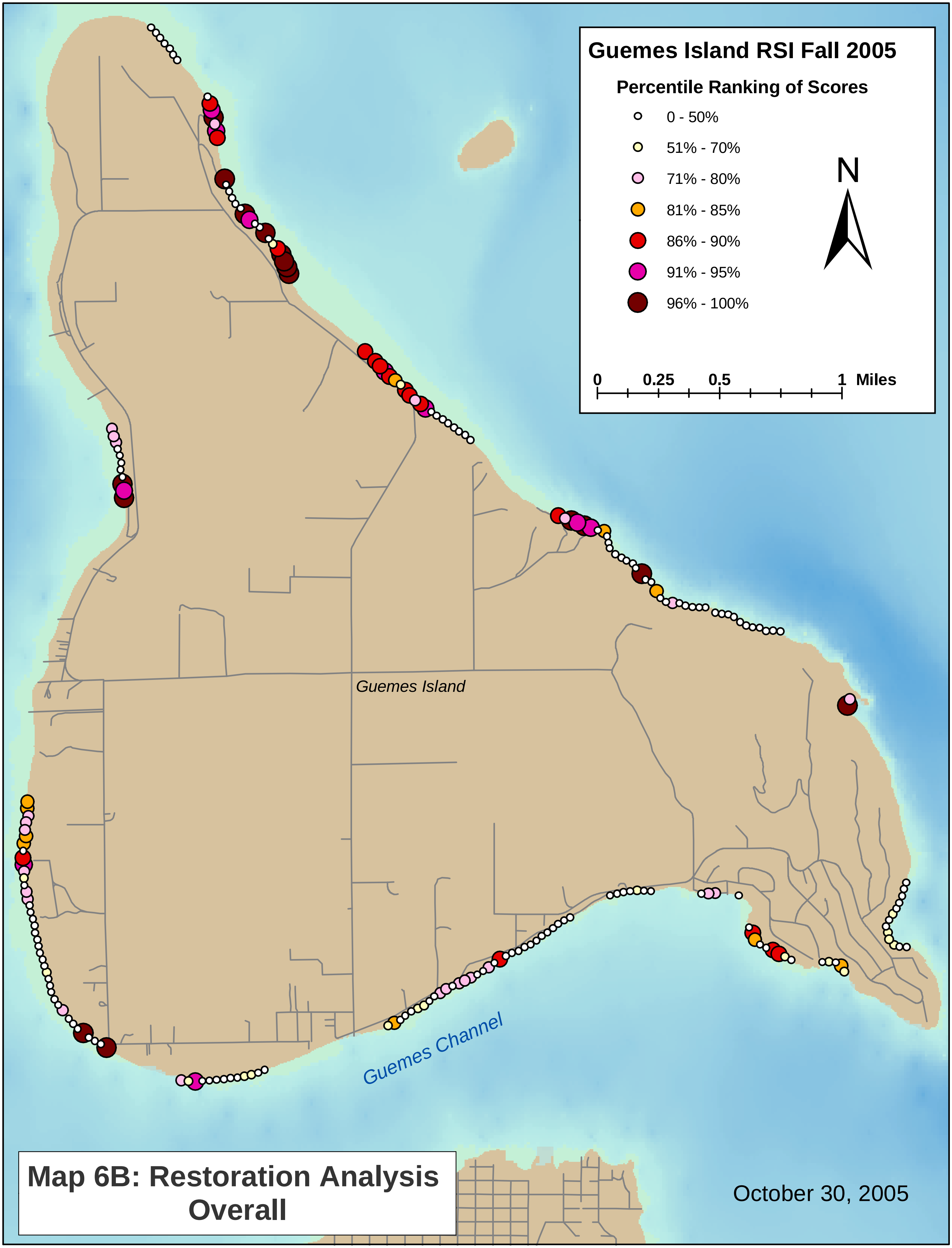
1) The North Beach area;
2) The Young's Park area;
3) The Seaway Hollow area; and
4) The West Beach area.

North Beach scored high for restoration on all five of the analyses. Young's Park scored high for restoration on forage fish, juvenile salmonid and marine birds. Seaway Hollow and West Beach scored high for restoration on forage fish, juvenile salmonid, aquatic vegetation, and marine birds. High restoration scores were primarily due to residential areas and associated structures. When comparing the overall conservation sites to the overall restoration sites the sites of North Beach and West Beach that did not score high in conservation scored high in restoration. These general areas had multiple sites scoring in the top decile in the combined analysis. Therefore these would be the most logical areas to start consideration for restoration projects.



Map 6A: Conservation Analysis Overall

October 30, 2005


Guemes Island RSI Fall 2005
Percentile Ranking of Scores
0 - 50%
51% - 70%
71% - 80%
81% - 85%
86% - 90%
91% - 95%
96% - 100%
N
0
0.25
0.5
1 Miles
Guemes Island
Guemes Channel
Map 6B: Restoration Analysis Overall
October 30, 2005

Conclusion

Five general areas of focus for conservation and/or restoration consideration are recommended based on RSI scores and a general knowledge of Guemes Island. The focus areas, as shown on Map 7, are:

1) The Starfish Rock area (Conservation);
2) The North Beach area (Restoration/Conservation);
3) The West Beach area (Restoration/Conservation);
4) The Young's Park area (Restoration); and
5) The Seaway Hollow area (Restoration).

I) The Starfish Rock area is a stretch of beach about 900 feet long, surrounded by rock cliffs, and contained by two points that are only crossable at low tide. The beach provides good habitat for forage fish, salmon, marine birds, and marine vegetation. It scored high on the feeder bluff analysis because of the size of its cliffs, but since the cliffs are rocky it does not provide sediment. This beach is protected by its inaccessibility.

II) The North Beach area is recommended for Restoration/Conservation, which means North Beach has high quality habitat with a few habitat detractors that give some sites higher scores with regard to restoration rather then conservation. Sites are distributed over a large area with many land owners. The beach is popular for clamming, crabbing, and fishing. Its high bluff areas scored high in conservation for forage fish, salmon, vegetation, and marine birds. However, restoration sites were also found in the more populated lowland areas where residential structures like bulkhead affect the quality of the habitat. North Beach would be an excellent site for restoration through education.

III) The West beach area is also recommended for Restoration/Conservation. It provides good forage fish, salmon, aquatic vegetation, and marine bird habitat. A single parcel is adjacent to most of this area. The RSI analysis supports the conservation of this parcel. There is some restoration potential around the three southern sites of West Beach, where forage fish, salmon, aquatic vegetation, and marine birds are negatively impacted. Habitat in this area may benefit from bulkhead removal and vegetation buffering. There is a high density of land ownership on either end of the beach.

IV) The Young's Park area, a well used recreational area, is recommended for restoration. It provides good forage fish, salmon, and marine bird habitat. High restoration scores are due to the adjacent residential areas and associated structures.

V) The Seaway Hollow area provides good forage fish, salmon, aquatic vegetation, and marine bird habitat. It is more remote than the other focus areas and may be a good community for restoration education. High restoration scores were primarily due to residential areas and associated structures. There are no houses along the beach. Most structures there are boat houses and picnic patios. Habitat will benefit from vegetation buffers.

Starfish Point, West Beach, and the southern high bluff area of North Beach, are adjacent to single ownership parcels, therefore they may be good conservation targets. The North Beach and Young's Park areas have high restoration scores because of beach houses directly adjacent to the beach. Most are too close to make bulkhead improvement feasible; however there are still some residents without bulkheads that are interested in finding soft shoreline alternatives. Seaway hollow is a small community while West Beach is surrounded by large communities. North Beach, West Beach, Seaway Hollow, and Young's Park would be ideal for restoration education programs.

In addition to the five recommendations based on the analysis, four other potential projects were identified. These recommendations are based on the inventory findings and the interests expressed by the community during the survey.

- Further Spartina surveys;
- South Shore feeder bluff conservation and restoration;
- Cooks Cove Marsh; and
- Creosote pier Removal.

Spartina has been discovered on the island. More widespread surveys and public education will protect the island from future habitat degradation.

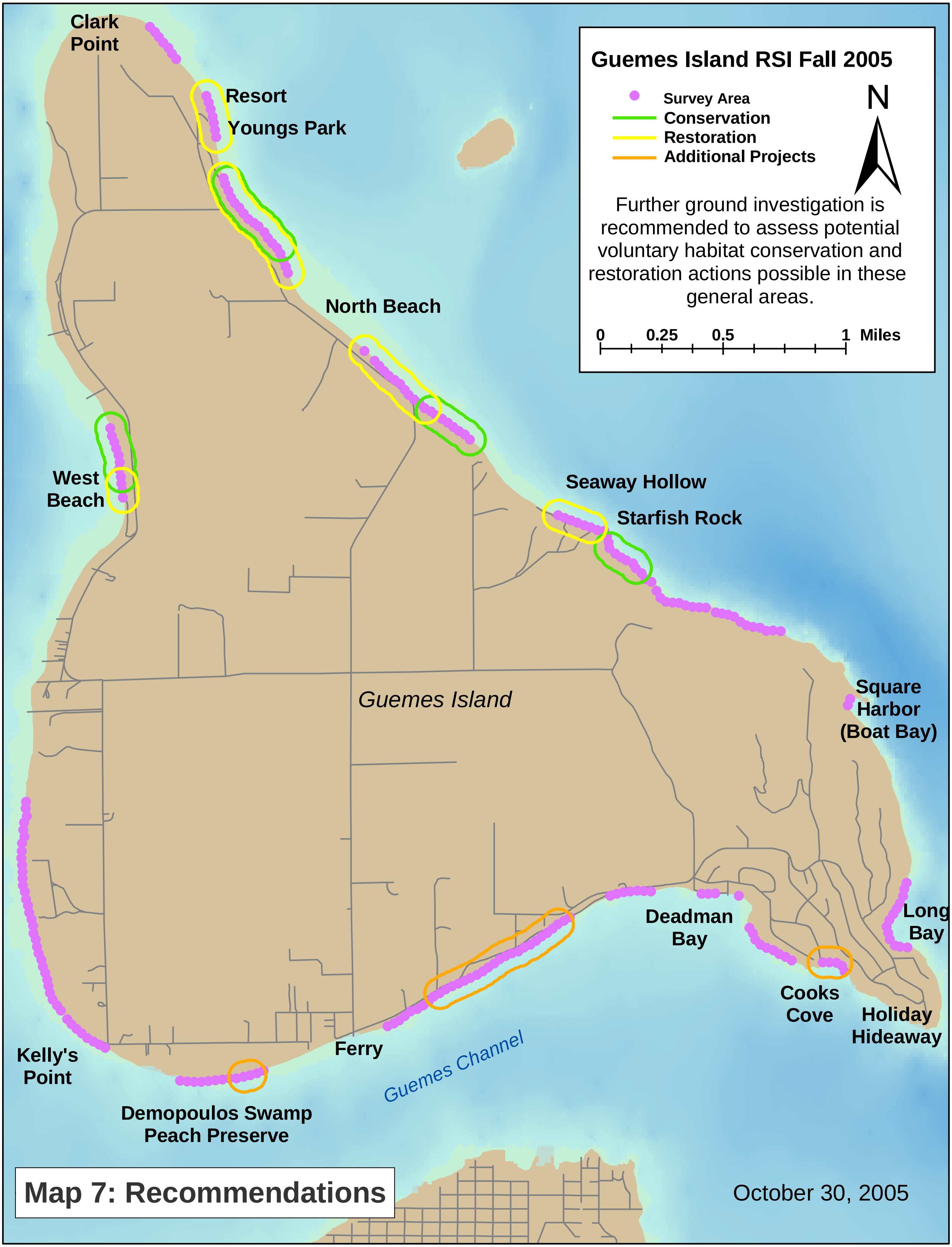
South shore is one of the most active feeder bluffs on the island. South Shore Road has had to be moved back because of intense erosion. Conservation buffers and shoreline vegetation may improve habitat for this area. There are also restoration possibilities on its western end.

Cooks Cove marsh was historically open to the saltwater. Reconnecting the marsh to saltwater would provide habitat to juvenile salmonids.

Creosote piers were found in two locations on the island. Thirty three derelict pilings were observed at Peach Preserve from an old dock and Kelly's Point also had pilings in the intertidal. Creosote has been observed in bulkheads on the island, some new and some failed. There is potential for removal projects and education.

<u>Recommendations</u>

Further ground investigation of the focus areas (Map 7) is recommended to assess their potential for voluntary conservation and restoration actions. Continued outreach and education would also benefit the entire community. This survey was not designed to produce the final word on specific site selection. Of the area of Guemes Island surveyed these are the priority sites our study recommends. These focus areas have not been ranked in order of priority. When considering projects for habitat conservation it is customary to consider some factors that are not included in this study. These factors include size, adjacency to conserved areas, threat of habitat destruction, price, and landowner willingness.



Guemes Island RSI Fall 2005
Survey Area
Conservation
Restoration
Additional Projects
N
Further ground investigation is recommended to assess potential voluntary habitat conservation and restoration actions possible in these general areas.
0 0.25 0.5 1 Miles
Clark Point
Resort
Youngs Park
North Beach
West Beach
Seaway Hollow
Starfish Rock
Guemes Island
Square Harbor (Boat Bay)
Long Bay
Deadman Bay
Cooks Cove
Holiday Hideaway
Ferry
Guemes Channel
Kelly's Point
Demopoulos Swamp Peach Preserve
Map 7: Recommendations
October 30, 2005

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Appendix A,

Guemes Island 2005

Rapid Shoreline Inventory

Data Maps

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Map Table of Contents

Appendix B,

Guemes Island 2005

Rapid Shoreline Inventory

Species Lists

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Appendix C,

Rapid Shoreline Inventory Protocol

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Appendix D,

Rapid Shoreline Inventory Data Form

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Appendix E,

Guemes Island Bays Blueprint Map Book

2005

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