# Strategic Salmon Recovery Planning in San Juan County Washington:
# The Pulling It All Together (PIAT) Project

**Report to the San Juan County Lead Entity for Salmon Recovery**

**and the Washington State Salmon Recovery Funding Board**

**RCO #10-1789**

**December 2012**

**Final**

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## Acknowledgements

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**Introduction**

Over the last few years, salmon recovery efforts in San Juan County (Water Resources Inventory Area 2) have concentrated on performing assessments necessary to fill critical data gaps. These assessments successfully documented many habitats critical for salmon recovery and provided a better understanding of how, when and where salmon are utilizing San Juan County's shorelines, fresh and marine waters.

With several completed assessments of various individual elements of the nearshore ecosystem, including mapping of habitat, shoreline modifications, geomorphology and fish utilization, WRIA 2 required an integrated analysis in order for the data to be analyzed and to cohesively support salmon recovery planning efforts within San Juan County. The goal of the Pulling It All Together project (PIAT) was to bring these various assessments and data sets together to create a tool for prioritizing protection and restoration actions for San Juan County (SJC).

The original objective of this project was to apply all of the science now available to identify and prioritize the best opportunities for protection and restoration of WRIA2's freshwater and nearshore areas. After review of existing available countywide datasets for freshwater habitats, species and stressors, it was determined to move forward with a strategic planning process for salmon recovery actions only for the marine nearshore environments of the county. More detailed information on freshwater systems is due to be completed within the next year but was not available in time for this analysis.

A project team of Friends of the San Juans, Coastal Geologic Services, Anchor QEA and Confluence Environmental were selected by the San Juan County Salmon Recovery Lead Entity organization to complete the PIAT assessment with funding support provided by the Washington State Salmon Recovery Funding Board. Project match was provided by ESRI as well as individual project partners and technical advisors. In addition to the project team, an interdisciplinary technical team of local and regional salmon recovery and nearshore experts, practitioners and data providers was convened, primarily to guide the conceptual approach and framework of the strategic planning process. Project participants and their affiliations and areas of expertise are provided in Appendix A. Project Teams.

The development of a restoration and protection plan creates a common understanding of priority areas and the necessary actions/efforts that are critical for the recovery of salmon. PIAT project results provide a framework for prioritizing and sequencing restoration and protection actions to support the Puget Sound Chinook salmon recovery plan and marine ecosystem recovery in WRIA2. Results will be incorporated into updates to the local salmon recovery work plan and inform the ongoing adaptive management process underway with the Puget Sound Regional Recovery Implementation Technical Team (RITT).

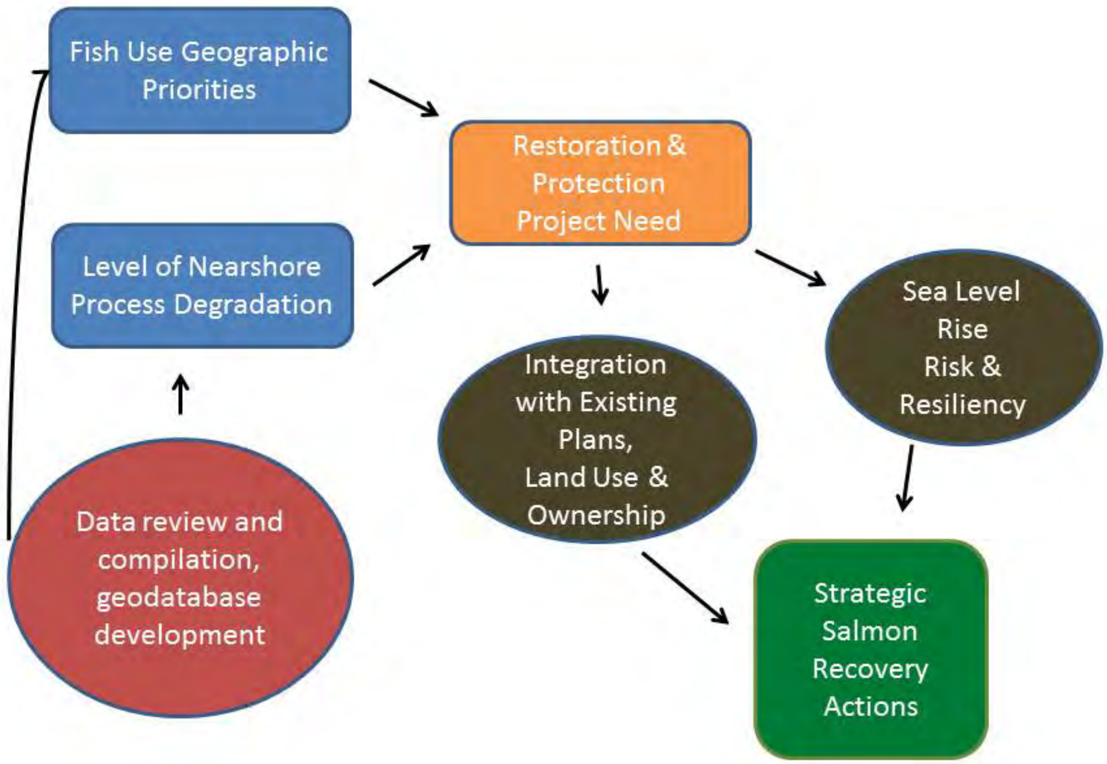
## Overview of Project Approach and Data Sources

### Conceptual Approach

The Pulling It All Together (PIAT) salmon recovery strategic planning project adopted key ecological attributes and indicators for estuarine and marine habitats from work completed by the Puget Sound Chinook Salmon Regional Implementation Technical Team (RITT). Spatial data on shoreforms and stressors as well as conceptual and analytical frameworks from the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) were also adapted and applied. Primary hypotheses of the San Juan County and nearshore marine chapters of the Puget Sound Chinook salmon recovery plan were adopted as top priorities for this strategic planning process, including prioritization of out-migrating juvenile Chinook and forage fish.

Under guidance of the San Juan County salmon recovery coordinator, the SJC Salmon Technical Advisory Group (SJC TAG) and a broader technical team formed specifically to support early stages of the project (Appendix A), the project team developed an approach based on improved understanding of wild Chinook salmon, forage fish, and geomorphic mapping countywide and at the shoreform unit scale. The overall approach included a shoreform and landscape scale evaluation of fish use, a shoreform scale analysis of degradation of key nearshore processes, and a sea level rise screening tool was developed to assess the relative resilience of priority habitats, which was integrated into the final list of priority actions. Existing, parcel-scale information, including land use and shoreline master program designations, restoration and protection priorities from completed plans and reports, and ownership, were also integrated with project results as the final steps of fine scale analysis. As the majority of work completed by the PIAT project was at the shoreform scale, integration of existing parcel-scale results also supported inclusion of site specific factors such as ecological communities. See Figure 1. PIAT Project Road Map.

Figure 1. PIAT Project Road Map.



Project Geodatabase

Project assessment was conducted using ARC 10 Geographic Information Systems. The primary unit of analysis in the PIAT project analysis was the geomorphic shoreform. The project started out using a sub-set of the Puget Sound Nearshore Ecosystem Recovery Project (PSNERP) geodatabase for San Juan County. The project database was clipped from the north sound geodatabase using the county boundary as a clip feature. All PSNERP feature data layers and feature datasets were retained in the clipping process.

Multiple changes were made to the underlying database, including changing from PSNERP geographic scale units (GSUs) to geomorphic shoreforms as the basic analytical unit and updating the geomorphic shoreform layer to accurately reflect results of finer scale data sets such as the drift cell (CGS 2010) and pocket beach (CGS 2011) mapping efforts. Updating of the shoreform layer was conducted by James Slocomb, using rules developed by CGS, and was initially qa/qc'ed by Slocomb using aerial photos and later reviewed by both FSJ and CGS project staff. Additionally the feature data layers from multiple additional spatially explicit nearshore data sets were added as feature layers in a local feature dataset within the clipped PSNERP geodatabase, including forage fish spawning habitat and shoreline modification inventory project results. A separate but similar shoreform based geodatabase was provided by the nearshore fish utilization (Beamer and Fresh 2012) project that contained all the data regarding utilization of the shoreline by juvenile salmonids and forage fish. Late in the project spatial joins were performed between the two databases as part of the prioritization analysis. A list of the existing data sets reviewed and applied to various elements of this strategic planning process is described in Table 1. Existing and Newly Developed Spatial Data Applied to Project.

Table 1. Existing and New San Juan County-wide Data Applied to PIAT Project

| Name | Source (Date) |
|---|---|
| Geomorphic shoreform mapping for San Juan County | Coastal Geologic Services (2010) |
| Modification Inventory Restoration Opportunities Report | Friends of the San Juans (FSJ 2011) |
| Shoreline Modification Inventory for San Juan County | FSJ (2010) |
| Eelgrass (outer line) Mapping for San Juan County | FSJ, Dept. of Natural Resources (DNR) and University of WA (UW) (2004) |
| Puget Sound Change Analysis Geodatabase | PSNERP (2009) |
| Bull kelp classification | FSJ, DNR and UW (2007) |
| Forage fish spawning habitat | Washington Department of Fish and Wildlife (WDFW) and FSJ (2004) |
| Nearshore fish utilization | Beamer and Fresh (2012) |
| Herring spawning grounds | WDFW, priority habitats and species |
| Geomorphic shoreform | PSNERP (2009) based on Shipman 2008 typology |
| Geomorphic shoreform | RITT adaption of Shipman typology (2012) |
| Parcel link | SJC GIS Library |
| Land Use Designation | SJC GIS Library |
| Shoreline Master program designation (current) | SJC GIS Library (2011) |
| LiDAR DEM | SJC Public Works (2009) |
| SJC Structure Layer | SJC Public Works (2012) |
| Stream Typing | Wild Fish Conservancy (2010) |
| Streams | SJC GIS Library |
| Salmon Habitat Protection Blueprint | FSJ, San Juan Preservation Trust and SJC Land Bank (2008) |
| Tide Data | NOAA |
| Washington State ShoreZone Inventory | DNR (2001) |
| High resolution Infrared vertical aerial photographs | DNR (2004), FSJ and DNR (2006) |
| High resolution oblique aerial photographs | WA Department of Ecology (2002) |
| High resolution vertical aerial photographs | WA Department of Ecology (2008) |
| New- Marine Riparian Inventory- cover type and overhanging vegetation | FSJ PIAT Project (2012) |
| New- Pocket Beach Mapping | CGS PIAT Project (2011) |
| New- Sea Level Rise Inundation Maps | CGS PIAT Project (2012) |
| New- Geomorphic shoreforms | FSJ PIAT Project (2012) |

New Data

The PIAT project included the development of new countywide data sets, including an inventory of marine riparian vegetation (vegetation cover type and overhanging), pocket beach mapping, sea level rise (SLR) inundation maps, and an updated geomorphic shoreform map for San Juan County.

*Marine Riparian:* Riparian vegetation provides important habitat and process functions to freshwater and marine systems, including microclimate, structure, fish prey production, water quality, wildlife habitat, nutrient input, shade and large woody debris (Brennan et al 2007). Recent local and regional research on juvenile salmon diets have identified insects from terrestrial sources as an important component (Brennan et al 2007, Barsh personal communication 2010) and also highlighted the role riparian vegetation plays in supporting prey items for juvenile salmon (Sobosinski et al 2010, Rice 2006). Riparian vegetation was the one remaining *Valued Ecosystem Component* (Leschine and Peterson 2007) that was not supported by an existing county-wide data set, limiting application of PSNERP strategic approaches to the finer scale county-wide analysis proposed within the project's request for proposal. Thus before fine scale analysis began, project partners completed an inventory of marine riparian vegetation (vegetation cover type and overhanging). For a detailed description of methods, results and maps, see Appendix B. Marine Riparian Inventory.

*Pocket Beaches:* Natural pocket beaches, found only along bedrock shores, are common in San Juan County. Recent nearshore fish utilization research in San Juan County found that the presence probability for many juvenile fish species, including Chinook, was higher for pocket beaches than other geomorphic shoreforms. Review of existing shoreform classification maps indicated that many apparent of pocket beaches were mapped as rocky shores, due to the coarse nature of previous mapping efforts outside of drift cell systems. Shorelines outside of littoral drift cells were historically mapped as having No Appreciable Drift (NAD), which has been interpreted by many people as being exclusively bedrock shores. However, many small pocket beaches exist in these areas. To assure that this mapping effort was accurately capturing the extent of pocket beaches and their associated valuable habitats, partners expanded the scope to include mapping of pocket beaches. Coastal Geologic Services mapped all pocket beaches with a greater than 50 foot DNR high water shoreline beach (non-bedrock) and contained within bedrock headlands. For a detailed description of methods and results, see Appendix C. Pocket Beach Mapping.

*Sea Level Rise Risk and Resiliency Assessment:* Relative risk and resilience to valuable nearshore habitats in San Juan County from implications of climate change and sea level rise was assessed. Risk and resilience were assessed using a suite of indicators to identify which habitats will be strained due to systemic and site-specific shoreline alterations, largely resulting from shoreline development. Inundation maps were developed for the entire county using a LiDAR (light detection and ranging) remote sensing data-based GIS analysis and low and very high sea level rise projections as defined in the San Juan County Critical Areas Ordinance Best Available Science Document.

One of the goals of the PIAT project was to identify projects that are viable in the long-term, as well as projects that have the potential to reduce risk and habitat loss, while decreasing risk (see sea level rise screening tool section near the end of this report). Results can also be used to identify the greatest sources of risk that could be mitigated to prevent potential habitat loss, and inform resource and property managers of the spatial extent of the potential imapct of climate change and sea level rise in San Juan County to both habitat and infrastructure. Results also highlight the necessity to protect the most pristine, resilient habitats from future impacts, such as armoring. Detailed method and results of the risk and resiliency assessment for priority nearshore habitats is provided in Appendix D. Sea Level Rise and Risk and Resiliency Assessment.

Individual project reports, map books and geodatabases are associated with each new data product developed for the project (see Appendices B. Marine Riparian Inventory, C. Pocket Beach Mapping and D. Sea Level Rise Risk and Resiliency Assessment). In addition, each primary project element and its associated resultant data layers exist within the project's ARC GIS geodatabase.

Existing and new data sets were then applied to the following primary project analyses at the shoreform scale:

- Identification of priority areas based on unmarked juvenile Chinook presence probability, rearing forage fish presence probability and forage fish spawning habitat at the shoreform and landscape region scale.
- Stressor (i.e. shoreline modifications) distribution and extent.
- A degradation analysis for seven nearshore ecosystem processes, based on the presence of physical stressors.
- Risk and resiliency climate change and sea level rise assessment for priority fish use shoreforms.
- Identification of restoration and protection priority shoreforms based on fish use and level of intactness.
- Integration of restoration and protection priority results with existing salmon recovery priority sites, comprehensive plan shoreline and land use designations, and ownership.
- Application of a sea level rise screening tool to restoration and protection priorities (to identify areas of high resilience to target for protection and restoration actions and locations where enhancement action can increase resilience to effects of climate change and sea level rise).

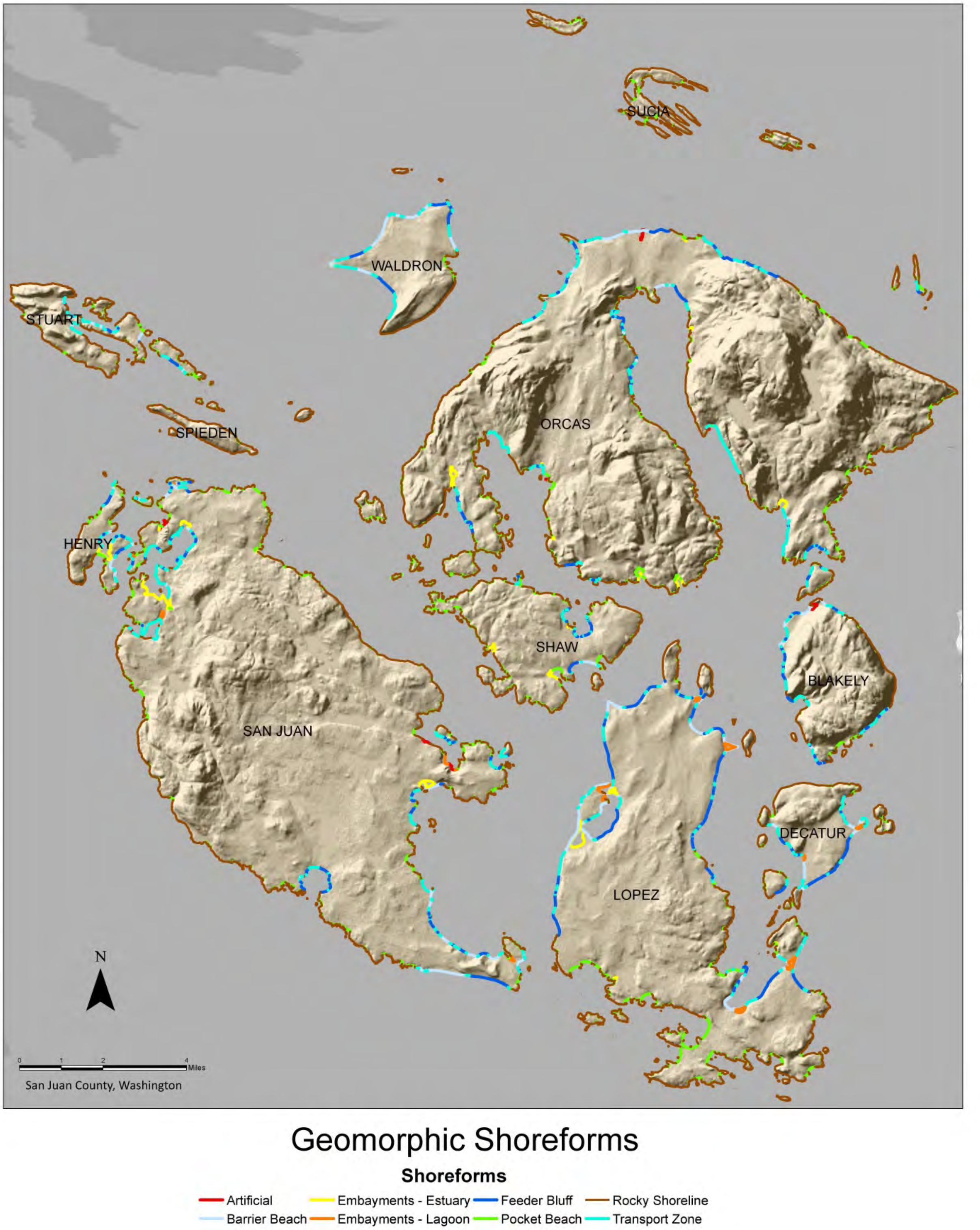
**Updated Geomorphic Shoreform Map**

Multiple classification systems exist to describe marine shorelines. Shoreforms are often grouped by the dominant processes occurring within them, that most influence their character and configuration. For this project, the Shipman (2008) typology used by the Puget Sound Nearshore Ecosystem Restoration Project's (PSNERP) change analysis was adapted, with finer scale data for drift cells and pocket beaches from Coastal Geologic Services and embayment designations from the Regional Implementation Technical Team (RITT) applied. This mix of coarse and high resolution data was used to provide county-wide coverage that would most accurately link with habitat data and coastal processes. The final shoreform classification used was also consistent with Adaptive Management Guidance documents developed for marine shorelines and San Juan County by the RITT (RITT 2012).

Table 2. Geomorphic Shoreforms of San Juan County.

| Shoreform | Count | % SJC Count | Length in Miles | % SJC Shore Length |
|---|---|---|---|---|
| Artificial | 11 | <1% | 2.6 | <1% |
| Barrier Beach | 185 | 5% | 25 | 6% |
| Transport Zone | 404 | 13% | 34 | 8% |
| Feeder Bluff | 432 | 13% | 30 | 7% |
| Embayment-estuary | 38 | 1% | 12 | 3% |
| Embayment-lagoon | 16 | <1% | 5 | 1% |
| Pocket Beach | 945 | 29% | 48 | 12% |
| Rocky Shores | 1,185 | 37% | 250 | 61% |
| sum | 3,216 | 100% | 408 miles | 100% |

Figure 2. Geomorphic Shoreforms of San Juan County.



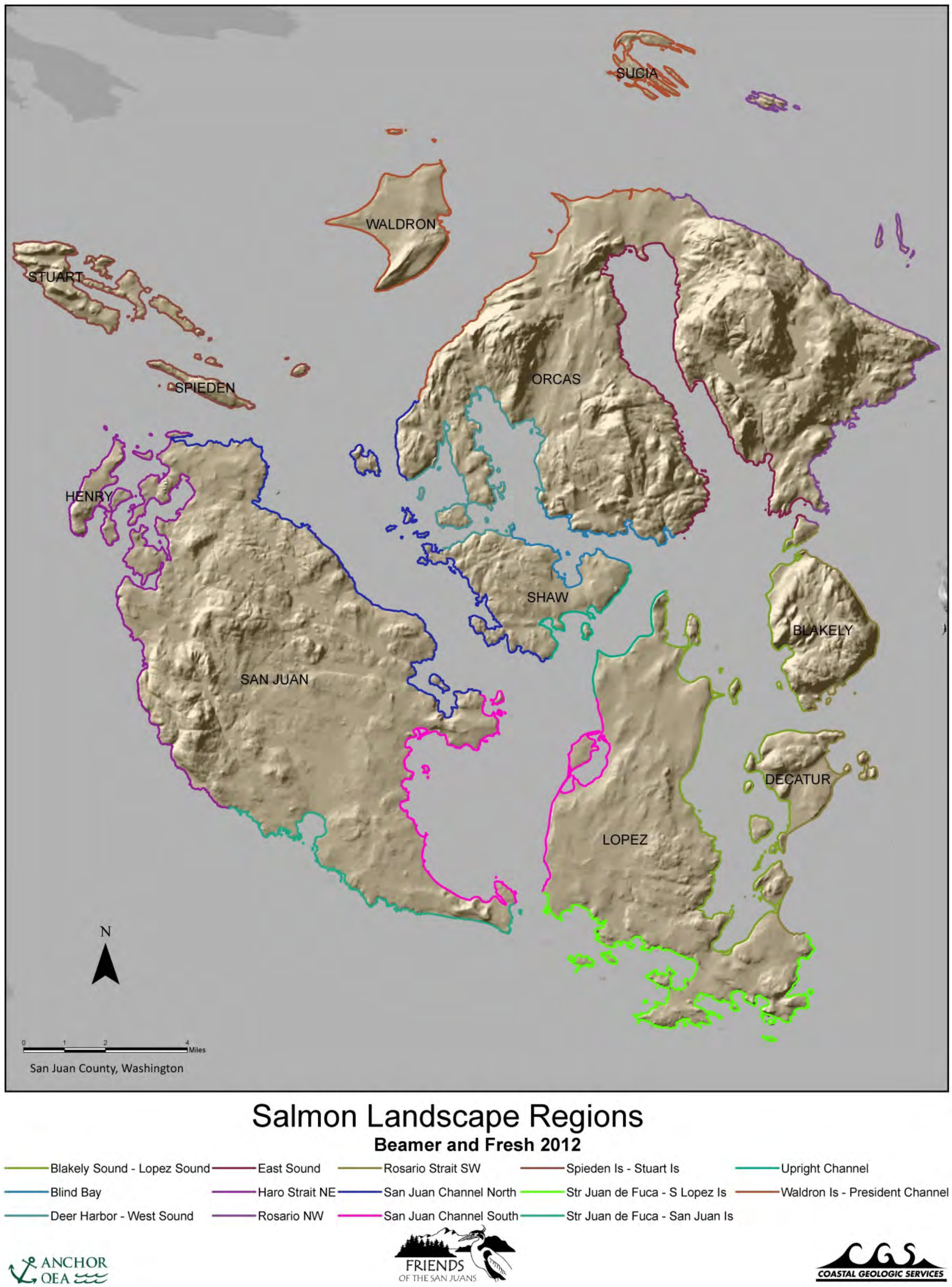
**Priority Areas Based on Fish Use**

A primary project task was to identify priority geographic areas within San Juan County for salmon recovery actions. The current recovery plan chapter identifies types of projects and emphasizes habitat protection for juvenile Chinook salmon and forage fish, but lacked the spatially explicit information to provide any guidance on specific regions or habitat types to focus efforts. Based on the priorities in the San Juan County chapter of the Puget Sound Chinook Salmon Recovery Plan (Shared Strategy 2009), available countywide data sets, and input from the project's technical teams, this project used a combination of fish presence data for out-migrating wild Chinook salmon, rearing forage fish and forage fish spawning habitat. It should be noted that different areas would likely result from a prioritization based on presence probability of hatchery (marked) salmon. While this analysis was not completed, the framework exists to include it at a later date, if desired. Priorities were identified at the geomorphic shoreform and landscape region scale. Shoreform specific data of Chinook salmon and forage fish habitat utilization was applied from Beamer and Fresh (2012) and WDFW/FSJ (2004). These data were joined to the final shoreform layer developed for this project which included the following shoreforms:

- artificial,
- barrier beaches,
- embayment estuaries,
- embayment lagoons,
- feeder bluffs,
- transport zones,
- pocket beaches and
- rocky shores.

Landscape regions applied were developed by the countywide nearshore fish utilization project (Beamer and Fresh 2012), and are based on conceptual migratory pathways for juvenile Pacific salmon throughout the San Juan Archipelago. The fourteen of the 16 regions identified by Beamer and Fresh (2012) that were located within San Juan County's boundaries were applied to the prioritization process (see Figure 3. Salmon Landscape Regions, below).

Figure 3. Salmon Landscape Regions.



Fish Use Priority Criteria

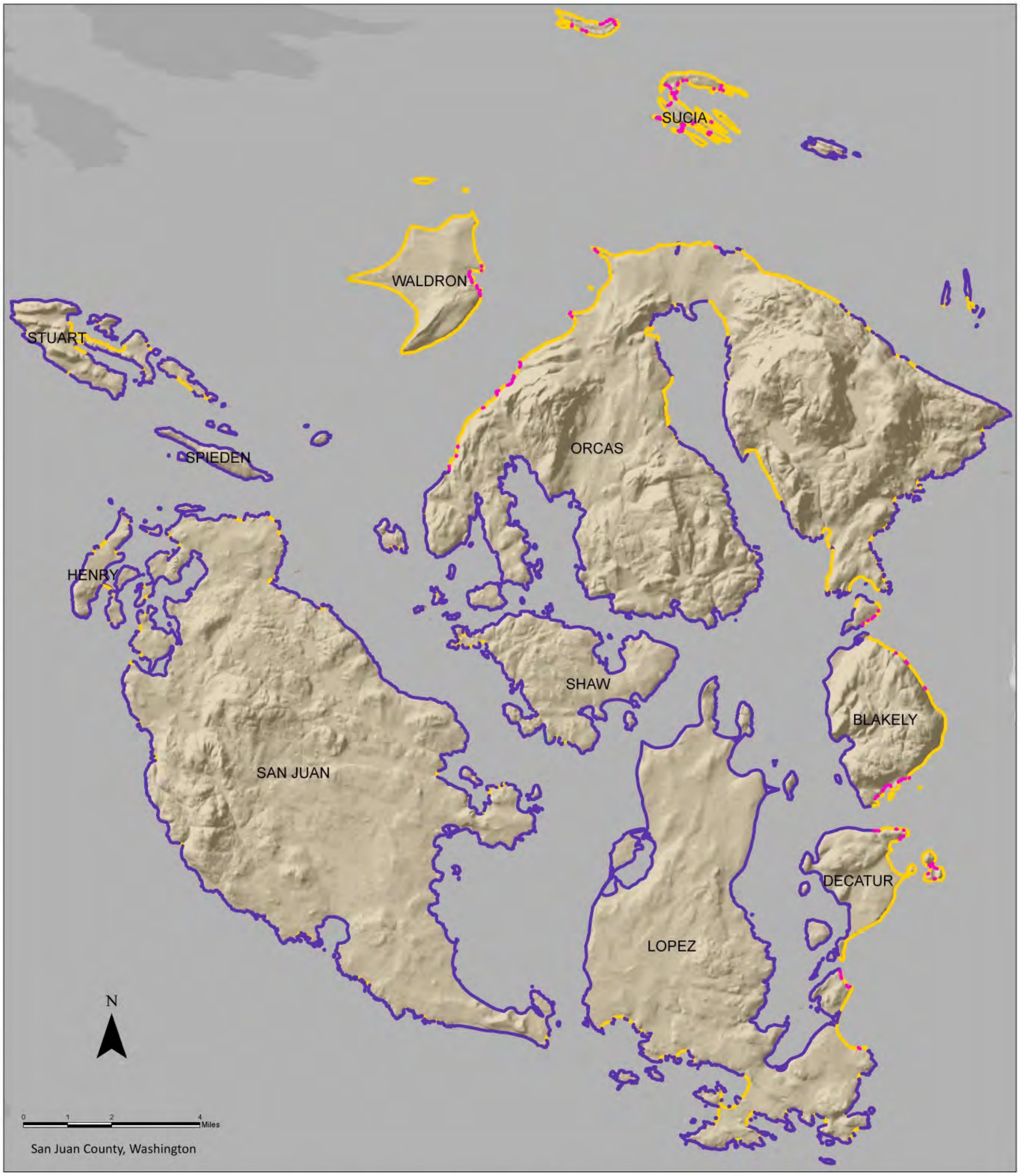
*Juvenile Chinook Salmon Presence Probability*: For two years, from March through September, the nearshore fish utilization project completed twice-monthly beach seines at 81 sites across San Juan County (Beamer and Fresh 2012). Pacific salmon were documented in all shoreform types, and all landscape regions of the county, underscoring the significance of all of the county's marine shorelines as migratory habitat for juvenile salmonids. However, presence probability was found to be correlated with landscape region and geomorphic shoreform (Beamer and Fresh 2012). Juvenile salmon data for unmarked Chinook were applied to this analysis, as the best representation of wild Chinook populations.

Pocket beaches proved to be particularly significant for wild juvenile Chinook (Beamer and Fresh 2012), as were exterior regions on the northeastern, east and southeastern portions of the county. Abundance was also found to be positively correlated with presence probability. Beamer and Fresh (2012) presence probability results for wild (unmarked) juvenile Chinook were classified into high, medium and low presence probabilities, based on natural breaks, and used in the identification and ranking of fish use priority shoreforms. See Figure 4. Unmarked (wild) Juvenile Chinook Salmon Presence Probability Map.

*Rearing Forage Fish Presence Probability*: Similar to the Chinook presence probability data described above, presence probability models were developed for forage fish species including Pacific herring, Pacific sand lance and surf smelt (Beamer and Fresh 2012). Results also correlated with abundance, shoreform and region. Beamer and Fresh (2012) presence probability results for herring, sand lance and smelt were classified in the PIAT assessment into one combined rearing forage fish presence probability high, medium and low natural breaks classification and used in the identification and ranking of fish use priority shoreforms. See Figure 5. Rearing Forage Fish Presence Probability Map.

*Forage Fish Beach Spawning Habitat*: Forage fish spawning habitat was classified into three categories for use in the identification and ranking of fish use priority shoreforms, including high, for documented forage fish spawning sites; medium, for suitable spawning habitat; and low for unsuitable spawning habitat (rocky shores). Data sources for the forage fish spawning habitat ranking include Washington Department of Fish and Wildlife priority habitats and species maps, Friends of the San Juans forage fish spawning habitat assessment results and the updated shoreforms final geomorphic shoreform spatial database. See Figure 6. Forage Fish Beach Spawning Habitat.

Figure 4. Unmarked (wild) Juvenile Chinook Salmon Presence Probability.




Rearing Juvenile Chinook

**Presence Probability (Beamer & Fresh 2012)**

HIGH MEDIUM LOW

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Figure 5. Rearing Forage Fish Presence Probability.

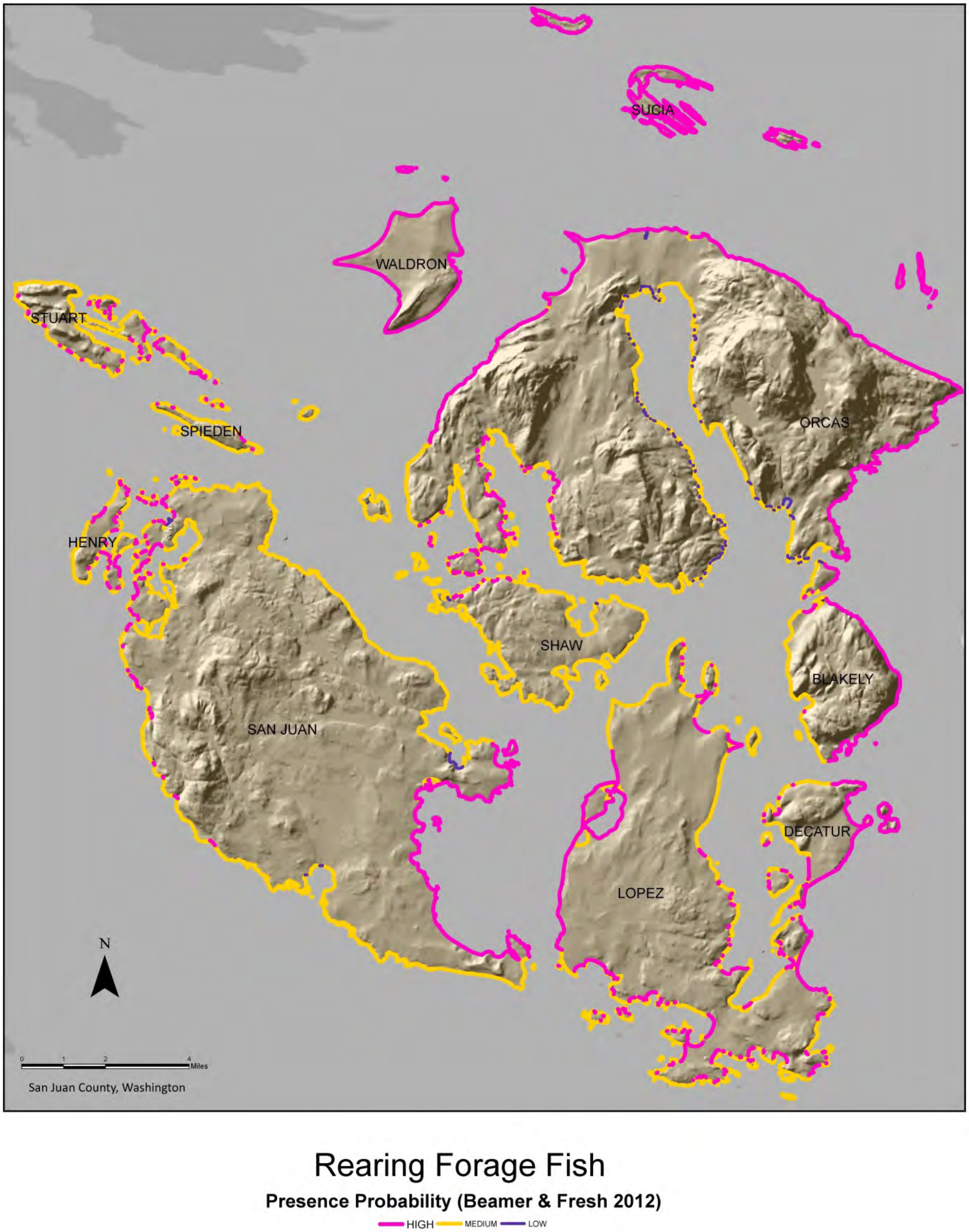
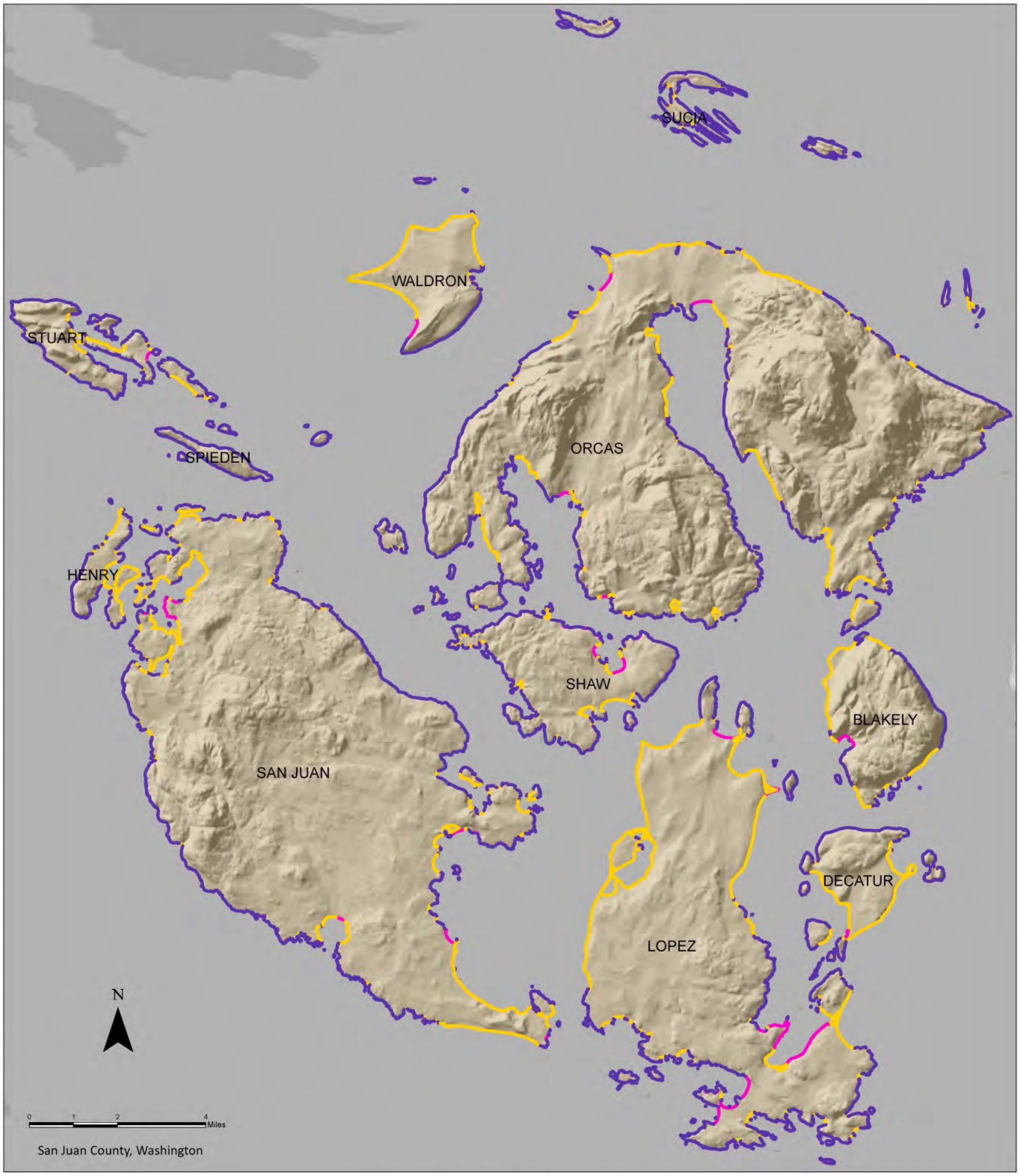


Figure 6. Beach Spawning Forage Fish Habitat.




# Beach-Spawning Forage Fish Habitat

**(Washington Department of Fish & Wildlife and Friends of the San Juans 2004)**

HIGH — MEDIUM — LOW

Geographic ‘fish use’ priorities were developed at multiple scales, including geomorphic shoreform and landscape region. Consistent with the San Juan County Chapter of the Puget Sound Chinook Salmon Recovery Plan, the prioritization focused on juvenile Chinook and forage fish factors, including the presence probability of wild (unmarked) juvenile Chinook from the Beamer and Fresh nearshore fish utilization study (2012); presence probability of forage fish, based on aggregated presence probability data for Pacific herring, surf smelt and Pacific sand lance (Beamer and Fresh 2012); and beach-spawning forage fish habitat (WDFW and FSJ 2004). Each of these criteria was assigned a high, medium or low ranking representing three natural breaks for the presence probability data, and known (high), potential (medium) and unsuitable (low) forage fish spawning habitat. Ranking metrics are described in Table 3, below.

Table 3. Priority Fish Use Shoreforms- ranking criteria.

| Ranking | Wild juvenile Chinook presence probability | Rearing forage fish presence probability | Forage fish spawning habitat |
|---|---|---|---|
| Highest | H | H | H |
| Highest | H | M | H |
| Highest | H | H | M |
| Highest | M | H | H |
| High | H | M | M |
| High | M | H | M |
| High | M | M | H |
| High | M | M | M |
| High | H | L | H |
| High | H | H | L |
| High | L | H | H |

<u>Priority Fish Use Shoreforms</u>

Highest priority salmon recovery shoreforms based on the fish use prioritization - 103 shoreforms and 8 miles, including:

- 98 pocket beaches (7 miles),
- 3 transport zones,
- 1 barrier beach and
- 1 feeder bluff.

High priority salmon recovery shoreforms based on the fish use prioritization - 777 shoreforms and 59 miles, including:

- 503 pocket beaches (27 miles),
- 116 transport zones (14 miles),
- 99 feeder bluffs (9 miles),
- 53 barrier beaches (8 miles),
- 1 embayment lagoon (.35 mile) and
- 5 rocky (0.6 miles).

See Figure 7. Priority Fish Use Shoreforms and Map Book 1. Priority Fish Use Areas.  Priority fish use shoreforms and regions were used in subsequent analyses completed as part of this assessment including protection and restoration prioritizations, sea level rise risk and resiliency, and land use designation.

Figure 7. Priority Fish Use Shoreforms.

Priority Fish Use Landscape Scale Regions

To incorporate connectivity into the fish use geographic area identification, prioritization was also conducted at the landscape region scale. As described by the RITT, connectivity in the context of Puget Sound Chinook salmon recovery is necessary for the dispersal and migration of salmon and salmon prey, as well as the development and expression of diverse salmonid life histories (RITT 2012). Connectivity is defined as the availability of or access to habitats which are required by each Chinook life stage (RITT). Landscape regions from the Beamer and Fresh fish utilization study (2012) were classified as highest, high and moderate salmon recovery fish use regions based on the presence and distribution of highest and high priority shoreforms (Figure 8. Priority Fish Use Regions.). See also Map Book 1. Priority Fish Use Areas for detailed maps. It should be noted geographic prioritization is a tool to focus recovery efforts, identify projects that address multiple needs (e.g. nearshore processes) and, if possible, would be implemented first. It does not mean that “good” projects will not exist outside of these regions. For example, many projects specifically targeting forage fish spawning habitat restoration or protection are likely to be located outside of the top priority regions and shoreforms, as that is where the majority of the documented spawning habitat in the county exists.

*Highest Priority* - Four landscape regions were identified as highest priority based on fish use factors, including Waldron Island-President’s Channel, Haro Strait NE, Rosario Strait SW and Strait of Juan de Fuca/South Lopez Island, totaling 143 miles, or 35% of the county’s marine shorelines. See Figure 8. Priority Fish Use Regions.

*High Priority* - Five landscape regions were identified as high priority based on fish use factors, including East Sound, Rosario Strait NW, San Juan Channel North, Spieden Island/Stuart Island and Strait of Juan de Fuca/San Juan Island, totaling 143.5 miles, or 35% of the county’s marine shorelines. See Figure 8. Priority Fish Use Regions.

*Moderate Priority* - Five landscape regions were identified as moderate priority based on fish use factors, including Blind Bay/Harney Channel, Deer Harbor/West Sound, Upright Channel, Blakely Sound/Lopez Sound and San Juan Channel South, totaling 122 shoreline miles, 30 % of the county’s marine shorelines. See Figure 8. Priority Fish Use Regions.

Table 4. Priority Fish Use Regions – shoreform distribution.

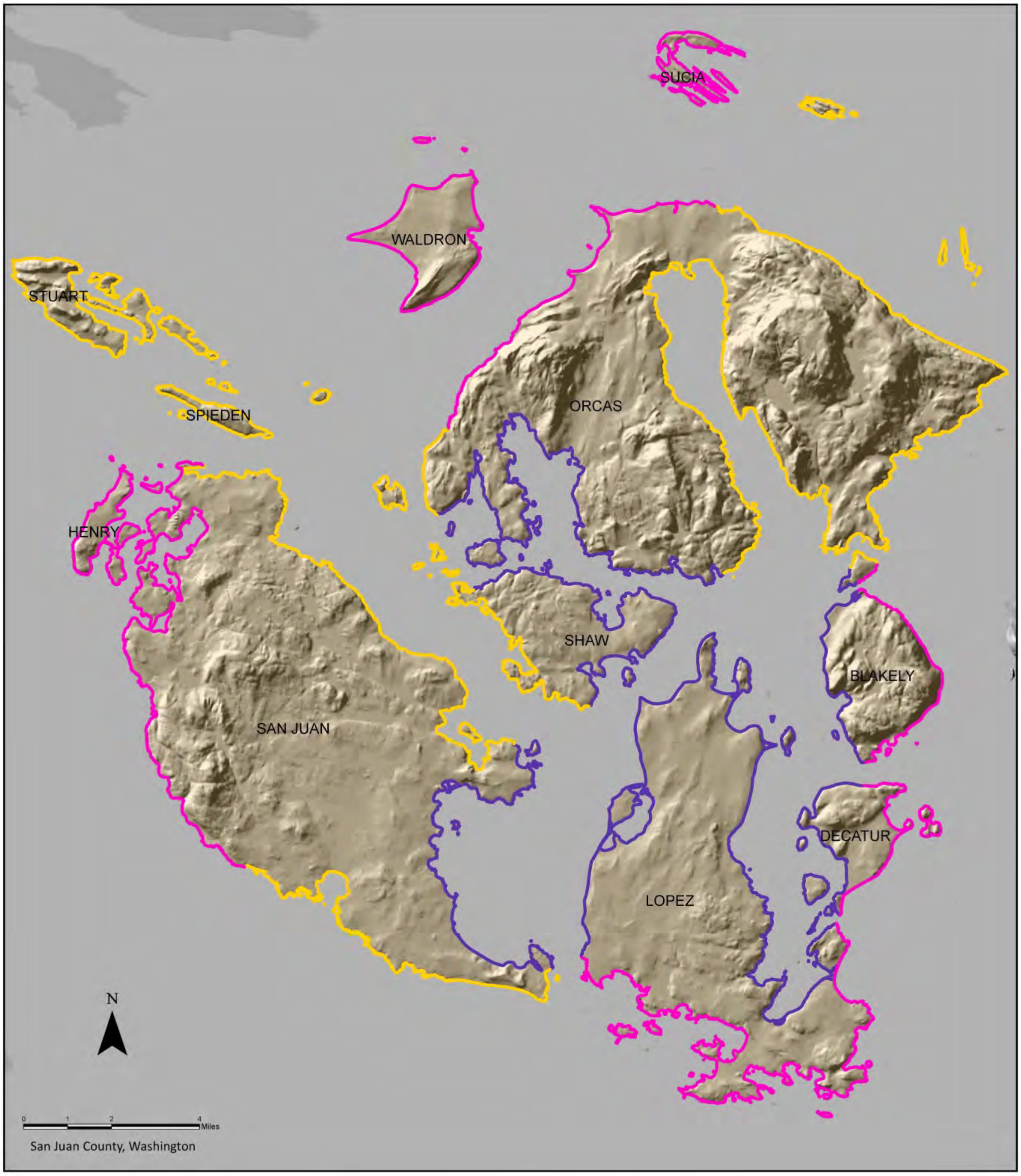
| Shoreform | Highest Priority | | High Priority | | Moderate Priority | |
|---|---|---|---|---|---|---|
| | *count* | *Length (miles)* | *count* | *Length (miles)* | *count* | *Length (miles)* |
| Artificial | 4 | 1.1 | 3 | 0.7 | 4 | 0.8 |
| Barrier Beach | 65 | 8.6 | 41 | 3.6 | 79 | 13 |
| Transport Zone | 136 | 12.6 | 97 | 9.7 | 171 | 12 |
| Feeder Bluff | 103 | 7.9 | 89 | 5.8 | 240 | 16 |
| Embay-estuary | 7 | 3.6 | 6 | 1.5 | 25 | 6.7 |
| Embay-lagoon | 3 | 1.0 | 3 | 0.5 | 10 | 4 |
| Pocket Beach | 260 | 17 | 418 | 20 | 267 | 11 |
| Rocky | 353 | 89 | 497 | 100 | 335 | 60 |
| sum | 931 | 142 | 1154 | 142 | 1131 | 125 |
| | 29% SJC shoreforms | 35% shore miles | 36% SJC shoreforms | 35% shore miles | 35% SJC shoreforms | 30% shore miles |

Table 5. Priority Fish Use Landscape Scale Regions- distribution.

| Landscape Region* | Highest Priority | High Priority | Moderate Priority |
|---|---|---|---|
| | *miles* | *miles* | *miles* |
| Haro Strait NE | 41 | | |
| Rosario Strait SW | 19 | | |
| Strait of Juan de Fuca/S. Lopez | 35 | | |
| Waldron Island/President's channel | 48 | | |
| Eastsound | | 25 | |
| Rosario NW | | 27 | |
| San Juan Channel North | | 40 | |
| Spieden Island/Stuart Island | | 35.5 | |
| Strait of Juan de Fuca/San Juan Island | | 16 | |
| Deer Harbor/West Sound | | | 25 |
| San Juan Channel South | | | 30 |
| Upright Channel | | | 11 |
| Blakely Sound/Lopez Sound | | | 43 |
| Blind Bay/Harney Channel | | | 13 |
| totals | 143 (35%) | 143.5 (35%) | 122 (30%) |

*Landscape regions from Beamer and Fresh (2012) See Figure 3. Salmon Landscape Regions.

Figure 8. Priority Fish Use Regions.




Priority Fish Use Regions

**Landscape Regions (Beamer & Fresh 2012)**

HIGHEST HIGH MODERATE

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**Nearshore Process Degradation**

Once the spatial priorities were identified based on the likelihood of fish use, this PIAT assessment focused on a characterization of the relative need for restoration. To do so, the distribution and understood impacts of several types of shoreline modifiers (i.e., stressors) were analyzed.

Conceptual Framework

The process degradation analysis conducted for this project integrates Puget Sound Recovery Implementation Technical Team (RITT) guidance on nearshore processes and key ecological attributes and is consistent with the PSNERP approach to addressing strategic needs in Puget Sound (Schlenger et al 2011). Key ecological attributes (KEA's) are defined by the RITT (2012) as: "*the characteristics of an ecosystem component that, if present, would support a viable component but, if missing or altered, would lead to loss or degradation of the component over time. KEAs can be used to assess the status of a component, develop protection and restoration objectives for conservation, and focus monitoring and adaptive management programs. For the purposes of this framework, KEAs are "characteristics necessary for salmon recovery."* The nearshore process degradation analysis adapted the RITT's nearshore framework to San Juan County's unique environment and the quality and applicability of available countywide datasets.

Shoreline Stressors

Stressor selection was based on guidance from RITT/PSP adaptive management documents for San Juan County, the PSNERP Strategic Needs Assessment and the availability and quality of existing countywide data. The majority of stressor data was linear in nature, with some aerial data, such as that for overwater structures and impervious surface. Stressors included in the final degradation analysis included:

- shoreline armoring,
- roads,
- tidal barriers,
- groins,
- boat ramps,
- marinas,
- overwater structures,
- breakwaters/jetties and
- impervious surface.

Primary data sources for the applied stressor data were the PSNERP Strategic Needs Assessment (impervious surface, overwater structures, tidal barriers) and the San Juan County Inventory of Shoreline Modification (Friends of the San Juans 2010). Stressors that were considered but not included in the final analysis due to data availability or quality included outfalls, tide gates, dams, nearshore fill, water quality, and freshwater withdrawals (ground or surface).

In general, San Juan County's shorelines are characterized by moderate to high numbers of relatively small stressors. While geographic distribution of stressors is widespread, stressors are concentrated within more highly developed regions of the county and within certain geomorphic shoreforms. Disregarding artificial shorelines, embayment lagoons, embayment estuaries, feeder bluffs and barrier beaches are most degraded shoreforms. Rocky shorelines have the fewest stressors, by count and length. The most common stressors along San Juan County's marine shorelines include armoring, roads, overwater structures and marinas. Armoring is the dominant stressor type by count, with 900 shoreforms with armored sections of shoreline and just over 20 marine shoreline miles. Roads are the stressor with the largest linear extent, with 22 miles and 200 shoreforms. Nearly 500 overwater structures (excluding marinas) are located along San Juan County shorelines, representing 72 acres of areal coverage of inter and subtidal habitats. While fewer in number (approximately 50), marinas (including community docks) are located along nearly five miles of linear extent of marine shoreline.

Stressors by shoreform were calculated using linear extent of each stressor type within each unique geomorphic shoreform in the county. Overlapping stressors were counted only once for the areas of overlap, so for each unique geomorphic shoreform in the county the percentage of the total length impacted by one or more of the included stressors is provided. A 10% length for transport zones means that county-wide, 10% of the total linear extent of transport zone shoreforms have a stressor along them, while the range varies within individual transport zones. Information was also compiled by stressor count; a 50% count for barrier beaches means that half of the total barrier beach shoreforms within San Juan County have one or more stressors present. For most stressors, data was available on the linear extent of each individual stressor. For boat ramps and groins a set width was assigned to each modification type, 16 feet for ramps and 9 feet for groins, based on an average width generated from visual survey of the ramps and groins. For docks, only the length of the part of the dock located along the shoreline was counted; overwater structure area was calculated for the solar radiation nearshore process.

Table 6. San Juan County Stressors by Shoreform.

| *Shoreform* | *% Stressor by Count* | *% Stressor by Length* |
|---|---|---|
| Artificial | 100% | 100% |
| Barrier beach | 41% | 24% |
| Transport zone | 38% | 10% |
| Feeder bluff | 48% | 31% |
| Embayment estuary | 47% | 25% |
| Embayment lagoon | 88% | 36% |
| Pocket beach | 26% | 17% |
| Rocky | 23% | <1% |

Understanding of stressor distribution and extent can inform identification of specific kinds of project actions, in specific shoreforms, that might be prioritized as part of salmon recovery actions in San Juan County. Stressor data was also applied to a countywide degradation analysis for key nearshore marine ecosystem processes, which are described in more detail below.

Degradation Assessment Methods

For each unique shoreline segment, or geomorphic shoreform, the degradation of individual nearshore ecosystem processes relevant in that shoreform was assessed based on the distribution of physical stressors. Seven nearshore processes were evaluated in the degradation analysis, including:

- coastal sediment dynamics,
- wind and waves,
- tidal hydrology,
- freshwater hydrology,
- tide channel formation and maintenance,
- detritus potential and
- solar radiation.

The degradation assessment metrics for each nearshore process are explained in detail below. Stressors applied in at least one of the nearshore process degradation analysis included:

- shoreline armoring,
- nearshore fill,
- tidal barriers,
- breakwaters and jetties,
- shoreline roads,
- marina,
- overwater structures,
- groins,
- boat ramps,
- impervious surface and
- reductions in marine riparian vegetation.

Assessment of each nearshore process was limited to the shoreforms in which that process predominantly occurs; for example, coastal sediment dynamics primarily occurs along feeder bluffs in contrast to bedrock shores. For details of the nearshore marine ecosystem processes and their relevant shoreforms and stressors, see Appendix E. Process Degradation Matrix.

In the absence of large river systems the distributary channel formation and maintenance KEA's were applied to tidal channels only, and freshwater hydrology was evaluated with a watershed scale impervious surface measure, instead of a looking at both fluvial sediment dynamics and freshwater hydrology. In addition, habitat connectivity was addressed, but through the geographic (fish use) prioritization component of this project, and not evaluated through the process degradation analysis with the other key ecological attributes.

Each shoreform was analyzed for each relevant process, with results reported for each process. In addition, a composite estimate of degradation is provided by adding all process degradation results of a shoreform together and dividing by the number of applicable processes. This normalization was necessary because some shoreforms naturally support more processes than others. Normalized sum results for each of the 3,216 unique shoreforms were used as a measure of degradation (or inverse of intactness) and applied to restoration and protection project identification analyses. Additional methods descriptions are provided within each individual process degradation analysis description, below. A summary of results is also provided.

Coastal Sediment Dynamics

Coastal sediment dynamics are the processes that supply, transport, and deposit sediment. The RITT includes KEA"s for coastal sediment dynamics within drift cell systems and pocket beaches (RITT 2012). The coastal sediment dynamic nearshore ecosystem process was evaluated for all shoreforms except rocky and artificial. Degradation was measured as the percent length of armor, tidal barrier, roads, marinas, groins, breakwater/jetties and boat ramps for each unique feeder bluff, barrier beach, transport zone and pocket beach shoreform. For embayment estuaries and embayment lagoons degradation of coastal sediment dynamics was measured as the percent length of armor, tidal barrier, road, marina and boat ramp stressors.

In terms of percentages of shoreforms impacted (count) embayment lagoons, estuaries and feeder bluffs were the most impacted geomorphic shoreform for the coastal sediment dynamics nearshore ecosystem process. While a lower percentage of pocket beaches (25%) had degraded coastal sediment dynamics, the total length impacted (just under 7 miles) was highest, followed by feeder bluffs (6.5 miles). Summary results for each shoreform are provided in Table 7. Process Degradation- coastal sediment dynamics.

Table 7. Process Degradation- coastal sediment dynamics.

| Coastal Sediment Dynamics | | | | |
|---|---|---|---|---|
| Shoreform | Shoreform with Stressor Count (%) | Shoreform with Stressor Length Miles | Percent Degraded (Length) Mean | Percent Degraded (Length) Median |
| Barrier Beach | 76 (41%) | 5 miles | 45% | 28% |
| Embayment estuary | 18 (47%) | 2.6 miles | 20% | 18% |
| Embayment lagoon | 15 (94%) | 1.6 miles | 35% | 33% |
| Feeder Bluff | 207 (48%) | 6.5 miles | 59% | 61% |
| Pocket Beach | 247 (26%) | 6.7 miles | 36% | 25% |
| Transport Zone | 157 (39%) | 4.6 miles | 45% | 34% |

Wind and Waves

Healthy drift cell and rocky shoreline pocket beach systems require wind driven waves to move coastal sediments (RITT 2012).

The wind and waves nearshore ecosystem process was evaluated for all shoreforms. Degradation for all shoreforms except rocky was measured as the percent length of the following stressors: armor, breakwater/jetty, shoreline roads, marina, overwater structure, groins and boat ramps. Degradation for rocky shores was measured as the percent length per unique shoreform of armor, breakwater/jetty, marina and overwater structures. With essentially the same stressor metrics as coastal sediment dynamics, results for the wind and waves coastal process are also similar, with embayment lagoons, estuaries and feeder bluff shoreforms the most impacted. Pocket beaches and rocky shores had lower overall percentages, but still showed degradation for this process. Summary results by shoreform are provided below in Table 8. Process Degradation-wind and waves.

Table 8. Process Degradation-wind and waves.

| Wind and Waves | | | | |
|---|---|---|---|---|
| Shoreform | Shoreform with Stressor Count (%) | Shoreform with Stressor Length Miles | Percent Degraded (Length) Mean | Percent Degraded (Length) Median |
| Artificial | 11 (100%) | 2.4 miles | 90% | 100% |
| Barrier Beach | 76 (41%) | 4.7 miles | 44% | 26% |
| Transport zone | 155 (38%) | 4.5 miles | 45% | 34% |
| Feeder bluff | 207 (48%) | 6.5 miles | 60% | 61% |
| Embayment estuary | 18 (47%) | 2.3 miles | 18% | 10% |
| Embayment lagoon | 14 (88%) | 1.1 miles | 27% | 22% |
| Pocket beach | 246 (26%) | 6.6 miles | 35% | 24% |
| Rocky | 260 (22%) | 3.7 miles | 12% | 4% |

Tidal Hydrology

Tidal circulation affects the transport of sediment and detritus as well as the movement of organisms and patterns in salinity and primary and secondary production (RITT 2012). Tidal inundation of nearshore marine shoreforms determines the area and elevation of habitat and vegetative zones (RITT 2012). Structures such as dikes and tidal barriers built in the nearshore zone to prevent tides from encroaching on land disrupt tidal hydrology and displace the tidally determined habitats and ecological communities that otherwise would have been present (RITT 2012). While dikes are rare in San Juan County, tidal barriers exist, including those created by bulkheads and shoreline roads.

Degradation of the tidal hydrology nearshore ecosystem process was evaluated for all shoreforms except artificial and rocky, measured by the percent length of the armoring and tidal barrier stressors. Tidal hydrology degradation was most significant for embayment estuary and lagoon shoreforms, followed by feeder bluffs, barrier beaches and transport zones. As with other degradation results, while percentages of impacted pocket beach shoreforms was relatively low (22%), the length of impact (5 miles) was relatively high, second only to feeder bluffs (5.3 miles). Summary results by shoreform are provided below in Table 9. Process Degradation- tidal hydrology.

Table 9. Process Degradation- tidal hydrology.

| Tidal Hydrology | | | | |
|---|---|---|---|---|
| Shoreform | Shoreform with Stressor Count (%) | Shoreform with Stressor Length Miles | Percent Degraded (Length) Mean | Percent Degraded (Length) Median |
| Barrier Beach | 53 (29%) | 3.3 miles | 38% | 20% |
| Transport zone | 113 (28%) | 2.8 miles | 37% | 22% |
| Feeder bluff | 177 (41%) | 5.3 miles | 56% | 52% |
| Embayment estuary | 15 (93%) | 1.1 miles | 12% | 8% |
| Embayment lagoon | 9 (56%) | 0.8 miles | 32% | 21% |
| Pocket beach | 205 (22%) | 5 miles | 36% | 25% |

Freshwater Hydrology

Freshwater discharge introduces sediment, nutrients, detritus, and pollutants to estuaries and nearshore marine waters downstream (RITT 2012). Potential impacts of human modification of freshwater hydrology to estuaries and the nearshore marine environment include an increase in water column turbidity due to land clearing, elevated contaminant loading due to development, and adverse changes in salinity and temperature due to water withdrawal or loss of riparian vegetation (RITT 2012). Freshwater inputs can be an important driver of habitat diversity and complexity; alternatively they can deliver the upland's problems to the marine environment (RITT 2012).

Existing countywide data sets to use in evaluating the freshwater hydrology ecosystem process were extremely limited. While detailed information was available for some sites or sections of the county, in general freshwater hydrology is an area where additional research is needed to fully inform salmon recovery efforts.

For this process, degradation to the freshwater hydrology nearshore ecosystem process was evaluated for all shoreforms with streams flowing to marine waters, measured as the percentage of watershed area with greater than 10% impervious surface. The PSNERP percent impervious and Geographic Scale Units (GSU) layers were used in conjunction with the final shoreform layer. In this analysis the midpoint of the shoreform was used to select a PSNERP GSU. The percentage of the GSU that contained areas of greater than ten percent impervious coverage were calculated and the result written back to the shoreform attribute table. This analysis was performed by a custom python script.

Overall, degradation to freshwater hydrology (as measured by percentage of watershed impervious surface) was quite low across San Juan County, in part a reflection of the low numbers of streams in the county but also due to the more rural and residential nature of shoreline development activities here. Embayment estuaries were the most commonly impacted shoreform type, with 53% of embayment estuaries having watershed with greater than 10% impervious surface. Summary results by shoreform are provided below in Table 10. Process Degradation- freshwater hydrology.

Table 10. Process Degradation- freshwater hydrology.

| Freshwater Hydrology | | | | | |
|---|---|---|---|---|---|
| Shoreforms with Streams | Shoreform with Stressor Count (% of shoreforms with streams) | % watershed with 10% or more impervious surface | | Percent Degraded Mean | Percent Degraded Median |
| | | Min | Max | | |
| Artificial | 1 (9%) | 42% | 42% | 42% | 42% |
| Barrier Beach | 19 (10%) | 6% | 42% | 14% | 11% |
| Transport zone | 19 (5%) | 6% | 25% | 12% | 11% |
| Feeder Bluff | 20 (5%) | 5% | 23% | 15% | 15% |
| Embayment estuary | 20 (53%) | 2% | 76% | 18% | 11% |
| Pocket beach | 65 (7%) | 1% | 40% | 13% | 10% |
| Rocky | 41 (3%) | 1% | 40% | 11% | 8% |

Tidal Channel Formation and Maintenance

Tidal channels are conduits for water, sediment, nutrients, detritus, and aquatic organisms, and link highly productive wetlands to the nearshore marine environment (RITT 2012). Tidal channel formation and maintenance depend on the tidal prism (i.e., the volume of water between low and high tides that flushes the channels during tidal exchange), which can be impacted directly through the use of dikes and tide gates to limit flooding, or indirectly through the conversion of upslope wetlands to other land uses (RITT 2012).

Degradation of the tidal channel formation nearshore ecosystem process was evaluated for all shoreforms with streams, measured by the percent shoreform length of the armoring and tidal barrier stressors. While the highest percentage of shoreforms with degraded tidal channel processes, by geomorphic shoreform type, feeder bluffs, pocket beaches and transport zones all had considerable (28-58% depending on shoreform and mean or median measurement) degradation of this process for those shoreforms where degradation occurred. Summary results by shoreform are provided below in Table 11. Process Degradation- tidal channel formation and maintenance.

Table 11. Process Degradation- tidal channel formation and maintenance.

| Tide Channel Formation and Maintenance | | | | |
|---|---|---|---|---|
| Shoreform with Streams | Shoreform with Stressor Count (%) | Shoreform with Stressor Length Miles | Percent Degraded (length) Mean | Percent Degraded (length) Median |
| Artificial | 1 (9%) | 0.1 miles | 70% | 70% |
| Barrier Beach | 9 (5%) | 0.4 miles | 21% | 11% |
| Transport zone | 12 (3%) | 1 mile | 52% | 29% |
| Feeder bluff | 16 (4%) | 0.9 miles | 58% | 57% |
| Embayment estuary | 11 (29%) | 0.8 miles | 12% | 8% |
| Pocket beach | 30 (3%) | 1.4 miles | 36% | 28% |
| Rocky | 12 (1%) | 0.2 miles | 8% | 4% |

Detritus Potential

Detritus consists of a variety of materials, ranging from decaying submerged aquatic vegetation to marsh plants in coastal wetlands, or from leaves to logs (i.e., LWD) in upland habitats (RITT 2012). In addition to providing food web support, detritus (particularly LWD) serves a structural function by affecting tidal channel morphology and beach morphology, supplies perches for wildlife, beach micro-habitat for invertebrates, and nurse logs which affect vegetation community composition and succession (RITT 2012). Sources of detritus include watersheds, marine riparian zones, tidal marshes, and intertidal/subtidal zones (RITT 2012).

Degradation of the detritus potential nearshore ecosystem process was evaluated using marine riparian vegetation data developed for this project. For embayment estuaries and embayment lagoon shoreforms (commonly characterized by naturally low vegetation cover), degradation of detritus potential was assigned based on the vegetation type (forest, shrub and below two feet vegetated) coverage classifications for each shoreform and its landward 200 foot buffer polygon. Estuary and lagoon shoreform polygons with no vegetation were considered 100% degraded, those with .01-25% vegetation coverage were considered 75% degraded, shoreforms with 26-50% vegetation coverage were considered 50% degraded, shoreforms with 51-75% vegetation were considered 25% degraded and shoreform buffer polygons with 76-100% vegetation coverage were considered intact.

For all other shoreforms, the degradation of detritus potential was evaluated by the percentage of the shoreform with overhanging (OH) marine riparian vegetation, using the same degradation scoring formulas as described above for the vegetative cover assessment in the embayment estuary and embayment lagoon shoreforms (0% OH veg =100% degraded, >01-25% OH veg=75% degraded, etc.). Due to the high likelihood of natural bedrock or coastal prairie along rocky shorelines, and the lively debate amongst the technical team on the relative value of rocky shorelines as sources of detritus for juvenile salmonids, detritus potential was not evaluated for rocky shoreforms.

The geomorphic shoreforms most impacted by the detritus potential coastal process degradation were artificial shoreforms, barrier beaches and embayment lagoons, followed by pocket beaches. As overall degradation of this process is quite low in adjacent shoreforms, the higher barrier beach numbers may be a reflection of places with less overhanging vegetation as a natural condition such as spits. Minimally impacted shoreforms included feeder bluffs, embayment estuaries and transport zones. Summary results by shoreform are provided below in Table 12. Process Degradation- detritus potential.

Table 12. Process Degradation- detritus potential.

| Detritus Potential | | | | |
|---|---|---|---|---|
| Shoreforms | Percent degraded* | | Percent Degraded Mean | Percent Degraded Median |
| Overhanging Vegetation Metric | | | | |
| | Min. | Max. | | |
| Artificial | 50% | 100% | 70% | 75% |
| Barrier Beach | 0% | 100% | 59% | 75% |
| Transport zone | 0% | 100% | 23% | 0% |
| Feeder bluff | 0% | 100% | 21% | 0% |
| Pocket beach | 0% | 100% | 29% | 25% |
| Vegetation Cover Metric | | | | |
| Embayment estuary | 0% | 75% | 34% | 25% |
| Embayment lagoons | 25% | 75% | 58% | 50% |

*degradation based on presence or absence of overhanging marine riparian vegetation; degradation will include places where shrub and tree layers are not naturally supported, such as barrier spits, bedrock or native prairie shoreline systems.

Vegetation Enhancement

Opportunities to enhance marine riparian vegetation were identified through selection of shoreforms where detritus potential was the only stressor present. While all sites will not be suitable to support additional vegetation due to natural constraints or existing development patterns, these sites represent good places to target education and stewardship efforts as much action may be possible through voluntary means. See Figure 9. Marine Riparian Enhancement Potential Map (shoreforms where detritus potential is the only stressor present).

Figure 9. Marine Riparian Enhancement Potential.


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Solar Radiation

Solar radiation is a principal driver of the growth of submerged aquatic vegetation and over-water structures can shade out submerged aquatic vegetation such as eelgrass and kelps (RITT 2012).

Degradation of the solar radiation nearshore ecosystem process was evaluated for all unique shoreforms by the area of overwater structures within the shoreform. Because this is a metric based on area, percent degradation was calculated by dividing the total area of overwater structures within a shoreform by the maximum amount of overwater structure area that was found in any San Juan County shoreform, providing a relative measurement of impact among shoreforms with the presence of overwater structures as a stressor. By shoreform count, artificial shoreforms and embayment estuary shoreforms have the greatest percentage of shoreforms impacted by overwater structures. By far the greatest aerial extent of degradation to solar radiation was documented in rocky and artificial shoreforms. Additional shoreforms with relatively large overwater structure area, and degraded solar radiation process, include pocket beaches, transport zones and feeder bluffs. Summary results by shoreform are provided below in Table 13. Process Degradation- solar radiation.

Table 13. Process Degradation- solar radiation.

| Solar Radiation | | | | | | |
|---|---|---|---|---|---|---|
| Shoreforms | Shoreform with stressor count (%) | Percent degraded* (%) | | Percent Degraded Mean | Percent Degraded Median | Sum Degraded (area) |
| Aquatic area shaded by marina or overwater structure | | | | | | |
| | | Min. | Max. | | | |
| Artificial | 9 (82%) | 1% | 100% | 20% | 11% | 829,154 sq. ft. |
| Barrier Beach | 31 (17%) | 1% | 5% | 1% | 0.5% | 92,419 sq. ft. |
| Transport zone | 65 (16%) | 1% | 26% | 1% | 0.5% | 411,135 sq. ft. |
| Feeder bluff | 51 (12%) | 1% | 27% | 2% | 0.5% | 406,614 sq. ft. |
| Embayment estuary | 11 (29%) | 1% | 4% | 1% | 0.5% | 40,272 sq. ft. |
| Embayment lagoons | 5 (31%) | 1% | 1% | 0.5% | 0.5% | 8,580 sq. ft. |
| Pocket beach | 87 (9%) | 1% | 26% | 1% | 0.5% | 482,607 sq. ft. |
| Rocky | 171 (14%) | 1% | 43% | 1% | 0.5% | 866,341 sq. ft. |
| SJC sum | | | | | | 72 acres OWS |

*% degraded calculated by dividing sum of the OWS area per unique shoreform and dividing that by the largest OWS areal coverage in the county (472,358 sq. ft. in an artificial shoreform)

Summary Process Degradation Results

The individual nearshore process degradation results were combined to provide a relative measure of the level of degradation (or intactness) for each geomorphic shoreform. Results were combined for comparisons across all individual geomorphic shoreforms within each type, such as all feeder bluffs, as well as county-wide across all shoreform types. While conditions within San Juan County are relatively good when compared to other more developed areas, with many intact processes and shoreforms (approximately 50%), substantial restoration need and opportunities do exist. Nearshore process degradation results also highlight the important role improved protection will need to play in support of salmon recovery efforts in the San Juans.

As would be expected, degradation scores were higher in the more highly developed locations of the ferry serviced islands of county, including urban growth areas, hamlets and in proximity to major developments such as marinas, resorts and other places with smaller average shoreline lot sizes. Degradation was also higher along 'soft' or non-rocky shoreforms and in more enclosed areas including sounds, bays and harbors. Parts of the county with the most impacted nearshore processes include the regions of: Friday Harbor, Roche Harbor, Eastsound (south and north shores), Fisherman Bay, West Sound, Orcas Village, Blind Bay, Olga, NE Lopez, SW Decatur, Rosario and the MacKaye Harbor/Barlow region of south Lopez. The areas of the county with the most intact nearshore processes include the outer islands of Sucia, Patos, Matia, Blakely, Stuart and Waldron, as well as east Orcas, large sections of the eastern and western shores of San Juan Island and south Lopez.

Places with low to moderate degradation (approximately 40%) provide excellent restoration opportunities as more feasible and cost effective places where improvements can be made. Results also indicate which processes are most impacted in the county and by relationship which stressors are most influential to degradation scores. For San Juan County, coastal sediment dynamics, wind and waves and shoreline armoring, were identified as top processes and stressors requiring attention. Shoreline armoring impacts multiple nearshore processes and exists in relatively high abundance when compared to other shoreline stressors.

These results, when applied with the fish use geographic priority areas, can help target projects at sites where either protection of intact areas from future degradation or restoration of multiple nearshore ecosystem processes to aid salmon recovery efforts, are the most important actions. See Tables 14. Process Degradation- median percent degraded across shoreforms and processes and Table 15. Normalized Sum of Process Degradation for summary results for each geomorphic shoreform type by both nearshore ecosystem process and degradation level. Detailed degradation results are also provided in Figure 10. Normalized Sum of Process Degradation and Map Book 2. Nearshore Process Degradation.

Table 14. Process Degradation- median percent degraded across shoreforms and processes.

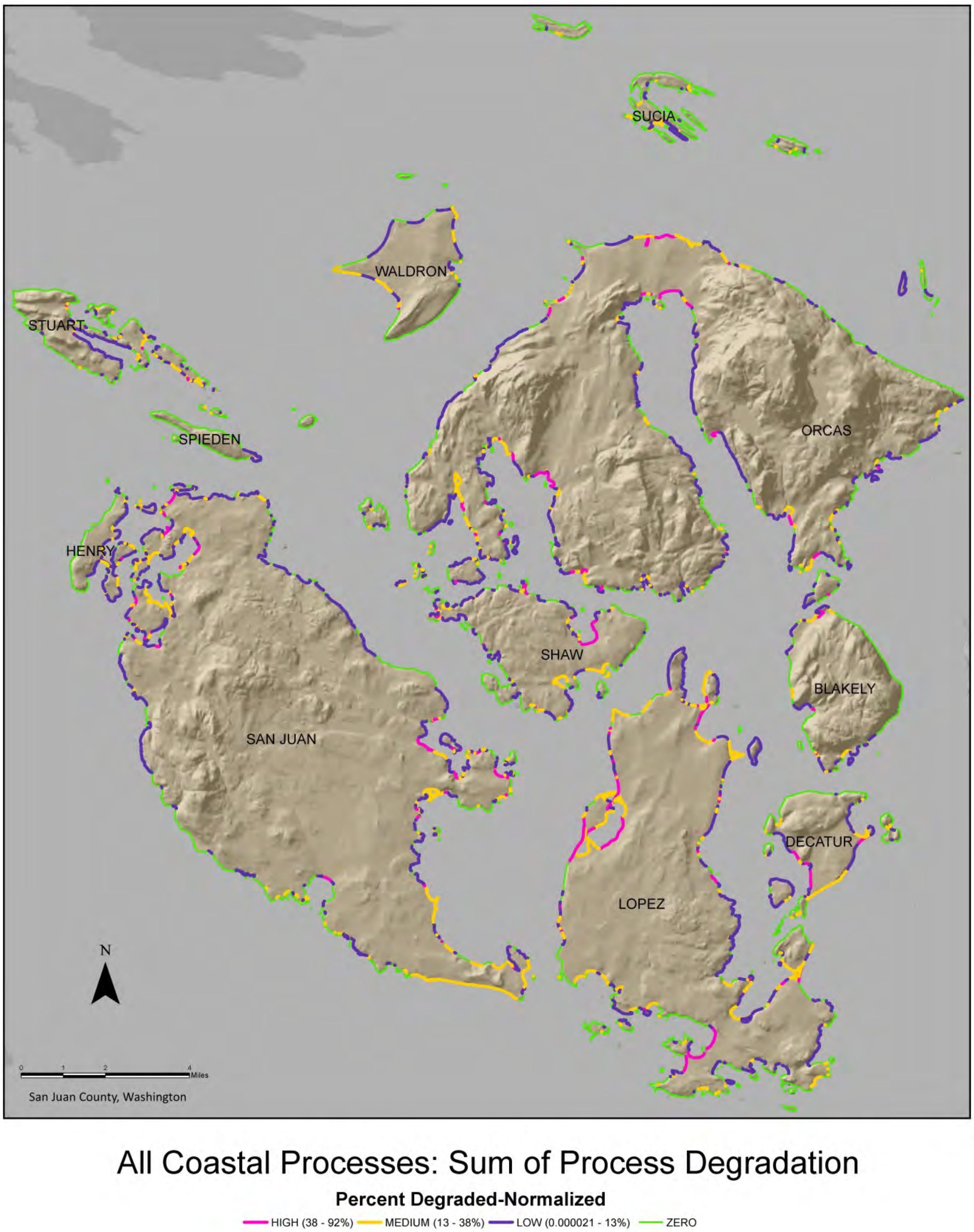
| Median Percent Degraded | | | | | | | |
|---|---|---|---|---|---|---|---|
| Process / Shoreform | Coastal Sediment Dynamics | Wind and Waves | Tidal Hydrology | Tidal Channel | Freshwater Hydrology | Detritus Potential | Solar Radiation |
| Artificial | n/a | 100% | n/a | 70% | 42% | 75% | 11% |
| Barrier beach | 28% | 26% | 20% | 11% | 11% | 75% | 0.5% |
| Transport zone | 34% | 34% | 22% | 29% | 11% | 0% | 0.5% |
| Feeder Bluff | 61% | 61% | 52% | 57% | 15% | 0% | 0.5% |
| Embayment estuary | 18% | 10% | 8% | 8% | 11% | 25% | 0.5% |
| Embayment lagoon | 33% | 22% | 21% | n/a | n/a | 50% | 0.5% |
| Pocket beach | 25% | 25% | 25% | 28% | 10% | 25% | 0.5% |
| Rocky | n/a | 4% | n/a | 4% | 8% | n/a | 0.5% |

Table 15. Normalized Sum of Process Degradation.
(three categories, natural breaks, for all degradation values above zero)

| Sum of Process Degradation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Shoreform | 0% Degradation | | Low Degradation (.01-12.9%) | | Medium Degradation (13- 38%) | | High Degradation (38.8-91.6%) | |
| | Count | Miles | Count | Miles | Count | Miles | Count | Miles |
| Artificial | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 2.6 |
| Barrier Beach | 26 | 1 | 35 | 5.1 | 94 | 14.8 | 30 | 4.4 |
| Transport Zone | 153 | 11 | 112 | 13.1 | 86 | 7.47 | 53 | 2.6 |
| Feeder Bluff | 141 | 8.6 | 95 | 11.4 | 89 | 6 | 107 | 5.6 |
| Embay-estuary | 4 | 0.16 | 22 | 3.6 | 12 | 8 | 0 | 0 |
| Embay-lagoon | 0 | 0 | 5 | 0.4 | 10 | 3.3 | 1 | 0.3 |
| Pocket Beach | 319 | 11.5 | 296 | 16.7 | 268 | 15.2 | 62 | 4.75 |
| Rocky | 884 | 181 | 267 | 65.2 | 28 | 3.4 | 6 | 0.33 |
| sum | 1527 | 213 | 832 | 115 | 587 | 58 | 270 | 21 |
| | 47% SJC shore-forms | 52% shore length | 26% SJC shore-forms | 28% shore length | 18% SJC shore-forms | 14% shore length | 8% SJC shore-forms | 5% shore length |

(Normalized by the number of processes affecting that shoreform. Results shown as zero and three natural breaks for all degradation >0).

Figure 10. Normalized Sum of Process Degradation.



**Restoration and Protection Project Need**

The fish use geographic prioritization and analysis of nearshore process degradation stages of the PIAT assessment each provide information useful to strategic salmon recovery planning and shoreline management efforts in San Juan County. Results of the fish use geographic prioritization and process degradation analyses were then applied together to the identification of priority protection and restoration actions at the shoreform scale, essentially combining the information to identify “where to work” (landscape or shoreform) and “what to do” (restoration or protection).

Places with intact coastal processes and high salmon recovery value were mapped as top protection priorities, while places with low to moderate levels of process degradation and high salmon recovery value were mapped as restoration priorities. Places with high degradation scores in high salmon recovery value areas were not ranked as top restoration priorities based on concerns about the feasibility of restoration actions as well as the cost/benefit associated with such extensive work. In some cases, where degradation was present but relatively low, and the salmon recovery value was the highest, the same shoreforms were identified as priorities for both protection and restoration actions (see Table 16 and 17, below). Due to the relatively intact condition of about half of San Juan County’s marine shorelines and the large regions of the county with significant salmon recovery value based on fish use, more shoreline is identified for protection, rather than restoration actions. However, many feasible restoration opportunities also exist, with low numbers of stressors present in many priority shoreforms.

Once restoration and protection priorities were identified at the geomorphic shoreform scale based on application of the fish use and degradation assessment results together, these PIAT project priorities were later integrated with multiple additional data sets including: existing salmon recovery priorities, land use and shoreline designation, property ownership and a sea level rise screening tool. This approach supports inclusion of finer scale data into the analysis, builds on existing work that has been completed, and provides information on likely threats to long term protection or constraints that may limit restoration feasibility. However, exploration of protection and restoration project need, based strictly on fish use factors and process degradation results, provides a good assessment of the scope of what the salmon recovery effort in San Juan County will entail, and where those efforts should occur.

Priority Protection Shoreforms

Priority protection shoreforms were identified based on a combination of fish use priorities and degradation analysis results. Places that ranked as the top salmon recovery landscape regions based on the juvenile Chinook, rearing forage fish, forage fish spawning habitat and connectivity fish use criteria and were intact (e.g. had shoreform nearshore process degradations scores of zero), were considered the top places to focus protection actions. These included 469 shoreforms. Medium protection priority shoreforms were defined as places with zero process degradation and medium fish use priority ranking (610 shoreforms), or, places with low degradation and highest fish use ranking (225 shoreforms). Detailed protection priority results and maps are provided in Figures 11. High Protection Priority

Shoreforms and 12. Medium Protection Priority Shoreforms and Table 16. Priority Protection Shoreforms.

Table 16. Priority Protection Shoreforms.

| Shoreform | High Priority* | | Medium Priority** | | Medium Priority*** | | Protection Priority Totals | |
|---|---|---|---|---|---|---|---|---|
| | count | miles | count | miles | count | miles | count | miles |
| Artificial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Barrier Beach | 12 | 0.7 | 8 | 0.2 | 13 | 3.6 | 33 | 4.5 |
| Transport Zone | 52 | 4.6 | 34 | 2.6 | 40 | 4.5 | 126 | 12 |
| Feeder Bluff | 40 | 2.7 | 35 | 1.9 | 21 | 2.5 | 96 | 7 |
| Embay-estuary | 0 | 0 | 2 | 0.1 | 3 | 1.2 | 5 | 1.3 |
| Embay-lagoon | 0 | 0 | 0 | 0 | 1 | 0.4 | 1 | 0.4 |
| Pocket Beach | 78 | 3.3 | 151 | 5.7 | 87 | 5.8 | 316 | 15 |
| Rocky | 287 | 71 | 380 | 75 | 60 | 17 | 727 | 163 |
| Sum | 469 | 82 | 610 | 85 | 225 | 35.3 | 1304 | 203 |
| | | | | | | | 40% SJC shoreforms | 50% shore length |

* Normalized process degradation =0 and fish use region=Highest

**Normalized process degradation = 0 and fish use region =High

***Normalized process degradation= Low and fish use region= High. Note: these shoreforms are also identified as high priorities for restoration.

Figure 11. High Protection Priority Shoreforms.

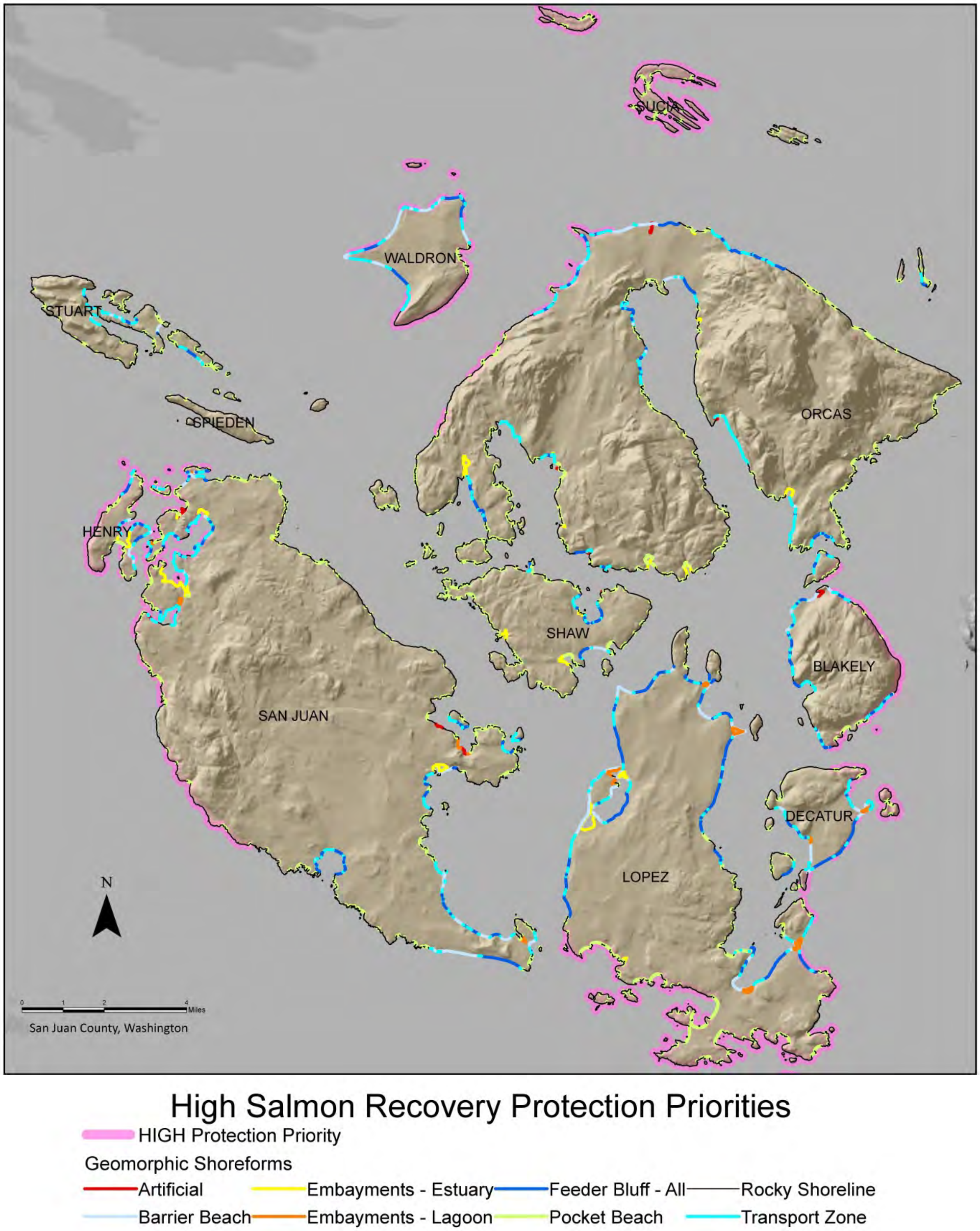



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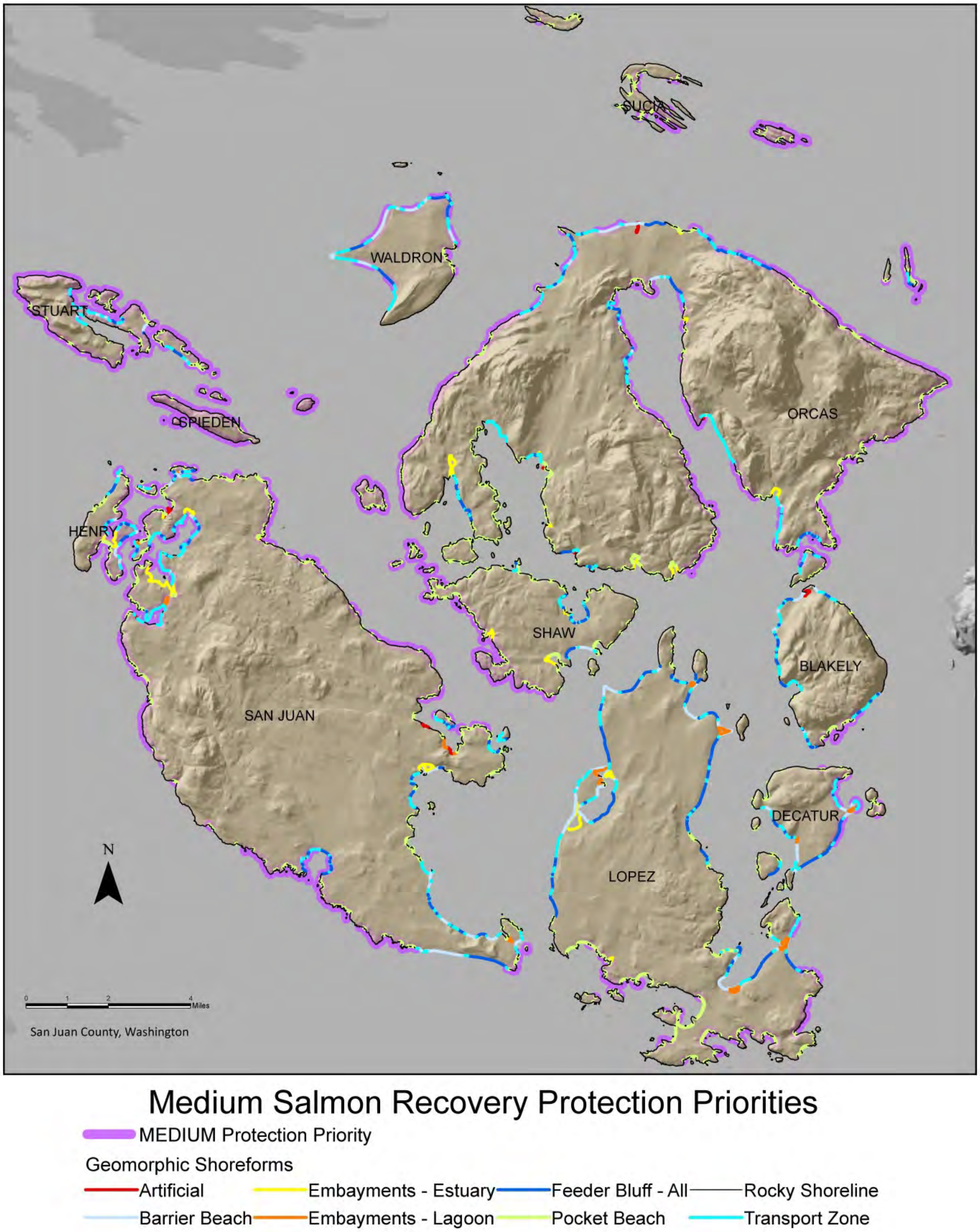
Figure 12. Medium Protection Priority Shoreforms.



**Restoration Priorities**

Priority restoration shoreforms were also identified based on a combination of fish use priorities and degradation analysis results. Places that ranked as the top salmon recovery landscape regions based on the juvenile Chinook, rearing forage fish, forage fish spawning habitat and connectivity fish use criteria and had low to moderate levels of nearshore process degradation were considered the top places to focus restoration efforts. These included 404 shoreforms.

Places with low or moderate process degradation and medium fish use ranking were considered moderate restoration priorities (481 shoreforms), as were places with high degradation scores and high fish use (58 shoreforms). See Figures 13. High Restoration Priority Shoreforms and 14. Medium Priority Restoration Shoreforms Maps and Table 17. Priority Restoration Shoreforms.

Table 17. Priority Restoration Shoreforms.

| Shoreform | High Restoration priority* | | Medium Restoration Priority** | | Medium Restoration Priority*** | | Restoration Priority Totals | |
|---|---|---|---|---|---|---|---|---|
| | *count* | *miles* | *count* | *miles* | *count* | *miles* | *count* | *miles* |
| Artificial | 0 | 0 | 0 | 0 | 4 | 1.1 | 4 | 1.1 |
| Barrier Beach | 45 | 6.8 | 29 | 2.9 | 8 | 1.1 | 82 | 11 |
| Transport Zone | 72 | 7.3 | 54 | 6.6 | 12 | 0.6 | 138 | 15 |
| Feeder Bluff | 52 | 4.4 | 37 | 3.2 | 19 | 1 | 108 | 8.6 |
| Embay-estuary | 7 | 3.5 | 4 | 1.4 | 0 | 0 | 11 | 4.5 |
| Embay-lagoon | 3 | 1 | 3 | 0.5 | 0 | 0 | 6 | 1.5 |
| Pocket Beach | 160 | 12 | 241 | 13 | 14 | 2.2 | 415 | 27 |
| Rocky | 65 | 18 | 113 | 25 | 1 | 0 | 179 | 43 |
| sum | 404 | 53 | 481 | 53 | 58 | 6 | 943 | 111 |
| | | | | | | | 29% SJC shoreforms | 27% shore length |

*normalized process degradation =low or medium and fish use region= highest. Note: a portion of these sites (those with low process degradation) are also medium priority for protection)

** normalized process degradation =low or medium and fish use region=high

***normalized process degradation high and fish use region =highest

Figure 13. High Priority Restoration Shoreforms.

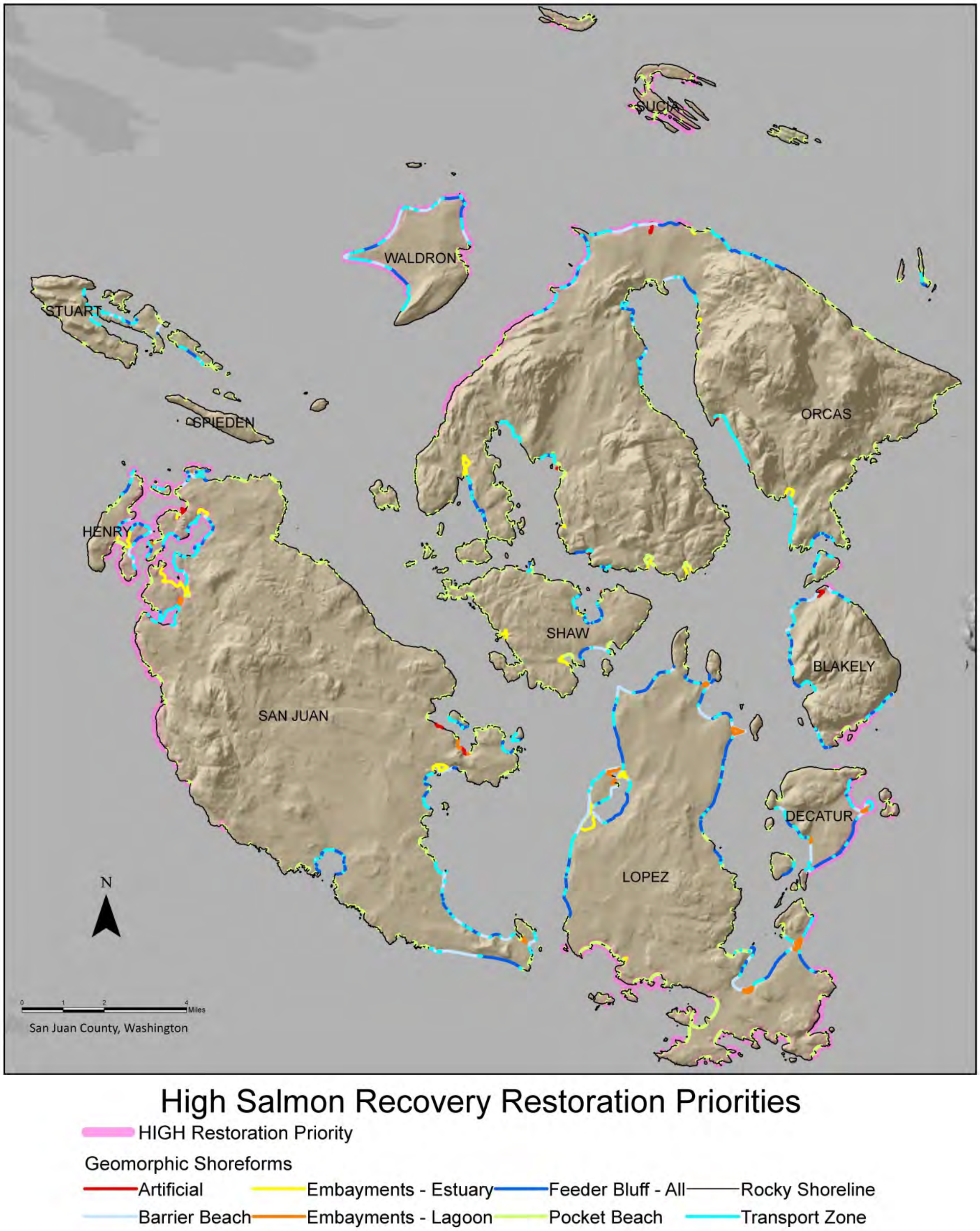



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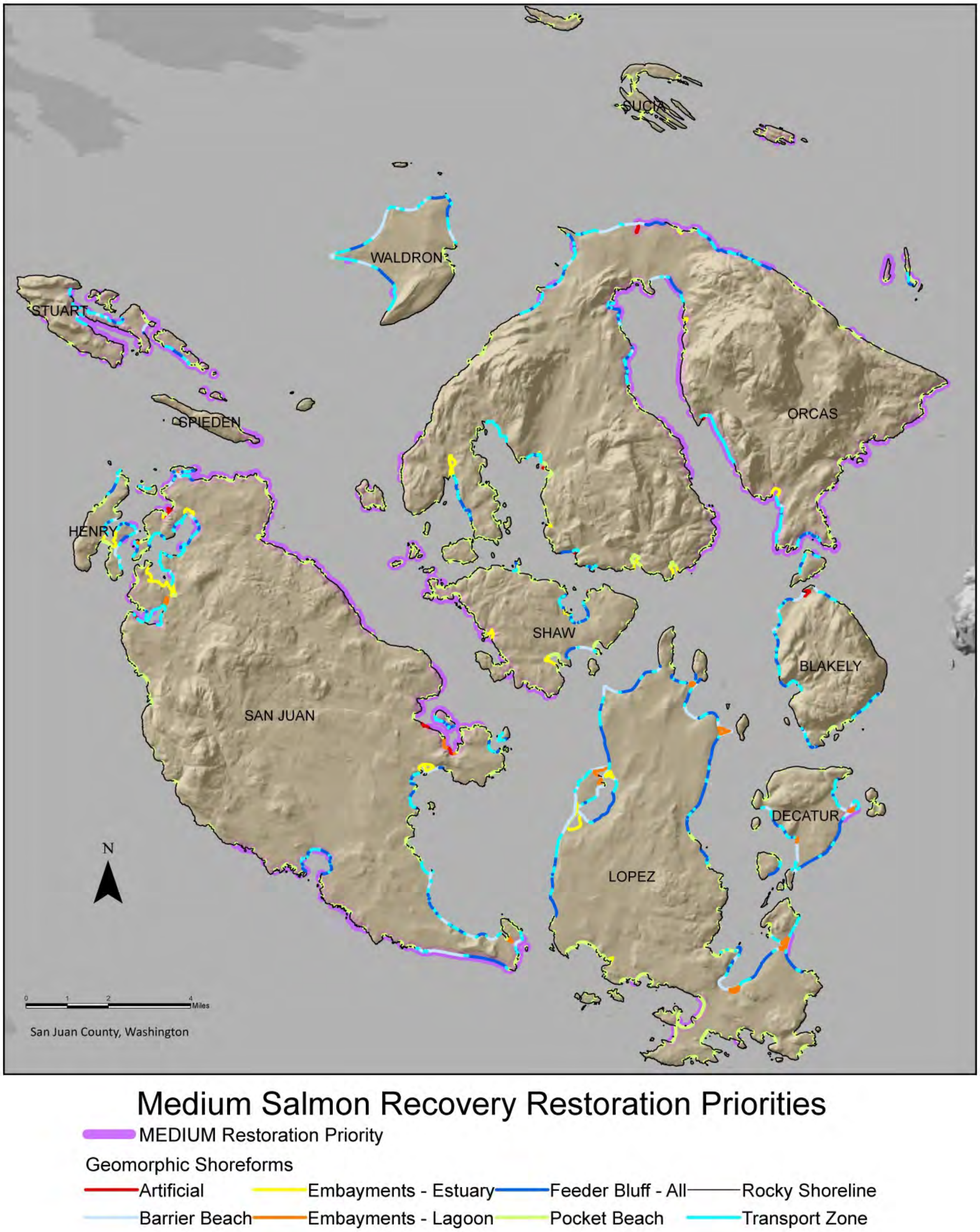
Figure 14. Medium Priority Restoration Shoreforms.



**Integration with Previously Identified Priority Actions, Ownership and Land Use**

High priority protection and restoration shoreforms from this process were cross referenced with existing priorities identified from completed work in San Juan County, including conservation and restoration bluffs identified by the countywide feeder bluff mapping project (MacLennan et al. 2010) as well as parcels identified as priorities for in the salmon habitat protection blueprint (FSJ et al 2008). Integration with existing work captures priorities identified at different scales (such as drift cell or tax parcel) and avoids duplication of efforts. As much of the existing salmon recovery prioritization within San Juan County has been based on a site level assessment of the presence of ecological communities such as eelgrass, kelp, forage fish spawning beaches and shoreline modifications; integration with existing work allowed this project to focus on a broader scale geographic prioritization as well as a detailed degradation assessment at the shoreform scale.

<u>Integration with Existing Protection Priorities</u>

*Feeder Bluffs:* Overlaying of priority protection shoreforms and protection feeder bluffs identified by the San Juan County current and historic condition feeder bluff mapping project (MacLennan et al. 2010) identified two feeder bluffs. Both are located on NE corner of Waldron Island and comprise a total of 659 linear feet of shoreline. In addition to protecting processes within the shoreform as identified by this project, protection of those sites would also improve overall protection at the drift cell scale.

*Existing Protection Opportunities:* High protection priority shoreforms identified in this process that were also identified as protection priorities in the Habitat Protection Blueprint (FSJ, PT and SJC LB 2007) included 18 shoreforms for a total of 7 linear miles of marine shoreline. Shoreforms were concentrated in a few regions of the county, including: North Henry, Pearl and San Juan Islands, west side San Juan Island, South Lopez, Sucia and East Obstruction. Shoreforms identified as protection priorities in both processes included 2 feeder bluffs, 4 pocket beaches, 11 rocky shores, and 1 transport zone.

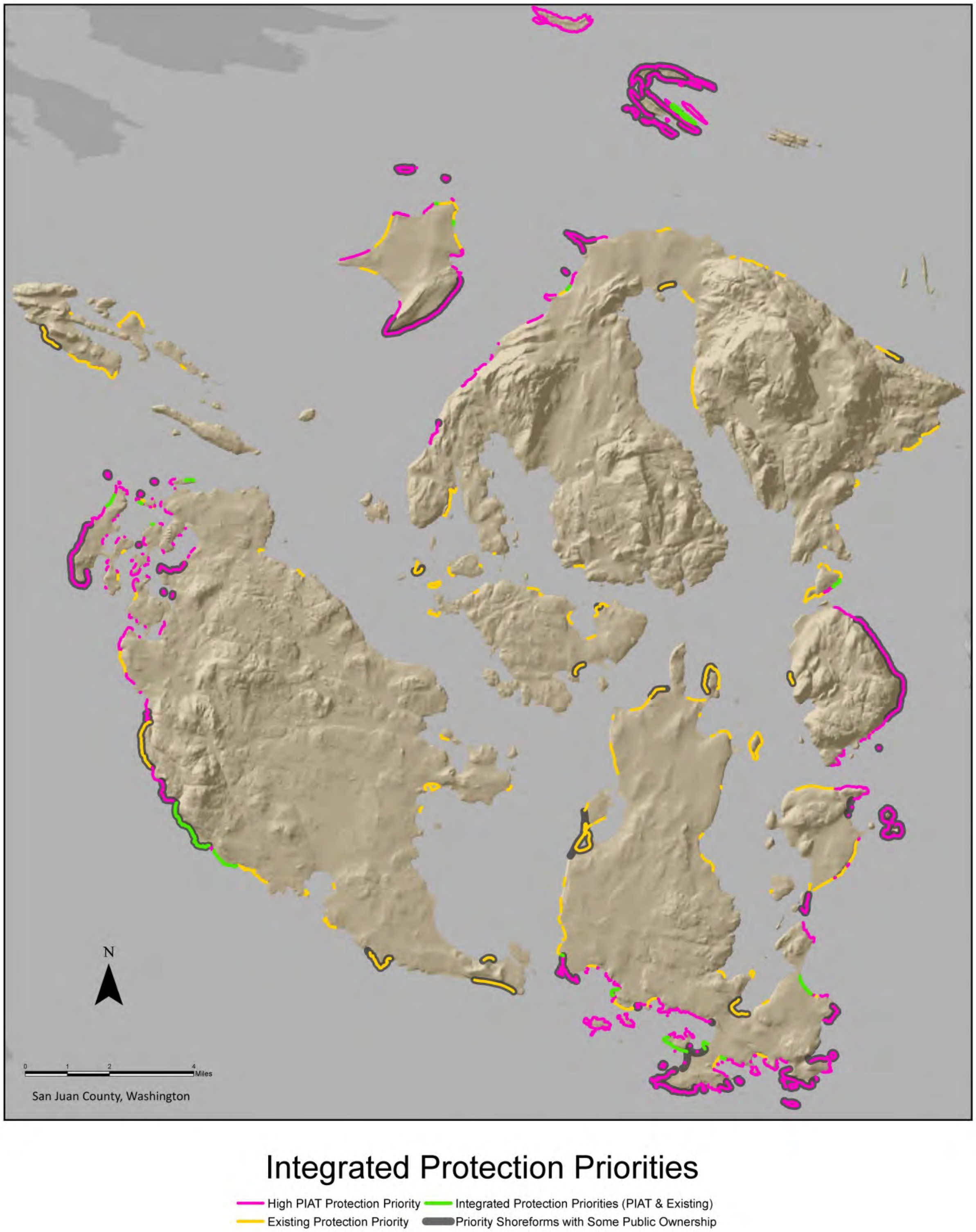
*Shoreline Parcel Ownership:* For the purposes of this salmon recovery planning project, public ownership of shoreline parcels was defined as: all San Juan County, State of Washington and United States Government properties, as well as parcels owned by OPALCO, San Juan Preservation Trust, Seattle Pacific University, The Nature Conservancy, The Tulalip Tribes and the University of Washington for their existing role in land and shoreline conservation and salmon recovery efforts and quasi-public characteristics. The intent is to identify those locations where implementation of restoration or protection actions may be more likely than on privately held parcels.

Of the 5,274 total waterfront tax parcels in San Juan County, 227 (4%) met the definition of public we used for the project including: OPALCO (1), SJC Land Bank (38), SJC Parks (14), SJC Public Works (9), San Juan Preservation Trust (27), Seattle Pacific University (7), State of Washington (53), The Nature Conservancy: (4), University of Washington (9), The Tulalip Tribes (2) and the United States Government (63).

One hundred and eight high protection priority shoreforms have some public ownership along their shoreline, including 77 rocky shores, 11 pocket beaches, 10 transport zones, 5 feeder bluffs and 5 barrier beaches.

In general, salmon recovery opportunities tend to be more feasible on publicly owned shoreline parcels, in part a result of the longer term nature of the ownership pattern. There are, of course, exceptions to such generalities and the identification of public ownership parcels within priority protection shoreforms is not intended to diminish efforts with private owners along privately owned priority protection shoreforms. However, there are many circumstances where public ownership can benefit a project's success, such as the leveraged opportunity to acquire a priority salmon recovery site adjacent to or in close proximity to an already protected parcel. Identification of publicly owned tax parcels within priority restoration and protection shoreforms simply provides another layer of information to guide the development of successful salmon recovery projects. See Figure 15. Integrated Protection Priority Shoreforms Map and Map Book 3 Integrated Protection Priorities.

Figure 15. Integrated Protection Priority Shoreforms.

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Integration with Existing Restoration Priorities

*Feeder bluff:* High restoration priority shoreforms from this process that were also identified as priority restoration feeder bluffs by the San Juan County current and historic condition feeder bluff mapping project (MacLennan et al. 2010). Three feeder bluffs, 354 linear feet of shoreline, located on NE Henry Island (2) and south of YMCA Camp Orkila on Orcas Island along President's Channel. In addition to restoring nearshore processes within the shoreform as identified by this project, restoration of these bluff sites would also improve overall conditions at the drift cell scale.

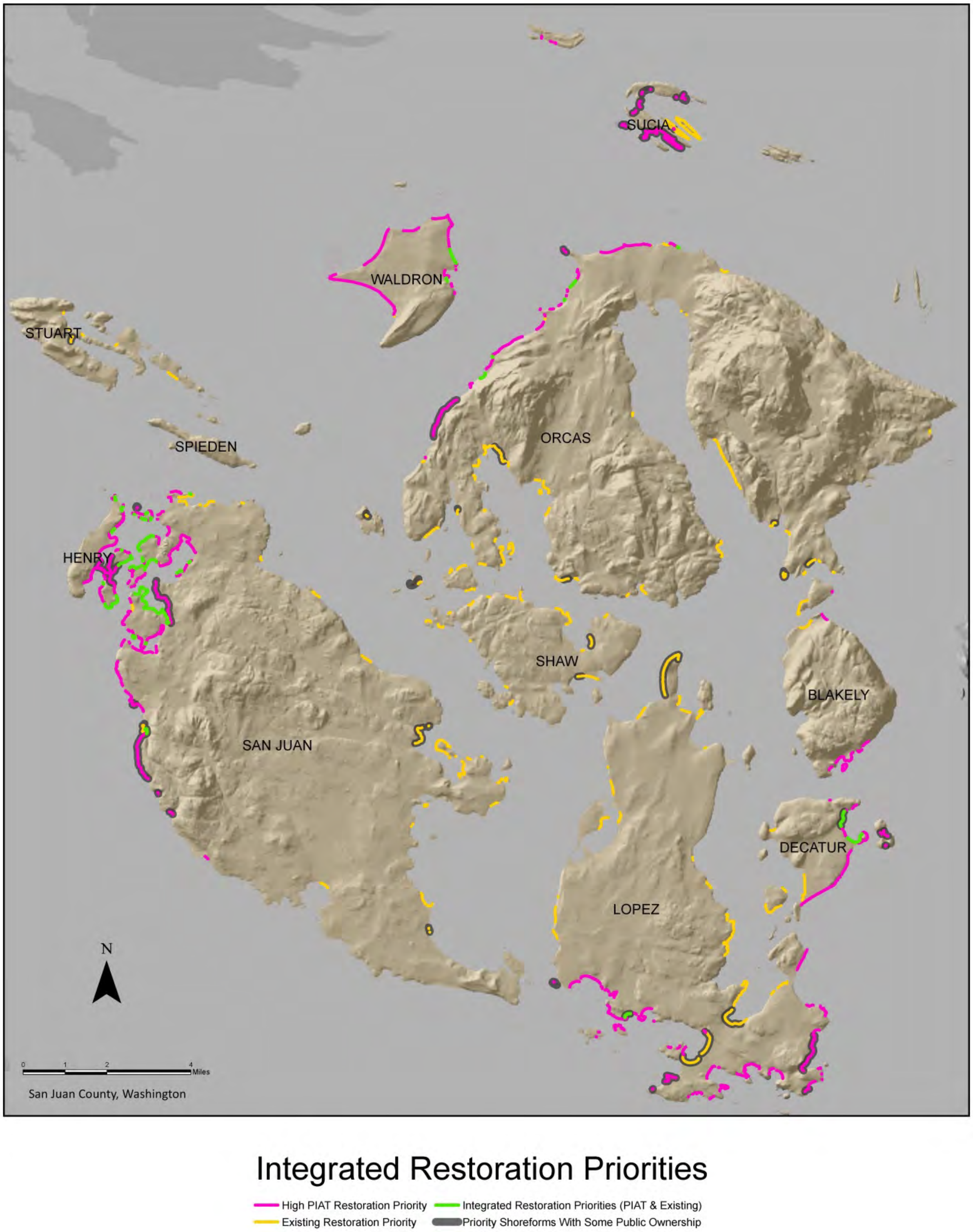
*Existing Restoration Opportunities*: High restoration priority shoreforms identified in this process that were also identified as restoration priorities in the San Juan County Shoreline Modification Inventory Restoration Opportunities report (FSJ 2011) included 45 shoreforms for a total of 7.5 linear miles of marine shoreline. Shoreforms were concentrated in a few regions of the County, including NW San Juan Island, East Henry Island and Pearl Island; NE Waldron and NW Orcas Islands, NE Decatur and SE Lopez. Shoreforms identified as restoration priorities in both processes included 6 barrier beaches, 1 embayment estuary, 5 feeder bluffs, 15 pocket beaches, 15 rocky shores and 4 transport zones.

*Shoreline Parcel Ownership:* For the purposes of this salmon recovery planning project, public ownership of shoreline parcels was defined as: all San Juan County, State of Washington and United States Government properties, as well as parcels owned by OPALCO, San Juan Preservation Trust, Seattle Pacific University, The Nature Conservancy, The Tulalip Tribes and the University of Washington for their existing role in land and shoreline conservation and salmon recovery efforts and quasi-public characteristics. The intent is to identify those locations where implementation of restoration or protection actions may be more likely than on privately held parcels.

Of the 5,274 total waterfront tax parcels in San Juan County, 227 (4%) met the definition of public we used for the project including: OPALCO (1), SJC Land Bank (38), SJC Parks (14), SJC Public Works (9), San Juan Preservation Trust (27), Seattle Pacific University (7), State of Washington (53), The Nature Conservancy: (4), University of Washington (9), The Tulalip Tribes (2) and the United States Government (63).

Fifty seven high priority restoration shoreforms have some public ownership (as defined by this project), including 35 pocket beaches, 9 rocky shores, 6 transport zones, 4 barrier beaches, 2 embayment estuaries and 1 feeder bluff. While not an essential component of a project's success, public ownership can provide some benefit to a project, such as in house capacity to assist with design, installation and monitoring, such as through a public works department. See Figure 16. Integration- Restoration Priorities Map and Map Book 4 Integrated Restoration Priorities.

Figure 16. Integrated Restoration Priorities.



Shoreline and Land Use Designations

A combination of shoreline and land use designations guide what development activities can happen along the marine shoreline of San Juan County, under the Growth Management and Shoreline Master Program components of the county's comprehensive plan. Review of protection and restoration priorities and their relationship to existing land and shoreline designations can help inform salmon recovery efforts by providing some level of assurance related to the degree of future threats. Results can also inform the County's shoreline master program updates, and assessment of success of past protective designations, through review of alliance between priority areas and the level of degradation (or intactness) within those designations.

Conservancy and Natural are the most protective shoreline and land use designations. The policies section of the Shoreline Master Program describes "the purpose of the conservancy designation is to protect, conserve and manage existing natural resources and systems and/or valuable historic, educational scientific areas without precluding compatible human uses." (SJC SMP 16.40.405). "the purpose of the Natural designation is to preserve rare or valuable natural resources by regulating uses which are likely to degrade or alter such resources (SJC SMP 16.40.406). Shoreforms in Conservancy, Natural or a combination of Natural and Conservancy in San Juan County existing Shoreline Master Program (SMP) designations include: 1,367 shoreforms along 206 marine shoreline miles.

The land use districts Conservancy and Natural have the same description of purpose as that defined for shorelines above (San Juan County Comprehensive Plan 2010 section 2.4 special districts). Land use designation of shoreline properties in Conservancy, Natural or a combination of Natural and Conservancy Land Use designations include 624 shoreforms and 104 marine shoreline miles. Regions of the county where protective land use designation correlates best with priority salmon recovery areas include the Sucia/Matia outer island complex and south Lopez; some site level correlation also occurs on Waldron Island and at the Point Doughty region of Orcas Island.

Priority Fish Use Regions and Designation

When using fish use priority regions as the basis for analysis, a total of 931 individual shoreforms and 141 marine shoreline miles have been identified by this process as highest priority regions. Of these, 590 (63% of the highest priority) shoreforms are designated as either Conservancy, Natural or a combination of Natural and Conservancy under the Shoreline Master Program, for a total of 100 (70% of the highest priority) marine shoreline miles. 212 (23%) shoreforms from the highest fish use priority regions are classified as Conservancy, Natural or a combination of Natural and Conservancy Land Use Designation, for a total of 45.5 (32% of fish use highest priorities) marine shoreline miles.

Process Degradation and Designation

A total of 1,527 shoreforms (213 marine shoreline miles) scored zero in the degradation analysis, indicating a high level of intact nearshore marine processes important to salmon and salmon habitat. Of these, 774 shoreforms (135 marine shoreline miles) are designated as Conservancy, Natural or a combination of Natural and Conservancy under the Shoreline Master Program. 401 shoreforms (81 marine shoreline miles) are classified as Conservancy, Natural or a combination of Natural and Conservancy Land Use Designation.

<u>Protection Priorities and Designation</u>

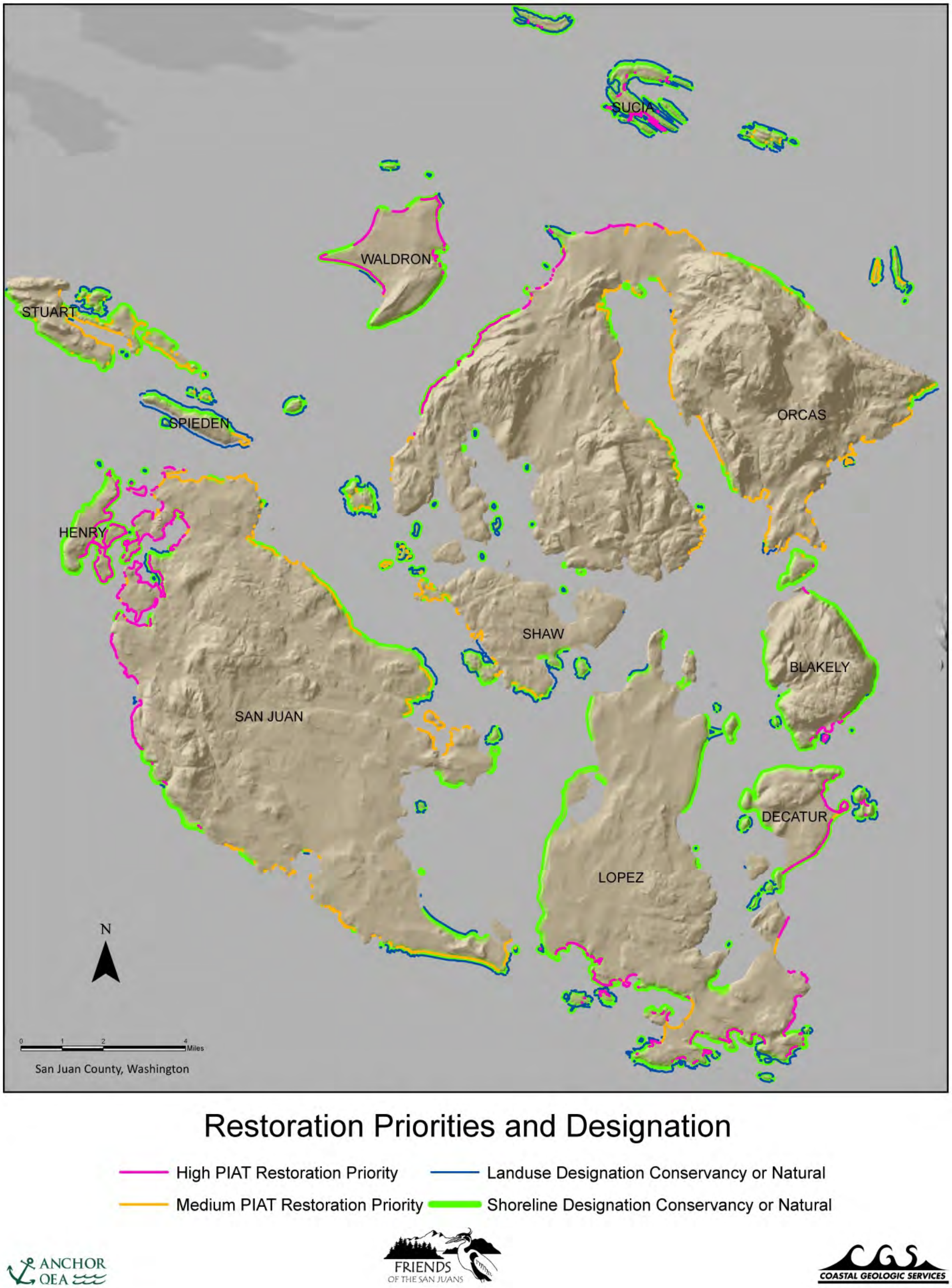
A total of 332 shoreforms (50 marine shoreline miles) of high protection priority shoreforms are designated as Conservancy, Natural or a combination of Natural and Conservancy under the Shoreline Master program. A total of 142 shoreforms, (38.5 marine shoreline miles) of high protection priority shoreforms are designated as either Conservancy, Natural or a combination of Natural and Conservancy under the County Land Use Designation. See Figure 17.Protection Priorities and Designation.

<u>Restoration Priorities and Designation</u>

A total of 244 shoreforms (30 marine shoreline miles) of high restoration priority shoreforms are designated as Conservancy, Natural or a combination of Natural and Conservancy under the Shoreline Master Program. These shoreforms may represent the most appropriate places to implement restoration and enhancement actions; if the more protective shoreline and land use designations are successful at minimizing future impacts to shoreline habitats and processes in these areas as intended. See Figure 18. Restoration Priorities and Designation.

Figure 17. Protection Priorities and Designation.

Figure 18. Restoration Priorities and Design<br>ation.



**Long-term Habitat Resiliency- Sea Level Rise Screening Tool**

The relative risk and resilience to valuable nearshore habitats in San Juan County from implications of climate change and sea level rise (SLR) was assessed. Risk and resilience were assessed using a suite of indicators to identify which habitats will be strained due to systemic and site-specific shoreline alterations, largely resulting from shoreline development. Resiliency results were applied to target areas for long-term protection and restoration actions, and to identify those sources of risk that could be addressed through enhancement actions to improve resiliency and prevent habitat loss. Detailed method and results of the risk and resiliency assessment for priority nearshore habitats is provided in Appendix D. Sea Level Rise and Risk and Resiliency Assessment.

Resiliency results were applied to restroation and protection priorities to identify those places where protection and restoration actions identified by this strategic planning process have the likelihood of weathering the impacts of sea level rise. In addition, opportunities to improve resiliency to the effects of climate change and sea level rise, by completing other identified priority restoration actions, were also identified.

Resiliency was assessed for all highest and high priority fish use shoreforms. Resiliency was measured using multiple metrics including: resilient drift cells (>75% of historic sediment supply intact); resilient pocket beaches (<25% armored length); no bedrock; no inundated buildings or roads (using low and very high sea level rise projection inundation maps); and no armoring.

Shoreline degradation and sea level rise risk are typically inversely correlated, except where bedrock geology is expected to limit the shoreline translation process. Shoreforms with no to low process-degradation are likely to have high resilience and therefore be optimal protection targets, particularly if identified as areas with high fish use. Areas in which shoreform degradation is low or moderate, thereby compromising resilience, and fish utilization is high, should be considered restoration target areas. By adequately addressing the sources of degradation with restoration actions, shoreform and habitat resilience is likely to increase. Additionally, shoreforms in which resilience is low, degradation is only moderate and fish utilization is high, should be targeted for enhancement/restoration to improve overall resilience of the valuable habitats.

It should be noted though, that shoreforms with considerable (landward) bedrock exposures should not be targeted for restoration/enhancement and preservation as the geology could present a natural constraint to beach translation, resulting in reduced habitat area. Shoreforms with bedrock geology were screened out of the sea level rise resiliency analysis so as to focus restoration and conservation efforts on only those habitats that are most likely to sustain sea level rise.

*Resilient Protection Priority Shoreforms*: Priority salmon recovery shoreforms identified for protection that also score high for resiliency included 9 transport zones, 8 pocket beaches, 6 feeder bluffs and 3 barrier beaches. These sites represent the best long-term habitat protection investment in terms of salmon recovery and sea level resiliency factors.

*Resilient Restoration Priority Shoreforms*: The same suit of shoreform types, pocket beaches (31), transport zones (18), feeder bluffs (17) and barrier beaches (11) were places that scored high for salmon recovery restoration and resiliency, representing the best long-term investment in habitat improvements.

*Enhancement- opportunities to increase resiliency:* Opportunities to increase resiliency to sea level rise at priority salmon recovery shoreforms was actually quite limited, with a handful of pocket beaches and barrier beaches identified.

Table 18. Priority Shoreforms and Sea Level Rise Resiliency.

| Shoreform | Protection Priority Shoreforms and Sea Level Rise Resiliency (count) | | Restoration Priority Shoreforms and Sea Level Rise Resiliency (count) | | Enhancement- opportunities to Increase Sea level Rise Resiliency (count) | |
|---|---|---|---|---|---|---|
| | High | Medium | High | Medium | High | Medium |
| Artificial | 0 | 0 | 0 | 0 | 0 | 0 |
| Barrier Beach | 3 | 11 | 11 | 4 | 1 | 1 |
| Transport Zone | 9 | 24 | 18 | 10 | 0 | 1 |
| Feeder Bluff | 6 | 22 | 17 | 12 | 0 | 1 |
| Embayment Estuary | 0 | 0 | 0 | 0 | 0 | 0 |
| Embayment Lagoon | 0 | 0 | 0 | 0 | 0 | 0 |
| Pocket Beach | 8 | 52 | 31 | 66 | 2 | 2 |
| Rocky | n/a | n/a | n/a | n/a | n/a | n/a |
| sum | 26 | 109 | 77 | 92 | 3 | 5 |

Figure 19. Long-term Protection Priorities- sea level rise resiliency.

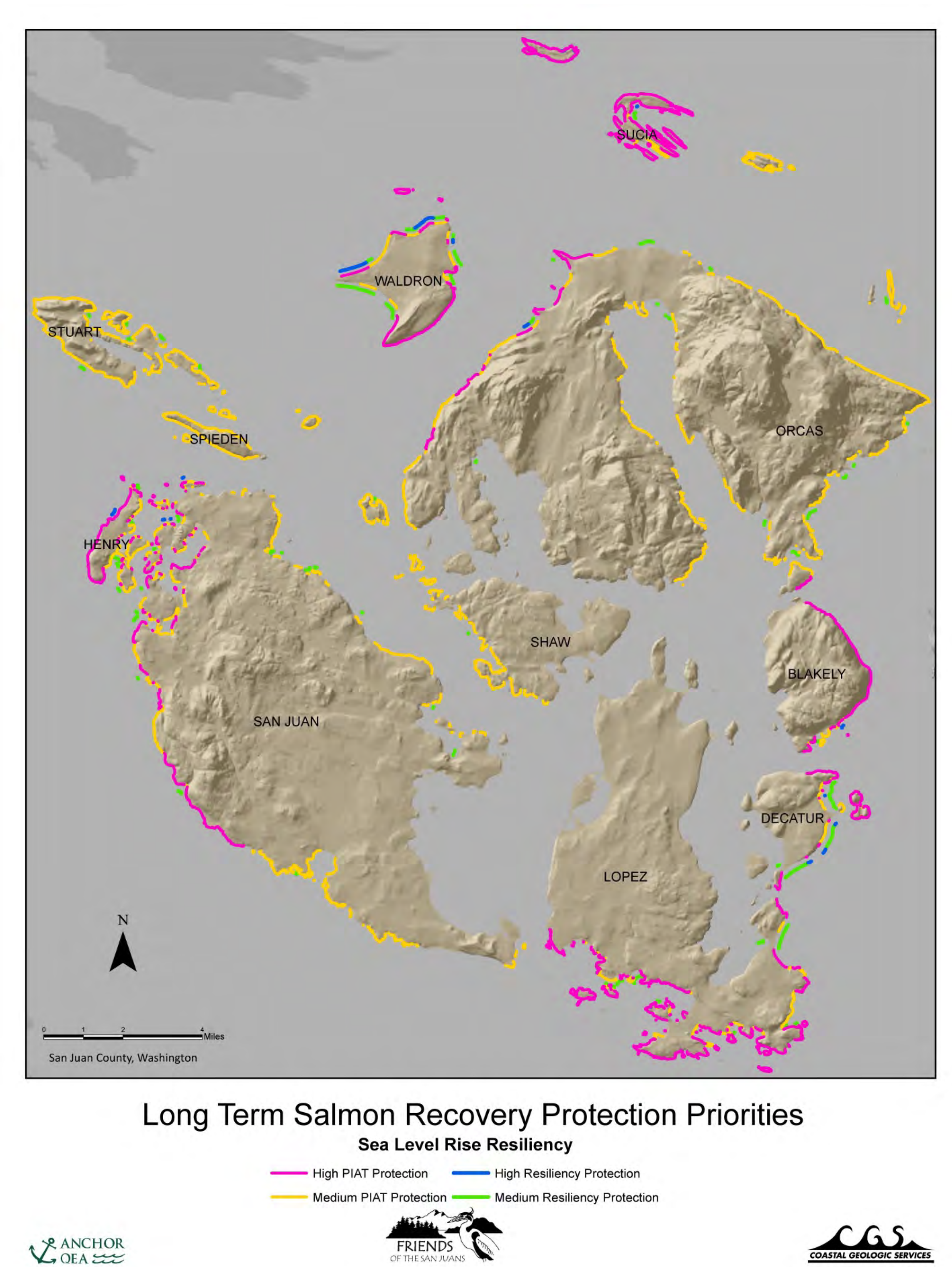
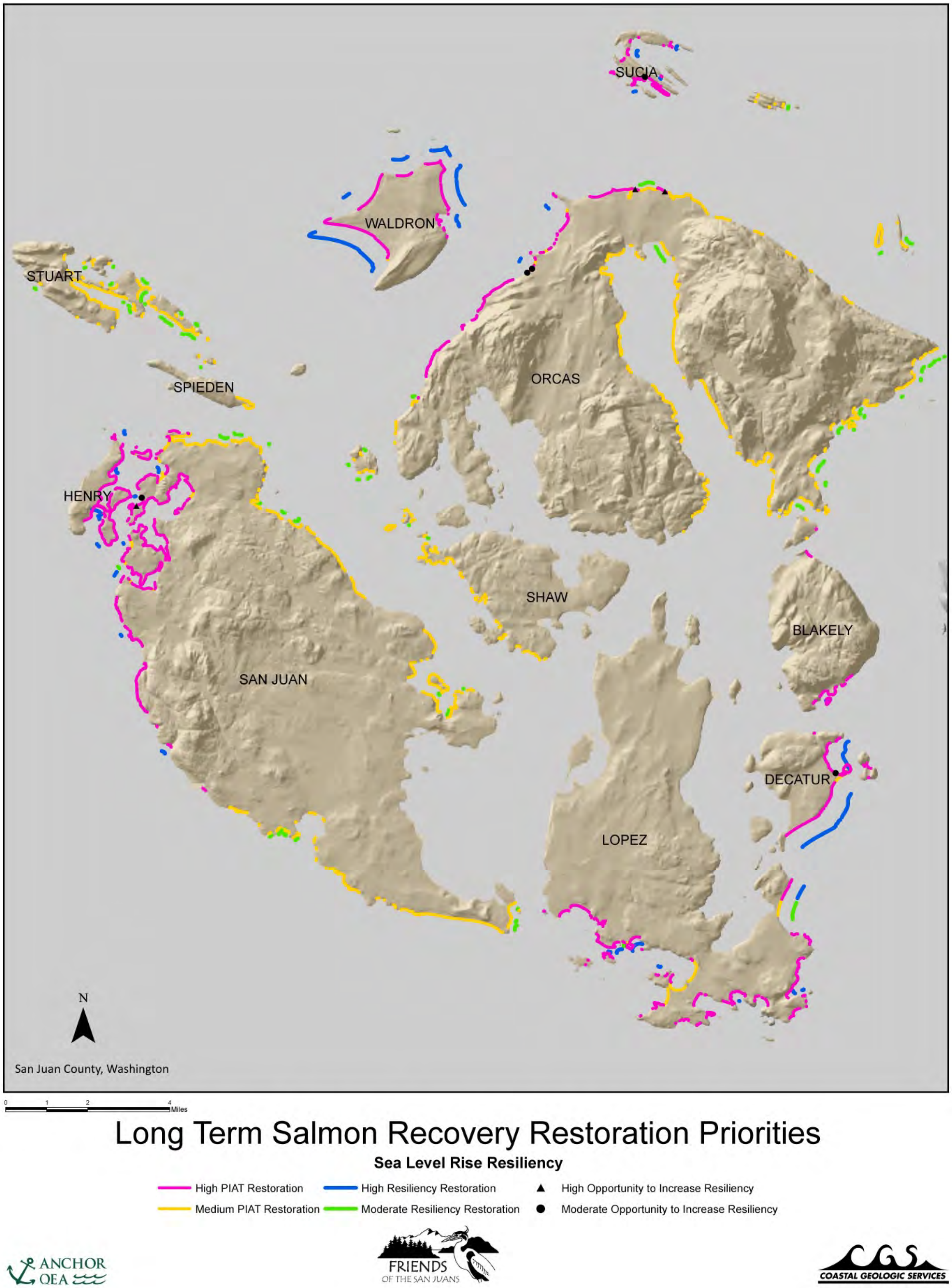


Figure 20. Long-term Restoration Priorities and Opportunities to Enhance Sea Level Rise Resiliency.



**Key Findings and Recommendations**

PIAT project results provide a landscape and shoreform scale approach to prioritizing salmon recovery efforts in San Juan County. Results can be applied directly to adaptive management and salmon recovery efforts in San Juan County, as well as to other relevant processes such as the Shoreline Master Program Update. While each stage of the project builds on the last, each stage of the project also provides valuable information on its own that may be applied in future efforts; as such, every key outcome is maintained as an attribute in the project's geodatabase. This supports application of project results in a multitude of ways instead of as a strict numerical list with no connection to the underlying data layers. For example one might focus work within one specific priority salmon recovery landscape region, or shoreform type, or work to ameliorate the impacts to a specific nearshore ecosystem process, or of a particular stressor. Or, more conventionally, start with the highest priority protection sites; move on to the medium sites, etc.

A summary of key findings and recommendations are provided below.

<u>Top Priority Landscape Regions and Associated Salmon Recovery Actions</u>

*Waldron Island/President's Channel:* The top salmon recovery action for this region is protection. With virtually all shorelines ranked as top or medium protection priorities, restoration of the minimally degraded sites in this region is also a top salmon recovery priority for San Juan County. The Waldron Island and NW Orcas sections of this region are dominated by drift cell systems, while the Sucia Island and West Orcas Island regions consist primary of rocky shores and pocket beaches. Overall nearshore processes throughout much of this important region are intact, or have low levels of degradation, providing significant protection and feasible restoration opportunities. Sections of shoreline on Waldron and Sucia Islands have detritus potential as the only stressor, so some opportunities to enhance marine riparian vegetation may exist, primarily along drift cell and pocket beach shoreforms. Significant public ownership exists within this landscape region, which may improve efforts to increase habitat condition, connectivity and positively influence landowner willingness factors. This region has the highest correlation with existing protection priorities and some correlation with restoration priorities, based on drift cell condition analysis and the presence of priority ecological communities (CGS 2010, FSJ 2008 and 2011). In terms of sea level rise resiliency, this is the top region for long-term protection and restoration projects, and also includes the highest number of sites where enhancement actions can increase resiliency.

*Rosario Channel SW:* This region along the eastern edge of the county has a high percentage of protection priority shoreforms. Shoreform distribution in this area is a combination of rocky shores, pocket beaches and drift cell systems. Nearly all of the shoreline is ranked as high or medium protection priority, with intact protection areas at the north Blakely Island portion of the region, and areas of low degradation that are top restoration (and medium protection) priorities located to the south along E. Decatur and SE Lopez shores. Some opportunity exists where detritus potential is the only stressor and riparian vegetation condition may be able to be enhanced (E. Decatur and SE Blakely). Highly degraded shoreforms are extremely limited in this region.  While no existing protection priorities were identified in this region, there is scattered public ownership which may provide some initial opportunity. There is significant overlap with existing restoration priorities for restoration projects along the east shorelines of Decatur Island.  After the Waldron/President's channel region, the Rosario Channel SW region has the highest long -term protection and restoration priorities based on resiliency to the effects of climate change and sea level rise as well as one site (Decatur Island) where enhancement action can improve resiliency to sea level rise.

*Strait of Juan de Fuca/S. Lopez*: This region has a fairly well balanced combination of protection and restoration needs. This landscape region consists exclusively of rocky shores and extensive pocket beaches. With a high percentage of high protection priority shoreforms, multiple feasible priority restoration opportunities also exist at many pocket beaches with low degradations scores. While the majority of the region has degradation scores of zero or the low range, considerable areas of highly degraded shores also exist along Agate Beach, Barlow Bay and MacKaye Harbor areas of south Lopez. The region has some long term protection and restoration sites with resiliency to sea level rise, primary smaller, dispersed sites, including intact or low degradation pocket beaches. There is some public ownership in the region, as well as some overlap with existing priorities, especially protection.

*Haro Strait NE:* The primary salmon recovery need in this priority region is restoration. The region has very few fully intact areas, primarily the rocky western shore of Henry and San Juan Islands along Haro Strait.  This landscape region is highly diverse, with all shoreforms represented including: rocky shores, pocket beaches, drift cells (feeder bluff, transport zone, barrier beaches), embayment estuaries and embayment lagoon shoretypes. Areas with minimal process degradation are concentrated along rocky shores. In contrast, pocket beaches and drift cells were a mix of moderate and highly degraded. The region has substantial integrated restoration priorities, the largest amount of any region in the county, mostly concentrated at the northern half of the region, in the more developed areas of Nelson, Westcott, Garrison and Mitchell bays. A few scattered sites exist (Henry, Pearl, Westcott Bay) where detritus potential is the only stressor and marine riparian enhancement could be conducted to improve conditions. A few scattered protection priority sites also exist, on north Henry and Pearl Islands. There is limited public ownership in this region, primarily located at English Camp National park, within Westcott and Garrison Bays. Many small sites are resilient to sea level rise; a few protection and most restoration priorities, mostly on pocket beaches.

<u>Sea Level Rise Resiliency</u>

Geomorphic shoreforms where resiliency to sea level rise was ranked as high or medium provide the potential for effective long-term salmon recovery actions, including restoration and protection. Landscape regions with larger sections of shorelines with high sea level rise resiliency as well as priority salmon recovery actions include Waldron Island/President's Channel (mostly Waldron and Sucia Islands) and Rosario SW (east Decatur Island and parts of SE Lopez). The Haro Strait NE, Rosario NE and Strait of Juan de Fuca-S. Lopez landscape regions provide multiple, smaller opportunities across scattered sites. Additional opportunities associated with climate change/sea level rise that would increase resilience while benefiting salmon habitat include the restoration of landward tidal estuaries and lagoons that are currently disconnected or degraded.

<u>Nearshore Processes Degradation</u>

*Primary Stressors:* Top stressors in San Juan County included armoring, tidal barriers, roads and overwater structures. Existing regulatory and voluntary tools can be used to reduce the proliferation of these common threats and promote transition (through removal, relocation or replacement with alternative designs) to more natural conditions. In addition, extensive restoration and protection opportunities exist with private and public landowners but lack a comprehensive approach to implementation. For example, pocket beaches, which are identified as critical salmon recovery priorities, have relatively low risk of erosion but are where a high proportion of armoring exists, indicating a disconnect between threat and response that could be addressed through improved education and/or policies. Long term maintenance of pocket beaches are at risk from armoring due to the minimal sediment input and slow evolution process of this geomorphic shoreform type (RITT 2012).

*Detritus Recruitment and Retention:* Process degradation results identify those shoreforms where detritus potential is the only impacted nearshore process. While many of these areas would not naturally support marine riparian vegetation (spits, rocky balds, etc.) those areas that have had vegetation removed provide a significant and relatively low cost, technically straightforward habitat improvement opportunity. Funds or educational efforts could be targeted towards marine riparian restoration and enhancement actions within priority regions.

*Freshwater Hydrology:* Process degradation results identify impacts to freshwater hydrology from increasing percentages of impervious surface within coastal drainage basins as a stressor to watch in San Juan County, with many areas nearing the threshold levels often identified as critical for the retention of watershed and ecosystem processes. Special attention is needed for watershed areas upland of embayments related to this nearshore process.

*Coastal Sediment Dynamics and Wind and Waves:* The most impacted shoreforms for these related nearshore processes include feeder bluffs and transport zones which showed the highest median impact at the countywide scale. Shoreform types that showed high individual impacts to the coastal sediment dynamics and wind and waves nearshore processes (up to 100% of some shoreforms) also included barrier beaches and embayment lagoons.

*Tidal channel formation and maintenance:* The most impacted individual shoreforms for tidal channel nearshore process include feeder bluffs, barrier beaches, pocket beaches and transport zones.

*Tidal hydrology:* Feeder bluffs are the shoreform type with the have highest median impact to the tidal hydrology nearshore process. Individual transport zones, barrier beaches and feeder bluffs are also highly impacted (up to 100%) in San Juan County for this process.

*Solar radiation:* The most impacted geomorphic shoreforms for solar radiation included feeder bluffs, pocket beaches, transport zones and rocky, which showed impact ranging to 25%.

Shoreline Designation

Approximately one third (41 miles) of the highest priority fish use regions identified by the PIAT assessment are not currently designated as Conservancy or Natural under the Shoreline Master Program. In addition, 36% (78 miles) of intact (nearshore process degradation score of zero) marine shorelines are also not designated as Conservancy or Natural under the current Shoreline Master Program. The Shoreline Master Program Update provides an opportunity to improve long-term protection of intact and priority shorelines through re-designation of top priority and intact shoreforms.

Additional Research and Analysis

*Freshwater Systems:* A lack of county-wide data sets on freshwater systems in San Juan County limited the scope of this strategic planning effort to the marine nearshore environment. Additional work is needed to improve understanding of freshwater systems at the county, watershed and individual stream scales. Once stream typing, fish presence studies and mapping data on the location and type of freshwater stressors such as diversions, stream crossings and dams is completed by Wild Fish Conservancy, the Lead Entity and Salmon TAG can review spatial results with PIAT nearshore results to complete a comprehensive update of the Salmon Recovery Work Plan.

*Other Salmon:* - While the focus of this effort was wild juvenile Chinook salmon, results of the degradation analysis and the framework for identifying geographic priorities could be applied to the identification of priorities for hatchery fish, as well as for additional species of salmon. For example, outmigrating juvenile Chinook of hatchery origin were most common in the Eastsound and Lopez/Blakely Sound landscape regions (Beamer and Fresh 2012). Restoration and protection needs identified by this process in those regions could be targeted to directly benefit locally produced hatchery Chinook.

**Conclusions**

While improved long term protection of intact habitat in priority regions remains the top salmon recovery strategy for San Juan County, salmon recovery actions for San Juan County include restoration or other physical alterations, as well as changes in management, through voluntary or regulatory means. For example, changes to shoreline use designations under the Shoreline Master Program or other regulatory approaches such as the Critical Areas Ordinance could be employed to improve protection of remaining intact habitats and processes in priority shoreforms and regions. Conservation organizations and the county can use acquisition, easement or the current use tax benefit rating system as tools to target protection efforts by landscape region, geomorphic shoreform and/or nearshore process. Process degradation results support the development of restoration strategies that address top stressors and/or maximize the number of nearshore processes impacted, improving the efficiency and effectiveness of recovery actions.

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