DOCUMENTED SURF SMELT AND PACIFIC SAND LANCE SPAWNING BEACHES IN SAN JUAN COUNTY WITH A SUMMARY OF PROTECTION AND RESTORATION PRIORITIES FOR FORAGE FISH HABITAT

FINAL REPORT

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Background

With the listing of many Puget Sound salmon stocks as threatened or endangered, the issue of maintaining forage fish stocks has been identified as a high priority. All the important forage fishes in our region (Pacific herring, surf smelt and Pacific sand lance) depend on nearshore marine habitats for spawning and rearing. Protection of nearshore habitats utilized as spawning and rearing areas for forage fish will be required if salmon recovery is to be successful.

Other priority fish and wildlife species in San Juan waters that depend on forage fish as critical prey resources include six stocks of Puget Sound rockfish; multiple species of seabirds, including the federally threatened marbled murrelet; and our resident marine mammal species. The same forage fish species and spawning habitat of interest in salmon recovery will also be vital for the protection and restoration of these additional key marine species.

The Washington Department of Fish and Wildlife (WDFW) presently endeavors to protect all known, documented surf smelt and Pacific sand lance spawning beaches from impacts of shoreline development. "No Net Loss" regulations for the protection of known forage fish spawning sites are included in the Washington State Administrative Code "Hydraulic Code Rules" (WAC 220-110). Washington Department of Fish and Wildlife conducted the intertidal baitfish spawning beach survey project from 1991 through 1997, with the goal of documenting spawning beaches of the surf smelt and the Pacific sand lance throughout Puget Sound. In 1997, the project was de-prioritized and lost the majority of its funding, despite incomplete assessments for northern Puget Sound. Because habitat protections are provided to documented spawning sites, not potential spawning beaches, the cooperative San Juan County (SJC) Forage Fish Project was developed as a means of completing the spawning habitat inventories in the San Juan County portion of northern Puget Sound.

Project Partners

The **San Juan County Forage Fish Habitat Assessment Project** was initiated in 2000. Project partners and roles include:

Friends of the San Juans (FSJ) manages the project. FSJ provides project coordination, design, protocols, training, field staff, data analysis and reporting. FSJ recruits and manages volunteers and coordinates field training and community outreach.

The **San Juan County Marine Resources Committee** (MRC) co-manages the project and assists with project design, protocols, training, community outreach, data analysis, and reporting. Dr. Lawrence Moulton, acting as the MRC forage fish coordinator, assisted with project design, protocols development, training of personnel in the use of field protocols, analysis of field and laboratory data, and reporting of sampling results.

Washington Department of Fish and Wildlife, through Dan Penttila, provided protocol development, field and lab training, technical expertise and project quality assurance and quality control. A 29-year member of the Washington Department of Fish and Wildlife (WDFW), Penttila is the fish biologist who first discovered Pacific sand lance spawning depositions on Puget Sound beaches. Penttila has led the research and inventory of surf smelt and Pacific sand

lance spawning habitats throughout Puget Sound and the Washington Coast. Through an interlocal agreement, Penttila assists the forage fish project, and provides training, technical review and quality assurance/control. He authored the paper on surf smelt egg survival as it relates to riparian shade and coauthored the protocol now in use for mapping forage fish spawning habitat. Washington Department of Fish and Wildlife applies San Juan County Forage Fish Project data in its Hydraulic Project Approval Process.

University of Washington Friday Harbor Laboratories provides technical and lab support for sample analysis.

San Juan County applies forage fish project data to the review and action of shoreline project applications. Direction from the Board of County Commissioners to all County Department Heads in a Memorandum of Understanding (MOU) addresses the role of forage fish data. The MOU states that through the Marine Resources Committee, the county is participating in the inventory and mapping of nearshore habitat for spawning forage fish. The data collection and mapping protocols are designed and controlled to ensure that the product represents the "best available science" to identify spawning habitat. The memorandum instructs all county department directors to use the information. See *Appendix A: San Juan County "Best Available Science" Forage Fish Spawning Habitat Memorandum.*

Funding for the San Juan County Forage Fish Project has been provided by the generous support of: The Washington State Salmon Recovery Funding Board, The Northwest Straits Commission, The SeaDoc Society (formerly the Marine Ecosystem Health Program), NOAA/FishAmerica, The Russell Family Foundation, The Bullitt Foundation, Duraboat, Town of Friday Harbor, The San Juan County Marine Resources Committee and the National Fish and Wildlife Foundation.

Protocol Development and Potential Habitat Mapping

The purpose of the San Juan County Forage Fish Project was to document nearshore habitat supporting forage fish spawning activity within San Juan County. Once identified, these habitats may be adequately protected under existing Washington State Administrative Code (Hydraulic Code WAC 220-110) and the San Juan County Shoreline Master Program. In addition, initial protection and restoration priorities for forage fish habitat were identified and a nearshore marine education campaign was implemented.

Phase 1 of the SJC Forage Fish Project reviewed the status of existing information on forage fish spawning locations in the county and adapted Washington Department of Fish and Wildlife field and lab protocols for documenting surf smelt and Pacific sand lance spawning sites. This portion of the study was funded by a grant from the Northwest Straits Commission. The protocols were developed for use throughout the northern Puget Sound region so that surveys of spawning areas in other counties would employ consistent methods. Field and lab protocol were adapted from established WDFW methodology and written out for repeatable application and use by trained biologists across the region. In surveys conducted in San Juan County from 1989 to 1999, Washington Department of Fish and Wildlife documented 14 surf smelt and eight Pacific sand lance spawning sites (Penttila 1999). See *Appendix B: Forage Fish Spawning Distribution in San Juan County and Protocols for Sampling Intertidal and Nearshore Regions* and *Appendix C:*

In Consideration of the Sustenance of Salmon. Updating Critical Area Ordinances with Best Available Science: A Forage Fish Story for more information on initial steps of the Forage Fish Project.

Following protocol development and the summary of existing information, the Forage Fish Project identified and mapped the distribution of potential surf smelt and Pacific sand lance spawning beaches within San Juan County. Aerial photo analysis with follow-up field verification at a subset of the sites identified over 600 beaches (roughly 80 miles) of potential spawning habitat in San Juan County. Once potential spawning habitat was mapped, it was overlaid with county ownership maps to identify land ownership of potential spawning beaches for outreach activities. Over 1,700 individual owners with potential forage fish spawning habitat received introductory information on the San Juan County Forage Fish Project. See *Appendix D: Distribution of Potential Surf Smelt and Pacific Sand Lance Spawning Habitat in San Juan County* for more information on potential habitat mapping and initial shoreline landowner contact.

Database Development and Methodology

The Forage Fish Project database has the ability to view, analyze and trace to its original source, all the data collected. Information is compiled in an interactive tabular and spatial database, with linked digital imagery of field and lab reports and beach images. The use of linked imagery in the database allows the database user to verify the accuracy of the data entry and where a field surveyors comments were difficult to interpret, the original text and source has been preserved. All descriptive fields that use a standard coding per Washington Department of Fish Wildlife field and lab protocols are similarly coded and the data is entered via lookup tables that ensure accuracy. The database was developed to be compatible with both San Juan County and Washington Department of Fish and Wildlife internal mapping systems and its structure is used throughout the northern Puget Sound region by other forage fish and nearshore habitat projects.

The spatially explicit Arc View Forage Fish Project database includes historic Washington Department of Fish and Wildlife forage fish spawning habitat data, as well as additional nearshore variables including locations of eelgrass and county and state shoreline maps. This geographic information systems project contains spatial links to the forage fish project photos and is connected to the tabular Access database. One particular feature of this connection is programming that allows the user to link to the Access database data viewing and editing forms by clicking on a survey site point in Arc View. All maps contained in this report can be found within the Arc View project.

Training and Volunteers

Citizen involvement has been a primary objective of the San Juan County Forage Fish Project. Nine volunteer trainings were held on six islands (Orcas, San Juan, Shaw, Waldron, Stuart and Lopez) over the three years of the San Juan County Forage Fish Project, providing classroom and field sessions on the biology and habitat of forage fish as well as field training of the survey protocol. 75 citizens participated in the forage fish trainings and assisted with forage fish field surveys. Volunteers provided 1083 hours of assistance to the forage fish project. 754 hours

devoted to field surveys and 329 hours in training and educational events. See *Appendix E: San Juan County Forage Fish Volunteer Photos.*

Spawning Habitat Surveys

Identification of Potential Spawning Habitat

Phase 1 of the San Juan County Forage Fish Spawning Habitat Assessment Project used aerial photo analysis and field verification to identify 631 potential surf smelt and Pacific sand lance spawning sites on 25 islands in the San Juans. Original potential spawning habitat distribution for San Juan County included 80 miles of potential spawning habitat. Of the original 631 potential spawning sites, 579 (92%) received field visits by certified Forage Fish Project survey staff. 67 (11%) of the mapped potential spawning habitat beaches, as identified in Phase 1: Potential Habitat Mapping, were determined at the time of the field visit to be unsuitable spawning habitat. Bulk samples were not collected from these sites, and the 4.4 miles were removed from the overall potential spawning habitat distribution. This reduction in actual potential habitat matches results from the field verification phase of potential habitat mapping conducted on Shaw Island and was an expected project outcome (Moulton 2000). In the course of field surveys an additional 26 potential spawning sites were identified, sampled and added to the overall potential forage fish spawning habitat maps for San Juan County, adding just under a mile of new potential spawning habitat. For an adjusted total of 590 potential spawning sites and just under 77 miles of potential forage fish spawning habitat. See *Figure 1. Distribution of Potential Spawning Habitat in San Juan County.*

Field Surveys

Between July of 2001 and December of 2003, 1251 bulk samples and forage fish field surveys were collected from 538 sites on 24 islands, representing 91% of potential spawning habitat San Juan County. Nine percent of potential spawning sites were not sampled as a result of: existing protected status (e.g.: total length in preservation lands), physical access issues, time constraints or a lack of landowner permission (just 17 sites out of 590 potential spawn beaches were not sampled due to denied access). Of the sampled sites, 254 (47%) were sampled one time and 284 (53%) were visited a minimum of two (and up to 11) times. See *Figure 2. San Juan County Forage Fish Project Sample Sites.*

At each survey site with suitable potential habitat, a bulk substrate sample was collected to determine evidence of spawn. Additional information on a variety of nearshore habitat variables was also recorded during field surveys. Variables recorded at each station included: latitude/longitude; tidal elevation; coded entries for beach substrate type, sample transect elevation, shade, spawn evidence and density; spawn incubation habitat width, potential spawn habitat length, and upland conditions. In addition, the presence of docks, eelgrass beds, seawalls, freshwater influence, outflow pipes, boat ramps and other major beach features were recorded. A digital photograph of the sample beach, with a latitude/longitude and date/time recorded on every photo, was also taken with each sample. See *Appendix F: Forage Fish Project Field Survey Sheet.*

Outreach and Education

Shoreline Landowners

As the day-to-day managers of forage fish spawning habitat in San Juan County, shoreline landowners were a major focus of information and outreach efforts related to the Forage Fish Project. Prior to initiating any field surveys in 2001, a mailing was sent to all landowners with potential forage fish spawning habitat (over 1,700) describing the forage fish project and requesting access for field survey work. As the project was implemented, personal communication between the project coordinator and shoreline landowners was ongoing, with more than 200 shoreline landowners receiving detailed information about the forage fish survey project. Over 100 shoreline landowners were present on their beaches at the time of the field survey. A Forage Fish Project update and thank you was mailed to 244 shoreline landowners. See *Appendix G: Forage Fish Project Outreach to Shoreline Landowners.*

Youth Programs

A variety of school and youth groups are involved in the San Juan County Forage Fish Project. Over three hundred local youth have participated in the project to date. Student participation has involved classroom, field and lab sessions and nearshore fish seines. Students learn about the significance of forage fish in the marine food web and the importance of healthy beach habitat for spawning. Students are also introduced to the field and lab protocol and the use of the scientific method and equipment to conduct applied research. To meet demand for ongoing educational programs relating to the forage fish project, Friends of the San Juans has secured funds to host a workshop in the summer of 2004 for local educators with the University of Washington Marine Labs Outreach Program. For photos of local students conducting Forage Fish Project field and lab activities, see *Appendix H: SJC Forage Fish Project- Youth Photos.* Specific schools and youth groups involved in the forage fish project are described below:

- Shaw Island 4-H: forage fish classroom, field, lab, poster presentations and nearshore habitat restoration. Fall 2003- current.
- YMCA Camp Orkila Marine Day Camp: forage fish classroom, field and lab. Summer 2002 and 2003.
- YMCA Camp Orkila's At Risk Urban Youth Program: forage fish field and lab. Spring 2003.
- Waldron School: forage fish classroom, field and lab. Fall 2003-current.
- Stuart School: forage fish classroom, field and lab. January through June 2003.
- Friday Harbor Middle School: forage fish classroom, field and lab, January 2003 through January 2004.
- Orcas Alternative Public School Program: forage fish classroom, field and lab. Fall 2003-current.
- Spring Street School: forage fish classroom, field and lab. Fall 2003.
- Lopez School: 8th Grade Community Service Project: forage fish classroom, field and lab. Spring 2003.

Student Interns

Six student interns participated in the San Juan County Forage Fish Project. Interns ranged from high school to the graduate school level. Interns assisted with a variety of tasks based on their interests and experience. Participants and projects included: Friday Harbor High School students who conducted forage fish research, writing and volunteer workshop preparation; a University of Washington School of Marine Affairs graduate student who wrote a white paper on Best Available Science; a Rollins College student who conducted forage fish lab analysis; a Spring Street School High School student who assisted with forage fish field and lab activities; a Western Washington University student who helped coordinate and implement a forage fish habitat restoration pilot project; and two University of Washington law students who assisted with forage fish field surveys.

Community Programs

In addition to outreach and education efforts targeted to specific groups (students, shoreline landowners,) information on the forage fish project has been presented to San Juan County residents in a variety of ways, including displays at public events, targeted training sessions, articles in local and regional papers and a National Public Radio story that reached over 3 million listeners. The objectives of community outreach efforts were to increase the general understanding and awareness of the community as to the presence and significance of forage fish in the marine ecosystem and the importance of healthy beach habitats for spawning sites. Efforts were made to coordinate with ongoing marine education efforts, especially those focused on salmon, orca whales or the nearshore marine environment.

Forage fish displays were presented at both the San Juan County Fair and the Orcas Library Fair in 2001, 2002 and 2003. In cooperation with The Whale Museum, a nearshore habitat exhibit was developed and on exhibition at the museum in 2001. A short presentation on the "Ecological role of forage fish" was made at the San Juan Island Earth Day Festival, in April of 2003. The Forage Fish Project coordinator staffed the forage fish lab for The University of Washington Friday Harbor Labs Bi-Annual Open House in 2003. Forage Fish and Eelgrass displays were posted at numerous public workshops and special events, such as the Salmon People- San Juan Community Theater event, community Marine Resources Committee meetings and the Waldron Island Community Fair. See *Appendix I: SJC Forage Fish Project-Educational Posters.*

Forage fish and nearshore habitat field sessions were held at annual Friends of the San Juans meetings, in September 2002 and 2003. Forage fish and nearshore marine habitat training was provided to new Outdoor Education and Salmon Center staff at YMCA Camp Orkila, each fall since the project's inception. A forage fish and nearshore marine habitat session was provided for the San Juan County Conservation District's Watershed Stewardship training program in the fall of 2003. A forage fish and nearshore marine habitat Educator's Toolkit was produced in 2001 and distributed to 40 local and regional educators. See *Appendix J: Educator's Toolkit-Cover and Contents.* Nine volunteer trainings were held on six islands, with 75 community members trained to assist with field surveys. In-field outreach was conducted with over 150 members of the general public over the course of field surveys; these interactions occurred primarily at public beaches and marine parks.

Articles on the role of forage fish in the marine ecosystem (and the SJC Forage Fish Project) were published in the Audubon Society's San Juan Island chapter newsletter (*The Trumpeter vol. 22 no. 3*), November 2003 and in the Skagit Fisheries Enhancement Group's 2003 winter/spring newsletter. Numerous articles on forage fish and nearshore marine habitats were published in the Friends of the San Juans quarterly newsletters. Volunteers from the San Juan County Forage Fish Project were highlighted in the Puget Sound Action Team's *2003 Report to the Legislature* and the project was also covered in The Northwest Straits Commission *Benchmark Report* in 2004. Extensive outreach efforts were made with local media and the forage fish project was covered numerous times. See *Appendix K: San Juan County Forage Fish Project Media.*

Data Distribution

The initial focus of the San Juan County Forage Fish Project was to identify forage fish spawning beaches and get the information on documented spawning sites to land managers charged with protecting known spawn locations, primarily the Washington Department of Fish and Wildlife, San Juan County and the Army Corps of Engineers.

Survey results of documented spawning sites were regularly distributed to WDFW and SJC. Three major distributions of data were provided to over seventy-five local, regional, state, federal and tribal governments; non-profit organizations; and private industry (predominately land use consultants). The comprehensive data distributions included a cover letter describing documented spawn locations, map sets and data disks with spatially explicit spawn habitat data for San Juan County in both PDF and Arc View formats. Large data distributions occurred in April of 2002, April of 2003 and February of 2004. See *Appendix L: San Juan County Forage Fish Project Distribution Map Set and Disk.*

In addition to communications regarding documented spawning habitat data, information on the overall San Juan County Forage Fish Project was presented to local and regional coastal scientists and land managers at numerous events over the three years of the project. Presentations covered project protocol, partnerships, documented spawn sites, the nearshore habitat database, education and involvement activities, application of the data and the identification of protection and restoration priorities. See *Appendix M: Example SJC Forage Fish Project Power Point.*

The survey portion of the Forage Fish Project concluded with two public presentations of results to policymakers:

1. Forage fish habitat, regulation and best available science training held for all San Juan County staff (and interested state park, national park, consultant, and non-governmental organization staff scientists, managers and planners), January 2004. See *Appendix N: County Forage Fish In-Service- Agenda and Participant List.*
2. Presentation to The Northwest Straits Commission Evaluation Committee, January 2004.

Additional forage fish project presentations to land managers included:

- Presentation at the annual Northwest Straits Commission/Marine Resources Committee Conference, November 2003.
- Shared Strategies Regional Salmon Coordination Meeting, November 2003.

- Poster Presentation at the Puget Sound Salmonid Conference, October 2003.
- Presentation and field trip with U.S. Department of Interior staff, August 2003.
- Poster Presentation at the Georgia Basin- Puget Sound Marine Research Conference, March 2003.
- Presentation to The Northwest Straits Commission Board, January 2003.
- Forage fish presentation at the Marine Ecosystem Health Project Conference, September 2002.
- Forage fish display at the Northwest Straits Commission/Marine Resources Committee Annual Conference, 2002.
- Monthly updates to: San Juan County Marine Resources Committee, Salmon Recovery Funding Board Lead Entity, Northwest Straits Commission, Washington Department of Fish and Wildlife and the San Juan County Planning Director, 2001-2003.

Survey Results

The San Juan County Forage Fish Project documented positive surf smelt or sand lance spawn at 50 beaches in San Juan County, 39 (62%) of which were previously undocumented spawning sites. Coupled with the historic Washington Department of Fish and Wildlife data, 63 discrete spawning locations are documented for San Juan County, representing 11% of potential spawning sites and 16% of potential spawning habitat by length. See *Figure 3. WDFW and SJC Forage Fish Project Documented Spawning Sites*.

Surf smelt spawn has been documented at 59 sites in San Juan County, while Pacific sand lance spawn activity has been documented at eight beaches. Four sites, Jackson's Beach and Cattle Point on San Juan Island, and two Mackaye Harbor sites on Lopez Island, are documented to contain both surf smelt and Pacific sand lance spawning sites. From the 81 positive samples collected at 63 discrete spawning beaches on eight islands in San Juan County, a total of 12.66 linear miles is now protected under "no net loss" regulations as documented forage fish spawning habitat.

Documented spawn sites include: two surf smelt sites on Blakely Island (0.24 miles protected); one surf smelt site on Decatur Island (0.16 miles protected); 17 sites on Lopez Island (three Pacific sand lance and 16 surf smelt, 6.16 miles protected); 11 sites on Orcas (two sand lance and nine surf smelt, 1.3 miles protected); 17 sites on San Juan Island (three sand lance and 16 surf smelt, 2.7 miles protected); 13 sites on Shaw Island (all surf smelt, 1.8 miles protected); one surf smelt site on Stuart Island (0.15 miles protected) and one surf smelt site on Waldron Island (0.15 miles protected). See *Figure 4. Documented Surf Smelt and Pacific Sand Lance Spawning Sites in San Juan County.*

The San Juan County Forage Fish Project also identified evidence of spawn activity (one-egg sites that do not meet the legal protocol requirement of two eggs for WAC protection) at nine additional locations on four islands. These include one-egg surf smelt sites on Orcas and Lopez Islands and one-egg Pacific sand lance sites on Orcas (four sites), Lopez (one site) and Waldron (one site). See *Figure 5. Spawn Evidence Sites in San Juan County* for the locations of 1-egg sites.

Application of Forage Fish Data: Results and Discussion

Initial analysis of the Forage Fish Project database has identified a range of protection and restoration priorities for forage fish habitat in San Juan County. Application of data from the San Juan County Forage Fish Project provides an objective, resource-based method of identifying project types and prioritizing sites for nearshore protection and restoration efforts. The Forage Fish Project database supports spatial and tabular identification of a wide range of protection and restoration variables as well as detailed overlays of multiple factors to identify priority habitats. Preliminary analysis has been completed for the following parameters: existing land protections, marine riparian protection priorities, freshwater influence, roads along the backshore, stormwater impact, seawalls and bulkheads, and marine riparian restoration priorities. Each parameter is then sorted depending on its impact to documented or potential forage fish spawning habitat in San Juan County, providing the first phase of prioritization.

The documentation of positive spawning sites and the identification of critical forage fish habitat regions that has been completed by the SJC Forage Fish Project greatly improves the efficiency and effectiveness of protection and restoration efforts by targeting the most significant habitats in San Juan County. Protection strategies include securing long-term preservation of forage fish habitat through improved land management by public and private entities, direct acquisition and conservation easements designed to meet specific nearshore marine habitat objectives. Preliminary restoration analysis focuses attention on seawalls, stormwater, shoreline vegetation and roads. Results of the initial protection and restoration analysis from the San Juan County Forage Fish Project are outlined below.

Critical Nearshore Habitat-Priority Forage Fish Regions

The San Juan County Forage Fish Project has identified four priority forage fish spawning habitat regions in the county. Information on these significant nearshore marine habitats is provided to San Juan County planners for inclusion in the critical areas update to the Comprehensive Plan. Information on Pacific herring, surf smelt and Pacific sand lance were included in the identification of priority nearshore habitat regions. Priority forage fish spawning regions were identified in consultation with the Washington Department of Fish and Wildlife and share the following characteristics:

1. Spawn activity of multiple species of forage fish documented in region.
2. Multiple spawning sites documented in close proximity.
3. Spawn activity documented in multiple seasons.
4. Spawn activity documented in region by historic WDFW surveys (1989-1999) and by the San Juan County Forage Fish Spawning Habitat Assessment Project (2000-2003).

The four priority forage fish nearshore habitat regions identified for San Juan County are:

A. Mud/Hunter Bay Region, Lopez Island
   - Eight surf smelt spawning sites.
   - Pacific herring spawn activity throughout the entire region.
   - Forage fish spawn activity noted February, March, April, May and September.

B. Westsound and Blind Bay Region, Orcas and Shaw Islands
    - 20 surf smelt spawning sites.
    - Three Pacific herring spawning sites.
    - One Pacific sand lance spawning site.
    - Forage fish spawn activity noted March, May, June, July, August, September, and November.

C. Mackaye Harbor Region, Lopez Island
    - Six surf smelt spawning sites.
    - Two Pacific sand lance spawning sites.
    - Forage fish spawn activity noted March, May, August, November, December, and January.

D. Greater Westcott Bay Region, San Juan Island.
    - 12 surf smelt spawning sites.
    - Pacific herring spawning throughout the region.
    - Forage fish spawn activity noted May, June, August, September, November, December, January, February, March and April.

See *Figure 6. Critical Nearshore Habitat-Priority Forage Fish Spawning Regions In San Juan County* for a map of priority forage fish regions.

Existing Protections

San Juan County Forage Fish Project beaches with their entire length in San Juan County Land Bank, San Juan Preservation Trust, The Nature Conservancy or University of Washington land ownership are categorized as protected sites based on the long-term management objectives of these organizations. One documented surf smelt spawning site is currently protected, representing just over 1.5% of the total number of documented spawning sites. A pocket beach on Lopez Island located on the San Juan County Land Bank's Upright Head Preserve is the one documented spawning site currently in protected status. Less than one mile of potential or documented forage fish spawning habitat is currently protected under existing land ownership and management conditions in San Juan County. Five islands have forage fish habitat beaches in protected status, including one documented spawn site on Lopez Island (177 ft.), two potential spawn sites on San Juan Island (341 ft), six potential spawn sites on Shaw Island (2,088 ft), one potential spawn site on Stuart Island (1,367 ft), and three potential spawn sites on Yellow Island (466 ft).

Beaches with their entire length in San Juan County Parks, United States Coast Guard, Washington State Parks, National Parks, or Washington Department of Natural Resources lands are categorized as moderately protected forage fish spawning habitat. While these sites are publicly owned and unlikely to host major development activities over the long term, they are also common locations for shoreline modifications that can negatively impact forage fish habitat, most frequently docks and boat ramps. Nine documented surf smelt or sand lance spawning sites are located on National Parks (seven), State Parks (one) and County Parks (one) lands on Lopez

and San Juan Islands, representing 15% of documented spawning sites. A one-egg spawn evidence site is also located on San Juan County Park property on Lopez Island.

64 potential or documented forage fish spawning beaches are moderately protected under existing ownership and management conditions in San Juan County, representing 8.8 miles (11%) of habitat. These include five sites on James Island (1,407ft), six sites on Jones Island (1,949ft), three sites on Lopez Island (8,196ft), six sites on Matia Island (1,534ft), five sites on Orcas Island (1,278ft), four sites on Patos (924ft), 15 sites on San Juan (22,615ft), one site on Shaw Island (160ft), three sites on Stuart Island (1,749ft), 12 sites on Stuart Island (5,469ft), and four sites on Turn Island (2,017ft). See *Figure 7. Protected Forage Fish Habitat in San Juan County.*

Riparian Habitat Protection

Riparian habitat plays an important role in the health of the nearshore marine environment. Coastal forests provide shade to forage fish spawning habitat, bank stability, water quality protection, food web input through detritus and prey items and a source of large, woody debris which can help build backshore areas. Research conducted across Puget Sound by Penttila (2001) found that egg survival of incubating summer surf smelt was significantly higher at beaches with good shade and intact marine riparian forests, suggesting that attention should be paid to protecting these habitats. Analysis of the SJC Forage Fish Project nearshore habitat database provides a first-level identification of priority marine riparian protection sites in documented and potential forage fish spawning habitats.

Seven documented forage fish spawning sites with greater than 75% shade were identified as high priority sites for marine riparian protections efforts, one site on Orcas, and three each on San Juan and Shaw Islands. An additional 36 potential forage fish spawn habitat sites with 75% or greater shade values were identified, representing the next level of prioritization for marine riparian habitat in the county. Shade values are characterized for individual survey sites, not entire beach lengths, so one forage fish beach could have a variety of shade conditions at different locations along its length. The spatial nature of the database identifies the exact location of those sites with high shade value along any particular beach length. These areas can then be targeted for additional site analysis and inclusion in habitat protection strategies, including acquisition and easement plans of public entities and private land protection organizations such as the San Juan County Land Bank and the San Juan Preservation Trust. See *Figure 8. Priority Marine Riparian Habitat at Potential and Documented Forage Fish Spawning Sites in San Juan County.*

Freshwater Seeps, Springs or Streams

The presence of natural, freshwater influences to forage fish spawning habitat is thought to improve microclimate conditions and potentially influence success of spawning by forage fish. Freshwater influence is also an important ecological factor for additional, non-forage fish, salmon recovery goals for San Juan County. Freshwater influence was recorded in the notes section of the forage fish field surveys and can be used to aid in the prioritization nearshore marine habitat protection efforts. 27 forage fish project beaches with freshwater influence were

documented in the San Juans, including one site on Blakely Island, two on Lopez Island, 15 sites on Orcas Island, two on Shaw island and seven on San Juan Island, representing 4% of total potential spawning beaches. Five freshwater influence sites are located on documented spawning beaches (7% of documented sites), including surf smelt sites on Lopez, Blakely and Orcas Islands and a Pacific sand lance site on San Juan Island. Freshwater influence was also noted on two Pacific sand lance sites on Orcas Island. This estimate is conservative as forage fish field protocols targeted survey points at greater than 1,000 ft. intervals along potential spawning beaches and likely missed some freshwater influence sites. Overlaying the documented and potential forage fish spawning habitat maps with the county stream layer can identify additional freshwater influence on forage fish beaches. See *Figure 9. Freshwater Influence on Potential and Documented Forage Fish Spawning Habitat in San Juan County.*

Riparian Vegetation Restoration

Marine riparian vegetation plays an important role in the overall health of the nearshore environment. In areas where vegetation is removed, damaged, or altered, the nearshore habitat is negatively affected both directly through sedimentation and indirectly through changes in nutrient flow, shading, and presence of large woody debris. Analysis of the San Juan County Forage Fish Project nearshore habitat database identified priority marine riparian vegetation restoration sites in potential and documented forage fish spawning habitats. Roughly 1,000 forage fish field survey sites with shading of less than 50% were documented in the course of field surveys. Shade values of less than 50% were noted during 64 field surveys on 42 documented forage fish spawning beaches. Shade values are characterized for individual survey sites, not entire beach lengths, so one forage fish beach could have a variety of shade conditions at different locations along its length. These preliminary results indicate that roughly two-thirds of documented forage fish spawning sites in San Juan County have at least some portion of their length limited in terms of marine riparian vegetation and shading of incubating eggs. The spatial nature of the database identifies exact locations with low shade value along any particular beach length, facilitating next steps in project prioritizations and development. These sites can be targeted for additional site analysis and inclusion in habitat restoration strategies, such as the marine riparian restoration pilot projects currently underway. See *Figure 10. Marine Riparian Restoration Priorities for Forage Fish Habitat in San Juan County.*

Roads

A major, existing impact to forage fish spawning habitat in San Juan County are roads located along the backshore. Road installation, long-term presence, and maintenance activities are potentially or currently impacting coastal processes and beach habitat. Potential forage fish spawning beaches with roads in close proximity were noted during forage fish field surveys. 34 forage fish beaches were identified as having roads located along the backshore, for a total of 14.12 miles of documented or potential forage fish spawning habitat with existing roads. Of these beaches, 11 are documented forage fish spawning beaches (eight documented surf smelt sites, two documented Pacific sand lance sites, one documented surf smelt and Pacific sand lance spawn site and two one-egg sites), for a total of 7.8 miles of spawning beach impacted by roads. Forage fish project staff have met with and provided forage fish information to the San Juan County Public Works Department Director and county project engineers. Additional distribution

of spawning habitat data and discussions of improved road development and maintenance strategies will be conducted with road department staff to minimize impacts of future actions. See *Figure 11. Potential and Documented Forage Fish Spawning Habitat in Close Proximity to Roads in San Juan County.*

Outflow Pipes/Stormwater Drainage

Information on potential pollution impacts to forage fish spawning habitat was noted in the course of forage fish surveys by recording the presence of outflow pipes in the field. Ten outflow pipes were noted at forage fish project beaches; two on documented surf smelt spawning beaches and the remaining eight at potential spawning sites. The urban areas of Eastsound on Orcas Island and Fisherman's Village on Lopez Island are both located in close proximity to potential forage fish spawning beaches. As unincorporated towns, both communities currently lack stormwater systems. Numerous hamlets throughout the archipelago also drain onto documented or potential forage fish spawning sites, most notable are Olga and Westsound, which both have outflow pipes draining directly onto documented surf smelt spawning habitat. San Juan County planners are currently working on a stormwater management plan; regular updates from the forage fish project on documented spawning sites have been provided to stormwater project staff. See *Figure 12. Stormwater Outflow Pipes in Potential or Documented Forage Fish Spawning Habitat in San Juan County.*

Additional information on the potential stormwater impacts to forage fish spawning habitat and protection and restoration efforts can be gleaned from analysis of the county watershed inventories associated with the priority forage fish spawning regions identified in the forage fish project (See *Figure 6. Critical Habitat- Priority Forage Fish Regions in SJC).* The San Juan County watersheds that impact these important nearshore ecological regions include: Westsound Watershed, Blind Bay Watershed, Wasp Passage Watershed, Mud/Hunter Bay Watershed, Mackaye Harbor Watershed, Westcott/Garrison Bay Watershed and the Mitchell Bay Watershed.

Seawalls and Bulkheads

Because forage fish depend on nearshore habitat for their survival, they are especially vulnerable to shoreline development. Shoreline armoring – the addition of structures or material along the shoreline to decrease the impact of waves and currents, or to prevent the erosion of banks or bluffs – is one of the major contributors to loss of shoreline habitat. Shoreline armoring structures, such as sea walls, rip rap, and bulkheads, often bury the upper intertidal zone and increase erosion along the shoreline. They effectively prevent erosion of banks and bluffs, cutting off the sediment supply from a feeder bluff or upper beach causing the habitat structure to shift to a lower elevation, higher energy, and a harder substrate. Net drift continues to carry away the fine sediments that are there and thus armored beaches over time can become areas of hardpan mud and bedrock, unsuitable for spawning forage fish. The direct, indirect, and cumulative impacts of shoreline modification are complex. Limiting shoreline modification is one way to preserve the health of nearshore habitat.

Information on potential structural impacts to forage fish spawning habitat was noted in the course of forage fish surveys by recording the presence of seawalls, bulkheads or jetties in the

field. Seawalls were noted on 72 forage fish project beaches (12% of total number of beaches), including ten documented surf smelt spawning sites (16% of documented sites), and three one-egg Pacific sand lance sites. This estimate is conservative as forage fish field protocols targeted survey points at greater than 1,000 ft. intervals along potential spawning beaches and likely missed some shoreline structures. The majority of seawalls in potential or documented forage fish spawning habitat were noted on Orcas Island (31), followed by San Juan (16), Lopez (10), Shaw (6), Brown (2), Crane (1), Waldron (2), Sucia (2), Blakely (1) and Decatur (1). See *Figure 13. Seawalls or Bulkheads on Potential or Documented Forage Fish Spawning Habitat in San Juan County.*

Alternatives to shoreline armoring exist and should be explored to protect and restore forage fish spawning habitat in San Juan County. The San Juan County Forage Fish Project nearshore habitat database provides a first level of analysis to address the issue of shoreline modification; in addition to the location of noted seawalls provided here, the database contains notes on the type of shoreline structure (wood, rock or concrete) and field survey site photos also provide information on the condition of existing structures, aiding in the ranking of restoration priorities.

Beach nourishment can be used in combination with development setbacks to maintain property as well as to minimize impacts to nearshore marine habitat. In nourishment projects, sand or gravel of the same sediment grain size of the natural substrate is transported from a land or offshore site and placed either directly on the beach, or seaward of the beach. Two such projects have been implemented in the San Juans (Blakely and Orcas Islands) and both have proved successful and popular with private landowners. Coastal vegetation is another management alternative that can improve slope stability. Natural protection of shorelines can also be provided by large woody debris that has naturally fallen on the beach or has drifted in. Surface and groundwater management can also have a huge impact on reducing erosion. Building setbacks reduce the stress on the slope to the beach, slow erosion, and allow for some natural erosion without concern for the structure. Constructing homes and other buildings a safe distance from eroding shorelines or bluffs is considered the safest and least expensive alternative to shoreline modifications.

Next Steps

The collaborative San Juan County Forage Fish Project has had a significant local and regional impact as a model for public-private partnerships to meet important scientific and land management objectives. Major accomplishments of the SJC Forage Fish Project include:

- Partnerships created;
- Protocol developed;
- Historic data compiled and mapped;
- Potential spawning habitat mapped;
- Nearshore database developed;
- Surf smelt and Pacific sand lance spawning habitat assessment conducted;
- Protection and restoration priorities identified;
- Shoreline landowners informed and engaged;
- Students and community volunteers involved and educated;
- Awareness by the general public improved; and

- Communication and distribution of information with scientists and land managers ongoing.

With the spawning habitat assessment phase of the project complete, the SJC Forage Fish Project now plans to expand the application and use of forage fish data by both public and private land managers. When combined with the comprehensive eelgrass mapping and herring spawn results expected later this spring, San Juan County will have the information it needs to ensure these critical habitat areas are protected from no net loss. Work with landowners will also emphasize the application of results, focusing on the development and implementation of nearshore marine restoration and protection projects. With over 400 miles of shoreline, the nearshore marine habitats of San Juan County play an important role in regional salmon recovery efforts as forage fish spawning sites and feeding, refuge and migration corridors for salmon species. Tagging efforts in the San Juans have identified 16 stocks of Coho as well as 5 federally listed stocks of Chinook (four fall and one spring); healthy nearshore marine habitats and food webs are an essential component in the life histories of these stocks.

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San Juan County Forage Fish Project

Initial and Adjusted Distribution of Potential Spawning Habitat in San Juan County

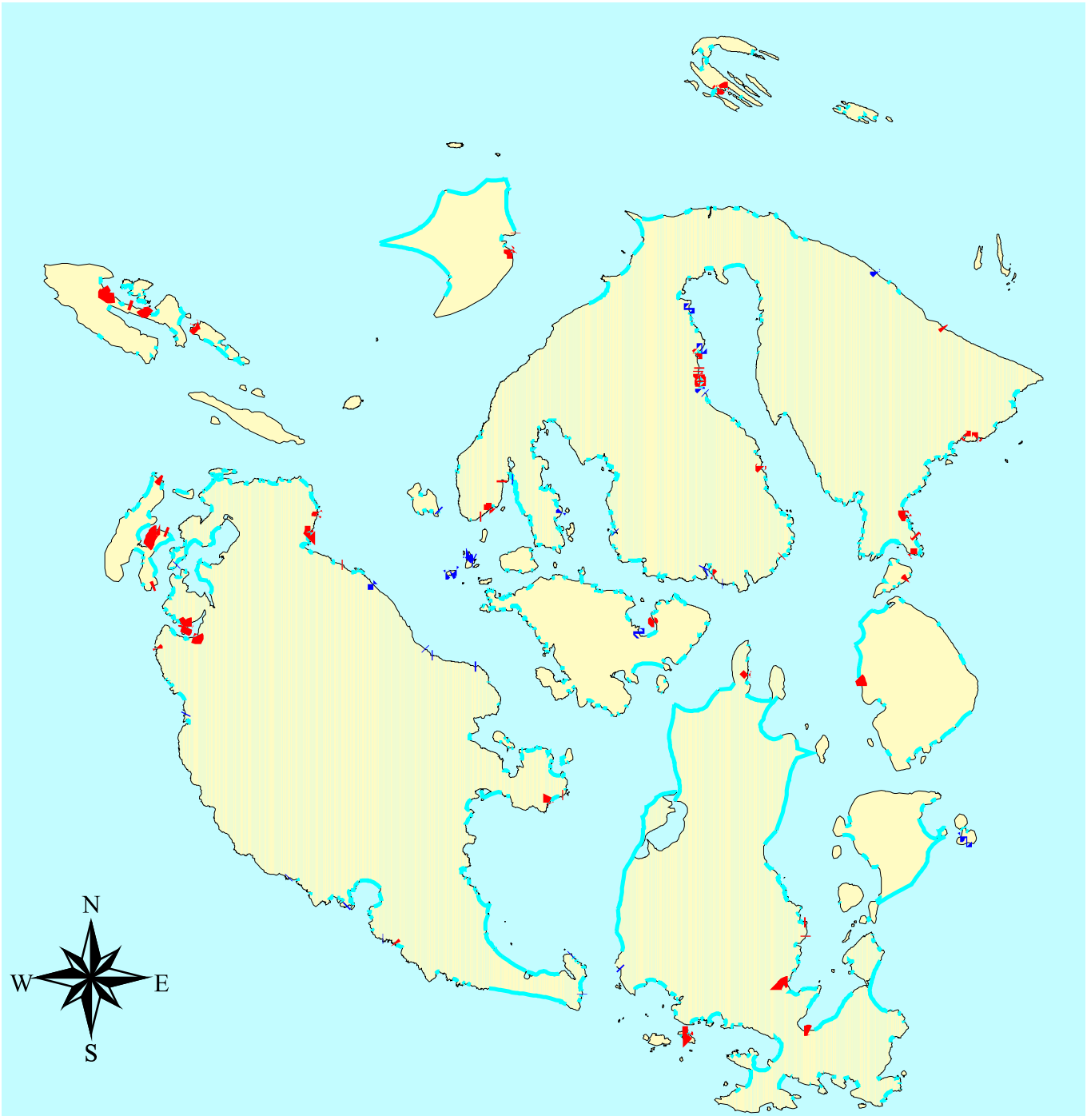
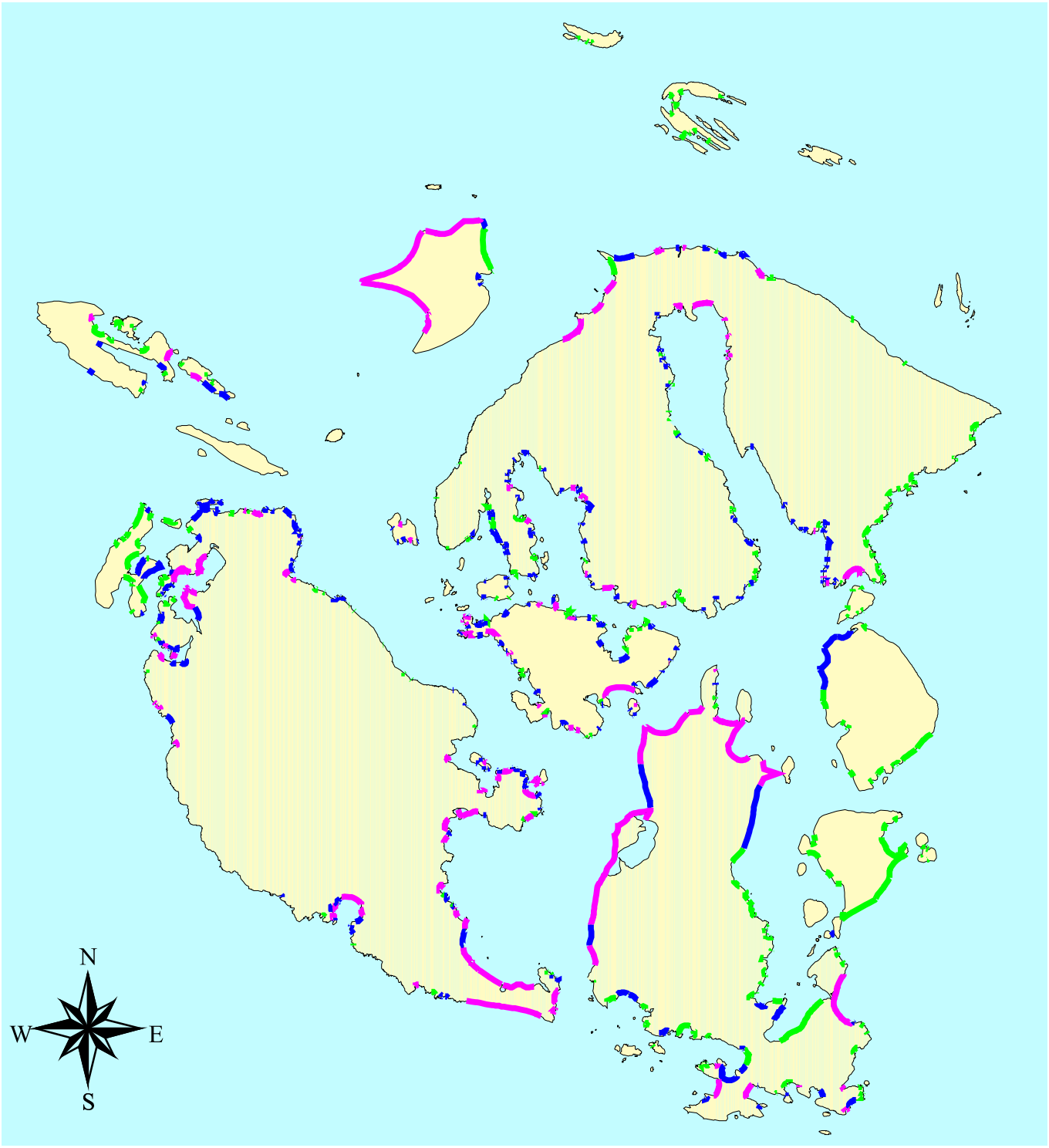


Figure 1

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Number of Surveys Performed



Number of Surveys

1 Survey

2 Surveys

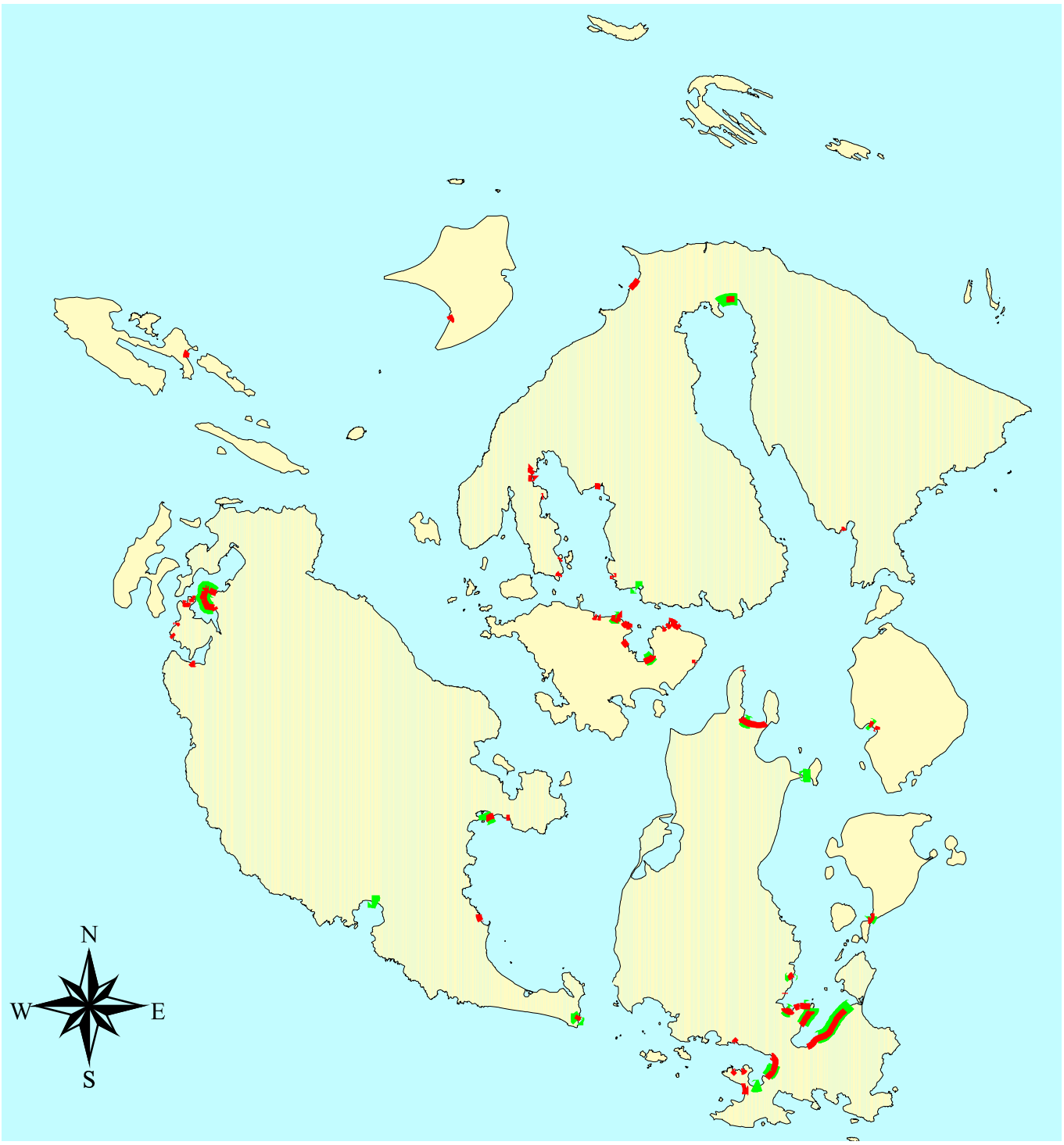
3 - 11 Surveys

Figure 2

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

WDFW and SJC Documented Spawning Sites



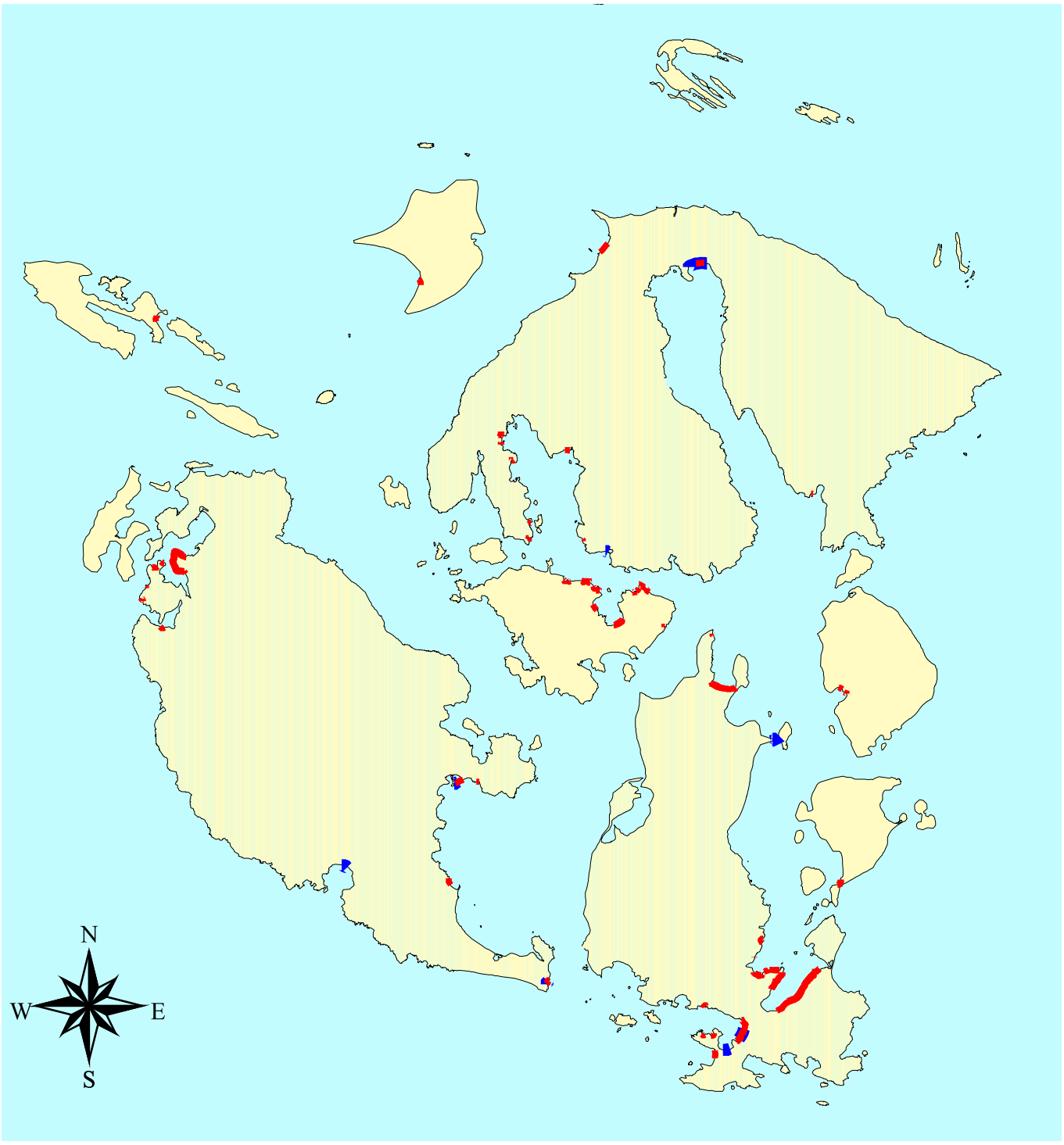
San Juan County Documented Sites
WDFW Documented Spawn Sites

Figure 3

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Documented Surf Smelt and Sand Lance Spawn Sites in San Juan County



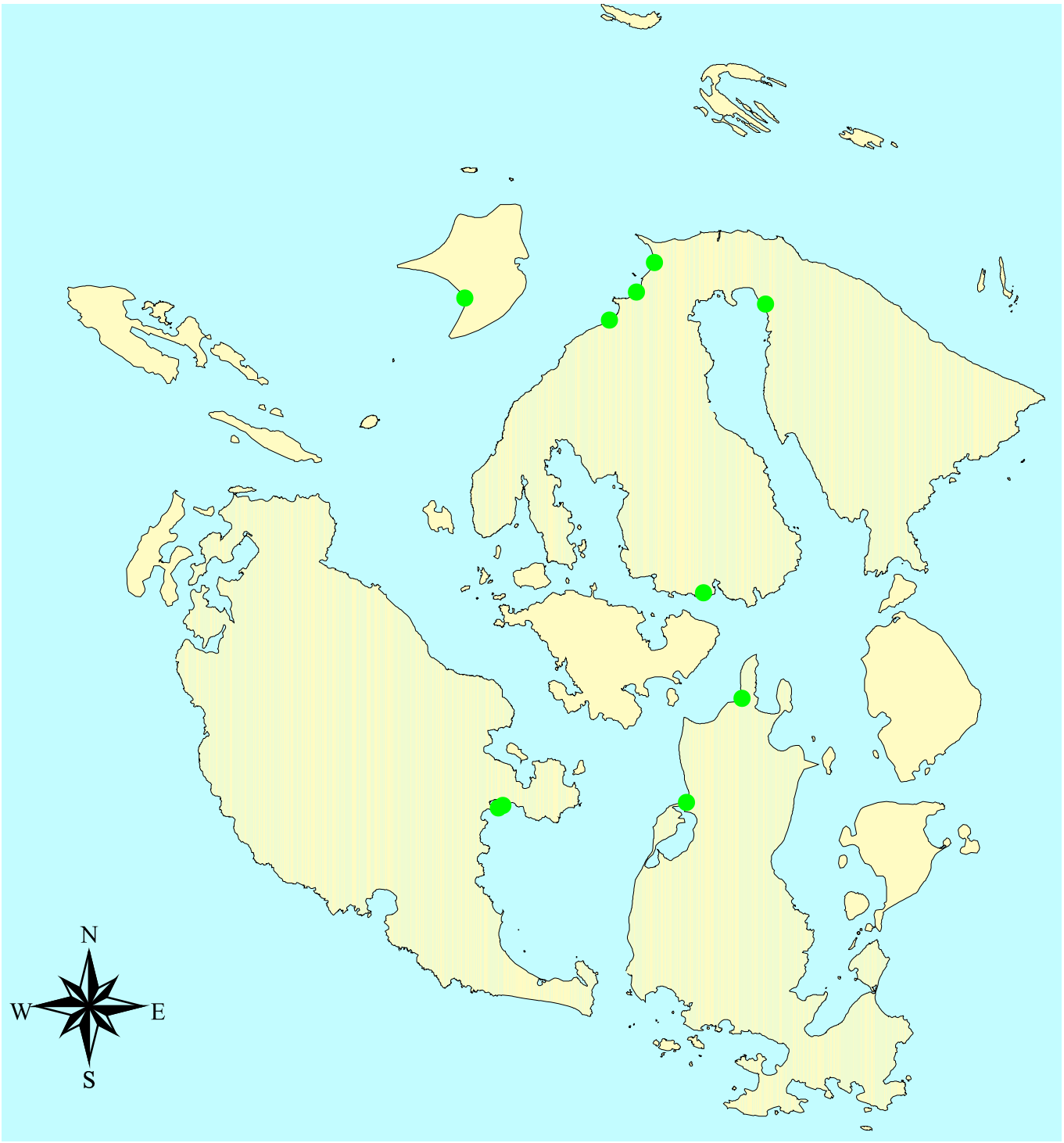
Documented Surf Smelt Spawn Sites
Documented Pacific Sand Lance Spawn Sites

Figure 4

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Spawn Evidence Sites in San Juan County



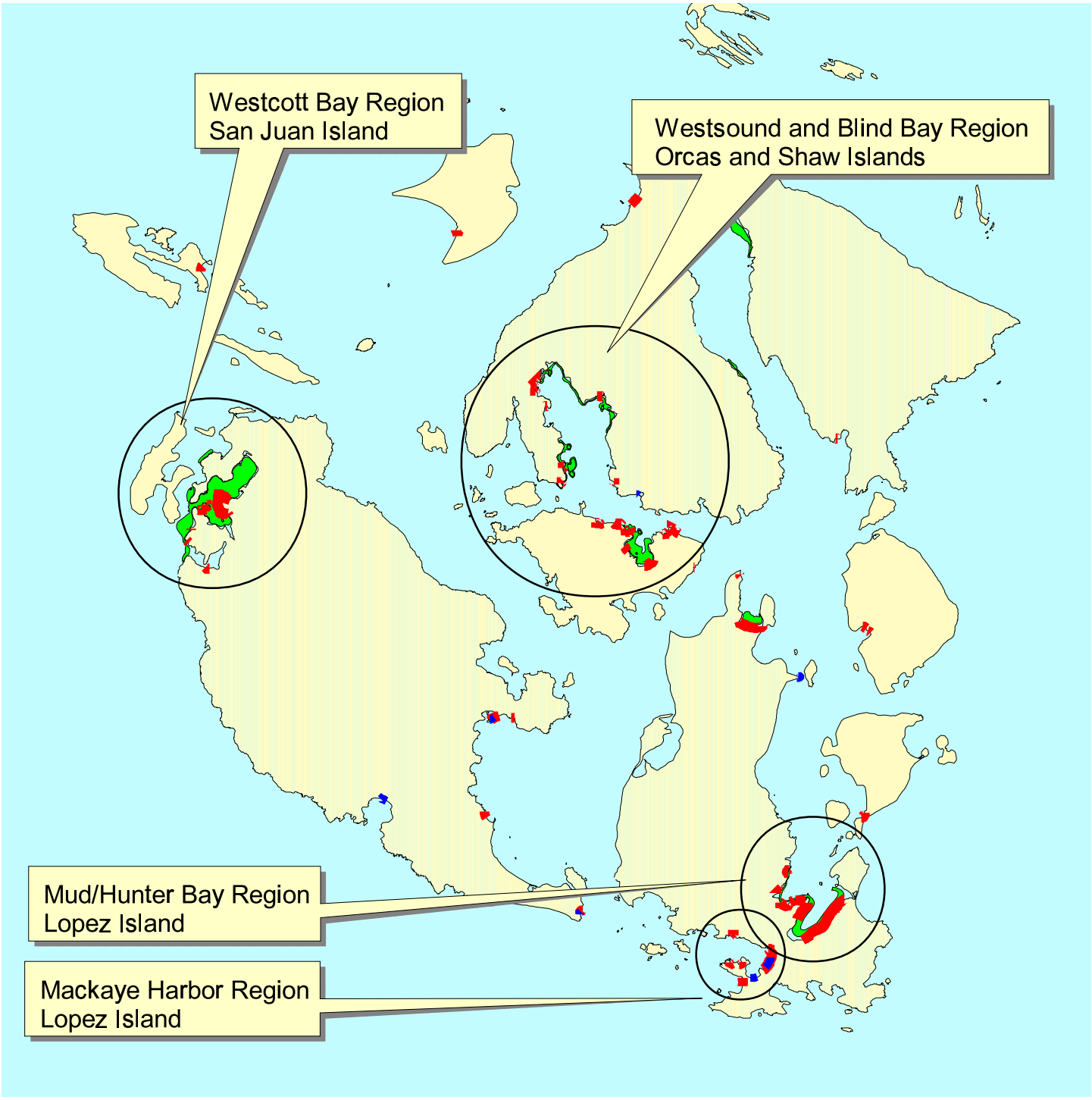
● 1 Egg Spawn Evidence Sites

Figure 5

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Critical Nearshore Habitat- Priority Forage Fish Spawning Regions in San Juan County



Sand Lance Spawn Beaches

Smelt Spawn Beaches

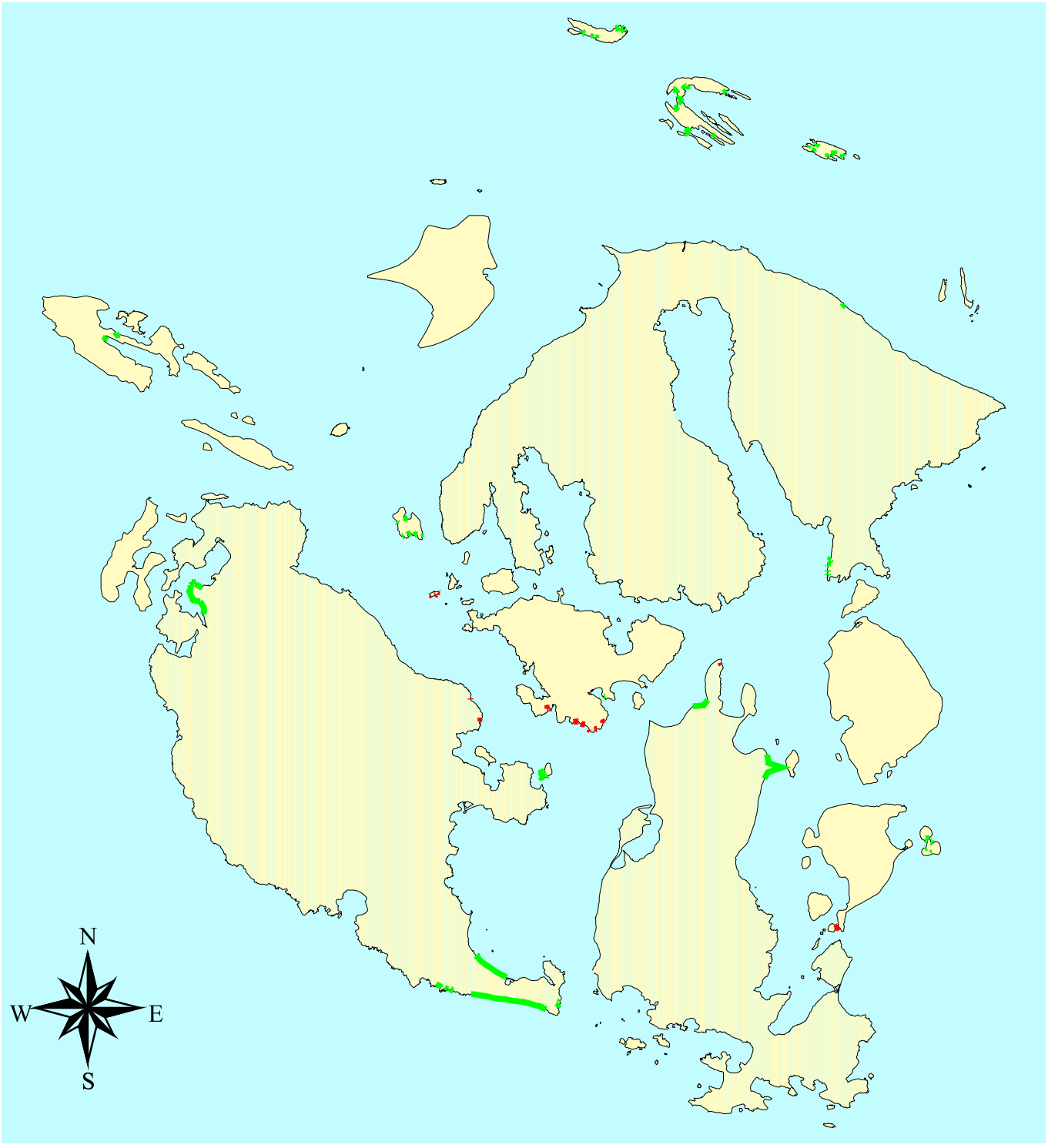
Herring Spawn Areas

Figure 6

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Protected Forage Fish Habitat in San Juan County



Beaches Protected By Ownership

Moderately Protected

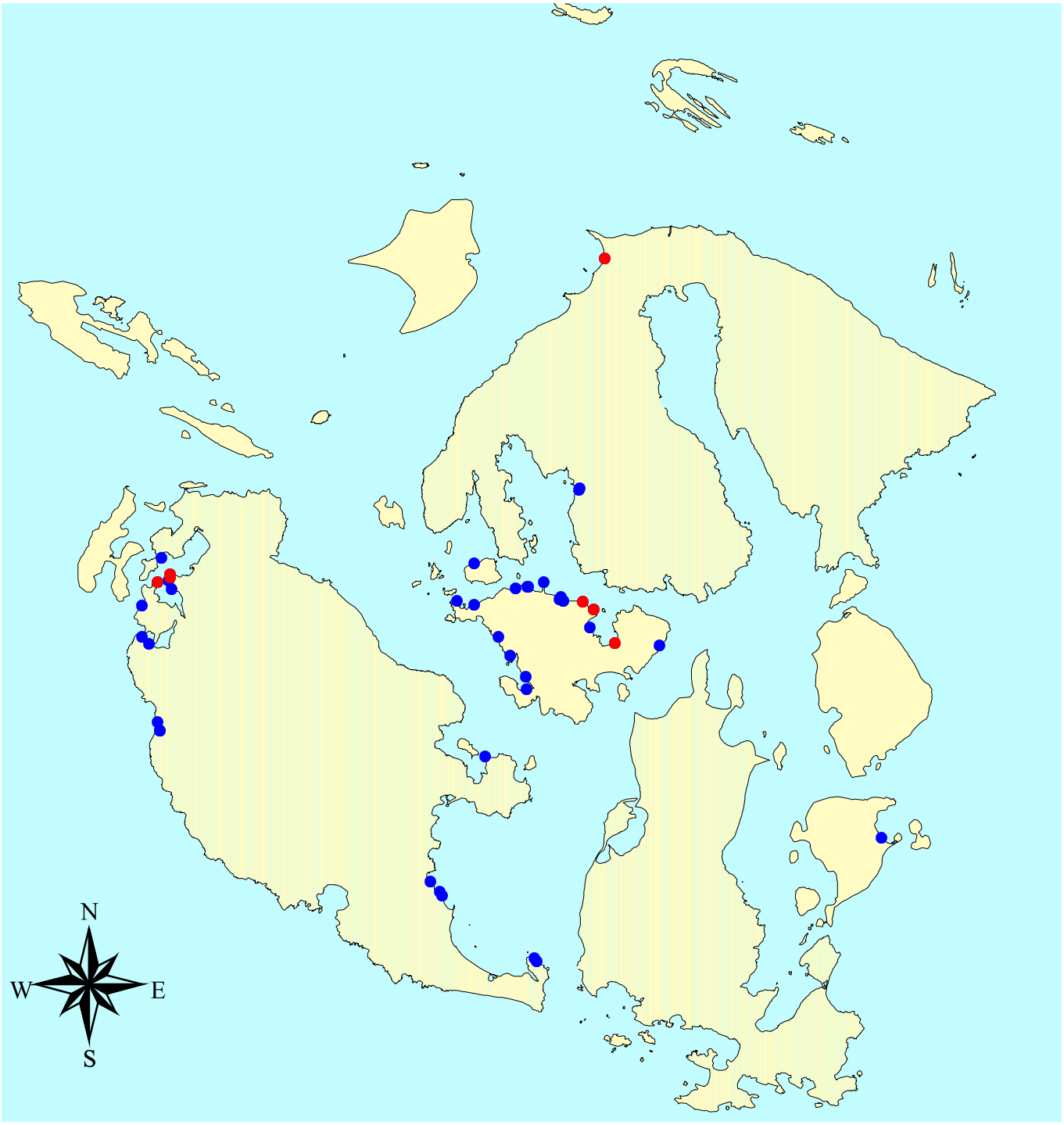
Fully Protected

Figure 7

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Priority Marine Riparian Habitat at Potential and Documented Forage Fish Spawning Habitat



High Protection Priority
- Documented Spawn Sites with 75% or more shading

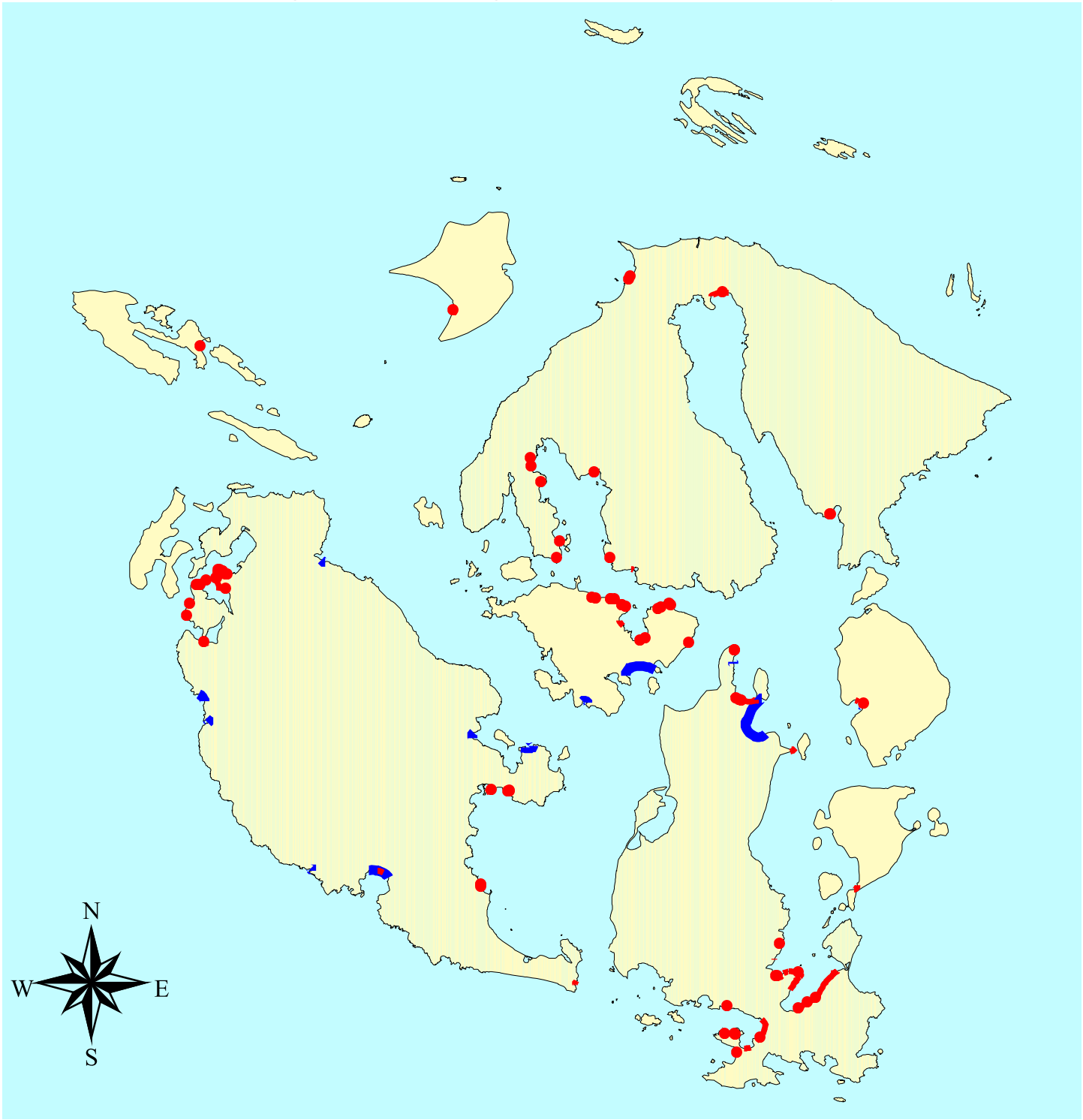
Moderate Protection Priority
- Potential Spawn Habitat with 75% or more Shading

Figure 8

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Freshwater Influence on Potential and Documented Forage Fish Spawning Habitat in San Juan County



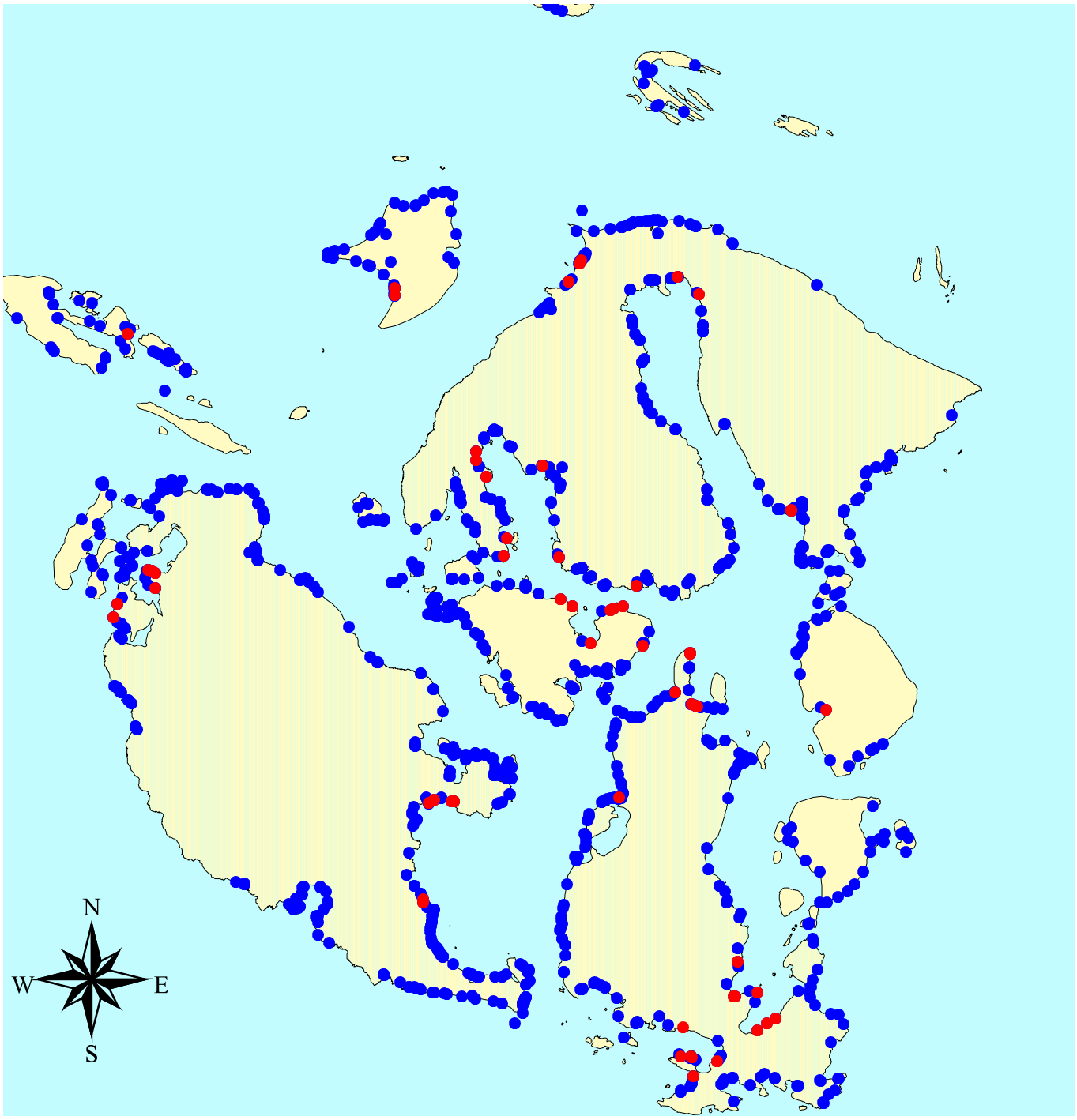
Documented Spawn Sites
Beaches with Fresh Water Influence

Figure 9

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Marine Riparian Restoration Priorities for Forage Fish Habitat



High Priority

- Documented Spawn Sites with less than 50% Shading

Moderate Priority

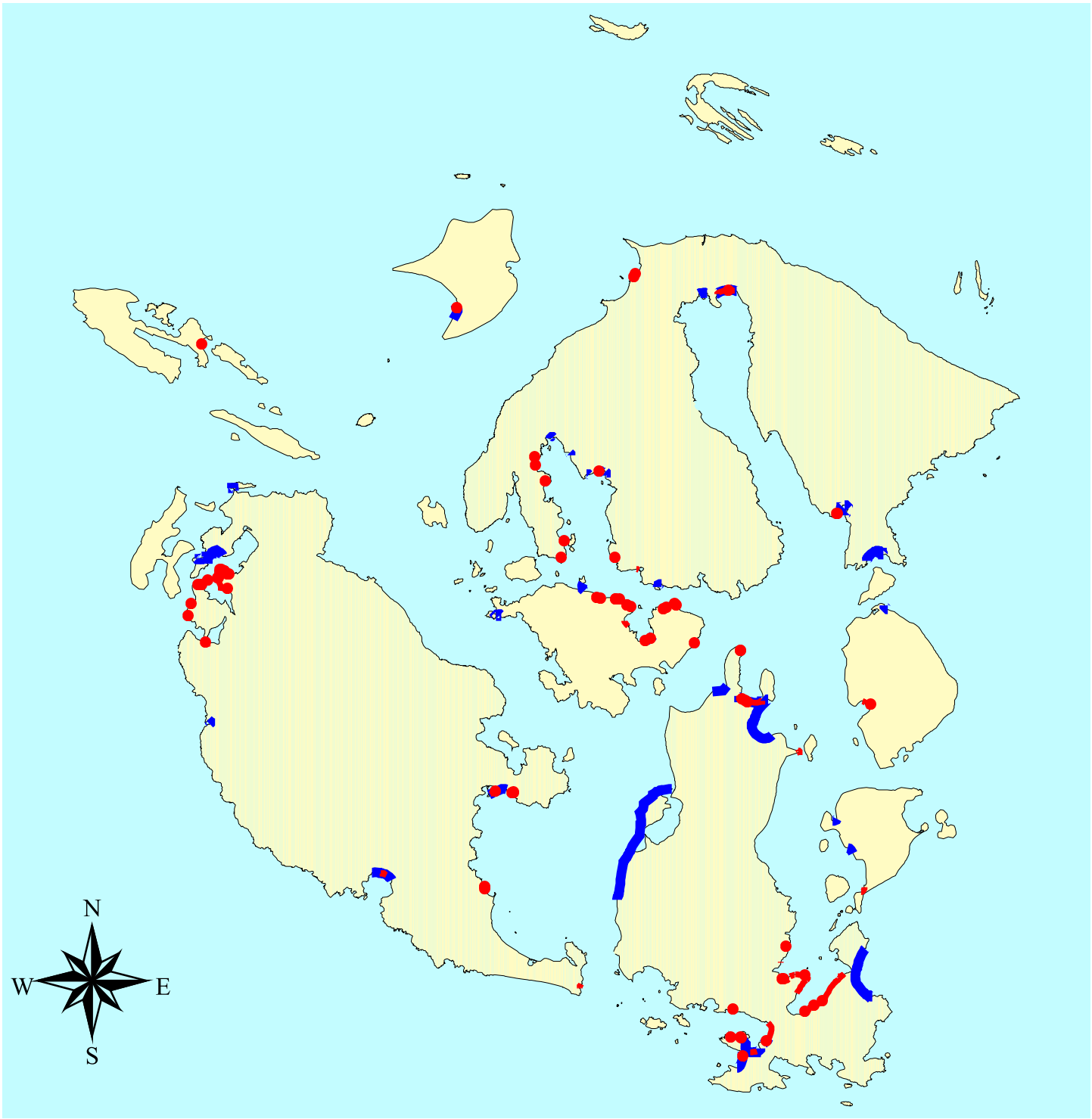
- Potential Spawn Habitat with less than 50% Shading

Figure 10

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Potential and Documented Forage Fish Spawning Habitat in Close Proximity to Roads in San Juan County.



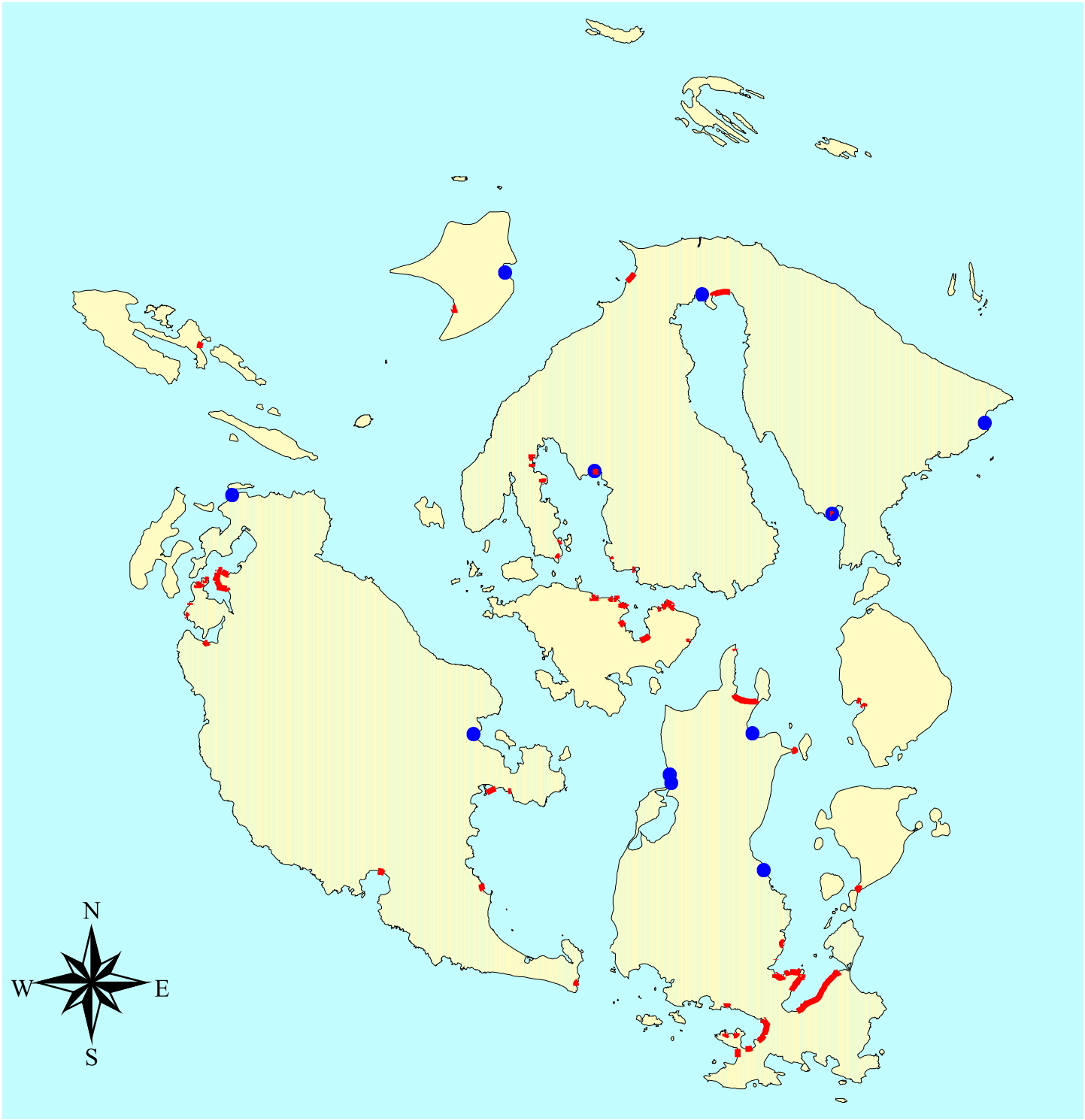
Documented Spawn Sites
Road Along Backshore

Figure 11

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Stormwater Outflow Pipes in Potential or Documented Forage Fish Spawning Habitat



Outflow Pipes

Documented Spawn Habitat

Figure 12

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report

San Juan County Forage Fish Project

Seawalls or Bulkheads on Potential or Documented Forage Fish Spawning Habitat

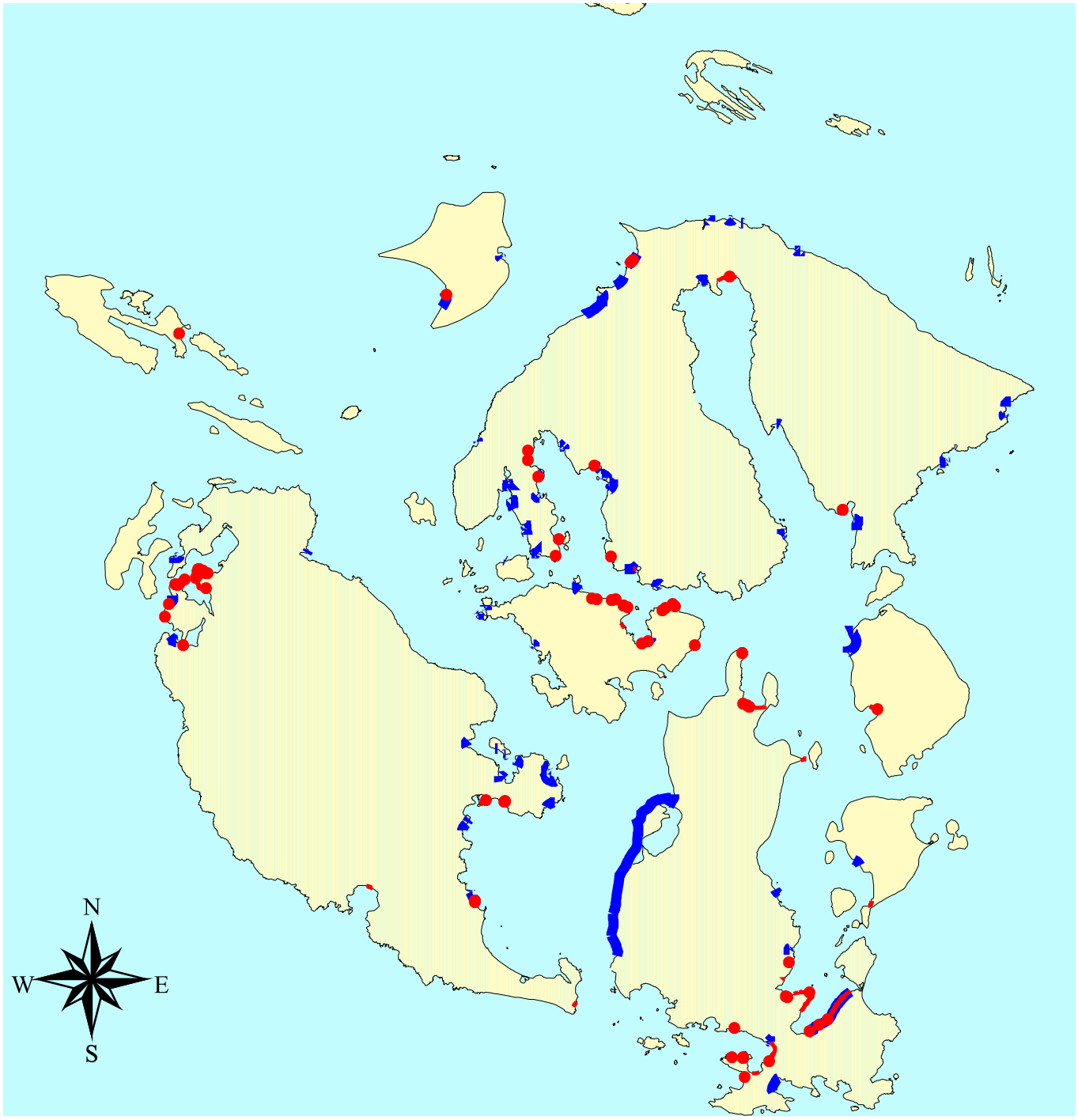


Figure 13

Note: Data from San Juan County Forage Fish Spawning Habitat Project Final Report