San Juan County Shoreline Modification Inventory
Restoration Opportunities Report

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San Juan County Shoreline Modification Inventory

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Coastal geomorphic processes create and maintain the nearshore habitats upon which many Puget Sound species of concern rely, including forage fish spawning areas, and juvenile salmonid rearing and migratory habitats, among others (Fresh 2006, Penttila 2007, Johannessen and MacLennan 2007). A recent study by C. Rice (2006) documented the effects of shoreline modifications on Puget Sound beaches on surf smelt mortality. Results showed that anthropogenic alteration of the shoreline typically makes beaches less suitable for surf smelt embryo survival when compared with unmodified shores (Rice 2006). Loss of marine riparian areas is commonly associated with shoreline development and modified shores.

Shore modifications, almost without exception, impact the ecological functioning of nearshore coastal systems and the proliferation of these structures has been viewed as one of the greatest threats (Thom et al. 1994). Modifications often result in the loss of the very feature that attracted coastal property owners in the first place, the beach (Fletcher et al. 1997). Bulkheads and other shore modifications that bury habitat, and limit bluff erosion and littoral sediment transport have led to major changes in sediment supply and associated changes in beach and habitat stability. The cumulative impact of human modifications to the shoreline may be far-reaching in terms of both habitat and existing human activities, particularly in the face of anticipated increases in the rate of sea level rise and storm induced erosion.

With over 400 miles of shoreline located at the confluence of Puget Sound, Georgia Strait and the Strait of Juan de Fuca, the nearshore marine habitats of San Juan County (SJC) play a critical role in the regional ecosystem. The same forage fish species and nearshore habitats of interest in salmon recovery are also vital to the protection and restoration of additional key marine species including six stocks of Puget Sound rockfish; multiple species of seabirds, including the federally threatened Marbled murrelet; and the federally threatened Southern Resident Killer Whale.

Shoreline modification is identified as a top threat to the SJC marine ecosystem (SJC Marine Stewardship Area Plan 2007). In 2009, FSJ conducted a boat-based inventory and mapping project of shoreline modifications for all 400+ miles of marine shoreline within San Juan County. Just under 4,000 modifications were mapped, photographed and described. Modifications in San Juan County include: 710 armored beaches, 472 docks, 32 groins, 55 marine railways, 70 improved boat ramps, 116 piling groupings (425 pilings), 50 marina/jetty/breakwater, and 191 “other” on-beach structures (FSJ 2010). Information on structure size, material, tidal elevation and collection were recorded where relevant to inform understanding of potential habitat impacts and support the identification and prioritization of restoration opportunities. For more information on the Shoreline Modification Inventory for San Juan County methods and results, please see the project’s *Executive Summary* and *Readme* reports.

Restoration Project Identification and Prioritization

In 2010, results of the 2009 shoreline modification inventory were applied to a countywide identification and prioritization of potential restoration opportunities. Restoration opportunities were identified and prioritized using a combination of data sets on priority habitats and species, geomorphic shoretype, and details of the modification itself, such as size, tidal elevation, material and condition. Opportunities to reduce the impacts of existing structures through design and material changes, for those structures unlikely to be removed, such as docks, were also noted.

Targeted outreach efforts were conducted for sites identified in the restoration prioritization. Informational mailings targeted two types of habitat improvement opportunities: 1) identifying landowners interested in restoration through modification removal at top ranked sites, and 2) reaching owners of degraded or poor condition docks and bulkheads, highlighting specific actions they can take to reduce habitat impacts if they are considering repair or replacement activities. Outreach materials included information on priority nearshore marine species and habitats, the impacts of modifications, by type such as dock, buoy or bulkhead, as well as ways to reduce impacts, through removal or redesign of existing structures.

Friends of the San Juans has secured grant funds to continue project cultivation work with interested landowners of top priority restoration project sites into the future, including completing expert site visits, restoration feasibility analyses and preliminary designs. Targeted mailings offered these free services to interested landowners at highly ranked sites.

Mooring buoys results have been applied to a related buoy upgrade cost share program being piloted by Friends of the San Juans, through which multiple outdated buoy designs were removed from eelgrass habitat in the summer of 2011. Additional eelgrass restoration through buoy redesign or relocation work planned for 2012.

Criteria used in the identification and ranking of restoration opportunities from the 2009 inventory of shoreline modifications and restoration ranking results are described below and shown in the associated map books. The report and map books are organized into two categories: *over and in water structures* (buoys, pilings and docks), followed by *on-beach structures* (improved boat ramps, groins and armoring).

Restoration Opportunities- Over and In Water Structures

The potential removal of over and in water structures covered in the shoreline modification inventory restoration prioritization included buoys, pilings and docks. Marinas and large community docks were not ranked for restoration potential as the opportunity for removal is considered unlikely, or low. Restoration opportunity for buoys, pilings and docks was conducted for all structures within those project types, and rankings were based on proximity to priority habitats and species including eelgrass, known Pacific herring spawning grounds, and documented presence of out-migrating juvenile salmon. Results were binned into Top, High and Moderate restoration opportunity categories. See Figure 1. Over and In Water Structures Restoration Prioritization map book.

BUOYS

A total of 1,914 mooring buoys and floats were recorded in the 2009 field inventory, including 1,835 buoys and 79 floats (not associated with a dock or marina). This is an average of 4.7 buoys per linear marine shoreline mile (FSJ 2010). Buoys are heavily concentrated within embayments and protected pocket beaches.

Improperly sited or designed mooring buoys can negatively impact submerged aquatic vegetation including eelgrass and macro algae such as kelps, priority habitats for forage fish and out-migrating juvenile salmon. Impacts primary occur through the anchor to surface line contacting the bed at low tide events. Additional impacts include anchor drag, shading, and the introduction of pollution. One third of mapped mooring buoys were located in eelgrass, and 50% were located in close proximity. With an estimated one-third of the mooring buoys in Puget Sound, a significant restoration opportunity exists in San Juan County to improve habitat, especially for eelgrass.

Potential habitat restoration opportunities from buoy upgrades (redesigns), removals or relocations were prioritized based on the proximity to priority habitats and species. No assessment was made of buoy use, condition or distribution (e.g. numbers of buoys in a specific bay or region…). Three hundred and thirty five buoys, 18% of buoys in San Juan County, were identified as priority habitat restoration opportunities. The top two buoys identified were located within eelgrass and in close proximity to known herring spawning grounds as well as documented out-migrating juvenile salmon presence. The high restoration category included 293 buoys, for proximity to eelgrass and either documented herring grounds or out-migrating juvenile salmon. The moderate priority category used the same factors as the high category, with larger proximity distances, and included 140 buoys. See Table One below for a countywide and island breakout. While the individual impact of any one mooring buoy may be relatively small, the combination of high numbers of buoys and the relatively simple and low cost solutions to buoy impacts (relocation away from priority habitats or upgrade to latest design), makes this restoration project type a top habitat improvement opportunity for San Juan County.

Table 1. Buoy Restoration Prioritization

Restoration Priority	Ranking Criteria	Number of Buoys	
Top priority for removal, design upgrade or relocation	Proximity to eelgrass (100 ft) and herring spawning grounds (100 ft) and juvenile salmon (0.5 miles)	***SJC***	***2***
		SJI	0
		Shaw	0
		Orcas	2
		Lopez	0
		Outer Islands	0
High priority for removal, design upgrade or relocation	Proximity to eelgrass (100 ft) and proximity to juvenile salmon (0.5 miles) or herring spawning grounds (100 ft)	***SJC***	***293***
		SJI	56
		Shaw	31
		Orcas	68
		Lopez	74
		Outer Islands	64
Moderate priority for removal, design upgrade or relocation	Proximity to eelgrass (200 ft) and herring spawning grounds (200 ft) or juvenile salmon (0.5 miles)	***SJC***	***140***
		SJI	35
		Shaw	24
		Orcas	24
		Lopez	55
		Outer Islands	2

PILINGS

One hundred and sixteen groupings of pilings not associated with another existing structure such as a dock or marina were documented along San Juan County's marine shorelines, including 425 individual pilings (FSJ 2010). Piling material was overwhelmingly creosote (89%) (FSJ 2010).

The primary habitat impact from pilings is the leaching of toxins from the creosote wood material and its effect on water quality conditions for aquatic life. Studies on the effects of creosote wood contamination on spawning Pacific herring show that PAH contamination from 40 year old pilings in surface waters caused significant reductions in hatching success and increased abnormalities in surviving larvae (Vines et al 2000, Stratus 2005a). Impacts of PAH's in surface waters have also been studied for trout, with immune effects documented at the lowest observable concentrations (Karrow et al 1999, Stratus 2005a). Many studies have also investigated thresholds for biological effects of PAH concentrations in sediment. Effects on benthic fish included: liver lesions, spawning inhibition, infertile eggs and abnormal larvae (Stratus 2005a). While direct impacts to salmonids from PAH's in contaminated marine surface waters or sediments are believed to be relatively low, salmonids are potentially at risk of exposure from consumption of contaminated prey (Poston 2001). In addition, if emerging science shows that certain stocks of outmigrating juvenile salmon spend considerable time in shallower nearshore marine environments, direct impacts may occur in areas with high PAH's.

Potential habitat restoration opportunities from piling removals were prioritized based on the proximity to priority habitats and species as well as piling material. A total of ten piling groupings were identified as high or moderate priorities for restoration through removal, for proximity to eelgrass and known Pacific herring spawning grounds or documented out-migrating juvenile salmon presence. As the majority of these pilings are not still in use or serving any purpose, removal of creosote pilings from priority habitats is likely a restoration opportunity with a high potential for broad landowner and community support.

Table 2. Pile Removal Prioritization

Restoration Priority	Ranking Criteria	Number of Piling Groupings	
High priority	Creosote piles and proximity to eelgrass (100 ft) and herring spawning grounds (100 ft) or juvenile salmon (0.5 mile)	***SJC***	***9***
		SJI	2
		Shaw	2
		Orcas	5
		Lopez	0
		Outer Islands	0
Moderate priority	Creosote piles and proximity to eelgrass (200 ft) and herring spawning grounds (200 ft) or juvenile salmon (0.5m)	***SJC***	***10***
		SJI	2
		Shaw	2
		Orcas	5
		Lopez	1
		Outer Islands	0

DOCKS

A total of 472 docks (excluding marinas and large community docks) were documented along San Juan County's marine shorelines (FSJ 2010). Of these, very few had incorporated best design practices for minimizing habitat impacts. Of the 472 docks recorded, 42 (8%) had grated floats and 17 (3%) had grated piers. 356 (77%) docks with creosote wood piles and/or decking were recorded. 39 (8%) docks were noted to be in poor condition (FSJ 2010).

Over-water structures of any kind will result in loss of some habitat functions due to short-term (construction activities) and long-term (permanent structure features) impacts. Piers, docks, mooring floats and other types of overwater structures have the potential to alter the physical characteristics of nearshore environments both at the site and beyond the footprint of the structure. By altering the physical processes that operate in the nearshore environment, such as light penetration, wave energy, and sediment transport, overwater structures can promote changes in habitats. Once habitats are altered, the species using those habitats and the way those habitats are used may also change, affecting the biological community in a number of ways. For example, the shaded, deep-water environment under piers can create a favorable habitat for predatory fish. Juvenile salmon tend to migrate out around structures that shade the water column and into deeper water where they are exposed to increased predation. Overwater structures can also impair habitat function. For example, by shading the nearshore environment and altering wave energy and sediment transport characteristics, overwater structures can degrade eelgrass habitat, which is an important refuge for a variety of important marine species. Docks are often also associated with shoreline armoring- to secure the pier- which can directly bury intertidal habitat and interrupt natural coastal sediment processes as well as the removal of marine riparian vegetation.

While full dock removal is unlikely to be a broadly applied restoration action for landowner willingness reasons, significant opportunities to at least reduce habitat impacts through design, size, orientation and material upgrades do provide some project potential. Investment in this area should be focused on educating owners of existing docks about impact reduction, requiring improvements through repair/replace permit processes and working programmatically to reduce the ongoing proliferation of docks in the county.

Potential habitat restoration opportunities from dock design upgrades or dock removals were prioritized based on the proximity to priority habitats and species including eelgrass, forage fish spawning habitat and out-migrating juvenile, salmon, as well as the current design, material and condition of the dock (pier, float and ramp) structure itself. A total of 259 docks were identified as high (51) or moderate (208) restoration opportunities.

Table 3. Dock Removal Prioritization

Restoration Priority	Ranking Criteria	Number of Docks	
High Priority- a	Degraded condition dock and proximity to eelgrass (100 ft) and proximity to herring spawning grounds (100 ft) or proximity to juvenile salmon (0.5 mile)	***SJC***	***5***
		SJI	2
		Shaw	1
		Orcas	0
		Lopez	2
		Outer Islands	0
High Priority- b	Any condition dock and un-grated float and proximity to eelgrass (100 ft) and proximity to herring spawning grounds (100 ft) or proximity to juvenile salmon (0.5 mile)	***SJC***	***51***
		SJI	12
		Shaw	10
		Orcas	12
		Lopez	5
		Outer Islands	12
Moderate Priority-a	Degraded condition dock and proximity to eelgrass (200 ft)	***SJC***	***19***
		SJI	9
		Shaw	3
		Orcas	1
		Lopez	3
		Outer Islands	3
Moderate Priority-b	Creosote dock and proximity to herring spawn (200 ft)	***SJC***	***54***
		SJI	19
		Shaw	3
		Orcas	19
		Lopez	11
		Outer Islands	2
Moderate Priority-c	Any condition dock and un-grated float and proximity to eelgrass (200 ft)	***SJC***	***225***
		SJI	67
		Shaw	18
		Orcas	47
		Lopez	17
		Outer Islands	76

Restoration Opportunities- On Beach Structures

On-beach shoreline modifications including improved boat ramps, groins and armoring (bulkheads) were analyzed for restoration potential based on a combination of factors including proximity to priority habitats and species including eelgrass, documented surf smelt and/or sand lance spawning beaches and out-migrating juvenile salmon presence. Geomorphic shoretype location and features of the modification itself were also included in the restoration prioritization. Higher priority was assigned for structures located within drift cell systems for their likely off-site impacts to geomorphic processes in addition to the site specific habitat impacts. Ramps and groins were binned into high and moderate restoration ranking categories, while a more detailed, numerical analysis that factored in the feasibility of structure removal in addition to habitat benefits was conducted for shoreline armoring. See Figure 2. On-Beach Structures Restoration Prioritization map book.

<u>IMPROVED BOAT RAMPS</u>

Seventy improved boat ramps, which includes permanent on-beach structures such as concrete pads were documented along the marine shorelines of San Juan County in the 2009 inventory (FSJ 2010).

Boat ramps directly bury intertidal and subtidal habitat and can affect coastal sediment processes that form and maintain beaches. Ramps are often also associated with the removal of marine riparian vegetation and the introduction of pollution and exotic species to the marine environment.

Potential habitat restoration opportunities from the removal of improved boat ramps were prioritized based on the proximity to priority habitats and species including eelgrass, forage fish spawning habitat and out-migrating juvenile salmon, as well as whether or not the structure was located in a drift cell system or on a pocket beach geomorphic shoretype. Condition of the structure and likelihood of removal were not included in the ranking criteria for boat ramps. 53 improved boat ramps (76%) were identified as restoration priorities for removal; 26 high priority and 27 moderate priority.

Table 4. Improved Boat Ramp Removal Prioritization

Restoration Priority	Ranking Criteria	Number of Boat Ramps	
High Priority-A	Improved boat ramp and documented forage fish(surf smelt and/or sand lance) spawn (100ft)	***SJC***	***8***
		SJI	0
		Orcas	1
		Shaw	3
		Lopez	4
		Outer Islands	0
High Priority-B	Improved boat ramp and drift cell and eelgrass (300 ft) or juvenile salmon (0.5 m) or herring spawning grounds (500 ft)	***SJC***	***26***
		SJI	5
		Orcas	7
		Shaw	1
		Lopez	7
		Outer Islands	6
Moderate Priority- A	Improved boat ramp and potential forage fish (surf smelt and/or sand lance) spawn (100 ft) and drift cell	***SJC***	***20***
		SJI	3
		Orcas	5
		Shaw	1
		Lopez	4
		Outer Islands	7
Moderate Priority- B	Improved boat ramp and potential forage fish (surf smelt and/or sand lance) spawn and pocket beach	***SJC***	***29***
		SJI	8
		Orcas	11
		Shaw	3
		Lopez	4
		Outer Islands	3

GROINS

Thirty two groins were documented along the marine shorelines of San Juan County (FSJ 2010). The lower elevation of all documented groins was below the water line at the time of the survey. Upper beach elevations of groin structures ranged from +2 M.L.L.W. to +9 M.L.L.W., with a mean of +3.8 M.L.L.W.(FSJ 2010). Groin elevation can play an important role in evaluating potential or likely impacts to habitat and habitat forming processes such as burial of forage fish spawning substrate and disruption of sediment transport.

Groins directly bury intertidal and subtidal habitats and interrupt the natural coastal sediment processes that form and maintain beaches.

Potential habitat restoration opportunities from the removal of groins were prioritized based on the proximity to priority habitats and species including eelgrass, forage fish spawning habitat and out-migrating juvenile salmon, as well as whether or not the structure was located in a drift cell system or on a pocket beach geomorphic shoretype. Condition of the structure and likelihood of removal were not included in the ranking criteria for groins. A total of 20 groins (63%) were identified as priorities for removal, including 14 high priority and 6 moderate priority sites.

Table 5. Groin Removal Prioritization

Restoration Priority	Ranking Criteria	Number of Groins	
High Priority-A	Groin and documented forage fish (surf smelt and/or sand lance) spawn (100ft)	***SJC***	***5***
		SJI	0
		Orcas	0
		Shaw	1
		Lopez	4
		Outer Islands	0
High Priority-B	Groin and drift cell and eelgrass (300ft) or juvenile salmon (0.5 mile) or herring spawning grounds (500 ft)	***SJC***	***18***
		SJI	4
		Orcas	0
		Shaw	2
		Lopez	9
		Outer Islands	3
Moderate Priority-A	Groin and potential forage fish (surf smelt and/or sand lance) spawn (100 ft) and drift cell	***SJC***	***12***
		SJI	4
		Orcas	0
		Shaw	1
		Lopez	5
		Outer Islands	2
Moderate Priority-B	Groin and potential forage fish (surf smelt and/or sand lance) spawn (100ft) and pocket beach	***SJC***	***10***
		SJI	5
		Orcas	1
		Shaw	2
		Lopez	2
		Outer Islands	0

ARMORING

A total of 710 individual modifications were recorded for shoreline armoring, covering over 18 linear miles of SJC's total marine shorelines (FSJ 2010). The minimum armor length recorded was 6.5 feet (FSJ 2010). Maximum armor length recorded in the 2009 inventory was 3,513 feet and the mean length of armoring was 137 feet (FSJ 2010). The majority of armoring, 674 (95%) are associated with residential bulkheads (FSJ 2010). Armoring was also associated with beach access (155), roads (51), boat ramps (20), stormwater outfalls (14), road ends (8), breakwaters (3), groins (3) and jettys (2) (FSJ 2010).

Shoreline armoring including riprap, retaining walls, bulkheads, and other forms of shoreline armoring structures can have a number of adverse impacts on the marine shoreline environment. The adverse effects of these structures can occur through a variety of mechanisms that have been documented (Shipman et al. 2010). These adverse effects are particularly evident in areas where these structures have been constructed below the OHW elevation (Shipman et al. 2010). Development activities, such as clearing vegetation and modifying site drainage, can make erosion worse. Bulkheads and rock walls can reduce erosion caused by wave action, but they often do little to prevent continued erosion and sliding of the upper bank. They will not prevent the beach itself from eroding. In fact, bulkheads can cause increased erosion of the beach when waves reflect off the hard structure and erode nearby shorelines (Shipman et al. 2010).

1,096 shoreline tax parcels (24%) had armoring present in the 2009 surveys (FSJ 2010). As documented by the San Juan Initiative's Case Study (MacLennan and Johannessen 2008), armoring was concentrated on sand/gravel or "soft", non-rock shorelines. When analyzed with tax parcels on the approximately 320 miles of rocky shorelines removed, the proportion of armored soft shore shoreline tax parcels increases to nearly half of shoreline parcels (49%) (FSJ 2010). While just 4% of the total marine shorelines within San Juan County are armored, the percent armored jumps to 22.5% for the 80 miles of sand/gravel shorelines (FSJ 2010).

The majority of shoreline armoring consists of large rock (505), followed by small rock (364), wood (182), creosote wood (56), concrete (140) and gabion basket (9) construction (FSJ 2010). While the

majority of armoring was in good condition (483), a significant proportion, (200) were in degraded or poor condition (FSJ 2010). The waterward toe of bulkhead elevations ranged from a minimum of -2 M.L.L.W. to a high of + 11 M.L.L.W., with a mean of +5.7 M.L.L.W.(FSJ 2010). These results indicate that the majority of bulkheads are located where they are directly impacting intertidal habitats through burial. As one example of direct habitat impacts, forage fish spawning and incubation normally occurs on upper beach habitat within the +7 to +9 M.L.L.W tidal elevation zone (Moulton and Penttila 2001). In addition to direct burial impacts, lower elevation structures also typically have larger indirect effects such as increased erosion at the ends and toe of the structure, bulkhead associated vegetation removal and loss of fine sediments over time on the beach face.

All sites with greater than 5 linear shoreline feet of armoring were included in the restoration prioritization. The numerical ranking included removal feasibility criteria as well as scores based on habitat benefit. Scoring criteria were adapted from an earlier Friends of the San Juans project completed in partnership with Coastal Geologic Services, the *Soft Shore Restoration Blueprint for Forage Fish Spawning Beaches in San Juan County, Washington* (Johannessen and MacLennan 2006). Changes to the scoring reflect the improved level of detail now available, such as bulkhead condition and location information from the modification inventory project as well as geomorphic mapping results that allow us to site projects within their drift cell context.

The 48 potential armor removal restoration sites (residential bulkheads or armored roads) with the highest combined feasibility and habitat value scores are considered the best opportunities for restoration. Top ranked sites include multiple County roads as well as residential bulkheads. Armor removal projects with the top five scores (combined scores of 30 and above- see Tables 6 and 7 for armor removal feasibility and habitat benefit scoring and rationale) included potential restoration project locations on southwest Decatur Island, multiple south Lopez Island sites, such as Barlow Bay, Agate Beach, MacKaye Harbor and additional smaller pocket beaches and Blind Bay, Shaw Island.

Outreach efforts to identify landowners interested in exploring restoration opportunities are underway and some match funds have been secured to provide technical site visits to willing landowners and explore restoration alternatives.

Table 6. Armor Removal Feasibility Scoring and Rationale

Feasibility Factor & Score	Rationale
1. Armor Condition **a) Good or unknown (0)** **b) Mixed (1)** **c) Poor (3)**	Bulkheads in degraded or failed condition are likely candidates for repair or replacement in the short term, providing an opportunity for removal or alternative shore protection design. In addition, current landowner investment in the structure is likely lower.
2. Fetch **a) > 12 miles (0)** **b) 8.1-12 miles (1)** **c) 5.1-8 miles (2)** **d) 3.1-5 miles (3)** **e) 0-3 miles (4)**	Higher energy beaches have greater erosion potential and are less successful nourishment projects.
3. Aspect/orientation **a) South (0)** **b) North (1)** **c) West and east (2)**	Exposure to prevailing/predominant winds (southerlies) is associated with more frequent high wave energy events thus more rapid erosion rates.
4. Adjacent shores **a) Modified (0)** **b) Unmodified soft shore (1)** **c) Unmodified bedrock shore (2)**	Modifications can result in end effects or exacerbated erosion on the adjacent shore. Unmodified high elevation banks may provide some natural sediment into the beach system. Bedrock often acts as a headland- and traps sediment, increasing the long-term sustainability of the project.
5. Adequate setback (distance to structure) **a) 0-25 ft (0)** **b) 26-50 ft (1)** **c) 50-75 ft (2)** **d) > 75 ft (3)**	Enables some erosion to occur over the long term, reduces risk to homes/infrastructure.
6. Location in drift cell and pocket beaches **a) Feeder bluff exceptional (0)** **b) Feeder bluff (1)** **c) Transport zone (2)** **d) Accretionary shores (5)** **e) Pocket beach (3)**	Sites near the drift cell origin (feeder bluffs) are more likely to be erosive. Mid cell, no appreciable drift areas and pocket beaches typically have negligible erosion/accretion, and the cell terminus is often accretionary- thus possessing greater long term project sustainability (sediment retention).

Note: *scoring criteria adapted from Johannessen, J. and A. MacLennan 2006. Soft shore restoration blueprint for forage fish spawning beaches in San Juan County, Washington. In partnership with Friends of the San Juans. Report to the WA State Salmon Recovery Funding Board.*

Table 7. Armor Removal Habitat Enhancement Value Scoring and Rationale

Habitat Enhancement Value Factor & Score	Habitat Benefit Rationale
7. Armor length **a) <50 ft (1 pt)** **b) 51-150 ft (2)** **c) 151-300 ft (3)** **d) 301-500 ft (4)** **e) 500+ ft (5)**	Rehabilitation of long modifications provides greater benefits as greater length of intertidal area typically provides greater benefit versus cost.
8. Armor elevation **a) < 0 MLLW (7)** **b) 0 to 3 MLLW (6)** **c) 3 to 6 MLLW (5)** **d) 7 to 10 MLLW (4)** **e) > 10 MLLW (2)**	Modification elevations are relative to MLLW. Low elevation modifications eliminate forage fish spawning habitat, reduce shoreline connectivity and increase the risk of predation of out-migrating juvenile salmon.
9. Proximity to documented forage fish (surf smelt or sand lance) spawning habitat (100 ft) (8)	Documented forage fish spawning habitat is of more value due to their known presence and the species propensity for site fidelity.
10. Proximity to potential forage fish (surf smelt or sand lance) spawning habitat (100 ft) (2)	Documented forage fish spawning habitat is of more value due to their known presence and the species propensity for site fidelity.
11. Location in a priority restoration feeder bluff (within 100 ft) (3)	Feeder bluffs provide sediment to entire drift cell systems, maintaining beaches beyond the project site scale.
12. Proximity to freshwater (500 ft) (2)	Estuarine nearshore conditions (Osmoregulation- physiological support for outmigrating juvenile salmon). Also a source of nutrients and terrestrial insects transfer from upland to marine environment.
13. Proximity to outmigrating juvenile salmon (0.5 miles) (2)	In an area known to be utilized by outmigrating juvenile salmon as they pass through the shallow waters of San Juan County.
14. Proximity to eelgrass (300 ft) (2)	In time, armoring can change sediment conditions in front of the structure, causing a loss of the fine sediments eelgrass requires to grow.
15. Proximity to herring spawning grounds (300 ft) (2)	In San Juan County, eelgrass is the predominant submerged aquatic vegetation utilized for spawning by Pacific herring. Armored shores can also cause site specific increases in predation risk for small fish.

Note: *scoring criteria adapted from Johannessen, J. and A. MacLennan 2006. Soft shore restoration blueprint for forage fish spawning beaches in San Juan County, Washington. In partnership with Friends of the San Juans. Report to the WA State Salmon Recovery Funding Board.*

Conclusions

The majority of shoreline development activity in San Juan County occurs through incremental single-family development and individual shoreline alterations. The magnitude of these impacts may only become evident cumulatively over time. In addition, significant county infrastructure is located in close proximity to marine shorelines and is negatively impacting habitat and habitat forming processes. Many degraded, outdated or unnecessary shoreline structures were documented in the 2009 Shoreline Modification Inventory for San Juan County. The shoreline modification restoration prioritization identifies important restoration opportunities for improving nearshore marine habitat conditions at public and private sites across the county.

The location of most modifications along non rocky shorelines means that impacts are concentrated in areas important to forage fish spawning habitat as well as the coastal sediment processes critical to forming and maintaining local beaches. With just 12 miles of documented forage fish spawning habitat and a limited number of feeder bluffs in San Juan County, restoration actions as well as improved protections will be needed to ensure maintenance of these and other important habitats and processes over the long term.

Restoration prioritization results can be applied by restoration practitioners, private landowners, managers of public infrastructure, and policy makers. For example, the large number of degraded bulkheads presents a significant opportunity to restore habitat through structure removal where feasible or habitat enhancement through rebuilding structures in a less impactful location and design, such as soft shore protection. Outdated mooring buoy installations located in priority eelgrass or herring spawning habitats can be upgraded to less impactful designs, or relocated, away from the most sensitive habitats. In some cases, landowners may be willing to consider removal of existing modifications, particularly where they are in poor condition or not serving any current purpose. The county itself, through its oversight of public infrastructure, has a major opportunity to improve habitat, as well as the long term viability of infrastructure, through relocation of roads away from critical habitats and implementation of improved maintenance and repair practices at remaining structures such as boat ramps and docks.

San Juan County's marine shorelines provide numerous forage fish spawning sites, eelgrass meadows, kelp beds, and feeding, refuge and migration corridors for salmon, seabirds and marine mammals. The success of regional salmon and orca recovery efforts is critically dependent on the protection and restoration of habitats and habitat forming processes. However, sensitive nearshore ecosystems in the San Juans and throughout Puget Sound are suffering from the ongoing impacts of shoreline modification activities.

Shoreline modifications pose a significant threat to the ecological functioning of coastal systems. The cumulative impact of human modifications on nearshore habitats and shoreline processes that sustain them may be far-reaching, particularly in light of anticipated increases in sea level and storm-induced erosion. A combination of improved protection for intact shorelines and restoration of degraded sites is needed.

References

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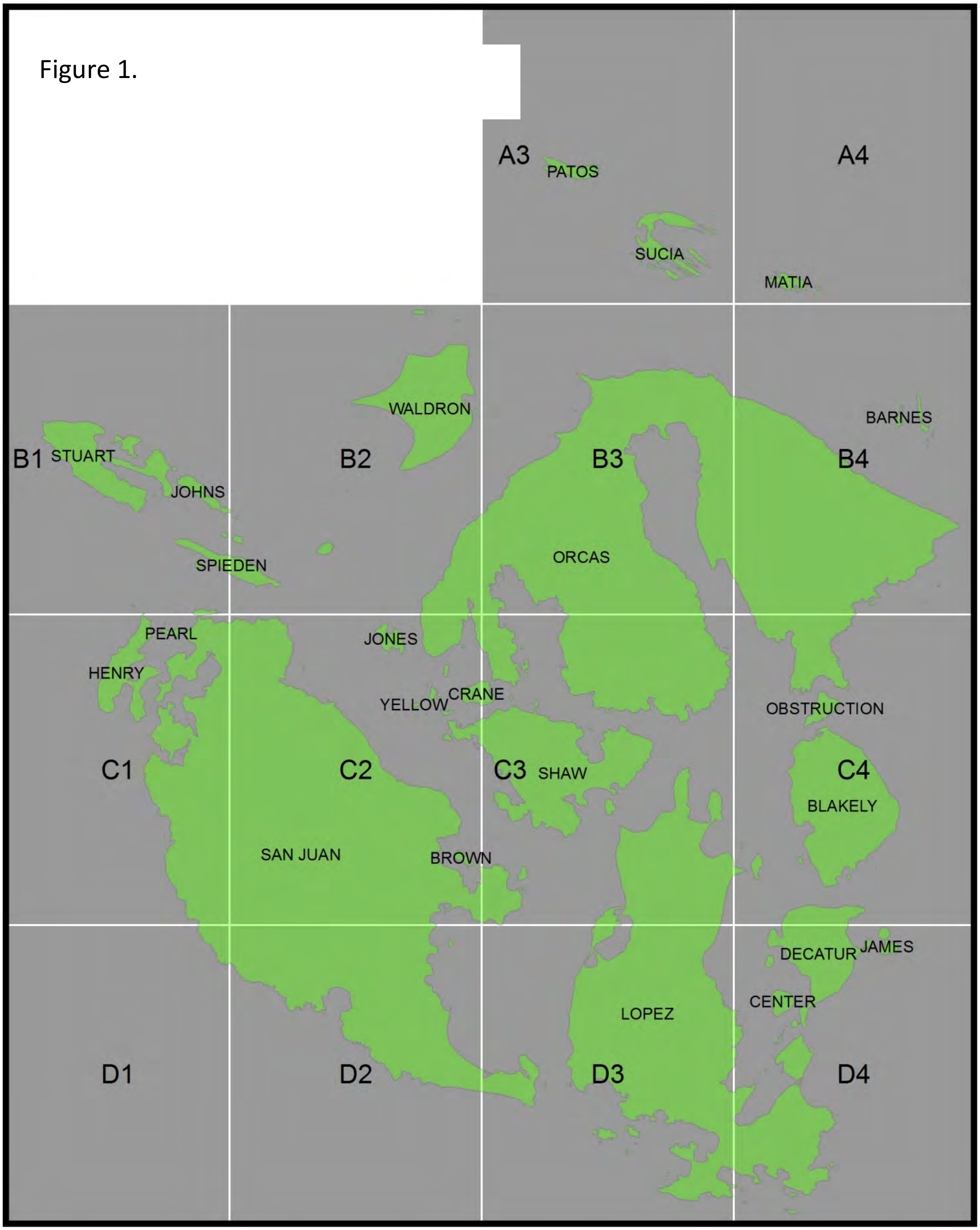
Figure 1.

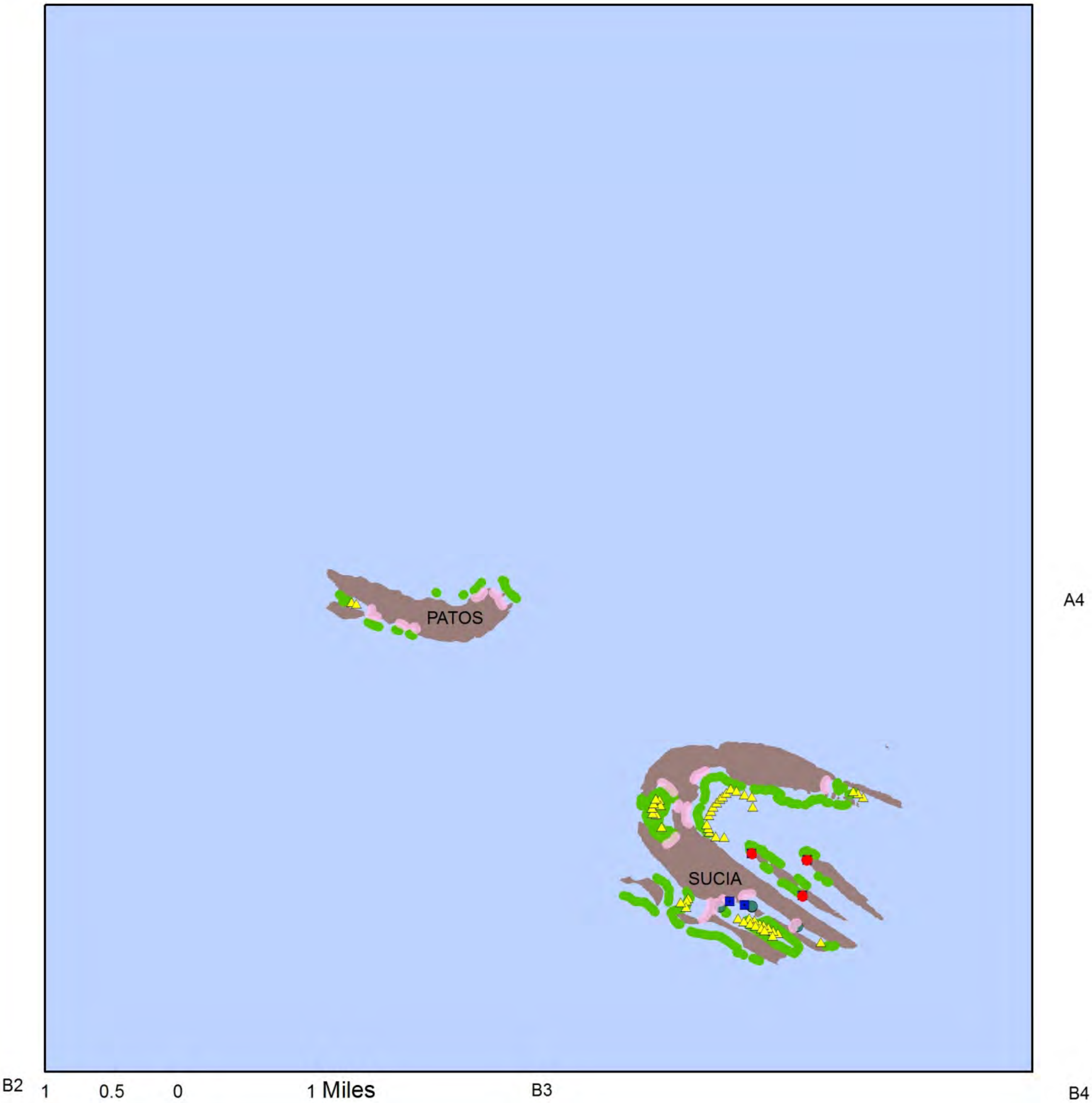


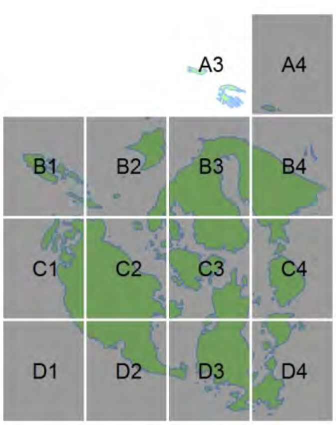
San Juan County Shoreline Modification Inventory
OVER WATER STRUCTURE Restoration Prioritization

MAPBOOK

FRIENDS OF THE SAN JUANS

San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization





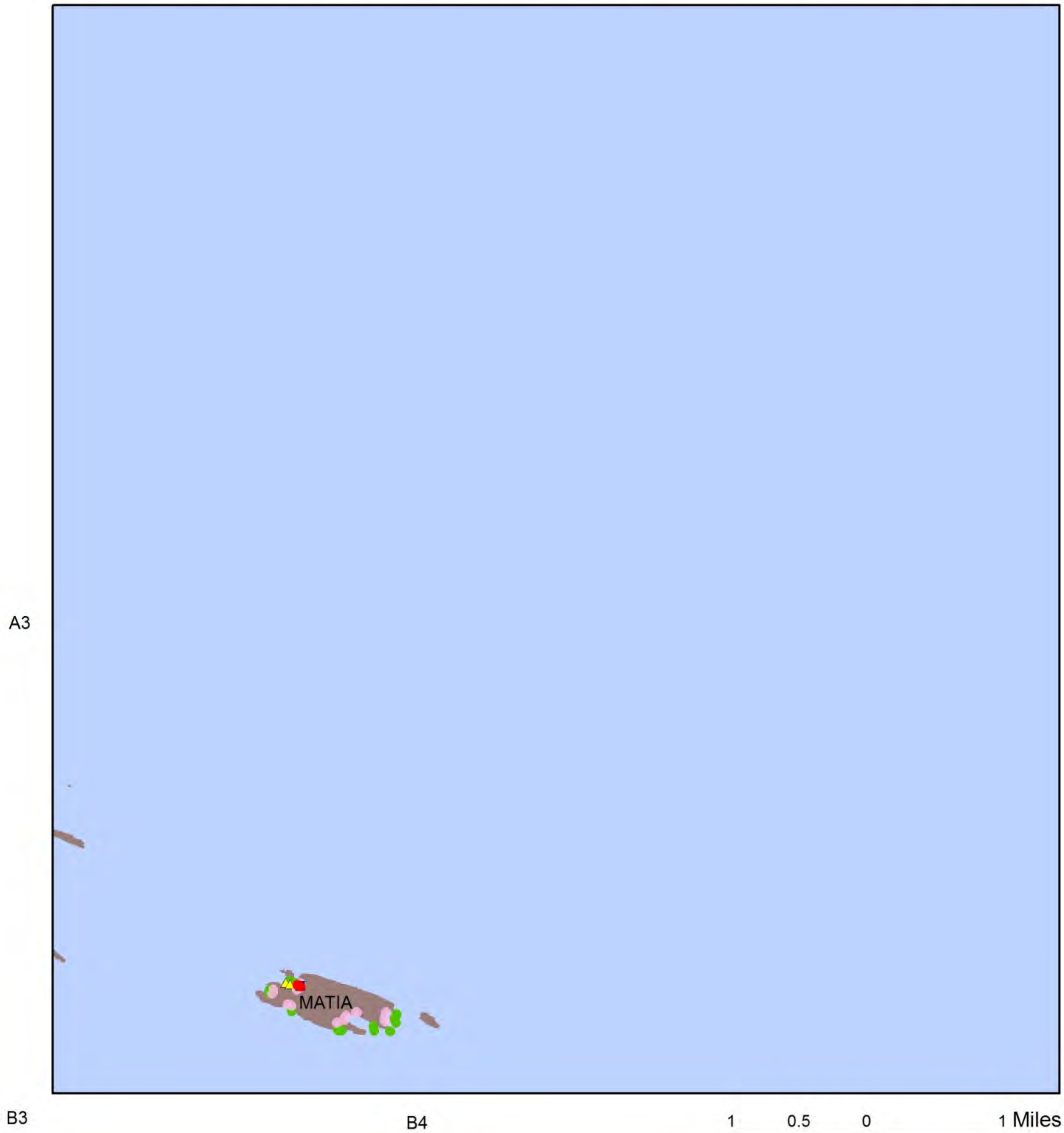
N

Legend

- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

A3

San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization

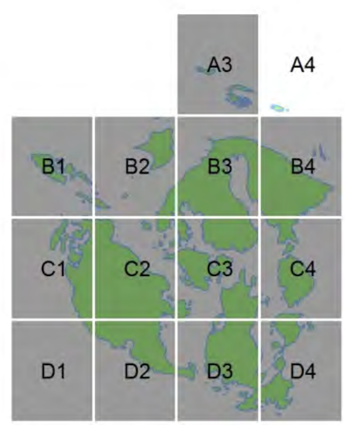


FRIENDS OF THE SAN JUANS

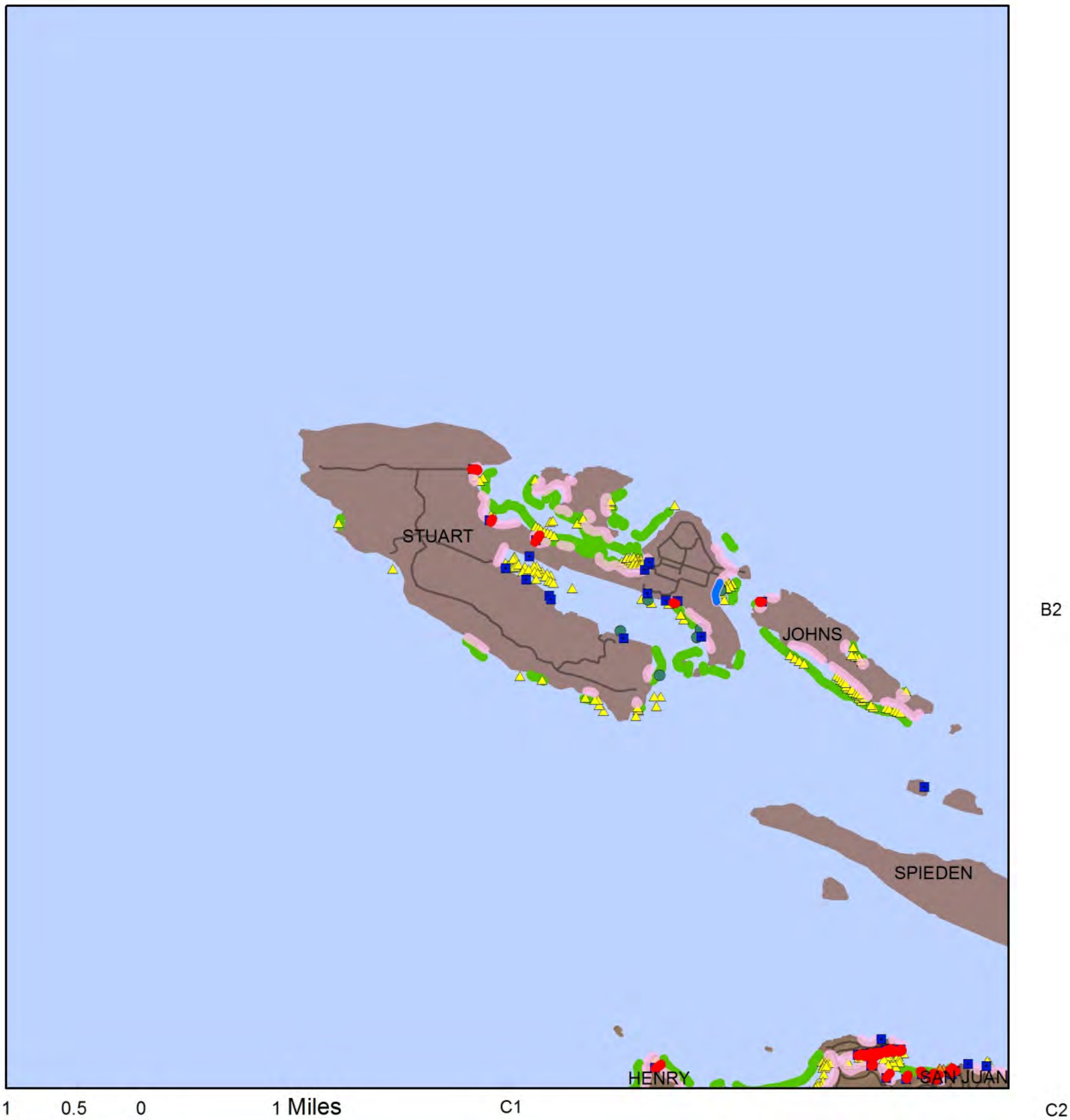
Legend

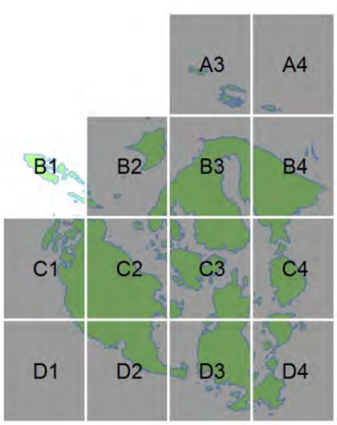
- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

A4



San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization





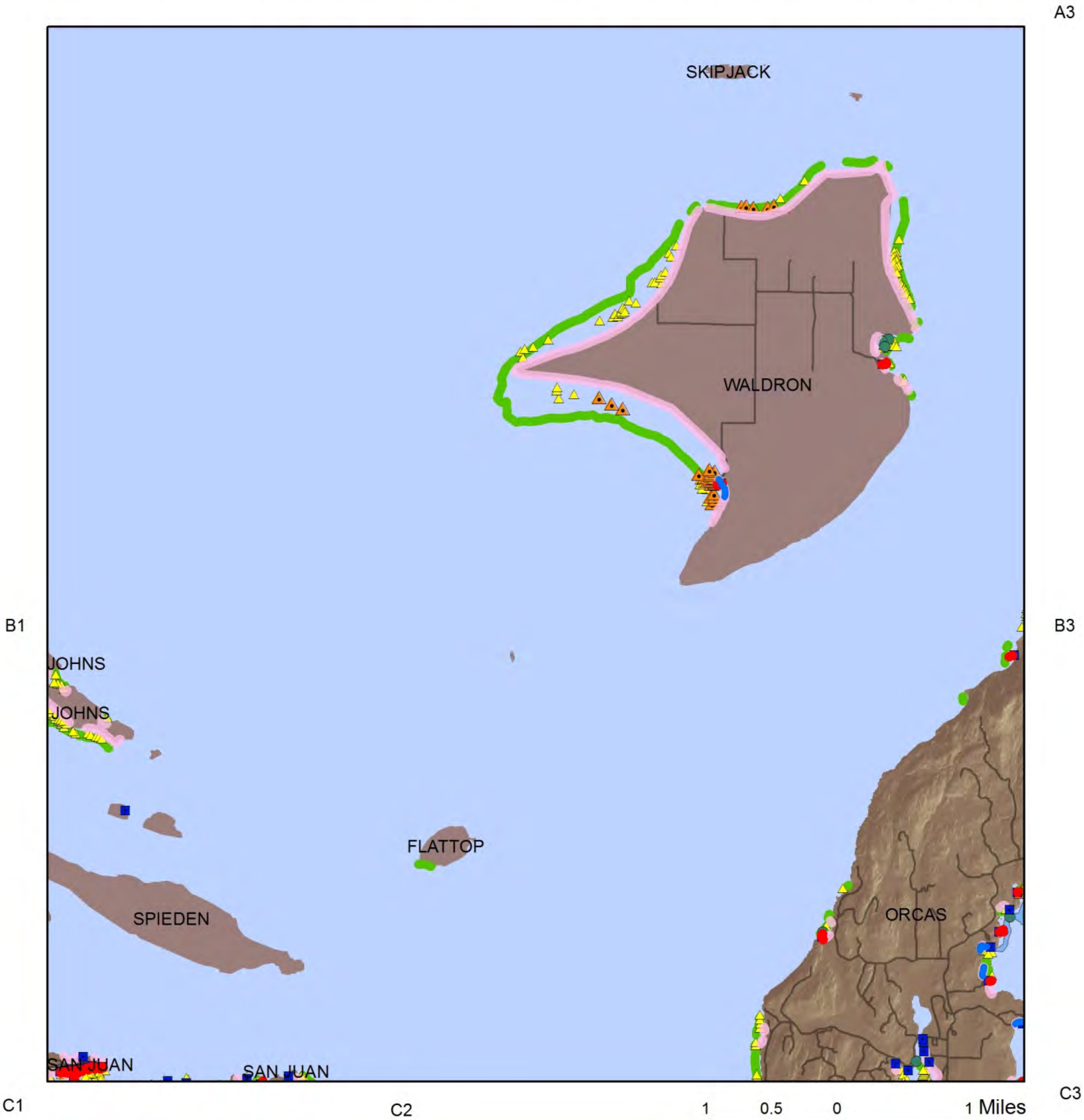
Legend

- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

FRIENDS OF THE SAN JUANS

B1

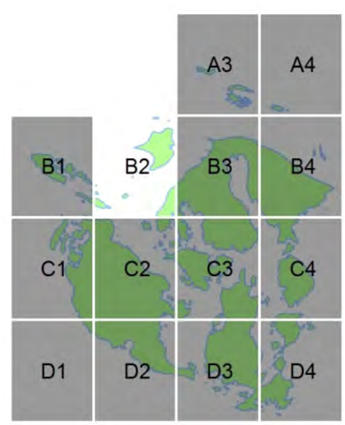
San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization



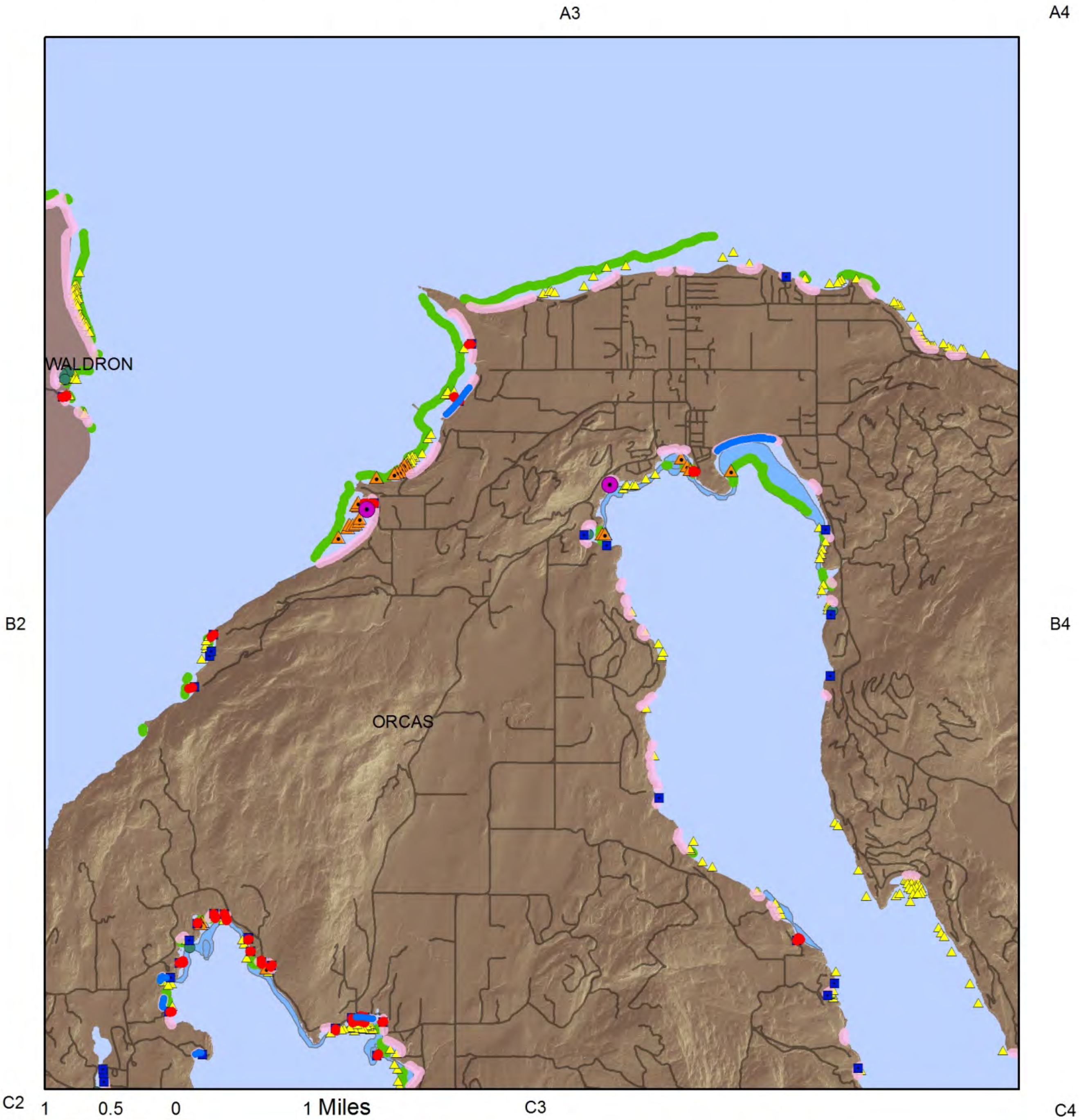
Legend

Dock Priority Restoration	Known Forage Fish Spawn Habitat
Mooring Buoy Priority Restoration	Potential Forage Fish Spawn Habitat
Piling Priority Restoration	Deep Water Edge Eelgrass
Dock	Herring Spawning Grounds
Mooring Buoy	
Pilings	
Roads	

B2



San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization



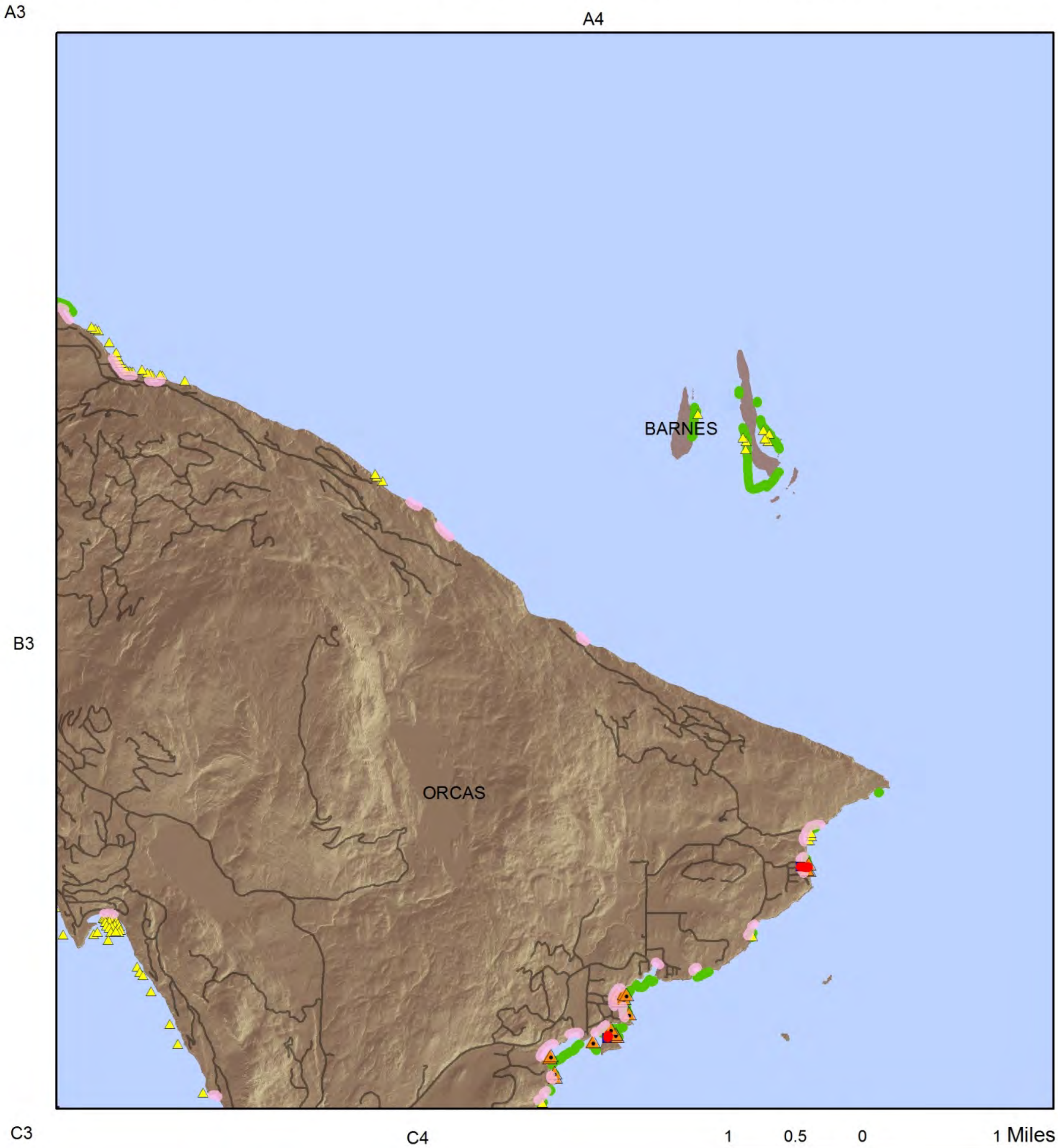
Legend

- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

B3

FRIENDS OF THE SAN JUANS

San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization



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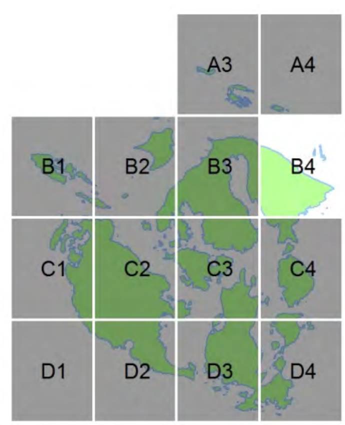
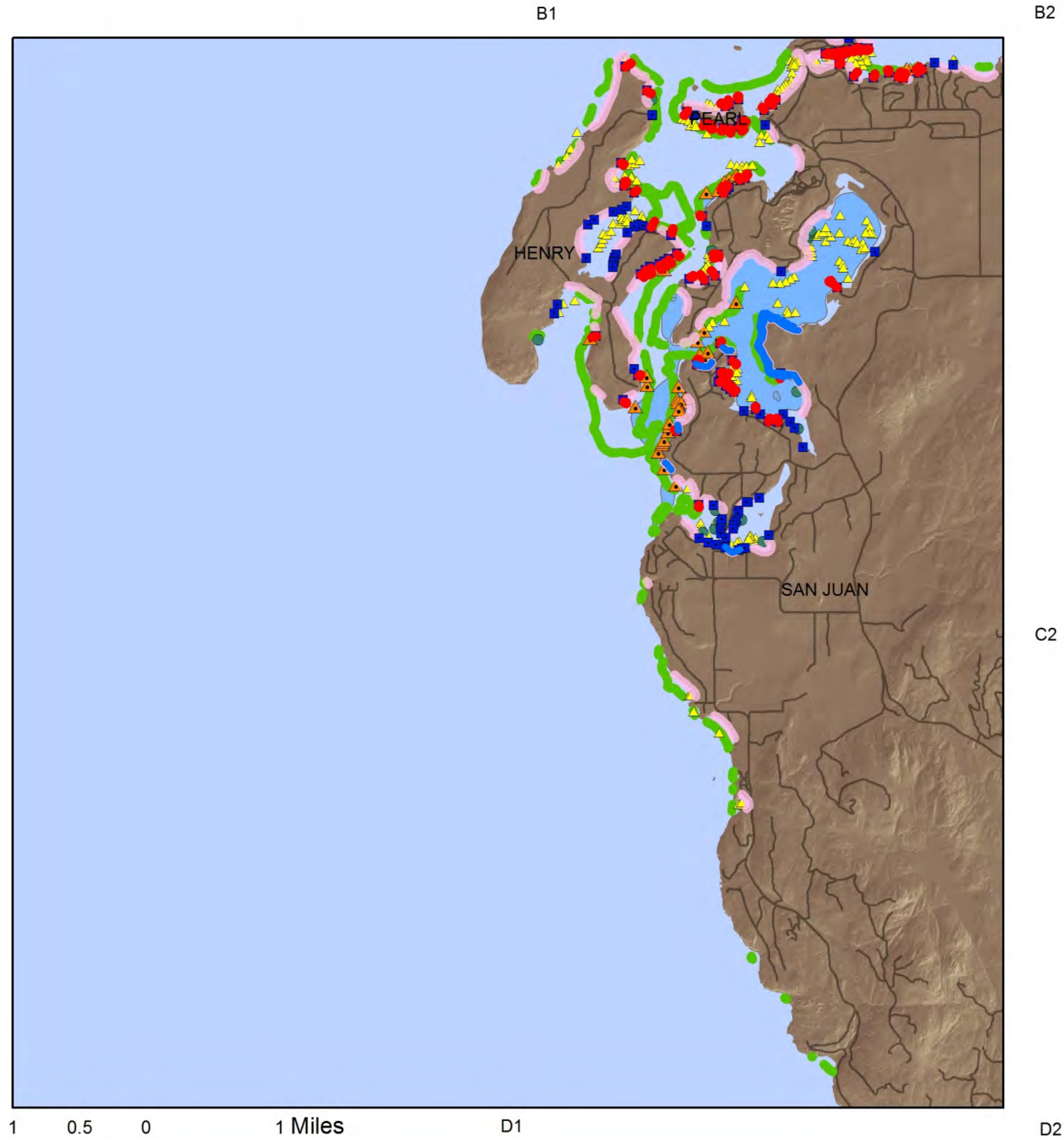
Legend

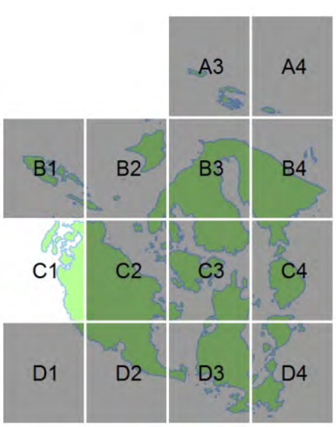
- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

B4



San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization





N

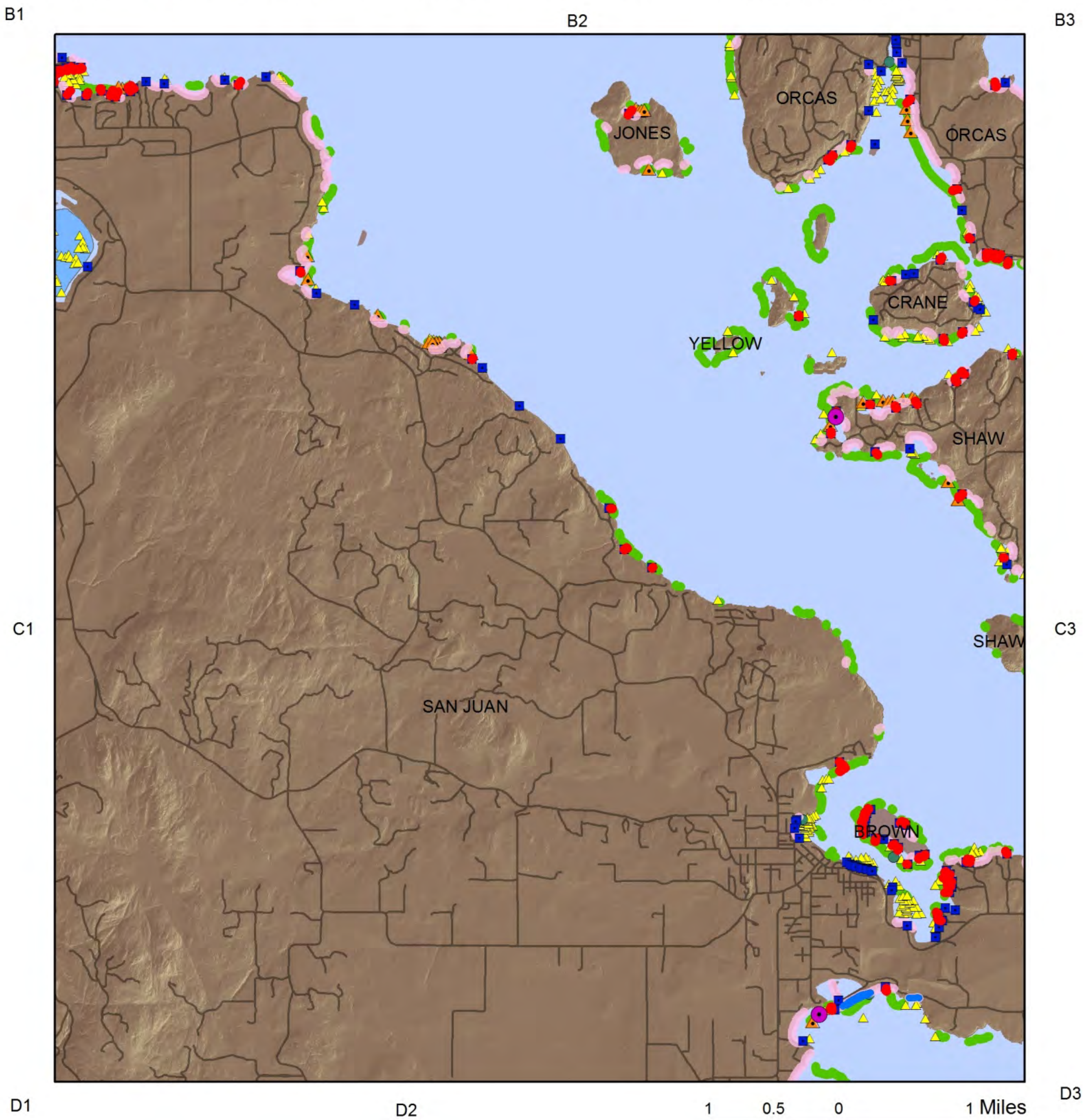
FRIENDS OF THE SAN JUANS

Legend

- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

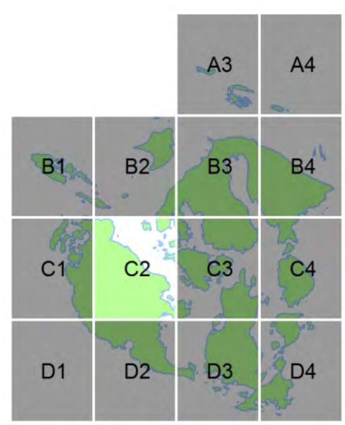
C1

San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization



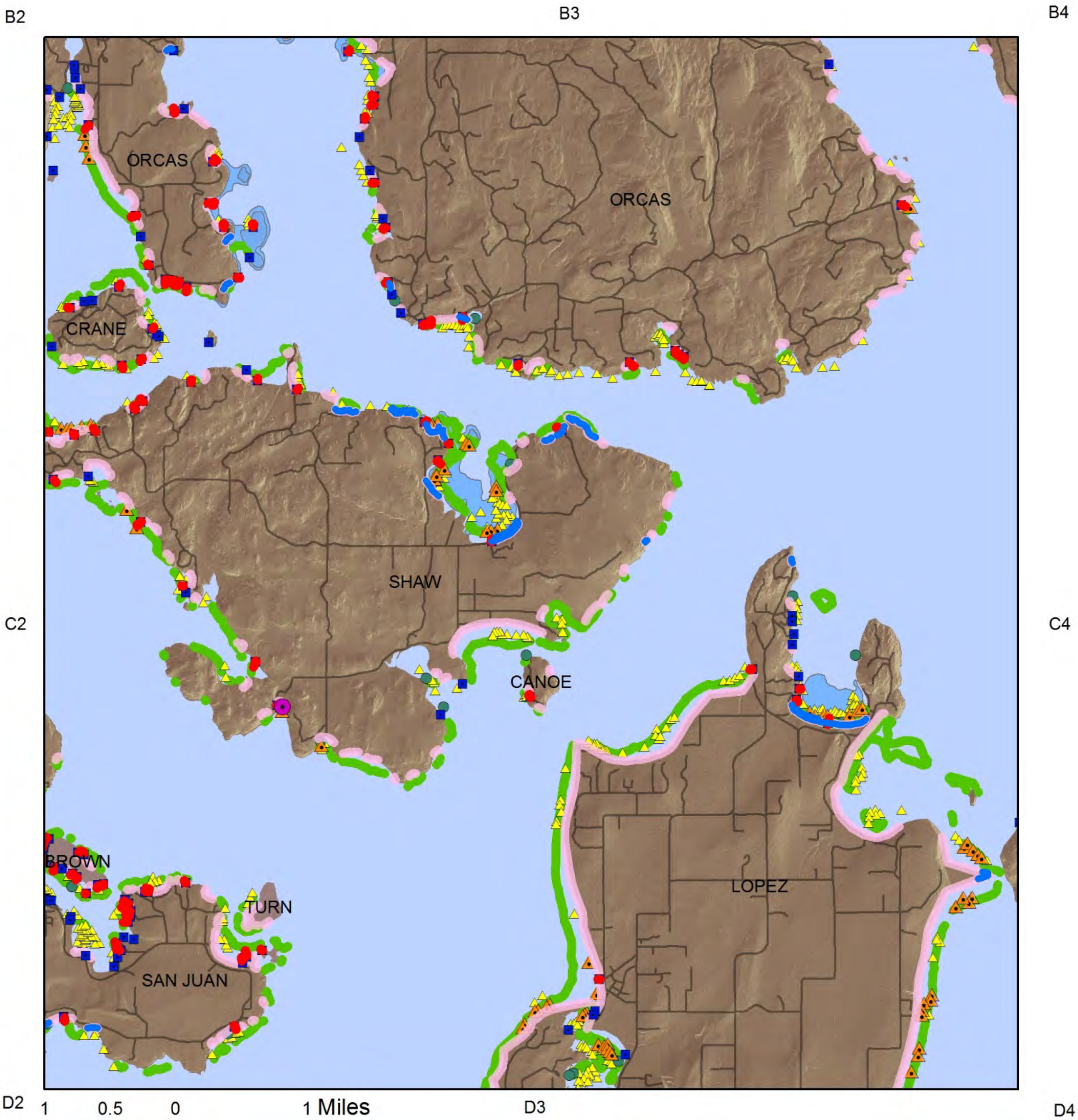
Legend

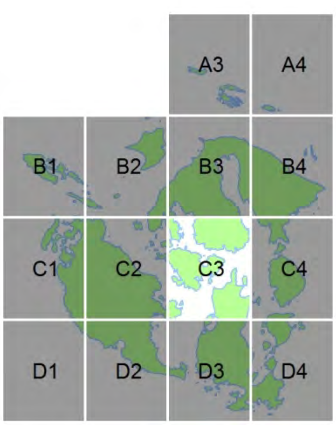
- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds



C2

San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization





N

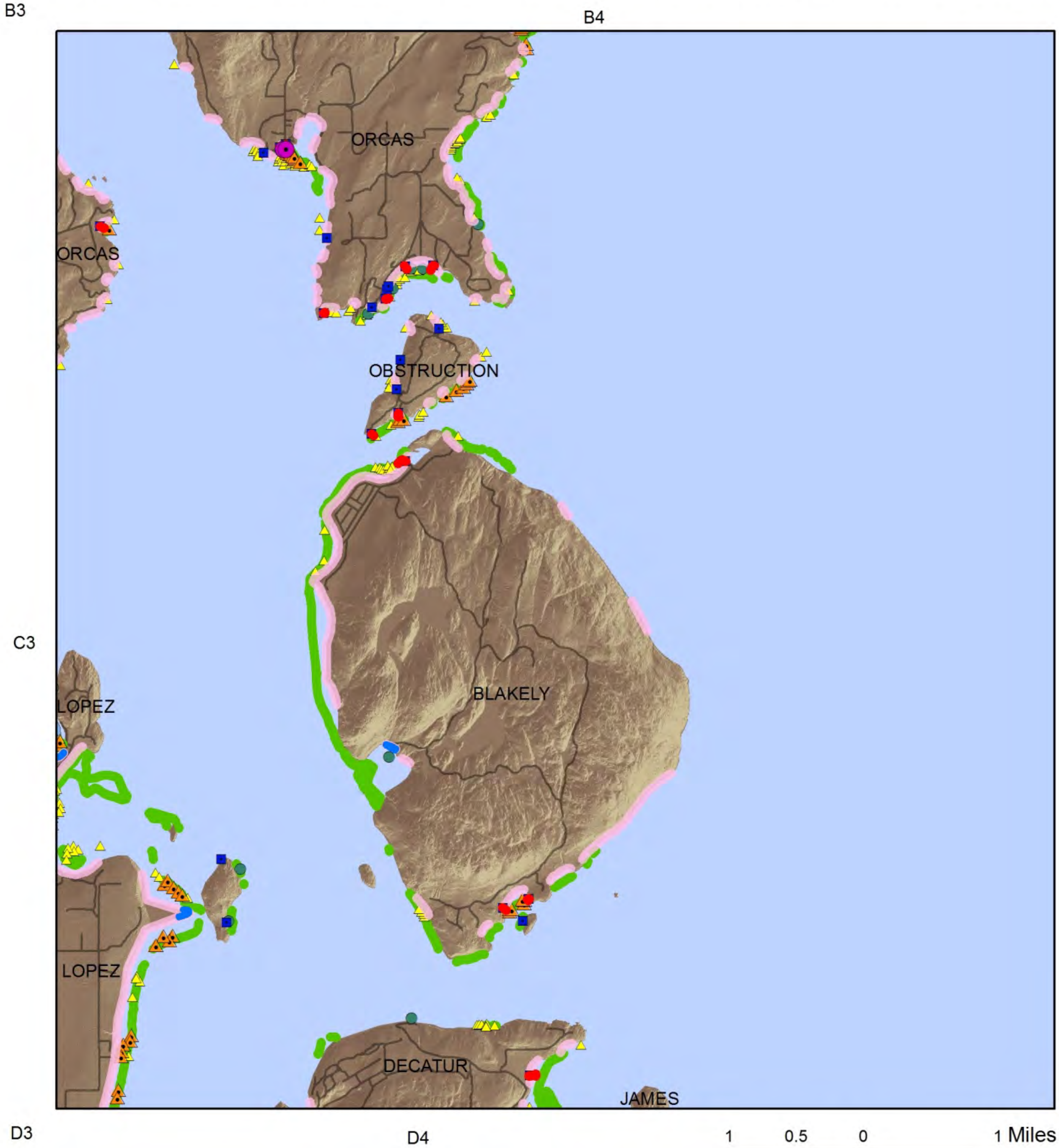
FRIENDS OF THE SAN JUANS

Legend

- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

C3

San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization



N

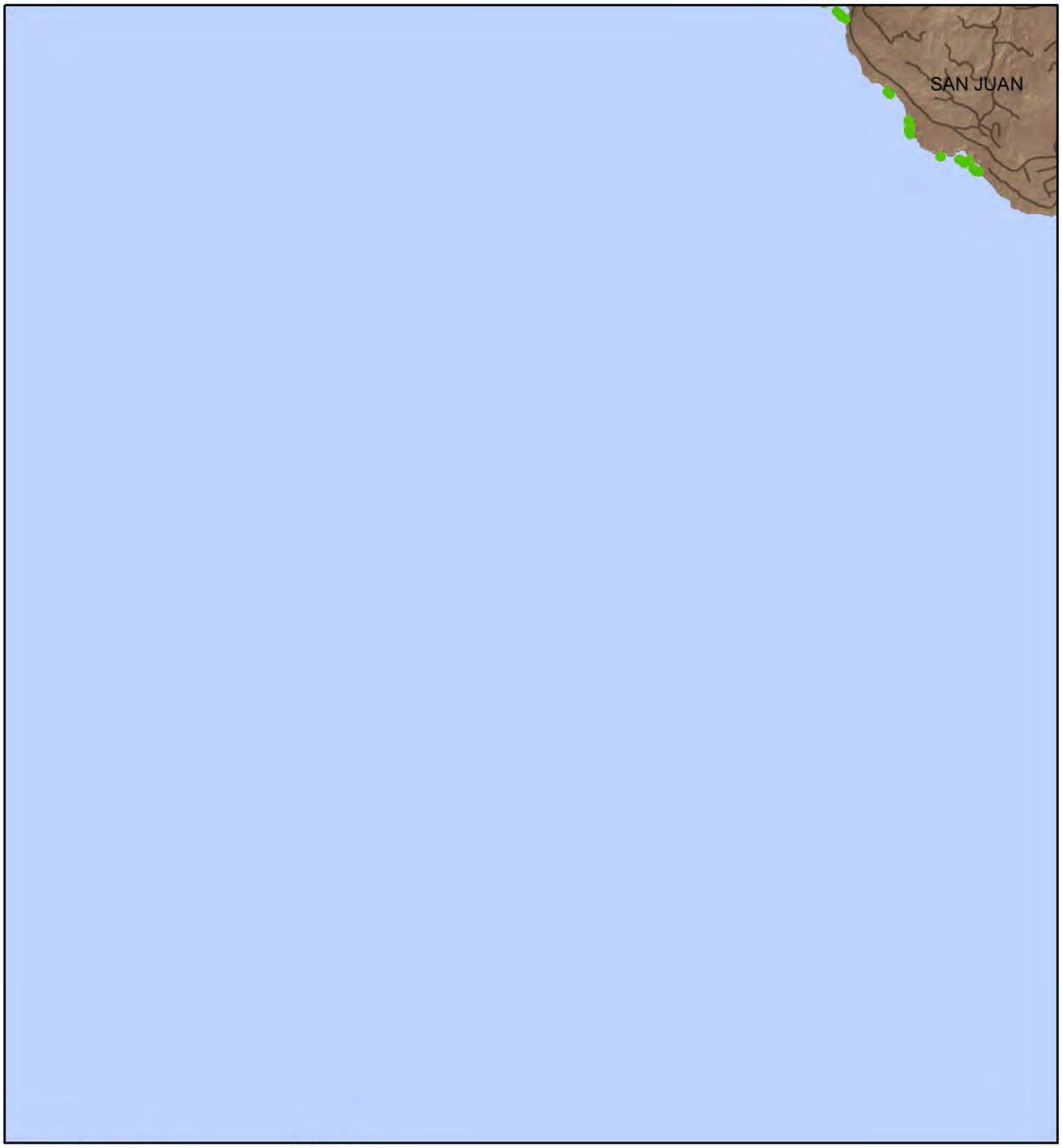
Legend

- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

C4

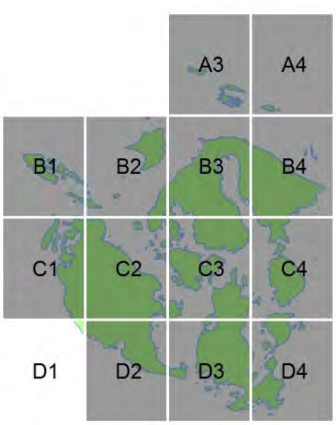
San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization

C1 C2



D2

1 0.5 0 1 Miles



N

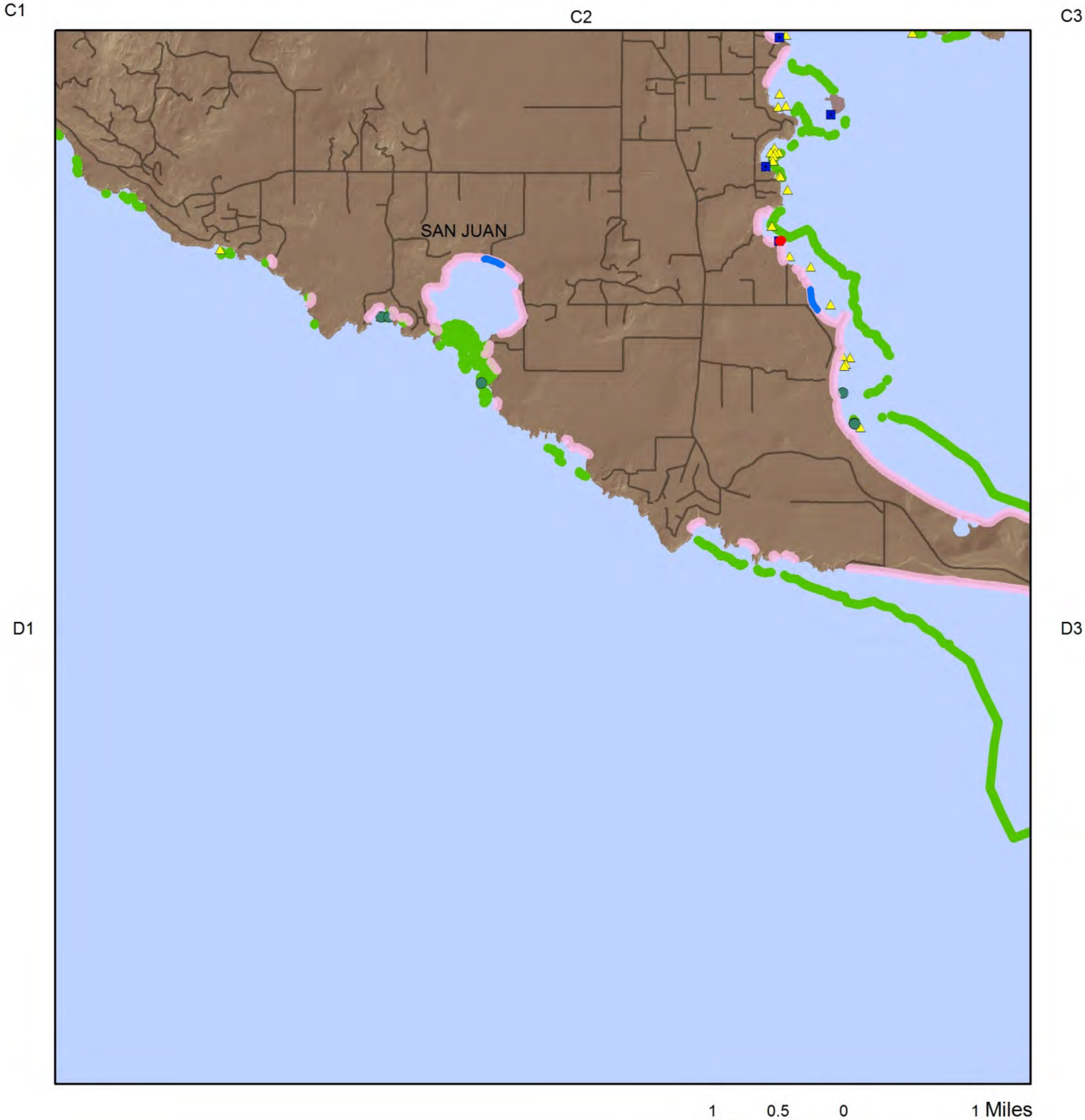
FRIENDS OF THE SAN JUANS

Legend

Dock Priority Restoration	Roads
Mooring Buoy Priority Restoration	Known Forage Fish Spawn Habitat
Piling Priority Restoration	Potential Forage Fish Spawn Habitat
Dock	Deep Water Edge Eelgrass
Mooring Buoy	Herring Spawning Grounds
Pilings	

D1

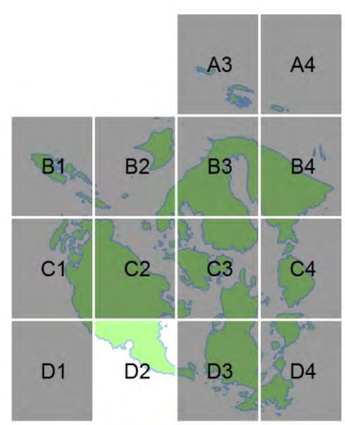
San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization



N

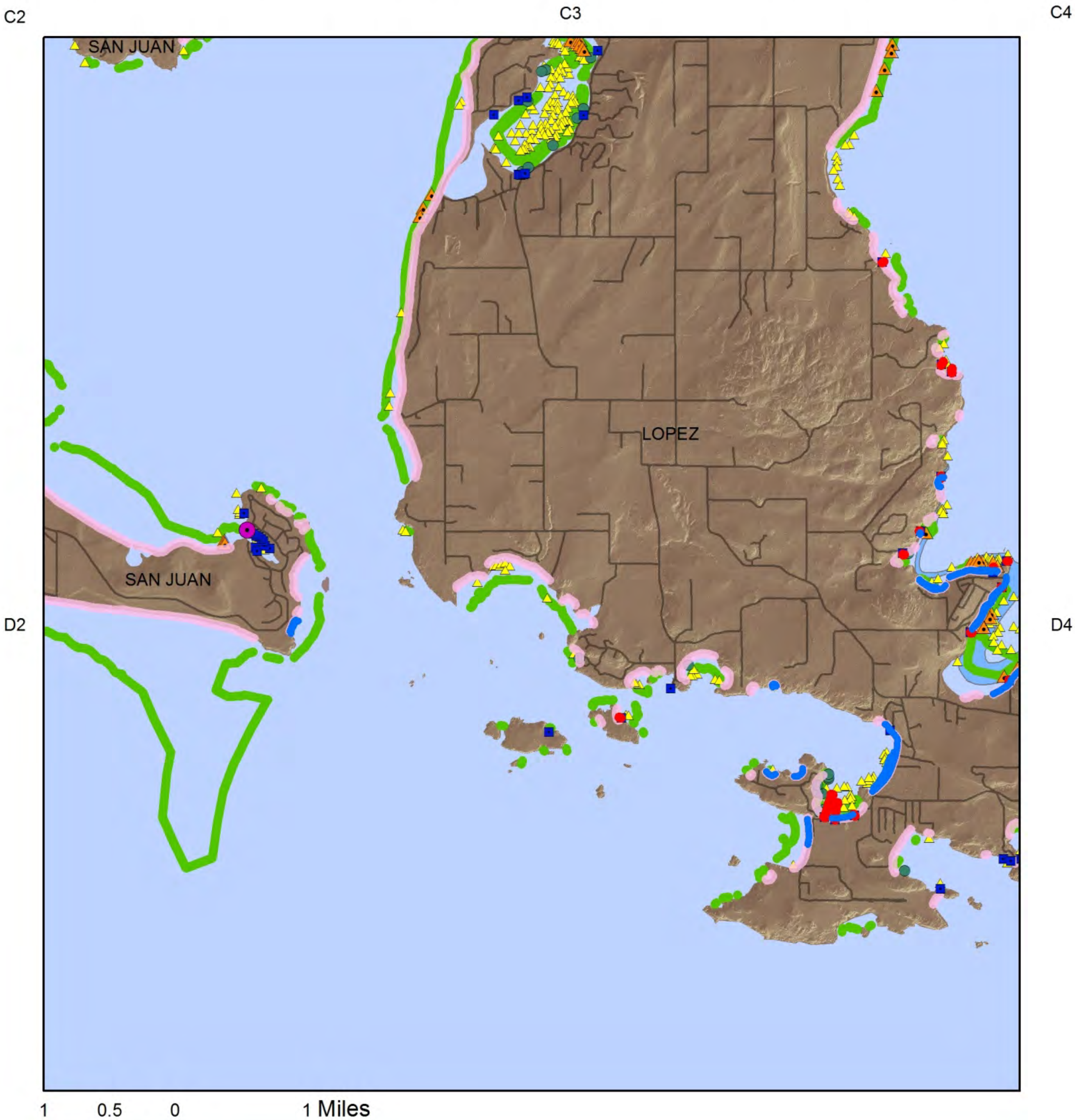
Legend

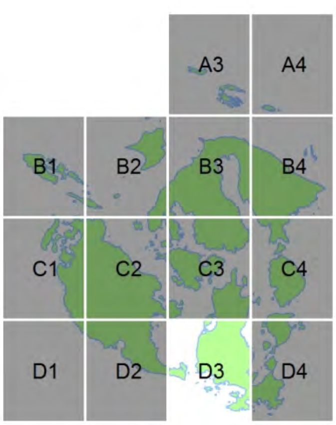
- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds



D2

San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization





N

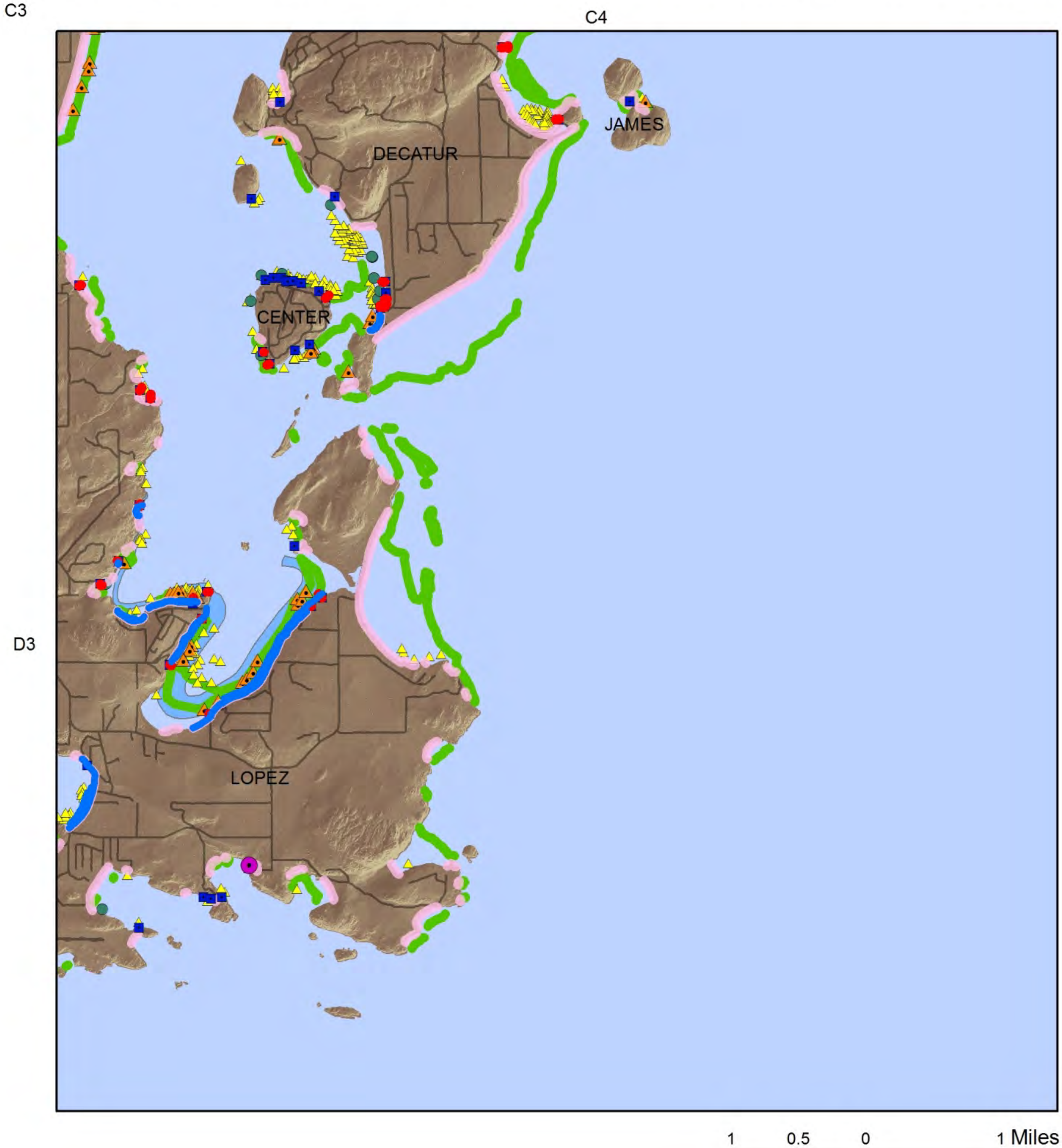
FRIENDS OF THE SAN JUANS

Legend

- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

D3

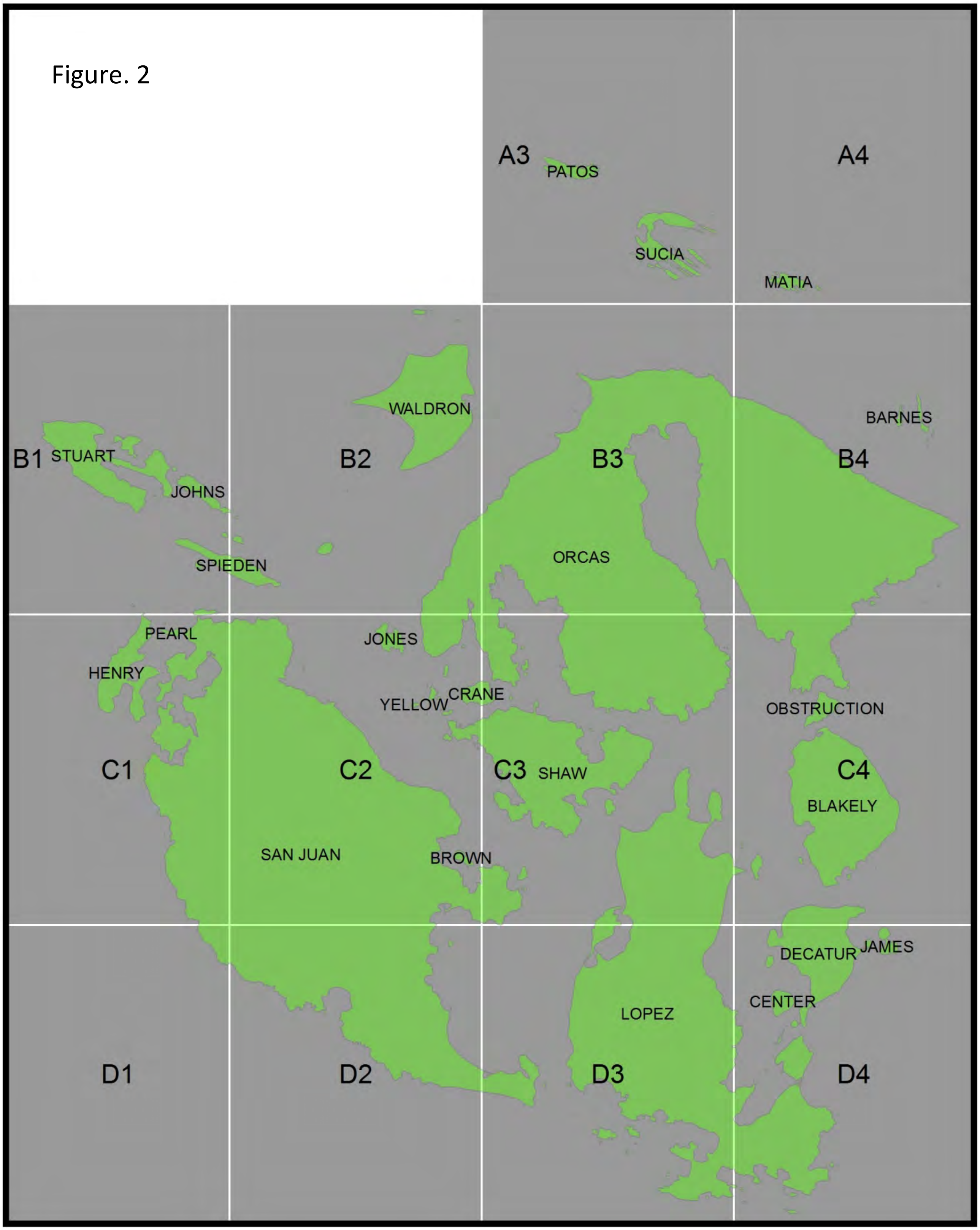
San Juan County Shoreline Modification Inventory
IN & OVER WATER STRUCTURE Restoration Prioritization



Legend

- Dock Priority Restoration
- Mooring Buoy Priority Restoration
- Piling Priority Restoration
- Dock
- Mooring Buoy
- Pilings
- Roads
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

D4



San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization

MAPBOOK

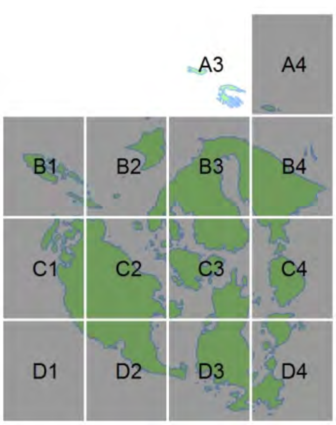
FRIENDS OF THE SAN JUANS

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization

A4

B2 1 0.5 0 1 Miles B3 B4

N

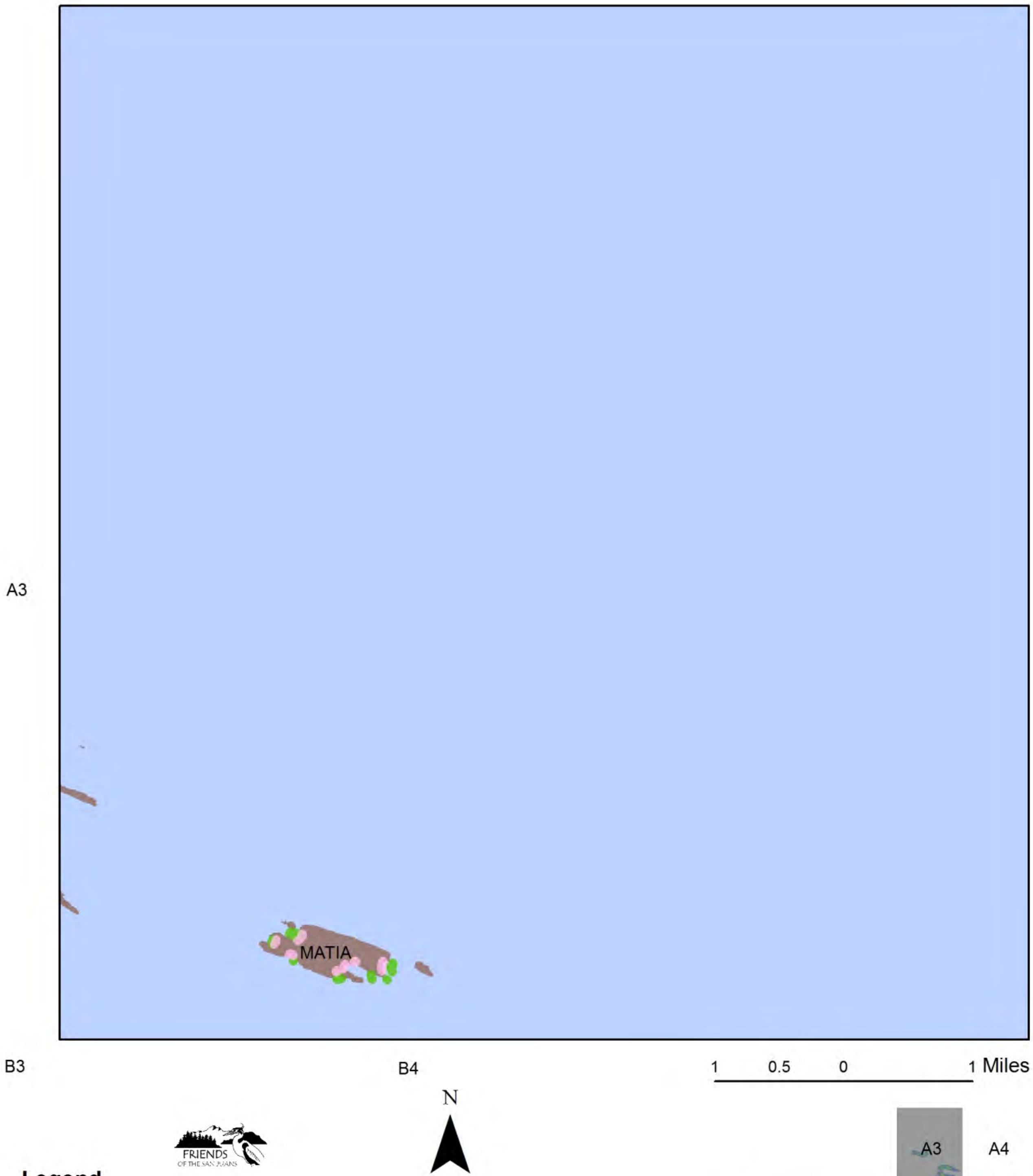


Legend

- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

A3

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization



Legend

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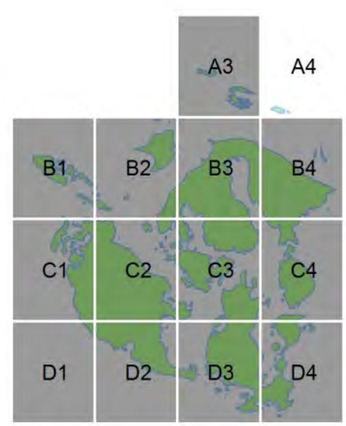
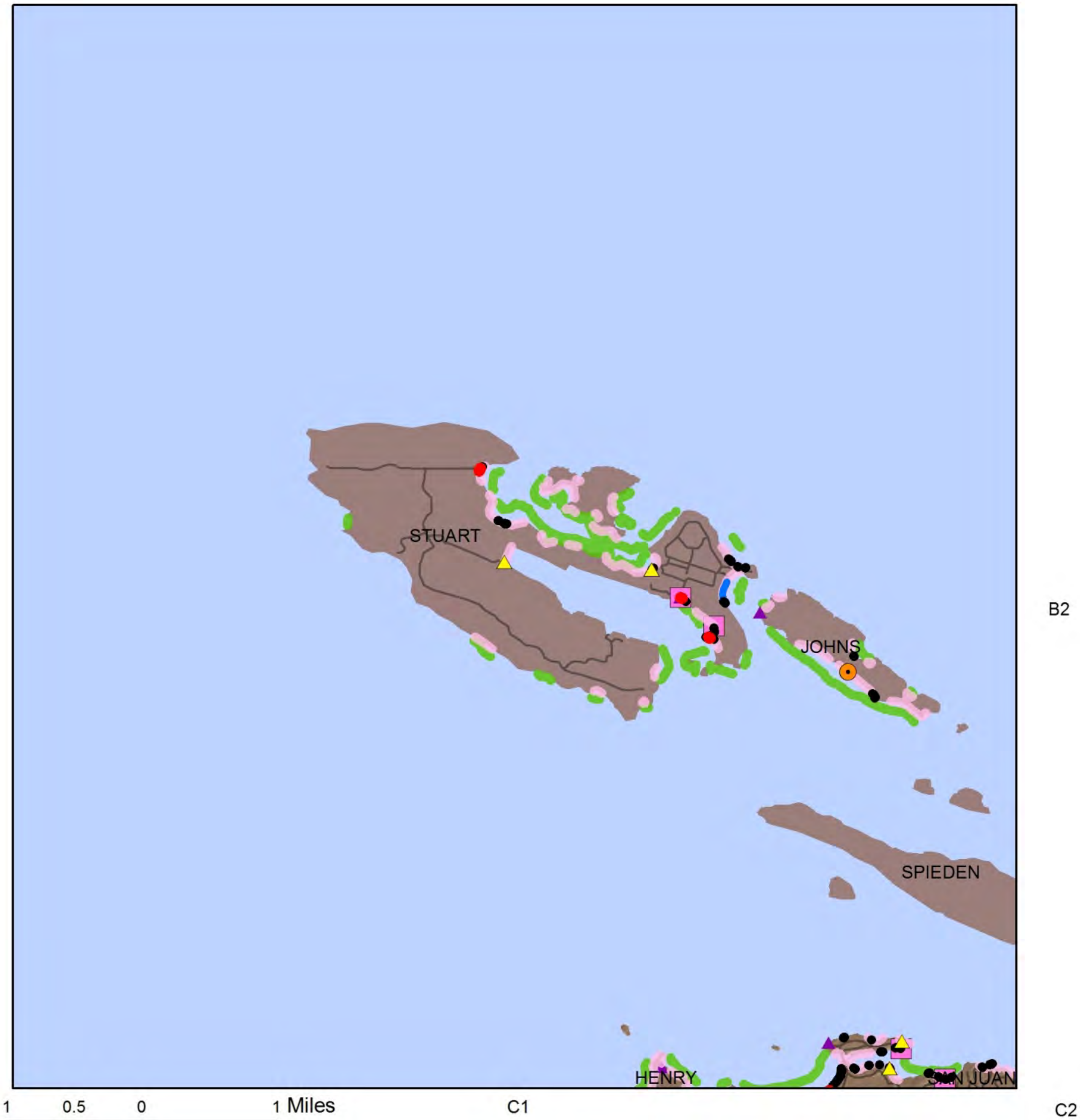
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

A4



San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization



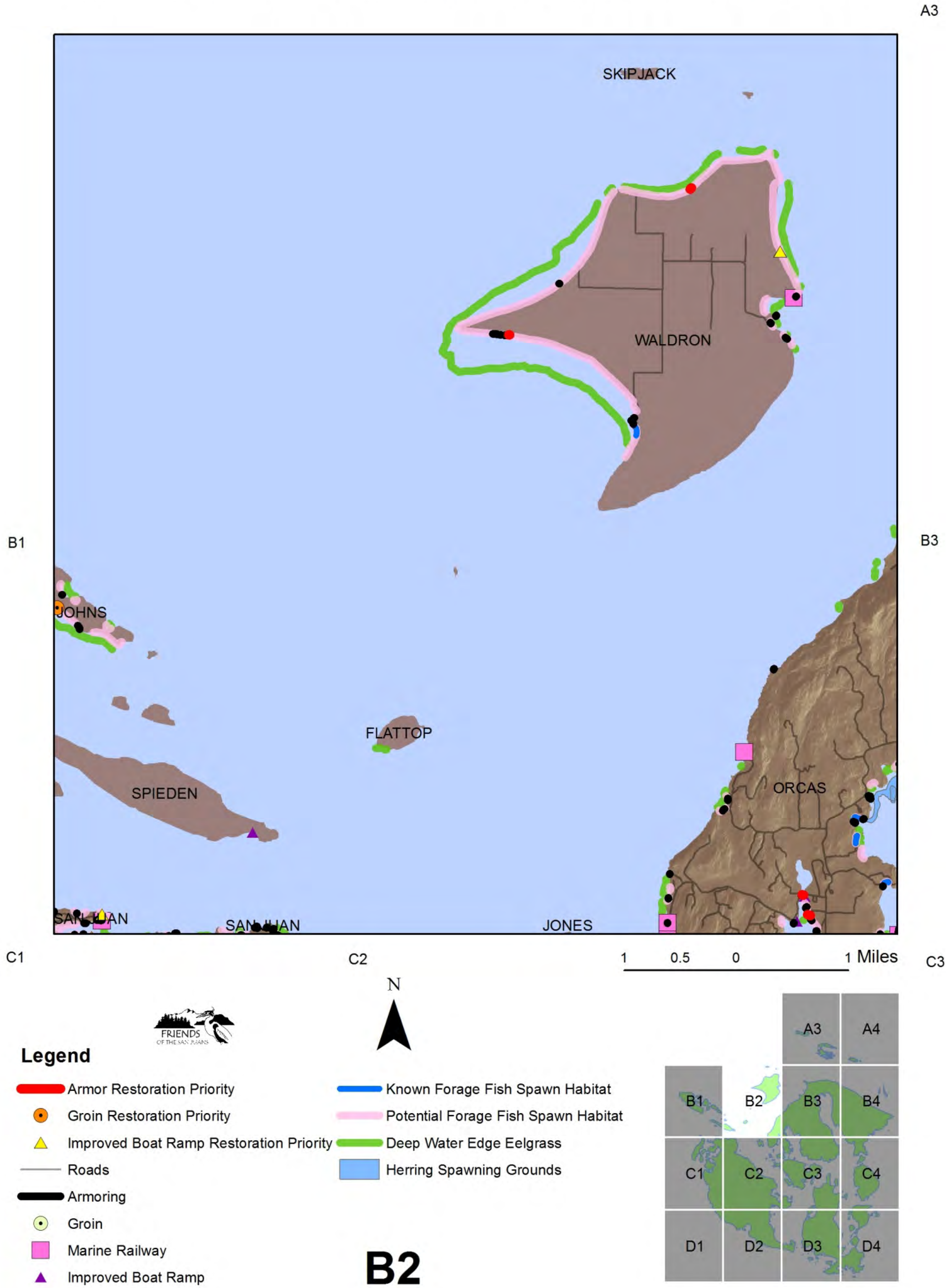
N

Legend

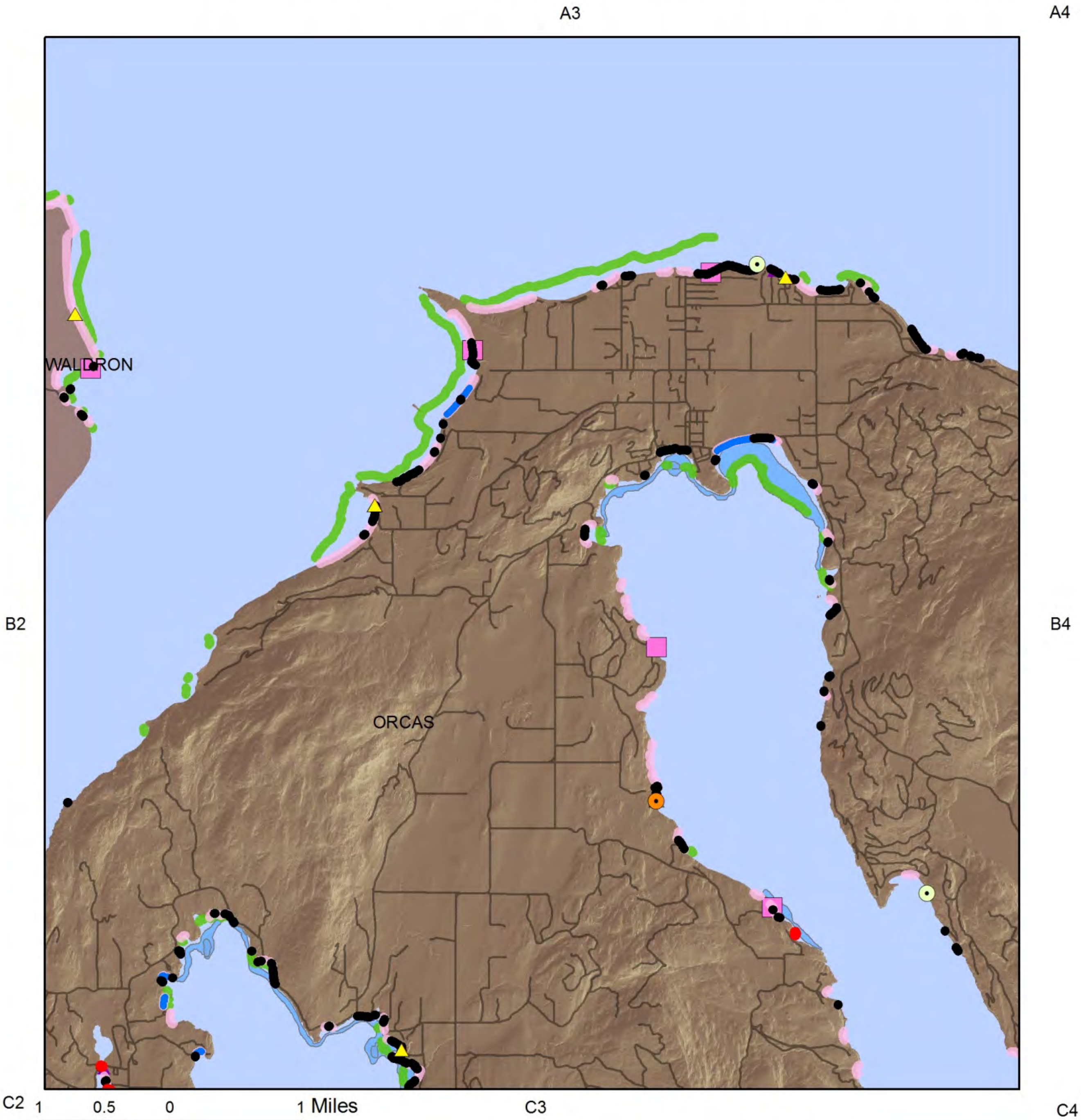
- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

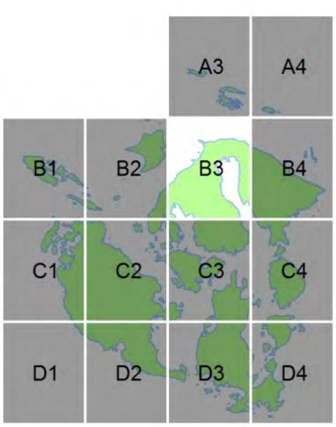
B1

San Juan County Shoreline Modification Inventory ON BEACH STRUCTURE Restoration Prioritization



San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization





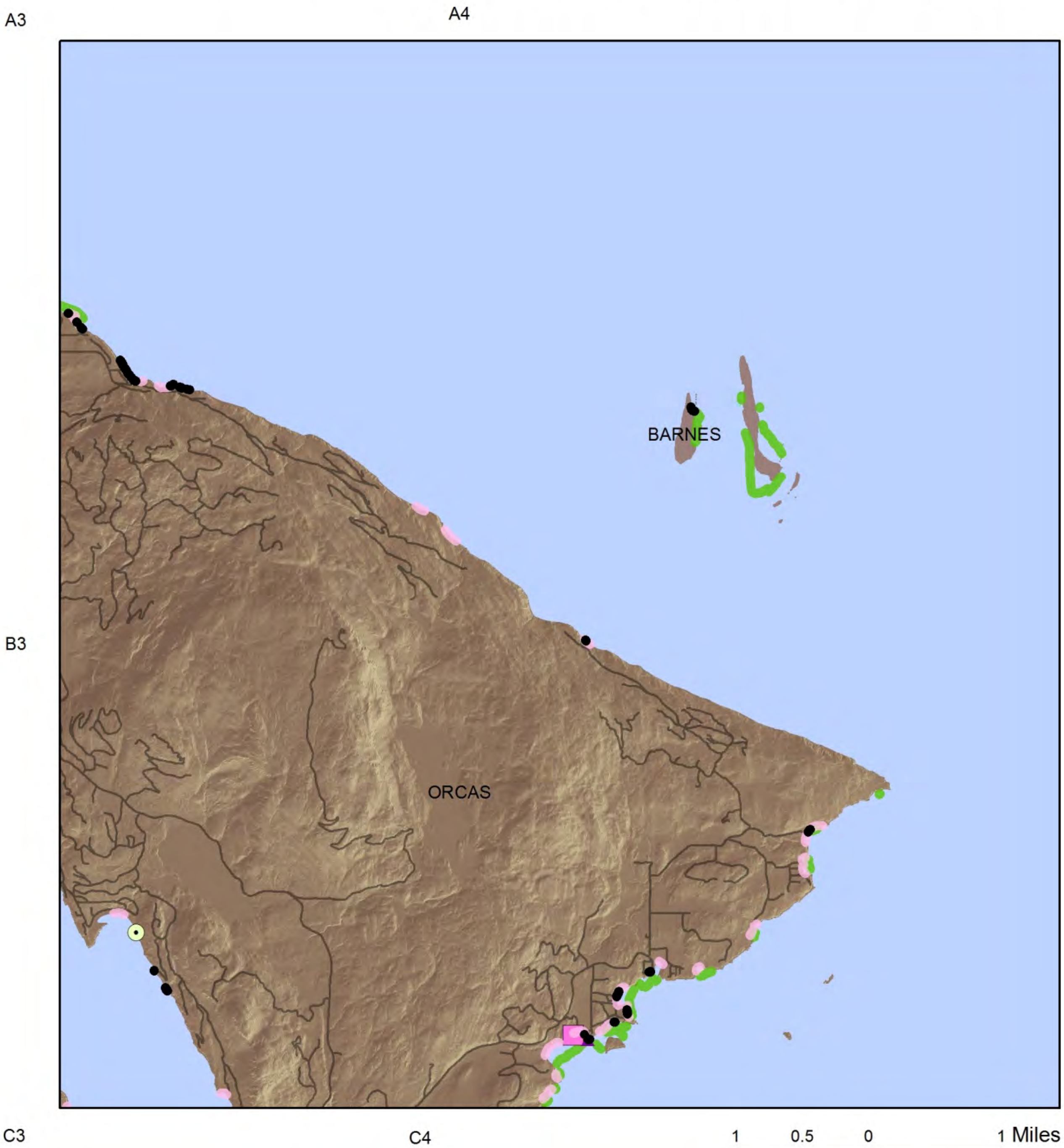
N

Legend

- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

B3

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization



Legend

- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
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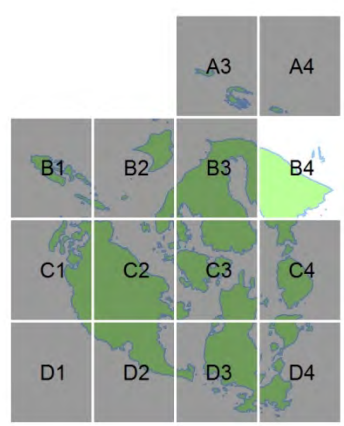
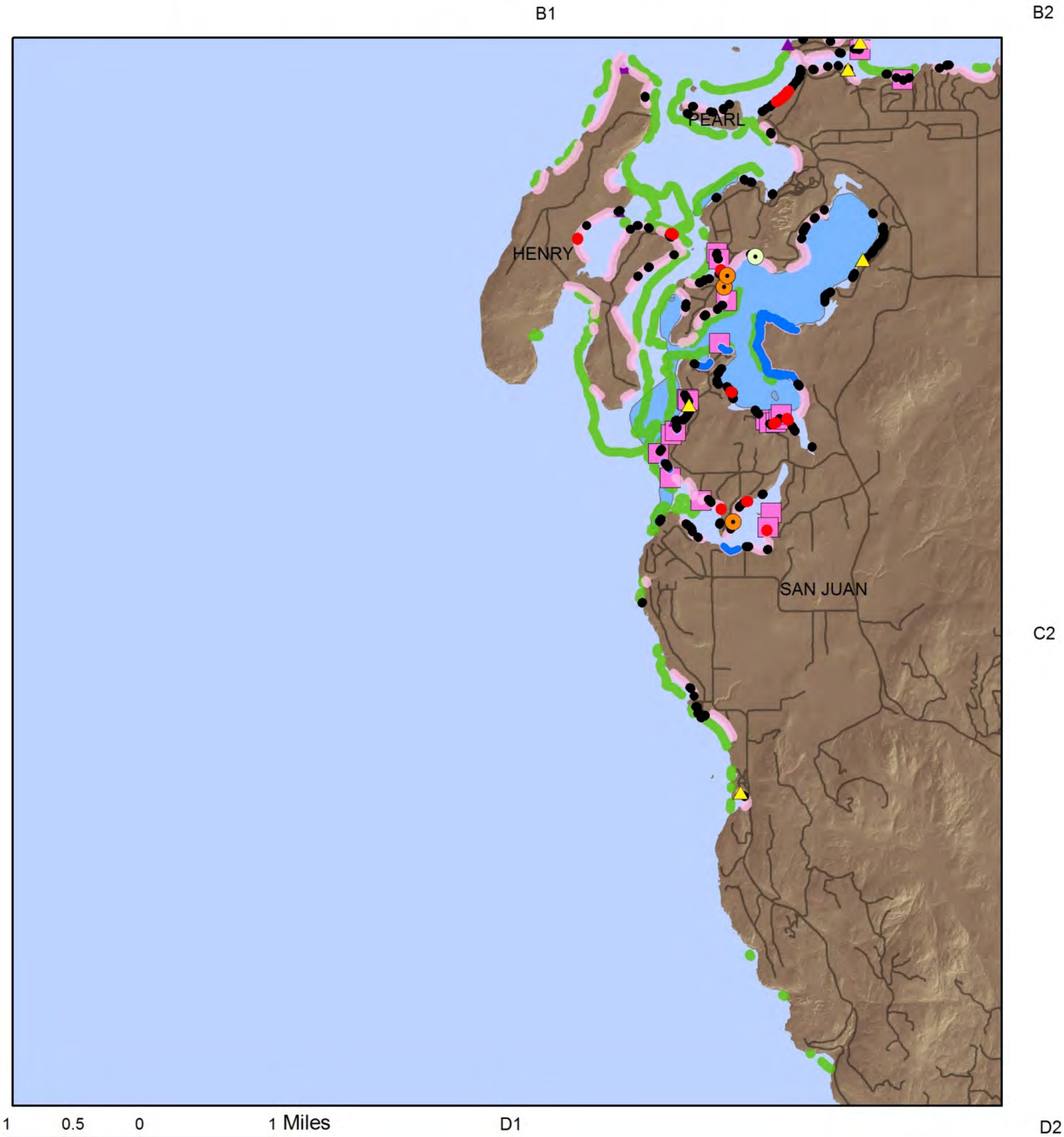
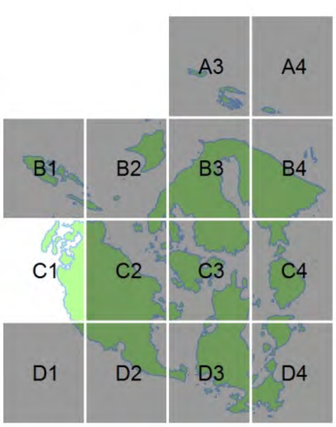
- Herring Spawning Grounds



B4

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization





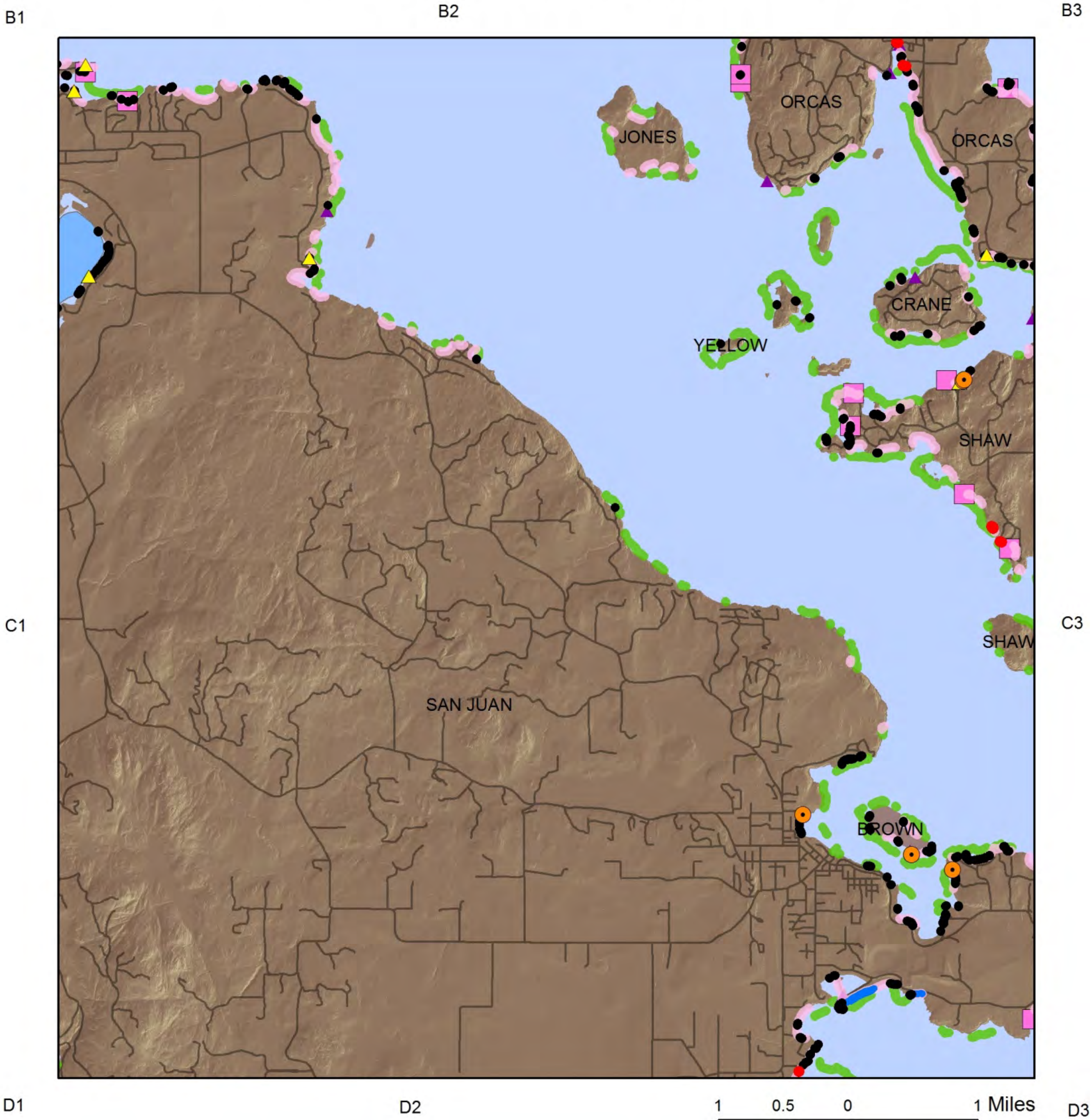
N

Legend

- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

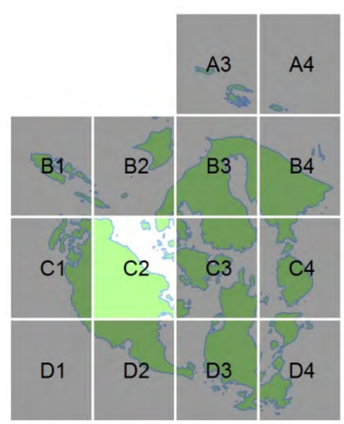
C1

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization



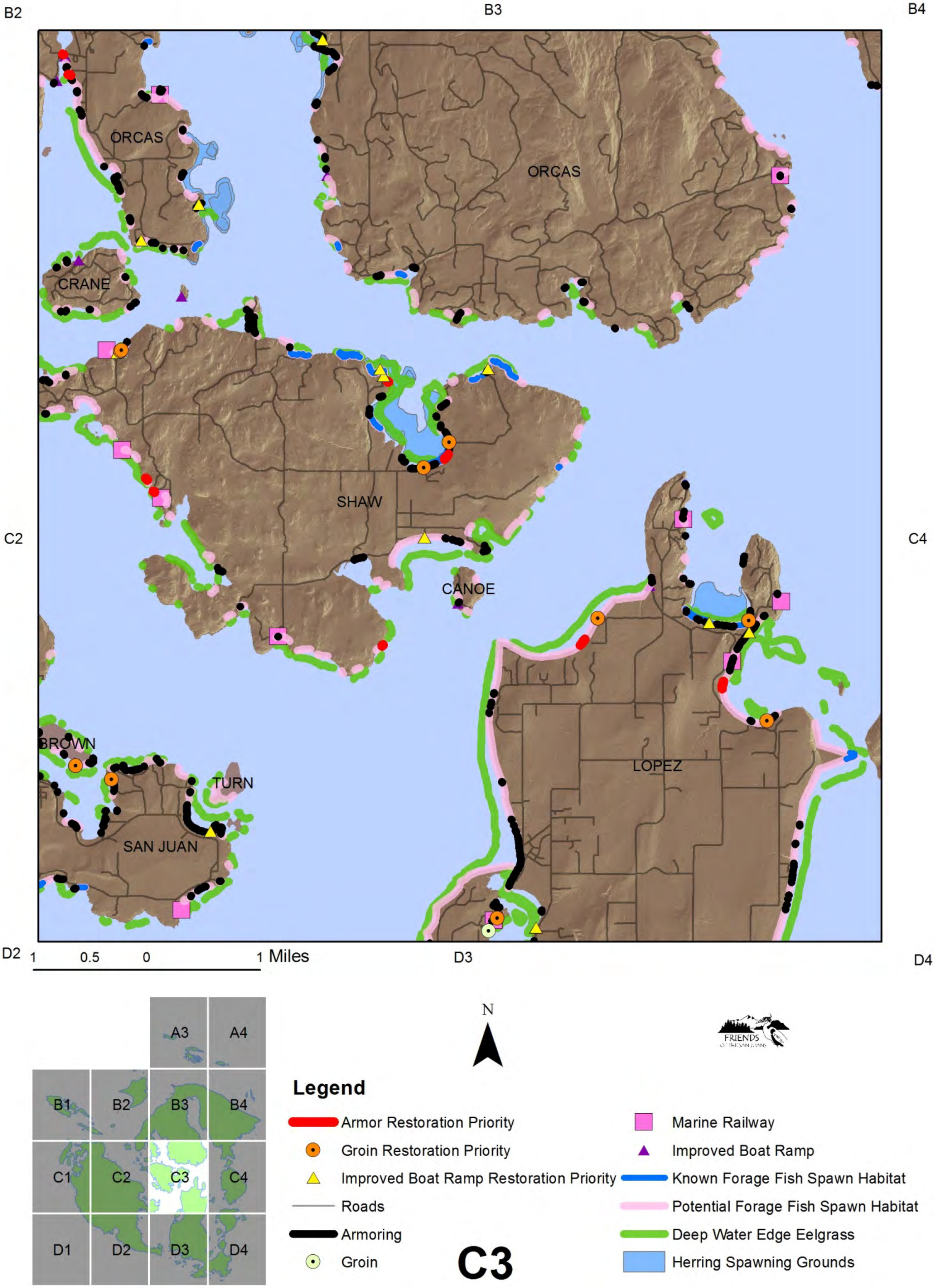
Legend

- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds



C2

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization

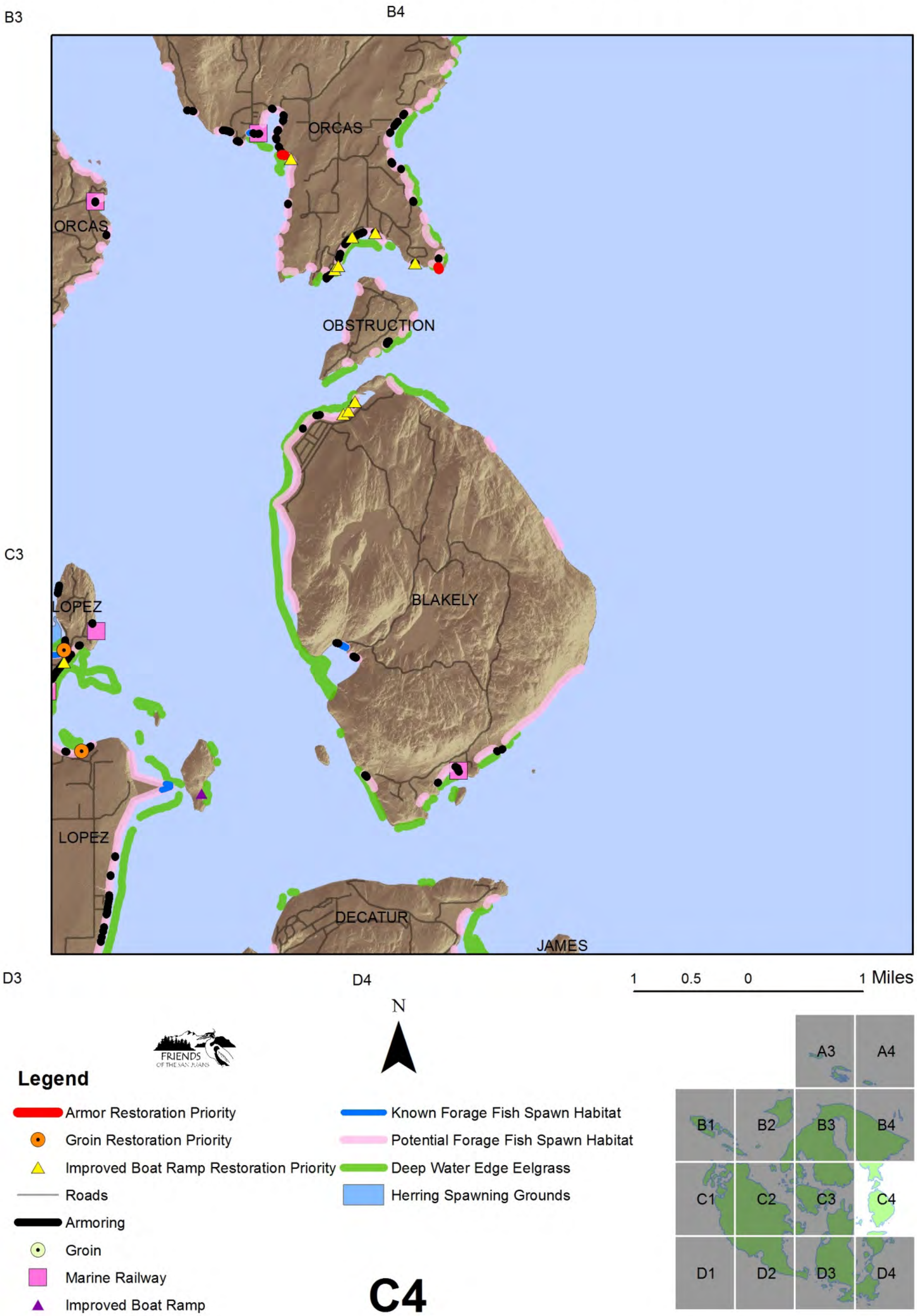


Legend

- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

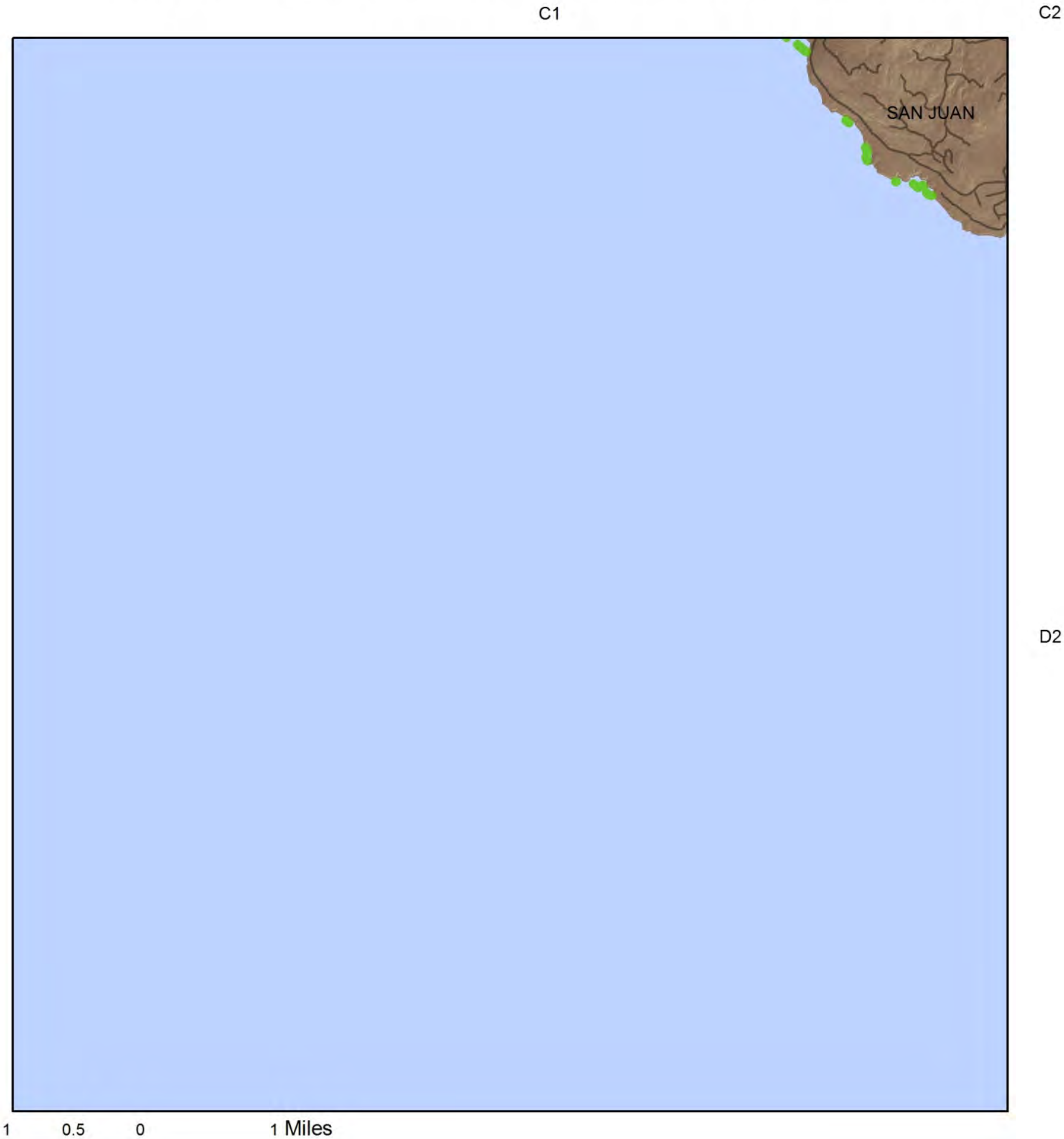
C3

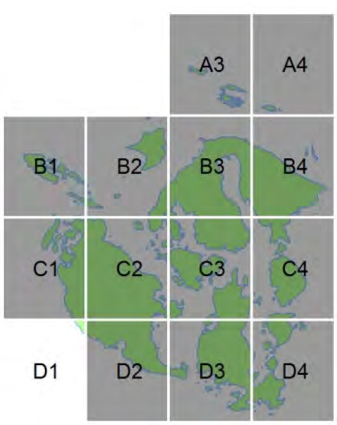
San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization



C4

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization





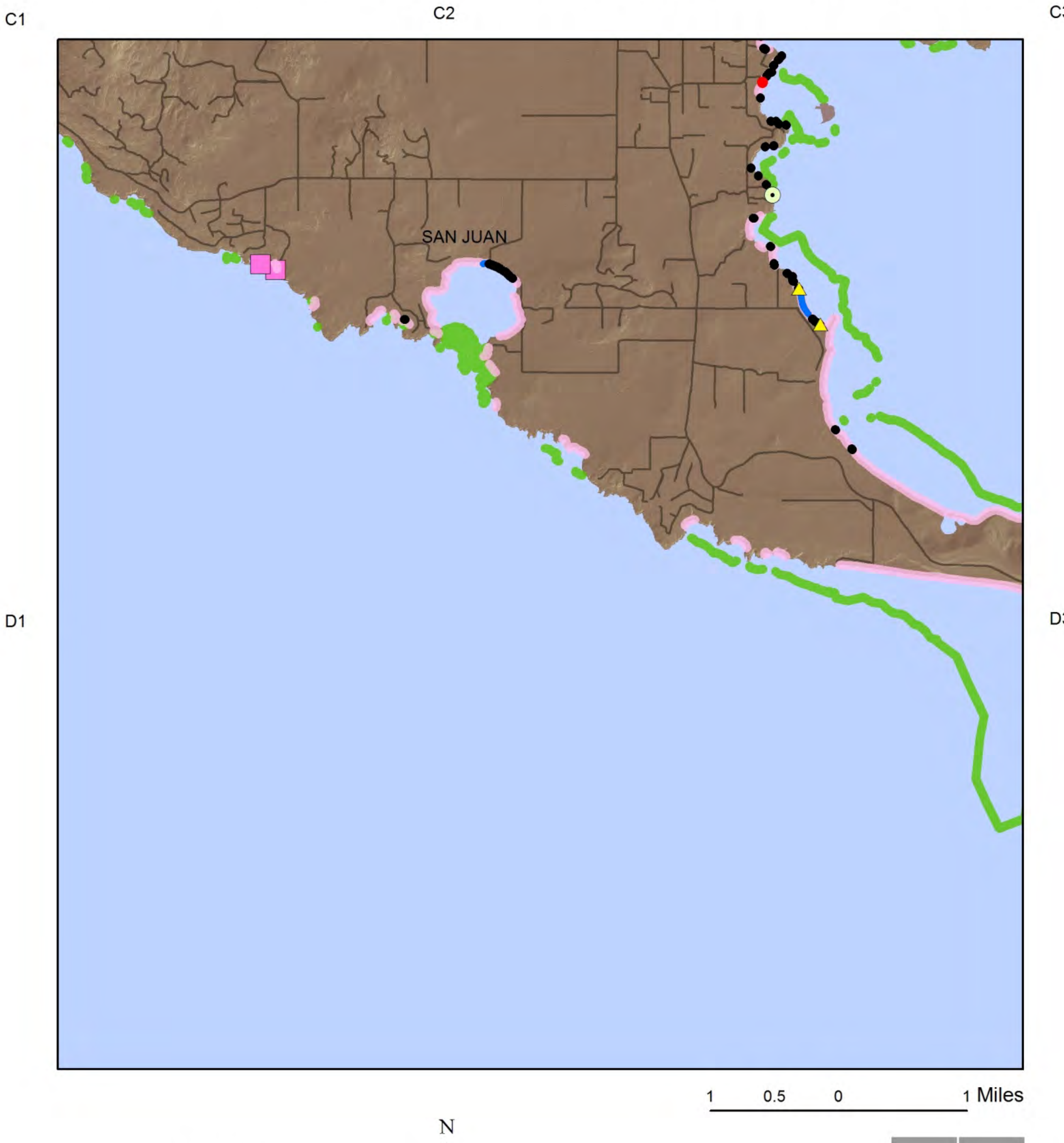
N

Legend

- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

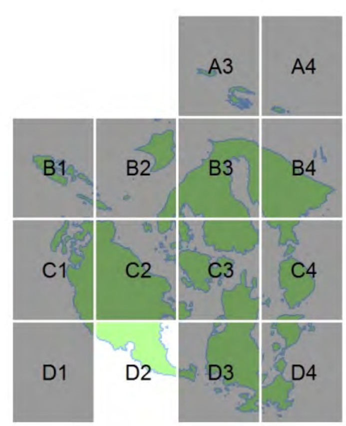
D1

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization



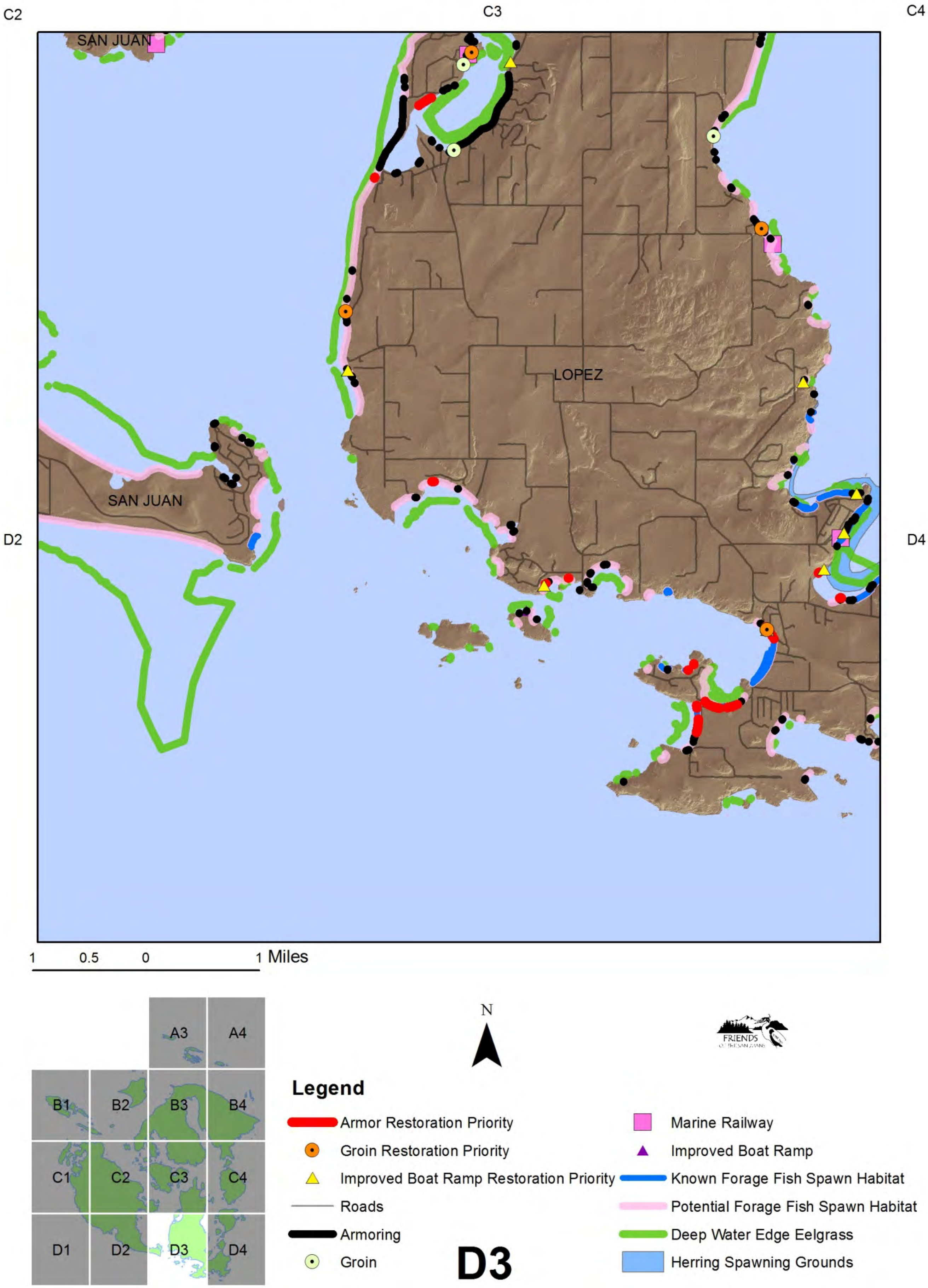
Legend

Armor Restoration Priority
Groin Restoration Priority
Improved Boat Ramp Restoration Priority
Roads
Armoring
Groin
Marine Railway
Improved Boat Ramp
Known Forage Fish Spawn Habitat
Potential Forage Fish Spawn Habitat
Deep Water Edge Eelgrass
Herring Spawning Grounds



D2

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization

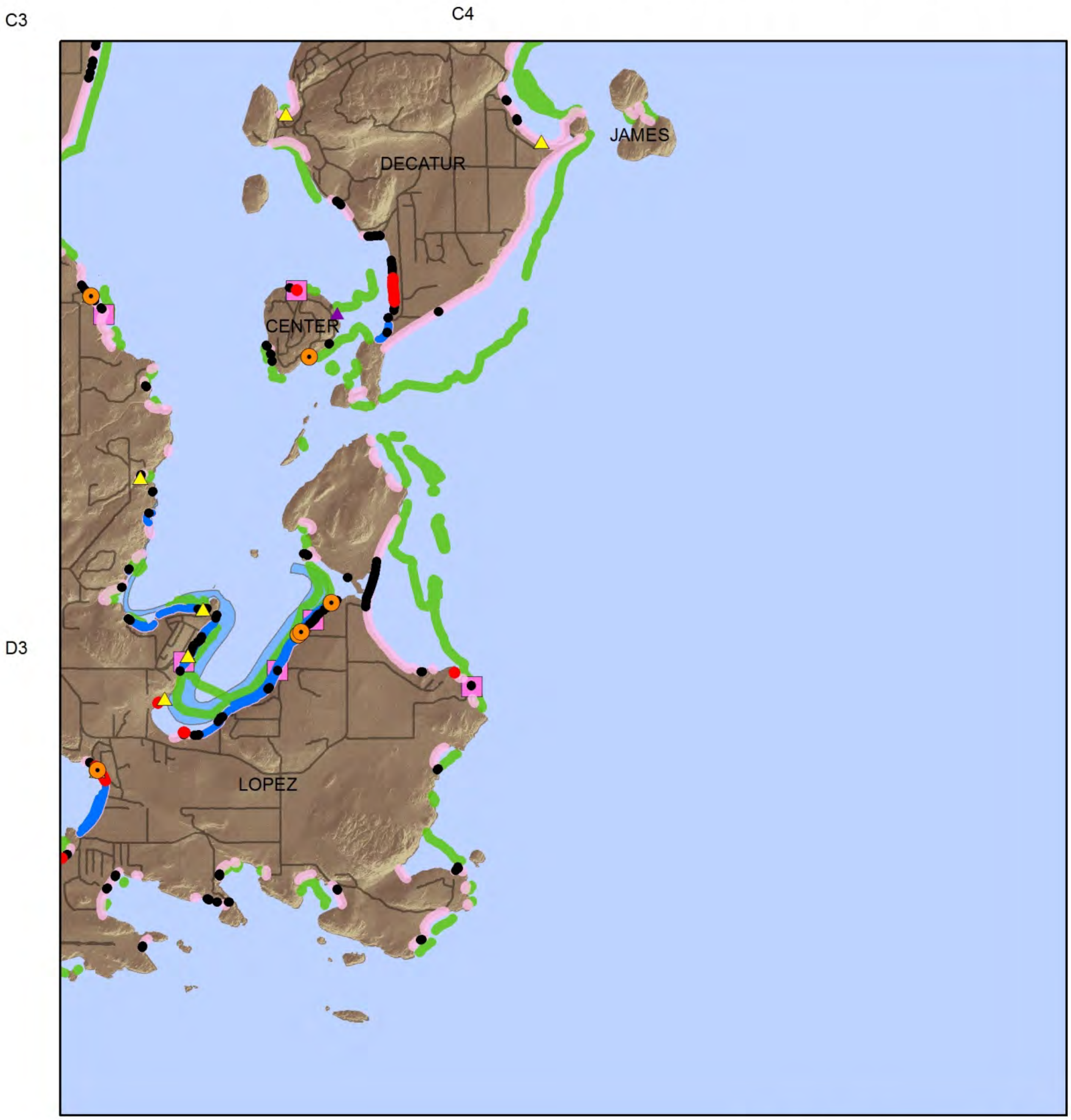


Legend

- Armor Restoration Priority
- Groin Restoration Priority
- Improved Boat Ramp Restoration Priority
- Roads
- Armoring
- Groin
- Marine Railway
- Improved Boat Ramp
- Known Forage Fish Spawn Habitat
- Potential Forage Fish Spawn Habitat
- Deep Water Edge Eelgrass
- Herring Spawning Grounds

D3

San Juan County Shoreline Modification Inventory
ON BEACH STRUCTURE Restoration Prioritization

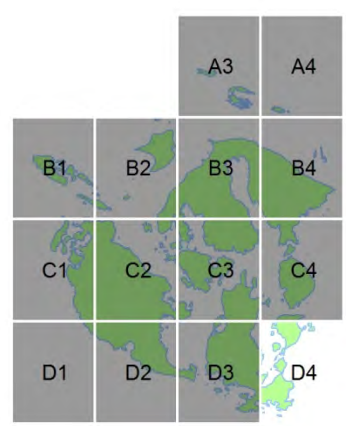


1 0.5 0 1 Miles

N

Legend

Armor Restoration Priority
Groin Restoration Priority
Improved Boat Ramp Restoration Priority
Roads
Armoring
Groin
Marine Railway
Improved Boat Ramp
Known Forage Fish Spawn Habitat
Potential Forage Fish Spawn Habitat
Deep Water Edge Eelgrass
Herring Spawning Grounds



D4