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TECHNICAL MEMORANDUM

Date: July 16, 2024

To: Kelly Zupich, Island County Public Health Natural Resource Specialist

Copy to: Island County Marine Resources Committee

From: Lauren Ode-Giles, Andrea MacLennan

Subject: Island County 2023 Shoreline Armor Survey—Methods and Results (Phase 1 and Phase 2)

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Executive Summary

Herrera Environmental Consultants conducted boat-based mapping of the shorelines of Whidbey and Camano Islands on behalf of the Island County Marine Resources Committee (MRC), to document the presence of hard shoreline armor across the county. As part of Phase 1 of this project, shoreline armor mapping was compared to results of a similar mapping effort completed in 2016, to identify changes in armor presence and characteristics across the 7-year period (2016 to 2023). In Phase 2, all shoreline permits were evaluated in association with areas in which armor change was documented.

This mapping effort was focused on the presence of hard armor, which is defined as: "rigid, permanent design techniques used to stabilize shorelines and prevent erosion" (Johannessen et al. 2014). Soft shore protection, which is also sometimes referred to as soft armor, differs from hard armor in that it is comprised largely of beach nourishment sediment and is therefore dynamic and appears like adjacent beaches and is often anchored by large woody debris that may or may not be cabled to large rock or buried cement blocks.

Phase 1 results identified a relatively minor net change in the length of shoreline armor. This was largely attributed to the considerable length of armor removal (2.3 miles) that had occurred in the County over the study period (2016–2023). The Phase 1 change analysis identified approximately 286,044 feet (54.1 miles or 25.3 percent of the Island County shoreline) of shoreline armor in 2023, compared to 284,252 feet (53.8 miles or 25.2 percent of the shoreline) in 2016. This constitutes a net increase of approximately 1,790 feet (0.3 miles) of mapped shoreline armor between 2016 and 2023. An estimated 14,404 feet (2.7 miles) of new shoreline armor has been installed along Island County marine shorelines since 2016. Approximately 12,600 feet (2.4 miles) of armor has been removed from Island County shores since 2016 mapping.

The Phase 2 objective was to identify the co-occurrence of new armor installations and modifications (expansions) of existing armor between 2016 and 2023, with corresponding permits for development in the nearshore. Results of Phase 2 identified 22 permits to install new hard shore armor and/or repair or modify existing armor during the study period. Of the 14,116 linear feet of new shore armor spatially compared with tax parcel boundaries, approximately 1,920 feet (14 percent) was associated with an approved permit to install new shoreline armor.

Phase 2 also entailed analyzed changes in armor characteristics (e.g. tidal elevation, condition) between 2016 and 2023, changes in the occurrence of new armor along different coastal landforms or geomorphic shoretypes, and the co-location of shore armor with forage fish spawning habitat. Of the approximately 271,300 feet (51.3 miles) of shore armor mapped in both 2016 and 2021, approximately 9,970 feet (1.9 miles) was mapped as being in better condition in 2023 than in 2016. Approximately 99,320 feet (18.8 miles) of shore armor mapped in both 2016 and 2023 was mapped at a farther-waterward (toe) elevation in 2023 relative to 2016. This may be the result of armor toppling from wave attack during storm events, beach narrowing, and/or loss of beach driftwood deposits following large storm events. Several noteworthy winter storms that involved king tides compounded by storm surges occurred between 2016 and 2023. Additionally, differences in mapped features interpretation between 2016 and 2023 were likely due to differences in mapped armor elevation.

Shore armor that was present in 2023 mapping but not in 2016 was most frequently mapped on accretion shoreforms (8,260 feet or 59 percent of new armor), followed by feeder bluffs (2,820 feet or 20 percent of new armor) and transport zones (13 percent of new armor). Forage fish spawning has been documented along 108 miles of Island County shoreline (50.1 percent of the total shoreline). Armor was present along approximately 32 miles (169,287 feet) of forage fish spawning habitat in 2016 and 32.4 miles (171,114 feet) of shoreline in 2023 (29.6 percent and 29.9 percent of the documented forage fish spawning habitat, respectively). Of this net additional 0.4 miles (1,827 feet) of armored forage fish spawning habitat, 345 feet (19 percent) was associated with approved shore armor permit records.

Approach

Field Methods

Field-based data collection was conducted over 11 field days between September 18 and October 19, 2023. Mapping was conducted by boat, in teams of two experienced coastal scientists, following the shoreline armor mapping methods described in *Armor Mapping Methods for the Puget Sound Region* (CGS, 2018). All team members reviewed methods for interpreting coastal conditions and assigning shoreline armor characteristics prior to initiating field work (Figure 1). All data capture and entry was carried out by the same coastal geospatial scientist, to maximize consistency.

Figure 1. Representative Examples of Hard Shoreline Armor Encountered in Island County.

		
Concrete Bulkhead with Derelict Vertical Wood Piles	**Stacked Rock Revetment**	**Creosote-Treated Wooden Bulkhead Adjacent to a Metal Sheet-Pile Wall**

Mapping was conducted using an EOS Arrow 100 sub-meter GPS unit with real-time kinematic (RTK) corrections (Figure 2.1), which received virtual offsets from a linked LaserTech TruPulse 360-series laser rangefinder (Figure 2.2). A TruPulse 360B laser rangefinder was used during the first 8 days of data collection, and a TruPulse 360R was used for the final 3 days of mapping. Laser rangefinders were calibrated by following manufacturer guidelines at the beginning of each field day. The accuracy of the laser rangefinder was periodically evaluated across each day.

Figure 2.1. EOS Arrow 100 GPS Receiver and Antenna Mounted to the Field Boat.	Figure 2.2. Field Staff Conducting Offset Mapping Using a TruPulse 360-Series Laser Rangefinder and Esri FieldMaps Application.
	

To promote data collection efficiency and to reduce opportunities for transcription error and data loss, digital field forms constructed in ArcGIS FieldMaps were used in lieu of printed field forms. The same shoreline armor attributes described in CGS 2018 were documented in this mapping effort (material composition, tidal elevation, armor condition, other notes). The use of ArcGIS FieldMaps also allowed field staff to view the presence of armor from the previous 2016 mapping effort, while conducting data collection and checking for consistency.

This mapping effort was concerned with mapping hard shoreline armor (a rigid structure designed to protect bluffs and beaches from erosion; WDFW, 2014). Soft shoreline protection installations (adaptable, semi-movable erosion protection design constructed from logs, gravel, and other shore-native materials; WDFW, 2014) were not consistently mapped, as these installatiosn can be difficult to distinguish in the field. Suspected soft shore installations and other constructed coastal features of interest, including boat ramps, boat houses, and chained/anchored logs, were mapped as single GPS points during field data collection. These points were reviewed and augmented with high-resolution air photos after field-based data collection in the same manner as shoreline armor points. As these other features were not the focus of this 2023 mapping effort, no warranty is made regarding the completeness of this supplemental feature layer.

Data Review

Review and quality control of mapped data was conducted at several stages across the project. During initial data collection, the placement of GPS-offset and shoreline armor points was visually inspected in real-time using the FieldMaps application. Air photos in the app and previously mapped armor from the 2016 mapping event could be viewed to confirm that relative point placement was occurring as expected.

Following initial data collection, mapped armor points were reviewed in Esri ArcGIS Pro for completeness, accuracy, and consistency of mapped points and attributes. In all instances where shoreline armor was mapped in 2016 but not observed in 2023, high resolution aerial photography (Island County Oblique Viewer, 2020) was reviewed to confirm the absence of shoreline armor.

In limited instances where the nearshore was too shallow to allow for direct placement of GPS-offset points on shoreline armor, GPS points were placed offshore and positioned in desktop analysis based on field photos and high-resolution-air-photo review. The interior of private marinas and shallow coves were not subject to mapping updates in this 2023 analysis. Armor attributes in these areas were copied from the 2016 mapping event.

Data Processing

Mapping was conducted using an EOS Arrow 100 sub-meter GPS unit with RTK corrections, which did not require additional differential corrections in-postprocessing.

Following review and validation of all mapped shoreline armor points, GPS-collected and remotely mapped armor attributes were processed from individual armor vertices into polyline features in ArcGIS Pro. Herrera applied a semi-automated approach based on the approach described in CGS (2018) to improve data production efficiency. Rather than manually digitizing each armor segment from mapped offset points, each point was assigned a sequential identifying number derived from the alongshore direction in which mapping was conducted. For example, a section of continuous armor would be comprised of increasing ID numbers from start to end (e.g., a set of three points—start, change, end—with ID numbers 347, 348, 349; Figure 3). After ID numbers were assigned, armor segments were automatically generated using the "points to lines" geospatial processing tool; the attributes of each armor segment were assigned from the leading point in the sequence. Lines generated with an "end"-type point as their origin were deleted, as these represented areas with no shoreline armor.

Figure 3. Example of Armor Lines Generated Using Sequentially Assigned Identifiers, with Attributes Populated from Start to End.

After lines were generated to describe the extent of shoreline armor from offset-mapped points, the length of each armor segment was populated to a new "pre-snap armor length" field. This allowed for preservation of initial armor extents prior to conforming to the WDNR ShoreZone Shoreline (Berry, et al., 2001).

Other mapped features, including the presence of boat ramps, cabled logs, and other noted features, were visually reviewed from high-resolution air photos and exported as points to separate geospatial feature classes.

Data products produced from this analysis include:

- Armor lines and attributes mapped in 2023 (including a pre-snap length field), conforming to the ShoreZone Shoreline (discontinuous line segments, mapping only where armor was present)
- A merged layer containing complete ShoreZone Shoreline geometry (continuous), including armor lines and attributes mapped in 2023 and a field indicating whether armor was present in 2016 and in 2023 for direct comparison (does not include pre-snap length field)
- Other layers
  - Boat ramps
  - Cabled logs and other features of note

Figure A1 (Appendix A) depicts the full extent of shoreline armor mapped in Island County in 2023. A full description of the attributes associated with each geospatial feature class is included in Appendix B.

Change Analysis—Presence of Potential New Armor

A preliminary, targeted evaluation was conducted in the first phase of this analysis to identify where armor was not mapped in 2016 but was mapped in 2023.

The total length of shoreline armor mapped in Island County was compared between 2016 and 2023, using either the pre-snap armor length attributes (as described in the Data Processing section) or the post-snap (ShoreZone Shoreline-conforming) measurement. Both measurement methods were applied, to identify net differences in shoreline armor presence between the 2016 and 2023 mapping events.

A minimum margin of acceptance for mapping errors/comparisons between the ShoreZone Shoreline-conforming measurements in the merged 2016 and 2023 geospatial layer was set at 5 feet. This is based on the cumulative error of:

- The median horizontal root mean squared (HRMS) error of the Arrow 100 RTK GPS unit plus 2 standard deviations: 0.52 foot + (0.61 foot * 2) = 1.73 feet
- The accuracy of the TruPulse 360-series laser rangefinder for a low-quality target: +/- 3 feet

This produced a cumulative error of 4.73 feet, which was rounded to 5 feet as a cautious minimum margin of acceptance.

This minimum margin of acceptance is considered separately from the 20-foot minimum mapping unit described in the armor mapping methods. The minimum mapping unit serves as a threshold under which shoreline armor is not included in the mapping dataset. The minimum margin of acceptance is applied to filter out areas of minimal change (within the potential error margin of the mapping technology) between armor mapping results in 2016 and 2023.

Supplemental spatial analysis was conducted in Phase 2, to evaluate whether potential new armor was installed adjacent to extant shore armor. Shared endpoints of linear armor features were identified between armor mapped in 2016 and armor segments mapped only in 2023 (not in 2016). A minimum margin of acceptance of 5 feet was applied, to filter out segments below the cumulative mapping error.

Change Analysis—Armor Characteristics

Change in the characteristics (condition, composition, and relative elevation) of mapped shore armor between the 2016 and 2023 mapping events was conducted, to identify areas where potential alterations to existing shore armor occurred over the study period. This could include modifications to the material, structural footprint, and/or tidal elevation of shore armor. Improvements in mapped armor condition (e.g., from "functional/failing" to "sound" between 2016 and 2023) were of particular interest, because in the absence of human intervention the mapped condition of shore armor is expected to either stay the same or worsen over time. Differences in the mapped shore armor elevation (e.g., from "MHHW-OHWM" to "Below MSL") were also of interest; this may indicate changes in the footprint and configuration of existing shore armor, due to breakdown and redistribution of armor materials over time (e.g., rocks from

a stacked revetment falling to lower beach elevations during storm events) or due to direct human modifications.

The results of both the 2023 shoreline armor survey and the earlier 2016 mapping event were spatially manipulated to conform with the WDFW ShoreZone shoreline spatial dataset. As such, these spatial armor records from 2016 and 2023 could be spatially intersected to allow for direct comparison of mapped armor characteristics across the two shore armor survey events.

Permit Analysis

The Island County MRC provided Herrera with a database of aggregated permit records from the various Planning Departments of Island County, including Island County, Oak Harbor, Coupeville, and Langley. Pre-processing of permit records was performed, in order to remove duplicate entries (e.g., identical permit application number, description, issue date, and parcel location appearing multiple times in the permit records) and to consolidate multiple permit records associated with a single parcel (so that no data would be lost during subsequent steps of joining permit records with tax parcel boundaries). During pre-processing, consistent permit attributes were assigned for efficient comparison and quantification. Boolean (true/false) fields were developed and assigned, to describe the type of permit issued (armor, soft shore, other work in the nearshore), whether a permit was issued after-the-fact or as an emergency permit, whether the permit was approved, and the nature of the action requested under the permit (e.g., installation of new armor, repair of existing armor, removal of existing armor, replacement of existing armor, and/or modification of existing armor). Permits that described soft-shore protection actions were assigned to both the "armor" and "soft shore" classes. Permits describing both armor-related actions and other actions in the nearshore (e.g., removal of an existing boat ramp) were flagged as both "armor" and "other" types of permits. Shore permits could have more than one described action (e.g., remove and replace a portion of an existing bulkhead; repair an existing portion of another bulkhead on the same property).

Pre-processing was also applied for the Island County tax parcel geospatial data layer, to remove duplicate parcel records and avoid duplicate-counting of shore armor impacts and extents during subsequent phases of analysis. Artificial property boundaries were created to integrate armor permits along the county right-of-way. In places, the boundaries of tax parcels were artificially extended waterward in GIS to enable direct comparison of permit records and mapped changes. Permit records were associated with the modified tax parcels, using a tabular join based on the property tax ID. These tax parcels were then spatially intersected with the results of the 2016 and 2023 armor mapping efforts, to allow for joint evaluation of permits and documented changes in shore armor attributes.

The product of spatially intersecting mapped changes in shore armor presence and attributes with permit-associated tax parcel boundaries was exported and evaluated in a tabular format. The table was used to evaluate permit and mapping results for:

- Mapped changes in shore armor (presence, characteristics) associated with an issued permit
- Mapped changes in shore armor that were not associated with an issued permit
- The co-occurrence of permits for other shore development actions and mapped changes in shore armor

As with the armor change analysis, a 5-foot minimum margin of acceptance for mapped changes in armor length was applied. Armor units that were less than 5 feet in length and indicated a change in elevation, composition, or condition were excluded from this analysis. Calculations of the length of shoreline associated with issued permits are based on the intersection of tax parcel boundaries with the WDNR ShoreZone Shoreline-conforming armor mapping results. This does not mean that a permit was issued with the intent of modifying the entire shoreline associated with a property. However, as most permit records do not state the length of associated shoreline to be modified under the permit, it is challenging to otherwise quantify the length of potentially modified shoreline.

Other Analysis

Results of the 2016 and 2023 armor mapping efforts were spatially intersected with records of documented forage fish spawning habitat (WDFW, 2023), to quantify direct impacts to forage fish spawning habitat. Shore armor records were also spatially intersected with mapped geomorphic shoretypes, using the *Beach Strategies for Nearshore Restoration and Protection* (CGS, 2017) classification, to explore the degree to which different shoretypes are likely to be altered by shoreline armoring.

Results

Change Analysis—Presence of Potential New Armor

The objective of the preliminary change analysis was focused on identifying where shore armor was mapped in 2023 but was not mapped in 2016. Changes in the mapped presence of armor may be the combined results of:

- Installations of new shoreline armor since the 2016 mapping event, including extensions of the footprint of existing shoreline armor
- Incomplete mapping of shoreline armor in 2016 (especially where armor was derelict, where weather and tides precluded direct shore observation, and/or where visual obstructions to armor were present, such as overhanging vegetation, piled drift logs, backshore vegetation, etc.)
- Differences in the interpretation of shoreline armor origin/end points based on the availability of higher-resolution aerial photography, relative to the 2016 mapping event (where remote mapping and/or remote validation of armor placement occurred).

A summary of the mapped presence of shoreline armor in 2016 and 2023 is presented in Table 1. This summary table includes both measures of pre-snap and post-snap armor lengths (as described in the Data Processing section). The reported pre-snap armor length is less than the reported post-snap armor length for both 2016 and 2023 shoreline armor mapping. While the pre-snap lines represent accurate placement of the GPS-mapped armor positions along the shoreline, the resultant lines have a simpler shoreline geometry than the ShoreZone Shoreline. Additionally, differences in the placement of GPS-mapped points alongshore can substantially alter the resultant pre-snap armor lengths, especially in areas of continuous, relatively uniform armor composition (Figure 4). For these reasons, the post-snap armor lengths will be used for reporting change in this Phase 1 report (subject to the 5-foot minimum margin of acceptance).

Figure 4. Example of Difference in GPS Point Placement in 2016 and 2023 Mapping Efforts Relative to the ShoreZone Shoreline that Produced Different Pre-Snap Shoreline Armor Measurement Results.

Based on the post-snap armor length measurements, approximately one-quarter (25 percent) of Whidbey and Camano Islands was armored in 2016 and 2023 (Table 1; Appendix A. Figures 1 and 2). Approximately 271,640 feet (51.4 miles) of shoreline armor was mapped as being present in both 2016 and 2023 mapping, in addition to approximately 12,600 feet (2.4 miles) of armor present in 2016 that was not mapped as present in 2023 and approximately 14,400 feet (2.7 miles) of armor present in 2023 that was not mapped in 2016 (Table 1). This represents a net increase in shoreline armor of 1,790 feet (0.3 miles) between 2016 and 2023 (Table 1).

Table 1. Summary of Mapped Shoreline Armor, 2023 and 2016.

Mapped Armor Presence	Armor Length, 2016 (feet/percent of county shoreline)	Armor Length, 2023 (feet/percent of county shoreline)
Total pre-snap armor length	280,744 (24.9 percent)	276,614 (24.5 percent)
Total post-snap armor length[a,b]	283,893 (25.2 percent)	285,662 (25.3 percent)
Length of armor present in both 2016 and 2023[a,b]	271,640 (24.0 percent)	
Length of armor present only in 2016 or only in 2023[a,b]	12,612 (1.1 percent)	14,404 (1.3 percent)
Difference in armor length, 2023–2016[a,b]	1,793 (0.1 percent)	

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

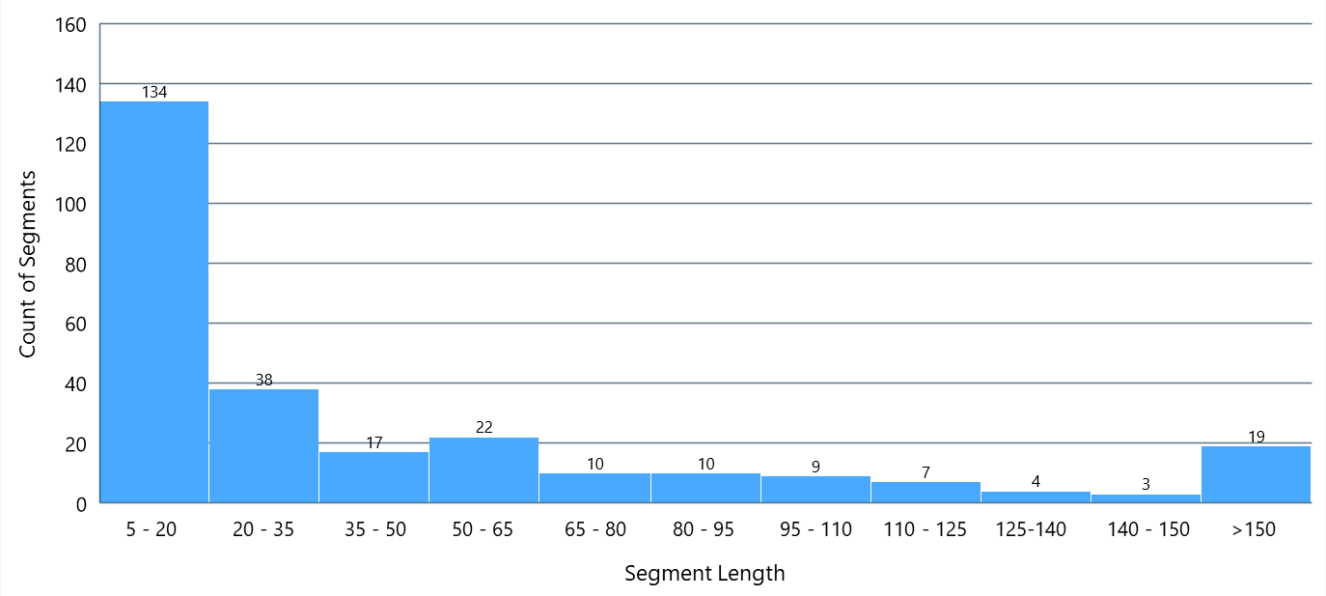
[b] This calculation references the ShoreZone Shoreline-conforming (post-snap) armor length, not the pre-snap armor length.

A total of 308 shoreline armor segments were mapped in 2016 but not in 2023, representing a potential loss of armor. Of those, 111 segments had a length of less than 5 feet and were screened out of the preliminary change analysis results. Of the remaining 197 armor segments mapped only in 2016,

80 (41 percent) had a post-snap length between 5 and 20 feet, and 117 (59 percent) had a length greater than 20 feet (Figure A4).

Of the 391 shoreline armor segments mapped in 2023 but not in 2016 (representing a potential addition of armor), 118 were screened out for having a length less than 5 feet, leaving 273 segments of potential new armor. Of these, 134 (49 percent) had a length between 5 and 20 feet, 55 (20 percent) had a length between 20 and 50 feet, and 84 (30 percent) had a length greater than 50 feet (Figure 5). The spatial distribution of potential new armor segments by length is explored in Figure A4.

Figure 5. Distribution of the Lengths of Potential New (present in 2023 but not in 2016) Shore Armor Segments.



Armor segments with a length of less than 5 feet were omitted.

Of the new shore armor mapped in 2023, approximately 9,300 feet (64 percent) was installed adjacent to or between existing sections of shore armor (Table 2). The remaining 5,100 feet (36 percent) was installed independent of existing shore armor (Table 2).

Table 2. Summary of Potential New Shore Armor Adjacent to Existing (Mapped in 2016) Shore Armor.

Potential New Shore Armor—Adjacency Class	Armor Length (feet, percent of potential new armor)
Installed adjacent to existing shore armor[a] [b]	9,286 (64 percent)
Not adjacent to existing shore armor[a] [b]	5,118 (36 percent)
Total length of potential new armor[a] [b]	14,404

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[b] This calculation references the ShoreZone Shoreline-conforming (post-snap) armor length, not the pre-snap armor length.

A subset of segments where there was a potential change in armor presence between 2016 and 2023 (gain or loss) was spot-checked against air photos, in order to understand the potential nature of change. Twenty segments were checked (4 percent of change segments >5 feet), with lengths ranging from 5.1 to 448 feet. Nine of the checked segments (45 percent) appeared to represent areas of real on-the-ground change between 2016 and 2023 conditions. Seven of the checked segments (35 percent) appeared to be the result of differences in alignment of the post-snap armor extents. This brief review could not determine whether four change segments (20 percent) were the result of actual differences in mapped conditions.

The spatial distribution of armor that was mapped in 2023 but not in 2016 was relatively uniform across Whidbey and Camano Islands, though Camano and southern Whidbey Island did have relatively more new armor than central and northern Whidbey Island (Appendix A, Figure 3).

It is important to emphasize that, for the reasons previously described, this analysis alone does not conclude that armor was added between 2016 and 2023 in all cases. This analysis also does not capture soft shore installations, as soft shore is challenging to visually identify. Soft shore installations were also not mapped in the 2016 survey event, and, as such, there is no baseline available for comparison. Where observed, cabled logs were mapped separately in the 2023 shore armor survey event and are included in the "other features" geospatial file.

Change Analysis—Armor Characteristics

The mapped condition of shore armor segments in 2016 and 2023 were compared, in order to identify areas in which the condition of shore armor changed over the study period. Several record-breaking storm events occurred between the 2016 and 2023 survey events, and an overall degradation of shore armor condition is an expected outcome. Marked improvements in the condition of shore armor over the study period may be indicative of repairs or modifications to existing shore armor (Table 3). Permit records were explored in association with each of these mapped changes in armor condition, the results of which are described in the following subsection (*Permit Analysis*). The 5-foot minimum acceptance criteria was applied when evaluating the quantity and distribution of mapped change in armor condition. Changes in condition were only evaluated where armor was mapped in both 2016 and 2023.

Table 3. Mapped Changes in Shore Armor Condition, 2016–2023 [a] [b].

	Length of Mapped Armor Condition (feet) in 2023			
Length of Mapped Armor Conditions (feet) in 2016	**Sound**	**Functional/Failing**	**Derelict**	***Total***
Sound	132,484	74,166	11,071	217,721
Functional/Failing	3,767	17,393	12,268	33,429
Derelict	2,275	3,928	13,981	20,183
Total	138,525	95,488	37,320	271,333

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[b] This calculation references the ShoreZone Shoreline-conforming (post-snap) armor length, not the pre-snap armor length.

[c] Table cells highlighted in gray indicate potential improvements in shore armor condition between the 2016 and 2023 mapping events

Of the approximately 271,300 feet of shore armor mapped in both 2016 and 2023, 261,300 feet (96 percent) either did not change in mapped condition (e.g., was mapped as "sound" in both 2016 and 2023) or worsened in condition (e.g., was mapped as "sound" in 2016 and "functional/failing" in 2023; Table 3). Mapped improvements in armor condition (from derelict to functional/failing, derelict to sound, or functional/failing to sound) were identified along 9,970 feet of shoreline (Table 3). The distribution of changes in mapped armor condition are included in Figure A5.

Overall, the condition of shore armor (armor present in both 2016 and 2023) appears to have worsened over the analysis period; 33,429 feet (12 percent) of extant shore armor was mapped as "functional/ failing" in 2016, compared to 95,488 feet (35 percent) of shore armor mapped as "functional/failing" in 2023 (Table 3). Several recent, noteworthy winter storms resulting from king tide events that coincide with storm surge are potentially driving this overall degradation in armor condition. Some of this change in mapped armor condition may also be the product of differences in shore armor interpretation between the 2016 and 2023 survey events.

Mapped changes in shore armor elevation between 2016 and 2023 were similarly compared, to identify areas where the direct impacts by shore armor had changed, whether through human-driven alterations to armor footprints or through the progressive degradation and breakup of shore armor over time (Table 4). Changes in armor condition were only evaluated where armor was mapped in both 2016 and 2023, and where armor condition was documented in the 2016 mapping records.

Table 4. Mapped Changes in Shore Armor Elevation, 2016–2023[a] [b] [c].

Length of Mapped Armor Elevation by Class in 2016 (feet)	Length of Mapped Armor Elevation by Class in 2023 (feet)					
	Upland	**OHWM-Upland**	**MHHW-OHWM**	**MSL-MHWM**	**Below MSL**	***Total***
Upland	374	**119**	**53**	**--**	**--**	*546*
OHWM-Upland	579	5,190	**1,950**	**2,185**	**809**	*10,714*
MHHW-OHWM	667	10,882	66,301	**36,274**	**9,666**	*123,791*
MSL-MHHW	**--**	1,094	16,401	49,498	**48,264**	*115,256*
Below MSL	**--**	**--**	1,412	4,438	15,177	*21,026*
Total	*1,620*	*17,285*	*86,117*	*92,395*	*73,916*	*271,333*

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[b] This calculation references the ShoreZone Shoreline-conforming (post-snap) armor length, not the pre-snap armor length.

[c] Table cells highlighted in gray indicate potential waterward encroachment of armor between 2016 and 2023 mapping events

Based on this analysis, most shore armor mapped in both 2016 and 2023 (63 percent; 172,013 feet) had either no change in armor elevation or an elevation that was mapped as being farther landward in 2023 than in 2016 (Table 4). Of the shore armor that was mapped as having a farther-waterward (more-encroaching) toe elevation in 2023 than in 2016, 86,607 feet of shore armor was mapped as being one class farther landward in 2023 than in 2016 (e.g., from Upland in 2016 to OHWM-Upland in 2023; Table 4). Approximately 12,713 feet of shore armor was mapped as being two classes farther landward in

2023 (e.g., from Upland to MHHW-OHWM), and approximately 809 feet was mapped as being three classes father landward in 2016 (Table 4). Differences in the interpretation of shore armor toe elevations between 2016 and 2023 mapping likely contributed (at least partially) to these mapping discrepancies, particularly where small differences in elevation class were documented. The spatial distribution of changes in mapped armor class elevation are included in Figure A6.

The mapped material composition of shore armor was also documented in 2016 and 2023 shore armor mapping. Due to the methods used for classifying armor types, it is challenging to make useful comparisons of the quantity and length of shore armor represented by each material type (since units of shore armor can be mapped as containing multiple material types). The exception is creosote-treated wood, which should be mapped as a discrete unit from surrounding armor types in each instance where it occurs. A summary of the length of creosote-treated wood present in 2016 and 2023 shore armor mapping is provided in Table 5.

Table 5. Summary of Creosote-Treated Wood Mapped in 2016 and 2023 Armor Surveys[a] [b].

Creosote-Treated Wood Presence	Armor Length (feet)
Mapped only in 2016 (possibly removed between 2016-2023)	1,315
Mapped in both 2016 and 2023	16,522
Mapped only in 2023 (possibly added between 2016-2023)	1,877

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[b] This calculation references the ShoreZone Shoreline-conforming (post-snap) armor length, not the pre-snap armor length.

This analysis appears to show a marginal net increase of 562 feet in the mapped presence of creosote-treated wood as armor material between 2016 and 2023. This result may be in part the result of actual increases in creosote-treated wood and in part the result of differences in feature interpretation during field-based mapping.

Permit Analysis

Over the 2016–2023 study period, 207 unique applications related to shoreline armor were submitted to the jurisdictions of Island County, Coupeville, Langley, and Oak Harbor, of which 158 (76 percent) were approved (Table 6). Among the permits that were approved, 21 (13 percent) were issued as emergency permits, and 8 (5 percent) were issued after-the-fact (Table 6). Over that same period, 14 unique applications for soft shore protection were submitted, of which 13 (93 percent) were issued (Table 6). Other unique permits pertaining to shore development (modification/construction of boat ramps, boat houses, piles, beach access stairs, tram footings, etc.) were also highlighted in the permit analysis, in the event that such alterations to the nearshore were interpreted as changes in shoreline hard armoring during field mapping.

Table 6. Count of Permit Applications, 2016–2023[a].

Permit Actions	Development Type		
	Shore Armor	Soft Shore protection	Other Shore Development[b]
Permit applications submitted	206	14	156
Permits issued	158	13	111
After-the-fact permits issued	8	1	6
Emergency permits issued	21	1	1

[a] Permit categories are not mutually-exclusive. A single permit may contain elements pertaining to hard armor, soft shore protection, and/or other shore development actions (e.g., a permit to remove hard armor, install soft shore protection, and install a boat ramp would count in all development types).

[b] "Other shore development" may include activities pertaining to boat ramps, piers, access stairs, tram landing areas, and other activities that can co-occur with shore armor.

Shore armor permits were consolidated and flagged based on pertinent classes of permitted development action. These classes are not mutually exclusive, as a permit may be flagged for both the removal of an existing hard bulkhead and the installation of soft shore protection. Of the total 158 issued permits that are related to hard shore armor (Table 6), 22 (14 percent) involved new armor installation, 5 (3.1 percent) involved outright removal of existing shore armor, and 69 (43 percent) included replacement of existing shore armor (Table 7). Shore armor repair was an element in 71 (50 percent) issued permits, and modifying existing armor (e.g., adding a wing wall) was an element in 10 (6 percent) issued hard armor permits (Table 7). Permits that were issued for shore armor installation, modification, and removal were generally well-distributed across Island County, with some clumps in areas of denser residential development (e.g., along Mutiny Bay and Holmes Harbor, Appendix A, Figure 7). Of the 13 issued permits including soft shore protection, 8 (61 percent) involved installation of new soft shore protection, with the remainder including elements related to armor repair, removal, and replacement (Table 7).

Table 7. Count of Approved Hard and Soft Shore Armor Permits by Action, 2016–2023[a].

Permit Actions	Development Type	
	Shore armor	Soft shore protection
Install new armor	22	8
Repair existing armor	71	3
Remove existing armor	5	2
Replace existing armor	69	2
Modify existing armor	10	0

[a] Permit categories and actions are not mutually exclusive.

The results of the analysis of mapped armor change (potential gain, loss, and/or change in characteristics) between the 2016 and 2023 mapping events were spatially compared with records of issued permits for shore development over the same period. Modifications to existing shore armor over

the study period were summarized, to include (1) areas where the mapped condition of shore armor improved between 2016 and 2023 events and (2) where the change in shore armor elevation changed by two or more classes. Changes in armor material were not specifically addressed in this summary of shore armor modifications, as the aggregate mapping approach to shore armor material composition makes it difficult to meaningfully distinguish between changes across large regions.

The co-occurrence of mapped changes in shore armor (presence, characteristics) is summarized in Table 8 (by count of tax parcels) and Table 9 (by length of associated shoreline). The values reported in Table 9 reflect the intersection of mapped shore armor changes within shore-adjacent parcel boundaries. The actual lengths of permitted action in the shoreline were not documented in most permit records, and discrepancies between length of permitted change and mapped change were not evaluated. Length of change in shore armor in the permit analysis may differ slightly from mapped change in armor presence and characteristics due to differences in the applied computational context.

Table 8. Summary of Association Between Mapped Armor Changes and Issued Permits by Shore Action and Permit Type (by Tax Parcel Count), 2016–2023[a] [b] [c].

Type of Mapped Shore Change	Parcels with Mapped Shore Change	Parcels with Mapped Change not Associated with Permit Application	Parcels with Mapped Change and Approved Permit	Parcels with Mapped Change and Unapproved Permit	Count of Parcels with Issued Permit Action					
					Install Armor	Remove Armor	Repair Armor	Replace Armor	Modify Armor	"Other" Permit Type
Armor added	324	307	14	3	14	0	6	4	1	3
Armor removed	216	213	3	0	6	3	3	4	2	1
Armor modified [d]	348	323	21	4	1	2	11	11	2	1

[a] Permit actions are not mutually exclusive.

[b] "Other shore development" may include activities pertaining to boat ramps, piers, access stairs, tram landing areas, and other activities that can co-occur with shore armor.

[c] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[d] Modifications of existing shore armor between 2016 and 2023 mapping events, based on a summary of where armor improved in condition between the two mapping events and/or changed in mapped shore armor elevation by two or more elevation classes.

New shoreline armor was mapped on 324 tax parcels in 2023 (corresponding with approximately 14,116 feet of new shoreline armor; Table 8, 9). Of those, 14 parcels (4 percent) could be associated with an approved permit for new shore armor (Table 8; Figure 6). An additional three parcels (1 percent) could be associated with a permit application that had been submitted but was either pending or had been denied (Table 8; Figure 6). The remaining 307 parcels with new shore armor (95%) had no associated permit records (Table 8; Figure 6). Similar ratios of mapped change to issued permits were also present for parcels where armor had been removed or modified, with 99 percent of armor removal not

associated with a permit application (213 of 216 parcels), and 93 percent of armor modifications not associated with a permit application (323 of 348 parcels; Table 8).

Percentages of permitted and unpermitted change were similar when calculating change by length of modified shoreline. Of the 14,116 feet of new armor mapped over the study period, approximately 1,920 feet (14 percent) could be associated with an issued permit for installing new shore armor (Table 9). Over 2.3 miles of new shoreline armor (12,037 feet; 85 percent) was not associated with an issued permit (Table 9). An additional 157 feet of new shoreline armor could be associated with permit applications that had been submitted, but had not been approved (pending or denied; Table 9).

Approximately 12,300 feet of shore armor was removed between the 2016 and 2023 survey events, of which 600 feet (5 percent) could be associated with an issued permit for shore armor removal (Table 9). This could be partially explained by the fact that not all shore armor removal projects required a county shoreline permit, and that some loss of shore armor could occur with landslide events or breakdown of material.

Table 9. Summary of Association Between Mapped Armor Changes and Issued Permits by Shore Action and Permit Type (by Shoreline Length), 2016–2023[a b c].

Type of Mapped Shore Change	Total Length of Mapped Change (feet)	Mapped Change Not Associated with Permit Application (feet)	Mapped Change Associated with Approved Permit (feet)	Mapped Change Associated with Unapproved Permit Application (feet)	Length of Shoreline Associated with Issued Permit Action (feet)					
					Install Armor	Remove Armor	Repair Armor	Replace Armor	Modify Armor	"Other" Permit Type
Armor added	14,116	12,037	1,921	157	1,921	-	164	121	19	427
Armor removed	12,324	11,724	600	-	885	600	142	407	124	350
Armor modified [d]	24,757	22,462	1,629	666	460	235	693	990	156	460

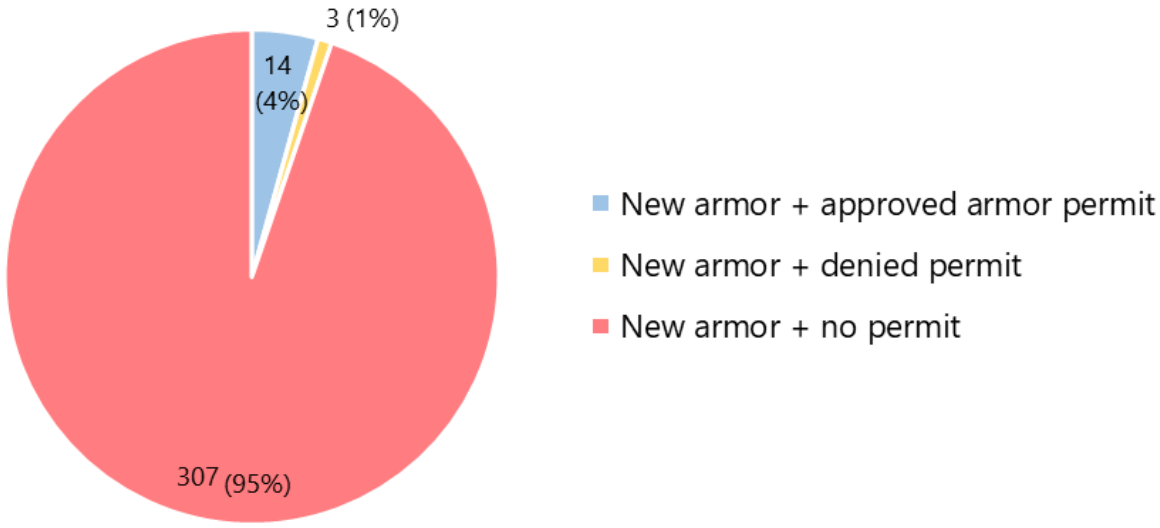
[a] Permit actions are not mutually exclusive.

[b] "Other shore development" may include activities pertaining to boat ramps, piers, access stairs, tram landing areas, and other activities that can co-occur with shore armor.

[c] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[d] Modifications of existing shore armor between 2016 and 2023 mapping events, based on a summary of where armor improved in condition between the two mapping events and/or changed in mapped shore armor elevation by two or more elevation classes.

Figure 6. Parcels with New Shore Armor Associated with Approved, Denied, and No Permit Records.



Approximately 24,760 feet of shore armor was mapped as having been modified between the 2016 and 2023 events (Table 9). Where potential modifications to shore armor were mapped, 1,630 feet (7 percent) could be associated with an approved permit for armor repair, replacement, and/or modifications (Table 9).

The geographic distribution of mapped changes in shore armor and association with issued permits is included in Figure A7.

Other Analysis

Documented forage fish spawning habitat (WDFW, 2023) was compared to the mapped change in shore armor presence and to issued permits over the study period. 163,250 feet (29 percent) of documented forage fish spawning habitat was armored in both mapping events (2023 and 2016), with 6,037 feet (1 percent) of forage fish spawning armored in 2016 but not in 2023 (loss of shore armor), and 7,864 (1 percent) of spawning habitat armored in 2023 but not in 2016 (addition of shore armor; Table 10). Approved permits for the installation of new shore armor could be associated with 345 feet of shoreline with documented forage fish spawning (Table 10). Note that the length of permit-associated shoreline does not necessarily reflect the total length of shore on which armor installation was permitted to occur, as many of the permit records do not document this. The co-location and spatial distribution of forage fish spawning habitat, shore armor, and issued permits is included in Figure A8.

Table 10. Summary of Forage Fish Spawning Habitat Co-Location With Mapped Shoreline Armor and Permit Records, 2016–2023[a].

Mapped Change in Armor Attributes	Forage Fish Spawning Habitat Length in feet (Percent of Total Spawning Habitat)	Length Of Shoreline with Corresponding Armor Permit Records in feet (Percent of Change Accounted for Through Permit Records)
Armored in 2023, not in 2016	7,864 (1 percent)	345[b] (4 percent)
Armored in 2023 and in 2016	163,250 (29 percent)	--
Armored in 2016, not in 2023	6,037 (1 percent)	270[c] (4 percent)
Unarmored in 2023 and 2016	395,274 (69 percent)	--
Total forage fish spawning habitat	572,425	*615 (0 percent)*

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[b] Length of shoreline associated with issued permits for armor installation

[c] Length of shoreline associated with issued permits for armor removal

The co-location of mapped changes in the presence of armor and geomorphic shoretypes was evaluated, to identify which shoretypes were the most likely to be in an armored condition and to understand which shoretypes may be more likely to be armored in the future. Geomorphic shoretypes referenced in this analysis follow those generated and cited in *Beach Strategies for Nearshore Protection and Restoration* (CGS, 2017).

Among shorelines that were armored in both 2016 and 2023, accretion shoreforms and feeder bluffs were the most commonly-armored shoretype in Island County, accounting for approximately 40% of the shore armor present across survey events (Table 11). Of the 271,271 feet of shore armor present in both 2016 and 2023, 105,286 feet (40 percent) was present on feeder bluffs and 106,020 was documented on accretion shoreforms (40 percent; Table 11). The remainder of mapped shore armor present in both 2016 and 2023 mapping events was found along transport zones (15 percent of armor) and shoretypes with no appreciable drift (NAD; cumulatively 20,383 feet of armor, or 6 percent of armor in both survey events; Table 11).

Table 11. Summary of Armored Geomorphic Shoretypes (Mapped in both 2016 and 2023) (Shore Armor Presence Unchanged)[a].

Geomorphic Shoretype[b]	Length of Armored Shoreline in both 2016 and 2023 (feet)	Length of Unarmored Shoreline in both 2016 and 2023 (feet)	Percentage of Overall Shoreline Armor Present in both 2016 and 2023 by Shoretype
Accretion Shoreform	106,020	300,207	39 percent
Feeder Bluff	105,286	212,599	39 percent
Transport Zone	39,363	112,532	15 percent
No Appreciable Drift—Artificial	12,019	16,605	4 percent
No Appreciable Drift—Low Energy	6,821	79,256	3 percent
No Appreciable Drift—Delta	1,543	16,987	1 percent
Feeder Bluff—Exceptional	--	77,442	--
Pocket Beach	178	1,576	0 percent
Pocket Beach—Artificial	40	442	0 percent
Grand Total	*271,271*	*827,793*	--

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[b] No Appreciable Drift—Bedrock shoretypes omitted from this summary table, as no shore armor segments associated with NAD-Bedrock shores were detected beyond the 5-foot margin of spatial error in 2016 or 2023.

Approximately 14,620 feet of new shore armor was mapped in 2023 (Table 12). The majority of this shoreline armor was mapped on accretion shoreforms (8,489 feet; 58 percent of new armor), followed by feeder bluffs (2,792 feet; 19 percent of new armor) and transport zones (1,854 feet; 13 percent of new armor; Table 12). The potential presence of new armor was compared against approved shore armor permits for new armor installation. Of the 8,489 feet of new potential armor on accretion shoreforms, approximately 1,397 feet could be associated with approved armor installation permits (17 percent of new accretion shoreform armor; Table 12). Approximately 265 of 2,792 feet (9 percent) of new armor on feeder bluff shoretypes could be associated with an issued permit (Table 12). All new armor on pocket beach-artificial shoretypes could be associated with an issued permit. No issued permits could be associated with transport zone, NAD-low energy, NAD-delta, feeder bluff-exceptional, or pocket beach shoretypes (Table 12). The spatial distribution of issued armor installation permits by associated geomorphic shoretype is included in Figure A9.

Table 12. Summary of Geomorphic Shoretype Co-Location with Mapped Shoreline Armor Present in Only 2023, Not in 2016 (Potential New Shore Armor) and Issued Permits[a].

Geomorphic Shoretype[b]	Length of Potential New Shore Armor	Percentage of Potential New Shore Armor by Shoretype	Length of Shoreline Co-Located with Mapped Change in Armor Presence and Issued Permits[c]	Percentage of Potential New Shore Armor Accounted for by Issued Permits
Accretion Shoreform	8,266	59 percent	1,398	17 percent
Feeder Bluff	2,815	20 percent	265	9 percent
Transport Zone	1,842	13 percent	--	0 percent
No Appreciable Drift—Artificial	757	5 percent	154	20 percent
No Appreciable Drift—Low Energy	19	0 percent	--	0 percent
No Appreciable Drift—Delta	28	0 percent	--	0 percent
Feeder Bluff – Exceptional	274	2 percent	--	0 percent
Pocket Beach	11	0 percent	--	0 percent
Pocket Beach—Artificial	105	1 percent	105	100 percent
Grand Total	14,116	--	*1,920*	14 percent

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[b] No Appreciable Drift—Bedrock shoretypes omitted from this summary table, as no shore armor segments associated with NAD-Bedrock shores were detected beyond the 5-foot margin of spatial error

[c] Total length of shoreline with both an issued permit for new armor installation and a mapped difference in the presence of shore armor between the 2016-2023 mapping events. This may overestimate the amount of permitted armor installed, as the entire shoreline length of a parcel is considered (most permit records do not specify the length of armor to be installed)

Approximately 12,324 feet of shore armor was removed between 2016 and 2023 (Table 13). This potential armor removal was compared to mapped geomorphic shoretypes and issued permits for shore armor removal over the study period. Of the shore armor removed, a majority was present along feeder bluffs (6,149 feet, or 50 percent of the total removed shore armor) and accretion shoreforms (4,705 feet, or 38 percent of the removed shore armor; Table 13). During the 2023 field mapping efforts, multiple sections of shore armor that had been mapped along feeder bluffs in 2016 appeared to have been buried or destroyed by landslide events (Figure 6).

Permits for removal of shore armor and mapped loss of shore armor could only be co-located with 270 feet of transport zone shoretype (27 percent of the total 992 feet of armor loss along transport zone shorelines) and 330 feet of accretion shoreform shorelines (7 percent of the total 4,705 feet of armor lost; Table 13). The spatial distribution of issued armor installation permits by associated geomorphic shoretype is in Figure A10.

Figure 7. Partially-Armored Feeder Bluff on Whidbey Island.

This reach of shoreline was mapped as armored in 2016, but shore armor was largely buried or destroyed following a local landslide during 2023 mapping.

Table 13. Summary of Geomorphic Shoretype Co-Location with Mapped Shoreline Armor Present in Only 2016, Not in 2023 (Potential Shore Armor Removal) and Issued Permits[a].

Geomorphic Shoretype[b]	Length of Potential Shore Armor Removal	Percentage of Potential Shore Armor Removal by Shoretype	Length of Shoreline Co-Located with Mapped Loss of Armor and Issued Permits[c]	Percentage of Potential Shore Armor Removal Accounted for by Issued Permits
Accretion Shoreform	4,705	50 percent	330	7 percent
Feeder Bluff	6,149	38 percent	--	--
Transport Zone	997	8 percent	270	27 percent
No Appreciable Drift—Artificial	56	0 percent	--	--
No Appreciable Drift—Low Energy	270	2 percent	--	--
No Appreciable Drift—Delta	140	1 percent	--	--
Feeder Bluff—Exceptional	--	--	--	--
Pocket Beach	--	--	--	--
Pocket Beach—Artificial	7	0 percent	--	--
Grand Total	*12,324*	--	*600*	*5 percent*

[a] Shoreline armor segments with a length of less than 5 feet were considered to be below the margin of spatial error for change detection and were omitted when summarizing ShoreZone-conforming armor lengths.

[b] No Appreciable Drift—Bedrock shoretypes omitted from this summary table, as no shore armor segments associated with NAD-Bedrock shores were detected beyond the 5-foot margin of spatial error

[c] Total length of shoreline with both an issued permit for shore armor removal and a mapped difference in the presence of shore armor between the 2016 and 2023 mapping events. This may overestimate the amount of permitted armor removed, as the entire shoreline length of a parcel is considered (most permit records do not specify the length of armor to be removed)

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Appendix A

Shoreline Armor Map Folio

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Figure A1.1 - Armor Mapped in 2023, Island County

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 5,000 10,000 20,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A1. Armor mapped in 2023
Date: 4/17/2024
Author: lodegiles

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Figure A1.2 - Armor Mapped in 2023, North Whidbey Island

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Figure A1.3 - Armor Mapped in 2023, Central Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,500 3,000 6,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A1. Armor mapped in 2023
Date: 4/17/2024
Author: lodegiles

Figure A1.4 - Armor Mapped in 2023, South Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 2,000 4,000 8,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A1. Armor mapped in 2023
Date: 4/17/2024
Author: lodegiles

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Figure A1.5 - Armor Mapped in 2023, North Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A1. Armor mapped in 2023
Date: 4/17/2024
Author: lodegiles

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Figure A1.6 - Armor Mapped in 2023, South Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

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File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A1. Armor mapped in 2023
Date: 4/17/2024
Author: lodegiles

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Figure A2.1 - Armor Mapped in 2016, Island County

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 5,000 10,000 20,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A2_Armor mapped in 2016
Date: 4/17/2024
Author: lodegiles

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Figure A2.2 - Armor Mapped in 2016, North Whidbey Island

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Figure A2.3 - Armor Mapped in 2016, Central Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,500 3,000 6,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A2_Armor mapped in 2016
Date: 4/17/2024
Author: lodegiles

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Figure A2.4 - Armor Mapped in 2016, South Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 2,000 4,000 8,000 Feet

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Date: 4/17/2024
Author: lodegiles

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Figure A2.5 - Armor Mapped in 2016, North Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

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Figure A2.6 - Armor Mapped in 2016, South Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

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File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A2_Armor mapped in 2016
Date: 4/17/2024
Author: lodegiles

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Figure A3.1 - Armor Mapped in 2023 (Not Mapped in 2016) by Length, Island County

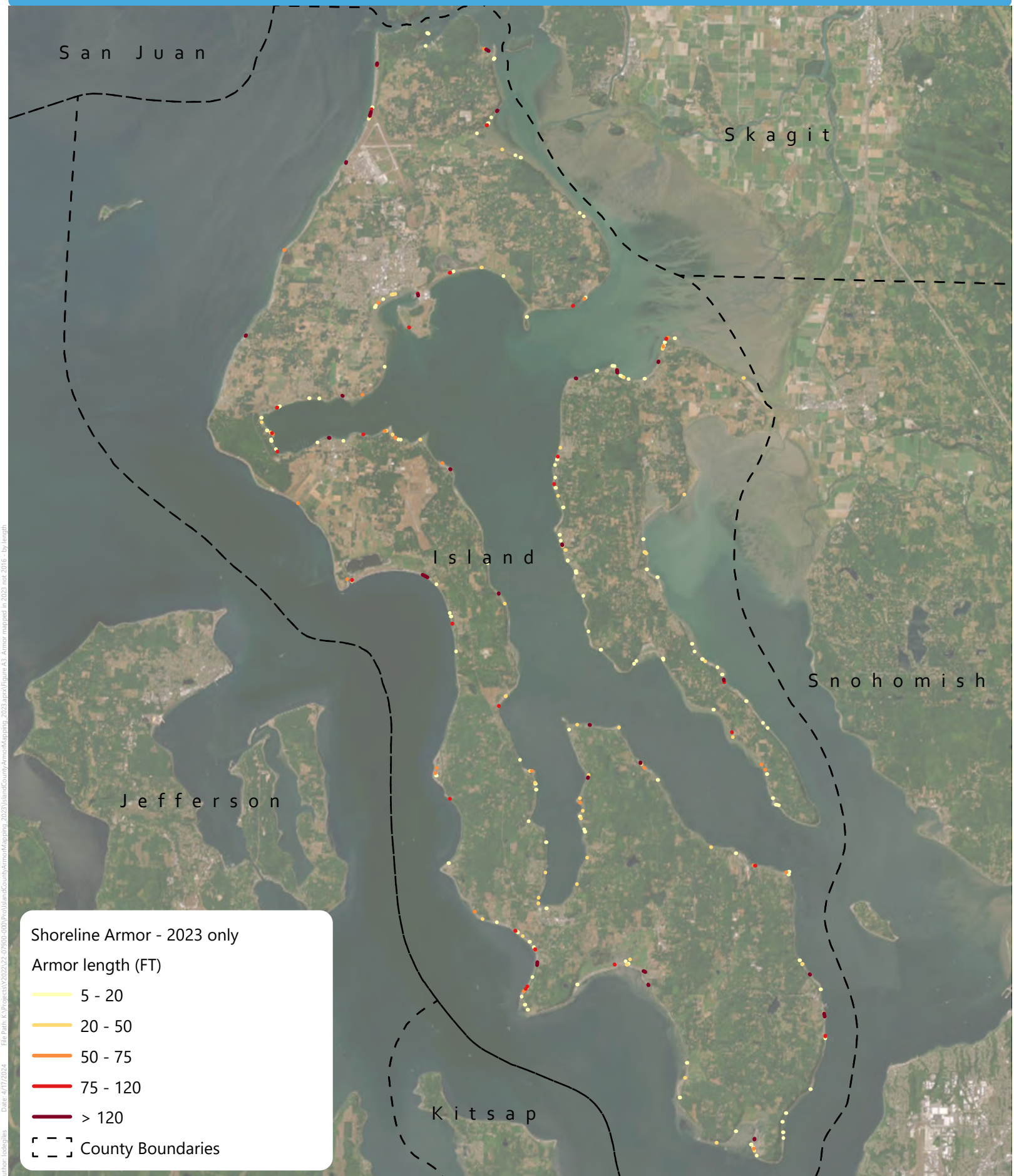

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Figure A3.2 - Armor Mapped in 2023 (Not Mapped in 2016) by Length, North Whidbey Island

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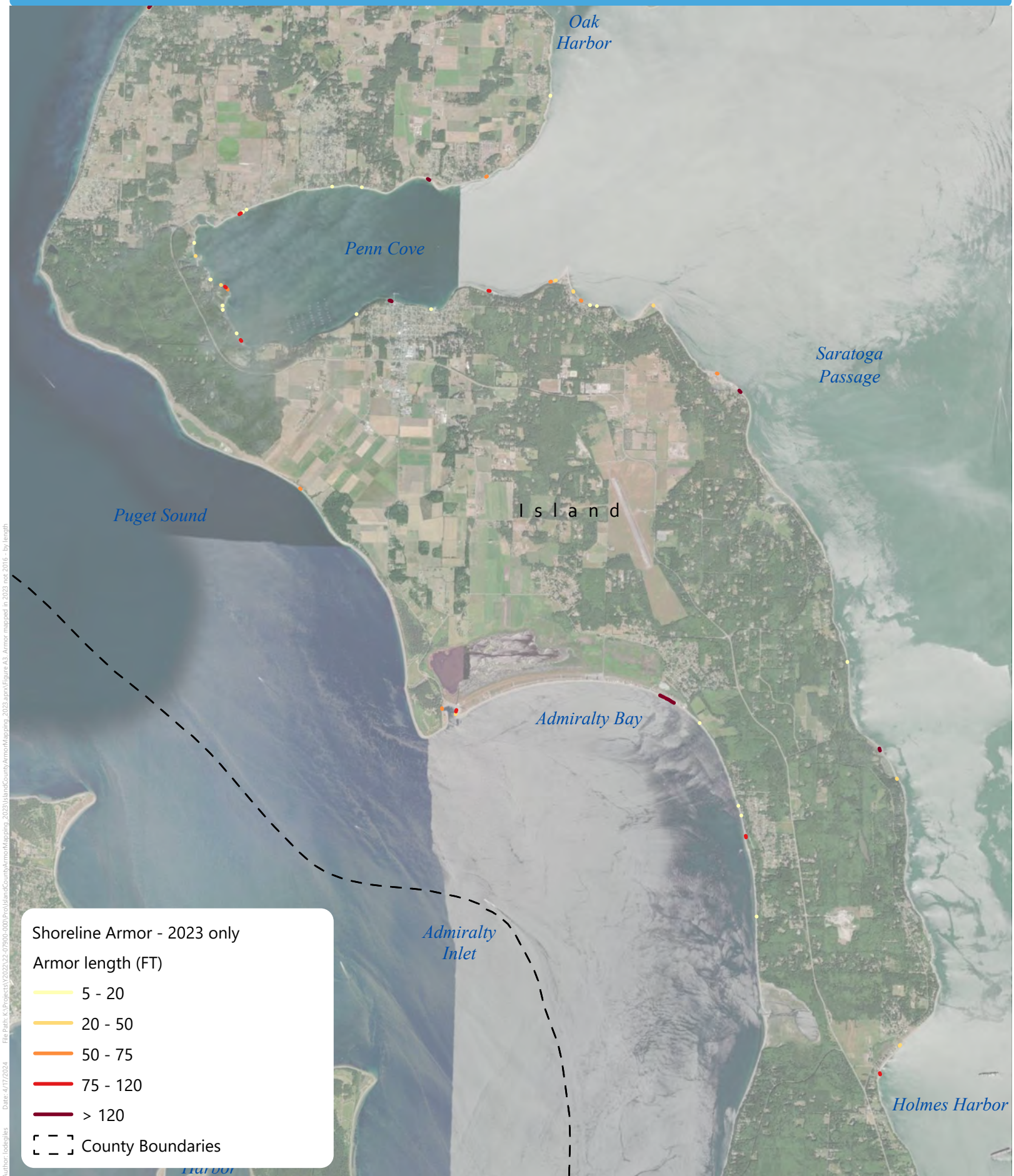
Figure A3.3 - Armor Mapped in 2023 (Not Mapped in 2016) by Length, Central Whidbey Island



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0 1,500 3,000 6,000 Feet

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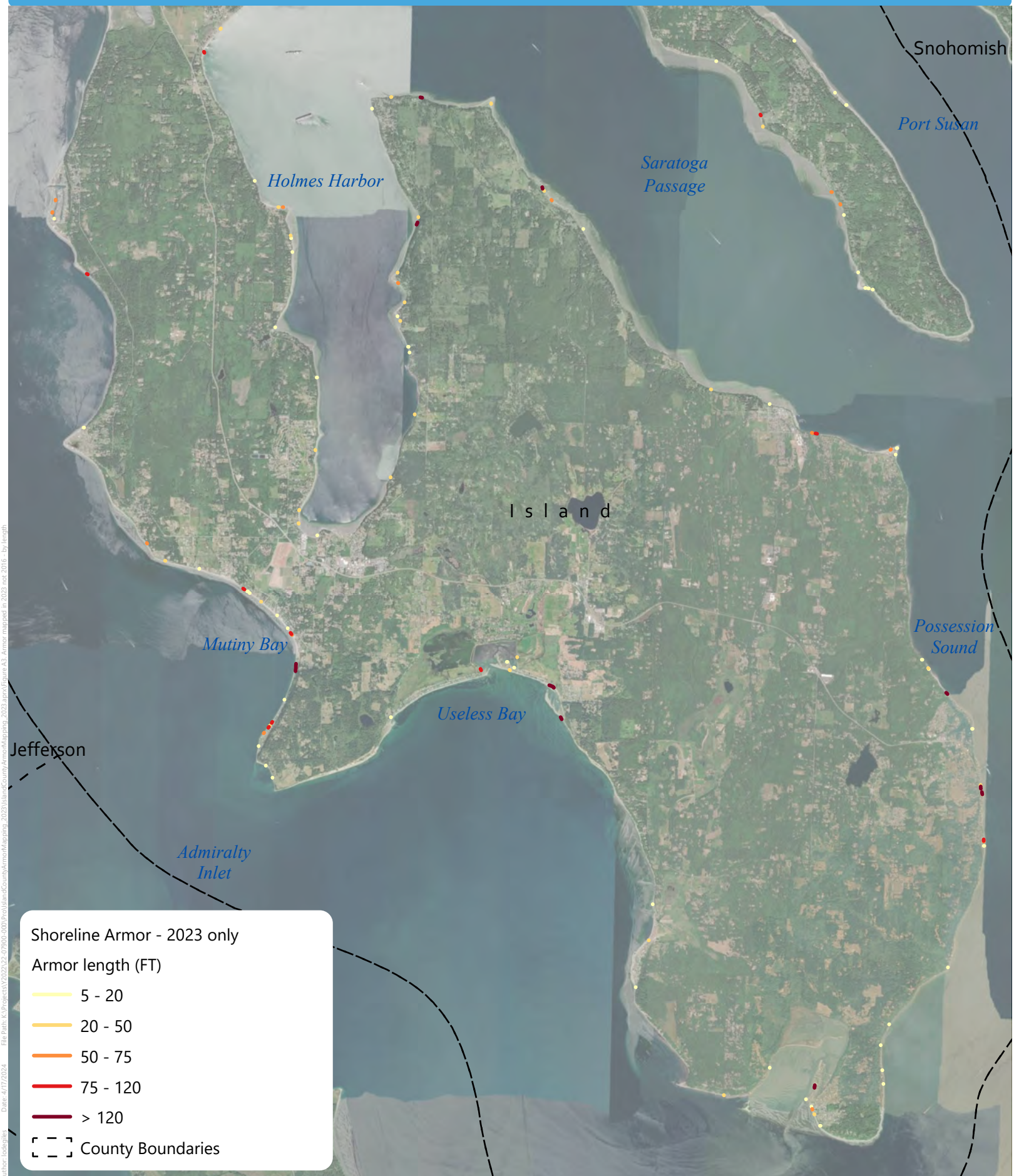
Figure A3.4 - Armor Mapped in 2023 (Not Mapped in 2016) by Length, South Whidbey Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 2,000 4,000 8,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A3. Armor mapped in 2023 not 2016 - by length
Date: 4/17/2024
Author: lodegiles

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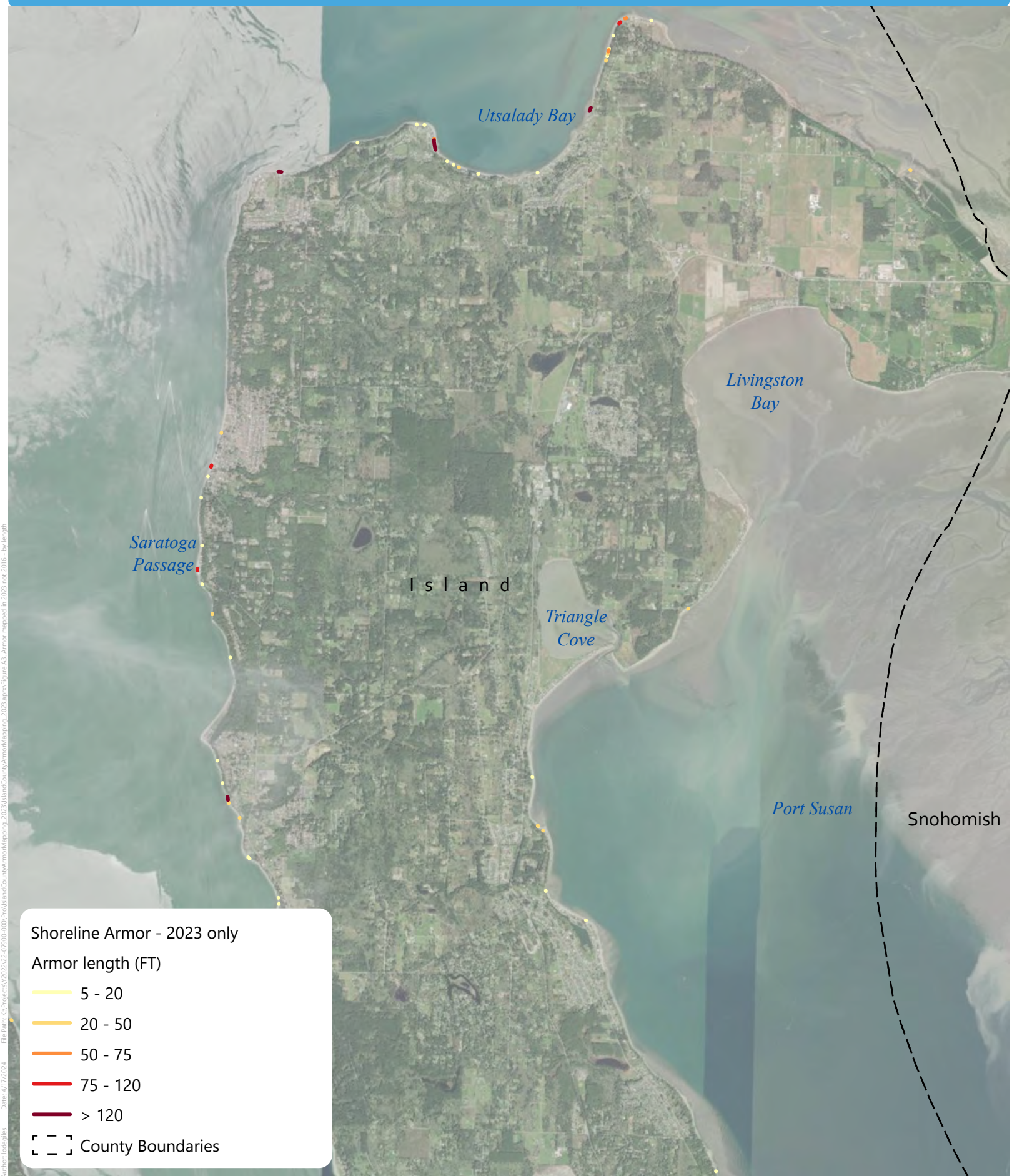
Figure A3.5 - Armor Mapped in 2023 (Not Mapped in 2016) by Length, North Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

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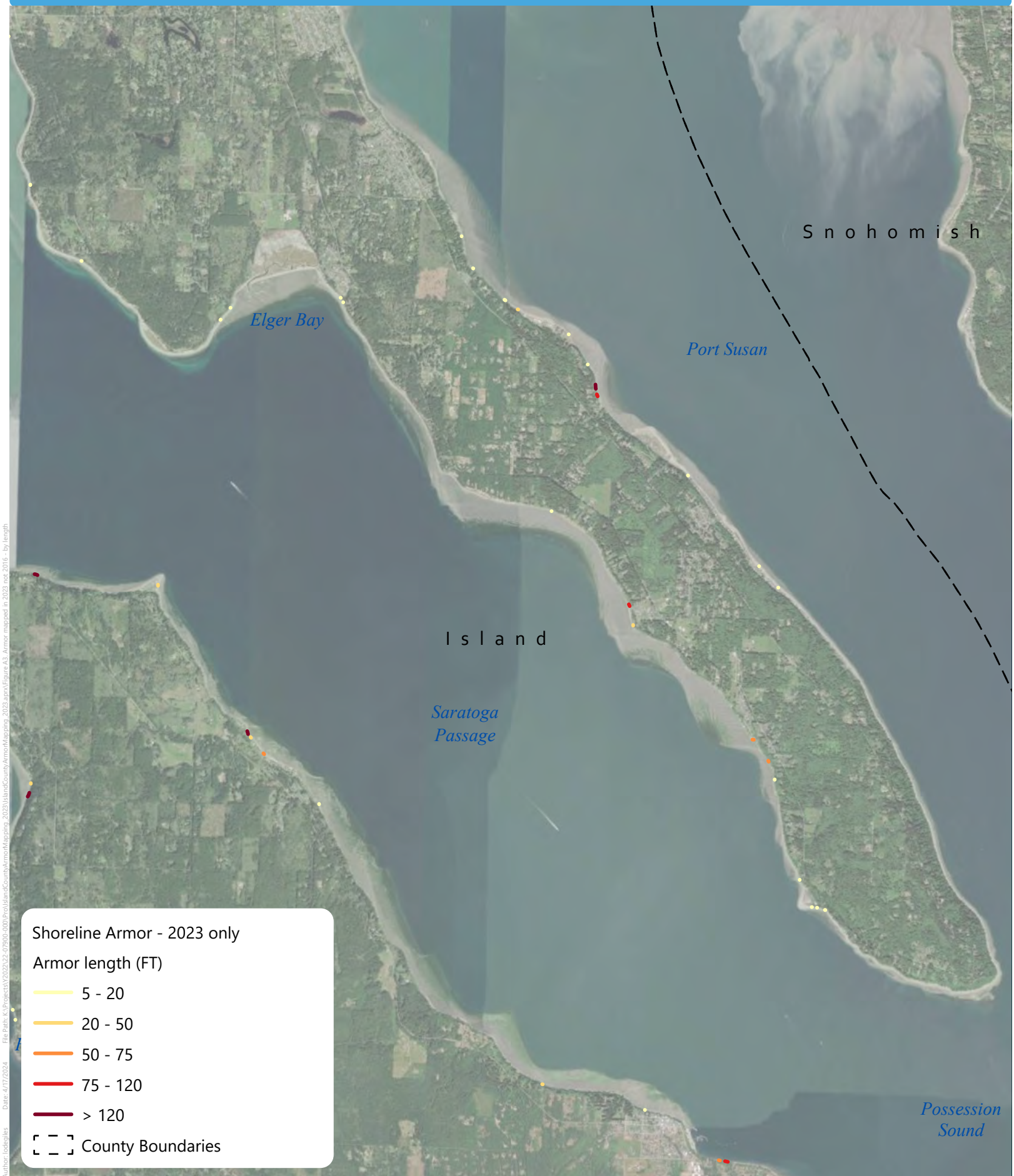
Figure A3.6 - Armor Mapped in 2023 (Not Mapped in 2016) by Length, South Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

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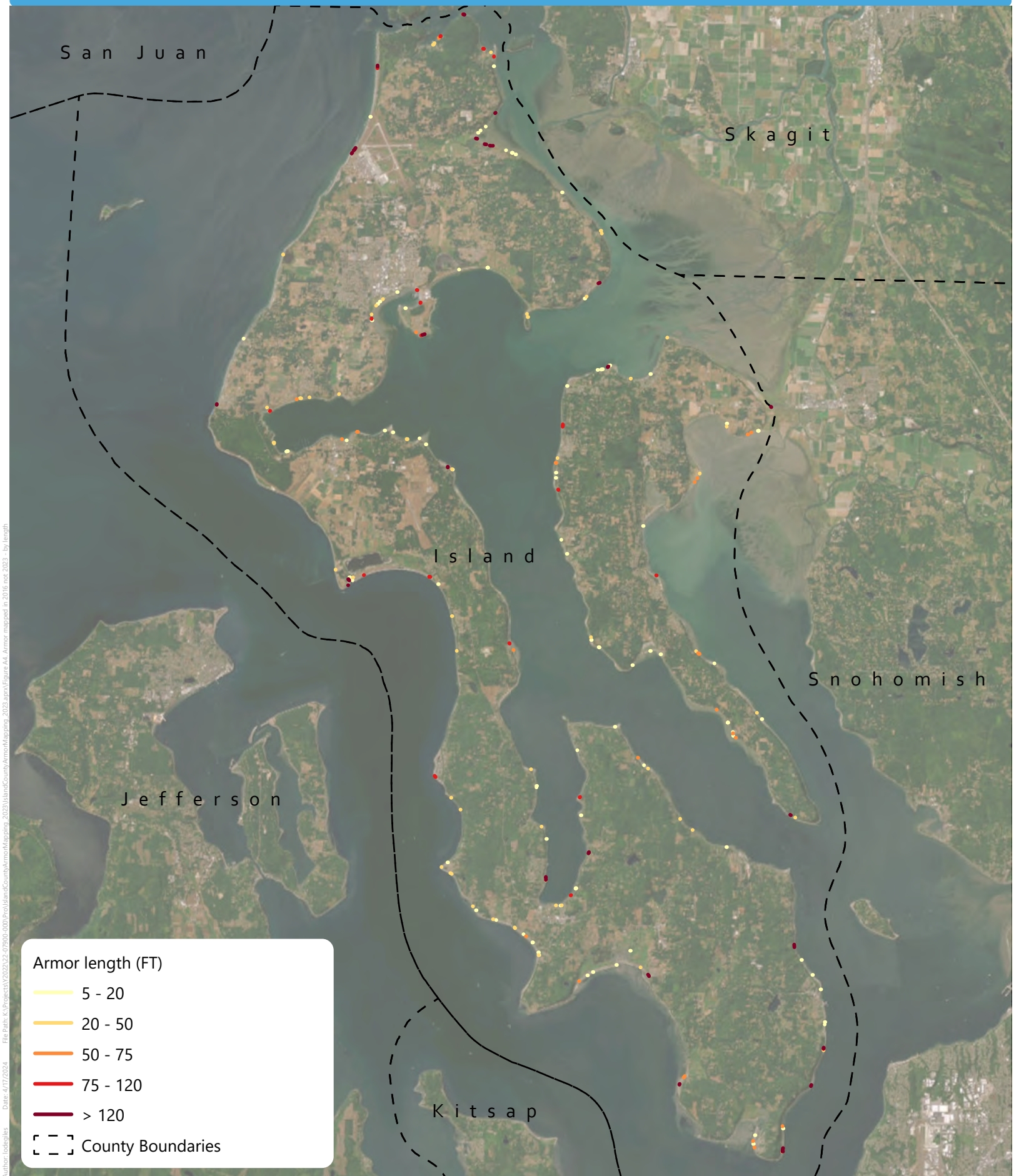
Figure A4.1 - Armor Mapped in 2016 (Not Mapped in 2023) by Length, Island County



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 5,000 10,000 20,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A4 Armor mapped in 2016 not 2023 - by length
Date: 4/17/2024
Author: lodegiles

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Figure A4.2 - Armor Mapped in 2016 (Not Mapped in 2023) by Length, North Whidbey Island

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0 2,000 4,000 8,000 Feet

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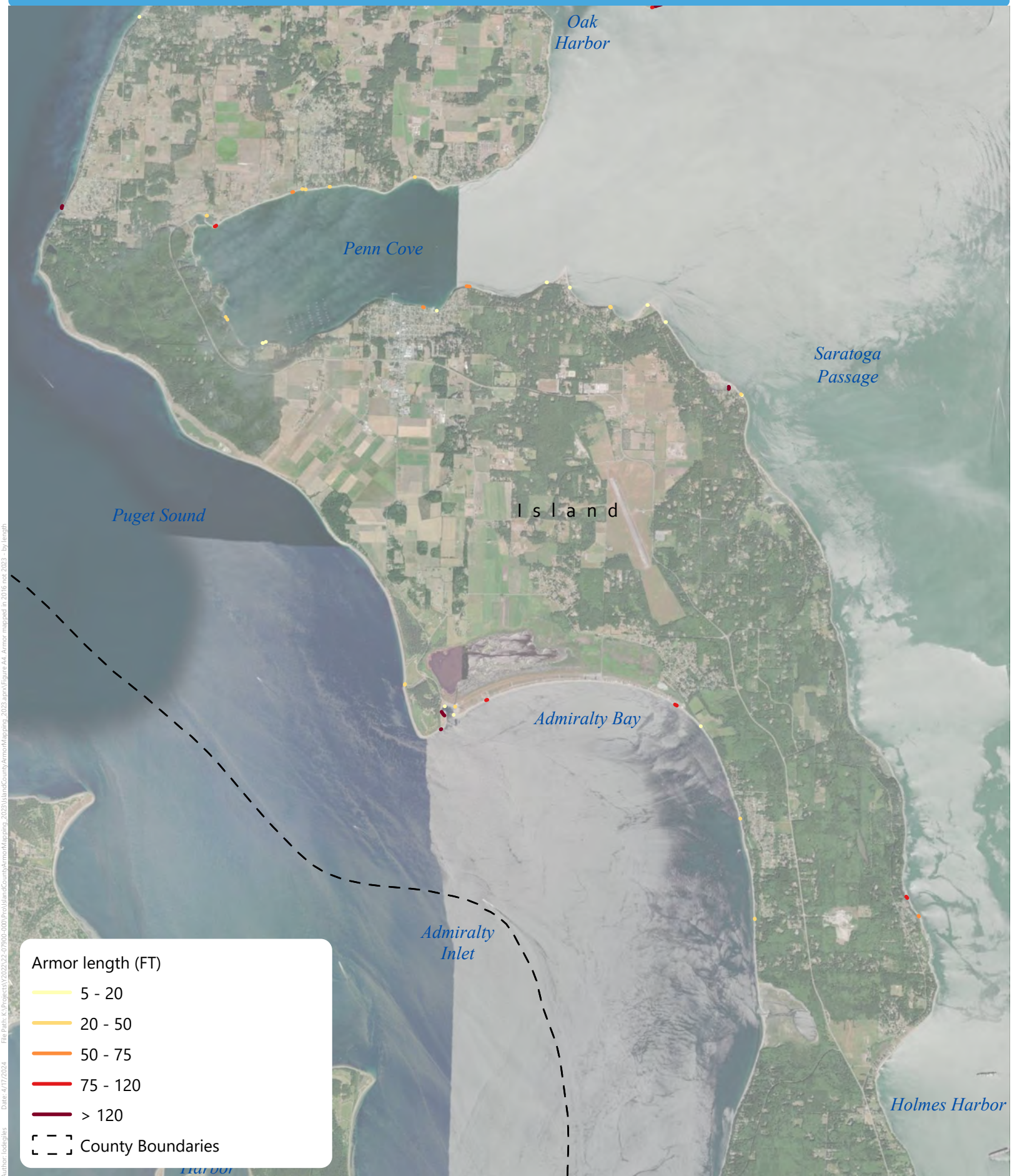
Figure A4.3 - Armor Mapped in 2016 (Not Mapped in 2023) by Length, Central Whidbey Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,500 3,000 6,000 Feet

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Figure A4.4 - Armor Mapped in 2016 (Not Mapped in 2023) by Length, South Whidbey Island

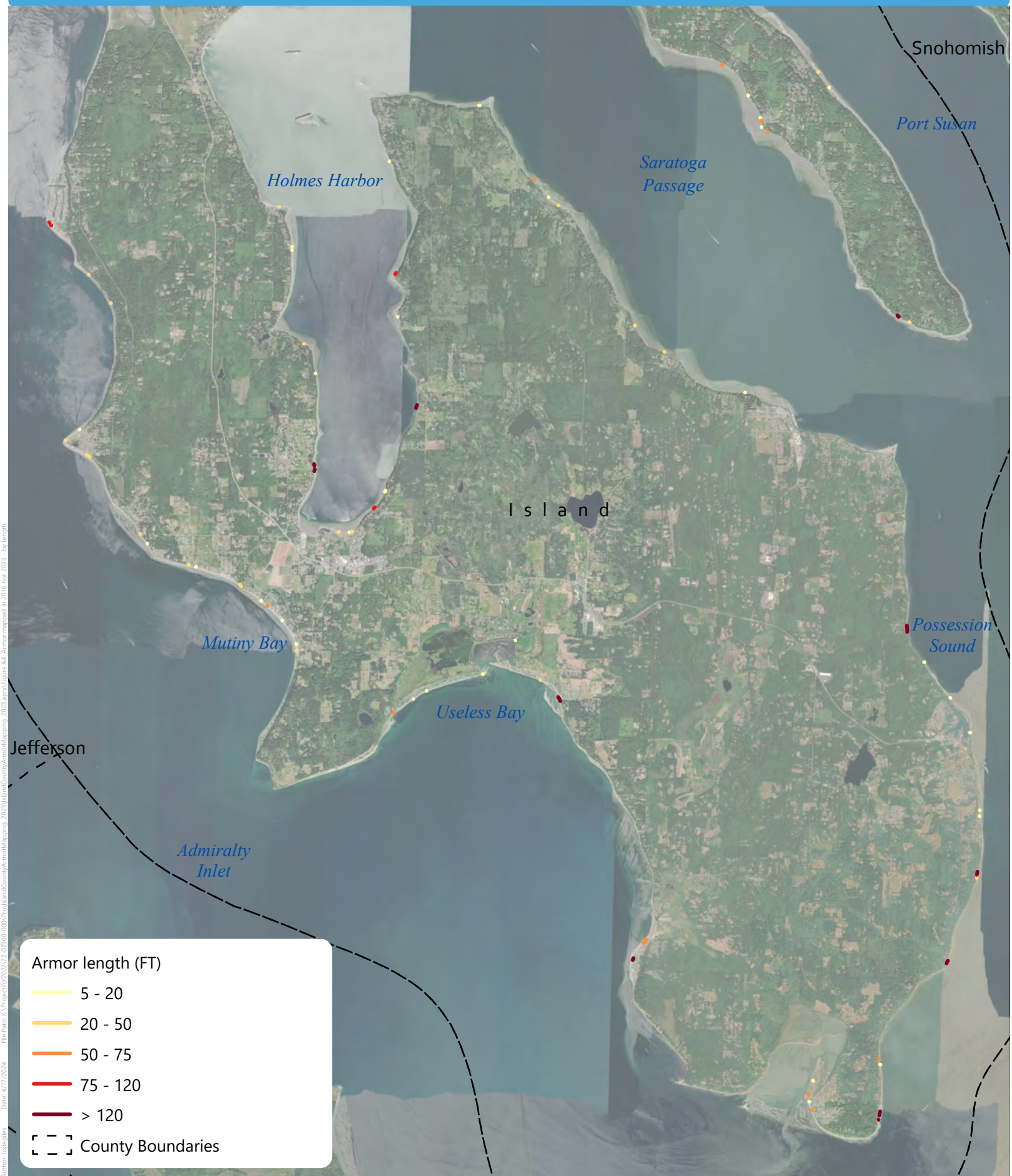

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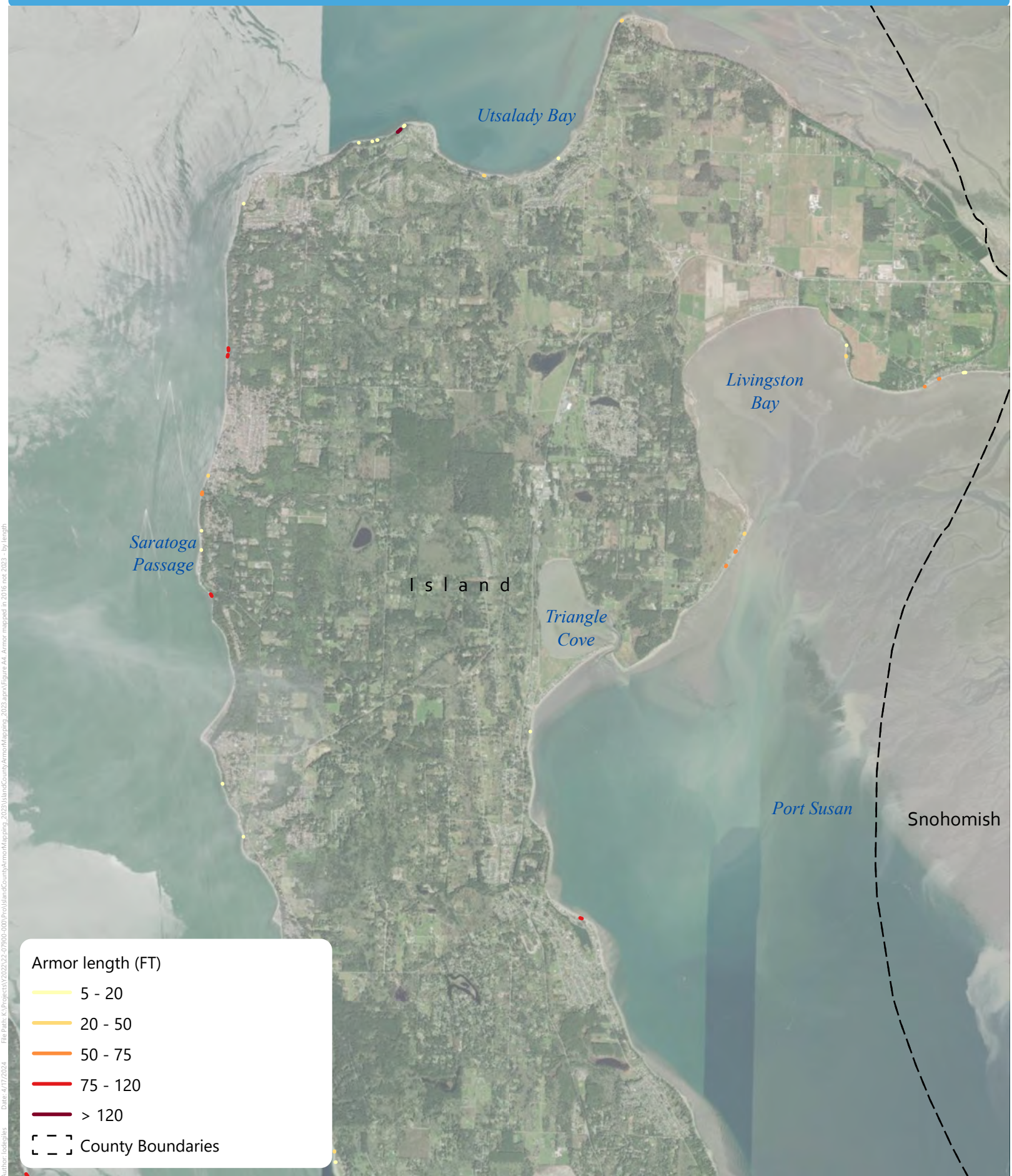
Figure A4.5 - Armor Mapped in 2016 (Not Mapped in 2023) by Length, North Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A4 Armor mapped in 2016 not 2023 - by length
Date: 4/17/2024
Author: lodegiles

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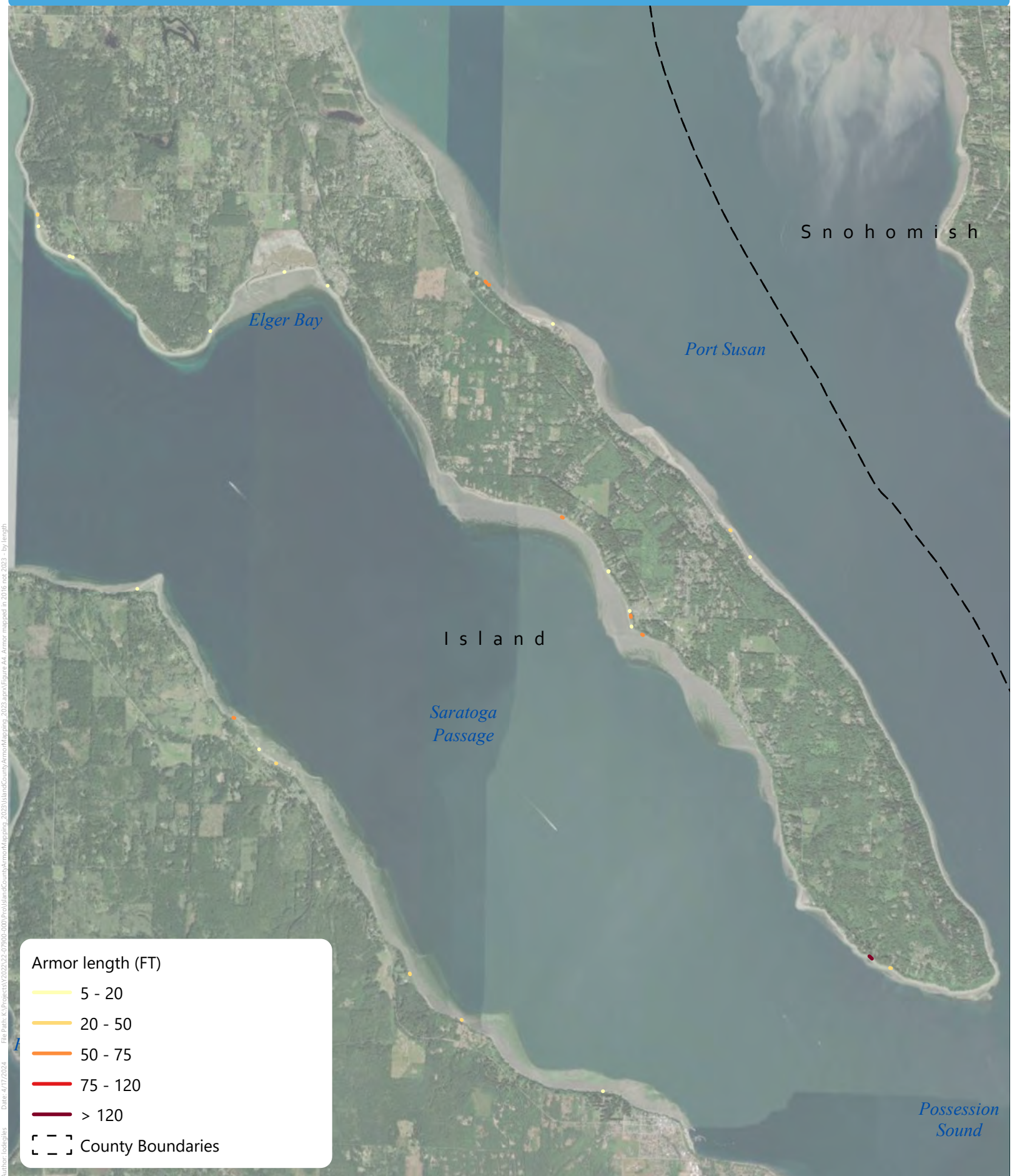
Figure A4.6 - Armor Mapped in 2016 (Not Mapped in 2023) by Length, South Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A4 Armor mapped in 2016 not 2023 - by length
Date: 4/17/2024
Author: Iodegiles

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Figure A5.1 - Change in Mapped Armor Condition from 2016 to 2023, Island County

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 5,000 10,000 20,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A5. Change in mapped armor condition, 2016 - 2023
Date: 4/20/2024
Author: lodegiles

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Figure A5.2 - Change in Mapped Armor Condition from 2016 to 2023, North Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 2,0004,000 8,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCountyArmorMapping_2023\IslandCountyArmorMapping_2023.aprx\Figure A5. Change in mapped armor condition, 2016 - 2023
Date: 4/20/2024
Author: Iodegiles

Figure A5.3 - Change in Mapped Armor Condition from 2016 to 2023, Central Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A5_Change in mapped armor condition_2016 - 2023
Date: 4/20/2024
Author: lodegiles

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Figure A5.4 - Change in Mapped Armor Condition from 2016 to 2023, South Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

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File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCountyArmorMapping_2023\IslandCountyArmorMapping_2023.aprx\Figure A5. Change in mapped armor condition, 2016 - 2023
Date: 4/20/2024
Author: lodegiles

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Figure A5.5 - Change in Mapped Armor Condition from 2016 to 2023, North Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCountyArmorMapping_2023\IslandCountyArmorMapping_2023.aprx\Figure A5_Change in mapped armor condition_2016 - 2023
Date: 4/20/2024
Author: lodegiles

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Figure A5.6 - Change in Mapped Armor Condition from 2016 to 2023, South Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A5. Change in mapped armor condition, 2016 - 2023
Date: 4/20/2024
Author: lodegiles

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Figure A6.1 - Change in Mapped Armor Elevation from 2016 to 2023, Island County

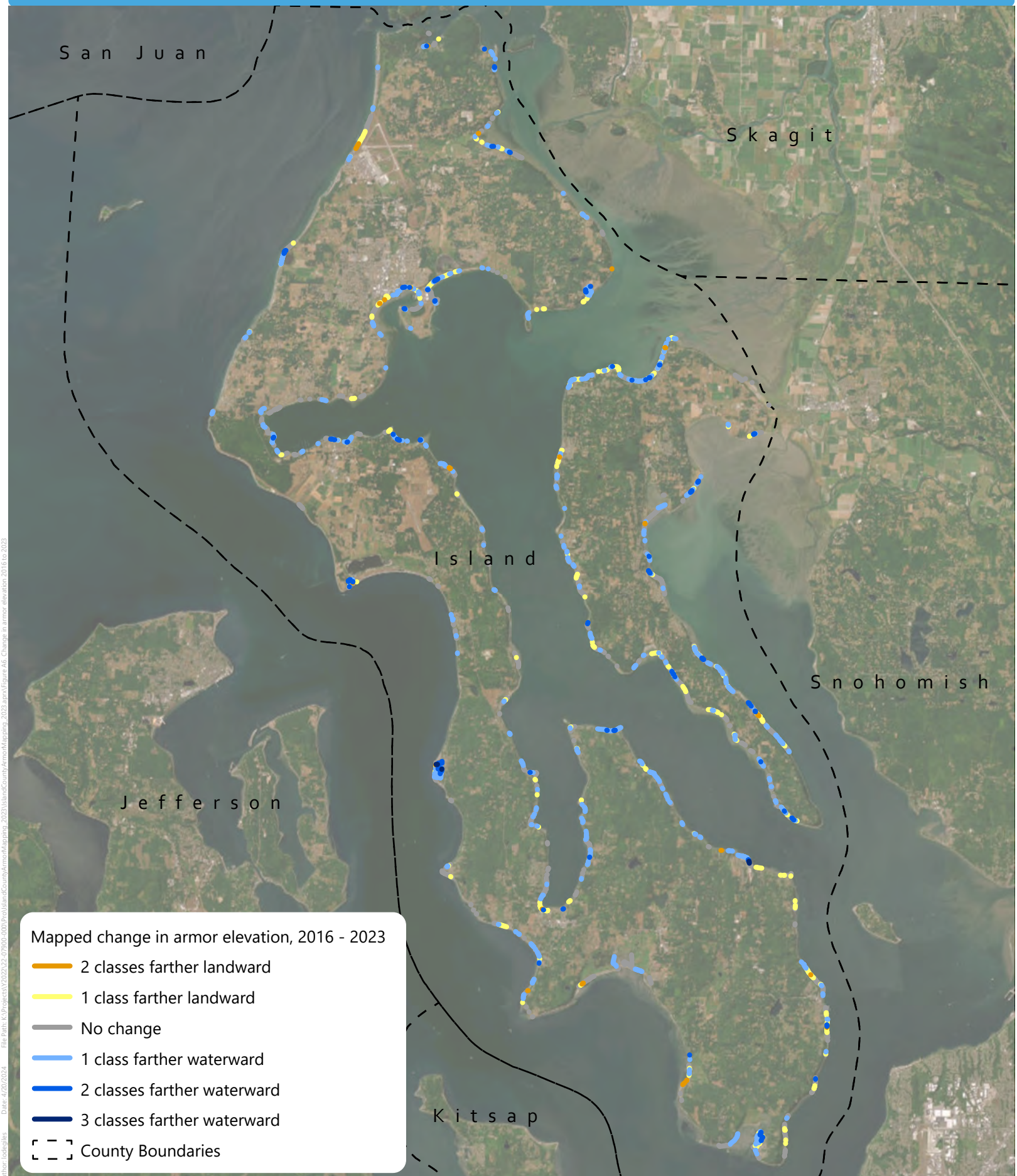

Figure 6.2 - Change in Mapped Armor Elevation from 2016 to 2023, North Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 2,000 4,000 8,000 Feet

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Figure 6.3 - Change in Mapped Armor Elevation from 2016 to 2023, Central Whidbey Island

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023.aprx\Figure A6. Change in armor elevation 2016 to 2023
Date: 4/20/2024
Author: lodegiles

Figure 6.4 - Change in Mapped Armor Elevation from 2016 to 2023, South Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 2,000 4,000 8,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCountyArmorMapping_2023\IslandCountyArmorMapping_2023.aprx\Figure A6. Change in armor elevation 2016 to 2023
Date: 4/20/2024
Author: lodegiles

HERRERA
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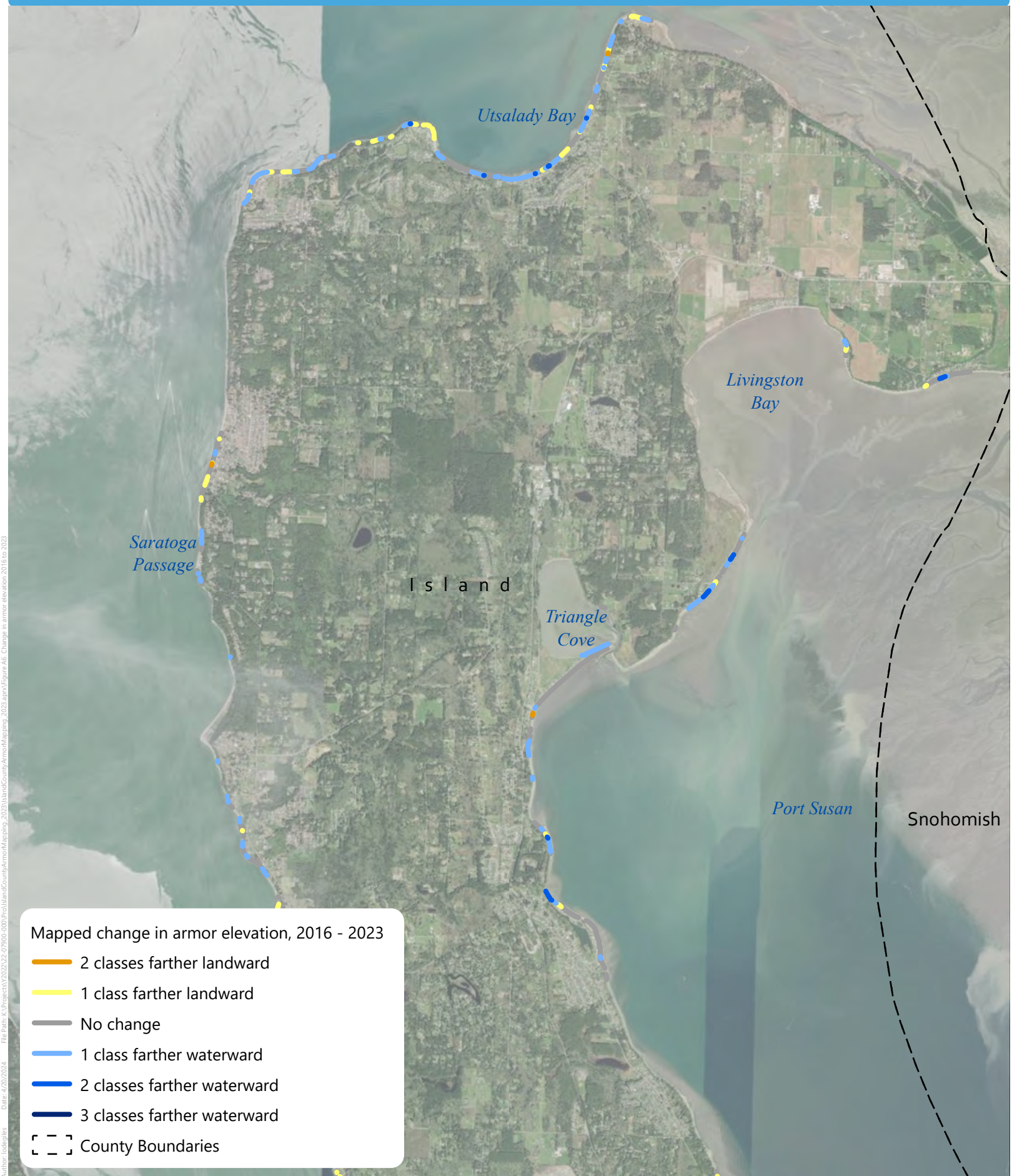
Figure 6.5 - Change in Mapped Armor Elevation from 2016 to 2023, North Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A6. Change in armor elevation 2016 to 2023
Date: 4/20/2024
Author: Iodegiles

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Figure 6.6 - Change in Mapped Armor Elevation from 2016 to 2023, South Camano Island

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A6. Change in armor elevation 2016 to 2023
Date: 4/20/2024
Author: lodegiles

Figure A7.1 - Mapped Changes in Shore Armor Characteristics and Issued Permits, 2016 to 2023, Island County

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 5,000 10,000 20,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A10. Permit analysis results 2016 to 2023
Date: 4/19/2024
Author: lodegiles

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Figure 7.2 - Mapped Changes in Shore Armor Characteristics and Issued Permits, 2016 to 2023, North Whidbey Island

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Figure 7.3 - Mapped Changes in Shore Armor Characteristics and Issued Permits, 2016 to 2023, Central Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,500 3,000 6,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A10. Permit analysis results 2016 to 2023
Date: 4/19/2024
Author: lodegiles

Figure 7.4 - Mapped Changes in Shore Armor Characteristics and Issued Permits, 2016 to 2023, South Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 2,000 4,000 8,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A10. Permit analysis results 2016 to 2023

Date: 4/19/2024

Author: lodegiles

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Figure 7.5 - Mapped Changes in Shore Armor Characteristics and Issued Permits, 2016 to 2023, North Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A10. Permit analysis results 2016 to 2023
Date: 4/19/2024
Author: lodegiles

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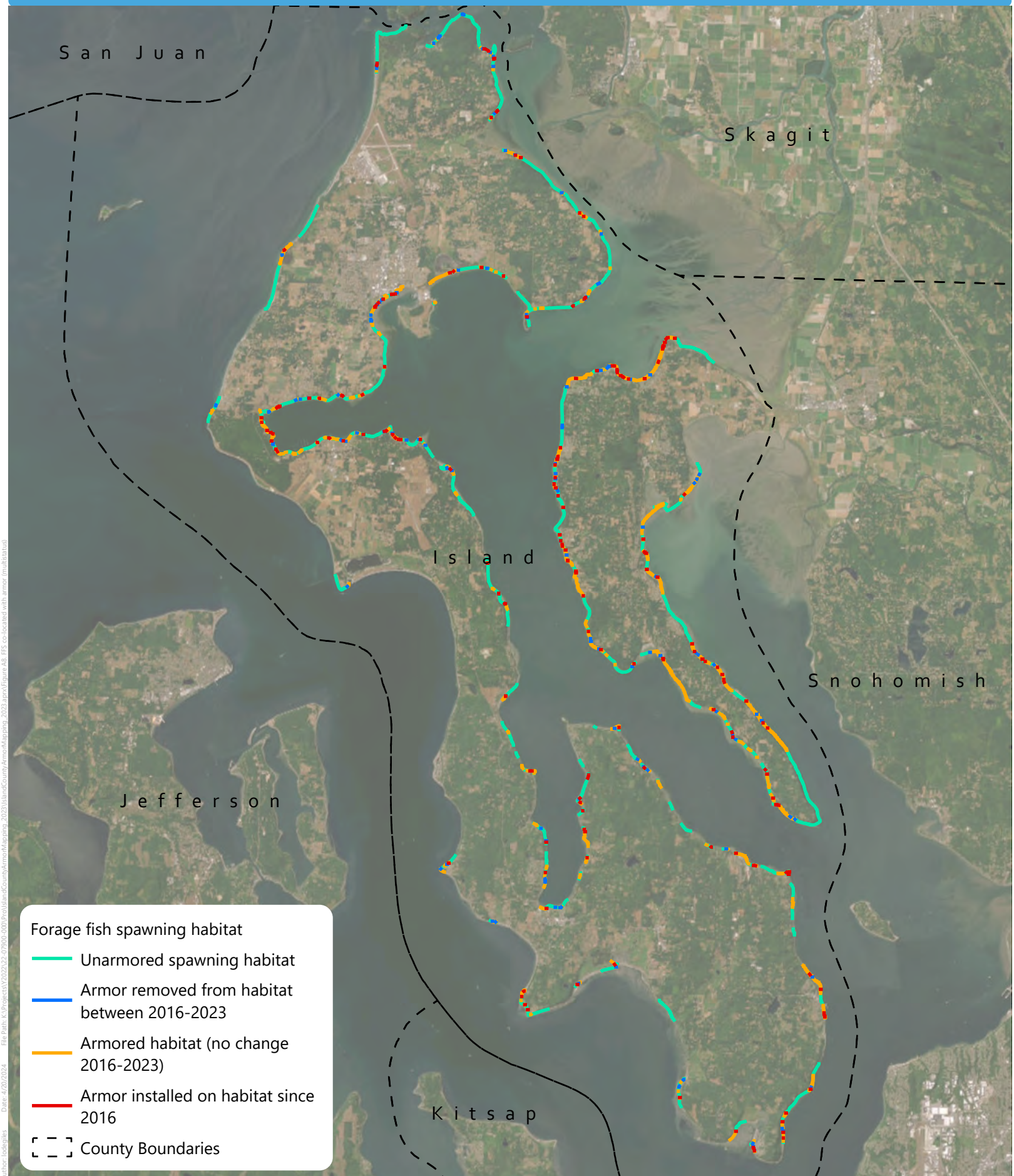
Figure 7.6 - Mapped Changes in Shore Armor Characteristics and Issued Permits, 2016 to 2023, South Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

Figure A8.1 - Co-location of Forage Fish Spawning Habitat and Mapped Armor, 2016 to 2023, Island County



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

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Figure A8.2 - Co-location of Forage Fish Spawning Habitat and Mapped Armor, 2016 to 2023, North Whidbey Island

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCountyArmorMapping_2023\IslandCountyArmorMapping_2023.aprx\Figure A8. FFS co-located with armor (multistatus)
Date: 4/20/2024
Author: Iodegiles

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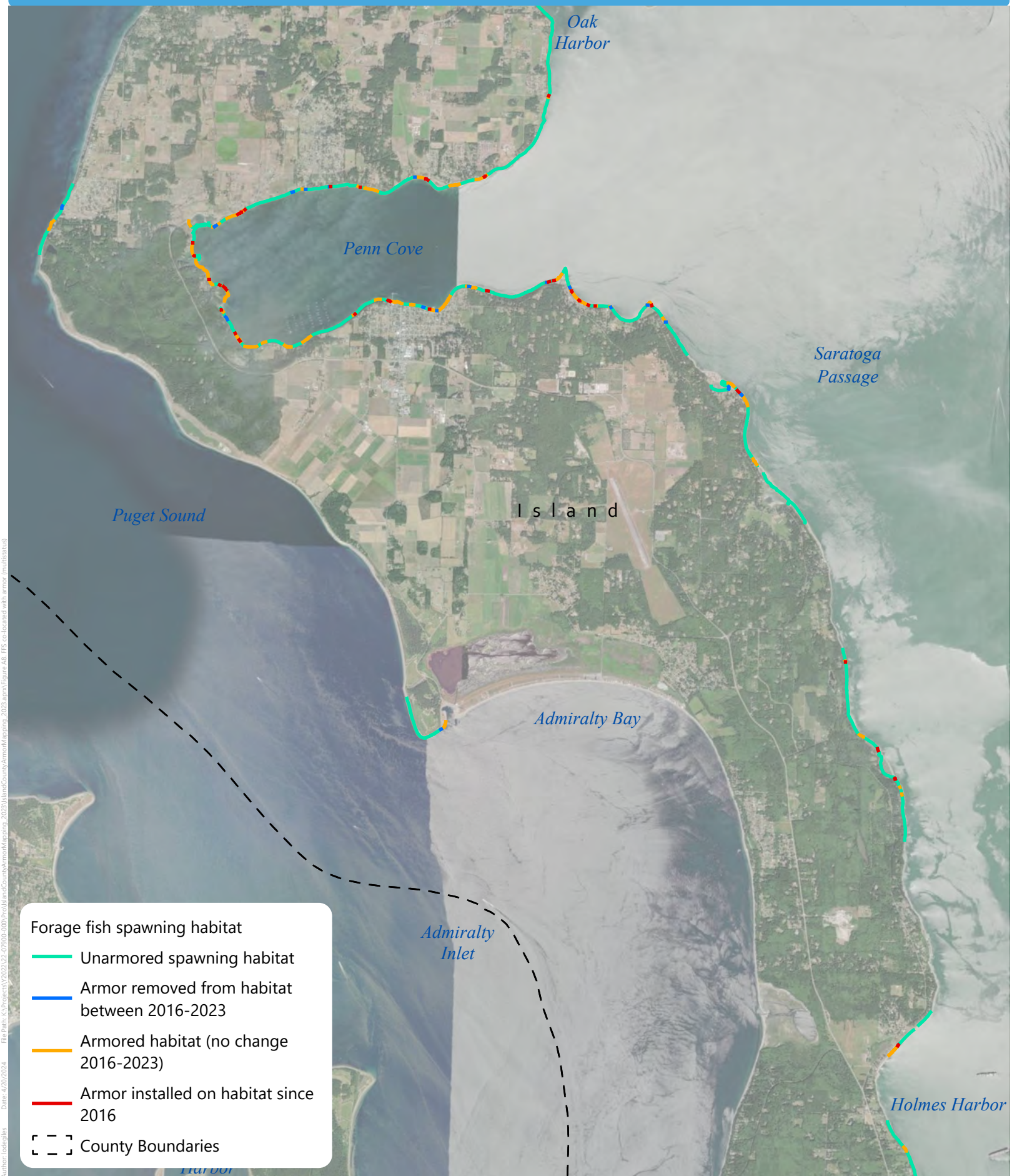
Figure A8.3 - Co-location of Forage Fish Spawning Habitat and Mapped Armor, 2016 to 2023, Central Whidbey Island

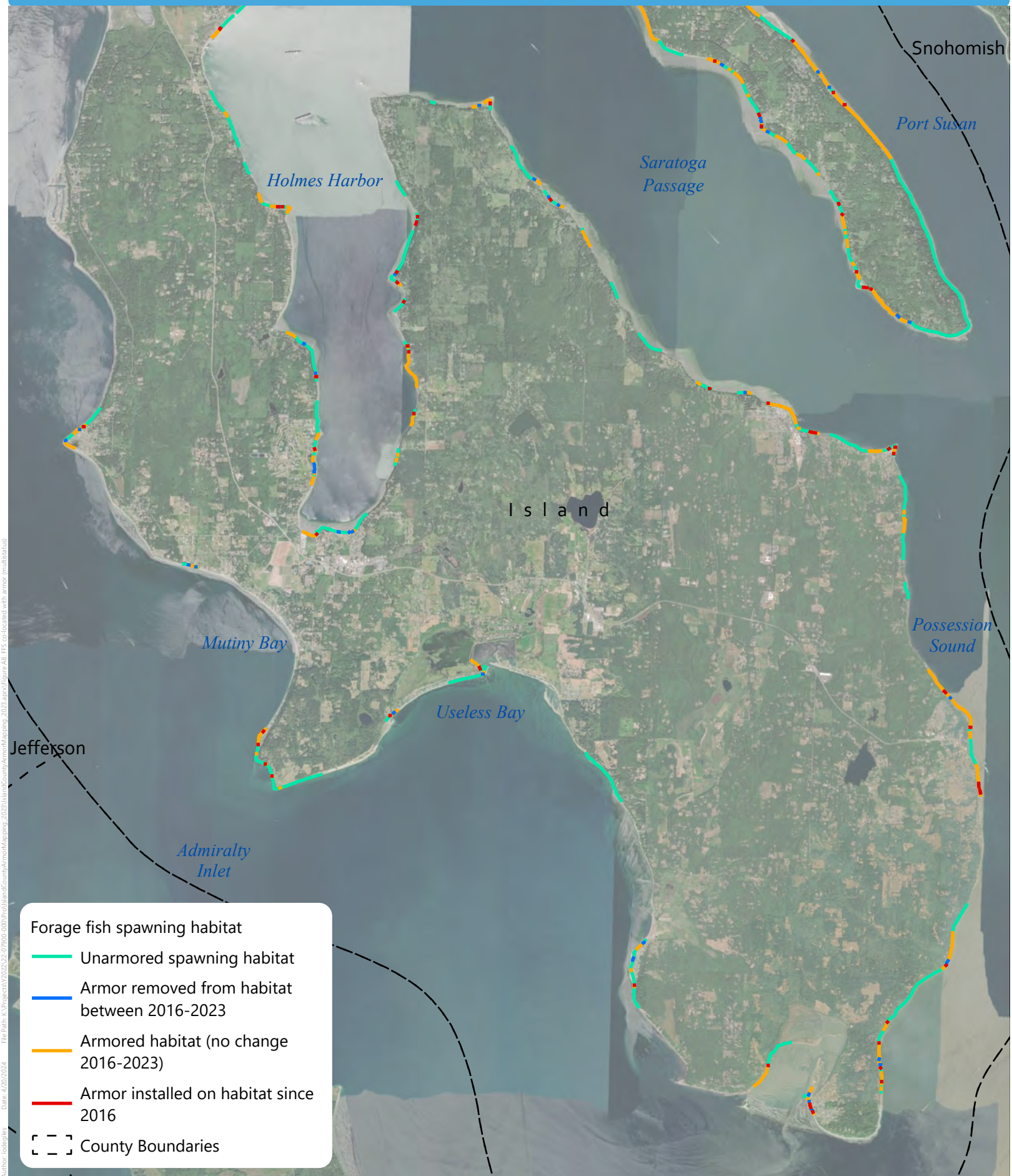


Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,500 3,000 6,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023.aprx\Figure A8. FFS co-located with armor (multistatus)
Date: 4/20/2024
Author: lodegiles

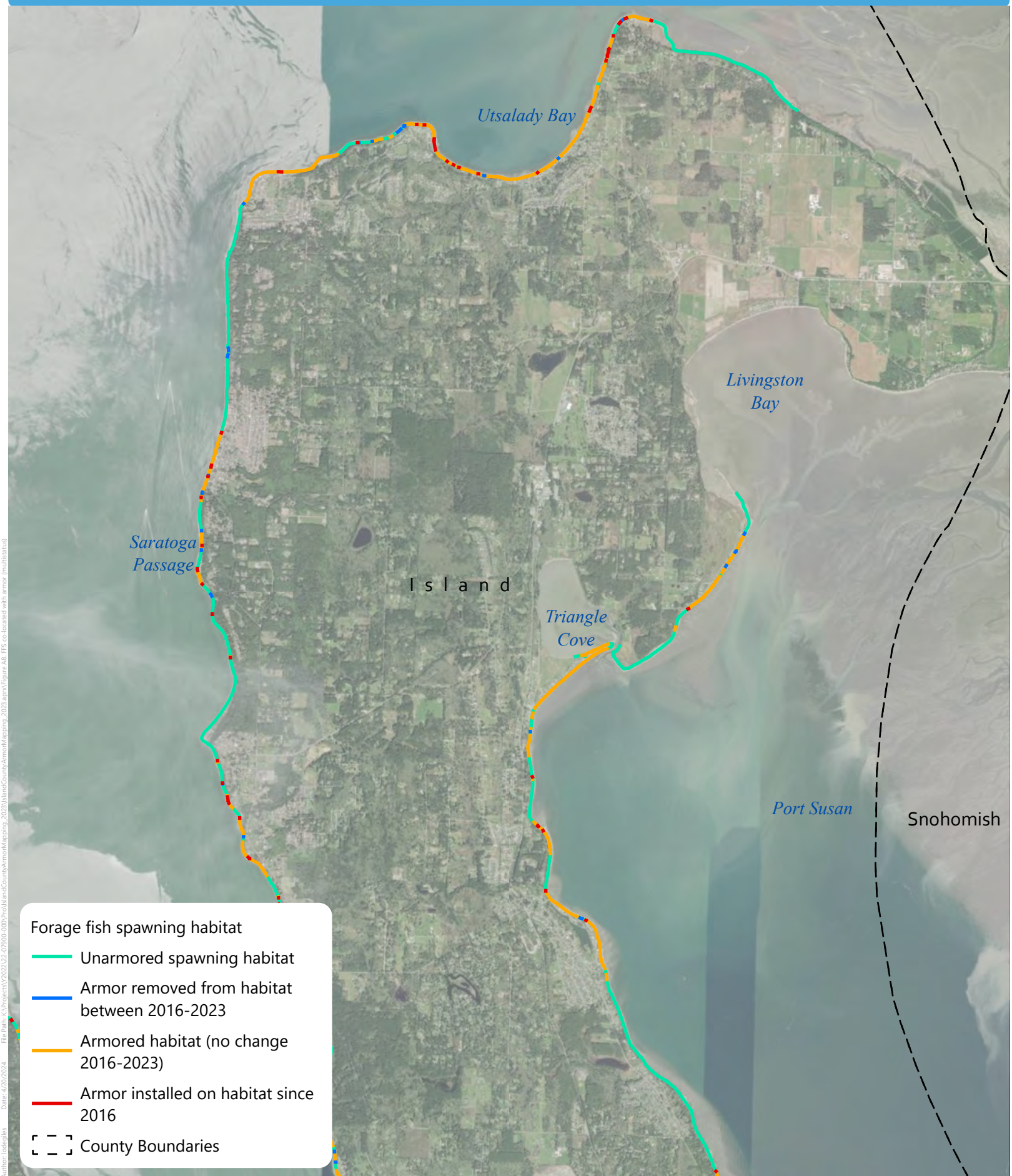
Figure A8.4 - Co-location of Forage Fish Spawning Habitat and Mapped Armor, 2016 to 2023, South Whidbey Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCountyArmorMapping_2023\IslandCountyArmorMapping_2023.aprx\Figure A8. FFS co-located with armor (multistatus)
Date: 4/20/2024
Author: lodegiles

Figure A8.5 - Co-location of Forage Fish Spawning Habitat and Mapped Armor, 2016 to 2023, North Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

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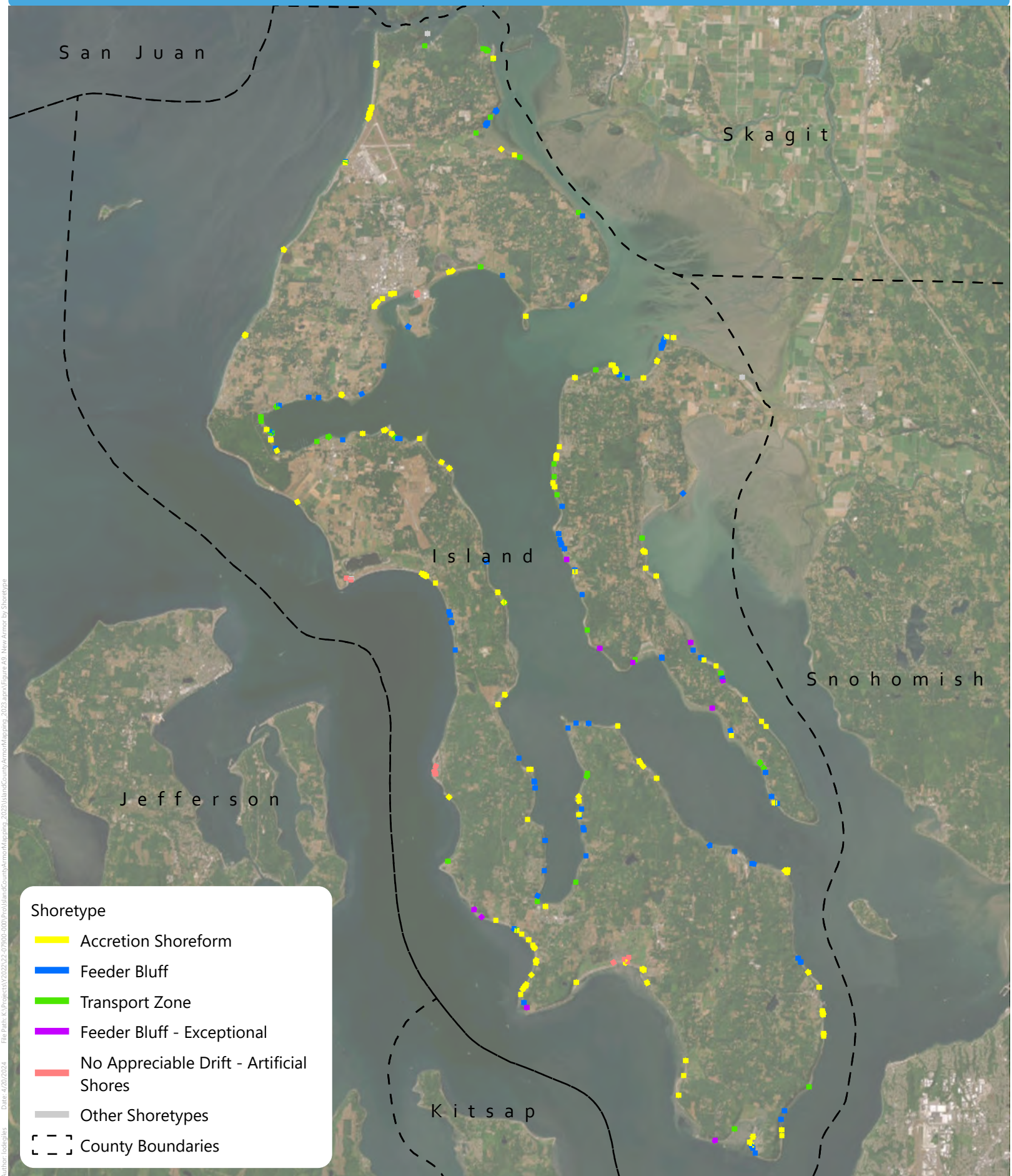
Figure A8.6 - Co-location of Forage Fish Spawning Habitat and Mapped Armor, 2016 to 2023, South Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023.aprx\Figure A8. FFS co-located with armor (multistatus)
Date: 4/20/2024
Author: lodegiles

Figure A9.1 - Armor Mapped in 2023 (Not Mapped in 2016) by Shoretype, Island County



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

Figure A9.2 - Armor Mapped in 2023 (Not Mapped in 2016) by Shoretype, North Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 2,000 4,000 8,000 Feet

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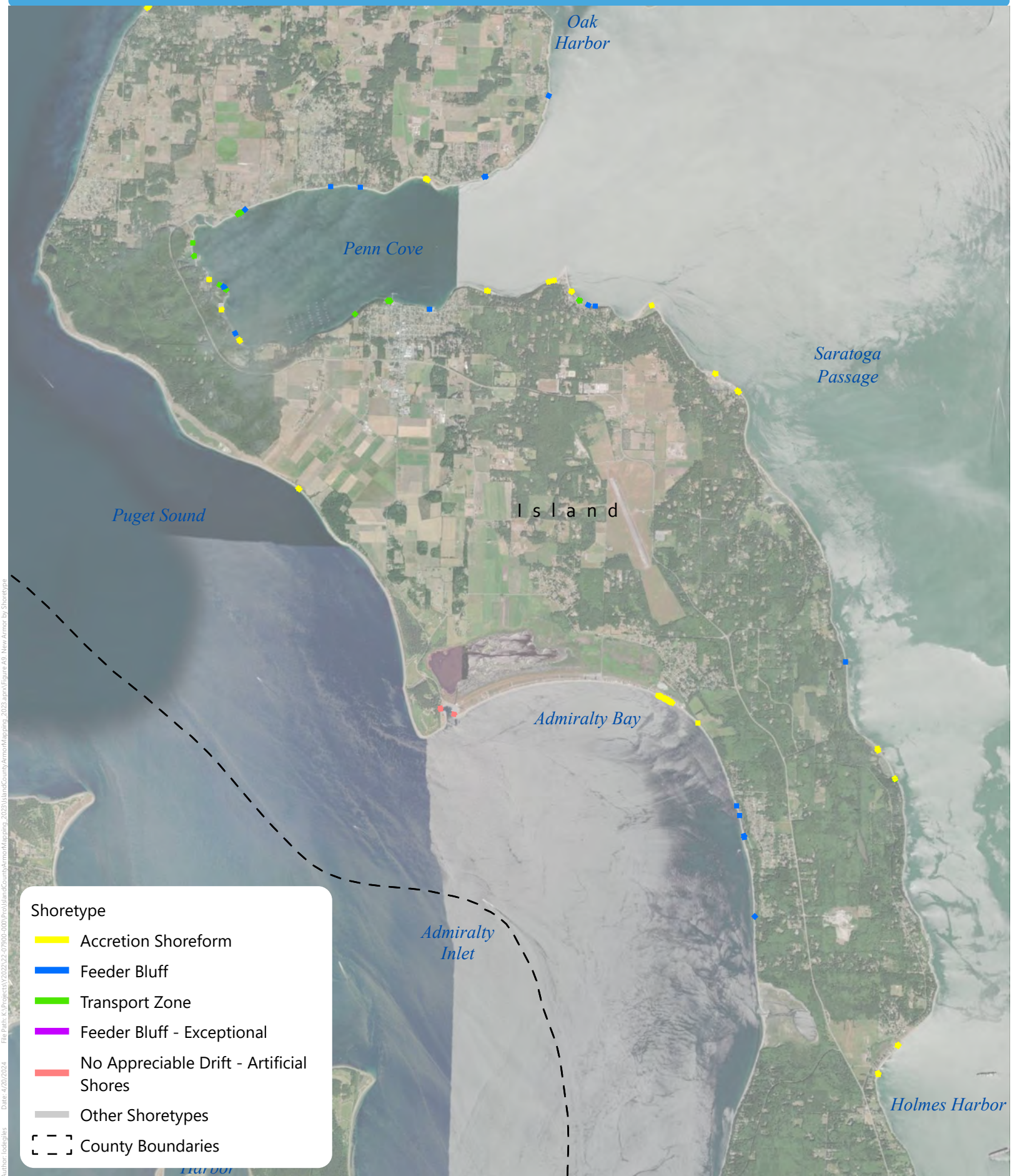
Figure A9.3 - Armor Mapped in 2023 (Not Mapped in 2016) by Shoretype, Central Whidbey Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

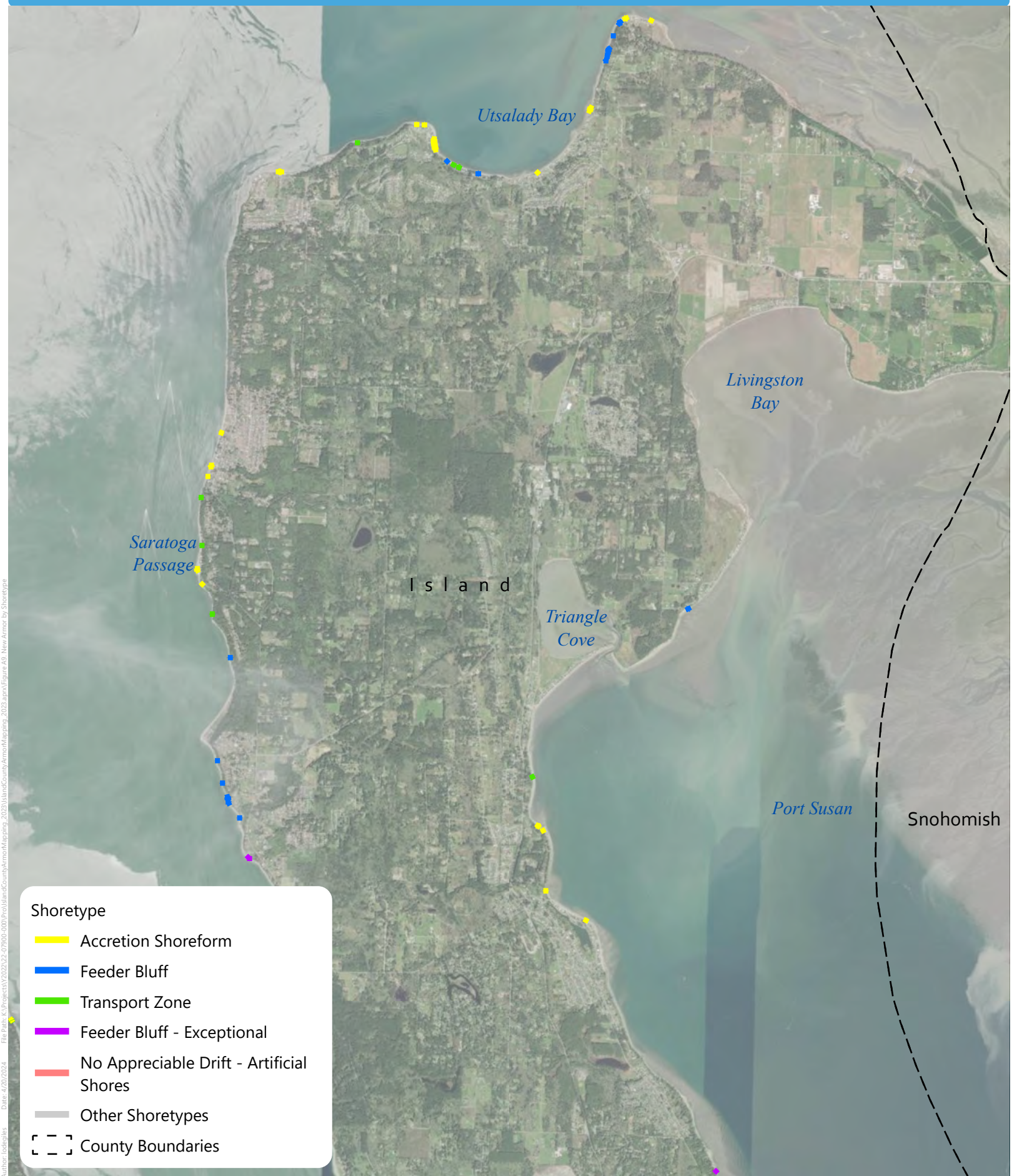
0 1,500 3,000 6,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023.aprx\Figure A9_New Armor by Shoretype
Date: 4/20/2024
Author: lodegiles

Figure A9.4 - Armor Mapped in 2023 (Not Mapped in 2016) by Shoretype, South Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

Figure A9.5 - Armor Mapped in 2023 (Not Mapped in 2016) by Shoretype, North Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

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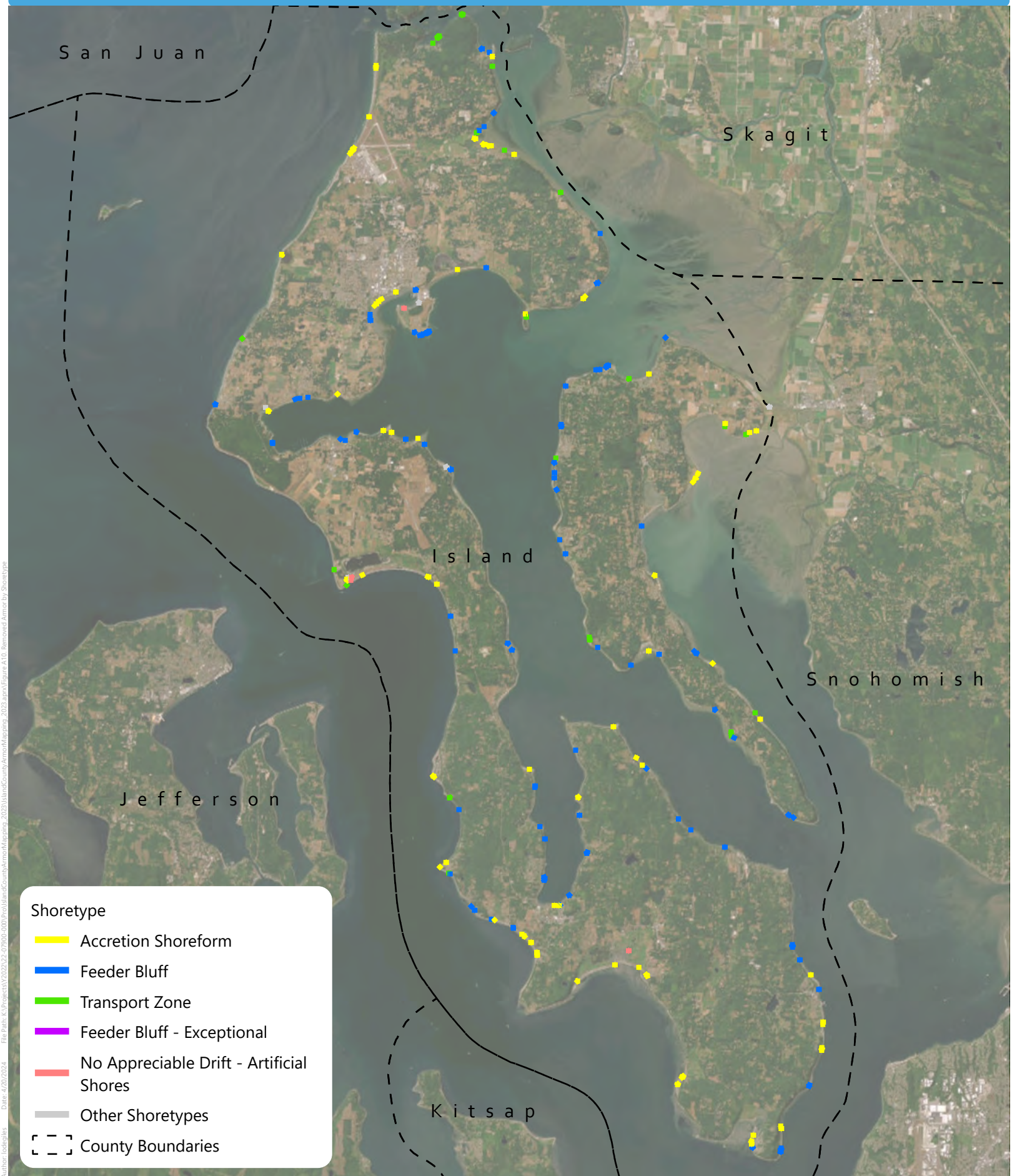
Figure A9.6 - Armor Mapped in 2023 (Not Mapped in 2016) by Shoretype, South Camano Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A9_New Armor by Shoretype
Date: 4/20/2024
Author: lodegiles

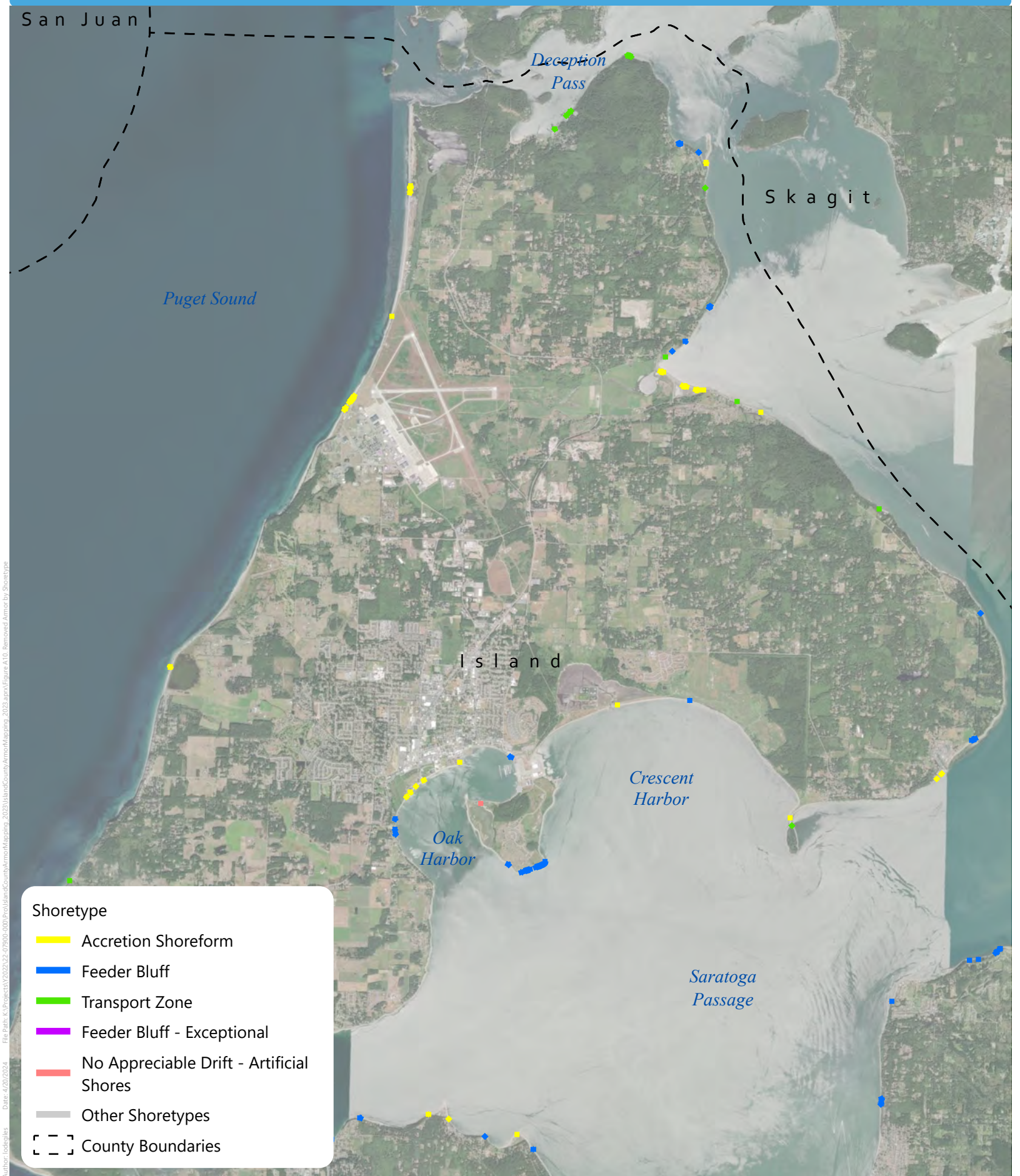
Figure A10.1 - Armor Mapped in 2016 (Not Mapped in 2023) by Shoretype, Island County



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 5,000 10,000 20,000 Feet

Figure A10.2 - Armor Mapped in 2016 (Not Mapped in 2023) by Shoretype, North Whidbey Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

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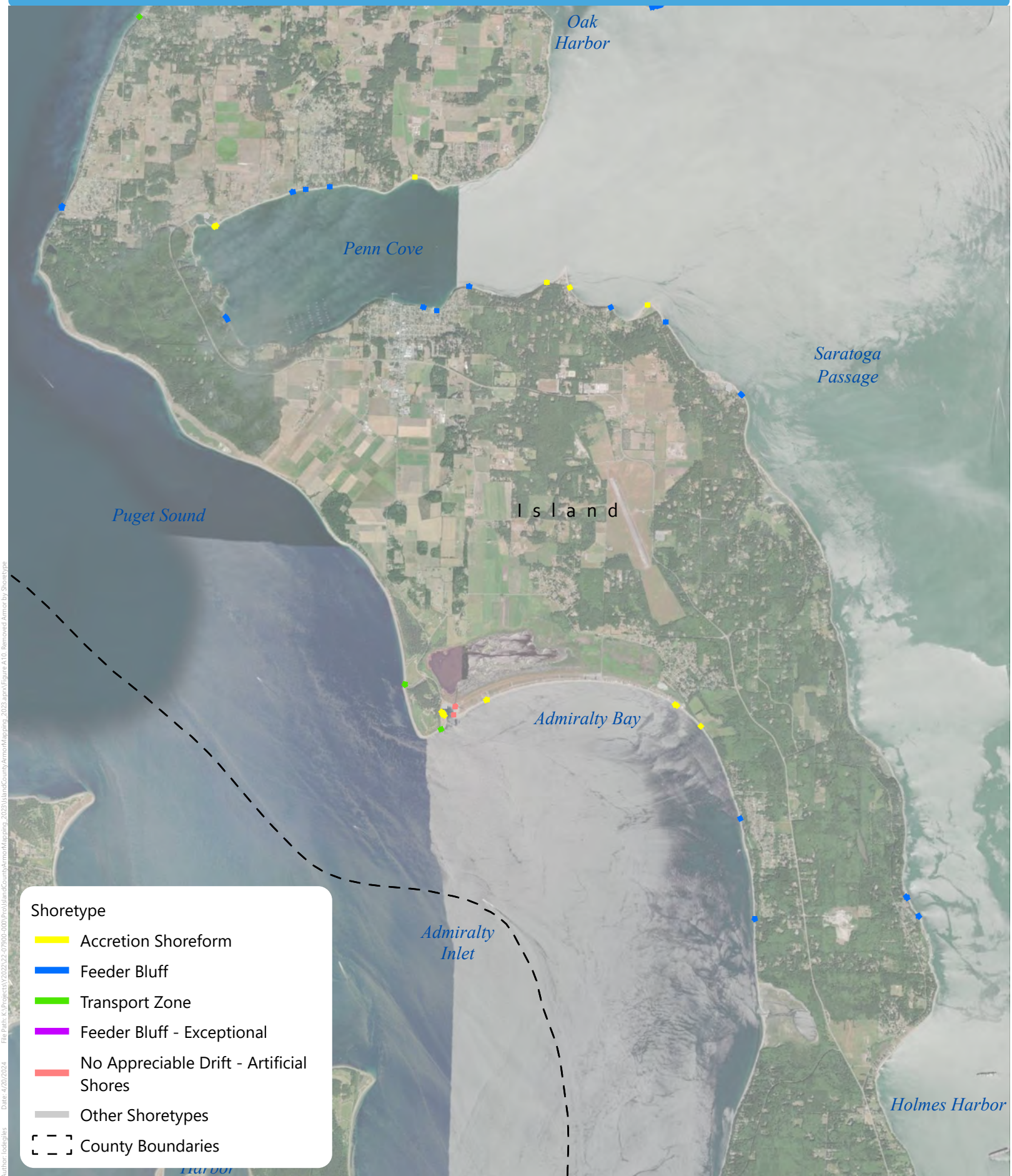
Figure A10.3 - Armor Mapped in 2016 (Not Mapped in 2023) by Shoretype, Central Whidbey Island



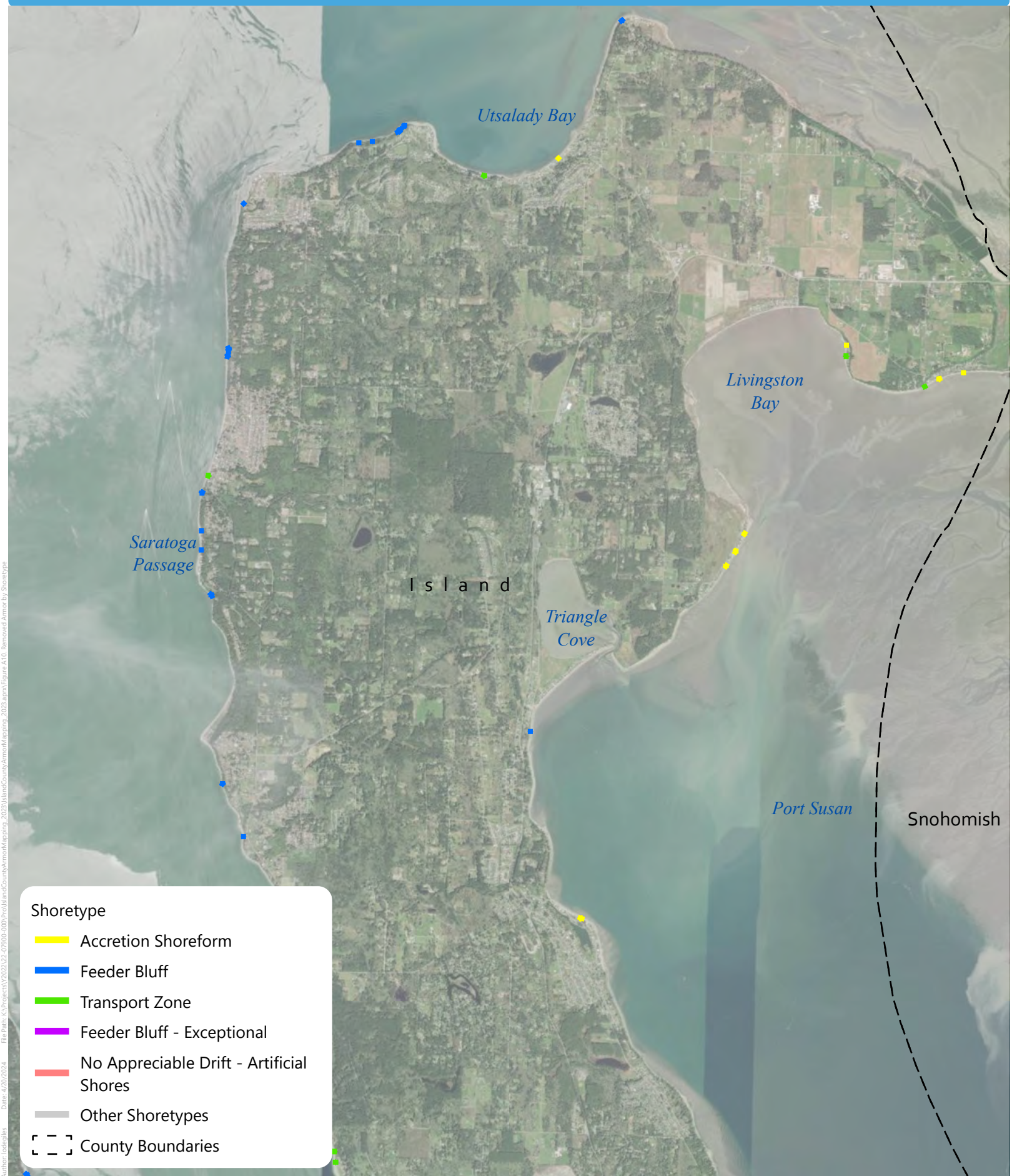
Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

File Path: K:\Projects\Y2022\22-07900-000\Pro\IslandCounty\ArmorMapping_2023\IslandCounty\ArmorMapping_2023.aprx\Figure A10. Removed Armor by Shoretype
Date: 4/20/2024
Author: lodegiles

Figure A10.4 - Armor Mapped in 2016 (Not Mapped in 2023) by Shoretype, South Whidbey Island

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

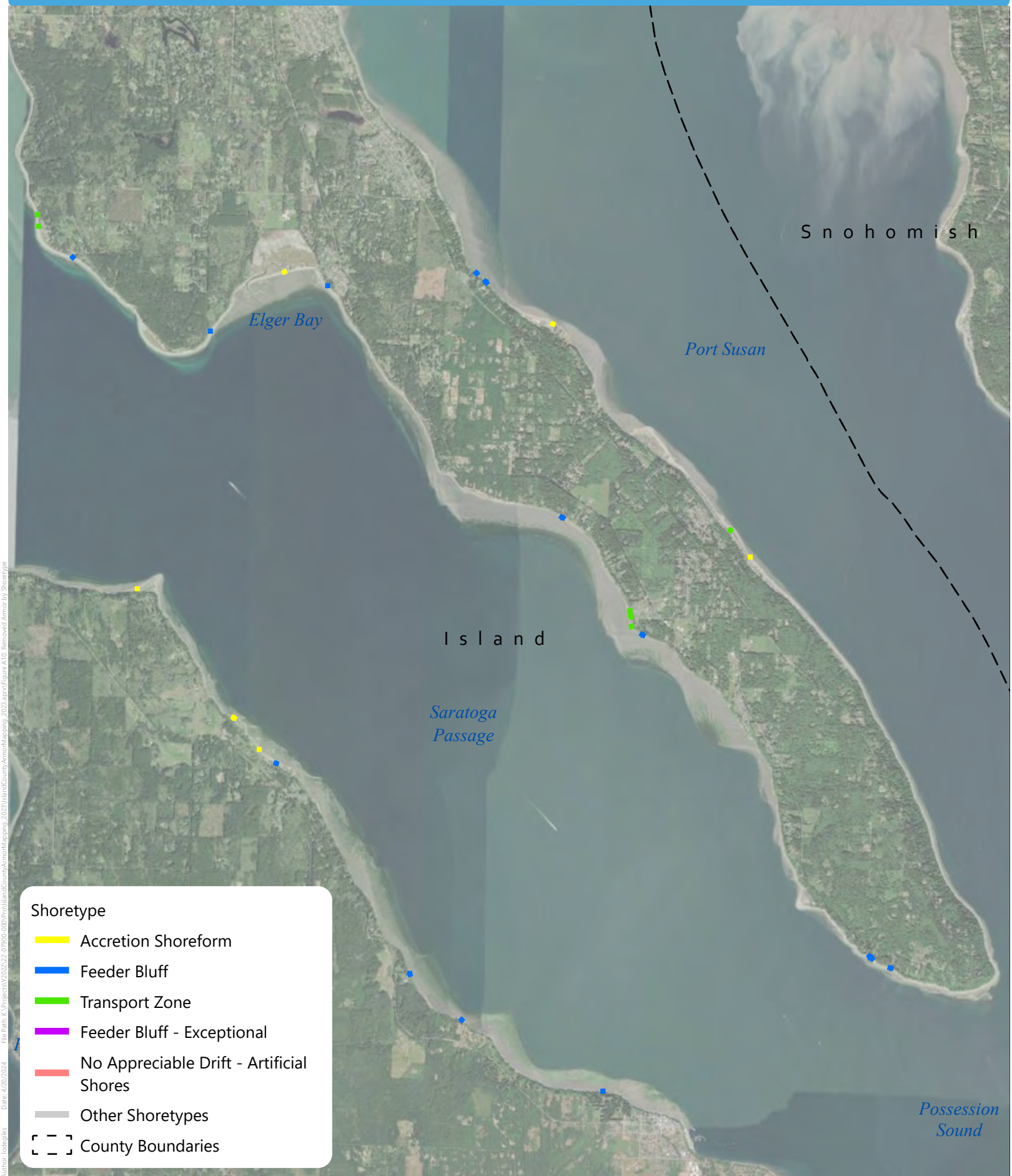
Figure A10.5 - Armor Mapped in 2016 (Not Mapped in 2023) by Shoretype, North Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

Figure A10.6 - Armor Mapped in 2016 (Not Mapped in 2023) by Shoretype, South Camano Island



Produced by Herrera Environmental Consultants (herrerainc.com) | Sources:

0 1,250 2,500 5,000 Feet

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Appendix B

Mapped Armor Geospatial Attributes—2023

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This Appendix describes the feature class attributes associated with geospatial deliverables for the Island County Shoreline Armor Mapping Phase 1 geodatabase.

Table B-1. Geospatial Attribute Table Field Names, Field Types, and Descriptions for the ICAM_ShorelineArmor_2023 Feature Class.

Field Name	Data Type	Description
ObjectID	Object ID	Automatically generated field with unique object identifier
MappingMethod	Text	Distinguishes between features mapped using field or remote methods
Armored	Boolean	Presence of armor (0 = no armor; 1 = armor)
ArmorRock	Boolean	Armor includes rock material (0 = no rock; 1 = includes rock)
ArmorConcrete	Boolean	Armor includes concrete material (0 = no concrete; 1 = includes concrete)
ArmorWood	Boolean	Armor includes wood material (0 = no wood; 1 = includes wood)
ArmorWoodCreosoted	Boolean	Armor includes creosote-treated wood material (0 = no creosote-treated wood; 1 = includes creosote-treated wood)
ArmorOther	Boolean	Armor includes other material types not otherwise specified (0 = no other material; 1 = includes other material)
ArmorElevation	Text	Relative tidal elevation of armor (U = Above extreme high water (upland); D = Ordinary high water mark to extreme high water (dunegrass area); HW = Mean higher high water to ordinary high water mark; Below_HW = Mean sea level to mean higher high water; SL = Below or at sea level)
ArmorCondition	Text	Armor condition (Ok = no signs of failure; F = Functional but failing; D = Derelict)
ArmorNotes	Text	Additional notes related to armor mapping, material composition, etc.
CreationDate	Date	Date on which associated armor vertex was mapped
Creator	Text	User account associated with vertex mapping
EditDate	Date	Date on which associated armor vertex was last edited
Editor	Text	User account associated with last vertex edit
SegmentType	Text	Associated origin point of armor from field or remote mapping (Start = beginning of mapped armor segment; Change = Change in composition of armor)
PreSnapLenFT	Numerical	Length of armor segment prior to snapping and conformation with the WDFW ShoreZone Shoreline dataset
Shape_Length	Numerical	Automatically generated field; length of line feature in feet

Table B-2. Geospatial Attribute Table Field Names, Field Types, and Descriptions for the ICAM_ShorelineArmor_2016_2023_Comparable Feature Class.		
Field Name	**Data Type**	**Description**
ObjectID	Object ID	Automatically generated field with unique object identifier
MappingMethod	Text	Distinguishes between features mapped using field or remote methods
Armored	Boolean	Presence of armor (0 = no armor; 1 = armor)
ArmorRock	Boolean	Armor includes rock material (0 = no rock; 1 = includes rock)
ArmorConcrete	Boolean	Armor includes concrete material (0 = no concrete; 1 = includes concrete)
ArmorWood	Boolean	Armor includes wood material (0 = no wood; 1 = includes wood)
ArmorWoodCreosoted	Boolean	Armor includes creosote-treated wood material (0 = no creosote-treated wood; 1 = includes creosote-treated wood)
ArmorOther	Boolean	Armor includes other material types not otherwise specified (0 = no other material; 1 = includes other material)
ArmorElevation	Text	Relative tidal elevation of armor (U = Above extreme high water (upland); D = Ordinary high water mark to extreme high water (dunegrass area); HW = Mean higher high water to ordinary high water mark; Below_HW = Mean sea level to mean higher high water; SL = Below or at sea level)
ArmorCondition	Text	Armor condition (Ok = no signs of failure; F = Functional but failing; D = Derelict)
ArmorNotes	Text	Additional notes related to armor mapping, material composition, etc.
Armored16	Boolean	Armor was mapped as present in 2016 (0 = no armor mapped in 2016; 1 = armor mapped in 2016)
Armored23	Boolean	Armor was mapped as present in 2023 (0 = no armor mapped in 2023; 1 = armor mapped in 2023)
SegmentType	Text	Associated origin point of armor from field or remote mapping (Start = beginning of mapped armor segment; Change = Change in composition of armor)
CreationDate	Date	Date on which associated armor vertex was mapped
Creator	Text	User account associated with vertex mapping
EditDate	Date	Date on which associated armor vertex was last edited
Editor	Text	User account associated with last vertex edit
Shape_Length	Numerical	Automatically generated field; length of line feature in feet

Table B-3. Geospatial Attribute Table Field Names, Field Types, and Descriptions for the ICAM_BoatRamps Feature Class.		
Field Name	**Data Type**	**Description**
ObjectID	Object ID	Automatically generated field with unique object identifier
MappingMethod	Text	Distinguishes between features mapped using field or remote methods
BoatRamp	Boolean	Presence of boat ramp (0 = no boat ramp; 1 = boat ramp)
RampRock	Boolean	Boat ramp includes rock material (0 = no rock; 1 = includes rock)
RampConcrete	Boolean	Boat ramp includes concrete material (0 = no concrete; 1 = includes concrete)
RampWood	Boolean	Boat ramp includes wood material (0 = no wood; 1 = includes wood)
RampWoodCreosoted	Boolean	Boat ramp includes creosote-treated wood material (0 = no creosote-treated wood; 1 = includes creosote-treated wood)
RampOther	Boolean	Boat ramp includes other material types not otherwise specified (0 = no other material; 1 = includes other material)
RampElevation	Text	Relative tidal elevation of boat ramp (U = Above extreme high water (upland); D = Ordinary high water mark to extreme high water (dunegrass area); HW = Mean higher high water to ordinary high water mark; Below_HW = Mean sea level to mean higher high water; SL = Below or at sea level)
RampCondition	Text	Boat ramp condition (Ok = no signs of failure; F = Functional but failing; D = Derelict)
FeatureNotes	Text	Additional notes related to boat ramp mapping, associated features, etc.
GlobalID	Text	Automatically generated field with Global ID; links boat ramp points to field photographs
CreationDate	Date	Date on which associated boat ramp was mapped
Creator	Text	User account associated with boat ramp mapping
EditDate	Date	Date on which associated boat ramp was last edited
Editor	Text	User account associated with boat ramp edit

Table B-4. Geospatial Attribute Table Field Names, Field Types, and Descriptions for the ICAM_OtherFeatures Feature Class.		
Field Name	**Data Type**	**Description**
ObjectID	Object ID	Automatically generated field with unique object identifier
MappingMethod	Text	Distinguishes between features mapped using field or remote methods
Armored	Boolean	Presence of armor (0 = no armor; 1 = armor)
ArmorRock	Boolean	Armor includes rock material (0 = no rock; 1 = includes rock)
ArmorConcrete	Boolean	Armor includes concrete material (0 = no concrete; 1 = includes concrete)
ArmorWood	Boolean	Armor includes wood material (0 = no wood; 1 = includes wood)
ArmorWoodCreosoted	Boolean	Armor includes creosote-treated wood material (0 = no creosote-treated wood; 1 = includes creosote-treated wood)
ArmorOther	Boolean	Armor includes other material types not otherwise specified (0 = no other material; 1 = includes other material)
FeatureElevation	Text	Relative tidal elevation of armor/associated feature (U = Above extreme high water (upland); D = Ordinary high water mark to extreme high water (dunegrass area); HW = Mean higher high water to ordinary high water mark; Below_HW = Mean sea level to mean higher high water; SL = Below or at sea level)
FeatureCondition	Text	Feature condition (Ok = no signs of failure; F = Functional but failing; D = Derelict)
FeatureNotes	Text	Additional notes related to other feature mapping, material composition, etc.
GlobalID	Text	Automatically generated field with Global ID; links feature points to field photographs
CreationDate	Date	Date on which feature was mapped
Creator	Text	User account associated with feature mapping
EditDate	Date	Date on which associated feature was last edited
Editor	Text	User account associated with feature edit

Table B-5. Geospatial Attribute Table Field Names, Field Types, and Descriptions for the ICAM_ShorelineArmor_2016_2023_Comparable_FullAttributes Feature Class.		
Field Name	**Data Type**	**Description**
ObjectID	Object ID	Automatically generated field with unique object identifier
Armored_23	Boolean	Presence of armor in 2023 mapping (0 = no armor; 1 = armor)
Rock_23	Boolean	Armor includes rock material in 2023 mapping (0 = no rock; 1 = includes rock)
Concrete_23	Boolean	Armor includes concrete material in 2023 mapping (0 = no concrete; 1 = includes concrete)
Wood_23	Boolean	Armor includes wood material in 2023 mapping (0 = no wood; 1 = includes wood)
Wood_Cr_23	Boolean	Armor includes creosote-treated wood material in 2023 mapping (0 = no creosote-treated wood; 1 = includes creosote-treated wood)
Other_23	Boolean	Armor includes other material types not otherwise specified in 2023 mapping (0 = no other material; 1 = includes other material)
Elevation_23	Text	Relative tidal elevation of armor in 2023 mapping (U = Above extreme high water (upland); D = Ordinary high water mark to extreme high water (dunegrass area); HW = Mean higher high water to ordinary high water mark; Below_HW = Mean sea level to mean higher high water; SL = Below or at sea level)
Condition_23	Text	Armor condition in 2023 mapping (Ok = no signs of failure; F = Functional but failing; D = Derelict)
InstallAdjacent_23	Boolean	New armor in 2023 mapping located adjacent to armor that was present in 2016 (0 = new armor not located adjacent to existing armor; 1 = new armor adjacent to existing armor)
Shoretype	Text	Geomorphic shoretype of adjacent shoreline (from CGS 2018).
Armored_16	Boolean	Presence of armor in 2016 mapping (0 = no armor mapped in 2016; 1 = armor mapped in 2016)
Rock_16	Boolean	Armor includes rock material in 2016 mapping (0 = no rock; 1 = includes rock)
Concrete_16	Boolean	Armor includes concrete material in 2016 mapping (0 = no concrete; 1 = includes concrete)
Wood_16	Boolean	Armor includes wood material in 2016 mapping (0 = no wood; 1 = includes wood)
Wood_Cr_16	Boolean	Armor includes creosote-treated wood material in 2016 mapping (0 = no creosote-treated wood; 1 = includes creosote-treated wood)
Other_16	Boolean	Armor includes other material types not otherwise specified in 2016 mapping (0 = no other material; 1 = includes other material)
Elevation_16	Text	Relative tidal elevation of armor in 2016 mapping (U = Above extreme high water (upland); D = Ordinary high water mark to extreme high water (dunegrass area); HW = Mean higher high water to ordinary high water mark; Below_HW = Mean sea level to mean higher high water; SL = Below or at sea level)
Condition_16	Text	Armor condition in 2016 mapping (Ok = no signs of failure; F = Functional but failing; D = Derelict)
ArmorAdd	Boolean	Armor apparently added in 2023 mapping (0 = no change in armor presence between 2016-2023; 1 = armor present in 2023 but not in 2016)

Table B-5. Geospatial Attribute Table Field Names, Field Types, and Descriptions for the ICAM_ShorelineArmor_2016_2023_Comparable_FullAttributes Feature Class.		
Field Name	**Data Type**	**Description**
ArmorLoss	Boolean	Armor apparently lost since 2016 mapping (0 = no change in armor presence between 2016-2023; 1 = armor present in 2016 but not in 2023)
ChgArmorElev	Boolean	Armor elevation different in 2016 and 2023 mapping (0 = no change in armor elevation; 1 = difference in 2016 and 2023 mapped armor elevation)
ChgArmorCond	Boolean	Armor condition different in 2016 and 2023 mapping (0 = no change in armor condition; 1 = difference in 2016 and 2023 mapped armor condition)
ChgArmorElev2plus	Boolean	Armor elevation changed by two or more classes (0 = armor elevation unchanged or changed by one elevation class between 2016 and 2023 mapping; 1 = armor elevation changed by two or more elevation classes between events)
ChgArmorCond_Improve	Boolean	Armor condition changed from poorer to better condition between mapping events (0 = armor condition did not improve between 2016 and 2023; 1 = armor condition changed from D to F, D to Ok, or F to OK between events)
Shape_Length	Numerical	Automatically generated field; length of line feature in feet