
memorandum

Date: June 28, 2020
To: Aimee Kinney, Puget Sound Institute
Cc: Mike Fisher, Northern Economics
From: Lauren Øde-Giles, Avery Maverick
Re: Shore Friendly Revolving Loan Program – Market Estimates

Background

The objective of this task is to quantify the potential market size of a potential Shore Friendly Revolving Loan Program. In a future study by project partners, the market size will be used to model the potential funding program, from which the required amount of seed money will be determined to implement the program. The ways in which the potential market size was estimated, and the total number of parcels and shoreline lengths associated with those estimates are summarized below.

In 2014, CGS developed a shoreline parcel geodatabase for the Washington State Department of Fish and Wildlife (WDFW) as part of the Shore Friendly social marketing program (Colehour + Cohen et al., 2014) and updated this database in 2020 using best-available data sources (Coastal Geologic Services, 2020). Each parcel was assigned to a different segment population based on the shoreline conditions found within the subject property and the appropriate outreach messages for those conditions. The nine different segments were assigned in GIS based on the following input datasets and shoreline conditions (Table 1; Figure 1). Detailed descriptions of data sources and methods used to develop the 2014 and 2020 shore parcel segmentation values are described in the associated project reports: *Social Marketing Approach and Campaign Implementation Tools for the Reduction of Puget Sound Shoreline Armor* (2014); and *Updated Shore Friendly Parcel Segmentation* (2020).

Table 1. Shoreline attributes, values, and sources used to develop the 2014 and 2020 shoreline parcel segmentation databases (Colehour + Cohen et al., 2014; Coastal Geologic Services, 2020).

Shoreline Attribute	Values	Notes	Source
Armor Presence	Yes / No	Armor presence indicated where armor length > 20 FT	MacLennan et al., 2013
Structure on Property	Yes / No	Land use code interpretations; Algorithmically generated building polygons	County assessors (Multiple); Microsoft (2018)
Erosion Potential	None Low Medium High	Based on parcel-scale wave energy categories and shoretypes	MacLennan et al., 2013 Simenstad et al., 2011 WDNR, 2001

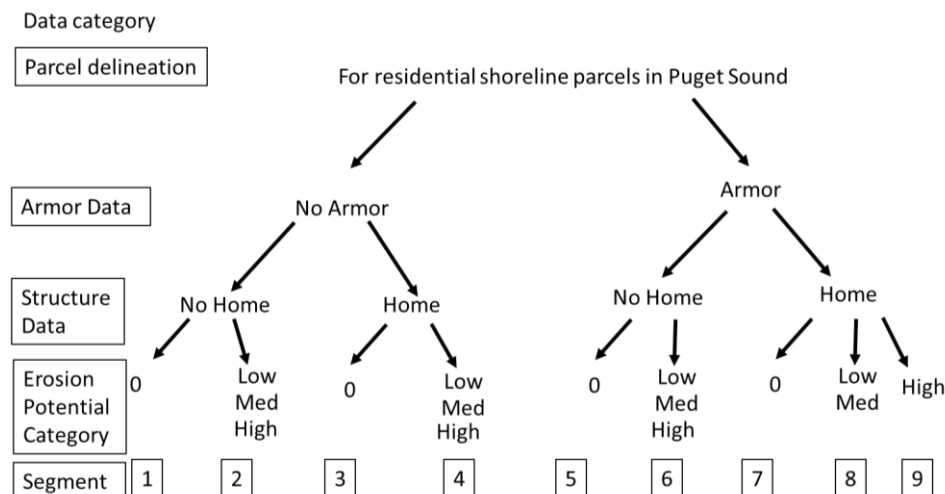


Figure 1. 2014 Shore Friendly parcel segmentation framework and associated datasets.

The property characteristics used to assign these segments (armor presence, structure presence, erosion potential (EP)) and additional characterization of parcel elevation (low, high) were used as the basis for identifying and quantifying the potential market for the Shore Friendly Revolving Loan Fund.

Methods

Methods applied to estimate the number of Puget Sound residential properties potentially eligible for the proposed program (i.e., potential demand) are briefly described in this section. Characteristics of residential, coastal properties including structure (homes) and shore armor presence/absence, shoretype, and estimated fetch were sourced from the Shore Friendly (2020) parcel segmentation update. Additional parcel characteristics (low elevation, bluff) were selected based on shoretype attributes present in the *Beach Strategies for Puget Sound Restoration* geodatabase (CGS, 2017).

A series of queries were applied to assign different scenarios and associated Shore Friendly management recommendations to parcels based on parcel characteristics using data from the Shore Friendly parcel segmentation updates (Coastal Geologic Services, 2020; Table 2). Queries were based on the presence/absence of a structure (home), presence/absence of shore armor, wave energy (none, low, medium, high), and shoretype (bluffs or low elevation). Wave energy and geomorphic shoretype were used to characterize the erosion potential (EP) of a given parcel, which can inform the types of shore protection that may be appropriate for a given site (Johannessen et al., 2014). Where a coastal parcel encompassed more than one shoretype, the shoretype associated with the highest erosion potential was used to assign the overall erosion potential categories assigned to a given parcel (Colehour + Cohen et al., 2014; Coastal Geologic Services, 2020).

Scenarios were based on a subset of the nine Shore Friendly parcel segments outlined in Figure 1, with additional restrictions based on parcel elevation and bluff presence/absence. Parcels that did not contain a house (Shore Friendly segments 1, 2, 5, 6) were excluded, as it was understood that homeowners at these properties would be less likely to pursue Shore Friendly actions and grants (Colehour + Cohen et al., 2014). The ten scenarios were defined in order to identify the types of Shore Friendly management actions that could potentially be recommended for each parcel.

Table 2. Matrix of queries used to assign parcels to scenarios 1-10, and potential management actions associated with each scenario. Shore Friendly segments used as the basis for each scenario and query method are included, and are denoted with a subset identifier (b = parcels contain a bluff; e = parcels exclude bluffs and/or low elevation shores; f = parcels may be at risk of flooding (contain low elevation shore)).

Scenario	SF Segment	Query Method	Cumulative Length (FT)	Number of Parcels	Recommended Actions			
					Armor Removal	Soft Shore Protection	Relocate home	Elevate home
1	3f	Low elevation shores in SF segment 3	361,985	1,787				X
2*	4b	Bluff shoreforms in SF segment 4*	954,756	5,965		X	X	
3	4e	SF segment 4, excluding bluff and low elevation shores	1,041,098	4,924		X		
4*	4f	Low elevation shores in SF segment 4*	680,230	3,959		X		X
5	7f	Low elevation shores in SF Segment 7	151,552	1,044	X			X
6	7e	SF segment 7, excluding low elevation shores	14,013	84	X			
7*	8b	Bluff shoreforms and medium EP sites in SF segment 8*	503,652	4,324	X	X	X	
8	8e	SF segment 8, excluding bluffs, low elevation shores, and medium EP sites	144,225	771	X	X		
9*	8f	Low elevation shores in SF segment 8 *	595,758	4,420	X	X		X
10	9b	Bluff shoreforms in SF segment 9	109,323	675	X		X	

* Where site classified as both containing a bluff and low-elevation shoreform, predominant shoretypes used to avoid assigning parcels to more than one scenario.

Each parcel could potentially be assigned to one or more scenarios, resulting in multiple possible recommended actions. Parcels could also be assigned to no actions. Potential management actions include:

- ◆ Armor (Bulkhead) Removal
- ◆ Soft Shore Protection
- ◆ Structure Relocation
- ◆ Structure Elevation

Armor removal was deemed appropriate for any parcel that contained armor (scenarios 5-10). The conditions found within a shoreline parcel that make the use of soft shore protection feasible are outlined in the *Marine Shorelines Design Guidelines* (Johannessen et al., 2014). Parcels with low to moderate erosion potential that did not contain bluff shoretypes were identified as appropriate for soft

shore protection (scenarios 2-4, 7-9). Soft shore protection is generally only feasible at bluff parcels if they are subject to low wave energy (Johannessen et al., 2014). Structure relocation is feasible at parcels that are not exclusively low-elevation shores (scenarios 2, 7, 10), and structure elevation is feasible on low elevation parcels (scenarios 1, 4, 5, 9).

Although many parcels share common shore characteristics, each parcel was associated with only one scenario. For example, while scenarios 5 and 6 both apply to parcels with armor and a house (Shore Friendly segment 7), scenario 5 selects for explicitly low-elevation parcels while scenario 6 excludes low-elevation parcels. In this way, the recommended actions for a low-elevation parcel with armor and a house would be sourced from scenario 5 (armor removal, elevate home), but not from scenario 6 (armor removal only; Table 2).

Multiple parcels were identified as containing both a bluff shoretype (FB, FBE, FB-T) and a low elevation shoretype (AS, NAD-LE, NAD-D) along their length. In order to avoid including these parcels under more than one scenario (ex: scenarios 2 and 4), the predominant shoretype by length belonging to either of these categories (bluff or low elevation) was used to assign potentially-conflicting parcels to only one scenario. Such potential conflicts were resolved on 472 parcels

Results

Sound-wide Overview

The potential market size for the proposed loan program includes a total of 27,953 residential shoreline parcels which account for 4.6 million FT or 863 miles of shoreline (Table 2). Among parcels where Shore Friendly actions were deemed feasible, armor removal was recommended for 40% of parcels, soft shore protection was recommended for 87%, structure relocation was recommended for 39%, and structure elevation was recommended for 40%. Results are discussed briefly in this section.

There are 44,988 shoreline residential parcels along the shores of Puget Sound identified in the Shore Friendly parcel database (Coastal Geologic Services, 2020). Parcels vary in length from tens of feet to over 6 miles in length, with an average length of 163 FT and a standard deviation of 340 FT. Each parcel consists of one or more geomorphic shoretypes, with most parcels containing more than one shoretype. Feeder bluffs (FB, FBE, FB-T) were the dominant shoretype on 37% of parcels (16,733 parcels). Low elevation shoretypes (AS, NAD-LE, NAD-D) were the dominant shoretype across 27% of parcels (12,154 parcels). Both dominant and non-dominant shoretypes were used to establish whether a parcel contained a bluff or low-elevation shoretype.

Due to the complex, crenulated nature of Puget Sound shorelines, fetch or wave exposure is highly variable. Most parcels (53%) in Puget Sound have moderate (maximum fetch greater than 5 miles but less than 15 miles) to low wave energy (maximum fetch less than or equal to 5 miles) and the region is generally considered to be a fetch-limited environment (Finlayson, 2006). Additionally, most parcels are described as having a medium erosion potential (67%), with 27% of parcels described as having no to low erosion potential, and 6% of parcels described as having high erosion potential.

The risk of coastal flooding is most likely to be observed on low lying shores that have evolved as the result of long-term depositional processes, referred to as accretion shoreforms. However, it is important to note that many accretion shoreforms are no longer accreting, and some are erosional overall.

Accretion shoreform parcels are potential sites for structure elevation, relocation, or soft shore protection.

Accretion shoreforms are popular locations for shoreline development and there are 7,838 parcels in which accretion shoreforms are the dominant shoretype. An additional 9,084 parcels have a portion of accretion shoreform within them. Other low elevation shores potentially vulnerable to flooding include shores found within large scale river deltas, and inner lagoon and small estuarine shores. These shores typically have less wave energy but are still vulnerable to high water events and particularly sea level rise. When including these shoretypes in addition to accretion shoreforms that are vulnerable to coastal flooding (found within inner lagoon and estuarine embayment shores) there are 13,281 parcels vulnerable to coastal flooding.

Potential Armor Removal Parcels

The number of parcels potentially eligible for armor removal is 11,318 or approximately 40% of parcels included in the potential market (Table 3). The cumulative shoreline length of these residential projects totals just over 1.5 million FT (285 miles; Table 4). These projects are associated with scenarios 1-6 in Table 3 and include parcels that are armored, have an upland structure, and are subject to low to high wave energy (Table 2). Both Island and Kitsap Counties had over 2,000 parcels potentially eligible for armor removal (37% of potential armor removal parcels contained in these two counties; Table 3), with parcels in Kitsap County representing 66,700 FT (12.6 miles) more cumulative shore length than Island County (Table 4). Over 1,200 potential armor removal parcels were identified in both King and Pierce Counties (Table 3). Clallam County has the fewest number of parcels potentially eligible for armor removal with 141 parcels at a cumulative length of 23,097 FT (4.3 miles; Tables 3, 4; Figures A1-A4).

Table 3. Matrix of residential shoreline parcels in each county and the number of parcels that are potentially eligible for each recommended Shore Friendly action.

County	Number of Parcels in Potential Market	Armor Removal	Soft Shore Protection	Relocate Home	Elevate Home
Clallam	764	141	685	311	340
Island	4,737	2,187	4,565	2,112	2,210
Jefferson	2,167	536	1,861	1,039	731
King	1,810	1,382	1,685	1,367	370
Kitsap	4,251	2,053	3,335	1,670	2,027
Mason	2,539	903	2,218	691	1,346
Pierce	2,566	1,290	2,003	1,210	1,102
San Juan	3,402	535	3,166	458	690
Skagit	1,646	644	1,466	535	544
Snohomish	1,107	781	925	671	426
Thurston	1,161	373	854	497	507
Whatcom	1,803	493	1,600	403	917
Total	27,953	11,318	24,363	10,964	11,210

Table 4. Summary of the length of shoreline associated with potentially eligible parcels for each recommended Shore Friendly action across Puget Sound counties.

County	Length of shoreline in potential market (FT)	Armor Removal	Soft Shore Protection	Relocate Home	Elevate Home
Clallam	160,313	23,097	136,541	65,962	69,301
Island	538,246	205,644	508,711	276,894	214,613
Jefferson	390,123	82,987	334,726	194,441	136,638
King	185,011	130,161	168,108	132,411	42,058
Kitsap	574,505	272,354	442,189	212,715	301,708
Mason	404,344	128,257	342,684	103,823	236,482
Pierce	393,361	187,039	304,168	178,027	188,082
San Juan	1,038,092	195,337	989,214	111,960	204,620
Skagit	276,899	82,942	244,381	84,957	95,707
Snohomish	142,377	77,870	123,029	67,204	74,796
Thurston	218,849	65,776	141,732	71,933	126,479
Whatcom	220,459	53,047	184,237	53,391	99,043
Total	4,542,580	1,504,511	3,919,720	1,553,719	1,789,525

Potential Soft Shore Protection Parcels

Parcels that are potentially eligible for soft shore protection comprise approximately 87% (24,363) of Puget Sound residential parcels and are associated with scenarios 2-4 and 7-9 (Table 2, Table 4). Cumulatively, residential properties where soft shore protection may be appropriate account for approximately 3.9 million FT (742 miles) of Puget Sound shoreline. There are 9,515 parcels where both soft shore protection and armor removal would be appropriate (Scenarios 7 – 9; Table 6). These parcels have a cumulative shore length of 1.2 million FT (236 miles), of which 870,000 FT (165 miles) is armored.

Table 5. Summary of the number of Shore Friendly management actions that can be associated with Puget Sound residential parcels. Parcels with no recommended Shore Friendly actions could not be classified under any scenarios, and as such are not included in the potential market for the Shore Friendly Revolving Loan Program.

Number of Recommended Shore Friendly Actions	Total No. Parcels	Armor Removal	Soft Shore Protection	Relocate Home	Elevate Home
0	17,035	--	--	--	--
1	6,795	84	4924	--	1,787
2	12,414	2,490	10,695	6,640	5,003
3	8,744	8,744	8,744	4,324	4,420
Total	44,988	11,318	24,363	10,964	11,210

Over 4,500 parcels potentially eligible for soft shore protection were identified in Island County (Table 3), accounting for approximately 509,000 FT (96.4 miles) of shoreline (Table 4). However, parcels in San Juan County represented the greatest shoreline length of potential soft shore protection sites (989,000

FT; 187 miles; Table 4). The three counties with the greatest number of potential soft shore protection parcels (Island, Kitsap, San Juan) accounted for approximately 45% of all potential soft shore protection sites (Table 3). Clallam, Snohomish, and Thurston counties contained the fewest parcels eligible for potential soft shore protection and represented the least cumulative shoreline length for soft shore protection (Tables 3, 4).

Table 6. Co-occurrence of different recommended Shore Friendly management actions across all Puget Sound residential parcels. Cells indicate the number of parcels for which a given combination of management actions could be appropriate based on assigned scenarios (i.e.: there are 9,515 parcels for which armor removal and/or soft shore protection could be an appropriate management action). Bold cells indicate the total number of parcels on which a given management action could be appropriate (i.e.: there are 24,363 parcels where soft shore protection (alone or in combination with other management actions) could be appropriate).

Shore Friendly Action	Armor Removal	Soft Shore Protection	Relocate Home	Elevate Home
Armor Removal	11,318	9,515	4,999	5,464
Soft Shore Protection	9,515	24,363	10,289	8,379
Relocate Home	4,999	10,289	10,964	--
Elevate Home	5,464	8,379	--	11,210

Potential Structure Relocation and Elevation Parcels

A total of 10,964 or approximately 39% of residential shoreline parcels were identified as potential opportunities for structure relocation (Table 3). Potentially eligible parcels for structure relocation accounted for 1.5 million FT (294 miles) of Puget Sound shoreline (Table 4). It should be noted that in instances where structure relocation is recommended as a management action, structure elevation could be implemented simultaneously as appropriate. As such, while no scenarios explicitly list both home relocation and elevation as recommended Shore Friendly actions, both may be appropriate under certain site conditions. Additional costs associated with implementing structure elevation in conjunction with structure relocation are considered to be minor.

A total of 11,210 parcels (approximately 40%) of Puget Sound parcels were identified as feasible for structure elevation (Table 3), accounting for approximately 1.8 million FT (339 miles) of Puget Sound shore. Structure elevation is only recommended on low elevation sites (Scenarios 1, 4, 6, 9; Table 2). However, as mentioned above, individual site characteristics may allow for home relocation in addition to elevation. Kitsap County has the most parcels eligible for structure relocation with 6,063 parcels. Island and Kitsap Counties each have approximately 2,000 parcels potentially eligible for structure elevation (Table 3).

Management Actions per Parcel

As noted previously, each residential parcel could have one, multiple, or zero Shore Friendly management recommendations applied to it depending on which scenarios applied to that parcel. Table 5 summarizes the number of management recommendations applicable to each parcel. A total of

17,035 parcels (38% of all Puget Sound residential parcels; Table 5) were not assigned to any scenarios, and as such, those parcels did not have any associated Shore Friendly actions and are not included in the potential market for the Shore Friendly Revolving Loan Program. This may include parcels that have no home on the property to protect, or parcels where high EP and/or wave exposure would reduce the effectiveness of Shore Friendly actions, as examples.

Nearly one-fourth of parcels included in the potential Shore Friendly loan market had only one recommended Shore Friendly management action (6,795; Table 5). Among parcels with only one recommended action, soft shore protection was the most common (4,924 parcels; 18% of parcels in the potential market). Parcels associated with two or more management recommendations accounted for more than three-quarters (76%) of parcels in the potential market (Table 5).

Discussion

Within the Puget Sound region, there is evidence of increased interest in implementing Shore Friendly techniques for protecting nearshore assets in lieu of conventional hard armor-based approaches. According to shoreline armor permit data from the WDFW Hydraulic Project Approval (HPA) permitting system, the annual net change in the length of shore armor (new armor – removed armor) has decreased in recent years (“PS Info | Net change in permitted shoreline armor”). From 2005 to 2015 the average net addition of shore armor was approximately 1 mile per year. This rate was approximately 0.5 miles per year between 2016 to 2018.

Across all residential parcels in the potential market, only 7% (2,052 parcels of 27,953) were classified as having a high erosion potential. As such, implementation of Shore Friendly techniques is considered a viable option for a majority of parcels in the potential market. While the widespread presence of bluffs (dominant shoretype on 37% of all database parcels) in Puget Sound does preclude the use of soft shore techniques in places, other techniques such as structure relocation can be recommended in regions exposed to moderate and high wave energy.

Island and Kitsap counties contained the greatest number of parcels within the potential loan program market (4,737 and 4,251, respectively), followed by San Juan, Pierce, Mason, and Jefferson counties (all contained more than 2,100 potential parcels; Table 3). Despite having fewer eligible parcels than Island or Kitsap counties, San Juan County contained the greatest cumulative length of shoreline (1.0 million FT; 196 miles) for which Shore Friendly recommendations could be applied (Table 4).

Potential Shore Friendly management actions have been recommended across all Puget Sound residential parcels, with some parcels being assigned to multiple scenarios and associated management actions. For sites where a Shore Friendly loan is enacted, it is possible that only one Shore Friendly action (i.e.: armor removal) is undertaken, or that multiple Shore Friendly actions are pursued (i.e.: armor removal with soft shore protection). As mentioned previously, approximately one quarter of parcels in the potential market were assigned only one recommended action, while two or more recommended actions were applied to the remaining parcels (Table 5). In some instances, multiple Shore Friendly actions (i.e.: armor removal with soft shore protection and home relocation) may be necessary to restore nearshore processes and protect property infrastructure. In other instances, there may be several appropriate actions that could be implemented, but the nature of the property may require that only a selection of these actions be applied. The number and combination of Shore Friendly

actions that should be implemented on a property-by-property basis should be determined in site-specific investigations by coastal professionals.

ATTACHMENTS:

Map Folio – Figures A1 – A4

Figure A1. Residential shoreline parcels eligible for armor removal.

Figure A2. Residential shoreline parcels eligible for soft shore protection.

Figure A3. Residential shoreline parcels eligible for structure relocation.

Figure A4. Residential shoreline parcels eligible for structure elevation.

References

- Coastal Geologic Services, 2017. Beach Strategies GIS User's Guide (Prepared as part of the Beach Strategies Project No. 14–2308, Appendix A). Bellingham, WA.
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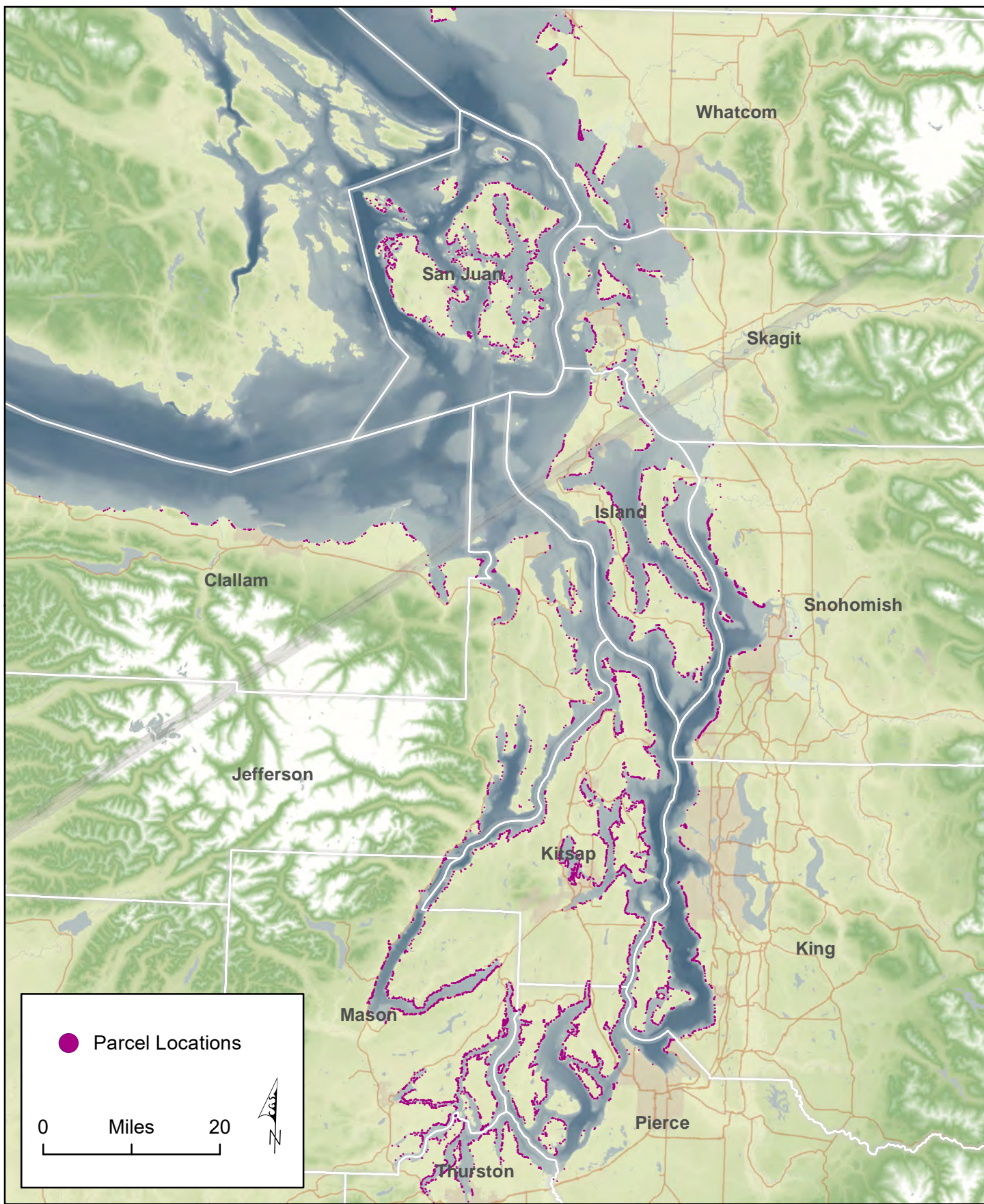


Figure A1. Residential shoreline parcels eligible for armor removal.

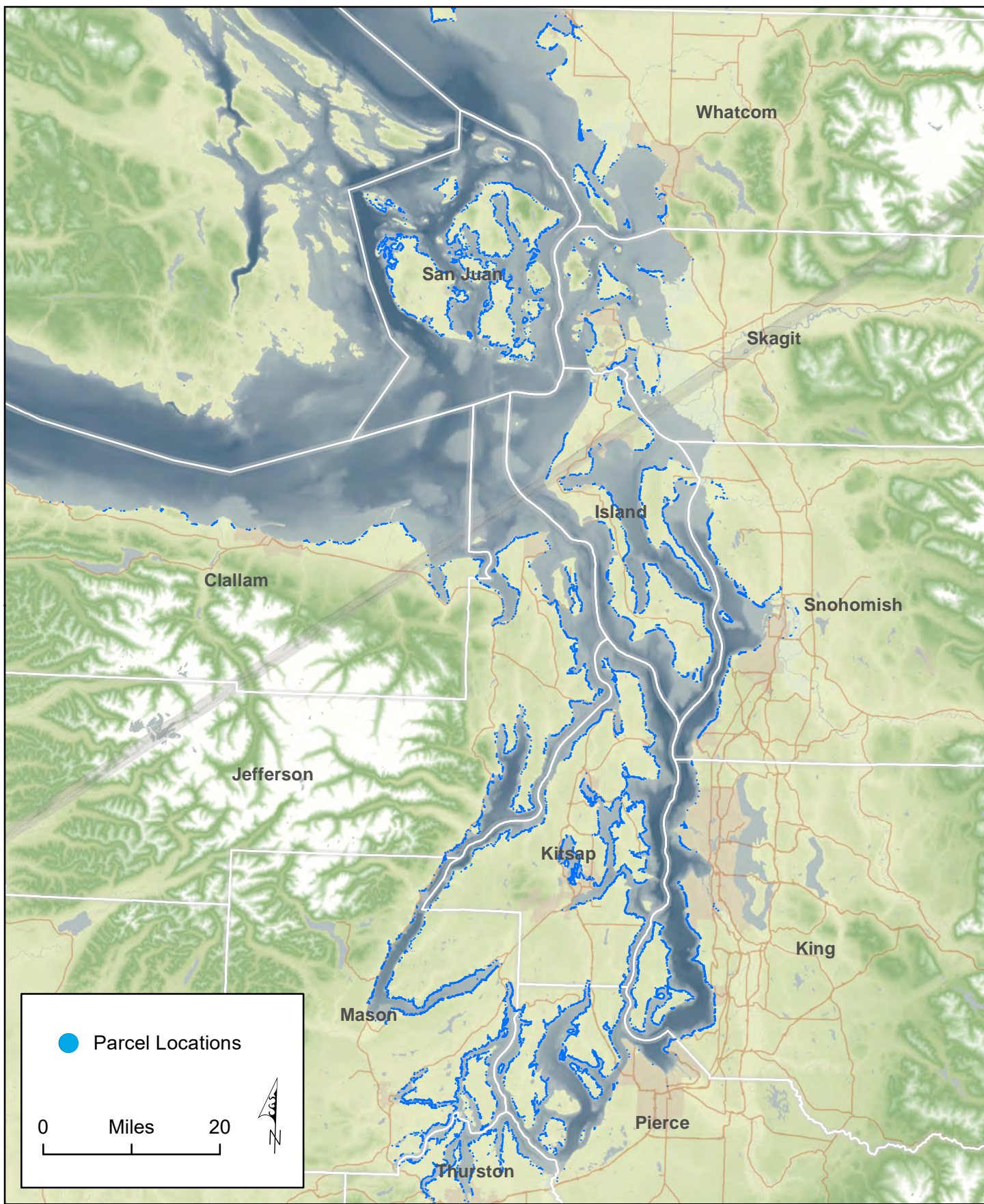


Figure A2. Residential shoreline parcels eligible for soft shore protection.

Residential Shoreline Loan Program Feasibility Study - Market Estimates



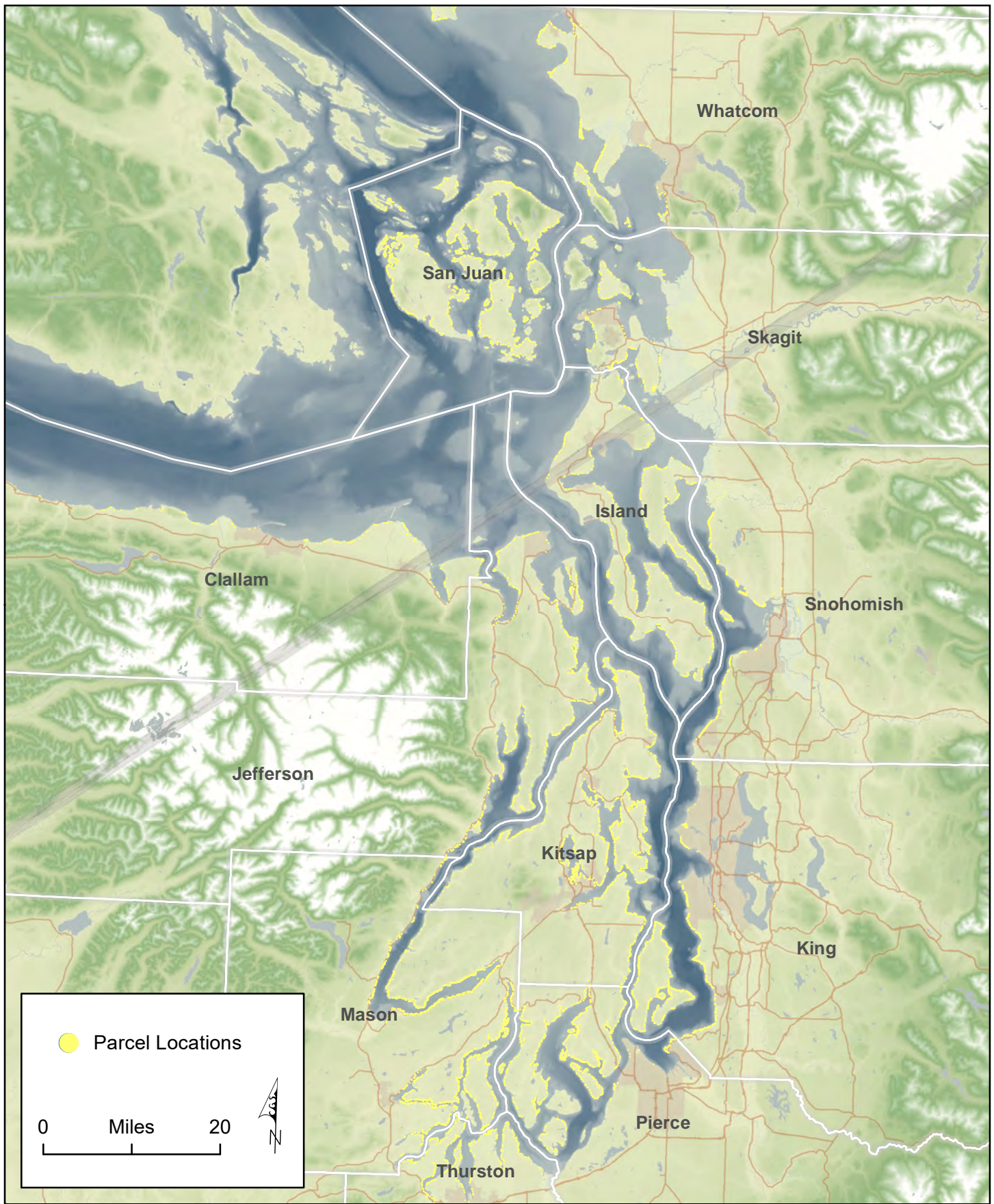


Figure A3. Residential shoreline parcels eligible for structure relocation.

Residential Shoreline Loan Program Feasibility Study - Market Estimates

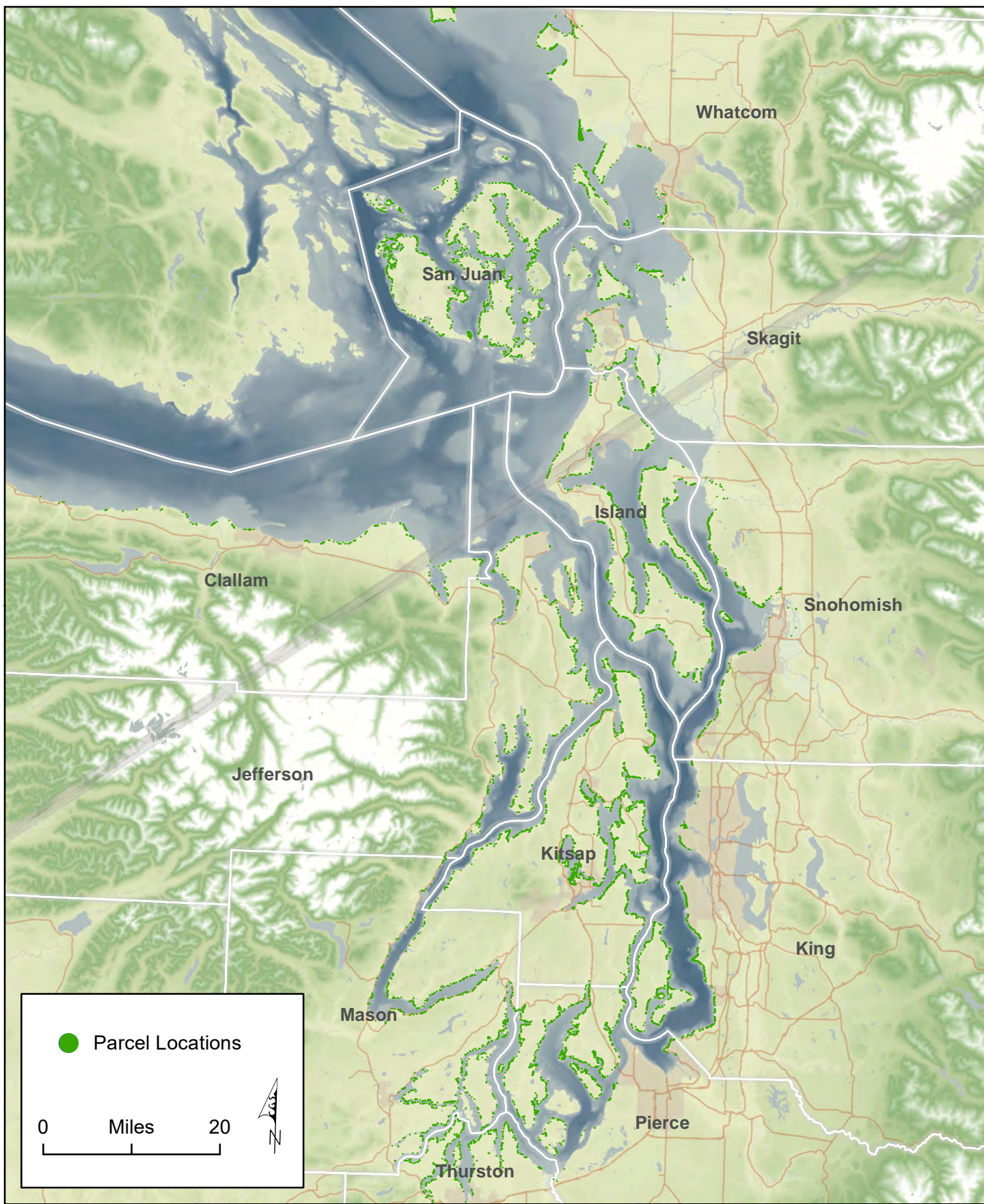


Figure A4. Residential shoreline parcels eligible for structure elevation.