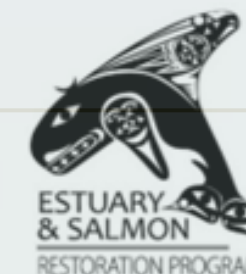

MAPPING MARINE RIPARIAN CONDITIONS IN PUGET SOUND

Kai Ross, Elene Trujillo, Jason Hall
Cramer Fish Sciences

ESRP Learning Project 20-1941P Webinar
July 22, 2025



WASHINGTON STATE
Recreation and
Conservation Office



Integrated regional spatial data tools to inform management

- Mapping marine riparian habitat
 - PRISM#20-1941 [Today](#)
- Mapping tidal restriction and wetland features
 - PRISM#20-1941 [Thursday's webinar](#)
- Automated tools to calculate landscape connectivity
 - PRISM#22-1764 [Wrapping up](#)



Presentation Outline



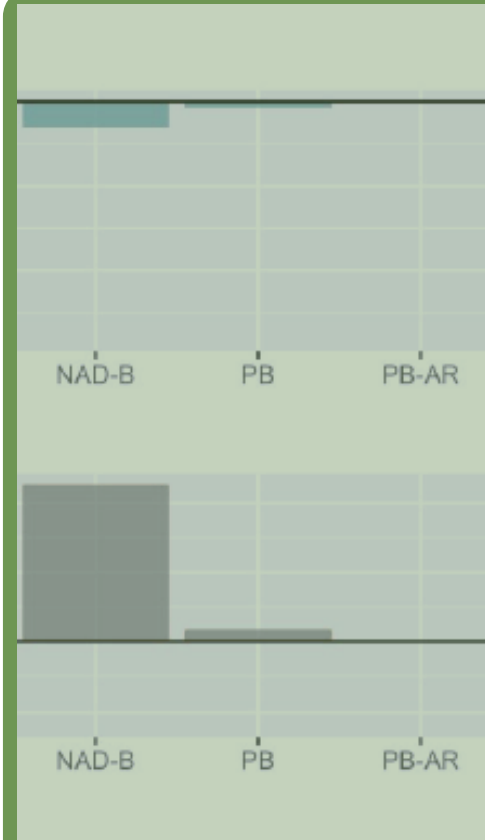
MARINE RIPARIAN MAPPING



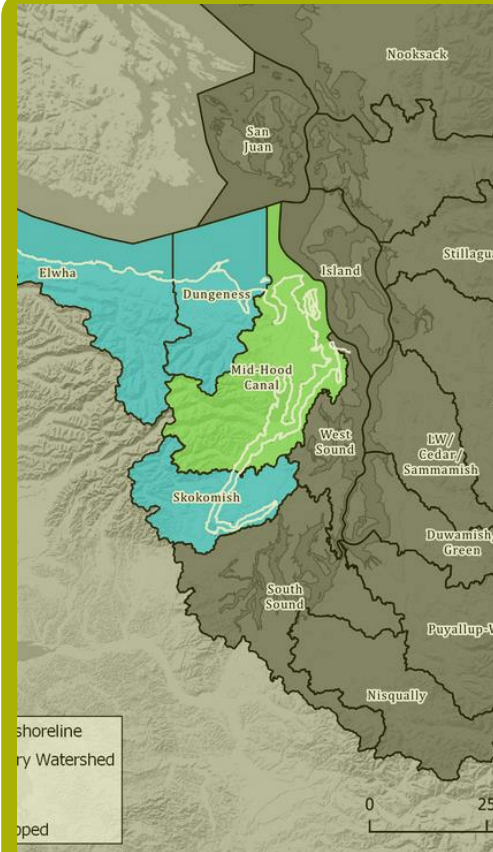
Background



Approach



Results



Conclusions

Thank you!

Project funded by WDFW-ESRP and RCO
•ESRP Learning Project, [PRISM #20-1941P](#)

Our Technical Advisory Group:

- J. Toft, D. Spilsbury, T. Zackey, J. Greenberg, K. Pierce, J. Chamberlin, C. Greene

Our Project Partners:

- Tim Beechie, NWFSC retired
- Oleksandr Stefankiv, WA Ecology
- Tish Conway-Cranos (WDFW, ESRP)
- Jennifer Burke (PSP)

Regional reviewers



Photo: Whidbey Camano Land Trust

marine riparian mapping



Background





Marine Riparian Habitat

Habitat Structure

Connects terrestrial and aquatic systems
Erosion control
Stability of upper beach

Social and Ecological Functions

Fish and wildlife habitat
Temperature control
Solar radiation protection
Wood and organic material inputs

Natural Buffer

Sediment control
Nutrient control
Pollution filter for run off
Maintains water quality



Marine Riparian Habitat

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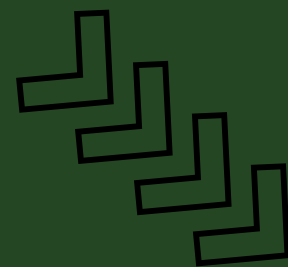
Sediment control
Nutrient control
Pollution filter for run off
Maintains water quality

Many ecological functions + effective pollution control
within 0-200 ft from shore



Habitat fragmentation

Shoreline development
results in loss and
disconnection of marine
riparian forests



Photos: King County



Reduced Function

Reduced nearshore habitat
function and quality

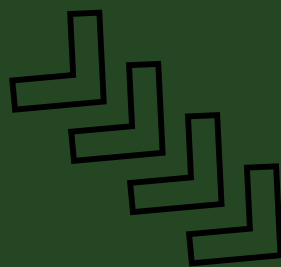
Decreased function of
nearshore habitat across
shoreforms

Structural changes and response



Habitat fragmentation

Shoreline development
results in loss and
disconnection of marine
riparian forests



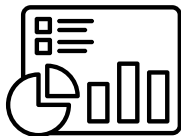
Photos: King County



Reduced Function

Reduced nearshore habitat
function and quality

Decreased function of
nearshore habitat across
shoreforms



Lack of Data

Piecemeal S&T
Lack of restoration prioritization
Inability to track progress
Poor recovery targets

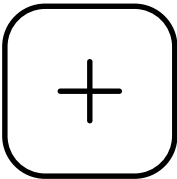




Photo: Washington Association of Land Trust

Leverages Data

Builds on existing protocols

Integrates regional datasets + expertise

Collaboration

CFS developed in collaboration with NOAA, PSP, and PSEMP

Mapping Marine Riparian Habitat



Supports regional reporting and restoration planning



PUGET SOUND ECOSYSTEM MONITORING PROGRAM

Today's webinar: Tools, rather than reporting



Comparing



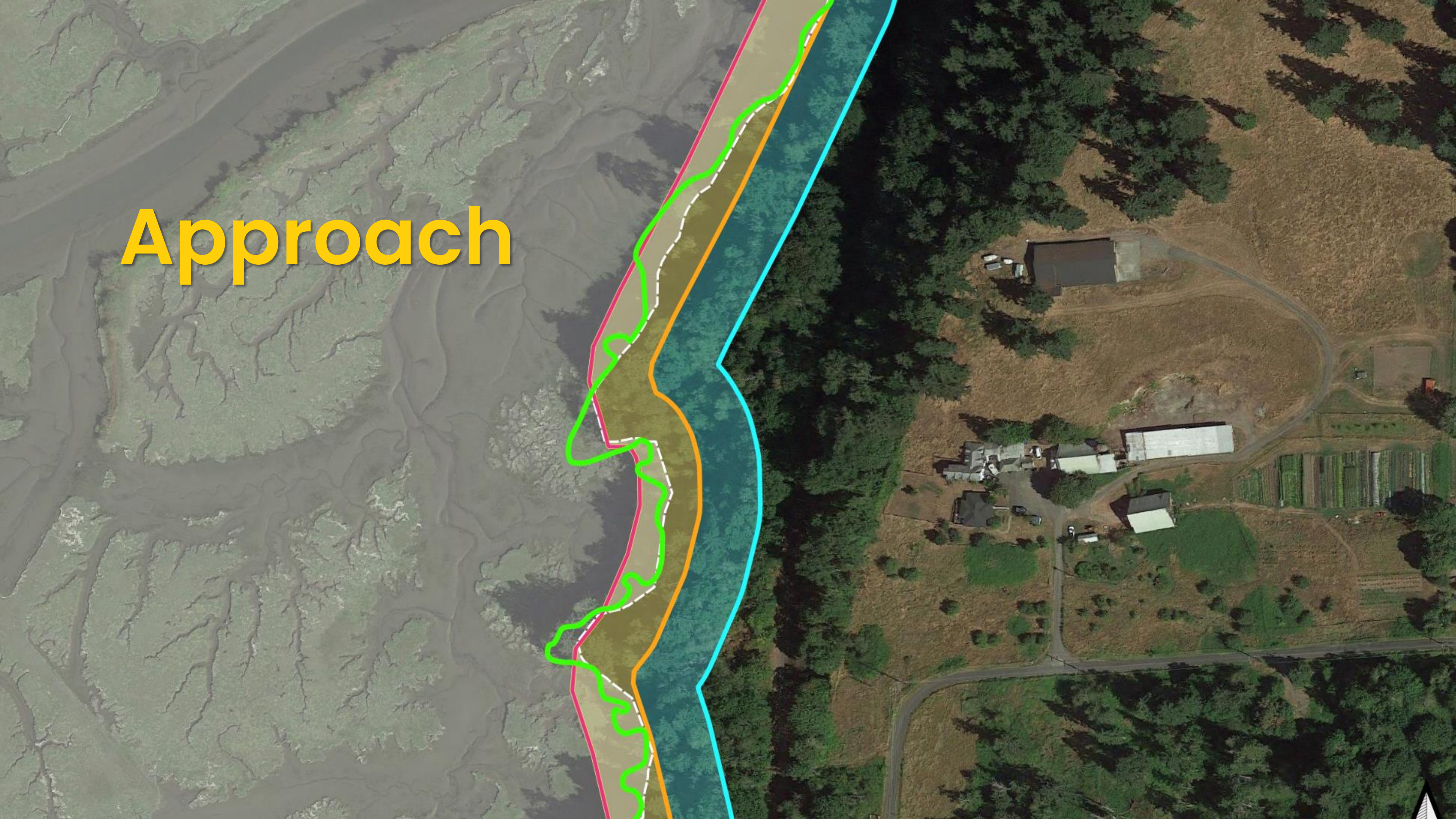
+ / -



Application



Approach



Previous (yet separate) protocols

Two measures of marine riparian forest cover:

Percent Forested Cover

Hall et al. 2019:

Based on Beach Strategies NGF
(CGS 2017) and HRLC (Pierce 2015,19)

No info on riparian processes
Shoreline alignment issues

Contiguous Forest Cover

NOAA 2024:

Based on SHSTMP pilot study and
PSEMP Nearshore WG workshop

Pilot 2017
Addresses alignment issues



Implement two methods:

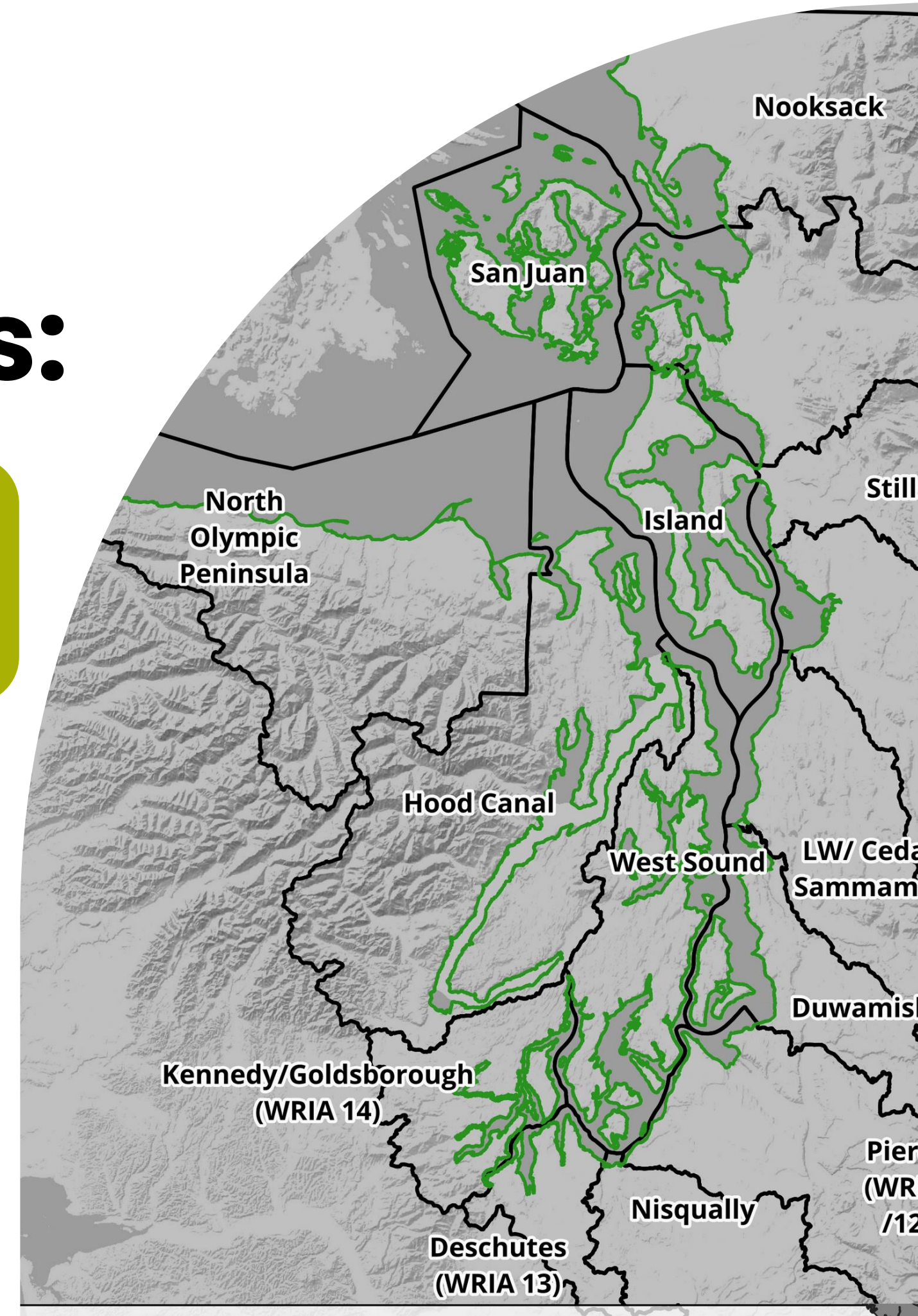
**WIDTH OF
CONTIGUOUS COVER**

2009, 2017

**PERCENT
FORESTED COVER**

2013, 2017

- Entire Puget Sound shoreline
- Two data years
- Updated shoreline at OHWM (NOAA)
- Compared mapping methods
- Habitat status and trend reporting



Width of Contiguous Forested Cover

30 ft

60 ft

100 ft

150 ft

200 ft

0 100 200 ft

Contiguous Forest Approach



**Measured from
OHWM shoreline
landward**

**Ended at break of
>10 feet**



**Segment / attribute
by
Beach Strategies
Shoreform**

- Time points: 2009 and 2017
- Corrected shoreline and segment by forest width class
- Oblique shoreline imagery
- 1-m LiDAR DTM hillshade and normalized digital surface model
- Real color and CIR NAIP imagery
- Polyline dataset

WIDTH OF CONTIGUOUS COVER

2009, 2017

- Estimates width of contiguous forest starting from shoreline
- Identifies breaks in forest cover
- Separated into width classes:
 - No forest
 - <30,
 - 30-60
 - 60-100
 - 100-150
 - 150-200
 - 200+
- Records cause of break
- May indicate loss of function due to development or fragmentation



MARINE RIPARIAN MAPPING



CONTIGUOUS FORESTED WIDTH

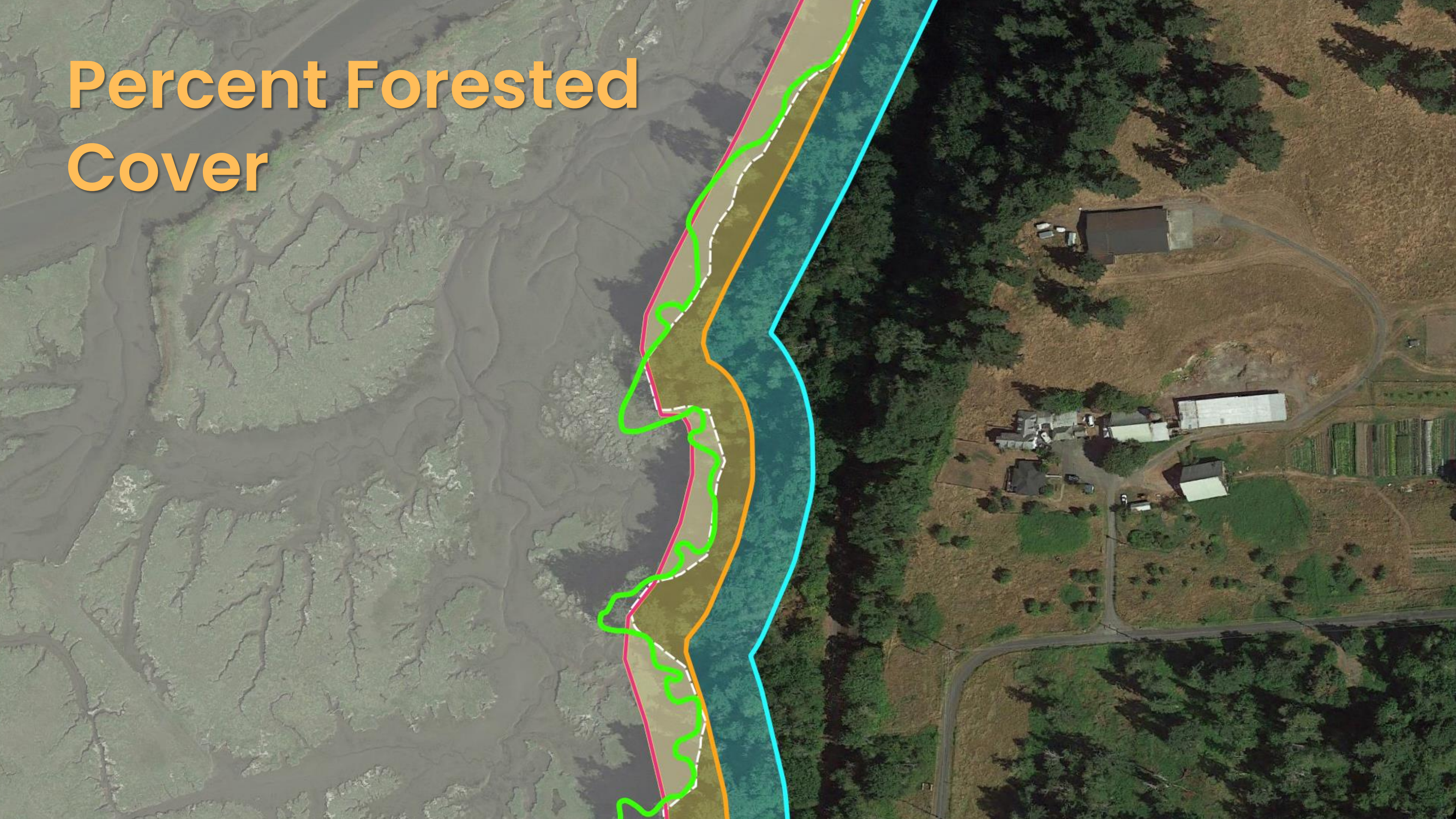


Width Class



- Proportion of current shoreline that is vegetated by shoreform
- Highlight causes of discontinuity
- Proportions by width class to explore fragmentation

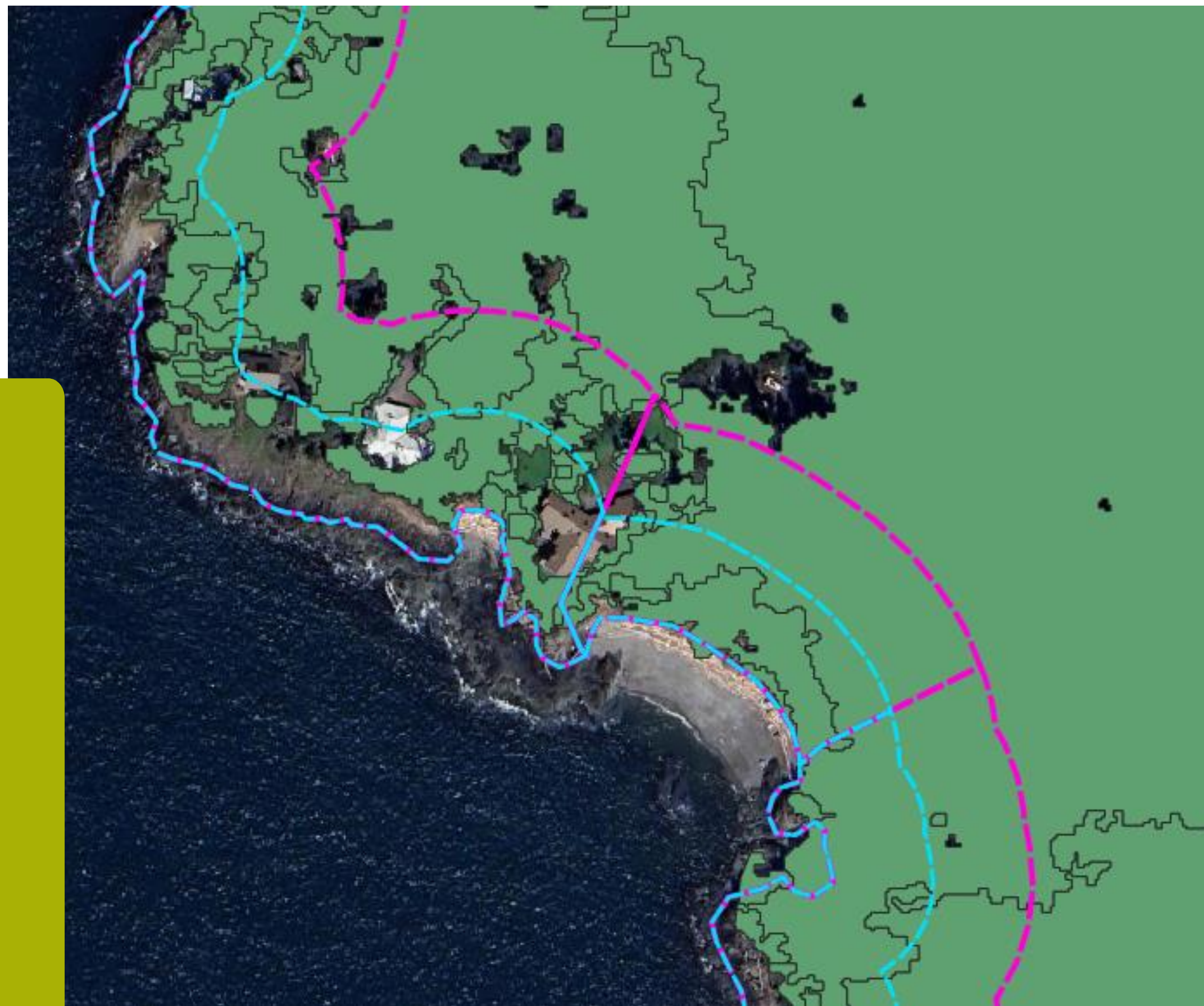
Percent Forested Cover



PERCENT FORESTED COVER

2013, 2017

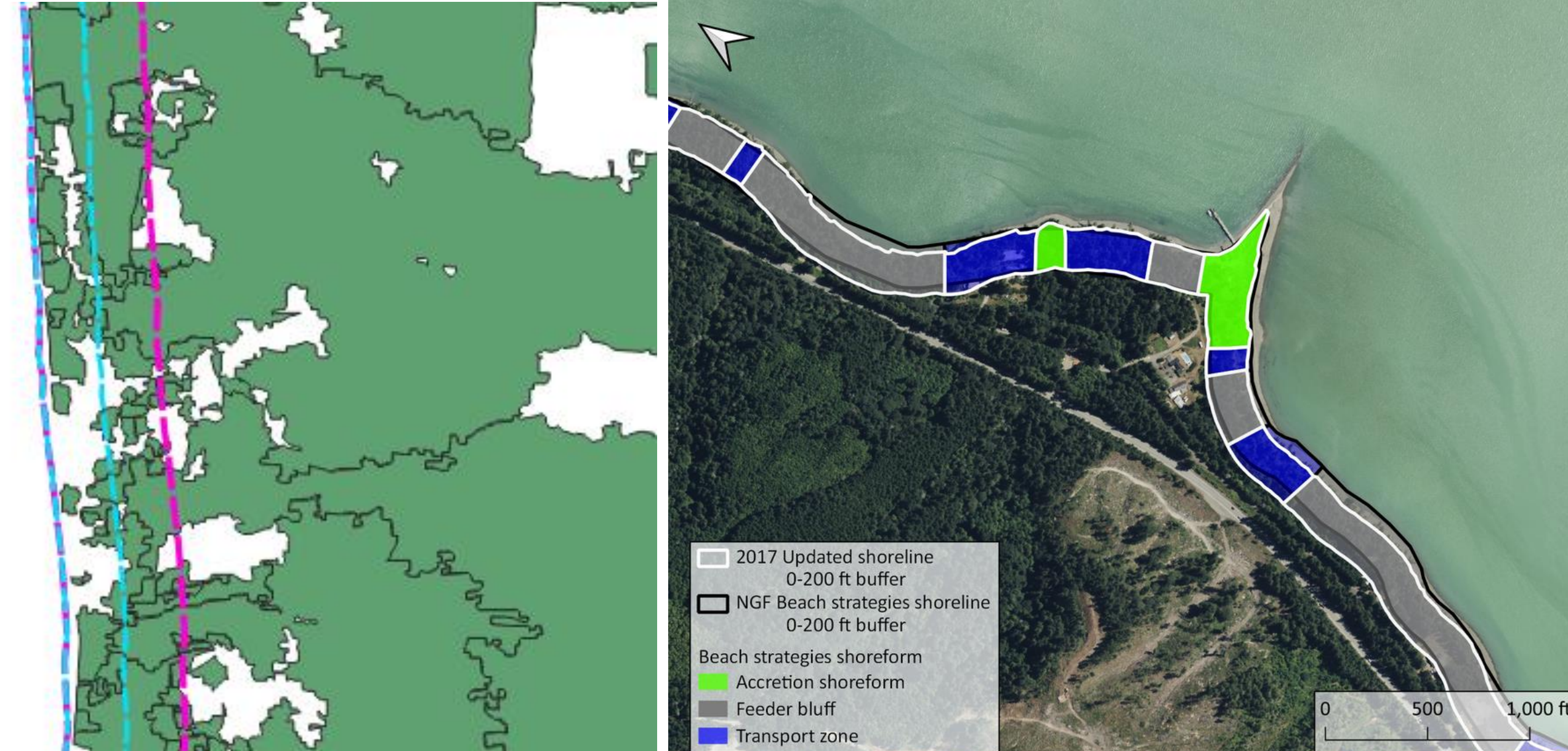
- Estimates forest cover within riparian buffers:
 - 0–100ft
 - 0–200ft
- High Resolution Land Cover data
- Percent or acres of forested cover along shoreline



MARINE RIPARIAN MAPPING

Percent Forested Cover

- Time points: 2013 and 2017
- Summarized WDFW HRLC data for each buffer polygon
- Calculates count of land cover and total area of forested cover classes
- Segmented and attributed with Beach Strategies shoreform
- Polygon dataset



Width of 100 and 200ft

Buffered shoreline by
100 and 200 ft landward

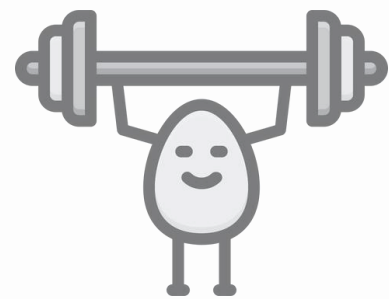
Segmented by Shoreform

Segmented and attributed
with Beach Strategies
shoreform



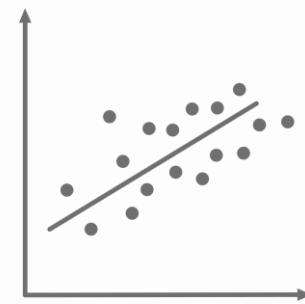
Results

WHAT WE ASSESSED



Strengths and weaknesses

What are the pros and cons of each approach?



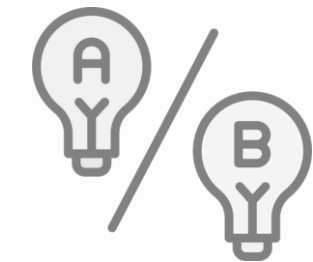
Correlation between methods

How correlated are the two methods?



Land cover change consistency

Is change consistent between the two datasets?



Compare Land Cover Change Datasets

How does percent forested cover compare to the WDFW HRCD dataset (2013, 2017)?

Percent Forest Cover + Contiguous Forest Cover

**Percent Forest Cover
+
HRCD Data**

Data Overview

Regional and local trends

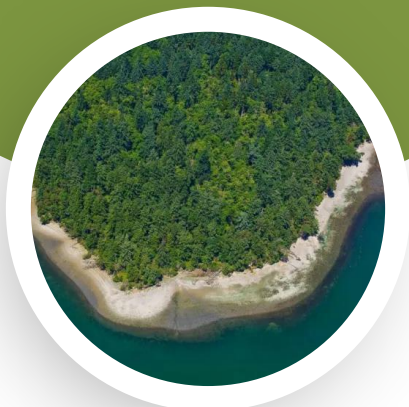


PUGET SOUND RIPARIAN CONDITIONS

Photo: J Bridgman

2,312 miles

Puget Sound
shoreline mapped



74%

Puget Sound shoreline
has no forested cover
directly next to the
shoreline



85%

Human modifications
accounted for the majority
of breaks in contiguous
cover



**Shoreform
types differ**

FB, FB-talus, transport
zones, and pocket beaches
more riparian cover



LOCAL RIPARIAN CONDITIONS



Largest decreases in riparian forest: Island

Largest reductions in
forest cover adjacent to
the shoreline



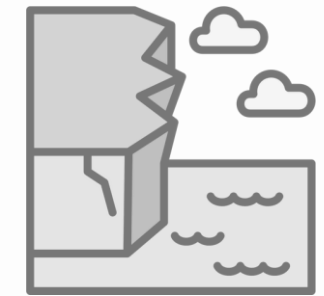
Gains in riparian forest: North Olympic

Large gains in noted in
North Olympic Peninsula,
Skagit, and San Juan



Most impaired: Urban areas

Cedar-Sammamish, WRIA
10/12, and Snohomish have
more impaired riparian
conditions comparatively



Longest stretches of marine riparian

Kennedy-Goldborough,
Hood Canal, and
Deschutes with highest
with contiguous
forested cover widths of
0-30ft or higher

Correlation between methods

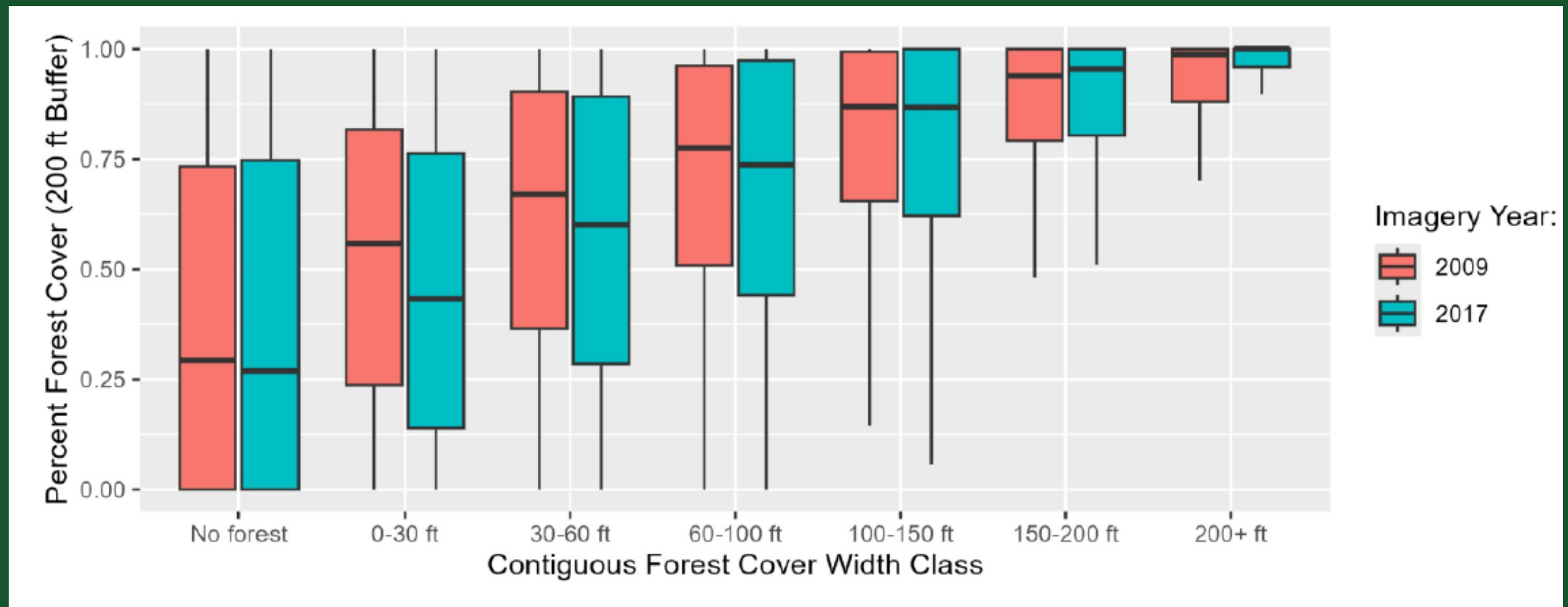
Do we see similar patterns?

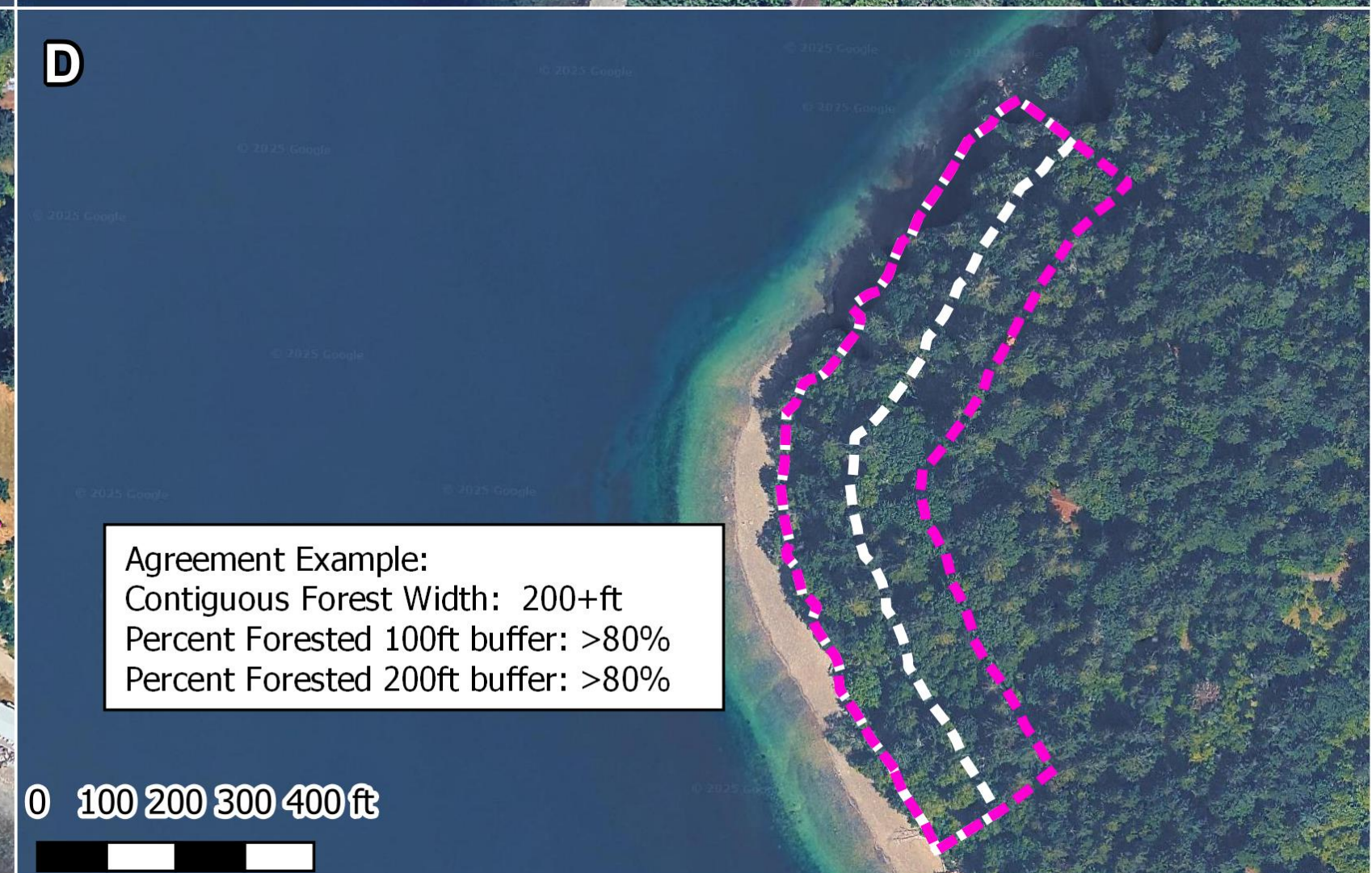
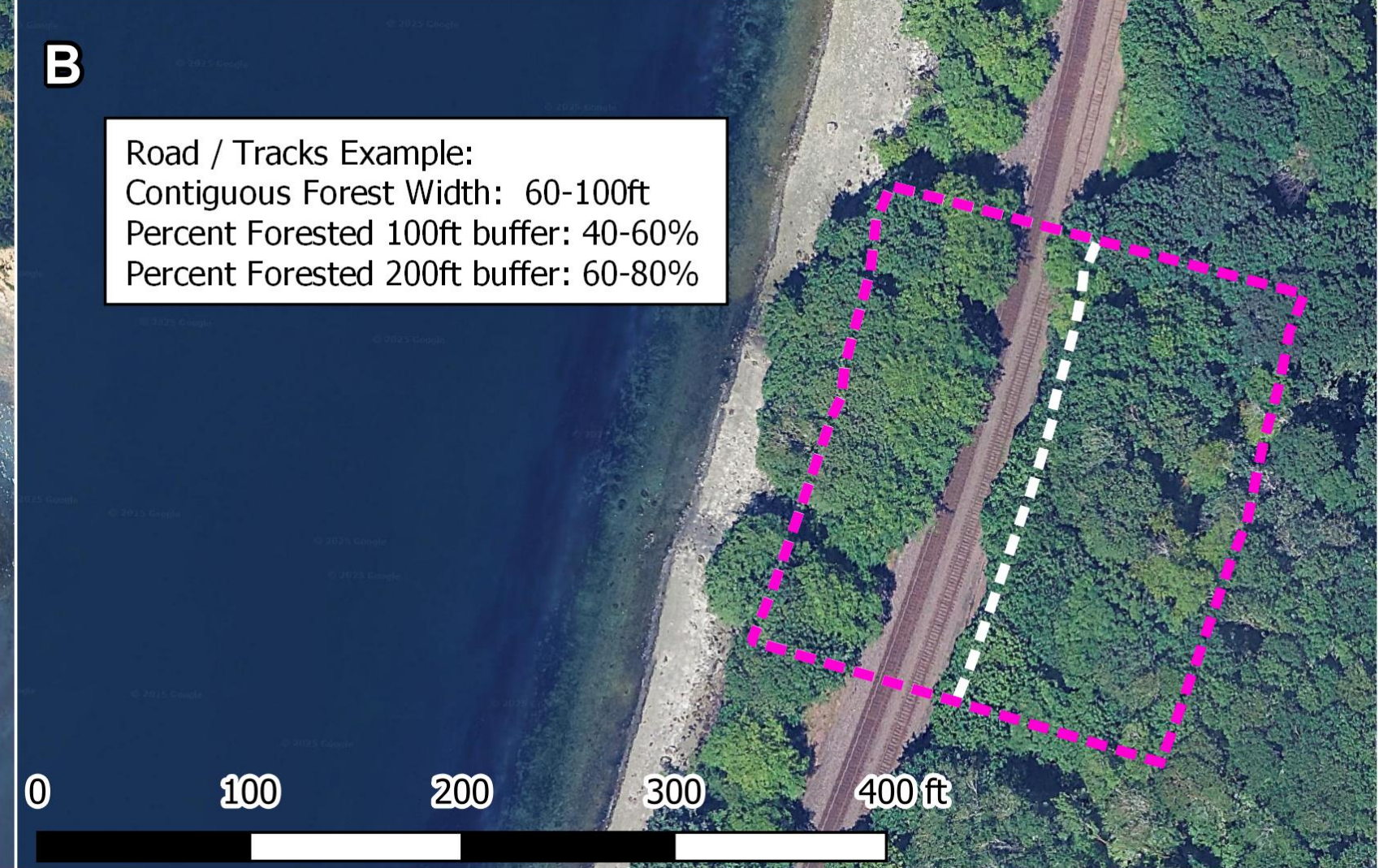
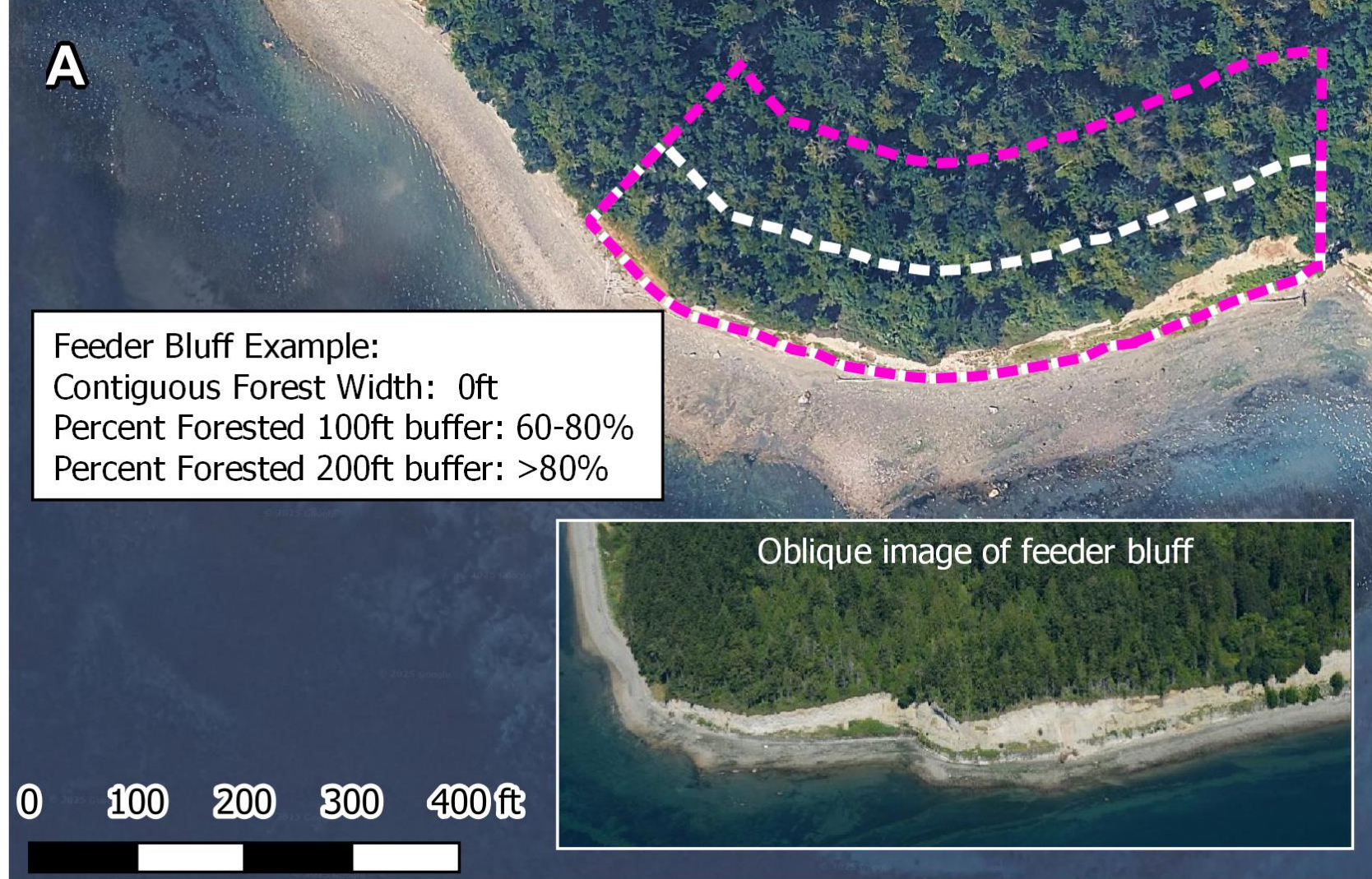




Methods provide similar results.

- Percent forested cover increases with increasing contiguous forested cover width
- Percent forested cover was high (>75%) where contiguous forested width was high (>200-ft)
- Small changes between time points in both metrics
- Shoreform and local changes generally similar across region
- Forest cover showed large losses in both 0-100 and 0-200ft (approx 4%) distances





Change Between Years



Regional trend: Impacted riparian zone of influence

At the shoreline

0-100-ft

Contiguous

Breaks increased by about
7 miles (net change)

Percent Forest

Net 0.2% reduction in
forest cover (54 acres)

Inland from shore

0-200-ft

200ft+ decreased by about
4 miles (net change)

Net 0.6% reduction in
forest cover (57 acres)

Change over time

Small regional differences were noted between two methods.

Percent forested cover detected greater changes over time.

- Marine riparian conditions were mixed by shoreform type.
- Greatest decreases in riparian cover: Island County (20%), Stillaguamish (15%), Kennedy-Goldsborough (10%).
- Greatest gains: N. Olympic Peninsula (22%), Skagit (10%), and San Juan (8%).
- Forest cover remains steady in West Sound.

Comparing Regional Land Cover Change Datasets

How does percent forested cover compare to the WDFW HRCD dataset (2013, 2017)?



Change Datasets



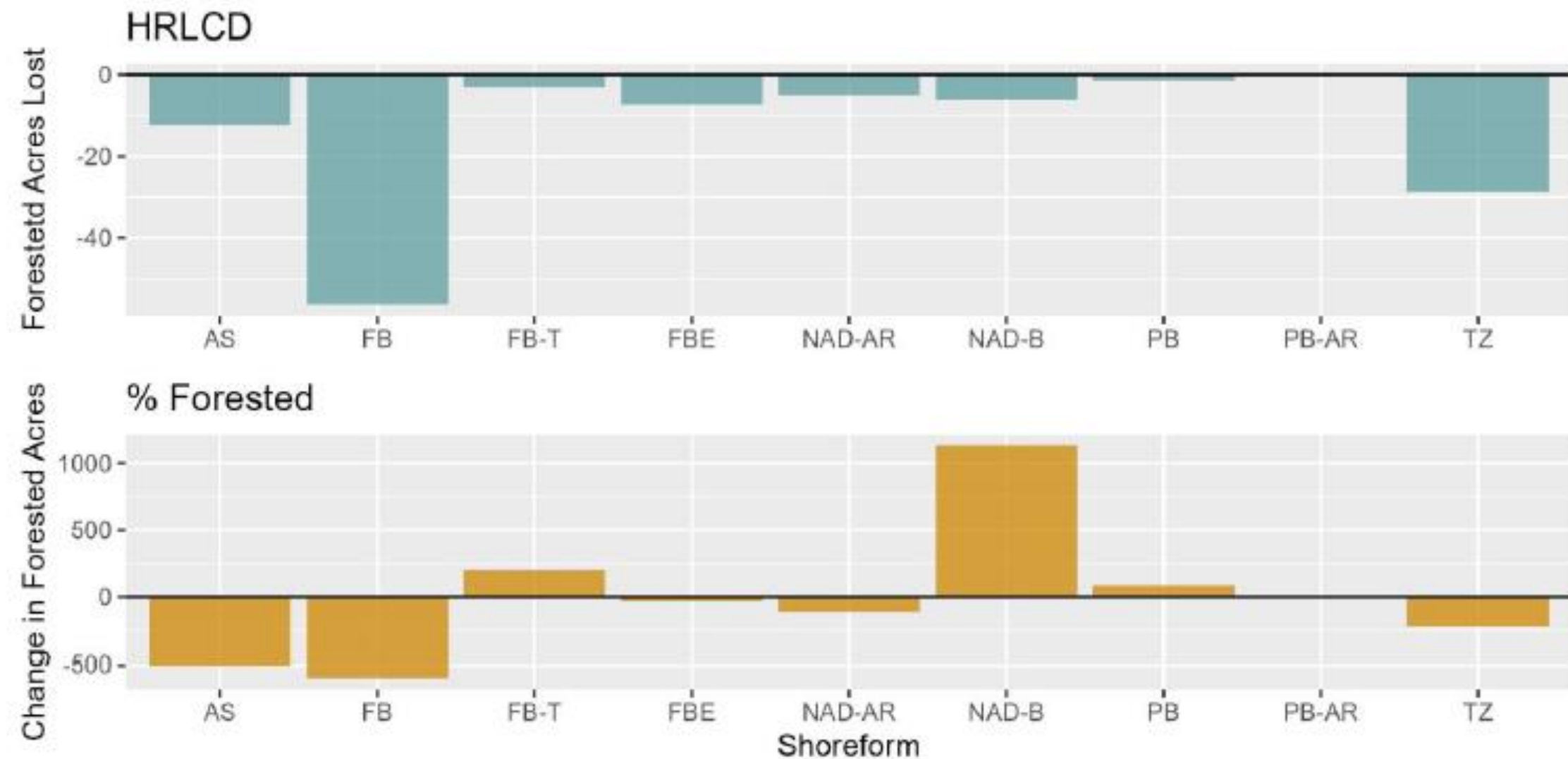
Moderately positive correlation

High Resolution Change Detection Data:

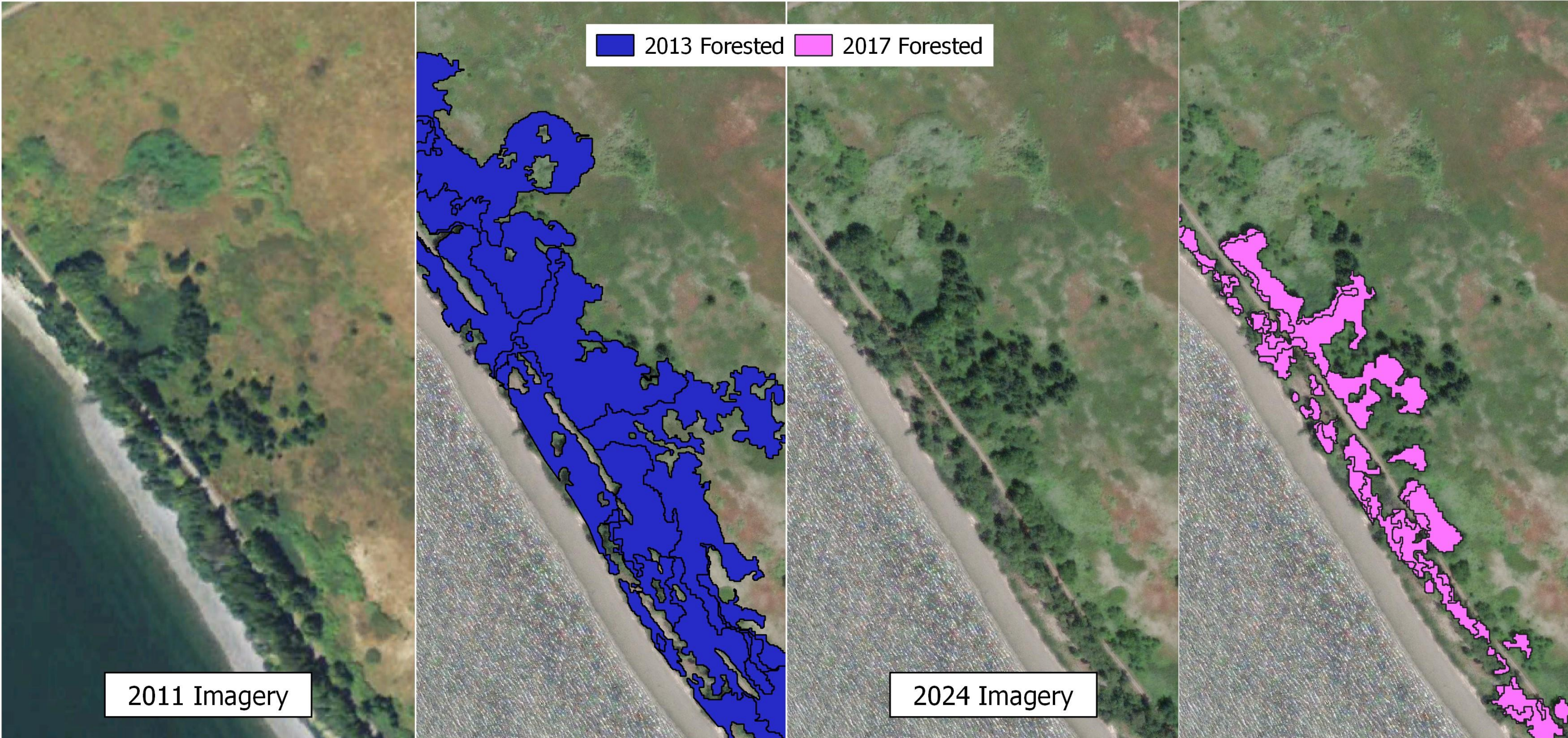
- HRCD data only focuses on forest loss
- Transport zone losses > Accretionary losses

Percent Forested Cover:

- Greatest losses in feeder bluff and accretionary
- Gains in feeder bluff talus, no appreciable drift artificial, and pocket beach (also lowest loss in HRCD)



Graph shoreform abbreviations: Accretion, Feeder Bluff, Feeder Bluff-Talus, No Appreciable Drift-Artificial, No Appreciable Drift-Bedrock, Pocket Beach, Pocket Beach-Artificial, Transport Zone



- Differences in scale, methodology, and years compared
- Highlights some QA /QC issues with both HRLC, and HRCD datasets



Conclusions



MARINE RIPARIAN MAPPING

The two protocols offer different, yet complementary data.





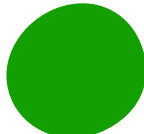
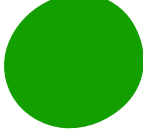
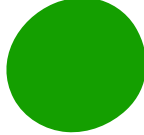
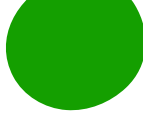
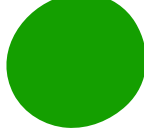
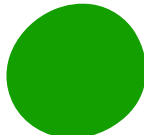
The two protocols offer different, yet complementary data.



Comparatively, **both protocols have strengths and weakness**, but can be used together for a more complete marine riparian story.



Strengths | Weaknesses

Metric qualities	Contiguous Cover	% Forest Cover	Combined Protocols
Quantity of marine riparian habitat			
Condition of marine riparian habitat			
Possible disruptions in marine riparian processes			
Changes in cover within riparian zone of influence			
Effort/time to implement protocol	Intensive	Efficient	Intensive
Identify and prioritize restoration opportunities			

 Effective  Somewhat effective  Not effective



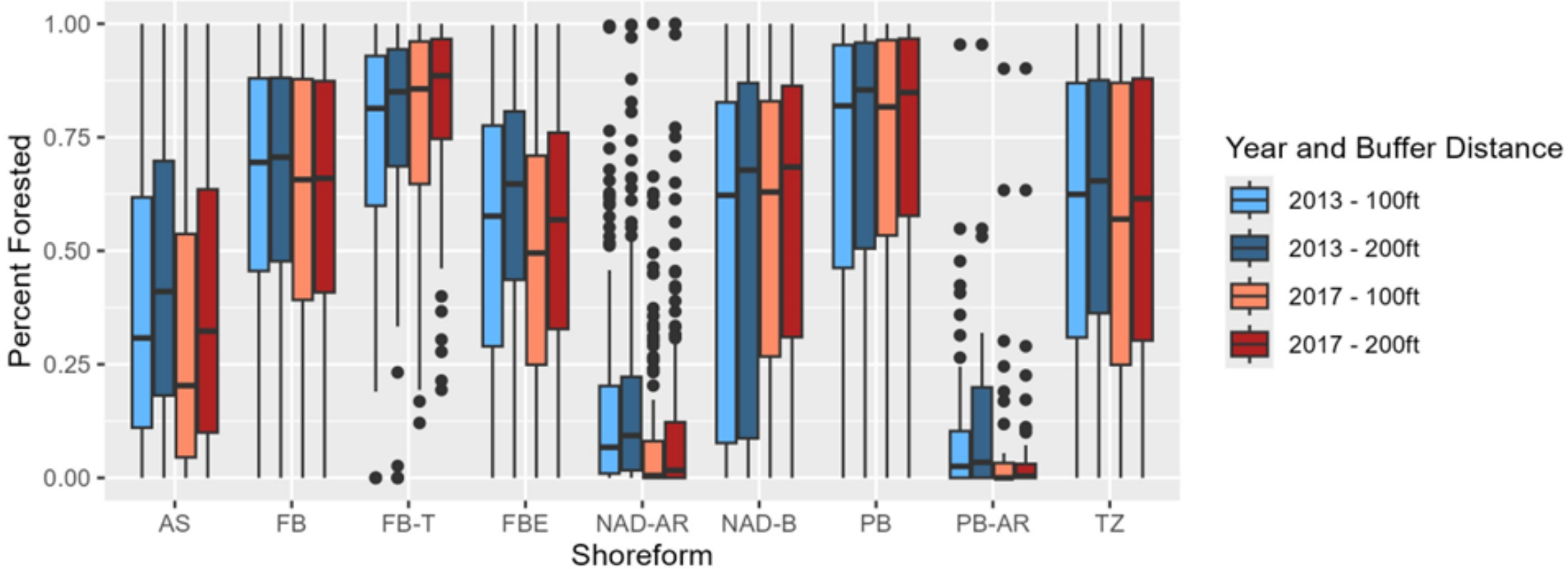
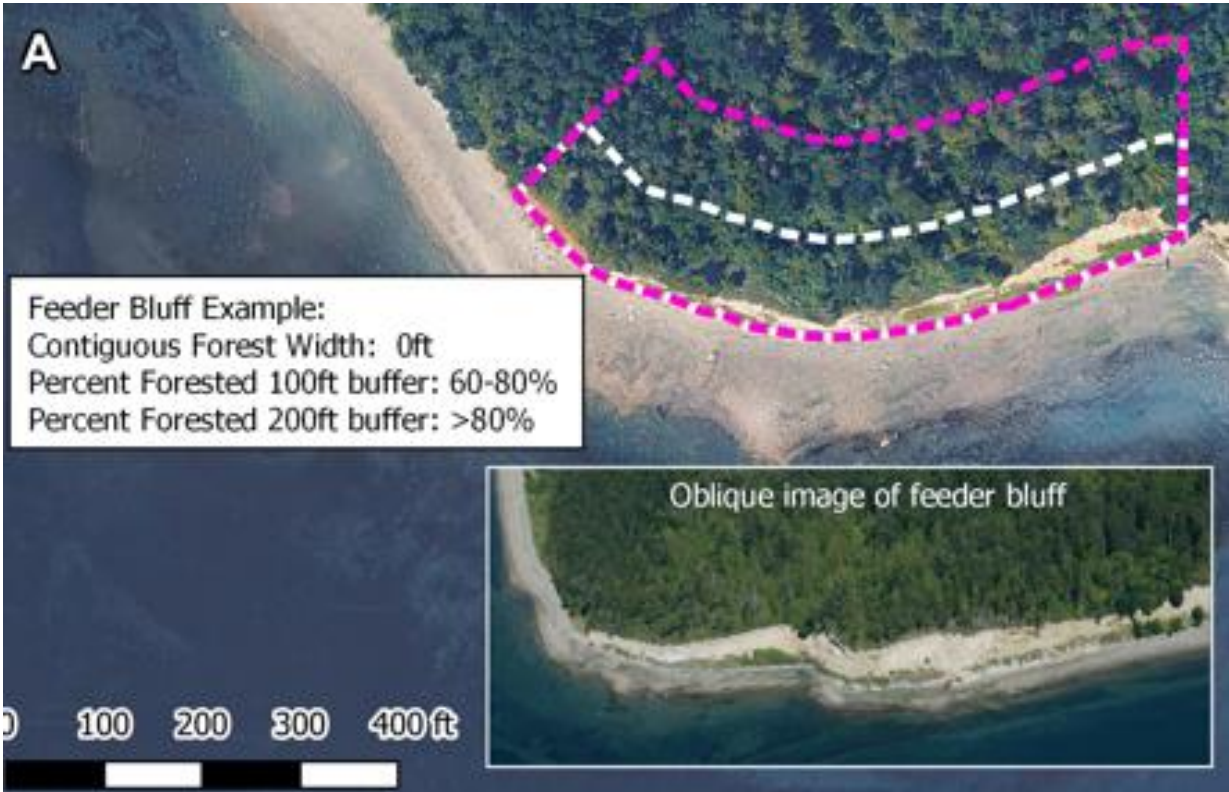
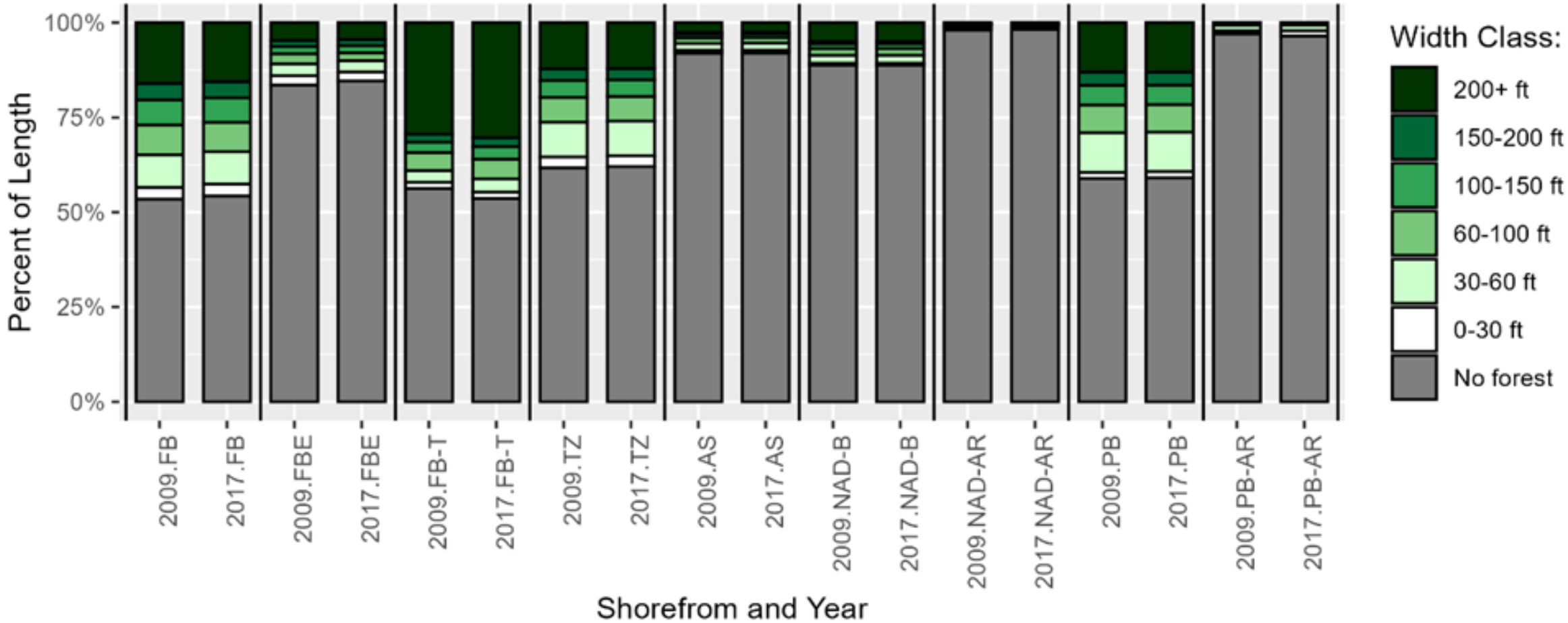
The two protocols offer different, yet complementary data.



Data patterns are similar, but **interpretations of the data can differ** when assessing habitat status and trends.

Considering Shoreform

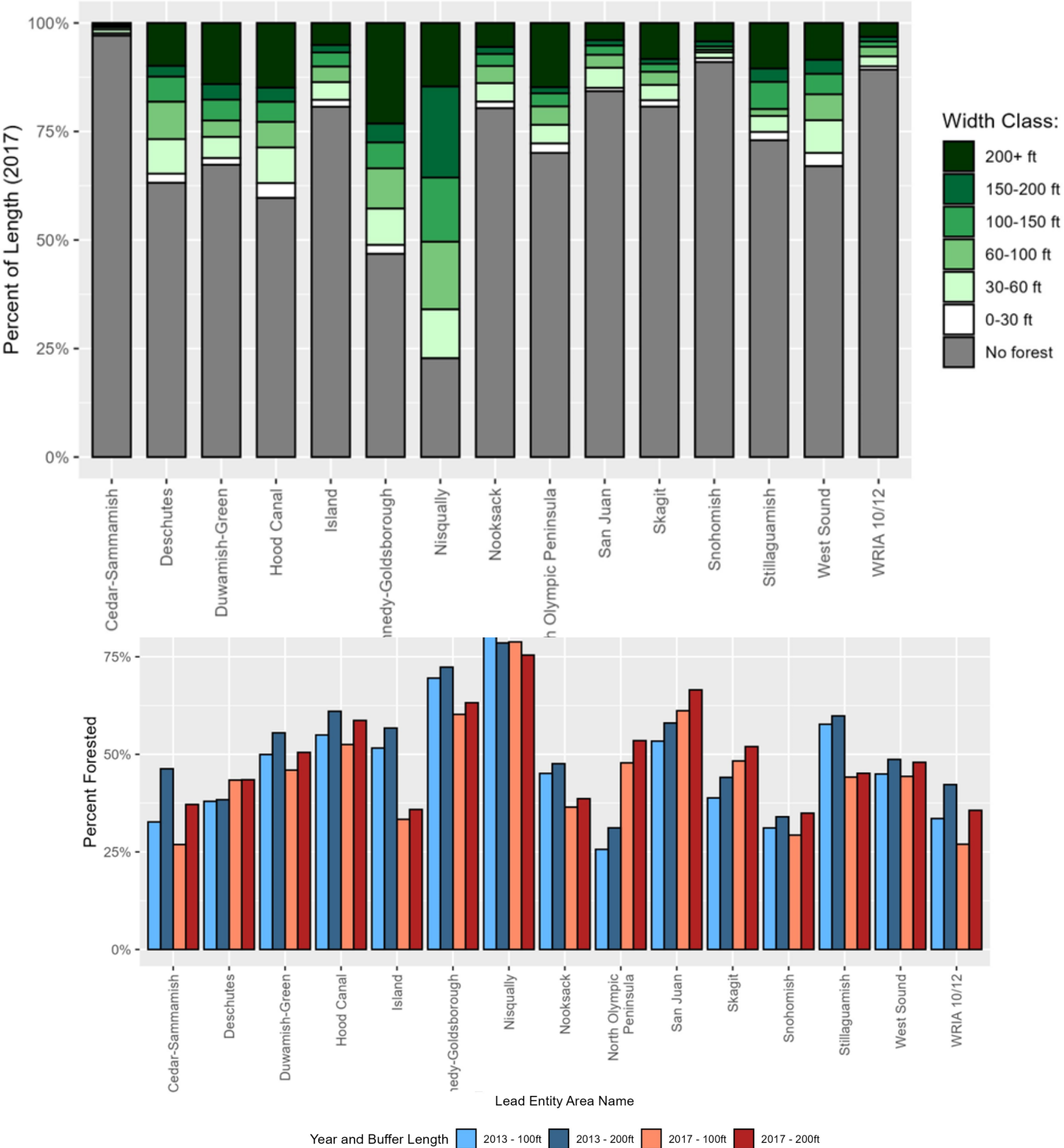
Strong patterns of forest cover by shoreform type

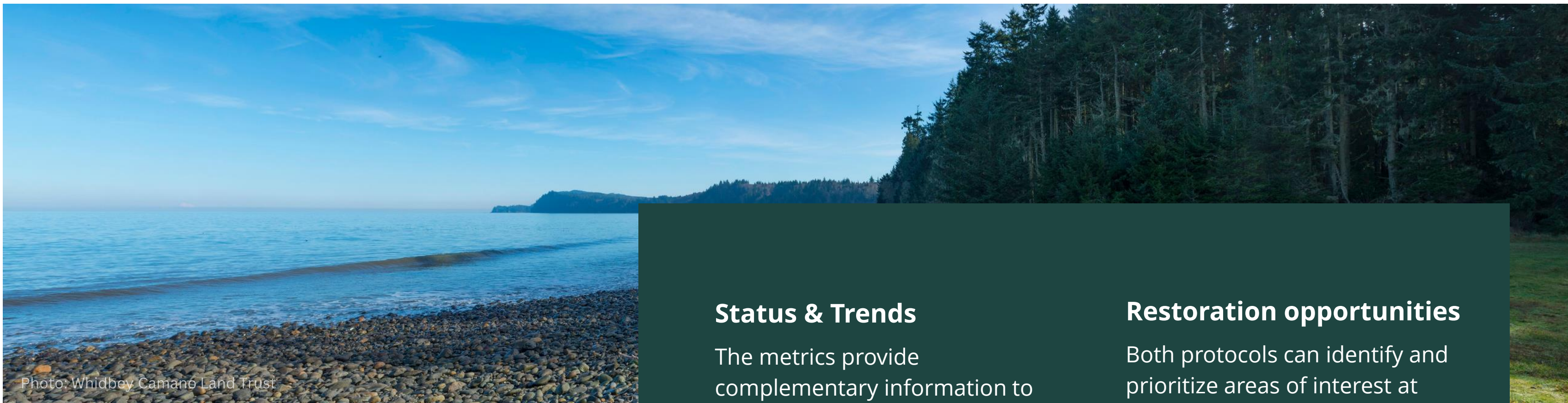


Shoreform abbreviations: Accretion, Feeder Bluff, Feeder Bluff-Talus, No Appreciable Drift-Artificial, No Appreciable Drift-Bedrock, Pocket Beach, Pocket Beach-Artificial, Transport Zone

Local patterns for management

- Identification of restoration & conservation opportunities
- Consider breaks and forested areas together





Management Applications

Use of the protocols rely on the management question and riparian functions of interest.

Status & Trends

The metrics provide complementary information to guide reporting of marine riparian habitat.

Can be utilized for:

- quantifying marine riparian habitat at various scales
- describing marine riparian conditions
- detecting change over time

Restoration opportunities

Both protocols can identify and prioritize areas of interest at various scales, shoreforms, and LE areas.

Can be utilized for:

- local recovery planning
- strategic restoration
- reporting progress



Recommendations

The two protocols for quantifying and describing marine riparian habitat should be used together to report status & trends.

-
- This effort produced an **updated, publicly usable and accessible data product** that integrates existing protocols and fills data gaps.
 - **Metrics** support recovery planning and prioritization.
 - **Final protocol development is recommended** for the Puget Sound.



Next steps



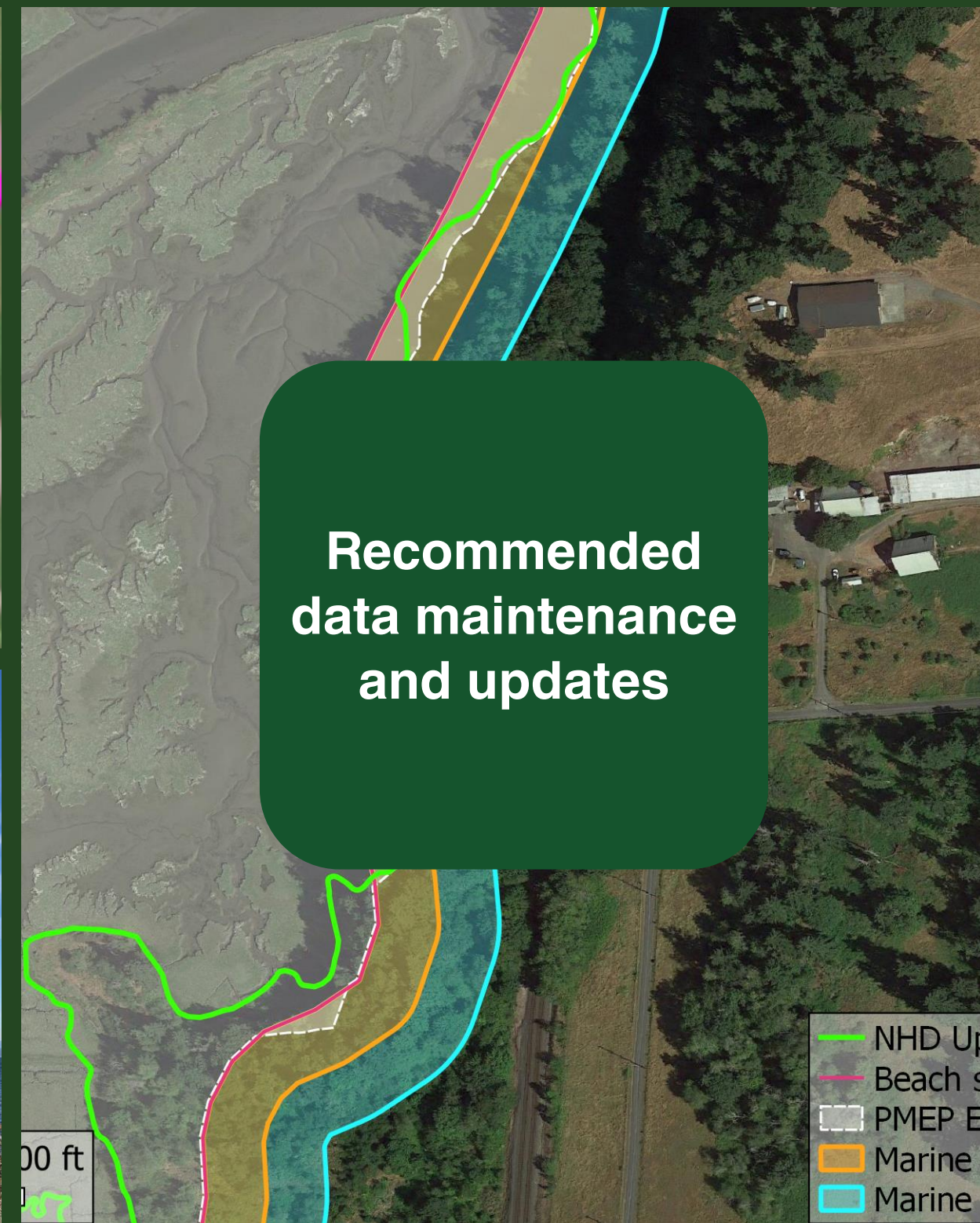
Regional indicator development and refinement



Further review & validation



Identify & prioritize restoration opportunities



Recommended data maintenance and updates



THANK YOU!



Questions?

Marine Riparian Mapping | Cramer Fish Sciences

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