



Apr 5th, 10:00 AM - 11:30 AM

## Seven years of development and change within 200' of the shore in Puget Sound

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Pierce, Kenneth; Quinn, Timothy P. (Thomas Peter); Folkerts, Keith; Miller, Jeanne; Samson, Kevin; and Muller, Matt, "Seven years of development and change within 200' of the shore in Puget Sound" (2018). *Salish Sea Ecosystem Conference*. 119.

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**Speaker**

Kenneth Pierce, Timothy P. (Thomas Peter) Quinn, Keith Folkerts, Jeanne Miller, Kevin Samson, and Matt Muller

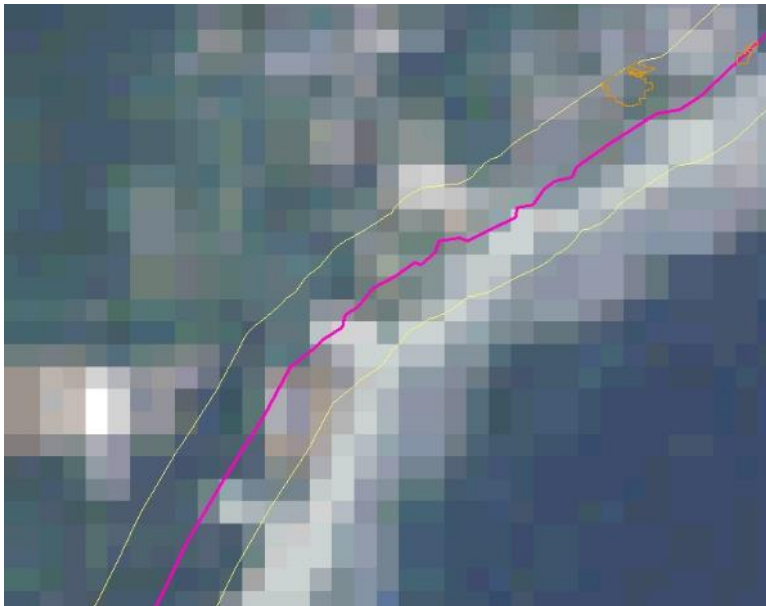
# A New View of Shoreline Terrestrial Change:

Mapping shoreline urbanization and forestry activities  
from 2006-2013 using high-resolution (1-m) imagery data

Kenneth B. Pierce Jr., Timothy Quinn, Keith Folkerts,  
Jeanne Miller, Kevin Samson  
WDFW Habitat Science Division

Apr 5, 2018

Landsat



NAIP



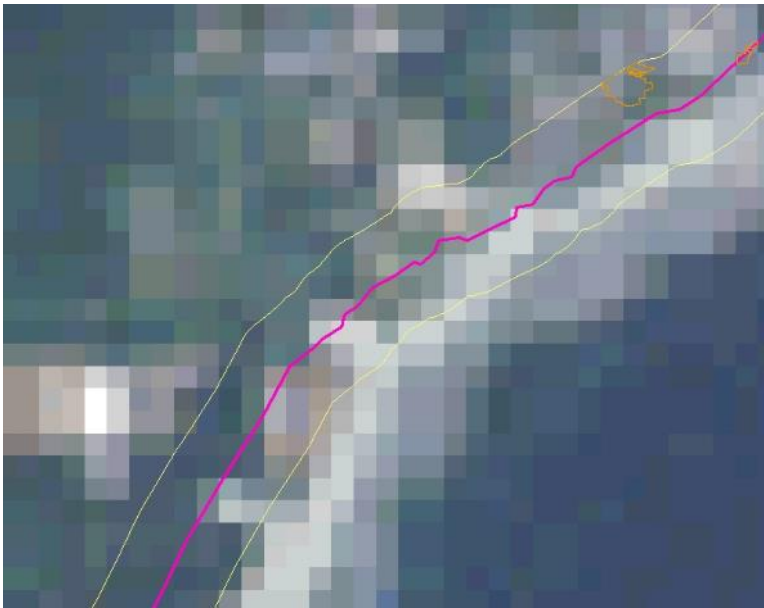
# WA Dept. of Fish & Wildlife's High Resolution Change Detection Program

- Land cover change measured from 1m NAIP data
- Use aerial imagery as source and truth
- Focuses on mapping urbanization and canopy loss
- Completed/funded time-periods
  - 2006-2009
  - 2009-2011
  - 2011-2013
  - 2013-2015 (coming mid-summer 2018)
  - 2015-2017 (fall 2019)

# Shoreline Monitoring Methods

- Satellite/Aerial Remote sensing
  - Shoreline itself (aggrading, eroding, slope, etc.)
  - Upland urbanization
  - Shoreline vegetation
  - Restoration success
- Beach surveys / Field sampling / Boat surveys
  - Shoreline itself (aggrading, eroding, slope, etc.)
  - Shoreline vegetation
  - Restoration success
  - Biological response
  - Water quality
  - Shoreline armoring

# Two views of the shore



Landsat 30-m pixel  
139-ft diagonal



NAIP 1-m pixel  
4.6-ft diagonal



# 2006-2013 Puget Sound Change Map

- 142,548 Change events
- 218,770 Change acres
- 57,834 Acres Canopy removal
- 155,656 Acres Timber harvest
- 12,500 Acres New Impervious



Scale: ~219,000 acres

Event size is exaggerated for visibility.

# Mixed to Developed Example



Cover: Mixed Non-built

Area: 0.68 acres



Change Type: Development

Changed area: 50%

Tree decrease: 25%

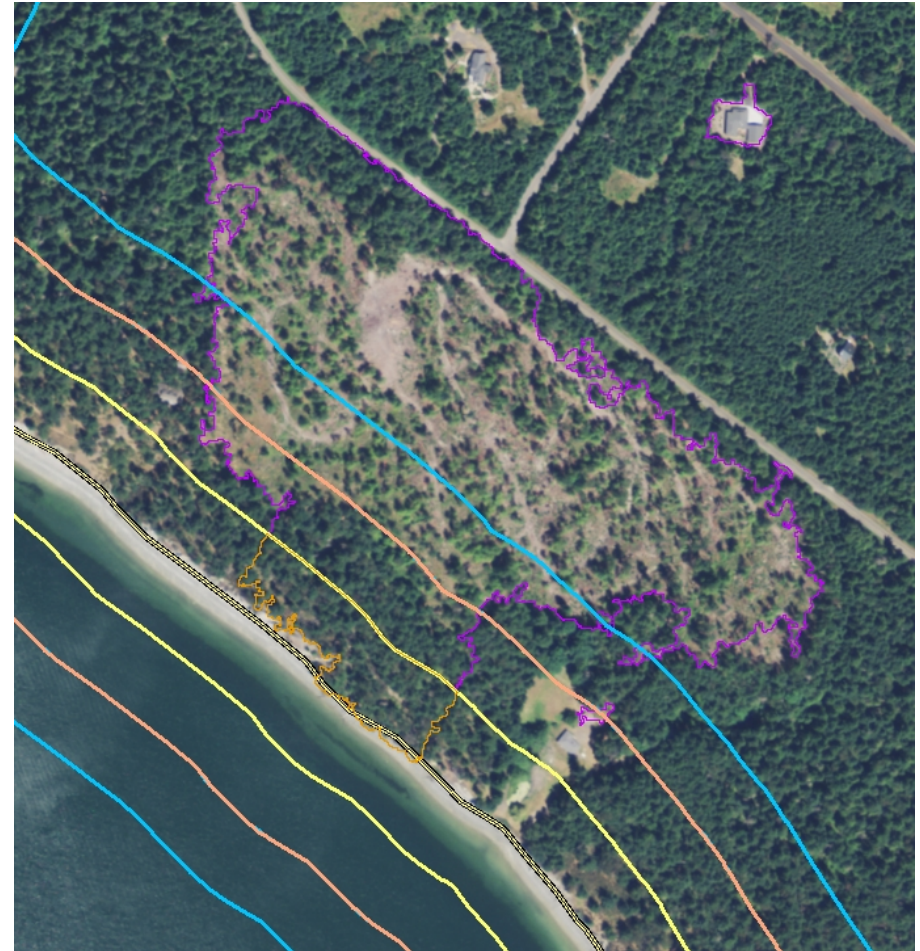
Impervious increase: 25%

Semi-pervious increase: 25%



# Analysis procedure

1. Clipped all change polygons along the 4,000 km shoreline to the
  1. 0-200'
  2. 200'-400'
  3. 400'-600'
2. Reassessed change within just 0-200' buffer area.
3. Added second change descriptor
  1. Verified change
  2. Landslide
  3. Error: positional
  4. Error: human
4. Clipped CCAP change polygons and reassessed change within the 0-200' buffer



# HRCDD Positional Error

Change location, 32 acres



# HRCO Positional Error

Change location, 32 acres  
75% Canopy loss



HRCO assumes change is evenly  
distributed

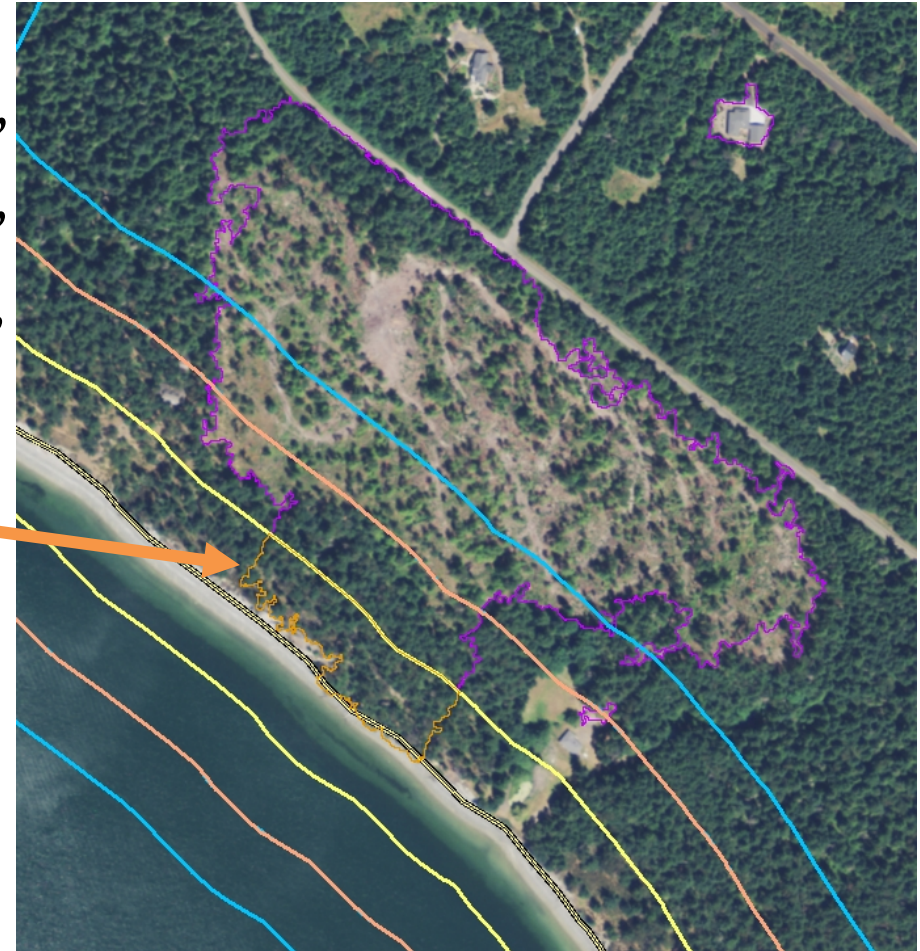


# HRCO Positional Error

Change location, 32 acres  
75% Canopy loss

Change polygon 0-200'  
Area 2.8 acres

600'  
400'  
200'



HRCO assumes change is evenly distributed

# HRCDD Positional Error

2006



HRCDD assumes change is evenly distributed



# HRCD Positional Error

2009

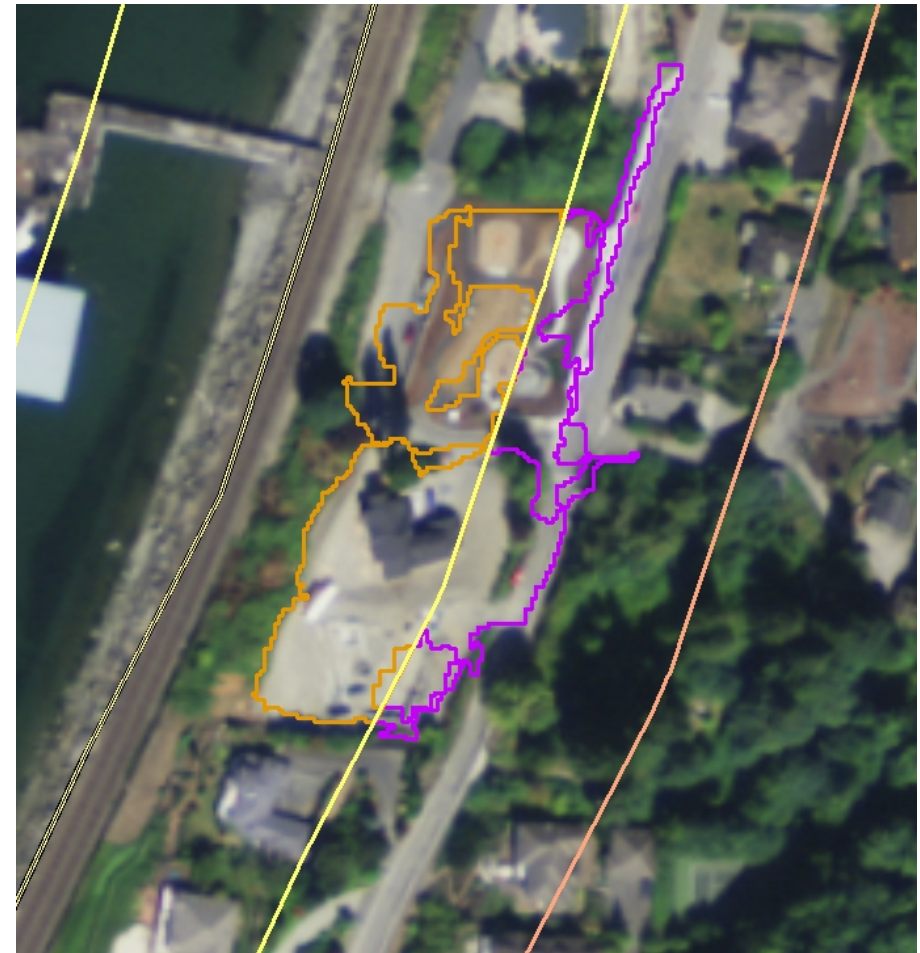


HRCD assumes change is evenly distributed

# HRCO Positional Error

2011

Change polygon 0-200'  
Area 0.7 acres



HRCO assumes change is evenly  
distributed

# HRCD 2006-2013

- Three time periods 2006-2009, 2009-2011, 2011-2013
- 19 WRIAs per time period
- Change locations
  - 0-200' : 2,951
  - 0-400' : 4,733
  - 0-600' : 6,194



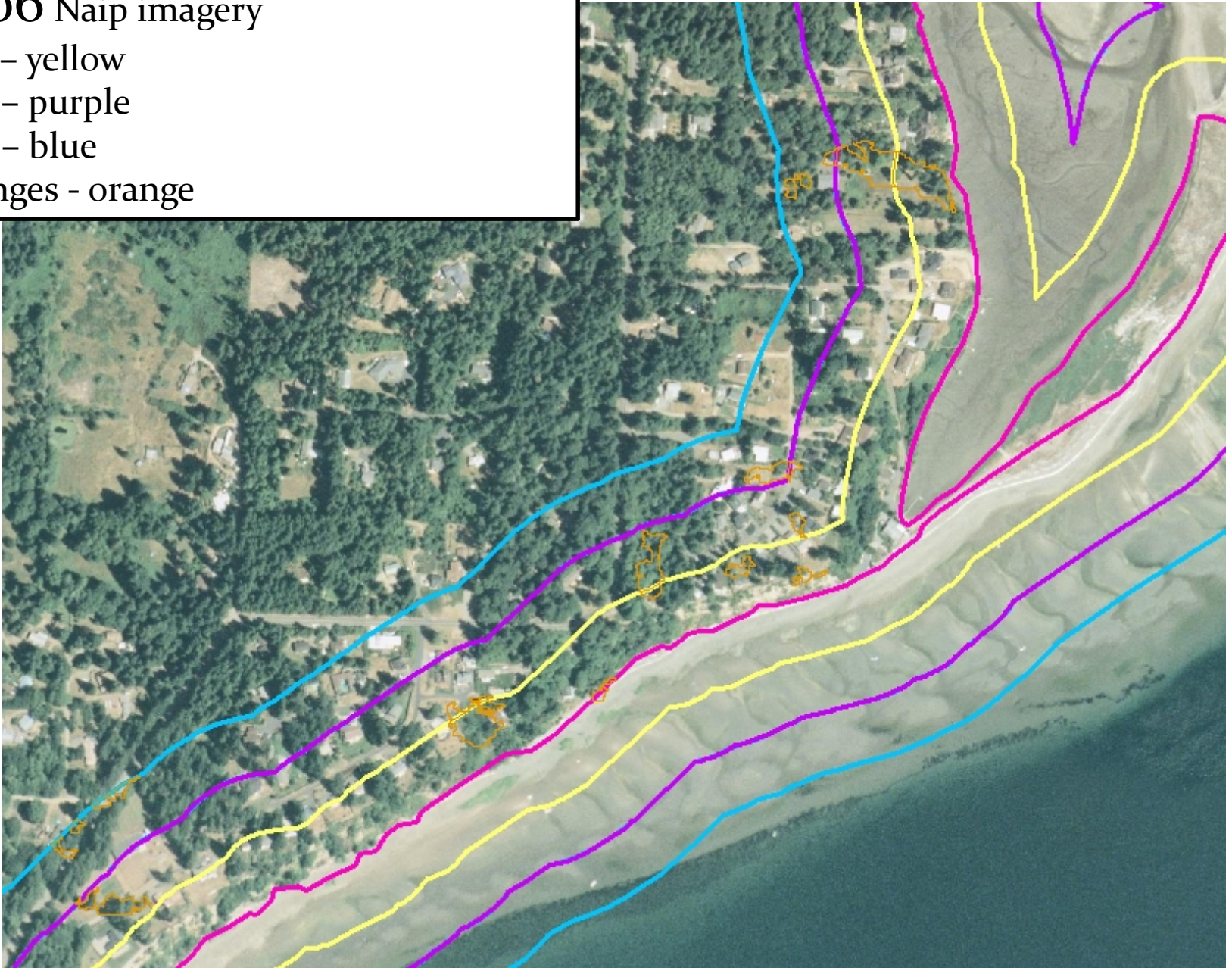
# 2006 Naip imagery

200' - yellow

400' - purple

600' - blue

Changes - orange





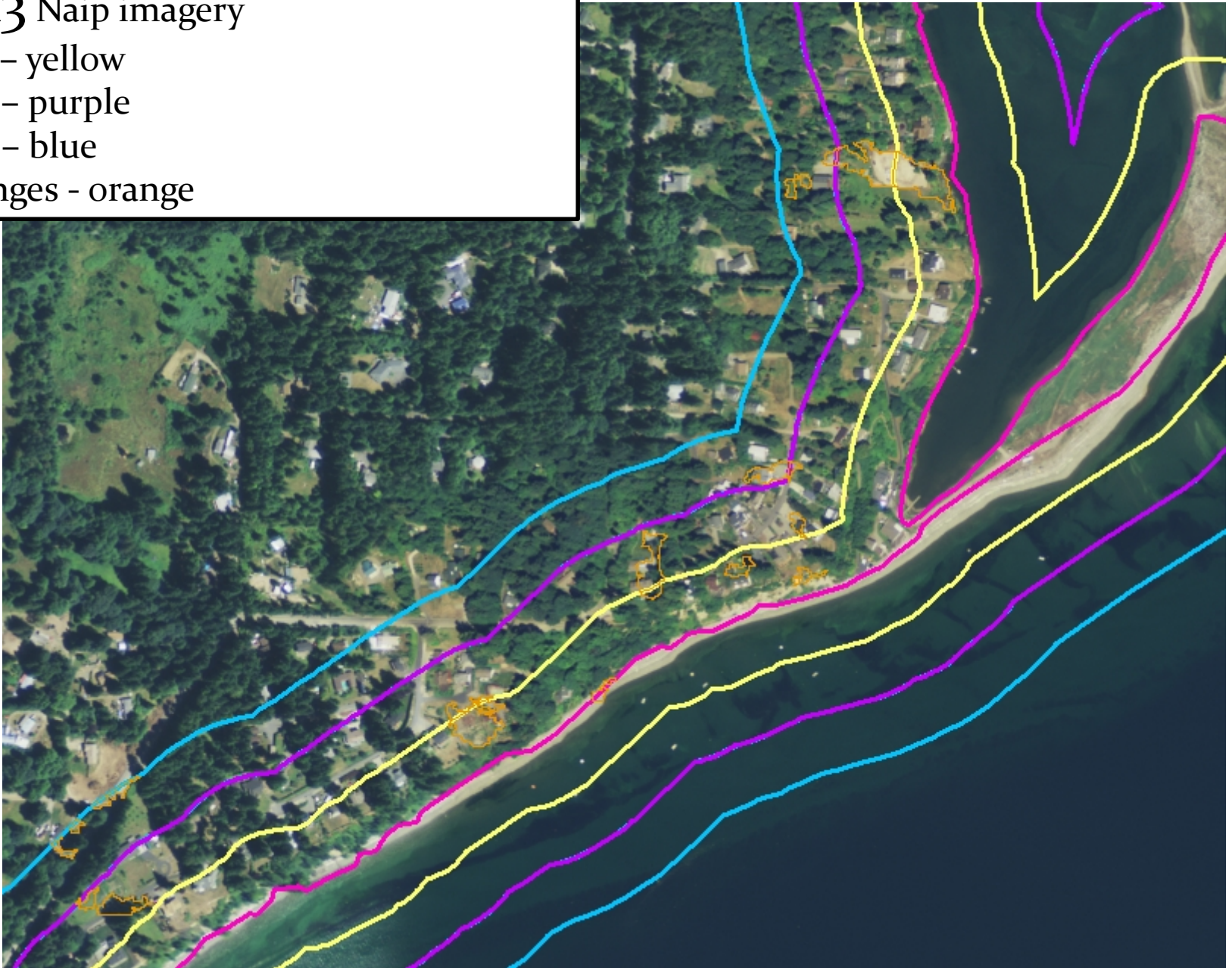
## 2013 Naip imagery

200' - yellow

400' - purple

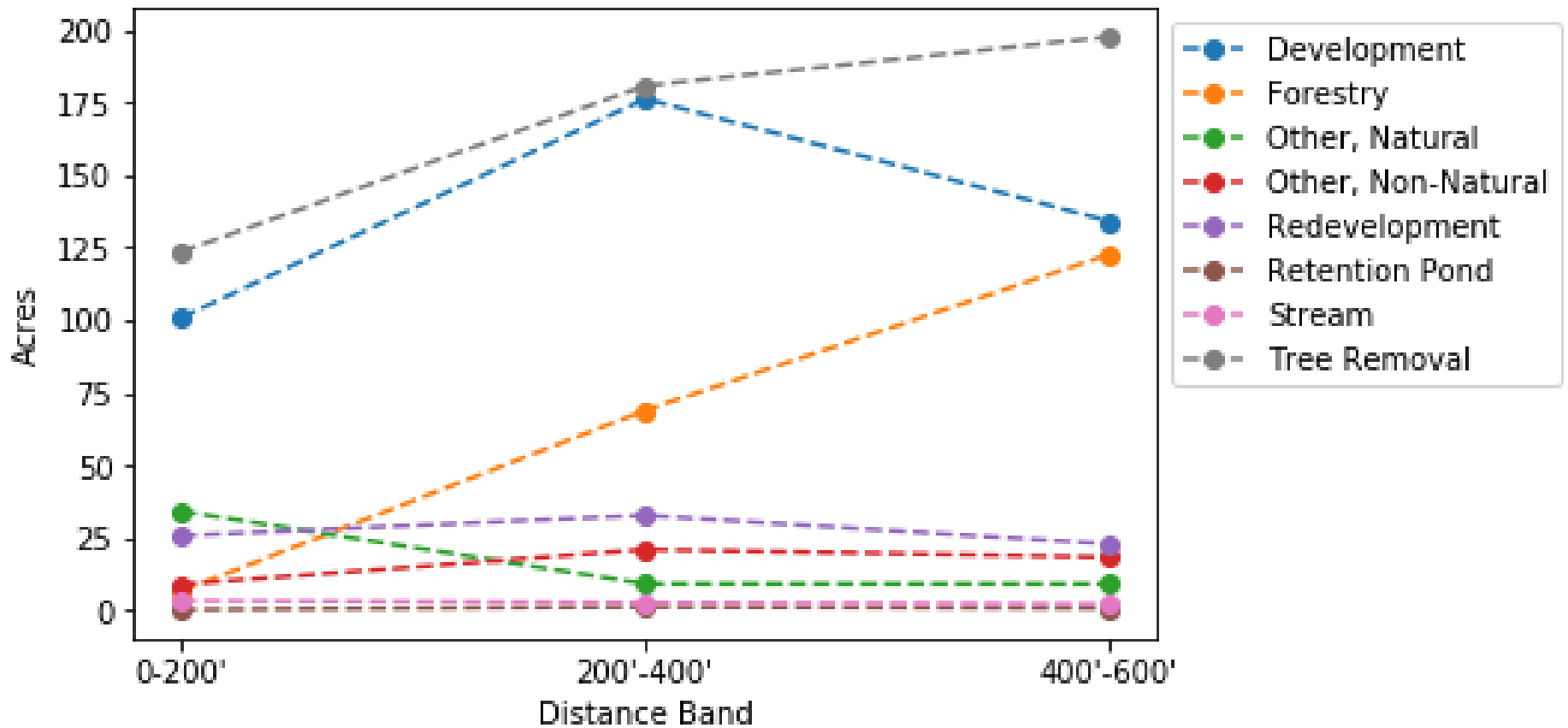
600' - blue

Changes - orange





# Change by agent



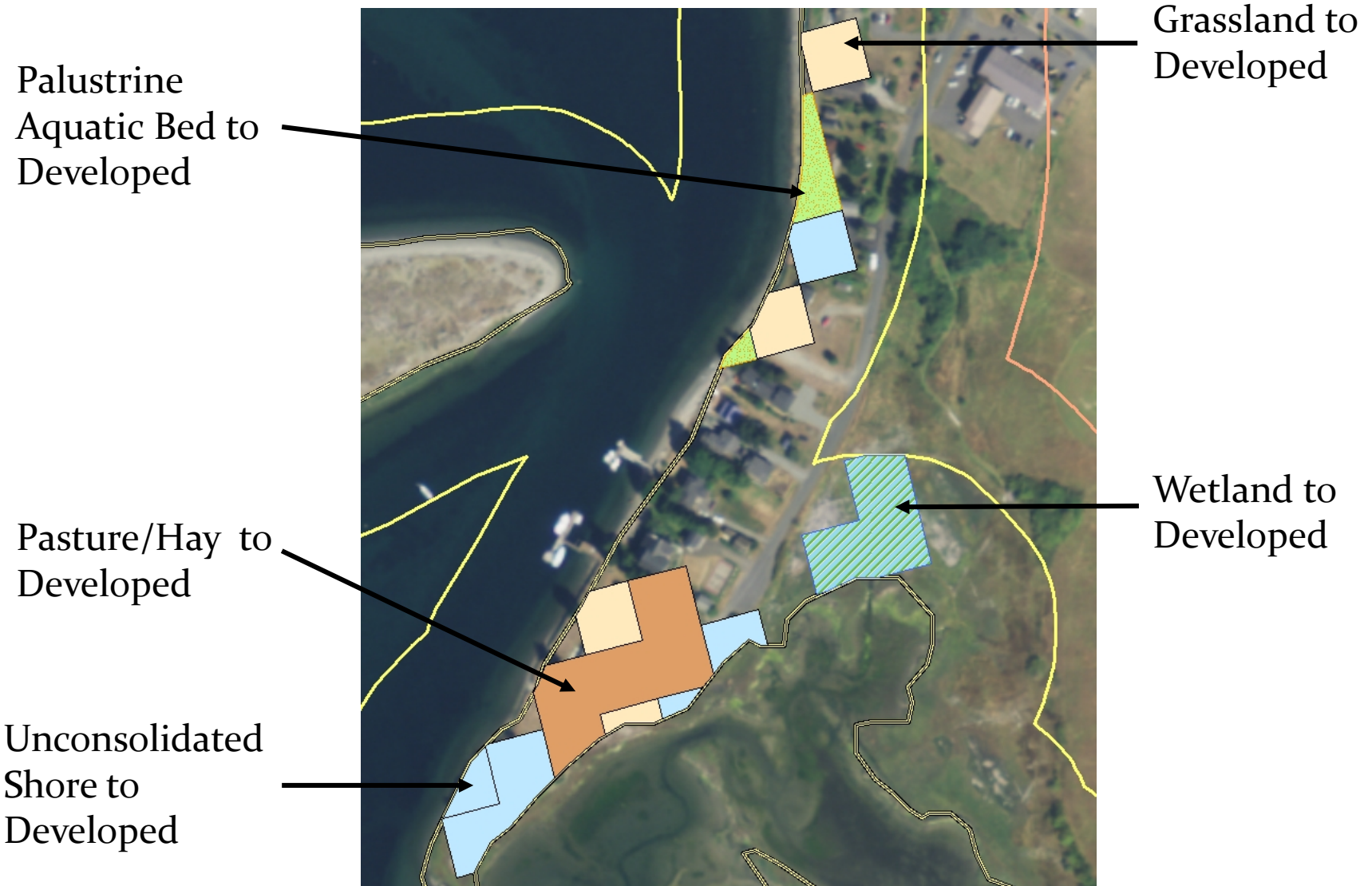
2006



2011



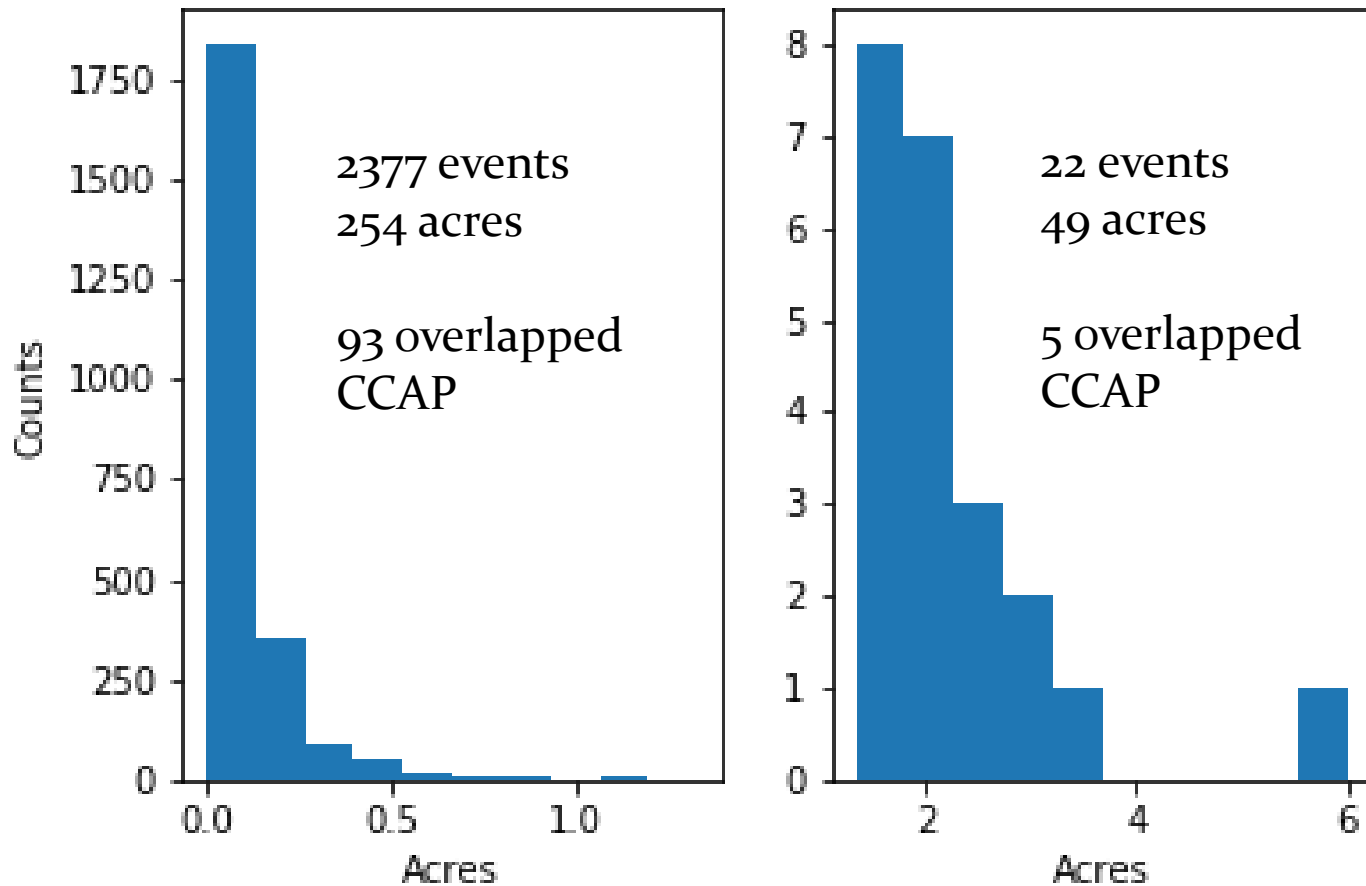
# CCAP error example



# HRCO-CCAP Comparison

	CCAP 2006-2011	HRCO 2006-2011
Intersecting Polygons 0-200'	928	2128
Area 0-200'	335 ac	369 ac
Reported change	335 ac	234 ac
Verified mapped change	<b>11 ac</b>	<b>207 ac</b>
Verified change locations	<b>103</b>	<b>1857</b>

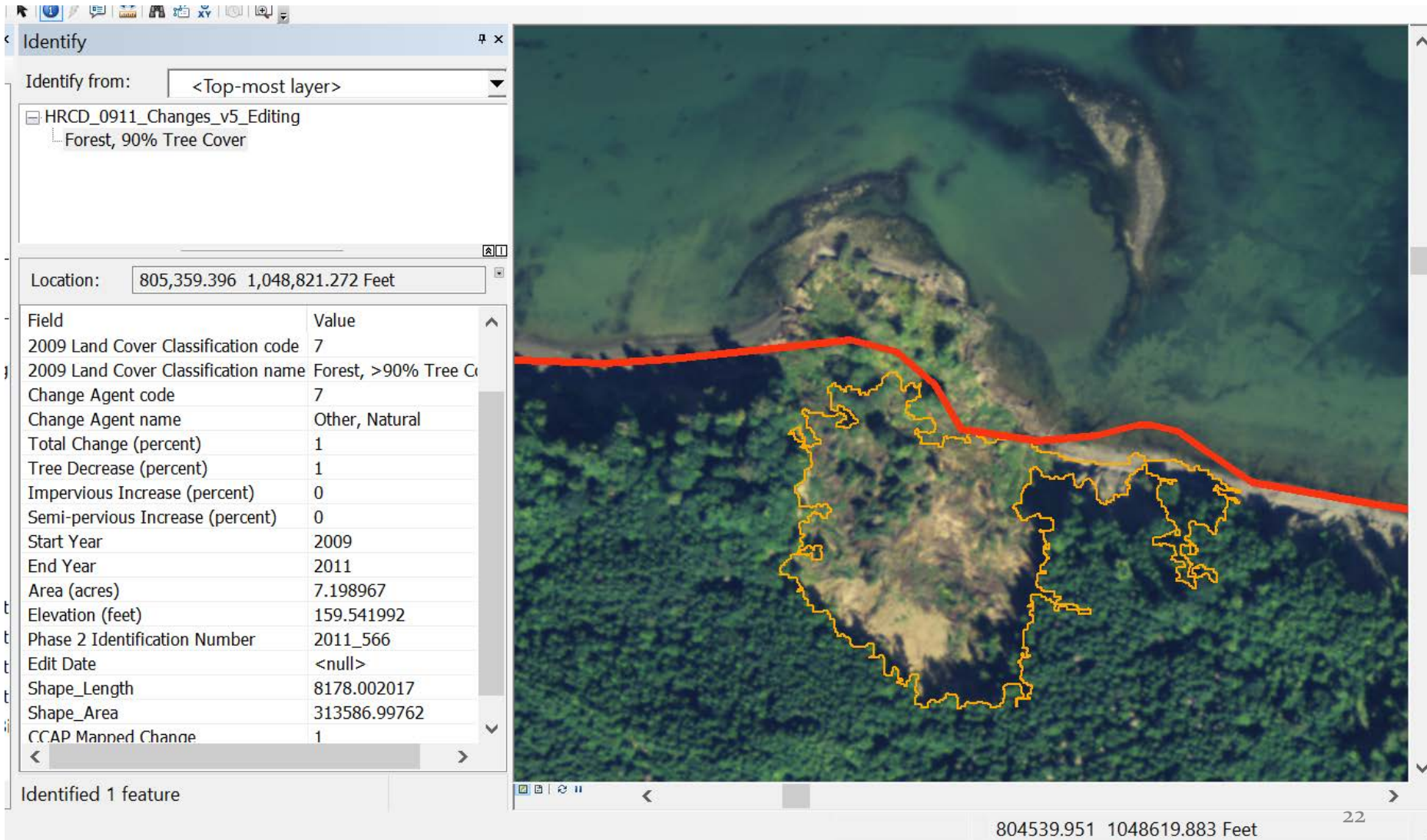
# HRCDC changes split at CCAP minimum mapping unit of 1.33 acres



HRCDC counts include 2011-2013 locations. This time period not yet mapped by CCAP



# Largest of 226 Landslides



Identify

Identify from: <Top-most layer>

HRCD\_0911\_Changes\_v5\_Editing

- Forest, 90% Tree Cover

Location: 805,359.396 1,048,821.272 Feet

Field	Value
2009 Land Cover Classification code	7
2009 Land Cover Classification name	Forest, >90% Tree C
Change Agent code	7
Change Agent name	Other, Natural
Total Change (percent)	1
Tree Decrease (percent)	1
Impervious Increase (percent)	0
Semi-pervious Increase (percent)	0
Start Year	2009
End Year	2011
Area (acres)	7.198967
Elevation (feet)	159.541992
Phase 2 Identification Number	2011_566
Edit Date	<null>
Shape_Length	8178.002017
Shape_Area	313586.99762
CCAP Manned Change	1

Identified 1 feature

804539.951 1048619.883 Feet

22



# Largest change location (6 acres)





Largest change location (6 acres)





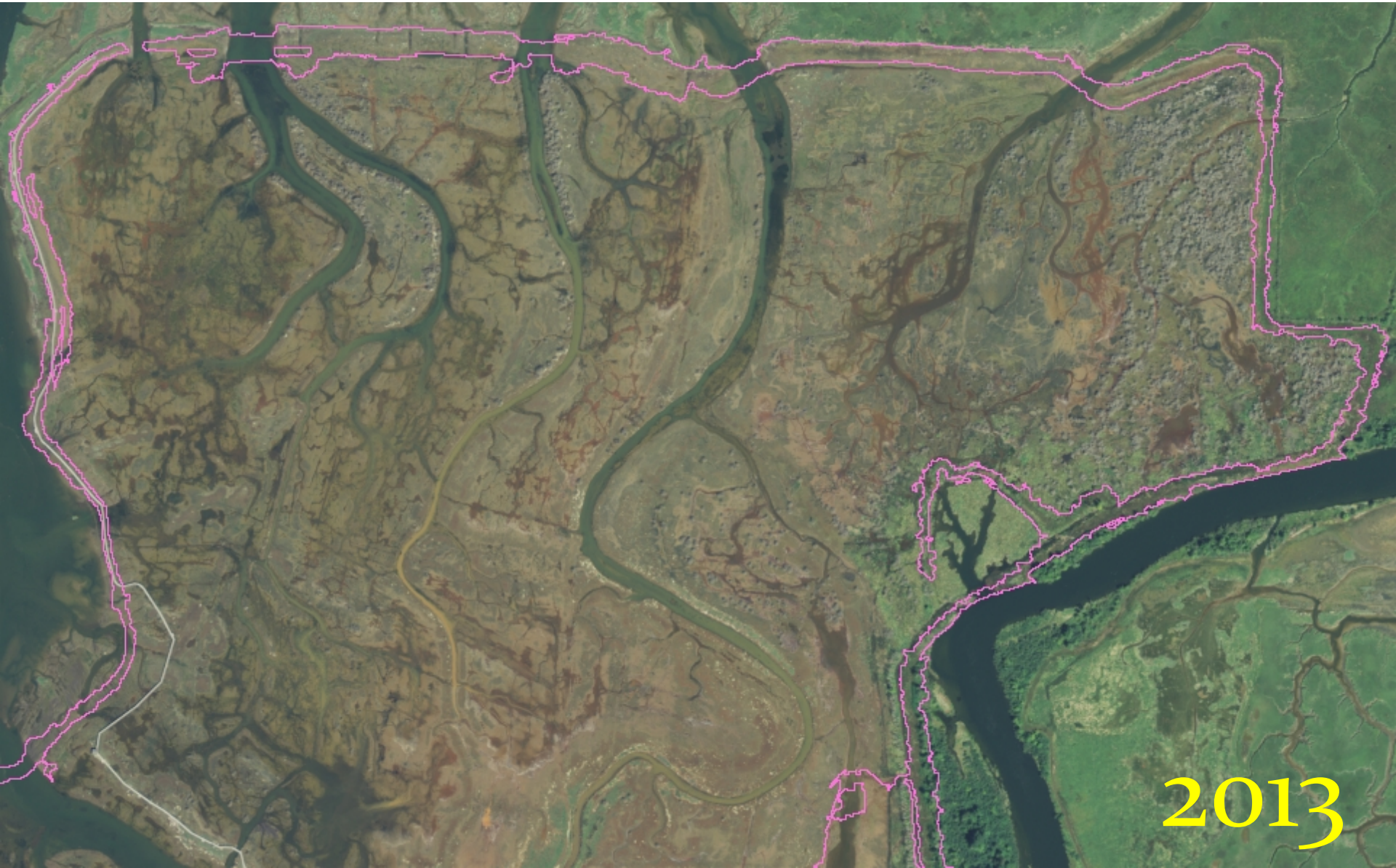
# Largest change location (6 acres)



2011



# Largest change location (6 acres)





# Largest change location (6 acres)



# Summary

- Land-cover change along the shoreline management zone primarily occurs as events that are smaller than the minimum detection threshold for Landsat analyses.
- HRCD provides a fully verified database of land-cover change locations specifically focusing on canopy loss and urbanization with a minimum mapping unit of 1/20 acre.
- HRCD mapped 303 acres of change in 2,399 change locations within the 2500-mile by 200-foot strip of land along the Puget Sound shoreline during 2006-2013

# Thanks!

Data: [www.PSHRCD.com](http://www.PSHRCD.com)

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  - EPA Lead Organization Grants administered by Dept. of Ecology and Dept. of Commerce
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  - Dept. of Ecology Wetlands Grant
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# Reanalysis of HRCD shoreline change polygons (acres)

	HRCD	HRCD Reanalysis	Difference	Locations
Anthropogenic	250	268	18	2179
Natural	33	35	2	243
Positional Error	36	0	-36	384
Human Error	20	0	-20*	132
<b>Total</b>	<b>339</b>	<b>303</b>	<b>-36</b>	<b>2938</b>

*\* 16 acres of human error was during the initial 2006-2009 analysis*