

Floodplains by Design Project and Floodplain Recovery in the Puget Sound Basin

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US Geological Survey
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Floodplains by Design Project

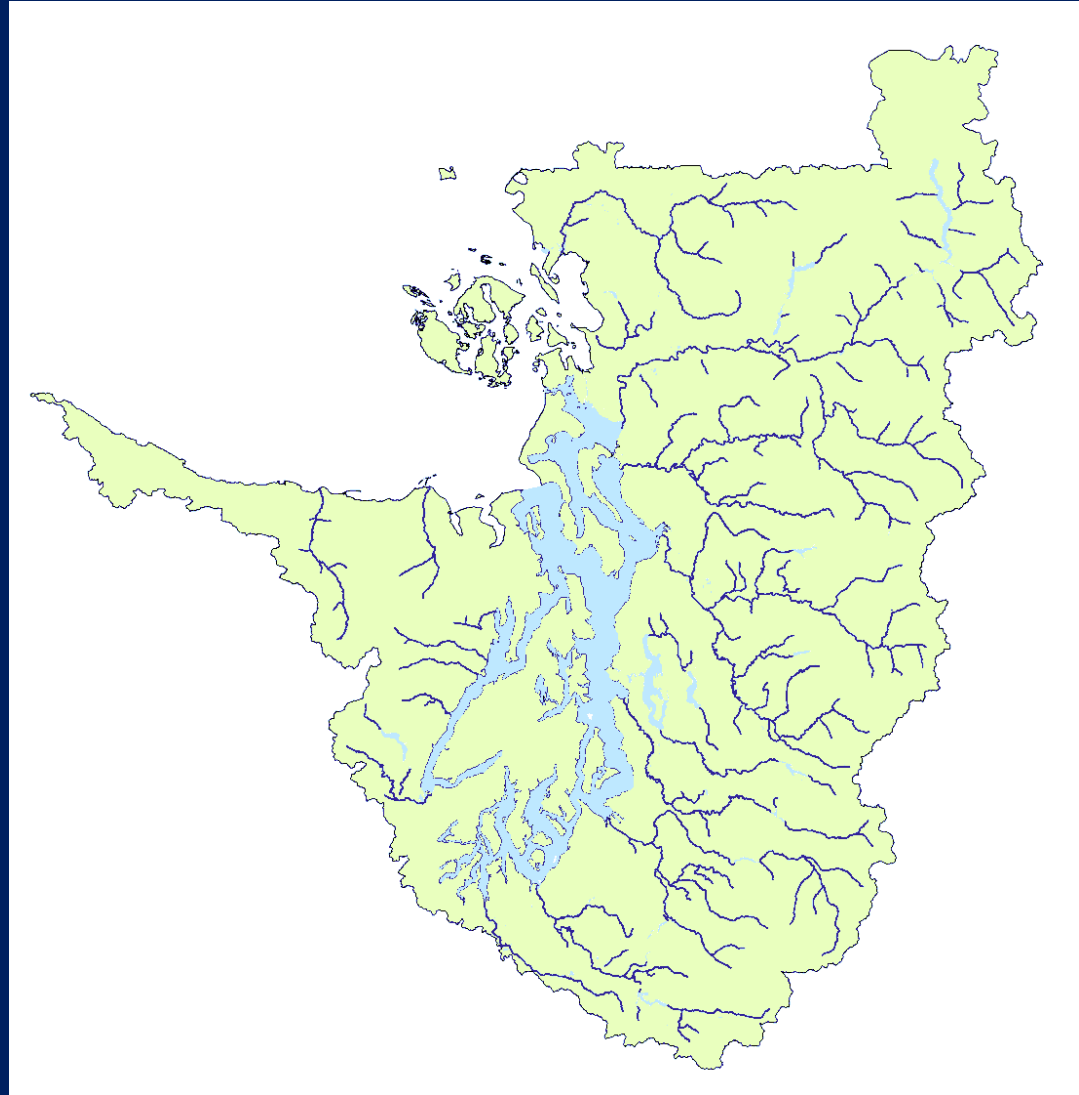
Goals:

Identify opportunities (places) to improve floodplain function and reduce flood risk along the 17 major rivers in Puget Sound Basin

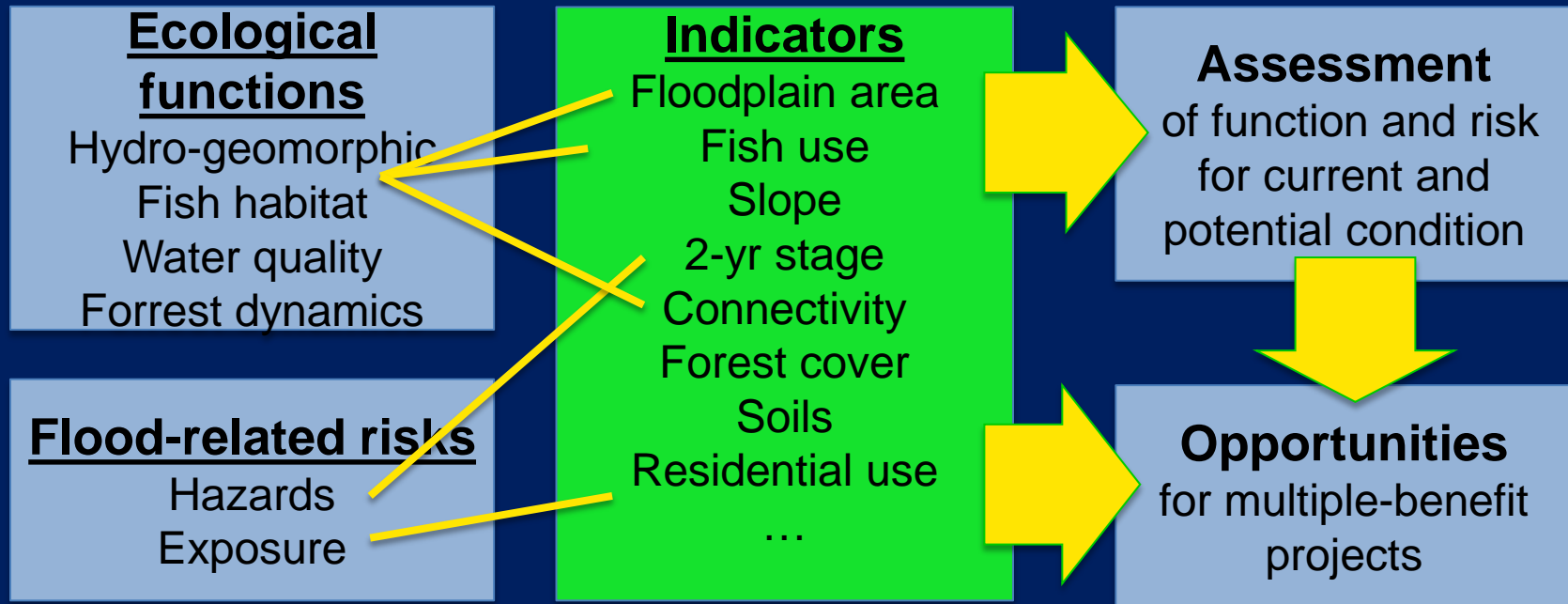
Develop funding sources and policy solutions to accelerate floodplain recovery.

Partners:

The Nature Conservancy, PSP, USGS, NOAA, FEMA, USACE, EPA, WDOE, WEMD



Analytical Framework for Floodplain Assessment



For ecological functions,
Biophysical indicators provide information on potential function
Human indicators provide information on degradation of function

Ecological Functions

1. Store and route flood water
2. Supply wood and sediment to the river
3. Retain/remove sediment, organic material, nutrients, and contaminants from water
4. Supports riparian forest and wetlands
5. Act as a corridor for terrestrial migration
6. Provide rearing habitat for salmon
7. Provide flood refugia for salmon
8. Supports salmon spawning and migration

Flood-related Risk

Hazards

1. Inundation during major winter storms (10-yr flood)
2. Bank erosion and channel avulsion
3. Levee over-topping or failure
4. Reliance on unsustainable maintenance and repair
5. Inundation during large (100-year) flood

Exposure

1. Critical infrastructure
2. Residences
3. Commercial/Industrial
4. Agriculture

Indicators

Data sources

- NHD high resolution (1:24,000) hydrography (USGS)
- Stage records (USGS)
- National Elevation Dataset (NED), 10 m resolution (USGS)
- LiDAR (PSLC)
- Levees (WWU, USACE)
- Roads (US Census TIGER)
- Land cover (NOAA CCAP, USGS NLCD)
- Land use (WA Dept. of Revenue)
- Salmon stocks (WDFW)
- Soils (SURRGO, NRCS)
- Flood zones (100-yr floodplain, floodways) (FEMA)
- NFIP claims (FEMA)
- Key facilities (water systems, wastewater discharges, fire stations, hospitals) (WDOH, WDOE)

Channel gradient

Median annual (2-yr) flood divided by active channel width

Depth on connected low floodplain at 10-yr stage divided by depth 10-yr flood

Low floodplain area having hydric soils with high organic content (percent)

Fraction of basin regulated for flood control

Low floodplain area connected to river (per mainstem channel length)

Natural vegetation cover on low floodplain (percent)

Active channel area bordering forest (percent)

Active channel areas bordering roads or levees (percent)

Natural vegetation cover on valley bottom (percent)

Number of salmon stocks

Active channel area (divided by mainstem length)

Active channel edge length (perimeter)

Floodplain area connected to river channel

Length of rivers upstream that support salmon

100-yr flood divided by floodway width

Channel banks

High sinuosity

Post-glacial valley, decreasing valley slope

Levees in 100-yr floodplain

Levees in poor condition

Residential and commercial land use on floodplain

Roads on low floodplain (density)

Flood insurance claims in valley bottom area

Hospitals, fire stations, wastewater discharges on low floodplain

Water systems on low floodplain

Area of agricultural land use

Area of industrial/commercial land use on low floodplain

Linking functions and hazards to indicators

Channel gradient	Median annual (2-yr) flood divided by active channel width	Depth on connected low floodplain at 10-yr stage divided by depth 10-yr flood	Low floodplain area having hydric soils with high organic content (percent)	Fraction of basin regulated for flood control	Low floodplain area connected to river (per mainstem channel length)	Natural vegetation cover on low floodplain (percent)	Active channel area bordering forest (percent)	Active channel areas bordering roads or levees (percent)	Natural vegetation cover on valley bottom (percent)	Number of salmon stocks	Active channel area (divided by mainstem length)	Active channel edge length (perimeter)	Floodplain area connected to river channel	Length of rivers upstream that support salmon
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ECOLOGICAL FUNCTIONS

1. Store and route flood water
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6. Supports salmon spawning and migration (channel dynamics)
7. Supports riparian forest and wetlands
8. Act as a corridor for terrestrial migration

FLOOD-RELATED HAZARDS

1. Inundation during major winter storms (2- to 10-year floods)
2. Bank erosion
3. Channel avulsion
4. Levee over-topping or failure
5. Reliance on unsustainable maintenance and repair
6. Inundation during large (100-year) flood

FLOOD-RELATED EXPOSURE

1. Critical infrastructure
2. Residences
3. Commercial
4. Agriculture

Linking functions and hazards to indicators

100-yr flood divided by floodway width

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Levees in poor condition

Residential and commercial land use on floodplain

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Flood insurance claims in valley bottom area
Hospitals, fire stations, wastewater discharges on low floodplain

Water systems on low floodplain

Levees in poor condition (?)

Area of agricultural land use

Area of industrial/commercial land use on low floodplain

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How is FbD project addressing degradation?

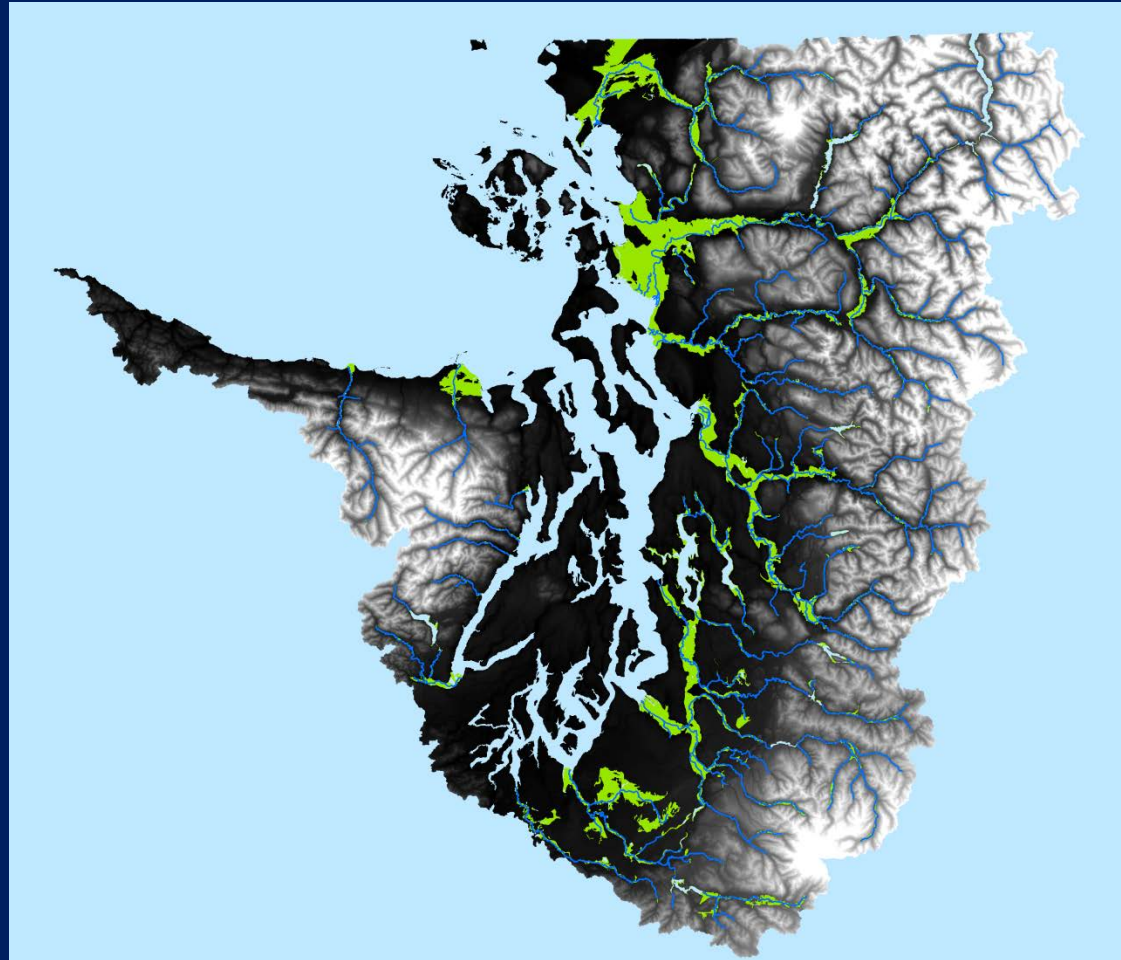
- Degraded areas are places where floodplain function could be improved.
- Degradation is “measured” in terms of human impacts rather than explicitly in terms of the loss of function.
- Human impacts that can be addressed by floodplain restoration projects: disconnection of floodplain areas by roads and levees, bank armoring, land cover changes (loss of forest), land use
- Human impacts that affect function but would not be addressed by floodplain restoration projects : flood regulation, water quality

Spatial Framework

Valley bottom areas along major rivers comprise about:

- 5%** of the basin;
- 30%** of highly developed urban areas; and
- 70%** of cultivated land

(Land cover data from NOAA Coastal Change Analysis Program , 2006)



Terminology

Valley bottom: areas < 10 m above river elevation (green)

Low floodplain: areas below ~ 10-yr stage (light blue)

Active channel: areas below ~ 2-yr stage and connected to river (dark blue – except disconnect patches)



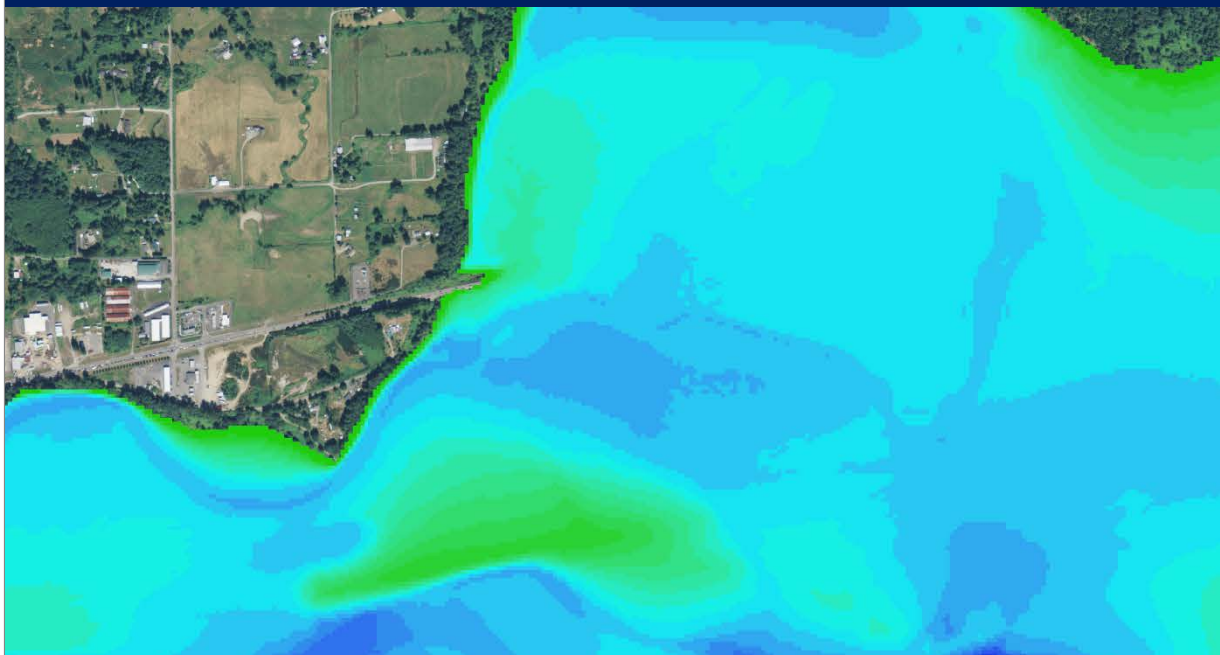
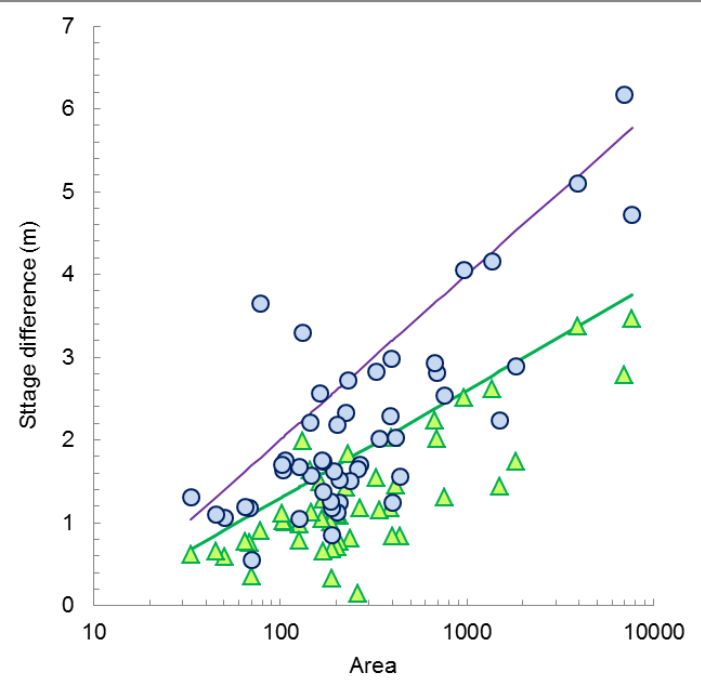


Valley bottom: areas < 10 m above river

Active channel

Low floodplain: areas < 10 yr stage

Skykomish River at the confluence with Wallace River

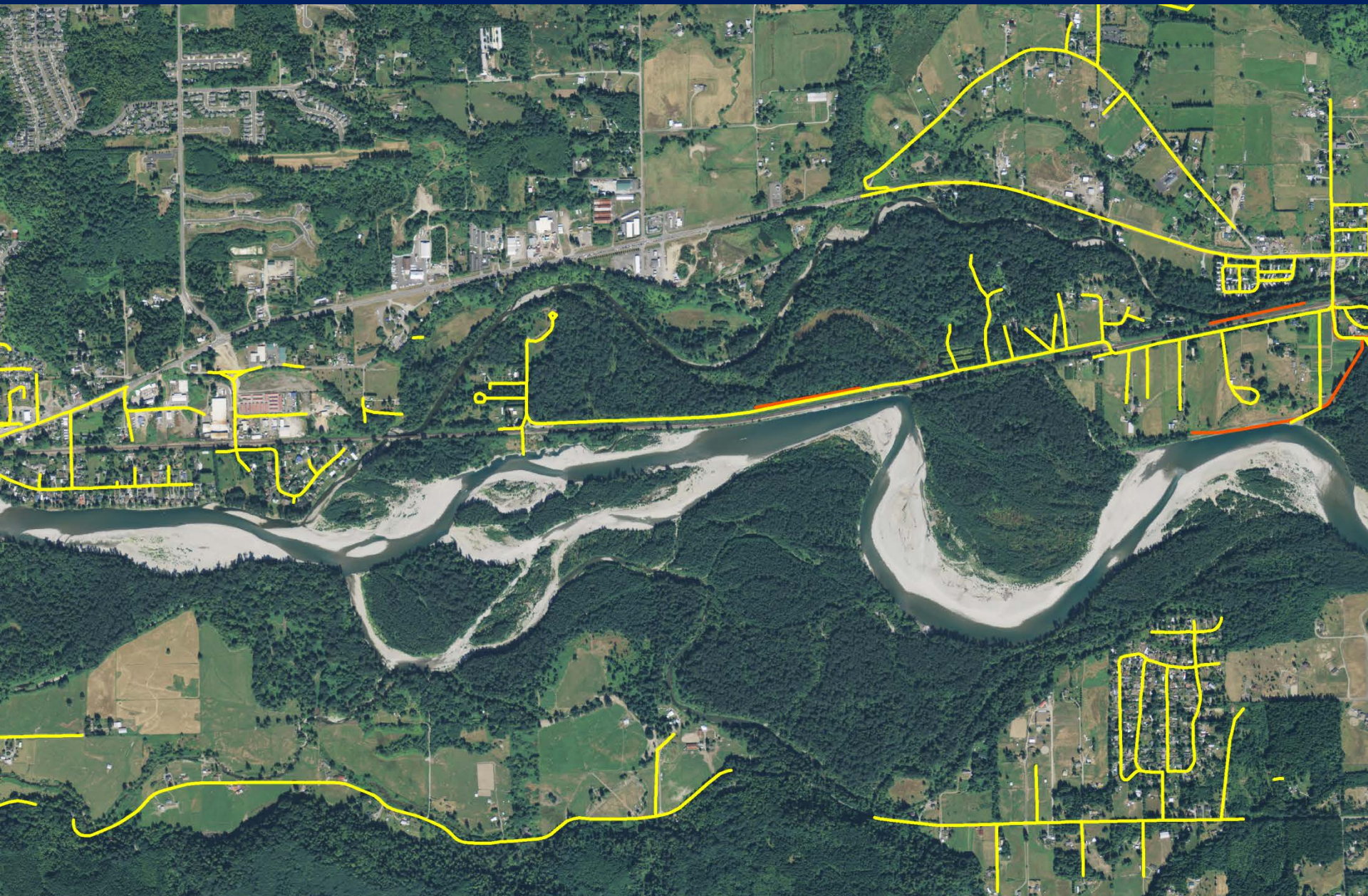


Active channel

Low floodplain: areas < 10 yr stage

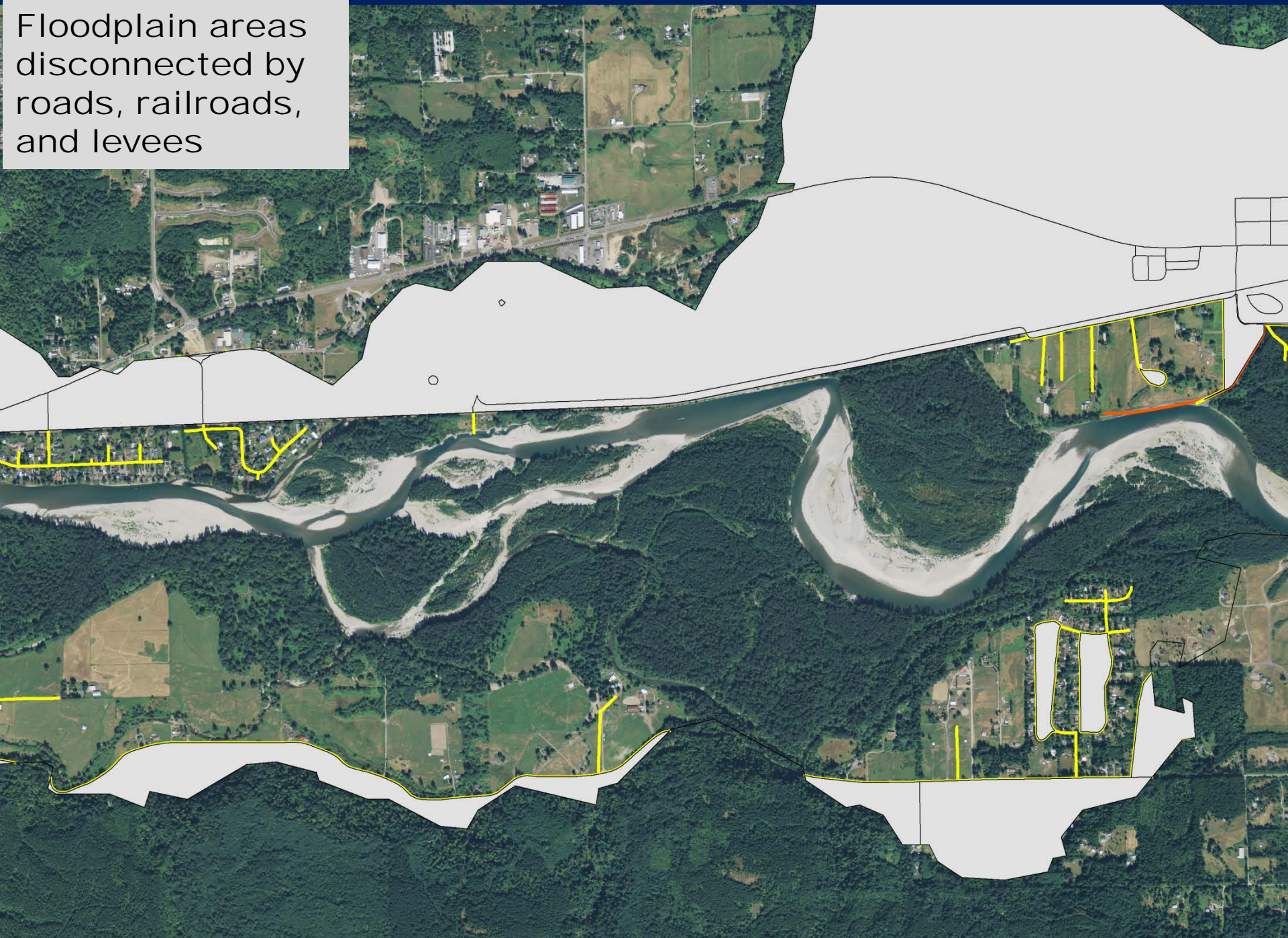
Valley bottom: areas < 10 m above river

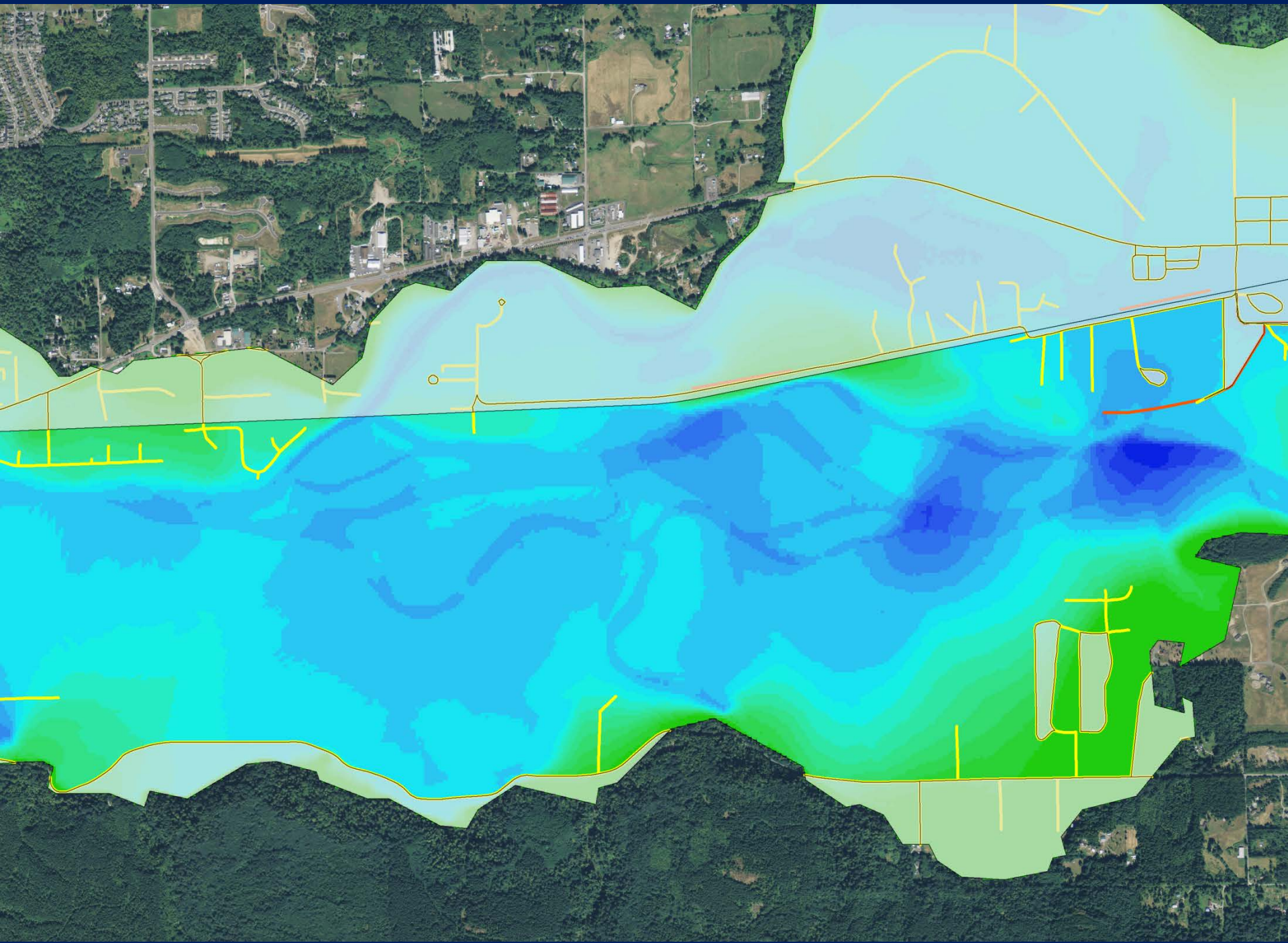
Height above Water Surface (HAWS) combined with river stage



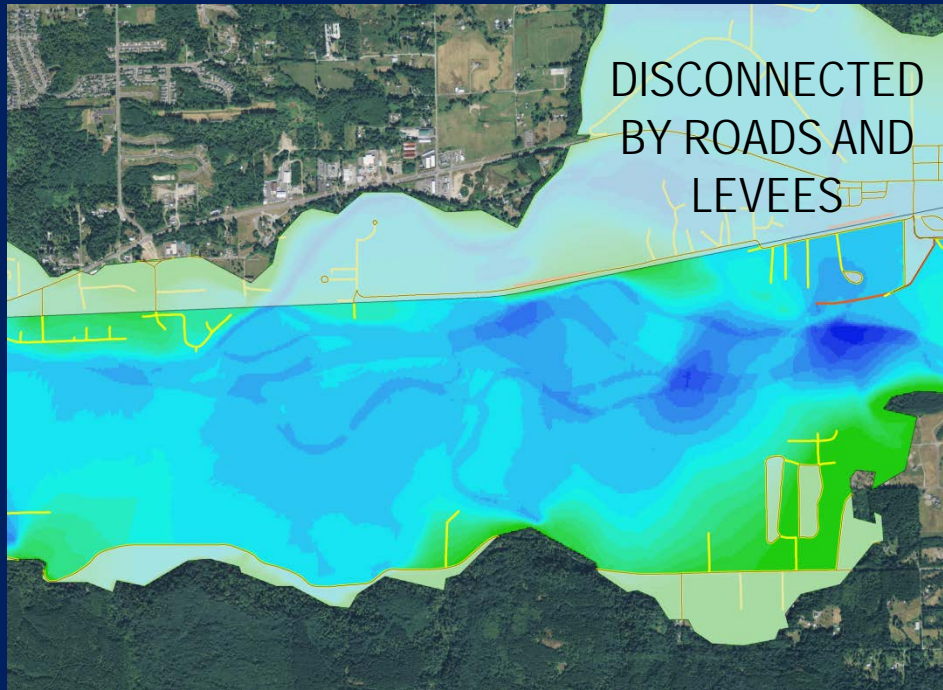
Roads and levees will be used to assess bank armoring

Floodplain areas disconnected by roads, railroads, and levees





Ecological function and flood-related risk vary across a floodplain based on lateral and vertical proximity and connectivity to a river

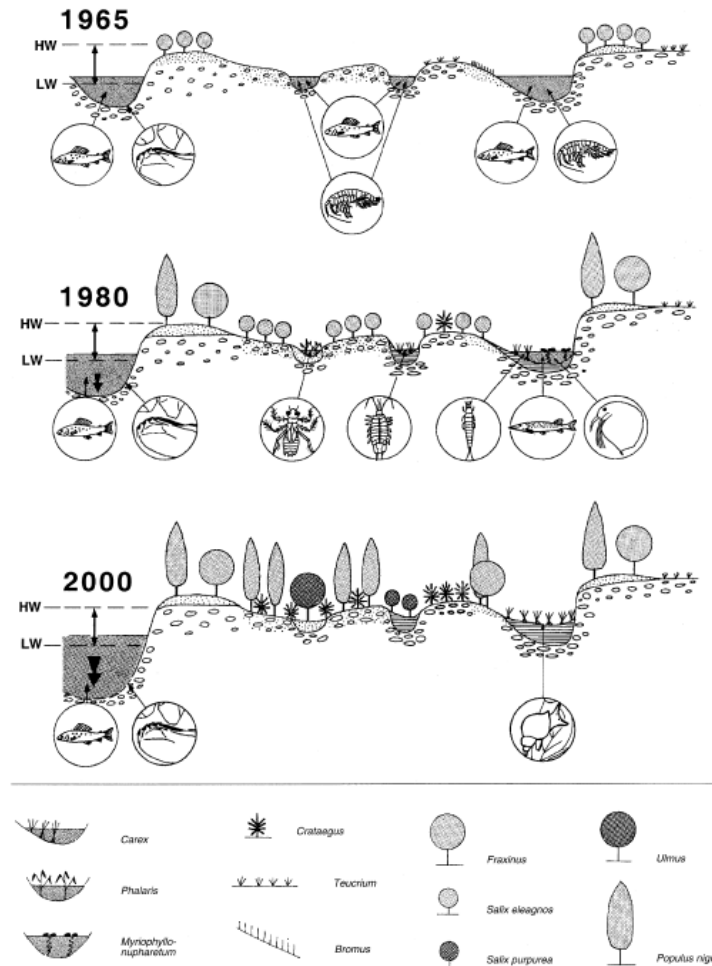


Land surface elevation relative to the Skykomish River

Areas closer to the channel are disturbed more frequently, wide floodplains are needed to support succession of late seral stage vegetation (Konrad 2012)

Floodplain succession transect

Source: Ward et al. 2002



Overview for Puget Sound Floodplains

	<u>Area</u>	<u>Currently connected</u>
Valley bottom:	2,800 sq km	1,700 sq km
Low floodplain:	2,200 sq km	1,400 sq km
Active channel:	1,400 sq km	990 sq km

1 sq km ~ 250 acres

Assessment Output

Qualitative rating (high, medium, low):

- Current condition of each ecological function
- Current level of each hazard or exposure

Categories and narrative description of potential:

- To improve function and types of actions needed (e.g., reconnect floodplain, re-forestation)
- To reduce risk and types of actions needed

Some technical issues related to the target

- Different parts of a floodplain have different functions
(compare the active channel to distant parts of the valley bottom)
- Each function is impacted by a different set of human actions
- Degree of degradation depends on both the functions impacted and the spatial extent of those impacts

FbD approach

Assess each function independently based on a specified set of human actions that impact that function

Use a “binary” assessment of degradation locally (is a given function impacted by human actions at a point on the floodplain?)

Assess the degree of degradation in terms of area (how much of a floodplain is impacted?)

Focus on “improving” function rather than “restoring” function (“restoration” connotes a high level of all functions)

Fundamental issues regarding floodplain indicators

Floodplains are important to people (30% of highly urban area and 70% of cultivated area)

Do human uses figure into floodplain indicators?

Others?

Questions?

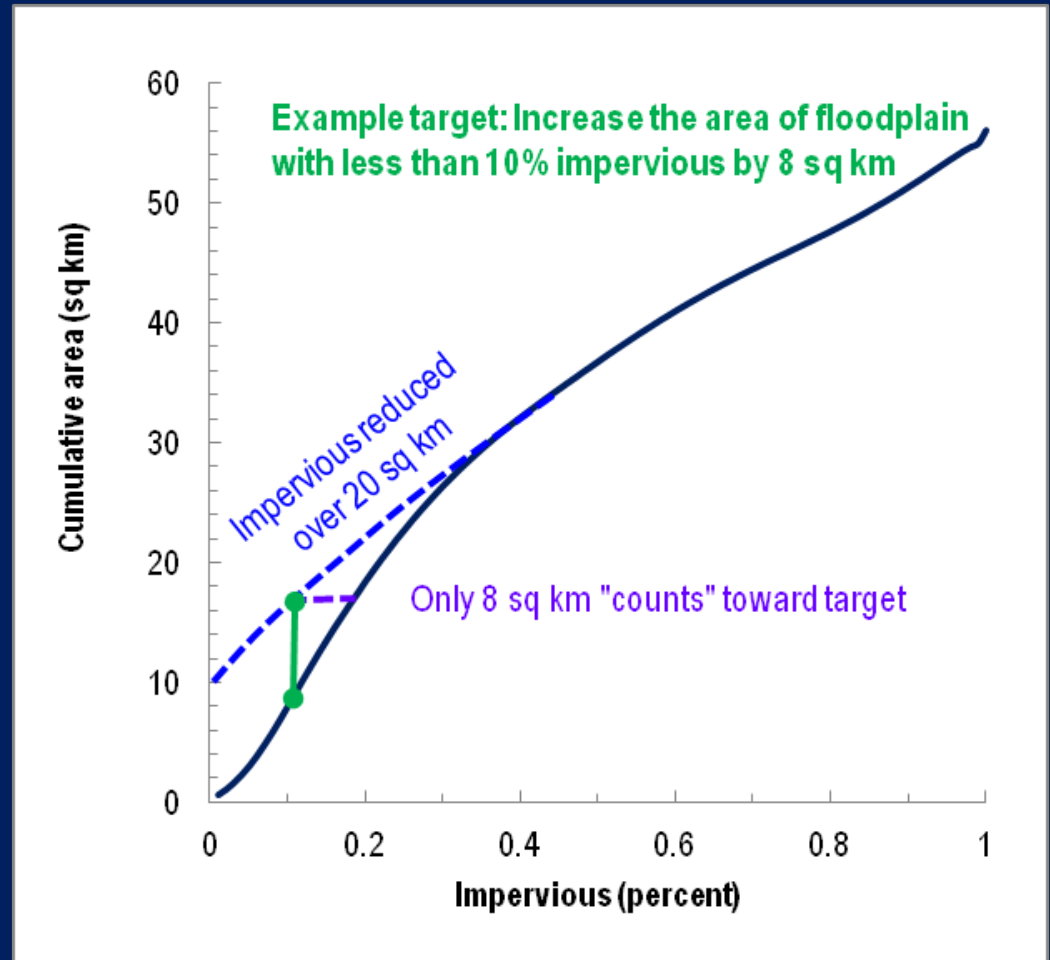
No scientific thresholds for “degraded” and “functional”

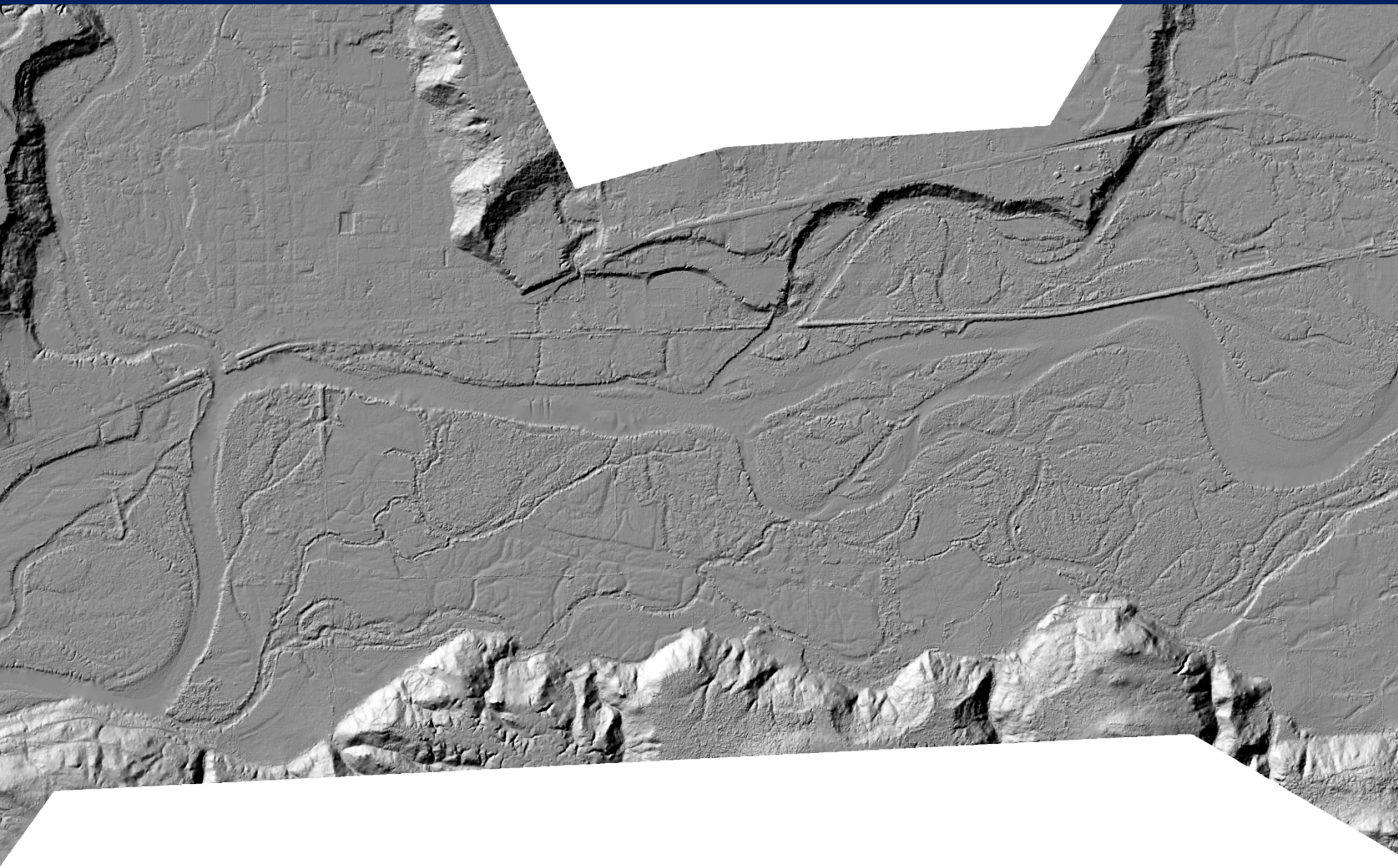
“Degraded” and “functional” need to be interpreted:

1) to calculate the area of floodplain for the recovery target;

2) to identify the places where function can be recovered; and

3) to assess the degree of improvement required for recovery.





LiDAR data may be used to resolve smaller features

LiDAR coverage in Puget Sound

