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

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USGS
science for a changing world

# Floodplains by Design Project

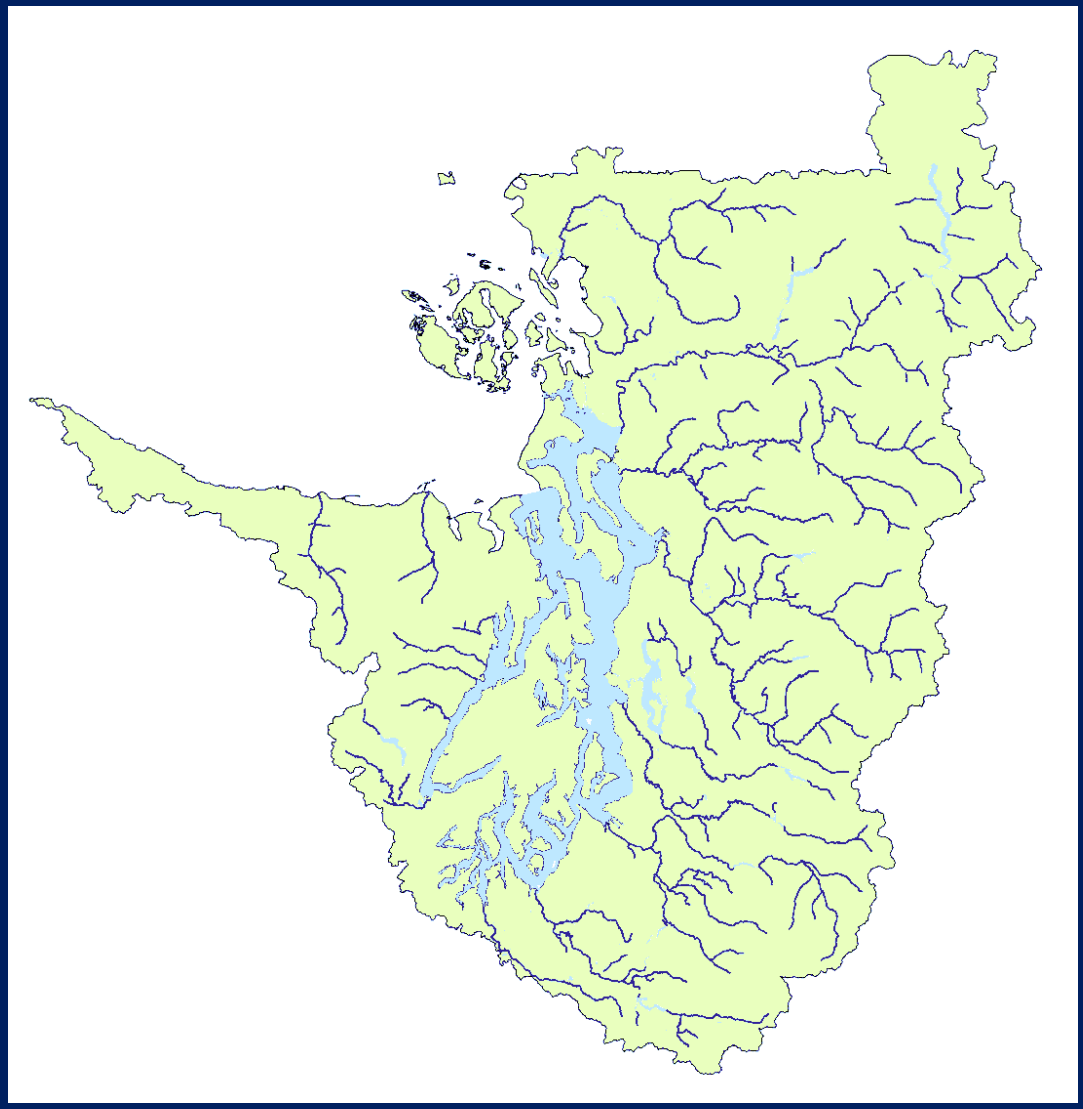
Goals:

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

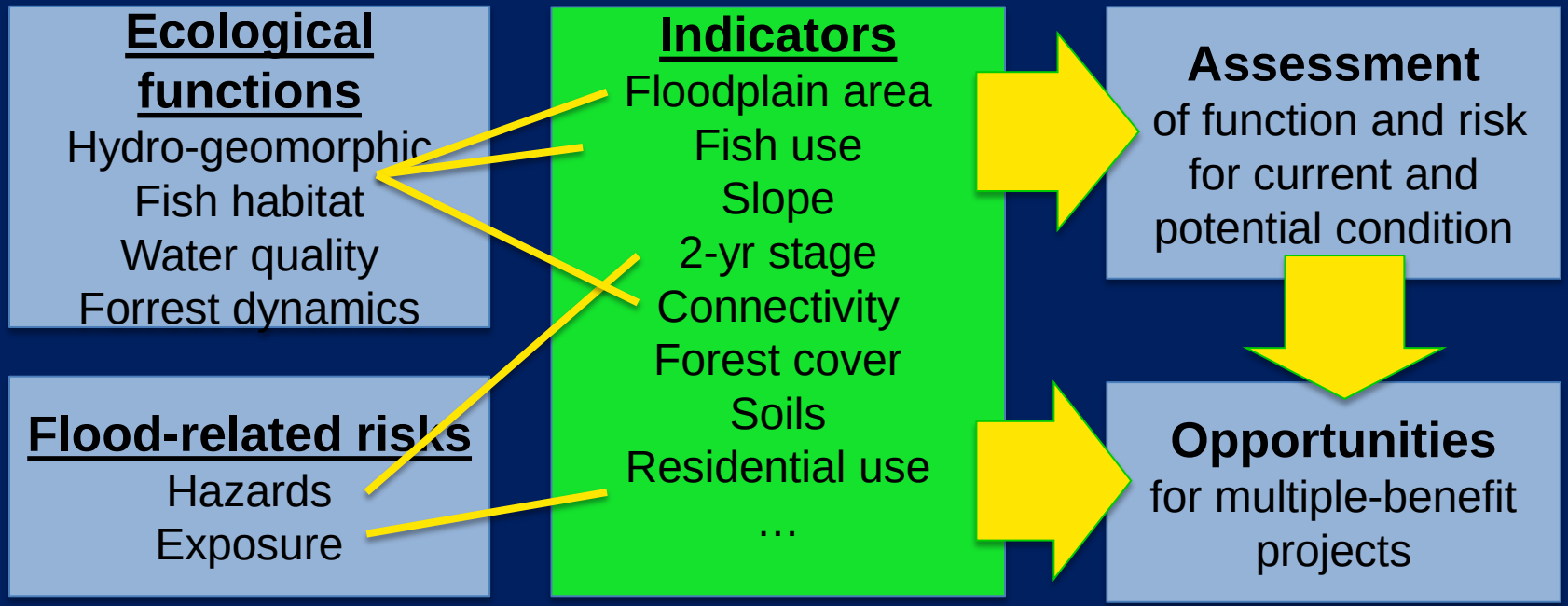
Develop funding sources and policy solutions to accelerate floodplain recovery.

Partners:

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



# Analytical Framework for Floodplain Assessmentt




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 commerical 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 agricultura 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ECOLOGICAL FUNCTIONS | | | | | | | | | | | | | | | |
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| 4. Provide rearing habitat for salmon | | | | | | | | | | | | | | | |
| 5. Provide flood refugia for salmon | | | | | | | | | | | | | | | |
| 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 | | | | | | | | | | | | | | | |
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| 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 | Channel banks | High sinuosity | Post-glacial valley, decreasing valley slope | Levees in 100-yr floodplain | Levees in poor condition | Residential and commerical 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 | Levees in poor condition (?) | Area of agricultura land use | Area of industrial/commercial land use on low floodplain |
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# How is FbD project addressing degradation?

- Degraded area are places where floodplain function could be improved.
- Degradation is "measured" in terms of human impacts rather than explicitly in term 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

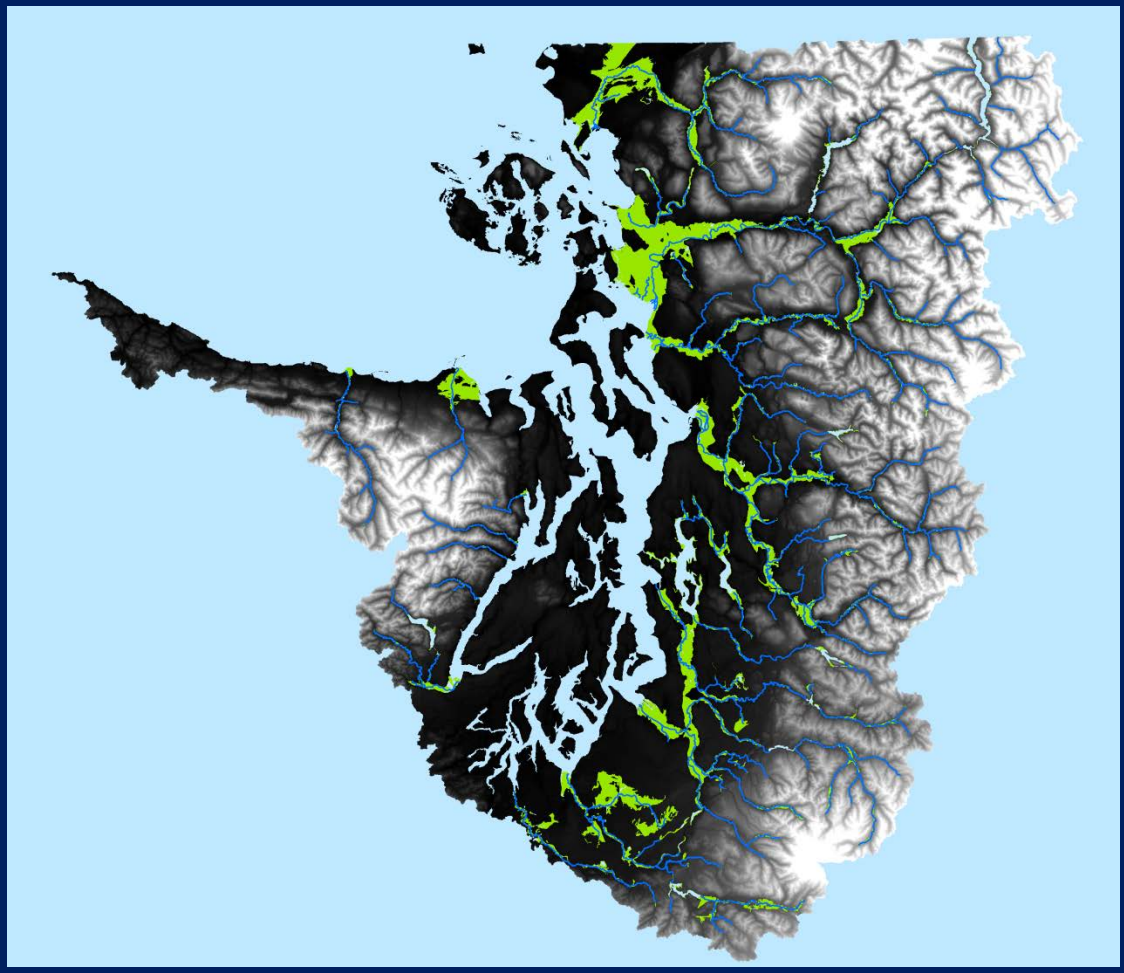
Valley bottom areas along major rivers comprise about:

**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*)

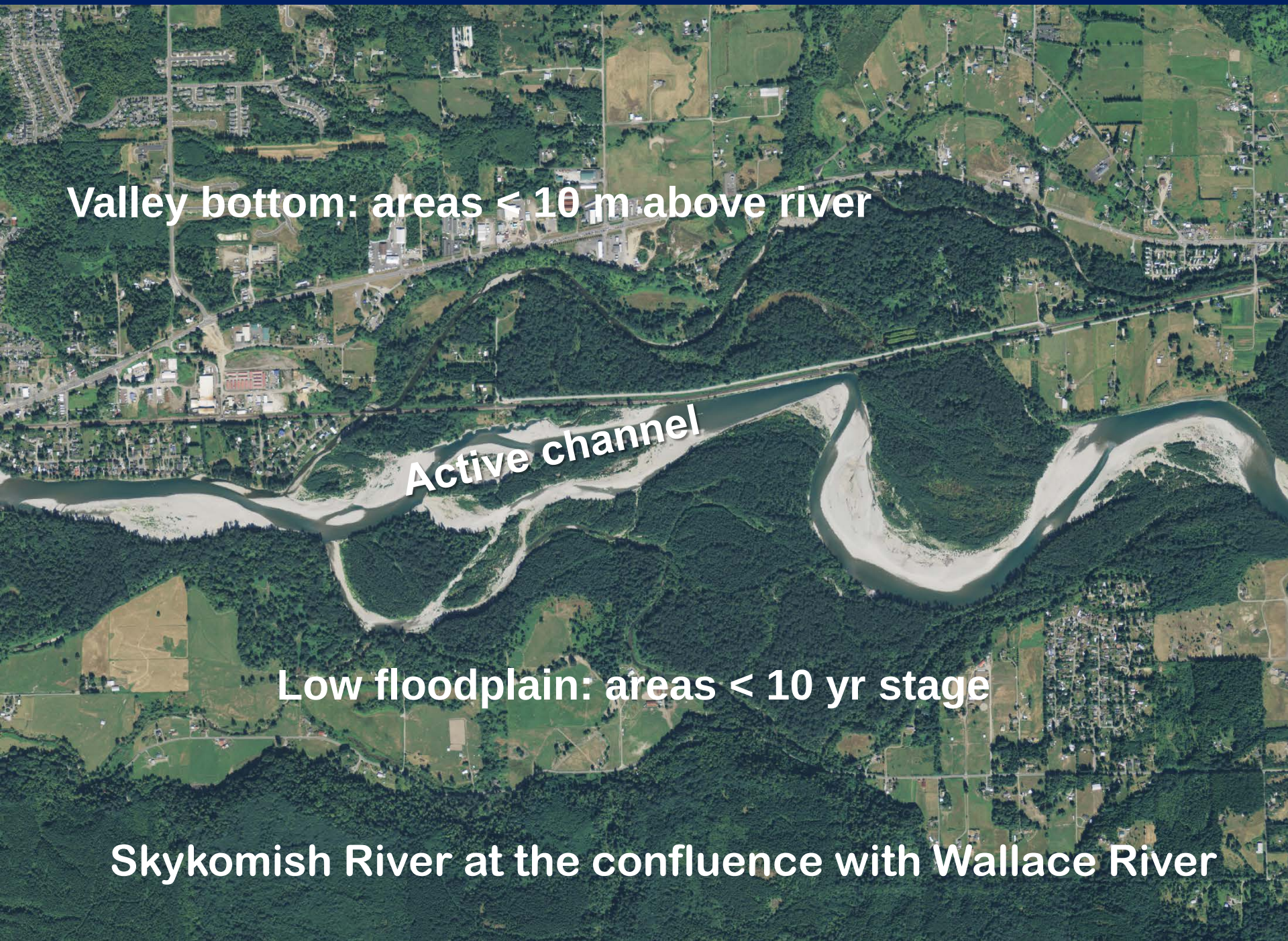


# Terminology

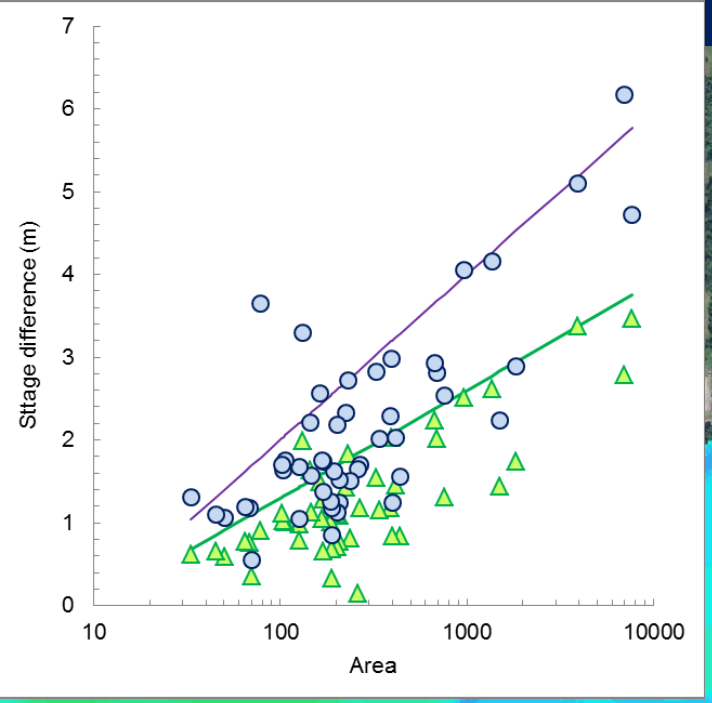
Valley bottom: areas < 10 m above river elevation (green)

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)




Skykomish River at the confluence with Wallace River




Active channel

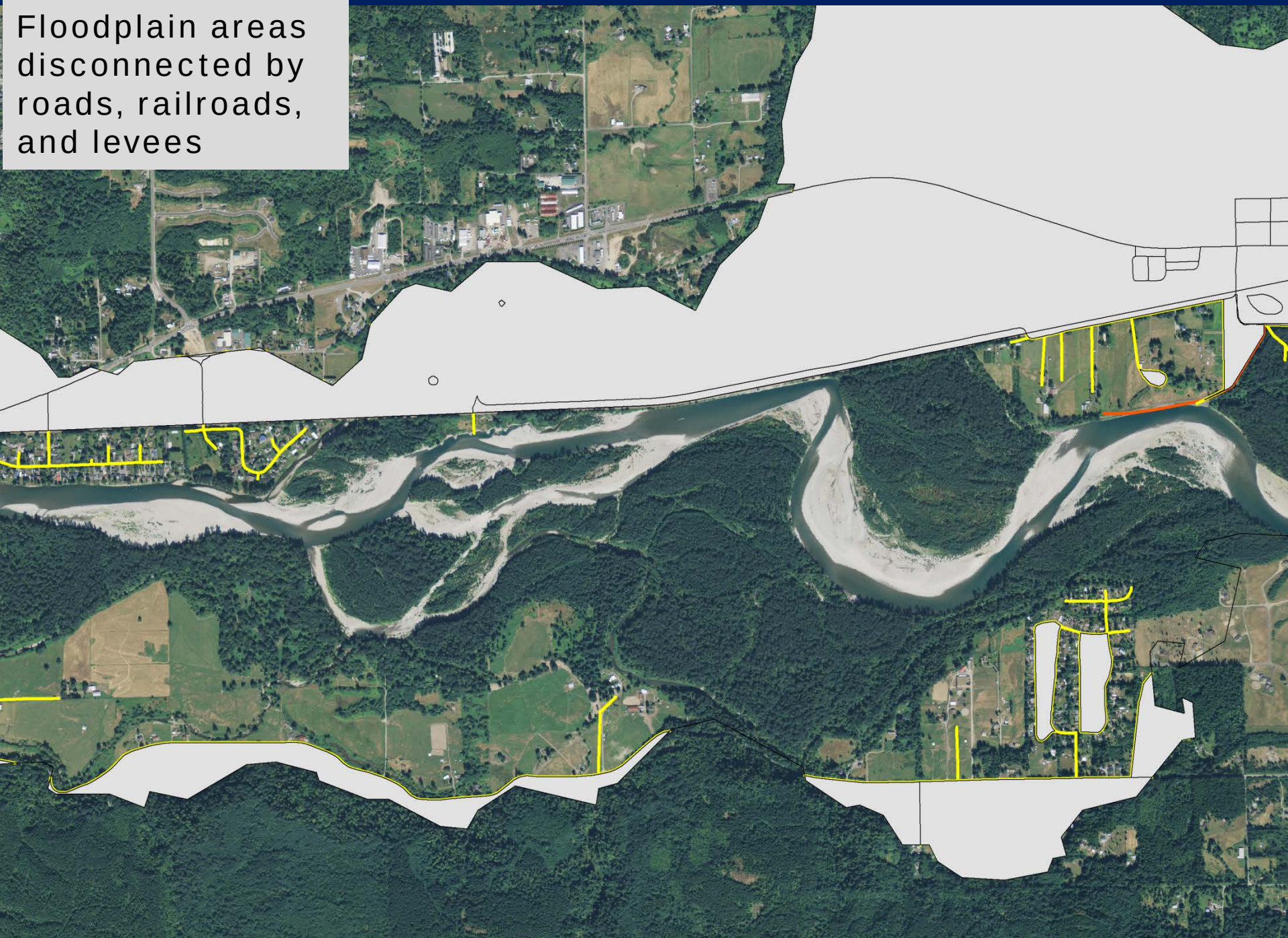
Low floodplain: areas < 10 yr stage

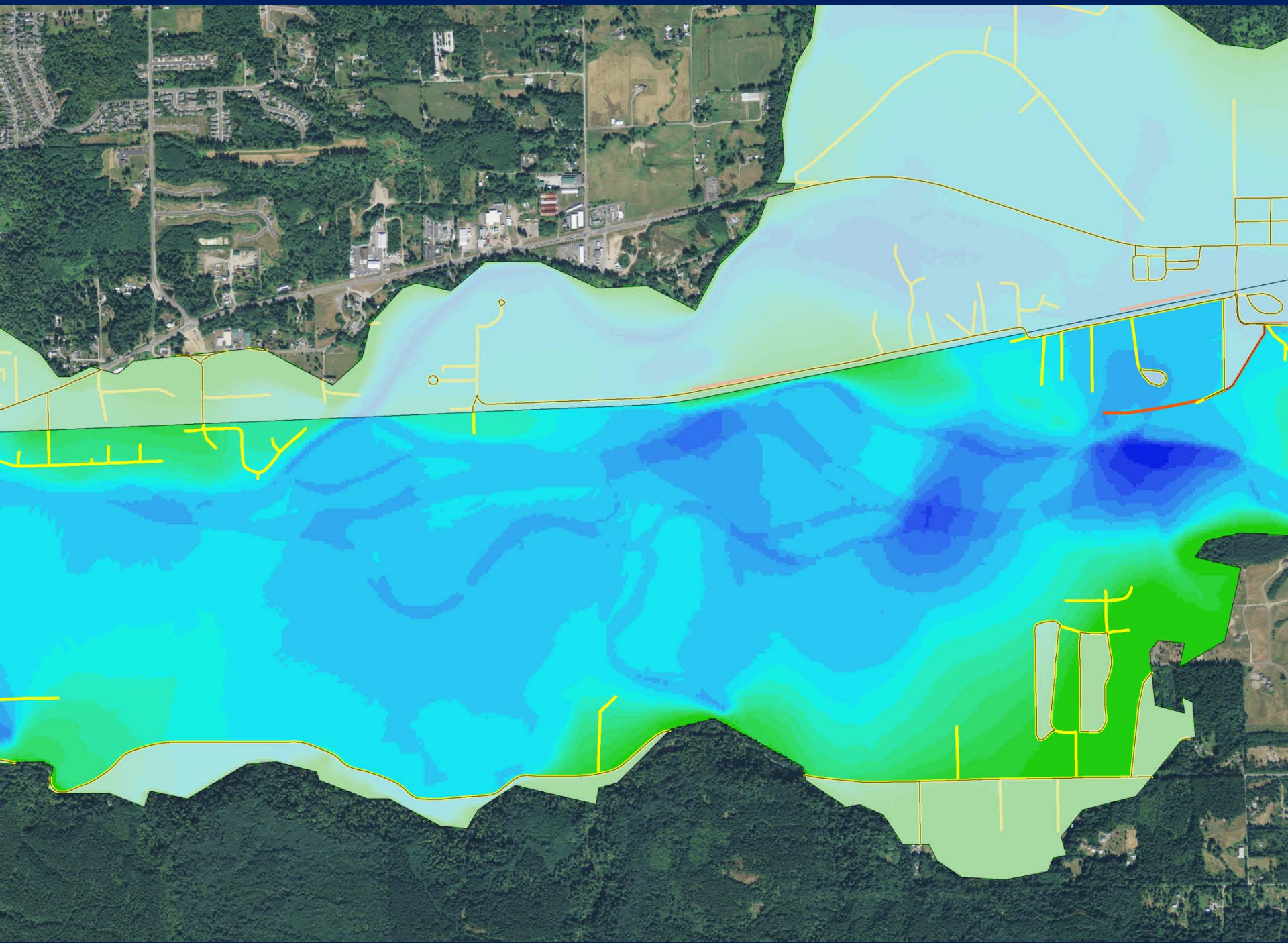
Valley bottom: areas < 10 m above river

Height above Water Surface (HAWS) combined with river stage

Roads and levees will be used to assess bank armoring

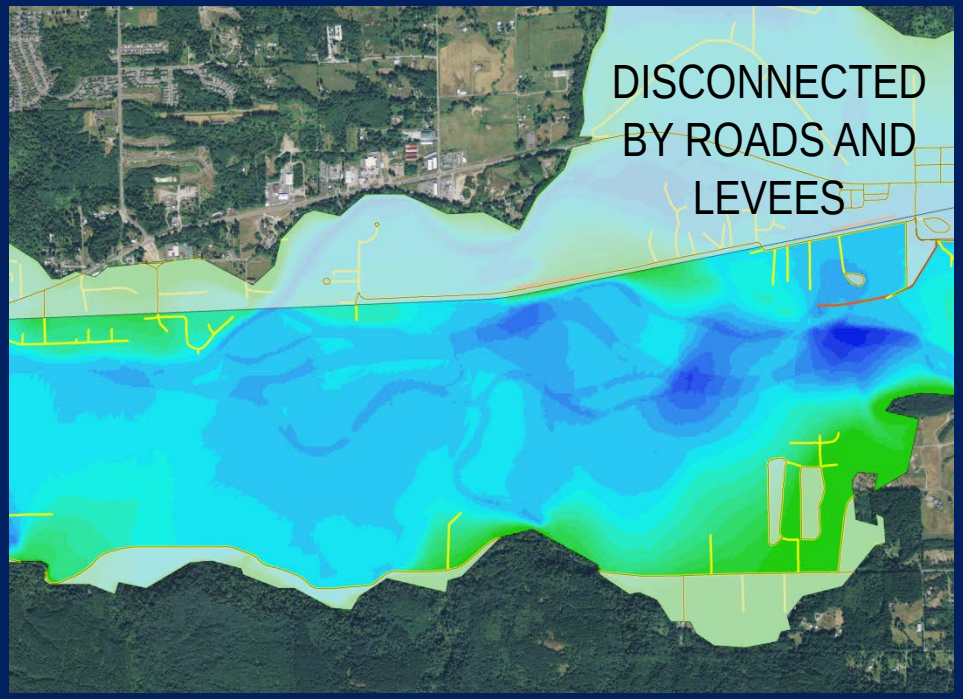
Floodplain areas disconnected by roads, railroads, and levees





# Ecological function and flood-related risk vary across a floodplain

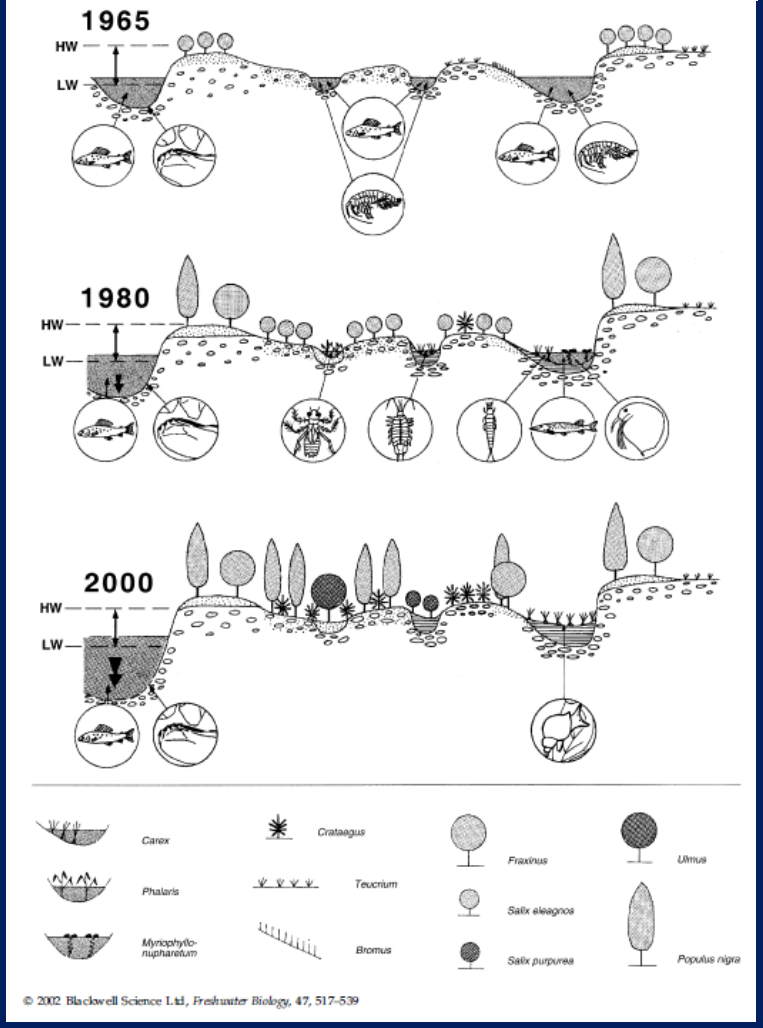
based on lateral and vertical proximity and connectivity to a river




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

| | Area | Currently connected |
|---|---|---|
| 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?

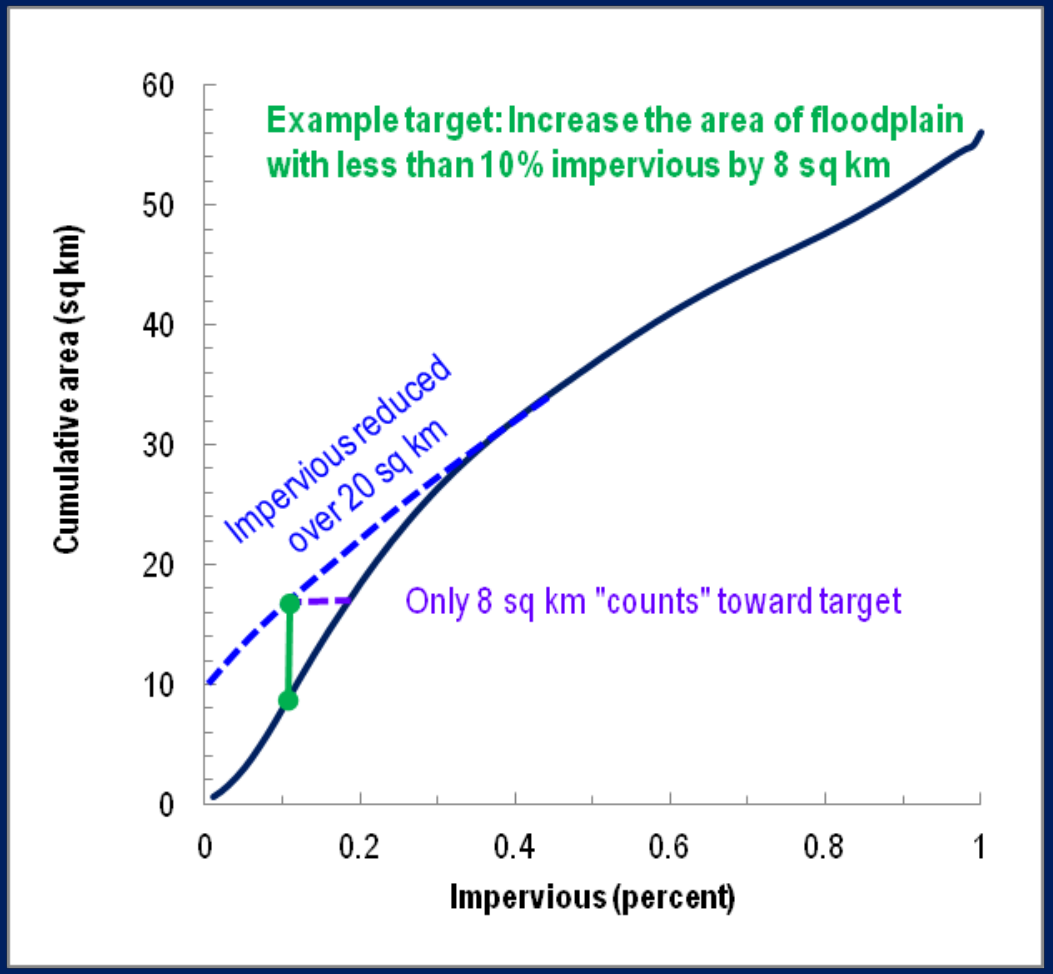
# No scientific thresholds for “degraded” and “functional”

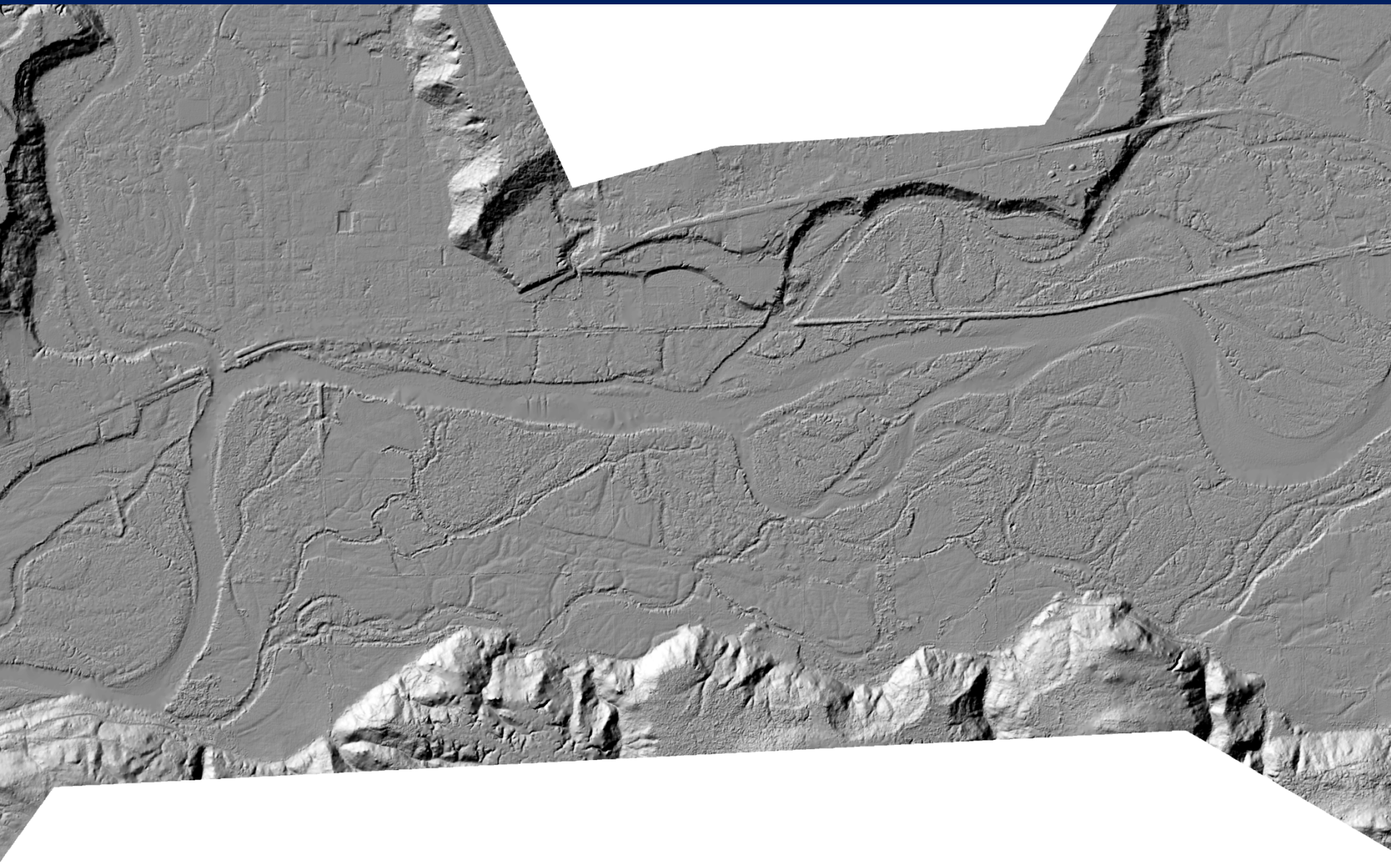
“Degraded” and “functional” need to be interpreted:

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 improvement required for recovery.





LiDAR data may be used to resolve smaller features

# LiDAR coverage in Puget Sound