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Flow and Rearing Habitat Relations in the Willamette River:

Initial findings and next steps

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Adam Stonewall
Matthew Yates

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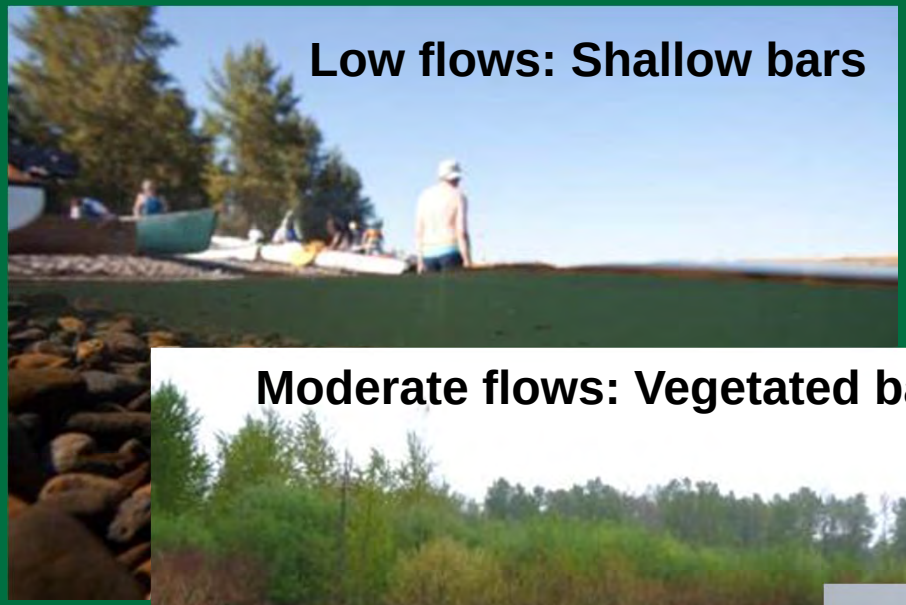
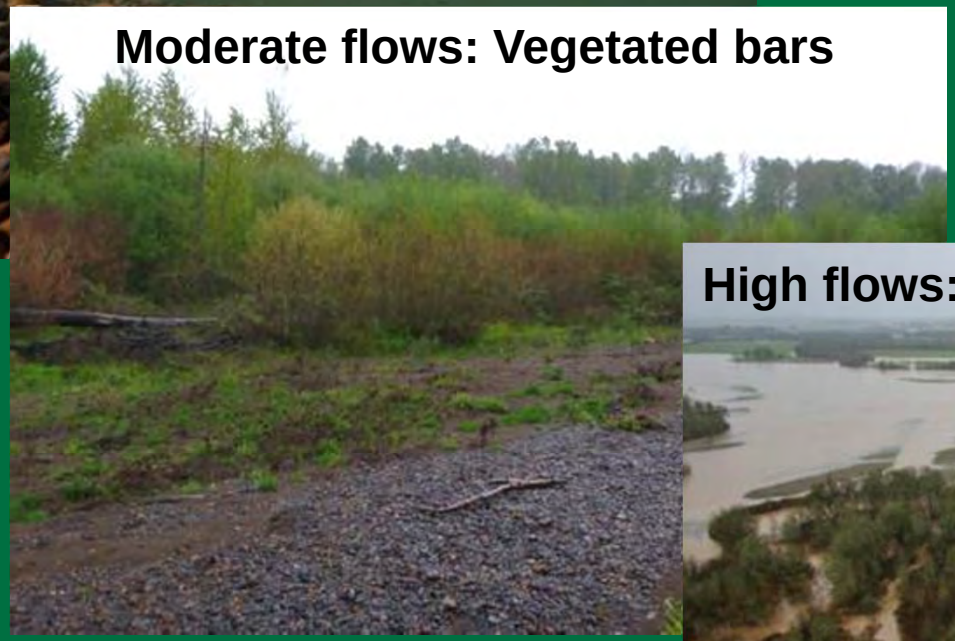
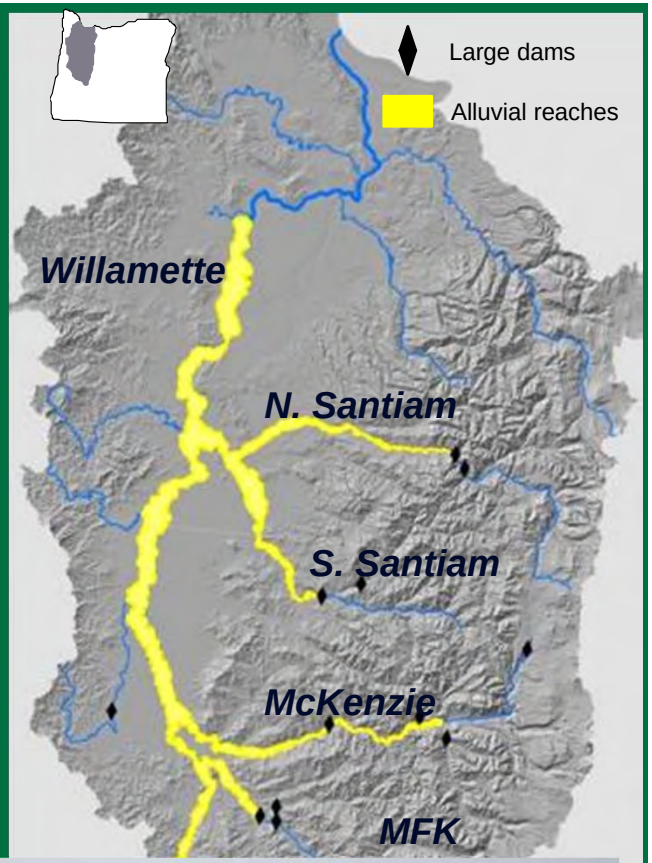
U.S. Geological Survey

Rearing Habitat for Spring Chinook







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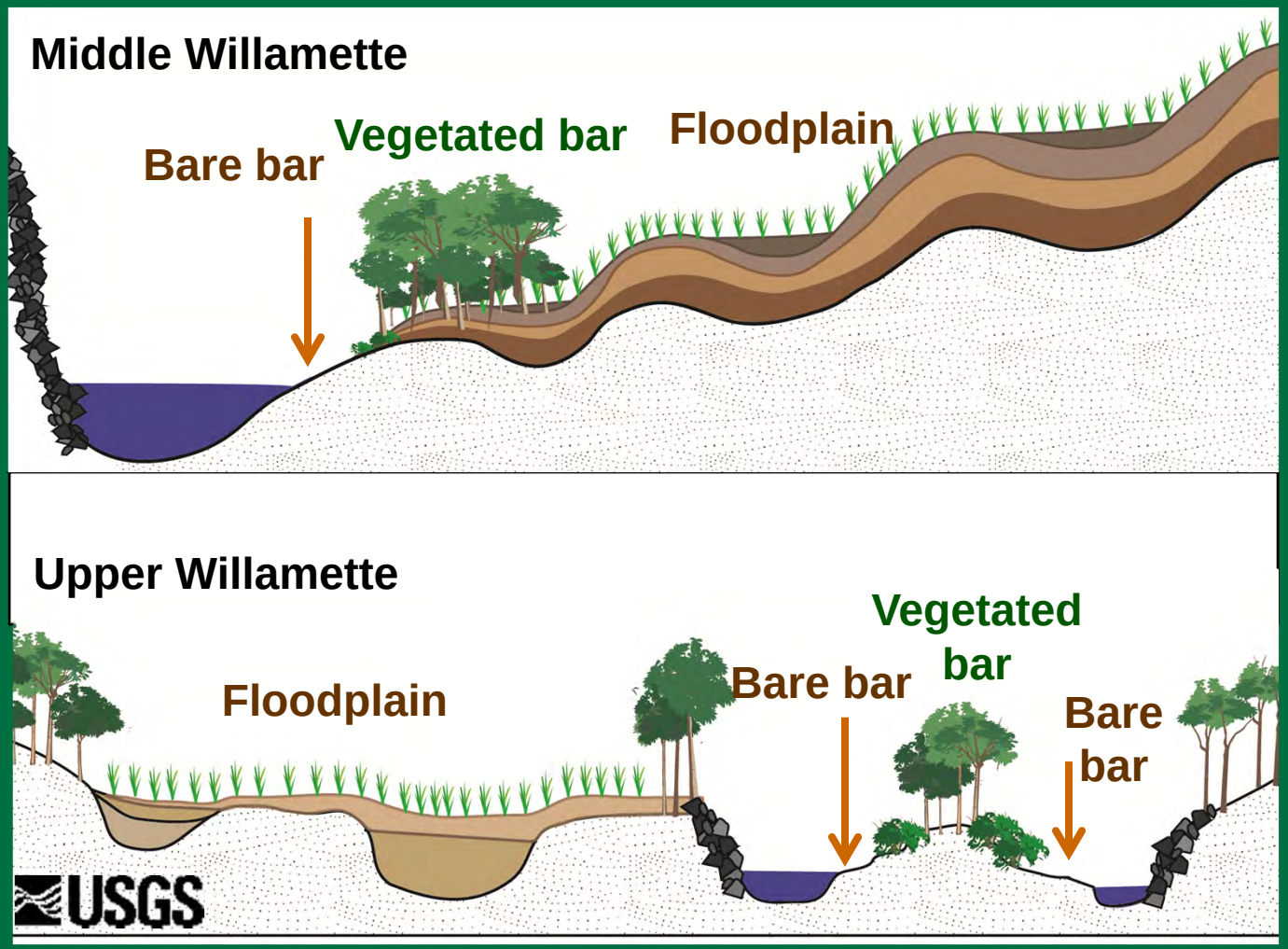
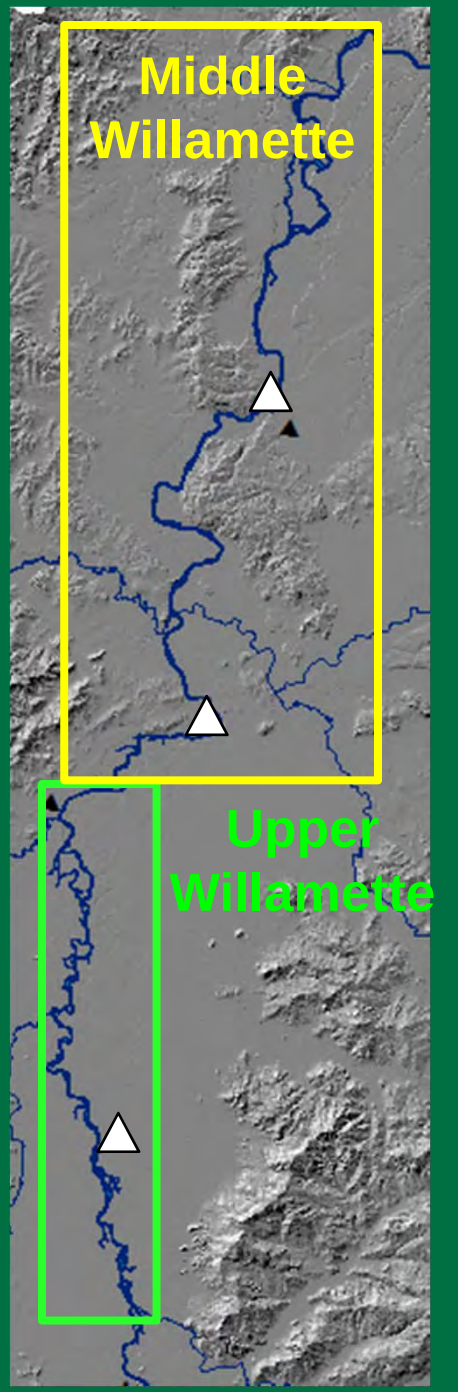
Habitat descriptions from Luke Whitman, Tom Friesen (ODFW) , Stan Gregory (OSU), Dave Hulse (UO), River Design Group

Photo courtesy Freshwaters Illustrated

Channel morphology and habitats vary longitudinally

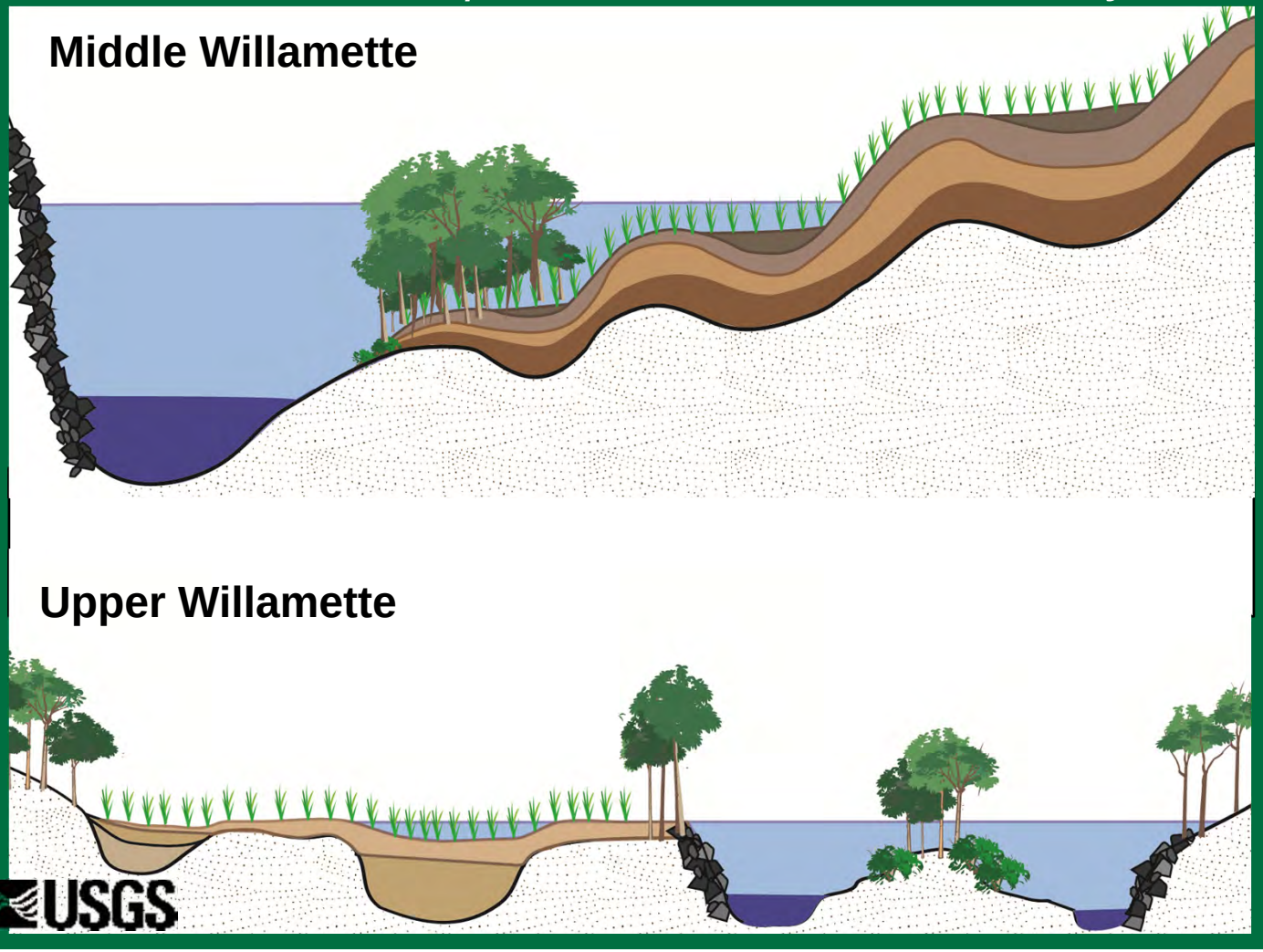
Channel morphology reflects large-scale geological controls, historical and present-day geomorphic processes

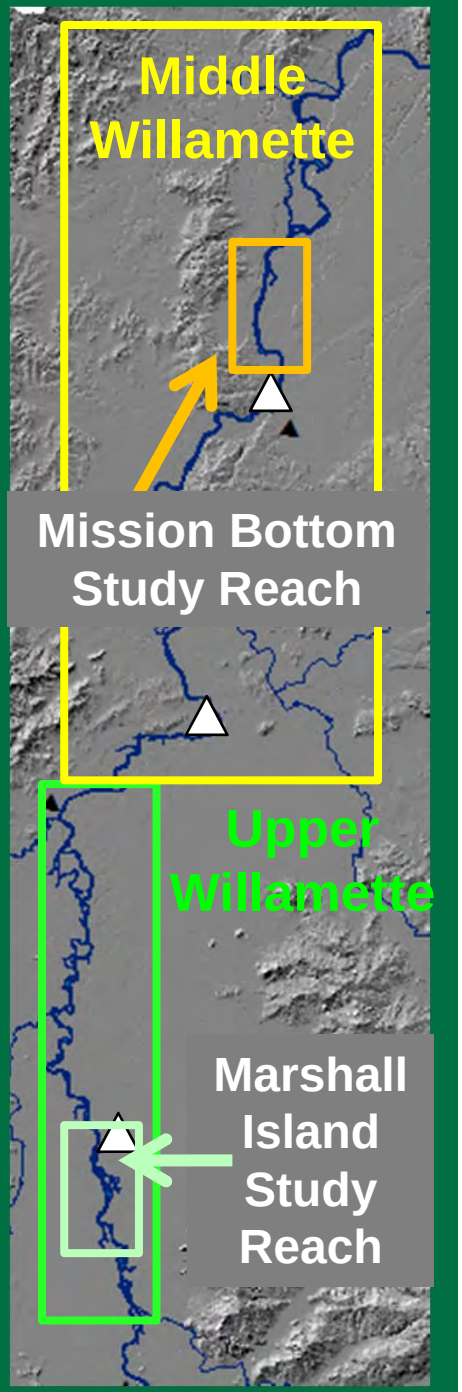




Hydrogeomorphology varies longitudinally

Interactions between flow, stage, floodplain morphology dictate inundation patterns and habitat availability





Willamette River Study Approach

Phase 1: Fall 2016

Low flow rearing habitats
6,000-12,000 cfs at Salem

Inundation mapping from aerial photographs collected at different flows

Moderate flow rearing habitats (12,000-40,000 cfs at Salem)

2D hydraulic modeling with existing data

Phase 2: Spring 2017

Detailed, river-scale 1D and 2D modeling and habitat classification using new bathymetric lidar

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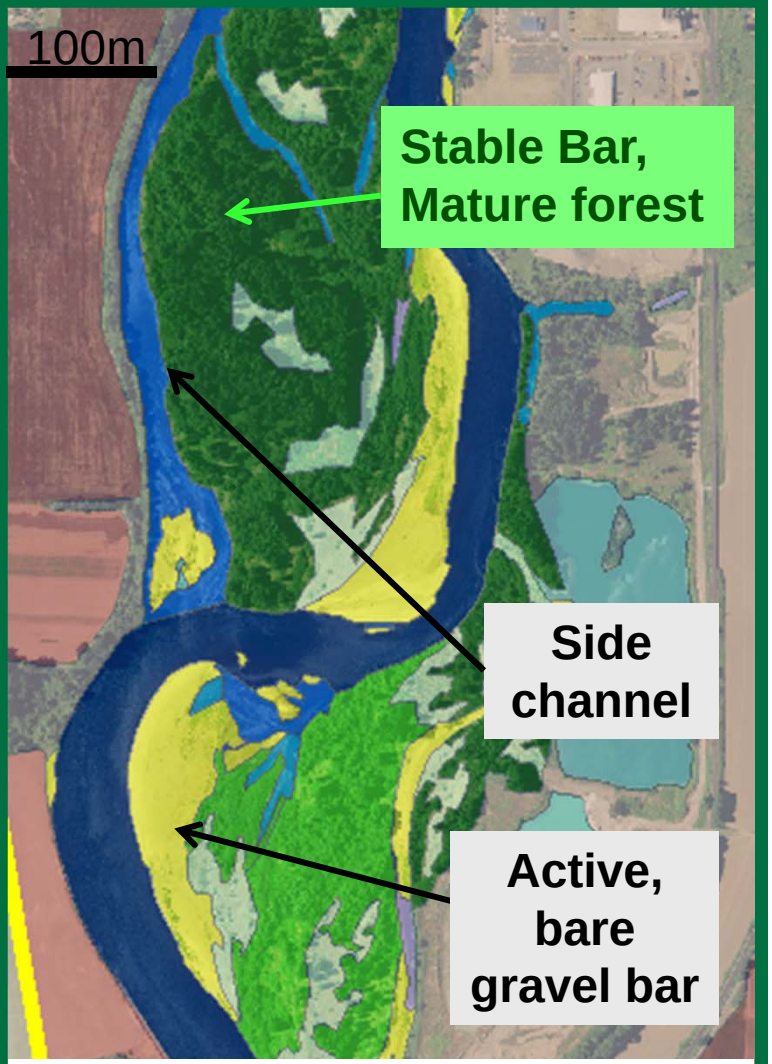
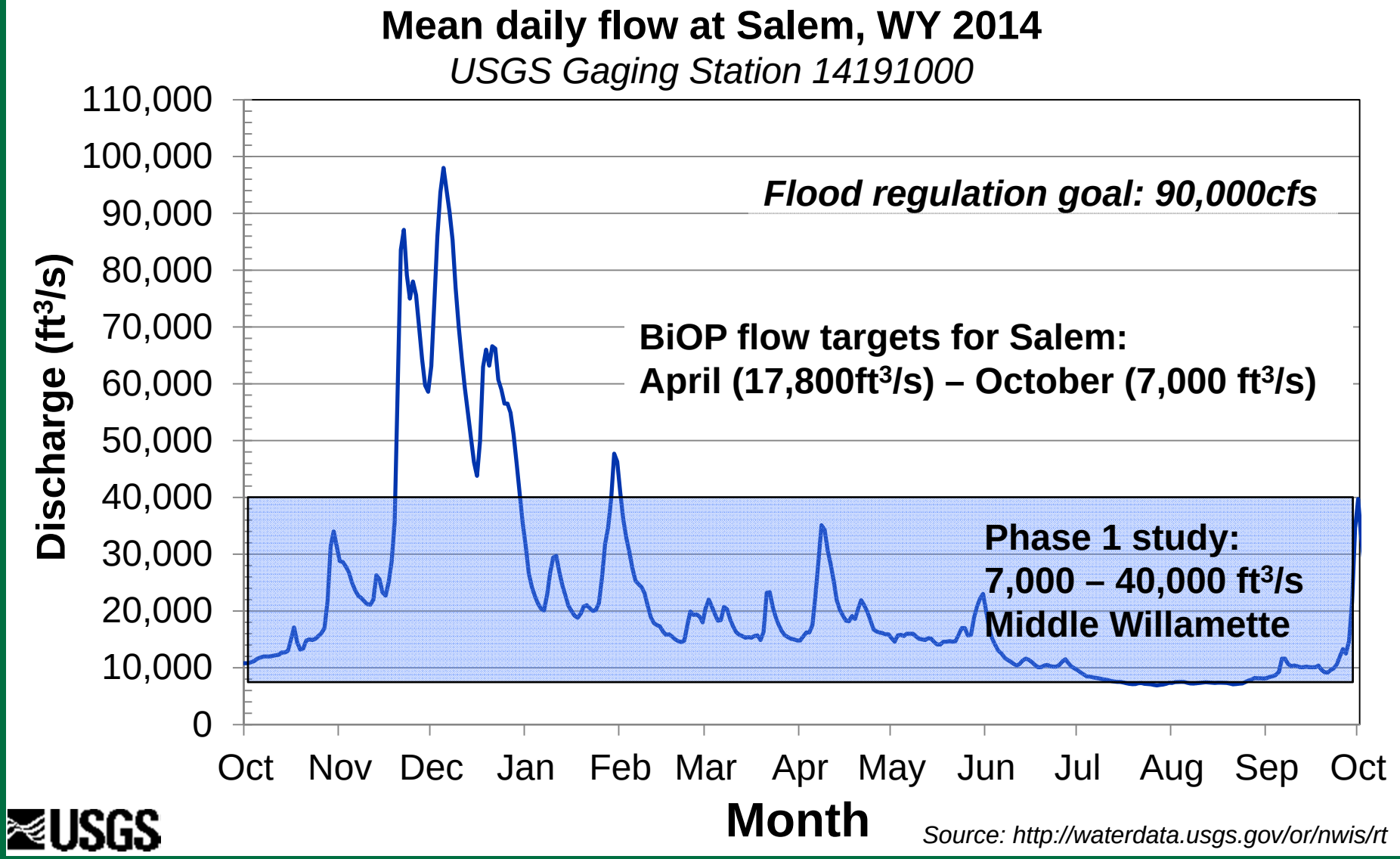
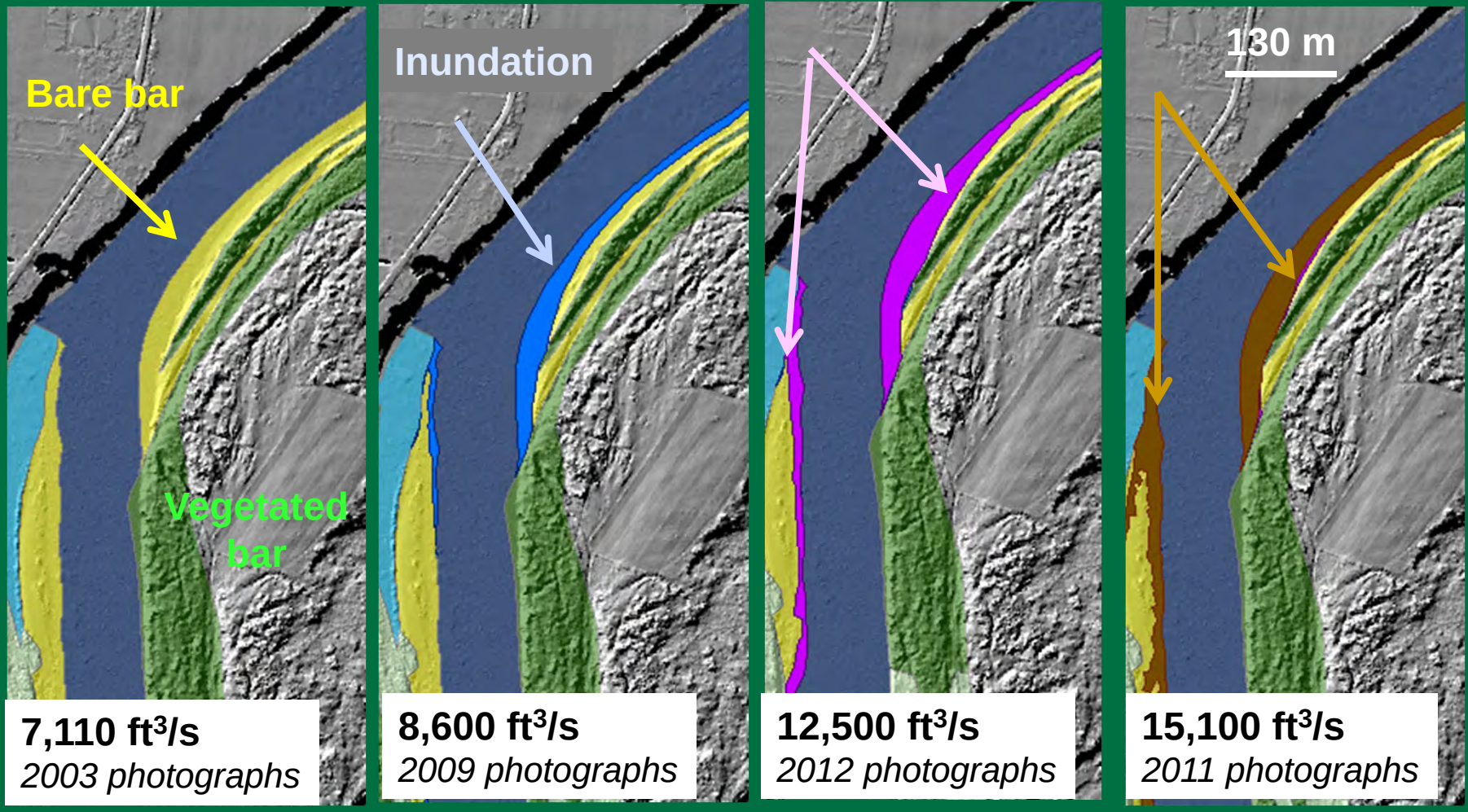


2016 NAIP aerial photograph and USGS geomorphic mapping. Provisional data.

Streamflow focus for this study: low to moderate flows



Low-flow shallow bar rearing habitat:
Mission Bottom Reach 7,100-15,100 ft³/s at Salem



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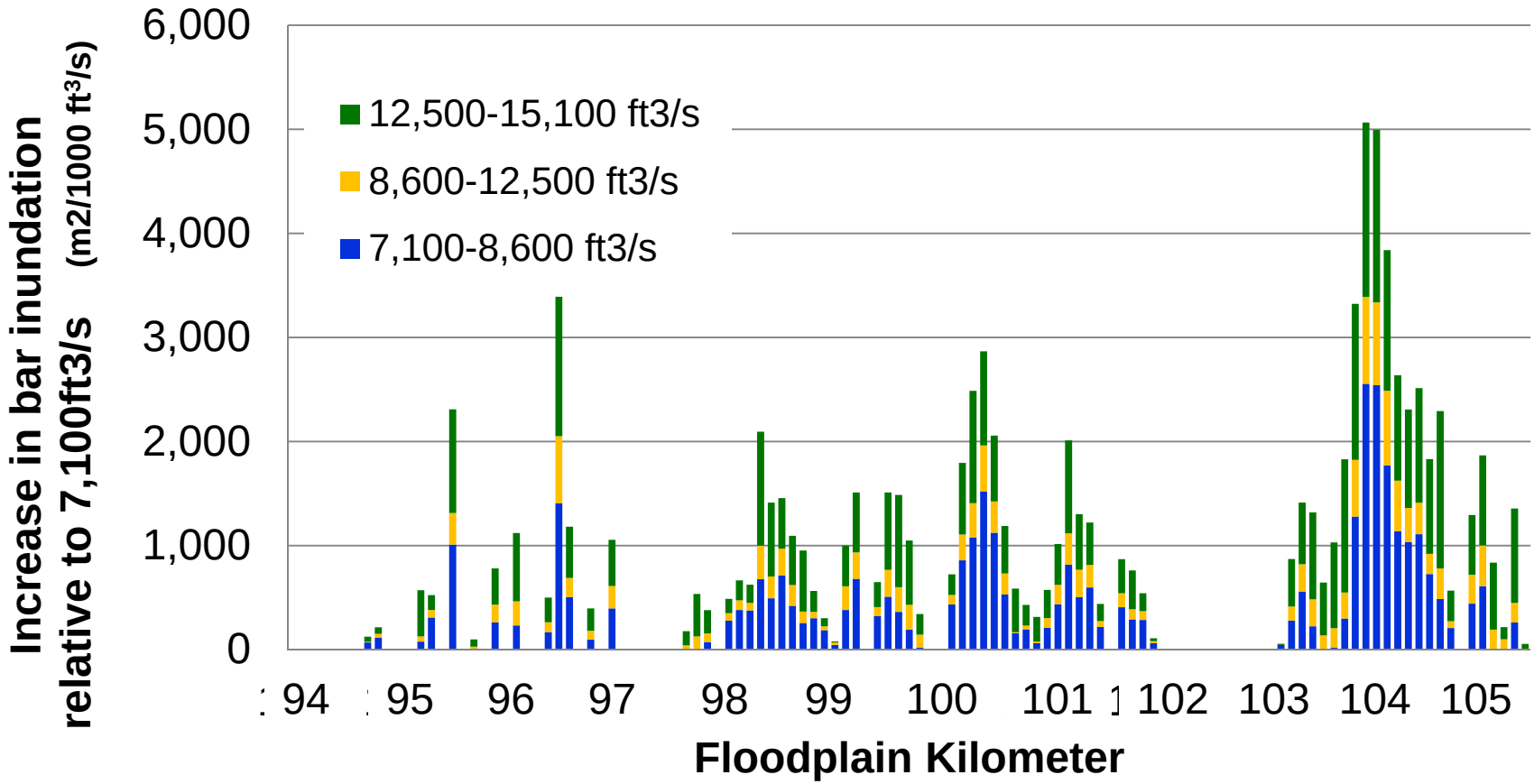
2008 lidar topography overlain with USGS aerial photograph mapping

Influence of flow on shallow bar habitat:
Mission Bottom Reach 7,100-15,100 ft³/s at Salem



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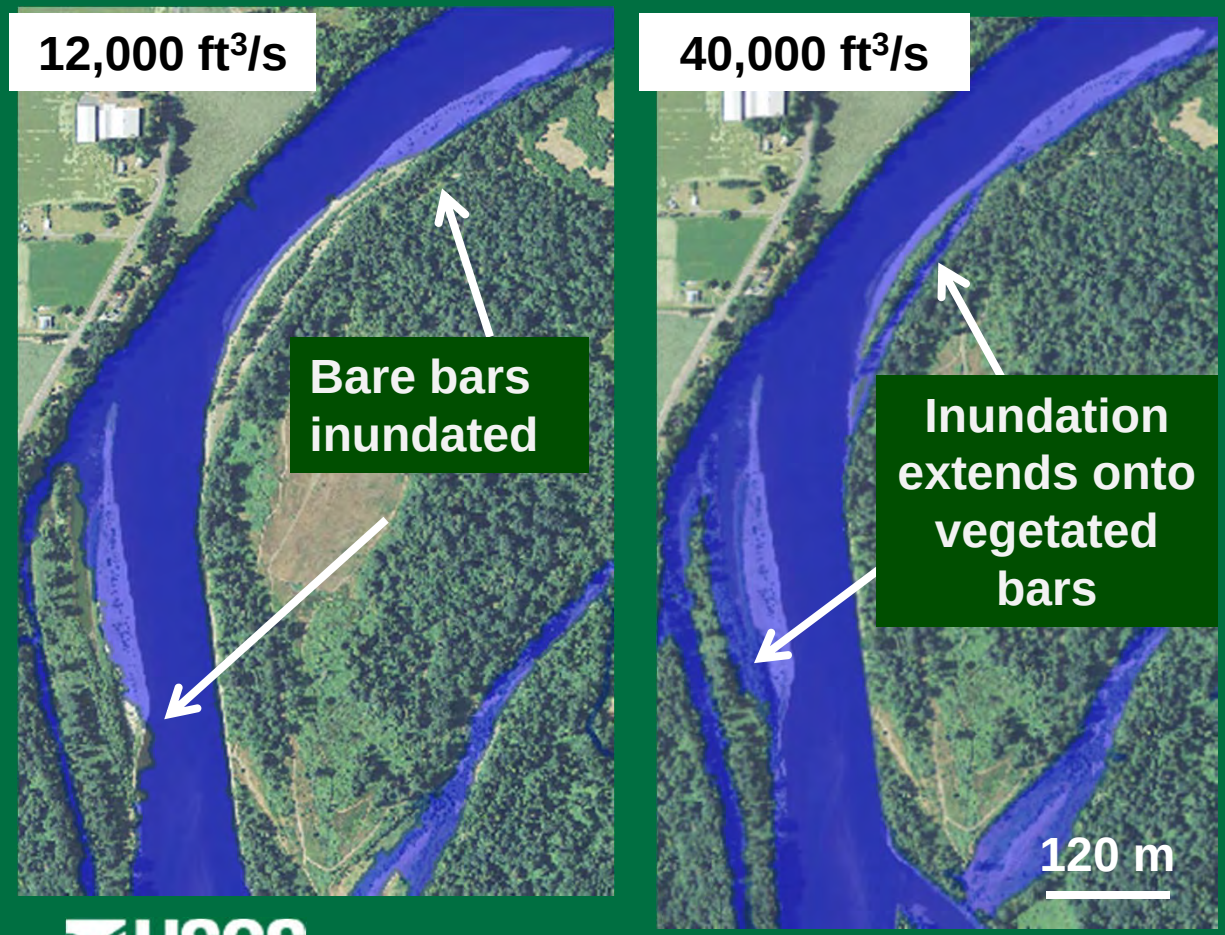
Inundation at moderate flows:

Mission Bottom Reach, 12,000-40,000 ft^3/s at Salem

Inundation maps from uncalibrated 2D hydraulic modeling utilizing 2002 bathymetry and 2008/09 lidar. Provisional results, subject to revision.



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High quality rearing habitats at these flows:

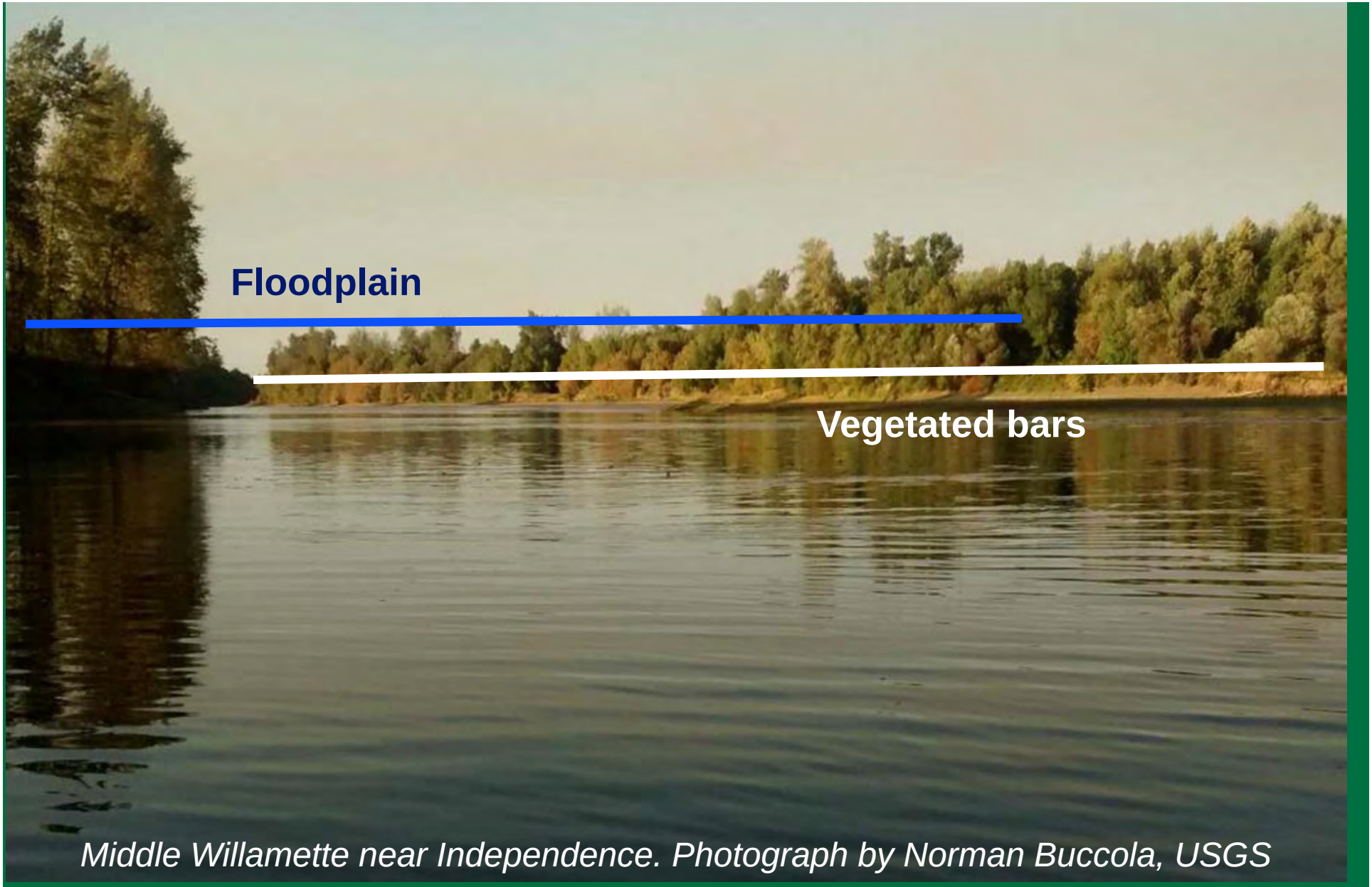
Inundated, gently sloping topography

Vegetation height >1m

Connected to main channel

(modified from Van Remoortere 2014, with input from ODFW, OSU, UO)

Aerial photography source: NAIP



Middle Willamette near Independence. Photograph by Norman Buccola, USGS

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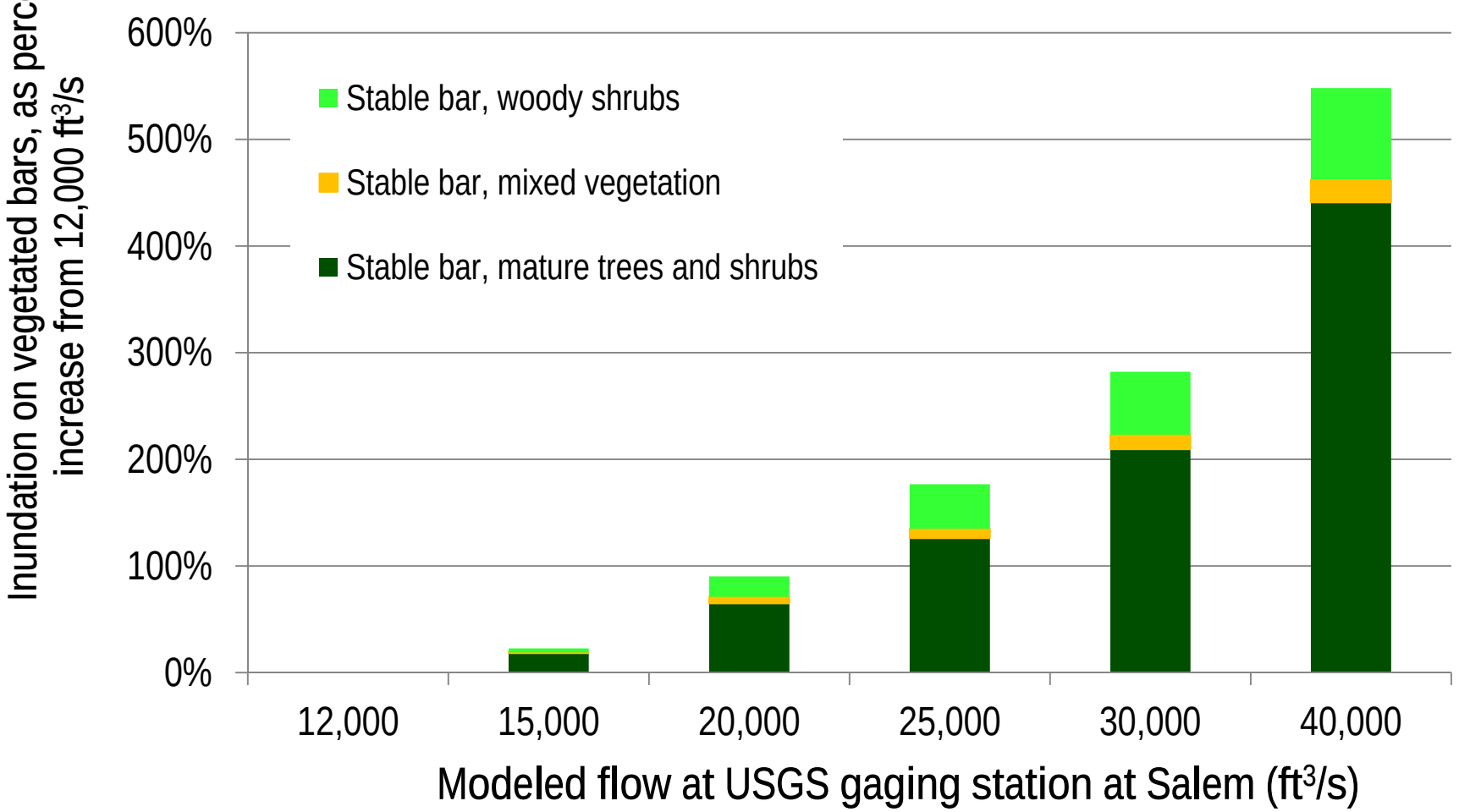
Mission Bottom Reach, Middle Willamette River
Flow-area relationship for vegetated bar habitat



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Side channel in Middle Willamette River near Santiam River confluence. Photograph by Joseph Mangano, USGS.

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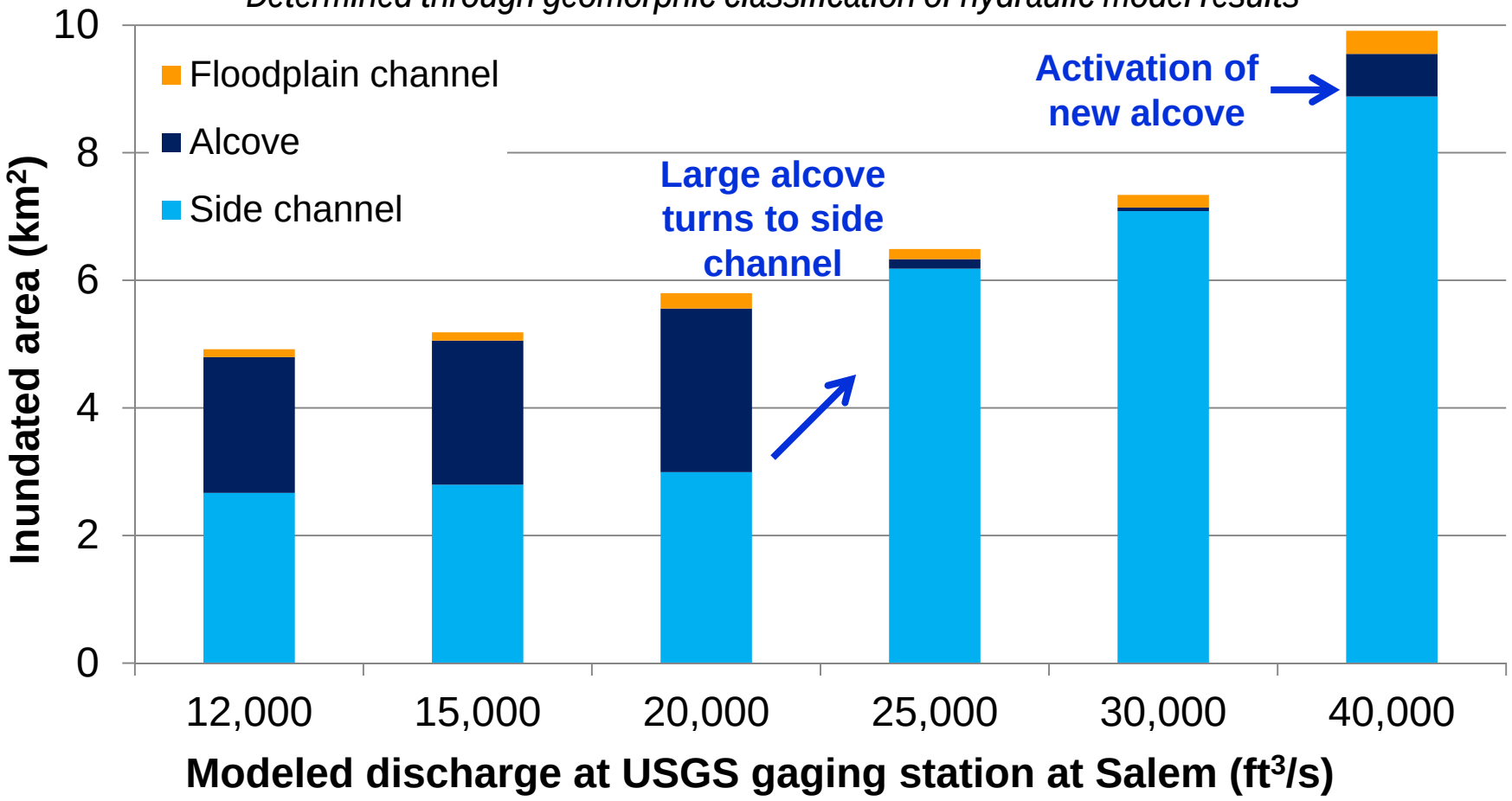
Mission Bottom Reach, Middle Willamette River
Flow-area relationship for off-channel habitats

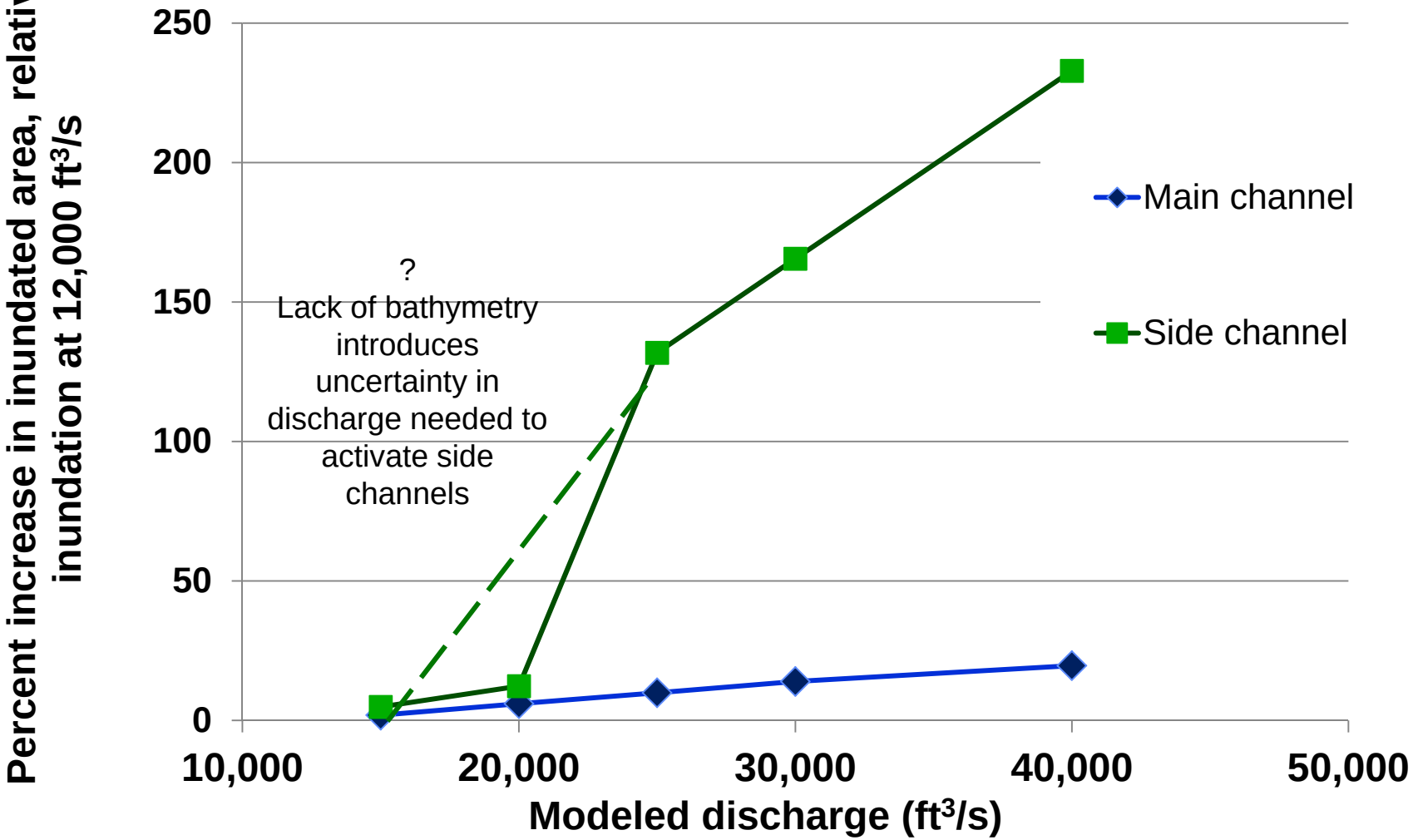
Determined through geomorphic classification of hydraulic model results



Mission Bottom Reach, Middle Willamette River

Increase in side channels potentially utilized as off-channel habitats, relative to 12,000 ft^3/s

Determined through geomorphic classification of hydraulic model results



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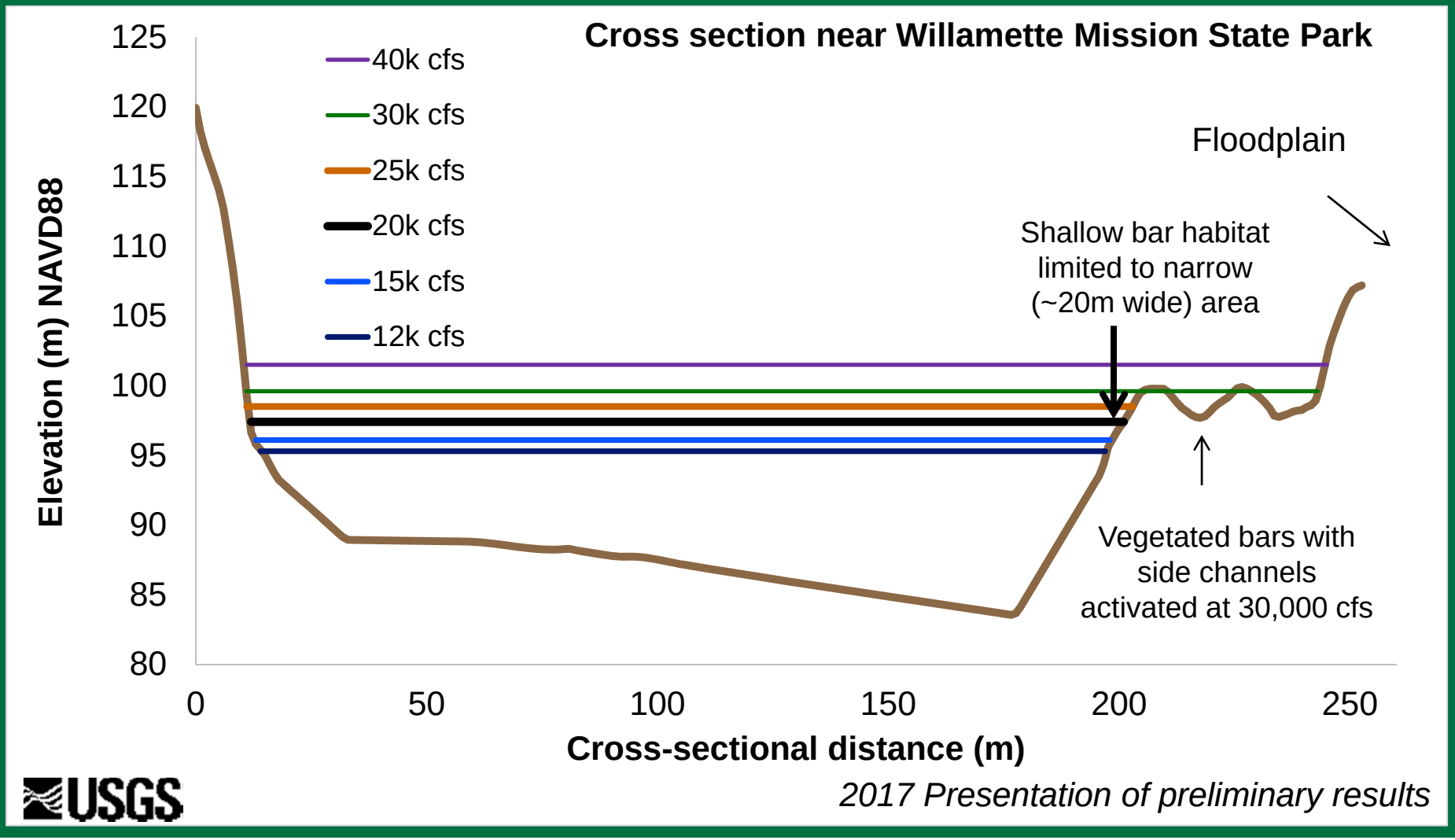
Hydrogeomorphic relations
Middle Willamette: Mission Bottom Reach

Stage and inundation extent determined for flows ranging 12,000-40,000 ft^3/s from hydraulic modeling.



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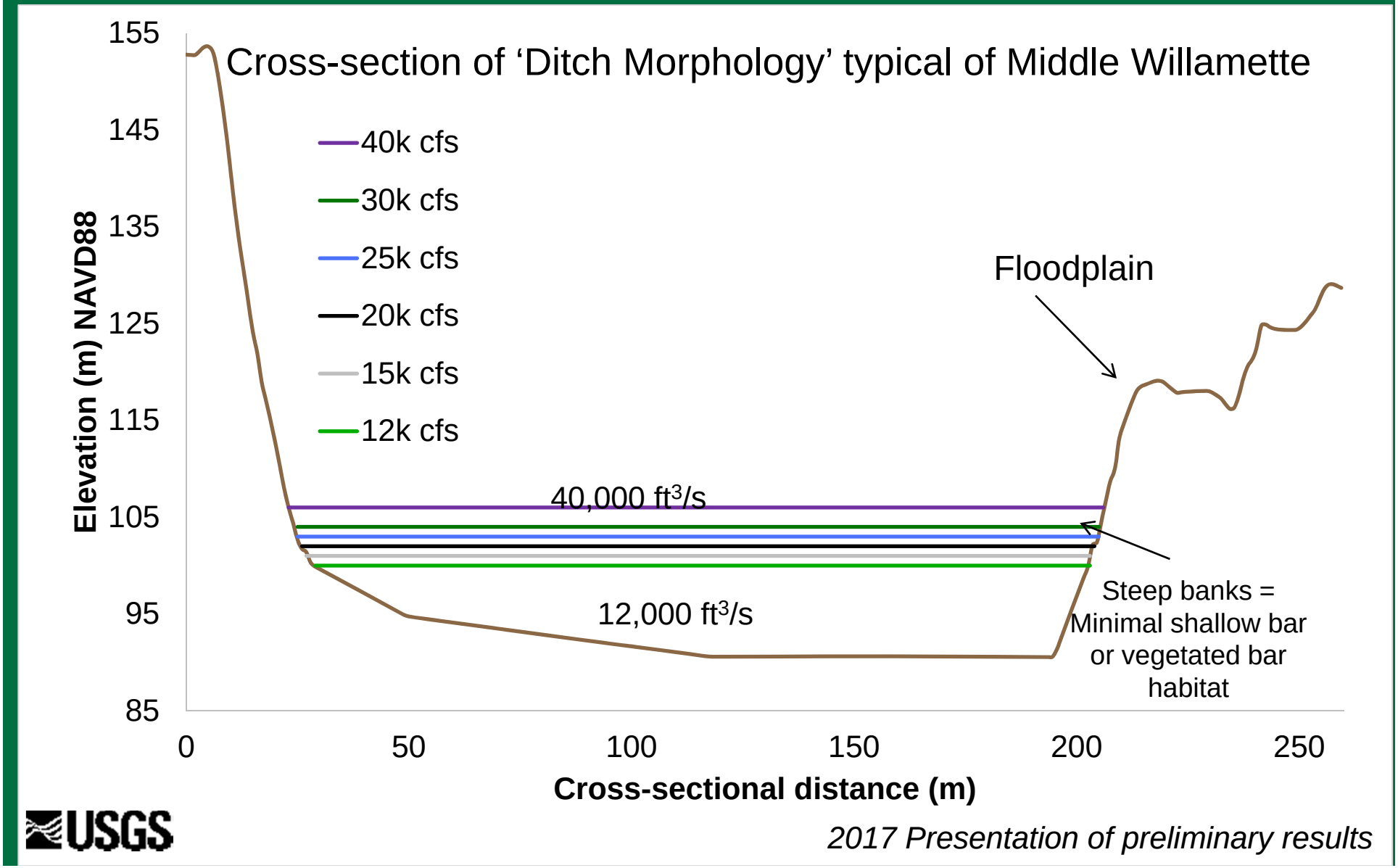

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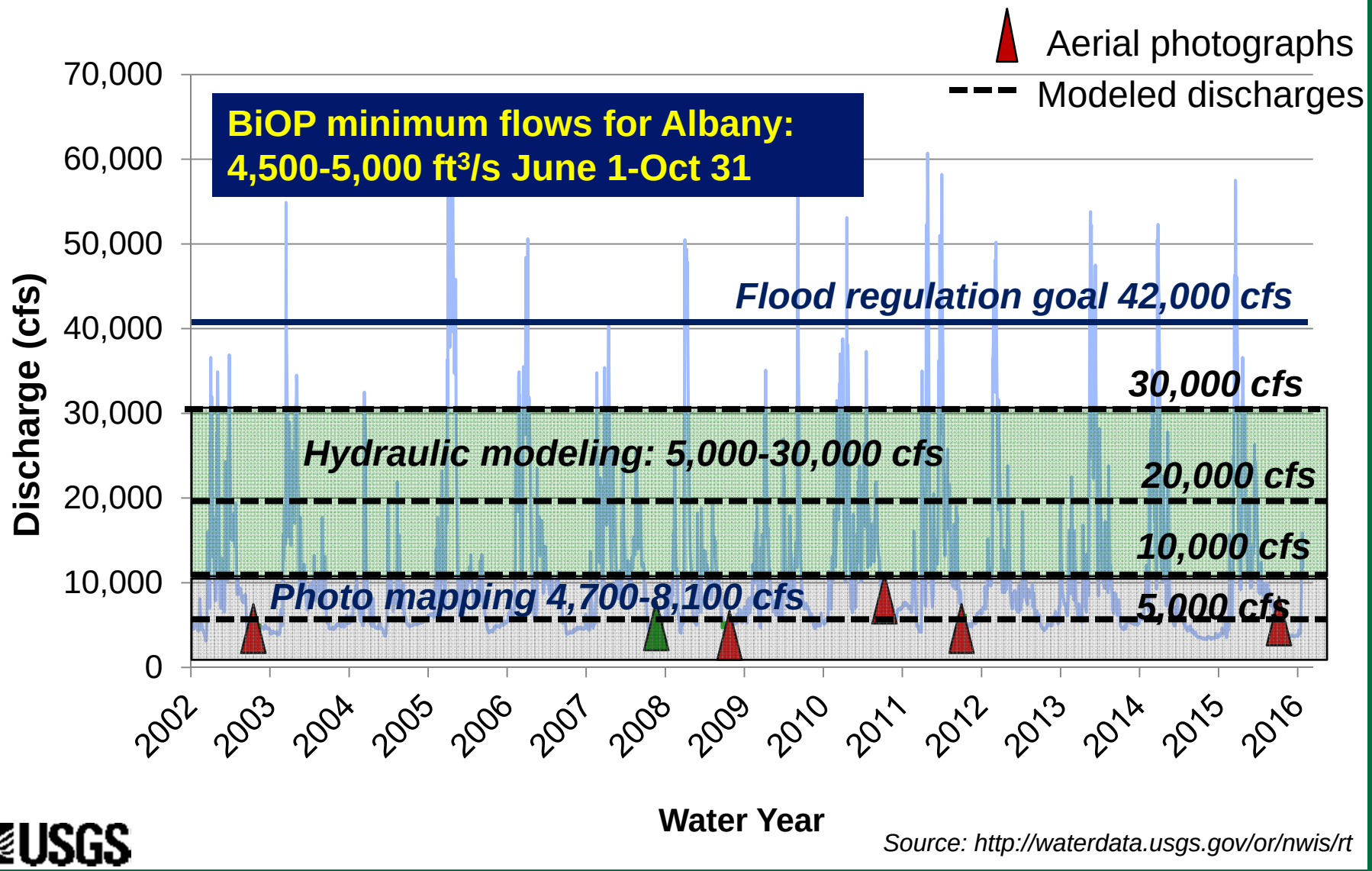
Upper Willamette River:

Mean Daily Flow at USGS gaging station at Harrisburg, 2003-2016

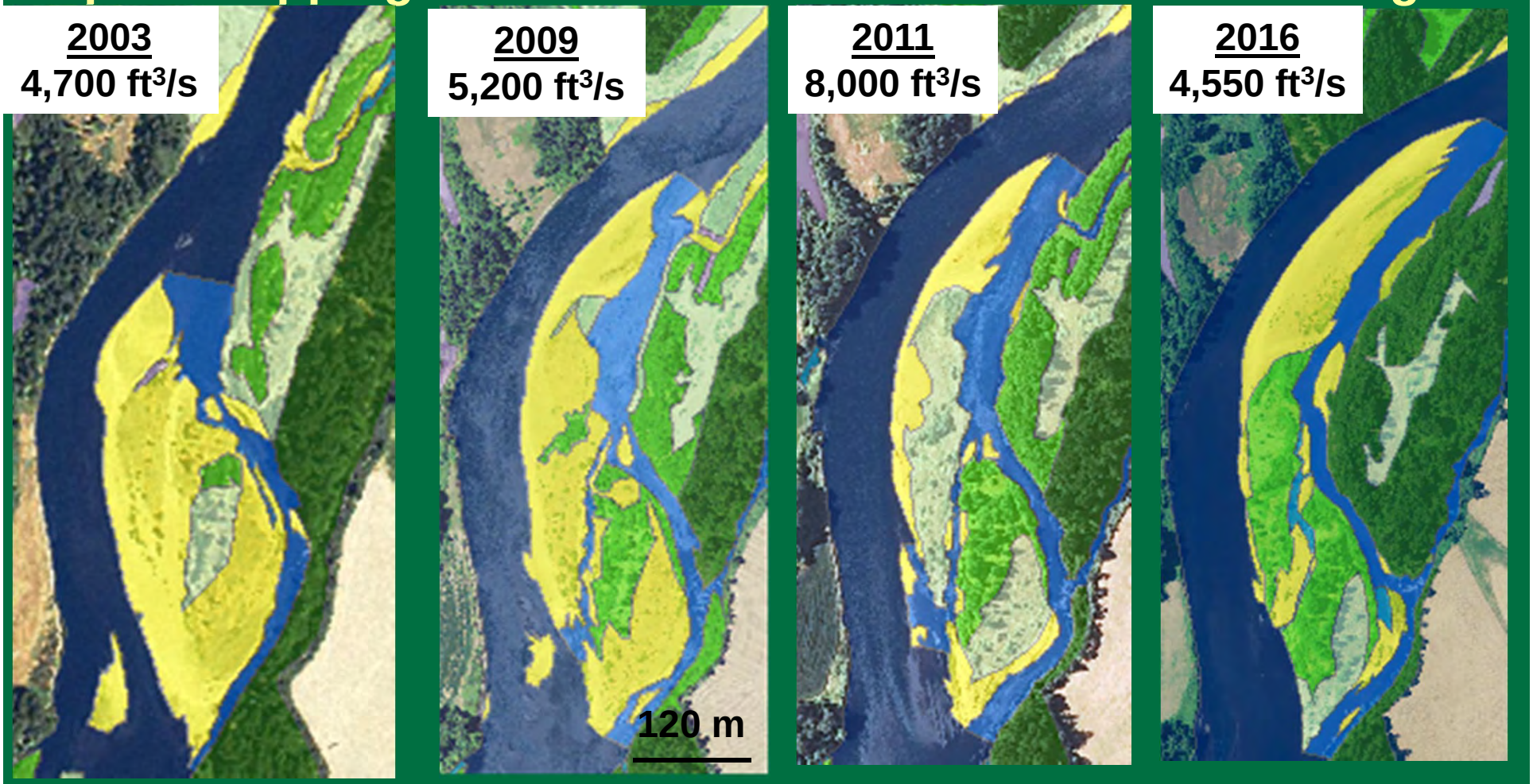


USGS

Source: http://waterdata.usgs.gov/or/nwis/rt

Upper Willamette low flow rearing habitats

Repeat mapping of Marshall Island Reach near Harrisburg



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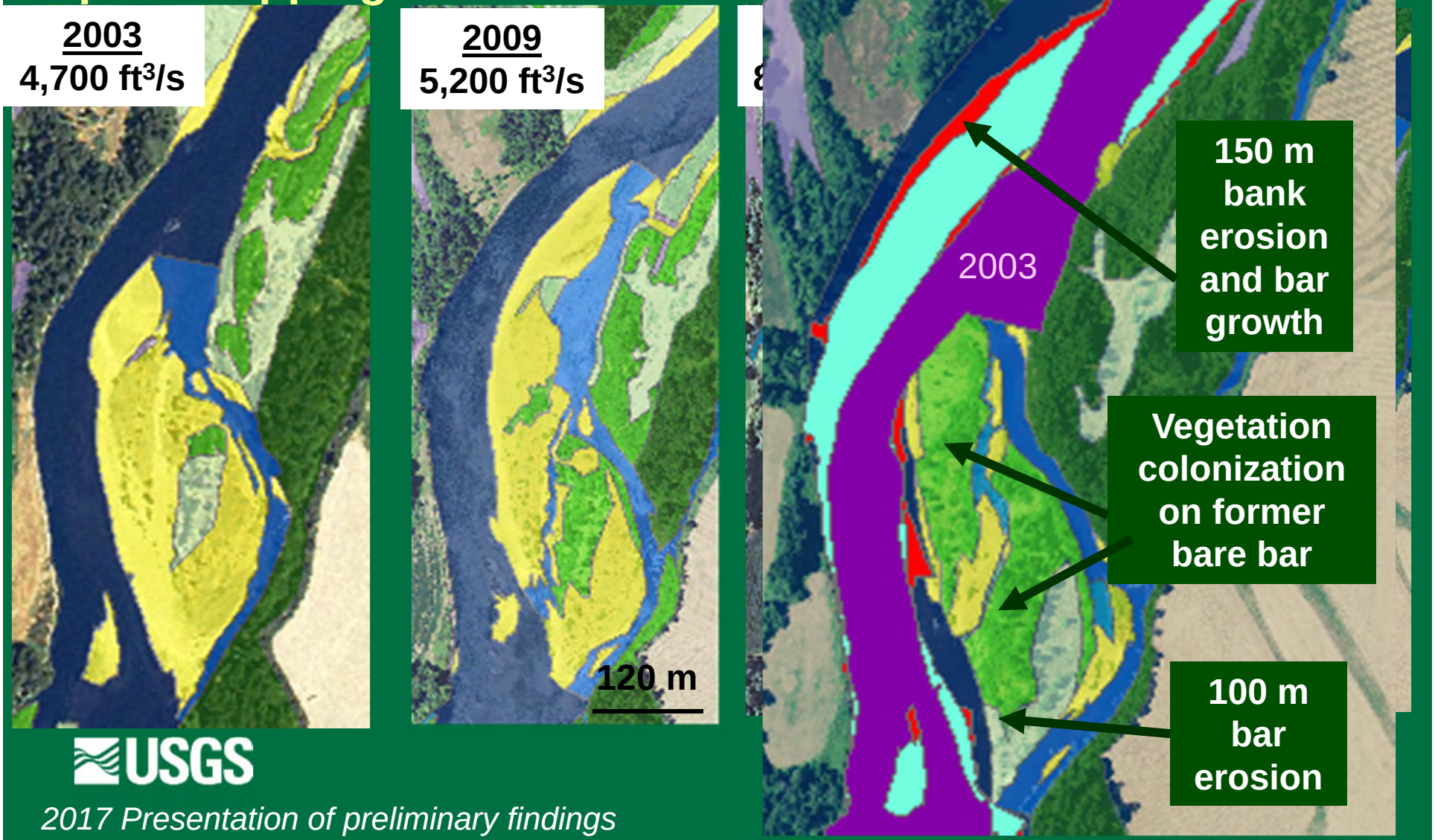
Upper Willamette low flow rearing habitats

Repeat mapping of Marshall Islar



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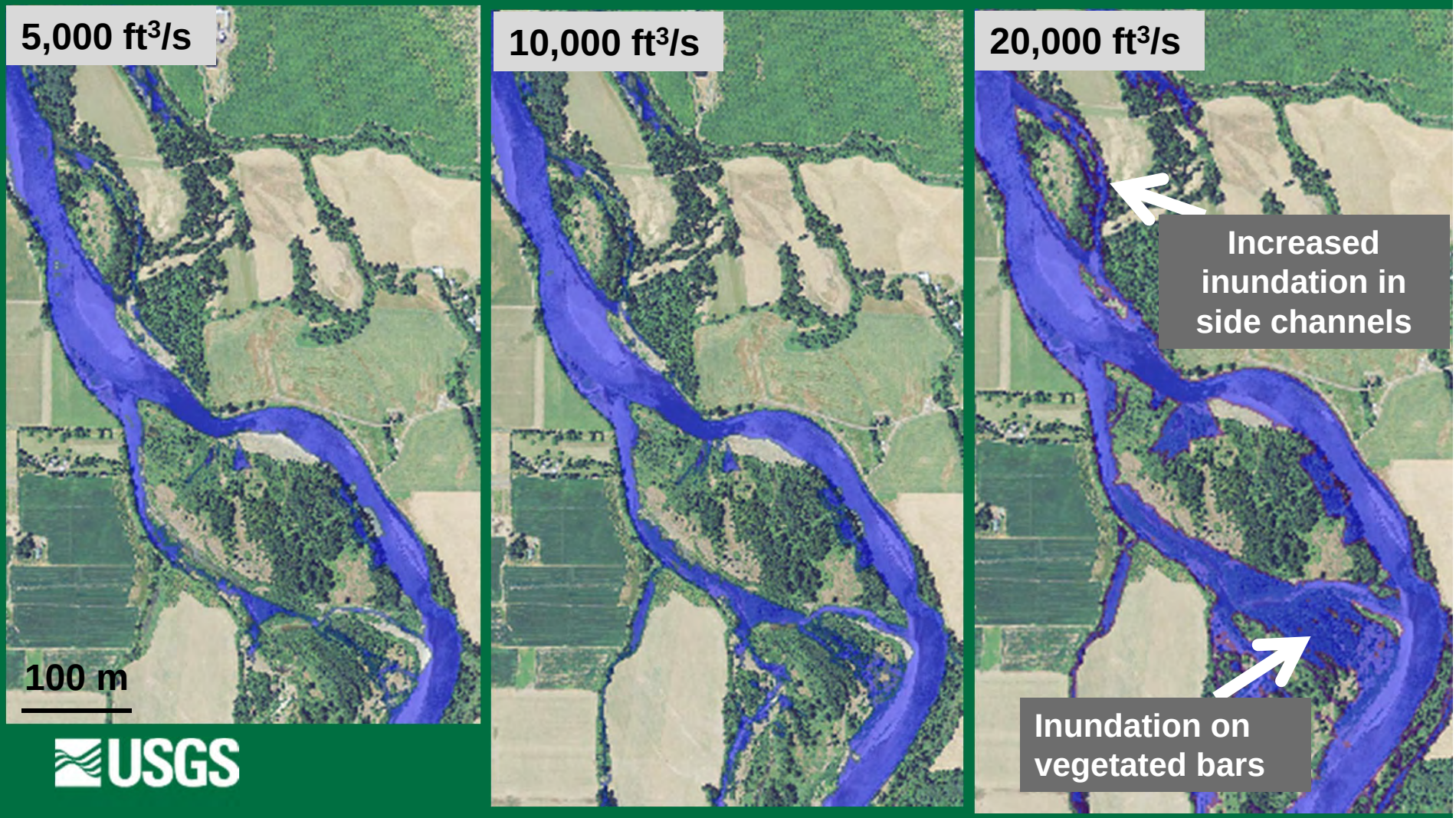
Inundation at moderate flows:

Marshall Island Reach of Upper Willamette

5,000-30,000 ft^3/s at Harrisburg



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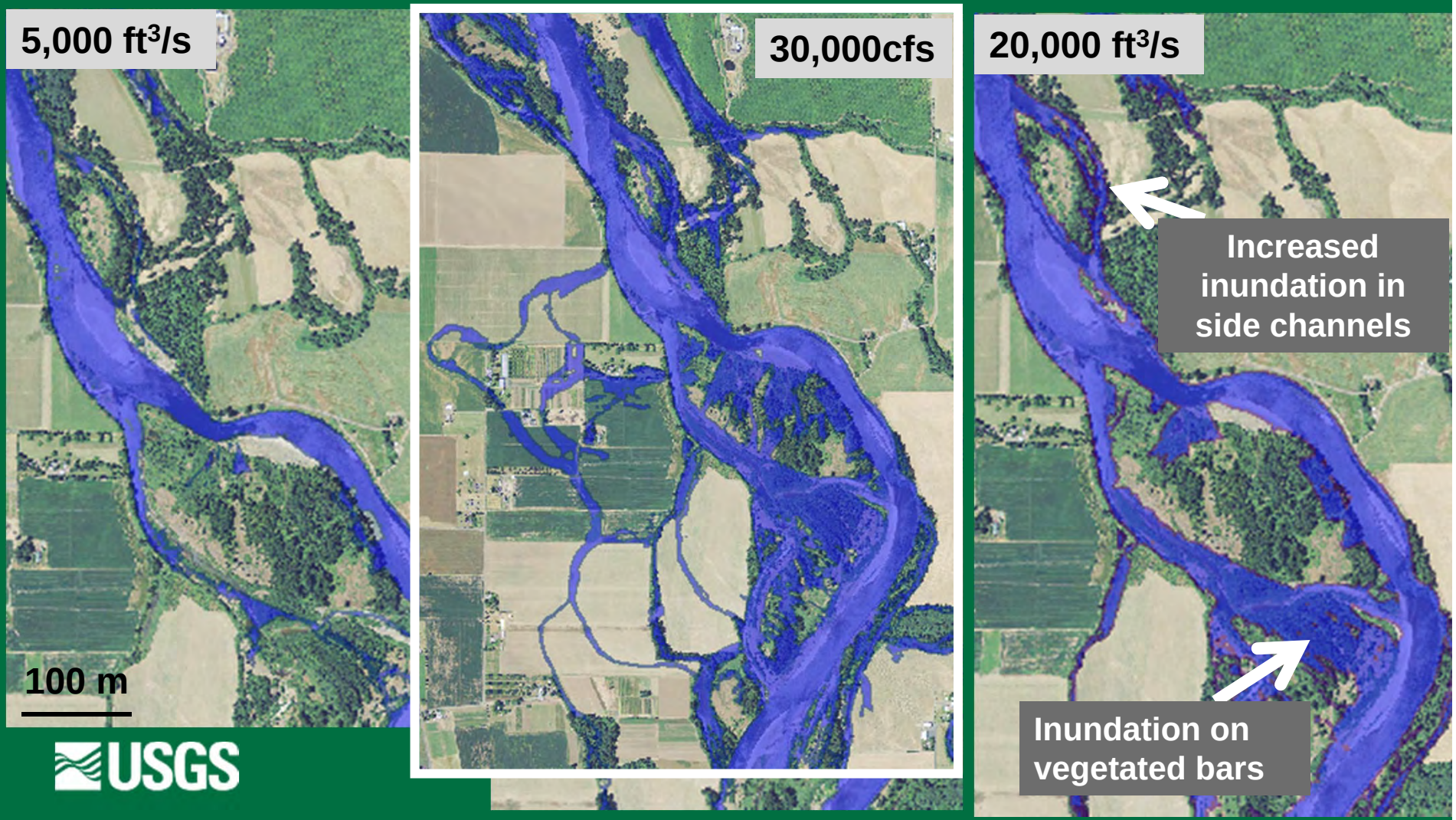

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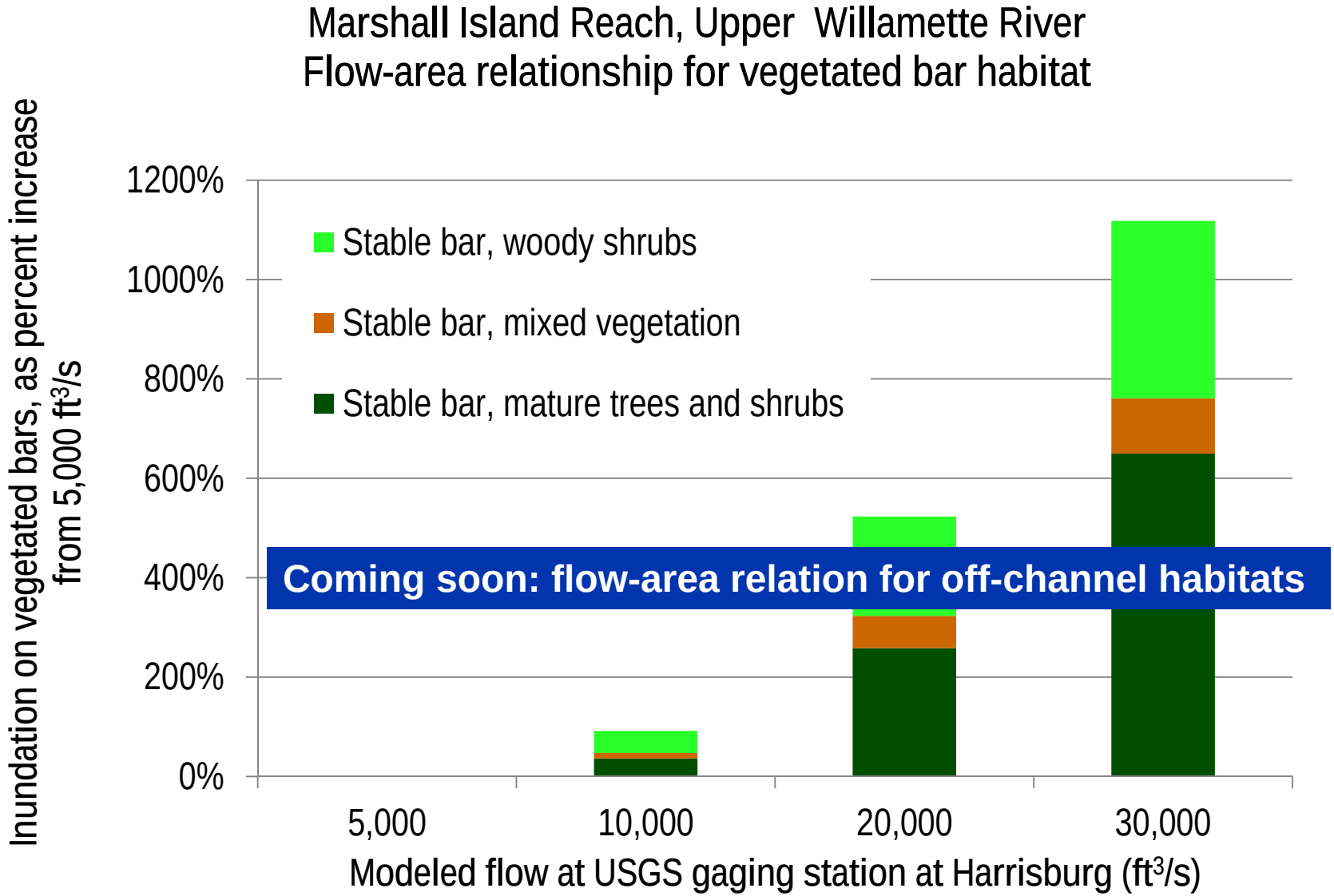

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Typical vegetated bar area on Upper Willamette with successional bands of willow and cottonwood flanking the bare, actively shifting portion of bar. Near Green Island. Photo by Joseph Mangano, USGS.

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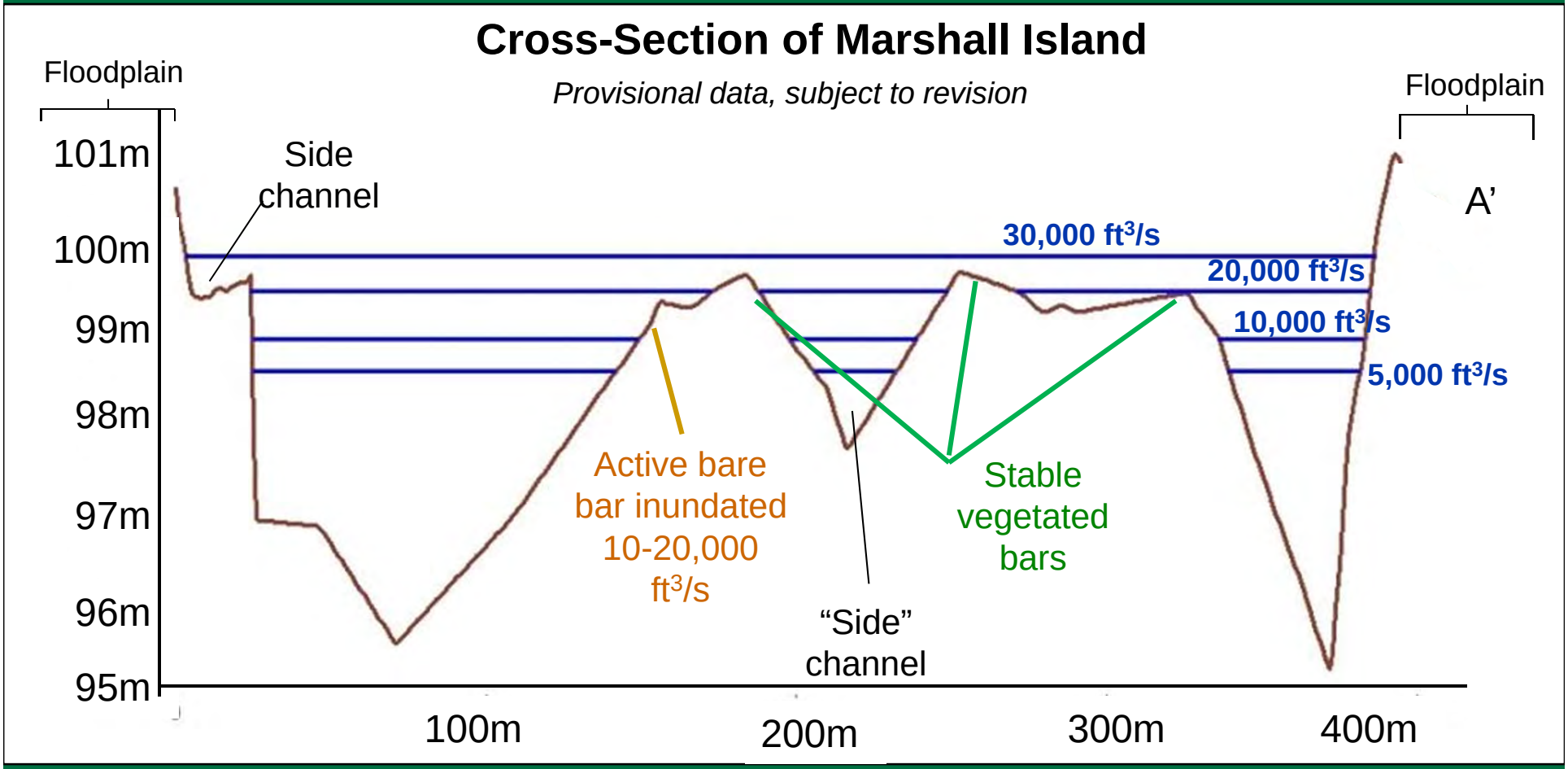
Hydrogeomorphic Relations

Marshall Island Reach, Upper Willamette

5,000-30,000 ft³/s at USGS gaging station at Harrisburg



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Summary

Mission Bottom Reach, Middle Willamette

- **Low-flow, shallow bar habitat 6,000 ft^3/s to ~15,000 ft^3/s**
- **Inundation of vegetated bars 15,000 ft^3/s to 40,000 ft^3/s**
- **Floodplains inundated at flows higher than 40,000 ft^3/s**

Marshall Island Reach, Upper Willamette

- **Low-flow, shallow bar habitat 5,000-10,000 ft^3/s**
- **Large increase in vegetated bar habitat between 10,000 -20,000 ft^3/s**
- **Floodplains inundated at flows higher than 30,000 ft^3/s**

Open questions to be addressed in Phase 2:

- **With increasing discharge, are losses in shallow bar habitat offset by increases in vegetated bar habitat (or other suitable habitat?)**
- **Are there certain discharges where rearing habitat is especially limited?**
- **How do these relations vary along entire river corridor?**
- **What are tradeoffs between suitable depths, velocities and temperature?**

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Willamette River Flow Objectives

Table 2-8 Mainstem Willamette Flow Objectives (USACE 2007a Table 3-2).

Time Period	7-Day Moving Average[1] Minimum Flow at Salem (cfs)	Instantaneous Minimum Flow at Salem (cfs)	Minimum Flow at Albany (cfs) [2]
April 1 - 30	17,800	14,300	---
May 1 - 31	15,000	12,000	---
June 1 - 15	13,000	10,500	4,500
June 16 - 30	8,700	7,000	4,500
July 1 - 31	---	6,000	4,500
August 1 - 15	---	6,000	5,000
August 16 - 31	---	6,500	5,000
September 1 - 30	---	7,000	5,000
October 1 - 31	---	7,000	5,000

Middle Willamette

Upper Willamette

USGS

From Willamette Project Biological Opinion, pg 2-44

Willamette River Flow Objectives

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Considerations for developing flow targets to maximizing rearing habitats:

- Lots of uncertainty and spatial variability, so better to think in ranges not values
- Quantify habitat increases in terms of percentage, not absolute value
- Increments of 2,000 ft^3/s (or greater) more suited to large river morphology

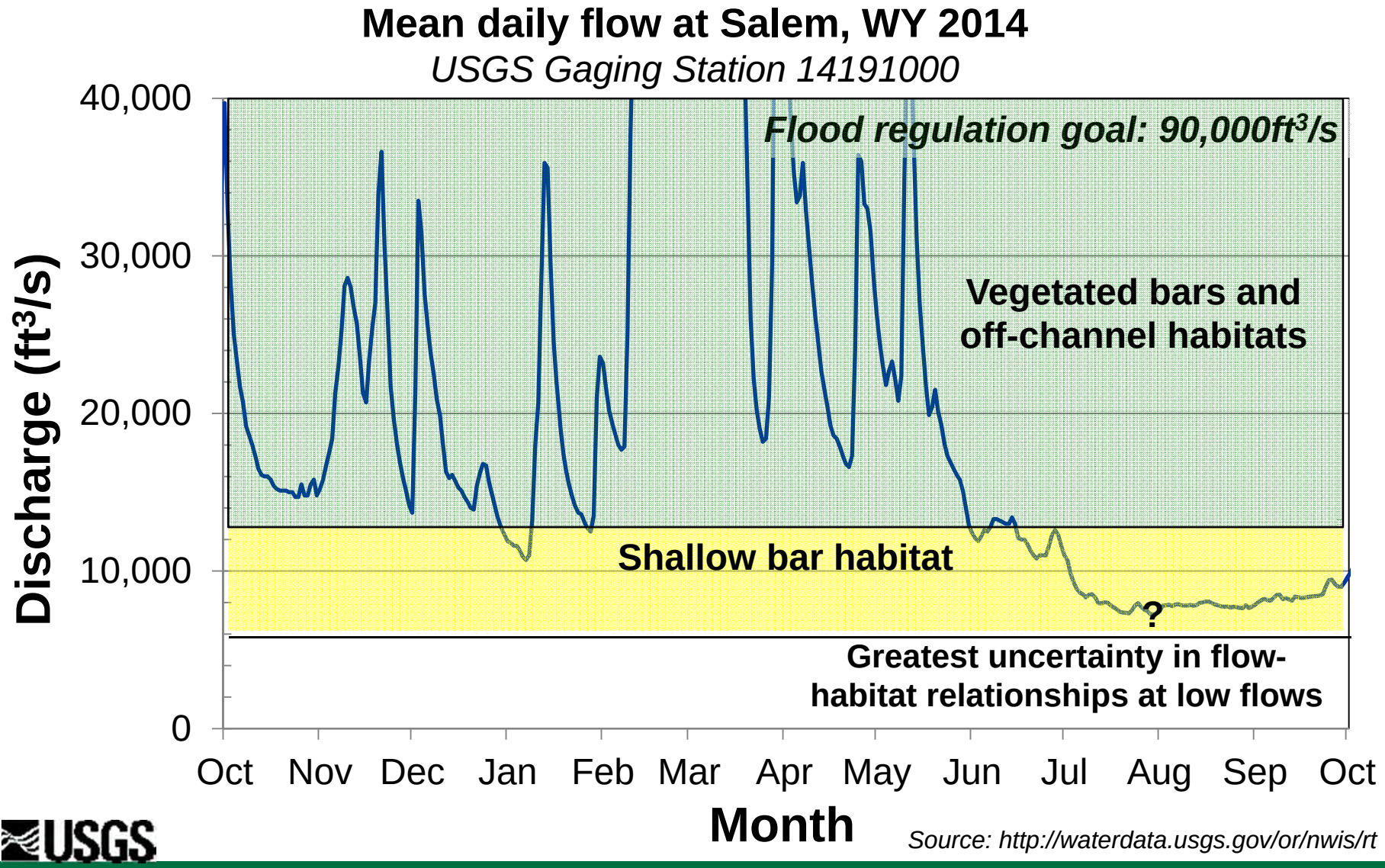
Middle Willamette

Upper Willamette

USGS

From Willamette Project Biological Opinion, pg 2-44

Implications for flow management:
Year round rearing habitats in Middle Willamette



USGS

Source: http://waterdata.usgs.gov/or/nwis/rt

Acknowledgements

Rich Piaskowski, Jake Macdonald, Greg Taylor, Jeff Ballantine (USACE)

Luke Whitman, Tom Friesen, Kirk Schroeder, Brian Bangs, Brian Cannon, Tim Hardin (ODFW)

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Anne Mullan, Stephanie Burchfield (NOAA Fisheries)

Dave Hulse (UO)

Stan Gregory (OSU)

Jeremy Monroe (Freshwaters Illustrated)

Mackenzie Keith, Norm Buccola, Alexandria Costello, Krista Jones, Brandon Overstreet (USGS)

Project Team: Tess Harden, James White, Adam Stonewall, JoJo Mangano, Gabe Gordon, Matthew Yates (USGS)

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Photo courtesy Freshwaters Illustrated

Questions?

rosewall@usgs.gov

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Photograph courtesy Freshwaters Illustrated

Extra slides

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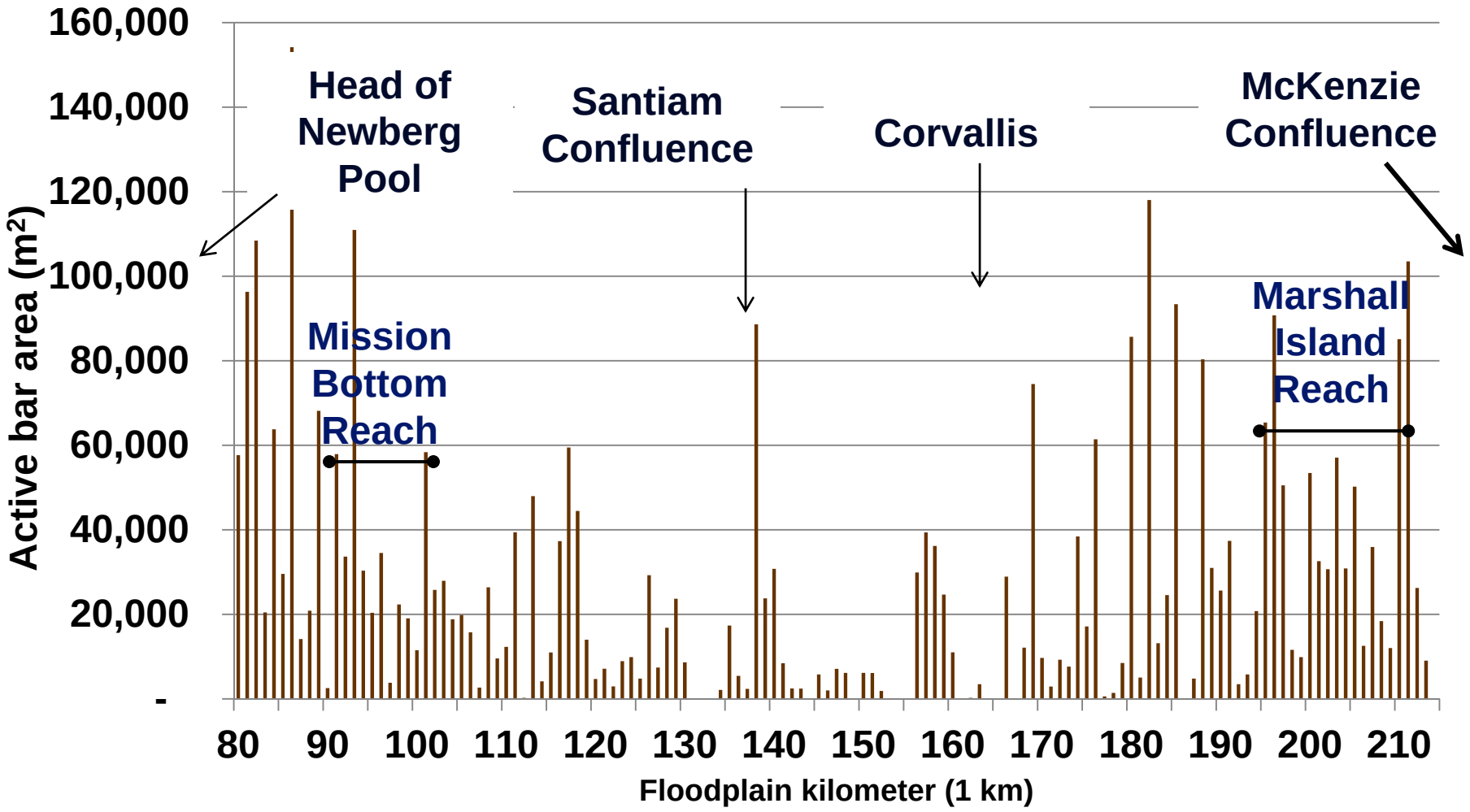
Distribution of bare gravel bars

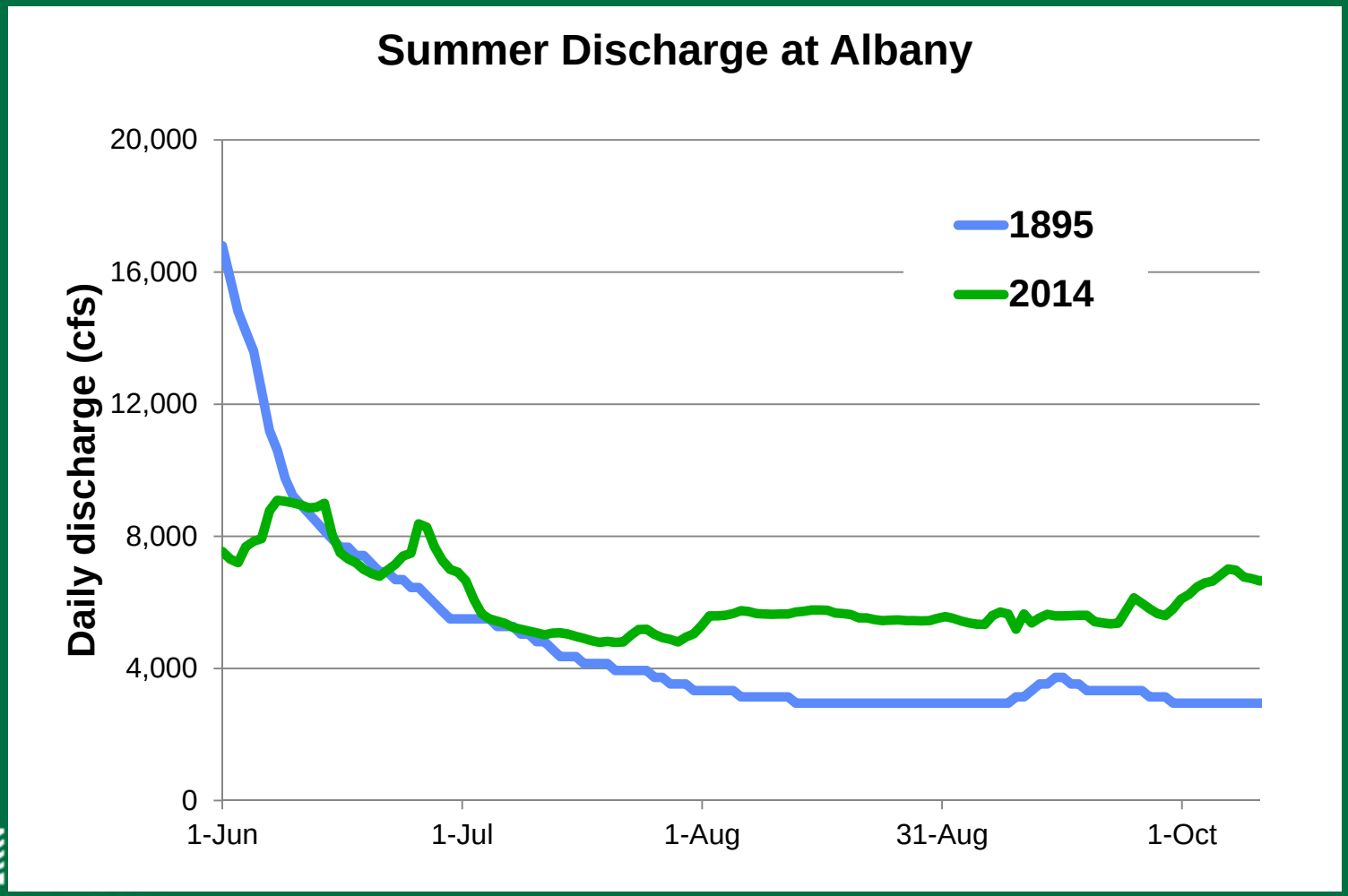
(ca. 2008, as mapped from lidar by USGS)



Provisional data, subject to revision

Historical flows (probably) not suitable analogs for present-day system

Modern rivers fundamentally different than historical conditions, so optimal seasonal flows for habitat availability likely also different



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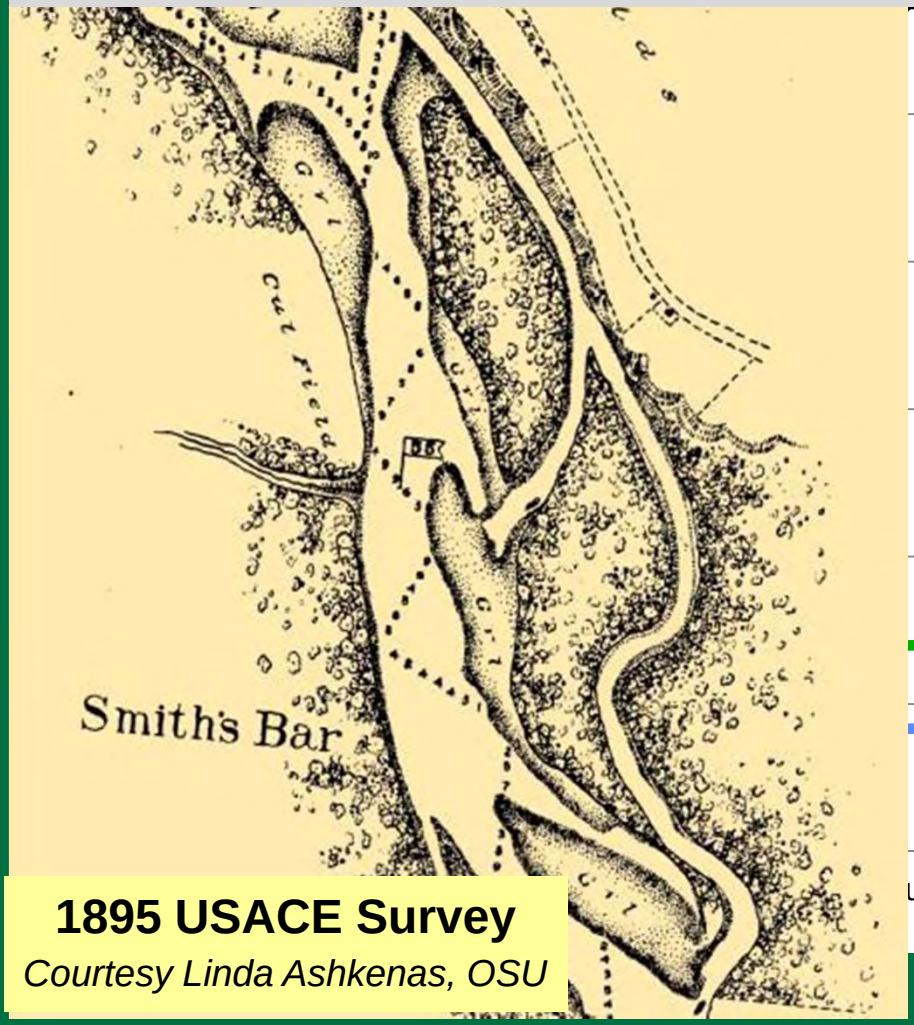
Snaggy Bend Bar, above Dayton, Middle Willamette



1895 USACE Survey

Courtesy Linda Ashkenas, OSU

2011 Air Photo