



**NOAA
FISHERIES**

8.3 West Coast Protected Fish Species Program Review

Non-native species research:
overview of past, present and future efforts

Beth Sanderson

5 May 2015



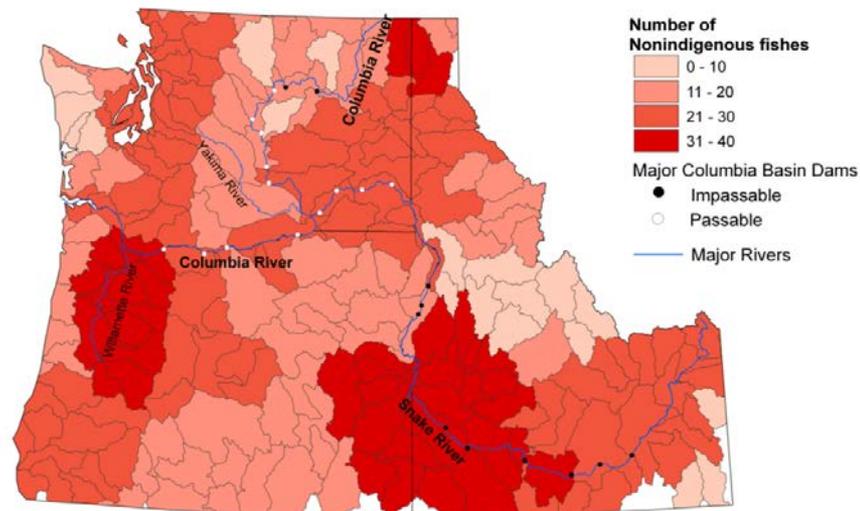
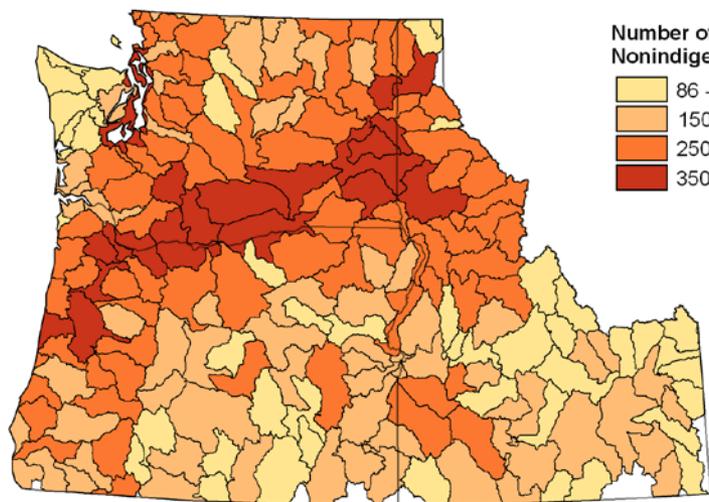
Research Areas

1. Distribution
2. Population biology / demography
3. Direct and indirect effects
4. Climate
5. Management

PAST

Nonindigenous Species of the Pacific Northwest: An Overlooked Risk to Endangered Salmon?

BETH L. SANDERSON, KATIE A. BARNAS, AND A. MICHELLE WARGO RUB



Independent Scientific Advisory Board

NON-NATIVE SPECIES IMPACTS ON NATIVE SALMONIDS IN THE COLUMBIA RIVER BASIN

Including Recommendations for Evaluating the Use of Non-Native Fish Species in Resident Fish Substitution Projects



Independent Scientific Advisory Board

July 15, 2008
(with minor correction September 4, 2008, page 36)
ISAB Non-native Species Report
ISAB 2008-4

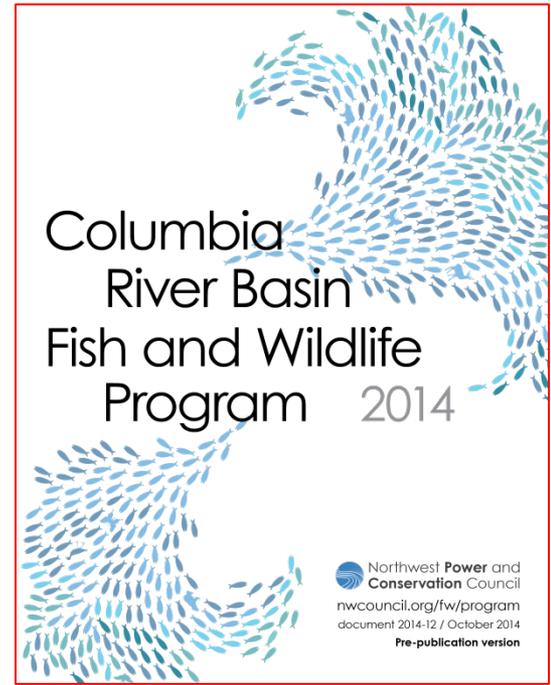
Columbia River Food Webs: Developing a Broader Scientific Foundation for Fish and Wildlife Restoration



Independent Scientific Advisory Board

Document ISAB 2011-1
January 7, 2011

Columbia River Basin Fish and Wildlife Program 2014

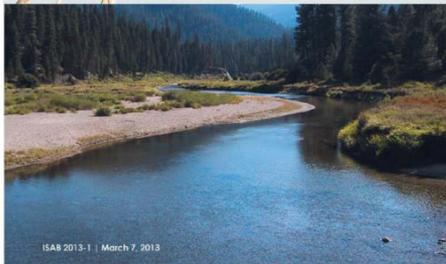


Northwest Power and
Conservation Council
nwcouncil.org/fw/program
document 2014-12 / October 2014
Pre-publication version

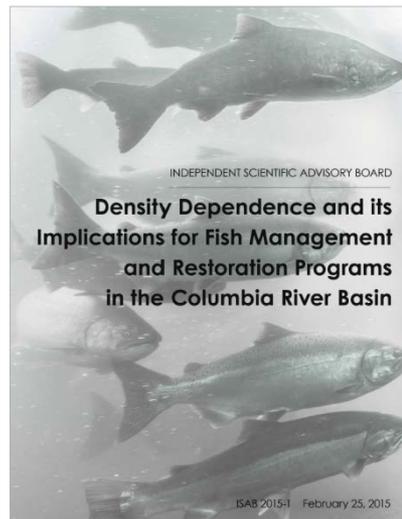


INDEPENDENT SCIENTIFIC ADVISORY BOARD

Review of the 2009 Columbia River Basin Fish and Wildlife Program



ISAB 2013-1 | March 7, 2013



INDEPENDENT SCIENTIFIC ADVISORY BOARD

Density Dependence and its Implications for Fish Management and Restoration Programs in the Columbia River Basin

ISAB 2015-1 February 25, 2015

Threats to sustainability
loss of biological diversity, climate change, proliferation of chemicals and contaminants, **novel hybrid communities: non-native species and predation**, uncertainty about carrying capacity, artificial propagation, and harvest strategies.

PAST

Effects of non-native brook trout (*Salvelinus fontinalis*) on threatened juvenile Chinook (*Onchorhynchus tshawytscha*) in an Idaho stream

Macneale et al. 2009.
Ecology of Freshwater Fish

Use of an ecosystem-based model to evaluate alternative conservation strategies for juvenile Chinook salmon in a headwater stream.

Warren et al. 2014.
N. Am. J. Fisheries Management



- Habitat
- Feeding behavior
- Species interactions



Smallmouth Bass in the Pacific Northwest: A Threat to Native Species; a Benefit for Anglers

Reviews in Fisheries Science, 19(3):305-315, 2011

MICHAEL P. CAREY,¹ BETH L. SANDERSON,¹ THOMAS A. FRIESEN,²
KATIE A. BARNAS,¹ and JULIAN D. OLDEN³

Potential to negatively affect native species



Important recreational fishery



Conflict



Native invaders – challenges for science, management, policy, and society

Michael P Carey^{1*†}, Beth L Sanderson¹, Katie A Barnas¹, and Julian D Olden²

Front Ecol Environ 2012; doi:10.1890/110060

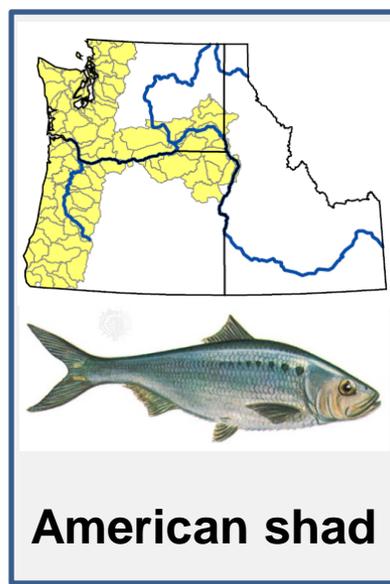
Panel 1. Examples of native invaders that interact with threatened and endangered salmon in the US Pacific Northwest, including (a) Caspian terns (*Hydroprogne caspia*), (b) rainbow trout (*Oncorhynchus mykiss*), (c) northern pikeminnow (*Ptychocheilus oregonensis*), and (d) marine mammals, such as California sea lions (*Zalophus californianus*), Steller sea lions (*Eumetopias jubatus*), and Pacific harbor seals (*Phoca vitulina richardsi*; pictured)

	(a) Caspian terns	(b) Rainbow trout	(c) Northern pikeminnow	(d) Marine mammals
Mechanisms resulting in native invaders	 <p>Dam construction and waterway dredging created dredge spoil islands with high nesting success due to no predators and stable water levels.^{1,2,3} Fish hatcheries provide a stable food supply.⁴</p>	 <p>Stocking to new locales and supplementing existing populations to artificially enhance recreational fishing opportunities.</p>	 <p>Dams and the creation of reservoir habitat has led to high abundances.⁸ Dams increased the amount of rearing habitat and raised water temperatures, leading to higher predation rates.</p>	 <p>Fish passage ladders at dams congregate salmonids, creating areas of high capture efficiency.</p>
Examples of impacts from native invaders	Rice Island: 8.1 million salmon consumed in 1997 and 12.4 million salmon consumed in 1998 ¹ prior to mitigation. East Sand Island: over 5 million salmon consumed annually (on average) from 2000 to 2010. Crescent Island: 465 000 salmonids consumed in 2000 and 679 000 in 2001. ⁵	Stocked into previously fishless lakes, thereby reducing native species. ⁶ Effects of supplemented populations are not available. Hybridization with wild populations or other salmonids. ⁷	Example of salmon losses (in millions): Bonneville 1.0; Dalles 2.3; John Day 1.2; McNary 0.6; Priest Rapids 0.2; Wanapum 0.2; Rock Island 0.5; Rocky Reach 0.2; Wells <0.1; Ice Harbor <0.1; Lower Monumental 0.1; Little Goose 0.2; Lower Granite 0.1. ⁹	Sea lions and harbor seals consumed ~4960 salmon (2.7% of the salmon run) at the Bonneville Dam in 2009. ¹⁰
Public perception	Mixed	Positive	Negative	Mixed
Current management	Shrink and relocate colony ¹	Stocking and fishing regulations	Angler reward program and trapping	Physical barriers, hazing, and relocation ¹⁰

Notes: ¹Roby et al. (2003); ²Collis et al. (2002); ³Wiese et al. (2008); ⁴Suryan et al. (2004); ⁵Antolos et al. (2005); ⁶Drake and Naiman (2000); ⁷Muhlfeld et al. (2009); ⁸Zimmerman and Ward (1999); ⁹Re-created from Table 1 in Beamesderfer et al. (1996); ¹⁰Stansell et al. (2009).

Panel 2. Management of a native species (northern pikeminnow) and a non-native species (smallmouth bass) in the US Pacific Northwest.



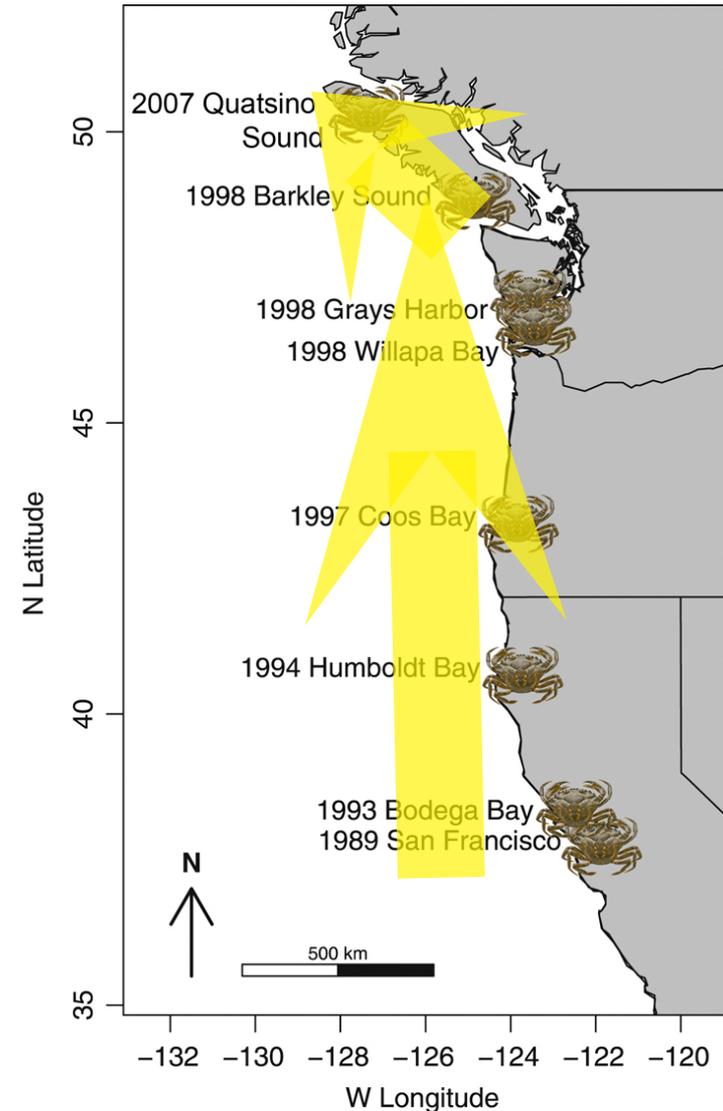
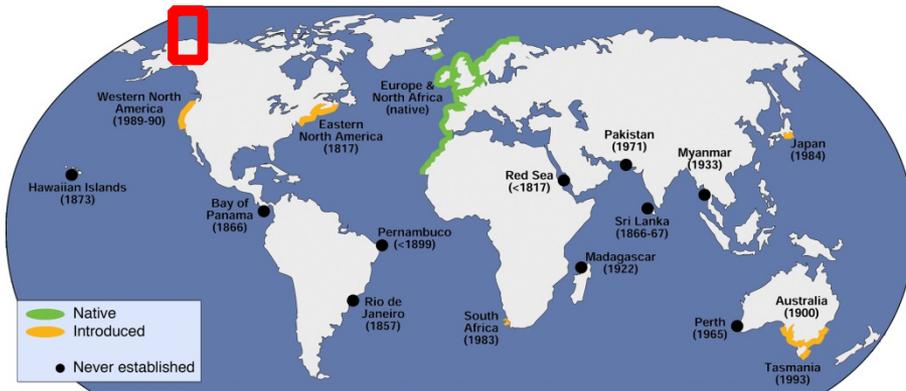


- Hasselman, D.J., Hinrichsen, R.A., Shields, B.A. & Ebbesmeyer, C.C. (2012). American Shad of the Pacific Coast: A Harmful Invasive Species or Benign Introduction? *Fisheries*, 37, 115-122.
- Hasselman, D.J., Hinrichsen, R.A., Shields, B.A. & Ebbesmeyer, C.C. (2012). The Rapid Establishment, Dispersal, and Increased Abundance of Invasive American Shad in the Pacific Northwest. *Fisheries*, 37, 103-114.
- Hasselman, D.J., Ricard, D. & Bentzen, P. (2013). Genetic diversity and differentiation in a wide ranging anadromous fish, American shad (*Alosa sapidissima*), is correlated with latitude. *Mol Ecol*, 22, 1558-1573.
- Hinrichsen, R.A., Hasselman, D.J., Ebbesmeyer, C.C. & Shields, B.A. (2013). The Role of Impoundments, Temperature, and Discharge on Colonization of the Columbia River Basin, USA, by Nonindigenous American Shad. *Trans. Am. Fish. Soc.*, 142, 887-900.



Green crab: Northward Advance along West Coast of the USA & Canada

See, KE & BE Feist. 2010. Reconstructing the range expansion and subsequent invasion of introduced European green crab along the west coast of the United States. *Biological Invasions*. 12(5): 1305-1318.





Ballast Water

Cohen, A.N. (2010) **Non-native Bacterial and Viral Pathogens in Ballast Water: Potential for Impacts to ESA-listed Species under NOAA's Jurisdiction**. pp. 85. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Endangered Species Division, Silver Spring, MD.

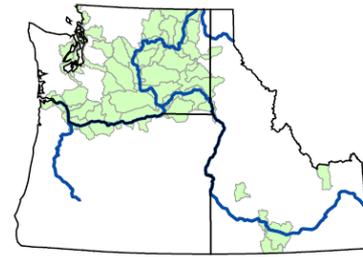
Bacterial & viral
pathogens



Taxonomic groups

(Cetaceans, pinnipeds,
turtles, fish, abalone,
corals, seagrasses)

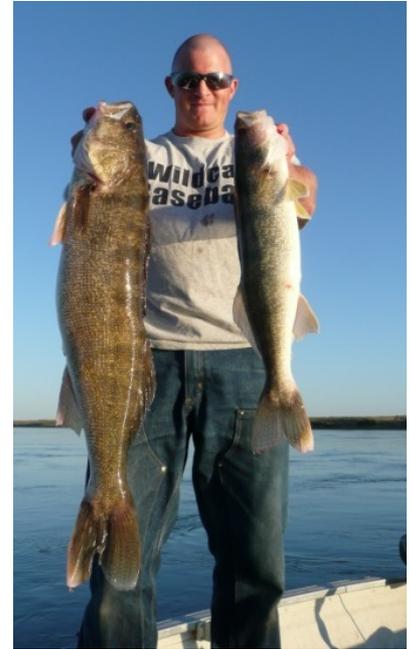
Seasonal shifts in walleye diets related to juvenile salmon migrations



Using food web approach to examine ecological role of walleye in relation to other major prey and predator species



20.32 lbs
John Grubenhoff
Lake Wallula, Benton County
February 28, 2014



Matt Nesbit
(2-year Internal Grant)



(Lake WA, March 17, 2015)
(Photos from Eric Warner)

Now

Habitat alterations and a non-native predator, Striped Bass, increase native salmon mortality in the California Central Valley, USA

Megan Sabal, Sean Hayes, Joseph Merz, and Jose
(in review)

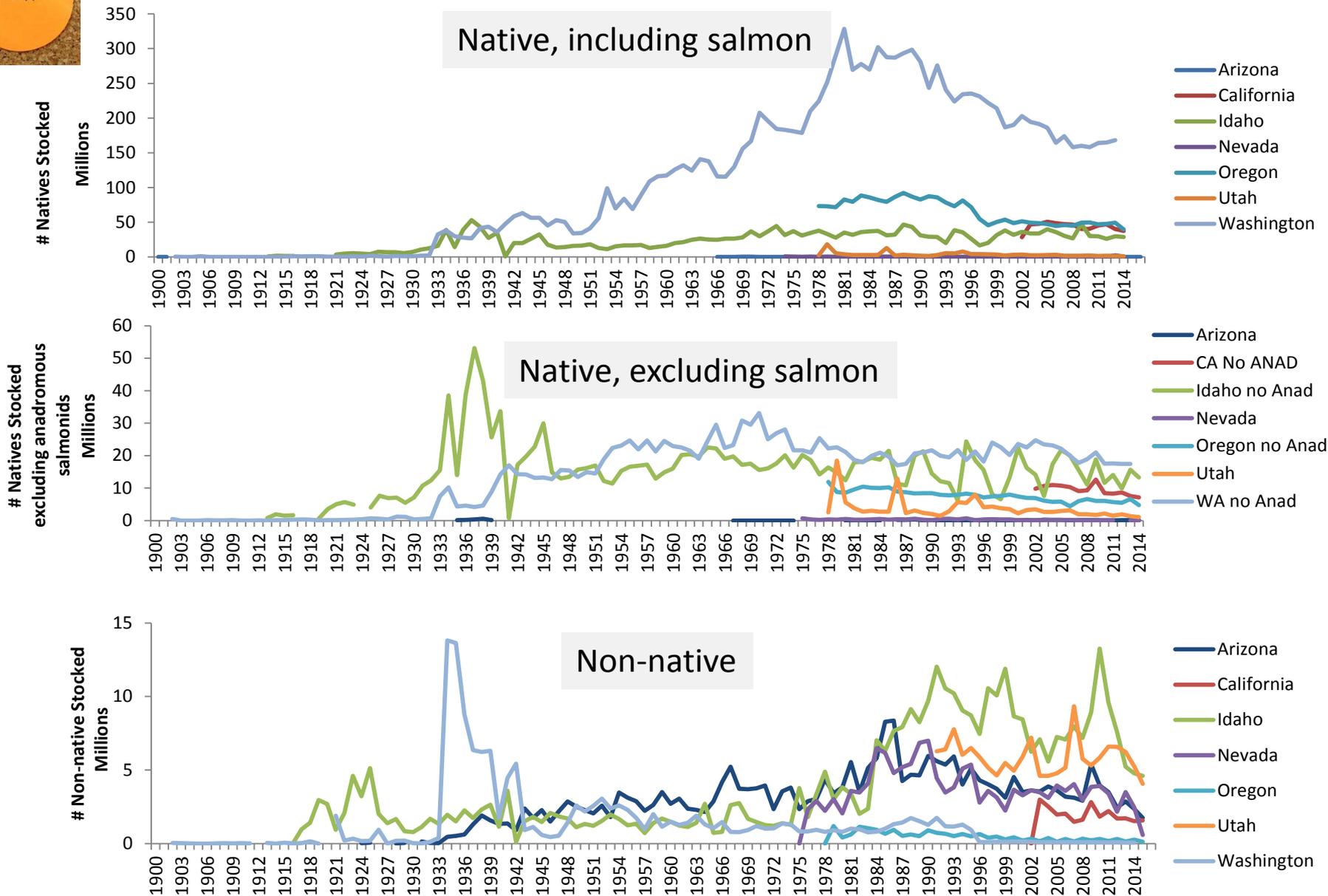


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10-29% out-migrating juvenile salmon consumed

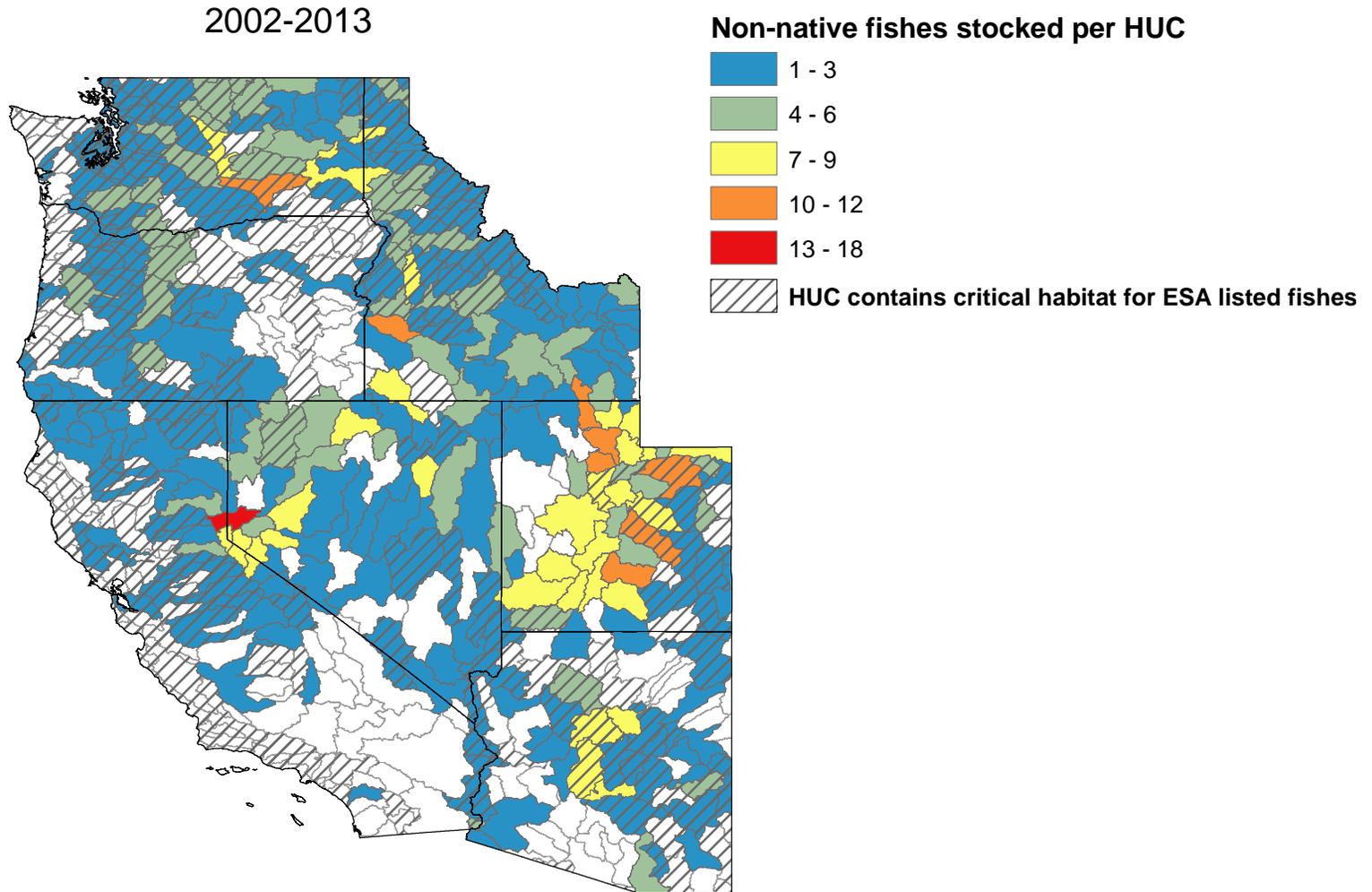
History of fish stocking practices in the west



* All warmwater sportfish stocking in CA is by private entities – no state records kept



Locations stocked w/ non-natives overlap with critical habitat



Now

Invasive Eelgrass *Zostera japonica*

Interactions among native eelgrass (*Z. marina*), *Spartina*, nearshore ecosystems, salmon, shellfish growers, native and non-native oysters, and management practices (e.g., use of herbicides)



Zostera in Padilla Bay Estuary Reserve



Native Olympia oysters
Manchester's new shellfish hatchery



How can we be poised to respond to new problems and issues?

- **Changes in management practices**
 - Missed opportunity in 2013
- **New arrivals (shad, walleye, pike)**
- **Climate change**
- **Species interactions**



(Lake WA, April 2015, Eric Warner)



“Numerous pike found in Roosevelt's Kettle Arm”

<http://www.spokesman.com>

(Lake Roosevelt, March 2015)



Addressing non-natives species needs with limited resources?

- Mine existing data
- Networking
- Partnering w/ recreational fishing groups, rafting guides, etc.
- Power of post docs
- Hitch non-natives work to other 'hot topics' and priorities
(climate change, ocean acidification, Tsunami debris, etc.)