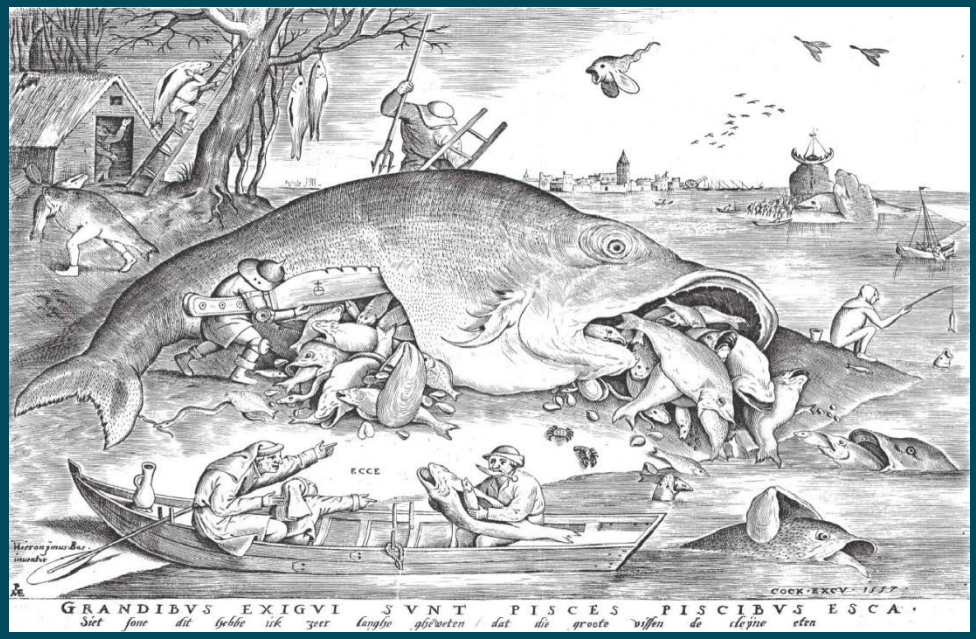
Food Webs:
Developing a Broader Scientific Foundation for Fish & Wildlife Restoration



Science-Policy Workshop: Predation
Portland, Oregon 9 August 2012

Robert J Naiman
University of Washington
and ISAB

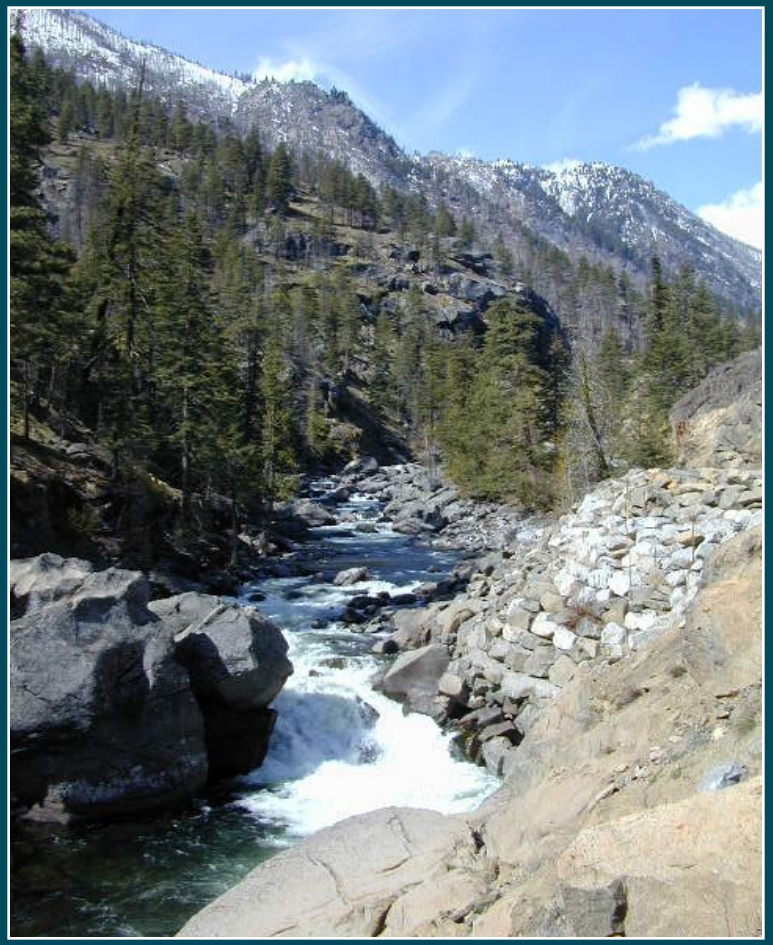
Review Objective & Approach

- **Provide a fundamental understanding of aquatic food webs in the Columbia River Basin and their effects on native fish restoration efforts**

- Compile and review the diverse literature to produce a coherent summary
- Identify future food web-related research directions for improving restoration of fish and wildlife in the Basin
- Present current scientific understanding in a form that can be used by policy makers in the Fish & Wildlife Program

Why Focus on Food Webs?

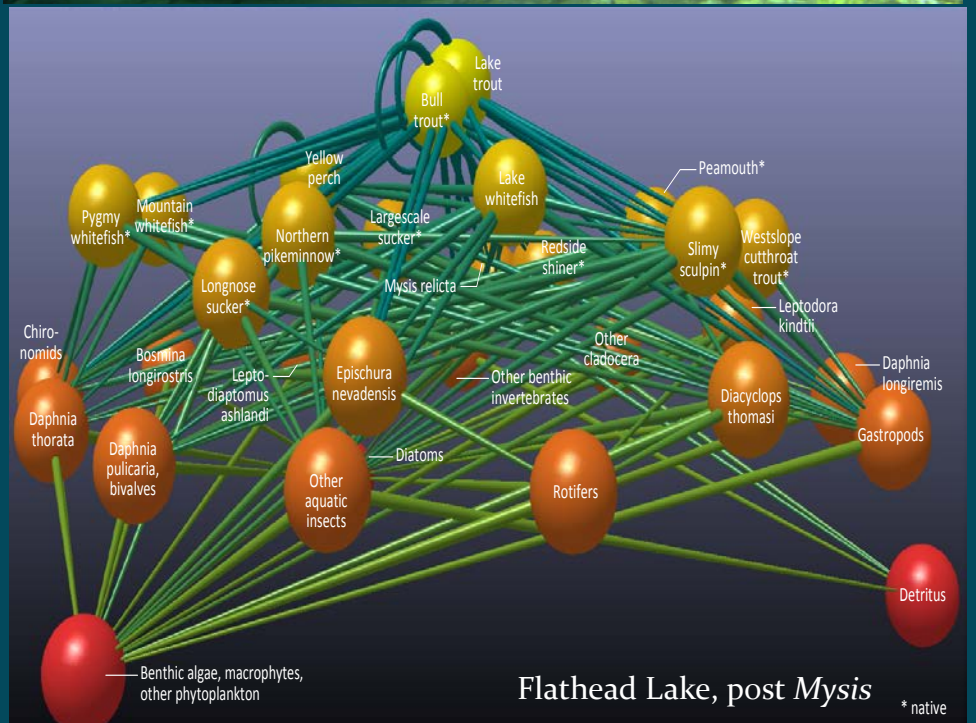
1. Reveal insights into basic ecosystem properties underpinning, abundance productivity and resilience
2. Considerable food comes from external sources — including subsidies from MDN, headwater tributaries, and adjacent riparian and terrestrial habitats
3. Important trophic pathways and food sources vary over time and space
4. Fishes use an array of habitat types to complete their life cycles



Food Webs

Highly Critical Issues:

- *Uncertainty about the Aggregate Carrying Capacity of the Basin*
- *Proliferation of Chemicals and Contaminants*
- *Consequences of Non-native Species: Hybrid Food Webs*



Carrying Capacity

- Most anadromous salmonids in the Basin originate from hatcheries; well over half total smolt abundance
- Hatchery-reared fish interact trophically with wild salmon and other native species as predators, competitors or prey
- Surprisingly little is known about the impact of hatchery releases on natural food webs in the Basin

Carry Capacity

Food demand of spring-summer Chinook salmon smolts

Lower Granite Dam to Bonneville, 461 km

~9 million hatchery and wild yearling Chinook, May 2008

~13 day migration

Total food required: 166.5 metric tons (mt)

33.3 mt dipterans

52.1 mt other insects

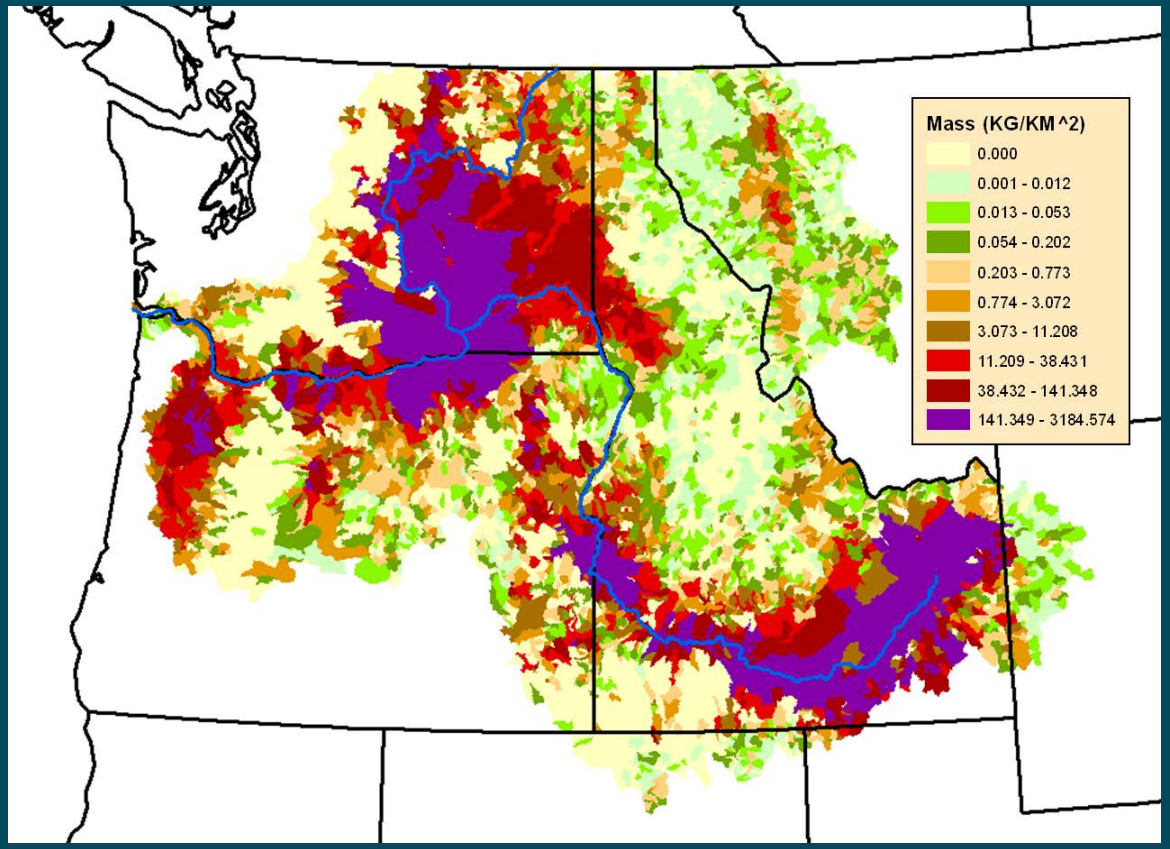
38.8 mt Daphnia

42.2 mt amphipods

Each million juvenile shad consume 25-52 mt of food during July-September

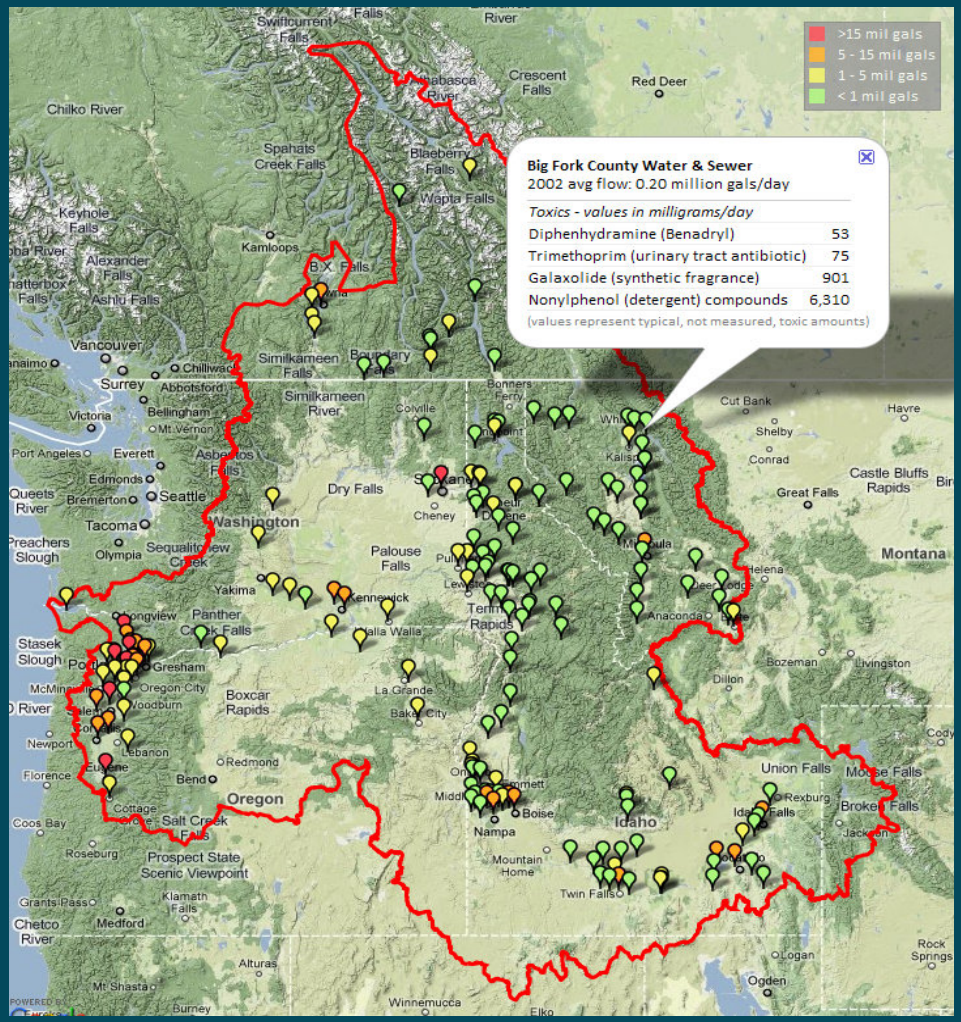
Contaminants & Bioaccumulation

- ~182 pesticides (herbicides & insecticides) in use
- 45,939 mt of active ingredients applied annually

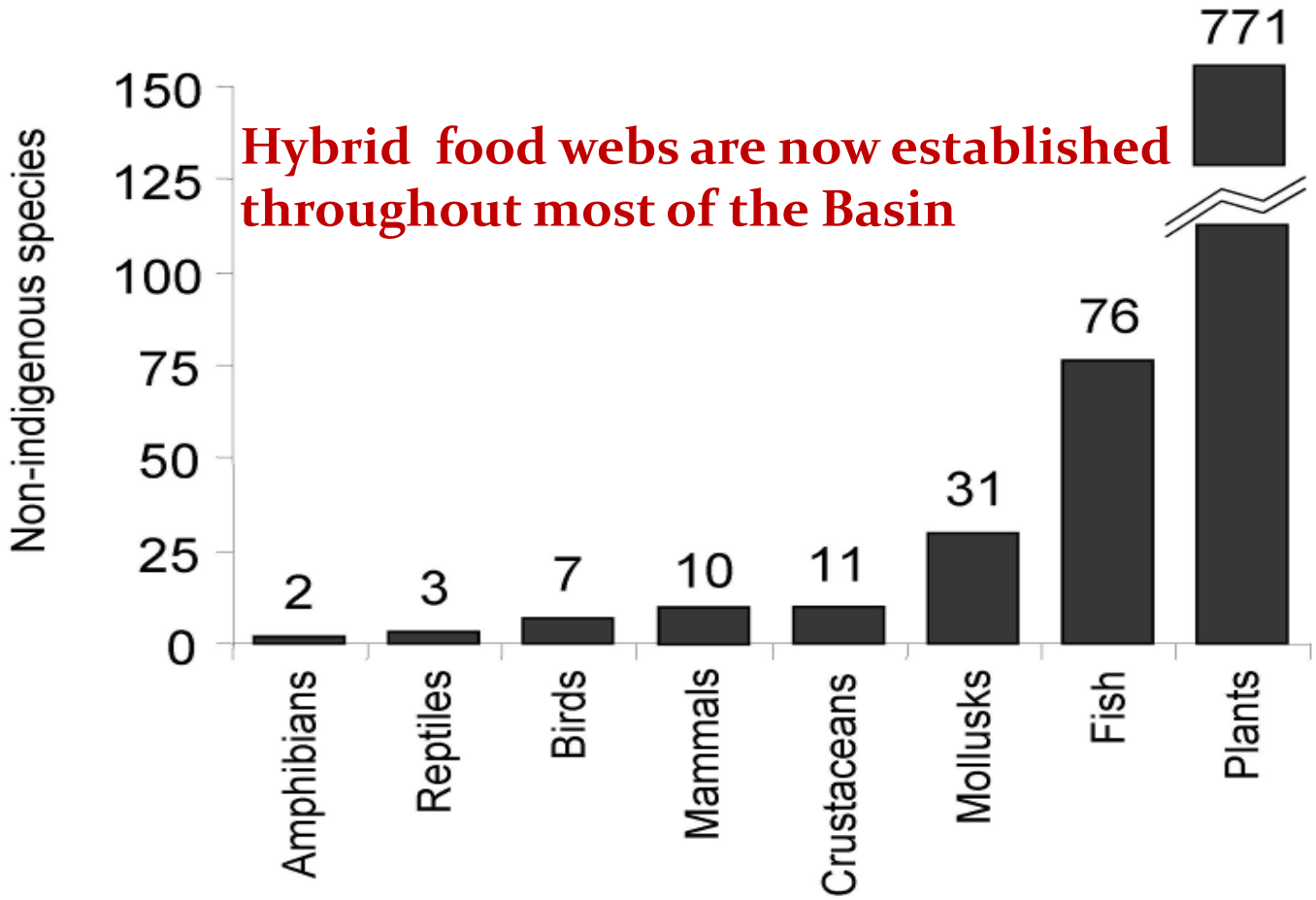


Contaminants & Bioaccumulation

- 169 US and 18 Canadian wastewater treatment plants
- Contributions from current and emerging industrial contaminants (e.g., PAHs, PBDEs, pharmaceuticals and personal care products) remain largely unknown



Non-Native Species



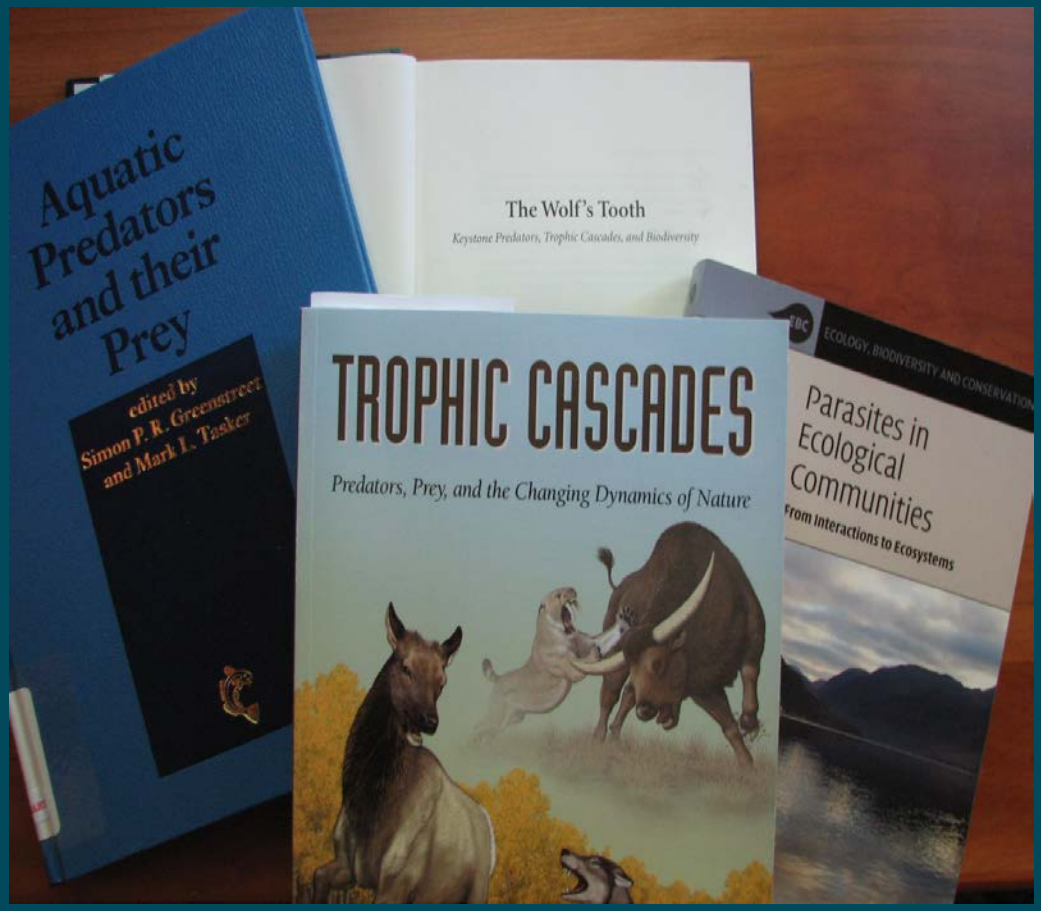
Hybrid food webs are now established throughout most of the Basin

Sanderson et al. 2009

Important Issues to Consider

Predation in the CRB

Predator-Prey Interactions in Fishery Management are not new. What lessons are useful to Columbia River restoration?



Important Issues to Consider

Predation in the CRB

Carrying Capacity and Hatchery Production

Consequences of Trophic Cascades

Effects of Contaminants on Prey Abundance and Behavior

Managing Predator-Prey Interactions in Dynamic Hybrid Communities

Strategic Planning for Environmental Change

Humans as Predators

Humans as Predators

People kill more large fish than any other predator in the Basin

Each year, on average, fisheries take ~500,000 Pacific salmon and steelhead, ~47,000 sturgeon, ~51,000 American shad, ~200,000 northern pikeminnow (bounty program), plus other fishes

These harvests imply a fishing mortality rate of ~30% for salmonids (of both hatchery and wild origin) but only ~1% for the non-native shad population

In comparison, total predation mortality on anadromous salmonids by birds and mammals is unlikely to exceed 20%.

Food Web Implications for Restoration

Identify Food Web-related Properties (e.g., predator-prey) that Maintain Desired Ecosystem States and that Sustain Resilient Communities

Accept Hybrid Food Webs as Legitimate Targets, while Maintaining Productivity

Restore and Manage for a Changing World

Do we need a Food Web or a Predator-Prey Model for the Columbia Basin?

Closing Remarks

The Columbia Basin is an ever-changing 'hybrid' system with an inherently limited capacity to produce fish – presenting great management challenges as well as unique opportunities for coordination

A food web or predator-prey perspective provides a *necessary* complement to ongoing emphases on hydrosystem, habitat, hatcheries and harvest (the four Hs)

The full report can be found at:

http://www.nwcouncil.org/library/isab/2011-1/