ISAB

Independent Scientific Advisory Board
for the Northwest Power and Conservation Council,
Columbia River Basin Indian Tribes,
and NOAA Fisheries
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204

March 29, 2012

To: **Fish and Wildlife Committee, Northwest Power and Conservation Council**

From: **Erik Merrill, Manager, Independent Scientific Review Program**

Subject: **ISAB Presentation on High Level Indicators for Monitoring Diversity**

Dr. Richard Alldredge, ISAB Chair, will present findings from the ISAB's memo on High Level Indicators for Monitoring Diversity (ISAB 2012-2, attached). The memo was developed in response to questions from the Council that arose during the ISAB's October 2011 presentation of the report, *Using a Comprehensive Landscape Approach for More Effective Conservation and Restoration* (ISAB 2011-4). The ISAB recommended that the Council and others "rebalance the vision for restoration" by giving greater attention to the value of diversity and resilience. Council members asked the ISAB for guidance in choosing appropriate High Level Indicators (HLIs) for monitoring and discussion of diversity to help meet the Program's fish and wildlife objectives. The ISAB's memo briefly covers concepts of diversity then focuses on identifying potential HLIs that are linked primarily to salmon and their habitat, including HLIs that could be summarized from existing information.

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MEMORANDUM (ISAB 2012-2) **February 10, 2012**

To: **ISAB Administrative Oversight Panel**
Joan Dukes, Chair, Northwest Power and Conservation Council
Paul Lumley, Executive Director, Columbia River Inter-Tribal Fish Commission
John Stein, Science Director, NOAA-Fisheries Northwest Fisheries Science Center

From: **Rich Alldredge, ISAB Chair**

Subject: **High Level Indicators for Monitoring Diversity**

Background

On October 11, 2011, ISAB members presented a summary of the report: Using a Comprehensive Landscape Approach for More Effective Conservation and Restoration (ISAB 2011-4) to the Council. The ISAB recommended that the Council and others "rebalance the vision for restoration" by giving greater attention to the value of diversity and resilience. The importance of diversity is clearly recognized in the vision, scientific principles, and throughout the text of the Council's Fish and Wildlife Program. But in our view, in public, agency, and political discussion, the importance of diversity, particularly for salmon and steelhead, has been overshadowed by an emphasis on abundance and productivity.

Following the presentation, Council members asked the ISAB for guidance in choosing appropriate High Level Indicators (HLIs) for monitoring and discussion of diversity to help meet the fish and wildlife objectives for the Columbia Basin. During initial scoping discussions for our response, Council staff urged the ISAB to consider measures that could be summarized from existing information. Therefore, in this response to Council, we first briefly discuss concepts of diversity then focus on identifying potential HLIs that are linked primarily to salmon, their habitats and watersheds.

Concepts of Diversity

Biological diversity is critical to adaptive capacity and resilience to changing conditions that affect productivity and abundance of fish and wildlife and the human communities that benefit from them. Sustaining biological diversity will require renewed efforts to understand, monitor, conserve, and restore this diversity and also require attention to socio-economic issues and diversity in a broader discussion.

Biological diversity is multi-dimensional, and a number of different measures could be important for Columbia Basin monitoring and management. *Phenotypic and life history diversity* measures variation in the morphological or behavioral traits expressed by individuals within and among populations; *genetic diversity* measures variation in heritable traits (genes) within and among populations and reflects evolutionary history and evolutionary potential; *taxonomic diversity* measures the number and relative abundance of recognized species; and *ecological* or *functional diversity* measures variation in the roles, or functional organization, of components of the ecosystem. Biological diversity, in all its dimensions, ultimately depends on the maintenance of diversity in landscapes, habitats, and the biophysical and ecological processes that shape them.

Biological diversity is linked to *social and economic diversity* as well. Communication and understanding of the role that biological diversity plays for people is key to the choices people make to address natural resource issues. But diversity in human systems themselves is also important. Resilience and adaptive capacity in both human and natural systems is ultimately underpinned by diversity brought about by alternative ways of thinking and doing, and by recognizing that long term benefits may require some loss of short term control. One concern is that socioeconomic systems tend to select current conditions over alternatives that may have more diverse and resilient future outcomes (Fernandez 1991). People in socioeconomic networks tend to interact with those who have similar characteristics, attitudes, and behaviors (McPherson et al. 2001, Centola 2011) that can narrow the alternatives considered with respect to diversity and resilience. The Council will benefit from raising interest and understanding among a greater diversity of participants, which will lead to broader and more effective support for conservation and restoration actions. Surveys of public understanding and views of diversity should inform any long-term attempt to build support for a more broadly based program.

Over the last two centuries, the Columbia Basin has lost diversity in many dimensions, although some taxonomic diversity has been gained through the introduction and expansion of non-native species. Some attempts to quantify changes and establish a historical frame of reference exist for salmon and steelhead. A few efforts have focused on life history diversity, genetic diversity, and representation of historic habitats at the scale of the entire Basin (Lee et al. 1997, Burke 2004, Bottom et al. 2005, Gustafson et al. 2007, McClure et al. 2008). Others have considered populations at finer scales (Isaak et al. 2003, Moore et al. 2010). For the most part, changes in diversity have been linked to large scale land conversion (Lee et al. 1997); impassable dams and large scale habitat loss (McClure et al. 2008); replacement of widely dispersed, natural sources of production with simpler, concentrated, artificial ones (Burke 2004); species introductions for recreational fishing; and even manipulation of migrations that affect habitat use by juveniles (Bottom et al. 2005). All these issues are the focus of considerable funding, research, restoration, policy reform, and debate. But, the fact remains there is limited baseline information or capacity to generate and understand trends in diversity and their ties to actions being implemented across the Basin.

Suggested Steps

One possibility for defining appropriate diversity HLIs is to summarize information synthesized in the five-year status reviews for salmon recovery (Ford et al. 2010) and that reported by the Columbia Basin Fish and Wildlife Authority (CBFWA 2011). Viability risk has been characterized based on indices of abundance, productivity, diversity, and spatial structure across populations and broader recovery units. Summaries of the number or proportion of populations at risk overall, or more specifically, of those failing to meet required conditions of diversity and spatial structure, could be used to portray trends at different scales across watersheds, subbasins, recovery units, and even the entire Basin. Color-coded maps or summaries of the number or proportion of populations in each class could provide a sense of existing conditions and highlight any changes over the five-year review period. A comparison with the conditions believed to exist before development could provide useful context.

Council staff, the ISAB, or others might be able to develop more refined HLIs with other existing data, but that will require efforts to better understand the availability, utility, and limitations of the information. For example, existing monitoring of adult and juvenile migrants may provide information on variation in size, timing, and duration of habitat use, at different points in the river system. Burke (2004) showed substantial changes have occurred in life history patterns for migrating juveniles in the estuary. It may be possible to explore similar patterns with data from routine counting, marking and recovery efforts currently in place for river and tributary sites. Recent work exploring salmon life history patterns in the estuary might be extended to track changes in life history diversity in response to hatchery reform and habitat actions across the entire Basin. The infrastructure used to monitor juvenile outmigration and adult returns provides data on spatial and temporal patterns in migration, the size and age when scales are collected, and origin of migrants. Aggregate migration patterns reflect the relative contributions of geographically distinct populations and production areas, major life history types, habitat opportunities, and the influence of hatcheries and transport measures (Bottom et al. 2005). Thus, changing migration patterns could provide important clues about changing conditions or the effects of large-scale interventions in the Basin. Exploration of the temporal and spatial resolution of data needed to distinguish normal environmental variation such as year-to-year differences from longer-term trends associated with changes in underlying biological diversity will be important.

The relative stability, or alternatively the variability, in abundance of individuals can provide an indirect measure of diversity. This is because the performance of populations is directly influenced by underlying diversity in life history characteristics, population structure, and the representation of a spatially diverse salmon "portfolio" (Schindler et al., 2010). Isaak et al. (2003) and Moore et al. (2010) used redd counts for Chinook salmon from the Middle Fork Salmon River and Snake River to show that stability of populations or groups of populations was tied to the spatial representation of spawning habitats. The implication is that consistent and continuous monitoring of abundance might be used to define an important component of salmon spatial diversity. Long-term measures of abundance both in the river (2011) and among individual populations (Ford et al. 2010) are widely available. Work like that done in the Snake River could be extended to other systems and larger scales allowing resolution of trends indicative of local and regional diversity in much of the Basin. But, again this will require some effort to understand and resolve meaningful patterns.

A variety of initiatives aim to catalogue habitat restoration actions, habitat condition, and population sizes across watersheds and recovery units. It may be possible to summarize consistent measures of spatial diversity or representation of habitat and populations as another proxy for phenotypic, life history and genetic diversity that cannot be measured directly. For example, the U.S. Forest Service has developed a nationwide Watershed Condition Framework to track the condition of 6th level HUCs and also supports several large-scale habitat monitoring efforts within the Basin, such as PIBO and AREMP. The recovery status review explores the application of remote sensing to characterize land cover and its change through time and summarizes measures of abundance across multiple populations or larger recovery units (Ford et al. 2010). Using some of the ideas above, it may be possible to summarize consistent measures of the spatial structure of populations, functioning watersheds or landscapes that ultimately underpin multiple forms of diversity. Walters and Cahoon (1985) provide an example of this approach based on relative abundance among salmon stocks. Isaak et al. (2006) used the same approach to consider the loss of spatial diversity in the Middle Fork Salmon. Simple summaries of the spatial distribution fish or habitat condition across populations could illuminate trends across larger networks or recovery units and environmental gradients (McClure et al. 2008).

Broader and more consistent assessment of habitat conditions and the representation of functional diversity sustained by a diverse network of habitats might be refined by combining data from traditional and remote sensing methods with data from ongoing large-scale monitoring by the Forest Service, EPA, or other groups. Results from such efforts might be integrated with emerging landscape, watershed, and stream channel classification systems (Beechie and Imaki 2011, Whittier et al. 2011) to more effectively characterize and track the distribution of well-functioning watersheds and landscapes as well as the appropriate distribution of restoration actions to achieve a more diverse representation. Council staff members, in collaboration with the Northwest Habitat Institute, have developed measures of functional diversity for wildlife that can be linked to existing land cover and condition (Marcot and Vander Heyden 2001). These measures might be extended to consider ecological and functional conditions for aquatic systems. The evolving tools of systematic conservation planning might be used to strengthen our understanding of the relationships between landscape and ecological conditions and all forms of biological and ecological diversity (Strecker et al. 2011).

Genetic markers, a baseline of genetic structure and variability, and the analytical capacity to exploit them (Roegner et al. 2010) have expanded dramatically in recent years making it possible to consider both the diversity and representation of populations or population groups across the large regions. These tools might be adapted to consider representation of genetic diversity and production sites as fish move through the river and across time.

Recent efforts to characterize fish communities and the role of invasive species in the basin (Lee et al. 1997, Sanderson et al. 2009) might be formalized as periodic measures of broad taxonomic diversity and ecological function (Magurran et al. 2011).

Moving Forward

With a possible exception of the recovery status information, development of HLIs for biological diversity will require significant work. New spatial and temporal summaries of existing data on abundance may provide substantial information about diversity for example, but some effort will be needed to understand the gaps in, and limitations of, those data. We recommend that Council staff, the ISAB, or some other entity identify and evaluate specific HLI measures that can be gleaned from existing data and ongoing efforts. Data gaps should be identified and prioritized, and strategies developed for filling these gaps. Studies that evaluate and quantify the links between the different forms of diversity with abundance, productivity, and resilience should be pursued. Innovative research and other activities, such as focused workshops, should explore alternative ways to monitor diversity and guide further investment.

These scientific questions should not delay increased engagement of Basin residents in discussions to better understand and incorporate diversity into Council objectives and goals. An important step will be greater socioeconomic engagement on HLIs for diversity (ISAB 2011-4, Criterion 1). The discussion above is about measures of biological diversity, but successful restoration of fish and wildlife populations depends on public knowledge and support. The diversity of fish and wildlife is linked to socioeconomic systems (Smith 1994, Berkes et al. 2003) and has been eroded by human actions (Bottom 1997, Mitchell and Duncan 2009). A specific HLI, such as the ratio of wild to hatchery salmon in run segments, could be used to engage public discussion about the relation that diversity and resilience have with efforts to influence abundance and productivity. A simple accounting of the number of extant populations or the viability risk of populations outlined above could serve a similar purpose. As the diversity discussion progresses, indicators of public knowledge and support for including a diversity metric in the Fish and Wildlife Program would be useful to explore.

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High Level Indicators for Monitoring Diversity

Presented by:

Rich Alldredge, ISAB

Bruce Rieman, ISAB

NPCC Fish and Wildlife Committee

Skamania, WA

April 10, 2012

Genesis of HLI Diversity Task

- ISAB Landscape Report presented to the Council, October 2011
- Council members requested ISAB guidance on choosing HLIs for diversity
- Council staff urged use of measures that could be summarized from existing information.

ISAB HLI Diversity Memo
February 12, 2012

- Present concepts of diversity
- Identify potential HLIs
- Offer recommendations

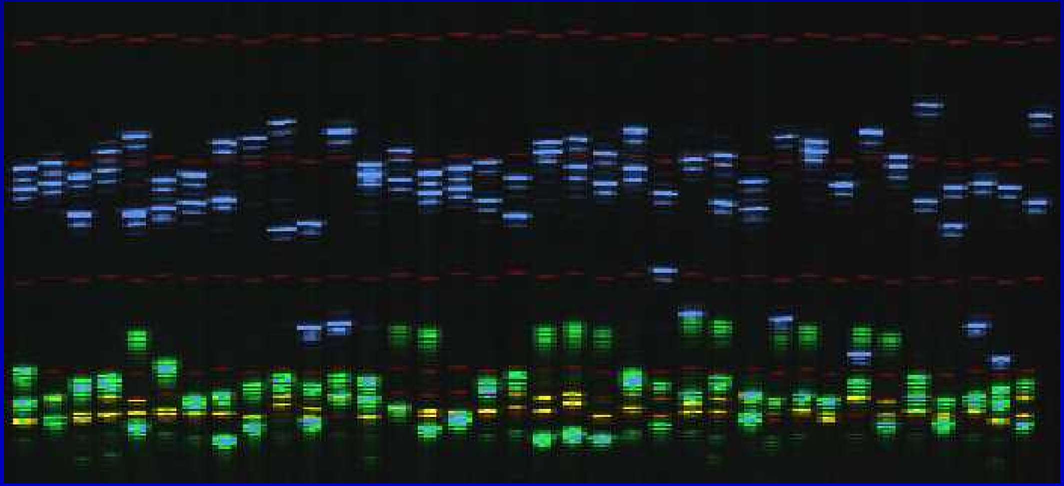
Concepts of Diversity

- **Biological Diversity — provides resilience to changing conditions affecting productivity and abundance of fish and wildlife and human communities that benefit from them**

Concepts of Diversity

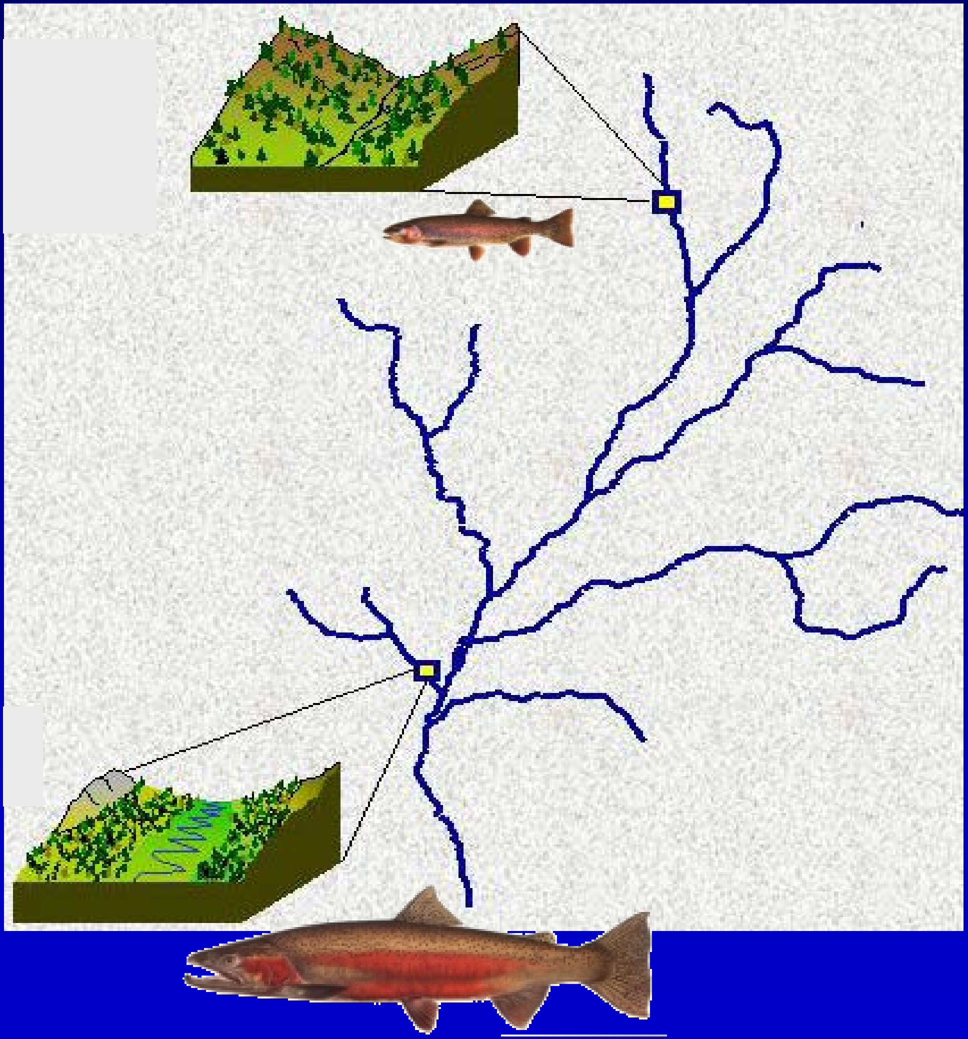
Biological Diversity is Multidimensional

- ***Genetic diversity***
- ***Taxonomic diversity***
- ***Ecological* or *functional diversity***
- ***Phenotypic and life history diversity***



Concepts of Diversity

Biological diversity depends on maintaining diversity in landscapes, habitats, and biophysical and ecological processes

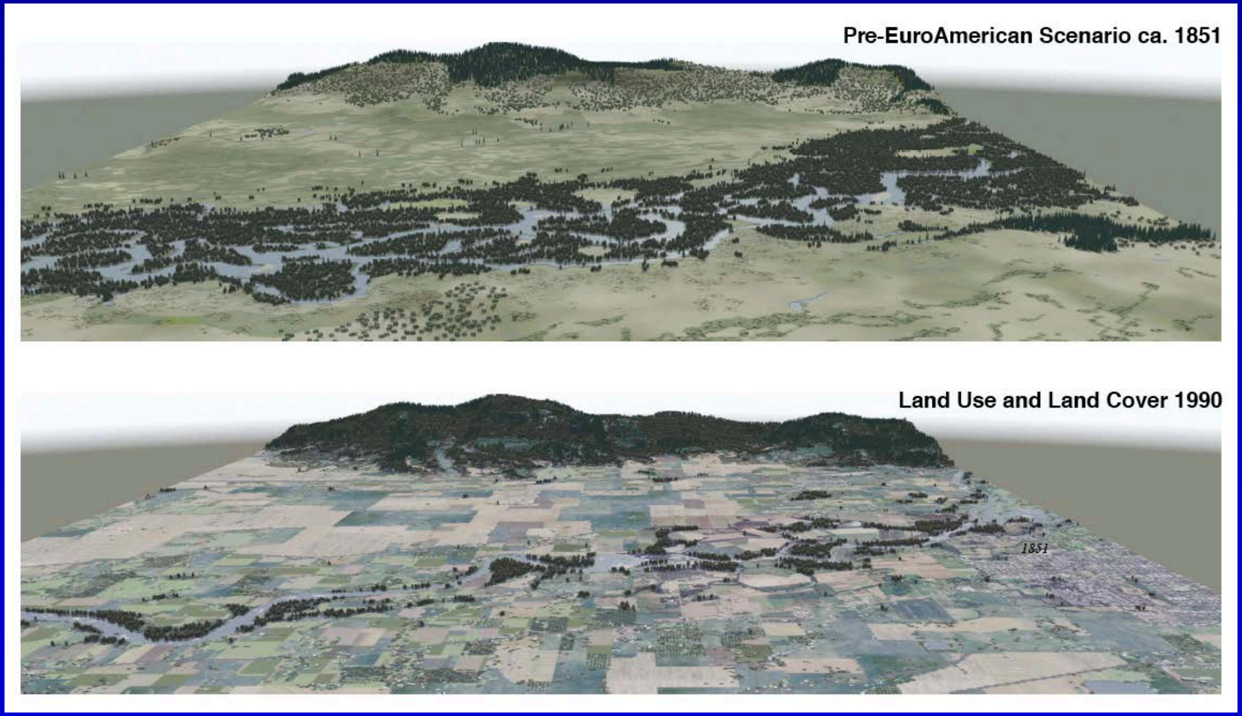


Concepts of Diversity

Biological diversity is linked to social and economic diversity

Current Status

- Over the last two centuries, the Columbia Basin has lost diversity in many dimensions.
- There is limited baseline information or capacity to generate and understand trends in diversity.



Next Steps - Potential HLIs

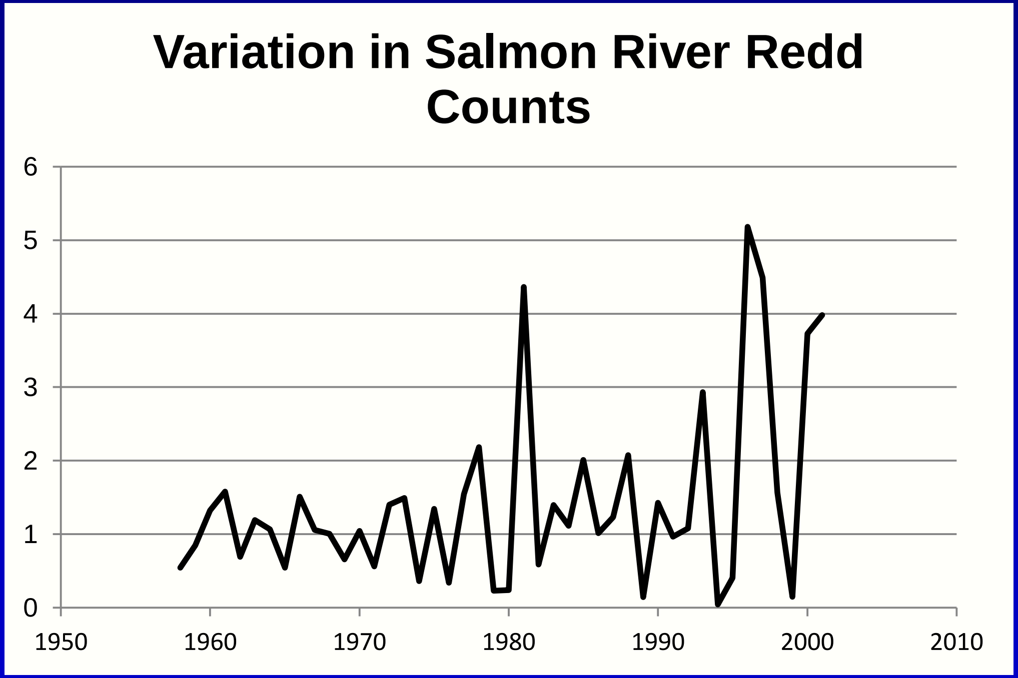
- Summarize NOAA status reviews for salmon recovery and CBFWA information
- Show trends in # of populations failing to meet diversity and spatial structure conditions.

Table 22. Upper Salmon MPG. Summary of current population status vs. ICTRT viability criteria

Upper Salmon River MPG	Abundance/Productivity Metrics				Spatial Structure and Diversity Metrics			Overall Viability Rating
Population	*ICTRT Minimum Threshold*	*Natural Spawning Abundance*	*ICTRT Productivity*	*Integrated A/P Risk*	*Natural Processes Risk*	*Diversity Risk*	*Integrated SS/D Risk*	
North Fork 2000-2009	500	Insufficient data	Insufficient data	High	Low	Low	Low	HIGH RISK
1995-2004				High				
Lemhi River 2000-2009	2000	96 (38-582)	0.94 (0.59-1.52)	High	High	High	High	HIGH RISK
1995-2004		92 (10-582)	1.13 (0.74-1.73)	High				
Pahsimeroi River 2000-2009	1000	154 (80-316)	0.58 (0.33-1.04)	High	Moderate	High	High	HIGH RISK
1995-2004		91 (11-298)	0.48 (0.25-0.96)	High				
Upper Salmon Lower Mainstem 2000-2009	2000	120 (37-378)	1.16 (0.83-1.61)	High	Low	Low	Low	HIGH RISK
1995-2004		83 (9-378)	1.28 (0.93-1.76)	High				
East Fork Salmon River 2000-2009	1000	178 (68-784)	1.04 (0.66-1.65)	High	Low	High	high	HIGH RISK
1995-2004		104 (6-784)	1.16 (0.66-1.65)	High				
Yankee Fork 2000-2009	500	21 (2-324)	0.80 (0.38-1.68)	High	Moderate	High	High	HIGH RISK
1995-2004		16 (0-153)	1.01 (0.51-2.01)	High				
Valley Creek 2000-2009	500	78 (13-292)	1.21 (0.78-1.91)	High	Low	Moderate	Moderate	HIGH RISK
1995-2004		38 (0-292)	1.21 (0.78-1.89)	High				
Upper Salmon Mainstem 2000-2009	1000	313 (98-743)	1.21 (0.87-1.71)	High	Very Low	Moderate	Moderate	HIGH RISK
1995-2004		181 (9-743)	1.42 (0.95-2.13)	High				

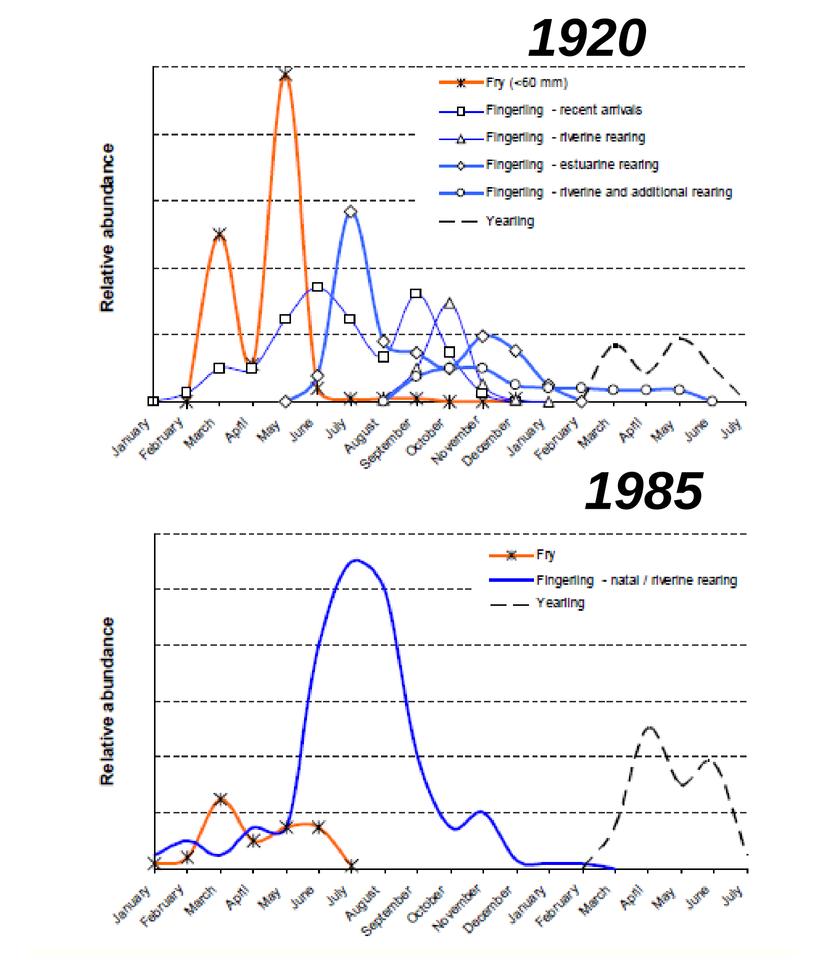
Next Steps - Potential HLIs

Quantify the relative stability and variability in abundance of individuals.



Next Steps - Potential HLIs

- **Explore patterns from current counting, marking and recovery efforts.**
- **Examine migration patterns for clues about changing conditions or effects of interventions**



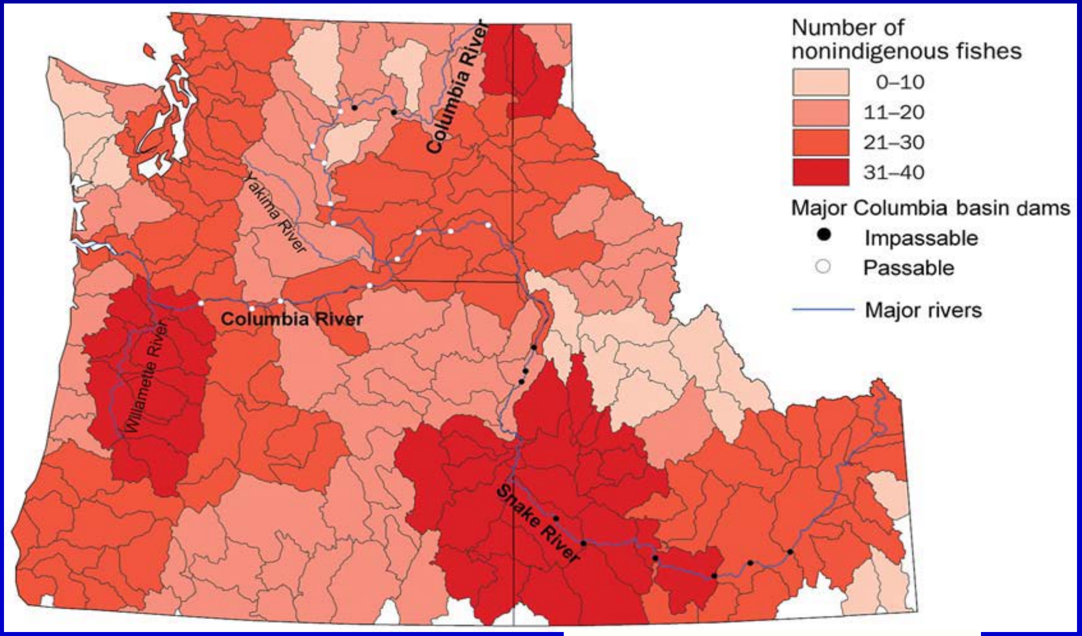
Bottom et al., 2005

Next Steps - Potential HLIs

- Use classification systems to track well-functioning landscapes and relate to measures of population spatial structure
- Extend measures of wildlife diversity to ecological and functional conditions for aquatic systems.
- Use systematic conservation planning to relate biological diversity with landscape and ecological conditions

Next Steps - Potential HLIs

- Use genetic markers to represent diversity across time and fish movement
- Characterize fish communities and invasive species as measures of taxonomic diversity and ecological function



Sanderson et al., 2009

Moving Forward

Select an entity to lead efforts to:

- evaluate specific HLI measures from existing data
- identify and prioritize data gaps
- develop strategies for filling these gaps.

Support studies to evaluate links between forms of diversity with abundance, productivity, and resilience.

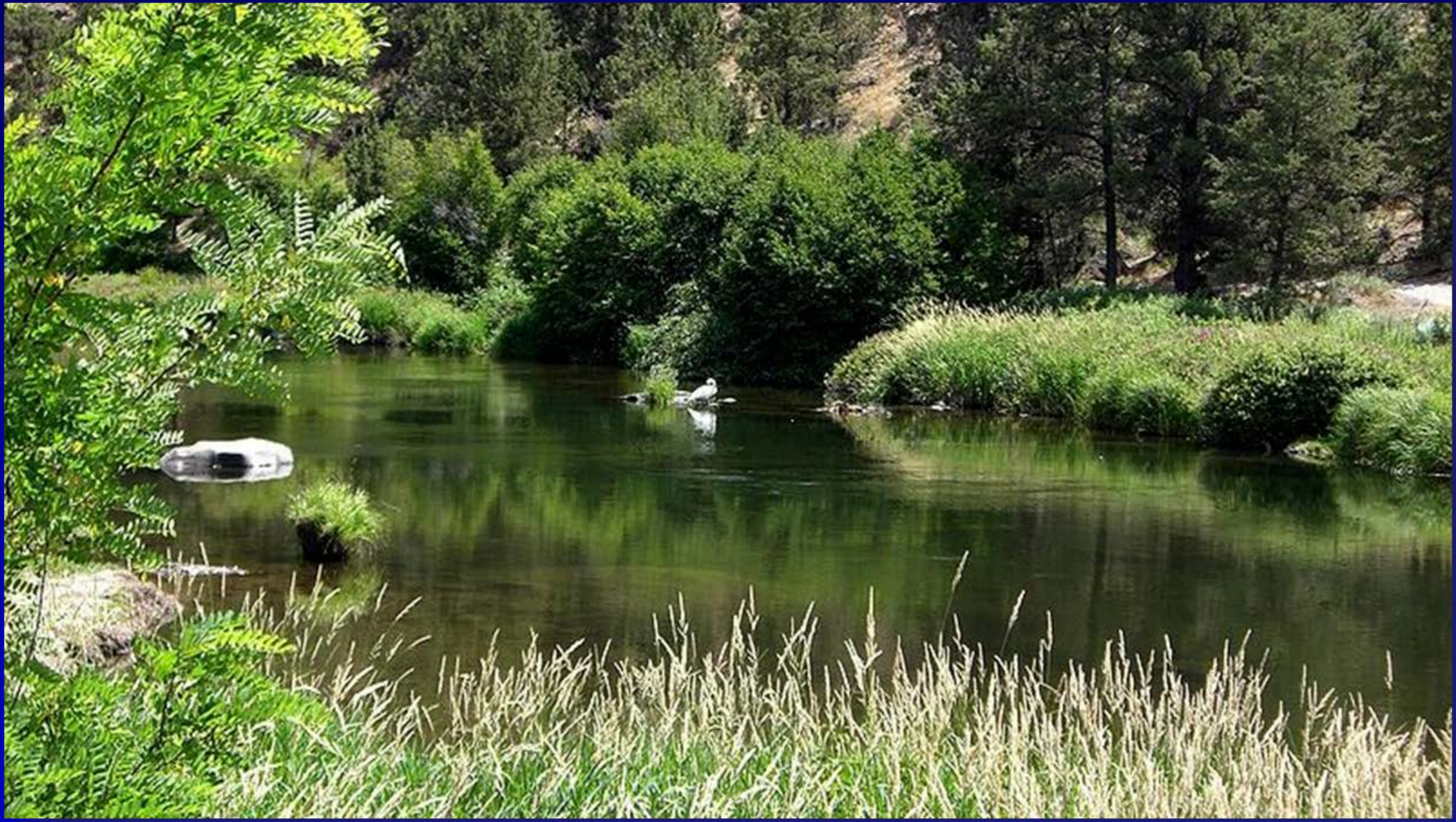
Support research and other activities, such as workshops, to explore alternative ways to monitor diversity and guide further investment.

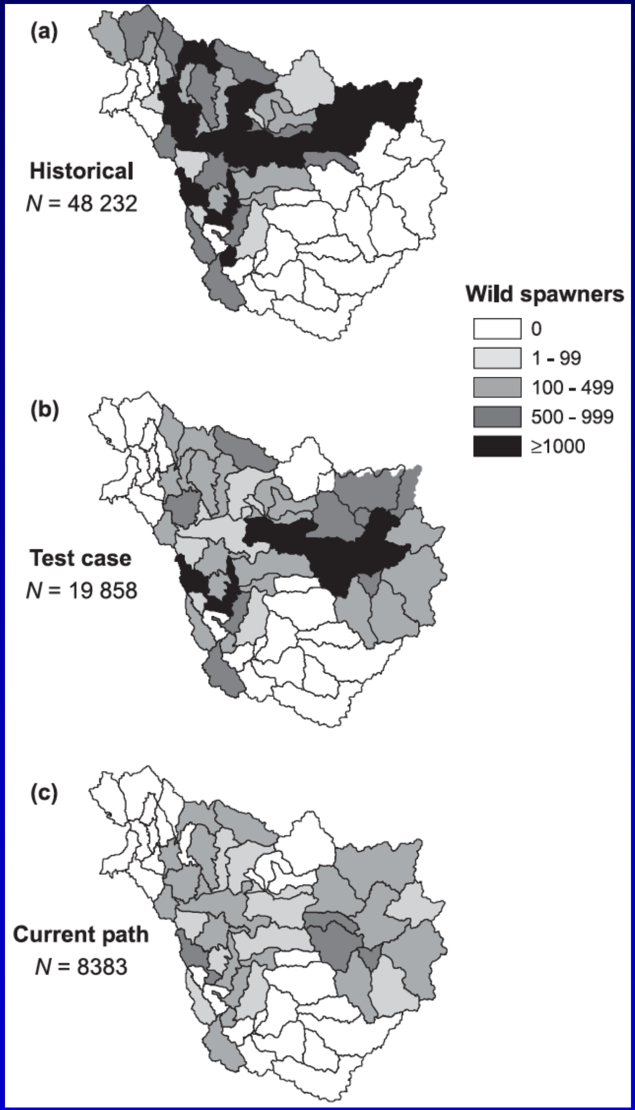
Moving Forward

- Because diversity of fish and wildlife is linked to socioeconomic systems, encourage public involvement in monitoring diversity.

- Emphasize relationships of diversity and resilience with efforts to influence abundance and productivity

Thank You!!!




(a)
Historical
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Current path
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0
1 - 99
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