



Klamath River – understanding where we are going, sequencing actions and expectations for *O. mykiss*

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Steelhead Management Meeting – 11 December 2025





T. Williams



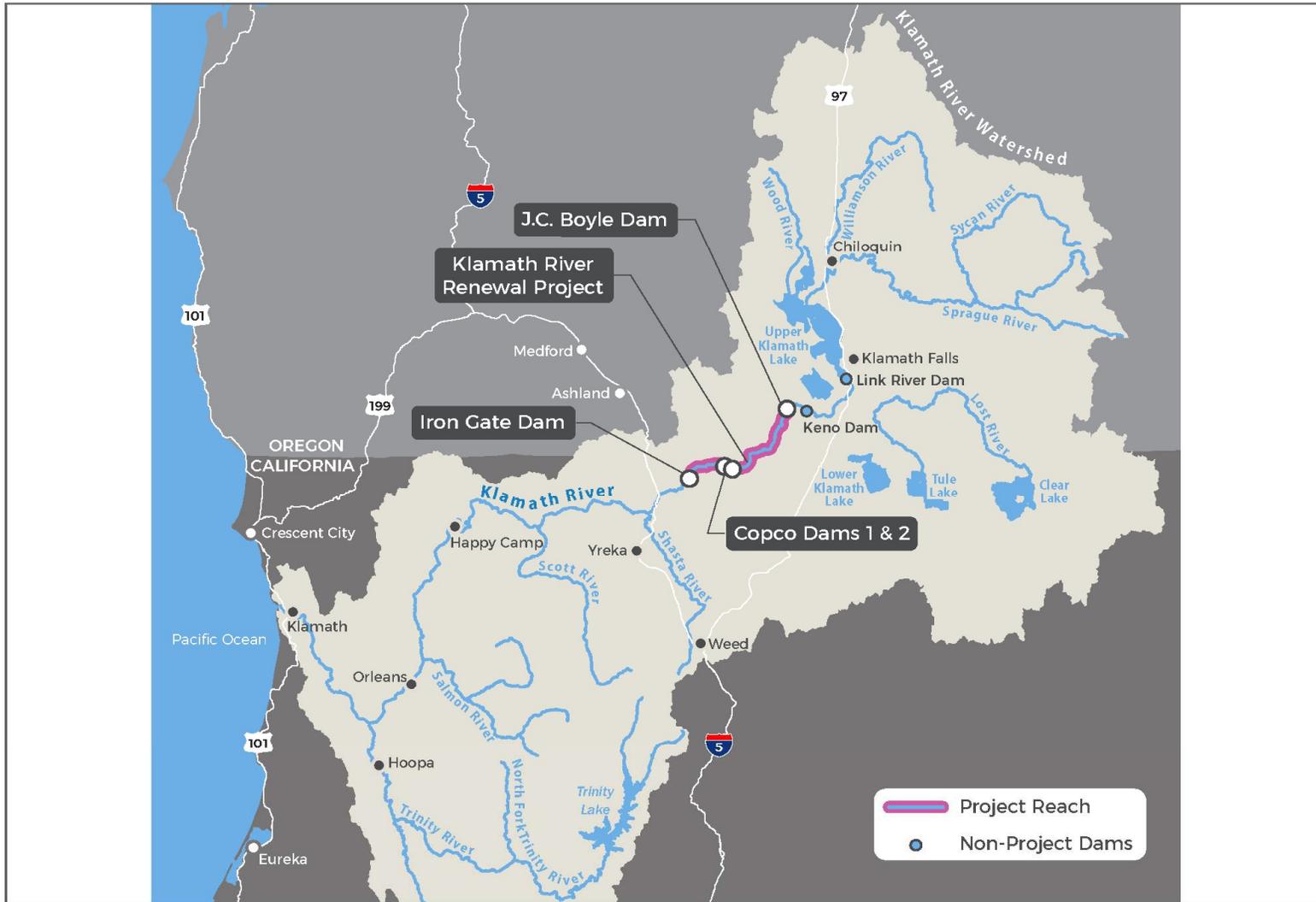
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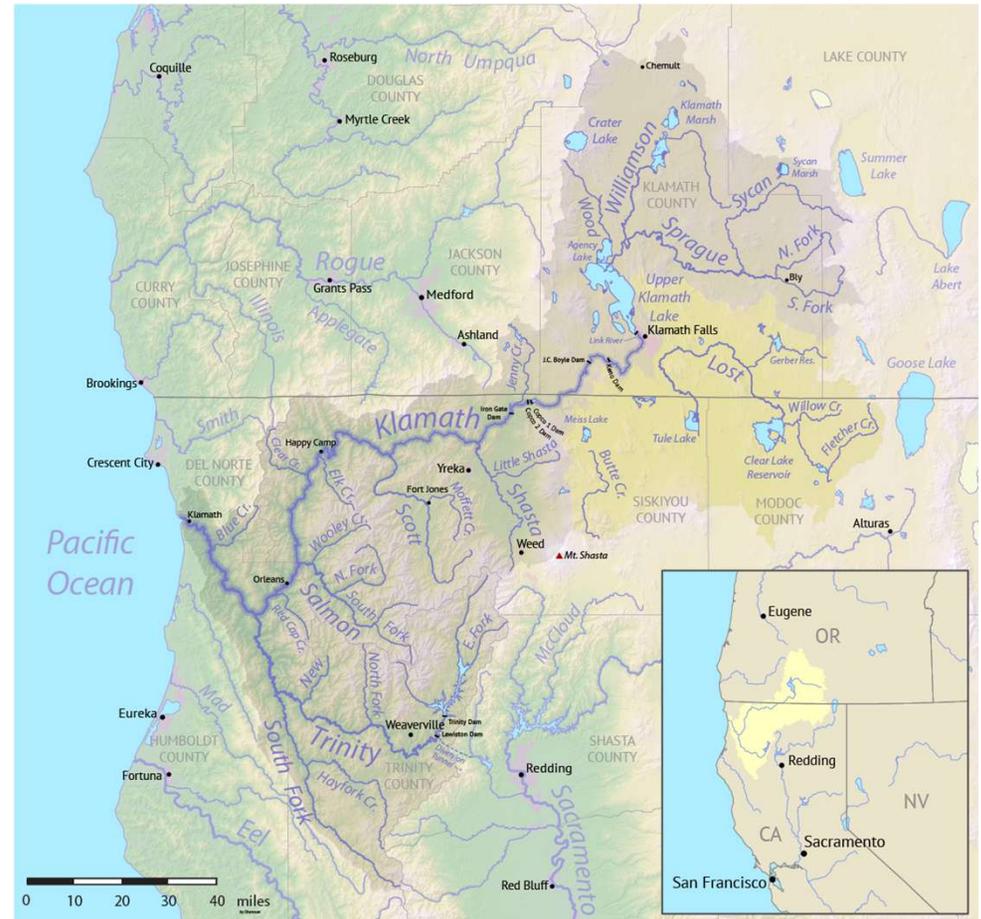


B. Cluer



Klamath Facts

- Located in N CA and So OR
- 15,679 miles² Watershed Area
- Historically
 - Klamath historically 3rd largest salmon producer on West Coast
 - Chinook salmon, coho salmon, steelhead, lamprey, trout, and suckers
 - Important Tribal, recreational and commercial fisheries.
- Today
 - coho salmon and suckers ESA-listed
 - spring Chinook salmon petitioned (CESA-listed)
 - Fall-run Chinook salmon fishery closures
 - Dams block 420 miles + of habitat



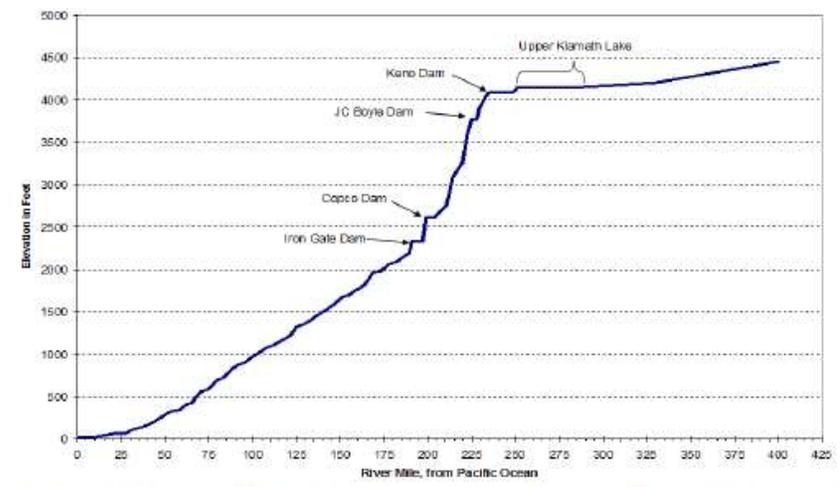
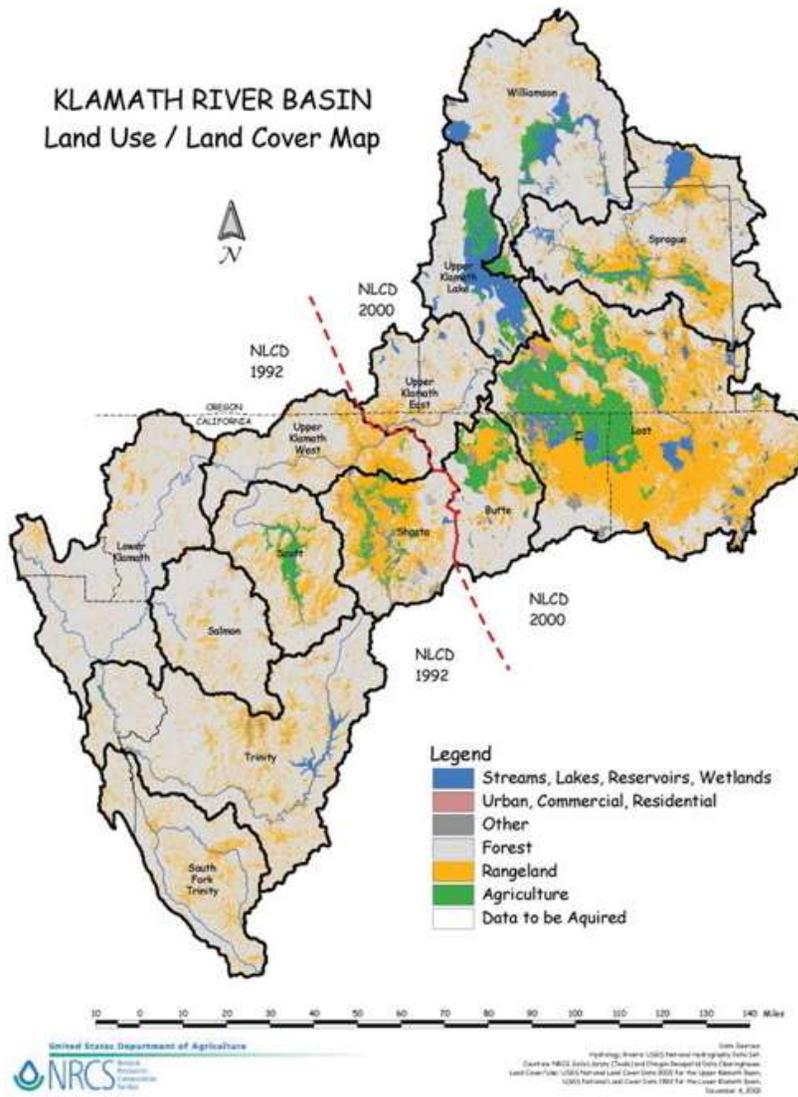


Figure 7.2. Slope of the Klamath River from Upper Klamath Lake to the Pacific Ocean. Note the gentle slope upstream from the reservoirs compared to the slope downstream. This is opposite of most watershed settings and is important context for the production of deposits stored in the reservoirs, as well as the transport of deposits by the river if released upon dam removal.

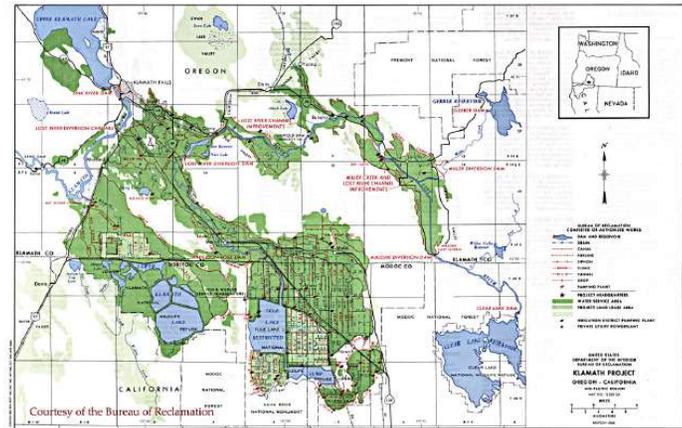
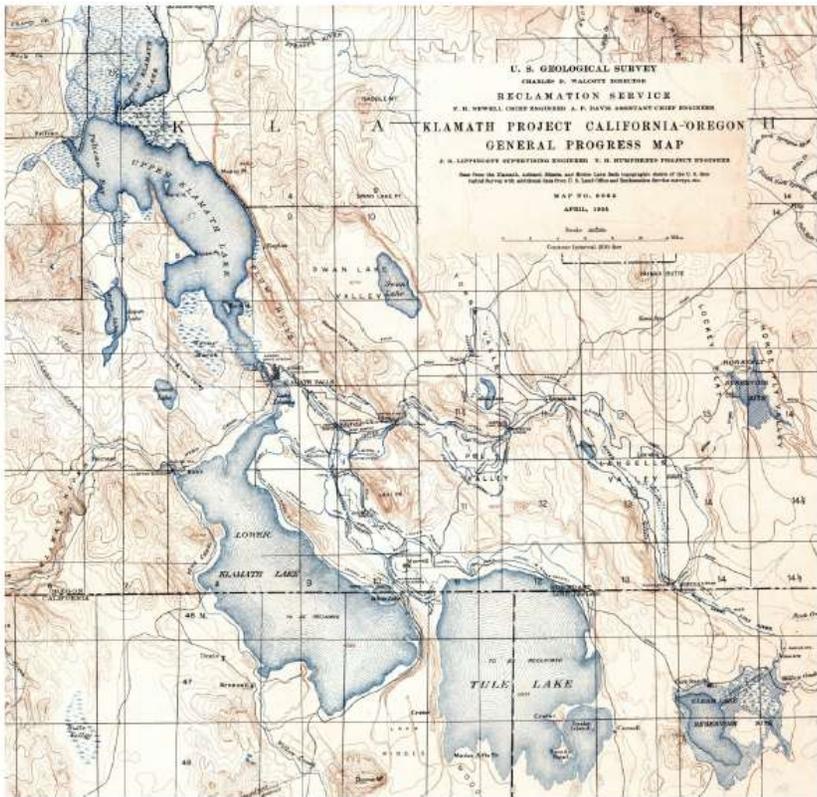


Figure 3-6. This 1998 Klamath Project map shows that about 25 percent of the original wetland area remains.



Figure 3-7. View across Lower Klamath National Wildlife Refuge, a remnant of Lower Klamath Lake. (Photograph by Charles Palmer, USGS.)

- Salmon wars
- Fish kill
- Engage at corporate level
- Water quality issues
- Loss of traditional fishing opportunities (upper and lower Basin)



The Klamath River Fish Kill of 2002;
Analysis of Contributing Factors



Yurok Tribal Fisheries Program
February 2004

Final Report

Prepared by:
Michael Betchik
Dave Hillmeier
Ronnie M. Pierce





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- **A conceptual framework was needed to provide consistent guidance and encourage productive conversations and planning**
- **An agreed upon desired future condition was required, the re-establishment of viable and self-sustaining fish populations**
- **The focus was on, and continues to be on restoring ecological and physical processes – to restore a connected, dynamic, and resilient basin for anadromous fish and communities**

First – manage expectations, understand where you are going – desired future landscape. Focus relentlessly on processes not parts, dynamic not static, movement and connectivity, tracking change in the environment and the conditions of the habitat across space and time. Expectations need to account for both short and long time scales.



Resist the temptation to do something just to be able to assure one's self and others that "something" was done. Actions taken need to be consistent with the desired future condition or at least consistent with an ultimate path or trajectory towards that future condition.



Focus on the desired future condition and lock in on that outcome.

Assess actions on the measure of “does it get us there”

Not always a straight line, we may sometimes have to tack, but always focused on where we want to go.



“Tacking” but still aiming for the future, making adjustments or temporary changes to the path or strategy while still holding onto a long-term goal or vision.

The process can be seen as a dynamic approach where one is adapting to current conditions while maintaining a sense of direction and purpose towards a desired future landscape.



To be viable (i.e., persist) – fish need to be able to track changes in environment

- **Individuals (within and between life stages)**
- **Populations**
- **Watersheds**
- **Regions / ESUs**
- **Species**



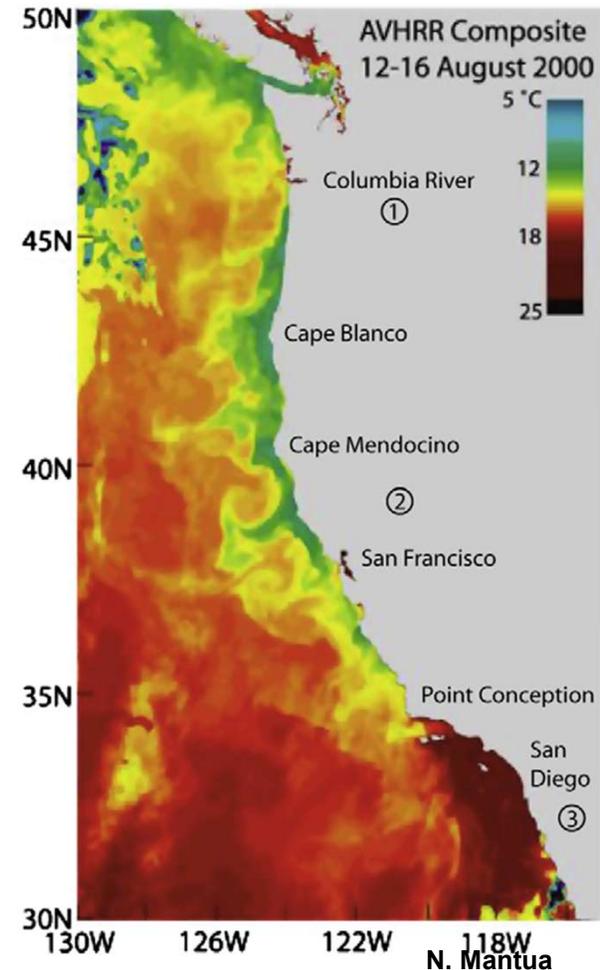
Natural disturbance events that influence salmonid populations throughout their range include:

- fires
- landslides
- glaciers
- earthquakes
- volcanic eruptions
- floods



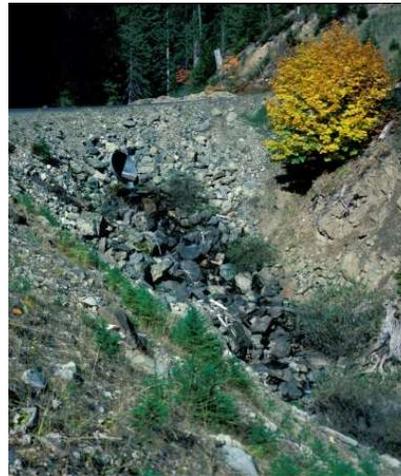
The California Current System is dynamic

This mid-summer surface temperature snapshot shows how complex and diverse “ocean conditions” are at any given time in response to variable weather, winds, ocean currents, etc.



Anthropogenic constraints that can influence the ability of salmonid populations to track changes in environmental conditions include:

- barriers
- land management activities (e.g., timber, agriculture)
- Fire / floods (magnitude, frequency)
- water withdrawal



VSP Viable Salmonid Populations

Viability of populations are evaluated based on four parameters (VSP parameters):

- **abundance**
- **population growth rate**
- **spatial structure**
- **diversity**

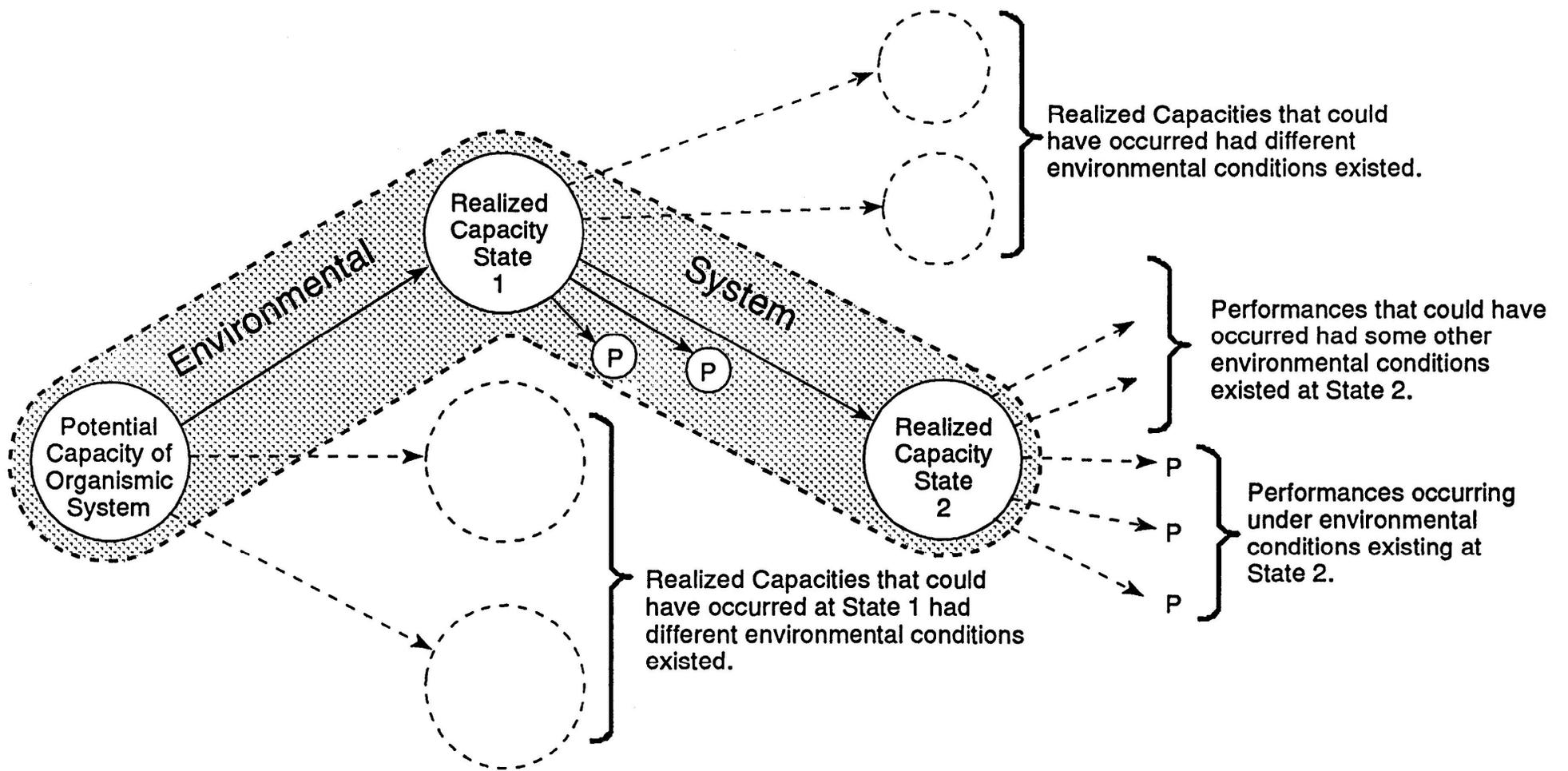
ESU viability

- **catastrophic events**
- **long-term demographic processes**
- **long-term evolutionary potential**

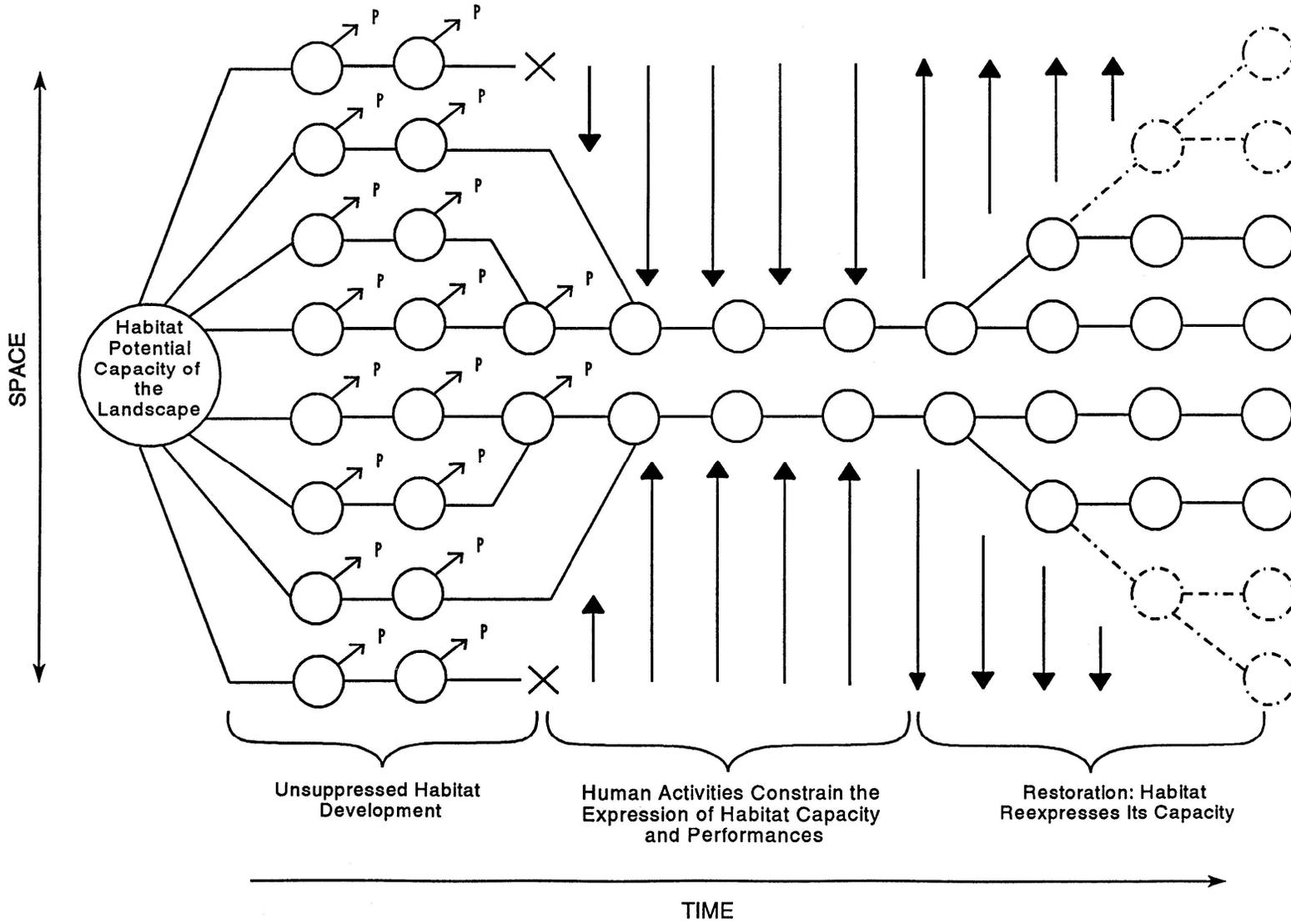
**McElhany et al. 2000. Viable salmonid populations and the recovery of Evolutionarily Significant Units. NOAA Technical Memorandum NMFS-NWFSC-42.
<http://www.nwr.noaa.gov/1salmon/salmesa/pubs.htm>**

VSP Checklist

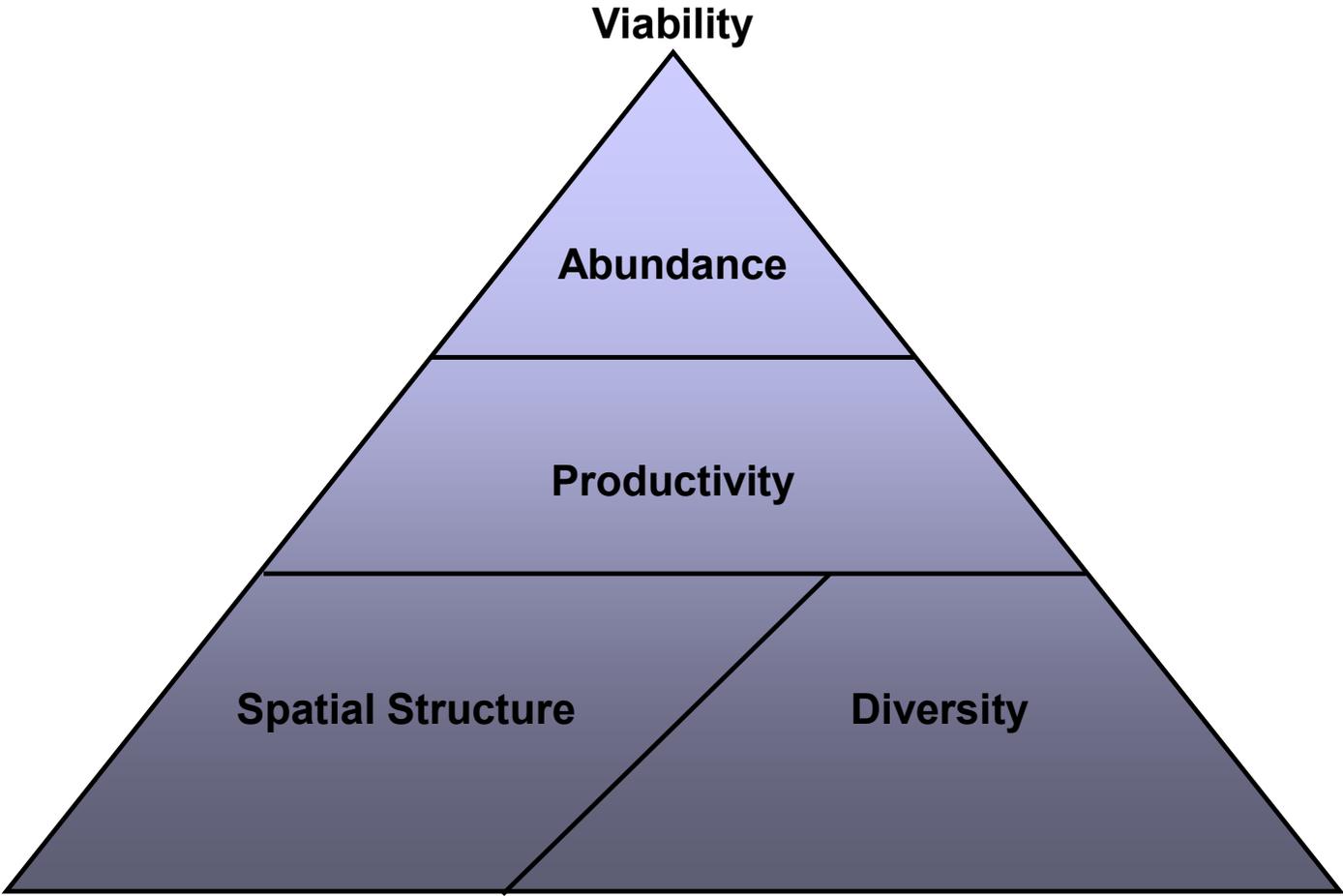
- Abundance
- Productivity
- Spatial Structure
- Diversity

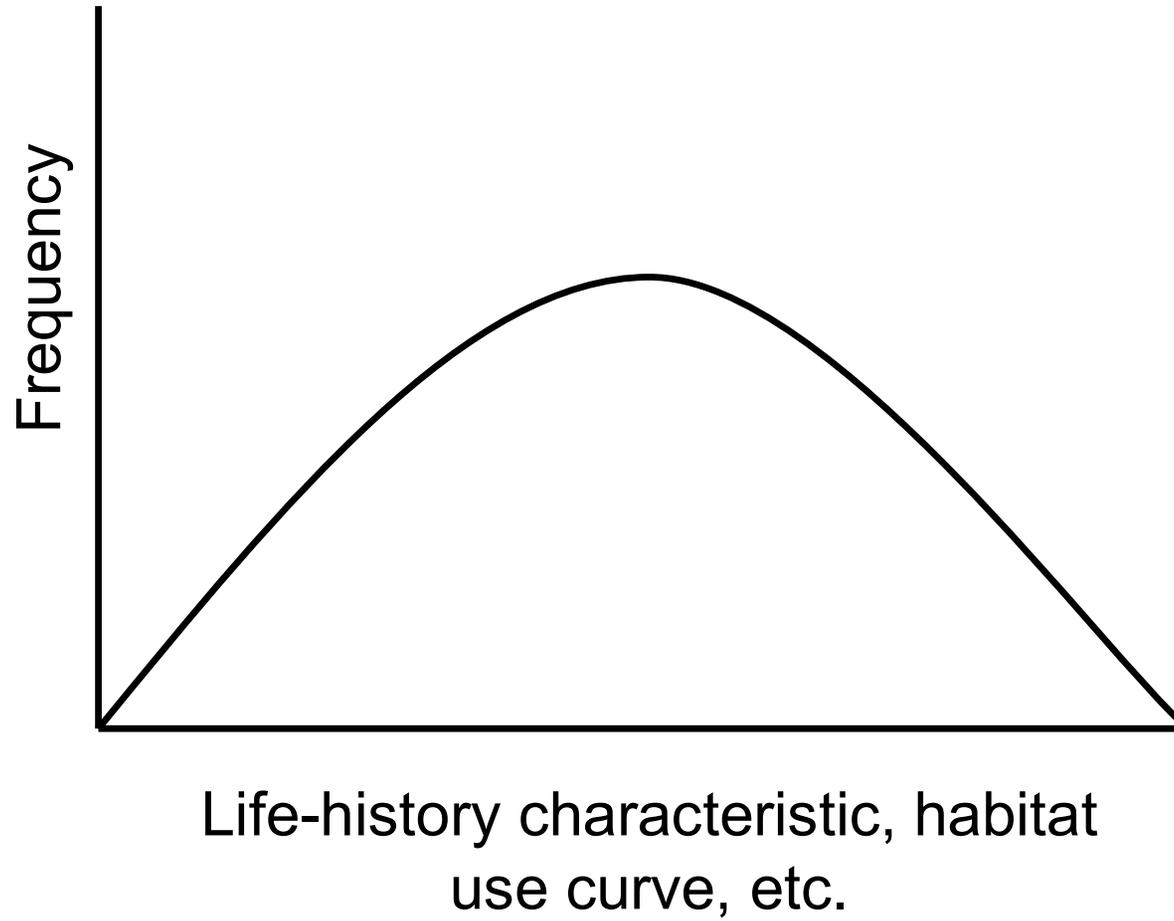


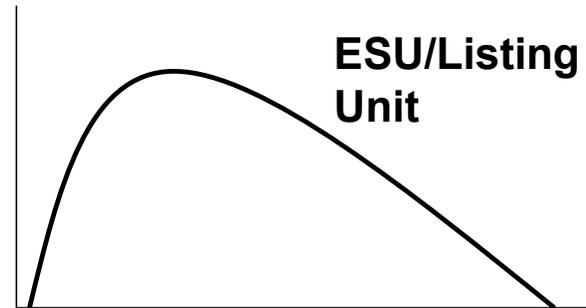
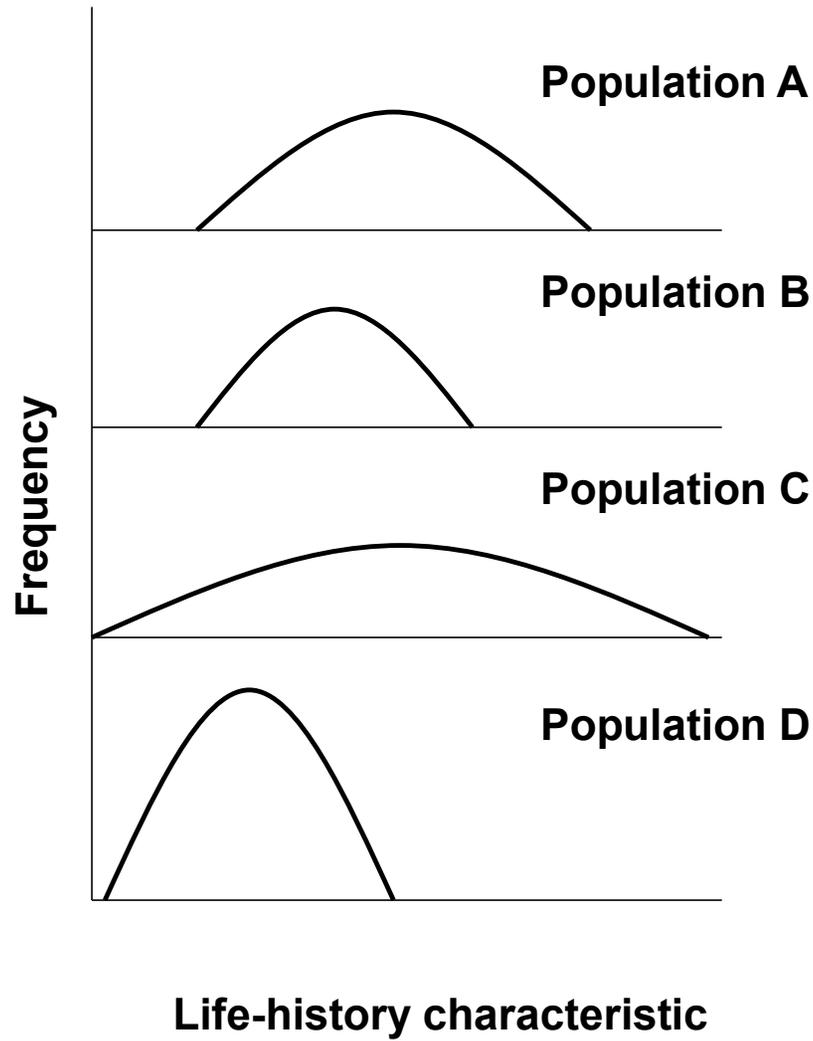
From Ebersole et al. 1997. *Envir. Mgt.* 21:1-14.



From Ebersole et al. 1997. *Envir. Mgt.* 21:1-14.







LETTERS

Population diversity and the portfolio effect in an exploited species

Daniel E. Schindler¹, Ray Hilborn¹, Brandon Chasco¹, Christopher P. Boatright¹, Thomas P. Quinn¹, Lauren A. Rogers¹ & Michael S. Webster²

One of the most pervasive themes in ecology is that biological diversity stabilizes ecosystem processes and the services they provide to society^{1–4}, a concept that has become a common argument for biodiversity conservation⁵. Species-rich communities are thought to produce more temporally stable ecosystem services because of the complementary or independent dynamics among species that perform similar ecosystem functions⁶. Such variance dampening within communities is referred to as a portfolio effect⁷ and is analogous to the effects of asset diversity on the stability of financial portfolios⁸. In ecology, these arguments have focused on the effects of species diversity on ecosystem stability but have not considered the importance of biologically relevant diversity within individual species⁹. Current rates of population extirpation are probably at least three orders of magnitude higher than species extinction rates¹⁰, so there is a pressing need to clarify how population and life history diversity affect the performance of individual species in providing important ecosystem services. Here we use five decades of data from *Oncorhynchus nerka* (sockeye salmon) in Bristol Bay, Alaska, to provide the first quantification of portfolio effects that derive from population and life history diversity in an important and heavily exploited species. Variability in annual Bristol Bay salmon returns is 2.2 times lower than it would be if the system consisted of a single homogenous population rather than the several hundred discrete populations it currently consists of. Furthermore, if it were a single homogeneous population, such increased variability would lead to ten times more frequent fisheries closures. Portfolio effects are also evident in watershed food webs, where they stabilize and extend predator access to salmon resources. Our results demonstrate the critical importance of maintaining population diversity for stabilizing ecosystem services and securing the economies and livelihoods that depend on them. The reliability of ecosystem services will erode faster than indicated by species loss alone.

The recent focus on ecosystem-based management of renewable resources emphasizes species interactions and how these are affected by human activities within exploited ecosystems. However, there is growing recognition that population diversity within exploited species can contribute to their long-term sustainability and should be incorporated more explicitly into management and conservation schemes^{11,12}. For example, it has been argued¹³ that population diversity reduced the temporal variability of sockeye salmon fisheries in Bristol Bay because of complementary dynamics in different components of the stock complex. Similar phenomena are now appreciated qualitatively in other marine ecosystems¹⁴. However, at present there are neither quantitative estimates of the strength of portfolio effects produced by population and life history diversity in exploited species, nor an objective assessment of the benefits of population diversity to human economies and ecosystem services in general.

From 1950 to 2008, sockeye salmon supported the most valuable fisheries in the United States (landed value, US\$7,900,000,000), and 63% of the associated revenue came from Bristol Bay (see Supplementary Information for details). The total economic value of this fishery is considerably higher when considering the retail, cultural and recreational value of these fish. Income from sockeye salmon in Bristol Bay is the major source of personal income for most Bristol Bay communities, and landing taxes provide the major funding for local school districts. Thus, the interannual reliability of this fishery has critical and direct consequences for the livelihoods of people in this region.

Population diversity within the stock complex of Bristol Bay sockeye substantially reduces the interannual variability experienced by the commercial fishery, which intercepts sockeye salmon as they enter each of the nine major rivers of this region (Fig. 1a). Each river stock contains tens to hundreds of locally adapted populations distributed among tributaries and lakes (Fig. 1b and Supplementary Fig. 1). This remarkable diversity in sockeye reflects their ability to thrive in a wide range of habitat conditions, the reproductive isolation of populations by precise homing to natal spawning sites, and their capacity for micro-evolution¹⁵. Thus, the Bristol Bay sockeye fishery integrates across substantial population diversity both within and among watersheds.

Annual sockeye returns to the Bristol Bay stock complex were considerably less variable (coefficient of variation (standard deviation divided by mean), CV = 55%) than those observed for individual rivers (average CV = 77%; Fig. 1c) for 1962–2008. Annual returns to individual populations spawning in streams of the Wood River system, where long-term detailed population assessments are available (Fig. 1b), were more variable (average CV = 95%) than both the aggregate of these streams (CV = 67%) and the total returns to the Wood River (CV = 60%; Fig. 1c). Thus, annual sockeye returns become increasingly more stable across the complexity hierarchy ranging from individual spawning populations to stocks associated with the watersheds of major rivers and, eventually, to the regional stock complex of Bristol Bay.

The degree of temporal covariation among portfolio assets controls the strength of portfolio effects¹⁶; the buffering effects of asset diversity on variability of the aggregate portfolio become weaker as asset dynamics become more synchronous. Analysis of the covariation among river stocks and among stream populations (that is, the analogues of assets in an investment portfolio) showed that annual sockeye returns were only weakly synchronous (and some negatively correlated) both within and among the watersheds of Bristol Bay. This lack of synchrony among populations of Bristol Bay sockeye occurred despite many commonalities in their migration corridors, nursery habitats and seasonal timing of migrations between freshwater and marine environments. Furthermore, strong shifts in climatic conditions



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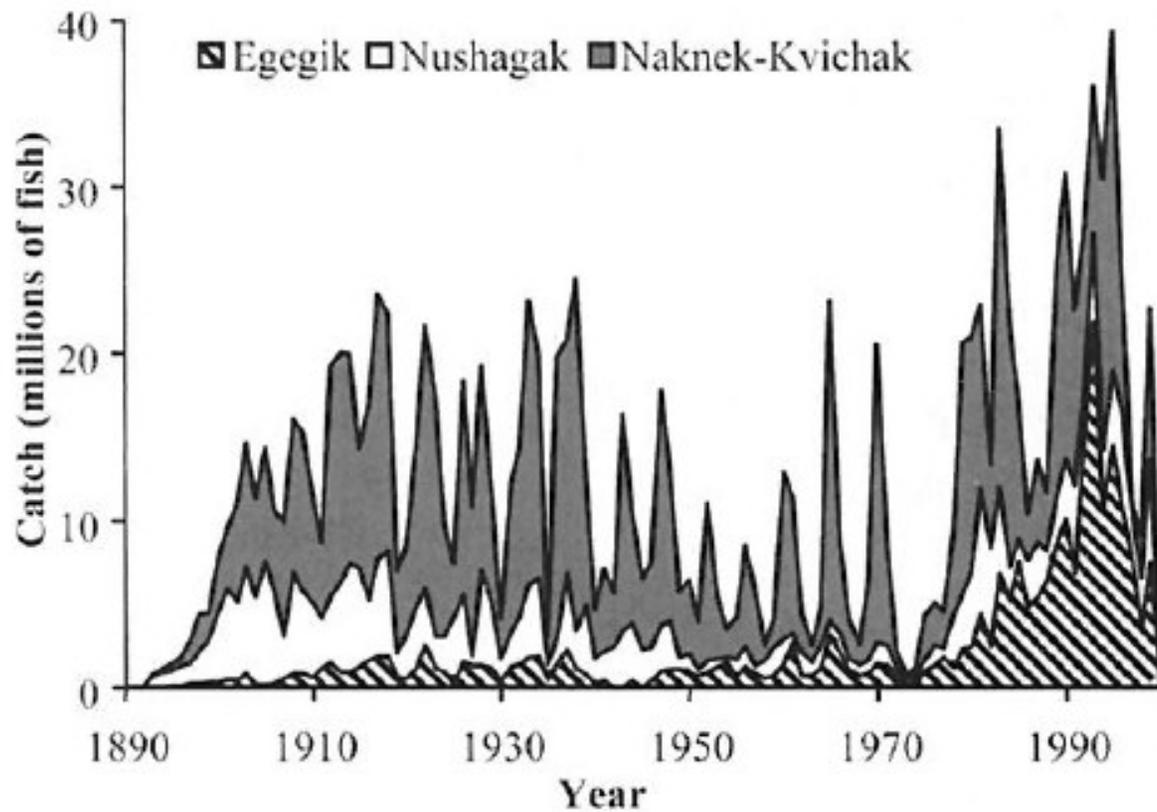


Fig. 3. Catch history of the three major fishing areas within Bristol Bay, Alaska. Contributions of the minor districts, Ugashik and Togiak, have averaged 4.6% since 1955.

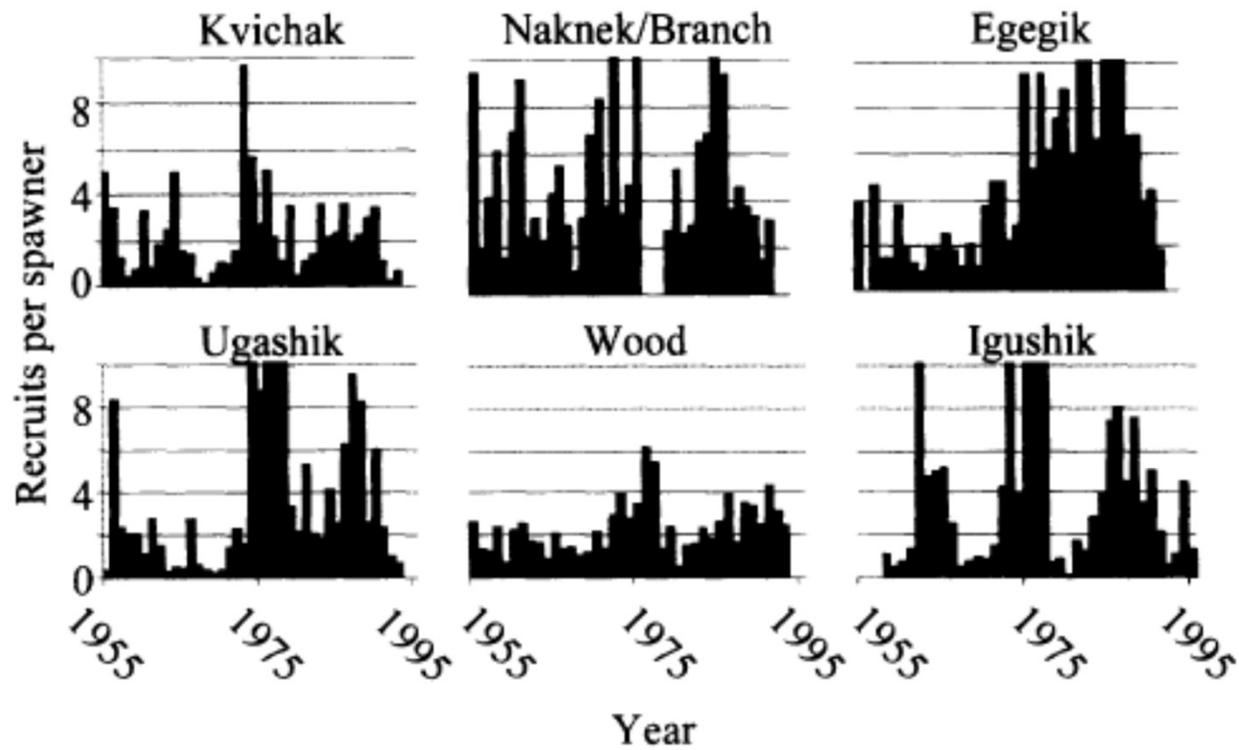


Fig. 4. Number of recruits per spawner for different Bristol Bay sockeye salmon stocks. Values >10 were truncated; the maximum was 27.4 for the Ugashik River in 1978.

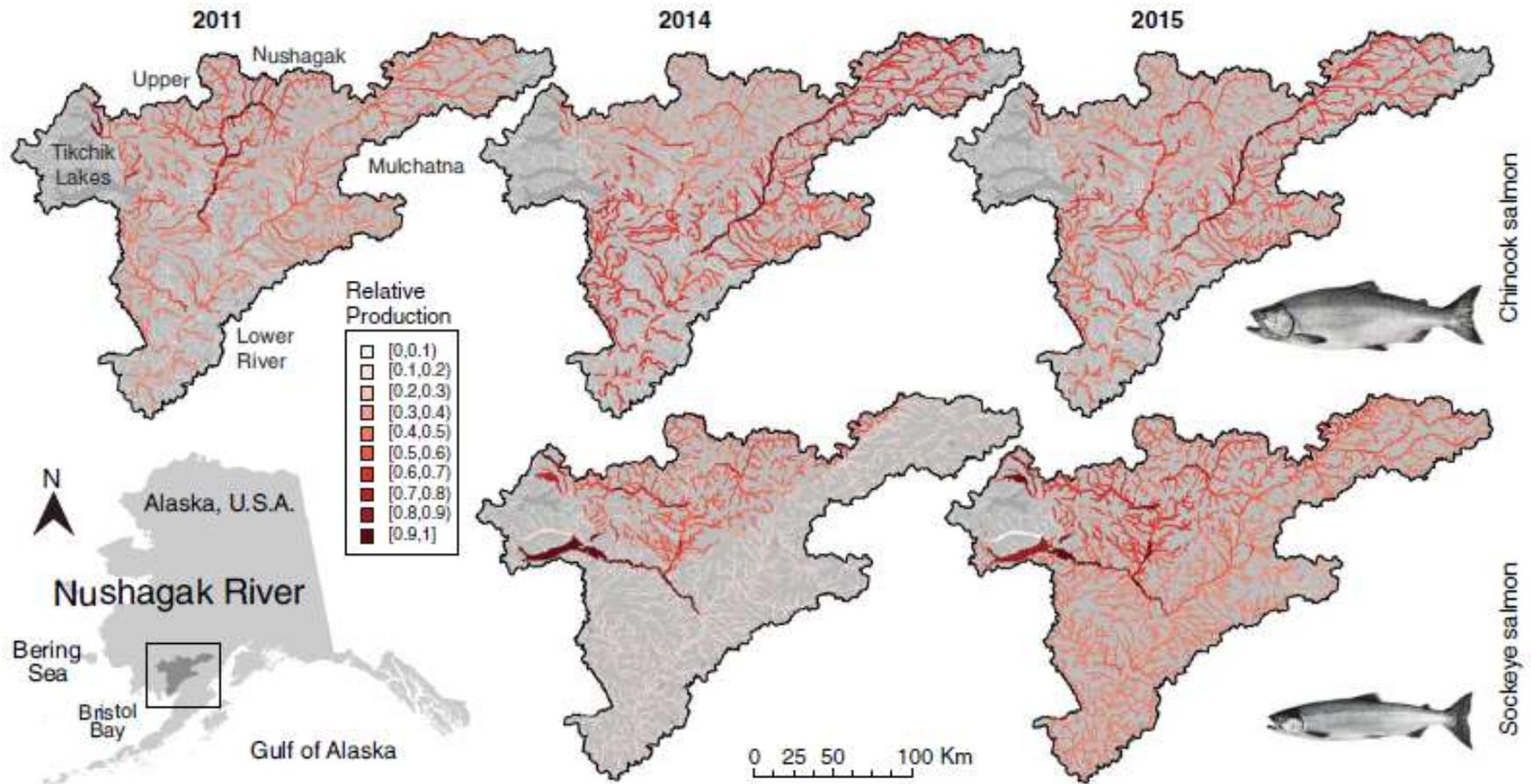


Fig. 1. Productive habitats for salmon shift across river basins. Areas of high Chinook salmon production in 2011 shifted from the upper Nushagak River to the Mulchatna River in 2014 and 2015. Sockeye salmon production was concentrated in Tikchik lakes in 2014 but was more evenly distributed in 2015 including across riverine habitats.

Brennan et al. 2019. Shifting habitats mosaics and fish production across river basins. *Science* 364:783–786.

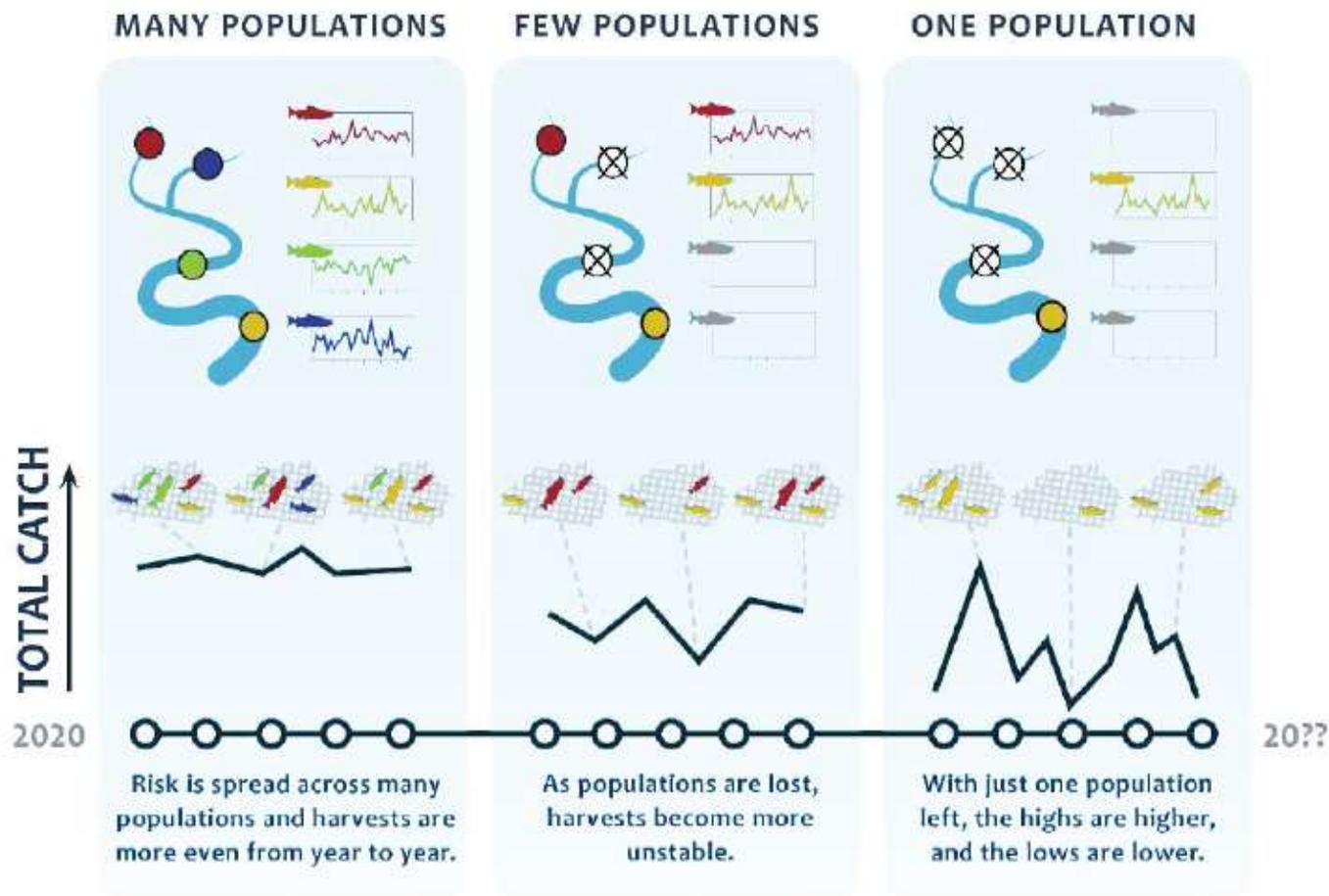
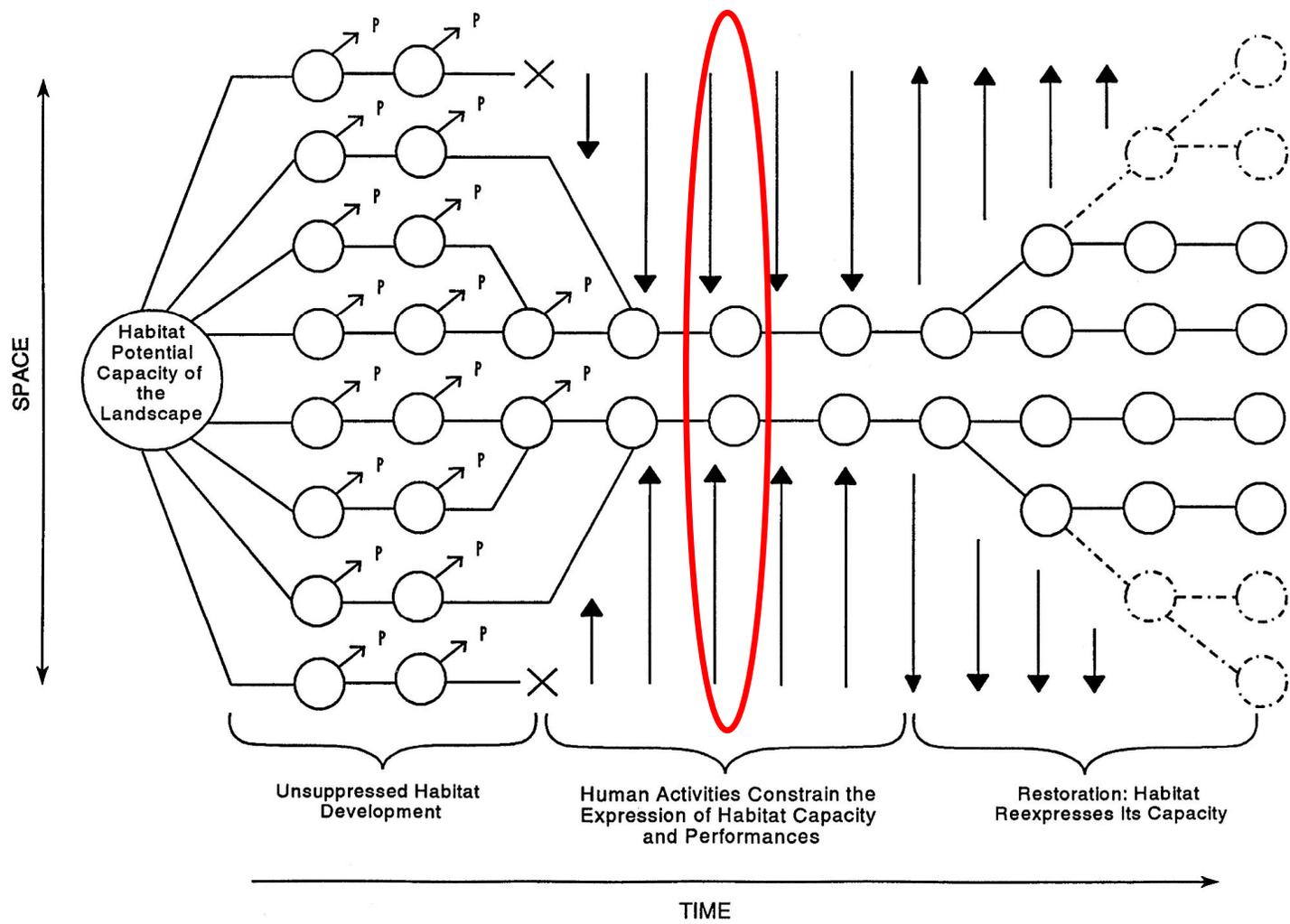
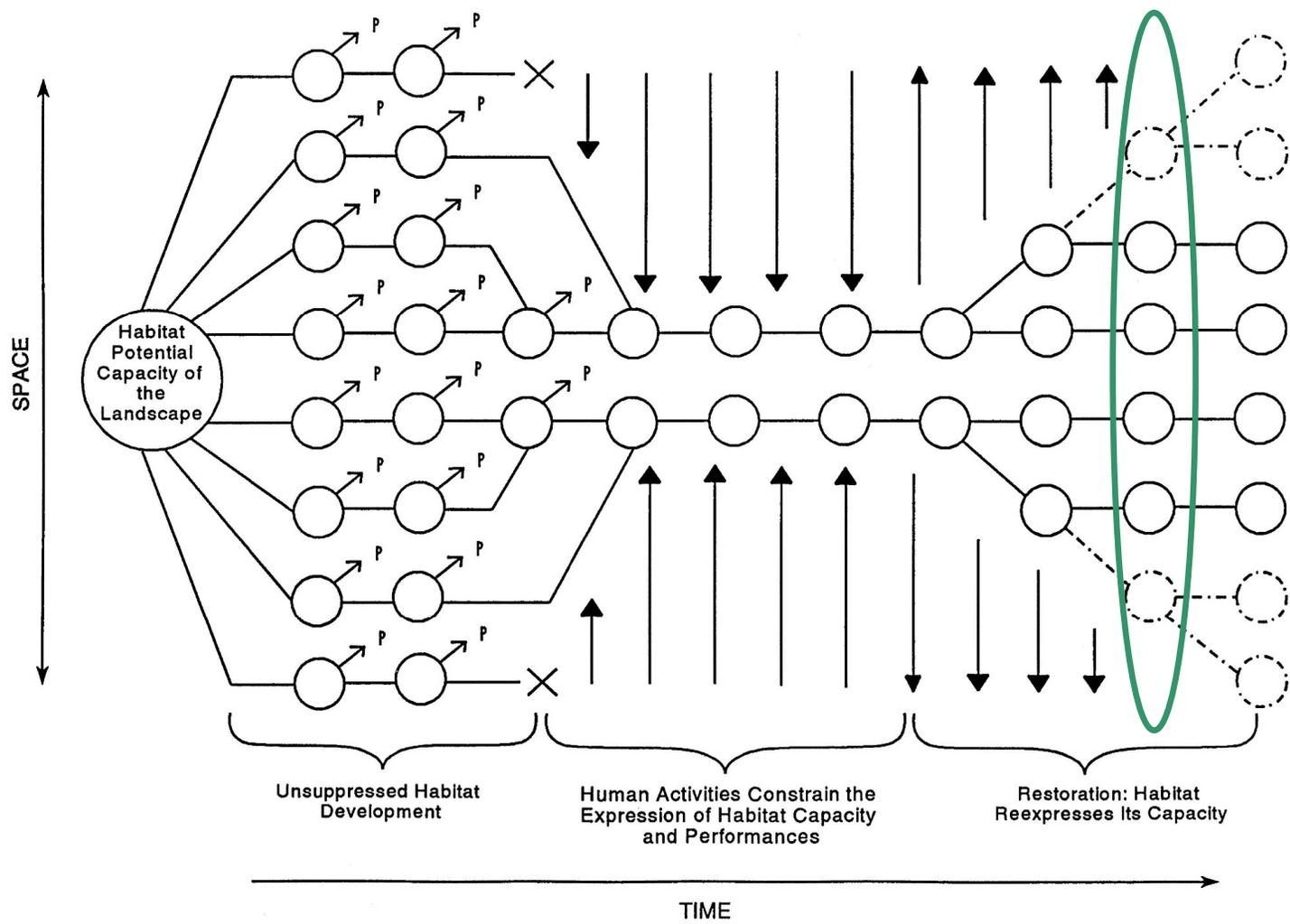


Figure 2: Illustration of how population diversity contributes to harvest stability. When diversity is high, individual populations doing very well can compensate for those that are doing badly, leading to a more stable average harvest over time. When diversity is low, all your eggs are in one basket and so harvest is more unpredictable from year to year

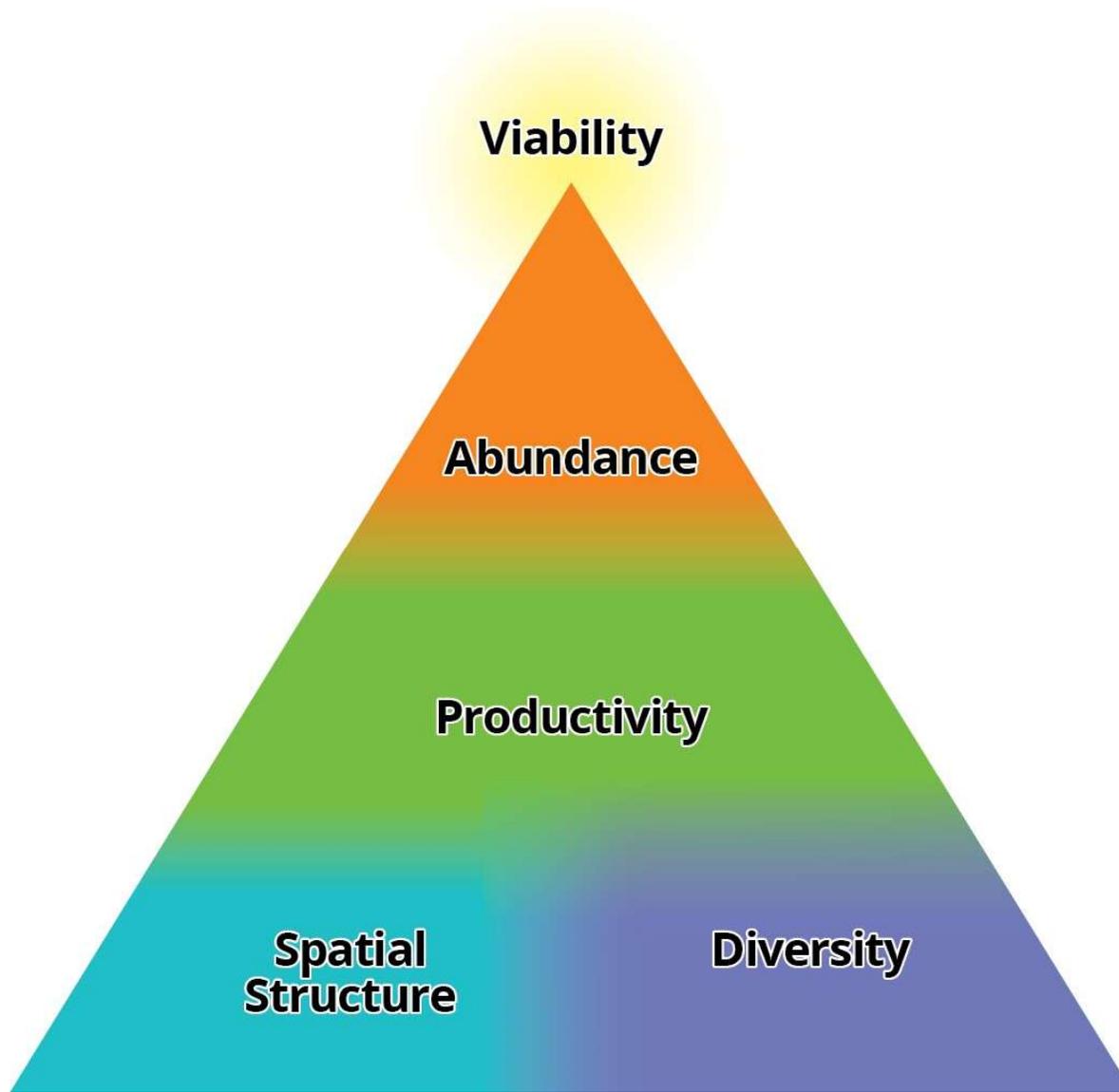
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From Ebersole et al. 1997. *Envir. Mgt.* 21:1-14.



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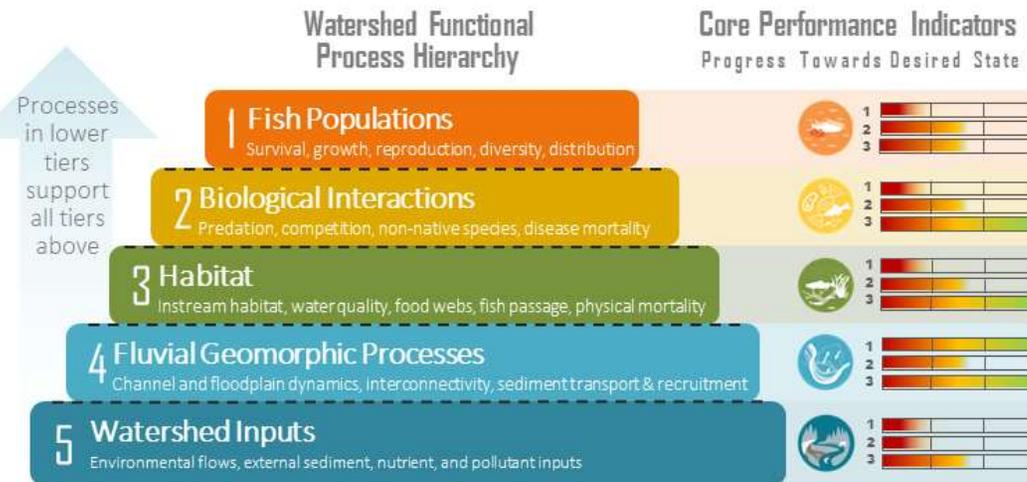
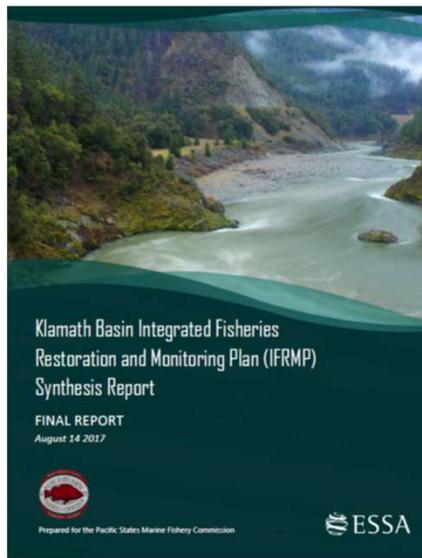
Viability

Abundance

Productivity

**Spatial
Structure**

Diversity



The IFRMP uses a structured, updatable approach to restoration project prioritization based on a **process-based approach**. The IFRMP's underpinnings and prioritization methods identify and address multiple root causes of watershed degradation **by prioritizing the restoration of landscape-scale ecological processes and functions to benefit the entire aquatic ecosystem, rather than the traditional focus on addressing the resulting symptoms for individual sites and species.**



Guest Editorial, part of a Special Feature on [Pathways to Resilient Salmon Ecosystems](#)
Reconnecting Social and Ecological Resilience in Salmon Ecosystems

[Daniel L. Bottom](#)¹, [Kim K. Jones](#)², [Charles A. Simenstad](#)³, and [Courtland L. Smith](#)⁴

ABSTRACT. Fishery management programs designed to control Pacific salmon (*Oncorhynchus* spp.) for optimum production have failed to prevent widespread fish population decline and have caused greater uncertainty for salmon, their ecosystems, and the people who depend upon them. In this special feature introduction, we explore several key attributes of ecosystem resilience that have been overlooked by traditional salmon management approaches. The dynamics of salmon ecosystems involve social–ecological interactions across multiple scales that create difficult mismatches with the many jurisdictions that manage fisheries and other natural resources. Of particular importance to ecosystem resilience are large-scale shifts in oceanic and climatic regimes or in global economic conditions that unpredictably alter social and ecological systems. Past management actions that did not account for such changes have undermined salmon population resilience and increased the risk of irreversible regime shifts in salmon ecosystems. Because salmon convey important provisioning, cultural, and supporting services to their local watersheds, widespread population decline has undermined both human well-being and ecosystem resilience. Strengthening resilience will require expanding habitat opportunities for salmon populations to express their maximum life-history variation. Such actions also may benefit the “response diversity” of local communities by expanding the opportunities for people to express diverse social and economic values. Reestablishing social–ecological connections in salmon ecosystems will provide important ecosystem services, including those that depend on clean water, ample stream flows, functional wetlands and floodplains, intact riparian systems, and abundant fish populations.

Key Words: fishery management; Pacific Northwest; Pacific salmon; resilience; salmon ecosystem

INTRODUCTION

In an open letter to the Oregon State legislature in 1875, U.S. Commissioner of Fish and Fisheries Spencer Baird painted a grim future for Pacific salmon (*Oncorhynchus* spp.) in the Columbia River (Baird 1875). Based on the collapse of Atlantic salmon (*Salmo salar*) in Northeast American rivers decades earlier, Baird predicted that Columbia River salmon would suffer a similar fate for the same reasons: habitat loss, excessive harvest, and dams and other impediments to fish migration. The Commissioner enthusiastically endorsed hatchery technology as the means to maintain a stable salmon supply and to avoid the highly unpopular regulatory alternatives. Numerous state and federal fishery management agencies were established thereafter, and Baird’s simple formula—artificial fish propagation to compensate for habitat loss and

intensive harvest—was institutionalized, setting the priorities for U.S. fishery management for the next century (Bottom 1997).

Despite such early knowledge of the principal threats, Baird’s predicted collapse of Columbia River salmon proved quite accurate. The total annual run of all anadromous salmon in the basin, estimated at 10 to 16 million fish before European settlement (Northwest Power Planning Council 1986), has declined to around one million fish, of which approximately 80% or more are now produced artificially in hatcheries (Northwest Power Planning Council 1992, National Research Council 1996, Genovaese and Emmett 1997). Of the estimated 385 historical Columbia River populations of five salmon species—chum (*O. keta*), coho (*O. kisutch*), sockeye (*O. nerka*), Chinook (*O. tshawytscha*), and steelhead (*O. mykiss*)—212

“Of particular importance to ecosystem resilience are large-scale shifts in oceanic and climatic regimes or in global economic conditions that unpredictably alter social and ecological systems”

“Strengthening resilience will require expanding habitat opportunities for salmon populations to express their maximum life-history variation”

¹NOAA Fisheries, Northwest Fisheries Science Center, ²Oregon Department of Fish and Wildlife, ³University of Washington, ⁴Department of Anthropology, Oregon State University

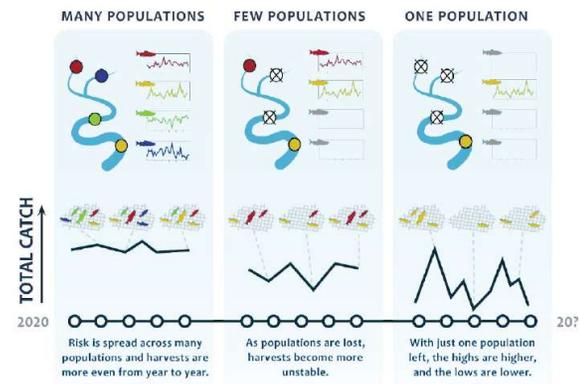
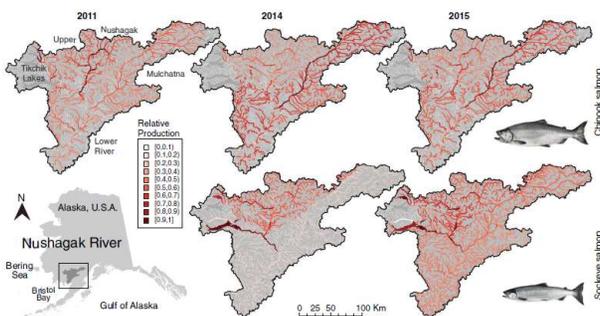
***“First, biologists, managers, and planners need to think in longer time frames than they are generally accustomed to using. They need to acknowledge that ecosystems are dynamic in space and time over these longer periods.*”**

Reeves et al. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. *American Fisheries Society Symposium* 17:334–349.

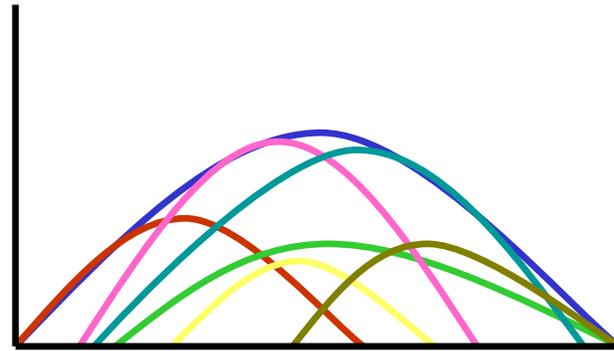
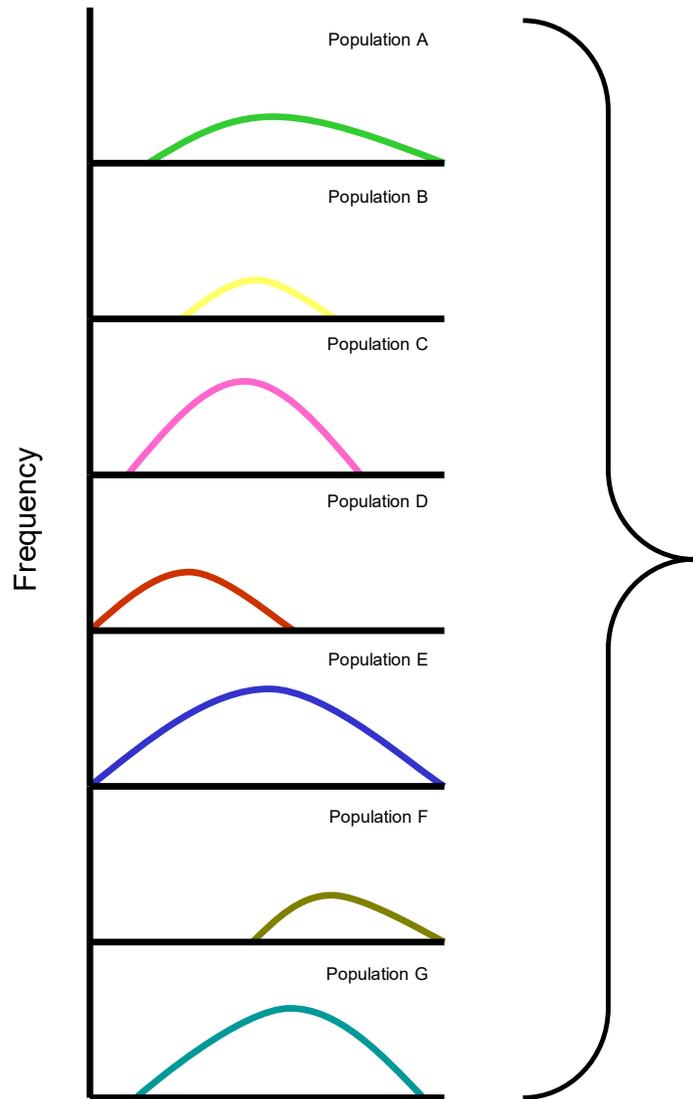


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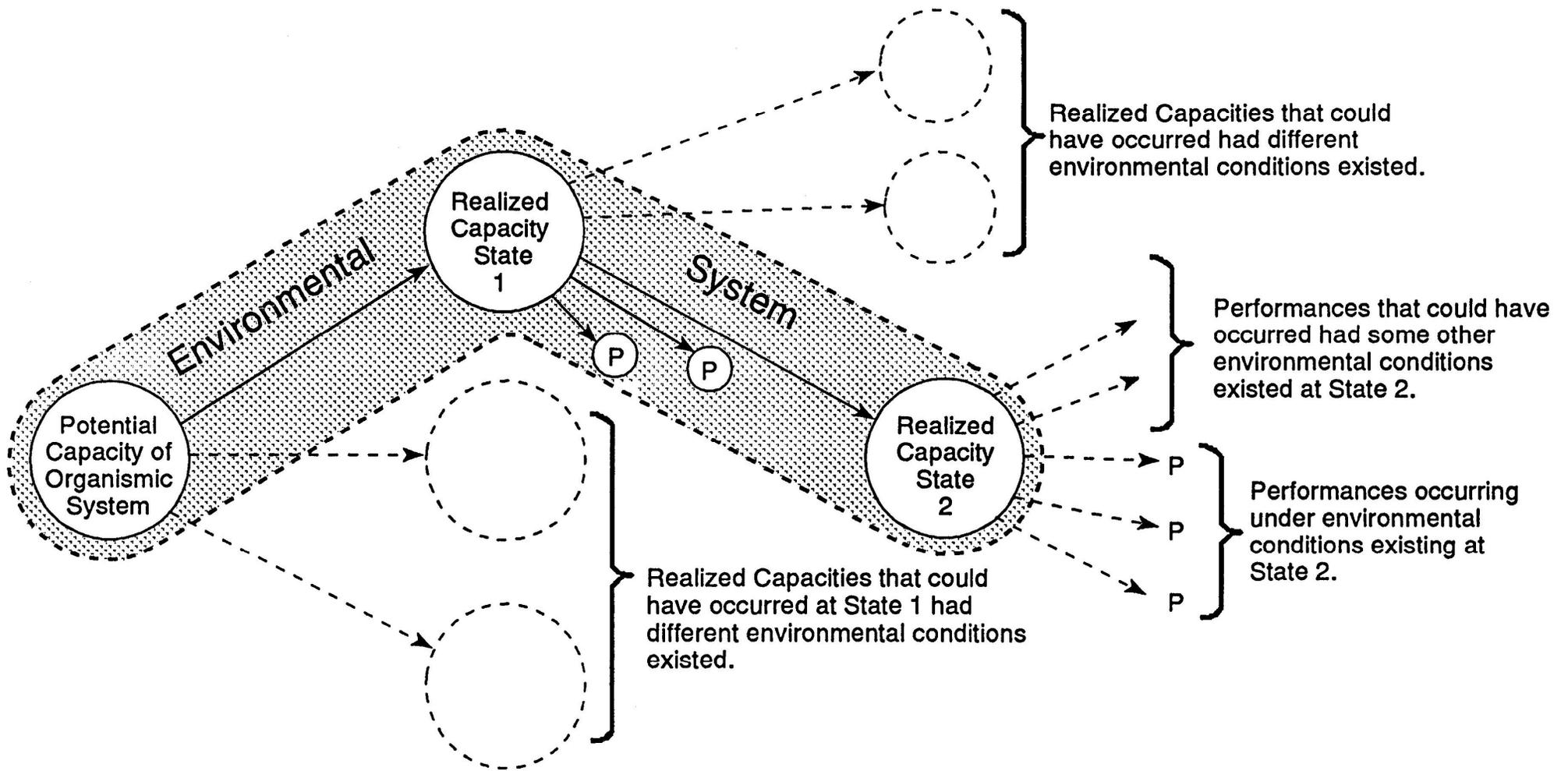
“Shifting habitat mosaics are a central feature of what makes ecosystems resilient. Because patterns of high and low production, or conditions most suitable for growth, shift among locations through time, the biological performance of a landscape tends to be more reliable at aggregate spatial scales. This means that conservation of the processes that generate and maintain heterogeneity and connectivity across landscapes (e.g., fires, floods, and migration) is as important as the biological communities that they support”



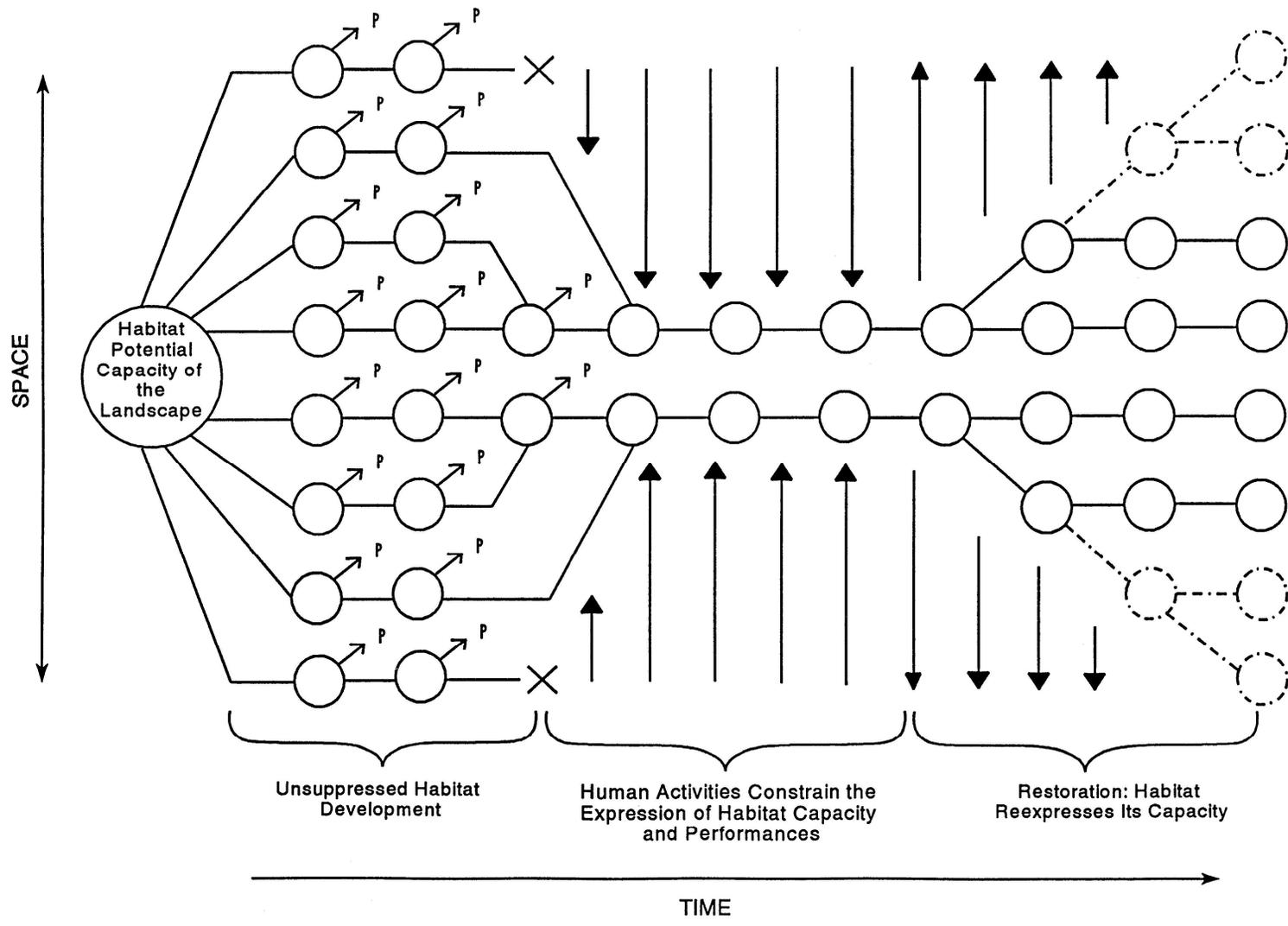
Brennan et al. 2019. Shifting habitats mosaics and fish production across river basins. Science 364:783–786.



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From Ebersole et al. 1997. *Envir. Mgt.* 21:1-14.

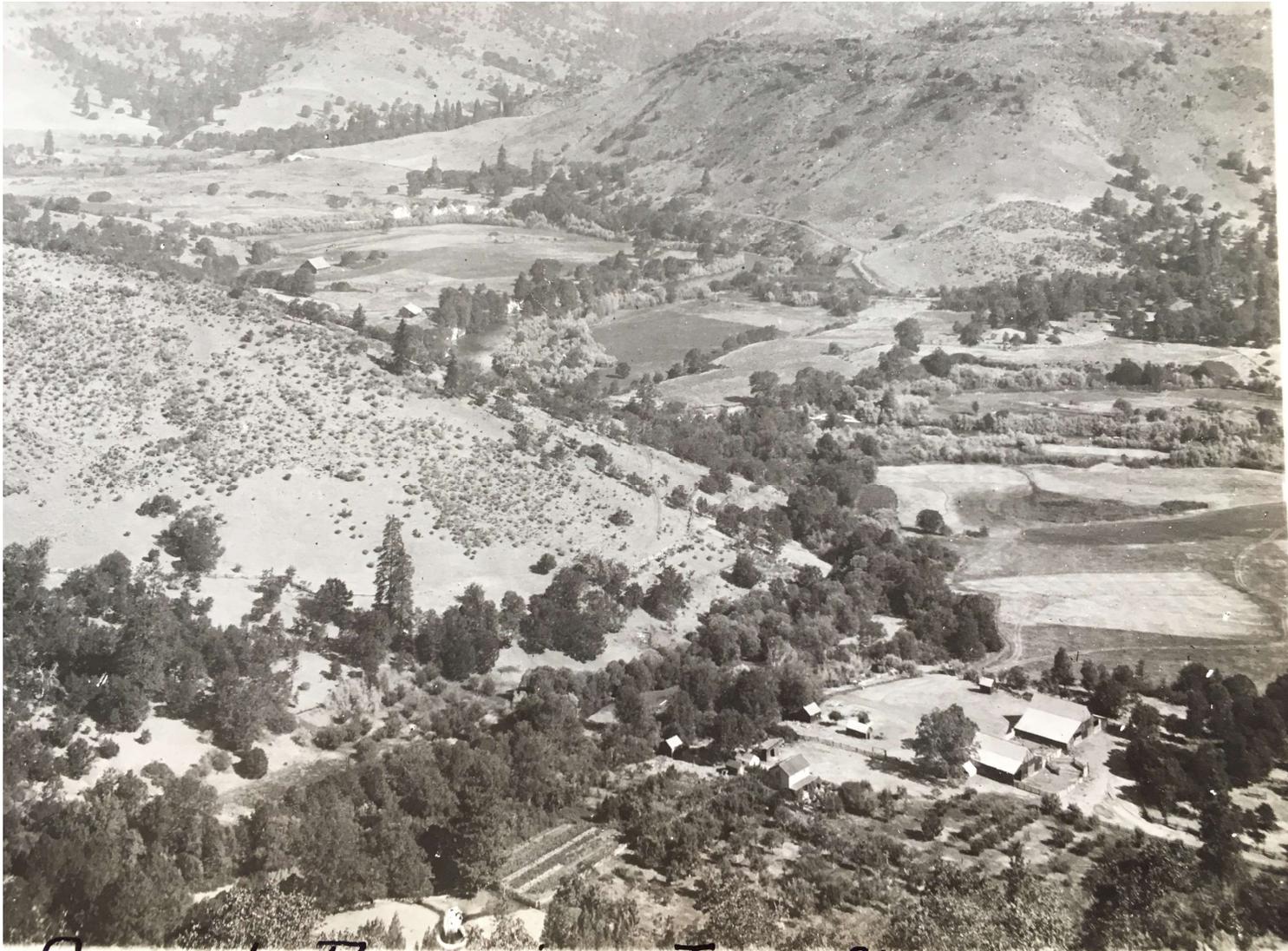


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Know where you are going – know where WE are going – desired future landscape – shared vision.

Focus relentlessly on processes not parts, dynamic not static, movement and connectivity, tracking change in the environment, and the conditions of the habitat across space and time.





Caden 1 - Reservoir - June 1910

Photo provided by S. Wright



Photo provided by S. Wright

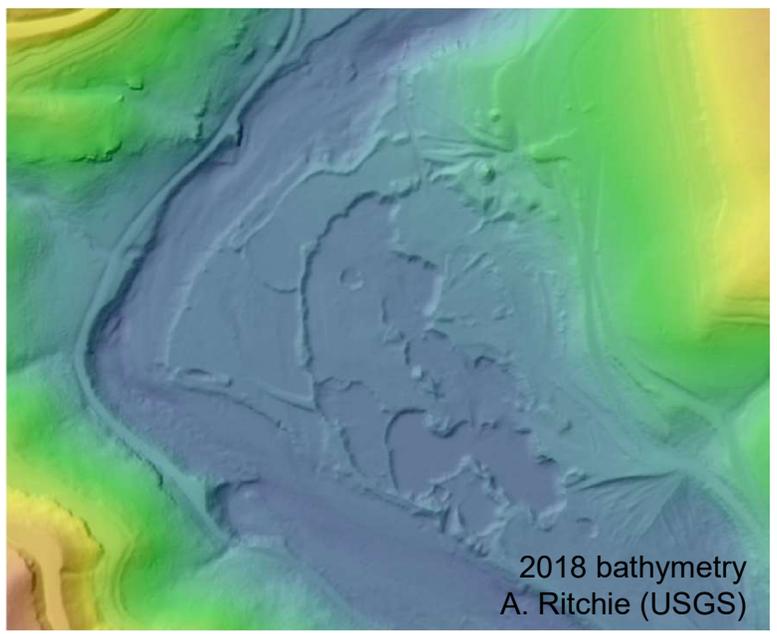
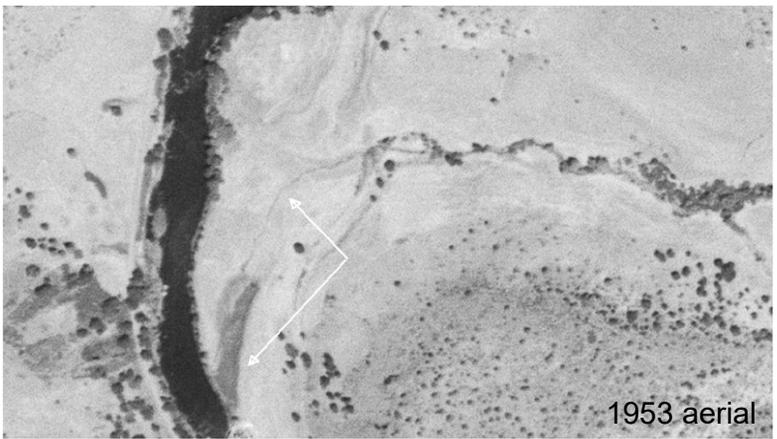
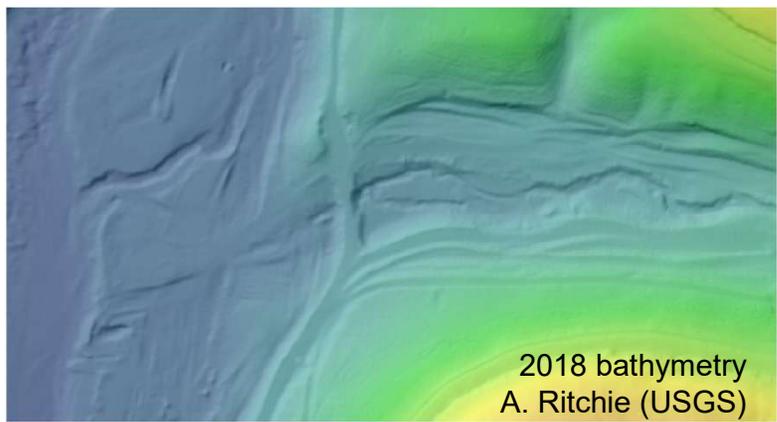




Photo provided by S. Wright



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Copco No. 1 – Construction Photos



Concrete rubble from Phase 5B blast partially removed.

9 August 2024

Copco No. 1 – Construction Photos



Cutting upper portion
of the powerhouse
backfill to grade.

9 August 2024



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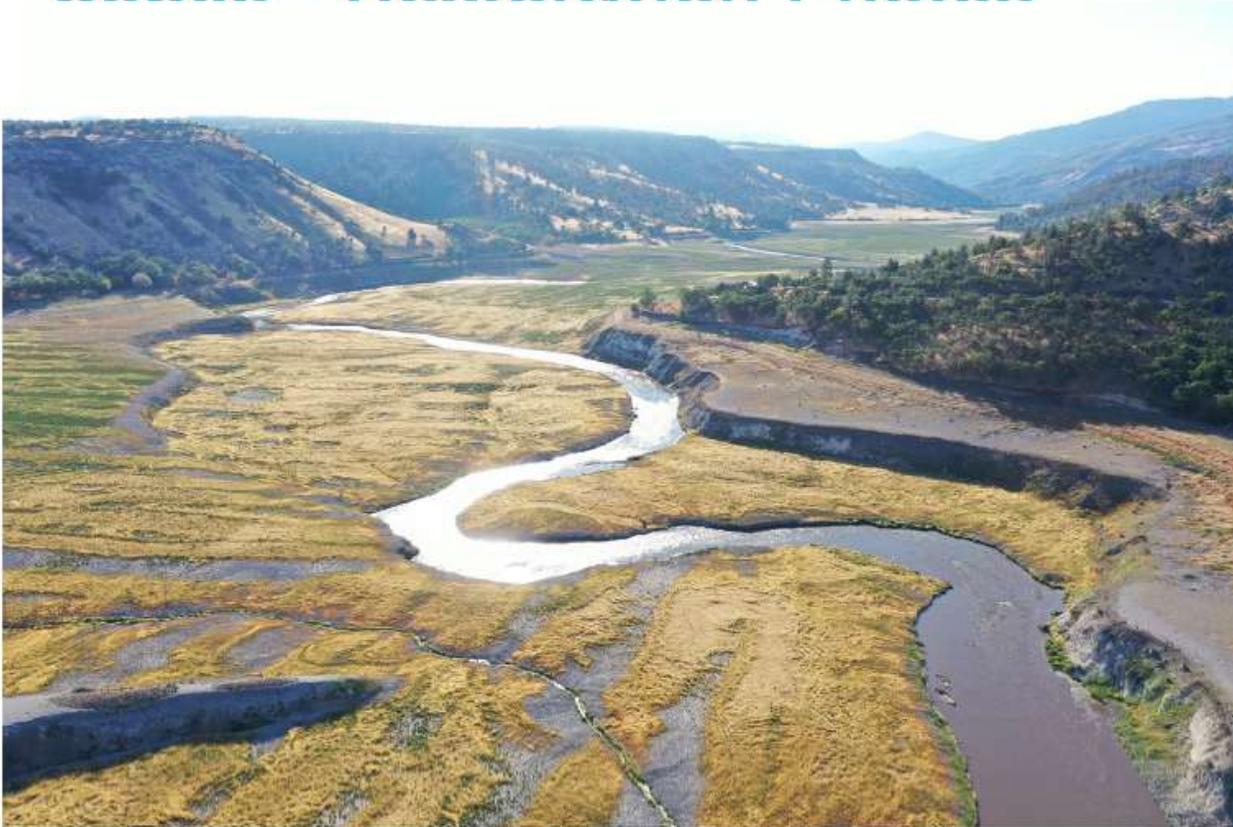


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Conco- Restoration Photos



Copco Reservoir looking
upstream.

31 July 2024

Photo: Olivia Vosburg, Resource Environmental Solutions

Copco – Restoration Photos



Copco Reservoir at Beaver
Creek.

31 July 2024

Photo: Olivia Vosburg, Resource Environmental Solutions



Photo provided by S. Wright



Photo provided by S. Wright



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Iron Gate– Construction Photos



Embankment removal progress – looking downstream.

18 July 2024

Iron Gate – Construction Photos



Embankment removal
progress – looking upstream.

9 August 2024





BB-45

Dam site - looking upstream
9/23/56



JULY 1957

Photo provided by S. Wright



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Craig Tucker

JC Boyle – Construction Photos



JC Boyle dam embankment
removal and erosion
protection material placement.

26 July 2024

JC Boyle – Construction Photos



JC Boyle
cofferdam breach.

30 July 2024

JC Boyle – Construction Photos



JC Boyle spillway
structure demolition.

7 August 2024

JC Boyle – Construction Photos



JC Boyle cofferdam breach looking downstream through dam embankment section.

31 July 2024





D. Chase (RES)



D. Chase (RES)



T. Williams

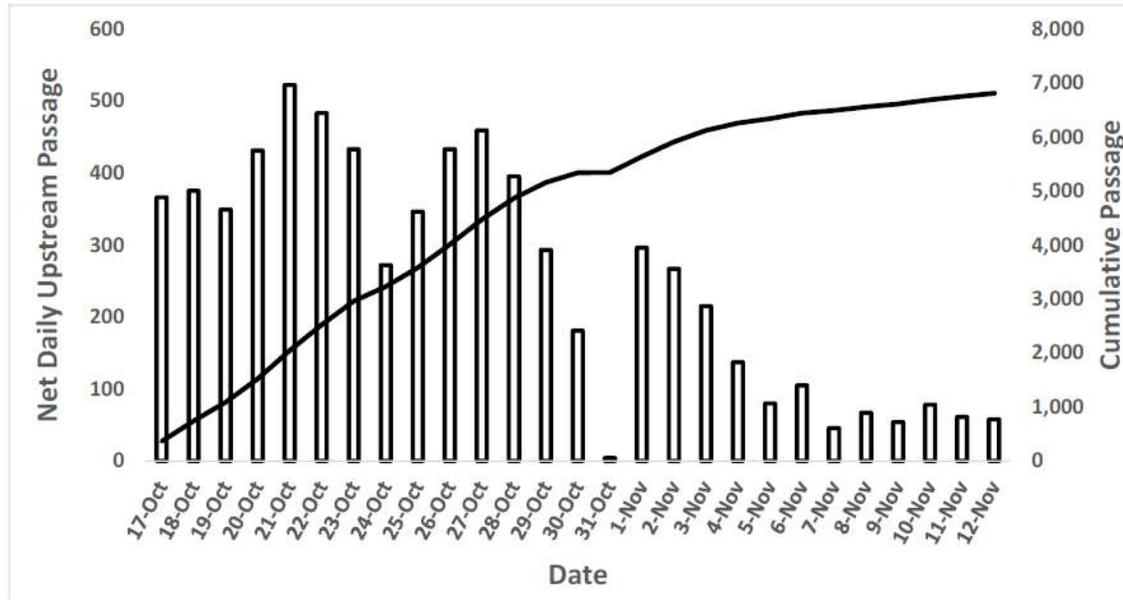


Figure 2. Daily passage (left hand y-axis) and cumulative passage (right hand y-axis) of SONAR targets measuring over 55 cm at the Iron Gate SONAR station from October 17, 2024 through November 12, 2024. Note that October 30 only had data for 60% of the 24-hour period and October 31 only had data for 9% of the 24-hour period.

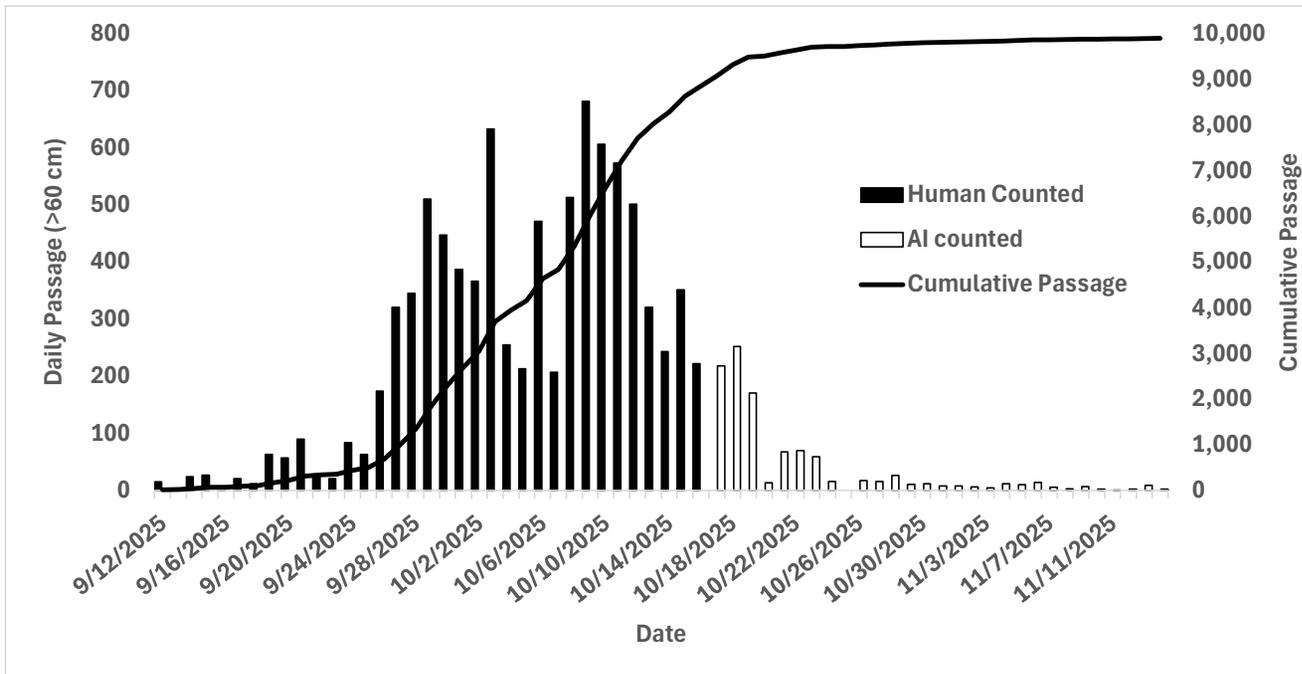


Figure 1. Daily passage (left hand y-axis) and cumulative passage (right hand y-axis) of SONAR targets measuring over 60 cm at the SONAR site located at the former Iron Gate dam site on the Klamath River.



Klamath River Project Adult Fish Counting Facility In-season Update

December 5, 2025

The California Department of Fish and Wildlife annually operates adult fish counting facilities on the Shasta River, Scott River, Bogus Creek, Jenny Creek and Shovel Creek. This in-season update provides preliminary 2025 net upstream passage of Fall-run Chinook Salmon and Coho Salmon to each counting facility. Preliminary in-season updates will be provided as data becomes available throughout the season. The Shasta River station began operating on August 28, 2025 and a net upstream passage of **5,860** adult Chinook Salmon, **5** adult Coho Salmon and **278** adult (>16") *Oncorhynchus mykiss* have been counted through December 4, 2025. The Bogus Creek station began operating on September 30, 2025 and a net upstream passage of **316** adult Chinook Salmon, **6** adult Coho Salmon and **2** adult (>16") *Oncorhynchus mykiss* have been counted through December 4, 2025. The Scott River station began operating on September 23, 2025 and a net upstream passage of **2,879** adult Chinook Salmon, **71** adult Coho Salmon and **140** adult (>16") *Oncorhynchus mykiss* have been counted through December 4, 2025. The Jenny Creek station began operating on September 19, 2025 and a net upstream passage of **208** adult Chinook Salmon, **0** adult Coho Salmon and **1** adult (>16") *Oncorhynchus mykiss* have been counted through December 4, 2025. The Shovel Creek station began operating on September 15, 2025 and a net upstream passage of **263** Chinook Salmon, **4** Coho Salmon, and **0** adult (>16") *O. mykiss* have been counted through December 4, 2025. Bogus, Jenny and Shovel weirs were removed to avoid damage from forecasted precipitation on October 24, 2025. Bogus was reinstalled on October 27, 2025, Jenny was reinstalled on October 29, 2025 and Shovel was reinstalled on October 30, 2025. Again on November 4, 2024 Scott, Bogus, Jenny and Shovel weirs were removed due to forecasted precipitation. A Sonar unit was installed at the Scott weir site until November 19, 2025 when the video weir was reinstalled, this sonar data will be reviewed and reported in the annual report. The Bogus Creek weir was reinstalled on November 6, 2025. The Jenny Creek weir was reinstalled on November 18, 2025. The Shovel weir was reinstalled on November 12, 2025. The Shasta River station is located roughly 600 feet upstream of the confluence with the Klamath River. The Scott River station is 18 miles upstream of the confluence with the Klamath River. The Bogus Creek station is 0.25 miles upstream of the confluence with the Klamath River. The Jenny Creek station is located roughly 200 feet upstream of the confluence with the Klamath River. The Shovel Creek station is located roughly 100 feet upstream of the confluence with the Klamath River. Depending on the year significant fractions of the adult salmonid populations in the Scott River and Bogus Creek spawn downstream of the counting stations. This in-season update doesn't report the spawning escapement that is observed downstream of these stations. Final reports detailing the total escapement to each river will be available after the data is finalized. If you have questions regarding these in-season updates please contact Domenic Giudice domenic.giudice@wildlife.ca.gov or Jonathan Kang Jonathan.kang@wildlife.ca.gov.

Shasta River: 5,800 adult Chinook salmon, 5 adult coho salmon, 278 steelhead

The Scott River: 2,879 adult Chinook salmon, 71 adult coho salmon, 140 steelhead

Jenny Creek: 208 Chinook salmon, 71 adult coho salmon, 140 steelhead

Shovel Creek: 263 Chinook salmon, 4 coho salmon, 1 steelhead





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