Upper Willamette River Reintroduction and Monitoring

NOAA FISHERIES

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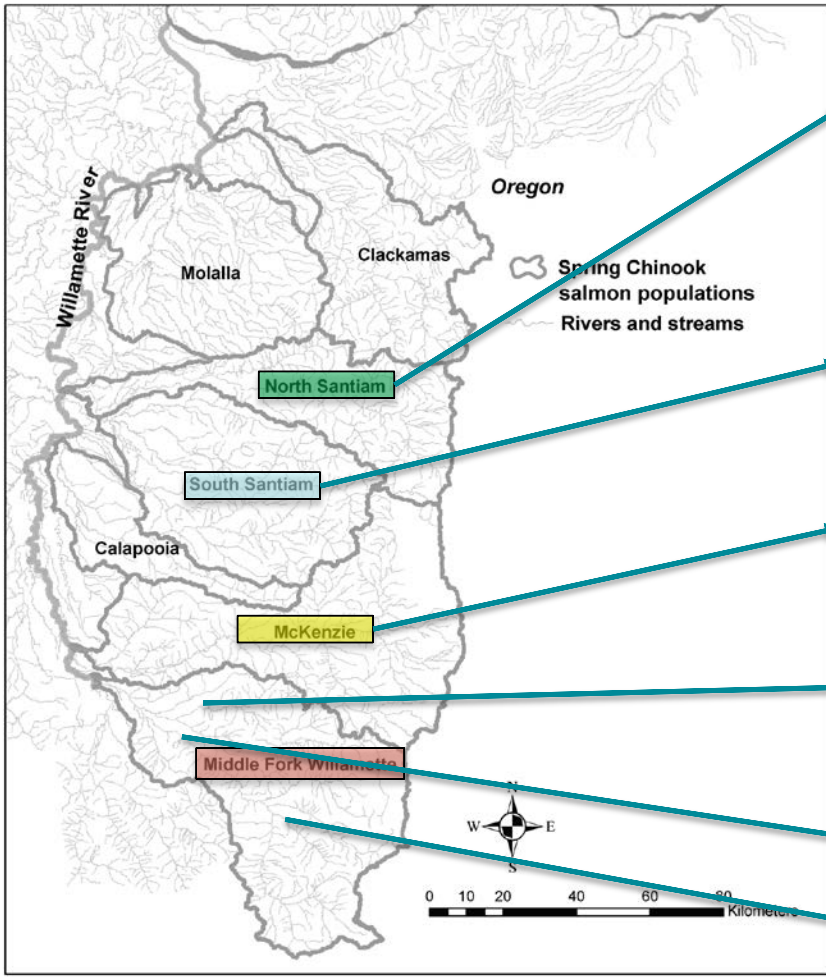
- Willamette Science Review
- 7 February 2018

Reintroduction and Monitoring Programs

Present and Future



Big Cliff/Detroit Dam (1953)	Chinook salmon Steelhead
Foster Dam (1968) Green Peter Dam (1967-68)	Chinook salmon Steelhead
Cougar Dam (1964)	Chinook salmon
Fall Creek Dam (1966)	Chinook salmon
Dexter/Lookout Dam (1954)	Chinook salmon
Hills Creek Dam (1961)	Chinook salmon

Reintroduction:

- Conditions are different for each population/tributary
  - Status of each population
    - Natural component – Hatchery component
  - Habitat conditions
    - Below and above dams
  - Juvenile and adult passage opportunities*
    - Existing
    - Future

* Not including engineering aspects

Reintroduction: Founders

- Natural origin spawners/recruits (NOS/NOR):
  - Naturally-produced and locally-adapted, these fish are the most likely to be successful.
  - Most NOR Chinook salmon have “some” hatchery legacy – some more than others.
  - Isolation from headwater areas may limit success (adapted to lowland areas)
  - Some are natural offspring of ”experimental fish” put above dams (NOR_{above}).
  - Feral non-native early winter and summer steelhead and fall-run Chinook salmon.
- Hatchery origin spawners/recruits (HOS/HOR):
  - Subject to domestication in hatchery. Some programs 50-100 years old.
  - Domestication may limit reproductive success in the wild
  - Considerable mixing of hatchery stocks prior to to 1990s
  - Few transfers from outside of UWR
  - Most Chinook salmon hatchery broodstocks are genetically similar their natural local counterparts.

- pHOS – Proportion hatchery fish spawning naturally (based on ad clips/otoliths)
- PNI – Proportionate natural spawners: Relative selection influence (hatchery vs ”wild”) Based on natural fish in hatchery broodstock /pHOS. PNI of 0.50 is neutral, PNI > 0.50 more locally adapted. Improve PNI – reduce pHOS and increase NORs in broodstock.

Reintroduction: Founders Life History Stage

- Introducing Adults (NOR and NOR_{above} > HOR)
  - Natural mate and spawning site selection
  - Gravel excavation/carcass deposition
  - Potential for first generation fallback
- Introducing Eggs/Juveniles
  - Some local adaptation incubation/release site
  - Release site selection (distribution)
  - Ability to screen parents for pathogens
  - Maybe option when source population is small
    - Steelhead

Reintroduction: Phases

- Preservation
- Recolonization
- Local Adaptation
- Viable Natural Population

From Peters et al. 2014

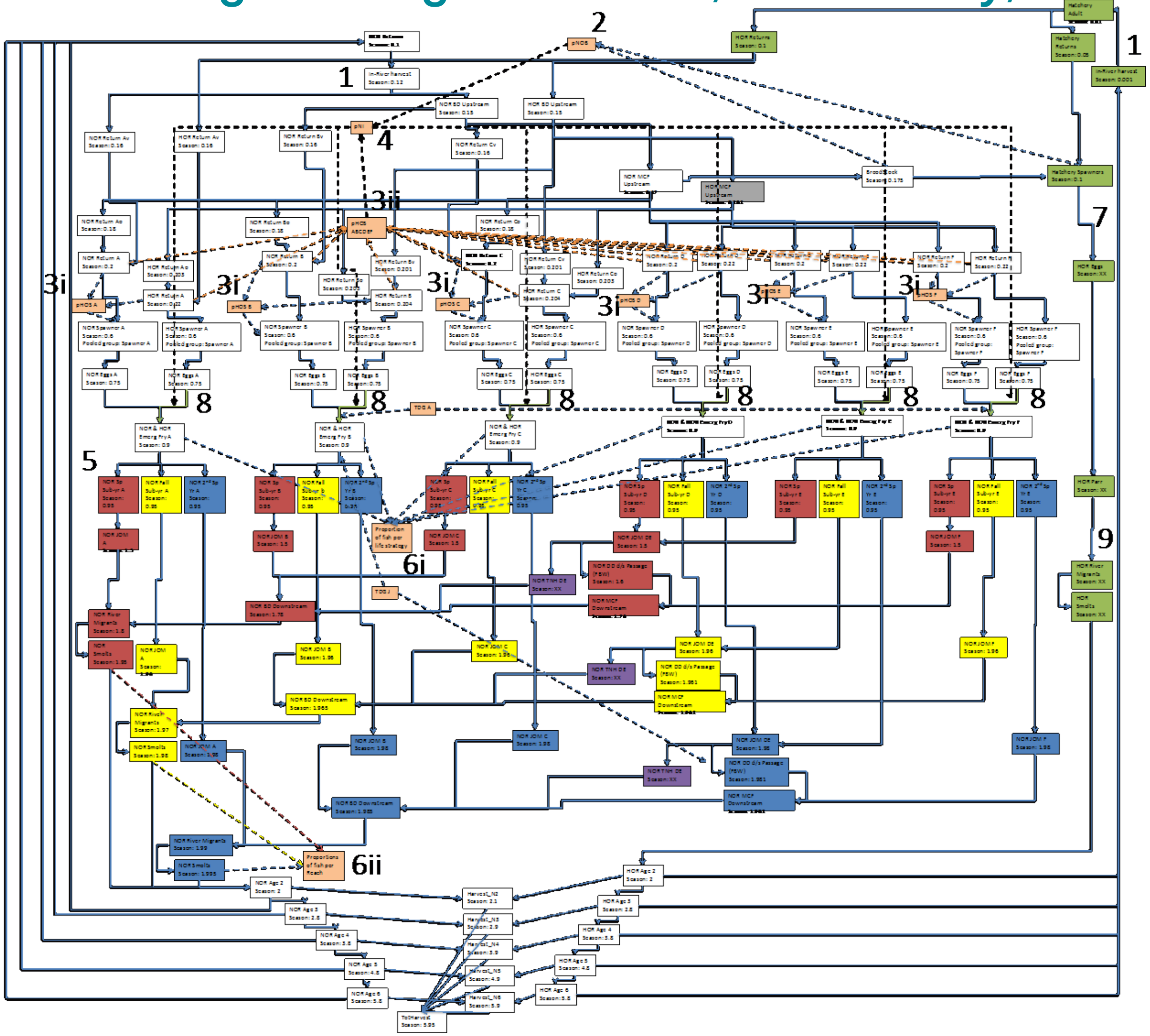
Reintroduction: Preservation Phase

- Pre-dam passage (S/S) < 1
- Focus on Founder population
  - Maintaining genetic diversity: NOR and HOR
    - Large effective population abundance (Ne)
    - Limiting the influence of non-local populations
    - PNI (proportionate natural influence) ≥ 0.50
      - Local adaptation ≥ domestication
  - Providing sufficient fish for reintroduction, while preserving source population (quantity & quality)
- Monitoring
  - Research specific monitoring
  - Population Status (VSP parameters)
    - Abundance/Productivity/Spatial Structure/Diversity

Preservation Phase: Research

- Research & Monitoring
  - Understanding juvenile emigration
    - Behavioral/physiological windows
    - Cues
  - Downstream passage alternatives
    - Pilot studies
      - Spill
      - Drawdown (Fall and/or Spring)
      - Collection facilities
  - Adult transportation
  - Above dam habitat condition
    - Coordinating habitat restoration
  - Informing life cycle modeling

Life Cycle Model:
Estimating life stage survivals, uncertainty, variability



Legend

- Spring Sub-yearling
- Fall Sub-yearling
- 2nd Spring Yearling
- Hatchery origin

Updates to SLAM:
1. In-River harvest is included.
2. Dynamic driver is used to calculate pNOB.
3. Dynamic driver is used to calculate i) pHOS per reach (e.g., pHOS A) and ii) pHOS across ALL reaches (called pHOS ABCDEF; orange dashed line).
4. Dynamic driver to calculate pNI (linking to pNOB and pHOS ABCDEF; black dashed line).
5. Three life strategies used (see legend).
6. Dynamic driver to keep track of the proportion of i) juveniles exiting each reach and ii) juveniles in each life strategy.
7. Life cycle of hatchery fish is expanded.
8. Domestication discount to HOR eggs (green line) that incorporates pNI dynamic driver (black dashed line); see next page for formula.
9. Hatchery production should be constant at 1,265,000 HOR River Migrants.

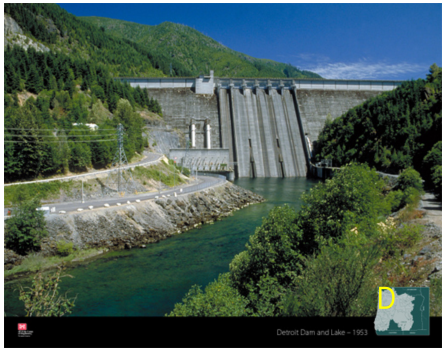
Preservation Phase: Monitoring Source Population Status

- Viable Salmonid Population-VSP Criteria
  - Abundance/Productivity
    - Fish counts
    - Return ratios (R/S), (S/S), CRR
  - Spatial Structure
    - Habitat utilization
      - Tracking fish/stream surveys
      - Juveniles, Adults, Redds
  - Diversity
    - Measuring multiple LH traits
      - Timing, age, juvenile trajectories, body size

Populations: Preservation Phase

Populations	Species	NOR (5 year)	Hatchery Surplus ‘16	Dam (Passage)	Fish above	Below Dam Population	Founders
MF North Fork Middle Fork	Chinook	> 50	4,332	Dexter/Lookout	HOR*(ex)* NOR_{Above}	High pHOS	NOR≈HOR
MF Hills Creek	Chinook	>> 50(0)	4,332	Hills Creek	HOR*(ex)*	High pHOS	NOR≈HOR
North Santiam	Chinook	468	2,415	Big Cliff/Detroit	HOR*(ex)*	High pHOS	NOR>HOR
	Steelhead	*733**	*NA*	Big Cliff/Detroit	No	pHOS ≈ 0	NOR,NOR_H
Middle Santiam	Chinook	623	2,925	Green Peter	No	High pHOS	NOR>HOR
	Steelhead	*170**	*NA*	Green Peter	No	pHOS ≈ 0	NOR,NOR_H
McKenzie	Chinook	1,671	3,336	Cougar	HOR*(ex)* NOR_{Above}	Low pHOS	NOR>HOR

(*) Dam Count (*not spawners*)



Reintroductions: Recolonization Phase

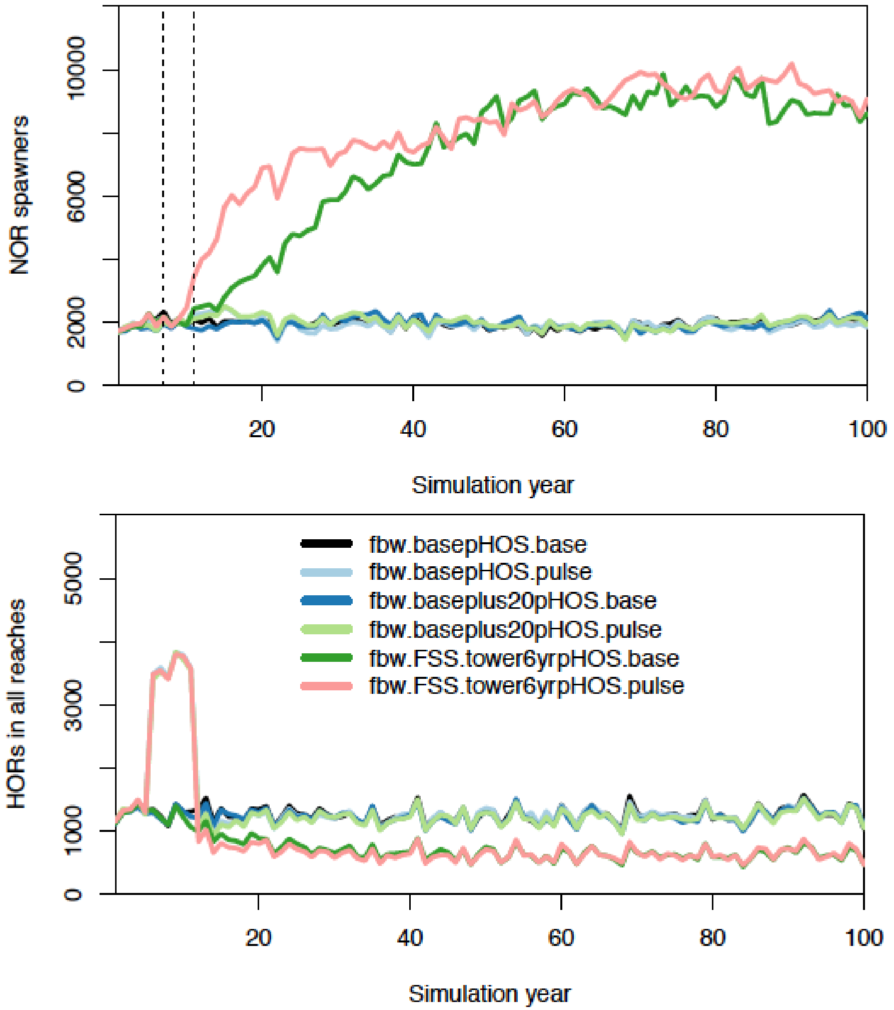
- Passage Structures or Procedures fully operational
  - Adult Collection Facilities
  - Juvenile Passage Facilities/Operations
  - (S/S ≥ 1) at least replacement
- Managing colonizers
  - Identifying returning NOR_{Above}
  - Balancing use of NORs and HORs (NOR≈HOR ??)
- Improving habitat conditions
- Monitoring
  - Colonizer studies (Distribution, reproductive success)
  - Population (VSP parameters)
    - Abundance/Productivity/Spatial Structure/Diversity)
  - Research specific monitoring

Base Population/Founders – How many are enough ?

- Protecting source population abundance
  - Not mining source population
  - Maintaining minimum abundance
- Provide sufficient founder abundance
  - Abundance benefits
    - Avoid depensation (Allee effects)
    - Gravel excavation
    - Homing fidelity
    - Predator "swamping"
  - Male:Female (250 NOR♂:250 HOR♀:250 NOR♀)
- Providing sufficient genetic diversity
  - 50/500 Ne Rule
    - 50 Ne<N, N≈250-500 with caveats (Short-term – inbreeding prevention,)
    - 500 Ne<N, N≈2500-5000 with caveats (Long-term evolutionary)
  - Life history representation (Across run/spawn times)

Anderson et al. 2015

Reintroduction Pulse: McKenzie Scenario



1. Initiate prior to completion
2. 5 year period
3. 300 to 3000 HOR adults
4. Returning NORs used to reseed areas.
5. Further HOR releases not necessary or greatly reduced.

Reintroduction: Local Adaptation Phase

- Expanding above dam sub-population
- Modification of passage/collection structures
  - Improving survival
  - Improving life history trajectories
- Improving habitat
- Colonizer management
  - Reduction in hatchery contribution (pHOS>0.10)
  - Expanding abundance (R/S > or >>1)
- Monitoring
  - Distinguishing between below and above spawners
  - Population (VSP parameters)
    - Abundance/Productivity/Spatial Structure/Diversity

Populations: Local Adaptation

Populations	Species	NOR (5 year)	Hatchery Surplus	Dam (Passage)	Juvenile Passage	Fish above	Below Dam Population
South Santiam	Chinook	623	2,925	Foster	Weir/Gates	NOR	High pHOS
	Steelhead	*170**	*NA*	Foster	Weir/Gates	NOR	Low pHOS
MF Fall Creek	Chinook	*361**	*4,332*	Fall Creek	Drawdown	NOR	High pHOS

(*) Dam Count (*not spawners*)

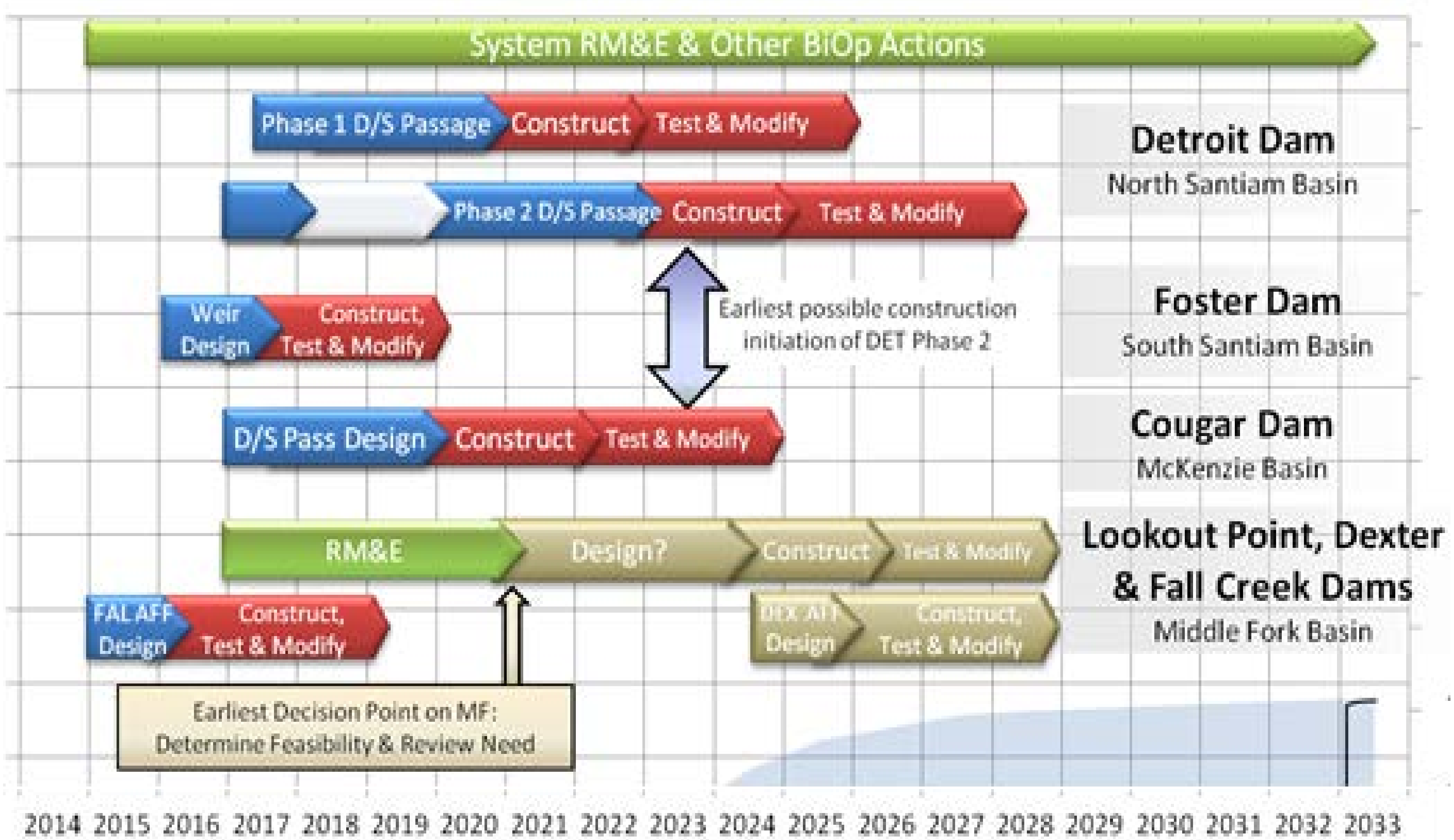
Only NORs passed above Dams

Above dam population abundances limited by downstream passage survival and habitat quality

Reintroduction: Viable Natural Population

- Above dam sub-population nears capacity
- Stabilized NOR abundance and distribution
- Elimination of hatchery supplementation above dam
- Monitoring
  - Population (VSP parameters)
    - Abundance/Productivity/Spatial Structure/Diversity
  - No need to distinguish between below and above dam NOR population segments.

Reintroduction: Timetable



Reintroduction: Summary

- Preservation
  - Maintaining source population
    - Minimizing domestication and maximizing abundance
- Recolonization
  - Maximizing use of returning $\text{NORs}_{\text{Above}}$ *(where possible)*
  - Understanding NOR≈HOR relationship
    - Where pHOS is high, near equivalence
  - Consider the use of large numbers of HORs *(short term)*
- Local Adaptation
  - Reducing HOR influence
  - Targeting factors limiting capacity/productivity
  - Enabling juvenile emigration pathways
- Viable Salmonid Population
  - Abundance/Productivity/Spatial Structure/Diversity

Generalized Reintroduction Process

Phase	Preservation	Recolonization	Local Adaptation	Viable Natural Population
Goal	Prevent extinction and preserve diversity of source population	Access new habitats, successfully spawning and producing smolts	Maintain and increase diversity to abundance threshold	Population meets or exceeds VSP goals
Duration	Until provisions for efficient passage are effected	Begins at least four years prior to completion of passage structure	5 to 20+ years Depending on environmental conditions	5 to 20+ years Depending on environmental conditions
Metric/Standard	S/S≥1.0 PNI>0.5	S/S ≈ 1.0 PNI may be less than 0.5 initially above dam	S/S >> 1.0 Reduce pHOS ≥ 0.10	Meets VSP abundance targets NOR only above dam

Adapted from Peters et al. 2014

Monitoring

Monitoring: Satisfying Data Needs

- Population Status (Viable Salmonid Population-VSP)
  - Abundance/Productivity
    - Fish counts
    - Return ratios (R/S), (S/S), CRR
  - Spatial Structure
    - Habitat utilization – tracking fish/stream surveys
      - Juveniles, Adults, Redds
  - Diversity
    - Measuring multiple LH traits
      - Timing, age, juvenile trajectories, body size
- Research specific monitoring (duplication of effort with VSP)
  - Relying on existing monitoring infastructure

Monitoring

- Monitoring at “key” Life History Stages
  - Fry, subyearlings, outmigrants (smolts), adults, spawners, kelts.
- Monitoring at critical migration points
  - Emergent (headwater), structures (reservoirs, dams), estuary, ocean.
- Matching sampling goal with life history, location, and technology.
- Monitoring over the long term data series to filter environmental variability

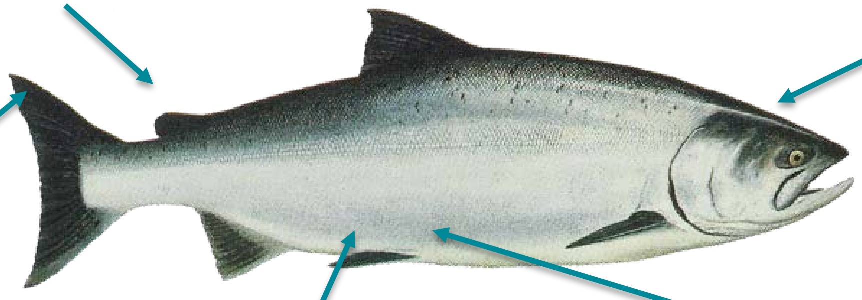
Monitoring: Identifying Groups

Ad Clip – Hatchery Origin

Video counts
Selective harvest
pHOS levels

Coded Wire Tag

Release group origin
Recovery network
Ocean distribution
Carcass recovery needed



Genetic Tag

Pedigree studies
Requires handling to sample/resample
Cost
Samples can be archived

PIT (Passive Integrated Transponder) Tag

Inserted in juveniles (55 mm)
Non-lethal monitoring
Lifetime serviceability
Short range
Detection network

Radio/Acoustic Tag

Varying sizes (larger juveniles)
Non-lethal monitoring
Moderate range
Limited transmission life
Cost
Detection network

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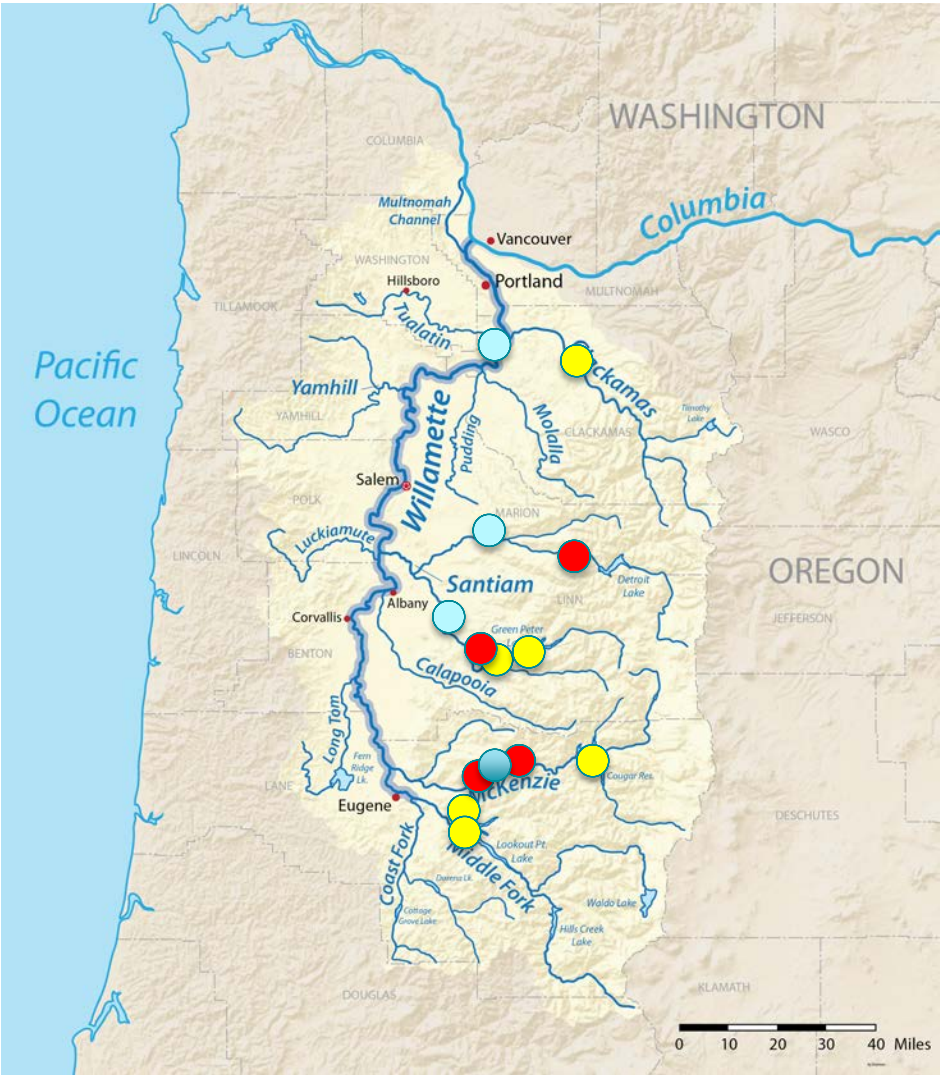
Monitoring/Census Sites



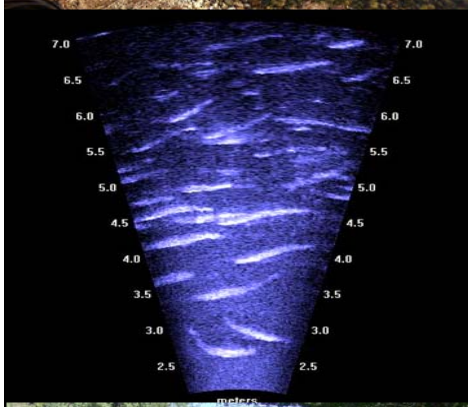
- Hatchery collection points
- Dam adult collection sites
- Low-head dam census sites

These sites provide access to fish, video counts, physical sampling, tagging, or tag detection.

Additional tag detection or sonar survey sites could be developed.

Is this enough to effectively monitor?

Supplemental Census Points



- In river tag detection
  - Pit tag arrays
  - Radio tag detection
  - Stand alone arrays or on structures
- Didson sonar - counts
- Juvenile trapping (aka screw trapping)
  - Allows handling (genetics, body size)
  - Size bias

Monitoring/Stream Survey: Boots on the ground

- Ground surveys necessary where prespawning mortality is highly variable – correcting dam counts
- Redd counts provide alternative census estimate to fish counts
- Redd surveys provide information on spawning time variability and spatial distribution
- Carcass sampling allows for genetic and life history data collection (especially below dams)
- Can be complete or subsampled. Many sampling designs for stream surveys, subsampling requires knowledge of distribution.

Monitoring

1. Basin-wide network of monitoring stations – counts and fish ID (manual/video/electronic tag). Uniform methodology across populations.
2. Handling/sampling at juvenile/adult collection facilities -- body size, sex, age(scales), genetic samples.
3. On the ground stream surveys for juveniles and adults to describe spatial structure and abundance, prespawning mortality, and carcass sampling.

Avoid breaks in time series or monitoring protocol, these add uncertainty in trend analysis. Need to be consistent in techniques (apples to apples) – or – allow for transition from old to new monitoring techniques.

Lack of Data = Uncertainty = Risk

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