Using Salmon as a Bioindicator of the Health of the Columbia River at Hanford

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BACKGROUND

*Assessing human, ecological, and cultural health on DOE-sites is important to legacy wastes management

*Assessment is especially important at Hanford because of the Columbia River.

*The Columbia River is central to the culture and economy of the northwest, especially Tribes.

*Salmon are an iconic, keystone species for the Columbia River

OBJECTIVES

•To develop a biomonitoring plan that will assure the public that DOE (past & present) activities are not adversely impacting the salmon populations in the Columbia River

METHODS

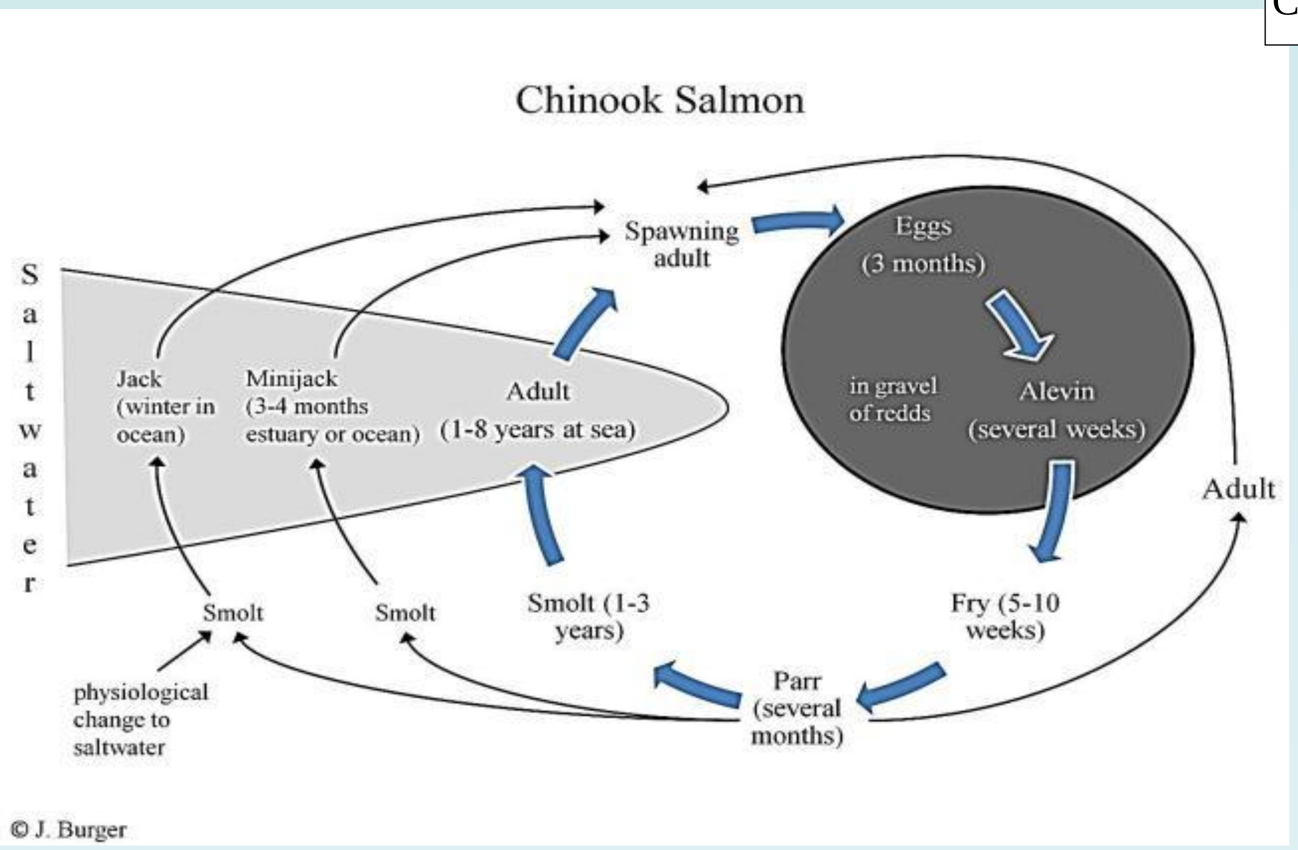
*Reading and synthesizing information from books, refereed literature, and grey literature

*Synthesize a model or paradigm of factors affecting salmon populations

APPROACH

1. Understand salmon life cycles
2. Identify pressure points and vulnerabilities
3. Understand factors affecting reproduction and survival
4. Select endpoints

LIFE CYCLE OF SALMON



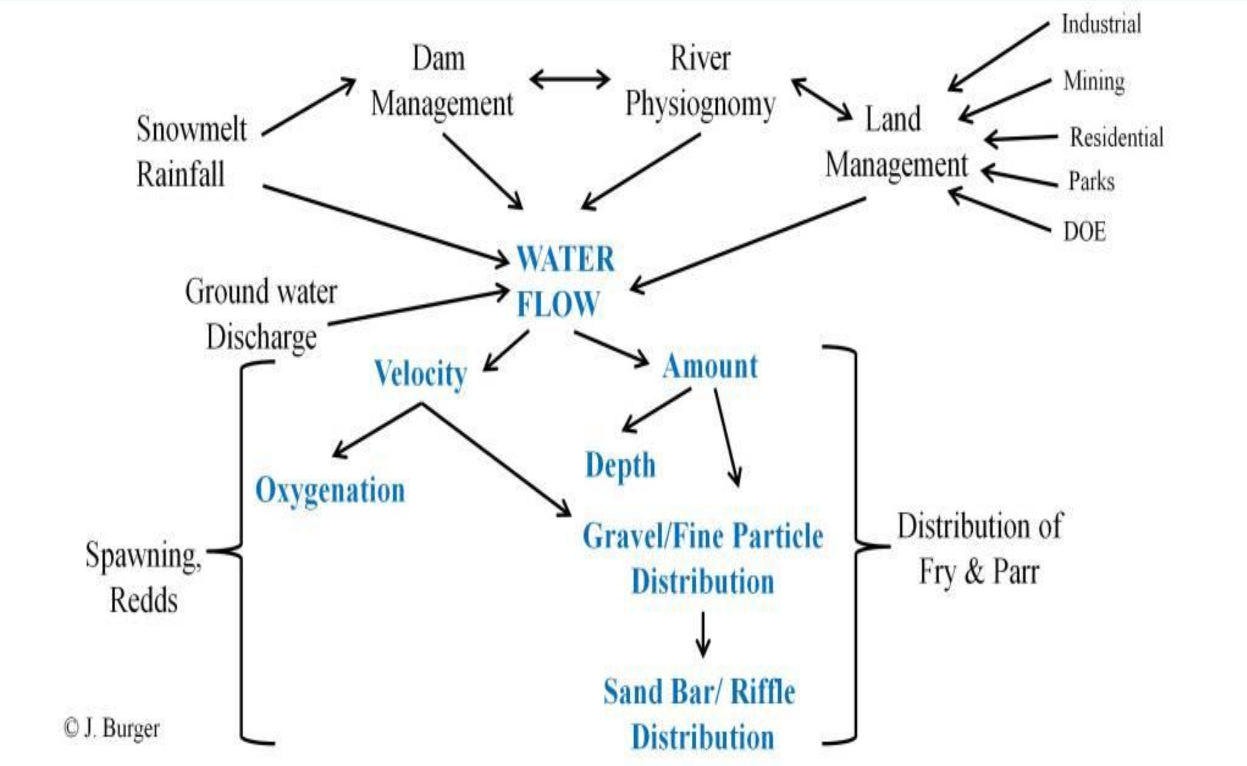
PRESSURE POINTS OR VULNERABILITIES

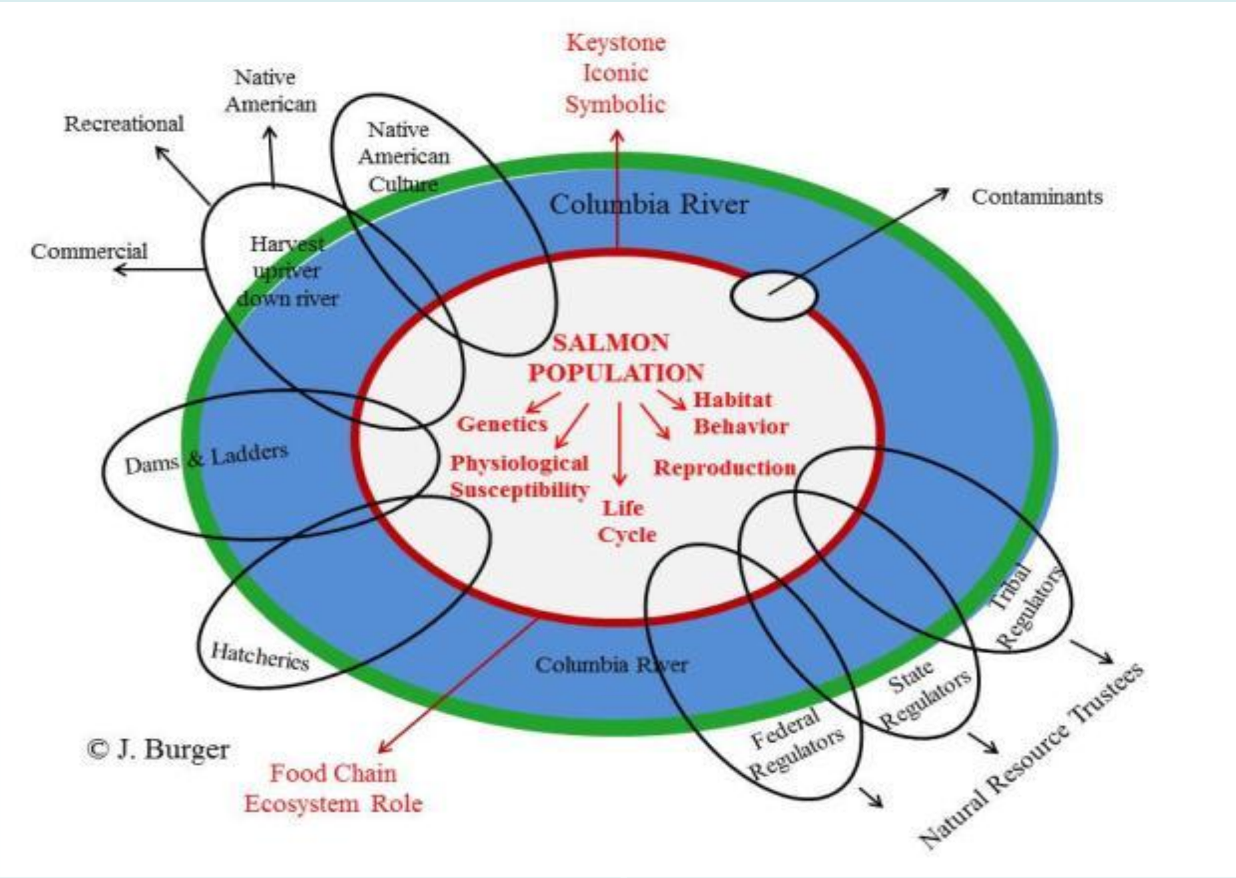
Spawning and Fertilization: Females "dig" redds in gravel and deposit eggs, which imbibe water after males fertilize

- **Eggs and Alevins:** Environmental conditions play a key role in survival of eggs and alevins.
- **Fry/Parr**: When young swim up to water interface and eat, they are vulnerable to contaminants in the food chain.
- **Smolt:** Smolt move down-river to the estuary where they are vulnerable to predators.
- **Adults:** Adult salmon spend up to seven years foraging in the ocean, find food and avoiding predators.
- **Spawning Adults:** Adults face two main stressors: making their way upstream to spawning areas and selecting sites for redds
- **Redds** are in contact with pore water and are located to allow suitable water flow to provide sufficient oxygen.

FACTOR AFFECTING SALMON POPULATIONS IN THE COLUMBIA RIVER
Key Characteristics for Redds and Spawning of Chinook Salmon in the Columbia River

Characteristic	Optimal values	References
Grain size	No fine material, but rather gravel 2.5 to 15.0 cm. Less than 5 % fine grain	Groves and Chandler 1999
Water depth	0.3 – 9.5 m	Hanrahan et al. 2004 2005 (check date); Hatten et al. 2009
Water velocity	Values range from 0.23 to 2.25 m/sec, some authors report greater than 1m/sec	Geist et al. 2000; Hanrahan et al. 2004 2005. Hatten et al. 2009
Stream flow fluctuations	Reduced, will not spawn with great fluctuations	Beckman and Larsen 2005; Hatten et al. 2009
Dissolved Oxygen	9mg/L	Geist et al. 2000
Channel bed slope	0 to 5 %	Geist et al. 2000; Hanrahan et al. 2004, 2005
Conductivity	0.009 to 0.21 cm/sec	Arntzen et al. 2001





RECOVERY MEASURES AS MEASUREMENT ENDPOINTS

Species (stage)1	Method	Reference
Chinook-smolt	Increase smolt hatchery releases; Provide bypass at dams or transportation around dams; Change flow	Raymond 1988
Chinook (fall)	Establish normative flow regimes	Dauble et al. 2003
Salmon	Maintain correct thermal characteristics	Goniea et al. 2006
Salmon	Restoration of habitat for all life stages; Reduce mortality, including harvest; Plan hydropower mitigation	Williams et al. 1999
Salmon in estuaries	Restore estuarine habitat; Plan hydropower mitigation Restore flow; Time releases to reduce bird predation	Bottom et al. 2004;Collis et al. 2001
Chinook in Hanford Reach	Hold stream flows steady during peak spawning Recovery actions aimed at harvest, hatcher, hydro and habitat; Restore connectivity; Address entire network, interconnections; Address cultural aspects	Hatten et al. 2009;UCSRB 2007;Liss et al. 2006
Salmon Hanford Reach	DOE, Environmental protection Agency (EPA) and others should fill data gaps with respect to effects of chromium on salmon to determine how to increase survival and population levels.	OHWB 2002 Bisson et al 2006

MEASUREMENT ENDPOINTS

Physical	Snowmelt levels Presence of suitable gravel beds/river location Grain size of gravel Water depth and velocity Stream flow fluctuations Dissolved oxygen levels Chanel bed slope Hydraulic conductivity
Biology of Salmon	Population levels of salmon – for each species Different life stages, over years, dams Growth and survival by life stage Time to reach spawning Location and number of redds/location/river section Toxic chemical levels by life stage Change in suitable spawning areas over time
Other Biotic Factors	Predation rates (particularly of smolt in estuaries) Food availability
Contamination	Contaminant levels in different life stages (health of salmon and their predators) Contaminant levels in adults (human health, particularly for Tribes) Determining contaminants of concern (human and eco-receptor health)
Recovery Measures	Hatchery Production Contribution of hatcheries to spawning adult population Dam passage success (including fallback rates) Harvest measures Stream flow data measures
Tribal Measures	Harvest rates (and relationship to traditional harvest) Hatchery production Success of tribal/non-tribal hatcheries in contribution to spawning adults

Acknowledgements and notes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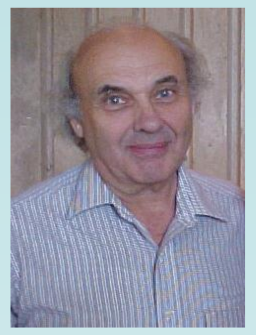
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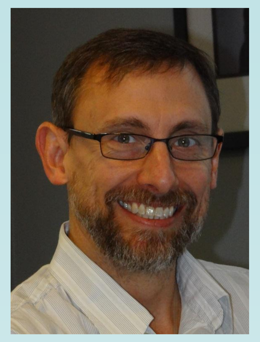
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