Fish Water Management Tool (FWMT)

"fish-friendly flows"

Balancing fisheries, flood control and water allocation benefits

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our Water reserves are limited

- Water is a precious resource shared among several needs and demands (aquatic life, wildlife, agriculture, municipal supply, fishing, recreation, industry, aesthetic value, etc.).
- Rising human demands in the Okanagan Valley are threatening our water abundance.
- Climate changes and urban development increase the need to preserve and carefully manage our water.

our Fish populations are threatened

- Historically, Okanagan River had abundant runs of Sockeye, Chinook, Coho and Steelhead.
- Today, Okanagan Coho is extinct; Chinook and Steelhead are in danger of becoming locally extinct;
- Sockeye returns have recently increased to support modest levels of harvest by the Okanagan Nation in some years.
- Okanagan Lake supported important Kokanee fisheries prior to dramatic declines in the 1980s

Management of our water affects us

Series of dams were built in the Okanagan and Columbia rivers (1915-1965). Those dams are operated to meet human needs in terms of:

- Flood and drought control.
- Water allocation for various users, including water diversions for irrigation purposes.

Management of our water affects our fish

Adequate management of lake water level and river discharge can protect the various life history stages of sockeye and kokanee throughout the system. For example,

- Improve Okanagan Lake water level in the winter to prevent desiccation of kokanee eggs.
- Improve Okanagan River flows in the spring to avoid scouring sockeye alevins from their nest; and improve winter flows to avoid desiccation of sockeye eggs.
- Improve Osoyoos Lake water temperature and oxygen level conditions in late summer to not stress sockeye juveniles and adults that are in the lake.

FWMT supports water management decisions

Tools to reduce the uncertainties

Difficulties in water management are due to various uncertainties, such as annual & seasonal water supplies, exact timing of fish life stage events, etc. FMWT was developed to reduce those uncertainties.

User-friendly tools

FWMT models predict the consequences of management decisions on fish and other users. FWMT allows water managers to identify optimal solutions to complex water management decisions

A collaborative approach

FWMT satisfies conflicting objectives, such as:

- increasing fish production without increasing risk of flood or drought, and
- private industry, First Nations, Federal and Provincial interests.

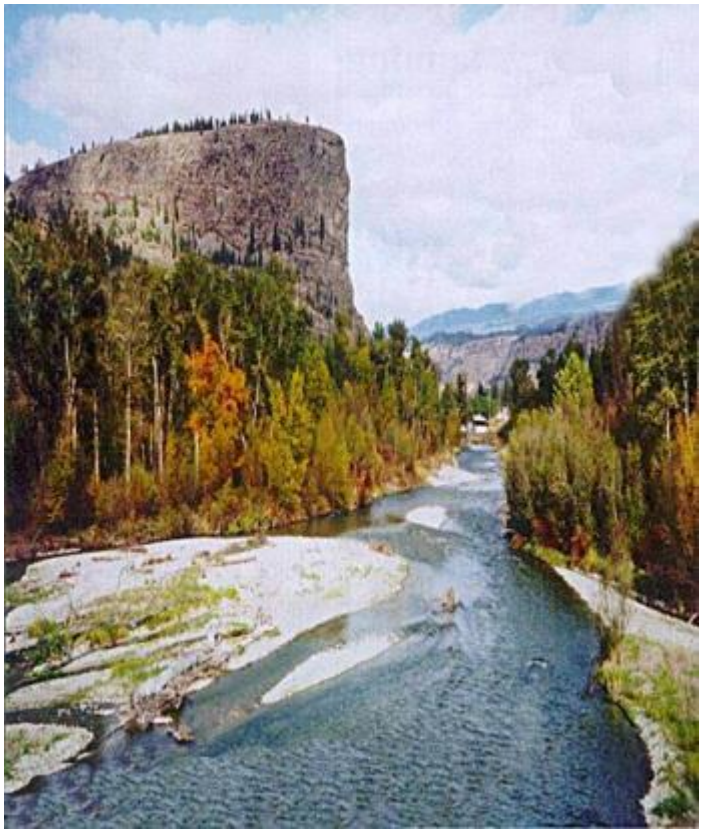
Okanagan Watershed Hydrology

Okanagan Lake

Drainage area= 6,090 sq km

Surface area = 341 sq km

Average outflow = 14.7 m3/s

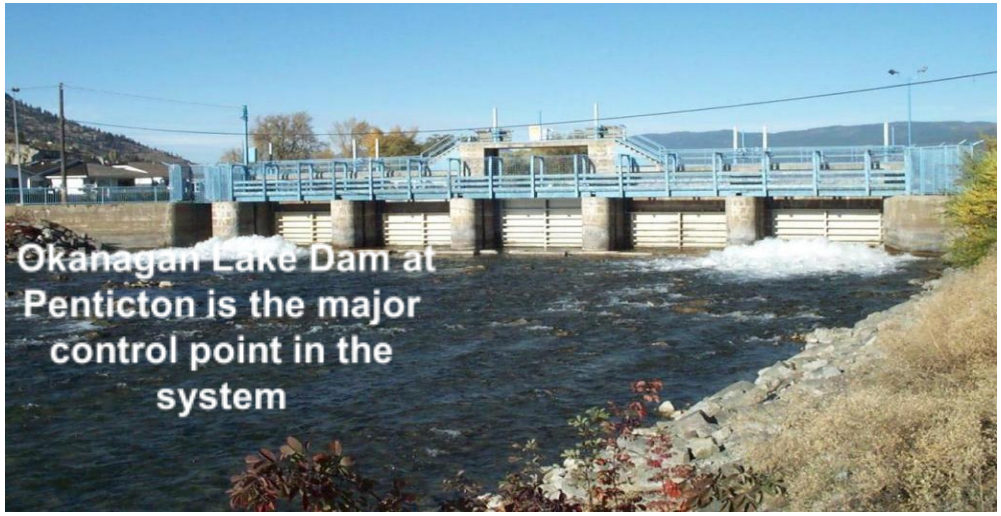


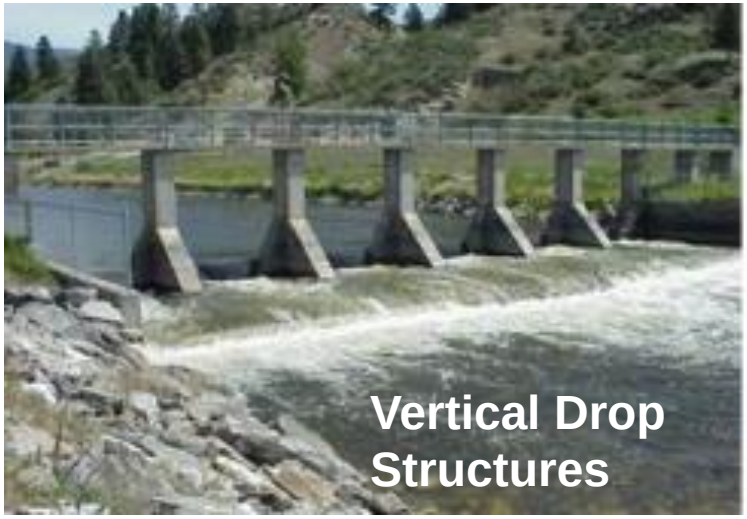
Okanagan River:

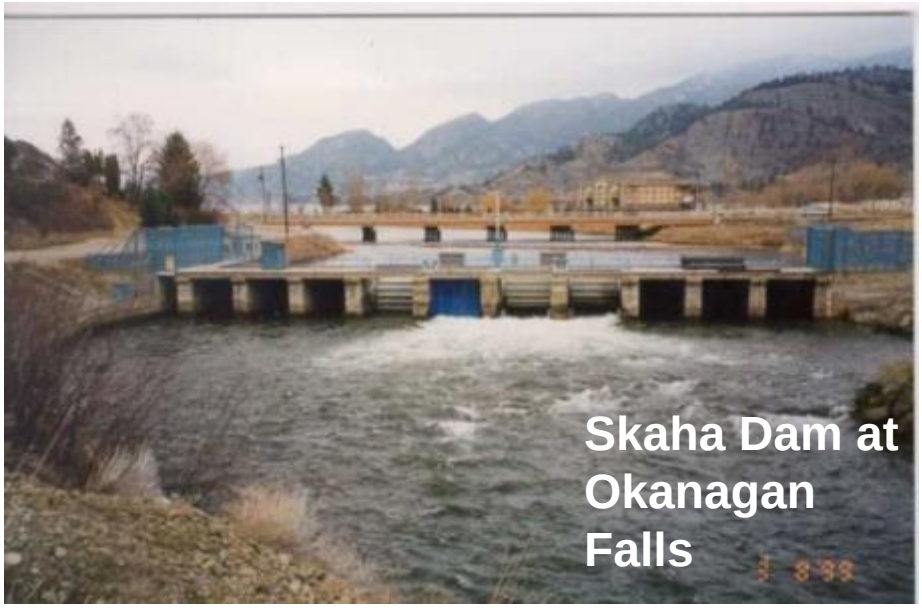
Natural = 8.4 km

Channelized = 16.2 km

The Okanagan Lake Regulation System is managed by a series of dams







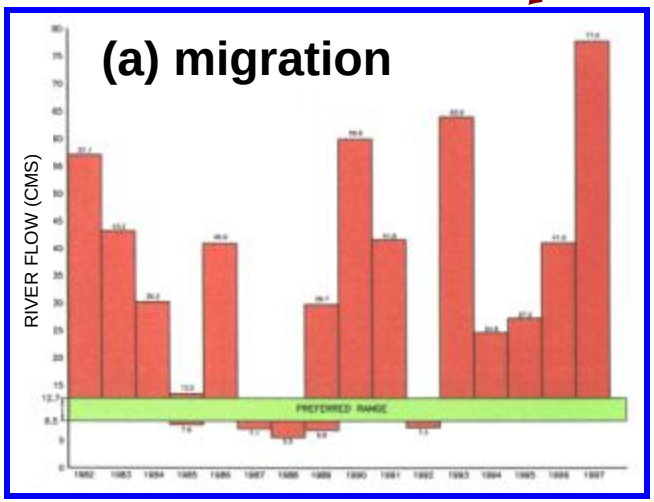
How are Release Patterns Determined?

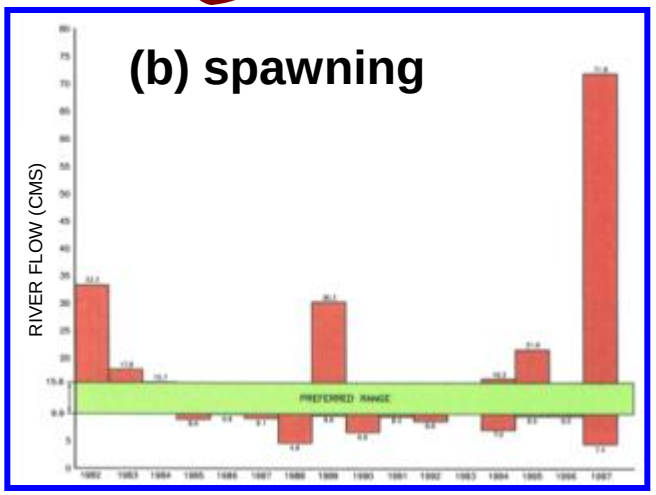
Okanagan Basin Implementation Agreement

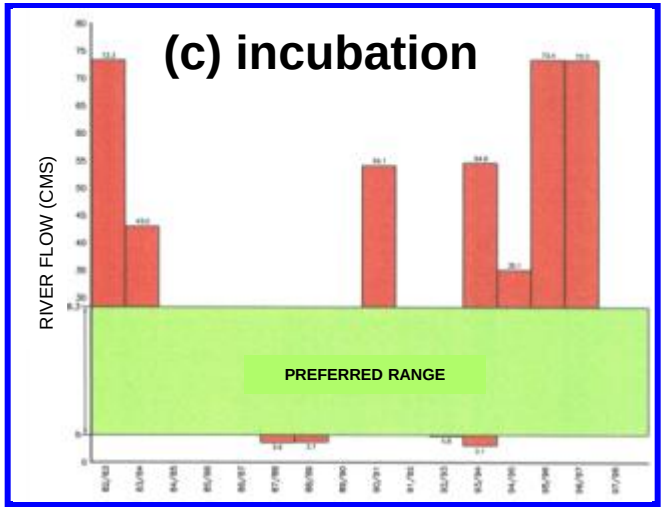
Recommended lake levels and flows to minimize impacts to fish at various life stages:

- Adult migration, 8.5-12.7 cms (Aug. 1 – Sept 15)
- Spawning, 9.9-15.6 cms (Sept. 16 – Oct. 31)
- Incubation, 5.0-28.3 cms; (Nov.1 – Feb. 15) must be ≥ 50% spawning
- Fry migration. 5.0-28.3 cms(Feb. 16 – Apr. 30)
- Maintain Okanagan lake at ≤ 341.9 m for shore spawning kokanee

Operator Challenges







OBA preferred flow range

Observed flow range

From 1982-1997 river discharge exceeded OBA fishery flows in:

(a) 13 of 16 yrs for adult migration

(b) 7 of 16 yrs for spawning and

(c) 7 of 16 yrs for egg incubation & fry migration

Why were targets not being met?

- Forecast uncertainty re: freshet inflow volumes and capacity to match lake spill or storage to spring inflows
- Effects of environmental variability (water levels, flow, temp.) on risk assessments given competing economic, social & environmental demands of multiple “parties” & authorities.
- Competing economic, social & environmental demands
- Communication barriers
- Decisions about water storage or release based on
  - rules of thumb,
  - past experience
  - incomplete information.

Impacts to fish

- Desiccation and scour of sockeye eggs in Okanagan River, desiccation of Okanagan Lake kokanee eggs.
- These issues contributed to the decline of Okanagan sockeye.
- Okanagan sockeye hit a low in 1994 with <2000 fish passing Wells Dam.
- So what was done?

Canadian Okanagan Basin Technical Working Group

- Formed in 1996 to address salmon stock and habitat restoration issues in the basin
- Members:
  - Okanagan Nation Alliance
  - Canadian Department of Fisheries and Oceans
  - BC Ministry of Forests, Lands and Natural Resource Operations and Rural Development

- This group identified possible solutions to address salmon restoration.
- The project that was identified as having the biggest potential was the FWMT.
- The COBTWG partnered with Douglas County PUD for the development of the FWMT.

Development of the FWMT

•The Okanagan system is relatively data rich with respect to climate, hydrology, and life history information on high value species of fish.

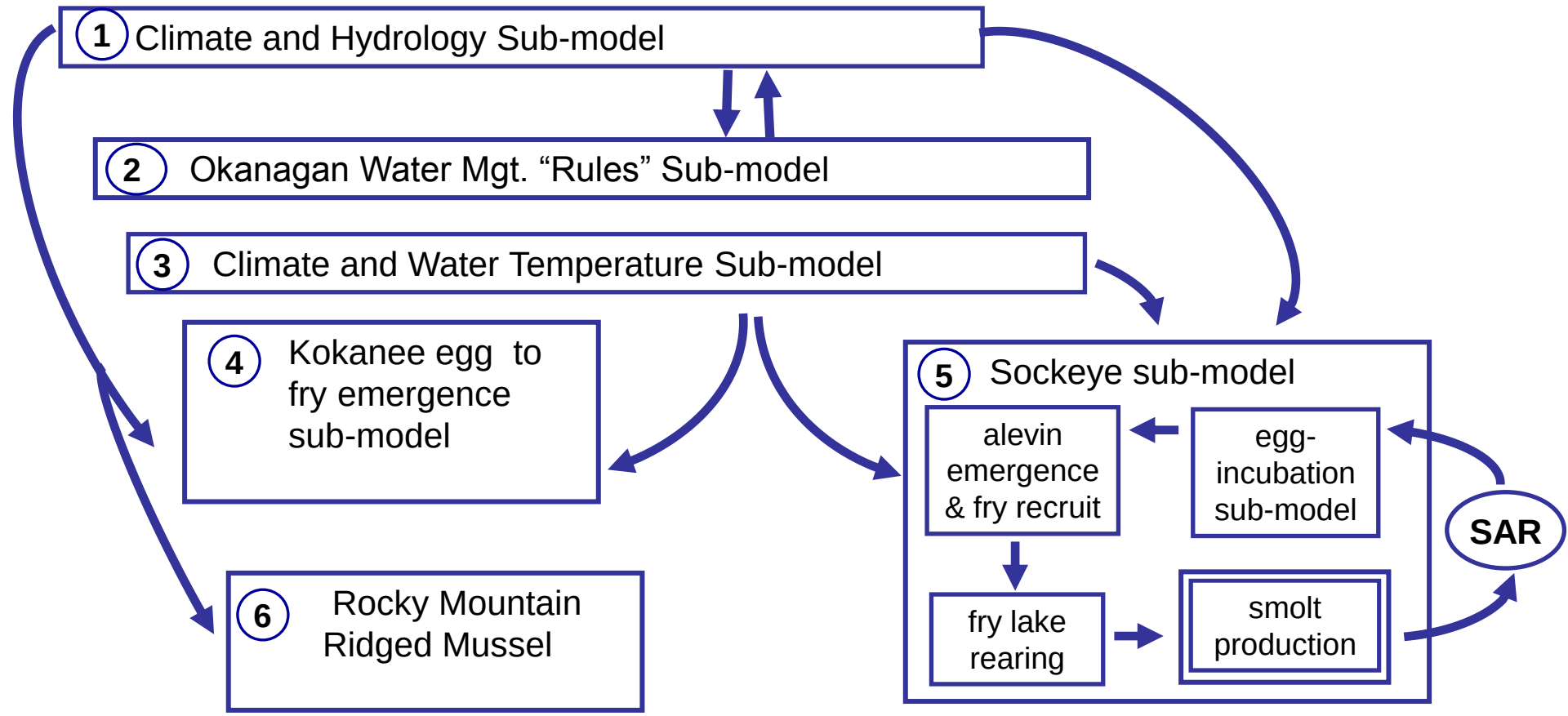
•Given the availability of such rich information sources, the FWMT system is a coupled set of 6 biophysical models of key relationships (among climate, water, fish & property) used to predict consequences of water management decisions for fish & other water users.

•Over the last 3 years the FWMT has been modernized.

Fish-Water Management Tool

- It is an internet accessible, computer simulation model that allows an operations team of fish-and-water managers to “game” in real-time with various water storage or release options and weigh the associated risks and benefits of each prior to key decision points that may be separated by days to weeks (even hours)
- Field surveys are used to validate FWMT timing of sockeye emergence, dessication of kokanee eggs
- The FWMT Operations group discusses forecasts and makes joint decisions

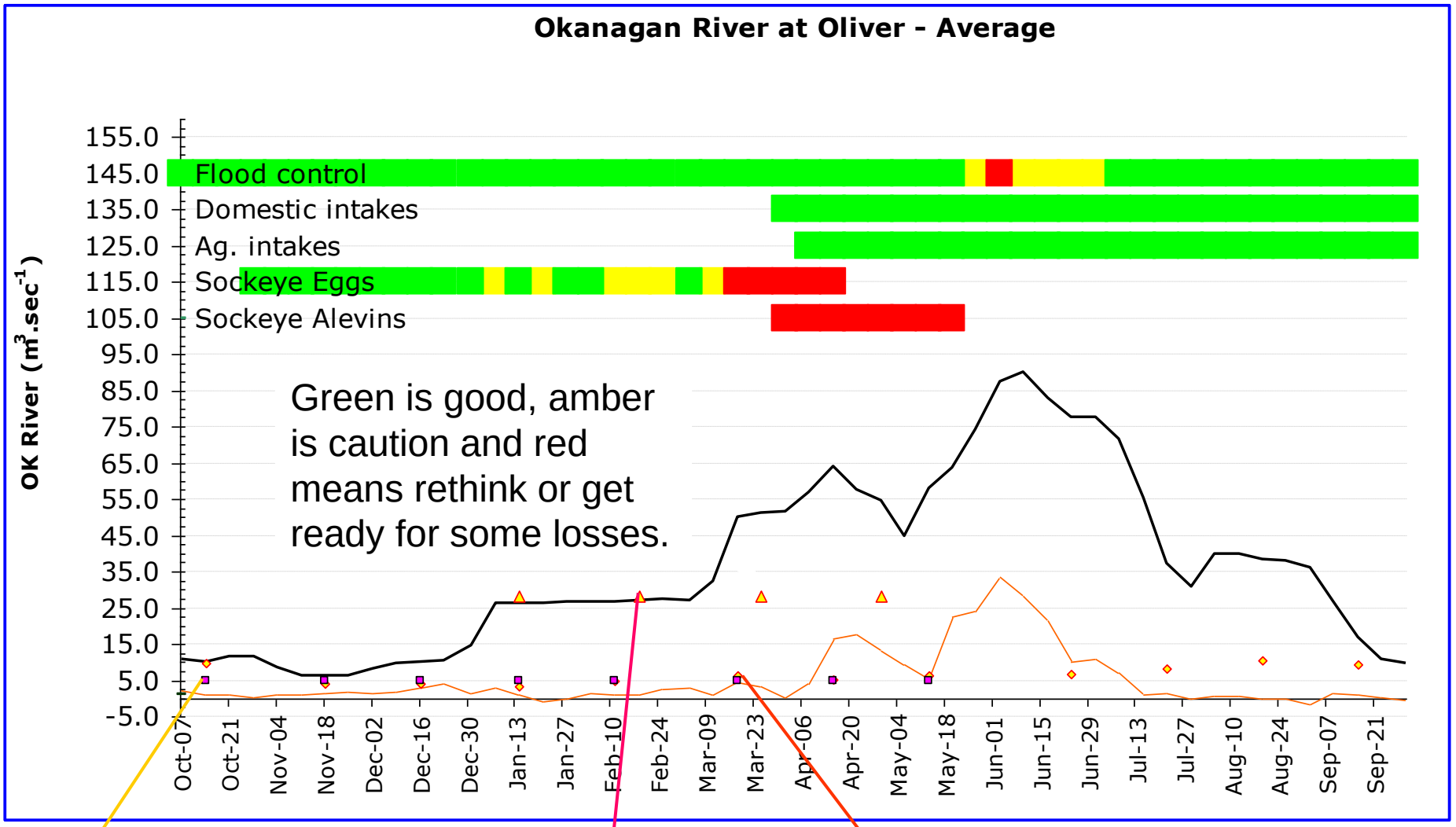
FWMT Sub-models



The Fish and Water Management Tools (FWMT) System is a coupled set of 6 biophysical models of key relationships (among climate, water, fish & property) used to predict consequences of water mgt. decisions for fish & other water users. FWMT may be used to explore impacts of water management decisions in real-time, retrospective or prospective-modes to deal with interactions among climate variation, water supply & fish populations.

OBA Recommendation		Green	Red	Time Period	Relevant Flow / Elev. Metric
Flood control (Ok Lake)	Lake elevation (m)	341.3 – 342.5	> 342.5; < 341.3	All	Average[1]
Shore spawning kokanee (Ok Lake)	Lake elevation (m)	<= 341.9	> 341.9	On October 15	Minimum
Sockeye migration (Ok River)	River flow (m^3/s)	8.5 – 28.3	> 28.3; < 8.5	Aug. 1 to Sept. 15	Average[2]
Sockeye spawning (Ok River)	River flow (m^3/s)	9.9 – 15.8	> 15.8; < 9.9	Sept. 16 to Oct. 15	Average[3]
Sockeye incubation and emergence (Ok River)	River flow (m^3/s)	5.0 – 28.3	> 28.3; < 5.0	Nov. 1 to Apr 30	Average[4]
Water intake requirements (Ok Lake)	Lake elevation (m)	340.4 – 343.0	> 343.0 < 340.4	All	Average
Wharves and boat ramps (Ok Lake)	Lake elevation (m)	340.3 – 343.0	> 343.0 < 340.4	All	Average

1. The OBA allows for deviations from this range under conditions of "high volume runoff" or "prolonged drought conditions".
2. The OBA Compliance report uses the Aug 1 to Sept 15 "approximate" time period listed in the OBA, even though migration timing is likely to vary from year to year in response to temperature and other factors. Because the simulation year starts on October 1, the sockeye submodel does not include a separate migration life phase.
3. The OBA Compliance report uses the Sept 16 to Oct 31 "approximate" time period listed in the OBA, even though spawn timing in the sockeye submodel varies from year to year in response to water temperatures.
4. The OBA Compliance report uses the Nov 1 to Apr 30 "approximate" time period listed in the OBA, even though incubation and emergence timing in the sockeye submodel varies from year to year in response to water temperatures. The OBA also includes an additional requirement that incubation/emergence flows be not less than 50% of flow during spawning period to avoid egg stranding and dessication. The hazard indicator in the OBA Compliance report does not include this additional flow requirement.



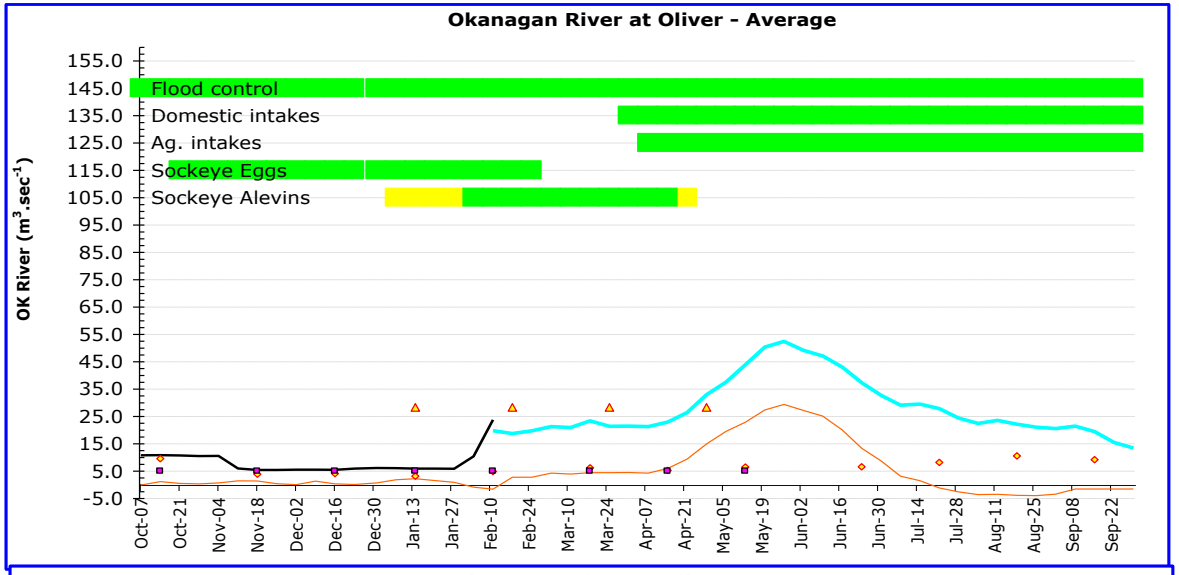
BC-Washington Co-Operative Plan minimum flow targets

Okanagan Basin Agreement target to min. sox scour

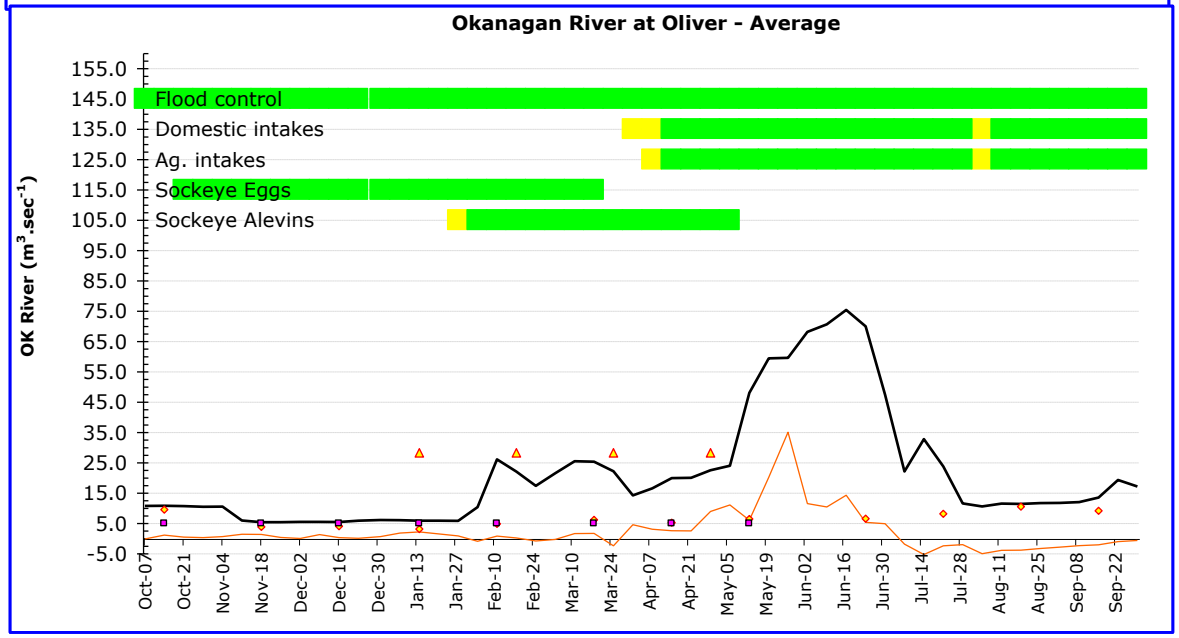
Sockeye biologist's rule of thumb to avoid de-watering

Managing with FWMT to avoid flood risk and redd scour in 2005-2006

(A) Actual (black) and predicted (blue)flows at Oliver (sockeye spawning grounds) 9-Feb-06; tributary inflow (red)

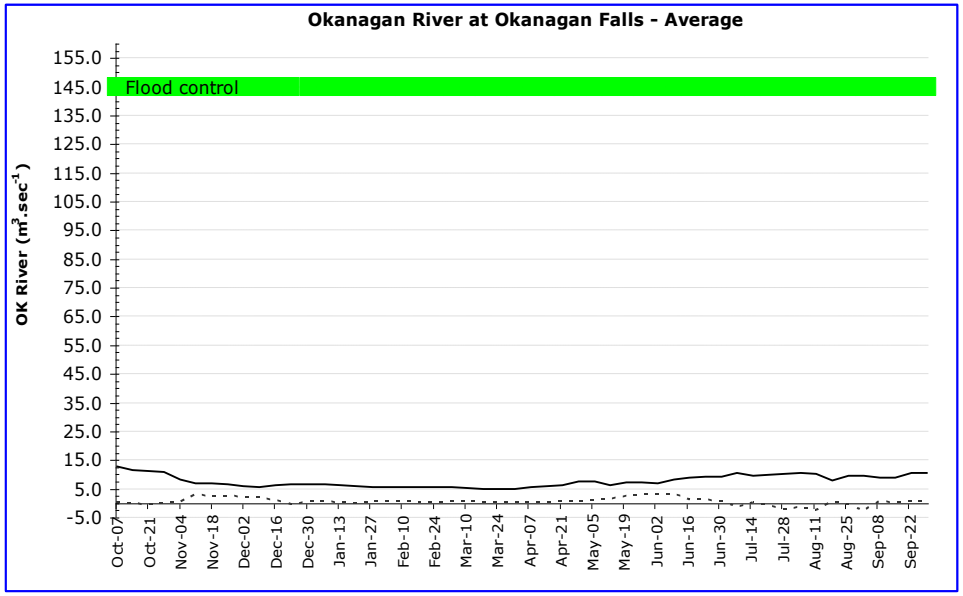


(B) Final outcome at Oliver (sockeye spawning grounds) 30-Sep-06

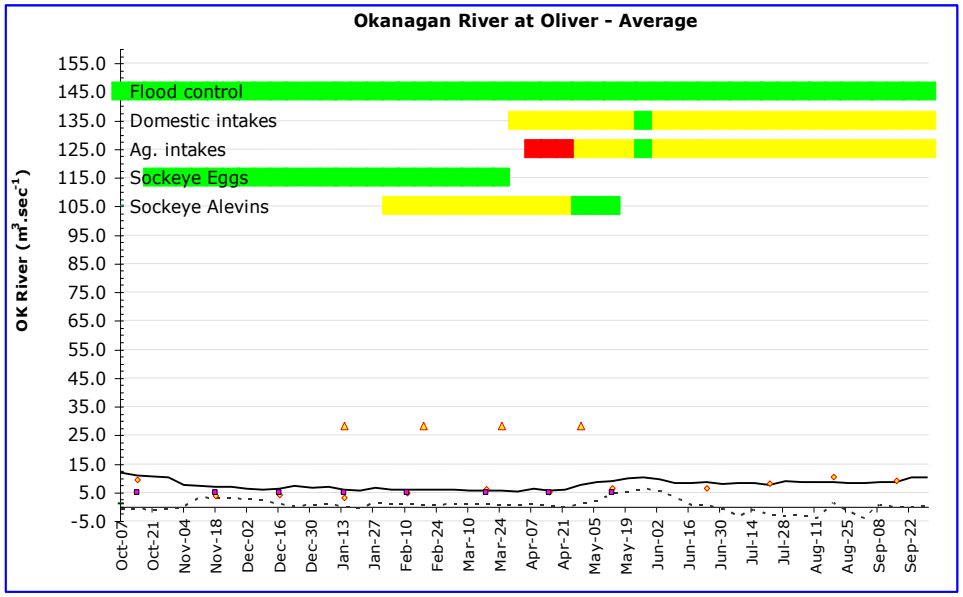


Managing with FWMT to avoid drought induced losses of fry in 2008-09

C. Okanagan River at Ok Falls



D. Okanagan River at Oliver



FWMT Results to Date

- Since deployment in fall of 2005 we have avoided:
  - (a)major drought and desiccation, or flood and scour losses fry production in-river (potential 2018 losses have not been evaluated) and
  - (b) most temp-O_2 induced losses of fry rearing in-lake (i.e. reduced density-independent losses of fry & smolt production.
- Improved communications between fisheries and water managers
- Improved compliance with recommended flows
- Increased returns

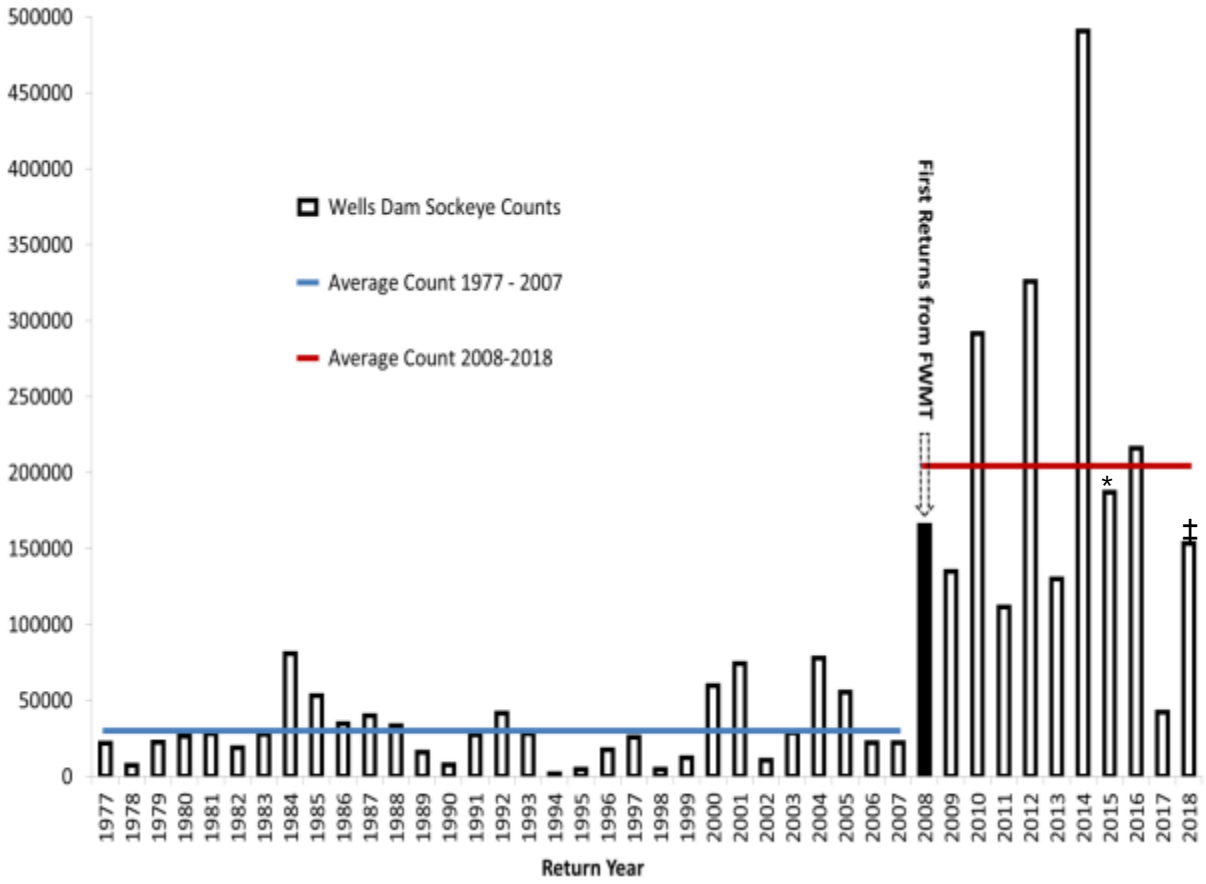
FISH-WATER MANAGEMENT TOOL BOOSTS OKANAGAN SOCKEYE

Using a computer model and real-time hydrological/biological data—the Fish-Water Management Tool (FWMT)—for managing Okanagan River flows maximizes survival of Sockeye eggs and juveniles contributing to a spectacular resurgence in adult Sockeye returns

Douglas PUD and Canadian partners developed the FWMT—a web-based computer model that guides Canadian water and fish managers to fish-friendly decisions on water releases from dams in the Canadian Okanagan.

FWMT benefits Sockeye by, 1) stabilizing flows during fall spawning, 2) preventing dewatering of eggs during incubation, 3) preventing flows that could scour alevins from redds before spring emergence, and 4) oxygenating water for juveniles and adults in Osoyoos Lake during late summer.

Continued funding by Douglas PUD maintains the model, allows Canadian partners to collect the physical (climate, hydrology, temperature, etc.) and biological (Sockeye spawning, fry emergence, etc.) data necessary to populate the model, and to staff the modeling process to inform water-management decisions for the benefit of sockeye, flood control, irrigation, and recreation.



* In 2015, more than one-half of the 510,000 returns to Bonneville Dam perished before reaching Wells Dam due to record-high water temperatures in the lower Columbia River.
‡ 2018 Incomplete count at Wells Dam as of 9-13-2018.

- The FWMT was developed for a large, regulated system with storage, however, the concepts of “fish-friendly flows”/EFNs can be adapted to smaller systems.

- Target flows can be set and monitored

- Collaboration is possible!

For more information:

Kim D. Hyatt, Clint A. D. Alexander & Margot M. Stockwell (2015) **A decision support system for improving "fish friendly" flow compliance in the regulated Okanagan Lake and River System of British Columbia, Canadian Water Resources Journal / Revue canadienne des ressources hydriques**, 40:1, 87-110, DOI: 10.1080/07011784.2014.985510

http://dx.doi.org/10.1080/07011784.2014.985510

For an informational video about the success of the FWMT:

http://www.douglaspud.org/your-pud/district-videos

Thank you

Okanagan Nation Alliance

BRITISH COLUMBIA
Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Fisheries and Oceans Canada
Pêches et Océans Canada

Department of Fisheries and Oceans Canada

Douglas County Public Utility District