

The effects of mainstem flow, water velocity and spill on salmon and steelhead populations of the Columbia River

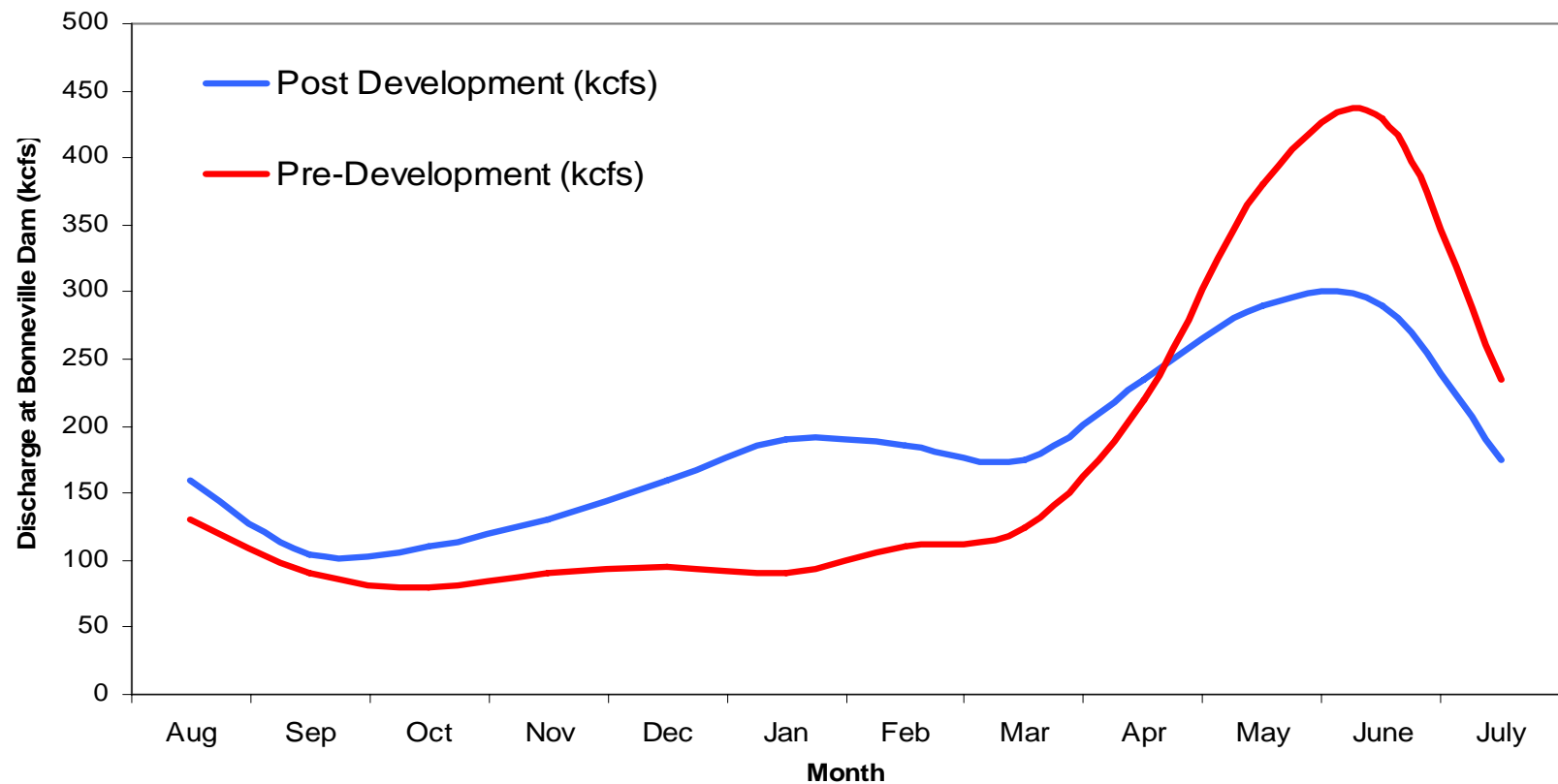
Columbia River Inter Tribal Fish Commission
October 12, 2006

Jerry McCann and Margaret Filardo
Fish Passage Center

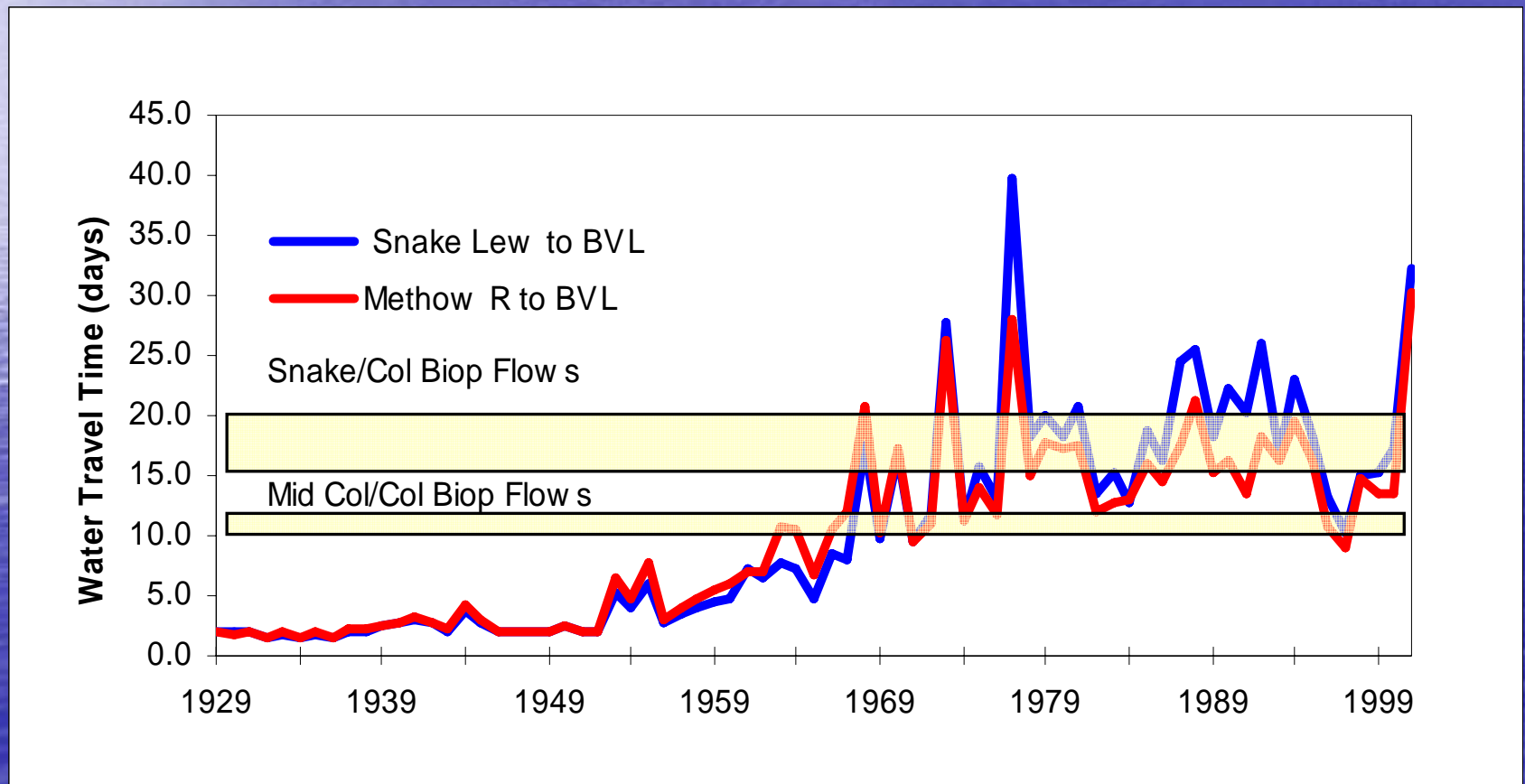
An aerial photograph of a vast, deep blue ocean stretching to the horizon. The sky above is a lighter blue with wispy, white clouds. The sun is visible on the left side, creating a bright, shimmering reflection on the water's surface. The overall scene is serene and expansive.

A Hydrographic Perspective

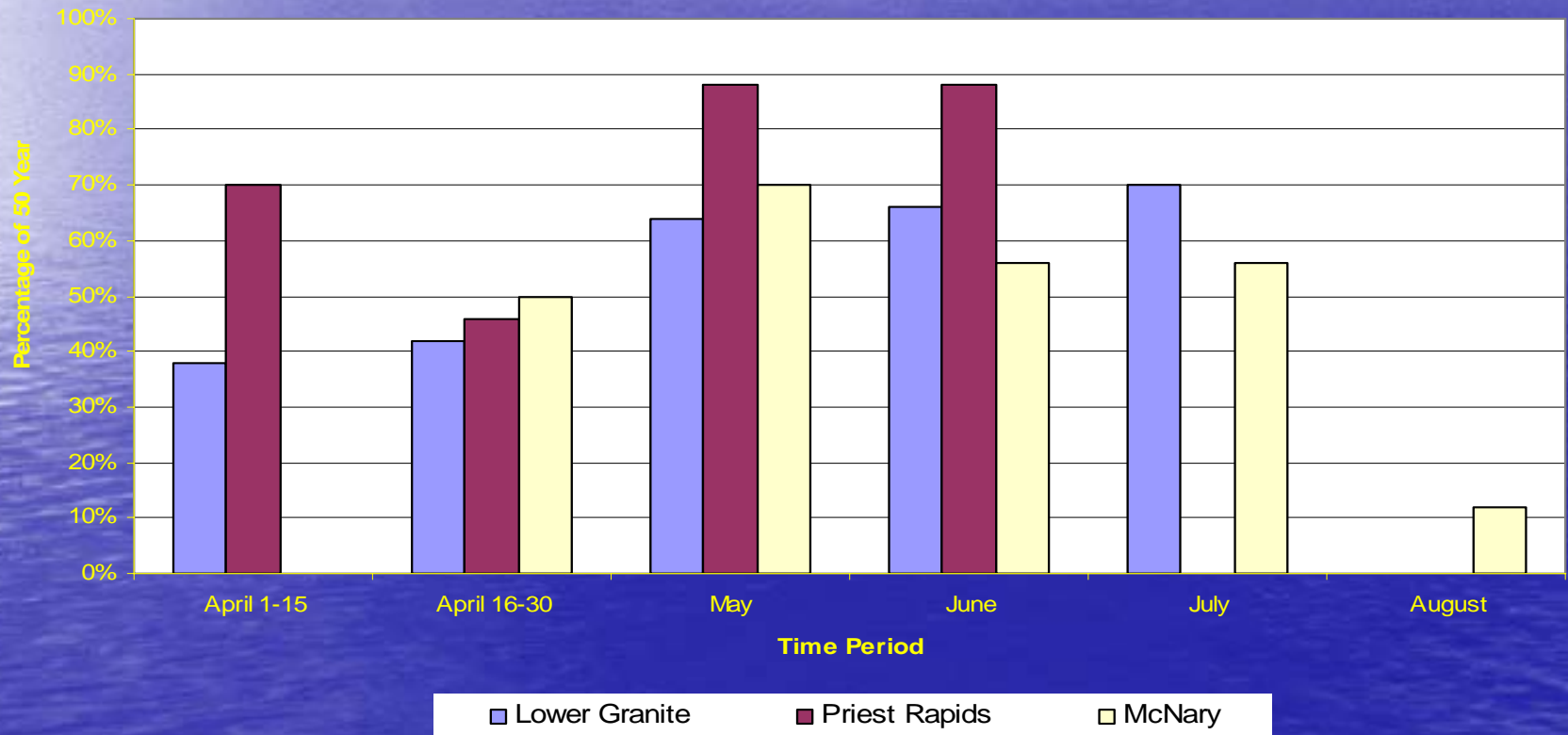
Historic and Present Flow



Historic and Present Water Travel Times (Volume/Flow)



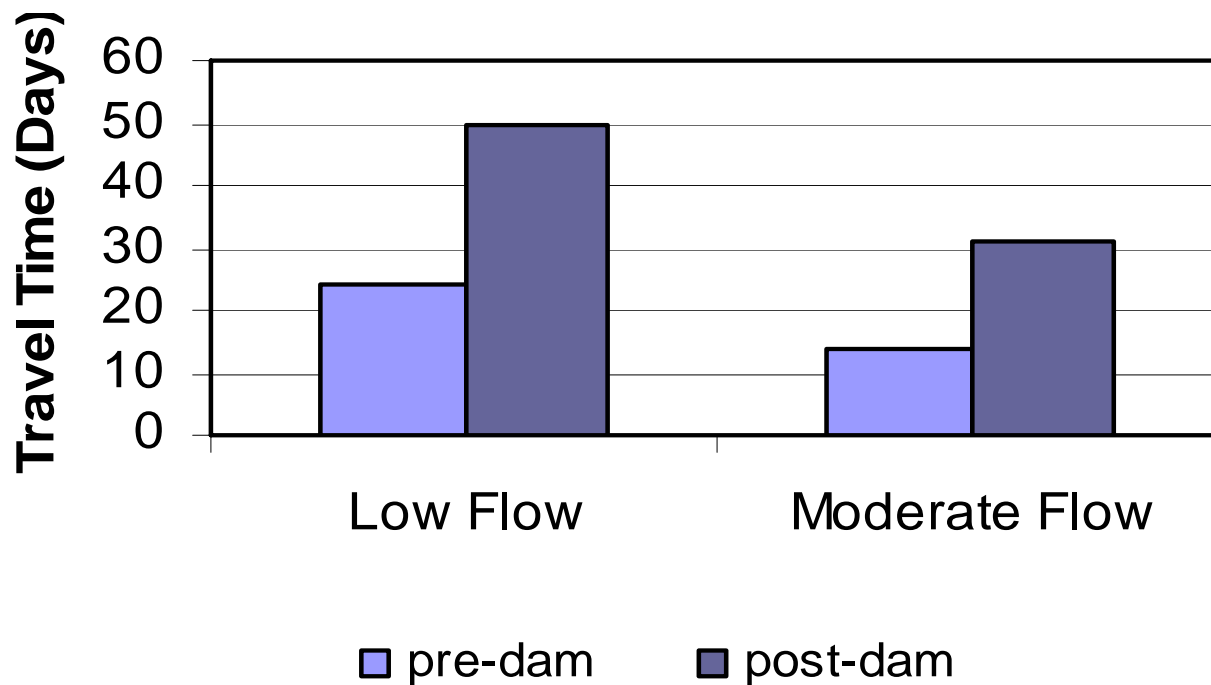
Likelihood of Meeting Biological Opinion Flow Objectives Under Current Operations





Estimated Travel Time for wild Chinook from the Salmon River to the Mouth of the Columbia River

(derived from Raymond 1979)



Smolt migration: Why focus on flow and spill?

Mechanisms:

Flow affects:

- Time to estuary;
- Temperature exposure;
- Energy reserves and stress;
- Timing of salt-water entry;
- Estuary plume.

Spill affects:

- Spill reduces project mortality by avoiding turbine passage;
- Spill reduces passage delay;
- Predator avoidance;
- Spill allows juvenile migrants to avoid adverse conditions such as high water temperatures;
- Spill results in reduced cumulative passage effects leads to reduced delayed mortality.

Measurements:

- Travel Time;
- Direct survival (estimated by inriver or reach survival);
- Delayed mortality (related to fish condition, not observed directly).

Juvenile Salmon Analyses

Travel Time and Survival



S/S

Freshwater

Smolts-per-spawner

Lower Granite

Little Goose

Monumental

Ice Harbor

McNary

John Day

The Dalles

Bonneville

Direct survival through dams

Direct survival transported fish

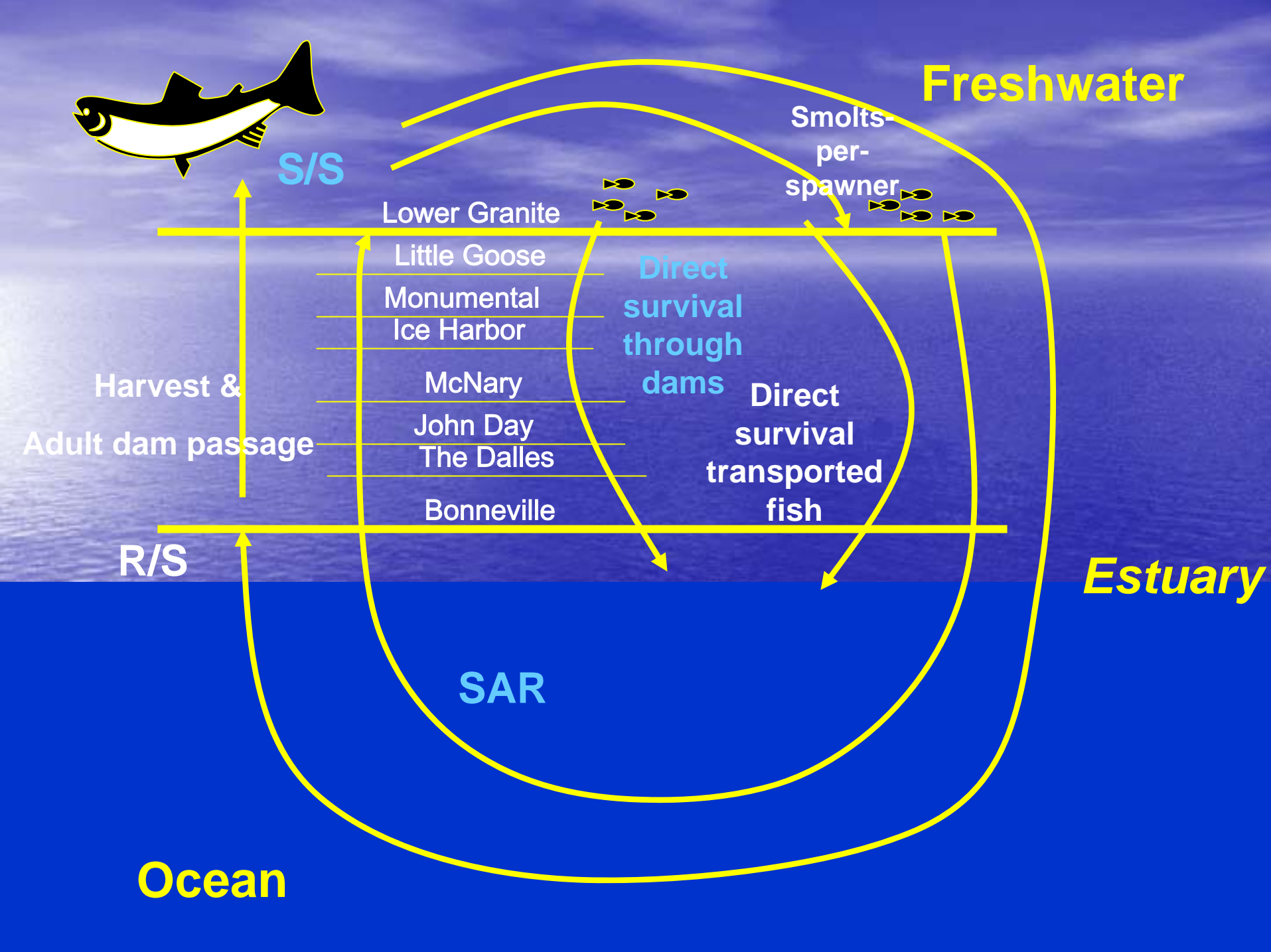
Harvest & Adult dam passage

R/S

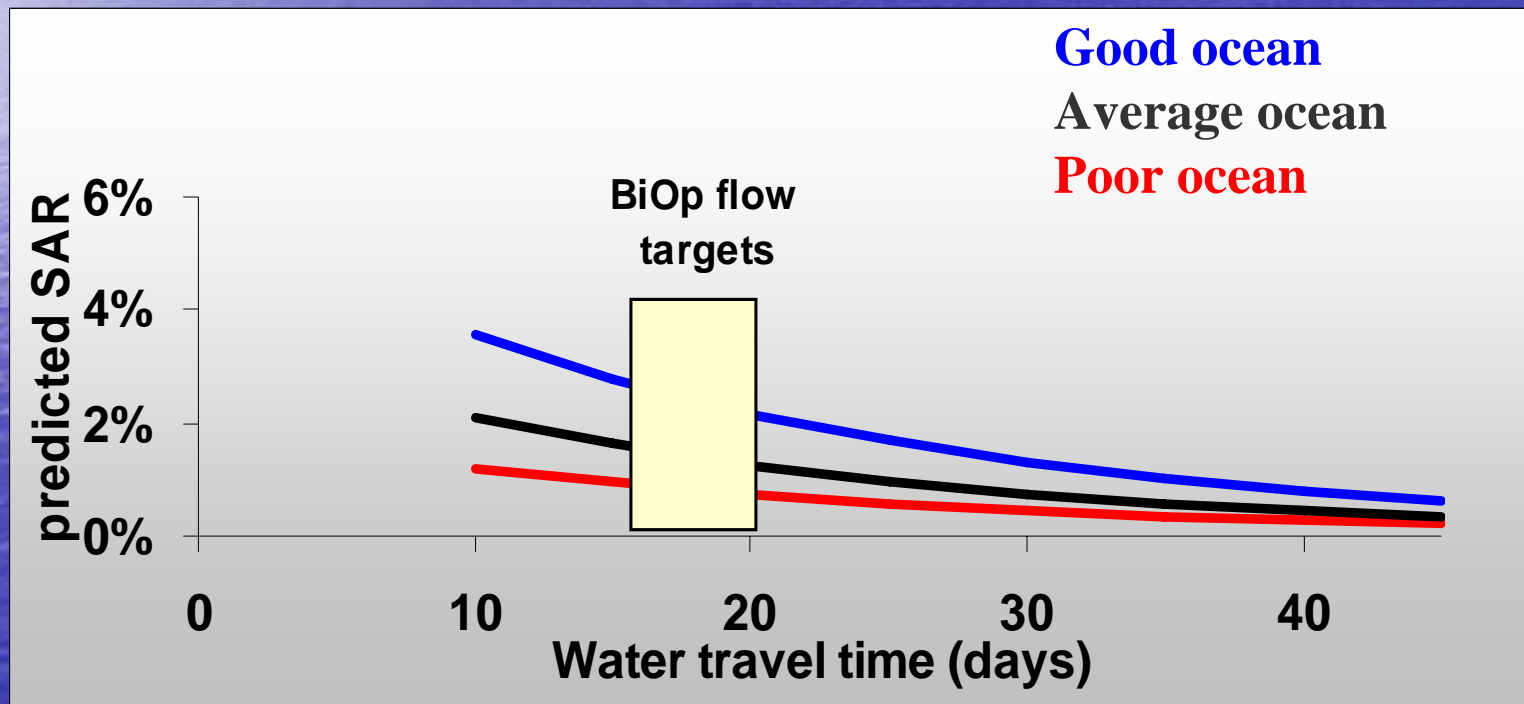
Estuary

SAR

Ocean



Influence of Water Travel Time and Ocean Effect on Spring/Summer Chinook SAR (predicted)



Snake R. spring/summer chinook

Methods for Travel Time

- Smolt travel time is defined as the amount of time needed for juvenile migrants to transit the river system between any two points.
- All estimates made using of PIT tag technology.

- Median travel time estimates were calculated for each temporal release block for the Lower Granite to McNary Dam Reach, Rock Island to McNary Dam Reach and McNary to Bonneville Dam Reach.



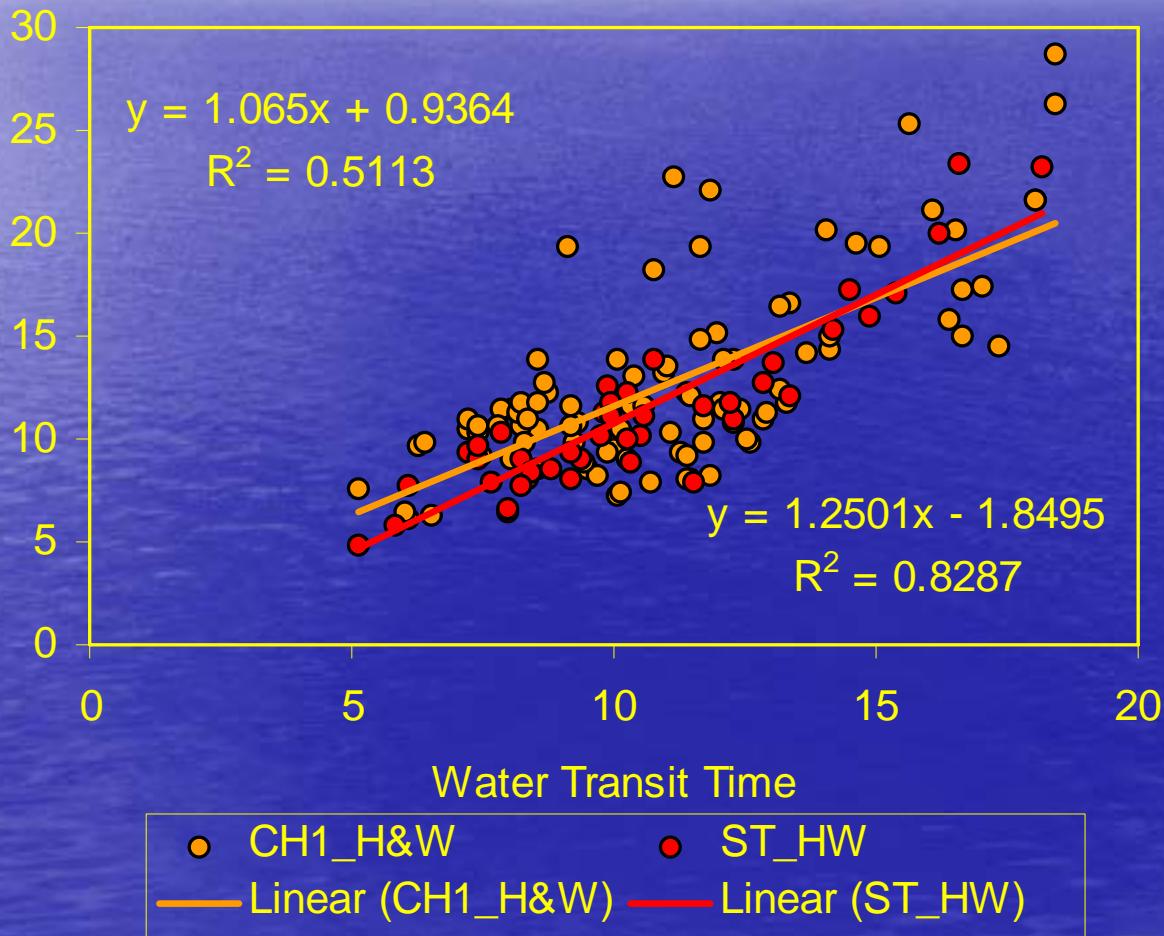
Methods for Reach Survival Estimates

- Survival estimated using Cormack-Jolly-Seber tag-recapture methodology.
- Time series limited by installation of PIT tag facilities (John Day 1998).
- Longest time series available for Snake River migrants (also has the greatest changes in variables of interest)

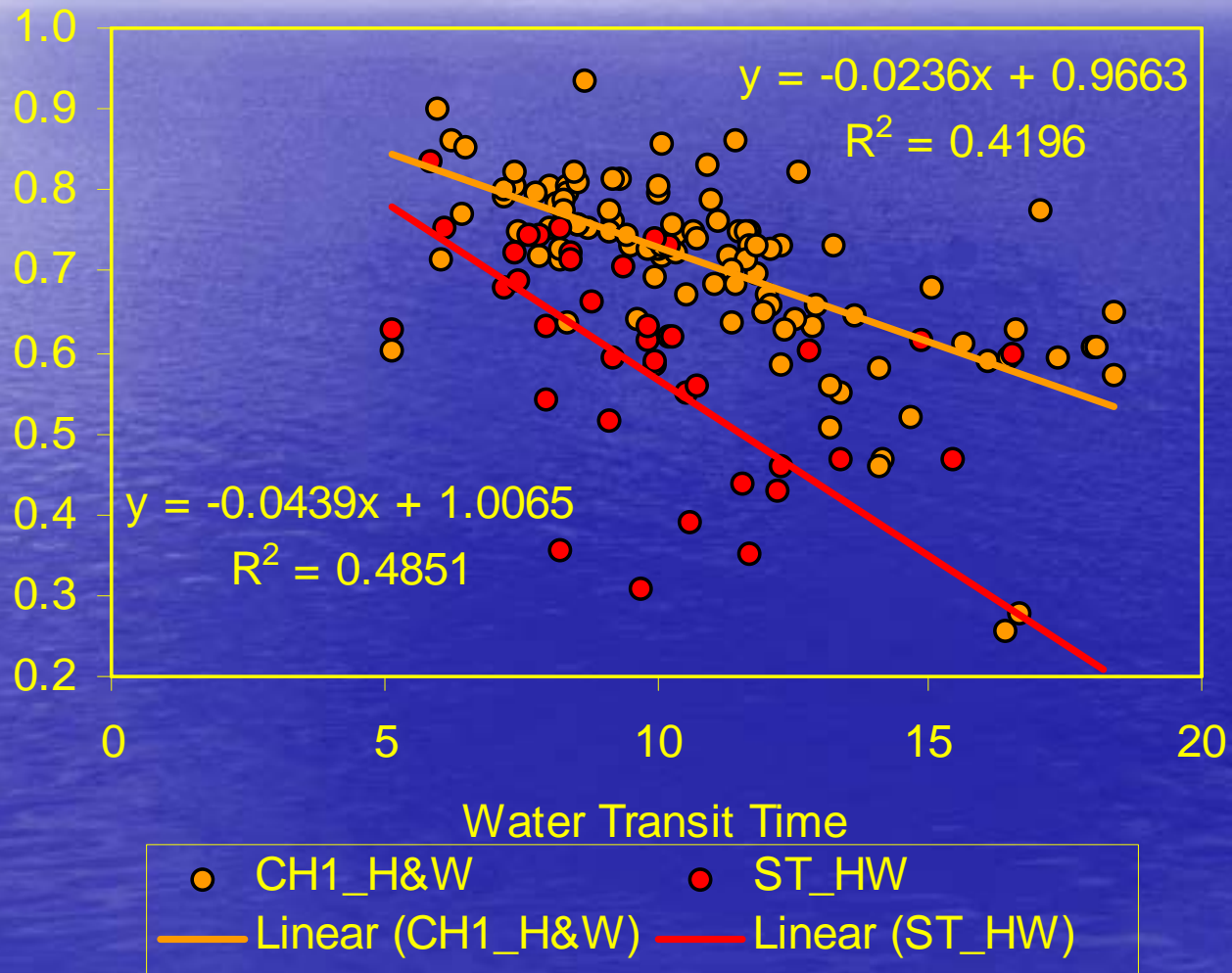
Environmental Variables

- **Water Transit Time**
 - Flow variable quantified as the summation of water transit times for each reservoir incorporated in a reach.
- **Spill Proportion**
 - Daily Spill/Total discharge averaged over a seven day median passage window for each species and project.
- **Water Temperature**
 - averages of river temperature developed for 7 day blocks around the median dates of passage.

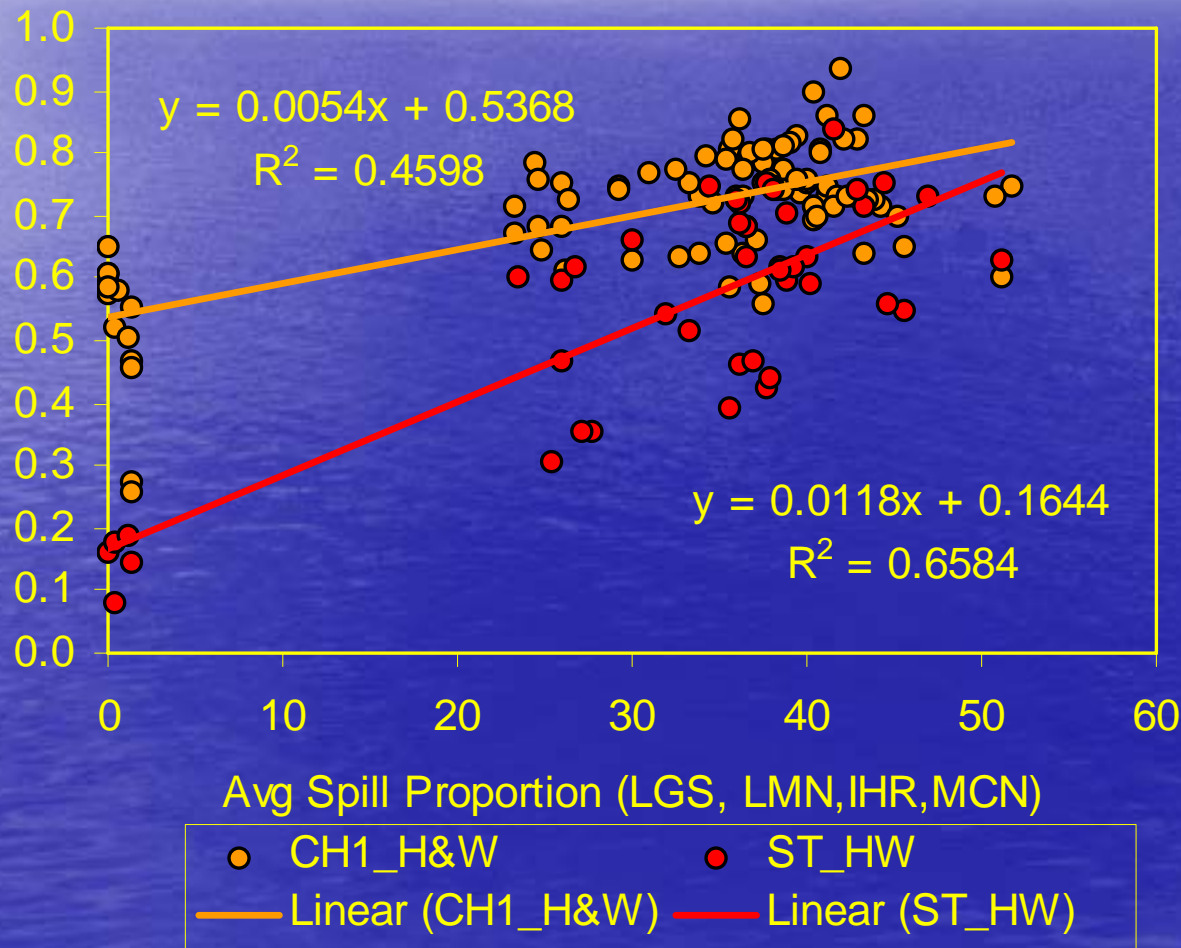
Yearling Chinook and Steelhead Travel Time versus WTT LGR to McN 1998 to 2005



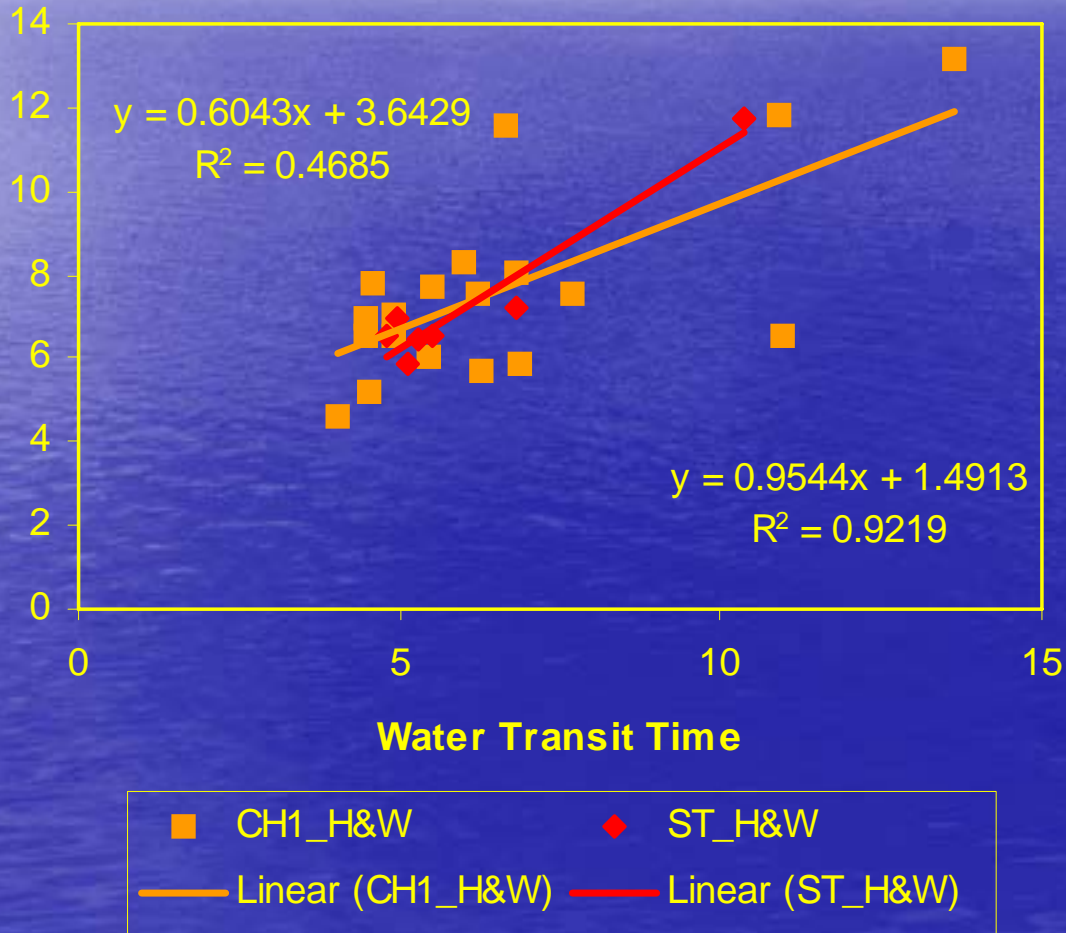
Yearling Chinook and Steelhead Survival versus WTT LGR to McN



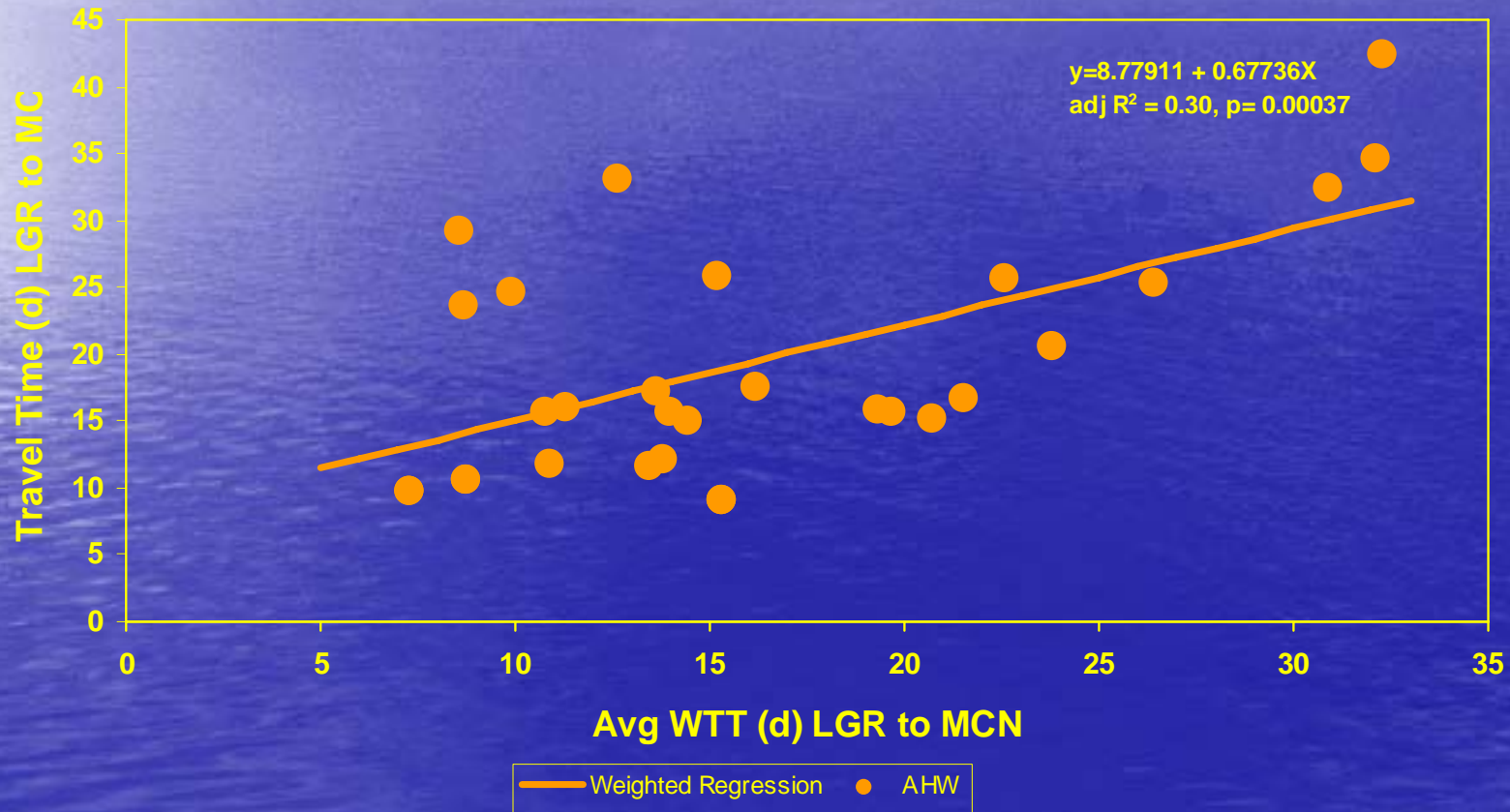
Yearling Chinook and Steelhead Survival versus Avg Proportion Spill LGR to McN



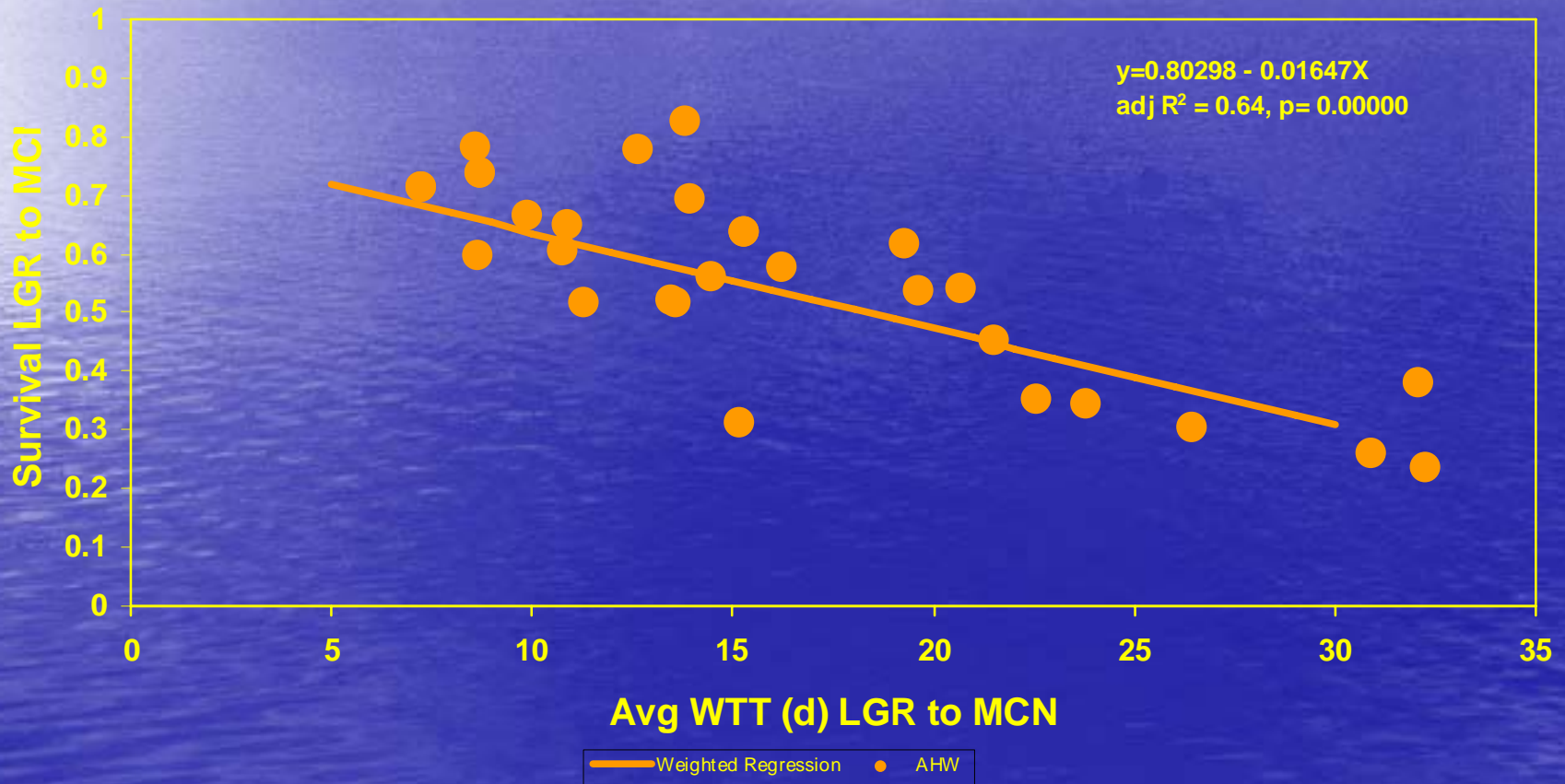
Yearling Chinook and Steelhead Travel Time versus WTT McN to BVL



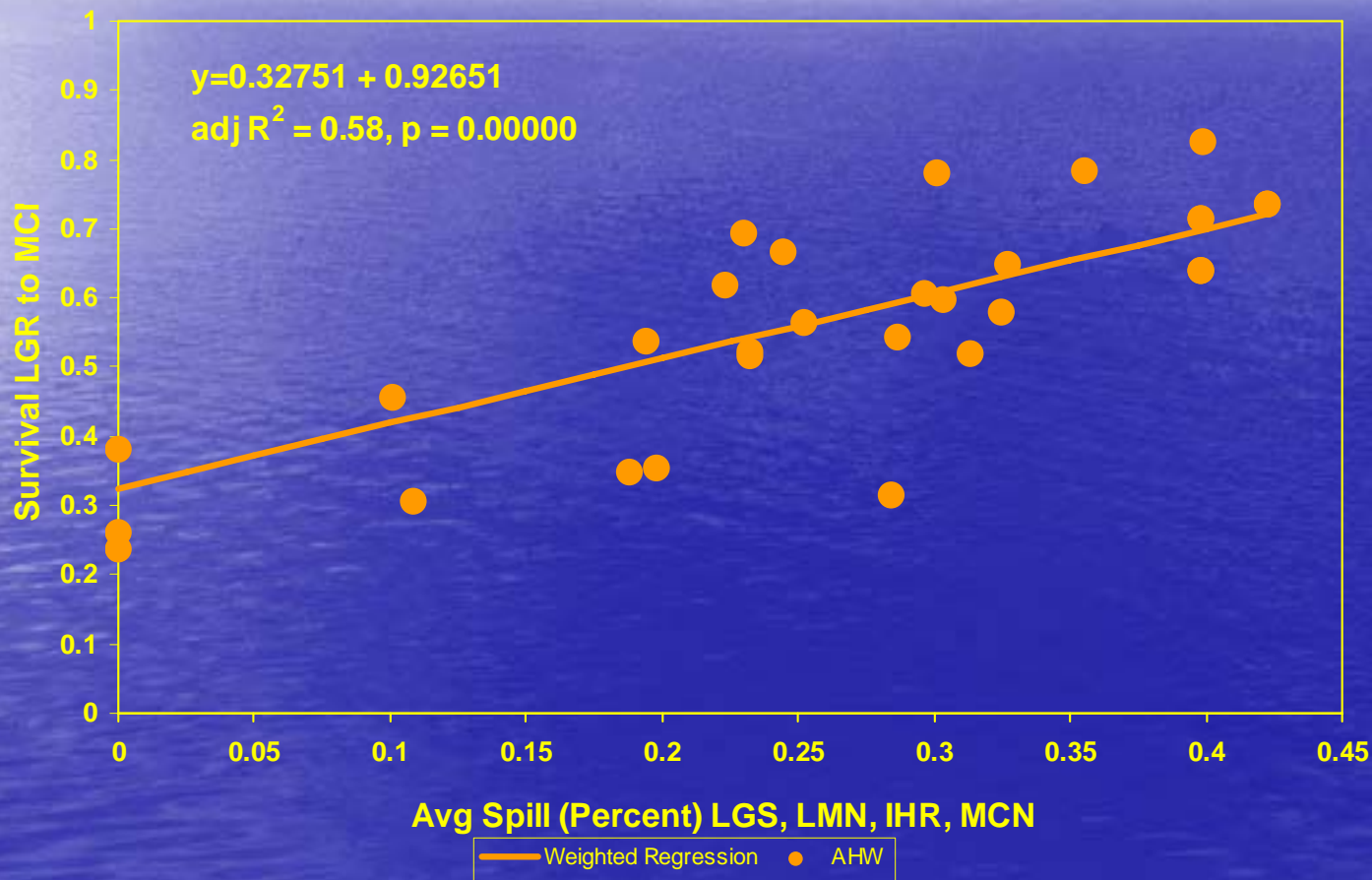
Subyearling Chinook Travel Time versus WTT Lower Granite Dam to McNary Dam



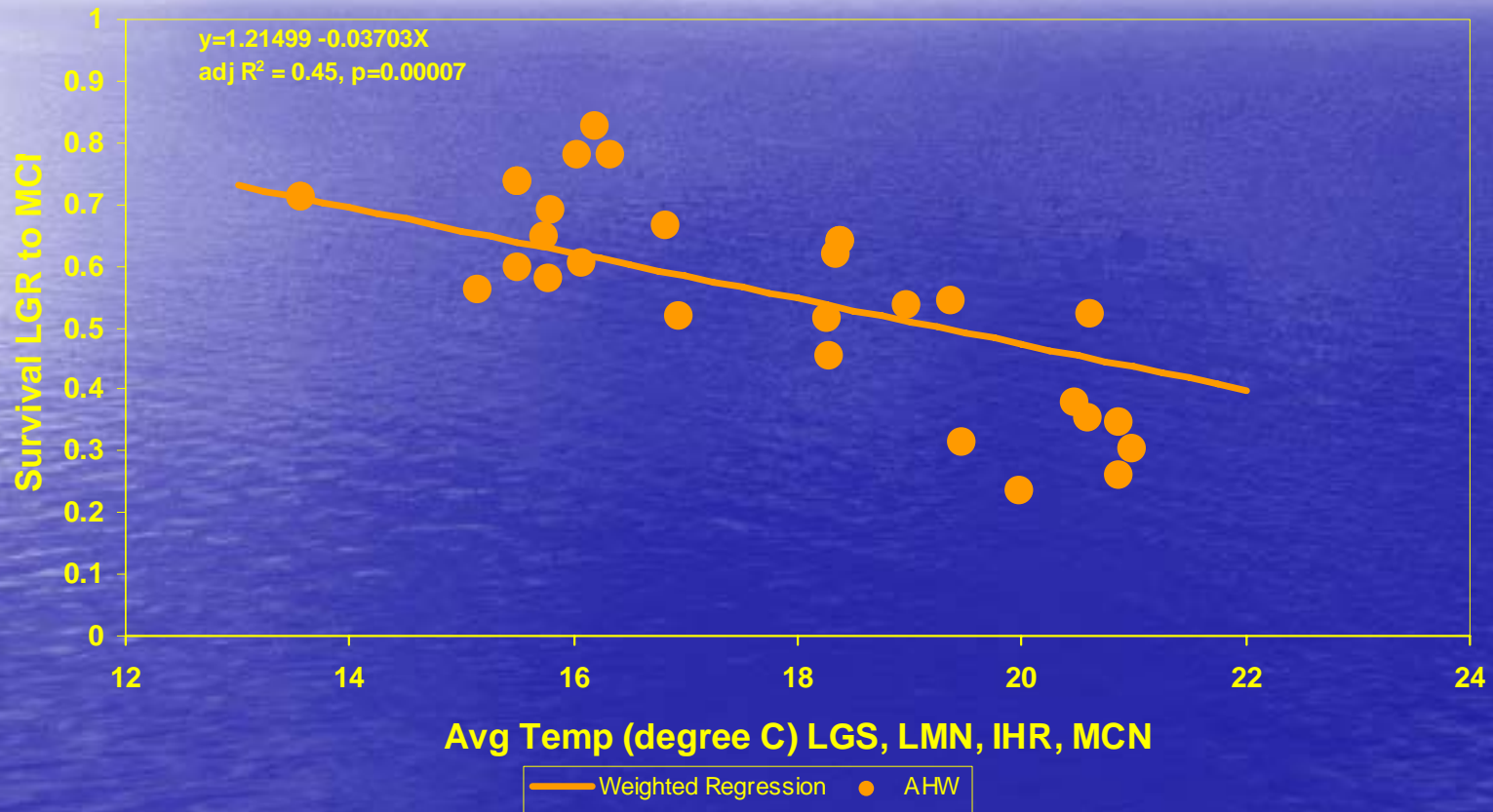
Subyearling Chinook Survival versus WTT Lower Granite to McNary Dam



Subyearling Chinook Survival versus Avg Spill Lower Granite to McNary Dam 1998 to 2006



Subyearling Chinook Survival versus Avg Temp Lower Granite to McNary Dam



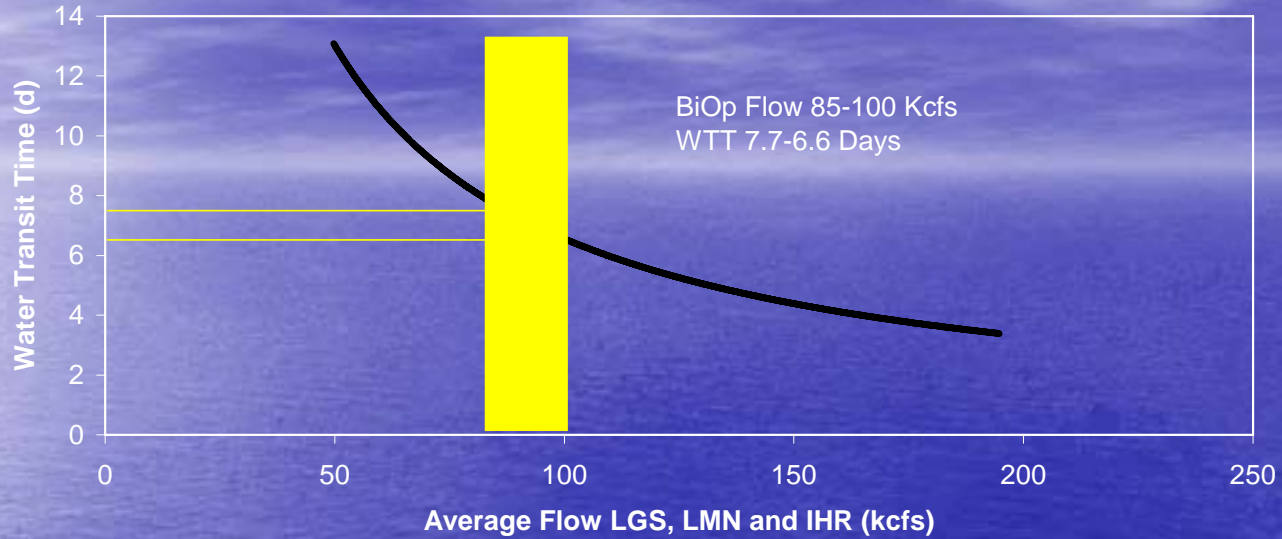
Juvenile Summary

- All data collected and analyzed to-date shows flow and spill as the important factors affecting the overall survival of juvenile migrants transiting the hydroelectric power system.
- Flow and spill affect the migration timing and ocean entry of juvenile salmonids.
- Small incremental changes in flow volumes are difficult to quantify for fish survival.
- However, all data collected suggests that decreasing flows increases the risk to the already high risk populations.
- Given BIOP flow targets stocks are still at risk (average-poor climate/ocean conditions). Any degradation in flows will place stocks at higher risk.



Flow vs Water Transit Time

Lower Granite Tailwater to Ice Harbor Dam



McNary to Bonneville Dam

