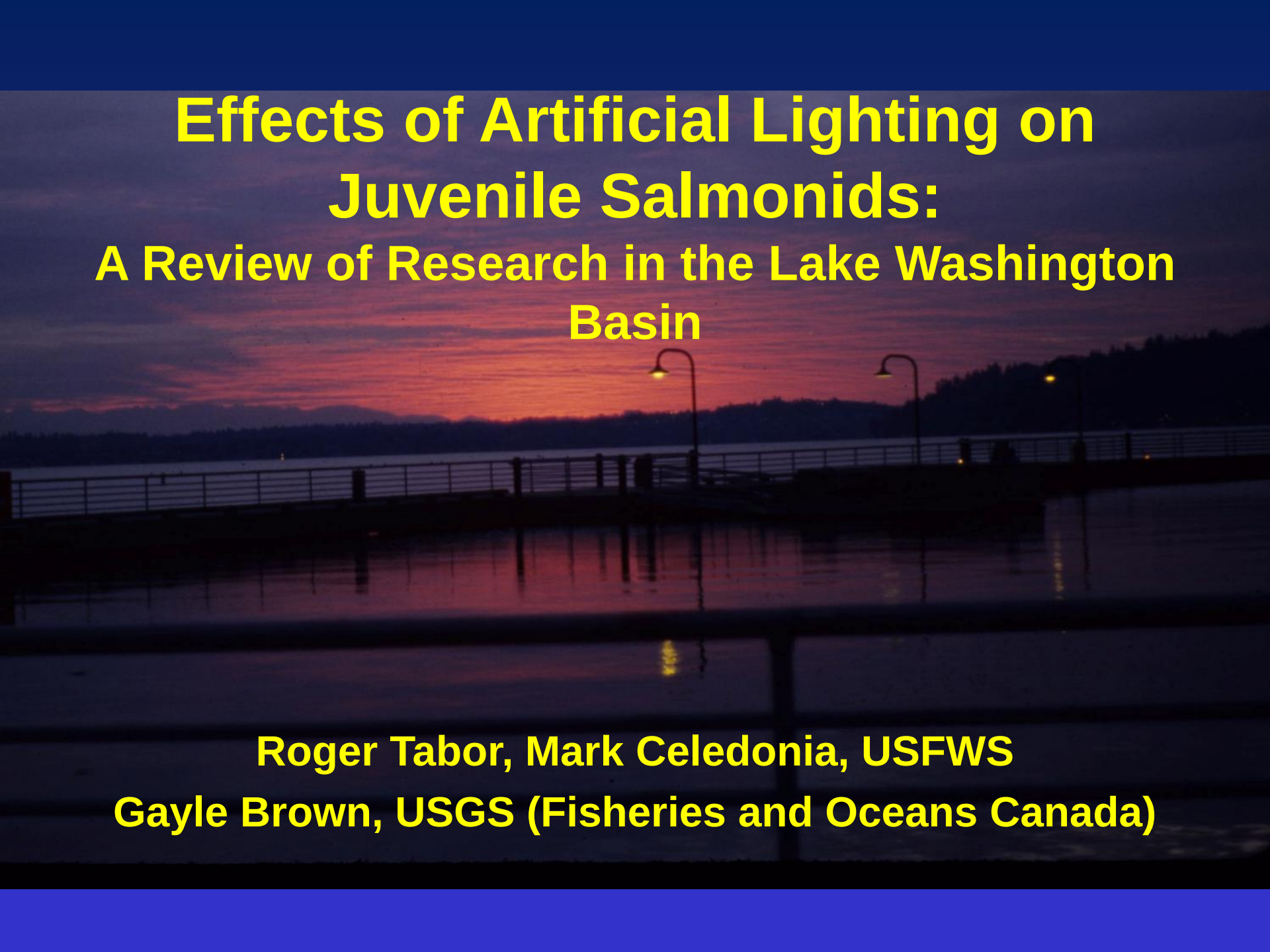


Effects of Artificial Lighting on Juvenile Salmonids:

A Review of Research in the Lake Washington Basin

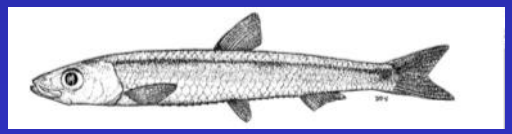
Roger Tabor, Mark Celedonia, USFWS

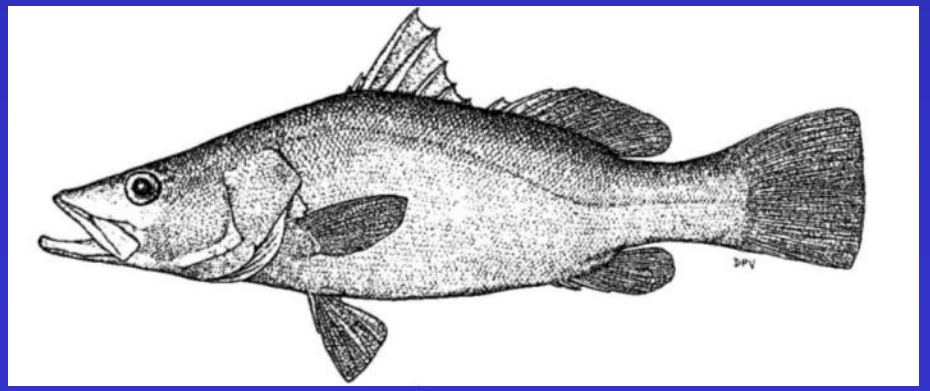
Gayle Brown, USGS (Fisheries and Oceans Canada)

Uses of Artificial Lighting

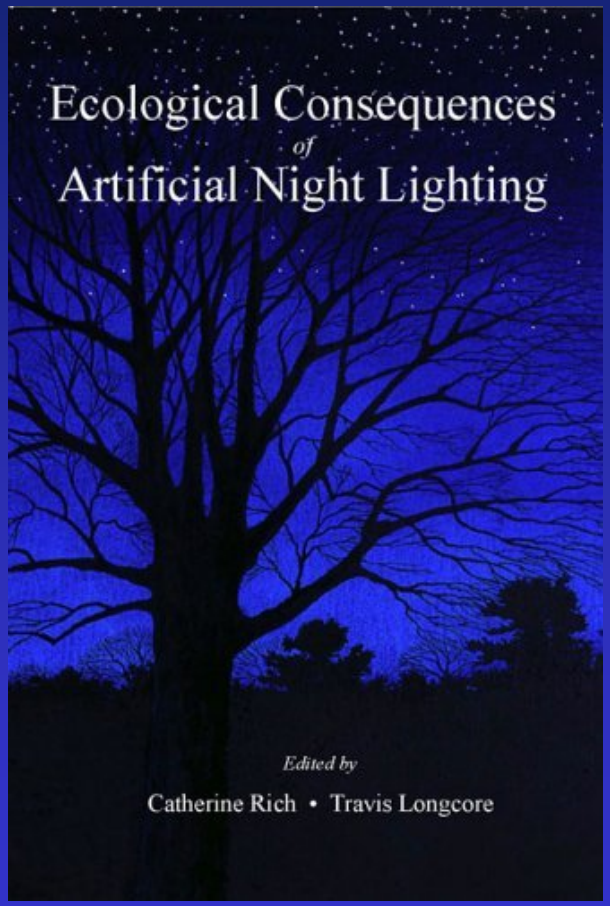
- Kona's Manta Rays

- Lake Tanganyika's clupeid fishery





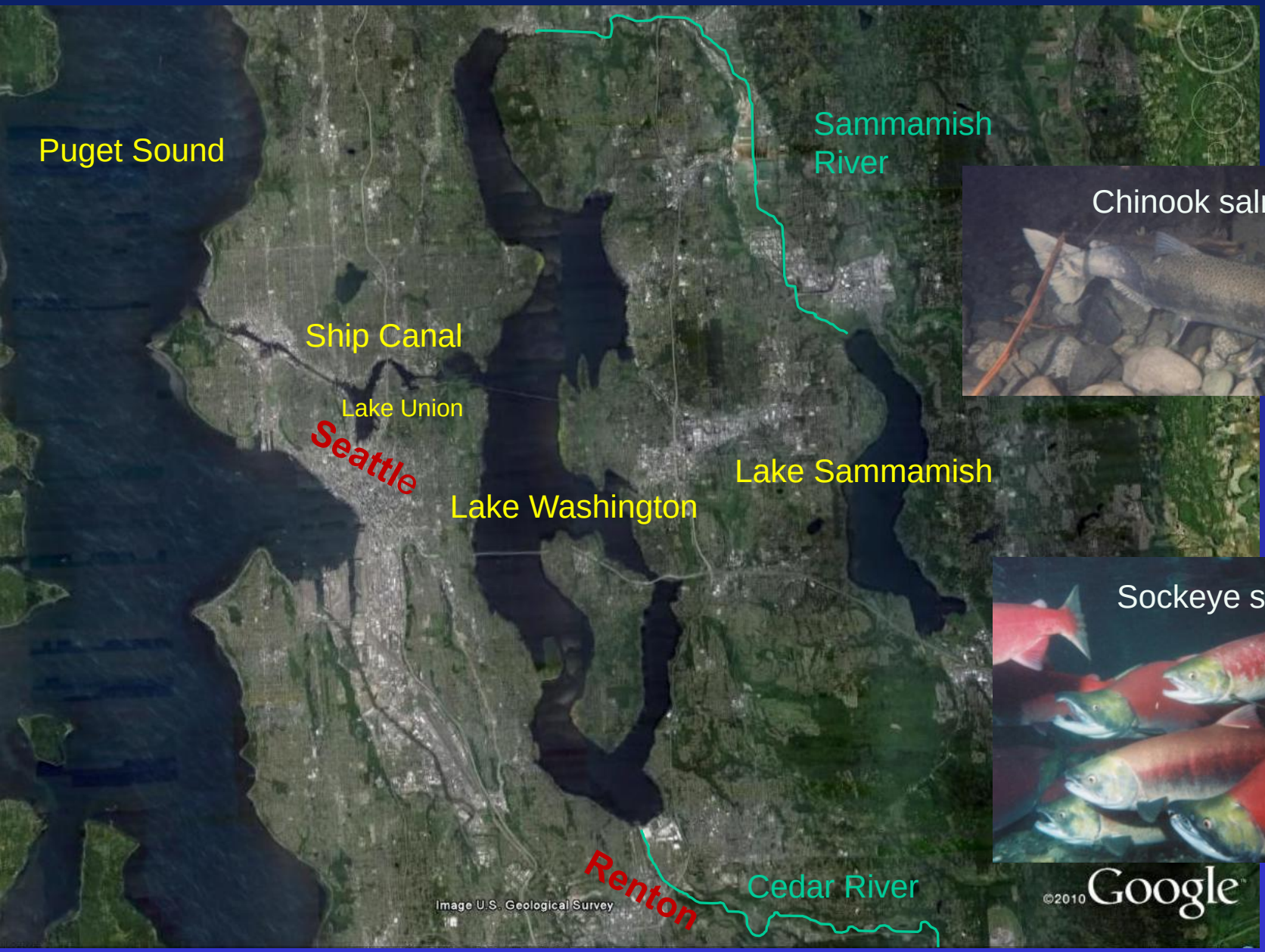
Artificial Lighting



Pacific Northwest

Seattle, Washington – from Lake Union

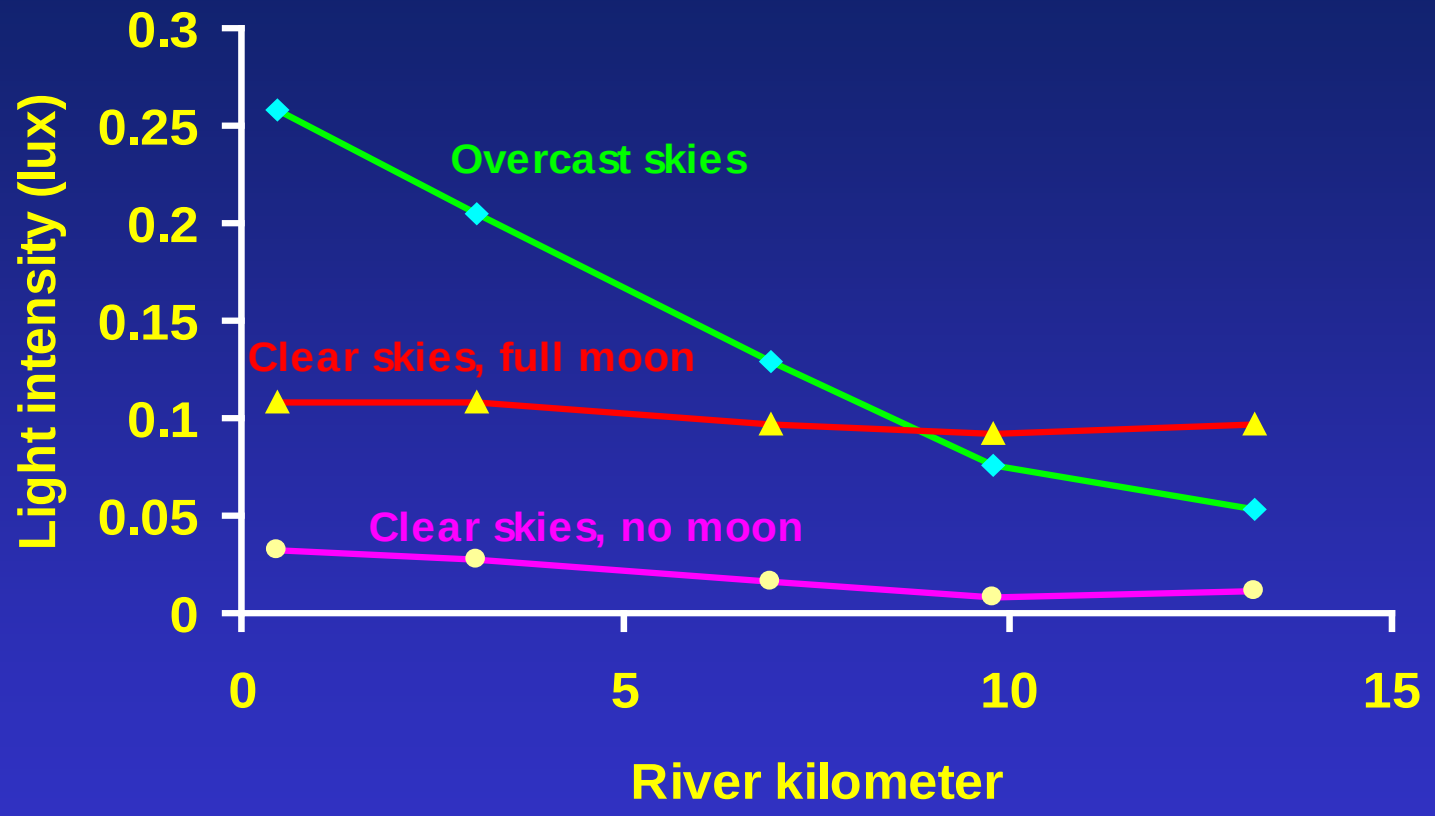
Lake Washington Basin



Light Sources

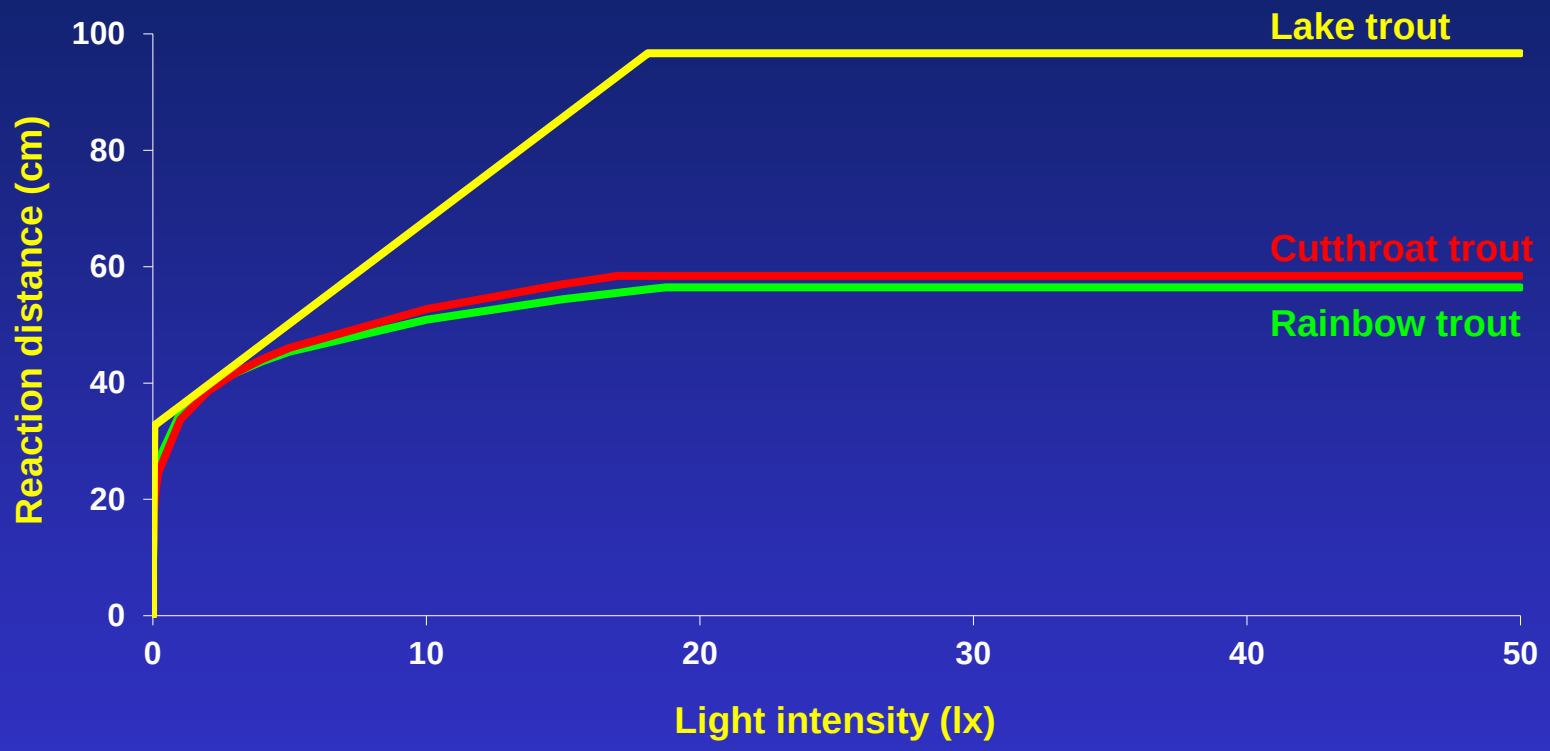
Office: 600 lux
Sunlight: 50,000 lux

A) No direct artificial lighting – Cedar River



B) Direct artificial lighting: 0.2 – 60 lux

Prey Detection of Piscivorous Salmonids

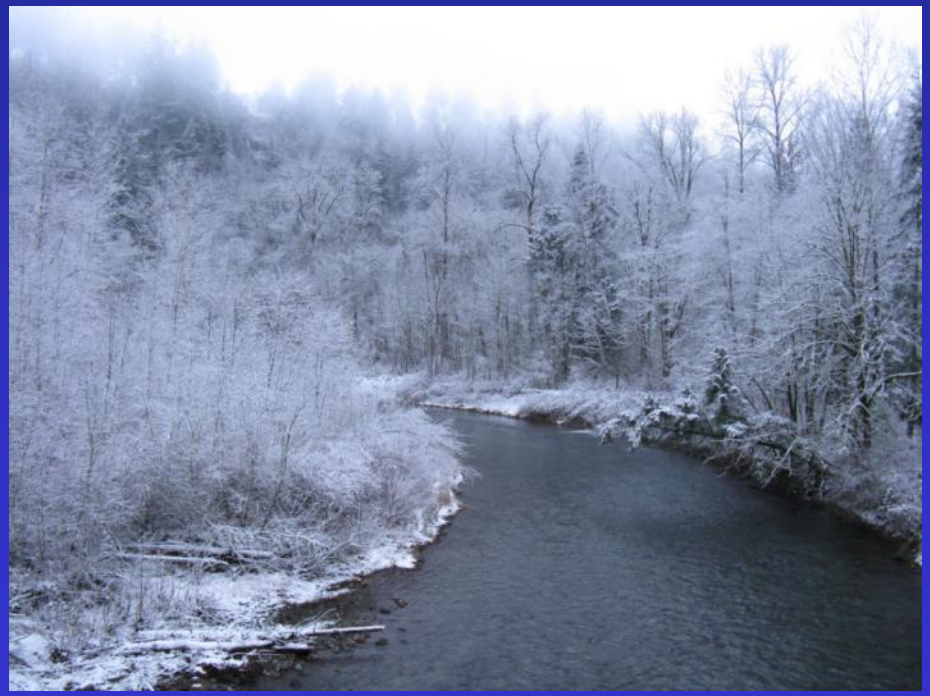


Mazur and Beauchamp. 2003. Visual prey detection among species of piscivorous salmonids. Environmental Biology of Fishes 67:397-405.

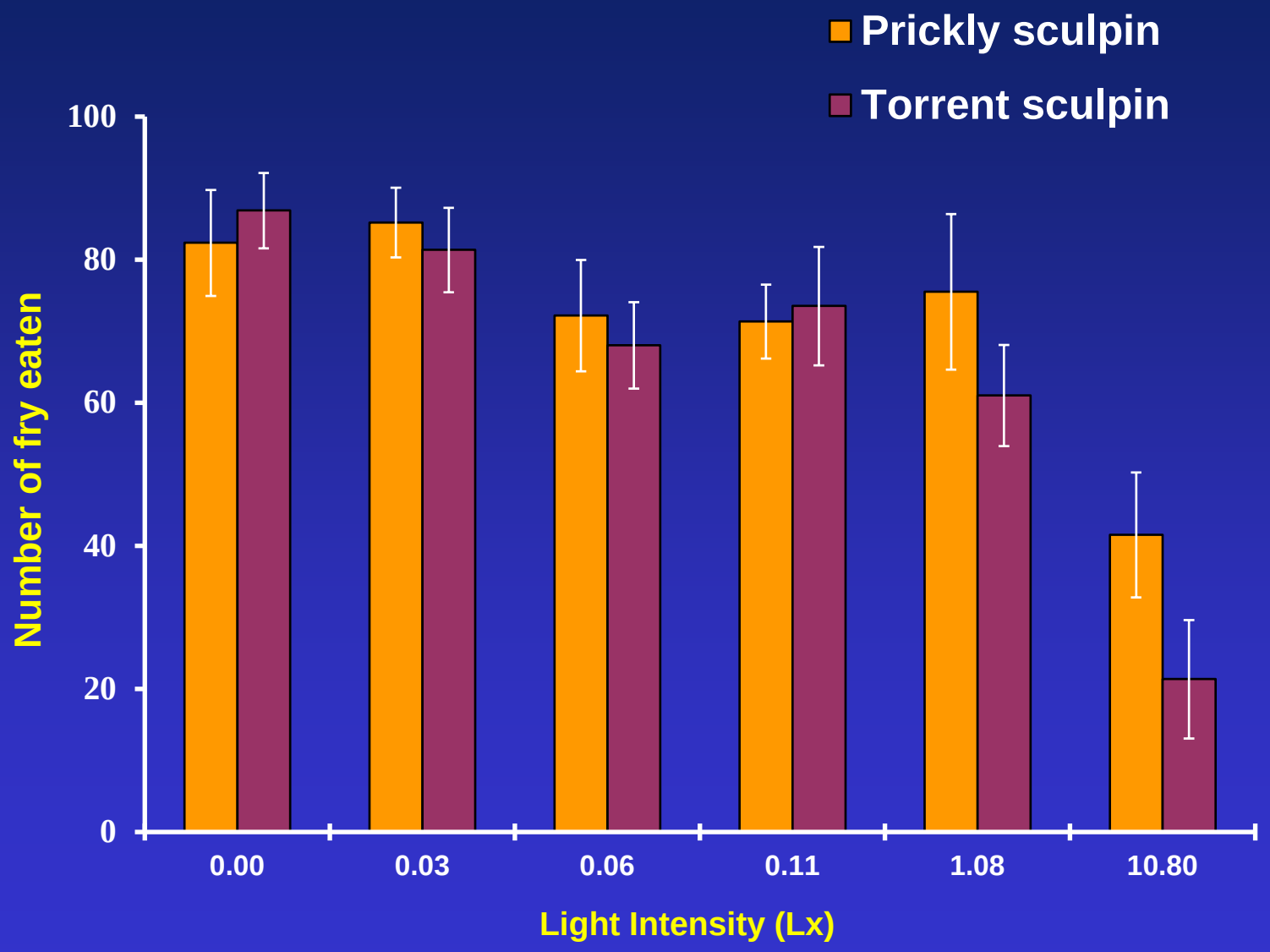
Cedar River

Sockeye salmon fry and Sculpin Study

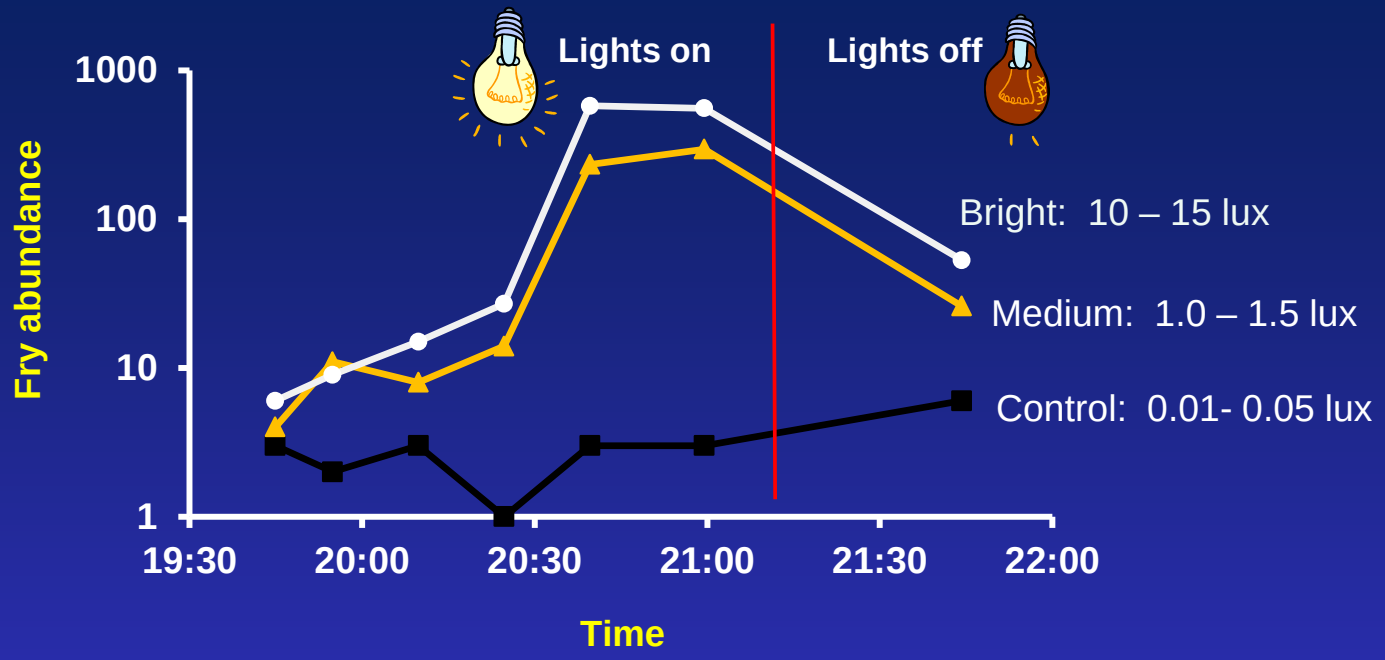
- **Sockeye salmon fry**
  - Migrate at night
  - One or two nights to reach the lake
  - Select mid-channel areas with high velocities
- **Sculpin**
  - Predator of sockeye fry
  - Abundant
  - Easy to work with in lab
  - Sedentary



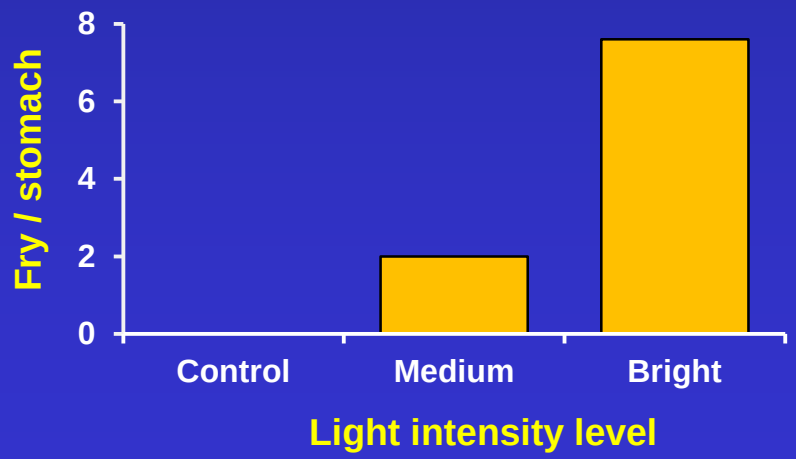
Tank Experiments



Cedar River field experiment - March 1999



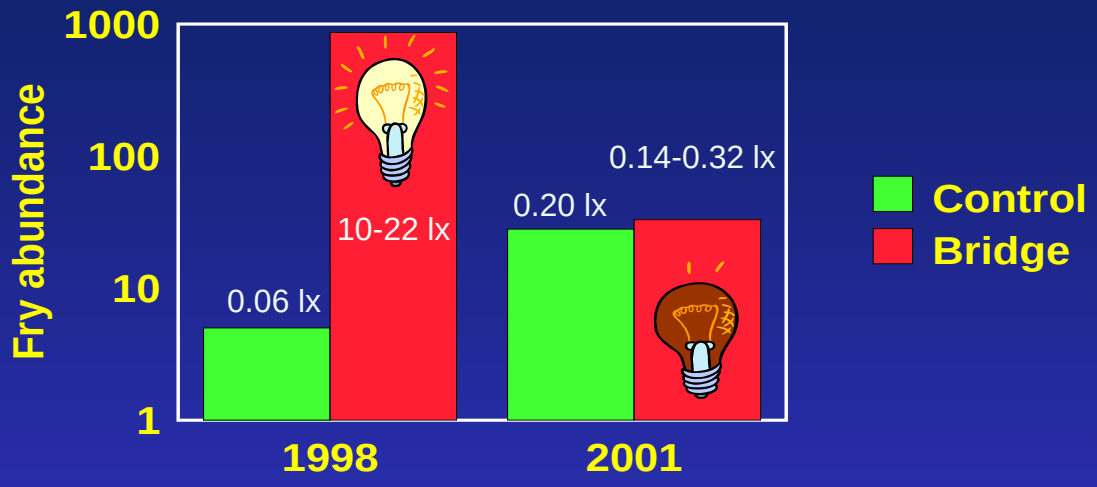
Cottid Predation



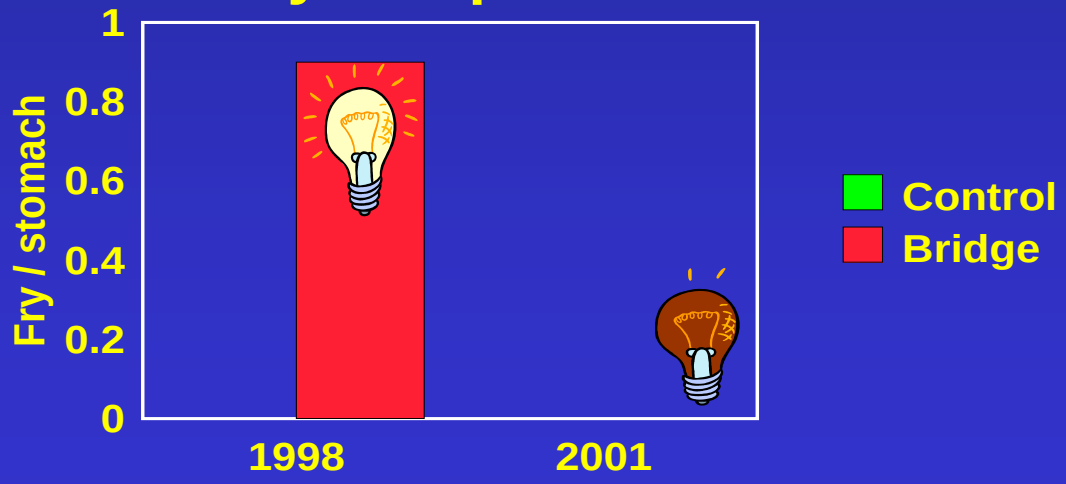
I-405 Bridge Walkway

I-405 Bridge Walkway

Fry abundance

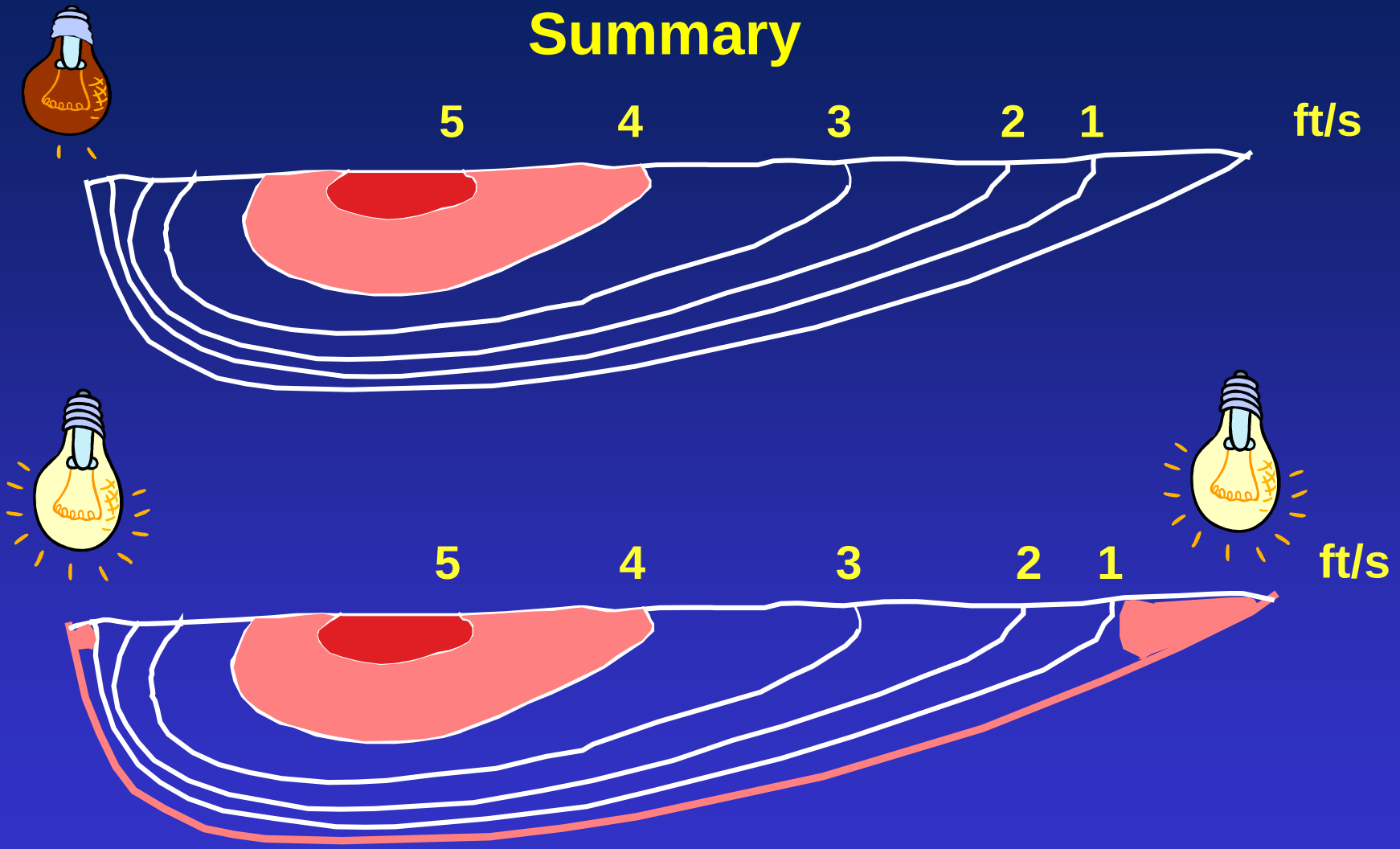


Predation by sculpins



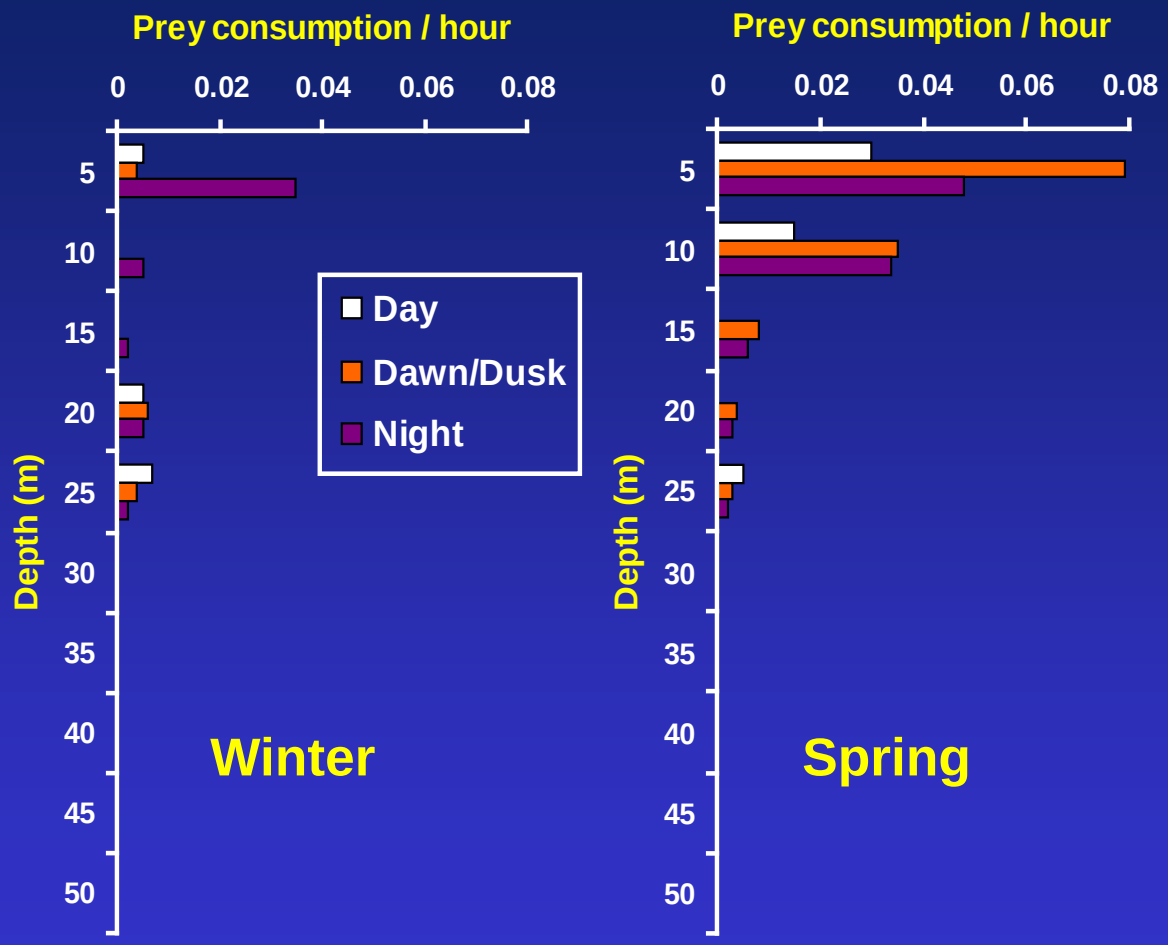
Sockeye salmon fry migration

Summary



Tabor, Brown, and Luiting. 2004. The effect of light on sockeye fry migratory behavior and cottid predation. North American Journal of Fisheries Management 24:128-145.

Cutthroat Trout - Lake Washington
Visual Foraging Model



Mazur and Beauchamp. 2006. Linking piscivory to fish distributions with a visual foraging model. Journal of Fish Biology 69:151-175.

Cedar River/Lake Washington Juvenile Chinook Salmon

- Juveniles rear in Cedar River or Lake Washington
- Inhabit shallow shoreline areas from January to May

Artificial Lighting Experiment

February 23, 2005

Mean length – 49 mm FL

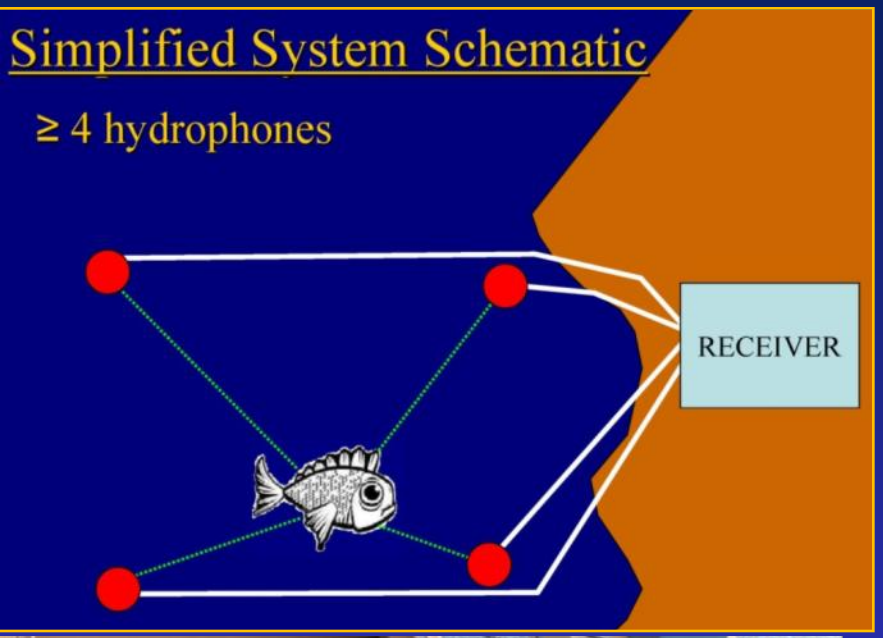
0.2 – 0.3 lux

Mean: 5 – 10 lux
Max: 80 – 100 lux

Chinook Salmon Smolts

- Outmigrate from Lake Washington and through Ship Canal in May-July
- Migrate along shoreline

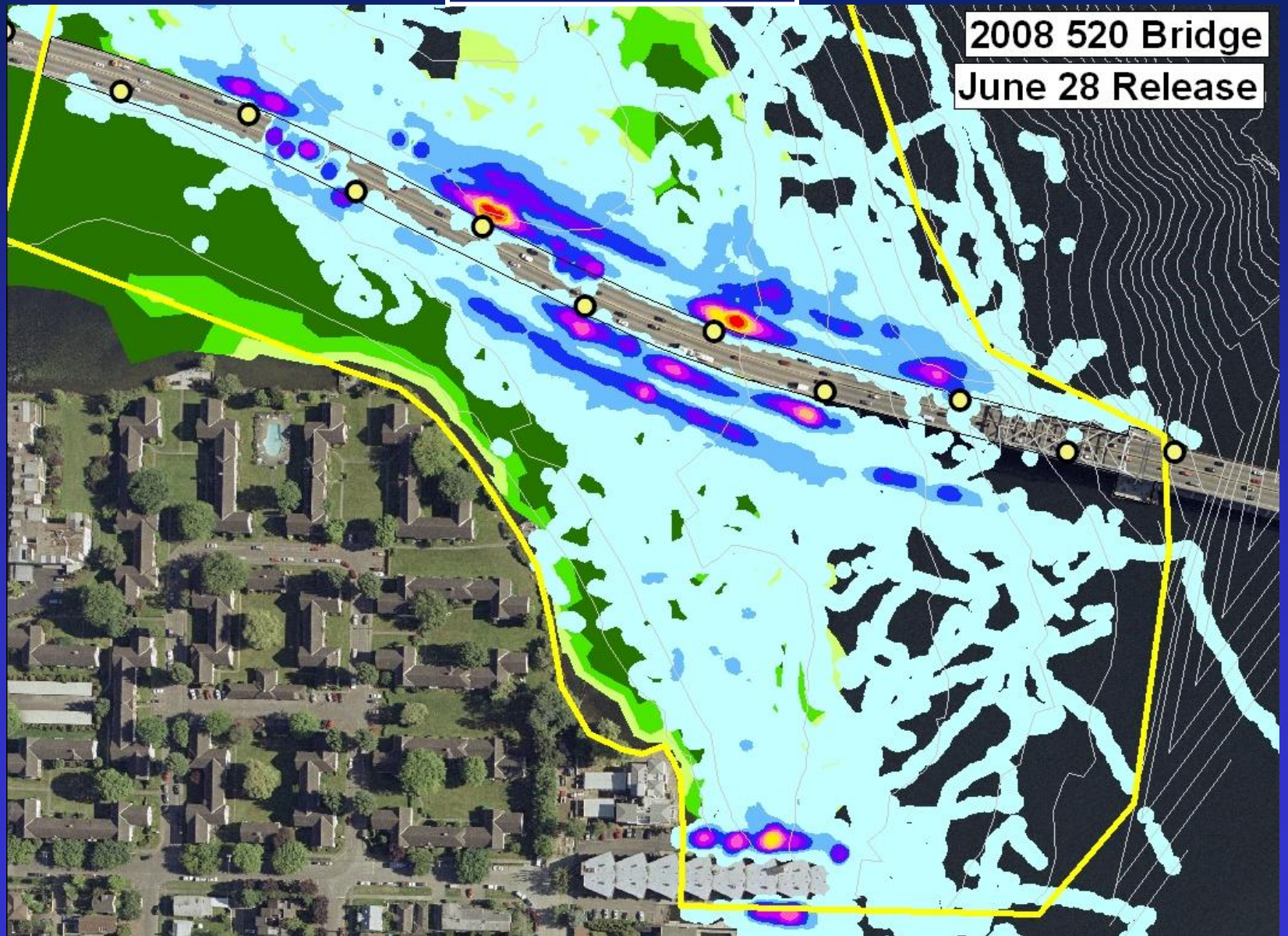
Fine-scale Acoustic Tracking - HTI



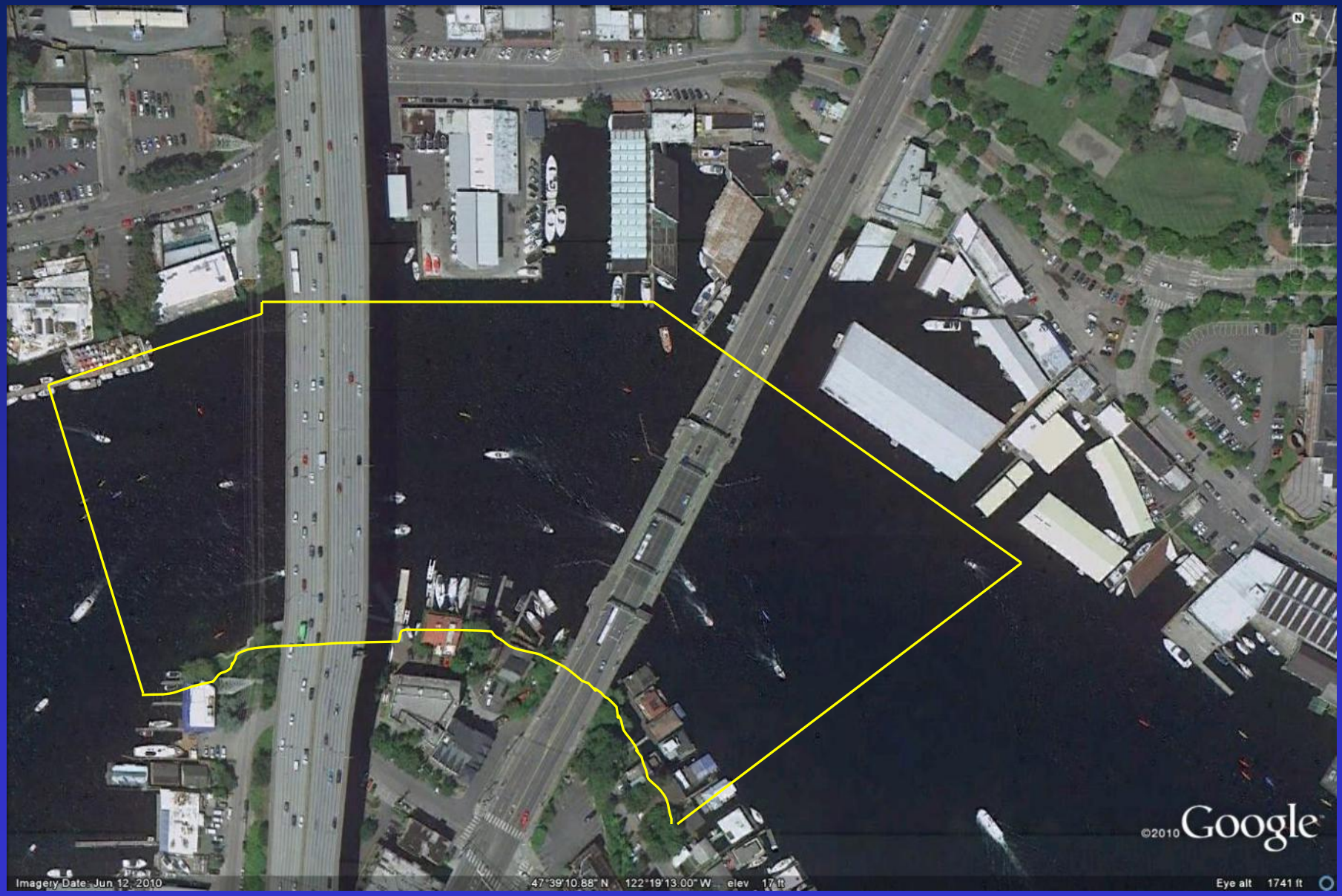
SR 520 Bridge – west end

SR 520 Bridge – west end - June 26th release group

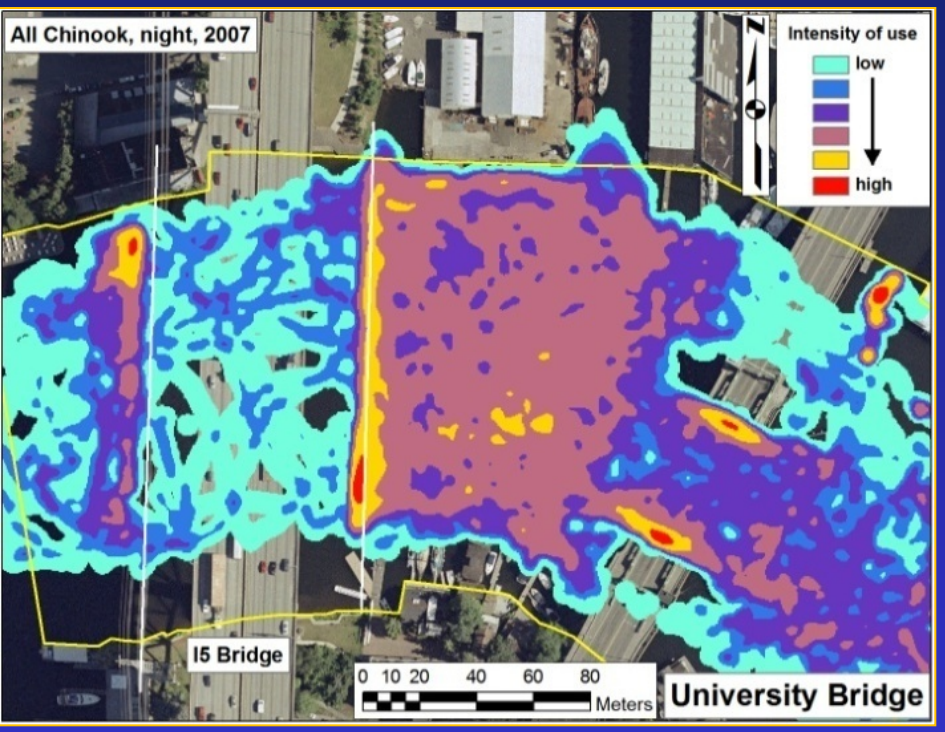
0.2-0.9 lux ambient
2.1-20.0 lux near lights

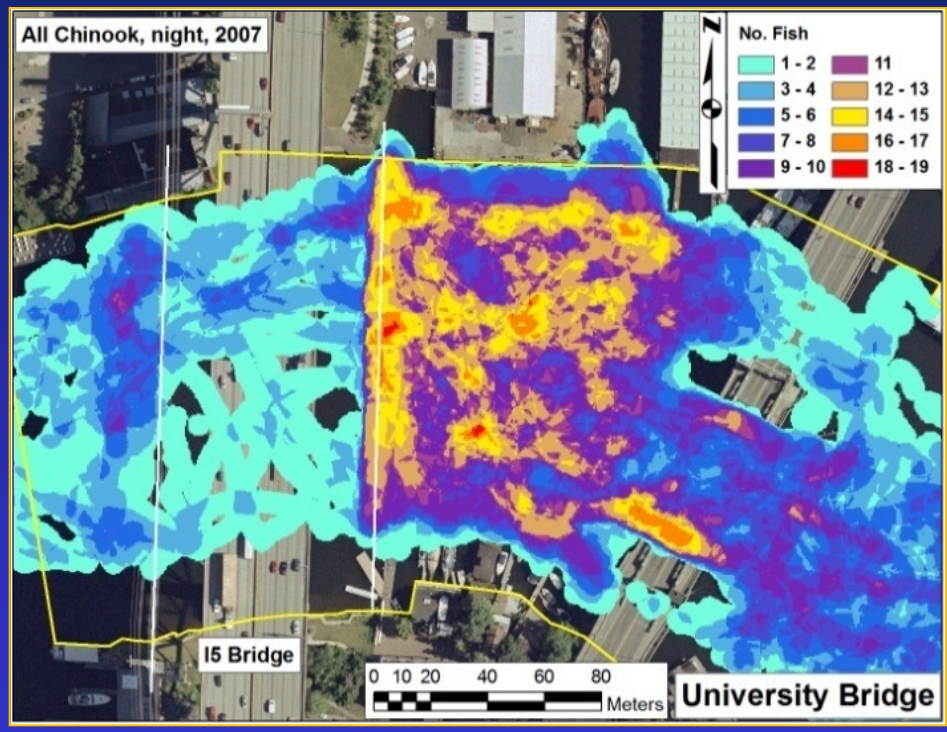


I-5 / University Bridges – Ship Canal



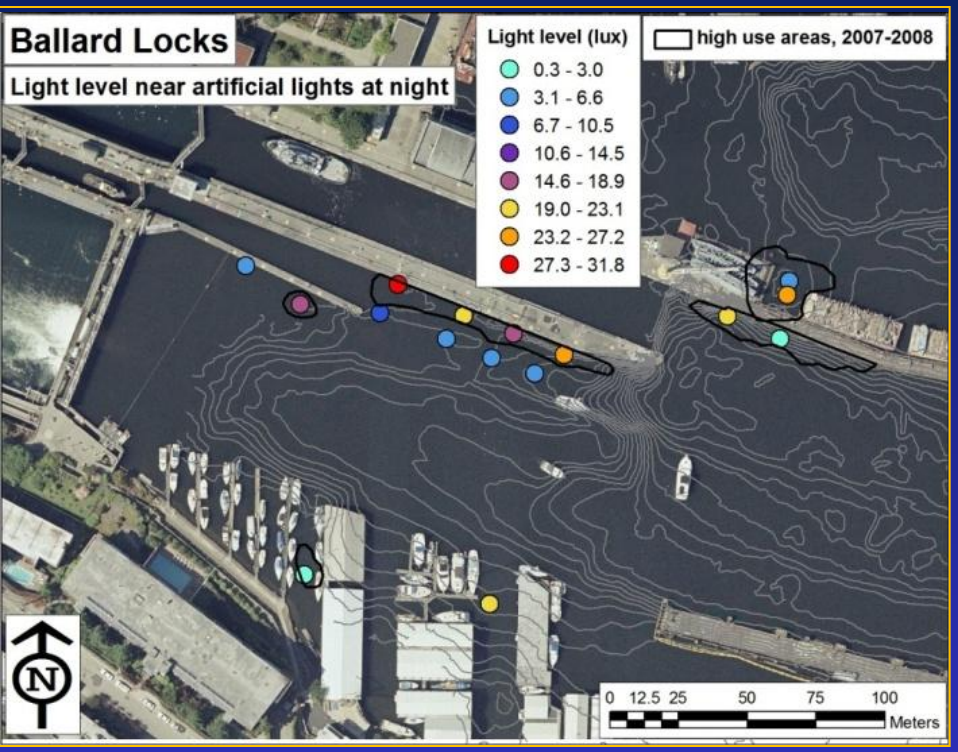
I-5 / University Bridges – Ship Canal
June-July 2007

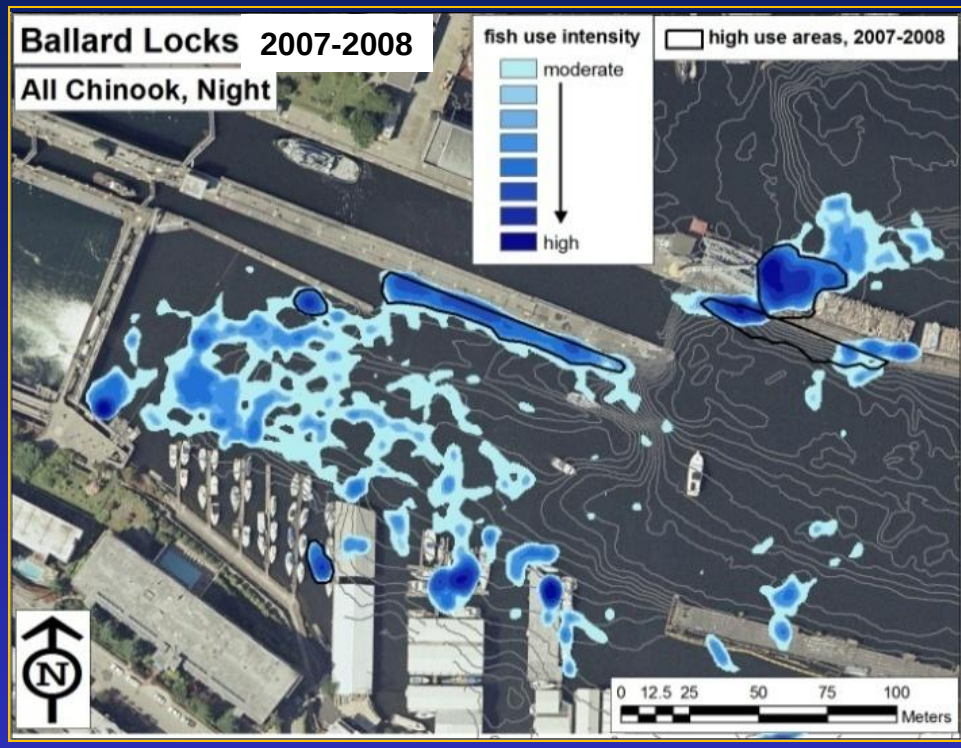




0.2-0.5 lux in shadow
1.6-2.0 lux along light edge

Ballard Locks 2007-2008





0.0-0.2 lux ambient
3-32 lux in heavy Chinook areas

Celedonia et al. Draft report. Movement and habitat use of Chinook salmon smolts at the SR 520 Bridge.

Celedonia et al. Draft report. Movement and habitat use of Chinook salmon smolts in the Ship Canal.

Potential Predators


Great blue heron

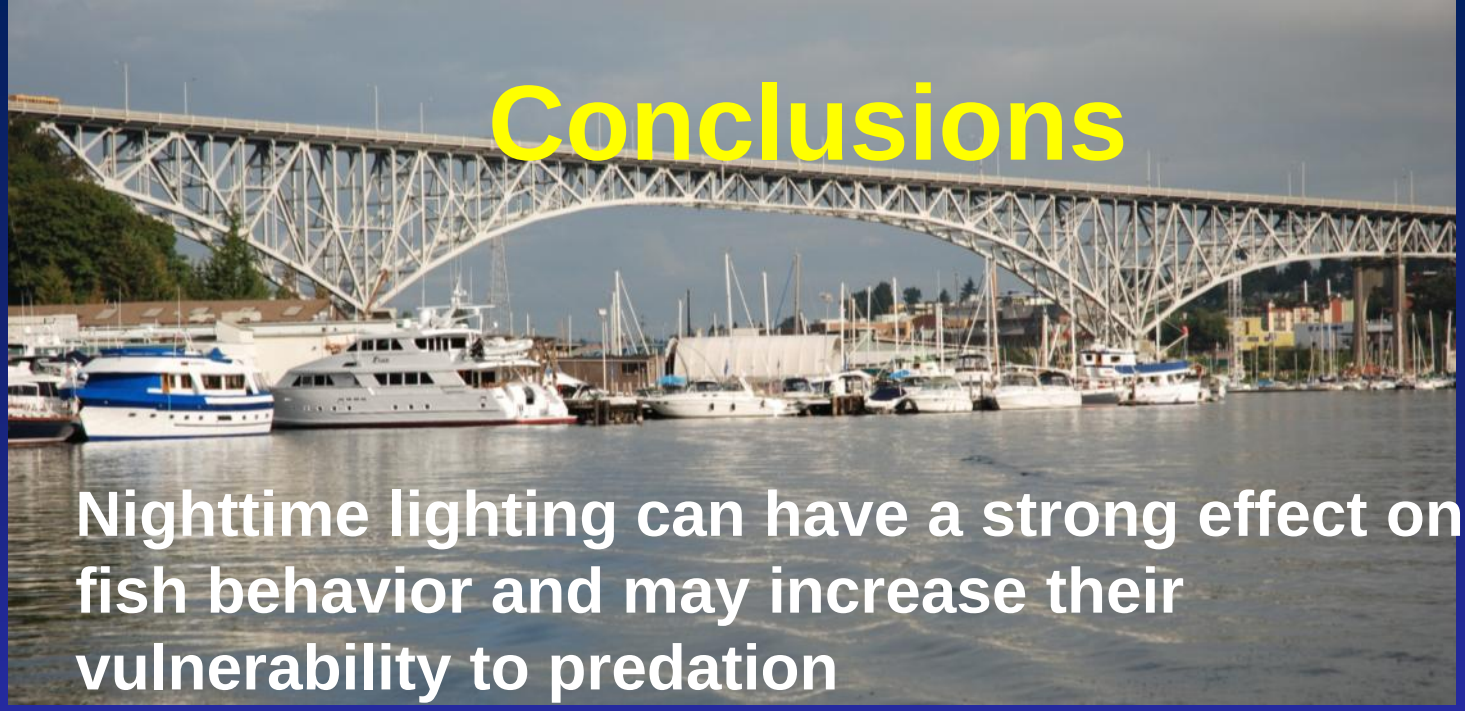

Cutthroat trout

Northern pikeminnow


Western grebe


Smallmouth bass

Conclusions



- Nighttime lighting can have a strong effect on fish behavior and may increase their vulnerability to predation
- Light is an important element of predator - prey relationships
- Assessments on the effects of lighting need to examine the behavior of both predator and prey under natural conditions
- Environmental assessments need to include the effects of artificial lighting

Acknowledgements

Seattle Public Utilities – SPU

US Army Corps of Engineers – COE

City of Renton

Washington Department of Fish and Wildlife – WDFW

King County

University of Washington – UW

Washington State Department of Transportation – WSDOT

Hydroacoustic Technology Inc – HTI

U.S. Geological Survey - USGS

USFWS Employees