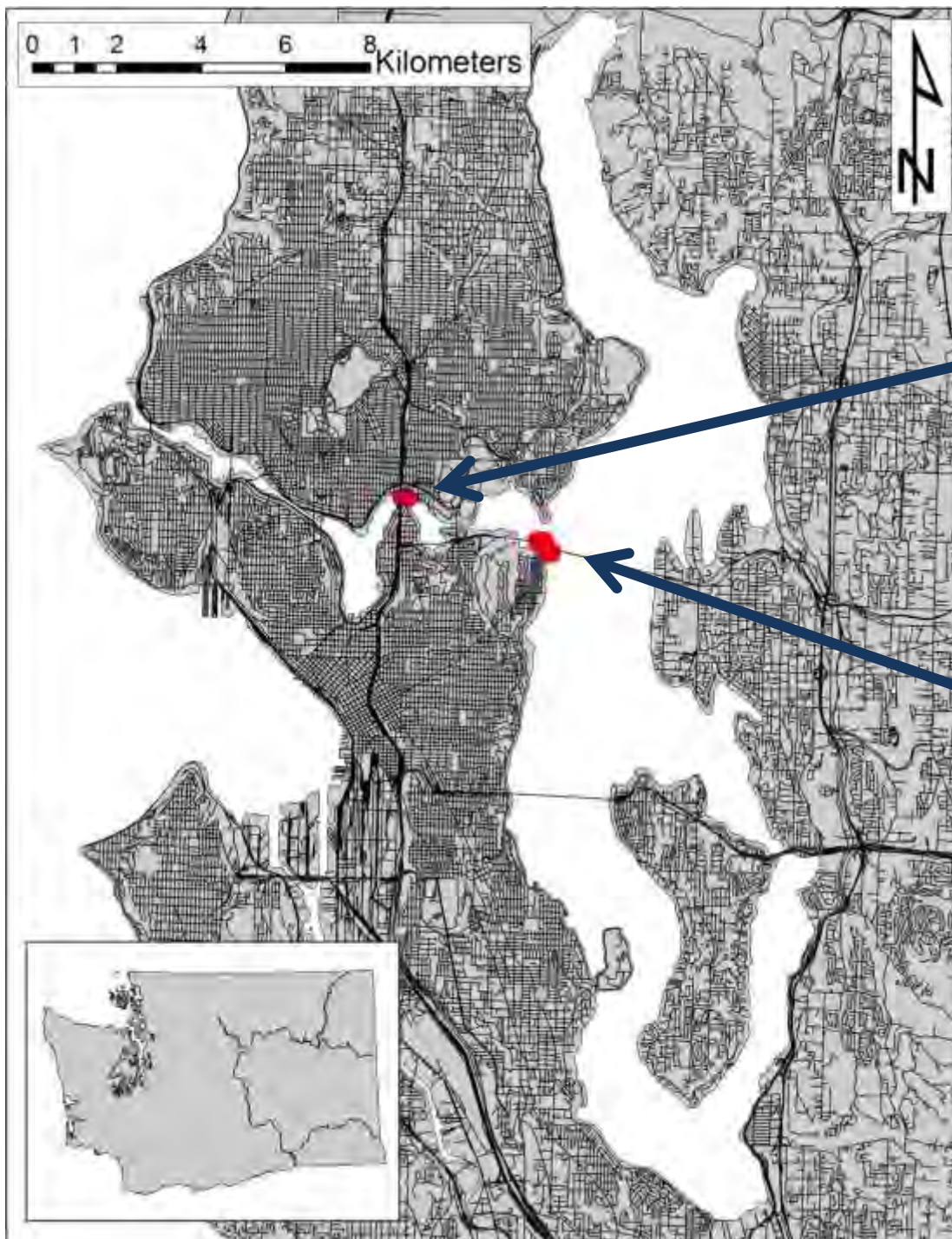


Bright Lights, Big City
Chinook Salmon Smolt Nightlife in Lake Washington
and the Ship Canal

Mark Celedonia and Roger Tabor

Presentation to the WRIA 8 Technical Workshop
November 17, 2015



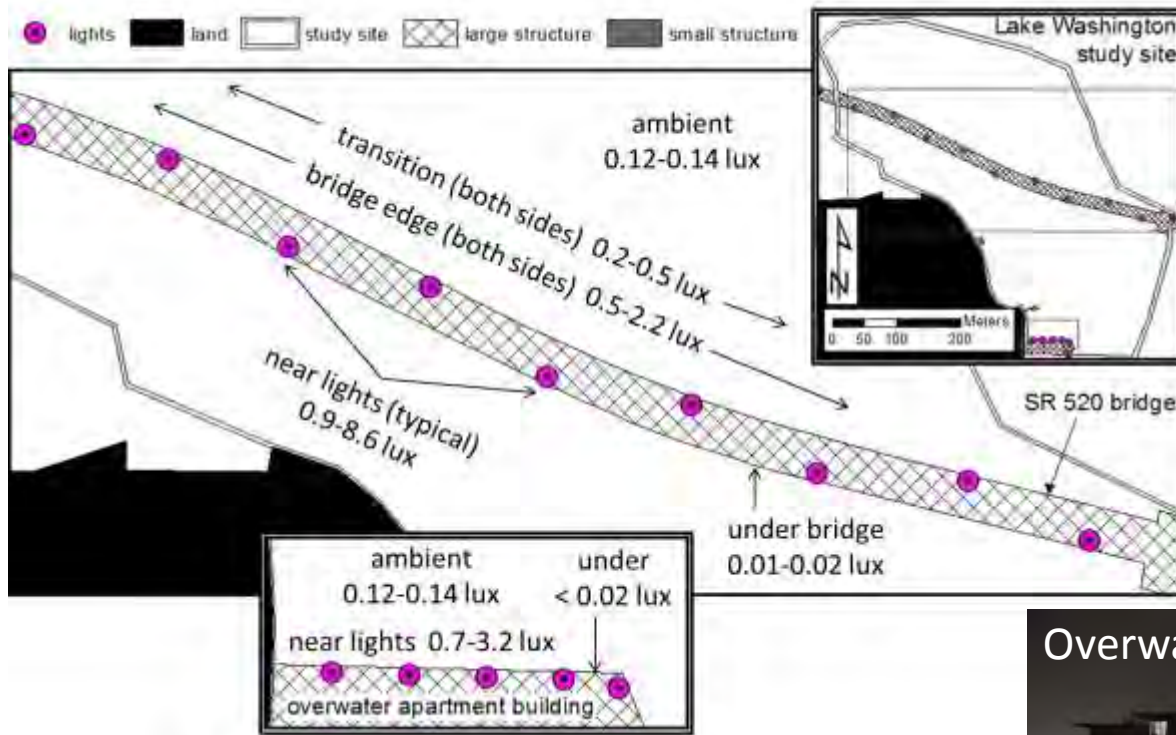
Study sites

15 bridge & University Bridge

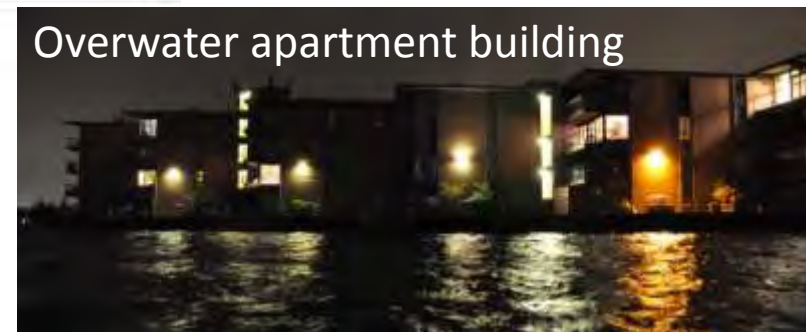
SR 520 bridge

- Fine-scale acoustic tracking (± 1 m resolution)
- 3-second ping rate
- Issaquah Hatchery fish
- Released tagged fish during June - July, 2007 - 2008

SR 520 bridge

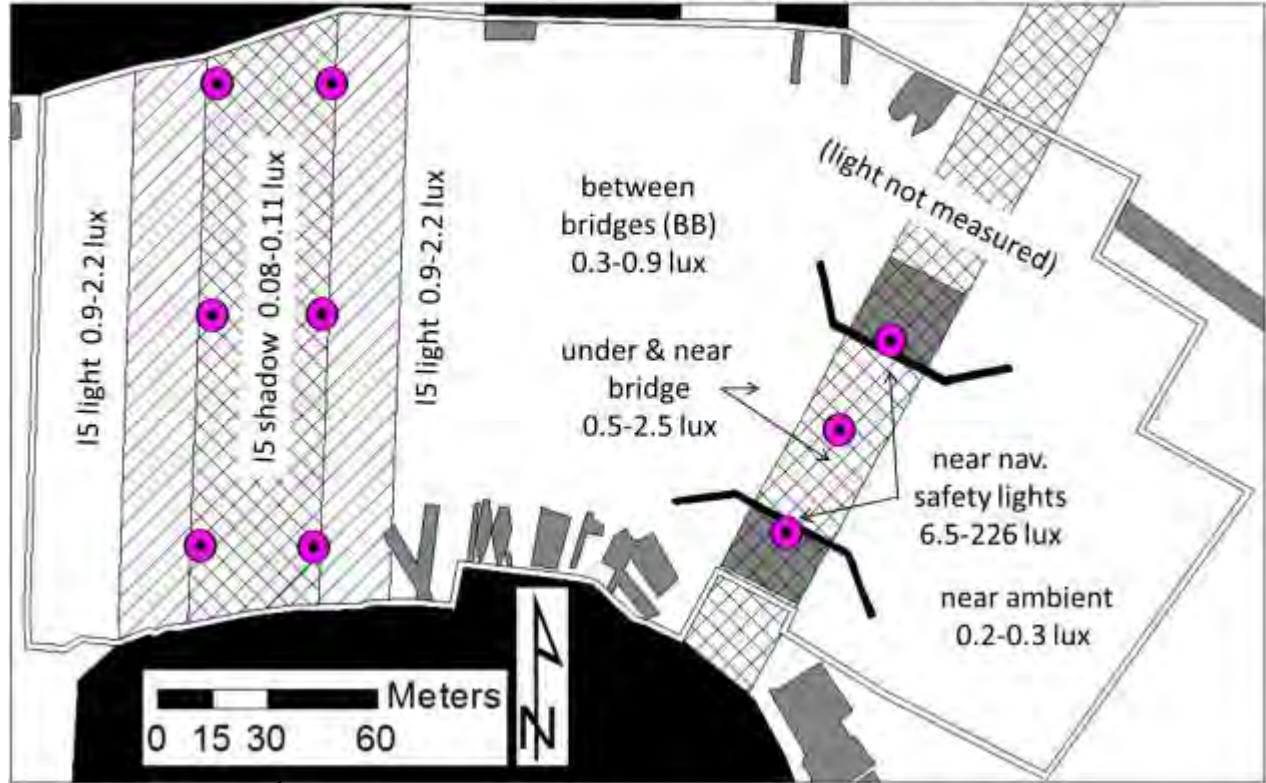
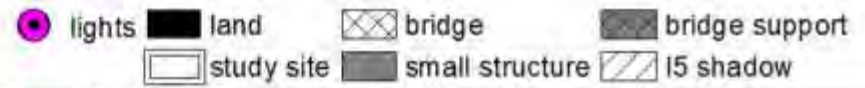


Sodium-type lamps (orange)



Light measurements taken on one night only (mostly cloudy).

15 bridge & University Bridge



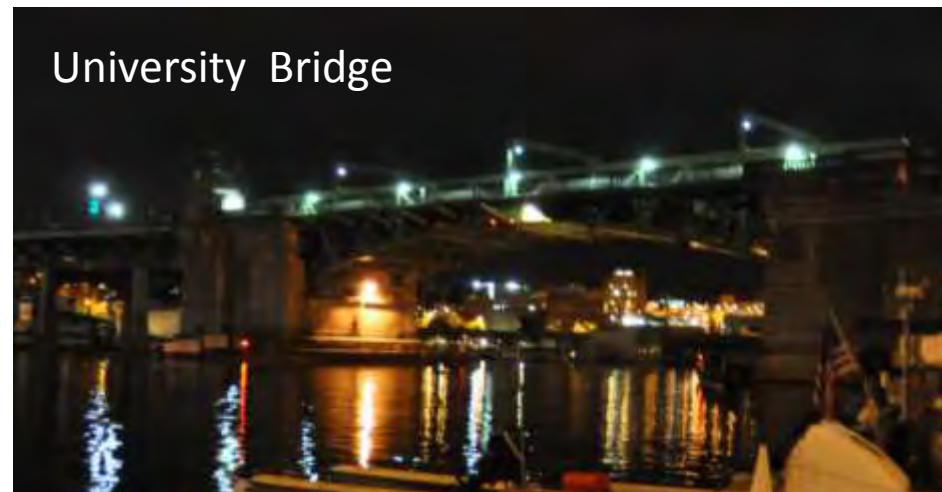
Deck lighting on University Bridge not shown

Sodium-type lamps (orange):

- 15 bridge deck
- Lights under Univ. Bridge

Fluorescent and cool-color emitting lamps:

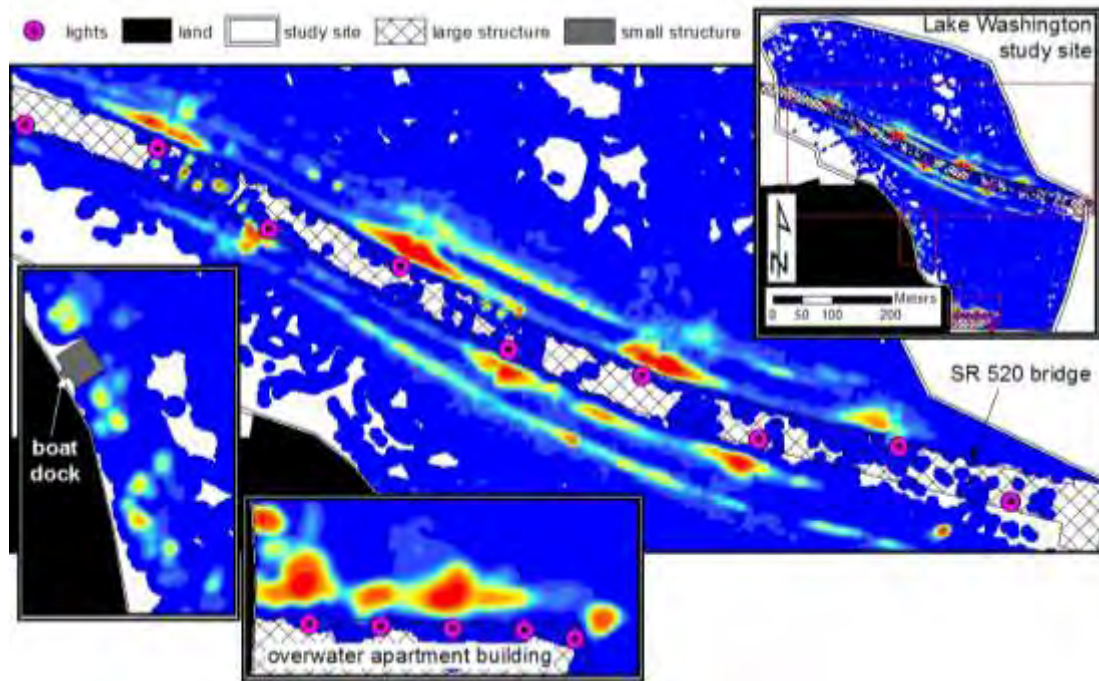
- Univ. Bridge deck
- Boater signage



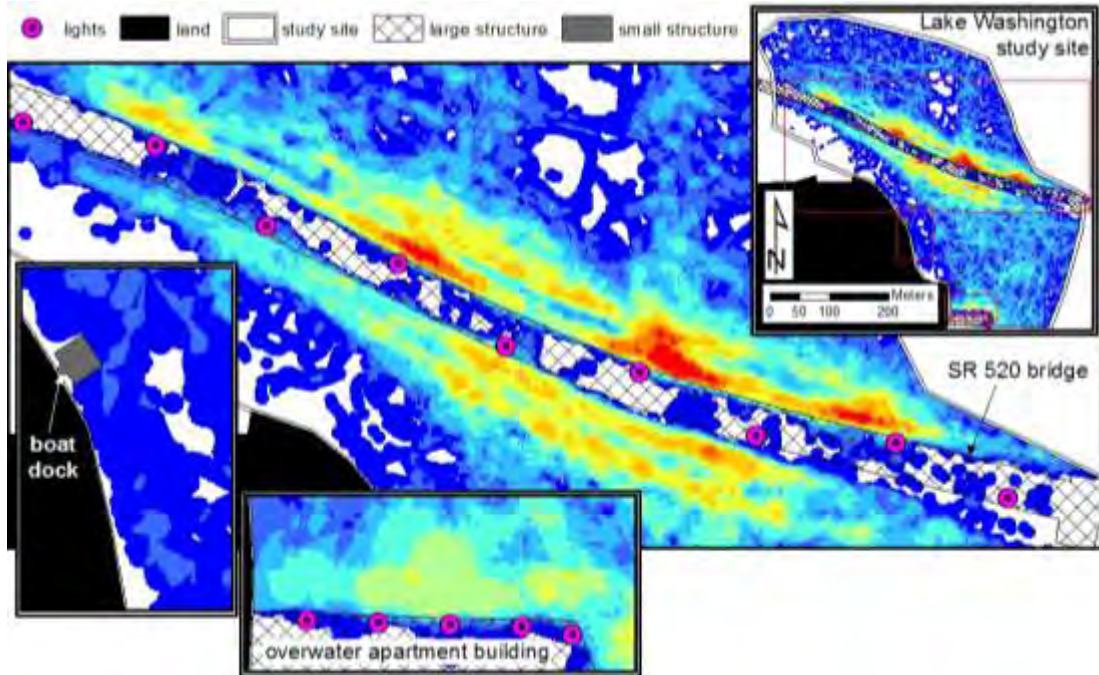
SR 520 bridge

2007 & 2008, n = 78

Density plot
(all fish combined):

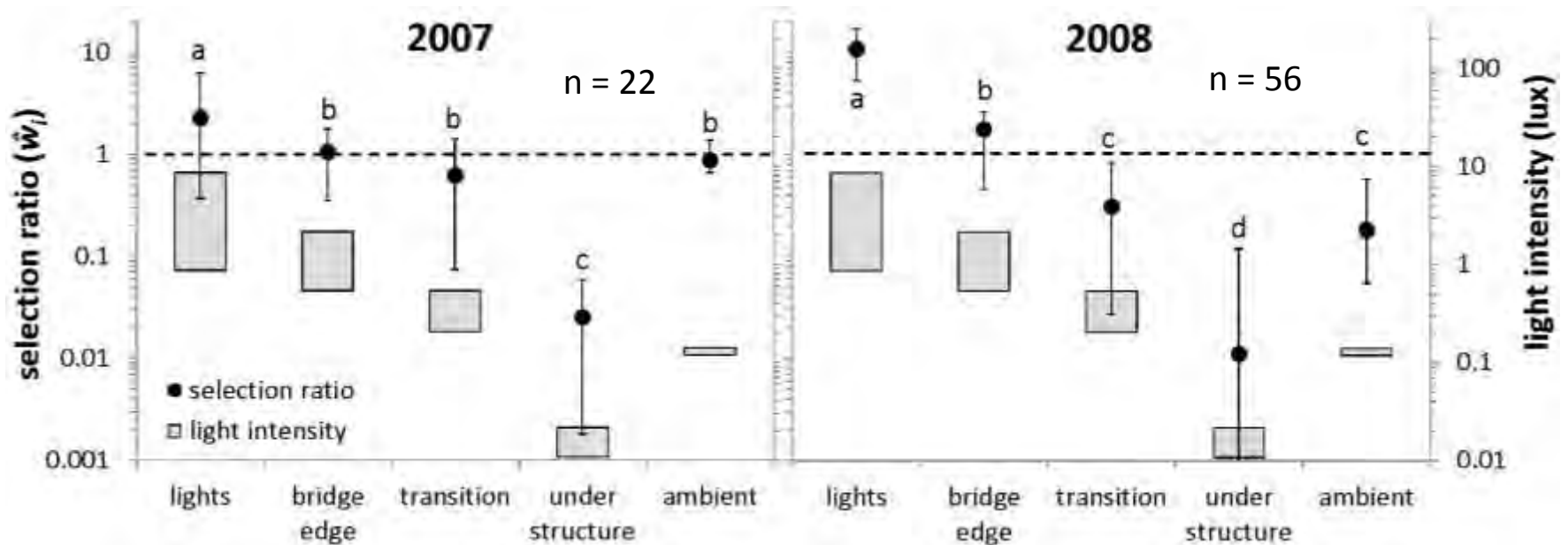


Spatial histogram
(all fish combined):



- Hot spots at lights and along shadow lines.
- Avoidance of shaded areas beneath structures.

Habitat selection at SR 520 bridge site

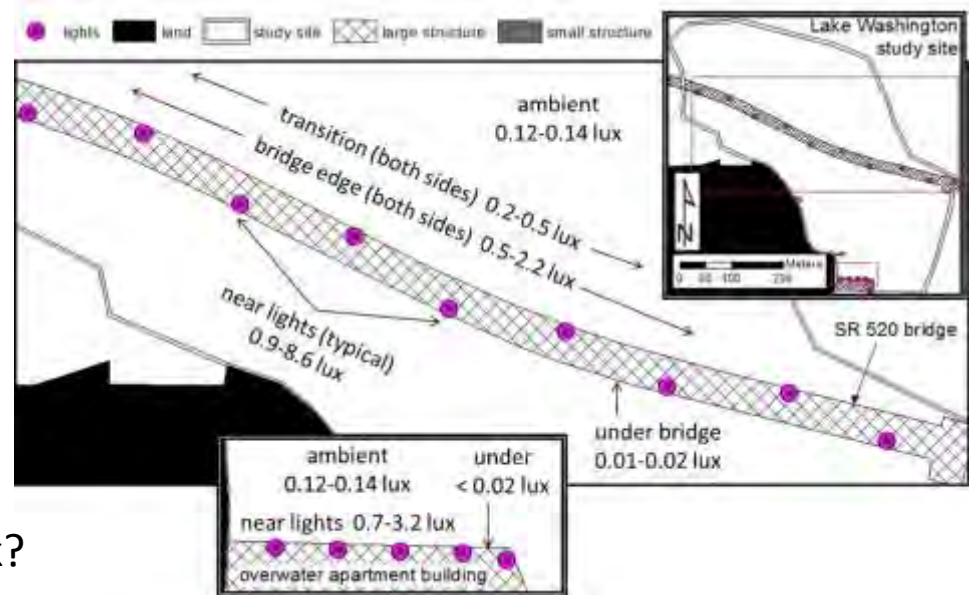


Stronger selection in 2008:

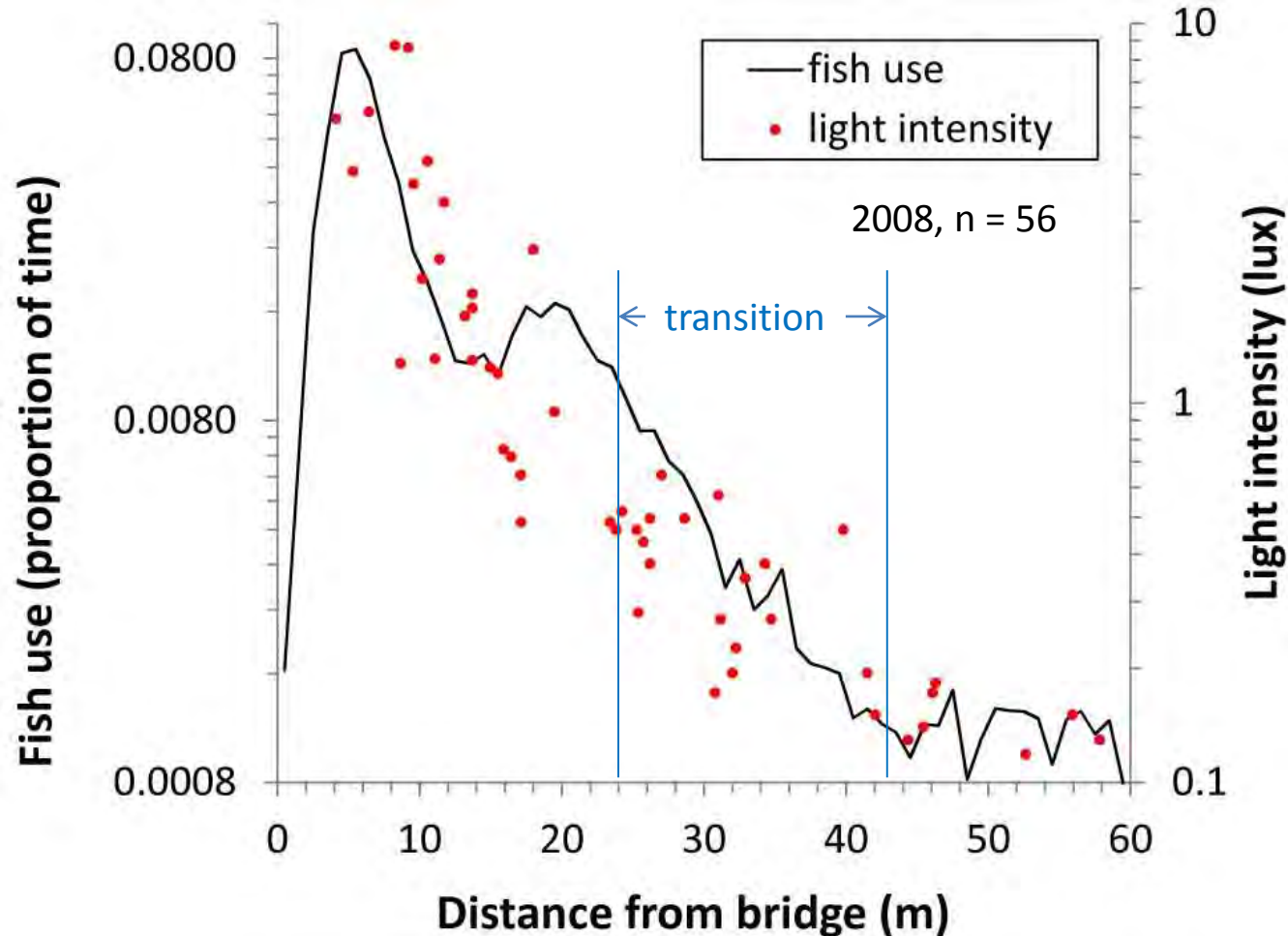
- Higher \hat{w}_i in brightly lit areas
- Avoidance of dimly lit (transition) and ambient areas
- All-night presence under bright lights (vs. ephemeral in 2007)

Possible explanations:

- Warmer in 2007, advanced smoltification?
- More turbid in 2008, less predation risk?



SR 520 bridge (2008)

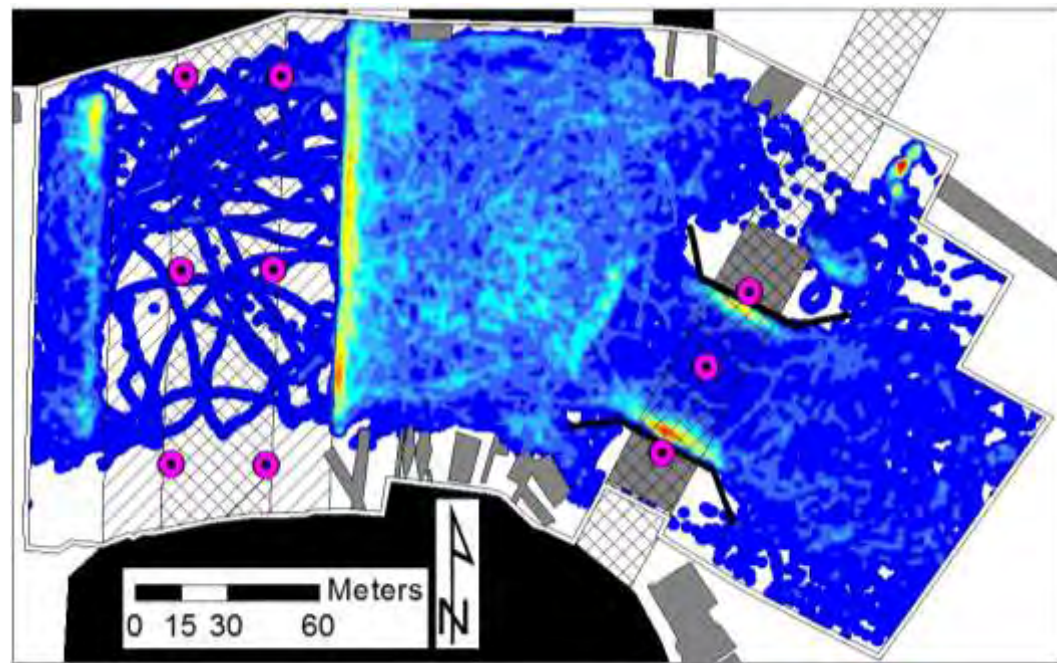


- Influence of lighting extends 43 m from bridge.
- Fish use of lit areas attains minimum at ambient (not evident in habitat selection calcs).
- Note peak at outer shadow line.

I5 & University Bridges

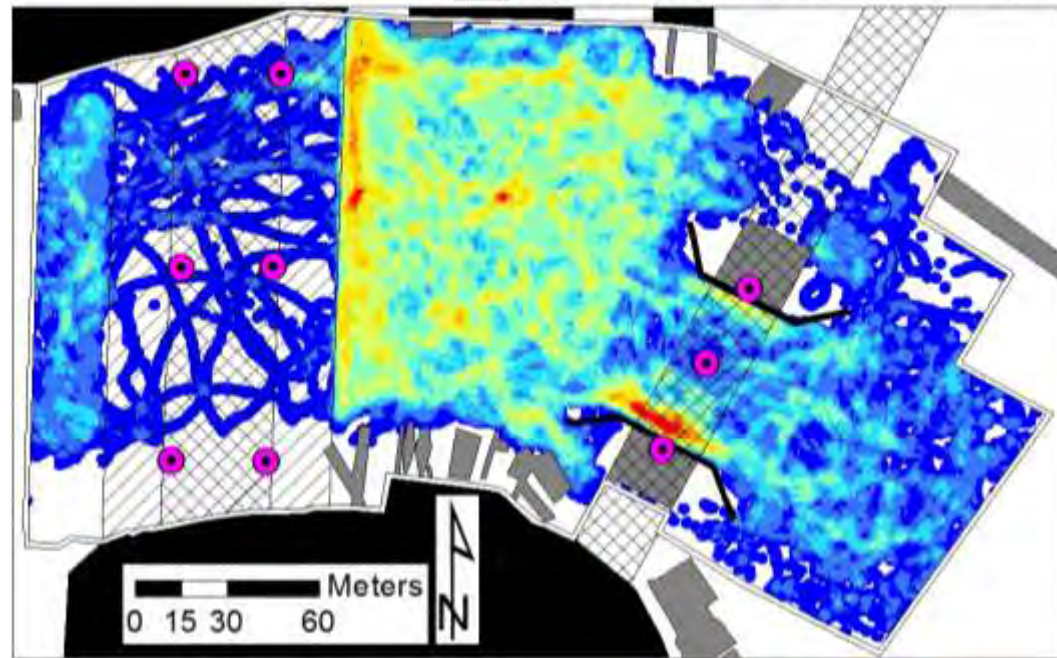
2007 & 2008, n = 38

Density plot
(all fish combined):



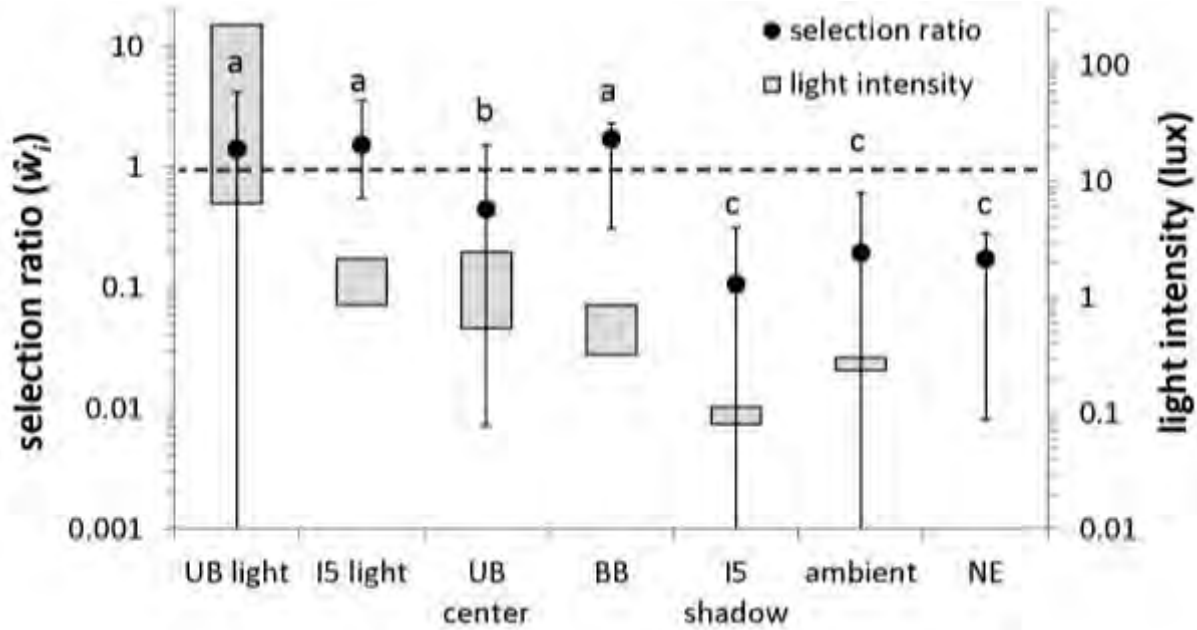
● lights ■ land ▨ bridge ■ bridge support
□ study site ■ small structure ▩ bridge shadow

Spatial histogram
(all fish combined):



- Hot spots at lights and along shadow lines
- Avoidance of moderately lit area beneath University Bridge
- Avoidance of I5 bridge shadow

Habitat selection at I5 & University Bridges

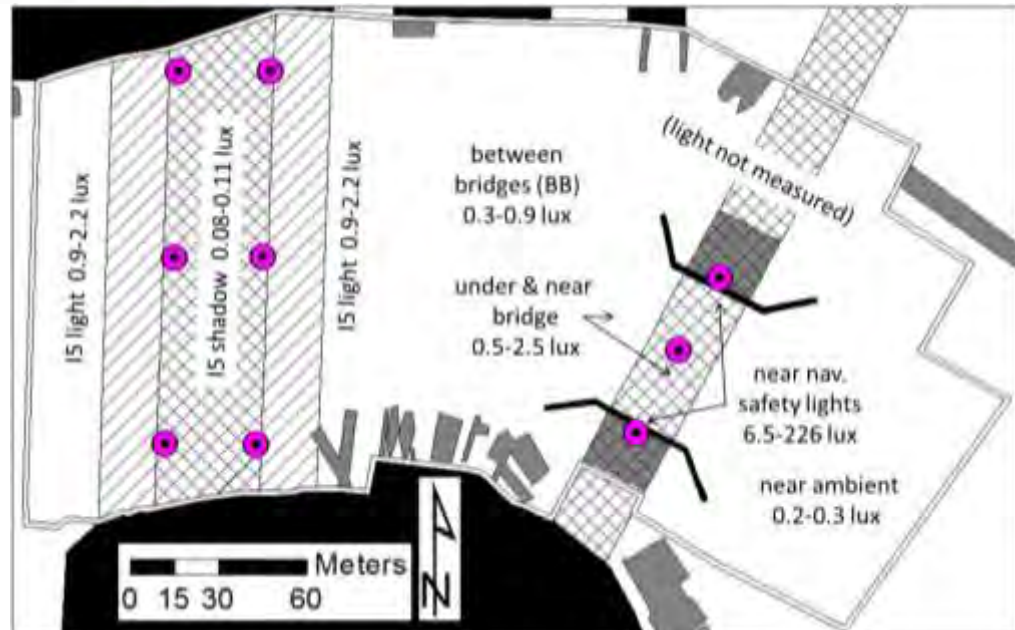


2007, n = 31
2008, n = 7

Selection for lit areas above ambient, regardless of intensity (BB = UB light)

Lower selection for moderately lit area near University Bridge

- Type of light?



Attraction to light and predation risk

North American Journal of Fisheries Management 24:128–145, 2004
© Copyright by the American Fisheries Society 2004

The Effect of Light Intensity on Sockeye Salmon Fry Migratory Behavior and Predation by Cottids in the Cedar River, Washington

ROGER A. TABOR*

*U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office,
510 Desmond Drive Southeast, Suite 102, Lacey, Washington 98503, USA*

GAYLE S. BROWN¹

*U.S. Geological Survey, Western Fisheries Research Center,
6505 65th Street, Seattle, Washington 98115, USA*

VICTORIA T. LUITING²

*U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office,
510 Desmond Drive Southeast, Suite 102, Lacey, Washington 98503, USA*

Despite suboptimal lighting for predators, concentration of juvenile fish under artificial lights can increase predation rate.

Fish are not the only predators that may seek to capitalize on forage opportunities under lights.

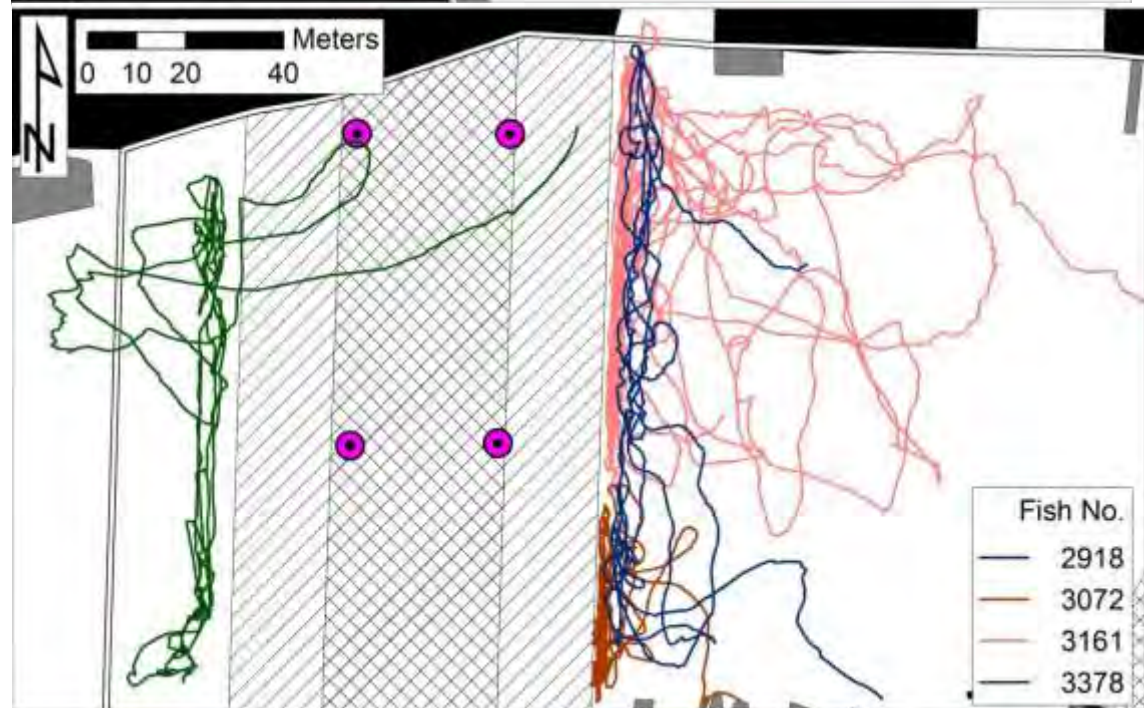
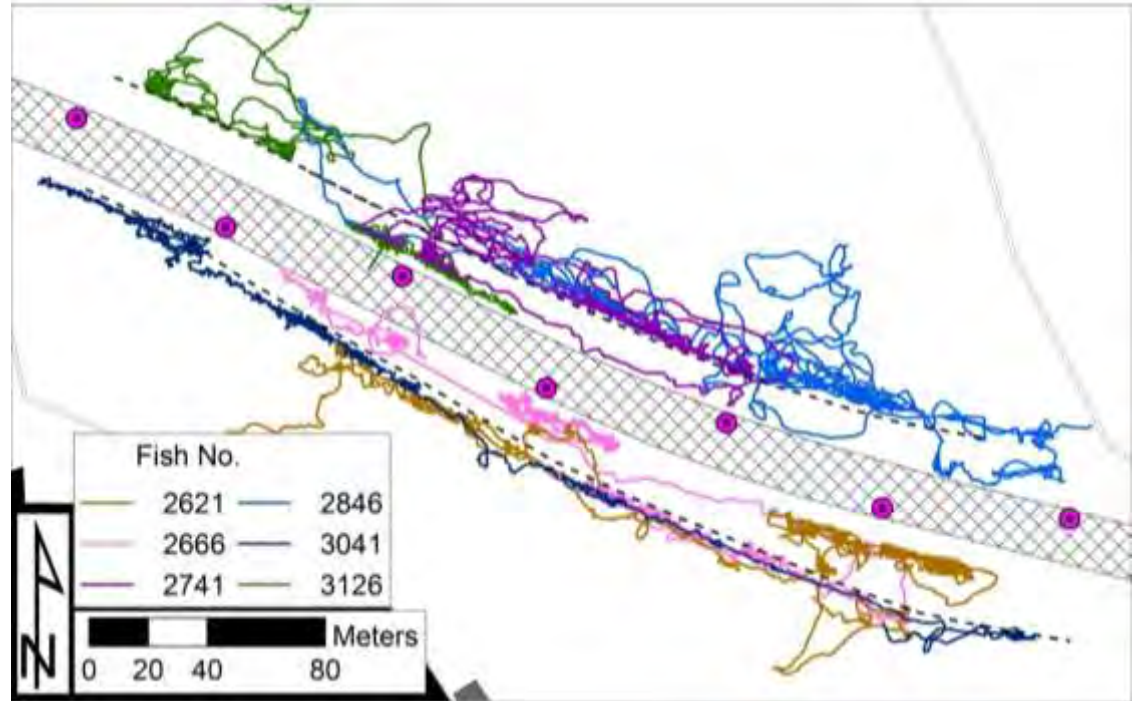
To what extent to these effect Chinook?



Orienting along shadow lines

Implications:

- Shadow as source of cover?
- As ambush site?

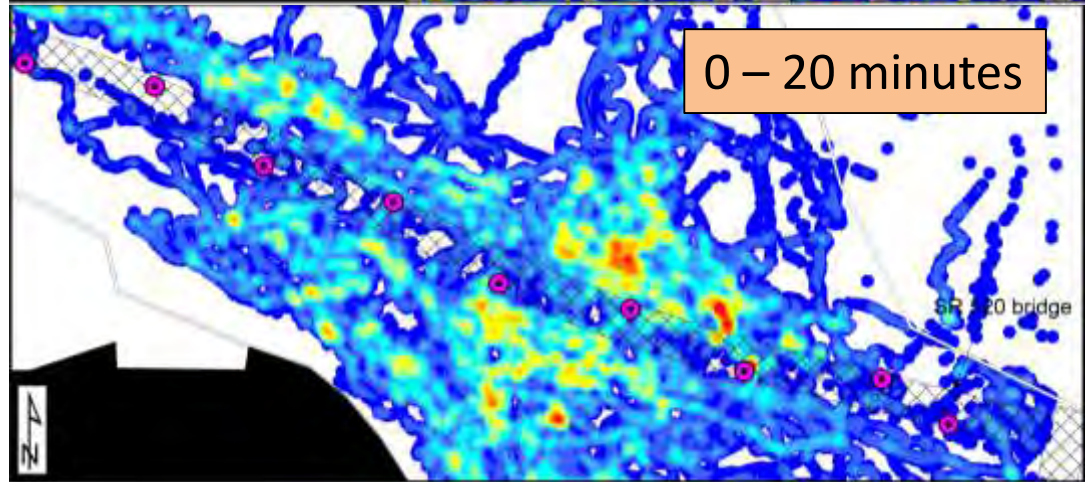
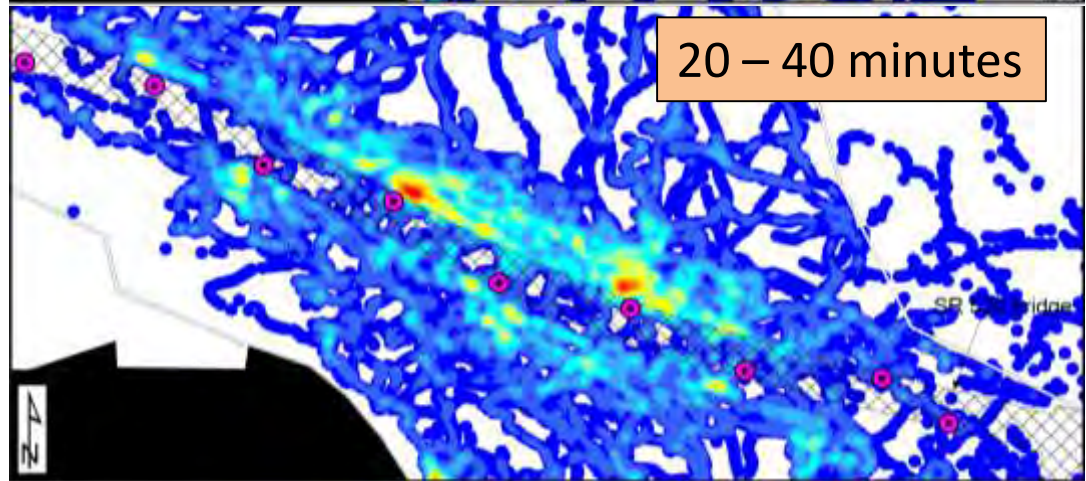
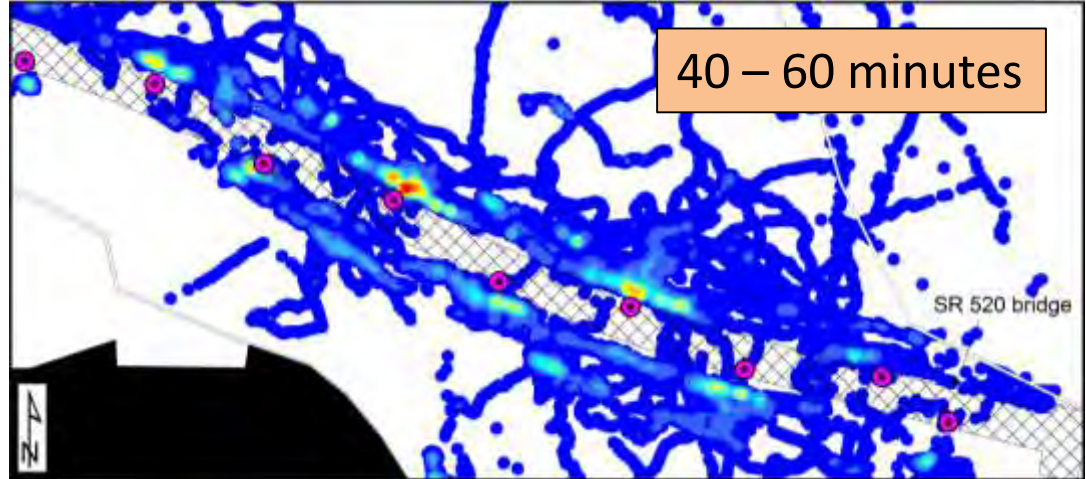


When does attraction to artificial light start and end? (relative to sunrise and sunset)

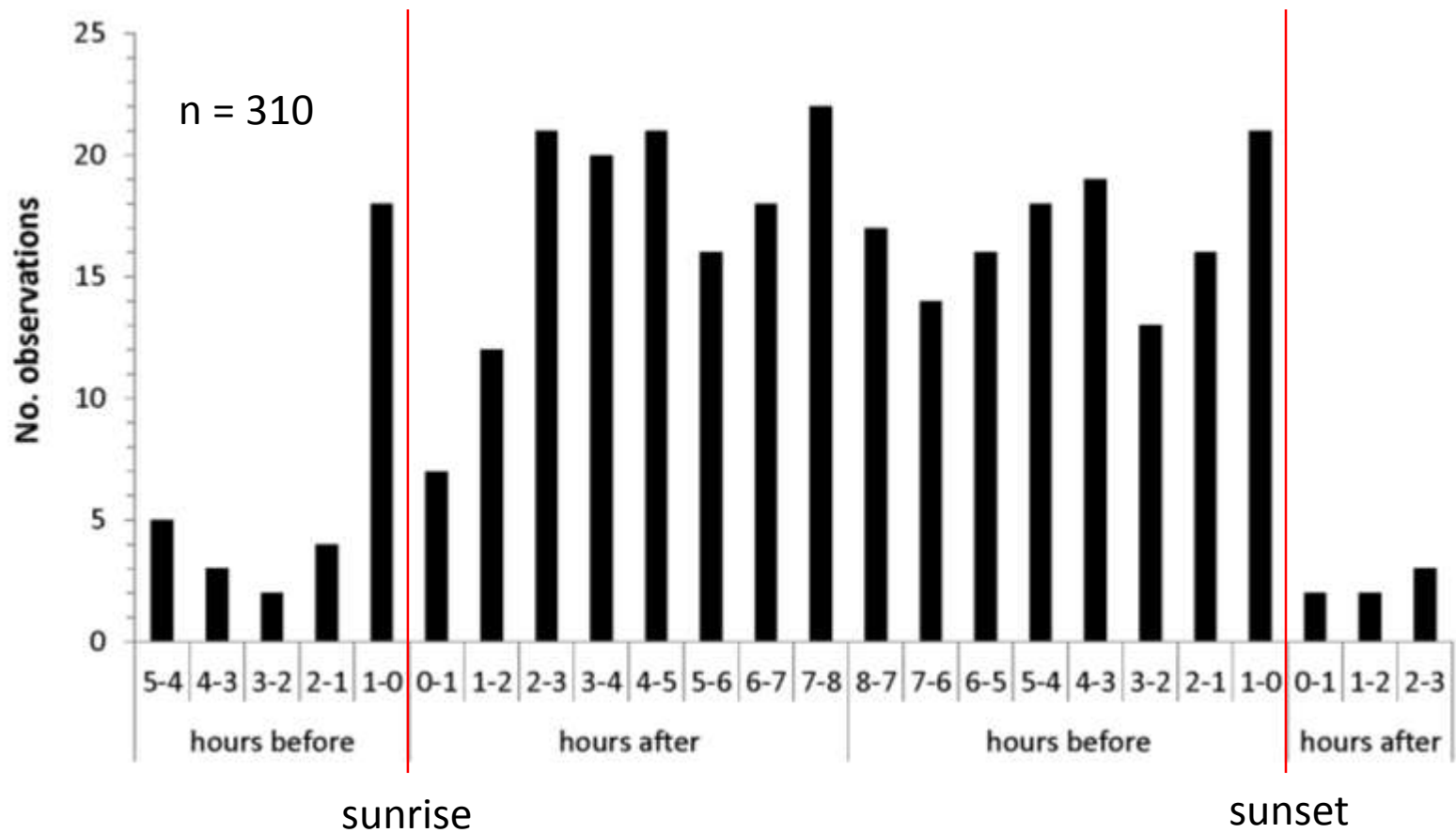
Minutes before sunrise:

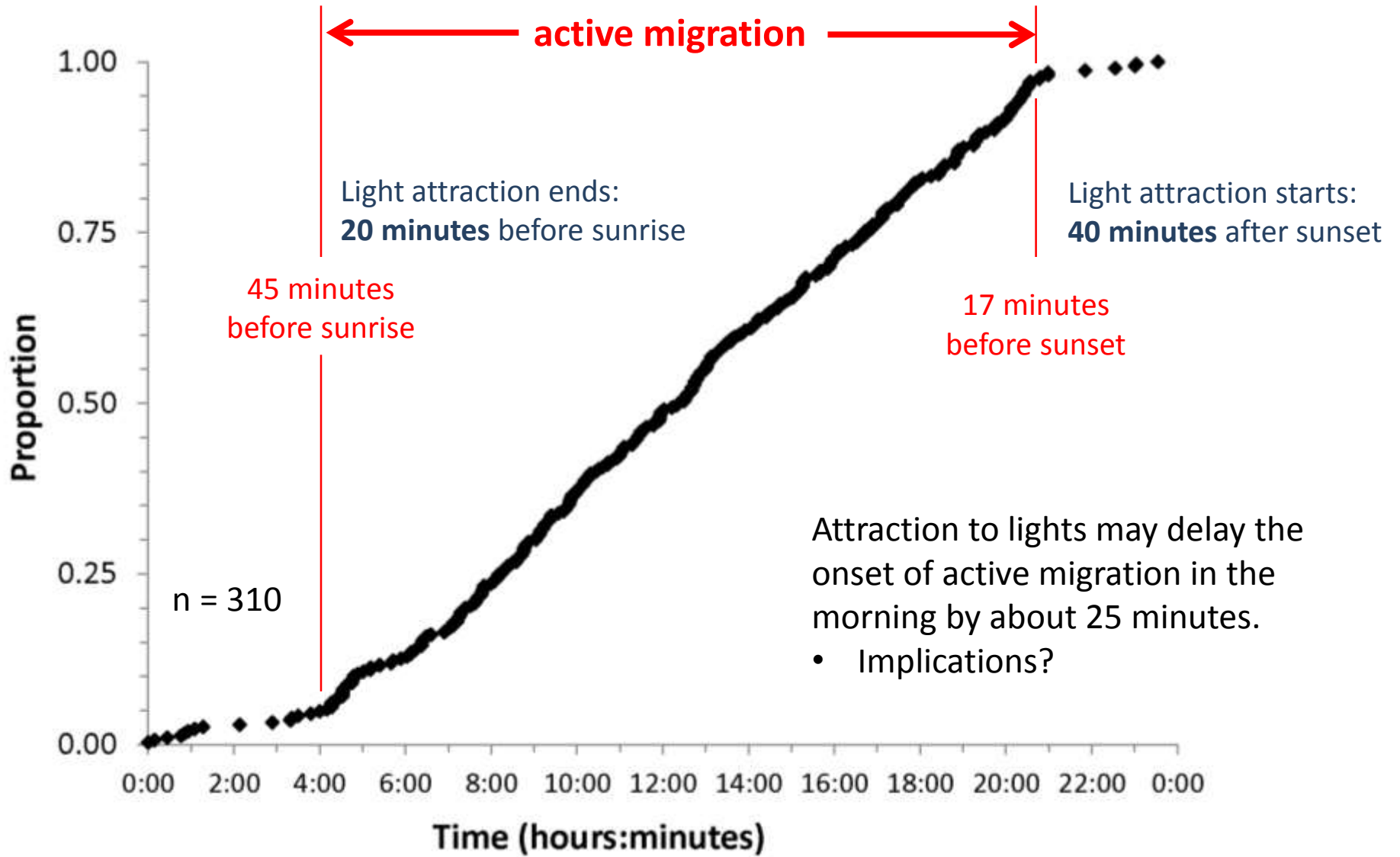
- Attraction dissipates by 20 minutes before sunrise
- Attraction begins about 40 minutes after sunset

What does this mean for migration?



Time of day when Chinook salmon actively migrate





Recommendations

- Investigate implications of light and attraction.
 - Increased foraging & growth?
 - Shadow lines – net positive or negative?
 - Predation.
 - Migration delay.
- Investigate ways to further minimize attraction.
 - Type of light (wavelength spectrum)
 - Switching lights off and on
- Projects near and over water should incorporate efforts to minimize spill lighting onto water.
 - Is light necessary? Is proposed light intensity necessary?
 - Shield lights. Direct light onto intended areas.
 - Can lights be turned off at certain times?
 - Avoid focal areas of bright light.
 - Use ambient as reference.
 - Avoid shadow lines. Consider adding light beneath bridges.

Questions & Discussion

