Are Seasonal Patterns of Differential Marine Survival of Barged to Run-of-River Juvenile Spring Chinook Salmon Explain by Counteracting Patterns of Smoltification and Fish Condition?

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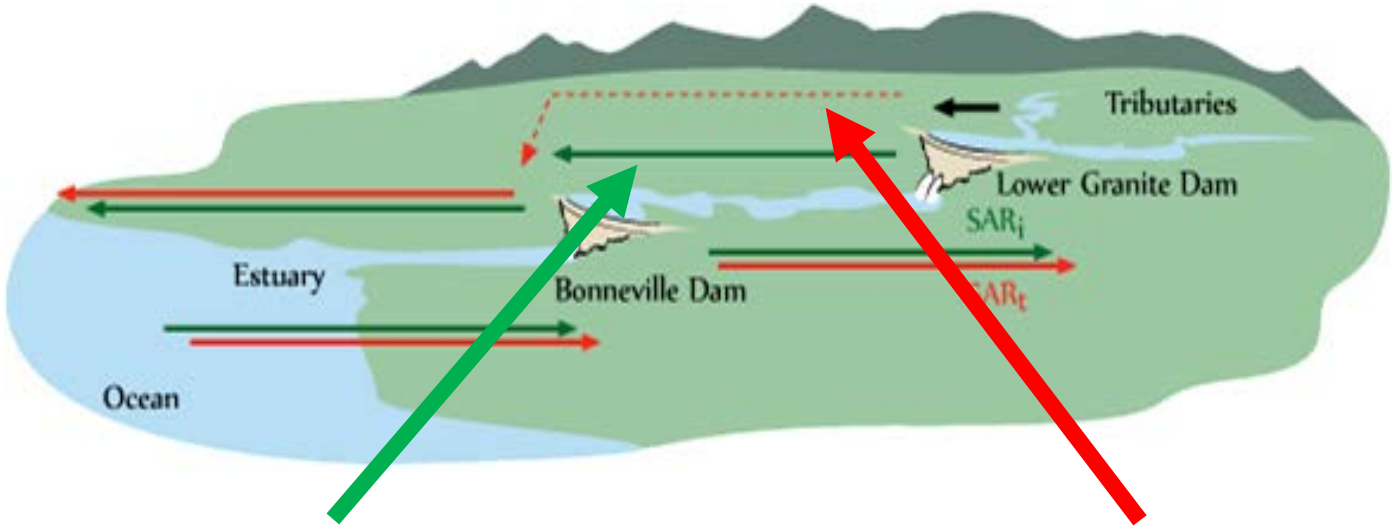
Bonneville
POWER ADMINISTRATION

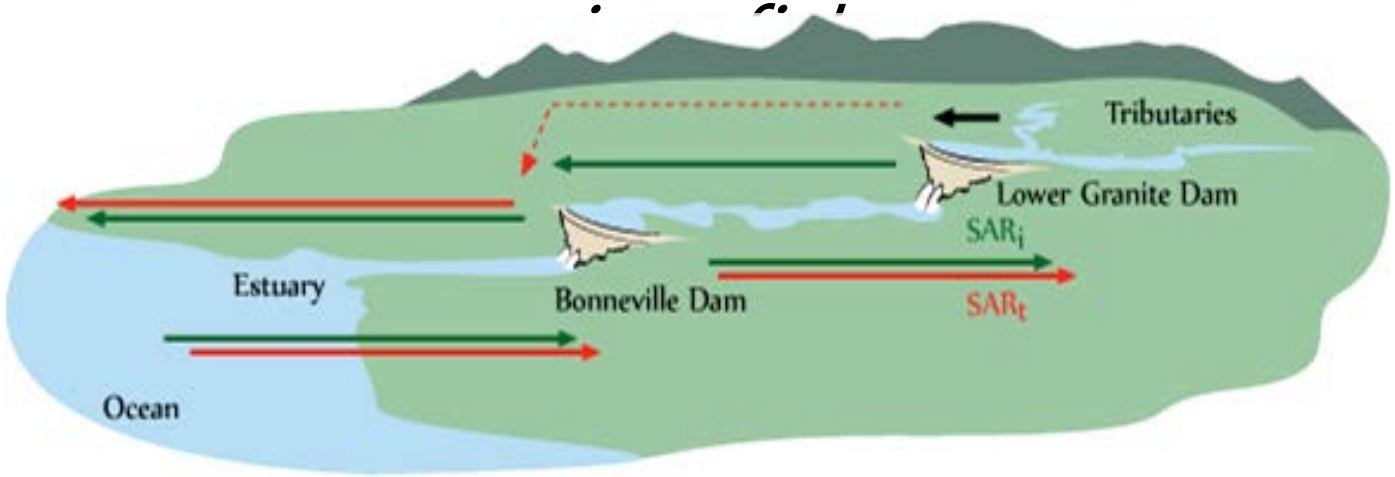
Transporting fish around dams is a major fish recovery program



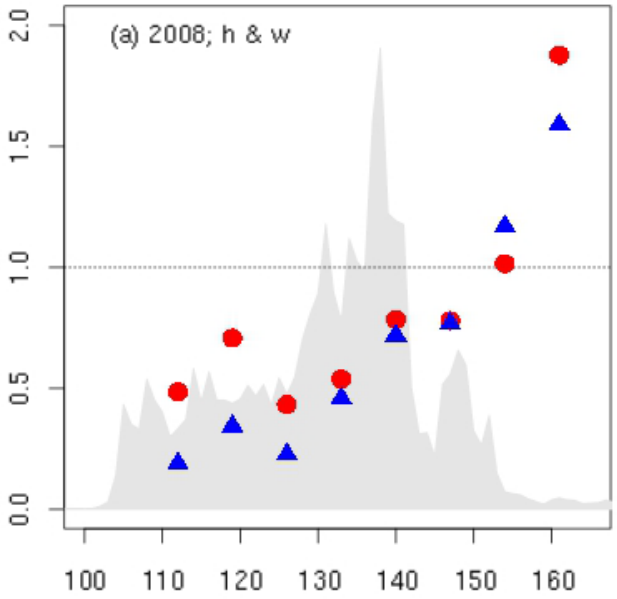
Run of River ~ 50%

Barge survival ~100%

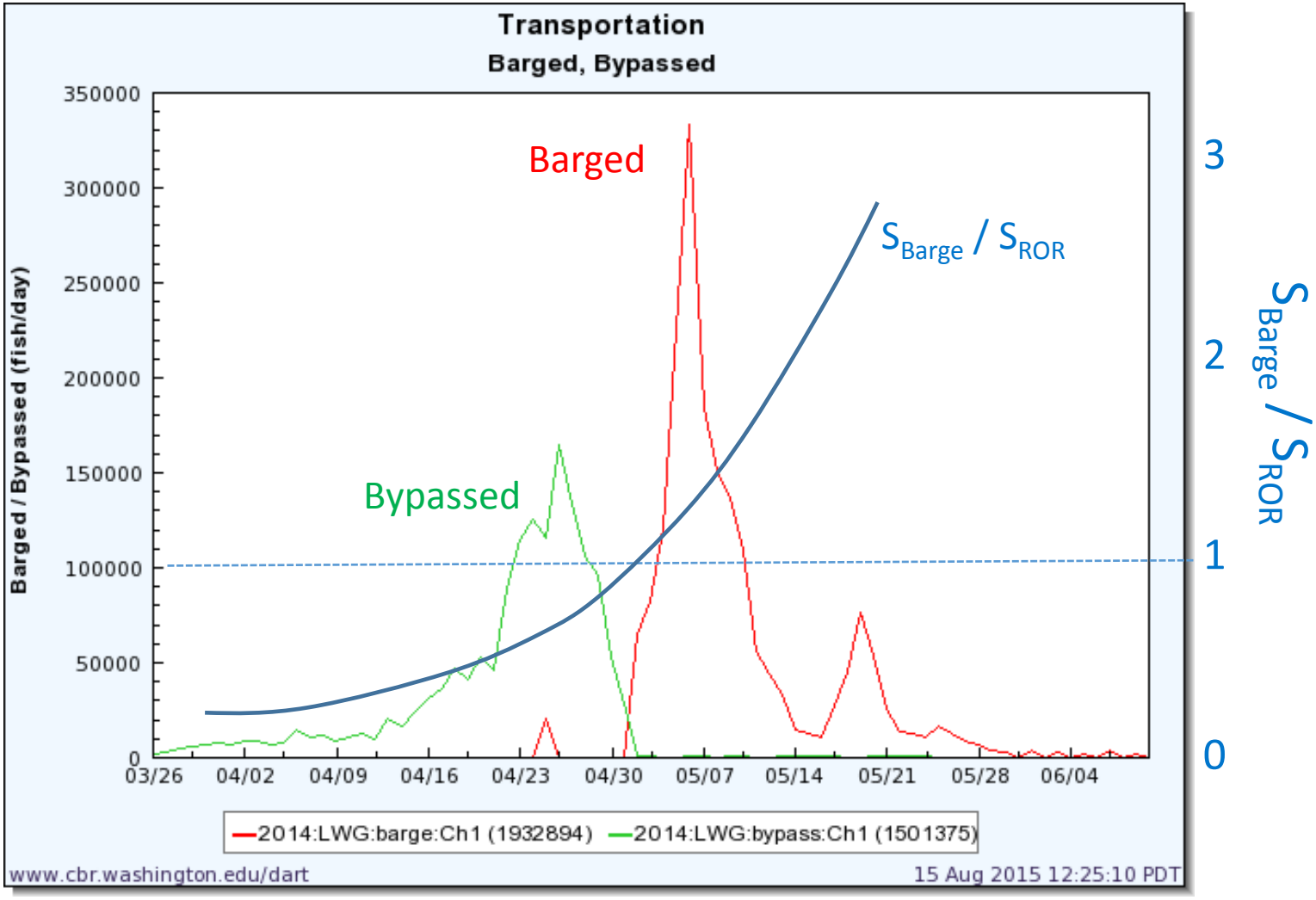
However, in the ocean survival of barged fish is often lower than run-of-



$$D = \frac{Barge\ Survival}{ROR\ Survival}$$



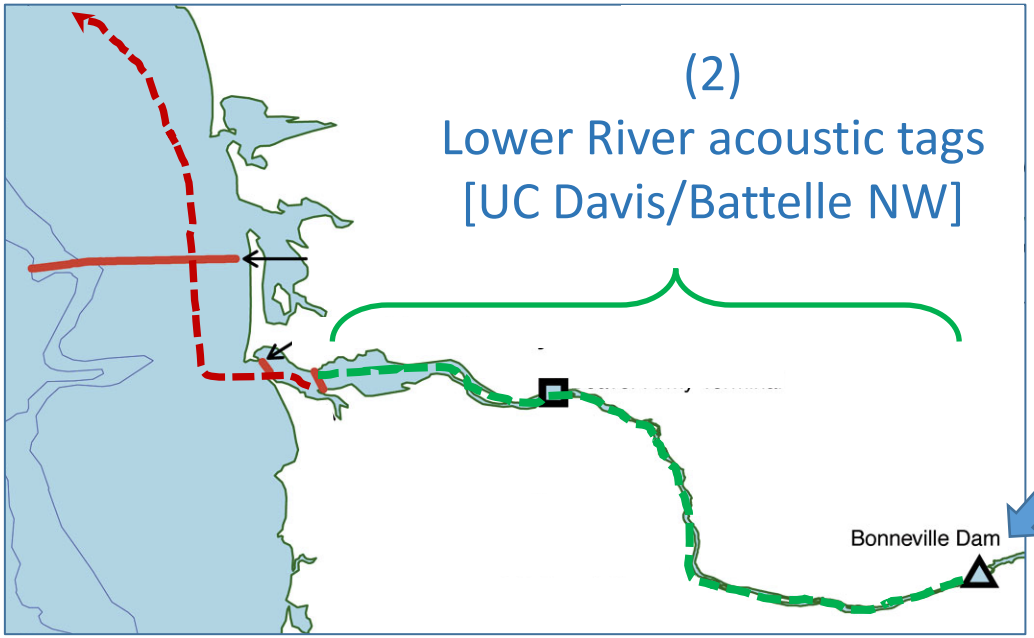
Because barged fish ocean survival is low in April, transportation is delayed to May



What controls the seasonal pattern in D?

2008-2009 studies *suggest fish smoltification level and energy content are important*

(3)
Ocean
acoustic tags
[Kintama
Research]



(2)
Lower River acoustic tags
[UC Davis/Battelle NW]

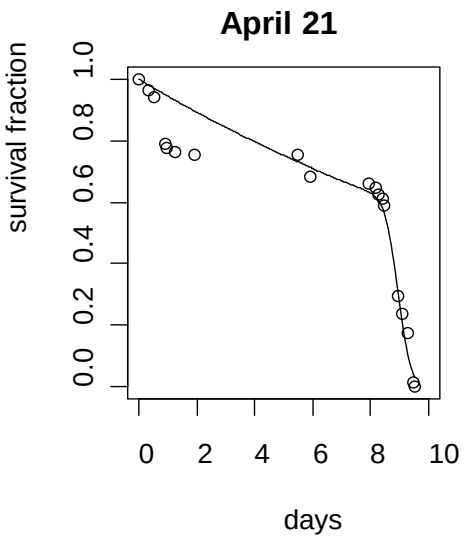
(1)
Bonneville
Challenge test
[UW]

(4)
PIT tag estimate of D
[NOAA]

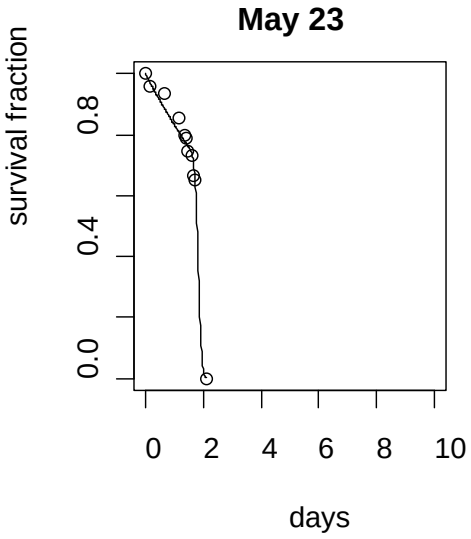
Evidence for seasonal variation of energy density

Challenge tests

Time to mortality (*m*) in stress challenge is index of fish energy (Gosselin 2011)



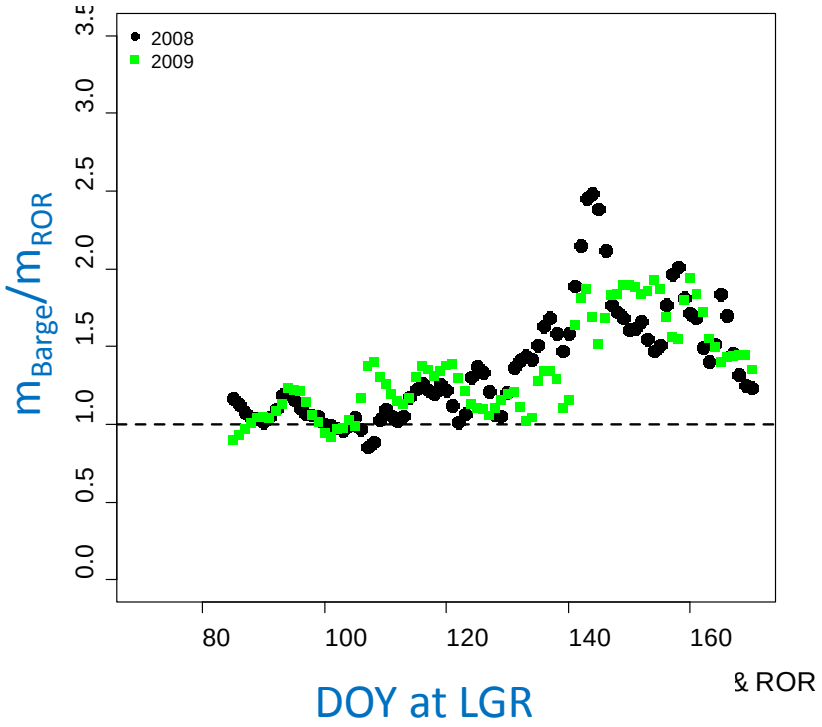
9 days to threshold



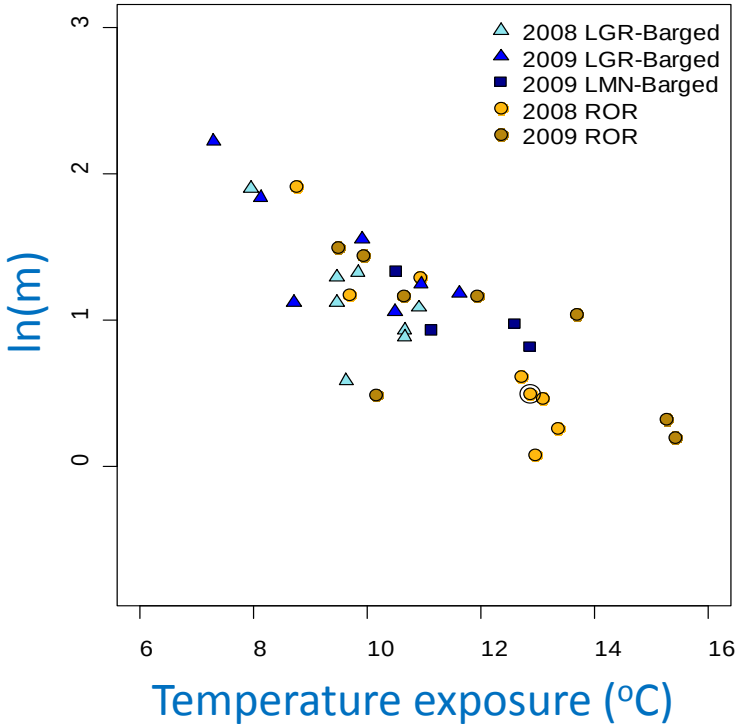
2 days to threshold

Bonneville Study

ROR fish loose energy faster than Barge fish
(Gosselin 2011)



The difference may involve temperature
(Gosselin 2011)



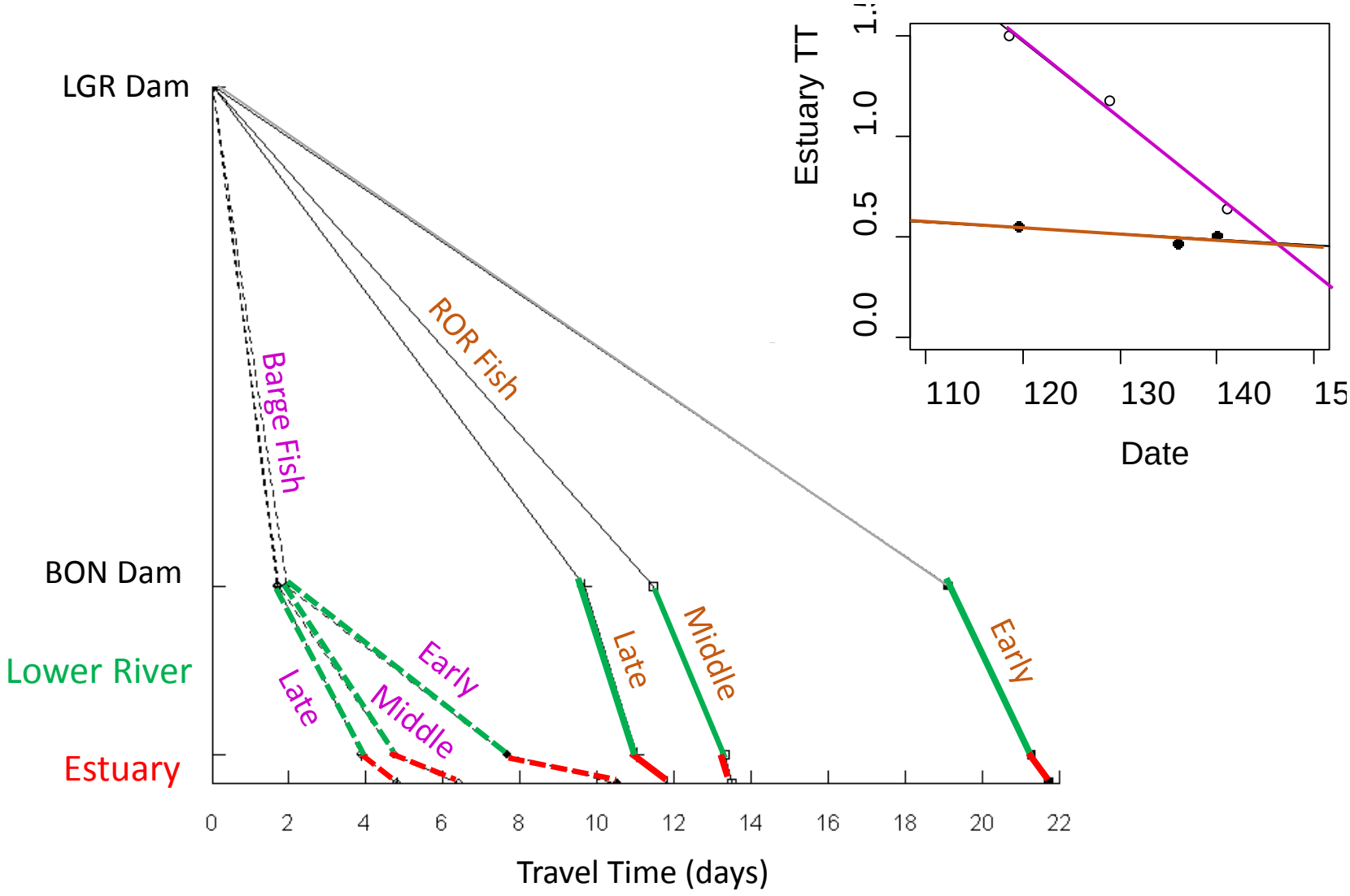
River temperature relates to challenge mortality $\log(m) = a + b\theta$

Evidence for seasonal variation in smoltification

Migration Travel Time

Early Barge Fish have Long Estuary Travel Time

(Eder et al. 2009)

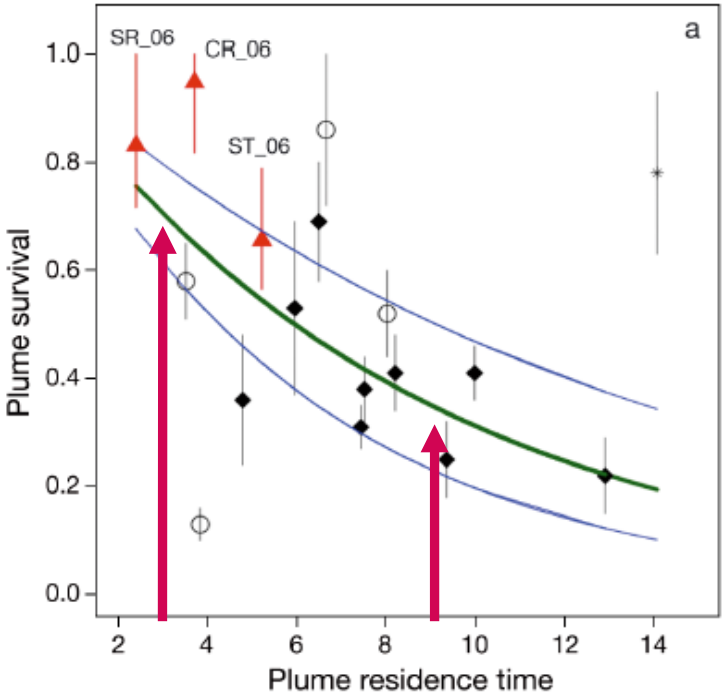


Evidence travel time affects D

Plume Survival

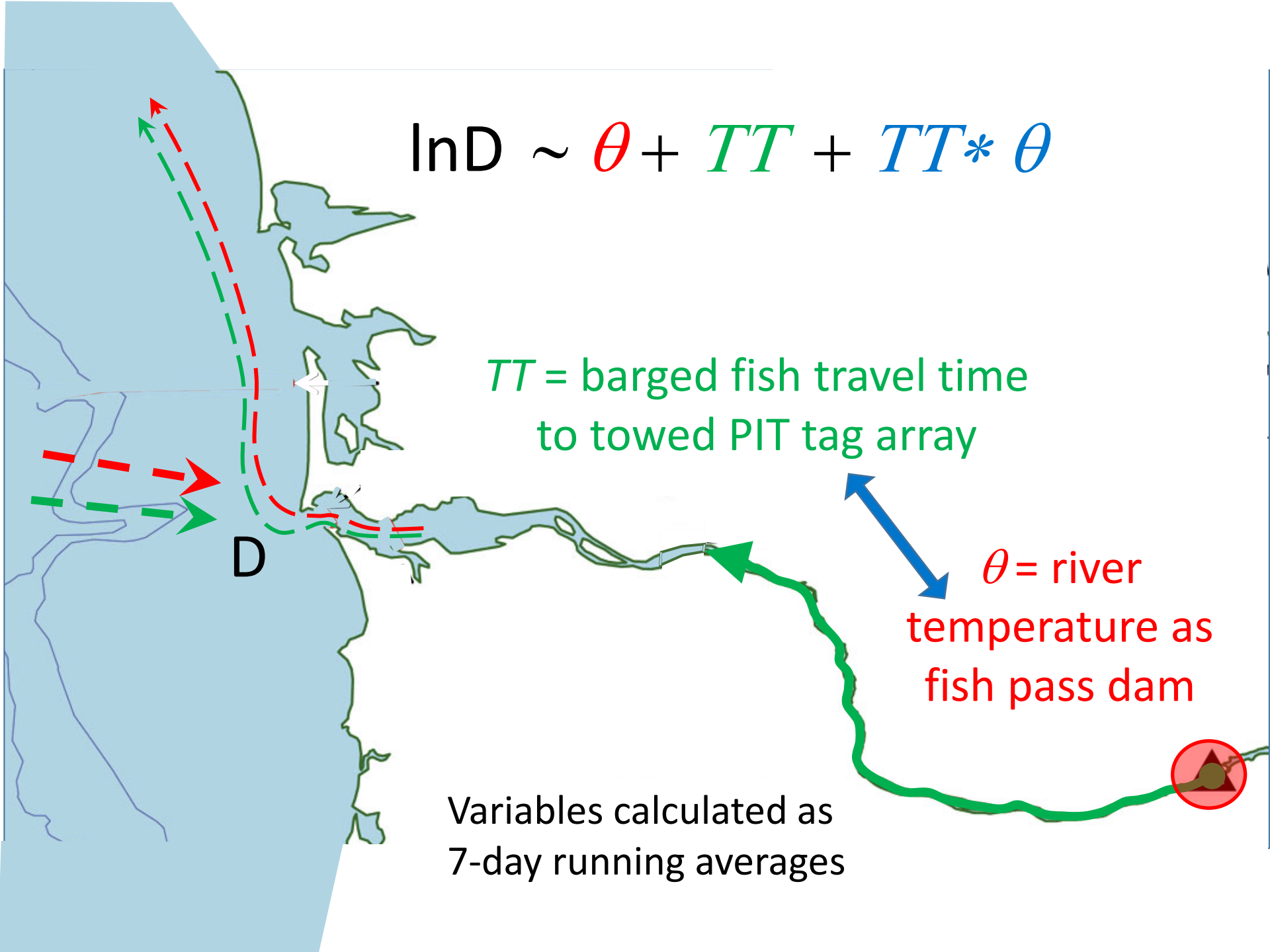
Relationship of river/estuary TT to Plume TT

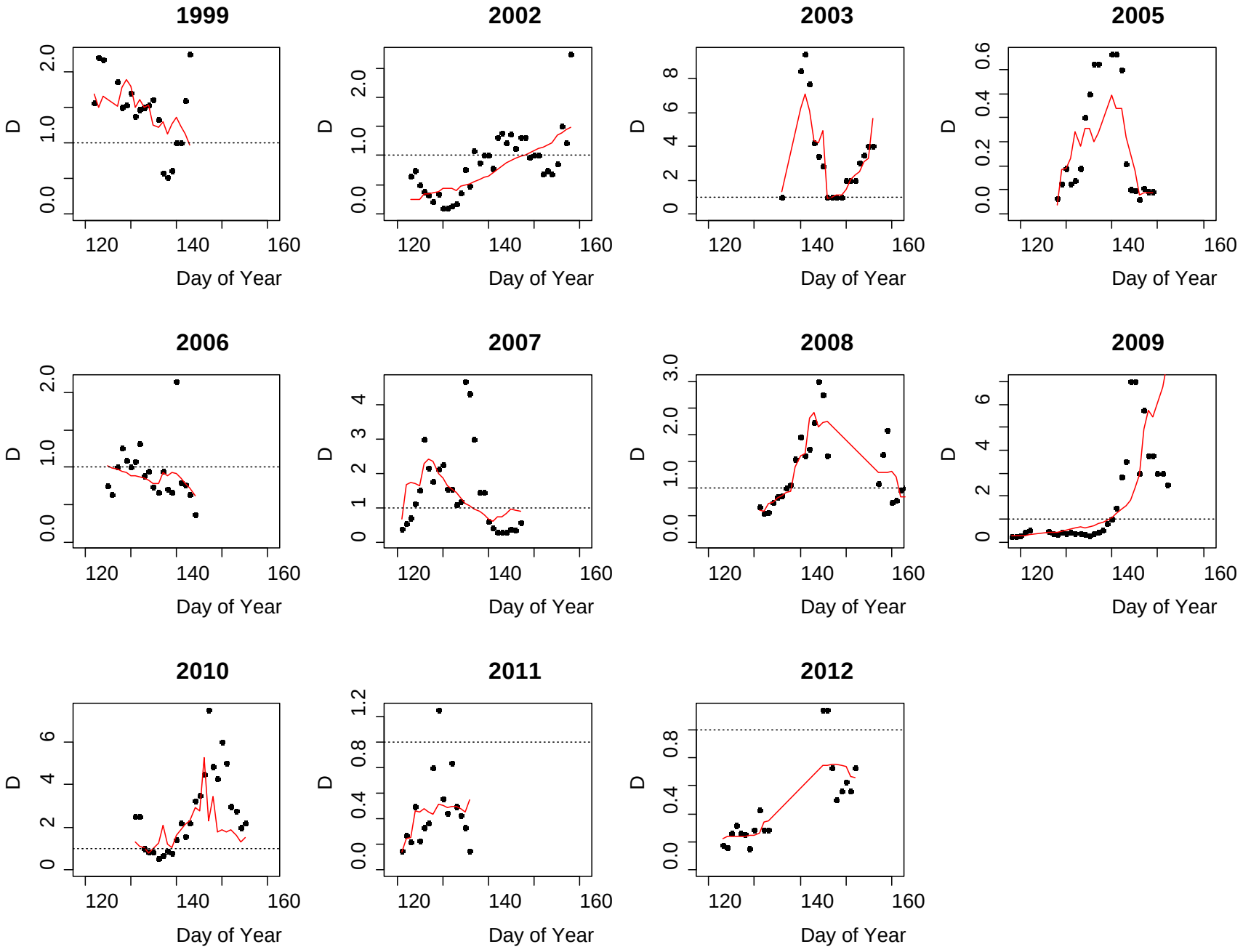
Could account for seasonal doubling in D



Brosnan et al. (2014)

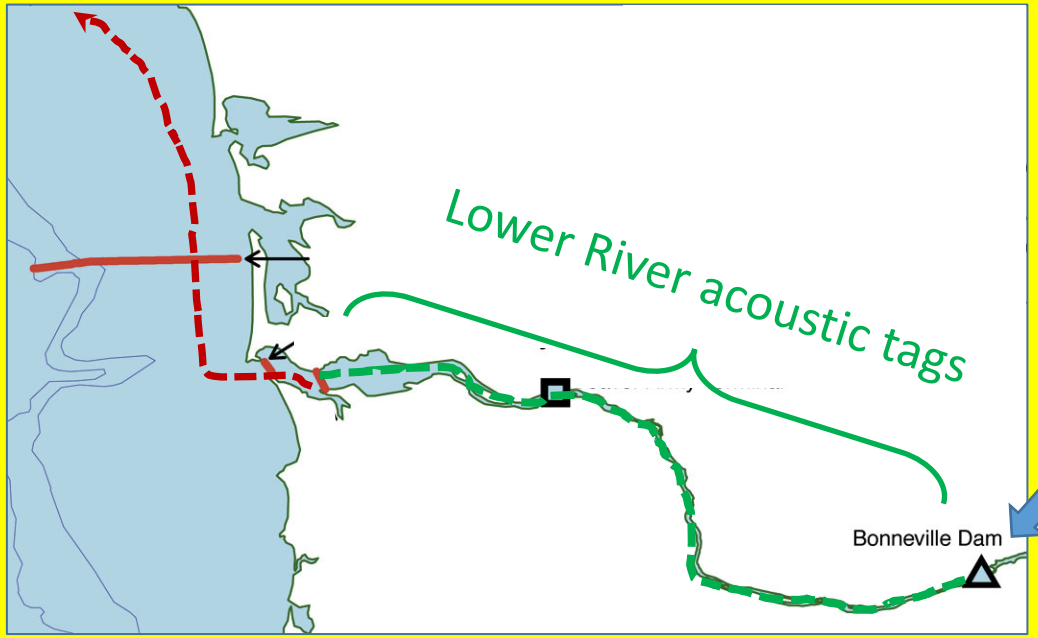
Can regression models using migration temperature and lower river travel time fit seasonal patterns in D?


$\ln D \sim \theta + TT + TT * \theta$
TT = barged fish travel time to towed PIT tag array
θ = river temperature as fish pass dam
D
Variables calculated as 7-day running averages


1999
2002
2003
2005
2006
2007
2008
2009
2010
2011
2012
D
Day of Year
120
140
160

Field studies and regression modeling suggest travel time and temperature contribute to seasonal variation of *D*

Ocean acoustic tags



Bonneville Challenge test

Regression model of TT and θ to D

However

TT and θ coefficients differ each year

Indicating these indirect measures are insufficient to *predict* year-to-year pattern of *D*

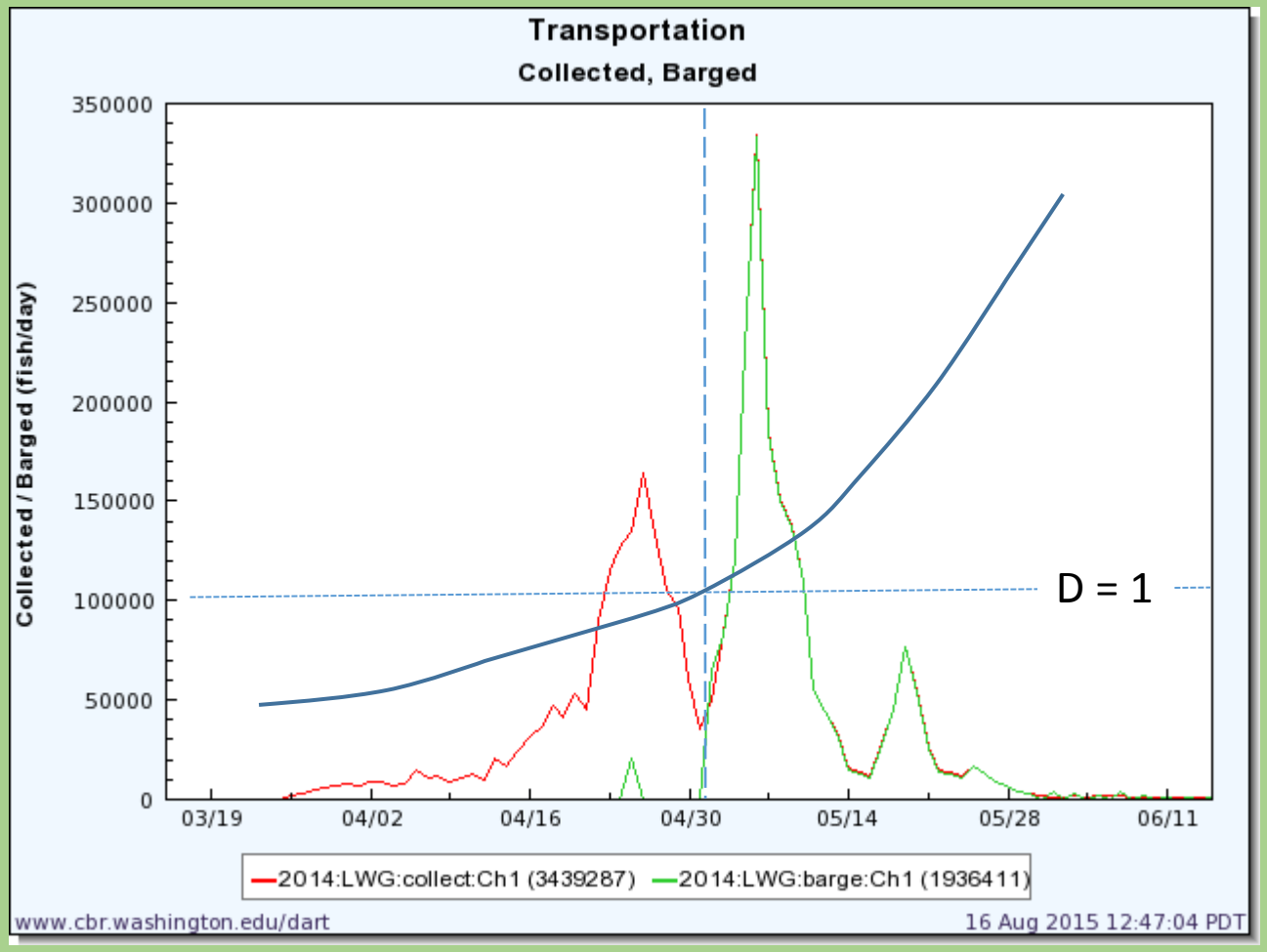
Suggested work for developing an in-season predictor of D

Characterize smolt bioenergetic state with real-time energy density measures at LGR

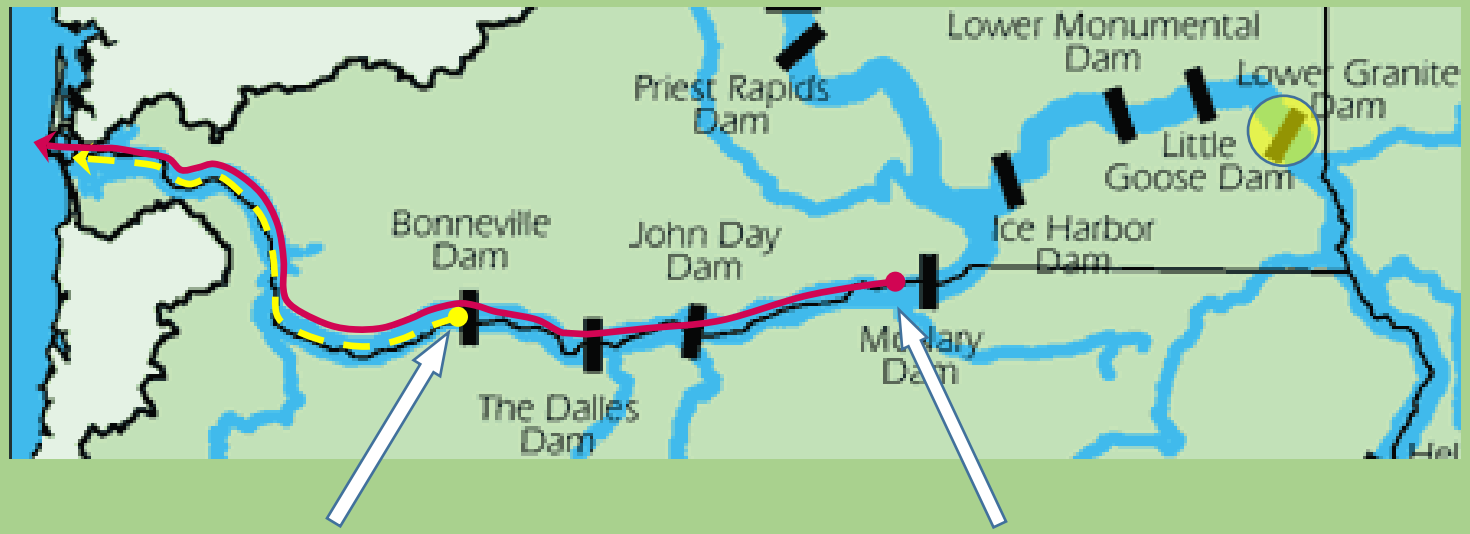
Characterize ability to enter saltwater with real-time measures of smoltification and/or fish velocity above and below BON

Potential Management Actions based on in-season predictions of D

Action 1
Real-time scheduling of fish transportation when river and fish conditions indicate D > 1



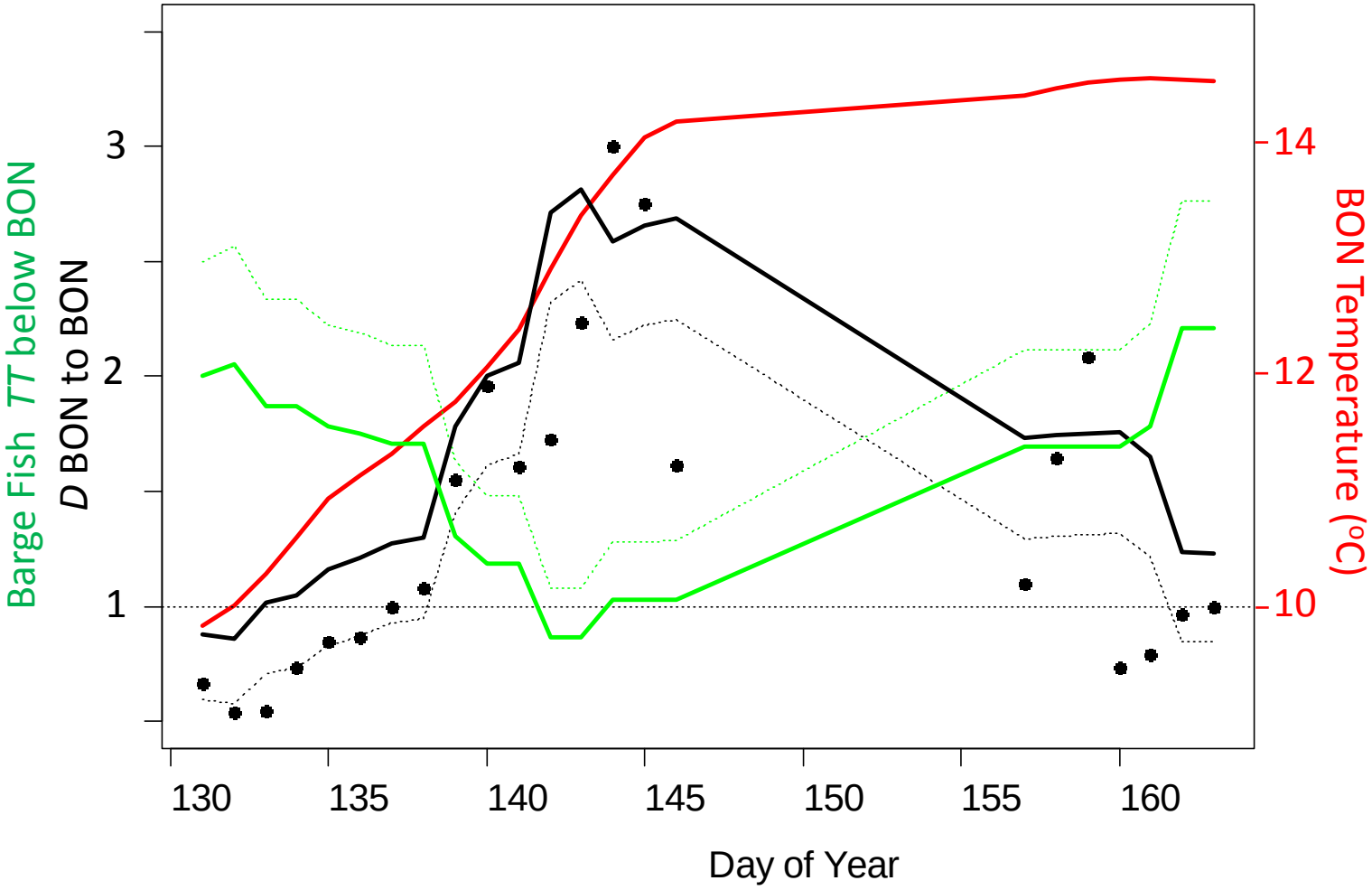
Action 2
Release smolts upstream to increase smoltification and reduce estuary/plume travel time



Current release
2 days TT to estuary

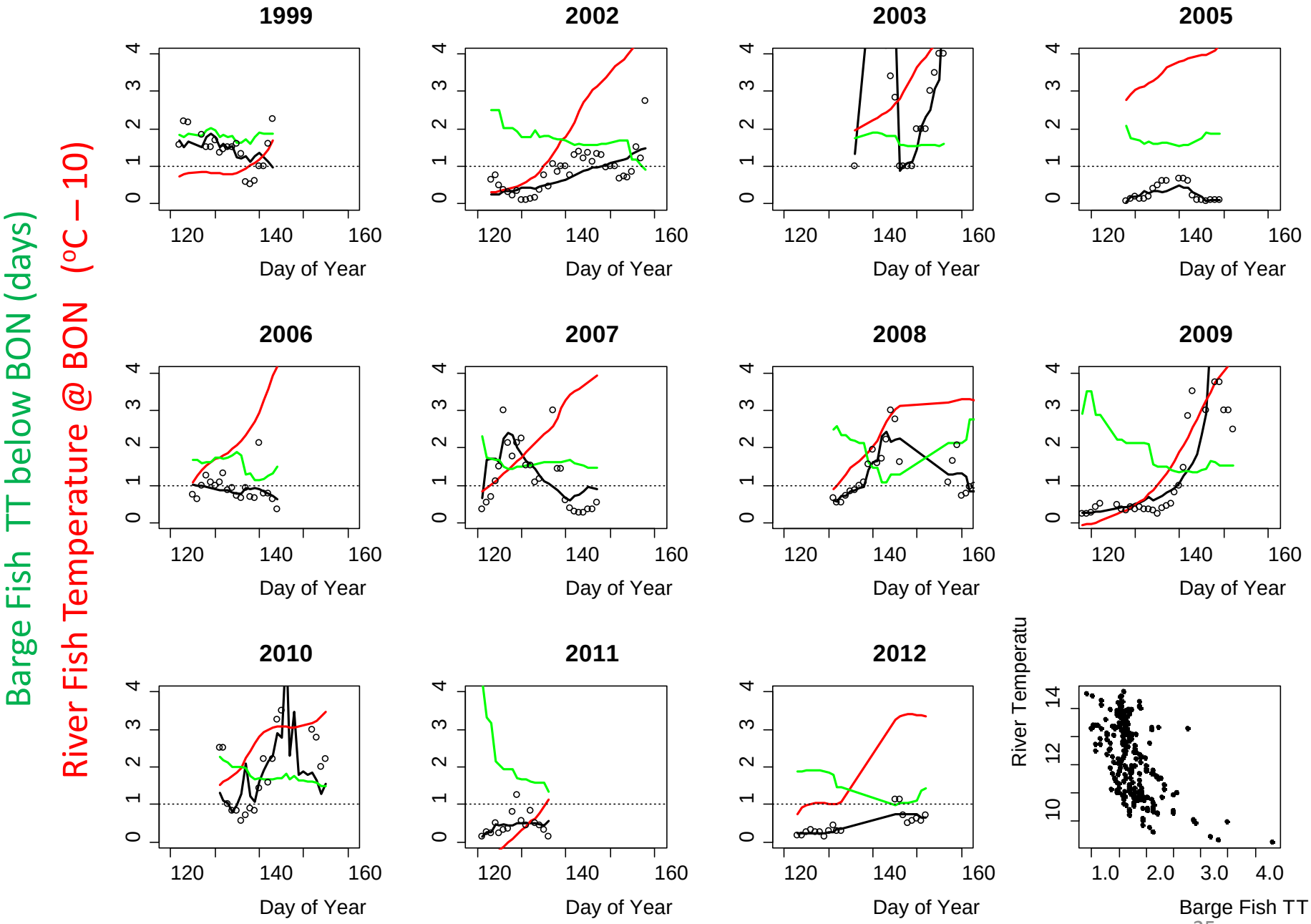
Upstream release
5 days TT to estuary

Modeled effect of reducing Estuary TT by 20%



Main Points

- Fish smoltification and energy density affect D
- Prediction of D will require real-time measurements
- With predictions of D
  - Transportation scheduling can be optimized
  - Ocean survival of barged fish might be significantly improved


Barge Fish TT below BON (days)
River Fish Temperature @ BON (°C – 10)
1999
2002
2003
2005
2006
2007
2008
2009
2010
2011
2012
Day of Year
River Temperatu
Barge Fish TT