RAPID POPULATION INCREASE AND UPRIVER SPREAD OF AMERICAN SHAD IN THE COLUMBIA RIVER

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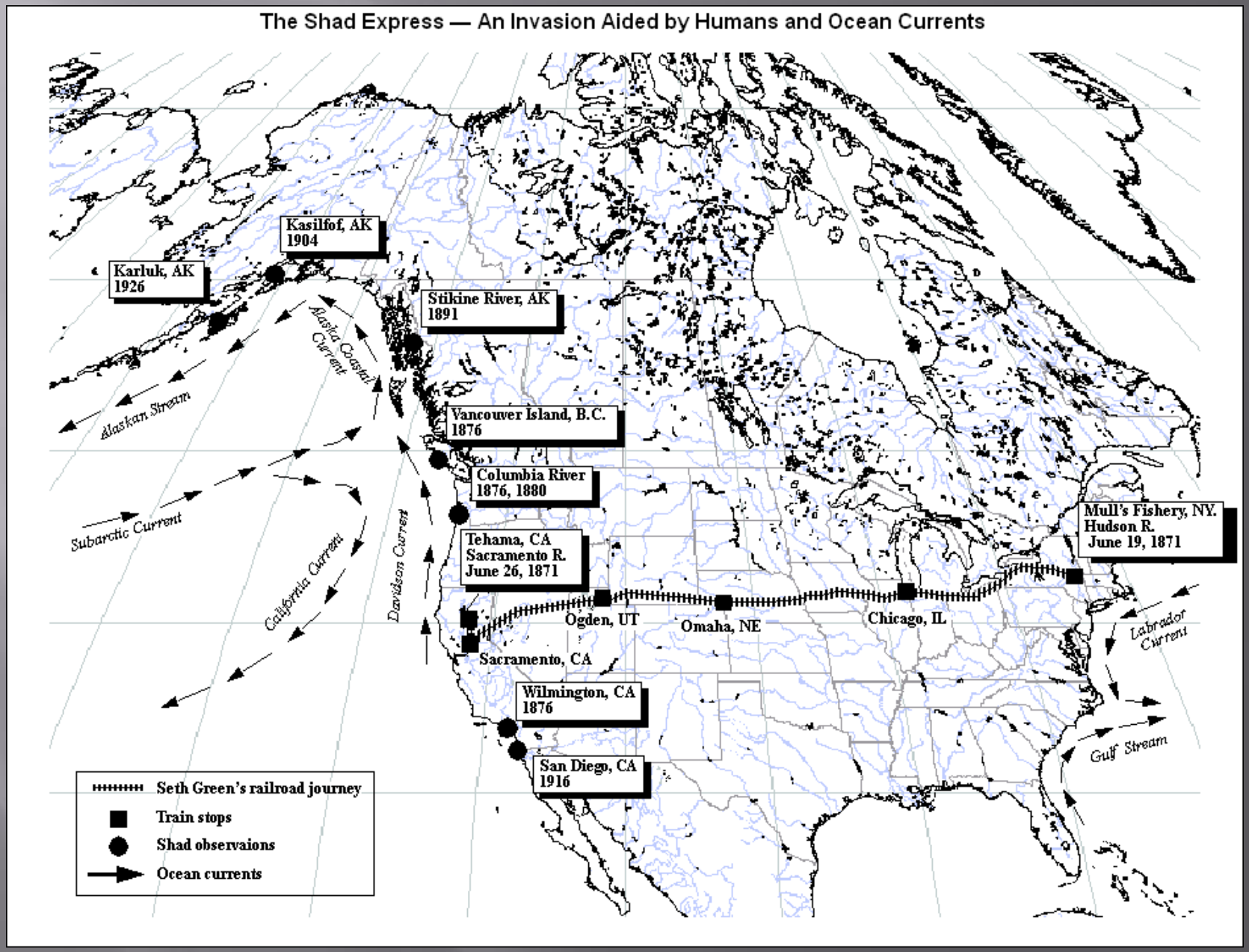


Courtesy of the Shad Foundation

American shad collected near Astoria in 1880 by David Starr Jordan

Photo of specimen USNM 027322 courtesy of Sandra J. Raredon, Smithsonian Institution, Division of Fishes

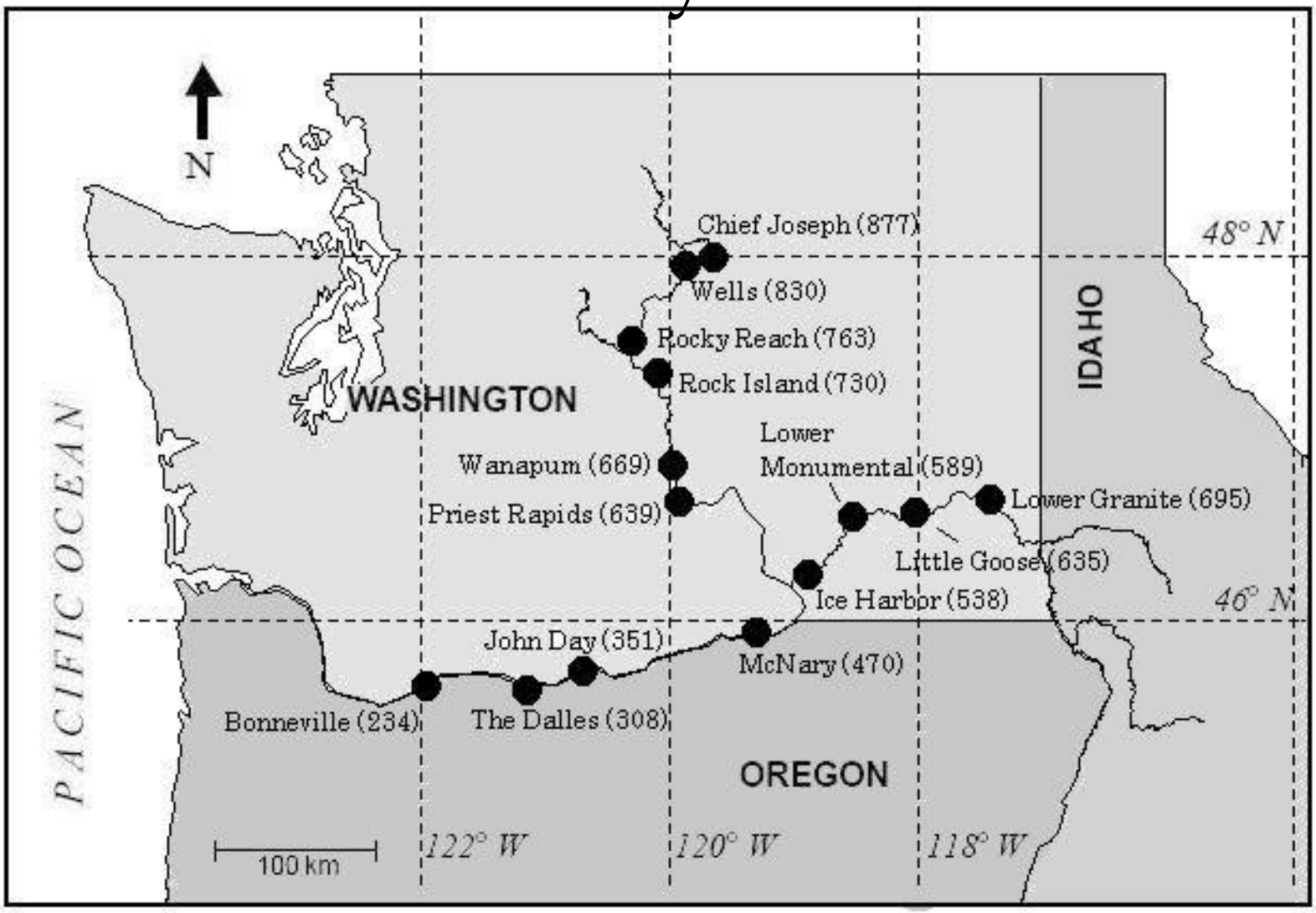
Documenting the Biological Invasion

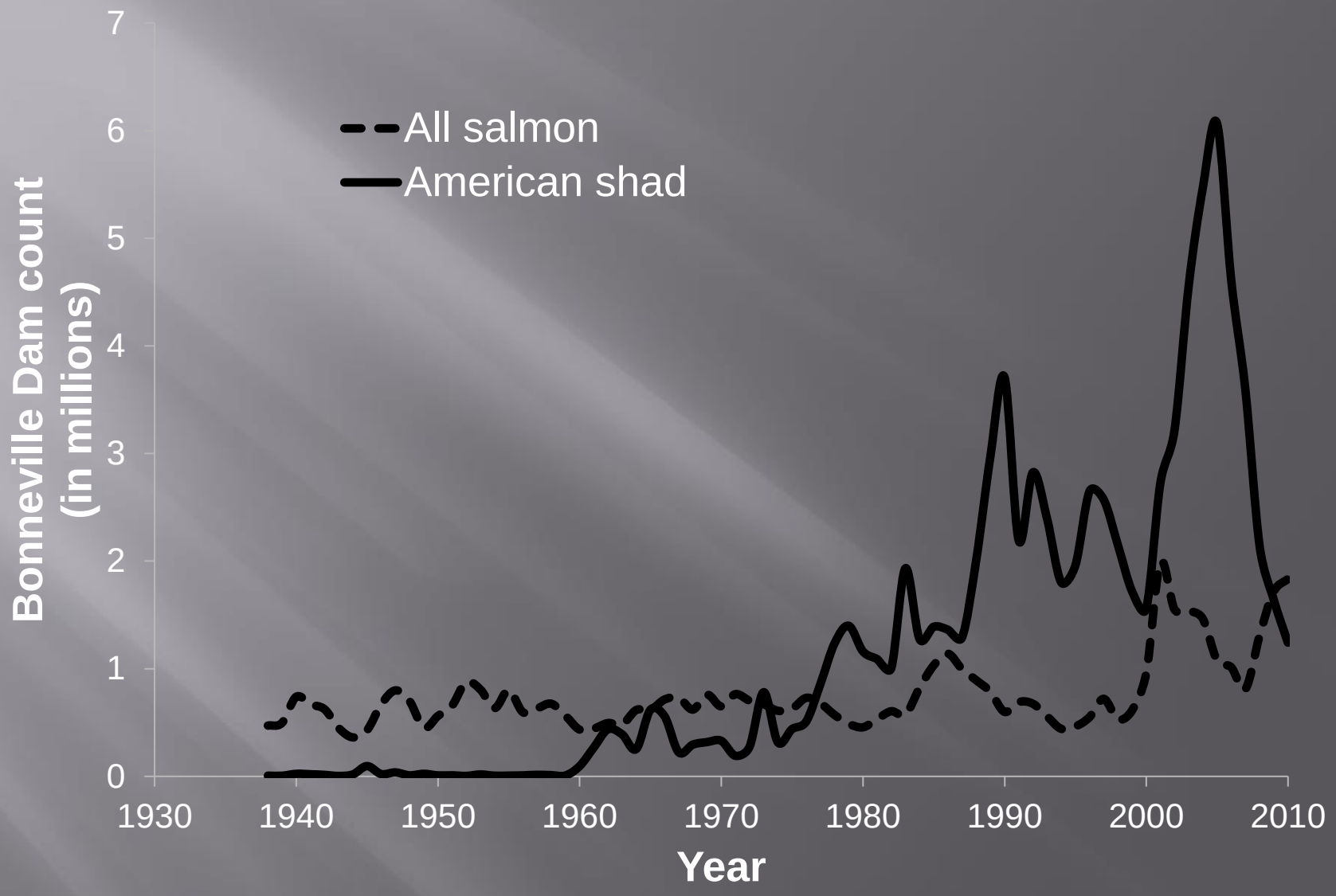
- Columbia river shad present an opportunity to document the spread of an invasive species as a result of habitat change.
- The U.S. Army Corp of Engineers has tallied adult shad, and collected daily water temperature and discharge data at Bonneville Dam (rkm 234) since 1938.
- Over the century following their initial invasion, the Columbia River was transformed from a free-flowing river into a series of lakes.

Methods

- Compare adult population abundances of shad and all salmonid species.
- Develop spawner-recruit data series and compare with increases in contiguous mainstem reservoir habitat.
- Use differences between dam counts to characterize upriver distribution.
- Use regression analysis to test for relationships between upriver distribution, water temperature, and discharge.

Study Area


N
Chief Joseph (877)
Wells (830)
Rocky Reach (763)
Rock Island (730)
WASHINGTON
IDAHO
Wanapum (669)
Priest Rapids (639)
Lower Monumental (589)
Lower Granite (695)
Little Goose (635)
Ice Harbor (538)
McNary (470)
John Day (351)
The Dalles (308)
Bonneville (234)
OREGON
PACIFIC OCEAN
48° N
46° N
122° W
120° W
118° W
100 km

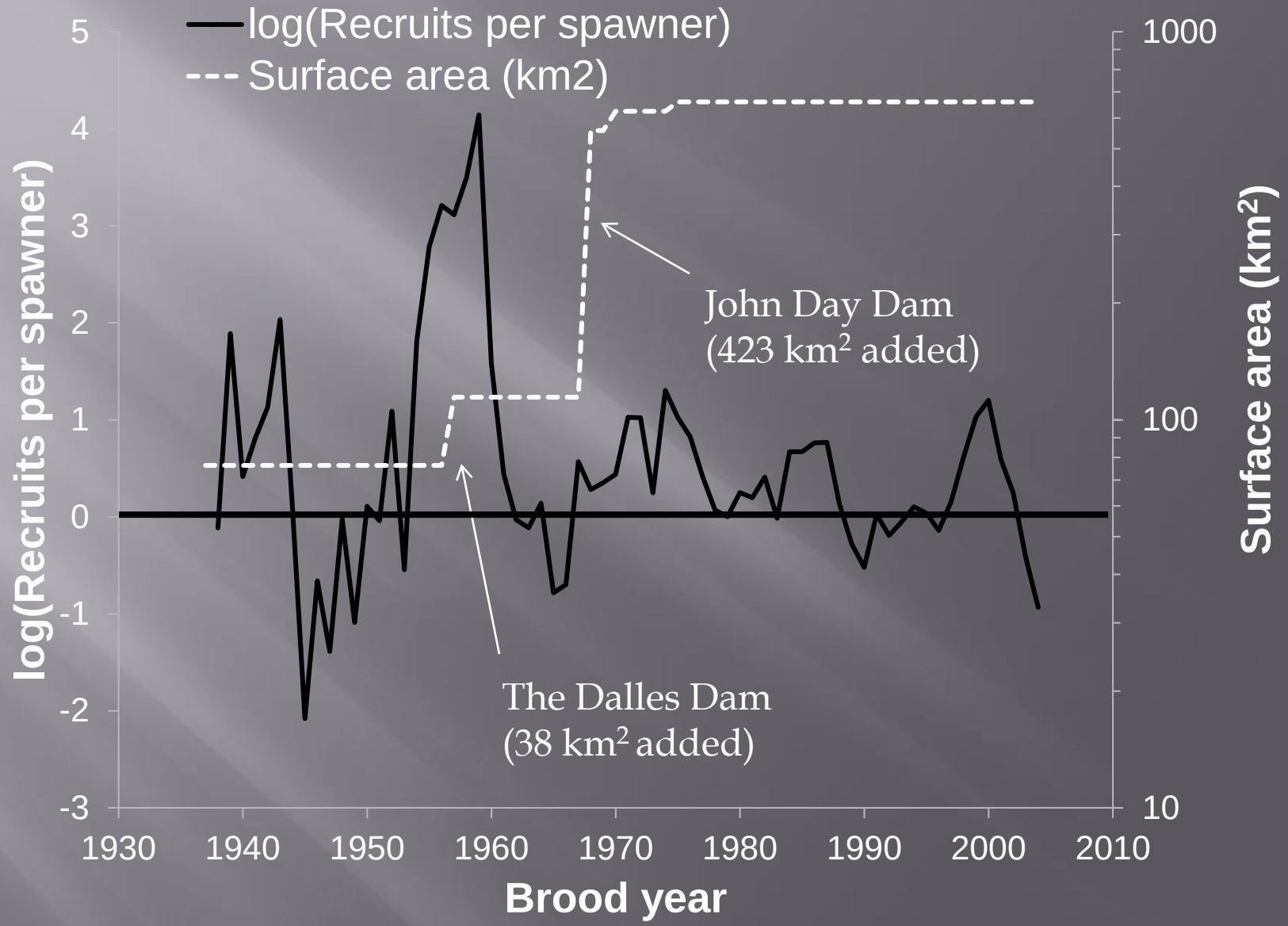


Data source: U.S. Army Corp of Engineers

Crude Recruitment Calculation

- Recruits = average adult returns 3-6 years later
- We chose 3-6 years because spawning adults aged using otoliths on the Columbia River (56%; 14 of 25) were 3 years old, with one 2-year-old fish and ten fish aged 4-6 years old (Petersen et al. 2003)

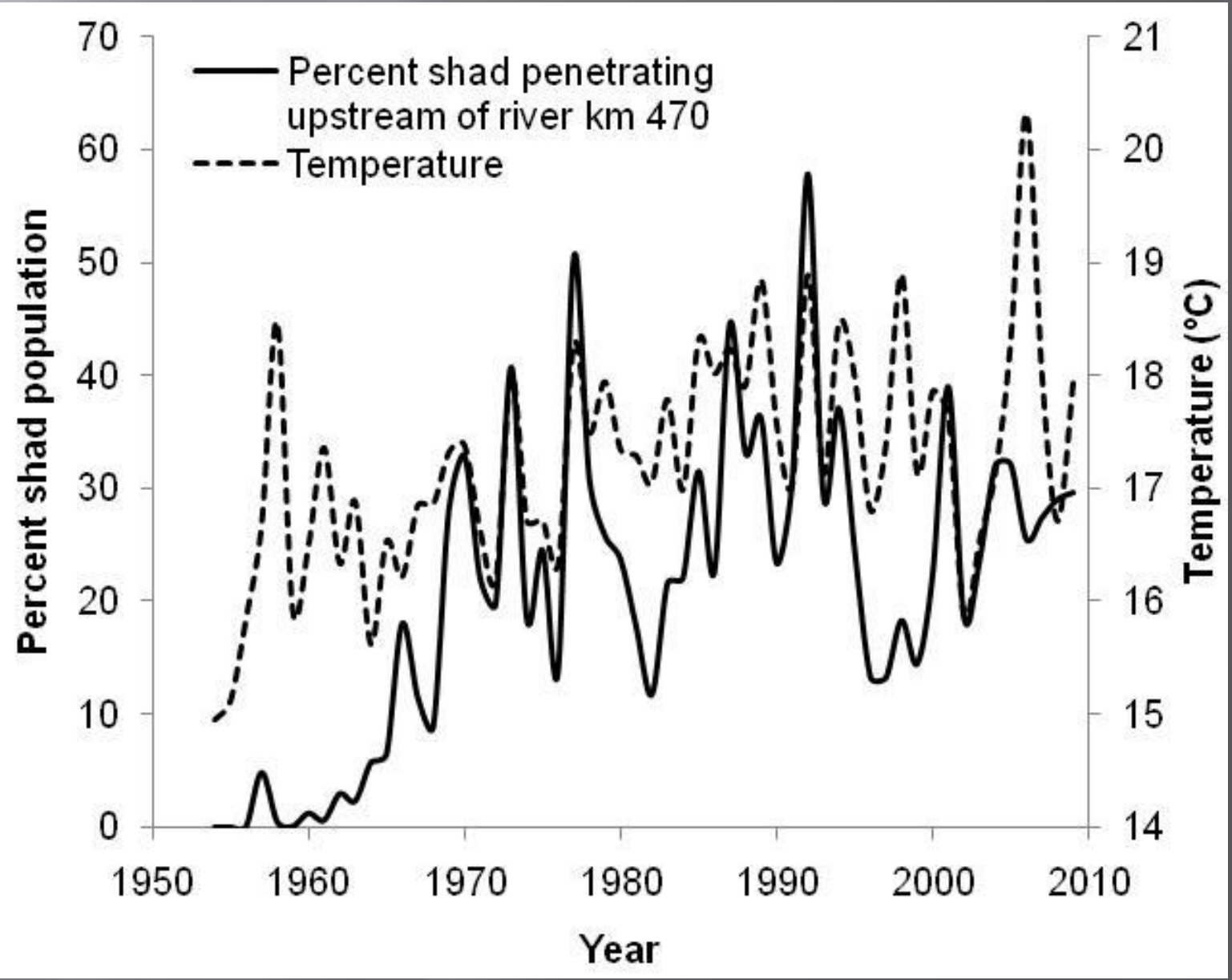
Petersen, J.H., Hinrichsen, R.A., Gadomski, D.M., Feil, D.H., and Rondorf, D.W. 2003. American shad in the Columbia River. American Fisheries Society Symposium 35: 141-155.



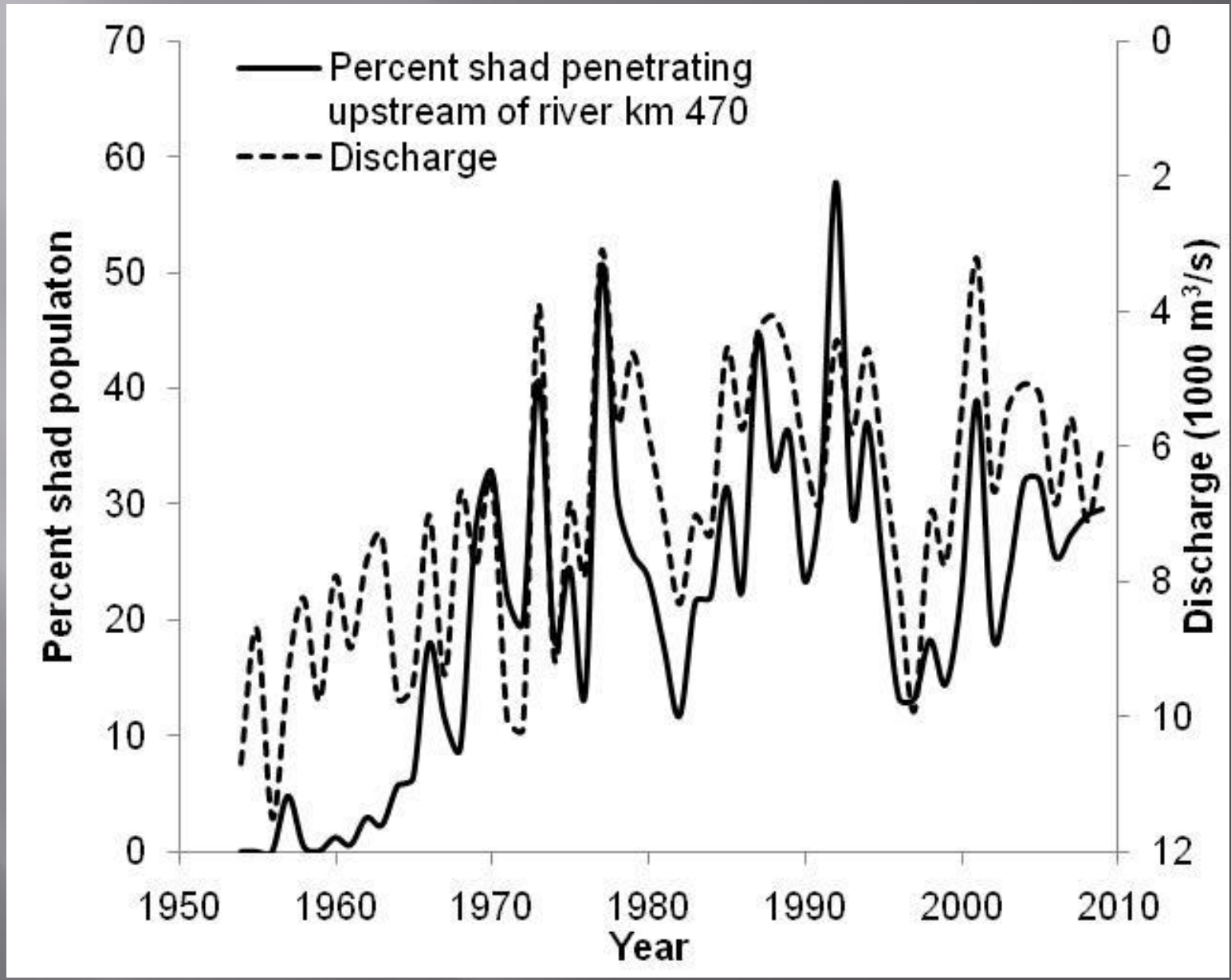
Data source: U.S. Army Corp of Engineers

Celilo Falls (rkm 323)

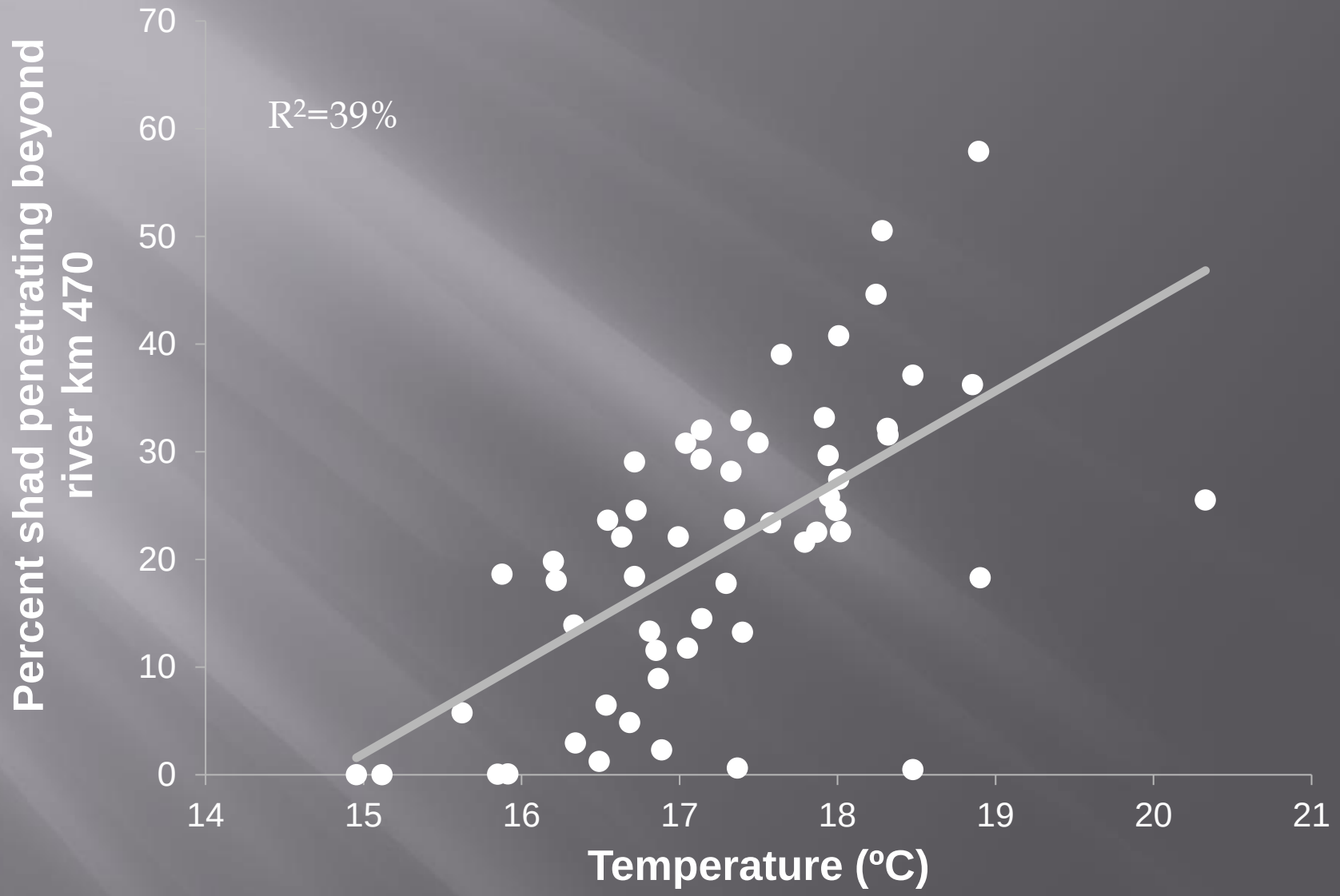
Courtesy of Oregon Historical Society, Negative ORHI 88625



Data source: U.S. Army Corp of Engineers



Data sources: U.S. Army Corp of Engineers and U.S. Geological Survey



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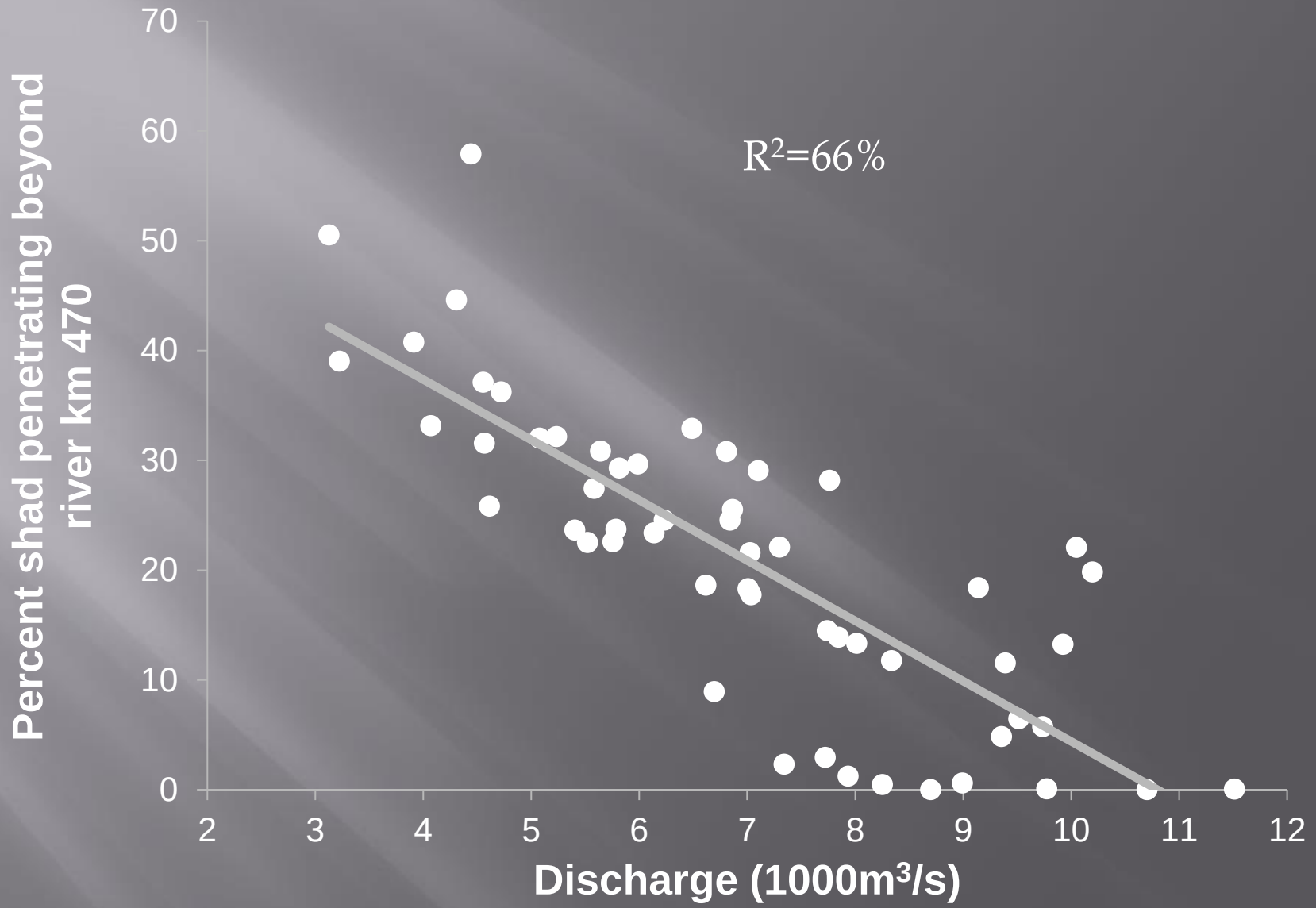
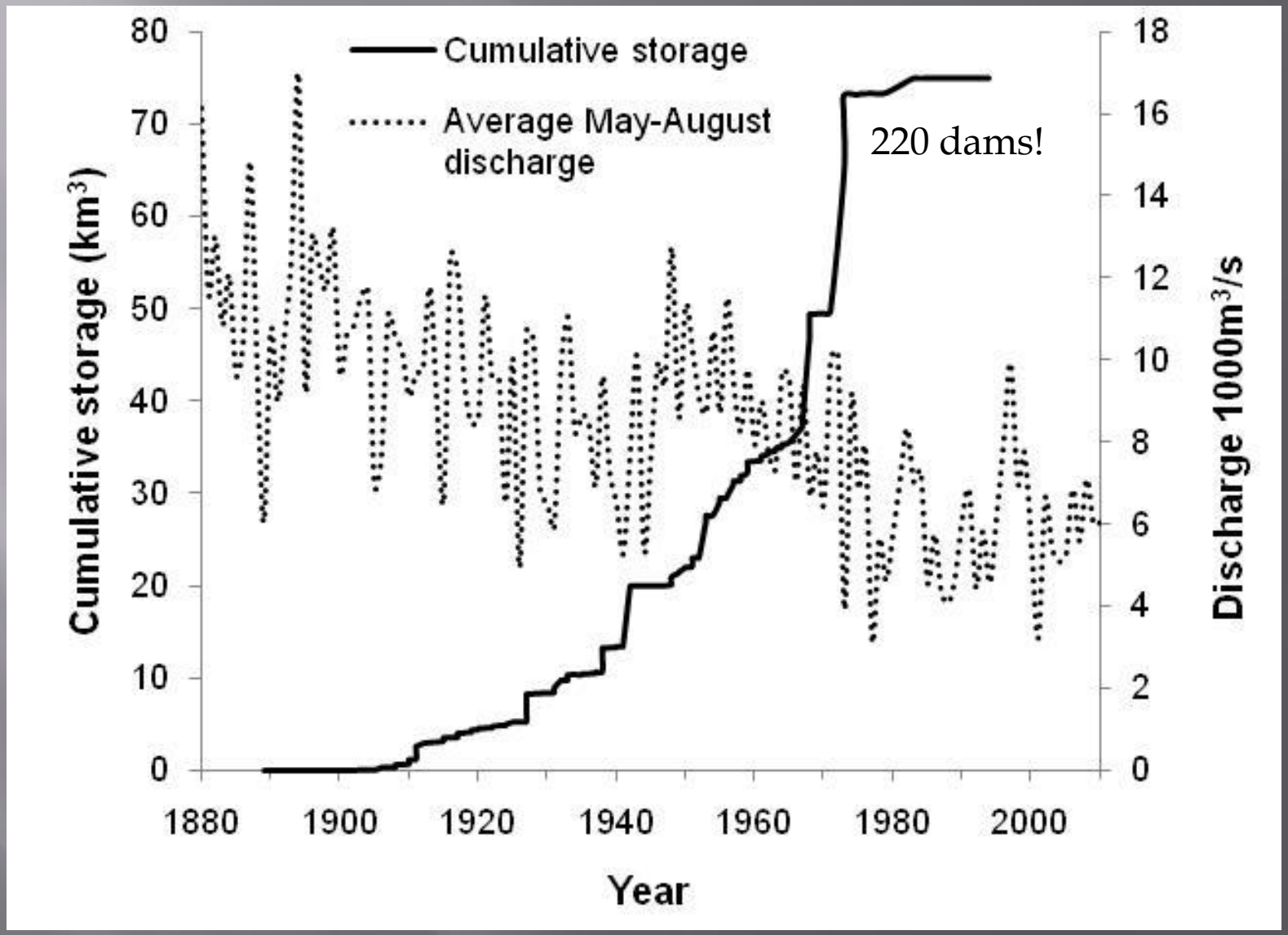


Data source: U.S. Army Corp of Engineers and U.S. Geological Survey

Regression Results

Model	df	R^2	AIC
$Dist = \beta_0 + \beta_1 * Temp$	53	38%	428.88
$Dist = \beta_0 + \beta_1 * Discharge$	53	66%	396.56
$Dist = \beta_0 + \beta_1 * Temp + \beta_2 * Discharge + \beta_3 * Temp * Discharge$	**51**	**70%**	**392.29**



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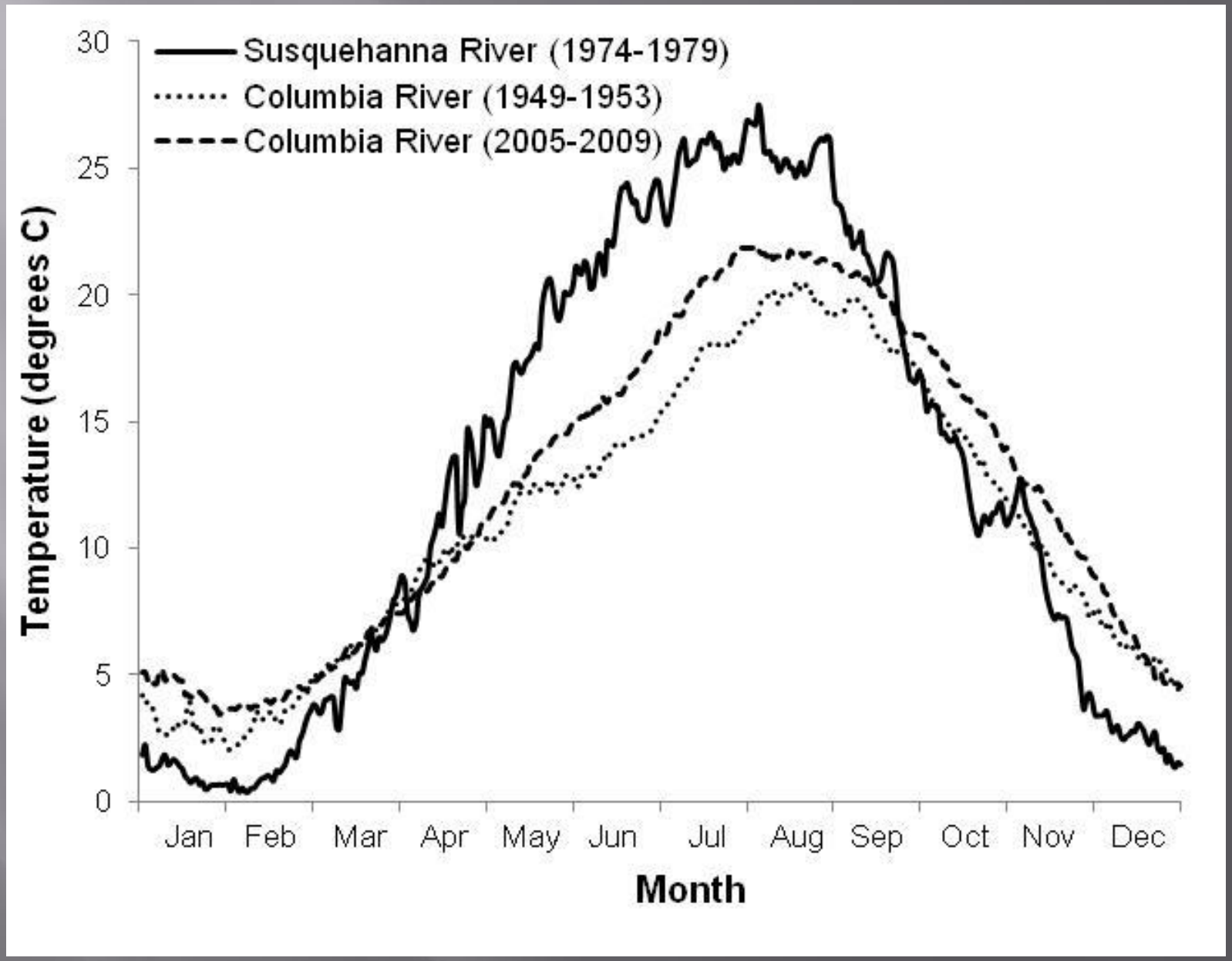

Data sources: U.S. Army Corp of Engineers and U.S. Geological Survey

Conclusions

- There was rapid spread and population growth of shad upstream of Bonneville Dam after The Dalles was constructed in the late 1950s.
- The upriver distribution of adult shad was strongly related to temperature and discharge measured in the lower mainstem of the Columbia River.

Future Research

- $$$ is a problem in a salmon-centric world.
- Jim Petersen et al. (2003) called for research on:
  - ~~Long-term trends or spatial variation in patterns~~
  - A measure of true American shad abundance!
  - Role of larval and juvenile American shad in the food web (e.g., Haskell et al. 2006)
  - Factors limiting adult returns
  - Ocean distribution of adults
  - Interactions between American shad and endangered or threatened salmonids throughout the river

"And now, in conclusion, I can only say, that if they do not have shad in the Pacific ocean there will be but one cause—the roily water caused by washing the mountains for gold. However I think the fish will get through all right." – SETH GREEN (1872)

Source: Harper's Weekly Feb. 8 1873

"...12,000 fry in four 8-gallon milk cans."