



Importance of water temperature in the management of American river Chinook Salmon and steelhead:

How cool does it really need to be and when?

Rob Titus

**California Department of Fish & Wildlife
Fisheries Branch, Sacramento**

Salmon anglers on the American River at Sailor Bar. Photo: Terry Linton, CDFW

**Save the American River Association
Effie Yeaw Nature Center • December 6, 2014**



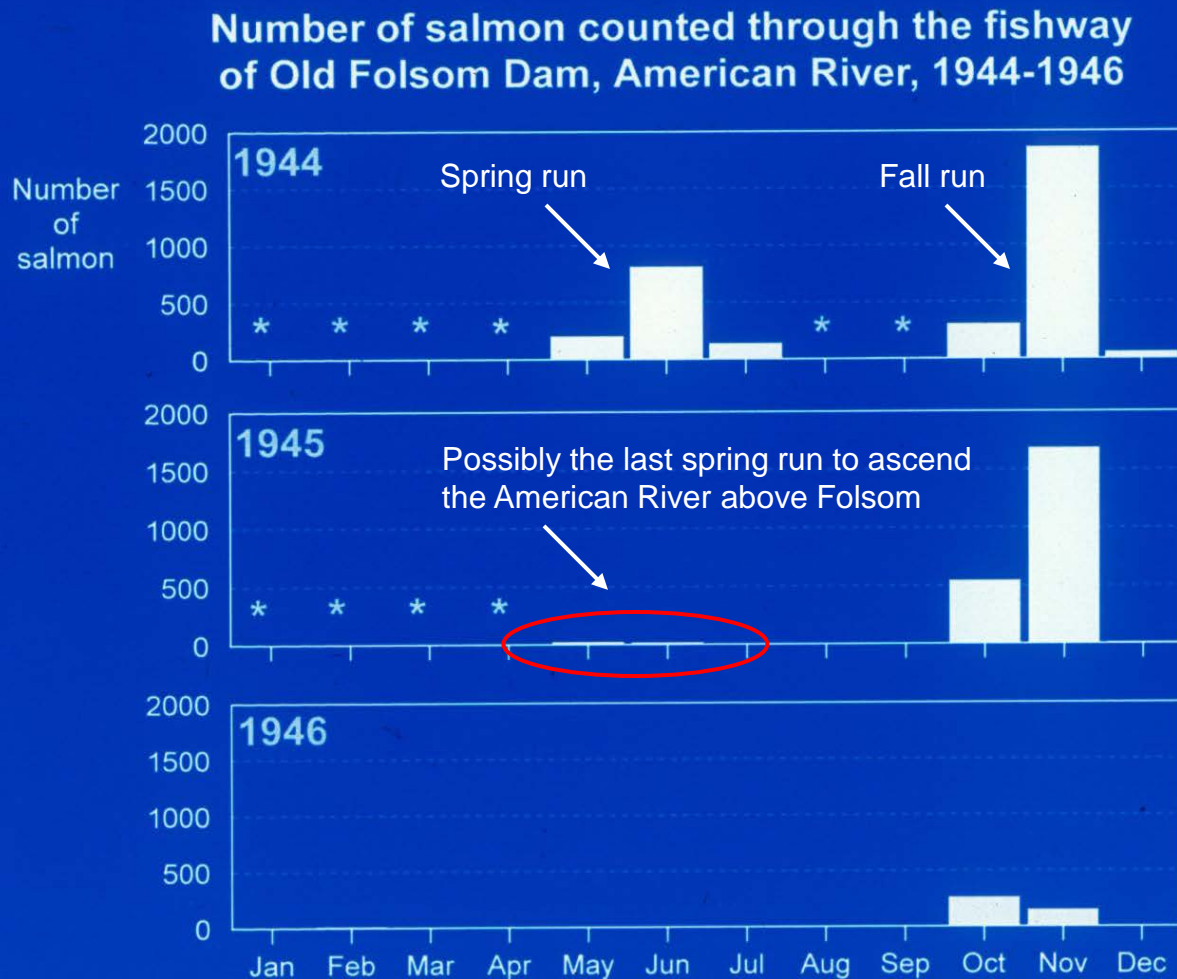
Periods of flow and temperature management on the lower American River

- Pre-Folsom Project: up to about 1950
 - Spring-run Chinook still in the system



Salmon anglers on the American River at Sailor Bar. Photo: Terry Linton, CDFW

Spring-run Chinook salmon still in the system prior to construction of the Folsom Project



* Not actively looking for salmon in the fishway



Periods of flow and temperature management on the lower American River

- Pre-Folsom Project: up to about 1950
- Era of USBR control: 1950s – c. 1990
 - SWRCB Water Right Decision D-893
 - 500 cfs from mid-September through December
 - 250 cfs from Jan. 1 through September 15



Salmon anglers on the American River at Sailor Bar. Photo: Terry Linton, CDFW



Periods of flow and temperature management on the lower American River

- Judge Hodge Era: 1990s
 - Formation of American River Operations Group (AROG)
 - Court mandated studies to reduce uncertainty
 - ESA listing of Central Valley steelhead: 1997



Salmon anglers on the American River at Sailor Bar. Photo: Terry Linton, CDFW



Periods of flow and temperature management on the lower American River

- Recent temperature management: 2000s
 - 2001 → studies on juvenile steelhead oversummering
 - 2004 → discovery of “rosy anus” in juvenile steelhead
 - 2007 → Flow Management Standard
 - 2009 → OCAP Biological Opinion for the CVP/SWP



Salmon anglers on the American River at Sailor Bar. Photo: Terry Linton, CDFW



Importance of water temperature

- **Question:** *How does temperature affect salmon and steelhead in the lower American River?*



Juvenile Chinook salmon, Dry Creek, Placer Co. Photo: Bill Snider



Fish are ectotherms!



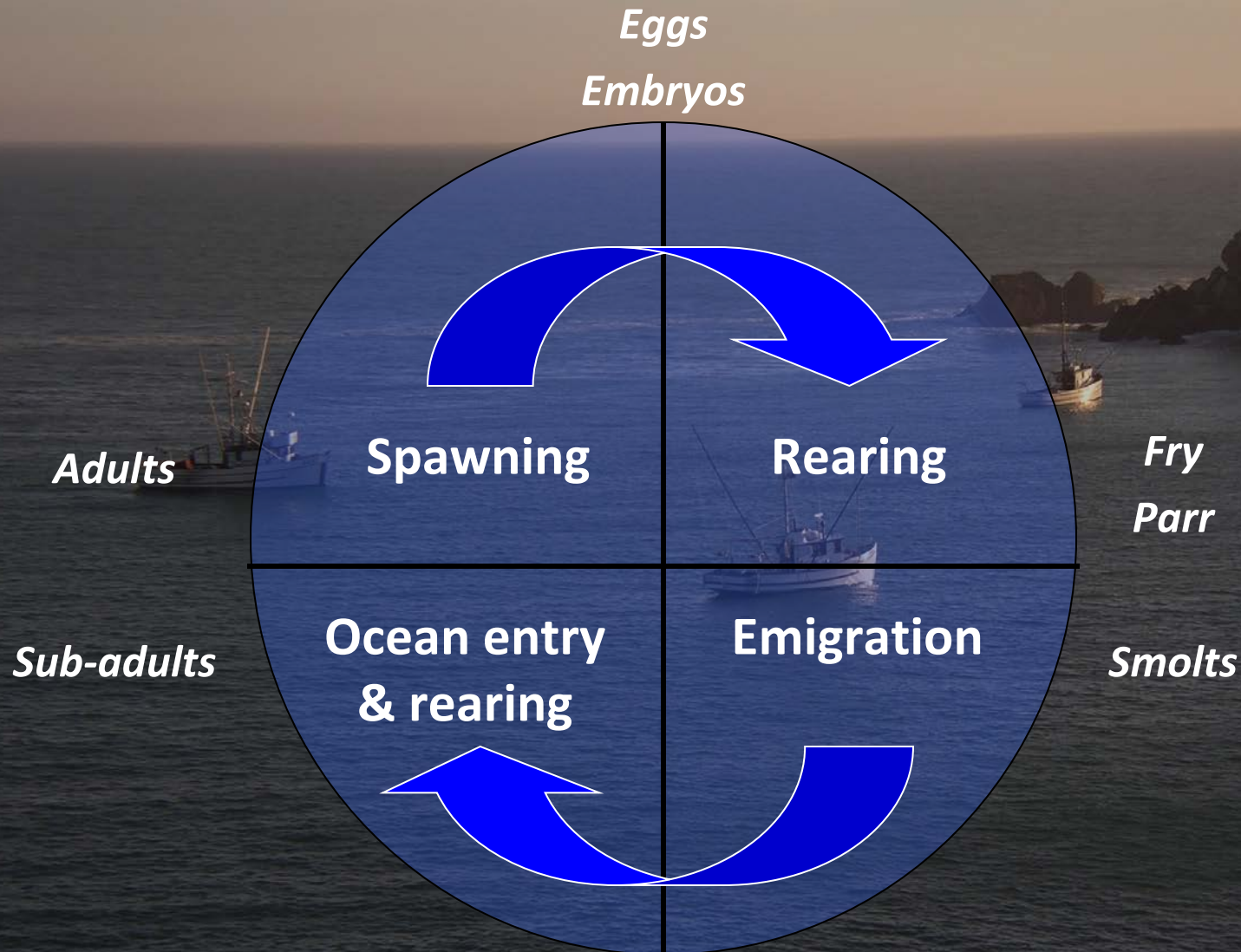
Chinook salmon (*Oncorhynchus tshawytscha*)



Steelhead rainbow trout (*Oncorhynchus mykiss*)



Life is split between fresh and salt water – anadromous life cycle



Salmon trollers off Point Ross, Sonoma Co. Photo: Rob Titus



Basic habitat needs of salmon & steelhead in fresh water

- 1. Sufficient flow of cool, well-oxygenated water*
- 2. Clean gravels for redds*

Flow and water temperature limit Chinook salmon and steelhead production on the American River



Lower Sunrise Bar at 1,500 cfs. Photo: Rob Titus



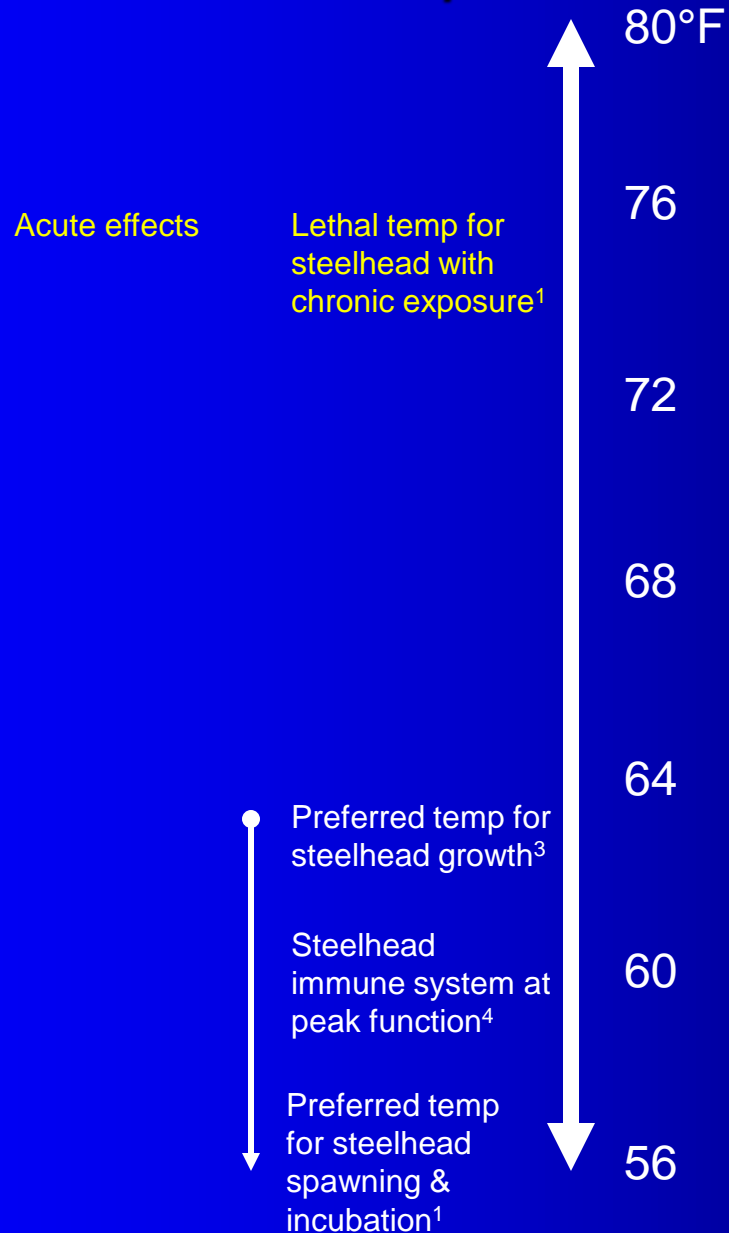
Competing temperature demands between Chinook salmon and steelhead

- Juvenile steelhead oversummering
 - *Need daily mean water temperature of 65 °F or lower*
- Chinook salmon spawning in fall
 - *Water temperature below 60 °F (58 °F or less for eggs)*
- Limited coldwater pool in Folsom Lake



Salmon anglers on the American River at Sailor Bar. Photo: Terry Linton, CDFW

Steelhead Temperature Requirements



¹ Moyle (2002)

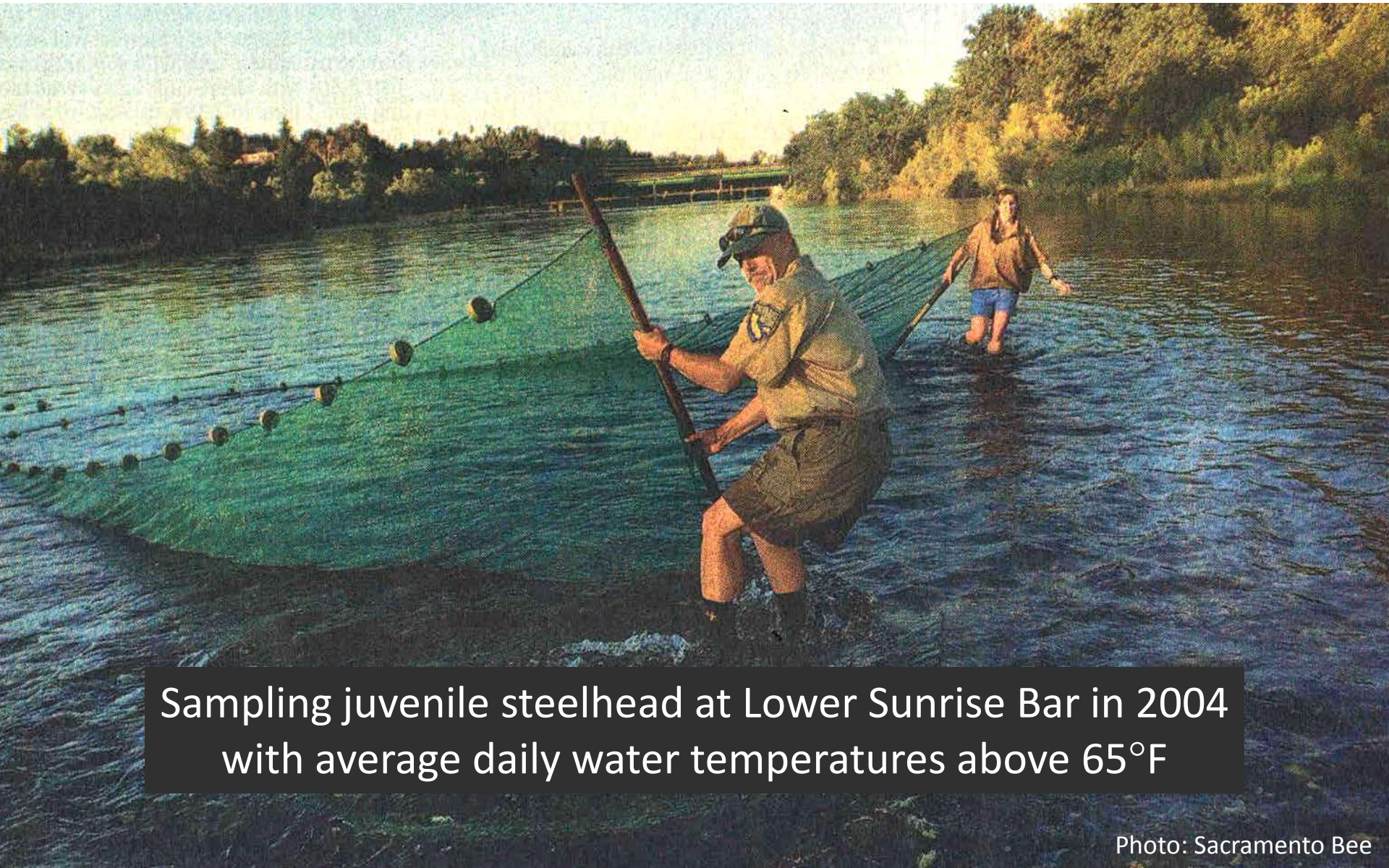
² Present study

³ Myrick and Cech (2000)

⁴ W. Cox, DFG, pers. comm.



Assessment of juvenile steelhead on the lower American River: 2001 and onward

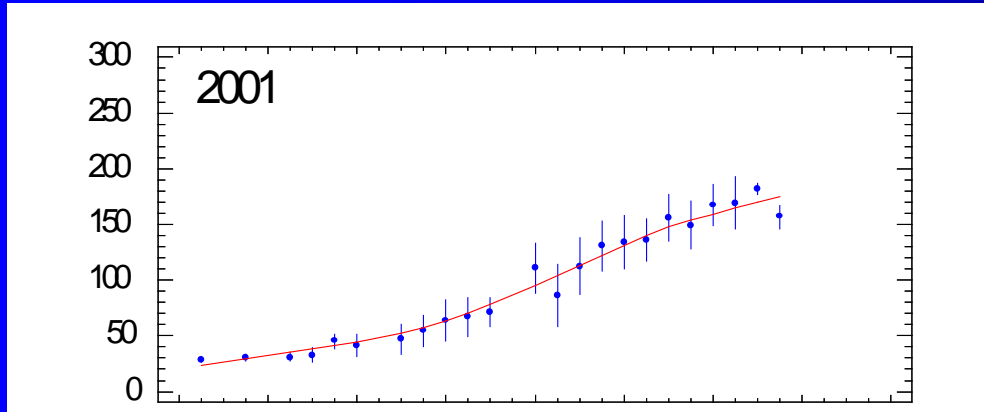


Sampling juvenile steelhead at Lower Sunrise Bar in 2004
with average daily water temperatures above 65°F

Mean individual growth rates of *PIT-tagged steelhead*

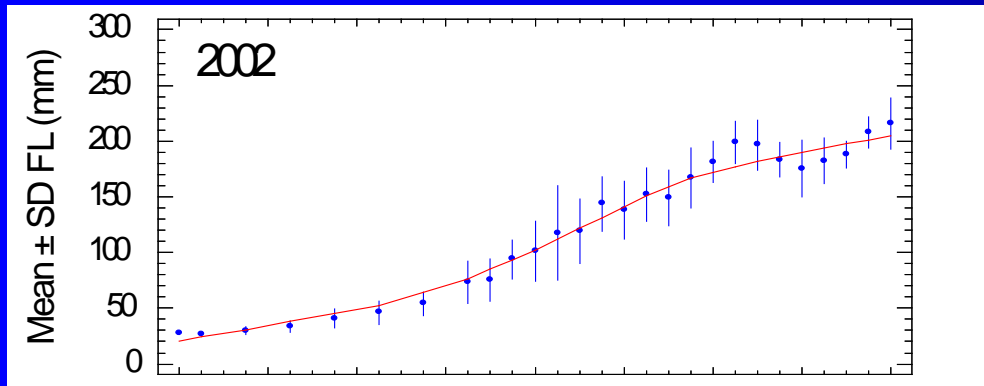
- 0.82 mm / day

- $n = 9$



- 1.07 mm / day

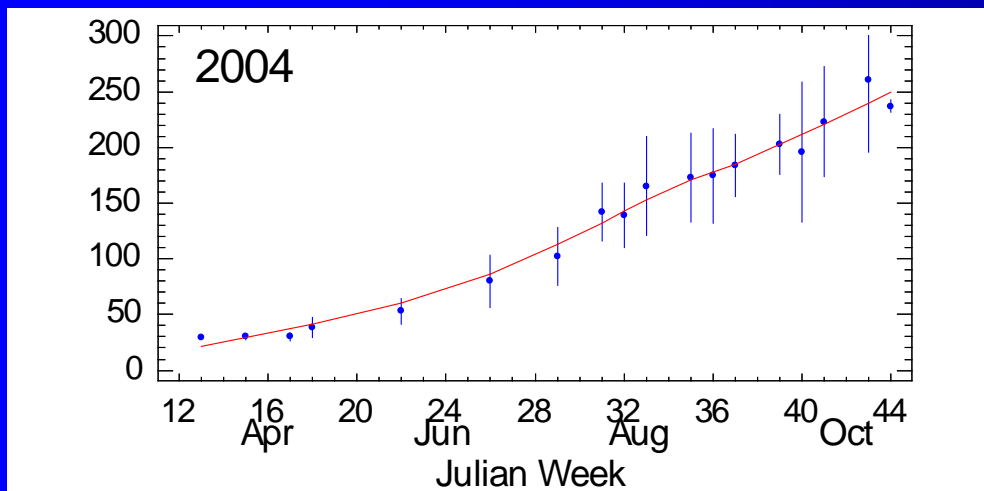
- $n = 47$



Generally, juvenile steelhead grow very quickly on the lower American River

- 1.02 mm / day

- $n = 38$





Lower American River
Habitat Unit: 152
July 28, 2004
157 mm, 52.9 g

Juvenile steelhead with high
condition factor

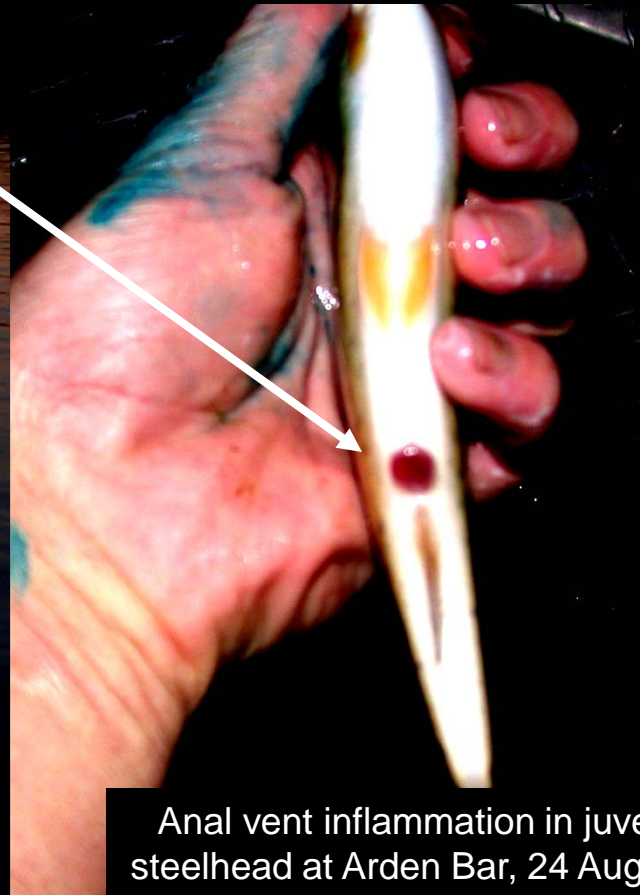
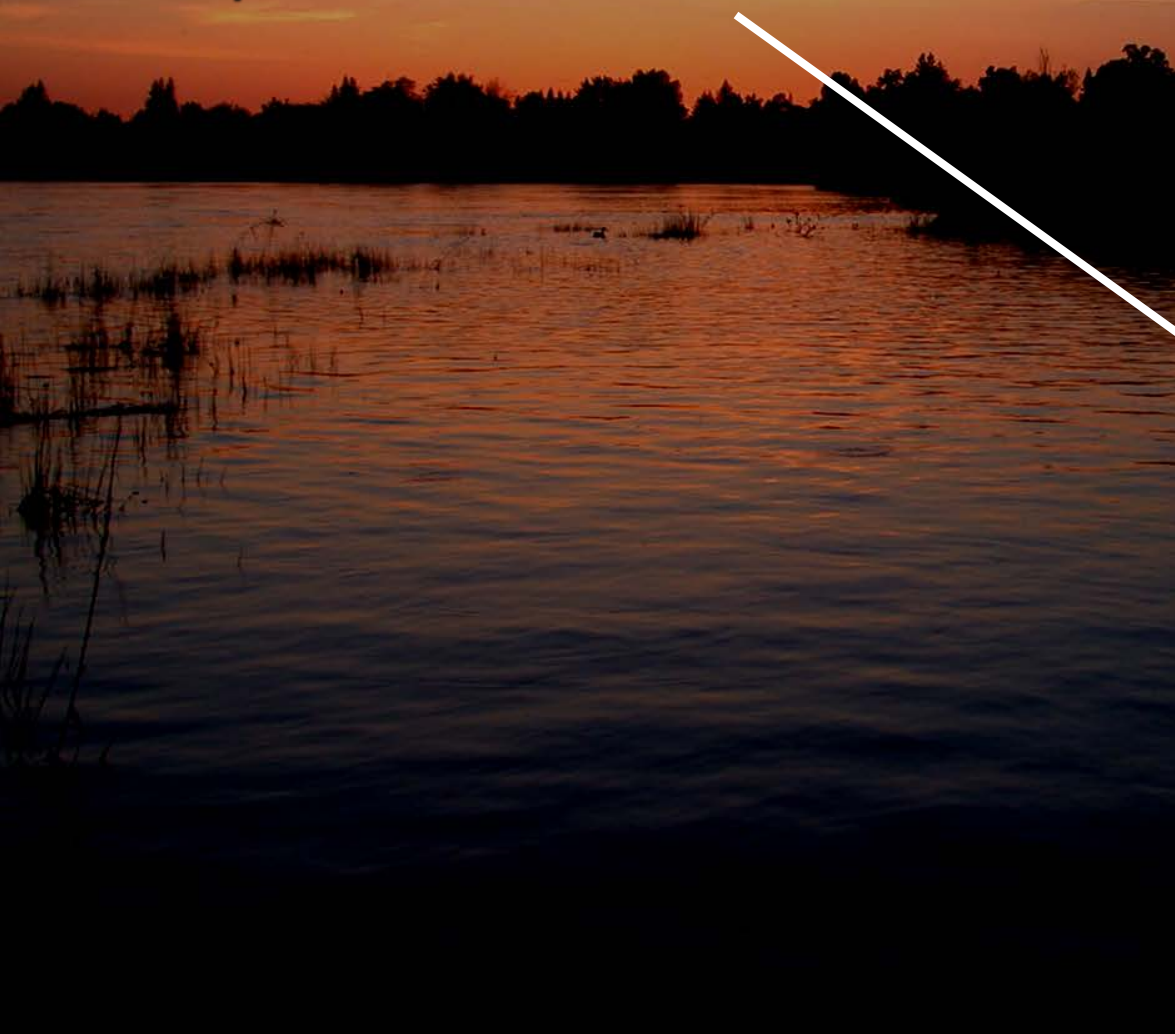
$K = 1.37$



Juvenile steelhead in poor condition,
Secret Ravine (Dry Creek drainage), 12 Nov 2004

$K = 0.78$

In August 2004, we began to observe signs of disease among wild steelhead sampled in the lower American River



Anal vent inflammation in juvenile steelhead at Arden Bar, 24 Aug 2004

FISH PATHOLOGIST REPORT

Location

Lower American River

Date

October 6, 2004

Species

Steelhead

Holding Area

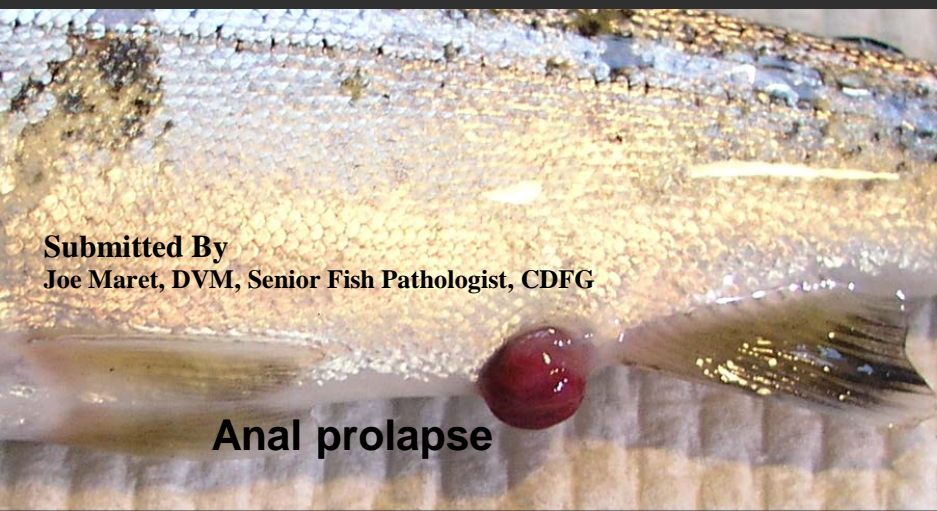
NA – wild fish

Parasites and Disease Condition

Fish presented with “rosy anus”. Internally, fish showed inflammation of the posterior intestine. Moderate to high numbers of mixed, motile bacteria were observed in scrapes of inflamed areas. Aside from the “rosy anus”, the steelhead appeared to be in excellent body condition.

Comments

The bacteria infection is the likely cause of the “rosy anus”. Steelhead may be more susceptible to bacteria infection due to stress from higher than optimal water temperatures. Fish were ~8 inches in length.



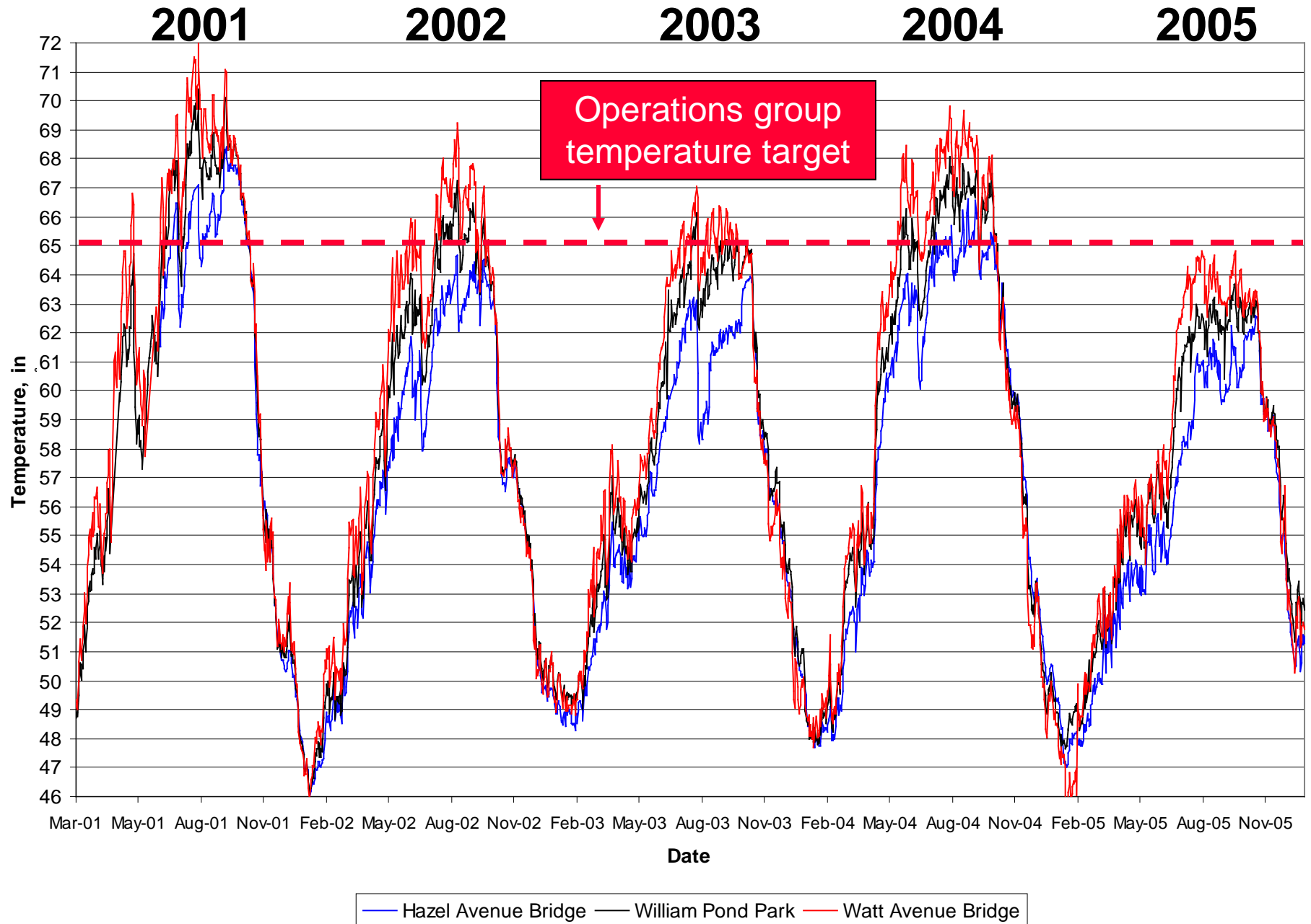
Submitted By

Joe Maret, DVM, Senior Fish Pathologist, CDFG

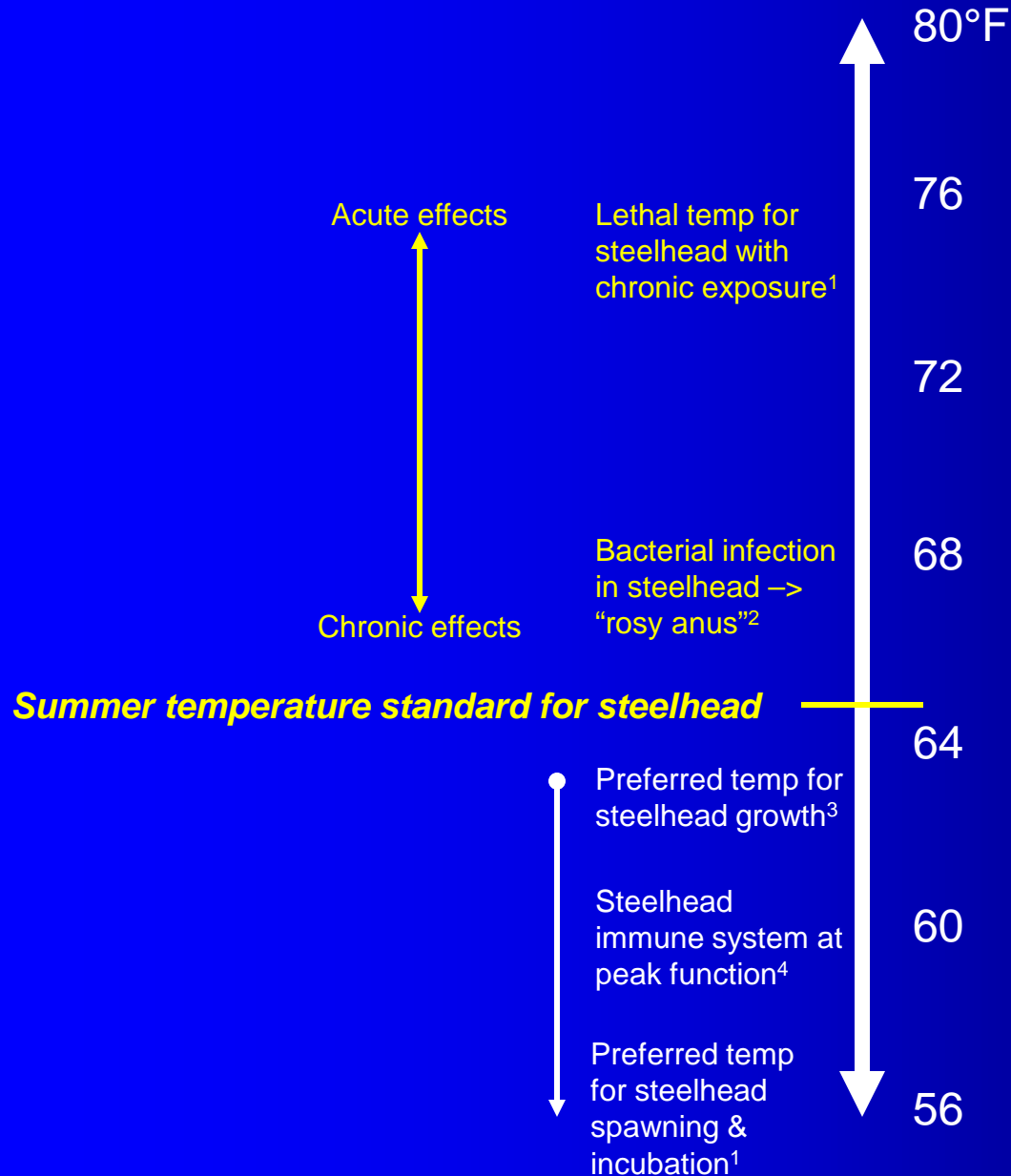


Photos: Rob Titus, CDFW

Annual thermograph on the lower American River



Steelhead Temperature Requirements



¹ Moyle (2002)

² Present study

³ Myrick and Cech (2000)

⁴ W. Cox, DFG, pers. comm.

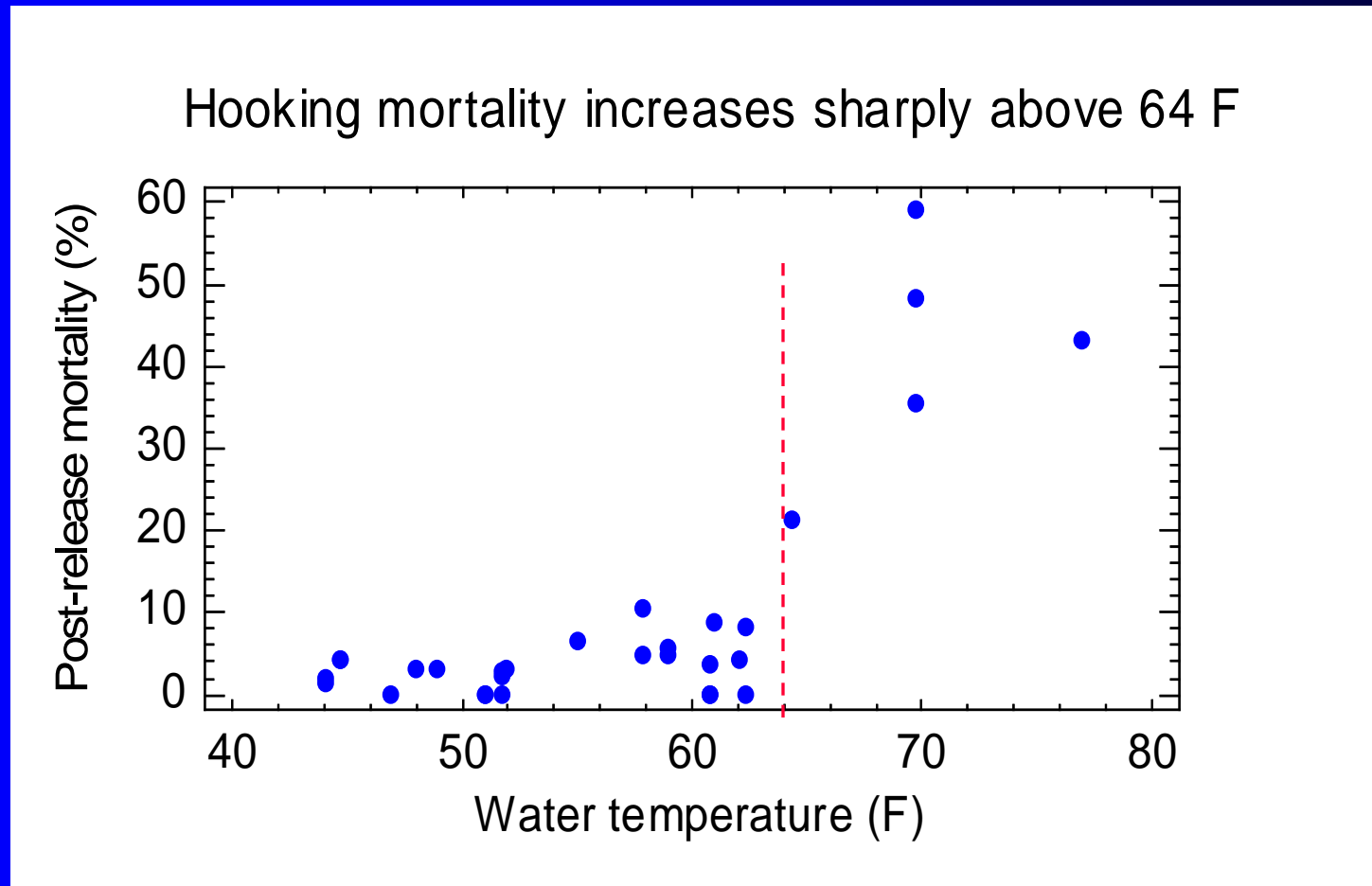
Protective regulations for wild steelhead

- Barbless hooks
 - Zero bag limit
- } Facilitate catch-and-release fisheries



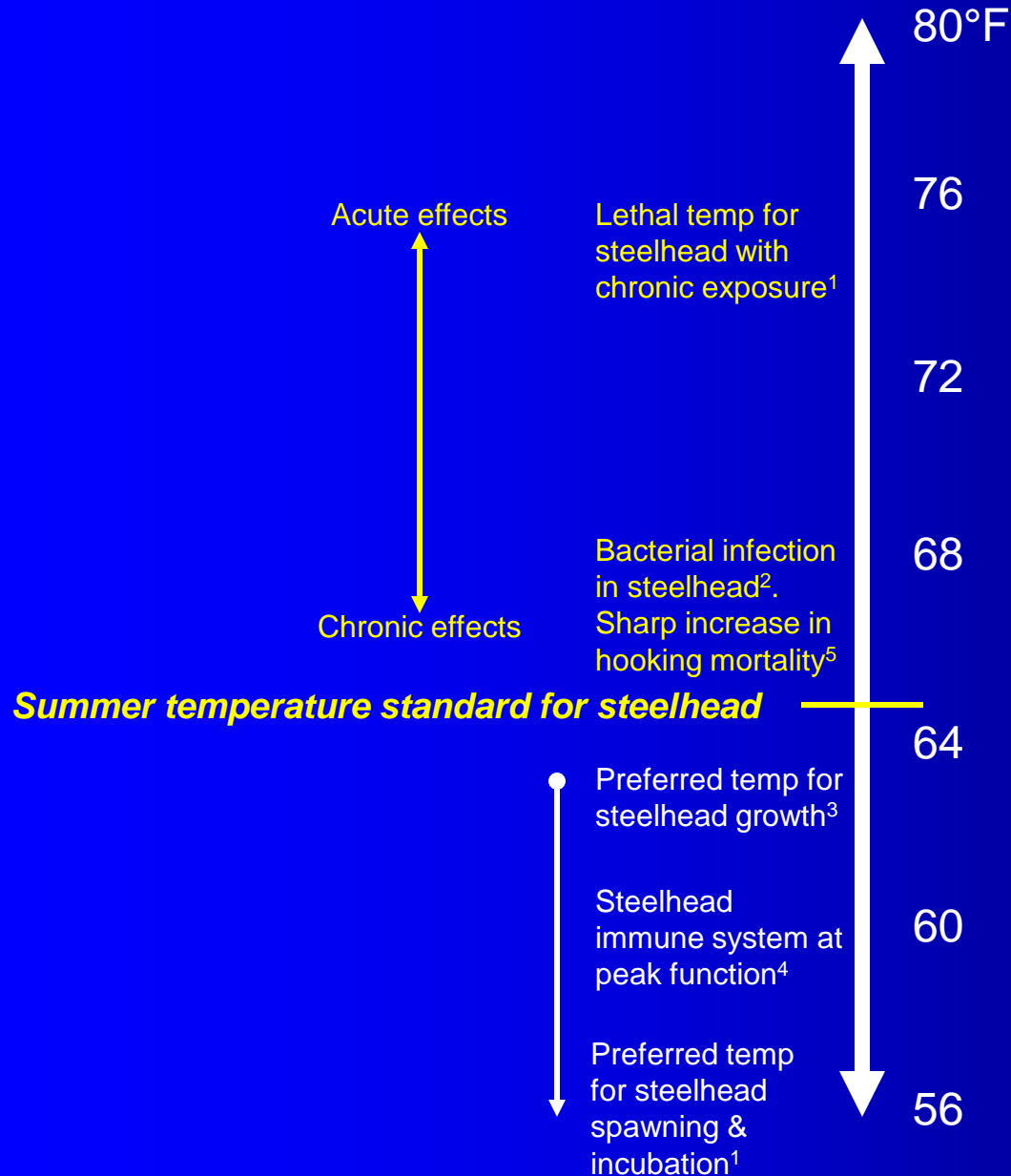
Source: www.flyguysoutfitting.com/barbless.html

*Post-release mortality of steelhead/rainbow and cutthroat trout**



* Fish captured with artificial lures and flies

Steelhead Temperature Requirements



¹ Moyle (2002)

² Present study

³ Myrick and Cech (2000)

⁴ W. Cox, DFG, pers. comm.

⁵ Titus & Vanicek (1988), others



1,500 cfs in October 2004

***Rearing space in bar
complex habitats
decreases with drop
in flow***

Riffle at Arden Bar



1,000 cfs in September 2004

***Are steelhead
displaced into deeper
water habitats where
predators are
abundant?***

Photos: Mike Brown, DFG

Steelhead Temperature Requirements

**Large (30-40 species),
complex warmwater fish
community with high
predation risk**

Acute effects

Chronic effects

Summer temperature standard for steelhead

**Small (4-5 species), simple
coldwater fish community
with low predation risk**

Lethal temp for
steelhead with
chronic exposure¹

Bacterial infection
in steelhead².
Sharp increase in
hooking mortality

Preferred temp for
steelhead growth³

Steelhead
immune system at
peak function⁴

Preferred temp
for steelhead
spawning &
incubation¹

80

76

72

68

64

60

56

Upper limit for
striped bass
rearing¹

86

Temp range for
adult largemouth
bass growth¹

Temp range for
striped bass
spawning: Apr-
Jun¹

Temp range for
largemouth bass
spawning: Apr-
Jun¹

Temp range for
pikeminnow
rearing¹

Temp range for
pikeminnow
spawning: Apr-
May¹

¹ Moyle (2002)

² Present study

³ Myrick and Cech (2000)

⁴ W. Cox, DFG, pers. comm.

⁵ Titus & Vanicek (1988), others



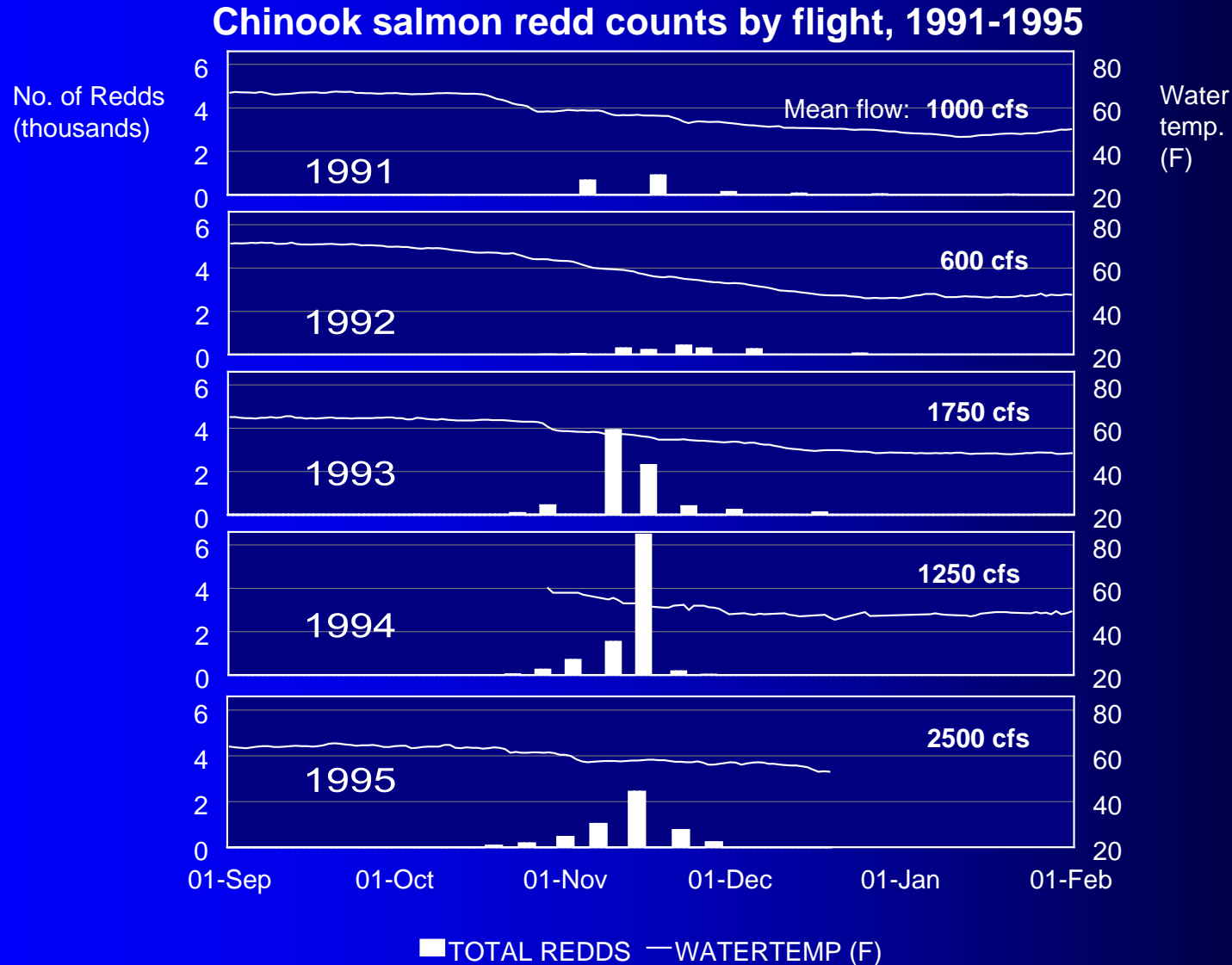
Temperature effects on Chinook salmon spawning on the lower American River



Aerial view of Chinook salmon redds at Upper Sunrise

Photo: CDFW

Chinook salmon initiate spawning when mean daily water temperature falls below 60°F





High pre-spawning mortality of Chinook at low flow and high temperature

- In 2001, about two-thirds of adult females died before spawning
 - *Very large spawner population (over 150,000 adults)*
- Suitable spawning conditions
 - *~2,500 cfs to accommodate ~70,000 adults*
 - *Water temperature below 60 °F (58 °F or less for eggs)*



Salmon anglers on the American River at Sailor Bar. Photo: Terry Linton, CDFW



Bottom-line temperature considerations

- Daily mean water temperature of 65°F *or less* at Watt Avenue to protect steelhead
- Regulatory connections
 - ESA recovery, Fish and Game Code 5937



Steelhead catch on the lower American River



Bottom-line temperature considerations

- Enhance coldwater pool in Folsom Lake to maintain biodiversity of Chinook salmon on the American
- Balance temperature needs of Chinook salmon and steelhead

