Homing Patterns of Wild and Supplemented Salmon Within a Watershed: Tradeoffs between Homing and Spawning Site Selection

Andrew Dittman
Donald Larsen
Mary Moser
Darran May
Dave Fast
Mark Johnston

Outline

-Homing/imprinting:
Why should we care?

-The YKFP project

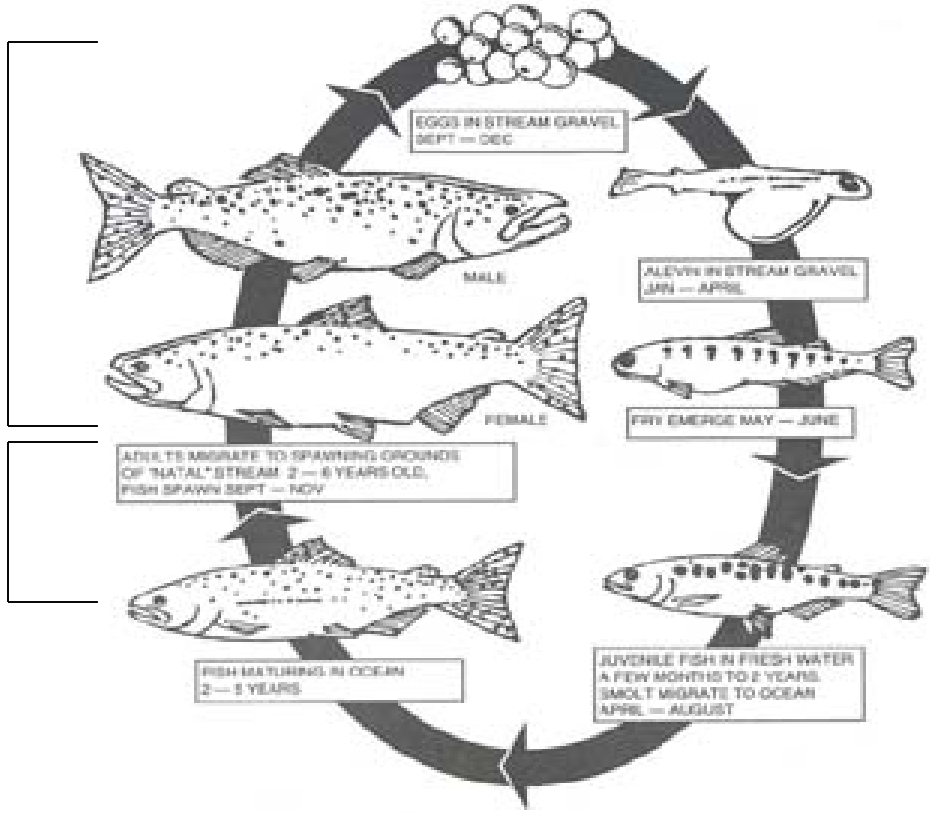
-Homing patterns of Yakima Spring chinook

-Teanaway utilization

Spring chinook salmon: imprinting and homing

Homing to the natal site, release site; Spawning site selection; Mate choice

Homing to the natal watershed; holding areas



LIFE CYCLE OF CHINOOK SALMON

Presumed sensitive periods for imprinting

Smolting: sensitive period for imprinting; transfer to acclimation sites

Definitions

Homing:

For wild fish, home is the natal stream where they hatched and emerged from the gravel (<u>but</u> also spawning site selection; mate choice).

For hatchery-reared fish, home is less well defined:

- **Site of release?**
- **Rearing site(s)?**
- **Ancestral spawning grounds?**

In general, fish released offsite from their hatchery typically return to their release site (Donaldson and Allen 1958; many others…)

NOAA Salmon Recovery Efforts

-Abundance

-Productivity (Population Growth rate)

-Diversity

-Spatial Structure

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42,156 p.

NOAA Salmon Recovery Efforts

-Abundance

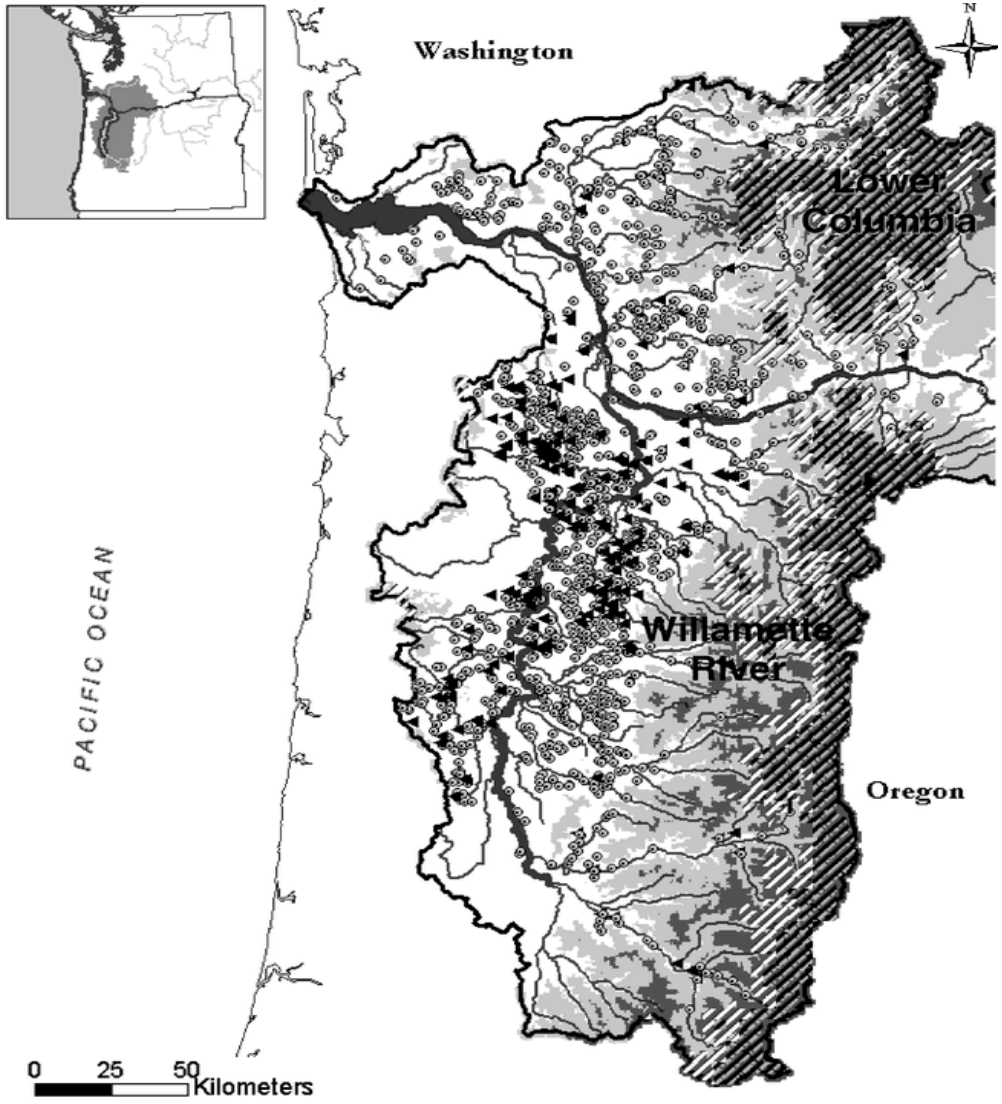
-Productivity (Population Growth rate)

-Diversity

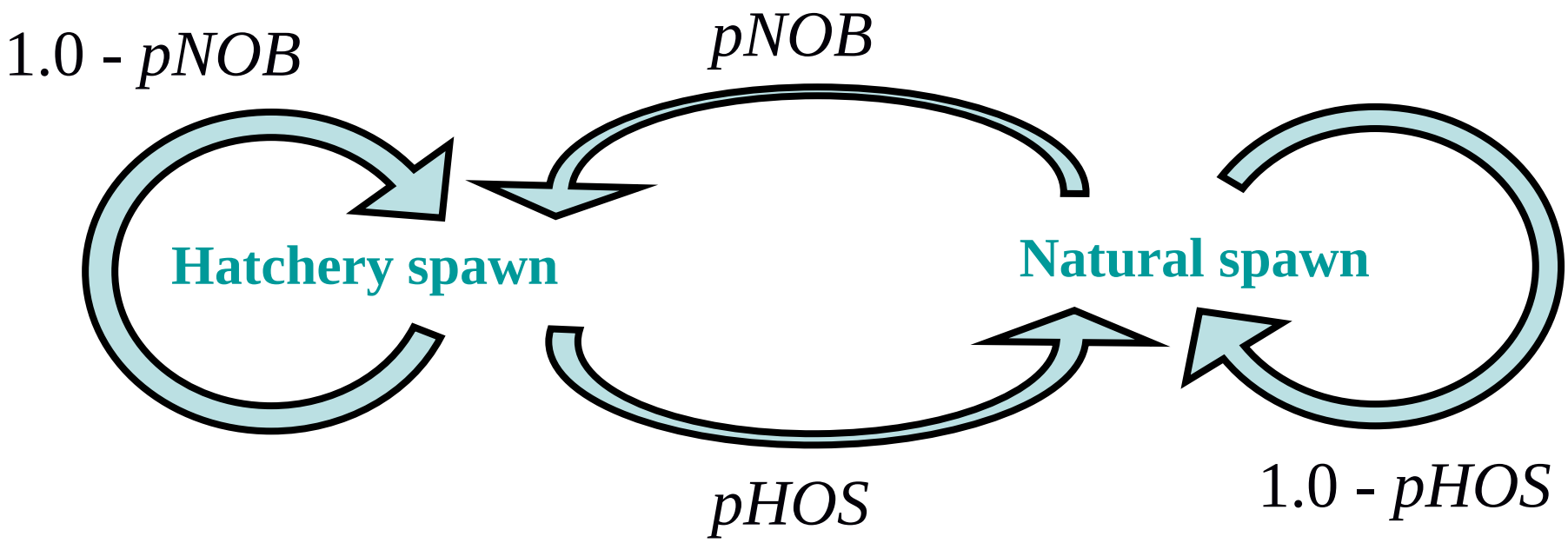
-Spatial Structure

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42,156 p.

Barrier removal and habitat recovery



Sheer and Steel 2006. TAFS



pNOB = proportion of hatchery broodstock composed of natural-origin adults

pHOS = proportion of naturally-spawning fish composed of hatchery-origin adults

"Rear and release fish in ways that improve homing to the hatchery."

HSRG Reviews of Columbia River Hatchery Programs 2007

Habitat Impacts

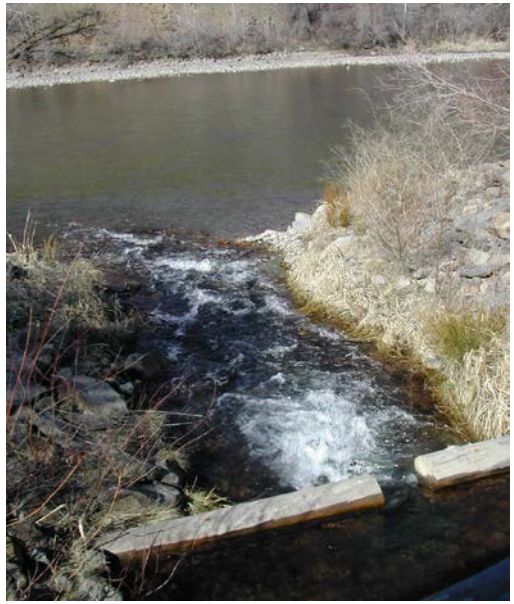
Logging

Dams

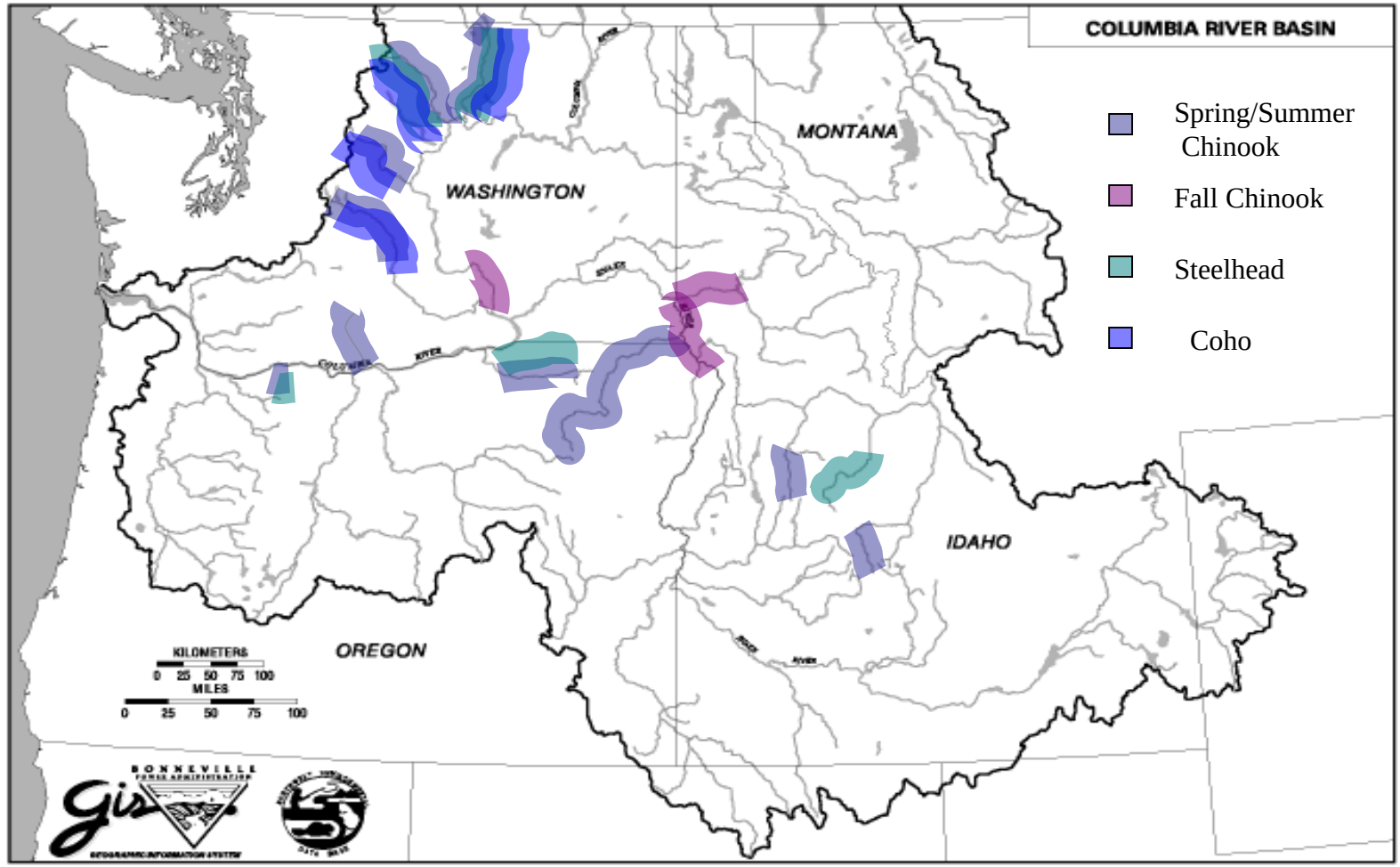
Irrigation

Development

Satellite acclimation sites in supplementation



The growing role of acclimation facilities in supplementation programs



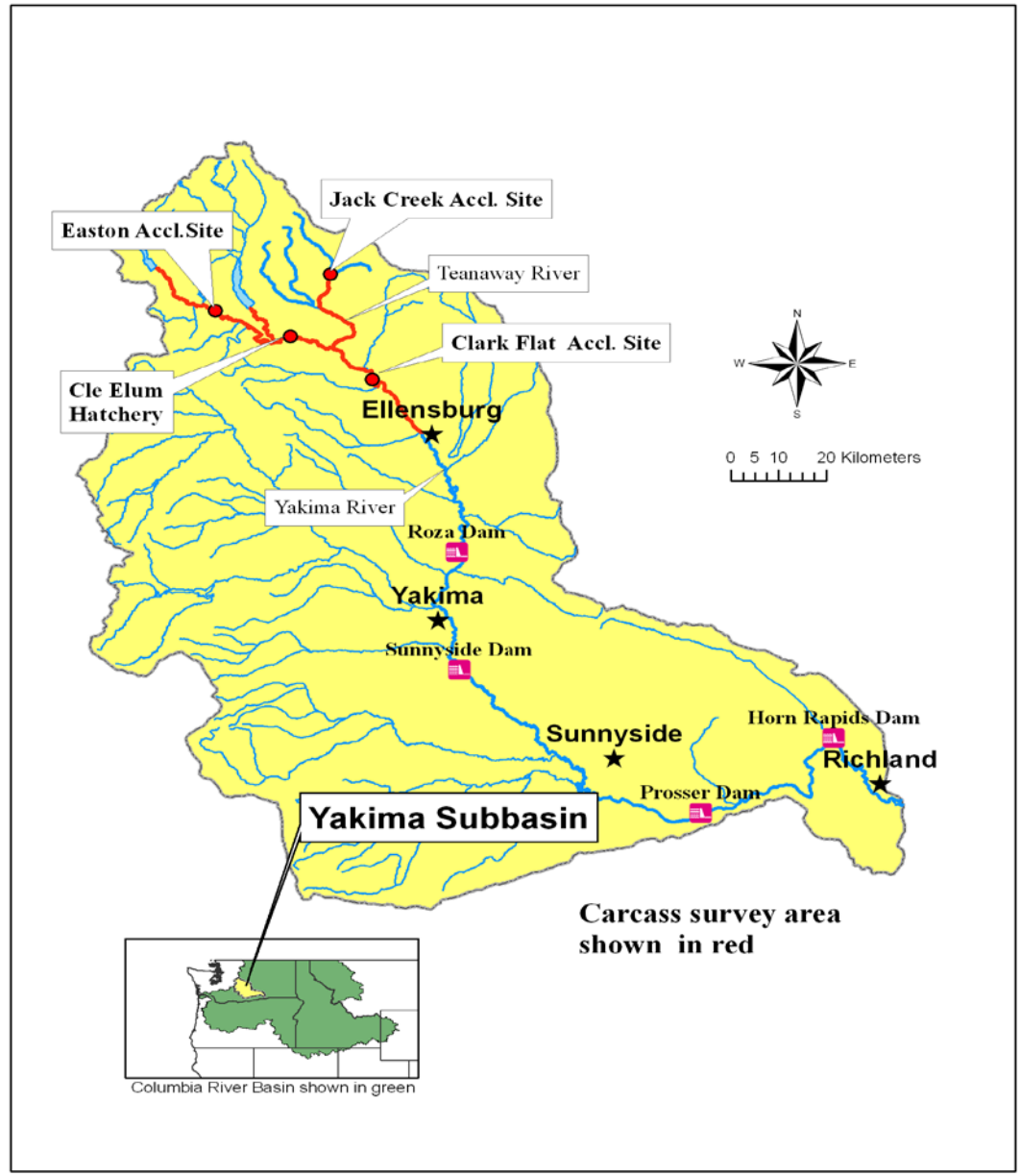
Outline

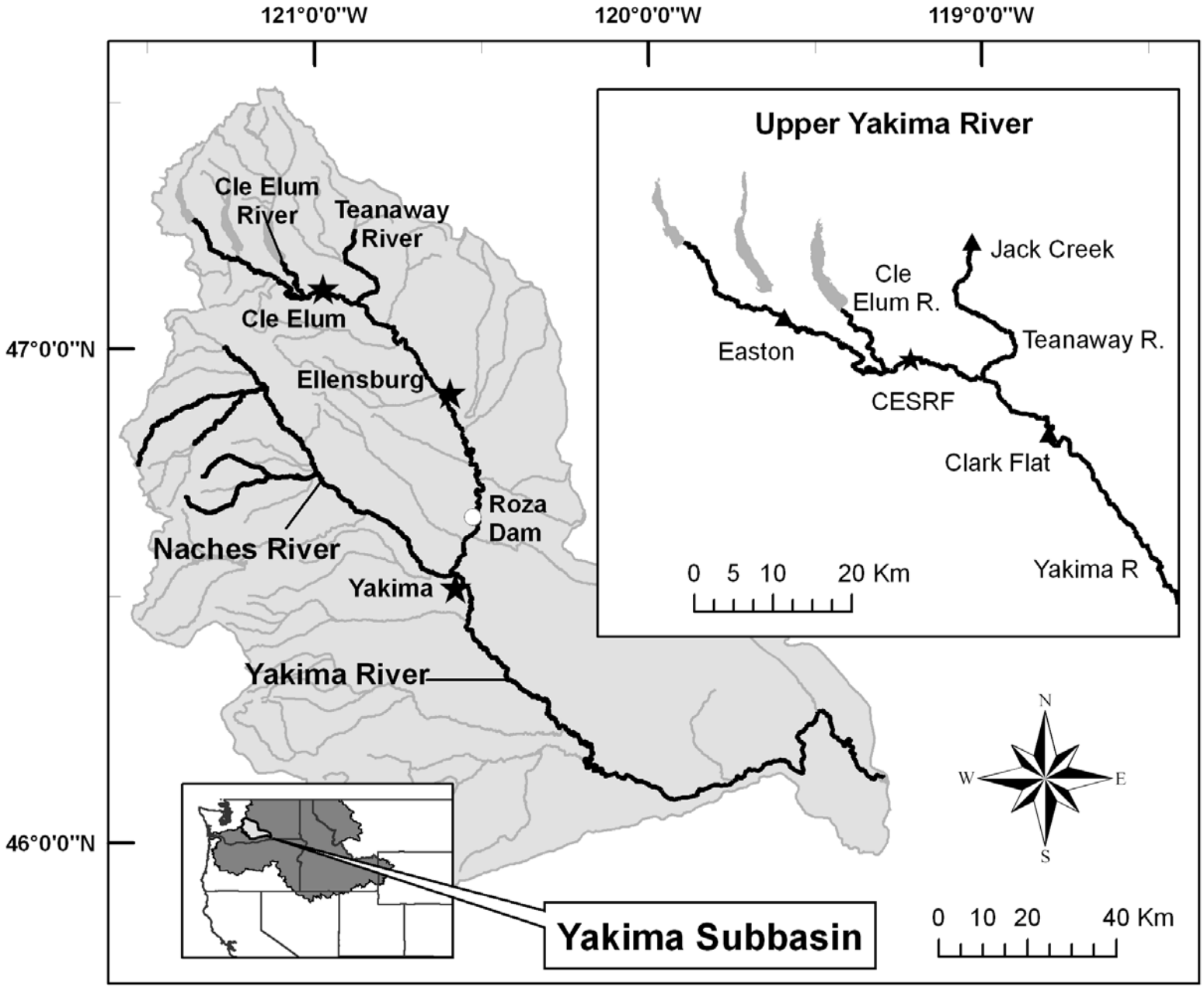
-Homing/imprinting:
Why should we care?

-The YKFP project

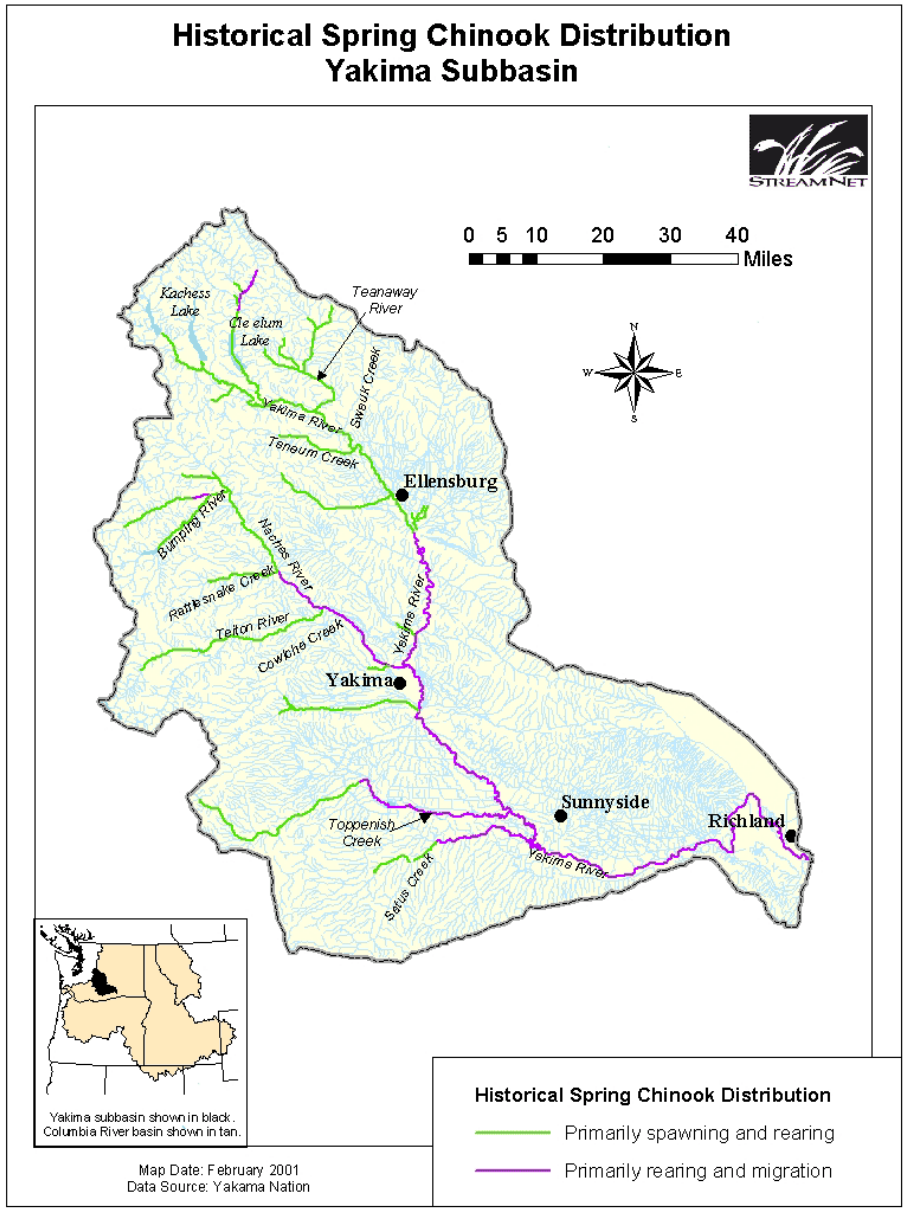
-Homing patterns of Yakima Spring chinook

-Teanaway Utilization



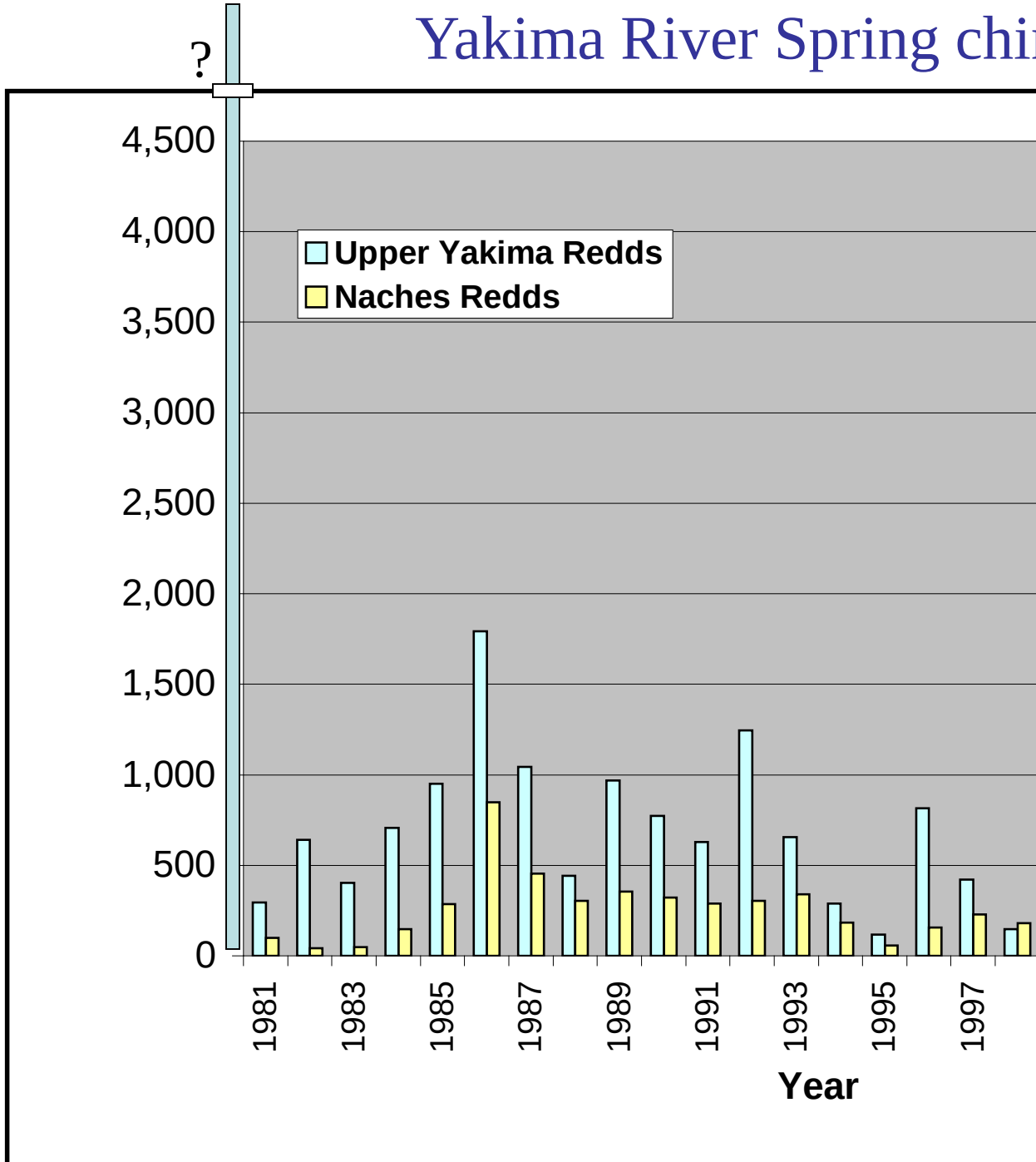

121°0'0"W
120°0'0"W
119°0'0"W
47°0'0"N
46°0'0"N
Cle Elum River
Teanaway River
Cle Elum
Ellensburg
Roza Dam
Naches River
Yakima
Yakima River
Upper Yakima River
Jack Creek
Cle Elum R.
Teanaway R.
Easton
CESRF
Clark Flat
Yakima R
0 5 10 20 Km
N
W
E
S
0 10 20 40 Km
Yakima Subbasin

Yakima River Spring chinook population



Historical levels of Yakima Spring chinook estimated to be ~200,000 spawners

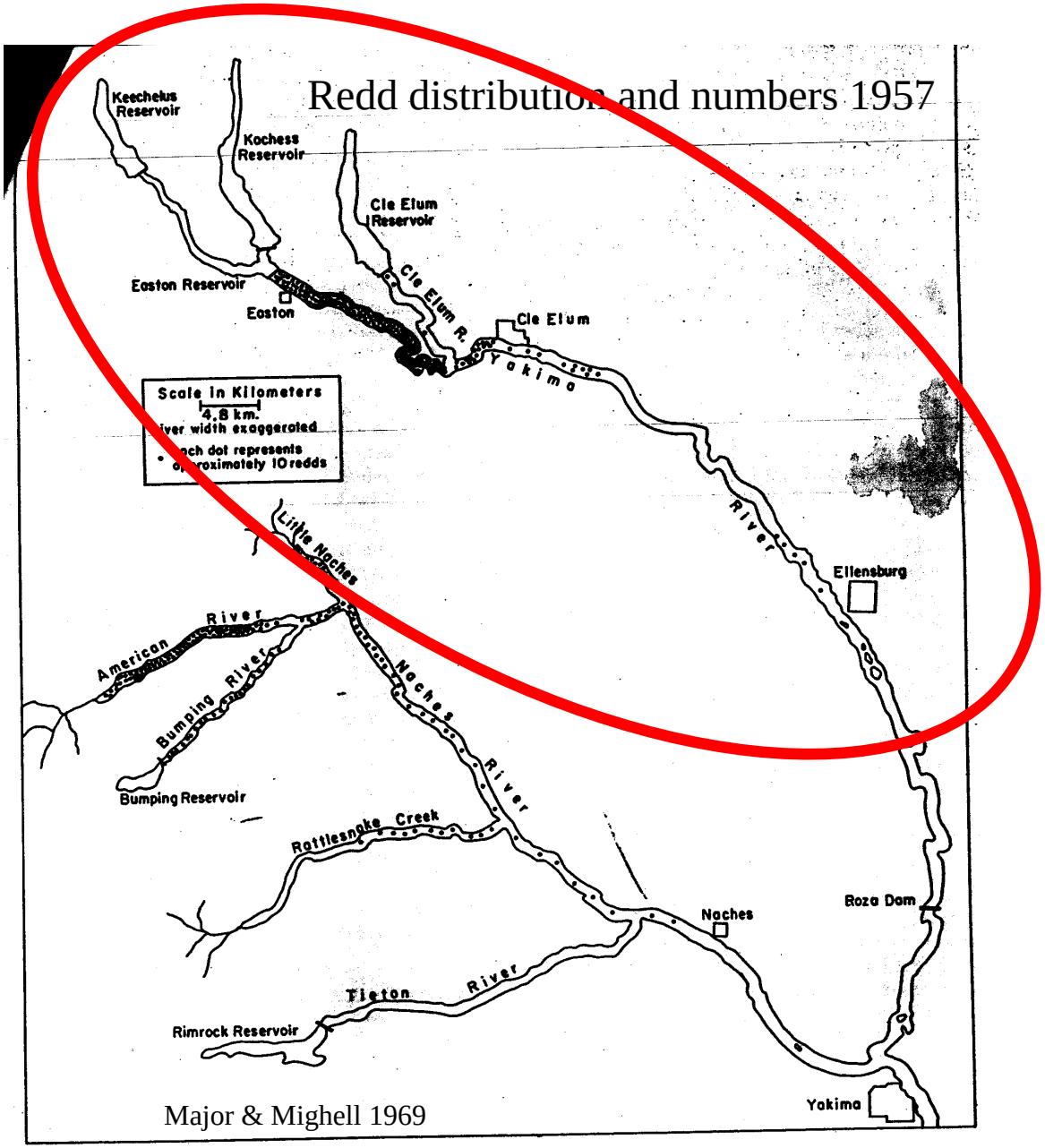
Yakima River Spring chinook population



Historical levels of Yakima Spring chinook estimated to be ~200,000 spawners

By mid-1900's, dams, logging, and flow regulation for irrigation contributed to a dramatic decline in numbers. Average run size in 1980-1990's = 3500 fish

Yakima River Spring chinook population

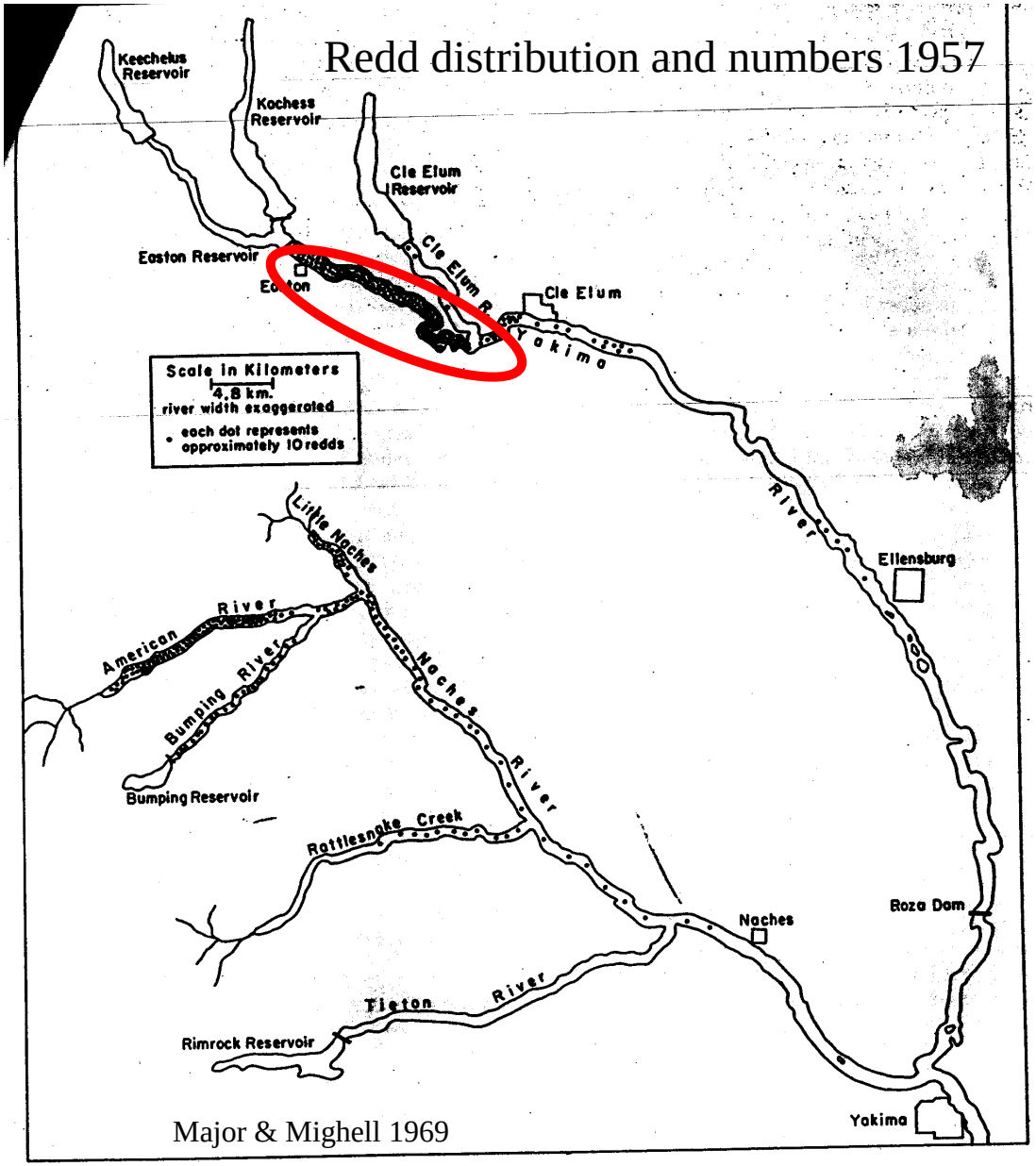


Historical levels of Yakima Spring chinook estimated to be ~200,000 spawners

By mid-1900's, dams, logging, and flow regulation for irrigation contributed to a dramatic decline in numbers. Average run size in 1980-1990's = 3500 fish

With decline in numbers, there was a concurrent restriction in spawning distribution

Yakima River Spring chinook population

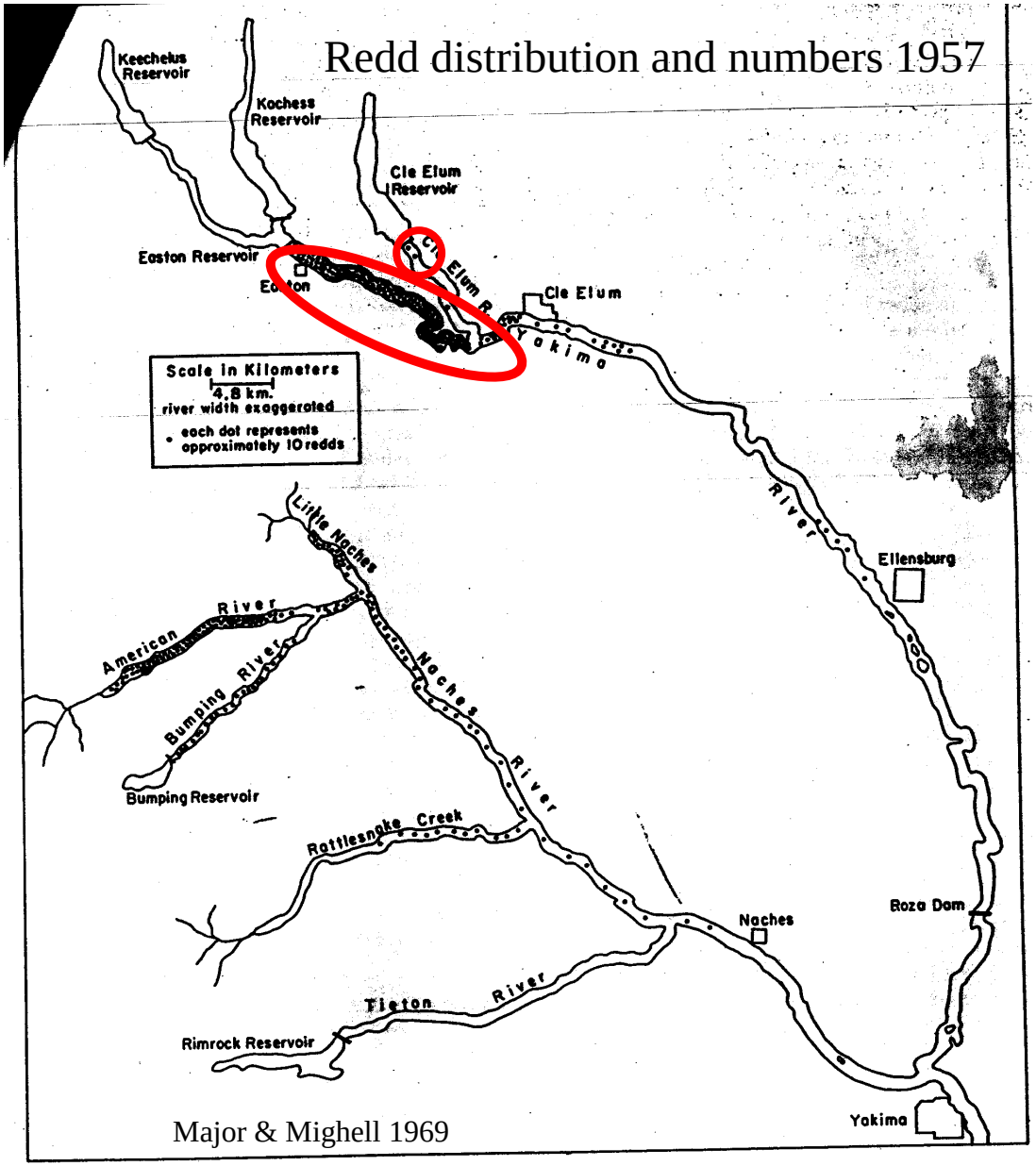


Historical levels of Yakima Spring chinook estimated to be ~200,000 spawners

By mid-1900's, dams, logging, and flow regulation for irrigation contributed to a dramatic decline in numbers. Average run size in 1980-1990's = 3500 fish

With decline in numbers, there was a concurrent restriction in spawning distribution

Yakima River Spring chinook population

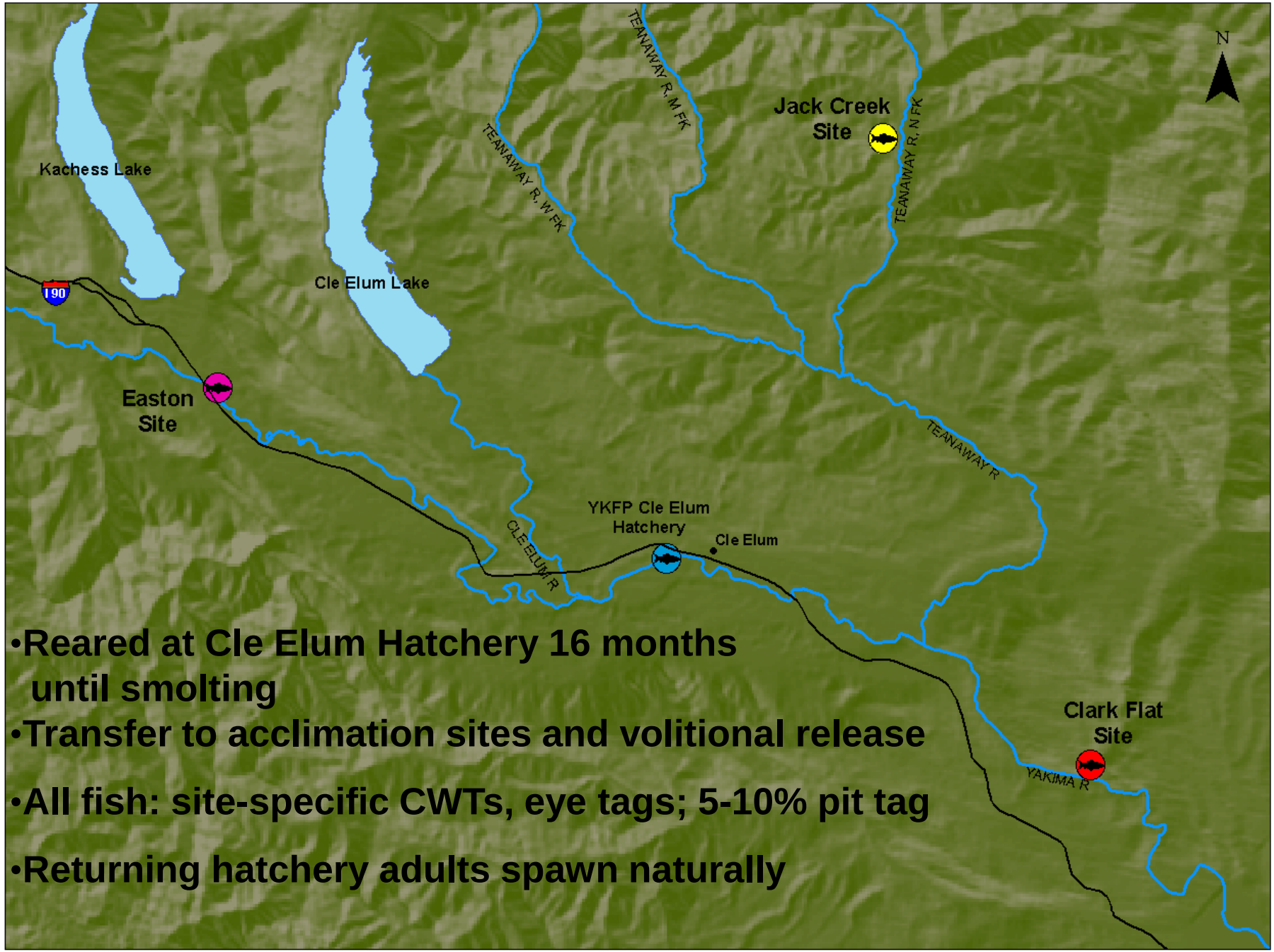


Historical levels of Yakima Spring chinook estimated to be ~200,000 spawners

By mid-1900's, dams, logging, and flow regulation for irrigation contributed to a dramatic decline in numbers. Average run size in 1980-1990's = 3500 fish

With decline in numbers, there was a concurrent restriction in spawning distribution

YKFP Spring chinook supplementation research program



Objectives

Identify and compare the spatial and temporal patterns of homing in wild/naturally spawning vs. hatchery-reared fish

-Efficacy of Acclimation

-Recolonization of underutilized habitat

-Wild vs. Hatchery

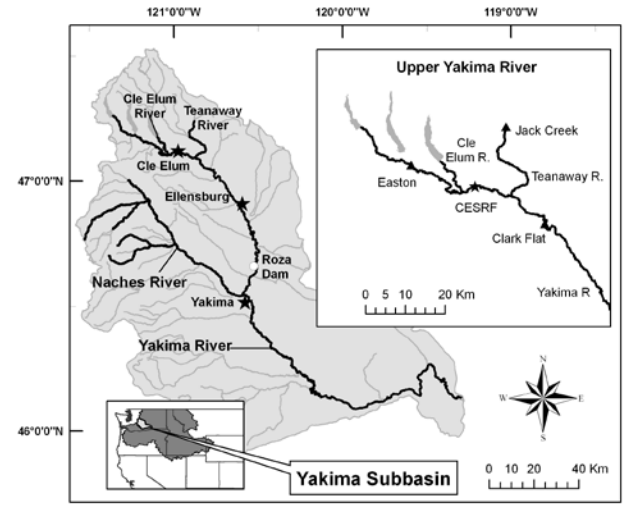
-Pre- vs. post supplementation

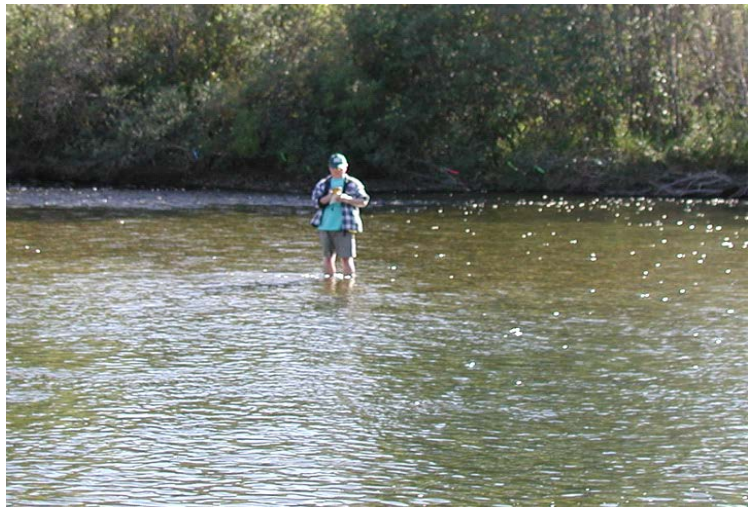
-Insights about homing tradeoffs

Methods

Comprehensive carcass surveys of upper Yakima Basin (2002-2007)

-GPS location (3 m accuracy); date
-hatchery/wild
-male/female; jack, precocious
-length, scale
-tag location, recovery
-egg retention; disease
-dna, otolith
-goo factor (surrogate for spawn timing)





Summary data

	Year					
	2002	**2003**	**2004**	**2005**	**2006**	**2007**
Total Run	8091	3258	10187	5717	3235	2295
Wild*	395	162	1982	1348	492	259
Easton	404	96	177	52	139	130
Clark Flat	608	192	397	47	135	116
Jack Creek	324	138	298	187	188	117
Total sampled	1731	588	2854	1634	954	622
(% of total run)	(21.4%)	(18.1%)	(28.0%)	(28.6%)	(29.5%)	(27.1%)

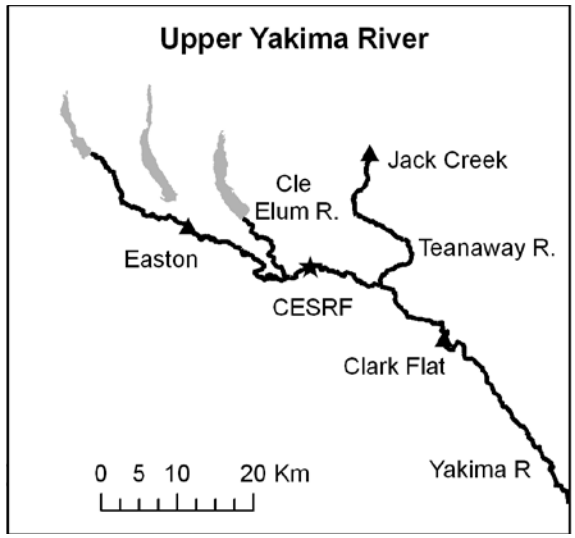
Data

Distribution of carcasses and redds near Cle Elum hatchery

-Log-linear regression models to test for effects of acclimation site, gender, age at return, return year, and brood year on the between river (i.e.Yakima River and its tributaries) distribution of spawners.

- Kruskal-Wallis analysis followed by pair-wise comparisons to examine within river distributions

Tributary distribution of spawners

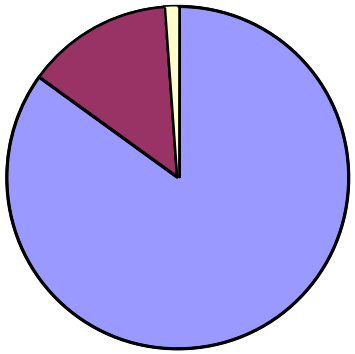


Yakima River

Cle Elum River

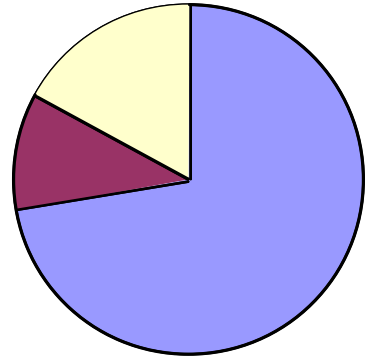
Teanaway River

Wild



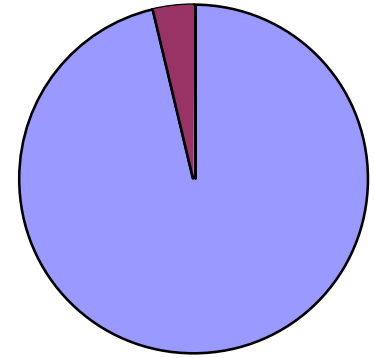
$\neq$

Jack Creek



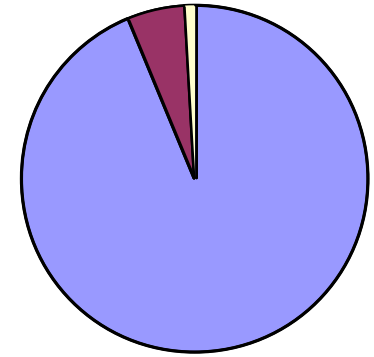
$\neq$

Easton



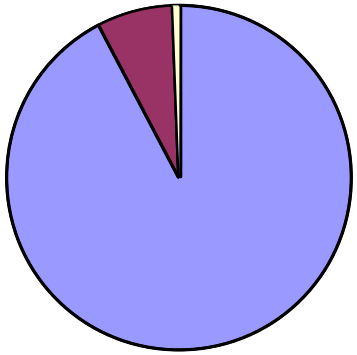
$\simeq$

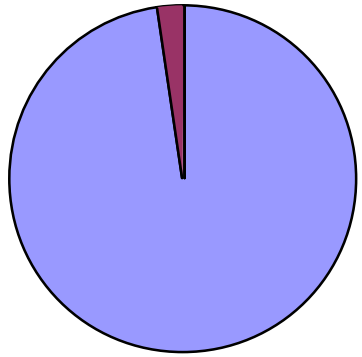
Clark Flat

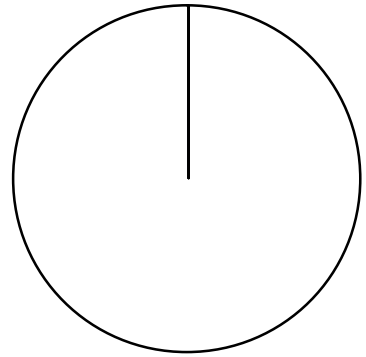


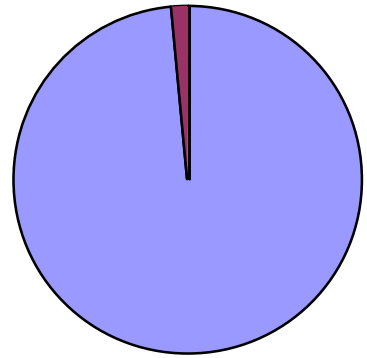
Tributary distribution of spawners

2007







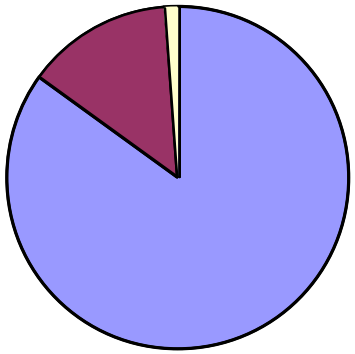


Wild

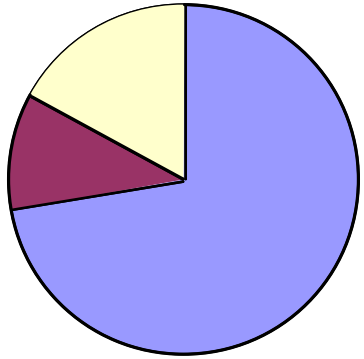
Jack Creek

Easton

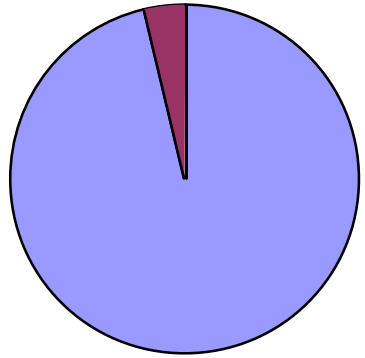
Clark Flat



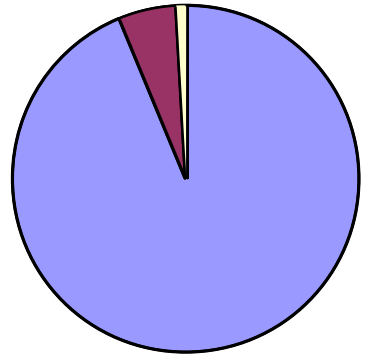
≠



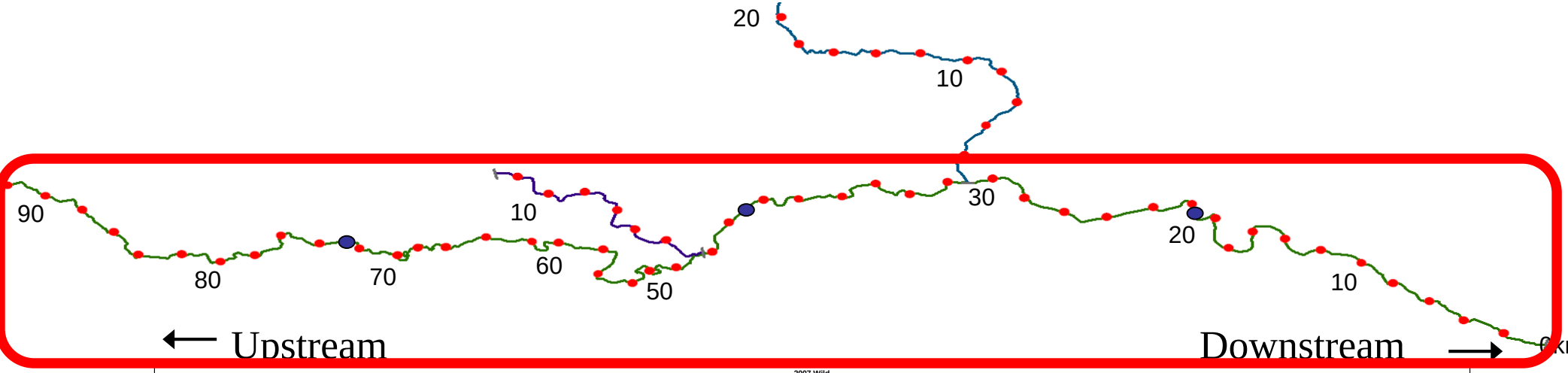
≠

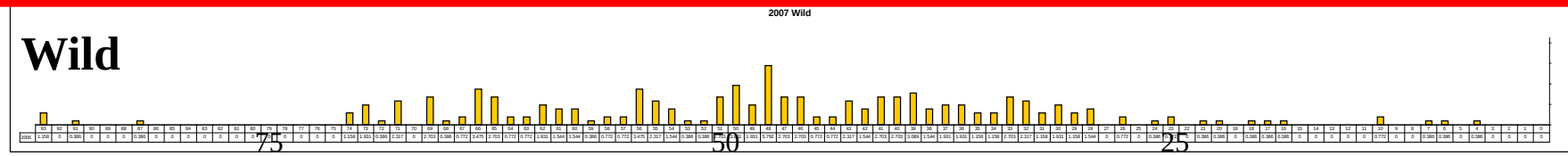


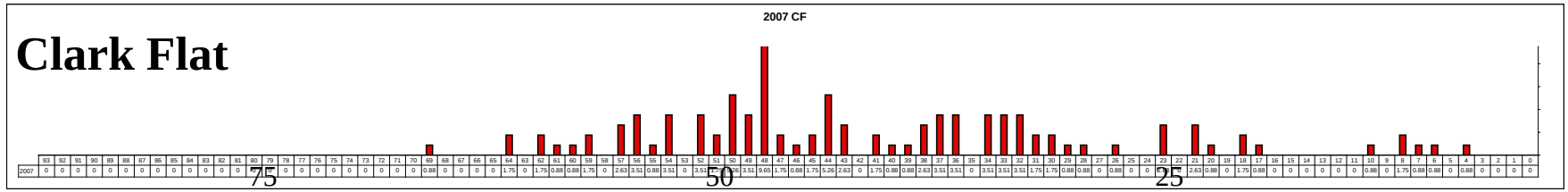
≅

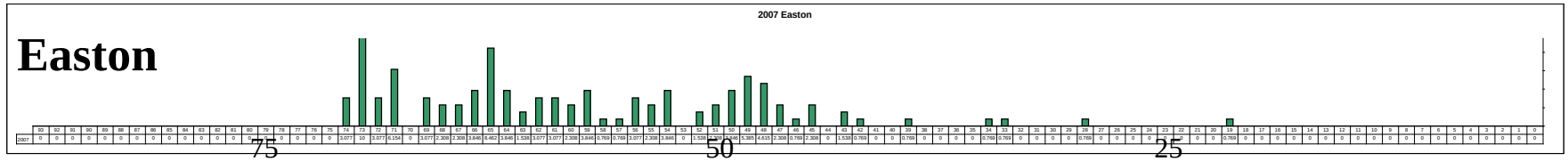


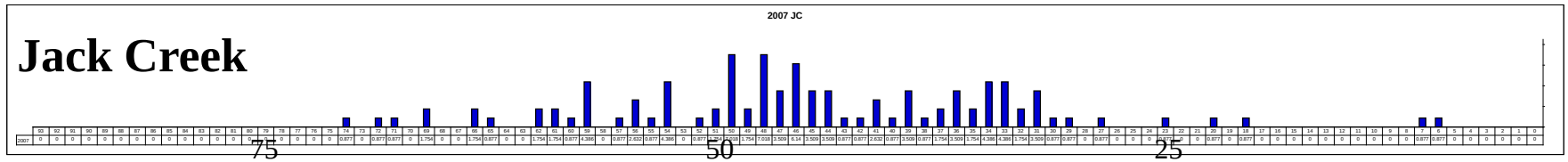
2007 Yakima River Distribution



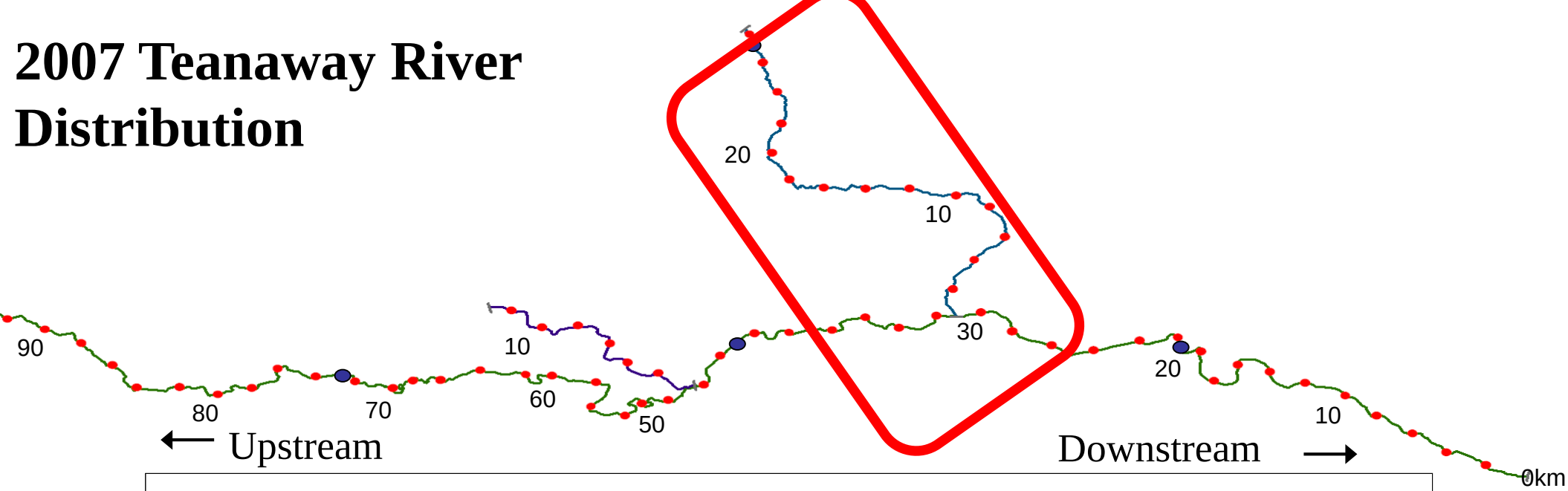


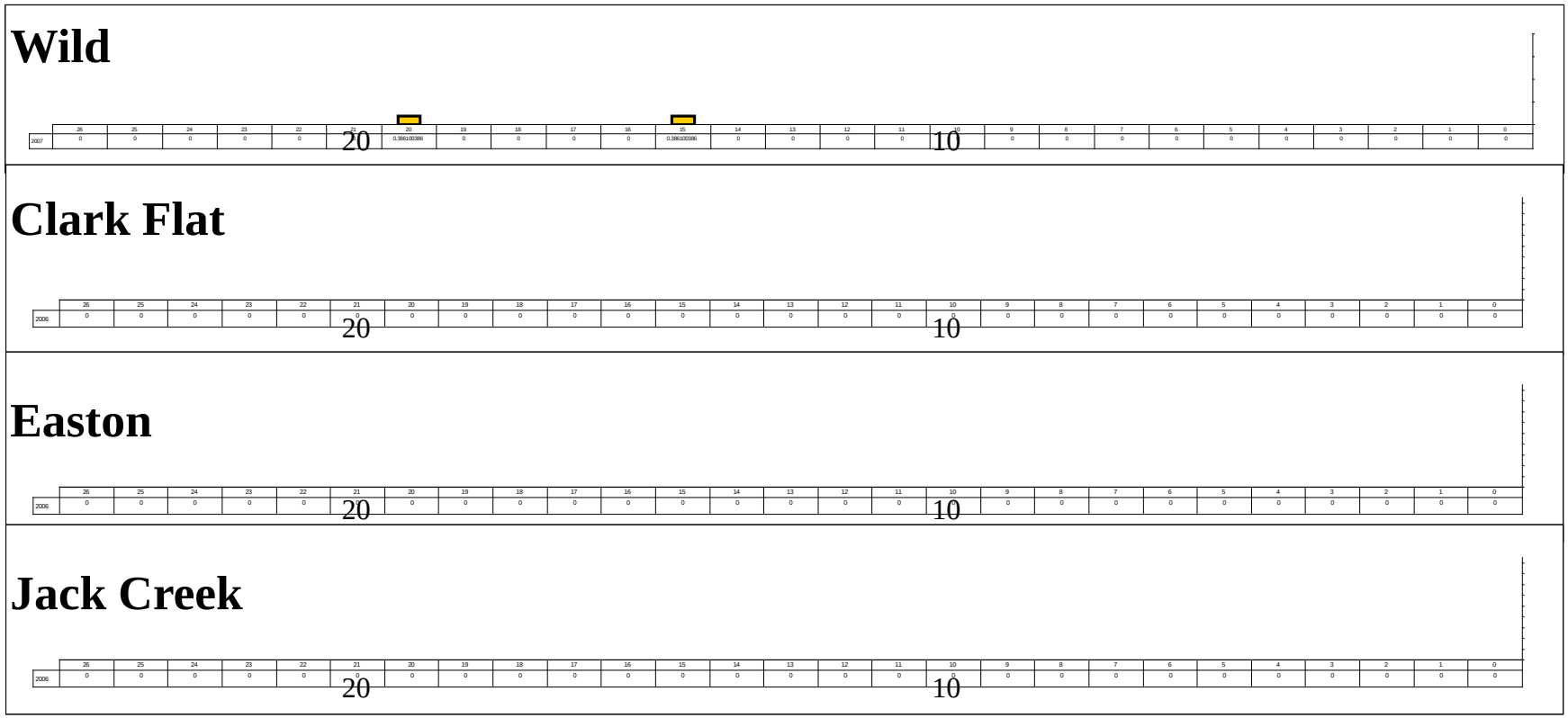




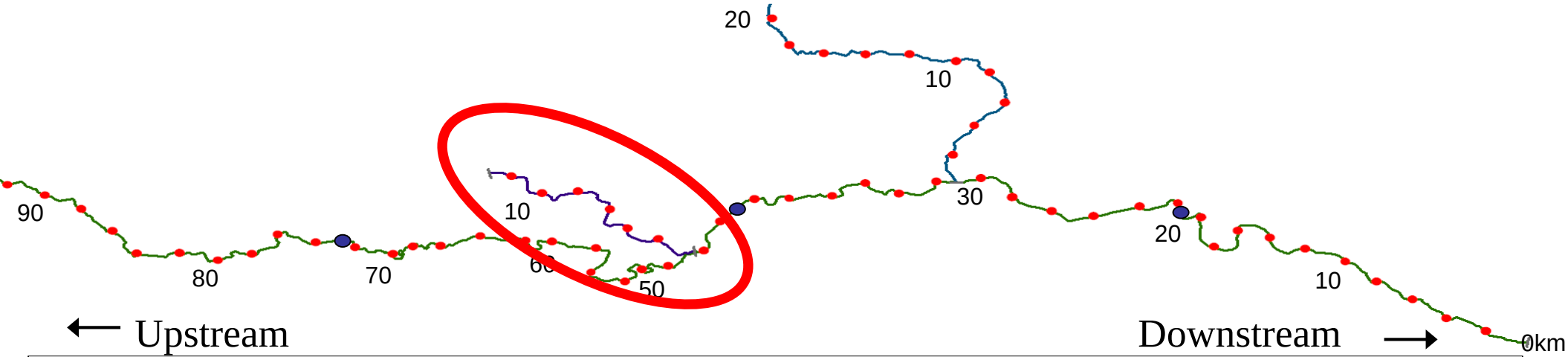


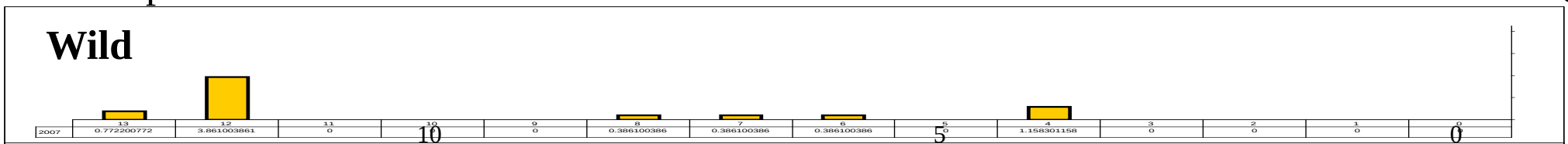
2007 Teanaway River Distribution

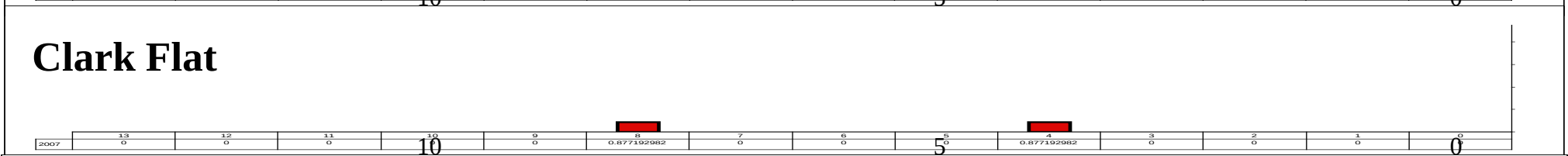


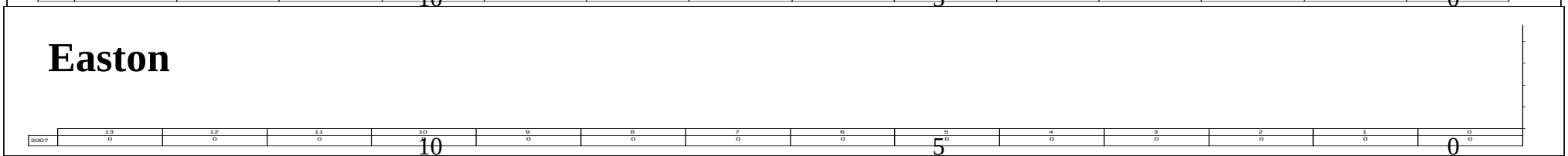


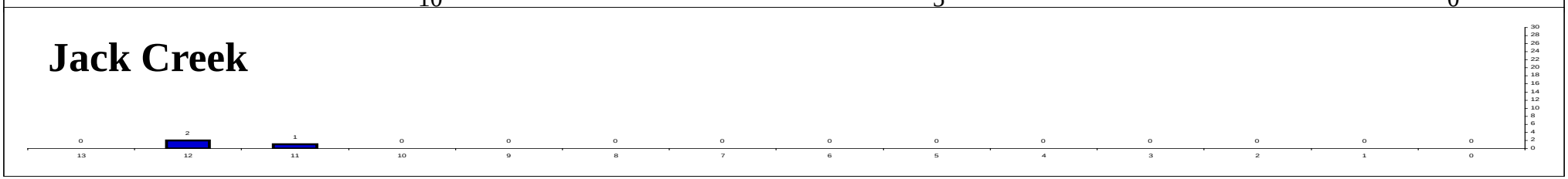
2007 Cle Elum River Distribution











Outline

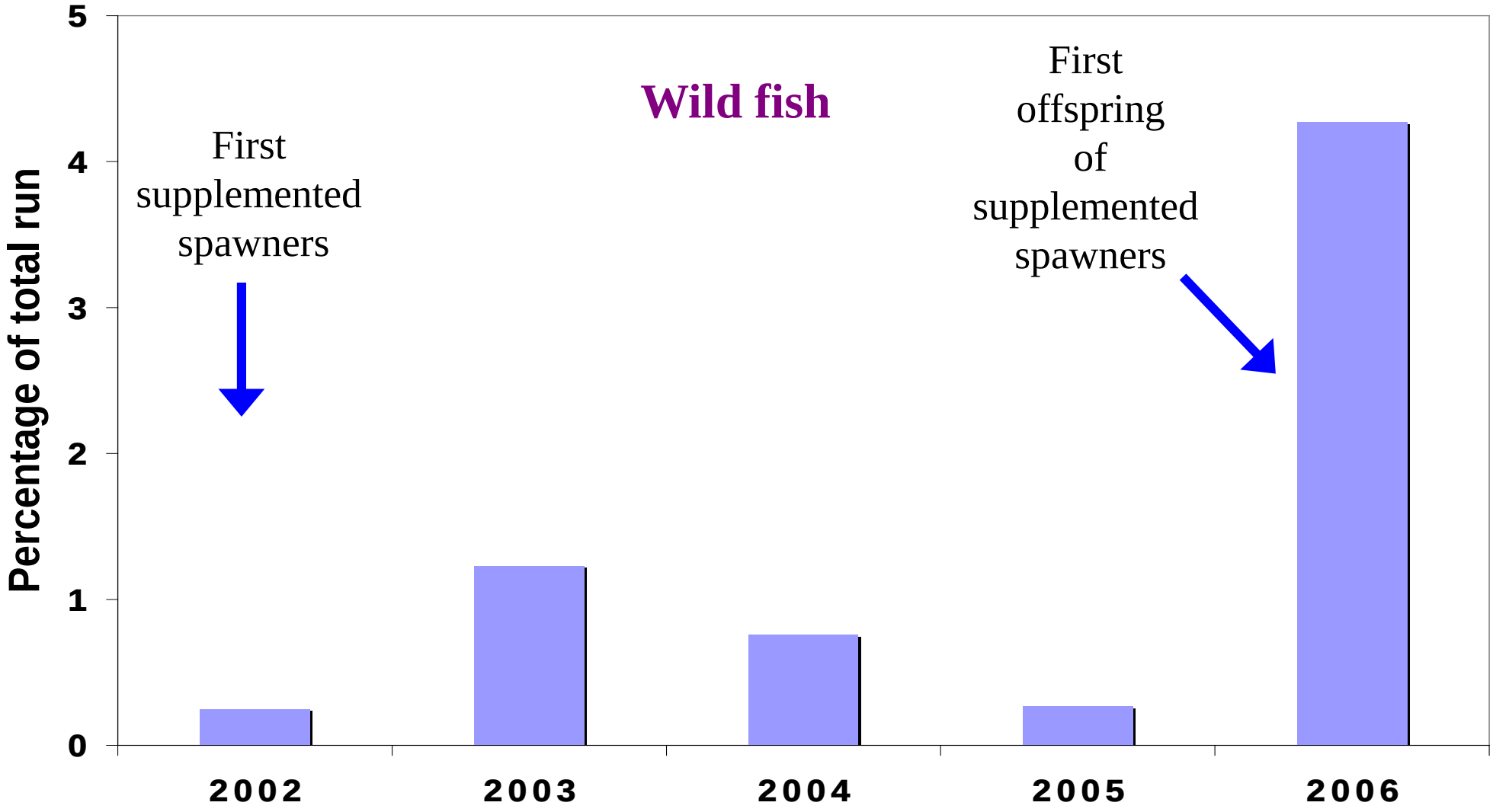
-Homing/imprinting:
Why should we care?

-The YKFP project

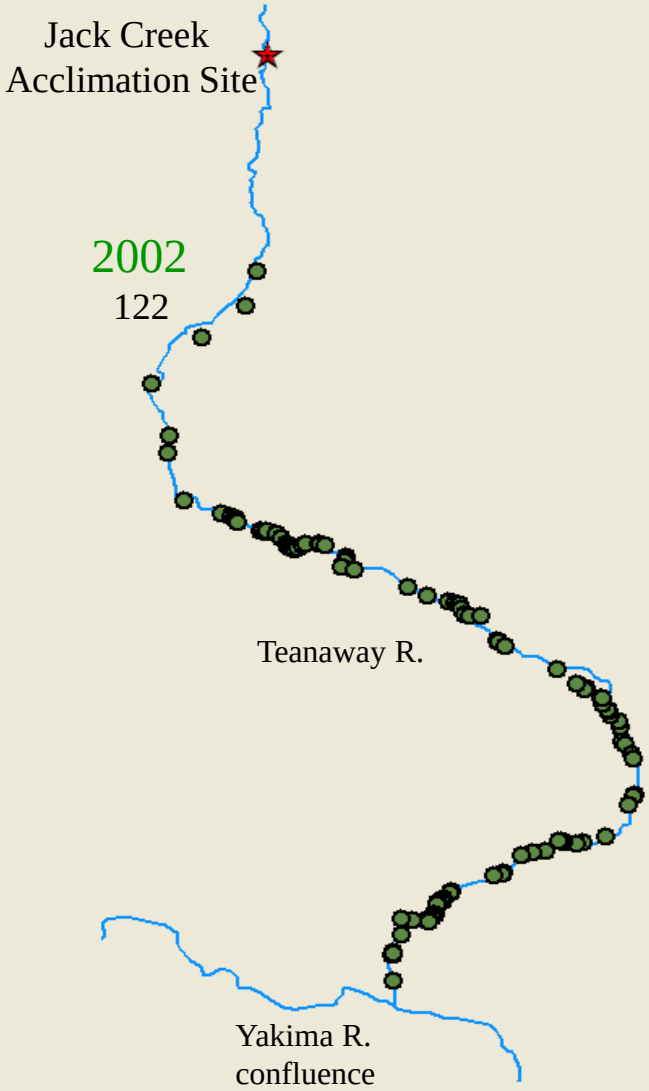
-Homing patterns of
Yakima Spring chinook

-Teanaway utilization

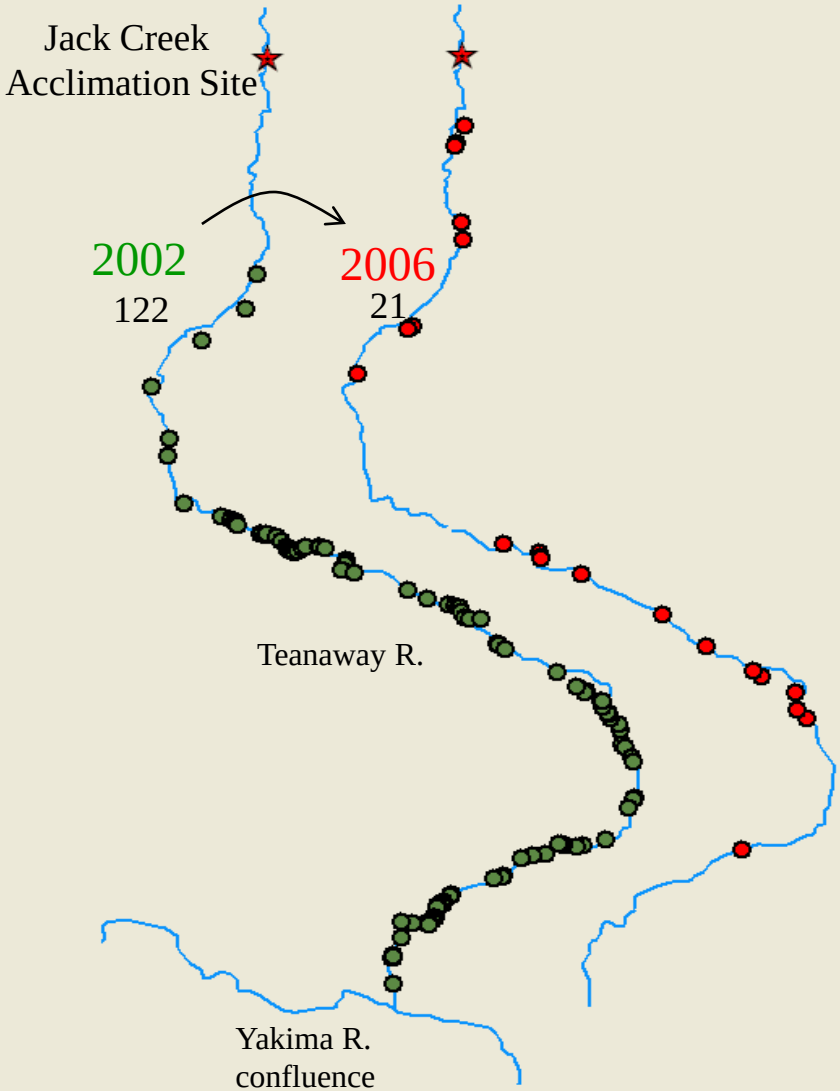
Utilization of Teanaway River for Spawning



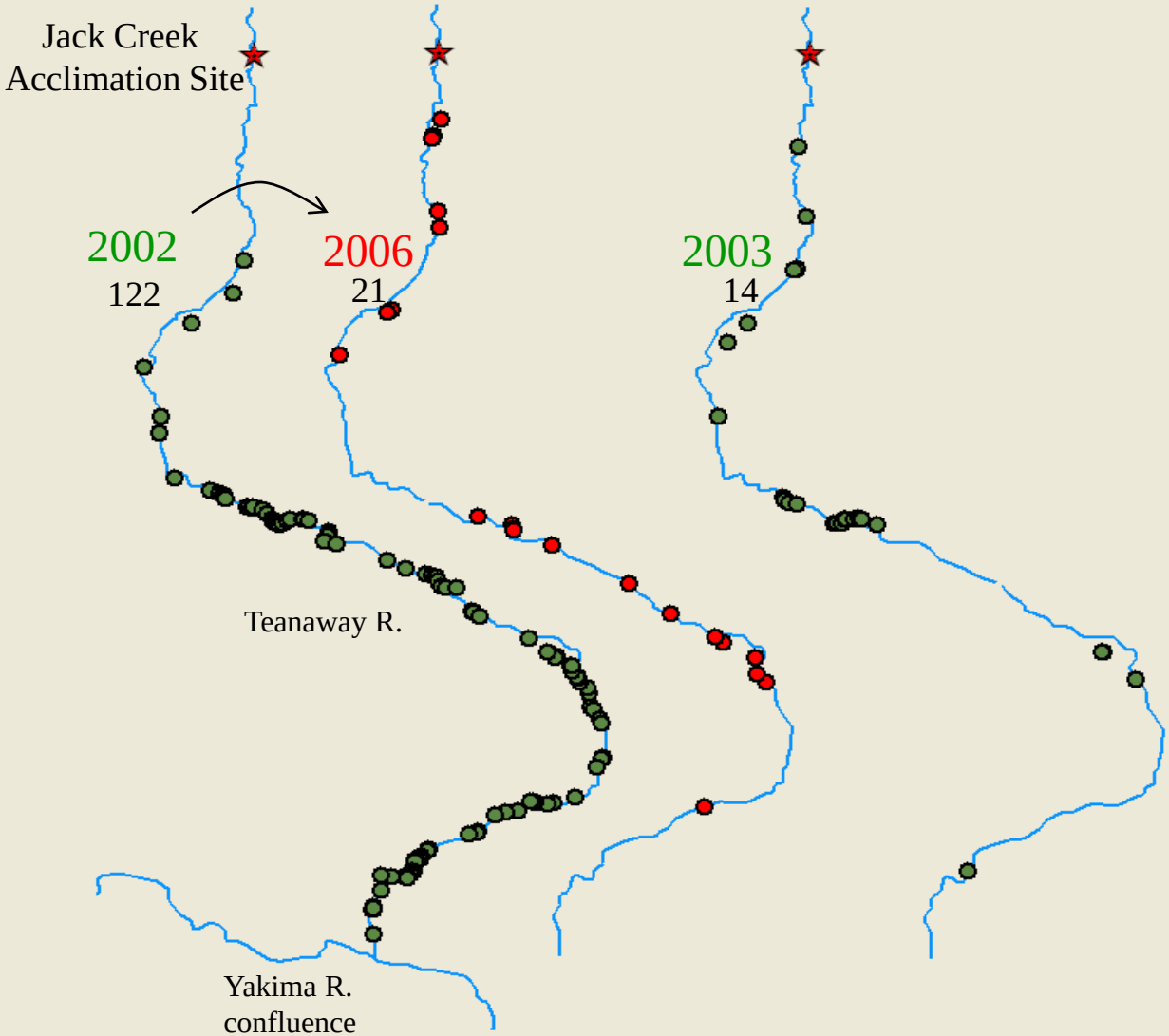
Effects of supplementation on Teanaway River spawning



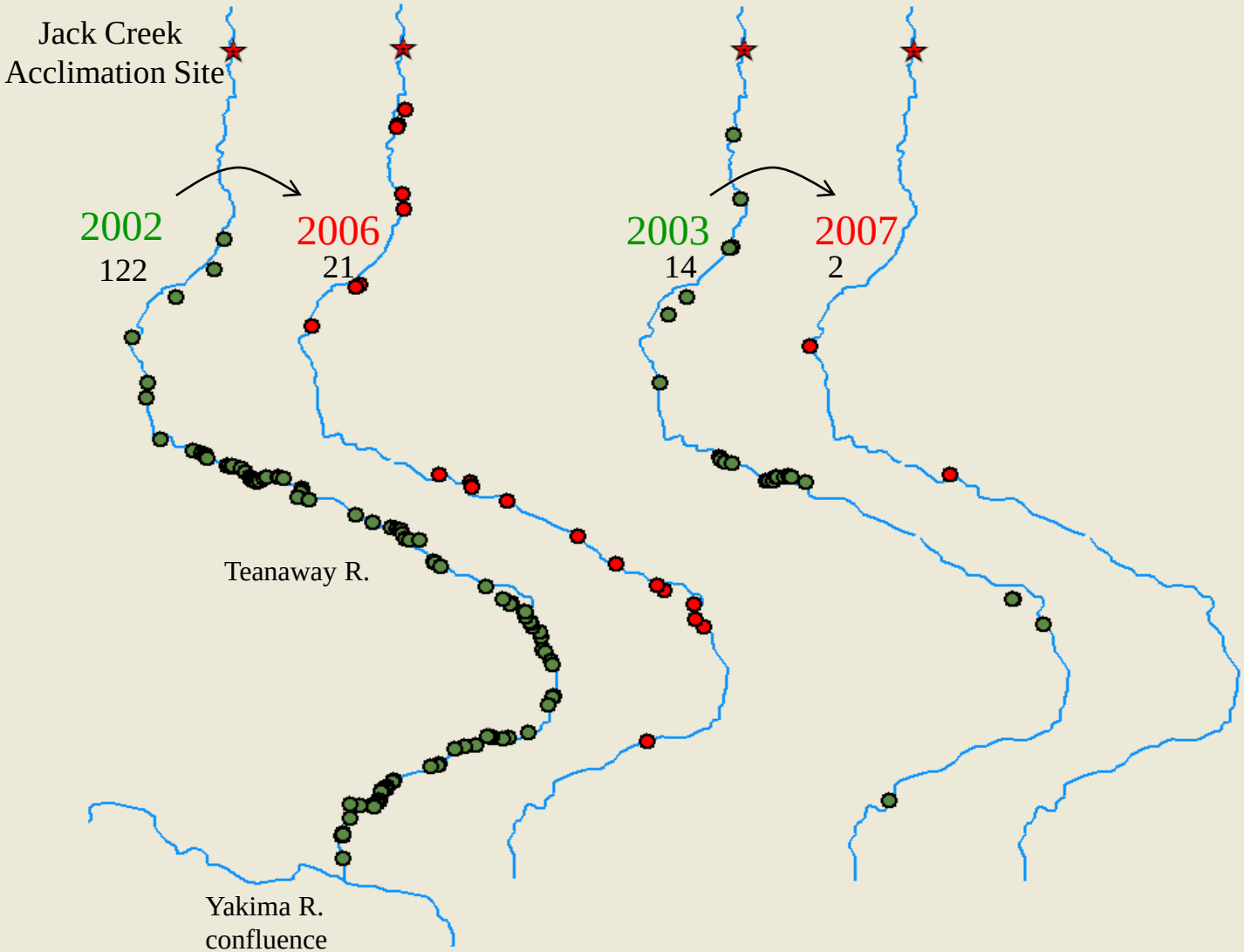
Effects of supplementation on Teanaway River spawning



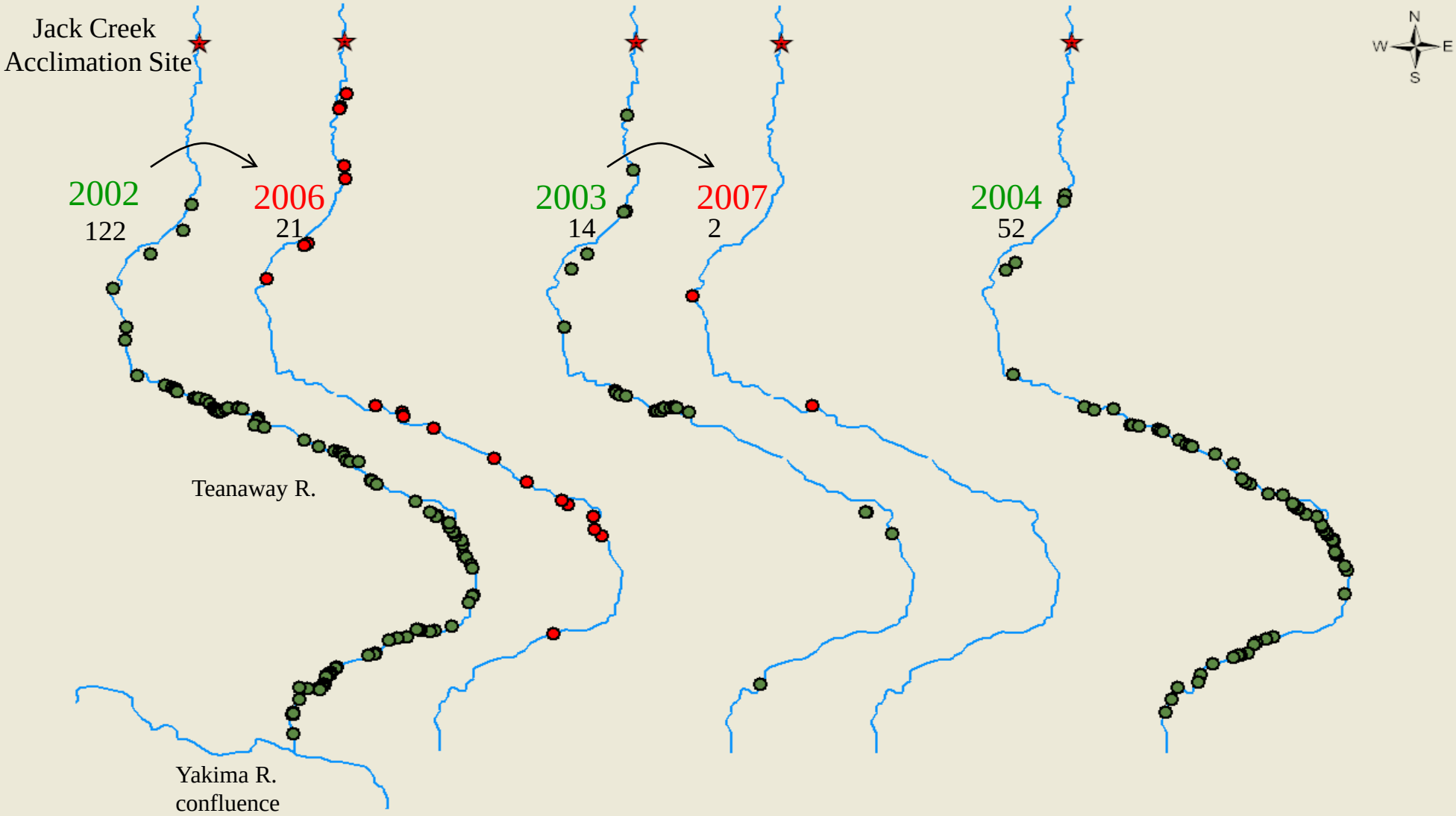
Effects of supplementation on Teanaway River spawning



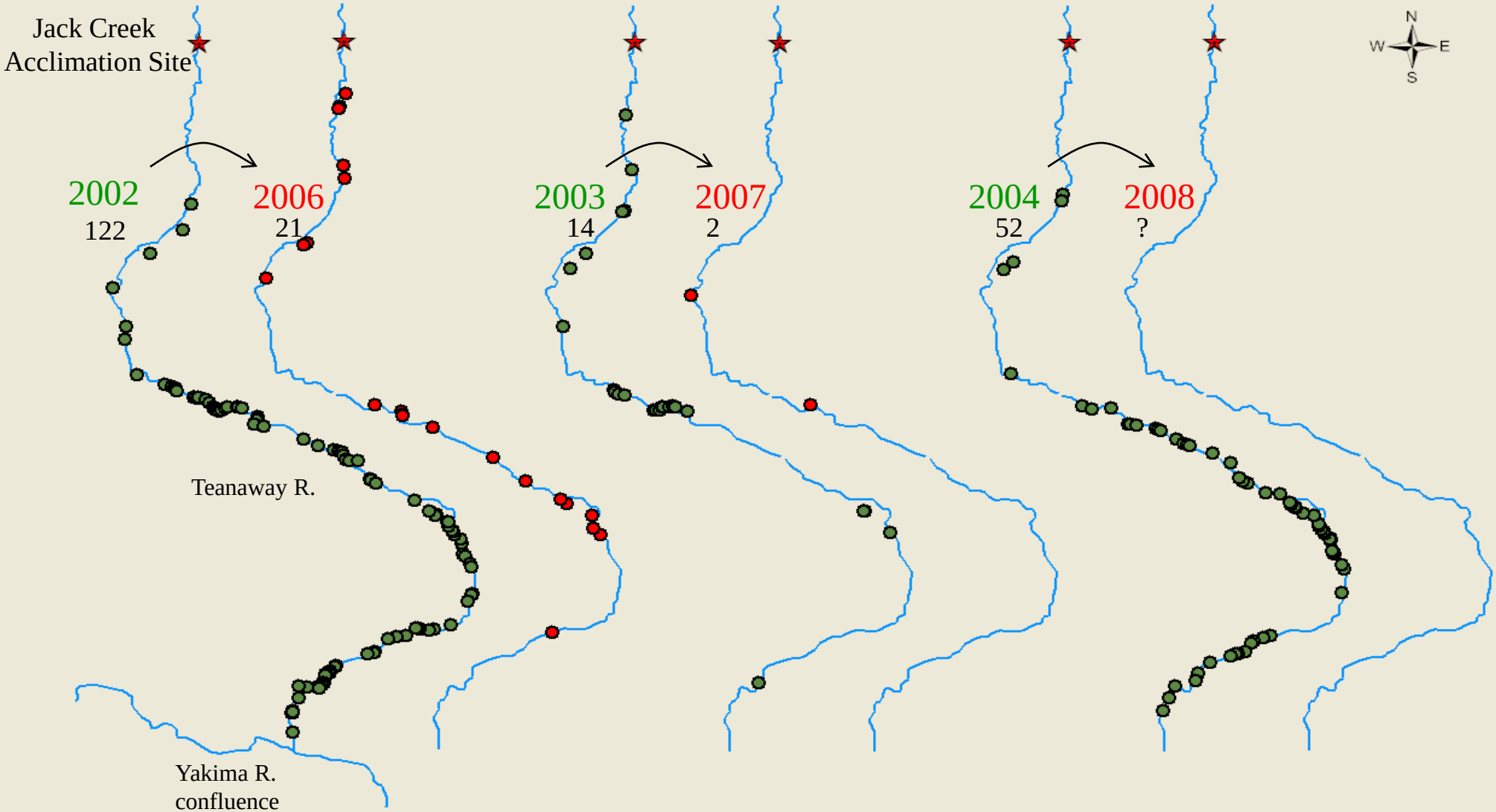
Effects of supplementation on Teanaway River spawning



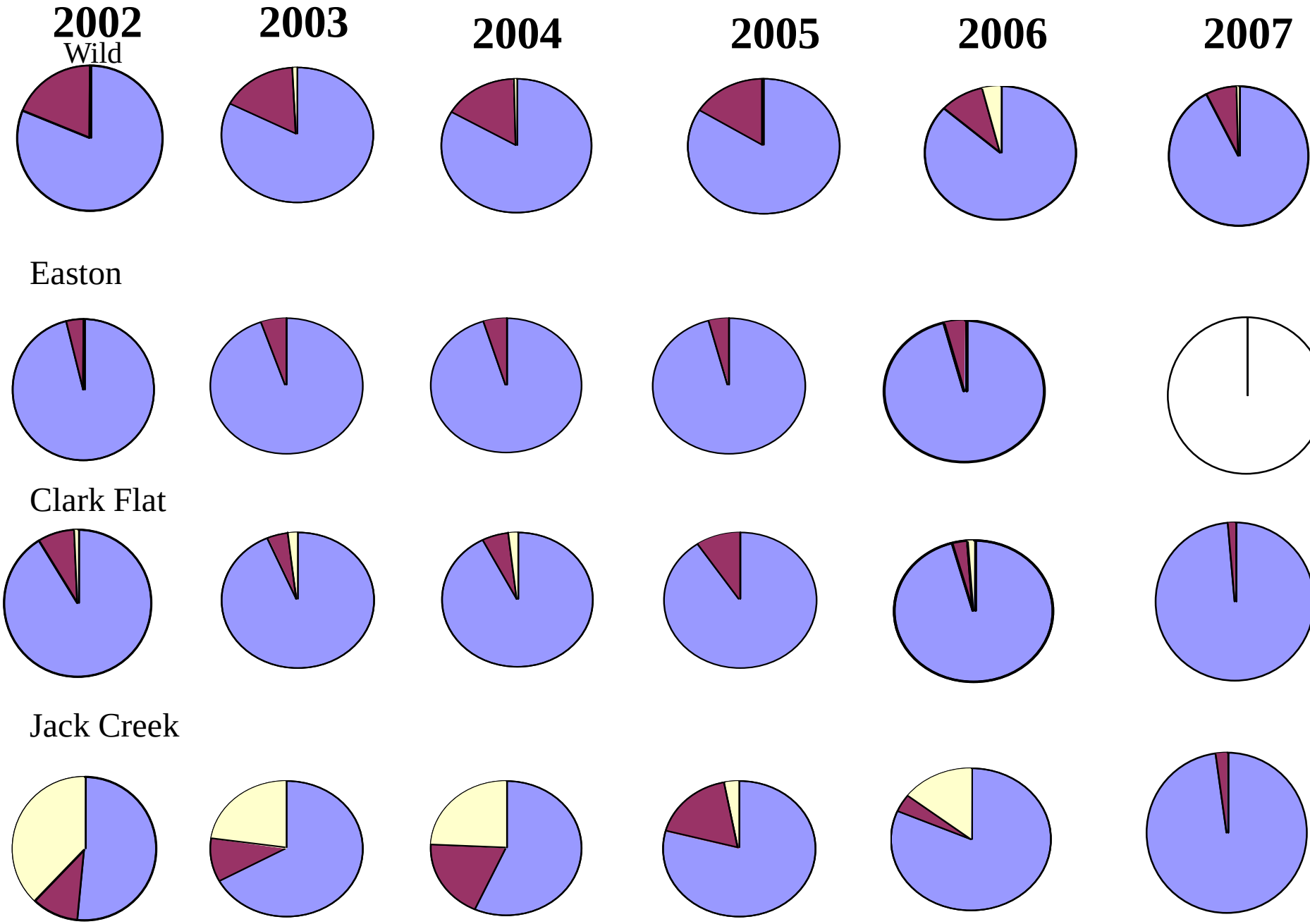
Effects of supplementation on Teanaway River spawning

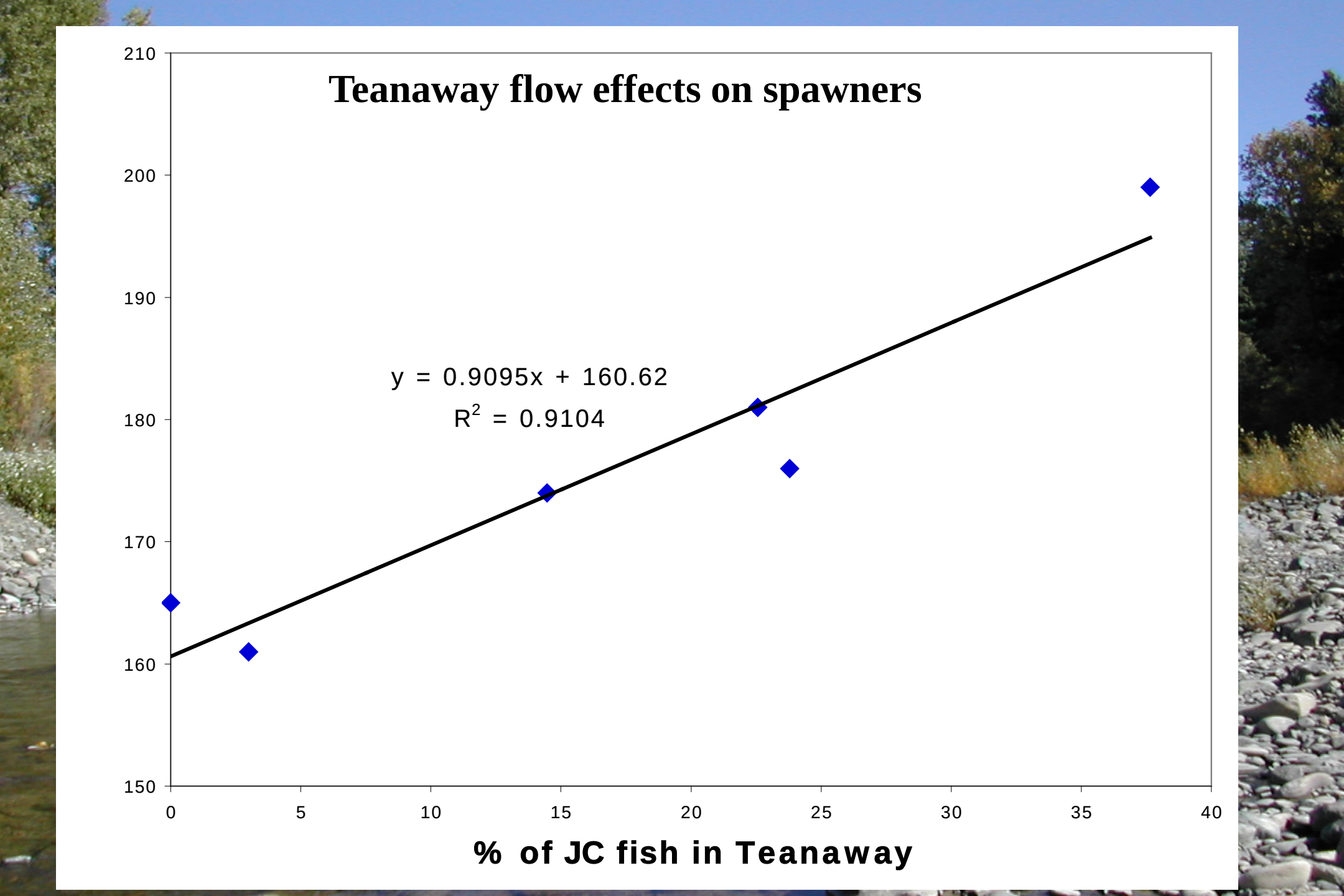


Effects of supplementation on Teanaway River spawning



Tributary distribution of spawners




Teanaway flow effects on spawners
y = 0.9095x + 160.62
R2 = 0.9104
210
200
190
180
170
160
150
0
5
10
15
20
25
30
35
40
% of JC fish in Teanaway

Conclusions

-Salmon can/do imprint and home to release sites as evidenced by homing of Jack Creek fish to the Teanaway R. and proximity of Easton fish to their release site. Some evidence for earlier"hatchery" imprinting/homing

-<u>However</u>, the majority of Jack Creek fish "strayed" into the Cle Elum and mainstem Yakima River and relatively few Clark Flat fish spawned in the vicinity of their acclimation facility suggesting either some level of imprinting failure or tradeoffs between homing and habitat selection

-Habitat selection or behavioral interactions may be an important contributing factor in spawning site selection given the high densities in specific areas that are used by all fish regardless of origin

-Hatchery-reared fish were recovered in almost all spawning areas utilized by wild fish suggesting the potential for impacts of hatchery fish on wild populations

-Some indication of reproductive success for hatchery fish targeted to underutilized areas but jury still out (and not without potential consequences - strays)

Acknowledgements

Yakama Nation
Bill Bosch
Yakama biologists

WDFW
Lynne Anderson

Field help
Jaime Athos
Brian Burke
Walt Dickhoff
Mike Hayes
Michelle Havey
Becky Kihslinger
Eric Kummerow
Andy Pierce
Linda Rhodes
Julie Scheurer
Deb Harstad
Jenn Debose
Matt Nesbit
Nathan Dumdei
Physiology team

Funding
NW Fisheries Science Center