Reproductive success of colonizing Chinook and coho salmon

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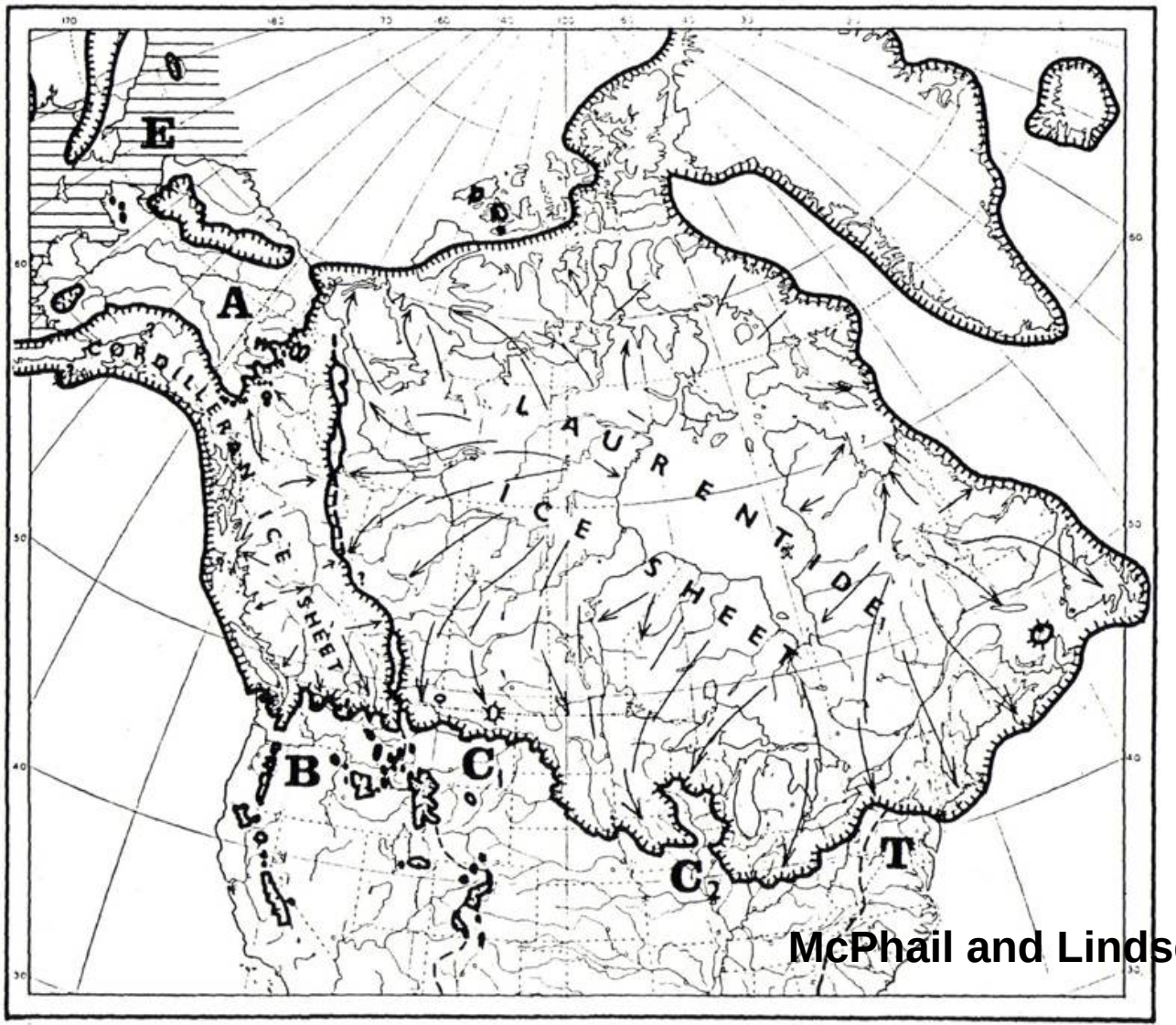
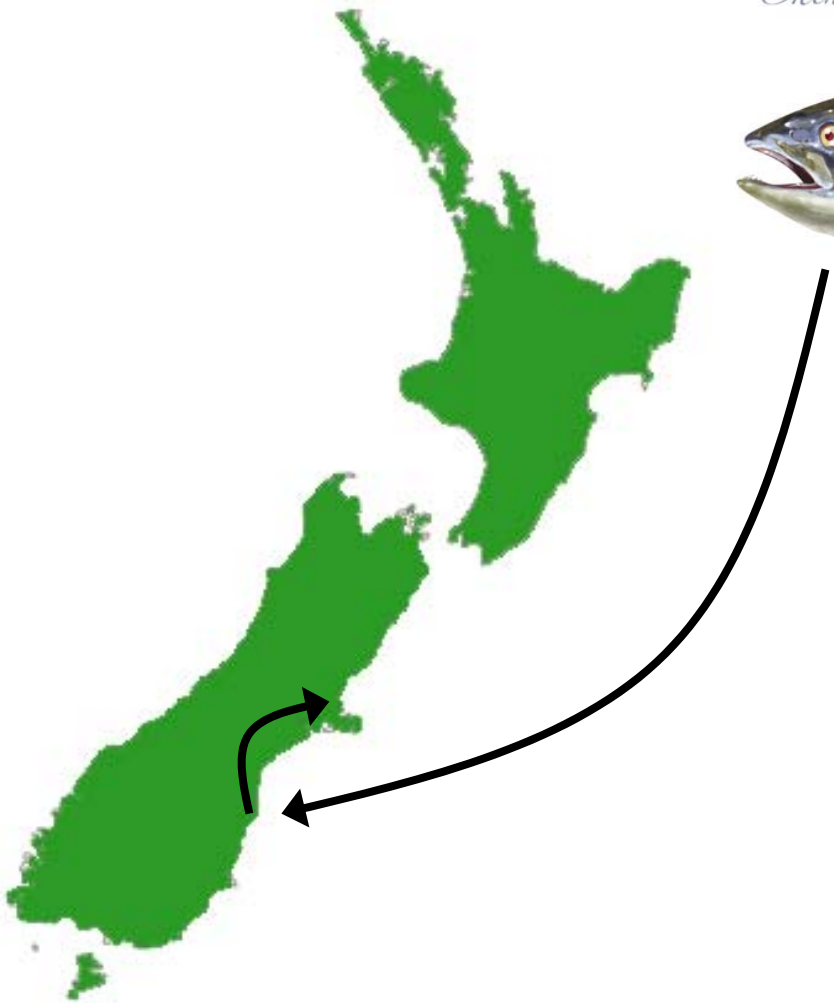
Wisconsin glacial period

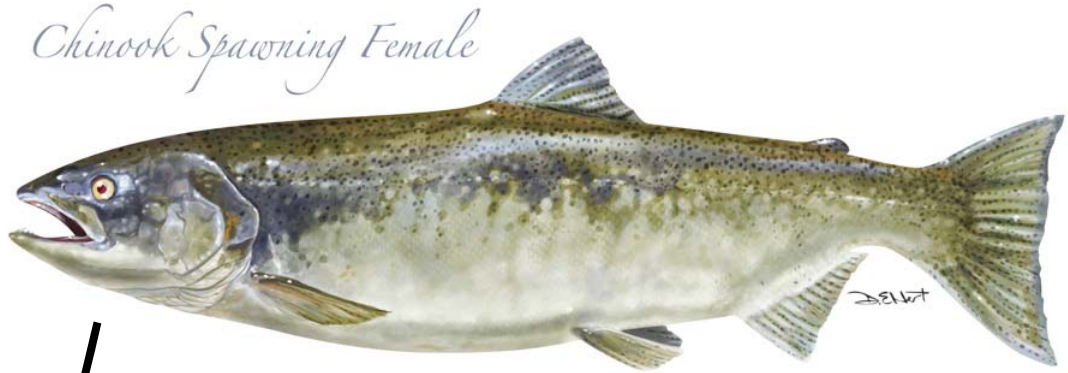
50,000 to 10,000 years ago



McPhail and Lindsey 1970

Chinook salmon in New Zealand



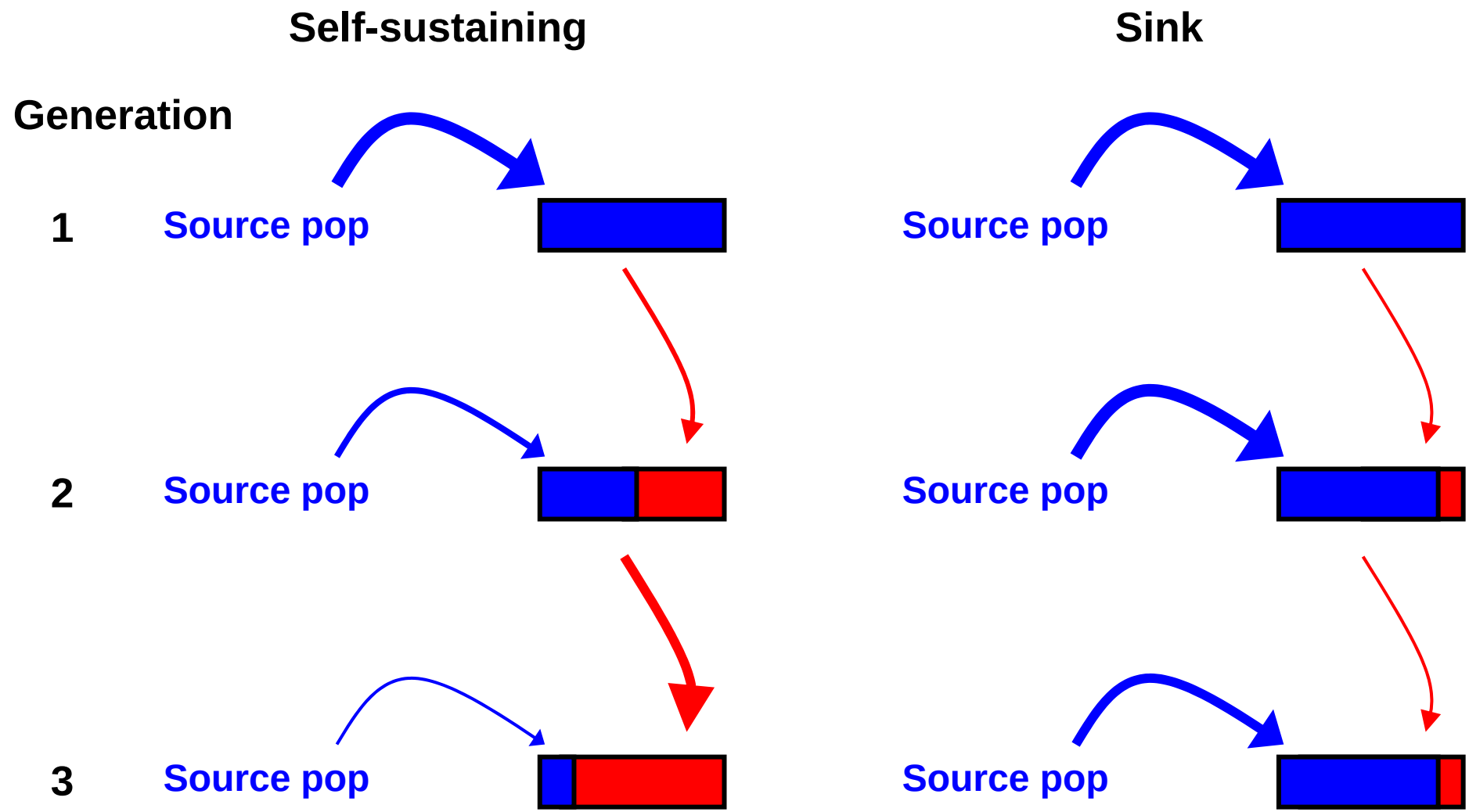


Transplanted from Sacramento River to South Island from 1901 to 1907

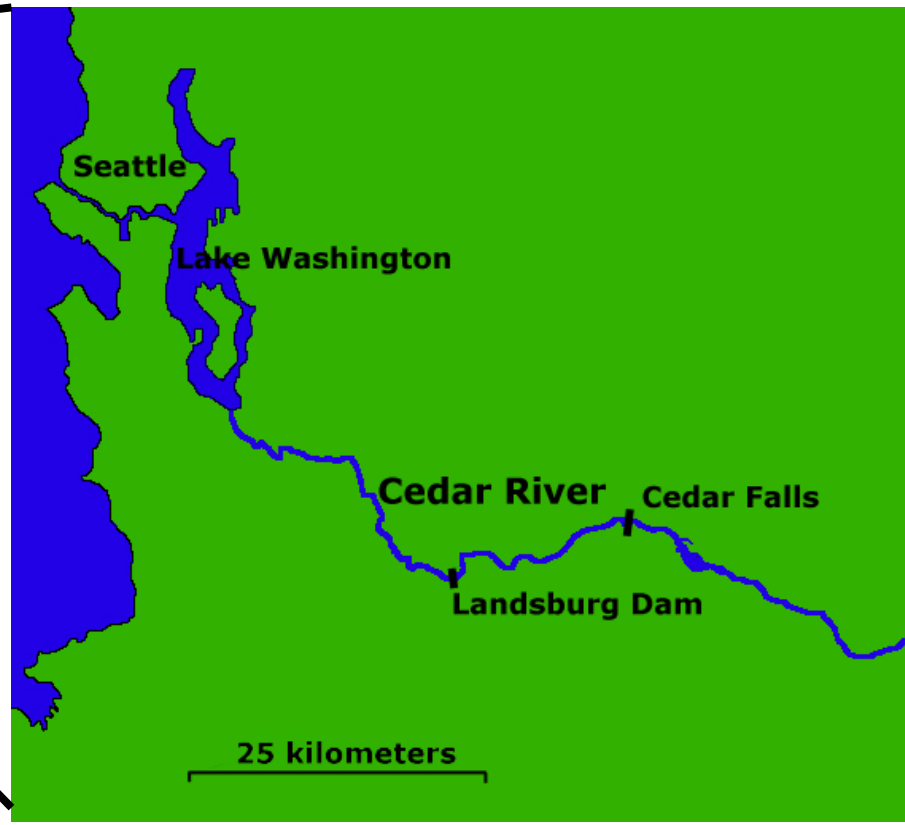
Colonized rivers to the north through natural dispersal by 1915

Quinn et al., 2001

Alternative hypotheses

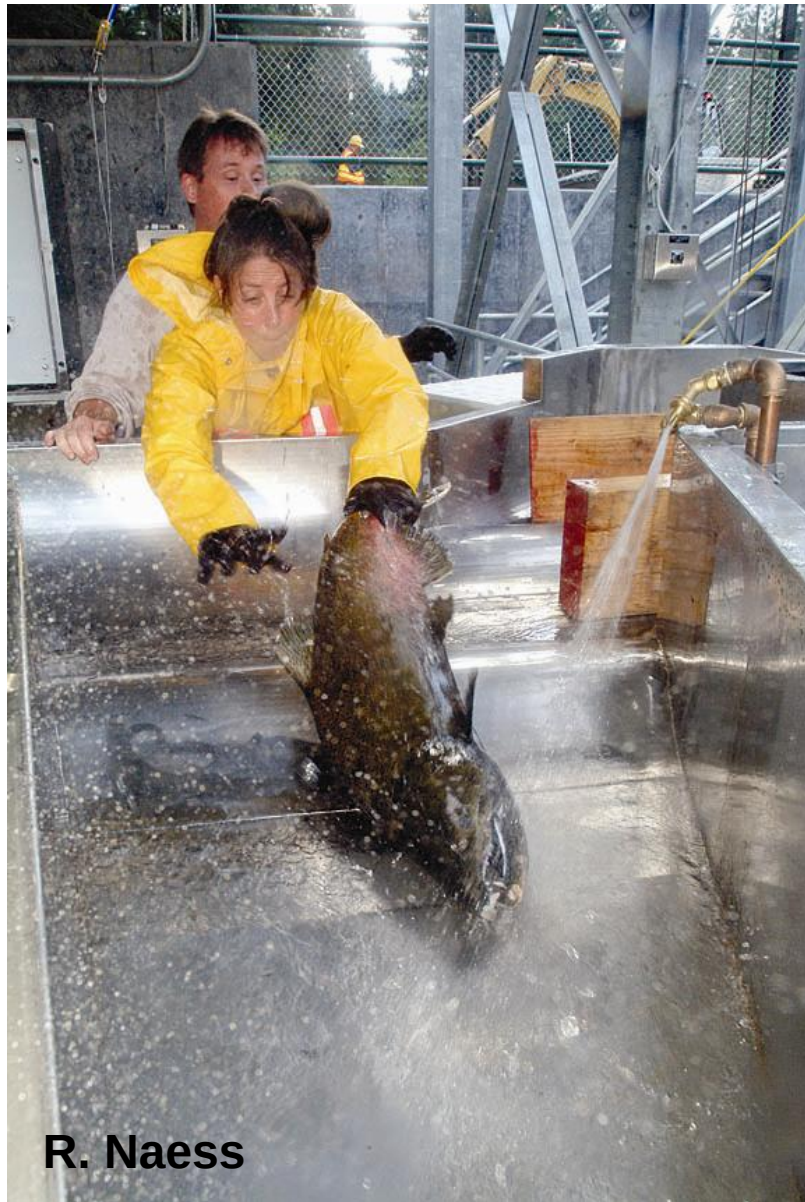


Cedar River, Washington

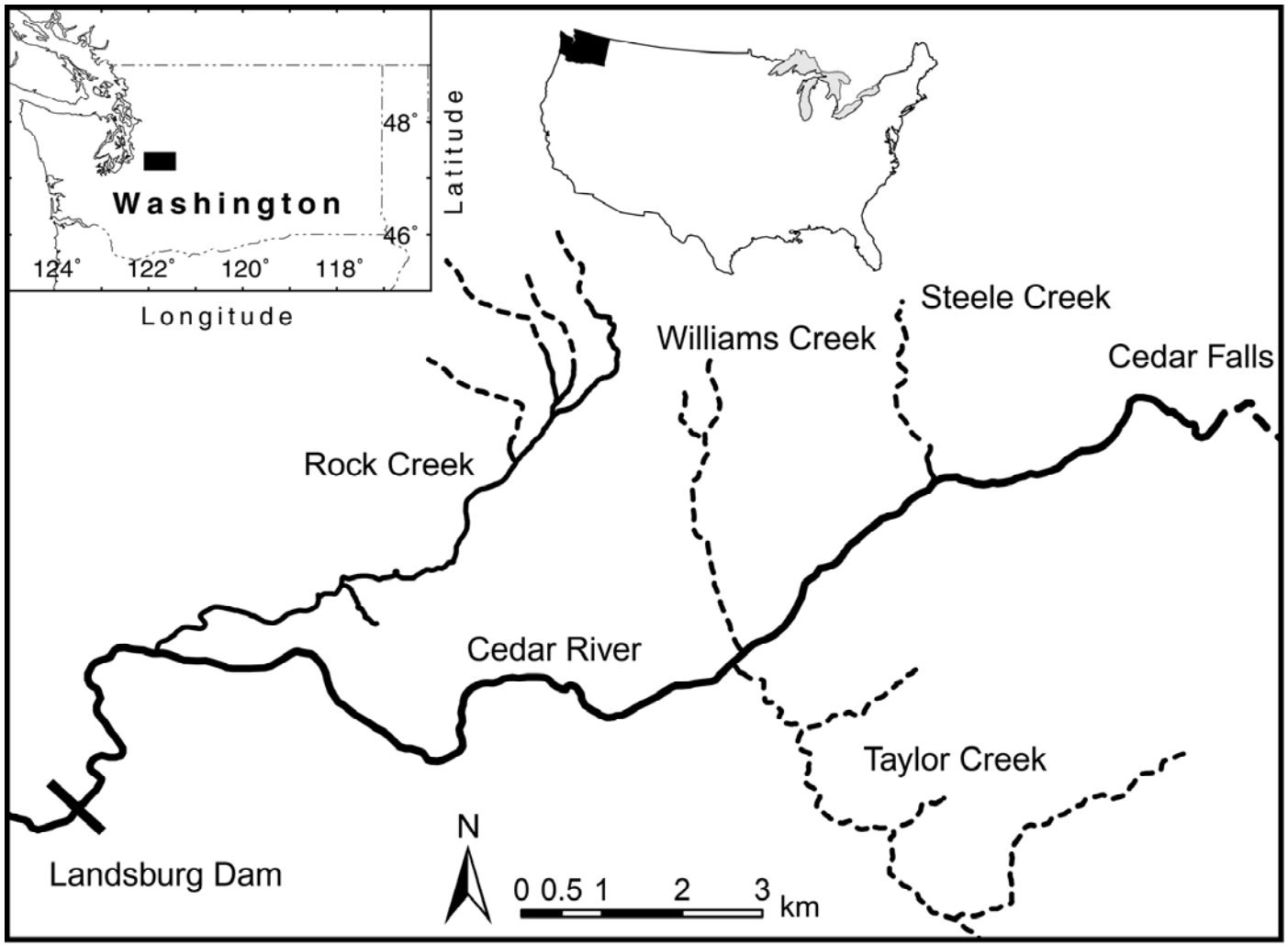


Fish passage at Landsburg Dam

Beginning September, 2003 Seattle Public Utilities passes chinook salmon, coho salmon and steelhead above Landsburg Dam



Newly accessible habitat



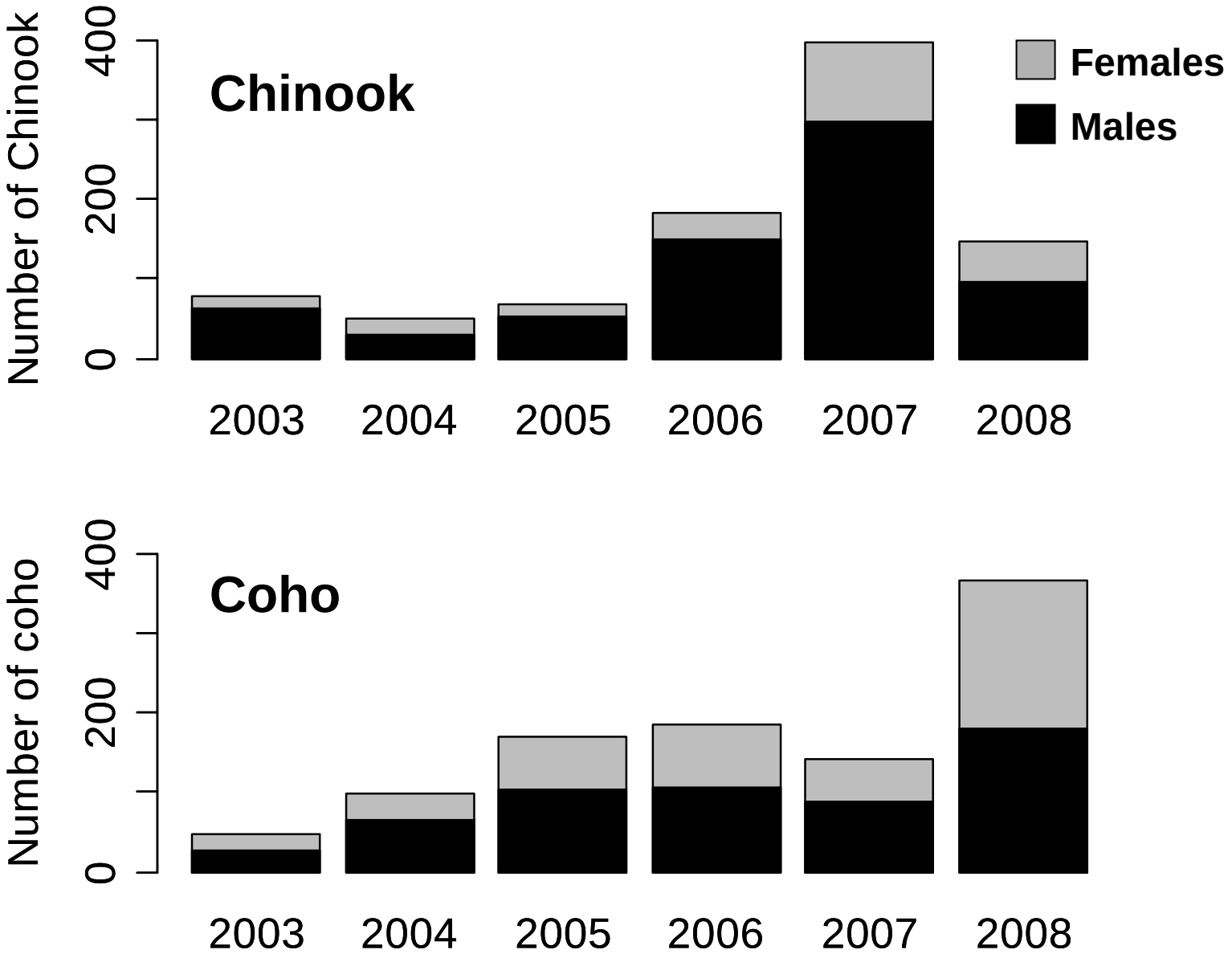
Inaccessible habitat

Research question

How successful are colonizing Chinook and coho salmon?

1. **Population productivity**
2. **Individual reproductive success**
    - **A. Natural origin vs. hatchery Chinook salmon**
    - **B. Selection on breeding date in coho salmon**

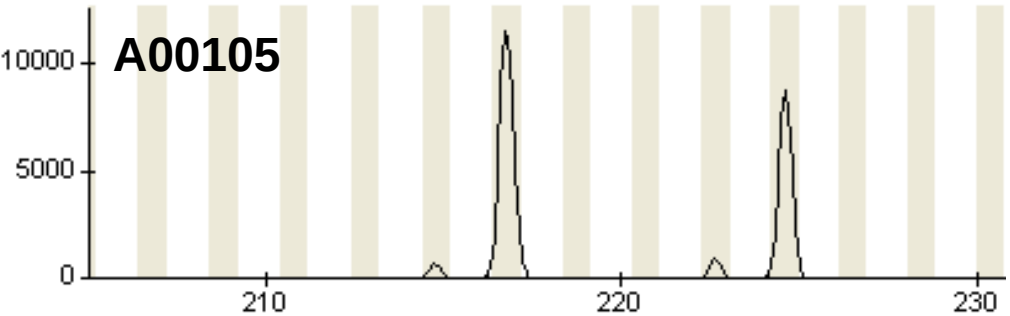
Fish passage at Landsburg Dam



Methods

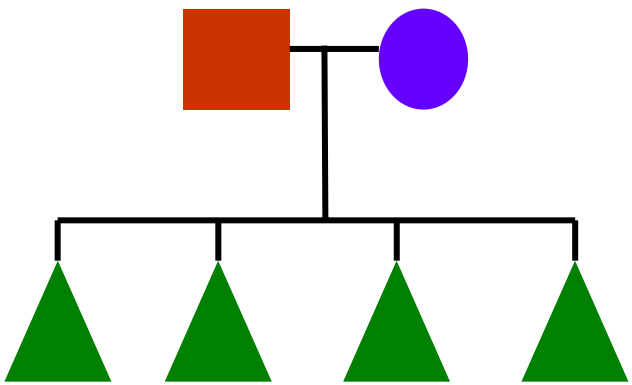
Collect tissue samples

Paul Faulds and John McDowell
Seattle Public Utilities



Genotype salmon at 10 microsatellite DNA markers

Will Atlas
Simon Fraser University

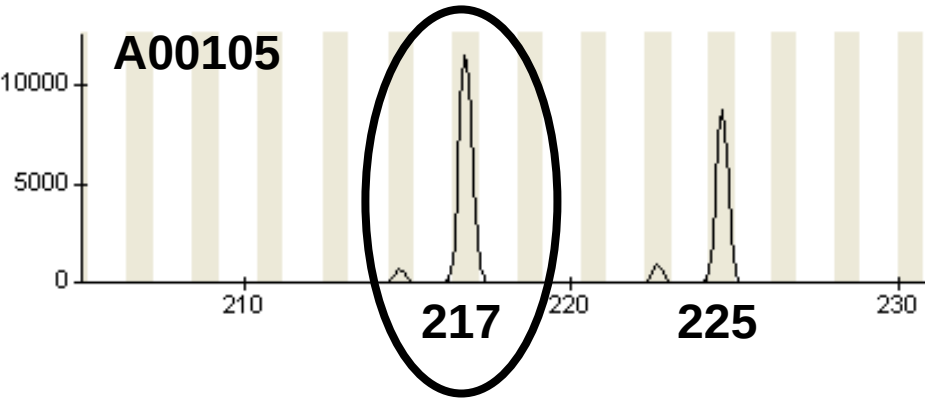


Assign parentage using likelihood based algorithm


Coho Spawning Male

X


Coho Spawning Female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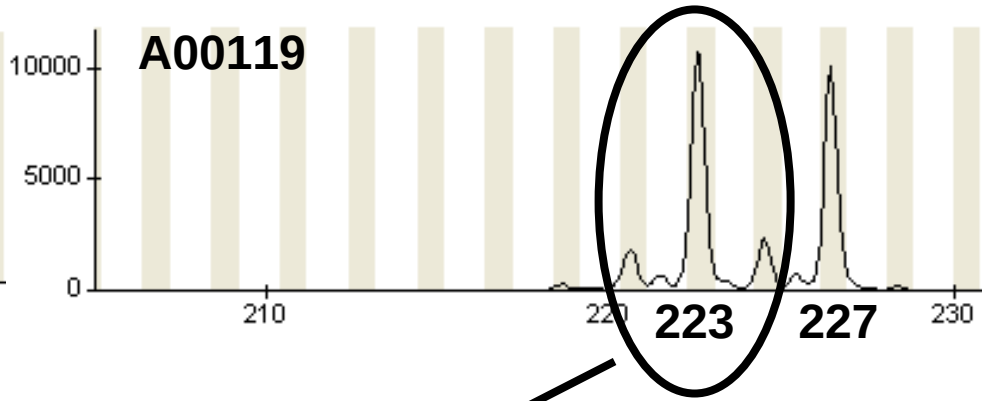
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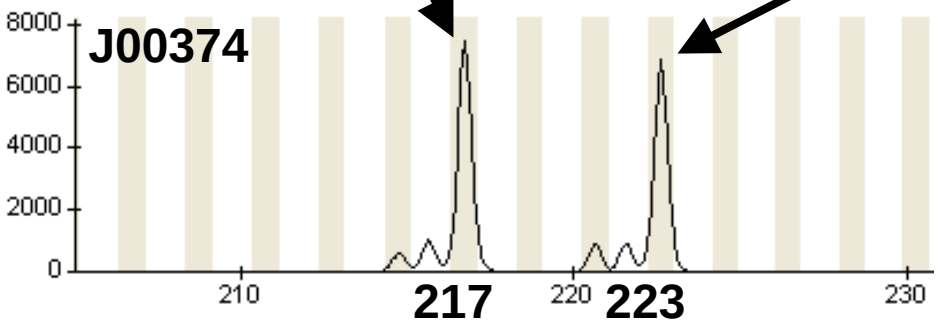
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R. Bell

Chinook

Mature age 2-5

One complete and one partial brood

3.7 % error rate

Offspring return year	Parents
2003	
2004	
2005	2003
2006	2003 2004
2007	2003 2004 2005
2008	2003 2004 2005 2006

Coho

Mature age 2-3

Three complete broods

3.9 % error rate

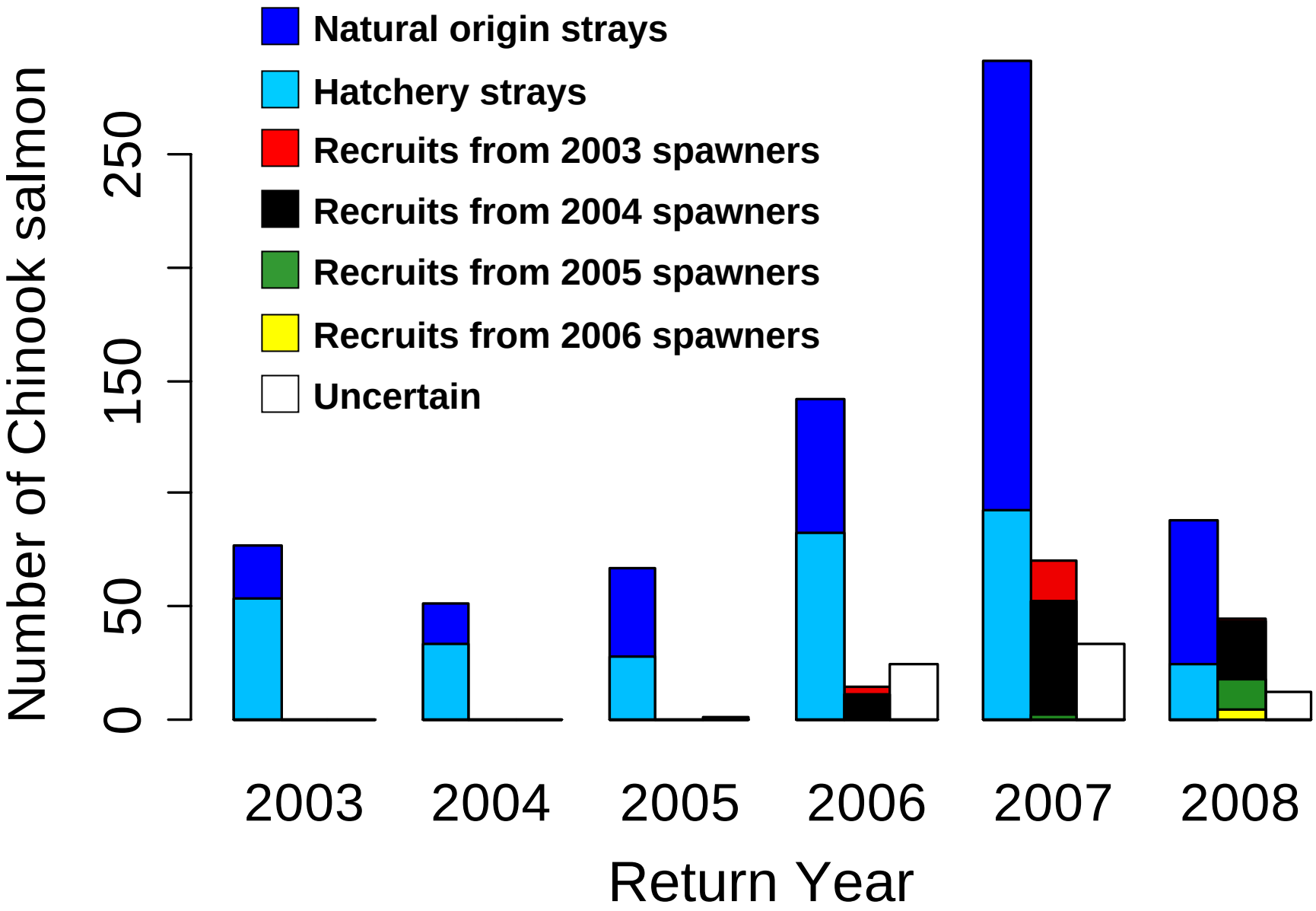
Offspring return year	Parents
2003	
2004	
2005	2003
2006	2003 2004
2007	2004 2005
2008	2005 2006

Chinook parentage assignments

Offspring return year	Analyzed	No parents	Dad only	Mom only	Two parents
2005	40	39	1	0	0
2006	99	60	19	5	15
2007	302	198	12	22	70
2008	120	63	4	8	45

Strays **Uncertain** **Recruits**

Chinook: strays vs. recruits

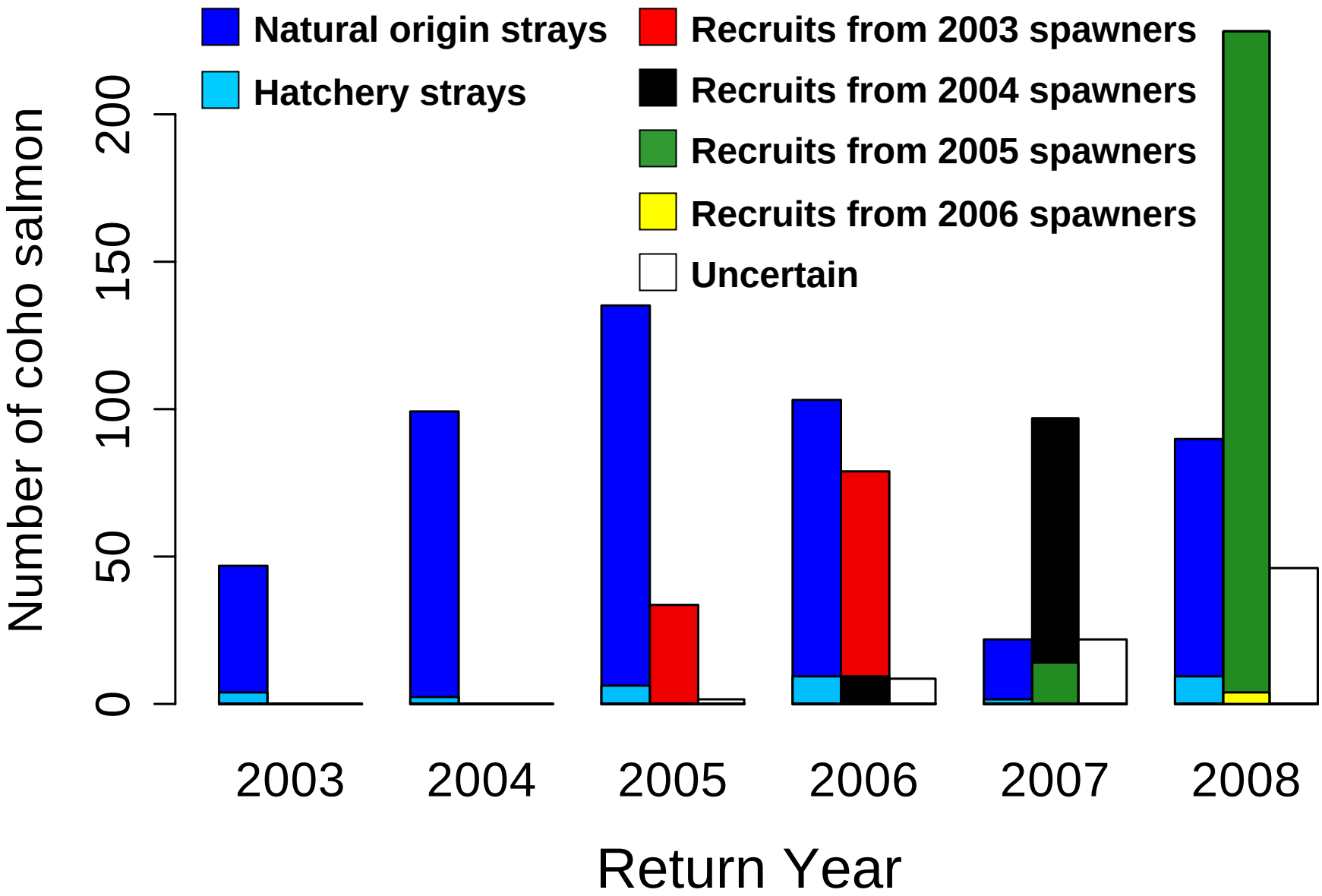


Coho parentage assignments

Offspring return year	Analyzed	No parents	Dad only	Mom only	Two parents
2005	163	129	0	1	33
2006	181	94	2	6	79
2007	140	21	4	18	97
2008	355	81	36	10	228

Strays **Uncertain** **Recruits**

Coho: strays vs. recruits



Population productivity comparison

Recruits per spawner: returning female salmon produced by female spawners

Species	Brood Year	Spawners analyzed	Minimum recruits per spawner
Chinook	2003	16	0.56
Chinook	2004	22	1.09
Coho	2003	20	2.20
Coho	2004	34	1.09
Coho	2005	66	1.92

Estimates are minima because they do not include

-Salmon produced above dam that spawn themselves below dam

-5 yr old Chinook from BY 2004

-Salmon harvested by recreational, commercial, and tribal fisheries

Spill over effect?

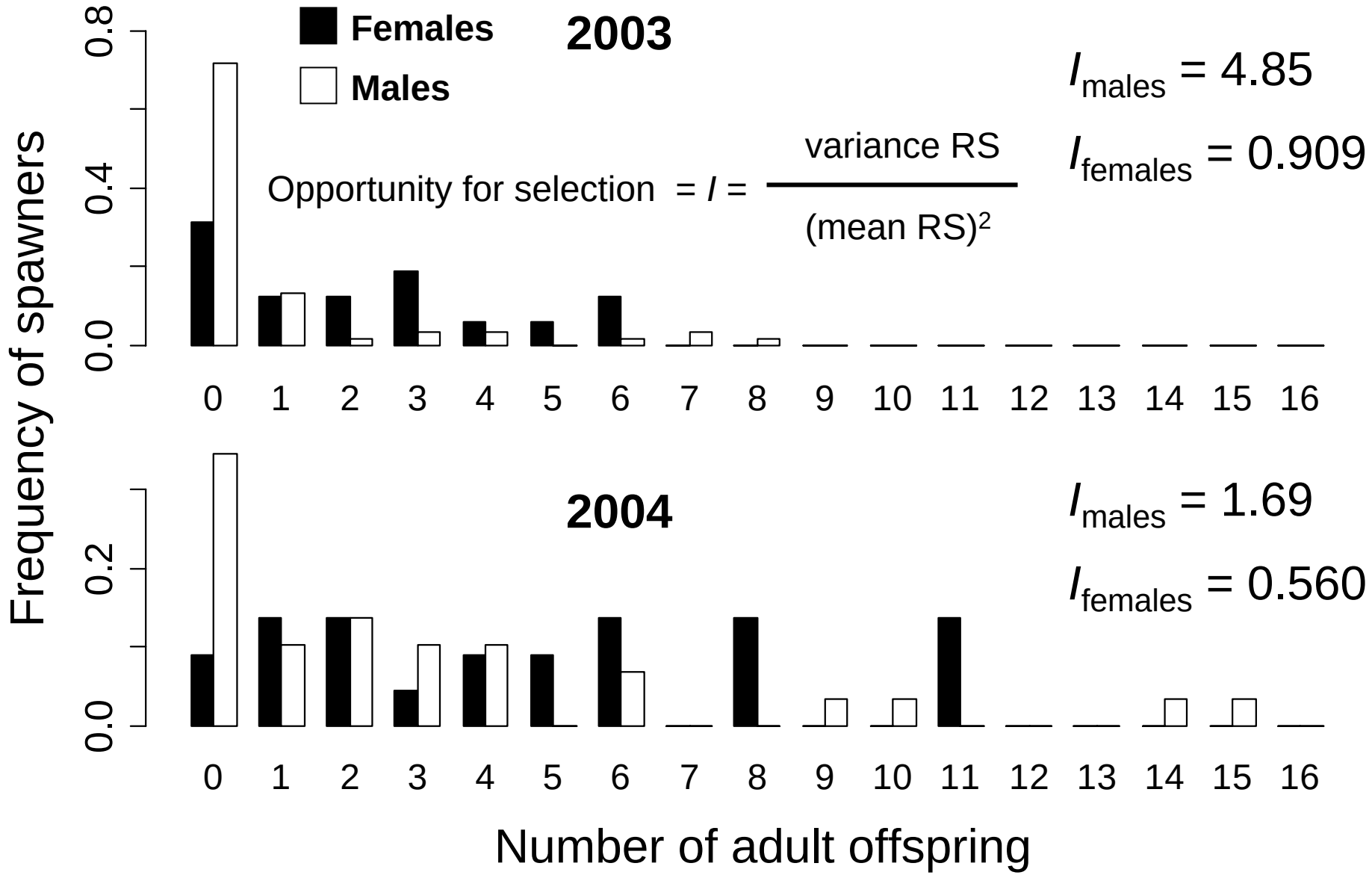
Do salmon spawning above the dam increase abundances below it?

Offspring return year	Analyzed	No parents	Dad only	Mom only	Two parents
2006	31	26	2	2	1

Scale samples: Larry Lowe, Steve Foley, and Anne Marshall, WDFW

video: David Chapin, Seattle Public Utilities

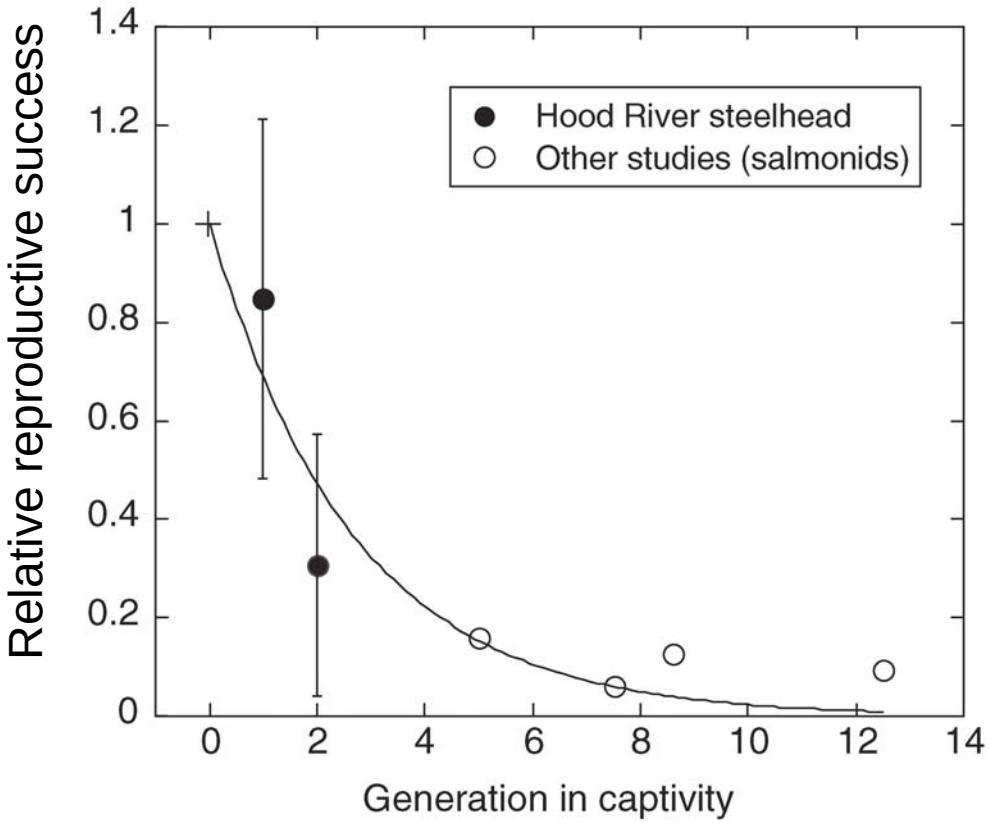
Chinook individual reproductive success



Fitness of hatchery salmon

T. Quinn

$$\text{Relative RS} = \frac{\text{Adult offspring per hatchery parent}}{\text{Adult offspring per wild parent}}$$



Araki et al., 2007, *Science* 318: 100 - 103

Local Chinook hatcheries

Univ. of Washington

~ 200,000 Chinook fry

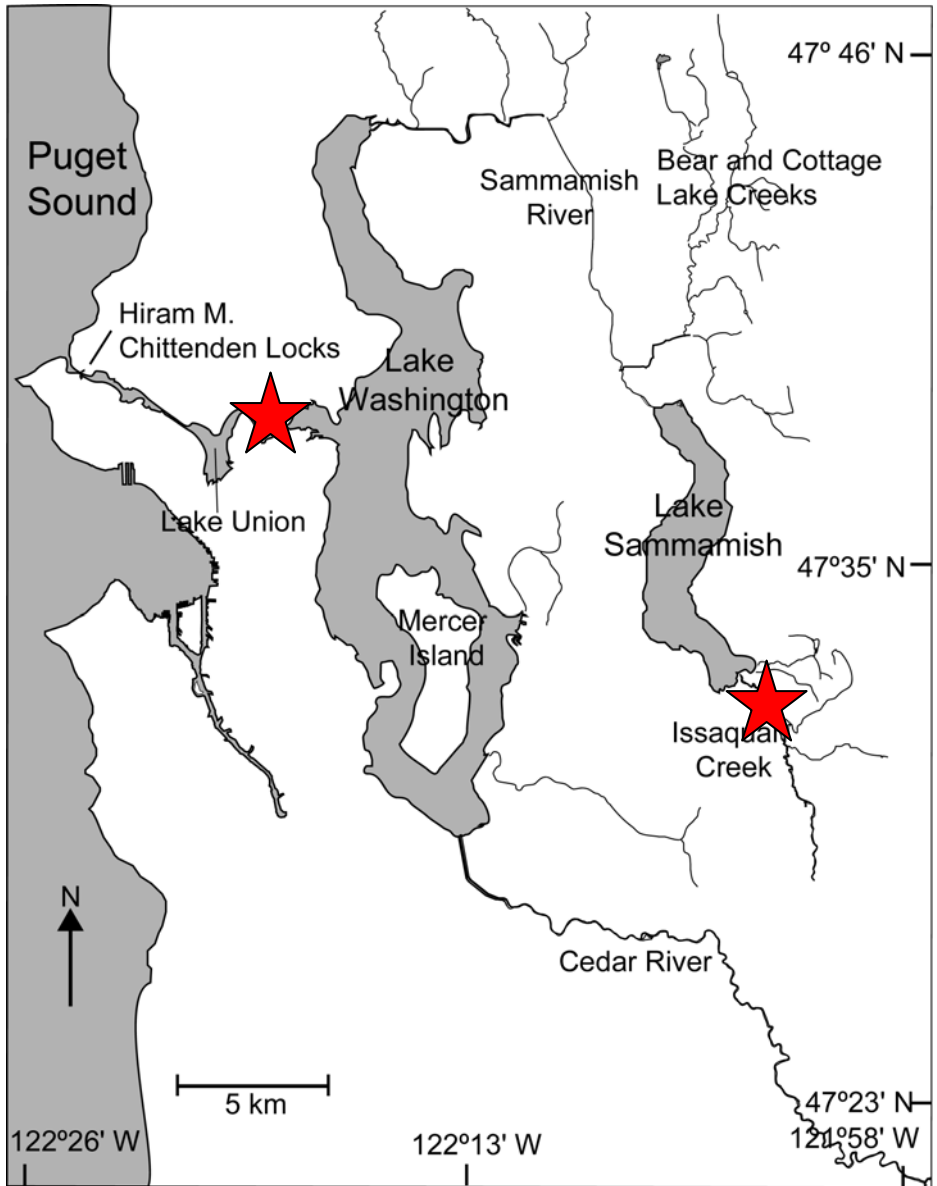
Goals: research and education

WDFW Issaquah Creek

~ 2,000,000 Chinook fry

~ Goals: harvest and education

Map: J. Newell



Natural origin vs. hatchery production

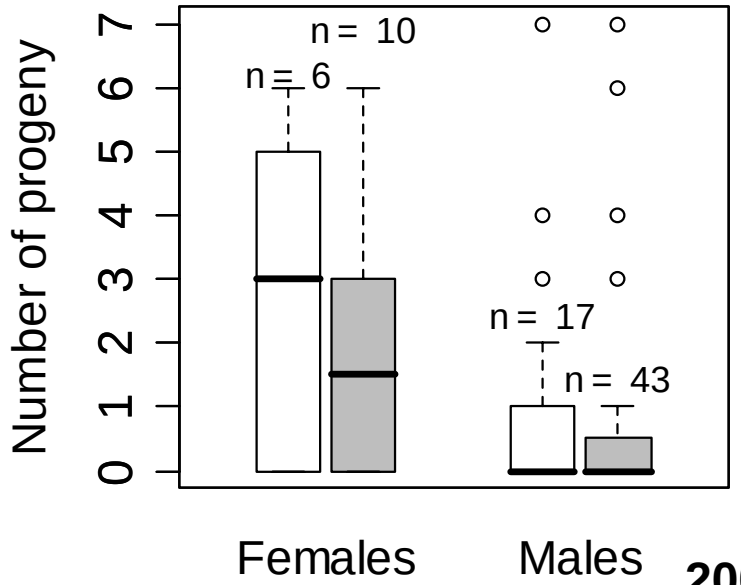
Natural origin

Hatchery

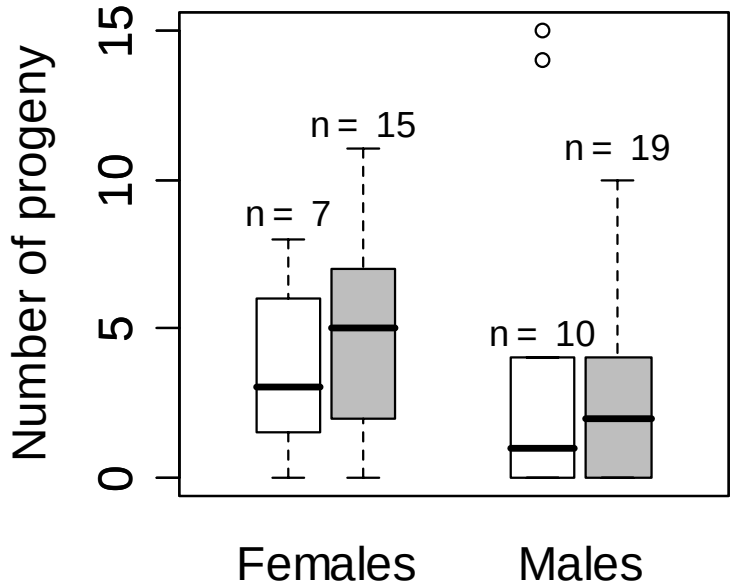
$$\text{Relative RS} = \frac{\text{Adult offspring per hatchery parent}}{\text{Adult offspring per natural origin parent}}$$

Year	Sex	Rel RS	p
2003	Males	0.747	> 0.10
2003	Females	0.671	> 0.10
2004	Males	0.748	> 0.10
2004	Females	1.42	> 0.10

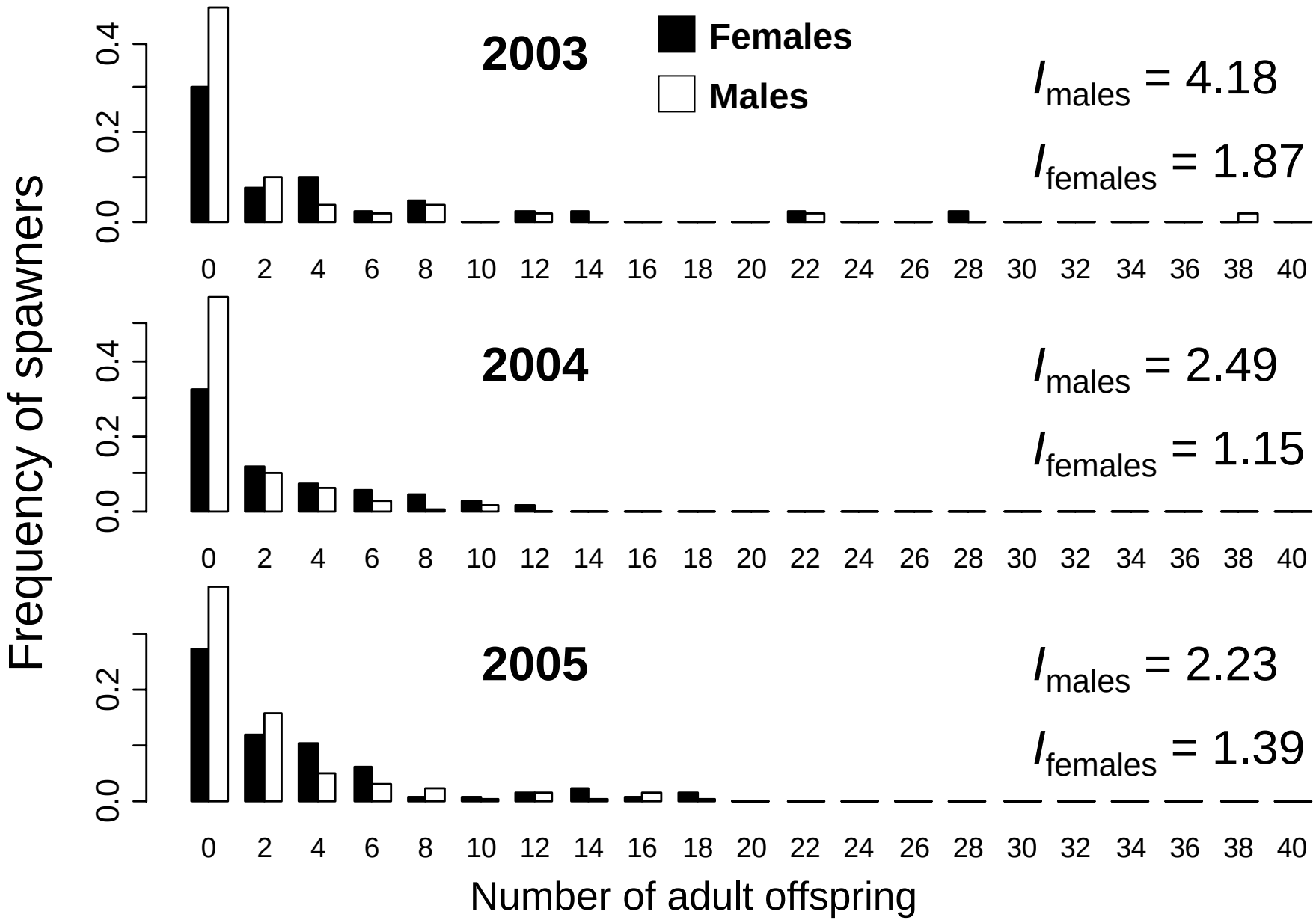
2003



2004



Coho individual reproductive success



Breeding date in coho salmon

Its good to be early…

Prior residence

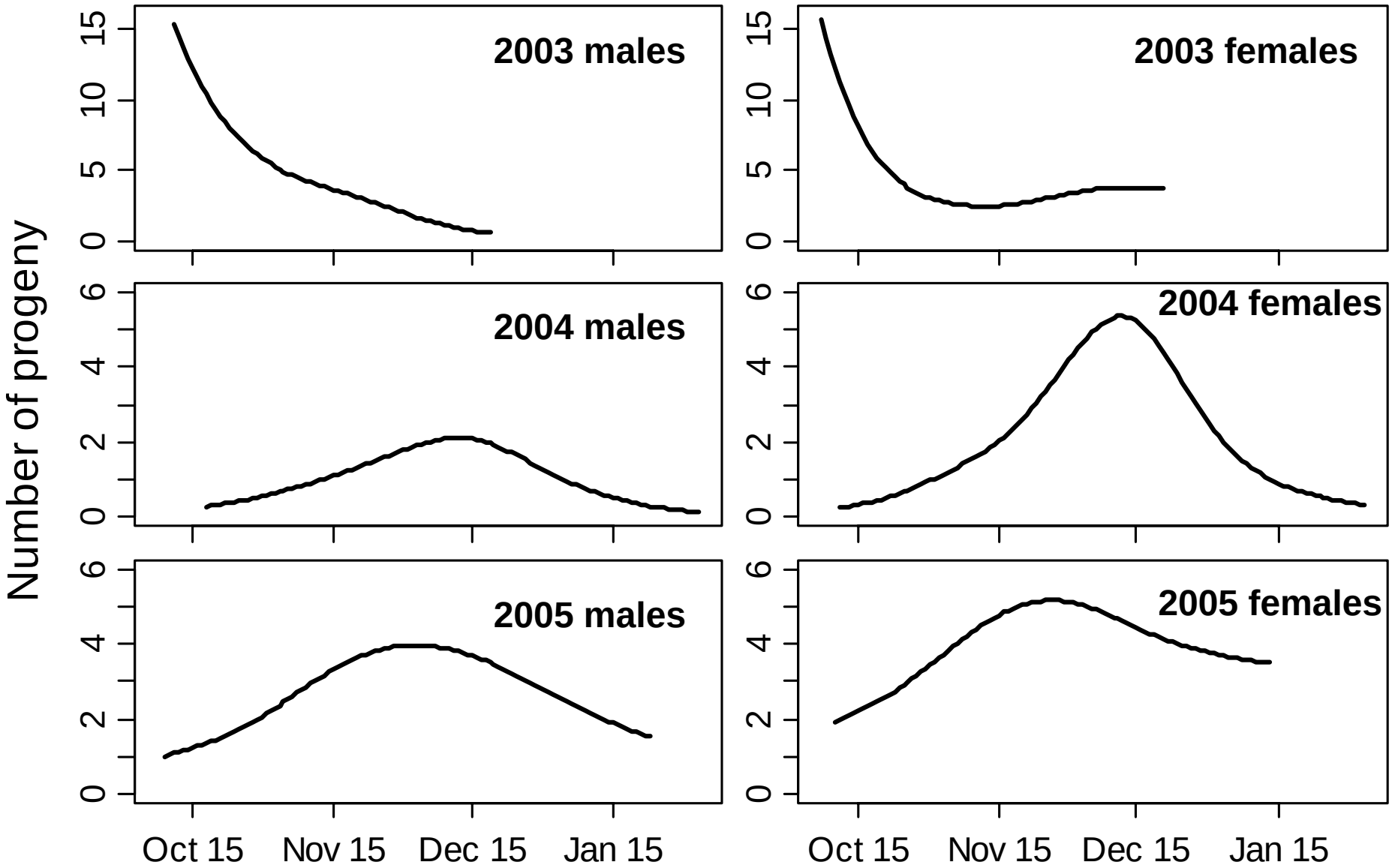
Early emergence of offspring

…but not *too* early.

Egg scour

Predation on offspring

Breeding date in coho salmon



Results summary

Under a policy of natural recolonization, both Chinook salmon and coho salmon ascended the fish ladder as soon as the new habitat became available

Chinook salmon population still dependent on strays from the lower river

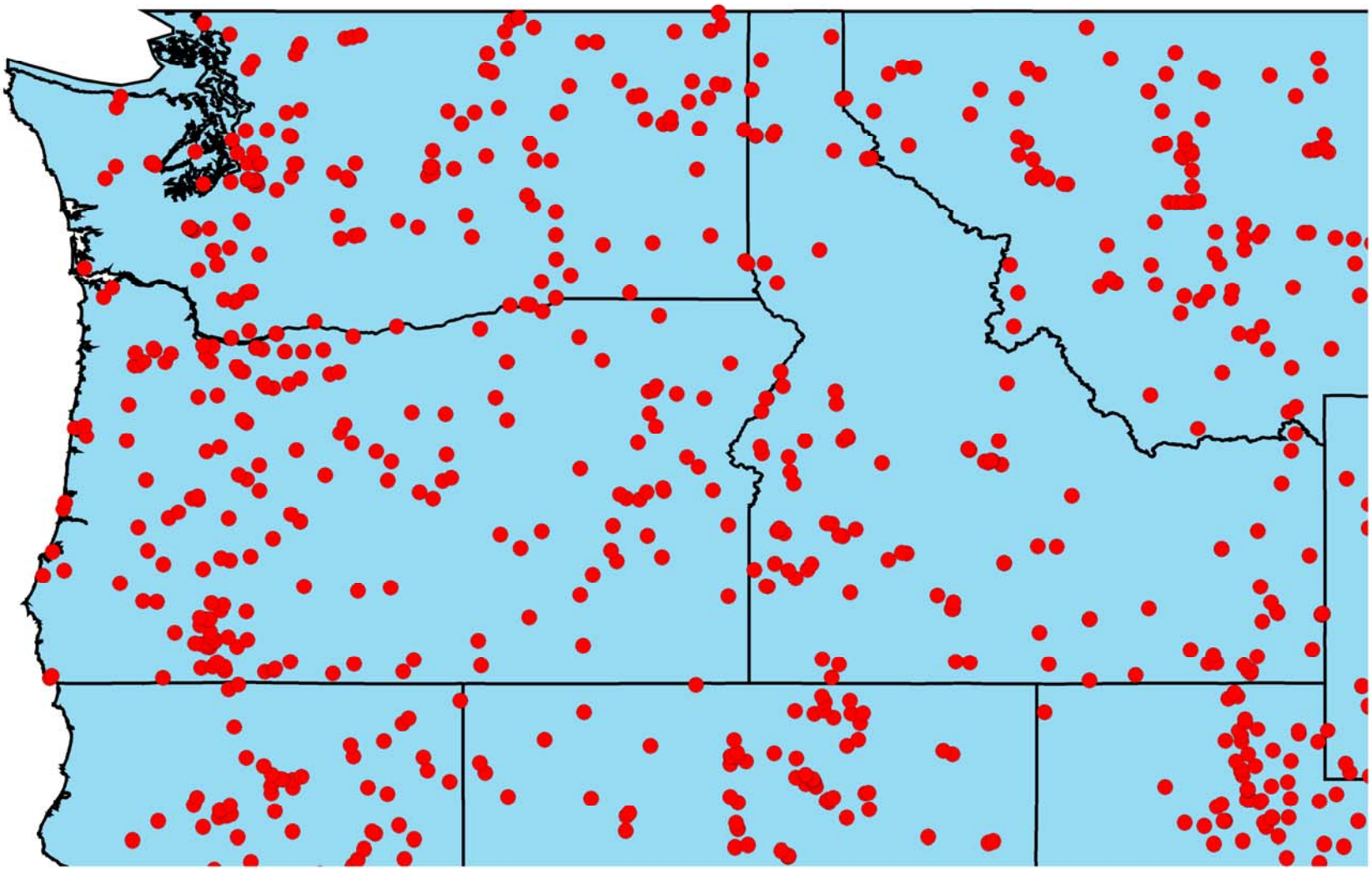
Coho salmon population currently self-sustaining

Great variation in individual reproductive success; more variation in males than females

Some, but not conclusive, evidence that Chinook hatchery males less productive than natural origin males; no consistent pattern for females

Breeding date had a strong but variable influence on coho salmon reproductive success

Dams in the Northwest



Data source: National Inventory of Dams, US Army Corps Engineers

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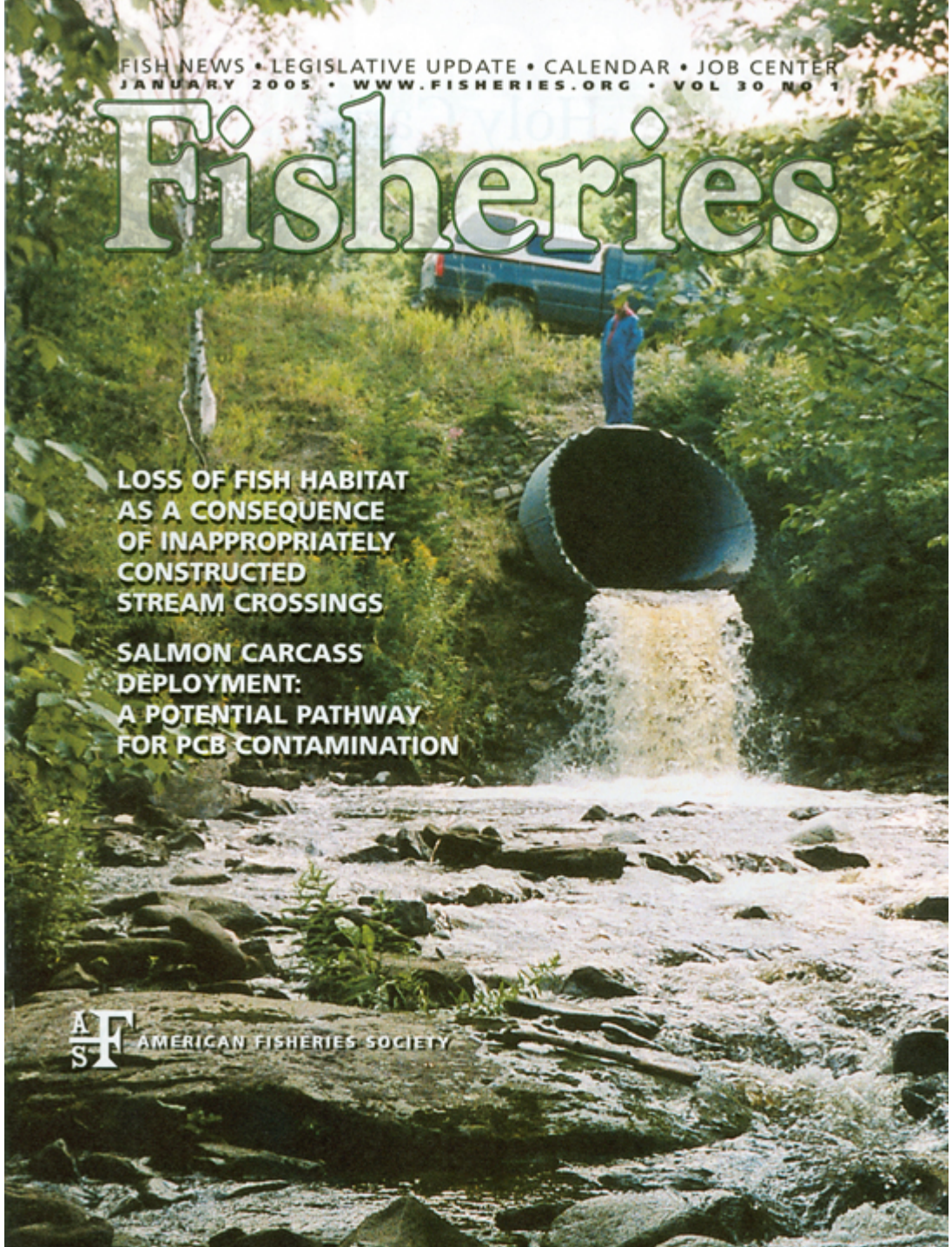

LOSS OF FISH HABITAT AS A CONSEQUENCE OF INAPPROPRIATELY CONSTRUCTED STREAM CROSSINGS

SALMON CARCASS DEPLOYMENT: A POTENTIAL PATHWAY FOR PCB CONTAMINATION

AFS AMERICAN FISHERIES SOCIETY

Condit Dam, White Salmon River, WA

Glines Canyon Dam, Elwha River, WA

Pelton Dam, Deschutes River, OR

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Danielle Mitchell
Todd Seamons
Erin McClelland
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Kerry Naish

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Seattle Public Utilities

Sea Grant Washington

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Species	Year	Sex	Sex ratio (M/F)	N	I
Chinook	2003	Male	3.94	60	4.85
Chinook	2003	Female	3.94	16	0.909
Chinook	2004	Male	1.32	29	1.69
Chinook	2004	Female	1.32	22	0.560
Coho	2003	Male	1.24	25	4.18
Coho	2003	Female	1.24	20	1.87
Coho	2004	Male	1.91	65	2.49
Coho	2004	Female	1.91	34	1.15
Coho	2005	Male	1.58	103	2.23
Coho	2005	Female	1.58	66	1.39

Chinook counts not adjusted for recycled fish that were discovered via matching genotypes

Colonization and conservation

Active or passive transport?

photos: Jim Peaco, NPS digital slide archive

Taxa	N	Success (%)
Birds	105	63
Mammals	77	73

Wolf et al., 1993, *Conservation Biology* 10: 1142 - 1154