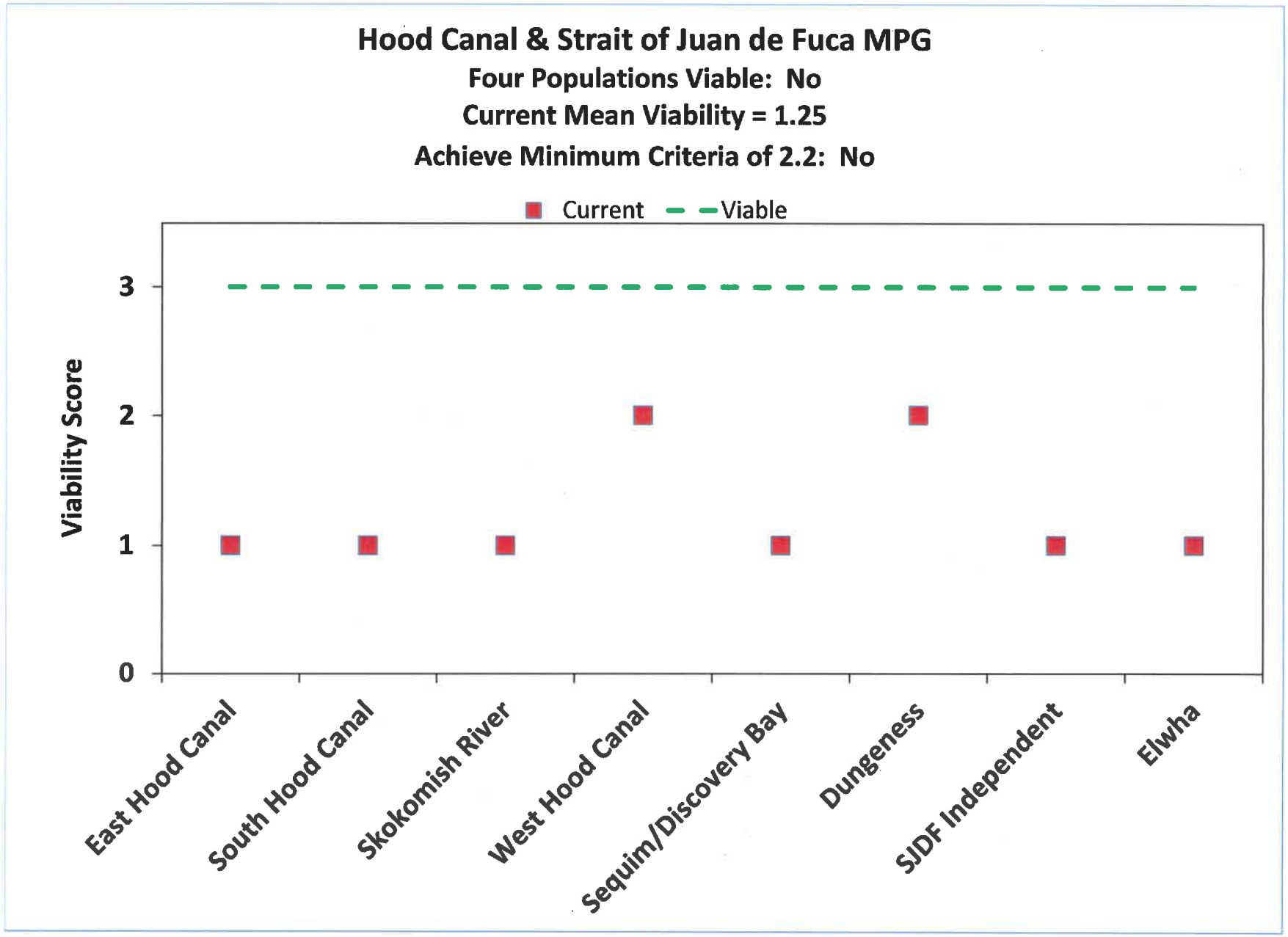
Hood Canal & Strait of Juan de Fuca MPG
Four Populations Viable: No
Current Mean Viability = 1.25
Achieve Minimum Criteria of 2.2: No
Current
Viable
Viability Score
3
2
1
0
East Hood Canal
South Hood Canal
Skokomish River
West Hood Canal
Sequim/Discovery Bay
Dungeness
SJDF Independent
Elwha

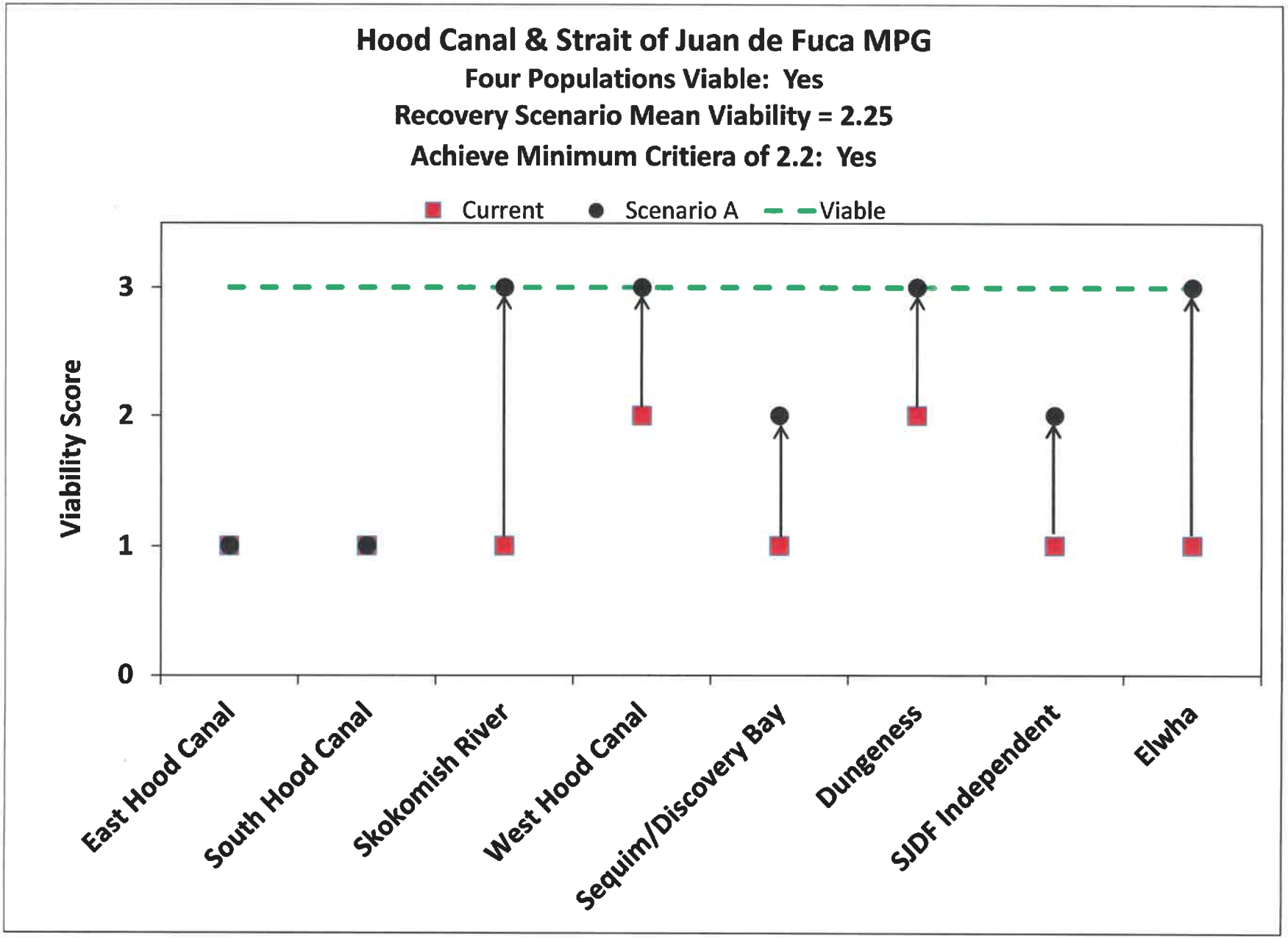
Hood Canal & Strait of Juan de Fuca MPG
Four Populations Viable: Yes
Recovery Scenario Mean Viability = 2.25
Achieve Minimum Critiera of 2.2: Yes
Current
Scenario A
Viable
Viability Score
3
2
1
0
East Hood Canal
South Hood Canal
Skokomish River
West Hood Canal
Sequim/Discovery Bay
Dungeness
SJDF Independent
Elwha

Table 1. Factors to consider in the designation of Hood Canal populations as Primary, Contributing, or Stabilizing.

Population or Watershed	Run Type	NOAA Intrinsic Potential (IP) [1/]	Average Spawners (2007-2016)	NOAA Viability Assessment P(Viable) [1/]	Past Hatchery Gene Flow	% Public Land	Hydrology [1/]
Skokomish	Winter	20,060	646	Low	[2/]	71%	40% Rain & Snow 25% Rain
East Hood Canal	Winter	2,540	85	Low	[2/]	23%	100% Lowland
West Hood Canal	Winter	7,217	165	Moderate	[2/]	76%	31% Rain & Snow 31% Lowland
South Hood Canal	Winter	5,970	95	Low	[2/]	38%	92% Lowland 8% Rain

[1/] Source: Puget Sound Technical Recovery Team 2013.

[2/] No releases of early winter steelhead for more than 10 years.

Hood Canal Planning Template

Draft May 23, 2017

Part A. Recovery Scenario

A recovery scenario is a combination of populations and population status levels that meet Technical Recovery Team (TRT) guidance for a viable Distinct Population Segment (DPS). The scenario represents one of many possible combinations of populations and recovery goals that could meet DPS and Major Population Group (MPG)-level viability criteria. Different scenarios may fulfill the biological requirements for recovery but can have unique implications for various stakeholders. Selection of a scenario for incorporation into the recovery plan is in part a policy decision based on scientific, biological, social, cultural, political, and economic considerations (drawn with modification from Lower Columbia Salmon Recovery and Subbasin Plan (2004)).

The Lower Columbia Salmon Recovery Plan (2010) provides the following description of the population designations:

a. ***Primary populations*** are targeted for restoration to high (95-99% probability) or very high (> 99% probability) viability. These populations are the foundation of salmon recovery. Primary populations are typically the strongest extant populations and/or those with the best prospects for protection or restoration. These typically include populations at high or medium viability during the listing baseline.
b. ***Contributing populations*** are those for which some improvement will be needed to achieve a stratum-wide average of medium viability (75 – 94% probability). Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery. Varying levels of improvement are identified for contributing populations. Some contributing populations are targeted for substantial improvements whereas more limited increases are identified for others.
c. ***Stabilizing populations*** are those that would be maintained at baseline levels. These are typically populations at very low viability during the listing baseline. Stabilizing populations might include those where significance is low, feasibility is low, and uncertainty is high. While stabilizing populations are not targeted for significant improvement, substantive recovery actions will typically be required to avoid further degradation.

Task

Our first task is to develop an initial proposal for a recovery scenario for Hood Canal populations which are part of the larger Hood Canal/Strait of Juan de Fuca MPG. We may revise this proposal as we assess the implications for recovery actions, and after we add the Strait of Juan de Fuca populations. Bearing in mind the historical importance of the population and current status, designate each of the following populations as Primary, Contributing, or Stabilizing. In order to achieve draft viability criteria for the MPG as a

whole, a proposed recovery scenario should identify at least one population as Primary (highest viability category) and not more than one as Stabilizing (lowest viability category). Several examples have been completed in the table below.

Population	Contribution to Recovery	Comments
East Hood Canal Tributaries Winter Run		
South Hood Canal Tributaries Winter Run	Contributing	
Skokomish River Winter Run	Primary	
West Hood Canal Tributaries Winter Run		

Hood Canal Planning Template

Draft May 23, 2017

Part B. Aspirational Objectives for Recreational Fishery

The aspirational objectives describe the desired future state for recreational fisheries in the short- (5-10 years) and long-term (more than 10 years). Aspirational objectives may not be achievable, particularly in the short-term, given conservation or resource constraints. Nevertheless, they are important to initiate the discussion of our vision for the future of Puget Sound steelhead. Through an iterative process we will "true up" our aspirational objectives with the conservation framework of the recovery scenario.

In developing the aspirational objectives, it may be helpful to recall several of the objectives the advisory group has identified:

1) describes a path toward diverse and sustainable fishing opportunities, with benchmarks to assess our progress;
2) recognizes the importance of steelhead and steelhead fisheries to our rural communities;
3) promotes greater understanding of steelhead populations through an experimental approach, and recognizes that adaptive management will be required to be successful;
4) is not constrained by previous fishery and hatchery management approaches;
5) identifies watershed-specific strategies for fisheries and artificial production programs designed to achieve specific seasons and fishery types (catch and release, catch and keep, rivers with no hatchery production); and
6) enjoys broad support among stakeholders interested in steelhead, including fishers and those interested in steelhead as a part of the Puget Sound ecosystem.

Task

Our second task is to identify our aspirational objectives for recreational fisheries for the short- and long-term. Although there are many types of recreational fisheries, perhaps the two broadest categories are catch-and-release and catch-and-keep. For catch-and-release fisheries, please identify the months for the fishery and the approximate angler days (i.e., 1000 anglers each fishing 10 days would be 10000 angler days). For catch-and-keep fisheries, please identify the months for the fishery and the approximate catch. Several examples have been completed in the table below.

Short Term

Population	Catch-and-Release			Catch-and-Keep		
	Directed at Wild Steelhead?	Months	Angler Days	Directed at Wild Steelhead?	Months	Catch
East Hood Canal Tributaries Winter Run			-			
South Hood Canal Tributaries Winter Run				No	Dec. – Jan.	300
Skokomish River Winter Run	No	Feb. - April	250			
West Hood Canal Tributaries Winter Run						

Long Term

Population	Catch-and-Release			Catch-and-Keep		
	Directed at Wild Steelhead?	Months	Angler Days	Directed at Wild Steelhead?	Months	Catch
East Hood Canal Tributaries Winter Run						
South Hood Canal Tributaries Winter Run				No	Dec. – Jan.	300
Skokomish River Winter Run	No	Feb. - April	500			
West Hood Canal Tributaries Winter Run						

Notes

NOAA's criteria for limit 5 may help inform the development of the aspirational objectives for the recreational fishery. The 4(d) rule is under the Fishery and Hatchery tab of your notebook. Several key concepts are provided below:

- Proposed management actions must recognize the significant differences in risk associated with viable and critical population threshold states and respond accordingly to minimize the long-term risks to population persistence. Harvest actions impacting populations that are functioning at or above the viable threshold must be designed to maintain the population or management unit at or above that level. For populations shown with a high degree of confidence to be above critical levels but not yet at viable levels, harvest management must not appreciably slow the population's achievement of viable function. Harvest actions impacting populations that are functioning at or below critical threshold must not be allowed to appreciably increase genetic and demographic risks facing the population and must be designed to permit the population's achievement of viable function, unless the plan demonstrates that the likelihood of survival and recovery of the entire ESU in the wild would not be appreciably reduced by greater risks to that individual population.
- Set escapement objectives or maximum exploitation rates for each management unit or population based on its status and on a harvest program that assures that those rates or objectives are not exceeded. Maximum exploitation rates must not appreciably reduce the likelihood of survival and recovery of the ESU. Management of fisheries where artificially propagated fish predominate must not compromise the management objectives for commingled naturally spawned populations.
- Display a biologically based rationale demonstrating that the harvest management strategy will not appreciably reduce the likelihood of survival and recovery of the ESU in the wild, over the entire period of time the proposed harvest management strategy affects the population, including effects reasonably certain to occur after the proposed actions cease.

Part C. Potential Artificial Production Programs to Meet Fishery or Conservation Objectives

An artificial production program may be a management action to help achieve fishery or conservation objectives. As discussed above for the aspirational objectives for the recreational fishery, we will need to "true up" our any proposed hatchery programs with the conservation framework of the recovery scenario.

In general, a segregated hatchery strategy will only be appropriate for a catch-and-keep fishery, while an integrated hatchery strategy may be used for a conservation program, for a catch-and-keep fishery, or for a catch-release-fishery.

In evaluating options for hatchery programs, it may be helpful to recall several of the objectives the advisory group has identified:

1) promotes the conservation and recovery of Puget Sound steelhead;
2) is informed by our scientific understanding of steelhead and the factors affecting their abundance, productivity, diversity, and spatial structure;
3) promotes greater understanding of steelhead populations through an experimental approach, and recognizes that adaptive management will be required to be successful;
4) is not constrained by previous fishery and hatchery management approaches; and
5) identifies watershed-specific strategies for fisheries and artificial production programs designed to achieve specific seasons and fishery types (catch and release, catch and keep, rivers with no hatchery production).

Task

Our third task is to assess if a hatchery program might help achieve provide initial consideration of whether an artificial production program might help achieve our conservation and aspirational fishery objectives. Please indicate in the tables below (short- and long-term) whether a hatchery program should be initially considered as a management action. Several examples have been completed in the tables below.

Short Term

Population	No Hatchery Releases	Conservation Program	Catch-and-Keep Hatchery Strategy		Catch-and Release Integrated Strategy
			Integrated	Segregated	
East Hood Canal Tributaries Winter Run					
South Hood Canal Tributaries Winter Run				✓	
Skokomish River Winter Run					✓
West Hood Canal Tributaries Winter Run					

Long Term

Population	No Hatchery Releases	Conservation Program	Catch-and-Keep Hatchery Strategy		Catch-and Release Integrated Strategy
			Integrated	Segregated	
East Hood Canal Tributaries Winter Run					
South Hood Canal Tributaries Winter Run				✓	
Skokomish River Winter Run					✓
West Hood Canal Tributaries Winter Run					

Notes

1) Hatchery Guidance. The Hatchery Scientific Review Group (2014) has provided the following guidance for broodstock management for programs designated as Primary, Contributing, or Stabilizing (pHOS – proportion hatchery-origin spawners; PNI – proportionate natural influence).

Hatchery Program Strategy	Population Designation	PNI	Effective pHOS	Gene Flow
Integrated	Primary Contributing Stabilizing	≥ 0.67 ≥ 0.50 1/	< 0.30 < 0.30 1/	NA
Segregated	Primary Contributing Stabilizing	NA	< 0.05 < 0.10 1/	< 0.02 Not Established 1/

1/ Standards for Stabilizing populations are situation specific.

Hood Canal Planning Template

Draft May 23, 2017

Part D. Proposed Portfolio

The proposed portfolio combines the recovery scenario, the aspirational fishery objectives, and the proposed hatchery programs. Department technical staff will subsequently analyze the proposed portfolio and identify any potential conflicts between the conservation objectives, aspirational fishery objectives, and hatchery broodstock management guidance. At our next meeting we will work to "true-up" any misalignment.

Task

Using the previous work on parts A-C, and discussions with the advisory group, describe your proposed portfolio. Several examples have been completed in the tables below.

Short Term

Population	Contribution to Recovery	Conservation Program (Y or N)	Fishery			Hatchery Program		
			Directed at Wild Fish (Y or N)	Type	Aspirational Objective	Strategy	PNI Criteria	pHOS or Gene Flow Limit
East Hood Canal Tributaries Winter Run								
South Hood Canal Tributaries Winter Run	Contributing		No	Catch & Keep	300 fish	Segregated	NA	-
Skokomish River Winter Run	Primary		No	Catch & Release	250 angler days	Integrated	≥ 0.67	< 0.02 gene flow
West Hood Canal Tributaries Winter Run								

Long Term

Population	Contribution to Recovery	Conservation Program (Y or N)	Fishery			Hatchery Program		
			Directed at Wild Fish (Y or N)	Type	Aspirational Objective	Strategy	PNI Criteria	pHOS or Gene Flow Limit
East Hood Canal Tributaries Winter Run								
South Hood Canal Tributaries Winter Run	Contributing		No	Catch & Keep	300 fish	Segregated	NA	-
Skokomish River Winter Run	Primary		No	Catch & Release	500 angler days	Integrated	≥ 0.67	< 0.02 gene flow
West Hood Canal Tributaries Winter Run								

Steelhead Historical Database

WDFW Fish Mgmt HQ, 600 Capitol Way N, Olympia 98501, (360) 902-2820/2817

Puget Sound DPS
Eastside Hood Canal MU
Big Beef Creek Winter-run Steelhead

WRIA 15.0389 **Mason County**

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement			Total Runsize			Smolt	Revised: May 8th, 2017 bl
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	May Release Return N+2	Comments
1960/61														Sport Estimates taken from WDFW CRC Data
1961/62			138											
1962/63			109											
1963/64			148											
1964/65			242											
1965/66			104											
1966/67			29											
1967/68			32											
1968/69			62											
1969/70			22											
1970/71			32											
1971/72			6											
1972/73			12											
1973/74														
1974/75			3											
1975/76			7											
1976/77			2											
1977/78														
1978/79														
1979/80														
1980/81														
1981/82														
1982/83			3											
1983/84														
1984/85														
1985/86														
1986/87														
1987/88														
1988/89														
1989/90														
1990/91														
1991/92														
1992/93														
1993/94														
1994/95														
1995/96														
1996/97														
1997/98														
1998/99														
1999/00														
2000/01														
2001/02														
2002/03														
2003/04														
2004/05														
2005/06														
2006/07														
2007/08								58						
2008/09								5						
2009/10								2						
2010/11								6						
2011/12								11						
2012/13								55						
2013/14								3						
2014/15								50						
2015/16								16						
2016/17														

Escapement goal =??
Index Escapement Goal = ??
Wild river entry: E. Dec - L. May
Wild spawn: M. Feb - E. Jun

Steelhead Historical Database

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Puget Sound DPS
East Hood Canal MU
Dewatto River Winter-run Steelhead **WRIA 15.0420** **Mason County**

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement			Total Runsize			Smolt	Revised: May 9, 2017 bl
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	May Release Return N+2	Comments
1960/61														Sport Estimates taken from WDFW CRC Data
1961/62			33											
1962/63			173											Catch Record Card (CRC) reporting season change:
1963/64			63											Prior to 2000: 1 May to 30 April CRC year
1964/65			46											Year 2000: 1 May to 31 Mar CRC year
1965/66			71											2001 and on: 1 April to 31 March CRC year
1966/67			90											
1967/68			76											
1968/69			77											
1969/70			50										10,020	
1970/71			175										8,780	
1971/72			109										10,133	
1972/73			66										10,060	
1973/74			111										8,640	
1974/75			85										10,014	
1975/76			115										10,013	
1976/77			94										10,000	
1977/78			54											
1978/79			92			0							10,006	Escapement goal =138
1979/80			74			0							10,010	*Index Escapement Goal = 81*
1980/81			23			0		12					10,254	Wild river entry: E. Dec - L. May
1981/82			44			0		34					12,362	Wild spawn: M. Feb - E. Jun
1982/83			38			0		22					9,996	
1983/84			36			0		86					11,999	
1984/85			73			0		102					12,011	First Ad-clip
1985/86			102			91		32					10,010	
1986/87	8	11	19			81		3					9,895	WSR
1987/88	13	0	13			61		23					3,000	
1988/89	2	2	4			0		22					10,080	
1989/90	2	0	2			0							14,799	
1990/91	2	2	4			0							10,011	
1991/92			0			0							0	1992 SaSSI status: Depressed
1992/93			0			0		40					0	
1993/94			0			0		18					0	
1994/95			0			0		22					4,784	
1995/96			0			0		39					0	Hatchery releases stopped
1996/97			0			0		11					0	
1997/98			0			0		28					0	
1998/99			0			0		15					0	
1999/00			0			0		23					0	
2000/01			0			0		19					0	
2001/02			0			0		30					0	2002 SaSI status: Depressed
2002/03			0			0		18					0	
2003/04			0			0		39					0	
2004/05			0			0		23					0	Winter SH season closure begins 2004/05
2005/06			0			0		53					0	
2006/07			0			0		28					0	
2007/08			0			0		49					0	Begin Hood Canal SH supplementation program and
2008/09			0			0		15					7,375	research in 2007 (NOAA, WDFW, Tribes, LLTK, HCSEG)
2009/10			0			0		13					1,600	
2010/11			0			0		92					6,622	
2011/12			0			0		55					4,905	
2012/13			0			0		203					5,500	
2013/14			0			0		28					6,214	
2014/15			0			0		110					6,689	
2015/16			0			0		50						
2016/17														

Dewatto River adult steelhead releases: release year 2011, 226; release year 2012, 26; release year 2013, 228; release year 2014, 21. Supplementation adults are excluded from anticipated run size forecast

Steelhead Historical Database

WDFW Fish Mgmt HQ, 600 Capitol Way N, Olympia 98501, (360) 902-2820/2817

Puget Sound DPS
South Hood Canal MU
Tahuya River Winter-run Steelhead

WRIA 15.0446 **Mason County**

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement			Total Runsize			Smolt -May Release	Revised: May 9th, 2017.bl
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Return N+2	Comments
1960/61													0	Sport Estimates taken from WDFW CRC Data
1961/62			59										0	
1962/63			127										0	Catch Record Card (CRC) reporting season change:
1963/64			282										14,966	Prior to 2000: 1 May to 30 April CRC year
1964/65			337										5,150	Year 2000: 1 May to 31 Mar CRC year
1965/66			287										0	2001 and on: 1 April to 31 March CRC year
1966/67			250										4,971	
1967/68			196										5,055	
1968/69			143										5,022	
1969/70			108										19,762	
1970/71			329										9,967	
1971/72			253										10,107	
1972/73			92										10,229	
1973/74			77										10,328	
1974/75			89										10,003	
1975/76			115										10,040	
1976/77			53										10,295	
1977/78			75										10,000	*WDFW Escapement goal = 266 index*, 373 total
1978/79			44			0							9,894	
1979/80			109			0							10,075	Wild river entry: E. Dec - L. May
1980/81			74			0		94					10,500	Wild spawn: E. Mar - E. Jun
1981/82			37			0		86					10,684	
1982/83			46			0		44					8,400	
1983/84			71			11	241	172					15,096	Total redd count escapement
1984/85			115			0	162	185					10,308	
1985/86			86			0	71	142					10,043	
1986/87	14	9	23			3		119					10,005	First ad-clip returns; WSR
1987/88	7	17	24			0	121	102		128			10,000	
1988/89	4	4	8			0	148	142		152			10,002	
1989/90	5	3	8			0		164					15,002	
1990/91	7	7	14			0		122					0	
1991/92	0	2	2			0		73					0	1992 SaSSI status: Depressed
1992/93	0	7	7			0		75					0	
1993/94	3	0	3			0		77					9,790	
1994/95	3	0	3			0		78					14,976	Hatchery releases stopped
1995/96	8	4	12			0		92					0	
1996/97			0			0		144					0	
1997/98			0			0		126					0	
1998/99	6	6	12			0		340					0	
1999/00	2	0	2			0		191					0	
2000/01			0			0		133					0	
2001/02			0			0		97					0	2002 SaSI status: Depressed
2002/03			0			0		53					0	
2003/04			0			0		168					0	
2004/05			0			0		91					0	
2005/06			0			0		183					0	
2006/07			0			0		175					0	Winter SH season closure begins 2004/05
2007/08			0			0		144					0	
2008/09			0			0		53					0	
2009/10			0			0		68					0	
2010/11			0			0		47					0	
2011/12			0			0		78					0	
2012/13			0			0		68					0	
2013/14			0			0		37					0	
2014/15			0			0		62					0	
2015/16			0			0		62						
2016/17														

Steelhead Historical Database

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Puget Sound DPS
South Hood Canal MU
Union River Winter-run Steelhead

WRIA 15.0503 **Mason County**

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement			Total Runsize			Smolt	Revised: May 9th, 2017 bl
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	May Release Return N+2	Comments
1960/61														Sport Estimates taken from WDFW CRC Data
1961/62			92											
1962/63			234											Catch Record Card (CRC) reporting season change:
1963/64			549											Prior to 2000: 1 May to 30 April CRC year
1964/65			264											Year 2000: 1 May to 31 Mar CRC year
1965/66			366											2001 and on: 1 April to 31 March CRC year
1966/67			124											
1967/68			161											
1968/69			89											
1969/70			42											
1970/71			233											
1971/72			271											
1972/73			52											
1973/74			90											
1974/75			134											
1975/76			101											
1976/77			135											
1977/78			51											
1978/79			312											
1979/80			81											Wild river entry: E. Dec - L. May
1980/81			67											Wild spawn: E. Mar - E. Jun
1981/82			41											
1982/83			40											
1983/84			43											*Index redd count escapement*
1984/85			83											
1985/86			143											
1986/87	9	11	20											First ad-clip returns; WSR
1987/88	10	2	12											
1988/89	32	6	38											
1989/90	10	2	12											
1990/91	8	6	14											
1991/92	2	2	4											1992 SaSSI status: Depressed
1992/93	11	2	13											
1993/94			0											
1994/95	3	0	3											
1995/96	4	0	4			0								
1996/97			0			0								
1997/98			0			0		*45*						
1998/99			0			0		*65*						
1999/00			0			0		*50*						
2000/01			0			0		*73*						
2001/02			0			0		*49*						2002 SaSI status: Depressed
2002/03			0			0		*50*						
2003/04			0			0		*58*						
2004/05			0			0		*23*						
2005/06			0			0		*86*						
2006/07			0			0		*21*						Winter SH season closure begins 2004/05
2007/08			0			0		*15*						
2008/09			0			0		*15*						
2009/10			0			0		*21*						
2010/11			0			0		*11*						
2011/12			0			0		*16*						
2012/13			0			0		*8*						
2013/14			0			0		*6*						
2014/15			0			0		*28*						
2015/16			0			0		*13*						
2016/17														

Steelhead Historical Database

WDFW Fish Mgmt HQ, 600 Capitol Way N, Olympia 98501, (360) 902-2820/2817

Puget Sound DPS
Skokomish MU
Skokomish River System Winter-run Steelhead **WRIA 16.0001** **Mason County**
Includes Vance Creek

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement			Total Runsize			Smolt	Revised: May 9th, 2017 bl
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	~May Release Return N+2	Comments
1960/61													14816	Sport Estimates taken from WDFW CRC Data
1961/62			677										21988	
1962/63			680										15265	Catch Record Card (CRC) reporting season change:
1963/64			1180										0	Prior to 2000: 1 May to 30 April CRC year
1964/65			7										21000	Year 2000: 1 May to 31 Mar CRC year
1965/66			30										14730	2001 and on: 1 April to 31 March CRC year
1966/67			33										26080	
1967/68			21										5257	
1968/69			0										15431	
1969/70			0										39389	
1970/71			10										21433	
1971/72			2										20022	
1972/73			2										20010	
1973/74			4										15090	
1974/75			6										13847	
1975/76			280										18775	
1976/77			347										15086	
1977/78			239										35,759	**WDFW EG=1,357**
1978/79			277			302							18,688	
1979/80			302			113							10,480	Wild river entry: E. Dec - L. May
1980/81			161			286							17,035	Wild spawn: M. Feb - M. Jun
1981/82			145			344		822					27,228	
1982/83			202			247		659					14,788	Segregated harvest hatchery program
1983/84			202			161		777					27,082	Eggs transferred in
1984/85			327			306		968					29,558	
1985/86			332			400		866					23,075	Total escapement based on redd counts
1986/87	127	37	164			274		546					20,942	Begin ad-clip
1987/88	72	15	87			231		742					20,025	**WSR since 1/1/87**
1988/89	46	13	59			51		1,444					44,760	
1989/90	68	2	70			57		370					39,975	
1990/91	14	2	16			23		729					30,033	1992 SaSSI status: Depressed
1991/92	21	2	23			3		172	minimum				19,934	Incomplete surveys due to high flows, estimate is a minimum
1992/93	0	2	2			13			a/				28,508	Incomplete surveys due to high flows; no estimate possible
1993/94	8	6	14			20		473					20,049	
1994/95	6	3	9			0		398					39,130	
1995/96	24	0	24			0			a/				39,296	Incomplete surveys due to high flows; no estimate possible
1996/97	23	2	25			0			a/				53,684	Incomplete surveys due to high flows; no estimate possible
1997/98	10	0	10			0		373					14,688	
1998/99	9	3	12			0		311					53,495	
1999/00	26	2	28			0		261					46,700	
2000/01	22	0	22			0		286					62,280	2002 SaSI status: Depressed
2001/02	100	0	100			0		156	minimum				62,976	Incomplete surveys due to high flows, estimate is a minimum
2002/03	16	0	16			0		132	minimum				68,356	Incomplete surveys due to high flows, estimate is a minimum
2003/04	26	0	26			0		233					55,803	
2004/05	16	0	16			0			a/				49,946	Hatchery release program terminated
2005/06	6	0	6			0		231					0	
2006/07	6	0	6			4		354					0	
2007/08	2	0	2			9		252	b/				4,100	Winter SH season closure begins 2007/08
2008/09			0			6		502					23,747	Begin Hood Canal SH supplementation program and research in
2009/10			0			4		319					20,530	2007 (NOAA, WDFW, Tribes, LLTK, HCSEG)
2010/11			0			12		424					26,642	
2011/12			0			24		499					23,989	
2012/13			0			15		1,028					22,717	
2013/14			0			7		614					27,258	
2014/15			0			13		1,338					18,334	
2015/16			0			6		1,126						
2016/17														

Steelhead Historical Database

WDFW Fish Mgmt HQ, 600 Capitol Way N, Olympia 98501, (360) 902-2820/2817

Puget Sound DPS
West Hood Canal MU
Hamma Hamma River Winter-run Steelhead

WRIA 16.0251

Mason County

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement			Total Runsize			Smolt	Revised: May 9, 2017 bl
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild a/	H&W.Total	Hatchery	Wild	H&W Total	~May Release Return N+2	Comments
1960/61													0	Sport Estimates taken from WDFW CRC Data
1961/62			100										0	
1962/63			218										0	Catch Record Card (CRC) reporting season change:
1963/64			358										0	Prior to 2000: 1 May to 30 April CRC year
1964/65			314										0	Year 2000: 1 May to 31 Mar CRC year
1965/66			222										0	2001 and on: 1 April to 31 March CRC year
1966/67			82										0	
1967/68			80										0	
1968/69			13										0	
1969/70			22										0	
1970/71			104										0	
1971/72			112										0	
1972/73			20										0	
1973/74			12										0	
1974/75			36										0	
1975/76			30										0	
1976/77			83										0	
1977/78			51										0	*WDFW Escapement goal = 91 in index;* 119 total
1978/79			32										0	Esc. Index area = RM 0.3 to 2.2, plus John Cr.
1979/80			78			0							0	
1980/81			43			0							0	Wild river entry: E. Dec - L. May
1981/82			90			20							0	Wild spawn: M. Feb - M. Jun
1982/83			38			0							0	
1983/84			150			0							0	
1984/85			150			0							0	
1985/86			38			0							0	
1986/87	3	44	47			0							0	
1987/88	13	11	24			0							0	
1988/89	2	8	10			0							0	
1989/90	2	4	6			0							0	
1990/91			0			0							0	
1991/92	4	0	4			0							0	1992 SaSSI stock status: Unknown
1992/93	2	0	2			0							0	
1993/94			0			0							0	
1994/95			0			0		13			13		0	Begin WSR in 1994/95
1995/96			0			0		8			8		0	
1996/97			0			0		35			35		0	
1997/98			0			0		18			18		0	Begin supplementation in '98 and habitat restoration plan
1998/99			0			0		21			21		0	Integrated recovery hatchery program
1999/00			0			0		19			19		0	
2000/01			4			0		3			3		1,524	2002 SaSI stock status: Depressed
2001/02			0			0		230			230		1,336	Esc.incl. 197 (81F+116M) captive-reared adults release
2002/03			0			0		134			134		481	Esc.incl. 4 (2 F + 2 M) captive-reared adults release
2003/04			0			0		214			214		877	Esc.incl. 76 (35F + 41M) captive-reared adults release
2004/05			0			0		123			123		0	
2005/06			0			0		70			70		2,043	Supplementation program ended
2006/07			0			0		171			171		2,573	Esc. incl. 139 captive-reared adults release
2007/08			0			0		175			175		0	Winter SH season closure begins 2006/07
2008/09			0			0		72			72		0	
2009/10			0			0		37			37		0	
2010/11			0			0		53			53		0	
2011/12			0			0		43			43		0	
2012/13			0			0		41			41		0	
2013/14			0			0		58			58		0	
2014/15			0			0		52			52		0	
2015/16			0			0		37			37			
2016/17														

a/ Includes 197, 4, 76, 0, 0, 139, and 131 steelhead adults released into Hamma Hamma River from supplementation program during 2001-02 through 2007-08 seasons, respectively

Adjusted escapement and redd counting method 2006/07 to 2015/16

Steelhead Historical Database

WDFW Fish Mgmt HQ, 600 Capitol Way N, Olympia 98501, (360) 902-2820/2817

Puget Sound DPS
West Hood Canal ESU
Duckabush River Winter-run Steelhead

WRIA 16.0351 **Jefferson County**

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement			Total Runsize			Smolt ~May Release	Revised: May 9th, 2017 bl Comments
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Return N+2	
1960/61													10,319	Sport Estimates taken from WDFW CRC Data
1961/62			232										12,845	
1962/63			475										20,160	Catch Record Card (CRC) reporting season change:
1963/64			980										20,360	Prior to 2000: 1 May to 30 April CRC year
1964/65			409										21,610	Year 2000: 1 May to 31 Mar CRC year
1965/66			439										13,456	2001 and on: 1 April to 31 March CRC year
1966/67			331										19,900	
1967/68			236										12,000	
1968/69			54										19,420	
1969/70			66										19,750	
1970/71			342										19,987	
1971/72			235										19,017	
1972/73			174										20,010	
1973/74			208										19,825	
1974/75			263										20,119	
1975/76			334										15,000	
1976/77			139										35,477	
1977/78			530										20,005	*WDFW Escapement goal = 82 in index;* 158 total
1978/79			404			0							26,420	Esc. Index = RM 0.0 to 2.6
1979/80			575			0							15,114	
1980/81			288			16							15,000	Wild river entry: E. Dec - L. May
1981/82			253			75							17,773	Wild spawn: M. Feb - M. Jun
1982/83			148			59							18,100	Segregated harvest hatchery program
1983/84			230			117							19,951	Eggs transferred in
1984/85			231			47							20,007	
1985/86			201			52							20,086	
1986/87	89	57	146			12							22,264	Begin ad-clip
1987/88	69	42	111			0							5,000	
1988/89	45	30	75			0							20,015	
1989/90	31	30	61			0							19,987	
1990/91	10	10	20			0							14,994	
1991/92	26	22	48			0							0	1992 SaSSI stock status: Depressed
1992/93	10	7	17			0							15,101	
1993/94	13	0	13			0							17,010	
1994/95	14	0	14			0							15,142	WSR begins 1994/95
1995/96	20	0	20			0							5,018	
1996/97	9	0	9			0		19	minimum				10,080	
1997/98	9	0	9			0		6	minimum				0	Poor visibility during survey season
1998/99	3	0	3			0		29	minimum				10,032	
1999/00	0	0	0			0		36					10,638	
2000/01	0	0	0			0		13					10,151	
2001/02	28	0	28			0		16					10,032	2002 SaSI stock status: Depressed
2002/03	0	0	0			0		8					10,028	
2003/04	2	0	2			0		29					10,032	
2004/05	2	0	2			0		10					0	Hatchery release program discontinued
2005/06	0	0	0			0		21					0	
2006/07	0	0	0			0		15					0	Begin Hood Canal SH supplementation program and
2007/08	0	0	0			0		16					0	research in 2007 (NOAA, WDFW, Tribes, LLTK, HCSEG)
2008/09	0	0	0			0		20					1,924	Winter SH season closure begins 2006/07
2009/10	0	0	0			0		26					0	
2010/11	0	0	0			0		110					140	
2011/12	0	0	0			0		92					1,505	
2012/13	0	0	0			0		48					4,777	
2013/14	0	0	0			0		56					4,482	

Steelhead Historical Database

WDFW Fish Mgmt HQ, 600 Capitol Way N, Olympia 98501, (360) 902-2820/2817

Puget Sound DPS
West Hood Canal MU
Dosewallips River Winter-run Steelhead **WRIA 16.0442** **Jefferson County**

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement c/			Total Runsize			Smolt	Revised: May 9th, 2017 bl
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	May Release Return N+2	Comments
1960/61													15,003	Sport Estimates taken from WDFW CRC Data
1961/62			302										16,860	
1962/63			471										20,050	
1963/64			1208										37,440	Catch Record Card (CRC) reporting season change:
1964/65			541										21,180	Prior to 2000: 1 May to 30 April CRC year
1965/66			512										19,925	Year 2000: 1 May to 31 Mar CRC year
1966/67			351										20,000	2001 and on: 1 April to 31 March CRC year
1967/68			359										17,000	
1968/69			116										19,420	
1969/70			118										20,118	
1970/71			353										20,032	
1971/72			308										20,025	
1972/73			255										20,015	
1973/74			251										19,800	
1974/75			265										20,007	
1975/76			304										15,008	
1976/77			43										25,033	
1977/78			496										20,006	WDFW Escapement goal = 318 in index from redd counts
1978/79			234			0							30,002	Esc. Index = RM 0.2-3.0; 3.6-5.4; 7.0-11.0; 11.5-12.0
1979/80			478			0							25,184	WDFW Total EG = 438
1980/81			389			2							23,178	Wild river entry: E. Dec - L. May
1981/82			218			136							23,747	Wild spawn: M. Feb - M. Jun
1982/83			173			134							18,151	Segregated harvest hatchery program
1983/84			262			143							20,032	Eggs transferred in
1984/85			283			119							25,093	
1985/86			167			91							20,796	
1986/87	69	86	155			0							19,554	Begin ad-clip
1987/88	72	41	113			9							15,002	*Index escapement data in italics*
1988/89	24	10	34			0							25,350	
1989/90	35	14	49			0							25,028	
1990/91	24	8	32			0							15,111	
1991/92	4	2	6			0							6,570	1992 SaSSI stock status: Depressed
1992/93	0	7	7			0							15,031	
1993/94	12	11	23			0							20,112	
1994/95	6	0	6			0		79					14,742	WSR begins 1994/95
1995/96	12	0	12			0		55					5,018	
1996/97	3	0	3			0		60					12,648	
1997/98	11	0	11			0		49	minimum				0	Poor visibility during survey season
1998/99			0			0		99	minimum				12,540	
1999/00			0			0		78					12,339	
2000/01			0			0		89					12,529	
2001/02	32	0	32			0		52					12,552	2002 SaSI stock status: Depressed
2002/03			0			0		96					12,512	
2003/04			0			0			a/				12,533	Incomplete esc. Surveys: poor vis. and high flows
2004/05	2	0	2			0			a/				0	Hatchery releases discontinued
2005/06			0			0							0	*District estimates that index met represent 95% of total*
2006/07			0			0		15	b/				0	Winter SH season closure begins 2006/07
2007/08			0			0		42	b/				0	
2008/09			0			0			a/				0	
2009/10			0			0			a/				0	
2010/11			0			0		31	b/				0	
2011/12			0			0		11	b/				0	
2012/13			0			0			a/				0	
2013/14			0			0			a/				0	
2014/15			0			0		23					0	
2015/16			0			0			a/					
2016/17														

a/ No escapement estimate was made because of high flows and/or poor visibility during surveys.

b/ Minimum estimate due to frequency of surveys

c/ 79 placeholder escapement used in pre & post season (escapement) estimation. In annual Harvest Management Plans.

Steelhead Historical Database

WDFW Fish Mgmt HQ, 600 Capitol Way N, Olympia 98501, (360) 902-2820/2817

Puget Sound DPS
West Hood Canal MU
Quilcene System Winter-run Steelhead **WRIA 17.0012** **Jefferson County**
(Big Quilcene/Little Quilcene)

1May-30Apr

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement (Little Quilcene)			Total Runsize			Smolt	Revised: May 9th, 2017 bl
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	~May Release Return N+2	Comments
1960/61														Sport Estimates taken from WDFW CRC Data
1961/62			37											
1962/63			105										10,041	
1963/64			462										10,094	Catch Record Card (CRC) reporting season change:
1964/65			206										9,920	Prior to 2000: 1 May to 30 April CRC year
1965/66			236										10,000	Year 2000: 1 May to 31 Mar CRC year
1966/67			139										10,000	2001 and on: 1 April to 31 March CRC year
1967/68			123										10,000	
1968/69			118										10,315	
1969/70			46										9,902	
1970/71			121										10,260	
1971/72			282										10,350	
1972/73			118										10,356	
1973/74			158										10,046	
1974/75			213										20,849	
1975/76			197										10,547	
1976/77			14										15,000	
1977/78			269										15,080	No escapement goal established
1978/79			40										15,007	Harvest data for Big Quilcene R. and Little Quilcene R.
1979/80			95			0							15,309	
1980/81			118			0							9,585	Wild river entry: E. Dec - L. May
1981/82			55			0							0	Wild spawn: M. Feb - M. Jun
1982/83			22			0							13,060	Smolt releases into Big Quilcene
1983/84			53			0							11,900	
1984/85			53			16							10,312	
1985/86			22			7							10,200	
1986/87	19	13	32			8							10,152	*Escapement index redd counts*
1987/88	21	2	23			0							5,300	
1988/89	6	4	10			0							5,075	
1989/90	18	14	32			0							10,164	
1990/91	2	2	4			0							10,081	
1991/92			0			0							0	1992 SaSSI stock status: Unknown
1992/93	2	2	4			0							0	
1993/94			0			0							0	
1994/95	9	9	18			0							0	WSR begins 1994/95
1995/96	4	0	4			0							0	
1996/97			0			0							0	
1997/98			0			0							0	
1998/99	9	9	18			0		*29*					0	Escapement data for Little Quilcene
1999/00			0			0		*15*					0	
2000/01	43	4	47			0		*8*					0	
2001/02	21	33	54			0		*30*					0	2002 SaSI stockstatus: Unknown
2002/03	8	0	8			0		*16*					0	
2003/04	4	0	4			0		*36*					0	
2004/05	2	0	2			0		*no estimate*	a/				0	
2005/06			0			0		*76*					0	
2006/07			0			0		*39*					0	
2007/08			0			0		*41*					0	
2008/09			0			0		*6*	b/				0	Winter SH season closure begins 2008/09
2009/10			0			0		*40*					0	
2010/11			0			0		*31*					0	
2011/12			0			0		*10*					0	
2012/13			0			0		*32*					0	
2013/14			0			0		*7*					0	
2014/15			0			0		*11*					0	
2015/16			0			0		*19*						
2016/17														

a/ no escapement estimate - high flows and/or poor visibility

b/ minimum estimate due to frequency of surveys

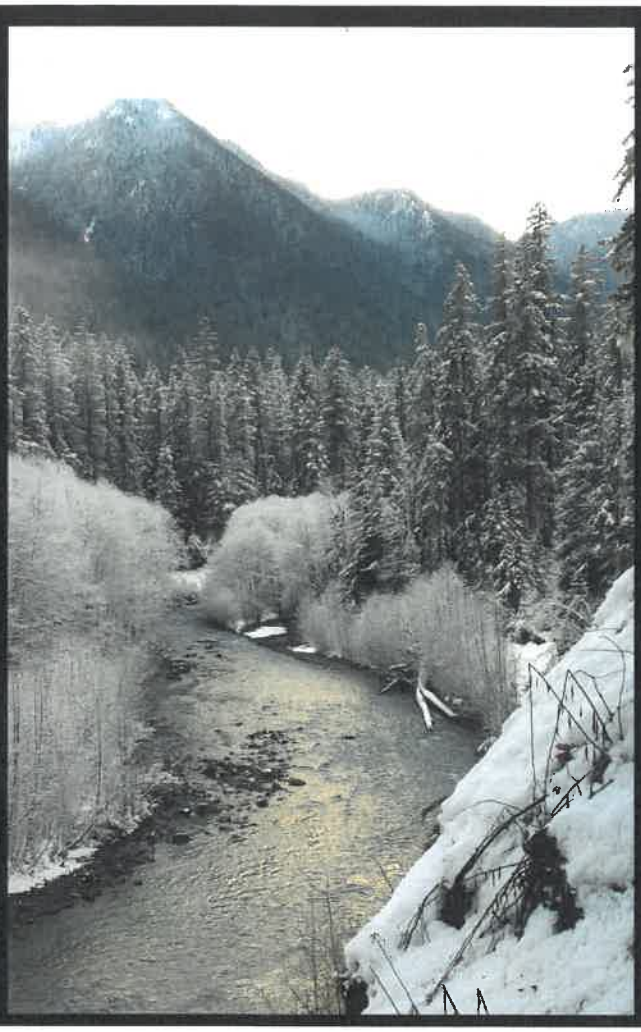
Hood Canal & Strait of Juan de Fuca

"I spent most winters hiking and fishing the jewels of Hood Canal - the Skokomish, Duckabush, Dosewallips, Hamma Hamma, and even the petite Quilcene. It was common in late February during periods of low water to count over a hundred steelhead laying in the famed deeps of the Blue Hole on the Hamma Hamma.

But wild steelhead have dwindled to near extinction, and no longer do hardy anglers brave the winter weather to fish in these beautiful waters.

I am committed to our plan for restoring Hood Canal steelhead and our cultural heritage."

Bill Herzog



Objectives (examples only)

Short Term (2018 - 2022)

- Ensure that no Primary populations are extirpated through the use of conservation hatchery programs and other implementation of other conservation actions.
- Provide winter steelhead fisheries in W Hood Canal and Strait of Juan de Fuca rivers:
  - ✓ Early season retention fisheries in the X and Y rivers
  - ✓ Late season non-retention fishery in Z River

Long Term

- Provide two additional winter steelhead fisheries:
  - ✓ ...
  - ✓ ...

Hood Canal & Strait of Juan de Fuca

Actions (examples)

Ongoing

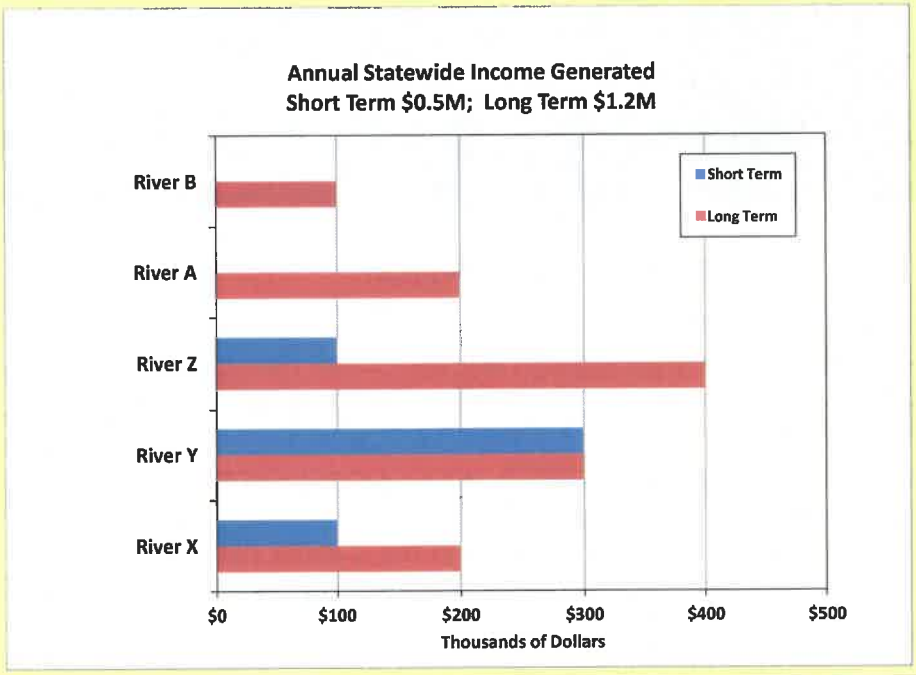
- Monitor the effectiveness of hatchery conservation programs and modify as necessary to meet restoration objectives.

Short Term (2018 - 2022)

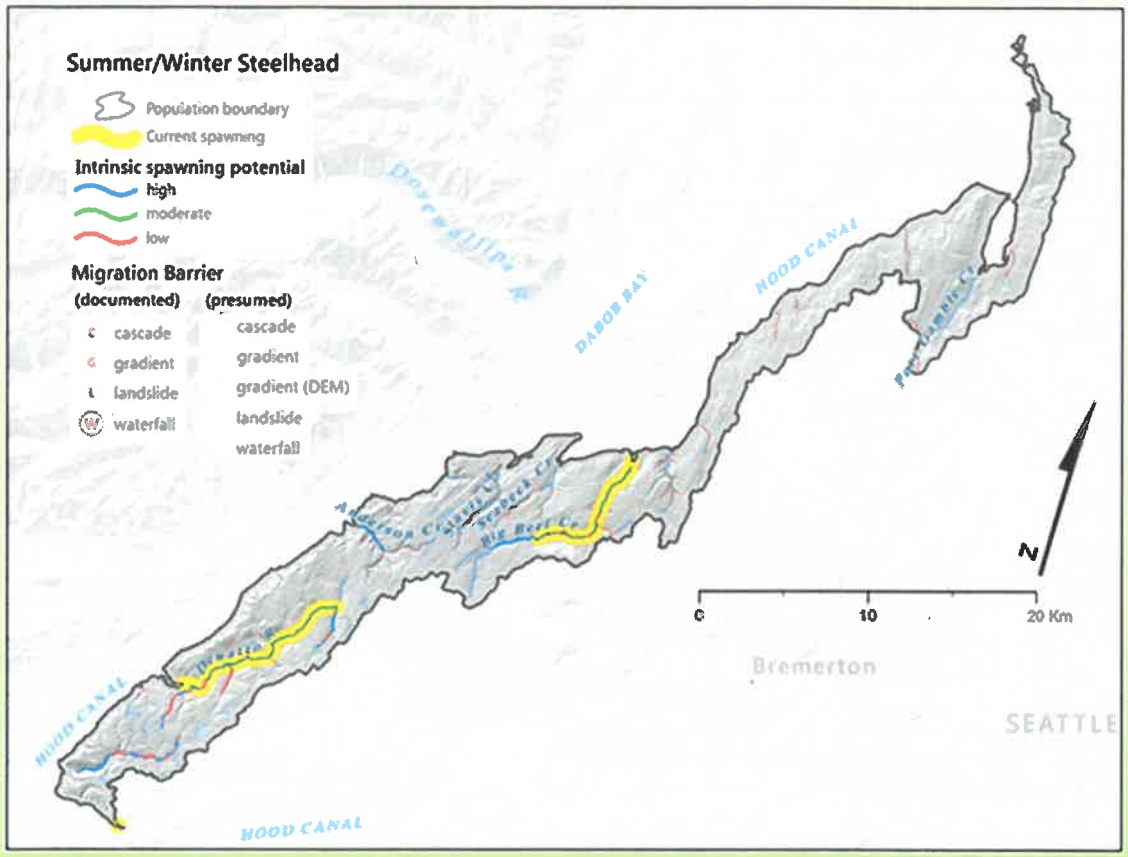
- Identify actions to address survival bottleneck at the Hood Canal Bridge.
- Initiate an early winter steelhead program on the Y River.
- Develop with the comanagers a Resource Management Plan for the Z River.

Long Term

- ...

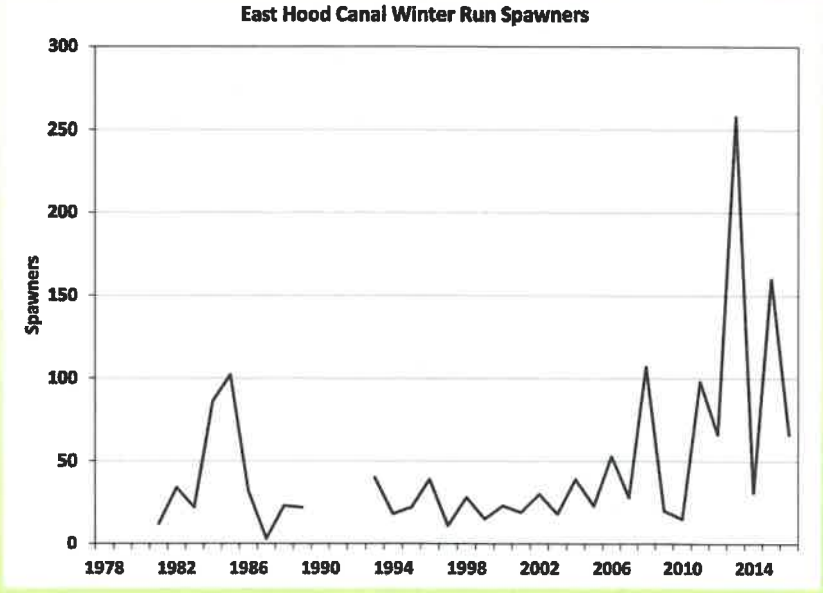


East Hood Canal Winter Run



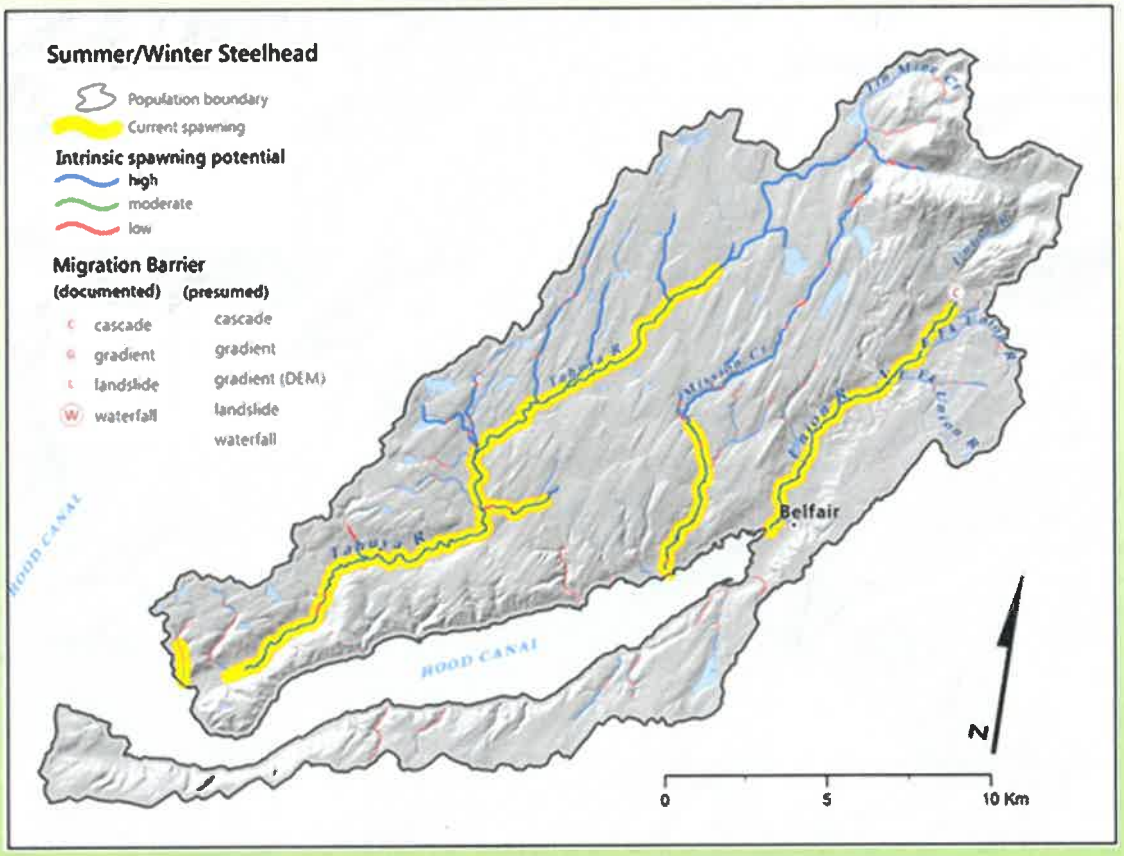
Viability Assessment

Abundance	
Adults	
Juveniles	
QET	
Productivity	
Smolts/Sp.	
Adults/Sm.	
Lambda	
Iteroparity	
Diversity	
Hatchery	
Spawn Time	
Residents	
Age	
Spatial Structure	



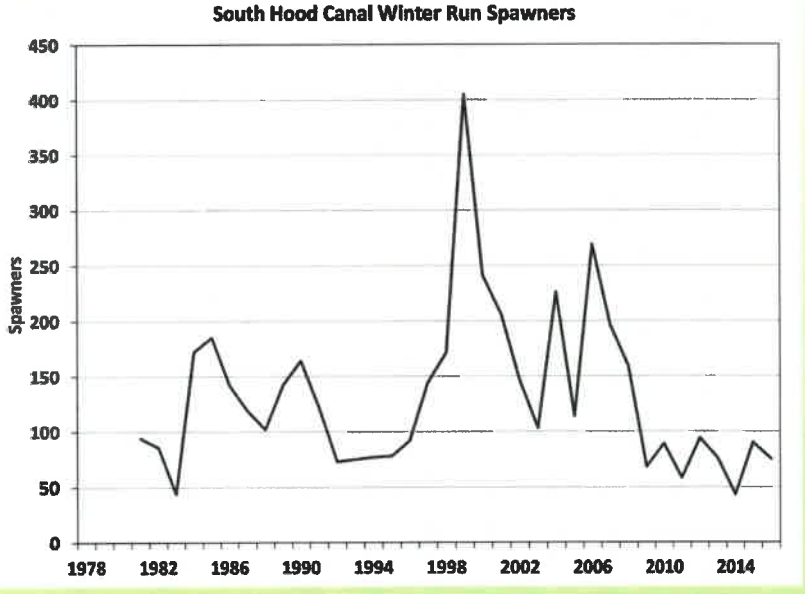
Note: Spawner estimates include only the Dewatto River before 2008, and the Dewatto River and Big Beef Creek beginning in 2008. Dewatto spawner estimates include adult supplementation releases beginning in 2011.

South Hood Canal Winter Run

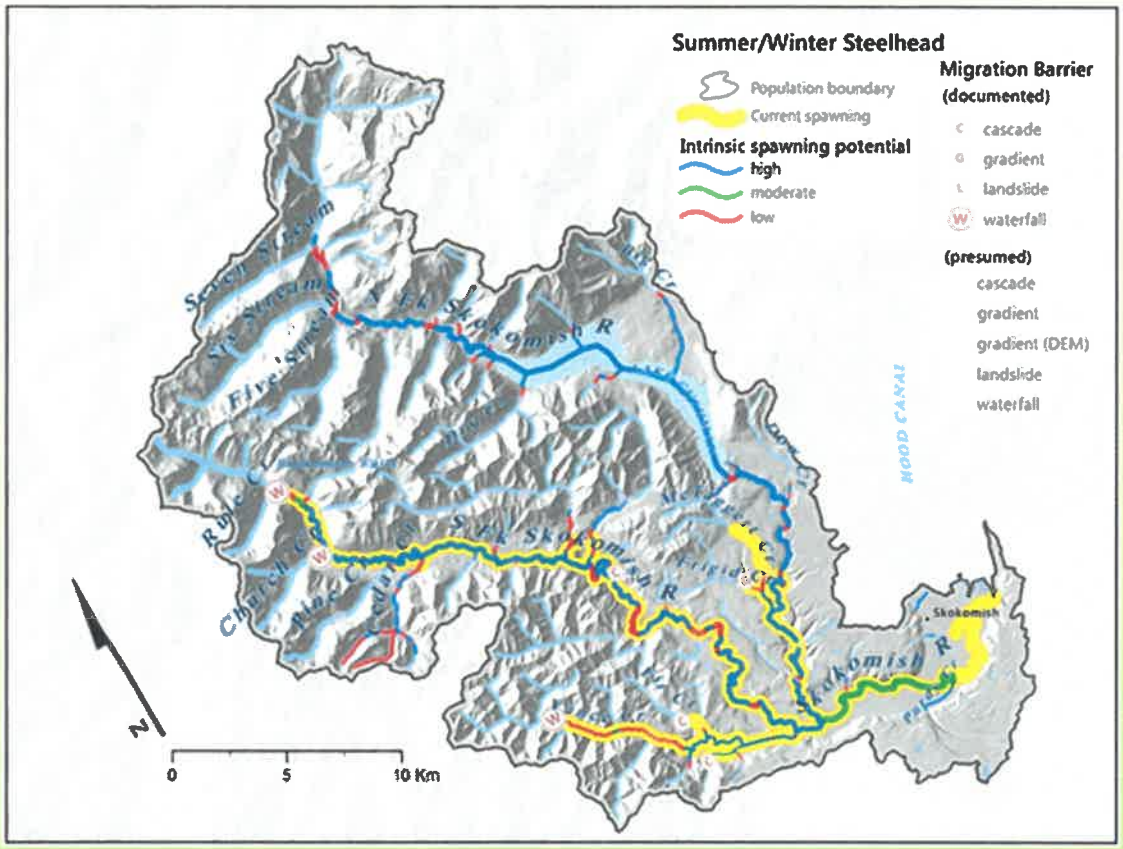


Viability Assessment

Abundance	
Adults	
Juveniles	
QET	
Productivity	
Smolts/Sp.	
Adults/Sm.	
Lambda	
Iteroparity	
Diversity	
Hatchery	
Spawn Time	
Residents	
Age	
Spatial Structure	
Spawn IP	
Spawn Time	

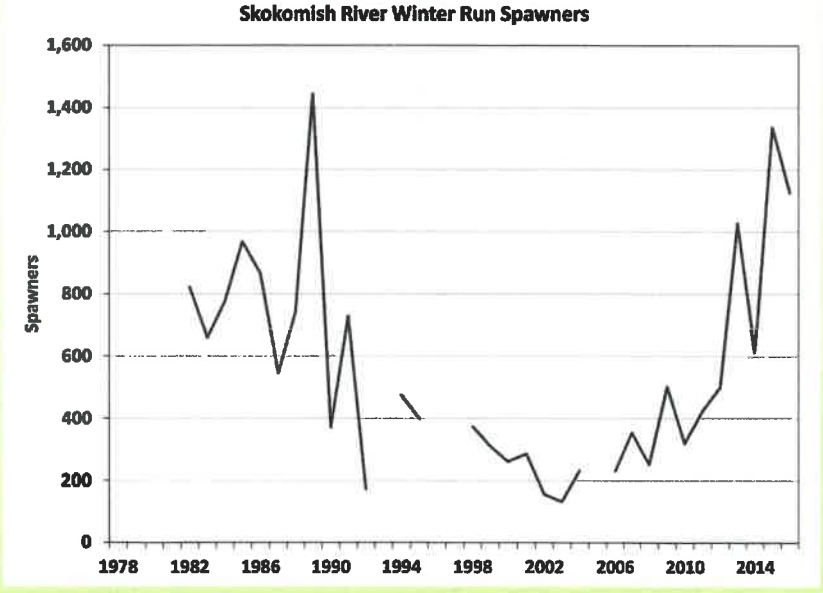


Skokomish River Winter Run



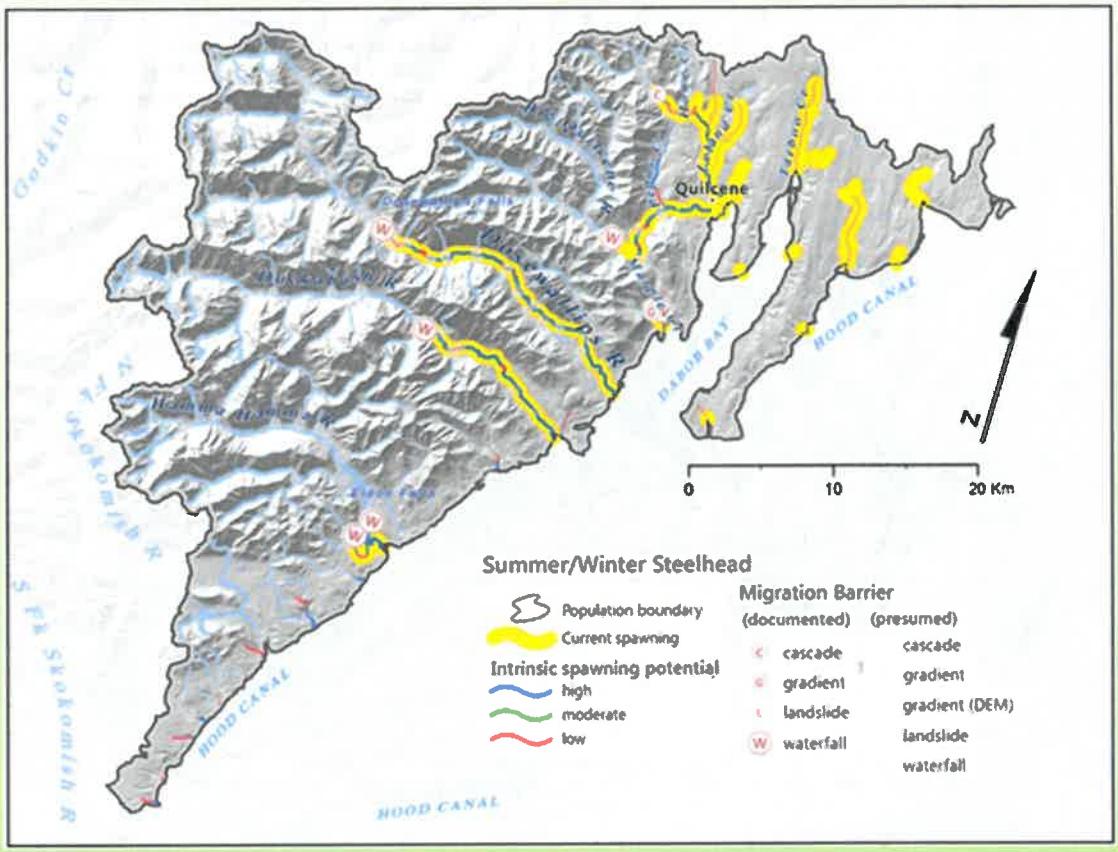
Viability Assessment

Abundance	
Adults	
Juveniles	
QET	
Productivity	
Smolts/Sp.	
Adults/Sm.	
Lambda	
Iteroparity	
Diversity	
Hatchery	
Spawn Time	
Residents	
Age	



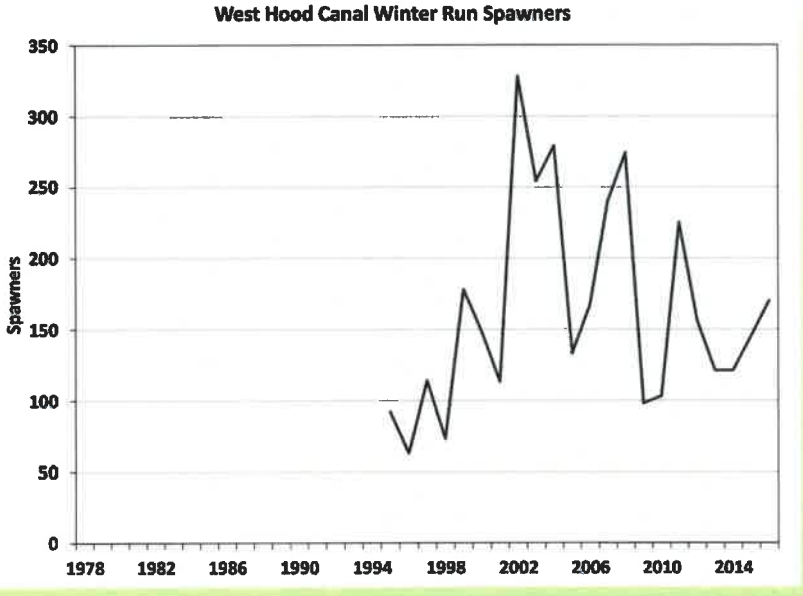
Note: Spawner estimates include adult supplementation releases beginning in 2011.

West Hood Canal Tributaries Winter Run



Viability Assessment

Abundance	
Adults	
Juveniles	
QET	
Productivity	
Smolts/Sp.	
Adults/Sm.	
Lambda	
Iteroparity	
Diversity	
Hatchery	
Spawn Time	
Residents	
Age	
Spatial Structure	



Note: Spawner estimates do not include all rivers (Little Quilcene, Hamma Hamma, Duckabush, and Dosewallips) in each year and include adult supplementation releases beginning in 2002.

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West Coast Region

What we have learned about managing hatcheries and fisheries for threatened and endangered salmon and steelhead

Rob Jones
NMFS West Coast Region
May 2017

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West Coast Region

First experience was in the Columbia River more than 25 years ago and then the Central Valley of California followed in rapid succession by the Oregon Coast and then salmon and steelhead in Hood Canal and Puget Sound. In total, there are some 330 hatchery programs, coast-wide, that NMFS is familiar with.

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A little bit about the Law of Last Resort, the Federal Endangered Species Act of 1973

Sec. 2.(a) Findings.

Sec. 3(3) Definitions

After all-else fails, there are high expectations & demands for accountability – **"shall"** not when practicable, etc…

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Overarching Lessons Learned

1) **No action** is not an option.

2) **Best Available Science is** your starting place for every decision.

3) **Attack uncertainty**, Act – Verify – Adjust – its called learning.

4) **Adjust up** to find the management sweet-spot and avoid damage.

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Overarching Lessons Learned cont.

5) **Site-specific strategies** are favored over traditional landscape management.

6) **Reasonable certainty.**

7) **Show your work.**

8) **Sequence** instead of prioritize.

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What counts, what are we shooting for?

VSP metrics

Populations that rely on subsidies in natural spawners provided by artificial propagation i.e., hatchery production, **are not viable**.

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Guidance for Designing Hatchery Programs

see Sec. 2.4.1 of the NMFS Biological Opinions

Say no to broodstocks originating from outside a DPS, develop/use the most local-origin broodstock, avoid transfers.

Limit the removal of NOF for hatchery broodstock purposes.

Limit the handling of NOF during broodstock collection.

Limit gene flow between hatchery fish and fish from natural populations.

Establish refuges or reserves with no direct hatchery influence.

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Guidance for Designing Hatchery Programs cont.

Limit ecological interactions that disadvantage NOF, i.e., competition and predation.

Marking, tailor it based on the purpose of the program and compliance monitoring needs.

M&E for performance tracking and compliance purposes, even at the expense of production, e.g., if funding is limited.

Facilities meet screen and water diversion criteria and do not reduce spatial structure or productivity.

Fisheries, manage them based on the abundance of NOF.

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Guidance for Designing Hatchery Programs cont.

Considering the well-being of the resource, **there are pros and cons benefits and risks from hatcheries.**

Faced with the question is a conservation hatchery program the right fit the right tool for the job, use this Test - **Is the natural population better off with or without hatchery intervention ?**

Guidance for Designing Hatchery Programs cont.

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Risk Tolerances and natural population roles in recovery

But, the math has to add up.

DPS/ESU status depends on MPG viability + natural population viability.

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Guidance for Designing Fisheries

Abundance based management, the more NOF the more fishing – above the critical threshold follow a sliding-scale.

Aspire to this model; 1) preseason NOF forecast, 2) managers design their fisheries based on a NOF sliding-scale, 3) in-season monitoring, 4) ALL fishing stops when the sliding-scale limit is met, and 5) post season reporting and evaluation (see ESA exemptions for Nez Perce, Umatilla, Shoshone Bannock, OR, and WA spring Chinook salmon fisheries in NE Oregon).

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Guidance for Designing Fisheries cont.

In terminal areas where there are no hatchery fish and subject to very specific conditions, NMFS has also created a mechanism under the ESA to allow the direct take of a threatened species, (see Limit 4 of the final 4(d) rule at 65 FR 42422, July 10, 2000).

Oregon Coast coho salmon is an example.

Directed catch-and-release fisheries could also apply for an exemption under this limit.

Evaluating the benefits and risks of conservation hatchery programs for steelhead in Hood Canal

Barry Berejikian
Katy Doctor
Don Van Doornik
Megan Moore

25 May 2017

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Northwest Fisheries Science Center

Manchester Research Station

Topics

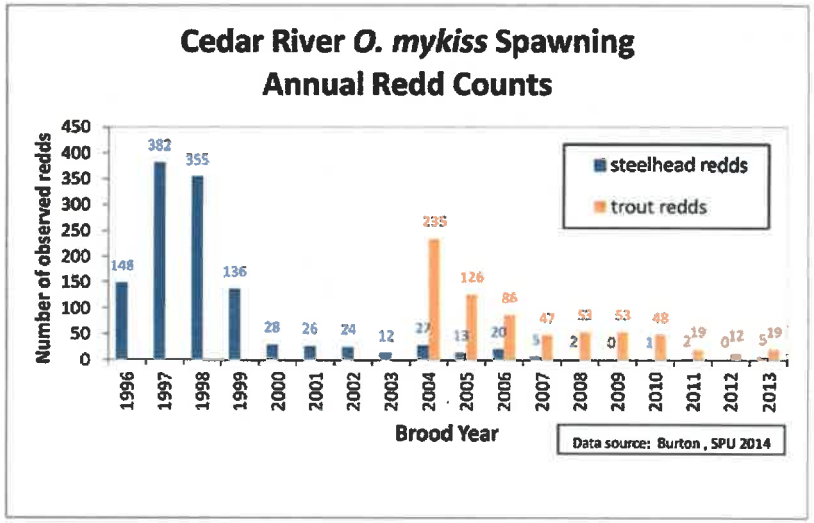
- Rationale for conservation hatcheries
- Diversity among Hood Canal *O. mykiss* populations
- Alternatives to artificial spawning
- Customized rearing and release practices
- Natural population response to supplementation

Rationale for conservation hatcheries

- **Management:** Preserve "Distinct Population Segments" of species Threatened or Endangered with extinction under the US Endangered Species Act.

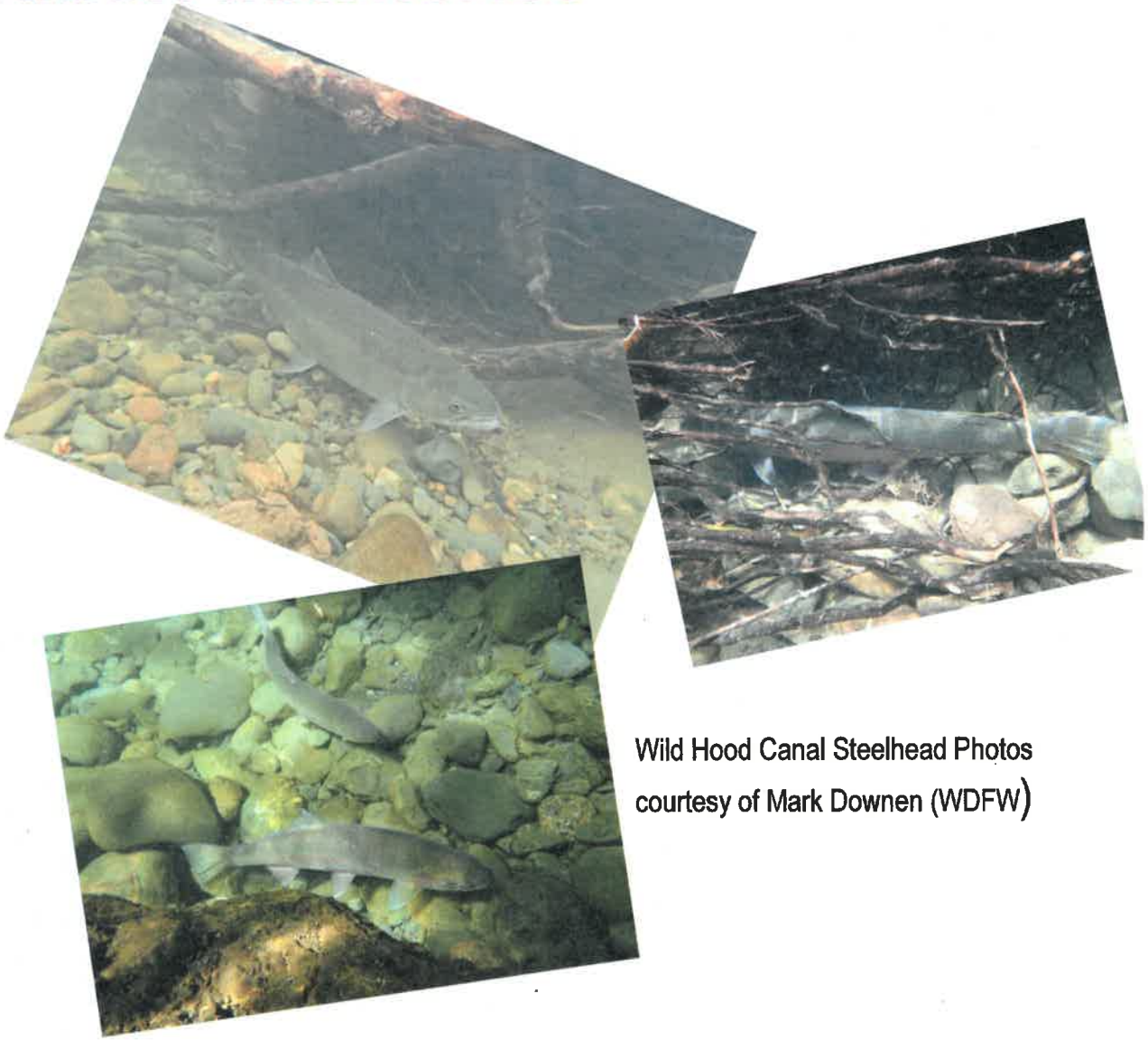
- **Ecological mechanisms:**
  - Habitat limitations – human disturbance
  - Depensation (see Lierman and Hilborn 2001: Fish and Fisheries)

- **Risks of inaction:**
  - Genetic drift
  - Inbreeding
  - Extirpation



Risks of conservation hatcheries

- Mining broodstock
- Fitness loss
  - Environmental
  - Genetic
  - Heritable epigenetic
- Genetic variation
  - Founder effects
  - Ryman-Laikre effects
- Ecological impacts
  - Predation
  - Competition
  - Disease

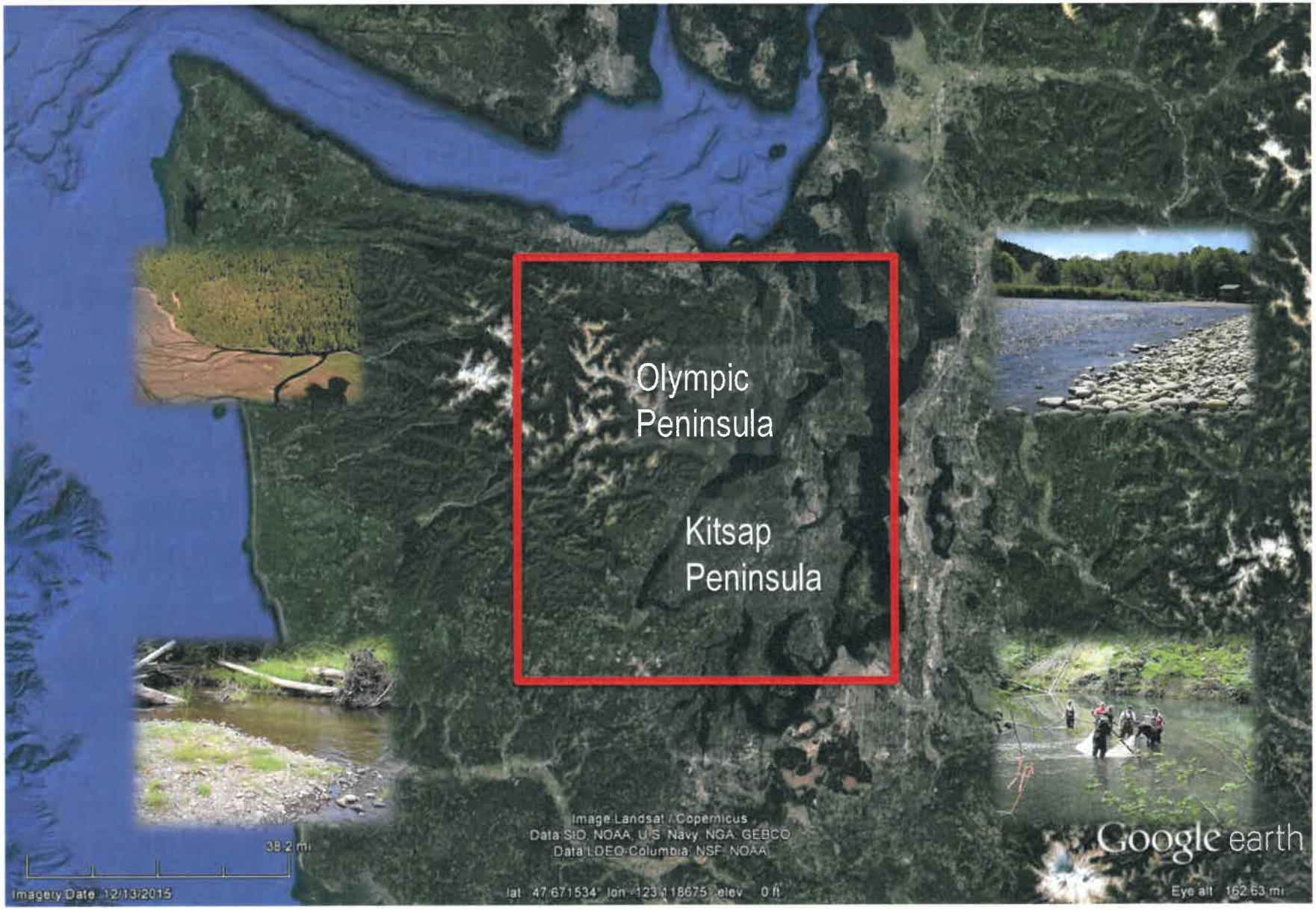


Wild Hood Canal Steelhead Photos courtesy of Mark Downen (WDFW)

Hood Canal Steelhead

- Depressed natural populations
- Effects of "the 4 H's" not obvious
  - Hatchery – no genetic legacy from past stocking efforts
  - Harvest – harvest probably contributed to decline, but not a factor in recent decades
  - Habitat condition – variable (some good, some not so good)
  - Hydropower – minor
- Most likely stuck in a rut…
  - possible depensatory mechanisms
  - poor marine conditions
  - Life history dynamics (residency-anadromy)

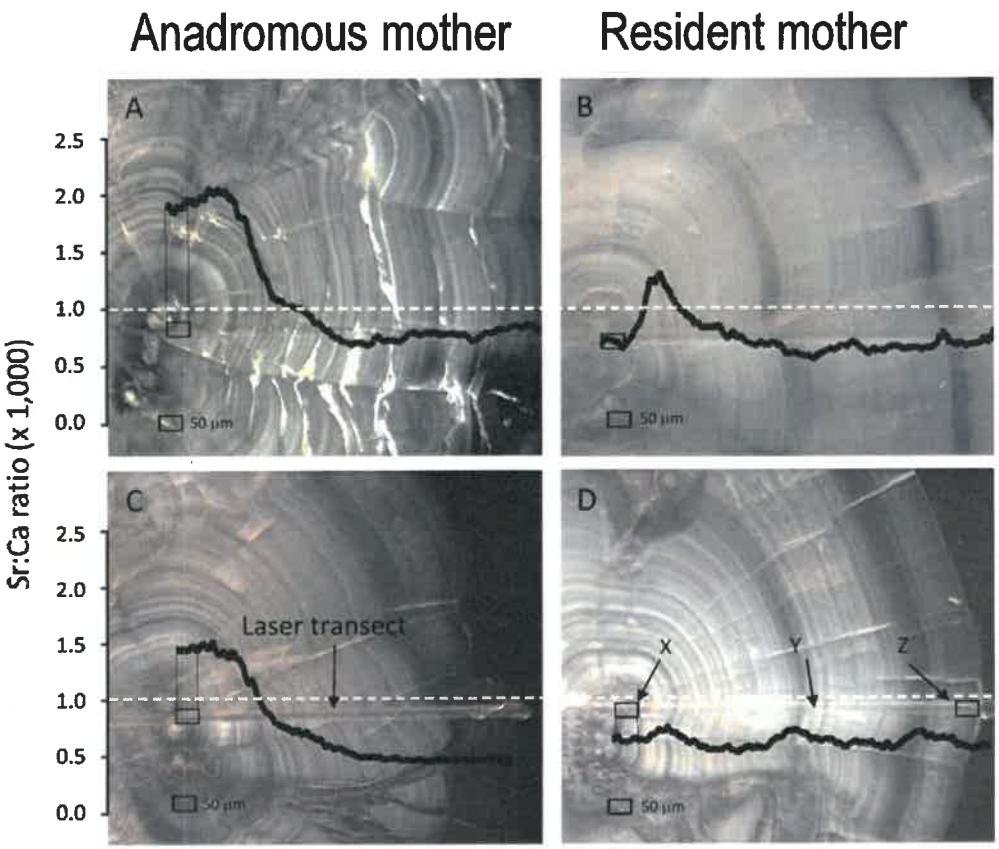
Hood Canal Watershed

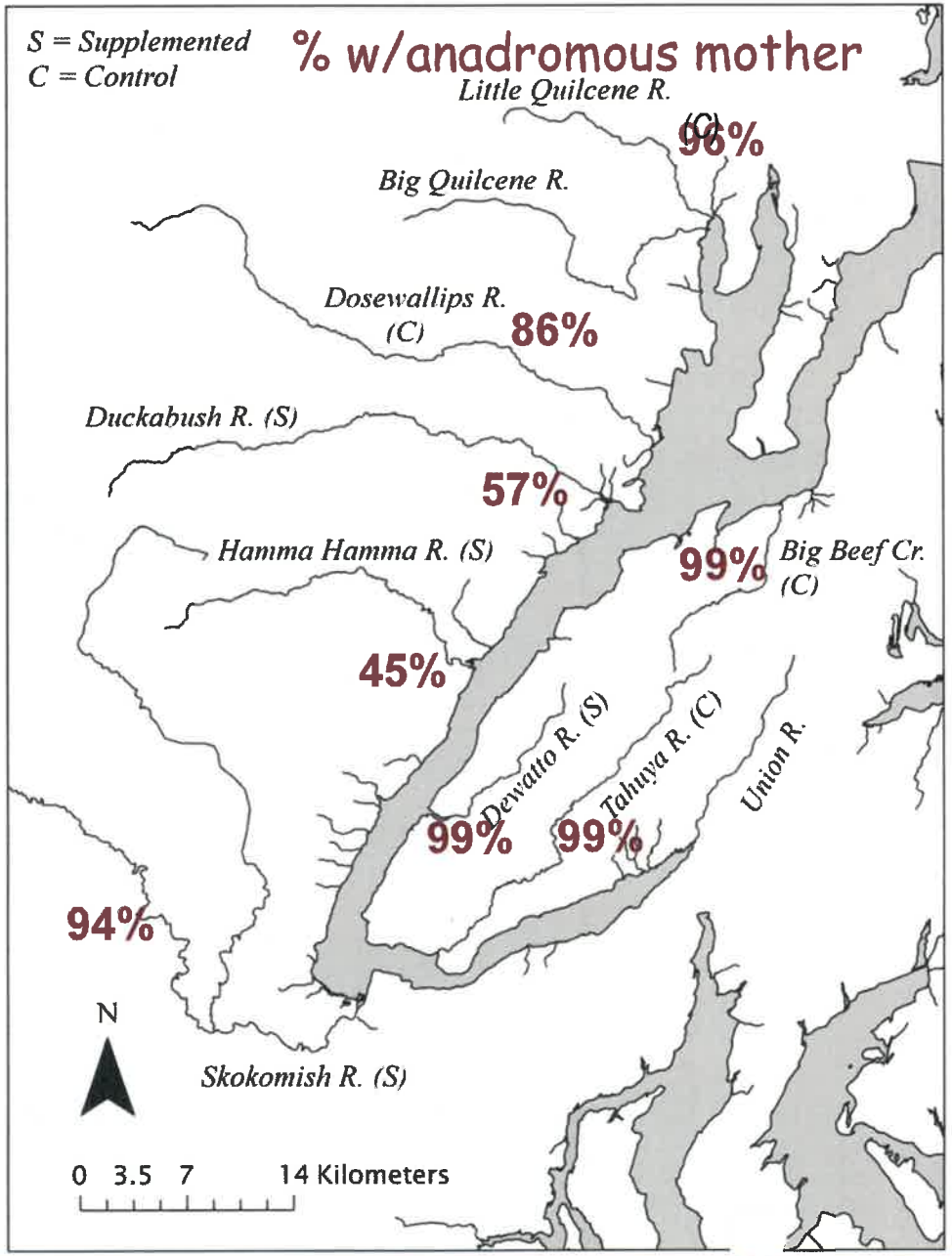


Pre-supplementation population status

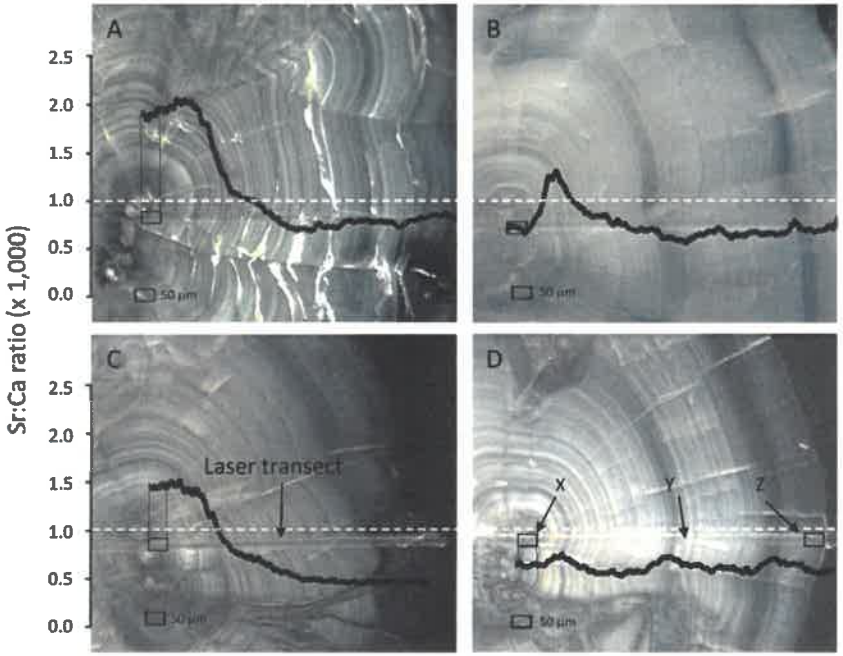
- Life history diversity
- Spawn timing
- Smolt migration timing
- Genetic diversity and population structure

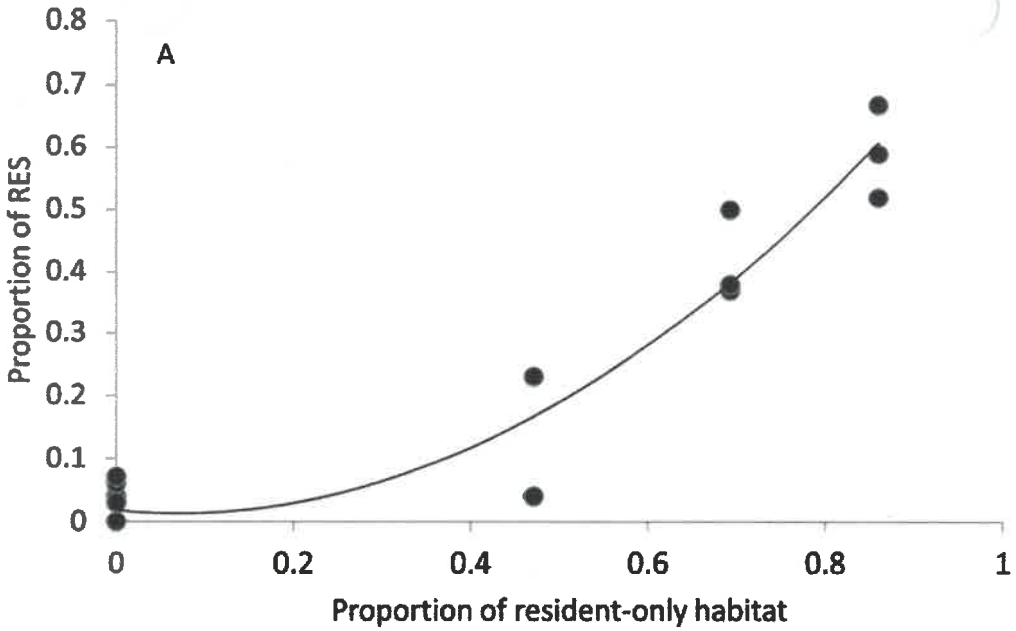
Life history: partial migration

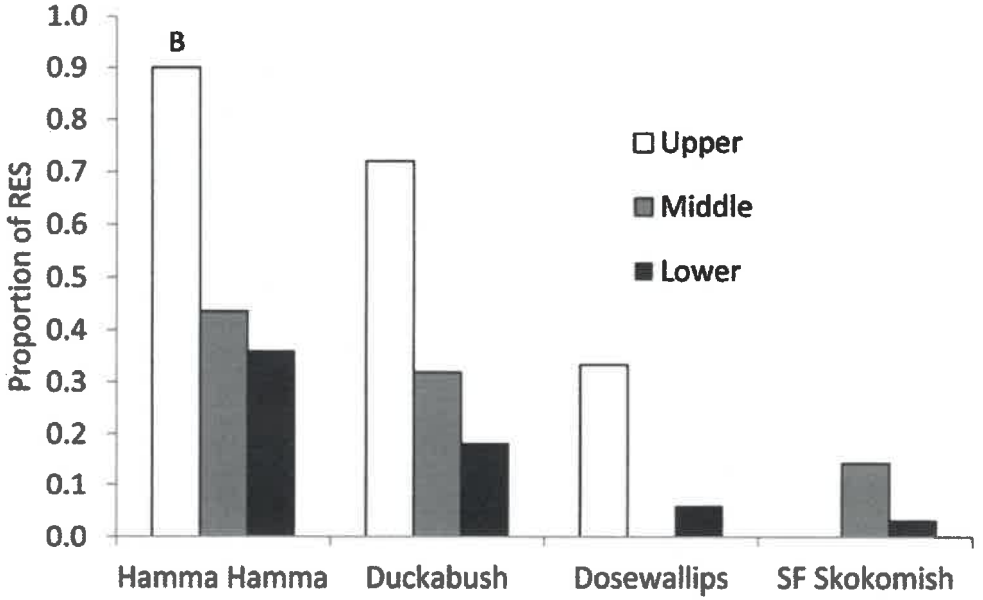




Life history: partial migration

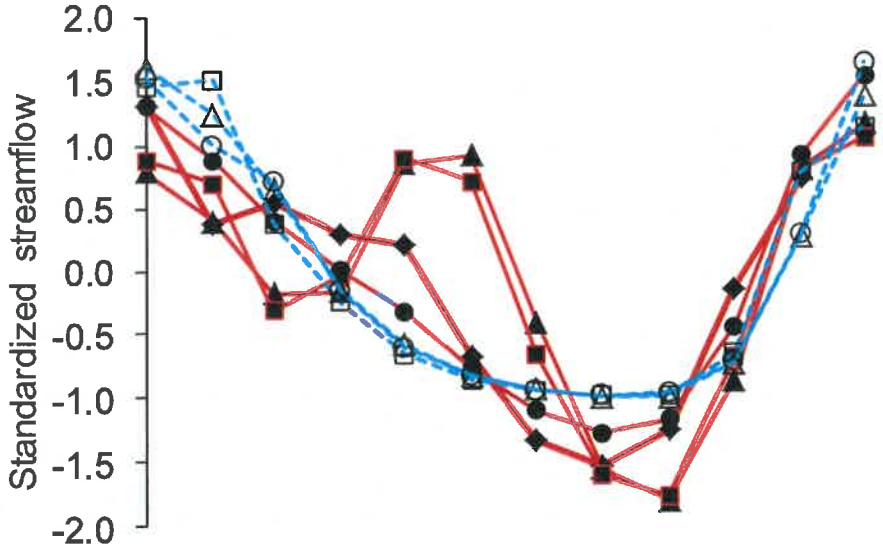


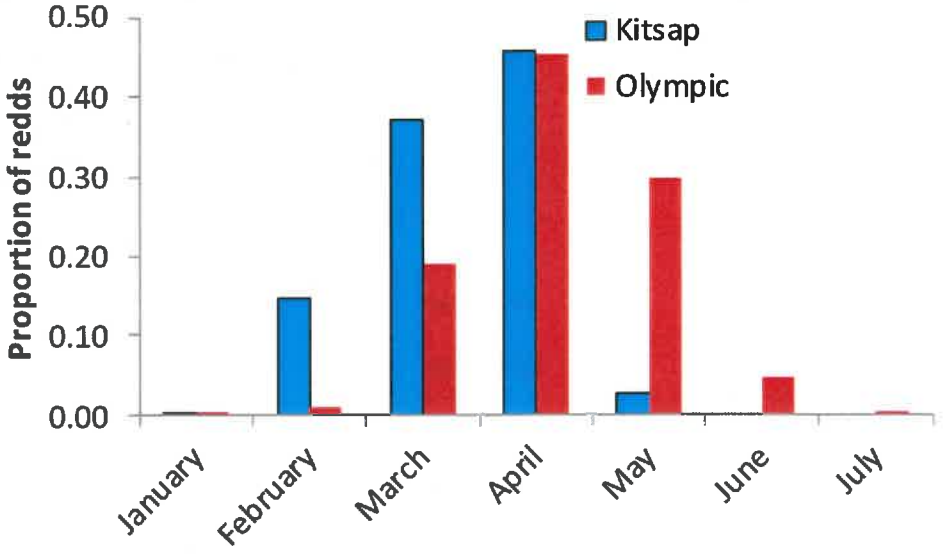


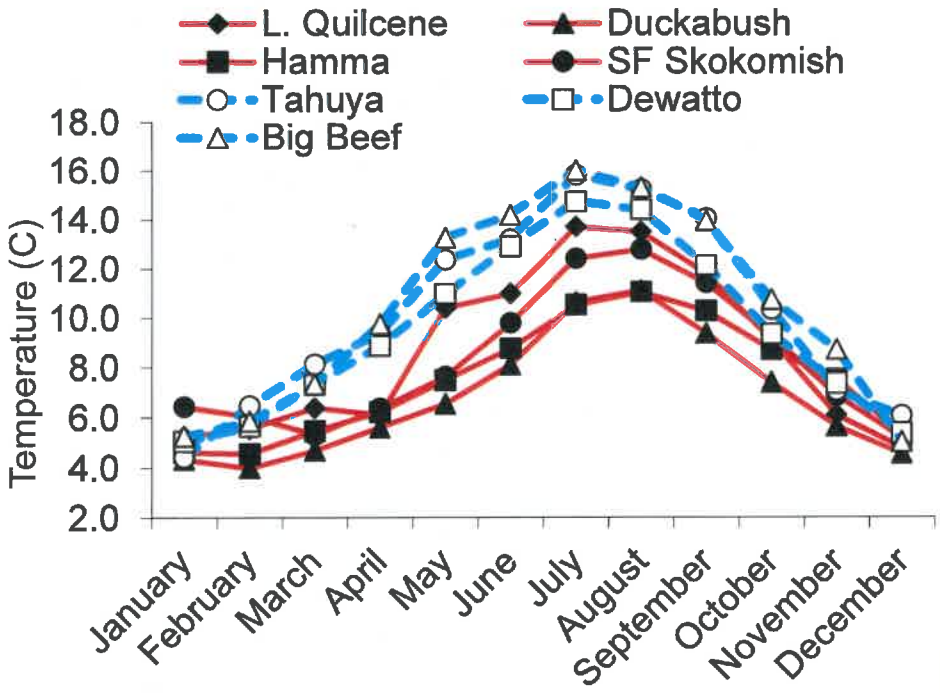


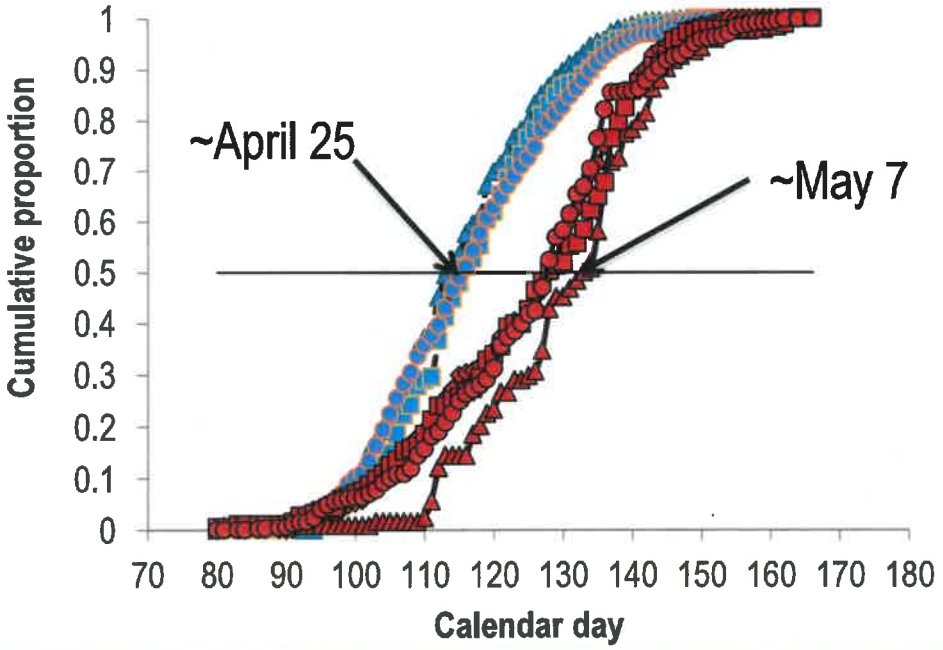
Berejikian et al. 2013. Can J. Fish Aquat. Sci.)

Life history: Spawning and smolt migration timing

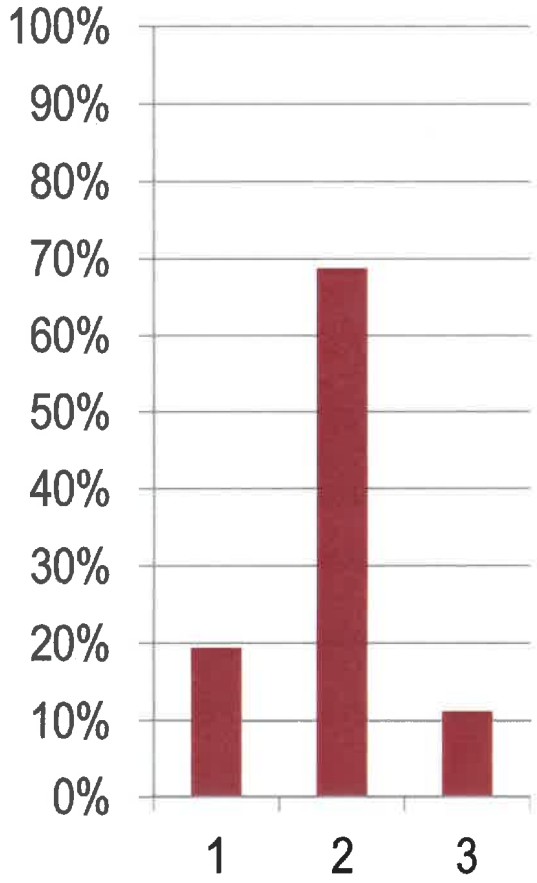


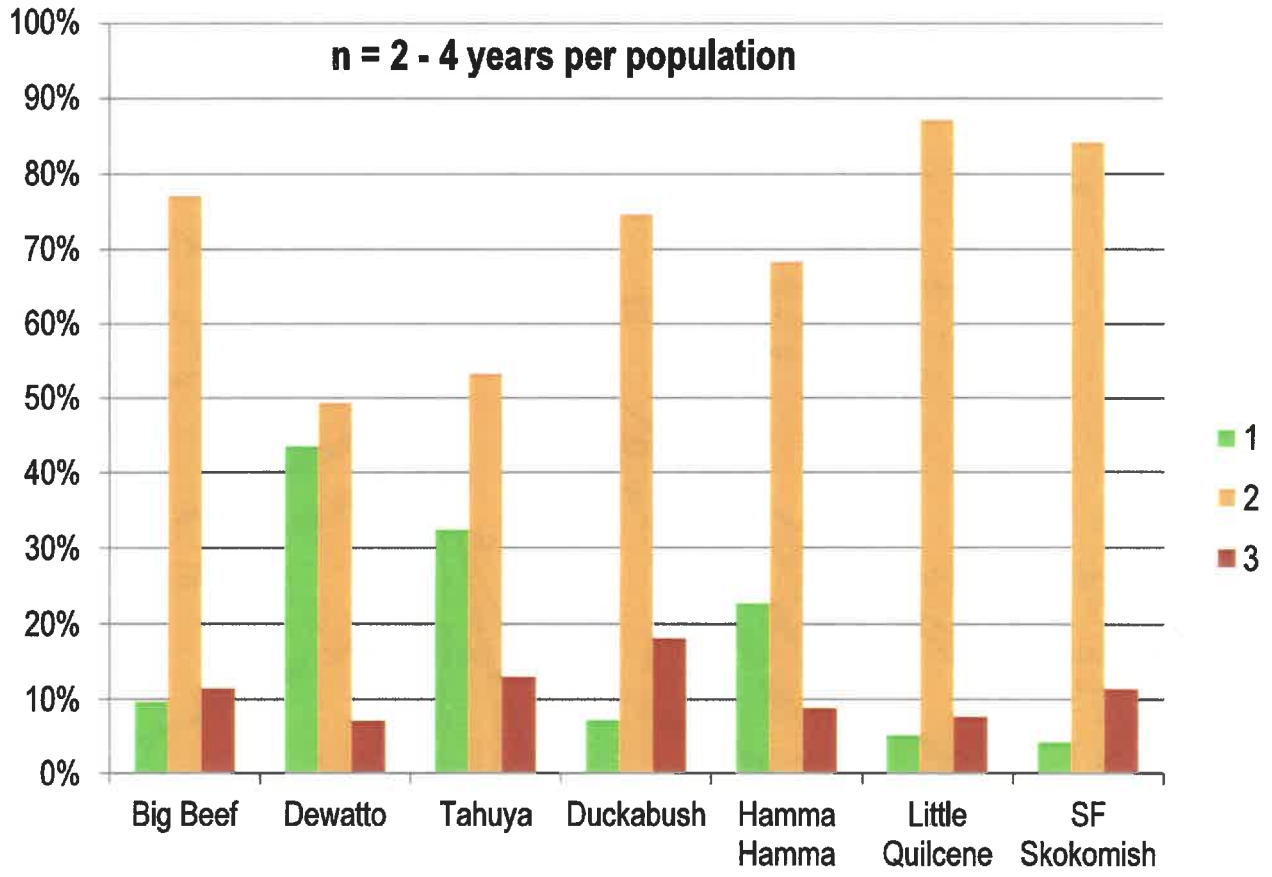






Life history: age-at-smoltification





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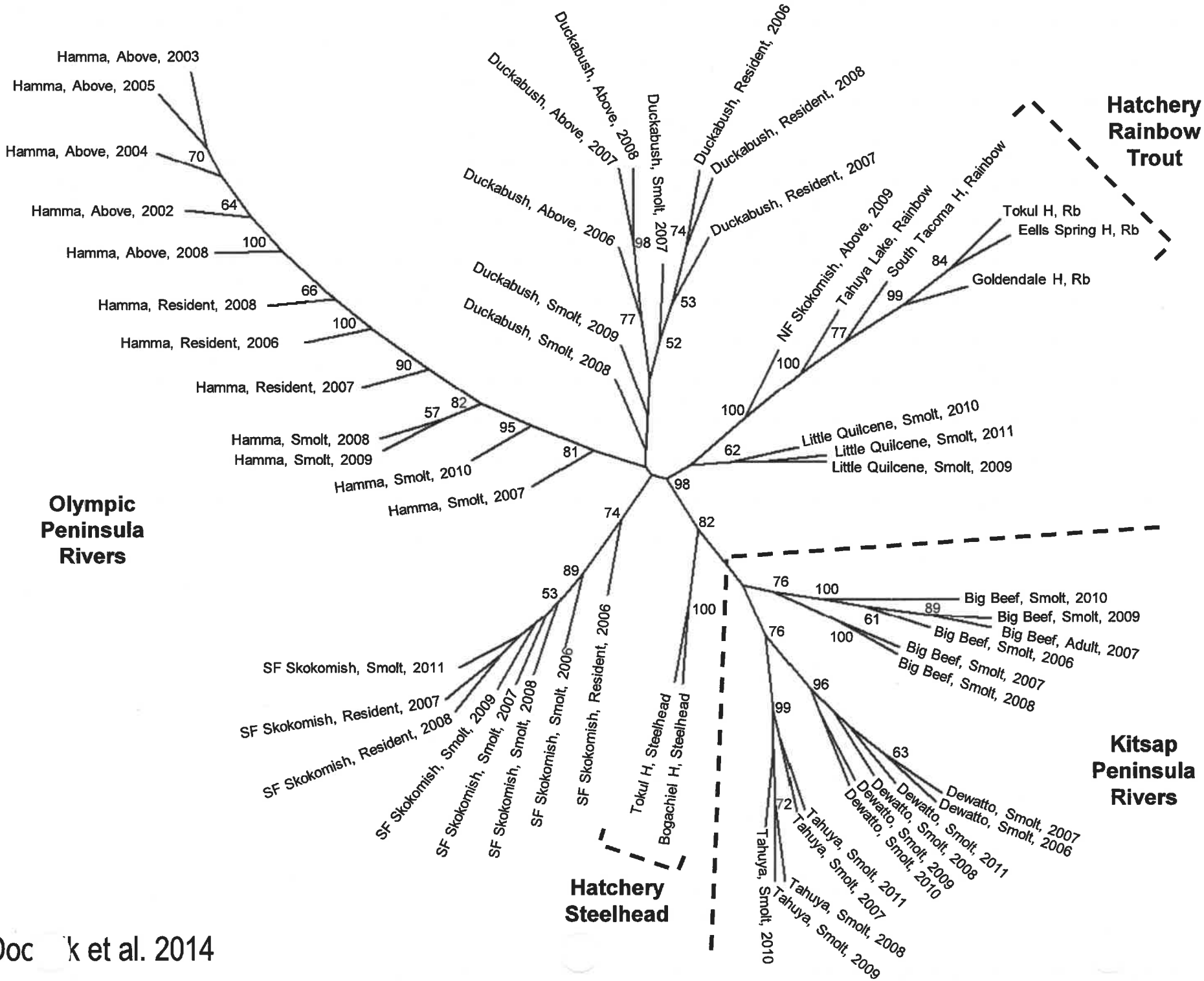
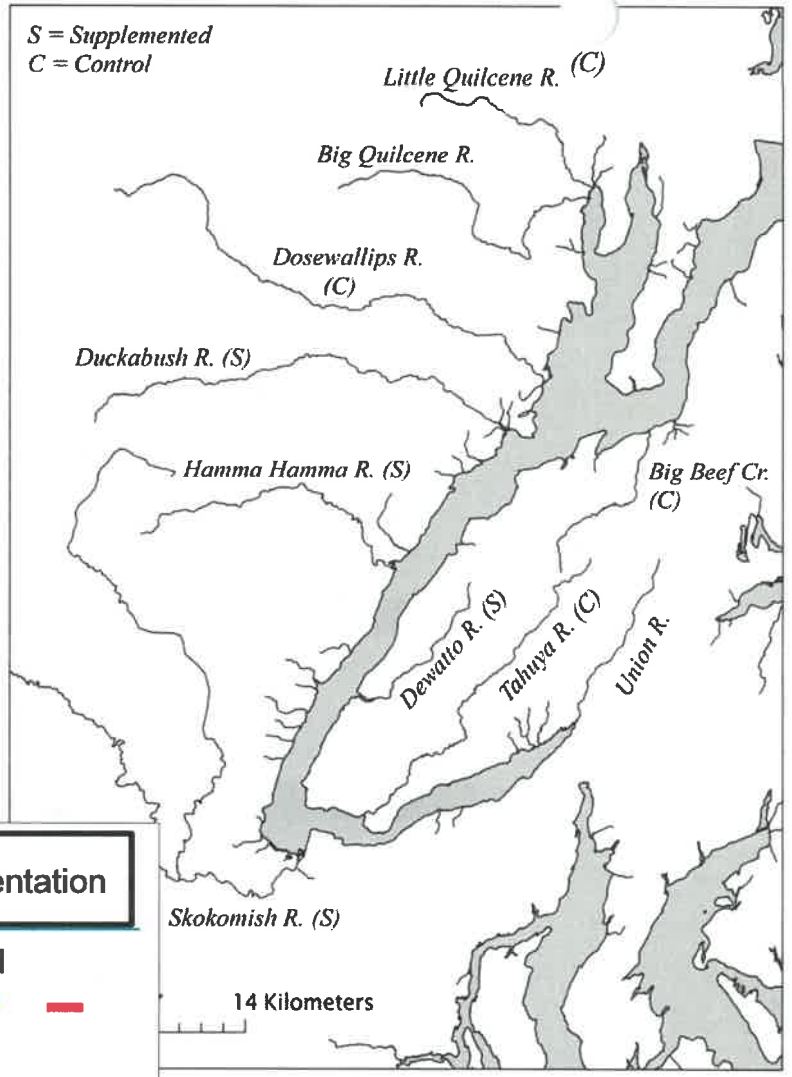
Ageing: WDFW ageing laboratory

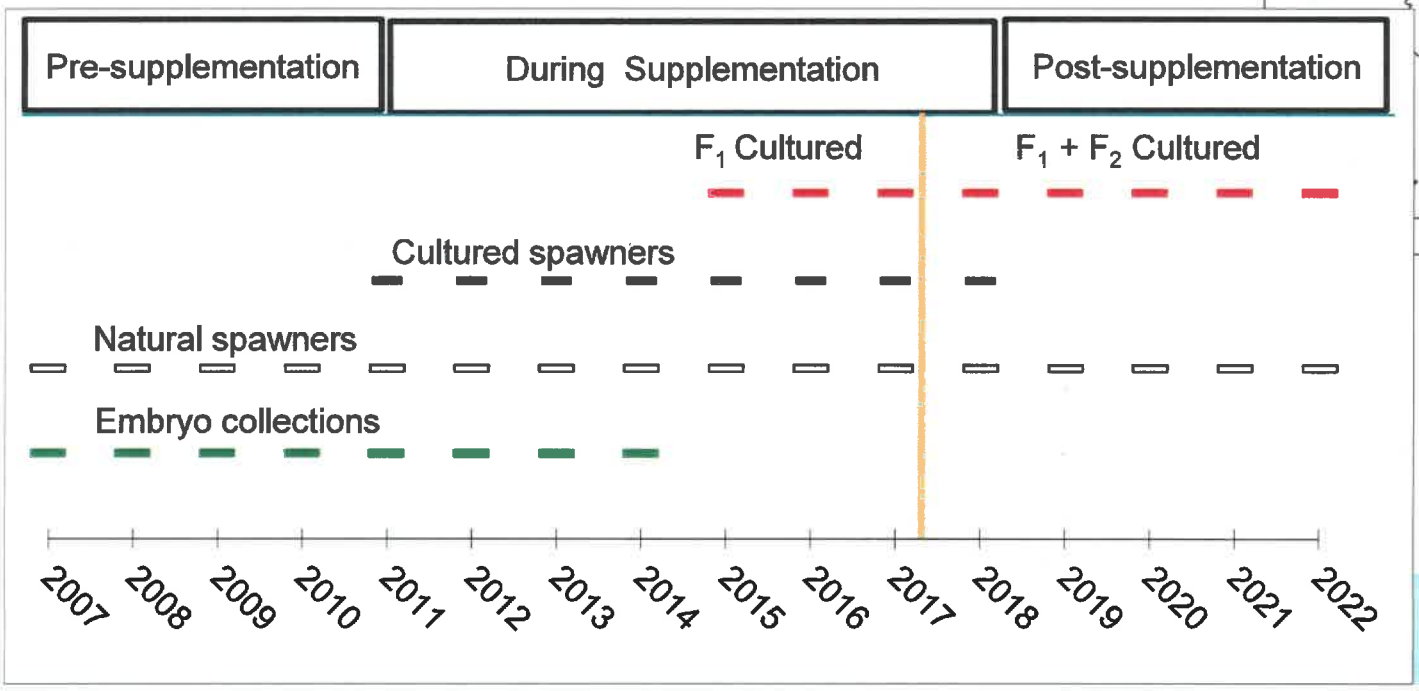


Van Doc k et al. 2014

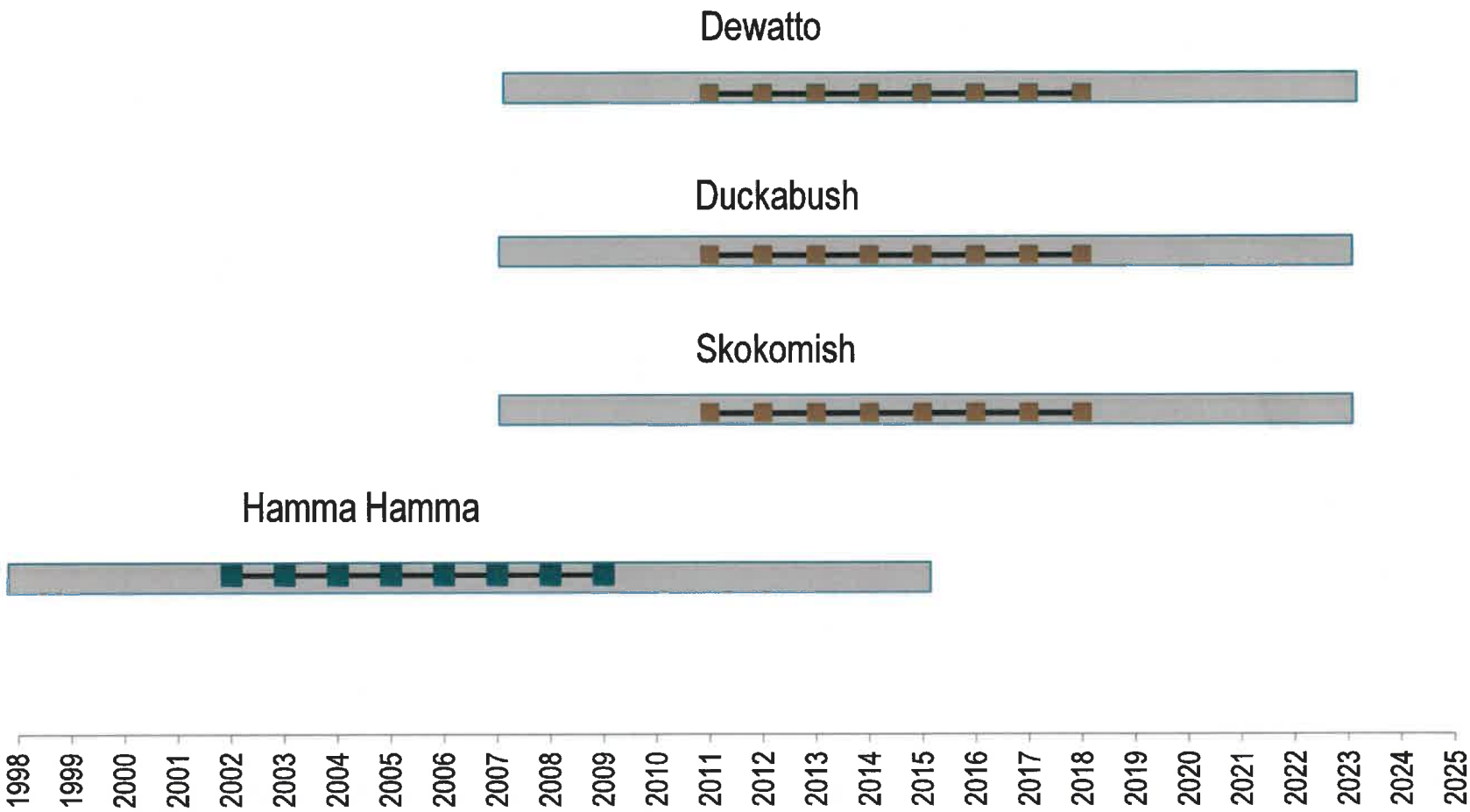
Hatchery experiment

- Replicated, before-during-after-control-impact experiment (RBACI)
- Response variables =
  - redd abundance
  - spawn timing,
  - freshwater productivity (egg to smolt)
  - life history diversity
  - genetic variation
  - Additional 'value added' studies





Hood Canal steelhead conservation hatchery time frames



This is a different kind of program

Typical hatchery	Hood Canal Steelhead Project
Collect adults	Hydraulic removal of embryos from natural redds
Artificially spawn adults	No artificial spawning at any point
Rear juveniles at high density to age-1	Rear juveniles at low density to age-2
Release all fish at smolt stage	Rear some smolts to maturity and release

Source of natural-origin fish for captive rearing

- Adult collections
  - Few adults returning
  - Difficult to capture
  - Protracted run timing
  - Variable maturation
  - Few eggs needed
- Parr or smolt collections
  - Can produce skewed sex ratios in some cases
  - pathogens carried into captivity
  - transitions to artificial diets can be challenging
- Eyed embryos
  - Few previous attempts
  - requires accommodating flow regime
  - careful monitoring of TUs
  - Risk to eggs unknown

Embryo collections

Hydraulic redd sampling



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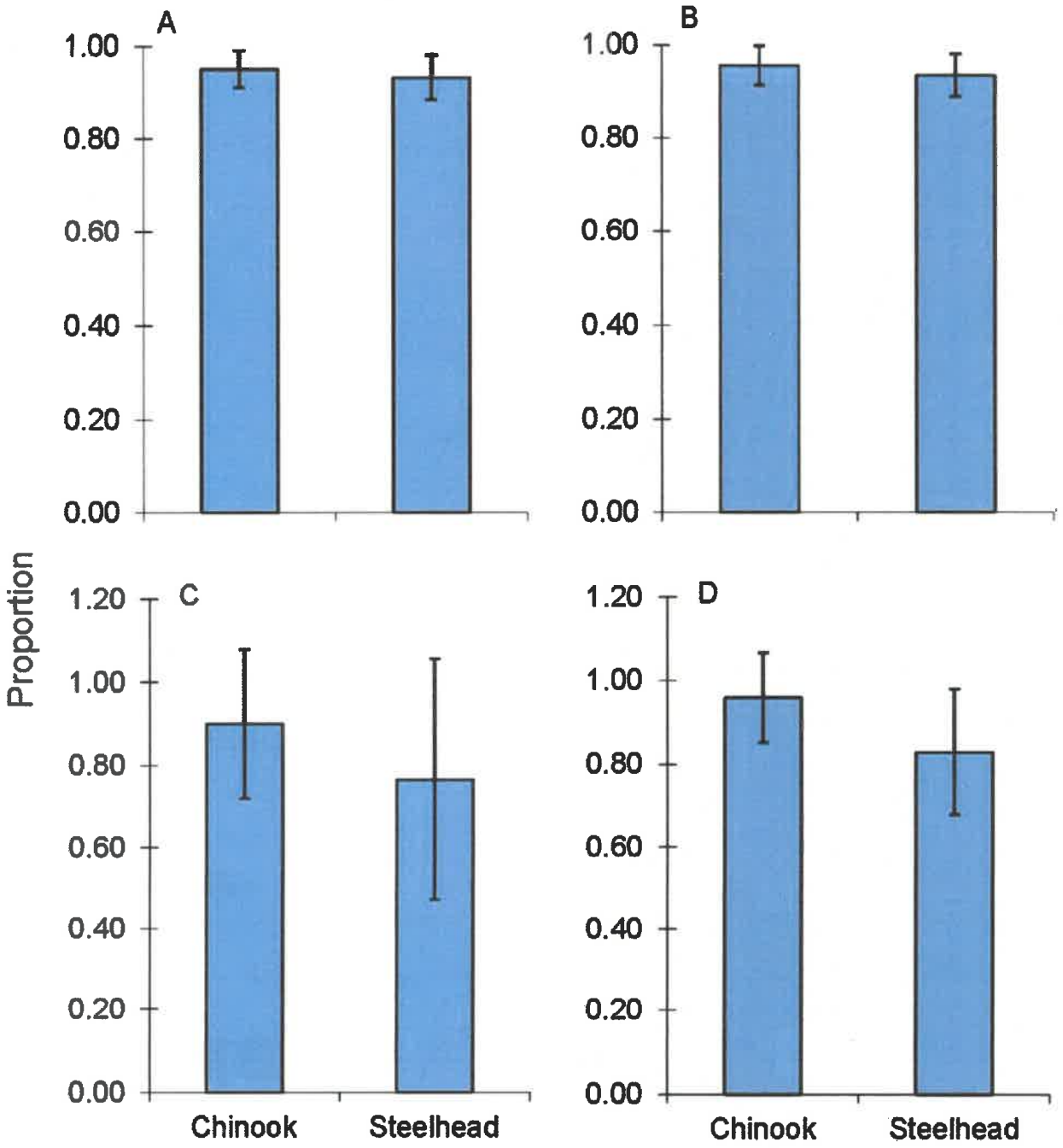
A) Viable at the time of collection

B) Survival from collection to stocking into hatchery tanks.

C) Sampled redds that produced viable embryos

D) Eggs collected relative to the egg collection goal for each conservation hatchery program.

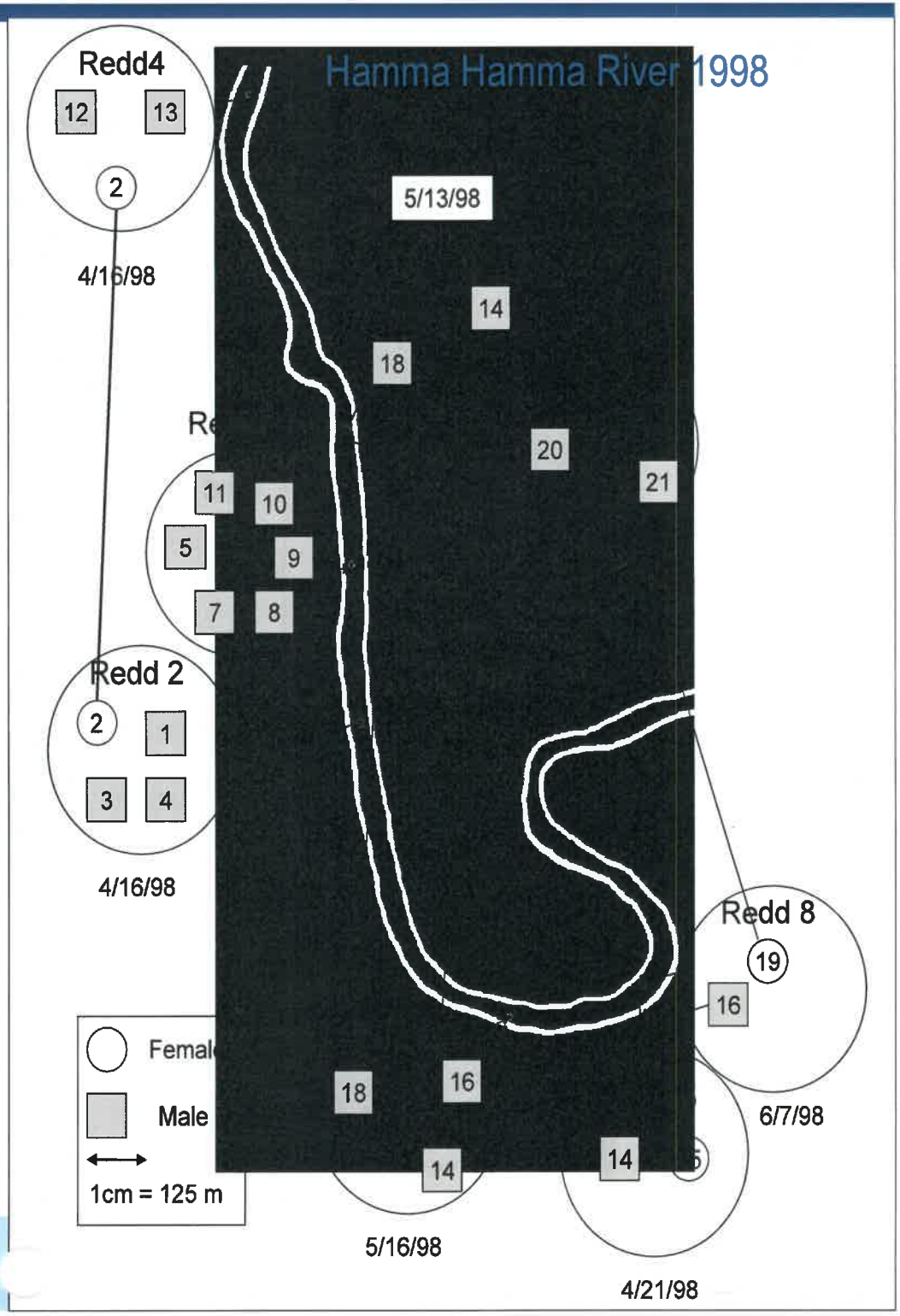


Steelhead mating patterns are complex!

- Parentage reconstruction based on relatedness values
- Assumed female spawning completed within one week
- Assumed males could contribute throughout

- Try doing this in a hatchery!

Kuligowski et al. 2005. Trans. Am. Fish. Soc.



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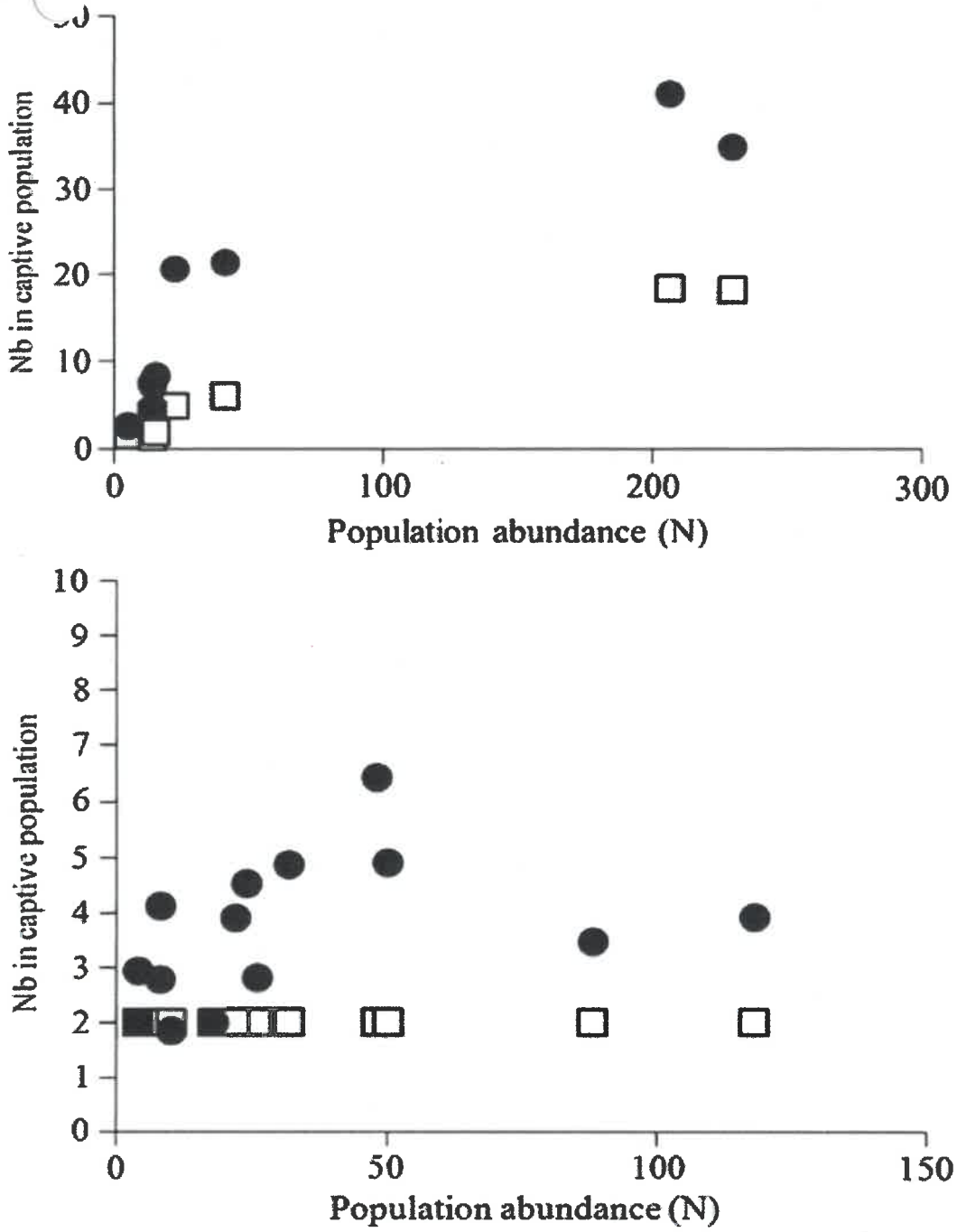


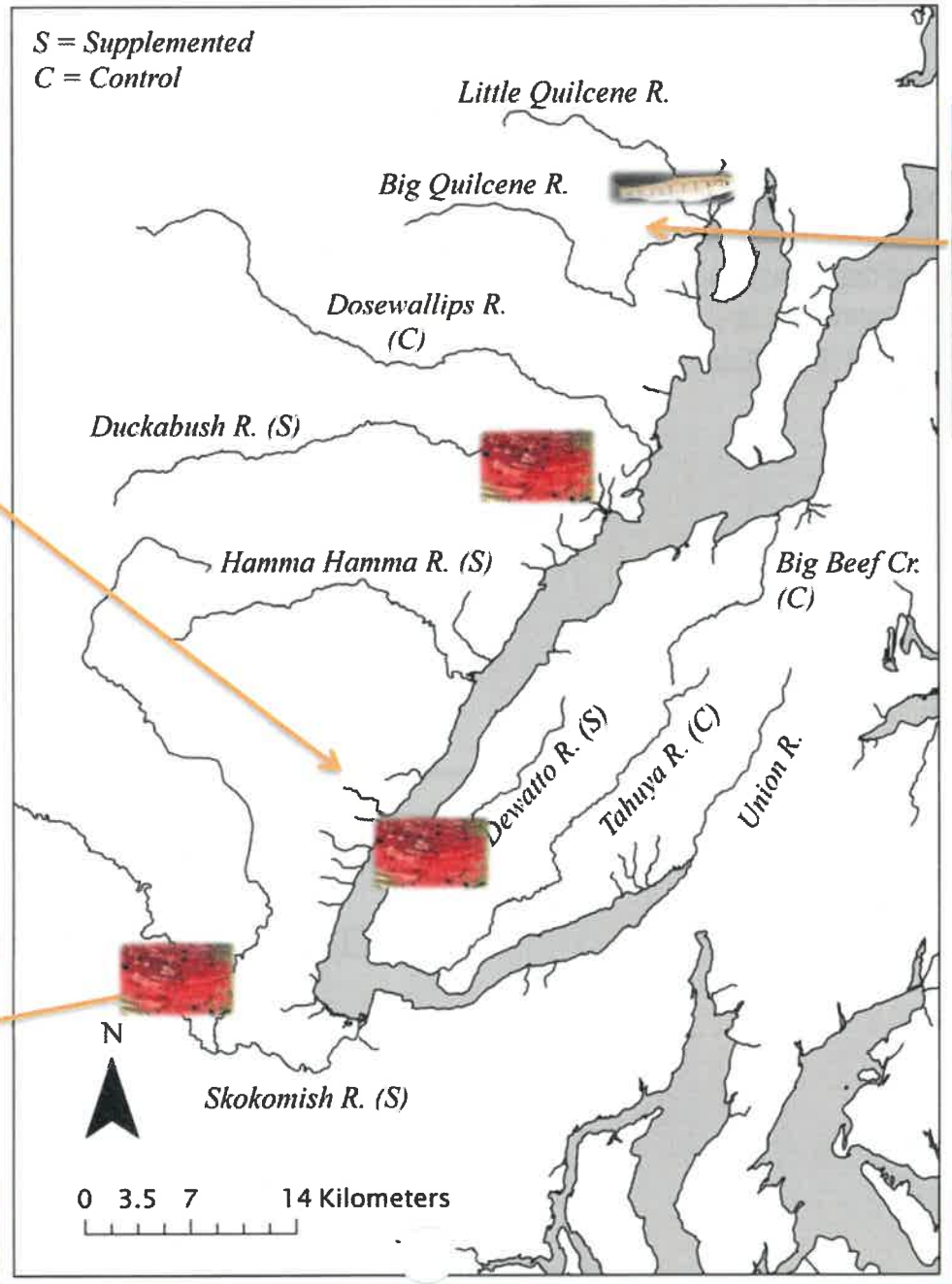
FIGURE 2. Estimated effective number of breeders (*Nb*) represented in captive populations of Hood Canal steelhead (top panel) and Salmon River Chinook salmon (bottom panel) obtained from hydraulic egg sampling (shaded circles) in comparison with *Nb* obtained from hypothetical 1:1 artificial spawning of captured adults (open squares) in conservation hatchery programs.

Egg and fish transfers

Lilliwaup Hatchery

Quilcene National Fish Hatchery

Quilcene National Fish Hatchery Photo Credit: Ron Wong



McKernan Hatchery

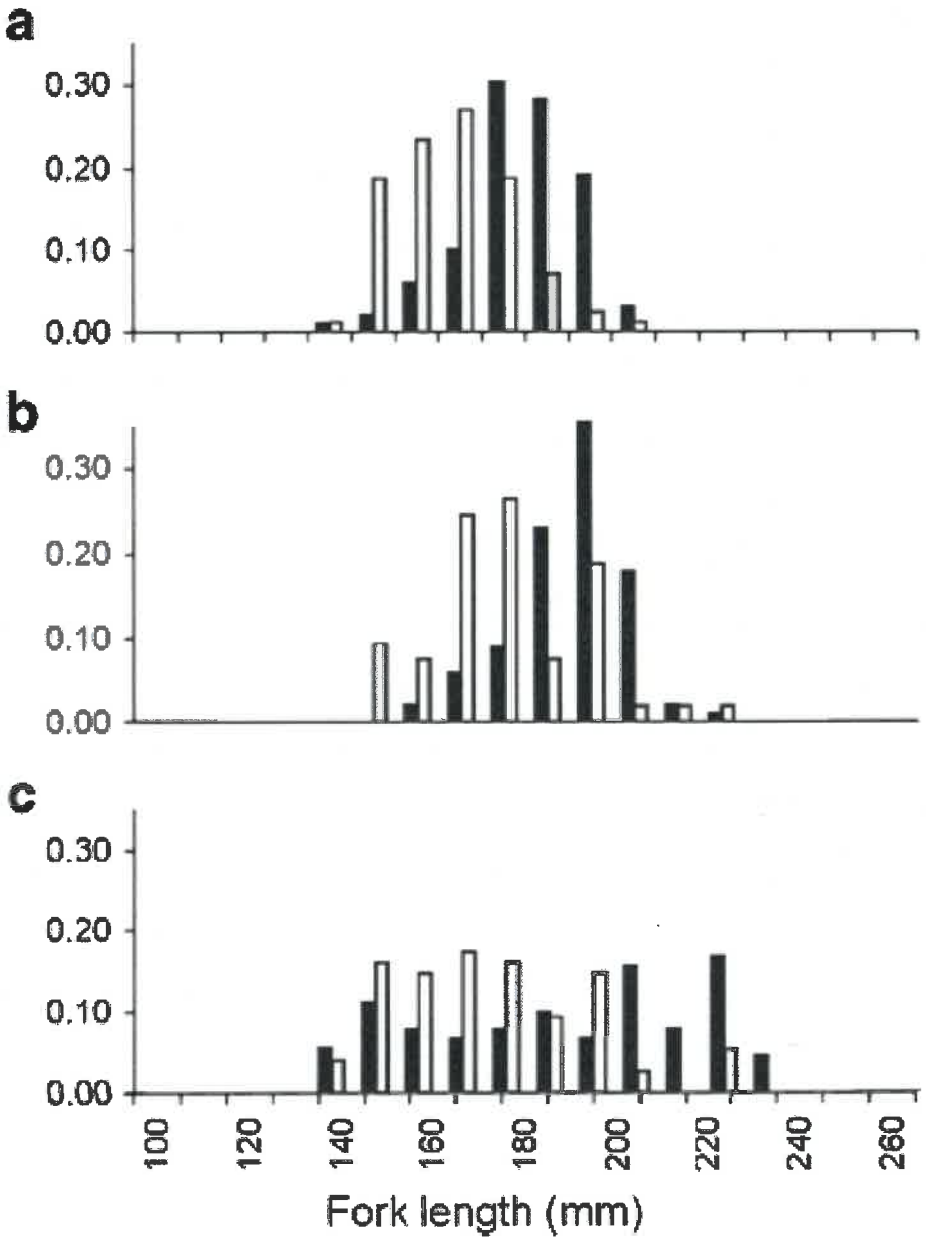
Egg collection, rearing and release numbers

River	Brood Year	Total Redds Observed	Redds for Egg Collection	Eggs Collected	Hatchery # Eggs in	Hatchery ponded	Number of fish released SRG Age-1	SRG Age-2	ARG Age-4	ARG Age-5	ARG Age-6	Total released
Dewatto	2007	17	16	9,429	9,438	9,012	0	7,375	226	26	1	7,628
Dewatto	2008	30	18	9,065	9,065	9,123	0	6,807	0	0	0	6,807
Dewatto	2009	9	9	9,523	9,471	9,072	0	6,571	228	31	3	6,833
Dewatto	2010	8	7	5,861	5,861	5,556	51	4,905	0	0	0	4,956
Dewatto	2011	57	19	8,495	7,276	6,493	0	5,272	213	48	4	5,537
Dewatto	2012	34	12	8,08[illegible]	7,631	7,089	0	6,183	0	0	0	6,183
Dewatto	2013	130	16	8,293	8,242	7,117	0	6,473	245			6,718
Dewatto	2014	17	12	6,021	5,800	5,051	0	4,239	0	0	0	4,239
Duckabush	2007	10	6	2,623	3,020	2,807	0	1,574	164	45		1,783
Duckabush	2008	11	8	6,101	5,882	5,750	0	4,671	65	70	4	4,810
Duckabush	2009	8	1	49	44	34	0	0	0	0	0	0
Duckabush	2010	18	6	3,149	3,149	2,917	140	1,743	196	0	0	2,079
Duckabush	2011	77	12	5,967	5,967	5,135	0	2,550	0	0	0	2,550
Duckabush	2012	64	10	6,010	6,335	5,354	0	4,782	211	10		5,003
Duckabush	2013	34	8	7,016	7,016	4,735	0	4,713	0	0	0	4,713
Duckabush	2014	39	8	2,136	2,136	1,755	0	1,700	0	0	0	1,700
Skokomish	2007	235	35	33,965	35,290	35,290	4,091	23,747	54	17	0	27,909
Skokomish	2008	155	50	34,595	34,813	34,813	200	20,529	0	0	0	20,729
Skokomish	2009	280	40	29,843	29,843	29,843	0	26,642	228	29	0	26,899
Skokomish	2010	169	38	29,710	29,710	29,710	0	23,989	0	0	0	23,989
Skokomish	2011	243	36	31,405	31,405	31,405	0	22,717	329	28	2	23,076
Skokomish	2012	307	30	30,705	30,705	30,705	0	27,258	0	0	0	27,258
Skokomish	2013	668	39	30,414	30,414	30,414	0	18,005	185			18,190
Skokomish	2014	390	42	30,531	30,531	30,531	0	14,769	0	0	0	14,769
Total							4,482	247,214	2,344	304	14	239,589

Below egg collection goal in most years

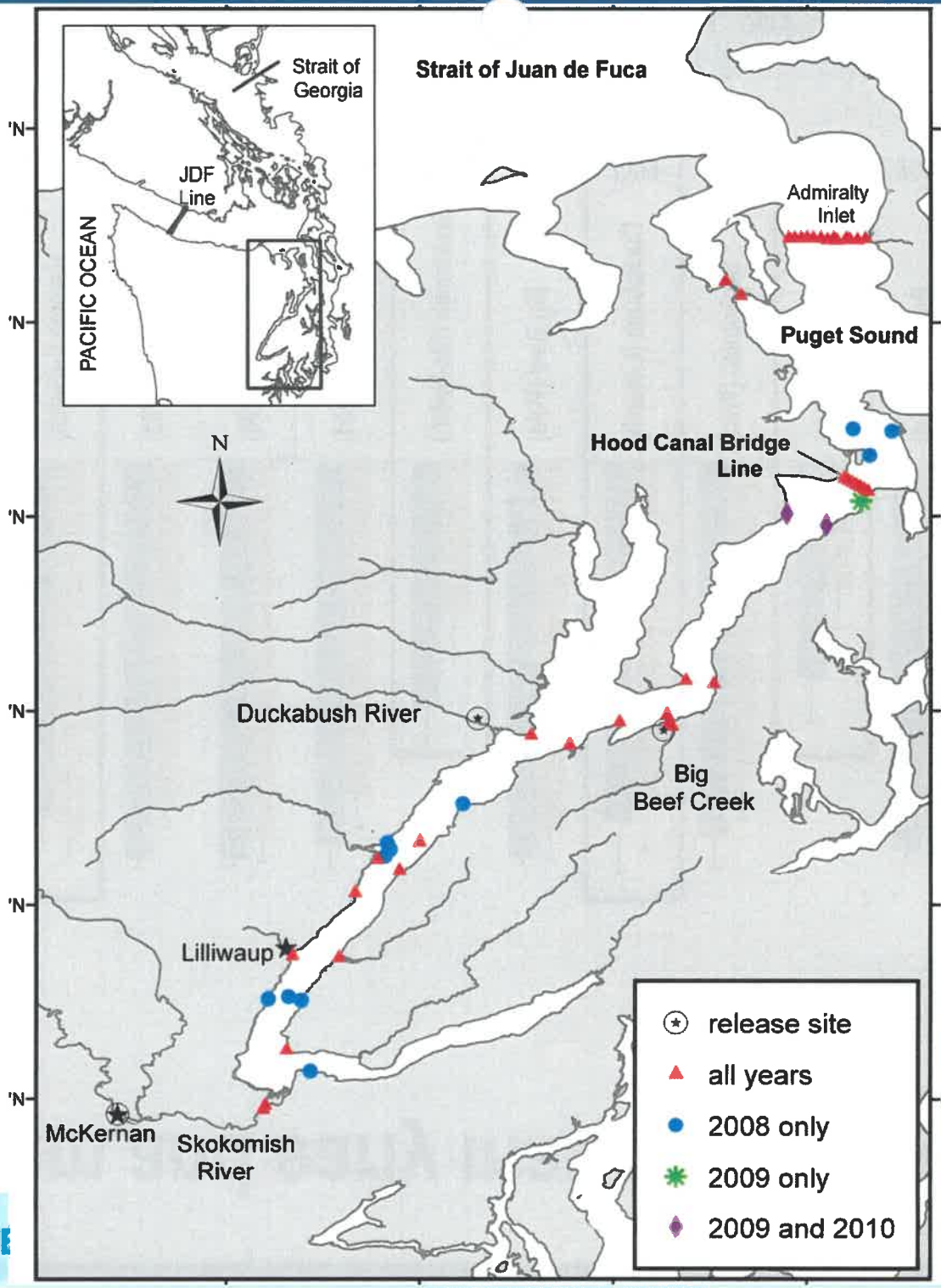
In-culture mortality - predation

Age-2 smolt rearing programs



Berejikian et al. 2011. Env. Biol. Fish

Post-release survival



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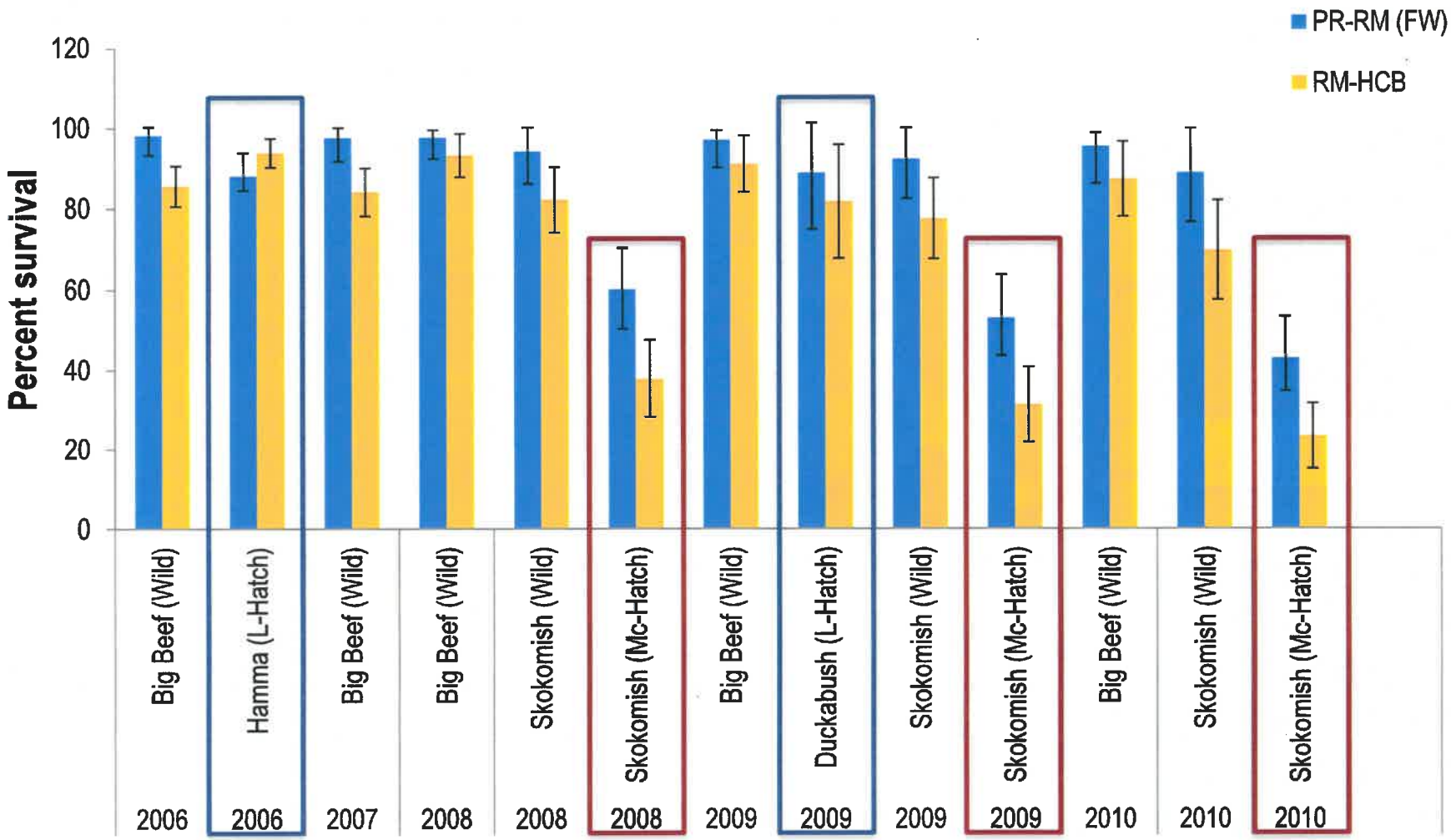
Downstream and early marine survival rates



Moore et al. 2012 PLOS One

Between-hatchery differences

	Lilliwaup Hatchery (Duckabush & Dewatto)	McKernan Hatchery (Skokomish)
Mean water temperature	8.9° C	8.6 ° C
Feed Manufacturer	Bio-Oregon	Bio-Oregon
Feeding frequency	3x/d, 4 days/wk	2-3x/d, 7 days/wk
Mean density index (to age-1)	0.0066	0.290
Mean density index (age-1 to age-2)	0.0065	0.056
Vessel size/shape (to age-1)	10' circular	16' circular
Vessel size/shape (age-1 to age-2)	20' circular	12 x 140' raceway
# of size sorts (to age-1)	2	1

Moore et al. 2012. PLOS One

Captive rearing and adult release

Table 1. Captive broodstock programs for maintenance or recovery of imperiled anadromous salmonids in North America.

Species	River/lake origin	Region	Number of stocks	Status of program	Strategies/ objectives[a]
Chinook salmon	Sacramento River	Central CA	1	Ongoing	Yes/yes
Chinook salmon	White River	Puget Sound, WA	1	Terminated[b]	Yes/yes
Chinook salmon	Tucannon River	Columbia River, WA	1	Ongoing	Yes/yes
Chinook salmon	Dungeness River	E. Straits of Juan de Fuca, WA	1	Ongoing	Yes/no
Chinook salmon	Mid-Columbia River	Central, WA	1	–	No/no
Chinook salmon	Grand Ronde Rivers and tributaries	Snake River, OR	3	Ongoing	Yes/yes
Chinook salmon	Salmon River tributaries	Snake River, ID	3	Ongoing	Yes/yes
Chinook salmon	Squamish River	Howe Sound, BC	1 of 5[e]	Terminated	Yes/yes
Chinook salmon	Puntledge River	Vancouver Island	1 of 5[e]	Pre-release	Yes/yes
Atlantic salmon	Gulf of Maine	Gulf of ME	8	Ongoing	Yes/yes
Steelhead	Hamma Hamma River	Hood Canal, WA	1	Ongoing	Yes/yes
Steelhead	E. Vancouver Island rivers	Vancouver Island, BC	5 (3)[c]	Ongoing	Yes/yes
Sockeye salmon	Redfish Lake	Stanley Basin, ID	1	Ongoing	Yes/yes
Sockeye salmon	Sackinaw Lake	Georgia Strait, BC	1 of 5[e]	Pre-release	Yes/yes
Sockeye salmon	Owikeno Lake	Central Coast, BC	1 of 5[e]	Pre-release	Yes/yes
Sockeye salmon	Cultus Lake	Fraser River	1 of 5[e]	Pre-release	Yes/yes
Coho	Scott Creek	Central CA coast	1	Pre-release[d]	Yes/yes
Coho	Dry Creek	Russian River, CA coast	1	Pre-release[d]	No/no

[a] The strategies/objectives column indicates whether ("yes") or not ("no") survey information was obtained for (i) reintroduction strategies implemented (first response) and (ii) importance of management objectives (second response).

[b] Fish are no longer reared to adult in captivity.

[c] The program initially included five populations, but has subsequently been reduced to three.

[d] Fish have been collected for rearing to adult but have not yet matured.

[e] For the purposes of the analysis in Tables 2 and 3, the five salmon populations (three sockeye and two Chinook) in British Columbia are considered to be managed as part of one program, because the single survey response we received covered all five programs and assigned a common "importance" score to each.

Berejikian et al. 2004. Am Fish. Soc. Symp 44:229-241

Effects of pre-smolt and post-smolt rearing environment on survival, body size and age-at-maturity

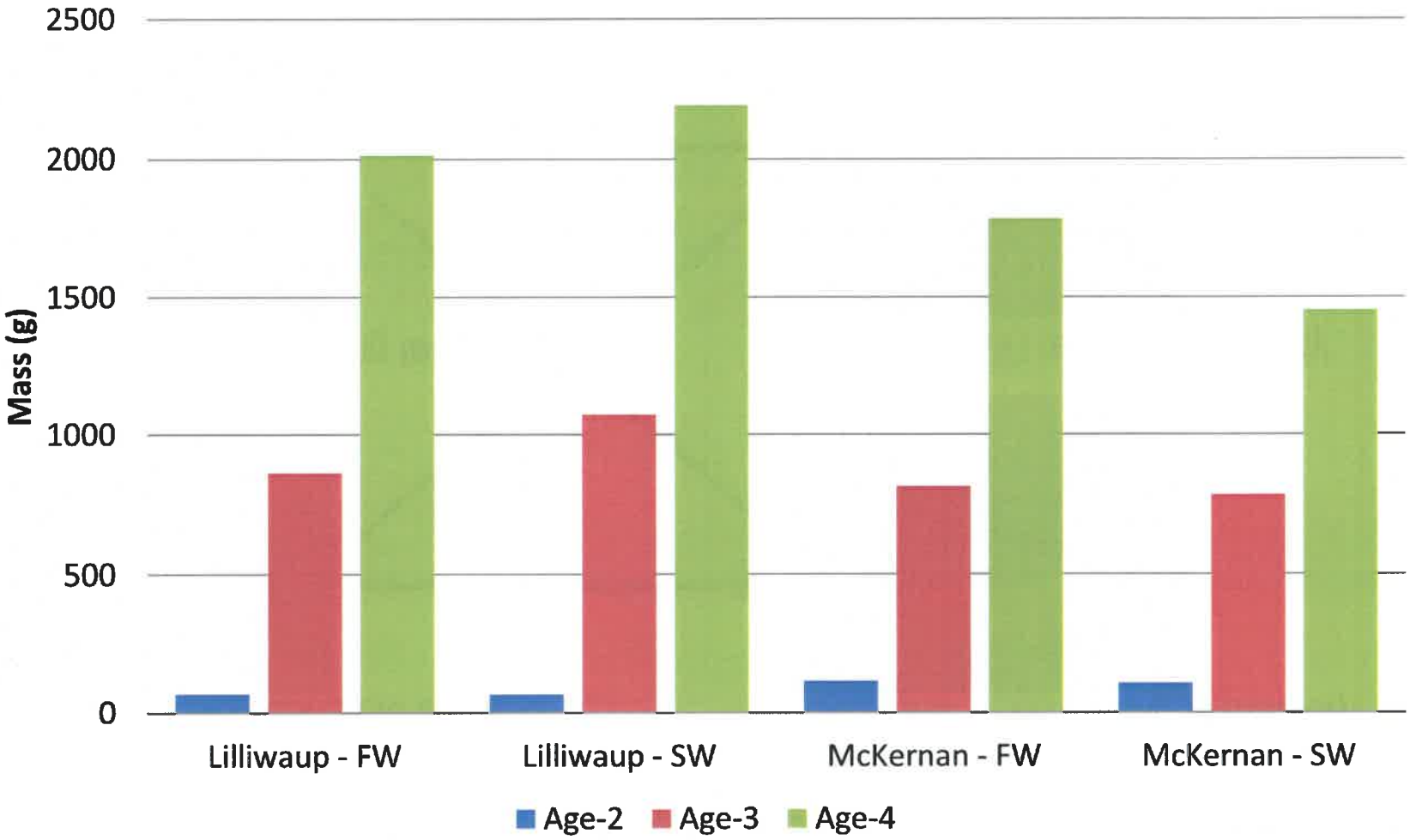
Lilliwaup Hatchery rearing to smolt

Freshwater (FW) rearing to maturity

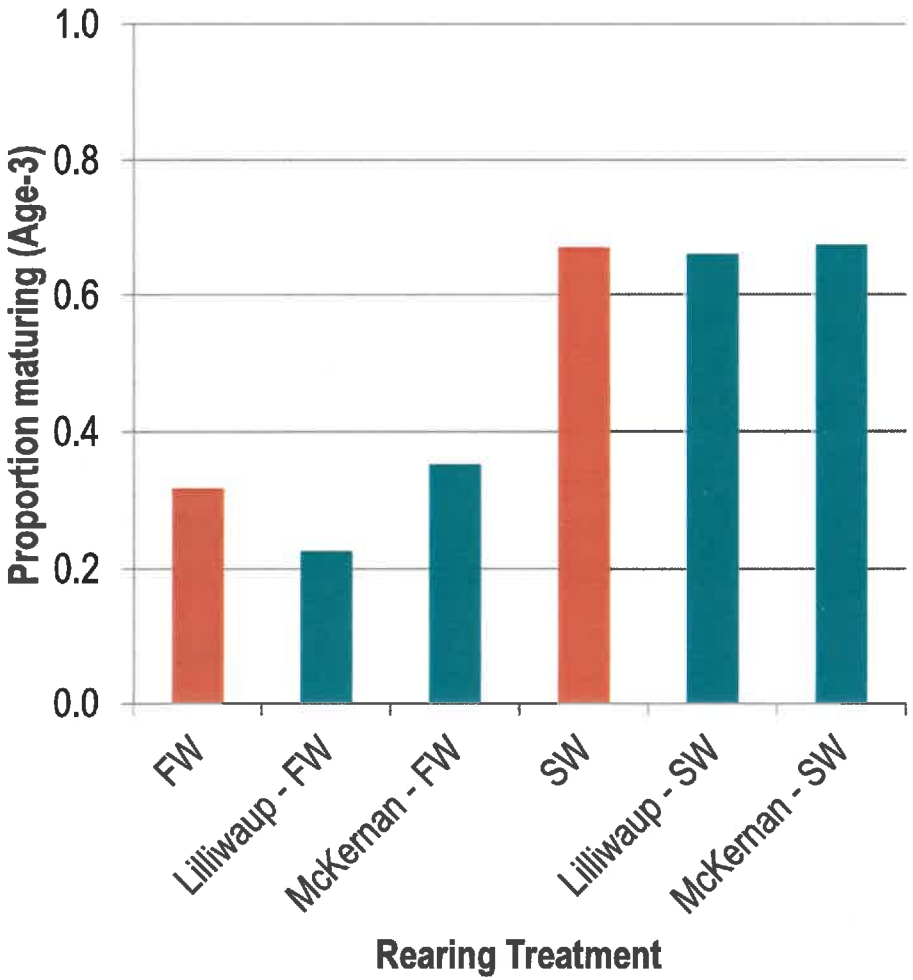
McKernan Hatchery rearing to smolt

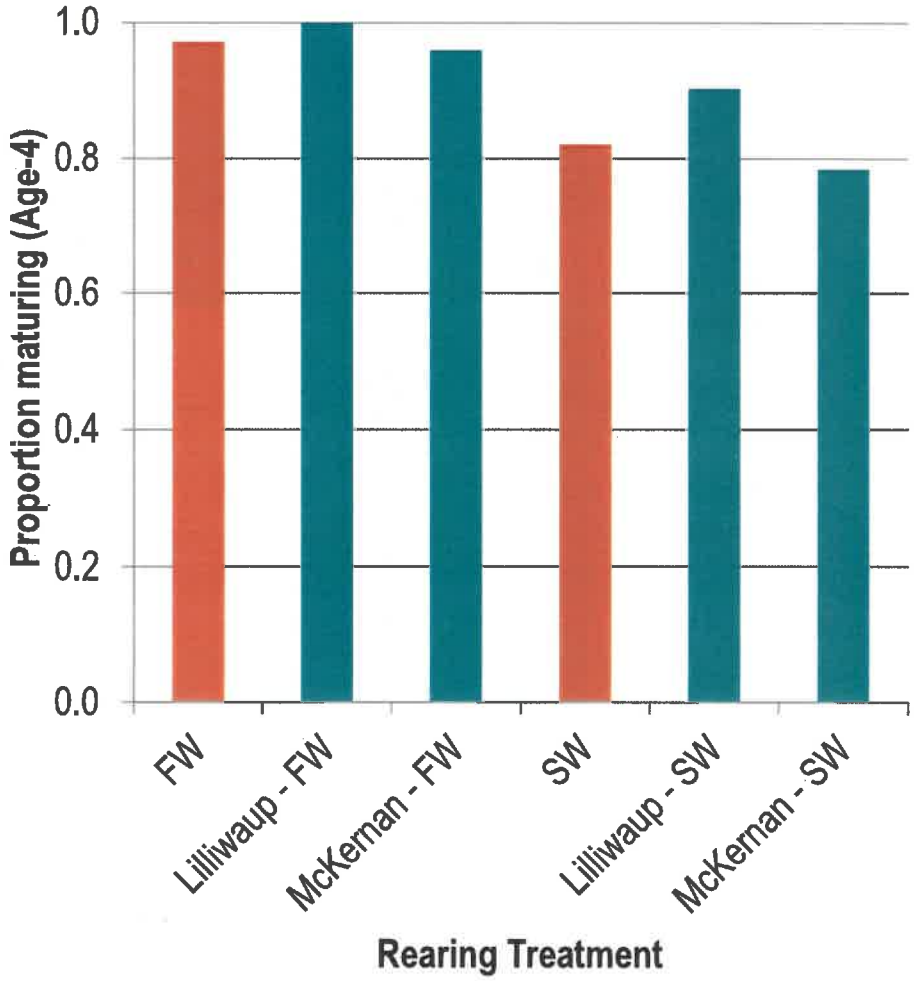
Seawater (SW) rearing to maturity

Size-at-age

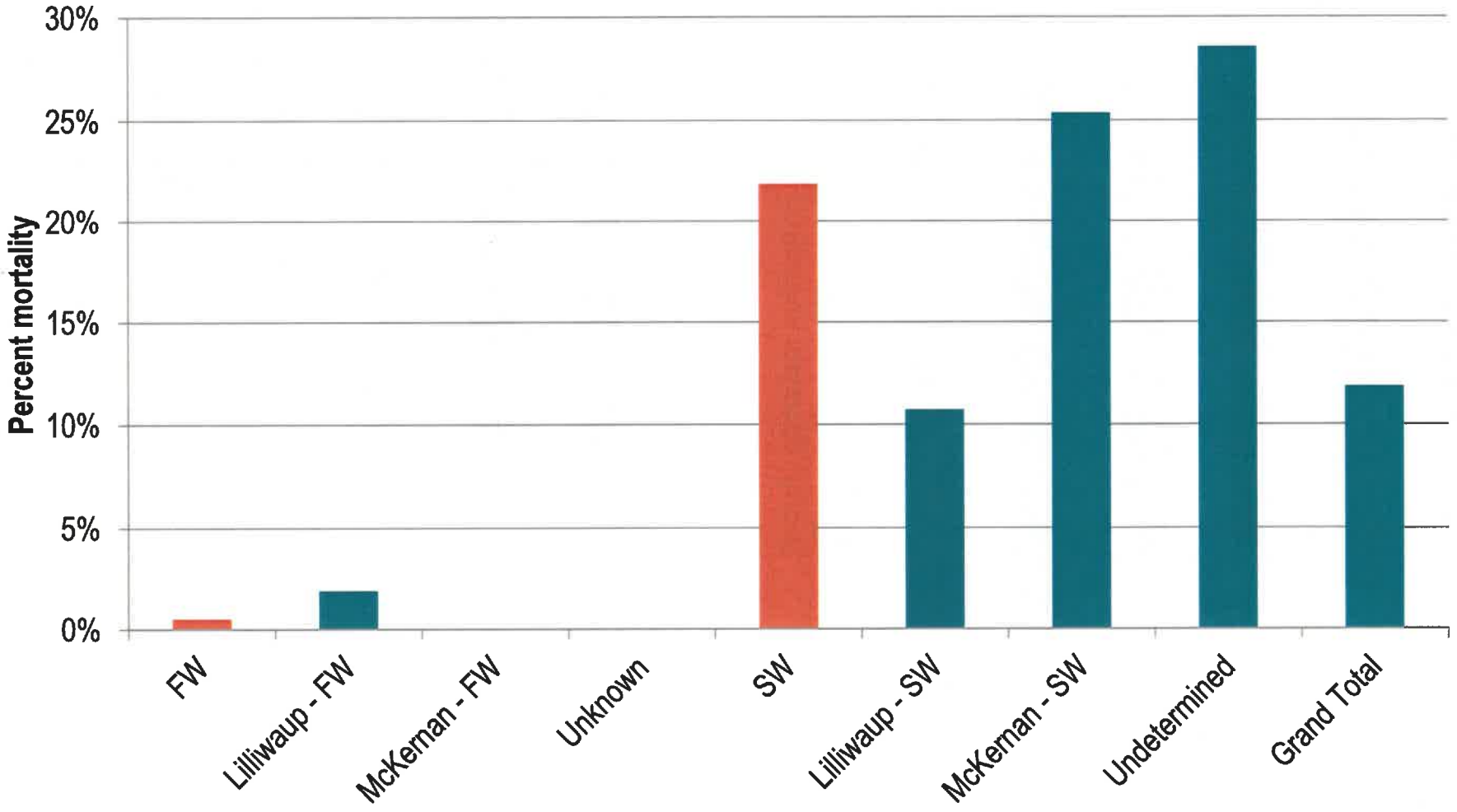

2500
2000
1500
1000
500
0
Mass (g)
Lilliwaup - FW
Lilliwaup - SW
McKernan - FW
McKernan - SW
Age-2
Age-3
Age-4

Age-at-maturity





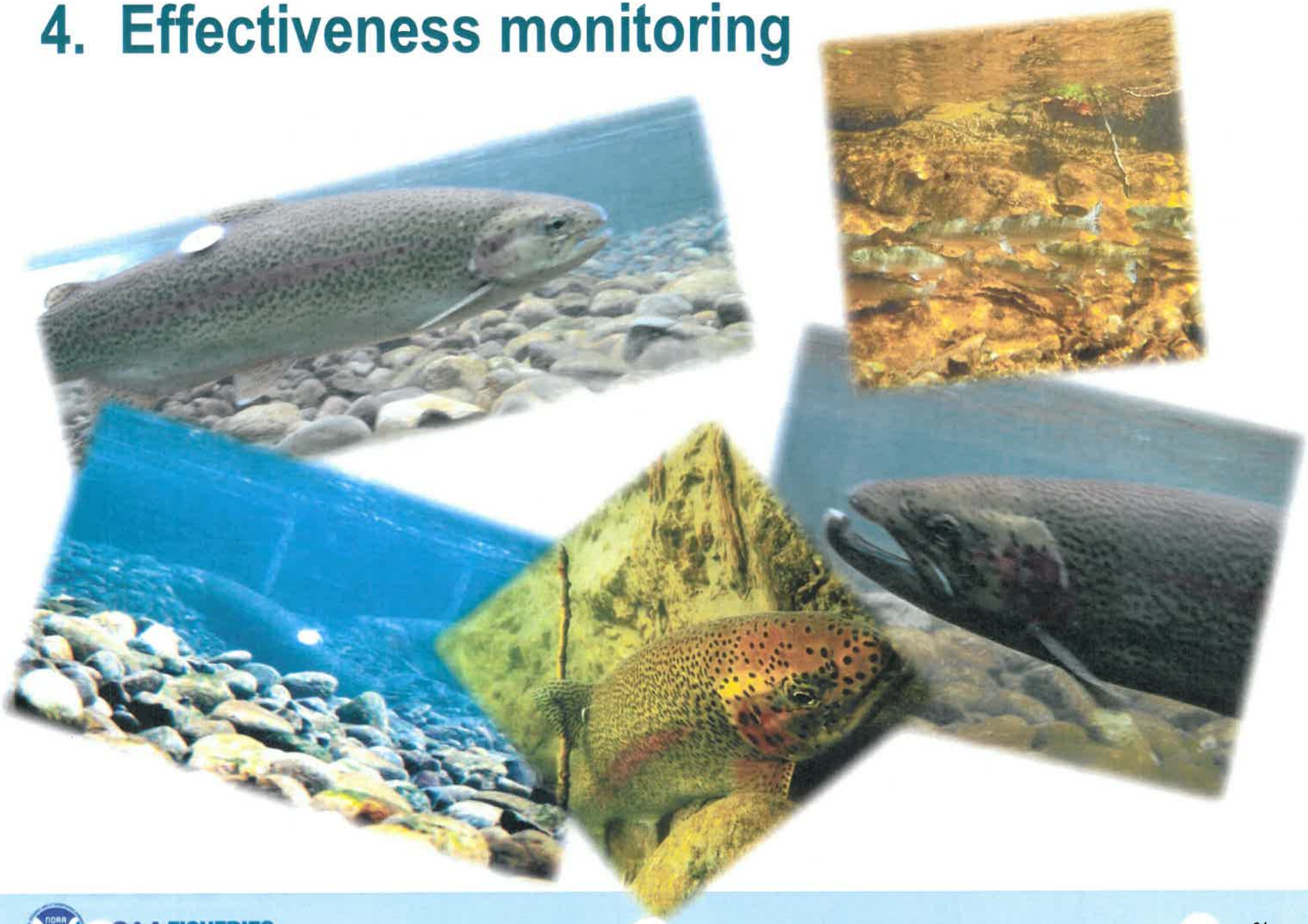
In-culture mortality



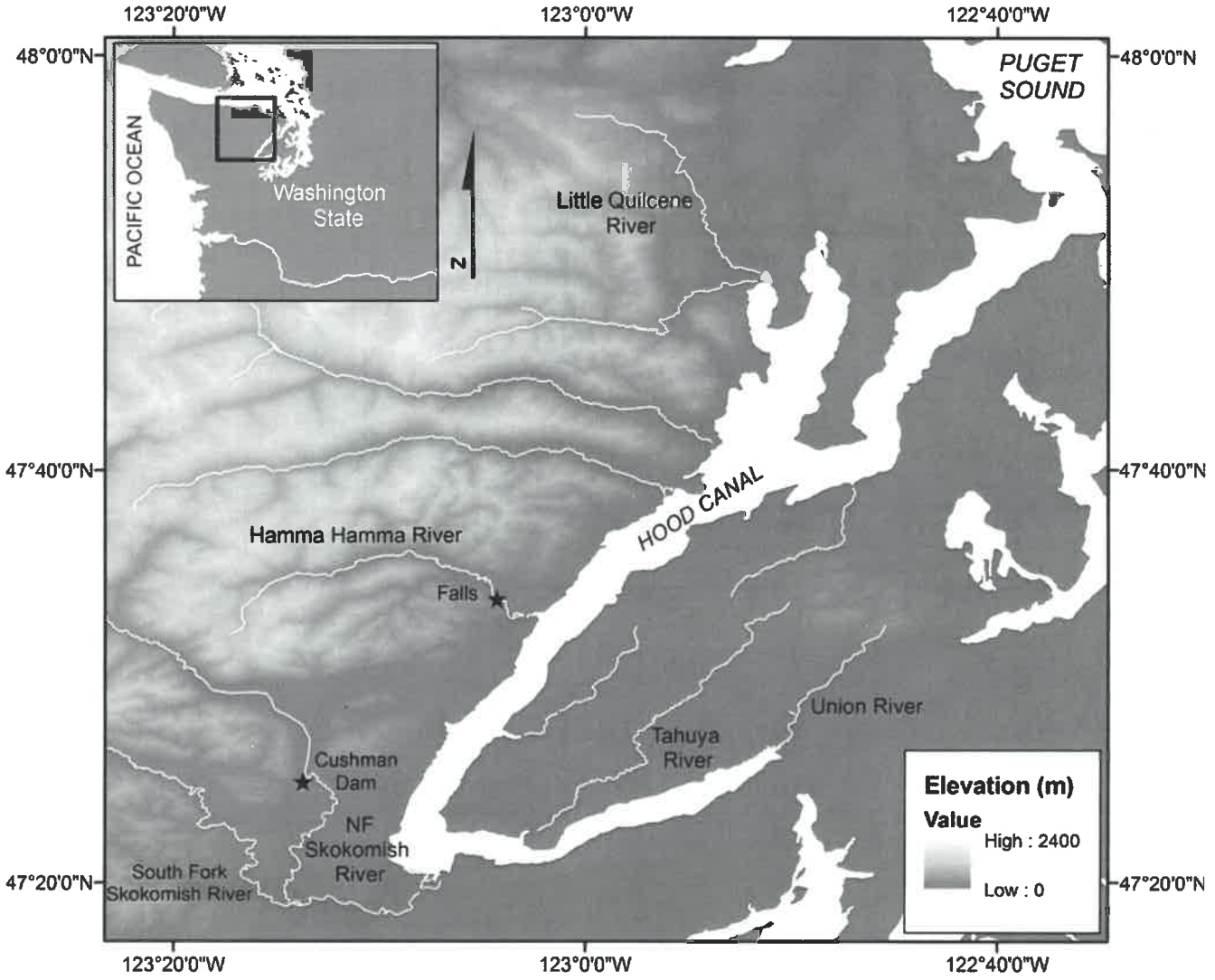
ARG Culture summary

- Smolts reared at the McKernan Hatchery were larger at age-2, even though identical protocols were issued.
- Seawater rearing resulted in higher mortality and smaller size at maturity, but only for fish reared at the McKernan Hatchery.
- Seawater rearing may be most beneficial if high smolt quality can be achieved.

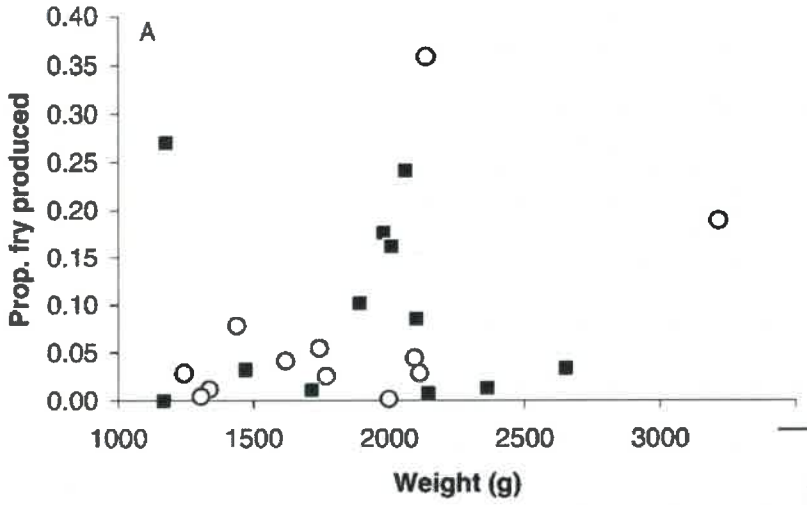
4. Effectiveness monitoring

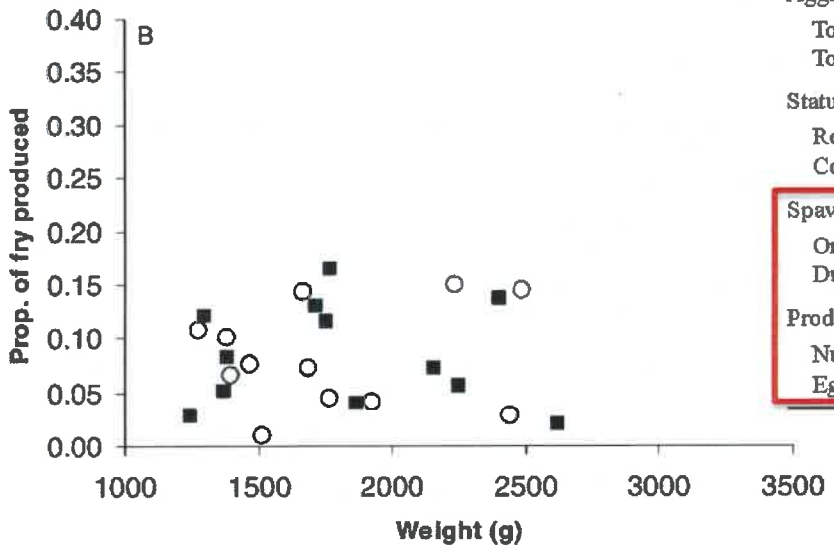


Effectiveness monitoring: Hamma Hamma 1998-2015



Breeding success of captively reared steelhead





Dependent variable	Treatment		Channel	
	High velocity	Low velocity	A side	B side
Nest construction				
Nest building	0.011 (0.011)	0.011 (0.014)	0.015 (0.012)	0.008 (0.012)
Aggression				
Toward female	1.917 (3.175)	2.250 (1.960)	2.333 (3.393)	1.833 (1.528)
Toward male	5.417 (7.821)	5.250 (6.703)	6.333 (8.261)	4.333 (5.975)
Status				
Redd holding	0.067 (0.095)	0.062 (0.067)	0.081 (0.103)	0.048 (0.047)
Courted by male(s)	0.063 (0.070)	0.047 (0.044)	0.077 (0.072)	0.033 (0.028)
Spawning duration				
Onset (d)	18.25 (19.68)	23.53 (16.28)	22.28 (21.80)	19.50 (13.72)
Duration (d)	3.94 (1.86)	4.09 (2.00)	3.39 (1.48)	4.64 (2.10)
Production				
Number of nests	6.42 (2.39)	7.92 (2.02)	7.42 (2.81)	6.92 (1.73)
Eggs deposited	0.984 (0.031)	0.991 (0.14)	0.977 (0.031)	0.998 (0.003)

Berejikian et al. 2005. Trans. Am. Fish. Soc.

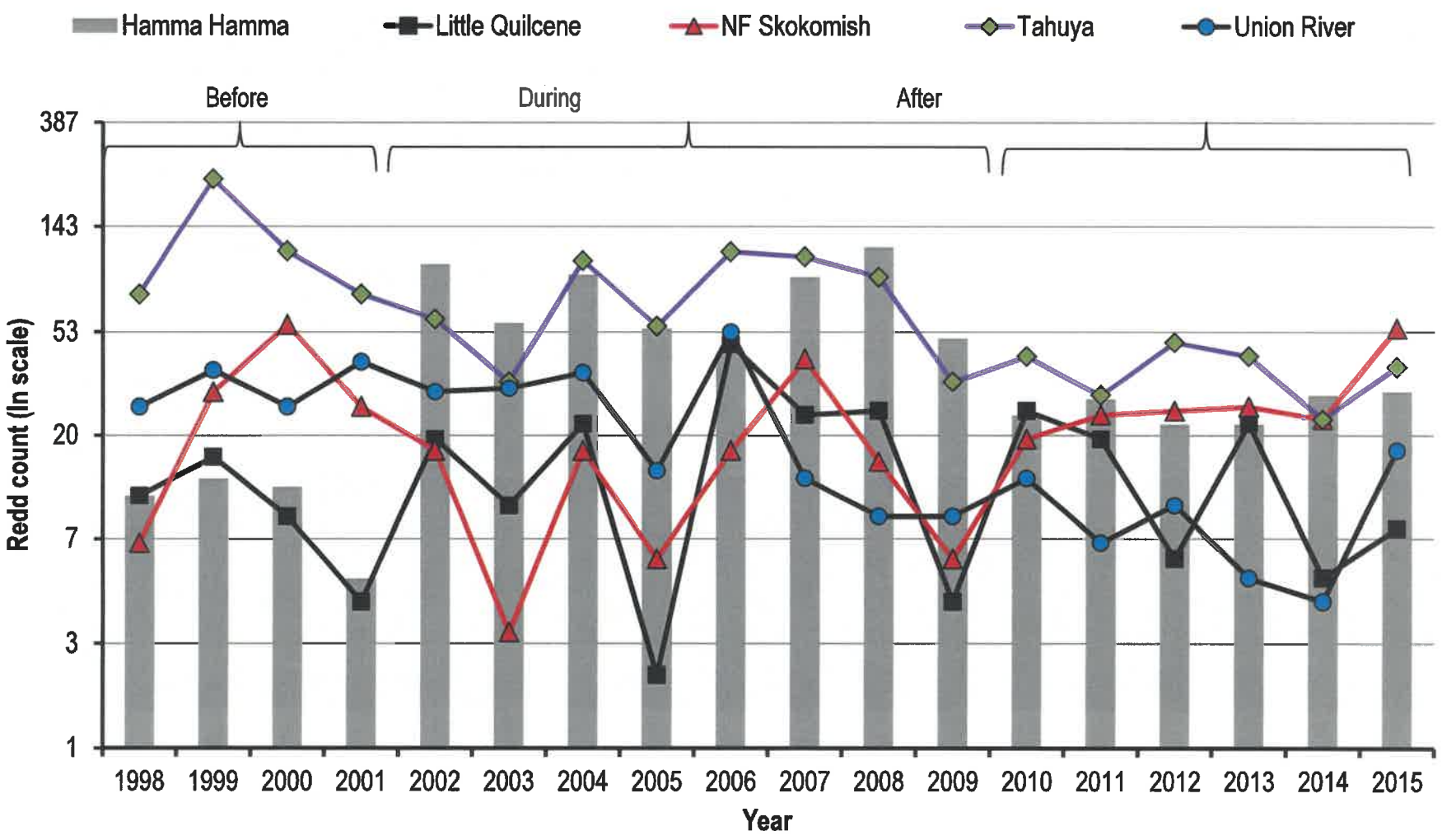
Steelhead released into the Hamma Hamma River

Brood year	Redds sampled	Eggs Collected	Juveniles released	Adults released	
				Age-4	Age-5
1998	8	4,683	3,235	81 (116)	2 (2)
1999	6	2,588	1,802		
2000	7	1,622	1,090	35 (41)	10 (15)
2001	4	2,000	1,454		
2003	23	4,105	2,043	58 (80)	60 (77)
2005	16	4,723	2,080		

Berejikian and Van Doornik in prep

Average annual redd survey effort (+/- sd)

	Frequency		Distance	
	Before	After	Before	After
Hamma Hamma	12 (1.2)	13 (2.0)	33.7 (1.2)	31.7 (7.5)
Little Quilcene	4 (2.1)	9 (2.2)	23.4 (13.5)	67.8 (24.9)
NF Skokomish	6 (0.6)	22 (13.9)	25.4 (5.2)	75.4 (35.4)
Union	7 (1.7)	10 (2.8)	49.4 (6.1)	34.5 (9.4)
Tahuya	16 (3.0)	14 (2.4)	124.9 (16.3)	116.1 (26.9)



Berejikian and Van Doornik in prep

BACI ANOVA

Table 2. ANOVA results for the primary response variable of interest (redd abundance) and two response variables that provide measures of effort expended on redd surveys (number of days and total distance surveyed; see methods for definitions).

Source of variation	df	MS	F-Ratio	p-Value
CATEGORY (Treatment or Control)	1	1.026	3.015	0.091
PERIOD (Before or After)	1	0.402	1.181	0.285
PERIOD* CATEGORY	1	4.325	12.705	0.001
POPULATION(CATEGORY)	3	5.476	16.086	0.000
YEAR(PERIOD)	8	0.400	1.174	0.342
Error	35	0.340		

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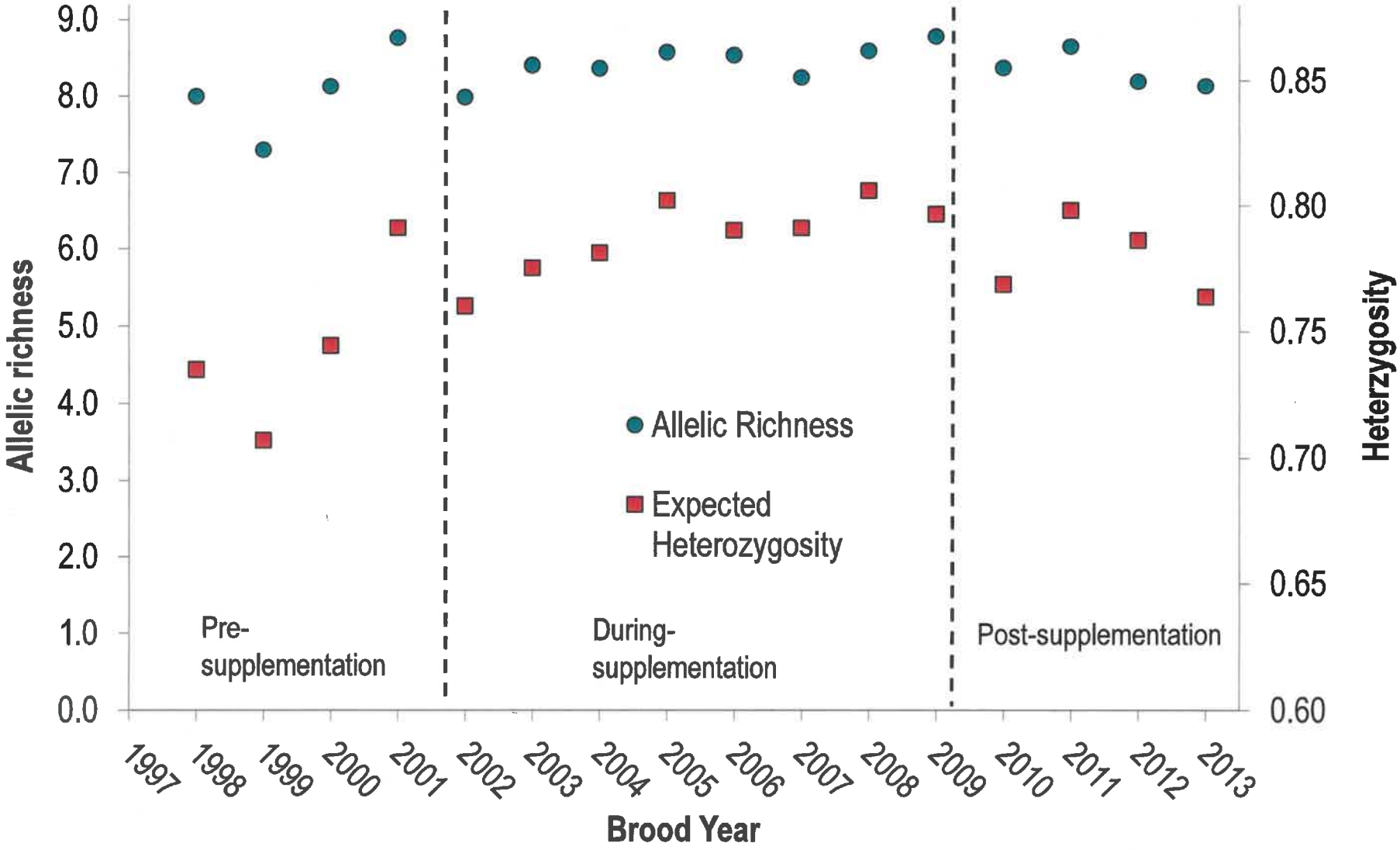
Genetic diversity



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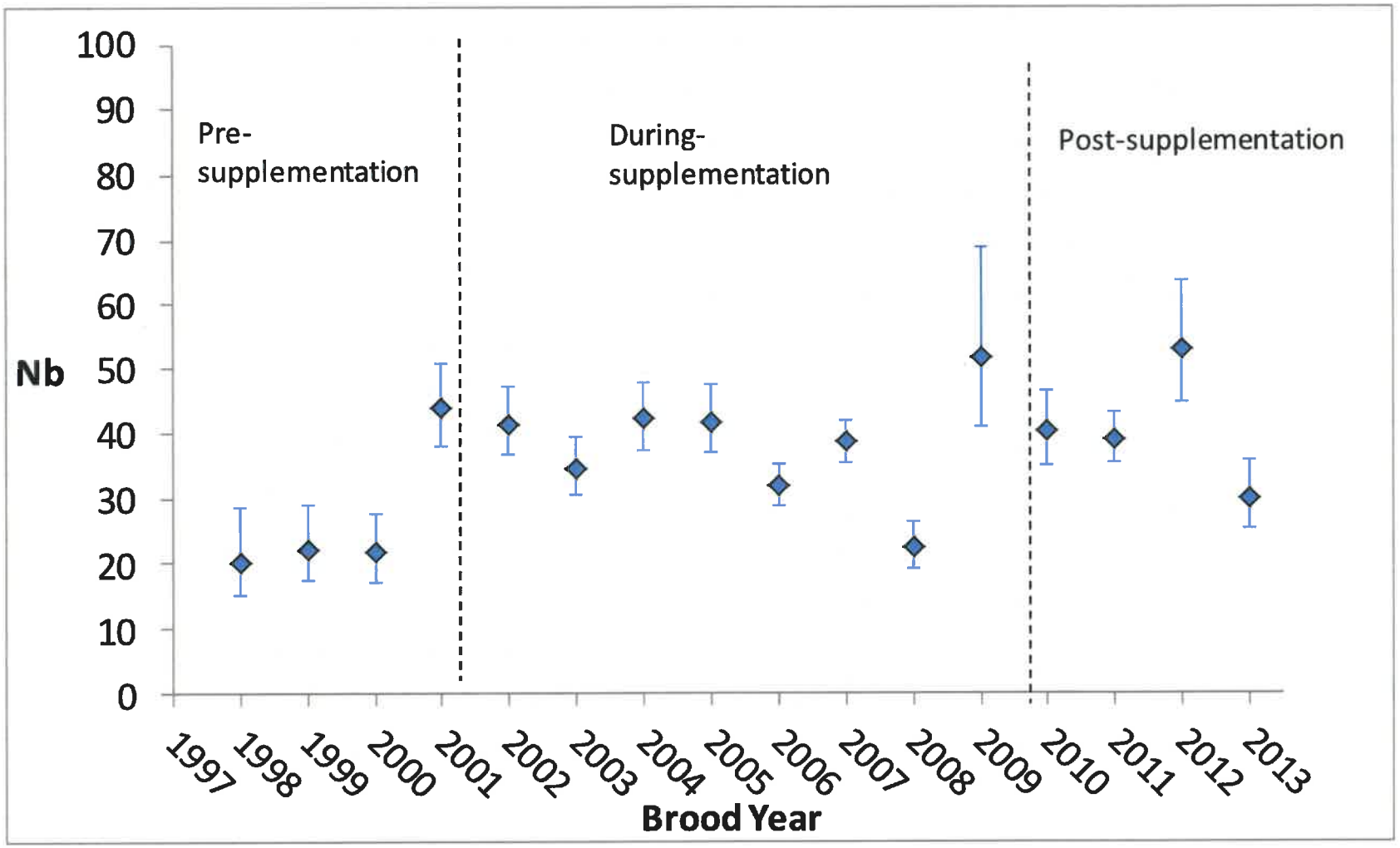
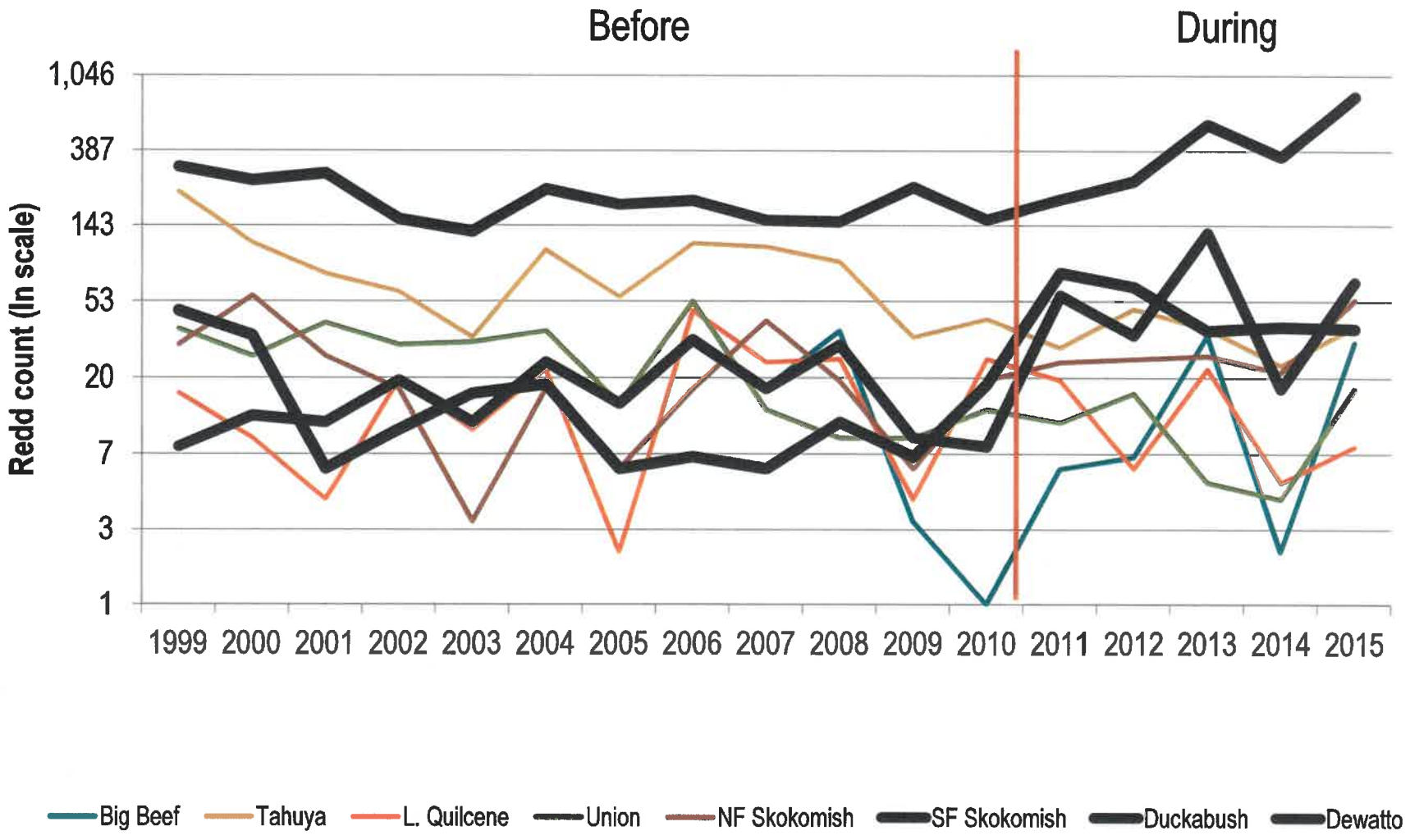
Effective number of breeders (Nb)

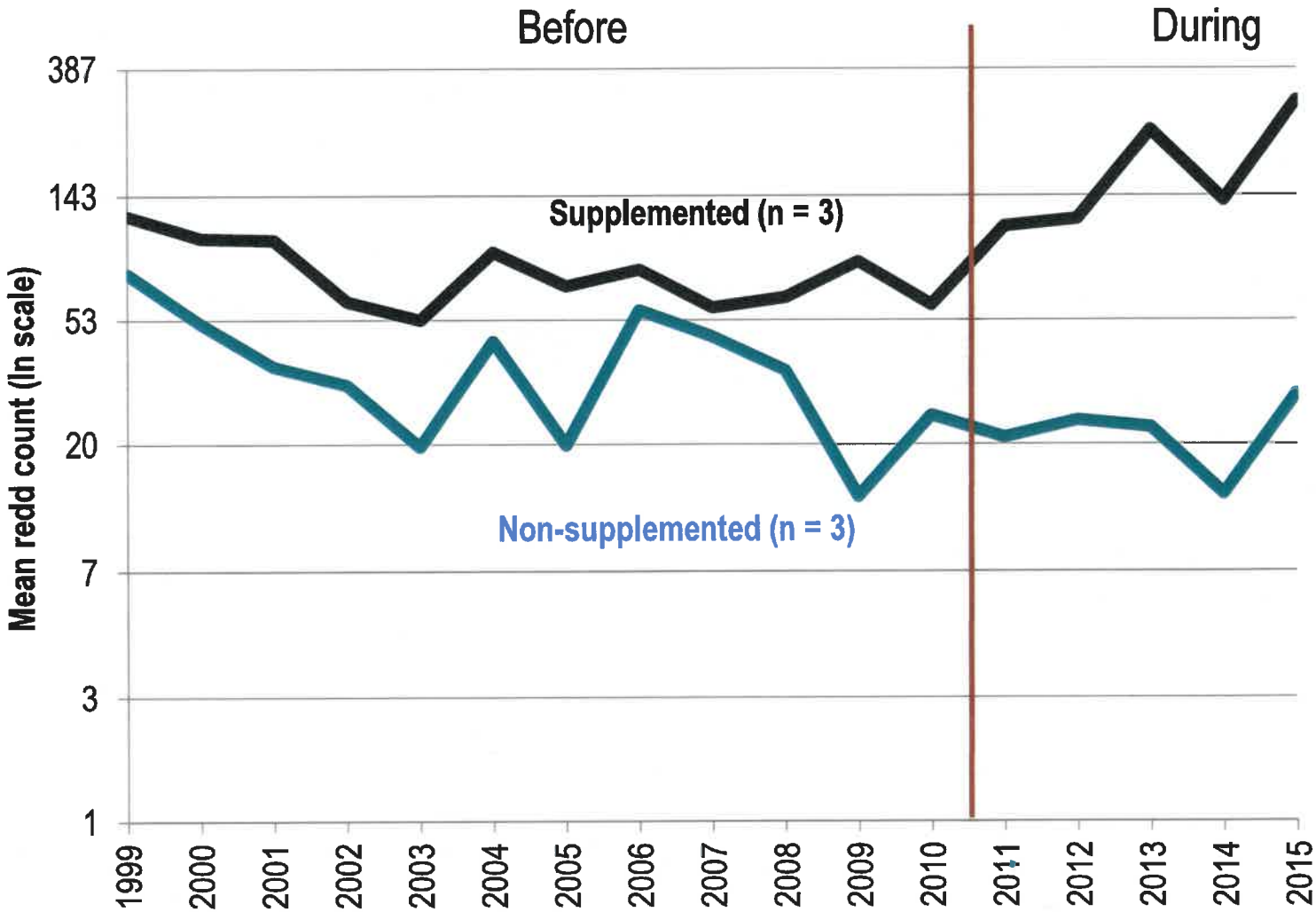


Berejikian and Van Doornik in prep

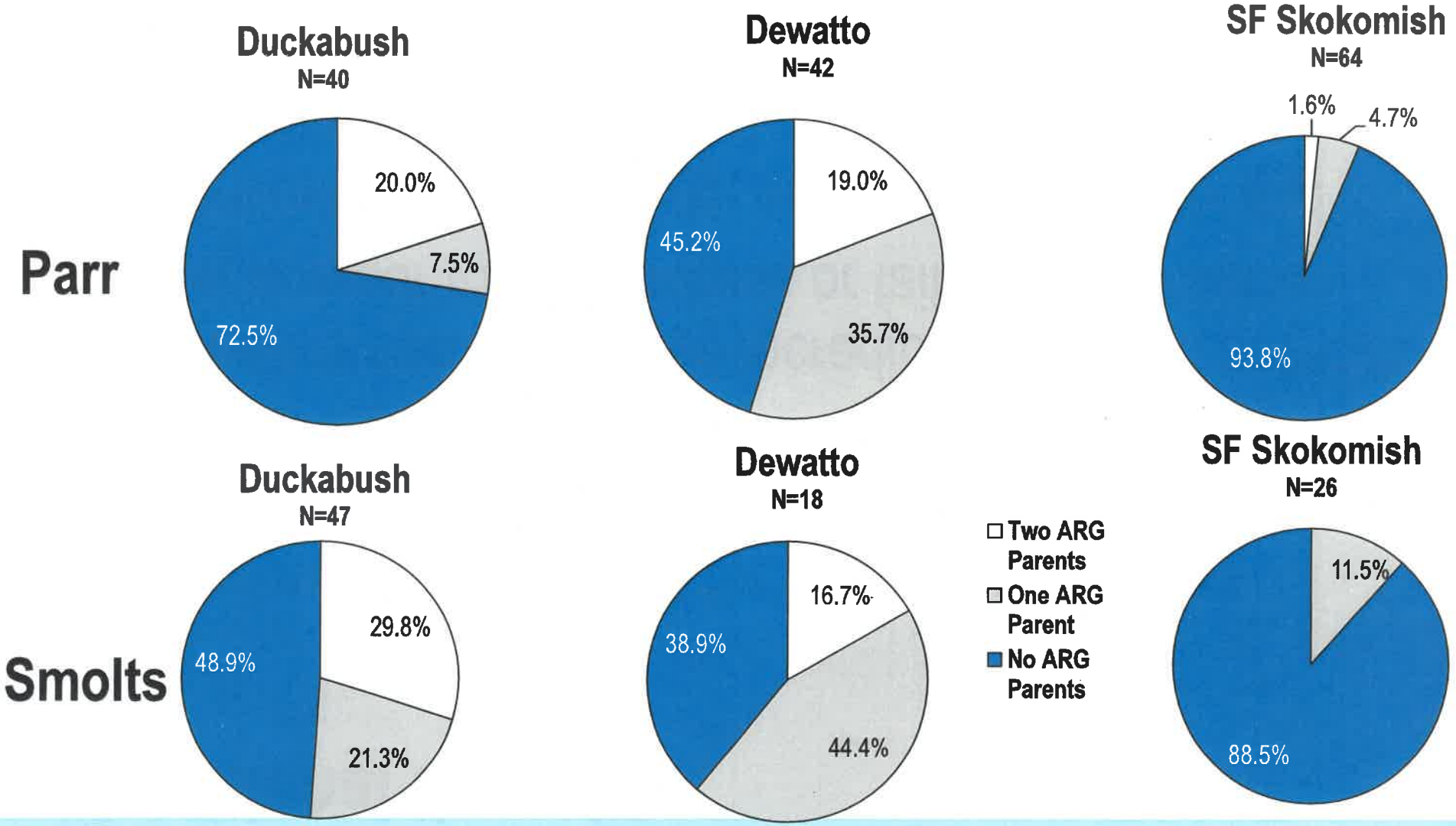
Population-specific redd abundance in the larger Hood Canal Experiment



Mean redd abundance in Hood Canal streams



Naturally produced juveniles from ARG steelhead (BY 2011)



NOAA FISHERIES

Van Doornik and Doctor et al. unpublished data

Additional thoughts

- Captive rearing to adult for iteroparous species alleviates some problems associated with captive rearing
- Details of fish culture are incredibly important and can play a major role in success or failure of a program
- Monitoring is challenging, but aided by energy and commitment of collaborators
- Expect different responses in different environments and for different stocks.