RRS Project Review

Project ID: 2003-063-00[1]

Title: Natural Reproductive Success and Demographic Effects of Hatchery-Origin Steelhead in Abernathy Creek, Washington

Short Description: This project aims to evaluate the relative reproductive success (RRS) of naturally spawning hatchery and natural origin steelhead in Abernathy Creek, WA, and to assess the overall demographic effects of hatchery fish supplementation relative to two adjacent control streams, Germany and Mill Creeks.

Sponsor: U.S. Fish and Wildlife Service

BiOp association:

RPA 63.1: Measure effect of safety-net & conservation programs
RPA 64.1: Estimate relative reproductive success (RRS) of hatchery
RPA 64.2: Determine if artificial production contributes to recovery

Is this an Accord project? No

Budget (2008 to present):

BPA	Total	$4,890,724
	FY16	$ 590,072
Cost share	Total	$1,182,293
	USFWS	$ 737,293 (2008-2014)
	WDFW	$ 445,000 (2009-2014)

Proposal from last Categorical Review:

https://www.cbfish.org/Proposal.mvc/Summary/RMECAT-2003-063-00

Most recent Council recommendation:

https://www.cbfish.org/Assessment.mvc/CouncilRecommendationAssessmentSummary/Assessment/2003-063-00-NPCC-20110125

Date of most recent annual report available on Pisces/cbfish?

FY15 Annual Report. *Natural Reproductive Success and Demographic Effects of Hatchery-Origin Steelhead in Abernathy Creek, Washington*. Submitted April 2016.
https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P148481

[1] This is one of the six exclusively RRS projects in the program.

Short summary of project reporting compliance: Contract management and project performance has been excellent. Sponsor was on time with all annual reports. To date, 9 peer-reviewed scientific papers have been published from this project.

Summary of the scope of the project as it was reviewed by Council: The sponsors proposed to continue the project conducted at US Fish and Wildlife Service's (FWS's) Abernathy Fish Technology Center (AFTC) that was first approved for funding in 2004. Specifically, continue to evaluate relative reproductive success between hatchery origin and natural origin steelhead, simultaneously investigating methods of operating a conservation hatchery and the effectiveness of artificial production of an integrated broodstock on recovery.

Summary of the scope of the project now: This project has faced logistical challenges with executing field work and meeting the sample sizes required to have sufficient data to estimate RRS. Low genetic assignment rates suggest that there may be fish contributing to the population that are not being sampled, such as a resident rainbow trout population or juveniles spawned below the weir by non-sampled parents. Although genetic samples are still being collected from returning adults, it is not clear if the RRS portion of their project will continue. The sponsors suggest that the focus of their work should shift to investigating casual mechanisms for reduced RRS in integrated hatchery programs, and research of conservation hatchery methods.

Has the scope of this project changed significantly since it was reviewed? Yes. The sponsors have been unable to resolve the logistical challenges faced in trying to estimate RRS of hatchery and natural origin steelhead in the study streams. Small sample size and low parental assignment rates preclude strong conclusions regarding RRS in Abernathy Creek. Despite these challenges, this project is contributing valuable information on the relative fitness of hatchery steelhead from integrated broodstock programs. The sponsors are focusing on conservation hatchery practices that minimize genetic and ecological risks to natural origin populations, and furthering research into the mechanisms causing domestication selection in integrated hatchery programs.

Link to ISRP/AB Critical Uncertainties Appendix D review:

http://www.nwcouncil.org/media/7149871/isabisrp2016-1appendixd.pdf#page=126

Comments: This project has a strong link to the 2008 FCRPS BiOp (RPA 63.1, 64.1, & 64.2) and addresses critical uncertainties in the NOAA Fisheries ESA Recovery Plan for the Lower Columbia River Steelhead ESU. This project also responds to research priorities in the State of Washington's Statewide Steelhead Management Plan. The sponsor addressed all Council recommendations since the review, has been timely with all required deliverables and contracting deadlines, and the quality of their work is exemplary

"Multiple aspects of the current study require that any closing of the project occur in several phases to ensure complete collection of data and return on investment from fish that have already been produced. With the current contracting cycle, discontinuation of the steelhead smolt production would require advance notice of at least a single calendar year to avoid the requirement of euthanizing a year

class of fish. Additionally, BPA has already invested in the production of several year classes of steelhead that are currently at sea. Fish produced from the spawning run in 2014 would not return to the hatchery until 2017, and fish produced from the 2015 spawning run will not return to the hatchery until 2018. Similarly, fish being released this year (2016) will not return to the station until 2019, and fish that have already been spawned and will be released in 2017 will not return until 2020."

Questions to all project sponsors with RRS studies:

- How does this project inform (1) the Council's Research Plan and (2) the Council's Fish and Wildlife Program objectives?
- Can any results from this study be extrapolated to other geographic locations or other populations?
- How does the Idaho Supplementation Study inform this project?
- Does this project have any of the following elements:
    (a) A scientific question
    (b) A hypothesis
    (c) A specific time frame within which to answer the question posed
- How was it determined which species or geographic area to study?
- How does this effort work or collaborate with other RRS projects on aspects of the study (methodology, data and conclusions)?
- How does density dependence factor in to this study moving forward?

Questions relative to this project:

- The RRS elements of this project have been unsuccessful. Based on these experiences, what advice to other researchers do the sponsors have when selecting populations or geographic areas to conduct RRS studies?
- What valuable information has the project contributed to integrated broodstock programs?
- Which hatchery practices would be the focus of any future research? How long would it take to evaluate hatchery practices?

Natural Reproductive Success and Demographic Effects of Hatchery-Origin Steelhead in Abernathy Creek, Washington

Concept

Natural Reproductive Success and Demographic Effects of Hatchery-Origin Steelhead in Abernathy Creek, Washington:

Can newly-developed, native broodstocks of steelhead derived from captively-reared parr potentially contribute to recovery of naturally spawning populations?

Project Proposal to BPA to address NMFS *RPA Action 182*

April 11, 2003

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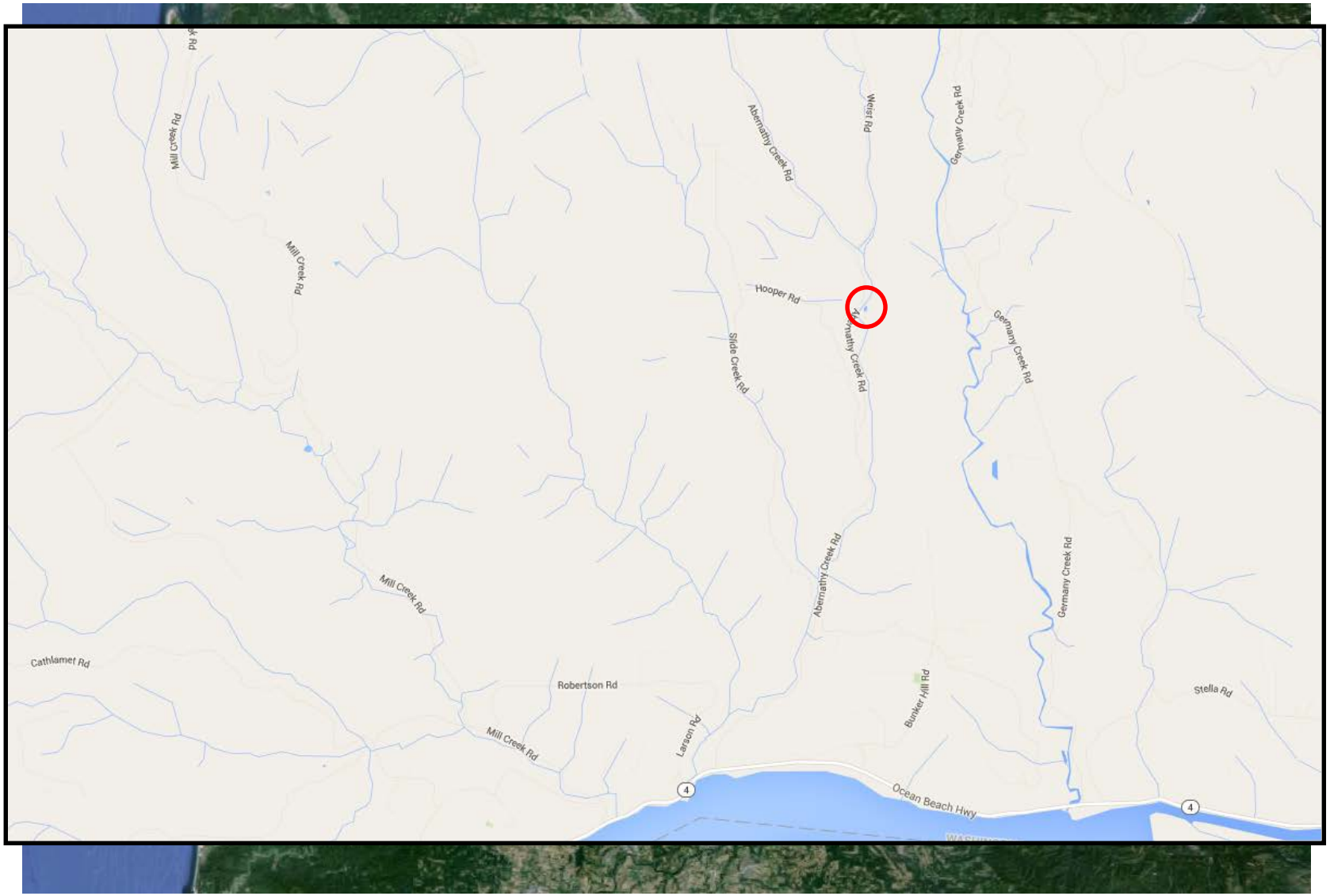
and
Patricia A. Crandell

U.S. Fish & Wildlife Service
Abernathy Fish Technology Center
1440 Abernathy Creek Road
Longview, WA 98632

Study Site


Mill Creek Rd
Abernathy Creek Rd
Weist Rd
Germany Creek Rd
Hooper Rd
Slide Creek Rd
Cathlamet Rd
Robertson Rd
Larson Rd
Bunker Hill Rd
Stella Rd
Ocean Beach Hwy
4

AFTC conservation hatchery program

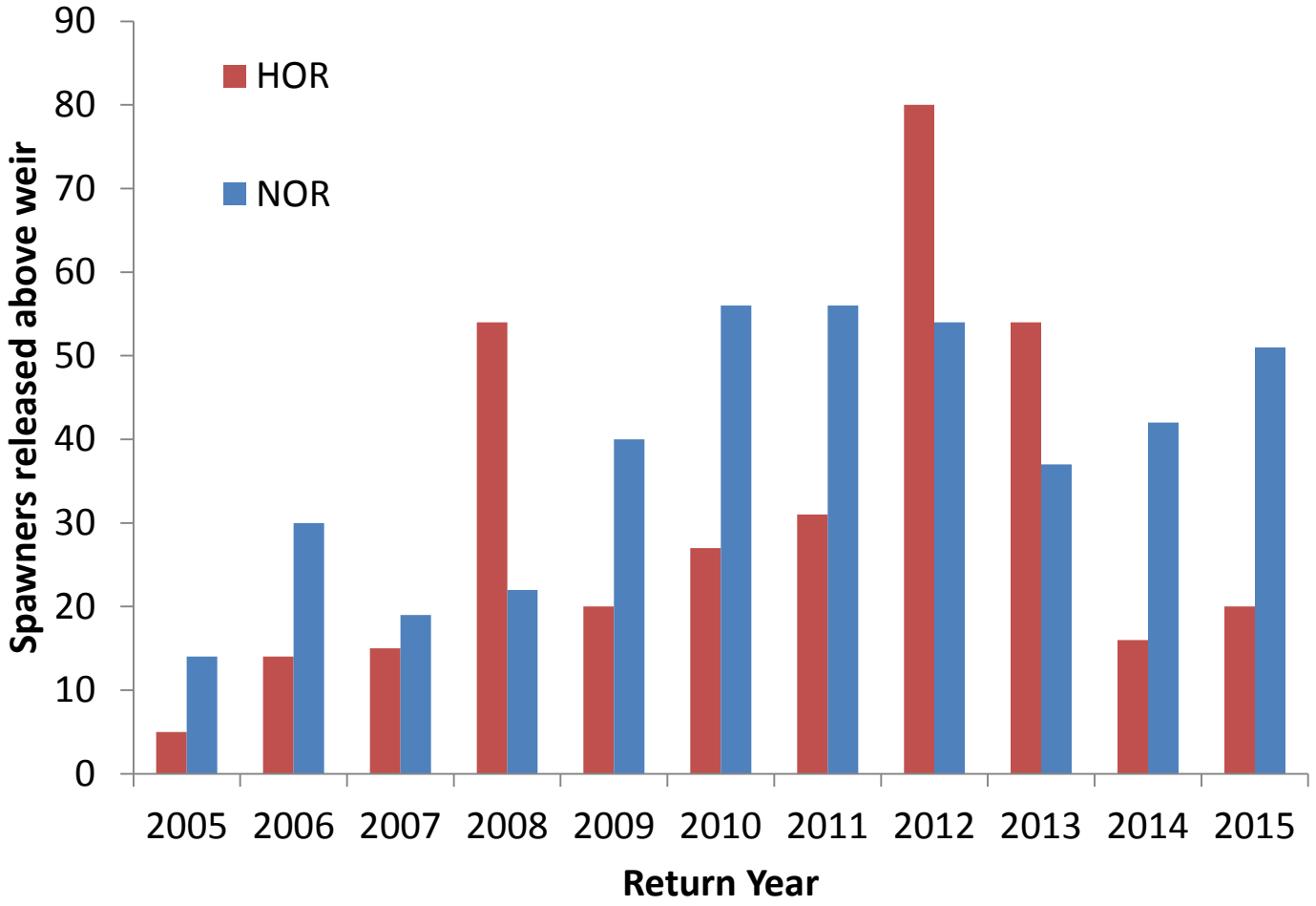
- 1999 – 2001: Juvenile NOR steelhead captured from Abernathy Creek and reared to sexual maturity (n=500 / yr.)

- Maintain genetic integration between populations
  - Hatchery spawning ratio: 1/3 NOR, 2/3 HOR
  - Passed fish ratio: 2/3 NOR, 1/3 HOR

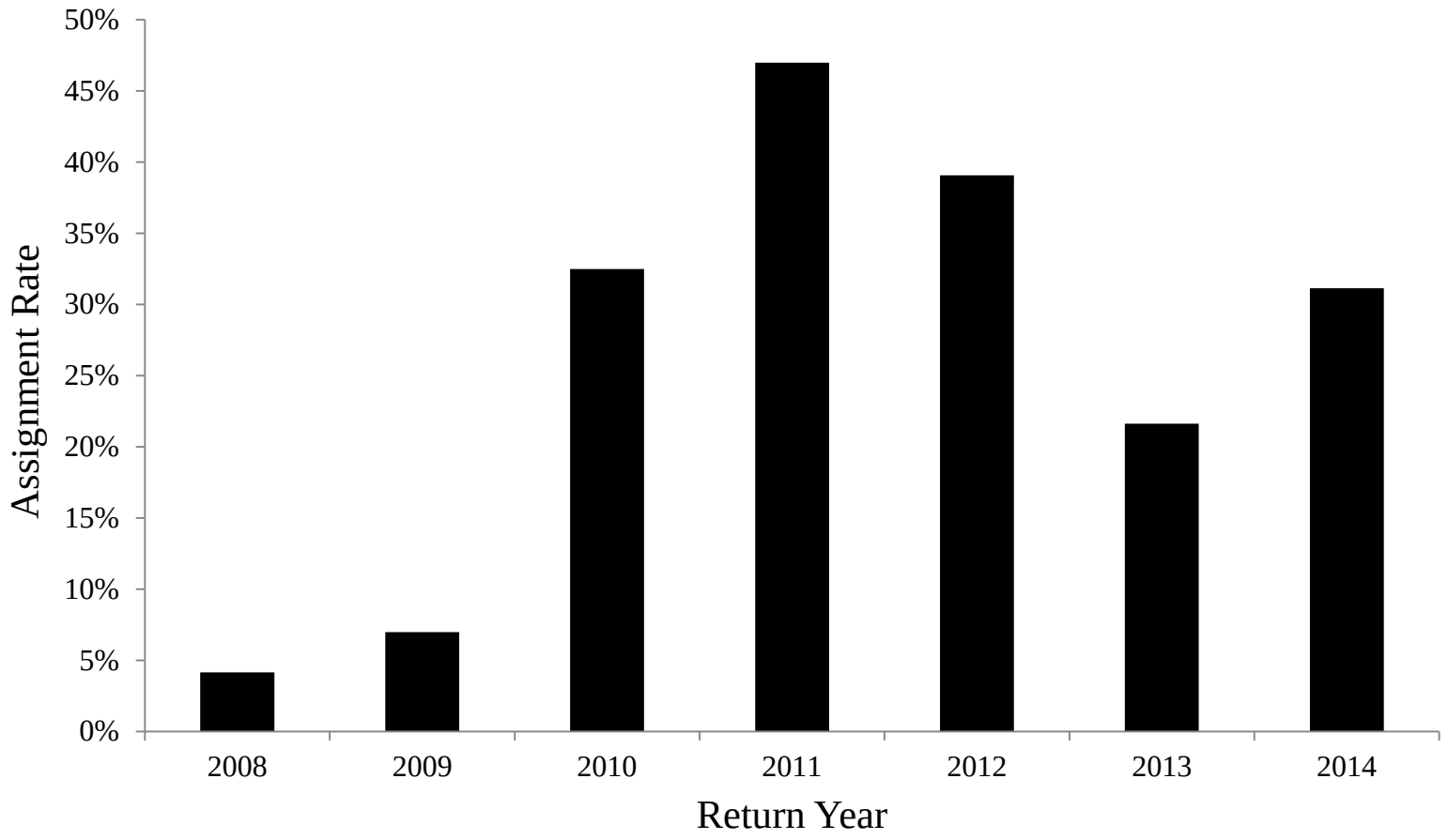
- Release 20,000 HOR steelhead annually (max)

CONSERVING AMERICA'S fisheries
U.S. Fish & Wildlife Service

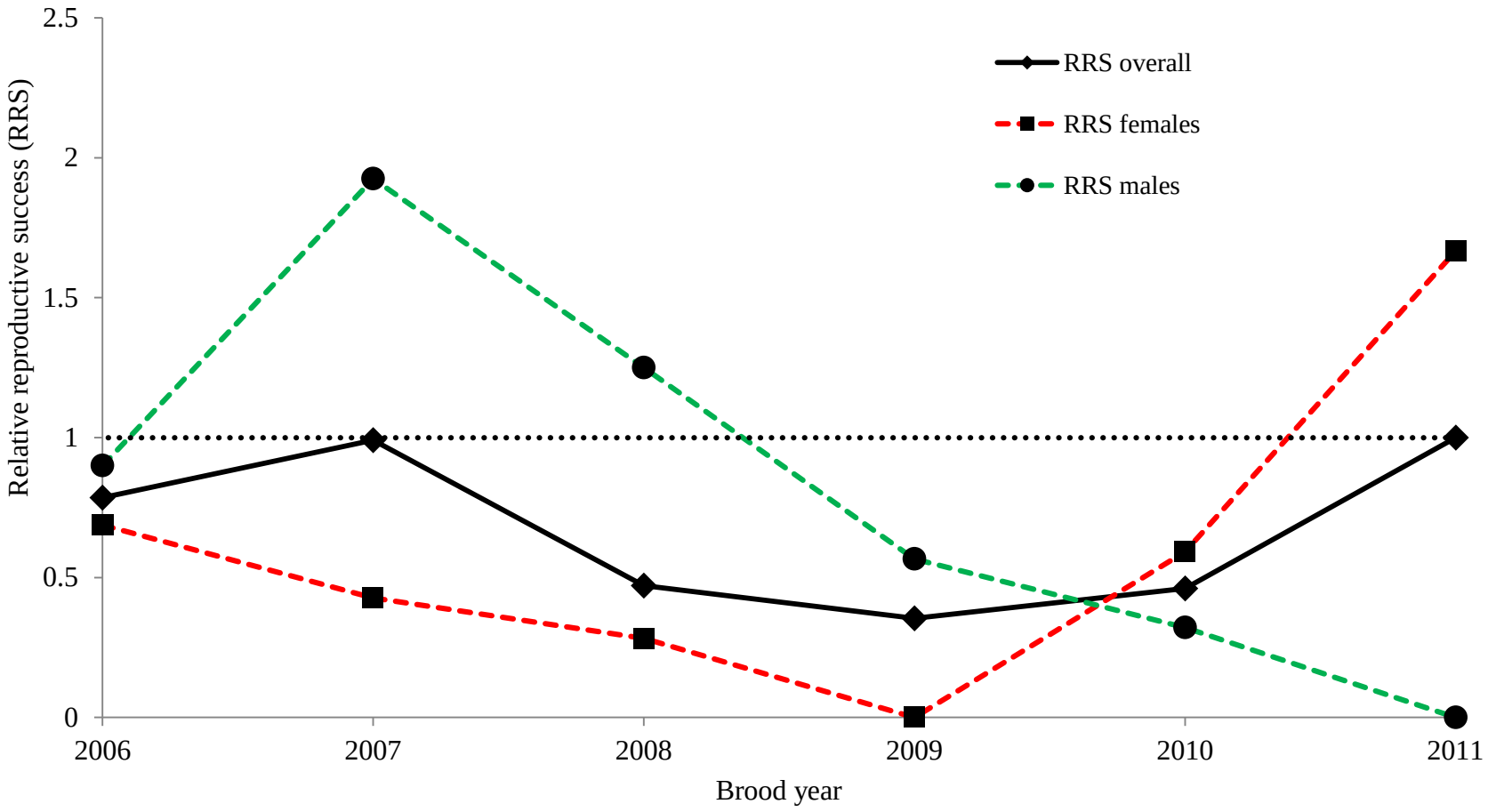
Adult returns



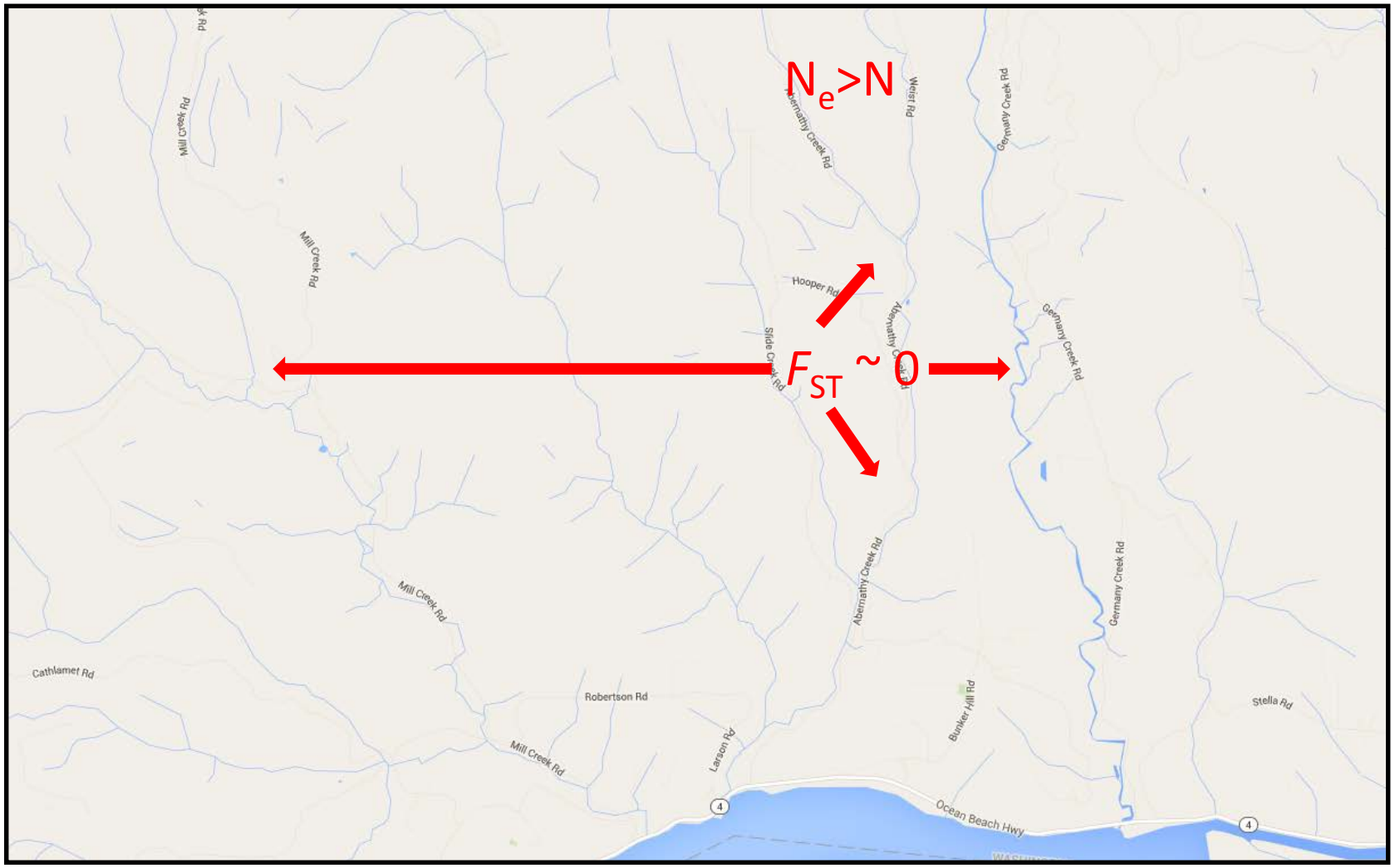
% NOR adult returns matched with parents



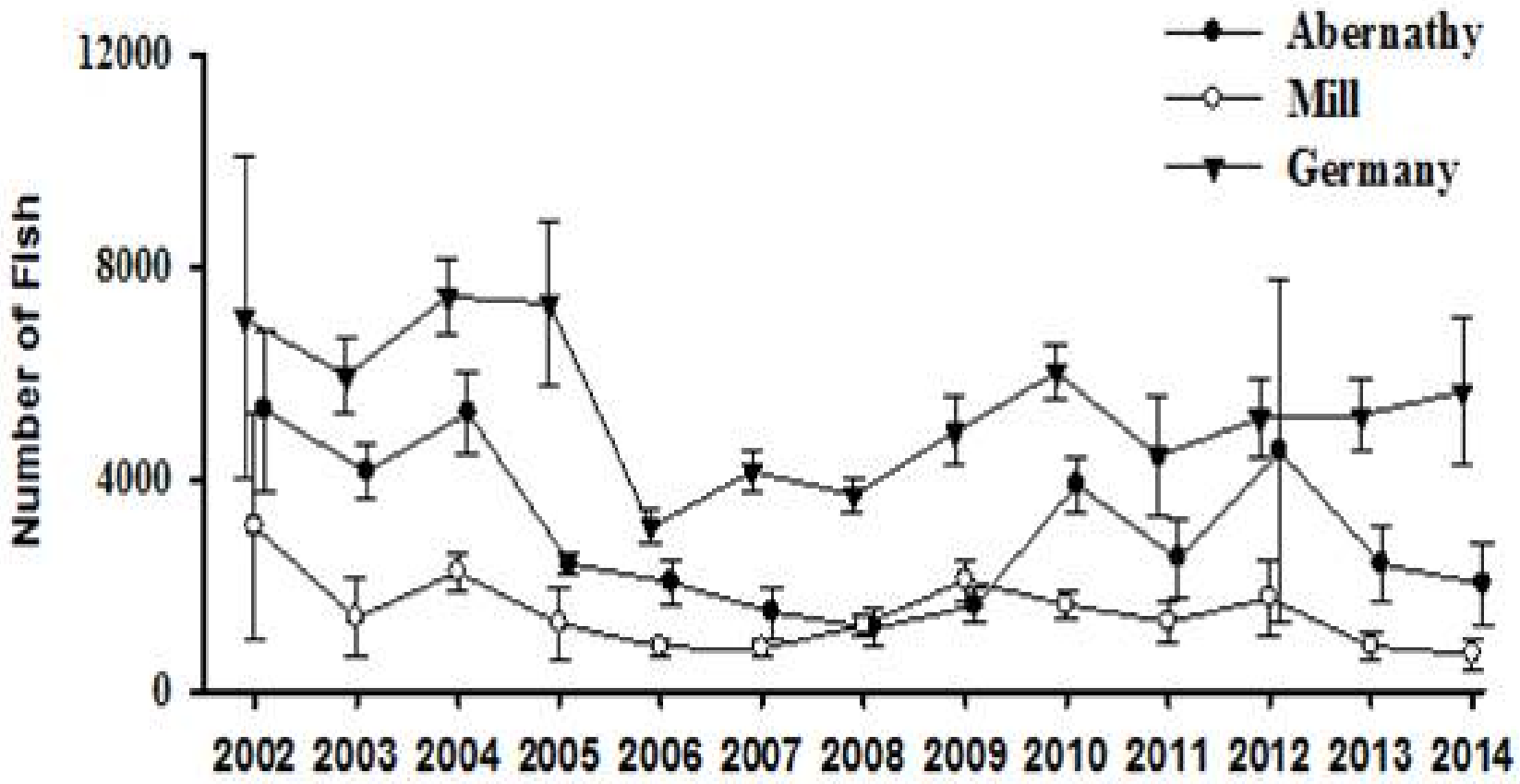
RRS of HOR fish



How reliable are RRS estimates?



Smolt production



Data from M. Zimmerman, WDFW

HOR vs NOR Life history

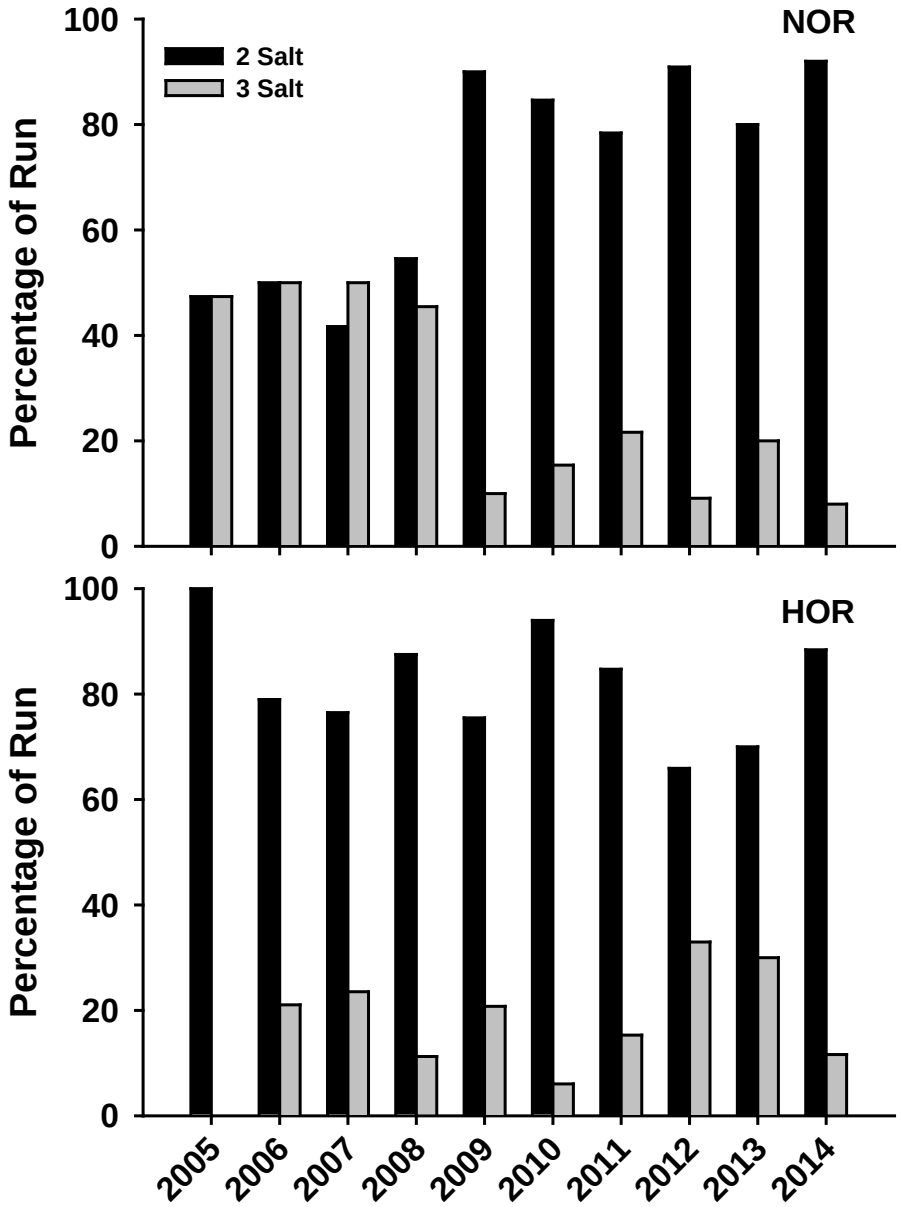
NOR (historical)

- Smolts: emigrate at one (19%), two (65%), and three (16%) years of age.
- Saltwater age for adult females captured 2005-2008, N=49, 51% 2 salt, 49% 3 salt
- Six age classes of returning adult females: 1.2, 2.2, 3.2, 1.3, 2.3, and 3.3

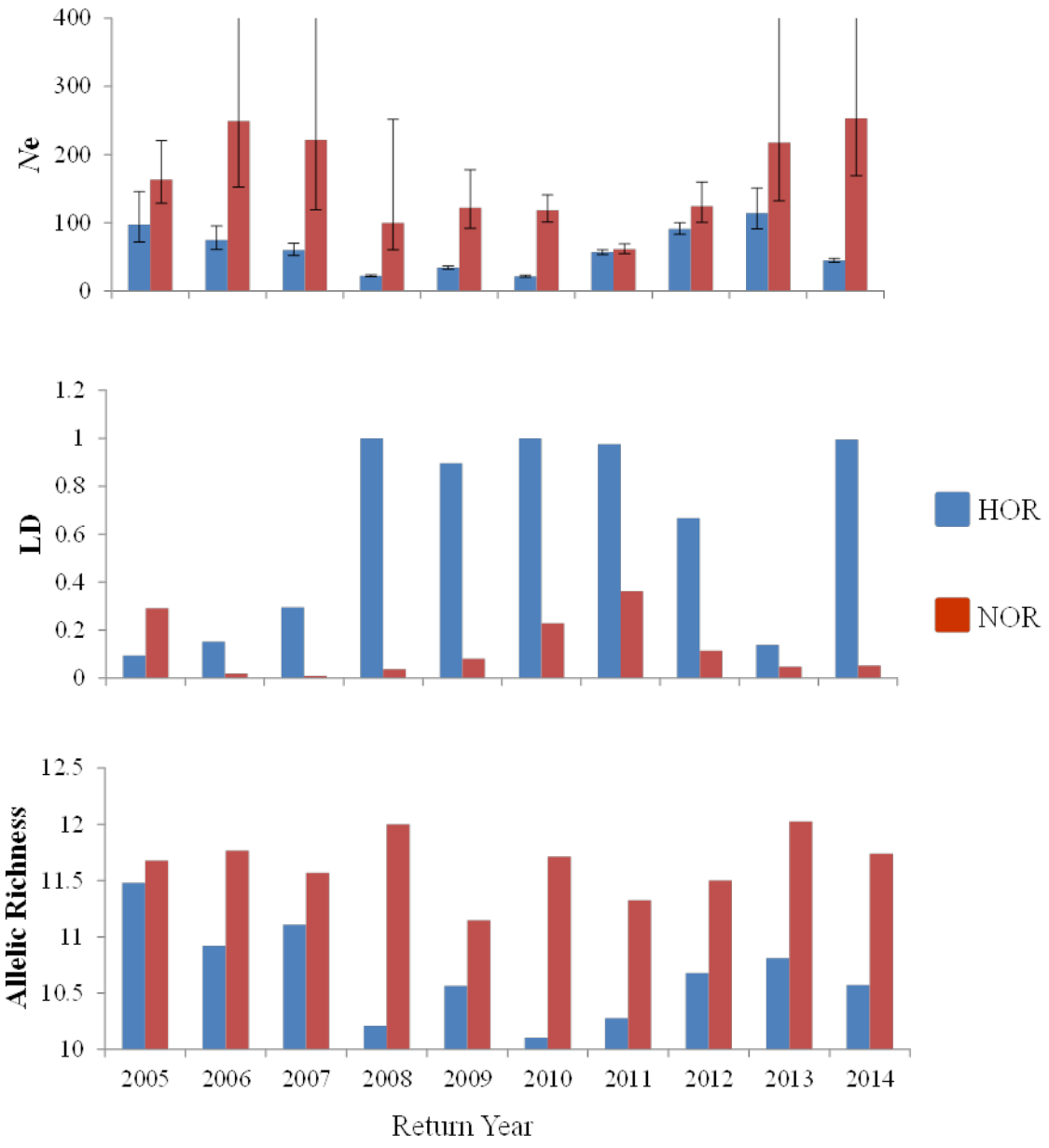
HOR

- Smolts: forced released at one year of age
- Saltwater age for adult females captured 2005-2008, N=126, 86.5% 2 salt, 13.5% 3 salt
- Two age classes of returning adult females: 1.2 and 1.3

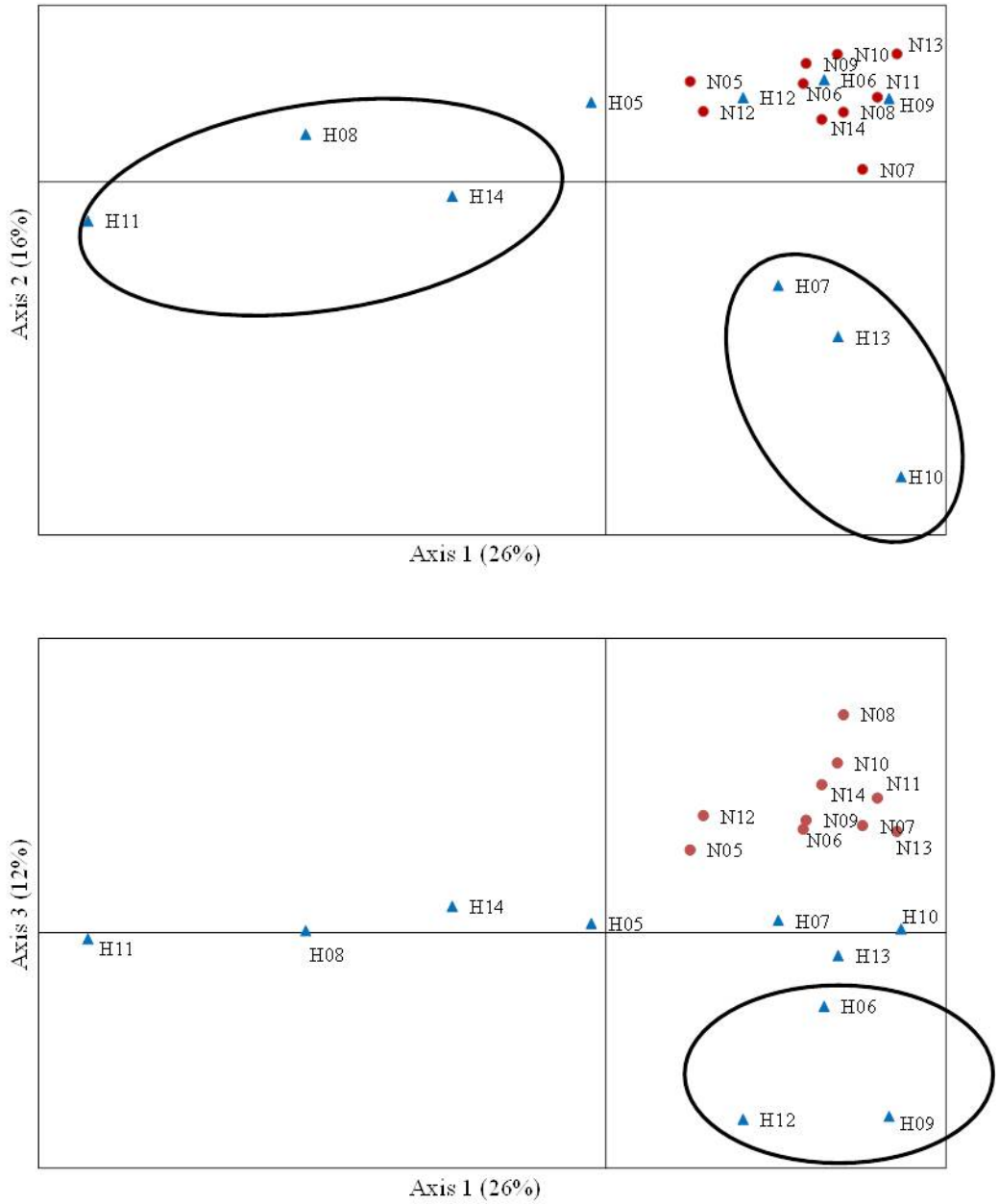
Adult saltwater age



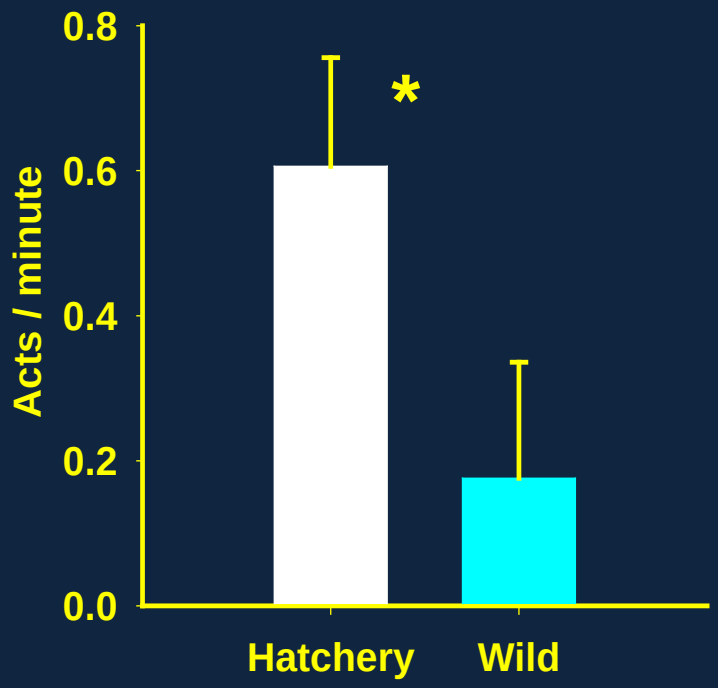
HOR vs NOR genetic diversity

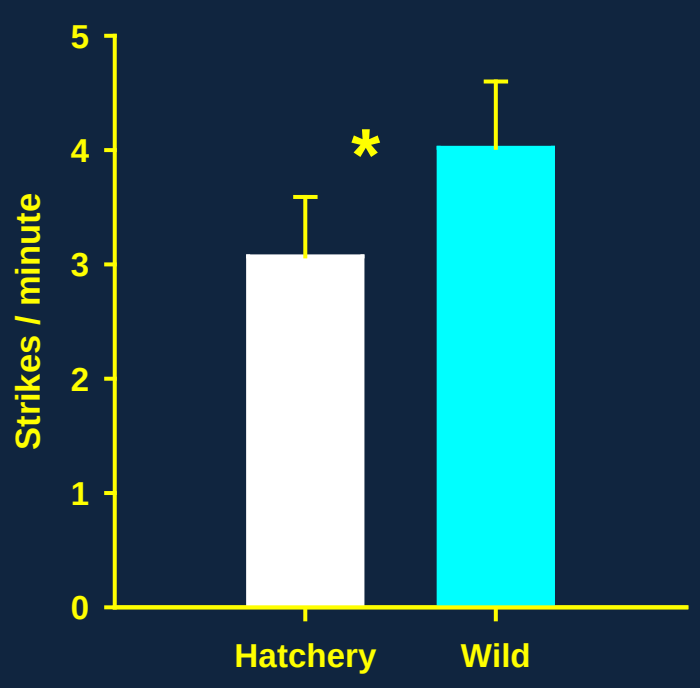


HOR vs NOR genetic diversity

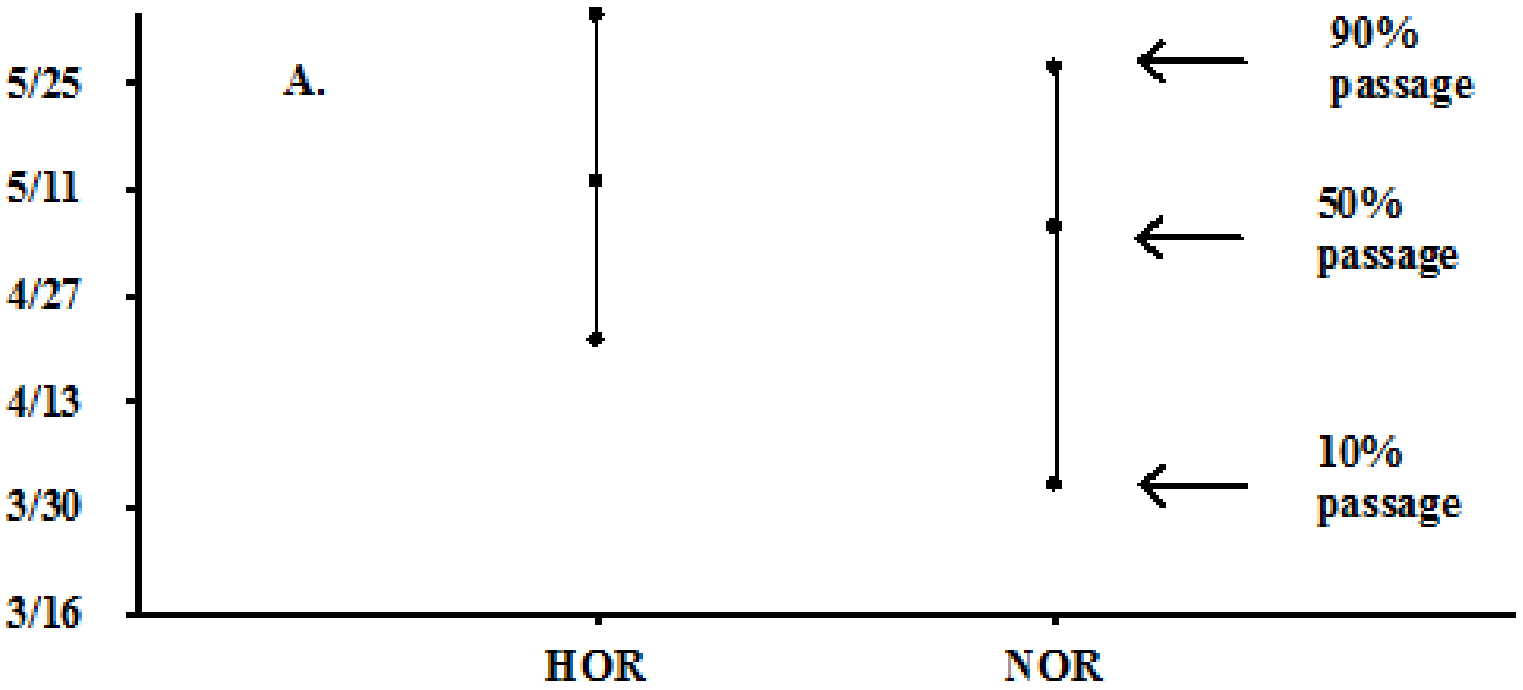


HOR vs NOR juvenile behavior





HOR vs NOR outmigration timing



HOR vs NOR bird predation

Higher risk
Low ATPase
Activity

Lower risk
High ATPase
Activity

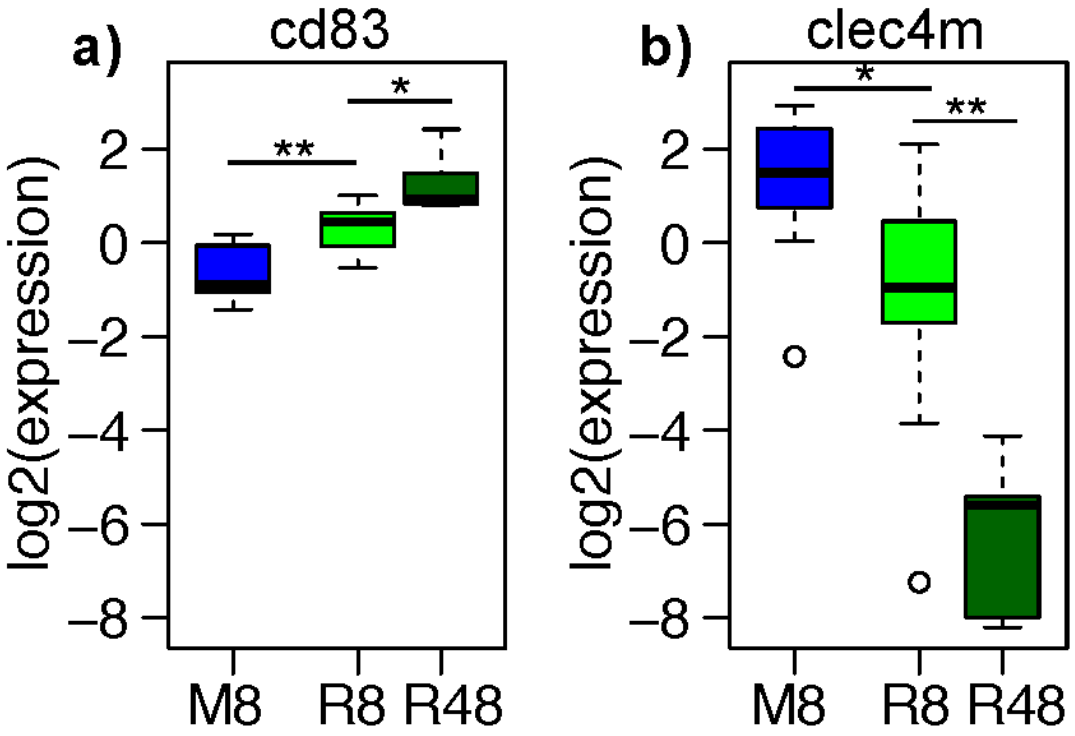
Ocean

River

Kennedy et al. 2007, CJFAS 64:1506-1516

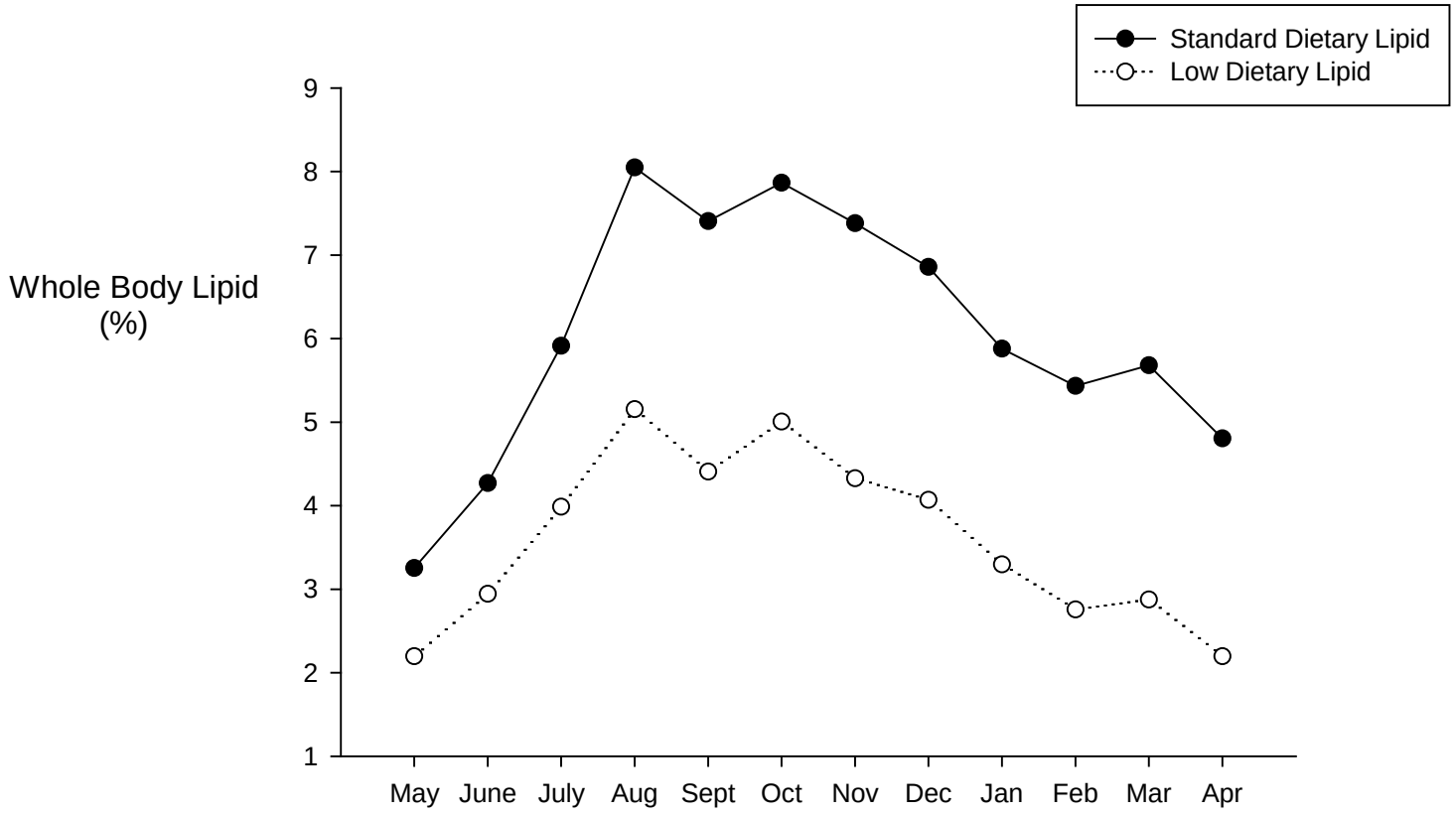
Response to hatchery conditions

1) Compare expression of immune function genes in fish raised in creek water versus well water.



Response to hatchery conditions

2) Compare physiology, behavior and gene expression of fish fed commercial diets to those fed low-lipid diets



Conclusions

- Initial broodstock captured genetic diversity of NOR population
- Evaluation of RRS concordant with other studies but limited by study design issues
- Evaluation of conservation hatchery practices has revealed several patterns
  - HOR smolts differ behaviorally, physiologically, genetically
- Variation in steelhead smolt abundance masks any effect of supplementation

Future directions

- Integrate redd survey data to better compare to control streams
- Short term: Alternative rearing techniques to minimize phenotypic divergence
  - Two-year smolt program
  - Low lipid feeding trial
- Long term: Determine when domestication selection occurs
  - Natural mate selection vs. random spawning

Acknowledgements

USFWS:
D. Campton, W. Ardren, D. Hawkins, K. Ostrand, C. Taylor, K. Hanson, J. Holmes, B. Kennedy, M. Smith, J. Von Bargen, P. Crandell, B. Adams, D. Bingham, P. DeHaan, R. Glenn, K. Hawke, D. Peterson, J. Poole, W. Simpson, K. Steinke, S. Swartout

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WDFW:
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Council questions regarding RRS studies

How does this project inform

(1) the Council's Research Plan

Critical uncertainties 1 and 2 under hatchery focal research theme

(2) the Council's Fish and Wildlife Program objectives?

Theme Two: Ensure Species Survival by Promoting Abundance, Diversity and Adaptability

Questions Regarding RRS studies

Can any results from this study be extrapolated to other geographic locations or other populations?

- Need to understand steelhead population dynamics /structure to effectively design RRS studies
- Desire to keep research programs in non-listed populations (below Cowlitz for SH?)

Questions Regarding RRS studies

How does the Idaho Supplementation Study inform this project?

Questions Regarding RRS studies

Does this project have any of the following elements:

- A scientific question
  - What measures can we follow at a conservation hatchery to minimize domestication impacts?
- A hypothesis
  - Producing fish using alternative methods (e.g. low lipid diet, volitional release, crossing with and without relatedness guidelines) will result in similar responses between HOR and NOR (e.g., residual rates, migration timing, gene expression, return rates…)
- A specific time frame within which to answer the question posed
  - 4 years minimum for low lipid diet evaluation.

Questions Regarding RRS studies

How was it determined which species or geographic area to study?

- Populations not thought to be significantly influenced by hydroelectric facilities
- Population not ESA listed
- 3 streams (control for some aspects)

Questions Regarding RRS studies

How does this effort work or collaborate with other RRS projects on aspects of the study (methodology, data and conclusions)?

Questions Regarding RRS studies

How does density dependence factor in to this study moving forward?

- The impacts of ongoing habitat restoration projects in Abernathy Creek and other watersheds nearby on the current project are difficult to predict.
- The IMW designation given to Mill, Abernathy, and Germany creeks results in a substantial effort by the State of Washington to monitor steelhead populations in these watersheds. By pooling resources with the State in we have established a long-term M&E program for these populations.

Council questions regarding this study

The RRS elements of this project have been unsuccessful. Based on these experiences, what advice to other researchers do the sponsors have when selecting populations or geographic areas to conduct RRS studies?

1. Demographic / population structure surveys
2. Statistical power analysis of system
3. Sampling logistics

Council questions Regarding this study

What valuable information has the project contributed to integrated broodstock programs?

- Juvenile brood to avoid population mining was successful, but spawning immediately resulted in typical artifacts
- Need to establish series of contingencies for prioritizing conservation and production targets
- Challenges associated with small numbers of returning fish over a long period
- Negative ecological interactions between HOR and NOR smolts may occur during spring migration as migration timing, diet, and microhabitat use were similar.
- Insight gained regarding a number of culture practices and resulting impacts on HOR fish

Council questions regarding this study

Which hatchery practices would be the focus of any future research? How long would it take to evaluate hatchery practices?

1. Conservation nutrition
2. Measures which reduce the potential for negative interactions Between HOR and NOR
3. Spawning an rearing protocols to reduce divergence between HOR and NOR

2-4 years to collect info previously funded tasks

Questions?

Historical Changes in Fish Feed

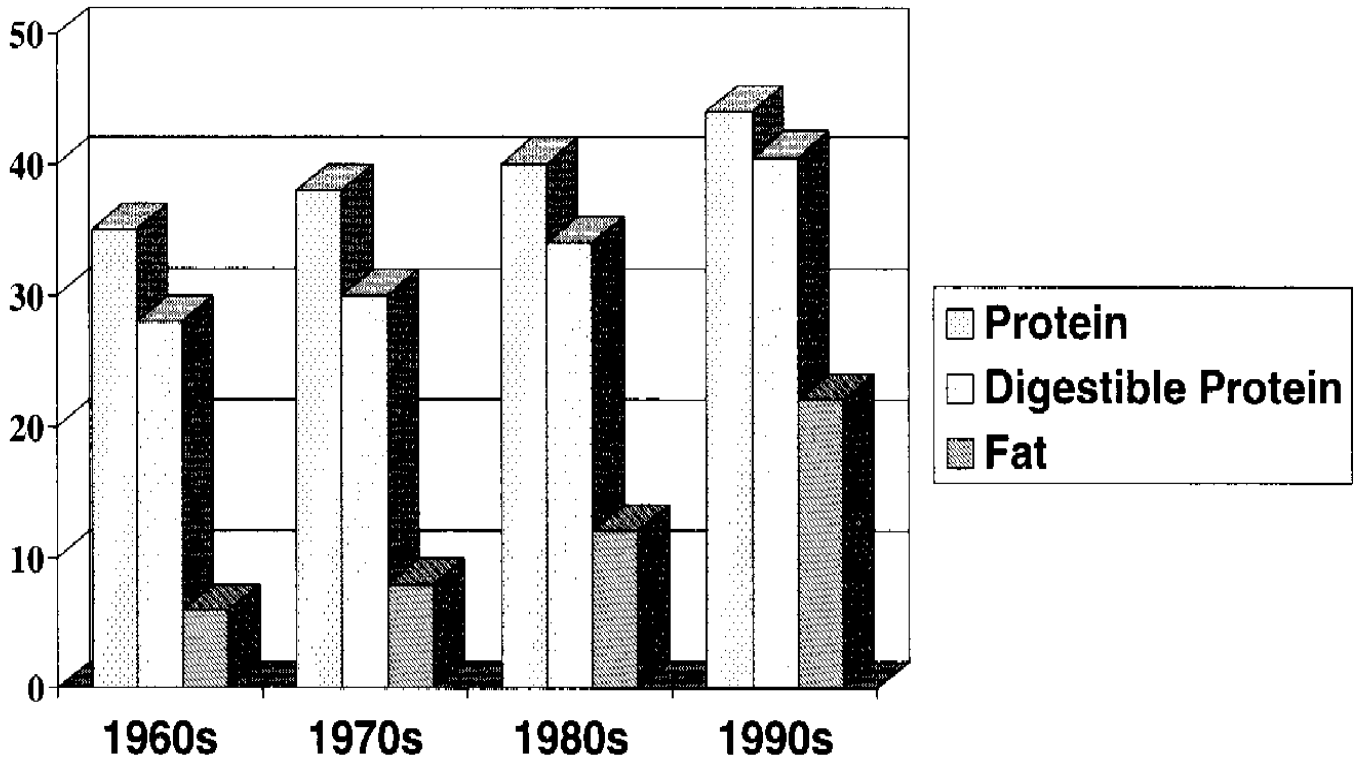

FIGURE 4. Changes in total protein, digestible protein, and lipid levels in trout feeds over the past 40 years.

Body Lipid Concentrations in Hatchery and Wild Fish

Table 4.15

Mean proximate composition and energy content of the whole bodies and fi

Source	Life history stage sex, rearing conditions	Dry matter (%)	Protein	Lipid (% of dry matte	Carb
Whole body					
O. mykiss					
	C	–	69.6	18.6	
	1 year (w)	–	67.9	24.0	
	1 year (c)				