Challenges Associated with Age-2 Steelhead Smolt Rearing at Winthrop National Fish Hatchery, in the Methow River Subbasin, WA

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BACKGROUND & STUDY SITE

Winthrop National Fish Hatchery (WNFH)

- Produces ESA-listed summer steelhead

1990s: ESA listing of Upper Columbia River (UCR) steelhead

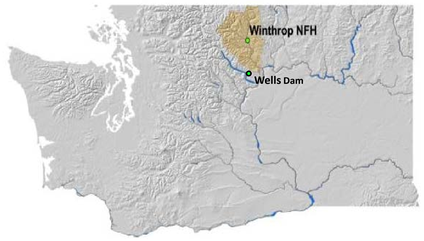
- Growing body of scientific literature supported notion that hatchery reform was necessary for recovery of wild stocks

2000s: Hatchery Reform & Federal Columbia River Power System (FCRPS) Biol. Opinion

- Directed many programs to implement hatchery reform measures

FCRPS BiOp specifically directed WNFH to:

- Transition from use of Wells Dam composite stock to a locally collected, high pNOB (% natural-origin brood) Methow River stock steelhead program.
- Limit pHOS (% hatchery-origin spawners) in nature.
- Late tributary arrival and spawn timing, coupled with WNFH's cold water supply, necessitated a 2-year (S2) smolt rearing program to raise migration-ready smolts.



2008 - Present : REFORM IMPLEMENTATION

Major program modification:

Transition to local, high pNOB broodstock

Key components of local broodstock transition process

- Natural brood collected in upper Methow Sub-basin, primarily via angling
- Challenging collection - interagency effort (WDFW, Doulas PUD, & Yakama Nation)
- ***Transition required shift from yearling (S1) smolt program to 2-year (S2) program***
- Transitional period; success achieved in last few years (see Table below)
- Juvenile and adult evaluations occurred during transition period

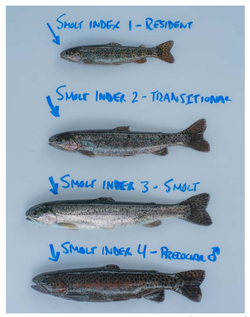
Winthrop NFH steelhead smolt release summary during yearling (S1) > 2-year smolt (S2) transitional period (2008 through 2014)

Broodyear	Release Year	Rearing Strategy	Smolts by Strategy	Release Year Total	% via Local Brood	pNOB
2007	2008	S1	116,897	116,897	0	0.000
2008	2009	S1	102,418	102,418	0	0.500
2008	2010	S2	29,170	100,378	29%	0.000
2009		S1	71,208			0.000
2009	2011	S2	43,205	107,141	40%	0.325
2010		S1	63,936			0.500
2010	2012	S2	59,352	117,210	51%	0.500
2011		S1	57,858			0.500
2011	2013	S2	57,894	111,721	52%	0.146
2012		S1	53,827			0.500
2012	2014	S2	90,599	140,398	65%	0.219
2013		S1	49,799			0.500
2013	2015	S2	76,078	95,995	78%	0.153
2014		S1	19,917			0.000
2014	2016	S2	128,585	128,585	100%	0.894
2015	2017	S2	220,032	220,032	100%	0.638 – 0.663[2]
[1]2016	2018	S2	200,000	200,000	100%	0.782 – 0.810[2]
[1]2017	2019	S2	200,000	200,000	100%	0.806 – 0.812[2]

[1]Approximate numbers for juveniles currently on-station

Pre-release sampling at WNFH

Maturing gonads in male steelhead parr



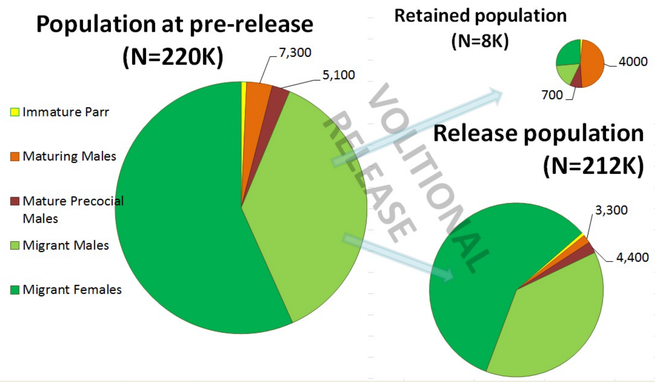
Steelhead smolt stages (indices)

Intensive Juvenile Monitoring Phase During S1 to S2 Transition Period

- Transitional phase from brood years 2008-2014 allowed for multi-year, paired comparisons
- Monitoring during transition initially focused on juvenile performance (adult studies are ongoing)

Juvenile Monitoring Showed:

- Difficult at WNFH to grow S1 smolts to consistent migration-ready size (later spawn time & cold water)
- S1 rearing has less time to make up margin for error in growth/program
- S2 rearing allows hatchery manager time to more consistently grow migration-ready size smolts
- S2 smolts migrated faster and exhibited comparable , if not slightly better, outmigration survival, though this was largely explained by size (fork length). Interestingly, S1 smolts displayed better survival at size.
- S1 & S2 groups produce similar proportions of non-migrants (NM) but through different mechanisms:
  - S1 NM are typically immature parr that fail to reach smoltification size threshold
  - S2 NM are typically sexually mature precocial male parr
- The release of precocial parr presents potential genetic and ecological impacts to mitigate



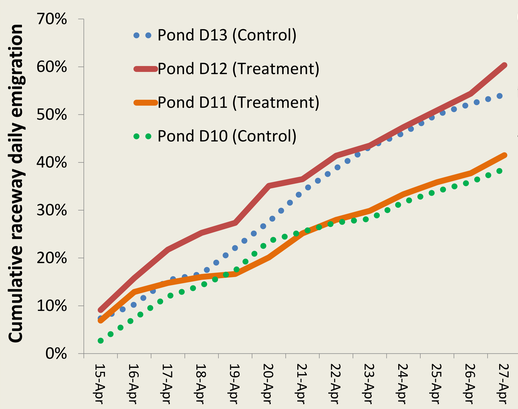
Volitional Release Tool:

- Less effective at retaining precocial male parr than for immature parr, more common in S1 rearing.
- ***BUT,*** preliminary data suggest tool is effective at reducing actively maturing male parr (for next-year spawning). These are visually/externally indistinguishable from migrants (orange in chart)

RECENT & ONGOING INVESTIGATOINS – Focus on Residualism

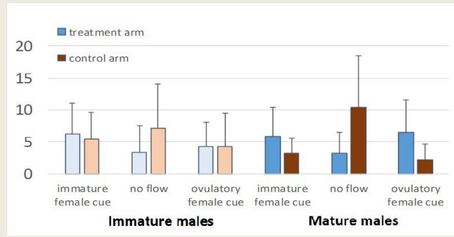
HAREM (Hen-Affected-Residualism, Emigration, & Management)

Objective and hypothesis: Retention and management of precocious male parr steelhead in a volitional release could be affected through use of sexually-mature steelhead females in raceways as visual or pheromonal attractants.

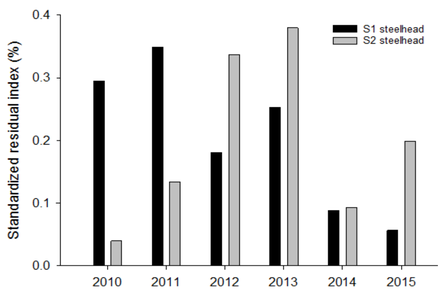


Ovulated females were placed into two replicate raceways (treatment) with two replicate raceways that lacked hens (control). 300 PIT-tagged precocial male parr were placed into each raceway and emigration rates were compared. The method did not prove a useful tool for production-scale operations at WNFH as no clear pattern of emigration/retention was observed.

Y-Maze Behavioral Experiments



Sister study to HAREM. Objective and hypothesis: Introduction of different pheromonal cues in a Y-maze environment can elicit differential behavior that may be exploited in the future to differentially manage immature, maturing, and mature, non-migrant steelhead parr. Preliminary results from a 2018 pilot project suggest that there may be some opportunity.



PIT-based analyses

Left: Standardized CPUE for residualized *O. mykiss* resulting from S1 and S2 releases at WNFH (Tatara et al., *in press*).

Continued PIT-based analyses aim at monitoring residualism rates, explaining physiological mechanisms, determining (relative) abundance and distribution, estimating over-winter survival (low) and out-year seaward migrations (minimal), and developing tools effective in mitigating ecological and gene flow concerns associated with non-migrants.

The Methow Subbasin is one of the most "wired" watersheds in the Columbia Basin, but PIT-based assessments remain difficult!

Precocial parr courting female steelhead on redd.

Future Directions:

- Experimentation/feasibility analysis of mixed broodyear rearing strategies to reduce risk of interbreeding and mitigate N_e in small related programs.
- Expansion and development of PIT-based abundance/survival analyses
- Continued focus on development of tools to differentially retain non-migrants
- Future efforts could include:
  - Altered release timing using real-time population structure
  - Pheromone-based removal /trapping of precocial males
  - Manual sorting to remove non-migrants
  - Alterative feeding and rearing regimes

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