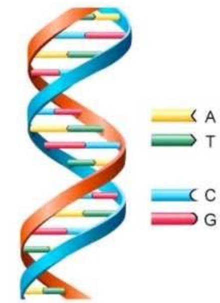
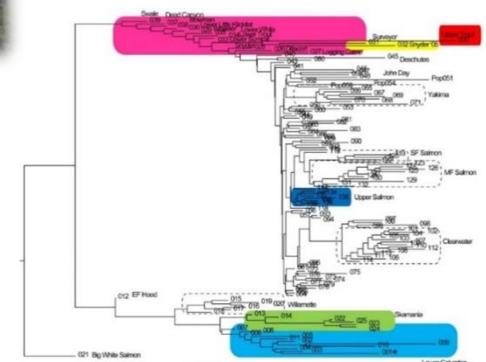
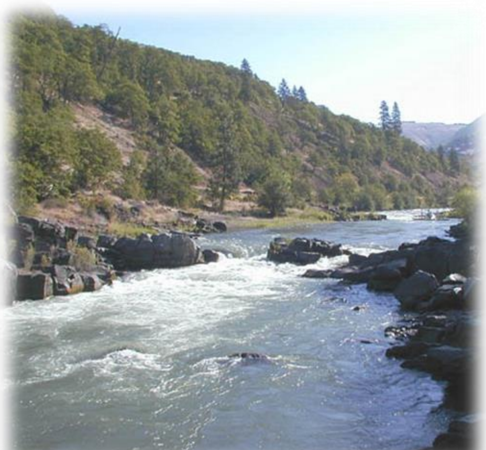
Hatchery, wild, or out-of-town visitor?

Evaluating steelhead spawning interactions in the Klickitat River — Updated results from genetic and radio telemetry monitoring

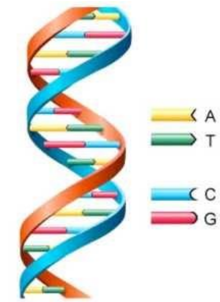


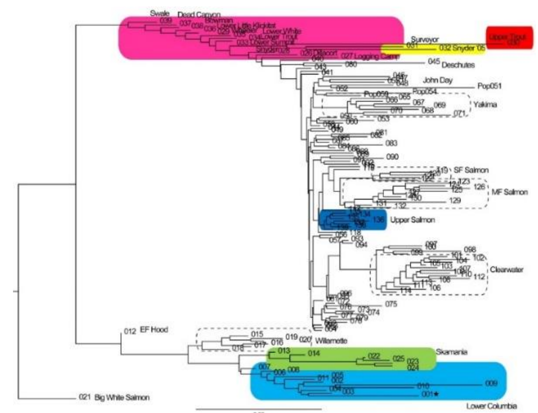




Joe Zendt
Fisheries Biologist
Yakama Nation Fisheries Program

Acknowledgements





Scott Spino
John Washines
Bennie Martinez
Nicolas Romero
Shawn Bechtol

Shane Keep
Brady Allen
Leroy Sutton
Carrie Munz

Toby Kock
Adam Pope
Russ Perry

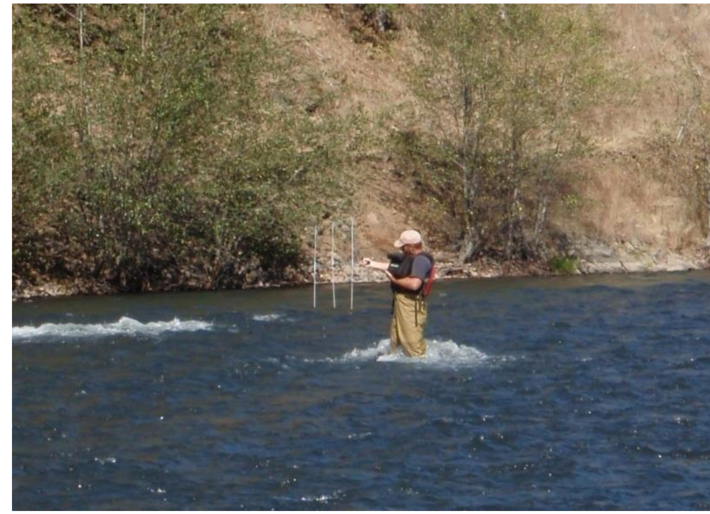
Erin Collins
Jon Hess
Shawn Narum

Background & General Outline

- ESA-listed native steelhead population in Klickitat
- Radio Telemetry study 2009-2014
- Genetic Analysis of 2012-2021 samples
- Common Objectives:
  - Patterns in Hatchery and Wild Spawner interactions
  - Spawning and Behavior of various Genetic groups (Out-of-subbasin strays, etc.)
  - Spawning Patterns in Summer- and Winter-run steelhead (aka Early- and Late-run)

Radio Telemetry Study 2009-2014

- Tagged at Lyle Falls adult trap at Rkm 3.8 (RM 2.4)
- Mobile and fixed-site detections
- Detection data reviewed to determine natural spawners vs. other fates
  - Spawn locations and start/end dates



Received: 11 February 2023 | Revised: 14 July 2023 | Accepted: 1 August 2023

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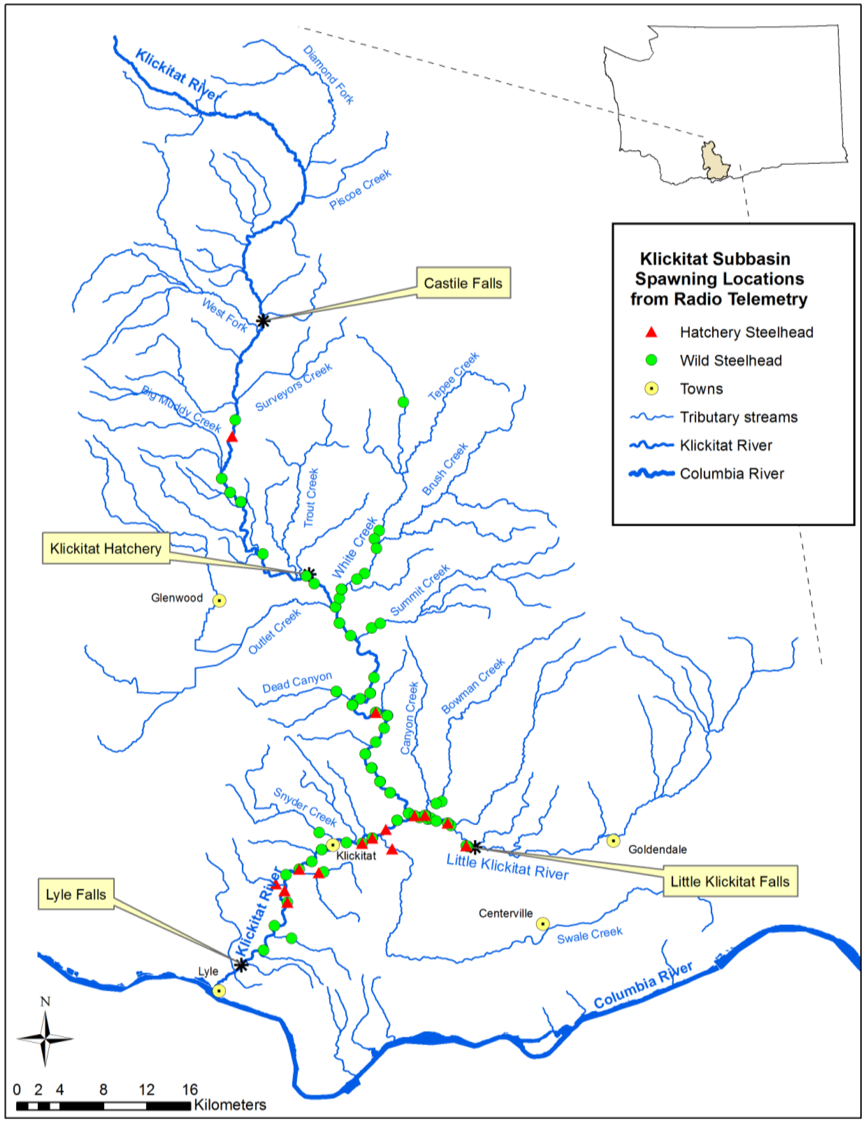
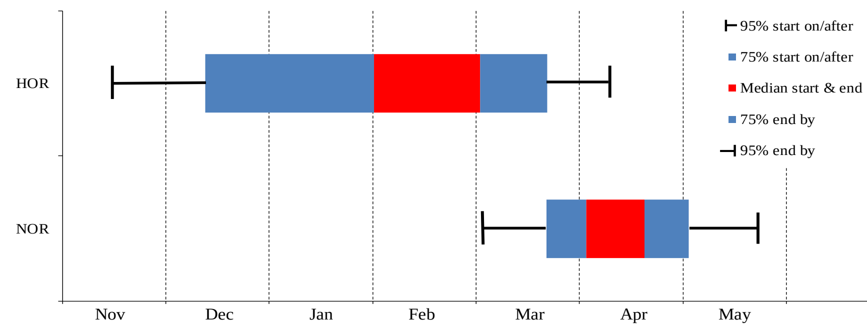
ARTICLE

Spatial and temporal overlap between hatchery- and natural-origin steelhead and Chinook Salmon during spawning in the Klickitat River, Washington, USA

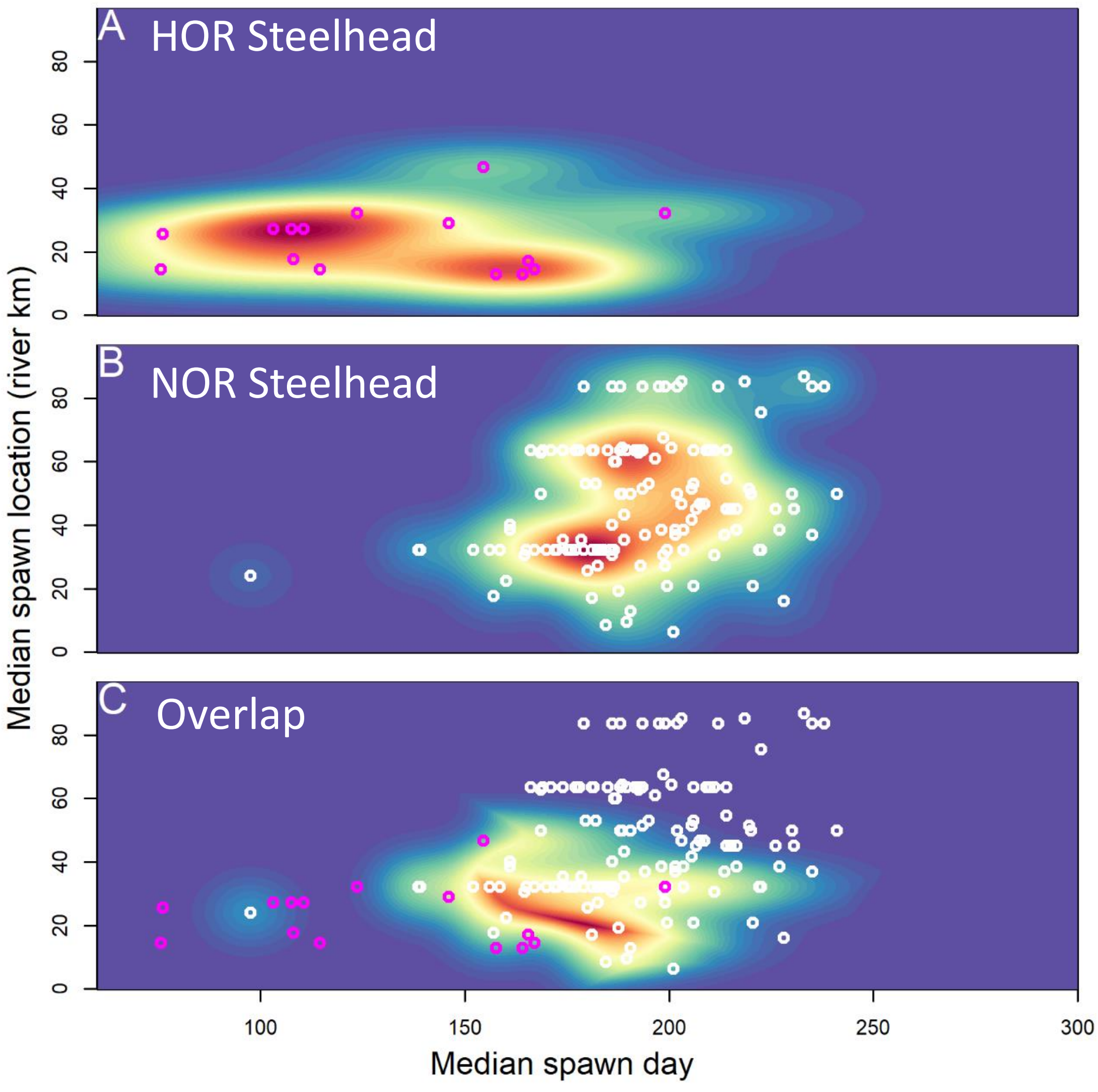
Joseph S. Zendt[1] | M. Brady Allen[2] | Tobias J. Kock[3] | Russell W. Perry[3] | Adam C. Pope[3]



Steelhead Spawn Timing and Locations



75% of Wild Steelhead started spawning after 75% of Hatchery steelhead had completed spawning.



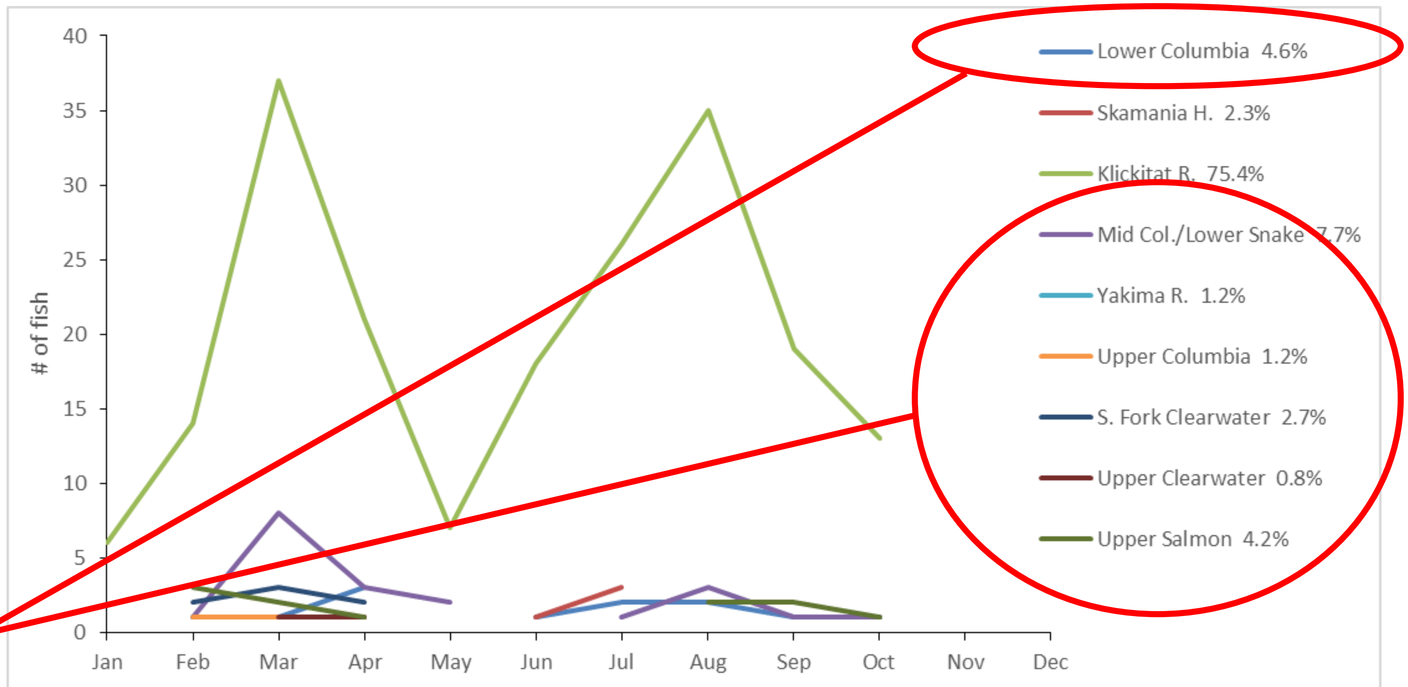
Overlap = 25.4%
(95% CI = 22.5–27.9%)

Observed pHOS = 12%

More accurate pHOS =
12% * 25% = 3% ??

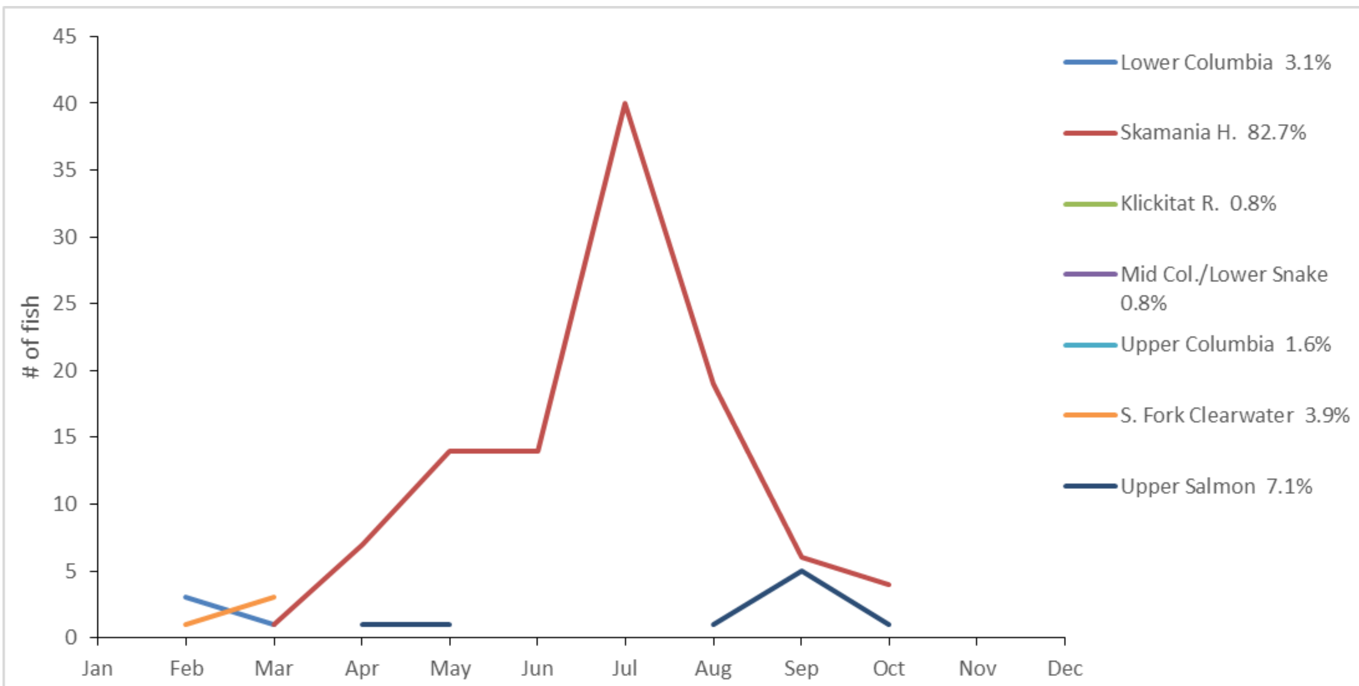
Radio Tagging and Genetic Stock Identification

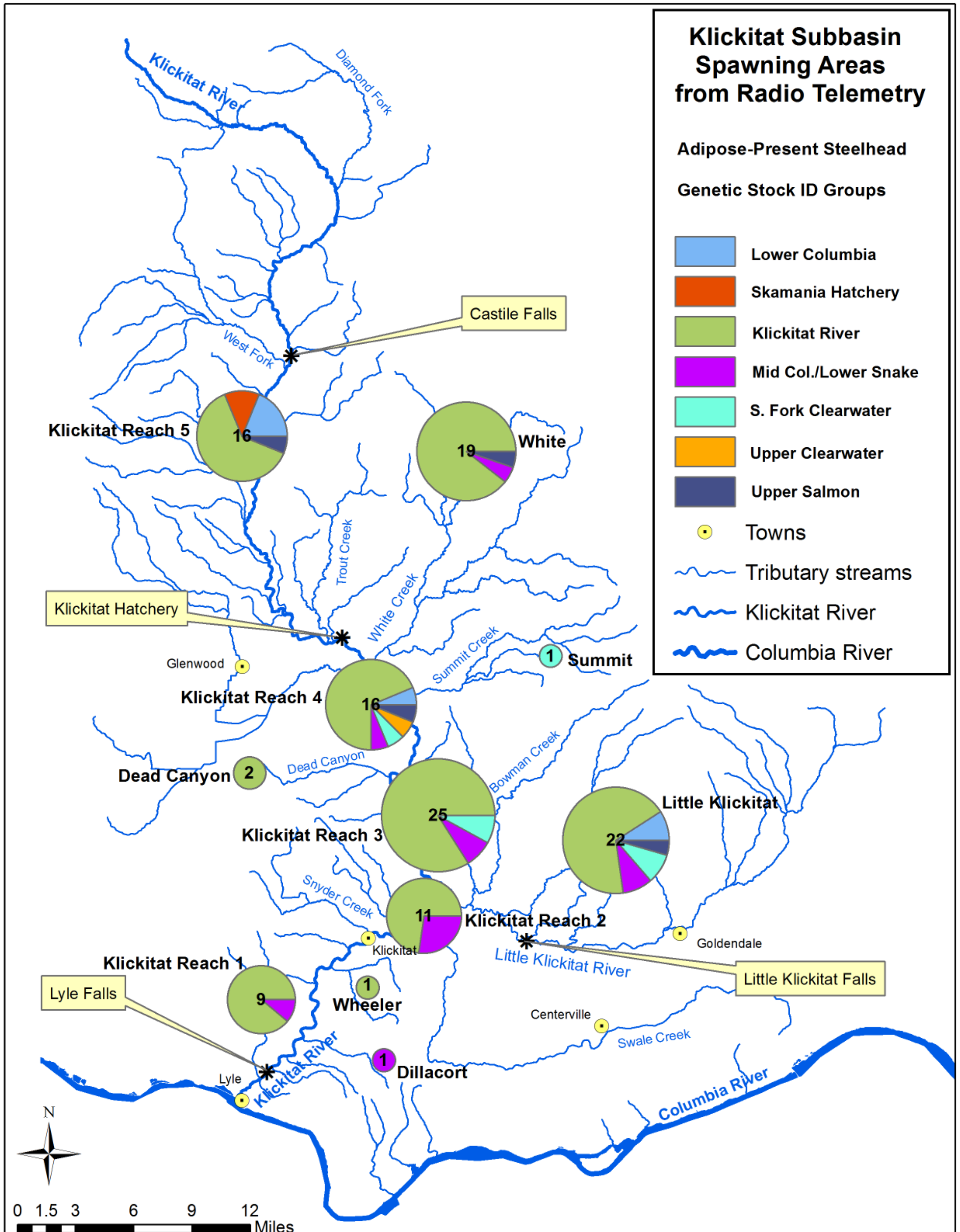
Adipose-present steelhead
(N = 260)



Out-of-Klickitat stocks also comprised 23% of natural spawners

Adipose-clipped steelhead
(N = 127)

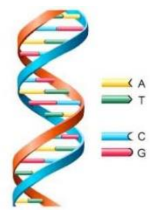


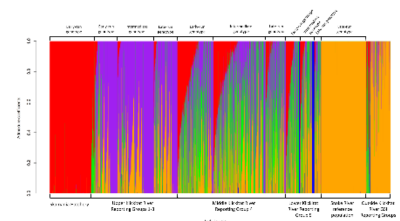

Klickitat Subbasin
Spawning Areas
from Radio Telemetry
Adipose-Present Steelhead
Genetic Stock ID Groups
Lower Columbia
Skamania Hatchery
Klickitat River
Mid Col./Lower Snake
S. Fork Clearwater
Upper Clearwater
Upper Salmon
Towns
Tributary streams
Klickitat River
Columbia River
Klickitat River
Diamond Fork
Castile Falls
West Fork
Klickitat Reach 5
16
19
White
Trout Creek
White Creek
Klickitat Hatchery
Summit Creek
1
Summit
Glenwood
Klickitat Reach 4
16
Dead Canyon
2
Dead Canyon
Bowman Creek
25
Klickitat Reach 3
Little Klickitat
22
Snyder Creek
11
Klickitat Reach 2
Klickitat
Goldendale
Little Klickitat River
Little Klickitat Falls
Klickitat Reach 1
1
Wheeler
Lyle Falls
9
Centerville
Swale Creek
1
Dillacort
Lyle
Klickitat River
Columbia River
N
0 1.5 3 6 9 12
Miles

Genetic Analysis 2012-2021

- Adults sampled at Lyle Falls adult trap at Rkm 3.8 (RM 2.4)
- Juveniles sampled at smolt trap Rkm 4.6 (RM 2.8) and tributary streams

- GSI…PBT…





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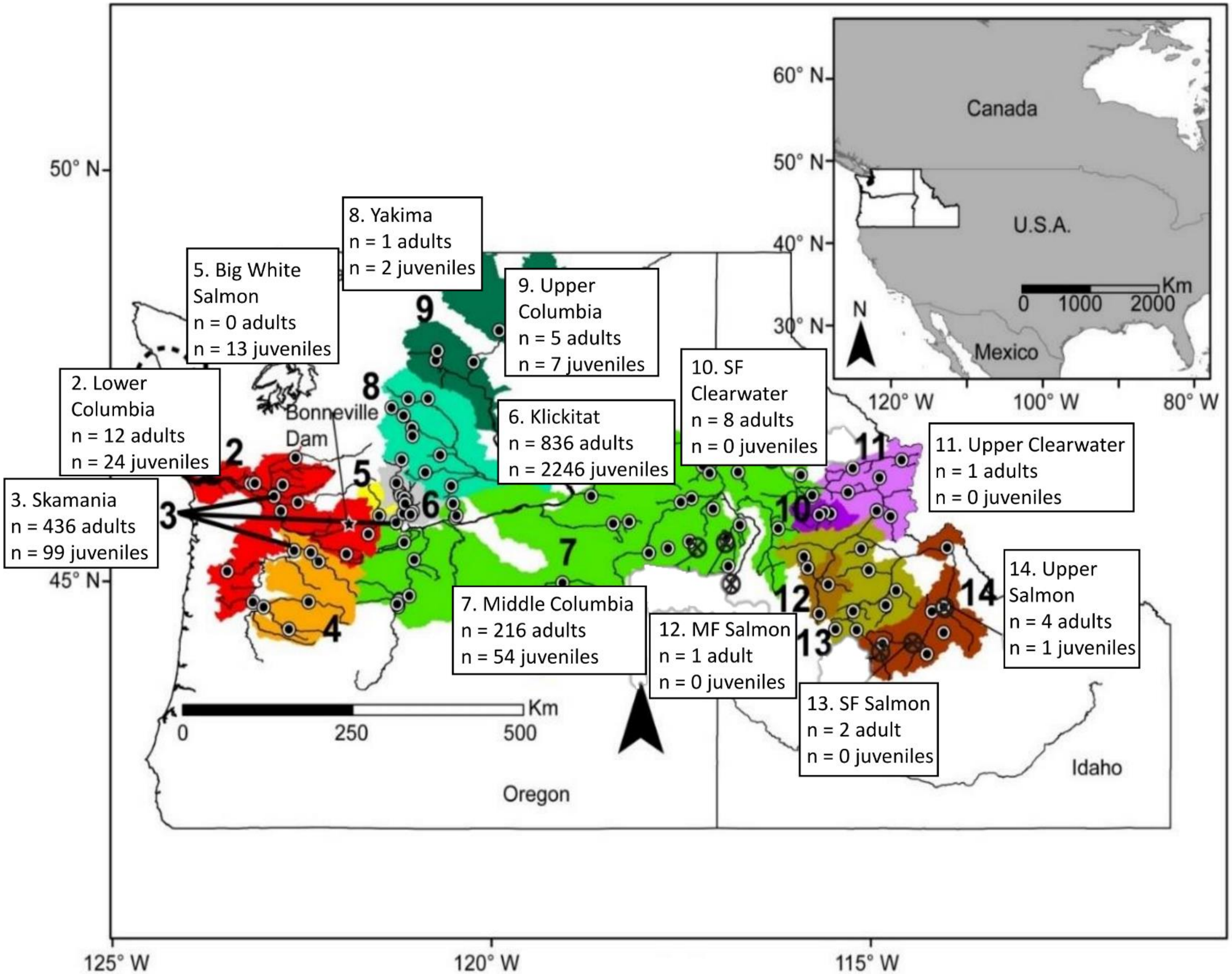
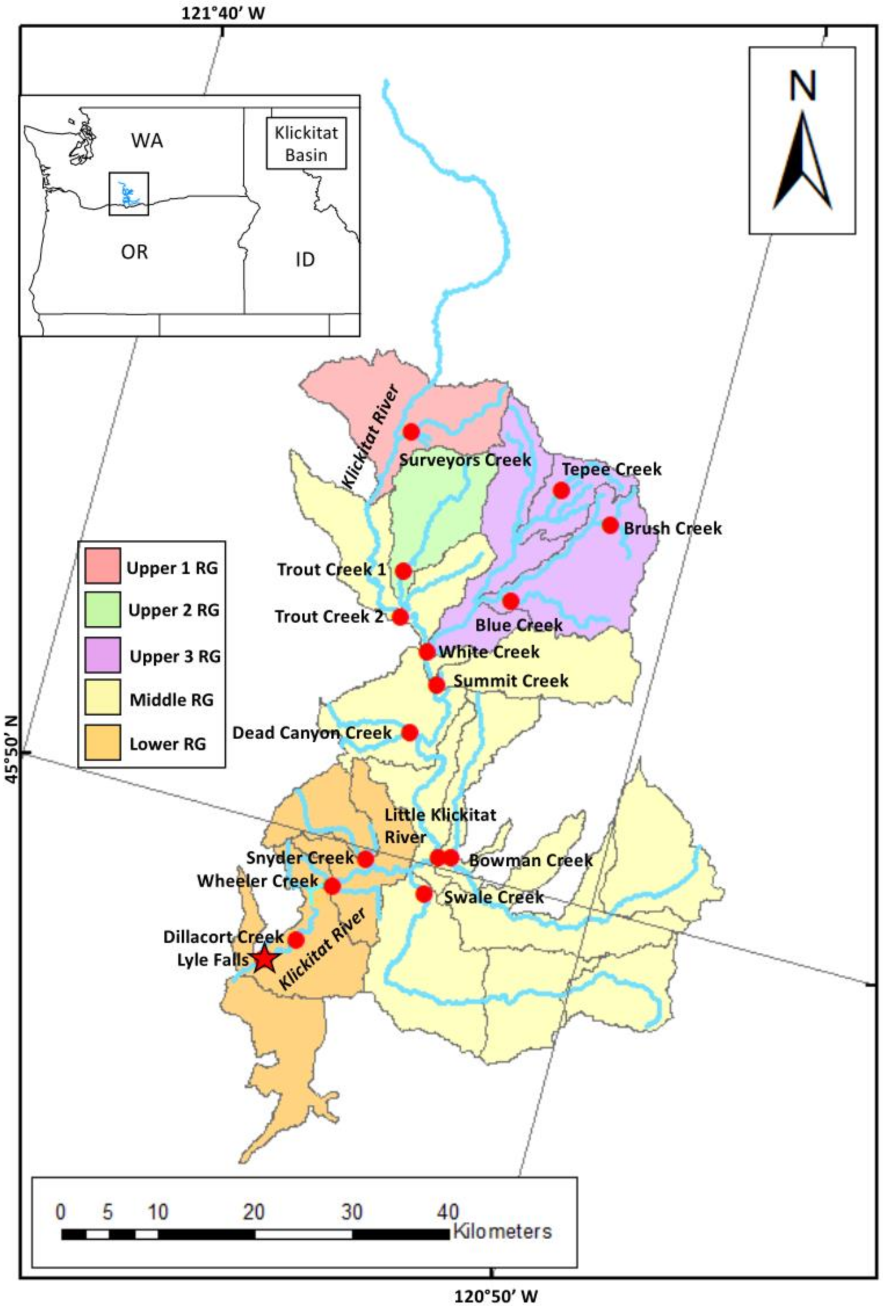
ARTICLE

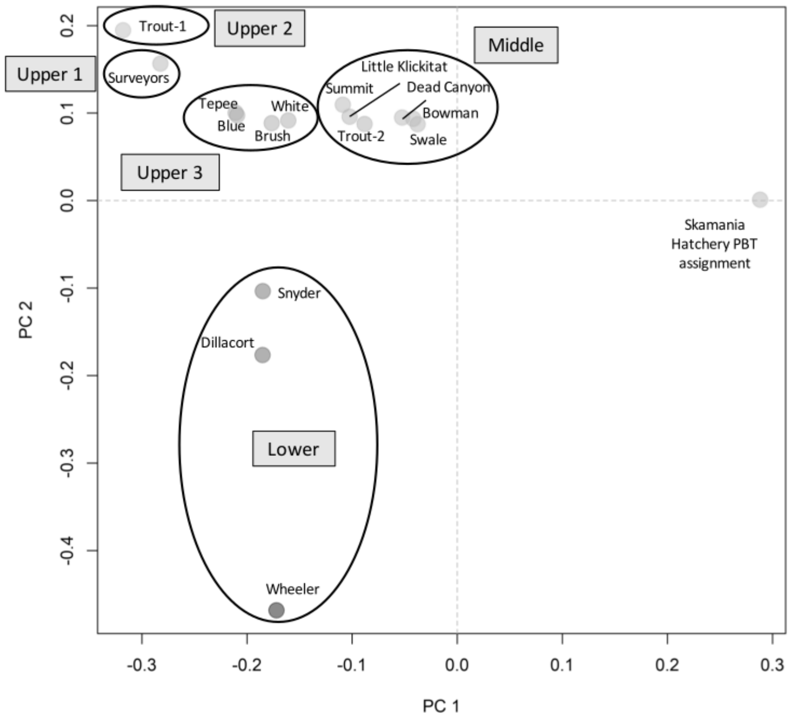
Genetic monitoring of steelhead in the Klickitat River to estimate productivity, straying, and migration timing

Erin E. Collins[1] | Jon E. Hess[2] | Shawn Bechtol[3] | Nicolas Romero[3] | Shawn R. Narum[4] | Joseph S. Zendt[3]

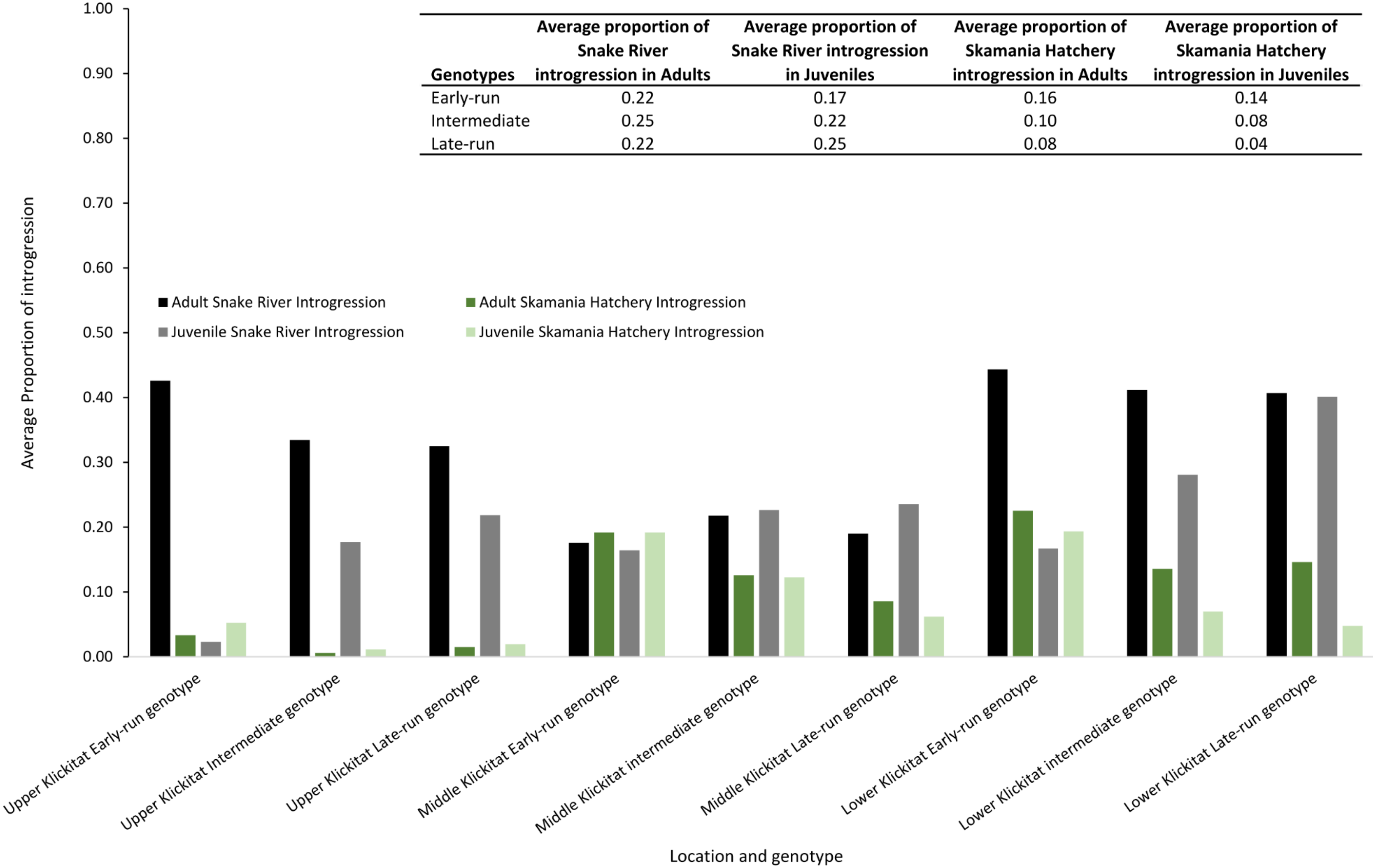


Genetic stock identification (GSI) assignments across the Columbia River basin for adult and juvenile steelhead collected from 2012 through 2021.



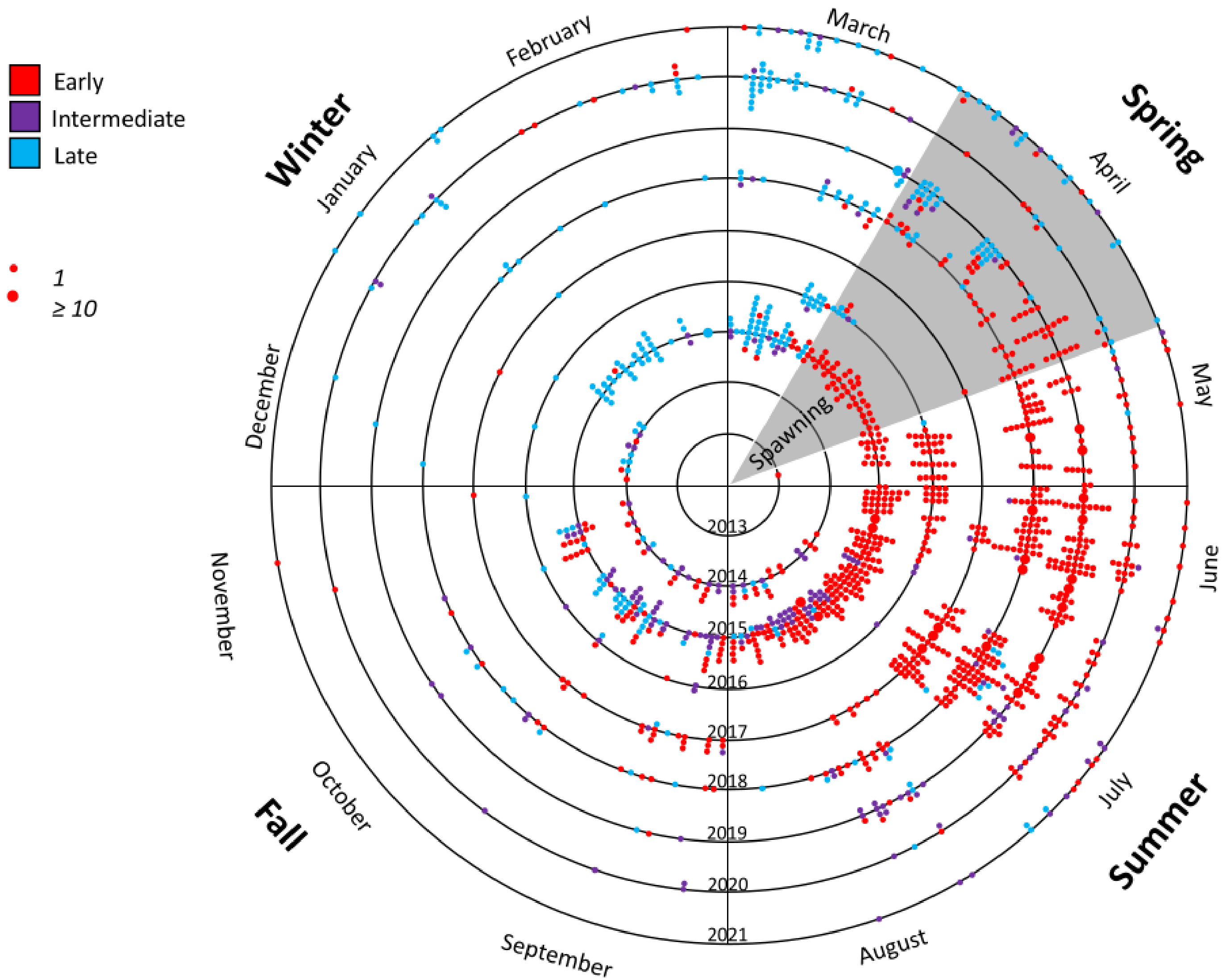


Principle component analysis (PCA) of collections of O. mykiss from tributaries throughout the Klickitat River sub-basin. Skamania Hatchery steelhead are included as a reference for the primary hatchery stock released in this system.



Genotypes	Average proportion of Snake River introgression in Adults	Average proportion of Snake River introgression in Juveniles	Average proportion of Skamania Hatchery introgression in Adults	Average proportion of Skamania Hatchery introgression in Juveniles
Early-run	0.22	0.17	0.16	0.14
Intermediate	0.25	0.22	0.10	0.08
Late-run	0.22	0.25	0.08	0.04

Average proportions of Skamania introgression determined from admixture analysis results. Each group is identified by region of the Klickitat River and by run-timing genotype. The table at the top right contains averages of all individuals within each run-timing genotype.



Seasonal migration timing for individual adult steelhead captured at the Lyle Falls trap in the lower Klickitat River between 2013 and 2021. Black rings of the circle represent steelhead migrations for each sample year. The approximate spawning season in upstream tributaries is shown in the gray shaded piece of spring, but migration timing of steelhead is shown as observed earlier at the trap located downstream at Lyle Falls. Each point is positioned according to the date each adult steelhead returned to the Klickitat River, with colors to indicate the genotype (homozygous early, heterozygous/intermediate, and homozygous late). Size of each dot reflects the number of samples for a given date.

Conclusions

- Klickitat natural-origin steelhead display strong distinction from Skamania Hatchery fish and high genetic diversity
  - Different geographic areas within the Klickitat subbasin
  - Run timing (summer, winter, and intermediate genotypes)
- Adult steelhead from sources outside the Klickitat enter the Klickitat River regularly (some likely for thermal refuge), with >20% of both hatchery- and natural-origin steelhead sampled at Lyle Falls being from outside stocks (most of them from Snake River populations)
- Out-of-subbasin fish appear to contribute as much or more in terms of genetic introgression with native Klickitat fish (especially in the lower Klickitat subbasin) than Skamania Hatchery fish do

Genetic monitoring of steelhead in the Klickitat River to estimate productivity, straying, and migration timing

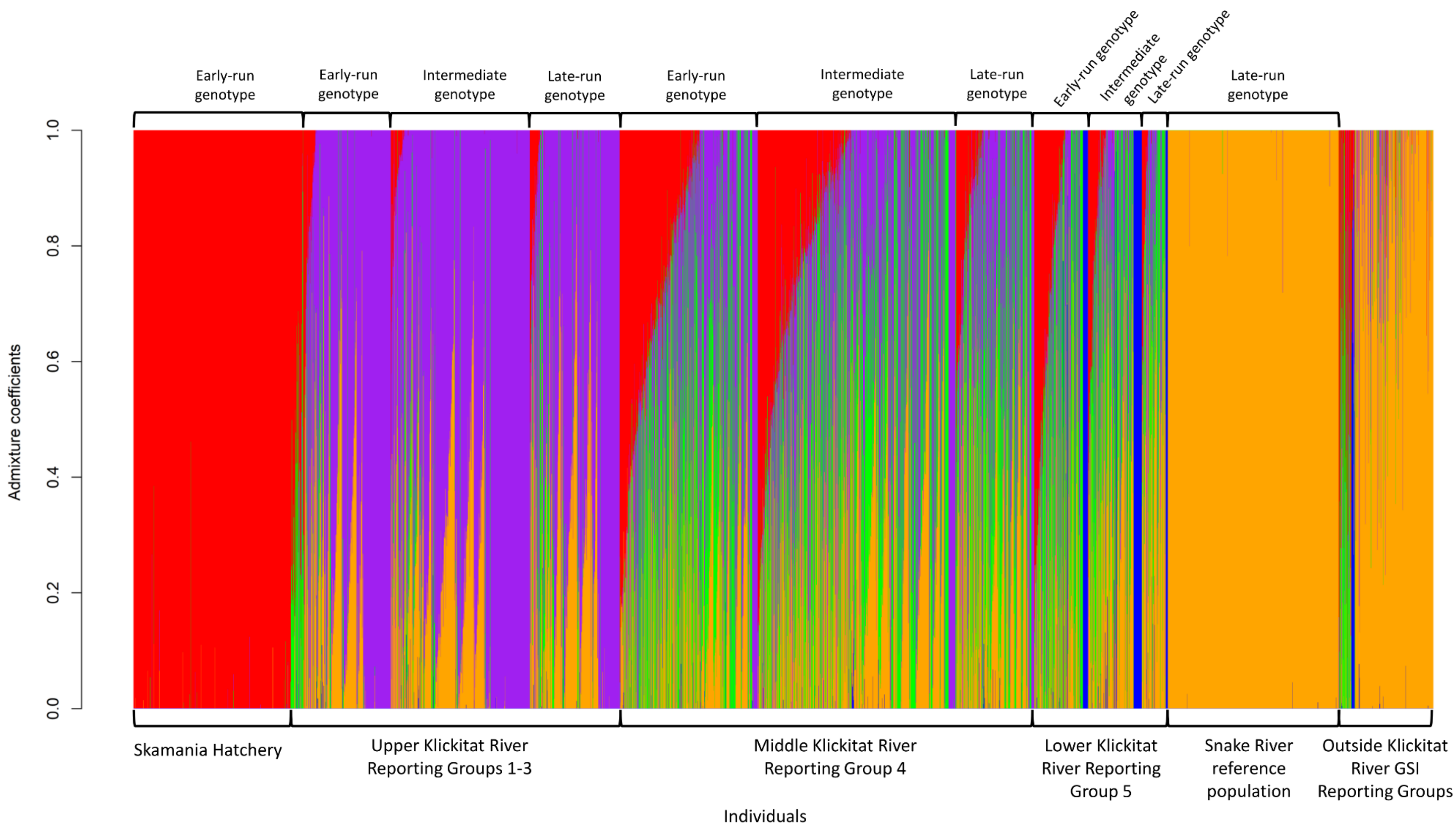
https://doi.org/10.1002/nafm.10921

Spatial and temporal overlap between hatchery- and natural-origin steelhead and spring Chinook Salmon during spawning in the Klickitat River

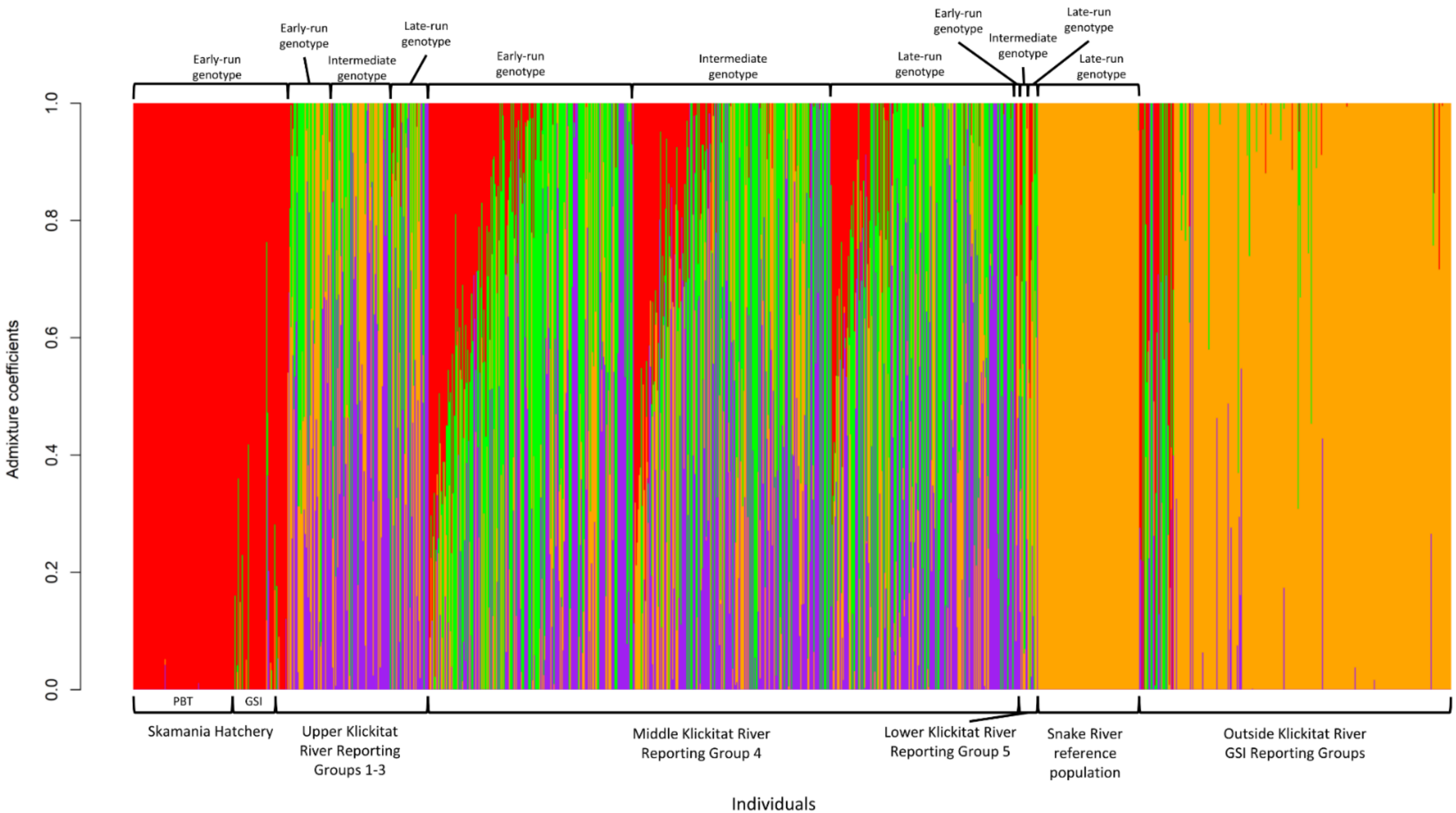
https://doi.org/10.1002/nafm.10945

Yakama Nation Fisheries

Supplementary Slides



Admixture plots of natural-origin **juvenile** steelhead mixture samples from the Klickitat River with individuals sorted by geographic location (bottom) and migration ecotype (top). Admixture results for neutral markers (ΔK=5) with individuals assigned to various fine-scale GSI reporting groups (Skamania Hatchery-red, Upper Klickitat-purple, Middle Klickitat-green, Lower Klickitat-blue, and a Snake River reference population-orange.



Admixture plot (ΔK=4) of adipose-present putatively natural-origin **adult** steelhead mixture samples from the Klickitat River and assigned to various fine-scale GSI reporting groups based on neutral markers (Skamania Hatchery-red, Upper Klickitat-purple, Middle Klickitat-green, Lower Klickitat-blue, and a Snake River reference population-orange. For individuals within each reporting group, they are sorted by run-timing genotypes representing early, intermediate, and late migration as labeled at the top. Individuals assigned outside of the Klickitat River with GSI methods were also included in the analysis. The individuals that assigned to the Lower Columbia, Willamette, and Upper Columbia reporting groups were green and red. The individuals that assigned to the Middle Columbia, Yakima, SF Clearwater, Upper Clearwater, SF Salmon, MF Salmon, and Upper Salmon were orange.