

Utility of Parentage Based Tagging for Research, Monitoring, and Evaluation of Hatchery Programs within the Columbia River Basin



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Introduction

- Salmon and steelhead hatchery programs in the Columbia River Basin (CRB) play a critical role in supporting healthy population abundances and mitigating the effects of hydrosystems.
- Parentage-based Tagging (PBT) is a modern genetic tool that has several advantages over conventional tagging methods (e.g., coded wire tags, physical marks, and Passive Integrated Transponders).

- Nearly 100% Tag Rates.
- No Tag Shedding.
- Non-lethal tag recovery from any life stage.

Objectives

- Test whether the following stock metrics for SY2023 Chinook Salmon (Ots) and steelhead (Omy) collections had matching observed vs. expected values:
 - Percent (%) PBT assignment rate
 - Age/Stock composition
 - Bonneville Dam adult abundance compared to hatchery juvenile releases.

Methods

- Data via Genotyping-in-Thousands by sequencing (Campbell et al. 2015)
- Identified duplicate genotypes, failed samples (missing > 10% of the genetic markers), and PBT and GSI assignments to calculate tag rates (Horn et al. 2023)
- Genetic Stock Identification (GSI) is used to identify individuals that were not assigned by PBT.
- “Expected % PBT rate” = weighted average tag rate of all broodstocks that assigned to each spawn year (SY). “Observed % PBT rate” = proportion of collection assigned by PBT.
- Number of observed GSI assignments of SY2023 collections that matched expected stock group = “% correct” GSI stock.
- Juvenile releases from each hatchery (Fish Passage Center) were regressed against estimates of adult abundance at Bonneville Dam (BON).



Broodstock assigned to hatchery parents

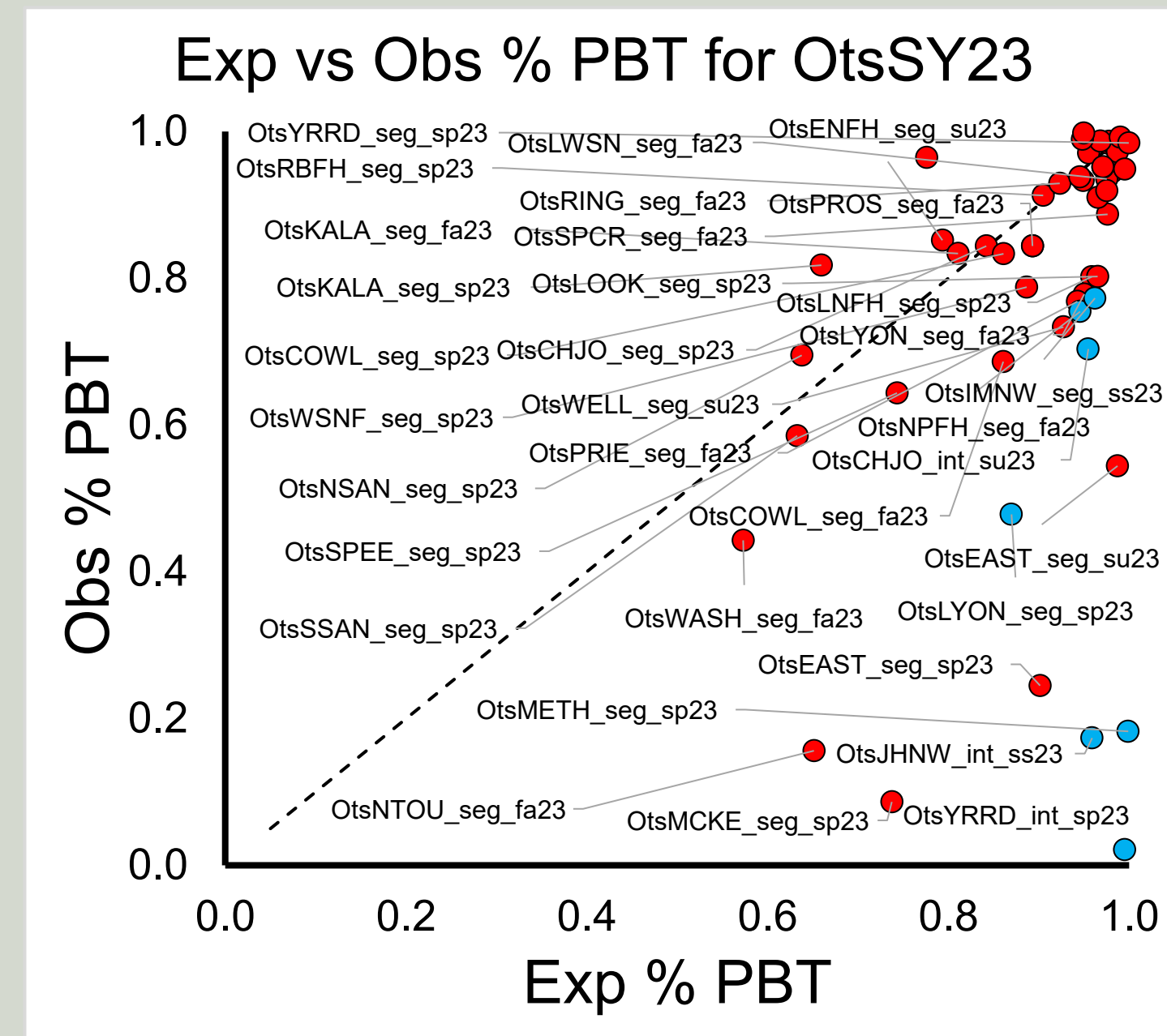


Fig. 2. Exp vs. Obs % PBT for OtsSY23

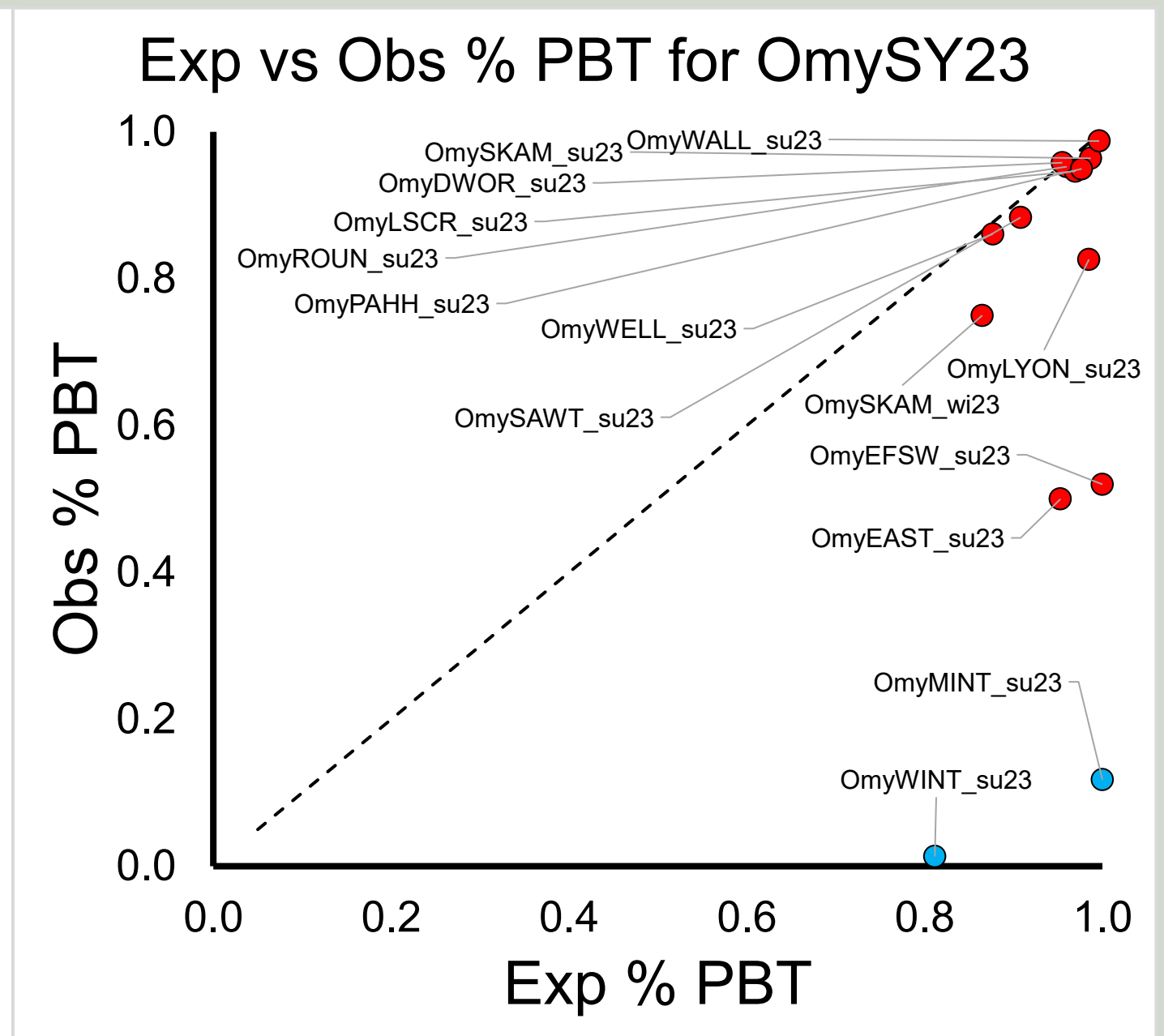


Fig. 3. Exp vs. Obs % PBT for OmySY23

Note: Integrated broodstocks (blue) and all other broodstocks are mostly segregated (red). The 1:1 line of expected vs. observed % PBT rates is shown for reference (dashed line) below which are collections with observed tag rates lower than expected.

Age/Stock Composition

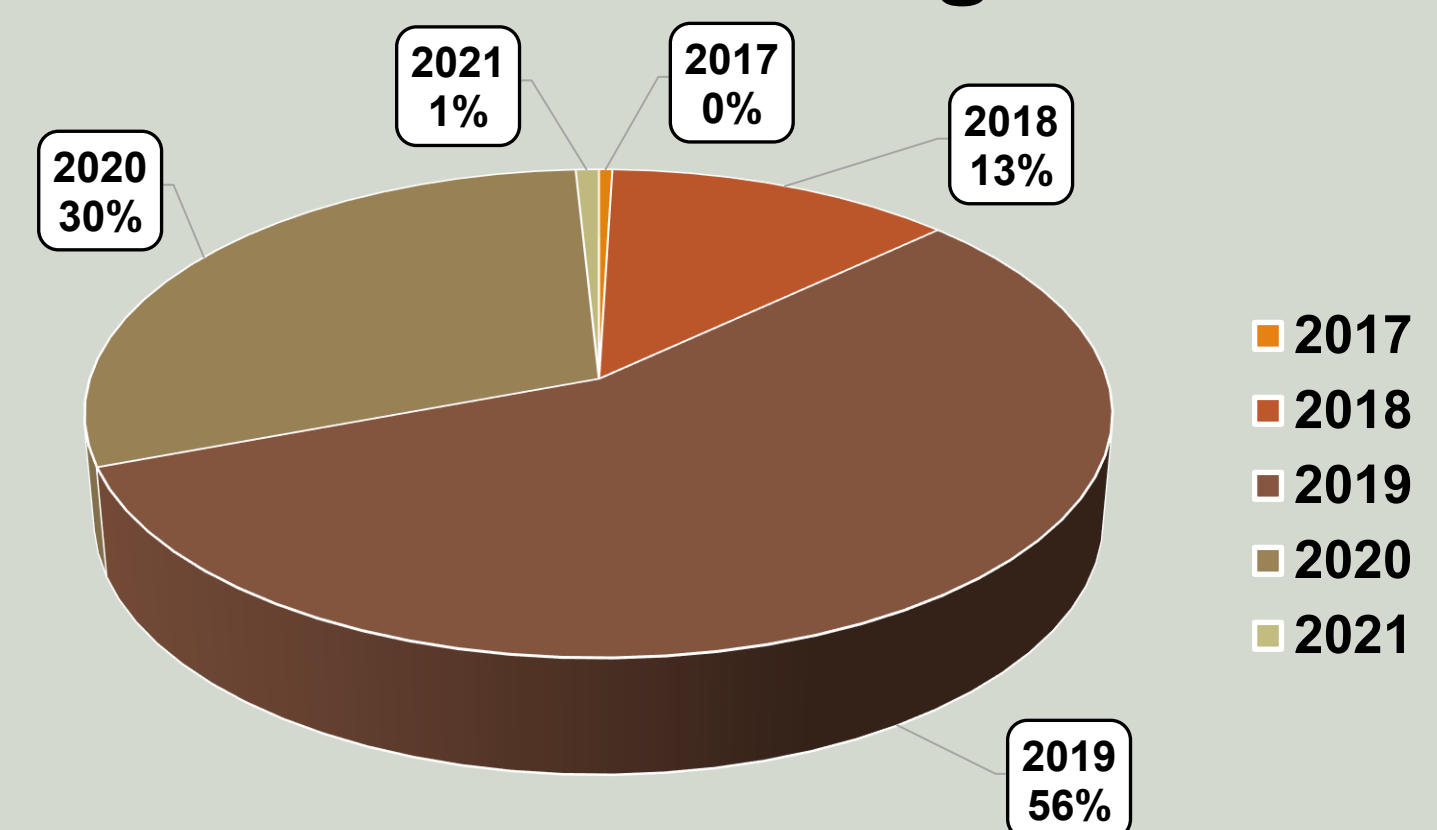


Fig. 4. Age Composition OtsSY2023

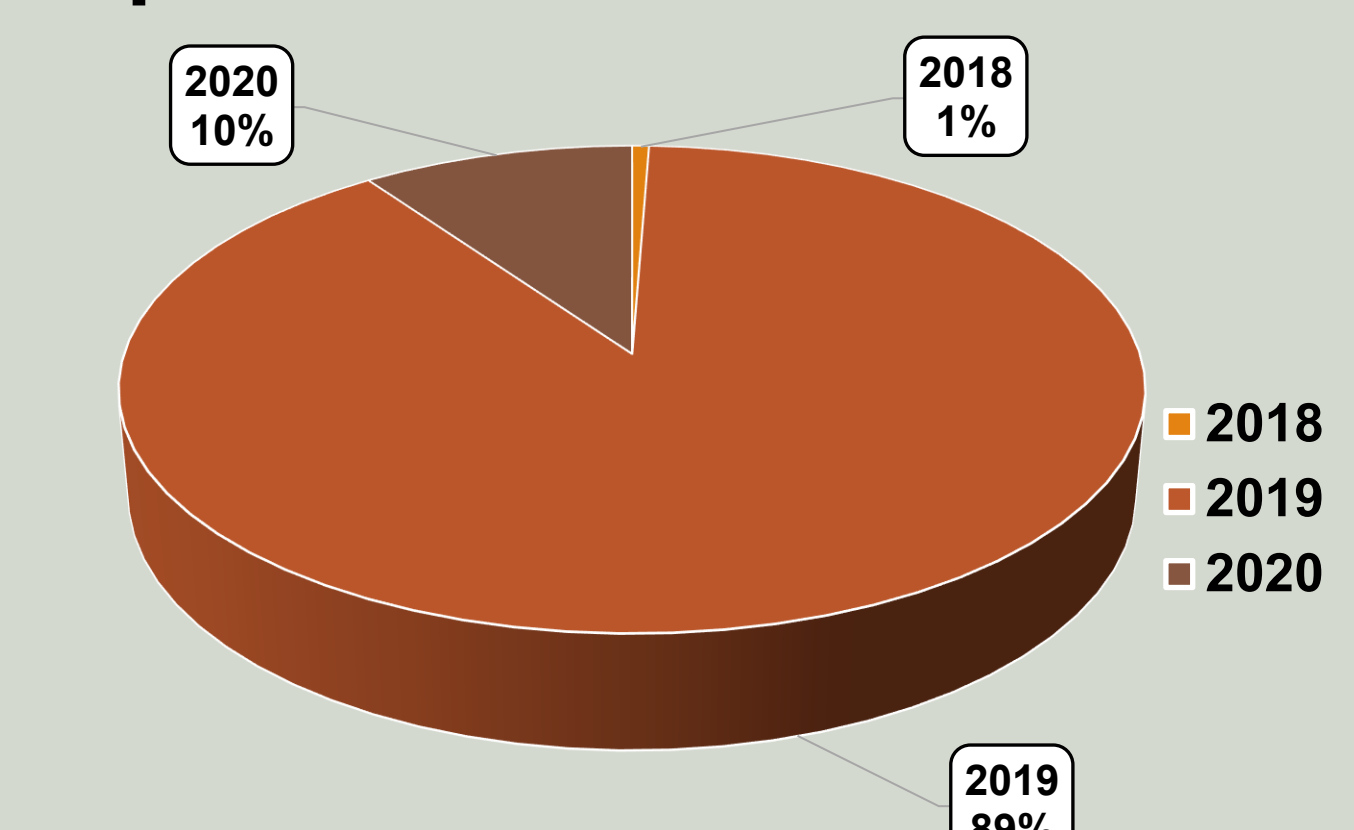


Fig. 5. Age Composition OmySY2023

Note: For OtsSY2023 collections the ages are indicated by brood years 2021 (age-2), 2020 (age-3 jacks), 2019 (age-4 the expected dominant age class), 2018 (age-5), and 2017 (age-6). For OmySY2023 collections, the major ocean ages are brood years 2020 (1 ocean), 2019 (2 ocean), and 2018 (3 ocean).

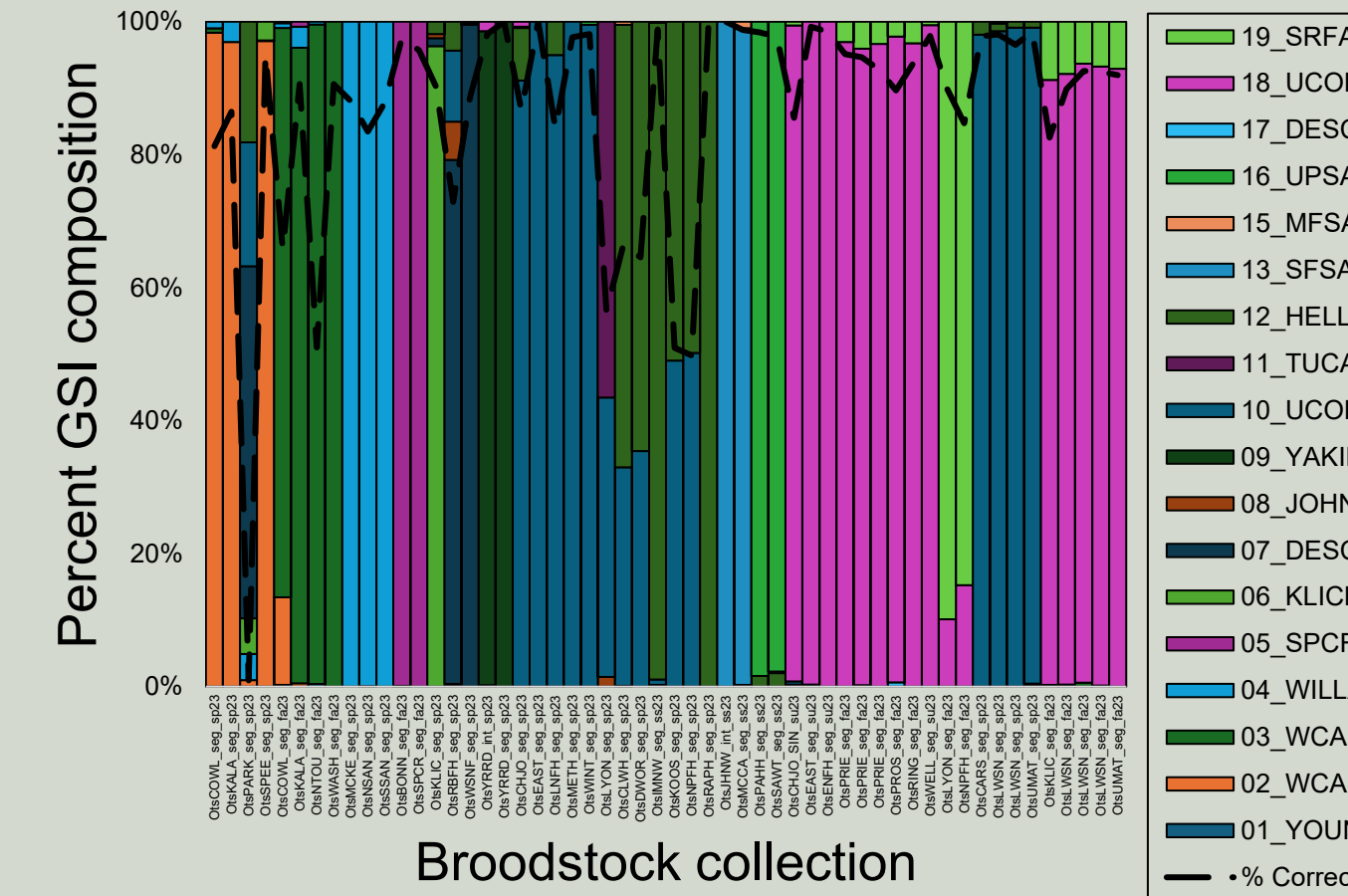


Fig. 6. Stock Composition OtsSY2023

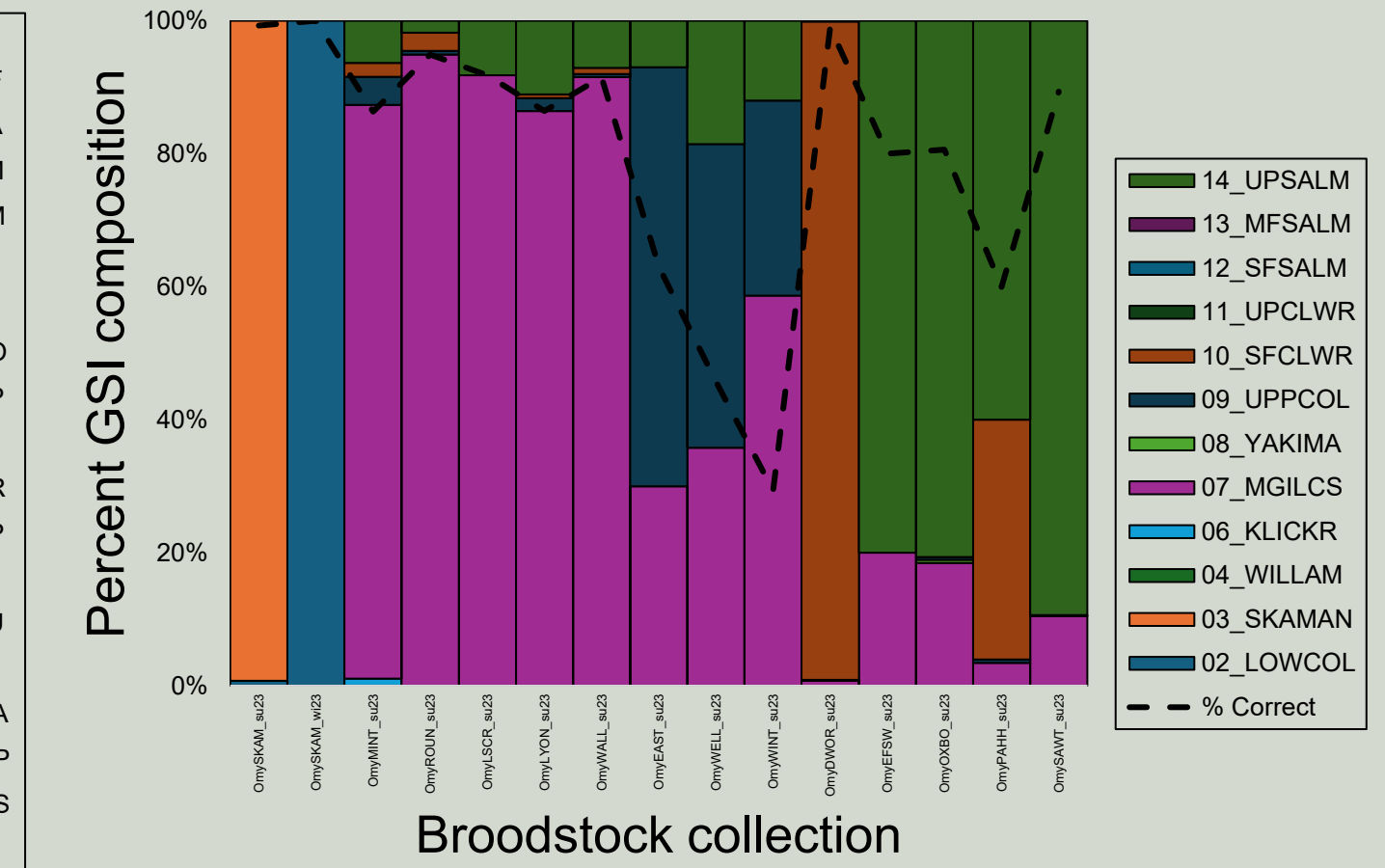


Fig. 7. Stock Composition OmySY2023

Note: Dotted line represents “% correct” GSI stock. Each PBT collection has an expected GSI reporting group given the geographic location of the hatchery and the history of the hatchery stock utilized by the hatchery. The colors of the stacked bars represent observed GSI reporting groups that comprised individuals of each hatchery collection (shown on the X axis).



PBT-based smolt-to-adult survival

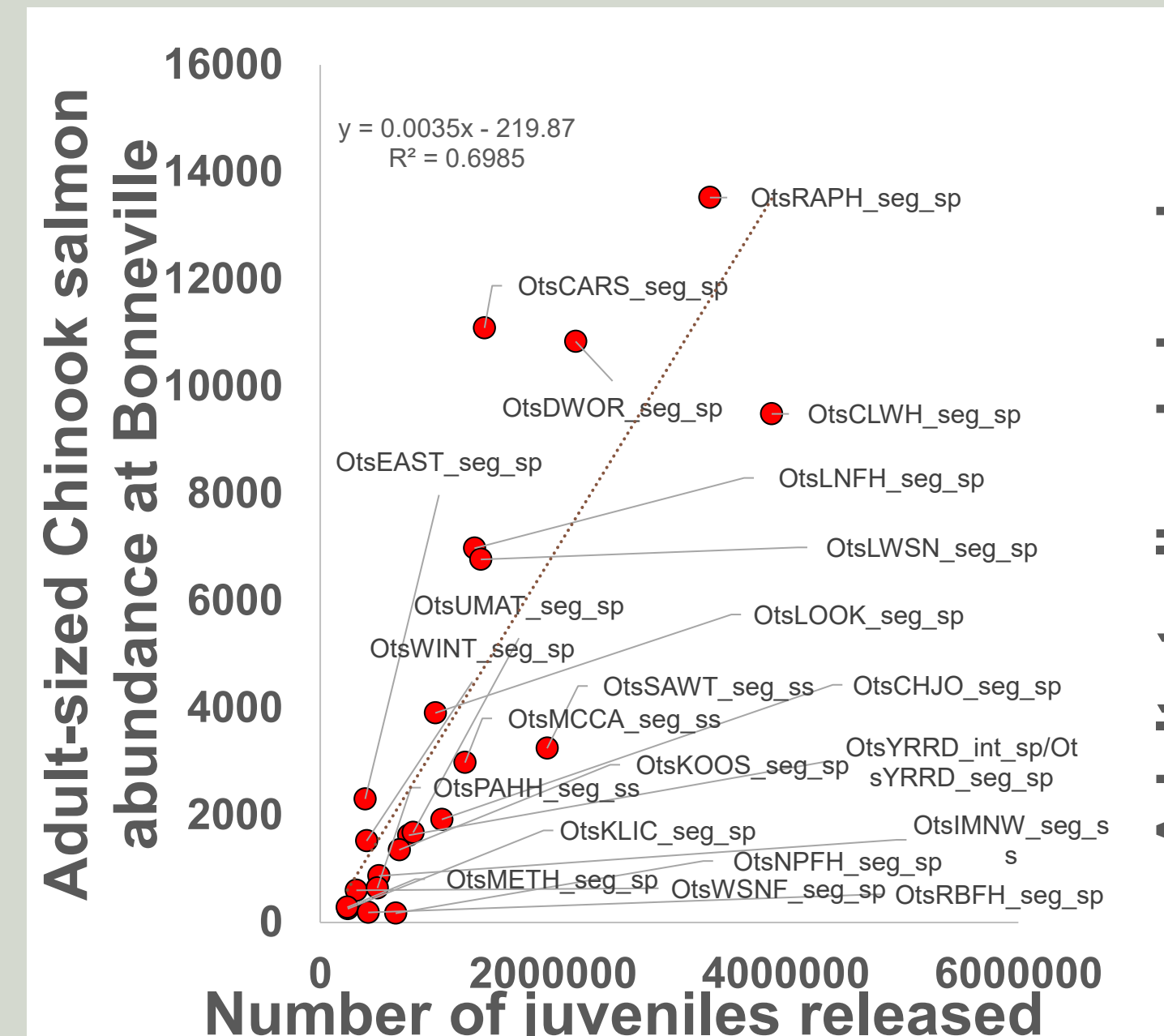


Fig. 8. Spring Chinook hatchery releases Vs. Bonneville Dam abundance of Columbia River BY2020 broodstocks

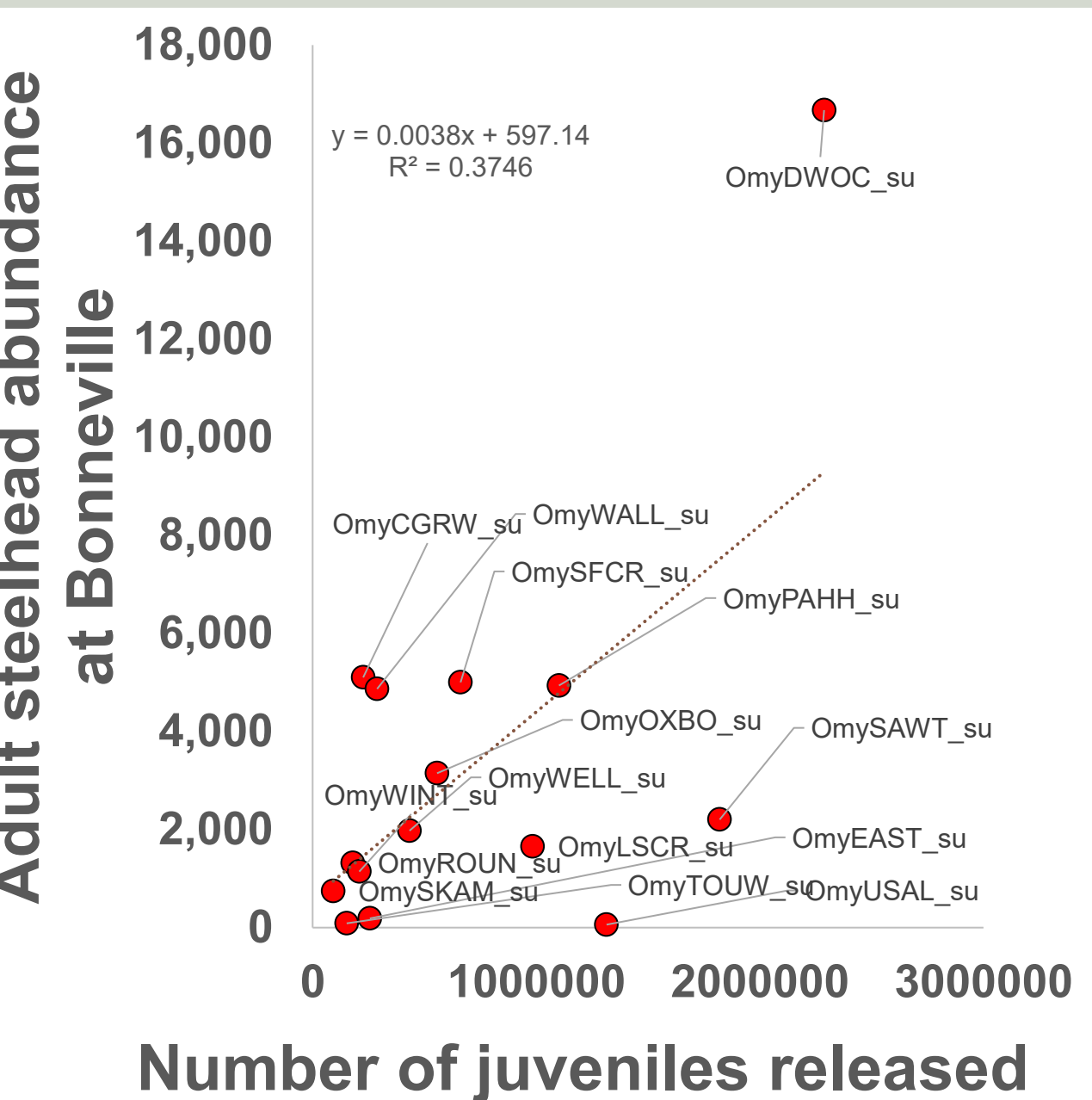


Fig. 9. Steelhead hatchery releases Vs. Bonneville Dam abundance of Columbia River BY2020 broodstocks

Results/Discussion

- Expected % PBT rates of 52 Chinook Salmon collections (N=56,149) averaged 89.9% (57.3% – 100%, Fig. 2). Expected % PBT rates of 15 Steelhead collections (N=5,019) averaged 94.6% (81.2% - 100%, Fig. 3).
- Reasons for relatively low observed % PBT rates include the use of natural-origin fish for broodstock (e.g., integrated broodstock OtsJHNW_int_ss23 and OtsYRRD_int_sp23, Fig. 1 map site #54 and #34 / OmyMINT_su23 and OmyWINT_su23, Fig. 1 map site #30 and #43) as well as gaps in the baseline (culling of stock, unacquired samples, etc.).
- Ages of the SY2023 collections were comprised mostly of 4-year-olds as expected for Chinook (Fig. 4) and mostly 2-ocean age for Steelhead (Fig.5).
- The % correct GSI was high for both Chinook (avg. 86.6%, range 0.95% - 100%, Fig 6) and steelhead (avg. 79.8% (range 29.3% - 100%, Fig. 7).
- Reasons for low % correct GSI include reintroduced out-of-basin stock (e.g., OtsPARK_seg_sp23, map site #23, expected GSI was 02_WCASSP but obs. GSI 07_DESCSP + 10_UCOLSP which were reintroduced).
- The linear regressions showed that effectively for every 286 juvenile spring Chinook release = 1 adult size return @ BON (Fig. 8). For every 263 juvenile steelhead released = 1 adult return @ BON (Fig. 9). Moderate fits of these regressions suggest generally greater numbers of juveniles released results in more adult returns.

References

- Campbell et al. 2015
- Horn et al. 2023
- Fish Passage Center

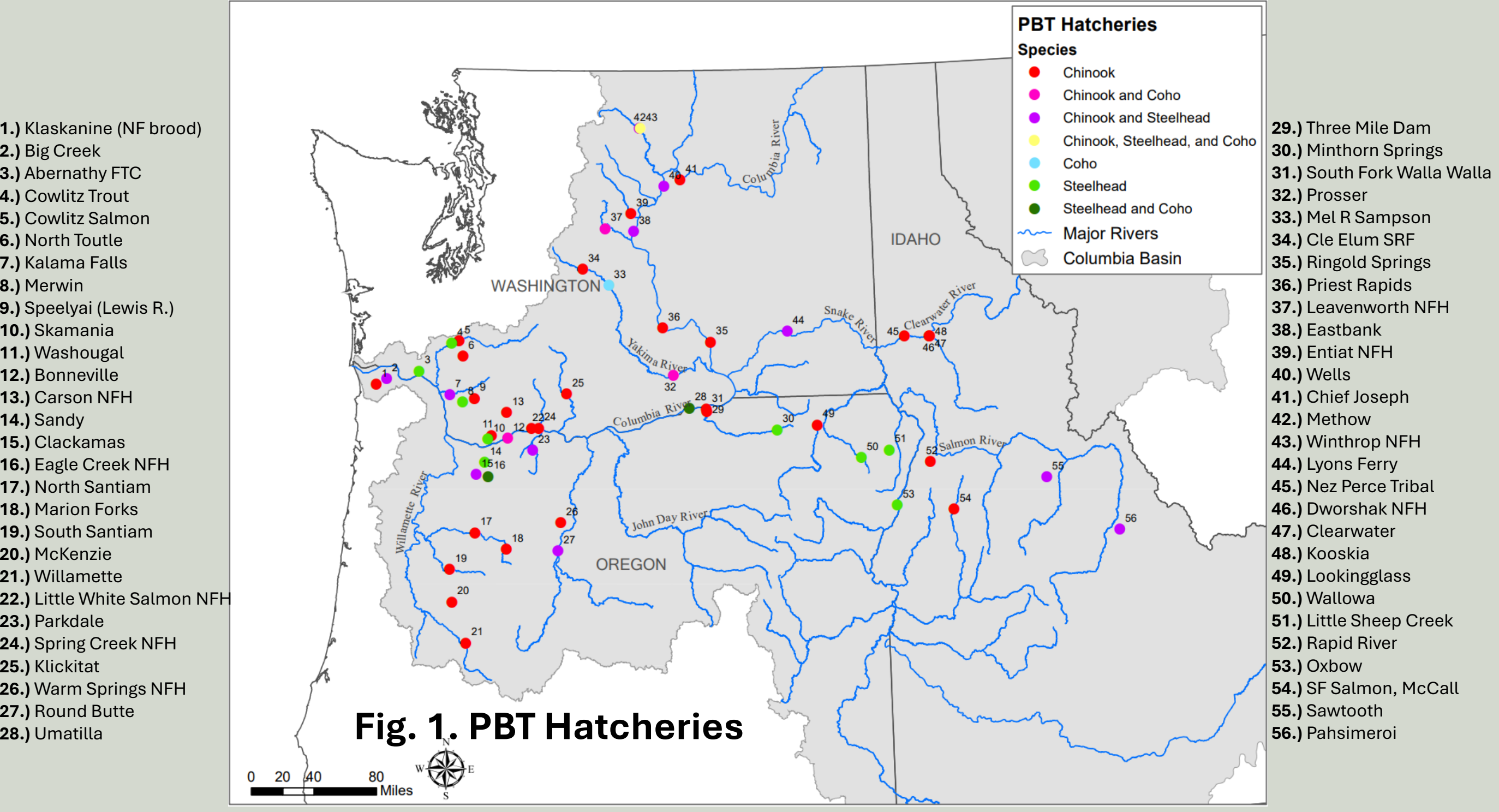
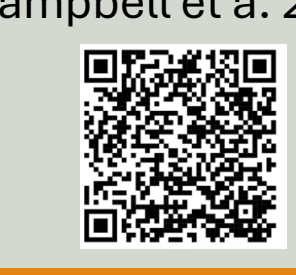


Fig. 1. PBT Hatcheries

- PBT Hatcheries**
- 1.) Klaskanine (NF brood)
 - 2.) Big Creek
 - 3.) Abernathy FTC
 - 4.) Cowlitz Trout
 - 5.) Cowlitz Salmon
 - 6.) North Toutle
 - 7.) Kalama Falls
 - 8.) Merwin
 - 9.) Speerlyai (Lewis R.)
 - 10.) Skamania
 - 11.) Washougal
 - 12.) Bonneville
 - 13.) Carson NFH
 - 14.) Sandy
 - 15.) Clackamas
 - 16.) Eagle Creek NFH
 - 17.) North Santiam
 - 18.) Marion Forks
 - 19.) South Santiam
 - 20.) McKenzie
 - 21.) Willamette
 - 22.) Little White Salmon NFH
 - 23.) Parkdale
 - 24.) Spring Creek NFH
 - 25.) Klickitat
 - 26.) Warm Springs NFH
 - 27.) Round Butte
 - 28.) Umatilla
 - 29.) Three Mile Dam
 - 30.) Minthorn Springs
 - 31.) South Fork Walla Walla
 - 32.) Prosser
 - 33.) Mel R Sampson
 - 34.) Cle Elum SRF
 - 35.) Ringold Springs
 - 36.) Priest Rapids
 - 37.) Leavenworth NFH
 - 38.) Eastbank
 - 39.) Entiat NFH
 - 40.) Wells
 - 41.) Chief Joseph
 - 42.) Methow
 - 43.) Winthrop NFH
 - 44.) Lyons Ferry
 - 45.) Nez Perce Tribal
 - 46.) Dworshak NFH
 - 47.) Clearwater
 - 48.) Kooskia
 - 49.) Lookingglass
 - 50.) Wallowa
 - 51.) Little Sheep Creek
 - 52.) Rapid River
 - 53.) Oxbow
 - 54.) SF Salmon, McCall
 - 55.) Sawtooth
 - 56.) Palsimeroi