INTEGRATING PARENTAGE BASED TAGGING WITH GENETIC STOCK IDENTIFICATION RESOLVES ORIGINS OF COLUMBIA RIVER BASIN STEELHEAD

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WHERE ARE THEY FROM?

• Resolving the origins of anadromous fishes in mixed stock aggregates is a central fisheries management problem
  • need to understand the relative proportion of fish from stocks that are of conservation/management concern

• Marine harvest of mixed stock assemblages

• Large river basins with multiple genetic stocks are analogous
  • Columbia River Basin salmonids
COLUMBIA RIVER BASIN

• Large drainage (688,000 km$^2$)
  • dynamic landscape shaped by geological forces

• Supports multiple genetic lineages for some
  anadromous salmonids (e.g., Narum et al. 2010)
  • broadly consistent with the Cascade Mountain
    Crest
  • multiple genetic stocks that support fisheries
    • several of conservation concern
Steelhead

- Two major lineages
  - coastal and inland (Blankenship et al. 2011)
    - multiple genetic stocks
  - DPSs protected under ESA (USFWS 2006)

- Mixed stock assemblages
  - tribal and recreational fisheries
  - monitoring program at Bonneville Dam
    - fisheries independent data to estimate relative stock proportions
HATCHERY SUPPLEMENTATION

• Steelhead spawning hatcheries throughout CRB (four regions)
HATCHERY SUPPLEMENTATION

• Annually release approx. 15 million smolts
  • majority released by Snake River hatcheries

![Hatchery steelhead smolt releases by year](data: www.fpc.org)
HATCHERY SUPPLEMENTATION

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Proportional hatchery steelhead smolt releases 1977-2015

- Below Bonneville
- Bonneville-McNary
- McNary-Chief Joseph
- Snake

65%

Data: www.fpc.org
HATCHERY SUPPLEMENTATION

• Annually release approx. 15 million smolts
  • majority released by Snake River hatcheries
  • Snake River hatcheries release 81% of smolts anticipated to be encountered as returning adults in Bonneville Dam monitoring program

Proportional hatchery steelhead smolt releases 1977-2015 (excluding below Bonneville)

- 81%

data: www.fpc.org
GENETIC STOCK COMPOSITION

- Two complementary approaches:
  - Parentage Based Tagging (PBT; 95 SNPs)
    - baseline of hatchery broodstock genetic data
    - identify hatchery stock of all offspring encountered in mixed aggregates
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  - baseline of hatchery broodstock genetic data
  - identify hatchery stock of all offspring encountered in mixed aggregates

- Genetic Stock Identification (GSI; 180 SNPs)
  - 116 baseline collections representing 14 reporting groups
  - identify the most likely population of origin for natural origin and (non-clipped) hatchery origin fish encountered in mixed aggregates
• Snake River hatcheries have provided PBT baselines since 2008
  • permitted assignment of hatchery origin adults returning to Columbia River since 2010
  • estimation of relative contribution of specific hatchery stocks to total number of returning adults passing Bonneville Dam limited to Snake River hatcheries
PBT BASELINES

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  - permitted assignment of hatchery origin adults returning to Columbia River since 2010
  - estimation of relative contribution of specific hatchery stocks to total number of returning adults passing Bonneville Dam limited to Snake River hatcheries
    - hatchery origin fish from outside the Snake River (18%) have been assigned to reporting groups via GSI
EXPANSION OF PBT BASELINES

• Effort to include additional hatcheries throughout the Columbia River Basin began in 2012

• Addition of several hatcheries above Bonneville Dam improved genetic assignments of hatchery origin fish encountered in monitoring program

• PBT and GSI combined improved estimates of stock specific abundance and run-timing for mixed stock aggregates encountered at Bonneville Dam in 2015
• Monitoring program operation 2015
  • stat weeks 15-42 (Apr. 5-Oct 17)
  • restrictions (stat weeks 27-38)
Caveats

- Monitoring program operation 2015
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- Sampling and tagging rates
  - Bonneville monitoring program (0.1-2.9%)
  - PBT tag rate (94-100%)
    - result based on ‘sample-tag rate corrected proportions’

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Caveats

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- Not all hatchery origin fish are adipose clipped
  - HOR (clipped and non-clipped), NOR (non-clipped)

![Proportion non-clipped fish assigned by GSI and PBT](chart)

- GSI (83%)
- PBT (17%)
Stock Composition of HOR (clipped)

- 12% of clipped HOR fish assigned to Columbia River hatcheries (n~18,500)
  - prior to PBT expansion: assigned to ‘MGILCS’ and ‘UPCOL’
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  - prior to PBT expansion: assigned to ‘MGILCS’ and ‘UPCOL’

- Columbia River hatcheries:
  - Wells (7%), Round Butte (4.4%)

- Snake River hatcheries:
  - Dworshak (19%), Pahsimeroi (17%), Wallowa (16%), Lyons Ferry (13%)
STOCK SPECIFIC ABUNDANCE 2015

- Re-classify hatcheries by GSI RepGrp
- Hatchery origin (clipped and non-clipped) and natural origin
## Stock Specific Run-Timing 2015

![Graph showing run timing of HOR (clipped)](image)

### Run timing of HOR (clipped)

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Stock Specific Run-Timing 2015

- Hatchery origin (clipped and non-clipped)
Stock specific run-timing 2015

- Natural origin (non-clipped)
SUMMARY

• PBT and GSI resolved the relative stock proportions for hatchery and natural origin steelhead encountered as mixed stock aggregates in the Bonneville Dam monitoring program
  • stock specific abundance and run-timing estimates

• PBT expansion identified the origins for 12% of clipped fish from Columbia River hatcheries (n~18,500)
  • future expansion of PBT baselines will refine genetic assignments even further
## Acknowledgements

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- David Sohappy

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- Larry “Bubba” Holliday
- Jens Lovtang