Discerning population connectivity and natal origins of Pacific herring (Clupea pallasi): inferences on population structure from otolith chemistry

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Discerning connectivity and natal fidelity of Pacific herring (*Clupea pallasi*): Inferences on population structure from otolith chemistry

Wade D. Smith, Tony Pitcher, Margot Hessing-Lewis, Brian P.V. Hunt, Evgeny A. Pakhomov
Exchange of individuals among groups critical to persistence & resilience of populations
Otoliths: Records of growth & environmental history over the lifetime individuals (daily, seasonal, annual)
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Natal core – marker of environment at birth

Edge – record of most recent environment
Objectives

Evaluate the extent of mixing & natal fidelity among spawning groups using intrinsic chemical “tags”

1) Evaluate baseline differences in water chemistry among spawning sites

2) Identify contributions of distinct natal sources among & within spawning groups

3) Infer extent of movement & mixing at regional & local scales
Methods: Field Sampling
Methods: Characterizing Water Chemistry

Water samples acidified & filtered

Elemental concentrations measured using Inductively Coupled Optical Emission Spectrometer:

B, Li, Mg, Ca, Cr, Mn, Rb, Sr, V, Ba, Pb
Methods: Quantifying Otolith Chemistry

Otoliths assayed using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)

24 elements assayed: Li, Mg, Mn, Sr, Ba, Pb
Results: Water Chemistry

Significant variation in water chemistry among spawn sites
MANOVA (p = 0.002, Pillai’s = 4.24), SIMPER
Results: Water Chemistry

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**Results: Water Chemistry**

**Significant variation in water chemistry among spawn sites**

MANOVA ($p = 0.002$, Pillai’s $= 4.24$), SIMPER
Results: Regional Variation in Natal Tags

- Are natal tags distinctive among regions or sites (mixing)?

- Are tags similar within sites?

  - MRPP to test HO of no difference among groups

  - DFA test ability to distinguish among groups based on natal tags
Results: Regional Variation in Natal Tags

**Course Scale:** Natal signatures differed significantly among management regions (MRPP, $T = -26.3$ Overall DFA: 94%)

Northern Salish Sea tag useful tracer
Results: Regional Variation in Natal Tags

**Course Scale:** Natal signatures differed significantly among management regions (MRPP, $T = -26.3$ Overall DFA: 94%)

Strong variation among signatures along Central Coast
Results: Regional Variation in Natal Tags

**Course Scale:** Significant variation in natal source contributions *within* Central Coast unit (MRPP, \( T = -16.0 \); Overall DFA: 88%)

Low mixing/exchange (high fidelity) evident in some sites
Results: Local Variation in Natal Tags

Significant differences in natal chemical tags within & among sites (MRPP, $T = -9.46$; Overall DFA 58%)

Degree of mixing (source contributions) varies among spawning sites

High group fidelity within some spawn sites
Results: Variation in the present (Edges)

Fine Scale: local variation in edge chemistry?

Test resolution based on known origins
**Fine Scale:** successfully assigned herring to specific spawning sites (MRPP, $T = -2.9$; Overall DFA 73%)

Otolith chemistry supports discrimination at local scales – 10s kms

Differential movement patterns among co-occurring fish
Ongoing: Characterizing Site-Specific Natal Signatures

Collections of late state embryos to establish baseline of variation in natal elemental composition
Conclusions

- Regional differences in natal tags provide a tool for tracing exchange/mixing among regional source populations.

- Similarity in natal tags within some groups indicates high level of group fidelity.

- Differences in natal & edge chemistry suggest differences in life/migration histories among co-occurring groups within management units.
Thank you!

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