Finding Nemo in Puget Sound: 
larval dispersal estimates from genetic parental 
identification in brown rockfish 
(*Sebastes auriculatus*)

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Outline

• Marine Protected Areas (MPAs) and connectivity

• Genetic differentiation vs connectivity
  – $F_{ST}$
  – Isolation by distance (IBD)

• Brown rockfish in Puget Sound
  – Identification of offspring of known parents
  – Self-recruitment
  – Oceanography
  – Otoliths
  – We found Nemo!
Marine Protected Areas and Fish Dispersal

- Functions of MPAs
  - Fisheries conservation

- Three major questions
  1. How much export?
     - Benefit to surrounding fisheries
  2. How much self-recruitment?
     - Benefit to MPA ecosystem
  3. How much exchange between MPAs
     - Allow gene flow and adaptation to environmental change

- Important for MPA design
  - Size & spacing
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Marine fish dispersal and population genetics

- Genetic differentiation
  - Population size
  - Population history

- Difference in quantity measured
  - Ecology
    - Mean dispersal
    - Short term
  - Genetics
    - Rare migrants
    - Long term

Gilg & Hilbish 2003
Isolation by distance

- Correlation between genetic and geographic distance
  - dispersal distance
  - Migration (mating) between adjacent populations

- Also for continuous populations

- Limited dispersal in many marine species
  - High self recruitment
  - We should find Nemo!
Brown rockfish
*(Sebastes auriculatus)*

- **Adults**
  - Small home ranges
  - Long lived (~20 y)
  - Mature at ~ 3 years
  - Live bearing

- **Larvae**
  - 3 months pelagic
  - Little known about behavior

- **Habitat**
  - Low relief/shallow/low energy for juveniles
  - High relief/deeper/low energy for adults
Brown rockfish (Sebastes auriculatus)

- Genetic differentiation in CA
  - Isolation by distance
  - Mean dispersal ~ 10 km
  - 40% of larvae should settle within 5 km

- 1837 fish sampled
- Point Heyer
  - 469 adults
  - > 50%
  - 578 juveniles
  - 240 sub-adults
How to find Nemo

Oceanography
Otoliths
Genetics

reef-resident adults
larvae
recruiting juveniles
DNA
otolith (SrCl)
Oceanography
PRISM Oceanographic model

- Drifter tracks broadly corresponds to PRISM oceanographic model
- Used to predict larval dispersal
  - Passive particles
  - Released at Point Heyer
  - Predicted settlement sites
Seasonal variation in drifter trajectories

Latitude

Date (2007)

6-Aug  26-Aug  15-Sep  5-Oct  25-Oct

D1  D2  D3  Pt Heyer
Otolith microchemistry
Transgenerational tagging with SrCl

- Sr replaces Ca in hard parts
- Successfully transfers to pre-parturition larvae – How?
- Detected with micro-probe or laser ablation
Otolith microchemistry

Sr detection

Electron Source
15 kV 12nA

Otolith Surface

back-scattered electrons

secondary electrons

X-rays

detector
Otolith microchemistry

Results

Skull of 6mm brown rockfish larva

Kuroki, Buckley, LeClair, & Hauser. 2010. *Journal of Fish Biology*

Distance from edge to edge (um)
Genetic parentage assignment

- **Mendelian inheritance**
  - Offspring match parents at one allele at each locus
  - May match by chance
    - 1000 adults x 1000 offspring: 1 million comparisons

- **16 Microsatellites**
  - Avg 45 alleles / locus
  - Low chance of random match
    - Low chance of false positive parent offspring pairs
We found Nemo!

- **7 Nemos**
  - offspring of known parents at Point Heyer
  - 4 from parents at Point Heyer
    - 1 with both parents
    - 3 from elsewhere
- **818 juveniles and sub-adults sampled**
  - 50% adults sampled
  - 0.5% of juveniles
  - 4% self recruitment
- **Mean dispersal distance 10km**
  - 40% settlement expected within 5 km
  - No juvenile habitats nearby
What about sister/brother kinships?

- **Should dispersal resolve like parent offspring**
  - Preliminary results
- **High power**
  - Can distinguish full sibs from unrelated

![Graph showing relatedness coefficients](image-url)
Full siblings in pairwise comparisons

- **Isolation by distance**
  - Lower proportion of full sibs at larger distances

- **No evidence of isolated populations?**
  - Global $F_{ST} = 0.000$, 99% CI
  - High power of marker set
    - $F_{ST} > 0.0005$
    - Spatial autocorrelation

![Graph showing proportion of full sibs vs distance (km)](image)

- $R^2 = 0.1043$
- $P = 0.013$

![Graph showing spatial autocorrelation](image)
Conclusion

• We found Nemo!
  – But not as many as expected

• Low self recruitment
  – Origin of Nemos random
    • But small sample size
  – But some evidence for isolation by distance from kinship

• Implication
  – Puget Sound populations well connected
  – Source vs sink populations?

• Methodological
  – Parentage assignment works
    • Multidisciplinary approach
Acknowledgements

- **Funding**
  - Washington Sea Grant
  - SeaDoc Society
  - SAFS

- **Laboratory**
  - James Rhydderch
  - Lyndsay Newton
  - Melissa Baird

- **Sampling**
  - WDFW: Ocean Eveningsong, Jesse Schultz, Tony Parra, Jim West, Michael Ulrich, Lisa Hillier