Predicting and Monitoring the Effects of a Habitat Restoration Project on Metapopulation Viability of Two Federally Listed Species in a Tributary of the Columbia River

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• **EcoAnalysts**
  – Leading algal and benthic macroinvertebrate taxonomy labs in U.S.
    • Freshwater, estuary, and marine
  – Primary and secondary production studies
  – Food web studies
  – Biodiversity and IBI analysis and development
  – MPVAs
• This presentation part of a nine year Idaho Power Company- FERC relicensing project on mid-Snake River
Introduction

Loss of habitat and invasive species are the leading causes of extinction worldwide

- Habitat restoration/reduced impact of invasive species critical for survival of many T and Es
- Most T and Es now occur as isolated or metapopulations
- Spatially explicit predictive models that incorporate metapopulation dynamics can be useful tools: pre- restoration of habitats
What is a metapopulation?

“Populations within a population”

Fragmented populations

- Limited dispersal
- Anthropomorphic disturbance (populations are becoming more fragmented)

Viability mostly affected by:

- Habitat environmental correlation
- Dispersal (connectivity)

In a metapopulation, populations “blink in and out of extinction” (Hanski 1999)
There are several threatened and endangered freshwater gastropods, mid-Snake River, Idaho, a tributary of CR

*Lanx* sp. (Banbury Springs limpet)

*Taylorconcha serpenticola* (Bliss Rapids Snail)

There is also this bad girl

*Potamopyrgus antipodarum* (NZMS)
Taylorconcha serpenticola
(Bliss Rapids Snail)
Current known distribution of *Taylorconcha* (~80 river km)
Lanx sp. (Banbury Springs limpet)
Current known distribution of *Lanx*
• Both BRS and Lanx prefer cold-water, lotic, cobble habitats
New Zealand Mudsnail (Potamopyrgus antipodarum)

*HIGHLY INVASIVE*
Objective

Model the effect of the reduction of Morgan Lake on the viability of *Bliss Rapids Snail* and *Lanx* by:

- Altering dispersal rates
- Increasing habitat
- Decreasing invasive *Potamopyrgus* densities

Recommend management strategies
Morgan Lake at Banbury Springs
RAMAS Metapop

• Parameters held constant
  ✓ 10,000 simulations (replications)
  ✓ 200 time steps (generation time)
  ✓ Correlation (habitat/environmental)
  ✓ Density dependence
    – *Taylorconcha* density dependent (scramble competition)
    – *Lanx* density independent (perhaps Allee effect)

• Parameters modified (scenarios/sensitivity)
  ✓ Dispersal
  ✓ Increased habitat (population abundance)
  ✓ Reducing std dev. of $r$ of *Taylorconcha* (surrogate for *P.a.* densities)
 Interval Extinction Risk (IER) defined:

IER is the probability that BRS or Lanx metapopulation density will fall below a range of densities at least once during the 200 time steps.

Each point in the curve can be interpreted as “there is a Y% risk that the metapopulation density will fall below X (density) at least once during the 200 time steps”.

(RAMAS® Metapop by H.R. Akçakaya. Copyright © 1998 by Applied Biomathematics)
Increased Dispersal of Taylorconcha

Effect of Dispersal on Taylorconcha Extinction Risk

Dispersal = \downarrow \text{Extinction Risk}

- with Morgan Lake (no dispersal)
- without Morgan Lake (.001 dispersal)
- without Morgan Lake (.01 dispersal)
- without Morgan Lake (complete dispersal)
Increased habitat for Taylorconcha

Increased Habitat Availability for Taylorconcha

Habitat = \downarrow \text{Extinction Risk}

- Orange line with Morgan Lake (no change)
- Purple line without Morgan Lake
Increasing Habitat, Decreased Potamopyrgus

Increased Habitat Availability, Decreased Potamopyrgus

- Habitat + Potamopyrgus = Extinction Risk
- With Morgan Lake (no change)
- Without Morgan Lake

Decreasing Densities

Probability

0.0
0.2
0.4
0.6
0.8
1.0

Decreasing Densities

Habitat + Potamopyrgus = Extinction Risk

With Morgan Lake (no change)
Without Morgan Lake
Increased Dispersal of Lanx

Effect of Dispersal on Lanx Extinction Risk

Dispersal = ? Extinction Risk

- with Morgan Lake (no dispersal)
- without Morgan Lake (.001 dispersal)
- without Morgan Lake (.01 dispersal)
- without Morgan Lake (.1 dispersal)
- without Morgan Lake (complete dispersal)

Decreasing Densities

Probability
**Increased habitat for Lanx**

Increased Habitat Availability for Lanx

![Graph showing probability vs. decreasing densities with and without Morgan Lake.](image)

- **Dispersal = 0.01**
- **Habitat = Extinction Risk**

- **With Morgan Lake (no change):** Orange line
- **Without Morgan Lake:** Blue line
Conclusions

For **BRS**:  

- Increased dispersal
- Increased habitat
- Decreased *Potamopyrgus*  

\[\text{\{Reduced Extinction Risk\}}\]

For **Lanx**:  

- Increased habitat  = reduced Extinction Risk
- Increased dispersal  = does not always reduce Extinction Risk

Viability is more sensitive to dispersal rates because of initial low densities.

There is an optimal dispersal rate for *Lanx*, which needs to be determined.
Recommendations

- Reduction of Morgan Lake is beneficial to *Taylorconcha* and *Lanx* viability: however, careful planning is necessary
- Slow drawdown of ML may be better
- Trans-locate super colony (genetic considerations)
- Add cobble habitat to restored sections
- Monitor all three species populations before and after restoration
Relevance to CRE

• MPVAs often used for salmonid management but rarely used for mollusks
• MPVAs best used to compare management/restoration strategies not as absolute predictors of viability
• Understanding and incorporating metapopulation dynamics is important for most T and E restoration projects in CRE
Acknowledgments

Idaho Power Company, Boise, Idaho

US Fish & Wildlife Service, Snake River Field Office, Boise, Idaho