INTERACTIONS: Northern range expansion of small mouth bass and yellow perch predicted based on predicted climate warming scenarios. The bottleneck for both fish is whether the young of the year can grow large enough to survive their first winter.

Northern limit with high food
Northern limit with low food
Where starvation presently affects bass population

Current range

Shuter and Post 1990

Figure 13.—Current geographical distribution (shaded area) of smallmouth bass in the northern USA and Canada (Robbins and MacCrimmon 1974; Lee et al. 1980). The solid line A marks the predicted distributional limit (Lc) for a high level of food availability (P = 1.0); the solid line B marks the predicted limit for a lower level of food availability (P = 0.6); the dashed line C marks where winter starvation begins to influence population behavior.

Figure 15.—Shift in the predicted northern limits (Lc) for yellow perch and smallmouth bass under a climate-warming scenario of +4°C, with food availability fixed at P = 0.4. The predicted limit for yellow perch shifts (P arrows) from the southernmost solid line to the more northerly solid line. The predicted limit for smallmouth bass shifts (3 arrows) from the dashed line to the solid line immediately above it. The postwarming limit for smallmouth bass is essentially coincident with the prewarming limit for yellow perch.
The Earth’s major terrestrial biomes are most clearly separated on a graph of temperature vs precipitation.
### Prediction*

<table>
<thead>
<tr>
<th>Observation</th>
<th>Response variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>absent</td>
<td>absent</td>
</tr>
</tbody>
</table>

N hot spot?

Grazing hot spot?

**Predictor variable(s):** e.g., PAR
Definitions:

**Relict population**: Residual population left over from time when environment could support its survival and reproduction, which can no longer replace itself locally.

**Sink habitat**: Habitat where death rates exceed birth rates, and organisms are present only because of immigration from Source Habitats (where births exceed deaths).

**Resource subsidy**: Resources produced in one habitat that support consumers in a second habitat.
Spiders
Phytophagous insects
Plants

Detritivorous amphipods and flies
Beach wrack (drift seaweed)

Allochthonous subsidies (Polis and Hurd 1995)
Lizard Density (spring 1997)

- Cobble Bar: [High density]
- Upland Meadow: [Low density]
Enclosures--91 sq. m
3 juvenile S. occidentalis

Subsidy reduction
• increased emigration
• reduced growth if lizards enclosed

Sabo and Power
2002, Ecology
Relict population: Residual population left over from time when environment could support its survival and reproduction, which can no longer replace itself locally.

Sink habitat: Habitat where death rates exceed birth rates, and organisms are present only because of immigration from Source Habitats (where births exceed deaths).

Resource subsidy: Resources produced in one habitat that support consumers in a second habitat.
Spotted (habitat and feeding specialist, old growth obligate) vs Barred Owl (generalist, feeds in agricultural areas, nests in forests, outcompetes Spotted Owl when old growth is fragmented and surrounded by fields).

Edge effects in fragmented habitats create population sinks

Scott Robinson: Cowbirds feed in agricultural fields, and lay eggs in nests of forest-dwelling songbirds. Cowbird parasitism is making midwestern forest fragments a sink for songbirds:

Immigration + death > birth + emigration

Songbird immigration to midwest is from southeastern forests.
Iwata et al. 2003: higher bird densities along meandering than straight river reaches.


Terms:

Biomes: biogeographical regions distinguished by different fauna and flora.
Propagule: individual or group of conspecific individuals capable of founding a population.
Relict: residue of a population that can no longer replace itself under current conditions
Resource subsidy: resources produced in one habitat that support consumers in another
Sink habitats: population death rates exceed birth rates, and numbers are maintained only by immigration from source habitats, where births exceed deaths and emigration exceeds immigration.

Macan's (1963) Filter: If a species is absent from a habitat, is it because of:
1) Dispersal?
   yes: hasn't yet arrived
   no: propagules have arrived, but populations don't persist
2) Behavior?
   yes: colonists avoid this habitat
   no: colonists do select this habitat, but don't persist
3) Abiotic factors?
   yes: temperature, salinity, soil moisture, pH, etc. are outside the range that the species can tolerate
   no: abiotic conditions are benign enough
4) Biotic interactions?:
   yes: species are excluded by predators, pathogens, parasites, competitors, or the lack of mutualists or prey
   no:......
   Interactions?? Sampling?? History???