Salmon—salmon, conservation, management

Salmon are a fairly resilient group of species.

- Fast generation times
- Have lots of offspring
- Rapidly evolve
- Phenotypic plasticity
- Diversity of populations

However, they have been impacted by a variety of human impacts.

Threats to salmon populations

Threats to salmon are classified as the 4H's

1. **Hatcheries—**can swamp local adaptations of wild fish through genetic effects, competition with wild fish, increasing harvest rates on wild populations.

2. **Habitat—**salmon need relatively cold, well oxygenated water. They also need sediments that don't have much fine sediment as this can smother eggs.

3. **Hydropower—**dams can block upstream habitat as well as degrade downstream habitat.

4. **Harvest—**commercial fisheries often harvest upwards of 60+% of returning fish. Recreational and first nations can also contribute to direct harvest of returning salmon.

5. Plus some others (that don't conveniently start with H):
    a. **Disease**

    b. **Climate change**

    c. **Invasive species**

Through the combination of these impacts, a large number of salmon populations have been extirpated.

- In B.C., in an assessment of 5487 salmon populations
    - 142 salmon populations gone extinct
    - 624 populations at high risk of extirpation
- B.C. salmon populations are estimated to be about 13-50% of historical abundance.
- Status of salmon the United States is much worse, where approximately 50% of populations were extirpated or at risk of extirpation.

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HOW ARE SALMON POPULATIONS GENERALLY MANAGED?

Salmon management often focuses on how many fish can be harvested by large-scale commercial fisheries. The fishery usually happens at the mouths of the rivers as the salmon are on their way back to spawn.

Maximum sustainable yield--Most salmon management is based on trying to harvest as many fish as possible, while allowing enough to spawn so that the next generation is big enough.

Basic population model--Salmon management demands models to predict how many fish come back. These models can be complex or simple. The simplest models usually assume that the number of fish that will come back is some function of the number of parents, while taking into consideration density dependence.

Density dependence—the number of successful offspring an individual will be influenced by the density. For example, competition for food will drive density dependence.

Beverton-Holt Stock-Recruit Function

$R=aS/(1+bS)$

R = Recruits. Recruits to the next generation. This could be the number of spawners produced by the previous generation of spawners. This is what the model is predicting.

S=Spawners. The number of parents. This is a model input.

a = constant. This parameter can be interpreted as the productivity of the stock (without any density dependence).

b = constant. This parameter influences the strength of density dependence.

- These a and b parameters will determine the maximum sustainable yield.
- a and b will vary depending on population and species.

CHALLENGES

Environmental variability. a and b could vary through time, perhaps ocean variability influences stock productivity. This also makes it difficult to estimate a and b.

Mixed stock fisheries. Fisheries at the mouths of rivers often harvest multiple populations of salmon at the same time. If these populations are different sized or differently productive, then the less productive stocks will get driven to extirpation.

E.g., Skeena River