Issues and conservation concerns associated with management of Alaskan fisheries

Paul Spencer

Alaska Fisheries Science Center, Seattle, WA USA

The Role of Stock Identification in Stock Assessments

Most stock assessment models (and management systems) assume a homogeneous population of fish for which productivity can be characterized.

If stock is too large – "important differences within the unit stock may be neglected"

If stock is too small – "interactions with other groups of fish may be important"

(from Gulland 1983)

Definitions of "stock"

Early definitions defined "stocks" in terms of the fishery:

Dahl (1909) – a stock is a source of fish.
Russell (1931) – a stock is the exploitable portion of the population.

Later definitions recognized stocks as ecological entities:

Booke (1981) – "a species group, or population, of fish that maintains and sustains itself over time in a definable area."

Ihssen at al. (1981) – ". . . An intraspecific group of randomly mating individuals with temporal or spatial integrity"

Why hasn't genetic information been more directly utilized in definitions of stock structure?

(Waples, R.S., A.E. Punt, and J.M. Cope. 2008. Integrating genetic data into management of marine resources: how can we do it better?)

1) Differences in time scales of interest between geneticists and fisheries scientists
2) Difficulty in inferring demographic independence from genetic data
3) Difficulty in developing meaningful hypothesis tests

1) Differences in time scales of study

On ecological time scales, the cohesive forces are demographic. We are interested in migration rate m.

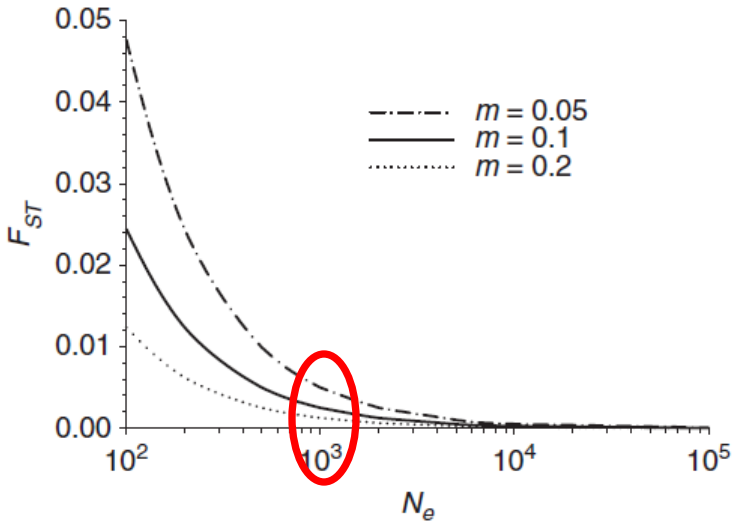
On evolutionary time scales, the cohesive forces are genetic. We are interested in the combined parameter mN_e (the number of migrants).

(from Waples et al. 2008)

2) Difficulty in inferring demographic independence from genetic data

The level of migration corresponding to demographic independence (10%; Hastings 1993) is very high in evolutionary terms.

For populations with large N_e, "it is a very challenging task to use genetic data to distinguish between migration rates that do and do not lead to demographic independence." In other words, levels of migration that are significant demographically may not be significant in evolutionary terms.



(from Waples et al. 2008)

3) Difficulty in developing meaningful hypothesis tests

An example hypothesis test is :

H_o: The collected samples are drawn from a single, panmictic population
H_a: The collected samples are not drawn from a single, panmictic population

However, "what managers really want to know is *how much* more likely is local breeding than migration"

"Best available science" -- various lines of evidence are considered in determining stock structure.

Example: School shark in Australia and New Zealand (Punt et al. 2000)
Genetic data does not strongly suggest separate stocks, but tagging data does.

(from Waples et al. 2008)

Consideration of both genotypic and phenotypic variation in defining stock structure has also been proposed:

Begg, G.A. and J.R. Waldman. 1999. An holistic approach to fish stock identification. Fisheries Research 43:35-44.

Begg, G.A., J.A. Hare, and D.D. Sheehan. 1999. The role of life-history parameters as indicators of stock structure. Fisheries Research 43:141-163.

"Although phenotypic differences do not provide direct evidence of genetic isolation. . . , they can indicate prolonged separation of postlarval fish in different environments" (Begg and Waldman 1999)

Types of data (other than genetic data):

1) Mark-recapture data
2) Age/size composition from catch or survey data.
3) Life-history characteristics (growth, reproduction)
4) Parasites
5) Otolith microchemistry
6) Meristics
7) Morphometrics
8) Scale and otolith analyses

What have been the issues with identifying stock structure with some Bering Sea/Aleutian Islands (BSAI) stocks?

The BSAI rougheye rockfish "complex":

- The complex includes "true" rougheye rockfish in addition to blackspotted rockfish.

- Several types of data, including growth patterns, survey age and length composition data, and genetic data, indicate area differences either for blackspotted rockfish or for the two-species complex.

- Also, ecological differences between the Aleutian Islands and EBS have been demonstrated.

    a) Special issue of studies on "Oceanography and Ecology of the Aleutian Archipelago" (Fisheries Oceanography 14 (Suppl. 1), 2005)

    b) Development of Aleutian Islands Fisheries Ecosystem Plan (AIFEP)

- The rougheye complex is harvested as bycatch, and abundance is not evenly distributed throughout the BSAI. Finer-scale partitioning would lead to smaller TACs in the BS area.

BSAI Pacific cod:

Q: Are Pacific cod in the EBS and AI sufficiently differentiated that there should be separate harvest specifications for each area?

Biological support for the presence of stock structure

- Genetic differences (isolation by distance, significant AMOVAs)
- Differences in length-at-age & length and age compositions
- Differences in polar-lipid fatty acid composition (local adaptation?)
- Presence of spawning sites and possible oceanographic mechanisms for larval retention in the AI
- Tagging suggests very limited movement between EBS and AI
- Different ecological relationships
- Different population trajectories?
- Ecological differences between the EBS and AI

Implementation of EBS and AI specifications is complicated by problems with allocating catch to gear sectors

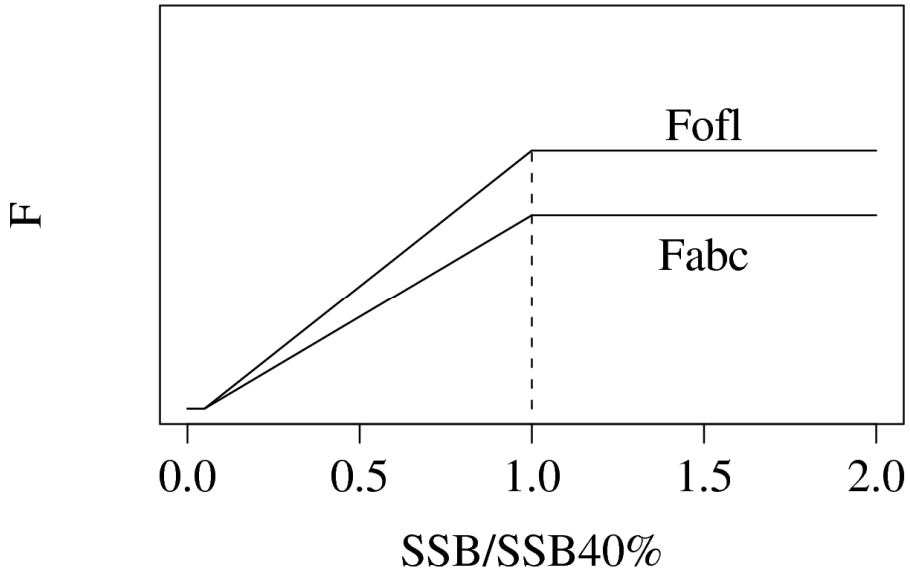
In the BSAI area, what factors have influenced our interpretation of data on stock structure?

1) Difficulty in understanding the genetic data

2) Institutional inertia – Often, the spatial implications of genetic data are difficult to interpret in the context of our management system. It is difficult to change the current system of spatial management unless we have very clear support and agreement that this is beneficial.

3) Lack of objective criteria for definition of stocks

How do we interpret stock structure with uncertain data? What does a precautionary approach to defining stock structure look like?



Here is how we interpret the precautionary approach with respect to harvest rate

"Persistence of the full diversity of spawning stocks within each management unit should, therefore, become a principle of management" (Stephenson, 1999)

Adaptation to local environments may exist among fish populations (Hauser and Carvalho 2008).

Questions to be addressed (hopefully today)

1) How should fisheries scientists and managers interpret gradual changes in genetic diversity (i.e., the "isolation by distance" pattern)?

2) What is F_{st}? What factors affect its magnitude for large, marine populations? How should we interpret small, but significant values of F_{st}?

3) What is the role of non-genetic data in interpretation of stock structure?

4) How do we interpret stock structure with uncertain and/or contradictory data? Is the burden of proof to unequivocally demonstrate stock structure with all data types, or does a precautionary principle apply?