Guidelines for Establishing Project Objectives for Biological Fisheries Investigations

Contributed by:
Dr. David R. Bernard[1]

When developing biological fishery investigation proposal, there are often two types of objectives: management applications and statistical. They can be one in the same, but more often are not. Management objectives are usually expressed as a question, such as "Is this chinook salmon harvest sustainable?" "Are we meeting our escapement objectives?" or "Is infection by *Ichthyophonus* detrimental to production?" The issues are implicitly management hypotheses (" Harvest is sustainable," "Desired escapement is maintained," or "*Ichthyophonus* impairs production") that can be rephrased to become scientific objectives ("To determine if harvest is sustainable," "To assess if desired escapement has been achieved," or "To determine if *Ichthyophonus* impairs production.") These management objectives are essential when judging the importance and relevance of the proposed work.

Statistical objectives concern evidence that would confirm or disconfirm a scientific hypothesis or explanation (confirm here means to increase the likelihood of being true). The evidence is in the form of estimates from sampling programs ("to estimate harvest"), from experiments ("to test the hypothesis that temperature increases mortality"), or from observational studies ("to test the hypothesis that infected fish suffer the same mortality rate as uninfected"). Statistical evidence must be relevant to the scientific hypothesis being tested and must be obtainable with the proposed methods and proposed levels of funding. For this reason, statistical objectives when feasible should be the centerpiece of detailed investigative plans, and these objectives should have statistical criteria.

Detailed investigation proposals should develop objectives specified in terms of estimates and tests and each with criteria for the following reasons:

1. Statistical criteria will allow fisheries managers to determine what they believe to be an acceptable risk of obtaining bad evidence.
2. Sample sizes are linked to statistical criteria; and
3. Funding is linked to sample sizes.

Having the project investigators describe in writing how they made these links will demonstrate that the problem or eventual application of the information has been thoroughly considered. In other words the investigator has considered how good an estimate or test needs to be to support their scientific hypothesis. They've calculated how intensively they need to sample or experiment to get such an estimate or test, and they have figured out how much money they will

[1] Dr. Bernard is Supervisor of Research and Technical Services, Sport Fish Division, Alaska Department of Fish and Game, and is a member of the Technical Review Committee.

need to get the samples or run the experiment. In short, the detailed project proposal serves as evidence that project personnel are likely to successfully conclude the proposed project. Unfortunately, there has been a tendency not to require such rigor, especially statistical rigor, in plans by groups without access to statisticians, biometricians, or their advice. Collective experience of agencies with stock assessment, harvest monitoring, and surveys relative to fish populations and fisheries has shown that without this rigor the chance of failure greatly increased for these projects. Failure in this instance usually takes the form of gathering statistical evidence that is irrelevant to the scientific objective or, more often, obtaining statistical evidence that is too biased or imprecise to be useful. Management decisions made with this type of data are difficult to defend and more importantly may cause harm to the fishery resource or rural subsistence users who depend on the resource.

Establishing Statistically Sound Project Objectives. Objectives concern estimates and tests that "drive" the study through determination of sample sizes, experimental designs, and/or sampling designs. If sampling is involved in attaining an objective, objective statements begin with the infinitives "to estimate" or "to test." Other infinitives, such as "to assess," "to determine," "to measure," and "to evaluate" are ambiguous and have no statistical meaning. Objective criteria are attached to each objective statement. For example:

> *To estimate the ...(statistic)... such that the estimate is within d units (or d percent) of the actual ...(parameter)... (1-)x100 percent of the time.*
>
> *To estimate the abundance of mature burbot in Lake Louise such that the estimate is within 10% of the actual abundance 95% percent of the time.*
>
> *To test the hypothesis that ...such to detect at least a difference of d units between ...(treatment means)... with a and b probabilities of Type I and II errors, respectively.*
>
> *To test the hypothesis that survival rates of coho salmon hooked and released in the estuary of the Little Susitna River are the same as those coho salmon hooked and released farther upstream such to detect at least a difference of 0.10 between survival rates with = 0.05 and = 0.10.*

The quality of the desired estimate or test is specified through the objective criteria. These criteria and an a priori measure of variance and/or abundance obtained from a pilot study or from similar work will be used to set sample sizes. Specification of statistical criteria is of paramount importance; this is the means by which appropriate levels of sampling can be determined. Other ways to specify criteria are acceptable just so long as they are understandable and unambiguous.

If populations are censused (every member handled), objectives do not have statistical criteria because the sample size and the population size are implicitly the same.

> *To count the number of adult coho salmon entering Bear Lake to spawn.*

Some estimates or tests will not drive sampling. For instance, catch in a sport fishery can be estimated for two species with a creel survey, but only the harvest of one species may be

important to management. If harvest of the secondary species will be calculated, these items are listed as tasks in a separate paragraph in this section.

References:

Bernard, D.R., W.H. Arvey, and R.A. Holmes. 1993. Operational planning: the Dall River and rescue of its sport fishery. Fisheries 18(2): 6-13.

Statistical power can improve fisheries research and management.1990 Canadian Journal of Fisheries and Aquatic Sciences 47:2-15.