Salmon Stocks at Risk:
What's the Stock and What's the Risk?

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ABSTRACT: Fisheries managers and fisheries population biologists and geneticists have 2 big problems when talking about salmon stocks at risk: disagreement about what a stock is, and too little to go on about what is at risk. We recommend leaving the word *stock* to fisheries managers, with the traditional emphasis on groups of fish managed as a unit. We recommend reserving the word *deme* to mean a smaller-scaled stable population of interbreeding salmon, with the emphasis on genetic discreteness. We hope maintaining this distinction can help promote a freer discussion of fluctuations in run sizes and help direct more attention to biological issues, like the underpinnings of sustainable fish production. Second, we want to turn the question around from "are stocks at risk?" to "what is at risk?" We conclude that if concrete services that humans enjoy from salmon populations were fairly evaluated against activities that put those services at risk, sustainability is undervalued.

More than 17 years have passed since the 1980 Stock Concept International Symposium (STOCS 1981), but fisheries managers, population biologists, geneticists, and government officials still do not agree on what stocks are. Our experience comes from the "stocks at risk" inquiry in Alaska (as explained by Baker et al. 1996) and from many meetings and discussions about enhancement and development in Alaska. These experiences have often left us discouraged because so much energy and time was wasted talking about matters that have not led to a better understanding of what is really at stake.

Retrospectively, much of the confusion stems from the fact that the word *stock* has taken on a whole range of meanings in salmon biology and management. With an eye toward management, Ricker (1975:5) defined a *stock* as, "The part of a fish population which is under consideration from the point of view of actual or potential utilization." Although managers incorporate biological notions when they call a collection of fish a stock, the emphasis here is on the business of conducting orderly and sustainable fisheries using groups of fish that are manageable (Van Alen *in press*).

Those who approach this word genetically and biologically traditionally lean more toward a different definition offered by Ricker, who also defined *stock* as "the fish spawning in a particular lake or stream (or portion of it) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place" (Ricker 1972:28). Following in the same spirit, an even sharper definition was advanced by Booke (1981:1479): "a population of fish that maintains and sustains Castle-Hardy-Weinberg equilibrium." These definitions of *stock* obviously emphasize genetics, something quite different than Ricker's 1975 management-based definition.

Ambiguity and confusion really accelerate when those who use *stock* in the management sense fail to realize that, while they would like to talk about a genetic stock, they don't know which fish compose interbreeding units. Beating back the confusion would be good, but this is not the only reason for developing a richer vocabulary. Even if their fears are groundless, declines in something called a *stock* within the context of the Endangered Species Act has some fishery administrators worried that the world will come crashing down on their heads.

We suggest that giving a new word to the smaller genetically discrete units may lead to a freer and less guarded discussion about population fluctuations. For this reason we propose that population biologists and geneticists abandon the word *stock* when they mean something other than Ricker's 1975 definition.

The authors of the influential book *Upstream* (National Research Council 1996) recognized this problem with the word *stock*; they used *deme* for an

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unequivocal word with genetic meaning. *The American Heritage Dictionary* (1992) defines *deme* as "a local, usually stable population of interbreeding organisms of the same kind or species." King and Stansfield (1990) provide a similar definition in their dictionary of genetic terms.

The introduction of the word *deme* into the vocabulary at first seemed a big step forward, but it is increasingly being used at meetings and in other discussions about harvest policy as a more fashionable synonym for *stock*, causing the same confusion the word *stock* has caused. Along with this trend, we see people claiming that demes must — urgently — be delineated and managed directly so as to reduce some kind of risk to sustainability. That just is not possible if the word *deme* is used as we propose here. To really understand what a deme is and to really understand the biological basis of salmon production, we need to know the scale of faithful homing, the stability of demes, and the way demes interact in metapopulations. To delineate salmon demes, we need to know the specifics of straying, introgression, and local adaptation — things that are almost entirely unknown for salmon.

What *is* possible is our ability to critically examine harvest policies that are practical and feasible, and then choose only from those policies that reduce risk and protect demes indirectly. For example, managers can ensure they are allowing escapement from all temporal segments of the run. Schmidt et al. (1997) found that constant-harvest rate policies have unintended biological and management consequences that can lower stock sizes and reduce stock productivity in sockeye salmon — 2 things that threaten demic structure. Eggers (1992) showed constant-harvest rate policies provide less protection and lower stock sizes during years of weak runs, as compared to fixed-escapement goal policies. Ironically, constant-harvest rate policies have traditionally been referred to as "risk adverse" (Deriso 1985) for reasons having nothing to do with risks to sustainability or genetics, but rather as a way to characterize some kind of optimum harvest.

The academic foundation of salmon management came from an optimistic goal to maximize the yield from an aggregation of stocks (e.g., Bevan 1986), not from scary concerns about risk and loss (see Snedaker and de Sylva 1994 for a tongue-in-cheek example of what we mean). Expensive catastrophes occur almost daily while striving for optimum use of one thing or another. Examples include the loss of salmon in the Snake River, loss of groundfish off George's Bank, misuse of capital in the savings-and-loan scandal of the 1980s, and many similar examples you can find in any newspaper. Why do disasters result from trying to make optimum use of electricity, social well-being, fish, and timber production? Part of the explanation is given by Clark (1991), who discussed the bias against sustainable development.

In resource management, a closely related answer is that risk and loss are not taken as seriously as a potential payoff. Decision-makers often frame questions about risk in the form of a statistical hypothesis test when the questions are not fundamentally statistical or about a hypothesis. Decision-makers want substantial evidence against the null hypothesis of "no problem" before the alternative hypothesis of "big problem" can be used to trigger a prudent but expensive action. Simply capturing the null hypothesis for one side of the argument provides a tremendous tactical advantage.

Like the word *stock*, the word *risk* can mean more than one thing. It can mean a specific undesirable outcome or some measure of the effect of that bad outcome, such as the loss of some amount of money in a gamble. Risk can also mean the probability or chance that this outcome will occur. We use the word *risk* to mean an economic measure of the amount lost when an undesirable outcome occurs, combined with the probability that outcome will occur. Understanding the underpinnings of salmon biology links us to the possible outcomes resulting from our actions. Understanding of the services humans expect to derive from salmon or other animals links us to what we might lose under various unwanted outcomes. In other words, we need to turn the question around from "are *stocks* at risk?" to "just what is at risk?"

A conspicuous point is that it is not the risk to salmon stocks that will motivate expensive conservation actions, it is the risk to benefits these salmon populations afford humans. Obvious services are things like inputs to commercial, subsistence, or recreational fisheries. Slightly less obvious services that many humans desire are ecological inputs — like providing food for bears and other wildlife or just the esthetic value of their existence. More subtle services might be in the form of a buffer against catastrophic loss of salmon breeding populations; for example, one population might be needed in the future as a source of strays to repopulate an area where production is lost. Here, the service is one of insurance. Most can see these animals are important to people now and important to people in the future. But in the future salmon might be important in other ways — including ways we cannot yet imagine.

Estimating the risk various development actions pose to services we value is an economic exercise. An honest review of much of the work in this area shows a poorly reasoned attempt to apologize for consumption and undervalue sustainability (Costanza et al. 1991). The constant attention on *what might be gained* keeps attention off *what might be lost*. In short, we need to frame debates around actions that affect sustainability, in terms of risk, to concrete services from salmon populations.

To really know what's at risk, we need more information. The questions are: What is the scale of homing and straying between demes? How much of the genetic variability represents local adaptation? What is the actual amount of gene flow? To what extent is introgression resisted by local adaptation and selection? How does the loss of one deme affect others? How will these animals respond to unavoidable habitat and environmental changes? What can we do to preserve services from the populations?

To really know what's at risk, however, we need to better understand and express how important the services are that salmon will provide to people in the future. But to make a difference, we need to convince decision-makers that risk is as important as the potential gain when dealing with a risky proposition. In other words, let's look at the best options for rational and sustainable human use of salmon and let's get to work to scientifically define the true worth of salmon and the biological basis of their production.

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