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Noteworthy for Managers

Randall Brown

Here are two examples of programs of possible interest to Interagency Program staff and management.

CVPIA Fish Team

Over the past several weeks a small team of biologists has been grappling with nine actions proposed by the Department of Interior to help increase populations of several anadromous fish using the Sacramento/San Joaquin estuary. Team members include Wim Kimmerer, Marty Kjelson, Roger Guinee, Jim White, Terry Mills, Ken Lentz, Gary Stern, Elise Holland, Chuck Hanson, Serge Birk, Pete Rhoads, and me.

Although the team has made progress defining the actions and designing many of them in the form of tests to better evaluate their contribution to species recovery, there has not been complete agreement on their scientific underpinnings. At the October 8 meeting, the team discussed a process to clarify our understanding of the science behind these and other management actions to protect and enhance fish populations. We agreed that the Interagency Program (perhaps in cooperation with the Modeling Forum) will sponsor one or more workshops to examine X_2 as a management tool. The workshop(s) will probably be held early in 1998. Although we generally agreed to the need for similar evaluations of striped bass and salmon data, we did not agree on a process. Some team members recommended that the Interagency Program conduct these evaluations, but others were not convinced that this was the best forum.

Watershed Protection and Restoration Council

On July 31, 1997, Governor Pete Wilson created the Watershed Protection and Restoration Council, which will be responsible for oversight of State activities to protect and enhance watersheds and the conservation and restoration of anadromous salmonids in California. The council will have a working group (consisting of agency directors and executive officers of Northern California regional water quality control boards and chaired by the SWRCB Executive Officer), a science panel, and three advisory committees. A general program goal it develop a program of California conservation actions that will allow the National Marine Fisheries Service to promulgate a rule that, in effect, allows California to manage the recovery of federally listed anadromous salmonids such as steelhead and coho.

The Watershed Protection and Restoration Council may have direct and indirect effects on the Interagency Program. One direct effect is that Jerry Johns (SWRCB) is deeply involved in the working group and will have less time to devote to IEP activities. The program also includes a requirement to develop a list of recovery and monitoring activities that can protect and conserve anadromous salmonid resources. In the bay/delta and Central Valley, the monitoring could complement existing Interagency Program elements.

Flow Effects and Density Dependence in Striped Bass

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Among the numerous challenges facing fisheries scientists are determining causes of long-term trends, assessing environmental effects on populations, and detecting compensatory mechanisms within populations. This report summarizes some of the analyses I have recently conducted to investigate these issues with regard to striped bass in the San Francisco estuary.

Two features of the bay/delta striped bass population are well known: the influence of freshwater flow and diversions on abundance or survival of young, and the long-term decline. The effects of flow during early development on abundance of adult striped bass is evident in data going back to the 1930s (Stevens 1977). Effects on young bass of outflow (Turner and Chadwick 1972) and export flow (Chadwick *et al* 1977) have also been known for a considerable time. Although the mechanism for effects of exports is obvious, that for flow is not. Proposed mechanisms for increased young survival with increased flow include variation of spawning time, inputs of nutrients or organic matter, dilution of toxic substances, reduced settlement of eggs, turbidity effects on visual predation on young bass, and transport to favorable feeding grounds (Turner and Chadwick 1972; Stevens *et al* 1985).

Explanations for the long-term decline have also varied, but in recent years export flows, and consequent entrainment of young fish, have been advanced as the principal cause of the decline (DFG 1987). Although adult mortality has increased during that time as well, the principal mechanism for the decline has been reported as a positive feedback between entrainment, reduced recruitment, subsequently reduced adult abundance and egg supply, resulting ultimately in still lower young-of-the-year abundance. Bennett and Howard (this issue) offer an alternative explanation: migration of older adults to the ocean has increased since 1977 as a response to generally warmer sea surface temperature, and this migration has reduced the abundance of older, more fecund adults and therefore the egg supply.

Any fish population must have at least one compensatory mechanism to support a sustainable fishery. Compensatory mechanisms or density dependence are most often detected as saturating functions describing the relationship between two successive life stages (most often stock size and recruitment). In the case of a stock-recruit curve, as the spawning stock increases recruitment increases initially, then either levels off (Beverton-Holt curve) or begins to decline (Ricker curve). In either case, there is a restriction in the life cycle that limits the total number of recruits around a maximum called the "carrying capacity". Density dependence may also be detected as a negative relationship between abundance and growth rate, or, less frequently, between abundance and survival or mortality. In the latter case, density dependence is indicated by mortality that increases with increasing population size.

In this report, I present several analyses and draw several conclusions about the decline, the influence of flow and exports, and the effect of density dependence. In contrast to the analyses reported by Bennett and Howard (this issue), I examined only data from within the estuary, and focused mainly on conditions leading up to recruitment at age 3.

Analyses

Striped bass are long-lived and can reproduce repeatedly. Analyses relating abundance of this population to environmental conditions can encounter difficulties with autocorrelation, and results can be difficult to interpret because of the feedback through the life cycle. Therefore I analyzed survival indices (ratios of abundance indices of successive life stages) or mortality (time rates of change of abundance).

Space does not permit a complete exposition of the data used or analyses performed. Briefly, I used a variety of data for various segments of the life cycle of striped bass. These included data on abundance of adults (catch-per-effort data or Petersen estimates based on mark/recapture), adult mortality (based on tag returns), fecundity, abundance of eggs and larvae, and abundance indices and raw data from summer tow-net, fall midwater trawl, San Francisco Bay study, and salvage sampling.

Data analyses focused on the relationship of abundance and survival to flow and evidence for density dependence. Most of the analyses comprised linear regression, in some cases using modern techniques such as robust or tree regression (Venables and Ripley 1994). The analysis was based on explorations of the data using various graphical techniques. Regression and other analyses are reported only if examination of plots of residuals revealed that the assumptions underlying the regression methods were met.

Time Trends

The time course of abundance of adults (Figure 1) reveals three key features. First, all age classes have de-