Compensatory Mechanisms as Relevant to Poseidon's Mitigation Proposal (A Response to Comments dated April 1, 2009 by Pete Raimondi)

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Comment: Per Dr. Raimondi, the conclusion that, "CDP impingement will be compensated for by the . . . 55.4 wetland acres restored or created" assumes that "there is compensatory mortality." Dr. Raimondi states that: "The bottom line is that wetland acreage created or restored based on entrainment impacts cannot be also used to mitigate for impingement impacts unless one invokes compensatory mortality, which is specifically not done in I&E determinations."

Response:

In his comments, Dr. Raimondi does not quarrel with the validity of compensatory mortality (mechanisms) as an ecological principle; it is well established that compensatory mechanisms exist and operate in nature. Rather, he concludes that Poseidon must rely on compensatory mechanisms in order to conclude that the 55.4 acres of mitigation will be sufficient to fully offset projected impingement and entrainment associated with stand-alone operations. Poseidon's mitigation acreage is sufficient, however, to offset both entrainment and impingement *without presuming* .

Compensatory mechanisms

Compensatory mechanisms is the concept that marine life lost due to entrainment does not necessarily disrupt fish populations because the fish populations compensate for the losses. In this context, would presume that entrainment associated with the intake system would not necessarily disrupt the fish populations in the Agua Hedionda Lagoon.

A biological population that persists despite natural fluctuations in the environment must have some level of compensatory process, i.e., an increase in the survival, growth, and/or fecundity with reductions in population size. The concept of compensation is known as "density-dependence" by ecologists, and is fundamental to the understanding and management of all biological populations. This compensatory ability is the key factor that allows fish populations to maintain themselves when subjected to fishing mortality, and is fundamental in fishery management. If compensation did not exist, species could not sustain themselves in highly variable natural environments and in the face of long-term anthropogenic stresses, such as mortality from fishing.

Compensatory mechanisms assumed in fisheries management

The operation of compensation in aquatic populations has been the focus of fishery management research for decades. The role of compensation in present practice of fisheries management and regulation is perhaps best characterized by the following quote from a study by the National Research Council (NRC), Committee on Fish Stock Assessment:

> Many species appear to have strongly compensatory spawner-recruit relationships; that is per capita recruitment increases significantly as stock size decreases. Reference levels are now more commonly based on a % SSBPR [spawning stock biomass per recruit], but the percentage is often specified by analogy with other stocks or by using the results [of comparisons among other biological reference points]. Knowledge of the compensatory capacity of the

> stock is necessary to define the most appropriate biological reference points for a stock. Even without such knowledge, however, a conservative % [SSBPR] still can be selected (Sissenwine and Shepherd 1987). (NRC 1998).

This quote illustrates an important change in fisheries management approach that has occurred within the past twenty years (i.e., taking compensation into account).

The role of compensation in the management of major fisheries by resource agencies is discussed in detail in Hilborn and Walters (1992). Quantitative estimates of compensation are employed in fishery management for such things as stock protection from overfishing and to define criteria for optimal utilization. Different mechanisms of compensation have been well studied in both terrestrial and aquatic systems (Krebs 1985; Hassell et al. 1989) for most animal groups (Hassell 1978) and for plants (Harper 1977).

Population processes such as survival, growth, reproduction and movement (e .g., migration) are density-dependent if their rates change as population density changes. Processes that limit population growth at high densities (e.g., lower survival, growth and immigration), or increase numerical growth at low population densities (e .g., higher survival, growth and emigration) are examples of direct density dependence or, compensation. Direct density dependent or compensatory processes tend to stabilize population size.

Recent fishery management regulations implemented the 1996 Sustainable Fisheries Act (amending the Magnuson-Stevens Fishery Management Act) call for overfishing definitions to be based on measures of spawning biomass or other measures of productive capacity (NMFS 1998). These revised guidelines called for overfishing and overfished thresholds to be defined in terms of a maximum fishing mortality threshold (based on spawning stock biomass per recruit) and a minimum stock biomass threshold (spawning stock biomass), or reasonable proxies thereof. Fishing based thresholds should be set to obtain a long-term average catch approximating Maximum Sustainable Yield.

These regulations are based on the belief that fishery stocks can be reduced via fishing to levels well below their unfished stock biomass without the stock suffering long-term declines in recruitment (recruitment overfishing). This indicates that government resource agencies explicitly rely on compensation when determining allowable fishing levels. The basis for a sustainable fishery is that the fish population has the ability at some densities to increase at a rate greater than that required for replacement (Goodyear 1993). In short, fishery managers consider the removal of 70 to 80 percent of an unfished stock's biomass, and 65 to 80 percent of a stock's reproductive potential, to be safe, given the compensatory reserve inherent in most fish stocks. This suggestion is supported by the scientific literature (e .g., Clark 1993; Goodyear 1993, 1996; Mace 1994).

Recent studies include the use of life history theory to develop a general framework for comparing the population dynamics of different fish species. Fisheries biologists have conducted many long-term research studies to estimate abundance over time. These studies can be used to estimate the extent of density dependent mortality and, if performed over multiple life-history stages, can be used to infer at which life-history stage compensation is occurring.

Yield-based measures have traditionally been used to determine if overfishing is occurring-whether individuals are caught before they have grown to a size that will maximize yield per recruit. Spawning biomass-based measures (e .g., stock biomass per recruit or spawning stock biomass) are used to determine if overfishing is occurring- whether fishing will affect the stock's ability to replace itself which also takes into account compensatory mechanisms..

Extensive studies of commercially important demersal fish have revealed a strong influence of density on mortality in the juvenile demersal stage after settlement to the bottom with the most extensive analysis was carried out by Myers and Cadigan (1993 a and b). They compiled and analyzed all long-term surveys for marine and estuarine demersal fish from which density dependent mortality could be reliably estimated. They tested the hypothesis that population variability is created and regulated at the juvenile stage for seventeen populations of cod (Gadus morhua), haddock (Melanogrammus aeglefinus), whiting (Merlangius merlangus), plaice (Pleuronectes platessa), yellowtail flounder (Limanda ferruginae) , and sole (Solea vulgaris) in the North Sea, Irish Sea, Barents Sea, Baltic Sea, the New England coast and the Grand Banks of Newfoundland. Myers and Cadigan concluded that the juvenile stage was crucial for density-dependent population regulation in these species but that the source of interannual variability in year-class strength occurs during the larval stage or the very early juvenile stage. This provided some of the scientific basis for the use of compensation by fisheries managers. Gobies are also a demersal species.

Compensatory mechanisms in the context of impingement and entrainment studies

The use of compensatory mechanisms has long been a contested issue regarding impingement and entrainment determinations (McFadden 1977). In many cases, data available has simply been inadequate to demonstrate compensatory mechanisms. For example, Richkus and McLean (2000) had been consultants for the Maryland Power Plant Siting Commission and its subsequent commissions and addressed the issue for many years in the Chesapeake Bay. After decades of study, they concluded that the large losses of fish in cooling water intakes were not having an impact on the fish in the Chesapeake Bay. The primary reason for this conclusion is the fish populations’ ability to make up for those losses due to compensatory mechanisms.

Poseidon could have assumed in Agua Hedionda Lagoon when projecting mitigation acreage, but it conservatively did not. Instead, Poseidon calculated entrainment and calculated impingement and is establishing sufficient mitigation acreage to fully offset both.

Conclusion

Compensatory mechanisms are an accepted scientific fact. They are used by regulatory managers in the management of recreationally and commercially important fish populations. It has been incorporated by Congress into the Magnuson Stevens Act. Poseidon Resources has conservatively not included compensation into its estimate for the mitigation acres.