California State Water Resources Control Board Hearing Regarding the Salton Sea

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Salinity Effects

In my previous testimony, for the Planning and Conservation League, I described selected key aspects of the present-day ecosystem of the Salton Sea. The water transfer, if it is carried out as planned, will have the effect of increasing the rate at which the Sea becomes more saline, which in turn will have dramatic impacts on the Sea ecosystem.

Now let me turn to a consideration of **how this ecosystem might be affected by an increase in salinity** from the present level of 43-46 g/L. The framework used for this exercise by the EIR seems inappropriate, and its detailed conclusions about critical salinity levels for particular species and processes by and large unfounded. Unfortunately, I cannot present an alternative set of conclusions, but I can lay out a better framework.

I find myself obliged to repeat essentially the same critique I offered in 1991of two efforts to assess the consequences of increasing salinity at Mono Lake (Hurlbert 1991). One was carried out by a committee of the National Academy of Sciences, another by a group assembled by the Community and Organization Research Institute at UC Santa Barbara.

First, we should not be focusing on critical salinities, those that will halt reproduction or cause extinction of particular species. **We should focus on how production varies with salinity.** Abundance or productivity of a given population can be expected to change continuously as salinity is gradually increased over any given range. For most species large decreases in production will have occurred long before salinity gets to the point of halting reproduction or killing all individuals in the species. For neither the pelicans or the fishermen will it matter when the last 10,000 tilapia kick the bucket - the pelicans and fishermen will have left long before that point is reached.

As we analyze the impact of this transfer on the fish and wildlife of the Salton Sea, what this means
is this - to the extent the transfer speeds the rate at which the sea becomes more saline, it will have an immediate, adverse impact on fish species. The impact will not simply register the day a certain
threshold is crossed, it will begin as soon as inflows to the Sea decrease and it will increase in severity as the transfer ramps up.

In the EIR for the transfer, the focus on critical salinities has served to obscure and minimize the impact the transfer may have. At the Salton Sea, we should be concerned with **production of invertebrates** as these constitute food supplies for fish and birds - and with **production of fish** as these constitute food supplies for fishermen and birds. What we need to know is how production varies with salinity to for each of the more important species.

In my critique of the Mono Lake evaluations, I presented this figure. **[Mono prodn-sal curves]**
It contrasts two ways of thinking and talking about these things -- one emphasizing a gradual change model and the other emphasizing a 'plateau and threshold' model. The latter involves thinking in terms of critical or threshold salinities. Production is more or less constant over a wide range of salinities, and then suddenly it is crashing and the species is tumbling down a cliff.

This way of thinking produces statements such as "Tilapia abundance likely would decline at salinity levels greater than 60 g/L" (EIR, p. 3.2-147). Such statements abound in the EIR and none can be justified. They are especially dangerous because these numbers are then used to estimate differences among project alternatives as to when doomsday would hit for a species. And those estimates are implied to be a reliable basis for deciding among alternatives.

There are also numerous instances of internal inconsistency. So we also read that the probability of "reproductive failure for tilapia [is] moderate to high" at 50 g/L (EIR, Table 3.2-43). This seems to conflict with the earlier statement.

Unfortunately we do not know what true salinity-production curve is for tilapia or any other species.

If the curve for tilapia looked like that for X-5 in the bottom graph, then the hump would probably be at a salinity of 10-15 g/L. And current tilapia production in the Sea might be a half or a quarter that. Presumably the rise in salinity over the last few decades from 35 g/L to 45 g/L has already had a depressing effect on tilapia production. That is to say, other things being equal, we would expect tilapia production to increase if we could lower the salinity to 35 g/L now.

All of this argumentation ignores the multiple indirect effects of salinity. These can be strong but we have no way of estimating them. Tilapia populations, for example, would be affected if salinity altered abundances of the species that prey on them (corvina), that they eat (zooplankters), that parasitize them (*Amyloodinium*), or that compete with them.

We are in a position to say only that all fish in the Salton Sea are stressed by current salinity levels and that reproductive rates, survival rates and individual growth rates - the determinants of production - are differently affected by salinity in each species. We do not know at what salinity any one of these species will disappear from the system.

Of course, as decisionmakers you are concerned with what this uncertainty means for whether the

transfer will have an unreasonable effect on fish and wildlife. Let us consider what we do know. all
fish in the Salton Sea are stressed by current salinity levels. The transfer will accelerate the increase in the rate of salinity, at least if the transfer is carried out in the way proposed in the EIR. That will further stress the already stressed fish species in the Sea. Reproduction that is currently sporadic will become more sporadic, and ultimately, populations will decline sooner than they would have in the absence of the transfer.

From a short-term management perspective, then, we should be concerned about any action that has
the potential to reduce inflows to the Sea, as any such action will have adverse impacts. From a long-
term management perspective we should be worrying about how to lower salinity soon and what problems would be caused for fish-eating birds if the fish populations crashed. Fish can always be restocked but a few years without this as a feeding ground could be a serious problem for some fish-eaters.

The EIR emphasizes **how productive the Salton Sea would become of halotolerant species** such as brine shrimp and brine flies once fish were gone (EIR, p. 3.2-141). It holds up Mono Lake as a model, as a lake used by large numbers of invertebrate-eating birds. This scenario neglects some fundamental issues.

First, as salinity increases beyond the point where fish have been eliminated, the productivity of these halotolerant species decreases. They must divert more of the energy they obtain from food to osmoregulation and less to growth and reproduction. Highly saline lakes have low rates of production per unit area, even if a few species might become very abundant.

More fundamentallly, Mono Lake and the Salton Sea are radically different **[Mono vs Salton]**
types of lakes, as shown in the following table (Mono Lake information
courtesy of R. Jellison, Sierra Nevada Aquatic Research Laboratory). Mono Lake in several ways is a much more benign lake for brine shrimp and brineflies than is the Salton Sea, despite its high salinity and high pH.

In the Salton Sea, appearance of brine shrimp probably would not occur until the predaceous copepod *Apocyclops* disappeared. It has been show to be able to reproduce at salinities up to at least 68g/L (Dexter 1993). Thus there likely would be a long interval between the time the fish populations crashed and the time brine shrimp appeared in abundance. In Mono Lake, on the other hand, a high pH will preclude such predaceous copepods from colonizing the lake and affecting brine shrimp even when the salinity decreases further.

Brinefly larvae are likely to be restricted to much shallower water at the Salton Sea than they are at Mono Lake, mainly because consistently good summertime oxygen conditions occur to much greater depth at Mono Lake than at the Salton Sea. Just as the benthic pileworm is now restricted to very shallow waters during the warmer half of the year, so will be the benthic brine fly larvae.

. Light penetrates to greater depths in Mono Lake also, allowing more extensive growth of the benthic algae the brinefly larvae feed on.

If the Salton Sea shriveled up so much that it became very shallow, the water column would be better mixed and benthic algae could occupy more of the bottom. But the lake would be very small and extremely saline, and produce very little food for birds.

Likewise with respect to the Great Salt Lake. Birds do feed on brineflies and brine shrimp there too, because the lake is huge. But on a per unit area basis the lake has a low productivity simply because of its very high salinity (> 200 g/L).

If the Salton Sea increases markedly in salinity and decreases markedly in surface area, it will not become like Mono Lake or the Great Salt Lake. It will soon become like the large, highly saline, generally bird-free pond behind the dike between Rock Hill and Obsidian Butte. Not in size perhaps, but in value to wildlife and recreation.

I thank you for the opportunity to present this testimony.

References

My testimony is based on information that is summarized in particular documents or in manuscripts in preparation , as well as on personal observations made in the field at the Sea over many years. The principal documents used include, in addition to the water transfer EIR itself:

Detwiler, P. M., M. F. Coe and D. M. Dexter. 2002. The benthic invertebrates of the Salton Sea: distribution and seasonal dynamics. Hydrobiologia (in press).

Dexter, D.M. 1993. Salinity tolerance of the copepod *Apocyclops dengizicus* (Lepeschkin, 1900), a key food chain organism in the Salton Sea, California. Hydrobiologia 267:203-297.

Hurlbert, S.H. 1991. Salinity thresholds, lake size and history: A critique of the NAS and CORI reports on Mono Lake. Bull. South. California Acad. Sci. 90:41-57.

Riedel, R. and Costa-Pierce, B. 2001. Review of the fisheries of the Salton Sea, California, USA: past, present, future. Reviews in Fisheries Science 9:239-270.

SSERG. 2001. Reconnaissance of the biological limnology of the Salton Sea: final report. Salton Sea Ecosystem Research Group, Department of Biology and Center for Inland Waters, San Diego State University, San Diego, California. 1100 pp. [this contains many manuscripts that are now either published or in press, as well as some preliminary reports].

The benthic invertebrates of the Salton Sea: distribution and seasonal dynamics.

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Abstract

The distribution and seasonal dynamics of the benthic macroinvertebrate populations in the Salton Sea were investigated during 1999 by bimonthly sampling of bottom sediments at depths of 2–12m, shallow water rocky substrates, and littoral barnacle shell substrates in the first survey of the invertebrate community since 1956. The macroinvertebrates of the Salton Sea include only a few species, most of which thrive on several different substrates. The principal infaunal organisms are the polychaetes *Neanthes succinea* and *Streblospio benedicti,* and the oligochaetes *Thalassodrilides gurwitschi, T. belli,* and an enchytraeid. All but *Neanthes* are new records for the Sea. Benthic crustacean species are *Gammarus mucronatus, Corophium louisianum*, and *Balanus amphitrite*.

The pileworm *Neanthes succinea* (Frey and Leuckart) is a key prey species for fish and birds, and is the dominant macroinvertebrate on the Sea bottom at depths of 2-12 m. Area-weighted estimates of standing stock of *N. succinea* in September and November 1999 were 2 orders of magnitude less than biomass estimated to be present in September and November 1956. During 1999, population abundance varied spatially and temporally.

Abundance declined greatly in offshore sediments at depths >2m during summer and fall, due to decreasing oxygen levels at the sediment surface. In contrast, *Neanthes* persisted year round on shoreline rocks, where densities of all invertebrate species and biomass of *Neanthes* increased from January to November. The rocky shoreline had the highest numbers of organisms per unit area. In that habitat maximum densities of *Neanthes* and the amphipods *Gammarus mucronatus* and *Corophium louisianum* exceeded previously reported values for those species from other locations. This demonstrates the high productivity of the Salton Sea, and the importance of the rocky shoreline habitat as a refuge for *Neanthes* and other food organisms for fish and birds during seasonal anoxia.

Introduction

The Salton Sea has great ecological importance within the Pacific Flyway for migratory and resident bird species due in part to the abundant invertebrate populations that serve as a food base for birds. Restoration objectives of the Salton Sea Reclamation Act of 1998 include maintaining habitat components for waterfowl as well as maintaining the present fishery. The infaunal polychaete *Neanthes succinea* is the most important benthic link between the detritus accumulating on the sediments and the higher trophic levels including predaceous fish and birds, and constitutes a major portion of the diet of adult bairdiella and juvenile orangemouth corvina between 30–60 mm (Quast, 1961; Whitney, 1961). Despite the importance of *Neanthes* in the trophic structure of the Salton Sea ecosystem, there have been few ecological studies on this species at the Salton Sea. The abundance and standing stock of *Neanthes* in sediments were last estimated in 1956 by Carpelan & Linsley (1961a), but shoreline habitats were not examined. More recent