Apologia

Tactical Investigations Proposals from SDSU

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A number of tactical investigation proposals were outlined by myself prior to the task force meeting. A few may be written up prior to or early in the meeting. These are not intended to forestall the team approaches to developing proposals, but the SDSU contingent is in an unusual position relative to the task force and its objectives. I have been teaching a course on the ecology of the Salton Sea-Lower Colorado Delta for about 20 years and my lab has been doing ecological research on the Salton Sea for about 7 years. We currently have 6 manuscripts in press or in preparation, based mostly on a 15-month long Salton Sea experimental microecoystem study that examined the effects of 5 salinity levels (30, 39, 48, 57, and 65 g/L) and of tilapia grazing on plankton, benthos, and nutrient cycling.

During this past year we have also prepared and submitted to federal agencies two large research proposals for work at the Salton Sea. Our tactical investigation proposals represent abstracts of components of those proposals as well as some new ideas. One of our large proposals titled "Harmful algal blooms at the Salton Sea, California" was submitted to the NSF/EPA/NOAA Program on the Ecology and Oceanography of Harmful Algal Blooms (EcoHAB). It received very good reviews but was not one of the 10 proposals funded. Of the 60 proposals submitted, it was the only one focused on a lake, and it was in competition with proposals from all the strongest marine laboratories in the country for funds designated for marine research!. It will be revised and resubmitted. A second proposal titled "Fish Ecology, Nutrient Budgets and Eutrophication Reversal at the Salton Sea" is presently under review at NSF.

Tactical Investigations
(SDSU-1)

I. Title: Analysis and Reversal of Eutrophication at the Salton Sea

II. Introduction. The Salton Sea is extremely eutrophic. Phytoplankton blooms of varying composition and color, and including toxic species, are a permanent feature. They yield Secchi disk readings mostly in the range of 20-150 cm and cause occasional extended periods of anoxia in bottom waters and midday oxygen levels in surface waters that often exceed 200% of saturation. When the lake is stratified high levels of ammonia and hydrogen sulfide accumulate in the bottom waters. When the lake subsequently mixes, fish and other organisms are exposed to these toxic substances as well as sudden drops in oxygen levels. It is thought that toxic algal blooms may have been one cause of wildlife mortality at the lake, but no definitive tests of this idea have been carried out. In a few episodes, diseases,such as avian botulism or Newcastle's disease have been determined to be the proximate causes of bird die-offs. The fundamental problem, however, is eutrophication. As the lake has no outlet and as inflowing agricultural wastewaters are high in nutrients and agricultural chemicals, these continue to build up in the system. Domestic wastewaters, treated and untreated, and storm run-off also flow into the Sea and contribute nutrients in lesser amounts.

The dense phytoplankton blooms also, for most people, reduce the lake's attractiveness for water-based recreation. Odors occasionally produced by decomposition of organic matter in the lake have the same effect.

The only serious study of the lake's eutrophication was carried out in the late 1960s by the Federal Water Quality Administration (USDI 1970). The study had some methodological difficulties, but it estimated loading rates to the Salton Sea of 0.022 moles $P/m^2/yr$ and 0.93 moles $N/m^2/yr$. These are very high. The molar ratio of total P to total N (TN:TP) in the annual inflow was 42, and in the lake itself it varied seasonally over the range 51-155. These high ratios make it very likely that if phytoplankton abundance is nutrient-limited, it is P, not N, that is the limiting nutrient. The report suggested that the phytoplankton was more likely limited by light (self-shading) than by nutrients, but this is uncertain. In any case, it seems clear that if reversal of eutrophication is to be attempted it would be more readily and efficiently accomplished by P removal than by N removal.

There are two principal ways in which eutrophication might be reversed. One would be by a two-way pumped exchange of water between the Salton Sea and the Sea of Cortez. Another would entail both harvesting of P from the lake, perhaps via tilapia harvests, and simultaneous reduction of P loadings to the lake.

Because tilapia appears to be very abundant, feeds on both phyto- and zooplankton, and is fast growing, it has promise as a vehicle for P removal. This was demonstrated in a Salton Sea microecosystem experiment conducted at SDSU. Six months after a single 8 g, juvenile tilapia was introduced in an experimental tank, water column TP was reduced by 64 percent as the tilapia grew to 28 g (Gonzalez et al. 1997). The initial stocking rate was equivalent to 130 kg

of fish per hectare. This is probably lower than the standing crop of fish in the Salton Sea.

If a tilapia harvest approach to nutrient removal is feasible and desirable, it should be implemented soon as it will depend on high tilapia densities and growth rates, and these will decline as salinity continues to increase.

III. Justification. There are likely several proximate causes and mechanisms for current wildlife losses at the Sea. We believe, however, that eutrophication and algal blooms are a root cause for most of them . Even if salinity levels can be lowered by the large engineering projects under consideration, wildlife losses are likely to continue unless eutrophication can be reversed.

IV. Objectives. The general objectives are to determine the amounts of N and P entering the lake, their specific sources, their behavior within the lake, and the possible ways of reducing them. Specific objectives are:

A. To determine nutrient loadings and their sources by intensitve monitoring of inflow waters over two years. This will be an update of the USDI (1970) study of 30 years ago.

B. To determine the degree to which nutrients in the sediments are susceptible to being recycled back into the water column and to what extent they seem to be indefinitely immobilized in the sediments. This will make use of nutrient data for the lake itself that are being gathered under a separate research project.

C. To assess potential methods for and economic feasiblity of reducing nutrient loadings from specific source, e.g. by reduced wastewater production, tertiary waste water rtreatment, or artificial tilapia-periphyton systems (Drenner et al. 1997).

D. To determine the rate of incorporation of nutrients into fish tissue and the feasibility of significant nutrient reduction via harvesting of both fish kills and live fish. This will make use of fisheries data gathered under a separate proposal.

E. To investigate the technical, economic, and legal aspects of commericializing the large scale harvest of tilapia for use as human food, animal food, or fertilizer.

F. To develop models for the above systems, subsystems and relations.

G. To recommend nutrient reduction steps and pilot projects for tilapia harvesting, depuration, and commericialization of fish product.

V. Products.

A. Year 1: nutrient budget for comparison with that of 1968-69; preliminary analysis of nutrient reduction and removal possibilities

B. Year 2: two-year nutrient budget information; recommendations for restoration methodologies.

C. Year 3: data analysis and report writing; implementation of pilot projects

VI. Anticipated Focus of Recommendations. The results of this research bear on goals 1B and 1C, are fundamental to understanding of the lake ecosystem and to all proposals for its restoration to a healthier state.

References

Drenner, R.W. et al. 1997. Ecological water treatment system for removal of phosphorus and nitrogen from polluted water. Ecological Applications (in press).

Gonzalez, M. R., C. M. Hart, J.E. Verfaillie, & S. H. Hurlbert, 1997.Salinity and fish effects on Salton Sea microecosystems: water chemistry. Hydrobiologia (in press).

U .S.D.I., 1970. Salton Sea California: water quality and ecological management considerations. U.S. Dept. Interior, Federal Water Quality Administration, Pacific Southwest Region. 53 pp.

VII. Budget.

Category	*Year 1*	*Year 2*	*Year 3*
Personnel	99,700	101,300	103,000
Equipment	42,000	0	0
Supplies	12,700	6,900	6,400
Travel	16,100	17,500	17,500
Indirect Costs	70,000	63,000	64,000
Total costs	240,500	188,700	190,900

VIII. Recommended Entities to Perform Work: SDSU Center for Inland Waters, in collaboration with CRWQCB, CVWD, and IID?

IX. Submitted by:

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