ABA Consultants P.O. Box 1151 Capitola, California 95010 (408) 479-0277
Environmental Research, Assessment and Planning

Moro Cojo Tidegates 1990 Monitoring Report

Prepared For

Monterey County Flood Control District

P.O.Box 930
Salinas CA 93902

Prepared By

ABA Consultants

January 15, 1991

ABA Consultants P.O. Box 1151 Capitola, California 95010 (408) 479-0277
Environmental Research, Assessment and Planning

Moro Cojo Slough Tidegates 1990 Monitoring Report

Prepared for

Monterey County Flood Control District

15 January 1990

1. BACKGROUND

During November 1988 the tide gates for the Moro Cojo Slough at Moss Landing Road were replaced by the Monterey County Flood Control District. ABA Consultants wrote a biological assessment which recommended that the tide gates be opened slightly to allow limited saltwater input into the mouth of the slough. This restricted tidal exchange was meant to simulate the conditions that existed before the tide gates were replaced. The final decision on the amount of tidal flow to allow into Moro Cojo was to await the completion of the final Moro Cojo Wetland Management Plan. The Monterey County Planning Department is mandated to complete the Moro Cojo Plan as part of the Local Coastal Program, and the plan completion was required as a permit condition to the Flood Control District for the tide gate replacement. The Moro Cojo Plan has not yet even been started, so the final decision on the amount of salt water to allow up Moro Cojo is still pending.

As part of the permit conditions for the tide gate replacement, the Flood Control District was required to periodically monitor the mouth of Moro Cojo, and submit letter reports to the Coastal Commission with the observations and recommendations for changes in the tide gate level. To fulfill this requirement, ABA Consultants has made two site inspections, in April and November, 1990. The results and recommendations are presented herein.

2. SITE INSPECTION OF APRIL 7, 1990

2.1. METHODS

Data were collected by using non-quantitative visual observations of habitats, by semi-quantitative sampling through examination of scoops of intertidal and subtidal sediments, and by hand-operated beach seine sweeps.

2.2. TIDE GATES

The tide gates were observed during ebbing and flooding tides. Under both tidal regimes the gates allowed a reasonably strong flow of water. Salinity on both sides of the gates was 34 parts per thousand, normal for seawater. Because of the bottle-neck effects of the tide gates under Moss Landing Road there is a lag in time and magnitude of water level on the west side of Highway One. That effect is even greater on the east side of the Highway One culverts where the tides are delayed by several hours.

2.3. FLORAL PATTERNS

Numerous large sheets of *Ulva*, a green alga, formed dense matrices up to 2 plus feet thick. These robust growths were particularly dense in the lower part of east Moro Cojo (within 200 - 300 feet east of the tide gates) and in west Moro Cojo. There was little *Ruppia* (Ditch-grass) on the west side and it was greatly reduced on the east side from the previous observations (October 1988). The densities and distribution of *Enteromorpha* appeared similar to but somewhat greater than those in October 1988, generally replacing *Ulva* east of the Highway One culverts in east Moro Cojo. Undoubtedly a pulse in growth owing to normal spring activity is responsible for some of the vigor of these two plants. These two species provide cover and habitat for the amphipods and Brackish-water Snail.

2.4. FAUNAL PATTERNS

2.4.1. Endangered Species

The strong flow of water through the culverts results in homogeneous water conditions on both sides, and therefore similar habitats with similar fauna. Consequently, the Brackish-water Snail, an endangered species, was abundant on both sides of the culverts in about the same order of magnitude as it was on just the east side during the October 1988 survey, i.e. in densities of 10,000's per square meter. This pattern of snail densities is similar to that observed by Kellogg (1980), and unlike our 1988 observations when densities were low on the west side.

2.4.2. Invertebrates

Several species of amphipods were more abundant this April than in the 1988 survey: *Eogammarus confervicolus*,*Allorchestes angusta*, and *Corophium insidiosum*. Individuals of all three species were conspicuously abundant and actively swimming. A high proportion of individuals of all three of these species were in a vigorous reproductive phase: coupling and with females carrying eggs. The pulse in population size and surge in reproductive activity were undoubtedly a function of normal spring-time activity coupled with the very favorable habitat and low level of predation. Other invertebrates were present, such as spionids (polychaete worms), flies, and *Battilaria* snails the populations of which appeared similar to those of 1988.

2.4.3. Vertebrates

A single site inspection cannot produce a comprehensive bird census. Previous incidental observations have indicated normal bird use: Long-necked Stilts and various other species of shorebirds, gulls, and ducks were seen. In April 15 Western Sandpipers

were observed feeding on *Eogammarus* along the shallow.intertidal flat east of the highway. The birds were taking advantage of the large population increase of the amphipod which probably forced many individuals to the peripheral habitat of shallow water and little algal cover.

The predominant fish captured from beach seine sweeps was the Arrow Goby (*Clevlandia ios*), a small fish noted for its non-obligate occupation of invertebrate burrows. More than a dozen were captured from both sides of the tide gates. One Threespine Stickleback was taken from the east side and 1 Staghorn Sculpin from the west side.

3. SITE INSPECTION OCTOBER 3, 1990

3.1. METHODS

We visually inspected the Moro Cojo Slough in the vicinity of the Highway One culvert and the Moss Landing Road tide gates. The site visit was on 3 October 1990, during mid-morning. Qualitative and semi-quantitative samples were obtained by visual inspection, scooping water, sediment and algae and by sieving known areas of sediment (diameter of the sieve) and estimated volumes of water through a 500μ screen.

3.2. TIDE GATES

3.2.1. Water

The water in Moro Cojo Slough from the tide gates under Moss Landing Road on up stream appeared to have no currents, aside from a faint flow on the immediate surface generated by breezes. The standing water was high, at the level of a fairly high tide. The only evidence of water movement was the sound of trickling water echoing and resounding through the tide gate under Moss Landing Road, where Moro Cojo meets the harbor.

Water temperature was normal throughout most of the slough, about 16° to 18°C. However on the east side of Highway One the bottom 10 to 20cm of water was much warmer, around 25°C. This odd temperature inversion is probably the result of warm surface water warming, evaporating, becoming hypersaline and therefore heavier, then sinking to the bottom. Field estimates of salinity indicated hypersaline water, probably 40 parts per thousand (35 ppt or less is normal for seawater). The temperature inversion and hypersalinity are manifestations of the lack of mixing currents.

3.2.2. Sediments

Bottom sediments were anoxic everywhere that we looked: from several hundred yards east of Highway One all the way to the tide gate under Moss Landing Road. The sediments were anoxic even at the sediment/water interface probably due in part to the heavy cover of vegetation overlying the the bottom. While most of the vegetation was living, it clogged the entire water column and helped prevent any water movement, thereby resulting in stagnation and anoxia. Dead plant material settling to the bottom would charge the system with organic material to be broken down anaerobically if not enough oxygen were present. However, the bottom sediments were anoxic over the entire bottom as far as we could tell, even where vegetation cover was not heavy. Consequently, the cause of anoxia is probably simply lack of water flow, to which the dense vegetation only contributed.

3.3. FLORA PATTERNS

Moro Cojo Slough, east of Highway One, was choked with a dense growth of Ulva. Ulva along with Enteromorpha comprised 100% of the bottom cover for several hundred feet east of the Highway One culvert. Dense vegetation cover continued up-slough to the first bend, and even to the relict fence gradually thinning past there. Only a small amount of Ruppia occurred, and only near the fence. There was some dead and bleached Ulva on the alkali flat surface on the south border of the slough, especially on the west shore (i.e. next to the Highway One embankment). Dense Ulva completely covered the water surface immediately to the west of Highway One. No Ruppia was present there and virtually no Enteromorpha. Ulva was the dominant plant near the Moss Landing Road culvert also, although here it was broken into small pieces, apparently by the domestic ducks that live here.

3.4. FAUNAL PATTERNS

3.4.1. Endangered Species

The Brackish-water Snail was found only on the east side of Highway One, and only in the southwest corner of that part of the slough next to the highway embankment. The anoxic sediments prevented them from inhabiting the bottom. Snails were moderately abundant on Ulva within that very specific and limited area, only a few square meters in extent. The snails were found only within of the Ulva habitat. The snail density there was in the magnitude of a few thousand per meter square. We inspected Ulva over the greater part of both sides of the Highway One culvert and found no more snails. These observations contrast markedly with our spring observations wherein we observed many snails over a relatively wide areal extent.

3.4.2. Other invertebrates

We saw some Battilaria snails along the east edge of the Highway One embankment bordering the slough on the east side of the highway. Typically, these animals occurred in the mud right at the water level. In the same part of the slough a few water boatmen (Insecta:Corixidae) occurred. And a few amphipod carcasses, entire but decomposing, were observed there. It is extraordinarily rare to see dead amphipods such as these, old and decomposing but whole. They were indicative of undisturbed and very stagnant water and an absence of predators/scavengers. Spionid (polychaete worms) tubes were present last spring, many thousands per meter square in the mud by the relict fence. In fact that area supported a dense mat of their tubes. This fall only a few tubes were extant under the Ulva cover, and these tubes fell apart upon being touched. The anoxia, water level and faunal condition of this part of the slough is in very strong contrast to its condition last spring.

On the west of Highway One, serpulid (polychaete worms) tubes were the dominant faunal element. These small, coiled, calcareous tubes were affixed to the Ulva in great numbers, several to many tens of thousands per square meter. Serpulids are opportunistic animals with planktonic larvae. They may settle in large numbers on available, but usually temporary, habitat. Water boatmen, also very opportunistic animals, are inhabitants often of very marginal, biologically unattractive settings. Many water boatmen occupied a heavily anoxic smelling basin next to the main body of the slough.

Near the tide gates under Moss Landing Road ducks had stirred up the water and the bottom so that the water was muddy and had an anoxic smell to it. Here we observed quite a few (thousands per square meter over about 10 square meters) *Nebalia pugettensis* , a small invertebrate that often typifies slightly anoxic mud. We had not observed these animals in the Moro Cojo Slough previously.

3.4.3. Vertebrates

We observed no birds except a half dozen domestic ducks near the Moss Landing Road tide gate. The anoxic conditions would probably be repulsive to birds attempting to feed within or even near the sediment. Furthermore there was little for birds to feed on.

Two fish were observed, both near the east side of the Highway One culvert. Both fish were Three-spined Sticklebacks, one was dead and the other alive. The dead fish did not appear to have been dead long and there was no apparent cause of death. However the anoxic conditions, hypersaline water, relatively high water temperature, and lack of

prey produced an unfavorable environment in which a dead fish would not be unexpected.

4. WATER QUALITY OBSERVATIONS

4.1. WATER DEPTH OBSERVATIONS

Water depth measurements at the tide gate were made by Flood Control District staff from 5 December 1988 to 11 December 1990. Readings were taken from a tide staff placed 30 feet south of the tidegates. The results, tabulated in Table 1, show that the tidegate opening served to maintain the water depth in the range from -1.1 to -2.4 feet NGVD. The majority of the readings are within the range that was proposed in the original biological assessment of -1.5 to -2.0 feet NGVD, however there were times when the depth ranged somewhat above or below the recommended range. The deviation from the recommended range is considered minor, but the water depth range will be monitored over the long term to be assure there are no concerns.

4.2. HYDROLOGY

The Elkhorn Slough Foundation has been monitoring a hydrology station to the east of the Highway One bridge in Moro Cojo for the last several years. Water samples are taken at the surface, and analyzed for salinity, turbidity, pH, and dissolved oxygen. The results are tabulated in ABA Consultants (1990): Highway One Improvement Study Background Report: Surface Water Quality in the Moss Landing Vicinity. The Foundation study, performed by volunteers, provides essential data on hydrological patterns in the Moss Landing/Elkhorn Slough area. The study is marred somewhat by the lack of nutrient analyses. Nutrient analyses (nitrates and ammonia) are necessary to help determine the causes of eutrophication.

5. SUMMARY OF OBSERVATIONS

Animal densities during the fall season might be expected to be much reduced from those densities we observed this spring. However, the extremely low faunal densities in the slough are far below any possible normal seasonal change. Furthermore the kinds of animals present, mostly water boatmen and Nebalians, are indicative of a degraded habitat. These qualitative and quantitative changes from last spring underscore the dramatic chemical and physical changes that have occurred. Water motion appears to be nearly non-existent. This stagnation leads to and compounds temperature increases, hypersalinity, oxygen depletion, and finally anoxia (no oxygen). In turn anoxia strongly limits animal life. And, as demonstrated here, even a fairly robust flora cannot benefit animals in the presence of strongly anoxic muds. The Brackish-water Snail, adapted to

Table 1. Water depth measurements made by Monterey County Flood Control District from December 1988 until December 1990. Measurements are in feet in relation to NGVD.

DATE	TIME	ELEVATION	DATE	TIME	ELEVATION
1988			**1990**		
5 Dec	15:30	-1.5	12 Feb	?	-2.1
12 Dec	13:30	-1.3	22 Feb	11:30	-1.9
1989			20 Mar	11:40	-2.2
3 Jan	13:00	-1.4	10 Apr	12:30	-1.5
5 Jan	?	-2.0	17 Apr	13:00	-1.5
9 Jan	13:00	-1.8	18 Apr	11:30	-1.5
20 Jan	14:00	-2.0	19 Apr	09:30	-1.4
26 Jan	13:00	-1.8	21 Apr	08:30	-1.4
31 Jan	14:30	-1.7	23 Apr	14:15	-1.5
14 Feb	14:00	-1.5	25 Apr	12:00	-1.7
19 June	16:00	-1.7	26 Apr	08:30	-2.1
20 June	11:30	-1.9	30 Apr	07:30	-1.7
26 June	14:30	-1.5	3 May	13:30	-1.8
11 July	15:30	-1.1	7 May	14:00	-1.5
13 July	14:30	-1.4	8 May	10:00	-1.6
22 Aug	14:00	-1.6	16 May	13:30	-1.9
30 Aug	?	-1.6	23 June	08:00	-2.0
12 Sept	?	-1.8	30 June	07:30	-1.6
28 Sept	09:00	-1.8	14 July	07:30	-1.7

DATE	TIME	ELEVATION	DATE	TIME	ELEVATION
1990			22 Sept	10:00	-2.0
15 July	08:00	-1.4	24 Sept.	11:30	-2.0
27 July	10:30	-1.4	1 Oct	14:00	-2.0
13 Aug	09:30	-1.2	2 Oct	08:00	-2.0
17 Aug	09:00	-1.6	22 Oct	10:00	-2.2
20 Aug	09:00	-2.0	25 Oct	11:15	-2.2
21 Aug	13:30	-1.7	27 Oct	09:45	-2.2
22 Aug	13:20	-1.6	2 Nov	10:30	-2.2
23 Aug	15:15	-1.5	5 Nov	10:30	-2.4
24 Aug	09:00	-1.9	16 Nov	10:30	-2.4
27 Aug	08:15	-1.2	21 Nov	11:30	-1.9
29 Aug	14:35	-1.1	26 Nov	10:00	-1.6
30 Aug	11:00	-1.2	30 Nov	10:45	-1.6
31 Aug	14:30	-1.3	4 Dec	14:15	-2.0
4 Sept	14:35	-1.5	11 Dec	13:00	-1.6
7 Sept	09:00	-1.2			
11 Sept	10:00	-1.5			
17 Sept	08:20	-2.0			
21 Sept	08:45	-2.0			

these estuaries, still does poorly when too much water lies stagnant too long. The amphipods that were abundant in the spring are robust and opportunistic species, able to do well in a habitat shunned by most other species. Nonetheless even they cannot withstand the anoxia as it has developed in Moro Cojo. These species are utilized as a food source by vertebrate predators such as birds and fish. Given the lack of invertebrate prey surviving the anoxic conditions, it is not surprising that no birds and only a single individual fish was observed.

We suspect that the on-going drought has compounded the water-quality problems in the tidegate lagoon. In normal years there is probably significant flow down Moro Cojo Slough, which would act to keep the lagoon better flushed. Much of the normal runoff in the summer is probably from agricultural return flows. With the drought, more farmers are probably using water conservation practices, which along with depleted flows from springs, has led to reduced flow in Moro Cojo. When (or if) the drought relents, we expect that the problem might be lessened.

6. RECOMMENDATIONS

1) The comprehensive Moro Cojo Wetland Management Plan should be completed as soon as possible. The lack of a long-term plan severely limits the ability of biologists to manage the habitats around the slough mouth. Particularly given the presence of an endangered species in the area, it is important that the habitat not be allowed to degrade to the point where the local Brackish-water Snail population is destroyed. With the flap valves present on the tide gates at Moss Landing Road, the means for managing the habit is available. All that is lacking is a plan.

2) Until the Moro Cojo Plan is completed, the frequency of monitoring should be increased to keep closer watch on water quality and biological populations around the slough mouth. The current frequency of monitoring allows habitat degradation to be somewhat documented, but does not provide the frequency of data necessary to respond to habitat changes. The recent local history of plan completion indicates that it will probably take from 1 to 5 years for the Moro Cojo Plan to be started, completed, and implemented. Given the observed habitat degradation at Moro Cojo, remedial action should be taken immediately. Even without the completed plan, a responsible group could take steps to prevent further degradation. All efforts should be made to have the increased monitoring program in place by late spring, 1991. Potential problems that might require action, such as anoxic conditions, will probably not be evident until summer. The group contracted to do the monitoring (see 4 below) can determine an appropriate frequency and density of monitoring.

3) The Flood Control District should contract with the Elkhorn Slough Foundation to add a hydrology station at the tide gate to the south of Moss Landing Road. It is recommended that the new station be sampled at least monthly. Such monthly sampling allows an accurate profile of the conditions at the station. In addition to the data normally taken by the Foundation, the water level should be read from the tide staff. An exchange can be negotiated between the Foundation and Flood Control whereby the Foundation monitors the extra station in even exchange for nutrient analyses being run on the samples by the Flood Control District's lab. The Foundation would continue to perform the other analyses (salinity, pH, etc.). The addition of nutrient analyses will enhance the utility of the Foundation Study, and the hydrology monitoring at the Flood Control tide gates is essential.

4) As a longterm goal, we recommend that the monitoring be performed by either the Elkhorn Slough Foundation or the Moss Landing Marine Labs. Both organizations are active in wetland activities in the Elkhorn Slough area, and have much better overview of regional research than other potential monitoring organizations. As non-profit educational institutions, the Foundation and the Marine Lab have a stake in generating as much useful information from the monitoring programs as possible, and seeing to it that it is used in future management projects. There are several wetland monitoring programs currently underway in the region, including the Moro Cojo tidegate monitoring, and several more are possible in the near future. If the maximum amount is to be learned from this activity, it is preferable that all such research be carried out by one organization. The monitoring by the organization will meet the needs and requirements of the various projects and permits in the Elkhorn Slough region, at the same time as making a real contribution to our knowledge of our region.

However, until the Plan is in place, it is appropriate for ABA to continue the monitoring activity. Particularly if the water quality monitoring is being performed by the Elkhorn Slough Foundation, there is no compelling reason for one of the research organizations to take over until it is known what they will be doing. It is also the Flood Control District's expressed desire not to 'switch horses in mid-stream', as the saying goes. ABA can perform monitoring to maintain compliance with the permit conditions for the project, and will be able to wave a red flag if water quality conditions become critical.