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PART 4. COASTAL, ESTUARINE, AND ENVIRONMENTAL PROBLEMS

Treasure Island, St. Petersburg, Florida



CHAPTER 106

ENVIRONMENTAL PLANNING OF A BAY AND COASTAL LAGOON SYSTEM

by

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The 1970s are, it seems, the beginning of an "age of environmental awareness " Never before has our nation been so conscious of the necessity for protection of the quality of its waters, its air, its aesthetic environment, and the productivity of its earth, and never has it been so aware of the potential, within man's actions for progress for the pollution of his environment or the creation of imbalance within the natural dynamic system. The realization is growing that the system of natural dynamics, the ecosystem and the natural aesthetic environment in which we live are, in fact, part of a complete interrelated, interdependent and synergistic "Environmental System " Man made modification of any part of the System carries with it the potential of effects extending throughout the rest of the system, often resulting in major, and at times catastrophic, modification of the natural balance of the physical environment as we know it today.

Though the principles of environmental sensitivity are only newly being adopted by our media, our community leaders and our elected officials, there are some who have been advocating and practicing the principles of environmental planning for some time. It has long seemed logical that major engineering or planning programs, capable of generating extensive modifications to the environment into which they are interposed, should be considered, throughout all their phases in terms of the entire spectrum of environmental factors which make up the site and its surroundings--yet rarely is this the case.

An area of particular environmental sensitivity lies in our ocean and along our coastline. Here nature's forces are at their most dynamic, while her ecological delicacy is often at its most vulnerable. The ocean's waters frequently act as a transfer medium, permitting the impact of man's modification at a specific location to be felt over great distances. We need only to remember any of numerous examples of the loss of beaches, radical modification of coastline characteristics, extensive changes or virtual annihilation of segments of our coastal ecosystem, and the effects of heated waste water emitted from power plant cooling systems upon adjacent ecosystems, to be aware of the potential effects of man's change upon downcoast areas within the ocean system.

Nature is not always capable of coping with her own problems, however. Frequently the natural sediment movement processes at work in our coastal waters or heavy growth of natural plant life can be as instrumental in smothering a portion of an ecosystem as any actions taken by man. Such is the case in many of the intertidal lagoons along the coastline, whose fate it is to disappear, transformed by sedimentation into a muddy meadow, if nature is allowed to run her course without man's intervention.

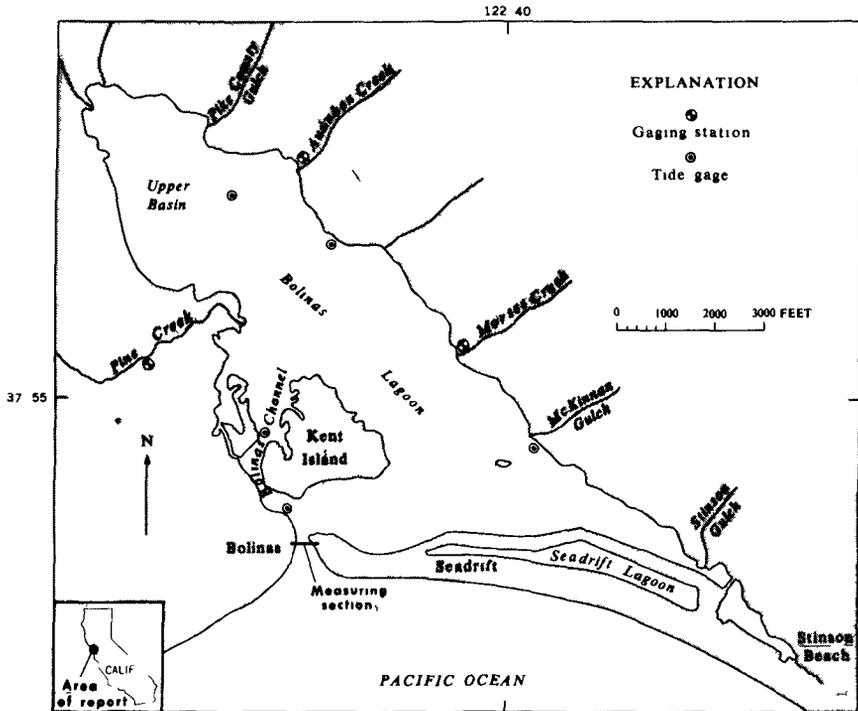


Figure 1 Bolinas Lagoon

Few more illustrative examples of such conditions, combined with the complete range of ocean environmental systems, exists than at Bolinas Lagoon on the west coast of California, twelve miles north of San Francisco (Figure 1). Bolinas Lagoon is a triangular, intertidal coastal lagoon three miles long and one and one-half miles wide, which lies in the rift valley of the San Andreas Earthquake fault which runs the length of the State of California. The Lagoon is separated from the Pacific Ocean by a curving sandspit, which, together with the high cliffs of the Bolinas Headland and Duxbury Reef to the west, form a typical hooked bay configuration. The main channel, the only link between the Lagoon and the ocean, lies between the sandspit and the beginning of the headland at the south-westerly corner of the Lagoon, adjacent to the historical town of Bolinas. Through a geological phenomenon, radically different geological formations flank the Lagoon on either side of the fault, contrasting the softly rolling, steep yet stable, Franciscan formation hills of the coastal range to the east, with the highly erodible miocene marine terraces of the Bolinas Mesa Headlands and the beginnings of the Point Reyes Peninsula to the west. Sedimentation has continued unchecked for centuries, with some encouragement by man's logging operations in the 1870s when the watershed lands were denuded to serve the need for timber for the building of San Francisco. Today the Lagoon's circulatory pattern is virtually

inoperative as a self-flushing, self-maintaining, dynamic system, and an offshore bar has grown across the channel mouth further minimizing the flow of oxygenated tidal water to the Lagoon. The extremely productive ecosystem of the Lagoon shows signs of faltering, with die-off occurring in areas no longer adequately supplied with tidal circulation. Clam populations, subsurface life systems, juvenile fish nurseries which serve the plentiful offshore fishery at the Farrallon Islands, bird feeding grounds, and harbor seal habitats all face the prospect of certain death if the process of nature continues unchecked, and with them will disappear many of man's recreational and sports opportunities, as well as a significant water resource of national and statewide importance.

Man has added to the complexity of the problem. The State of California has, for many years, designated Bolinas Lagoon as a priority site for a primary Harbor of Refuge to serve ocean sailors and fishermen from San Francisco Bay in times of fog, storm and emergency. The Lagoon is heavily polluted due to a continuous inflow of untreated effluent from an antiquated sewage collection system serving the town of Bolinas. The pressures for development of the watershed, as an extension of the growing metropolitan area of San Francisco, are mounting, and the growing flow of tourist visitors to the beaches of the area and to the newly-established Point Reyes National Seashore is placing new stress upon the small beach communities of the area, and upon the Lagoon itself, through a growing demand for use as a recreational resource.

There are still some who advocate inaction in the name of conservation, fearing, apparently, that man's modification of the natural processes may result in catastrophe rather than survival, apparently mindless of the fact that nature is on a suicide course of her own in Bolinas Lagoon, which can only be reversed by an act of God or by man's intervention. Fortunately there are others who recognize the potential for the survival and in the utilization of the Lagoon through a plan of action, created by man and based upon a deep understanding of the environmental systems which are Bolinas Lagoon.

In 1966 Norman T. Gilroy and Associates, Planners, Architects and Consultants in Environmental Design of Mill Valley, California, were engaged by local agencies to coordinate, implement and report on a multi-disciplinary program of study and research into the natural environmental systems of Bolinas Lagoon and its watershed, designed to act as the first step for planning the long-term conservation and use of the region and the Lagoon. From a virtually nonexistent economic base, thirty-six Federal, State, local, private and university research and funding programs were assembled into an integrated program of investigation valued at over \$208,000.

The natural environment of Bolinas Lagoon was analyzed in its three fundamental segments (1)*

a) The Watershed — Field investigations of the mineralogic and soil characteristics of sediment sources in the watershed lands, of the flow, velocity, and sediment transport characteristics of tributary water courses, and of local surface drainage systems and regional rainfall.

* See References

characteristics were undertaken by the U S Geological Survey (2) and the U S Soil Conservation Service over a 3-year period. An innovative graphic analysis system was utilized to define the sensitivity of the watershed to both erosion and change through development. Remedial measures to control and lessen natural sedimentation, and guidelines to guard against future acceleration of sedimentation through development in the watershed were defined for inclusion in local regulatory ordinances. Strong indications linked massive erosion of the Bolinas Headland, which has caused a 125-foot retreat in the 7,000 foot long, 120 foot high cliff-line over the past 56 years (and is caused by the combined action of groundwater-generated slides in the cliff face and the battering of heavy ocean storm waves), with the choking inundation of the Lagoon itself with light sediments. A combined buffer beach, intercept drainage gallery and surface drainage system are proposed to combat at source a problem which evidently pervades the entire dynamic system of Bolinas Lagoon.

b) The system of natural dynamics of Bolinas Lagoon and Bolinas Bay — A broad range of studies under the guidance of the U S Geological Survey was undertaken in the Lagoon itself. The Lagoon studies were supplemented by other studies in Bolinas Bay by the U S G S (2) and by the University of California under the guidance of J W Johnson. Following a detailed hydrographic and topographic survey of Bolinas Lagoon utilizing laser surveying techniques, periodic monitoring programs of flow velocities and sediment loads in the main channel to the ocean and in the circulatory network within the Lagoon were completed. The mineralogical characteristics of the bottom sediments of the Lagoon were analyzed and compared with the characteristics of sediment sources. Time lapse photography over a 15-month period monitored the changes in configuration of the sandspit and the main channel, and graphic comparisons were made between a series of quarterly bathymetric surveys of Bolinas Bay to plot the quantitative transport of sediments within the Bay itself. These studies were coupled with a mineralogical analysis of the bottom sediments of Bolinas Bay by P Wilde, a series of field observation studies and measurements of wave characteristics, a beach profile monitoring program, and mathematical analysis of the refraction of deep water storm waves as they impinge upon the shoreline of the sandspit. Much of this work is described in greater detail in companion papers by J W Johnson and P Wilde. (See Chapters 85 and 86)

The system of natural dynamics of Bolinas Lagoon and Bolinas Bay was thus defined. Contrary to previous assumptions, it was found that the littoral system of Bolinas Bay is largely self-contained, with sand moving onshore and offshore on a seasonal basis. This fact is confirmed by ecological studies of the bottom sediments of Bolinas Bay, which reveal a host ecosystem incapable of surviving in the everchanging conditions which would be consistent with an extensive downcoast littoral transport system. An arrowhead jetty channel stabilization system is recommended at a cost of \$2,500,000--a considerable reduction from the \$11,000,000 structures recommended previously using "worst case" design criteria without benefit of field research.

c) The Ecosystem — A series of 14 studies of the ecosystem of Bolinas Lagoon was completed by a team led by Joel Gustafson of Resources and Ecology Projects, Inc (3). Eighteen months of field studies mapped vegetation, fish nurseries, mollusk populations and defined key index species and the trophic food chain. A graphic "sensitivity analysis" of the Lagoon was completed, "grading" the Lagoon by degree of importance or sensitivity in the four major elements of the ecosystem, i.e., sub-surface life (clams, worms, shrimp, etc.), bird wading and feeding areas, fish and marine animal habitats, and marine aquatic and terrestrial plant life. A composite analysis of the four resulting charts indicates clearly the areas of greatest sensitivity in most need of preservation through establishment of a wildlife refuge, and those areas most able to cope with man's intrusion without damage to the ecosystem as a whole. Recommended restoration of the circulatory system of the Lagoon will renew the flow of oxygenated water to nourish the biota, while permitting flushing of pollutants and use of the Lagoon by man for recreation and harbor purposes. The study resulted in the moving of the primary harbor site location which had been deemed suitable for years, yet which, when scientifically examined, proved to be at the heart of the most delicate, ecologically important, area of the Lagoon system. A computer model of the circulatory system was built and tested, and is a medium for evaluation of all proposed physical change within the Lagoon for the future.

Having defined the natural systems of Bolinas Lagoon and evaluated their areas of sensitivity, decisions for the future of Bolinas Lagoon can be made in an atmosphere truly sensitive to the host environment. Examination of the future demands of man in the watershed have resulted in various recommendations which will permit nature and man's activities to co-exist, in some cases the improvements that will accompany man's uses will themselves be beneficial to the system as a whole. Not the least of these will be the maintenance of an open artery between the ocean and the Lagoon. Separation of the specific functions which the Harbor of Refuge must serve has prompted the innovative concept of a summer harbor located outside of the Lagoon behind the breakwater to cope with the maximum need for shelter in times of summer fog or emergency, and a small basin within the Lagoon to serve the lesser winter storm refuge need at a location protective of the overall ecological system. The quality of the natural biotic system has been recognized, and is utilized in a proposed marine biological research and education center and in various conservation-oriented recreation and park functions on the perimeter of the Lagoon. Large portions of the land necessary are already passing into the public domain through acquisition utilizing State and Federal funds. The Town of Bolinas is proposed for preservation and restoration as a historical landmark, with its beaches expanded through the cliff erosion solution recommended, and with its traffic problems largely solved as a part of the plan. Channel stabilization programs, cliff erosion solutions, harbor of refuge facilities, sewage treatment facilities and public use concepts have all been designed as multipurpose facilities, permitting funding through a number of State and Federal programs and enabling a relatively small community to implement solutions of considerable magnitude through proper structuring at the design concept stage.

REFERENCES

- 1 Gilroy, Norman T (1970) Bolinas Lagoon Its system of environmental dynamics and recommendations for its future preservation and utilization Prepared for the Advisory Commission on Navigation and Ocean Development, State of California, the Board of Harbor Commissioners of the Bolinas Harbor District and the County of Marin
- 2 Ritter, John R (1969) Preliminary studies of sedimentation and hydrology in Bolinas Lagoon, Marin County, California, May 1967-June 1968, U S G S Open-File Report, April 4, 1969
- 3 Gustafson, Joel F (1968-69) Ecological studies of Bolinas Lagoon, Parts 1, 2 and 3 (also see appendices of Reference 1)