

# NEWSLETTER

June 1990

Readers are encouraged to submit brief articles or ideas for articles. Correspondence, including requests for changes in the mailing list, should be addressed to Randy Brown, California Department of Water Resources, 3251 S Street, Sacramento, CA 95816.

## Invasion of San Francisco Bay by *Potamocorbula amurensis* – A Major Perturbation?

Continuing studies of the invasion of San Francisco Bay by the Asian bivalve *Potamocorbula amurensis* show that this clam is having a major effect on benthic and pelagic communities of the northern reach of the bay.

As reported in the June 1989 *Newsletter* and in a soon-to-be-published report (J.T. Carlton *et al.*, in press, Marine Ecology Progress Series), this clam was first discovered in Suisun Bay during October 1986. It spread rapidly throughout the Suisun and San Pablo Bay area and is now found nearly everywhere in the bay irrespective of salinity, water depth, and sediment type.

Long-term benthic sampling in Grizzly Bay by DWR (Station D7) and Regional Effects Monitoring Program sampling nearby (Station REM-GB) have provided an unusual opportunity to document the time course of this invasion (F.H. Nichols *et al.*, in press, Marine Ecology Progress Series). Data from these two programs reveal that benthic community dynamics in the Suisun Bay area have been dramatically altered since arrival of the Asian clam.

From 1977 through 1986, the macrobenthic community at the Grizzly Bay monitoring site varied predictably in response to river inflow. During years of

normal or high streamflow, the community consisted of 3 to 6 brackish or freshwater species. During dry periods, the number of species doubled as such estuarine species as the soft-shell clam *Mya arenaria* were able to colonize areas farther up the estuary.

In June 1987, at the beginning of the present drought, large numbers ( $> 12,000/m^2$ ) of juvenile *P. amurensis* were discovered at the site. By mid-summer 1988, when the low-flow community should have become fully reestablished, the new clam was extremely abundant and typical estuarine species never appeared. Despite continuing low flows, both the number of species and total non-*Potamocorbula* individuals continued to decline through 1988, when, except for the occasional appearance of a few specimens of other species, only *P. amurensis* was found. This situation has continued through spring 1990.

*P. amurensis* is a suspension feeder that, in its present abundances, may be capable of consuming a major fraction of the phytoplankton produced in northern San Francisco Bay. Many years of data show that the Suisun Bay region of the estuary normally features a winter minimum and a summer maximum in both primary productivity and phytoplankton biomass. A study in 1988 showed an extreme departure from this norm: the annual rate of primary productivity was

only 20 g C/m<sup>2</sup>/yr, a rate lower than is found in many nutrient-poor environments, and chlorophyll *a* never exceeded 3 mg/m<sup>3</sup> (USGS, unpublished data). Although maximum photosynthetic rates per unit of plant biomass were no different from those of previous years, the normal summer maxima in biomass and primary productivity never occurred.

Nutrients, abundant at all times, could not be considered limiting. As in previous years, productivity was highly correlated with biomass and available light. Therefore, the low primary productivity rate can only be explained if we assume phytoplankton biomass is being rapidly consumed. The most likely explanation is consumption by the newly introduced, benthic suspension-feeding clam.

This conclusion is being tested in the laboratory over a range of flow velocities in small test containers and a laboratory flume. Initial results show that filtration rates can vary from 100 to 700 L/g clam ash-free dry weight/day – rates that are sufficient to account for the reductions in phytoplankton biomass in northern San Francisco Bay during 1988 (USGS, unpublished data).

Additional field and laboratory results show that the new clam may be having a major effect on the zooplankton communities of northern San Francisco Bay as

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well (R. Orsi and W. Kimmerer, unpublished data). Until 1977, the zooplankton community at intermediate salinities within the San Francisco Bay estuary was dominated by the copepod *Eurytemora affinis*. During 1977 to 1979, abundance of *Eurytemora* declined and an introduced copepod, *Sinocalanus doerri*, became established upstream of *Eurytemora*. In 1988, an introduced cladoceran, *Pseudodiaptomus forbesi*, became abundant, while *Eurytemora* abundance declined by about two orders of magnitude. Preliminary laboratory experiments showed that the clam consumed early life stages of *Eurytemora* but not of *Pseudodiaptomus* in numbers sufficient to explain the change in abundance, and that reproduction of *Eurytemora* was not food-limited (W. Kimmerer, unpublished data). These results suggest that differential predation can be important in determining distribution and abundance of zooplankton species in the estuary.

It is apparent that successful establishment of *Potamocorbula* in San Francisco Bay — to the point it has displaced established benthic species, reduced phytoplankton biomass to extremely low levels, and altered zooplankton community dynamics — is cause for concern regarding the effect of these changes on beneficial uses of the estuary.

These findings raise some questions:

- » Is the dominance of *Potamocorbula* in Grizzly Bay indicative of its influence throughout the null/entrapment zone region?
- » Is the population increasing, stabilized, or decreasing with time?
- » Will its distribution and abundance be limited by freshwater inflows; i.e., reduced during periods of normal or high river inflows?
- » Given its present abundance, biomass, and growth rate, do its food requirements exceed available production in the Suisun Bay area?

To answer these questions, USGS began a benthic sampling program in May 1988 to augment the DWR and Regional Effects sampling in the area. This new program includes monthly sampling of the benthic fauna at six sites in Suisun Bay (including near DWR-D7 and REM-GB) and an additional site in the Sacramento River off Rio Vista, with methodology essentially the same as that used in the Regional Effects Monitoring Program.

One of the goals is to determine the rate at which soft tissue is added during growth in carbon units on an annual basis ( $g\ C/m^2/yr$ ). Knowing the rate of *Potamocorbula* tissue growth will allow us to begin to quantify its contribution to the carbon budget of the null/entrapment zone and its potential importance as a food item for bottom-feeding fish and birds.

Another goal is to continue sampling until we have a year of "normal" streamflow to characterize *Potamocorbula* population dynamics over the full range of environmental conditions and, particularly, its response to a prolonged period of low salinity.

The continuing USGS benthic sampling throughout the Suisun Bay region will complement the DWR collection effort in the Delta. The combined data sets will allow us to document long-term patterns and impacts of this latest species introduction.

(F. H. Nichols, USGS)

## Estuarine Research Federation

The next national meeting of the Estuarine Research Federation is scheduled for the week of November 10, 1991, in San Francisco.

The committee established to organize the meeting consists of: John Conomos, Fred Nichols, Jim Cloern, Sam Luoma, Larry Schemel, Jim Kelley, and Randy Brown. It is likely that a session dealing with San Francisco Bay will be included on the agenda — perhaps sponsored by the San Francisco Bay and Estuarine Association.

Anyone with ideas about general session topics should contact Jim Cloern at 415/354-3357. A call for papers for the San Francisco Bay session will be made later this year.

Information regarding membership in ERF can be obtained by writing:

Estuarine Research Federation  
P.O. Box 544  
Crownsville, MD 21032-0544

More details regarding this meeting will be provided in subsequent issues of this and ERF newsletters.

## Staff Notes

- Some recent DWR personnel changes affect the Interagency Program. Randy Brown is now Chief of the Environmental Studies Branch and will step down as chair of the Fisheries/Water Quality Technical Committee but will continue as DWR's coordinator. (Marty Kjelson, USFWS, is the new chair of the committee.) Steve Ford has been appointed Chief of the Bay/Delta Studies Section, which includes the Interagency Program activities. Finally, Bellory Fong is Program Manager for the Interagency Program and will serve on the Fisheries/Water Quality Committee and chair the Pollutant Committee.
- Also in DWR, Kamyar Guivetchi, an engineer, is now working in the Suisun Marsh Planning Unit. His initial work focuses on numerical modeling that can be used to predict changes in Suisun Marsh salinities due to outflow, facility operations, and local freshwater and drainage inputs.

- The Stockton office of DFG recently hired two new fishery biologists and a wildlife biologist. The fishery biologists will work on the young striped bass project. Fishery biologist Tim Heyne is completing an MS degree at Fresno State. Katie Perry, the other fishery biologist, has already attained an MS degree from San Diego State. Both of them will be working for Lee Miller. Wildlife biologist Laura Briden, a graduate of Fresno State, will work on wildlife in the Delta, Suisun Marsh, and elsewhere under the direction of Frank Wernette.
- Donna Douke also recently joined the DFG staff in Stockton as a Staff Services Analyst. In effect, she will serve as an administrative officer for the Bay/Delta Project, coordinating budget, fiscal, and personnel matters. Most recently, Donna worked for DFG's Personnel Section in Sacramento.

## A SPECIAL STUDY TO DETERMINE SPATIAL DISTRIBUTION OF *Potamocorbula amurensis*

The Striped Bass Food Chain Subcommittee has proposed a special study to determine spatial distribution of *P. amurensis* in the northern bays and western Delta. The main objectives are:

- » To determine the current spatial distribution of *P. amurensis* in San Pablo and Suisun bays, the major sloughs of Suisun Marsh, and the major channels of the western Delta.
- » To derive total abundance and size class distribution estimates. This information will help us understand the ecological impacts of *P. amurensis* on this system and will enable us to design meaningful laboratory experiments.
- » To design and conduct a reproducible study and repeat the study after a high outflow (wet) year.

The study is designed to collect and process benthic samples from about 200 sites, using procedures employed by the DWR monitoring program. Sampling sites will be uniformly distributed throughout the study area. Both the *San Carlos* (DWR crew) and the *Scrutiny* (USBR crew) will be used for sample collection. Personnel from the SWRCB



916/322-6225

For the last year, we have invited you to call 916/322-6225 or 6226 for copies of reports, additional information, or whatever. If you have called, you have probably spoken with Mary Gilleland, who keeps track of all we promise you. Mary is secretary to *Newsletter* co-editor Randy Brown. She'll probably be extra busy after you all scan page 5 of this issue.

and University of California, Davis, will help as needed. Only one sample will be collected at each site. We estimate that all sites can be sampled in 2 weeks or less.

Sample analysis at the time of collection will be limited to gross estimates of the substrate composition. Further analyses of the washed samples will be done by Wayne Fields of Hydrozoology Inc. Analyses will include separating whole organisms from material remaining on the sieve and determining total abundance and size class distribution of *P. amurensis* collected. All organisms from each sample will be preserved and archived. Sample analysis should take no more than 2 months.

Data analysis will consist of:

- » A map of the study area showing sampling sites, bathymetry, and major substrate types. Clam abundance at each site will be plotted on this map.
- » A report summarizing general trends as well as specific trends in size class and spatial distribution among regions of the sample area.  
(Zach Hymanson, DWR)

## NOTEWORTHY —

- » **Hydrodynamics Committee** — The Agency Coordinators recently approved formation of a Hydrodynamics Technical Committee to direct hydrodynamic activities of the Interagency Program. Larry Smith, USGS, will chair this committee and work with committee members, coordinators, and members of other technical committees and outside interests to develop, conduct, evaluate, and coordinate hydrodynamic-related data collection and modeling programs.
- » **Interagency MOU** — Interagency Directors recently signed off on a new Memorandum of Understanding regarding conduct of the Interagency Program. The U.S. Army Corps of Engineers will formally join the Program and will be represented by Mark Dettle at the coordination level.
- » **Peer Review Panel** — As authorized by the Agency Coordinators, the San Francisco Bay element is seeking to establish a panel to provide periodic technical review of the program. Nominations for the panel are being solicited from such organizations as the Environmental Defense Fund, State Water Contractors, and individuals from around and outside the bay, including members of the panel convened in 1988 to review the Bay Program.
- » **Salmon Smolt Survival Studies** — During April and May, tagged Chinook salmon smolts were released in the southern Delta so their survival through the Delta could be compared under high and low export conditions and with low San Joaquin River flow of 1,500-2,000 cfs. Salmon were released when CVP/SWP export levels were high (~10,000 cfs) in the last half of April and low (~2,300-2,800 cfs) in the first half of May. The lower May exports were largely due to shutdown of the California Aqueduct for repairs (to be completed in July) combined with a decrease in CVP exports. Recoveries of smolts were made at the CVP/SWP fish salvage facilities and by midwater trawl at Chipps Island. Tags will be recovered later from the ocean fishery.

## UNIT OF THE MONTH – USBR Bay/Delta Program

USBR staff began working on Bay/Delta environmental studies in the late 1960s. As one of the original four agencies that formed the Interagency Program in 1970, USBR greatly expanded its role in Bay/Delta environmental studies. Since then, we have participated in management of the overall program and contributed funding to the DFG and USFWS fisheries programs.

Initial studies included design and implementation of baseline water quality monitoring and phytoplankton dynamic studies as part of USBR's proposed San Luis Drain program. In 1975 USBR discontinued its role in the baseline water quality monitoring program (DWR assumed full responsibility) and began to conduct cause-and-effect studies in the estuary. In the mid- to late 1970s, USBR staff conducted special studies to develop much of the information now available on the *entrainment zone*, a term we coined. We also developed much of the information on phytoplankton dynamics in the Delta and Suisun Bay during this period and assisted in development of phytoplankton and sediment models for the estuary. During the 1970s we were also active in the Suisun Marsh. We developed and conducted the first baseline salinity monitoring program, developed the Suisun Marsh model (via contract to Hugo Fisher, Inc.), and conducted basic research on use of waste water for marsh reclamation.

In the 1980s, USBR was instrumental in developing an Interagency data base, which all program participants now use for environmental data storage. We helped develop the basic concepts eventually incorporated by the Environmental Protection Agency into *STORET*, which is now used nationally. During this same period, USBR conducted a number of varied and diverse estuarine evaluations and studies in such areas as hydrodynamics, macrophyte production, benthic uptake of heavy metals, selenium dynamics (along with DWR), and long-term water quality and phytoplankton trends.

USBR is currently developing methods to continuously monitor striped bass spawning in the Sacramento River and Delta. We believe this work has some potential as a management tool to increase young striped bass survival through operation of the water projects.

USBR has supported and employed a number of students over the years. Some of those who started out in our program now work full time for other organizations studying the estuary. Part-time employees working on our striped bass program at this time are Debra Belasich and Debbie Cloney.

A number of publications and reports have been released over the years and are available through USBR or the Interagency Program.

### Our Permanent Staff

**Jim Arthur**, Supervising Aquatic Biologist, has a BS in Zoology from CSU, Fresno, and an MS in Botany from UC, Davis. Jim is USBR's Bay/Delta Program Manager and supervises those working on estuarine environmental studies. Since 1984, Jim has served as USBR's coordinator to the Interagency Program. His past experience includes research in aquatic weed control, development of biological nutrient removal systems, and research in water quality and fisheries.

**Doug Ball**, Microbiologist, has a BS in Biology from CSU, Fresno, and an MS in Botany from UC, Davis, with specialization in the study of aquatic plants and algae. His major work has been in mosquito and aquatic weed control, basic water quality, and biological production in freshwater and estuarine environments.

**Sheryl Baughman**, Aquatic Biologist, has a BS in Biological Science and a BS in Chemistry from Metropolitan State College in Denver. Sheryl chairs the Interagency Data Management Technical Committee and supervises a 5-member data management team for USBR.

**George Collins**, Aquatic Biologist, has a BS in Biology from UC, Davis. George has worked in the Environmental Health Laboratory at McClellan AFB, and he managed and operated USBR's Water Quality Laboratory from 1967-1980. He now works on environmental studies in the Bay and Delta.

**Lloyd Hess**, Fishery Biologist, has a BS and an MS in Fisheries from CSU, Humboldt. Lloyd has over 20 years of fisheries experience, primarily on the East Coast. His experience includes working on hybrid "wiper" bass (striped bass crossed with white bass) as well as working with both parent species. Lloyd has been working on several fisheries-related problems at USBR.

**Henry Wong**, Hydraulic Engineer, has a BS and an MS in Civil Engineering from Old Dominion University. His primary responsibility at USBR has been in the field of hydrodynamic and water quality modeling. Henry is the USBR representative on the Interagency Hydrodynamic Technical Committee. He has been working on development of a Delta model.