

NEWSLETTER

This is the first edition of the Interagency Ecological Study Program *Newsletter*. Subsequent editions will be published quarterly. The goal is to provide staff of the cooperating agencies and others with periodic updates of programs and findings from the Interagency Program and related studies in the Bay/Delta system. 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.

The Interagency Ecological Study Program

For readers not familiar with the Interagency Program, here is a brief introduction. A more complete description can be found in the program's 1985-86 annual report, available by request (916/322-6226).

The Interagency Program was created by a 1970 Memorandum of Agreement between the California Departments of Fish and Game and Water Resources, the U.S. Bureau of Reclamation, and the U.S. Fish and Wildlife Service as an expansion of a DWR/DFG Delta Fish and Wildlife Protection Study started in 1961. The State Water Resources Control Board and the U.S. Geological Survey were added in 1985 as part of an expanded study of circulation and mixing in San Francisco Bay and the Delta.

In general, program goals involve determining the effects on the Bay/Delta ecological system of operating the State and Federal water projects and finding means of eliminating, reducing, or mitigating adverse impacts.

Sorting out project impacts from other human impacts and from natural fluctuations in abundance of key organisms requires that staff obtain and interpret an extensive set of data on basic biological, chemical, and physical variables. These data are also available to others for environmental impact assessments, regulatory hearings, and planning.

The Interagency Program is organized around five technical committees that provide day-to-day technical direction and supervision (see the chart on page 2). We are considering adding a pollutant-related technical committee. Two important subcommittees study the Delta food chain and hydrodynamics of the Bay/Delta system.

Agency coordinators meet periodically to review the program and budget and establish funding priorities when necessary. Agency Directors meet annually to review overall program progress.

Although not formally part of the Interagency Program, DWR's Decision 1485 compliance water quality monitoring program collects basic data in the Delta, Suisun Bay, San Pablo Bay, and Suisun Marsh.

The current annual budget is about \$5 million, with the approximate contribution by agency as shown below:

DWR	\$2,200,000
DFG	\$900,000
USBR	\$1,700,000
USFWS	\$56,000
SWRCB	\$266,000
USGS	\$260,000

Interagency Program information is available through raw data summaries, technical reports, journal articles, annual reports, and this newsletter. The *Newsletter* will list new reports and a contact person for each.

Staff and coordinators are looking at the entire interagency effort to determine if the present structure and study elements can provide information to answer complex environmental questions. We will keep you posted as to major program changes.

Some typical current projects under each technical committee are listed on page 2.

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**Fisheries and Water Quality
Technical Committee**

- Index abundance of striped bass at various life stages.
- Evaluate condition of larval striped bass.
- Study survival of fall run Chinook salmon through the Delta.
- Estimate effect of fishing on abundance of white sturgeon.
- Index zooplankton abundance in the Delta and Suisun Bay.
- Monitor health of adult striped bass.

**Fish Facilities
Technical Committee**

- Monitor losses of striped bass, Chinook salmon, steelhead trout, and other fish at the State and Federal pumps.
- Monitor fish impacts of State Water Project Delta facilities such as the North Bay Aqueduct, Montezuma Slough Control Gates, and Middle River barrier.
- Develop operational or physical means of reducing fish losses at State Water Project Delta facilities.

**San Francisco Bay
Technical Committee**

- Monitor abundance of fish and shrimp in the Bay.
- Develop mathematical models of circulation and mixing in the Bay.
- Collect salinity and temperature data needed to describe stratification and to develop and calibrate the mathematical models.
- Prepare annual DAYFLOW report, which uses inflows, exports, and internal Delta water consumption to calculate outflow and various internal Delta flows.
- Study sources and distribution of selenium in the Bay and Delta.

**Suisun Marsh
Technical Committee**

- Oversee implementation of the Suisun Marsh Plan of Protection.
- Coordinate data collection for vegetation, water quality, water levels, and fish in the marsh.
- Develop mathematical model of circulation and salinity in the marsh.

**Data Management
Technical Committee**

- Work with other technical committees to get the data bases into an electronic storage and retrieval system (*STORET* in most cases).

NOTEWORTHY —

- » The hydrodynamic study has recently added a continuous salinity and temperature recording site at the Golden Gate. Another site will soon be added in the South Bay near the Dumbarton Bridge.
- » Interagency staff met in late May with representatives of the California Academy of Science, Estuary Project, and U.S. Geological Survey to work out details of a joint program to obtain greater involvement of academia in Bay/Delta studies. We are hopeful that the program can begin awarding grants in mid-1990.
- » In late April, the San Francisco Bay Regional Water Quality Control Board collected water samples from 26 locations throughout the Bay for analyses of dissolved trace metals. Interagency staff and boat were used to help collect samples. The Regional Board plans to repeat this sampling three more times.
- » By the end of April, tagging crews had captured 5,071 striped bass 16 inches or larger and had tagged 4,043 of them. About 7 percent of tagged bass were of hatchery origin.
- » The *DAYFLOW* report for water year 1988 is now available.
- » Wim Kimmerer, Biosystems Analysis (consultant to USBR), has prepared a narrative conceptual model of the early life history of striped bass in the Bay and Delta. The model was developed for, and with the help of, the food chain subcommittee. Copies are available by request (916/322-6226).
- » Diane Knutson (DFG) has submitted the 1987 *Striped Bass Health Monitoring Report* to the SWRCB and is working on the 1988 report. There will be minimal field and laboratory work in 1989. Staff time will be devoted to reassessing program objectives and methods.

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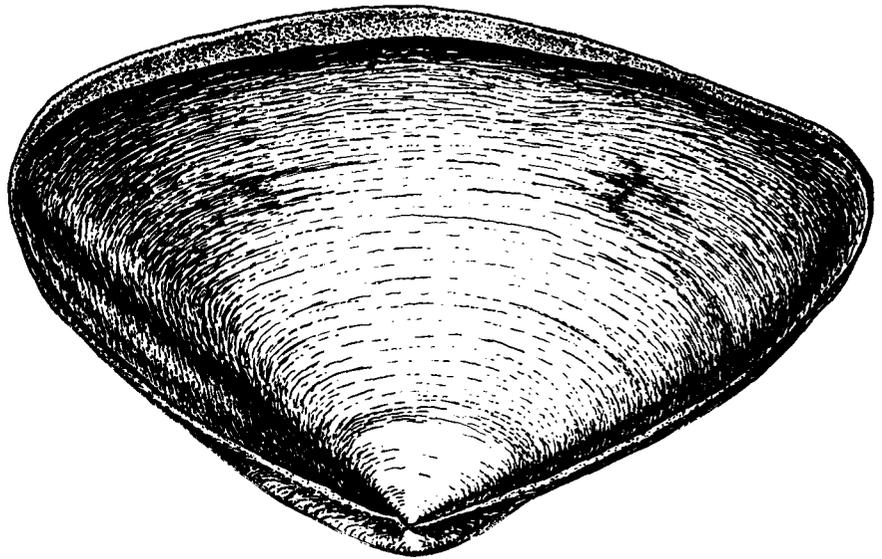
Potamocorbula amurensis Discovered in San Francisco Bay

The small Asian clam, *Potamocorbula amurensis*, is now a major component of benthic communities in most areas of northern San Francisco Bay and some areas of South Bay. Because of its wide tolerance of salinity and other environmental variables and its high abundance in many areas, benthic ecologists believe this recent invasion may represent a major and permanent change in the bay system.

The first evidence of an important invasion was the occurrence of large numbers of small specimens in areas of Suisun and Grizzly bays in the late spring of 1987. The subsequent effort to estimate the time and place of introduction and to document the dispersal of the species illustrates the benefits of cooperation and communication among the agencies and institutions monitoring and conducting research in the bay.

James T. Carlton from the University of Oregon, an expert on West Coast introductions, believes *Potamocorbula amurensis* was introduced when a ship from an Asian port of origin discharged its ballast water in San Francisco Bay. Several programs were collecting benthic macrofauna from both the northern and southern reaches of the bay at that time:

- DWR's "Decision 1485 Compliance Monitoring Program" was regularly monitoring sites landward of Carquinez Strait (monthly or bimonthly).
- A new program, "Regional Effects Monitoring", conducted by the USGS in cooperation with the SWRCB, was sampling regularly in Grizzly Bay, San Pablo Bay (2 sites), the central bay, and South Bay (4 sites).
- The oceanography class at Diablo Valley College was collecting specimens at 10 sites between Carquinez Strait and Antioch three times a year.
- National Oceanographic and Atmospheric Administration's "Status and Trends Program" was collecting samples in San Pablo Bay once or twice a year.



Ink drawing by Roger Meyers (Menlo Park, CA) of a specimen of *Potamocorbula amurensis* from San Francisco Bay. Specimens up to about an inch long have been collected.

The time and place of introduction — late summer of 1986 near Carquinez Strait — was estimated by examining archived specimens from these programs. An interesting scenario for the initial dispersal was developed by pooling information from these programs.

No specimens of *Potamocorbula amurensis* had been collected in San Francisco Bay or in any other West Coast estuary prior to October 1986. From September to December 1986, more than 130 benthic samples were collected by the four programs in the area of northern San Francisco Bay between San Pablo Bay and Sherman Island. Only 3 samples, all collected by Diablo Valley College in Suisun Bay, contained the new clam, a single small specimen in each sample.

In January and February 1987, USGS and NOAA found low numbers of small specimens in samples collected just seaward of Carquinez Strait. DWR and USGS reported only an occasional specimen in samples from Grizzly Bay between January and April, but Diablo Valley College found many specimens in about half the samples collected in Suisun Bay and Carquinez Strait during April. In May and June, USGS and DWR found extremely high densities of small specimens (up to 25,000 per square meter) in Grizzly Bay. By mid-summer, DWR collected specimens as far landward as Point Sacramento and Sherman Lake, and USGS collected specimens at both deep and shallow

water sites in San Pablo Bay. During late summer and fall 1987, USGS found a few specimens in the central and southern bays, and by the end of 1988 *Potamocorbula amurensis* was collected at most locations in the southern bay.

It was truly fortunate that the programs archived sample material, at least for some key stations or for a limited time. In early samples when specimens of *Potamocorbula amurensis* were few and small, it was difficult to differentiate them from the soft-shell clam *Mya arenaria*. Mature specimens of the new clam are easy to identify because one valve is larger than the other, a feature that in San Francisco Bay is unique to this clam (see drawing). Once sorters knew what to look for, examination of archived material yielded the few specimens collected between October 1986 and April 1987.

Early detection and documentation of such a species introduction, normally a rare occurrence, was possible in San Francisco Bay only because of the geographical and temporal coverage provided by the combined programs. By fall 1987, agencies and institutions and their contractors were actively exchanging data, sample material, and resources such as taxonomic expertise. The level of cooperation and coordination among programs added to the excitement as data from each program provided a piece to the puzzle. (Larry Schemel, USGS)

Another New Copepod

With its paired egg sacs, it looked like the native *Cyclops* species, but closer examination sent the biologist to the books. The references confirmed that it was an Asiatic species belonging to the genus *Pseudodiaptomus*. Specimens were sent to the Smithsonian, and the official word was *Pseudodiaptomus forbesi*, a native of the China coast. Another copepod had slipped into the estuary.

Copepods are tiny crustaceans a millimeter or so in length. Although small, they are an extremely important food for larval striped bass, which themselves are only about 5 millimeters long when they first begin feeding.

Within the last 10 years, three Chinese copepods have been introduced to the Sacramento-San Joaquin estuary, and a Japanese species was discovered that may have been here for over 20 years.

The latest arrival was first seen in 1987 and became abundant in mid-summer of 1988. There are actually two species of the newcomer, and last summer and fall they were the dominant copepods throughout Suisun Bay and the Delta. So far this year, they have been rare. They probably require high temperatures to develop large populations. If so, they will not be available to feed the young striped bass that hatch in the spring.

None of the introduced copepods appears to be as good a food for young striped bass as is the native *Eurytemora*, and *Eurytemora* has undergone a long-term decline in abundance. Also, its

young stages are vulnerable to predation by the introduced clam described on page 3, which for some reason did not eat the young of *Pseudodiaptomus* in lab experiments. One of the Chinese copepods, *Sinocalanus*, is eaten by bass, but tests show that bass are more efficient at feeding on *Eurytemora*.

The Asiatic copepods have apparently hitchhiked here in the ballast water tanks of freighters. DFG has contacted the National Marine Fisheries Service and will be working through the Western and National Associations of Fish and Wildlife Agencies to influence the passage of laws to prohibit dumping ballast water in inland waters. Risks associated with unintentional introduction of exotic organisms and their potential effect on productive food chains are just too great. (Jim Orsi, DFG)

Continuous Monitoring of Striped Bass Eggs and Larvae

USBR has been working to develop an automated device to sample striped bass eggs and larvae during the April-June spawning period. As proposed, the device could be mounted on a pontoon boat.

The sampling device will be tested to determine if it can be used to determine the timing and quantity of striped bass eggs and larvae passing a point below the primary spawning area on the Sacramento River. This information could be used to "trigger" protective measures in the Delta, such as closing the Delta Cross Channel gates or releasing flows. More accurate measurements of striped bass eggs and larvae may enable us to better assess survival rates in the Delta and downstream.

Future uses could include continuous monitoring of eggs and larvae at the Federal and State water export pumps. Losses of eggs and larvae at the pumps are already being estimated by towed net surveys. A comparison of the two methods would be used to determine which is most effective for developing these estimates.

Three samplers were tested to check: their ability to run unattended for a minimum of 12 hours, their personnel

requirements, and whether they adequately sampled eggs and larvae passing that point in the river. With all these samplers, the goal is to have estimates within one day of sample collection.

Two of the samplers — a cylindrical upflow tank and a stilling box with a cone collector — are run off the intake to a sewage sludge pump hung over the side of the boat or barge. The pump is capable of passing a 4-inch-diameter rock without damage. This installation provides high volume with low water pressure. The third sampler is a modified plankton net capable of running unattended for 24 hours. All three samplers have been effective so far.

In addition to running all three samplers 24 hours a day, 7 days a week, since April 18, USBR is sampling river cross sections.

The study was conducted at the U.S. Army Corps of Engineers' storage facility on the Sacramento River at Bryte, near Sacramento. Twice-a-day sampling began April 18 and continued until the majority of bass spawning was complete. USBR's Sacramento staff was assisted in this effort by biologists from the Boulder City and Denver offices. The samples are being checked by Dr. Johnson Wang, a specialist on early life stages of fish, for accuracy in identification and effectiveness in sort-

ing eggs and larvae from debris. USBR will prepare a report by late summer. (Jim Arthur, USBR)

STAFF NOTES —

- » USBR recently hired a fisheries biologist to work on the Interagency Program. Lloyd Hess, who has a BS and MS from Humboldt State, came to USBR from the Sacramento office of the Army Corps of Engineers.
- » Dwight Russell, a DWR engineer, has replaced Peter Lee as Chief of DWR's Suisun Marsh Planning and will chair the Suisun Marsh Technical Committee.
- » Peggy Lehman (DWR) has stepped down as chair of the Food Chain Subcommittee to devote more time to data analysis. Peggy will help the new chair, Don Kelley, achieve an orderly transition.
- » Marty Kjelson (USFWS) and Sheila Greene (DWR) continue to work with several fishery scientists to develop a Delta salmon survival model. Pat Brandes (USFWS), the third member of this team, will be returning from maternity leave about January 1.
- » Jon Burau, a bay modeler for USGS, will attend Stanford next fall to obtain an MS in Engineering.

Entrapment Zone Study

Interagency scientists and consultants working on the striped bass food chain committee have proposed a multidiscipline study of the entrapment zone. The goal is to improve understanding of how the entrapment zone functions to enhance productivity, how striped bass and zooplankton are retained and distributed vertically in the estuary, and how interactions of striped bass and zooplankton affect survival and growth of young bass.

The entrapment zone is the portion of the estuary where seaward-flowing fresh water overlays the more dense, saline ocean water, resulting in a 2-layered mixing zone characterized by flocculation, aggregation, and accumulation of suspended materials from upstream. This area often contains the highest concentrations of phytoplankton, zooplankton, and larval fish in the estuary.

While we generally understand the basic physical and biological processes that result in an entrapment zone, we do not understand how survival of a particular organism, such as larval striped bass, is affected by these processes. Standing crop of the zone can vary with quantity of freshwater flows, which in turn control the position of the zone in the system.

There are also questions about sources of carbon for the food chain. Are food chains largely phytoplankton-derived, or do terrestrial inputs of detritus provide carbon for zooplankton that ultimately feed striped bass?

The decline in striped bass abundance in recent years has been a major impetus for considering this study. One possible cause for the striped bass decline is starvation of early feeding bass larvae, possibly due to a decline in abundance of the copepod *Eurytemora affinis*, an important species in the entrapment zone and a primary food for bass larvae.

Another reason for initiating the study now is that the recent population explosion of the clam *Potamocorbula* may affect productivity and species composition of the entrapment zone. During 1988, when *Potamocorbula* became abundant, the *Eurytemora* population

declined drastically. Laboratory studies demonstrated that the clam can feed on *Eurytemora*, but we don't know if this occurs in the field. The low *Eurytemora* abundance may have been partly to blame for the record low production of young striped bass last summer, when the annual index of young striped bass abundance was only 4.6. From 1959 through 1987, the abundance indices averaged 51.4 and ranged from 6.3 to 117.2.

(Don Stevens, DFG)

Annual DFG Striped Bass Egg and Larva Survey

Much of the variation in production of young striped bass and subsequent recruitment to adult stocks is determined within the first few months of life. The annual egg and larva survey provides information about the survival of striped bass eggs and larvae and how it is affected by environmental factors.

Abundances of larval striped bass, their zooplankton food supply, and other fish and larvae are measured by sampling at 42 sites in the estuary from mid-April to early July. Fish larvae are sorted from the samples, identified, and measured and some bass stomachs are examined to determine the extent to which various zooplankton groups are used as food.

This year we've added sampling in and above the entrapment zone (region near upper end of the salinity gradient where fresh and salt water mix) to collect larval bass for estimating their ages and growth histories from daily growth rings on their otoliths (ear bones). Histological and morphological analyses will also be pursued to determine how their health and condition are affected by available food supplies.

Striped bass egg and larva abundance is also being measured at the Federal and State water project diversions to assess the extent to which these diversions remove young bass from the Delta.

(Lee Miller, DFG)

Sturgeon Program

Sturgeon are an increasingly important sport fish due to the burgeoning human population of Northern California and the decline in some other major sport fish populations. Experience from the commercial sturgeon fishery in our estuary in the late 1800s and decreases in exploited sturgeon populations elsewhere make it clear that over-harvest can depress the population.

Tagging studies show that sturgeon abundance varied by an order of magnitude from the 1950s through the 1970s, while harvest rate remained low and relatively stable, suggesting that abundance was largely controlled by environmental factors. Limited evidence suggests that year-class strength is associated with out-flow; higher flows produce stronger year classes.

Since spawning success and young sturgeon survival seem to be important in determining abundance of adult fish, DFG is directing additional research toward understanding these mechanisms.

Studies to begin this spring will better define spawning areas in the Sacramento River, which supports the major spawning run, so spawning can be protected from further habitat alterations.

DFG will also develop an index of year class strength based on netting in the estuary and estimated survival rates of young sturgeon. This should enable DFG to relate abundance and survival of young sturgeon to environmental factors that might be controlled to the advantage of the population.

DFG will continue to intermittently tag legal-sized sturgeon to monitor their abundance and mortality rates. The next tagging is scheduled for fall 1990.

(Dave Kohlhorst, DFG)

Interagency Ecological Study Program
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U.S. Bureau of Reclamation

California Department of Fish and Game
U.S. Fish and Wildlife Service
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