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Catches (mostly yearlings) were sporadic until 12 November when a catch of 21 chinook salmon was made. Chinook catches steadily increased (the traps were not fishing from 25 November until 30 November) to a peak of 260 (mostly fry) fish on 6 December. Catch numbers are currently decreasing at Knights Landing.

Sacramento Kodiak trawling began for the season on 3 September. Twenty-four late fall-run, 11 spring-run, 2 fall-run and 73 winter-run-sized chinook salmon have been captured through 28 December. This number of winter-run chinook is higher than last season's recoveries during the same period. Our first winter-run-sized capture occurred on 22 September in the beach seine at Clarksburg (river mile 43). The Delta Cross Channel closed on 8 September due to high flows and remained closed in order to protect emigrants from diversion off of the mainstem Sacramento River. The total delta winter-run-sized catch through December reached 393 fish (trawling and beach seining efforts combined).

Kodiak trawling three days per week on the San Joaquin River at Mossdale began on 4 November. No salmon were detected through the end of December. Winter-run-sized chinook salmon were first detected leaving the delta at Chipps Island on 1 December. A total of 12 chinook was captured at Chipps Island during this quarter. Incidental take of delta smelt started to climb in late October, which limited the trawling effort under Endangered Species Act restrictions. To avoid capturing delta smelt, sampling was conducted on a pilot basis at an alternate site near the Benicia Bridge in lower Suisun Bay with little success in capturing chinook salmon.

A late-fall chinook salmon, coded wire tag experiment is underway to evaluate the potential effects of State and federal project exports on juvenile chinook salmon survival through the central delta. These late-fall, hatchery chinook are used as surrogates for spring-run and winter-run chinook, which also emigrate during this period. Paired releases were made in early and late December at Ryde (Sacramento River mainstem) and Georgiana Slough, assuming that low to moderate outflow and low export levels (less than 2,000 cfs) following both sets of releases will provide good conditions in the south delta and result in similar survival indices for the Georgiana Slough groups relative to the Ryde groups. Two sets of releases under the same flow and export conditions will provide a replicate of this data point, which is difficult to achieve. The Delta Cross Channel will be closed during both test periods. A control group was released at Port Chicago on 22 December for independent survival verification by way of ocean recoveries. Preliminary recoveries of the first set of releases still show a significant survival advantage for the Ryde group. Due to heavy rainfall, flows in the lower Sacramento River were very high (up to about 60,000 cfs) during the recovery period, which changed the experimental conditions. Flows are expected to be much lower during the replicate. Survival indices will be calculated after all recoveries have been made. The salvage facilities at the State Water Project have recovered two Georgiana Slough fish and no Ryde fish from the first set of releases.

Delta Smelt Investigations

Dale Sweetnam, Department of Fish and Game

The third delta smelt workshop was completed on 1 and 2 October. Although it was not well attended, the conference offered quality research that was well received. A prioritized list of future delta smelt research needs including those of CALFED and the CMARP process was assembled by both agency and stakeholder representatives. A full description of the workshop is included in this newsletter. (See "The Third Delta Smelt Workshop".)

The fall midwater trawl survey was finally completed on 22 December. Numerous boat breakdowns and harsh weather resulted in only 77% of the scheduled stations being sampled in December. The index for December was 70.1. This sets the annual fall index (the sum of the September through December indices), at 417.6, slightly greater than the 1997 index of 360.8. Distribution was centered in Suisun Bay with few fish found in the San Pablo Bay and the lower Sacramento River. One interesting point about the 1998 index is that it breaks the "odd-even year" fluctuation that has been observed in the 1990s.

Mitten Crab (*Eriocheir sinensis*) Depletion of Dissolved Oxygen in a Confined Space

George Parker and Jane Arnold, Department of Fish and Game

In September and October, the number of mitten crabs (*Eriocheir sinensis*) entering the John E. Skinner Delta Fish Protective Facility (Skinner Fish Facility) was estimated to be over 20,000 per day. This large number of crabs impacted normal salvage fish operations and additional DWR and DFG staff were brought on to handle the extra work. To reduce the number of crabs in each truck load of fish, up to four fish hauls were done in a twenty-four-hour period and crabs were cleaned out of the holding tanks at regular intervals. Despite the best efforts of DWR and DFG staff to control the numbers of crabs, every crab could not be eliminated from the bucket used to load fish into the truck. At times, some fish died in the loading bucket, possibly because of the stress of being crowded by crabs, or

because the amount of dissolved oxygen (DO) reached critical levels.

To test if mitten crabs could indeed deplete DO levels, some initial tests were performed by DFG staff at the Skinner Fish Facility. Various numbers of crabs were held for 90 minutes in a 439-liter tank of ambient water, while a control tank with no crabs was tested simultaneously. DO levels did drop markedly in the tank containing mitten crabs, especially when the test tank contained more than 70 crabs. These initial tests indicate as few as 1,600 mitten crabs in the fish-hauling truck (2,500 gallons) could reduce DO to lethal levels for salvaged fish. The bucket used to transfer fish from the holding tanks to the truck holds a mere 500 gallons, thus the fish mortality noted earlier may have been due solely to low DO levels rather than any direct interaction between fish and crabs. More tests are planned and a final report is expected by fall 1999.

Mysid Shrimp

Jim Orsi, Department of Fish and Game

A third species of east Asian mysid has been identified from specimens taken in San Pablo Bay by the Neomysis/Zooplankton Study. Dr. Richard Modlin of the University of Alabama searched the literature and determined that our specimens were *Acanthomysis hwanhaiensis*, a native of Korea. This species was found from South San Francisco Bay to San Pablo Bay in September 1997, our first lower bays survey and was the most abundant mysid present at this time. Its high abundance (maximum 36/m^3) and widespread distribution indicate that it must have been introduced prior to 1997. We also caught *A. hwanhaiensis* in 1998. Prior to the 1997 sampling we had not sampled these bays since 1976, when we only caught a few *Neomysis mercedis*. Still unidentified are several juvenile mysids of still another species taken in San Pablo Bay last year. Adults are needed for species identification.

Prior to the catch of the Korean species we had one species each from China and Japan, as well as one species of cryptic origin, *Deltamysis holmquistae*. We also have six native mysids, only three of which have been taken in our samples.

Acanthomysis bowmani was surprisingly abundant in October in Suisun Slough; its abundance reached 179/m^3. It was also abundant in November in the San Joaquin River at Stockton where 49/m^3 were captured. *Neomysis mercedis* was rare; its greatest abundance was only 0.7/m^3 at Stockton in November. It was found at only three stations in October and November, but this is an improvement since none were captured in these months in 1997.

Zooplankton

Jim Orsi, Department of Fish and Game

Limnoithona tetraspina was the most abundant copepod in October and November, but was much less abundant than it was in 1997. *Pseudodiaptomus forbesi* was second most abundant. *Eurytemora* began to appear in October as it normally does, but did not become abundant anywhere we sampled. Notable was the very low abundance of *Tortanus,* which was not found in San Pablo Bay as would be expected, but at Martinez and in western Suisun Bay instead. *Acartiella sinensis* was only about a tenth as abundant in 1997. *Sinocalanus*, *Diaptomus*, and *Cyclops* were the only copepods more abundant in 1998 than in 1997. Cladocerans and rotifers were somewhat more abundant in 1997.

Shallow Water Habitat Workshop Summary

Carole McIvor (US Geological Survey), Larry Brown (US Bureau of Reclamation), and Zachary Hymanson (Department of Water Resources)

Introduction

On 24 June 1998 the IEP, representatives from the IEP Science Advisory Group (C. McIvor, J. Cloern, S. Monismith), CALFED, and several independent researchers held a day-long workshop on shallow water habitat. The meeting took place at the USGS office in Menlo Park, California and was attended by 27 people. The agenda was an ambitious one and included the following goals:

1. Develop a research strategy
2. Develop a consensus on a working definition of shallow water habitat
3. Identify processes and strategies for better integration, coordination of shallow water habitat studies and programs
4. Identify ideas and issues for monitoring restoration projects
5. Discuss the ecosystem impacts (both positive and negative) of restoring shallow water habitat.

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Notes on the Invasion of the Chinese Mitten Crab (*Eriocheir sinensis*) and their Entrainment at the Tracy Fish Collection Facility

Scott Siegfried, US Bureau of Reclamation

There has been an exponential increase in the numbers of Chinese mitten crabs entrained at the Tracy Fish Collection Facility (TFCF) since they were first collected there in September 1996. These catadramous crabs have expanded their range from the San Francisco Bay into the Sacramento–San Joaquin Delta. They are drawn on their annual seaward breeding migration to Central Valley Project export flows pumped through the TFCF. The numbers entrained at the TFCF increased from dozens in 1996 to tens of thousands in 1997 to over 775,000 in 1998. Of the crabs entrained at the TFCF in 1998, over 500,000 were extrapolated from ten-minute fish counts taken every two hours (subsampling) and an additional 275,000 or more may have been removed by trapping. Over 90% were collected in September and October (Figure 1). When peaks began in 1997 and 1998, they coincided closely with the onset of cooler water temperatures (Figures 2 and 3).

As the numbers and range of mitten crabs has increased, so has the length of time over which they are collected. Now they are captured nearly year-round. The majority entrained have been males (Figure 4), travelling at night (Figure 5). Trapping efforts at TFCF indicate that they primarily move along the bottom of the channel. If the crabs continue to increase at the present rate and south delta barriers are not in place, as many as 20 million may migrate to the TFCF in September and October 1999.

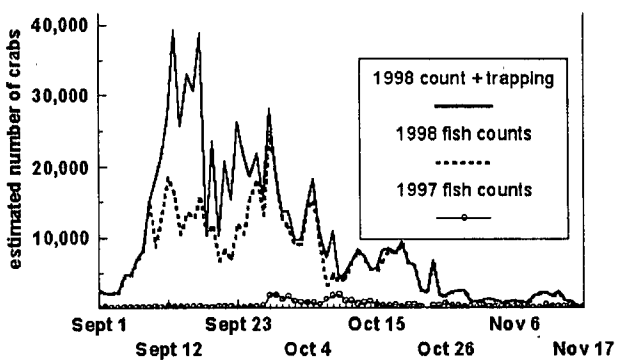

Figure 1 Comparison between estimated numbers of Chinese mitten crabs entrained daily at the TFCF expanded from ten-minute fish counts in 1998 with trapping and ten-minute fish counts in 1997 and 1998 with no trapping

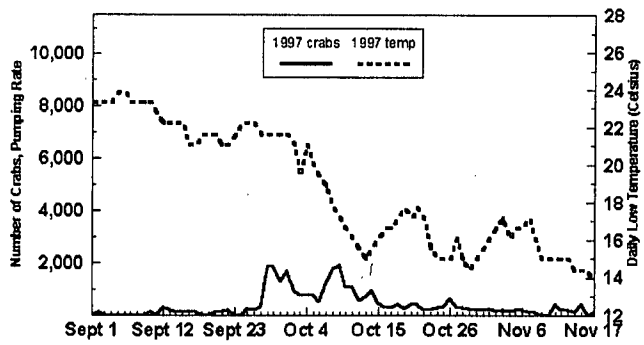

Figure 2 Comparison between estimated numbers of Chinese mitten crabs collected daily at the TFCF expanded from ten-minute fish counts and daily low water temperature in 1997

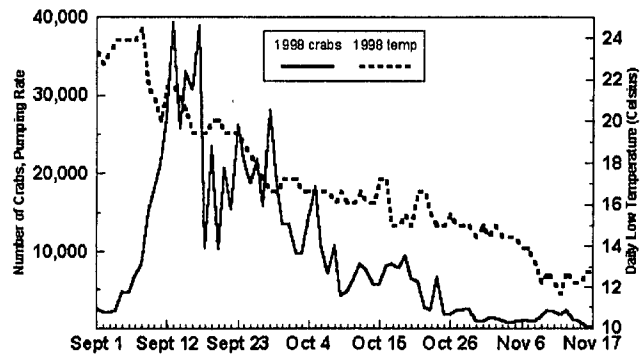

Figure 3 Comparison between estimated numbers of Chinese mitten crabs collected daily with trapping at the TFCF expanded from ten-minute fish counts and daily low water temperature

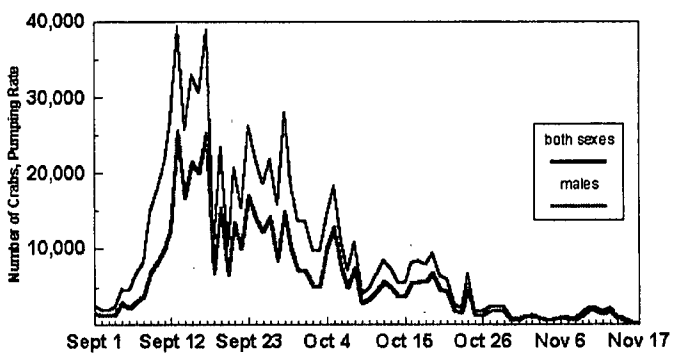

Figure 4 Sex ratio of Chinese mitten crabs collected daily at the TFCF expanded from ten-minute fish counts from 1 Sep to 18 Nov 1998. Based on sex ratio data of TFCF mitten crabs verified by Kathy Hieb, DFG.

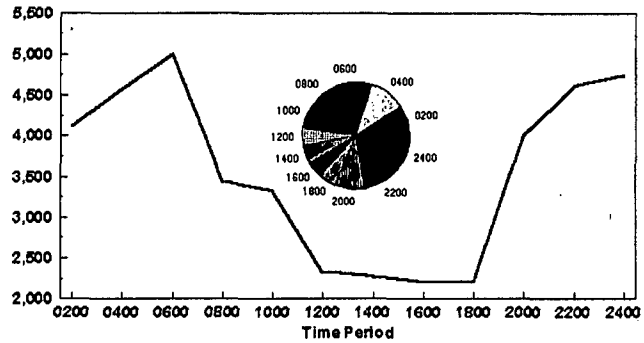

Figure 5 Diel composition of Chinese mitten crabs collected in ten-minute fish counts with trapping from 1 Sep to 18 Nov 1998

In September 1998, the mitten crabs began to migrate to the TFCF in such high numbers that they clogged many of the fish salvage features. This resulted in the deaths of thousands of fish that would have been salvaged under normal operations. To successfully salvage fish, it became imperative to separate them from crabs. Mechanical crab removal or separation efforts were completed in the secondary channel and holding tanks and included trapping, dipping, and screening. Captured crabs were buried and killed off-site. The effects of crab trapping on fish salvage were not well quantified but numerous qualitative observations were made. White catfish, yellowfin gobies, and other bottom dwelling fish species were captured in traps (direct loss) while few or none of the midwater or pelagic fish species were captured. Indirect loss due to the traps' interference with salvage "criteria" flows could not be determined from the limited testing.

Another effort involved using a travelling screen, originally designed for removing debris in the secondary channel laboratory model located at USBR's Denver Technical Services Center (TSC). This unit was tried and tested for removing mitten crabs from TFCF's secondary channels. This modular unit fit within the eight foot wide channel, but did not occupy its entire height. The screen was operated for six days and was at least 80% efficient under most conditions. TSC engineers believe that with improvements to better fit the TFCF secondaries, it could remove over 90% of the crabs. Plans are underway to have a full-sized unit built and installed to fit the TFCF's secondary channels before the mitten crab migration in 1999. This unit will be the centerpiece of a mitten crab management plan for TFCF that will also include an ambitious suite of contingencies.

DELTA SMELT INVESTIGATIONS

Dale A. Sweetnam, Department of Fish and Game

Both 1997 and 1998 hydrologies were characterized as "wet" but resulted in very different environmental conditions for delta smelt. Peak outflows in 1998 occurred in February with minor peaks in March and June (Figure 1). Flows remained unusually high through June (>50,000 cfs). In contrast, 1997 peak outflows occurred in January; however, by March, flow conditions resembled a "dry" year. Additional analyses are ongoing to determine how the changes in habitat conditions brought about by these different hydrologies affected the delta smelt population.

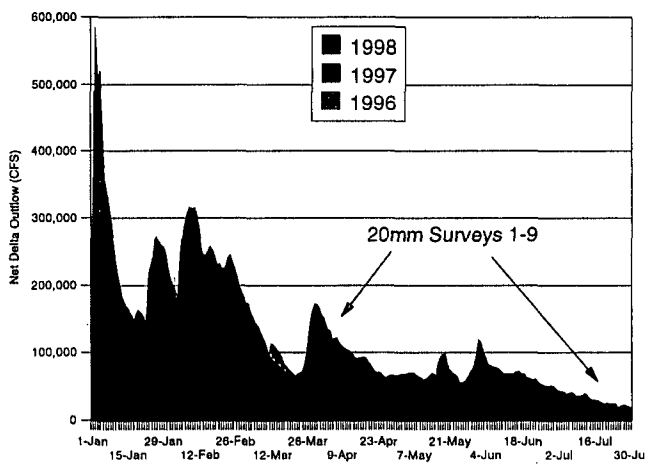

Figure 1 Net delta outflow index for January through July 1998 and 1997. Vertical bars represent the dates of the nine 20 mm surveys.

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Preliminary results were presented at the IEP Annual Workshop at Asilomar Conference Center in Pacific Grove, California.

Reference

Stewart R. 2001. Applications of stable isotope research in understanding complex ecological processes in the San Francisco Estuary. IEP Newsletter 14(4):27–32.

San Francisco Bay Fisheries Monitoring

Kathy Hieb (DFG), khieb@delta.dfg.ca.gov

The San Francisco Bay Study continued to sample fishes and macroinvertebrates monthly from October to December 2001. Notable collections included a substantial number of Pacific sardine: most fish were ages one, two, and three—all year classes produced after the last El Niño event (1998). Most likely these fish were spawned in the Southern California Bight and migrated north, since ocean temperatures have been too cool for successful local reproduction in recent years.

A recently detected introduced shrimp was identified as *Exopalaemon modestus* (Heller 1862) by Greg Jensen of University of Washington and confirmed by Cai Yixiong of the National University of Singapore. This is a freshwater species and a member of the family Palaemonidae. Its native range includes East Siberia, Korea, mainland China, and Taiwan. It was first collected in the Columbia River in 1995, so it is not known if our population originated from Asia or the Columbia River. In the San Francisco Estuary it appears to be most common upstream of the confluence of the Sacramento and San Joaquin rivers. The largest single collection to date was from a fall midwater trawl tow near Stockton in fall 2001. They have been reported as far upstream as the upper Yolo Bypass[1] in the Sacramento River watershed and Mossdale on the San Joaquin River. Not much is known about the life history in its native range, as *E. modestus* are not intensively harvested. Specimens have been saved or reported by IEP studies that typically do not report shrimp; we plan to work cooperatively to develop some key life history information for this estuary, such as relative abundance, distribution, location and timing of reproduction, and rearing areas.

1. See article by Zeug and others on page 13 for more information.

Based on otter trawl catches from October to December 2001, the adult Chinese mitten crab (*Eriocheir sinensis*) population is larger than in 1999 and 2000. However, catches in fall 2001 were far lower than in 1998, the year with the highest adult mitten crab abundance to date.

Catches of the introduced shokihaze goby, *Tridentiger barbatus*, continued to increase in 2001. The Bay Study collected 559 shokihaze gobies in 2001, up from 121 in 2000, 11 in 1999, 16 in 1998, and 4 in 1997. We collected only 60 shimofuri gobies (*T. bifasciatus*), and 30 chameleon gobies (*T. trigonocephalus*) during 2001. We collected shokihaze gobies from San Pablo Bay to Rio Vista on the Sacramento River and San Andreas Shoal on the San Joaquin River. In 2001 the majority of larger shokihaze gobies (>60 mm total length, TL) continued to be collected in Suisun Bay, while most of the smaller fish (<25 mm TL) were collected in the lower Sacramento River near Sherman Island.

Juvenile Fish Monitoring

Rick Burmester (USFWS)

The USFWS continued monitoring of juvenile salmon and resident during the fall and early winter of 2001–2002. We base juvenile chinook race designations on the Greene modification of the Fisher size criteria.

Winter-run sized juvenile chinook were first collected on October 15 in the Sacramento area beach seine. Winter run were first captured at Chipps Island on December 3. These fish continue to be collected throughout the Sacramento River and Chipps Island sampling area.

Late fall-run sized chinook were first observed entering the Delta on November 16 at Verona, then at Chipps Island on November 26. Only ten late fall run have been collected in the lower Sacramento River beach seine, 43 in the Sacramento area beach seines and trawl, 1 in the interior Delta and 35 at Chipps Island.

Spring-run sized chinook were detected from Colusa State Park downstream into the Sacramento area on November 26. These fish have not been detected at Chipps Island and only two have been captured in the interior Delta. Totals to date include 151 for the lower Sacramento River beach seine and 150 in the Sacramento area beach seines and trawl.

Fall-run sized chinook were first collected in the Sacramento area on December 4 and at Chipps Island

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Spring Midwater Trawl Survey

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The Spring Midwater Trawl Survey commenced in January 2001 and continued through March 2001. It is designed to monitor distribution and relative abundance of delta smelt (*Hypomesus transpacificus*). One hundred and thirty-two delta smelt were caught: 46 in both January and February, and 43 in March. In January, 82% of the delta smelt catch occurred in Suisun Bay near Freeman Island, the remainder were caught in the lower Sacramento River to the southeast corner of Horseshoe Bend. In February and March, Suisun Bay accounted for a smaller percentage of the total delta smelt catch, 57% and 35%, respectively. In March, 28% of the delta smelt catch was in the North and South Mokelumne rivers, mostly at the mouths of Sycamore and Hog sloughs.

In March 2001, the spring survey collected a new species of freshwater shrimp near Rough and Ready Island belonging to the family Palaemonidae. Preliminary analysis indicates that this shrimp is not one of the native North American palaemonids (Greg Jensen, personal communication). Identification to species may take several months, as the specimens may have to be sent to the Netherlands for additional confirmation. Other collections this year have been made by the USFWS Beach Seine Survey at Liberty Island (Jason Hanni, personal communication), and the DFG Bay Study near Sherman Island (Kathy Hieb, personal communication).

Notes

Greg Jensen. University of Washington. Personal communication with Kathy Hieb on March 20, 2001.

Jason Hanni. United States Fish and Wildlife Service. Conversation with author in March 2001.

Kathy Hieb. California Department of Fish and Game. Conversation with author in March 2001.

Rock Slough Monitoring Program

Jerry Morinaka, DFG
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The Contra Costa Water District used the Rock Slough intake intermittently from January through March 2001. Whenever the intake was used, the diverted water was either used for maintaining the water levels in the Contra Costa Canal or the water was blended with Los Vaqueros Reservoir water to supply the canal. A sieve-net was used to monitor fish entrainment on five occasions at the Rock Slough intake of the Contra Costa Canal from January through March. No sampling was conducted at the facility during Contra Costa Water District's 15-day no-diversion period, February 21 through March 7. Few fish were caught at the intake from January through March, and none of these fish were species of concern. Fish entrainment monitoring will continue once per week throughout the year.

The acquisition of land rights for the future screened facility at the Rock Slough intake has continued to be a problem. The start of construction for the facility has been postponed until 2002, and completion of the facility is extended to December 2003. Due to present problems with land acquisition, the site for the screened facility may have to be moved to a new location along Rock Slough.

Old River Fish Screen Facility (Los Vaqueros) Monitoring Program

Jerry Morinaka, DFG
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The Old River Fish Screen Facility was shut down from September 16, 2000, through the end of January 2001. A sieve-net was used to evaluate fish entrainment three times a week in front of the screens and behind the screens at the facility in February and March. No sampling was conducted at the facility during Contra Costa Water District's 15-day no-diversion period, February 21 through March 7. Few fish were captured in front of the facility and behind the fish screens, similar to entrainment in previous years during these months. No listed fish species were captured and the only fish captured behind the fish screens were large juvenile and adult fish residing within the facility. Monitoring in front of the facility and behind the screens will continue three times per week through June.

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News from Around the Estuary

First Observation of an Exotic Water Flea, *Daphnia lumholtzi*, in the Delta

Anke Mueller-Solger (DWR and UC Davis)
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The water flea *Daphnia lumholtzi* is native to Africa, Asia, and Australia and recently invaded the US. It was first observed in the southeastern US about 10 years ago (Havel and Hebert 1993). Since then, it has been found in many lentic and lotic water bodies across the eastern part of the continent (Figure 1). It has become especially common in warm (up to approx. 30 °C) reservoirs in mid to late summer (Work and Gophen 1999). During the rest of the year the species persists in the form of ephippia (resting stage, Figure 2). In this article I report the first observation of *D. lumholtzi* in the Sacramento-San Joaquin Delta and discuss its potential implications.

I found several *D. lumholtzi* specimens in zooplankton samples from Clifton Court Forebay collected during a CALFED sampling cruise on July 21, 1999. Subsequent identification by several zooplankton experts confirmed the species as *Daphnia lumholtzi*. This is the only observation of this species in the Delta and only the second observation in a western US state. No further CALFED zooplankton sampling was conducted in Clifton Court Forebay after July 1999 and there is no IEP zooplankton monitoring station in or near Clifton Court. It is currently unknown if *D. lumholtzi* has become established in Clifton Court Forebay and possibly elsewhere in the Delta, and what its ecological effects might be. It is also not known if it has spread southward via the Delta-Mendota Canal or the California Aqueduct.

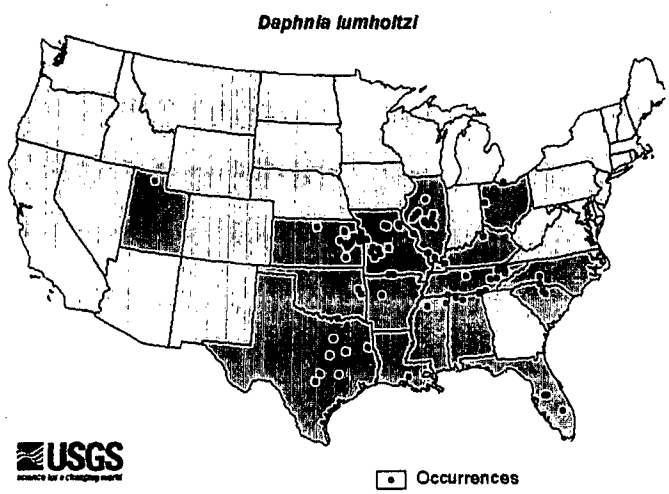

Figure 1 *D. lumholtzi* distribution in the US before Delta observations. Map created by the Nonindigenous Aquatic Species (NAS) information resource for the United States Geological Survey, http://nas.er.usgs.gov/.

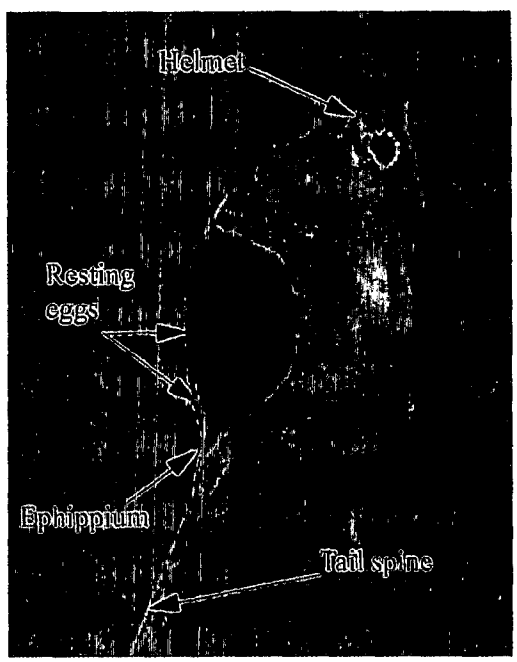

Figure 2 *D. lumholtzi* with two resting eggs encased in the chitinous ephippium. The ephippium is a thick, resistant part of the dorsal carapace of sexual females and develops in response to unfavorable conditions such as crowding, lack of food, or oxygen depletion. The ephippium with the two resting eggs is shed when the female molts. The eggs can remain viable for up to 50 years. Photo: Anke Mueller-Solger, DWR.

D. lumholtzi is well known for its ability to develop long tail spines and helmets (head spines) as well as elongated, pointed fornices (Figure 3). Mature females have been shown to reach up to 5.6 mm in total body length with the tail and head spines contributing 68% (3.8 mm) of the total length (Sorensen and Sterner 1992). Spine length increases in the presence of predators (Tollrian 1994), insecticides (Hanazato and Dodson 1993), and warmer water temperatures (Sharma and Dattagupta 1985). Crowding and colder temperatures reduce spine length (Burns 2000). Very high temperatures result in helmet deformation and mortality (Work and Gophen 1995).

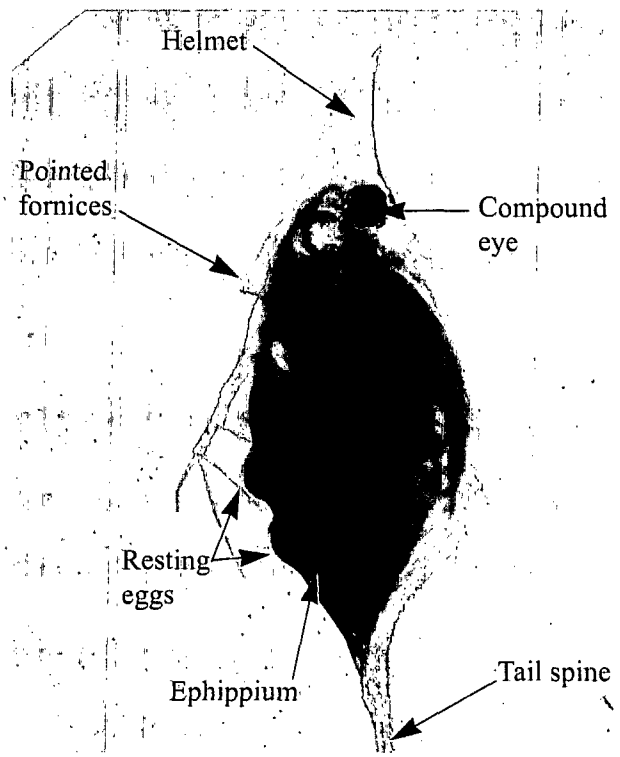

Figure 3 The *D. lumholtzi* shown here has a relatively short helmet. This specimen is the offspring of one of the original Clifton Court organisms raised in a batch culture. The helmet length decreased under culture conditions (20 °C, *Scenedesmus* as food), possibly due to crowding. Under different conditions, the helmet can be three times as long. Note the pointed, elongated fornices and the protruding resting eggs in the encasing ephippium. Photo: Anke Mueller-Solger, DWR.

D. lumholtzi often coexists with zooplanktivorous predators such as small fish and predatory invertebrates. The long tail and head spines and possibly the unusually pointed fornices protect this species against predation by fish smaller than about 50 mm in length (Kolar and Wahl 1998; Lester and Luecke 2001). In contrast, *D. lumholtzi* can be a preferred prey species for larger fishes. Sometimes *D. lumholtzi* also exhibits nocturnal vertical migration, thus avoiding visual predators (Davidson and Kelso 1997).

Introduction of *D. lumholtzi* into pelagic food webs can have severe ecological implications. Due to its high temperature tolerance and protection against predation, *D. lumholtzi* may have a competitive advantage over native zooplankton species in warm water bodies with high predator densities. In the Delta, this might be the case in summer in warm water as found in Clifton Court Forebay in summer. The high turbidity in the Delta affords these large cladocerans additional protection against visual predators. If *D. lumholtzi* became a dominant species in the Delta, small fishes such as juvenile salmon and delta smelt might suffer food shortages. However, such direct negative effects of *D. lumholtzi* on native fish larvae in the Delta may be limited because most native fish larvae occur in early spring and *D. lumholtzi* populations typically peak in late summer. On the other hand, there may be substantial and possibly equally harmful indirect effects such as those observed by Kolar and others (1997): Within very few years after the invasion of Lake Springfield, Illinois, by *D. lumholtzi*, the zooplankton community composition shifted from cladocerans to copepods in spring. According to Kolar and others (1997), this shift may have resulted from *D. lumholtzi*'s ability to avoid predation and outcompete native cladocerans in late summer, leading to less overwintering adults of native cladocera and in consequence a smaller pool of reproductive individuals the next spring.

It is currently unclear how and from where *D. lumholtzi* invaded Clifton Court Forebay. Populations in the eastern U.S. were possibly introduced together with nile perch imported from Africa in the early 1980s (Havel and Hebert 1993). It would be interesting to know if the Clifton Court population migrated westward across the entire US (as other invasive invertebrates such as the zebra mussel might also do) or if it invaded Clifton Court directly from Asia or Australia. Genetic comparisons with other US, Asian, Australian, and African populations would help answer this question. Furthermore, the current population dynamics and distribution of *D. lumholtzi* in the Delta need to be investigated and compared to those of other aquatic species in the Delta to assess possible ecological effects. If the *D. lumholtzi* population is in fact expanding, the effects on fish species in the Delta should be investigated in more detail. Zooplankton field

sampling aimed at detecting *D. lumholtzi* will be conducted in and around Clifton Court Forebay this summer by DWR scientists.

Acknowledgements

I thank the CALFED POC research team headed by Jim Cloern (USGS) for sampling assistance and Doerthe Mueller-Navarra (UCD), Jim Orsi (DFG), and Ralph Tollrian (U. Muenchen, Germany) for providing independent species identifications.

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IEP NEWSLETTER

Interagency Ecological Program for the San Francisco Estuary

News from Around the Estuary

Eurytemora affinis is Introduced

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The origin of *Eurytemora affinis*, an important copepod food item for young and small fishes in the estuary, has been the subject of some speculation. This copepod has a circumglobal distribution—it is found on both coasts of North America and Eurasia and on the Gulf coast of the United States. Its distribution has implied successive introductions from an undetermined source region. Some scientists believe the San Francisco Estuary population was introduced from New Jersey by way of railroad tank cars that carried striped bass here in the late 19th century.

Recently, Dr. Carol Lee of the University of Wisconsin, published a paper on the phylogeny of *Eurytemora affinis* (Lee 2000). Using DNA analysis, she determined that the species probably originated in an ice-free Arctic about 3 million years ago. Then, as the climate cooled, populations moved south onto both coasts of Asia and America and branched into a group of morphologically indistinguishable and reproductively isolated sibling species. Dr. Lee has identified two clades of the *E. affinis* species complex in North America: the North Pacific and the North American. The latter is composed of three subclades: North Atlantic, Atlantic, and Gulf. Significantly, two of the West Coast's populations, one from Gray's Harbor, Washington, and one from the San Francisco Estuary, belong to the Atlantic clade.

In e-mail communications, Dr. Lee said that she believes that the two West Coast populations of the Atlantic clade originated on the East Coast of North America. They are genetically closest to specimens from Martha's Vineyard and are separated from them by only two mutations out of 652 base pairs in the cytochrome oxidase I (COI) gene. However, she had no specimens from New Jersey, the source region of striped bass, to compare with them. On the other hand, the transplanted Atlantic clade populations are separated from the native North Pacific clade populations by 17% to 19% differences in base pairs in the COI gene.

The speculation that *E. affinis* was introduced is, therefore, confirmed. While it is theoretically possible that a North Pacific clade *E. affinis* is also present, a second clade should reveal its presence by having different population maxima in time, space, or salinity. No such differences have been observed. This means that before the introduction there was no native copepod species abundant in the low salinity zone (0.6 to 6.0 psu) of this estuary. It could only have been inhabited by stragglers of the marine *Acartia* spp. and of the freshwater *Diaptomus* and *Cyclops* groups. When fish culturists introduced striped bass in the estuary, they also unknowingly provided them with a food source that very likely enabled them to become established. But more—*E. affinis* was formerly the most important food item of delta smelt (*Pseudodiaptomus forbesi* has replaced it). What did delta smelt eat before *E. affinis* arrived and was the delta smelt population as abundant before the advent of *E. affinis* as it was during the 1960s? These questions can not be answered but make us realize that supposedly ideal feeding conditions for both native and introduced fishes may have been only relatively recently created by the inadvertent introduction of *E. affinis*.

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Status of the Chinese Mitten Crab and Control Plans at the State and Federal Fish Facilities

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Each fall, Chinese mitten crabs (*Eriocheir sinensis*) migrate downstream from freshwater rearing areas, such as the Delta and Sacramento and San Joaquin rivers, to spawn in the saline waters of Suisun and San Pablo bays. The migration begins in late August and continues

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