CALFED BAY-DELTA PROGRAM

NEWS FROM THE CALFED BAY-DELTA SCIENCE PROGRAM

SCIENCE IN ACTION

Scrutinizing the Delta Cross Channel

Two gray gates closed against the great waters of the Sacramento River may have more to do with salmon survival and water quality than anything else in the North Delta, scientists think. Unfortunately it's not an open and shut case, based on scientific research begun this fall and scheduled to continue for two more years. Open, the gates allow some of the river to make a left turn into a short man-made canal known as the Delta Cross Channel, freshening up water supplies downstream for exports to cities and farms. Closed, they prevent young Sacramento Basin salmon headed out to the ocean from getting swept off course and into the inner channels of the Delta, where their chances of survival plummet.

Moveable gates to the Delta Cross Channel. Open, the gates allowed tidal flows of about 9,000 cubic feet per second (cfs) and net flows of about 4,000 cfs to pass through the channel, according to fall 2000 hydrodynamic monitoring.

"Whether or not the gates are open is one of the strongest influences on smolt survival there is," says Christina Swanson, a biologist working for The Bay Institute environmental group.

Scientists recently zeroed in on the timing of gate closures, trying to find a magic combination pegged to the tidal cycle that could help both fish and water quality. In one of the most intensive research efforts undertaken in the history of California's clashes over water use, fifteen scientists from eight agencies descended on the junction of the Delta Cross Channel and the Sacramento River via boats, trucks and computers for a period of about ten weeks starting in September 2000. They tracked 120,000 outgoing salmon smolts with paint marks, radio tags, acoustic echoes and nets; they clocked water quantities, qualities and velocities, noting how things changed as river flows encountered strong tides moving in and out; and they even followed 100 adult salmon swimming up toward the cross channel from the San Joaquin River, to see if the operation of the gates somehow changed their course.

"This research project was like Operation Desert Storm, in terms of logistics," says Dave Briggs of the Contra Costa Water District, who monitored water quality during the studies. Briggs found that opening the gates only during the flooding portion of the tidal cycle achieved nearly the same water quality benefits as leaving them open all the time. These same flood tides, however, also shunted all the water and some salmon yearlings into the channel, his peers found.

"This new research has shown us a system that is much more complex than a bunch of blue lines on a map," says U.S. EPA's Bruce Herbold, who coordinated the cross channel science.

More of the science specifics are explained inside (see RESEARCH pp. 3-7), as well as gate management implications for the future (see APPLICATION, p. 7). Both the science, and whatever operational changes result, are aimed at making sure that resource managers are better prepared to manage the kind of water quality nightmare that happened in fall 1999.

It started in November that year, when both the federal and state water projects were pumping at full capacity despite low river outflows and precipitation. Resource managers, meanwhile, noted the first flush of endangered spring-run salmon coming down from their natal streams and ordered the cross channel gates closed. The salmon didn't make it any easier by coming down in one big bunch: instead, they "dribbled out," says observers, triggered by small pulses of outflow from a series of small storms.

Continued page 2

HISTORY

ORIGINS & OPERATIONS

The federal Bureau of Reclamation created the Delta Cross Channel in 1953 to transport high quality fresh Sacramento River water into the interior Delta. The Delta is a labyrinth of rivers and sloughs draining 40% of the state into San Francisco Bay — creating the West Coast's largest estuary — and its watershed provides drinking water to 22 million Californians . Water quality had been a growing problem since the 1920s and 1930s due to salinity build up and pollution from agricultural runoff.

Over the cross channel gates are signs warning that they "may be opened or closed at any time" and that a loud horn will be sounded twenty minutes before the technician pushes the button. There are no pumps—the channel works entirely through natural flows. The channel diverts Sacramento River water into Snodgrass Slough and the Mokelumne River, where it flows through natural channels until it reaches the federal Tracy Pumping Plant, about fifty miles away. Without the Delta Cross Channel, that water would have to take a much more circuitous route down the Delta, where it would mix with more brackish Bay water, before getting to Tracy.

Originally the gates were closed only when high Sacramento River flows threatened to flood the narrow Delta channels. Since 199?, they have also been operated in an attempt to protect endangered Sacramento Basin salmon migrating up and down the river. An annual gate closure schedule, part of which is at the discretion of state and federal fish and wildlife agencies, was developed based on the Biological Opinion written to protect the winter run under the Endangered Species Act, and on historical data suggesting that survival was 2-3 times lower for any salmon diverted from the river's mainstem and into the Central Delta. The closure plan was later expanded to protect other salmon runs and codified in the 1994 federal-state Bay Delta Accord and 1995 State Water Quality Control Plan. See schedule at: www.mp.usbr.gov/cvo .

Scrutinizing the Delta Cross Channel

Sacramento River bend, with Delta Cross Channel (at left) flowing into Snodgrass Slough and down toward the Mokelumne River.

With the gates closed, the water quality at the export pumps in the South Delta steadily worsened, nearing maximum allowable standards for salinity as little or no "fresh" Sacramento River water made it through the cross channel and down to South Delta intakes. Then December's always energetic tides kicked in, exacerbating salt water intrusion.

In a classic water wars clash, demands to open the gates amplified, as water and resource managers faced off and pounded the table. The fish managers held firm and the gates stayed closed. On December 20, the water arriving at the Contra Costa Water District's Rock Slough intake exceeded the state's 250 milligrams per liter standard for chloride.

"Closing the gates trashed water quality and exporters screamed like stuck pigs," says Swanson.

To prevent this from happening again, all parties agreed, as one of hundreds of action items spelled out in the CALFED Record of Decision signed in August 2000, to study the pros and cons of various Delta Cross Channel gate closure scenarios for three years. (CALFED is an interagency and stakeholder effort launched in 1995 to balance the water needs of fish, cities, farms and the environment.) Mere months after the signing, researchers were out on the water doing the first studies, an amazing turnaround time for both science and bureaucracy.

"We had the right people in the right place at the right time," says Kim Taylor of the CALFED Science Program, explaining that the Bay-Delta's Interagency Ecological Program had already invested enough research dollars in how to measure flows that by fall 2000 scientists was ready to do side-by-side studies on fish using, for the first time in this region, hydroacoustic techniques perfected in Colorado and the Northwest. "We were able to combine their expertise with our flows capabilities and CALFED's money to tackle the problem," she says.

A core team of scientists developed eight hypotheses about how fish and flows and water quality interact in and around the cross channel, and then set out to test their hypotheses (see page 3). "They thoroughly followed the scientific method," says Steve Macaulay of the State Department of Water Resources, one of the agencies pounding on the table back in 1999. "The fact that we got some very good information in terms of results, that half a dozen agencies were able to marshal gear, staff, and money to make this happen overnight, is really exciting. I've never seen a more pumped up group of biologists. It shows a big change in individual and institutional attitudes."

Attitudes were very different in the heat of the water wars in the 1980s, says Macaulay, when a drought and a winter-run salmon population that dropped to a few hundred pitted endangered species against water supply in a war for California's scarce water like never before. "It was like the Cold War back then," says Macaulay. "Everyone was competing, with agency biologists working for one side or the other, for different masters or purposes. It was just like the Russians and the Americans, with 'our German scientists are better than yours.'"

In those days, he says, there was a lot of friction between those managing water and those managing fish, particularly at the staff level. The beginnings of a truce came with the 1994 Bay-Delta Accord, when the first who-gets-what-water bargains were struck, and grew as the Central Valley Water Project Improvement Act and CALFED forced long-competing agencies and stakeholders into years of meetings over water allocations, until old enemies were pulling out pictures of their kids during coffee breaks, says Macaulay. By the time the cross channel research came along, everyone was primed to collaborate, and had the technical know-how to find out what was really going on in the water, versus projecting it from computers and labs.

Indeed everyone's pet peeves and pet solutions to our water problems seem to have fallen away in the face of this major reality check. "Nobody engaged in these studies is giving the 'mini peripheral canal' speech in the background," says Tim Quinn of Southern California's Metropolitan Water District, referring to the hot button association of the cross channel and other proposed canals with the unpopular 'peripheral canal' proposed to solve Delta water quality problems back in the 1980s. "It's notable that the scientists are being scientists, approaching this on an absolutely objective basis."

Working on the cross channel stuff also gave scientists an unprecedented taste of teamwork. "This is the first study I've seen in over three decades that had this magnitude of multidisciplinary expertise all in one place at one time. There was tremendous coordination between studies," says Dave Vogel of Natural Resource Scientists Inc., one of the participating biologists.

The coordination not only paid off in brainwork but also at the bank. Using CALFED's connections, the cross channel scientists were able to piggyback their work on boats and studies already headed out onto the water through the Interagency Ecological Program (IEP). Without the IEP's resources already in place, and the program's willingness to sacrifice some regular monitoring activities to provide vessels and captains, the new research might not have happened, say participants. "If we'd sent a consultant out to do this we'd have spent well over a million dollars, " added CALFED project manager Ron Ott. The studies cost $400,000.

"CALFED turned a corner here, not just in the North Delta, but across the board," says Tim Quinn, who expressed particular praise for CALFED's science czar. "Sam Luoma has done a great job of creating a world class approach to science. It makes a lot of us much more comfortable with the road we're on."

RESEARCH

Science by Storm

Scientists running eight hypotheses about Delta Cross Channel impacts on fish, flows and water quality through the ringer this fall came to four basic conclusions: true, false, probably and unclear. Two more years of follow-up studies will help them clarify these findings and suggest ways in which CALFED might improve operations of the cross channel gates. In the meantime, the first year's results have given them some good leads about how South Delta water quality changes with experimental gate operations, and where fish in the vicinity of the gates go under various flow, tide and daylight conditions.

"True" turned out to be the resounding conclusion regarding the first hypothesis, in which scientists speculated that opening the gates only during the flood tide would achieve approximately the same water quality objectives as leaving them open all the time. Between September and December 2000, engineers opened and closed the gates at different frequencies pegged to the tides while the Department of Water Resources environmental monitoring program made hourly recordings of electric conductivity (one of the easiest ways to estimate salinity in estuarine waters). Measurements were made at Jersey Point, where water is susceptible to cross channel effects, and Chipps Island, a "control" location, where gate closures have no effect - see map p. 7.

Researcher Dave Briggs of the Contra Costa Water District found that opening the gates for two local flood tides per day did not have any measurable effect on south Delta salinity, because the net flows through the cross channel didn't change much.Opening the gates for only one local flood tide per day did affect local flow, however, and thus may have resulted in a "small" degradation in water quality, although Briggs isn't sure.

"You can't just go out there and flip a gate shut and say 'let's measure the effects everywhere,'" says Briggs. "There's too much inertia in the Delta. Things don't happen that fast. In fact, the Delta is a very tricky place to conduct a hydrodynamic experiment. In ideal science, you fix everything and vary only one parameter. But here in the Delta, you have rains and heat waves, tides and seawater intrusion, a hundred farmers suddenly deciding to irrigate, exporters shutting the pumps on and off. Trying to pick out the effects of a pretty small factor like a 25% gate opening is difficult, if not almost indiscernible."

Briggs concluded that the biggest factor controlling South Delta salinity is not the cross channel gates, but seawater intrusion due to low Delta outflows. The second most significant factor is the spring neap tidal cycle, when tides are bigger and stronger than normal (see Tidal Trivia, p.5), he says.

What was less clear, in terms of true or false results, was the work on the salmon side of the science. The other seven hypotheses all tackled the question of just how sensitive salmon, young and old, up- and down-migrating, would be to the experimental operations of the Delta Cross Channel gates with the tides.

Continued page 4

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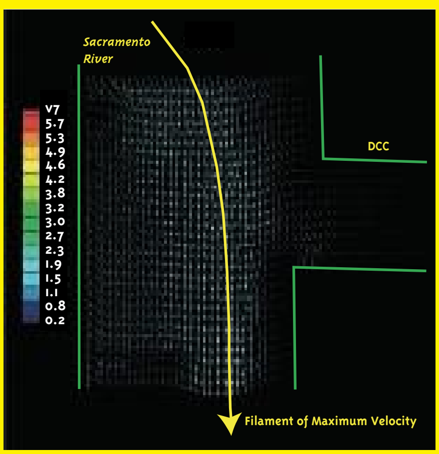

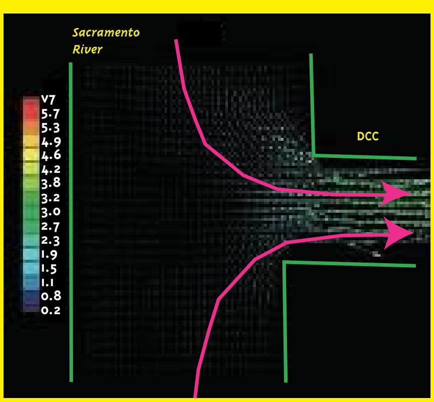

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HYPOTHESES

1. Opening the cross channel gates only during the flooding portion of the tidal cycle will achieve approximately the same water quality objectives as the fully open state. TRUE

2. Distribution of adult and juvenile fish within and near the channel is a function of the distribution of their preferred velocities. UNCLEAR, NEEDS WORK

3. The percentage of juveniles entering the Delta Cross Channel is a function of flows into the channel when they are near it. TRUE

4. Outmigrating juveniles move down more during the day than during the night. UNCLEAR

5. Outmigrating juveniles move down more on ebb than flood tides. NOT REALLY MEASURED AS STATED

6. Outmigrating salmon tend to remain near one bank so that at the Delta Cross Channel, fish near the left bank are more likely to enter the Central Delta that fish on the right bank. PROBABLY.

7. Tidal operation of the cross channel will attract more adult salmon up the lower forks of the Mokelumne than when fully closed. UNCLEAR? MAYBE?

8. Tidal operation of the cross channel will lead to quicker, more successful migration of adults from the Central Delta to the Sacramento than the fully closed condition. PROBABLE, BUT VERY SURPRISING HOW ROUNDABOUT ADULT MIGRATION PATHS CAN BE, IRRESPECTIVE OF ANY GATE EFFECTS.

Biologists seeking salmon catch a carp.

Science By Storm

"There's always been a debate about whether fish go with the flow," says CALFED's Kim Taylor. "Some biologists say they do and others say they go where they want to go because they can swim. We don't really know how much of where they go is driven by flow, versus behavior. In these studies, we had the tools to figure out what this combination might be under specific local flow conditions."

To see where the water was going while others tracked the fish, the U.S. Geological Survey's Jon Burau placed a series of velocity meters called "dopplers" (or ADCPs) upstream, within, and downstream of the cross channel. He also set drifters — little sailboats — in the water at the same time and place that biologists were releasing fish, and attached dopplers to the boats being used to catch and track the fish. That way, researchers had good hydrodynamic data for every fish data point.

"We kind of knew where the water went, but only had average flow numbers," says Randy Brown, retired coordinator of the Interagency Ecological Program, who has overseen fish and flow research for three decades. "Jon gave us more minute-by-minute changes." Indeed Burau played a pivotal role in linking data collection and interpretation across disciplines, say all involved.

Burau was surprised to see that the change in conditions, when the flood tide comes up the river to the junction with the cross channel, is anything but gradual. "You're out there in the channel on a boat, and nothing's going on, and suddenly bam, it's just flowing like crazy. Within half an hour, flow velocities go from zero to four and a half cfs, stronger than currents we typically see in the Carquinez Strait. You never see such extreme acceleration down in the Bay."

As the flood tide came on, Sacramento River water not only poured into the cross channel from upstream, says Burau, but was also pushed into the cross channel from below the junction by the tides.

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"River flows go from bi-directional below the cross channel to unidirectional upstream of the cross channel," he says.

Burau also noted that the cross channel is on the outside edge of a river bend, which can create a kind of slingshot for flows and fish (see above). "As the flow goes around the bend, the filament of maximum velocity hugs the inside of the bank then wings over to the outside of the bend, augmenting the currents there" he says.

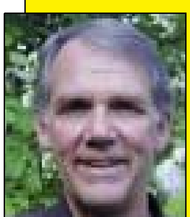
Spray-dyed smolt.

What all this means, unfortunately, is that when flows do go into the cross channel, they're so fast and strong they take any young salmon in the area with them. This is exactly what Mark Pierce of the U.S. Fish & Wildlife Service confirmed when, in mid-November, he marked 120,000 salmon smolts with a special dye, trucked them in from the Coleman National Fish Hatchery, released them into the Sacramento River three miles upstream of the channel, and then recovered them again downstream, via mid-water trawls, to see where they ended up (see graphs).

"The salmon moved into the cross channel when the water moved into it," says Pierce.

Of the 120,000 smolts released, researchers recovered a total of 618. But more important than the numbers were where and when trawlers picked up the fish relative to where and when

OUTLOOK



TRADITIONAL SCIENCE AND NEW TECHNOLOGY

SAM LUOMA
LEAD SCIENTIST
CALFED

"The Delta Cross Channel research that was done last fall put new technology to work in an interdisciplinary framework. Salmon people have their ideas about how water moves, and water people have their models of how water moves, but this is one of the first times they've gotten their ideas together in a quantitative way, and used both experimental and traditional technologies to test them out.

"They used radio tags and hydroacoustic surveys to track salmon movements, and simultaneously measured real-time flows and tidal movements around the channel in ways that could be translated into pictures and animation. It's only in the last year or two that we've had the ability to move these instruments into place so quickly and to watch water move in three dimensions. The resulting pictures made very complex science easy to grasp for everyone involved.

"The Delta Cross Channel research is a sign of CALFED's openness to experimental science. But one experiment is never enough; you have to have a body of knowledge to make good management decisions. We also need to appreciate that it takes decades of investment in tools like fish tracking and hydrodynamic instrumentation and models to prepare us for breakthroughs like this.

"In the past, scientists and resource managers have not always been optimistic about the value of understanding estuarine processes: but this shows us that there is cause for optimism, that through the rigorous application of science we can sort through at least some of the complexities of our ecosystem and it's management challenges. Creative or unanticipated solutions to conflicts can be the result. It is important that CALFED continue to encourage rigorous science, and the kind of interagency, university and private sector collaboration and cooperation tapped to scrutinize the Delta Cross Channel."

Midwater trawl.

truckers released them. The smolts had been dye marked with red, orange and two shades of green, so that one color could be released on the ebb tide, one color on the flood tide — with time of day variations — and one color each on the east and west banks.

"We were testing to see if the fish do something different on a flood tide, do they hold over or go to the shallows, for example," says Pierce. But they don't. The fish showed up in the channel trawls very shortly after the flood tide kicked in. During the ebb tide, little or no fish showed, or it took them a lot longer to get to the channel. In terms of the east versus west bank release differences, the numbers recovered from each bank were pretty equal.

"It's only one test, under one set of flows, one fall, but to me it's fairly convincing for a pilot study," says Pierce.

A hydro-acoustic team led by Mike Horn of the U.S. Bureau of Reclamation and the U.S Geological Survey's Gordon Mueller helped confirm the dispersion of most of the released smolts. Acoustic technology sends sound waves through the water to detect fish, and to determine their size, densities and depth within the water column. Zigzagging across water with the echo-sounders pinging away during the week of November 13th, for example, the team identified 301 target fish in the vicinity of the channel, of which 258 were in the Sacramento downriver of the channel, and 43 in the channel itself. The proportion closely correlated with the trawling data.

How did Horn know which of the dots on his screens were the smolts, and which were other similar sized fish? You can never be completely sure, he says, but by getting a reading on background fish levels and sizes before the smolts were released, and then picking out everything above background, they can get a pretty good idea.

According to the surveys, the smolts took 4-5 hours to reach the gates from their release point three miles upstream, an hour longer on a flood tide. The lead fish generally went with the current, while the rest dispersed over the whole river reach in the time it took to get to the gates. Most of the fish stayed 5-6 meters below the surface. It appeared they might be avoiding surface waters during daylight hours, says Horn. Since the fish weren't in the top couple of meters during the day, they might also have been out of reach of the trawler's nets.

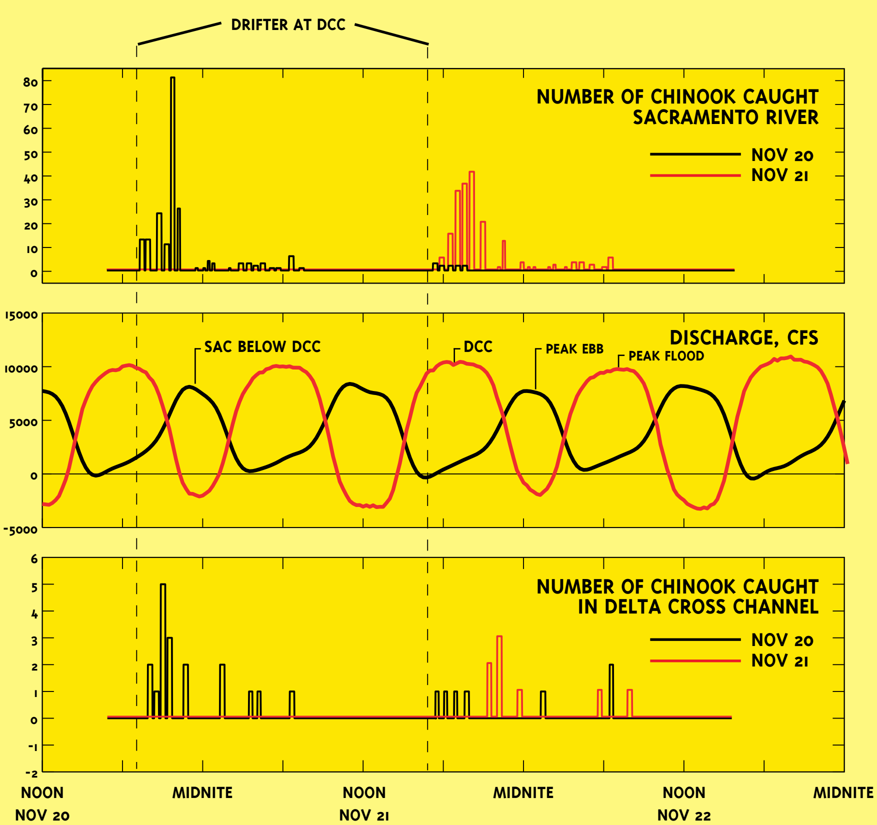
"It was neat to compare the different views of fish that came with the

Continued page 6

TIDAL TRIVIA

A flood tide moves upriver; an ebb tide flows back toward the ocean. Each happens twice per day (two floods, and two ebbs) based on the position of the moon. Every 14 days throughout the year, the amplitude of the tide gets higher during new and full moons (called "spring" tides but in this case the word "spring" has nothing to do with the season) and lower during half moons (called "neap" tides). Seawater intrusion is not the same thing as tides but tends to be greater during spring tides.

SALMON SMOLT TRAWL RESULTS



Midwater trawl. November 20: When the fish showed up in the Sacramento River trawl, the flood tide was beginning and flow was moving into the Delta Cross Channel. There was then very little delay until fish showed up in the cross channel trawl. November 21: When the fish showed up in the Sacramento River trawl, the tide was still ebbing and the cross channel flow was zero for several hours until flow started into the cross channel on the flood tide.

Source: Pierce & Burau

different gear," says EPA's Bruce Herbold. "Data from one kind of gear explained data from another. When we weren't catching fish in the trawl, for example, the acoustics told us they were down deeper in the water column, or just not there at all."

Fyke net.

The acoustic data also suggested that the fish were not "bank-faithful," favoring one bank over another all the way downstream as many biologists have long thought. Pierce and others noted a similar lack of bank significance, although this may have been because the hatchery fish had little time to acclimate to river conditions.

Burau thinks the lack of bank fidelity in the catch can be explained by the local flow structure in the Sacramento River upstream of the cross channel. He noticed, for example, that all his drifters, which like the fish were released on opposite sides of the river, immediately migrated to the west bank where they traveled, en mass, until they reached the cross channel. If fish did the same thing, they would have arrived at the channel completely mixed, he says.

To take a closer look at how individual smolts might behave, Dave Vogel of Natural Resource Scientists Inc. radio tagged 94 fish and released them in 16 small groups both up and downstream of the channel opening prior to Pierce's mass releases. The radio tag releases occurred during day and night, flood and ebb tides, and from the left and right banks as well as mid-channel.

Each of the 94 salmon yearlings (which averaged 150 mm long) carried a one gram radio transmitter. The transmitters sit in a miniature saddle, painted in a camouflage color to match the back of the fish, and held on and cinched up via a couple of stainless steel wires threaded beneath the dorsal fin. As the fish grows, the whole thing falls off. But in the meantime, each fish has its own unique radio frequencies.

Sitting in his boat under a big antenna using GPS positioning and triangulation to follow the fish, Vogel found out several interesting things. He too saw the fish move into the cross channel on the flood tide. But he also noticed that some of the radio tagged fish migrated past the cross channel down the river, but were then pulled back in by the tide. "Just because they pass the channel opening, doesn't mean they're free from being entrained," he says. Of the fish that did enter the cross channel from Sacramento river, none exited back out into the river. They all went into the Central Delta.

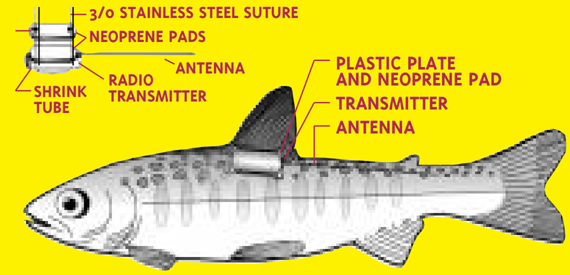
Although there were subtle differences between day and night, fish release locations in the channel (i.e. left or right bank) didn't appear to make much difference to entrainment in the Delta Cross Channel, corroborating the other smolt study results.

One of Vogel's vessels also carried a doppler to record water velocity where radio-tagged fish were detected. He and Jon Burau found that the smolts moved slightly slower than the ambient water velocity. "With smolts, the ratio between how fast they can swim and how fast the currents are is very small," says Burau. "They can't just swim away like larger adults."

And swim away, or anywhere they pleased, was exactly what big

Fish & Wildlife's Jeff McLain with salmon caught in fyke net (behind).

EXTERNALLY ATTACHED ONE-GRAM RADIO TRANSMITTER
ON A JUVENILE CHINOOK SALMON



salmon tracked by the cross channel research team did. Instead of looking at yearling salmon headed out to sea, Dan Odenweller, and staff of the California Department of Fish & Game's Fish Facilities Research Unit, inserted sonic tags in the stomachs of 112 adult Chinook salmon, released them in the Central Delta in the San Joaquin River, and tracked them as they migrated upstream to spawn (see map p.7).

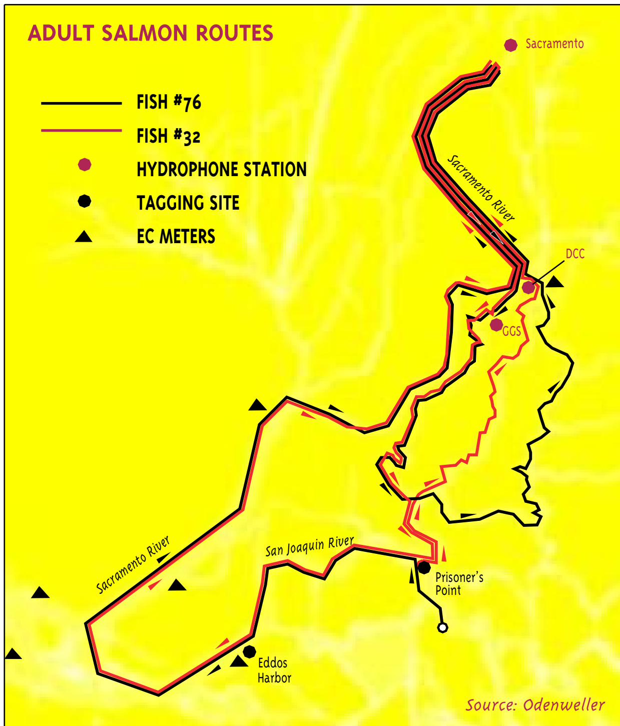
Researchers wanted to know if the tidal gate operations attracted more or less adult salmon into the lower Mokelumne River leading up the cross channel, and if the fish got delayed by, or stuck behind, the closed gates. In general, freshwater outflows, such as those pouring through the cross channel into the Mokelumne and San Joaquin on a flood tide, attract adult salmon.

Unlike the little smolts who had to go with the flow, the big fish found their way upstream in all different ways, says Odenweller. Looking at his results, CALFED's Ron Ott was surprised to see the "randomness of how an adult fish goes wherever it wants to, jumps from one river system into another, migrates up and downstream. They really move around a lot."

Odenweller found that 66% of 71 fish tracked exited the Central Delta via the Sacramento River at Hood, and 14% via the San Joaquin River at Mossdale.

Five of the fish used the cross channel and/or Georgiana Slough on their way to the Sacramento River. In other words, though many of the big fish were headed back to the Sacramento from the San Joaquin, the experimental gate operations didn't pose a significant migratory barrier (the gates were never completely closed while the adults were being tracked, however).

A combination of acoustic tracking and fyke net samples confirmed Odenweller's big fish results. U.S. Fish & Wildlife's Jeff MacLain rolled



the fyke nets — 24-foot-long and ten-foot wide hoop nets — down the sides of local levees and set two in the water in the Delta Cross Channel and two more in Georgiana Slough .

"The more gear you use, the more you learn about different life stages of the fish in different conditions, " says MacLain. "As we were catching the fish, we were reporting back to the acoustic people so they knew what to look for."

Out of a total of 30 adult fish caught in the Delta Cross Channel, MacLain found salmon to be the most common anadromous species. Based on the smallest adult salmon he captured (45 centimeters in length), acoustic trackers set their equipment to find fish over 40 centimeters long. The nets also trapped a lot of resident fish of the same large size who were hanging out along the banks. Acoustic trackers used this information on species composition in the nets to estimate salmon densities.

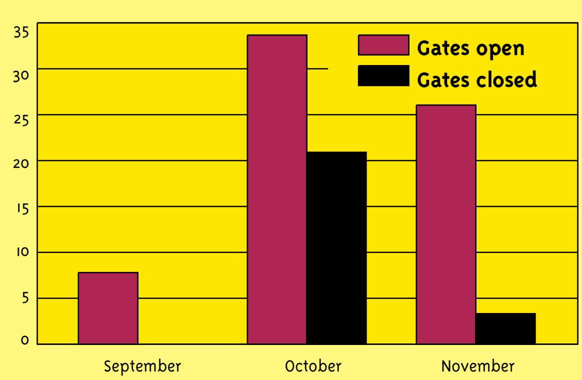
The acoustic team's subsequent surveys detected a total of 38 target fish over 40 centimeters long. They saw higher densities of large fish within the Delta Cross Channel with the gates open, and, once again, found no evidence of spawners congregating behind closed gates. The acoustic results suggested cross channel salmon densities of about 12.4 fish per hectare when the gates were closed and 19.9 fish per hectare when the gates were open. According to Gordon Mueller, his numbers were reasonably comparable to what Odenweller found with the radio tracked fish.

The science team is now busy planning follow up studies for next year. Some scientists want to change gear, others the timing of fish releases and gate closures, and others the length and scope of their studies. For guidance on what to do next, the cross channel team presented its results to the CALFED Science Review Panel this May, which is now preparing feedback.

"I still can't believe all the gear worked," says EPA's Herbold. "But the fact that we took a variety of approaches to the same question, and that they mutually reinforced one another, gives us a great deal of confidence in the results."

"The hoped-for result — being able to close the gates on the ebb and open them on the flood tide in a way that would benefit both fish and water quality, giving us the best of both worlds — didn't happen," says Fish & Wildlife's Pierce. "But that doesn't mean we can't tease out some compromise in management of the gates that will have partial benefits for both."

LARGE FISH DENSITIES
GREATER THAN 40cm/ha



Measured in the Delta Cross Channel with fish acoustics gear during September, October and November, 2000
Source: Horn and Mueller.

APPLICATION

SCIENCE THAT WON'T SIT ON THE SHELF

Though no one is jumping to conclusions about the Delta Cross Channel research results yet, scientists are already out in the field applying the same interdisciplinary approach to other Delta problem junctions and everyone is mulling over what all this may mean in the game of balancing fish and water quality needs down the road.

The obvious result of the research, loss of salmon yearlings on the flood tide, doesn't mean we have to close the gates every time the water rises, say the scientists. But it does mean hard work next fall to try and pin down the threshold — gates open on a flood tide 5, 10, 20% of the time — at which water quality actually takes a significant turn for the worse. Partial closures may be the ticket. Or even a hard look at the bigger picture of the cross channel's relative contribution to water quality overall.

After that, scientists need to delve deeper into whether there is some specific time in the span of night and day, rising and lowering tides, days of the month, when fish densities are lower. "If we can find some behavioral components, ways in which fish use differences in flows and times to move differently, then we may have some management suggestions," says the Geological Survey's Jon Burau. These might be things like closing only on the flood tide at night, or during the acceleration period of the flood tide."

"The data show how dynamic our system is, and how it changes over a very short period of time. We haven't really ever talked about how to manage on that time scale, in days and hours versus months and years," says CALFED's Kim Taylor.

The data and management options could also change dramatically in the coming years of study. "We don't have a definitive answer yet," cautions Fish & Game's Dan Odenweller. "It's only one year of data, and we haven't seen a dry or a flood year yet. Things could all go south."

The research does suggest, however, a few ways to do a better job of tracking where the fish are. Tracking related to gate closure orders is now done through a combination of trawling and rotary screw traps. But if, as the acoustic data suggest, the fish are not in the upper

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TEAMWORK

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water column during daylight when the trawls occur, or may avoid visible nets in clear waters, then we need some other ways to find them.

Everyone seems to agree now that the addition of some acoustic monitoring, which takes a lot less human muscle and dollars than a trawl, and can even be mounted on pilings and accessed via cell phones, could help find the fish minute to minute. "With acoustics, we can locate fish without even touching them, instead of going out with a net and stressing already stressed fish," says Fish & Wildlife's Jeff McLain.

Certainly the research "undermines the trust we have long placed in trawling data," says EPA's Bruce Herbold. He thinks regulators may need to be more cautious now about ordering up gate closures. "Instead of saying, 'oh there's two fish, close the gates,' we might say, 'oh they're starting to come down, let's close them every other flood tide. Or let's check the hydro-acoustic monitors and only close the gates when we really see a lot of fish.'"

Apart from fish tracking tips, the Delta Cross Channel research highlighted a couple of important design issues that shouldn't be forgotten in the planning of any other future canals. First, don't locate the new diversion point on the outside edge of a river bend, or you maybe dealing with more fish than you need to. "Coming out of the river at a ninety degree angle like the Delta Cross Channel probably isn't a good idea," says Jeff McLain. Second, don't ignore the potential influences of tides on fish movements.

If gate operations can't be fine-tuned to save the smolts, then the next step may be to screen them out. The Bay Institute's Christina Swanson sees such a screen as unlikely. "Given the channel's location, we're talking something that's technically very difficult, a huge 300-400-yard- wide screen, and a town in the way to boot. You can't flatten a historic town," she says.

There's also the problem that a permanent screen might do exactly what the gates do not: allow flows through, attracting adult salmon but not giving them any way through the screen. This in turn might require the construction of some upstream fish passage facilities, such as ladders or elevators or locks. All of these engineering wonders — screens, ladders, new canals — are part of CALFED's larger research agenda.

"This kind of science will help us get the right combo of infrastructure and investments," says the Metropolitan Water District's Tim Quinn. "Based on what we are learning, I'm quite confident we will operate the system differently and better."

How, if at all, will this new science bear on any future crisis of 1999 proportions? Water Resource's Steve Macaulay says it shows us the need for far more comprehensive real time monitoring of where the fish are, and more frequent communication between fish folk and water folk. Unlike back then, "Water quality is now prominently on the radar of fish and supply people," he says. It also suggests that gate operations may from now on be more a matter of real time science than politics. "Right now the way it works is we close the gates until the political heat gets so bad we open them again," says CALFED's Ott. "It may never be this way again."

The cross channel research experience, meanwhile, is already helping to set the science agenda for other problem spots at river junctions and barriers throughout the Delta. This May, Jon Burau was out on a boat setting up more hydrodynamic monitoring in the South Delta, the next frontier for CALFED's priority on multidisciplinary, collaborative studies.

A similar team to that mobilized for the cross channel gates will examine real time fish and flows associated with the barrier at the head of Old River, as well as other mobile barriers proposed to deal with localized salinity, temperature and reverse flow problems along the San Joaquin River. They'll also be looking at whether fish are benefiting from new management agreements (VAMP) and export pumping changes.

"We've jumped from the frying pan into the fire," says Burau.

"We've come a long way toward being able to specify what is needed for fish and what is needed for water quality, and discovered that they aren't exactly in conflict. In this case knowing more has given us many more tools," says Herbold.

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LOOK OUT for more detailed discussion of the DCC science in summer 2001 newsletters of the Interagency Ecological Program.