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WFRC Research News

(news you can use to thrive and survive!)

Editor, Gary A. Wedemeyer *Issue No. 2, Spring 2003*

In this Issue

Shipley Ships Out !

by Gary Wedemeyer

As you probably have heard by now, WFRC Center Director Frank Shipley has decided to exchange “the best job I ever had” for a position as Deputy Regional Biologist at the Western Regional Office where he will oversee all 6 Western Regional Science Centers.

I know I speak for all of us when I say that Frank will be sorely missed. In his eight years as WFRC Center Director, he has been an untiring advocate for good science as we have moved through a jungle of distracting administrative and other organizational changes. In his new position, Frank will report to Ann Kinsinger, whom we have also grown to respect for her unwavering support of BRD scientists and their work in the Western region.

In an exclusive interview with this reporter, Frank stated that “he will miss us too”, whom he characterizes as “the best group of people that I have ever worked with: talented, motivated, and easy to get along with (most of the time!).” In the interim, the very capable Lyman Thorsteinson will take over as Acting Center Director – a job he has already been doing much of the time lately while Frank has been away on WRO assignments.

When asked if he had any last words for the WFRC staff before he left for downtown, Dr. Shipley responded “tell everybody at the lab “So Long, and Thanks For All the Fish!”

A Brief Message From the RD

by Doug Buffington

Safty/Security

The past several weeks have been unsettling for many reasons. I emphasize my confidence in all of you to carry out the work of the USGS while protecting the safety and well being of our employees.

Our Region extends from above the Arctic Circle to the Mexican border; from the deserts of the interior West to the far west Pacific Islands. We work in remote wildernesses and in sight of the nation's busiest ports. One-size-fits-all or "tops down" management does not work in our Region for most things, and certainly not in emergency situations. To use but a single example, most of us were not even aware of the devastation from

typhoons in Guam, and the role of our employees, until after the event. Our folks there, however, did us all proud.

Changes in alert status and threat assessments, and the possibility of an even more elevated status in the future raise questions about what we should do. Our Continuity Of Operations (COO) plans and emergency plans that were revised after 9/11 in most cases do not take into account the new alert color code threat assessment system now in use by the Department of Homeland Security. Major issues, such as when do we close facilities or leave buildings have not been clear. Fortunately the Director has clarified some of those issues for us in his memorandum about Code Red Status. We will continue to try to clarify more complex threat assessment issues and the relationship of USGS management actions on alert status for all of you.

Your Science Center Director and other Center Directors know the local conditions, who the appropriate law enforcement officials may be, and who should be contacted from the General Services Administration and the Federal Police & Protective Services. Continue to keep open communications with them. Make sure that you keep communication links open with your supervisory chain because information will be coming from that source, as well as through the administrative chain. I much prefer to see redundant information being sent during these difficult times than that USGS scientists and employees in the Western Region not be informed. If you have questions, ask them. I and all the members of the Western Leadership Team will be available to you as needed.

On Competitve Sourcing:
I appreciated the give and take of our recent meeting at the Center. I am also visiting the Cascades Volcano Observatory and the Washington District Office in Tacoma during the next few weeks. It is important that every employee of the USGS gets to voice their views and concerns about ongoing issues. I was also especially pleased with the astuteness of our USGS employees' questions, including those from your Center, when we did the town hall meeting on outsourcing. I was in the room with all of the Regional Directors, several of the Associate Directors, Amy Holley. as well as Scott Morton and others.

This is an extraordinary difficult topic, and your professionalism was noted by all of us. Let me add an additional observation. You have heard the term "... and the government wins" to express what is happening, when the fact that our employees are competitively the best way as proven by the result of an outsourcing competition. Note that the expression is not "...and the employees win." We are convinced that the employees doing the inventory activities under study provide the best deal for the taxpayer. If we can demonstrate this in the competitions, in effect we are saying that the government had it right all along and our employees are doing their jobs the most cost effective way.

Thanks to all of you, and those who work for you, for your professionalism.

Our Dixon Field Station

by Mike Saiki

The WFRC Dixon Field Station (aka Dixon Duty Station) is located in the northern portion of the Sacramento/San Joaquin Delta upstream from San Francisco Bay, about 25 miles west of Sacramento, California. It is co-housed with the Dixon Field Station of the Western Ecological Research Center. The precurser of the Dixon Duty Station was established in March 1978 by the FWS Columbia National Fisheries Research Laboratory (now known as the BRD Columbia Environmental Research Center), and has subsequently been affiliated with several science centers as the current BRD organization evolved. The Dixon Duty Station became part of WFRC in April 1997.

Research at the Dixon Duty Station historically focused on fishery impacts from environmental contaminants and water quality degradation. The first investigation undertaken by Dixon staff involved a general comparison of fish species assemblages and environmental conditions in irrigated and non-irrigated portions of the San Joaquin Valley floor, with corollary studies that examined variations in life history characteristics of the bluegill (*Lepomis macrochirus*) and body burdens of organochlorine pesticides in bluegill and common carp (*Cyprinus carpio*). This investigation led to an exploratory study of fishes inhabiting

Kesterson Reservoir, a series of shallow evaporation ponds used for disposal of brackish subsurface agricultural drainage water originating from the west side of the San Joaquin Valley. As part of the exploratory study, a few samples of western mosquitofish (*Gambusia affinis*) were collected and analyzed for selected chemical contaminants, including trace elements. This cursory examination of trace elements led to the discovery of extraordinarily high concentrations of selenium. At the time (1982), the measured concentrations of selenium were far higher than values previously known to accumulate in fish. Over the next 6-8 years, Dixon staff conducted a number of field investigations that assessed the spatial (geographic) extent of selenium contamination, the concentrations of selenium present in various trophic levels, and the ecotoxicological effects on fish inhabiting highly seleniferous environments. One finding was that reproduction in mosquitofish was adversely affected by selenium, with newborn fry experiencing teratogenic effects and high mortality. A laboratory investigation with juvenile chinook salmon (*Oncorhynchus tshawytscha*) and striped bass (*Morone saxatilis*) also examined the toxic effects of prolonged (30-day) exposure to unusual ion ratios (dominated by sodium sulfate) that typically characterize saline subsurface agricultural drainage water. The results showed that fish exposed to brackish or saline drainage water suffered from poor growth and, in the case of salmon, failed to undergo smoltification even though fish held in reconstituted seawater (major ions dominated by sodium chloride) grew well and underwent smoltification.

During 1991-1996, Dixon staff investigated the water quality tolerances of endangered Lost River and shortnose suckers (*Deltistes luxatus* and *Chasmistes brevirostris*) from Upper Klamath Lake by conducting a series of laboratory and field studies. These studies documented the lethal thresholds of larval and juvenile suckers to high temperature, low dissolved oxygen concentration, high pH, and high un-ionized ammonia concentration, and supported the working hypothesis that low dissolved oxygen concentrations associated with the senescence phase of algal blooms were mostly responsible for occasional die-offs of suckers in the lake.

In 1994, Dixon staff were transferred to the NBS California Science Center (now known as the Western Ecological Research Center). This administrative transfer resulted in a broadening of the research mission to include almost any aspect of fish ecology. For example, Dixon staff are investigating habitat requirements of the endangered desert pupfish (*Cyprinodon macularius*) in the Salton Sea basin and the threatened Santa Ana sucker (*Catostomus santaanae*) in the Los Angeles basin. In addition, they have characterized fish species assemblages in small coastal lagoons such as Mugu Lagoon in southern California and Abbotts Lagoon in north-central California, and in salt ponds and sloughs adjacent to San Francisco Bay. A new study on the habitat requirements of the endangered California freshwater shrimp (*Syncaris pacifica*) in streams north of San Francisco Bay was recently funded by the BRD Park Oriented Biological Support Program. Although Dixon staff continue to work on contaminant issues related to selenium and agricultural drainage water, they are also involved with field investigations of copper, cadmium, and zinc from acid-mine drainage and mercury from historical gold-mining activities.

Assets of the Dixon Duty Station include close proximity to Central Valley rivers and the San Francisco Bay/Delta, the local presence of several universities with strong research or management programs in fisheries and environmental toxicology, and an established working relationship with scientists from various federal and state agencies. Dixon staff work especially closely with graduate students from the California Cooperative Fishery Research Unit at Humboldt State University. Currently, two permanent employees (Mike Saiki and Barbara Martin) and several temporary technicians are stationed in Dixon. Relocation to a larger facility (possibly on the nearby campus of UC-Davis or elsewhere) is planned.

For more information contact Mike Saiki at the Dixon Duty Station (707) 678-0682 X617 or michael_saiki@usgs.gov

WFRC Arctic Charr Research.

by Alec Maule

The Problem

The Arctic charr (*Salvelinus alpinus*) in the northern most latitudes migrate to the ocean in the spring to feed and grow. This results in accumulation of polychlorinated biphenyls (PCB) in their visceral fat. During the winter, the charr reside in freshwater lakes and do not feed. They do mobilize lipids from adipose tissue for energy, which results in a re-distribution of PCBs to organs such as brain, spleen and heart. Results of this project will help to describe the effects of PCBs on physiological processes of charr and other salmonids. This project is funded under reimbursable agreement number 0PP-9908890 with the National Science Foundation.

Objectives

The long term objective of the work is to investigate the impact of persistent organic pollutants (POP) on critical tissue function and performance of anadromous Arctic charr. We will test two hypotheses: (1) the tissue re-distribution of PCB and their sublethal impact is tightly linked to metabolic status of the animal and (2) the tissue redistribution of PCB associated with fasting will decrease the overall performance charracteristics of the animals. Experiments will be performed in Norway, at the Kårvik Research Station, Tromsø and at a hatchery in Talvik, northern Norway

Methodology

Hatchery-reared Arctic charr are being contaminated with one of four concentrations (0, 1, 10, 100 mg/kg fish body weight) of Aroclor 1254 by force-feeding it in a capsule. After contamination, some fish will be fed and others will be starved to simulate the nutritional status of fish in the wild. After six months, physiological responses of the fish will be tested. Tests will include: disease resistance and innate immune response, stress response, saltwater adaptation, and metabolic responses. These physiological responses will be measured by looking at the whole animal response (e.g., survival), biochemical response (e.g., hormone or cytokine production) and molecular response (i.e., gene transcription).

Highlights and Key Findings

In 2000, we conducted experiments with hatchery charr that had been treated with 0, 1, 10 or 100 mg of Aroclor 1254 per kg body weight. All of these groups were fasted, but other fish in the 0 and 100 treatments were fed from the time of exposure until just before our experiments. The exposures were completed in Feb 2000. We conducted the following experiments: (1) disease challenge: 40 marked fish from each group were exposed to other fish that were infected with the fish pathogen *Aeromonas salmonicida*, the causative agent of furunculosus. We observed a dose-dependent increase in mortality of the fasted fish, with mortalities of 32, 42, 52, and 55% in the fish treated with increasing doses. We are in the process of assaying fish from each treatment that were not exposed to the pathogen for plasma, muscus and nare lysozyme, and plasma bactericidal activity, (2) handling stress after which fish were sampled at 1, 3, 6, 12 & 23 hours. We found a dose-dependent decrease in maximum plasma cortisol responses (Jørgensen et al., 2002) (3) Plasma and tissues from treatment and control fish that were not stressed or exposed to pathogen were collected and will be assayed for a number of physiological variables. In 2001, fish were treated with the same doses of Aroclor 1254 and we are assaying these to determine the mechanisms by which the contaminant reduced disease resistance and dampened the stress response.

Where Are We Headed In 2003?

The National Science Foundation has granted a no-cost extension for this project to December 31, 2003. During this year, we will complete three pending publications and prepare a proposal to continue this project. In the continuation project, we hope to collect maturing fish from two sites--one in which fish are heavily contaminated with PCBs and another where they are not. The fish will be taken to the Kårvik Research Station where they will be spawned and the progeny reared to determine if contamination of the parents has effects on the offspring.

For further information, contact Alec G. Maule, Columbia River Research Laboratory, alec_maule@usgs.gov 509-538-2299 x 239

Progress in Whirling Disease Research

by Charlotte Rasmussen

Myxobolus cerebralis, the causative agent of Whirling Disease (WD), infects both salmonid fish and a ubiquitous aquatic oligochaete worm, *Tubifex tubifex* (Oligochaeta: Tubificidae). Infection of *T. tubifex* produces the triactinomyxon (TAM) form of *M. cerebralis* that is infectious for salmonids. Myxospores of *M. cerebralis* develop in the cartilage of the infected fish. Once the fish dies, the myxospores are released into the environment and can be ingested by *T. tubifex,* completing an infection cycle. This complex host-parasite relationship has greatly hindered efforts to develop control strategies to prevent the spread of WD.

Although, WD has been detected in salmonid-containing watersheds throughout much of the US, the disease is highly variable among fish populations, both regionally and locally. For instance, WD has been particularly devastating to salmonid fish populations in the Rocky Mountain states where a 90% decline in rainbow trout populations in the Madison River, MT and the complete recruitment failure of rainbow trout in the Colorado River has caused widespread concern about the impact of WD on native and cold water fisheries. However, WD appears to have little effect on trout populations in the eastern United States.

The latest WD research is presented at annual meetings, organized by the Whirling Disease Foundation (Bozeman, MT) and held every February. Sponsored, in part, by the USGS and organized by Dr. Jim Winton (WFRC, USGS) and Dr. Jerri Bartholomew (Oregon State University), the 9th annual Whirling Disease Symposium was held February 6 and 7 at the Bell Harbor Conference Center on the Seattle waterfront.

The theme of this year's meeting, "Managing the Risk" included a keynote presentation by a risk analysis expert, Dr. Stuart MacDiarmid of the New Zealand Food Safety Authority. This was followed by several sessions, lead by Dr. MacDiarmid, with the participation of those in attendance to develop an initial draft of a WD risk assessment model. Dr. MacDiarmid's keynote address on the principles of Aquatic Animal Health Risk Analysis was an introduction for many participants into how one goes about assembling a risk analysis model. Risk analysis is a tool designed to provide decision makers, i.e. fisheries managers, with an objective, repeatable and documented assessment of the risks posed by a particular course of action. In a nutshell, you figure out what can go wrong, how likely it is to happen and what is the consequence and then determine what can be done to reduce the chances of these events from occurring. Flowcharts and scenario trees were used to clarify the process.

To aid Dr. MacDiarmid and the meeting attendees in preparing a risk assessment model, Dr. Jerri Bartholomew (Oregon State University), Dr. Billie Kerans (Montana State University), Dr. Ron Hedrick (UC, Davis), and Dr. Mike Stone (Wyoming fish and Game) gave excellent review presentations on factors influencing the introduction and establishment of *Myxobolus cerebralis* and factors that influence WD manifestation in fish. The review presentations were followed by contributed papers presenting data relevant to risk assessment. Studies on the genetics of *Tubifex tubifex* at the WFRC and UC Davis have shown that certain strains or lineages of *T. tubifex* produce significantly different amounts of TAMs when infected with the same number of myxospores. Using genetic markers, at least three different lineages of *T. tubifex* that are highly susceptible, moderately susceptible and resistant to *M. cerebralis* infection can be distinguished. Determining both size and the genetic composition of *T. tubifex* populations inhabiting streams and river systems would provide a predictive tool for managers to assess the potential for *M. cerebralis* infection of worms, the levels of parasite proliferation from infected worms and hence the severity of WD within a watershed.

T. tubifex is not the only aquatic worm in a stream and is often found in association with another tubificid, *Limnodrilus hoffmeisteri*. The role of tubificid interactions in the infection of *Tubifex tubifex* by *Myxobolus cerebralis* was examined by Leah Steinbach et al. at Montana State University and the WFRC. Two sets of experiments were performed. First, a highly susceptible strain of *T. tubifex* was co-cultured with *L. hoffmeisteri* which is resistant to *M. cerebralis* infection. The results of this experiment showed that the presence of *L.*

hoffmeisteri at low myxospores doses increased infection in *T. tubifex* indicating that *L. hoffmeisteri* is not deactivating myxopspores by ingestion, as has been previously suggested. Co-culturing resistant and susceptible strains of *T. tubifex* showed that resistant *T. tubifex* has an effect on susceptible *T. tubifex*, but the source of the effect cannot be designated to competition or deactivation. Moreover, resistant and susceptible *T. tubifex* interbreed in the lab at low frequencies.

Research in Colorado by Barry Nehring and colleagues at the Colorado Division of Wildlife has shown that stocking of Mc-positive catchable trout resulted in a demonstrable increase in the production and release of TAMs thereby increasing the risk of the spread and severity of WD. Studies performed by Dick Vincent (Montana Fish Wildlife and Parks) on the Madison River in Montana have suggested that water temperature and flows may influences the densities of infective TAMs present during critical periods when young-of-the-year trout are most susceptible to disease.

A poster reception, complete with great food, was held Thursday evening. Posters presented by Carla Hogge et al. (Idaho Department of Fish and Game) and Sylvia Murcia et al. (Montana State University, National Park Service, WFRC, US Fish and Wildlife Service) showed that *M. cerebralis* is not the only myxosporean parasite found in western waters. Work to develop monoclonal antibodies for a rapid identification of *T. tubifex* from streams by personnel without extensive training in oligochaete taxonomy by Don Roberts and colleagues at Utah Sate University is progressing. This group has developed monoclonal antibodies specific to another commonly found tubificid, *Rhyacodrilus* and to a genetically–distinct lineage of *T. tubifex*. Alison Colwell, Jim Winton and Charlotte Rasmussen presented preliminary evidence that *M. cerebralis* is unlikely to be passed directly from worm host to worm host without an intervening fish host stage. This has been assumed to be the case since Wolf and Markiw demonstrated the requirement for a worm host stage to complete the parasite lifecycle in 1984, but the possibility of worm to worm transmission without a fish host was never explicitly tested.

Sessions on Friday included talks by Mansour El Matbouli (University of Munich, Germany) who compared the disease susceptibility of the Hofer strain of rainbow trout and an North American stain of rainbow trout to *M. cerebralis* and three other fish pathogens. The Hofer strain of rainbow trout is very resistant to infection by *M. cerebralis* when compared to North American strains of rainbow trout but both strains appear to have similar susceptibility to the other fish pathogens tested. Hally Lukins, Al Zale and Rick Barrows (Montana State University, US Fish and Wildlife Service and USGS) presented some exciting work measuring temporal fluctuations in TAM densities using a very accurate and precise packed-bed filtration system that can be used directly to enumerate TAMs from open water. Relative densities of TAMs have been indirectly estimated using expensive and time-consuming sentinel cages where susceptible fish of standardized size and age are placed at numerous locations at various times along streams. These fish are then held for months in lab aquaria to allow the disease to progress before they are examined histologically for WD. This "TAMometer" can directly measure the distribution, abundance and dispersal of the *M. cerebralis* TAMs saving time and money. Moreover, data collected suggest not only a seasonal variability but diel variability in TAM densities in infected rivers.

A large-scale ecological study performed on the San Juan River in New Mexico by Bob Dubey and Colleen Colwell (New Mexico State University and USGS) assessing the distribution and environmental constraints of *T. tubifex* populations under controlled flow regimes indicated that several months after a scouring flow, *T. tubifex* population densities had recovered. Moreover, the different *T. tubifex* lineages seemed to favor different habitats. Preliminary studies in Pennsylvania streams performed by Adam Kaeser et al. (Pennsylvania State University), where WD seems not to be effecting rainbow trout populations, suggest that *T. tubifex* is not abundant and present only at areas of organic enrichment. Such as below duck farms. This may, in part, explain why WD is having little effect on salmonid populations in the eastern US.

Many more interesting posters and presentations highlighted new research on WD during the meeting. For a book of abstracts and information

about next years meeting contact the Whirling Disease Foundation at 406-585-0860 or on-line at www.whirling-disease.org.

The New WFRC Website

by Debra Becker

The new WFRC website is available for internal review at http://wfrc.usgs.gov. There are several pages that are still under development so you are invited to visit the site often to see what additions and changes have been made. As Webmaster, I would like you send me suggestions for improvements, comments on content, or ideas for future pages. With your support we can create a dynamic communication tool that will incorporate features that are useful to us, as well as to our partners, and the public. The WFRC website is presently scheduled to go public by April 15, 2003.

OutReach in Action

by Craig Robinson

"Would you like to be the new Outreach Coordinator?" I was asked shortly after New Years, and I replied with an enthusiastic "Yeah, sure!" "Great! Here's you're first task: A teacher called this morning, and wants to confirm that her group of middle school girls are coming to the CRRL in two weeks for a visit." Apparently the date had been previously set for this outreach, but the details had slipped through the cracks during the holiday season. Luckily I had the energetic support of the CRRL staff behind me!

Fourteen members of a girls' science club, and their advisor, wanted to come from Highland Park Middle School in Beaverton, OR, to visit the CRRL for four hours and learn about what we do as fish biologists, and specifically to interact with women scientists. The club was organized through Advocates for Women in Science, Engineering, and Mathematics (AWSEM, http://www.awsem.org), whose purpose is to...

> *"provide girls (grades 6-12) with fun and educational science, engineering and math activities. Girls do hands-on science and math activities with a group leader after school. Girls also go on site visits to meet and learn about women in science, math and engineering careers."*

After talking with the girls' teacher and the AWSEM coordinators in Portland about the goals of the visit, I held a planning meeting with interested CRRL staff and the ideas began to flow! The visit was scheduled for the morning of February 6th, and Biological Science Technicians, Lisa Roberts, Jacquelyn Schei, Amber Carlson, and Research Fishery Biologist, Matt Mesa, volunteered to lead and coordinate the visit with the help of numerous other CRRL staff.

When they arrived, the girls were split up into three groups according to the fishes on their name tags (i.e., chinook, lampreys, and sturgeon). Each group rotated through three activities: 1) Interactive Tour – Students toured the CRRL facility and actively participated in demonstrations of data analysis, fish capture techniques, fish care, and microscope use; 2) Fish Marking Techniques – Students had hands-on participation in demonstrations of gastric, surgical, and PIT tagging of juvenile salmonids and were given a handout describing methods of telemetry, anesthesia, and marking; and 3) Fish Physiology and Morphology – Students worked with staff biologists to identify the characteristics of different fish species, dissected juvenile steelhead, and processed blood samples from the steelhead to obtain plasma and measure hematocrits. "I think the girls enjoyed the hands-on participation," said Jacquelyn Schei. Amber Carlson added, "They also said they loved fish, so I think we accomplished our goals."

The visit concluded with a lunchtime question and answer session, where the students had the opportunity to ask the staff questions about being a fish biologist. Then came a round of Fish Biology Jeopardy! The jeopardy game, the brainchild of Amber Carlson and Cindy French (Biological Science Technician), reinforced the knowledge the girls had gained that day by drawing on the content of the three activities in which they participated. The competition was fierce, as the winners walked away with passes to OMSI (Oregon Museum of Science and Industry), but everyone left with smiles

on their faces and packets of USGS stickers, pencils, and bookmarks, as well as a sturgeon poster. Matt Mesa noted, "I think it's kind of a unique experience for kids to be able to come to a research lab and see what's being done to monitor and save valuable natural resources." "It was a great group of students (very bright, witty, and adventurous) and we'd love to host them again," said Lisa Roberts. Indeed, the CRRL looks forward to hosting AWSEM again, and hopefully we can expand our outreach to local schools as well. There are many young biologists in the making for us to reach if we can only make the effort!

Menlo Park Reorganizes

By Lyman Thorsteinson

The U.S. Geological Survey center in Menlo Park, a hub of Bay Area science for nearly five decades, is reorganizing, squeezed by the high cost of living and working in the area. The Menlo Park center, which will celebrate its 50th birthday next year, has been one of three national hubs of USGS research. Scientists there monitor and study earthquakes, keep track of stream flows and water quality, develop high-tech mapping techniques and perform a variety of other research. The reorganization is part of a plan to save money and attract a new generation of scientists while scattering the federal agency's research more evenly throughout the West.

Five years from now, only about 450 employees will remain at the campus on Middlefield Road. That's down from 680 today and 1,700 when the number of workers was near its peak in 1985. However, the goal is not to close the Menlo Park facility, but to make it just one of a network of smaller, specialized centers, mostly located in areas where lower housing costs will attract young scientists. According to Doug Buffington, Western Regional Director, the agency also needs to reduce the amount of office and lab space in the West. He said rising rents and salaries have been eating into the USGS budget, which has remained flat over the years when inflation is taken into account. Meanwhile, studies have shown that the agency has more space than it needs at many locations.

Earthquake and landslide scientists will stay at Menlo Park, together with some volcano experts, mappers and water researchers. Other groups will gradually move to cheaper locations, from Seattle and Sacramento to Tucson, Flagstaff, Ariz., and possibly Davis, California. One such center, for coastal and marine science, would be set up near labs operated by the University of California-Santa Cruz and the National Marine Fisheries Service on Monterey Bay.

When completed, the Santa Cruz move will give USGS scientists state-of-the-art labs that are much closer to the sea and nestled among a dozen other centers that specialize in ocean science around the bay. It's the kind of synergy that USGS officials hope to create at the other small centers, many of which will be located at or near universities. Fisheries research will go to Seattle, hydrologists to Sacramento and people studying climate and arid ecosystems to Tucson.

A Little Light Reading

Recent Articles by WFRC Scientists

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What the Critics are Saying About "Fishes of Alaska"

By Gary Wedemeyer

"it succeeds brilliantly....This work will remain the gold standard for its type for many years to come"
--Milton Love, UC Santa Barbara

"What an impressive work it is! I congratulate the authors for a most welcome addition to our knowledge of fishes of the region"
--Reeve Bailey, University of Michigan

"This volume is an indispensable tool for anyone working with or interested in the fishes of Alaska."
--Copeia, 2003, No. 1

Book Review.
by Gary Wedemeyer

Polak, Michael. (editor). 2003. Developmental Instability: Causes and Consequences. Oxford University Press.

This interesting new book on the emerging field of developmental instability stability contains several articles by our own John Emlen and Jeff Duda. These authors point out that evolutionary evolutionary biology has historically emphasized stability, especially as it concerns development. Anomalies have largely been neglected, yet they are the stuff of evolution: Since all selectable variation is a product of development, the concept of developmental instability could hold the key to understanding the origins of adaptive novelty.

As the chapters of this volume show, the new focus on developmental instability will cause evolutionary and developmental biologists to take a closer look at the unordered side of variation. Instability can be seen either as innovation or as noise. Labeled as noise, it has been on the junkheap of both developmental and evolutionary biology for decades. However, the new research on instabilities outlined in this book coincides with new progress in molecular biology, where genome studies are engendering new interest in the sources of variation and change. The result will be a new view of mutation, and a new appreciation of noise, with transposable elements causing massive "random" insertions and repetitions in genome structure, and "junk DNA" seen as potentially functional, and the realization that large pools of fragmentary transcripts lie unused within chromosomes The dark side of variation is "unstable" precisely because it is undirected by selection — not the same as being undirectable by selection. The fact that instabilities can be heritable, as discussed in some of the chapters of this book, shows that they are fuel for evolution under Darwinian selection. That these same properties can be related as well to the origins of evolutionary novelties makes them all the more interesting.