SOUTH BAY SALT POND RESTORATION PROJECT

Pond Ecology and Management Workshop Synopsis

DATE HELD: August 17, 2005, 9:00am-4:00pm

PURPOSES: To establish *our knowledge base*, especially with respect to ecological processes in managed ponds that affect water quality parameters; to *understand interactions* between the Bay (and sloughs) and the ponds; to *determine effective management actions* for dealing with water quality issues; to develop a clear idea of what topics should be included in a *Pond Ecology Science Synthesis* (focused literature review).

EXPECTED OUTCOMES:

1. Identify pond processes and interactions between the Bay and ponds that we understand well.
2. Identify pond processes and interactions between the Bay and ponds that affect water quality and wildlife that we don't understand well and require further study.
3. Develop a list of management approaches that could be used to address water quality problems in the short- and long-term.
4. Develop a list of short-term and longer-term applied studies needs.
5. Develop a list of topics that should be included in a Pond Ecology and Management Science Synthesis.

Morning Presentations

Presentation 1. Carl Wilcox, California Department of Fish and Game (DFG), discussed the reason the Initial Stewardship Plan (ISP) was implemented--to stop salt production, maintain wildlife values, and prepare ponds for restoration or long-term management. Under the ISP, Cargill removed brines from the system so that the ponds would be in a "restorable" condition. The reduction of salinity in the ponds was required before the RWQCB would allow initial discharge and circulation. ISP could either (1) receive a pond in the dry condition (which may still have high saline soils) or (2) in a wet condition in which the salinity had been reduced to or below 110 ppt. Most ponds that the DFG accepted were in the 60ppt range. Ed Gross, consultant, and Schaaf and Wheeler did extensive salinity modeling to determine how long it would take to reduce ponds to 44ppt or less and how to manage the ponds in the long-term to manage for 44ppt or less. For salinity management, ponds were broken up into 2 to 5 pond units. In 2004, ponds A1 to A7 in Alviso and, in Eden Landing, pond 10 and pond 2 systems began operation. Other systems began in 2005. The budget to implement physical structures was approximately $8-9 million. One goal is to have ponds be similar to intake ponds in salt-producing systems, i.e. have salinity levels close to Bay water. Also, we want management systems to minimize need for pumping and to raise salinity in the summer and reduce salinity later (batch ponds) to support bird species, such as phalaropes and grebes that seem to prefer mid- to high-salinity ponds. High elevation ponds, such as in the Eden Landing Complex, can be difficult to manage because it is more difficult to water back into those ponds and evaporation appears to be a significant issue in not getting salt to drop out. Currently, the Pond 10 system experiences muted tidal conditions, because a tide gate flap fell off. Although this is a temporary condition (full tidal action will be restored within months), the muted tidal conditions are very attractive to shorebirds.

Presentation 2. Clyde Morris, U.S. Fish and Wildlife Service (USFWS), discussed the Alviso Complex ponds and their management under the ISP. Nearly all the ponds in this complex have been transferred to USFWS. The exceptions are the Ravenswood Ponds and ponds A22 and 23. These will be transferred later when saline levels meet RWQCB standards. Ponds A3N and A8 are not part of the ISP system and are allowed to "batch up"; this condition was very attractive to grebes and phalaropes this summer. In 2004, A1 to A7 began operation under the ISP and the others, A8-18 began operation in 2005. There has been some success in creating "brine fly" suitable habitat in some of the Alviso ponds. A12, 13, and 15 are batch ponds under the ISP. Water from A15 is transferred to A16, where A17 water comes in to dilute the salinity. A18 is being transferred from Cargill to San Jose. Pond A17 and 18 are discharging into Artesian Slough. A18 provided great nesting habitat to a wide range of species, including snowy plover. The "Island Ponds", A19, A20 and A21, will be breached next year and will become fully tidal. The high saline ponds, A22 and 23, will be getting a control structure in 2005 to allow water circulation and thereby reduce the salinity. In this Complex as in Eden Landing, the system was designed to address salinity, and the system is working well to keep salinity within acceptable ranges. However, DO and pH have become problems, which we were not anticipating. Low dissolved oxygen (DO) conditions in A3W occurred due to algae build-up. After sampling throughout the pond, USFWS found most of the water met DO standards. Unfortunately, the control structure was put in a place where DO levels routinely drop very low due to algae build up (which dies and removes DO from the water). But, USFWS put in baffles, which draw higher salinity water from the center of the pond to the structure. This system seems to have addressed the DO issue. We now know that DO levels rise during the day and drop very low at night. So, to manage their ponds, Cargill closes their gates at night and opens them in the morning. This requires significant staff time. Four SolarBees were placed in A7, but do not seem to have made a significant difference in DO levels. What about closing gates during very low tide periods? After consultation with the Regional Water Quality Control Board, USFWS tried this in A2W and A16 and found that this approach didn't work. DO went below 3 mg/l for many hours in A16 ponds during this period which resulted in a fish kill after about 8 days. The ponds are reopened and are now back to the diurnal DO cycle.

- Audience Question: Can you increase water flow through the ponds to reduce algae build-up? Clyde and Carl stated that flow could be increased a little bit, but not more than about 4% over current conditions without putting in pumps. More water can be moved during spring tides versus neap tides.
- Clyde noted that the location of the monitoring device makes a difference. For example, a monitor outside the weir has higher DO than right inside the pond. Also, data collected at some ponds show that, at times, the slough water at the bottom of the channel coming into the ponds is below 5 mg/l.
- Audience Question: Is the cause of the DO problem macro or microalgae? Steve Hansen notes that it can be either, depending on the pond.
- Steve Moore, Regional Water Quality Control Board (RWQCB), stated that data collected by the USGS for the ISP at A16 appears to indicate you can close off a pond from the Bay for about 6 days before conditions deteriorate to well below 5 mg/l. Fred Nichols notes that many variables have an effect on the number of days you can close off a pond.

Presentation 3. Robert Schipf, RWQCB focused on RWQCB water quality standards, especially for DO. The 2004 South Bay Salt Pond Order stated that the minimum discharge level into receiving waters for DO is 5mg/l. An additional Order in 2005 for Pond A18 established a reporting/action trigger of 3.3mg/l or more (10^{th} percentile on a calendar weekly basis). Robert showed data collected by the USGS from Eden Landing ponds 10 in 2004. Results showed that Pond 10 met standard (3.3 level) 90% of time and Pond 2 only about 50% of the time. Muted tidal conditions show consistently higher DO in ponds than circulation conditions where intakes and outfalls are in different locations. In 2004, Pond A2W met the standard only 50% of the time and Pond A3W never met the DO standard. However, in 2005, A3W was meeting the standards, showing that the baffles were working well. In 2004 and 2005, Alviso ponds showed variable performance. Each pond is different. Pond A18 data show that if water is released only during the day, then data collected for these day releases show results meet the standard 80% of time. How do discharges affect the sloughs? Data on a sunny day and neap tide from top and bottom of Alviso Slough water column along slough showed likely impacts of A7 pond release on pH and DO along a 2 km stretch. During a cloudy day and spring tide there is more mixing. The DO pattern is different.

- Fred Nichols noted that you need to know the tidal cycle to interpret these data. Also, Steve Hansen pointed out that elevated pH is a signal from the ponds, a signal that did not occur on the second day.

Robert showed a creative approach to setting ecologically-meaningful standards for a particular area. In the Virginian province on the East Coast the EPA develop an SSO (site-specific objective) for DO. The SSO was driven by the most DO-sensitive, ecologically relevant endpoint, lobster adult growth, survival and juvenile survival. Would Coyote Creek slough, whose DO is controlled by the tidal cycle, meet the SSO standard for lobster? Sometimes yes, sometimes no. For a local SSO, we could develop our own standard based on local species. We could do our own lab tests and/or use existing data on relevantspecies from the East Coast site-specific DO standard data set.

Presentation 4. Nicole Athearn, USGS, followed with a summary of the type of sampling USGS is doing for the ISP, which resulted in the data Robert presented. ISP monitoring includes initial release monitoring (IRM), when ponds are exceeding 44ppt and continuous circulation monitoring (CCM), when ponds are at 44ppt or below. USGS collects data on a number of parameters and must regularly clean and calibrate meters. Water from ponds discharging to the Bay cannot be well characterized as this water passes over large mudflats, but those ponds discharging to the slough can be measured. Weekly water quality monitoring is required for IRM or if there are standards violations. CCM is monthly. Also, USGS collects benthic samples and water column metals. Jim Cloern's group at the USGS will help with analysis and additional data collection (chlorophyll *a*, nutrients, depth profiling) and instrument validation and calibration.

Presentation 5. Tim Mayer, USFWS, presented information on pond ecology. He deals with water quality issues in USFWS refuges throughout the West and he presented data from several other systems. Hydrology drives pond and wetland systems. Hydroperiod is the seasonal pattern of water levels. Do wetlands improve water quality? Yes and no, depending on the parameter. Water quality parameters of importance begin with water temperature. It is important to

understand conditions in the intake and receiving waters. Salinity or conductivity is central, but an issue we understand quite well in SF Bay ponds. In Hawaiian ponds, salinity--not DO--was the cause of fish kills. DO and pH are two parameters that are closely correlated and related to photosynthesis and organic decomposition, i.e., biotic processes. As DO goes up, CO2 goes down and pH goes up. The amount of DO saturation possible depends on the salinity, temperature and barometric pressure. The higher the salinity or temperature, the lower the DO saturation possible. Comparing the West Knox pond at Malheur NWR and the receiving water in the Blitzen River shows the pond variation is more extreme than the river. In Keali Pond, chlorophyll *a* is more productive in shallower conditions, as is TOC (total organic carbon). When the pond is most productive, the DO levels vary most extremely. Adding aeration structures at the outflow can increase DO levels in the receiving waters. Turbidity and suspended sediments are affected by wind speed. This affects light availability and algae growth. Nutrients affect primary productivity, which affects DO. Nitrogen is our limiting factor in the SF Bay productivity. Wetlands are permanent sinks for N. This is not the case for P, which undergoes a very complex biogeochemical cycle. Nutrient retention will change based on the type of plants present and seasonal flooding. Very low DO in wetlands are not uncommon, unexpected or even harmful.

- Audience Question: What about the levels of ammonia in ponds, which could affect pH? High pH can come from toxic levels of free ammonia that can kill fish. Steve Moore says the ambient ammonia levels in sloughs appear to be OK, since the treatment plants convert sewage ammonia to nitrate before discharge, but we don't know as much about ammonia concentrations in the ponds.

Presentation 6. David Schoellhamer, USGS, gave the final formal talk of the morning, on the effects of hydraulic engineering, including culverts, on pond ecology. His focus is how we can use these structures to create good wildlife habitat and meet water quality objectives. Water quality, through stratification, is strongly affected by mixing. Thermal stratification occurs as the pond heats up. Thermal stratification is broken down by wind mixing and by water cooling, which cause overturning of the water column. Winds cause wind-wave mixing, seiching, and langmuir circulation or cells. Dave showed photos of foam lines in the Bay that align with the langmuir cells, which are caused by counter-directional flows throughout the water column. This effect occurs on all scales. This effect helps to explain daily stratification and destratification in ponds. Dave presents data from Napa ponds to show daily patterns.
He used a simple box model to develop a pond hydraulics model. There is inflow, outflow, rainfall, and evaporation. Evaporation decreases as water density or salinity increases. Inflow and outflow depends on structure type, condition, and operation as well as tides. This is the control knob. Dave's box model is designed to develop water and salt budgets. For this model, known as SPOOM, we need to know the water transfer rates between ponds. The SPOOM model can be found in USGS WRI Report 03-4199 (on-line)
. Dave developed the model for the Napa Ponds and have evolved it for the Alviso Ponds to link to John Takekawa's bird data. The model includes water temperature, but not DO, and includes ISP operations and tidal influence on inflow and outflow. The model shows good correspondence with actual Napa Pond 3 data. He is now working on Alviso Pond A3W pond to create rating curves for flows between the sloughs and the ponds. Hydraulic engineering principles are used help to manage flow between ponds and manage exchange with sloughes to achieve desired water levels and salinities. Adaptive management is needed.

Presentation 7. John Takekawa, USGS, added a few points about linking the SPOOM model to bird use. For birds, water depth as well as timing and duration of inundation are critical. But, what is the biological response to the hydraulic conditions? John is looking at the response of the clam, *Malcoma baltica*, and a capitellid worm, which are not well adapted to high salinities and live in lower salinity ponds. Brine shrimp and brine flies are well adapted to high salinities, and these are important food species in high salinity ponds, such as batch ponds. Brine flies are a very important to birds, even more so than the shrimp. In Pond A16, as salinity decreased, fish moved in. Then, they were trapped when the tide gate was closed; they helped to deplete the DO when the pond was closed, resulting in the fish fill. California gulls were attracted to the dead fish and, while there, may have also wiped out tern chicks on islands in pond A16. I will be important to select target species for which to test the SPOOM model effects.

Afternoon Presentations and Discussions

Discussion on Outcomes 1 & 2: What do we know well and what don't we know well about pond processes and interactions between the Bay and ponds

- Dave notes that we understand evaporation, rainfall, heating and cooling.
- Hg—don't know this well in ponds.
- Do we understand physical processes in ponds? Jessie says we understand ponds better than sloughs.
- May need more data on pond parameters to characterize processes.
- Need more information on flow rates and how to manage low flow rates.
- More culverts equal more flow, but can flow be increases substantially? Probably not without pumping.
- Depth relates to rates of water turnover. Although, rate of turnover is also based on elevation of the ponds.
- Is there any interaction with the ground water, especially in Alviso? We don't seem to know.
- Could we model DO now? Fred says that only turnover rate will affect DO levels. Carl says that we probably don't know enough about DO, but internal pond DO levels seem only to be important as they affect receiving waters. So, how much effort do we want to put into modeling pond DO? Birds seem to respond well to ponds as they are managed now?
- Does the diurnal DO pattern have a negative effect on the ponds, sloughs and Bay? How does the pattern affect fish?
- Least terns seem to be doing well all over the Alviso ponds, which are now all like intake ponds, perhaps because there are now more fish in the ponds.
- Need to know what potential upsets that could occur in the ponds, what the consequences would be, and how might we manage to avoid and/or deal with the upsets.
- San Diego folks will be managing ponds there, but the type of management is not yet determined. Are the water quality standards stopping restoration and other actions that are ultimately beneficial? Are the standards overly restrictive? The system is altered already and some species are benefiting from this.

- San Diego folks asked Steve Moore if the standards are based on the biological needs of species? Steve says the standards do consider biotics. Ultimately, standards need to be based on responses of representative species.
- Carl says that we are working with the Board to see how the DO findings bear on the current standards and how those standards can best serve the Bay ecosystem. We need to find those indicator species, as Steve Moore and Robert Schlipf mentioned, to construct a DO standard that is protective of aquatic life in the Bay, sloughs, and ponds.
- Some parameters are very difficult to model, such as DO, so we need to learn as we go and manage adaptively.
- Clyde supports Steve's comments on indicator species and we need to know the special effects of pond discharges on sloughs and the Bays. Need more inclusion of Hg. Our future actions, to create ideal bird habitat, will make water quality issues even more challenging. We need to predict what water quality issues will be factors in the future.
- In sloughs, we don't have a handle on whether low DO conditions are common. How is DO related to tidal cycles, spring and neap, over the day? We don't have much info on the sloughs before the ISP. Could collect data on reference sloughs.
- Is it common that DO in the Bay is below 5mg/l? Jessie Evans says it is not common in the Bay channel.
- Steve Moore says water residence time is critical. We need to move beyond the way salt ponds were managed for salt and move toward meeting water quality standards. The Board will not compromise on this.
- How do we get the salinities in batch ponds back down to dischargeable levels? And how will flash mixing affect the water chemistry? Need an understanding of this issue. Clyde says we will be doing this and monitoring them soon.
- Will batch ponds be separated geographically in the system to protect the birds using them? Carl says, yes, our system will be dispersed, but it is a good question as to what extent these species depend on high salinity salt ponds.
- Is this Project working with the Ecosystem Reserve Research Centers? Our centers are at Elkhorn Slough and China Camp and are not too relevant.
- If we are creating habitat now that rare species are moving into, might these species prevent us from doing the restoration we'd like to do?
- How will flooding for migratory birds be managed with nesting species, especially in light of global warming?

Presentation 8. John Takekawa, USGS, and his team provided a summary of data they have collected from the Project ponds. John gave a brief overview of salt pond management for habitat. Salt ponds are habitat and he reviews a few papers on salt pond ecosystems. He showed the salina community changes as saline levels increase.

Then, Francine Mejia, USGS, gave a summary of the fish data collected in the Project ponds. She discussed the methods used to collect fish in the ponds (gill nets, minnow traps and seines) and sloughs (gill net and minnow traps). Fish were collected from March 2004 to March 2005. Sixty nine percent of species were native. Most fish were caught by seining. Topsmelt was the most abundant species in the ponds. Some relationships of fish with the data show that the longjaw mudsucker is directly correlated with pH. American shad and northern anchovy were weakly, inversely correlated with pH and salinity.

Nicole Athearn, USGS, reviewed water quality data in the ponds. In the Alviso, salinity over time has declined in ponds opened to the Bay and DO has increased over time. There was a disproportionate increase in bird numbers on the ponds opened to ISP action versus those not opened. Small and medium shorebird guilds increased most. Analyses show a number of relationships. Mudflat surveys show that birds are on the ponds when the mudflats are covered and then move to the mudflats as the tide recedes.

Discussion on Outcome 3: Develop a list of management approaches that could be used to address water quality problems in the short- and long-term.

- Can we use SPOOM to reduce residence time and algae growth to meet WQ standards? Dave says yes.
- Water quality data collected at the ponds in the central valley managed ponds developed by H.T. Harvey might provide useful pond data.
- We can add more culverts to manage water quality or change the size of the ponds as an option, rather than adding more culverts. It could be that it is better to manage smaller ponds. But, John Krause is concerned about how to increase discharge rates if ponds are internal. This could be done with more channels or perhaps changing pond elevations.
- We could add more aeration structures--cobbles, drop structures, bird cages—to increase DO going into receiving waters. This doesn't help the pond conditions, but Clyde notes that, at least birds, are responding well to pond conditions.
- In managing ponds, we can see that closing ponds for a number of days is a shock to the pond system, and no less an impact than a release of low DO water into sloughs.

Discussion on Outcome 4: Develop a list of short-term and longer-term applied studies needs.

- Need study of whether the pond diurnal pattern is actually a negative thing for pond species or for slough species. Vertical profiling would be needed to measure this.
- Nutrient studies to understand effects on biota. For example, are nutrients causing more ammonia release into the sloughs. How do nutrients affect DO dynamics? Might be important in ponds for controlling algae growth. Steve Moore notes that this is important but a second tier question. The Bay system is light limited, so the Water Board has not strictly regulated nutrients in discharges. Steve is more interested in minimizing water residence time and stagnation in the design of managed ponds than placing more stringent controls on nutrient discharges that could affect algal dynamics in managed ponds. Nicole did collect some nutrient data in the ponds that might be helpful.
- Experiments to test smaller pond sizes to see if they might be easier to manage. Clyde recommends A16 as a place to experiment both for enhanced bird habitat and WQ management.
- Island ponds require monitoring baseline conditions. Include Coyote Creek and Mud Slough in USGS monitoring as well as some 24-hour monitoring. Need to look at A14 transect data and San Jose data. Other data questions to address are the effects on water quality of sediment quality, changes to current ecological communities, and invasive species.
- Is a study needed to determine if planting *S. foliosa* can outcompete *S. alterniflora*? Probably not a good use of resources.

- Bill de Jager comments that new sediment source from the Hetch Hetchy project could be used to build pannes.
- How are leopard sharks getting in and out of the ponds, such as A2W, and how are they using that pond? Steve Moore asks if the sharks might be preying on slower, smaller fish in ponds that may be experiencing DO stress.
- How about studies on how changes to water quality as a result of the restoration project could benefit steelhead? There is not much information on rearing habitat needs for these fish in the South Bay.

Discussion on Outcome 5: Develop a list of topics that should be included in a Pond Ecology and Management Science Synthesis.

- Physical controls
- Receiving waters
- Biotic controls
- Management approaches tried elsewhere
- Mutli-species and multi-use systems
- SSOs on the East Coast and DO levels in natural systems
- Community groups to control pollutants

Next Workshop Ideas

- Focus on designing experiments to determine how best to manage ponds
- Discuss hat's been working or not working in other places and how would we implement good ideas here
- Review an outline for the pond science synthesis
- Present results of this year's data and talk about how corrective measures worked
- Other ideas on short and long-term management methods.
- Potential timing for the next pond workshop: January 2005

Workshop Attendees:

Nicole Athearn	USGS
Andree Breaux	Regional Water Board
Dan Bruinsma	City of San Jose
Deborah Clark	Center for Collaborative Policy
Brian Collins	U.S. Fish and Wildlife Service
Mary Cousins	UC Berkeley
Bill DeJager	U.S. Army Corps of Engineers
Ron Duke	HT Harvey & Associates
Eric Dunlavey	City of San Jose
Jessica Burton Evans	USGS
Arthur Feinstein	Citizens to Complete the Refuge
Tim Gasser	SJSU
Steve Hansen	S.R. Hansen & Associates
Mike Josselyn	SRA
John Krause	California Dept. of Fish and Game
Tim Mayer	U.S. Fish and Wildlife Service
Mike McGowen	Consultant
Francine Mejia	USGS
Sean Michael	Alviso Water Task Force
Steve Moore	Regional Water Quality Control Board
Clyde Morris	U.S. Fish and Wildlife Service

Fred Nichols	USGS, retired and Science Team
Michael Parenti	Brown and Caldwell
Teri Peterson	Cargill Salt Company
Peter Schafer	City of San Jose
Robert Schlipf	Regional Water Quality Control Board
David Schoellhamer	USGS
Tim Stevens	California Dept. of Fish and Game
Mendel Stewart	U.S. Fish and Wildlife Service
John Takekawa	USGS
George Trevino	Alviso Water Task Force
Victoria Touchstone	U.S. Fish and Wildlife Service (San Diego NWR Complex)
Lynne Trulio	Lead Scientist, SBSP Restoration Project and SJSU
Susanne von Rosenberg	Gaia Consulting, Inc.
Carl Wilcox	California Dept. of Fish and Game

Synopsis prepared by L. Trulio, October 25, 2006