

Central Valley Wetlands General Information

432. Benthic invertebrates at foraging locations of nine waterbird species in managed wetlands of the northern San Joaquin Valley, California.

Safran, R. J.; Isola, C. R.; Colwell, M. A.; and Williams, O. E.

Wetlands 17(3): 407-415. (1997)

NAL Call #: QH75.A1W47; ISSN: 0277-5212

Descriptors: wetlands/ USA, California, San Joaquin Valley/ invertebrates/ forages/ water depth/ site selection/ water birds/ benthic fauna/ midges/ aquatic habitats/ oligochaetes/ ecology/ zoobenthos/ aquatic birds/ habitat selection/ food availability/ Invertebrata

Abstract: The ecologies of waterbirds are closely tied to the distribution and abundance of food resources. For many species of waterfowl and shorebirds, benthic invertebrates (especially Chironomidae) are an important dietary component that influences habitat selection. Consequently, we sampled benthic invertebrates and measured water depth at foraging locations of nine waterbird species and paired random sites in the Grasslands of the northern San Joaquin Valley, California, USA from January to April 1994 and 1995. Our resulting habitat-selection models indicate significant differences in benthic invertebrate densities or biomasses at foraging and random locations for three of nine species and significant differences in water depths between foraging and random locations for four of nine species. Additionally, we observed significant interspecific differences in water depths at foraging locations - shorebirds used shallow habitats (<10 cm), whereas most waterfowl species foraged in deep water (>20 cm).

Waterfowl foraged over a wider range of water depths than shorebirds, indicating greater behavioral flexibility in habitat use. Our results indicate that selection of foraging habitat by smaller bodied waterbirds, including dowitchers, dunlin, western sandpiper, and least sandpiper is strongly influenced by water depth, which mediates the availability of benthic invertebrates. Additionally, foraging site selection of more mobile taxa that are able to forage in a wide range of water depths, including northern shoveler and American green-winged teal, is influenced by invertebrate biomass. The broad range of water depths used by waterfowl and the relatively restricted depths used by shorebirds indicate that water depth can be manipulated to benefit a multitude of waterbird species.

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433. Bird community patterns of spring-seasonal and semi-permanent wetlands in the Sacramento Valley, California.

Harris, P. Dawn

Corvallis, Oregon: Oregon State University, 2001.

Descriptors: wetlands/ restoration/ ecology/ birds/ California

434. A decision support system for adaptive real-time management of seasonal wetlands in California.

Quinn, N. W. T. and Hanna, W. M.

Environmental Modelling and Software 18(6): 503-511.

(2003); ISSN: 1364-8152

Descriptors: wetlands/ environment management/ environmental protection/ water flow/ rivers/ surface water/

models/ saline environments/ wildlife/ decision support systems/ salinity/ water management/ environmental management/ environmental legislation/ environmental monitoring/ ecosystem management/ salts/ saline water/ habitat/ nature conservation/ USA, California, San Joaquin Valley/ management tools/ aquatic birds

Abstract: This paper describes the development of a comprehensive flow and salinity monitoring system and application of a decision support system (DSS) to improve management of seasonal wetlands in the San Joaquin Valley of California. The Environmental Protection Agency regulates salinity discharges from non-point sources to the San Joaquin River using a procedure known as the total maximum daily load (TMDL) to allocate the assimilative capacity of the river for salt among watershed sources. Management of wetland sources of salt load will require the development of monitoring systems, more integrative management strategies and coordination with other entities. To obtain local cooperation, the Grassland Water District (GWD), whose primary function is to supply surface water to private duck clubs and manage wetlands, needs to communicate to local landowners the likely impacts of salinity regulation on the long-term health and function of wildfowl habitat. The project described in this paper will also provide this information. The models that form the backbone of the DSS, develop salinity balances at both a regional and local scale. The regional scale concentrates on deliveries to and exports from the GWD while the local scale focuses on an individual wetland unit where more intensive monitoring is being conducted. The design of the DSS is constrained to meet the needs of busy wetland managers and is being designed from the bottom up utilizing tools and procedures familiar to these individuals.
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435. Interspecific differences in habitat use of shorebirds and waterfowl foraging in managed wetlands of California's San Joaquin Valley.

Isola, C. R.; Colwell, M. A.; Taft, O. W.; and Safran, R. J.

Waterbirds 23(2): 196-203. (2000)

NAL Call #: QL671; ISSN: 1524-4695

Descriptors: bottom topography/ foraging/ habitat use/ interspecific differences/ managed wetlands/ water depth

Abstract: A common wetland management objective is to provide habitat for a diverse assemblage of species, which requires data on interspecific differences in habitat use. Consequently, we studied habitat use by ten water-bird taxa (four dabbling ducks and six shorebirds) foraging in managed, seasonal wetlands in the northern San Joaquin Valley, California during late winter and early spring of 1994 and 1995. A MANOVA analysis detected strong interspecific differences in habitat use, with water depth explaining 86% of differences among taxa in a discriminant function analysis. ANOVA identified four groups based on similarities in use of water depth: 1) small shore-birds (<5 cm); 2) large shorebirds (5-11 cm); 3) teal (10-15 cm); and large dabbling ducks (>20 cm). Among these groups, variation in water depth at foraging locations increased with size, suggesting that water depth constrained foraging by shorebirds and teal more than larger waterfowl. In California's Central Valley, where large numbers of

shorebirds and waterfowl winter, our findings suggest that managers can provide habitat for shorebirds and water-fowl by reducing the average depth to which habitats are flooded, especially during winter when deep-water habitat is abundant. Within a wetland complex or an individual wetland, this prescription will yield greatest diversity of water depth, and, hence, bird use in wetlands characterized by variable bottom topography.

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436. Modeling pollutant fate and transport in constructed wetlands.

Brown, Russell T.; Field, Joanne J.; Zanolli, Michael J.; and Crites, Ron W.

In: National Conference on Environmental Engineering.; pp. 532-539; 1994.

Abstract: The Constructed Wetlands Fate and Aquatic Transport Evaluation Model (CWFATE) was developed to evaluate alternative design and operations of the constructed wetlands treatment system (CWTS) at the Sacramento Regional Wastewater Treatment Plant in Elk Grove, California. The model simulates the daily fate and transport of metals and other influent pollutants in an effort to predict CWTS effluent concentrations, removal efficiency, and long-term bioaccumulation of pollutants in sediment, vegetation, organic material, and aquatic organisms. Due to the difficulty of obtaining scientific information for model verification, final calibration is postponed until further field data become available.

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437. Regional wetlands planning: A case study of coastal wetlands planning in the San Francisco Bay area & southern California.

Denisoff, C. and Movassaghi, M.

In: Taking a Look at California's Ocean Resources: An Agenda for the Future. (Held 24 Mar 1997-27 Mar 1997 at San Deigo, California.) Magoon, O. R.; Converse, H.; Baird, B.; and Miller-Henson, M. (eds.); Vol. 2.

Reston, Va.: American Society of Civil Engineers; pp. 1028-1037; 1998.

Notes: Conference: California and the World Ocean '97

Descriptors: wetlands/ marine resources/ resource management/ coastal zone management/ environment management/ regional planning/ salt marshes/ USA, California, San Francisco Bay/ USA, California, Southern/ case studies/ land reclamation/ land management/ agriculture/ estimating/ coasts/ coastal zone/ USA, California, San Francisco Cty./ conservation, wildlife management and recreation/ coastal zone management/ conservation and environmental protection/ techniques of planning/ environmental action/ legal/ governmental

Abstract: Historically, wetland habitats were often seen only as a breeding ground for disease-carrying mosquitoes. From approximately the mid-18th century through the middle of the 20th century, the vast majority of wetlands in the United States were drained and converted into agricultural land through policies of the federal and state governments for what were the considered more "productive" uses. For example, the Federal Swamp Land Acts - National Swamp and Overflowed Land Act- of the 1800's gave 65 million acres of wetlands to 15 states, including California, for reclamation. In 1866, the California Legislature Commissioned the Board of Swamp and Overflowed Land to manage these properties. In turn, by

1870, the majority of wetlands had been transferred to private ownership. Between 1850 and 1920, about 70 percent of California's wetlands were destroyed, largely by levee and drainage projects. These projects where in some cases subsidized to aid private developers in reclaiming swamplands for agricultural purposes, helping to make California the leading agricultural state in the Nation by 1887 (CA Department of Water Resources 1993).

Estimates of wetlands that historically existed in California range from 3 to 5 million acres. The current estimate of wetland acreage in California is approximately 454,000 acres; this represents an 85 to 90 percent reduction, the greatest percentage loss in the nation.

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438. Seasonal and semipermanent wetlands of California: Invertebrate community ecology and responses to management methods.

de Szalay, Ferenc A.; Euliss, Ned H.; and Batzer, Darold P. In: Invertebrates in freshwater wetlands of North America: Ecology and management/ Batzer, Darold P.; Rader, Russell B.; and Wissinger, Scott A.

New York: John Wiley & Sons, 1999; pp. 829-855.

Notes: ISBN: 0471292583

NAL Call #: QL365.4.A1158

Descriptors: Invertebrata/ disturbance by man/ habitat management/ seasonal and semipermanent wetlands management effect on fauna/ ecology/ semiaquatic habitat/ seasonal and semipermanent wetlands/ community ecology and management/ California/ seasonal and semipermanent wetlands community ecology and management

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439. Simulating vernal pool hydrologic regimes for two locations in California, USA.

Pyke, C. R.

Ecological Modelling 173(2-3): 109-127. (2004)

NAL Call #: QH541.15.M3E25; *ISSN:* 0304-3800

Descriptors: wetlands/ models/ community composition/ hydrology/ USA, California

Abstract: Ecological processes and community composition in vernal pools are dominated by a suite of interrelated hydrologic factors collectively described as a hydrologic regime. This study reports on the development of a hydrologic regime simulation model called PHYDO and its application to two locations in California. PHYDO calculates daily water balance using meteorological data and parameters describing basin morphology, soil characteristics, and vegetation cover. The model provides daily estimates of water depth, volume, and temperature, as well as statistics on seasonal and inter-annual variability. Model predictions are compared to field observations for coastal vernal pools in southern Santa Barbara County, CA, USA (2000-2001), and interior vernal pools near Oroville in the Central Valley of CA, USA (1994-1998). The model was also run for the period 1990-2000 to investigate patterns of inter-annual variation in hydrologic conditions at both sites. Results indicate that vernal pool hydrologic regimes can be modeled primarily based on the direct interception of precipitation and the loss of water to evapotranspiration. Results also suggest differences in hydrologic limiting factors between the sites. Storm frequency appears to be the primary control of hydrologic conditions for Santa Barbara pools, while basin morphology dominates conditions in Oroville. These findings suggest ecologically

important differences in hydrologic regimes between the two vernal pool localities, and PHYDO provides a new set of tools for quantifying these differences for a range of hydrologic variables.

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440. Using tidal salt marsh mesocosms to aid wetland restoration.

Callaway, J. C.; Zedler, J. B.; and Ross, D. L.

Restoration Ecology 5(2): 135-146. (June 1997)

NAL Call #: QH541.15.R45R515; ISSN: 1061-2971

Descriptors: wetlands/ environmental restoration/ salt marshes/ tides/ mesocosms/ USA, California/ environment management/ ecosystem management/ estuaries/ land reclamation/ hydrology/ *Salicornia virginica*/ USA, California, Tijuana Estuary/ reclamation/ protective measures and control

Abstract: Tidal wetland mesocosms at Tijuana River National Estuarine Research Reserve failed to elucidate effects of hydrologic treatments (excluded, impounded, and fully tidal systems) for most parameters measuring *Salicornia virginica* (pickleweed). Although soil salinity increased tidal flushing was excluded for 10 months (salinities rose similar to 20 to 50%), pickleweed cover and algal chlorophyll did not differ among treatments. Effects were seen only in pickleweed growth rates (similar to 30% decrease where tides were excluded) and normalized difference vegetation index (NDVI) measurements. We failed to show any differences between impounded and fully tidal conditions, because the mesocosms had coarse sediments, and impounded water drained easily via subsurface flow. However, the problems that we encountered with the mesocosms led to the following advice for future wetland restoration projects: (1) Mesocosms are useful for testing restoration techniques before an actual restoration project takes place. (2) Mesocosms should be used to test factors that may lead to more successful restoration in the future, including planting techniques, substrate conditions, and hydrology. (3) Mesocosms should be used to develop new assessment methods for monitoring wetland ecosystems. Because of the ability to control some environmental parameters while maintaining seminatural conditions, mesocosms offer great potential for the future evaluation of experimental restoration techniques.

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441. Vernal pool creation in the Sacramento Valley: A review of the issues surrounding its role as a conservation tool.

Sutter, Greg and Francisco, Robert.

In: *Ecology, Conservation, and Management of Vernal Pool Ecosystems*. (Held 19 Jun 1996-21 Jun 1996 at Sacramento, CA.) Witham, Carol W. (eds.): California Native Plant Society; pp. 190-194; 1998.

ISBN: 0-943460-37-9

<http://www.vernalpools.org/proceedings/sutter.pdf>

442. Waterbird communities in managed wetlands of varying water depth.

Colwell, M. A. and Taft, O. W.

Waterbirds 23(1): 45-55. (2000)

NAL Call #: QL671; ISSN: 0738-6028

Descriptors: wetlands/ habitat selection/ community composition/ species diversity/ aquatic birds/ water depth/ environment management/ ecosystem management/ ecological distribution/ habitat utilization/ winter/ USA, California/ Aves/ USA, California, San Joaquin Valley/ birds/ behaviour/ management/ birds

Abstract: Published accounts of interspecific differences in habitat use by waterbirds predict that shallow wetlands should accommodate more species and greater numbers of waterbirds than deep wetlands. We evaluated this hypothesis by examining relationships between winter (January/February) waterbird use (presence/absence, density and number of species) and average depth, variation in depth and size of 25 wetlands in the northern San Joaquin Valley, California. Bird densities correlated consistently with depth. Likelihood of use increased in shallow wetlands for all nine wading birds (shorebirds and ibis); densities of three dabbling duck species and Black-necked Stilt (*Himantopus mexicanus*) also increased in shallow wetlands, whereas use and densities of two diving birds increased in deep wetlands. We observed no statistically significant relationship between depth and densities of two other waterbird species. The number of species of waterbird, dabbling duck, and wading bird increased in shallow wetlands, whereas the number of species of diving bird increased in deep wetlands. Wetland size and topographic variation inconsistently predicted waterbird densities, but both characteristics correlated positively with number of species. Our results provide general support for shallow flooding of wetlands to provide habitat for more species. We conclude that managers seeking to provide foraging habitat for a diverse community of wintering waterbirds should flood wetlands to average depths of 10-20 cm, where topography can provide a range of depths attractive to a large number of species. However, this prescription is region-specific and influenced by the great diversity and abundance of waterfowl and shorebirds wintering in California's Central Valley.

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Effects of Agricultural Conservation Practices on Wetlands

443. Cattle grazing mediates climate change impacts on ephemeral wetlands.

Pyke, Christopher R. and Marty, Jaymee
Conservation Biology 19(5): 1619-1625. (Oct. 2005)
NAL Call #: QH75.A1C5; ISSN: 0888-8892.

Notes: Original Title: El Apacentamiento de Ganado Inluye en los Impactos del Cambio Climatico sobre Humedales Efimeros

<http://www.vernalpools.org/documents/Pyke%20and%20Marty%20Cons%20bio.pdf>

Descriptors: wetlands/ climatic changes/ grazing/ feeding behaviour/ amphibiotic species/ environmental impact/ resource management/ vulnerability/ rare species/ hydrology/ environmental effects/ precipitation/ reproduction/ conservation/ temperature effects/ *Ambystoma californiense*/ Caudata/ USA, California/ California tiger salamander/ salamanders/ habitat community studies/ conservation

Abstract: Climate change impacts depend in large part on land-management decisions; interactions between global changes and local resource management, however, rarely have been quantified. We used a combination of experimental manipulations and simulation modeling to investigate the effects of interactions between cattle grazing and regional climate change on vernal pool communities. Data from a grazing enclosure study indicated that 3 years after the removal of grazing, ungrazed vernal pools dried an average of 50 days per year earlier than grazed control pools. Modeling showed that regional climate change could also alter vernal pool hydrology. Increased temperatures and winter precipitation were predicted to increase periods of inundation. We evaluated the ecological implications of interactions between grazing and climate change for branchiopods and the California tiger salamander (*Ambystoma californiense*) at four sites spanning a latitudinal climate gradient. Grazing played an important role in maintaining the suitability of vernal pool hydrological conditions for fairy shrimp and salamander reproduction. The ecological importance of the interaction varied nonlinearly across the region. Our results show that grazing can confound hydrologic changes driven by climate change and play a critical role in maintaining the hydrologic suitability of vernal pools for endangered aquatic invertebrates and amphibians. These observations suggest an important limitation of impact assessments of climate change based on experiments in unmanaged ecosystems. The biophysical impacts of land management may be critical for understanding the vulnerability of ecological systems to climate change.

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444. Changes of soil and plant tissue selenium status in an upland grassland contaminated by selenium-rich agricultural drainage sediment after ten years transformed from a wetland habitat.

Wu, L.; Banuelos, G.; and Guo, X.
Ecotoxicology and Environmental Safety 47(2): 201-209. (Oct. 2000)

NAL Call #: QH545.A1E29; ISSN: 0147-6513
Descriptors: wetlands/ soil pollution/ plants/ selenium/ grasslands/ sediment pollution/ drainage water/ agriculture/ bioaccumulation/ trees/ soil contamination/ leaching/ environmental impact/ sources and fate of pollution

Abstract: A field survey was conducted in 1989, 1994, and 1999 in order to monitor the soil and vegetation Se concentrations at the Kesterson upland grassland contaminated by Se-rich drainage sediment. The rate of Se dissipation estimated by the change of soil Se concentration, via volatilization, found to be about 1.1% per year. Soil water-extractable Se increased in 1994, but greatly reduced in 1999. The increase of soil Se concentration in the top 15 cm of soil at the fresh-soil fill sites indicates that the plants were able to effectively take up the soluble soil Se from the lower soil profile and to deposit it on the top of the field. This process may reduce the rate of leaching of soil Se. Overall, the concentration of soil water-soluble Se was relatively low and it is unlikely that problems of transport of Se from the Kesterson soil to the adjacent uncontaminated environment by leaching can occur. Plant tissue Se concentration was found to coincide with the soil water-extractable Se concentration. The average plant tissue Se concentration and soil water-extractable Se detected in 1999 was about 10 $\mu\text{g Se g super}^{-1}$ and 110 $\mu\text{g Se kg super}^{-1}$ dry weight, respectively, and the estimated bioaccumulation value of this upland grassland is less than 10% of the previous wetland habitat. Therefore, the existing Kesterson grassland should not be at high risk to the environment.

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445. Effects of an agricultural drainwater bypass on fishes inhabiting the grassland water district and the lower San Joaquin River, California.

Saiki, M. K.; Martin, V. A.; Schwarzbach, S. E.; and May, T. W.

North American Journal of Fisheries Management 21(3): 624-635. (2001); ISSN: 1548-8675

Descriptors: grassland water district/ Lower San Joaquin River map/ California/ United States of America/ USA/ North America/ agricultural drainwater bypass/ freshwater fish/ community structure/ checklist/ abundance/ selenium concentration/ Se/ environmental factors/ abiotic factors/ water quality/ freshwater fish/ checklist/ impact of forestry or agriculture/ physiology, biology, biochemistry/ ecology and conservation

Abstract: The Grassland Bypass Project, which began operation in September 1996, was conceived as a means of diverting brackish selenium-contaminated agricultural drainwater away from canals and sloughs needed for transporting irrigation water to wetlands within the Grassland Water District (the Grasslands), Merced County, California. The seleniferous drainwater is now routed into the San Luis Drain for conveyance to North Mud Slough and eventual disposal in the San Joaquin River. The purpose of this study was to determine the extent to which the Grassland Bypass Project has affected fishes in sloughs and other surface waters within and downstream from the Grasslands. During September-October 1997, 9,795 fish representing 25 species were captured at 13 sampling sites. Although several species exhibited restricted spatial distributions, association analysis and cluster analysis failed to identify more than one fish species assemblage inhabiting the various sites. However, seleniferous drainwater from the San Luis Drain has influenced selenium concentrations in whole fish within North Mud Slough and the San Joaquin River. The highest

concentrations of selenium (12-23 $\mu\text{g/g}$, dry weight basis) were measured in green sunfish *Lepomis cyanellus* from the San Luis Drain where seleniferous drainwater is most concentrated, whereas the second highest concentrations occurred in green sunfish (7.6-17 $\mu\text{g/g}$) and bluegills *Lepomis macrochirus* (14-18 $\mu\text{g/g}$) from North Mud Slough immediately downstream from the drain. Although there was some variation, fish in the San Joaquin River generally contained higher body burdens of selenium when captured immediately below the mouth of North Mud Slough (3.1-4.9 $\mu\text{g/g}$ for green sunfish, 3.7-5.0 $\mu\text{g/g}$ for bluegills) than when captured upstream from the mouth (0.67-3.3 $\mu\text{g/g}$ for green sunfish, 0.59-3.7 $\mu\text{g/g}$ for bluegills). Waterborne selenium was the single most important predictor of selenium concentrations in green sunfish and bluegills, as judged by results from multiple-regression analyses. Among bluegills, water temperature also contributed to the prediction of selenium body burdens.
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446. Effects of cattle grazing on diversity in ephemeral wetlands.

Marty, Jaymee T.

Conservation Biology 19(5): 1626-1632. (Oct. 2005)
NAL Call #: QH75.A1C5; ISSN: 0888-8892.

Notes: Original Title: Efectos del Apacentamiento de Ganado sobre la Diversidad en Humedales Efimeros
<http://www.vernalpools.org/documents/Marty%20Cons%20Bio.pdf>

Descriptors: wetlands/ species diversity/ grazing/ feeding behaviour/ introduced species/ ranching/ endemic species/ life cycle/ nature conservation/ biodiversity/ rare species/ environmental impact/ aquatic plants/ species richness/ conservation/ USA, California, Central Valley/ habitat community studies/ conservation

Abstract: Cattle are usually thought of as a threat to biodiversity. In regions threatened by exotic species invasion and lacking native wild grazers, however, cattle may produce the type of disturbance that helps maintain diverse communities. Across 72 vernal pools, I examined the effect of different grazing treatments (ungrazed, continuously grazed, wet-season grazed and dry-season grazed) on vernal-pool plant and aquatic faunal diversity in the Central Valley of California. After 3 years of treatment, ungrazed pools had 88% higher cover of exotic annual grasses and 47% lower relative cover of native species than pools grazed at historical levels (continuously grazed). Species richness of native plants declined by 25% and aquatic invertebrate richness was 28% lower in the ungrazed compared with the continuously grazed treatments. Release from grazing reduced pool inundation period by 50 to 80%, making it difficult for some vernal-pool endemic species to complete their life cycle. My results show that one should not assume livestock and ranching operations are necessarily damaging to native communities. In my central California study site, grazing helped maintain native plant and aquatic diversity in vernal pools.

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447. Evaluation of the macroalga, muskgrass, for the phytoremediation of selenium-contaminated agricultural drainage water by microcosms.

Lin, Z. Q.; De Souza, M.; Pickering, I. J.; and Terry, N.

Journal of Environmental Quality 31(6): 2104-2110. (2002)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: wetlands/ selenium/ phytoremediation/ agriculture/ drainage/ macrophytes/ water pollution control/ aquatic macrophytes (Characeae)/ remediation/ volatile materials/ *Chara canescens*

Abstract: Previous field studies suggested that the macroalga, muskgrass (*Chara canescens* Desv. & Lois), plays an important role in the removal of selenium (Se) from agricultural drainage water. This study evaluated the efficiency of Se removal from drainage water by muskgrass-vegetated wetland microcosms, and determined the extent to which muskgrass removed Se through phytoextraction and biovolatilization. Six flow-through wetland microcosms were continuously supplied with drainage water containing an average Se concentration of 22 $\mu\text{g L}^{-1}$ over a 24-d experimental period. The Se mass input and outflow and the rate of Se volatilization were monitored daily for each microcosm. Three microcosms containing muskgrass reduced the daily mass Se input in the inflow drainage water by 72.1%; this compared with a reduction of 50.6% of the mass Se input for three unvegetated control microcosms. Selenium accumulated in muskgrass tissues accounted for 1.9% of the total mass Se input in the microcosm, followed by 0.5% via biological volatilization. The low rates of Se volatilization from selenate-supplied muskgrass, which were 10-fold less than from selenite, were probably due to a major rate limitation in the reduction of selenate to organic forms of Se in muskgrass. This conclusion was derived from X-ray absorption spectroscopy speciation analysis, which showed that muskgrass treated with selenite contained 91% of the total Se in organic forms (selenoethers and diselenides), compared with 47% in muskgrass treated with selenate.
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448. Grazing maintains diversity in seasonal wetlands.

Marty, Jaymee T.

In: 89th Annual Meeting Ecological Society of America - Lessons of Lewis and Clark: Ecological Exploration of Inhabited Landscapes. (Held 1 Aug 2004-6 Aug 2004 at Portland, Oregon.); Vol. 89.; pp. 326; 2004.

Descriptors: compatible management practice/ effect of cattle grazing/ species diversity/ vernal pool

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449. The impact of waterfowl foraging on the decomposition of rice straw: Mutual benefits for rice growers and waterfowl.

Bird, J. A.; Pettygrove, G. S.; and Eadie, J. M.

Journal of Applied Ecology 37(5): 728-741. (2000)
NAL Call #: 410 J828; ISSN: 0021-8901

Descriptors: agriculture/ ducks/ nitrogen/ straw disposal/ wetland management/ winter habitat

Abstract: 1. Recent legislation in California, USA, has restricted traditional open-field burning of rice straw residues, leading farmers to adopt alternative methods of straw disposal such as post-harvest flooding of rice fields. These changes may benefit wildlife because winter-flooded fallow rice fields provide foraging habitat to migratory waterfowl. In turn, the foraging activity of waterfowl may

help to increase rice straw decomposition, providing a reciprocal benefit to farmers. We examined the effects of waterfowl foraging activity on straw decomposition and nitrogen mineralization following rice harvest in a fallow flooded soil. 2. Experimental plots (25m²) were established on a silty clay soil and were subjected to two post-harvest treatments: wet-rolled or untilled. Mallard ducks *Arias platyrhynchos* were placed in one-half of the experimental plots, following a splitplot design, for a 3-week period, at a density equivalent to 33 birds ha⁻¹ over a season of 180 days to approximate regional abundance data. 3. Waterfowl foraging activity increased residual surface straw decomposition by 78% in untilled plots and 18% in wet-rolled plots compared with the respective unforaged plots. Average straw diameter in foraged plots was reduced to one-third that of unforaged plots. 4. Waterfowl foraging and field tillage reduced nitrogen (N) concentrations in the surface straw residue remaining at the end of the winter fallow period. Below-ground organic residue was not affected by waterfowl foraging, indicating that ducks did not incorporate the straw. There were no apparent additions of carbon (C) or N to the soil as a result of waterfowl activity. 5. We conclude that waterfowl foraging can substantially increase straw decomposition in flooded, fallow, rice fields. Accordingly, rice producers should consider agronomic practices that attract waterfowl, such as winter flooding, to maximize the decomposition of rice straw residue. At the upper end of regionally observed waterfowl densities (at or near 33 birds ha⁻¹ season⁻¹) waterfowl foraging activity may alleviate the need for autumn tillage. Shallow flooded rice fields will also provide important winter habitat to migratory waterfowl, aiding wetland management and conservation efforts in the Central Valley of California. 6. These results provide an example of how a mutually beneficial solution can be achieved that provides needed waterbird habitat while concomitantly alleviating an agricultural problem.
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450. Impacts of changing irrigation practices on waterfowl habitat use in the southern San Joaquin Valley, California.

Barnum, D. A. and Euliss, N. H.
California Fish and Game 77(1): 10-21. (1991)
NAL Call #: 410 C12; ISSN: 0008-1078
Descriptors: agricultural runoff/ California/ diurnal variation/ ducks/ irrigation/ Kern National Wildlife Refuge/ population dynamics/ seasonal variation/ ecological effects/ environmental impact/ irrigation effects/ irrigation practices/ San Joaquin Valley/ waterfowl/ habitat use/ hydrology/ water management/ mallards/ northern pintails/ cinnamon teal/ green-winged teal/ northern shovelers/ ruddy ducks
Abstract: Diurnal aerial census data were used to examine habitat use patterns of ducks wintering in the southern San Joaquin Valley, California from 1980-87. Densities (birds/ha) for the northern pintail (*Anas acuta*), mallard (*A. platyrhynchos*), green-winged teal (*A. crecca*), cinnamon teal (*A. cyanoptera*), shoveler (*A. clypeata*), ruddy duck (*Oxyura jamaicensis*), and total ducks, in each of five habitats, were determined--nocturnal habitat use by ducks may be very different than diurnal use and would therefore yield different densities. Low densities were observed for most species on evaporation ponds, hunting clubs and miscellaneous wetlands. Most hunting clubs were small, isolated parcels of wetland with food production limited by

cost and availability of irrigation water. The low densities observed on these wetlands suggests that they were not heavily used by wintering ducks. However, hunting clubs provided habitat important for attracting ducks away from contaminated evaporation ponds in September and again in late winter (January-February). Evaporation ponds were not heavily used by ducks, but the large area provided by evaporation ponds may affect use of these habitats in the future. Density for all species, except the ruddy duck, was highest on preirrigated croplands or Kern National Wildlife Refuge (Kern NWR). Ducks such as mallard and teal that use densely vegetated wetlands were probably attracted to the diversity of vegetative cover on Kern NWR. Other species, such as pintail, make use of Kern NWR's managed areas for diurnal feeding and resting. Preirrigated croplands had the highest density of pintail. The value of these shallow-flooded wetlands with their available waste grains may be similar to that of rice fields in the Sacramento Valley. Moreover, preirrigated fields provided large expanses of open water for diurnal resting locations important to pintail for predator detection.
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451. Long-term grazing study in spring-fed wetlands reveals management tradeoffs.

Allen-Diaz, B.; Jackson, R. D.; Bartolome, J. W.; Tate, K. W.; and Oates, L. G.
California Agriculture 58(3): 144-148. (2004)
NAL Call #: 100 C12Cag; ISSN: 0008-0845
Descriptors: wetlands/ grazing/ cattle/ springs (water)/ ecosystems/ California
This citation is from AGRICOLA.

452. Organic matter sources and rehabilitation of the Sacramento-San Joaquin Delta (California, USA).

Jassby, A. D. and Cloern, J. E.
Aquatic Conservation: Marine and Freshwater Ecosystems 10(5): 323-352. (2000)
NAL Call #: QH541.5.W3A67; ISSN: 1052-7613
Descriptors: environmental restoration/ rivers/ organic matter/ productivity/ restoration/ tributaries/ organic carbon/ recruitment/ fishery resources/ food availability/ fish larvae/ phytoplankton/ volume transport/ resource conservation/ ecosystem management/ environment management/ particulate organic matter/ conservation/ tidal rivers/ agricultural runoff/ ecosystems/ fisheries/ trophic level/ Pisces/ USA, California, Sacramento-San Joaquin Delta
Abstract: The Sacramento-San Joaquin River Delta, a complex mosaic of tidal freshwater habitats in California, is the focus of a major ecosystem rehabilitation effort because of significant long-term changes in critical ecosystem functions. One of these functions is the production, transport and transformation of organic matter that constitutes the primary food supply, which may be sub-optimal at trophic levels supporting fish recruitment. A long historical data set is used to define the most important organic matter sources, the factors underlying their variability, and the implications of ecosystem rehabilitation actions for these sources. Tributary-borne loading is the largest organic carbon source on an average annual Delta-wide basis; phytoplankton production and agricultural drainage are secondary; wastewater treatment plant discharge, tidal marsh drainage and possibly aquatic macrophyte production are tertiary; and benthic microalgal production, urban run-off and other sources are negligible.

Allochthonous dissolved organic carbon must be converted to particulate form - with losses due to hydraulic flushing and to heterotroph growth inefficiency - before it becomes available to the metazoan food web. When these losses are accounted for, phytoplankton production plays a much larger role than is evident from a simple accounting of bulk organic carbon sources, especially in seasons critical for larval development and recruitment success.

Phytoplankton-derived organic matter is also an important component of particulate loading to the Delta. The Delta is a net producer of organic matter in critically dry years but, because of water diversion from the Delta, transport of organic matter from the Delta to important, downstream nursery areas in San Francisco Bay is always less than transport into the Delta from upstream sources. Of proposed rehabilitation measures, increased use of floodplains probably offers the biggest increase in organic matter sources. An isolated diversion facility - channelling water from the Sacramento River around the Delta to the water projects - would result in substantial loading increases during winter and autumn, but little change in spring and summer when food availability probably matters most to developing organisms. Flow and fish barriers in the channel could have significant effects, especially on phytoplankton sources and in dry years, by eliminating 'short-circuits' in the transport of organic matter to diversion points. Finally, productivity of intentionally flooded islands probably would exceed that of adjacent channels because of lower turbidity and shallower mean depth, although vascular plants rather than phytoplankton could dominate if depths were too shallow.

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453. Review of 15 years of research on ecotoxicology and remediation of land contaminated by agricultural drainage sediment rich in selenium.

Wu, L.

Ecotoxicology and Environmental Safety 57(3): 257-269. (Mar. 2004)

NAL Call #: QH545.A1E29; ISSN: 0147-6513

Descriptors: wetlands/ selenium/ land reclamation/ bioaccumulation/ wildlife/ food chains/ drainage/ grasslands/ vegetation/ soil remediation/ water reservoirs/ sediment pollution/ leaching/ ecotoxicology/ pollution effects/ pollution control/ microorganisms/ salinity effects/ agricultural pollution/ habitats/ reservoirs/ water birds/ methylation/ drainage water/ sediment contamination/ remediation/ contamination/ nesting/ rooted aquatic plants/ safety/ *Gambusia affinis*/ USA, California, Kesterson/ USA, California, Kesterson Reservoir/ USA, California, Central Valley/ mosquitofish/ western mosquitofish/ land pollution/ ecosystems and energetics/ prevention and control/ effects of pollution/ water quality/ soil pollution: monitoring, control & remediation/ effects on organisms

Abstract: The consequences of elevated Se accumulation at the Kesterson Reservoir National Wildlife Refuge in the Central Valley of California created adverse effects on wildlife and led to extensive research on the behavior of Se in both the wetland and upland ecosystems. Selenium concentrations in water entering the Kesterson Reservoir averaged 300 $\mu\text{g/L}$ super(-1). In pond waters 20-30% of the Se was selenate, while only 2% was selenite in the drainage water entering the reservoir. Submerged rooted aquatic plants fed on by water birds were found to contain 18-390mg Sekg super(-1) dry weight. Mosquitofish

collected from the San Luis Drain contained 332mg Sekg super(-1), and those collected from the ponds ranged from 339 to 380mgkg super(-1). Livers of water birds had Se concentrations ranging from 19.9 to 127mgkg super(-1). The high concentrations of Se accumulation in the food chain of the wetland strongly suggest that Se bioaccumulation was the cause of death and deformity of embryos of the waterfowl nesting at the wetland habitat. In June 1986, the Kesterson Reservoir was closed to drain-water inputs, and the wetland was transformed to an upland grassland. New remedial plans were proposed. These new plans involved soil, water, and vegetation management to dissipate Se by bioaccumulation and volatilization through soil microorganisms and plants. The investigations of the potential transfer of Se from farm land into the crop and vegetables in the Central Valley indicated that plant tissue Se concentrations generally fall in a nonseleniferous category, except that the highest Se concentration of cotton was at a threshold where toxicity in animals could occur at a relatively low frequency. At the Kesterson upland grassland habitat, average total Se concentrations ranged from 500 to 8000 $\mu\text{g/kg}$ super(-1) and water-extractable Se ranged from 10 to 700 $\mu\text{g/kg}$ super(-1) in the top 15cm of soil and varied greatly, by a factor greater than 100, among soil samples. Uptake of Se by the plants was profoundly affected by the soil available Se concentration, soil moisture, pH, soil salinity, soil sulfate concentration, soil reoxidation condition, kind of plant species, and soil-management practices. The rate of soil Se dissipation at the Kesterson grassland system was from 1% (low methylation rate) to 5% (high methylation rate) Se inventory per year and it will take from 46 to 230 years to bring the soil Se down to a normal level, 4mg Sekg super(-1) soil. However, the Kesterson upland grassland habitat had Se bioaccumulation values less than 10% of those of the previous wetland. The potential food-chain contamination at the existing Kesterson grassland is much less problematic. No negative impact on wildlife has been reported for the upland habitat. Plants may contribute to the Se reoxidation process and be able to reduce the movement of Se in the soil. At the Kesterson grassland, the distribution of soil Se is extremely uneven; high levels of soil Se concentrated only in isolated spots. Therefore, leaching of soil Se is not at an area level. It is unlikely that problems of transport of Se from the Kesterson soil to the adjacent uncontaminated environment by leaching can occur.

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454. Salt toxicosis in ruddy ducks that winter on an agricultural evaporation basin in California.

Gordus, A. G.; Shivaprasad, H. L.; and Swift, P. K. *Journal of Wildlife Diseases* 38(1): 124-131. (2002)

NAL Call #: 41.9 W64B; ISSN: 0090-3558

Descriptors: brain sodium/ evaporation ponds/ hypersaline water/ *Oxyura jamaicensis*/ ruddy duck/ salt encrustation/ salt toxicosis

Abstract: Agricultural evaporation basins are used as a means to dispose of highly saline underground-tile-drainage water in the San Joaquin Valley (California, USA). The hypersaline water conditions encourage high aquatic invertebrate production, primarily brine shrimp (*Artemia franciscana*), which attract birds to those sites. Cool winter temperatures (<4 C) and hypersaline water conditions (>70,000 $\mu\text{hos/cm}$) resulted in feather salt encrustation and salt toxicosis in ruddy ducks (*Oxyura jamaicensis*).

During December 1998 and January 1999, approximately 200 dead and sick ruddy ducks were collected from an evaporation basin and five healthy control ruddy ducks were collected from a freshwater wetland. Brains contained ?1,890 ppm sodium (wet tissue mass) in seven dead birds and contained ?1.150 ppm sodium in the control birds. Liver arsenic, lead, and mercury concentrations were <1 ppm in all birds examined. Manganese, molybdenum, and copper liver concentrations did not differ significantly ($P > 0.05$) between the two groups of ducks. The dead ducks had significantly higher liver selenium, cadmium, iron, and zinc than the controls, but the concentrations were not sufficient to cause toxicity. Significant gross and microscopic lesions in most of the dead birds included conjunctivitis, lens opacity and cataract formation, vascular congestion in various organs most notably in the meninges of the brain, and myocardial and skeletal muscle degeneration.

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455. Selection of flooded agricultural fields and other landscapes by female northern pintails wintering in Tulare Basin, California.

Fleskes, J. P.; Jarvis, R. L.; and Gilmer, D. S. *Wildlife Society Bulletin* 31(3): 793-803. (2003)
 NAL Call #: SK357.A1W5; ISSN: 0091-7648
 Descriptors: wetlands/ radio-tagging/ agricultural land/ habitat selection/ habitat utilization/ water levels/ hunting/ marshes/ overwintering/ evaporation tanks/ drainage water/ habitat improvement (physical)/ ponds/ nature conservation/ females/ population dynamics/ aquatic birds/ agriculture/ *Anas acuta*/ USA, California, Tulare Basin/ USA, California, San Joaquin Valley/ northern pintail
 Abstract: Habitat selection and use are measures of relative importance of habitats to wildlife and necessary information for effective wildlife conservation. To measure the relative importance of flooded agricultural fields and other landscapes to northern pintails (*Anas acuta*) wintering in Tulare Basin (TB), California, we radiotagged female pintails during late August-early October, 1991-1993 in TB and other San Joaquin Valley areas and determined use and selection of these TB landscapes through March each year. Availability of landscape and field types in TB changed within and among years. Pintail use and selection (based upon use-to-availability log ratios) of landscape and field types differed among seasons, years, and diel periods. Fields flooded after harvest and before planting (i.e., pre-irrigated) were the most available, used, and selected landscape type before the hunting season (Prehunt). Safflower was the most available, used, and--except in 1993, when pre-irrigated fallow was available--selected pre-irrigated field type during Prehunt. Pre-irrigated barley-wheat received 19-22% of use before hunting season, but selection varied greatly among years and diel periods. During and after hunting season, managed marsh was the most available, used, and, along with floodwater areas, selected landscape type; pre-irrigated cotton and alfalfa were the least selected field types and accounted for less than or equal to 13% of pintail use. Agricultural drainwater evaporation ponds, sewage treatment ponds, and reservoirs accounted for 42-48% of flooded landscape available but were little used and least selected. Exodus of pintails from TB coincided with drying of pre-irrigated fallow, safflower, and barley-wheat fields early in winter, indicating that preferred habitats were lacking in TB during late winter.

Agriculture conservation programs could improve TB for pintails by increasing flooding of fallow and harvested safflower and grain fields. Conservation of remaining wetlands should concentrate on increasing the amount and productivity of marsh that is shallow-flooded as pre-irrigated grain fields dry. If pintails were provided with adequate preferred field and marsh habitats, including hunt-day sanctuaries, contaminant risks associated with exposure to drainwater evaporation ponds probably should remain low for these waterfowl even if their abundance in TB increased.

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456. Selenium in agricultural drainage: Essential nutrient or toxic threat?

Moore, S. B. *Journal of Irrigation and Drainage Engineering* 115(1): 21-28. (1989)
 NAL Call #: 290.9 AM3Ps (IR); ISSN: 0733-9437
 Abstract: The essential nutrient selenium is believed responsible for numerous deformities, reproductive failures, and deaths of migratory birds at Kesterson Reservoir in California's San Joaquin Valley. Wildlife problems at the reservoir appeared only a few years after the area began receiving selenium-laden subsurface drainage water from less than 42,000 acre (17,000 ha) or irrigated agricultural land on the west side of the valley. Although substantially reduced in acreage from their historic extent, the valley's wetland habitats continue to satisfy the wintering and migratory needs of substantial populations of Pacific Flyway migratory birds. Remnant anadromous fish populations struggle to survive the inadequate flows and low water quality of the valley's riverine habitats. It is estimated that in order to sustain intensively managed, irrigated agriculture and associated high levels of crop production, more than 1,000,000 acre (405,000 ha) of land on the west side of the valley must eventually be drained. Unless extraordinary measures are taken, the potential is great for contaminated agricultural drainage to further harm fish and wildlife resources of the San Joaquin Valley.
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457. Selenium in wetlands and waterfowl foods at Kesterson Reservoir California USA 1984.

Schuler C. A.; Anthony R. G.; and Ohlendorf H. M. *Archives of Environmental Contamination and Toxicology* 19(6): 845-853. (1990)
 NAL Call #: TD172.A7; ISSN: 0090-4341
 Descriptors: plants/ aquatic insects/ agrichemical/ water pollution/ environmental surveillance/ bioaccumulation/ health hazard/ toxicity
 Abstract: Kesterson Reservoir (Kesterson) received subsurface agricultural drainwater containing high levels of salts and selenium from farmland in the San Joaquin Valley of California. The accumulation of selenium in wetlands and waterfowl foods at Kesterson was investigated during May, August, and December of 1984. High concentrations of selenium were found in water, sediments, terrestrial and aquatic vegetation, and aquatic insects. Mean selenium concentrations in aquatic plants and insects ranged from 1.5 to 170 .mu.g/g dry weight and were about 11 to 290 times those found at a nearby reference site. Concentrations in some waterfowl food plants and insects at Kesterson were up to 64 times those reported to be a health hazard to birds. Selenium concentrations were more

seasonally variable in aquatic plants than in aquatic insects. Few differences in selenium accumulation were found among ponds. Deposition of selenium in plant parts was not uniform; rhizomes contained higher concentrations than seeds and leaves were intermediate. Most biota bioaccumulated maximum selenium concentrations that were 1,000 to nearly 5,00 times the concentration in the water.

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458. Water quality impacts from agricultural drainage of peat soils in the Sacramento-San Joaquin Delta.

Brown, Russ T.

In: International Water Resources Engineering Conference. (Held 3-7 Aug 1998 at Memphis, Tennessee.); Vol. 2. Reston, Va.: American Society of Civil Engineers; pp. 1165-1170; 1998.

NAL Call #: TC5 .J696 1998; ISBN: 0784403597

Abstract: Agricultural drainage from peat soils in the Sacramento-San Joaquin Delta impacts the water supply exported by the State Water Project (SWP) and Central Valley Project (CVP) pumping plants. A monthly planning model (DeltaDWQ) was developed that links the agricultural diversion and drainage for the Delta peat soils with the river inflows and transport in the Delta channels. This model accounts for the water budget, salinity budget, and dissolved organic carbon budget for the agricultural soils and the Delta channels to provide an integrated evaluation of the effects of agricultural drainage on export water quality. This model was used for impact assessment of the proposed Delta Wetlands project (JSA 1995) that would convert two Delta agricultural islands to reservoirs.

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459. Waterbird communities in rice fields subjected to different post-harvest treatments.

Day, John H. and Colwell, Mark A.

Colonial Waterbirds 21(2): 185-197. (1998);

ISSN: 0738-6028

Descriptors: community composition/ post harvest treatments/ rice fields/ habitat/ species richness/ wetland management

Abstract: In California's Sacramento Valley, the potential value of rice fields as habitat for waterbirds may vary with harvest method, postharvest treatment of rice straw (chopped, burned, plowed), and extent of flooding. Recent changes in rice harvesting methods (i.e., use of stripper-headers) and a legislative mandate to decrease burning of rice straw after harvest may alter habitat availability and use. Thus, we investigated species richness and community composition of nonbreeding waterbirds during October-March 1993-94 and 1994-95 in rice fields of the northern Sacramento Valley. Most (85-91% of land area) rice was conventionally harvested (i.e., cutter bar), and the remainder was stripped. Rice straw was left untreated in more than half of fields (52% in 1994 and 54% in 1995), especially in stripped fields (56-70%). In fields where farmers treated straw, the most common management methods were plowing (15-21%), burning (19-24%), and chopping (3-5%). Fields became increasingly wet from October through March as seasonal precipitation accumulated and farmers flooded fields to facilitate straw decomposition and provide habitat for ducks. Species richness of waterbirds was greater ($P < 0.002$) in conventionally-harvested fields than in stripped fields; within harvest methods, species richness was consistently greater ($P < 0.01$) in flooded than non-flooded fields. By contrast, species richness did not differ among straw treatments ($P > 0.23$). Species richness in stripped fields probably was low because foraging opportunities were limited by tall dense straw, decreased grain density, and infrequent flooding. We recommend that land managers wishing to provide habitat for a diverse waterbird community harvest rice using conventional methods and flood fields shallowly.

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Wetlands as Agricultural Conservation Practices

460. Accumulation, release, and solubility of arsenic, molybdenum, and vanadium in wetland sediments.

Fox, P. M. and Doner, H. E.

Journal of Environmental Quality 32(6): 2428-2435.

(Nov. 2003-Dec. 2003)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: artificial wetlands/ sediment pollution/ arsenic/ molybdenum/ vanadium/ agriculture/ trace elements/ drainage/ solubility/ bioaccumulation/ sediment contamination/ farm wastes/ water pollution sources/ wastewater treatment/ sediment chemistry/ drying/ redox potential/ redox reactions/ anthropogenic factors/ water pollution treatment/ agricultural runoff/ drainage water/ water quality control/ artificial wetlands/ sewage & wastewater treatment/ industrial effluents/ sources and fate of pollution/ protective measures and control/ water & wastewater treatment

Abstract: This study was undertaken to determine the fate of As, Mo, and V (trace elements, TEs) in the sediments of a constructed wetland in use for the remediation of potentially toxic trace element-contaminated agricultural

drainwater. After three years of wetland operation, sediment cores were collected to determine changes in TE concentrations as a function of depth and the effects of varying water column depth. All TE concentrations were highest in the top 2 to 4 cm and decreased with depth. Molybdenum accumulated in the wetland sediments, up to levels of 32.5 plus or minus 4.6, 30.2 plus or minus 8.9, and 59.3 plus or minus 26.1 mg kg super(-1) in the top 1 cm of sediment at water depths of 15, 30, and 60 cm, respectively. In the top 2 cm of sediment, As accumulated (28.2 plus or minus 3.0 mg kg super(-1)) only at the 60-cm water depth. Below 2 cm, as much as 10 mg kg super(-1) of As was lost from the sediment at all water depths. In most cases, V concentrations decreased in the sediment. In this wetland system, the lowest redox potentials were found near the sediment surface and increased with depth. Thus, in general As, Mo, and V concentrations in the sediment were highest under more reducing conditions and lowest under more oxidizing conditions. Most of the accumulated

Mo (73%) became water soluble on drying of samples. This has important implications for systems undergoing changes in redox status; for instance, if these wetland sediments are dried, potentially large amounts of Mo may be solubilized.
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461. Agricultural wetland management for conservation goals: Invertebrates in California ricelands.

O'Malley, Rachel Emerson

In: Invertebrates in freshwater wetlands of North America:

Ecology and management/ Batzer, Darold P.; Rader, Russell B.; and Wissinger, Scott A.

New York: John Wiley & Sons, 1999; pp. 857-885.

NAL Call #: QL365.4.A1158

Descriptors: Invertebrata/ farming and agriculture/ agricultural wetlands management for conservation/ conservation measures/ agricultural wetlands conservation goals/ habitat management/ agricultural wetlands/ cultivated land habitat/ California/ agricultural wetlands conservation value and management

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462. Dissolved organic carbon and disinfection by-product precursor release from managed peat soils.

Fleck, J. A.; Bossio, D. A.; and Fujii, R.

Journal of Environmental Quality 33(2): 465-475. (2004)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: wetlands/ soil pollution/ drinking water/ peat soils/ dissolved organic carbon/ soil organic matter/ land use change/ agricultural soils/ agricultural management/ biogeochemical cycles/ chlorine/ disinfectants/ carcinogens/ environmental factors/ biodegradation/ seasonal variation/ California

Abstract: A wetland restoration demonstration project examined the effects of a permanently flooded wetland on subsidence of peat soils. The project, started in 1997, was done on Twitchell Island, in the Sacramento-San Joaquin Delta of California. Conversion of agricultural land to a wetland has changed many of the biogeochemical processes controlling dissolved organic carbon (DOC) release from the peat soils, relative to the previous land use. Dissolved organic C in delta waters is a concern because it reacts with chlorine, added as a disinfectant in municipal drinking waters, to form carcinogenic disinfection byproducts (DBPs), including trihalomethanes (THMs) and haloacetic acids (HAAs). This study explores the effects of peat soil biogeochemistry on DOC and DBP release under agricultural and wetland management. Results indicate that organic matter source, extent of soil organic matter decomposition, and decomposition pathways all are factors in THM formation. The results show that historical management practices dominate the release of DOC and THM precursors. However, within-site differences indicate that recent management decisions can contribute to changes in DOC quality and THM precursor formation. Not all aromatic forms of carbon are highly reactive and certain environmental conditions produce the specific carbon structures that form THMs. Both HAA and THM precursors are elevated in the DOC released under wetland conditions. The findings of this study emphasize the need to further investigate the roles of organic matter sources, microbial decomposition pathways, and decomposition status of soil organic matter in the release of DOC and DBP precursors from delta soils under varying land-use practices.

This citation is from AGRICOLA.

463. Effects of inorganic nitrogen enrichment on mosquitoes (Diptera: Culicidae) and the associated aquatic community in constructed treatment wetlands.

Sanford, Michelle R.; Chan, Karrie; and Walton, William E.

Journal of Medical Entomology 42(5): 766-776. (2005)

NAL Call #: 421 J828; ISSN: 0022-2585

Descriptors: parasitology/ terrestrial ecology: ecology, environmental sciences/ agrichemicals/ biogeography: population studies/ wastewater/ constructed treatment wetland

Abstract: Ammonium nitrogen (NH₄-N) is a significant component of municipal and agricultural wastewaters, and nitrogen reduction is an important use of constructed treatment wetlands. The effects of ammonium nitrogen enrichment on resources of larval mosquitoes, larval mosquito abundance, adult mosquito production, and the abundance of related wetland organisms were examined in 0.1-ha replicate treatment wetlands. The hypothesis of a bottom-up effect induced by ammonium addition was not supported by bacterial abundance, mean bacterial cell size, or algal biomass in the water column. There was, however, a significant negative correlation between bacterial cell length and *Culex tarsalis* Coquillett (Diptera: Culicidae) larval abundance 1 wk later in wetlands enriched with ammonium nitrogen. Larval mosquito (*Culex* spp.) abundance in southern California wetlands enriched with NH₄-N (mean approximate to 3 mg/liter) was significantly greater than in control wetlands at ambient nitrogen levels (8.3 mg N(3)-N/liter, 0.1 mg NH₄-N/liter). Adult mosquito production was nine-fold greater and chironomid larvae were significantly more abundant in wetlands enriched with NH₄-N than in controls but other censused taxa exhibited no significant trends. Mosquitofish, *Gambusia affinis* (Baird & Girard), abundance was significantly reduced in enriched wetlands, but other potential mosquito predators were not significantly affected by ammonium enrichment.

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464. Evaluation of constructed wetland treatment performance for winery wastewater.

Grismer, M. E.; Carr, M. A.; and Shepherd, H. L.

Water Environment Research 75(5)(Sept. 2003-Oct. 2003)

NAL Call #: TD419.R47; ISSN: 1061-4303

Descriptors: wetlands/ suspended particulate matter/ chemical oxygen demand/ wastewater treatment/ agriculture/ water quality/ tracers/ ammonium compounds/ pH/ aeration/ industrial wastewater/ artificial wetlands/ food-processing wastes/ performance evaluation/ suspended solids/ tannins/ sampling/ retention time/ organic loading/ springs/ sulfates/ suspended load/ evaluation/ contamination/ ammonium/ USA, California/ wineries/ prevention and control/ wastewater treatment processes/ industrial effluents/ water & wastewater treatment

Abstract: Rapid expansion of wineries in rural California during the past three decades has created contamination problems related to winery wastewater treatment and disposal; however, little information is available about performance of on-site treatment systems. Here, the project objective was to determine full-scale, subsurface-flow constructed wetland retention times and treatment performance through assessment of water quality by daily sampling of total dissolved solids, pH, total suspended solids, chemical oxygen demand (COD), tannins, nitrate, ammonium, total Kjeldahl nitrogen, phosphate, sulfate, and sulfide across operating systems for winery wastewater

treatment. Measurements were conducted during both the fall crush season of heavy loading and the spring following bottling and racking operations at the winery. Simple decay model coefficients for these constituents as well as COD and tannin removal efficiencies from winery wastewater in bench-scale reactors are also determined. The bench-scale study used upward-flow, inoculated attached-growth (pea-gravel substrate) reactors fed synthetic winery wastewater. Inlet and outlet tracer studies for determination of actual retention times were essential to analyses of treatment performance from an operational subsurface-flow constructed wetland that had been overloaded due to failure to install a pretreatment system for suspended solids removal. Less intensive sampling conducted at a smaller operational winery wastewater constructed wetland that had used pretreatment suspended solids removal and aeration indicated that the constructed wetlands were capable of complete organic load removal from the winery wastewater.

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465. Functional equivalency between rice fields and seminatural wetland habitats.

Elphick, Chris S.

Conservation Biology 14(1): 181-191. (2000)

Descriptors: multivariate analysis: analytical method/ anthropogenic habitat/ behavior/ feeding efficiency/ food abundance/ foraging performance/ functional equivalency/ predation threat/ rice fields/ seminatural wetland habitat/ time allocation

Abstract: Evaluating the potential for anthropogenic habitats to act as surrogates for the natural habitats they replace is a key issue in conservation biology. In California, flooded rice fields are used by numerous aquatic birds during winter. If this habitat functions similarly to more natural wetlands, increased flooding may help replace the extensive wetlands that occurred in the region prior to agricultural development. I tested whether food abundance, perceived predation threat, foraging performance, and the way in which birds allocate their time to different behaviors differed between flooded rice fields and seminatural wetlands for several species of aquatic bird. When appropriate, I also compared flooded and unflooded fields. Invertebrate densities did not differ among habitats. Seminatural wetlands had less rice grain but more seeds from other plants than the two rice habitats. The frequency with which predators passed over a feeding area was lower in flooded fields than in unflooded fields or seminatural wetlands. Most differences in feeding performance and time allocation among habitats were small and statistically insignificant. For some species, feeding efficiency was greater in seminatural wetlands than in flooded fields. Increasing attack rates and the amount of time spent feeding when in flooded fields, however, may allow birds to compensate for reduced efficiency. Multivariate analyses showed that group size, predation threat, time of day, date, and water depth often were associated with behaviors, but that these variables rarely accounted for habitat differences. Flooded fields apparently provide equivalent foraging habitat to seminatural wetlands and, because of reduced predation threat, may be a safer habitat for waterbirds. Thus, if managed appropriately, one of the world's dominant forms of agriculture can provide valuable waterbird habitat.

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466. Heat as a tracer to estimate dissolved organic carbon flux from a restored wetland.

Burow, K. R.; Constantz, J.; and Fujii, R.

Ground Water 43(4): 545-556. (2005)

NAL Call #: TD403.G7; *ISSN:* 0017-467X

Descriptors: wetlands/ discharge/ ditches/ drainage/ geology/ groundwater flow/ heat/ heat transfer/ hydraulic conductivity/ hydrology/ mathematical models/ peat soils/ seepage/ soil types/ surface water/ water temperature

Abstract: Heat was used as a natural tracer to characterize shallow ground water flow beneath a complex wetland system. Hydrogeologic data were combined with measured vertical temperature profiles to constrain a series of two-dimensional, transient simulations of ground water flow and heat transport using the model code SUTRA (Voss 1990). The measured seasonal temperature signal reached depths of 2.7 m beneath the pond. Hydraulic conductivity was varied in each of the layers in the model in a systematic manual calibration of the two-dimensional model to obtain the best fit to the measured temperature and hydraulic head. Results of a series of representative best-fit simulations represent a range in hydraulic conductivity values that had the best agreement between simulated and observed temperatures and that resulted in simulated pond seepage values within 1 order of magnitude of pond seepage estimated from the water budget. Resulting estimates of ground water discharge to an adjacent agricultural drainage ditch were used to estimate potential dissolved organic carbon (DOC) loads resulting from the restored wetland. Estimated DOC loads ranged from 45 to 1340 g C/(m² year), which is higher than estimated DOC loads from surface water. In spite of the complexity in characterizing ground water flow in peat soils, using heat as a tracer provided a constrained estimate of subsurface flow from the pond to the agricultural drainage ditch.

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467. Isotopic evidence for changes in residue decomposition and N-cycling in winter flooded rice fields by foraging waterfowl.

Diepen, L. T. A. van; Groenigen, J. W. van; and Kessel, C. van

Agriculture, Ecosystems and Environment 102(1): 41-47. (2004)

NAL Call #: S601.A34; *ISSN:* 0167-8809

Descriptors: wetlands/ animal behaviour/ crop residues/ cycling/ decomposition/ flooding/ foraging/ isotope fractionation/ nitrogen/ rice/ rice straw/ straw/ waterfowl/ wild birds

Abstract: Winter flooded rice fields can serve as substitute habitat for migratory waterfowl. Not much is known about the effects of the foraging waterfowl on nutrient cycling in rice production systems. This study quantifies the effect of foraging waterfowl on decomposition of rice residue and N-cycling in a winter flooded rice field in the Sacramento Valley, California. Along two transects in a field, pairs of control plots and enclosure plots, which excluded waterfowl, were set up. The original straw residue within the inner 2 m² of the 3 m x 3 m plots was replaced by 15N labelled straw residue. The labelled residue was subsequently followed into the light fraction and mineral fraction of the soil through the winter flooding period. Foraging waterfowl increased the loss of 15N from the residue from 83 to 89%, but did not affect the mass decomposition and loss of total N of the residue. No significant effect of the waterfowl was

seen in the recovery of the residue N in the total soil N pool and in the light fraction, although there was a low recovery of residue N within these pools in the control treatments. The recovery of residue N in the NH₄⁺-N pool after winter flooding was significantly lower in the presence of waterfowl. The increased loss of residue N and lower recovery of residue N in the presence of waterfowl may indicate that the rate of N-cycling was increased. A better understanding of the N-cycle in winter flooded rice fields in the presence of waterfowl is needed to assess the potential benefits of winter flooding for the rice farmers.
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468. Management of rice fields for wetlands, water, and rice production.

Andrews, Elizabeth S. and Williams, Philip B.
In: National Conference on Hydraulic Engineering. (San Francisco, Calif.)
New York: American Society of Civil Engineers; pp. 1161-1166; 1993.
NAL Call #: TC5 .H824 1993; ISBN: 0872629201
Abstract: The feasibility of managing a portion of the Sacramento Valley's rice fields as wetlands for waterfowl use, storage, and aid in rice straw decomposition was evaluated. Approximately 95% of the area's original wetlands have been lost, and populations of resident and migratory waterfowl have declined as a result of this and other pressures on the ecosystem. The analysis showed that there was significant potential to manage rice acreages in the Sacramento Valley for winter wetlands for the benefit of farmers, waterfowl, and downstream water uses, though constraints to such operation are numerous.
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469. Microbial selenium volatilization in rhizosphere and bulk soils from a constructed wetland.

Azaizeh, H. A.; Gowthaman, S.; and Terry, N.
Journal of Environmental Quality 26(3): 666-672.
(May 1997-June 1997)
NAL Call #: QH540.J6; ISSN: 0047-2425
Descriptors: selenium/ rhizosphere/ *Scirpus robustus*/ plants/ microbial activity/ bacteria/ aeration/ bioremediation/ artificial wetlands/ soil bacteria/ irrigation/ drainage/ water pollution/ *scirpus robustus*/ rhizosphere/ selenium/ plants/ bacteria/ aeration/ bioremediation/ irrigation/ volatilization/ water pollution/ land pollution/ sources and fate of pollution/ mineral microbiology
Abstract: The potential of rhizosphere and bulk soil microbes to volatilize selenate, selenite, and selenomethionine was studied in liquid cultures under controlled conditions. Microbes cultured from the rhizosphere of bulrush (*Scirpus robustus*) plants showed higher Se volatilization than those from bulk soil of a flow-through, constructed wetland area contaminated with selenite. The data show that bacteria are the dominant microbes involved in Se volatilization; fungi contribute relatively little to this process. Bactericides significantly decreased both Se volatilization and the number of culturable bacteria in rhizosphere cultures compared to an untreated control. In the absence of added C, Se volatilization was greatest from selenomethionine, then selenite, then selenate. Aeration substantially increased the percentages of Se volatilized from rhizosphere soil cultures to which no C was added. Up to 95, 21, and 3% of the Se was volatilized from selenomethionine, selenite, and

selenate, respectively. When both C and aeration treatments were applied to the rhizosphere cultures, the corresponding percentages changed to 20, 57, and 4%, that is, selenomethionine volatilization by rhizosphere microbes decreased when C was added while selenite volatilization substantially increased. Since selenite volatilization was the greatest when rhizosphere microbes were supplied with C and aeration, we suggest that microbes in this selenite-contaminated wetland are adapted to volatilize Se by using C released from roots, and that Se volatilization may be enhanced by oxygen and environmental conditions provided by the plants.
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470. A palaeoenvironmental reconstruction to aid in the restoration of floodplain and wetland habitat on an upper deltaic plain, California, USA.

Brown, K. J. and Pasternack, G. B.
Environmental Conservation 32(2): 103-116. (June 2005)
NAL Call #: QH540.E55; ISSN: 0376-8929
Descriptors: wetlands/ environmental restoration/ sediments/ disturbance/ flood plains/ meadows/ habitat/ deltas/ historical account/ agriculture/ environment management/ forests/ conservation/ USA, California, Sacramento-San Joaquin Delta/ paleoecology/ environmental action/ general environmental engineering
Abstract: While tens of millions of dollars have been spent on land acquisition and planning for current and future floodplain and wetland restoration in the Sacramento-San Joaquin Delta, knowledge of the historical processes and landscape heterogeneity that are helpful in guiding the environmental restoration are often scarce. This study used palaeoenvironmental reconstruction to increase the historical perspective, with the aim of improving environmental management. Twelve sediment cores collected from the McCormack-Williamson Tract (MWT) leveed farmland and the juxtaposed Delta Meadows (DM) tidal wetland were sampled for a suite of environmental proxies. MWT was a non-tidal flood plain during much of the late-Holocene, with a mosaic of other habitats including dry uplands, riparian forests, and freshwater wetlands persisting nearby. Comparison with the regional sea-level history suggests that the upper delta gradually came under tidal influence 3000-800 calendar years before present (cal BP). Despite this, floodplain landforms and habitats prevailed at DM from 3650-330 cal BP, after which wetlands expanded, suggesting that a flood-based disturbance regime typified the upper delta for most of the late-Holocene. Recently, the upper deltaic plain has been profoundly disturbed by agriculture and other activities, rendering significant loss of habitat. It is believed that a flood-based disturbance regime will recur at MWT if the levees surrounding the tract are intentionally breached as planned for restoration, culminating in a variety of habitats similar to pre-agricultural conditions. Concentrations of Hg, Pb, As, and P pollutants elevated several-fold in surficial sediments are of particular concern, potentially becoming problematic after restoration.
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471. Patterns and dynamics of shorebird use of California's Central Valley.

David Shuford, W.; Page, G. W.; and Kjelson, J. E.
Condor 100(2): 227-244. (1998)

NAL Call #: QL671.C6; ISSN: 0021-8901

Descriptors: wetlands/ conservation/ distribution/ habitat use/ Pacific Flyway/ ricelands/ seasonal abundance
Abstract: Surveys of California's Central Valley between 1992-1995 document it as one of the most important regions in western North America to migratory and wintering shorebirds. Populations averaged 134,000 individuals in August, 211,000 in November, 303,000 in January, and 335,000 in April. Of 33 species, the 10 or 11 that averaged over 1,000 individuals each season accounted for 99% of total numbers. Managed wetlands, agricultural fields (especially rice), and agricultural evaporation ponds held the most shorebirds. Species varied their seasonal, geographic, and habitat use of the Central Valley, primarily in response to changes in water availability from rainfall or management practices and latitudinal variation in habitat availability mediated, in part, by climate. In the record rainfall year of 1994-1995, shorebird numbers increased 74% between November and January, primarily from coast-to-interior movements of the Dunlin (*Calidris alpina*) and Long-billed Dowitcher (*Limnodromus scolopaceus*) and local habitat shifts of Killdeer (*Charadrius vociferus*). Although the Valley's shorebirds face threats from poor or toxic water quality, changing agricultural practices, and habitat loss to urbanization, they should benefit from current efforts to increase flooding of rice fields and to secure a stable high quality water supply for wetlands. Development of a sound conservation strategy is crucial for the preservation of shorebird populations in the Central Valley, as this agriculturally-dominated landscape is among the most altered in North America and remains vulnerable to strong economic and population growth pressures that may impact shorebird habitats in the future.
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472. Screening and field evaluation of wetland algae species with superior capacities for the removal of selenium from agricultural drainage water.

Terry, N.

In: 1998-1999 Salinity/Drainage Program Annual Report; Series: Technical Progress Reports.
 Riverside, CA: UC Center for Water Resources, 1999; pp. 289-312.

Notes: Other number: Project 98-4

Descriptors: water pollution treatment/ agricultural runoff/ irrigation water/ selenium/ bioremediation/ freshwater organisms/ bioaccumulation/ volatile compounds/ drainage water/ sediment pollution/ pollution control/ plant physiology/ water quality control/ artificial wetlands/ water pollution control/ accumulation/ aquatic plants/ trace elements/ evaluation/ laboratories/ algae/ Chara/ USA, California, San Joaquin Valley/ USA, California, Tulare L./ freshwater macrophytes/ protective measures and control/ physiology, biochemistry, biophysics/ wastewater treatment processes/ water pollution: monitoring, control & remediation

Abstract: In this report we present data which demonstrates that Chara, a macroalga known to accumulate very high concentrations of trace elements, is able to remove significant amounts of Se from solution, by

accumulation in tissue and by volatilization. In only 8 days Chara removed 50% of the Se supplied in solution as 32 ppb selenate. In an experiment comparing the rates of Se accumulation and volatilization by Chara compared to twenty aquatic plant species, Chara exhibited the highest rates of Se accumulation and volatilization under laboratory conditions. We constructed wetland microcosms, and used them to treat Se-contaminated solution. These microcosms removed 70% of the Se from solution. Most of the Se was in the sediments, with some Se being accumulated and volatilized by the plants in the microcosm. These experiments showed that the microcosms can effectively simulate an actual constructed wetland. Now that we know that Chara is a superior candidate for the phytoremediation of Se and we know that microcosms can be used to effectively simulate actual constructed wetlands, we will plant Chara in microcosms supplied with selenate-contaminated agricultural drainage water (similar to the water flowing into the TLDD wetland). This experiment will determine the efficiency with which Chara will remove Se from agricultural drainage water flowing into a constructed wetland.

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473. Selenium accumulation in submerged aquatic macrophytes Potamogeton pectinatus L. and Ruppia maritima L. from water with elevated chloride and sulfate salinity.

Wu, L. and Guo, X.

Ecotoxicology and Environmental Safety 51(1): 22-27. (Jan. 2002)

NAL Call #: QH545.A1E29; ISSN: 0147-6513

Descriptors: wetlands/ selenium/ bioaccumulation/ macrophytes/ aquatic organisms/ sulfate/ agricultural pollution/ drainage/ aquatic plants/ agricultural runoff/ pollution effects/ brackishwater pollution/ aquatic macrophytes (Potamogetonaceae)/ aquatic macrophytes (Ruppiaceae)/ runoff (agricultural)/ heavy metals/ USA, California/ water pollution effects/ Potamogeton pectinatus/ Ruppia maritima/ widgeongrass/ macrophytes/ metabolism/ freshwater pollution/ pollution - organisms/ ecology/ toxicology/ effects of pollution/ effects of pollution/ effects on organisms

Abstract: Submerged aquatic macrophyte species *Potamogeton crispus* L. (curlyleaf pondweed) and *Ruppia maritima* L. (widgeongrass) were examined for selenium accumulation from agricultural drainage water in the field and under laboratory conditions. High concentrations of chloride and sulfate salts were found in the drainage water of the constructed wetland at Tulare Lake Drainage District, Corcoran, California. Samples of *P. crispus* and *R. maritima* collected from the field, had similar plant-tissue Se concentrations, but the rhizomes accumulated significantly greater amounts of Se than the shoot tissues. When the plants were grown in culture solution supplemented with either chloride or sulfate salt, *R. maritima* was found to be more salt tolerant than *P. crispus*, and *P. crispus* accumulated more Se than *R. maritima*. Free seleno-amino acids were detected in the plant tissue, and organic Se was detected in the culture solution after 10 days of growth. The release of organic Se into the water by the plants may have a negative impact on the wetland environment. Copyright 2002 Elsevier Science.

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474. Selenium removal and mass balance in a constructed flow-through wetland system.

Gao, S.; Tanji, K. K.; Peters, D. W.; Lin, Z. Q.; and Terry, N. *Journal of Environmental Quality* 32(4): 1557-1570. (2003)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: drainage/ plants (botany)/ selenium/ vaporization/ vegetation/ standing plants/ water contamination/ wetland/ models/ theoretical/ *Distichlis spicata*/ *Juncus balticus*/ *Ruppia maritima*/ *Schoenoplectus acutus*/ *Spartina alterniflora*/ *Typha latifolia*
Abstract: A field study on the removal of Se from agricultural subsurface drainage was conducted from May 1997 to February 2001 in the Tulare Lake Drainage District (TLDD) of San Joaquin Valley, California. A flow-through wetland system was constructed consisting of ten 15- x 76-m unlined cells that were continuously flooded and planted with either a monotype or combination of plants, including sturdy bulrush [*Schoenoplectus robustus* (Pursh) M.T. Strong], baltic rush (*Juncus balticus* Willd.), smooth cordgrass (*Spartina alterniflora* Loisel.), rabbitsfoot grass [*Polypogon monspeliensis* (L.) Desf.], saltgrass [*Distichlis spicata* (L.) Greene], cattail (*Typha latifolia* L.), tule [*Schoenoplectus acutus* (Muhl. ex Bigelow) A. Löve & D. Lo?ve], and widgeon grass (*Ruppia maritima* L.). One cell had no vegetation planted. The objectives of this research were to evaluate Se removal efficiency of each wetland cell and to carry out a mass balance on Se. The inflow drainage water to the cells had average annual Se concentrations of 19 to 22 $\mu\text{g L}^{-1}$ dominated by selenate [Se(VI), 95%]. Average weekly water residence time varied from about 3 to 15 d for Cells 1 through 7 (target 7 d), 19 to 33 d for Cells 8 and 9 (target 21 d), and 13 to 18 d for Cell 10 (target 14 d). Average weekly Se concentration ratios of outflow to inflow ranged from 0.45 to 0.79 and mass ratio (concentration x water volume) from 0.24 to 0.52 for year 2000, that is, 21 to 55% reduction in Se concentration and 48 to 76% Se removal in mass by the wetland, respectively. The nonvegetated cell showed the least Se removal both in concentration and in mass. The global mass balance showed that on the average about 59% of the total inflow Se was retained within the cells and Se outputs were outflow (35%), seepage (4%), and volatilization (2%). Independent measurements of the Se retained in the cells totaled 53% of the total Se inflow: 33% in the surface (0-20 cm) sediment, 18% in the organic detrital layer above the sediment, 2% in the fallen litter, <1% in the standing plants, and <1% in the surface water. Thus, about 6% of the total Se inflow was unaccounted for in the internal compartments.

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475. Selenium removal by constructed wetlands: Quantitative importance of biological volatilization in the treatment of selenium-laden agricultural drainage water.

Lin, Zhi Qing. and Terry, Norman.
Environmental Science and Technology 37(3): 606-615. (2003)

NAL Call #: TD420.A1E5; ISSN: 0013-936X
Descriptors: freshwater ecology: ecology, environmental sciences/ pollution assessment control and management/ bioremediation/ applied and field techniques/ agricultural drainage water/ constructed wetlands/ selenium contaminated drainage water management
Abstract: Management of selenium (Se)-contaminated

agricultural drainage water is one of the most important environmental issues in California. To evaluate the feasibility of utilizing constructed wetlands to remediate Se-laden drainage water and the role of biological volatilization in Se removal, 10 flow-through wetland cells were constructed in 1996 in Corcoran, California. The monthly monitoring study from May 1997 to December 1999 showed that the vegetated wetlands were capable of significantly reducing Se from the inflow drainage water; an average of 69.2% of the total Se mass in the inflow was removed. Most of the Se was retained in sediment, and <5% of the Se was accumulated in plant tissues. Selenium volatilization was highest in the rabbitfoot grass wetland cell, where 9.4% of the Se input was volatilized over a 2-year period. Volatilization was greater in spring and summer than in fall and winter. For example, in May and June of 1998, 35 and 48%, respectively, of the Se entering the rabbitfoot grass cell was volatilized, whereas in the winter months, <5% was volatilized. The feasibility of using constructed wetlands for Se remediation, methods for the enhancement of Se volatilization, and the importance of considering potential Se ecotoxicity are discussed.
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476. Selenium removal from irrigation drainage water flowing through constructed wetland cells with special attention to accumulation in sediments.

Gao, S.; Tanji, K. K.; Peters, D. W.; Lin, Z.; and Terry, N. *Water, Air, and Soil Pollution* 144(1): 263-284. (2003)
NAL Call #: TD172 .W36; ISSN: 0049-6979
Descriptors: sediment contamination/ fluvial sediments/ drainage water/ agricultural runoff/ selenium/ sinks/ artificial wetlands/ irrigation water/ drainage districts/ irrigation/ drainage/ sediments/ pollutant removal/ USA, California/ USA, California, Corcoran/ artificial wetlands
Abstract: A flow-through experimental wetland system has been under investigation since 1996 to remove selenium (Se) from agricultural drainage water in the Tulare Lake Drainage District at Corcoran, California, U.S.A. The system consists of ten cells which have dimensions of 15 x 76 m continuously flooded and various substrates planted. The objectives of this article are to present the overall performance in Se removal after establishing the wetland for three years, and to examine factors affecting Se removal with special attention to accumulation in the sediments. In 1999, The wetland cells reduced Se from inflow water by 32 to 65% in concentration and 43 to 89% in mass. Vegetation plays an important role in Se removal as non-vegetated cell showed the least removal of Se. The inflow drainage water was dominated by selenate (Se(VI), 91%) with smaller percentages of selenite (Se(IV), 7%) and organic Se (org-Se(II-), 2%). The outflow water from the cells contained an average of 47% Se(VI), 32% Se(IV) and 21% org-Se indicating reduction processes occurring in the wetland cells. The surface sediment appears as a large sink of Se removal. The highest Se concentration was found in fallen litter, followed by the fine organic detrital layer on the sediment surface. The sediment Se concentration dramatically decreased with increasing sediment depth. The mass distribution of Se, however, was sediment (0-20 cm) > fine detrital matter > fallen litter. Fractionation of surface sediment (0-5 cm) reveals that elemental Se was the largest fraction (ave. 47%) followed by organic matter-associated Se (34%). Soluble, adsorbed, and carbonate-associated Se accounted for 1.2, 3.1 and

2.5% of the total sediment Se, respectively. The major Se sink mechanism in the cells is the reduction of selenate to elemental Se and immobilization into the organic phase of the sediments.

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477. Selenium stable isotope ratios in California agricultural drainage water management systems.

Herbel, M. J.; Johnson, T. M.; Tanji, K. K.; Gao, S.; and Bullen, T. D.

Journal of Environmental Quality 31(4): 1146-1156. (2002)
NAL Call #: QH540.J6; ISSN: 0047-2425

Abstract: Selenium stable isotope ratios are known to shift in predictable ways during various microbial, chemical, and biological processes, and can be used to better understand Se cycling in contaminated environments. In this study we used Se stable isotopes to discern the mechanisms controlling the transformation of oxidized, aqueous forms of Se to reduced, insoluble forms in sediments of Se-affected environments. We measured $^{80}\text{Se}/^{76}\text{Se}$ in surface waters, shallow ground waters, evaporites, digested plants and sediments, and sequential extracts from several sites where agricultural drainage water is processed in the San Joaquin Valley of California. Selenium isotope analyses of samples obtained from the Tulare Lake Drainage District flow-through wetland reveal small isotopic contrasts (mean difference 0.7‰) between surface water and reduced Se species in the underlying sediments. Selenium in aquatic macrophytes was very similar isotopically to the NaOH and Na_2SO_3 sediment extracts designed to recover soluble organic Se and Se(O), respectively. For the integrated on-farm drainage management sites, evaporite salts were slightly (approximately 0.6‰) enriched in the heavier isotope relative to the inferred parent waters, whereas surface soils were slightly (approximately 1.4‰) depleted. Bacterial or chemical reduction of Se(VI) or Se(IV) may be occurring at these sites, but the small isotopic contrasts suggest that other, less isotopically fractionating mechanisms are responsible for accumulation of reduced forms in the sediments. These findings provide evidence that Se assimilation by plants and algae followed by deposition and mineralization is the dominant transformation pathway responsible for accumulation of reduced forms of Se in the wetland sediments.

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478. Trace element retention and release on minerals and soil in a constructed wetland.

Fox, Patricia M. and Doner, Harvey E.

Journal of Environmental Quality 31(1): 331-338. (2002)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: bioprocess engineering/ freshwater ecology: ecology, environmental sciences/ pollution assessment control and management/ soil science/ waste management: sanitation/ permeable bags/ field equipment/ agricultural drainwater: remediation, trace element contaminated/ air drying/ bulk soil: trace element retention/ field conditions/ flow through constructed wetland/ goethite coated quartz sand: trace element accumulation/ redox status changes/ sediment surface/ soil/ soil constituents: trace element retention/ water depth/ wetland cell

Abstract: Constructed wetlands are one method under investigation for the remediation of trace element-contaminated agricultural drainwater. A greater understanding of the retention of trace elements by the bulk

soil and soil constituents is necessary for their safe and effective use. To determine the capacity of soil, calcite, and goethite-coated quartz sand for retention of As, Mo, and V under field conditions, an in situ method was used whereby permeable bags containing those minerals were placed near the sediment surface of a flow-through constructed wetland for 3 or 12 mo. Accumulations of As, Mo, and V occurred on goethite-coated sand. Concentrations of Mo on goethite-coated sand were much higher in samples from a wetland cell with a water depth of 15 cm (38.23 ± 7.27 mg kg^{-1}) compared with those from a cell with a water depth of 3 cm (8.30 ± 1.45 mg kg^{-1}). Calcite sorbed no As and low amounts of Mo and V, indicating that it is not an important sink for those elements under these conditions. In soil bags, total As and V concentrations showed little change over 12 mo. Molybdenum accumulated in the soil bags, resulting in total concentrations (12 mo) of 27.22 ± 2.69 mg kg^{-1} and 11.42 ± 1.35 mg kg^{-1} at water depths of 15 and 3 cm, respectively. Nearly half of the Mo accumulation on soil became water soluble after air-drying. This has important implications for systems that may undergo changes in redox status, possibly resulting in large fluxes of water-soluble Mo.

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479. Water selenium speciation and sediment fractionation in a California flow-through wetland system.

Gao, S.; Tanji, K. K.; Peters, D. W.; and Herbel, M. J.

Journal of Environmental Quality 29(4): 1275-1283. (2000)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: wetlands/ selenium/ chemical speciation/ California

Abstract: A flow-through wetland system was established in the Tulare Lake Drainage District (TLDD) in California to determine if selenium (Se) from saline irrigation drainage can be removed prior to impoundment in evaporation basins to reduce potential toxicity to waterbirds. The objective of this research was to evaluate Se speciation, accumulation, and fractionation in the waters and sediments of the newly developed wetland system. The inlet water was dominated by selenate [Se(VI), 92%], with smaller percentages of selenite [Se(IV), 5%] and organic Se [org-Se(-II), 3%]. For the outflow water, the average percentage of Se(VI) was 72% in November 1997 and 59% in February 1999. This change may be due to an increase in either residence time and/or accumulation of organic detrital matter, which may enhance Se(VI) reduction processes. Selenium accumulation, transformation, and incorporation with the solid phase were all intensified in the surface sediment (<20 cm). The highest total Se concentrations in the sediments were found in the top 5 cm and concentrations dramatically decreased with depth. Elemental Se [Se(0)], as extracted by Na_2SO_3 , was the largest fraction (average of 46%) of the total sediment Se, followed by organic matter-associated Se (OM-Se) extracted by NaOH (average of 34%). Soluble, adsorbed, and carbonate-associated Se, as extracted by KCl, K_2HPO_4 (pH 8.0), and NaOAc (pH 5.0), were about 3, 10, and 3% of the total sediment Se, respectively. After establishing the wetland for 2 yr, significant Se removal from the flowing water was observed. The major sink mechanisms in the sediment are reduction to Se(0) and immobilization into the organic phase.

This citation is from AGRICOLA.

480. Winter management of Californian rice fields for waterbirds.

Elphick, C. S. and Oring, L. W.

Journal of Applied Ecology 35(1): 95-108. (1998)

NAL Call #: 410 J828; ISSN: 0021-8901

Descriptors: wetlands/ water management/ rice/ crop residues/ legislation/ burning/ waste management/ stubble/ wild birds/ nature conservation/ flooding/ submergence/ incorporation/ water/ depth/ land use/ decomposition

Abstract: Recent legislation designed to reduce air pollution has restricted Californian rice-farmers from burning rice stubble after harvest. Intentional flooding of fields during winter to speed straw decomposition is becoming increasingly common as growers seek alternatives to burning residual straw. The potential for flooded fields to act as a surrogate for destroyed wetland habitat may be an additional benefit in a region that hosts a large proportion of North America's wintering water birds. The degree to which water birds use flooded fields and whether the method of flooding affects their use was investigated. Intentionally flooded rice fields received significantly greater use by 24 of 31 species studied. Only great blue herons *Ardea herodias* and sandhill cranes *Grus canadensis* were significantly more common in unflooded fields. Geese densities did not differ between flooded and unflooded fields. There were no differences in the densities of most bird species in flooded fields that received different straw manipulations to improve decomposition rates. Exceptions included several small shore birds which occurred at highest densities in fields where straw was incorporated into the soil. For 14 species, it was tested whether preferred depths, suggested in the literature, received disproportionately higher use. Most of these species were more likely to be encountered within the suggested depth ranges. Depth, however, was a poor predictor of bird density. Depths of 15-20 cm resulted in frequent use by the greatest number of species. It is concluded that flooding rice fields increased suitable habitat for most, but not all, species studied. Different straw manipulation methods had little effect on most species. Water depth, however, was important in determining species occurrence. During the first half of the winter, water depths were greater than the median depths used by most species.

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