

The avifauna of constructed wetlands used for treating secondary wastewater at the Sacramento Regional Wastewater Treatment Plant

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INTRODUCTION

Constructed wetlands, designed for the treatment of municipal wastewater, are becoming more numerous as the economic advantages and purification potential of this natural technology become increasingly recognized. Although these wetlands are subject to operational and maintenance disturbances, research at several constructed wetlands throughout the country has demonstrated that the numbers and population densities of bird species using such sites is high compared to control wetlands (McAllister 1993). Kadlec and Knight (1996) summarized research indicating that the number of bird species using a treatment wetland was greater than that of a control site. These researchers concluded that constructed wetlands have significant habitat value for waterbirds. The importance of treatment wetlands as wildlife habitat is of particular significance given that 53% of natural wetlands have disappeared from the lower 48 states (Dahl 1990). Their value may even be greater in California, where more than 95% of the native wetlands have been destroyed or modified (Gilmer et al. 1982).

The Sacramento Regional Wastewater Treatment Plant (SRWTP) operates an 8.9-ha (22 acre) pilot constructed wetland facility in southern Sacramento County, California. This site was created in 1994. Initial observations by SRWTP staff indicated that the site harbored a diverse array of bird species, often in large numbers.

During the summer of 1996, we conducted avian research at the SRWTP facility in order to: (1) determine the bird species occurring in and around the constructed wetlands emphasizing any special status species or species which are considered rare for the area; (2) generate a list of bird species nesting at the constructed wetlands; and (3) generate quantitative data on the densities of bird species and their use of wetland habitats at the site.

This report summarizes some of our results. Further details and a full description of methods and results can be found in Jones et al. (1997).

STUDY SITE

The SRWTP constructed wetlands facility is located approximately 1 mile south of the city of Sacramento, between Interstate 5 and State Route 99. The treatment cells form an almost contiguous rectangular-shaped block of emer-

gent marsh habitat (Fig. 1). At the time of our study, the facility was operating in its third year. Approximately 1 million gallons/day of secondary effluent from the SRWTP is disinfected using ultra-violet light, then pumped to the treatment wetlands facility where it passes through the wetlands complex. The complex consists of 11 pairs of narrow cells, 15 m wide by 384 m long. Each cell is separated by a 4.5 m wide earthen berm. There are four different treatment types: batch, plug, overland and recycle flows Levkin et al. 1994).

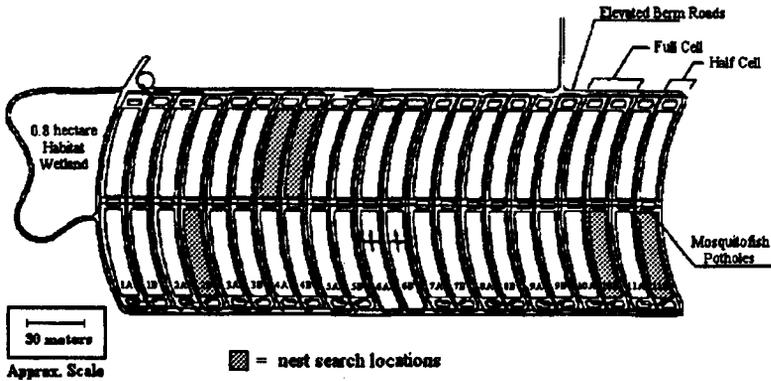


Figure 1. Flow diagram of the constructed wetlands.

Water levels within each cell are maintained within a range from 0.15-0.7 m. Patches of open water exist at the middle and both ends of each cell. These ponds are designed to provide refugia for mosquito fish (*Gambusia affinis*) during low water events. After passing through a wetland cell, the effluent is routed into a 0.8 ha pond ringed with emergent vegetation (the Habitat Wetland of Fig. 1) before being pumped back to SRWTP. The Habitat Wetland is intended to simulate a body of water which might receive such effluent in the future and serves as a final sampling site for the treatment process.

Tule (*Scirpus acutus*), cattail (*Typha* spp.), and California bulrush (*Scirpus californicus*), comprise the dominant vegetation within the wetland cells. Vegetation becomes dense during the growing season, with an average of 1,304 grams/m² of *Scirpus* and 1,031 grams/m² of *Typha* dried biomass, respectively. Duckweed (*Lemna* spp.) is present in varying degrees ranging from 0-100% of surface cover. The overland flow cell is dominated by *Cyperus eragrostis*, a perennial sedge (Nolte & Associates 1995).

METHODS

Research included nest searches, on foot, into selected areas. We surveyed portions (0.15 ha) of cells 2-B, 4-A, 10-B, and 11-B for nests on 8-9 May and 13 June 1996, by having 4 persons systematically comb the sample area on foot. As each nest was located, its construction, general location and contents were

described and recorded. We attempted to identify nests using Harrison (1979). If a determination to species was not possible, the nest was described and listed as unidentified. Nest densities for each species were calculated by dividing the number of nests by the corresponding sample area. Standard breeding bird criteria and nomenclature (Laughlin 1982) were used to determine and describe nesting status.

We gathered data on species densities by making weekly transect and point count surveys of five treatment cells (#s 1,3,5,6, and 7) and the Habitat Wetland (see Fig. 1). Only the results from line transect counts are discussed here. These areas were surveyed weekly from 1 April through 3 August 1996. All surveys were conducted between 0530 and 0930 hrs. Two observers spent 15 minutes walking a 297 m long transect at a steady pace. The center of the elevated berms between cells served as the transect lines. Observers counted birds on only one side of the line and no further than the cell boundary, thus limiting the survey to the cell of concern. Detections could be either visual or auditory, and the distance of each bird from the transect line was estimated

8-9 May 1996			
Cells 2BS, 4AN, 4BN, 10BS, 11BS			
Type	#	nests/acre	nests/hectare
MAWR nest (breeding and courtship)	63	33.78	84.45
8" AMCO/COMO nest	25	13.40	33.51
COMO nest	4	2.14	5.36
PBGR nest	2	1.07	2.68
4"-6" nest - unidentified	10	5.36	13.40
TOTAL	104	55.76	139.41

13 June 1996			
Cells 2BS, 4BN, 10BS, 11BS			
Type	#	nests/acre	nests/hectare
MAWR nest (breeding and courtship)	50	33.51	83.75
8" AMCO/COMO nest	18	12.06	30.15
AMCO nest	1	0.67	1.68
PBGR nest	2	1.34	3.35
4"-6" nest - unidentified	3	2.01	5.03
8"-10" nest - unidentified	2	1.34	3.35
14" nest - unidentified	1	0.67	1.68
TOTAL	77	51.61	128.98

Table 1. Nests found in treatment cells. MAWR=Marsh Wren; AMCO=American Coot; COMO=Common Moorhen; PBGR=Pied-billed Grebe.

to the nearest 1.5 m. Any detections within the 0-1.5 m band on the top of the berm were later eliminated from the calculations to confine our data set to the emergent marsh area only. Calculations to determine the sample area were also corrected to reflect this change. A 198 m long transect was located on the east bank of the Habitat Wetland. Observers spent 10 minutes walking this transect due to its shorter length. Birds observed outside the cell were excluded from the census. All other sampling procedures remained the same as those for the treatment cells.

In developing a species list for the site, we assigned sightings to one of the

Common Name	CW	<0.4	FO	Nest	Common Name	CW	<0.4	FO	Nest
Pied-billed Grebe	X			CO	Osprey			X	
American White Pelican	X				American Kestrel	X			
Double-crested Cormorant	X				Prairie Falcon			X	
Least Bittern	X			PO	Peregrine Falcon			X	
American Bittern	X			CO	Ring-necked Pheasant	X			CO
Black-crowned Night-Heron	X				Rock Dove	X			
Green Heron	X				Mourning Dove	X			PO
Snowy Egret	X				Barn Owl	X			CO
Great Egret	X				Great Horned Owl	X			
Great Blue Heron	X				Burrowing Owl	X			PR
Sandhill Crane			X		Anna's Hummingbird	X			
Tundra Swan			X		Belted Kingfisher	X			
Greater White-fronted Goose			X		Northern Flicker	X			
Canada Goose			X		Western Kingbird	X			
Mallard	X			CO	Tropical/Couch's Kingbird ¹		X		
Gadwall	X			CO	Ash-throated Flycatcher		X		
American Wigeon		X			Black Phoebe	X			PO
Northern Pintail		X			Say's Phoebe	X			
Northern Shoveler		X			Empidonax spp.	X			
Cinnamon Teal	X			CO	Tree Swallow	X			
Ruddy Duck	X				Northern Rough-winged Swallow	X			
Common Goldeneye	X				Cliff Swallow	X			
Bufflehead	X				Barn Swallow	X			
Virginia Rail	X			CO	Scrub Jay	X			
Sora	X			PO	Yellow-billed Magpie	X			
Common Moorhen	X			CO	American Crow	X			
American Coot	X			CO	Marsh Wren	X			CO
American Avocet	X			CO	American Robin	X			
Black-necked Stilt	X			CO	Loggerhead Shrike	X			
Killdeer	X			CO	Northern Mockingbird	X			
Whimbrel		X			American Pipit	X			
Long-billed Curlew		X			European Starling	X			
Greater Yellowlegs	X				Yellow-rumped Warbler	X			
Solitary Sandpiper	X				Common Yellowthroat	X			PR
Long-billed Dowitcher	X				Savannah Sparrow	X			
Common Snipe	X				Song Sparrow	X			PR
Least Sandpiper	X				White-crowned Sparrow	X			
Pectoral Sandpiper	X				Golden-crowned Sparrow	X			
gull spp.			X		Lincoln's Sparrow	X			
Caspian Tern			X		Western Meadowlark	X			PO
Turkey Vulture	X				Yellow-headed Blackbird	X			PO
White-tailed Kite	X				Red-winged Blackbird	X			CO
Northern Harrier	X			PR	Tricolored Blackbird	X			
Sharp-shinned Hawk	X				Brewer's Blackbird	X			
Cooper's Hawk	X				Brown-headed Cowbird	X			PR
Red-tailed Hawk	X				Great-tailed Grackle	X			PR
Swainson's Hawk			X		Bullock's Oriole	X			
					House Finch	X			

Table 2. Species observed at the constructed wetlands (CW), within 0.4 km of the site (<0.4), and flying over (FO). Nesting codes are Confirmed (CO), Probable (PR), and Possible (PO). 1=see text.

following three categories: 1) species observed within the constructed wetlands facility, 2) species observed within a 0.4 kilometer mile radius of the facility, and 3) species observed flying over the facility. Only presence or absence was noted for this portion of the study. These data, along with documented observations by other biologists during the study period, were used to produce the final species list.

RESULTS

We documented 15 confirmed, 6 probable, and 7 possible nesting species within the constructed wetlands facility (Table 1). Nests of only 4 of the 15 confirmed nesting species (Common Moorhen, American Coot, Pied-billed Grebe and Marsh Wren) were located during nest searches. We had difficulty distinguishing between moorhen and coot nests unless an adult or hatchling was observed. For the purpose of calculating nest densities, we developed a category combining the nests of these species.

Species	Strip Transect Data			
	Treatment Cells detections/hectare		Habitat Wetland detections/hectare	
	AVG	SD	AVG	SD
Pied-billed Grebe	0.26	1.03	1.83	2.18
Least Bittern	0.28	0.81	0.00	0.00
American Bittern	0.30	0.65	0.00	0.00
Green Heron	0.38	0.80	0.75	1.04
Mallard	1.11	2.24	0.25	0.56
Gadwall	0.41	0.63	0.93	0.97
Cinnamon Teal	1.08	1.20	1.92	1.15
Virginia Rail	0.90	1.11	0.00	0.00
Sora	0.24	0.93	0.74	1.67
Common Moorhen	10.40	5.68	3.76	3.04
American Coot	1.11	2.82	3.35	7.49
Marsh Wren	22.44	10.49	15.00	4.73
Common Yellowthroat	0.54	1.10	0.74	1.67
Song Sparrow	1.43	1.78	1.68	3.75
Red-winged Blackbird	6.68	7.46	37.39	51.33

Table 3. Birds detected/hectare (average and Standard Deviation) on strip transects of treatment cells and the Habitat Wetland, April-August 1996.

A total of 95 bird species were documented using the constructed wetlands and surrounding 0.4 kilometer radius area. We observed 80 species within the wetlands facility (including associated upland areas) and 23 species using the

emergent marsh wetland areas of the treatment cells or habitat cell. An additional 10 species were seen only in flight over the area (Table 2).

Nine California Species of Special Concern were documented using the facility: American White Pelican, Double-crested Cormorant, Least Bittern, Cooper's Hawk, Sharp-shinned Hawk, Northern Harrier, Burrowing Owl, Loggerhead Shrike, and Tricolored Blackbird. Two species we observed at the constructed wetlands were documented as first Sacramento County records: Least Bittern and Great-tailed Grackle. A possible Tropical Kingbird, reported as a "Tropical/Couch's Kingbird" on the Rio Cosumnes Christmas Bird Count of 21 December 1995, was also seen near the wetlands.

Wetland-dependent species found within the emergent marsh habitat at the site were: Pied-billed Grebe, Least Bittern, American Bittern, Green Heron, Virginia Rail, Sora, Common Moorhen, American Coot, Mallard, Gadwall, Cinnamon Teal, Marsh Wren, Common Yellowthroat, Song Sparrow and Red-winged Blackbird. Six species, including Anna's Hummingbird, Cliff Swallow, Northern Rough-winged Swallow, Black Phoebe, Yellow-headed Blackbird and Brown-headed Cowbird were detected at rates less than 0.01 detections/ha. Table 3 displays relative density values and standard deviations provided by the line transect data for each species at each study site during the breeding season (April -August 1996).

DISCUSSION

The list of nesting species on the site is for the most part typical of wetlands in this area. Further research should attempt to confirm the few species currently listed as potential or probable breeders. Of special interest is nesting activity by locally rare species, specifically Least Bittern.

The abundance and diversity of birdlife present at the SRWTP wetlands facility, after only 3 years of operation, is striking. This may be attributable to design and management factors necessary for water treatment. The wetlands, a series of long narrow cells, provide a large area of edge habitat that is appealing to many species. The ratio of edge to area of each cell is 0.14m:1m², resulting in 9,350 m of edge within the 8.9 ha wetlands. Other design features that may benefit waterbirds include berms (which could serve as upland refugia, nesting habitat or movement corridors between wetland cells) and the different treatment types used at the facility. Each of the five different treatment types require a different flow regime. This may be creating greater habitat diversity than exists within systems with a single flow regime, or even within natural wetlands.

Constructed wetlands managed for water treatment receive inputs not found in natural wetlands. Vegetation composition, a critical factor in water treatment, is managed for quick establishment and dense growth. Periodic disturbances, in the form of mechanical mowing and harvesting, insure variation in seral stages within the habitat. The addition of increased nutrient loads add to marsh productivity, through both vegetative growth and the

production of aquatic fauna as nutrients move through the food chain.

With the dramatic loss of freshwater wetlands in the Sacramento Valley, there are few large patches of permanent emergent wetlands remaining. The 8.9 ha treatment wetlands is one of the largest patches of dense tule-cattail wetland in the vicinity of the SRWTP. This, combined with a constant supply of small fish, aquatic invertebrates and terrestrial insects, has resulted in the rapid and intensive colonization by the full suite of local marsh-breeding birds, including rare species such as Least Bittern and Great-tailed Grackle.

The great-tailed grackle has been expanding its range north since it first appeared in California in 1964 (Small 1994). This species had been observed in counties both west and north of Sacramento and its eventual occurrence in the county had been expected (Tim Manolis, pers. comm). Further colonization of other parts of the county may be expected and should be monitored, as this species has the potential to become a pest (Ted Beedy, pers. comm.).

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