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Use of Waterbird Abundance for Saline Wetland Site Prioritization on St. Croix, United States Virgin Islands

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ABSTRACT.—We surveyed six species of waterbirds at saline sites to compare their distribution and abundance from April 2002 through December 2004 on St. Croix, United States Virgin Islands. Grebes (*Tachybaptus dominicus* and *Podilymbus podiceps*) were rare and rallids (*Gallinula chloropus* and *Fulica* spp.) were less restricted. White-cheeked Pintails (*Anas bahamensis*) and Green Herons (*Butorides virescens*) were widely distributed and numerous at saline sites. Maximum counts of pintails comprised 77% of the total number of all species combined. Pre-2002 data were similar to current data, although most sites of lesser importance were undersampled before 2002. More species and greater numbers of waterbirds occurred at salt ponds compared to other saline site types. Based on species rarity, richness, confirmed breeding, and maximum counts, the priority saline sites for conservation were five salt ponds, especially Southgate Pond and Rust-op-Twist, and Krause Lagoon Remnant. Our results suggest the historical loss of saline wetlands on St. Croix does not appear catastrophic for these six species. Man-made freshwater ponds may have compensated wetland loss for White-cheeked Pintails, Green Herons, and coots. Regardless, natural or altered saline wetlands, especially seasonal salt ponds, continue to contribute to avian biodiversity on insular St. Croix.

KEYWORDS.— abundance, *Anas bahamensis*, breeding sites, conservation, distribution, prioritization, saline wetlands, salt ponds, St. Croix, waterbirds

INTRODUCTION

About 50% of mangrove and associated saline wetlands have either been degraded or destroyed over the last 40-50 years on St. Croix, United States Virgin Islands (Conservation Data Center 2001). The greatest loss was Krause Lagoon, which was replaced by an industrial complex in the mid-1960s. About 438 ha of saline wetlands is now left on St. Croix, over 50% of which are salt ponds (229 ha; Conservation Data Center 2001). More than 20 species of waterbirds, including grebes, waterfowl, and rallids (Beatty 1930; Danforth 1930, 1935; Norton et al. 1986, Seaman 1973, 1980, 1993; Sladen 1992), currently breed in these saline wetlands on St. Croix. In addition, six species (White-cheeked Pintail *Anas bahamensis*, Least *Tachybaptus dominicus* and Pied-billed *Podilymbus podiceps* grebes, Green Heron *Butorides virescens*, Common Moorhen *Gallinula chloropus*, American *Fulica americana* and Caribbean *F. caribaea* coots combined as one) regularly nest in man-made freshwater ponds (McNair 2006, McNair and Cramer-Burke 2006, McNair et al., unpubl. data).

We surveyed these six species of waterbirds on St. Croix from April 2002 to December 2004 to determine their species composition and relative abundance in saline wetlands. All six species are year-round facultative nesters in wetland habitats when water levels are satisfactory (e.g., coots; McNair and Cramer-Burke 2006). Waterbird surveys in saline wetlands have been conducted before in the United States Virgin Islands (USVI), including St. Croix (Norton et al. 1986). However, breeding information was rarely collected. We confirmed breeding as essential in prioritizing saline sites for conservation. We expected

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seasonally flooded salt ponds to be generally preferred over other more saline site types on St. Croix because these waterbirds generally prefer freshwater or low salinity conditions (e.g., Storer 1992, Taylor 1996).

Materials and Methods

Study area

Saline wetlands consisted of 172 salt ponds, salt flats, mangrove wetlands, and mixed swamps (Conservation Data Center 2001). Most of these sites were small (<1 ha) and embedded into or contiguous with larger tracts of other saline habitat types. Consequently, we ground-truthed and pooled saline wetlands on St. Croix proper into 17 widely distributed sites based primarily upon geographic isolation. However, a few sites were contiguous (Altona Lagoon and Altona Lagoon salt flat) or almost contiguous (e.g., Manning Bay wetland complex and Krause Lagoon Remnant). This is unlike freshwater ponds, which always have well defined boundaries. These 17 saline wetland site names in alphabetical order and assigned numbers (see Fig. 1) are: Altona Lagoon (1), Altona Lagoon salt flat (2), Buccaneer Hotel putt hole 4 pond (3), Coakley Bay salt pond (4), Great Pond (5), Halfpenny Bay salt pond (6), Krause Lagoon (7), Krause Lagoon Remnant (8), Long Point Bay (9), Manning Bay wetland complex (10), Mount Fancy salt pond (11), Rust-op-Twist salt pond (12), Salt River Bay (13), Southgate Pond (14), University of Virgin Islands Wetlands (15), West End salt pond (16), and Williams-Prosperity salt pond (17). The dominant saline habitat type of each site was retained (e.g., salt pond, lagoon). Any pooling which occurred was consistent with the geographical distribution and integrity of pre-disturbance or pre-loss conditions of saline wetlands to facilitate comparisons with pre-2002 data. Pre-disturbance sites before 2002 are represented by: Krause Lagoon (Hovensa, St. Croix Renaissance Park, and Alucroix Channel which is collectively

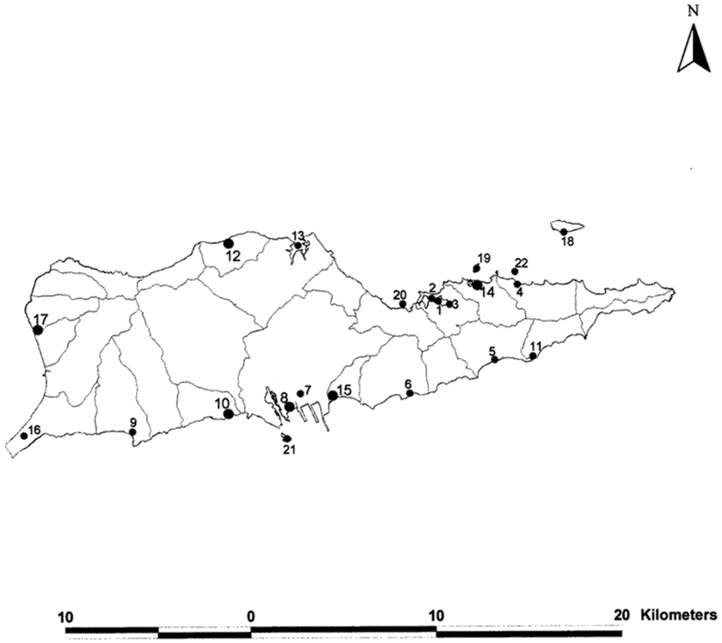

FIG. 1. Site numbers of saline wetlands sampled for the presence or absence of six species of breeding waterbirds on St. Croix from April 2002 to December 2004; two historical sites are also listed with current sites (see Table 1). Highly ranked wetlands are shown with large filled black circles and lowly ranked wetlands with small filled black circles.

named herein Krause Lagoon Remnant), Manning Bay wetlands complex (Manning Bay wetlands plus Fairplain Mouth salt pond), Salt River Bay (includes Sugar and Triton bays), and Southgate Pond (includes Green Cay Marina which was formerly part of this pond). In addition, a man-modified saline wetland on the grounds of the Buccaneer Hotel, erroneously listed as a freshwater wetland (Conservation Data Center 2001), was separated from Altona Lagoon. Altona Lagoon salt flat was also separated from Altona Lagoon. All extant saline wetlands sampled on St. Croix followed Imsand and Philibosian (1987), McNair et al. (2006), and names and locations herein. In addition, all cays off St. Croix (two with wetlands) were included in the sample since they provide habitat for several waterbirds. These cay names in alphabetical order and assigned numbers are: Buck Island (18), Green Cay (19), Protestant Cay (20), Ruth Island (21), and Sandy Cay (22). Full data for the four main cays (excluding Sandy Cay) are presented in Dammann and Nellis (1992).

Waterbird surveys

Surveys were conducted from April 2002 through December 2004. Each wetland was visited a minimum of eight times (Table 1). The median number of visits to salt ponds (25; $n = 11$) compared to the other three saline site types (34; $n = 9$: lagoons, cays, other; reduced to one category because of small sample sizes for each type) was not significantly different (Mann-Whitney U = 39.5, $P = 0.45$). Thus, the number of visits, while uneven, did not differ by saline site type and was sufficient (median values of 25 and 35) for these labile species to avoid correcting for biases, such as differences in maximum counts among saline site types because of differences in effort. Sites were visited when water levels were moderate to high. Rainfall included a 50-year event during mid-November 2003 (means of 40-55 cm depending on exact location on St. Croix) and Tropical Storm Jeanne during mid-September 2004. These wet periods followed a drought before November 2003, although water levels were generally high when sampling began in spring 2002.

We surveyed each site, using the area search method, by walking around its perimeter or wading and canoeing into lagoons to explore suitable habitat. While some species can be inconspicuous (e.g., grebes), birds were unlikely to have been overlooked given the intense effort involved. This held true even in large sites ($\leq$59 ha) because we avoided biased low counts in these by covering the entire area. Thus, we did not adjust our count data. The maximum number of adult and immature birds of each species (though not juveniles or other young) was recorded and used to measure relative abundance at each wetland. This is appropriate for wetlands that are isolated from each other (Dieni and Jones 2002).

Confirmed breeding evidence (e.g., active nests, adults with flightless young) is used to unambiguously identify breeding birds (Hayes and Samad 2002). With the exception of Green Heron, all young may leave the nest within hours of hatching. These young are generally visible if undisturbed. Incubation ($\geq$20 d) and nestling/brood periods ($\geq$35 d) for each species are prolonged, increasing chances of breeding confirmation for successful nests.

Published pre-2002 data on the six species of waterbirds, unpublished data in Department of Fish and Wildlife files, and museum collections (skin specimens, egg sets) were examined for additional site-specific information on species presence and confirmed breeding in saline wetlands on St. Croix. Confirmed breeding data must consist of material evidence or a detailed description of an active nest or dependent young. Data from Krause Lagoon (before mid-1960s) and Krause Lagoon Remnant were kept separate. An additional ephemeral site, Sandy Cay, was also added.

Data analysis

Data analyses other than basic descriptive statistics used non-parametric statistics (Wilcoxon Signed Ranks test, Spearman's Correlation test, Mann-Whitney test). The Wilcoxon Signed Ranks test was used to compare the median number of species present and confirmed breeding at saline

TABLE 1. Site name and type of saline wetland, and the presence[a] and confirmed breeding of six species of non-saltwater obligate waterbirds on St. Croix, United States Virgin Islands from April 2002 to December 2004 (with number of visits) and also before 2002[b] (unknown number of visits).

Site name (number of visits)	Site type	Species[c]						Total species per site	
		WCP	LG	PBG	GH	CM	COOT	Present	Confirmed
Altona Lagoon (19)	lagoon	no	absent	absent	yes	absent	no	3	1
Before 2002		no			yes		no	3	1
Altona Lagoon salt flat (23)	other	no	absent	absent	no	absent	absent	2	0
Before 2002								0	0
Buccaneer Hotel putt hole 4 pond (40)	salt pond	no	absent	no	no	no	absent	4	0
Before 2002								0	0
Coakley Bay salt pond (38)	salt pond	yes	absent	no	absent	absent	no	3	1
Before 2002		no		no			no	3	0
Great Pond (50)	lagoon	no	absent	absent	yes*	absent	absent	2	1
Before 2002		no			yes	no	no	4	1
Halfpenny Bay salt pond (8)	salt pond	absent	absent	absent	absent	absent	absent	0	0
Before 2002								0	0
Krause Lagoon—only Before 1963	lagoon	yes		no	no		no	4	1
Krause Lagoon Remnant (44)	other	yes*	absent	absent	no	no	no	4	1
1963-2001		no			yes	no	no	4	1
Long Point salt pond (14)	salt pond	absent	absent	absent	no	absent	absent	1	0
Before 2002								0	0
Manning Bay salt pond (52)	salt pond	yes	absent	absent	yes	yes*	no	4	3
Before 2002		no			yes			2	1
Mount Fancy salt pond (25)	salt pond	yes	absent	absent	absent	absent	no	2	1
Before 2002								0	0
Rust-op-Twist salt pond (20)	salt pond	no	no	absent	yes	yes*	no	5	2
Before 2002				no			no	2	0
Salt River Bay (53)	lagoon	no	absent	absent	yes*	absent	absent	2	1
Before 2002					no			1	0
Southgate Pond (128)	salt pond	yes*	no	yes	yes*	yes*	yes*	6	5
Before 2002		yes*		yes*	no	no	yes*	5	3

[a]Species present: yes indicates breeding confirmed, no indicates breeding unconfirmed; otherwise species is listed as absent (although not listed as such before 2002 because of uncertain effort and reporting rates at many sites).

[b]Sources before 2002 are: Newton and Newton 1859a, 1859b; Beatty 1930; Danforth 1930, 1935; Seaman 1973, 1980, 1993; Norton et al. 1986, Scott and Carbonell 1986, Imsand and Philibosian 1987, Meier et al. 1989, Sladen 1992, McNair, unpublished data; W. C. Knowles, R. L. Norton, R. A. Philibosian, F. W. Sladen, and J. A. Yntema, unpubl. data; United States National Museum (Washington, D.C.), and Western Foundation of Vertebrate Zoology (Santa Barbara, California), unpubl. data.

[c]Species names are: White-cheeked Pintail *Anas bahamensis* (WCP), Least Grebe *Tachybaptus dominicus* (LG), Pied-billed Grebe *Podilymbus podiceps* (PBG), Green Heron *Butorides virescens* (GH), Common Moorhen *Gallinula chloropus* (CM), and American *Fulica americana* and Caribbean *Fulica caribaea* coot combined (COOT).

[d]Small cay (5 × 10 m) which had disappeared at the latest by Hurricane Hugo (September 1989); cay formerly located ca. 450 m offshore due north of the point between Coakley Bay and Prune Bay.

*Multiple breeding confirmations.

TABLE 1. Continued.

Site name (number of visits)	Site type	Species[c]						Total species per site	
		WCP	LG	PBG	GH	CM	COOT	Present	Confirmed
UVI Wetlands (26)	salt pond	no	absent	absent	no	no	absent	3	0
Before 2002		no		no	yes	no	no	5	1
West End salt pond (20)	salt pond	no	absent	absent	no	absent	absent	2	0
Before 2002		no		no				2	0
Williams-Prosperity salt pond (25)	salt pond	no	absent	no	no	yes*	absent	4	1
Before 2002		no		no		yes	no	4	1
Buck Island (14)	cay	yes*	absent	absent	absent	absent	absent	1	1
Before 2002								0	0
Green Cay (33)	cay	yes*	absent	absent	no	absent	absent	2	1
Before 2002		yes*			no			2	1
Protestant Cay (53)	cay	absent	absent	absent	no	absent	absent	1	0
Before 2002								0	0
Ruth Island (34)	cay	yes	absent	absent	yes	absent	absent	2	2
Before 2002		yes*						1	1
Sandy Cay[d]—only Before 2002	cay	yes						1	1
Total number of sites species present		17	2	4	16	7	7		
Before 2002		13	0	7	9	5	9		
Total number of sites species confirmed breeding		8	0	1	7	4	1		
Before 2002		5	0	1	5	1	1		
% of sites present with confirmed breeding		47%	0%	25%	44%	57%	14%		
Before 2002		38%	nd	14%	56%	20%	11%		

[a]Species present: yes indicates breeding confirmed, no indicates breeding unconfirmed; otherwise species is listed as absent (although not listed as such before 2002 because of uncertain effort and reporting rates at many sites).

[b]Sources before 2002 are: Newton and Newton 1859a, 1859b; Beatty 1930; Danforth 1930, 1935; Seaman 1973, 1980, 1993; Norton et al. 1986, Scott and Carbonell 1986, Imsand and Philibosian 1987, Meier et al. 1989, Sladen 1992, McNair, unpublished data; W. C. Knowles, R. L. Norton, R. A. Philibosian, F. W. Sladen, and J. A. Yntema, unpubl. data; United States National Museum (Washington, D.C.), and Western Foundation of Vertebrate Zoology (Santa Barbara, California), unpubl. data.

[c]Species names are: White-cheeked Pintail *Anas bahamensis* (WCP), Least Grebe *Tachybaptus dominicus* (LG), Pied-billed Grebe *Podilymbus podiceps* (PBG), Green Heron *Butorides virescens* (GH), Common Moorhen *Gallinula chloropus* (CM), and American *Fulica americana* and Caribbean *Fulica caribaea* coot combined (COOT).

[d]Small cay (5 × 10 m) which had disappeared at the latest by Hurricane Hugo (September 1989); cay formerly located ca. 450 m offshore due north of the point between Coakley Bay and Prune Bay.

*Multiple breeding confirmations.

sites since 2002 to the same sites before 2002. The Spearman's Correlation test was used to compare the maximum counts of White-cheeked Pintails to the other five species combined since 2002. The Mann-Whitney test was used to compare the median number of species present, confirmed breeding species, and maximum counts of all six species combined at salt ponds to other saline site types since 2002. All analyses use an α-value of 0.05.

Species rarity (restricted distribution, low abundance), high number of species present (4-6 species), high number of confirmed breeding species, and high counts of species at saline wetlands were used as cri-

teria in descending importance to rank saline wetlands into two classes, high or low. Small sample sizes of different saline wetland types with low species richness on St. Croix precluded a more complex approach to ranking these wetlands based on investigations of criteria such as size, which was very useful for freshwater ponds (McNair et al., unpubl. data).

RESULTS

Least and Pied-billed grebes occurred at the fewest sites (2-4) since 2002, Common Moorhen and coots occurred at an intermediate number of sites (7), whereas White-cheeked Pintails and Green Herons occurred at the most sites (16-17) and were the only widely distributed species (Table 1). All six species occurred at Southgate Pond, five species at Rust-op-Twist salt pond, four species at four sites (three salt ponds, Krause Lagoon Remnant), and three or fewer species at the remaining sites.

Least Grebes did not breed at either saline site, whereas Pied-billed Grebes and coots only nested at Southgate Pond (Table 1). The remaining three species also nested at Southgate Pond and at 3-7 other sites. White-cheeked Pintails, Green Herons, and Common Moorhens were confirmed breeding at about 50% of the sites. Other than Southgate Pond, the only other site that had as many as three confirmed breeding species was the Manning Bay wetland complex, which included two salt ponds.

White-cheeked Pintails, Green Herons, and coots occurred at the greatest number of wetlands (9-13 sites) before 2002 (Table 1). White-cheeked Pintails and Green Herons were confirmed breeding at more sites and at a larger percentage of sites than were other species. Coots, Common Gallinules, and Pied-billed Grebes were only confirmed breeding at one site, this being Southgate Pond or Williams-Prosperity salt pond. By contrast, Least Grebes did not occur at any site. Southgate Pond, with three confirmed breeding species, was the only site with more than one. However, the same five waterbirds also occurred at the UVI Wetlands. Four species occurred at three sites (one salt pond, two lagoons; Krause Lagoon and Krause Lagoon Remnant combined as one where the number of species present and confirmed breeding species was identical). Aside from two of the cays (Buck Island, Protestant Cay), these waterbirds were not reported at five saline wetlands.

The number of species present and confirmed breeding at 20 sites since 2002 was significantly greater than before 2002 (species present: Wilcoxon Signed Ranks T = 18, $P = 0.05$; confirmed breeding: T = 3.5, $P = 0.02$). Quartile distributions indicated the number of species present before 2002 was underrepresented in the lowest quartile and that the number of confirmed breeding species before 2002 was underrepresented in the mid-quartile range (25-75%).

Maximum counts of White-cheeked Pintails over all saline sites since 2002 comprised 77% of the total number of all species combined. Maximum counts of White-cheeked Pintails were also highly correlated with the other five species combined ($n = 20$, $r_s = 0.54$; $P = 0.01$). Pintails occurred in substantial numbers (>30 birds) at nine sites (Table 2). Both grebes numbered less than 10 birds total and the remaining three species (Green Heron, rallids) each accounted for between 5-10% of the maximum counts at all sites combined. More birds occurred at Southgate Pond ($n = 218$, 24%) than at any other site. Southgate Pond accounted for 80% of the total number of coots.

The median number of species present (3 vs 2), confirmed breeding species (1 vs 1), and maximum counts for the total of six species of waterbirds (44 vs 13) at salt ponds ($n = 11$) compared to other saline site types ($n = 9$) was not significantly different (species present: Mann Whitney U = 30.5, $P = 0.14$; confirmed breeding: U = 46.5, $P = 0.81$; maximum counts: U = 35.5, $P = 0.29$). Nonetheless, more species and higher counts occurred at salt ponds.

Since 2002, each of the six species of waterbirds were present and nested at fewer saline than freshwater sites and were also less numerous at saline sites except for coots whose counts between saline and

TABLE 2. Site name and type of saline wetland and maximum counts of six species of non-saltwater obligate waterbirds on St. Croix, United States Virgin Islands from April 2002 to December 2004.

Site name	Site type	Species[a]						Total of maximum counts per site
		WCP	LG	PBG	GH	CM	COOT	
Altona Lagoon	lagoon	2	0	0	6	0	2	10
Altona Lagoon salt flat	other	36	0	0	3	0	0	39
Buccaneer Hotel putt hole 4 pond	salt pond	142	0	1	4	6	0	153
Coakley Bay salt pond	salt pond	69	0	1	0	0	3	73
Great Pond	lagoon	57	0	0	6	0	0	63
Halfpenny Bay salt pond	salt pond	0	0	0	0	0	0	0
Krause Lagoon Remnant	other	58	0	0	7	1	4	70
Long Point salt pond	salt pond	0	0	0	1	0	0	1
Manning Bay salt pond	salt pond	45	0	0	1	8	4	58
Mount Fancy salt pond	salt pond	41	0	0	0	0	3	44
Rust-op-Twist salt pond	salt pond	7	2	0	3	8	1	21
Salt River Bay	lagoon	9	0	0	8	0	0	17
Southgate Pond	salt pond	120	1	3	7	18	69	218
UVI Wetlands	salt pond	53	0	0	2	2	0	57
West End salt pond	salt pond	11	0	0	1	0	0	12
Williams-Prosperity salt pond	salt pond	5	0	1	4	6	0	16
Buck Island	cay	13	0	0	0	0	0	13
Green Cay	cay	5	0	0	1	0	0	6
Protestant Cay	cay	0	0	0	1	0	0	1
Ruth Island	cay	2	0	0	2	0	0	4
Total of maximum counts for all sites		693	3	6	61	51	86	900
Maximum counts for each species as % of total		77%	0.3%	0.6%	6.8%	5.7%	9.6%	

[a]Refer to Table 1 for species names.

freshwater habitats were nearly identical (Table 3). A large proportion of pintails were also counted at saline sites.

Five of the six current top ranked saline wetlands were salt ponds. The top ranked site was Southgate Pond, followed by (in alphabetical order) Manning Bay and Rust-op-Twist salt ponds, then by Krause Lagoon Remnant, UVI Wetlands, and Williams-Prosperity salt pond (Fig. 1). All other saline wetlands are considered lowly ranked for these six species of waterbirds.

DISCUSSION

Most studies of waterbird abundance in the Caribbean have been conducted on seabirds. Shorebirds and waterfowl have received the second highest level of investigative attention. However, studies have rarely focused on the other two groups, wading birds and marsh birds (van Halewyn and Norton 1984; Goosen et al. 1994, Collazo et al. 1995, Schreiber and Lee 2000; Gorman and Haig 2002, Pienkowski et al. 2005; McNair and Cramer-Burke 2006, Bradley and Norton 2007). This study is the first in the Caribbean to reliably inventory and monitor all saline sites over several years on a single island where breeding waterfowl, wading birds, and marsh birds also breed at freshwater sites.

Our results on St. Croix suggest a higher probability of detecting non-saltwater obligate waterbirds at salt ponds compared to other saline site types. Southgate Pond, while less than 50% of its original size

TABLE 3. Sum values for the number of sites where a species was present and confirmed breeding and the sum of maximum counts for each of six species of non-saltwater obligate waterbirds at saline wetlands and freshwater ponds on St. Croix, United States Virgin Islands from April 2002 to December 2004.

Parameter	Species[a]					
Habitat type	WCP	LG	PBG	GH	CM	COOT
Sum of sites species present						
Saline wetlands	17	2	4	16	7	7
Freshwater ponds	68	9	61	89	113	23
% saline/freshwater	25%	22%	7%	18%	6%	30%
Sum of sites species confirmed breeding						
Saline wetlands	8	0	1	7	4	1
Freshwater ponds	20	4	31	11	73	6
% saline/freshwater	40%	0%	3%	64%	5%	17%
Sum of maximum counts for all sites						
Saline wetlands	693	3	6	61	51	86
Freshwater ponds	886	14	141	175	700	85
% saline/freshwater	78%	21%	4%	35%	7%	101%

[a]Refer to Table 1 for species names.

(Gaines 2004, Gaines and Gladfelter 2004), remains the most important saline wetland for this suite of waterbirds (Sladen 1992, McNair 2006, McNair and Cramer-Burke 2006, McNair et al., unpubl. data). Other than Southgate Pond, however, grebes and coots did not nest at any other saline wetland. Pied-billed Grebes and coots formerly occurred more regularly at Rust-op-Twist salt pond, where Ruddy Ducks *Oxyura jamaicensis* once nested during the first-half of the 20th century (Seaman 1993). Common Moorhens, less restricted in their saline distribution than grebes or coots, still nest at Southgate Pond and some other sites. White-cheeked Pintails remain widespread and numerous in saline wetlands. We found their nests at three cays (cf., Green Cay; Meier et al. 1989). We also discovered many broods (≥20) at Southgate Pond, which is the best pintail breeding site in either freshwater or saline habitats on St. Croix. Nonetheless, pintails nested at fewer saline than freshwater sites. A substantial number of Green Herons also occur at saline sites, although this species is more numerous at freshwater ponds. They may also breed in upland habitats. Non-breeding birds may outnumber breeding birds at many sites (e.g., White-cheeked Pintails at Buccaneer Hotel hole 4 putt pond), so our approach avoided the conundrum of inadequate documentation of breeding evidence which has plagued many avifaunal surveys in the USVI (e.g., Dammann and Nellis 1992).

Ornithological surveys in the USVI and on St. Croix have focused on natural saline environments (e.g., Dewey and Nellis 1980, Dammann and Nellis 1992, Sladen 1992) rather than man-made freshwater wetlands (McNair et al., unpubl. data). Comparison of the number of species present and confirmed breeding at the 20 saline sites since 2002 and from before 2002 strongly suggest that all but the poorest sites were adequately sampled for the number of species present before 2002. However, all sites were inadequately sampled for confirmed breeding species before 2002 except the best sites (highest 25%). This comparison reinforces other documentation that breeding evidence in particular was undersampled on St. Croix before 2002 (McNair et al. 2006). Thus, apparent compensation at freshwater ponds for losses at saline sites can be difficult to infer because of the uneven amount of detailed information at many saline sites before 2002. Regardless, comparison of the current distribution and abundance of these waterbirds at freshwater wetlands compared to their pre-2002 and current status at saline wetlands on St. Croix suggests man-made freshwater ponds are critical for grebes and rallids. These species may have partly compen-

sated for loss of saline habitats. A probable exception is the coots at Southgate Pond. Still, reproduction and survival of local populations of these species must be separated from the effects of immigrants from nearby islands to conclusively document compensation effects. Loss of saline wetlands for White-cheeked Pintails and Green Herons may have been partly compensated by man-made freshwater ponds. However, saline wetlands remain very important for both of these species. Saline sites were generally visited more frequently than freshwater sites and their total area is much greater. Thus, comparisons between these two habitat types would otherwise favor saline sites. Regardless of whether compensation at freshwater ponds for losses at saline sites has occurred, future simultaneous surveys in both habitat types will provide precise site-based population estimates and better determine the relative importance of within-habitat and between-habitat processes influencing short-term fluctuations and long-term changes in the distribution and abundance of these six species of waterbirds on St. Croix. This includes elucidation of whether waterbird populations fluctuate in parallel within and between both habitat types as they did with respect to similar or covarying resources in saline habitats examined in this study.

Prioritization of wetlands for conservation purposes for these six species of waterbirds on St. Croix must still include saline wetlands. This is especially the case for Southgate Pond, which is irreplaceable (Sladen 1992, this study). Fortunately, Southgate Pond is now protected and management recommendations for coots and Ruddy Duck will soon be implemented (McNair and Cramer-Burke 2006; McNair and Cramer-Burke, unpubl. data). Protection and management had been recommended before for another highly ranked salt pond at Rust-op-Twist (W. C. Knowles, unpubl. report), but supporting data were lacking. Available information also indicates that the importance of Williams-Prosperity salt pond has been overlooked. Vagrants such as a Fulvous Whistling-Duck *Dendrocygna arborea*, Hooded Mergansers *Lophodytes cucullatus*, and Glossy Ibises *Plegadis falcinellus* also occurred at this site from the late 1950s to the early 1980s (Seaman 1959, 1993; McNair et al. 2006), a time during which it was apparently more suitable for a variety of waterbirds. Past and current results do not suggest any losses have occurred for these six species of waterbirds at Krause Lagoon compared to Krause Lagoon Remnant, the only top ranked saline wetland that is not a salt pond. However, the loss of three or four saltwater obligates at Krause Lagoon (Least Bittern *Ixobrychus exilis*, Clapper Rail *Rallus longirostris*, Snowy Plover *Charadrius alexandrinus*, Willet *Catoptrophorus semipalmatus*; Beatty 1930, 1943; Danforth 1935, Seaman 1973) that did not breed at other wetlands on St. Croix (except for Willet; McNair et al. 2006) supports our belief that Krause Lagoon Remnant should be restored as much as possible from its present state to its former condition as a permanent wetland. The contribution of waterbird abundance of breeding saltwater obligates to saline wetland site prioritization is required to complement this study herein on the contribution of non-saltwater obligate waterbirds.

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