COLONIAL WATERBIRDS

JOURNAL OF THE COLONIAL WATERBIRD SOCIETY

VOL. 20, NO. 3 | 1998 | PAGES 301-476

Status of the White-faced Ibis: Breeding Colony Dynamics of the Great Basin Population, 1985-1997

SUSAN L. EARNST[1], LARRY NEEL[2], GARY L. IVEY[3] AND TARA ZIMMERMAN[4]

[1]USGS Forest & Rangeland Ecosystem Science Center, Snake River Field Station, 970 Lusk, Boise ID 83706, USA
Internet: searnst@eagle.idbsu.edu

[2]Nevada Division of Wildlife, Region I Office, 380 West B Street, Fallon NV 89406, USA

[3]U.S. Fish & Wildlife Service, Malheur National Wildlife Refuge, HC 72-Box 245, Princeton OR 97721, USA

[4]U.S. Fish & Wildlife Service, Office of Migratory Birds-Reg. 1, 911 NE 11th Ave., Portland OR 97232, USA

Abstract.—The status of the White-faced Ibis (*Plegadis chihi*) in the Great Basin is of concern because of its small population size and the limited and dynamic nature of its breeding habitat. We analyzed existing annual survey data for the White-faced Ibis breeding in the Great Basin and surrounding area for 1985-1997. Methods varied among colonies and included flight-line counts and fixed-wing aircraft and helicopter surveys. The number of White-faced Ibis breeding pairs in the Great Basin area has nearly tripled since 1985, despite years of severe flooding and drought at major breeding areas. This growth is reflected in both peripheral (i.e., Oregon, California, Idaho) and core (i.e., Nevada and Utah) components of the population. Our data on colony dynamics in Oregon and Nevada illustrate the ability of the highly nomadic White-faced Ibis to compensate for poor conditions at traditional colony sites by moving among colonies and rapidly colonizing newly available wetlands. We suggest that the White-faced Ibis would benefit from a landscape mosaic of well-distributed peripheral wetlands and persistent colony sites. The nomadic nature of the White-faced Ibis and the dynamic nature of their breeding habitat necessitates that wetland management decisions and population monitoring be conducted in a regional context. *Received 30 March 1998; accepted 22 July 1993.*

Key words.—Ciconiiformes, conservation, wetlands, Great Basin, nomadism, *Plegadis chihi*, population trend, White-faced Ibis.

Colonial Waterbirds 21(3): 301-313, 1998

The White-faced Ibis (*Plegadis chihi*) in the Great Basin and surrounding area is a Species of Management Concern (USFWS 1995) based on its small population size and vulnerability to breeding habitat loss. Traditionally, most of the Great Basin ibis population has bred in Utah and Nevada with peripheral but growing colonies in Idaho, California, and Oregon (Sharp 1985; Ryder and Manry 1994). After apparently declining precipitously in the 1960s and 1970s (Capen 1977), number of breeding pairs in the Great Basin was estimated at only 7,500 in 1984 (Sharp 1985). In addition to the Great Basin population (as defined here), small numbers breed locally in Colorado, Wyoming, Montana, North and South Dakota, and southern Alberta, and large numbers breed in Louisiana, Texas, Mexico, and South America (reviewed in Ryder and Manry 1994). Interchange among these sites and Great Basin colonies has not been investigated.

In the arid Great Basin region, the White-faced Ibis breeds in semi-permanent wetlands which are susceptible to naturally-occurring droughts and floods. Local population fluctuations and colony abandonment reflect this vulnerability. The White-faced Ibis apparently compensates for wetland dynamics by moving among breeding colonies and colonizing new wetlands within and between years (e.g., Ryder 1967; Capen 1977; Ivey *et al.* 1988; Henny and Herron 1989). The nomadic nature of the White-faced Ibis, like that of several other colonial ciconiiforms, suggests that population dynamics, distribution, and trends be monitored at the regional or population scale (e.g., Frederick *et al.* 1996).

The status of the Great Basin breeding population has not been reviewed since 1984 (Sharp 1985). Increases in breeding numbers in Oregon, Idaho, and California during the 1980s and 1990s suggested either that the White-faced Ibis was increasing regionally or that individuals displaced from flooded Great Salt Lake marshes were colonizing elsewhere (e.g., Ivey *et al.* 1988; Follansbee and Mauser 1994; Trost and Gerstell 1994). An increase in wintering numbers also suggested a population increase (Shuford *et al.* 1989). Recognizing the need for a comprehensive estimate of the breeding population, U.S. Fish and Wildlife Service (USFWS) coordinated a regional survey of all historic, active, and probable colony sites in 1995. To further assess the 1985-1997 population trend, we compiled available annual survey data for all known colonies to:

1. Document changes in the distribution, abundance, and population trend of the White-faced Ibis breeding in the Great Basin and surrounding area during 1985-1997.
2. Interpret population-wide changes in ibis distribution and abundance in relation to wetland dynamics throughout the region.
3. Discuss implications for future monitoring, research, and conservation.

STUDY AREA AND METHODS

Annual surveys were available for Nevada, most of Oregon, the main California colonies (Colusa National Wildlife Refuge, Mendota Wildlife Management Area, Lower Klamath National Wildlife Refuge), and the largest Idaho colony (Bear Lake National Wildlife Refuge) (Fig. 1). Other Idaho colonies were surveyed in 1985, 1993, and 1995. Most Utah sites were well covered in 1985, 1987, 1988, and 1997. In order to interpret trends at the state and population level, we combined estimates from sites surveyed annually with those surveyed intermittently. For sites surveyed intermittently, the missing annual estimates were assumed to follow a linear trend from one survey to the next. In Nevada, Oregon, and California, where 89%, 84% and 95%, respectively, of the population were surveyed annually, intermittently-surveyed sites have little influence on shape of the overall trend. In contrast, Idaho's trend is based almost entirely on estimates from three years (only 34% of the population was surveyed annually). The Utah trend is also based on intermittent data, and all potential sites were not covered in each survey year, thus the Utah trend should be interpreted with caution. The Utah population comprises <30% of the Great Basin population and has minimum effect on the overall trend.

Three survey methods were used: "flight-line" (*sensu* Erwin and Ogden 1980), fixed-wing aircraft, and helicopter surveys. Surveys were conducted during incubation when we assumed that one parent remained at the nest while the other left to forage shortly after sunrise, and both were rarely at the nest together. During "flight-line" counts, the observer, stationed at a distance from the colony, counted individuals leaving the colony shortly after sunrise. Individuals counted were assumed to be only non-incubating parents. In contrast, fixed-wing aircraft and helicopter surveys were flown directly over the colony during mid-day and the incubating parent was counted as it flushed from (helicopter) or remained at (fixed-wing) the nest. With all methods, number of individuals counted was interpreted as an index of the number of breeding pairs (see Discussion). The detection rate of pairs present, i.e., ratio of individuals counted to actual breeding pairs present, in this case depends on number of parents at nests and ability to detect those present. Neither parameter was measured in this study. Nonetheless, the index provides an unbiased estimate of population trend as long as there is no temporal trend in detection rate. In this study, the opportunity for a temporal trend in the ratio was decreased, for example, by the consistency of survey method and effort among years within most colonies (e.g., helicopter in Nevada, fixed-wing in Oregon, and flight-line in Idaho and primary California colonies). Similarly, the observer was consistent within colonies among years in Nevada, Oregon, and Idaho. It is highly unlikely that any large or many small colonies were missed in the states comprising U.S. Fish and Wildlife Service, Region 1 (Nevada, Oregon, Idaho, California); however, in Utah coverage of small colonies was less complete.

Nevada

Sites were surveyed annually by helicopter in mid-May and mid-June (Neel 1996), unless noted below. Our analyses use the mid-May estimate plus any additional colonies found during the second flight or ground surveys. In 1991, surveys were not flown because the lack of nesting was documented at major colonies (Stillwater National Wildlife Refuge, Carson Lake), other historic sites were known to be dry, and observations during aerial waterfowl surveys indicated the lack of nesting at others (e.g., Canvasback Gun Club). Thus, for the purpose of this paper, Nevada was assumed to have very few or no breeding ibis in 1991 (see also Neel 1996). A few sites surveyed formally only since 1992 were assumed to have no breeders in other years because emergent vegetation was known to be absent (Sleeper Mine, Rye Patch Reservoir) or anecdotal information suggested the site was not used (Humboldt Wildlife Management Area, Iron Point, Quinn and Washoe Lakes). In addition, Ruby Lake National Wildlife Refuge was surveyed annually by air (1991-1997) or by ground counts of nests (1985-1990).

Utah

Ground estimates of ne
available for Fish Springs
1985-1997, Bear River Mig
1997, Bear River Club 1995-
1985-1988 and 1995. Surve
Bear River Migratory Bird R
cause marshes were floode
ing, thus we assumed that n
River Migratory Bird Refuge
Salt Lake marshes were su
and 1997 during aerial water
of Wildlife files); however, it
sites were missed, and thus
marshes" may be underestin

Oregon, Idaho, and Califor

In Oregon, Malheur Na
sites in Harney County were
Lake County were surveyed
(Ivey *et al.* 1988, and Malhe
files). Estimates were based
surveys and by ground surv
late in the season.

In Idaho, flight-line cou
colonies in 1984-1985 (Tro
Gerstell 1994) and 1995 (U
Lake National Wildlife Refu
R. Sjostrom, pers. comm.).

In California, annual fli
able for Colusa National Wi
Mendota Wildlife Managem
math National Wildlife Ref
identify and compile data fr
sites.

RESU

The number of bree
es in the Great Basin h
1985 despite years of s
1987) and drought (19
onies (Fig. 2a,b). Bree
exceeded the 1984 estin
pairs (Sharp 1985) du
study. The breeding po
atively stable from 19
1991 due in part to dro
vada, and has increase
drought ended (1993-1
crease was reflected in
(e.g., Oregon, Califor
(e.g., Nevada) compon
range (Fig. 2b). Althou
fornia populations inc
and Utah populations
(1991-1994), they cont
Nevada and Utah recove
and beyond (1995-1997

Utah

Ground estimates of nests or breeding pairs were available for Fish Springs National Wildlife Refuge 1985-1997, Bear River Migratory Bird Refuge 1990-1997, Bear River Club 1995-1997, and Cutler Reservoir 1985-1988 and 1995. Surveys were not conducted at Bear River Migratory Bird Refuge during 1986-1989 because marshes were flooded and not suitable for nesting, thus we assumed that no breeding occurred (Bear River Migratory Bird Refuge Narrative Reports). Other Salt Lake marshes were surveyed in 1985, 1987-1988, and 1997 during aerial waterfowl surveys (Utah Division of Wildlife files); however, it is possible that some colony sites were missed, and thus totals for "other Salt Lake marshes" may be underestimates.

Oregon, Idaho, and California

In Oregon, Malheur National Wildlife Refuge and sites in Harney County were surveyed annually; those in Lake County were surveyed in 1987, 1989, and 1995 (Ivey *et al.* 1988, and Malheur National Wildlife Refuge files). Estimates were based on helicopter or fixed-wing surveys and by ground surveys of colonies established late in the season.

In Idaho, flight-line counts were conducted at all colonies in 1984-1985 (Trost 1985), 1993 (Trost and Gerstell 1994) and 1995 (USFWS survey), and at Bear Lake National Wildlife Refuge in all years (refuge files, R. Sjostrom, pers. comm.).

In California, annual flight-line counts were available for Colusa National Wildlife Refuge, Finney Lake, Mendota Wildlife Management Area, and Lower Klamath National Wildlife Refuge. We also attempted to identify and compile data from all intermittently-active sites.

RESULTS

The number of breeding White-faced Ibises in the Great Basin has nearly tripled since 1985 despite years of severe flooding (1984-1987) and drought (1988-1992) at major colonies (Fig. 2a,b). Breeding population size exceeded the 1984 estimate of 7,500 breeding pairs (Sharp 1985) during each year of this study. The breeding population remained relatively stable from 1985-1990, dropped in 1991 due in part to drought conditions in Nevada, and has increased drastically since the drought ended (1993-1997). The overall increase was reflected in growth of peripheral (e.g., Oregon, California, Idaho) and core (e.g., Nevada) components of the breeding range (Fig. 2b). Although Oregon and California populations increased when Nevada and Utah populations were at their lowest (1991-1994), they continued to grow when Nevada and Utah recovered to previous levels and beyond (1995-1997) (Fig. 2b).

Nevada Breeding Population Trend

From 1980-1985, White-faced Ibises in Nevada increased steadily from 1,800 to 5,000 breeding pairs, then remained relatively stable through 1990 at 3,000-4,000 pairs (Neel 1996; Table 1; Fig. 2b). In 1990, over 70% of known nests in Nevada failed when Carson Lake and Canvasback Club marshes dried during chick-rearing. The population plummeted to almost no active pairs in 1991 when these marshes remained dry (Neel 1996). Recovery began in 1993 when colonies were initiated in newly available marshes at peripheral sites (Rye Patch Reservoir, Iron Point on the Humboldt River, Sleeper Goldmine, and Stillwater National Wildlife Refuge). In 1994-1997, ibises returned to Carson Lake and Canvasback Club and Nevada's breeding population increased rapidly to its highest level in the last two decades (8,000 pairs).

Oregon Breeding Population Trend

Breeding White-faced Ibises in Oregon have increased considerably since 1978 (see also Ivey *et al.* 1988). Numbers increased through 1989, were low during the drought years of 1990-1992, and then increased drastically through 1994. After declining nearly four-fold in 1995 due to drought, the population rebounded quickly through 1997 (Fig. 2b).

Colony dynamics suggest that large numbers moved among sites between years (Table 2). Prior to 1984, most of Oregon's ibises occupied colonies in central Malheur Lake. During 1984-1986, flood waters displaced ibises to remaining hardstem bulrush (*Scirpus acutus*) habitats along the northern shore. During 1987-1988, when 1,600 ibises abandoned northern Malheur sites due to drought, approximately equal numbers colonized the Blitzen Valley and continued to contribute to the overall increase in Oregon's breeding population (Ivey *et al.* 1988). Similarly, after 1995 when breeding pairs decreased from 8,400 to 2,700 due to low water conditions, particularly the drying of Diamond Swamp in the Blitzen Valley, ibises re-

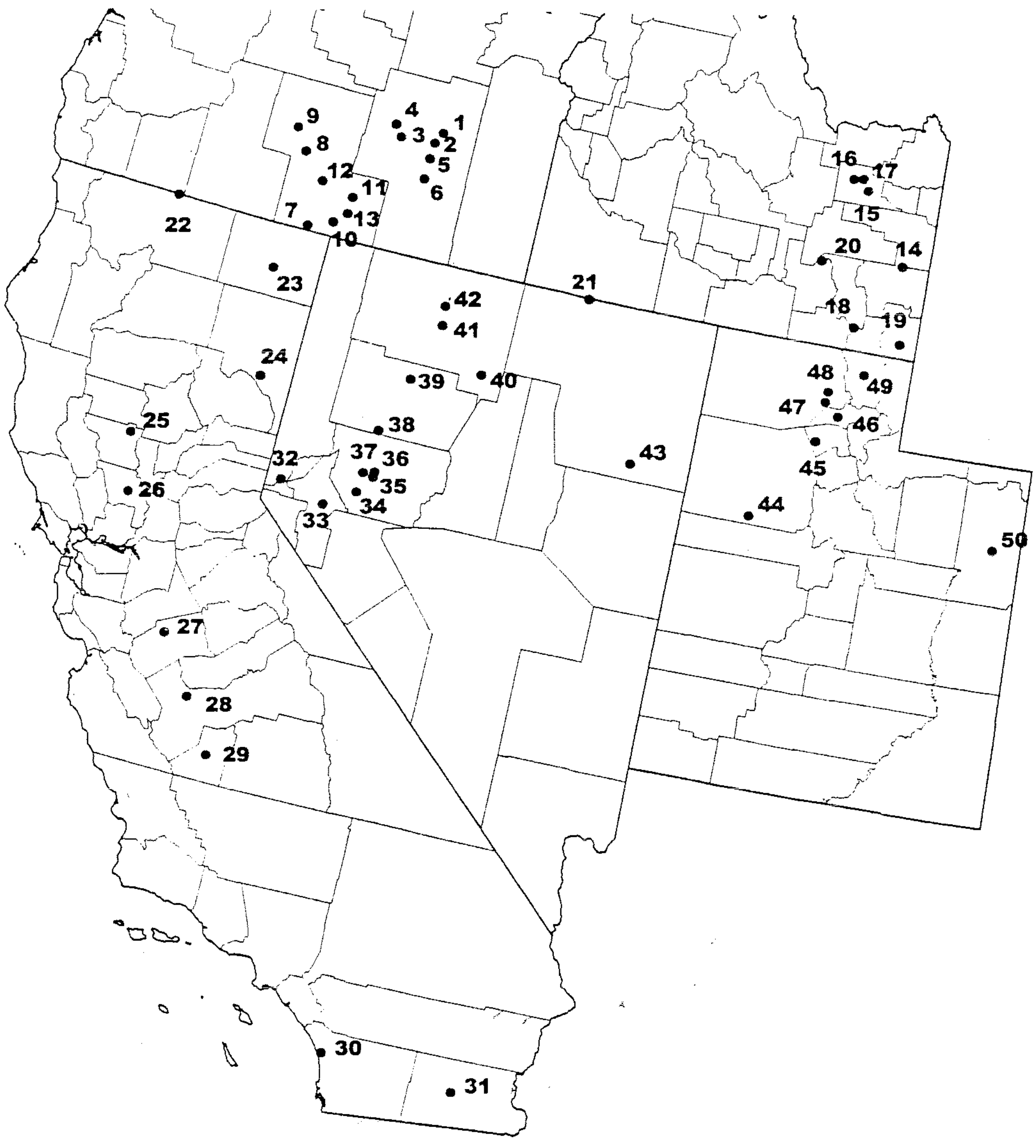


Figure 1. Active White-faced Ibis colonies in the Great Basin and surrounding area, 1985-1997[a].

OREGON
Malheur Lake Area
1. North Malheur Lake[b]
2. South Malheur Lake[c]

Warm Springs Valley
3. Warbler Pond
4. Silver Lake, Harney Co.

Blitzen Valley
5. North Blitzen Valley[d]
6 South Blitzen Valley[e]

Lake County
7. Goose Lake, Garret Marsh
8. Summer Lake WMA[f]
9. Silver Lake, Lake Co.
10. Greaser Reservoir
11. Anderson Lake
12. Chewaucan Lake
13. Crump Lake

IDAHO
14. Gray's Lake NWR
15. Market Lake WMA
16. Mud Lake WMA
17. Camas NWR
18. Oxford Slough WPA
19. Bear Lake NWR
20. American Falls Reservoir

Figure 1. (Continued) Active V

21. Duck Valley Indian Resv

CALIFORNIA
22. L. Klamath & Tule Lk N
23. Fairchild Swamp
24. Honey Lake
25. Colusa NWR
26. Woodland Sugar Ponds
27. San Luis NWR
28. Mendota WMA
29. Tulare Lake Basin
30. Guajome Lake
31. Finney Lake

NEVADA
32. Washoe Lake
33. Mason Valley WMA[g]
34. Carson Lake

[a]The following abbreviatio
fowl Production Area (WPA),
[b]Island Ranch, Nine-mile S
[c]Mouth of Blitzen River, M
[d]Lava Swamp, Diamond Sw
[e]Knox Pond, Boca Lake, Fa
[f]Includes Gold Dike Impou
[g]Includes Alkali Wildlife M
[h]Includes Harrison Duck C
[i]Willard Bay, Jackson and C
flow.
[j]Bear River Duck Club and

bounded quickly by mo
hardstem bulrush marsh
in the following two yea

Other between-year
did not appear related t
but may have been a res
ed habitat degradation.
pairs colonized a small
hardstem bulrush in Kn
Most above-ground vege
during nest-building, an
died. Breeders did not r
ever, a similar number c
ated new colonies at nea
and Diamond Swamp.

Idaho Breeding Populat

Idaho's breeding i
creased moderately duri
(Fig. 2b) and the 12-ye
breeding pairs is subst
previously recorded (be

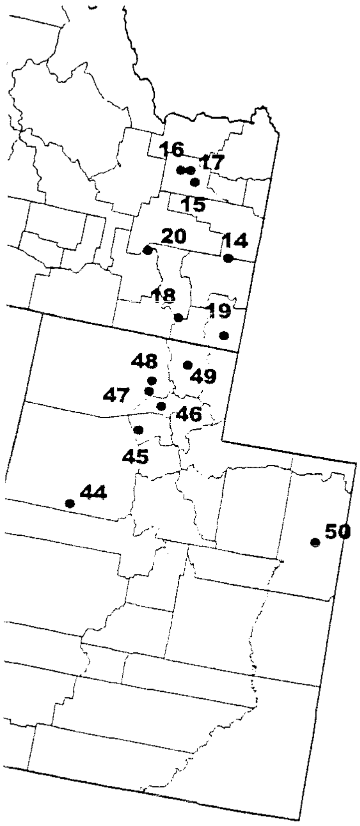


Figure 1. (Continued) Active White-faced Ibis colonies in the Great Basin and surrounding area, 1985-1997[a].

21. Duck Valley Indian Resvn.	35. Stillwater NWR
	36. Canvasback Club
CALIFORNIA	37. Harmon Reservoir
22. L. Klamath & Tule Lk NWRs	38. Humboldt WMA
23. Fairchild Swamp	39. Rye Patch Reservoir
24. Honey Lake	40. Iron Point
25. Colusa NWR	41. Sleeper Mine Wetland
26. Woodland Sugar Ponds	42. Quinn Lakes
27. San Luis NWR	43. Ruby Lake NWR
28. Mendota WMA	
29. Tulare Lake Basin	UTAH
30. Guajome Lake	44. Fish Springs NWR
31. Finney Lake	45. Farmington Bay WMA[h]
	46. Willard Bay Area[i]
NEVADA	47. Bear Riv. & Chespk. Clubs[j]
32. Washoe Lake	48. Bear River MBR
33. Mason Valley WMA[g]	49. Cutler Reservoir
34. Carson Lake	50. Ouray NWR

[a]The following abbreviations used: Wildlife Management Area (WMA), National Wildlife Refuge (NWR), Waterfowl Production Area (WPA), Reservation (Resvn.), and Migratory Bird Refuge (MBR).
[b]Island Ranch, Nine-mile Slough, Squarewell, Vogler Marsh, Red-S, Mouth of Silvies River.
[c]Mouth of Blitzen River, Malheur Lake, Sodhouse Bay.
[d]Lava Swamp, Diamond Swamp, Retherford Lake, Ibis Pond, Wright's Pond.
[e]Knox Pond, Boca Lake, Faye Field, North Meadow Field.
[f]Includes Gold Dike Impoundment, Link Marsh, Paulina Marsh, Sycan Marsh.
[g]Includes Alkali Wildlife Management Area.
[h]Includes Harrison Duck Club.
[i]Willard Bay, Jackson and Great Basin Marshes, Howard Slough, Harold Crane WMA, s. Corrine, Reeder Overflow.
[j]Bear River Duck Club and Chesapeake Duck Club.

bounded quickly by moving into recovered hardstem bulrush marshes in Malheur Lake in the following two years.

Other between-year colony movements did not appear related to water fluctuations but may have been a response to self-inflicted habitat degradation. In 1987-1988, 1,200 pairs colonized a small (two ha) patch of hardstem bulrush in Knox Pond (Table 2). Most above-ground vegetation was destroyed during nest-building, and the bulrush clone died. Breeders did not return in 1989; however, a similar number of nesting pairs initiated new colonies at nearby Retherford Lake and Diamond Swamp.

Idaho Breeding Population Trend

Idaho's breeding ibis population increased moderately during the past 12 years (Fig. 2b) and the 12-year average of 4,276 breeding pairs is substantially higher than previously recorded (between 20 and 1,500 pairs; Sharp 1985). Similarly, Bear Lake National Wildlife Refuge colonies, which comprise roughly one-third of Idaho's population, had approximately five times more breeding pairs in 1985-1997 (1,504 pairs) than in 1979-1984 (268 pairs; Table 3; Sharp 1985).

California Breeding Population Trend

Number of known breeders in California began increasing substantially in 1988 when a large colony was established at Lower Klamath National Wildlife Refuge (Fig. 2b). The Colusa National Wildlife Refuge population also increased during this period from 50 to 500 pairs during 1985 to 1989. Similarly, the Mendota Wildlife Management Area was recolonized in 1992, coinciding with increased availability of semi-permanent wetlands and irrigated uplands, and the colony continued to grow substantially through 1997.

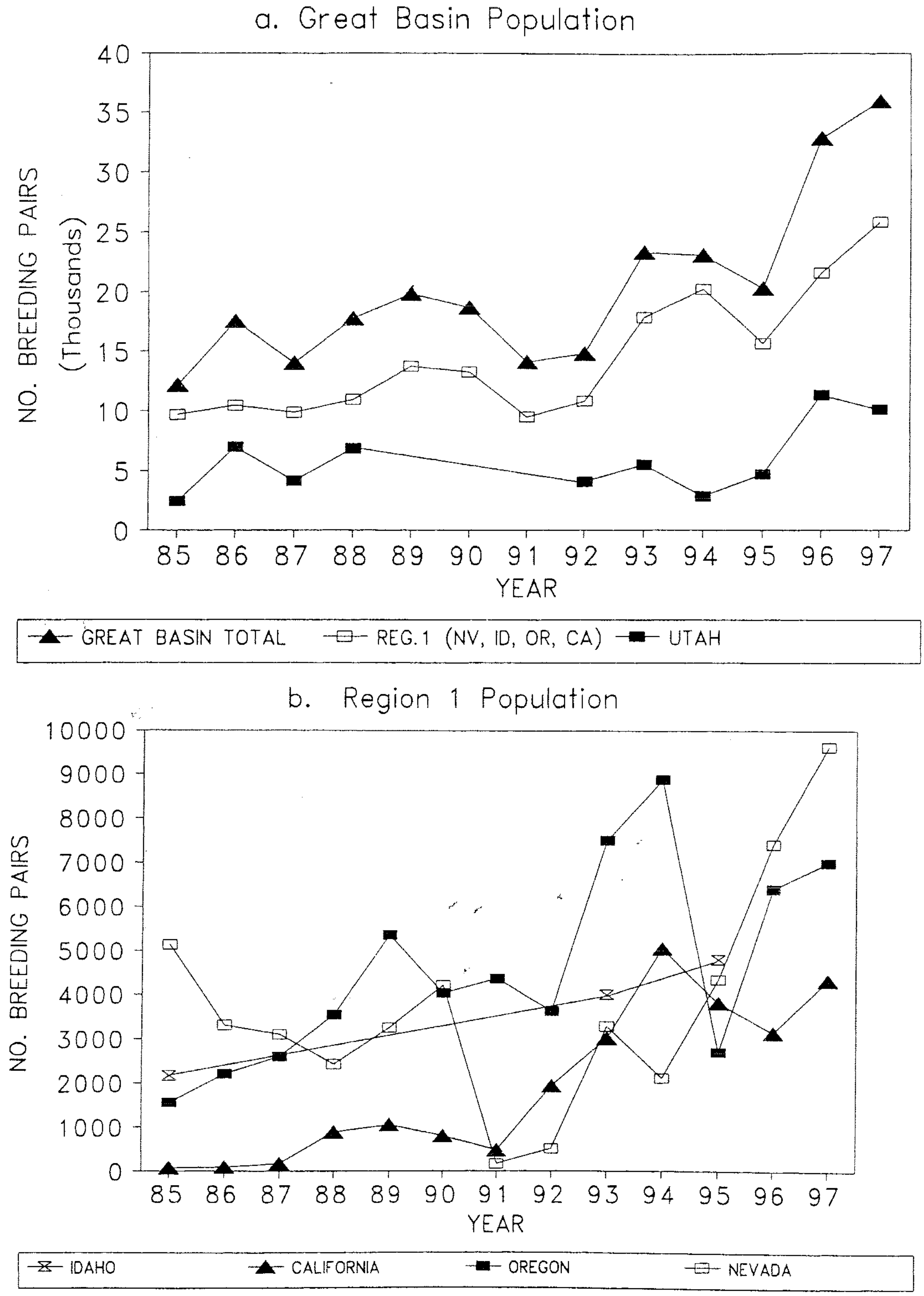
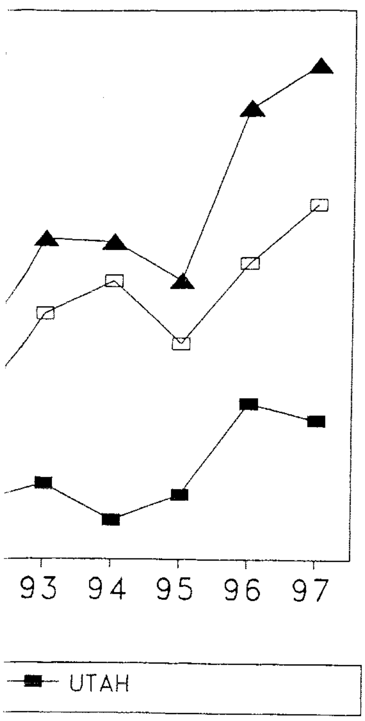


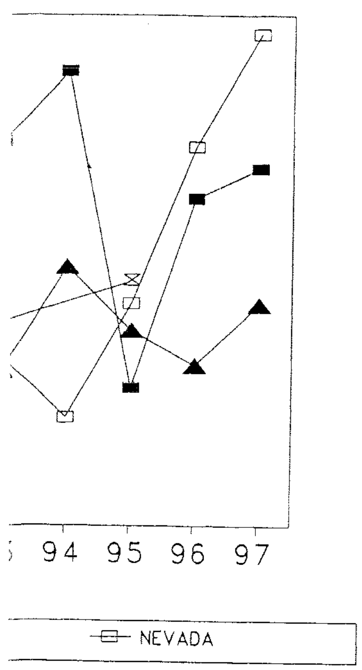
Figure. 2. a. White-faced Ibis breeding population trend, 1985-1997, in (a) the Great Basin area, including U.S. Fish and Wildlife Service Region 1 and Utah, and (b) in each state comprising Region 1 (Nevada, Idaho, California, Oregon).

Table 1. White-faced Ibis breeding colonies in Nevada, 1985-1997. Data from Nevada Division of Wildlife files unless noted otherwise.[a]

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Carson Lake	5,000	2,400	2,643	1,400	2,840	2,964	0	0	0	200	2,200	4,290	5,375
Stillwater NWR	0	0	30	0	0	0	0	0	475	100	42	385	830
Canvasback Club	0	75	300	1,000	235	1.175	0	315	0	486	535	475	350
Humboldt WMA	0	0	0	0	0	0	0	0	0	0	0	542	1,420
Rye Patch Reservoir	0	0	0	0	0	0	0	0	390	0	252	0	0
Sleeper Mine	0	0	0	0	0	0	0	0	285	507	397	480	0

on





Great Basin area, including U.S. Fish
ion 1 (Nevada, Idaho, California, Or-

Table 1. White-faced Ibis breeding colonies in Nevada, 1985-1997. Data from Nevada Division of Wildlife files unless noted otherwise.[a]

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Carson Lake	5,000	2,400	2,643	1,400	2,840	2,964	0	0	0	200	2,200	4,290	5,375
Stillwater NWR	0	0	30	0	0	0	0	0	475	100	42	385	830
Canvasback Club	0	75	300	1,000	235	1.175	0	315	0	486	535	475	350
Humboldt WMA	0	0	0	0	0	0	0	0	0	0	0	542	1,420
Rye Patch Reservoir	0	0	0	0	0	0	0	0	390	0	252	0	0
Sleeper Mine	0	0	0	0	0	0	0	0	285	507	397	480	0
Iron Point	0	0	0	0	0	0	0	0	600	0	0	0	0
Quinn Lakes	0	300	0	0	0	0	0	0	0	0	0	17	0
Ruby Lake NWR[b]	132	240	105	25	180	75	155	190	250	305	210	230	275
Others[c]	0	0	10	0	0	0	0	6	4	10	2	0	0

[a]The following abbreviations are used: National Wildlife Refuge (NWR) and Wildlife Management Area (WMA).
[b]Data from Ruby Lake NWR files, J. Mackay, pers. comm.; includes Franklin Lake colony: 65 pairs in 1985; 95 pairs in 1997; 0 pairs in 1986-1996.
[c]Non-zero counts from Alkali Lake WMA in 1987, Mason Valley WMA in 1992 and 1993, Harmon Reservoir in 1994, and Washoe Lake in 1995.

Small colonies active intermittently in California since 1985 include Woodland Sugar Ponds (1985 and 1988), Fairchild Swamp (1997), Honey Lake (1993-1997), Modoc National Wildlife Refuge (1989), Finney Lake (1992-1993), San Luis National Wildlife Refuge (1995), Tulare Lake Basin (at least 1997) see also Ivey and Severson 1984), Kern National Wildlife Refuge (at least 1995-1997), and Guajome Lake (1988, 1990, 1992-1995; Scott and Lee 1995) (Table 4).

Utah Breeding Population Trend

Although interpretation of Utah's trend is problematic because of incomplete coverage, the trends suggested by the data are not unexpected. When Bear River Migratory Bird Refuge marshes, which typically support large colonies, were unsuitable due to floods during 1985-1992, ibises moved elsewhere in Utah and perhaps other states (Table 5). For example, Cutler Reservoir colonies, which were not affected by the rising Salt Lake, grew considerably from 1985-1989 and had decreased substantially by 1995 when numbers were increasing on Bear River marshes. In 1996-1997, Utah's population was higher than any reported since 1977 (this study and Sharp 1985).

DISCUSSION

The breeding population of the White-faced Ibis in the Great Basin and surrounding area has nearly tripled since 1985. We believe our estimates of state and regional population trends to be largely unbiased because there was no tendency for overall survey effort to increase or decrease systematically during 1985-1997 in any state, and similarly, no reason to suspect a temporal trend in detection rate over the 12-year period. We are primarily concerned with population trend, did not estimate detection rates, and thus do not attempt to estimate breeding population size. Detection rates of colonial waterbirds are known to vary among methods, colonies, and other factors (e.g., Erwin and Ogden 1980; Erwin 1981). Further studies on White-faced Ibis are needed

Table 2. White-faced Ibis breeding colonies in Oregon, 1985-1997. Dashes indicate that site was not surveyed.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
NORTH MALHEUR LAKE													
Island Ranch	0	0	800	0	230	0	0	0	0	0	0	0	0
Nine-mile Slough	0	0	0	0	95	0	0	0	0	0	0	0	0
Squarewell	500	1,600	0	0	0	0	0	0	0	0	0	0	0
Vogler Marsh	450	0	0	0	0	0	0	0	0	0	0	0	0
Red-S	230	0	0	0	0	0	0	0	0	0	0	0	0
Mouth Silvies River	0	0	0	0	0	0	0	0	100	0	0	100	4,150
SOUTH MALHEUR LAKE													
Mouth Blitzen River	0	0	0	0	0	0	0	0	2,000	1,440	1,300	5,000	1,750
Sodhouse Bay	110	70	0	0	0	0	0	0	0	0	0	0	0
WARM SPRINGS VALLEY													
Warbler Pond	30	0	0	0	550	0	0	0	0	0	0	0	0
Silver Lake, Harney County	0	5	0	0	180	0	0	0	0	0	0	0	0
BLITZEN VALLEY													
Ibis Pond	0	0	0	0	0	300	0	0	300	0	0	800	800
Wright's Pond	0	0	350	0	0	0	0	0	0	0	0	0	0
Lava Swamp	0	0	125	0	0	0	0	0	1,300	0	1,100	200	0
Diamond Swamp	0	0	0	0	500	2,500	3,415	2,500	3,000	7,000	8	0	0
Retherford Lake	0	0	0	0	1,000	0	0	0	0	0	0	0	0
Knox Pond & Swamp	120	420	1,200	1,200	1,500	110	0	0	0	0	0	0	0
Boca Lake	0	0	0	0	0	0	0	150	200	0	0	0	0
Faye & N. Meadow Field	0	0	0	340	0	0	0	200	0	0	0	0	0
LAKE COUNTY													
Goose Lake	—	—	0	—	40	—	—	—	—	—	150	—	—
Summer Lake WMA[a]	0	0	0	0	62	40	75	0	0	200	30	0	225
Silver Lake, Lake County	—	—	60	—	0	—	—	—	—	—	0	—	—
Greaser Reservoir	—	—	40	—	12	—	—	—	—	—	0	—	—
Anderson Lake	—	—	20	—	0	—	—	—	—	—	0	—	—
Chewaucan Marshes	—	—	0	—	290	350	—	—	—	—	100	—	500
Crump Lake	—	—	0	—	800	—	—	—	—	—	10	—	—

[a]Summer Lake Wildlife Management Area (WMA); the 1997 count includes 150 pairs at Sycan Marsh and 75 pairs at Paulina Marsh.

Table 3. White-faced Ibis breeding colonies in Idaho 1985-1997. All data for 1985 and 1993 from Trost (1985) and Trost and Gerstell (1994).[a] Dashes indicate that site was not surveyed.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Gray's Lake NWR[b]	—	—	—	—	—	—	—	—	115	—	—	275	275
Duck Valley Ind. Resvn.	—	—	—	—	—	—	—	—	725	—	517	—	—
Oxford Slough	460	—	—	—	—	—	—	—	1,050	—	500	—	—
American Fall Resvr.	225	—	—	—	—	—	—	—	50	—	15	—	—
Market Lake WMA	460	—	—	—	—	—	—	—	750	—	1000	—	—
Mud Lk WMA	205	—	—	—	—	—	—	—	600	—	396	—	—

…amp	120	420	1,200	1,200	1,500	110	0	0	0	0	0	0	0
Boca Lake	0	0	0	0	0	0	0	150	200	0	0	0	0
Faye & N. Meadow Field	0	0	0	340	0	0	0	200	0	0	0	0	0
LAKE COUNTY													
Goose Lake	—	—	0	—	40	—	—	—	—	—	150	—	—
Summer Lake WMA[a]	0	0	0	0	62	40	75	0	0	200	30	0	225
Silver Lake, Lake County	—	—	60	—	0	—	—	—	—	—	0	—	—
Greaser Reservoir	—	—	40	—	12	—	—	—	—	—	0	—	—
Anderson Lake	—	—	20	—	0	—	—	—	—	—	0	—	—
Chewaucan Marshes	—	—	0	—	290	350	—	—	—	—	100	—	500
Crump Lake	—	—	0	—	800	—	—	—	—	—	10	—	—

[a]Summer Lake Wildlife Management Area (WMA); the 1997 count includes 150 pairs at Sycan Marsh and 75 pairs at Paulina Marsh.

Table 3. White-faced Ibis breeding colonies in Idaho 1985-1997. All data for 1985 and 1993 from Trost (1985) and Trost and Gerstell (1994).[a] Dashes indicate that site was not surveyed.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Gray's Lake NWR[b]	—	—	—	—	—	—	—	—	115	—	—	275	275
Duck Valley Ind. Resvn.	—	—	—	—	—	—	—	—	725	—	517	—	—
Oxford Slough	460	—	—	—	—	—	—	—	1,050	—	500	—	—
American Fall Resvr.	225	—	—	—	—	—	—	—	50	—	15	—	—
Market Lake WMA	460	—	—	—	—	—	—	—	750	—	1000	—	—
Mud Lk WMA	205	—	—	—	—	—	—	—	600	—	396	—	—
Bear Lake NWR[c]	810	2,638	1,600	1,350	1,200	1,200	1,500	1,600	600	1200	2100	1750	2000
Camas NWR[d]	10	10	10	200	225	225	0	0	122	0	56	150	200

[a]The following abbreviations are used: National Wildlife Refuge (NWR), Wildlife Management Area (WMA), Indian Reservation (Ind. Resvn.), and Reservoir (Resvr.). Estimates for 1985 are actually 1984-1985 combined estimates given by Trost (1985). Where Trost (1985) and Trost and Gerstell (1994) report a range rather than estimate number of breeding pairs, we use the mid-point.

[b]Nesting probable 1989-1990 and confirmed 1991-1992 (S. Bouffard, pers. comm.). Nesting thought unlikely 1985-1988; estimates for 1996-1997 are 250-320 nests (B. Pyle, pers. comm.).

[c]Bear Lake NWR files, R. Sjostrom, pers. comm.

[d]Camas NWR Narrative Reports, G. Deutscher, pers. comm.

Table 4. White-faced Ibis breeding colonies in California, 1985-1997.[a]

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Colusa NWR[b]	50	80	125	400	500	0	0	0	0	0	0	0	0
Mendota WMA[c]	0	0	0	0	0	0	0	463	1,057	890	1,672	2,047	2,950
L. Klamath NWR[d]	12	0	40	450	450	800	480	1,100	1,510	4,100	2,041	1,039	844
Other northern CA[e]	12	0	0	25	36	0	0	0	120	50	50	50	63
Other southern CA[f]	0	0	0	0	0	0	0	375	325	5	55	0	460

[a]The following abbreviations are used: National Wildlife Refuge (NWR), Wildlife Management Area (WMA), and California (CA).

[b]Sacramento NWR Narrative Reports, M. Wolder, pers. comm.

[c]S. Brueggeman, pers. comm.

[d]Lower Klamath NWR files, J.Beckstrand, pers. comm.

[e]Includes Woodland Sugar Ponds (12 pairs 1985; 25 pairs 1988; E. Beedy, pers. comm.); Modoc NWR (36 pairs 1989, R. Ryno, pers. comm.); Honey Lake (120 pairs 1993; approx. 50 pairs 1994-1997; B. Tatman, pers. comm.); Fairchild Swamp (13 pairs 1997; D. Shuford, pers. comm.).

[f]Includes Finney Lake (370 pairs 1992, 320 pairs 1993; K. Sturm, pers. comm.); Tulare Lake Basin (460 pairs in 1997, breeding likely in other years also, R. Hansen, pers. comm.; see also Ivey and Severson 1984); San Luis NWR Complex (50 pairs 1995; M. Peters, pers. comm.); Guajome Park (5-7 pairs 1992-1995, Scott and Lee 1995).

Table 5. White-faced Ibis breeding colonies in Utah, 1985-1997.[a] Surveys were most complete in 1985, 1987, 1988, and 1997. Dashes indicate that site was not surveyed. Data from Utah Division of Wildlife (UDW) files unless indicated otherwise.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Bear River MBR[b]	0	0	0	0	0	0	0	0	50	0	2,500	2,000	3,000
Bear River Club[c]	466	≤50	≤50	≤50	≤50	≤50	100+	100+	100+	100+	500	8,000	6,200
Cutler Reservoir[d]	200	5,000	2,000	3,000	1,000+	1,000+	1,000+	1,000+	1,000+	1,000+	500	—	—
Chesapeake Club	0	—	0	2,600	—	—	—	—	—	—	—	—	0
Reeder Overflow	0	—	0	1,100	—	—	—	—	—	—	—	—	0
So. Willard Bay[e]	500	—	2,000	0	—	—	—	—	238	—	—	—	0
Ogden Bay	946	—	0	0	—	—	—	—	—	—	—	—	0
Farmington Bay WMA	0	—	0	0	—	—	—	—	—	—	—	—	300
Harrison Duck Club	344	—	0	0	—	—	—	—	—	—	—	—	0
Fish Springs NWR[f]	0	100	(100)	(75)	(95)	(75)	(55)	(61)	(61)	161	200	147	(30)
Ouray NWR[g]	—	—	10	10	20+	20+	20+	20+	20+	20+	20+	20+	75

[a]The following abbreviations used: National Wildlife REfuge (NWR) and Wildlife Management Area (WMA).

[b]Bear River MBR riles (V. Roy, pers. comm.). Surveys not conducted 1986-1989; no nesting suspected because marshes were flooded.

[c]Population very low (≤50 pairs) during 1986-1990 when most marshes were flooded; number of breeding pairs grew steadily during 1991-1994 beginning with approximately 100 pairs in 1991 (G. Slott, pers. comm.).

[d]Estimates from J. Kadlec (pers. comm.), except 1995 from Bear River MBR files.

[e]Includes Great Basin Marsh (150 pairs in 1985), Jackson Marsh (350 pairs in 1985), Harold Crane WMA (1993), and a rough estimate of 2,000-3,000 pairs at South Willard Bay in 1987.

[f]1986 from Colonial Bird Register; 1994-1996 based on direct counts of nests from the ground and data in parentheses is number of pairs using refuge in mid-May (Fish Springs NWR files, J. Banta, pers. comm.); non-breeders are though to be rare at this refuge and estimates of pairs (adults divided by 2) correspond well with those of nests when both are available.

[g]1988-1989 Colonial Bird Register; thought to have increased steadily since late 1980s to 75 in 1997 (Ouray NWR files, K. Stone, pers. comm.).

to estimate detection rat
population size and to inv
detection rate inconsistenc
Our estimate of population
ened by the consistency wit
of survey method and eff
years.

The substantial increa
faced Ibis breeding popula
Basin during our study ma
ued rebound from very low
in the 1960s and 1970s. F
contribute to this increase
of DDT in the early 197
availability of irrigated farn
(Ryder and Manry 1994).
factor may be relevant to th
od. For example, DDE co
expected reproduction by
some segments of the Gre
population, an effect simil
ed for 1985-1986 (Henny
Henny 1997). Although i
is a favorite foraging habi
benow 1988) and is though
population growth (e.g.,
1994, Henny 1997), it is
habitat has increased regi
or even since the early 196
areas (e.g., southern Ore
Basin, NV). It is likely that
farmland have opposite an
fects on ibis reproductive
1997) and that their rela
difficult to determine.

The White-faced Ibis e
between-year nomadism,
sponse to the unpredicta
lands in the arid west.
White-faced Ibis and other
breeders to adapt to the sp
variability of their breedin
on the availability of a mc
wetlands and persistent
Takekawa and Beissinge
and Ogden 1997; and Ber
1997). Such wetlands are
spatial scale (e.g., multiple
that a single drying or flc
likely to affect all in a c
(Bennetts and Kitchen

to estimate detection rates and breeding population size and to investigate potential detection rate inconsistencies among years. Our estimate of population trend is strengthened by the consistency within most colonies of survey method and effort among survey years.

The substantial increase in the White-faced Ibis breeding population in the Great Basin during our study may reflect a continued rebound from very low population levels in the 1960s and 1970s. Factors thought to contribute to this increase are the banning of DDT in the early 1970s and increased availability of irrigated farmland for foraging (Ryder and Manry 1994). However, neither factor may be relevant to the 1985-1997 period. For example, DDE continues to reduce expected reproduction by as much as 20% in some segments of the Great Basin breeding population, an effect similar to that estimated for 1985-1986 (Henny and Herron 1989; Henny 1997). Although irrigated farmland is a favorite foraging habitat (Bray and Klebenow 1988) and is thought to contribute to population growth (e.g., Trost and Gerstell 1994, Henny 1997), it is not clear that this habitat has increased regionally since 1985 or even since the early 1960s in at least some areas (e.g., southern Oregon; Carson River Basin, NV). It is likely that DDE and irrigated farmland have opposite and confounding effects on ibis reproductive success (Henny 1997) and that their relative effects will be difficult to determine.

The White-faced Ibis exhibits within- and between-year nomadism, an effective response to the unpredictable nature of wetlands in the arid west. The ability of the White-faced Ibis and other nomadic wetland breeders to adapt to the spatial and temporal variability of their breeding habitat depends on the availability of a mosaic of peripheral wetlands and persistent colony sites (e.g, Takekawa and Beissinger 1989; Frederick and Ogden 1997; and Bennetts and Kitchen 1997). Such wetlands are most valuable at a spatial scale (e.g., multiple watersheds) such that a single drying or flooding event is unlikely to affect all in a correlated manner (Bennetts and Kitchen 1997). We suggest that the Great Basin and surrounding area comprised such a landscape during the years of this study and allowed the White-faced Ibis breeding population to maintain stability and growth despite multiple years of both a widespread flood and drought. The variable effect of the 1984-1987 flood on colony wetlands is a case in point. Although the flood destroyed Great Salt Lake marshes, it made other locations such as Carson Lake, parts of Malheur Lake, and the Blitzen Valley more suitable for breeding ibises. Similarly, the subsequent drought destroyed several colony sites but facilitated the return of marshes at Great Salt Lake and Malheur, and led to the drawdown and subsequent formation of new marshes at peripheral sites (e.g., Stillwater National Wildlife Refuge and Rye Patch Reservoir).

The ability of the White-faced Ibis to rapidly colonize new and periodically available sites enhances population stability during years when conditions are poor at traditional sites. This nomadism is exemplified by colony dynamics in Nevada and Oregon. In Nevada, traditional colony sites were unavailable due to drought in 1993 and ibises colonized newly-formed marshes at Sleeper Goldmine, Iron Point, and Rye Patch Reservoir. Similarly, when large colonies at Malheur Lake in Oregon were lost to a series of high and then low water events, approximately equal numbers colonized the Blitzen Valley, and then moved back to Malheur several years later when a major site in Blitzen Valley was lost to drought. Studies of individually-marked or transmittered breeders are proving invaluable in confirming and understanding the processes underlying colony dynamics (e.g., Kelchlin 1997; M. R. Fuller, pers. comm.).

Although our data suggest the Great Basin White-faced Ibis was able to maintain stability and growth despite several years of drought and flood during the past 12 years, we have little ability to predict population response to natural variability or water management practices in future years. Population stability of nomadic species in highly variable environments depends, in part, on duration and spatial extent of environmental fluctuations, availability of alternate wetlands when conditions at traditional sites are poor, and differences in demographic parameters during poor versus good years (e.g., Takekawa and Beissinger 1989; Beissinger 1995). Without models that incorporate such elements, and appropriate data on which to base the models, our ability to predict White-faced Ibis population trends is limited.

Conservation

Nomadic species pose special management and conservation challenges because of the large area they occupy and their unique population dynamics (e.g., Frederick *et al.* 1996). White-faced Ibis movements and population dynamics exemplify the ecological connectivity among wetlands in the Great Basin and indicate that wetland management decisions should be made in a regional context (see also Skagen and Knopf, 1993). A mosaic of wetlands, at a scale that ensures independence of water fluctuations, would benefit White-faced Ibis population stability. Such a mosaic would include traditional colony sites as well as peripheral wetlands which may be considered intermittently-used or unused based on past records, but which may be critical to long-term stability. A similar conservation strategy has been suggested for other nomadic wetland-breeders, White Ibis (*Eudocimus albus*) and Snail Kites (*Rostrhamus sociabilis*), in the southeastern United States (e.g., Frederick and Ogden 1997; and Bennetts and Kitchen 1997).

Nomadic species also pose special monitoring challenges and research needs. Population size, trends, distribution, and demographic parameters should be interpreted and monitored at a regional scale. Monitoring should be standardized among colonies, include suitable but previously unused wetlands, and be conducted frequently enough to ensure reasonable power to detect a trend, despite inherently high annual variation in number of breeding pairs. Rapid population declines may occur even in relatively large populations (Frederick *et al.* 1996). More data are needed on population dynamics including the effects of droughts and floods on productivity at local and regional scales, and within-year differences in productivity between colony sites and habitats. To identify the appropriate scale at which to maintain a mosaic of available wetlands, more data are needed on breeding dispersal (movements between consecutive breeding seasons) and natal dispersal (distance from natal colony to colony of first breeding) and their relation to the spatial configuration of available wetlands and active colonies. Similarly, interchange between Great Basin colonies and those in other regions should be investigated.

ACKNOWLEDGMENTS

We thank the following biologists who contributed data on ibis colonies or participated in the USFWS 1995 survey: W. Asserston, J. Banta, J. Beam, J. Beckstrand, S. Brueggeman, S. Bouffard, K. Castle, G. Deutscher, C. Foster, R. Hansen, J. Kadlec, E. Kelchlin, D. Kemner, A. Lindahl, J. Mackay, G. Mensik, D. Parker, D. Paul, M. Peters, T. Pool, W. Pyle, V. Roy, R. Ryno, N. Saake, D. Shad, D. Shuford, R. Sjostrom, G. Slott, M. St. Louis, K. Sturm, B. Tatman, C. Trost, P. Tuttle, P. Unitt, and M. Wolder. We thank T. Zarriello for preparing Figure 1 and J. Bart, M. Erwin, E. Kelchlin, C. Henny, and an anonymous reviewer for comments on an earlier draft.

LITERATURE CITED

Beissinger, S. R. 1995. Modeling extinction in periodic environments: Everglades water levels and Snail Kite population viability. Ecological Applications 5: 618-631.

Bennetts, R. E. and W. M. Kitchens. 1997. Population dynamics and conservation of snail kites in Florida: the importance of spatial and temporal scale. Colonial Waterbirds 20: 324-329.

Bray, M. P. and D. A. Klebenow. 1988. Feeding ecology of White-faced Ibises in a Great Basin valley, USA. Colonial Waterbirds 11: 24-31.

Capen, D. E. 1977 The impact of pesticides on the White-faced Ibis. Ph.D. dissertation, Utah State University, Logan, UT.

Erwin, M. R. 1981. Censusing wading bird colonies: an update on the "flight-line" count method. Colonial Waterbirds 4: 91-95.

Erwin, M. R. and J. C. Ogden. 1980. Multiple-factor influences upon feeding flight rates at wading bird colonies (Alias: are flight-line counts useful?). Proceedings of the 1979 Conference of the Colonial Waterbird Group 3: 225-234.

Follansbee, D. M. and D. M. Mauser. 1994. Ecology of breeding White-faced Ibis on Lower Klamath National Wildlife Refuge, California. Progress Report 1994. U.S. Fish and Wildlife Service, Klamath Basin National Wildlife Refuges, Tulelake, CA.

Frederick, P. C., K. L. Bildstein, B. Fleury and J. Ogden. 1996. Conservation of large, nomadic populations of

ts on productivity at local and re-
ıles, and within-year differences in
ity between colony sites and habi-
dentify the appropriate scale at
naintain a mosaic of available wet-
re data are needed on breeding
(movements between consecutive
seasons) and natal dispersal (dis-
n natal colony to colony of first
and their relation to the spatial
ion of available wetlands and ac-
es. Similarly, interchange between
n colonies and those in other re-
ld be investigated.

ACKNOWLEDGMENTS

the following biologists who contributed
lonies or participated in the USFWS 1995
erston, J. Banta, J. Beam, J. Beckstrand, S.
S. Bouffard, K. Castle, G. Deutscher, C.
sen, J. Kadlec, E. Kelchlin, D. Kemner, A.
ckay, G. Mensik, D. Parker, D. Paul, M. Pe-
. Pyle, V. Roy, R. Ryno, N. Saake, D. Shad,
Sjostrom, G. Slott, M. St. Louis, K. Sturm,
Trost, P. Tuttle, P. Unitt, and M. Wolder.
rriello for preparing Figure 1 and J. Bart,
elchlin, C. Henny, and an anonymous re-
ments on an earlier draft.

LITERATURE CITED

1995. Modeling extinction in periodic en-
Everglades water levels and Snail Kite pop-
lity. Ecological Applications 5: 618-631.
nd W. M. Kitchens. 1997. Population dy-
conservation of snail kites in Florida: the
of spatial and temporal scale. Colonial
20: 324-329.
D. A. Klebenow. 1988. Feeding ecology
ed Ibises in a Great Basin valley, USA.
terbirds 11: 24-31.
977 The impact of pesticides on the
Ibis. Ph.D. dissertation, Utah State Uni-
n, UT.
81. Censusing wading bird colonies: an
e "flight-line" count method. Colonial
: 91-95.
l J. C. Ogden. 1980. Multiple-factor in-
n feeding flight rates at wading bird col-
: are flight-line counts useful?).
of the 1979 Conference of the Colonial
oup 3: 225-234.
. and D. M. Mauser. 1994. Ecology of
ite-faced Ibis on Lower Klamath Na-
e Refuge, California. Progress Report
h and Wildlife Service, Klamath Basin
life Refuges, Tulelake, CA.
. L. Bildstein, B. Fleury and J. Ogden.
ation of large, nomadic populations of

White Ibises (*Eudocimus albus*) in the United States. Conservation Biology 10: 203-216.

Frederick, P. C. and J. C. Ogden. 1997. Philopatry and nomadism: contrasting long-term movement behavior and population dynamics of White Ibises and Wood Storks. Colonial Waterbirds 20: 316-323.

Henny, C. J. 1997. DDE still high in White-faced Ibis eggs from Carson Lake, Nevada. Colonial Waterbirds 20: 478-484.

Henny, C. J. and G. B. Herron. 1989. DDE, selenium, mercury, and White-faced Ibis reproduction at Carson Lake, Nevada. Journal of Wildlife Management 53: 1032-1045.

Ivey, G. L. and D. J. Severson. 1984. White-faced Ibis nesting in the southern San Joaquin Valley of California. Condor 86: 492-493.

Ivey, G. L., M. A. Stern and C. G. Carey. 1988. An increasing White-faced Ibis population in Oregon. Western Birds 19: 105-108.

Kelchlin, E. 1997. Habitat selection and reproductive success of White-faced Ibis in the Carson River Basin, Nevada. Final progress report for the 1996 season. Unpublished report, Stillwater National Wildlife Refuge, U.S. Fish and Wildlife Service, NV.

Neel, L. 1996. *In* Herron, Gary B. (ed.), Population surveys, species distribution, and key habitats of selected nongame species. Job Performance Report Project W-53-R-22. Nevada Division of Wildlife, Reno, NV.

Ryder, R. A. 1967. Distribution, migration and mortality of the White-faced Ibis (*Plegadis chihi*) in North America. Bird-Banding 38: 257-277.

Ryder, R. A. and D. E. Manry. 1994. White-faced Ibis (*Plegadis chihi*). *In* The Birds of North America, No. 130 (A. Poole and F. Gill, Eds.). The Academy of Natural Sciences, Philadelphia; The American Ornithologists' Union, Washington, D.C.

Scott, T. and P.-Y. Lee. 1995. Final report on the breeding of White-faced Ibis at Guajome Regional Park, San Diego County. Unpublished Report, Dept. of Parks and Recreation, San Diego County, CA.

Sharp, B. 1985. White-faced Ibis management guidelines: Great Basin population. Unpublished report, U.S. Fish and Wildlife Service, Portland, OR.

Shuford, W. D., C. M. Hickey, R. J. Safran and G. W. Page. 1989. A review of the status of the White-faced Ibis in winter in California. Western Birds 27: 169-196.

Skagen, S. K. and F. L. Knopf. 1993. Toward conservation of midcontinental shorebird migrations. Conservation Biology 7: 533-541.

Takekawa, J. E. and S. R. Beissinger. 1989. Cyclic drought, dispersal, and the conservation of the Snail Kite in Florida: lessons in critical habitat. Conservation Biology 3: 302-311.

Trost, C. H. 1985. Status and distribution of colonial nesting waterbirds in Idaho. Unpublished report to Nongame Wildlife Program, Idaho Fish and Game, Boise, ID.

Trost, C. H. and A. Gerstell. 1994. Status and distribution of colonial nesting waterbirds in southern Idaho, 1993. Technical Bulletin No. 94-6, Idaho Bureau of Land Management, Boise, ID.

U.S. Fish and Wildlife Service. 1995. Migratory nongame birds of management concern in the United States: the 1995 list. Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Washington, D.C.