Special Publication SJ99-SP2

NESTING SUCCESS, NUMBERS, AND DISPERSAL OF SNAIL KITES IN THE BLUE CYPRESS WATER MANAGEMENT AND CONSERVATION AREAS

1998 Final Report

prepared for

St. Johns River Water Management District
Environmental Sciences Division
P.O. Box 1429
Palatka, FL 32178-1429
Contract 96W192

By

Victoria J. Dreitz

Donald L. DeAngelis

and

Wiley M. Kitchens

January 1999

United States Geological Survey
Biological Resources Division
University of Miami
Department of Biology
P.O. 249118
Coral Gables, FL 33124-0421

ABSTRACT

The Blue Cypress Marsh Water Conservation Area and the Blue Cypress Water Management Area (collectively referred to as Blue Cypress Marshes [BCM]) were surveyed from 1996-1998 for foraging and nesting snail kites. A total of 51 nests were located throughout BCM. Annual nest success was 44%, 18%, and 11% for 1996, 1997, and 1998, respectively. Nest success has decreased the last two years. Overall nest success from 1996-1998 was 24%. This is below the average range, 32%-50% reported by on previous studies. Low nest success may be a result of unfavorable breeding habitat, including low apple snail densities and changes in vegetation structure (ie., cattail invasion of foraging area). An average of 0.45 young per nest and 1.92 young per successful nest were produced during the study. These results are within the range for BCM from previous years (1991 to 1995). Water depth and nest height could not statistically be tested as a influence on annual nest success because of the small sample size in the number of successful nests per year ($n < 10$).

The number of snail kites seen in the area between January to November of each year ranged from 18 to 129. The range falls within the number of birds seen in previous years. In 1997, BCM, Lake Tohopekaliga, and Water Conversation Area 3A exhibited a high concentration of kites. This may be a result of environmental conditions being favorable in these areas. However, in 1998, kites were observed in many of the wetland areas (ie., Water Conservation Area 2B, A.R.M. Loxahatchee Wildlife Refugee) in Florida. The correlation between the number of kites and water depth was not statistically significant. However, various errors are associated with count data and this can lead to misinterpretation of the data.

INTRODUCTION

Watersheds in central and southern Florida have experienced, and continue to experience, substantial degradation from drainage, impoundment, changes in water flow regimes, increased nutrient loadings, and invasion by exotic plants and animals (Walters et al. 1992, Davis and Ogden 1994). This has resulted in the current planning for some of the largest scale ecosystem restoration efforts ever undertaken (e.g, the St. Johns Basin Project, Central and South Florida Project Restudy, Kissimmee River Restoration, South Florida Ecosystem Restoration Initiative). Although other endangered species occur in central and southern Florida, snail kites (Rostrhamus sociabilis) can be considered indicator species useful for evaluating the results of the restoration efforts. This is because they are restricted to the watersheds within the central and southern Florida ecosystems and they depend on the entire network of wetlands scattered across this landscape.

The snail kite is an endangered raptor that feeds almost exclusively on one species of aquatic apple snail *(Pomacea paludosa)*. Therefore, survival of the species depends upon maintaining hydrologic regimes which support viable apple snail population. The spatial distribution of nesting and foraging areas for snail kite generally shifts from year to year (Bennetts and Kitchens 1997a, 1997b) as a result of hydrology, and/or and indirect effects of hydrology on apple snail abundance (Kushlan 1975) and nesting substrates. Monitoring nesting (or breeding) activity in snail kites will enable the assessment of hydrology on reproduction.

Because hydrological conditions, and consequently wildlife habitats, in one wetland area is likely to be accompanied by similar hydrological conditions in other wetland area in the same watershed, it is important to have multiple watersheds available for kites (Bennetts and Kitchens

1997a, 1997b). Therefore, habitat is available if hydrological conditions become unfavorable within a watershed. The Blue Cypress Marshes consisting of the Blue Cypress Water Conservation Area and the Blue Cypress Water Management Area is, for the most part, hydrologically disjunct from the other major habitats for snail kites in central and south Florida making it an extremely important component for the long-term viability of snail kites in Florida.

The purpose of this report is to monitor snail kite activities in Blue Cypress Marshes (referred to as BCM) as required by the biological opinion (FWS Log No: 4-1-96-246 [amended]) and to develop a database which will allow informed management decisions in reference to hydrological needs for the snail kite and the wetland area. The data consists of estimates of nesting success and the factors influencing nest success, the dispersal of snail kites banded in previous years, and the number of snail kites observed in BCM.

STUDY AREA AND METHODS

Our study area consisted of the BCM, Indian River County, Florida (Fig. 1). These areas comprise approximately 6,000 ha (15,000 acres) of marsh within the Upper St. Johns River Basin. Toland (1991, 1992, 1994) describes the vegetation and hydrologic characteristics in BCM.

During the 1996, 1997, and 1998 breeding season (Jan 1 to June 30), BCM was searched for nesting snail kites every two to three weeks. Nest monitoring followed guidelines suggested by Bennetts (1996). We used a Global Positioning System to determine the location of a nest and recorded nest substrate, nest height, and water depth. We estimated success by dividing the number of successful nests by the total of number of nests observed.

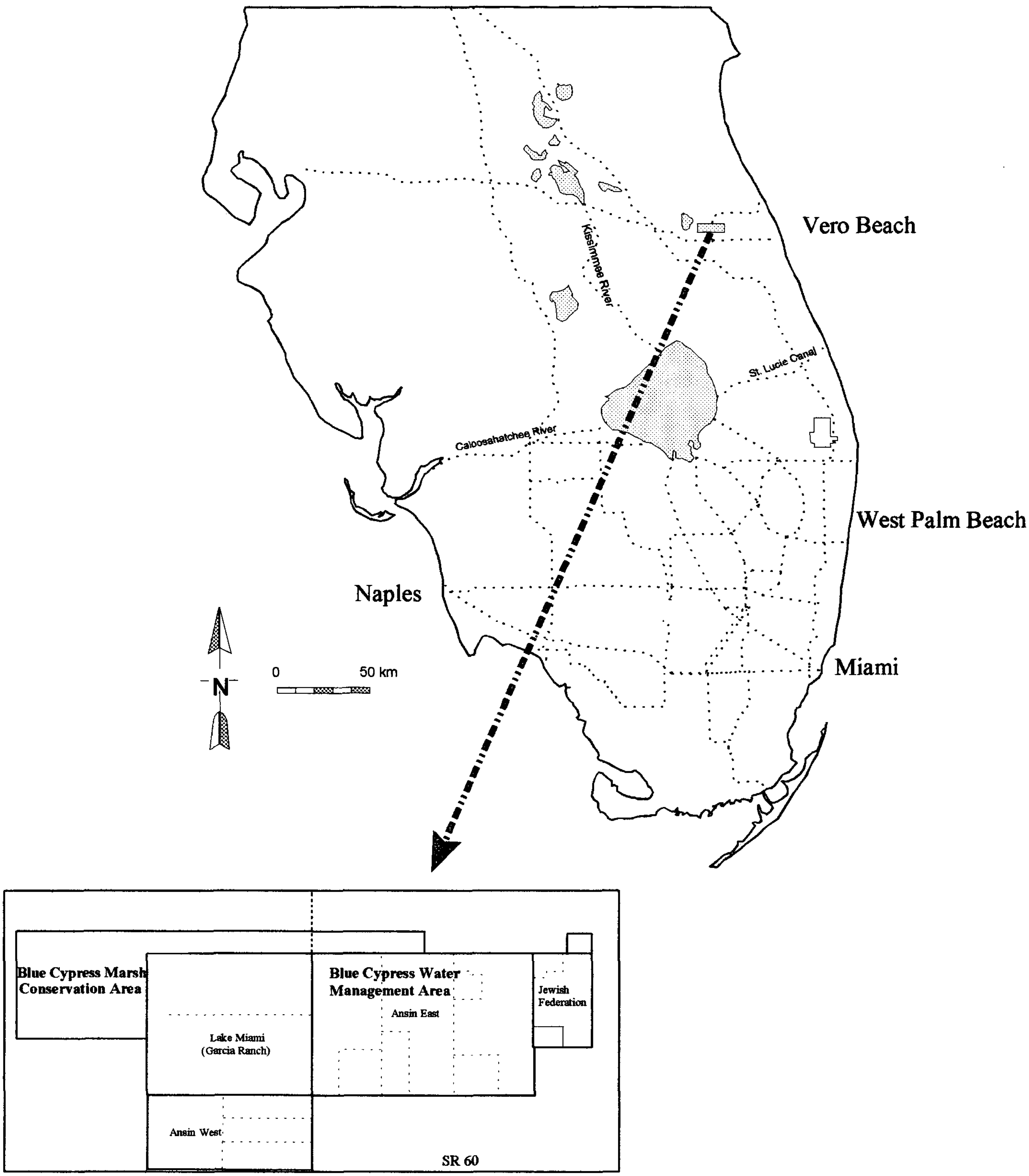


Figure 1. Blue Cypress Marsh Conservation Area and Blue Cypress Water Management in relation to central and southern Florida.

Systematic counts were conducted from Jan 24 to Nov 21 to determine overall kite use of the area. During the breeding period these counts conducted in conjunction with nest searching.

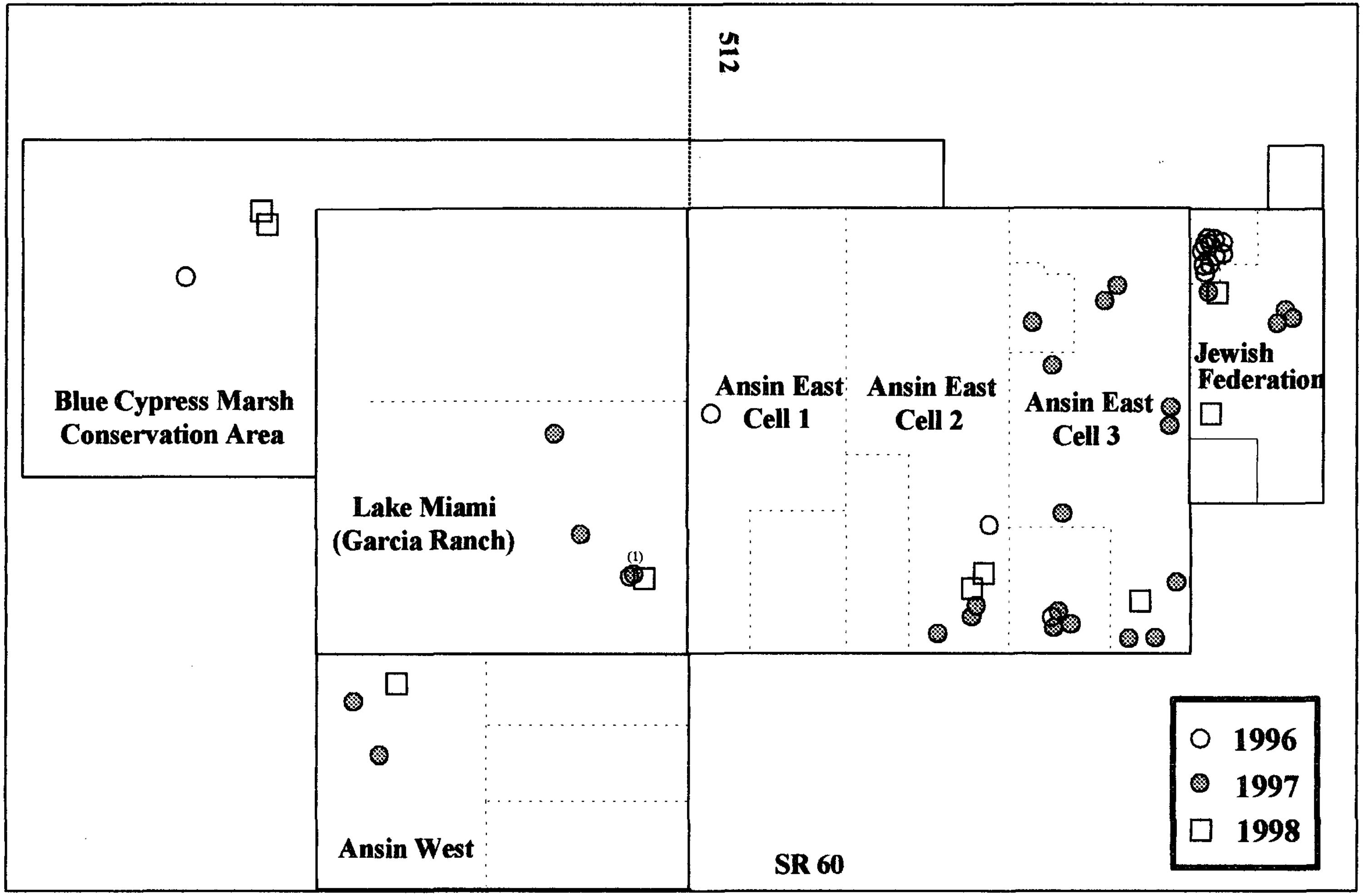
RESULTS

Spatial and temporal distribution of snail kite nesting activity

During this study we observed 16, 26 and 9 nests in 1996, 1997, and 1998, respectively (Fig 2). Snail kite nests were distributed throughout the study area (Fig 2). However, there was considerable year to year variation in the use of different subunits by nesting kites. Nesting activity had not been observed in Ansin West since 1991 (Toland 1991, 1992, 1994, Bennetts and Kitchens 1994, Bennetts et al. 1995, Dreitz et al. 1996). In 1997, two nests were found in Ansin West (Dreitz et al. 1997) and in 1998 one nest was found. (See Fig 3 for summary of nest location in each subunit since 1991).

Snail kites' reproductive effort is concentrated between January and June (Sykes et al. 1995); however, snail kites are capable of breeding in almost all months of the year (Snyder et al. 1989). In 1998, the first active nests were located on Mar 27 (Fig. 4) with eggs present. This occurrence of first active nests is almost one month later than the 1997 with initiation Feb 23 (Dreitz et al. 1997), one month earlier than the 1996 season with initiation the 23 April (Dreitz et al. 1996), but coincided with reports between 1991-1993 (Toland 1994). Nesting activity in the southern range (e.g., Everglades, Big Cypress National Preserve) began two to four weeks earlier (Dreitz et al. unpubl. data).

In 1998, a peak of nest initiation occurred in March, but a second, larger peak occurred in May (Fig. 4). Similar peaks in nest initiation were also observed in 1996 (Dreitz et al. 1996). This bi-model distribution has been reported previously in BCM by Bennetts and Kitchens (1995).



[1]Nest tree was used on two occassions during the 1997 breeding season.

Figure 2. Locations of Snail Kite nests in Blue Cypress Marshes from 1996 through 1998.

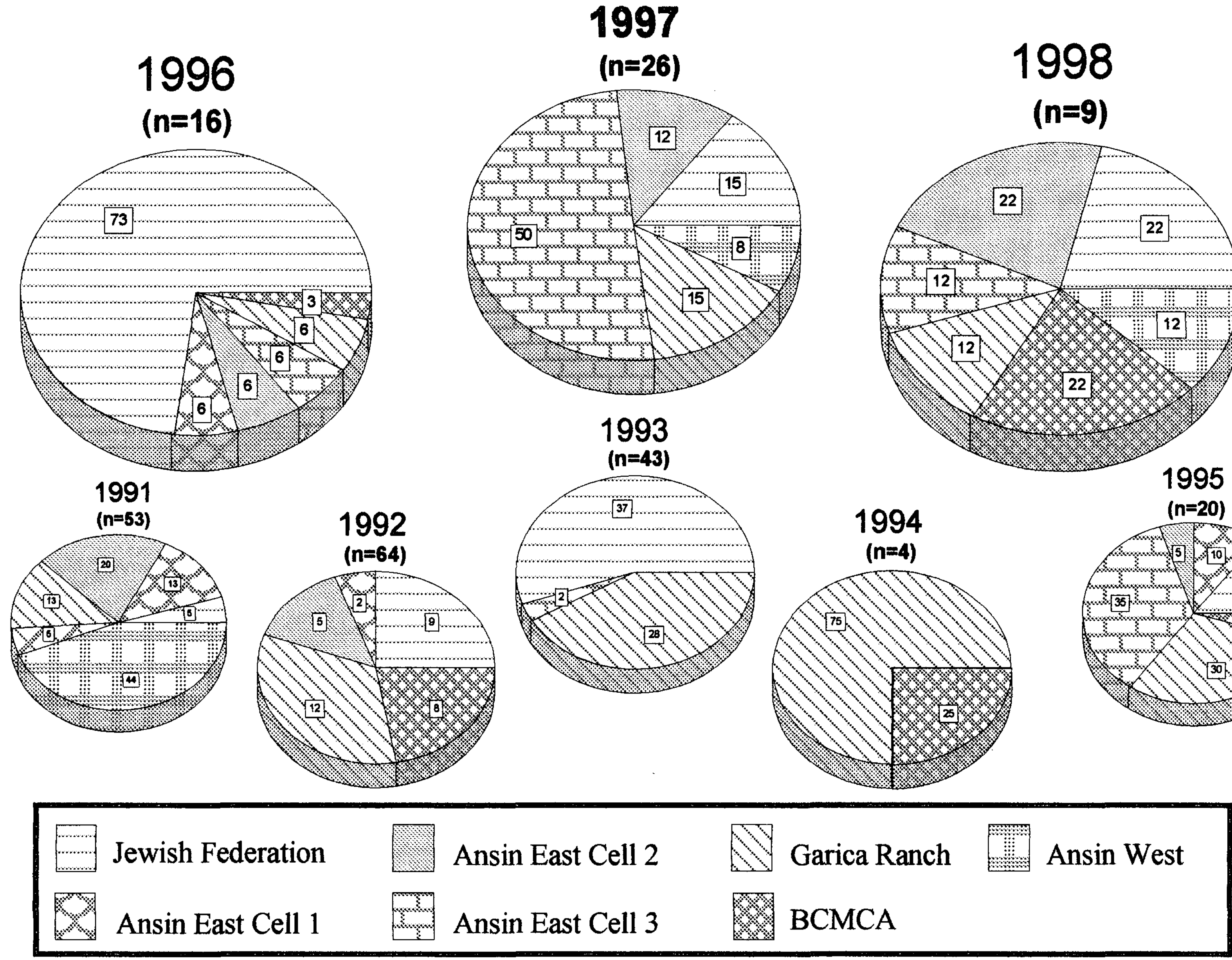


Figure 3. The percentage of active nests in each of the subunits of Blue Cypress Marshes during the 1991, 1992, 1993 (Toland 1991, 1992, 1994); 1994, 1995 (Bennetts and Kitchens 1994, 1995); 1996, 1997 (Dreitz et al. 1996, 1997); and 1998 breeding seasons.

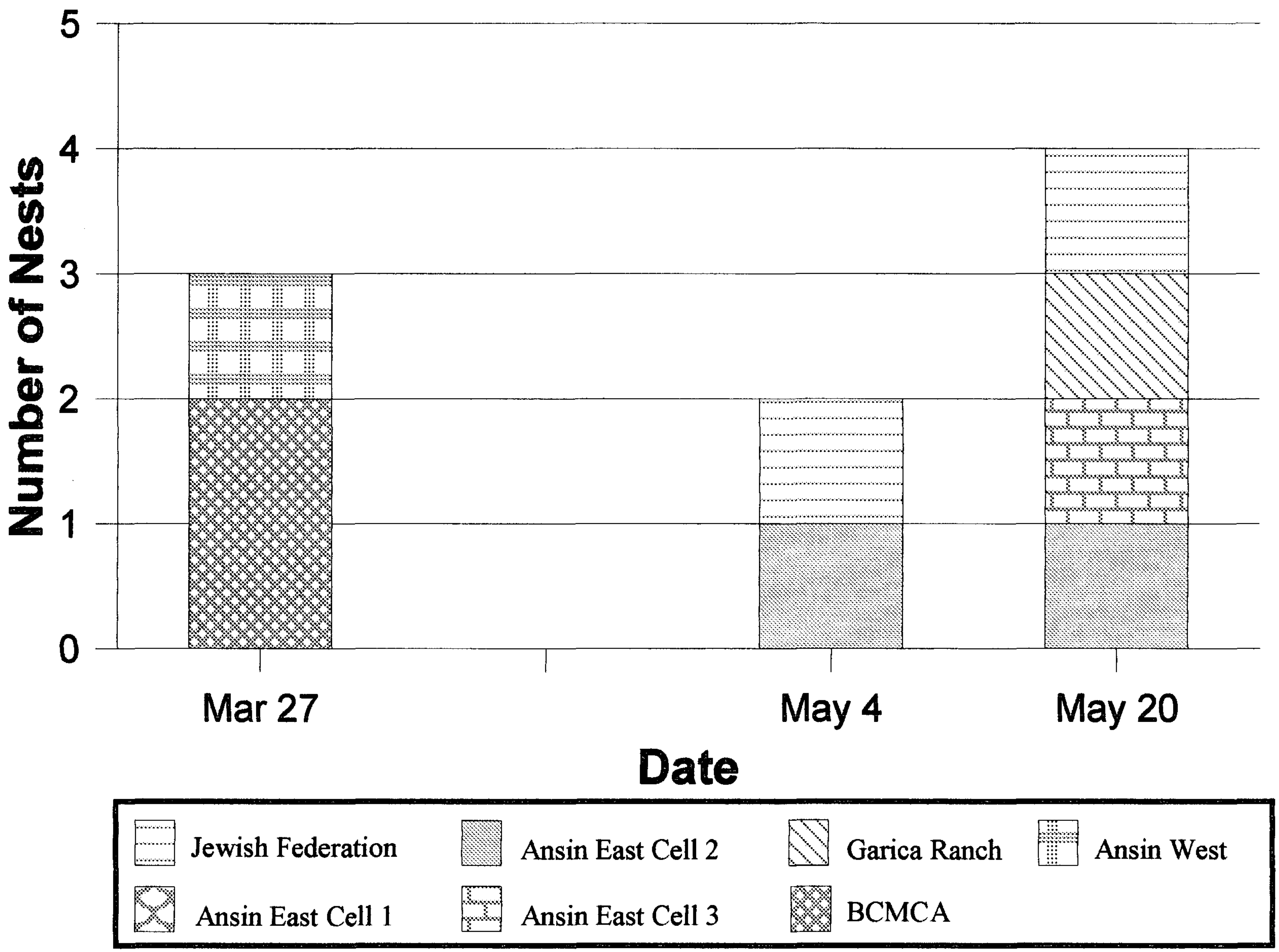


Figure 4. The number of active nests initiated in subunits during the 1998 breeding season in Blue Cypress Marshes.

Bennetts and Kitchens (1995) suggested this distribution may indicate more than one breeding attempt by a bird in BCM.

Nest-site characteristics

Nest-site characteristics are reported individually for 1998. Information for 1996 and 1997 are reported in Dreitz et al. (1996, 1997).

Nest Substrate

During the 1998 breeding season the main nesting substrate was cabbage palm (Sabal palmetto) (Fig. 5). Coastal-plain willow (Salix caroliniana), cattail (Typha spp.), cypress (Taxodium spp.) were also used. Cabbage palm comprised 33% of the substrates used with the remaining substrates each comprised 22% (Fig. 5). The average percentage cabbage palm used from 1990-1997 is 22%, the second most frequently used substrate (Fig. 5).

Water Depth

Water depth at nests during the 1998 breeding season averaged 0.66 m ($\pm$ 0.34 sd)(Fig. 6). This is within the range of water depths reported since 1991 (Table 1).

Nest Height

The average nest height during the 1998 breeding season was 2.7 m ($\pm$ 2.0 sd)(Fig. 7). This is within the range of the average nest height reported from 1991-1997 in the BCM (Table 1.)

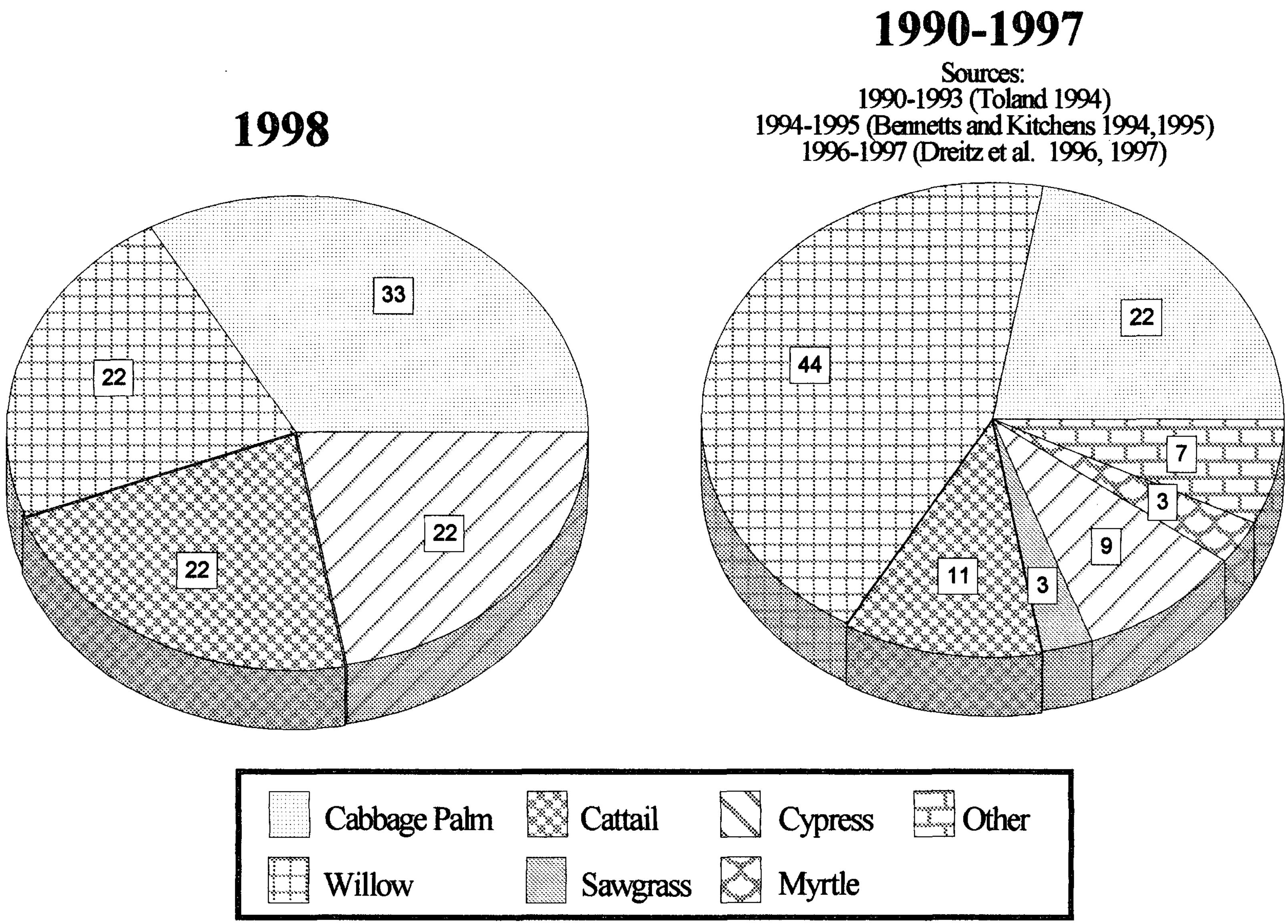


Figure 5. The percentage of nests in each substrate during the 1998 breeding season. The percentage for 1990-1997 (Toland 1994; Bennetts and Kitchens 1994, 1995; Dreitz et al. 1996, 1997) are shown for comparison.

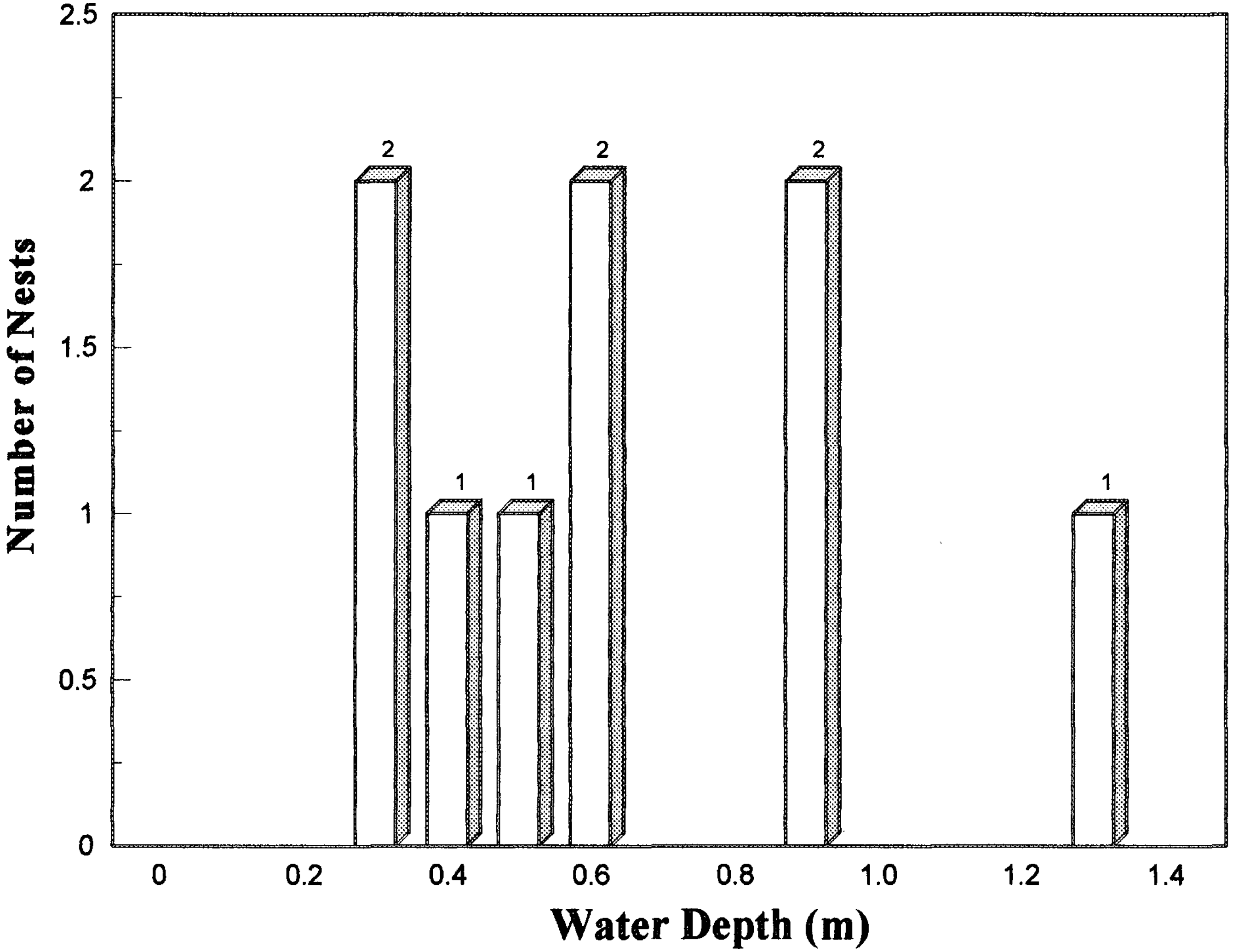


Figure 6. The number of active nests initiated in each 0.2 meter water depth class during 1998 breeding season.

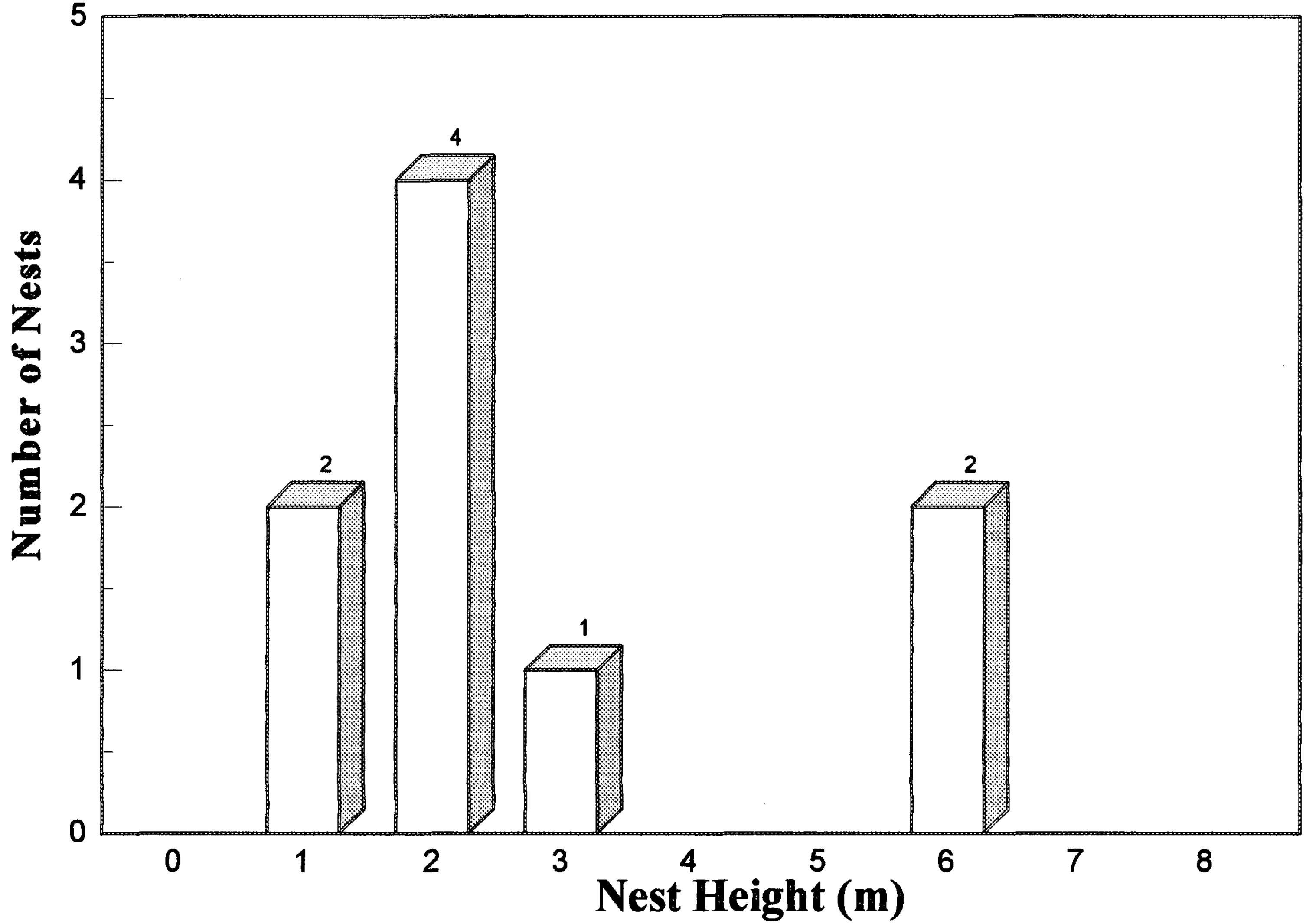


Figure 7. The number of active nests initiated in each meter height class during 1998 breeding season.

Table 1. Average water depth and nest height above water surface reported for the Blue Cypress Marshes for studies conducted from 1991 to 1998.

Year	$\bar{x}$ Water Depth (m)	$\bar{x}$ Nest Height (m)	Source
1991	0.55	3.6	Toland 1991
1992	0.75	2.6	Toland 1992
1993	0.78	2.0	Toland 1994
1994	0.62	3.3	Bennetts and Kitchens 1994
1995	0.73	3.2	Bennetts and Kitchens 1995
1996	0.53	2.8	Dreitz et al. 1996
1997	0.59	3.6	Dreitz et al. 1997
1998	0.66	2.7	Dreitz unpubl.data

Nest success

Overall nest success, or the percentage of nests that fledged at least one young during 1997 and 1998 and BCM was quite low (18% and 11%, respectively). However, in 1996, nest success (44%) fell within the average nest success for snail kites ranging from 32% (Snyder et al. 1989) to 50% (Sykes 1987)(reviewed by Sykes et al. 1995).

Table 2. Nesting success of snail kites reported for Blue Cypress Marshes from 1991 to 1998.

Year	Nest Success	N	Source
1991	20.5%	39	Toland 1991
1992	56.0%	59	Toland 1992
1993	32.5%	43	Toland 1994
1994	25.0%	4	Bennetts and Kitchens 1994
1995	20.0%	20	Bennetts and Kitchens 1995
1996	44.0%	16	Dreitz et al. 1996
1997	18.0%	26	Dreitz et al. 1997
1998	11.0%	9	Dreitz unpubl. data

Influences of Nest Success

There was an insufficient sample of nests (sample size of successful nests to small) to statistically evaluate the influence of nest success for each year. Toland (1991) suggested that successful nests tend to be over deeper water than unsuccessful nests but differences were not significant. The mean water depth of the successful nest ($\bar{x}$=1.30 m, n=1) during the 1998 breeding season was higher than unsuccessful nests ($\bar{x}$=0.58 m, n=8). Similar findings were reported for 1995 (Bennetts et al. 1995), 1996, and 1997 (Dreitz et al. 1996, 1997). Nest height of the successful nest ($\bar{x}$= 1.83 m, n=1) was lower than nest height of unsuccessful nests ($\bar{x}$=2.85 m, n=8). This finding is similar to 1997 (Dreitz et al. 1997) and 1995 (Bennetts and Kitchens 1995) findings but converse of 1996 (Dreitz et al. 1996).

Productivity

A minimum of one snail kite fledged from the BCM during the 1998 breeding season. The average number of young per nest was 0.11. This is lower than 0.27 reported by Dreitz et al. (1997), 0.94 reported by Dreitz et al. (1996), 0.35 reported by Bennetts et al. (1995) and 0.60 by Toland (1994). The average number of young per successful nest was 1.0. This is also lower than for BCM of 1.8 in 1997, 2.1 in 1996 (Dreitz et al. 1996, 1997), and 1.8 in 1995 (Bennetts et al. 1995).

Number of snail kites using the Blue Cypress Marshes during 1998

The number of snail kites counted in BCM ranged from 18 (Apr) to 51 (May)(Fig. 8 and 9). Prior to 1998 and 1997, most counts were conducted during the duration of the breeding

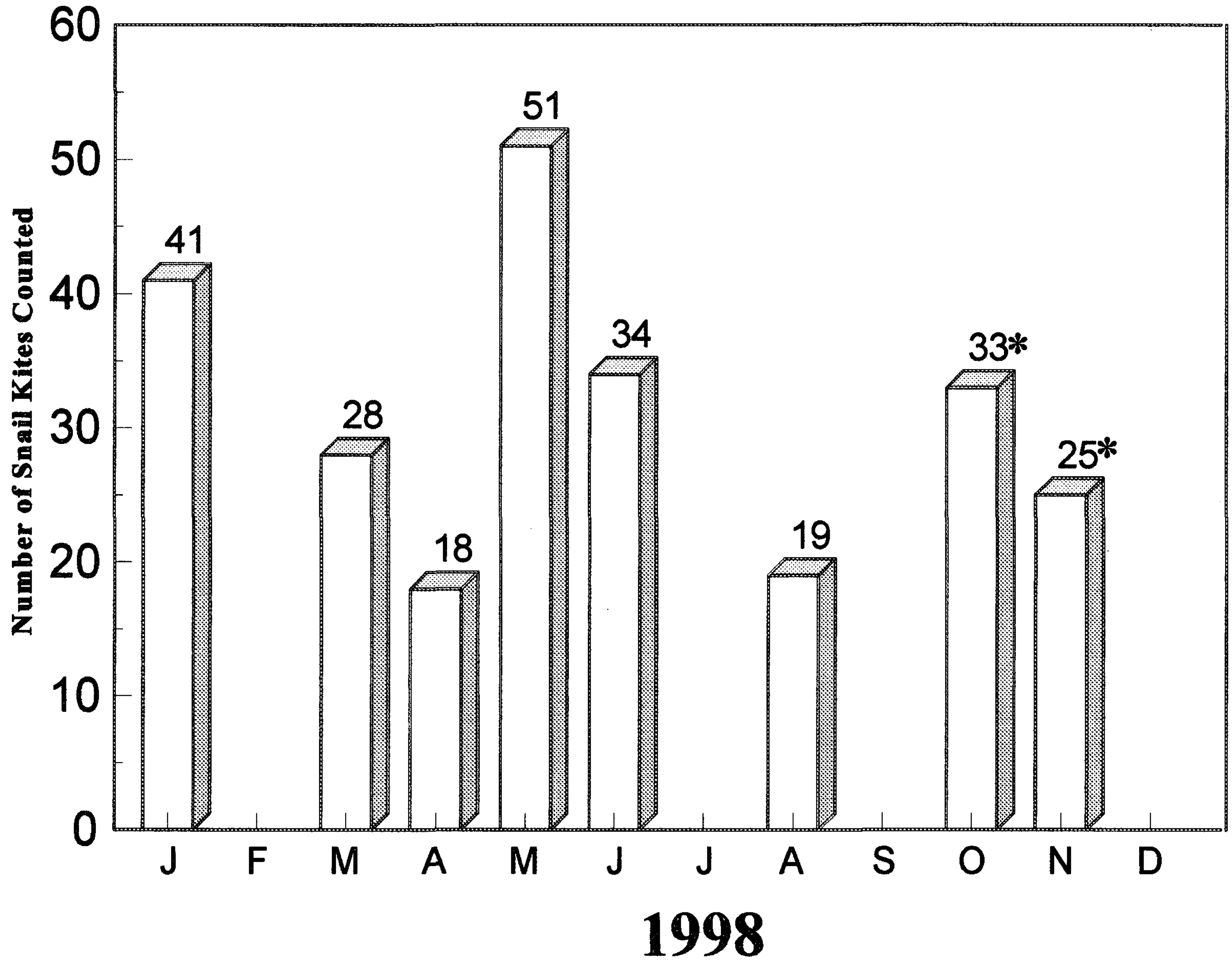


Figure 8. Number of Snail Kites counted during surveys conducted throughout Blue Cypress Water Management Area. Counts marked with (*) did not include tracts (e.g. BCMCA) where kites had not been seen during recent visits.

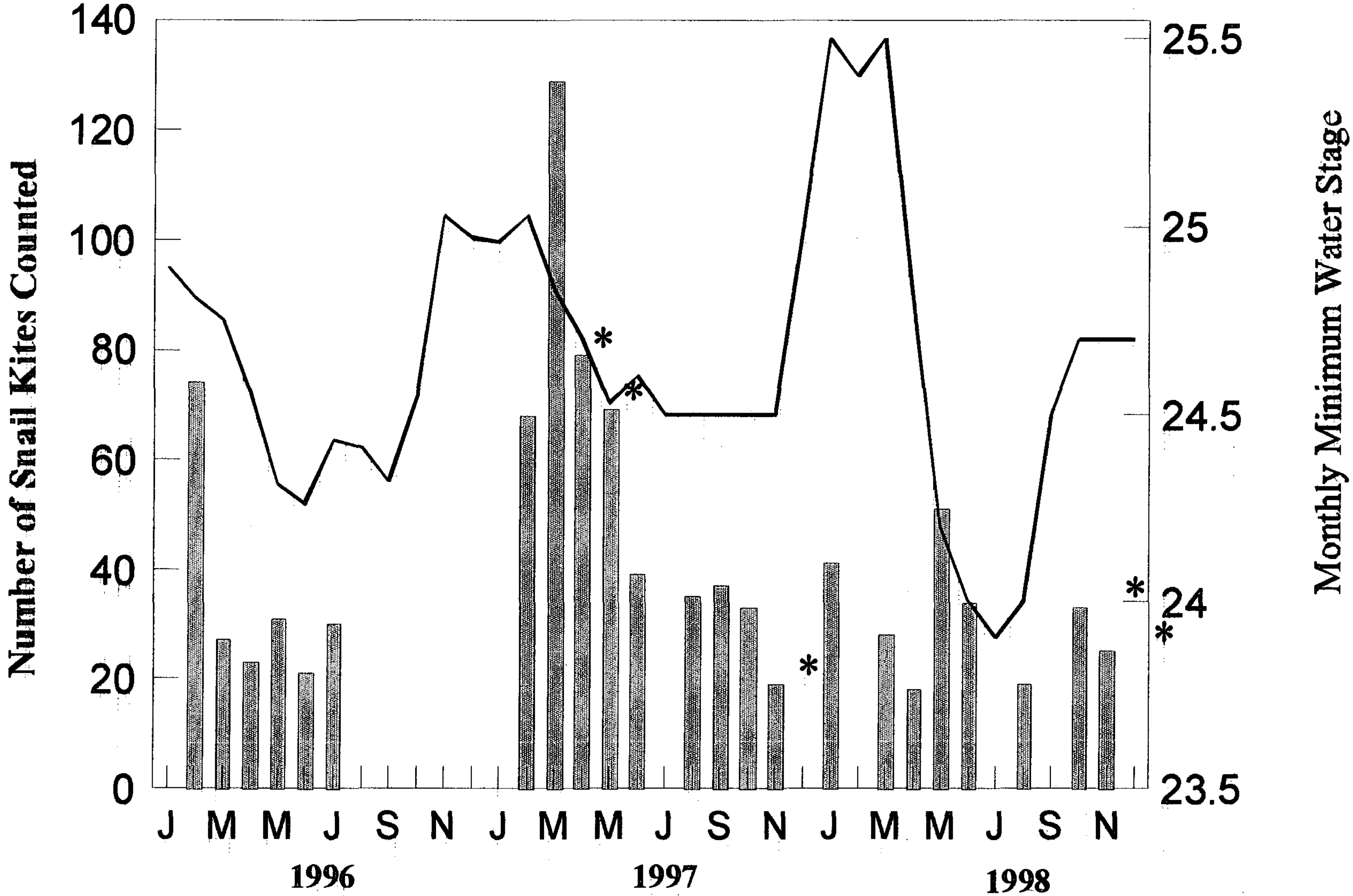


Figure 9. Number of Snail Kites counted in Blue Cypress Marshes from 1996-1998. Counts marked with (*) did not include some tracts (e.g. BCMCA) where kites had not been seen during recent visits. Also shown are monthly water stages reported for gauging station S251-E for the same time periods.

season. Therefore, for comparison we limited our counts from Feb through Jun. The number of kites seen during 1998 breeding season were within the range of other years: 1997, 31 to 129 birds (Dreitz et al. 1997); 1996, 20 to 74 (Dreitz et al. 1996); 1995 13 to 41 (Bennetts et al. 1995); and 1994, 7to 30 (Bennetts and Kitchens 1994). Most of the birds counted in 1998 were not actively nesting which was also observed in 1997 (Dreitz et al. 1997) and 1994 (Bennetts and Kitchens 1994). However, in 1995 and 1996 the kites count, excluding the February 1996 count, were in some stage of nesting, courtship or active nests (Bennetts et al. 1995, Dreitz et al. 1996).

The correlation between water levels and numbers of kites in BCM was not significant ($r=0.22$ $p=0.36$) from 1996-1998. Correlation did persist in 1994 and 1995 (Bennetts and Kitchens 1994, Bennetts et al. 1995). This differences in the duration of the surveys. From 1997 to 1998 surveys were conducted throughout the year. From 1995-1996, surveys were only conducted during the breeding season.

Sightings of Banded Birds During 1998

Fifteen different snail kites that were originally banded in BCM either as juveniles or adults between 1991-1997 were seen throughout the snail kites' range in central and south Florida. The wetland areas these kites were observed in include the West Palm Beach Water Catchment Area, BCM, Lake Okeechobee and Water Conservation Area (WCA)-3A. Three of the 15 individuals attempted to breed, but all were unsuccessful.

Twenty-two different banded snail kites were observed in BCM during the 1998 breeding season. The natal areas of 17 of the 22 kites are known. The kites of unknown natal areas were captured as an adult on Lake Okeechobee and in BCM. The known natal areas consisted of Lake

Kissimmee, East Lake Tohopekaliga, Lake Jackson, Lake Okeechobee, BCM, WCA-3A, and Everglades National Park. Some individuals were seen on more than one occasion in the same wetland area or in a different wetland.

DISCUSSION

Nest success in BCM has been relatively low the last two years (1997-1998). The reason for this decrease in nest success is not clear. In 1998, the spatial distribution of snail kite nesting activity included many of the wetland areas historically used in southern Florida. However, breeding activity in the northern portion including Lake Kissimmee, West Lake Tohopekaliga, and BCM was relatively low (J. Rodgers pers. comm., J. Buntz pers. comm). This may be a result of the occurrence of inclement weather in these areas during the early portion of the breeding season. That is, due to these unfavorable weather conditions (ie., cooler air temperature, increase winds), kites may have shifted to their southern range to attempt breeding.

Water conditions in BCM were quite favorable and similar to other years having a higher success. However, the hydrological regime for the area may be affecting the vegetation structure of BCM. As defined by Bennetts and Kitchens (1997a) as Miller et al (In press), BCM has experienced, on an yearly scale, normal to high water conditions since 1986. While several recommendations for kites have focused on prolonged inundation of wetland habitats (e.g., Stieglitz 1965, Stieglitz and Thompson 1967, Beissinger 1986), a critical issue that is usually ignored by these recommendations is that the lack of periodic drying events can detrimentally affect the kite's habitat (Bennetts et al. 1988, Bennetts and Kitchens 1997a, 1997b). Woody vegetation used as nesting substrates, and graminoid species that are essential for foraging habitat require periodic drying to reproduce and/or survive (Craighead 1971, Gunderson and Loftus 1993, Gunderson 1994). Beissinger (1995) suggested that interval between drying events in wetland areas should be at least 4.3 years to have viable population of kites. Bennetts and Kitchens (1997a) stated drying events in some of the major wetland areas used by kites is less than 4.3 years and the number of kites in these areas has generally been increasing. In BCM a major drying event has not occurred >10 years (see Bennetts et al. 1997a, Miller et al. In press).

When managing the hydrological conditions for kite habitat it is important that the whole network be considered and not particular wetland areas. Thus, if a local, regional, or widespread drying event occurs, individual wetland areas can be manipulated to support kites to avoid a decrease in the number of kites. Protection, monitoring, and management of habitat must be implemented over a broad spatial extent to encompass climatic variability within the kite's range and over periods long enough to measure habitat deterioration (Bennetts and Kitchens 1997b).

The number of snail kites using BCM fell with in the range of previous years. Bennetts and Kitchens (1997a) and Bennetts et al. (1999) stated the errors associated with count data. One of these errors is the count data is not a census, its simple the number of individuals observed. Further, correlating the number of snail kites with water levels can lead to misinterpretation of the data. Correlation approaches to time series data provide questionable results due to confounding variables, such as, temporal period and environmental variables (Draper and Smith 1981). That is, the only conclusions we can draw from these count data is presence or absence of snail kites in BCM. However, it is not uncommon, rather it is expected, for the use of wetland by kites to fluctuate throughout the state. Therefore, we recommend that management concerns focus on long-term trends in numbers and habitat quality, rather than on short-term fluctuations, which are a normal part of the snail kite's life history.

ACKNOWLEDGMENTS

We are grateful to our field biologists Malene Shannon and Nicole Kamrath, and the Florida Fish and Wildlife Cooperative Research Unit for their logistic support. We appreciate the support of the St. Johns River Water Management District, Steven J. Miller, Ken Snyder, and Edgar Lowe.

LITERATURE CITED

Beissinger, S.R. 1986. Demography, environmental uncertainty, and the evolution of mate desertion in the Snail kite. Ecology 67: 1445-1459.

Beissinger, S.R. 1995. Modeling extinction in periodic environments: Everglades water levels and Snail kite population viability. Ecol. Appl. 5: 618-631.

Bennetts, R.E. 1996. Suggested guidelines for monitoring Snail Kites nests in Florida. Florida Coop. Fish and Wildlife Res. Unit, University of Florida, Gainesville. 21 pp.

Bennetts, R.E., M.W. Collopy, and S.R. Beissinger. 1988. Nesting ecology of Snail kites in Water Conservation Area 3A. Dept of Wildlife and Range Sci., University of Florida, Gainesville. Florida Coop. Fish and Wildl. Res. Unit. Tech. Rep. No. 31. 174 pp.

Bennetts, R.E., and W.M. Kitchens. 1994. Numbers, distribution, and success of nesting Snail kites in the Blue Cypress Water Management and Conservation Areas. 1994 Final Report.

Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville. 15pp.

Bennetts, R.E. and W.M. Kitchens. 1997a. The demography and movements of Snail kites in Florida. Draft Report. Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville.

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

Bennetts, R.E., W.A. Link, J.R. Sauer, and P.W. Sykes, Jr. 1999. Sources of variability and estimation of the trajectory from a 26-year annual survey of Snail Kites in Florida. Auk: In press.

Bennetts, R.E., M.J. Steinkamp, and W.M. Kitchens. 1995. Numbers, distribution, and success of nesting Snail kites in the Blue Cypress Water Management and Conservation Areas. 1995 Final Report. Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville. 20pp.

Craighead, F.C., Sr. 1971. The trees of South Florida. Vol. 1. The natural environments and their succession. University of Miami Press, Coral Gables, Florida.

Draper, N.R., and H. Smith. 1981. Applied regression analysis, second edition. John Wiley and Sons. New York. 709pp.

Davis, S.M., and J.C. Ogden, Editors. 1994. Everglades: the ecosystem and its restoration. St. Lucie Press, Delray Beach, Florida, USA. 826pp.

Dreitz, V.J., D.D. DeAngelis, and W.M. Kitchens. 1996. Nesting success, numbers, and dispersal of Snail kites in the Blue Cypress Water Management and Conservation Areas. 1996 Annual Report. USGS/BRD, University of Miami, Coral Gables, FL 22pp.

Dreitz, V.J., D.D. DeAngelis, and W.M. Kitchens. 1997. Nesting success, numbers, and dispersal of Snail kites in the Blue Cypress Water Management and Conservation Areas. 1996 Annual Report. USGS/BRD, University of Miami, Coral Gables, FL 26pp.

Gunderson, L.H. 1994. Vegetation of the Everglades: Determinants of community composition. Pp. 323-340 *in* Everglades: the ecosystem and its restoration (S.M. Davis and J.C. Ogden, eds.) St. Lucie Press, Delray Beach, Florida.

Gunderson, L.H. and W.F. Loftus. 1993. The Everglades. Pp. 199-255 *in* Biodiversity of the southeaster United States/Lowland terrestrial communities (W.H. Martin, S.G. Boyce, and A.C. Echternact, eds.) John Wiley and Sons, New York.

Kushlan, J.A. 1975. Population changes of the apple snail, *Pomacea paludosa*, in the southern Everglades. Nautilus 89: 21-23.

Miller, S.J., R.E. Bennetts, and W.M. Kitchens. (In press). A simple technique for a standardized measure of regional patterns of water levels and hydrologic events. Wetland Ecology

Nichols, J.D., G.L. Hensler, and P.W. Sykes, Jr. 1980. Demography of the Everglade Kite: implications for population management. Ecol. Model. 9:215-232.

Postupalsky, S. 1974. Raptor reproductive success: some problems with methods, criteria, and terminology. Pp. 21-31 *in* Management of Raptors (F.N. Hamerstrom, Jr., B.E. Harrell, and R.R. Olendorff, eds.). Raptor Research Foundation, Vermillion, S.D.

Snyder, N.F.R., Beissinger, S.R., and R. Chandler. 1989. Reproduction and demography of the Florida Everglade (Snail) Kite. Condor 91:300-316.

Steenhof, K., and M.N. Kochert. 1982. An evaluation of methods used to estimate raptor nesting success. J. Wildl. Man. 46:885-893.

Stieglitz, W.O. 1965. The Everglade Kite (*Rostrhamus sociabilis plumbeus*). Report for the Bureau of Sport Fisheries and Wildlife, Division of Refuges, Washington, D.C.

Stieglitz, W.O. and R.L. Thompson. 1967. Status and life history of the Everglade Kite in the United States. Special Scientific Report, Wildlife No. 109., U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Washington D.C.

Sykes, P.W. 1978. Endangered Florida Everglade Kite. Pp. 4-7 *in* Rare and endangered biota of Florida, vol. 2 (H.W. Kale II, ed.). University Presses of Florida, Gainesville.

Sykes, P.W. 1983. Recent population trends of the Snail kite in Florida and its relationship to water levels. J. Field Ornithol. 54:237-246.

Sykes, P.W. 1987. Some aspects of the breeding biology of the Snail kite. J. Field. Ornithol. 58:171-189.

Sykes, P.W., J.A. Rodgers Jr, and R.E. Bennetts. 1995. Snail kite (*Rostrhamus sociabilis*). *In* The Birds of North America. (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington D.C.

Toland, B.T. 1991. Snail kite ecology in the upper St. Johns marshes. 1991 Annual Report. Florida Game and Fresh Water Fish Commission, Vero Beach, Florida. 13pp.

Toland, B.T. 1992. Snail kite ecology in the upper St. Johns marshes. 1992 Annual Report. Florida Game and Fresh Water Fish Commission, Vero Beach, Florida. 11pp.

Toland, B.T. 1994. Snail kite ecology and status reports of other species of regional concern in the upper St. Johns marshes. Final Report. Florida Game and Fresh Water Fish Commission, Vero Beach, Florida. 27pp.

Walters, C., L. Gunderson, and C.S. Holling. 1992. Experimental policies for water management in the Everglades. Ecological Applications 2:189-202.

Appendix A. Latitude and longitude coordinates of active Snail Kite nests found in Blue Cypress Water Management Area and Blue Cypress Water Conservation Area from 1996-1998.

Year	Nest Number	Latitude	Longitude
1996	001	27 40 .627	80 38 .619
1996	002	27 41 .592	80 35 .349
1996	003	27 40 .955	80 40 .816
1996	004	27 40 .658	80 38 .387
1996	573	27 40 .411	80 36 .599
1996	574	27 39 .978	80 36 .352
1996	575	27 41 .544	80 35 341
1996	576	27 41 .544	80 35 341
1996	577	27 41 .544	80 35 341
1996	590	27 41 .613	80 35 .266
1996	680	27 41 .544	80 35 341
1996	681	27 41 .544	80 35 341
1996	682	27 41 .592	80 35 .349
1996	683	27 41 .592	80 35 .349
1996	684	27 41 .592	80 35 .349
1996	695	27 41 .620	80 35.410
1997	001	27 40 .621	80 38 .600
1997	220	27 40 .025	80 36 .717
1997	226	27 39 .813	80 36 .700
1997	237	27 36 .544	80 36 .544
1997	247	27 41 .309	80 34 .766
1997	269	27 40 .844	80 38 .905
1997	302	25 48 .108	80 48 .866
1997	386	27 39 .802	80 35 .762
1997	578	27 40 .188	80 36 .400
1997	594	27 41 .193	80 36 .014
1997	686	27 40 .037	80 35 .816
1997	689	27 41 .243	80 36 .547

Appendix A.(continued)

1997	691	27 39 .729	80 35 .927
1997	692	27 39 .528	80 40 .318
1997	799	27 41 .265	80 35 .605
1997	844	27 40 .615	80 38 .940
1997	868	27 41 .529	80 35 .480
1997	869	27 39 .973	80 36 .387
1997	870	27 40 .072	80 36 .454
1997	875	27 39 .827	80 36 .845
1997	893	27 40 .682	80 35 .687
1997	900	27 40 .684	80 35 .689
1997	997	27 40 .549	80 35 .701
1997	2000	27 40 .451	80 38 .728
1997	2001	27 40 .791	80 38 .912
1997	3000	27 41 .318	80 36 .010
1998	155	27 41 .676	80 40 .859
1998	156	27 41 .539	80 40 .920
1998	157	27 39 .470	80 39 .772
1998	355	27 40 .009	80 36 .727
1998	356	27 41 .323	80 35 .587
1998	381	27 40 .211	80 38 .692
1998	382	27 40 .681	80 35 .599
1998	383	27 39 .987	80 35 .887
1998	384	27 39 .999	80 36 .693