Ecological Assessment of the 1994-1995 High Water Conditions in the Southern Everglades

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Influence of the 1994-1995 High Water Event on Survival, Reproduction, and Distribution of Snail Kites in the Florida Everglades

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Introduction

Beginning in the autumn of 1994 and extending into 1995 South Florida experienced a period of extremely high water. This conference was intended to compile information on how that high-water event (HWE) influenced the Everglades ecosystem. During this HWE we had an ongoing study of demography and movements of the endangered Snail Kite (*Rostrhamus sociabilis*) in Florida. Our research was not specifically targeted for this HWE, thus cause and effect relationships can not be inferred with a high degree of certainty. Nevertheless, data collected during this period may provide insights into the influence of this event on the demography and movements of Snail Kites. Here we present those data.

Methods

We studied the demography and movements of Snail Kites in Florida between 15 April 1992 and 15 April 1995 (Bennetts and Kitchens 1997). The purpose of our research was to better understand Snail Kite population dynamics and the influence of environmental conditions. Our emphasis was on obtaining reliable estimates of demographic and dispersal parameters to be used in a variety of management and modeling contexts. A complete description of the study methods can be found in Bennetts and Kitchens 1997).

Radio telemetry was the primary field method we used to obtain estimates of survival and movement reported here. Radio telemetry enabled assessment of "within-year" patterns of both survival and movement. Our goal was to annually capture (for three consecutive years) and radio tag 100 snail kites of which 60% were adults and 40% juveniles. Our targeted ratio of adults to juveniles was intended to emphasize adult survival because demography of long-lived avian species (e.g., Snail Kites) tends to be more sensitive to adult rather than juvenile survival. Additionally, we targeted a 50:50 sex ratio of adults to keep our sample balanced. Our annual sample size of 100 was based on estimates of
the statistical power to distinguish survival differences among groups (e.g., age or sex) or time periods.

We estimated survival of radio-tagged kites using a staggered entry design (Pollock et al. 1989) of the Kaplan-Meier product limit estimator (Kaplan and Meier 1958). Detailed descriptions of the estimator and its properties can be found in Kaplan and Meier (1958), Cox and Oakes (1984), Pollock et al. (1989), and White and Garrott (1990). For comparison among survivorship curves generated by the Kaplan-Meier estimator we used the log-rank tests (Savage 1956, Cox and Oakes 1984).

We used an arbitrary starting date of 15 April for our survival estimates. At this time we had a reasonable sample (n = 16 during our 1st year) to allow estimation of survival. Birds captured after 15 April were included in the analysis in accordance with the staggered entry procedures described by Pollock et al. (1989) and annual survival each year was based on a study year (SY) from April 15 to April 14, rather than a calendar year.

We attached 282 radio transmitters on 271 individual Snail Kites. Eleven birds were recaptured and re-tagged in a subsequent year. We were short (82%) of our targeted sample size of 100 birds during 1992, but fully attained our targeted sample sizes in 1993 and 1994. We were very close to our targeted age and sex ratios for all years (Bennetts and Kitchens 1997).

**Fig. 1.** Estimates of survivorship functions of radiotransmitted adult Snail Kites while they were present in each region during SY 1994 (15 April 1994-14 April 1995).

**Fig. 2.** Estimates of survivorship functions of radiotransmitted adult Snail Kites while they were present in the Everglades region during SY’s 1992-1994.
Effect of the HWE on survival. Our results indicated that adult survival during SY 1994 (i.e., between 15 April 1994 and 14 April 1995) was higher in the Everglades compared to other regions (Fig. 1); however, differences were only significant (P < 0.05) between the Everglades and Lake Okeechobee (Bennetts and Kitchens 1997). Adult survival during SY 1994 was intermediate compared to the two previous years (Fig. 2).

We observed similar results for juvenile survival. During SY 1994 survival in the Everglades was higher than the Kissimmee region, although not as high as at Lake Okeechobee (Fig. 3). Juvenile survival in the Everglades region during SY 1994 was intermediate compared to previous two years (Fig. 4).

Effect of the HWE on reproduction. The onset of the HWE began during the rainy season of 1994. Thus, the primary breeding season (January-June) of 1994 occurred before the HWE whereas, the 1995 breeding season occurred during the HWE (note that in contrast to survival, reproduction is reported based on a calendar, rather than study year).

Nest success, defined as producing at least one young to fledging, differed among four regions during the 1995 breeding season (* =12.09, 3 df, P=0.007, n=228). Success in the Everglades region (60.0%) was similar to the Kissimmee Chain-of-Lakes (61.5%), but was higher than Lake Okeechobee (50%) or the Upper St. Johns River (20%). Nest success in the Everglades region did not differ between the 1994 breeding season (before the HWE) and the 1995 season (* =1.63, 1 df, P=0.281, n=254). Although these differences were not significant, our estimate of success was actual higher in 1994 (67.1%) than 1995 (60.0%).

Successful Snail Kite nests typically produce 1, 2, or 3 young (overall statewide ave.=1.9) (reviewed by Bennetts and Kitchens 1997). During the 1995 breeding season
the number of young produced per successful nest did not differ among regions (* =8.01, 6 df, P=0.237, n=94). The average number of young per successful nest in the Everglades (ave.=1.96) was very close to the statewide average. The number of young per successful nest in the Everglades region did differ between the 1994 and 1995 breeding seasons (* =7.59, 2 df, P=0.022, n=119). However, this was probably attributable more to the average for 1994 having been below average (ave.=1.62), rather than 1995 having been exceptionally high.

Effect of the HWE on the distribution of nesting Snail Kites. The spatial distribution within WCA3A was similar for 1992, 1993, and 1994; although there were only 5 nests observed during 1992 (Fig. 5). During the 1995 breeding season most areas in WCA-3A had water depths > 1 m and many areas had depths > 1.5 m. The distribution of nesting kites shifted dramatically to the north during 1995, to an area (mostly within the Miccosukee Indian Reservation) of higher elevation and lower water depths, than had been observed during the previous 3 years.

Shifts in distribution of nesting kites also

**Fig. 5.** The distribution of Snail Kite nests in Water Conservation Area 3A during each year from 1992 through 1996.

**Fig. 6.** The distribution of Snail Kite nests in Water Conservation Area 2B during each year from 1992-1995.

**Fig. 7.** The distribution of Snail Kite nests in the Stairstep Unit of Big Cypress National Preserve during 1995-1996.
occurred in WCA-2B; however, they were not as pronounced as those in WCA-3A. During the HWE there was increased use of higher elevations (i.e., lower water levels), but substantial overlap occurred between the 1994 and 1995 breeding seasons (Fig. 6).

Wet prairie habitats within the Stairstep Unit of Big Cypress National Preserve are generally shorter in hydroperiod than those which occur in WCA-3A or WCA-2B. Although birds have used this area regularly during the non-nesting season for foraging, we had no indication of nesting activity prior to 1995. This is not surprising because, except for the very wettest portions, these prairies dried out for short periods of time during most years. In contrast to WCA3A, the areas used by kites (primarily in Lostman's, Dixon, and East Sloughs were generally the longer hydroperiod habitats within this wetland (Fig. 7). During the nesting season of 1995, we observed 24 nests in this area. During 1996 when more typical spring dry downs occurred only 8 nests were found in this region.

Discussion

Our results are inconclusive regarding the effect of the HWE on demography of Snail Kites. There certainly was no indication that the HWE had a negative impact on either survival or reproduction, and indications of a positive effect were conflicting. If higher adult survival in the Everglades during SY 1994 were attributable to the HWE, we would also have expected survival in the Everglades to have been higher during this period compared to previous years. In contrast, adult survival during SY 1994 was intermediate between the previous two years. This suggests that although conditions in the Everglades were good during SY 1994 compared to other regions, it would be difficult to attribute this to the HWE in light of comparisons to other years. Similarly, there was no convincing evidence that juvenile survival was directly affected by the HWE.

Our results for reproduction were similar to survival in that they provided conflicting evidence regarding the HWE. Nest success differed among regions, but was not lower in the Everglades than at least one other region not influenced by the HWE. Nest success in the Everglades region also was higher during 1994, before the HWE, although differences were not significant. The number of young produced per successful nest was very close to the overall statewide average in the Everglades region during the HWE, and did not differ among regions. Thus, we do not believe that the HWE had any substantial impact on reproduction.

Our data presented here focused on short-term (acute) effects of the HWE; however long-term (chronic) effects also are possible. Snail Kites may respond to the long-term effects (e.g., the hydrologic regime) quite differently than short-term effects (e.g., current water levels).

We suggest a conceptual framework to express a more comprehensive viewpoint of the
hydrologic conditions of Snail Kite habitat. Central to our concept is that there is a "window" of hydrologic conditions in which Snail Kites usually occur. This window represents the combined effects of hydrology from all time scales at a given location. For example, if we consider the effects of three time scales (in actuality the time scales form a continuum) that we will refer to as the (1) hydrologic regime, (2) intermediate hydro-history, and (3) current water levels. The hydrologic regime represents the water conditions that have occurred in an area over a period for at least several years. We are using it here to represent changes that require a relatively long response time. It includes changes to soils (which may occur over centuries) as well as changes to the dominant vegetation communities (which may occur from <1 to several decades).

The intermediate hydro-history refers to the conditions that have occurred within the previous few years. We are using it in this example to primarily represent the time since a local disturbance event (e.g., local drying) that may have influenced apple snail populations. Current water conditions are used in this example to represent local conditions (e.g., water depth) at a given point in time and space. These conditions may influence availability of food despite local abundance. Suitable Snail Kite habitat is inundated for relatively long periods (e.g., 1-5 year average return interval of drying events); however, excessive inundation (e.g., > 5-year average return interval) or water depths (> 1m) may result in habitat deterioration (Bennetts et al. 1994, Bennetts and Kitchens 1997).

Areas used by kites in recent years were not the longest hydroperiod within WCA-3A. Thus, with respect to the hydrologic regime, the current "window" currently is a relatively shorter hydroperiod portion of a long-hydroperiod wetland (Fig. 8). We can see the effect of the intermediate hydro-history and current conditions by looking at the annual differences in nesting distribution. Drought conditions in 1989 and 1990 probably resulted in a substantial decline of apple snail population. Based on our observations of the few birds that nested in WCA-3A during 1992, food was still very limited at that time and most birds were nesting in the northern portion of their range in Florida (Bennetts and Kitchens 1997). Consequently, the intermediate hydro-history was not very suitable for nesting in WCA-3A during 1992, but improved over the next few years. We believe that the shift in distribution during 1995 resulted from the current
conditions (i.e., water depth) being unsuitably high at that time at lower elevations. During the 1996 nesting season, kites shifted back to the south (Dreitz et al., unpubl. data), although many were still foraging in adjacent Everglades National Park and Big Cypress National Preserve where water depths had not been so extreme.

A quite different scenario occurred in the Stairstep Unit of Big Cypress National Preserve over this same time period that further illustrates our concept in a short-hydroperiod wetland. In contrast to WCA-3A, the areas used by kites (primarily in Lostman’s, Dixon, and East Sloughs) were generally the longer hydroperiod habitats within this wetland.

These areas often dry out during the nesting season and consequently were not typically used for nesting. The HWE provided an opportunity for suitable water levels to persist during the nesting season and nesting occurred as a result. Thus, our window shifted from suitable foraging habitat during the non-nesting (rainy) season, to suitable nesting habitat during the HWE.

Spatial and temporal variation is an integral part of the Florida wetlands landscape and Snail Kites are well adapted to this variability. If all areas were managed for high water, then Snail Kites would have limited habitat available during high water events and substantial habitat deterioration would likely occur. Similarly, if all areas were managed as short hydroperiod wetlands, then kites would only have habitat during high water events. We believe that it is this mosaic of hydrologic regimes and local conditions that enable kites to have habitat available during a variety of hydrologic conditions.

Literature Cited


