STATUS AND LIFE HISTORY OF THE EVERGLADE KITE IN THE UNITED STATES

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Abstract.--The Florida everglade kite, Rostrhamus sociabilis plumbeus, though reduced in numbers to hardly more than 20, still has a chance to survive. This northernmost subspecies is found only in southern Florida where its continued existence depends on the fresh-water marsh snail Pomacea paludis, its only food. Preservation of some suitable marsh areas, as in Loxahatchee National Wildlife Refuge, is essential to the survival of this endangered species.

The Florida everglade kite, Rostrhamus sociabilis plumbeus, the northern race of the wide-ranging everglade kite, or snail kite as it is frequently called, is one of the rarest birds occurring in the United States. Its numbers are smaller than those of the more widely publicized California condor and whooping crane.

Considerable emphasis is currently placed on the status and management of threatened wildlife. Scientists and the general public should be made aware of all available information on each species. This paper summarizes the literature, documents unpublished observations of the authors, and presents the current status of this endangered subspecies. Observations and conditions on the Loxahatchee National Wildlife Refuge are emphasized.

The authors are grateful to governmental agencies, private organizations, and individuals who provided valuable assistance in the preparation of this paper.

DESCRIPTION

Adult

The everglade kite (fig. 1) is a medium-sized bird with a total length of 16 to 18 inches and a wing spread of 44 to 45 inches. Its beak is long and slender, yellowish or reddish at base and black on the distal part, and is noticeably hooked. Leg color ranges from red to yellow. Male: Generally dark slate gray. Head and upper back may be a somewhat lighter mouse gray. Tail coverts, basal half of outer tail feathers, and narrow tips of all tail feathers are white, light gray, or cream. Female: Upper parts mainly fuscous. White line over eye. Under parts are buff, broadly streaked with fuscous. White tail patch as in male.

Immature

Like adult female, although generally darker.

Juvenile

Juvenal plumage is generally tawny and heavily streaked with various shades of brown.

Downy young

Generally buff with cinnamon patches on upper surfaces. Dark eye patch. Beak black and strongly hooked. Figure 2 illustrates typical plumage characteristics of an 18-day-old nestling that has lost part of the down.

Plumage and molts

Bent (1937)[1] stated that the juvenal plumage is worn through the first winter; he reported birds in faded juvenal plumage in March, April,

[1] See References beginning on page 20.

and May. Much of the body plumage, primaries, wing coverts, and tail are molted in the spring. Some authors reported molting birds as late as June. Bent (1937) stated that the young males acquire some slate-colored plumage on the upper parts and on the breast and that much of the new plumage is broadly edged with tawny or cinnamon. He suggested that the immature males in question may have been molting into second-year plumage. Our observations have not revealed birds in immature plumage which included slate gray as a part of the color pattern. Several authors indicate that it may take 2 to 3 years for immatures to attain adult plumage.

DISTRIBUTION

Past

The historic range of the everglade kite species (Rostrhamus sociabilis) extended from northwestern Florida southward to Argentina, west to northwestern Argentina; Ecuador; Colombia; Nicaragua; Guatemala; eastward to eastern South America and Cuba (Hellmayr and Conover, 1949; Friedmann, 1950). These authors, the most recent authorities on the distribution of races of the everglade kite, agree that the subspecies found in the United States (R. s. plumbeus) is confined to the peninsula of Florida. Three additional races occur in Cuba, Mexico, and Central and South America (fig. 3). The subspecies was first recorded for Florida by Edward Harris (1844) near the head of the Miami River (Howell, 1932). Sprunt (1950) stated that the everglade kite was common in most of the fresh-water marshes of Florida until about the early 1920's. Howell (1932) described the Florida range of the species as follows: "breeds locally in the southern and central parts, north (formerly) to Panasoffkee Lake and Crescent Lake. Recorded from the Wacissa River and probably bred in that vicinity."

Present

Widespread and intensive development, for flood control, grazing, citrus orcharding and other agricultural use, and urban land use, has drastically altered and materially reduced much of the original habitat of the kite. The current known range of the everglade kite in Florida includes the marshes of Lake Okeechobee, and Conservation Areas 1, 2, and 3 of the Central and Southern Florida Flood Control District (fig. 4). The most desirable kite habitat based on current bird use is to be found in the southern part of Conservation Area 1 (Loxahatchee National Wildlife Refuge), the eastern section of pool 2A in Conservation Area 2, and the marshes on the southwest and west shores of Lake Okeechobee. There are occasional records of kites north of Lake Okeechobee in the past 20 years--St. Marks in 1950 (Sprunt, 1954), Wakulla Springs (Brookfield, 1953), Sarasota in 1955 (Stevenson, 1955), and upper St. Johns in 1966 (H. V. Hines, personal communication). That the observations are scattered may be attributed to the wandering tendency of this bird. None of the publications reviewed reported everglade kites south of the Tamiami Trail since 1955.

POPULATIONS

Total numbers past and present

It is impossible to determine the former population levels of this species. Considering the vast acreage of fresh-water marsh habitat available before human development, and the concentrations of kites reported in the literature, past populations were much higher than those reported in recent years.

By 1950, Sprunt estimated, not more than 100 and probably fewer than 60 everglade kites remained in Florida. A survey of the Lake Okeechobee marshes in 1956 revealed 11 adults and six nests which produced two young (Wachenfeld, 1956). On that basis, Wachenfeld stated, 20 birds would be an optimistic estimate of the total kite population. Since the early 1960's most kite observations have been on Loxahatchee National Wildlife Refuge and Conservation Area 2. In 1963 eight kites were noted on Loxahatchee. On June 17 of the following year six adult males and nine adult females or immatures were counted.

Figure 1.--Everglade kites. Adult female on left and adult male on right.

Figure 2.--Young everglade kite approximately 18 days old.

Figure 3.--General range of subspecies of the everglade kite Rostrhamus sociabilis.

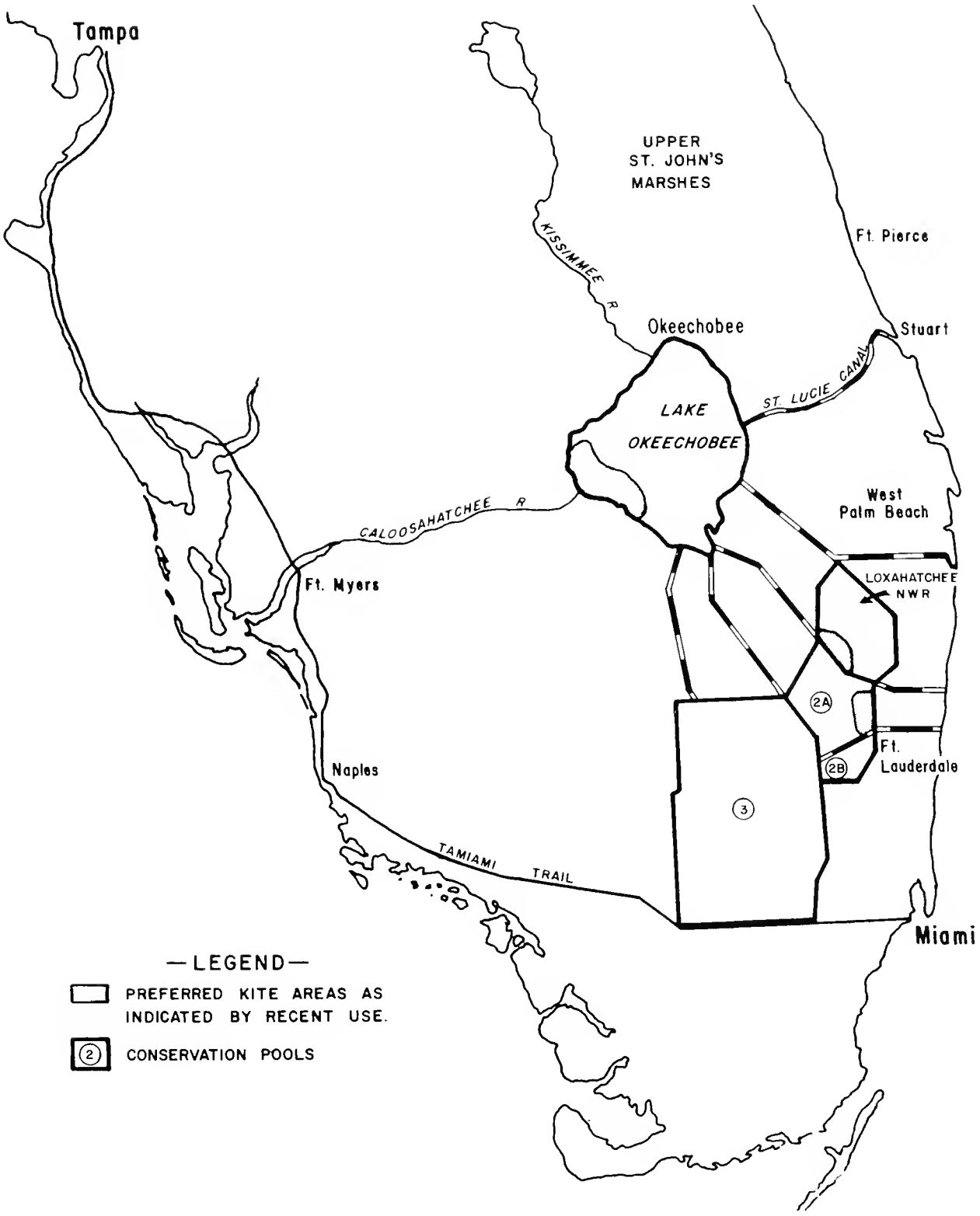

Figure 4.--Primary range of the everglade kite in south Florida, 1966.

Subsequent to this observation two young were reared, bringing the 1964 total to at least 17. Two kites were reported on Lake Okeechobee in 1964, but it was impossible to determine whether these birds had already been counted at Loxahatchee.

After the departure of the kites from Loxahatchee in the fall of 1964, very few reports of kites were received for a time. An extensive aerial and ground survey over most of the remaining kite habitat in south Florida was conducted by personnel of the Bureau of Sport Fisheries and Wildlife, August 23-25, 1965, and 10 everglade kites were observed, eight in the eastern half of Pool 2A in Conservation Area 2 and two on Lake Okeechobee.

Periodic surveys of Conservation Area 2, Lake Okeechobee, and the Loxahatchee Refuge have been carried out since 1965 to maintain a check on the kite population. Records of confirmed and unconfirmed observations were kept to obtain the most accurate population estimate possible.

The most significant report was of 21 kites observed in Pool 2A in February 1966 by Florida Game and Fresh Water Fish Commission personnel, the largest concentration reported in recent years. On April 15, 1966, the senior author observed 16 kites in Conservation Area 2. Four were known to be present on Lake Okeechobee on that date, indicating a minimum population of 20 birds in 1966.

Everglade kite use of Loxahatchee National Wildlife Refuge

Howell (1932) and Bent (1937) mentioned that the marshes now encompassed by the Loxahatchee Refuge historically were used by everglade kites. Bent stated that everglade kites were breeding commonly in the southern Everglades west of Palm Beach. Howell noted that they were breeding in numbers in the Loxahatchee Marsh in 1921.

Loxahatchee National Wildlife Refuge was established in 1951 under a lease and license agreement with the Central and Southern Florida Flood Control District (FCD), with the Bureau granted fish and wildlife management rights.

The first record of kites following refuge activation was contained in the September-December 1952 "Refuge Narrative Report" which stated that "several" had been sighted. A spasmodic use pattern is indicated by further refuge reports which note occasional sightings of one to three birds until 1962. One observation was recorded in March of that year, and in November the kites returned for a protracted period. There was continuous use of the refuge from November 12, 1962, until September 11, 1963. The highest number observed during this period included three adult males, two immature males, two adult females, and a single nestling. The 1963 nesting represented the first breeding record since the refuge was established.

After the June nesting effort the kites wandered off the refuge during the fall and winter months. They reappeared February 26, 1964, when five were observed. Numbers increased to a peak of 15 adults and immatures on June 17. On July 9, two nestlings about 30 days old were noted in the southwestern part of the refuge. Subsequent observations indicated that both probably reached flight stage. At this time the Loxahatchee Refuge supported the bulk of the everglade kite population in the United States, and possibly the entire population.

HABITAT

General

Everglade kites are inhabitants of fresh-water marshes which support adequate quantities of the fresh-water snail Pomacea paludosa, their only known food. Detailed descriptions of habitats used by kites are not found in the literature. The following comments will generally be restricted to our observations of areas kites have been known to use in recent years.

Loxahatchee Refuge

Of 195 kite observations on Loxahatchee which were identified by location, 98 percent come from the southwest section of the refuge

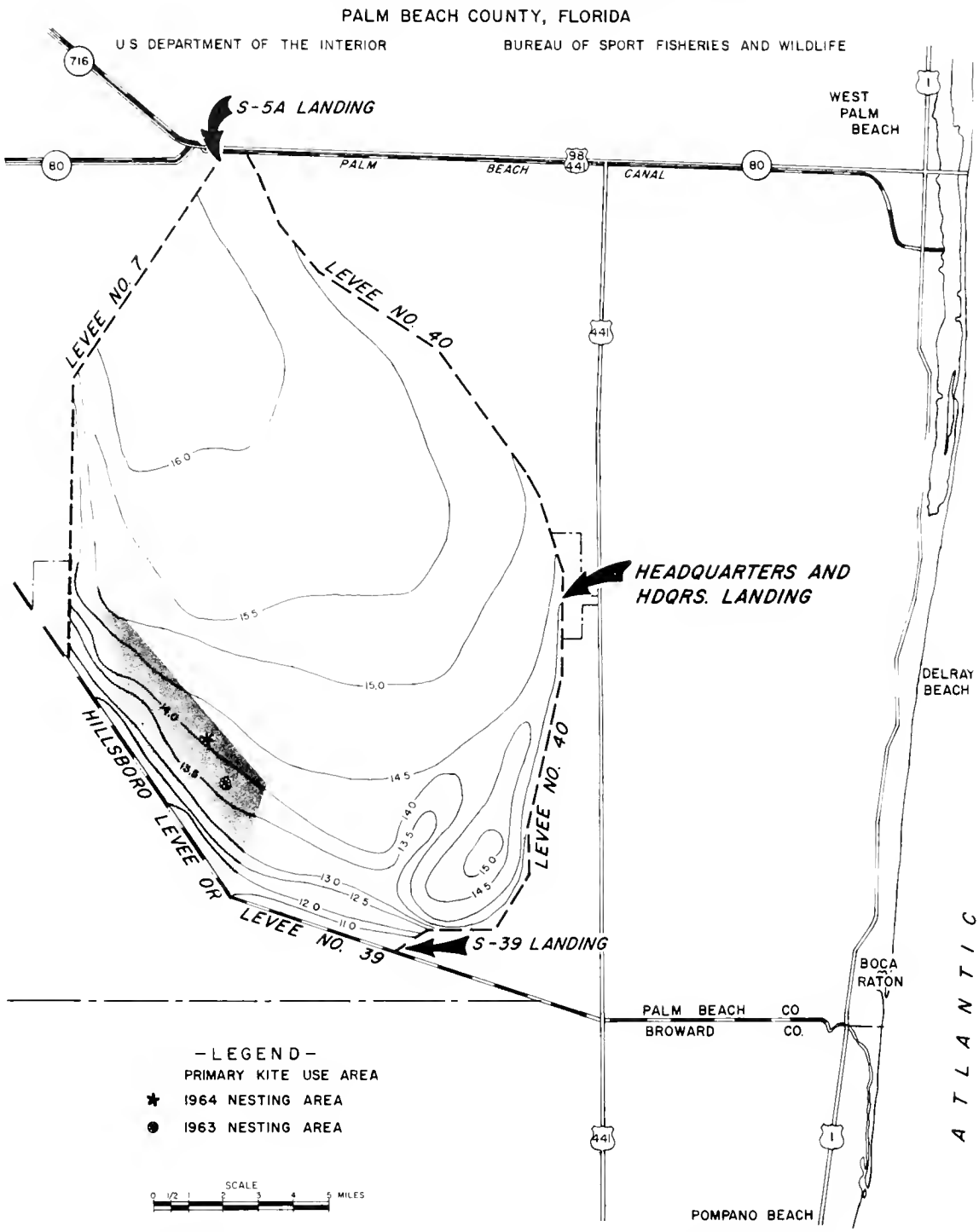

Figure 5.--Land elevations and primary everglade kite use area, Loxahatchee National Wildlife Refuge.

Figure 6.--Everglade kite habitat in southwestern section of Loxahatchee National Wildlife Refuge. Note abundance of open areas that are excellent snail habitat.

Figure 7.--Everglade kite habitat in the Moonshine Bay area of Lake Okeechobee.

(fig. 5). This area (fig. 6), encompassing approximately 11,500 acres, represents roughly 8 percent of the total refuge acreage. The only observations outside this area were near S-39 and in the vicinity of refuge headquarters.

Before construction of the Hillsboro Canal the present "kite area" of Loxahatchee was a transition zone between the sawgrass (Cladium jamaicensis) slough community to the north, and a second type characterized by a large number of tree islands interspersed with sawgrass and shrubs to the south. The vegetative communities were altered by flooding following the completion of the Hillsboro Canal and Levee 39 in July 1960. Many trees and shrubs on the tree islands died, and some sawgrass was eliminated. The area still contains a sizable acreage of sawgrass, broken up by a number of sloughs. Considerable areas of relatively open water exist, vegetated by low-growing species like white waterlily (Nymphaea odorata), big floatingheart (Nymphoides aquaticum), maidencane (Panicum hemitomon), sloughgrass (Panicum paludivagum), false maidencane (Sacciolepis striata), spikerushes (Eleocharis elongata and E. cellulosa), bulltongue (Sagittaria lancifolia), and pickerelweed (Pontederia lanceolata). The submergent vegetation is dominated by the bladderworts (Utricularia floridana and U. purpureum) and southern naiad (Naias guadalupensis). Muskgrass (Chara sp.) and waterweed (Elodea sp.) are locally common.

Pest plants like cattail (Typha domingensis), alligatorweed (Alternanthera philoxeroides), water-hyacinth (Eichornia crassipes), and waterlettuce (Pistia stratiotes) are present in the area.

The tree islands are very similar to those found in Conservation Area 2. Many dead snags remain standing, as they do in the former area. Dominants are holly (Ilex cassine) and willow (Salix amphibium). Waxmyrtle (Myrica cerifera) and buttonbush (Cephalanthus occidentalis) are also abundant. Pickerelweed, bulltongue, ferns, and sawgrass are commonly found in the understory.

The general soil types found within the area are Everglades peat and Loxahatchee peat.

Lake Okeechobee

Over the years, many sections of marsh surrounding the lake have been used by everglade kites at one time or another. In recent years (since 1950) the areas of most intensive use have been Kreamer-Torry Island, Redlight Reef, Turners Cove, and Moonshine Bay. Moonshine Bay, which includes several thousand acres in the southwestern part of the lake, has had the most use (fig. 7); it is generally open marsh, vegetated by low-growing grasses and other emergent aquatics. A few very small islands, covered by dense, low vegetation, are scattered through the marsh. The open marsh gradually intergrades with moderately dense sawgrass, which in turn gives way to low shrubs and trees on the highest elevations. Many pest plants present on Loxahatchee Refuge and Conservation Area 2 are also found on the lake.

Conservation Area 2

Conservation Area 2 is basically a mixed sawgrass-slough community interspersed with occasional tree islands (fig. 8). The interspersion of sawgrass and sloughs is probably the key to the appeal of the area to kites (see figure 9 for typical example). Excluding tree islands, the composition of areas in which kites have been observed ranges from 80 percent sawgrass and 20 percent slough to 60 percent sawgrass and 40 percent slough. Low-growing trees like waxmyrtle and holly are scattered throughout the sawgrass and provide perching sites and potential nesting sites. Many trees on the tree islands are dead, but some are still living. Tree islands are generally flooded with a few inches of water and are vegetated by holly, willow, waxmyrtle, buttonbush, an occasional redbay (Persea borbonia), ferns, pickerelweed, bulltongue, and miscellaneous other herbs and grasses. The tree islands are used as loafing areas and serve as potential nesting sites. White waterlily is the dominant plant of the sloughs; maidencane is locally common. Bladderworts are the most abundant submergents. Loxahatchee peat is the major soil type.

Water levels

Adequate water levels are the key to kite use of any area. Unless a permanent water supply can be maintained to support snail populations and the proper vegetative complex the area will become valueless to the birds. A consideration of the effects of water levels upon kite use of Loxahatchee Refuge and Pool 2A emphasizes the importance of this relationship.

Land elevations in the Loxahatchee kite area vary from 11.0 to 15.1 feet above sea level (fig. 5). At the highest scheduled water level (17.0 feet m.s.l.) the area would be flooded with 2 to 6 feet of water. At the lowest stage (14.0 feet m.s.l.) the northern part would be dry and the southern section shallowly flooded. Our present knowledge of snail life history is inadequate for us to fully evaluate the effects of scheduled levels upon molluscan populations, but prolonged dry periods are known to be detrimental to aquatic members of such populations.

The levee system surrounding Loxahatchee Refuge was completed in July 1960. Water levels have fluctuated erratically since that time, ranging from a low of 9.85 feet m.s.l. in May 1962 to a high of 18.12 feet in October 1960 (fig. 10). During periods of most intensive kite use, water depths generally ranged in 1963 from a few inches to 30 inches and in 1964 from 11 to 30 inches over the area of principal use. Water depths at the nesting tree islands during the breeding season ranged from 4 to 21 inches in 1963 and from 11 to 20 inches in 1964.

Water depths during May and June 1965, months when nesting was begun in the past, were extremely low. By early May only about half of the area was flooded. Levels continued to diminish until a low reading of 11.20 feet was recorded on May 28. At that time the entire refuge was virtually dry except for peripheral canals, alligator holes, and a small area in the vicinity of the Hillsboro Canal. These low levels may have been partly or completely responsible for lack of kite nesting on the refuge in 1965. Levels were generally favorable from February to mid-April, the period when some of the birds arrived on the refuge in 1963 and 1964.

The area most frequently used by kites in the eastern part of Pool 2A lies between the 10.5-foot and 11.5-foot contours. Levels within this area were generally favorable for kites during the 1963 and 1964 nesting seasons, as depths ranged from 1 to 2 feet during the former year and from 1.4 to 1.8 feet during the latter. For some unknown reason the birds selected Loxahatchee for nesting. This is not to rule out the possibility that some nesting may have occurred in Conservation Area 2, but no birds were reported from that area during the period under discussion. During 1965, water levels in Pool 2A were generally more favorable for kites than in Loxahatchee. The kite area of use in 2A did not go dry as it did on Loxahatchee, as water depths ranged from 0.2 foot to 2.7 feet during the February-to-July period.

LIFE HISTORY

Breeding season

Sprunt (1950) reported that the breeding season of the everglade kite may vary widely but is normally from late February until mid-June. The egg dates recorded in Bent (1937) for 68 Florida nests ranged from February 15 to July 20, with 34 records from March 13 to April 28. Observations by Bendire (1892) indicated a nesting season from the latter part of February to the first part of May, with most efforts in March or early April. Nicholson (1926) noted 10 nests in the upper St. Johns on April 27 that varied from the early construction stage up to nests containing young 12 days old. He also noted a brood of three already on the wing on that date. Henry Redding reported about 30 nests in the St. Johns River marshes between Feburary 14 and February 19, 1927 (Howell, 1932). Some of these nests contained young, and others fresh eggs. According to Sprunt (1950) the latest nests on record were observed by Clinton Sherman south of Clewiston, who found four nests with eggs and young on November 2, 1941, and another nest on November 9 containing three eggs.

In 1963 and 1964, when nesting was observed on Loxahatchee National Wildlife

Figure 8.--Area frequently used by everglade kites in the eastern section of Pool 2A, Conservation Area 2. Large tree island on left, numerous sloughs in center, and sawgrass with scattered sloughs on right.

Figure 9.--Typical everglade kite habitat. Slough to left, sawgrass to right and in background.

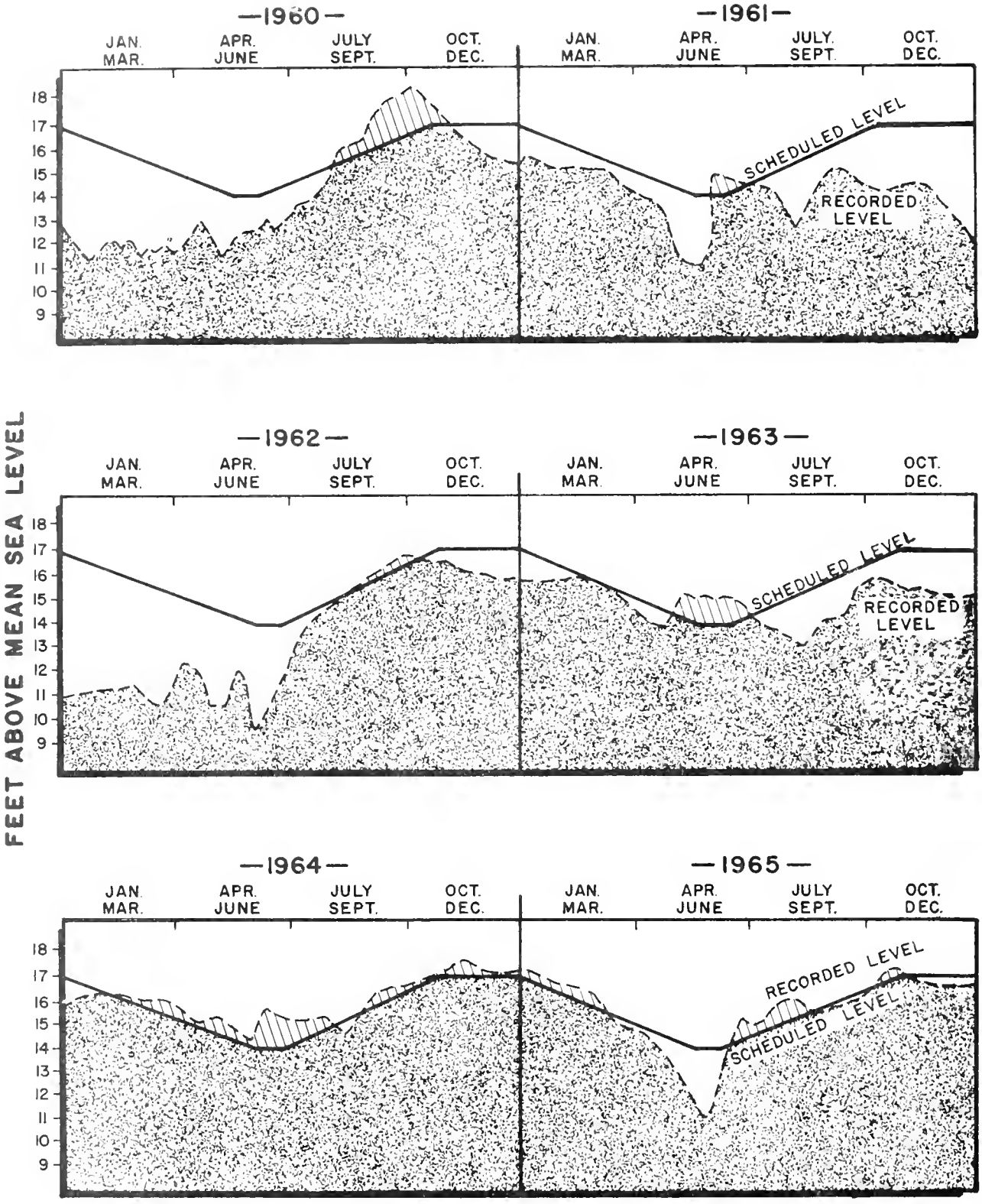

Figure 10.--Fluctuations in water levels in Loxahatchee National Wildlife Refuge, January 1960 to December 1965, as derived from gauge 1-8.

Refuge, the earliest nests were two observed on April 18, 1963, and one on April 25, 1963. Two later nests that year were discovered in May. The single 1964 nest was not located until July 9, when it contained young about 30 days old, indicating that it was started sometime in May. During 1965 the few known kites were located in Conservation Area 2 about 4 miles south of their former nesting area in Loxahatchee, and nesting, if any, went unobserved. In 1966 the birds stayed in Conservation Area 2, and three or possibly four nests were reported in February. This area was visited by the senior author on April 15, when two nests were observed. Nesting attempts on Lake Okeechobee were recorded in May and June. Nesting in Conservation Area 2 was begun in February 1967.

Territoriality

The everglade kite is relatively gregarious and normally nests in a loose colony. Sprunt (1950), Bendire (1892), and Nicholson (1926) all reported a colonial nesting tendency, although several authors noted that solitary nests were occasionally observed (Sprunt, 1950; Nicholson, 1926). Nicholson (1926) noted two nesting colonies in the St. Johns marshes only 150 yards apart. Bendire (1892) quoted a Mr. Gibson as having observed a colony of South American everglade kites breeding in a large swamp in Argentina. Twenty or thirty nests were spaced only a few yards apart in that aggregation.

Everglade kite nests on Loxahatchee were generally in loose colonies. In 1963 a total of five nests were constructed within an area of 6 or 7 acres. In 1964 the colony was fairly well restricted to a small tree island of approximately 1 1/2 acres.

Everglade kites have frequently been observed nesting in or adjacent to colonies of other species such as herons, egrets, and anhingas, indicating a certain amount of interspecific tolerance. Both kite nesting colonies on Loxahatchee have been situated on tree islands being used by other species for nesting. Anhingas and green herons were incubating and rearing young in the tree island used in 1963. The small tree island used in 1964 contained 25 to 35 nests, most of which were those of anhingas. Approximately 80 percent of the nests contained eggs or young. Some interspecific strife was noted in the latter situation. Kites were seen to dive at perched anhingas on several occasions, and if kites moved too close to an anhinga nest the adult anhingas would normally drive the intruders away. Kites apparently will tolerate a certain amount of disturbance before deserting their nests, although Sprunt (1950) noted that kite nests situated near heavily used boat trails on Lake Okeechobee were sometimes deserted, even though not closely approached. The stage of nesting probably has a considerable bearing on the amount of disturbance kites will tolerate, as it does with most birds. Care was taken to prevent disturbance of the Loxahatchee nesting colonies. When nests were approached, the adults normally responded by flying nearby, sometimes emitting a cackling type call. On several occasions nests with young were closely approached, but the adults failed to put in an appearance.

Courtship

The courtship behavior of the everglade kite has not been adequately described, and the literature contains few significant observations. One by John H. Baker was reported in Bent (1937). In this instance Baker saw a group of three kites soaring about 500 feet over the marsh, repeatedly folding their wings for sudden short dips, much as kingfishers and terns do when plunging. Townsend (1927) described a similar display. He noted that occasionally one would turn on its side and stretch its legs as if to grapple. The birds were also seen to fly to a considerable elevation, dive swiftly downward with wings curved back, and then turn completely over, end to end.

Stick carrying seems to be an integral part of the courtship display. The following notes were made while observing 10 kites in the vicinity of a small willow island on Loxahatchee Refuge in 1964. On numerous occasions a male was seen to break off a small twig and fly out over the marsh with it in its beak. Usually the kite would be harassed by a red-winged blackbird, drop the

twig, and return to a perch; at other times the bird would voluntarily drop the stick and return to the perch. Several times male kites with sticks in their beaks were observed flying to considerable heights before making a series of swooping dives with wings folded as they dived. At one time four birds were engaged in this activity. In 1966, a similar display of stick carrying and diving was observed by several persons.

In 1963, five nests were constructed, but only two contained eggs. On several occasions immature males were noted carrying sticks and standing on freshly constructed nests. Several of these "false" or dummy nests were also observed in 1964. Another interesting observation made in 1964 that may link stick carrying and false nest building to courtship behavior was performed by two adult males in the presence of a female. The female was perched some 2 feet to one side and slightly above a nest containing two green heron eggs. One male flew to the nest, walked around it several times, and picked up a twig from the nest. Within a few minutes this bird was driven off by another male with a considerable exchange of clucking calls. The second bird performed a display similar to that of the male which had been displaced. After about 10 minutes the female flew away. In another instance two males were observed flying to a nest which later proved to be the one in which the young were reared. Their actions were similar to that observed at the first nest, but no female could be seen nearby. In this instance the birds occasionally got into the nest in a position similar to that of an incubating bird, but remained in this position only two or three minutes.

Another display, while probably not courtship behavior, was also noted in 1964. Two birds were seen at a very high altitude, at first barely discernible to the naked eye, and shortly thereafter visible only with 7x-by-50 binoculars. The two birds flew very close together and did numerous steep dives, rolls, and turns. They were joined very briefly by a third bird which sailed out of sight after about 10 minutes. This impressive display lasted nearly one hour.

Nesting and nesting habitat

Generally kite nests are placed over water in low shrubs or trees. In some instances sawgrass has been used for nest support. Nicholson (1926) reported that of 10 nests found in one day on the upper St. Johns River marshes, three were in sawgrass clumps, while all others were in dead or partially dead myrtles. Howell (1932) stated that the nests are usually built over water in dead willows or myrtles in the marsh. He also stated that kite nests are frequently concealed by tall sawgrass which nearly always surrounds the site. Howell also noted kite nests in small cypress trees in the Loxahatchee marsh.

Sprunt (1945) stated that two general areas were used for nesting on Lake Okeechobee. Both were offshore and were vegetated by tall reeds and grasses interspersed with willows. Some kite nesting is known to have occurred on very small islands in the open marsh of Moonshine Bay. Nesting on the lake has been concentrated in areas vegetated with thick stands of willow, reeds, cattails, and bulrush (Scirpus sp.).

Relatively small tree islands normally flooded, and adjacent sawgrass areas were used by kites for nesting on Loxahatchee in 1963 and 1964. The tree island used in 1963 was 4 to 5 acres in size. The dominant feature was a rather dense stand of dead trees ranging from 10 to 20 feet in height, and dead shrubs. A few living willow and buttonbush plants were present. Pickerelweed and bulltongue were common members of the understory, with a few plants of cattail, sloughgrass, sawgrass, and ferns also present. Rather extensive sloughs surrounded much of the tree island, especially on the southwest and northeast sides.

In general, the 1964 site was similar to the 1963 site. This tree island of approximately 1 1/2 acres was covered at the time of use by many dead snags 15 to 20 feet tall and a number of green willows 10 to 16 feet tall. Pickerelweed was common in the understory, with cattail present in lesser quantities.

Figure 11.--Everglade kite nest constructed in dead holly.

Buttonbush, sloughgrass, and bulltongue were also present but even less abundant. Sloughs and stands of sawgrass surrounded the tree island. White waterlily was abundant in the former community. Other species of plants noted in close proximity to the tree island were smartweed (Polygonum hydropiperoides), giant foxtail (Setaria magna), bladderworts, southern naiad, spikerushes, and ferns.

Two 1966 nests were examined in Conservation Area 2. One of these was located in a dead holly tree 7 feet tall, situated in dense sawgrass at the edge of a long, narrow tree island (fig. 11). A second nest was observed approximately a fifth of a mile from the first. This nest was located in a solitary, dead holly tree in a rather dense stand of sawgrass. The general habitat used for nesting in Area 2 differs from that used on Loxahatchee in 1963 and 1964 in that the former area contains more sawgrass and less open water. Both areas contain a number of tree islands dominated by dead trees and shrubs.

Everglade kite nests are somewhat bulky structures which are normally slightly more flattened than hawk nests usually are. They are easily confused with anhinga nests. Loxahatchee nests were constructed with sections of dead branches and twigs from what appeared to be willow, holly, and myrtle. The cavity normally was roughly lined with green vegetation such as grasses or vines. Bendire (1892) examined a nest which he described as "carelessly put together . . . composed of dry willow twigs, some of them 1/2 inch in diameter, lined with small stems of a vine and a few willow leaves." Maynard (in Bendire, 1892) noted a kite nest lined with dry sawgrass heads. This nest was about 1 foot in diameter. Loxahatchee nests were not measured, but Bendire (1892) reported that a nest he examined was 16 to 13 inches in diameter and 8 inches deep. The cavity was 7 inches wide by 1 1/2 inches deep. Nicholson (1926) stated that a nest he examined was fairly compact and measured 15 inches in diameter and 12 inches deep. The cavity of this nest was 3 1/2 inches deep.

Nests are normally located less than 8 feet above the water. The highest nest was reported by H. L. Stoddard from Wakulla Springs (Sprunt, 1950). This particular nest was built in a large cypress 30 feet above the water. The two active nests in 1963 were located 6 feet and 6 1/2 feet from the water. The only active 1964 nest was situated 12 feet above the water in a live willow.

Eggs

As reported by several authors (Nicholson, 1926; Bent, 1937; Sprunt, 1945) the normal clutch of the everglade kite is three or four eggs, but occasionally there are only two. The largest clutch (six) was reported by H. L. Stoddard (Sprunt, 1950). The eggs are mostly oval in shape with an elliptical tendency in some. The shell is smooth without gloss. Bent (1937) stated that "the ground color is dull white or rarely creamy white, but is usually concealed by profuse markings. Some eggs are heavily and boldly blotched, some irregularly spotted or blotched, some finely sprinkled with minute dots, and some washed with light browns, hazel, or ochracous tawny, so completely as to conceal the ground cover. The markings are usually in shades of chestnut, auburn, or chocolate, but sometimes lighter browns, hazel or tawny; rarely the browns are combined with fawn color or cinnamon drab in a pretty pattern. An occasional egg is largely white with only a few scrawls or small spots of dull light browns." The single egg examined in 1963 possessed a light tan ground color and was heavily splotched and dotted with shades of medium brown.

Bent (1937) reported the average measurement of 65 eggs as 44.2 by 36.2 millimeters. The eggs showing the four extremes measured 59.4 by 37.9, 47.4 by 38.3, 40.1 by 34.8, and 43.9 by 33.0 millimeters.

Unfortunately, the incubation period for this species is unknown, and this fact complicates the back-dating of egg laying, hatching, etc. Bent (1937) reported that both sexes incubate and assist in rearing the young.

Young

Young everglade kites are altricial. The nestlings observed on Loxahatchee were still in the nest on July 28. They were very close to adult size at that time. Nicholson (1926) provided data on the growth rate for this species in the following observation: "on April 27 young kites 6 days old were in the downy stage, and upon our return May 12 they were practically full feathered and would have likely been able to fly by May 20." If his estimate of flight date was accurate, this would indicate that the young remained in the nest for approximately 30 days. Observations on Loxahatchee in 1964 indicate that the nest period is longer. The two birds observed in the nest on July 9 were estimated by Alexander Sprunt IV of the National Audubon Society to be about 30 days old. The young were still in the nest on July 28 when they were approximately 49 days old. Neither of these observations is based on a complete set of known dates; therefore, the nesting periods should be viewed as only rough approximations.

Nesting success

Nesting success for this species is extremely variable and in certain years is known to be quite low. Sprunt (1949) reported on the fate of 10 nests under observation on Lake Okeechobee in 1938. Each nest originally contained three eggs. In each of four nests only one egg hatched; in each of three nests two eggs hatched; in each of two nests all three eggs hatched; and in one nest no eggs hatched. Out of 30 eggs, 14 were infertile or failed to hatch for some unknown reason. Sprunt pointed out that 1938 was a year of low success, but that hatching success improved in 1939 and 1940. Wachenfeld (1956) summarized the fate of six active nests found on Lake Okeechobee in 1956. Two were destroyed by unknown causes; two were lost to predators (one to boattailed grackles and one presumably to a water moccasin); and the other two were tilted when water levels dropped and the reeds supporting the nests separated. In one of the tilted nests, one of three eggs hatched but the young drowned when the nest fell apart. In the other, three young hatched but one of these also drowned; the remaining two young were last observed as fledglings.

Three eggs were known to have been laid in nests on Loxahatchee in 1963. In one nest, one egg of two hatched and the young probably survived to flight stage. In another nest a single young was observed which subsequently died from unknown causes when about one-third grown. The latter nest may have originally contained additional eggs but (to prevent disturbance) was not inspected during the early stages of laying and incubation.

In 1964 only one active nest was known to exist. The original clutch size is unknown, but two young were observed in the nest at an

advanced stage of development. Both probably survived to flight stage.

No nests were observed in 1965. Three and possibly four nests were known to exist in Conservation Area 2 in 1966. Two eggs were deposited in one nest and three eggs in each of the other two. None of these eggs hatched. Two fledgling kites were observed in June 1966, indicating the presence of a fourth nest.

Three nests were observed in Conservation Area 2 in 1967. One nest containing three eggs was destroyed by an unknown predator. A single kite fledged from the second nest. Two nestlings were noted in the third nest; one died and the other reached flight stage.

Feeding habits

Personal observations and reports from various publications indicate that the fresh-water snail (Pomacea paludosa) comprises the entire diet of the everglade kite. Cottam and Knappen (1939) examined the stomachs and crops of four kites collected in Florida. Three stomachs contained only fleshy parts of Pomacea and the fourth (crop and stomach) 97 percent snail remains, 3 percent plant debris, two mites (Galunidae), and a midge larva (Chironomidae). All items other than the snail could have been picked up accidentally, either when the snail was captured or as snail stomach contents. Eight whole snails and parts of at least 12 others were represented in the four samples. Nicholson (1926) examined five stomachs of young and adult kites; only snail remains were present.

Numerous observations of kites capturing snails have been made by the writers and other refuge personnel. In the normal pattern the kite flies slowly over the marsh at a very low altitude, casting back and forth in search of its prey. Spotting a snail the kite drops swiftly and clutches the prey with its talons. Usually it carries the gastropod to a favored feeding perch where the snail is extracted from the shell and swallowed whole. Lang (in May 1935) reported that in the extraction process "the kite grasps the body of the snail, between the operculum and the shell, in its blunt-edged but deeply hooked bill. The muscular contraction of the snail's body apparently detaches it from its attachment within the shell, and a moment later, with a shake of the kite's head, the shell is tossed aside and the body swallowed, including the operculum." Howell (1932) reported that snails were swallowed in pieces half to three-fourths of an inch in length. Our observations indicate that adult kites swallow snail bodies whole after they have extracted them from the shells, which are discarded.

Some observers have reported seeing kites extract the snails while in flight, but the extraction process that we observed has been confined to perched birds. Usually a kite will sit on its perch for several minutes after capturing a snail before attempting extraction, but sometimes it will extract it immediately. The junior author handled several hundred Pomacea and noted that only when tapped on a hard surface or scratched repeatedly with a fingernail would the snails close the operculum so tight as to make extraction difficult.

SNAIL LIFE HISTORY

The fresh-water snail Pomacea paludosa, the only known food of the everglade kite, is little known itself. The information presented here is derived largely from limited observations.

Pomacea paludosa has a fairly extensive range compared with that of the everglade kite. The snail is found in most fresh-water areas over the State of Florida including parts of the Keys. This species is characterized by a globular shell, with a large body whorl. The spire is flat and depressed, sometimes making the coil flat. The aperture is somewhat expanded and the operculum concentric. The snail itself has a long siphon; left gill much smaller than right; muzzle ending in two long feelers; tentacles very long. General shell coloration is grayish green to olive green, with the upper surfaces sometimes faded to a light yellow or buff. The shell is frequently marked with uneven bands of darker green.

The presence of snails is easily detected by the presence of egg clusters. These egg masses have been noted year round on Loxahatchee National Wildlife Refuge. Eggs are

laid in limy capsules which are generally attached to emergent stems or leaves of aquatic vegetation (fig. 12) but may be attached to pilings, boats, sticks, posts, or other substrata. Observations in 1964 on Loxahatchee indicated that the snails normally deposit their eggs during the night, starting around 10 p.m. An account of egg laying in an aquarium was reported by Clayton J. Hurlbut (Innes, 1946): it began at 11:30 p.m. and lasted about two hours. The clusters are attached 4 to 12 inches above the surface of the water. Ligas (1956) reported that the number of eggs in 159 clusters examined ranged from 5 to 69 and averaged 28.8. Egg clusters examined at Loxahatchee were collected along canals and from the interior of the conservation pool; the number of eggs per cluster ranged from 3 to 82. For 99 clusters collected in the interior the average number of eggs was 25.6; for 77 clusters along canals it was 35.5. The eggs are 4 to 6 millimeters in diameter, and are pearly pink when first laid. The color changes to white before the snails hatch. Inglis (pers. comm.) reported that snails received from Loxahatchee for a pesticide study in 1964 laid two batches of eggs while being held in a 100-gallon tank. The first batch of 19 eggs hatched in 18 days. None of the second batch hatched. Eight freshly laid eggs were included in the shipment, and one of these hatched in 16 to 18 days.

The snails are largely nocturnal. Little is known about the feeding habits of the snail. The senior author fed two snails in a 3-gallon aquarium southern naiad, Elodea, coontail (Ceratophyllum demersum), bladderwort, water-hyacinth, and waterlettuce; the snails showed a preference for bladderwort, naiad, and Elodea. Stomach contents of three snails examined at the Patuxent Wildlife Research Center in 1965 revealed several invertebrates (an orabatid mite, a very small weevil-like beetle, and remains of an ostracod), as well as algae and vascular plant material. Two hundred fifteen live snails were held at the Center and fed fresh lettuce which the snails readily ate for about a week. Thereafter, feeding activity apparently stopped and mortality increased rapidly.

During period of low water levels on Loxahatchee, notably in 1962 and 1965, the snails were easily found, especially in the perimeter canals. Surprisingly large numbers of egg clusters, well distributed over the refuge, were observed soon after the return of water to the area in both 1962 and 1965, indicating that remnant populations survive. The Ampullaridae, of which Pomacea paludosa is a member, are characterized by Rogers (1908) as "an amphibious family of tropical distribution in both hemispheres . . . the gills lie in a large, partially closed breathing cavity, which adapts the mollusks to life out of the water. In dry seasons they bury themselves in mud, indeed, they survive removal from water for months, breathing air, but probably keeping the air chamber moist." It is not known whether Pomacea paludosa is capable of sustaining life in this manner. If it is, that fact would help explain the relatively rapid reappearance, in extensive areas, of such a slow-moving species. Live snails can float, and wind and water transportation also influence their distribution.

PROBLEMS AND LIMITING FACTORS

Habitat

Problems influencing the survival of the everglade kite are numerous and critical. Some are evident; others can only be theorized.

Development of the once vast freshwater marshes of Florida has probably contributed more to the reduction of kite range and numbers than any other factor. The reduction of marsh acreage is evidenced by the fact that only 1,537 square miles (56 percent) of the 2,746 square miles of original everglades remain today in a near-natural condition. The upper St. Johns River marshes in east-central Florida demonstrate the impact of habitat loss on the kite habitat and population. At one time everglade kites were considered fairly abundant in this area. Howell (1932) reported that D. J. Nicholson found 12 pairs of breeding birds near Fellsmere in 1925, and that Henry Redding observed about 30 nests in the St. Johns marshes in 1927. By 1950 only 4 pairs were estimated to inhabit these marshes. Published notes do not reveal any observations since 1951, but occasional wandering birds have been seen

Figure 12.--The freshwater snail (Pomacea paludosa) with typical egg clusters.

in the area (Hines, pers. comm.). Many of the original St. Johns marshes are now under intensive land uses including grazing, citrus orcharding, and flood control facilities.

Water

The problem of water is worthy of special mention. Water conservation has become a matter of grave importance in South Florida. This extensive area has an average rainfall of 55 to 60 inches, and includes a vast network of flood control and drainage systems. In recent years excessive water has not been as critical as the shortage of quality water in a satisfactory distribution pattern.

Water levels for Loxahatchee Refuge (fig. 10) clearly show that suitable kite marsh may be subject to periodic drought despite management efforts. The loss of all suitable kite habitat to periodic drought, either man-made or natural, is not inconceivable.

Hunting and disturbance

Several authors cite instances of kites being shot by duck hunters on Lake Okeechobee. Others have noted the possibility of nesting losses due to human disturbance. Everglade kites are fully protected by State law, but shooting by careless hunters and excessive human disturbance are still potential causes of mortality.

Pesticides

The environment of the everglade kite has been contaminated for years by various pesticides. In most cases we have a poor understanding of the direct effects of these pesticides or indirect effects through action on the kite's food chain. Large quantities of insecticides, herbicides, and fungicides are applied to the agricultural land around Lake Okeechobee and the FCD conservation areas. These compounds are transported through the canal systems and ultimately reach the interior of the conservation areas and the lake.

Thirty Pomocea snails collected on the south end of the Loxahatchee Refuge in 1965 were analyzed for chlorinated hydrocarbons. DDT, DDE, and BHC were found in minute quantities. A kite found dead and an infertile egg were analyzed in 1967 for chlorinated hydrocarbons. Very low concentrations of DDT, DDD, DDE, BHC, dieldrin, and heptachlor expoxide were isolated. Pesticide residues were extremely low and probably reflect the general contamination of the environment. So far as present knowledge indicates, such quantities should not have been hazardous to the kite or egg. The control of pest plants and insects has become part of land, water, and crop management. The use of 2,4-D amines and esters in Lake Okeechobee, the conservation areas, and FCD canals has been occurring for years. The long-term effect of pesticide residues in the ecosystem is difficult to evaluate. The potential adverse effects must be contrasted with the immediate probability of habitat loss or alteration caused by uncontrolled pest plant invasion.

Physiological and psychological factors

Several elements of the kite's physiological and psychological makeup may be limiting factors. The effects of inbreeding in a population of fewer than 25 birds is not known. Relatively low hatching success in recent years lends support to the theory that inbreeding may be a limiting factor. The psychological effect of smallness of population on a bird that demonstrates loose colonial nesting and is gregarious in nature is unknown at present. Nesting attempts on Loxahatchee Refuge in 1963 and 1964 were much lower than anticipated considering the potential breeding population.

Diseases and parasites

The potential threat to the kite by diseases and parasites is virtually unknown. Snails are known to serve as intermediate hosts for several species of internal parasites of wildlife. Drought and associated low water levels may cause snails and kites to concentrate in areas containing low-quality water. In such situations possible effects of disease and parasites on kite numbers cannot be overlooked.

Weather

Hurricanes and other climatic factors undoubtedly affect the kite. Direct wildlife mortality is to be expected during a severe hurricane, but of greater significance are the effects of wind and water on habitat.

THE FUTURE

The everglade kite population has managed to survive despite the many problems and limiting factors which confront it. The fact that the population has at least held its own during recent years indicates that with proper management and complete protection there is still a chance that numbers will eventually increase to the point where there is no immediate danger of extinction.

The remaining fresh-water marshes in Florida are constantly threatened with further encroachment. In recent years for example, Conservation Areas 1, 2, and 3, which contain some of the best remaining kite habitat, have been proposed as sites for oil pipelines, highways, TV towers, oil exploration, and further flood control development. These fresh-water marshes have a high value not only for the kite but also for numerous other species, including some others considered rare or endangered. Strong efforts should be made to maintain these areas in their present condition and to prevent additional destructive inroads.

Water conservation in south Florida is of paramount importance. Wildlife interests are closely tied to the water resource, and only through continuous effort will the kite and other wildlife species be assured of survival.

Careless hunters and other human disturbance will continue to be a serious threat as more and more people use the ever diminishing marshes for outdoor recreation. Some effort has been made to bring the plight of the endangered species to the attention of the public, but more intensified conservation education is needed.

Effects of other potential limiting factors such as pesticides and disease are poorly understood. The everglade kite's life history and ecology are not well known. A complete research program is needed before sound management recommendations can be formulated and implemented.

The road to recovery will not be easy or assured. A concerted effort by all natural resource agencies and the public at large will be necessary to achieve preservation of the everglade kite.

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