



## Literature Review of Florida Apple Snails and Snail Kites and Recommendations for their Adaptive Management

### Background

The snail kite (*Rostrhamus sociabilis plumbeus*), which has been federally listed as endangered since 1967, is found in the United States only in Florida. The snail kite primarily inhabits freshwater wetlands in the central and southern parts of the state, including the Everglades. This bird species is a dietary specialist that feeds almost exclusively on Florida apple snails (*Pomacea paludosa*) (Fig. 1), although snail kites are now feeding on non-native *Pomacea* snails in some areas (such as Lake Tohopekaliga in central Florida). The species is considered a key indicator of Everglades restoration due to its sole dependence on wetland habitats and its sensitivity to fluctuating ecosystem parameters, such as seasonal hydropatterns. A decline in the snail kite population started after 1999 (Martin et al. 2007), about the same time that the *South Florida Multi-Species Recovery Plan* was produced. Florida apple snail abundance also has decreased in some wetlands that historically supported the majority of the snail kite population (Water Conservation Area 3A, Lake Okeechobee; Darby et al. 2005, Darby 2006). Information important to conservation and management has been accumulating on the snail kite and apple snail for years. However, a review of hydrologic and habitat conditions that support these two species had not yet been produced. In light of the greater than 10-year population decline (Reichart et al. 2011) and the generally low native apple snail abundances found in several key wetlands (see above), it was an appropriate time to revisit our knowledge base for the snail kite and its nearly exclusive prey. This literature review and recommendations report is in response to calls to better integrate the information on apple snails and snail kites (Sustainable Ecosystems Institute 2007).



Figure 1. Male snail kite holding Florida apple snail.  
Photo by Rob Bennetts.

### Project Objectives

The objectives of this project were: 1) to develop a comprehensive report that reviews, summarizes, and synthesizes the available literature on the life histories of the snail kite and Florida apple snail, and to describe the ecosystem parameters (such as hydrology and plant community composition) that support them, and 2) to make recommendations for their adaptive management. The report also identifies information gaps and related research recommendations. The project incorporated an external review process that included a technical peer review (from an avian ecologist, macroinvertebrate ecologist, and plant biologist) and a review by state and federal agency personnel involved in snail kite conservation and management. Components of the report include:

- Description of population trends of the snail kite and apple snail and changes in hydrology and habitat conditions that appear to be associated with these trends, based on available peer-reviewed publications and reports.
- Description of methods used to monitor the two species, and of wetlands in which monitoring has been/is being conducted.
- Identification of restoration and management recommendations for snail kite and apple snail recovery that are based on the scientific literature and that are supported by snail kite, snail, and vegetation experts.
- Identification of long-term, system-wide, and specific-area monitoring needs essential to track the recovery progress of the snail kite, apple snail, and associated habitats.
- Identification of critical information gaps and recommended research projects pertinent to recovery of the species.

To meet a project goal of increasing public knowledge of snail kites and Florida apple snails and their recovery needs, the full report and fact sheet are available on The *Pomacea* Project website.

### Key Findings and Management Implications

The report provides overviews of the life history, ecology, and range of the snail kite and apple snail, and the history of monitoring and research of the two species since the late 1960s. A main focus of the report is on snail kite/apple snail demography and relationships to hydrology and vegetation. This information, as well as that on the influence of apple snail abundance on snail kite foraging, forms the basis (Table 1) for the management and monitoring recommendations in the report. The recommendations for management, monitoring, and restoration in an adaptive

**Table 1. Portion of table *Summary of trends and associations for snail kites*.**

TRENDS AND ASSOCIATIONS <sup>1</sup>
<b>Breeding Season</b>
Majority (89%) of nesting attempts in January–June.
Breeding may last longer with favorable water depths and abundant food.
Nesting peak may occur several weeks later in northern habitats.
<b>Nesting Substrates</b>
Woody substrate used most often except on some lakes.
Willow preferred when available.
Cattail and bulrush ( <i>Scirpus = Schoenoplectus</i> ) frequently used on central Florida lakes.
<b>Water Depths</b>
Water depths beneath nests range from 10 to 115 cm (average 40–60 cm) in Everglades; 94% of >200 nests initiated over water 20–80 cm deep in WCA3A in 1980s.
High water stages can lead to spatial shifts in nest distribution; kites avoided lower ground elevations (with depths >1.5 m) in WCA3A, WCA2B, and Lake Okeechobee.
Recession rates that lead to depths under nests <20 cm before nestlings fledge, especially during the peak breeding season, may result in lower fledging / juvenile survival rates.
<b>Foraging</b>
Snail densities less than ≈0.1–0.2/m <sup>2</sup> result in significantly longer capture times, decreased foraging bout success, and overall fewer kites foraging in the area.
Flooded marsh with low density emergent grasses and sedges best for foraging in Everglades; low density broad-leaved plants on lakes.
Foraging habitat commonly in close proximity to nesting habitat.
Depths less than ≈10 cm make snails unavailable to kites.

<sup>1</sup>Full table in the report includes detailed source information.

management framework come from past and current publications or reports, from U.S. Department of Interior cooperators, from the report authors, or from reviewers' comments during the external review process. The report includes eight recommendations for management, seven recommendations for monitoring, and seven recommendations for coordinated information gathering, analysis, and reporting. Key recommendations include:

- Develop hydrologic targets for management in wetlands deemed critical to snail kites using a similar approach to that used in the U.S. Fish & Wildlife Service *Multi-Species Transition Strategy for WCA3A*. Targets are needed for seasonal water depths, recession and ascension rates, and dry down return intervals and durations for wetland units that represent the majority of the kite's range from approximately Orlando southward to Everglades National Park.
- For wetland units deemed critical to snail kites, if adult-sized apple snail densities are reported to be less than approximately 0.1–0.2 snails per square meter, consider management options to increase native apple snail densities and improve snail availability to kites (for example, via plant management activities). This minimum snail density threshold may need to be revised as additional data are collected.
- Implement an apple snail monitoring program across the range of the snail kite. Such a range-wide effort should take advantage of monitoring that is ongoing and being conducted at the project-level scale. Sampling protocols should be standardized, cost-effective, and directly supportive of management.

- Establish a Coordinating Team or Committee for the snail kite with responsibilities that include forming a consensus on the best hydrologic and habitat conditions to support apple snails and snail kites, assessing needs for apple snail and snail kite monitoring, setting priorities for research and monitoring of kites and snails, and developing a communication plan to disseminate key information to natural resource agencies and the public.

During the development of the report, gaps were identified in the information needed for snail kite/apple snail management and conservation. These information gaps, which were developed into recommendations, are discussed below under *Recommendations for Future Studies*. As already noted, the report went through an external review process. All external review comments are provided in an appendix to the report, which also includes comment responses from the report authors. One of the key comments from members of natural resource agencies with wetland management responsibilities was to develop specific prescriptions for hydrologic management of wetlands to support snail kites and apple snails. More work is still needed in this area.

## Recommendations for Future Studies

One of the objectives of this project was to identify information gaps that can be filled by new research or monitoring studies. The report contains 15 research recommendations that are pertinent for management of snail kites and apple snails, including:

- Taking into consideration past reports, conduct analyses of appropriate return intervals for drying events in apple snail/snail kite habitats.
- Develop a habitat suitability index for snail kites that can be used as a real-time benchmark to assess habitat conditions throughout the snail kite network of habitats.
- Conduct research on the effects of a range of hydrologic metrics (for example, seasonal water depths) that influence and are optimal for snail oviposition and recruitment.
- Conduct a study to document movement and survival of adult snail kites during widespread drying events using satellite telemetry.
- Study the conditions that affect mating, reproduction, and dispersal in *Pomacea insularum* (an invasive, non-native species of apple snail).

### For references and additional information, visit:

<http://www.nps.gov/ever/naturescience/cesiass10-3.htm>  
[www.pomaceaproject.org](http://www.pomaceaproject.org)



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