

Abstract

Porphyrio porphyrio (*Fulica porphyrio* Linnaeus) was reported to the South Florida Water Management District in a Water Conservation Area and in constructed wetlands in the Everglades in 2006. A rapid assessment, including casual observations and surveys of land managers, indicated a limited number of *P. porphyrio* (~300 birds) was present, and an eradication attempt was initiated. From 2006 – 2008, more than 3100 *P. porphyrio* were killed by shotgun from airboats during 73 hunts, suggesting the initial population assessment was severely underestimated. After removing nearly 1500 *P. porphyrio* in 2008, we concluded that eradication was not possible. Failure of this eradication attempt is attributed to *P. porphyrio*'s affinity with dense emergent vegetation, which greatly limited shooting effectiveness. Further, the failed eradication underscores the importance of a reporting network to improve early detection and the chance to eliminate naturalized or feral populations of non-native species.

Keywords

Porphyrio porphyrio, eradication, distribution, abundance, Florida Everglades.

Attempted eradication of *Porphyrio porphyrio* Linnaeus in the Florida Everglades

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Introduction, Hypotheses and Problems for Management

More than 500 non-native species of fish, wildlife, and marine species, have been observed in Florida, with well over 100 of these introduced species reproducing and presumably being established, i.e., unlikely to be extirpated through natural processes or human intervention. Introduced birds account for the largest category of observed wildlife with 216 species reported and 67 species that have bred outside of captivity at least once (Bill Pranty personal communication). A large proportion of introductions is found primarily or exclusively in urban or suburban habitats in Florida, with very few introduced birds commonly found in conservation lands.

A prominent exception is *Porphyrio porphyrio* (*Fulica porphyrio* Linnaeus), which was reported by South Florida Water Management District vegetation management contractors in Everglades Water Conservation Area (WCA 2B, Broward County) and one Stormwater Treatment Area (STA 5, Hendry County) in March 2006 (Figure 1). *Porphyrio porphyrio* have a broad native distribution, with 13

subspecies and populations extending from southwest Europe through Southeast Asia and the Pacific Islands (Taylor 1998, but see Sangster 1998, Pranty et al. 2000). *Porphyrio porphyrio* is common in Australia and New Zealand, where they are considered an agricultural pest. Three Florida specimens have been identified as *P. p. poliocephalus* (Kratte et al. 2002, Bill Pranty personal communication), which is native from the Caspian Sea through Southeast Asia (Sangster 1998).

Porphyrio porphyrio escaped or were released from one or two private collections in Pembroke Pines, Florida, around or before 1996 (Pranty et al. 2000). Over the next several years, these birds successfully reproduced and dispersed locally, with 134 *P. porphyrio* counted during surveys in June 1999 (Pranty et al. 2000). Individual or pairs of *P. porphyrio* were reported as far as 80 km north of Pembroke Pines in 2000 and 2001, but apparently there was no significant movement into the Everglades Conservation Area. By 2004, *P. porphyrio* abundance in Pembroke Pines was greatly reduced indicating a severe

population reduction or movement to other areas (Bill Pranty personal communication). It is likely that the local *P. porphyrio* population expanded and colonized WCA 2B located 15 km to the north.

The appearance of a non-native bird closely related to or occupying the same habitat as the native *Porphyrio martinica* Linnaeus, *Gallinula chloropus* Linnaeus, and *Fulica americana* Gmelin, prompted a rapid assessment and subsequent attempt to eliminate what appeared to be an incipient population. In addition to potential predation on and competition with native species (Taylor 1998), we had concerns over potential negative impacts to vegetation planted in Stormwater Treatment Areas (STA) and in habitat improvement projects in the southern end of Lake Okeechobee. This manuscript details steps taken by the Florida Fish and Wildlife Conservation Commission (FWC) and the South Florida Water Management District (SFWMD) in the rapid assessment and subsequent eradication attempt for *P. porphyrio* in south Florida, and presents recommendations for protocols to deal with future discoveries and responses to non-native species.

Study Area

The southernmost part of the study area is primarily public conservation

land managed by state and federal agencies. The study area (Figure 1) also includes Lake Okeechobee, the Everglades Agricultural Area which is composed of private farms, and Reservation lands of the Miccosukee and Seminole Indian tribes.

Three Water Conservation Areas (WCAs) were constructed in the Everglades ecosystem to provide flood protection, water supply, and environmental benefits for south Florida through a system of levees, canals, and water control structures. WCA 2 and WCA 3 (271,880 ha) are located in western Broward, southern Palm Beach, and northwestern Miami-Dade counties, and are characterized by marsh, freshwater slough, and tree islands. Water Conservation Area 2 is subdivided by a levee into two water management units, WCA 2A and WCA 2B. Water Conservation Area 2B is approximately 9,583 ha. The primary vegetation in the area inhabited by *P. porphyrio* is *Eleocharis cellulosa* Torrey with mixed patches of *Typha domingensis* Persoon, *T. latifolia* Linnaeus, *Cladium jamaicense* Crantz, and *Salix caroliniana* Michaux. Water depth in this portion of WCA 2B typically remains above 0.85 m.

Stormwater Treatment Areas (STAs) are constructed wetlands that retain nutrients from agricultural runoff prior to its

Resumen

En 2006 se notificó al Distrito Sur de Gestión de Aguas de Florida que *Porphyrio porphyrio* (*Fulica porphyrio* Linnaeus) fue encontrada en un Área de Conservación de Aguas y en unos humedales artificiales de Everglades. Una rápida evaluación, que incluyó observaciones ocasionales y encuestas a los administradores de tierras, indicó la presencia de un limitado número de *P. porphyrio* (~300 aves), y se inició un intento de erradicación. Desde 2006 a 2008, fueron eliminados más de 3100 ejemplares de *P. porphyrio* usando escopetas desde hidrodreslizadores durante 73 jornadas de caza, lo que sugiere que la evaluación inicial de la población fue subestimada. Después de la eliminación de casi 1500 ejemplares de *P. porphyrio* en 2008, llegamos a la conclusión de que la erradicación no era posible. El fracaso de este intento de erradicación se atribuye a la afinidad de *P. porphyrio* con la densa vegetación emergente que limitaba en gran medida la eficacia de tiro. Además, el fallo en la erradicación subraya la importancia de una red de información para mejorar la detección precoz y la posibilidad de eliminar las poblaciones naturalizadas o silvestres de especies no nativas.

Palabras clave

Porphyrio porphyrio, erradicación, distribución, abundancia, Everglades de Florida.

flowing into the WCAs. Varying in size, configuration, and period of operation, the STAs are shallow (<0.5 m) freshwater marshes divided into treatment cells by interior levees. Water flows through these systems via water control structures, e.g., pump stations, gates, or culverts. The dominant aquatic plant communities in the treatment cells are broadly classified as emergent or submerged (Pietro et al. 2010). Substantial

nutrient inputs have fostered dense macrophyte communities in many cells within the STAs. As a consequence of the plant cover and relatively shallow water, STAs attract abundant bird life and are visited regularly by birders.

Methods

Informal field surveys were conducted to approximate the distribution and abundance of *P.*

porphyrio in the Everglades area south of Lake Okeechobee, and to assess the feasibility of eradication. After the initial reports to the SFWMD, FWC and SFWMD staff conducted a field survey of WCA 2B in May 2006. A visual survey of wetlands in the city of Pembroke Pines was conducted by FWC staff in summer 2006 to determine if significant numbers of *P. porphyrio* remained.

To refine the distribution of *P. porphyrio* in south Florida, federal, state, and local public landowners and land managers were contacted in June 2006. All reports were anecdotal, and the majority of land managers did not respond.

Because there were no relevant examples of bird eradications, we undertook this effort as an experimental project without rigorous methodology. In August 2006, *P. porphyrio* were approached by airboat and removed using dip nets. Only four birds were collected and this method was discarded as a practical option. Subsequently, *P. porphyrio* were killed using shotguns, primarily from airboats but occasionally from levees bordering the areas. Typically, airboats had one driver and one hunter; however, sometimes an observer and/or a second hunter were present. Airboats and drivers were provided

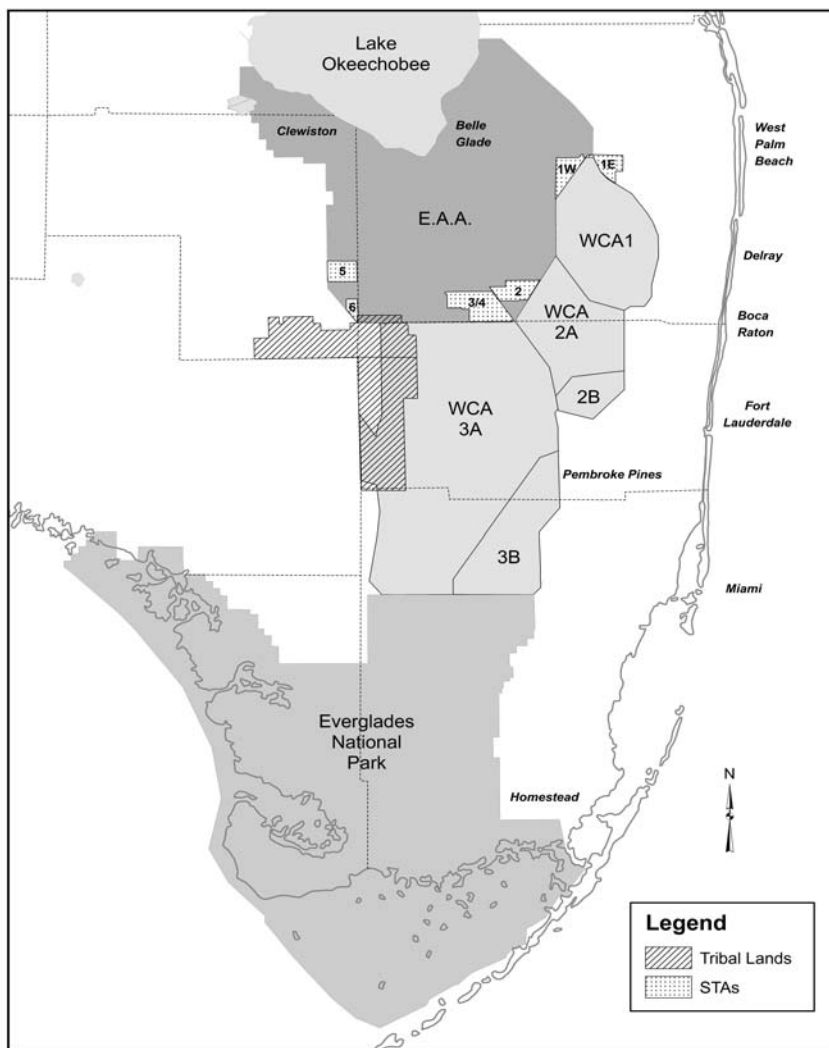


Figure 1. Principal land management and ownership in purple swamphen study area. E.A.A – Everglades Agricultural Area; WCA – Water Conservation Area; STA – Stormwater Treatment Area.

by SFWMD and FWC. Hunters were FWC employees in all but two instances, when other agency staff assisted. Staff time and equipment were coordinated with existing management activities, including road and structure construction, seasonal waterfowl hunts, and birding. No specific funding was allocated.

Results and Discussion

In May 2006, *P. porphyrio* were found in a 2000-ha area in the southern portion of WCA 2B. Nests and chicks were observed, with an estimated population of <100 birds. On the same day, several dozen *P. porphyrio* were observed in STA 5 in Hendry County, 40 km west of WCA 2B. During summer 2006, abundance in STA5 declined, but SFWMD staff observed *P. porphyrio* in STA1W (~35 km east of STA 5), concentrated in a cell with planted *Oryza sativa* Linnaeus. Subsequently, *P. porphyrio* were reported in additional STAs. Reports from land managers indicated that

birds had been observed intermittently in small numbers for at least a year at Lake Okeechobee, WCA 3A and WCA 1 (Loxahatchee National Wildlife Refuge) (Figure 1). No *P. porphyrio* were observed by FWC staff in a visual survey of Pembroke Pines wetlands in summer 2006, although birds could have been present in inaccessible gated homeowner communities.

Based on field observations and limited reports from other agencies, we estimated a population of approximately 300 *P. porphyrio* primarily in two locations, WCA 2B and STA 5. Because of the relatively low estimated population size and limited range, eradication was considered feasible. From October 4 through December 30, 2006, 333 *P. porphyrio* were removed by shotgun during 7 hunts (Table 1). Although STA 5 was inhabited by *P. porphyrio* in early 2006, abundance was greater at STA 1W later in the year when *P. porphyrio* were presumably feeding on abundant planted *O. sativa*. We realized our initial *P.*

porphyrio population estimate was low, and the number of hunts was tripled in 2007, removing four times as many *P. porphyrio* as in 2006. From January through March 2007, 242 *P. porphyrio* were removed during 8 hunts. No hunts were conducted from April through July due to low water levels that hindered access to many areas. From August through December 2007, 1181 *P. porphyrio* were removed during 17 hunts. Despite these removals, *P. porphyrio* abundance remained high in STA 1W, and the number of birds increased substantially at STA 3/4 and STA 5, at the western end of the known Florida range. We speculate that during our summer absence, *P. porphyrio* reproduced and recruited successfully, although we cannot rule out improved reporting as SFWMD land management staff became aware of the project. Based on 2007 results, we hunted consistently throughout 2008 and killed similar numbers of *P. porphyrio* as in the previous year (Figure 2). Although the number of

	WCA 2B	STA 1W	STA 5	STA3/4	STA2	STA6	Lake Okeechobee	TOTAL
2006	177 (4)	151 (2)	5 (1)	-	-	-	-	333
2007	273 (5)	521 (9)	181(5)	440 (5)	30 (1)	-	-	1445
2008	340 (10)	251 (10)	13 (3)	745 (13)	9 (1)	14 (1)	37 (3)	1409
TOTAL	790 (19)	923 (21)	199 (9)	1185 (18)	39 (2)	14 (1)	37 (3)	3187

Table 1. *Porphyrio porphyrio* harvest in Water Conservation Area (WCA) 2B, Stormwater Treatment Areas (STA), and Lake Okeechobee, Florida, October 2006 through December 2008. Number of hunts in parentheses (hunt = one day in an area, regardless of the number of boats or hunters).

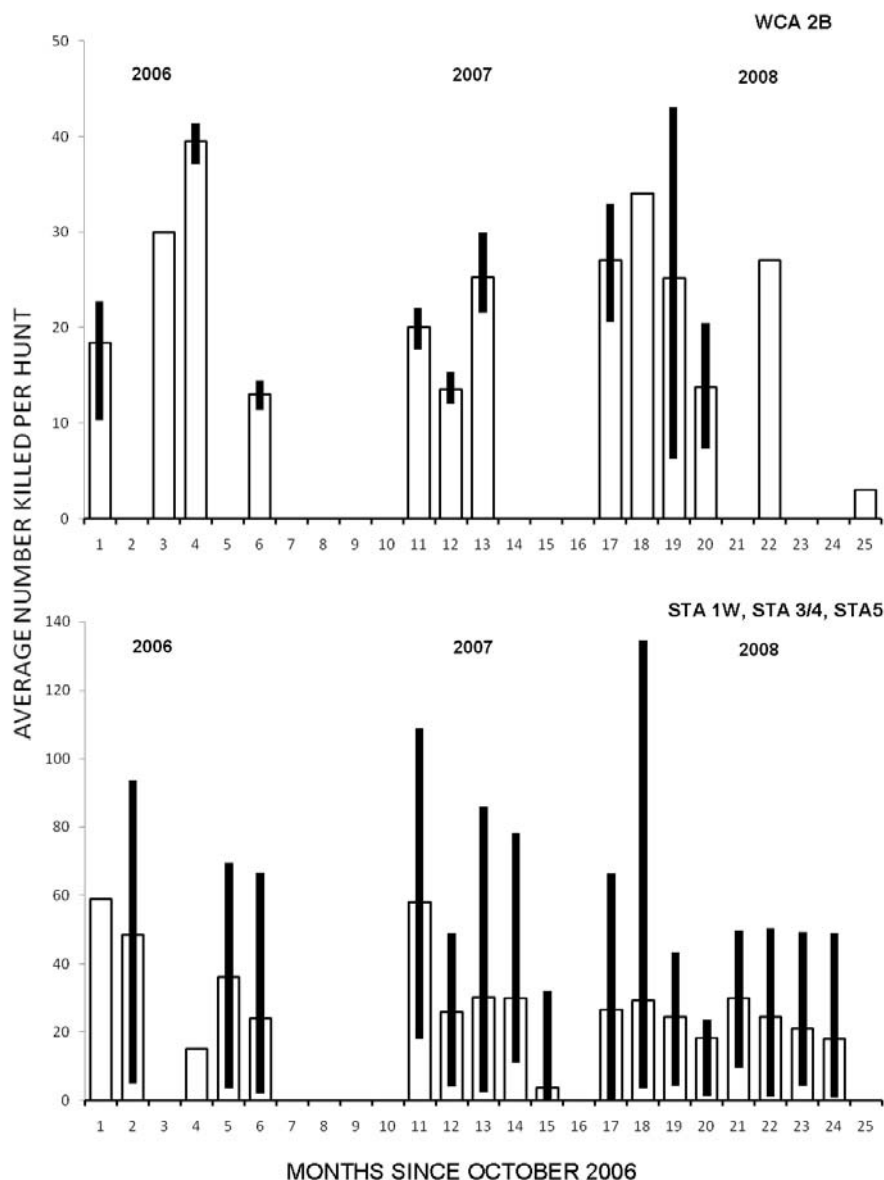


Figure 2. *Porphyrio porphyrio* harvest in Water Conservation Area 2B (WCA 2B) and three Stormwater Treatment Areas (STA), October 2006 through December 2008. Missing bars indicate months with no hunts; solid bars indicate range of number of birds killed in months with more than one hunt.

birds killed fluctuated among the areas, there was no indication that our efforts reduced the *P. porphyrio* population in targeted areas.

During the project, FWC staff reported numerous *P. porphyrio* from the south end of Lake Okeechobee in August 2008, representing a northward range

expansion of 40 km from STA 5 and 100 km northwest of the presumed release site. Following these observations, three hunts were conducted on Lake Okeechobee between September 4 and October 23, 2008, resulting in removal of 37 *P. porphyrio*. During the latter hunt, approximately 40 *P. porphyrio* were observed but not killed, many of

which were wary of the approaching airboat and flew long distances. This probably represents a dispersal of individuals from STA 3/4 and STA 5, although the birds could have dispersed from other sites with previous *P. porphyrio* observations. Subsequently, several dozen *P. porphyrio* were observed briefly in the western marshes of the lake (130 km from Pembroke Pines). A single *P. porphyrio* was sighted on Lake Istokpoga (50 km northwest of Lake Okeechobee) in January 2008, and one or two individuals persisted in the northwest end of Lake Okeechobee after the conclusion of this project. Although both lakes have abundant marsh habitats, only the southernmost portion of Lake Okeechobee continues to support a small number (< 30) of *P. porphyrio* on a consistent basis (Don Fox personal communication).

The failure to diminish numbers of *P. porphyrio* over 24 months, along with their geographic expansion during this time, led to termination of the eradication effort (Figure 2). Several factors accounted for our lack of success. *Porphyrio porphyrio* in the STAs were frequently found in heavily vegetated areas, reducing visibility and making harvest by shooting difficult. *Porphyrio porphyrio* were easily observed during a helicopter survey in *E. cellulosa* communities in WCA 2B, but very few birds were seen in *Typha* communities in STAs

during similar aerial surveys, even in areas known to be heavily used. A developmental eradication project for *Oxyura jamaicensis* Gmelin in the United Kingdom was successful in substantially reducing ruddy duck abundance during breeding, in part because the ducks were visible (Smith et al. 2005; Henderson & Robertson 2007). The preference of *P. porphyrio* for dense emergent vegetation eliminated the possibility of eradication by shooting in most areas in Florida.

Reducing the population through nest removal was unlikely to be successful, given the presumed abundance of nests and extensive area of suitable habitat. We observed ~12 nests in STA 1W, and birds were heard calling in dense *Typha* stands. However, our detection efficiency was minimal, considering the large numbers of *P. porphyrio* harvested in these areas in the latter part of 2008.

Movement within and between areas further hindered our eradication. In WCA 2B, coordinated hunts using multiple airboats resulted in the removal of relatively low numbers of *P. porphyrio* (15 – 30 per boat) during 2006 and 2007, with no apparent decline in abundance. From April 29 through May 2, 2008, hunts were conducted on consecutive days using two boats and hunters each day, with each assigned to specific areas within WCA 2B. The increased effort did

not significantly reduce *P. porphyrio* harvest, yielding 51, 32, 30, and 25 *P. porphyrio*, respectively. To assess the likelihood of emigration, concurrent visual surveys were conducted in Pembroke Pines and the adjacent WCA 2A that revealed fewer than five *P. porphyrio*. Subsequent to this project a telemetry study of five *P. porphyrio* captured in WCA 2B indicated very little movement and no egress from this area. We surmise that *P. porphyrio* moved locally in response to our hunting pressure and waterfowl hunting activities occurring seasonally in WCA 2B. Birds flushed by airboats frequently flew to nearby (<100m) emergent vegetation patches for shelter, which limited our effectiveness in reducing population abundance.

Although there was a resident population of *P. porphyrio* in WCA 2B, birds apparently moved between STAs and to surrounding properties as indicated by variable hunting success within and between years; five *P. porphyrio* fitted with radio transmitters in STA 1W moved to nearby STA 1 E. Water levels in the STAs fluctuate seasonally, which may have led to *P. porphyrio* movement as depth in some pools was <10 cm. Vegetation composition also changes over time, likely concentrating birds in areas with preferred food items, e.g., experimental planting of *O. sativa* in STA 1W.

Observations suggest that birds changed habits or dispersed in response to hunting pressure. As shooting progressed we observed many *P. porphyrio* running through the vegetation rather than flying. Some of the birds that took wing in response to approaching airboats flew long distances to other areas, although these movements did not appear to reflect permanent relocations.

Florida has no formal system for responding to newly introduced species; therefore, the initial assessment of distribution and abundance of *P. porphyrio* in conservation lands was limited to anecdotal information from land managers. We believe that the *P. porphyrio* population was considerably larger and occupied a greater area than we estimated at the outset of this project. Two *P. porphyrio* were photographed in Lake Okeechobee as early as 2001 (Bill Pranty, personal communication), and these birds may have dispersed to other wetlands without being observed. In addition, there are many agricultural properties that we could not access and for which we had limited sources of information. Only four *P. porphyrio* were observed during surveys in 2007 by the University of Florida of flooded *O. sativa* in the Everglades Agricultural Area (Palm Beach and Hendry

counties) (Elise Pearlstine personal communication). However, these surveys were not conducted for the purpose of locating *P. porphyrio*, nor were they comprehensive in their coverage. Although *P. porphyrio* appear to favor larger impoundments on public lands, their utilization of smaller, temporary wetlands in agricultural areas remains unknown.

This failed eradication attempt points out the importance of dedicated resources for early detection and rapid response. In contrast to the successful *O. jamaicensis* eradication in Europe (Smith et al. 2005; Henderson & Robertson 2007), our project was limited to existing staff within the constraints of their ongoing duties. We cannot speculate on the potential effects of greater staff and time availability, other than to state that more hunters and hunts might have helped reduce *P. porphyrio* abundance early in the project when the population was relatively small.

Although efforts to eliminate this introduced species failed, the current *P. porphyrio* distribution leaves two immediate management options and one long-term approach. The Florida range of *P. porphyrio* encompasses approximately 3000 km², but informal surveys suggest its distribution is patchy with a core area of perhaps <200 km². This

suggests that directed removal efforts could be continued to reduce the rate of population growth, which, together with other sources of mortality, may adversely impact *P. porphyrio* abundance. It is apparent that *P. porphyrio* move among the areas in the Everglades, and without associated surveys, it would be difficult to assess the effectiveness of this approach.

A second immediate option would be to attempt to limit expansion. As of July 2010, *P. porphyrio* were observed daily in STA 1W and STA 1E. However, since their appearance on Lake Okeechobee in 2008, *P. porphyrio* have been remained largely confined to the southern end of the lake. Consequently, periodic hunts on public waters on the northern end of the *P. porphyrio* Florida range may be effective in preventing further expansion. Currently, FWC is employing this approach by opportunistically removing *P. porphyrio* on Lake Okeechobee.

Ultimately, long-term management would be based on the type and magnitude of impacts of *P. porphyrio*, e.g., habitat disturbance through feeding, predation on native wildlife, and competition with native birds. Several accounts list vegetation as the primary food item for *P. porphyrio*, including agricultural crops in New Zealand (New Zealand Birds [http://](http://www.nzbirds.com/birds/pukeko.html)

www.nzbirds.com/birds/pukeko.html accessed December 23, 2008). In Victoria, Australia, gizzards contained 76% by volume plant material, and 22% of gizzards examined contained animal matter. *Porphyrio porphyrio* occasionally consume insects, earthworms, leeches, spiders, fish, frogs, lizards, water snakes, birds, and their eggs (Taylor 1998, Pranty et al. 2000). In Florida, Pranty et al. (2000) observed *P. porphyrio* in Pembroke Pines consuming local vegetation, bird seed, grass blades, and worms. Casual observation of gut contents of birds collected during this project suggests opportunistic feeding on locally available plants and minimal ingestion of animals. Of three *P. porphyrio* crops inspected from birds collected in WCA 2B, one had five *Planorbella scalaris* Jay, and the other two had no animal matter. In WCA 2B, *P. porphyrio* inhabit an area with extensive *E. cellulosa* that apparently serves as a food source and a place to nest. No obvious habitat impacts have been recorded, although extensive disturbance was observed in 2006. A thorough examination of *P. porphyrio* food items is necessary to evaluate the potential for impact to vegetated habitat and native wildlife.

Purple swampheens are related to three native Rallidae species, *Porphyrio martinica*, *Gallinula chloropus*, and *Fulica Americana*, which utilize the similar

habitats for either nesting or feeding. At current population levels, there does not appear to be competition for food or breeding sites. However, the *P. porphyrio* population has expanded considerably since their discovery in Florida during the latter 1990s, and interactions may change with increased abundance. In May 2006, *P. porphyrio* were observed apparently harassing nesting *Himantopus mexicanus* Muller in STA 5. In June 2010, a *P. porphyrio* was observed with an unidentified chick in its bill (Walter Betit personal communication). We were not able to dedicate time observing *P. porphyrio* interactions with other birds, and the degree and frequency of such interactions is unknown. Additionally, the broad native distribution of *P. porphyrio* suggests that its introduced range may increase significantly in Florida and beyond, with the potential to interact with a greater variety of native and exotic wildlife. We recommend long-term surveys to determine the risk of competition and predation by *P. porphyrio* on native birds.

Conclusions

The objective of rapid response to the discovery of *P. porphyrio* in conservation lands was to eradicate what was thought to be a small, isolated population, based on initial surveys of managing agencies. After

three years, including consistent effort throughout 2008, it was concluded that eradication was not possible and that long-term assessment and management is appropriate.

Our project demonstrates the need for dedicated funding for rapid assessments and eradication efforts. Although we were able to conduct a rudimentary assessment of public conservation lands, this was minimally effective because the managing agencies lacked resources to adequately survey for *P. porphyrio*. In addition, substantial private agricultural lands with potential *P. porphyrio* habitat might have been surveyed had funding been available.

The difficulty in eliminating *P. porphyrio* underscores the importance of early detection. A reporting network to improve early detection of non-native species should involve land managers, private landowners, and private citizens and be fully staffed for real-time reports. In addition, increased capacity to verify observations of non-native species is fundamental to effectively respond to incipient populations. Although there is no certainty that a reporting system would have prevented the establishment of *P. porphyrio*, such a network would have improved the chance to eliminate the feral population before birds moved into

public conservation lands in the Everglades.

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Bio-sketch

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