

PREY SELECTION BY THE SNAIL KITE (*ROSTRHAMUS SOCIABILIS*) IN PERMANENT AND TEMPORARY WETLANDS OF CENTRAL ARGENTINA

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Resumen. – Selección de presas por el caracolero (*Rostrhamus sociabilis*) en cuerpos de agua permanentes y temporarios del centro de Argentina. – En este estudio se analizó el patrón de selección de presas del caracolero (*Rostrhamus sociabilis*) sobre el caracol de agua dulce *Pomacea canaliculata* en la provincia de Buenos Aires, Argentina. Para esto se colectaron los restos presa de esta especie bajo las perchas de alimentación del caracolero y se colectaron individuos vivos de *P. canaliculata* en cinco cuerpos de agua temporarios y en tres lagunas. En cada localidad de muestreo, se comparó la distribución de frecuencias de los tamaños de los caracoles colectados de la población y de los caracoles predados por el caracolero. El caracolero seleccionó el tamaño de sus presas en todas las localidades; sin embargo, al patrón de selección difirió entre los diferentes tipos de ambientes. En las lagunas, el caracolero seleccionó presas de tamaño intermedio, pero en los cuerpos de agua temporarios seleccionó tanto las presas intermedias como las de mayor tamaño. A pesar de esto, el tamaño promedio de los caracoles predados en los cuerpos de agua temporarios fue 8–17 mm menor que en las lagunas. Las estimaciones de abundancia de caracoles (y, presumiblemente, su disponibilidad para los caracoleros) fueron mayores en los cuerpos de agua temporarios que en las lagunas. Las diferencias en la abundancia de presas y en la fisonomía del hábitat entre ambientes podrían ser responsables de las diferencias en el patrón de selección de presas observado.

Abstract. – Prey selection by snail kites (*Rostrhamus sociabilis*) on freshwater apple snails (*Pomacea canaliculata*) was studied in permanent and temporary wetlands in Buenos Aires province, Central Argentina. Live individuals of *P. canaliculata* and prey remains of this species left under perches by snail kites were collected in five temporary and three permanent wetlands. Frequency distributions of size of live and preyed-upon snails were compared at each sampling locality. Although snail kites selected prey by size both in temporary and permanent wetlands, the pattern of prey selection differed between wetland types. Snail kites selected prey of intermediate size in permanent wetlands but in temporary wetlands they selected for intermediate and large-sized snails. In spite of this selection pattern, snails preyed by snail kites in temporary wetlands were on average 8–17 mm smaller than in permanent wetlands. Estimates of snail abundance (and presumably prey availability) were higher in temporary wetlands than in permanent wetlands. Differences in habitat physiognomy and in snail abundance between both types of habitat could be responsible for differences in the pattern of prey selection between wetland types. Accepted 25 April 2011.

Key words: Argentina, prey selection, *Rostrhamus sociabilis*, Snail Kite, apple snail, *Pomacea canaliculata*.

INTRODUCTION

A fundamental objective in the study of foraging behavior is to determine how and why animals choose certain prey types. Optimal foraging theory is based on the principle that natural selection favors individuals that choose food items which supply the maximum net benefit (Emlen 1966, MacArthur & Pianka 1966). One prediction of optimal foraging theory is that diet breadth increases with decreasing abundance of preferred prey. Thus, when preys are scarce, predators should generalize and consume prey items in proportion to their abundance (Recher 1990). This prediction has received empirical support in the case of generalist foragers (Lacher *et al.* 1982, Stephens 1990, Thompson & Colgan 1990, Kaspari & Joern 1993); however, presumably because of their narrow diets, few studies have evaluated this prediction in specialist foragers. An obligatory trophic specialist feeds almost exclusively on only one food item regardless of its abundance or whether other alternative items are available (i.e., sea otters, aardwolves, pandas). Other specialist predators can be regarded as facultative specialists, which may act opportunistically, changing its primary prey item when other prey is available (Herbst & Mills 2010).

Snail kites (*Rostrhamus sociabilis*) are one of the most extreme specialist predators among raptorial birds feeding almost exclusively on freshwater apple snails of the genus *Pomacea* (Haverschmidt 1959, Brown & Amadon 1968, Snyder & Snyder 1970, Collett 1977, Beissinger 1983, 1990; Snyder & Kale 1983). They are nomadic predators that wander following the variation in prey availability caused by changes in the hydrology of freshwater bodies (Sykes 1979, Beissinger 1986), and can be found associated to both permanent and temporary wetlands (Thiollay 1994). Snail kites are visual predators that capture their prey with one of their talons on or near the

water surface. The snail is then immediately taken to a feeding perch where they consume the soft tissues discarding the shell and the operculum (Murphy 1955, Snyder & Snyder 1970, Collett 1977, Bourne & Berlin 1982, Beissinger 1983). Piles of shells and opercula, which are left generally undamaged, accumulate below feeding perches used by kites providing an excellent record of the characteristics of the prey consumed (Collett 1977, Beissinger 1983, Snyder & Kale 1983, Magalhães 1990, Bourne 1993, Tanaka *et al.* 2006).

Two major modes of foraging are displayed by snail kites while hunting for prey. They can fly over the water surface searching for snails (course hunting) or search visually from a perch, approximating their prey with a short flight (still hunting). Capture success using any of the two modes is similar and the adoption of a mode of foraging by individual snail kites varies with environmental characteristics (Beissinger 1983); for example, the availability of perching sites limits the adoption of the still hunting mode (Snyder & Snyder 1969, Valentine Darby *et al.* 1998, Tanaka *et al.* 2006). On the other hand, density of emergent vegetation also affects the foraging modes used by snail kites. In rice-culture habitats, Beissinger (1983) showed that as rice grew the frequency of still hunting decreased while course hunting attempts increased.

Beissinger (1983) showed that snail kites preferentially consume intermediate sized prey; large snails are preyed according to their proportional abundance in the field, and small snails are only occasionally preyed. However, is expected that size of prey will be affected by prey availability. Since the Snail Kite is visually oriented in search of prey, prey availability is not only a function of snail density; several factors, including the amount of vegetation cover and depth of the water body, may affect the availability of prey (Beissinger 1983, Bennetts *et al.* 2006).

In central and south-eastern Buenos Aires province, Argentina, snail kites are found between spring and early fall (FJM pers. observ.) foraging over both permanent and temporary wetlands. The Northward movements of snail kites in winter months are probably a consequence of snail inactivation during cold months (Petracci *et al.* 2004, Juhant 2010). Permanent wetlands generally include shallow lakes, which have gentle and shallow coasts with well developed emergent aquatic vegetation. Temporary wetlands consist of artificial channels or temporary ponds, which are shallower, smaller in surface and volume than permanent wetlands. Aquatic vegetation does not reach great development neither in height nor in density (Insausti *et al.* 2005).

Contrasting characteristics between wetland types suggest that apple snails are more exposed to Snail Kite predation in temporary wetlands than in permanent wetlands. In this study we characterize the patterns of prey selection by snail kites and make comparisons between permanent and temporary wetlands of central Argentina. We expect that because of environmental differences between wetland types, the patterns of prey selection by snail kites in both areas will differ, displaying a higher degree of selectivity in habitats with higher abundance of prey.

METHODS

Study area. Field work was conducted in Eastern Buenos Aires province, Central Argentina. In this region, annual rainfall (between 750 and 900 mm) is concentrated between spring and early fall, being summer the wettest season. However, frequency, distribution and intensity of rainfalls have an irregular pattern and vary between years (Sierra *et al.* 1994, Pérez 1999). This variability affects the hydrologic balance of aquatic ecosystems (by excess or deficit) and results in alternating events of

flood and drought (Fuschini Mejía 1994, Quirós *et al.* 2002) and consequently determines the spatial extent of wetlands in the region.

From December 2003 to April 2004, the diet characteristics of snail kites was studied in three permanent wetlands near Mar del Plata (38°02'S, 57°32'W) and in five temporary wetlands near Dolores (36°18'S, 57°39'W, Fig. 1). The permanent wetlands included in this study were Hinojales (H), de los Padres (LP), and Nahuel Rucá (NR) lakes. These wetlands are characterized by low average depth and coasts with gentle slope (Canevari *et al.* 1998), and well developed emergent vegetation (*Schoenoplectus californicus* and *Typha* sp.). In particular, *S. californicus* presents high densities of stems, forming dense patches. Floating species, such as *Ricciocarpus natans*, *Azolla* sp., and *Lemma* sp., partially cover the surface depending on the incoming wind direction and intensity.

Temporary wetlands included in this study were small depressions of 5–10 m of width that surround the roads in zones with poor drainage of water. These wetlands are less than 0.6 m in depth and their water volume is highly dependent on rainfall. Usually, these wetlands are dry for some part of the year; and during drought periods they remain dry for years. Temporary wetlands present scarcely developed macrophyte assemblages. *S. californicus* is a dominant emergent species, but only occur as isolated stems. Temporary wetlands included in this study were bordered, at least in one of their sides, by fences offering abundant feeding perches to snail kites. TW 1–5 was used to refer to these wetlands.

Data acquisition. At each sampling location feeding perches of snail kites were located and all prey remains found there were collected and stored in plastic bags. Since collection of shells was made between December to April and early vegetation growth during September

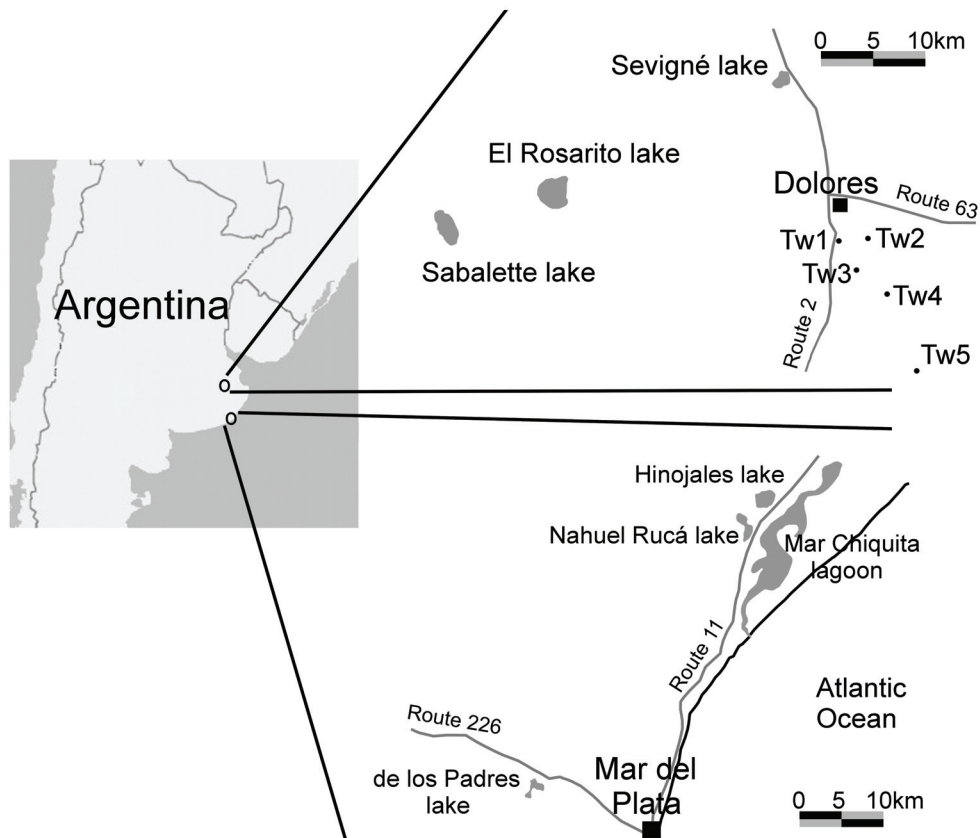


FIG. 1. Study zone and the relative position of each of the permanent and temporary wetlands.

to November trampled older shells, we considered that the probability of including snails preyed during the previous year was negligible. In addition, broken and discoloured shells were not included in the analyses. At the lab, prey remains were washed and oven dried at 70°C for 24 h.

Position of each feeding perch was registered by GPS. The distances between all feeding perches were determined for each site. In order to avoid bias in estimation as a consequence of isolated feeding perches, we determined for each feeding perch the distance to nearest neighbor. We average these values by

locality to obtain an estimate of feeding perch spatial distribution.

Studies of prey selection have biases when assessing prey availability. Even if the sampling protocol assures that the densities of all size-classes are reliably assessed, the way in that predators perceive that abundance is surely not coincident. Distinguishing between abundance or density of a prey item and its “true” availability to predators under field conditions is a major shortcoming when studying prey selection (Jaksic 1989). Lacking a better measure of prey availability from the point of view of snail kites, we choose to sam-

ple the snail populations using a drag net (0.36 m² with 5 mm of mesh diameter).

Live apple snails were collected in thirty 3-m transects at each sampling locality to assess size frequency distributions and abundance of snails. Transects were established in the proximity of the wetland border and allocated equally between sites with different types of vegetation, so as to include microhabitat heterogeneity as much as possible. When the number of snails collected were less than 50 individuals, additional longer transects were established; but live snails collected in these transects were used only to assess size frequency distributions and were not considered to estimate abundance. In each sampling locality, all live snails were collected in places that were similar to those where snail kites had been observed capturing prey. Live snails were collected 1–15 days later than prey remains.

Since biomass of apple snails correlates with external shell dimensions (Estebenet 1998), shell size (distance from the apex to the anterior lip of the aperture) was used as an estimator of prey size. The shell size was measured using vernier calipers. Only those live snails above the minimum prey size for snail kites registered in this study were included in the analyses.

Statistical analysis. Median sizes of preyed snails were compared between all localities with Kruskal-Wallis test. Bonferroni-corrected Mann-Whitney's *U*-tests (Zar 1984) were employed to make a posteriori comparisons between localities.

Size frequency distributions of live and preyed-upon snails in each locality were compared with Kolmogorov-Smirnov tests (Sokal & Rohlf 1981). To assess if the intensity in prey size selection by snail kites differs between wetland types, we first calculated for each locality the *D* statistics of the Kolmogorov-Smirnov test that contrast size fre-

quency distributions between live and preyed-upon snails. Then, we contrasted the *D* values obtained for permanent and temporary wetlands with Mann-Whitney's *U*-test (Zar 1984).

Ivlev's electivity index was used by locality to assess prey selection by size (Jacobs 1974). This index is defined as $E = (c-p)/(c+p)$, where *c* is the proportion of a given size-class preyed by snail kites and *p* is the proportion of that size-class available in the field. We used the sizes of the live snails sampled to assess prey availability in this analysis. *E* varies between -1 and 1, with positive and negative values indicating over-consumption and under-consumption, respectively, of a given size-class. At each locality confidence intervals for *E* at each size class were determined by bootstrapping (Efron & Tibshirani 1993), using 1000 bootstrap samples. Snails were grouped in 5-mm class intervals for these calculations.

Estimates of snail abundance were compared among localities with Kruskal-Wallis test. Bonferroni-corrected Mann-Whitney's *U*-tests (Zar 1984) were used to make a posteriori comparisons.

To assess the effects of abundance and size of snails in the foraging behavior of snail kites across sampling localities we analyzed the correlation between mean size of live and preyed snails; and also the correlation between the estimates of snail abundance and the intensity of selectivity given by the Kolmogorov-Smirnov test.

RESULTS

Prey remains (shells and opercula) were collected from 84 feeding perches; 40 in temporary wetlands and 44 in permanent wetlands. All feeding perches in temporary wetlands consisted of fence posts; whereas in permanent wetlands different classes of structures (trees, bushes, small elevations in the soil, and fence posts) were used as perches by snail kites.

Overall, 10,165 individual prey remains were collected (8388 from temporary and 1777 from permanent wetlands). All prey remains belonged to the freshwater apple snail *Pomacea canaliculata*, and ranged in size from 12.7 mm to 72.4 mm. A total of 1093 live snails (672 in temporary and 421 in permanent wetlands) were collected during field surveys and were used to estimate snail abundance. If we consider only snails above the lower size found in prey individuals (12.7 mm) sample size of live snails drops to 699 individuals (595 in temporary and 109 in permanent wetlands). Details of sample size by locality are presented in Fig. 2.

Median size of preyed snails was significantly different among sample sites ($\chi^2 = 2321.2$, $P < 0.001$, Fig. 2). Among temporary wetlands, size of preyed snails was not significantly different between TW 1, TW 2, TW 4 and TW 5 ($P > 0.05$ in all cases), but in TW 3 the median size of preyed snails was smaller than the rest of temporary wetlands ($P < 0.001$ in all cases). Among permanent wetlands, no difference in median size of preyed snail was found between LP and NR lakes ($P > 0.05$), but in H lake the Snail Kite preyed snails significantly bigger than others lakes ($P < 0.001$ in both cases). All comparisons involving a temporary wetland and a permanent wetland were statistically significant ($P < 0.001$ in all cases). Mean size of preyed snails was between 8.26–17.42 mm higher in permanent than in temporary wetlands (Fig. 2).

Snail kites showed differential size predation upon apple snails in all sites. Size-frequency distributions of preyed and live snails differed significantly in all wetlands (D : 0.32–0.7; $P < 0.05$ in all cases), with a clear overconsumption of larger snails (Fig. 2). Beyond differences in size-frequency distribution of live snails between the permanent or between the temporary wetlands, snail kites showed similar predation patterns in each wetland type. In temporary wetlands, several size

classes (between 25 and 45 mm) were preyed in similar proportion producing a size-frequency distribution more flattened than in permanent wetlands. On the other hand, in permanent wetlands two size classes (45–50 mm at LP and NR and 50–55 mm at H) were preyed in a proportion notably larger than the other size classes, producing a more restricted selection pattern. In spite of consistency in selection pattern in each wetland type, the mean intensity of size selectivity did not differ statistically between temporary ($D = 0.50$, $N = 5$) and permanent ($D = 0.64$, $N = 3$) wetlands ($U = 3.5$, $P = 0.24$).

Selectivity patterns of 5-mm classes of prey size by snail kites at all localities are showed in Fig. 3. In temporary wetland, the Snail Kite overconsumed all size class higher than 25 mm (TW 1, TW 2, and TW 3) or 30 mm (TW 4). The pattern of electivity was subtly different in TW 5 in which Ivlev's index was not significant for 45–55 mm size class. In permanent wetlands we observed that the Snail Kite significantly overconsumed snail between 35–55 mm at NR and between 40–55 mm at H and LP. The selectivity pattern in permanent wetlands was more variable between localities for prey size class bigger than 55 mm (Fig. 3). In general, these results indicated that snail kites preyed preferentially higher snails in permanent than in temporary wetland. Moreover, the electivity index showed a larger range of preferred prey in temporary than in permanent wetlands (Fig. 3).

The number of prey remains by feeding perch was always greater in temporary wetlands than in permanent wetlands (Table 1). On the other hand, the mean distance to the nearest perch was always lower in temporary wetlands (Table 1).

Snail abundance differed significantly among sample sites ($\chi^2 = 58.8$, $P < 0.001$). No differences were found among the three permanent wetlands ($P > 0.01$ in all cases) and

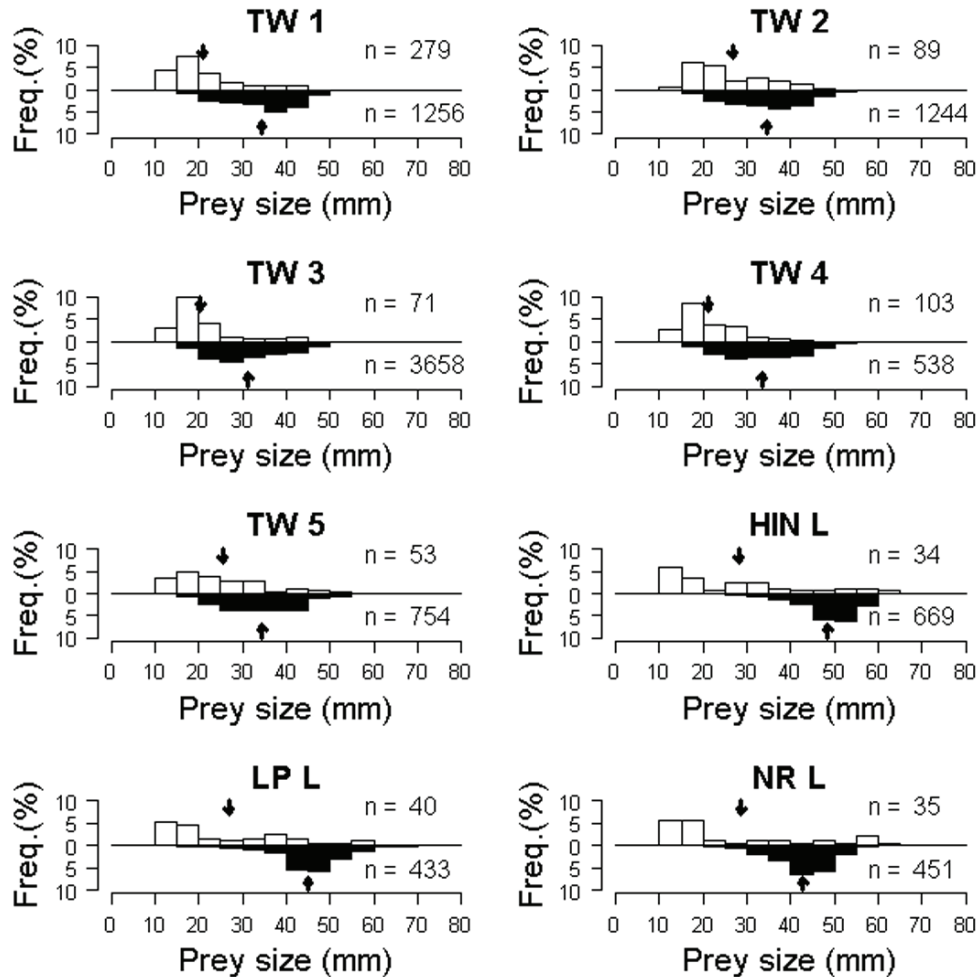


FIG. 2. Size frequency distributions of live apple snails (*Pomacea canaliculata*) collected during field surveys (white) and preyed-upon snail kites (*Rostrhamus sociabilis*, black) in temporary and permanent wetlands of Central Argentina. TW 1–5 refer to temporary wetlands 1–5, Hin L (Hinojales lake), LP L (De los Padres lake) and NR L (Nahuel Rucá lake). Sample sizes by locality are presented. The arrows represent the median of each frequency distribution.

among the five temporary wetlands ($P > 0.01$ in all cases) in the estimates of snail abundance. But, except in the comparison among TW 5 and NR ($P = 0.19$), all comparisons involving a temporary wetland and a permanent wetland were statistically significant ($P < 0.001$), being the estimates of snail abundance

in temporary wetlands notably higher than that estimated in permanent wetlands (Table 1). Before measuring the length of live snails, we pooled individuals collected in transects made to estimate snail abundance with those collected in additional samples. Therefore, we unfortunately do not know the sizes of snails

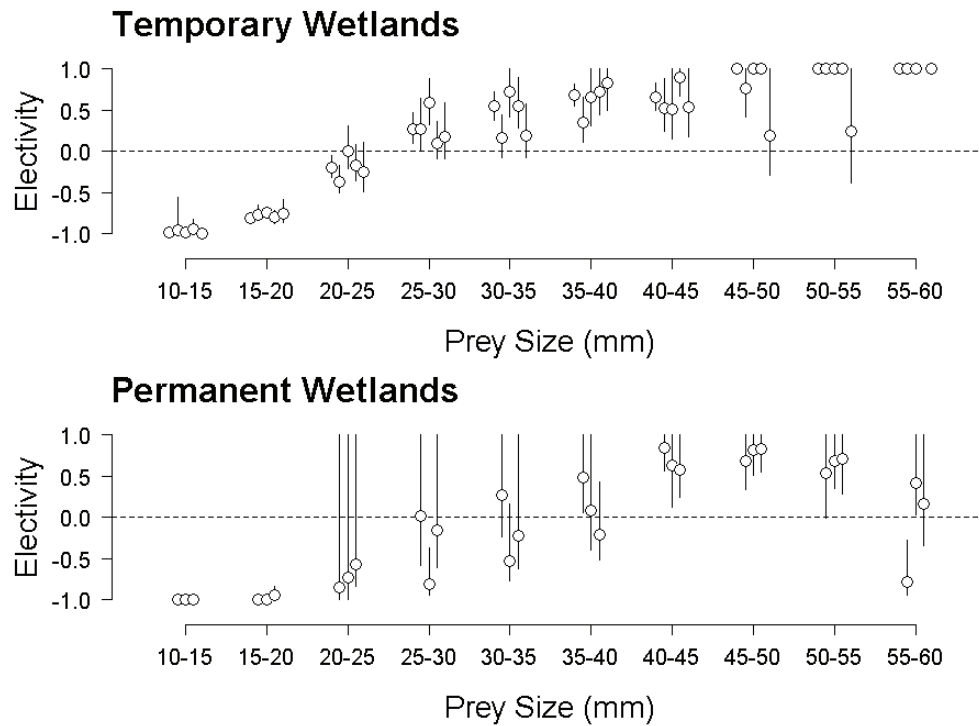


FIG. 3. Selection of prey size of apple snails (*Pomacea canaliculata*) by snails kites (*Rostrhamus sociabilis*) assessed using Ivlev's electivity index. The zero line denotes no selection, positive values indicate overconsumption and negative values denote underconsumption. Vertical bars show the bootstrapped 95% confidence interval. From left to right are shown the indices for Temporary Wetlands 1–5 and Nahuel Rucá, Hinojales, and De Los Padres lakes.

sampled during surveys of abundance. Thus, estimates of abundance were obtained using all snails, even those smaller than minimum prey size for snail kites in this study (12.7 mm). Because of this, estimates of snail abundance would have overestimated prey abundance. The proportion of live snails smaller than 12.7 mm ranged between 3–17 % in temporary wetlands and between 32–82 % in permanent wetlands. Therefore, differences in prey abundance among wetland types would be higher than those reported here.

Differences in estimates of snail abundance between wetlands is not reflected in the association between snail abundance and the

intensity of selectivity ($r = 0.40$, $P = 0.38$, $N = 8$). Neither was mean size of preyed snails significantly correlated to the size of live snails ($r = -0.38$, $P = 0.39$, $N = 8$).

DISCUSSION

Despite that along its distributional range snail kites prey upon many *Pomacea* species, they display a consistent pattern of prey size selectivity: overconsumption of prey individuals of intermediate size, underconsumption of small and abundant snails, and consumption of larger individuals in proportion to their respective field abundances (Snyder & Snyder

TABLE 1. Number of apple snails (*Pomacea canaliculata*) preyed by feeding perch, distance between nearest neighbour perches, and snails abundance estimates in permanent and temporary wetlands of central Argentina. TW = temporary wetland.

Locality	Preyed snail collected	Distance among nearest	Estimates of snail abundance
	below feeding perch	feeding perches	(snails/transect)
	Mean (SD)	Mean (SD)	Mean (sd)
TW 1	159 (118.7)	13.76 m (9.96)	1.07 (1.03)
TW 2	144.9 (58.4)	2.91 m (0.57)	1.13 (1.85)
TW 3	394 (226.4)	10.41 m (4.46)	0.67 (0.74)
TW 4	79.2 (34.4)	9.67 m (3.97)	0.77 (0.95)
TW 5	135.5 (128.2)	9.83 m (4.44)	0.61 (0.85)
Nahuel Rucá lake	51.7 (60.8)	190.1 m (254.92)	0.16 (0.44)
Hinojales lake	64.1 (85.3)	29.36 m (9.58)	0.03 (0.18)
De los Padres lake	22.1 (17.5)	27.31 m (35.82)	0.07 (0.25)

1969, Beissinger 1983). In general, this pattern agrees with our results of the three permanent wetlands in Central Argentina using Ivlev's electivity index. De Francesco *et al.* (2006) analyzed size-frequency distribution of snail preyed by the Snail Kite in the same three lakes analyzed in this study. In NR and LP lakes, they reported a size-frequency distribution very similar to that described in this study. These authors also reported a larger size for preyed snails in H, but unlike our results the size-frequency distribution was notably right-skewed in this wetland, suggesting a small temporal variation in the pattern of prey selection.

In temporary wetlands, snail kites also took in low proportion the smaller snails (< 20 mm), but unlike in permanent wetlands, Ivlev's electivity index showed that the Snail Kite not only preferred the medium-sized snails (25–45 mm) but also included large snails (> 45 mm). Snail kites preyed in these wetlands snails between 20–45 mm at approximately the same levels; even though the proportion in the population decreased gradually toward larger sizes. In this size-range we did not record peaks in consumption as pronounced as those observed in permanent wetlands. This suggest a less restrictive pattern of

prey size selection in temporary than in permanent wetlands.

Estimates of snail abundance differ notably between both wetland types. The maximum value of snail abundance recorded in permanent wetlands is even lower than minimum value obtained in temporary wetlands. It is important to recognize that a bias in the estimation of snail abundance could be produced by different capture probabilities for snails owing to differing vegetation cover between habitats (see Darby *et al.* 1999, Karunaratne *et al.* 2006). Given the high contrast in cover of emergent vegetation between wetland types, our estimates of snail abundance could not reflect prey availability as perceived by snail kites. However, some data would suggest that our estimates of snail abundance were not seriously biased in relation to actual prey availability as perceived by snail kites. First, at low levels of prey availability successive predation events would be spatially spread so snail kites would alternate the use of feeding perches to minimize the cost of prey transportation. By contrast, at high levels of prey availability, successive predation events are likely to occur close-by, increasing the probability of using the same feeding perch. Therefore, at high levels of prey avail-

ability we expect a higher number of prey items by feeding perch. On the other hand, it is more likely that a kite uses the same feeding perch in habitats where perches are scant or spatially spread, increasing the number of prey by feeding perch. The average number of prey per perch in our study was higher in temporary than in permanent wetlands, despite that the mean distance to the nearest perch was markedly lower in temporary wetlands. Thus, although our estimates of snail abundance could have been biased because to differences in vegetation structure, temporary wetlands apparently have higher levels of prey availability than permanent wetlands.

Beissinger (1983) suggests that the availability of prey for snail kites is not only a function of snail density, but is also affected by the depth of the water body, with a lower availability in deeper wetlands. Temporary wetlands not only have higher estimates of snail abundance, but also have shallower depth; therefore, snails would be more exposed to Snail Kite predation. Moreover, since snail kites need areas of open water for hunting (Haverschmidt 1959, Sykes 1979), availability of prey can be affected by the structure of the vegetation (Beissinger 1983). Snail kites avoid areas with dense vegetation (Bourne 1985a, Bennetts *et al.* 2006) because it may physically impede their ability to detect and gather prey once detected (Sykes 1987). Temporary wetlands quickly fluctuate in extension, and they are usually dry during parts of the year. This arrests the development of aquatic vegetation. By the contrast, permanent wetlands present a high degree of their coast covered by emergent vegetation. It could not only reduce prey detection but also limit the access of snail kites to their prey (Beissinger 1983, Sykes 1987). In summary, all of these features could concurrently determine a higher availability of prey for snail kites in temporary than in permanent wetlands.

Optimal foraging theory predicts that a predator must be more selective in environments of higher prey availability (Emlen 1966, MacArthur & Pianka 1966). In this sense, since the abundance (and presumably the availability) of prey is higher in temporary wetlands, snail kites must be more selective in this wetland type. Our results do not confirm this prediction. Our estimates of intensity of prey selection did not show differences between both environments. Moreover, despite estimates of snail abundance were higher in temporary wetlands; the size-range of selected prey was also wider there.

However, it is important to highlight that this prediction assumes that predators use the same search strategy in all environments. As a consequence the search cost is only a function of search time. Foraging modes displayed by snail kites differ considerably regarding energy costs. Course hunting requires active flight, involving much higher energy costs than still hunting (Valentine Darby *et al.* 1998, Biewener 2003). Foraging modes used by snail kites are influenced by the availability of good perches from where they can access to the water surface (Snyder & Snyder 1969, Valentine Darby *et al.* 1998, Tanaka *et al.* 2006) and by structure of the vegetation (Bennetts *et al.* 2006), being still hunting more used in sparse vegetation (Beissinger 1983). Having into account the contrasting characteristics in vegetation structure and perch availability between wetland types it is expected that still hunting to be more frequently used in temporary wetlands. If this is true, it would be energetically more costly to obtain a prey in permanent wetlands such that the energy obtained by prey here must be greater to maintain a positive energetic balance. This would be in accordance with the differences in prey selection we documented between wetland types. Anecdotal observations (FJM pers. observ.) suggest that still hunting is more frequently used in temporary wetland

whereas course hunting is commonly used in lakes.

Tanaka *et al.* (2006) evaluated the pattern of prey selection by snail kites in habitats with differing availability of perching sites. Unlike our results, they found that in areas with lower perch density snail kites selected smaller snails. These authors proposed that the small size of prey in this areas can be a consequence of the higher costs associated to the transport of snails to the feeding perch. Differences in transportation costs between large and small snails in the temporary wetlands we studied should be very low since the feeding perches are in the close border of the water body.

Temporary wetlands analyzed in this study are located 150–200 km north of permanent wetlands. Since the distance between wetland types could be travelled by snail kites in one day (Martin *et al.* 2006), population differences in prey selection by snail kites can be discarded. The abundance of temporary wetland is notably high in wet years near to Dolores and its number is reduced as we move toward South, until being very scarce near Mar del Plata. Near to Dolores, three lakes (Sabalette, Sevigne, and El Rosarito lakes) were surveyed in this study. In spite of aerial ovipositions of apple snails and rests of snails preyed by limpkins (*Aramus guarana*) were common in these sites, we did not observe neither snail kites nor feeding perches in these lakes. On the contrary, near Mar del Plata, snail kites were relatively common in lakes and its feeding perches were easily detected. This situation would suggest that snail kites actively selected temporary wetlands when these sites are available. Darby *et al.* (2006) showed a positive association between snail density and the number of snail kites foraging. Moreover, Bourne (1985b) tested the micropatch preference by snail kites considering snail density and prey size effects, showing that the Snail Kite preferred to forage in micropatches with high prey density.

Therefore, maybe the higher snail abundance and greater access to them in temporary wetland could trigger the selection of this type of habitat.

Since life-history traits of apple snails can be markedly affected by the temperature (Albrecht *et al.* 1999, Stevens *et al.* 2002), estimates of snail abundance could be affected by latitudinal differences among wetland types. Unfortunately, limited availability of temporary wetlands near Mar del Plata and the active use of temporary wetlands by snail kites near to Dolores prevent us from controlling this factor when comparing the prey selection pattern between wetland types.

Additional studies focusing in the adoption of alternative foraging modes by snail kites under different environmental conditions, regarding perch availability and vegetation structure, are required to fully understand the causes of the differences in the pattern of prey selection between the wetlands analyzed in this work.

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