Nota Curta / *Short Note*

Fishing behaviour of the Osprey *Pandion haliaetus* in an estuary in the northern Iberian Peninsula during autumn migration

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The fishing behaviour of the Osprey *Pandion haliaetus* in an estuary in the northern Iberian Peninsula during autumn stopover is described. All prey consisted of fish of the family Mugilidae (grey mullets) and overall fishing events lasted on average 6.3 min with a 68.8 % success rate (n = 61 fishing events). Adults were better fishers (92% of success) than young birds (40%). The occurrence of fishing events was independent of tidal period or tidal direction. However, fishing success was higher when the tide was rising. We discussed how grey mullet behaviour and abundance may explain these results.

Key words: Osprey, *Pandion haliaetus,* tidal influence, fishing success, autumn migration, Iberian Peninsula

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Due to persecution, pesticides, disturbance, acid rain, fishery and modern forestry practices, the population of the European Osprey *Pandion haliaetus* decreased substantially in the period up to the middle of the twentieth century (Saurola 1997, Schmidt & Muller 2008). However, in recent decades Osprey numbers have begun to recover almost everywhere within its historic range (Löhmus 2001, Wahl & Barbraud 2005, Bretagnolle *et al.* 2008, Bai *et al.* 2009), which has also expanded as a result of reintroduction programs (Dennis & Dixon 2001, Muriel *et al.* 2010).

Predators occupying top positions in food chains require skills and speed for prey capture (Ueoka & Koplin 1973). Ospreys are diurnal predators that feed almost exclusively on live fish (Poole 1989). Several authors have reported that osprey fishing success is significantly affected by environmental variables such as wind speed, light intensity and tides (Ueoka & Koplin 1973, Grubb 1977, Flemming & Smith 1990, Machmer & Ydenberg 1990, Castellanos-Vera & Rivera 2007). The individual's experience and ability (Szaro 1978) as well as the behaviour and abundance of prey species (Swenson 1979) also influence fishing success.

The aim of this study was to describe Osprey fishing patterns and prey species during autumn migration in an estuary in the northern Iberian Peninsula. The possible relationship between frequency and success of Osprey fishing events and tides is also considered.

Material and methods

Field surveys were conducted during autumn (from 22 August to 26 October) in 2008 and 2009 in the Urdaibai Biosphere Reserve on the northern Iberian Atlantic coast (Basque Coun-

try, Spain; 43°29'N 2°40"W) (Figure 1). This protected area occupies an area of 220 km^2 and includes an estuary (919 ha) surrounded by agricultural land (4,860 ha) and woodland (14,080 ha). Monterey Pine *Pinus radiata* plantations are the dominant woodland (nearly 80%) whereas natural woodland is uncommon and is characterised by holm Oak *Quercus ilex* wood (1582 ha).

Standard methods in studies of Osprey foraging ecology were used to evaluate fishing behaviour (Ueoka & Koplin 1973, Swenson 1978, Clancy 2005a, Strandberg & Alerstam 2007). A 20–60x spotting telescope and binoculars were used to make opportunistic observations of Osprey foraging events along the estuary. Hunting events were measured using a stopwatch; rainy or windy days were avoided. The number of successful and unsuccessful hunting events (that is, when an Osprey succeeded or failed to catch a fish), the total time of each event (the time in minutes from leaving to returning to the perch), and the number of dives per hunting event was recorded. Dive was only counted when birds touched the water surface or plunged. Whenever possible, birds were classified by plumage as either young (< 6 months old) or adult. Few of the birds carried any type of markings and so the independence of observations cannot be assured. However, recording was conducted over a long period of time, which increases the likelihood of independent observations of birds.

Tides were divided into six hourly periods using tide tables (Spanish Meteorology State Agency) and were classified as rising or falling in terms of water direction. χ^2 tests were used to examine the homogeneity of fishing observations within tidal periods and tidal directions, and to evaluate fishing success in relation to tidal stage and direction.

Prey species were identified to family level by direct field observation using the telescope. Photographs and video recordings made in previous autumns were also used to identify prey species.

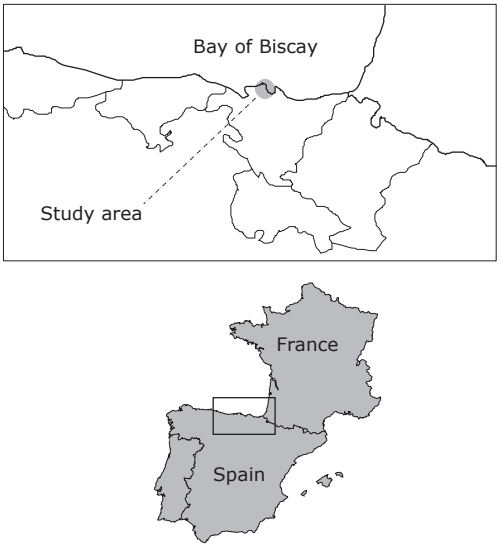

Figure 1. Location of the study area.
Localització de l'àrea d'estudi.

Results

A total of 76 opportunistic observations of Osprey fishing events were recorded across the daylight period (from 6 a.m. to 6 p.m.) (range: 3–11 event per hour) on 50 days. 61 complete hunting events were observed, of which 42 were successful and 19 unsuccessful (i.e. 68.8% fishing success; Table 1). Bird age was identified in 43 hunting events (27 adults and 16 young birds) and fishing success was 92% in adult and 40% in young Ospreys. The mean hunting event duration was 6.30 minutes (Table 1). When only successful fishing efforts were considered, the mean number of dives per hunt was 2.47 (Table 1); 42.8% of hunts were successful on the first dive.

Hunting events were recorded during all six hourly periods occurring between low and high tide (range: 8–19 events). Ospreys were no more active in any particular tidal period ($\chi^2 = 5.31$, df=5, $p = 0.378$) or tidal direction ($\chi^2 = 1.21$, df=1, $p = 0.271$). Fishing success was not associated with any tidal stage ($\chi^2 = 2.90$, df=5, $p = 0.715$), but was significantly higher when the tide was coming in (63.9%) than when it was going out (50%) ($\chi^2 = 7.50$, df=1, $p < 0.01$).

Altogether, 54 prey items were identified using the telescope (n=25), photography (n=17) and video recording (n=12) and all were identified as belonging to the family Mugilidae (grey mullets).

Discussion

Autumn fishing success of Ospreys at Urdaibai Reserve (68.8%) was similar to that reported for

Table 1. Osprey fishing parameters measured during autumn stopover at Urdaibai Biosphere Reserve (N Iberia). *Paràmetres pesquers de l'Àguila Pescadora mesurats durant la seva parada migratòria a la Reserva de la Biosfera d'Urdaibai (N de la península Ibèrica).*

	Successful	Unsuccessful	Total
Number of hunts	42 (68.8 %)	19 (31.1 %)	61
Number of dives	42 (27.1 %)	113 (72.9 %)	155
Mean foraging time (min) ± SD (n)	5.53 ± 5.98 (42)	8.31 ± 8.63 (15)	6.30 ± 6.93 (57)
Mean dives/hunt ± SD (n)	2.47 ± 1.85 (43)	2.94 ± 3.62 (16)	2.57± 2.48 (59)

other wintering and migrating Ospreys (Lekuona 1998: 65%, Silva & Olmos 2002: 71%, Strandberg & Alerstam 2007: 32.2–42.9%). Adult birds had great fishing success (92%), higher than reported worldwide for adult breeding Ospreys (MacCarter 1972: 83%, Garber 1972: 80%, French 1972: 86%, Ueoka & Koplin 1973: 82%, Szaro 1978: 57.5%, Swenson 1978: 45–48%, Flemming & Smith 1990: 50–76.6%, Clancy 2005a: 30%, Castellanos-Vera & Rivera, 2007: 61.3%, Harmata *et al.* 2007: 29-65%, Strandberg & Alerstam 2007: 44.4-53.4%). Young birds were less succesful, supporting the view that individual's experience plays a major role in hunting success (Szaro 1978, Poole 1989; Strandberg & Alerstam 2007). The average duration of a hunting event (6.3 min) was similar or lower than reported from breeding Osprey populations (Ueoka & Koplin 1973: 11.8 min, Szaro 1978: 38.3 min, Swenson 1978: 4.2 min, Machmer & Ydenberg 1989: 4.05 min, Castellanos-Vera & Rivera 2007: 7.5 min, Strandberg & Alerstam 2007: 13.7–15.8 min). Therefore, fishing success was high in a short fishing period, suggesting that Ospreys are very efficient hunters during their autumn stopovers in this study area. However, bad weather conditions, especially heavy wind and rain, could lead to a decrease in reported fishing success (Grubb 1977, Poole 1989, Machmer & Ydenberg 1990, Steeger *et al.* 1992, Castellanos-Vera & Rivera 2007).

The Osprey's diet appears to reflect local prey availability, since Ospreys are opportunistic foragers and take the most abundant and vulnerable fishes (Poole 1989, Gil Sánchez 1995, Francour & Thibault 1996). Swenson (1979) reported that the foraging behaviour of prey items is an important factor in determining Osprey fishing success, with benthic species being more vulnerable to Osprey attacks than fish that are not dependent on benthic food. Grey mullets appear to be particularly vulnerable as they are primarily benthic feeders; they are also slow swimmers and spend a lot of time near the water surface (Poole 1989, Francour & Thibault 1996). Various grey mullet species are found throughout the world in shallow coastal temperate and tropical waters (Thompson 1966) and have been reported as the main prey of Ospreys in several localities (Szaro 1978, Francour & Thibault 1996, Silva & Olmos 2002, Clancy 2005b, Sayago 2008). Grey mullets are the most abundant fish in temperate European estuaries (Knox 1986) and the striped *Mugil cephalus* and thick-lipped *Chelon labrosus* mullets are reported to be the commonest species in northern Iberian estuaries (García-Castrillo 1997), where they are very abundant, both in terms of number and biomass (*pers. obs*.).

In the study area Ospreys were active throughout the whole daylight period and did not appear to adjust their fishing activity to a particular tidal period or direction, although fishing success was higher during rising tides. Osprey fishing success may be influenced by tidal stages, although different responses to this factor have been reported (Ueoka & Koplin 1973, Stinson 1978, Flemming & Smith 1990, Castellanos-Vera & Rivera 2007). Daily estuarine movements of fishes are determined by local tidal conditions and therefore it has been suggested that prey behaviour may explain the reported differences in Osprey foraging responses to tidal conditions (Ueoka & Koplin 1973, Flemming & Smith 1990). Grey mullets in this study area are likely to be easier to catch as they migrate to the flooded mudflats with the incoming tide and start to feed more actively, as has been reported in several other estuarine fish species (Rountree & Able 1992, Cattrijsse *et al.* 1994). It is suggested that the high fishing success, the short time required to catch prey and

the activity patterns of the Ospreys observed in this study reflect a high prey availability due to the behaviour and abundance of grey mullet in this estuary.

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Resum

Comportament pesquer de l'Àguila Pescadora *Pandion haliaetus* en un estuari del nord de la península Ibèrica durant la migració de tardor

Es descriu el comportament de pesca de l'Àguila Pescadora *Pandion haliaetus* en un estuari del nord de península Ibérica. El temps mitjà emprat en cada acció pesquera va ser de 6,3 min i l'èxit de captura del 68,8%. Quan únicament es van considerar les accions protagonitzades per adults, l'èxit va augmentar fins el 92%. Tots els peixos capturats i identificats en aquest estudi pertanyien a la família Mugilidae. L'activitat pesquera de l'espècie no va estar associada a l'altura o a la direcció de la marea. No obstant això, l'èxit de pesca va ser major durant l'ascens mareal. Se suggereix que la rapidesa i l'elevat èxit de pesca registrat reflecteixen una gran disponibilitat de preses com a conseqüència del comportament dels mugílids i la seva abundància a l'estuari.

Resumen

Comportamiento pesquero del Águila Pescadora *Pandion haliaetus* en un estuario del norte de la península Ibérica durante la migración otoñal

Se describe el comportamiento de pesca del Águila Pescadora *Pandion haliaetus* en un estuario del norte de la península Ibérica. El tiempo medio empleado en cada evento pesquero fue de 6,3 min y el éxito de captura del 68,8%. Cuando únicamente se tuvieron en cuenta los eventos protagonizados por adultos, el éxito ascendió al 92%. Todos los peces capturados e identificados en este estudio pertenecían a la familia Mugilidae. La actividad pesquera de la especie no estuvo asociada a la altura o a la dirección de la marea. No obstante, el éxito de pesca fue mayor durante el ascenso mareal. Se sugiere que la rapidez y elevado éxito de pesca registrado reflejan una gran disponibilidad de presas como consecuencia del comportamiento de los mugílidos y su abundancia en el estuario.

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