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ACCURACY OF ESTIMATING THE SPECIES AND SIZES OF OSPREY PREY: A TEST OF METHODS

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ABSTRACT.—The accuracies of examining uneaten prey remains collected at feeding sites and of directly observing fish captured while birds forage, common methods of determining the species composition and size structure of prey in the diets of ospreys (*Pandion haliaetus*), were tested during the summer of 1992 at two shallow lakes in northeastern Scotland. Prey remains were collected below feeding perches and the number of heads and paired jaws was used to estimate the minimal number of each species in the diet. Key cranial bones were used for species identification and length estimation. Direct field observations were also made to identify the species and sizes of fish taken by foraging ospreys. Fish species were identified by body shape and lengths were estimated by comparison with the size of the ospreys. The accuracy of field observations was tested experimentally using a life-sized model osprey and a selection of northern pike (*Esox lucius*) and perch (*Perca fluviatilis*) of various sizes. Results showed that the analysis of prey remains gave an accurate estimation of the size range of osprey prey, although small fish (<25 cm) were underrepresented. Tests of field observations showed that most fish could be correctly identified on the basis of their body shape but there were consistent inter-observer differences in fish length estimations. These differences should be considered in studies using field estimates of prey size, particularly those involving energetic calculations where small errors in length estimations can lead to large errors in estimations of mass and, hence, energy.

KEY WORDS: *osprey; Pandion haliaetus; diet; prey estimation; field techniques.*

Exactitud de la estimación de tipos y tamaños de presas de *Pandion haliaetus*: una prueba de métodos

RESUMEN.—Las exactitudes de examinar presas no comidas que permanecen en los comederos y de observaciones directas de peces capturados mientras las aves se alimentan, métodos comunes de determinación de la composición de especies y tamaño de la estructura de presa en la dieta de *Pandion haliaetus*, fueron probados durante el verano de 1992 en dos lagos superficiales al noreste de Escocia. Los restos de las presas fueron colectados bajo comederos; el número de cráneos y pares mandibulares fueron usados para estimar el número mínimo de cada especie en la dieta. Claves de huesos craneales se usaron para la identificación de especies y estimación de longitud. También se hicieron observaciones de terreno para identificar los tipos y tamaños de peces capturados por águilas pescadoras. Las especies de peces fueron identificadas por la forma del cuerpo y la longitud fue estimada por comparación con el tamaño de la misma águila. La exactitud de las observaciones de campo fue probada experimentalmente usando un modelo "life-sized" del águila pescadora y una selección de varios tamaños de *Esox lucius* y *Perca fluviatilis*. Los resultados mostraron que el análisis de restos de presa entregan una estimación exacta del rango de tamaño de las presas del águila, aunque los peces pequeños fueron subrepresentados. Pruebas de observaciones de campo, mostraron que la mayoría de los peces podría ser identificado correctamente sobre la base de su forma corporal, en cambio hubo consistentes diferencias

entre observadores respecto a las estimaciones del largo. Estas diferencias podrían ser consideradas en estudios usando estimaciones de campo del tamaño de presa, particularmente aquellas que envuelven cálculos energéticos donde pequeños errores en las estimaciones de longitud podrían llevar a cometer grandes errores en estimaciones de masa y por lo tanto de energía.

[Traducción de Ivan Lazo]

The species composition and size structure of osprey (*Pandion haliaetus*) prey have been determined by collecting uneaten prey remains at nests and feeding perches, and by directly observing fish taken while ospreys forage (Poole 1989). There are potential biases associated with each method. Using the first, the frequency of small fish may be underestimated in the diet if, for example, they are completely ingested or their remains are hard to find. Conversely, overestimates may occur if large items are removed preferentially by scavengers such as corvids or foxes. The second method may also be biased because field identification and size-estimation of fish may be inaccurate (see discussion in Carss and Brockie 1994 for osprey and also Bayer 1985, Cezilly and Wallace 1988 for other species). In this study, we tested the errors associated with both methods of assessing osprey diets.

STUDY AREA AND METHODS

Data on osprey prey were collected at two lakes, Loch Davan (42 ha) and Loch Kinord (82 ha), in the Dinnet National Nature Reserve in northeast Scotland from June–August 1992. Pelagic fish species in these shallow (mean depth = 1.2 and 1.5 m, respectively), “kettle-hole” lochs were principally northern pike (*Esox lucius*) and perch (*Perca fluviatilis*). The only other fish was the common eel (*Anguilla anguilla*). The northern pike is a common top predator of freshwater ecosystems in Europe and North America and often found in association with perch; such simple fish communities are relatively common in Scotland.

Prey remains were collected below feeding sites (mainly telegraph poles but also trees) throughout the reserve and in adjacent areas. The number of heads or paired jaws was taken as the minimal number of each species in the diet and key cranial bones were extracted for species identification and length estimation following Carss and Brockie (1994).

Direct field observations of foraging ospreys were made by one observer (JDG) from June–August 1992 and all daylight hours from 0515–2230 H were sampled in a variety of weather conditions. Individual, foraging ospreys were watched from the loch shore with 8×32 bin-

oculars or a 15–65×70 telescope. Dives were classed as successful if a fish was seen to be carried away and unsuccessful if no fish was carried. The species of fish taken was identified from its body shape and its length was estimated by comparison with the size of the ospreys.

The accuracy of direct field observations of osprey prey was tested at the Institute of Terrestrial Ecology, Banchory, using a life-size model osprey (body = 55 cm, wing span = 155 cm) and a selection of pike and perch of various sizes that were caught in the study lochs. Fish were suspended between the talons of the model osprey which was then raised approximately 5 m into the air for a period of 10–20 sec. The model was observed against the sky from a distance similar to that encountered in the field (ca. 150 m). Ten pike (fork lengths [FL] = 10, 11, 12, 21, 21, 36, 36, 39, 40, 50 cm) and three perch (FL = 8, 9, 12 cm) were shown, 10 of which were presented twice. Fish were presented in arbitrary order and observers had no prior knowledge of the range of sizes to be expected. At some point during the trial, the model osprey was shown without a fish, giving a total of 24 presentations. Six observers, including the two authors, took part in the tests for a total of 144 observations. Data were analyzed by linear regression of the relative errors in the estimated fork lengths ($[\text{estimated} - \text{actual}]/\text{actual}$) on the actual fork lengths of fish presented to each observer. We tested for differences in either the slopes or the intercepts of each observer's estimation equation assuming (a) a different slope and a common intercept or, (b) a different intercept and a common slope for each observer.

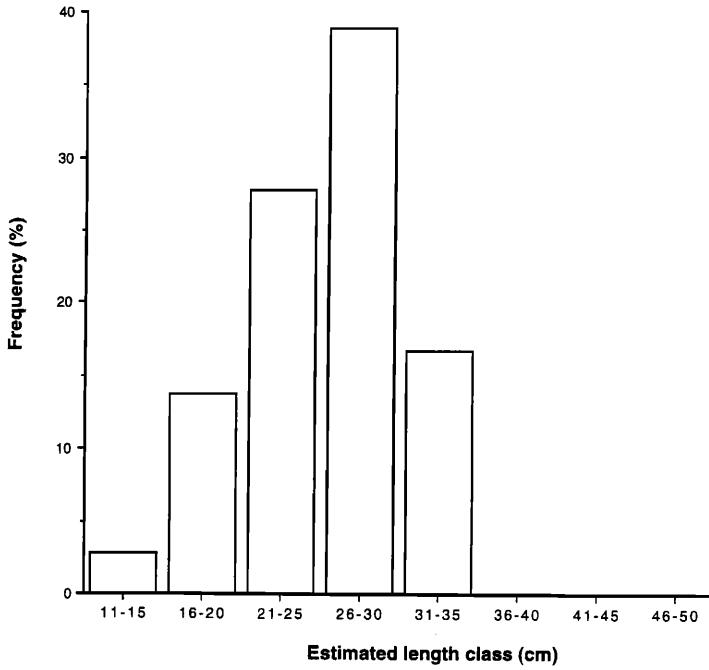
RESULTS AND DISCUSSION

Remains of 101 individual fish were collected between June–August. The majority of remains collected were fish heads, although some tails and intact carcasses were also found. Remains were mostly those of pike (64%) with the remainder being perch, as was expected given the simple fish community of the lakes. In general, piscivorous fishes are seldom found in the diets of ospreys (reviewed in Poole 1989). Perch and pike comprise no more than 16% and 37%, respectively, of the diet of European ospreys (Cramp and Simmons 1980).

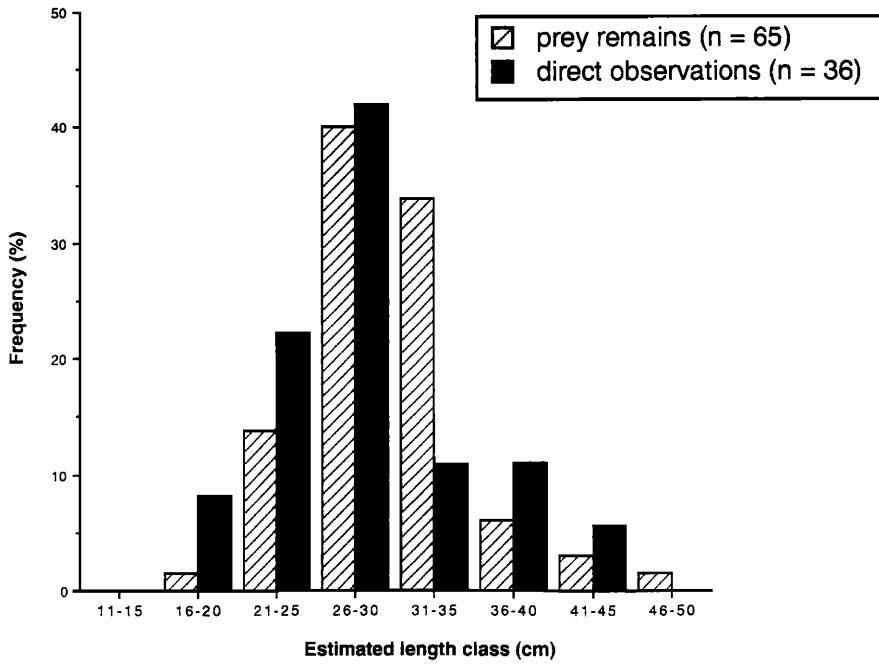
It was clear that ospreys took a particular size-

Figure 1. (a) Length classes of perch ($N = 36$) estimated from prey remains collected from feeding sites. (b) Length classes of pike estimated from both prey remains ($N = 65$) and field observations ($N = 36$) of foraging ospreys. Data collected from Dinnet National Nature Reserve, June–August 1992.

(a) Perch (n = 36)



(b) Pike



range of prey at Dinnet. Length estimates for pike ranged from 19–46 cm and those for perch were from 12–36 cm (Fig. 1a). These size ranges were similar to those reported by Cramp and Simmons (1980) and Poole (1989), and strikingly similar to those estimated using the same method in central Scotland (perch: range = 18–30 cm, $N = 16$; pike: range = 24–44 cm, $N = 25$) (Carss and Brockie 1994).

We observed 38 fish actually captured by foraging ospreys. All but two, perch with estimated lengths of 18 and 25 cm, were pike. Length estimates for pike (Fig. 1b) ranged from 16–44 cm ($\bar{x} = 27$ cm, $SE = 11$, $N = 36$). Overall, size ranges determined using this method were similar to those obtained using prey remains with the largest proportion of fish taken in the 26–30 cm range. Although not statistically significant (χ^2 test on numbers of fish remains and observations in <25 cm, 26–35 cm, and >36 cm size classes), small pike (<25 cm) were less frequently observed in prey remains than during direct field observations at the lochs, and fewer large pike (>30 cm) were seen taken than were represented in remains collected at nearby feeding perches. We concluded that estimates of osprey diets from prey remains probably gave a biased picture of the lengths of fish taken with the proportions of small fish being underrepresented.

We have found the undigested remains of fish up to 12 cm long in the guts of larger piscivorous fish that were partially eaten by ospreys. Therefore, the presence of small fish remains at nests or feeding sites does not necessarily imply that fish of this size have been taken directly by ospreys; such a phenomenon could explain the record of a 4 cm fish at the nest (McLean and Byrd 1991).

During field tests with the model osprey, all six observers were able to correctly determine when the osprey was not carrying a fish. Most fish (92.8%) in the remaining 138 experimental trials were correctly identified to species (5.8% misidentified and 1.5% unidentified). The eight misidentified fish (4 pike and 4 perch) were the smallest fish used in the trials (\bar{x} FL = 14 cm, $SE = 2.4$, range = 8–21 cm). Presumably, larger fish were correctly identified more often because of differences in their body shape, with pike tending to be elongate and perch deep-bodied. Observations of actual prey captures by ospreys usually last longer than 20 sec and real ospreys carry live fish which hold their fins erect increasing the opportunity for

Table 1. Percentages of osprey prey length estimates correctly and incorrectly assigned to arbitrary 5 cm size categories by each of six observers (a–f). Observers differed in their ability to correctly categorize estimations ($\chi^2 = 11.03$, $df = 5$, $P = 0.05$).

| LENGTH ESTIMATE | OBSERVER | | | | | |
|-----------------|----------|------|------|------|------|------|
| | a | b | c | d | e | f |
| % Correct | 34.8 | 52.2 | 43.5 | 21.7 | 26.1 | 60.9 |
| % Incorrect | 65.2 | 47.8 | 56.5 | 78.3 | 73.9 | 39.1 |
| Total estimates | 23 | 23 | 23 | 23 | 23 | 23 |

prey identification. Nevertheless, the accuracy of identifications may be reduced in other areas where confusion could arise between similarly-shaped fishes such as perch and roach (*Rutilus rutilus*), or pike and salmonids (*Salmo* spp., *Oncorhynchus* spp.).

The regression analysis showed that there was significant variation among observers in the estimation of fish sizes. Both the intercepts ($F_{5,126} = 10.7$, $df = 5$, $P < 0.001$) and slopes ($F_{5,126} = 13.4$, $df = 5$, $P < 0.001$) of observer regression lines differed significantly. We therefore concluded that such differences should be taken into account in studies relying on length estimates in the field.

Most (71%) of the 138 estimates were within 20% of the true lengths with those of one observer (JDG) being consistently within 10% of the actual lengths. Most observers estimated fish lengths within 3–9 cm of the actual length and one observer (JDG) estimated them with 2–4 cm accuracy. These values would likely be the same under actual field conditions for a similar observation distance. After length estimates were assigned to arbitrary 5 cm size classes (e.g., 6–10 cm, 11–15 cm), we were unable to improve observer accuracy and 39–78% of the estimates were still incorrectly assigned (Table 1). A further increase in the range of size classes used would increase the proportions of estimated lengths correctly identified, but such results would be increasingly less meaningful. Therefore, it is recommended that observers be tested before making size estimations of osprey prey in the field.

The experimental trials suggested that field observations of fish taken by foraging ospreys would give an accurate estimate of the proportions of each prey species in the diet but that size estimates of fish would be less reliable because some observers were able to estimate the lengths of fish more

accurately than others. This may have important implications for energetic studies where prey mass, rather than its length, is a crucial factor. Because body mass varies as the cube of length, small errors in length estimation will lead to large errors in the estimation of mass.

We found that accurate length estimates could be obtained from the collection of prey remains at feeding sites. While this also appeared to be a valid technique for estimating the size range of osprey prey, it underestimated the proportion of small fish (<25 cm) taken. Nevertheless, this method was far less labor intensive and, hence, cheaper, than direct observations in determining the diets of ospreys.

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