GLENN A. PROUDFOOT, *Caesar Kleberg Wildlife Research Institute, Campus Box 218, Texas A&M University-Kingsville, Kingsville, Texas 78363*; AND SAM L. BEASOM (deceased) *Caesar Kleberg Wildlife Research Institute, Campus Box 218, Texas A&M University-Kingsville, Kingsville, Texas 78363.* *Received 19 Nov. 1996, accepted 21 April 1997.*

Wilson Bull., 109(4), 1997, pp. 748–749

The significance of fishing by Northwestern Crows.—Fishing by crows has been reported anecdotally in a few cases, specifically in the Carrion Crow (*Corvus corone*) (Dunn 1985) and Northwestern Crow (*C. caurinus*) (Shepherd 1988). We describe here the behavior in greater detail and suggest that intertidal zone fishing provides a significant source of nutrition to Northwestern Crows during limited, but predictable foraging periods. On two occasions we have observed large groups of Northwestern Crows fishing systematically for Pacific sand lances (*Ammodytes hexapterus*) buried in sandy areas at very low tides.

The first observations were made on 25 August 1996 between 08:08 and 08:45 PST at Meadowdale Park Beach, north of Seattle, Washington on Puget Sound. The tide height ranged from .03 m above to −0.2 m below mean low tide during this period. The birds demonstrated a distinctive behavior of flipping sand to each side with their beak while digging a 5–8 cm hole in the sand. This usually resulted in the bird pulling out a silvery slender fish approximately 150 mm in length. The birds held the fish sideways in their bills initially, then set the fish on the sand, reoriented the fish lengthwise and swallowed it whole. This behavior was observed in the majority of birds on the beach at that time, numbering from 36 to 41. Three specific birds were observed for 10 minute focal samples, documenting their behavior both prior and subsequent to the capture of one of these fish. These observations indicated that a crow could find and handle a fish in less than five minutes. One of those three birds lost its prey to a conspecific: scrounging (intraspecific theft [Vickery et al. 1991]) was observed at high rates during periods of fishing. Gulls also took sand lances from crows and were never observed digging for the fish themselves.

The second observation period was on 28 August 1996 between 10:20 and 11:23 PST at Meadowdale Park Beach. The tide height during this period ranged from 0.1 m above to −0.3 m below mean low tide. Again, a large majority of the 28 birds on the beach were observed to perform this behavior, though it only occurred in this narrow window of time and tide height. We observed 12 "scrounges" of sand lances during this period. Again, gulls took fish from crows and were not observed searching or digging for fish.

We eventually obtained one of the fish by running up to birds who were digging but had not yet obtained their fish. This sample was confirmed as a Pacific sand lance (*Ammodytes hexapterus*). The high rate of both intra- and interspecific theft suggested to us that the sand lances were highly valued by both crows and gulls. We were particularly interested in the value of a fish in satisfying a crow's daily energy requirements. The average daily energy requirement of a 285g crow (Pyle et al. 1987) can be estimated at 403.7 kJ/day (Walsberg 1983). The average length of a sand lance is 15.5 cm with a caloric content of 22.52 kJ/g-dry weight (Vermeer & Devito 1986). We converted the average length into wet weight (Vermeer & Devito 1986) and converted wet weight to dry weight (0.29 g-dry/g-wet; Cooper 1978). This resulted in a value of 120.1 kJ/fish. In a similar fashion, the energy content of intertidal worms, a frequent intertidal food item (pers. obs.), (average dry-weight: 25mg) was calculated to be 0.42 kJ/worm (Goss-Custard 1977a, 1977b). Thus, the average crow needs only 3.4 sand lances/day to satisfy their daily energy requirements, whereas they would need 961.2 average-sized worms. Clearly these fish provide a valuable energetic

resource. However, the fish are only available bimonthly at the lowest tides (Shepherd 1988). In our study area, these lowest tides (<0 m) occur for 4–8 successive days and last approximately 30–60 minutes each day.

From a more general point-of-view, this resource is unusual in that it is highly valuable and limited, but predictable in its temporal distribution. Most food resources that are highly rewarding and of limited duration are unpredictable in their occurrence (e.g., insect molting swarms). Perhaps this unusual combination of characteristics explains why the resource produces such intense intra- and interspecific competition and has been exploited by crows (and through the foraging abilities of crows, other predators) in both the Kodiak Archipelago (Shepherd 1988) and the Puget Sound region.

Acknowledgements—We thank Doug Dailer and Bill Karras of the Snohomish County Parks & Recreation Dept. for their support and encouragement of this project.

LITERATURE CITED

CASTRO, G., N. STOYAN AND J. P. MYERS. 1989. Assimilation efficiency in birds: A function of taxon or food type? Comp. Biochem. Physiol. 92A:271–278.

COOPER, J. 1978. Energetic requirements for growth and maintenance of the Cape gannet (Aves: Sulidae). Zoologica Africana 13:305–317.

DUNN, P. J. 1985. Feeding methods of coastal Carrion Crows. British Birds 78:151–152.

GOSS-CUSTARD, J. D. 1977a. Optimal foraging and the size selection of worms by Redshank, *Tringa totanus*, in the field. Anim. Behav. 25:10–29.

———. 1977b. The energetics of prey selection by Redshank, *Tringa totanus* (L.), in relation to prey density. J. Anim. Ecol. 46:1–19.

PYLE, P., S. N. G. HOWELL, R. P. YUNICK, AND D. F. DESANTE. 1987. Identification Guide to North American Passerines. Slate Creek Press, Bolina, California.

SHEPHERD, D. A. 1988. Foraging interactions among Black-billed Magpies, Northwestern Crows, and Red Foxes on Kodiak Island, Alaska. Murrelet 69:68–69.

VERMEER, K. AND K. DEVITO. 1986. Size, caloric content, and association of prey fishes in meals of nestling Rhinoceros Auklets. Murrelet 67:1–9.

VICKERY, W. L., L-A GIRALDEAU, J. J. TEMPLETON, D. L. KRAMER, AND C. A. CHAPMAN. 1991. Producers, scroungers, and group foraging. Amer. Nat. 137:847–863.

WALSBURG, G. E. 1983. Avian ecological energetics. Pp. 161–220 *in* Avian biology Volume 7 (D. S. Farner and J. R. King, eds.). Academic Press, New York.

RENEE L. ROBINETTE AND JAMES C. HA, *Dept. of Psychology, Univ. of Washington, Box 351525, Seattle, Washington 98195.* *Received 28 January 1997, accepted 19 August 1997.*

Wilson Bull., 109(4), 1997, pp. 749–752

Long-term memory of an auditory stimulus for food in a natural population of the Mexican Jay.—The role of learning and memory in the development of foraging skills should be especially important in species that utilize a wide variety of food, as do many members of the family Corvidae (Goodwin 1976). Jays and other corvids can be easily conditioned in the laboratory to respond to various kinds of stimuli (usually visual) that signal the probable presence of food (Pietrewicz and Kamil 1981). For natural populations it is common knowledge that birds learn the locations of food and feeders, and experimental evidence of memory of locations of food is available (Kamil and Balda 1990, Shettleworth