Avocetta – vol. 50
doi: 10.30456/avo.30145

Even more generalist: an invasive crayfish as a novel food source for Common Buzzards

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Abstract

Generalist predators exploit a wide range of food resources, making them more adaptable. Sometimes, the appearance of a new species can lead to their exploitation, especially when it is abundant. In this sense, Red Swamp Crayfishes *Procambarus clarkii*, one of the most dangerous freshwater exotic species in the world, are an important food resource for some species in their non-native range.
We describe a newly observed behaviour and food source for Common Buzzards *Buteo buteo* in Western Iberia, where Red Swamp Crayfish appear to be a recurrent resource in late summer. The buzzards exhibited riverbank-patrolling behaviour and consumed this crustacean alongside other prey species. This behaviour represents the discovery of a new invertebrate taxon (Crustacea) in the diet of the Common Buzzard, thereby broadening its known trophic spectrum. Future research should explore whether Common Buzzards exploit similar resources in other regions, particularly where they may prey on other invasive species.

Keywords: Raptor, predation, invasive species, trophic, *Buteo*

INTRODUCTION

Red Swamp Crayfishes *Procambarus clarkii* (Girard, 1852) are known to be one of the worst invasive species in freshwater ecosystems globally (Vilá et al. 2010), supposing a threat to native biodiversity. This species has expanded considerably its original distribution range in Southern USA and Northern Mexico to other parts of America, Africa, Asia and Europe (Oficialdegi et al. 2020). In Spain, it was introduced in 1974 in the Guadalquivir marshes for commercial purposes (*Catálogo Español de Especies Invasoras*, 2013). Its life cycle has been profoundly studied there, where it seems to follow different phenological patterns depending on the type of habitat, being capable of reproducing all year round or having peaks in winter or summer (Alcorlo et al. 2008). From there, it has both expanded and been introduced independently to almost every place in Iberia, becoming one of the main conservation threats to the native Spanish crayfish *Austrapotamobius italicus* (e.g. Gil-Sánchez et al. 2006) and other native fauna such as several species of amphibians (e.g. Cruz et al. 2006). More generally, the Red Swamp Crayfish is known to have negative effects through predation on local organisms, community dominance, depletion of food resources, habitat alteration, competition, and food-web disruption (Souty-Grosset et al. 2016). However, since its introduction, it has become an important part of the diet of several predators (Tablado et al. 2010), especially semi-aquatic carnivores such as the Eurasian Otter *Lutra lutra* and some species of herons (Ardeidae spp.), storks (Ciconidae spp.) and gulls (Laridae spp.) that can exploit this resource (e.g. Correia 2001, Cano Alonso 2006). The role of crayfishes (Cambaridae) in raptors (referring here to the paraphyletic group composed by Accipitriformes, Falconiformes, Cathartiformes, Cariamiformes and Strigiformes) diet has not been studied in depth. In North America, there are some records of owls like the Barred Owl *Strix varia* (Livezey, 2007) and the Eastern Screech-Owl *Megascops asio* (Courter, 2017) and some species of hawk, especially the Red-shouldered Hawk *Buteo lineatus* (e.g. Johnston 2000, Fisher 2020) and Common Black-hawk *Buteogallus anthracinus* (Etzel et al. 2014) preying upon crayfish species. Focusing on Europe and the Iberian Peninsula, it has been described that Black Kites *Milvus migrans* have increased the consumption of *P. clarkii* in the period 1976-2002 in the Doñana National Park population, SW Iberia, in the place where Red Swamp Crayfishes were first introduced in Spain (Tablado et al. 2010).

In Europe, Common Buzzard *Buteo buteo* (L. 1758) is one of the most common raptor species and is recognized as generalist predator known to be capable of prey upon a great variety of species (Orta et al. 2022). This species usually catch preys from perches, although it can also show gliding or soaring flight, hover, or walk on the ground when it is actively looking for invertebrates (Orta et al. 2022). Although Common Buzzard

diet is wide, normally it is mainly composed by mammals, especially rabbits (Lagomorpha), rodents (Rodentia) and reptiles (mainly Squamata) which usually constitute the main food income during the breeding period (e.g. Valverde, 1967; Mañosa & Cordero, 1992) while invertebrates (mainly beetles (Coleoptera) and grasshoppers (Orthoptera)) play a more important role during the winter in some areas (Valverde, 1967; Bustamante, 1985). It can consume also carrion from roadkills (Elósegui, 1974), amphibians (Cramp & Simmons, 1980), nocturnal raptors such as Barn Owls *Tyto alba* (Bullock, 2006) and even fish, since Madge (1992) cited a predation event upon an eel. Although invertebrates can constitute an important part of the diet in certain populations and circumstances (Valverde 1967, Orta et al. 2022) the consumption of crustaceans has never been described for this species. The repeated detection of Common Buzzards along the river in a highly anthropogenic area led us to hypothesize that the birds are taking advantage of the crayfish mating season, when the animals are more visible and water levels are slightly lower. Although the sampling was carried out throughout the year, this behaviour was recorded only during this period. Crayfishes may suppose an important energy source during this part of the year, when the juvenile buzzards are flying. We also detected crayfish consumption by Eurasian Otters and American Mink *Neogale vison*, that consume them almost year-round, but also by Red Fox *Vulpes vulpes*, a more generalist carnivore that overlapped the consumption period with Common Buzzards, also suggesting the importance of this season.

MATERIALS AND METHODS

The study area is a narrow riparian forest dominated by black poplar (*Populus nigra*) and several willow species (*Salix* spp.) along the Tormes river in Salamanca (Western Iberia) (Figure 1). The surrounding landscape is highly anthropogenic, and the main available habitats are intensive corn (*Zea mays*) and potato (*Solanum tuberosum*) irrigated croplands. The breeding diurnal raptor community, obtained from personal observations and the species listed in two eBird hotspots embedded in the study area (eBird, 2024) includes Booted Eagle *Hieeraetus pennatus,* Short-toed Eagle *Circaetus gallicus,* Goshawk *Astur gentilis,* Sparrowhawk *Accipiter nisus,* Red Kite *Milvus milvus,* Black Kite *Milvus migrans,* Marsh Harrier *Circus aeruginosus* and Common Buzzard.

The buzzard pictures were noticed while checking the pictures of the cameras for other study designed for describing the mammal community living in forest remains in highly modified areas. We used ten Apeman H55 camera trap at a 40 cm height programmed to take 2 pictures every time the camera was activated. More information can be consulted in Fuentes-Lamas et al. (2025). Because it is not easy to distinguish between individuals in this species without marking, we assigned three codes to animals that

Figure 1. Study area in Western Iberia and locations of the camera traps**.** The one showing buzzard events is marked with a buzzard drawing.

we considered different based on plumage and colour. We distinguished the apparent age but did not confirm it, basing on the information in Blasco-Zumeta & Heinze (2023). Additional birds with similar plumage morphs may also have been present.

Other crayfish species are not present in the area. The closest location where the other invasive crayfish species present in the province, the Signal Crayfish *Pacifastacus leniusculus*, occur is 80 km away, in a completely different hydrographic basin (Tajo). The autochthonous crayfish *Austrapotamobius italicus* is extinct in the area since Red Swamp Crayfish arrived, so we were sure about the species identification. Moreover, Red Swamp Crayfish remains are commonly found in the area (authors, pers. comm.).

RESULTS

Cameras were active for a total of 320 non-consecutive days covering the four seasons, starting in May 2021 and finishing in March 2022. We recorded a total of 16 Common Buzzard presence records from 09/08/2021 until the 02/09/2021 representing a 2% of the records of that camera (CAM9) (Table 1) One apparently juvenile individual showed a lot of white

Table 1. Events in which buzzards appear in the camera trap, supposed individuals and behaviours. Dates are represented in day/month/year format. Behaviour: Predation (prey is observed in the pictures), Foraging (active foraging by walking), Perching (the buzzard is on a perch but not moving).

Date	Hour	Individual	Behaviour	Prey catch	Crayfish predation attempt
09/08/2021	18:06:41	Bb_1	Predation	Yes	Yes
19/08/2021	14:36:53	Bb_2	Foraging	-	-
19/08/2021	15:26:00	Bb_2	Foraging	-	-
19/08/2021	16:50:00	Bb_2	Foraging	-	-
20/08/2021	15:39:01	*NA*	Foraging	-	-
21/08/2021	14:19:56	Bb_2	Foraging	-	-
21/08/2021	15:01:00	Bb_2	Foraging	-	-
23/08/2021	10:23:33	Bb_2	Foraging	-	-
23/08/2021	13:25:00	Bb_2	Predation	Yes	No
23/08/2021	13:50:00	Bb_2	Perching	No	-
23/08/2021	15:20:00	Bb_2	Predation	No	Yes
24/08/2021	15:27:25	Bb_2	Predation	-	-
29/08/2021	13:13:59	Bb_3	Foraging	-	-
29/08/2021	14:00:43	Bb_3	Perching	-	-
01/09/2021	18:33:33	Bb_3	Predation	Yes	Yes
02/09/2021	17:56:01	Bb_3	Foraging	-	-

markings with some remaining of down feathers (Figure 2.3), one apparently adult individual showing full brown plumage (Figure 2.4), and one dark brown apparently adult individual (Figure 2.1). Buzzard behaviours were classified as either perching, foraging (referring to active, walking foraging), and predation, when an interaction with a prey was recorded (Figure 2).

In these records, we observed a new foraging behaviour for Common Buzzards feeding on Red Swamp Crayfishes following the riverbank while they were in search of invertebrates, perching or trying to catch prey (Fig. 2; Table 1). We recorded three events of successful buzzard-crayfish predation, four attempts by at least three individuals (Figure 3.1 and 3.3) and one event of caterpillar predation (Figure 3.2).

Apart from buzzard-crayfish predation events, we detected Red Foxes and American Mink catching crayfish during the same period (Figure 3.4-3.5).

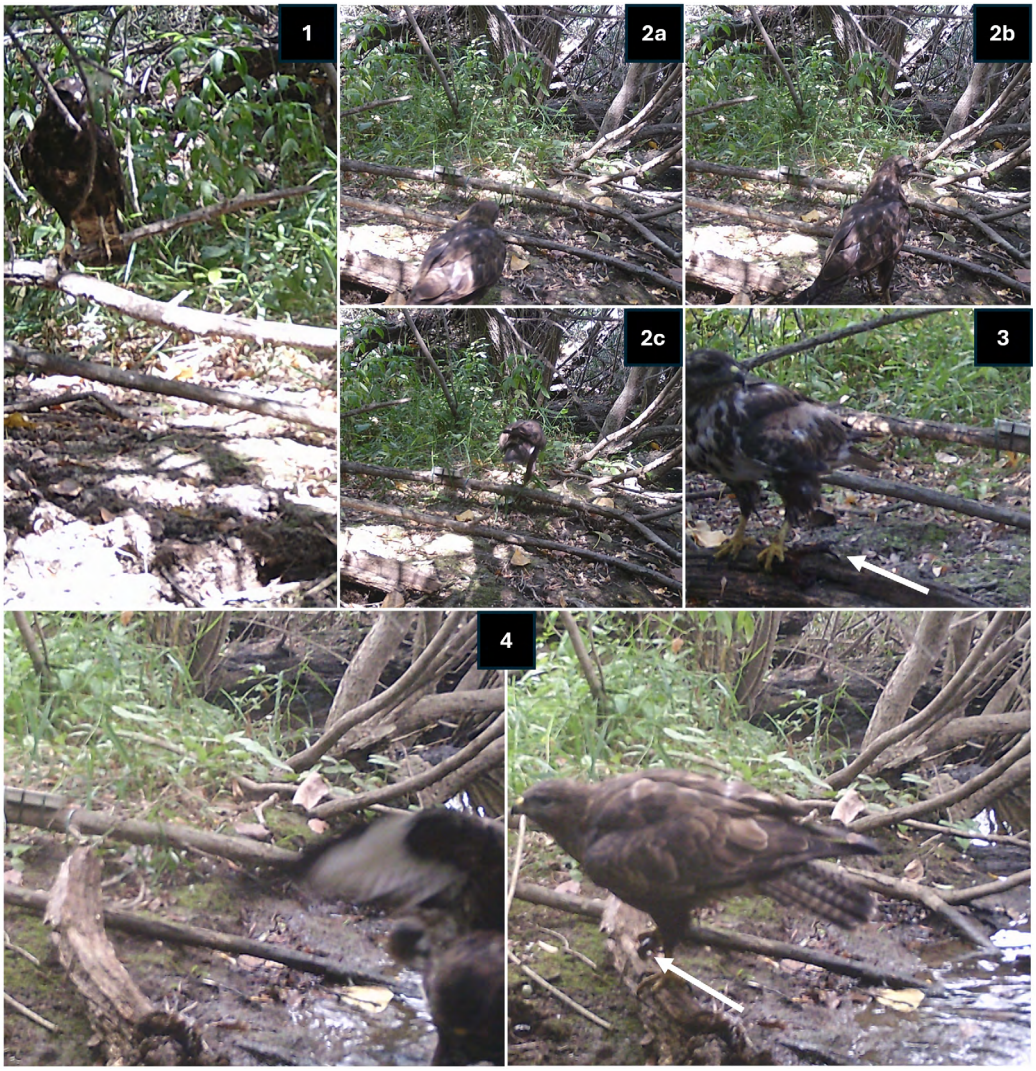

Figure 2. Foraging behaviours observed. 1) Common Buzzard perched, 2a-c) Common Buzzard patrolling the riverbank by walking 3) juvenile Common Buzzard with a Red Swamp Crayfish in its claws, 4) Successful catch of a Red Swamp Crayfish by an apparently adult Common Buzzard. The last two refer to "Predation" behaviour.

Figure 3. 1) Apparently adult Common Buzzard with a captured crayfish. 2) Common Buzzard with a caterpillar, 3) Juvenile Common Buzzard with a crayfish, 4) Fox preying upon a crayfish and 5) American Mink preying upon a crayfish.

DISCUSSION

Our results provide evidence that Common Buzzards can capture Red Swamp Crayfishes, representing a previously undescribed food item for this species. This observation adds to existing knowledge on the ecological plasticity of the Common Buzzard. The consumption of invertebrate preys by Common Buzzards has been described many times, showing a great preference for them in some areas (e.g. Valverde 1967). However, there is not any study that showed that Common Buzzards actively catch crayfishes or other crustaceans (Valverde 1967, Elósegi 1974, Bustamante 1985, Zuberogoitia et al. 2006, Tapia et al. 2007) neither in the monographies by Tapia (2016) and Orta et al. (2022). However, some similar species are known to consume Crustaceans in certain conditions (McCulloh et al. 2019) or are perfectly adapted to capture and consume them, supposing its main prey (Monsalvo et al. 2024). The reasons why Common Buzzards have been observed here so many times trying to or catching this kind of prey in this area could have several possible answers.

One possibility is that the detected individuals could be immature birds looking for potential prey, probably first calendar year

birds "experimenting" with different items. However, these cannot be considered as isolated events since this behaviour was observed three different days during the study period, suggesting that these birds visit that place consciously and consume crayfish as a part of their diet. In some pictures, the animals seem to actively look for this prey, walking next to the riverbank and catching them in the water when the level is low. After that, they usually move to a separate log to eat them. The fact that Red Foxes and American Minks have been also detected preying upon crayfish suggest during this time of the year crayfish could be an important food source for other animals, and they probably have a reproduction peak in this time, as it happens in other areas (Alcorlo et al. 2008).

A more frequent capture rate due to camera programming could have showed this behaviour deeply, but this was not the original aim of the study design. Finally, the fact that buzzards have been detected actively preying upon crayfishes in our study area could be also because it is an easier prey when they are out of the water, as well as other invertebrates like the caterpillar that appears in the Figure 3.2. The fact that they were only recorded catching crayfish at CAM9 is probably due to the proximity of this camera to water. In fact, they were only detected at this camera, catching crayfish or not. Although we can hypothesise about possible causes (e.g. the proximity of an undetected nest), camera traps—at least as deployed in this study—are not an appropriate method for detecting Common Buzzards or raptors in general. Therefore, this behaviour was most likely recorded by chance. Our findings improve our understanding of Common Buzzard ecology within our study site, whereby we document the first predation events of Red Swamp Crayfish throughout the species' range. Future research should expand on our preliminary findings outside of our study area to ascertain whether this generalist species has shifted its trophic niche in response to alien and invasive species in its foraging habitats.

Acknowledgements

To all the people that highly improved the quality of this paper by reviewing it, thank you for your unvaluable help. To all the people that, at some point, helped with fieldwork during the main study. In memoriam Daniel Saldaña, "Saldi", who would have loved to know about this behaviour.

Declarations

The authors have no competing interests to declare that are relevant to the content of this article.

All data generated and analysed during the current study are included in this published article. Additional data are available from the corresponding author upon reasonable request.

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Received: 14 November 2025
First Response: 21 November 2025
Final acceptance: 22 January 2026
Published online: 23 February 2026
Editor: Gianpasquale Chiatante