

Frugivory in Raptors: New Observations from Australia and a Global Review

James A. Fitzsimons ^{1,2,*}  and Jack Leighton ³¹ The Nature Conservancy, Suite 2-01, 60 Leicester Street, Carlton, VIC 3053, Australia² School of Life and Environmental Sciences, Deakin University, 221 Burwood Highway, Burwood, VIC 3125, Australia³ Tinaroo Waters Productions, Kairi, QLD 4872, Australia; birdsnbarra@tinarrowaters.com.au

* Correspondence: jfitzsimons@tnc.org

Simple Summary: Raptors (birds of prey) typically consume vertebrate and invertebrate prey. However, some species have also been recorded consuming fruits. We described instances of the Black Kite (*Milvus migrans*) and Whistling Kite (*Haliastur sphenurus*) consuming avocado (*Persea americana*) fruit in northern Australia. This appears to be the first instance of fruit consumption by raptors in Australia. We also review and document instances of fruit consumption by 29 species of raptors across the world, significantly more than previous reviews.

Abstract: The diets of raptors are some of the best studied and well-known of all bird groups. Raptors are typically carnivores, hunting and feeding on vertebrates and, for some species, invertebrates. Here, we described instances of the Black Kite (*Milvus migrans*) and Whistling Kite (*Haliastur sphenurus*) consuming non-native avocado (*Persea americana*) fruit in commercial orchards in northern Australia, over multiple years. This appears to be the first instance of frugivory by raptors in Australia. We review instances of frugivory for other raptor species globally. This review finds that 29 species of raptor from the families Falconidae, Accipitridae and Cathartidae have been recorded consuming fruit, significantly more than previous reviews.

Keywords: raptor; frugivory; fruit; diet; avocado; *Persea americana*; Black Kite *Milvus migrans*; Whistling Kite *Haliastur sphenurus*



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1. Introduction

The diets of diurnal raptors are some of the best studied and well-known of all bird groups (e.g., [1,2]). Raptors are typically carnivores, hunting and feeding on vertebrates and, often in smaller species, invertebrates, but with regional variation [1–4]. Some raptors are known to utilise vegetable matter such as fruit (e.g., [3,5,6]), with a small number utilising fruit on a regular basis (e.g., Palm-nut Vulture *Gypohierax angolensis* [2,7]), although generally raptors are not considered frugivores [8].

However, major reviews of Australian raptors [9–13] and other peer-reviewed and grey literature have not noted frugivory from raptor species occurring on that continent. Here, we described instances of frugivory in the Black Kite (*Milvus migrans*) and Whistling Kite (*Haliastur sphenurus*) in northern Australia over multiple years and review instances of frugivory for other raptor species globally. We define frugivory as the consumption of fruit, in line with other reviews [5,14], but do not imply raptors conduct exclusive or extensive frugivory (e.g., [15]).

2. Observations and Methods

2.1. Observations

In 2002, Jack Leighton (JL) first observed Black Kites around avocado (*Persea americana*) orchards (a tree species native to Mexico, but widely planted in commercial crops in many

countries) in flocks of approximately 100, at Mareeba, on the Atherton Tablelands, north Queensland, Australia (16°59'0" S, 145°25'0" E). That year there were low numbers of grasshoppers and locusts, which would be the main source of food for Black Kites, other than mice and native rats in the region (JL pers. obs.). Black Kites were observed eating the post-harvest avocado fruit that had dropped to the ground. In these instances, three or four Black Kites gathered around each fallen fruit and eat it where it lay on the ground. The fruit would average 200–300 g. In these and subsequent observations, kites were clearly seen to be consuming the flesh of the avocado fruit, rather than invertebrates on or near the fruit. Post consumption, Black Kites were observed to perch in a tall tree for the rest of the day with little further activity. In these observations, there seemed to be no attempt to carry the avocado fruit and it was assumed at this time that this may have been because the ripe fruit was soft and not easy to hold.

As a resident of the Atherton Tablelands and, at times, working in avocado orchards in the region, it is estimated that JL made over 100 observations of Black Kites (mostly) and Whistling Kites (occasionally) consuming avocado fruits over the period 2002 to 2020. Observations were made on an opportunistic basis and all instances of frugivory by kites were directly after harvest and for a period of no more than three months after harvest.

Most avocado farms (approximately 20, ranging from 5 to 20 ha) on the Atherton Tablelands had flocks of Black Kites in years of observation between 2002 and 2012. Kites would often be seen on the ground foraging in the manner described above. As the avocado orchards were at different elevations the fruit would ripen over a wide period of time (i.e., 8 to 10 months of the year) providing a relatively consistent resource.

From 2002–2012, a small avocado orchard at Wondecla (17°26'24" S, 145°25'48" E, approx. 900 m asl), north Queensland, had a population of Whistling Kites, which were also observed by JL foraging on fallen, ripe avocados, until the plantation was bulldozed in the early 2010s. At no times were Whistling Kites seen to forage with Black Kites at this location.

In 2013, at the Mareeba Airport (17°04'09" S, 145°25'09" E), where there were orchards on both sides of the highway, flocks of up to 400 Black Kites were feeding on fallen avocado fruit. In the same year, a flock in excess of 1000 Black Kites was present at the Mareeba Rubbish Tip. The years 2011 and 2012 were successful breeding years for the Long-haired Rat (*Rattus villosissimus*) in the Channel Country [16], which resulted in significant breeding events for Black Kites in the region (JL pers. obs.; consistent with previous Long-haired Rat eruption events in western Queensland [17]). This resulted in a large increase in the numbers of Black Kites in Queensland, and as food declined (particularly following drought of 2013), most Black Kites dispersed, causing irruptive movements to regions outside usual range elsewhere [9,18]. This is likely to be a cause of large numbers recorded on the Atherton Tablelands in 2013.

Between 2012 and 2018, there was a rapid expansion of avocado plantings on the Atherton Tablelands (e.g., [19]), with more and larger (20–500 ha) orchards. However, due to the newer practice of hedging the trees and topping, where all the fruit are easily picked via 'cherry-pickers' (aerial work platforms), there was fewer leftover fruit on the ground, and Black Kites seemed to be not as plentiful as they were in the past (or were more dispersed). Nonetheless, in May 2018 at an orchard in Mareeba, JL noted approximately 100 Black Kites (in previous years there would have been 400–500) (Figure 1). In these observations, competition between Straw-necked Ibis (*Threskiornis spinicollis*) and Black Kites for fallen fruit was observed (i.e., Ibis chasing Kites away; Figures 2 and 3; Supplementary video S1), as was a Black Kite carrying fallen fruit in its talons (Figure 4; Supplementary video S2). At the edge of the same orchard was a tip from the packing shed on the farm. The fruit at the tip were 'Hass' variety of avocado, which turn a dark colour as they ripen. Black Kites seemed uninterested in these and instead searched the orchard for 'Shepard' variety fruits—'Shepard' fruits are green when they ripen, and have a slightly thinner skin. A single Whistling Kite was also observed foraging on avocado fruits with Black Kites at this orchard.



Figure 1. Black Kites circling avocado orchards, Mareeba, Queensland, Australia. Photo: Jack Leighton.



Figure 2. Three Black Kites consuming avocado flesh, Mareeba, Queensland, Australia. Photo: Jack Leighton.



Figure 3. Straw-necked Ibis competing with Black Kites for fallen avocado fruits, Mareeba, Queensland, Australia (see also Supplementary video S1). Photo: Jack Leighton.



Figure 4. Black Kite with partially consumed avocado fruit held by left foot before flying off with the fruit, Mareeba, Queensland, Australia (see also Supplementary video S2). Photo: Jack Leighton.

We did not record quantitative data on fruit biomass ingested per unit of time, nor the relative intake of fruit compared to other prey types. JL has not observed Black or Whistling Kites breeding on the Atherton Tablelands. Their breeding usually occurs west of the Great Dividing Range when the seasons are good (i.e., rodent or locust plagues) and move to the east as their breeding grounds dry out (JL pers. obs.), although movement

patterns of Black Kites in Australia are not well known [9]. Most birds observed feeding on avocados were adults.

Avocado growers do not seem to have a concern with this scavenging behaviour, as the decaying fruit would otherwise harbour fungi. In nineteen years since the initial observations, no Black Kites have been observed picking or consuming fruit directly from the trees.

2.2. Literature Review

We reviewed major Australian and international handbooks, conducted literature searches using Google, Google Scholar and Scopus (with search terms which included the words “raptors” or “birds of prey”, with “frugivory” or “fruit” or “frugivorous”) and reviewed individual raptor species profiles in online databases such as Birds of the World (<https://birdsoftheworld.org/>, accessed on March–July 2021) in March–July 2021 for instances of frugivory in raptors. Searches were conducted in English, but non-English language sources were interrogated if they turned up in searches. Where relevant sources were found we interrogated the references in those sources and searched for other papers that may have cited those sources. All material that had original details of frugivory in raptors were included (books, book chapters, peer-reviewed journal articles, non-peer-reviewed articles, theses, websites, databases).

3. Results of Literature Review and Discussion

The Whistling Kite takes a variety of small animals (but particularly introduced European Rabbits *Oryctolagus cuniculus* and European Hares *Lepus europaeus occidentalis*) and carrion (especially in winter, the non-breeding season), including mammals, birds, reptiles, fish, crustaceans, insects, large carcasses, and offal [9]. In Australia, the Black Kite is a scavenger, taking carrion, offal and garbage, but also taking small mammals, small birds, reptiles, frogs, grasshoppers and fish [9]. It can exploit plagues of mammals (e.g., European Rabbits, House Mouse (*Mus musculus*) and Long-haired Rats) and locusts and grasshoppers [9].

The observations of Black Kites and Whistling Kites consuming avocado fruit over multiple years appear to be the first instances of frugivory by wild raptors in Australia. This represents the first instance of frugivory for the Whistling Kite, an endemic species to Australia, New Guinea, the Solomons and New Caledonia [9]. For the Black Kite, a raptor with a range from Africa, Europe, Asia and Australia, there are few other records of frugivory, none from the Australasian subspecies *M. m. affinis* and none of consumption of avocado. Those records include Thiollay [3] (p. 67), who stated that breeding Black Kites in the savannas of central Ivory Coast in Africa included a high proportion of oil palm *Elaeis guineensis* fruits in its diet and “even brought them in large numbers to their nest to feed the young, a remarkable practice, given that it would seem energetically unprofitable to carry in such largely indigestible fruits, one by one”. Cramp and Simmons [20] noted the only plant food recorded for Black Kites was the pericarp of oil palm nuts, while no records of fruit consumption by this species have been recorded in Asia [21,22] nor Australia [9].

In a review of frugivory by vertebrates in the adjoining Oriental (Indomalayan) Region, Corlett ([21], p. 430), suggested “hawks and their relatives generally feed on vertebrates and large insects, but there are reliable records of the consumption of small fruits by the Pacific Baza, *Aviceda subcristata* (Bell 1984 [23], Debus 1994 [24]), and Roberts (1991) [25] states that ‘other authors’ (not named) have recorded frugivory by the Oriental Honey-buzzard, *Pernis ptilorhynchus*”. Despite the breeding range for Pacific Baza extending from Australia, Indonesia, Papua New Guinea, and Solomon Islands, it appears all records of frugivory are from New Guinea (Table 1).

Major monographs on raptors or birds more generally and three previous reviews on frugivory in raptors (or specific families of raptors) identified different numbers and species (Table 1). Brown and Amadon [26] and Ferguson-Lees and Christie [2] in their reviews of raptors of the world identified fruit consumption by 13 and 18 species of raptors, respec-

tively, but while they provided a list of references for each species, did not cite the original sources of frugivory. Galetti and Guimarães [5] in describing seed dispersal by Crested Caracaras (*Caracara plancus*) identified 13 raptor species that consumed fruit, largely drawn from the 1995 *Handbook of the Birds of the World* ([27]; and chapters within, i.e., [1,3,4]) as well as source material used in that Handbook and subsequent records until 2004, but did not cite Ferguson-Lees and Christie [2]. Shlee [6], in documenting the first instance of the King Vulture (*Sarcoramphus papa*) consuming fruit (moriche palm *Mauritia flexuosa*), identified eight raptor species that consumed fruit, but did not cite del Hoyo et al. [27], Ferguson-Lees and Christie [2], or Galetti and Guimarães [5]. Pérez-Méndez and Rodríguez ([14], p. 141), in their review of raptors as seed dispersers, suggested “Sixteen of the 312 raptors considered by Ferguson-Lees and Christie [2] consume deliberately fruits at least occasionally”, listing those identified by Ferguson-Lees and Christie [2] (although they seem to have missed the Long-crested Eagle (*Lophaetus occipitalis*) and Great Black Hawk (*Buteogallus urubitinga*), which were both identified by Ferguson-Lees and Christie [2]), but they list 20 in total from that source, Galetti and Guimarães [5] and others. The online *Birds of the World* database, which was largely drawn from *Handbook of the Birds of the World* entries ([1,3,4], and individual species accounts within, plus additional information since 1994), as well as from Ferguson-Lees and Christie [2], documented 25 species as consuming fruit as of July 2021, but did not include records of the Oriental Honey-buzzard, Great Black Hawk and Plumbeous Kite (*Ictinia plumbea*) (Table 1). Based on these reviews, plus the addition of the Whistling Kite from the observations described in this paper, there are 29 species that have been known to consume fruit or other vegetable matter globally (Table 1). In addition, Ospreys (*Pandion haliaetus*) have been observed deliberately ingesting green algae (*Rhizoclonium* sp., belonging to the family Cladophoraceae) and slime near the banks of an agricultural water reservoir at Tenerife, Canary Islands [28].

The majority of the raptor species recorded consuming fruit, and also the most frequently consumed fruits, are rich in lipids (genera *Elaeis*, *Raphia*, *Cocos*, *Spondias*, etc.) [14]. Galetti and Guimarães [5] suggest that lipid-rich fruits could be used by generalist or insect-specialized raptors because they are chemically analogous to animal prey and may satisfy the raptor’s lipid needs. Likewise, Shlee [6], in observing King Vultures consuming fruits of moriche palms *Mauritia flexuosa* in Venezuela, suggested the fat content of that fruit may partially compensate for a lack of carrion.

Avocado fruits also have a high lipid content [29], which increase as they ripen [30]. Besides the observation of the Black Kite and Whistling Kite in this paper, the Black Vulture (*Coragyps atratus*) is the only other raptor species known to consume avocados (Table 1). Röhl [31] found that American Black Vultures feed on avocado when carrion is scarce.

The year 2002 was a bad drought year in North Queensland [32], and there were noticeably lower numbers of grasshoppers and locusts, which would be an important food source for Black Kites and Whistling Kites, other than mice and native rats (JL pers. obs.), and so may also have been a driver for avocado fruit consumption by these species. Similar to our observations on the Atherton Tableland, Woods [33] (p. 237) suggested many (non-raptor) bird species “are fond of ripe, soft avocados” in California, USA, and suggested that as the fruits are picked when hard, there is little conflict. The ripe (and thus soft) nature of the avocado fruit consumed by Black and Whistling Kites outlined in our observations also corresponds with frugivorous behaviour of other raptors, e.g., “rotting coconuts” [34], “rotten pumpkins” [35] and “rotting apples” [2].

However, at least nine raptor species consumed berries, figs and apples (including some species that have only been recorded consuming these), which would have lower lipid content than the fruits described above. The review by Shanahan et al. [36] of fig-eating vertebrate fauna did not include any raptors, despite three species being identified in our review.

Further research of kites in North Queensland and indeed other instances of frugivory in raptors could focus on (1) quantitative data on fruit biomass ingested per unit of time, (2) the relative intake, measured either as the percentage of successful feeding attempts or

the relative daily fruit intake, and (3) the annual variability of fruit availability during the multiple years.

Table 1. Comparisons of lists of raptors consuming fruits or other vegetable matter from major handbooks or reviews, as well as other records not listed in those sources, and observations from this paper.

Species	Source and Details of Fruits Consumed and Frugivory						
	Brown & Amadon [26]	Ferguson-Lees & Christie [2]	Galetti & Guimarães [5]	Shlee (2005) [6]	Pérez-Méndez & Rodríguez [14]	Birds of the World * https://birdsoftheworld.org/	Other Records or Further Detail
King Vulture (<i>Sarcorampus papa</i>)				Moriche palm fruit <i>Mauritia flexuosa</i> : [6]		"They have also been documented to feed on palm fruits [6]." [37]	
Black Vulture (<i>Coragyps atratus</i>)	"at times ripe and rotten fruit and vegetables, including nuts of the oil palm" and "pungent vegetable matter such as avocados"	"as well as bananas, avocados, fruits of oil and royal palms <i>Elaeis/Scheelea</i> , and copra."	"fruit": [38]	African oil palm (<i>Elaeis guineensis</i>) drupes: [39–41]; flesh of coconuts (<i>Cocos nucifera</i>) [39]; sweet potatoes and avocado (when carrion is scarce): [31,42]	Bananas, avocados, <i>Scheelea</i> , <i>Elaeis</i> , <i>Livistona australis</i> , and copra (the dried meat of the coconut): [2,43]	"Black Vultures also eat vegetable material and dung [42,44]" [45]	Fruit of rubber tree [46]. In Costa Rica, pulled unhusked coconuts onto road and ate coconut flesh after crushed by cars [46]
Turkey Vulture (<i>Cathartes aura</i>)	"Exceptionally . . . rotting fruit and vegetables, including pumpkins and the nuts of the oil palm"	"more occasionally, rotting vegetable matter, such as pumpkins and fruits of oil palm <i>Elaeis</i> "	<i>Acrocomia</i> , <i>Elaeis</i> , <i>Juniperus</i> , grapes: [47,48]	African oil palm (<i>Elaeis guineensis</i>) drupes: [40]; flesh of coconuts (<i>Cocos nucifera</i>) [34]; leaves, seeds, and bark of cottonwood trees: [49]; Moriche palm fruit <i>Mauritia flexuosa</i> : [6]	<i>Acrocomia sclerocarpa</i> , <i>Elaeis guineensis</i> , <i>Juniperus</i> , grapes: [2,5,43]	"Takes some plant material incidentally while feeding, including from gut of dead animals, or—probably when carrion is in short supply—deliberately (e.g., rotten pumpkins in Ohio; [35]), grapes and juniper berries in n. Mexico [47], or in Tropics, rotten coconuts [34] and palm fruit [50]. Plant material common in pellets, and may constitute up to 70–100% of content ([51], MJM)" [52]	
African Harrier-Hawk (<i>Polyboroides typus</i>)	"Oil palm fruit is eaten when available, but the bird's distribution is not coincident with the oil palm, nor dependent on it."	"in West Africa, predominantly oil-palm fruits"	<i>Elaeis</i> : [26,27,53]		<i>Elaeis guineensis</i> , <i>Ficus</i> : [2,5,54]	"Feeds extensively on fruits of <i>Elaeis</i> oil palm and other fruits in much of lowland tropical Africa" [55]	86% of the diet were palm fruits in Ivory Coast [54]
Madagascar Harrier-Hawk (<i>Polyboroides radiatus</i>)						" . . . one instance of taking pulp of fruits such as oil palm [56] . . ." [57]	
Palm-nut Vulture (<i>Angophanes angolensis</i>)	"husk of oil palm [<i>Elaeis guineensis</i>] nuts; <i>Raphia</i> fruit husks" and "will reject meat in favour of oil palm husk"	"Food fruit of oil palm <i>Elaeis guineensis</i> " and "One of only two significantly frugivorous raptors: eats fleshy parts of, especially, fruits of oil palm <i>Elaeis</i> and raffia palm <i>Raphia</i> which, together with wild dates, upas and occasional other fruits, form 58–65% of adult diet (juveniles up to 92%); grain and acacia seeds also recorded." Additionally, "Clambers about in tree to reach fruiting cluster and either swallows individual oil-palm fruits whole or plucks them one by one, holding each in foot to strip off skin and eat the oily orange mesocarp; raffia fruits have to be descaled before the equivalent thin yellow pulp can be reached."	<i>Elaeis</i> , <i>Raphia</i> , <i>Phoenix</i> : [26,27,53]	African oil palm (<i>Elaeis guineensis</i>) drupes: [54]	<i>Elaeis guineensis</i> , <i>Raphia vinifera</i> , <i>R. farinifera</i> , <i>Phoenix reclinata</i> , <i>Antiaris africana</i> , other fruits, <i>Acacia</i> seeds and cereals: [2,5,43,54]	"Mainly fleshy pericarp of <i>Elaeis guineensis</i> , <i>Raphia</i> and <i>Phoenix</i> [5] (Arecaceae) palm fruits, locally especially <i>R. farinifera</i> [58]; generally fruit constitutes 58–65% of adult diet and up to 92% for juveniles [2]. May also survive on other fruits (e.g., wild dates [2] and grain (including <i>Acacia</i> seeds [2]" [59]	In Ivory Coast vegetable items could collectively form more than 50% diet [54]
Egyptian Vulture (<i>Neophron percnopterus</i>)		"rotting fruit and vegetables"			Rotten pumpkins in garbage dumps: [2]	"rotting fruit and vegetables" [60]	
European Honey-buzzard (<i>Pernis ptilorhynchus</i>)	"Rarely berries, and in winter, oil palm fruits"	"and berries and other fruits"			Berries and other fruits: [2]	"Sometimes forages on ground for . . . berries [2]" [61]	
Oriental Honey-buzzard (<i>Pernis ptilorhynchus</i>)							"Roberts (1991) [25] states that 'other authors' (not named) have recorded frugivory by the Oriental Honey-buzzard, <i>Pernis ptilorhynchus</i> " [21]. Roberts [25] actually states "Other authors have recorded them consuming berries . . .", however also lumps both Oriental and European Honey-buzzards under the same entry, so this may potentially relate to European Honey-buzzard.

Table 1. Cont.

Species	Source and Details of Fruits Consumed and Frugivory						
	Brown & Amadon [26]	Ferguson-Lees & Christie [2]	Galetti & Guimarães [5]	Shlee (2005) [6]	Pérez-Méndez & Rodríguez [14]	Birds of the World * https://birdsoftheworld.org/	Other Records or Further Detail
Swallow-tailed Kite (<i>Elanoides forficatus</i>)		“more surprisingly, fruits” and “fruits mainly from canopy (sometimes from ground)”	<i>Byrsonima, Castilla, Cupania, Matayba, Sapium</i> , “fruits”: [27,38,48,62–65]		<i>Byrsonima, Castilla, Cupania vernalis, Matayba oppositifolia, Sapium</i> , and other fruits: [2,5,43]	“Fruit-eating is apparently common in tropics, with reports for Costa Rica (<i>Matayba oppositifolia</i>) [38], Colombia (<i>Castilla elastica</i>) [62], and Guatemala (unidentified species, [66]. Not reported for U.S.” [67]	
Pacific Baza (<i>Aviceda subcristata</i>)	“fruits of trees (which may have been swallowed by accident)”	“sometimes figs or other tree fruits commonly taken (perhaps especially in New Guinea)”			Figs and other fruits: [2]	“...small fruits (e.g., figs, perhaps especially in New Guinea)” [68]	In New Britain “consuming small whole fruits of a <i>Ficus</i> sp. On repeated occasions the hawk flew to a branch and flapped its wings while hanging on to the extremities of the foliage as it ate the fruits. Perhaps ten figs were eaten before the bird left. R. D. Mackay (pers. comm.) has seen fruits of <i>Trema orientalis</i> eaten by the species.” [23] (p. 210). Captive birds would readily eat lettuce leaves and would not breed without inclusion of lettuce in their diet [69]. “one had what appeared to be small tree fruits in its stomach” [70] (p. 188). ‘Fruit’ [71].
Black Baza (<i>Aviceda leuphotes</i>)						“Once recorded taking palm fruit nuts [72]” [73]	
Hooded Vulture (<i>Necrosyrtes monachus</i>)				African oil palm (<i>Elaeis guineensis</i>) drupes: [74]		“Occasionally feeds on fruits of oil palms (<i>Elaeis guineensis</i>) [74]” [75]	
Long-crested Eagle (<i>Lophaelagus occipitalis</i>)		“mulberries and wild figs”				“... rarely fish or fruit [2]” [76]	
Plumbeous Kite (<i>Ictinia plumbea</i>)							fruits of Batinga <i>Eugenia rostrifolia</i> [77]
Black Kite (<i>Milvus migrans</i>)	“pericarp of palm nuts”	“in West Africa frequently eats pericarps of oil palms <i>Elaeis</i> ”	<i>Elaeis</i> : [27,53]		<i>Elaeis</i> : [2]	“More unusually, vegetable matter, particularly oil-palm fruits” [78]	Avocado <i>Persea americana</i> (this paper)
Whistling Kite (<i>Haliastur sphenurus</i>)							Avocado <i>Persea americana</i> (this paper)
Great Black Hawk (<i>Buteogallus urubitinga</i>)		“Fruit”	<i>Spondias</i> : [27,48]		<i>Spondias lutea</i> : [43]		
Common Buzzard (<i>Buteo buteo</i>)						“In one instance, observed eating an apple of the dessert variety, “slightly bruised but not rotten [79]”” [80]	“Fruit is not among the foods of Common Buzzard listed in BWP (vol. 2), but The Handbook (vol. 3) refers to this species taking the berries of cranberry/bilberry <i>Vaccinium</i> .” [79]
Barred Forest-Falcon (<i>Micrastur ruficollis</i>)			<i>Blomia</i> : [81]		<i>Blomia</i> : [5]	“Recorded eating fruit (<i>Blomia prisca</i>) twice [82]” [83]	
Black Caracara (<i>Daptrius ater</i>)	“scales of palm fruits, <i>Mauritia</i> and <i>Desmoncus</i> .”	“also takes palm and other fruits” and “Palm fruits (<i>Desmoncus</i> and <i>Mauritia</i>) found in dense masses in several gizzards” and “Feeding on green figs <i>Ficus</i> ”	<i>Elaeis, Desmoncus, Mauritia</i> , “unidentified seeds”: [26,27,48,84,85]	fruits of palms (<i>Mauritia flexuosa</i> and <i>Desmoncus</i> sp.: [86]	<i>Desmoncus, Mauritia flexuosa, Elaeis, Ficus</i> : [2,5,43]	“... fruits, e.g., of palms (<i>Mauritia flexuosa</i> , <i>Elaeis, Desmoncus</i>), found in stomachs” [87]	
Red-throated Caracara (<i>Bycter americanus</i>)	“also eats much fruit and soft seed”	“feeds mainly on wasp/bee larvae and fruits” and “palm and other fruits and soft seeds”	<i>Poraqueiba</i> , “fruits”, “unidentified fruits”: [27,48,84,85]		<i>Poraqueiba</i> , fruits and soft seeds: [2,5,43]	“individuals have also been seen foraging on nut-sized fruits [88]” [89]	Palm seeds [90].
Carunculated Caracara (<i>Phalacrocorax carunculatus</i>)	“wheat, and vegetable matter”	“grain and other vegetable matter”			Unidentified seeds: [2]	“vegetable matter” [91]	

Table 1. Cont.

Species	Source and Details of Fruits Consumed and Frugivory						
	Brown & Amadon [26]	Ferguson-Lees & Christie [2]	Galetti & Guimarães [5]	Shlee (2005) [6]	Pérez-Méndez & Rodríguez [14]	Birds of the World * https://birdsoftheworld.org/	Other Records or Further Detail
Crested Caracara (<i>Caracara plancus</i>)	"perhaps occasionally vegetable matter"	"at least locally, in Surinam and Guyana, has learnt to feed on coconut flesh both during harvest and when dried as copra"	<i>Attalea, Elaeis, Cocos</i> , "beans", "peanuts": [5,27,48]	flesh of coconuts (<i>Cocos nucifera</i>): [47]	<i>Attalea phalerata, Elaeis oleifera, Cocos</i> (and copra), beans, peanuts: [2,5,43]	"It also eats palm (<i>Attalea phalerata</i>) fruits in the Brazilian Pantanal [5]. Haverschmidt [39] reported Crested Caracara feeding on coconuts, and 13 individuals were observed feeding on cracked pecans by holding down the pecan with one foot while picking at the nut with their bill [92]. Pellets collected at nests in Florida and Arizona regularly contain vegetative matter, mostly grasses, seeds, and leaves. Whether birds actively consume vegetation or ingest plant matter inadvertently while feeding on carrion or insects remains unresolved [93,94]." [95]	"on one occasion I observed a caracara feeding on cracked pecans at the Santa Cruz Flats" [96]. Peach Palm Fruits (<i>Bactris gasipaes</i>) [97]. <i>Buriti palm (Mauritia flexuosa)</i> fruit [98]. Pequi fruit (<i>Caryocar brasiliensis</i>) [99]. Fruits [100].
Yellow-headed Caracara (<i>Mitigo chimachima</i>)	"fruits of oil palms (<i>Elaeis</i> , introduced in its range) and occasionally other fruits, kernels of maize ..."	"some vegetable matter, including oil-palm fruits, dried coconut flesh (copra), other fruits, maize, and seeds and other recyclable material from horse dung."	<i>Elaeis, Byrsonima</i> : [27,48,84]	African oil palm (<i>Elaeis guineensis</i>) drupes: [86]	<i>Elaeis, Byrsonima</i> , copra, cork and unidentified seeds: [2,5]	"fruits of oil palm <i>Elaeis</i> (Arecaceae) [101] and <i>Byrsonima</i> (Malpighiaceae) [5]; maize" [102]	
Chimango Caracara (<i>Mitigo chimango</i>)	"some vegetable matter" and "sometimes wades in search of an edible fungus"	"... and some vegetable matter, including rotting apples, cereal seeds, fungi, and recyclable material from horse and cattle dung."			rotten apples, cereal seeds: [2]	"even vegetable matter, including rotten apples, cereal seeds, fungi and recyclable material from animal dung [2]" and "Elsewhere, in S Chile, year-round study using pellets identified coleopterans (34%), vegetable fibres (29%) and grass seeds (12%) as the most important trophic categories ... [103]." [104]	"... wades after a very different kind of food. At the bottom of pools collected on clayey soil after a summer shower, an edible fungus grows of a dull greenish colour and resembling gelatine. He has found that this fungus is good for food ... [105]"
Grey Kestrel (<i>Falco ardosiaceus</i>)		In West Africa occasionally eats nut fibre of oil-palms <i>Elaeis guineensis</i>			<i>Elaeis guineensis</i> : [2,54]	"Sometimes eats oil palm fruits (<i>Elaeis guineensis</i>)" [106]	
New Zealand Falcon (<i>Falco novaeseelandiae</i>)					<i>Leucopogon fraseri, Gaultheria depressa</i> : [107]	"One recorded feeding on fruits of <i>Leucopogon fraseri</i> (Ericaceae) [107]" [108]	
Bat Falcon (<i>Falco ruficularis</i>)			"small green fruit": P. Madrigal, pers. comm.		Small green fruits: [5,43]	"There is an unconfirmed record of this species taking small green fruits [5]". [109]	Source of 'P. Madrigal, pers. comm' in Galetti and Guimarães [5] is Garrigues [110]

* Largely drawn from *Handbook of the Birds of the World* entries ([1,3,4] and individual species accounts within, plus additional information since 1994). Accessed on 12 July 2021. ^ this food source is not listed in a review of birds consuming fungi [111].

4. Conclusions

Here, we document the first instances of frugivory by wild raptors in Australia, including the first instance frugivory for the Whistling Kite and the first instance of the Black Kite consuming avocados. Considering the lack of records in Australia, it is likely that the frugivory for both species is opportunistic, exploiting locally abundant fruit when other resources are scarce. Nonetheless, observations of Black Kites feeding on fallen avocado fruits over a period of almost 20 years suggests a more regular consumption, in North Queensland at least. In addition, we found 29 species of diurnal raptors documented in the literature (and our observations) to have consumed fruit, up from the 13 in the review by Galetti and Guimarães [5] and 18 by Ferguson-Lees and Christie [2]. The findings here support the statement by Galetti and Guimarães [5] (p. 134) that "Based on the scarcity of natural history data for several forest-dwelling species, it is possible that more species of kites and hawks eventually consume fruits, acting as non-specialized frugivores". However, we suggest it is likely that more raptor species than those that are forest-dwelling are likely to consume fruit. The episodic nature of the activity for most species may contribute to scarcity of records. Further observations of frugivory by raptors should be documented in order to better understand the frequency of the behaviour.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/birds2040025/s1>, Video S1: Black Kites consuming fallen avocado fruit and competition from Straw-necked Ibis, Mareeba, Queensland, Australia (Video: Jack Leighton); Video S2: Black

Kite consuming avocado fruit and flying off with the fruit, Mareeba, Queensland, Australia (Video: Jack Leighton).

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