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Avian Behavior, Ecology, and Evolution

From creek to canopy: the importance of fish in Western Screech-Owl (*Megascops kennicottii*) diets in British Columbia, Canada

Del arroyo al dosel: la importancia de los peces en la dieta de *Megascops kennicottii* en Columbia Británica, Canadá

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ABSTRACT. Being a generalist predator offers numerous advantages, including dietary flexibility that enables exploitation of abundant prey and adaptation to new habitats. However, even generalist predators may rely on specific prey during crucial life stages like reproduction. Therefore, comprehending the dietary habits of generalist predators holds significant conservation implications. In this study, we present diet and foraging observations of Western Screech-Owls (*Megascops kennicottii*) in southcentral British Columbia, Canada. Contrary to previous findings that emphasized small mammals as the primary prey in the northern part of their range, our observations highlight fish as a potentially important part of their diet. This challenges existing research and underscores the importance of considering aquatic prey in screech-owl conservation efforts. We advocate for further investigation into the ecological implications of aquatic prey consumption in their diet.

RESUMEN. Ser un depredador generalista ofrece numerosas ventajas, incluyendo una dieta flexible que permite tanto la explotación de presas abundantes como la adaptación a nuevos ambientes. No obstante, incluso los depredadores generalistas pueden depender de presas específicas durante etapas cruciales de sus ciclos de vida, como la reproducción. Por ello, comprender los hábitos tróficos de depredadores generalistas tiene implicancias significativas para la conservación. En este estudio, presentamos observaciones sobre la dieta y el comportamiento de forrajeo de *Megascops kennicottii* en el centro-sur de la Columbia Británica, Canadá. Contrariamente a los hallazgos previos que señalaban a los pequeños mamíferos como presa principal, nuestras observaciones destacan el papel potencialmente importante de los peces en su dieta. Esto cuestiona la investigación existente y subraya la importancia de considerar a las presas acuáticas en los esfuerzos de conservación de *Megascops kennicottii*. Abogamos por una mayor investigación sobre las implicancias ecológicas del consumo de presas acuáticas en su dieta.

Key Words: *breeding; conservation; diet; fishing; generalist; habitat use; Western Screech-Owls*

INTRODUCTION

Generalist predators often exhibit dietary flexibility, capitalizing on the availability of abundant prey (Doyle 2001, Kryshak et al. 2022). Many birds of prey, including specialist predators, switch to alternative prey species when primary prey becomes scarce or when a more abundant prey species becomes available (Charter et al. 2018, Buers et al. 2019, Kryshak et al. 2022). Exploiting abundant prey resources provides predators with a competitive advantage, particularly during critical life history stages such as reproduction (Doyle 2001). Spawning fish provide upstream ecosystems with an abundance of fatty prey and essential nutrients (Harding and Reynolds 2014), but their importance to nocturnal predators has largely gone unstudied.

Typically, species with generalist diets forage opportunistically and are less reliant on any one prey item (Hadad et al. 2022). Western Screech-Owls (*Megascops kennicottii*) are opportunistic hunters, with a far more varied diet than similarly-sized owl species such as Northern Saw-whet Owls (*Aegolius acadicus*; Rains 1997). Common diet items found in Western Screech-Owl pellets include small mammals, birds, insects, and to a lesser extent molluscs, annelids, crayfish, and fish (Rains 1997, Cannings and Angell 2001, Davis and Cannings 2008, Kissling and Lewis 2009). These dietary descriptions of Western Screech-Owls were primarily determined through pellet analysis, which often cannot detect prey items such as fish, frogs, and soft-bodied invertebrates such as moths (Lewis et al. 2004). Previous descriptions of Western Screech-Owls diet described these owls as generalist and varying across their range in dominant prey (Smith and Wilson 1971, Marks and Marks 1981, Rains 1997, Davis and Cannings 2008, Kissling et al. 2010). Screech-owls may be more reliant on small mammals in the northern parts of their range and more insectivorous in southern parts of their range (Cannings et al. 2020).

Fish remains have seldom been discovered in Western Screech-Owls' pellets, although they have been identified in pellets and stomach contents of owls dating as far back as 1892 (Cannings and Angell 2001). Pellet dissections may skew our perception of the diets of Western Screech-Owls, and potentially other *Megascops* species, because prey remains from small mammals preserve well, whereas fish and amphibian remains do not. Fish have been a documented food item in other *Megascops* owls across the Americas but have rarely been documented in pellets (Artuso 2010, Dinets 2011, Dybas da Natividade et al. 2023). The discrepancy in fish found in pellets likely reflects the difficulty in finding fish pellets in addition to a faster rate of decay than pellets that contain mammalian remains (Jordan 2005). Collectively, it seems likely that fish have been underestimated in the diet of Western Screech-Owls.

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In response to the limitations of pellet analysis, researchers have adopted innovative methods, such as analyzing DNA from talon or beak swabs or videography through cameras aimed at nests, to obtain a more precise understanding of the diet composition in birds of prey (Lewis et al. 2004, Brouellette 2021). Although videography offers data on diet composition, effective camera placement is crucial to capture reliable images for accurate prey identification (Zárybnická et al. 2011, Bilj and Heltai 2022), and videographic methods are limited to the foods brought to chicks on the nest, rather than capturing annual diets. Additionally, some owl species nest in hard-to-reach locations, such as cliff faces or high up in partially decomposed trees, making camera deployment challenging.

Here, we present camera data showing fish prey brought back to a nest as well as documenting owls fishing in a nearby river. We thus present support for fish being an important seasonal prey in the Western Screech-Owl's diet and we discuss how these observations fit into screech-owl breeding timing and population trends. We present video evidence that owls are not scavenging fish, but rather actively fishing within streams.

METHODS

The study area was within the Okanagan Very Dry Hot Ponderosa Pine (*Pinus ponderosa*) (PPxh1) zone according to the Biogeoclimatic Ecosystems Classification (Ryan et al. 2021). The region comprises various ecosystems, including riparian/wetland, grassland/shrub-steppe, dry low-elevation forest, rugged terrain, and open water ecosystems (Bezener et al. 2004). The climate is characterized by extreme dryness throughout all seasons, with an average annual rainfall of 350 mm. June receives the most precipitation, while March and April receive the least (Ryan et al. 2021). All owl monitoring and handling was done under a UBC Animal Care Permit (A21-0241), the provincial General Wildlife Permit (PE22-713883), and Federal Bird Banding Permit (10853G).

To locate active Western Screech-Owl territories, we conducted call playback surveys in the springs of 2022 and 2023 (Kennedy 2022). Each survey route comprised five stations spaced 400 m apart, with stations distributed between riparian (56.1%) and non-riparian (43.9%) habitats. Stations were considered riparian habitats if they were within 100 m of a watercourse. To locate nests, we sat within active territories at dusk and monitored owls using a Pulsar Helion Pro XP 50 monocular.

We used Reconyx Hyperfire2 cameras to monitor Western Screech-Owl nests (n = 18). All cameras were mounted to either the nest tree or an adjacent tree facing the nest cavity. Cameras were set to hyperfire mode and optimized nocturnal photographs with no delay between triggers. We chose photographs over video to save on card space and battery life to not disturb owls more often than necessary. When we obtained images of owls with prey, we identified to the finest taxon possible, i.e., order, family, or species; all were categorized into larger taxonomic groups, including (1) mammals, (2) insects, (3) birds, (4) amphibians, (5) annelids, and (6) fish.

Some owls were additionally monitored for related research (Buers 2024) via VHF radiotags (Holohil PD2). Owls were trapped in April of 2023 using standard netting practices with an audio lure and a mist net (Kissling and Lewis 2009). Radio tags were mounted using the leg loop attachment method (Streby et al. 2015). We selectively tagged male Western Screech-Owls to not interfere with female incubation and attain as much breeding habitat use of owls as possible. Owls were tracked during night and day throughout the breeding season. One tracking session led to the discovery of a fishing location, as an owl was observed perched over a stream watching the river for several minutes. We placed two Reconyx Hyperfire2 cameras on the fishing locations on opposite sides of the stream to monitor screech-owl fishing behavior; these cameras were in place from 7 July 2023 to 17 April 2024.

RESULTS

Out of 18 cameras on nests, one camera yielded high quality prey data, including fish; it was mounted ~1 m away from the nest cavity on an adjacent tree, and recorded data from 13 days prior to the chicks' fledging (02 June–15 June, 2023). Of the 119 prey detections from this nest, 111 were classified to order, family, or species. The male within this territory was radio-tagged, allowing for comparison of male and female provisioning of prey items to young as the tag was visible on our images. Five cameras failed to provide images of owls provisioning the nest. For the remaining 12 nests, we obtained a mean of 75.15±112.10 images of adult owls (range 0–340). Two of these 12 cameras obtained pictures of young owls but not the adults. Although we obtained 1289 images of owls, only 6 of these images, from 4 other nests, also showed prey. Of those six images, one was a snake and 5 were small mammals.

At the nest with high-resolution dietary information from the camera, the female screech-owl was the primary contributor of prey (n = 69, 59.0%), while the male brought back fewer but often larger prey (n = 48, 41.0%). Two prey were brought back by an adult of unknown sex because the back of the owl was not clearly visible in the photos, preventing us from determining the sex of the provisioning parent. Prey types varied across different times of the night, with small mammals predominantly delivered later in the night, and insects brought back after dusk and before dawn, most of which were delivered by the female (Fig. 1).

Fig. 1. Proportion of prey items from each taxonomic group brought back to the nest by the male and female Western Screech-Owl (*Megascops kennicottii*) by the hour overnight.

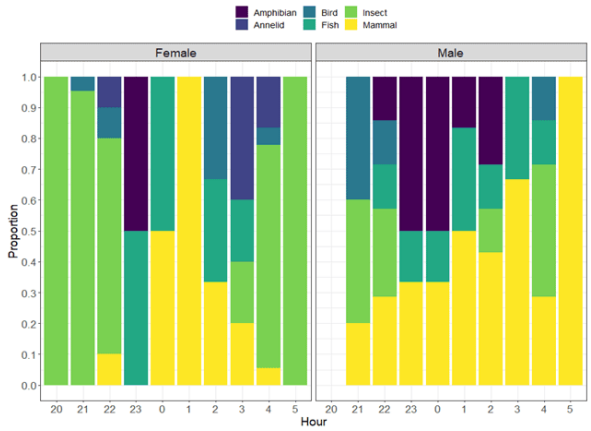
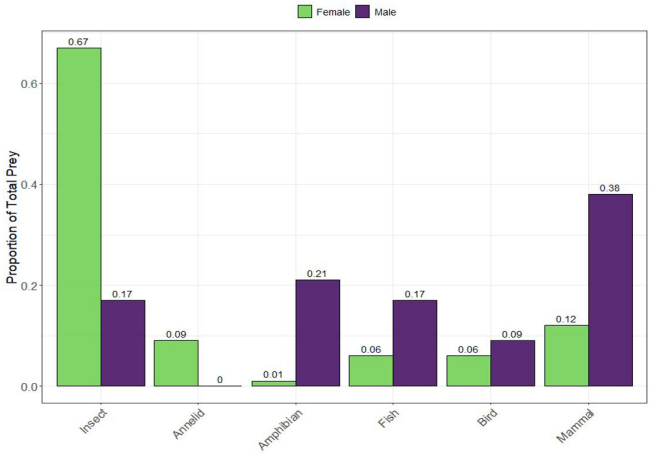


Fig. 2. Prey items brought back to the nest by adult Western Screech-Owls (*Megascops kennicottii*). Data are from camera images of one nest monitored in 2023.



Insects were the most commonly delivered prey. The frequency of occurrence for each prey type was: 47.1% insects, 21.8% small mammals, 10.1% fish, 9.2% amphibians, 6.7% birds, and 5.0% annelids (Fig. 2). Annelids were exclusively brought back by the female. The male provided 90.9% of amphibians. In the case of fish, the male provisioned 66.7%, while the female delivered 33.3% to the chicks (Fig. 2).

At the fishing location, spanning 10 months, a Western Screech-Owl was confirmed to have visited the site 22 times for an average of 2.2±1.8 times a month (Table 1, Fig. 3). The owl was successful in catching fish on two occasions, while during the other 20 visits, attempts to trap fish were unsuccessful. Furthermore, the owl was observed perching above the water on 10 occasions. In one instance captured on video, the owl was observed consuming a Common Earthworm (*Lumbricus terrestris*). These observations likely are an undercount, as the cameras use Passive Infrared motion detection (PIR), which may not consistently trigger for smaller, more insulated animals such as owls (Urbanek et al. 2019).

DISCUSSION

Our understanding of Western Screech-Owl dietary preferences has undergone substantial fluctuations over the past century. These descriptions have been derived from various sources, most often pellet analyses (Munroe 1929, Smith and Wilson 1971, Marks and Marks 1981, Rains 1997, Davis and Cannings 2008, Kissling and Lewis 2010). Early analyses of stomach contents suggested a predominantly insectivorous diet, while opportunistic photographic accounts depicted screech-owls as generalists (Munro 1929, Sealy 2015). Our observations derive from a specific nest, revealing a generalist diet with noteworthy contributions from moths, fish, and frogs (Fig 4.), components previously underrepresented in diet descriptions (Dybas da Natividade et al. 2023).

Our results derive from remote cameras. We note that despite having cameras on nests of 18 Western Screech-Owl pairs, only one camera yielded reliable prey data as parents brought prey to

Table 1. Behavioral observations of Western Screech-Owls (*Megascops kennicottii*) at a fishing spot located in Summerland, British Columbia.

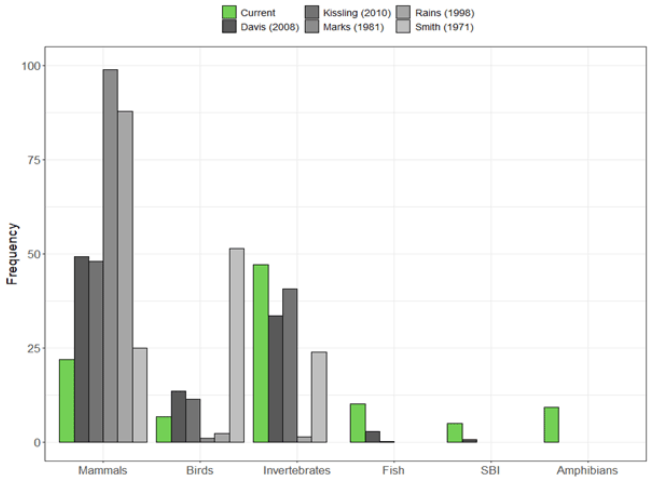
Date	Time	Observation
07 July 2023	3:48	Perched watching stream.
26 July 2023	4:47	Successfully caught small fish, perched, and eating.
31 July 2023	1:24	Perched watching stream.
01 August 2023	1:18	Perched watching stream.
09 August 2023	21:33	Failed attempt to catch something in stream.
11 September 2023	5:59	Failed attempt to catch something in stream.
01 October 2023	5:33	Owl perched with large common earthworm.
23 October 2023	23:22	Perched watching stream.
24 October 2023	21:14	Perched watching stream.
30 October 2023	4:08	Standing in stream, potentially trapped a small fish.
02 November 2023	6:26	Standing in stream pushing feet around silt, while raining.
25 January 2024	22:44	On prey within river, over frame.
28 January 2024	7:49	Perched on branch within stream.
02 March 2024	0:57	Perched on branch within stream.
02 March 2024	6:35	Recently bathed.
06 March 2024	23:49	Perched on branch within stream.
24 March 2024	4:36	Perched on branch within stream.
26 March 2024	5:16	Perched watching stream.
27 March 2024	23:52	Perched watching stream.
04 April 2024	1:26	Perched watching stream.
16 April 2024	2:53	Perched watching stream.
17 April 2024	4:34	Perched watching stream.

Fig. 3. Western Screech-Owl (*Megascops kennicottii*) female with salmonid (left) and Western Screech-Owl perched overlooking stream (right).

the chicks. The successful camera was positioned directly facing the cavity on a tree just 1.5 m away, providing an optimal angle and closeness for detection, a setup that was not possible at other nest sites. Given that we detected both substantial numbers of fish, frogs, and invertebrates via this method, in sharp contrast to pellet-based methods, we think it is important for other researchers to explore using cameras on nests as well. Because we relied on adjacent trees for placing cameras, many of our cameras were too distant to trigger reliably or at high enough resolution to see prey; future work might benefit from placing cameras on braces attached to the nest tree. Further, we note that many of the cameras did capture many images of the adult owls, but the owl movements were so swift that no prey were visible. It is telling that the other prey captured on cameras were all large-bodied, thus requiring more handling time.

Although Western Screech-Owls consumed a large proportion of small mammals, birds, and terrestrial invertebrates, our observations also highlighted the significance of amphibians, fish, and aquatic

Fig. 4. The relative frequency of occurrence of different prey groups found within the diet of Western Screech-Owls (*Megascops kennicottii*), showing the camera trap data from this study compared to five other studies on regurgitated prey remains, primarily through pellet analysis. SBI refers to soft bodied invertebrates, including mollusks and annelids. In the legend, Davis = Davis and Cannings (2008); Kissling = Kissling et al. (2010); Marks = Marks and Marks (1981); Smith = Smith and Wilson (1971).



invertebrates in their diet, prey that overlaps with other fish-owl diets. Tawny Fish-owls (*Ketupa flavipes*) in Taiwan primarily consume aquatic prey (> 98%), mainly invertebrates and frogs, whereas Brown Fish-owls (*Ketupa zeylonensis*) in India have a diet similar to the screech-owls, with fish ranking third in their diet (Wu et al. 2006, Dias and Borker 2023). Similarly, Barn Owls (*Tyto alba*) specialize on rodents as prey, but there are documented cases of them capturing fish (Bogiatto et al. 2006).

Previous characterizations of Western Screech-Owl foraging behavior depicted them as opportunistic sit-and-wait hunters with a generalist diet, akin to their eastern relative, the Eastern Screech-Owl (*Megascops asio*; Smith and Wilson 1971, Davis and Cannings 2008). Western Screech-Owls have a significantly smaller breastbone keel surface, relative to their body mass, than Eastern Screech-Owls. The keel surface reflects the cross-section of the wing muscle and therefore the power available for flight. This smaller keel suggests that Western Screech-Owls may have a reduced need for powered flight, which could arise if they historically experienced higher prey availability, whereas Eastern Screech-Owls might need to migrate locally and hunt and carry large prey farther occasionally because of less predictable prey (K. Koenraads, *personal communication*).

We also note that talon curvature suggests Western Screech-Owls may be partially adapted to piscivory. We measured the talon of a Western Screech-Owl (124.2±3.1°), which positions it between fish-specialists (121±6°; Cameron et al. 2023) and generalists (126 ±7°; Cameron et al. 2023). Further research on talon variation across the Western Screech-Owl's range is necessary to determine if this talon curvature is typical; if so, it does suggest Western Screech-Owls regularly consume fish.

Catching fish requires high effort, with even specialized fish-owls such as the Blakiston's Fish-Owl (*Bubo blakistoni*) having a lower prey capture success while catching fish than capturing frogs (Yamamoto 1988). We recorded videos of Western Screech-Owls engaging in fishing at a regularly frequented location. Notably, we observed the owls perching close to the water's surface and wading through the water to capture prey. These fishing behaviors were also documented in Blakiston's Fish-Owls and other species of fish-owls, showing intentional and deliberate capture of fish (Slaght and Surmach 2008).

A study investigating predation on Rainbow Trout (*Oncorhynchus mykiss*) in California revealed that Western Screech-Owls ranked as the second-highest avian predator of tethered trout. They were surpassed only by Belted Kingfishers (*Megaceryle alcyon*) but outperformed piscivorous species such as Great Blue Herons (*Ardea herodias*) and Common Mergansers (*Mergus merganser*; Harvey and Nakamoto 2013). Other species of *Megascops* owls have been observed incorporating fish into their diet, suggesting that fish may have a more significant ecological and dietary importance for these owls than previously recognized (Dybas da Natividade et al. 2023).

Importance of aquatic prey for owls

British Columbia hosts 67 native and 15 introduced freshwater fish species (McPhail and Carveth 1993). Global freshwater biodiversity loss is a well-established concern, with an 83% decline in freshwater megafauna observed from 1970 to 2012 (He 2019). In Canada, the majority of freshwater species are either classified as not at risk or have insufficient data, yet 11.7% of all freshwater species in Canada are designated as at risk; however, more research should be conducted on aquatic species as they are likely declining and not being protected (Desforges et al. 2022). The decline in Western Screech-Owls could indicate the loss of a crucial food source, considering the importance of prey biomass for predator reproduction and success (Hatton et al. 2015).

Rainbow Trout are prolific stream breeders in the interior of B. C., typically spawning in May and June, with a peak spawn date around 9 May and peak fry emergence on 18 June (2008–2013; Thorley and Andrusak 2017). The peak spawning period for trout in the interior coincides with the heightened energetic requirements of Western Screech-Owl chicks in the nest (Buers 2024). Eastern Screech-Owls experience their highest energetic demands between 14 and 16 days after chicks' hatch, aligning with the period when chicks become thermally independent of their parents and require increased resources (Lohrer 1985). Owls within our study had a mean hatch date of 4 May (n = 22 nests), which would place their peak energetic needs around 18–20 May. Thus, spawning fish might be a critical component for successful reproduction of Western Screech-Owls.

Observations of fishing behavior also reveal that owls engage in fishing activities year round, although the frequency and significance of these activities during different seasons remain uncertain. From September through April, we documented 22 fishing attempts, suggesting that fish may continue to play a substantial role in the diet of screech-owls throughout the year. It is important to note that Bull Trout (*Salvelinus confluentus*) and Kokanee Salmon (*Oncorhynchus nerka*) spawn in the fall, typically in September and October but subject to potential shifts due to climate change (McPhail and Baxter 1996, Moore 2024). These fish species likely provide owls with essential fat reserves as the

transition from summer to winter occurs. Further investigation is warranted to understand how alterations in the timing of freshwater fish spawning may impact screech-owl behavior and ecology across different seasons.

Conservation implications

Terrestrial vertebrates are a significant component of the Western Screech-Owl diet (Davis and Cannings 2008, COSEWIC 2012, Buers 2024). However, we underscore that conventional pellet dissections likely underestimate the importance of aquatic as well as invertebrate prey, with far-reaching implications for conservation efforts. Specifically, focusing on terrestrial habitat requirements and prey may lead to overlooking crucial aquatic habitat needs for screech-owls during breeding.

The role of fish and frogs in screech-owl ecology remains enigmatic, requiring future research to determine the extent to which aquatic prey contribute to screech-owl diets across different regions and seasons. It is conceivable that certain Western Screech-Owl populations rely more heavily on aquatic prey than others. Neglecting the consideration of aquatic habitat requirements could inadvertently contribute to the ongoing decline of these owls. We recommend that researchers address the following key aspects: (1) quantify the proportion of screech-owl diet composed of aquatic fauna, employing alternative methodologies to pellet analysis, (2) investigate the phenological timing of fish spawning versus use as prey to assess the potential for phenological mismatch due to climate change, and (3) explore whether screech-owls in proximity to fish-bearing streams exhibit higher reproductive output compared to those near non-fish-bearing streams or areas without streams.

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Data Availability:

Data will be available upon reasonable request to the authors.

LITERATURE CITED

Artuso, C. 2010. The diet of the Eastern Screech-Owl (*Megascops asio*) at the northern periphery of its range. Canadian Field-Naturalist 124(2):122-133. https://doi.org/10.22621/cfn.v124i2.1050

Bezener, A., M. Dunn, H. Richardson, O. Dyer, R. Hawes, and T. Hayes. 2004. South Okanagan-Similkameen Conservation Program: a multi-partnered, multi-species, multi-scale approach to conservation of species at risk. Proceedings of the Species at Risk 2004 Pathways to Recovery Conference. March 2–6, Victoria, British Columbia, Canada.

Bilj, H., and M Heltai. 2022. A narrative review on the use of camera traps and machine learning in wildlife research. Journal of Agricultural and Environmental Sciences 9(2):47-69. https://doi.org/10.18380/SZIE.COLUM.2022.9.2.47

Bogiatto, R. J., J. M. Broughton, V. I. Cannon, K. Dalton, and S. Arnold. 2006. Fish remains dominate Barn Owl pellets of northwestern Nevada. Western North American Naturalist 66 (3):395-396. https://doi.org/10.3398/1527-0904(2006)66[395:FRDBOP]2.0.CO;2

Brouellette, L. M. 2021. Cloacal swabbing as a tool to study diet in migrating raptors using DNA metabarcoding. University of Minnesota, Minneapolis, Minnesota, USA.

Buers, M. A. 2024. Are riparian areas thermal refugia for Western Screech-Owls? Thesis. University of British Columbia, Kelowna, British Columbia, Canada.

Buers, M. A., F. I. Doyle, K. J. Lawson, and K. E. Hodges. 2019. Effects of biosolids amendments on American Kestrel (*Falco sparverius*) nest-site selection and diet. Canadian Journal of Zoology 97(12):1186-1194. https://doi.org/10.1139/cjz-2019-0026

Cameron, C., D. H. Johnson, G. Gauthier, N. Lecomte, and J.-F. Therrien. 2023. Ecomorphological adaptations of owl feet and talons. Journal of Zoology 319(4):285-295. https://doi.org/10.1111/jzo.13044

Cannings, R. J., and T. Angell. 2001. Western Screech-Owl (*Otus kennicottii*). In A. Poole and F. Gill, editors. The birds of North America, No. 597. Philadelphia, Pennsylvania, USA. https://doi.org/10.2173/tbna.597.p

Cannings, R. J., T. Angell, P. Pyle, and M. A. Patten. 2020. Western Screech-Owl (*Megascops kennicottii*), version 1.0. In P. G. Rodewald, editor. Birds of the world. Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bow.wesowl1.01

Charter, M., I. Izhaki, and A. Roulin. 2018. The relationship between intra-guild diet overlap and breeding in owls in Israel. Population Ecology 60(4):397-403. https://doi.org/10.1007/s10144-018-0633-6

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2012. COSEWIC assessment and status report on the Western Screech-Owl (*Megascops kennicottii*): *kennicottii* subspecies and *macfarlanei* subspecies in Canada. COSEWIC, Ottawa, Ontario, Canada.

Davis, H., and R. J. Cannings. 2008. Diet of western screech-owls in the interior of British Columbia. British Columbia Birds 18:19-22.

Desforges, J. E., J. Clarke, E. J. Harmsen, A. M. Jardine, J. A. Robichaud, S. Serré, P. Chakrabarty, J. R. Bennett, D. E. L. Hanna, J. P. Smol, et al. 2022. The alarming state of freshwater biodiversity in Canada. Canadian Journal of Fisheries and Aquatic Sciences 79(2):352-365. https://doi.org/10.1139/cjfas-2021-0073

Dias, S. J., and A. S. Borker. 2023. An assessment of the diet of Brown Fish-Owl *Ketupa zeylonensis* (J.F. Gmelin, 1788) (Aves: Strigiformes: Strigidae) from two localities in the foothills of the Western Ghats of Goa, India. Journal of Threatened Taxa 15 (7):23514-23520. https://doi.org/10.11609/jott.8415.15.7.23514-23520

Dinets, V. 2011. Eastern Screech-Owl catches fish by wading. Wilson Journal of Ornithology 123(4):846-847. https://doi.org/10.1676/11-056.1

Doyle, F. I. 2001. Timing of reproduction by Red-tailed Hawks, Northern Goshawks and Great Horned Owls in the Kluane boreal forest of southwestern Yukon. Thesis. University of British Columbia, Vancouver, British Columbia, Canada.

Dybas da Natividade, B., R. Coutinho Mello, F. de Camargo Passos, and I. P. Bernardi. 2023. Predation of fish by Black-capped Screech-Owl *Megascops atricapilla* (Temminck, 1822) (Strigiformes: Strigidae). Ornithology Research 31:318-322. https://doi.org/10.1007/s43388-023-00152-2

Hadad, E., M. Charter, J. Z. Kosicki, and R. Yosef. 2022. Prey-base does not influence breeding success in Eagle Owls (*Bubo bubo*) in Judea, Israel. Animals 12(10):1280. https://doi.org/10.3390/ani12101280

Harding, J. N., and J. D. Reynolds. 2014. Opposing forces: evaluating multiple ecological roles of Pacific salmon in coastal stream ecosystems. Ecosphere 5(12):1-22. https://doi.org/10.1890/ES14-00207.1

Harvey, B. C., and R. J. Nakamoto. 2013. Seasonal and among-stream variation in predator encounter rates for fish prey. Transactions of the American Fisheries Society 142(3):621-627. https://doi.org/10.1080/00028487.2012.760485

Hatton, I. A., K. S. McCann, J. M. Fryxell, T. J. Davies, M. Smerlak, A. R. E. Sinclair, and M. Loreau. 2015. The predator-prey power law: biomass scaling across terrestrial and aquatic biomes. Science 349:aac6284. https://doi.org/10.1126/science.aac6284

He, F. 2019. Diversity and risk patterns of freshwater megafauna: a global perspective. Thesis. Freie Universität Berlin, Berlin, Germany.

Jordan, M. J. R. 2005. Dietary analysis for mammals and birds: a review of field techniques and animal-management applications. International Zoo Yearbook 39(1):108-116. https://doi.org/10.1111/j.1748-1090.2005.tb00010.x

Kennedy, J. 2022. Call playback survey methods for coastal Western Screech-Owl (*Megascops kennicottii kennicottii*). PMRA Scientific Methods Series (Part I). Pacific Megascops Research Alliance, British Columbia, Canada.

Kissling, M. L., and S. B. Lewis. 2009. Distribution, abundance, and ecology of forest owls in Southeast Alaska. U.S. Fish and Wildlife Service, Juneau Field Office, Alaska, USA, and Alaska Department of Fish and Game, Division of Wildlife Conservation, Douglas, Alaska, USA.

Kissling, M. L., S. B. Lewis, and G. Pendleton. 2010. Factors influencing the detectability of forest owls in southeastern Alaska. Condor 112(3):539-548. https://doi.org/10.1525/cond.2010.090217

Kryshak, N. F., E. D. Fountain, D. F. Hofstadter, B. P. Dotters, K. N. Roberts, C. M. Wood, K. G. Kelly, I. F. Schwarcz, P. J. Kulzer, A. K. Wray, H. A. Kramer, et al. 2022. DNA metabarcoding reveals the threat of rapidly expanding barred owl populations to native wildlife in western North America. Biological Conservation 273:109678. https://doi.org/10.1016/j.biocon.2022.109678

Lewis, S. B., M. R. Fuller, and K. Titus. 2004. A comparison of three methods for assessing raptor diet during the breeding season. Wildlife Society Bulletin 32(2):373-385. https://doi.org/10.2193/0091-7648(2004)32[373:ACOMFA]2.0.CO;2

Lohrer, F. E. 1985. Ontogeny of thermoregulation in the Eastern Screech-Owl. Journal of Field Ornithology 56(1):65-66.

Marks, J. S., and V. A. Marks. 1981. Comparative food habits of the Screech Owl and Long-eared Owl in southwestern Idaho. Murrelet 62:80-82. https://doi.org/10.2307/3534247

McPhail, J. D., and J. S. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life-history and habitat use in relation to compensation and improvement opportunities. Fisheries Management Report No. 104. BC Environment, Fisheries Branch.

McPhail, J. D., and R. Carveth. 1993. Field key to the freshwater fishes of British Columbia. Resources Inventory Committee, The Province of British Columbia, Canada.

Moore, E. 2024. Hydroclimatic controls and the influence of climate change on the timing of the Kokanee spawning period in Peachland, BC. Thesis. The University of British Columbia Okanagan, Kelowna, British Columbia, Canada.

Munro, J. A. 1929. Notes on the food habits of certain raptors in British Columbia and Alberta. Condor 31:112-116. https://doi.org/10.2307/1363092

Rains, C. 1997. Comparison of food habits of the Northern Saw-whet Owl (*Aegolius acadicus*) and the Western Screech-Owl (*Otus kennicottii*) in southwestern Idaho. Pages 339-346 in Biology and conservation of owls of the northern hemisphere: 2nd International Symposium. U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota, USA.

Ryan, M., D. Lloyd, and K. Iverson. 2021. A field guide to ecosystem classification and identification for southern British Columbia - Volume 1: The Southern Thompson-Okanagan. Land Management Handbook 76. Province of British Columbia, Victoria, British Columbia, Canada.

Sealy, S. G. 2015. European Starling depredated or scavenged by a Western Screech-Owl. Wildlife Afield 12(2):223-226.

Slaght, J. C., and S. G. Surmach. 2008. Biology and conservation of Blakiston's Fish-Owls (*Ketupa blakistoni*) in Russia: a review of the primary literature and an assessment of the secondary literature. Journal of Raptor Research 42(1):29-37. https://doi.org/10.3356/JRR-06-89.1

Smith, D. G., and C. R. Wilson. 1971. Notes on the winter food of Screech Owls in central Utah. Great Basin Naturalist 31 (2):83-84.

Streby, H. M., T. L. McAllister, S. M. Peterson, G. R. Kramer, J. A. Lehman, and D. E. Andersen. 2015. Minimizing marker mass and handling time when attaching radio-transmitters and geolocators to small songbirds. Condor 117(2):249-255. https://doi.org/10.1650/CONDOR-14-182.1

Thorley, J. L., and G. F. Andrusak. 2017. The fishing and natural mortality of large, piscivorous bull trout and rainbow trout in Kootenay Lake, British Columbia (2008–2013). PeerJ 5:e2874. https://doi.org/10.7717/peerj.2874

Urbanek, R. E., H. J. Ferreira, C. Olfenbuttel, C. G. Dukes, and G. Albers. 2019. See what you've been missing: an assessment of Reconyx® PC900 Hyperfire cameras. Wildlife Society Bulletin 43 (4):630-638. https://doi.org/10.1002/wsb.1015

Wu, H.-J., Y.-H. Sun, Y. Wang, and Y.-S. Tseng. 2006. Food habits of Tawny Fish-Owls in Sakatang Stream, Taiwan. Journal of Raptor Research 40(2):111-119. https://doi.org/10.3356/0892-1016(2006)40[111:FHOTFI]2.0.CO;2

Yamamoto, S. 1988. The hunting techniques of Blakiston's Fish-Owl (*Ketupa blakistoni*) in Hokkaido. Memoirs of Preparative Office Nemuro Municipal Museum 7:15-28.

Zárybnická, M., J. Riegert, and K. Šťastný. 2011. Diet composition in the Tengmalm's Owl (*Aegolius funereus*): a comparison of camera surveillance and pellet analysis. Ornis Fennica 88(3):147-153. https://doi.org/10.51812/of.133777