

COASTAL FOREST MERLIN PREY in RURAL (PASTURAL, RANGELAND, FARMLAND, SHORELINE) and RIPARIAN HABITAT OF THE PACIFIC NORTHWEST BIOREGION

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INTRODUCTION

A review of published accounts of the Coastal Forest Merlin (after Temple 1970) (aka "Black Merlin") food habits are scant and qualitative (Dawson and Bowles 1909); (Laing 1935), (Jewett 1953); (Kitchen 1941); (Gabrielson and Lincoln 1959); (Bent 1961); (Campbell et al. 1990); Sodhi et al. 1993); (Smith et al. 1997); (Wahl et al. 2005). Herein, we describe the species of birds that make up the majority of the Coastal Forest Merlin (Falco columbarius suckleyi) diet in these habitats. We also, looked for characteristics of these species that would make them likely to become prey or likely to avoid predation by Merlin.

This treatise is divided into two parts, a descriptive overview for the general reader (Part I) and a statistical treatment (Part II, for those who are interested in the methods used, or for data on specific species). For all readers, we hope to reinforce your respect for the landscape bio-diversity, it's wildlife and that the information herein, will lead to wise personal and community decision-making, regarding habitat use and wildlife conservation.

All field data were gathered by David P. Drummond, between 1983 and 2013, on the rural shores, estuaries, tidelands, farms, pastures, and rural residential areas frequented by Merlin. Roger C. Stillman conducted the statistical analysis and wrote the preliminary manuscript.

PART I: A DESCRIPTIVE OVERVIEW OF MERLIN PREY IN RURAL WASHINGTON STATE AND BRITISH COLUMBIA

If you look up in a forest canopy with enough persistence (and luck) you may notice a small, dark raptor. It will probably be hard to see, with is chestnut brown and whitish mottled plumage blending in with the foliage and sky. You might have been drawn by a movement, like a head bob or a wing stretch, that gives away its presence. This compact falcon looks insignificant until it is suddenly off its perch on an aerial chase of a flock of Cedar Waxwings or flying directly at an evasive cloud of panicked Dunlin. This is the Merlin and it is one of the most dashing hunters in the ethereal blue!

The Merlin is the second smallest falcon in the Pacific Northwest, the smallest being the American Kestrel. On the coastal to west slope region of the Cascade and Canadian Coast Mountain ranges, we can see three subspecies of Merlin: the resident population (Falco columbarius suckleyi, Coastal Forest Merlin, (aka: "Black Merlin") and the historically more northern, interior and more migratory population (F. c. columbarius, "Taiga Merlin"). The Taiga passes through the Coastal Forest Merlin's home range on its yearly migrations north and south, (as well as interfaces with it's own breeding distribution to the east and north) often stopping over to hunt, winter and occasionally to interbreed with the local Coastal Forest Merlin. Uncommonly, Prairie Merlin (F. c. richardsonii) are seen in migration or winter here. The Coastal Forest Merlin's annual distribution was studied from Juneau, Alaska to Prince Rupert, British Columbia and from Washington State to Baja, Mexico. If you wish to learn more about the study area, distribution, appearance and habits of these Merlin subspecies, visit the evolving Coastal Forest Merlin Project website at: coastalforestmerlinproject.org

Merlin are primarily hunters of small birds, although they supplement their diets with aerial insects in the mid to late summer, when these are common and abundant. Terrestrial mammals are very rarely hunted, but crepuscular bats are an uncommon prey item (Sodhi et. al. 1993). In our study, we see a preliminary breakdown of their diets by percent, using two sources: direct observation of predation and prey remains (primarily plumage).



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You will be able to immediately see some differences between the two sources of field information. Insect remains do not show up in the field observations, because their chiton exoskeletons do not remain easily detectable and recognizable.

Through both direct observation of predation and feather observations at Merlin sites we found that small passerines made up the greater part of the Merlin diet (Observed 53.98%; Remains 89.14%). Passerines observed being hunted or eaten included a variety of sparrows, the Eurasian "House Sparrow", Finches, Swallows, Waxwings, Blackbirds & kin, Warblers and Starlings. Analysis of feather remains revealed further variety of passerines, which are listed in Part II of this paper.

Non-passerine birds made up a much smaller segment of Merlin diets (Observed 0.88%; Remains 7.70%). They included Swifts, Rock Pigeon, the smaller woodpeckers, a (possible) grebe and shorebirds. Shorebirds that became prey included Dunlin, Western Sandpiper, Killdeer, Least Sandpiper and a Short-billed Dowitcher. Mammals are not an appreciable part of the Merlin's diet, although one rodent (probable Microtus townsendi sp.) was seen being eaten and the remains of one bat (probable Myotis sp.) were found at a Merlin site.

Observations also showed us that aerial insects were a significant supplement to Merlin diets, comprising 40.71% of identified prey, (Non-identified prey brought to mates, juveniles or nest sites were called "prey deliveries and exchanges" and these are discussed below). The Merlin adults and fledglings frequently "insect-hawked", on Dragonflies (Odonata) and rarely on Stoneflies (Plectcoptera).

BIRDS THAT BECAME PREY

We asked ourselves, "Who is eating what and when?" By asking "who", we were asking if the hunters or eaters were Taiga Merlins or Coastal Forest Merlins and if they were male or female adults or were Merlin fledglings and juveniles. By asking "what" we wondered if there was a significant difference in the diets of Coastal Forest Merlin, Taiga Merlin adults and juveniles. By asking "when" we were trying to find out if the diet varied during different parts of the year. The first graph clearly shows that prey deliveries to nest sites were done by the Coastal Forest Merlin. In fact, only three prey deliveries were seen that were attributed to Taiga Merlin. This can be explained by the fact that the Taiga Merlins are not common residents within the Coastal Forest Merlin nesting range (see Dickerman for subspecific field identification). They migrate and disperse south in the fall from their generally drier northern and interior nesting areas in the Northwest and Arctic regions. They are casually hunting through this region and wintering as far south as California, Mexico, Central and South America, even to Amazonian Brazil.

The second graph compares observed Coastal Forest Merlin hunts to Taiga Merlin hunts. September to November is a time for dispersal of Coastal Forest Merlin families and Taiga Merlin migration. The identified prey numbers were the same. December through February is a time of over-wintering. Again, the numbers of prey were nearly equal. In March and April, Taiga Merlin are migrating and dispersing back north to the Interior Northwest and Arctic, while Coastal Forest Merlin are establishing defended nesting territories and finding mates. Now we see the numbers of Taiga prey dropping in comparison to the Coastal Forest Merlin hunts. From May to August, the majority of Taiga Merlin are in the Interior and Arctic and the Coastal Forest Merlin are hunting for their mate and to feed their young. As we see, there were 36 CFMERL hunts and no Taiga Merlin hunts during that time.



INSECT PREY

The same pattern can be seen as Merlin hunt aerial insects. Only one insect hunt was observed by a Taiga Merlin and that was in November. This was very rare because aerial insects tend to disappear as the onset of winter approaches. All the rest of the "insect hawking" was done by Coastal Forest Merlin and a significant number of those were done by fledglings. Hunted insects included dragonflies, stoneflies and a few butterflies. As you can see, insect hunting coincided with the Coastal Forest Merlin reproductive season and peaked when the young fledge, in July. This makes sense for more than one reason. Dragonflies and other aerial insects are plentiful and fledglings are just learning to hunt. They are not yet adept at catching birds, but they can "insect hawk", with short distance flights, near the nest or in their incremental dispersion from the core breeding area to wetlands and other habitats. Therefore, aerial insects represent the "Stepping Stones to Survival" for inexperienced Merlin fledglings and a welcome new nutrient "snack" for adults seeking an alternate taste treat.





RISK OF BECOMING MERLIN PREY

We also asked ourselves, "Which birds are most at risk of becoming Merlin prey?" and conversely, "Which birds are not part of the Merlin diet?" This inevitably led to a third set of questions: "Why are some birds more (or less) at risk?"

One way to look at this is to make a frequency ratio of the number of sightings of predation of a type of bird to the number of times its group is observed on the landscape (no. of predations/no. of observations). This can be expressed as a predation percent for that species or family of birds.



It is evident that a simple prey to availability ratio might be misleading, because the numbers observed on the landscape varied so greatly (e.g. House Sparrow -3; all Sparrows -166). Perhaps looking at a simple ranking of prey, by family will be more revealing. In the graph, below, we look at families of birds that most frequently appeared in both our records of observed predation and our identification of feathers plumed from prey at Merlin activity sites. (Note: "Shorebirds" are in the family Scolopacidae, which are sandpipers and related species, such as Dunlin.) There isn't a very high correlation between the two data sets (0.19452), but this could be because of the difference between defining "prey" by feather remains and defining "prey" by

observation. We observed many predation events that did not result in a successful hunt, whereas, feather remains always meant the hunt was a success.



Can we discern any differences in those bird species that became prey frequently and those who rarely became prey? We compared likely prey with those that are less likely to become prey items. Here are a few of those comparisons. Each will give a clue to Merlin predation.

Frequently Prey	Rarely Prey
Barn Swallows	Rough-Winged Swallows
Dunlin	Plovers
House Finches	Purple Finches
House Sparrows	Spotted Towhees
Brown-Headed Cowbirds	Brewer's Blackbirds
Chickadees	Wrens
Robins	Hummingbirds

Rural Habitat

Let's compare the Barn Swallows and Rough-Winged Swallows: Over and over, our data showed birds who forage in tight or loose flocks in the open or above the canopy show up as Merlin prey (Swallows, Swifts, Cedar Waxwings, Red-Crossbills). So why are significantly more Barn Swallows taken than Rough-Winged Swallows? Barn Swallows are more gregarious and Northern Rough-Winged Swallows, are often solitary or in pairs. Barn Swallows will more often forage openly in flocks, in a wide variety of rural habitats, using barns and other structures for nesting, following tractors that flush insects and, generally being more available to Merlin predation.

Dunlin to Plovers: Both Dunlin (Family Scolopacidae) and Plovers (Family Charariidae) are shorebirds who forage openly in flocks. Dunlin are resident birds during the winter in the Coastal Forest Merlin range, where most Plover species (exception Black-bellied Plover) are migrating through and tend not to stay in the area. The size of the flock is another consideration. Dunlin flocks can number in the thousands (sometimes more than 10,000 in a flock), where Plover migrating flocks number in the low hundreds or less. Dunlin forage openly and are noted for flock evasive maneuvers, called a "Murmuration". This does not stop Merlin from being attracted to Dunlin flocks. The mass and length of the prey bird is another factor. Several plover species are simply too large for the Merlin to carry easily.

House Finch versus Purple Finch: This is a case of population dynamics. House Finches have moved into the region, following human development. They appear to be displacing Purple Finches. House Finches, as their name implies are comfortable in the increasingly residential-rural habitat. The males openly sing and display during mating season, making them Merlin prey targets.

House Sparrow versus Spotted Towhee: The House Sparrow is not a native species and we hypothesize it has probably not adapted to Merlin attacks. It originated in Africa, invaded Europe and was purposely let loose in North America by misguided people. It now has spread across North America and is actively displacing some of our own native birds, such as Western Bluebirds. The House Sparrow is attracted to human development and bird feeders, often foraging and displaying in the open. Males, especially seem more interested in supplanting other males of their species than in looking out for predators. The House Sparrow does not appear to be an adept, defensive flier. The Spotted Towhee, our largest, native sparrow is a relatively slow flier. It almost always forages from cover or near cover, on the ground. If it displays or perches, it almost always does so from within the low, shrub layer.

Brown-headed Cowbird versus Brewer's Blackbird: The Brown-headed Cowbird is another invasive species, which originally followed bison and cattle on the Great Plains, but are moving into the Pacific Northwest. This may be an example of a species, which may be naïve to the Coastal Forest Merlin's hunting style. Cowbirds, by the way, are nest parasites on our native bird populations, so Merlin are helping to control their population.

Chickadees versus Wrens: Wrens almost entirely forage under bushes and in the forest understory. The exception is the Marsh Wren. They are well camouflaged. They are shy and retiring, not visiting bird feeders. In contrast, Chickadees feed in tree canopies and frequent bird feeders, making them an available target of raptors.

Robins versus Hummingbirds: This is partly an energy issue. How much energy (kilocalories) will the prey provide compared with how much energy it takes to successfully hunt this bird? Robins forage and perch in the open and are slow fliers compared to Merlin. They also provide enough kcal for a single Merlin for a day. They tend to be hunted primarily by the larger females, being too large for the smaller male Merlin. On the other hand, The Rufous and Anna's

Hummingbirds are so small that they provide little energy for a hunter, plus they are extremely agile, fast fliers who can disappear into cover quickly.



Birds that forage within tree canopies and hide within the canopies when disturbed are less likely to become prey of Merlin. Merlin aerially chase flushed prey primarily in open to semi-open habitats.

What is the "Goldilocks Standard" for Merlin prey? First, birds that are most likely to become prey are readily available on the rural landscape: primarily, year round residents, then winter residents, and finally spring-summer visitors, called Neotropical migrants. They are most likely to be hunted if they forage in flocks in the open. Foraging from cover or in the open, but as solitaires or widely scattered groups greatly lessens their risk. The majority of prey birds have a mass between 20 to 50 grams (0.7 - 1.8 ounces). The second most hunted group has a mass of 51 to 100 grams (1.8 to 3.5 ounces) and the third most predated group had a mass of under 20 grams (<0.7 ounces). Birds with a mixed diet (insects, crustaceans, worms, seeds and fruit) were the major part of the Merlin diet. Secondarily, Merlin ate birds that consumed just invertebrates (insects or crustaceans). A third tier part of the diet was birds that ate primarily seeds, fruit and secondarily insects.

BIRDS THAT AVOIDED BECOMING PREY

Many birds were common on the landscape, but avoided being a Merlin food source. Here is a list of these "lucky" birds (some of which became prey of different predators). They are listed by the major trait that we hypothesize helped them avoid being eaten, in spite of being sighted on the rural, coastal landscape.

Too Big or Heavy for the Merlin to Hunt: Shorebirds such as Black Oystercatcher, Long-Billed Dowitcher, Greater Yellowlegs (though there is one case in the recent published literature, as well as, one with the Black-belled Plover), Lesser Yellowlegs, Whimbrel. Also, too massive were the Band-Tailed Pigeon and Pileated Woodpecker. **Appearing Only Rarely:** Shorebirds include the Willet, Ruff, Solitary Sandpiper, Sharp-tailed Sandpiper and Wandering Tattler. Other species included the European Collared Dove (although the senior author has observed a successful kill since this manuscript preparation), the Redpoll, White-Winged Crossbill, Townsend's Solitaire, Eastern Kingbird, Purple Martin, Yellow-Headed Blackbird, Mountain Chickadee, Mountain Bluebird, and California Quail. Anna's Hummingbird could be included on this list, although it is being seen in increasing numbers in the last couple of decades (and again, the senior author observed an Anna's becoming prey in January 2020).

Nocturnal Species: Common Nighthawk and Red-Necked Phalarope (Merlin hunt from predawn to post-dusk.)

Casual Migrants: Those species passing through the Merlin Range: Plovers, Pectoral Sandpiper, and Baird's Sandpiper.

Birds that have small food value for the energy that would be expended on catching them: Rufous Hummingbird, Ruby-Crowned Kinglet

PREDATION RISK INDEX

We assigned to each species a risk index number. This was calculated by looking at 12 characteristics of each species that became prey. Here is an example of how two of the "risk index" numbers were made. The first is the Brown Creeper (BRCR), which was not hunted. The second is for the frequently hunted Cedar Waxwing (CEWA). Low risk = 0. Some risk = 0.5. High risk = 1. Even though this risk index is based on arbitrary assignment of values, it seems to reveal some true patterns. In the example below, the Brown Creeper has a low risk (4) of becoming prey and the Cedar Waxwing has a much higher risk. We are certain that this index could be improved by further observation of each prey species. *Perhaps, it could be the starting point of a future study by someone who would like to follow this investigation.

BRCR = 3	Forage habit	Display	Color	Bird Feeders	Frequency	Flocking
	0	0	0	0	0.5	0
	Body gm,cm	Flushes?	Insectivore	Flight?	Native?	Sum RISK
	0.5	0	0.5	0.5	1	= 3
CEWA=8.5	Forage habit	Display	Color	Bird Feeders	Frequency	Flocking
	1	0.5	1	0	1	1
	Body cm/gm	Flushes?	Berries/fruit	Flight?	Native?	Sum RISK
	1	1	0.5	0.5	1	= 8.5

There was a 44% positive correlation (+0.44009) between the number of prey of a certain species and its risk number (source – feather remains). We also found the average-weighted risk factor (See part II for explanation.) of prey birds and non-prey birds. They show a similar pattern:

Observed prey, weighted-average risk = 6.42. Weighted-average risk of prey identified from feather remains = 6.68. Weighted average risk of observed birds that did not become prey = 4.42.



Consider the two species above: The Black Oyster Catcher (left photo) is too large to be Merlin prey. It is a resident within the coastal riparian areas within the Coastal Forest Merlin range. It forages openly, but solitarily or in pairs. The Dunlin (right photo) is an available spring and fall migrant, as well as resident in large numbers during the winter. It is also the right size for a hunting Merlin. It forages openly in large flocks.

PART II: DATA COLLECTION, ANALYSIS, RESULTS AND REFERENCES

Gathering Data: This exploratory food habits study encompassed four habitats over a region stretching from Prince Rupert, British Columbia to Los Gatos, California. All data were collected from surveys or nest site monitoring completed by the senior author. These observations occurred within riparian systems draining toward the Pacific Ocean, the Salish Sea, or the Canadian Coastal Passage. A few of the observations occurred on islands in the San Juans or coastal British Columbia. The four habitats within this region were classed WF (Western Lowland Coniferous/Mixed Forest), RF (Remnant Forests), Rural, and Urban. (See Coastal Forest Merlin Breeding Habitat paper by the authors on this website). This report is on the Rural findings, but the same methods may be used to analyze the other three environments.

There were 3,497 rural species sightings on Merlin hunting or breeding ranges, occurring between 1983 and 2013. In all, 118 avian species were sighted. There were also 284 prey deliveries of avian prey to active Merlin nest sites. These food items almost always had the tail, wings and heads removed, however 69 out of the 284 were identified as "passerine". Furthermore, there were 42 "field-bird" flock sightings. These were seen at a distance that made identification approximate. Field birds were almost always Sturnidae family, Starlings or members of the Ictaridae family, such as Red-winged Blackbirds or Brewer's Blackbirds. Population counts were not taken during observations, as the presence or absence of the species on the landscape was what was considered important. Exact numbers of prey species were counted, as it directly spoke to Merlin hunting behavior.

We have the history of predation at Merlin sites, from 1986 to 2013, as shown by plumed feathers found around the nesting area. This sample is based on over 4,000 prey remains. We also have the kilo-calorie requirements of Merlin adults and have algorithms to find the number of prey of each species it would take to fill these daily requirements. This varies, by species, as some prey are granivores, others insectivores or omnivorous, and all have their own weight ranges. The kcal requirements of the Merlin also vary by gender, age class and activity in the reproductive cycle.

All observations were classed by "frequency species were observed" and "frequency each species became prey". Bird prey observations were similarly classed by family and order. Prey were any birds that were observed being hunted, plumed, cached, delivered to a mate or juveniles, or eaten. Prey were also counted separately from the feather remains of over 4,000 individual birds whose feathers were found under Merlin pluming trees or near Merlin nest trees. These feathers were very carefully identified and data entry was quadruple quality-control checked. Prey frequency counts of field observations and feather data were kept separate throughout all statistical analysis. This allowed one set to be compared against the other without "cross contamination".

There are three kinds of frequency ranking that were performed on the data: 1. Frequency of prey, that were both observed as prey and whose feathers had proved evidence of being hunted (e.g. Savannah Sparrows); 2. Frequency of observed prey alone; 3. Frequency of prey, by feather evidence alone.

Prey data was collated from four sources:

- Field observations of fauna (avian, insect, and mammal) that fell within the biomass range of possible Merlin prey (1-350 grams). Field observations were considered the primary source (Snyder, N.F.R. and I.W. Wiley. 1976. Sexual size dimorphism in hawks and owls of North America. Ornithol. Monogr. 20). Field observations of fauna present consisted of lists of species, not the numbers of individuals in a group. For example, it was noted if Violet-green Swallows were present, not how many there were. The point was to find diversity of species that might become part of a Merlin's diet, not an actual census of each species.
- Field observations of predator-prey interactions between Merlin and prey (e.g. active hunts, chases, flushes, stoops, and kills, prey being plumed, prey being eaten or cached, and prey deliveries to a mate or to young). (Collopy, M.W. 1977. Food caching by female American Kestrels in winter. Condor 79:63-68; Snyder et. al., 1976; Sitter, G. 1983 and Feeding activity and behavior of Prairie Falcons in the Snake River Birds of

Prey Natural Area in southwestern Idaho. M.S. Thesis, University of Idaho, Moscow, ID U.S.A.)

- Feathers and partial or whole prey identified from the ground surrounding Merlin activity trees. (approximately 4,400 prey represented by 17,000 feathers). During the nesting stage, these pluming trees or "plucking stations" (Richard Mearns. 1983. Bird Study 30: 81-90. "The Diet of the Peregrine (Falco peregrinus) in south Scotland during the breeding season") were usually within 50 meters of the nest tree. Feathers were identified regularly, so that they reflected the current dietary regime/chronology.
- 4. Biomass measurements of field specimen birds (whole bodied and with head, wings, and tail removed, as is seen in birds caught by falcons.) When specimens were not available from our measurements, biomass measures from Cornell University were used.

Field observations and feather data were not combined, since A. Sharp (et. al. 2002) warned that "combining data from the two methods may result in a biased diet determination", and it was recommended that results be reported separately.

Merlin observed were identified by sex, age, and subspecies, when possible. Prey species were identified to species, if possible. If not possible, prey were identified by the next higher taxon which was applicable. Prey were also classified by foraging guilds. These guilds were: aquatic invertivores (AI, including all shorebirds), Piscivores (P), terrestrial invertivores (TB), granivores (G), and frugivores (F). Many birds are omnivorous, fitting into more than one category or changing foraging with the seasons. For simplicity's sake (see Barnes and Gerstenberger) the dominant foraging emphasis during the breeding season was chosen. For instance, sparrows concentrate on insects, spiders, and other invertebrates early in spring and eat more seed when the full seed crop has matured in late summer and fall. The guilds were used in the article "Using Feathers to Determine Mercury Contamination in Peregrine Falcons and Their Prey", Journal of Raptor Research 49(1): 42-58. 2015, Joseph G. Barnes and Shawn L. Gerstenberger.

Pellets were not a source of data, because the "pellets of some raptors, particularly Falconiformes, do not always contain remains of a significant portion of prey eaten." (Marti, Bechart, Jaksic. Food Habits' chapter of Biometry, 3rd Ed. Sokal and Rohlf. 1995. W. H. Freeman and Company, New York, NY. U.S.A.). As noted, Merlin behead avian prey and pull off the wings, tail, and major feathers. Mearns notes that with Peregrine Falcons short-billed birds may be eaten, head and all, but long-billed bird pellets may be missing the head. From our observations, this also applies to Merlin.

All observations and identifications were grouped by month and by habitat and feeding guild. Habitats were Western Lowland Coniferous-Hardwood Forests (WF), (Franklin et. al. 1981; Franklin and Dyrness. 1973), Remnant Forests (RF)(Dawson and Hostetler. 2010), Rural Landscapes (RL)(USDA definition of 'rural'); and Urban Forests (UF)(Nowak, et. al. USDA/ NSF document. 2010). Taxa, guilds and habitats were organized in what Colwell and Futuyma call a "resource matrix", essentially a spreadsheet. (Robert K. Colwell and Douglas J. Futuyma. 2002. "On the Measurement of Niche Breadth and Overlap". JSTOR: Ecology: Vol. 52, No. 4. P. 567.) Cells within the resource matrix contain either numbers of individuals or sightings, ratio of actual prey to observed prey, population frequency, biomass, or percent of total biomass.

There was concern that feather observations would not adequately represent other forms of prey fauna, such as insects (Bielefeldt, et. al. 1992 study of Cooper's Hawks). This was known to be true, as Merlin hawk insects, so the frequencies of prey shown by feather identification were only compared with the frequencies of observed avian prey, not all prey. Insect prey frequencies were included in niche breadth and dietary richness.

A possible problem was that the number of observations in different habitats was not equal. This was addressed by separating the data by habitat, so that skew errors from combining habitats would not happen. A related concern was that Merlin may be foraging in several different habitats, regardless of where their nesting territory was. This concern was addressed by comparing observed overlap (commonality) of prey species between habitats to actual prey frequencies at observation/collection points (Sorenson's Index of Commonality. See below).

Diets were "quantified by giving the percentages of samples in which each kind of prey occurred." (Marti et. al. Food Habits.) Our statistical methods were meant to answer, "Which species are the mainstays of this raptor's diet, either numerically or by biomass." (Marti, et. al. Food Habits.)

We also looked at whether a particular prey species' availability in the environment correlated with its representation in the prey base. If it did, we hypothesized that Merlin were opportunistically eating what was most common, in their prey size range. If potential prey species availability deviated significantly from actual prey frequency, we felt this would be grounds for further research: What was causing the Merlin to prey with more or less frequency on this particular species than its availability would suggest? Was there something in the species' niche or habits that made it less or more vulnerable? Was their kcal yield too low or extra rich? This was calculated by 'actual prey' to 'potential prey' ratios: A/P. Prey selection, rather than mere opportunism would be indicated by "those species taken in greater proportion than available." (R.E. Hunter, J.A. Crawford, R.E. Ambrose. Journal of Wildlife Management. 52 (4): 730-736. "Prey selection by Peregrine Falcons during the nestling stage".)

RESULTS AND FREQUENCY RANKINGS

First, we compared the prey species by habitat, using feather remains at Merlin sites.

This is the frequency of prey by family, from most to least frequent, between the four different Merlin habitats, using the plucked feathers as our source material. Follow-up reports on the other Merlin habitats will use this data.

Family all sites	Coastal and Lowland Mature Forests	Remnant Forests	Rural Pastoral and Shore	Urban Residential
HOSP 980	Swallows 173	Finches 91	Swallows 364	HOSP 899
Finches 789	Sparrows 128	Sparrows 90	Finches 131	Finches 440
Swallows 681	Sandpiper kin 89	Swallows 73	Waxwings 111	Swallows 71
Sparrows 352	Thrushes 111	Thrushes 31	Sparrows 78	Sparrows 55
Waxwings 232	Waxwings 57	Ictaridae 30	Ictaridae 67	Waxwings 38
Thrushes 223	Ictaridae 47	HOSP 27	Swifts 50	Ictaridae 38
Ictaridae 207	Warblers 38	Waxwings 24	Thrushes 46	Thrushes 33
Sandpiper kin 115	Swifts 31	Starlings 22	HOSP 32	Chickadees 28
Swifts 93	HOSP 21	Sandpiper kin 16	Starlings 26	Starlings 20
Warblers 93	Starlings 18	Warblers 16	Sandpiper kin 24	Warblers 17
Starlings 86	Chickadees 13	Swifts 6	Chickadees 23	Grosbeaks 10
Chickadees 69	Flycatchers 11	Flycatchers 6	Warblers 22	Swifts 6
Picidae 29	Kinglets 11	Chickadees 5	Picidae 11	Picidae 6
Grosbeaks 30	Finches 10	Kinglets 5	Vireos89	Bushtits 4
Flycatchers 22	Picidae 8	Grosbeaks 5	Bl.H. Grosbeak 7	Tanagers 3
Kinglets 21	Vireos 7	Picidae 4	Tanagers 5	Dippers 2
Vireos 18	Grosbeaks 6	Vireos 3	Flycatchers 4	Sandpiper kin 2
Tanagers 13	Tanagers 5	Nuthatches 2	Kinglets 4	Flycatchers 1
Bushtits 11	Bushtits 4	Bushtits 1	Nuthatches 3	Kinglets 1
Nuthatches 9	Nuthatches 3	Bat 1	Bushtits 2	Nuthatches 1
Creepers 3	Creepers 3	Dove 1	Bat 1	
Dippers 2	Bats 2			
Bats 4	Nighthawks 1			
Nighthawks 1				
Doves 1				

Frequency of Prey Families by Habitat

Rural habitat prey

Next, we looked at just the rural habitat species that included 72 passerines (1,892 observations); 30 shorebird species (756 observations) and 16 other non-passerine, avian species (283 observations). Also, there were 339 observations of aerial insect species and seven prey mammals.

When we ranked Prey Species (observed as prey and also identified from feather remains) these were found to be mainstays of the Merlin diet in rural settings.

Observed Prey	Identified from Remains ($N = 624$ prey)
1. American Goldfinches, 11	1. Cedar Waxwings, 231
2. Dunlins, 10	2. Tree Swallows, 69
3. House Sparrows, 5	3. Violet-green Swallow, Brown-Headed Cowbirds, 66 each
4. Cedar Waxwings, Rough-winged Swallows, Red-winged Blackbirds, 4 each	4. House Finch, 53
5. Dark-eyed Juncos, European Starling, 3 each	5. House Sparrows, 32
6. Brown-headed Cowbirds, Violet-Green Swallows, Savannah Sparrows, Western Sandpipers, 2 each	6. European Starling, 24
7. Tree Swallows, House Finches, Song Sparrows, Killdeer, Black-throated Grey Warblers, Yellow-rumped Warblers, 1 each	7. Dark-Eyed Junco, 24
	8. Rough-winged Swallows, Savannah Sparrows, Song Sparrows, 10 each
	9. Yellow-rumped Warblers, 9
	10. American Goldfinches, Black-throated Grey Warblers, 5 each
	11. Killdeer, 4
	12. Western Sandpipers, 2
	13. Red-winged Blackbirds, Dunlins, 1 each

Looking at the prey by avian family, one can see a different pattern emerge. Again this is a ranking by observed prey and prey remains.

Observed prey	Identified from feather remains
1. Scolopacidae (Dunlin, W. Sandpiper, Killdeer), 14	1. Hirundidae (Swallows), 364
2. Fringillidae (Finches), 12	2. Fringillidae (Finches), 149
3. Ictaridae (Blackbirds, Cowbirds), 10	3. Bombycillidae (Waxwings), 111
4. Hirundidae (Swallows), 7	4. Emberizidae (Sparrows), 78
5. Emberizidae (Sparrows), 6	5. Ictaridae (Blackbirds, Cowbirds, Meadowlarks), 67
6. Passeridae (House Sparrow), 5	6. Apodidae (Swifts), 50
7. Bombacillidae (Waxwings), 4	7. Turdidae (Thrushes), 48
8. Sturnidae (Starlings), 3	8. Passeridae, (House Sparrow), 32
9. Parididae (Warblers), 2	9. Sturnidae (Starlings), 26
	10. Paridae (Chickadees, 23) and Parididae (Warblers, 22)
	11. Picidae (Woodpeckers, Flickers, Sapsuckers), 11
	12. < 10: Black-Headed Grosbeak;Shorebirds related to sandpipers; Vireos;Tanagers; Flycatchers; Kinglets;Nuthatches; Bushtits

Frequency Ranking by Avian Order, from prey both observed and identified by remains

In calculating the frequency by the taxon level "Order" the 69 prey deliveries (identified as passerine) were included. PASSERINE PREY = 89.17%; Non Passerines (Scolopacidae) = 10.83%.

There were several prey species that only appeared in one of the two data sources. Looking at these allows us to see a more complete record of what the Merlin was eating.

Observed Prey Species

- 1. American Goldfinches, 11
- 2. Dunlins, 10
- 3. House Sparrows, 5

4. Red-winged Blackbirds, Cedar Waxwings, Rough-winged Swallows, 4 each

5. Dark-Eyed Juncos, Blackbird species, Starlings, 3 each

 6. Savannah Sparrows, Brown-headed Cowbirds, Western Sandpipers, Violet-green Swallows, 2 each

7. Song Sparrow, Am. Pipit Brewer's Blackbird, House Finch, Rock Pigeon, Short-billed Dowitcher, Killdeer, Tree Swallow, Black-throated Grey Warbler, Yellow-rumped Warbler, 1 each

Prey species identified by feather remains

- 1. Cedar Waxwings, 231
- 2. Barn Swallows, 126
- 3. Cliff Swallows, 96
- 4. Tree Swallows, 69

5. Violet-green Swallows, Brown-headed Cowbirds, 66

- 6. House Finches, 53
- 7. Pine Siskins, 39
- 8. Vaux's Swifts, House Sparrows, 32 each
- 9. European Starlings, 26

10. Dark-eyed Juncos, White-crowned Sparrows, 24 each

- 11. Red-Crossbills, 23
- 12. American Robins, 21
- 13. Black Swifts, 18
- 14. Chestnut-backed Chickadees, 17
- 15. Swainson's Thrushes, 11
- 16. Varied Thrushes, 10

17. Rough-winged Swallows, SavannahSparrows, Song Sparrows, Purple Finches,Yellow-rumped Warblers, 9 each

18. Sandpiper species, Black-capped Chickadees, 8

19. Black-headed Grosbeaks, 7

20. Hermit Thrushes, Spotted Towhees, Am. Goldfinches, Western Tanager, Orangecrowned Warblers, Black-throated Grey Warblers, 5 each

21. Killdeer, Hairy Woodpeckers, 4 each

22. Downy Woodpeckers, Northern Flickers,Warbling Vireos, Townsend's Warblers,Red-breasted Nuthatches, 3 each

23. Fox Sparrows, Gold-crowned Sparrows, Evening Grosbeaks, Bushtits, Western Sandpipers, Golden-crowned Kinglets, Ruby-crowned Kinglets, Hutton's Vireos, Red-eyed Vireos, 2 each

24. Lincoln Sparrow, Red-winged Blackbird, Least Sandpiper, Dunlin, Cassin's Vireo, Common Yellowthroat, Belted Kingfisher, 1 each

Avian Family Rankings:

Observed Prey Species	Identified Prey Species, from Feather Remains
1. Sandpipers and kin, 14	1. Swallows, 367
2. Finches, 12	2. Waxwings, 231
3. Blackbirds and kin, 10	3. Finches, 131
4. Swallows, 7	4. True Sparrows, 78
5. True Sparrows, 6	5. Blackbirds and kin, 67
6. House Sparrows, 5	6. Swifts, 50
7. Waxwings, 4	7. Thrushes, 47
8. Starlings, 3	8. House Sparrows, 32
9. Warblers, 2	9. Starlings, 26
10. Pipits, Pigeons, 1 each	10. Chickadees, 25
	11. Sandpipers and kin, 24

12. Warblers, 23
13. Woodpeckers and kin, 11
14. Vireos, 8
15. Black-headed Grosbeak (a cardinal, not a finch)
16. Tanagers, 5
17. Kinglets, 4
18. Nuthatches, 3
19, Bushtits, 2
20. Kingfisher, 1

Classed by Family, Passerines made up 78% of the observed prey and non-passerines, Sandpipers, 22%. Looking at the evidence of prey identified by feathers, passerines made up 96% of the prey base and non-passerines (sandpipers, woodpeckers, kingfisher) made up 4%.

NON-PREY SPECIES OBSERVED IN THE COASTAL RURAL/RIPARIAN HABITAT

As was explained in our Methods, birds over a certain body mass, body length, or leg/beak length, simply did not become part of the Merlin diet. Female Merlin, being larger than males are able to catch slightly larger prey, but their upper limit, from our observations, were American Robins, Varied Thrushes, and Rock Pigeons. The following birds were observed on the Merlin hunting or nesting landscape, but did not become part of their diet, as assessed by observation and feather remains. These birds are grouped by family and were assigned a "risk value" of predation by Merlin of zero (0).

Columbidae: Band-tailed Pigeons

Picidae: Pileated Woodpecker

Haematopodidae: Black-Oystercatcher

Scolopacidae: Long-Billed Dowitchers, Greater Yellowlegs, Lesser Yellowlegs, Whimbrels, Wandering Tattlers

Some birds appeared so rarely on the landscape that they were not a part of the diet that we could verify, either by observation or remains. Most normally inhabited ranges outside the Coastal Forest Merlin range. They were:

Columbidae: European Collared Dove (Eurasian). *After this above study period was complete the Principal Investigator, David Drummond observed a successful Merlin hunt of this species, which was a first observation (September 2016) for this ongoing field study. Scolopacidae: Willet (summers inland), Solitary Sandpiper (Arctic, Sub-Arctic), Ruff (Accidental visitor), Sharp-tailed Sandpiper (Eurasian)

Ictaridae: Yellow-headed Blackbird (Summers inland, rare West Side breeder)

Turdidae: Townsend's Solitaire (Cascade Mountains), Mountain Bluebird (Mountains and Migrant on coast. *(One observed in the prey remains)

Paridae: Mountain Chickadee (Cascade Mts.)

Odontophoridae (Galliform): California Quail (Coastal Chaparral of Oregon and California; highly protected by covering chaparral brush)

Fringillidae: White-winged Crossbill (Canadian and Alaskan taiga), Redpoll (Arctic, Sub-Arctic,

rare migrant/winter visitor)

Tyrannidae: Eastern Kingbird (intersects Merlin range on border of Puget Sound region)

Trochilidae (Trochiliformes): Anna's Hummingbird (Southern coastal; last three plus decades of increasing in the region, as the climate warms and winter feeding stations available)

RISK VALUE

The birds above were also assigned a risk value of zero, except for the Eastern Kingbird and Anna's Hummingbird (0.5).

Several species of shorebirds only make short stops as they migrate between the Arctic nesting grounds and winter grounds far to the south. These birds do not appear in our observed prey or in feather remains: Black-bellied Plover, American Golden Plover, Semipalmated Plover, Semipalmated Sandpiper, Pectoral Sandpiper, Baird's Sandpiper and Wandering Tattler.

Two species forage at night, the Common Nighthawk and the Red-necked Phalarope. Since Merlin are diurnal and crepuscular (dawn, dusk) hunters, these two species were not part of the observed diet. The phalarope is also a marine bird in the winter and the nighthawk is highly camouflaged and remains still in the ground cover, when not foraging overhead in the sky. These factors further reduced their risk.

Each species observed in the field or found in the feather remains was also described for 14 characteristics, which then could be used to find commonalities of frequent prey or species that were seemingly immune to predation. The prey characteristics are listed here, though a more exact description and their effects will be given in results. Arbitrary numbers were assigned as risk factors for each of these qualities. (The justification for this is familiarity with the species allowed for assignment of probabilities (either 0, 0.5, or 1.) A Risk Factor number could then be assigned to each species and it could be tested against the frequency of predation.

OBSERVED PREY RISK:

Prey	1	2	3	4	5	6	7	8	9	10	11	INDEX SCORE
AMGO	1	1	0.5	0.5	1	0	0.5	0.5	0	1	0	6
DUNL	1	1	1	1	0	1	1	0.5	0.5	1	0	8
HOSP	1	0.5	0.5	0.5	1	0.5	0.5	1	0.5	1	1	8
RWBL	1	0.5	1	0.5	0	0.5	0.5	0.5	0.5	1	0	6
CEWA	1	0.5	0.5	1	0	1	1	0.5	0.5	1	0	7
RWS W	1	0.5	0.5	0.5	0	1	0	0.5	0.5	1	0	5.5
DEJU	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	1	0	6.5
Bl.Bird	1	0.5	0.5	0.5	0	0.5	1	0.5	0.5	1	0	6
EUST	1	0.5	0.5	1	1	0.5	1	0.5	0.5	1	1	8.5
SASP	1	0.5	0.5	0.5	0	0.5	0	0.5	1	1	0	5.5
BHCO	1	0.5	0.5	0.5	0	0.5	0.5	1	1	1	1	7.5
WESA	1	0.5	0.5	1	0	1	1	0.5	0.5	1	0	7
VGSW	1	1	1	1	0	1	1	0.5	0.5	1	0	8
SOSP	1	0.5	0.5	0.5	1	0.5	0.5	0.5	1	1	0	7
AMPI	1	0	0	0.5	0	0.5	0.5	0.5	0.5	0	0	3.5
BRBL	1	0.5	0.5	0.5	0	0.5	1	0.5	0.5	1	0	6
HOFI	1	1	1	0.5	1	0.5	0.5	0.5	0.5	1	0.5	8
ROPI	0	0.5	1	1	0.5	1	1	0.5	0.5	1	0.5	7.5
SBDO	0	0.5	0.5	1	0	1	0.5	0.5	0.5	0	0	4.5
KILL	1	0.5	1	0.5	0	0.5	0.5	0.5	0.5	1	0	6
TRSW	1	0.5	0.5	1	0	1	1	0.5	0.5	1	0	7
BTGW	1	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	1	0	5.5
YRWA	1	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	1	0	5.5



APPENDIX 1: RISK DESCRIPTORS (14)

1a. Body Mass: A body mass over 300 grams is hunted so rarely by Merlin that it is a disqualifying characteristic (e.g. Band-tailed Pigeon). Most prey fell within the range of 20 to 100 grams. [m < 10g = 0; 11-20 g = 0.5; 21-100 grams = 1; 101-200 g = 0.5; 201 to 300 g = 0; m > 300 g = disqualifying]

1b. Body Length: A bird with a body length over 25 cm or legs and beaks longer than 10 cm did not appear in the prey base, therefore is counted as a disqualifying feature (e.g. Greater Yellowlegs). Most prey body length was in the range of 10 to 20 cm. Since body length is so strongly tied to body mass, it was not counted, except for the lengths mentioned above.

2. Color contrast to habitat: Bright colors contrasting with the habitat and dull coloration or camouflage are recognized as factors in species predation. [Male and Female dull or camouflaged = 0; Male colorful, Female dull = 0.5; Male and Female conspicuous = 1]

3. Display: Some birds perch openly to sing or display, while on their territory (e.g. Red-winged Blackbird males). Others sing or display from within the canopy or under cover (e.g. Spotted Towhees). Displaying openly carries a risk. [Display from cover = 0; Display from cover and open or male displays openly = 0.5; conspicuous, open display = 1]

4. Foraging: Some species forage under cover or within or close to the canopy (e.g. Brown Creepers). Others forage in the open (e.g. American Robins) or even in flight (e.g. Swallows, and Swifts). Open and aerial foraging was hypothesized as increasing risk of being hunted by Merlins. [Forages from cover = 0 or nocturnal; Forages in cover or briefly sallies from nearby cover = 0.5; Forages mostly in open = 1]

5. Visits Bird Feeders: Frequenting bird feeders was considered another possible risk, as we received frequent reports (over 25 years) of raptors targeting birds near or at bird feeders. [Never = 0; Rarely = 0.5; Frequently = 1]

6. Flushing or Startle Behavior: Some species of birds flush to the ground or brush or canopy cover (e.g. Bushtit). Some are flushed upward into the air (Horned Larks), where Merlin have the advantage. Some are flushed in flocks and perform evasive maneuvers called "murmurations" (e.g. Starlings, Dunlins), used to confuse predators. [Flushes to ground to canopy or to cover = 0; Evasive Maneuvers = 0.5; Flushes up into air or open = 1]

7. Flocking Behavior: Some birds forage and perch solitarily or in pairs, some in small feeding flocks, often of mixed species. And some like Starlings and Dunlins forage and rest in giant flocks, both attracting falcons and reducing the risk of each single individual. [Mostly solitary = 0; small loose or mixed feeding flocks, under 50 = 0.5; tightly organized, large flocks = 0.5]

8. Flight Speed and Maneuverability: Can the prey species outfly a Merlin? Merlin are faster than most birds in the study, but some birds are fast and highly maneuverable (e.g. Rufous Hummingbird). [Fast and maneuverable = 0; Fast for short distances near cover = 0.5; Significantly, slower and less maneuverable in air space = 1]

9. Food Source: During the course of this study, the food source of the prey animal seemed to play a role in their likelihood to become prey. [Hunts fish, reptiles, small mammals = 0; Eats invertebrates, including insects = 0.5; Eats mostly insects, other invertebrates and some seeds and other plant material = 1; Eats mostly seeds or fruit and some insects and invertebrates = 0.5; Eats seeds and fruit = 0.5]

10. Occurrence/Frequency: Birds were classed as "rare and accidentals", "migratory and transients", fall-winter residents in the region (during Merlin dispersal or Taiga Merlin migration), spring-summer residents in the region (during Merlin nesting season), and year-round residents in the region. When and how often species were seen on the landscape was thought to have an effect on the frequency that they became prey. [Rare = Disqualifying; Common migrant = 0.5; Fall/Winter Resident = 0.5; Spring/Summer Resident = 1; Year-Round Resident = 1]

11. Native, Alien, or Immigrant Species? During the course of our field observations we began to see a difference in predation frequency between native birds (e.g. Downy Woodpecker), introduced Eurasian alien species (e.g. House Sparrow, Starling), and immigrant species from other parts of North America (e.g. Brown-Headed Cowbird, House Finch). [Native = 0.5; Alien = 1; Immigrant = 1].

12. Diurnal or Nocturnal? Nocturnal species were not part of the observed Merlin diet (e.g. Common Nighthawk).

13. Actively aggressive toward Merlin? Corvids, such as crows and jays mob raptors. Species that mobbed Merlin were not part of the observed Merlin diet over the course of the study.

A similar index was done for all prey identified by feather remains and all observed birds that were not prey. In the interest of space, it is not included here.

The risk factors for each of the remaining species was calculated, using the 14 descriptors above and multiplied by the number of sightings. This gave the weighted risk of predation each species (sightings x risk). The average of these risk numbers is suggestive: Observed Prey, 6.42; Observed, but NOT prey 4.42; Prey identified by feathers, 6.69. Notice that the risk factors for Observed prey and Prey identified from feathers are similar, 6.45 and 6.69. Both are significantly higher than those species that were not prey (4.42). In the interest of saving space, 4 letter standard bird name codes for each species are used.

Observed Prey (average of weighted risk factors = 6.42)

ROPI 1x0=0; SBDO 1x0=0; KILL 1x5.5=5.5; WESA 2x6=12; DUNL 10x8=80; Sandpiper species 8x5=40; RWSW 4x5.5=22; TRSW 1x7=7; VGSW2x7=14; BTGW 1x4=4; YRWA 1x4=4; HOSP 5x8.5=42.5; SASP 2x4.5=9; SOSP 1x5.5=5.5; DEJU 3x5.5=16.5; AMPI 1x3=3; Blackbird species 3x7.5=22.5; BRBL 1x7.5=7.5; BHCO 2x8.5=17; RWBL 4x7=28; CEWA 4x6.5=26; AMGO 11x6=66; HOFI 1x7.5=7.5; EUST 3x8.5= 25.5

Feather Remains, Identified Prey (average of weighted risk factors = 6.68)

BLSW 18x7.5=135; VASW 32x7=224; BEKI 1x4.5=4.5; DOWO 3x5.5=16.5; HAWO 4x5.5=22; NOFL 3x6=18; RBSA 1x4.5=4.5; KILL 4x5.5=22; WESA 2x6=12; DUNL 1x8=8; LESA 1x6=6; Sandpiper species 8x5=40; BUSH 2x4=8; RBNU 3x3.5=10.5; GCKI 2x2.5=5; RCKI 2x3.5=7; CAVI 1x3.5=3.5; HUVI 2x3.5=7; REVI 2x3.5=7; WAVI 3x3.5=10.5; BASW 126x7=882; CLSW 96x7.5=730; RWSW 10x5.5=55; TRSW 69x7=483; VGSW 66x7=462; BCCH 8x5=40; CBCH 17x5=85; BTGW 5x4=20; COYE 1x4.5=4.5; OCWA 5x3.5=17.5; TOWA 3x4=12; YRWA 9x4=36; WETA 5x5=25; AMRO 21x8=168; HETH 5x3.5=17.5; SWTH 11x3.5=38.5; VATH 8x6.5=52; BHGR 7x4.5=31.5; HOSP 32x8.5=272; SASP 10x4.5=45; SOSP 10x5.5=55; WCSP 24x6=144; DEJU 24x5.5=132; FOSP 2x4=8; GCSP 2x5=10; LISP 1x3=3; SPTO 5x4.5=22.5; BHCO 66x8.5=561; RWBL 1x7=7; CEWA 111x6.5=711.5; AMGO 5x6=30; EVGR 2x5.5=11; HOFI 53x7.5=397.5; PISI 39x5.5=214.5; PUFI 9x5.5=49.5; RECR 23x6=138; EUST 26x8.5=221

Observed, but NOT prey: (average of weighted risk factors = 4.42)

SNBU 5x4=20; LALO 19x4=76; WEME 14x5=70; CONI 3x1.5=4.5; WIWR 15x2.5=37.5; MAWR 11x3=33; BEWR 14x2.5=35; RUHU 27x5=135; AMGP 16x4.5= 72; BBPL 82x5=410; SEPL 20x5=100; COSN 29x3.5=101.5; BLTU 31x5=155; RUTU 4x4.5=18; SURF 6x5=30; SAND 6x5=30; PESA 19x5.5=104.5; BASA 10x5.5=55; ROSA 5x5=25; BRCR 10x2.5=25; WIWA 14x3.5=49; YEWA 5x4=20; AMDI 3x3=9; NOSH 74x4.5=333; OXFL 3x5=15; PSFL 20x4.5=90; WIFL 11x4.5=49.5

APPENDIX 2: BIRD SPECIES WEIGHTS AND SIZES

Sources: Cornell University; Mass and Length measures from specimens

Corvids:			
-Crow, American	300-600 g	40-50cm	omnivores
-Crow, Northwest	399-444 g	33-41cm	
-Raven, Common	689-1,625 g	56-69cm	
-Jay, Steller's	100140 g	30-34 cm	
Dipper, American	43-67 g	14-20 cm	aquatic insects
Doves:			seeds
-Band Tailed Pigeons	342-364 g	33-40 cm	
-European Collared Dove	140-180 g	29-30 cm	
-Mourning Dove	96-170 g	23-34 cm	
-Rock Pigeon	265-380 g	30-36 cm	
Finches:			seeds and insects
-American Goldfinch*	11-20 g	11-13 cm	
-Crossbill, Red*	24-29 g	14-17 cm	
-Crossbill, White Winged	24-26 g	15-17 cm	
-House Finch*	16-27 g	13-14 cm	
-Pine Siskin*	12-18 g	11-14 cm	
-Purple Finch	18-32 g	12-16 cm	
-Grey Crowned Rosy Finch	22-60 g	14-21 cm	

Flycatchers and Kingbirds:			insects
-Eastern Kingbird	33-55 g	19-23 cm	
-Hammond's Flycatcher	8-12 g	12-14 cm	
-Olive Sided Flycatcher	34 g	19-20 cm	
-Pacific Slope Flycatcher	8-10 g	14-17 cm	
-Western Kingbird	37-46 g	20-24 cm	
-Wilson's Flycatcher			
-Western Wood Peewee	11-14 g	14-16 cm	
Hummingbirds:			
- Anna's H.	3-6 g	10 cm	nectar, insects
- Rufous H.	2-5 g	7-9 cm	
Kinglets:			insects
-Golden Crowned Kinglets *	5-10 g	10 cm	
-Ruby Crowned Kinglets *	5-10 g	11 cm	
Lark, Horned	28-48 g	18-20 cm	seeds, snails, slugs
Nighthawk, Common	65-98 g	22-24 cm	insects
Nuthatch, Red Breasted	8-13 g	14 cm	insects, seeds
Pipit, American	54 g	17 cm	aquatic insects, mollusks
Shorebirds:			marine invertebrates
-Baird's Sandpiper	27-63 g	14-18 cm	

-Black Oystercatcher	500-700 g	42-47 cm
-Black Turnstone	100-170 g	22-25 cm
-Buff Breasted Sandpiper	46-78 g	18-20 cm
-Common Snipe/Wilson's S.	79-146 g	27-32 cm
-Dowitcher, Long Billed	121 g	29-33 cm
-Dowitcher, Short Billed	90-120 g	25-29 cm
-Dunlin*	48-64 g	16-22 cm
-Greater Yellowlegs	111-235 g	29-33 cm
-Killdeer*	75-128 g	20-28 cm
-Least Sandpiper*	19-30 g	13-15 cm
-Lesser Yellowlegs	67-94 g	23-25 cm
-Marbled Godwit	285-454 g	42-48 cm
-Pectoral Sandpiper	41-105 g	22 cm
-Red Necked Phalarope*	61 g	20-21 cm
-Rock Sandpiper	57-130 g	18-24 cm
-Ruddy Turnstone	84-190 g	16-21 cm
-Sanderling	40-100 g	18-20 cm
-Semipalmated Sandpiper	21-32 g	13-15 cm
-Solitary Sandpiper	31-65 g	19-23 cm
-Wandering Tattler	60-169 g	26-30 cm
-Western Sandpiper	22-35 g	14-17 cm
-Whimbrel	310-493 g	44 cm
-Surfbird	133-230 g	24-26 cm-
-Golden Plover, Pacific	102-108 g	23-26 cm
-Plover, American Golden	122-194 g	24-28 cm
-Plover, Black Bellied	160-277 g	28-29 cm
-Plover, Semipalmated	47 g	17-19 cm

-Plover, Snowy	34-58 g	15-17 cm	
Shrike, Northern	57-79 g	23-24 cm	small animals
Sparrows:			seeds, insects
-House Sparrow*	22-29 g	15-17 cm	
All other sparrows			
-Dark Eyed Junco*	18-30 g	14-16 cm	
-Fox Sparrow	33-37 g	17-20 cm	
-Golden Crowned Sparrow	30-33 g	15-18 cm	
-Lazuli Bunting	13-18 g	13-15 cm	
-Lapland Longspur	23-33 g	15-16 cm	
-Lincoln Sparrow	17-19 g	13-15 cm	
-Savanna Sparrow*	15-28 g	11-15 cm	
-Snow Bunting	31-46 g	15 cm	
-Song Sparrow*	12-53 g	12-17 cm	
-Spotted Towhee	33-49 g	17-21 cm	
-White Crowned Sparrow*	25-28 g	15-16 cm	
Starlings, European	60-96 g	22 cm	berries, seeds, insects
Swallows:			insects
-Barn Swallows*	17-20 g	15-19 cm	
-Cliff Swallows*	19-34 g	13 cm	
-N. Rough Winged Sw.*	10-18 g	12-15 cm	
-Purple Martin *	27-31 g	19-22 cm	
-Tree Swallow*	16-25 g	12-15 cm	

-Violet Green Swallows*	14 g	12 cm	
Swifts:			insects
-Black Swifts	28-30 σ	18 - 20 cm	msoots
Vouv'a Swifts*	15 22 g	10 20 cm	
- vaux s Swifts	13-22 g		
-White Throated Swift	28-36 g	15-18 cm	
Tanager, Western	24-36 g	19 cm	fruit, insects
Thrushes:			berries, insects, worms
-American Robin*	77-85 g	26 cm	
-Dusky Thrush	55 g	25 cm	
-Hermit Thrush	27-37 g	18 cm	
-Mountain Bluebird	30 g	18-19 cm	
-Swainson's Thrush	23-45 g	18 cm	
-Townsend's Solitaire	30-35 g	20-22 cm	
-Varied Thrush*	65-100 g		
-Western Bluebird	40-44 g	18-20 cm	
Vireos:			fruit insects
Coopin's Vince/	12 10 -	11.14 area	
	15-16 g	11-14 CIII	
-Hutton's Vireo	9-15 g	12-13 cm	
-Red Eyed Vireo	12-26 g	12-13 cm	
-Warbling Vireo	10-16 g	12-13 cm	

Warblers :			insects
-Black Throated Grey W*	7-10 g	11-13 cm	
-Common Yellowthroat*	9-10 g	11-13 cm	
-MacGillivray's W*	9-13 g	10-15 cm	
-Orange Crowned*	7-11 g	11-14 cm	
-Townsend's W.*	7-11 g	12 cm	
-Wilson's W.*	5-10 g	10-12 cm	
-Yellow W.*	9-11 g	12-13 cm	
-Yellow Rumped W.*	12-13 g	12-14 cm	
-Yellow Throated W.*	9-11 g	13-14 cm	
Waxwings:			fruit, insects
-Bohemian Waxwing	45-69 g	16-19 cm	
-Cedar Waxwing*	32 g	14-17 cm	
Woodpeckers:			insects
-Downy Woodpecker *	21-28 g	14-17 cm	
-Hairy Woodpecker	40-95 g	18-26 cm	
-Northern Flicker	110-160 g	21-31 cm	
-Pileated Woodpecker	250-350 g	40-49 cm	
-Red Breasted Sapsucker	39-68 g	22-22 cm	
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Wrens:			insects, grubs
-Bewick's Wren	8-12 g	13 cm	
-House Wren	10-12 g	11-13 cm	
-Marsh Wren	9-14 g	10-14 cm	
-Winter Wren	8-12 g	8-12 cm	

SUMMARY

We trust this information reinforces your admiration and respect for the land and its wildlife and that the information herein, will lead to wise personal and community decision-making, regarding land use and wildlife conservation. The Pacific Northwest, specifically the coastal rural and riparian habitats currently support a wide diversity of resident and migrating birds. That said, this region is undergoing intense development through industry, changes in agriculture, industrial forestry and urbanization. Our preliminary studies showed the greatest avian diversity was found in ancient and mature forests, then rural habitats and remnant forests and the least diversity in urban environments. We need to be aware that our decisions will impact both predator and prey, and the complex food webs to which the Merlin and hundreds of other life form species belong.

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