Annotated Bibliography on the Ecology and Management of Invasive Species: European Starling (*Sturnus vulgaris*)

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For the Garry Oak Ecosystems Recovery Team
and the Nature Conservancy of Canada
Funding supplied by the Habitat Stewardship Program of the Government of Canada

January, 2003

Ace Bird Proofing Division, Ace doors Nergeco Partner. 2002. Problems caused by urban birds. Website: www.birdproofing.co.nz/birds.htm Accessed: November 19, 2002.

Ace Bird Proofing Division is a business that provides structural birdproofing for commercial sites in New Zealand. The site provides an extensive list of diseases carried by bird pests including *Campylobacter* spp, *Eschericia coli* 0157, *Listeria* spp, *Salmonella* spp, *Vibrio cholerae, Cryptococcus neoformans* and *Histoplasma capsulatum* however, it is not clear which of these diseases are carried by European starlings. Starlings can be a problem when they roost in large flocks because of the large amount of droppings and the potential for disease transmission. Starling distress calls can be used to prevent roosting. Sealing all openings with 28 mm mesh is an effective preventative measure. Complete control of the species is generally not feasible.

Adeney, J. M. 2001. Introduced Species Summary Project: European starling (Sturnus vulgaris). Website: www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/Sturnus_vulgaris.html. Accessed: November 23, 2002.

The paper was produced as part of the Introduced Species Summary Project at Columbia University. Papers on invasive species are written by students seeking Conservation Biology certificates and graduate students taking Invasion Biology courses. The website is designed to provide information on invasive species to land managers and the general public. The starling website provides a comprehensive species description that is easily understood by lay ornithologists as detailed by other references. Distribution is as described elsewhere and a map shows the current distribution of starlings in North America. The paper provides an excellent section entitled “Reasons why it has become established” which places the invasiveness of the species in an ecological context.

Reasons for starling establishment include: a high tolerance of proximity to humans, the ability to thrive in open habitats that have increased with human alteration of landscapes, a migratory nature which allows full exploitation of food resources in different areas, flexibility to allow the birds to change habits with changing environmental conditions, a highly aggressive nature that makes them very competitive with native species and the ability to exploit a range of habitat, nest sites and food. Starlings are usually found in large flocks which can significantly impact ecosystems. They disperse seeds and alter insect populations. Although starlings have been credited with controlling insect populations, they also damage crops and can not be relied on to consume only pest insects. Starlings will also eat newly planted seed and pull up seedlings. Starlings contaminate food and water with their droppings and potentially spread diseases to humans, livestock and wildlife. Aesthetic concerns with droppings, collisions with airplanes and the corrosive effect of the droppings are all further concerns. For Garry oak ecosystems, a crucial impact is the ability to compete for food and nest sites with native birds including woodpeckers, flycatchers, swallows, purple martins and bluebirds. Starlings will be almost impossible to eradicate now that they are established. The best control option is to exclude starlings from nesting sites and modify habitat by removing food and water. Other control options include frightening, repellents, poisoning, shooting and trapping. Starling poisons such as "Starlicide Complete" listed in the paper are not available in Canada. The author suggests a novel starling control could be to provide nest boxes away from native cavity nesters and remove the eggs and nestlings from these boxes. This suggestion will require further research to ensure that it does not inadvertently increase starling numbers.

Agriculture Western Australia. 2001. Farmnote No. 128/2000: Starling. More information from the website: www.agric.wa.gov.au. Accessed: November 23, 2002.

This fact sheet is designed to be used by the general public to identify European starlings, understand their basic life history and develop an awareness of their impacts. The species description and distribution information is the same as detailed by other references. Starlings feed in open grassy areas and can tolerate a range of human habitation from urban to rural. In Australia, starlings consume fruit and cereal crops and ruin livestock feed with their droppings. Starlings have caused population declines of native species and can kill roost trees. Starlings are extremely persistent and difficult to eradicate once established.

Beauchesne, S. M., and J. M. Cooper. 2002. Lewis's woodpecker stewardship account for the Garry oak ecosystems of southwestern British Columbia. Garry Oak Ecosystems Recovery Team, Victoria, BC.

This status report is written from current peer reviewed literature and expert interviews. Lewis's woodpecker has been extirpated from the Georgia Depression, and Washington and Oregon west of the Cascade Mountains. The extirpation range overlaps with most of the range of Garry oak ecosystems. Habitat loss is the biggest threat facing this species. Lewis's woodpecker populations are also limited by nest cavities which are currently used by European starlings. Lewis's woodpecker populations in Washington, Oregon and

coastal British Columbia began to decrease at the same time as starlings arrived although these two species currently co-exist in other locations. Because of the large numbers of European starling competitors and limited nest sites, control of this invasive species is recommended as an important component of Lewis's woodpecker recovery.

Beauchesne, S. M., P. Chytyk, and J. M. Cooper. 2002. Western bluebird stewardship account for the Garry oak ecosystems of southwestern British Columbia. Garry Oak Ecosystems Recovery Team, Victoria, BC.

This status report is written from current peer reviewed literature and expert interviews. Western bluebirds have been extirpated from the Gulf Islands and southeastern Vancouver Island and there are no records of the birds on Vancouver Island since 1997. The extirpation range overlaps with the location of most Garry oak ecosystems in Canada. Bluebirds nest in secondary cavities and breed in a range of habitat from open woodlands and forests to agricultural areas. Habitat loss is the biggest threat facing this species. Competition for nest sites with native and introduced species including European starlings may have also contributed to the decline of western bluebirds. In the Georgia Basin, western bluebird populations began to decrease at the same time as starlings arrived although these two species currently co-exist in other locations. Because of the large numbers of European starling competitors and limited nest sites, control of this invasive species is recommended as an important component of western bluebird recovery.

Belant, J. L., P. P. Woronecki, R. A. Dolbeer and T. W. Seamans. 1998. Ineffectiveness of five commercial deterrents for nesting starlings. Wildlife Society Bulletin 26 (2): 264-268.

Authors' abstract: We evaluated the effectiveness of phenethyl alcohol (PEA), eyespots, magnetic fields, and avian-predator effigies to deter European starlings (*Sturnus vulgaris*) from nesting in artificial cavities in Ohio during 1993, 1995, and 1996. Each year, 81 nest boxes attached to utility poles were assigned at random equally among 3 treatments (including control): 1993-PEA or eyespots, 1995-magnetic fields of 88 or 118 gauss, and 1996-great horned owl or merlin effigy. Starlings nested in 84% (1993), 58% (1995), and 90% (1996) of the boxes. There was no difference (P gtoreq 0.13) among treatments each year in 6-7 measures of starling nesting activity. Four species other than starlings (eastern bluebirds (*Sialia sialis*), house wrens (*Troglodytes aedon*), tree swallows (*Tachycineta bicolor*), and house sparrows (*Passer domesticus*)) occupied 13 (1993), 23 (1995), and 2 (1996) nest boxes. We conclude that PEA, eyespots, magnetic fields ltoreq 118 gauss, and avian-predator effigies are ineffective as deterrents for starlings nesting in artificial cavities.

Belant, J. L., T. W. Seamans, S. W. Gabrey and R. A. Dolbeer. 1995. Abundance of Gulls and Other Birds at Landfills in Northern Ohio. American Midland Naturalist 134 (1): 30-40.

Authors' abstract: We estimated the abundance of birds at three landfills in northern

Ohio from May 1991-July 1992 recording 699,350 individuals of 42 species. Gulls (*Larus* spp.) comprised 94.5% of the birds recorded followed by European starlings (*Sturnus vulgaris*, 5.0%) and turkey vultures (*Cathartes aura*, 0.3%). Gulls were primarily of two species, ring-billed (*L. delawarensis*, 74.49%) and herring (*L. argentatus*, 25.50%). The mean number of gulls per observation during July-January was at least five times the mean number observed during other months. The combined monthly mean number of gulls at the three landfills peaked in August (gt 4000 birds), with gulls virtually absent in February. Total numbers, species composition and age composition of gulls varied seasonally in response to breeding, foraging and migratory behavior of local and regional populations. More than 98% of gulls observed were recorded on or within 30 m of the ground. A mean of one +- 17 (SD) gulls per observation were observed soaring at gt 300 m elevation over the landfills. Species composition and seasonal abundance of birds varied considerably among the three landfills, even though they were operated similarly and were in close proximity to each other. To adequately assess the use of landfills by gulls and other birds, studies lasting gtoreq 1 year are required. Furthermore, the results from one landfill cannot necessarily be extrapolated to other landfills in the same region.

Berube, C. 2002. *Personal communication.* Ministry of Water, Land and Air Protection, Nanaimo, BC.

Permits will not be granted for the chemical control of European starlings except where they pose a serious health hazard. The hazard must be certified by the Workers' Compensation Board or the Health Board and all other suitable control methods must be tried first. Stupefying baits such as Alphachloralose are not available in Canada.

Blackwell, B. F., G. E. Bernhardt and R. A. Dolbeer. 2002. Lasers as nonlethal avian repellents. Journal of Wildlife Management 66 (1): 250-258.

Authors' abstract: Lasers have been demonstrated to be potentially effective avian repellents; however, studies combining adequate controls and replication that test such applications of lasers in wildlife management have not been reported. We conducted 2-choice cage tests to quantify the effectiveness of a 10-mW, continuous-wave, 633-nm laser as a visual repellent (treating a perch) against brown-headed cowbirds (*Molothrus ater*) and European starlings (*Sturnus vulgaris*), and a 68-mW, continuous- wave, 650-nm laser in dispersing (i.e., targeting birds with the laser) starlings and rock doves (*Columba livia*) from perches and Canada geese (*Branta canadensis*) and mallards (*Anas platyrhynchos*) from grass plots. All experiments were conducted under low ambient light (ltoreq3 1x) conditions. In 3 experiments with stationary and moving laser beams treating a randomly selected perch, brown-headed cowbirds were not repelled. Similarly, a moving beam did not repel European starlings from treated perches or cause them to disperse when targeted. Rock doves exhibited avoidance behavior only during the first 5 min of 6 80-min dispersal periods. Notably, 6 groups of geese (4 birds/group) exhibited marked avoidance of the beam during 20-min periods (n = 23), with a mean 96% of birds dispersed from laser-treated plots. Six groups of mallards (6 birds/group) also were dispersed (x = 57%) from treated plots during 20-min periods (n = 12), but habituated to

the beam after approximately 20 min. We contend that lasers will prove useful as avian repellents, but further controlled studies are needed to evaluate species-specific responses relative to laser power, beam type, wavelength, light conditions, and captive versus field scenarios.

Cabe, P. R. 1993. European Starling (*Sturnus vulgaris*). The Birds of North America, No. 48 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA and The American Ornithologists' Union, Washington, D.C.

This paper cites numerous peer reviewed papers and provides an extensive review of North American research on European starlings. The paper suggests that starlings are probably the most successful bird introduction to North America; the current population of 200 million birds across the continent is derived from only 80-100 individuals. After their introduction, there was a time lag of about 10 years before starlings began to quickly expand their range. Winter range expansion preceded the establishment of breeding populations and the range may still be increasing. General species description and distribution is the same as referenced elsewhere. Some populations of starlings are migratory and others are not and there is also migratory variation within populations and even between nestmates. Starlings migratory behaviour may have helped facilitate their rapid range expansion. Starlings can occupy a wide range of habitat but require open areas with short vegetation in addition to other food sources, nest cavities and water. They are generally not found in undisturbed, non-grassland areas. Starlings are opportunistic feeders; diet includes invertebrates, fruits, berries, cereals, seeds, garbage and livestock feed. During the late summer, fall and winter, starlings feed in large groups; the groups are smaller during the spring and summer. Starlings need to eat between 50-60 kcal/day. Resident males begin competing for nest sites in winter and migratory males begin in February or March. Nest construction begins by late March in Vancouver, British Columbia. Females choose males in part due to their nest sites. Nest sites, nest construction, egg size and colour, incubation, hatching, parental care and development of the young is as described in other references. Starlings have been known to live up to 21 years of age. Adult mortality ranges from 33-77% and juvenile mortality ranges from 55-65%. Starlings are host to a broad variety of diseases and parasites - other references provide examples of the infections and pests that are most transmissible to humans and other animals. Starlings quickly become accustomed to disturbances and other controls such as shooting, trapping and pesticides are listed as ineffective for long-term control. The paper also summarizes results from extensive general biological studies that use starlings as a study subject. The details on systematics, energetics, vocalizations, locomotion, self-maintenance, displays and moulting are not directly relevant to Garry oak ecosystems and are not summarized here.

Cabe, P. R. 1999. Dispersal and population structure in the European Starling. Condor 101 (2):451-454.

Author's abstract: Dispersal in birds can be estimated in several ways, including the use of banding data and the indirect use of genetic data. This study uses both of these to estimate dispersal and genetic population structure in the European Starling (*Sturnus*

vulgaris) in North America. Banding data imply that natal dispersal is quite high, and this finding is supported by the observed rapid colonization of North America. Genetic data, based on allozyme allele frequencies from populations in Virginia, Vermont, Colorado, and California, are consistent with a species with large demes and high rates of dispersal.

Cabe, P. R. 1998. The effects of founding bottlenecks on genetic variation in the European starling (*Sturnus vulgaris*) in North America. Heredity 80 (4): 519-525.

Author's abstract: Genetic variation in European starlings in North America was examined using enzyme electrophoresis and compared to that in their home range. The effect of the founding bottleneck matched theoretical predictions. Heterozygosity was unaffected, whereas allelic diversity may have decreased. Results from this study and others suggest that theoretical predictions of bottlenecks are robust for allozyme data, and applicable under a wide variety of conditions.

Campbell, R. W., N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, G. W. Kaiser, M. C. E. McNall and G. E. Smith. 1997. The Birds of British Columbia, Volume 3: Passerines (Flycatchers through Vireos). UBC Press, Vancouver, BC.

This is the most comprehensive reference available for our region and it is based on a comprehensive review of peer reviewed literature and provincial observations. The detailed range map includes breeding and nonbreeding chronology for the province. European starlings are listed as very common to very abundant in the Georgia Depression. They occur and breed throughout the Canadian range of Garry oak ecosystems. Starlings were first sighted in British Columbia in 1945 (only two years after the first sighting in Washington) and in Victoria in 1951. Starling habitat is closely linked to human habitation and the Georgia Depression has the densest winter population in the province. Starlings are generally not found in dense forests. At night, starlings roost in trees or buildings and during the day they move to other areas to feed. In April, the majority of starlings in the Georgia Depression leave for other breeding grounds. Nest sites are often associated with human habitation and are usually next to a source of water. Starlings will nest in nest boxes, cavities, buildings and other human-made structures. Nests are built from plant materials, feathers and a variety of found objects. Peak breeding time in the Georgia Depression is late April. Clutch size in the province ranges from 1-8 with an average of 3-4 eggs. Incubation time in British Columbia is 10-13 days. Starlings nest in cavities that are also used by native bluebirds, swallows, martins, wrens, kestrels, owls, buffleheads, goldeneyes, wood ducks and woodpeckers. Starlings will usurp the nest sites of native species but further research is needed to determine the full impact of starlings on these species. In the Georgia Depression, starlings are preyed on by Cooper's hawks and peregrine falcons. Starlings roost communally during the winter and flocks of up to 7,500 have been recorded in Victoria. Roosting starlings cause problems due to the sheer amount of their droppings, excessive noise and the potential for spreading diseases. Attempts to reduce their numbers have not been effective because they rapidly emigrate from adjacent areas. Scaring techniques only move the problem to another location. The best long-term solution is to exclude starlings from nest sites and roost areas. The best control option for roosting starlings seems to be a combination of

modifying habitat, enclosing and covering roost sites and using a broad range of scaring devices.

Chilvers, B. L., P. E. Cowan, D. C. Waddington, P. J. Kelly and T. J. Brown. 1998. The prevalence of infection of *Giardia* spp. and *Cryptosporidium* spp. in wild animals on farmland, southeastern North Island, New Zealand. International Journal of Environmental Health Research 8 (1): 59-64.

Authors' abstract: *Giardia* spp. cysts were detected in the faeces of 23.6% of 76 possums (*Trichosurus vulpecula*), 42.1% of 19 ship rats (*Rattus rattus*), 30.5% of 46 house mice (*Mus musculus*), 33.3% of 6 hedgehogs (*Erinaceus europaeus*), 33.3% of 3 ferrets (*Mustela furo*), 20% of 5 rabbits (*Oryctolagus cuniculus*), 35% of 20 blackbirds (*Turdus merula*), 50% of 14 thrushes (*Turdus philomelos*), 15.4% of 104 sparrows (*Passer domesticus*), 60% of 10 chaffinches (*Fringilla coelebs*), and 14.3% of 14 hedge sparrows (*Prunella modularis*) trapped on two farms in the Dannevirke area, southeastern North Island, New Zealand. *Cryptosporidium* cysts were detected in 12.8% of 39 possums, 37.5% of 8 ship rats, 11.8% of 17 house mice, 8.2% of 61 house sparrows, 21.4% of 14 thrushes and 1 of 2 starlings (*Sturnus vulgaris*) from the same area. Although one of the two farms had a history of human *Giardia* infection, no significant differences were found between the prevalence of *Giardia* in wild animals on the farms. There was a significantly lower prevalence of *Cryptosporidium* than *Giardia* in the wild animals tested. The role of wild animals in maintaining and spreading *Giardia* and *Cryptosporidium* in New Zealand is discussed.

Chow, J. 2000. *Sturnus vulgaris*: European starling. Website maintained by the Universityof Michigan. Website: animaldiversity.ummz.umich.edu/
Accessed: November 23, 2002.

The website provides background information on the range, description and life history of European starlings. The site is designed to be used for college students and uses limited references, none of which are peer reviewed. Starlings are native to Eurasia and have since spread globally except through the Neotropics (other references include North Africa as a wintering location in the native range). Species description is the same as detailed in other references. Starlings feed on seeds, fruit, vertebrates and invertebrates including earthworms and insects. The breeding season in the northern hemisphere is listed as spring to early summer. Starlings can have 3 clutches of approximately 5 eggs each. Incubation by the females lasts about 11 days. Starlings compete with native birds such as wrens, swallows and bluebirds for nest cavities. Starlings are often found in large flocks during breeding, feeding and roosting. Starlings are listed as a positive agricultural pest control and as a potential food source for Mediterranean peoples. However, their pest control is of limited value because, as indicated on the site, the starlings will eat the crops and well as the pests. Starlings are also known to spread diseases and be sucked into airplane engines causing engine malfunction.

Clark, L., B. Bryant and I. Mezine. 2000. Bird aversive properties of methyl anthranilate, yucca, *Xanthoxylum*, and their mixtures. Journal of Chemical Ecology 26

(5): 1219-1234.

Authors' abstract: We tested the bird aversive properties of methyl anthranilate, yucca extracts, and *Xanthoxylum* spp. extracts in one- and two-bottle drinking assays that used European starlings (*Sturnus vulgaris*). In one- and two-bottle tests, methyl anthranilate proved to be the more potent stimulus in producing an avoidance response. Starlings avoided consuming *Xanthoxylum* and yucca only in the two-bottle tests. Previous studies showed that yucca was a good adjuvant in stabilizing lipophilic compounds in water. Starlings did not avoid binary mixtures of methyl anthranilate and yucca differently from what would be expected if they were only responding to the solution's methyl anthranilate content. However, yucca enhanced the aversive qualities of *Xanthoxylum*. The ability to identify mode of action for repellency and synergistic combinations of chemicals derived from natural products for use in repellent mixtures is an important aspect of the development of cost- effective, environmentally safe repellents for use in conflict resolution between humans and wildlife.

Clark, L. 1997. Dermal contact repellents for starlings: Foot exposure to natural plant products. Journal of Wildlife Management 61 (4): 1352-1358.

Author's abstract: Identification and formulation of contact repellents are needed to prevent nuisance birds from roosting on architectural structures. In this study I showed the feet of starlings (*Sturnus vulgaris*) to be viable routes of exposure for contact dermal irritants, and that starlings will avoid perches treated with such irritants. In one experiment, starlings became agitated and hyperactive after their feet were immersed in 5% oil extracts of the spices cumin, rosemary and thyme, demonstrating that dermal exposure to chemicals could alter behavior. In a second experiment, I painted perches with pure compounds of plant origin (1% wt/wt). Starlings avoided perches treated with either R-limonene, S-limonene, and beta-pinene. The carbamate pesticide, methiocarb, was also a good dermal repellent. None of the extracts or compounds indicated that exposure resulted in illness for the dosages given and the delivery system tested. These results suggest that development of a nonlethal contact repellent for nuisance bird control may be feasible.

Copley, D., D. Fraser and C. J. Finlay. 1999. Purple Martins, *Progne subis*: A British Columbian success story. Canadian Field-Naturalist 113 (2): 226-229.

Authors' abstract: The limited historical data appear to indicate that in the late 1800s and early 1900s, Purple Martin populations were limited to southern Vancouver Island from north of Campbell River south to, and including, Victoria as well as the western Fraser valley on the mainland. With the arrival of the House Sparrow, *Passer domesticus*, martin numbers appeared to suffer a decline. By the late 1940s there were only a few scattered colonies that persisted. Habitat loss (dead snag and piling removal) began to play a major role, and this, combined with an increase in the European Starling, *Sturnus vulgaris*, population, resulted in a further population decline. By 1983, known martin nests in British Columbia were fewer than six. In 1985, concerned individuals began installing nest boxes. Just over a decade later the Purple Martin population in British Columbia has

grown to 146 pairs recorded in 1998.

Cooke, M. T. 1928. The spread of the European starling in North America (to 1928). United States Department of Agriculture, Circular No. 40 (1928). Available online at: www.wku.edu/~smithch/biogeog/COOK1928.htm Accessed: January 15, 2002.

This historical document provides a detailed description of the range expansion of European starlings in North America by carefully chronicling introduction attempts and dates when the birds were first sighted. The native distribution is listed as Eurasia with wintering grounds in northern Africa. At the time of publication, introduced starlings ranged from the Atlantic coast to the Mississippi River which was a doubling of the range from 4 years earlier. The earliest attempts to introduce starlings to North America are listed as before 1850 to West Chester, PA and then again to Cincinnati, Ohio between 1872 and 1873. These introduced birds did not survive. The species first became established in North America in 1890 when 80 birds were released to New York City. The first date they were sighted in Canada was 1919. The site provides insight into dispersal mechanisms of the early introductions.

Dall, S. R. X., I. C. Cuthill, N. Cook and M. Morphet. 1997. Learning about food: Starlings, Skinner boxes, and earthworms. Journal of the Experimental Analysis of Behavior 67 (2): 181-192.

Authors' abstract: Despite its importance as a tool for understanding a wide range of animal behavior, the study of reinforcement schedules in the laboratory has suffered from difficulties in the biological interpretation of its findings. This study is an operant-laboratory investigation of the ability of European starlings, *Sturnus vulgaris*, to learn to respond adaptively to the problem of foraging on patchily distributed prey that are uncertainly located in space. In order to maximize the biological relevance of the laboratory study, variation in the aggregation of earthworms, *Lumbricus terrestris* (a prey species), was rigorously quantified from the field, and the experimental birds were presented with reinforcement schedules designed to represent the extremes of the observed variation. The results demonstrate that, even for a single prey species, the degree to which individuals are aggregated can vary markedly over a range of spatial scales, and that starlings can rapidly learn to respond, in an adaptive manner, to these variations. These findings suggest that starlings are capable of adjusting their behavior to facilitate the efficient exploitation of prey that occurs in patches of an uncertain nature, and thus illustrate the heuristic value of an ecologically informed operant-laboratory approach to studying foraging behavior.

Dall, S. R. X. and I. C. Cuthill. 1997. Searching in patches by European starlings, *Sturnus vulgaris*. Behavioural Processes 39 (2): 149-159.

Authors' abstract: Despite the importance of within-patch search for predicting optimal patch-leaving strategy, little experimental effort has been devoted to the study of this foraging behaviour. In addition, predators' strategic responses to variability in features like the within-patch distribution of prey can have important consequences for their

dietary decisions. We therefore analyse the search paths of European starlings, *Sturnus vulgaris*, foraging individually in artificial patches that vary in the spatial distribution of buried prey in an outdoor aviary. The results demonstrate that the birds are searching differently depending on the order in which the experimental patch-types are experienced. We speculate that where the spatial predictability of prey is initially high the birds adopt a fixed search rule that results in area- concentrated search once a prey item is found, and performs well for both distributions encountered. However, where the predictability is initially low a more flexible strategy is adopted that results in increased area-concentrated search with experience of a patch type, independent of the actual within- patch distribution of prey. These findings suggest that starlings can use distinct strategies for different prey types, but they are classifying these types on subjective criteria that are difficult to predict from a priori reasoning.

Day, T. D. 1995. Bird species composition and abundance in relation to native plants in urban gardens, Hamilton, New Zealand. Notornis 42 (3): 175-186.

Author's abstract: During a census in gardens in Hamilton, 71.8% of the 4428 birds observed belonged to introduced species. A total of 15 species were observed. Bird species richness was positively correlated with native plant biomass and, more strongly, with total plant biomass. More birds were present in gardens with more native plants. Among the most common species, the abundance of the House Sparrow (*Passer domesticus*) decreased with increasing percentage of native plants, the Silvereye (*Zosterops lateralis*) increased, while Blackbirds (*Turdus merula*) and Starlings (*Sturnus vulgaris*) showed no significant change. This was typical for all other introduced bird species. Most other birds, including the Fantail (*Rhipidura fuliginosa*) and the Grey Warbler (*Gerygone igata*), were most abundant in gardens with higher native plant biomass. Notable was the absence of the Tui (*Prosthemadera novaeseelandiae*) from all censused areas in Hamilton at the time of observation. No significant variation between morning and evening samples was noted.

Dinsmore, J. J. 2001. Invasive birds in Iowa: Status, problems, and threats. Journal of the Iowa Academy of Science 108 (4): 212-220.

Author's abstract: A total of 18 invasive bird species has been introduced into or have expanded their range to include Iowa. These include ten non-North American species, one North American species that has been displaced and now is established in Iowa, and seven native species that have been released to re-established Iowa populations. Twelve of those are regularly occurring species in Iowa, and they comprise 3.0% (12 of 404) of the species known from Iowa and 5% (10 of 199) of Iowa's nesting avifauna. These percentages are similar to those found in neighboring states. Several more species are likely to become established in the near future. Two invasive species, European Starling (*Sturnus vulgaris*) and House Sparrow (*Passer domesticus*), are among the most numerous species found in Iowa and have negative effects on other species. Most of the older invasive bird species seem to have little effect on other bird species. Two species, Mute Swan (*Cygnus olor*) and Eurasian Collated-Dove (*Streptopelia decaocto*), are close to becoming established in Iowa. Both have the potential to be harmful to other bird

species.

Dobkin, D. S., A. C. Rich, J. A. Pretare and W. H. Pyle. 1995. Nest-site relationships among cavity-nesting birds of riparian and snowpocket aspen woodlands in the northwestern Great Basin. Condor 97 (3): 694-707.

Authors' abstract: We examined nest-site and nest-cavity characteristics for six species of cavity-nesting birds in montane riparian and snowpocket aspen (*Populus tremuloides*) woodlands in the northwestern Great Basin. Live trees and snags with DBH gt 24 cm were favored as nest sites by all species. Red-naped Sapsuckers (*Sphyrapicus nuchalis*) and Northern Flickers (*Colaptes auratus*) provided different sizes of nest cavities for a suite of nonexcavator species. Flickers preferentially nested in snags; sapsuckers nested primarily in live trees, but used live trees and snags in proportion to their availabilities. Relative abundances of excavators and nonexcavators were associated positively with numbers of cavities. Nest-site variables overlapped extensively among species; Tree Swallows (*Tachycineta bicolor*) relied heavily on sapsuckers for provision of nest cavities, European Starlings (*Sturnus vulgaris*) and Mountain Bluebirds (*Sialia currucoides*) primarily used flicker-excavated cavities, and House Wrens (*Troglodytes aedon*) used nest cavities across the broadest range of nest-site characteristics. Compass orientation of nest-cavity entrances was strongly bimodal, with most facing east or southwest. Cavity entrances of species that foraged largely outside of riparian woodlands were oriented toward woodland edge, in contrast to nest cavities used by species that foraged largely within riparian woodlands. Snowpocket woodlands were much more extensive than riparian aspen, but birds strongly preferred riparian aspen stands as nesting habitats, presumably due to the scarcity of large aspen in snowpockets. Nest cavities appear to be a limiting resource with high potential for interspecific nest-site competition in these woodlands. Decades of livestock overuse and fire suppression have greatly diminished the availability of large aspen in riparian habitats throughout the region.

Dolenec, Z. 2001. Correlations between egg characteristics and laying order in the starling (*Sturnus vulgaris*) in NW Croatia. Natura Croatica 10 (1): 11-17.

Author's abstract: This article analyses the effect of body weight and wing length of female starlings on clutch size as well as the effect of laying order on egg size. Egg length averaged 29.43 mm, egg breadth 21.32 mm, egg volume 6829 mm3, egg weight 6.92 g and egg shape index 1.38. There was no significant relationship between female body weight and clutch size and egg size ($p>0.05$). The same can be applied to the female wing length. A statistically significant positive correlation was found between mean egg volume and egg length ($r=0.68$; $p<0.001$; $n=48$) as well as egg breadth ($r=0.87$; $p<0.001$; $n=48$), egg length and egg shape index ($r=0.81$; $p<0.001$; $n=48$), whereas a statistically significant negative correlation was observed between egg breadth and egg shape index ($r=-0.38$; $p<0.01$; $n=48$). Generally, the laying order did not affect egg volume. According to the value of %D=-1.8 and the coefficient of egg weight variation (CV=9.39%) starlings follow the brood reduction strategy. The value of %D can be obtained by calculated the percentage of final egg volume in relationship to mean egg volume of the whole clutch (SLAGSVOLD et al., 1984).

Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The birder's handbook: a field guide to the natural history of North American birds. Simon & Schuster Inc., New York, NY.

This field guide provides detailed life history and ecology of the species. European starlings were introduced to New York City in 1890-1891. Starlings occupy a wide range of habitats including fields, woodlands, residential and urban areas. Both the males and females build nests in any available cavity in buildings or in trees up to 25 feet high. They compete with bluebirds and other secondary cavity nesters. The birds will nest in colonies. Starlings have 2-3 broods with an average of 4-6 eggs and the females will lay eggs in the nests of other species. Eggs are pale bluish or greenish white in colour and flecked with brown. Both sexes incubate the eggs for 12-14 days and the young are altricial. Starlings eat a range of invertebrates including insects, fruit and seeds.

Ferguson, R. N. and D. R. Drake. 1999. Influence of vegetation structure on spatial patterns of seed deposition by birds. New Zealand Journal of Botany 37 (4): 671-677.

Authors' abstract: The bird-disseminated species in the seed rain and the soil seed bank were sampled on Mana Island, New Zealand, to assess the importance of communally roosting starlings (*Sturnus vulgaris*) as seed dispersers. Density and species composition of dispersed seeds were compared between forested sites and grassland, representing potential perch sites and non-perch sites, respectively, to determine the influence of vegetation structure on deposition patterns of bird-dispersed seeds. Mean density of bird-dispersed seeds falling in forest was 3742 +- 914 seeds m-2 compared with 7.7 +- 1.0 seeds m-2 in grassland. This enormous disparity was reflected in the seed bank, with mean densities of 86 852 +- 16 579 and 883 +- 189 seeds m-2 for forest and grassland sites, respectively. Species richness in forest ranged from 3 to 23 species 0.25 m-2 for the seed rain, and from 1 to 19 species 0.002 m-2 for the seed bank. Relative abundance of most species differed between the seed rain and seed bank. The seed rain was dominated by native woody species (66.9% relative density of identified species); alien species comprised 26.6%. Native woody species were proportionally less important in the seed bank (51.1%) which was instead characterized by an increased proportion of alien species (45.3%), some of which may have persistent seed banks. The potential role of frugivorous birds in facilitating succession from grassland to native forest may be inhibited by a lack of dispersal of native seeds into grassland areas, and by the longevity of seeds of alien species in the soil.

Gammon, D. E. and B. A. Maurer. 2002. Evidence for non-uniform dispersal in the biological invasions of two naturalized North American bird species. Global Ecology and Biogeography 11 (2): 155-161.

Authors' abstract: Most previous attempts to model the geographical range expansion of an invading species assume random dispersal of organisms through a homogeneous environment. These models result in a series of uniformly increasing circles radiating out from the centre of origin over time. Although these models often give reasonable fits to

available data, they do not typically include mechanisms of dispersal. Alternatively, models that include assumptions of non-random dispersal and a heterogeneous environment inevitably results in an anisotropic or jagged invasion front. This front will include propagules of pioneer individuals for the expanding species. Existing data from biological invasions reveal that the spatial structure of an invading species usually exhibits these propagules. Using population data gathered from the past century, we investigated the propagules of two North American invading bird species: the European starling (*Sturnus vulgaris* Linnaeus), and the house finch (*Carpodacus mexicanus* Muller), and found a correlation between propagule location and habitat quality. These results suggest that dispersing individuals seek out favourable habitat and remain there, thus introducing a possible mechanism for explaining non-uniform dispersal during invasions. When combined with results from other studies, our results suggest that propagules provide starting points for future population expansion of an invading species.

Gering, J. C. and R. B. Blair. 1999. Predation on artificial bird nests along an urban gradient: Predatory risk or relaxation in urban environments? Ecography 22 (5): 532-541.

Authors' abstract: Urbanization - the anthropogenic conversion of natural ecosystems into human-dominated ecosystems - has occurred on global scales. The human-dominated landscape presents particular challenges to researchers because the effects of urbanization on ecological processes are not well understood. We investigated the influence of urbanization on predation by conducting an artificial nest experiment along an urban gradient of six sites ranging from natural to urbanized ecosystems. Previous hypotheses suggest that predation pressures in urban environments will either 1) increase because of the high abundance of exotic species which act as predators or 2) decrease due to the lack of natural predators. To determine relative predation pressures among sites along the urban gradient, we monitored the fates of 16 artificial avian nests at each of the six sites for a total of 96 nests in each year (1996, 1997). We analyzed the dependency of nest fate (depredated or undisturbed) on intensity of urbanization (sites along the urban gradient), nest height (ground, above-ground), and year using loglinear models. The frequency of nest predation was strongly dependent on site along the urban gradient, indicating that urbanization intensity was an important determinant of nest fate. Predation pressure exhibited an overall decline from natural to urban sites in both years, suggesting that urban environments have low predation pressures relative to natural areas. The predatory relaxation in urban environments may partially explain the greater abundance of some species in urban environments, particularly urban exploiters such as european starlings *Sturnis vulgaris*, house sparrows *Passer domesticus*, and rock doves *Columba livia*.

Gilkeson, L. A. and R. W. Adams (eds.). 1996. Chapter 11: Birds. In: Integrated Pest Management Manual for Structural Pests in British Columbia. Ministry of Environment, Lands and Parks, Victoria, BC. Available online at: wlapwww.gov.bc.ca/epd/ipm/docs/chap11.html Accessed: December 10, 2002

This training manual and reference was designed to guide pest managers and their clients

in dealing with invasive species and to promote the use of integrated pest management strategies that focus on prevention. The manual does not provide complete prescriptions but instead is designed as a lesson plan complete with study questions and a step by step approach to identify, monitor, prevent and control starlings and pigeons. Starlings often nest in inaccessible cavities which makes them difficult to remove once established. Nuisance birds should be carefully monitored to determine their favourite roost spots and to determine whether action is required. Action may only be necessary due to high numbers or high sensitivity of the site they are occupying. The best control option is to prevent roosting and nesting by using bird barriers (wire mesh screen, wire prongs or spikes, steel wires) and to eliminate food sources. Nets that can also trap native birds should not be used. Preferred control options move starlings to another area by using startle devices (recorded distress calls, propane cannons) or predator mimics (helium balloons with eyespots, raptor effigies) although these techniques quickly lose their effectiveness as the birds become accustomed to them. Population controls include trapping. The recommended euthanasia method is to break the birds' necks. The pesticide Avitrol is available only under a pesticide use permit when the birds are considered a serious nuisance or a workplace hazard.

Gregory, R. D. and S. R. Baillie. 1998. Large-scale habitat use of some declining British birds. Journal of Applied Ecology 35 (5): 785-799.

Authors' abstract: 1. Large-scale habitat use of eight species of breeding birds was considered using data collected across Britain. The species were skylark *Alauda arvensis* (L.), dunnock *Prunella modularis* (L.), blackbird *Turdus merula* (L.), song thrush *Turdus philomelos* (L.), starling *Sturnus vulgaris* (L.), linnet *Carduelis cannabina* (L.), bullfinch *Pyrrhula pyrrhula* (L.) and reed bunting *Emberiza schoeniclus* (L.). All are linked by roughly synchronous population declines over the last 25 years in southern Britain (and mostly in farmland landscapes). Discussion is limited to the conservation status of these species. 2. Breeding densities were estimated for broad habitat types and these were used to estimate population sizes within habitat types. Confidence limits on the estimates were derived using a bootstrap procedure. 3. For most species considered, farmland holds a high proportion of their population (in excess of 50% for four species), reflecting the predominance of this land use across Britain. This suggests that sympathetic changes in farming practices are likely to provide the best mechanism for improving the status of these species. 4. Substantial proportions of particular species occur outside farmland, but different species occur in different habitats. A considerable proportion of skylarks occur on upland moor, bullfinches in wooded habitats, and reed buntings in riparian habitats. Conservation of this group of species thus requires appropriate management of the wider countryside, including their main habitats. 5. Habitats associated with human habitation hold > 20% of the British populations of blackbird, song thrush and starling, and considerable numbers of other species. The management of parks, gardens and other 'green space' may have an important impact on their populations and should not be neglected by conservationists.

Gwinner, H. 1997. The function of green plants in nests of European starlings (*Sturnus vulgaris*). Behaviour 134 (5-6): 337-351.

Author's abstract: European starlings add fresh green plants to their dry nest material. Male starlings of our 60-nest-box colony carried 68 different plant species into their nests. Some males were polygynous and had 3-6 clutches, others were monogynous and had 1-2 clutches per reproductive season. The 'nest protection hypothesis' proposes that insecticidal compounds in green plants reduce the parasite load of the nests. The 'courtship hypothesis' predicts that carrying nest greenery is a courtship activity to attract females. The aim of this study was to collect field data suitable for distinguishing these two hypotheses. 1. Some plant species occurred more often in the nest-boxes than expected from their frequency in the nest-box environment. A significant number of these preferred plants were rich in volatiles, some of which are said to be insecticidal. But volatiles could also attract females and/or influence their breeding activity and the chicks' development directly. 2. The males carried greenery into their nest boxes maximal around 5 days before the onset of laying, when pair formation took place, and ceased this behaviour with egg deposition. The total amount of greenery deposited in a nest- box was a function of the number of days of courtship a male needed to attract a female. 3. Polygynous males deposited the same amount of greenery in their first nest as monogynous males. In additional nests polygynous males deposited more greenery. However, this was due to the fact that these additional nests were advertised for a longer time. 4. Nest- boxes used again for replacement broods (after clutch loss) or second broods (after fledgling of the 1st brood) in May contained fewer green plants than newly occupied nest-boxes at the same time, although according to the nest protection hypothesis re-used nests should contain more parasites. 5. Apart from green plants males also carried 'ornaments' such as flowers, pieces of bark, lichens, large feathers and human artifacts into their nests. There was a tendency of polygynous males to have a higher proportion of ornaments in their nests than monogynous males.

Ingold, D. J. 1996. Delayed nesting decreases reproductive success in Northern Flickers: Implications for competition with European starlings. Journal of Field Ornithology 67 (2):321-326.

Author's abstract: I monitored 31 pairs of Northern Flickers (*Colaptes auratus*) during five nesting seasons in east-central Ohio in order to determine the effects of time and harassment by European Starlings (*Sturnus vulgaris*) on reproductive output. Since flickers have proved to be highly vulnerable to competition with starlings for nest sites, flicker pairs are often forced to delay nesting until later in the season. If flicker reproductive success drops as the nesting season progresses, it is likely that flickers that loose nest cavities to starlings early in the season will produce fewer offspring than those which do not. Flicker clutch size for clutches completed before 1 June (early clutches), by which time most females that had not lost cavities to starlings had completed their initial clutches, was significantly larger than clutch size for clutches completed after 1 June (late clutches). Flicker nestling and fledgling numbers from early clutches were also significantly greater than those from late clutches. Flicker clutch size and number of fledglings were negatively correlated with date. Since at least 58% of flicker pairs that delayed clutch completion until after 1 June were forced to delay by starlings, their reductions in fecundity can be attributed to competition with starlings.

Ingold, D. J. 1998. The influence of starlings on flicker reproduction when both naturally excavated cavities and artificial nest boxes are available. Wilson Bulletin 110 (2): 218-225.

Author's abstract: I monitored 54 pairs of Northern Flickers (*Colaptes auratus*), with artificial nest boxes placed near their nest cavities, during three breeding seasons in Ohio to determine whether such boxes would help reduce nest-site competition by European Starlings (*Sturnus vulgaris*). Twenty-seven of 40 flicker pairs in the presence of starlings (68%) lost a total of 42 cavities to starlings in spite of the presence of a nearby flicker nest box, and nine of these pairs lost two or more cavities to starlings. Thus, the presence of nest boxes did not appear to help nesting flickers and in fact may have deterred them by attracting additional starlings. During initial nest attempts, flicker pairs without starlings produced larger clutches, more nestlings and more fledglings than flickers with starlings. Flicker pairs without starlings were not adversely affected by the presence of a nearby nest box and 64% of such pairs eventually fledged young from their excavated nest cavities. Conversely, no pairs without starlings and only one pair with starlings opted to nest in a nest box versus their excavated or renovated nest cavity. Only 3 of 40 starling pairs opted to nest in a box when excavated flicker cavities were available. However, starlings eventually fledged young in only 9 of the 42 flicker cavities they usurped (21%).

Jenkins, A. R. and G. M. Avery. 1999. Diets of breeding Peregrine and Lanner Falcons in South Africa. Journal of Raptor Research 33 (3):190-206.

Authors' abstract: The diets of breeding Peregrine (*Falco peregrinus*) and Lanner (*F. biarmicus*) Falcons in South Africa were determined from the analysis of prey remains collected at nest sites and through direct observations to determine the regional variation in Peregrine Falcon prey and to measure diet overlap, and the potential for competition between Peregrine Falcons and sympatric congeners. Direct observations suggested that remains under-sampled small prey by about 10% and over-sampled large prey by about 8%. Peregrine and Lanner Falcons preyed mostly on birds. Pigeons and Streptopelia doves comprised the bulk (38- 66% by frequency; 68-85% by mass) of the Peregrine Falcon prey in each of three study areas. Columbids were supplemented by starlings (mostly European Starling (*Sturnus vulgaris*)) on the Cape Peninsula, sandgrouse (*Pterocles* spp.) and swifts (*Apus* spp.) on the Orange River, and mousebirds (*Colius* spp.) in the Soutpansberg. Cape Peninsula Peregrine Falcons had the least diver se diet, the narrowest feeding niche and they took the largest proportion of juvenile birds. Peregrine Falcons on the Orange River had the broadest feeding niche and preyed mainly on 'commuter' species rather than sedentary residents. Lanner Falcons in the Soutpansberg took mainly terrestrial or cursorial species, particularly young chickens (*Gallus gallus*, 40%; 37%) and charadriids, but columbids were also important. The diets of sympatric Peregrine and Lanner Falcons overlapped by about 35%. Peregrines Falcons concentrated their foraging on woodland and cliff-dwelling prey, while Lanner Falcons took mainly open-country species. Close-neighboring pairs of congeners did not obviously affect the food-niche parameters of either species suggesting that they were not actively competing

Johnson, R. J. and Glahn, J. F. 1998. Starling management in Agriculture: Nebraska Cooperative Extension NCR 451. Website: www.urbanwildlifesociety.org/UWS/BrdCtrl/StrlgCntrlUoNE.htm#damage. Accessed: November 22, 2002.

This website is a North Central Regional Extension Publication that involved the cooperation of 8 states and the US Department of Agriculture. This website is a comprehensive resource for identifying the impacts and potential control methods of European starlings from an agricultural perspective. Although references are not included, the publication has been subject to peer review. Johnson and Glahn estimate the starling population in the United States to be 140 million birds. Background information on identification, distribution, habitat and life history of the starling is as described in other references. Starlings are credited for eating pest invertebrates and the site suggests that starlings may play an important future role in integrated pest management. Excluding starlings from buildings and nest sites is the best control measure. Johnson and Glahn provide details for keeping starlings out of buildings, feed bunkers and preventing roosting on buildings. Netting is recommended for protecting fruit crops but netting should not be used in Garry oak ecosystems where it can trap native birds. Remove available food and water, especially during the winter. The site provides numerous suggestions of how best to accomplish this in agricultural areas. Frightening devices (e. g. distress calls, propane cannons, alarms, lights, eye spot balloons, hawk kites, mylar reflective tape) can be used to disperse starlings from roost sites. These devices should be used for 3-4 evenings in a row just as the birds begin to roost. A variety of changing devices may be most effective because starlings quickly become accustomed to the disturbance. Harassment should begin early before the birds become accustomed to roosting at a site and should be persistent. Ultrasonic devices are not effective. Johnson and Glahn suggest trapping is an impractical control although other authors suggest it is effective. Shooting can disperse starlings but is not an effective control. The site also mentions the chemical control "Starlicide Complete" which is not available in British Columbia.

Kern, W. J. 2001. European Starling. Website maintained by the University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences. Website: http://edis.ifas.ufl.edu/UW118. Accessed: November 23, 2002.

The Institute of Food and Agricultural Sciences based at the University of Florida is a federal, state and local government supported program that focuses on research and public extension. Although the website is hosted by a university, the only references provided are two field guides. However, the website is a comprehensive resource for potential control methods for European starlings. The website provides background information on identification, distribution, habitat and life history of the starling as detailed in other references. Many of the impacts are not directly relevant to Garry oak ecosystems including aesthetic concerns, contamination of food and livestock feed, loud noises from the flocks, damage to crops and droppings damaging the finish on vehicles. However, starlings can also damage roost trees and are vectors for a range of parasites

and diseases including mites, stick-tight fleas, soft ticks, bedbugs, dermestid beetles, *Salmonella* food poisoning, *Blastomycosis, Histoplasmosis , Toxoplasmosis, Coccidiosis, Chlamydiosis* , Q Fever, encephalitis, Newcastle disease, poultry fowl pox, swine gastroenteritis, tapeworms, parasitic nematodes and poultry parasitic fluke. These diseases infect livestock but may also be transmitted to humans. Although not mentioned here, some of these diseases may also impact native bird species. The site provides extensive control measures many of which are highly applicable in Garry oak ecosystems. The best control option is to exclude starlings by sealing all potential nest site openings, preventing starlings from accessing food sources such as livestock grain, removing perches from bird houses built for native birds, closing purple martin houses after the martins leave and pruning trees to create more open growth. Kern provides detailed drawings and descriptions of a wide range of trap designs that can be used depending on the number of birds and the situation. Shooting, chemical controls, tactile repellents and/or ultrasonic devices are rarely effective and are not recommended. Sound repellents and scare devices may be effective for short period of time but starlings quickly become used to them.

Liker, A., M. Markus, A. Vozar, E. Zemankovics and L. Rozsa. 2001. Distribution of *Carnus hemapterus* in a starling colony. Canadian Journal of Zoology 79 (4): 574-580.

Authors' abstract: The distribution of the haematophagous fly *Carnus hemapterus* among starling (*Sturnus vulgaris*) broods was investigated in a nest-box colony. Prevalence of infection was 94% among broods and 69% among individual nestlings, while median abundance was 54 flies per brood (range 0-284 flies; n = 33) and 8 flies per individual nestling (range 0-117 flies; n = 140). Parasites exhibited an aggregated distribution among starling broods. *Carnus hemapterus* populations changed significantly during the development of nestlings: fly abundance increased rapidly after nestlings hatched, peaked 5-8 days after hatching, and decreased thereafter. The proportion of winged flies (assumed to be the transmissive form) and the proportion of male flies decreased with increasing nestling mass. Measures of within-colony spatial position of nests were not related to mean brood abundance, proportion of winged flies, or sex ratio of the flies. Parasite abundance did not correlate with mortality rate or growth rate of nestlings. In conclusion, nestling developmental stage was the only significant predictor of variation in *C. hemapterus* populations in this starling colony.

Lindell, C. 1996. Patterns of nest usurpation: When should species converge on nest niches? Condor 98 (3): 464-473.

Author's abstract: The acceptability of a nest to more than one species and the convergence of species on a nest niche is demonstrated through nest usurpation. I compiled examples of nest usurpation from the literature to examine patterns regarding the species and nest sites that tend to be usurped, those species likely to be usurpers, and the habitats in which usurpation occurs. Cavities and enclosed nests are more likely to be usurped than cup nests. Species that excavate or build these types of nests, like the Picidae and the Furnariidae, are likely to be the hosts of usurpers. Particular groups are

prone to usurping nests, including introduced species like the House Sparrow (*Passer domesticus*) and European Starling (*Sturnus vulgaris*). Cavity usurpations were more likely to be observed in temperate than tropical/subtropical zones, and about equally likely to be observed in closed and open habitats, while enclosed nest usurpations were observed more frequently in open than closed habitats, and more often in tropical/subtropical than temperate zones. Usurpation of all nest types is more likely to occur in tropical/subtropical zones than expected, based on the number of studies in the literature conducted in these zones. Usurpation of all nest types is less likely to occur in open, and more likely to occur in moderately open habitats than expected, based on the number of studies in the literature conducted in these habitats. Instances of cavity usurpation, recorded primarily in temperate zones, across a variety of habitats, do not contribute to these general patterns. Nest- site convergence through nest usurpation may be more likely to occur in moderately open tropical habitats because of: 1) the availability of enclosed nests, 2) the limited structural heterogeneity of the vegetation, which limits the possibility of nest-niche partitioning, and 3) the high diversity of potential nest competitors and predators. In such environments, interspecific nesting associations may be a more effective generalized nest defense strategy than using a nest site that is difficult to find.

MacDonald, A. 2002. *Personal communication.* Birder, Victoria, BC.

MacDonald suggests that maintaining habitat for hawks and owls, installing raptor perches and maintaining standing, dead trees, also known as wildlife trees, will encourage the presence of birds of prey and may help control European starling populations. MacDonald also recommends removing potential food sources including introduced berry-producing plants such as English hawthorne (*Crataegus monogyna*) and English ivy (*Hedera helix*). Reducing the extent of lawns, and allowing grasses to grow long and leaf litter to accumulate may limit starling access to soil invertebrates.

Masan, P. 1999. New mite species of the cohort Uropodina (Acarina, Mesostigmata) from Slovakia. Biologia 54 (2): 121-133.

Author's abstract: Eight new mite species of the cohort Uropodina have been described from Slovakia. The deutonymphs of *Uroseius trogicolis* sp. n., *Trichouropoda polysetosa* sp. n. and *Discourella* (?) *pulcherrima* sp. n. were found to be phoretic on beetles of the genera *Trox* (Scarabaeidae), *Cerambyx* (Cerambycidae) and *Tenebrio* (Tenebrionidae), respectively. The male of *U. trogicolis* sp. n. was also caught in the nest of *Sturnus vulgaris*. The adults and deutonymphs of *Uroobovella mrciaki* sp. n. and *Uropoda mihali* sp. n. were found in the nests of *Sciurus vulgaris* and *Marmota marmota*, respectively. The adults and deutonymphs of *Dinychus kaluzi* sp. n., *Uroobovella slovaca* sp. n. and *Uropoda orszaghi* sp. n. were extracted from litter samples.

Mason, J. R. and G. Epple. 1998. Evaluation of bird repellent additives to simulated pesticide carrier formation. Crop Protection 17 (8): 657-659.

Authors' abstract: No-till agriculture involves the use of pelleted and granular pesticides

and chemically treated seeds. Some of these products kill birds. The present experiments were designed to investigate whether four candidate repellents (methyl anthranilate, ortho-aminoacetophenone, d-pulegone, and pine oil) would reduce consumption by European starlings (*Sturnus vulgaris*) of clay particles similar in size and shape to particles normally used for pesticide delivery. AU substances reduced consumption ($P < 0.05$), although none completely eliminated it. To achieve further reductions in consumption, other particle characteristics might be considered. These include the use of colors that make particles indistinct from the substrate, and a texture or particle size that diminishes the likelihood that particles will be ingested as grit.

Mason, J. R. and G. Linz. 1997. Repellency of garlic extract to European starlings. Crop Protection 16 (2): 107-107.

Authors' abstract: Garlic and garlic oil were recently exempted from pesticide registration requirements, increasing the attractiveness of these substances as candidate vertebrate repellents. Because anecdotal evidence suggests that garlic may repel birds, the present experiment was designed to evaluate the aversiveness of garlic to European starlings (*Sturnus vulgaris*). Samples of feed were mixed with garlic oil to produce concentrations ranging from 1.0-0.1% (vol/mass). All garlic concentrations reduced consumption relative to consumption of untreated feed in two-cup choice tests (P lt 0.05). These results are consistent with the possibility that garlic oil may be used to repel these birds.

Mason, J. R. and D. N. Matthew. 1996. Evaluation of neem as a bird repellent chemical. International Journal of Pest Management 42 (1): 47-49.

Authors' abstract: Neem extract (*Azadirachta indica*) is effective as an insect antifeedant, and limited evidence suggests that it may be useful as a repellent for birds. The present experiments were designed to test this proposition. In Experiment 1, European Starlings (*Sturnus vulgaris*) were presented with feed adulterated with a commercially available neem preparation (Nimin). The results showed that the highest test concentration (1.5% m/m) was avoided. In Experiment 2, starlings were presented with an aqueous extract of neem leaves and serial dilutions of that extract. All extract concentrations were avoided relative to untreated water. We conclude that neem is an economical and biologically safe bird repellent and that it may be useful in developing nations where neem is indigenous or introduced, and when synthetic pesticides are difficult to obtain or expensive.

Mazgajski, T. D. 2000. Competition for nest sites between the Starling *Sturnus vulgaris* and other cavity nesters: Study in forest park. Acta Ornithologica 35 (1): 103-107.

Author's abstract: Three species of cavity nesters potentially competitive with the Starling - the Great Spotted Woodpecker *Dendrocopos major*, Middle Spotted Woodpecker *D. medius* and Nuthatch Sitta *europaea* were studied in the years 1997-1999. The number of suitable nest sites for Starlings and competitive pressure were manipulated by increasing or decreasing the availability of nest boxes. Increased nest-site competition did not lead to significant changes in number among the studied species. The

Starling was found to take over up to 25% of holes chosen by Nuthatches for breeding. Increased availability of nest sites did not protect Nuthatches from cavity losses, but reduced their frequency. Only 20% of Nuthatch pairs that lost their holes renested successfully in the same breeding season. No impact of Starlings on breeding woodpeckers was noted.

McClurg, D. 2002. Scanning the sky for starlings. Whatcom watch online: story display. Website: www.whatcomwatch.org/php/WW_open.php?id=175&PHPSESSID=f1b108a7ffbc71221dc18e31c82fa7fd Accessed: January 10, 2002.

This article chronicles the attempts of an agricultural community in Whatcom County to control starlings and provides useful lessons for managers in Garry oak ecosystems. In 1997, farmers and local government financed a trapping and euthanasia (with carbon dioxide) program with a budget of $25,000/year. A range of scaring techniques had been tried but none have been as successful as the trapping program. The poison DRC-1339 has also been used occasionally. Wildlife agents state that the program has controlled starling populations although the starlings have not been eradicated and continue to impact urban and rural residents. Some residents oppose the program because it kills the birds. Starling control in Garry oak ecosystems may face similar animal rights concerns. The farmers have also been excluding the starlings from barns and cavities but the birds nest and roost in adjacent areas.

Meijer, T. and U. Langer. 1995. Food availability and egg-laying of captive European starlings. Condor 97 (3): 718-728.

Authors' abstract: We investigated egg-laying in captive European starlings, *Sturnus vulgaris*, with moderate differences in food availability. From February-March onwards, experimentally food- rationed (FR) birds got 80% of the food ration of an ad libitum fed control (AL-FR) group, which led to a reduction in body mass and activity, and a redigestion of feces. FR birds showed less courtship behavior than AL-FR birds, and did not start laying until their food ration was increased to 90%, during the second half of the breeding season. Fewer FR than AL-FR females started laying. Among those that did, body mass was 6-7 g lower than that of AL-FR females throughout courtship, laying and incubation. No differences in clutch size, egg mass and egg composition were found. Compared to the AL-FR birds, mean laying date was 11-14 days earlier in ad libitum fed (AL) starlings that had no visual contact with FR birds. Initiation of egg-laying in FR starlings apparently was triggered by increased food availability, whereas that of AL-FR starlings may have been delayed because of the near absence of breeding activity among the FR birds with which they were in visual contact.

Miskelly, C. M., P. M. Sagar, A. J. D. Tennyson and R. P. Scofield. 2001. Birds of the Snares Islands, New Zealand. Notornis 48 (1): 1-40.

Authors' abstract: Bird records from the Snares Islands between Dec 1982 and Oct 2000 are summarised. Population estimates and distributions are given for the 29 breeding

species. Bird species recorded breeding on the Snares Is for the first time since 1982 were southern black-browed albatross (*Diomedea melanophrys*), Chatham Island albatross (*D. eremita*), mallard (*Anas platyrhynchos*), southern black-backed gull (*Larus dominicanus)*, fantail (*Rhipidura fuliginosa*), and starling (*Sturnus vulgaris*). Fantails are now abundant on the Snares Is. Published work on the breeding chronology and breeding success of 8 intensively studied species is summarised, and new information on breeding ecology is presented for all breeding species. Sightings of 70 non-breeding and vagrant species are summarised; 34 of these were new records from the Snares Is since 1980. The total bird list for the Snares Is is now 99 species, with a further 8 species reported from boats offshore.

Montalti, D. and G. Kopij. 2001. Bird community of inner La Plata City, Argentina. Acta Ornithologica 36 (2): 161-164.

Authors' abstract: During the years 1991-2000, 101 bird species were recorded in the city of La Plata, Argentina, 47 of which were breeding ones. The most abundant species were: *Zenaida auriculata, Columba livia, Funarius rufus, Pitangus sulphuratus, Zonotrichia capensis* and *Passer domesticus. Columba maculosa, C. picazuro, Furnarius rufus, Turdus rufiventris* and *Molothrus bonariensis* have increased in number, while *Passer domesticus* has decreased. *Zonotrichia capensis* may successfully compete for food with *Passer domesticus. Sturnus vulgaris* and *Acridotheres cristatellus* are new species in the breeding avifauna of La Plata city.

Mueller, H. C., N. S. Mueller, D. D. Berger, G. Allez, W. G. Robichaud and J. L. Kaspar. 2000. Age and sex differences in the size of prey of the Sharp-shinned Hawk. Journal of Field Ornithology 71 (3): 399-408.

Authors' abstract: We trapped Sharp-shinned Hawks (*Accipiter striatus*) during fall migration, using House Sparrows (*Passer domesticus)*, European Starlings (S*turnus vulgaris*), and Ringed Turtle Doves (*Streptopelia risoria*) as lures. Adults and males initiated attacks on sparrows more frequently than juveniles and females. Adult females initiated attacks on starlings and doves more often than adult males, but there was no such difference between the sexes in juveniles. Females actually struck all three species of lure more frequently than males, and juvenile females struck lures more frequently than adult females. There was no age difference in the incidence of strikes by males. Larger (longer-winged) juvenile males and females attacked starlings more often than smaller juveniles, but there were no size differences in strikes on prey in any age and sex group of hawks, suggesting that sexual dimorphism in size is not a result of selection for differences in prey size. Females struck disproportionately larger lures than males, presumably because they are less efficient at capturing smaller prey. Juveniles attacked doves as frequently as starlings, and there was little age difference in the incidence of strikes, suggesting that inexperience in judging the size of prey is an inadequate explanation for the many attacks that fail to result in strikes.

Olsson, O., M. Bruun and H. G. Smith. 2002. Starling foraging success in relation to agricultural land-use. Ecography 25 (3): 363-371.

Authors' abstract: Changes in agricultural land-use have been suggested to contribute to the decline of several bird species through negative effects on their food supply during breeding. One important change in land-use has been loss of pastures, especially permanent pastures. In this study we investigated how different forms of agricultural land-use affected foraging success of a declining bird species, the European starling *Sturnus vulgaris*. We let caged starlings forage in different forms of agricultural fields and determined time spent foraging and foraging success. The starlings' activity level (time spent actively foraging) as well as the number of prey caught per time unit was strongly related to the abundance of prey in soil samples. Also the body mass change during the experiment was positively related to activity level and prey capture rate. We found consistent differences in foraging variables between habitats. In spring sown grain starlings were least active and found fewer prey items at a lower rate than in any other habitat. The other three habitats differed less, but in general mowed hay fields appeared slightly more valuable than the cultivated and natural pastures. We did not find any differences between natural and cultivated pastures in foraging variables. Thus, starling foraging success is higher in grass- covered fields than in cultivated fields, but the management of the grass-covered fields mattered less. The results are consistent with starlings having higher population densities and breeding success in areas with higher availability of pasture. We suggest that the physical structure of the habitat (sward height) and moisture may be additional variables that need to be taken into account to explain starling breeding density and success in the agricultural landscape.

Professional Ecological Services. 1999. Service report: repelling starlings from 1300 and 1400 block Walnut Street. Prepared for City of Victoria Parks, Victoria, BC.

Professional Ecological Services was hired to deal with a large flock of starlings that was overnight roosting in boulevard trees in a residential area. A survey of the location just prior to control implementation in July determined that approximately 200 starlings entered the site from 3 locations about an hour before sunset. The birds were harassed by spotters and broadcasted starling distress calls. On subsequent nights after controls were implemented, fewer starlings attempted to roost and after 4 days of control, no starlings were roosting. Professional Ecological Services was not confident of the numbers reported during the 4 days of control because starlings were confused with other birds such as robins in the dark conditions by inexperienced staff. The reduction in starling roosting may have been also due to a resident hawk which disturbed starling behaviour although this factor is downplayed in the report.

Sandell, M. I. and M. Diemer. 1999. Intraspecific brood parasitism: A strategy for floating females in the European starling. Animal Behaviour 57 (1): 197-202.

Authors' abstract: In many bird species, there is a floating population of females that are excluded from breeding because of competition for limited breeding resources. Female floaters may enhance their reproductive success by engaging in intraspecific brood parasitism. We studied female floaters in a population of European starlings, *Sturnus vulgaris*, in order to determine their identity and potential parasitic behaviour. Females

were caught after being attracted to nestboxes with artificial nests during 1993-1995. None of the females was known to have a nest of her own at capture but 47% of the females either laid an egg in the nest or carried a fully developed egg within the reproductive tract, indicating that they were intraspecific brood parasites. The floating females were significantly younger and smaller than breeding females. Of 13 females equipped with radiotransmitters and followed daily, all but one started a breeding attempt of their own after 3-8 days and the majority settled as secondary females or mated with males where the original female had disappeared. This suggests that females that are unable to compete successfully for nest sites or males early in the breeding season may use intraspecific brood parasitism to enhance reproductive success during the period that they are constrained from breeding. The importance of settling rapidly because of a seasonal decline in reproductive success may also promote the evolution of intraspecific brood parasitism in the starling. The relative reproductive success of combining egg dumping with breeding compared with traditional breeding will depend on the costs of delaying breeding as well as the probability of finding a mate later in the breeding season.

Sandell, M. I. and H. G. Smith. 1997. Female aggression in the European starling during the breeding season. Animal Behaviour 53 (1): 13-23.

Authors' abstract: Intraspecific female aggression during the breeding season can have several different functions: defence of resources, defence against intraspecific brood parasitism and defence of mating status. The intraspecific aggressive behaviour of breeding female starlings, *Sturnus vulgaris*, was examined by exposing them to a simulated intrusion of a conspecific bird. A caged male or female starling was placed close to the nest of a breeding pair. Aggressiveness was scored as the proportion of time birds spent near the caged birds after discovery. Caged females elicited stronger responses from females than caged males. Females sang at caged females and sometimes also attacked them. They were most aggressive towards them during the pre-laying period and less so during the egg-laying, incubation and nestling periods. Females were more aggressive towards a caged female when their mate had access to an additional nestbox to which he could attract an additional female, then when he had not. A time-budget study demonstrated that females spent more time near their nest site during the pre-laying period when their mate had access to an additional nestbox than when he had not. These patterns are most consistent with females trying to secure male brood-rearing assistance by preventing or delaying the settlement of secondary females, since early established secondary females may compete for male help in incubating eggs and feeding nestlings.

Sandell, M. I. 1998. Female aggression and the maintenance of monogamy: Female behaviour predicts male mating status in European starlings. Proceedings of the Royal Society of London Series B Biological Sciences 265 (1403): 1307-1311.

Author's abstract: Any reduction in the fitness of a breeding female induced by the settlement of additional females with her mate creates a conflict between the sexes over mating system. In birds, females are often aggressive towards other females but few studies have been able to quantify the importance of female- female aggression for the

maintenance of monogamy. This study of the European starling, *Sturnus vulgaris*, quantifies male and female behaviour towards a potential prospecting female, presented in a cage during the pre-laying period, and relates it to the subsequent mating status of the male. A solitary breeding male was given the opportunity to attract an additional mate, which almost half of the males did. No biometric characters of the male or female were related to the subsequent mating status. Males demonstrated mate-attraction behaviour towards the caged female but the behaviour of the male did not predict the likelihood to attract an additional female. However, the proportion of time that the female spent near the potential settler was related to mating status, indicating that females that reacted more strongly towards a potential female competitor maintained their monogamous status. These results suggest that female behaviour may play an important role in shaping the mating system of facultatively polygynous species.

Seamans, T. W., C. D. Lovell, R. A. Dolbeer and J. D. Cepek. 2001. Evaluation of mirrors to deter nesting starlings. Wildlife Society Bulletin 29 (4): 1061-1066.

Authors' abstract: European starlings (*Sturnus vulgaris*) nesting in buildings and other structures can cause health, nuisance, and safety problems. We evaluated effectiveness of flashing lights combined with mirrors, and mirrors alone, as deterrents for starlings nesting in starling nest boxes in northern Ohio, 1998-2000. Each year, 100 nest boxes attached to utility poles were randomly assigned equally among 4 treatments (including untreated boxes): 1998-mirrored (internally placed on the back and 2 side walls of nest boxes), mirrored with red-flashing lights, and mirrored with green-flashing lights; 1999-convex mirror above entrance hole, convex mirror at back of nest box, and flat mirror at back of nest box; 2000-mirrors on 3 sides with exposed surface areas of 263 cm2, 527 cm2, or 790 cm2. Starlings nested in 67% (1998) and 78% (1999 and 2000) of the nest boxes. In 1998, boxes within the 3 treatments with mirrors, regardless of lights, had fewer nests and fewer nests with eggs, nestlings, or fledglings than did control boxes (Pltoreq0.002). Boxes with mirrors and lights had fewer ($P<0.05$) nestlings than mirrored boxes. No difference was noted in number of fledglings produced/nest with nestlings for each treatment. In 1999 and 2000 there was no difference ($P>0.25$) among the 4 treatments in proportion of nest boxes with starling nests, eggs, nestlings, and young fledged. However, in 2000, boxes with complete mirror coverage did show the lowest occupancy rate of the 4 treatments. Mean dates of first egg, clutch size, number of nestlings, and number of fledglings/nest also were similar ($P>0.06$) among treatments. We conclude that mirrors, although slightly repellent under some configurations, are not a practical method to repel starlings from nesting in structures.

Shore, T. 1997. Peregrine falcons can help control starling damage: falconer uses trained birds to rid starlings from vineyard hot-spots. Website: smartwine.com. Accessed: July 27, 1998

This article originally published in the Wine Business Monthly describes a falconer's technique for scaring starlings from ripe grapes in vineyards. A trained peregrine falcon is released during peak starling feeding times (dawn-9:30 am and 2:30-4:00 pm). Starlings are naturally afraid of the falcon and are too nervous to feed when the raptor is

in the air. The falconer either lets the falcon soar on the thermal air currents or uses lure flying (the falcon repeatedly dives after an attached piece of meat). Using peregrines for control of starlings in Garry oak ecosystems would be a low impact, effective control. Locating a falconer and determining the impacts on native birds will require further research.

Smith, H. G. and M. I. Sandell. 1998. Intersexual competition in a polygynous mating system. Oikos 83 (3): 484-495.

Authors' abstract: In the facultatively polygynous European starling (*Sturnus vulgaris*) males attract from one to four mates. Males gain by mating polygynously because they produce more offspring by doing so. This is true also genetically, since polygynous males on average father the same proportion of offspring as monogamous males. However, the marginal benefit of attracting additional mates is negatively affected by extra-pair parentage, which is slightly higher in males' secondary broods. Whereas mating as a secondary female is a better option for floater females than either not reproducing at all or reproducing as a brood parasite, already mated females suffer a cost when their mates attract additional mates. This is because they have to share the parental care provided by the male. Males divide parental investment primarily in relation to the timing of the broods produced by their females, investing mainly in the earliest brood. Male parentage has little effect on male care. Already mated females use aggression to prevent floater females to establish a pair-bond with their mates. The mating system in the starling results from the differing interests of males and females. To be able to construct models predicting when a particular mating system should be expected, more has to be learnt about the costs of male mate attraction and nest defence behaviour and female aggression.

Stankiewicz, M., G. Gadamski and S. W. Gawronski. 2001. Genetic variation and phylogenetic relationships of triazine-resistant and triazine-susceptible biotypes of *Solanum nigrum*: Analysis using RAPD markers. Weed Research 41 (4): 287-300.

Authors' abstract: The expansion of weed species is a major problem in agriculture, especially when the number of herbicide-resistant biotypes is rising continuously. The major ecological questions associated with the evolution of herbicide resistance involve an intricate understanding of the interplay between gene frequency, fitness, inheritance and gene flow. In this study, the RAPD (Random Amplified Polymorphic DNA) technique, which facilitates detection of variability at DNA level, was used to examine the spread of *Solanum nigrum* L. populations. Twenty-five populations, from Poland, France and the UK, were analysed. Six populations from Poland and one from France showed target site-based triazine resistance. The genetic relationship between individuals was studied using the RAPD technique. It was found that some resistant populations from the Gabin and Grojec areas show very high affinity levels compared with individuals from France. Three groups of populations in which resistance had developed independently were distinguished. The results of the present investigation suggest that migratory birds, such as *Turdus pilaris* L. and *Sturnus vulgaris* L., play an important in spreading *S. nigrum* seeds.

Stevens, G. R. and L. Clark. 1998. Bird repellents: Development of avian-specific tear gases for resolution of human-wildlife conflicts. International Biodeterioration & Biodegradation 42 (2-3): 153-160.

Authors' abstract: The use of bird repellents may be required when human activities place birds in danger, e.g., hazardous waste sites, or when birds cause damage to crops, architectural structures, or are a source of zoonotic disease. Typical protective measures to keep birds away from areas include exclusion by use of netting, hazing (i.e., scaring tactics) and chemical repellents. Birds can rapidly habituate to visual and auditory hazing if the use of these tactics falls into a predictable pattern, or if the sign stimuli are not coupled with a salient aversive reinforcing stimulus. Chemical repellents are typically used to render a resource unpalatable and, as a consequence, create a disincentive for a bird to visit a particular area. Methyl anthranilate (MA) is a potent avian chemosensory irritant. In this paper, we explore the possibility of employing MA aerosols as a bird deterrent strategy. We determine the behavioral response of starlings (*Sturnus vulgaris*) to each of three aerosols: water or yucca extract (controls) and ReJeX-iT TP-40TM (a 40% MA solution), and found that starlings were irritated by exposure to the MA aerosol. Moreover, starlings did not habituate to repeated exposure to MA aerosols. We determined in the laboratory that the starlings' threshold for irritation to a formulated aerosol was 8% MA.

Weitzel, N. H. 1988. Nest-site competition between the European starling and native breeding birds in northwestern Nevada. The Condor (90): 515-517.

Author's abstract: Since the European Starling (*Sturnus vulgaris*) first became established in New York City in 1890 (Chapman 1906) the species has spread across all of North America. It eventually reached Nevada in 1947 (Ryser 1985) and was first recorded breeding in 1956, at Jiggs, Nevada (Gullion 1956). By now the starling is a common breeding bird throughout Nevada. Despite its widespread occurrence, no studies have been made on this species' effects on the native breeding populations in the state. Here I report on nest-site competition between starlings and native birds in northwestern Nevada over a 10-year period.

Whelan, C. J., K. A. Schmidt, B. B. Steele, W. J. Quinn and S. Dilger. 1998. Are bird-consumed fruits complementary resources? Oikos 83 (1): 195-205.

Authors' abstract: We conducted field experiments in 1994 and 1995 to determine whether fleshy fruits consumed by North American, migrant passerines are antagonistic, complementary, or perfectly substitutable resources. Joint consumption of resources that are antagonistic results in reduced fitness, whereas joint consumption of those that are complementary resources results in increased fitness, than would be predicted from consumption of a linearly weighted sum of the two (or more) resources. Joint consumption of perfectly substitutable resources results in fitness equal to that predicted by consumption of the linearly weighted sum of the resources. Of ten pairs of fruit species tested, eight exhibited resource complementarity (sign test, $P < 0.05$); however,

the strength of complementarity varied among the species pairs. In the two comparisons in which evidence for complementarity was not found, most fruit consumption appeared to have been accomplished by seed predators rather than true frugivores (house finches, *Carpodacus mexicanus*, in one case, and eastern chipmunk, *Tamias striatus*, in a second). In a replication of the second comparison, most consumption of one fruit species was due to a flock of starlings (*Sturnus vulgaris*), a species lacking sucrase activity (which may help explain the result). We suggest that resource complementarity is generally common among fruits, which may help explain why so few frugivores are found to specialize on only a single or even a small number of fruit species. Resource complementarity has important implications for the ecological and evolutionary interactions of avian frugivores and fruit-producing plants. The biochemical and physiological bases of complementarity are unknown, but could involve nutrients, secondary metabolites toxins, or both.

Whitehead, S. C., J. Wright and P. A. Cotton. 1996. Measuring the impact of parental foraging by starlings (*Sturnus vulgaris*) on soil invertebrate prey availability: An exclosure experiment. Oikos 76 (3): 511-521.

Authors' abstract: Depletion of soil invertebrate availabilities by starling foraging during the breeding season was investigated by using exclosures to create areas where the birds could not feed. A field 'preferred' by the wild birds was compared with a 'non- preferred' field. Prey biomass was measured from soil cores and the foraging success of individuals feeding in experimental enclosures gave a measure of prey availability. Foraging by these birds resulted in significant short-term depletion after a few hours of foraging. Trials conducted after a 24-h interval showed that this depletion was due to removal of prey by the birds rather than invertebrate movements. Comparison with exclosure sites at the end of the chick-feeding period showed that foraging by the wild birds caused significant long-term depletion. This depletion was greatest in the 'preferred' field, which offered a higher availability of leatherjackets *Tipula paludosa*. The 'non-preferred' field yielded lower capture rates, despite a higher earthworm biomass in the soil cores. These findings suggest that soil core analysis alone is insufficient to predict the foraging success of starlings and other birds feeding on soil invertebrates. The significant reduction in prey availability to parent starlings is discussed in relation to the number of parental foraging trips made to the two fields.

Whitmore, R. C. and R. C. Whitmore. 1997. Late fall and early spring bird observations for Mulege, Baja California Sur, Mexico. Great Basin Naturalist 57 (2): 131-141.

Authors' abstract: Observational data from spring and fall 1996 and spring 1997 for the region near Mulege, Baja California Sur, Mexico, are summarized in tabular form. In addition, new or noteworthy data for 17 species are annotated to provide clarification of previously published records. A uniquely plumaged bird, too far south for a female American Robin (*Turdus migratorius*) in basic plumage and too far north for the endemic "San Lucas" Robin (*Turdus migratorius confinis*) and intermediate in coloration between the two, was recorded. Range expansions are documented for several species including

European Starling (*Sturnus vulgaris*), Anna's Hummingbird (*Calypte anna*), Western Meadowlark (*Sturnella neglecta*), White-faced Ibis (*Plegadis chichi*), and White-fronted Goose (*Anser albifrons*). Least Grebes (*Tachybaptus dominicus*), a species of concern which is apparently declining in numbers, and Belding's Yellowthroat (*Geothlypis beldingi*), a species endemic to Baja California Sur, were observed in the freshwater marsh during all 3 study periods.

Wildlife Damage Control. 2002. Starlings. Website: www.wildlifedamagecontrol.com/starlings.htm Accessed: November 23, 2002.

The website is maintained by a pest control business and provides information and manuals about starling control for pest managers and their clients. The site has a dramatic photo of a several foot high starling nest in an attic. The best control option is to prevent starlings from nesting by sealing openings. Openings such as exhaust or dryer vents can be sealed with vent guards. The website offers useful precautions for preventing disease transmission when handling birds or bird nests. Protective clothing can prevent infection by ectoparasites. These parasites can also be killed with pesticides. Diseases can be prevented by wearing HEPA filter masks. Starlings also cause problems when they roost in large flocks during the winter and most repellents are not effective.