Birds and plane safety at Juneau Airport

Richard Carstensen and Bob Armstrong
for Juneau Audubon Society • Sept 2004

Birds and plane safety at Juneau Airport

Richard Carstensen and Bob Armstrong, for the Juneau Audubon Society, *Sept 2004*

Between December 3, 2001 and November 22, 2002, we conducted monthly point counts for SWCA at three locations on Juneau International Airport (JNU) property. Our report to SWCA on this work is titled *Bird use of Juneau Airport Property* (Carstensen and Armstrong, 2002) and can be downloaded at *www.jnu-eis.org/documents/bird%20report.pdf*.

The goal of our study for SWCA was to document bird use of airport property, to better understand prospective losses to birds, should their habitats be developed or rendered intentionally less attractive to large birds that could damage airplanes in a collision. Our field methods were not designed to evaluate safety issues. Previous work (Wilmoth *et al*. 2001, FAA, 2002) had addressed birds and airplane safety.

During the course of our airport-property point counts, and a concurrent study of bird concentrations throughout the greater Mendenhall Wetlands (the "Hotspots" study, Armstrong *et al*. 2004, for Juneau Audubon Society, JAS), we became concerned that existing studies, policies and recommendations did not adequately resolve the many challenging issues of bird/airplane interactions. Some of our concerns are outlined in the *Synthesis and recommendations* section of the Hotspots report.

The following report to JAS contains additional observations and recommendations that may be of use to managers, agencies and the public, as we collectively seek to improve airport safety, and to maintain or enhance bird habitat on the surrounding wetlands. As we stated in our Hotspots report, and further develop here, these are not necessarily conflicting mandates.

Three study areas on airport property

Carstensen and Armstrong (2002) describes 3 areas within JNU property where monthly point counts were conducted. Seven point-count circles were visited at Floatplane Pond Woodland, three in Duck Creek Triangle, and one in the Jordan Creek Triangle. Regular comparisons of bird activity in these areas–in some cases quantifiable but for the most part stemming from incidental observations–raised questions about the efficacy of past and proposed habitat alterations to reduce the risk of bird strikes.

Birds of concern

We use the term "birds of concern" to encompass five groups of large birds deemed threatening to planes: heron, waterfowl, gulls, eagle and corvids. These bird species range in weight from a few ounces to 23 pounds. Two of these "groups"–heron and eagle–are represented locally by only a single species. The other three groups contain multiple species:

Waterfowl: The *Birds of Mendenhall Wetlands Checklist* (Armstrong, *et al*., 2002, for JAS) lists 32 species as at least "rare" in one season on the wetlands.

Gulls and terns: Nine species are listed as at least "rare."

Corvids: Four species are listed.

All of these birds are heavy enough to damage planes in a strike, and–with the exception of some of the less common or marine-oriented waterfowl species–their habitat preferences and behavior bring them into airplane flight space on a seasonal or year-round basis.

Although our comments below focus on these groups of large birds, it should not be assumed that smaller species pose no risk to planes. Small birds such as starlings that form large flocks have caused strikes and human fatalities at airports in the lower 48 states. At Juneau airport such large flocks of small birds are relatively uncommon. (Shorebirds may be an exception.) Risk assessment is an inexact science, especially in regard to the flight behavior of seasonally changing bird populations. We have focused on these larger birds because in our estimation, and that of others (Wilmoth *et al*. 2001, FAA, 2002) these are the groups most likely to cause strikes at JNU.

In a summarization of world research on bird strikes, Sodhi (2002) also concluded that weight is very significant. The weights in parentheses below are from *The Sibley Guide to*

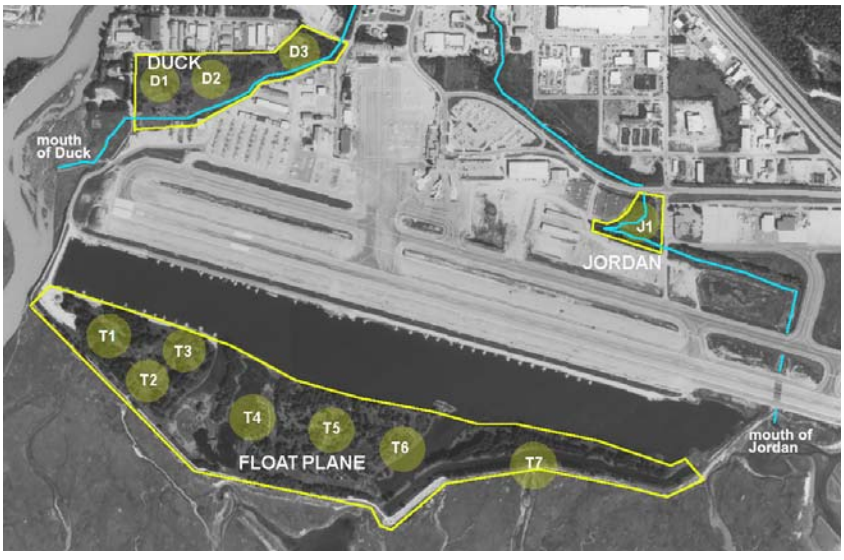

Fig 1 *Three areas where monthly point counts were taken. Yellow circles show approximate 50 m radius for the 11 count locations.*

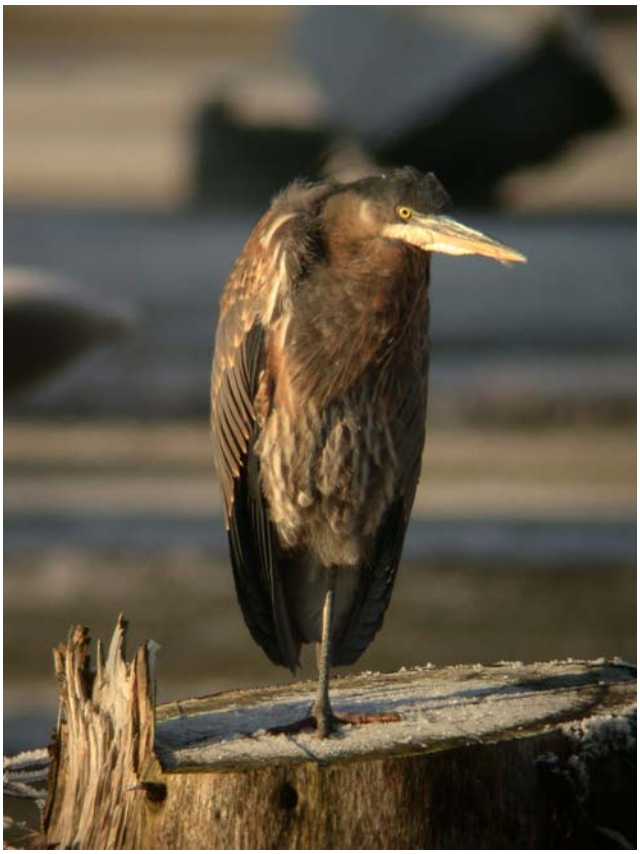

Fig 2 *Immature heron resting on stump of spruce, cut to remove habitat for dangerous birds. Jordan Triangle, 01/02/03.*

Birds, 2000. Aside from weight, other major factors in bird strikes pointed to by Sodhi are:

1) age (immatures are more likely to be struck)

2) migration (likelihood is 5 times higher during periods of passage, due to increased numbers)

3) bird fatigue

4) bird inexperience with local conditions.

Heron

Great Blue Herons (5.3 lb) caused the two most serious of 21 bird strikes recorded at JNU over the past decade (FAA, 2002). Herons are big, relatively unmaneuverable in flight, and often fly to and from foraging locations in the dark.

Heron numbers seem to be increasing in Juneau since the 1970s, possibly because of reduced harassment by teenaged humans (Rich Gordon, pers. comm.). Their increased relaxation near human observers over the past quarter century has been dramatic. Unfortunately, this makes it harder to discourage herons from using habitats near the airport, particularly in prime fishing locations.

While numbers are increasing, herons are rare by comparison with all other birds of concern, making their involvement with 2 serious strikes all the more remarkable. On the December 15, 2001 Christmas Bird Count 37 observers reported only 7 herons in the entire Juneau count circle. Two weeks later we flushed 3 herons out of the Jordan triangle; a substantial portion of Juneau's overwintering herons were using an area that was freshly cleared of trees specifically to discourage them.

In addition to our formal 10-minute point count visits, we have often seen and photographed heron in Jordan Creek Triangle when driving by in daytime. It's likely that they make even more use of Jordan Creek by night.

Waterfowl

Many waterfowl species frequent the Mendenhall Refuge, but we can narrow down the list of primary birds of concern to those few that regularly use habitats on airport property, or cross the approach routes at high enough elevation to come into contact with airplanes*. In winter, the list includes Canada Goose (8 lb), Mallard (2.4 lb), Greater Scaup (2.3 lb), and Bufflehead (13 oz).

During migration, we could add Trumpeter Swan (23 lb), Tundra Swan (14.4 lb), Greater White-fronted Goose (4.8 lb), Snow Goose (5.3 lb), American Wigeon (1.6 lb), and American Green-winged Teal (12 oz). Several other dabbling duck species that frequent the arms of the Floatplane Pond in spring and fall might make the list, but behaviorally and ecologically they resemble the above ducks, and need not be discussed individually.

In our opinion, the two most potentially dangerous waterfowl species at JNU are Mallard and Canada Goose. Of these, we have recorded only Mallard on our point counts north of the runway at Duck and

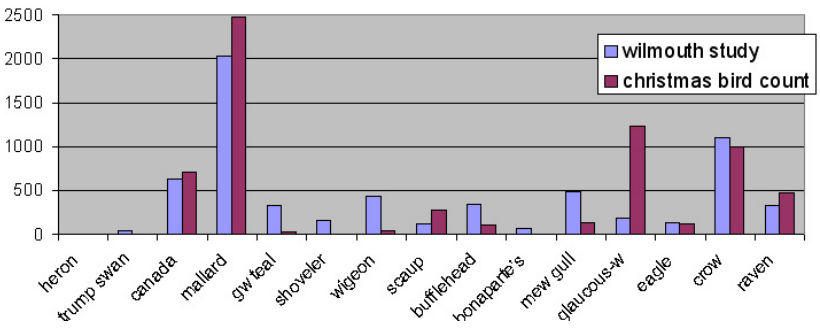

Fig 3 *Two sources of data for populations of "birds of concern." Wilmoth (2001) shows total birds counted on 12 sample areas of 11.5 acres each at JNU, from May 1999 to May 2000. These data include repeat counts of individuals seen on successive visits. Christmas Bird Count shows average number of individuals counted in one day within the 15-mile-diameter Juneau Count Circle for the years 1998-2002. Double counts are possible, but CBC compilers try to avoid this.*

** Examples of waterfowl that probably pose lesser risk at JNU are Surf Scoters (2.1 lb) and White-winged Scoters (3.7 lb). Although seasonally the most abundant water birds on the Refuge, they tend to congregate off the end of Mendenhall Penninsula or in the deeper parts of Gastineau Channel. In flight, they form long lines, staying low over the water. They would therefore more likely be struck by a floatplane rising or setting down in such locations (or by the proposed "flying boat") than by planes in the airport vicinity. We have not observed them crossing JNU approach paths.*

Fig 4 *Ditch-grass generally grows in shallows that geese, swans and dabblers can reach by up-ending.*

Fig 5 *Trumpeter Swan at junction of Floatplane Pond and west arm, a delight to birders but a threat to airplane safety.*

Jordan Creeks. Geese are apparently unwilling to forage in such small, confined areas, but do frequently pass by overhead. Mallards, in contrast, are adept at dropping into small ponds and narrow sloughs, and can rise from them almost vertically when frightened. Even in winter, Mallards are twice as numerous in the Juneau Christmas Bird Count circle as Glaucous-winged Gulls, the second most common bird of concern (fig 3). Their frequent use of fresh and salt water habitats both north and south of the runway results in regular flights through airplane landing space.

Vancouver Canada Goose is a local non-migratory subspecies, one of the heaviest in North America. They are present on the Mendenhall Refuge during all but the midsummer breeding/molting months. Canada Goose feeding and resting areas cluster around the runway (Hotspots report, page 37), and their flight patterns regularly take them through airplane landing space.

Of special concern is the daily route taken by Canada Geese during hunting season. A large percentage of resident geese and mallards take refuge from hunters on Auke Lake by day. At dusk, about 1/2 hour after the last legal shooting light, geese leave the lake for the Mendenhall Wetlands. Laurie Fergusen Craig (pers. comm.) lives on Glacier Highway between the lake and the refuge, and is frequently able to record the timing and numbers of passing geese. Their route from the lake often takes them directly through the airplane approach path to the runway.

These birds graze Lyngbye sedges and other salt marsh plants throughout the night. According to Jim King (pers. comm.), the timing of their morning departure is less consistent than that of their evening arrival. They sometimes wait until the first shots are fired before departing.

Two other ducks that use the Floatplane Pond throughout the colder months (until freezing) are Greater Scaup and Bufflehead. Both are divers, adapted to the deeper waters of the landing pond (as opposed to the dabblers that tip up for ditch-grass in the shallower east and west arms). These species are of concern to floatplane pilots. They are highly habituated to noise and traffic, and often simply dive or scuttle a short distance out of the way of oncoming planes.

In spring 2002, many observers noted that northbound Greater White-fronted and Snow Geese seemed tamer around people and traffic than in previous years. We recorded this behavior not only at JNU, but also at Angoon and Gustavus. Both species overwinter in marshes in California. Severe droughts there in recent years forced the US Fish and Wildlife Service to shut down many of the foraging ponds on National Wildlife Refuges. We speculate that as a result, some geese are becoming habituated to more humanized feeding locations such as watered lawns and highway margins. They may then be carrying their habituation north with them in migration.

The consequences are disturbing to airport staff. Greater White-fronted and Snow Geese both grazed on seeded grass margins of roads, taxiways and runways in spring, 2003. It's hard to predict if such habituation will increase or decline. Fall hunting season "re-educates" many of these geese to avoid people.

In fall, airport hazing staff rely on assistance from hunters permitted to use the Floatplane Pond security area. Several blinds are available to these hunters at the junction of the east and west arms with the Floatplane Pond. It may be possible by directed hazing to train Juneau-resident

Fig 6 *Mallards sometimes nest in the floatplane basin area.*

Fig 7 *The three commonest gull species at JNU. Bonaparte's are absent in winter.*

mallards to avoid these areas, but during fall migration a new set of "naive" dabblers passes through each day. Hunters are permitted to set out decoys at the margin of the Floatplane Pond to lure in migratory birds in order to teach them not to use an area they will likely never see again. We consider this practise illogical, and recommend that it be discontinued.

Firing by hunters that have other motivations in addition to airplane safety may also frighten birds in unpredictable directions. Wilmoth (2001) discusses potential for unintended consequences of hunting in the security area. He observed hunter-dispersed ducks to circle for up to 5 minutes before settling. On one occasion, birds fired upon by hunters flew north across the runway and landed in Impact Pond near the bend in Jordan Creek. Similarly, the passage of waterfowl between the Floatplane Pond and Miller-Honsinger Pond takes birds across the runway on a regular basis. Hunter disturbances increase the frequency of these flights. Even professional hazing can backfire. Laurie Fergusen Craig (Juneau Empire, 4/29/01) watched airport staff haze swans that were feeding on the western margins of Floatplane Pond, causing them to circle several times over the runway before landing to feed again.

Of 191 ducks dropped at JNU by hunters in 1999, 15% escaped Wilmoth (2001). These birds attract eagles and scavengers such as corvids to Floatplane Pond.

Duck hunters using the refuge outside of airport property actually drive birds onto sloughs and ponds near the runway. Constant firing throughout the fall hunting season keeps waterfowl searching for unhunted locations. JNU employee Brad Gruening (pers. comm.) says that one of his most consistent hazing challenges is in the sloughs paralleling the east end of the runway on the south side. These sloughs are within airport property, and accessible only to JNU-permitted hunters, who tend to prefer the established blinds in Floatplane Pond Woodland. Without repeated hazing, hundreds of geese and ducks pile up alongside the runway.

It is difficult with currently available data to evaluate the relative risk to aircraft of different groups of birds of concern at JNU. Several pilots including waterfowl biologists Jack Hodges and Jim King have mentioned to us that they are impressed with the agility of gulls in flight compared to that of ducks, geese and swans. Waterfowl in general may thus pose greater hazards to aircraft than do gulls and terns.

Gulls

"Around the world, gulls (*Larus spp*.) account for the majority of strikes on civilian as well as military aircraft." (Sodhi, 2002). While this statement may appear to contradict our speculation above, consider that JNU is centered over the estuaries of two streams and a major glacial river, within one of the prime waterfowl gathering areas of Southeast Alaska. Such an unfortunate location may tip the odds of airstrike from gulls toward waterfowl.

Be that as it may, gulls pose an undeniable risk to aircraft. Juneau gull species, in order of abundance, are: Glaucous-winged (2.2 lb), Mew (15 oz), Bonaparte's (7 oz), Herring (2.5 lb), and Thayer's (2.2 lb). Herring and Thayers are much less common than the first three species. Bonaparte gulls are seasonally common, but leave in the winter months, and are also much lighter, almost as agile in flight as terns.

Both Glaucous-winged and Mew Gulls are common at JNU. Of the two, Glaucous-wings are more likely to attend to human garbage in parking lots, at dumpsters, etc. Glaucous-wings also nest on the bare rocks near Mendenhall Glacier, thus passing regularly through JNU approach routes on foraging excursions to and from the

Fig 8 *Gulls gather by the thousands off of DIPAC hatchery to feed on ground-up salmon, and at the mouths of Mendenhall River, Fish, Salmon and Lemon Creeks during spawning time. These birds "commute" between foraging and resting places at fairly high elevations, frequently placing them in JNU flight space.*

Fig 9 *Brad Gruening hazes eagles off of runway anemometer perch with 12 gauge cracker shells near mouth of Jordan Creek. The eagles returned to this perch within 10 minutes.*

Fig 10 *Eagle perched on runway approach lights. This is a convenient scanning post immediately next to Mendenhall River.*

ocean. This is the only gull we recorded on our Duck and Jordan triangle sites north of the runway during point count periods in 2002.

Mew Gulls do frequent the airport, however. Wilmoth (2001) observed twice as many Mews as Glaucous-wings over a year-long study at JNU (fig 3). On December 12, 2002, hazing staff killed 7 Glaucous-winged and 1 Mew out of a mixed flock of several hundred foraging in seeded grass on the runway margin. (Brad Gruening, pers comm) Airport staff speculate that earthworms or possibly grit for gizzards are the attractants. Gulls are very intelligent, and if hazers merely fire at foraging groups, they soon return. Killing a number out of the flock prevents return, at least temporarily.

Crops of the sacrificed birds were not saved for examination. Crops offer important information that should be routinely gathered whenever birds are killed or found dead near the runway.

Eagle

Like herons, Bald Eagles (9.5 lb) are top predators, therefore numerically uncommon compared to other birds of concern. Also like herons, however, eagles have been involved in serious strikes at JNU (FAA, 2002). Eagles are less maneuverable than gulls and corvids in flight, especially when carrying food.

A famously habituated pair of eagles have nested in Floatplane Pond Woodland for the past few years, entertaining dike trail walkers. They often perch directly over the trail in low cottonwoods. This pair, named Nellie and Juan, are territorial, chasing other eagles from the western end of the woodland. A second pair uses perches at the eastern end, including anemometer posts over the Jordan Creek culvert when salmon are running. These airport-resident birds may actually serve as hazers themselves, of more dangerous nonresident eagles. Sodhi (2002) discusses the greater airplane-savvy of airport resident birds compared to transients, and especially immatures.

At times, large congregations of eagles gather off the west end of the runway, attracted to food like eulachon. One of us (Armstrong) observed eagles being dispersed by airport staff. The birds separated into two flocks and circled over the east and west ends of the runway.

The fact that both eagles and herons have been involved more than once in strikes at JNU makes it clear that more than numerical abundance is

Fig11 *Successful eagle nest near T2, summer 2001.*

Fig 12 *Ravens and crows are much more manueverable in flight than eagles, as can be seen during mobbing.*

involved in the likelihood of a bird strike. Further study is needed of bird flight behavior at JNU.

Corvids

Common Raven (2.6 lb) and Northwestern Crow (13 oz) are both common at JNU. Crows were the second most common bird of concern (total 1100 birds) during Wilmoth's May 1999-to-May 2000 JNU study. In contrast, we recorded a total of only 8 crows throughout 2002 within our eleven 50-meter count circles (total of 22 hours of observation, in 10-minute periods). Many other crows were seen outside of the circles and count periods, but it does seem that they have recently become less numerous at JNU. Like Bill Wilmoth, Rich Gordan (pers comm) has observed nesting crows at the end of the spur dike–our T3 point count area–but not for the past several years. Crows are vocal and hard to miss when nesting, and it is unlikely that we could have overlooked them.

Closed spruce forest, among the least productive of all airport habitats for foraging birds and mammals, *does* attract communally nesting crows. We initially assumed that airport hazing staff had discouraged crow nesting here, but learned later that they had not done this. So the reason for crow declines is a mystery to us.

Ravens were more common than crows during our 2002 study. A favored location for ravens was the recently cleared Jordan Creek Triangle. On several occasions we found garbage flown into this site by ravens, surrounded by their tracks in the snow.

From 1990 to 2002, 7 crows were struck by aircraft at JFK International Airport. During the same period, kestrels were struck 37 times and harriers were struck 15 times. These extremely manueverable raptors usually manage to elude even the agile crows during interactions, and are presumably much less common than crows at JFK. This leads us to speculate that the high intelligence of crows (and certainly of ravens) helps to account for the relative rarity of corvid strikes.

Ravens are known to damage parked planes, particularly those with fabric skin. Raven is perhaps less likely to be struck than to do the striking.

The two remaining corvids of the airport area–Steller's Jay (3.7 oz) and Black-billed Magpie (6 oz)–tend to stick low over trees, and are not often seen passing through JNU flight space.

Tree clearing–past and proposed

Between Yandukin and Crest Avenue is a 3.8 acre (1.5 hectare) undeveloped riparian corridor–considered by fisheries biologists to be one of the most productive and valuable reaches of Jordan Creek. We mapped and studied the hydrology, fisheries and bird use of this reach with Dan Bishop in 1986 (Bishop et al, 1987). ADF&G and SWCA have continued to monitor weirs below both Yandukin and Crest culverts, documenting the exceptional importance of this area to fish.

Fig 13 ***Above****: Jordan Creek Triangle in 1986.* ***Below****: in summer 2001, shortly after trees were cleared.*

In February 2001, on a 6-to-2 vote of Juneau's Planning Commission, all spruce trees were removed from this Jordan Creek Triangle. According to airport officials at the time:

" . . . the trees obscure air traffic controllers' views of part of some taxiways and helicopter operations, provide habitat for birds that fly across runways, and could be a hazard for aircraft that stray from the regular flight path. . . Cutting down the trees would remove cover for birds and let airport workers see where birds are on the ground and try to scare them away." (Eric Fry, Juneau Empire, 2/28/01)

The decision was controversial. Because further tree clearing has been proposed for the Floatplane Pond Woodland, it is important to examine the results at Jordan Triangle. Although SWCA initially requested our bird survey work only in the Duck Creek Triangle and Floatplane Pond Woodland, we recommended establishing a comparison site in Jordan Triangle to gather information on how the avian community responds to this type of

Fig 14 *View west to Jordan triangle, June 1991. Crest culvert at lower left. Close encroachment of spruce (left) and alder/willow (right) along creek channel probably inhibited most birds of concern.*

Fig 15 *Looking downstream to Crest culvert, 4/28/02. Logging of marginal spruce and deciduous brush improved the view and takeoff space for heron, mallard, and gulls.*

habitat alteration. Our point count circle here became known as J1 (fig.1)

The lower (southernmost) third of the Jordan triangle channel is contained by dikes. Improved drainage on these raised surfaces allowed establishment of fast-growing spruces sometime after 1962. Upstream, the entire surrounding surface is active floodplain, and this reach supported only the more flood-tolerant willows and alders. These upstream channels meander naturally, with undercut banks, sheltering root masses, and more diverse in-stream cover than in the channelized portion. Overhanging deciduous foliage of willow and alder formerly shaded the stream and provided nitrogen-rich litter, until they were cleared in 2001.

To some human eyes, the Jordan triangle is now a scene of devastation. Responding in part to complaints, the airport hired a contractor to chip down the stumps most visible from Crest Avenue to ground level. This action was cosmetic, and had little effect on habitat values. To avian eyes, or at least to birds of concern, the Jordan Creek clearcut is more inviting now than when the stream was thickly fringed with shrubs and spruces.

At the February 2001 planning commission hearing, the following arguments, pro and con, were recorded:

Airport officials said trimming the tree tops wouldn't alleviate the bird problem. . . .“We need to get rid of the cover, and that's getting rid of all the trees,” said Ralph Sanford, who manages wildlife control at the airport.

But Ben Kirkpatrick, area habitat biologist for the state Department of Fish and Game, said great blue herons and eagles will continue to use the stream if the trees are removed, and they'll have a clear flight path across the runway. An open stream may attract more gulls, as well, he said.

“I would urge erring on the side of caution,” airport manager Allan Heese told the commission. “We feel strongly that the removal of these trees will allow us to manage that bird hazard a lot easier and more efficiently than now.” (Eric Fry, *Juneau Empire*, 2/28/01)

Our point count data and incidental observations suggest that Kirkpatrick was right. Most birds of concern are probably making increased use of Jordan Triangle. Furthermore, the improved visibility has not made it much easier for hazers remaining in or close to their vehicles to detect and scare birds from the meandering and slash-obscured channels. Often on our bird counts, we were unaware of the presence of heron or mallard until we walked into the site, flushing the birds.

Lacking data on bird use of Jordan Creek Triangle prior to tree removal, we must look to other comparisons of closed versus open habitats. Of the remaining 10 point count locations, the easternmost site on Duck Creek (D3) most closely resembles the pre-logging conditions at J1. The apparent low attractiveness of D3 to birds of concern (fig 17) is interesting. All of our point counts in semi-forested cover on airport property yield similarly depauperate tallies of large, problematic birds.

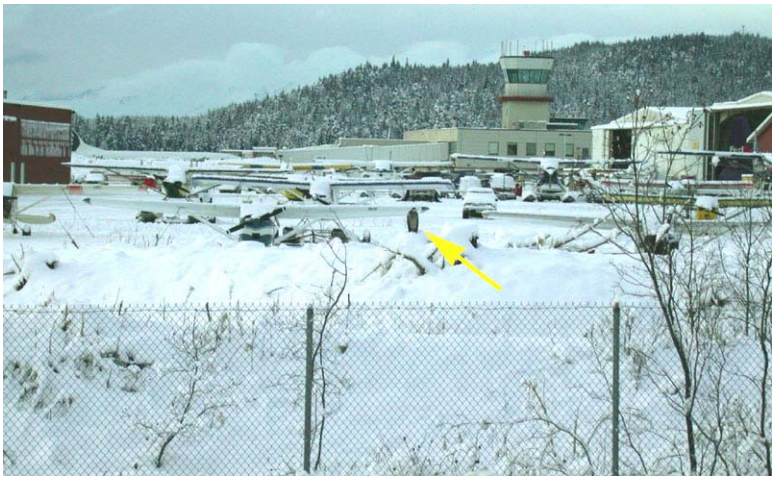

Fig 16 *Heron resting on cleared dike, Jordan Creek triangle.*

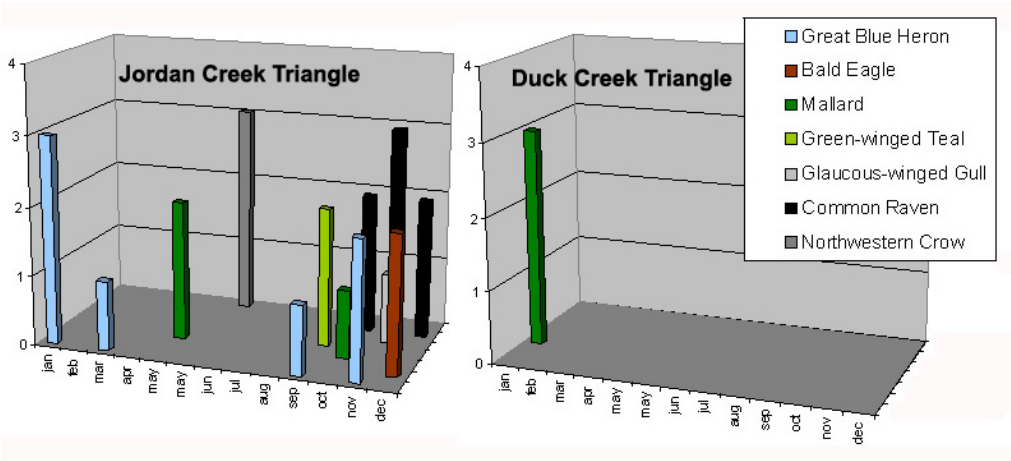

Fig 17 *# birds within 50 meter radius on monthly 10-minute point counts in 2002, JNU. Only the 7 species of concern recorded on these sites are shown.* ***Left****: J1, cleared of trees to reduce attractiveness to birds* ***Right****: D3, retaining conifer/deciduous cover similar to that existing on Jordan Creek before logging. Total # individuals for birds of concern: Jordan 25; Duck 3. The 3 mallards at D3 were not on the creek but flying overhead.*

The same great weight and relative lack of agility that make heron and waterfowl dangerous to planes also makes them tend to avoid tight spaces where takeoff options are limited, and where predators cannot be seen approaching. Eagles and gulls, while somewhat more maneuverable, likewise rarely use closed cover with poor visibility. All of these birds probably make more use of the Jordan Creek Triangle now than they did before logging.

Ravens and crows are highly maneuverable and unafraid of closed cover. They certainly used Jordan Triangle before trees were cleared. But even these birds may be finding more more food at Jordan Triangle (or bringing more in from MacDonald's etc) than prior to logging.

Throughout winter 01-02, we documented very high populations of long-tailed voles–an irruptive species–in all meadow/brush communities at Juneau Airport. Tree removal definitely improved conditions for long-tailed voles at Jordan triangle. In addition to ravens, voles attract raptors and short-eared owls (large but extremely agile birds and probably way down on the list of likely airstrike hazards). On March 15, 2002, we found heron tracks in snow, wandering throughout the Jordan triangle far away from the creek itself, hunting voles.

In our opinion, the best compromise for Jordan Creek Triangle would have been to top the spruces, as favored at the hearing by commissioners Kendziorek and Gladziszewski, as well as local habitat biologists. This would have allowed the control tower full view of those portions of airport service roads, etc, not already obscured by hangar proliferation, and would also have maintained dense cover near the stream. This cover not only maintains quality fish habitat, but reduces the appeal of fish streams to most birds of concern.

Airport habitats ranked by attractiveness to birds of concern - implications for proposed development

As stated in the JNU Wildlife Hazard Management Plan (FAA, 2002), foraging habitat is generally a more significant attractant, at least in terms of airport safety issues, than is nesting or roosting habitat. It's easier to deter birds from use of nesting/roosting habitat (eg. crow use of conifers) than from key foraging habitat (Wilmoth 2001).

To evaluate airport-area habitats according to their foraging value for the five major groups of birds of concern, we developed a ranking system (fig 19). To each of 12 habitats we assigned a subjective score (highest value = 3: no value = 0)*. Non-foraging values were disregarded. To give additional weight to the first three groups of birds, scores for eagle and corvids were divided by two. Any individual habitat could arguably be bumped up or down a rank or two, but the overall trend is clear.The ranking has many implications for airport management.

Least attractive habitats Ideally the lowest ranking habitats should be those closest to the runway and Floatplane Pond. Young closed conifer forest should not be cleared but *planted*, wherever upward growth will not eventually obscure critical views from the control tower. Even better is deciduous brush, because it has less potential to block tower views, and is more valuable to fish and non-threatening wildlife like songbirds.

The most attractive habitats In contrast, highest ranking habitats should be farthest from the runway and Floatplane Pond. The 5 highest ranking habitats are aquatic, and JNU is literally surrounded with them. The highest risk habitat - shallow lagoons - could be filled, dredged deeper, or wire-gridded. But that would still leave the second and third most attractive habitats–tidal mudflat/slough and the Mendenhall River–that bracket the east and west ends of the runway.

The fourth highest-risk habitat is anadromous stream. Duck and Jordan Creeks are severely impaired anadromous channels, badly in need of restoration. Such work is currently opposed by airport management and the FAA because of safety concerns. We believe there are ways to improve stream habitat for rearing fish and non-threatening birds while reducing their attractiveness to birds of concern (see page 54 of our Hotspots report).

** A slightly different and more data-driven approach to this ranking is explained on page 54 of our Hotspots report. There we used actual species counts from airport-area habitats. Results were similar to those of this more subjective ranking.*

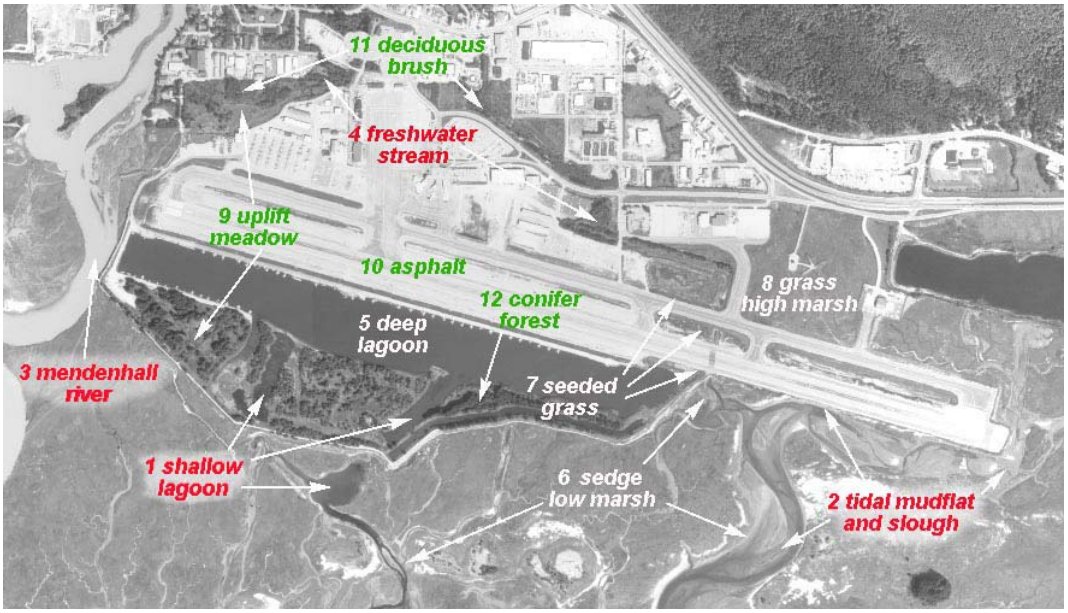

Fig 18 *Habitats indicated in red are examples of highest foraging value to birds of concern, thus pose highest risk to airport safety. Habitats in white are intermediate. Habitat examples in green are least attractive to birds of concern, and should be promoted on surfaces close to the runway and floatplane pond.*

It is hard to imagine an alternate airport location between Taku Inlet and Berner's Bay that would pose higher risk of bird strikes than JNU. It's also hard to name a location that would have greater impact to fish and wildlife habitat. Airport managers have inherited a mammoth challenge and responsibility on both counts.

Seeded grass Wilmoth (2001) discusses the liabilities of seeded grass runway margins. We ranked this habitat 7th most attractive out of 12. It would score even higher if we gave corvids equal weight to heron, waterfowl and gulls. We agree that pavement or coarse gravel would be less attractive than seeded grass to birds of concern.

Ditch-grass The east and west "finger ponds"–southward-extending arms of Floatplane Pond–are examples of shallow lagoons, the highest ranking of all 12 habitats at JNU for birds of concern. Much of this high value stems from availability of ditch-grass (*Ruppia maritima*), which attracts not only grazing waterfowl but predators seeking the swarms of sticklebacks and invertebrates that thrive in ditch-grass beds. Ditch-grass grows best in shallow ponds with coarse sediment, and in intermediate salinity (pure sea water kills it, and in fresh water other species like milfoil out-compete it). Proposals have included mechanical or herbicide removal, stretching of wire grids over water to deter birds, deepening of the arms to a depth unsuitable for ditch-grass, and filling in the arms entirely.

Fig 19 *Bird habitats near Juneau Airport facilities, ranked from most to least attractive*

habitat	heron	wtfowl	gull	eagle	corvid	total
shallow lagoon	3	3	3	1.5	1.5	12
tidal mudflat and slough	3	3	3	1	1.5	11.5
Mendenhall River	2	3	2	1.5	1.5	10
freshwater stream	3	2	2	1	1	9
deep lagoon	1	2	1	1	1	6
sedge low marsh	1	3	1	0.5	0.5	6
seeded grass	0	1	2	0.5	0.5	4
grass high marsh	1	1	1	0.5	0.5	4
diverse "uplift meadow"	1	1	1	0	0.5	3.5
asphalt	0	0	1	0.5	0.5	2
deciduous brush	0	0	0	0	0.5	0.5
closed conifer forest	0	0	0	0	0	0

We suggest filling *just the junctions* of the east and west arms, cutting off their connection with the Floatplane Pond. A mix of spruce, cottonwood, alder and willow should be planted on the fill. Overhanging deciduous cover would discourage loafing gulls and waterfowl and provide foraging/breeding habitat only to low-risk songbirds. A continuous strip of this habitat should rim the south edge of Floatplane Pond. If crows attempted to nest in spruce-dominated sections they could easily be hazed until they abandoned their rookeries. Trees at the junction of the arms with Floatplane Pond would provide a deflecting barrier for low-flying waterfowl that now move freely between them.

Cutting off the connection might also alter salinities enough to kill ditch-grass. If not, a connection could be opened from the arms to Otter Pond and associated tidal sloughs, admitting water with higher salt content.

As we suggested 17 years ago (Bishop et al, 1987), ditch-grass ponds are extremely valuable wildlife habitat, and are rare features on the Mendenhall Refuge. Since our 1987 study, Impact Pond (5 acres of ditch-grass pond on the north side of the runway) has been completely filled. We support this action, as well as proposed elimination of ditch-grass in the shallow lagoons of Floatplane Pond area. We also feel that ditch-grass ponds should be at the top of the list of mitigating actions elsewhere on the Mendenhall Refuge. They are obviously possible to create; we've done it repeatedly quite by accident.

We discuss options for mitigation ponds on page 55 of our Hotspots report.

Waterfowl hunting

We discuss waterfowl hunting and its implications

Fig 20 *Central Floatplane Pond Woodland, Oct 8, 2002, taken on flight with USFWS. Fall color shift distinguishes spruce from deciduous cover. East and west arms ("finger ponds") support ditch-grass, highly attractive to grazing birds, especially in spring. If this habitat is eliminated in the interests of plane safety, we should try to create similar habitat at greater remove from the airport.*

for airplane safety on page 57 of our Hotspots report. We only wish to reiterate here that hunting has created safety issues at JNU, and that improvements are needed in management of hunting on the Mendenhall Wetlands.

Hunting is a long-established tradition on Mendenhall Refuge and was one of the missions of its founders. The refuge is especially important as a place for young people to learn hunting skills, an area easily accessible for those who lack the means or time to travel to more remote locations. We do not oppose bird hunting. But we agree with Cain *et al*. (1988) that creation of closed areas at some distance from the runway could draw birds away, and possibly even improve hunting in those areas nearby that remain open. It might also reduce the need for so many waterfowl to take refuge on Auke Lake. Logical places to consider hunting closures would include the areas we've identified as possible sites for created ditch-grass ponds. For maximum benefit to birds and airport safety, such sites should be dog-free.

Proposed relocation of Duck Creek

Airport plans call for relocation of the current channel of Duck Creek to the northern edge of Duck Triangle. The southern portion would then be paved over to provide expanded tie-down space. In addition to the need for growth of airport facilities, an often-cited rationale for channel relocation is the elimination of a bird attractant.

As Wilmoth (2001) discusses, however, proposed relocation of the mouth of Duck Creek to a point slightly farther upstream on Mendenhall River would not clearly reduce the bird strike potential at JNU. More can be done to improve safety by altering riparian habitats than by changing the location of airport streams. We believe that creative habitat alterations can discourage birds of concern while retaining key features of fish habitat. Scenarios for stream-margin habitat alterations are discussed on page 54 of our Hotspots report. Here we describe particulars of the habitats within Duck Creek Triangle, in regard to both safety issues and the loss of land-bird habitat. For further information on this area, and on the implications of channel relocation, see Carstensen (1996).

Southwestern (downstream) margins of Duck Creek are flooded on extreme high tides that extend well above the Radcliffe culvert. A thin belt of Lyngbye sedge borders the creek on inner terraces, but otherwise the vegetation consists of high marsh species like hairgrass and silver-weed. Because salinities are much reduced by fresh water here, species like shooting star and spikerush, not usually part of the high marsh, join the hairgrass in the area along Duck Creek just below extreme high water. This unusual species mix is not especially attractive to waterbirds. Only the Lyngbye sedge belt and small amounts of ditch-grass in the bed of lowermost Duck Creek serve to lure occasional mallards. Ducks were never seen upstream in the vicinity of D3 where encroaching shrubs make takeoff difficult.

The current, dredged bed of Duck Creek within Duck Triangle is primarily coarse sand, excessively well drained.

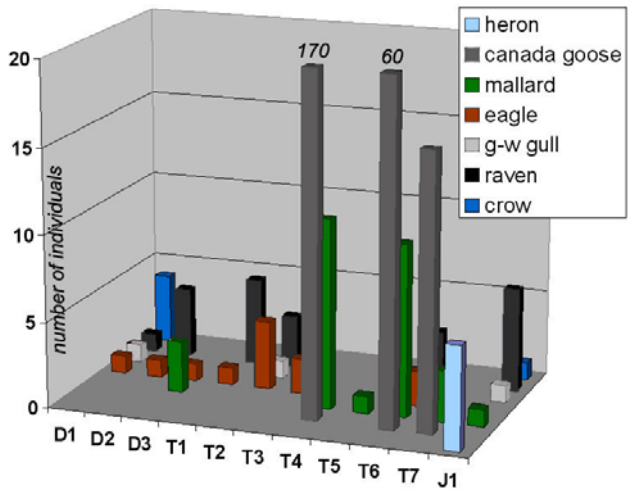

Fig 21 Birds of concern. Number recorded during 2002 on 11 point count sites*. Locations of count circles are shown in fig 1. High counts at T4 and T6 are Canada Geese feeding on ditchgrass in April in the west and east arms, respectively, of the floatplane pond. The only herons observed on count circles in 2002 were at Jordan triangle.*

Fig 22 *Duck Creek Triangle. Color infrared imagery commissioned by SWCA in summer 2001.*

Dewatering is common, especially in spring when salmonids are outmigrating. Northward relocation of Duck Creek, if done skillfully, would offer opportunities to improve fish habitat in one of the most damaged reaches of Duck Creek. The proposed more northerly channel, however, would almost completely eliminate the locally-uncommon deciduous habitat that supports the highest landbird densities we measured on airport property. (fig 28). A relocation would do little to reduce attractiveness to the larger birds of concern; in our experience these are already of low occurrence in the Duck triangle.

Whether Duck Creek is relocated or remains in its present channel, we recommend a fringe of overhanging deciduous alder and willow, as described and illustrated in our Hotspots report. A good model for habitat manipulation can be seen on Jordan Creek just upstream from Yandukin Drive (fig 23).

The FAA opposes salmon enhancement efforts on Duck and Jordan Creeks because this presumably attracts birds of concern. But there are many ways to enhance salmonid habitat and each of them affects bird habitat in different ways. By our subjective ranking system, anadromous streams are the 4th most attractive to birds of concern of 12 JNU habitats (fig 19). In their present configuration they are highly attractive to heron, moderately attractive to mallards (but not geese), and moderately attractive to Glaucous-winged (not Mew) Gulls, eagles, and corvids.

Great blue heron, for example, prey more successfully on sticklebacks than on juvenile salmonids. (Butler, 1997) Altering a stream in ways that favor salmonids over sticklebacks (increased flow and shade, reduced backwatering) will reduce activity by herons. Herons currently using Jordan Creek Triangle may well be less drawn to salmonids than to sticklebacks and long-tailed voles, both of which were increased by tree removal.

Deciduous songbird habitats

Comparing our JNU breeding bird data to that of Gende and Willson (2001) for streams with mature coniferous context (fig 25) , the airport emerges as a great place for "brush birds:" kinglets, robins, warblers and sparrows. These small songbirds are rarely implicated in damaging air strikes, and their presence is compatible with airport safety.

Deciduous brush habitat is early successional. It is much less common in Southeast Alaska than coniferous forest. Examples of deciduous habitats include: avalanche chutes, corridors of larger streams and rivers, clearcuts where severe soil disturbance favors alder seed germination, recently deglaciated areas, and coastal fringes, especially along uplifting coastlines.

While scattered deciduous trees and shrubs are common along Juneau's coastlines, development has removed most of those patches large enough to attract large numbers of breeding birds or "stopover" migrants. Duck Creek Triangle and the Floatplane Pond Woodland are outstanding in this regard.

Fig 23 *Jordan Creek upstream from Yandukin Drive, February 2003. This reach should be a model for habitat manipulation efforts within Airport property. Densely overhanging deciduous foliage makes this habitat difficult to use for birds of concern. Few of these trees will ever grow high enough to obscure views from the tower. In summer, the alders and willows shade the stream, cooling water temperatures. Root systems help bind the banks and provide overhanging cover for rearing salmonids. Leaf litter into the stream is the food base for invertebrates that feed young fish.*

Perhaps the most unique characteristic of Juneau Airport deciduous habitat is its "island" character. The focusing tendency of island habitat patches for migratory birds is known as the Central Park effect. We discuss this phenomenon on page 44 of our Hotspots report.

The combination of excellent songbird viewing with the great accessibility of sloughs and lagoons that attract waterfowl and shorebirds makes the Airport Dike Trail the premier location in Juneau for SeaWeek birding field trips and Discovery Southeast bird outings. These exceptional bird values of Juneau Airport property must be held in mind as we evaluate proposals for habitat change to improve safety conditions. The challenge is to maintain or improve conditions for songbirds and other non-threatening species while making the airport area less attractive to birds of concern.

DIPAC fish

DIPAC hatchery releases millions of salmon young per year (30 million in 2001) into waters immediately adjacent to the Mendenhall Wetlands. Many of these fish rear throughout the wetlands before heading out to deeper water. As adults many stray into refuge streams. We suspect that most, if not all of the salmon spawning in the lower reaches of Duck Creek are of DIPAC origin. These fish create a much greater attractant to birds than all of the fish naturally produced from Duck and Jordan Creeks combined. Seen in this light, enhancement of the natural runs from Duck and Jordan would have virtually no effect on the amount of gull, eagle and corvid activity at their estuaries. Opposition to such enhancement might therefore be more logically directed at the actual point of origin of the bird-attracting fish.

Need for further study and for more public participation in decisions involving bird/safety issues.

Barring relocation of the airport to Douglas Island (which merits discussion) we may have to accept the necessity of reducing the attractiveness of Juneau Airport's surrounding habitats to heron, waterfowl, gulls, eagles and corvids. **But we must mitigate for resulting habitat loss at safe distances from the runway**.

Obviously, national experts in wildlife hazard management have an important role to play at JNU. But we believe that mistakes have already been made as a result of the failure to incorporate local knowledge. An example is the tree clearing at Jordan triangle. Other actions proposed in the Wildlife Hazard Management Plan (FAA, 2002) appear equally unrealistic to us.

To more effectively inform such management decisions, an intensive bird monitoring program must be established, expanding upon the Wilmoth and SWCA work. In 2002, the local office of USFWS planned such a study but was subsequently informed by Wildlife Services that they would not conduct it. In addition to addressing the uniqueness of Juneau's bird/mammal/fish habitats, a bird/plane safety program should solicit the observations and opinions of local birders, naturalists and researchers with deep knowledge of many aspects of the Mendenhall Wetlands. As we have shown, the unintended consequences of tree clearing were predicted by local biologists whose opinions were not heeded.

A recent FAA Advisory Circular (AC150/5200-33A) recommends the establishment of a Wildlife Hazards

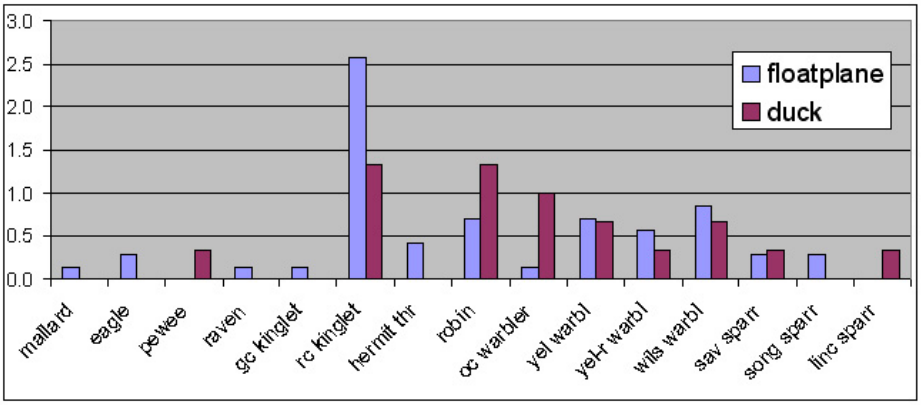

Fig 24 *Number of breeding birds per point count, comparing floatplane basin area (7 sites) to Duck triangle (3 sites). Number shown is the greater value for two count periods during time of peak song in May and June.*

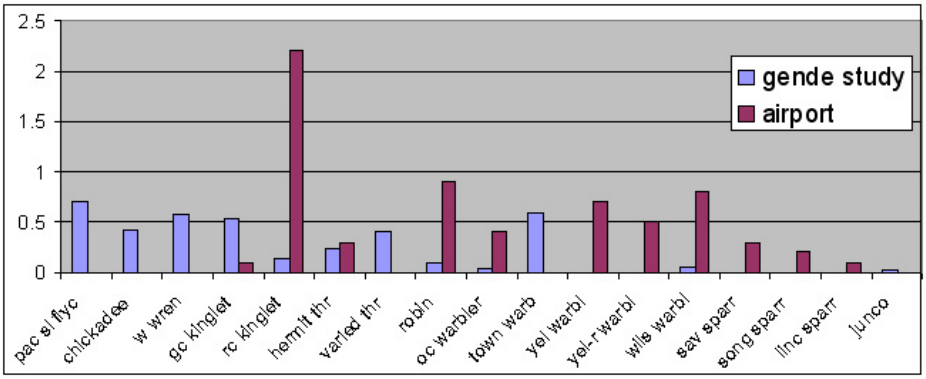

Fig 25 *Number of breeding birds per point count, comparing our combined floatplane basin and Duck triangle sites to data for anadromous salmon streams in conifer forest in the Juneau area (Gende and Willson,2001). Birds on left are conifer forest species; birds on right tend to be deciduous brush and mixed forest species.*

Fig 26 *Western Wood Pewee, a rare nester locally, was present in breeding season at Duck triangle*

Fig 27 *Middle school field trip on Airport Dike Trail, Juneau's best location for educational birding.*

Working Group, and states: "Whether on or off the airport, the input of all parties must be considered when a potentially hazardous wildlife attractant is being proposed."

No community in Southeast enjoys the level of wildlife and fisheries expertise available in Juneau. Many of those experts are devoted dike trail walkers. Local knowledge can contribute as much to safety improvements as to habitat enhancement. We all fly. We all wish to fly more safely.

References

Armstrong, R, and R. Gordon, 2002, Birds of Mendenhall Wetlands, checklist, Juneau Audubon Society.

Armstrong, R, R. Carstensen and M. Willson, 2004, Hotspots: Bird survey of Mendenhall Wetlands, April 2002 to May 2003, Juneau Audubon Society and Taku Conservation Society.

Bishop, D, R. Armstrong, and R. Carstensen 1987. Environmental analysis of lower Jordan Creek and nearby wetlands in regard to planned airport taxiway extension, Environaid, Juneau, AK.

Butler, R, 1997. The Great Blue Heron, *UBC Press, Vancouver.*

Cain, S., J Hodges, and E. Robinson-Wilson, 1988, Bird Use of the Mendenhall Wetlands in Juneau, Alaska. USFWS, Juneau, AK

Carstensen, R. 1996. Vegetation mapping of lower Duck Creek, and comments on proposed channel relocation. Report to R&M Engineering, for Duck Creek Relocation EA.

Carstensen, R, and R. Armstrong, 2002, Bird use of Juneau Airport Property, SWCA/FAA

Gende, S. and M. Willson, 2001. Passerine densities in riparian forests of Southest. Alaska: potential effects of anadromous spawning salmon. The Condor, *103:624-629*

Federal Aviation Administration. 2002. Wildlife Hazard Management Plan for Juneau International Airport, Juneau, Alaska

Federal Aviation Administration. July 27, 2004. Hazardous wildlife attractants on or near airports. AC 150/5200-33A.

Sodhi, N. 2002. Competition in the air: birds versus aircraft. The Auk, *vol 119 No 3*

Wilmoth, W., R. Rossi and M. Linnell, 2001, Wildlife Hazard Assessment for Juneau International Airport, Juneau, Alaska, USDA Wildlife Services.

Acknowledgements

Mary Willson was our partner in the Hotspots study and helped with the development of many ideas in this report. Conversations with Richard Gordon, Steve Zimmerman, Catherine Pohl and Laurie Fergusen Craig added further observations and speculations. We thank SWCA and FAA for critical review that improved the accuracy of this report. Opinions expressed here, and any errors of fact or interpretation, are strictly those of the authors.

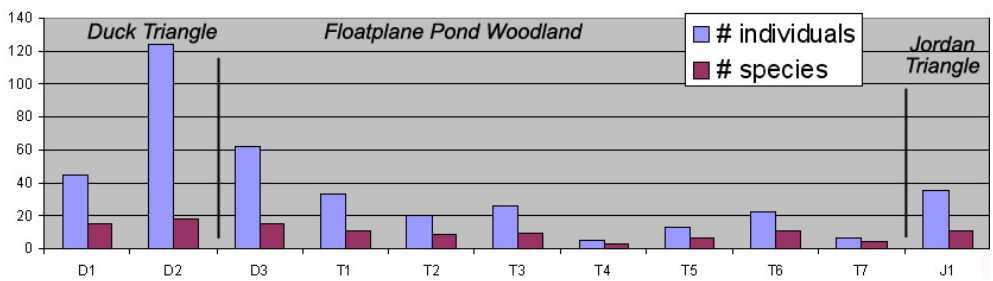

Fig 28 Landbirds at JNU *(excludes waterbirds) Number of individuals counted and species richness for 11 point count circles in 2002. Site locations are shown in fig 1.*