

# Management of Mammalian Predators of Dusky Canada Geese on the Copper River Delta, Alaska

David W. Crowley



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**Cover Photo:** A pair of dusky Canada geese on the Copper River Delta in 2008. © 2008 Jill Crowley.

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## Abstract

The dusky Canada goose (*Branta canadensis occidentalis*) nests primarily on the Copper River Delta (CRD), Alaska and winters in the Pacific Northwest. The dusky population declined from 16,000 in 1990 to 6,700 in 2009. Low recruitment caused by nest and gosling predation has been primarily responsible for the population decline; however, recent surveys provide some optimism for a reversal of the trend. Adult dusky survival is adequate because hunter harvest in the Pacific Flyway has been restricted since 1984, and several refuges were established to benefit duskies. Harvest restrictions on dusky geese limit managers' ability to control population size, distribution, and crop depredation of other Canada goose subspecies on wintering grounds, and require complicated goose hunting regulations and intensive monitoring of the harvest.

Predation on the CRD breeding grounds has changed as long-term succession has produced increasingly larger areas of shrub and tree cover favorable to predators. Bald eagles are the primary predator of duskies, responsible in the late 1990s for more than 70% of observed nest depredations, compared to approximately 13% for brown bears and 5% for canids and other birds combined. Eagles and mink are the primary gosling predators. Factors such as alternate prey availability, weather, and compensatory predation often moderate or exacerbate predation. With no regulatory authority over eagles, ADF&G is limited to managing mammalian predators, including brown bear, coyote, gray wolf, and mink. Since 1987 ADFG has increasingly liberalized harvest regulations for these predators, successfully limiting population sizes of bears and wolves on the CRD, and mink and coyotes along the highway corridor. We propose the following actions to augment ongoing management: 1) maintain Egg Island as a coyote-free, brood-rearing area, 2) promote the harvesting of mink and coyotes by trappers to help conserve duskies 3) support limited brown bear commercial guiding south of the Copper River Highway 4) implement a spring mink trapping program if deemed necessary.

**Key Words:** Dusky Canada goose, *Branta canadensis occidentalis*, Copper River Delta, Dusky Management Plan, population status, predator management, mammalian predator, Pacific Flyway, bald eagle, coyote, brown bear, mink, wolf, eulachon

## Introduction

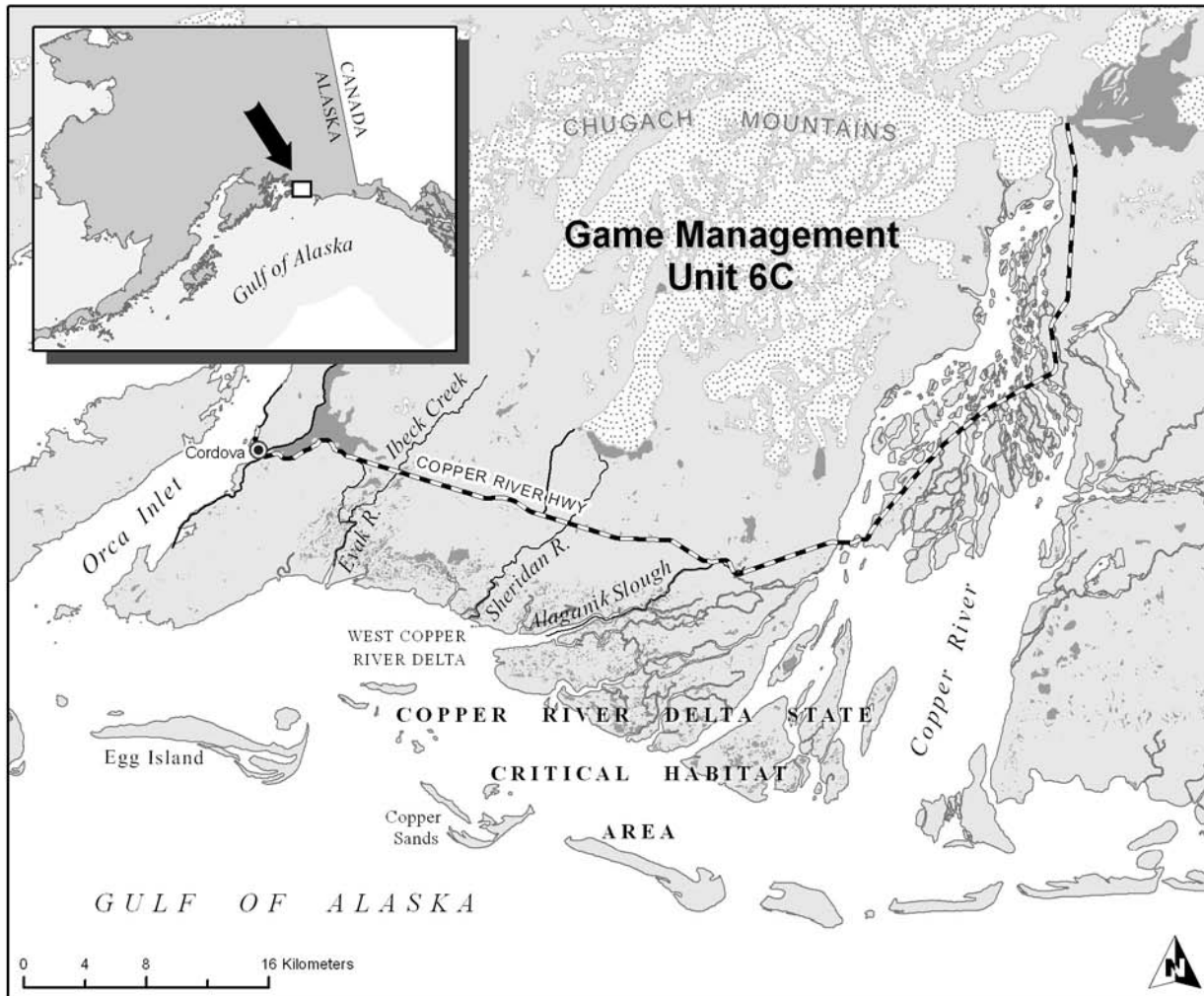
The dusky Canada goose (*Branta canadensis occidentalis*; hereafter dusky) is a dark-breasted race of Canada geese that nests primarily on the Copper River Delta (CRD) on the North Gulf Coast of Alaska. Dusky goose management has been challenging and costly from Alaska breeding grounds to wintering grounds in Oregon and Washington since the 1950s (Bromley and Rothe 2003). Over the decades population declines have prompted increasingly restrictive harvest quotas (1970s – present), creation of 3 federal refuges in Oregon (1960s), and various predator management schemes in Alaska (1980s – present). Meanwhile, other Canada goose subspecies wintering in the Pacific Northwest increased tremendously in number, in large part because of management efforts to benefit dusky. Substantial damage to agricultural fields impelled the development of a crop depredation control plan and creative hunting regulations to protect dusky while maximizing harvest of other subspecies. Nevertheless, the dusky population continued to decline during the last 20 years. The decline has been largely attributed to lack of recruitment caused by predation of nests and goslings on the breeding grounds (Bromley and Rothe 2003).

Campbell and Griese (1987) investigated methods for reducing predation on dusky geese on the CRD for recommendation to the Pacific Flyway Council. The objectives of predator control were to either 1) reduce the number of predators (by lethal and nonlethal means) or 2) provide alternative prey to predators. Lethal reduction could include liberalizing harvest regulations, bounty payment programs, hiring a trapper or agency contractor, or aerial gunning by Alaska Department of Fish and Game (ADF&G) staff or permittees (Campbell and Griese 1987). Nonlethal reduction might involve translocation, sterilization, aversive taste conditioning, captive brood rearing, or predator exclusion such as the artificial nest island program conducted by the U.S. Forest Service, Cordova Ranger District (USFS) since 1984 (Fode and Meyers 2008). Alternate prey could be provided by supplemental feeding or by increasing another prey species; however either means has the dissuading potential to increase population size of primary and secondary predators. Over the last 2 decades dusky managers have deliberated over, and in some cases implemented these management techniques.

Predator management on the CRD is greatly complicated by the variety and evolving composition of species preying on dusky Canada geese. In addition, it is difficult to estimate how management of a particular predator species could affect interactions among all predators, and to predict net effects on dusky goose production (Pacific Flyway Council 2008). The CRD is approximately 1120 km<sup>2</sup> of logistically challenging wild lands with very low road density and few navigable waterways. Management operations are difficult and expensive. Consequently, the Pacific Flyway Council adopted a broad series of management actions to benefit dusky should the population drop below pre-determined population thresholds (Pacific Flyway Council 2008). In 2009, the 3-year running average for the dusky population dropped below 10,000 geese (Larned and Stehn 2009), triggering more aggressive management actions in the Dusky Management Plan (Pacific Flyway Council 2008). Therefore, it is timely to evaluate predator management actions taken during the last 23 years, some of which have successfully limited population size for some predators. This paper also reviews recently-published dusky goose research regarding predator-prey relationships, and considers additional actions that may be feasible and effective in restoring the dusky population.

## Dusky Population Status

Most dusky nesting, and consequently research and management activities, occurs on the west of the Copper River (WCRD) in Game Management Unit 6C (Fig. 1). The CRD is a designated State Critical Habitat Area located in Game Management Unit 6 on the North Gulf Coast of Alaska. Unit 6C lies west of the Copper River, south of the Chugach Mountains, east of Orca Inlet, and north of the Gulf of Alaska (Fig. 1). Campbell (1990) provided a description of vegetation succession and hydrology on the CRD. Dusky arrive in late March or early April and usually initiate nesting during the last week of April through the first week of May.



**Figure 1. West Copper River Delta, Alaska, in ADF&G Game Management Unit 6C.**

The dusky population declined from about 16,000 in 1990 to an historically low level of 6,700 (or 3-year running average of 8,680) in 2009 (Larned and Stehn 2009). Estimated annual survival rate for adult dusky was adequate ( $>80\%$  during the last 12 years, Dan Collins, Biologist, USFWS, unpublished data), and human harvest of dusky was not considered a limiting factor to population growth because of restrictive hunting regulations enacted in 1984 for Alaska, Oregon, and Washington. Harvest regulations remain liberal in British Columbia (B.C. Ministry of



Environment 2009) where duskies occur on Vancouver and Queen Charlotte Islands during winter (Hansen 1961a, ADFG unpublished banding data), though dusky harvest is apparently low (Andre Breault, Biologist, Canadian Wildlife Service, unpublished data).

Decline of the dusky population during most of the last 2 decades was attributed predation on the breeding grounds, resulting in low nest success (21–31%; Grand et al. 2006) and gosling survival (14–41%; Fondell et al. 2008a). Over the last three years, however, this situation improved substantially. Annual production surveys conducted in midsummer by ADF&G indicated very high production (37–47% young observed) during 2008 – 2010, exceeding the Dusky Management Plan objective of 20% young (10-year running average) during all 3 years (Petrula 2010). The USFS also observed an increase in number and rate of artificial nest islands successfully used by duskies during the last 2 years (Jason Fode, Biologist, USFS, personal communication) and the breeding bird survey in spring 2010 indicated an increase to 9,500 geese (U.S. Fish and Wildlife Service 2010). These factors may signal a reversal in the downward trend of the dusky population.



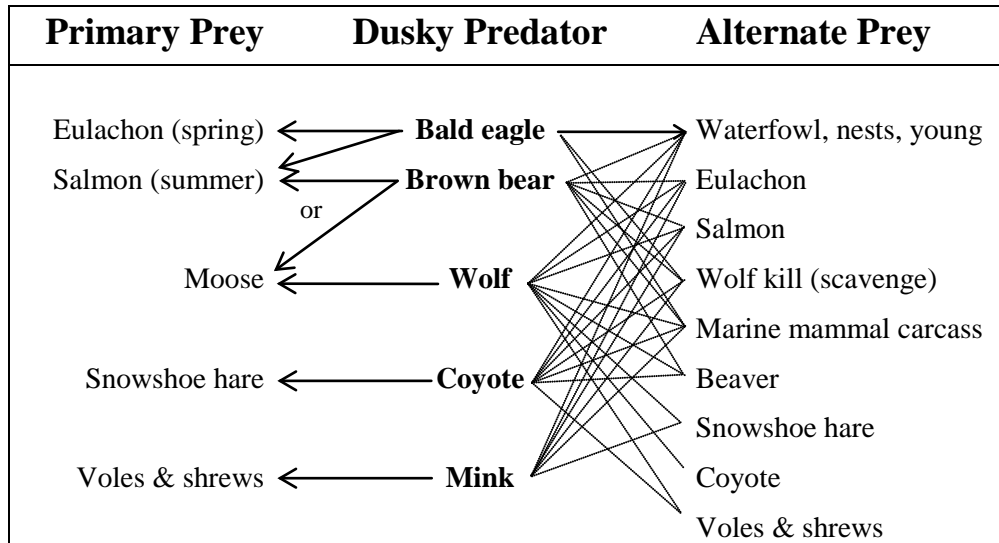
**Figure 2. ADF&G surveys the Copper River Delta with helicopter pilot Troy Cambier to determine reproductive success of dusky geese. © 2009 ADF&G, photo by Mike Petrula. Inset photo © 2009 ADF&G, by David Crowley.**

## Predator Dynamics on the Copper River Delta

Breeding duskies are subject to a suite of mammalian and avian predators (Fig. 3). Of 10 mammalian predators that occur on the CRD, four species regularly prey on nests and goslings: brown bears (*Ursus arctos*), coyotes (*Canis latrans*), gray wolves (*C. lupus*) and American mink (*Mustela vison*). Long-term habitat succession on the CRD, resulting from uplift caused by the 1964 earthquake, has produced increasingly larger areas of shrub and tree cover favorable to predators (Campbell 1990). As plant succession advanced on the CRD, those predators important in limiting dusky productivity have changed over time (Bromley and Rothe 2003). Prior to uplift, nest destruction was caused primarily by tidal flooding (Hansen 1961b). By the mid 1970's jaegers and gulls caused most nest destruction and brown bears were first recognized as nest predators (Bromley 1976, Mickelson 1985). Brown bears became the most important predator by the late 1980s, attributed with 50% of depredated nests (Campbell 1990). At that time bald eagles (*Haliaeetus leucocephalis*) killed few geese and were not considered nest predators (Mickelson 1985). By the late 1990's eagles became the most significant predator, responsible for over 70% of depredated nests, while brown bears destroyed approximately 13% (Anthony et al. 2004). ADF&G has no management authority over the federally protected bald eagle.

Nest predation by eagles is alleviated seasonally by leaf-out and, more importantly, with the arrival of the anadromous eulachon (*Thaleichthys pacificus*), a preferred forage fish that spawns in sloughs and rivers on the CRD (Fig. 4) (Miller et al. 2006). Timing and abundance of eulachon runs are unpredictable (Moffitt et al. 2002, Marston et al. 2002), but the fish often arrive 1–3 weeks after peak nest initiation of dusky geese. Moderate-sized but timely eulachon runs probably contributed to high dusky productivity observed during the last 3 years. Mammalian predators also feed on eulachon (Marston et al. 2002, Mickelson 1985, personal observation). Predation by mammals tended to occur during the later part of the nesting season (Anthony et al 2006, Grand et al. 2006, Miller et al. 2006).

The highest source of dusky gosling mortality to age 45 days was predation, primarily by eagles and mink, but daily survival rate (DSR) was also negatively related to precipitation (Fondell et al. 2008b). Fate of goslings after 45 days of age was unknown, but DSR presumably increased after the first few weeks of life (Fondell et al. 2008a) and scant leg band returns from 1996–2008 suggested that hatch-year (HY) duskies had a survival rate of about 60% (Collins unpublished data). During the annual production survey conducted July 2008, Petrula (2008) observed 1,700 goslings WCRD, resulting in the highest production index in over 30 years. Yet the 2009 annual breeding survey (May 22–23) indicated a continued, significant decline in the population (Larned and Stehn 2009). This and adequate HY survival rate (Collins unpublished data) suggested that a segment of the population (e.g., nonbreeders or HY cohort) arrived after the breeding survey, or spent the breeding season elsewhere. Hence, while predation from nest initiation to 45 days is a major limiting factor, this possible missing cohort suggests that there are other aspects of population dynamics or behavior that are not explained by predation on the breeding grounds.



**Figure 3. A simplified view of predator-prey relationships on the Copper River Delta suggests some management complications, particularly because bald eagles are the most significant dusky goose predator.**

## Mammalian Predators

This section provides species accounts for mammalian predators including population size if known, impact of predation on duskies, and management of each species. Population trends of furbearers were monitored primarily through harvest records and trapper survey. Beginning in 2006, I recorded linear track density of furbearers and their prey on snowmobile transects (10 km total). In addition, observations of wolf and coyote were recorded during aerial moose (*Alces alces*) surveys. Although sightability was highly variable, observations of predators and tracks provided information for qualitative assessment, and at best provided minimum pack size for wolves and minimum density indices for coyotes. Mink, otter, wolf, and coyote have no trapping bag limits and current seasons begin 10 November. In addition to trapping seasons, wolf and coyote also have open hunting seasons.

### COYOTE

Coyote numbers in Alaska cycle with availability of their primary prey, the snowshoe hare (*Lepus americanus*) (Prugh 2004), and Carnes (2004) reported that hares were the most important prey of coyotes on WCRD. Because there are no density estimates for coastal coyotes in Alaska, we have only qualitative assessment of abundance. Coyotes were aerial hunted extensively on the CRD during the predator bounty era, which probably controlled population size into the 1960's. Following statehood and elimination of bounties and aerial gunning, coyotes increased in number. The hare and coyote cycle peaked in Unit 6 during the late 1990s (personal observation) and is either approaching or recently reached the next peak based on track counts and winter density index (unpublished data).

Although coyotes do prey on duskies and their nests, they are apparently not a particularly sought-after prey. I could detect no relationship between indices of coyote abundance and dusky

production ( $F = 0.37$ ,  $P = 0.31$ ), a result consistent with Anthony et al. (2004) who found canids to be only minor nest predators. As coyote abundance has recently cycled upward toward another peak, dusky production indices have been unusually high (Petrula 2010). Carnes (2004) reported that waterfowl remains (unspecified) occurred in less than 4% of coyote scat during the 1990s. Coyotes have abundant alternate food resources (Fig. 3); primarily moose (scavenged from wolf kills) and small mammals, but which also include salmon (*Oncorhynchus* spp.), beaver, porcupine, eulachon, various plants and berries (Carnes 2004, Mickelson 1985).

Coyote harvest regulations were liberalized considerably by the Alaska Board of Game (BOG) beginning in 1987 to reduce dusky predation (Griese 1990) (Table 1). During 1987–2006, the trapping season was 1 month longer than adjacent units, and in 1987–1991 hunting regulations allowed year-round spotlighting with no bag limit. These regulations were the most liberal that ADF&G has tested to date in order to control coyotes (Griese 1990, personal observation). The BOG eventually realigned Unit 6C regulations with adjacent areas, ostensibly because coyote harvest did not increase (Nowlin 1998). However, actual harvest was unknown because pelt sealing or reporting was not required. Between 1986 and late 1990s nest predation by canids decreased from 17% (Campbell 1986) to less than 5% (Anthony et al. 2004). This decline in rate of canid predation could be attributed to any number of factors including increasing eagle population, higher hare abundance (primary prey for coyote), and establishment of wolves that provided moose carcasses as a new alternate food source.

**Table 1. Coyote hunting and trapping regulations in Game Management Unit 6C.**

Year	Season(month/yr)	Bag Limit
<b>State coyote trapping</b>		
Pre-1987	11/1–3/31	No limit
1987–2006	11/10–4/30	No limit
2007–present	11/10–3/31	No limit
<b>State coyote hunting</b>		
Pre-1987	9/1–4/30	2
1987–1990	Year round	No limit and night spotlighting allowed
1991–2003	9/1–4/30	2
2004–2008	8/10–4/30	10
2009–present	8/10–5/25	10
<b>Federal subsistence coyote hunting</b>		
1990–2009	Year round	No limit

The Copper River Highway corridor (Fig 1) is probably an area of reduced mammalian predators. Trapping and hunting occurs mostly within 1 km of the road, which provides consistently good access and focused effort, while access to the majority of WCRD is difficult and seasonally variable. Although coyote pelts have low market value, some recreational trappers set for coyotes and predator calling is popular among hunters. There remains the opportunity to hunt coyotes year-round with no limit (Table 1). Based on conversations with trappers I estimate that coyote harvest on WCRD ranges from 10 to 30 annually. Disturbance by other recreationists and highway vehicles further reduces use of the road corridor by large predators. Between Ibek Creek and Sheridan River (Fig 1), typically dozens of goslings and adult geese are visible in suitable habitat adjacent to the road during summer.

Increasing numbers of dusky geese and goslings were observed on Egg Island during recent production surveys (Petrula 2010). Coyotes have been present on Egg Island in the past (Campbell 1988), but during the 2005 and 2006 nesting seasons no sign of any mammalian predators were observed by shorebird researchers living on the island (Bishop 2007; H. River Gates, USFWS, personal communication), nor did I see any during multiple visits in 2010. Brood flocks were observed grazing far from any water bodies where flightless goslings and molting adults could possibly escape from coyotes or other predators.

I tested the feasibility of diversionary feeding of predators as a means to reduce nest predation during that period of time before eulachon normally arrive. The objectives were to evaluate the logistics of implementing the project and determine if predators would use bait blocks as a food source. I anchored two 130 kg blocks of gradually-thawing fish carcasses in the lower Alaganik Slough area in early May 2009. Bait blocks were visually monitored during daylight hours, during May 3–5, 2009. I checked bait daily for tracks to determine if bait was visited at night. No coyotes or eagles fed at bait blocks, but tracks indicated a single visit by a brown bear sow with cub. However, sea lion and bird activity signaled that eulachon were already running in the Alaganik during the trial (Fig. 4), which negatively biased feeding at bait blocks by predators. This early and persistent eulachon run contributed to high dusky productivity observed in 2009 (Miller et al. 2006). It became apparent that the scale at which diversionary feeding must occur rendered this technique unfeasible even if bait was eaten by predators. Coincident with diversionary feeding, aversive taste conditioning of bald eagles was also tested and determined unfeasible by Fondell and Hupp (2009).



**Figure 4. Hundreds of glaucous-winged gulls and 23 bald eagles were present on this reach of Alaganik Slough feeding on eulachon in April 2009. © 2009 ADF&G, photo by David Crowley.**

## **WOLF**

Wolves were not present in Unit 6 when moose were introduced in the 1950's. Moose increased rapidly on the CRD during the 1960's in pristine and wolf-free habitat. Wolves eventually immigrated via the Copper River corridor and became established on WCRD around 1980. Thus an unintended consequence of the moose introduction was the addition of another mammalian dusky predator. Typical of a colonizing species, the wolf population increased rapidly; it peaked around 1988 at 18–20 wolves, and since has declined and stabilized at a lower density (Griese 1989, Crowley 2006).

Although moose are the primary prey of CRD wolves, predation on dusky nests may have been substantial during peak wolf density. Predation of dusky nests and molting adults was readily observed after wolves declined in the early 1990's (Stephenson and Van Ballenberghe 1995). Fondell et al. (2008a) reported that wolves and coyotes preyed upon similar proportions of goslings observed killed on WCRD during the late 1990s, while Carnes (2004) found waterfowl remains and egg fragments more frequently in wolf scat than coyote scat. Recently a lone wolf was observed depredated dusky nests along the lower Eyak River (Fig. 1) (Julius Reynolds, ADF&G biologist retired, personal communication). Nevertheless, canids were observed taking only about 5% of depredated dusky nests during the late 1990s (Anthony et al. 2004). Like coyotes, wolves feed on a variety of alternative prey, including salmon and beaver.

Wolves may limit coyote abundance (Berger and Gese 2007, Prugh 2004) on the WCRD, where they have been observed killing coyotes (Carnes 2004, personal observation). Coyotes are considered prey and eaten in their entirety by CRD wolves, a behavior rarely seen elsewhere (Carnes 2004). Allowing wolves to increase on WCRD to further reduce coyotes is not practical because: 1) wolves prey on nests, goslings and molting geese; 2) wolves kill moose; and 3) the resulting loss of opportunity to hunt both moose and wolves would be socially unacceptable.

Since becoming established, wolves have been managed for low density on WCRD to reduce predation on moose and dusky populations. Unit 6C is typical of road-accessible areas of Alaska where a wolf population can be limited by trapping and hunting. Wolves are valued for trophy

and pelt value and are highly sought after by trappers. Wolf trapping season occurs during 10 November – 31 March with no limit. Hunting season is 10 August – 30 April with a bag limit that increased from 2 to 5 beginning in 1990 to reduce predation on both goose and moose on the CRD. These liberal seasons and bag limits have limited their number to 2 – 6 wolves in packs or singles on WCRD. Current wolf numbers are acceptable to the public and predation on dusky geese is probably insignificant (Anthony et al. 2004); therefore, no further management actions on wolves are warranted.

## **BROWN BEAR**

Brown bears are common on road accessible areas of WCRD and abundant on the remainder of the CRD. Campbell and Griese (1987) used radio telemetry to estimate that 35 to 48 bears resided on the WCRD during the mid 1980's. Using the population estimate for brown bears of Campbell and Griese (1987) as a baseline, ADF&G has assessed bear population annually since 1987 using harvest size, sex and age characteristics from bear sealing data, deterministic modeling, and field observations (Griese 1995). The 2009 post-hunt population size for brown bears was approximately 100–180 in Unit 6C, around 25–40 of which spent time on WCRD, which was similar to the mid-1980s estimate.

Dusky geese and nests are not primary prey for brown bears. After emerging from dens, brown bears move out to the CRD late in April or early May to forage on early spring growth of sedges, grasses, and equisetum (Campbell 1991). As May progresses, bears prey on moose calves, beaver, goose eggs, eulachon and salmon. The earliest reported nest predation by brown bears was May 21 (Anthony et al. 2004), several weeks after nest initiation and coincident with the onset of moose calving, the timing and location of which consistently overlaps with dusky nesting. The proportion of nests destroyed by brown bears declined from 50% during the 1980s (Campbell 1990) to 13% during the late 1990s (Anthony et al. 2004). Campbell (1987) temporarily reduced the WCRD bear population by 40–60% to test their effect on nest success. The proportion of nests destroyed by bears declined as a result, but nesting success did not improve overall because of compensatory predation by other species (Fig. 3). ADFG increased the moose population from an estimated 300–350 to 400–500 moose by 2007 to benefit human use. Over 350 calves are theoretically born each spring (unpublished data), which has potentially reduced alternate prey requirements for brown bears.

Further liberalization of current brown bear regulations would have little effect on bear harvest. Hunting regulations for Unit 6C have become as liberal as those first enacted in the 1960s. Until 1997, brown bears were managed conservatively because of perceived low density and rate of reproduction. An apparently increasing population and predation on both dusky goose nests and moose calves prompted gradually liberalized seasons and bag limits during the last 2 decades. One week was added to the spring season in 1987, the bag limit increased from 1 bear every 4 years to 1 bear per year in 1997, in-unit sealing and reporting restrictions were removed in 2005, and 10 days were added to the season beginning in spring 2010. Even though mean annual harvest increased by only 1.1 bears ( $F=0.99$ ,  $P = 0.33$ ) for the 12 years after bag limit was increased to 1 bear per year, the less restricted bag limit allowed occasional higher harvest (up to 8–13% of the population) that reduced population size. The 2008 harvest of 13 bears was the highest on record. The majority of bears observed in dusky nesting areas tend to be sows with cubs, which are illegal to harvest, or immature bears of lower value to hunters. Furthermore,

harvest sustainability and viewing opportunity of brown bears has higher priority than increasing bear harvest in order to protect an unknown, but probably inconsequential, number of dusky nests.

### **AMERICAN MINK**

Fondell et al. (2008a) identified mink as an important predator of dusky goslings on WCRD. Mink are common to abundant on WCRD (Crowley 2007), but there are no estimates of density for mink in Alaska. If mink density is 2 per km<sup>2</sup> as found in other northern freshwater systems (Linscombe et al. 1982), then our theoretical population size would be a minimum of 600 mink on the mainland south of the highway (Fig. 1). Robards (1955) reported that 720 mink were trapped on the WCRD during 1954 alone, which he believed suppressed the mink population considerably. Average annual harvest during the 1970's was 200 mink (ADF&G unpublished data). Current harvest is approximately 40 – 60 mink per year.

Mink trapping season runs from 10 November through 28 February with no bag limit. Mink season was increased by 1 month (to 28 February) in 2001. Further extension of the season is not feasible because pelts begin to singe (losing what little value they have) and incidental capture of pine marten (*Martes americana*) is possible. As with coyotes, mink harvest reporting is not required, low pelt price limits harvest, and trapping probably limits mink numbers along the highway only. Post-season test-trapping along the highway in 2010 indicated low mink density.

### **OTHER MAMMALS**

Formerly abundant on WCRD, red fox (*Vulpes vulpes*) have been rare to absent for many years (Campbell and Griese 1987, Carnes 2004). An annual harvest of 50–60 occurred during the 1950s (Michelson 1985) but very few taken since 1972 (Griese 1988). Foxes were probably extirpated by coyotes and wolves as they became more abundant (Griese 1990), perhaps another unexpected effect of the moose introduction. Lynx (*Lynx canadensis*) are cyclically uncommon or absent on the CRD and are not considered dusky predators. Wolverines (*Gulo gulo*) are common in mountainous areas of Unit 6 but rarely visit the delta after spring break up.

River otter (*Lontra canadensis*) pelts have fetched high prices during most of the last decade and trapping is limiting their numbers on some areas of WCRD (unpublished data). Otter season opened 20 days earlier beginning in 1987 to allow more harvest. Tracks observed during aerial moose surveys indicate that otters are more abundant east of the Copper River where there are no trappers (unpublished data). Fondell et al. (2008a) found that river otters were infrequent predators of goslings. Consequently, changes in management are not under consideration.

## **Predator Management Options**

This section addresses remaining actions that could be feasibly attempted to control mammalian predators on WCRD, with the obvious caveat that they do not address the most significant predator of duskies, the bald eagle. Legal and sociopolitical considerations aside, identifying and destroying nest-depredating eagles would be more effective than controlling mammalian predators.



## **COYOTE**

Coyote control on the CRD would entail intensive effort, difficult logistics, and high costs. Predator control is difficult because of the region's large size and extensive forest and shrub cover. Shooting from a helicopter during winter would probably provide the only effective method. With no helicopters in Cordova, air support would be a limiting factor, and weather windows are variable and brief during winter. Given the currently small contribution of coyotes to nest predation and doubts that a sufficient proportion of the population could be removed, such intensive action would warrant a careful analysis of potential benefits to nest success vs. costs (Pacific Flyway Council 2008). The cost of formal predator control programs in terms of funding, legal defense in court, and state and federal planning processes did not have the support of agencies involved in Alaska at a dusky management meeting held December 2, 2009.

In contrast, Egg Island (Fig. 1), lying off the mainland and surrounded by ocean channels that rarely freeze, could be managed as a coyote-free brood-rearing area. Coyotes attempting colonization could be eliminated from the island under harvest regulations without formal predator control.

Further liberalization of the trapping season for coyotes is not feasible because of the potential for incidental catch of other species such as duskies and moose calves during spring. Local hunters already may take coyotes year round with no bag limit. Trappers and hunters will be encouraged to harvest coyotes to conserve duskies.

## **AMERICAN MINK**

Post-season test-trapping for mink along the CRH in April 2010 indicated that mink could be caught without catching marten. Marten occur on unforested habitat on the CRD during winters with heavy snow but probably retreat before snow melt. Although boat travel on the delta is easier for trappers in the spring, poor pelt value would discourage participation once pelts have singed. Therefore, the hiring of 1 or 2 ADF&G technicians or USDA Wildlife Services to trap under a nuisance permit would probably be required.

ADF&G will inform and encourage trappers to set for mink and inform other organizations of dusky conservation efforts to avoid conflicting policies. For example, a city ordinance proposed to prohibit trapping along roads and trails to protect free-roaming dogs (and supported by a local chapter of Audubon Alaska) would have ended most mink harvest in the brood-rearing area between Ibek Creek and Sheridan River (Fig. 1). A much-debated, amended ordinance banned leg-hold traps for coyote but allowed snaring and mink trapping to continue in the corridor.

## **BROWN BEARS**

Commercial guiding for brown bears is currently not permitted on WCRD under the Chugach National Forest Plan. Allowing guides, who usually seek large mature boars, would require a public review and change to the Forest Plan, but could result in an additional 1 to 3 bears being taken annually. Through their permitting process the U.S. Forest Service, Cordova Ranger District could direct guiding to important nesting areas on the outer WCRD to maximize the benefit of any additional harvest, most of which would be adult male bears preferred by guides. Beyond limited guiding for large boars, ADF&G is opposed to any further liberalization in season or bag limit on the CRD.

## Conclusions

ADF&G has managed mammalian predators to benefit duskies for nearly 25 years. During that period, bald eagles became the most significant dusky predator by far, which casts doubt on the need for increasingly aggressive control of mammalian predators. ADF&G has no management authority over the federally protected bald eagle. Record-high production indices during 2008 – 2010 occurred without additional predator control beyond the usual trapping and hunting harvest. Predicting effects of predator control is problematic given other factors that moderate or exacerbate mammalian predation, including alternate prey (Fig. 3), weather, compensatory predation, intra-specific competition, and even timing of leaf-out.

Harvest regulations for both brown bear and wolf have been liberalized to the extent that human harvest is limiting populations on WCRD. Neither bears nor wolves were primary predators of dusky nests or goslings during the late 1990s. Therefore, with the exception of carefully directed and limited guiding for bears, ADF&G will support no further liberalizations of regulations for brown bears or wolves.

Coyotes can be hunted year-round with no bag limit on the CRD. Coyotes are probably not limited by human harvest with the exception of the highway corridor. Given the coyote's relatively insignificant status as a predator on nests and goslings, large-scale predator control programs are not supported by dusky management agencies in Alaska. However, monitoring and maintaining Egg Island as a coyote-free brood-rearing area should benefit the dusky population which has recently been rebuilding on the island.

Mink are a significant predator of dusky goslings. Mink are probably limited by trapping along the highway corridor, but not elsewhere on WCRD because of difficult winter access and low market value. Spring trapping by agency personnel may be a feasible technique to reduce coastal mink, where duskies nest at high density and very little public trapping occurs. Meanwhile, trappers will be annually encouraged to set for mink and coyote to conserve duskies.

### MANAGEMENT OPTIONS SUMMARY

ADF&G proposes the following actions to augment ongoing management of predators:

- Maintain Egg Island as a coyote-free, brood-rearing area.
- Develop a program to provide information for trappers and other user groups describing how harvesting mink and coyotes can help conserve duskies.
- Assist USFS in crafting a guide use permit for limited brown bear guiding on WCRD.
- Investigate the feasibility of a spring mink control program to be conducted by agency personnel or contracts and implement if appropriate.

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