Potential effects of the Sterling Highway realignment on brown bears near Cooper Landing, Alaska:

a look at defense of life or property kills and probability of landscape use by adult female brown bears

A report submitted to:

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and
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Executive Summary

The Problem

The Sterling Highway from mile post (MP) 45 to MP 60 follows the Kenai River Valley through the Kenai Mountain range and is constricted by the Kenai River, tributary creeks, and steep valley walls (ADOT&PF 2004). The scenic nature of the area and world-class fishing on the Kenai and Russian rivers combine to create serious congestion problems for the highway from May through September. This level of congestion has created safety issues for highway travelers, especially in areas where high-speed traffic conflicts with vehicles turning on and off the highway (HDR Alaska, Inc. 2003).

The following road construction alternatives are being considered to address this problem (Fig 1):

- **No-build Alternative –** Under the No-build Alternative, the Sterling Highway would continue to be maintained and bridge replacement would occur according to ADOT&PF highway maintenance bridge replacement schedules.
- **Cooper Creek Alternative –** This alternative follows the existing Sterling Highway alignment, except for a 5.6-km section through Cooper Landing. Heading west from MP 45, the alternative follows the existing alignment at Kenai Lake. At Snug Harbor Road (MP 47.7), the alternative turns south and rejoins the existing corridor at MP 51.3.
- **"G" South –** This alternative uses a new corridor north of the existing roadway between MP 46.3 and MP 51.6. Heading west from MP 45, the alternative departs the existing corridor at MP 46.3. The alternative crosses the Kenai River and then rejoins the existing alignment at MP 51.6.
- **Juneau Creek "F" Wilderness –** This alternative creates a new corridor north of the existing roadway between MP 46.3 and MP 55.6. Heading west from MP 45, the alternative departs the existing corridor at MP 46.3 and rejoins the existing corridor at MP 55.6.

Background

- The realignment of the Sterling Highway may affect resources on National Forest lands.
- The USDA Forest Service (USFS) has had a primary role in developing several models to assess brown bear habitat capability, to describe patterns of landscape use by female brown bears (*Ursus arctos*), and to describe patterns of brown bears killed in defense of life or property (DLP). This work was accomplished through the effort of the member agencies of the Interagency Brown Bear Study Team: Alaska Department of Fish and Game, USFS, U. S. Fish and Wildlife Service, and National Park Service. The data supporting these modeling efforts were collected under the aegis of the MOU dated 5 July 1984, with 4 amendments in 1998, and updated 1 May 2003 under USFS Agreement No. 03MU-111004-026.
- The Federal Highway Administration, HDR Alaska, Inc. and the Alaska Department of Transportation and Public Facilities (ADOT&PF) requested information from the USFS regarding the potential effects on brown bears of realignment of the Sterling Highway through the Chugach National Forest.
- This project falls under the USFS Agreement No. 04CO-111004-010.

Our Purpose

- To determine the effects of alternatives for realigning the Sterling Highway near Cooper Landing, Alaska and subsequent ancillary development on brown bears.

Key Findings for the Assessment Area

- Mean road densities increased 11 to 25% by alternative (i.e., 28 to 65 m/km^2 increase), resulting in a potential decrease of relative probability of occurrence of brown bears of 2.3 to 5.3%.
- Mean densities of houses and cabins increased from 21 to 57% by alternative (i.e., 0.3 to 0.8 units/km^2 increase) resulting in a potential decrease of relative probability of occurrence of brown bears of 5.4 to 8.0%.
- Probability of occurrence of brown bears killed in defense of life or property increased from 3.8 to 6.2% by alternative.

Introduction

Brown bears on the Kenai Peninsula have been the subject of study by the Interagency Brown Bear Study Team (IBBST) for approximately 20 years, resulting in *A Conservation Assessment of the Kenai Peninsula Brown Bear* (IBBST 2001) and several other publications (e.g., Jacobs and Schloeder 1992, Suring et al. 1998, Hilderbrand et al 1999*a,b,c*, Suring and Del Frate 2002). Initial applications of a cumulative effects model developed by the IBBST indicated that large reductions in habitat effectiveness resulted from past land management activities (Suring et al. 1998). Current and planned development activities on the Kenai Peninsula have the potential for additional reductions in habitat capability and for increased human encounters with brown bears and increased DLP kills (e.g., Martinka 1982). Population viability was a main reason the Alaska Department of Fish and Game (ADF&G) listed brown bears on the Kenai Peninsula as a population of special concern (Del Frate 1999).

The number of brown bears on the Kenai Peninsula is unknown. ADF&G estimated an approximate population of 280 (IBBST 2001) but the accuracy of this estimate is uncertain. The occupied range of brown bears on the Kenai Peninsula was determined through sighting and kill records (i.e., the landscape scale); a density coefficient was developed from estimates derived in other Alaska studies to come up with the population estimate. The IBBST has developed a genetic mark-recapture technique to more accurately estimate the population. This estimate will provide a foundation for further effects analyses. Population viability will be of particular interest if the new population estimate is low and if mortality (human-caused and otherwise) on the Kenai Peninsula is higher than potential immigration or recruitment of individuals. This concern has been raised in a recent letter from 7 non-government organizations (signed by Corrie Bosman – Center for Biological Diversity) to Mr. Jeff Hughes, former Regional Supervisor, ADF&G (12 January 2004).

Assessments of landscape use, brown bears killed in DLP, and genetic subdivisions are 3 of the large-scale projects that have been recently completed by the IBBST.

Landscape use.—Analysis of the relationship of brown bear movement patterns to landscape and human-use variables led to the development of resource selection functions (RSFs) that describe relative probabilities of occurrence of female brown bears across the Kenai Peninsula (Suring et al. 2004*a*). These models were developed to describe female brown bear habitat use patterns across large-scales and have been subjected to rigorous statistical testing.

Maps of these probabilities across the Kenai Peninsula were generated through geographic information system (GIS) processes.

Defense of life or property kills.—Habitat modification and human activities have resulted in increased numbers of brown bears killed in DLP in recent decades (Suring and Del Frate 2002). The human population on the Kenai Peninsula has expanded from just over 9,000 in 1960 to approximately 50,000 in 2000. Bears killed in DLP totaled approximately 20 in each decade in the 1970's and the 1980's, and then increased to 50 from 1990 to 1999 (Suring and Del Frate 2002). While the human population continued steady growth over this time, the rate of DLP kills has continued to increase (Table 1). There were 49 brown bears reported killed (non-hunting mortality) on the Kenai Peninsula from 2000-2003 (J. Selinger, ADF&G Area Biologist for the Kenai Peninsula, *personal communication*). Seven of these brown bears died as a result of vehicle collisions.

Genetic considerations.—A recent genetics study focused on whether Kenai Peninsula brown bears were composed of two geographically separated non-interbreeding populations. Using samples collected from 1996-2001, brown bears on the Peninsula (1) appeared to be one large panmictic population, with no genetic subdivisions; (2) showed neither significant evidence of inbreeding nor any signature of a significant historical bottleneck; and, (3) had the genetic structure of a peninsular population (Jackson et al. in preparation). Barriers such as mountains and glaciers on the Kenai Peninsula, as well as the 17.7 km isthmus at Turnagain arm, seemed insignificant in reducing gene flow.

Assessment Area

For this analysis, we developed an assessment area along the Sterling Highway from MP 45 to MP 60 within 1,000 m north of the Juneau Creek alternative alignment and within 1,000 m south of the Cooper Creek alternative alignment (Fig. 1). Total area included 6,237 ha. This area encompassed 108 radio locations of female brown bears captured in the vicinity of the assessment area from 1995 through 1998 and coincided with spring and summer habitat for female brown bears in this area. This assessment area size provided a scale that was expected to produce results that would be meaningful for decision makers using the results of this analysis and biologically relevant to brown bears potentially using habitat in the vicinity of the proposed actions. The 1,000-m buffer was also consistent with the designation of assessment area boundaries used by Suring et al. (2004*b*). Thus, the assessment area boundaries were chosen for administrative and biological reasons.

Methods

We considered the proposed alternatives for the Sterling Highway realignment using modeled algorithms developed in the RSF and DLP studies (Suring and Del Frate 2002, Suring et al. 2004*a*). Two analyses were completed; the first indicated the relative probability of occurrence of female brown bears (i.e., RSF analyses) and the second showed the relative probability of DLP kills of brown bears (i.e., DLP analysis). We included ancillary development (i.e., subdivisions, access roads, and trail heads) in our analyses when it was coupled with the proposed road infrastructure.

RSF analyses.—It is often assumed that animals will select resources in space and time that will maximize their probability of survival and the survival of their offspring (Buskirk and Millspaugh 2004). A corollary to this is that high quality resources will be selected by animals more than low quality resources. One of the simplest ways to estimate RSFs that describe these patterns is to use logistic regression in association with data on used and available resources (Manley et al. 2002).

The results of these types of analyses are proportional to the probability of the occurrence by a species of interest across land areas. They may be used to characterize factors influencing habitat use by a species and, with GIS applications, may be made spatially explicit (Suring et al. 2004*b*). Research efforts recently reported in the scientific literature have found RSFs to be reliable in predicting animal distribution and habitat use and useful in cumulative effects analysis, land-management planning, and population viability analyses (e.g., Boyce et al. 1994, Boyce and McDonald 1999, Boyce and Waller 2003). However, they are best applied in landscape level analyses (e.g., Boyce and Waller 2003) and may be less reliable for site-specific analyses.

Development of RSFs describing landscape use by female brown bears on the Kenai Peninsula was based on locations of 43 adult female radio-collared bears from 1995-2000, from which over 30,000 telemetry point locations were obtained (Suring et al. 2004*a*). The RSF analyses on the Kenai Peninsula considered 4 strata (i.e., female brown bears with and without cubs, during spring and summer) based on distinct movement and landscape use patterns exhibited by female brown bears (Suring et al. 2004*a*). In brief, landscape use by female brown bears was modeled by logistic regression with multiple explanatory variables. Final models were determined through backwards model selection with a significance level of 0.05. Variable selection was conducted for each stratum separately. Variables were included in the RSF models when significant differences occurred between used and available locations. Through this process, variables were eliminated so the models included those most specifically impacting habitat selections by bears. From 2 to 6 variables were selected for each model (i.e., for each stratum).

RSF models were developed for each of the 4 strata at the landscape scale and at the level of use areas of individual female brown bears, resulting in 8 different models (Suring et al. 2004*a*). The 8 models were each constructed with and without land cover variables and the resulting 16 models were tested against an independent set of relocations of female brown bears. The following models were determined to perform the best in describing landscape-use patterns within each of 3 strata:

- Spring with cubs, landscape scale, without land cover
- Summer with cubs, landscape scale, with land cover
- Summer without cubs, within use area, without land cover

The models for the 4th strata (spring without cubs) could not be evaluated because of limited sample size in the evaluation data set. The landscape scale, with land cover model was used to assess the potential effect on brown bears in this stratum.

Variables considered in the RSF models for each stratum that may vary by alternative included road density and density of developed structures (Table 2). The "summer with cubs" model did not contain any variables that would be modified by alternative, so it was not included in the analyses. This does not necessarily mean that female brown bears in summer with cubs were unaffected by the road development, fragmentation, or any other result of landscape change.

DLP analyses.—Methods similar to those used in the RSF analysis were used to identify landscape attributes associated with locations of brown bears killed in DLP (Suring and Del Frate 2002). Characteristics of a DLP site and landscape variables were compared statistically using discrete choice variables measuring the likelihood of a DLP event occurring in the presence or absence of landscape characteristics (Manly et al. 2002). Predictive models were initially developed at 4 scales (within 400 m, 3,000 m, and 8,000 m radius of kill locations, and within watersheds) to estimate the relative probability that a DLP kill will occur in association with certain landscape attributes. The analysis at each scale incorporated DLP kill records with accuracy known to be within the distance named in the scale (e.g., analysis of kill locations at the 3,000 m scale included locations used in the 400 m scale analysis). In applying this work, we chose the 3,000 m scale model as the most appropriate model for analysis in relation to Sterling Highway alternatives. Variables considered in the DLP model for the 3,000 m scale that may vary by alternative included road density and density of recreation sites (Table 2).

Ancillary developments.—We addressed ancillary developments that are expected to occur within the assessment area as a result of road construction, by alternative, so that additional potential effects on brown bears were taken into account. Consideration was given to development of housing subdivisions and access roads, recreation trail development, and recreation site development (Table 3). We did not identify any additional recreation trail construction associated with any of the alternatives. We added two new trailheads for the Bean Creek and Resurrection Pass trails where they intersected with the road in the Juneau Creek alternative. We also added one new trailhead for the Bean Creek trail where it crossed the road in alternative G South. New trailheads were not added for the Stetson Creek trail; we assumed the trail will run under a major bridge, and access from the road would not be available. Subdivision of land for housing development was added to the Cooper Creek and the Juneau Creek alternatives as ancillary developments. Water bodies, wetlands, and slopes > 30% within the 177-ha 394b parcel (Cooper Creek) and the 437-ha 395 parcel (Juneau Creek) were eliminated as potential housing sites (G. F. Xavier, Forest Engineer, Chugach National Forest, *personal communication*). This left 159 ha within the 394b parcel and 382 ha within the 395 parcel available for housing sites. Each parcel was evenly divided into ~ 2.1 ha (5 ac) lots; one structure was assumed per lot. This resulted in adding 70 structures to parcel 394b and 181 structures to parcel 395[1]. We added 1.8 km of access road to parcel 394b. Existing roads in parcel 395 were assumed to be adequate for access to home sites.

[1] Lots were divided into parcels approximately 2 ha in size. Eliminating wetlands and steep slopes as potential building sites resulted in some parcels of varying size. One-hundred-eighty-one parcels (and structures) associated with Unit 395 were added into the analyses (99 lots ~2 ha; range 1.3 – 2.8 ha). In Unit 394b, 70 parcels (and structures) were added into the analyses (40 lots ~ 2 ha; range 1.3 – 3.6 ha)

GIS analyses.—All analyses were completed using GRID functions available in ArcGIS with a 30-m cell size[2]. Origin and development of baseline grids accessed by the models were described in Suring et al. (2004*b*). The original baseline grids were updated to include all housing developments prior to 2003 (Table 3). New road density and housing development density grids were constructed for each alternative following the process described in Suring et al. (2004*b*). RSF and DLP models were applied using programs written in Arc Macro Language (AML). Results were summarized by class within the assessment area and by a single mean value for the assessment area for each model. Classes included none, low, moderate, high, and very high for the RSF probabilities of occurrence of female brown bears and low, moderate, and high for the probabilities of DLP kills.

Evaluation of assessment area.—To provide a context for the assessment area relative to the Kenai Peninsula as a whole, we compared the current probability of occurrence in the assessment area, as measured by RSF values, with the range of brown bears throughout the Kenai Peninsula. Mean RSF values were calculated for each of the strata in the assessment area using the FOCALMEAN function in ArcGIS GRID. Similar means were calculated for the entire Kenai Peninsula and for the study area portion of the Kenai Peninsula used to develop the RSFs (see Suring et al. 2004*a*). A 6,253-ha moving window was also used to calculate mean RSF values for an area approximating the size of the assessment area around every 30-m cell in the RSF study area. A random sample of >14,000 mean values from this area was used to calculate a mean of RSF values for simulated assessment areas throughout the range of brown bears on the Kenai Peninsula.

Results

In this report, higher numbers represent a higher probability (i.e., ***relative*** probability of occurrence of female brown bears for the RSF analyses and ***relative*** probability of DLP kills of brown bears occurring for the DLP analysis). The values are relative numbers and can only be compared with similar results within each stratum (i.e., the spring-without cubs model results cannot be directly compared with the results from the summer-without cubs model). Numbers resulting from applying an equation to changing conditions can be compared to numbers from

[2] Density AMLs used a 34.5-m cell size. The original AMLs were tested with a 30-m cell, however, 34.5 m was used as the closest approximation for constructing a 1,000 x 1,000-m neighborhood in the FOCALSUM function.

prior conditions within the same strata. The general spatial patterns (e.g., high to low) may be compared among strata.

Comparison of probability of occurrence of female brown bears, as defined by RSF values, among the assessment area and measurements throughout the Kenai Peninsula showed the assessment area contained a higher probability of occurrence for female brown bears without cubs than the rest of the Kenai Peninsula in general (Table 4). Probability of occurrence for female brown bears with cubs was slightly lower than the rest of the Kenai Peninsula in general. These results are an indication that habitat quality for female brown bears was higher in the assessment area than Kenai Peninsula wide because female brown bears with cubs tend to select lower quality habitat so that they may avoid contact with other brown bears (Suring et al. 2004*a*).

Mean densities of roads increased in the three action alternatives over the current condition within the assessment area (Table 5). The Cooper Creek and G South alternatives increased 10.9% and 12.2%, respectively. The Juneau Creek alternative road density increased 25.1%. Mean density of housing structures in the G South alternative did not increase over current conditions. The Cooper Creek and Juneau Creek alternatives increased 21% and 57%, respectively.

Assessment-area-wide mean RSF values representing the effect of roads through the model for spring-with cubs showed a reduction in probability of occurrence that ranged from approximately 2.3 to 2.8% for the Cooper Creek and G South alternatives to 5.3% for the Juneau Creek alternative (Table 6). A closer examination of the distribution of these reductions showed that areas of moderate probability of occurrence were generally reduced to low probability of occurrence (Table 7).

Assessment-area-wide mean RSF values representing the effect of housing developments through the models for the strata spring-without cubs and summer-without cubs showed a reduction in probability of occurrence that ranged from approximately 5.4% to 5.9% for the Cooper Creek alternative and from approximately 6.2% to 8.0% for the Juneau Creek alternative (Table 6). A closer examination of the distribution of these reductions for the Cooper Creek alternative showed that areas of very high through low probability of occurrence were generally reduced to no probability of occurrence (Table 7). Reductions from the Juneau Creek alternative were from areas of low probability of occurrence to no probability of occurrence. The G South alternative did not result in any reduction in probability of occurrence because it was assumed that this alternative would not facilitate increased housing developments (Tables 6 and 7).

The risk of brown bears killed in DLP increased approximately 3.8% with the Cooper Creek and G South alternatives (Table 6). The Juneau Creek alternative was estimated to increase risk approximately 6.2%. It appears the most of this increase resulted from the increase in road density rather than from the increase in density of trailheads. The density of trailheads increased very little as a result of the action alternatives (Table 5). Under all alternatives, areas of low risk were converted to areas of moderate risk with some increase in areas of high risk (Table 8).

Conclusions and Implications for Management

Persistence of brown bears is affected by three factors: 1) quality of habitat, 2) number of humans within that habitat, and 3) the relationship of those humans to brown bears (Mattson et al. 1996, McLellan 1998, Apps et al. 2004). Landscape-scale changes, natural or anthropogenic, influence brown bear populations through changes in habitat suitability, displacement or disruption of movement patterns, or reduced survival. These changes may result in fragmentation of brown bear habitat, modifications of brown bear habitat use, and decreased population sustainability. Numerous studies, in addition to the two that were the basis for this analysis, have documented avoidance of otherwise suitable habitats by brown bears because of the close proximity of roads and other developments (e.g., McLellan 1989, Mace et al. 1996, Wielgus, et al. 2002, Gibeau et al. 2002, McLoughlin et al. 2003) and increased mortality of brown bears in association with human development (e.g., Naves et al. 2003, Nielsen et al. 2004).

The assessment area was typical of good quality habitat for brown bears on the Kenai Peninsula. During the late spring and summer, brown bears concentrate along low-elevation valley bottoms and salmon streams in the area. Our modeling exercise indicated that as roads and human developments associated with the Sterling Highway realignment encroach on these habitats, the probability of occurrence of brown bears in these areas would decrease. However, for brown bears that do continue to use the area it will become a mortality sink (e.g., Delibes et al. 2001). Our results also indicate that the probability of encounters between humans and brown bears will increase resulting in the subsequent death of an increased number of brown bears.

The results of this assessment show that the modifications of the landscape associated with alternatives for the realignment of the Sterling Highway will have a negative effect on probability of occurrence for female brown bears and will increase the risk of mortality for all brown bears. Density of roads and housing structures increased the most for the Juneau Creek alternative, resulting in (1) lower probability of occurrence of female brown bears, and (2) the greatest increase of risk to bears killed in defense of life or property, when compared to the other alternatives. The cumulative effects of these and other management impacts on the Kenai Peninsula brown bear population should be carefully considered during the decision-making process.

This analysis did not address the potential effects associated with ecological permeability, such as how brown bears may respond to higher traffic volume, faster traffic speeds, or increased landscape fragmentation due to multiple road corridors. Nor did we address mitigation measures that could be implemented, such as garbage transfer stations.

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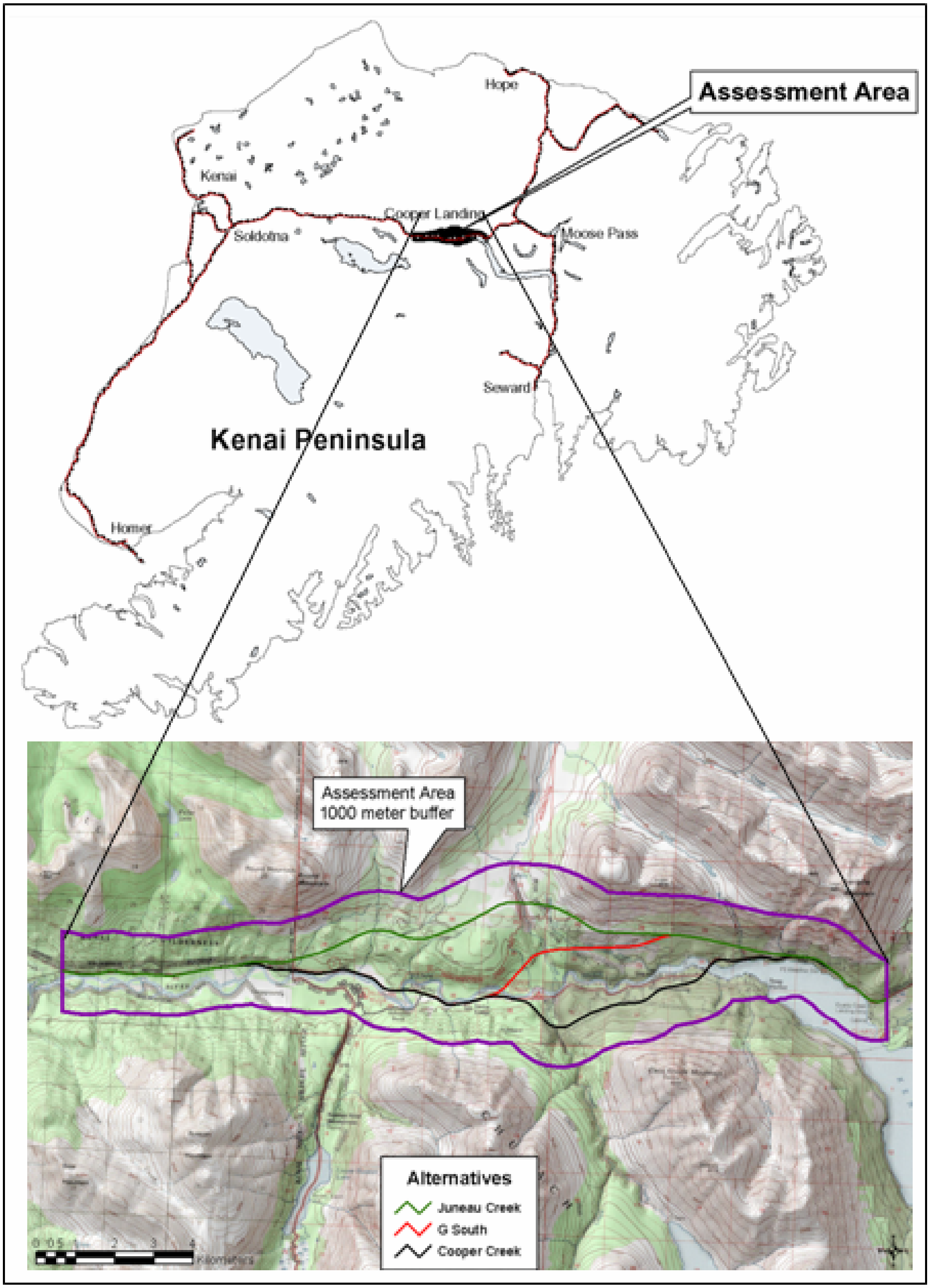

Figure 1. Proposed alternatives for realignment of the Sterling Highway with the assessment area boundary.

Table 1. Brown bears killed in defense of life or property and other non-hunting mortality on the Kenai Peninsula, 2000-2003.

Cause of death	Year				Total
	2000	2001	2002	2003	
DLP kills					
Property	1	9	5	6	21
Fishing	0	0	1	4	5
Hunting/trapping	1	3	1	3	7
Recreating	1	0	1	5	7
Management related	0	0	1	0	1
Vehicle collision	0	1	6	0	7
Total	3	13	15	18	49

Table 2. Variables included in resource selection function (RSF) strata and defense of life or property (DLP) kill models selected were used in the evaluation of alternatives for the Sterling Highway realignment, Cooper Landing, Alaska. Density units are in no./km^2 or m/ km^2, distance units are in m, and elevation is in m.

Variables by model				
RSF models/strata				DLP model
Spring, with cubs	Spring, without cubs	Summer, with cubs	Summer, without cubs	3,000 m scale
Distance to cover	Distance to cover	Distance to cover	Distance to cover	Density of trails
Density of all salmon spawning streams	Density of all salmon spawning streams	Density of all salmon spawning streams	Density of high potential salmon spawning streams	Density of high potential salmon spawning streams
Density of all roads[a]	Density of human development[a]	Distance to salmon spawning lakes	Distance to high potential salmon spawning streams	Density of all roads[a]
			Density of human development[a]	Density of all recreation sites[a]
			Density of low-use recreation sites	
			Elevation	

[a]Variables whose values may vary by alternative.

Table 3. Proposed ancillary development associated with the alternatives for realignment of the Sterling Highway near Cooper Landing, Alaska.

Parcel name	Location	1˚ source	2˚ source	Decision for the assessment
Unit 394b	East of Gwin's Lodge	DNR 2001	P. Ostrander[c] (pers. comm.)	Added in Cooper Creek alternative
Unit 395	Juneau Bench	DNR 2001	P. Ostrander[c] (pers. comm.)	Added in Juneau Creek alternative
Bean Creek	Bean Creek Rd.	None	P. Ostrander[c] (pers. comm.)	Added to baseline
CIRI[a]	Sportsman's Landing	Older CIRI map	HDR[b]/CIRI	Access road and 5 structures on 17 ha parcel added to baseline
CIRI	Land exchange site	CIRI map and web site	HDR	5 structures added to baseline
KPB[c] Proposed	Cooper Landing			Not considered in assessment
KPB Proposed	Subdivision at mile post 46	Older KPB map		Not considered in assessment

[a] Cook Inlet Region, Inc., Anchorage, Alaska
[b] HDR Alaska, Inc., Anchorage, Alaska
[c] Kenai Peninsula Borough, Soldotna, Alaska

Table 4. Comparison of habitat quality for female brown bears, as defined by resource selection function (RSF) values, among the Sterling Highway realignment assessment area and measurements throughout the rest of the Kenai Peninsula.

Evaluation area	RSF model values by strata (SE)		
	Spring, without cubs	Spring, with cubs	Summer, without cubs
Assessment area	0.191 (0.0001)	0.281 (0.0008)	0.184 (0.00005)
Kenai Peninsula	0.130 (0.000043)	0.291 (0.000044)	0.120 (0.000032)
RSF study area	0.135 (0.000050)	0.291 (0.000050)	0.124 (0.000038)
Random sample	0.132 (0.0005)	0.288 (0.0005)	0.120 (0.0007)

Table 5. Mean densities of roads and structures by alternative within the assessment area associated with the Sterling Highway realignment near Cooper Landing, Alaska.

Development	Current condition	Mean density by alternative (SE) Cooper Creek	G South	Juneau Creek
Roads (m/sq. km)	257.6 (1.384)	285.5 (1.448)	288.9 (1.464)	322.3 (1.543)
Percent change		**10.9**	**12.2**	**25.1**
Structures (no./sq. km)	1.3 (0.015)	1.6 (0.016)	1.3 (0.015)	2.1 (0.017)
Percent change		**21.0**	**0.0**	**57.0**
Recreation sites (no./sq. km)	0.030 (0.001)	0.030 (0.001)	0.034 (0.001)	0.039 (0.001)
Percent change		**0.0**	**13.3**	**30.0**

Table 6. Mean relative probabilities from resource selection function (RSF) modeling of the occurrence of female brown bears and occurrence of kills of brown bears associated with defense of life and property (DLP) by alternative within the assessment area associated with the Sterling Highway realignment near Cooper Landing, Alaska. When the percentage change in DLP is positive it means a higher probability of occurrence of DLP. When the percentage change in RSF is negative, it means a lower probability of occurrence of female brown bears.

	Mean relative probability of occurrence (SE)			
		Alternative		
Model and RSF Strata	Current Condition	Cooper Creek	G South	Juneau Creek
DLP	0.194 (0.00048)	0.201 (0.00050)	0.201 (0.00049)	0.206 (0.00049)
Percent change		**3.6**	**3.6**	**6.1**
RSF - Spring, without cubs	0.191 (0.00150)	0.180 (0.00148)	0.191 (0.00150)	0.179 (0.00152)
Percent change		**- 5.8**	**0.0**	**- 6.3**
RSF - Spring, with cubs	0.281 (0.00080)	0.275 (0.00083)	0.273 (0.00082)	0.266 (0.00083)
Percent change		**- 2.1**	**- 2.8**	**- 5.3**
RSF - Summer, without cubs	0.184 (0.00082)	0.174 (0.00081)	0.184 (0.00082)	0.169 (0.00084)
Percent change		**- 5.4**	**0.0**	**- 8.2**

Table 7. Percentage of area changed from the current condition of relative probability of occurrence classes for female brown bears associated with alternatives for the Sterling Highway realignment in the vicinity of Cooper Landing, Alaska.

	Percentage of area								
	Spring, without cubs (development effect)			Spring, with cubs (road effect)			Summer, without cubs (development effect)		
	Alternative			Alternative			Alternative		
Probability of Occurrence	Cooper Creek	G South[a]	Juneau Creek	Cooper Creek	G South	Juneau Creek	Cooper Creek	G South[a]	Juneau Creek
None	3.9	N/A	9.3	0.1	0.1	0.5	9.7	N/A	8.8
Low	-2.8	N/A	-9.3	2.8	2.4	5.4	-6.4	N/A	-8.7
Moderate	-0.4	N/A	0.0	-2.7	-2.4	-5.8	-0.7	N/A	0.0
High	-0.5	N/A	0.0	-0.1	0.0	0.1	-2.1	N/A	0.0
Very high	-0.1	N/A	0.0	0.0	-0.1	-0.2	-0.5	N/A	0.0

[a] The values did not change with a development effect for G-South because the mean density of housing structures in the G South alternative did not increase over current conditions.

Table 8. Percentage of area changed from the current condition of relative probability of occurrence for kills of brown bears in defense of life or property (DLP)

Probability of occurrence of DLP kills	Percentage of area — Alternative: Cooper Creek	G South	Juneau Creek
Low	-2.1	-2.4	-3.6
Moderate	1.4	2.3	3.0
High	0.7	0.1	0.6

Appendix A – Reviewers of earlier versions of this report

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Appendix B – Presentations of the results of this assessment

Goldstein, Michael I., Lowell H. Suring, and Karin Preston. The potential effects of the Sterling Highway realignment on brown bear habitat capability – Cooper Landing, Alaska. USDA Forest Service Alaska Regional Office, 14 April 2004, Juneau, Alaska.

Goldstein, Michael I., Lowell H. Suring, and Karin Preston. Using models to evaluate the potential effects of the Sterling Highway realignment on brown bear habitat capability. Annual Meeting of USDA Forest Service Wildlife Ecologists, 20-22 April 2004, San Diego, California.

Goldstein, Michael I., Lowell H. Suring, and Karin Preston. Putting science to work: using resource selection functions to evaluate the effect of development on brown bears on the Kenai Peninsula. Northwest Section of The Wildlife Society, 1-3 May 2004, Girdwood, Alaska.