Alaska Department of Fish and Game
Division of Wildlife Conservation
September 2003

Analysis and Publication of Sitka Black-tailed Deer Research in Southeast Alaska, 1978–1998

Matthew D. Kirchhoff

Research Final Performance Report
1 July 1999–30 September 2003
Federal Aid in Wildlife Restoration
Grant W-27-3 to W-33-2, Project 2.12

If using information from this report, please credit the author(s) and the Alaska Department of Fish and Game. The reference may include the following: Kirchhoff, M. D. 2003. Analysis and Publication of Sitka Black-tailed Deer Research in Southeast Alaska, 1978–1998. Alaska Department of Fish and Game. Federal aid in wildlife restoration research final performance report, grants W-27-3 to W-33-2, project 2.12. Juneau, Alaska. 22 pp.

FEDERAL AID
FINAL RESEARCH REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

PROJECT TITLE: Analysis and publication of Sitka black-tailed deer research in Southeast Alaska, 1978-1998.

PRINCIPAL INVESTIGATORS: Matthew Kirchhoff, WBIII, (ADF&G, Douglas)

FEDERAL AID GRANT PROGRAM: Funding for this research came from Federal Aid in Wildlife Restoration and Federal Outreach Funding.

GRANT AND SEGMENT NR.: W-27-3, W-27-4, W-27-5, W-33-1, W-33-2

PROJECT NR.: 2.12

WORK LOCATION: No field work was involved. Writing and analysis were performed in Douglas, AK.

STATE: Alaska

PERIOD: 1 July 1999–30 September 2003.

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

In 1989 I became the principle investigator for Sitka black-tailed deer (*Odocileus hemionus sitkensis*) research in region 1. Over the next decade, I supervised 4 federal aid research projects. Although final research reports have been published on these projects, and some technical publications produced, there were aspects of this work that had not been published in peer-reviewed journals. Other technical aspects of the deer work were not in a form that made the information easily accessible to the public. The main purpose of this project is to make unpublished research findings more available to our peers and the general public. A listing of these federal aid projects, and a brief description of the problem or need that prompted the research follow.

<u>Evaluation of methods for assessing deer population trends in Southeast Alaska (W-22-6 and W-23-1,2,3, 1987–90).</u>

The research was aimed at evaluating the division's traditional methods for monitoring deer populations across the region, including identification of potential biases and limitations associated with different monitoring techniques (principally aerial surveys, hunter surveys, and pellet-group surveys). A significant job in that research project included the capture and transport of 13 deer to an unpopulated island near Juneau to determine the relationship between pellet-group density and known deer density. That work gave biologists the ability to estimate actual deer densities in different watersheds across the region. Although the scope of inference is limited, actual deer abundance is rarely known with this degree of certainty, making the research potentially publishable.

Effects of forest fragmentation on deer in Southeast Alaska (W-23-3,4,5, W-24-1,2, 1990–93)

This project represented an effort to expand our current knowledge about how deer use different *types* of habitat, including the effects of patch size, shape, and insularity on the relative value of a patch of habitat. The initial phase of work examined deer use and habitat attributes on 97 small islands in Sea Otter Sound, each representing a highly discrete, insular patch of habitat. The second phase of work was aimed at evaluating the value of "islands" of old growth surrounded by a "sea" of even-aged forest. Due to the large amount of time, money, and manpower needed to adequately measure forage abundance and deer use in the larger landscape (including the "sea" of young clearcuts), phase 2 of the project was terminated after 1 field season. The data gathered in phase 1, however, was important for the insights it provided into the role wolves (*Canis lupus*) play in determining habitat selection by deer. Those results were publishable, and sparked subsequent Ph.D. research involving deer, wolves, and habitat selection in managed landscapes (W-25-1).

Effects of selection logging on deer habitat in Southeast Alaska (W-24-4, 1994–98)

This research project was aimed at evaluating silvicultural alternatives to clearcut logging. In Southeast Alaska, the deer research to date indicated the existing practice of clearcutting would have long-term negative consequences for deer. One of the principle stumbling blocks to the adoption of alternatives in Alaska was the lack of information on stand response to different harvest prescriptions. In this project, I looked at how varying intensities of logging – from removing a single tree from a stand, to removing nearly all trees from a stand – affected stand composition, biomass, and forest structure. These attributes could be used to infer the likely value of the resulting stand to deer. The results of this research are relevant to forest management on the Tongass, and the role of disturbance intensity in shaping old-growth forests generally. This work should be publishable in wildlife or forestry journals.

Effects of even-aged timber management on survivorship in Sitka black-tailed deer, Southeast Alaska (W-25-1, 1996–1999)

The final federal aid research project examined the effects of even-aged forest management on survivorship in deer. It was the first such research effort aimed at measuring population level responses to managed habitats at the landscape scale, as well as more traditional evaluations of patterns of habitat selection by deer. The project was started under my leadership, with the recruitment of Chris Farmer, a Ph.D. candidate, to conduct a study on Heceta Island. Midway through that study, responsibility for administrative oversight was transferred to David Person (DWC, Ketchikan), who had been hired in Ketchikan to conduct predator-prey research. Chris Farmer is taking the lead on publications stemming from this research, with myself and D. Person as coauthors.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS

The ecology of Sitka black-tailed deer in Southeast Alaska has been well studied. Early research by Dr. David Klein (USFWS, ADFG) focused on the relationship between range and body condition in deer (e.g., Klein and Olson 1960, Klein 1963, 1965, 1979). Dr. Olaf Wallmo (USFS, Forestry Science Lab) studied deer response to secondary forest succession following logging (Wallmo and Schoen 1979, Wallmo and Schoen 1980, Wallmo 1981), and worked in close collaboration with the Department of Fish and Game. On Dr. Wallmo's retirement, Dr. John Schoen continued the research on deer, focusing on habitat selection, and deer-habitat relationships (Schoen et al. 1981, 1984, 1988, Schoen and Kirchhoff 1985, 1990). Dr. Thomas Hanley, who succeeded Dr. Wallmo at the Forestry Sciences Lab, focused his research on the nutritional ecology of Sitka black-tailed deer (Hanley 1987, 1993, Hanley et al. 1985, 1989, 1992, Hanley and McKendrick 1985, Hanley and Rose 1987, Hanley and Rogers 1989). I assisted Schoen and Wallmo in their deer research through the 1980s, and published work in collaboration with them on deer use of edge (Kirchhoff and Schoen 1983), snow-forest relationships (Kirchhoff and Schoen 1987), habitat selection by deer (Schoen and Kirchoff 1990), and habitat evaluation techniques (Kirchhoff and Hanley 1992). Ken Pitcher (DWC Anchorage) oversaw deer research in the region for 1 year following Schoen's tenure; and I succeeded Ken Pitcher in 1989.

There is other research that deserves mention for contributing significantly to our knowledge of deer in Southeast Alaska. This includes work on habitat selection (Bloom 1978, Rose 1982, Yeo and Peek 1992, Farmer 2002), nutritional ecology (Parker et al. 1993, 1999) interactions with wolves (VanBallenberge and Hanley 1984, Person et al. 2001, and effects of precommercial thinning (Doerr and Sandburg 1986). Appendix A includes citations for the above, as well as citations for all deer- and habitat-related publications from 1978–present which were supported, in part, by Pittman-Robertson Federal Aid funding (indicated by bold-face type).

III. FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

The sole objective of this Federal Aid project is to make an accumulation of unpublished data on deer and forest ecology more readily available to the scientific community, agency personnel, and the public. We have done this by writing technical and non-technical publications and making public presentations on our research. Our findings are summarized in the following topical categories:

<u>Monitoring Deer Populations</u>

Because of the dense forest cover in this region, deer cannot be surveyed through direct counts. Instead, we use persistent indices of deer use (e.g., tracks, fecal pellet-groups, browsed twigs). While indices can detect relative changes in populations from year to year (i.e., trends), they are generally not used to develop actual population counts because the relationship between the index and the population size is not known. Kevin White (DWC, Douglas) and I have submitted a paper to the Wildlife Society Bulletin describing our research on Portland Island in which we determined that relationship. The paper is titled: "Monitoring deer populations in forested environments: linking survey data to actual population size." An abstract is included in appendix B.

Forest Ecology

Much of the work we do in Southeast Alaska focuses on forest ecology. How forest succession proceeds after different levels of disturbance (including logging), determines relative value of that habitat for deer and other wildlife. Knowing the relative contribution of marine-derived nitrogen to the growth of large diameter trees, (which are indicative of high-value deer winter range) helps us predict and map important winter habitats. A paper published in *Ecology* (Kirchhoff *in press*) comments on the relative importance of spawning salmon as a causal factor in the rapid growth of trees in riparian systems, concluding that salmon probably plays a secondary role to soil drainage in controlling where stands of large trees are likely to develop.

A second paper titled: How selective logging affects forest composition and structure in Southeast Alaska: implications for Sitka black-tailed deer, has been submitted to *Northwest Science.*(Kirchhoff and Thompson*, in review).* In this study, we found that low-intensity selective logging closely mimics the predominant natural disturbance pattern on the forest, and can provide both adequate canopy cover (for snow interception) and abundant understory (for forage) for deer. We provide specific recommendations to land managers on how much of a stand's basal area can be removed while still preserving the structural and compositional features of the stand that are important for deer.

A third publication is a 20-page, full-color booklet, coauthored with Kevin White, titled "The Alaskan Rainforest." Written for the general public, it includes sections on the forest natural history, ecological inter-relationships, forest wildlife (including deer), and conservation. It has been well received and widely distributed by regional educators and the tourism industry. Copies are available from the Douglas Regional office, or for bulk orders, by special arrangements with the printer.

Modeling Deer-Habitat Relationships

The Forest Service presently uses habitat suitability index (HSI) models to evaluate and portray the effects of timber harvesting on deer. These models are loosely based on findings from early habitat use studies (both radio-telemetry and pellet-group based), but have also been modified considerably over time based on "professional judgment." They do not have a strong empirical base, and in recent years, their reliability has been increasingly questioned. Those concerns have led to cooperative efforts by the Forest Service, Forestry Sciences Lab, Sealaska Corp. and ADF&G to develop alternative models and approaches to predicting the population response of deer to logging. Initial work has focused on energetic models that predict carrying capacity from data on forage abundance, quality, and availability in different habitat types. The theoretical basis for this work is sound (see nutritional work by Hanley and others, cited earlier). However, this type of model requires reliable data on the plant species and amounts of plant biomass available to deer in different habitats, in different seasons. Moreover, because large land areas are typically evaluated by models, the habitat types used must be interpretable from satellite or aerial photos.

In a manuscript coauthored with Chris Farmer, titled: "Deer habitats in managed coastal temperate rainforest: classification and relative use," we propose a classification system of habitat based on ground-based measures of plant composition and biomass gathered over a large landscape scale (Heceta Island). Because the sampling design was randomized, and a cluster analysis used to derive the habitat classification system, it is arguably a very representative dataset (including representative variance), and as such is a valuable dataset for use in modeling. The paper was submitted to *Forest Science*, but was rejected for having a focus too narrow for that journal's readership. Chris Farmer is currently revising the paper and plans to resubmit to a smaller, more regionally focused journal (e.g., *Northwest Science*). Chris has a second manuscript coauthored with D. Person and T. Bowyer titled: Using risk ratios to assess the influence of landscapes on fitness: deer survivorship in the coastal temperate rainforest of Alaska. This manuscript is in the final stages of internal review, and will be submitted by year end. Abstracts of these papers are included in Appendix B.

I collaborated with Dr. John Emlen on a paper titled "Fitting population models from field data," which was published in *Ecological Modeling*. We hypothesized that the deer occupying different islands in Sea Otter Sound were making habitat selection choices based on a variety of factors, including food type, food abundance, overstory characteristics, predation risk, and competition with other deer. The interactions likely to occur among these factors are nonlinear and highly dynamic. Hypotheses about the form of these relationships are not hard to construct, but the experimental manipulations needed to evaluate their defining coefficients are difficult. In this paper we present an empirical approach for determining these coefficients without the need for costly environmental manipulation. We demonstrated the approach using the Sea Otter Sound dataset as one example. An abstract is included in Appendix B

<u>Deer-wolf-habitat interactions</u>

Most of the deer research conducted by the Department between 1975 and 1980 was conducted on Admiralty and Chichagof Islands in northern Southeast Alaska. Neither of these islands are inhabited by wolves. Research in the early 1990s in Sea Otter Sound, and by D. Person (DWC, Ketchikan) on Prince of Wales Island, shed new light on the important role predators play in influencing habitat selection and regulating deer numbers. Earlier work by Klein (1963, 1965) had already documented the dramatic differences in deer range condition between islands with and without wolves, and the fact that deer that occurred at low densities on islands with wolves tended to be larger and healthier than deer that were food-limited on wolf-free islands. In a paper titled, "Deer and Wolves: the Alaska perspective," I describe deer-wolf-habitat interaction in Alaska, drawing on deer survey data from islands throughout Southeast Alaska with and without wolves (Kirchhoff and White 2002), and from an island (Coronation) where wolves were experimentally introduced in the 1960s and then subsequently exterminated. We modeled how an introduced population of deer on the Queen Charlotte Islands would likely respond to a hypothetical introduction of wolves. The paper will be published by the Canadian Wildlife Service as part of a special volume dealing with introduced species on the Queen Charlotte Islands.

<u>Miscellaneous Deer Papers</u>

I am the Alaska representative on the Western States and Provinces Mule Deer (*Odocoileus hemionus*) Working Group, established by the Western Association of Fish and Wildlife Agencies). I work with other biologists on mule deer management and research problems in the western United Sates and Canadian Provinces. One of our recently completed projects was the publication of a book summarizing important issues relating to Mule Deer across the western United States and Canada. The ecology and management issues facing Sitka black-tailed deer are quite different than those facing other subspecies of mule deer. For example, in Washington and Oregon, where there is relatively little old growth remaining, managers typically recommend clearcutting even-aged second-growth stands to improve forage production and deer productivity. In Alaska, protection of high-quality old-growth forest is still an option, and one that is far superior for deer in the more northerly range of Sitka black-tails. I was a coauthor on a chapter titled: “Ecoregional differences in population dynamics.” This is the second chapter in a book titled, “Mule Deer Conservation: Issues and Management Strategies,” published by the Western Association of Fish and Wildlife Agencies and the J. H. Berryman Institute.

I served as a committee member and advisor to Christian Englestoft, a graduate student doing research on Sitka black-tailed deer on the Queen Charlotte Islands in British Columbia. He had originally contacted me with questions about how to conduct browse utilization surveys for deer. Our collaboration led to one publication from his master’s thesis, titled: “Herbivory and the missing understory on Haida Gwaii (Queen Charlotte Islands).” The paper describes the relationship between deer density and the depleted condition of the understory vegetation across the Queen Charlotte Islands. The paper will be published by the Canadian Wildlife Service as part of a special volume dealing with introduced species on the Queen Charlotte Islands. An abstract of the paper is included in Appendix B.

IV. MANAGEMENT IMPLICATIONS

Management implications vary with each specific research topic. They are summarized generally above, and more specifically in the individual publications.

V. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN FOR LAST SEGMENT PERIOD ONLY (if not reported in previous performance report)

There are 2 segment periods that have not been reported on in previous progress reports. The first of these segments includes the period from 1 July 2002 to 30 June 2003, which in this report is referred to as “FY 03 segment.” The second includes an approved extension from 1 July–30 September 2003, which is referred to as “FY 04 segment.” The final report for this project is due 90 days after the end of the FY04 segment (December 31, 2003); however, I am submitting the report by October 1st to close out the project early.

W-33-1: FY 03 segment (October 2002–June 2003)

<u>Job1. Analyze data necessary to write manuscripts for publication.</u> I worked on data dealing with selection logging in Southeast Alaska for a paper submitted to Northwest Science. I also worked with Dave Person on a model to predict deer response to the introduction of wolves on the Queen Charlotte Islands. These data were for a paper titled, “The Alaska perspective: deer in the presence of wolves.” Analyses were conducted on a personal computer using SPSS for the selective logging analysis, and Excel for the deer modeling.

<u>Job 2. Prepare manuscripts for publication.</u>

Manuscripts worked on during this report period included revisions or first drafts of the following manuscripts:

Emlen, J. M., D. C. Freeman, M. D. Kirchhoff, C. L. Alados, J. Escos, and J. J. Duda. 2003. Fitting population models from field data. *Ecological modeling* 162:119-143.

Englestoft, C., M. D. Kirchhoff, and D. Eastman. *In press*. Herbivory and the missing understory on Haida Gwaii (Queen Charlotte Islands). Occasional paper, Canadian Wildlife Service, Ottawa, Canada.

Heffelfinger, J. R., L. H. Carpenter, L. C. Bender, G. L. Erickson, M. D. Kirchhoff, E.R. Loft, and W. M. Glasgow. 2003. Ecoregional differences in population dynamics (Chapter 2): *in*: J. C. deVos, M. R. Conover, and N. E. Headrick, (eds.). Mule deer conservation: issues and management strategies. Western Association of Fish and Wildlife Agencies and the J.H. Berryman Institute.

Kirchhoff M. D., 2003. Effects of salmon-derived nitrogen on riparian forest growth – a comment. Ecology (in press).

Kirchhoff, M. D. and Simon R. G., *in review*, How selective logging affects plant composition and structure in temperate rainforest of Southeast Alaska: implications for Sitka black-tailed deer. *Northwest Science*___.

Kirchhoff M. D. and K. S. White 2002. The Alaskan Rainforest. Alaska Department of Fish and Game, Federal Aid Outreach Project, Douglas, AK 99824. 20 pages.

Kirchhoff, M. D. and D. K. Person. *In press*. The Alaska perspective: Deer in the presence of wolves. Occasional paper, Canadian Wildlife Service, Ottawa, Canada. .

FY04 segment (July 2003–August 2003) (W-33-2)

<u>Job 1. Prepare manuscripts for publication</u>.

Manuscripts worked on during this report period included revisions or first drafts of the following manuscripts:

Kirchhoff, M. D. and Simon R. G., *in review*, How selective logging affects plant composition and structure in temperate rainforests of Southeast Alaska: implications for Sitka black-tailed deer. *Northwest Science*___.

White, K. S. and M. D. Kirchhoff, *in review*, Monitoring deer populations in forested environments: linking survey data to actual population size. Wildlife Society Bulletin. ________.

If either of the papers should be rejected, we would consider correcting any identified deficiencies in the analysis, and submitting to a different journal. Revisions to the Wildlife

Society Bulletin paper will be made by K. White. I will make revisions to the Northwest Science paper. Assuming work on revisions will extend beyond October 1, minor jobs will be included in future work plans to allow for this.

VI. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THE LAST SEGMENT PERIOD, IF NOT REPORTED PREVIOUSLY

None.

VII. PUBLICATIONS

Citation for articles published or accepted (in press) during this project include:

Emlen, J. M., D. C. Freeman, M. D. Kirchhoff, C. L. Alados, J. Escos, and J. J. Duda. 2003. Fitting population models from field data. *Ecological modeling* 162:119-143.

Englestoft, C., M. D. Kirchhoff, and D. Eastman. *In press*. Herbivory and the missing understory on Haida Gwaii (Queen Charlotte Islands). Occasional paper, Canadian Wildlife Service, Ottawa, Canada.

Heffelfinger, J. R., L. H. Carpenter, L. C. Bender, G. L. Erickson, M. D. Kirchhoff, E.R. Loft, and W. M. Glasgow. 2003. Ecoregional differences in population dynamics (Chapter 2): *in*: J. C. deVos, M. R. Conover, and N. E. Headrick, (eds.). Mule deer conservation: issues and management strategies. Western Association of Fish and Wildlife Agencies and the J.H. Berryman Institute.

Kirchhoff M. D., 2003. Effects of salmon-derived nitrogen on riparian forest growth – a comment. Ecology (in press).

Kirchhoff M. D. and K. S. White 2002. The Alaskan Rainforest. Alaska Department of Fish and Game, Federal Aid Outreach Project, Douglas, AK 99824. 20 pages.

Kirchhoff, M. D. and D. K. Person. *In press*. The Alaska perspective: Deer in the presence of wolves. Occasional paper, Canadian Wildlife Service, Ottawa, Canada.

Citations for articles submitted to journals, but not yet accepted, include:

Kirchhoff, M. D. and Simon R. G., *in review*, How selective logging affects plant composition and structure in temperate rainforests of Southeast Alaska: implications for Sitka black-tailed deer. *Northwest Science*___.

White, K. S. and M. D. Kirchhoff, *in review*, Monitoring deer populations in forested environments: linking survey data to actual population size. Wildlife Society Bulletin. ________.

Farmer, C. J., and M. D. Kirchhoff. (*in prep)*. Deer habitats in managed coastal temperate rainforest: classification and relative use.

VIII. RESEARCH EVALUATION AND RECOMMENDATIONS

Progress on data analysis and publications was interrupted when we started a new federal aid project: Development of a Passive-Capture Technique for Radiotagging Large Animals (July 1, 2001 – June 30, 2002 [W-27-5] July 1, 2002 – Sept. 30, 2002 [W-33-1], Job 15.10). The interruption resulted in postponement of manuscripts that should have been submitted 1–2 years earlier when the work was fresh in mind, and fresh to the scientific community. In the future, I would recommend that manuscripts be submitted for publication before pursuing new research. Publication of results would have a higher priority if, at the conclusion of a studies, discrete federal aid jobs were developed that focused solely on publication of findings.

IX. PROJECT COSTS FROM LAST SEGMENT PERIOD ONLY

<u>FY 03 Segment (1 July 2002 – 30 June 2003)</u>

Total Costs:	43.4
Federal Share:	32.5
State Share	10.9

<u>FY 04 Extension (1 July 2003 – 30 Sept 2003)</u>

Total Costs:	20.0
Federal Share:	15.0
State Share	5.0

X. APPENDIX A.

Literature Cited and References on Deer and Forest Ecology in SE Alaska. Participation made possible by Pittman-Robertson Federal Aid funding is designated with the recipient's name(s) shown in bold type.

Bloom, A. 1978. Sitka black-tailed deer winter range in the Kadashan Bay area, Southeast Alaska. *Journal of Wildlife Management* 42:108-112.

Doerr, J. G. and N. H. Sandburg. 1986. Effects of precommercial thinning on understory vegetation and deer habitat utilization on Big level island in Southeast Alaska. *Forest Science* 32(4):1092-1095.

Emlen, J. M., D. C. Freeman, **M. D. Kirchhoff**, C. L. Alados, J. Escos, and J. J. Duda. 2003. Fitting population models from field data. *Ecological modeling* 162:119-143.

Englestoft, C., **M. D. Kirchhoff**, and D. Eastman. *In review*. Herbivory and the missing understory on Haida Gwaii (Queen Charlotte Islands). Occasional paper, Canadian Wildlife Service, Ottawa, Canada.

Fagen, R. 1988. Population effects of habitat change: a quantitative assessment. *Journal of Wildlife Management* 52:41-46.

Farmer, C. J. 2002. Survival and habitat selection of Sitka back-tailed deer (*Odocoileus hemionus sitkensis*) in a fragmented coastal temperate rainforest. Ph.D. Dissertation. S.U.N.Y. College of Environmental Sciences and Forestry at Syracuse, NY.

Farmer, C. J. (*in prep*.). Fear and foraging on the Tongass: a dynamic optimization model of habitat selection by Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) under predation risk.

Farmer, C. J., D. K. Person, and R. T Bowyer. (*in prep*). Using risk ratios to assess the influence of landscapes on fitness: deer survivorship in the coastal temperate rainforest of Alaska.

Farmer, C. J., and **M. D. Kirchhoff**. (*in prep)*. Deer habitats in managed coastal temperate rainforest: classification and relative use. *Forest Science*.

Hanley, T. A. 1986. Physical and chemical response of understory vegetation to deer use in southeastern Alaska. *Canadian Journal of Forest Research* 17:195-199.

Hanley, T. A. 1987. Physical and chemical response of understory vegetation to deer use in southeastern Alaska. *Canadian Journal of Forest Research* 17:195-199.

Hanley, T. A. 1993. Balancing economic development, biological conservation, and human culture: the Sitka black-tailed deer (*Odocolieus hemionus sitkensis*) as an ecological indicator. *Biological Conservation* 66:61-67.

Hanley, T.A. 1996. Potential role of deer (*Cervidae*) as ecological indicators of forest management. *Forest Ecology and Management* 88:199-204.

Hanley, T. A., and J. D. McKendrick. 1983. Seasonal changes in chemical composition and nutritive value of native forages in spruce-hemlock forest, Southeast Alaska. Research paper PNW-312 41pp.

Hanley, T. A., and J. D. McKendrick. 1985. Potential nutritional limitations for black-tailed deer in a spruce-hemlock forest, Southeast Alaska. *Journal of Wildlife Management* 49:103-114.

Hanley, T. A. and J. J. Rogers. 1989. Estimating carrying capacity with simultaneous nutritional constraints. Research Note. PNW-RN-485. Portland, OR. USDA Forest Service, PNW Research Station. 25pp.

Hanley, T. A. and C. L. Rose. 1987. Influence of overstory on snow depth and density in hemlock-spruce stands: implications for management of deer habitat in southeastern Alaska. Research Note PNW-RN-459. Portland, OR. USDA Forest Service, PNW Research Station. 11pp

Hanley, T. A., R. G. Gates, B. VanHorne, and J. D. McKendrick. 1985a. Forest stand-age related differences in apparent nutritional quality of forage for deer in southeastern Alaska. *In*: Provenze, F. D, J. T. Flinders, E. D. MacArthur and E Durant, (eds), proceedings of a symposium on Plant-animal interactions, 1985, Snowbird, UT. 9-17.

Hanley, T. A., C. T. Robbins, and D. E. Spalinger. 1989. Forest habitats and the nutritional ecology of Sitka black-tailed deer: a research synthesis with implications for management. USDA Forest Service, Pacific Northwest Research Station, General Tchnical Report, PNW GTR-230.

Hanley, T. A., C. T. Robbins, A. E. Hagerman, and C. MacArthur. 1992. Predicting digestible protein and digestible dry matter in tannin-containing forages consumed by ruminants. *Ecology* 73:537-541.

Hanley, T. A., D. E. Spalinger, K. A. Hanley, and **J. W. Schoen.** 1985b. Relationships between fecal and rumen analyses for deer diet assessments in Southeast Alaska. *Northwest Science* 59, 10-16.

Hanley, T. A., O. C. Wallmo, **J. W. Schoen**, and **M. D. Kirchhoff**. 1985c. Habitat relationships Sitka black-tailed deer. USDA Forest Service Admin Doc 151. Juneau. 32pp.

Heffelfinger, J. R., L. H. Carpenter, L. C. Bender, G. L. Erickson, **M. D. Kirchhoff**, E.R. Loft, and W. M. Glasgow. 2003. Ecoregional differences in population dynamics (Chapter 2): *in*: J. C. deVos, M. R. Conover, and N. E. Headrick, (eds.). Mule deer conservation: issues and management strategies. Western Association of Fish and Wildlife Agencies and the J.H. Berryman Institute.

Kirchhoff, M. D. 1988. Silent Music. *Natural History*. (97) August.

Kirchhoff, M. D. 1994. Rescue for a Rainforest. *Defenders* 69(2):9-17.

Kirchhoff, M. D. *in press*. Effects of salmon derived nitrogen on riparian forest growth and implications for stream productivity - a comment. *Ecology* **____**.

Kirchhoff, M. D. and **D. N. Larsen**. 1998. Dietary overlap between native Sitka black-tailed deer and introduced elk in Southeast Alaska. *Journal of Wildlife Management* 62(1):236-242.

Kirchhoff, M. D. and **D. K. Person**. *In press*. The Alaska perspective: deer populations in the presence of wolves. Occasional paper, Canadian Wildlife Service, Ottawa, Canada.

Kirchhoff, M. D. and **J. W. Schoen**. 1983. Black-tailed deer use in relation to forest clear-cut edges in Southeast Alaska. *Journal of Wildlife Management* 47:497-501.

Kirchhoff, M. D. and **J. W. Schoen**. 1987. Forest cover and snow: implications for deer habitat in Southeast Alaska. *Journal of Wildlife Management* 51:28-33.

Kirchhoff, M. D. and T. A. Hanley. 1992. A quick-cruise method for assessing deer winter range in Southeast Alaska. US Forest Service, *Habitat Hotline*. 92-1. 6pp.

Kirchhoff, M. D. and S. R. G. Thomson. *in review*. How selective logging affects plant composition and structure in temperate rainforests of Southeast Alaska: implications for Sitka black tailed deer. *Northwest Science*___

Kirchhoff, M. D. and **K. S. White**. 2002. The Alaskan Rainforest. Alaska Department of Fish and Game, Federal Aid Outreach Program, Douglas AK. 18pp.

Kirchhoff, M. D., J. W. Schoen, and T. M. Franklin. 1995. A model for science-based conservation advocacy: Tongass National Forest case history. *Wildlife Society Bulletin* 18:453-458.

Kirchhoff, M. D. and others. 1990. Chapter 6: the Deer Submodel. In: R. D. Fight, L. D. Garrett, and D. L. Weyermann. (eds.) SAMM: a prototype Southeast Alaska multi-resource model. Pacific Northwest Research Station, General technical report, *PNW-GTR-255*. Portland.

Klein, D. R. 1963. Physiological response of deer to ranges of varying quality. Ph. D. Dissertation, University of British Columbia. 167 pp.

Klein, D. R. 1964. Range-related differences in growth of deer reflected in skeletal ratios. *Journal of Wildlife Management* 32:350-367.

Klein, D. R. 1965. Ecology of deer range in Alaska. *Ecological Monographs* 35:259-284.

Klein, D. R. 1979. Ecology of deer range in Alaska. Pages 25-32 *in* O.C. Wallmo and J. W. Schoen, editors. Sitka black-tailed deer: Proceedings of a conference in Juneau, Alaska. USDA Forest Service. Series No. R10-48, May 1979.

Klein, D. R. and S. T. Olson. 1960. Natural mortality patterns of deer in Southeast Alaska. *Journal of Wildlife Management* 24:80-88.

Lentfer, J. W., **J. W. Schoen**, **J. W. Mathews**, and **M. D. Kirchhoff** 1980. Solving the puzzle of forest relationships. *Alaska Fish Tails and Game Trails* 12:6-9.

Mankowski J. D. and J. M. Peek. 1985. Habitat use by Sitka black-tailed deer in logged and unlogged forests of Southeast Alaska. USDA Admin study 85-0501. Tongass National Forest, Ketchikan. 43 pp.

Meehan, W. R., T. R. Merrell, and T. A. Hanley (eds.). 1984. Fish and wildlife relationships on old-growth forests. Proceedings of a symposium held in Juneau, Alaska April 1982. Published by American Institute of Fisheries Biologists. 425 pp.

Nyberg, J. B., R. S. McNay, **M. D. Kirchhoff**, R. D. Forbes, F. L. Bunnell, and E. L. Richardson. 1989. Integrated management of timber and deer: coastal forests of British Columbia and Alaska. Pacific Northwest Research Station, General technical report, PNW-GTR-226. 65pp.

Parker, K. L., M. P. Gillingham, T. A. Hanley, and C. T. Robbins. 1993. Seasonal patterns in body mass, body composition, and water transfer rates of free ranging and captive black-tailed deer (*Odocoileus hemionus sitkensis*) in Alaska. Canadian Journal of Zoology 71:1397-1404.

Parker, K. L., M. P. Gillingham, T. A. Hanley, and C. T. Robbins. 1999. Energy and protein balance of free-ranging black-tailed deer in a natural forest environment. *Wildlife Mongraphs* No. 143. 48 pp.

Person, D. K., R. T. Bowyer, and V. Van Ballenberghe. 2001. Density-dependence of prey and functional responses of wolves: interpreting predator-prey ratios. *Alces*.

Regelin, W. L. 1979. Nutritional Interactions of black-tailed deer with their habitat in Southeast Alaska. Pages 60-68 *In*: O. C. Wallmo and J. W. Schoen (eds.). Sitka black-tailed deer: proceedings of a conference in Juneau, Alaska. USDA Forest Service. Series No. R10-48, May 1979.

Rose, C. L. 1982. Deer response to forest succession on Annette island, Southeast Alaska. M.Sc. Thesis, University of Alaska, Fairbanks. 55 pp.

Schoen, J. W. and O. C. Wallmo. 1979. Timber Management and Deer in Southeast Alaska: Current problems and research direction. Pages 69-85 *In*: O. C. Wallmo and J. W. Schoen (eds.). Sitka black-tailed deer: proceedings of a conference in Juneau, Alaska. USDA Forest Service. Series No. R10-48, May 1979.

Schoen, J. W. and **M. D. Kirchhoff**. 1985. Seasonal distribution and home range patterns of Sitka black-tailed deer in Southeast Alaska. *Journal of Wildlife Management* 49:96-103.

Schoen, J. W. and **M. D. Kirchhoff**. 1988. Little deer in the big woods. *Natural History* (97): August

Schoen, J. W. and **M. D. Kirchhoff**. 1990. Seasonal habitat use of Sitka black-tailed deer on Admiralty island, Alaska. *Journal of Wildlife Management* 54:371-378.

Schoen, J. W., M. D. Kirchhoff, and **J. H. Hughes**. 1988. Wildlife and old-growth forests in Southeastern Alaska. *Natural Areas Journal* 8:138-146.

Schoen, J.W., M.D. Kirchoff and O.C. Wallmo. 1984. Sitka black-tailed deer–old-growth forest relationships in Southeast Alaska: Implications for management. Pages 315-319 in: Meehan, W., T. Merrell, Jr. and T. Haney (eds.). Fish and wildlife relationships in old-growth forests: Proceedings of a symposium. American Institute of Fisheries Research Biologists. Morehead City, N.C. 425 pp.

Schoen, J.W., O.C. Wallmo, and **M. D. Kirchhoff**. 1981. Wildlife-forest relationships: is a revaluation of old-growth necessary? *Transactions of the North American Wildlife and Natural Resources Conference.* 54:121-133.

Van Ballenberghe, V. and T. A. Hanley. 1984. Predation on deer in relation to old-growth forest management in southeastern Alaska. Pages 291-296 *in* W. R. Meehan, T. R. Merril, and T. A. Hanley, editors. Fish and Wildlife relationships in old-growth forests. American institute of Fisheries Research Biologists, Morehead City, NC.

Wallmo, O. C. (ed.) 1981. Mule and black-tailed deer of North America. University of Nebraska Press, Lincoln NB. 605pp.

Wallmo, O. C. and **J. W. Schoen** (editors) 1979. Sitka black-tailed deer: proceedings of a conference in Juneau, Alaska. U.S. Department of Agriculture, Forest Service, Juneau, AK 99801. Series R10-48. 231 pp.

Wallmo, O. C. and **J. W. Schoen**. 1980. Response of deer to secondary forest succession in Southeast Alaska. *Forest Science* 26:448-462.

White, K. S. and M. D. Kirchhoff, *in review*, Monitoring deer populations in forested environments: linking survey data to actual population size. Wildlife Society Bulletin. **________**.

Yeo, J. J. and J. M. Peek. 1992. Habitat selection by female Sitka black-tailed deer in logged forests of Southeast Alaska. *Journal of Wildlife Management* 56:253-261.

APPENDIX B. ABSTRACTS OF PAPERS PUBLISHED, IN PRESS, OR SUBMITTED ON THIS PROJECT (AS OF 10/1/2003).

FITTING POPULATION MODELS FROM FIELD DATA.

John M. Emlen, Western Fisheries Research Center, Biological Resources Division, U.S. Geological Survey, 6506 NE 65th St., Seattle, WA 98115, USA.

D. C. Freeman, Department of Biological Sciences, Wayne State University, Detroit, MI 48202, USA.

M. D. Kirchhoff, Alaska Department of Fish and Game, P.O. Box 240020, Douglas, AK. 99824, USA

C. L. Alados, Instituto Pirenacio de Ecologia, Avenida Montanana 166, Apartado 202, 50080 Zaragoza, Spain

J. J. Duda, Western Fisheries Research Center, Biological Resources Division, U.S. Geological Survey, 6506 NE 65th St., Seattle, WA 98115, USA.

Abstract

The application of population and community ecology to solving real-world problems requires population and community dynamics models that reflect the myriad patterns of interaction among organisms and between the biotic and physical environments. Appropriate models are not hard to construct, but the experimental manipulations needed to evaluate their defining coefficients are often both time consuming and costly, and sometimes environmentally destructive, as well. In this paper we present an empirical approach for finding the coefficients of broadly inclusive models without the need for environmental manipulation, demonstrate the approach with both an animal and a plant example, and suggest possible applications.

Software has been developed, and is available from the senior author, with a manual describing both field and analytic procedures.

Key words: population models; prediction; interaction.

Emlen, J. M., D. C. Freeman, **M. D. Kirchhoff**, C. L. Alados, J. Escos, and J. J. Duda. 2003. Fitting population models from field data. *Ecological modeling* 162:119-143.

HOW SELECTIVE LOGGING AFFECTS PLANT COMPOSITION AND STRUCTURE IN TEMPERATE RAINFORESTS OF SOUTHEAST ALASKA: IMPLICATIONS FOR SITKA BLACK-TAILED DEER.

M. D. Kirchhoff and **S. R. G. Thomson,**
Wildlife Conservation, Alaska Department of Fish and Game, P.O. Box 240020, Douglas, AK 99824.

Abstract

The intensity of selective logging can vary in application, from removing a single tree from a stand to leaving a single tree standing. We wished to examine how plant composition and structure in the residual stand varied across this spectrum of selective logging intensities. We were particularly interested in the implications of these results for Sitka black-tailed deer, which require both abundant forage and an ample overstory for protection from deep snow. We examined the question retrospectively, by measuring the current vegetative condition of 43 stands that had been selectively logged between 1899 and 1946. The logging history of each stand was reconstructed from stumps and an analysis of tree rings in residual and new trees. All trees, snags, stumps, and down logs in the stand were measured and mapped. We measured height and density (of shrubs), estimated ground cover, and clipped and weighed current annual growth of leaves and stems to determine available biomass of each plant species. Results showed that tree growth rates increased with increasing logging intensity, but that dense tree stocking shaded out understory plants in heavily logged stands. Lightly logged stands exhibited both high understory production and a well-developed residual overstory. Evidence suggests that light selection logging which removes small clumps of trees dispersed throughout the stand can retain much of the diversity, productivity, and habitat value of the original old growth.

Kirchhoff, M. D. and S. R. G. Thomson. *in review*. How selective logging affects plant composition and structure in temperate rainforests of Southeast Alaska: implications for Sitka black tailed deer. *Northwest Science*___

MONITORING DEER POPULATIONS IN FORESTED ENVIRONMENTS: LINKING SURVEY DATA TO ACTUAL POPULATION SIZE.

Kevin S. White, Alaska Department of Fish and Game, Division of Wildlife Conservation, PO Box 240020, Douglas, AK 99824, USA, kevin_white@fishgame.state.ak.us

Matthew D. Kirchhoff, Alaska Department of Fish and Game, Division of Wildlife Conservation, PO Box 240020, Douglas, AK 99824, USA

Abstract

Monitoring wildlife populations in densely forested environments is difficult and field survey options are limited, particularly in remote areas. Indirect population monitoring techniques, such as sign surveys, are often the only available option for biologists charged with managing populations in such areas. The usefulness of such data relies on the existence of a known relationship between true population abundance and related survey information. Unfortunately, such relationships are rarely investigated, especially in free-ranging wildlife populations. Here we describe the results of a field experiment designed to evaluate the relationship between true population abundance and pellet-group density for Sitka black-tailed deer (*Odocoileus hemionus sitchensis*) in southeastern Alaska. We rely on data collected on a small, forested island (40 ha.) where 12 deer were experimentally translocated and patterns of occupancy were recorded over a set period of time. Results of replicate field surveys (n = 3), adjusted for effects of observer detection bias, indicated that deer density equated to 10.1 (±0.20) deer/km^2 for each pellet-group enumerated per $20m^2$ strip plot. Although this relationship is applicable to a single habitat type and a particular set of weather conditions, it provides an important initial estimate of the relationship between deer-pellet group density and population abundance for this ecosystem. Future investigations that focus on how precipitation and habitat type influence pellet persistence and detectability will be required before deer-pellet group survey results can be equated with absolute deer numbers at the landscape scale.

Key words: Alaska, Sitka black-tailed deer, *Odocoileus hemionus sitchensis*, population monitoring, pellet-group sampling, population abundance.
Wildlife Society Bulletin 00(0): 000-000

White, K. S. and M. D. Kirchhoff, *in review*, Monitoring deer populations in forested environments: linking survey data to actual population size. Wildlife Society Bulletin. ________.

DEER HABITATS IN MANAGED COASTAL TEMPERATE RAINFOREST: CLASSIFICATION AND RELATIVE USE

Christopher J. Farmer, Faculty of Environmental and Forest Biology, State University of New York, College of Environmental Science and Forestry, 1 Forestry Drive, Syracuse, New York. Telephone: 949-766-6378, fax: 907-465-4272 (c/o M. Kirchhoff), email: heceta01@msn.com

Matthew D. Kirchhoff, Alaska Department of Fish & Game, Division of Wildlife Conservation, PO Box 240020, Douglas, Alaska. Telephone: 907-465-4328, email: Matt_Kirchhoff@adfg.state.ak.us

[1]current address: 104 Bell Canyon Rd., Trabuco Canyon, Ca 92679

Abstract

Modeling the effects of clearcut logging on deer in temperate rainforests requires a habitat classification system that is reflective of the composition, biomass, and quality of forage in old growth and early successional cover types. We measured habitat attributes important to deer (forage composition, biomass, and hiding cover) on 394 random plots in Southeast Alaska, and used cluster analyses to identify seven cover types. These types differed in forage production and diversity, hiding cover, and relative use by deer. Clearcuts provided the highest forage biomass and the best security from predation, yet old growth received higher levels of deer use. The preference for old-growth cover types over early successional types presumably reflects the higher food value of this cover type. Food value encompasses forage biomass, nutritional quality, accessibility, and diversity. Although the abundant forage in young clearcuts may translate into high carrying capacity, other factors such as foraging efficiency have a greater effect on individual fitness, and exert a significant influence on habitat selection by deer. Models designed to predict the effect of clearcut logging on deer should incorporate information not only on forage biomass and hiding cover, but on factors affecting foraging efficiency, including forage quality and predation risk.

Key words: black-tailed deer, deer management, even-aged forest management, *Odocoileus*, Tongass National Forest

Farmer, C. J., and **M. D. Kirchhoff**. (*in prep)*. Deer habitats in managed coastal temperate rainforest: classification and relative use. *Forest Science*.

THE ALASKA PERSPECTIVE – DEER POPULATIONS IN THE PRESENCE OF WOLVES

Matthew D. Kirchhoff, Division of Wildlife Conservation, Alaska Department of Fish and Game, PO Box 240020, Douglas AK 99824 USA. 907-465-4328.
Mattdk@fishgame.state.ak.us

David K. Person, Division of Wildlife Conservation, Alaska Department of Fish and Game, 2030 Sea Level Drive, Ketchikan, AK 99907

Abstract

This paper examines the influence of wolves on Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) populations in Southeast Alaska, and attempts to predict the effects of introducing wolves (*Canis lupus*) to Haida Gwaii deer populations and their habitat. The comparison is apt because of strong similarities in the climate, geography and ecology of Haida Gwaii and Southeast Alaska.

In Southeast Alaska, large islands without wolves generally have significantly higher density deer populations than islands with wolves. In general, deer numbers on wolf-free islands in Southeast Alaska are about 40% higher than on islands with wolves. There is high variability, however, with deer numbers being lowest on islands where wolves and black bears (*Ursus americanus*) are abundant. Wherever deer are abundant in Southeast Alaska, the biomass and architecture of understory plants is noticeably affected, as on Haida Gwaii.

Southeast Alaska also provides an opportunity to examine the effects of the introduction and subsequent demise of wolves on a small (78 km^2) island in Southeast Alaska. In 1960, 4 wolves were placed on Coronation Island—an island with abundant deer but no native predators. Within 5 years, wolf numbers increased to 12, and deer populations plummeted. Lacking sufficient food, the wolf population eventually died out. With the wolves gone, deer populations rebounded to pre-introduction levels. This experiment confirmed the rapidity with which wolves can reduce a population of deer, and suggests that a relatively large geographic area is needed for a stable wolf-deer relationship to become established.

Finally, we employed a model developed previously by Person et al. (2001) to predict the likely response of deer to the hypothetical introduction of wolves on Haida Gwaii. Using empirically based model parameters on deer and wolf productivity, predation rates, and natural mortality in Southeast Alaska, we performed 500 Monte Carlo simulations to predict how deer, wolves, and carrying capacity will change over a 100-year period on Haida Gwaii.

The model predicts that in the 12 years after wolves are introduced, deer populations will decline by a third, from 113 thousand to 75 thousand deer. Wolf populations will peak 10 years after introduction, and then decline slightly to a stable population of about 550 individuals. The vegetation, released from heavy browsing pressure, will begin to grow back slowly, with K (carrying capacity) increasing about 1% per year. The deer, which now have access to more abundant, higher quality forage on a per capita basis, become more

productive. Deer populations begin to slowly rebuild, “out-producing” the predation loss, and reaching stable levels of about 85–90 thousand deer.

While this modeling exercise indicates potential for some success in restoring the pre-deer flora to the islands, deer will not disappear. They will always exist at high enough population levels to exert a measurable influence on the flora, especially highly preferred forage species. There are other side effects of introducing an exotic species that would also have to be considered. For example, wolves could wreak havoc with ground nesting birds, including the ancient murrelet (*Synthliboramphus antiquus)* whose Haida Gwaii population represents half of the remaining world population. Ground nesting waterfowl and shorebirds on Graham Island would similarly be vulnerable. If side effects can be controlled, natural predation appears to be one possible way to reduce deer numbers significantly over large areas of Haida Gwaii, and contribute to the restoration of the natural flora.

Key words: Canis lupus, deer, Haida Gwaii, Odocoileus hemionus sitkensis, wolves, logging, carrying capacity, Queen Charlotte islands, Southeast Alaska.

Kirchhoff, M. D. and **D. K. Person**. *In press*. The Alaska perspective: deer populations in the presence of wolves. Occasional paper, Canadian Wildlife Service, Ottawa, Canada.

HERBIVORY AND THE MISSING UNDERSTORY ON HAIDA GWAII (QUEEN CHARLOTTE ISLANDS), CANADA.

Christian Engelstoft, Dept. of Biology, University of Victoria, Po. Box 3020, Stn CSC, Victoria, British Columbia, V8W 3N5, Canada.

Matthew D. Kirchhoff, Alaska Dept. of Fish and Game, Po. Box 240020, Douglas, Alaska, 99824, USA.

Donald Eastman, Dept. of Biology, University of Victoria, Po. Box 3020, Stn CSC, Victoria, British Columbia, V8W 3N5, Canada.

Abstract
Since the introduction of deer to Haida Gwaii, understory biomass and deer density have not been monitored. In this study, we estimate the current understory biomass and relative deer density in old growth stands, mainly on the Skidegate Plateau. The results provide baseline data for future restoration and monitoring efforts. Regressions were developed to estimate aboveground biomass (shrubs and herbs), available biomass (potential food for deer), and the biomass eaten by deer. We encountered 13 herb species, 6 fern species and 7 shrub species in the 110 sample sites. The aboveground biomass (excluding *Gaultheria shallon*) ranged from 0 to 2137 kg/ha, with a mean of 258 kg/ha (SD = 388) and a median of 82 kg/ha. The average available biomass ranged from 0 to 641 kg/ha, with a mean of 7 kg/ha (SD = 14) and a median of 2.6 kg/ha. The biomass consumed by deer ranged from 0.4 to 22.5 kg/ha, with a mean of 4.0 kg/ha (SD = 4.4) and a median of 3.0 kg/ha. We measured pellet-group density as a surrogate for deer density (or deer-days use). Deer density ranged from 0 to 1840 PG/ha, with a mean of 402 PG/ha (SD = 362) and a median of 300 PG/ha. Deer density was unrelated to either aboveground or available biomass, nor was deer density correlated with canopy cover or other overstory attributes. We attributed the lack of correlations to the fact that in areas where deer concentrated, heavy browsing effectively eliminated the understory. Deer may be attracted to areas where forage is plentiful, but the more deer-days use an area receives, the more biomass is consumed. Over the course of a winter, biomass may be largely eliminated in some heavily used areas, leaving high pellet-group densities and much diminished understory biomass. Western red cedar (*Thuja plicata*) is a favored forage species of deer, and has been largely eliminated from the understory by browsing pressure. Cedar's future as a codominant overstory species on Haida Gwaii is in jeopardy. Presently, forage biomass available to deer on Haida Gwaii is low compared to other areas where deer are subject to predation pressure and more severe winters. During severe winters, we expect widespread starvation in the deer population due to the limited amount of forage in most old growth stands. During mild winters, deer will make use of extensive non-forest and early successional forest to find forage. Although deer will be abundant, they will be nutritionally stressed and relatively unproductive.

Key words: Browse, Haida Gwaii, Queen Charlotte Islands, Herbivory, *Odocoileus hemionus sitkensis*, Old growth, Sitka black-tailed deer, Relative deer density, Blechnum spicant, regression estimates.

Englestoft, C., **M. D. Kirchhoff**, and D. Eastman. *In review*. Herbivory and the missing understory on Haida Gwaii (Queen Charlotte Islands). Occasional paper, Canadian Wildlife Service, Ottawa, Canada.

XI. PREPARED BY:

Matthew D. Kirchhoff
Wildlife Biologist III

SUBMITTED BY:

Dale Rabe
Acting Regional Supervisor

APPROVED BY:

____
Thomas W. Paul
Federal Aid Coordinator
Division of Wildlife Conservation

____
Matthew H. Robus, Director
Division of Wildlife Conservation

APPROVAL DATE: __________________