Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report
1 July 1994-30 June 1996

Effects of Selection Logging on Deer Habitat in Southeast Alaska

Matthew D Kirchhoff

Costello

Grants W-24-4
W-24-5
Study 2.11
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STATE OF ALASKA
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RESEARCH PROGRESS REPORT

STATE: ALASKA STUDY NO.: 2.11

GRANT NO: W-24-4
W-24-5

STUDY TITLE: Effects of Selection Logging on Deer Habitat in Southeast Alaska

PERIOD: 1 July 1994-30 June 1996 (with additional data collected July-August 1996)

SUMMARY

This research was designed to show how the removal of individual trees, or small groups of trees, by selection logging affected the composition, structure, and habitat value of the forest in Southeast Alaska. Emphasis was placed on the functional relationship between changing overstory structure and the composition and abundance of shrubs and herb-layer plants. The goal was to develop prescriptive alternatives to clear-cutting that mimic natural disturbance patterns and thus better preserve habitat quality for Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) and other old-growth-associated wildlife.

Forty-three 0.01 ha study plots were established in stands that had been selectively logged between 1900 and 1950 in Southeast Alaska. Selectively logged stands are very common in coastal areas on productive sites and, with practice, can be reliably identified by boat. Trees >5 cm dbh (diameter at breast height) ranged from 23 trees per plot to 99 trees per plot. Logging intensity ranged from very light (1 large tree logged) to very heavy (all large trees logged). Analysis of understory and overstory data are still incomplete; however, qualitative impressions indicate that lighter selection harvesting results in conditions that more closely approximate old-growth conditions. In comparison, very heavy selection logging, particularly on upland sites, results in conditions similar to even-aged second growth. Understory response may differ on riparian versus upland sites, particularly in stands dominated by salmonberry (*Rubus spectablis*) and devil's club (*Oplopanax horridus*).

No further fieldwork is anticipated on this project. Over the next year, work will include detailed tree ring analysis, spatial analysis of stem maps, analysis of canopy cover, and quantification of understory and overstory biomass on these plots. I expect to have a final report in the form of a manuscript submitted for publication by August 31, 1998.

Key words: old growth, retrospective, selection logging, silviculture, Southeast Alaska, wildlife habitat.

CONTENTS

BACKGROUND

Logging and Wildlife

Since the early 1940s, timber in Southeast Alaska has been harvested almost exclusively by the clear-cut method. While clear-cutting offers a number of economic and silvicultural advantages over other harvest methods (Ruth and Harris 1979), it also causes significant, long-lasting changes in the vegetative composition and structure of the stand (Alaback 1982). These changes can create adverse habitat conditions for a number of old growth-associated wildlife species, including Sitka black-tailed deer *(Odocoileus hemionus sitkensis)*, marten (*Martes americana*), goshawks (*Accipiter gentilis*) and others (Schoen et al. 1988, USFS 1991, Suring et al. 1993).

In Southeast Alaska, much forest and wildlife research has focused on habitat relationships of Sitka black-tailed deer (ref. in ADFG 1995). Those studies show deer use of close-canopied, second-growth stands (30-150 years postlogging) is many times lower than in nearby old growth (Wallmo and Schoen 1980, Rose 1984, Mankowski and Peek 1985, Yeo and Peek 1992). This low use is presumably due to the lack of forage characteristic of mid to late seral stands (Alaback 1982). In comparison, old growth provides deer with good overstory cover for snow interception, as well as relatively abundant, high-quality forage (Bloom 1978, Alaback 1982, Hanley et al 1989, Schoen and Kirchhoff 1990). The cumulative conversion of productive old-growth habitat into even-aged second growth is expected to result in long-term declines in deer (Wallmo and Schoen 1980, Fagan 1988, USFS 1991).

Forest Disturbance and Ecosystem Management

Forest disturbance, whether natural or human-caused, is a process that occurs along gradients of intensity and frequency. A windstorm, fire, or landslide that fells every tree in a stand would be considered an intense, or catastrophic disturbance. In Southeast Alaska, such high-intensity disturbances are rare. In 1961 only 1.4 percent of the forest area on Prince of Wales and adjoining islands showed evidence of high-intensity disturbance from either complete or partial blowdown (data from A.S. Harris, cited in Brady and Hanley 1984). By comparison, low-intensity disturbance, such as a single decadent tree toppling in a storm, is frequent (Harris and Farr 1974). This natural pattern of low-intensity, high-frequency disturbances is important for perpetuating small gaps in the forest canopy and maintaining the diversity and abundance of understory plants characteristic of old growth (Brady and Hanley 1984).

One of the goals of ecosystem management (Bormann et al. 1994, Jensen and Bourgeron 1994) is to develop management practices that more closely emulate natural disturbance regimes. At present, the only silvicultural system in use (clear-cutting) emulates a disturbance pattern (complete blowdown) that in nature is very rare. If management practices are to be at all proportional to what occurs naturally, greater emphasis must be placed on single tree and small-group selection harvest. This fact was recognized by the former Chief of the Forest Service, Dale Robertson, who in 1992 declared an agency goal of reducing clear-cutting on National Forest lands by 70% (USFS 1992*a*). While direction exists to consider alternatives to clear-cutting in Alaska (USFS 1992*b*), progress to date has been slow (Kirchhoff 1995). Last year on the Tongass, clear-cutting accounted for over 99% of the total area logged (USFS, unpubl. data).

Gaining public support for alternative harvest methods is a key ingredient of ecosystem management (Shindler et al. 1995). Currently, there is inadequate information on the ecological and economic ramifications of these alternatives, which precludes an informed, supportive public. The purpose of this study, with its wildlife habitat perspective, is to provide information on how alternative harvest methods affect the forest. Specifically, I examine how variation in intensity of overstory disturbance affects the diversity and abundance of vascular plants in the understory.

STUDY OBJECTIVES

This research was designed to show how the removal of individual trees, or small groups of trees, by selection logging affected the composition, structure, and habitat value of the forest in Southeast Alaska. Emphasis was placed on the functional relationship between changing overstory structure and the composition and abundance of shrubs and herb-layer plants. The goal was to develop prescriptive alternatives to clear-cutting that mimic natural disturbance patterns, and thus better preserve habitat quality for Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) and other old-growth associated wildlife.

STUDY DESIGN

The response of trees and understory vegetation to disturbance varies over long time periods. For example, it may take 30 years or longer for regenerating conifers to shade out the understory in a clear-cut, and another 150-250 years before natural canopy gaps form and the understory becomes reestablished (Alaback 1982). Experimental treatments installed today can yield valuable information on the economics of alternative harvest methods and short-term stand response (e.g., 1-5 years); however, the more important long-term questions often remain unanswered.

Alternatively, it is possible to look retrospectively at sites that were selectively logged 75 to 100 years ago and infer long-term response from the vegetation existing today (Thomas et al. 1993). Fortunately, Southeast Alaska has a long, well-documented logging history that includes an era of selection logging (e.g., Robinson 1938, Harris and Farr 1974, Cooper and Beier 1981). Throughout the late 1800s and early 1900s, many of the large, high-quality Sitka spruce (*Picea sitchensis*) within 300 m of tidewater were felled and hauled from the woods by handloggers. Evidence of this activity can still be seen in the form of springboard notches cut into high stumps along much of the shoreline. From historical sales records and maps, ranger diaries, and existing historical atlases, scores of sites partially logged before 1935 (>60 years old) were identified throughout the region (ADFG, unpubl. data). These, and others located in the field, represent the pool from which actual study stands were selected.

Forest vegetation in Southeast Alaska differs from hectare to hectare in response to varying soil type, drainage, and disturbance history. The effect of a single disturbance event (e.g., selective logging) 50 to 100 years ago can easily be masked, or confounded by prior or subsequent disturbance on the site. Picking "typical" sites, whether logged or unlogged, under these circumstances is impossible. Discerning treatment effects amid high natural variability can only be achieved with large sample sizes.

The goal was to sample >40 selectively logged sites well-distributed throughout the archipelago. Time since disturbance for all sites was to be similar (60-90 years). These older sites are of most interest from a management perspective because under current clear-cutting methods, second-growth stands this age are among the poorest for deer. Site-to-site variation was minimized by working only in spruce or spruce-hemlock (*Picea sitchensis-tsuga heterophylla*) forest types, on moderately to highly productive soils, and at low elevations within 500 m of tidewater. When possible, 2 or more study plots were to be located in a single selectively logged stand, with plots spanning a range of selective logging intensities.

Stands selected for measurement had from 5% to 90% of their original basal area removed. In addition to partially logged sites, several 60-90 year-old clearcuts were measured for comparative purposes. Nonlinear regression analysis will be used to describe the response of various understory plants (biomass of individual species and forage classes) over the range of measured disturbance intensities. If warranted, separate regressions will be generated for spruce and spruce-hemlock sites and for alluvial flats and upland slopes. Specific sampling methodology follows.

METHODS

Sample Plots

Partially logged stands were identified from existing maps and sale records (ADFG, unpubl. data), or from field reconnaissance. Release dates were determined from cores of residual trees to confirm logging date. Once a suitable stand was identified, one to three 0.1 ha plots were located in the stand. Stands which had experienced subsequent selective logging or human disturbance were avoided.

Each sample plot was located such that the most disturbed area (evidenced by stumps) fell within the plot. The four sides of the plot were oriented in north-south and east-west directions. The average slope, aspect and elevation of the plot was recorded. The corners of the plot were permanently marked with flagged stakes, and one plot corner (or a nearby tree) was heavily flagged and marked with a numbered metal tag. Crews recorded the bearing, and exact distance from this corner to a corresponding witness tree on the beach. The GPS location, and a written description of the witness tree, was recorded to allow others to relocate these stands for future research and monitoring purposes.

Overstory

Because gap formation from selective logging so strongly influences patterns of understory development, information on the precise spacing and structure of overstory trees was essential. A complete stem map of all trees > 5 cm dbh (diameter at breast height) was constructed for each plot. The location of each tree was determined with reference to fiberglass measuring tapes stretched in N-S and E-W directions that subdivided the plot into 16 compartments (Figure 1). For each tree, crews recorded the location, species, dbh, crown ratio, tree height (with a relaskop), and presence or absence of defect indicators (conks, frost cracks, broken tops etc.) (Farr et al. 1976). Gross and net volume of each tree (Bones 1968) will be computed. Location and dbh of old stumps were recorded to show exact location and intensity of logging disturbance. Five live trees in the vicinity of old stumps in the stand were cored to verify logging (release) date.

Canopy cover was measured using methods described in Kirchhoff and Schoen (1987). Photographs were be taken with a mid-length telephoto lens (70-80 mm), projected vertically from 2 m above the forest floor at each of 9 sample points. Sample points occur where E-W and N-S running fiberglass tapes intersect in the stand (Figure 1). Percent canopy cover will later be determined by overlaying a 100-dot grid on the photograph and counting the number of points occluded by canopy. A wide angle lens (35 mm) was used to photograph the stand from each corner (looking toward plot center) as a visual record of current vegetation and structure.

Down Wood

Down wood serves many important functions in an old growth stand (Franklin et al 1981), and it's removal through selective logging may alter long-term patterns of understory development relative to old growth. Thus, a complete map of all down wood > 25 cm mean diameter was constructed for each plot. Crews drew the approximate location of each down log on data forms with reference to measuring tapes that subdivided the plot. The length, mean diameter, and decay class (ref. Alaback and Hastings 1995) of each log was noted.

Shrubs

Regression-based estimates of shrub biomass can be problematic due to site variation, intensive deer browsing, and highly clumped distribution patterns (Alaback 1986, Pitt and Schwab 1988, Kirchhoff 1994). Clip and weigh techniques measure biomass directly and are the most accurate method of determining biomass. However, because of high labor and expense, this method is usually restricted to intensive research endeavors (Pitt and Schwab 1988). Alternatively, plotless density estimators can alleviate much of the labor involved in fixed quadrat sampling. Simulation tests show certain plotless density estimators perform well over a range of densities and spatial patterns (Engeman et al. 1994). Of these, the variable area transect (VAT) method (Parker 1979) ranks as one of the best performing, most practical, and easily computed (Engeman et al. 1994). Pre-testing using this technique showed it to be more efficient and more accurate for estimating shrub stem densities than uniformly spaced 1 m^2 circular quadrats (ADFG, unpubl. data).

The fiberglass tapes used to subdivide the plot form a 3 x 3 grid of 9 sample points (Figure 1). The locations of these sample points are weighted slightly toward plot center to minimize edge influence. Shrubs were sampled with 1-m wide variable area transects extending outward from each sample point in 4 principal directions. Crews recorded species, minimum basal diameter, height class, and distance to the 3 nearest shrub stems (>10 cm tall) along each transect. For the third shrub stem, crews tallied the number of browsed twigs. This shrub was then destructively sampled for biomass estimation.

After shaking any surface water from this shrub, crews snipped all green stems smaller than 3 mm in diameter. *Vaccinium* twigs this size encompass >90% of normal deer browse (Kirchhoff 1994). These clipped twigs, including attached leaves but not fruits, were weighed to the nearest 0.1 g. For tall plants, where biomass in the upper layers is unavailable to deer, separate weights were gathered for fractions above and below 1.5 m. All plant fractions were frozen and will later be oven-dried to determine appropriate wet weight:dry weight and leaf weight:stem weight conversion ratios for the plot.

The following attributes of the shrub layer will be computed: stem density by species, basal area by species, height distribution by species, and available biomass of leaves, stems, and current annual growth for each species. *Vaccinium ovalifolium* and *Vaccinium alaskensis* will not be differentiated.

HERBS

Herb-layer vegetation (including shrubs <10 cm tall) was sampled by clipping and weighing the vegetation over a series of 36 0.1 m^2 circular plots uniformly distributed in the stand. The plots were located 8 ft (2.44 m) in 4 principal directions (E,W, N, and S) from each of 9 reference points (Figure 1). Each plant rooted in the 0.1 m^2 plot was clipped at moss level, aggregated by species, and weighed to the nearest 0.1 g. A subsample (1 plant per species per plot) was collected and will be oven dried and reweighed to determine the appropriate wet weight:dry weight conversion factors.

This particular quadrat size and plot layout was designed for forbs and half shrubs (e.g., *Cornus canadensis, Rubus pedatus, Tiarella trifoliata*) that are small and relatively common. These represent important food plants for deer. Other plants, such as *Lysichiton americanum*, may be important for deer, but because of their size and sparse distribution may not be adequately sampled. Crews also estimated percent cover and mapped (within the 16 areas demarcated by the fiberglass tapes) *L. americanum, Oplopanax horridus*, and any other large, sparsely distributed plants that may not be adequately sampled by 0.1 m^2 quadrats.

RESULTS

The field portion of this project is completed, with 43 study plots sampled across Southeast Alaska (Figure 1). These include 14 stands sampled 19-30 August 1995 on Admiralty and Kuiu Islands and 29 stands sampled 1 July-7 August 1996 on Kosciusko, Heceta, and Prince of Wales islands. Historically, selective logging was concentrated in these areas because they are relatively productive. We found that selectively logged stands could be predictably located from a boat if the stand was: (1) within 500 m of mean low tide, (2) contained trees >50 m tall with a significant proportion of spruce, and (3) canopy was uneven, including some snags.

Analysis of tree ring data is not yet complete, but of the stands analyzed, the oldest logging activity dates back to 1902, and the most recent logging activity dates back to 1947. Most of the stands sampled appear to have been selectively logged between 1932 and 1942. Stem density ranged from 23-99 live stems per plot.

Numerical data on understory and overstory composition are currently being keypunched and will be analyzed this winter. Based on the fieldwork, we believe light selective logging provides more understory than very heavy selective logging, although considerable variation exists among the sites. It also appears the understory response differs depending on whether the plot is located in a riparian area or an upland site, with riparian sites remaining more open and productive following logging. This may reflect wet microsites in riparian areas which promote aggressive and persistent growth of salmonberry and devil's club. Further analysis and discussion will be provided in the final report in August 1998.

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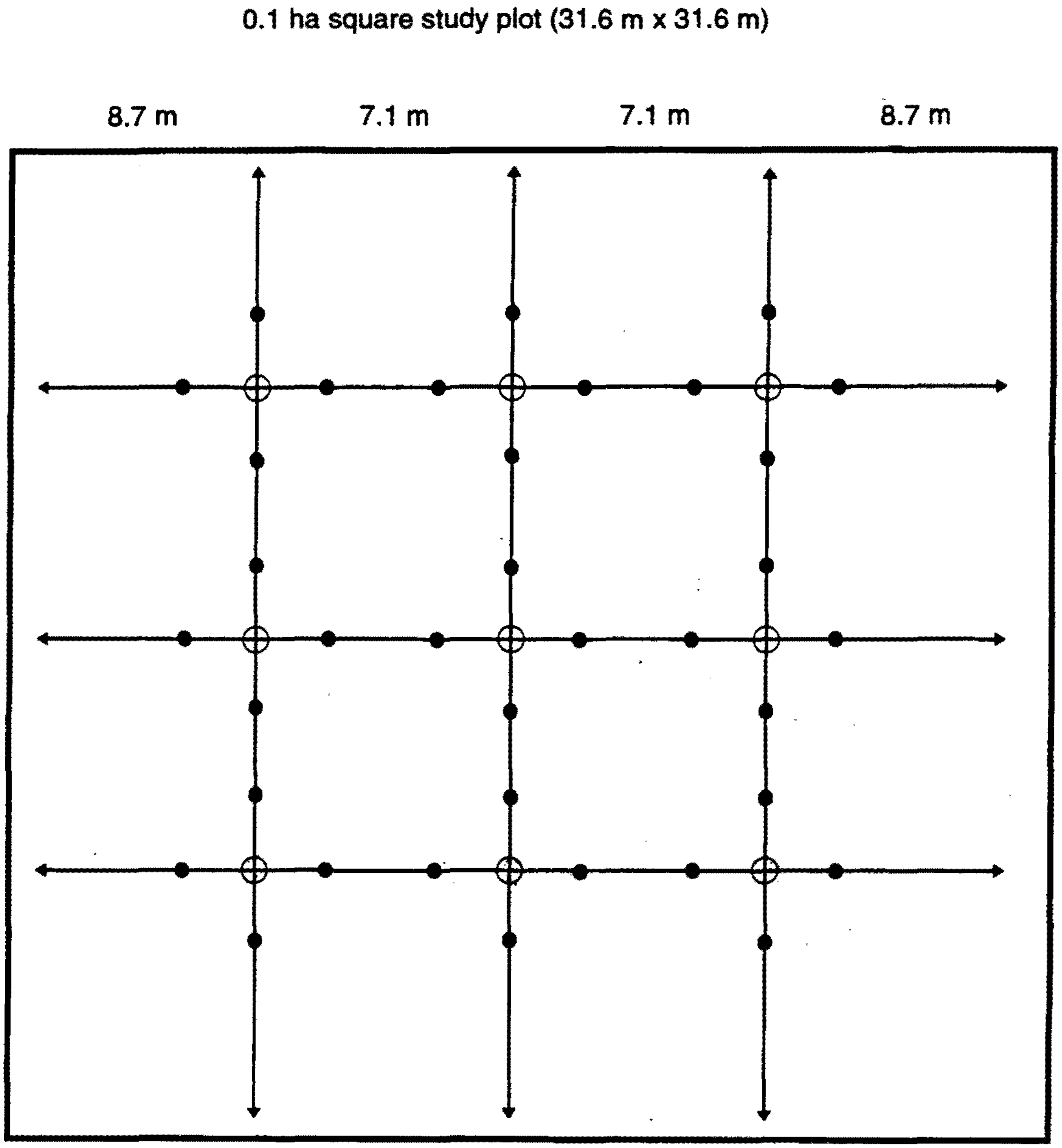
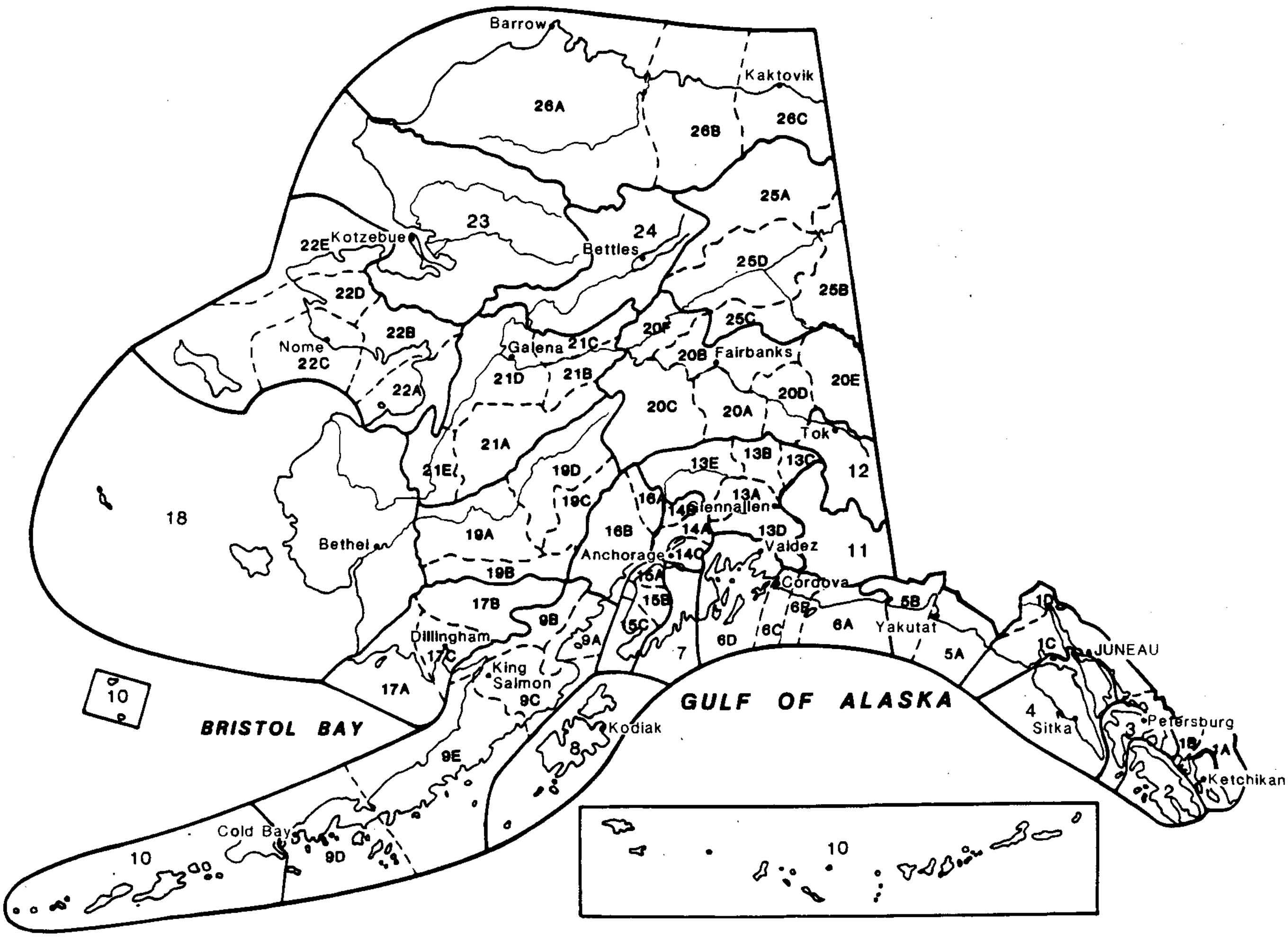


Figure 1. Study plot layout showing location of 0.1 m^2 circular quadrats (●) for sampling herb-layer vegetation, and 9 points (⊕) which serve as the starting points for variable area transects to sample shrub-layer vegetation. Variable area transects are 1 m wide and extend from each sample point in N,S, E, and W directions until the 3rd shrub in the transect is encountered. Photographs of the canopy will be taken at the 9 points (⊕). The exact location of all trees, stumps, and down logs in the plot will be mapped.

Alaska's Game Management Units



The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve, and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge, and attitu for responsible hunting. Seventy-five percent of the funds for this report are from Federal Aid.

Pat Costello