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Detecting Vegetation Change in Kenai Fjords National Park: A Revisit of 15-Year-Old Inventory Plots

Natural Resource Technical Report NPS/SWAN/NRTR—2010/329



ON THE COVER
Beach berm and Aialik Glacier at the head of Aialik Bay, Kenai Fjords National Park
Photograph by: Tina Boucher

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May 2010

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

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Please cite this publication as:

Boucher, T. V., A. E. Miller, and K. W. Boggs. 2010. Detecting vegetation change in Kenai Fjords National Park: A revisit of 15-year-old inventory plots. Natural Resource Technical Report NPS/SWAN/NRTR—2010/329. National Park Service, Fort Collins, Colorado.

NPS 186/102211, May 2010

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Abstract

In 2008 we revisited 22 sites along the coast of Kenai Fjords National Park initially sampled in 1993. Our goal was to conduct a pilot study to assess vegetation change on early and late successional plant communities, and to assess the feasibility of relocating plots that had not been permanently marked. We sampled 10 plots that were glaciated during the maximum extent of the Little Ice Age (LIA, ca. 1850), and 12 plots that were beyond the maximum glacial extent. Plots were grouped into the following categories: forest, tall shrub, dwarf shrub-forb, and coastal herbaceous meadow.

Because plots were not permanently marked in 1993, we were not able to accurately relocate 13 out of 22 plots. Where we could not relocate the exact plot center, we sampled in homogeneous vegetation in the general area of the original plot. We took repeat photographs where possible to document vegetation change within the plots and in the surrounding landscape. While we were able to identify some consistent trends, other changes could have been due to relocation error. Where the plot data may have fallen short, the repeat landscape photos provide a valuable indication of the scale of vegetation change across the landscape.

Observed trends in the plot data included increased species richness in early successional shrub plots and increased salmonberry (*Rubus spectabilis*) cover on disturbance slopes outside the LIA maximum. Landscape photos corroborated the increase in *Rubus spectabilis* observed in several plots, possibly indicating a change in frequency or severity of the disturbance regime on active side slopes. In coastal herbaceous meadows we saw a decrease in beach rye (*Leymus mollis*) cover and increase in forb cover likely due to natural successional processes and isostatic rebound. Late seral forests appeared fairly stable, while young spruce forests showed trends similar to those in the early successional shrub plots.

This study provides an indication of the nature of change in vegetation over a 15-year window on recently deglaciated terrain and on older landscapes, and provides insight into possible future research efforts. However, this study was not designed to replace a monitoring program, and we do not advocate using this plot design for future long-term monitoring efforts.

Acknowledgments

The National Park Service provided funding for this study through the Southwest Alaska Network. We thank Bill Thompson, Chuck Lindsay, and Christina Kriedeman for assistance with field data collection. The captain and crew of the National Park Service boat, The Serac, provided transportation and logistical support. We thank Lindsey Flagstad, Alaska Natural Heritage Program, and Laura Phillips, Kenai Fjords National Park, for their recommendations on improving an earlier version of this manuscript.

Introduction

A primary goal of biological monitoring is to describe current status and trends in ecosystem structure and composition in order to better understand their dynamic nature (Bennett et al. 2006). The high northern latitudes are currently warming at almost twice the rate as the lower latitudes, and this rate of warming is projected over the next century (ACIA 2004). These documented changes in climate are expected to have broad implications for the ecosystems of Kenai Fjords National Park (KEFJ).

Glaciers in KEFJ have been receding since the Little Ice Age (LIA) maximum, approximately 1850 A.D. (Wiles and Calkin 1994). Recession rates appear to have accelerated more recently, with ice cover on the Harding Icefield and Grewingk-Yalik Glacier Complex decreasing by approximately 2.2% in the period between 1986 and 2000 (Hall et al. 2005).

Climate warming has a direct effect on the extent of exposed terrain resulting from glacial recession and an indirect effect on disturbance regimes dependent on runoff and snowpack. The frequency and severity of avalanches may be altered by changes in winter snow depth, and the flooding pattern of outwash plains will be altered by glacial retreat. Documenting changes to vegetation composition and structure on different landscapes is key to understanding how climate change will affect the ecosystems of KEFJ.

Alder (*Alnus viridis* ssp. *sinuata*) often establishes in the wake of the receding ice and may persist for decades to centuries (Heusser 1983). However, successional trajectories may diverge through time as species richness increases, or as disturbance resets the successional pathway in these ecosystems (Cattelino et al. 1979, Noble and Slatyer 1980, Halpern 1988, Flagstad 2007).

In this study, we document short-term changes in vegetation composition and structure in early successional and mid- to late-successional glacial landscapes (Kuletz et al. 1994, DeVelice et al. 1995). Additionally, we evaluate the feasiblility of relocating plots that were not permanently referenced on the ground.

Methods

Study Area

Kenai Fjords National Park is characterized by deep fjords with tidewater glaciers, steep active sideslopes, and rocky headlands. The Harding Icefield mantels much of the alpine terrain and provides the source for distributary glaciers. KEFJ has a wet maritime climate with cool rainy summers and mild snowy winters. The mean annual temperature is 4.6°C with a mean July temperature of 13.6°C and a mean January temperature of -3.2°C (Seward, Alaska 1971-2000, NCDC 2000).

Glacial recession since the LIA maximum has exposed new terrain that is now vegetated with early seral vegetation, including herbaceous vegetation, low and tall shrubs, and young spruce forest. Beyond the LIA maximum, landscapes have not been glaciated since the Wisconsin glacial advance 10,500 BP (Harris et al. 1997). Below treeline these landscapes are dominated by old growth coniferous forest and forested and non-forested wetlands. Alpine environments are dominated by herbaceous meadows, dwarf shrub heath, and low and tall shrub. Ecosystems experiencing chronic disturbance, such as flood plains and avalanche slopes, are typically dominated by alder (*Alnus viridis* ssp. *sinuata*) or willow (*Salix* spp.) on both older and younger landscapes.

Sampling Design

In 1993, 39 sites were selected along the coastline of Kenai Fjords for marbled murrelet dawn watch and habitat surveys (Kuletz et al. 1994, DeVelice et al. 1995). At each site, inventory crews sampled vegetation within a 1-km radius of the coastal point. Sampling was conducted using methods described by DeVelice et al. (1999). Major community types, including both forested and non-forested types, were documented within the 1-km radius area. Sampling plots were selected in homogeneous vegetation, in stands that were large enough to encompass the 500 m^2 or 50 m^2 plots used in forests and non-forests. Within each plot, visual estimates of percent canopy cover were made for each vascular plant species. Vegetation cover by structual layer and life form were also recorded. On forested plots, tree height by species and diameter class was recorded, and representative trees were aged using an increment borer. Plots were not permanently marked on the ground, but detailed notes, photographs, and pin-pricks made on aerial photos aided in relocation. Pin-pricks were digitized into a GIS database in 2008.

In 2008, we reviewed all plot location information and photos and selected 22 plots that we thought would be possible to relocate (Figure 1). We were particularly interested in revisiting plots that had detailed site and landscape photos and represented terrains that were glaciated during the LIA, as well as those sites that remained ice-free. During the summer of 2008 we revisited these plots and resampled them using the same methods used in 1993.

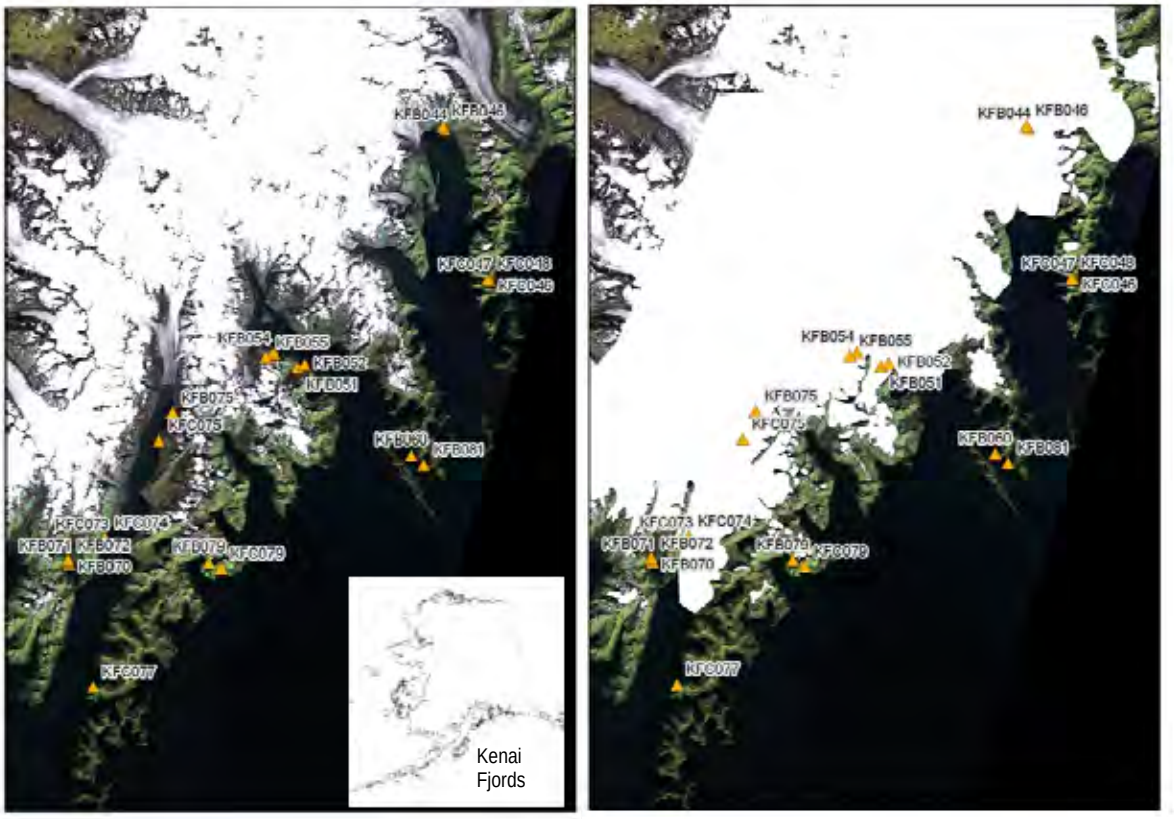


Figure 1. Map of Kenai Fjords National Park showing locations of the 1993 plots revisited in 2008. The image on the left shows current glacial extent, and the image right shows the maximum glacial extent at the height of the Little Ice Age (Crowell and Mann 1995).

Analysis

Vegetation variables were entered into an Access database. Nonmetric multi-dimensional scaling (NMS; McCune and Mefford 2006) was used to evaluate species composition and to illustrate sample plot relationship to environmental and successional gradients. We used vectors linking plots sampled in 1993 and 2008 to show relative direction and magnitude of change in species composition in plot pairs. Pearson correlation coefficients were used to assess the relationship of species to the ordination axes. We performed hierarchical agglomerative clustering with Euclildean distance and Ward's linkage method to define vegetation types (McCune and Mefford 2006). We used the 2008 measurements to define the groups so that change between 1993 and 2008 could be evaluated by vegetation type in association tables.

Shannon's diversity and species richness were calculated for each 50 m^2 plot in 1993 and 2008. Because plot size affects the number of species observed, we did not include the 500 m^2 plots in the species diversity comparisons. Paired t-tests were used to evaluate change in species abundance, diversity, and richness between 1993 and 2008 on the 50 m^2 plots.

Results

Group Membership and Ordination

Of the 22 resampled plots, 13 were relocated in the general area of the original plot, but in 9 locations we were able to relocate the plot center with a high level of confidence by referencing boulders, trees, and other landscape features visible in the 1993 photos.

Hierarchical clustering revealed 7 distinct vegetation groups (Table 1): alder (n=8), young spruce (n=2), spruce – hemlock (n=3), wet hemlock (n=1), salmonberry (n=2), dwarf shrub – forb (n=3), and coastal herbaceous meadow (n=3). The alder group contained 2 plots co-dominated by willow. In order to display compositional changes in the association tables, we further split the alder group into alder (n=6) and alder-willow (n=2).

Table 1. Group membership as defined by cluster analysis.

Plot	2008 Cluster	Relocation Confidence	Max Glacial Extent	Plot Radius (feet)
KFC046	Dwarf Shrub Forb	low	outside	13
KFC047	Dwarf Shrub Forb	low	outside	13
KFB079	Dwarf Shrub Forb	high	outside	13
KFB060	Spruce - Hemlock	very high	outside	41
KFB081	Spruce - Hemlock	low	outside	41
KFC077	Spruce - Hemlock	low	outside	41
KFB076	Wet Hemlock	high	outside	13
KFB072	Young Spruce	high	outside	41
KFB052	Young Spruce	low	within	13
KFB044	Coastal Herbaceous Meadow	high	within	13
KFB070	Coastal Herbaceous Meadow	low	outside	13
KFC074	Coastal Herbaceous Meadow	high	within	13
KFB051	Alder	low	within	13
KFB054	Alder	low	within	13
KFC073	Alder	low	within	13
KFC075	Alder	low	within	13
KFB055	Alder	high	within	13
KFB075	Alder	low	within	13
KFB071	Willow-Alder*	low	outside	13
KFB046	Willow-Alder*	low	within	13
KFC079	Salmonberry (Alder)	high	outside	13
KFC048	Salmonberry	high	outside	13

Ordination using NMS showed distinct grouping by life form (Figure 2). Plots were also arranged along axes according to environmental and successional gradients. Axis 2 showed a gradient from herbaceous to woody vegetation with herbaceous plots along the lower portion of the axis, shrub plots in the intermediate positions, and coniferous forest in the upper portion of the gradient; Axis 2 also appeared to reflect a successional gradient. Species associated with later seral stages were positively correlated with Axis 2; i.e., *Picea sitchensis* (r=0.50), *Tsuga mertensiana* (r=0.40), *Rubus pedatus* (r=0.41), *Vaccinium ovalifolium* (r=0.43), *Oplopanax*

horridus (*r*=0.44), and *Tiarella trifoliata* (*r*=0.45). Species associated with early seral herbaceous stages and coastal meadows were negatively correlated with the axis: *Leymus mollis* (r=-0.69) and *Festuca rubra* (*r*=-0.6). Plots were arranged along Axis 1 according to a gradient in site moisture, with well-drained sites on the far left end of the axis, mesic sites in intermediate positions, and wettest sites on the far right. Species commonly found in wet habitats were positively correlated with Axis 1 and included *Nephrophyllidium crista-galli* (*r*=0.52), *Geum calthifolium* (*r*=0.49), *Coptis trifoliata* (*r*=0.40). Species negatively correlated with Axis 1 included *Alnus viridis* ssp. *sinuata* (*r*=-0.7), *Carex mertensii* (*r*=-0.44), and *Chamerion latifolium* (*r*=-0.42).

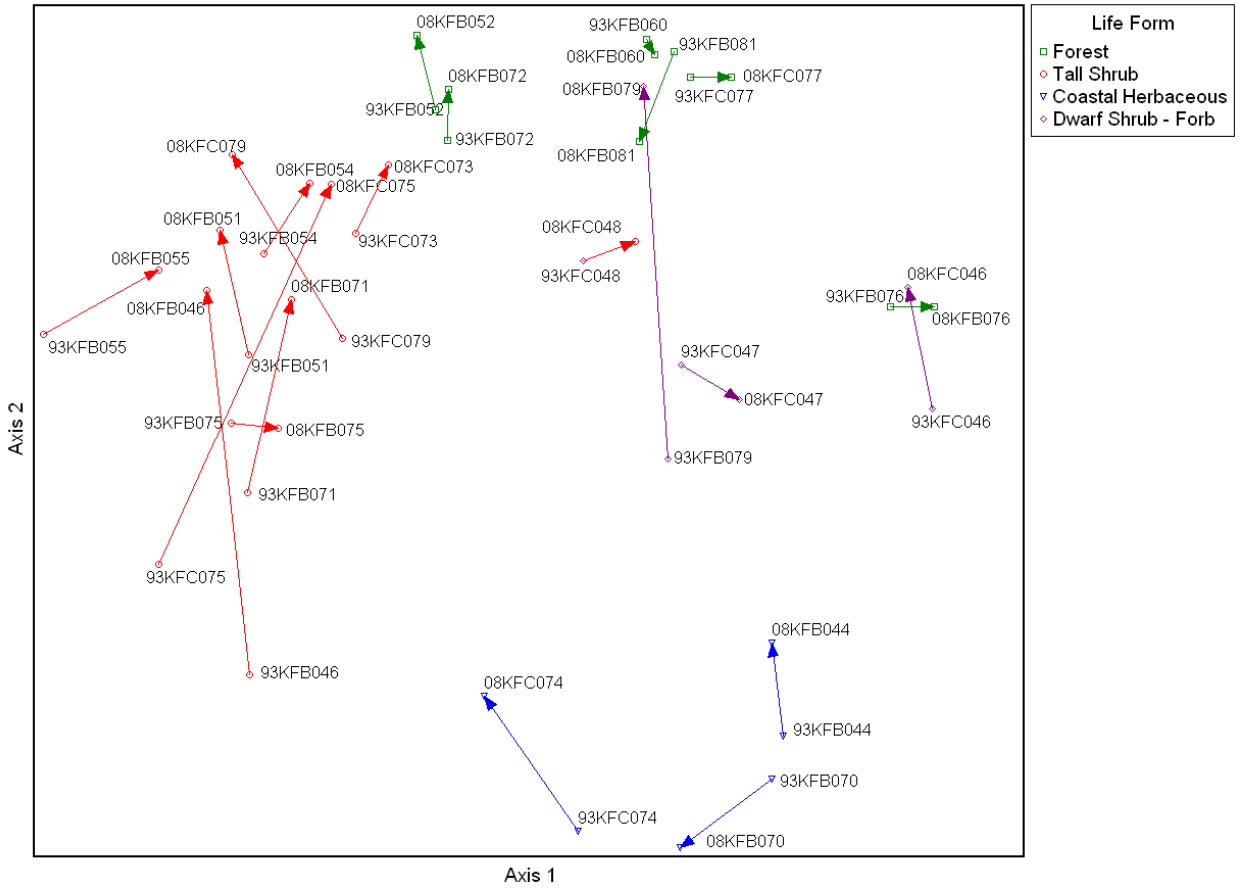


Figure 2. NMS Ordination of plots in species space. Vector arrows show direction of change in species composition in each plot from 1993 to 2008. Forest includes: young spruce (KFB052, KFB072), spruce–hemlock (KFB060, KFB081, KFC077), wet hemlock (KFB076). Tall shrub includes: salmonberry (KFC079, KFC048-dwarf shrub in 1993), alder (KFB051, KFB054, KFC073, KFC075, KFB055, KFB075) and alder-willow (KFB071, KFB046). The remaining life form groups, dwarf shrub – Forb (n=3) and coastal herbaceous meadow (n=3), are the same as the vegetation types and were not aggregated in the NMS display. Axis 1 is correlated with increasing site moisture, and Axis 2 is correlated with a gradient in plant community succession with early seral herbaceous communities at the low end of the axis and mid- to late-seral communities at the upper end of the axis.

Tall Shrub Group: Alder, Alder-Willow and Salmonberry

In the ordination overlay, we combined the alder, alder-willow and salmonberry groups into the tall shrub group. There was a consistent direction of change between 1993 and 2008 within this group on both recently deglaciated and outer coastal sites (Figure 2). The general trend was toward later seral species and greater species richness. On the combined tall shrub plots, mean species richness increased significantly from 11.5 to 16.8 between 1993 and 2008 ($P = 0.007$, paired two-sided t-test). The increase in Shannon's diversity was not significant ($P = 0.11$, paired two-sided t-test).

Tall shrub plots within the area glaciated during the LIA maximum that were dominated by *Alnus viridis* ssp. *sinuata* showed no significant difference in canopy cover of *Alnus viridis* ssp. *sinuata* between 1993 and 2008 ($P = 1$, paired two-sided t-test). Average canopy height of shrubs on recently deglaciated sites increased from 9.3 ft in 1003 to 12.3 ft in 2008 but the change was not highly significant ($P = .10$, paired two-sided t-test). Plot KFB055 (Figure 3), provides an example of a recently deglaciated tall shrub site that had a canopy cover of *Alnus viridis* ssp. *sinuata* of 40% at both sampling dates. Shrub height increased from 5 ft in 1993 to 9 ft in 2008.

On the six plots that were classified as alder, understory species composition shifted, showing a loss of early seral grass diversity and an increase in mid-seral to late species such as *Rubus spectabilis*, ferns, and *Sambucus racemosa* (Table 2). Early seral grass and forb species that occurred in 1993 but not in 2008 included *Agrostis mertensii, Achillea millefolium* var. *boreale,* and *Elymus alaskanus* ssp. *latiglumis*; mid- to late seral species that occurred in 2008 but not 1993 included *Rubus spectabilis, Circaea alpina, Luetkea pectinata, Orthilia secunda, Pyrola asarifolia, Rubus arcticus, Listera cordata, Moneses uniflora,* and *Vaccinium ovalifolium*.



Figure 3. Plot KFB055 occurred on a recently deglaciated active colluvial slope. Note that *Alnus viridis* ssp. *sinuata* is common in both 1993 and 2008. In the later photo, the shrub height has increased and obscured some of the landscape features visible in 1993.

Table 2. Alder association table.

	1993		2008	
Alder (n = 6)	**Average**	**%Freq**	**Average**	**%Freq**
Alnus viridis ssp. *sinuata*	58.3	100	56.7	100
Calamagrostis canadensis	30.0	83	22.2	100
Athyrium filix-femina	2.5	67	3.2	100
Carex mertensii	0.7	67	0.9	100
Salix sitchensis	7.3	67	4.5	83
Aruncus dioicus var. *acuminatus*	5.0	17	13.3	33
Chamerion angustifolium	3.3	17	0.7	33
Stellaria borealis ssp. *sitchana*	2.4	83	0.4	67
Epilobium sp.	1.0	67	0.4	67
Salix alaxensis	2.2	33	0.2	17
Equisetum arvense	1.8	33	0.7	33
Heuchera glabra	1.4	83	0.8	50
Chamerion latifolium	0.8	50	0.5	17
Dryopteris expansa	0.5	17	6.3	83
Picea sitchensis	0.4	50	0.7	33
Sambucus racemosa	0.3	33	4.3	50
Oplopanax horridus	0.2	33	0.0	17
Stellaria crispa	0.2	17	0.5	67
Prenanthes alata	0.2	17	0.4	67
Phegopteris connectilis	0.0	17	0.5	17
Luzula parviflora	0.0	17	0.2	17
Streptopus amplexifolius	0.2	17	0.4	50
Trisetum spicatum	0.2	17	0.0	17
Artemisia tilesii	1.7	17	0.0	0
Agrostis mertensii	0.7	33	0.0	0
Poa arctica	0.7	33	0.0	0
Viola glabella	0.5	17	0.0	0
Achillea millefolium var. *boreale*	0.2	17	0.0	0
Carex aquatilis	0.2	17	0.0	0
Elymus alaskanus ssp. *latiglumis*	0.2	17	0.0	0
Heracleum maximum	0.2	17	0.0	0
Salix barclayi	0.2	17	0.0	0
Rubus spectabilis	0	0	4.0	67
Circaea alpina	0	0	0.5	17
Osmorhiza purpurea	0	0	0.2	33
Carex macrochaeta	0	0	0.2	17
Cryptogramma sitchensis	0	0	0.2	17
Luetkea pectinata	0	0	0.2	17
Orthilia secunda	0	0	0.2	17
Pyrola asarifolia	0	0	0.2	17
Rubus arcticus	0	0	0.2	17
Veratrum viride	0	0	0.2	17
Cystopteris fragilis	0	0	0.0	17
Galium trifidum	0	0	0.0	17
Listera cordata	0	0	0.0	17
Moneses uniflora	0	0	0.0	17
Oxyria digyna	0	0	0.0	17
Poa palustris	0	0	0.0	17
Vaccinium ovalifolium	0	0	0.0	17

Black = occurred in both 1993 and 2008
Purple = occurred in 1993 but not 2008
Red = occurred in 2008 but not 1993
Plots: KFB051, KFB054, KFC073, KFC075, KFB055, KFB075

Rubus spectabilis increased from 3.3 % cover to 15.4% cover on the combined tall shrub plots between 1993 and 2008; however, the result was not highly significant (P = 0.08; paired two-sided t-test). The increases occurred in plots that were both within and outside of the maximum glacial extent line. *Rubus spectabilis* occurred on two of ten shrub plots in 1993, and in 2008 it occurred on an additional four plots. On the two plots that were classified as salmonberry through cluster analysis, *Rubus spectabilis* increased from 16.5% to 65% (Table 3).

Table 3. Salmonberry association table.

	1993		2008	
Salmonberry (n = 2)	**Ave**	**%Freq**	**Ave**	**%Freq**
Rubus spectabilis	16.5	100	65	100
Alnus viridis ssp. *sinuata*	41.5	100	25	100
Athyrium filix-femina	5.5	100	6.5	100
Calamagrostis canadensis	11.5	100	3	100
Geranium erianthum	1	100	5	50
Carex macrochaeta	2	100	1.5	50
Aruncus dioicus var. *acuminatus*	15	50	1	100
Luetkea pectinata	5	50	10	50
Sambucus racemosa	0.5	50	10	50
Viola langsdorfii	0.5	50	5	50
Veratrum viride	15	50	1.5	50
Petasites frigidus var. *frigida*	5	50	1.5	50
Sanguisorba canadensis	1.5	50	1.5	50
Vahlodea atropurpurea	1.5	50	1.5	50
Heracleum maximum	0.5	50	1.5	50
Thelypteris quelpaertensis	0.5	50	0.5	50
Heuchera glabra	2	100	0	0
Achillea millefolium var. *boreale*	1.5	50	0	0
Epilobium ciliatum ssp. *cliatum*	1.5	50	0	0
Claytonia sibirica	0.5	50	0	0
Picea sitchensis	0.5	50	0	0
Polypodium glycyrrhiza	0.5	50	0	0
Stellaria crispa	0	0	1	100
Cardamine oligosperma var. *kamtschatica*	0	0	0.1	100
Tellima grandiflora	0	0	1.5	50
Deschampsia cespitosa	0	0	0.5	50
Dryopteris expansa	0	0	0.5	50
Epilobium anagallidifolium	0	0	0.5	50
Epilobium hornemannii ssp. *behringianum*	0	0	0.5	50
Prenanthes alata	0	0	0.5	50
Aconitum delphiniifolium	0	0	0.1	50
Aquilegia formosa	0	0	0.1	50
Conioselinum chinense	0	0	0.1	50
Cystopteris fragilis	0	0	0.1	50
Geum macrophyllum	0	0	0.1	50
Osmorhiza purpurea	0	0	0.1	50
Platanthera chorisiana	0	0	0.1	50

Black = occurred in both 1993 and 2008
Purple = occurred in 1993 but not 2008
Red = occurred in 2008 but not 1993
Plots: KFC079, KFC048

Plot KFC079 was located on the outer coast on an active colluvial slope (Figure 4). Between 1993 and 2008, combined herbaceous cover decreased from 60 percent to 23 percent cover. Herbaceous patches and exposed rock visible in the 1993 photo have filled in with *Rubus spectabilis* in the 2008 photo. Between 1993 and 2008 *Rubus spectabilis* increased from 30% to 80% cover.



Figure 4. Plot KFC079 occurred on an active headland slope, outside the LIA glacial maximum. Red arrows show plot center. *Rubus spectabilis* has encroached into the herbaceous area between 1993 and 2008. Despite evidence of ongoing slope instability, shrubs have increased on both the lower and upper slopes.

Plot KFC048 shifted in composition from dwarf shrub-forb in 1993 to salmonberry in 2008 (Figure 5). This plot was accurately relocated by referencing landscape features visible in the 1993 photo. Within the plot, *Rubus spectabilis* increased from 3 to 50 percent cover, and in the area surrounding the plot, most of the herbaceous meadow visible in the 1993 photo had been invaded by *Rubus spectabilis* in 2008.



Figure 5. Plot KFC048 occurred on an active alpine colluvial slope outside LIA glacial maximum. Note that the herbaceous meadow visible in the 1993 photo at the base of the colluvial fan upslope from the plot marker has filled in with *Rubus spectabilis* in 2008. Shrub height has increased in 2008.

In the alder-willow group (n=2), neither plot was relocated with high confidence. The low percent frequency and the high number of new species in the association table could be related to this uncertainty (Table 4). Plot KFB046 occurred in a riparian corridor at the head of Aialilk Bay that had changed dramatically between the two sampling dates. In 1993, a major tributary of the

main drainage was running through the plot and surrounding area, but in 2008, this tributary was dry and the water flow was contained in the main channel. The relocation of the sample plot was approximate, but the surrounding vegetation was relatively homogenous with variations in amount of the dominant willows, *Salix sitchensis* and *Salix alaxensis*. The vector linking the two measurements (Figure 2) shows a large magnitude of change which could be due to both the change in hydrology and relocation error.

Table 4. Alder-willow association table.

	1993		2008	
Alder - Willow(n=2)	**Ave**	**%Freq**	**Ave**	**%Freq**
Salix sitchensis	45	50	35	100
Salix alaxensis	30	50	15	50
Alnus viridis ssp. *sinuata*	5	50	15	100
Equisetum arvense	25.5	100	30.5	100
Calamagrostis canadensis	5	50	2	100
Picea sitchensis	1.5	50	5	50
Pyrola asarifolia	0.5	50	15	50
Poa sp.	0.5	50	0	0
Cornus canadensis	0	0	0.5	50
Epilobium hornemannii ssp. *behringianum*	0	0	0.5	50
Moneses uniflora	0	0	0.5	50
Oplopanax horridus	0	0	0.5	50
Orthilia secunda	0	0	0.5	50
Stellaria crispa	0	0	0.5	50
Vaccinium ovalifolium	0	0	0.5	50
Arabis lyrata	0	0	0.05	50
Athyrium filix-femina	0	0	0.05	50
Carex mertensii	0	0	0.05	50
Cardamine oligosperma var. *kam*	0	0	0.05	50
Carex sp.	0	0	0.05	50
Cinna latifolia	0	0	0.05	50
Claytonia sibirica	0	0	0.05	50
Epilobium lactiflorum	0	0	0.05	50
Heuchera glabra	0	0	0.05	50
Mimulus guttatus	0	0	0.05	50
Oxyria digyna	0	0	0.05	50
Polemonium acutiflorum	0	0	0.05	50
Poa leptocoma	0	0	0.05	50
Poa nemoralis ssp. *interior*	0	0	0.05	50
Romanzoffia sitchensis	0	0	0.05	50
Rubus arcticus	0	0	0.05	50
Saxifraga nelsoniana ssp. *nels*	0	0	0.05	50
Stellaria borealis ssp. *sitcha*	0	0	0.05	50

Black = occurred in both 1993 and 2008
Purple = occurred in 1993 but not 2008
Red = occurred in 2008 but not 1993
Plots: KFB071, KFB046

Forest Group: Young Spruce, Spruce–Hemlock, and Wet Hemlock

The young spruce plots (KFB052, KFB072) occurred in large, homogenous, early-seral spruce stands. Although the relocation was approximate, the plots showed a consistent direction of change from 1993 to 2008. The trend toward later seral species was similar to that displayed in the tall shrub group (Figure 2). Changes in species cover between 1993 and 2008 include an increase in *Picea sitchensis* from 50% to 65%, a decrease in *Alnus viridis* ssp. *sinuata* from 21.5% to 16.5%, and a decrease in *Calamagrostis canadensis* from 6.5% to 0.1% (Table 5).

Table 5. Young spruce association table.

	1993		2008	
Young Spruce (n=2)	**Average**	**%Freq**	**Ave**	**%Freq**
Picea sitchensis	50	100	65	100
Alnus viridis ssp. *sinuata*	21.5	100	16.5	100
Calamagrostis canadensis	6.5	100	0.1	100
Dryopteris expansa	2	100	5.5	100
Rubus spectabilis	0.55	100	1	100
Heuchera glabra	0.55	100	0.55	100
Aruncus dioicus var. *acuminatus*	0.55	100	0.1	100
Athyrium filix-femina	5.5	100	0.5	50
Vaccinium ovalifolium	0.1	100	1.5	50
Carex mertensii	0.1	100	0.5	50
Epilobium sp.	0.55	100	0.05	50
Prenanthes alata	0.5	50	0.55	100
Streptopus amplexifolius	0.5	50	0.55	100
Carex macrochaeta	0.5	50	0.1	100
Orthilia secunda	1.5	50	0.5	50
Equisetum arvense	10	50	1.5	50
Tsuga mertensiana	0.5	50	0.5	50
Salix sitchensis	0.5	50	0.05	50
Moneses uniflora	0.05	50	0.5	50
Stellaria borealis ssp. *sitchana*	0.05	50	0.05	50
Saxifraga nelsoniana ssp. *nelsoniana*	0.55	100	0	0
Petasites frigidus var. *frigidus*	0.5	50	0	0
Pyrola asarifolia	0.5	50	0	0
Rubus arcticus	0.5	50	0	0
Phegopteris connectilis	1.5	50	0	0
Agrostis mertensii	0.05	50	0	0
Cardamine oligosperma var. *kamtschatica*	0.05	50	0	0
Claytonia sibirica	0.05	50	0	0
Geranium erianthum	0.05	50	0	0
Geum macrophyllum	0.05	50	0	0
Gymnocarpium dryopteris	0.05	50	0	0
Phleum alpinum	0.05	50	0	0
Polemonium acutiflorum	0.05	50	0	0
Sanguisorba canadensis	0.05	50	0	0
Sambucus racemosa	0.05	50	0	0
Spiraea stevenii	0.05	50	0	0
Rubus pedatus	0	0	5.5	100
Oplopanax horridus	0	0	0.55	100
Salix barclayi	0	0	1.5	50
Heracleum maximum	0	0	0.5	50
Tiarella trifoliata	0	0	0.5	50
Listera cordata	0	0	0.05	50

Black = occurred in both 1993 and 2008
Purple = occurred in 1993 but not 2008
Red = occurred in 2008 but not 1993
Plots: KFB052, KFB072

All three spruce–hemlock plots (KFB060, KFB081, KFC077) were in mature forests. KFB060 was relocated exactly on the original plot center as referenced by a boulder and trees (Figure 6). This plot showed increased shrub cover and height with *Vaccinium ovalifolium* showing the greatest increase (from 30 to 70 percent cover), but other species showed little change in cover, and the vector linking the 1993 and 2008 readings is short. The remaining two plots (KFB081, KFC077) were relocated approximately. The direction of change was not consistent, and the magnitude of change was relatively small. In these two plots the differences between 1993 and 2008 may be attributed to the uncertainty of the plot relocation and differences in understory species composition (Table 6).



Figure 6. We relocated Plot KFB060 by triangulating among the two large tree boles and the moss-covered boulder. Note the increased shrub cover obscuring the base of both large tree boles in 2008. In 1993 the dominant cover on the boulder is moss, in 2008 the boulder shows increased cover of grasses and shrubs. The large tree on the left had died between 1993 and 2008.

Table 6. Spruce–hemlock association table.

	1993		2008	
Spruce - Hemlock (n=3)	**Ave**	**%Freq**	**Ave**	**%Freq**
Vaccinium ovalifolium	43.3	100	66.7	100
Tsuga mertensiana	40.0	100	40.0	100
Picea sitchensis	21.0	100	30.0	100
Rubus spectabilis	8.7	100	2.3	100
Dryopteris expansa	5.3	100	1.7	100
Rubus pedatus	3.0	100	7.7	100
Cornus canadensis	3.0	100	4.7	100
Oplopanax horridus	2.3	100	1.0	100
Streptopus amplexifolius	1.0	100	0.7	100
Listera cordata	0.4	100	0.7	100
Veratrum viride	1.0	100	0.7	67
Tiarella trifoliata	0.7	67	0.7	100
Menziesia ferruginea	1.3	67	7.3	100
Calamagrostis nutkaensis	13.3	67	4.3	67
Carex macrochaeta	2.0	67	0.4	67
Gymnocarpium dryopteris	1.3	67	4.3	67
Alnus viridis ssp. *sinuata*	1.0	33	1.0	33
Phegopteris connectilis	1.0	33	0.3	33
Harrimanella stelleriana	0.3	33	0.0	33
Prenanthes alata	0.0	33	0.0	33
Elliottia pyroliflorus	0.3	33	0.0	0
Geum calthifolium	0.0	33	0.0	0
Heuchera glabra	0.0	33	0.0	0
Platanthera sp.	0.0	33	0.0	0
Athyrium filix-femina	0	0	0.3	33
Nephrophyllidium crista-galli	0	0	0.3	33
Thelypteris quelpaertensis	0	0	0.3	33
Lycopodium annotinum	0	0	0.1	67
Blechnum spicant	0	0	0.0	33
Calamagrostis canadensis	0	0	0.0	33
Coptis trifolia	0	0	0.0	33
Moneses uniflora	0	0	0.0	33
Sorbus sitchensis	0	0	0.0	33

Black = occurred in both 1993 and 2008
Purple = occurred in 1993 but not 2008
Red = occurred in 2008 but not 1993
Plots: KFB060, KFB081, KFC077

One plot (KFB076) was classified as wet hemlock. This plot occurred as a forested inclusion in a wetland mosaic. The vector length was short, indicating little difference between measurements (Figure 2, Table 7).

Table 7. Wet hemlock association table.

	1993		2008	
Wet Hemlock (n = 1)	**Average**	**% Freq**	**Average**	**% Freq**
Nephrophyllidium crista-galli	60	100	70	100
Empetrum nigrum	60	100	50	100
Tsuga mertensiana	30	100	30	100
Elliottia pyroliflorus	20	100	10	100
Carex anthoxanthea	10	100	10	100
Cornus canadensis	10	100	3	100
Vaccinium ovalifolium	3	100	10	100
Erigeron peregrinus	3	100	3	100
Vaccinium vitis-idaea	3	100	3	100
Geum calthifolium	3	100	1	100
Malus fusca	3	100	1	100
Picea sitchensis	3	100	1	100
Agrostis aequivalvis	1	100	1	100
Carex macrochaeta	1	100	1	100
Gentiana douglasiana	1	100	1	100
Gymnocarpium dryopteris	1	100	1	100
Menziesia ferruginea	1	100	1	100
Phegopteris connectilis	1	100	1	100
Thelypteris quelpaertensis	1	100	1	100
Trientalis europaea	1	100	1	100
Coptis trifolia	0.1	100	0.1	100
Alnus viridis ssp. *sinuata*	3	100	0	0
Sorbus sitchensis	3	100	0	0
Anemone narcissiflora	1	100	0	0
Deschampsia cespitosa	1	100	0	0
Gentiana platypetala	0.1	100	0	0
Streptopus amplexifolius	0.1	100	0	0
Calamagrostis nutkaensis	0	0	3	100
Carex pauciflora	0	0	3	100
Deschampsia beringensis	0	0	1	100
Geranium erianthum	0	0	1	100
Lycopodium annotinum	0	0	1	100
Maianthemum dilatatum	0	0	1	100
Vaccinium uliginosum	0	0	1	100
Viburnum edule	0	0	1	100
Platanthera stricta	0	0	0.1	100
Spiranthes romanzoffiana	0	0	0.1	100

Black = occurred in both 1993 and 2008
Purple = occurred in 1993 but not 2008
Red = occurred in 2008 but not 1993
Plot: KFB076

Dwarf Shrub - Forb

In 1993 four plots were classified to the dwarf shrub-forb group, but in 2008, one plot (KFC048) shifted to the salmonberry group, described above (Figure 5). Among the remaining 3 plots, only one was relocated with high confidence, KFB079. Within the plot there was not much change in shrub composition, but the surrounding landscape appears to have filled in with shrubs including *Rubus spectabilis* and *Elliotia pyroliflora* (Figure 7). In this case, the plot was located in a small and distinct community type, and the same three species were dominant at both measurements (*Luetkea pectinata*, *Sanguisorba canadensis*, and *Carex machrochaeta*). Because of the small size of the community type, a slight difference in plot relocation may have lead to a relatively

large difference in species composition and long vector length. The 2008 measurement had a higher number of forb and fern species (*Sanguisorba canadensis*, *Geranium erianthum*, *Athyrium filix-femina*, and *Dryopteris expansa*) and a lower number of graminoid species than the 1993 measurement. This change could have been due to either relocation error or a real shift in species composition. We did not have confidence in the relocation accuracy in the remaining two plots in this group (KFC046 and KFC047). Within the dwarf shrub-forb group, there was no definitive trend in the sample data (Table 8, Appendix 2); however, photos showing the surrounding terrain indicate an increase in shrub cover at the landscape level.

Table 8. Dwarf shrub – forb association table.

	1993		2008	
Dwarf Shrub - Forb (n=3)	**Average**	**%Freq**	**Average**	**% Freq**
Luetkea pectinata	30.0	100	40.0	100
Carex macrochaeta	11.3	100	8.0	100
Calamagrostis canadensis	10.0	67	7.0	100
Geranium erianthum	1.3	67	2.0	100
Sanguisorba canadensis	10.0	33	20.4	100
Dryopteris expansa	0.3	33	0.7	100
Petasites frigidus var. *frigid*	1.3	67	2.0	67
Alnus viridis ssp. sinuata	0.7	67	0.7	67
Vahlodea atropurpurea	6.7	67	3.3	33
Elliottia pyroliflorus	0.7	67	0.3	33
Nephrophyllidium crista-galli	10.0	33	13.7	67
Viola langsdorfii	0.3	33	4.3	67
Vaccinium ovalifolium	0.3	33	1.3	67
Geum calthifolium	0.3	33	0.7	67
Harrimanella stelleriana	16.7	33	13.3	33
Chamerion angustifolium	6.7	33	13.3	33
Viola epipsila	1.0	33	1.0	33
Phyllodoce aleutica	1.0	33	0.3	33
Picea sitchensis	0.0	33	0.0	33
Lycopodium clavatum	1.0	33	0	0
Loiseleuria procumbens	0.3	33	0	0
Carex sp.	0.7	67	0	0
Deschampsia cespitosa	0.7	67	0	0
Luzula parviflora	0.1	67	0	0
Epilobium anagallidifolium	0	0	1.4	100
Prenanthes alata	0	0	0.4	100
Athyrium filix-femina	0	0	1.3	67
Trientalis europaea	0	0	0.4	67
Rubus spectabilis	0	0	1.0	33
Cardamine oligosperma var. *kamchatica*	0	0	0.3	33
Carex pyrenaica ssp. *micropoda*	0	0	0.3	33
Heracleum maximum	0	0	0.3	33
Phegopteris connectilis	0	0	0.3	33
Saxifraga nelsoniana ssp. *nelsoniana*	0	0	0.3	33
Streptopus amplexifolius	0	0	0.3	33
Veratrum viride	0	0	0.3	33
Cryptogramma sitchensis	0	0	0.0	33
Platanthera chorisiana	0	0	0.0	33
Rhodiola integrifolia ssp. *integrifolia*	0	0	0.0	33

Black = occurred in both 1993 and 2008
Purple = occurred in 1993 but not 2008
Red = occurred in 2008 but not 1993
Plots: KFC046, KFC047, KFB079



Figure 7. Plot KFB079 occurred on an active colluvial slope outside LIA glacial maximum. Red arrow indicates plot location. Note the rectangular boulder in gully below the plot: in 1993 the boulder is surrounded by herbaceous meadow vegetation, in 2008, shrubs have encroached in the gully and the herbaceous area is reduced.

Coastal Herbaceous Meadow

Ordination vectors indicated a consistent direction of change on two (KFC074 and KFB044) of three plots in the coastal herbaceous meadow group (Figure 2). Both of these plots were relocated fairly accurately using landscape features. The third plot, KFB070, did not have adequate information for an accurate relocation. The predominant change was a transition from stands dominated by *Leymus mollis* to stands with a more even mix of forbs and grasses. Average cover of *Leymus mollis* decreased from 73 to 37 percent cover between 1993 and 2008. Average cover of *Lathyrus japonicus* var. *maritimus*, *Angelica lucida*, *Chamerion angustifolium* and *Calamagrostis canadensis* all increased between 1993 and 2008 (Figure 8, Table 9).



Figure 8. Plot KFB044 occurred at the head of Aialik Bay. Between 1993 and 2008 the beach berm on which the plot occurred shifted from a community dominated by *Leymus mollis* to a beach meadow community with high forb diversity. In 2008, shrub encroachment is evident on the outwash plain in the background.

Table 9. Coastal herbaceous meadow association table.

	1993		2008	
Coastal Herbaceous Meadow (n=3)	**Average**	**%Freq**	**Average**	**%Freq**
Leymus mollis ssp. *mollis*	72.7	100	36.7	100
Galium trifidum	1.7	100	0.1	67
Festuca rubra	6.7	67	4.3	67
Lathyrus japonicus var. *maritimus*	0.4	67	20.0	67
Trientalis europaea	0.7	67	0.3	33
Angelica lucida	3.3	33	13.7	67
Calamagrostis canadensis	1.0	33	16.7	67
Achillea millefolium var. *boreale*	0.3	33	3.7	67
Deschampsia cespitosa	1.0	33	1.0	33
Lupinus nootkatensis	1.0	33	0.3	33
Fritillaria camschatcensis	0.3	33	0.0	33
Rubus arcticus	0.0	33	10.0	33
Carex macrochaeta	0.0	33	1.0	33
Conioselinum chinense	0.0	33	0.0	33
Honckenya peploides	0.3	33	0	0
Ligusticum scoticum	0.3	33	0	0
Polygonum viviparum	0.3	33	0	0
Stellaria borealis ssp. *sitchana*	0.3	33	0	0
Hordeum brachyantherum	0.0	33	0	0
Iris setosa	0.0	33	0	0
Chamerion angustifolium	0	0	11.0	67
Rhinanthus minor	0	0	1.0	33
Calamagrostis deschampsioides	0	0	0.7	33
Heracleum maximum	0	0	0.3	33
Rumex aquaticus var. *fenestratus*	0	0	0.3	33
Sanguisorba canadensis	0	0	0.3	33
Viola langsdorfii	0	0	0.3	33
Athyrium filix-femina	0	0	0.0	33
Epilobium ciliatum ssp. *glandulosum*	0	0	0.0	33
Phleum alpinum	0	0	0.0	33
Poa macrocalyx	0	0	0.0	33

Black = occurred in both 1993 and 2008
Purple = occurred in 1993 but not 2008
Red = occurred in 2008 but not 1993
Plots: KFC074, KFB070, KFB044

Discussion

The direction of vascular plant community change was more consistent on the recently deglaciated plots than on older landscapes. Many of the shrub and young spruce forest plots on recently deglaciated sites occurred in homogeneous stands, so a remeasurement in the general vicinity of the plot was likely to represent the pattern of change across the stand. Thus, it is likely that the results of the plot data on the recently deglaciated landscapes represent real change, as opposed to relocation error. Succession after glacial retreat has been well documented, and our results from these sites, which indicate change towards later seral conditions, are consistent with published studies (Reiners et al. 1971, Matthews and Whittaker 1987, Matthews 1992, Fastie1995).

There was no pattern in the magnitude of change, as indicated by the variation in length of the vectors linking plot pairs, between plots that occurred on recently deglaciated terrain and those that occurred on older landscapes. Because of the uncertainty in many of the plot relocations, especially within forest, herbaceous, and dwarf shrub-forb stands, it is not possible to draw firm conclusions about the rate of change in species composition at the plot level across different landscape ages. Within the tall shrub group, the two longest vectors occurred on plots that were within the LIA maximum; however, one plot (KFB046) was in an outwash floodplain channel in 1993, but in 2008 the channel had shifted away from the plot. The effect of the change in hydrology was likely a factor in the observed magnitude of change. The second plot (KFC075) was relocated with low confidence. Plots within the tall shrub group showed a remarkably consistent direction of change across both young and old landscapes. Within the dwarf shrub-forb group, the longest vector occurred on plot KFB079, which is located outside the LIA maximum. Within the forest group, the magnitude of change was relatively small between all plots; however, the direction of change was consistent on plots within the LIA maximum, (KFB052 and KFB072), but inconsistent on the older forest plots that occurred outside the LIA maximum. Within the coastal herbaceous meadow group, the length of the vectors was similar across all 3 plots. The 2 plots that occurred within the LIA maximum (KFC074 and KFB044), showed a consistent direction of change and both were relocated with high confidence. The observed changes are consistent with successional processes related to isostatic rebound (Larsen et al. 2005, Mann and Streveler 2008) and beach aggregation (Carter 1988, Boggs 2000). The third plot (KFB070) occurred outside the LIA maximum, but was relocated with low confidence, rendering conclusions about the direction of change difficult in this group.

Repeat photographs showing the plot and surrounding landscape provide a credible representation of the changes that occurred between 1993 and 2008. These landscape photographs show broader trends than could be captured in the plot data. While we expected to see change in sites that had been recently deglaciated, we were surprised that plots or photos on older landscapes also showed substantial changes in shrub cover. Landscape photos show an increase in shrub cover on disturbance slopes in environments that were not glaciated during the LIA maximum. For example, steep side slopes that are prone to avalanches and rock fall show more in-growth of shrubs, particularly *Rubus spectabilis*, in 2008 than in 1993. This may indicate a trend toward later seral stages linked to a change in the frequency or severity of disturbance. This trend could be linked to changes in slope stability or changes in snowpack and avalanche cycle. Further studies investigating the potential changes in snowpack and avalanche frequency are needed to determine whether the increase in shrubs on these slopes is linked to changes in the disturbance cycle related to warming temperatures.

In general, forested plots were more difficult to relocate because plot photos often did not capture landscape features that could be used to accurately reestablish the plot center. Only one forested plot (KFB060) was relocated accurately. In order to evaluate whether the changes seen in this plot (which included a dramatic increase in *Vaccinium ovlaifolium*) are part of a larger trend or simply associated with a forest gap resulting from the death of a canopy tree, we would need monitoring results from permanently marked forest plots. Despite the observed understory changes in this plot, the magnitude of change displayed by the successional vector was short; suggesting that this mature plant community is stable.

Permanent plot referencing through the use of markers and sub-meter georeferencing would reduce the degree of uncertainty in the interpretation of results and also reduce the amount of noise reflected in the data. Additionally, a plot design better suited to change detection, such as the SWAN vegetation monitoring protocol (Miller et al. 2010), would provide more robust results. Future efforts to relocate plots that are not permanently referenced on the ground should focus on those plots with photos of landscape features that allow visual relocation. Relocating and re-photographing additional plots from the 1993 inventory across a larger segment of the coast line would be useful in order to determine the extent of shrub expansion on disturbance slopes outside the maximum extent of the LIA glaciers; however, we do not recommend this approach as a replacement for the establishment of a permanent long-term monitoring plots.

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Appendix A. Plot Coordinates

	NAD 83	
Plot ID	**Latitude**	**Longitude**
KFB044	59.95337	-149.69786
KFB046	59.95628	-149.70166
KFB051	59.74789	-149.98993
KFB052	59.75013	-149.97652
KFB054	59.76217	-150.03137
KFB055	59.75878	-150.04451
KFB060	59.66311	-149.79512
KFB070	59.58347	-150.41896
KFB071	59.58597	-150.42165
KFB072	59.58742	-150.42068
KFB075	59.71411	-150.21986
KFB076	59.48794	-150.34236
KFB079	59.57783	-150.16805
KFB081	59.65368	-149.77397
KFC046	59.81509	-149.63557
KFC047	59.81579	-149.63611
KFC048	59.81616	-149.63857
KFC073	59.60351	-150.35114
KFC074	59.60463	-150.35135
KFC075	59.68953	-150.24550
KFC077	59.47176	-150.38705
KFC079	59.57163	-150.14774

Appendix B. Plot Data

(deleted species with less than 0.1% cover)

	Wet Hemlock		Spruce - Hemlock						Young Spruce			
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFB076	KFB076	KFB060	KFB060	KFB081	KFB081	KFC077	KFC077	KFB052	KFB052	KFB072	KFB072
TREE												
Picea sitchensis	3	1	40	40	3	40	20	10	40	60	60	70
Tsuga mertensiana	30	30	20	20	50	40	50	60	1	1	-	-
SHRUB												
Alnus viridis ssp. sinuata	3	-	-	-	3	3	-	-	40	30	3	3
Rubus spectabilis	-	-	3	3	20	3	3	1	1	1	0	1
Elliottia pyroliflora	20	10	-	-	1	-	-	-	-	-	-	-
Malus fusca	3	1	-	-	-	-	-	-	-	-	-	-
Menziesia ferruginea	1	1	1	1	3	20	-	1	-	-	-	-
Oplopanax horridus	-	-	1	1	3	1	3	1	-	0	-	1
Salix alaxensis	-	-	-	-	-	-	-	-	-	-	-	-
Salix barclayi	-	-	-	-	-	-	-	-	-	3	-	-
Sambucus racemosa	-	-	-	-	-	-	-	-	0	-	-	-
Salix sitchensis	-	-	-	-	-	-	-	-	-	-	1	0
Sorbus sitchensis	3	-	-	-	-	-	-	0	-	-	-	-
Vaccinium ovalifolium	3	10	40	70	30	70	60	60	0	-	0	3
Viburnum edule	-	1	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum	60	50	-	-	-	-	-	-	-	-	-	-
Harrimanella stelleriana	-	-	-	-	1	-	-	0	-	-	-	-
Loiseleuria procumbens	-	-	-	-	-	-	-	-	-	-	-	-
Phyllodoce aleutica	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	-	1	-	-	-	-	-	-	-	-	-	-
Vaccinium vitis-idaea	3	3	-	-	-	-	-	-	-	-	-	-
FORB												
Achillea millefolium var. borealis	-	-	-	-	-	-	-	-	-	-	-	-
Angelica lucida	-	-	-	-	-	-	-	-	-	-	-	-
Anemone narcissiflora	1	-	-	-	-	-	-	-	-	-	-	-
Aruncus dioicus var. acuminatus	-	-	-	-	-	-	-	-	1	0	0	0
Artemisia tilesii	-	-	-	-	-	-	-	-	-	-	-	-
Cardamine oligosperma var. kamtschatica	-	-	-	-	-	-	-	-	-	-	0	-
Chamerion angustifolium ssp. angustifolium	-	-	-	-	-	-	-	-	-	-	-	-
Chamerion latifolium	-	-	-	-	-	-	-	-	-	-	-	-
Circaea alpina	-	-	-	-	-	-	-	-	-	-	-	-
Claytonia sibirica	-	-	-	-	-	-	-	-	-	-	0	-
Cornus canadensis	10	3	3	3	3	10	3	1	-	-	-	-
Conioselinum chinense	-	-	-	-	-	-	-	-	-	-	-	-
Coptis trifolia	0	0	-	-	-	-	-	0	-	-	-	-
Epilobium anagallidifolium	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. ciliatum	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. glandulosum	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium hornemannii ssp. behringianum	-	-	-	-	-	-	-	-	-	0	-	-
Epilobium	-	-	-	-	-	-	-	-	1	-	0	-
Erigeron peregrinus	3	3	-	-	-	-	-	-	-	-	-	-
Fritillaria camschatcensis	-	-	-	-	-	-	-	-	-	-	-	-
Galium trifidum	-	-	-	-	-	-	-	-	-	-	-	-
Geum calthifolium	3	1	-	-	0	-	-	-	-	-	-	-

	Wet Hemlock		Spruce - Hemlock						Young Spruce			
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFB076	KFB076	KFB060	KFB060	KFB081	KFB081	KFC077	KFC077	KFB052	KFB052	KFB072	KFB072
Gentiana douglasiana	1	1	-	-	-	-	-	-	-	-	-	-
Geranium erianthum	-	1	-	-	-	-	-	-	-	-	0	-
Geum macrophyllum	-	-	-	-	-	-	-	-	-	-	0	-
Heuchera glabra	-	-	-	-	0	-	-	-	1	1	0	0
Heracleum maximum	-	-	-	-	-	-	-	-	-	-	-	1
Honckenya peploides	-	-	-	-	-	-	-	-	-	-	-	-
Lathyrus japonicus var. maritimus	-	-	-	-	-	-	-	-	-	-	-	-
Listera cordata	-	-	0	1	0	0	1	1	-	-	-	0
Ligusticum scoticum	-	-	-	-	-	-	-	-	-	-	-	-
Lupinus nootkatensis	-	-	-	-	-	-	-	-	-	-	-	-
Luetkea pectinata	-	-	-	-	-	-	-	-	-	-	-	-
Maianthemum dilatatum	-	1	-	-	-	-	-	-	-	-	-	-
Mimulus guttatus	-	-	-	-	-	-	-	-	-	-	-	-
Moneses uniflora	-	-	-	-	-	0	-	-	-	-	0	1
Nephrophyllidium crista-galli	60	70	-	-	-	-	-	1	-	-	-	-
Orthilia secunda	-	-	-	-	-	-	-	-	-	-	3	1
Osmorhiza purpurea	-	-	-	-	-	-	-	-	-	-	-	-
Oxyria digyna	-	-	-	-	-	-	-	-	-	-	-	-
Petasites frigidus var. frigidus	-	-	-	-	-	-	-	-	-	-	1	-
Platanthera chorisiana	-	-	-	-	-	-	-	-	-	-	-	-
Polemonium acutiflorum	-	-	-	-	-	-	-	-	-	-	0	-
Polygonum viviparum	-	-	-	-	-	-	-	-	-	-	-	-
Prenanthes alata	-	-	-	-	0	-	-	0	1	1	-	0
Pyrola asarifolia	-	-	-	-	-	-	-	-	-	-	1	-
Rhinanthus minor	-	-	-	-	-	-	-	-	-	-	-	-
Rumex aquaticus var. fenestratus	-	-	-	-	-	-	-	-	-	-	-	-
Rubus arcticus	-	-	-	-	-	-	-	-	-	-	1	-
Rubus pedatus	-	-	3	10	3	10	3	3	-	1	-	10
Sanguisorba canadensis	-	-	-	-	-	-	-	-	-	-	0	-
Saxifraga nelsoniana ssp. nelsoniana	-	-	-	-	-	-	-	-	0	-	1	-
Spiranthes romanzoffiana	-	0	-	-	-	-	-	-	-	-	-	-
Streptopus amplexifolius	0	-	1	1	1	0	1	1	-	0	1	1
Stellaria borealis ssp. sitchana	-	-	-	-	-	-	-	-	-	-	0	0
Stellaria crispa	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria	-	-	-	-	-	-	-	-	-	-	-	-
Tellima grandiflora	-	-	-	-	-	-	-	-	-	-	-	-
Tiarella trifoliata	-	-	1	1	1	0	-	1	-	1	-	-
Trientalis europaea	1	1	-	-	-	-	-	-	-	-	-	-
Veratrum viride	-	-	1	1	1	-	1	1	-	-	-	-
Viola epipsila	-	-	-	-	-	-	-	-	-	-	-	-
Viola glabella	-	-	-	-	-	-	-	-	-	-	-	-
Viola langsdorffii	-	-	-	-	-	-	-	-	-	-	-	-
GRAMINOID												
Agrostis aequivalvis	1	1	-	-	-	-	-	-	-	-	-	-
Agrostis mertensii	-	-	-	-	-	-	-	-	-	-	0	-
Calamagrostis canadensis	-	-	-	-	-	-	-	0	10	0	3	0

	Wet Hemlock		Spruce - Hemlock						Young Spruce			
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFB076	KFB076	KFB060	KFB060	KFB081	KFB081	KFC077	KFC077	KFB052	KFB052	KFB072	KFB072
Calamagrostis nutkaensis	-	3	20	10	20	3	-	-	-	-	-	-
Deschampsia beringensis	-	1	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa	1	-	-	-	-	-	-	-	-	-	-	-
Elymus alaskanus ssp. latiglumis	-	-	-	-	-	-	-	-	-	-	-	-
Festuca rubra	-	-	-	-	-	-	-	-	-	-	-	-
Leymus mollis ssp. mollis	-	-	-	-	-	-	-	-	-	-	-	-
Phleum alpinum	-	-	-	-	-	-	-	-	-	-	0	-
Poa	-	-	-	-	-	-	-	-	-	-	-	-
Poa arctica	-	-	-	-	-	-	-	-	-	-	-	-
Polypodium glycyrrhiza	-	-	-	-	-	-	-	-	-	-	-	-
Trisetum spicatum	-	-	-	-	-	-	-	-	-	-	-	-
Vahlodea atropurpurea	-	-	-	-	-	-	-	-	-	-	-	-
Carex anthoxanthea	10	10	-	-	-	-	-	-	-	-	-	-
Carex aquatilis	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis deschampsioides	-	-	-	-	-	-	-	-	-	-	-	-
Carex macrochaeta	1	1	-	0	3	-	3	1	-	0	1	0
Carex mertensii	-	-	-	-	-	-	-	-	0	-	0	1
Carex pauciflora	-	3	-	-	-	-	-	-	-	-	-	-
Carex pyrenaica ssp. micropoda	-	-	-	-	-	-	-	-	-	-	-	-
Carex	-	-	-	-	-	-	-	-	-	-	-	-
Luzula parviflora	-	-	-	-	-	-	-	-	-	-	-	-
FERNS AND ALLIES												
Athyrium filix-femina	-	-	-	-	-	1	-	-	10	1	1	-
Cryptogramma sitchensis	-	-	-	-	-	-	-	-	-	-	-	-
Cystopteris fragilis	-	-	-	-	-	-	-	-	-	-	-	-
Dryopteris expansa	-	-	3	1	3	1	10	3	3	10	1	1
Equisetum arvense	-	-	-	-	-	-	-	-	-	-	20	3
Gymnocarpium dryopteris	1	1	3	3	1	10	-	-	-	-	0	-
Lycopodium annotinum	-	1	-	-	-	0	-	0	-	-	-	-
Lycopodium clavatum	-	-	-	-	-	-	-	-	-	-	-	-
Phegopteris connectilis	1	1	-	-	3	-	-	1	3	-	-	-
Thelypteris quelpaertensis	1	1	-	-	-	-	-	1	-	-	-	-

	Alder												Willow-Alder			
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFB054	KFB054	KFB055	KFB055	KFB051	KFB051	KFB075	KFB075	KFC073	KFC073	KFC075	KFC075	KFB071	KFB071	KFB046	KFB046
TREE																
Picea sitchensis	-	1	0	-	-	-	1	-	-	-	1	3	3	10	-	-
Tsuga mertensiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUB																
Alnus viridis ssp. sinuata	50	40	40	40	60	50	90	90	50	60	60	60	10	20	-	10
Rubus spectabilis	-	10	-	-	-	3	-	-	-	10	-	1	-	-	-	-
Elliottia pyroliflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Malus fusca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menziesia ferruginea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oplopanax horridus	0	0	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Salix alaxensis	-	-	-	-	-	-	-	-	10	1	3	-	-	-	60	30
Salix barclayi	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Sambucus racemosa	1	3	-	-	1	20	-	3	-	-	-	-	-	-	-	-
Salix sitchensis	-	-	-	3	3	3	1	1	30	10	10	10	90	50	-	20
Sorbus sitchensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium ovalifolium	-	-	-	-	-	0	-	-	-	-	-	-	-	1	-	-
Viburnum edule	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrimanella stelleriana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Loiseleuria procumbens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phyllodoce aleutica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium vitis-idaea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORB																
Achillea millefolium var. borealis	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Angelica lucida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anemone narcissiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aruncus dioicus var. acuminatus	-	-	-	-	-	70	-	-	30	10	-	-	-	-	-	-
Artemisia tilesii	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-
Cardamine oligosperma var. kam.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Chamerion angustifolium ssp. ang.	-	-	-	-	20	3	-	-	-	-	-	1	-	-	-	-
Chamerion latifolium	-	-	3	3	-	-	-	-	1	-	1	-	-	-	-	-
Circaea alpina	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
Claytonia sibirica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Cornus canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Conioselinum chinense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coptis trifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium anagallidifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. ciliatum	-	-	-	-	-	-	1	-	-	-	3	-	-	-	-	-
Epilobium ciliatum ssp. gland.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium hornemannii ssp. behr.	-	0	-	1	-	-	-	0	-	-	-	1	-	-	-	1
Epilobium	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Erigeron peregrinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fritillaria camschatcensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium trifidum	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
Geum calthifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Alder												Willow-Alder			
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFB054	KFB054	KFB055	KFB055	KFB051	KFB051	KFB075	KFB075	KFC073	KFC073	KFC075	KFC075	KFB071	KFB071	KFB046	KFB046
Gentiana douglasiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geranium erianthum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geum macrophyllum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heuchera glabra	3	3	0	-	1	-	1	1	3	1	-	-	-	0	-	-
Heracleum maximum	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Honckenya peploides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lathyrus japonicus var. maritimus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Listera cordata	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
Ligusticum scoticum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lupinus nootkatensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Luetkea pectinata	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Maianthemum dilatatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mimulus guttatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Moneses uniflora	-	-	-	-	-	-	-	-	-	0	-	-	-	1	-	-
Nephrophyllidium crista-galli	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthilia secunda	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
Osmorhiza purpurea	-	-	-	-	-	-	-	-	-	1	-	0	-	-	-	-
Oxyria digyna	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0
Petasites frigidus var. frigidus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platanthera chorisiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polemonium acutiflorum	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
Polygonum viviparum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prenanthes alata	-	0	-	0	-	-	-	-	1	1	-	1	-	-	-	-
Pyrola asarifolia	-	-	-	-	-	-	-	-	-	1	-	-	1	30	-	-
Rhinanthus minor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rumex aquaticus var. fenestratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus arcticus	-	-	-	-	-	-	-	-	-	1	-	-	-	0	-	-
Rubus pedatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sanguisorba canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saxifraga nelsoniana ssp. nelson.	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
Spiranthes romanzoffiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Streptopus amplexifolius	-	0	-	-	-	-	-	-	1	1	-	1	-	-	-	-
Stellaria borealis ssp. sitchana	-	-	-	1	-	-	1	0	3	0	10	1	-	-	-	0
Stellaria crispa	1	1	-	0	-	1	-	-	-	1	-	-	-	-	-	1
Stellaria	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellima grandiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tiarella trifoliata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis europaea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Veratrum viride	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Viola epipsila	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola glabella	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Viola langsdorffii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAMINOID																
Agrostis aequivalvis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agrostis mertensii	-	-	-	-	-	-	1	-	-	-	3	-	-	-	-	-
Calamagrostis canadensis	40	20	0	3	50	10	60	80	30	10	-	10	10	3	-	1

	Alder												Willow-Alder			
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFB054	KFB054	KFB055	KFB055	KFB051	KFB051	KFB075	KFB075	KFC073	KFC073	KFC075	KFC075	KFB071	KFB071	KFB046	KFB046
Calamagrostis nutkaensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia beringensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elymus alaskanus ssp. latiglumis	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Festuca rubra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leymus mollis ssp. mollis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phleum alpinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Poa arctica	-	-	-	-	-	-	1	-	-	-	3	-	-	-	-	-
Polypodium glycyrrhiza	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trisetum spicatum	-	-	-	0	-	-	-	-	-	-	1	-	-	-	-	-
Vahlodea atropurpurea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex anthoxanthea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex aquatilis	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis deschampsioides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex macrochaeta	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Carex mertensii	-	1	-	1	1	1	1	0	1	1	-	1	-	0	-	-
Carex pauciflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex pyrenaica ssp. micropoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	0
Luzula parviflora	-	-	0	1	-	-	-	-	-	-	-	-	-	-	-	-
FERNS AND ALLIES																
Athyrium filix-femina	10	10	-	1	1	3	1	1	3	3	-	1	-	0	-	-
Cryptogramma sitchensis	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Cystopteris fragilis	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
Dryopteris expansa	3	30	-	-	-	1	-	1	-	3	-	3	-	-	-	-
Equisetum arvense	-	-	-	-	-	-	-	1	10	3	1	-	50	60	1	1
Gymnocarpium dryopteris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopodium annotinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopodium clavatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phegopteris connectilis	-	-	0	-	-	-	-	-	-	3	-	-	-	-	-	-
Thelypteris quelpaertensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Salmonberry				**Dwarf Shrub-Forb**						Coastal Herbaceous Meadow					
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFC048	KFC048	KFC079	KFC079	KFB079	KFB079	KFC046	KFC046	KFC047	KFC047	KFB044	KFB044	KFB070	KFB070	KFC074	KFC074
TREE																
Picea sitchensis	-	-	1	-	-	-	0	0	-	-	-	-	-	-	-	-
Tsuga mertensiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUB																
Alnus viridis ssp. sinuata	3	10	80	40	1	-	1	1	-	1	-	-	-	-	-	-
Rubus spectabilis	3	50	30	80	-	3	-	-	-	-	-	-	-	-	-	-
Elliottia pyroliflora	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
Malus fusca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menziesia ferruginea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oplopanax horridus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix alaxensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix barclayi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sambucus racemosa	-	-	1	20	-	-	-	-	-	-	-	-	-	-	-	-
Salix sitchensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sorbus sitchensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium ovalifolium	-	-	-	-	-	-	1	3	-	1	-	-	-	-	-	-
Viburnum edule	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrimanella stelleriana	-	-	-	-	-	-	50	40	-	-	-	-	-	-	-	-
Loiseleuria procumbens	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Phyllodoce aleutica	-	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium vitis-idaea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORB																
Achillea millefolium var. borealis	-	-	3	-	-	-	-	-	-	-	1	10	-	-	-	1
Angelica lucida	-	-	-	-	-	-	-	-	-	-	10	40	-	-	-	1
Anemone narcissiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aruncus dioicus var. acuminatus	-	1	30	1	-	-	-	-	-	-	-	-	-	-	-	-
Artemisia tilesii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardamine oligosperma var. kam.	-	0	-	0	-	1	-	-	-	-	-	-	-	-	-	-
Chamerion angustifolium ssp. ang.	-	-	-	-	-	-	-	-	20	40	-	30	-	-	-	3
Chamerion latifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Circaea alpina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Claytonia sibirica	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Cornus canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conioselinum chinense	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	0
Coptis trifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium anagallidifolium	-	1	-	-	-	3	-	1	-	0	-	-	-	-	-	-
Epilobium ciliatum ssp. ciliatum	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. gland.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Epilobium hornemannii ssp. beh.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erigeron peregrinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fritillaria camschatcensis	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-
Galium trifidum	-	-	-	-	-	-	-	-	-	-	3	-	1	0	1	0
Geum calthifolium	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-

	Salmonberry				Dwarf Shrub-Forb						Coastal Herbaceous Meadow					
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFC048	KFC048	KFC079	KFC079	KFB079	KFB079	KFC046	KFC046	KFC047	KFC047	KFB044	KFB044	KFB070	KFB070	KFC074	KFC074
Gentiana douglasiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geranium erianthum	1	10	1	-	1	3	-	0	3	3	-	-	-	-	-	-
Geum macrophyllum	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
Heuchera glabra	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Heracleum maximum	-	-	1	3	-	1	-	-	-	-	-	-	-	-	-	1
Honckenya peploides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Lathyrus japonicus var. maritimus	-	-	-	-	-	-	-	-	-	-	0	-	-	0	1	60
Listera cordata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ligusticum scoticum	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Lupinus nootkatensis	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-
Luetkea pectinata	10	20	-	-	40	30	10	40	40	50	-	-	-	-	-	-
Maianthemum dilatatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mimulus guttatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moneses uniflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nephrophyllidium crista-galli	-	-	-	-	-	1	30	40	-	-	-	-	-	-	-	-
Orthilia secunda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osmorhiza purpurea	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxyria digyna	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petasites frigidus var. frigidus	10	3	-	-	3	3	-	-	1	3	-	-	-	-	-	-
Platanthera chorisiana	-	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-
Polemonium acutiflorum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum viviparum	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Prenanthes alata	-	1	-	-	-	1	-	0	-	0	-	-	-	-	-	-
Pyrola asarifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhinanthus minor	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Rumex aquaticus var. fenestratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Rubus arcticus	-	-	-	-	-	-	-	-	-	-	0	30	-	-	-	-
Rubus pedatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sanguisorba canadensis	3	3	-	-	30	60	-	1	-	0	-	1	-	-	-	-
Saxifraga nelsoniana ssp. nels.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Spiranthes romanzoffiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Streptopus amplexifolius	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Stellaria borealis ssp. sitchana	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Stellaria crispa	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellima grandiflora	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Tiarella trifoliata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis europaea	-	-	-	-	-	-	-	0	-	1	1	1	1	-	-	-
Veratrum viride	30	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Viola epipsila	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-
Viola glabella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola langsdorffii	1	10	-	-	-	-	-	3	1	10	-	1	-	-	-	-
GRAMINOID																
Agrostis aequivalvis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agrostis mertensii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis	20	3	3	3	20	10	-	1	10	10	-	10	-	-	3	40

	Salmonberry				Dwarf Shrub-Forb						Coastal Herbaceous Meadow					
	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008	1993	2008
	KFC048	KFC048	KFC079	KFC079	KFB079	KFB079	KFC046	KFC046	KFC047	KFC047	KFB044	KFB044	KFB070	KFB070	KFC074	KFC074
Calamagrostis nutkaensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia beringensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa	-	1	-	-	1	-	1	-	-	-	3	3	-	-	-	-
Elymus alaskanus ssp. latiglumis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Festuca rubra	-	-	-	-	-	-	-	-	-	-	10	3	10	10	-	-
Leymus mollis ssp. mollis	-	-	-	-	-	-	-	-	-	-	30	10	98	70	90	30
Phleum alpinum	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
Poa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poa arctica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypodium glycyrrhiza	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Trisetum spicatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vahlodea atropurpurea	3	3	-	-	10	-	-	-	10	10	-	-	-	-	-	-
Carex anthoxanthea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex aquatilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis deschampsioides	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Carex macrochaeta	1	3	3	-	30	20	1	1	3	3	-	3	-	-	-	-
Carex mertensii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex pauciflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex pyrenaica ssp. micropoda	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Carex	-	-	-	-	1	-	1	-	-	-	0	-	-	-	-	-
Luzula parviflora	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-
FERNS AND ALLIES																
Athyrium filix-femina	1	3	10	10	-	3	-	-	-	1	-	-	-	-	-	0
Cryptogramma sitchensis	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-
Cystopteris fragilis	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
Dryopteris expansa	-	1	-	-	-	1	-	0	1	1	-	-	-	-	-	-
Equisetum arvense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gymnocarpium dryopteris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopodium annotinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopodium clavatum	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Phegopteris connectilis	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Thelypteris quelpaertensis	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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NPS 186/102211, May 2010

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