Appendix B: Characteristics of Historical Riverine Forests

ABSTRACT

We developed statistical descriptions of historical forests from GLO bearing tree records, based on our compilation of these records into GIS coverages. These summaries indicate the frequency and basal areas of trees and their geomorphic, habitat, and elevational setting. These summaries can be applied to forest restoration planning, and for understanding the species likely historically to have contributed pieces of large wood to rivers in the study area. More specific analyses can be made by querying the GIS coverages from which these data are summarized.

INTRODUCTION

This appendix summarizes the historical forest composition in the study area as indicated by bearing tree records from the General Land Office (GLO) field survey. Appendix A describes our sources and methods. The data presented include frequency, expressed as the number or proportion of a species in a given sub-sample of a study area, and dominance as expressed by the portion of total basal area that a species represents in the same sub-sample. Sub-samples include the immediately streamside forest, a sample created from the bearing trees established by the GLO surveyors at the banks of navigable streams, and valley-bottom forests, which include the rest of the floodplain exclusive of the immediately streamside area, and terraces and fans. We also present diameter distributions and elevation ranges, aggregated for each watershed, for the most common trees. Table A-11 in Appendix A lists the common names of bearing trees in the study area, and their likely or possible scientific equivalents.

NOOKSACK RIVER

Delta Streamside Forests. On riverbanks in the greater Nooksack delta, alder (red alder, *Alnus rubra*; on first use we cite the common name used by surveyors, and the probable species) was the most common bearing tree (Figure B-1) Descriptions from an 1868 expedition by E. T. Coleman (Coleman 1869) describe the banks as "adorned with several species of willow, alder, the crab-apple," which are the three most common species in the GLO survey. Spruce (Sitka spruce, *Picea sitchensis*), however, accounted by far for the most basal area (Figure B-1), being the only large (if relatively infrequently occurring) tree.

Lower Mainstem Streamside and Valley-Bottom Forests. Alder was the most common tree bearing of the lower mainstem forests. (Alder was also the most common throughout the Nooksack study area, accounting for 42% of all bearing trees). In streamside forests, cottonwood (black cottonwood, *Populus trichocarpa*) was almost as common as alder (Figure B-1), and accounted for nearly as much of the basal area as spruce (Figure B-1), which, similar to the delta, had the greatest relative dominance among conifers. Coleman (1869) confirms the presence of cottonwood, describing "long rows of lofty cotton-wood trees."

Farther away from the stream, the valley bottom forest exclusive of wetlands was dominated in basal area by cedar (western redcedar, *Thuja plicata*) rather than spruce (Figure B-1); alder was most abundant (Figure B-1). Within the extensive palustrine wetlands in the lower mainstem, species composition was similar to that in the streamside areas except that cottonwood was not present, few trees were large (see Appendix C, Figure C-2), crabapple (western crabapple, *Malus fusca*) was common; birch (probably paper birch, *Betula papyrifera* (included in "other" category in Figure C-2) was also present.

Upper Mainstem Forests. Compared to the lower mainstem, cottonwood was less common in the upper mainstem streamside forests (Figure B-2). Alder was the most common tree in both valley bottom and

streamside forests; cedar was nearly as common as alder in the valley bottom forests. In both areas cedar dominated basal area, and fir (probably Douglas fir, *Pseudotsuga menziesii*) was a significant forest constituent.

Forests of the Three Forks. Alder was overwhelmingly the most common tree in the streamside forest of the three forks (Figures B-3 and B-4) and dominated by basal area, except in the South Fork where a few large cedars existed in the sample. The valley bottom forests were more diverse, and dominated in basal area by conifers (the Middle Fork valley bottom is not shown in Figure B-4 because the small sample size was small), with all four of the common conifers well represented (Figure B-3 and Figure B-4).

Nooksack River Summary. Throughout the study area, cedar were the largest trees (Figure B-5A). Among a relatively small sample (120 trees) the mean diameter of cedar was 78 cm (median 61 cm), with individuals as large as 305 cm. Douglas fir (mean diameter 59 cm, median 51 cm, maximum 183 cm) and Sitka spruce (mean diameter 59 cm, median 41 cm, maximum 183 cm) were the other large conifers. Black cottonwood was the only hardwood tree to attain a large diameter (mean diameter 49 cm, median 35 cm, maximum 172 cm). No other tree species had a mean or median diameter greater than 30 cm. Red alder and bigleaf maple both had mean and median diameters greater than 20 cm (alder mean diameter 27 cm, median 25 cm, maximum 76 cm; maple mean diameter 30 cm, median 25 cm, maximum 102 cm).

Tree species also had distinct elevation ranges (Figure B-5B). For example, while it occurred within a fairly large range in elevation, most Sitka spruce grew at low elevations, the lowest elevations among conifers on average, consistent with its importance on the delta and lower mainstem. Western redcedar, Douglas fir, and western hemlock (*Tsuga heterophylla)* tended to grow at increasingly greater elevations, respectively. Among hardwoods, crabapple, willow, and birch occurred at low elevations, reflecting their importance on the delta and lower mainstem. Cottonwood had a relatively restricted range, centering on moderate elevations, reflecting its importance in the lower mainstem. Alder was ubiquitous, having had the widest range among tree species in addition to being the most common.

These data suggest the species that would have provided very large wood to rivers, and thus potentially function as key pieces for jams, and how it varied along the river. On the delta, Sitka spruce would have been the only recruitable species large enough to function as a key piece. In the lower mainstem, black cottonwood would have augmented spruce as a source of key pieces. In both the delta and the lower mainstem, the rate of river migration was low (see Collins and Sheikh 2002), and so the immediately streamside trees are the best indicator of potentially recruitable trees. In the upper mainstem, cedar would have been the most common potentially recruitable key piece, and secondarily spruce, fir, cottonwood and larger maple. In the forks, cedar and fir would have been the most commonly available large wood, and secondarily cottonwood and maple.

SKAGIT RIVER

Delta Valley-Bottom and Terrace Forests. Strong contrasts are evident between forests that grew on the active floodplain (but distant from river banks) compared to forests on higher river terraces. While the valley-bottom forests (Figure B-6 A and C) are broadly comparable to the valley-bottom forests of the Nooksack area in their diversity and in the abundance of hardwoods, terrace forests (Figure B-6 B and D) in the Skagit were conifer-dominated, with hemlock the most common bearing tree. Cedar was the second most frequent bearing tree, and it accounted for most of the basal area.

Delta Streamside Forests. Streamside forests show a gradual increase in coniferous influence and diversity moving from estuarine, to tidal freshwater, to freshwater forests (Figure B-7). Spruce is the only conifer in the estuarine streamside forests, which is joined by cedar in the tidal freshwater zone, and some Douglas fir and western hemlock in the freshwater streamside forests. Alder, crabapple and willow are common hardwoods in estuarine and tidal-freshwater areas, with cottonwood also appearing in the tidal freshwater and freshwater forests (Figure B-7).

Upper Skagit and Lower Sauk Forests. While the sample size is smaller on alluvial fans compared to alluvial terraces, limiting detailed comparison, both are conifer-dominated (Figure B-8).

Elevation and Diameter Summary. Spruce, cedar, fir, hemlock, cottonwood, and maple were the largest trees (Figure B-9A). In streamside areas (from which trees are most likely to recruit to rivers), spruce was confined to lower elevations (Figure B-9C) and maple was more common at higher elevations, as was hemlock and fir. Cedar was the largest tree in the Skagit River bearing tree sample, with individual treesin a relatively small sample (210 trees) of 380 cm in diameter. There was overall a distinct elevational pattern to species composition (Figure B-9B); among streamside conifers, tidewater spruce gives way to cedar, fir, and at highest elevations, hemlock, as streamside trees. A distinct pattern is also shown in the occurrence of hardwoods, with most clustering in the lower elevations, cottonwood in the mid elevations, and maple the higher. The distribution of alder is influenced by the larger sample size in the delta, but it's overall elevational distribution is broad, similar to the Nooksack (Figure B-5 B).

STILLAGUAMISH RIVER

The Stillaguamish valley bottom forests (Figure B-10) were broadly similar in composition to those of the Skagit study area; the Stillaguamish's alluvial terrace forests contrasted to the Skagit's in having more fir than hemlock (Figure B-10). Fir, not cedar, were also the largest trees in the Stillaguamish study area (Figure B-10), although cedar and spruce were nearly as large as fir. The overall pattern of elevational range in the Stillaguamish (Figure B-12) was also broadly similar to that in the Skagit.

SNOHOMISH RIVER

Streamside Forests in Estuarine Vegetation Zone. The bearing tree sample size is small in the estuarine tidal riparian forest (Figure B-13). The limited sample includes juniper, alder, crabapple, cedar, and

spruce in descending order of abundance (Figure B-13). Alder constitute the largest proportion of total basal area.

Riverine-Tidal Riparian Forest. Most of the mainstem as far upstream as river kilometer 27 is tidally influenced. In tidal-freshwater riparian forest, alder was the most common tree (Figure B-13), accounting for more than 40% of bearing trees. Broad-leafed deciduous trees account for almost three-fourths (73%) of trees. Cedar accounts for the largest proportion of basal area (Figure B-13). Bearing trees were larger in diameter and more closely spaced in the tidal-freshwater riparian forests than in the estuarine riparian forest.

Non-tidal Riparian Forests. The sample size of bearing trees is also small in the upstream non-tidal riparian forest (Figure B-13). Willow, cottonwood, and alder (in diminishing order of abundance) were the most common trees in the dominantly deciduous forest (15 of 19 trees). Cottonwood, bigleaf maple, spruce, and cedar (in decreasing order of total basal area) accounted for most of the basal area.

Floodplain Forests. Conifers accounted for only 25% of trees on the floodplain (compared to 58% in estuarine riparian forests, 26% in tidal-freshwater riparian forests, and 16% in non-tidal riparian forests). Alder, vine maple, spruce, and cedar were the most common trees (Figure B-14). Cedar accounted for more than half of basal area (Figure B-14).

SKYKOMISH RIVER

Floodplain Forests. Vine maple, hemlock, maple, and alder were the most common bearing trees in the Skykomish floodplain, accounting for 20%, 19%, 18%, and 15%, respectively (Figure B-15). Fir, spruce and cedar were the largest trees (averaging 92 cm, 67 cm, and 60 cm, respectively); fir accounted for nearly one-half of the basal area (Figure B-15).

Riparian Forests. Alder, vine maple, cottonwood, and willow (in diminishing order of abundance) were the most common trees in the dominantly deciduous forest (38%, 15%, 14%, and 8%, respectively; Figure B-15). Alder also dominated by basal area, accounting for 32%. The average diameter of bearing trees was 36 cm. The forest was 82% hardwood by frequency and 62% by basal area (Figure B-15).

Terraces. Forests on a series of glacial alluvial terraces in the upper Skykomish River (Figure B-15) were overwhelmingly dominated by hemlock and fir (Figure B-15), together accounting for 72% of all trees. Spruce, cedar, maple, and fir were the largest trees (127 cm, 86 cm, 86 cm, and 85 cm, respectively). Fir accounted for 57% of the basal area (Figure B-15). Deciduous trees accounted for only 18% of bearing trees .

Along the Snohomish-Skykomish river valley, there were identifiable elevation ranges for many forest tree species (Figure 5-16). Among conifers, juniper (*Juniperus scopulorum*) and yew (*Taxus brevifolia*) were confined to within a few meters of sea level, and pine (*Pinus contorta*) only slightly higher in elevation (and farther upriver). Spruce were also clustered near to tidewater, although their individuals were found at higher elevations. Cedar, hemlock and fir occurred in increasingly higher elevations (Figure B-16). Among hardwoods, crabapple clustered in the lowest elevations, followed in an upstream direction by willow. Alder had the greatest elevation range of hardwoods (Figure B-16).

SNOQUALMIE RIVER

Streamside Forests. Most streamside trees were hardwoods: alder, willow, vine maple, maple, cottonwood, and crabapple (Figure B-17). Conifers accounted for only 7% of streamside trees. Because bearing trees underestimate the frequency of small-diameter species such as vine maple and alder, conifers probably accounted for even less than 7% of trees. However, the few conifers accounted for 43% of streamside basal area (Figure B-17), indicating that conifers were the largest trees and would have

provided nearly half the dead wood biomass to rivers from immediate streamside forests. Cedar alone, which accounted for 4% of stems, comprised 27% of streamside basal area, and averaged 97 cm (38 inches) in diameter (Figure B-17A); spruce, which averaged 91 cm (36 inches) in diameter, accounted for only 2% of stem number, but 14% of basal area. Maple (average diameter 54 cm or 21 inches, range of 10-132 cm or 4-52 inches) and cottonwood (average diameter 54 cm or 21 inches, range of 8-152 cm or 3-60 inches) were the dominant hardwoods by basal area, both accounting for 18% and 15% of the total, respectively. Alder was the third hardwood having an average diameter substantially greater than 15 cm, averaging 35 cm (14 inches).

Floodplain Forests. Conifers were somewhat more abundant in the forest more distant from the river although still accounting for only 21% of the stem number (compared to 7% in streamside areas), they accounted for 46% of basal area (Figure B-17). Cedar was the largest tree, averaging 91 cm (36 inches) and ranging from 8 to 305 cm (3-120 inches) in diameter (Figure B-18A). Similar to the streamside forest, maple and cottonwood were the largest hardwoods (mean = 58 cm or 23 inches and 58 cm or 23 inches, respectively). However, because of the slow rate of channel migration in the Snoqualmie River, bearing trees from the immediately streamside area are most representative of the dead wood that would enter the river.

Trees were distributed predictably relative to the riverbank elevation (Figure B-18B). The data in Figure B-18B were developed by comparing present-day elevation shown on LIDAR DEM for locations of GLO notes to the present-day riverbank elevation nearest to the point. The elevation distribution of spruce shows a tolerance for seasonally-inundated sites, generally occurring 1-2 m below the river bank elevation, and alder and willow occurred as much as 4 m below the riverbank elevation.

Snoqualmie River Summary. The immediately streamside forest was dominated by a variety of hard-woods. Of these, only maple, cottonwood, and alder were typically of a large enough size as to be expected to create stable in-channel wood. The few conifers immediately streamside, primarily cedar and

spruce, could be quite large [diameter ranges of 15-244 cm (6-96 inches) and 13-203 cm (5-80 inches), respectively]. Cedar, spruce, maple, and cottonwood would be expected to have been the most common key pieces in jams. Observations in the Snohomish River (Collins et al., 2002) indicate that hardwoods with a broadly shaped crown, such as maple, are likely to form snags within the main channel.

IN-CHANNEL WOOD

Field data from Pacific Northwest rivers that have been relatively unmodified in the past few centuries (e.g. Abbe and Montgomery 1996; Collins et al. 2002) and archival studies (Sedell and Luchessa 1981; Sedell and Frogatt 1984; Collins et al. 2002) suggest that rivers such as those in the study area would have had numerous wood jams. These jams would have had important functions at a wide range of scales, such as creating pools, causing avulsions and flow splits, and routing water and sediment at the valley scale (Collins et al. 2002; Montgomery et al. in press). For detail on wood in individual rivers in the study area, see Colllins and Sheikh (2002a, 2002b) and Collins et al. (2001).

REFERENCES CITED

Abbe, T. B. and D. R. Montgomery. 1996. Large woody debris jams, channel hydraulics and habitat formation in large rivers. *Regulated Rivers Research and Management* 12: 201-221.

Coleman, E. T. 1869. Mountaineering on the Pacific. *Harper's Monthly Magazine* 40: 793-817.

Collins, B. D. and D. R. Montgomery. 2002. Forest development, wood jams and restoration of floodplain rivers in the Puget Lowland. *Restoration Ecology* 10(2): 237-247.

Collins, B. D., D. R. Montgomery, and A. D. Haas. 2002. Historical changes in the distribution and functions of large wood in Puget Lowland rivers. *Canadian Journal of Fisheries & Aquatic Sciences* 59: 66-76.

Collins, B. D., and A. J. Sheikh. 2002a. Historical riverine dynamics and habitats of the Nooksack River. Interim report to the Nooksack Indian Tribe, Natural Resources Department, Deming, WA, July 19, 2002.

Collins, B. D., and A. J. Sheikh. 2002b. Mapping historical conditions in the Snoqualmie River valley (RM 0 – RM 40). Report to King County Department of Natural Resources, Seattle, WA. February 21, 2002.

Montgomery, D. R., B. D. Collins, J. M. Buffington, and T. B. Abbe. In press. Geomorphic effects of wood in rivers. In S. V. Gregory (ed.) *Wood in World Rivers*. American Fisheries Society, Bethesda.

Plummer, G. H., Plummer, F. G., and Rankine, J. H. 1902. Map of Washington showing classification of lands. Plate 1 in: H. Gannet, The forests of Washington, a revision of estimates. *U. S. Geological Survey Professional Paper* 5, Series H, Forestry 2. 38 p.

Sedell, J. R. and K. J. Luchessa. 1981. Using the historical record as an aid to salmonid habitat enhancement. In N. B. Arementrout (ed.) *Acquisition and Utilization of Aquatic Habitat Inventory Information*. American Fisheries Society, pp. 210-223.

Sedell, J. R. and Froggatt, J. L. 1984. Importance of streamside forests to large rivers: The isolation of the Willamette River, Oregon, U. S. A., from its floodplain by snagging and streamside forest removal. *Verh. Internat. Verein. Limnol. (International Association of Theoretical and Applied Limnology)* 22:1828-1834.

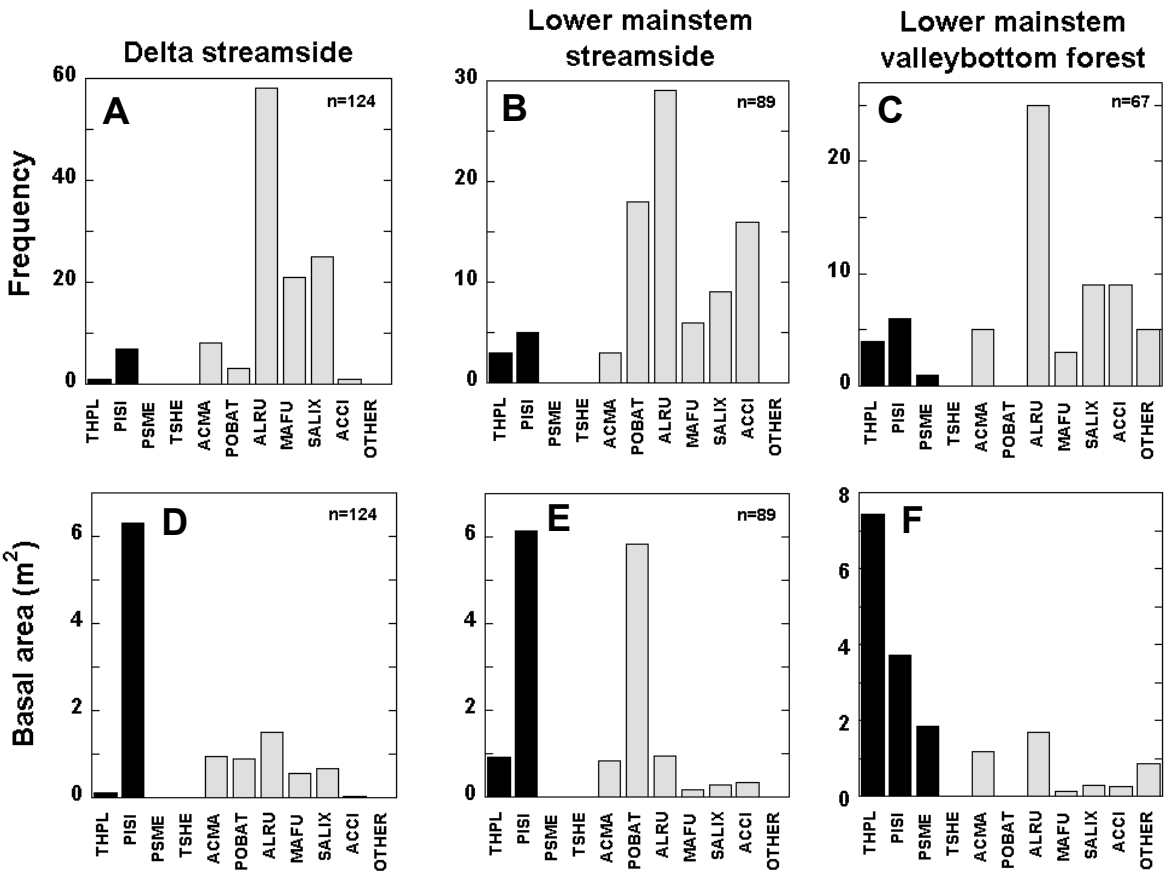

Figure B-1. GLO bearing trees in the lower Nooksack River area. Frequency in (A) delta streamside forests, (B) lower mainstem streamside, and (C) lower mainstem valley bottom forests. Bottom tier is basal area for the same areas. Conifers have dark-shaded bar. THPL: western redcedar (*Thuja plicata)*; PISI: Sitka spruce (*Picea sitchensis)*; PSME: Douglas fir (*Pseudotsuga menziesii)* may also include some grand fir *(Abies grandis)*; TSHE: western hemlock (*Tsuga heterophylla)*; ACMA: bigleaf maple (*Acer macrophyllum)*; POBAT: black cottonwood (*Populus trichocarpa)*; ALRU: Red alder (*Alnus rubra)*; MAFU: Pacific crabapple (*Malus fusca)*; SALIX: Willow (*Salix spp.);* ACCI: vine maple (*Acer circinatum)*.

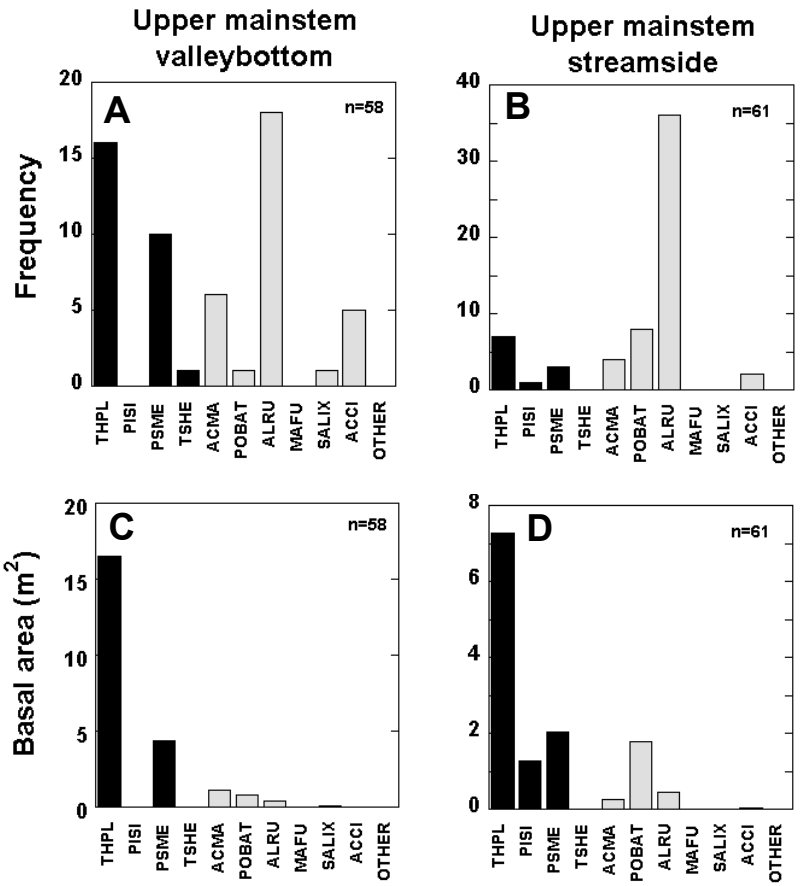

Figure B-2. GLO bearing trees in the upper mainstem of the Nooksack River area. Frequency (A) and basal area (C) in valley bottom forests; and frequency (B) and basal area (D) in streamside forests. Conifers have dark-shaded bar. Species abbreviations are as in Figure 4-1.

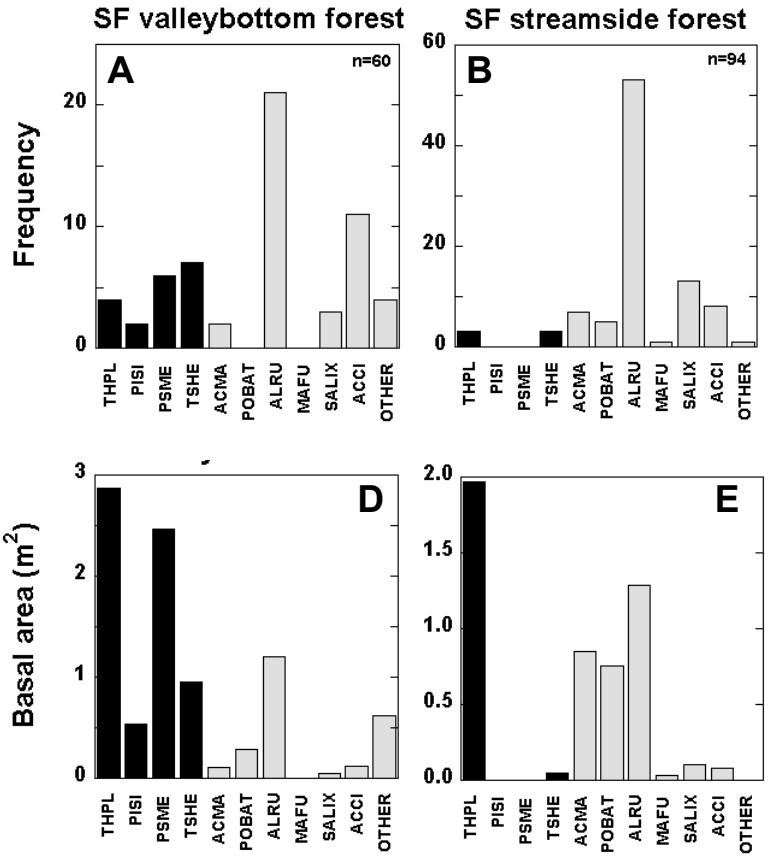

Figure B-3. GLO bearing trees in the South Fork Nooksack River area. Frequency (A) and basal area (D) in valley bottom forests; frequency (B) and basal area (C) in streamside forests. Conifers have dark-shaded bar. Species abbreviations are as in Figure 4-1.

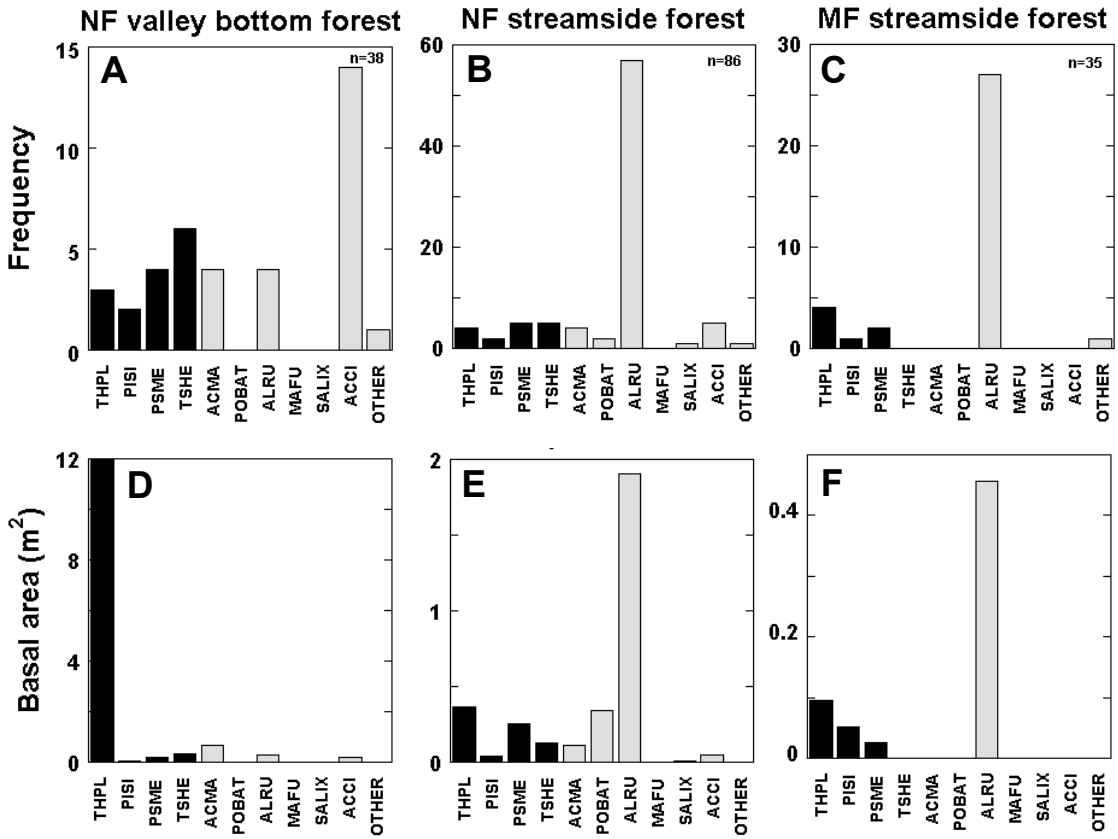

Figure B-4. GLO bearing trees in the North and Middle Fork Nooksack River areas. Frequency (A) and basal area () in North Fork valley bottom forests; frequency (B) and basal area (E) in North Fork riparian forests; and frequency (C) and basal area (F) in Middle Fork riparian forests. Conifers have dark-shaded bar. Species abbreviations are as in Figure 4-1.

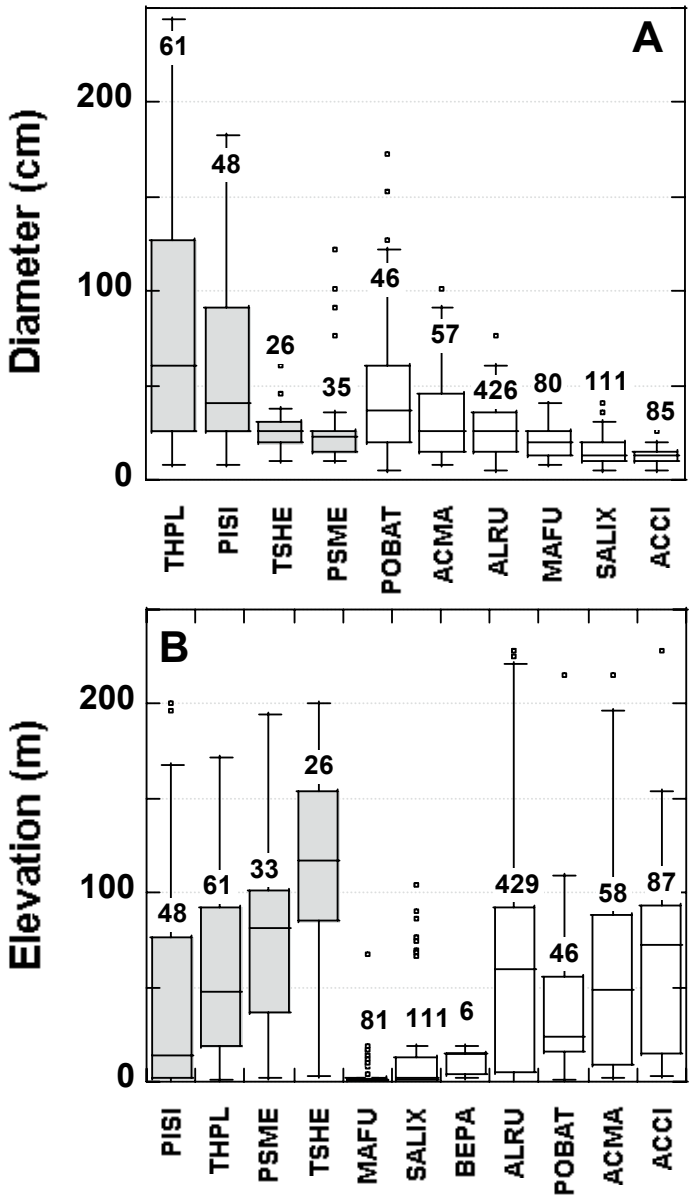

Figure B-5. A) Distribution of bearing trees diameters in the Nooksack River study area. B) Elevation of bearing trees. Conifers have shaded bars. Numbers are sample size. Species abbreviations are as in Figure 4-1. Each box encloses 50% of the data. Horizontal line within box represents median. The lines extending from the top and bottom of boxes indicate minimum and maximum values, excepting outlier values (circles) greater than the inner quartile plus 1.5 times the inner two quartiles.

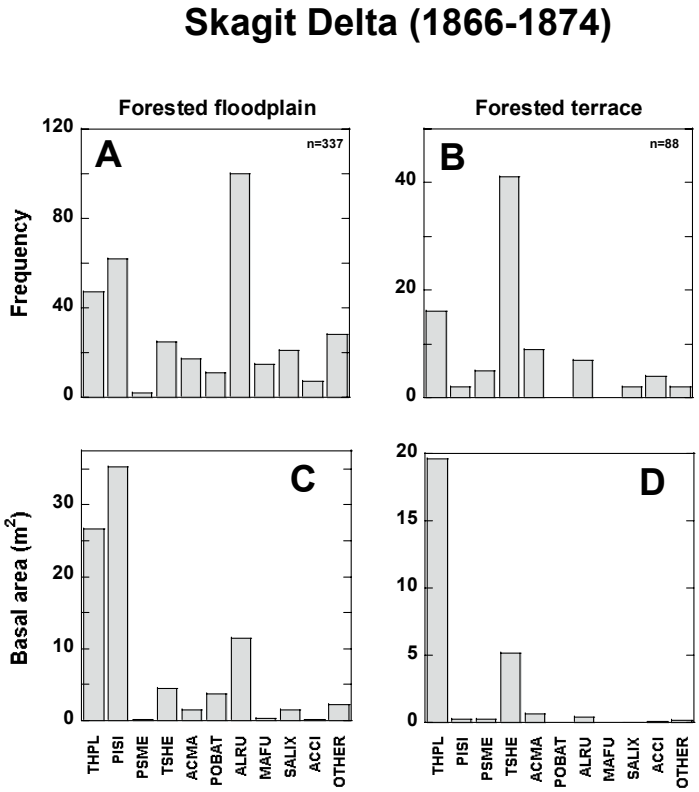

Figure B-6. Bearing trees from GLO field notes on the Skagit River. (A) frequency of trees in the forested floodplain map unit, and (B) in forested terraces. Bottom tier is cumulative basal area in the same areas. Abbreviations are as in Figure 4-1.

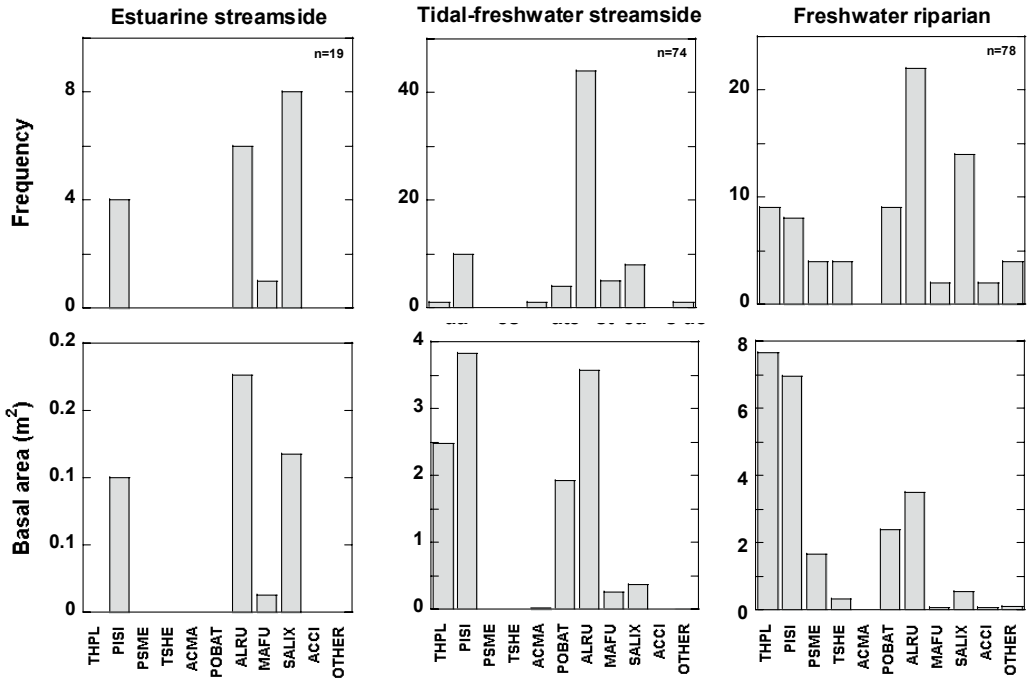

Figure B-7. Bearing trees from GLO field notes on the Skagit River. Top tier, from left to right: frequency of trees in delta streamside, tidal-freshwater streamside, and freshwater streamside. Bottom tier is cumulative basal area in the same areas. Abbreviations are as in Figure 4-1.

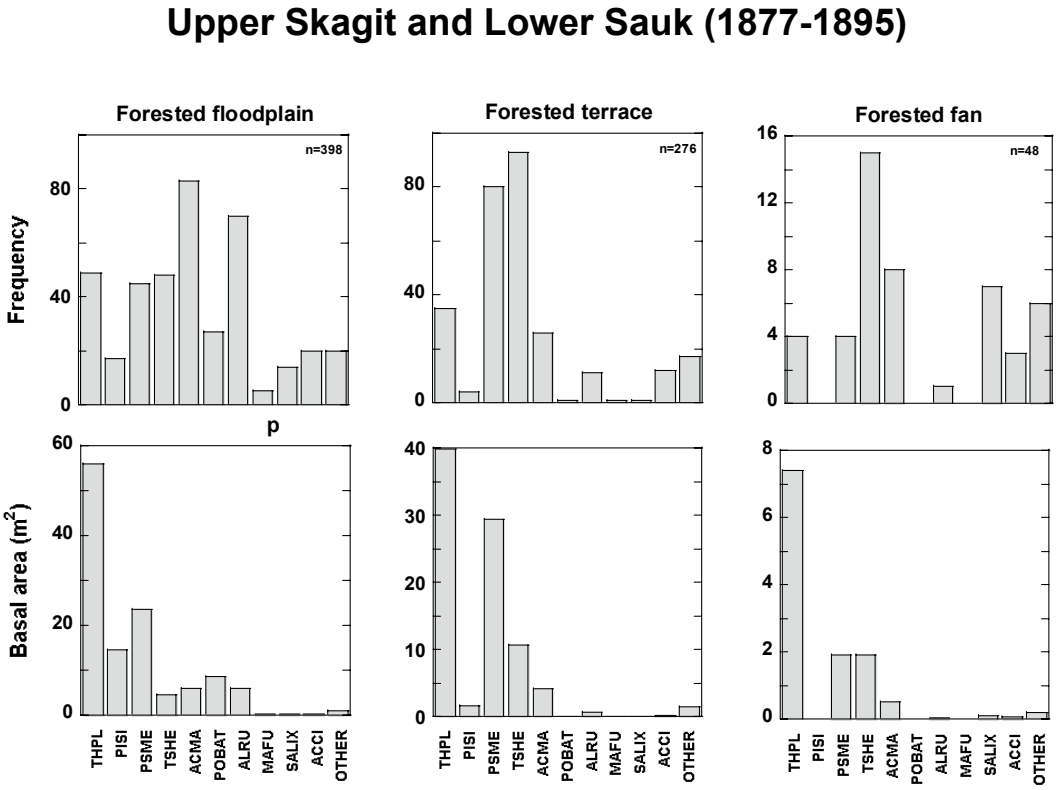

Figure B-8. Bearing trees from GLO field notes on the Skagit River. Top tier, from left to right: frequency of trees in forested floodplain, forested terrace, and forested fans. Bottom tier is cumulative basal area in the same areas. Abbreviations are as in Figure 4-1.

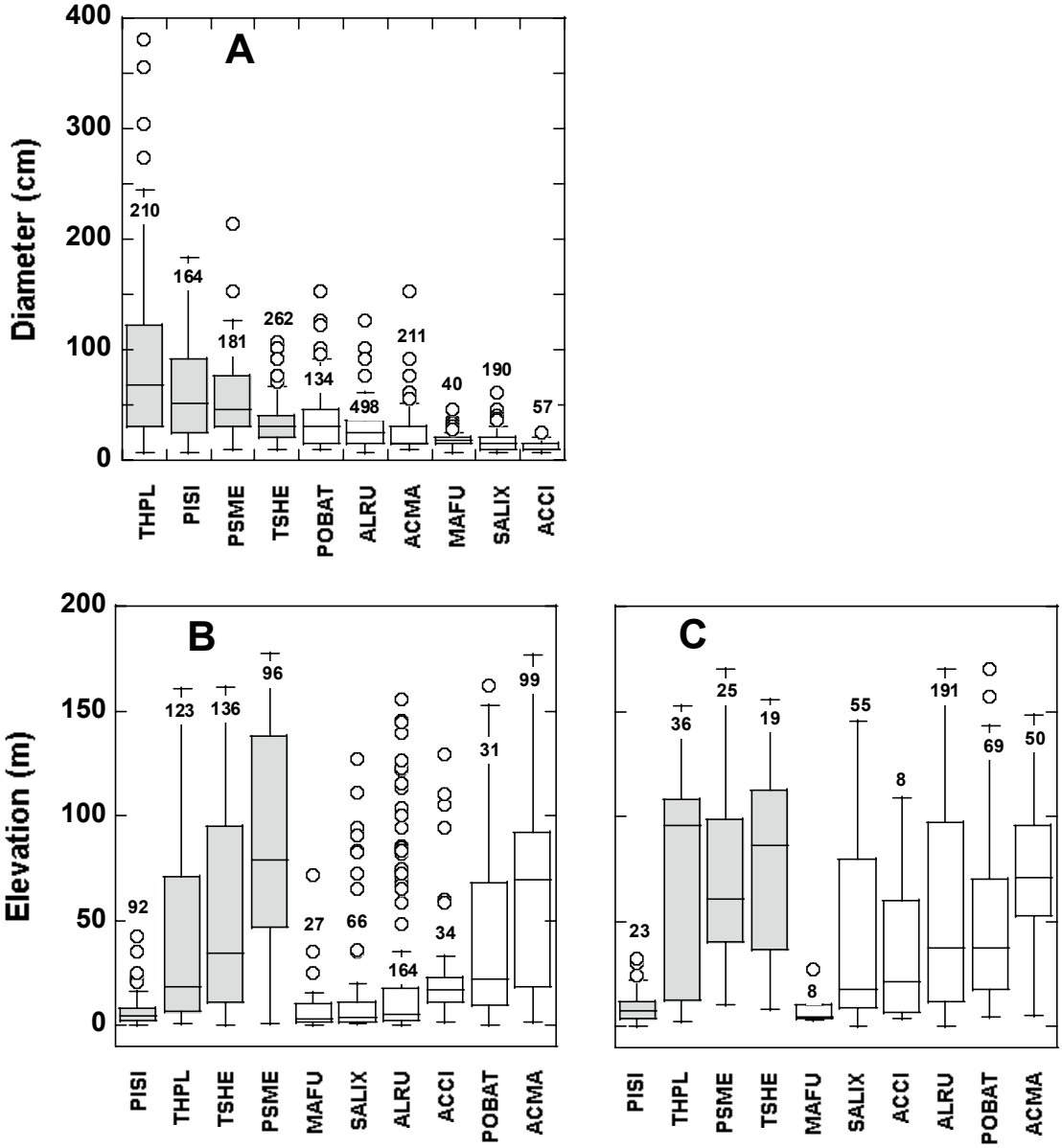

Figure B-9. (A) Diameter of 10 most common tree species in the Skagit River study area. (B) Elevation of GLO bearing trees in valley bottom (not stream-adjacent) and (C) in streamside areas. Conifers have shaded bars. In both plots, numbers are sample size for each species; format is as in Figure 4-5.

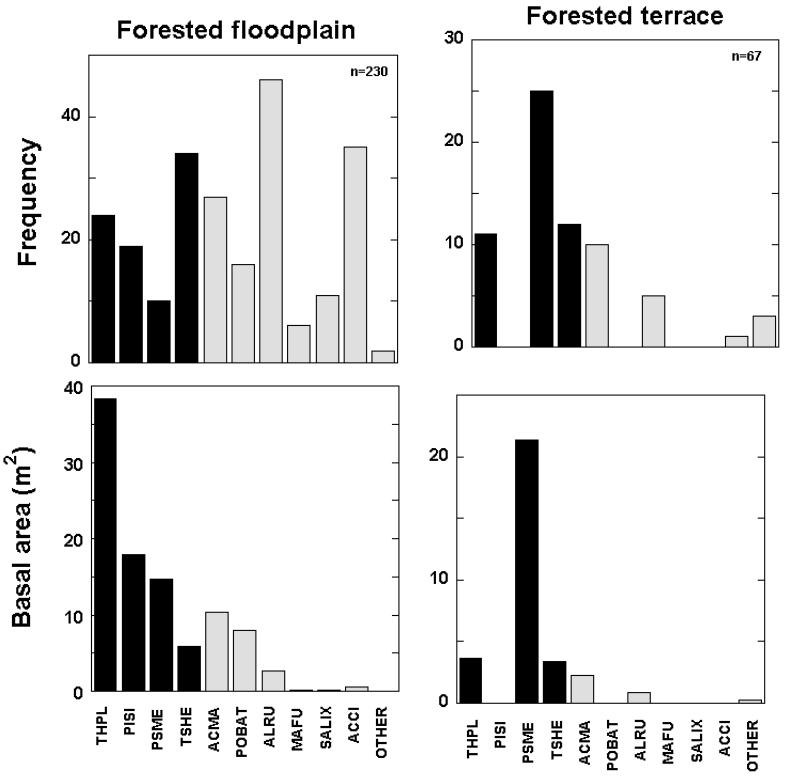

Figure B-10. Bearing trees from GLO field notes on the Stillaguamish River study area. Top tier, from left to right: frequency of trees in floodplain forests, and river terrace forests. Bottom tier is cumulative basal area in the same areas. Conifers have dark-shaded bar. Species abbreviations are as in Figure 4-1. "Other" species include: hazel (beaked hazelnut*, Corylus cornuta var. californica*); bearberry or barberry (uncertain, possibly Oregon grape, *Mahonia aquifolium*); cherry (bitter cherry, *Prunus emarginata);* elder (red elderberry*, Sambucus racemosa*).

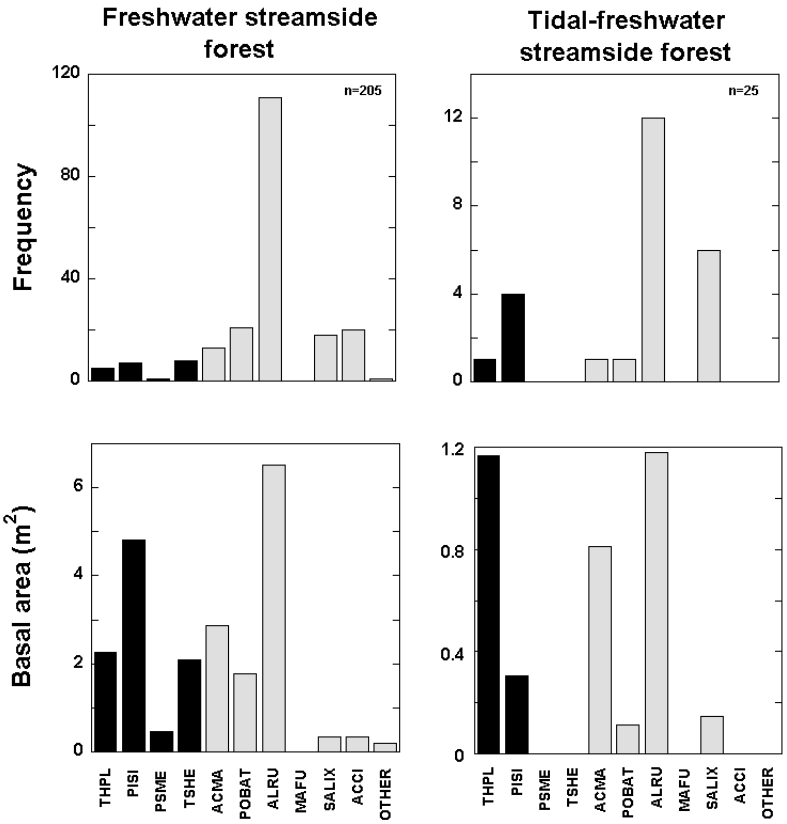

Figure B-11. Bearing trees from GLO field notes on the Stillaguamish River valley. Top tier, from left to right: frequency of trees in floodplain forests, streamside forests, and river terrace forests. Bottom tier is cumulative basal area in the same areas. Conifers have dark-shaded bar. "Other" includes western yew (*Taxus brevifolia*).

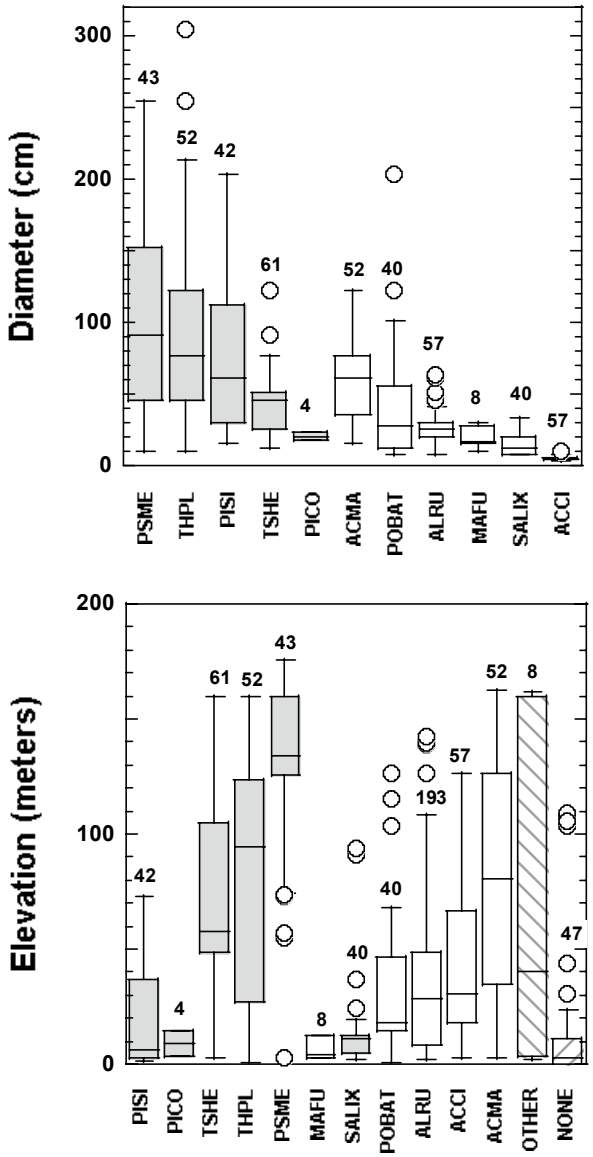

Figure B-12. A) Distribution of bearing trees diameters in the Stillaguamish study area. B) Elevation of bearing trees. Conifers have shaded bars. Numbers are sample size. Species abbreviations are as in Figure 4-1. See Figure 4-5 for explanation of format.

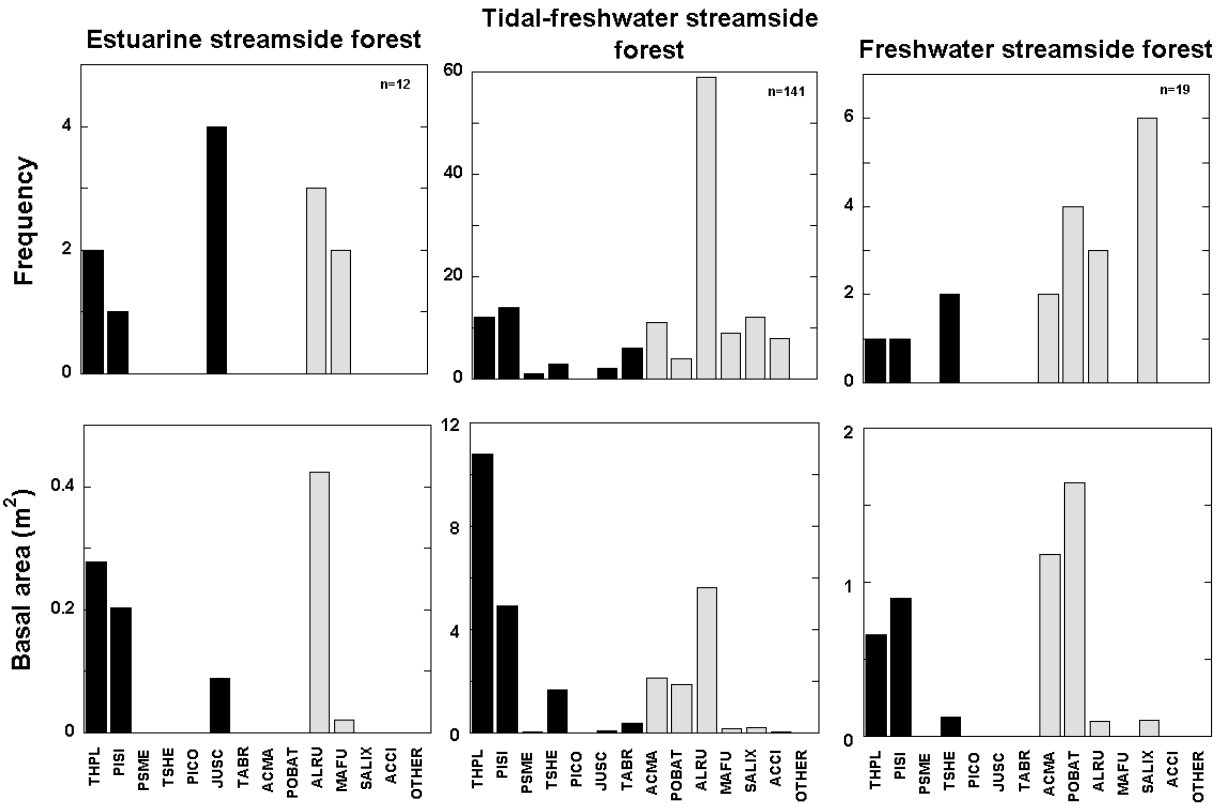

Figure B-13. Bearing trees from GLO field notes on the Snohomish River valley. Top tier, from left to right: frequency of trees in estuarine streamside forests, riverine-tidal streamside forests, and non-tidal freshwater forests. Bottom tier is cumulative basal area in the same areas. Conifers have dark-shaded bar. Species abbreviations are as in Figure 4-1.

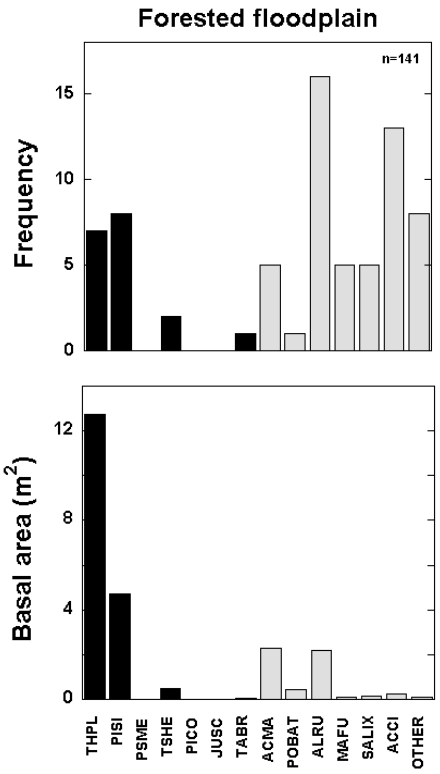

Figure B-14. Bearing trees from GLO field notes on the Snohomish River valley, for the forested floodplain. Conifers have dark-shaded bar. Species abbreviations are as in Figure 5-2. "Other" species include: dogwood *(*western flowering dogwood*, Cornus nuttallii)*, hazel (beaked hazelnut*, Corylus cornuta var. californica*); bearberry or barberry (uncertain, possibly Oregon grape, *Mahonia aquifolium*).

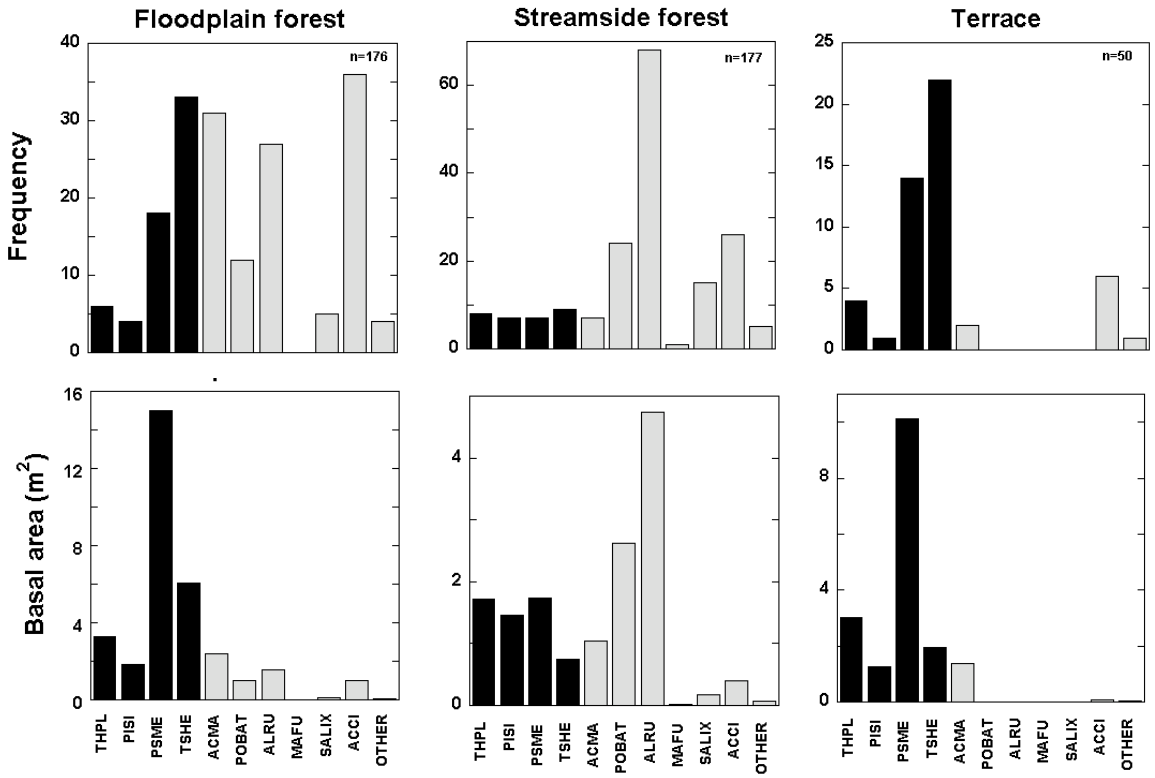

Figure B-15. Bearing trees from GLO field notes on the Skykomish River valley. Top tier, from left to right: frequency of trees in floodplain forests, streamside forests, and river terrace forests. Bottom tier is cumulative basal area in the same areas. Conifers have dark-shaded bar. Abbreviations are as in Figure 4-1. "Other" species include: dogwood *(*western flowering dogwood*, Cornus nuttallii)*, hazel (beaked hazelnut*, Corylus cornuta var. californica*); bearberry or barberry (uncertain, possibly Oregon grape, *Mahonia aquifolium*).

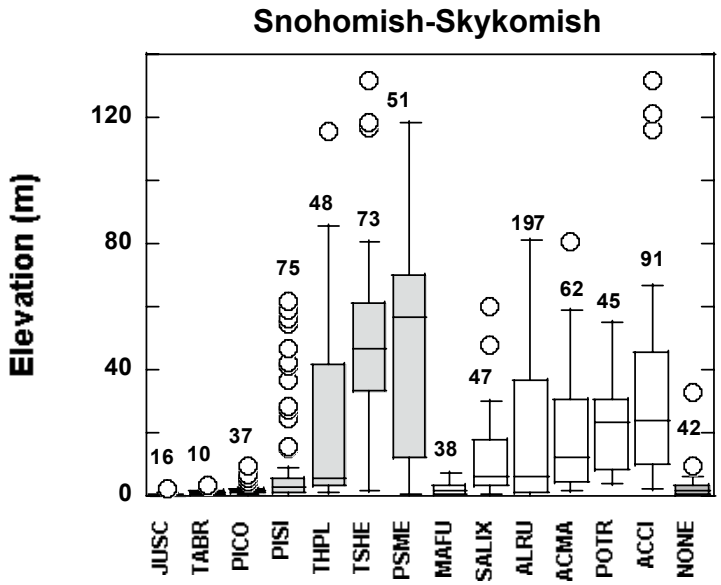

Figure B-16. Elevation range of GLO bearing trees in the Snohomish-Skykomish river valley. Numbers are sample size. Format is as in Figure 4-5.

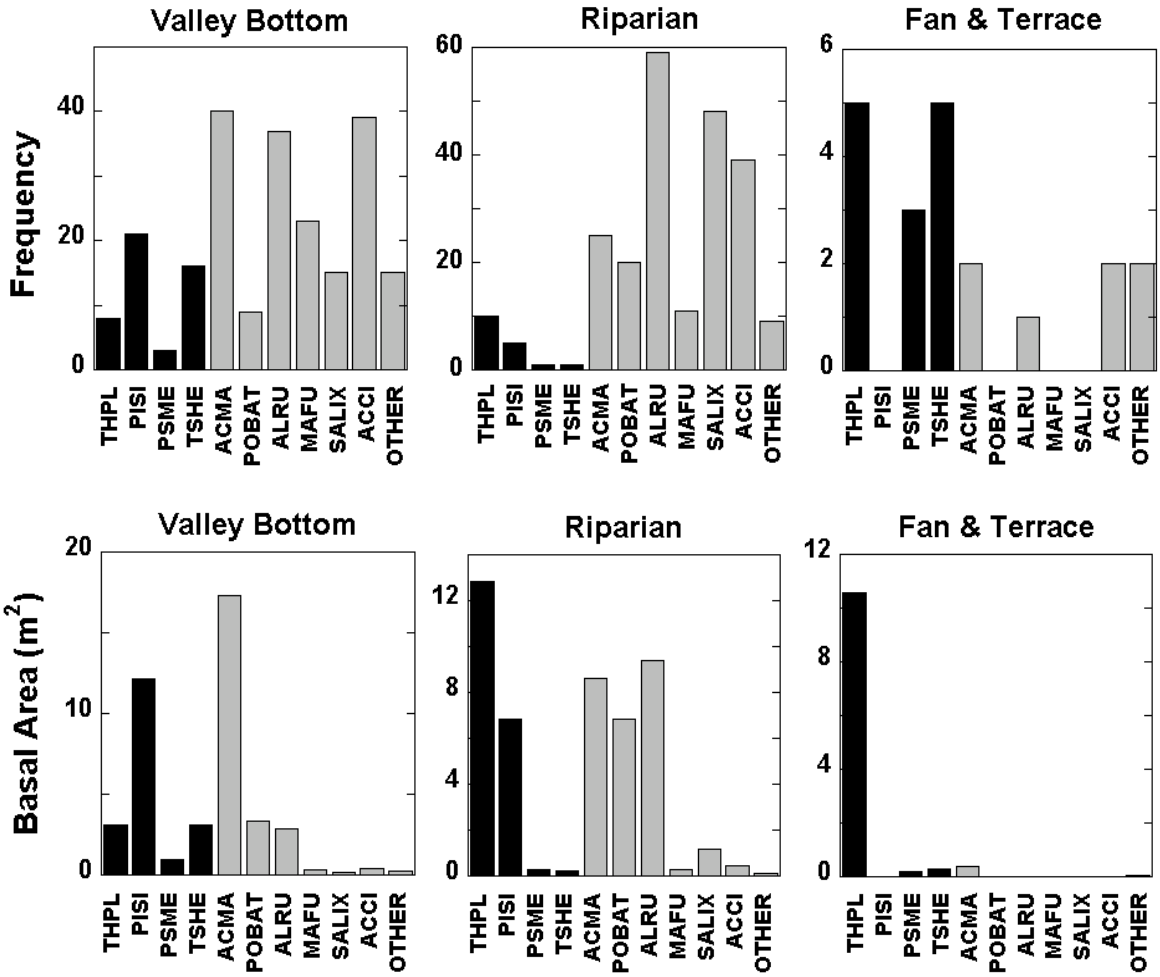

Figure B-17. Bearing trees from GLO field notes in the Snoqualmie River valley. Top tier, from left to right: frequency of trees in (valley bottom forest, stream-adjacent forest, and alluvial fans and river terraces. Bottom tier, left to right: cumulative basal area in valley bottom forest, stream-adjacent forest, and fans and terraces. Coniferous species have dark-shaded bar. Species abbreviations are as in Figure 4-1. "Other" species include: dogwood *(*western flowering dogwood*, Cornus nuttallii)*, hazel (beaked hazelnut*, Corylus cornuta var. californica*); bearberry or barberry (uncertain, possibly Oregon grape, *Mahonia aquifolium*); chittemwood (cascara*, Rhamnus purshiana*), cherry (bitter cherry, *Prunus emarginata);* elder (red elderberry*, Sambucus racemosa*).

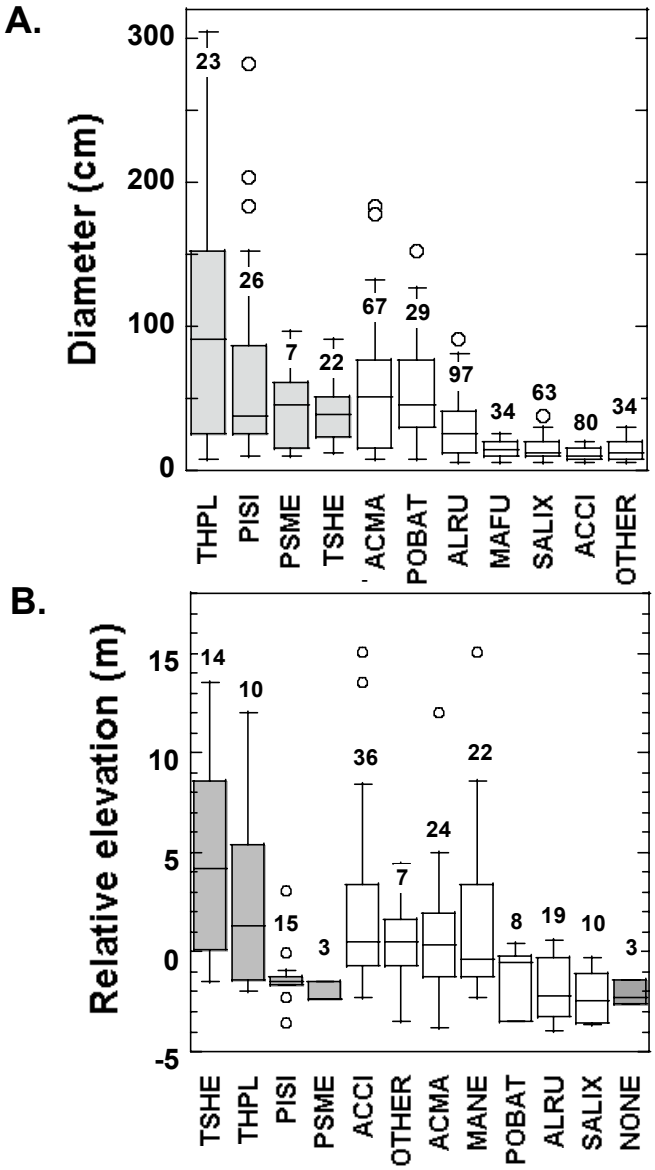

Figure B-18. A. Distribution of diameters of GLO bearing trees in the Snoqualmie River valley. B. Elevation of GLO bearing trees relative to the Snoqualmie River's bank. Conifers have shaded bars. In both plots, numbers are sample size for each species. Species abbreviations are as in Figure 4-1. Conifers have shaded boxes. Box and whisker plot parameters are as in Figure 4-5.