SOILS AND ASSOCIATED ECOSYSTEMS OF THE TONGASS

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USDA Forest Service, Alaska Region

DRAFT - June 1969

<u>Supplement</u> to:

Dynamics of understory biomass in Sitka spruce - western hemlock forests of southeast Alaska. by Paul B. Alaback, Department of Forest Science, School of Forestry, Oregon State University, Corvallis, OR 97331

Published in ECOLOGY 63(6), December 1982

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CHAPTER 100 - INTRODUCTION

An ecosystem is a community of organisms and its physical environment. A terrestrial ecosystem may be defined as an area of land including its climate, soils, and plant and animal life. It is a complex system with many complicated interactions and interdependencies.

As a land management agency, the Forest Service manages, manipulates, ecosystems. We should all be aware of their functioning. Similar management practices in differing ecosystems can have strikingly different results, ranging from complete success to disaster.

Although enough is known about most of the terrestrial ecosystems of southeast Alaska to broadly classify and describe them, a tremendous amount of additional study and research is needed before we will understand the details of their functioning. For instance, we are sure of many of the processes at work in these ecosystems but lack quantitative data to characterize them. Many management decisions are based, necessarily, on incomplete ecological knowledge. We need intensified effort and additional investigations to develop some of the missing data needed to manage southeast Alaska's resources on a sounder ecological basis.

Some statements in this report are, necessarily, based on incomplete data. However, the information is as accurate as present knowledge allows. As more knowledge becomes available, this report will be revised and expanded.

The purpose of the report is to provide information helpful to management; to aid in gathering facts needed for resource and multiple use decisions; and to help the Region's soils program be more efficient in these goals.

CHAPTER 200 - GEOGRAPHY

This report will be limited to the roughly 15 million acres of the Alaska Region in the Tongass National Forest. It consists of a complex of islands and a strip of mainland. In all, it is over 400 miles long by 100 to 150 miles wide, spanning over 5 degrees of latitude and nearly 10 degrees of longitude. Topography ranges from broad flats and rolling lowlands to rugged, precipitous mountains. Summits are generally 5,000 feet or less, except for the higher peaks and extensive icefields along the mainland.

210 - Geology

Rock types vary greatly. There are extensive areas of granitic, metamorphic, volcanic, and calcareous rocks. Bedrock type, except for some rocks of unusual mineralogy, has little influence on ecosystem occurrence, except as it influences soil drainage and the distribution of the alpine. Granitic rocks are generally more massive and resistant to glacial erosion than the other rock types, consequently they often form the more extensive mountain systems with extensive alpine ecosystems. They also tend to have relatively high proportions of very poorly drained (muskeg) soils. Marble and limestone areas, with their extensive fracturing and good subsurface drainage, often have very low proportions of poorly and very poorly drained soils, unless they are overlain by compact glacial till.

Pleistocene glaciation has had a major influence on the topography, soils and ecosystems of southeast Alaska. During the maximum Pleistocene advance, glacial ice covered most of the land. U-shaped valleys, rolling glaciated lowlands, drumlins, cirques, outwash terraces, etc., dominate the landforms of the area.

Major ice recession occurred about 10,000 years ago, the "Time Zero" for most soils and ecosystems of southeast Alaska. Compact glacial till, evidently formed from the great pressure of the ice on overridden (basal) till, is extensive up to about 1,500 feet elevation in many U-shaped valleys. Most mineral soils are derived primarily from ablation till, even those over bedrock. Till deposits become thinner at higher elevations, evidently due to the lesser volumes of ice to melt and deposit loads of till. Till deposits also tend to be thicker on south and west facing slopes than on north and east facing slopes.

Most valleys have a low terrace where the soils are young, derived from relatively recent alluvium and a high terrace where the soils are older, derived from alluvium deposited by glacial melt-water.

Post-glacial ash and pumice deposits are extensive on Southeastern Revilla Island and the Kruzof-Northern Baranof-Southern Chichagof Islands area. Ash from Kruzof Island has been dated at about 9,000 years ago. It was evidently deposited near the end of ice recession. In the Kadashan Watershed, a north facing drainage of Chichagof Island, most ash deposits occur on a high terrace, with only a few patches occurring in the higher uplands. This indicates that much of the ash fell on glacial ice. Ash from this same source mantles the sides other U-shaped valleys closer to the source on Kruzof Island.

The "Little Ice Age" affected most glaciers in southeast Alaska. Ice advance began prior to 2,000 years ago, reaching its maximum about 200 years ago (600 years ago at Yakutat). Most glaciers are still receding quite rapidl,, leaving young, rapidly-developing soils and ecosystems.

The "Little Ice Age" evidently caused considerable land depression. In-place tree stumps are found below high tide on beaches in Glacier Bay and the east side of the Chilkat Peninsula.

Land emergence is presently quite rapid in northern southeast Alaska, due to isostatic rebound after the "Little Ice Age." Rates of 1.5 cm of uplift per year are still extensive with a maximum of over 4 cm per year in Glacier Bay. Uplift after major Pleistocene ice recession was evidently even more extensive, as former beaches and marine clays up to several hundred feet above sea level are common throughout southeast Alaska. In the Sitka area, the ash mantle extends down to 50 feet elevation or less, indicating the major post-glacial uplift (if any in that area) occurred prior to its deposition, about 9,000 years ago.

220 - Climate

The climate of southeast Alaska is cool and wet. Summers are relatively cool and extreme winter cold is uncommon, except in the higher elevations. Precipitation is abundant and there is no pronounced dry season, although October is usually the wettest month. Strong winds and associated blowdown problems are frequent. Some climatic data for representative stations are in Tables 220.1 -d 220.2.

Average annual precipitation at sea level, except for drier areas at

Table [illegible]. Mean annual precipitation, temperature, and evaporation for available stations in southeast Alaska. Potential evapotranspiration is calculated from climatic data and, for these stations, should approximate actual evapotranspiration. Taken from Patric, J. H. and P. E. Black. 1969. Potential evapotranspiration and climate in Alaska by Thornthwaite's classification. USDA Forest Service Res. Paper PNW-71.

Station Name	Elevation (feet)	Latitude (North)	Longitude (West)	Mean Annual Temperature (°F.)	Mean Annual Precipitation (inches)	Potential Evapo-transpiration (inches)
Angoon	35	57°30'	134°35'	40.7	39.10	21.10
Annette	18	55°04'	131°39'	45.6	96.59	23.70
Annex Creek	24	58°19'	134°06'	39.8	109.11	20.91
Auke Bay	35	58°24'	134°40'	41.4	5[illegible].33	17.79
Baranof	20	57°08'	134°50'	41.5	151.68	20.98
Beaver Falls	35	55°23'	13[illegible]°28'	44.2	153.73	22.83
Bell Island	10	55°55'	13[illegible]°35'	43.6	108.67	22.24
Calder	20	56°10'	132°27'	43.1	112.26	22.20
Cape Decision	39	56°00'	134°08'	43.7	76.49	21.73
Cape Spencer	81	58°12'	136°39'	42.2	68.77	21.85
Chichagof	10	57°40'	136°05'	41.9	122.91	21.38
Craig	13	55°29'	133°09'	44.9	106.26	23.46
Eldred Rock	55	58°58'	135°13'	41.9	51.21	21.50
Five Finger Light	70	57°16'	133°37'	43.4	57.84	22.48
Fort Tongass	20	54°45'	130°35'	47.8	133.8	24.92
Guard Island	20	55°27'	131°53'	46.0	65.43	23.90
Gull Cove	18	58°12'	136°09'	41.6	102.84	21.02
Hollis	15	55°28'	132°40'	44.2	103.58	22.83
Hyder	9	55°55'	130°01'	40.9	89.58	21.30
Juneau	72	58°18'	134°24'	42.5	90.25	21.89
Juneau Airport	12	58°22'	134°35'	40.5	54.62	20.63
Kake	8	56°59'	133°55'	42.7	54.51	21.89
Ketchikan	15	55°21'	131°39'	46.1	151.19	23.74
Killisnoo	20	57°22'	134°29'	40.7	52.9	20.67
Kinsham Cove	13	57°41'	136°06'	44.[illegible]	117.0	22.14
Lincoln Rock	25	56°03'	132°46'	44.9	60.31	23.39
Little Port Walter	14	56°23'	134°39'	43.2	222.47	22.32
Mendenhall	85	58°24'	134°32'	40.0	93.73	20.71
Perseverence Camp	1100	58°18'	134°20'	37.7	160.1	18.85
Petersburg	50	56°49'	132°57'	42.3	105.01	21.69

Table , Cont.

Station Name	Elevation (feet)	Latitude (North)	Longitude (West)	Mean Annual Temperature (°F.)	Mean Annual Precipitation (inches)	Potential Evapo-transpiration (inches)
Point Retreat	20	58°25'	134°57'	42.2	78.68	21.38
Port Alexander	18	56°10'	134°45'	43.8	169.10	22.80
Salmon Creek Beach	20	58°19'	134°28'	40.9	106.8	20.09
Sitka	67	57°03'	135°20'	43.3	96.33	22.64
Sucaton Bay	16	55°19'	130°47'	42.1	104.59	21.26
Sulzer	25	55°12'	132°49'	46.0	111.1	24.01
Tenakee	19	57°47'	135°12'	42.8	68.41	21.01
Thane	20	58°15'	134°21'	41.5	81.5	19.54
Tree Point	36	54°48'	130°56'	45.8	96.67	23.94
View Cove	13	55°04'	133°04	46.3	161.87	24.09
Windham	6	57°32'	133°29'	41.2	100.10	19.85
Wrangell	37	56°28'	132°23'	43.7	82.90	22.60
Yakutat	28	59°31'	139°40'	39.3	134.15	19.80

NORMALS, MEANS, AND EXTREMES

LATITUDE 55° 02' N
LONGITUDE 131° 34' W
ELEVATION (ground) 110 Feet

ANNETTE, ALASKA
ANNETTE AIRPORT

Month	Temperature Normal Daily maximum	Daily minimum	Monthly	Extremes Record highest	Year	Record lowest	Year	Normal degree days	Precipitation Normal total	Maximum monthly	Year	Minimum monthly	Year
(a)	(b)	(b)	(b)	7		7		(b)	(b)	20		20	
J	38.4	30.3	34.4	61	1961	9	1969	949	11.36	20.49	1958	0.77	1950
F	39.7	32.5	35.1	63	1963	21	1961	831	8.54	16.26	1963	0.73	1962
M	42.8	32.7	37.8	59	1965	15	1962	843	9.55	23.57	1962+	3.00	1965
A	48.3	37.3	43.4	72	1963	22	1964	648	9.12	21.35	1947	1.23	1948
M	55.9	42.3	49.2	88	1963	32	1965+	493	7.07	14.48	1966	2.75	1948
J	60.8	47.8	54.3	80	1961+	37	1965	321	5.67	15.40	1956	1.15	1958
J	63.2	51.4	57.3	85	1961+	41	1965	242	6.02	10.85	1959	2.56	1955
A	64.8	52.2	58.4	93	1958	41	1963	208	7.51	23.72	1958	0.91	1956
S	59.7	48.5	54.1	75	1967	34	1964	327	9.88	16.56	1963	2.52	1965
O	51.1	42.5	46.7	71	1964	20	1961	567	16.88	36.67	1958	0.93	1952
N	44.5	36.3	40.4	64	1962	10	1963	738	14.65	28.59	1959	4.22	1967+
D	40.1	31.9	36.0	67	1962	1	1964	899	12.11	28.90	1959	4.35	1955
YR	50.9	40.3	45.6	90	AUG. 1960	1	DEC. 1964	7069	110.36	36.67	OCT. 1958	0.7[illegible]	[illegible]

Month	Precipitation Maximum in 24 hrs.	Year	Snow, Sleet Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity 4 AM	10 AM	4 PM	10 PM	Wind Mean hourly speed	Prevailing direction	Fastest mile Speed	Direction	Year
(a)	20		20	20		20		7	7	7	7	19	15	19	19	
J	4.63	1962	17.6	36.2	1952	10.4	1943	80	81	77	81	12.7	ESE	58	16	1948
F	5.58	1965	10.7	29.8	1948	14.2	1948	81	80	75	80	12.8	SE	58	16	1956+
M	4.82	1964	14.3	24.2	1963	11.7	1956	78	72	65	75	11.6	SE	47	16	1953
A	4.75	1956	1.3	8.8	1956	6.8	1956	81	72	64	77	11.3	SSE	60	16	1952
M	4.29	1958	3.3	5.0	1964	5.0	1964	84	72	66	79	9.3	SSE	44	16	1958
J	3.70	1962	0.0	0.3		0.0		87	75	68	83	9.2	SSE	44	16	1959
J	2.63	1967	0.0	0.0		0.0		87	77	67	81	8.1	SSE	35	16	1956+
A	4.68	1956	0.0	0.0		0.0		88	79	71	84	8.4	SSE	40	16	1955
S	5.04	1952	T	0.0		T	1950+	85	83	71	83	9.7	SE	51	11	1963
O	7.59	1953	0.3	4.2	1956	3.2	1956	84	83	78	84	12.9	SE	55	16	1950+
N	5.19	1957	3.5	9.3	1967+	6.1	1959	81	80	78	83	13.2	ESE	51	16	1958
D	5.20	1959	12.6	44.8	1964	17.8	1964	79	78	77	79	13.5	ESE	58	16	1959+
YR	7.59	OCT. 1958	51.4	44.8	DEC. 1964	[illegible]	FEB. 1948	83	77	71	80	11.3	SSE	60	16	APR. 1952

Month	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures Max. 70° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below	Average daily solar radiation - langleys
(a)		20	20	20	20	20	20	20	20	7	7	7	7	12
J		8.0	5	3	23	20	4	*	1	0	4	16	0	55
F		8.2	3	4	21	19	3	0	*	0	*	13	0	116
M		7.8	5	4	22	18	3	0	1	0	1	13	0	230
A		7.6	4	6	20	17	1	1	*	*	0	5	0	355
M		7.8	4	6	21	17	*	0	1	2	0	1	0	443
J		8.1	2	6	22	15	0	*	1	4	0	0	0	430
J		7.8	4	6	21	14	0	*	2	9	0	0	0	414
A		7.7	4	6	21	14	0	*	3	9	0	0	0	373
S		7.9	4	6	20	17	0	*	4	3	0	0	0	234
O		8.7	2	3	20	25	*	*	1	*	0	1	0	113
N		8.5	3	3	24	23	2	*	1	0	2	11	0	56
D		8.6	2	4	25	23	3	*	*	0	4	15	0	36
YR		8.0	42	57	266	222	16	2	17	26	12	70	0	237

Data for April - December [illegible] considered in extracting temperature extremes above.
Means and extremes in the above table are from the existing location. Annual extremes have been exceeded at other locations as follows:
Lowest temperature -4 in January 1947; minimum monthly precipitation 0.63 in August 1945.

ELEVATION (ground) 12 Feet

JUNEAU, ALASKA
JUNEAU AIRPORT

Month	Temperature Normal Daily maximum	Daily minimum	Monthly	Extremes Record highest	Year	Record lowest	Year	Normal degree days	Precipitation Normal total	Maximum monthly	Year	Minimum monthly	Year
(a)	(b)	(b)	(b)	24		24		(b)	(b)	24		24	
J	30.1	20.0	25.1	57	1958	-20	1966	1237	4.39	7.75	1965	0.96	1950
F	32.1	21.5	26.8	49	1953	-12	1949	1070	3.06	8.48	1956	0.96	1962
M	36.5	26.3	31.4	55	1965	-11	1956	1073	3.27	6.36	1968	1.20	1958
A	45.4	33.5	39.5	74	1958	6	1963	810	2.87	4.31	1947	0.27	1948
M	53.6	37.6	45.6	82	1947	25	1945+	601	3.24	6.13	1966	1.25	1946
J	60.0	43.7	52.3	86	1958	31	1965+	381	3.19	5.16	1949	1.08	1950+
J	63.7	47.8	55.8	86	1956	36	1950	301	4.49	7.76	1945	2.01	1947
A	61.5	46.8	54.1	83	1957	27	1960	338	5.32	12.31	1961	1.11	1956
S	55.2	42.9	49.0	72	1963	26	1961+	483	6.67	11.51	1948	2.36	1955
O	46.3	36.7	41.6	61	1956+	16	1965	725	8.33	13.27	1952	2.71	1953
N	39.2	29.4	34.3	56	1949	-5	1966	921	6.36	11.22	1956	1.06	1953
D	32.7	24.0	28.4	54	1944	-21	1964	1135	4.32	9.09	1950	2.30	1951
YR	46.6	33.7	40.1	86	JUN. 1958+	-21	DEC. 1964	9075	54.67	13.29	OCT. 1952	0.27	APR. 1948

Month	Precipitation Maximum in 24 hrs.	Year	Snow, Sleet Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity 4 AM	10 AM	4 PM	10 PM	Wind Mean hourly speed	Prevailing direction	Fastest mile Speed	Direction	Year
(a)	24		24	24		24		24	24	24	24	24	20	8	8	
J	2.76	1968	21.6	56.8	1966	19.8	1966	83	80	78	81	8.3	ESE	37	12	1967+
F	2.37	1949	21.9	88.3	1965	23.7	1949	83	82	76	83	8.6	ESE	43	12	1954
M	1.81	1948	18.7	52.8	1948	31.0	1948	83	77	68	80	8.9	ESE	43	11	1963
A	1.57	1952	3.6	46.3	1963	24.2	1963	86	73	63	81	8.7	ESE	43	11	1962
M	1.39	1958	0.1	1.2	1964	0.7	1945	89	73	62	79	8.3	ESE	40	12	1965+
J	1.92	1953	0.0	0.3		0.0		89	74	63	77	7.9	N	32	11	1965
J	1.80	1964	0.0	0.3		0.0		89	80	68	83	7.7	N	32	11	1961
A	2.37	1961	0.0	0.3		0.0		93	83	72	84	7.7	N	35	11	1960
S	3.17	1952	T	T	1956+	T	1956+	92	87	76	89	8.2	N	40	12	1967
O	4.66	1946	1.1	15.6	1956	8.0	1956	89	85	82	83	9.0	ESE	49	12	1953
N	3.36	1949	10.6	20.1	1958	16.5	1963	85	85	81	85	8.9	ESE	43	11	1961
D	3.56	1956	23.4	56.7	1964	25.6	1962	83	82	81	82	9.6	ESE	55	11	1963
YR	4.66	OCT. 1946	101.0	88.3	FEB. 1965	31.0	MAR. 1948	87	80	72	82	8.6	ESE	55	11	DEC. 1963

Month	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures Max. 70° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below
(a)	22	24	24	24	24	24	24	24	24	24	24	24	24
J	33	7.8	5	3	23	18	6	*	2	0	16	28	4
F	33	8.2	4	2	22	18	6	0	2	0	9	23	2
M	38	7.9	5	3	23	17	5	0	2	0	5	25	*
A	43	8.0	4	4	22	16	1	0	1	*	1	17	0
M	37	7.8	4	4	23	17	0	0	1	1	0	5	0
J	33	8.0	4	4	22	15	0	*	*	4	0	*	0
J	30	8.2	3	5	23	17	0	*	*	*	0	0	0
A	30	8.1	4	4	23	17	0	0	1	5	0	*	0
S	25	8.5	3	3	26	20	0	*	3	*	0	1	0
O	19	8.8	2	2	27	24	*	0	3	0	0	8	0
N	26	8.6	4	2	26	19	3	0	3	0	7	19	*
D	18	8.6	4	1	26	22	6	0	2	0	17	26	2
YR	31	8.2	46	37	282	211	26	*	21	[illegible]	50	149	9

Data for July - December 1943 considered in extracting extremes above.
Means and extremes in the above table are from the existing location. Annual extremes have been exceeded at other locations as follows:
Highest temperature 89 in July 1915; maximum monthly precipitation 25.87 in November 1936; minimum monthly precipitation 0.33 in July 1915, maximum precipitation in 24 hours 5.31 in September 1918.

the heads of major inland fiords, averages about 100 inches. Precipitation at higher elevations is usually greater, ranging to well over 300 inches, judging from stream runoff records. Precipitation amounts can vary markedly within short distances in irregular topography (fig. 220.1).

The frostfree season ranges from about 100 to over 200 days, and summer day lengths are long. Maximum summer day lengths range from 17.5 hours at Ketchikan to 18.5 hours at Juneau. Cloudiness is the rule. For instance, percent of possible sunshine, June through September, is 27.5 percent at the Juneau Airport.

Average growing season temperatures are relatively cool, ranging from about 51° to 55°. Temperatures rarely exceed 80° and average maximum temperatures in July range from 60° to 64°F. Soil temperatures are cool (fig. 220.2), but deep winter freezing rarely occurs.

Although the climate throughout southeast Alaska is broadly similar, some latitudinal gradients are apparent. Growing seasons are generally shorter (fig. 220.3), although growing season day lengths are longer, in northern southeast Alaska. Temperatures tend to be cooler in northern southeast, with the greatest difference occurring during the winter (fig. 220.4). Figure 220.4 indicates precipitation amounts are lowest during the summer in southern southeast, while northern southeast does not show this trend.

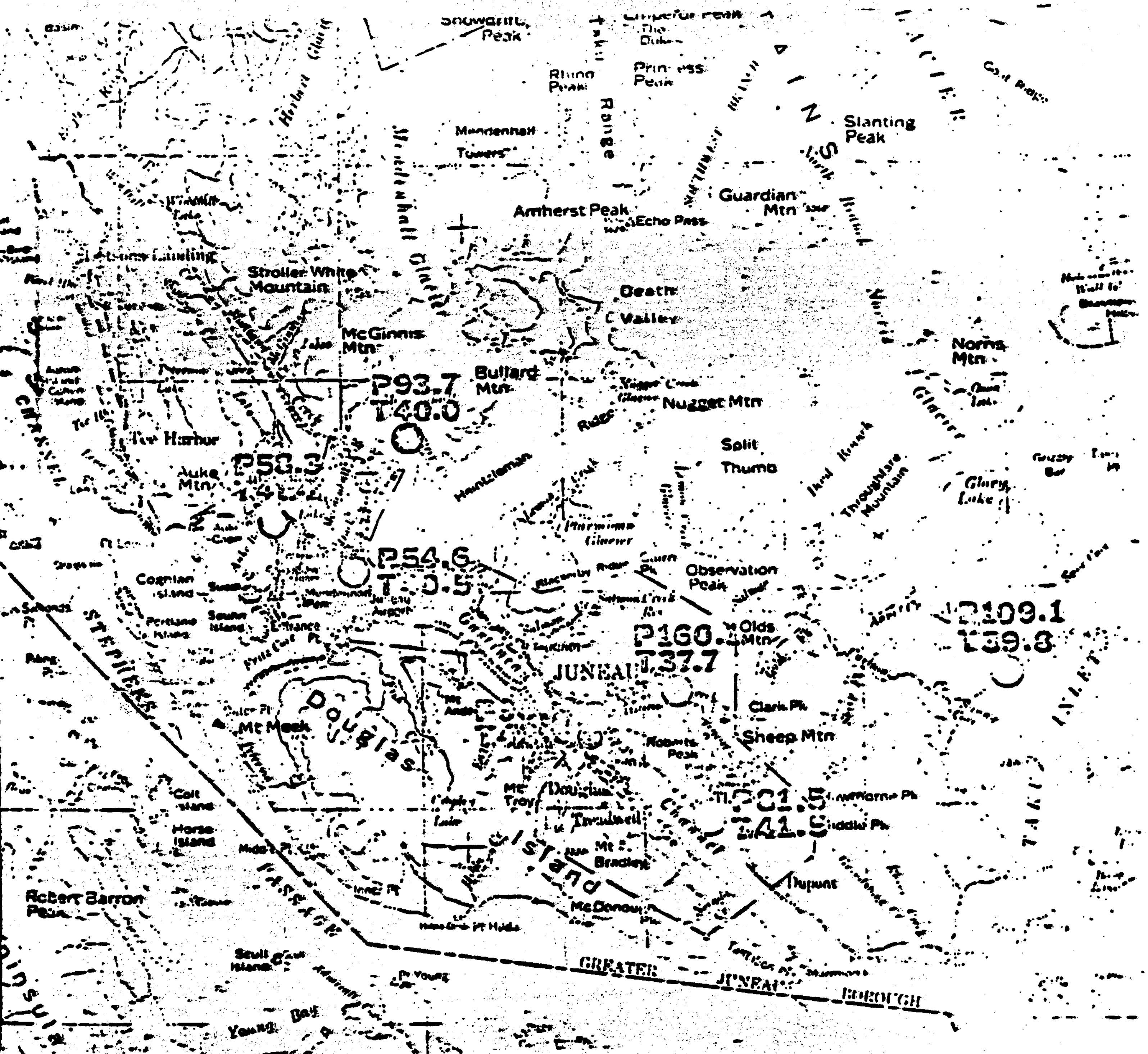
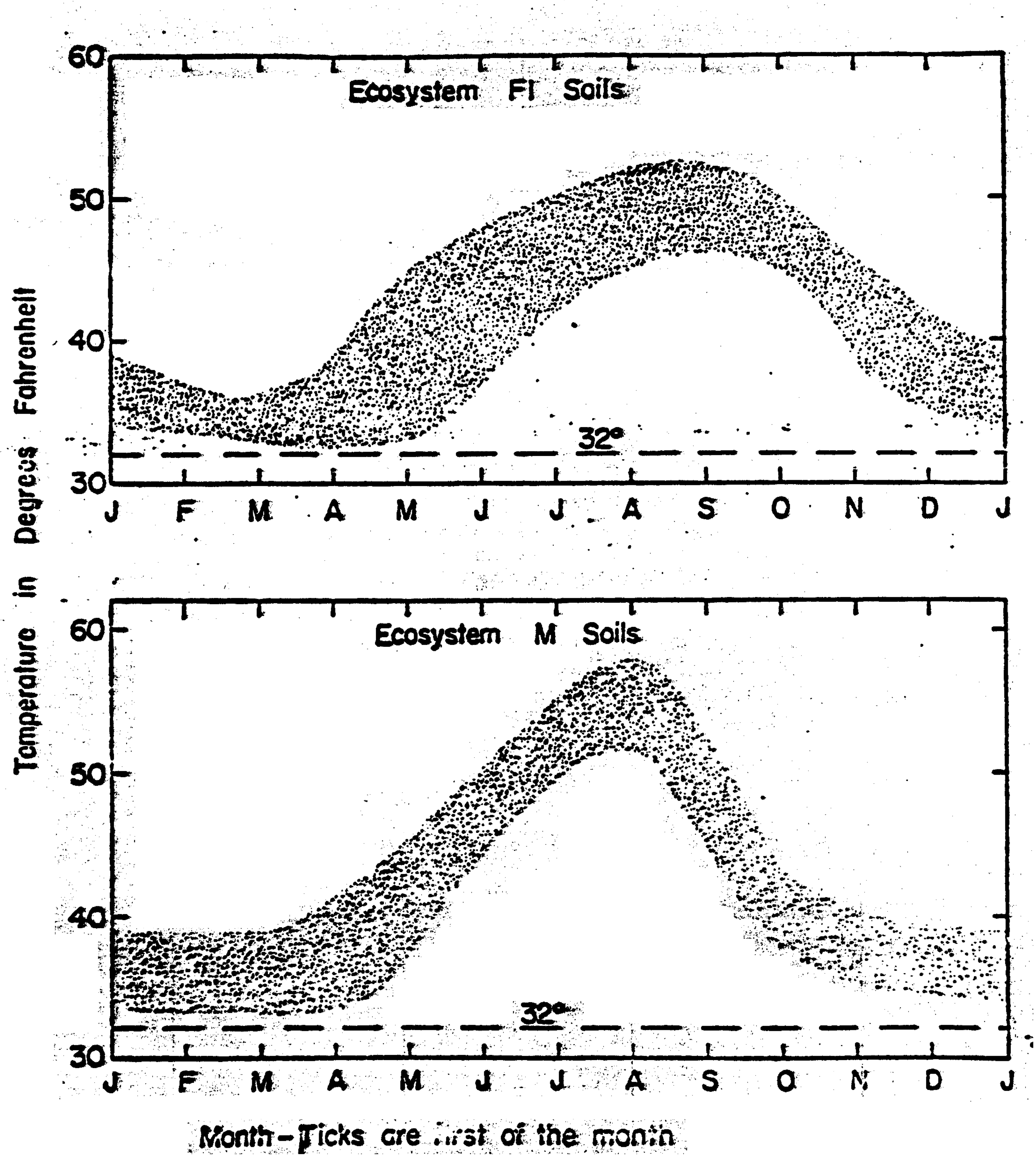


Figure 220.1. Average annual precipitation and temperature for stations in the Juneau area. Weather [illegible] is strongly influenced by orographic and air drainage effects and the proximity of ice-fields and continental air masses in Canada.

Figure 2202.2 Soil temperature at 20 inches depth in southeast Alaska. The shaded areas include measured temperatures, Ketchikan to Juneau, 1964 through 1966.



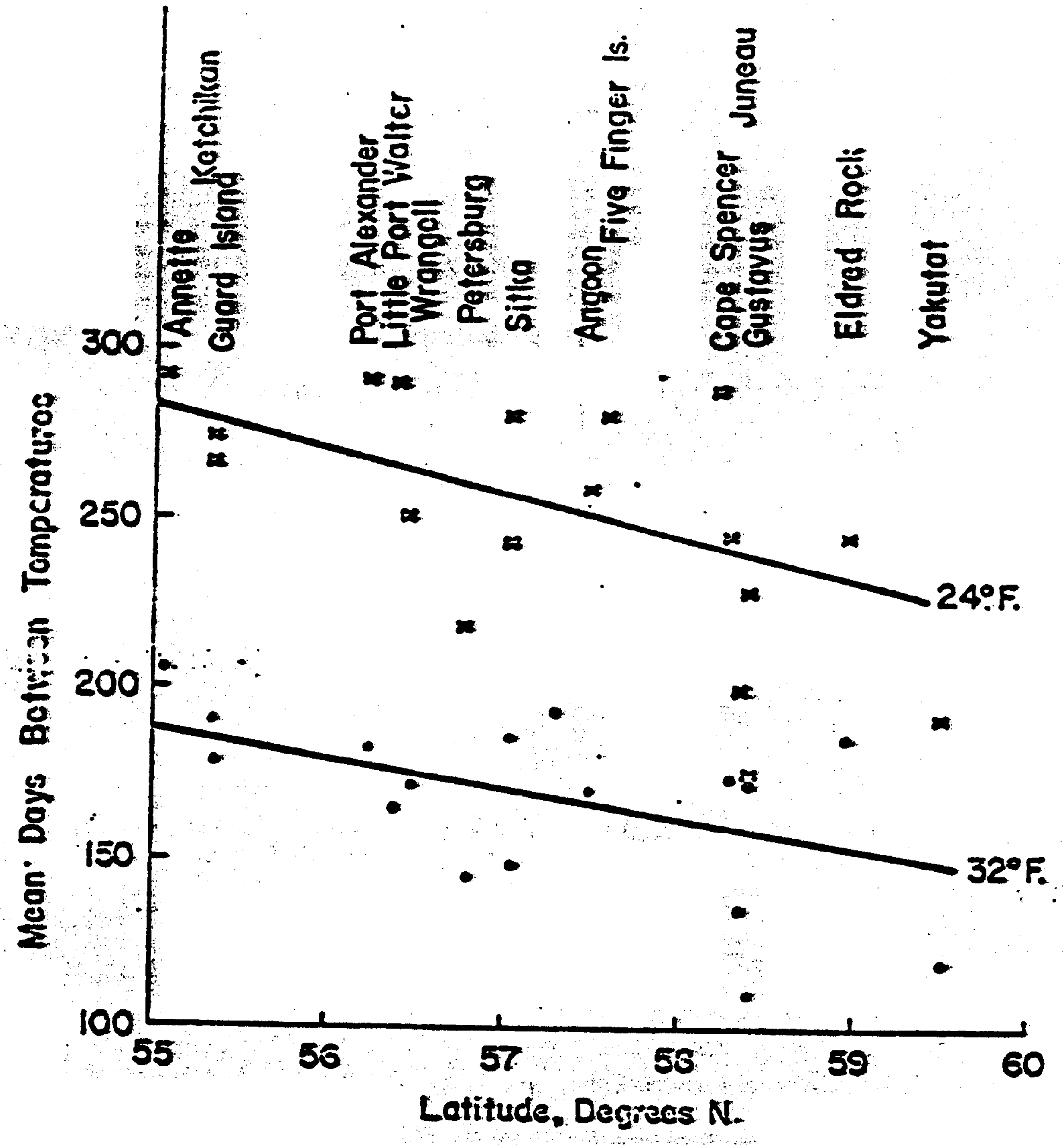


Figure 2203. Growing season at sea level stations. Lines fitted by eye.

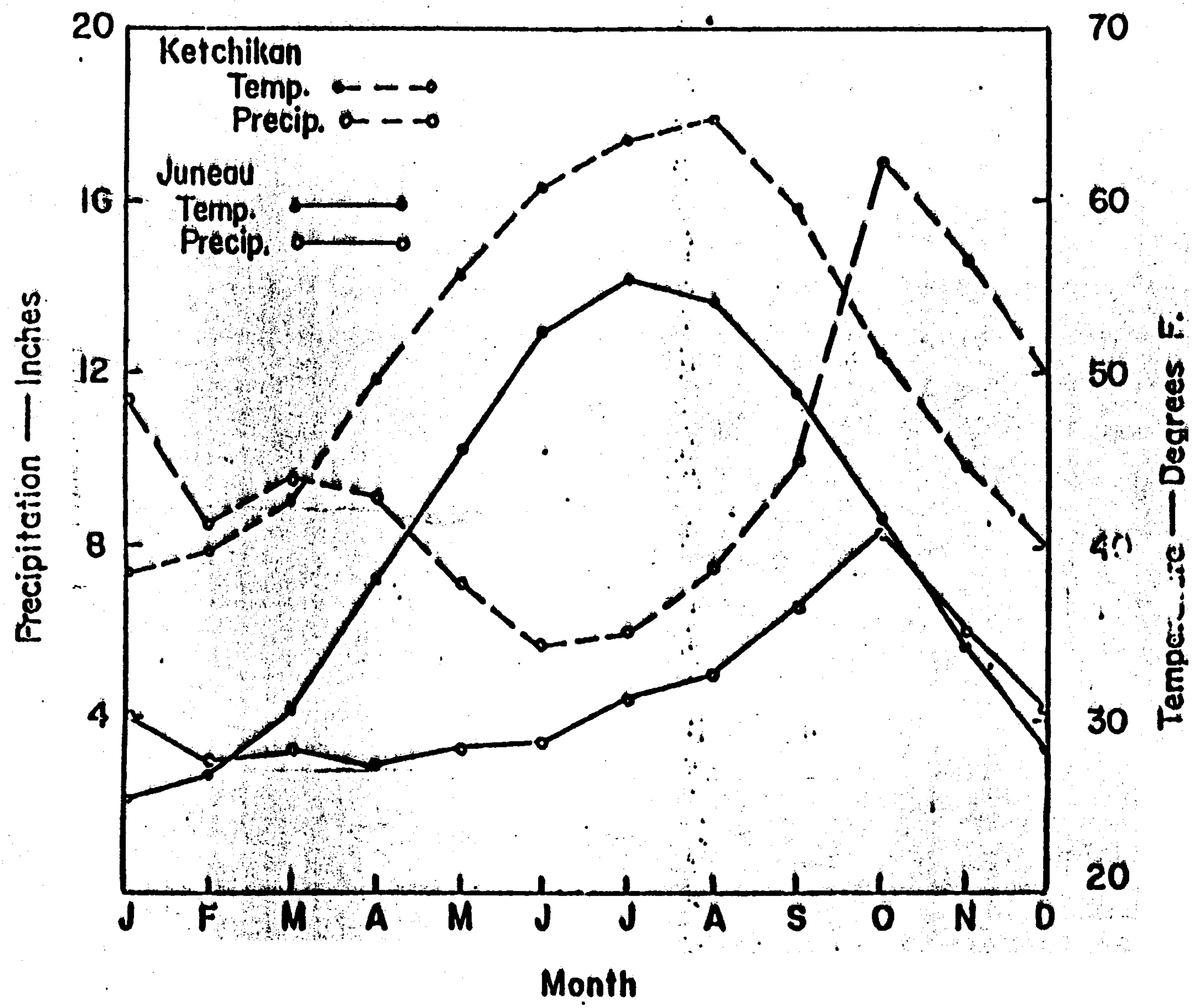


Figure 220.4. Temperature and precipitation, Juneau and Ketchikan.

CHAPTER 300 - ECOSYSTEM STUDY AND CLASSIFICATION METHODS

Since the Alaska Region initiated the soils program in southeast Alaska in 1961, over a million acres of land has been covered by detailed soil surveys (fig. 300). In addition, we have made numerous detailed soils investigations throughout southeast Alaska. Most of this information was developed from the soils program which has involved more than 20 man-years of intensive soils investigations.

Soils are described, classified, and characterized according to National standards. Ocular estimates of vegetation in percent ground cover of plant species at the site is recorded. Additional measurements, such as line intercept transects and tree growth measurements, are sometimes made for specific purposes. Soil samples are always taken by horizons. Laboratory methods are in Soil Survey Investigations Report #1 (USDA 1967). Observations of soil and ecosystem reaction to management, as will as results of research and studies are used extensively in this Handbook.

All soil series names used are tentative and subject to change during official Soil Conservation Service correlation.

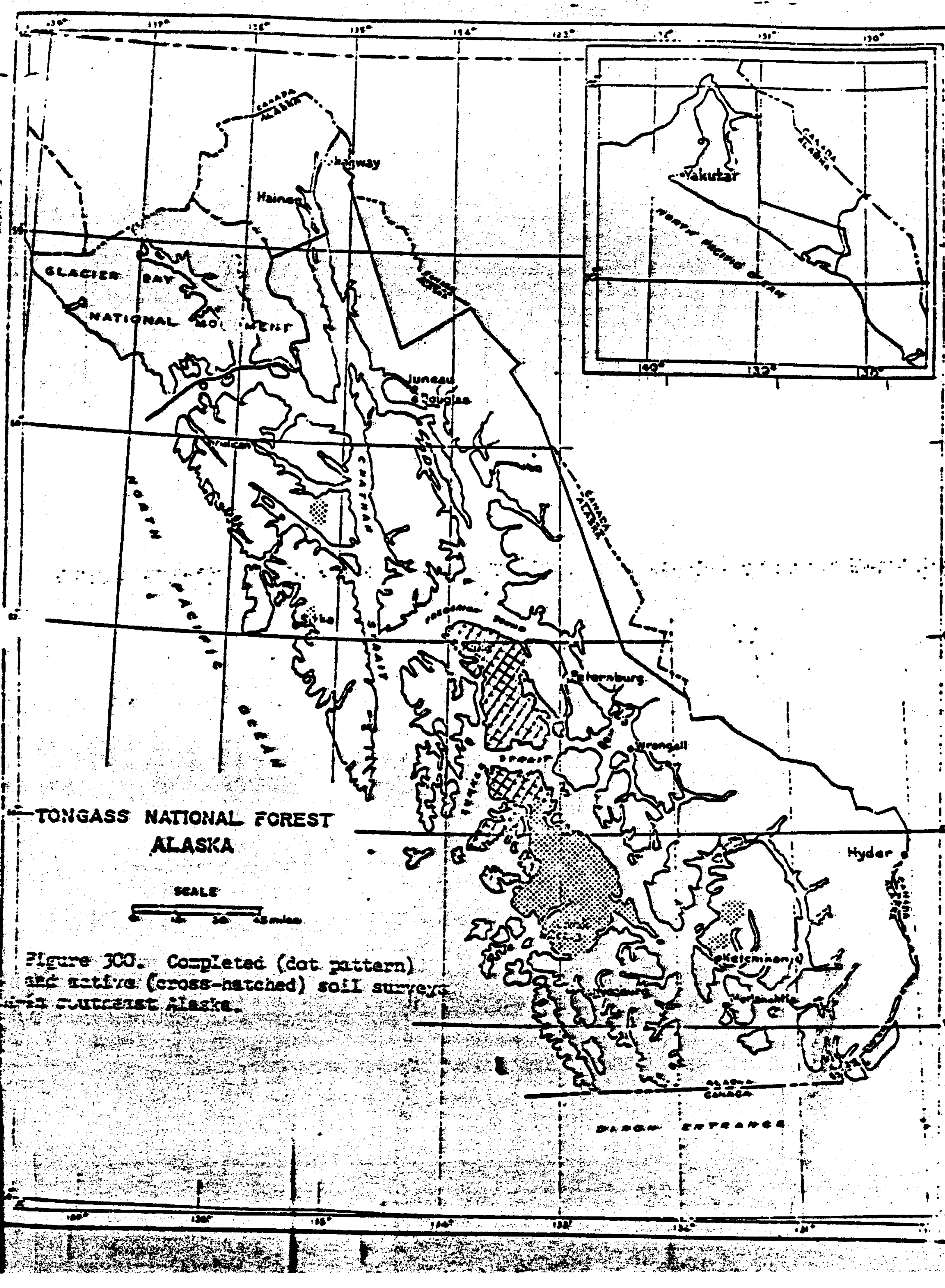


Figure 300. Completed (dot pattern) and active (cross-hatched) soil surveys in Southeast Alaska.

The first step in studying ecosystems is to stratify the landscape; to classify the ecosystems. Here, the terrestrial ecosystems of southeast Alaska have been classified on the basis of natural soil-vegetation complexes. Although gross vegetative types are used in the classification, primary emphasis is on soils, as they are more stable than vegetation and less likely to be altered by fire or management.

The ecosystems of the Tongass have been classified according to "families", "types", and "subtypes". Ecosystem families group ecosystems with broad vegetation-soil-environment similarities, such as "Forest", "Muskeg", "Alpine", etc. Families are subdivided into "ecosystem types". Within each type, species composition, productivity, secondary succession after fire or logging, and ecosystem functioning are similiar. Ecosystem types are subdivided into "subtypes", based on characteristics related to practical management features such as erosion and landslide hazards, depth to bedrock, compactibility, etc.

This ecosystem classification should not be confused with the soil classification system. The Soil Conservation Service has final USDA responsibility for classifying soils in the United States. Officially-recognized names are not available for all the soils of the Tongass. Therefore, soil names are not given for some ecosystems. Because the criteria used to classify soils are not always ecologically significant in southeast Alaska, some kinds of soils occure in more than one ecosystem type, and some ecosystem subtypes contain several closely-related, named soils.

This is not proposed as the ultimate classification; refinements and additional classes will likely be needed. However, almost all the natural ecosystems of southeast Alaska outside of the heads of major fiords with continental climates can be classified in this system.

Logical subdivisions of mature forested ecosystems, for instance, could be based on the stage of secondary succession: climax forest, old even aged, young growth, recently logged or burned, etc.

This classification is designed to stratify the landscapes of southeast Alaska into practical ecosystem types and subtypes to serve as a basis for management and for the extrapolation of management experience and research results.

CHAPTER 400 - ECOSYSTEM DESCRIPTIONS

401 - List of common ecosystems

The ecosystems of southeast Alaska that have thus far been mapped are as follows:

I. Mature ecosystems (those with slow rates of soil change)

D. Tide-influenced Meadow Ecosystems Family

Type D1. Sedge ecosystem

Type D2. Hairgrass ecosystem

Type D3. Beach ryegrass ecosystem

F. Forest Ecosystems Family

Type F1. Deep, freely-drained soils, ± 150 side index

Subtypes:

F1a. Derived from volcanic ash.

F1b. Derived from uplifted beaches.

F1c. Less than 4 feet of soil over compact till.

F1d. More than 5 feet deep.

F1f. Over fine-textured deposits.

F1n. 10 inches to 5 feet deep.

F1t. On terraces.

Type F2. Freely-drained soils, less than 10 inches over bedrock.

Subtypes:

F2n. 2-10 inches of mineral soil over bedrock, ± 120 site index.

F2r. 2 inches or less of mineral soil over bedrock, ± 90 site index.

Type F3. Deep, freely-drained soils, ± 130 site index.

Subtypes:

F3a. Derived from originally coarse-textured ash and pumice.

F3b. Derived from uplifted beaches.

F3g. Derived from very gravelly materials.

F3n. Derived from deep moraines.

F3o. Derived from sandy outwash over gravels.

Type F4. Somewhat poorly drained soils, ± 120 site index.

Subtypes:

F4a. Derived from volcanic ash.

F4b. Derived from uplifted beaches.

F4c. Less than 3 feet of soil over compact till.

F4d. More than 5 feet deep.

F4f. Over fine-textured deposits.

F4r. 3 feet or less of mineral soil over rock.

Type F5. Poorly-drained soils, ± 75 site index.

Subtypes:

F5b. Derived from uplifted beaches. site index ± 90.

F5c. Over compact till.

F5d. More than 10 feet of organic soil.

F5f. Over fine-textured deposits.

F5r. 4 feet or less of organic soil over rock.

Type F6. Somewhat poorly-drained soils of the high elevation, poor timber zone.

Type F7. Poorly-drained soils of the high elevation, poor timber zone.

Type Fx. Freely-drained soils, site index 40-100.

M. Muskeg Ecosystems Family

Type M1. Sphagnum muskeg.

Subtypes:

M1d. Very deep sphagnum muskeg.

M1n. Normal depth sphagnum muskegs.

Type M2. Sedge-slope muskeg.

Type M3. Sedge-flat muskeg.

A. Alpine Ecosystems

Type A1. Alpine heath.

Subtype A1a. With ash soils.

Type A2. Alpine sedge.

Subtype A2a. With ash substrata.

B. Brushy (snowslide) slopes Family.

X. Ecosystems with unusual properties.

Type X1. Somewhat poorly-drained soils of the low to intermediate elevations with pseudo-alpine vegetation.

Type X2. Freely-drained soils with pseudo-muskeg vegetation.

2. Young Ecosystems (those with relatively fast rates of soil change):

f1t. Young forest ecosystems on alluvium (not outwash) ± 150 site index.

f1l. Young forest ecosystems on landslide tracks that go through an alder stage.

f2l. Young forest ecosystems on landslide tracks that do not go through an alder stage.

410 - Mature Ecosystem Descriptions

Mature ecosystems are those that are undergoing, at most, only a slow rate of change of soil or overall vegetative pattern.

The kind of soil largely determines secondary succession. In the case of the forest ecosystems, some information on secondary succession is given.

411 - Key to the Mature Ecosystems of Southeast Alaska

I. Forest Ecosystems (those with or capable of producing at least a 50 percent canopy cover of conifers).

A. Soils of uplifted beaches.

1. Good drainage

a. Enough mineral fines to fill voids between gravels...F1b

b. Not enough mineral fines to fill voids between gravels...F3b

2. Somewhat poor drainage...F4b

3. Poor drainage...F5b

B. Soils not on uplifted beaches, but below the high elevation, poor timber zone.

1. Good drainage.

   a. Soils from volcanic ash

      (1) Originally sandy or coarser textured..........F3a

      (2) Originally medium textured....................F1a

   b. Soils derived from outwash gravels..................F3g

   c. Soils derived from sandy outwash...................F3o

   d. Other soils that were originally deep and coarse textured.....................................F3n

   e. Other soils with more than 10 inches of mineral soil

      (1) Less than 4 feet of mineral soil over compact till......................................F1c

      (2) Soils more than 5 feet deep...................F1d

      (3) Soils over fine textured deposits.............F1f

      (4) Soils on terrace deposits.....................F1t

      (5) Soils 10 inches to 5 feet deep over rock......F1n, Fx

   f. Soils with 2 to 10 inches of mineral soil over bedrock...F2, Fx

   g. Soils with zero to two inches of mineral soil......F2r

2. Somewhat poor drainage.

   a. Soils from volcanic ash............................F4a

   b. Soils over compact till............................F4c

   c. Soils more than 5 feet deep........................F4d

   d. Soils over fine textured deposits..................F4f

   e. Soils over rock....................................F4r

3. Poor drainage..F5

C. Soils of the high elevation, poor timber zone

   a. Somewhat poorly-drained mineral soils..............F6

b. Poorly-drained organic soils....................F7

II. Nonforest Ecosystem (those not capable of producing a 50 percent canopy cover of conifers).

A. Tide-influenced meadow ecosystems.

1. Lowest, sedge-dominated ecosystem....................D1

2. Intermediate zone; dominated by bunchgrasses and silverweed....................D2

3. Highest zone; dominated by beach ryegrass....................D3

B. Muskeg Ecosystems

1. Sphagnum peat soils, dominated by sphagnum and low-growing shrubs....................M1

2. Sphagnum peat soils more than 10 feet deep....................M1d

3. Fairly firm, often sloping, sedge peat soils dominated by relatively low sedges and/or scirpus, with various herbs and shrubs....................M2

4. Soft, flat-lying sedge peat soils, dominated by relatively tall sedges....................M3

C. Brushy (snowslide) slope ecosystems....................B

D. Alpine Ecosystems

1. Alpine heath....................A1

2. Alpine heath on volcanic ash soils....................A1a

3. Alpine sedge....................A2

4. Alpine sedge soils on volcanic ash....................A2a

E. Other mature ecosystems

1. Somewhat poorly-drained soils of low to intermediate elevations with pseudo-alpine vegetation....................X1

2. Freely-drained mineral soils with muskeg vegetation....X2

412 - D. Tide-influenced Meadow Ecosystems Family

Tide-influenced meadows occupy alluvial deposits between about mid-tide to extreme high tide levels at stream mouths. They are important as wildlife habitat and for their esthetic qualities.

Three significant ecosystem types are evident in these meadows, depending on elevation (frequency and duration of tidal inundation). Stephens and Billings, 1967, present more detailed data on these ecosystems.

412.1 - D1. Sedge Ecosystem

This is the lowest ecosystem of the tide-influenced meadows. They occur along occupied and abandoned stream channels and extend down to the mudflats which are essentially unvegetated. Soils are high in organic matter, usually having several inches of peat over the mineral soil, which in turn has a relatively high organic matter content. pH is about 5.8 and exchangeable bases are relatively high, especially magnesium and sodium. Vegetation is dominated by Lingbye sedge. Hairgrass and silverweed occur in small amounts along the upper portions of this community.

412.2 - D2. Hairgrass Ecosystem

This is the middle zone of the tide-influenced meadows. Soils have moderate amounts of organic matter. They have a thin litter layer underlain by dark brown mineral soil materials. pH is about 6.7 and exchangeable bases are relatively high, especially magnesium and sodium.

Vegetation is dominated by clumps of hairgrass and other grasses, with silverweed second in importance. Other plants that are frequently present include sedge, yarrow, shootingstar, beach pea, and beach ryegrass.

412.3 - D3. Beach ryegrass ecosystem

This is the highest zone of the tide-influenced meadows, occurring just below a brushy ecotone to the timbered soils above. The soils typically have a thin litter layer and thin A1 horizon. pH is about 7.3 and exchangeable bases are relatively high.

Vegetation is dominated by the high, lush beach ryegrass. Other grasses and yarrow are common, as are shootingstar, black lily, buttercup, sedge, and other plants.

413 - Forest Ecosystems Family

The mature forest ecosystems of southeast Alaska show remarkable affinities both in soils and vegetation. Stratification of forest ecosystems is primarily by soil drainage and depth, which are in turn closely related to site index (height at 100 years). For instance, most soils with free drainage that are more than 10 inches deep have remarkably uniform chemical properties in spite of varying parent materials and widely-spaced geographic locations. These same soils support very similar kinds of vegetation with similar productivities. Therefore, it seems logical to group them into one ecosystem type.

There is also a surprising uniformity of species growing on all mature forested soils, regardless of differences in soil drainage and productivity. Western hemlock, Sitka spruce, western redcedar, Alaska cedar, and mountain hemlock make up the vast bulk of the forest. Alpine fir and silver fir are rare and mostly confined to areas with much drier than normal climates, such as the heads of Lynn and Portland canals. Lodgepole pine is generally confined to muskegs and young post-fire stands. Where a seed source is available, red alder is an invader on exposed mineral soils, except on the slightly drouthy F3g and F3o soils.

Exposed mineral soil is a poor seedbed for several years, due to frost heave, until a cover of mosses becomes established. Some well-drained gravel soils may not have this problem.

There is a general trend of species composition with site quality. The lower the site index, the higher the proportion of hemlock and cedar, and the lower the proportion of Sitka spruce. After logging or fire, there is generally an increase in the Sitka spruce percentage, but young stands on low-site soils generally have lower proportions of Sitka spruce than young stands on high-site soils.

Young stands that develop after blowdown have less spruce and lower productivities than stands that come in after logging and/or burning on the same soil.

Western redcedar does not occur in the northern part of southeast Alaska, but often is a dominant species on low-site soils in the southern part. Alaska cedar becomes sporadic in its occurrence in the north part, although it is a major species on poorly-drained soils in southern part. In the north part, some areas have abundant Alaska cedars, while nearby areas have none—even though the soil pattern is identical. It may be the Alaska cedar has not yet occupied all the habitat suited to it and is still extending its range.

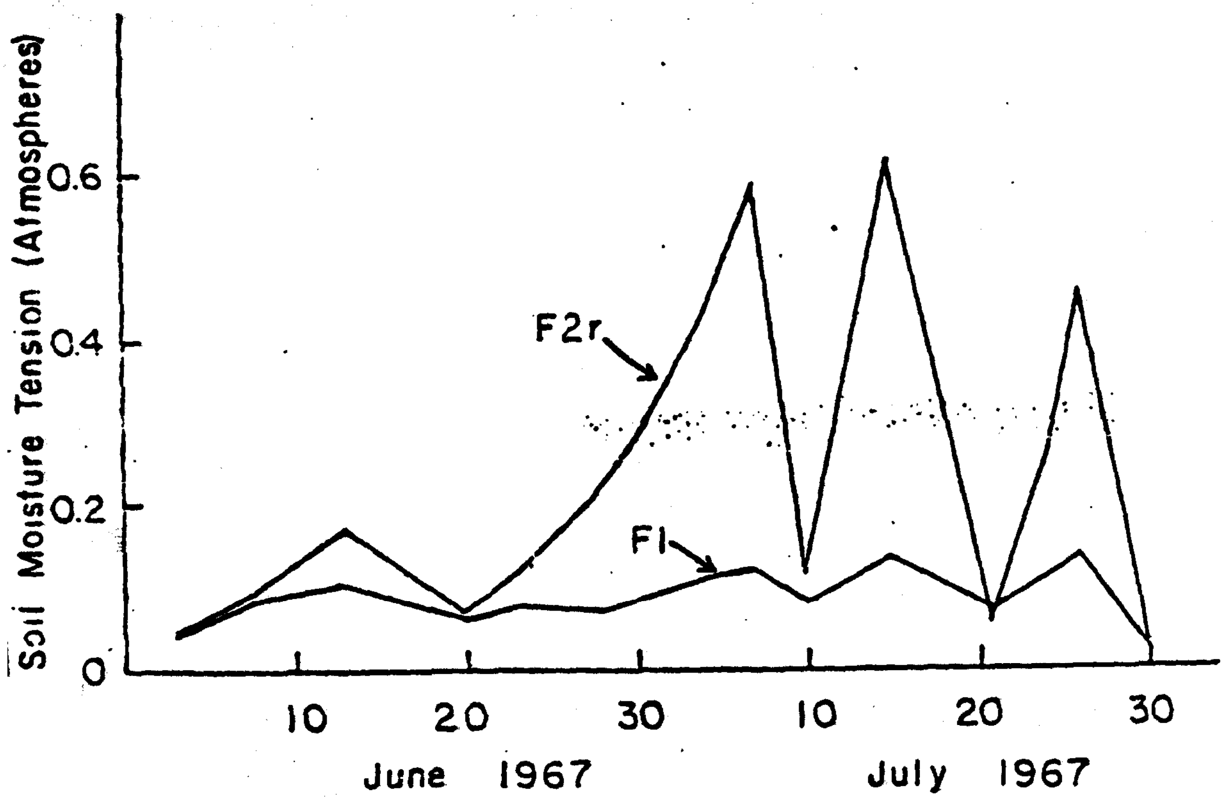
Understory vegetation is quite uniform in species composition, although density and vigor varies with the ecosystem type and canopy cover. After logging or fire, shrub and forb cover is great until the young forest begins to close canopy. In dense, even-aged stands about 25 to 75 years old, ground cover is largely restricted to mosses and fungi. As the stand matures and more light reaches the forest floor, the understory again increases.

Dominant shrubs are blueberries, rusty menziesia, devil's club, and red huckleberry. Low vegetation includes bunchberry, five-leaved bramble, single delight, gold thread, and a nearly complete carpet of mosses, dominantly Hylocomium and Rhytidiadelphus. On soils of restricted drainage, skunk cabbage, marsh marigold, and patches of shade-tolerant sphagnum also occur.

Soil moisture is ample for tree growth (fig. 413.01). Soil moisture tensions high enough to significantly reduce growth rates have not been recorded in southeast Alaska, although new hemlock growth was observed to die back on F3g and F3o soils in the abnormally dry summer of 1968.

Soil temperatures in the growing season are relatively low (fig. 220.2). This may tend to restrict decomposition and root activity.

Mature forested mineral soils have many similarities in physical properties, regardless of parent material, gravel and stone content, and drainage. They are very porous and friable in the solum (except for a



gure 413.01. Soil moisture tension in two ecosystems near Juneau. Readings at a depth of 4 inches into the mineral soil in the F1 soil and 4 inches [illegible] the duff in the F2r soil. Adapted from Patric and Stephens, 1968.

few soils with iron-cemented pans). Their active colloids are humus and oxides of iron and aluminum, not alumino-silicate clays. They are thixotropic. That is, they tend to have fair to good stability when undisturbed, but become fluid on disturbance. They hold large quantities of water at field capacity and wilting point (fig. 413.02). The soil materials are water erosion-resistant, but except for a few gravel soils, are readily disturbed by compactive forces.

<u>413.10</u> - <u>F1. Freely-drained soils at least 10 inches deep ± 150 site index.</u>

This extensive ecosystem type is on well- and moderately well-drained soils with at least 10 inches of mineral soil over bedrock. They occur from sea level to about 1,500 feet elevation. The soils vary widely in parent material and from sandy loam to silt loam in texture, with 0 to 75 percent coarse fragments by volume. They have three inches to a foot or more of surface organic matter (duff), a trace to 4 inches of gray A2, 1 to 3 inches of black or very dark reddish brown B21, and 6 inches to several feet of splotchy reddish brown to brown B3 horizons. Soils typical of this type include the Karta, Tolstoi, Ulloa, Sarkar, Kupreanof, Kadashan, Salt Chuck, Naukati, and Tokeen.

These soils rarely dry to field capacity or saturate to the point of surface runoff. Moisture is almost always moving through their sola.

Laboratory data for soils of ecosystem subtypes F1n, F1a, and F1c are in Table 413.1. Note the large quantities of plant nutrients held in the surface organic horizons. Their sola are extremely acid, except the lowest horizons of soils that overlie calcareous bedrock. Total

Figure 413.02. Soil moisture - tension relations for some forested soils in southeast Alaska. Note the large quantities of water held at relatively high tensions.

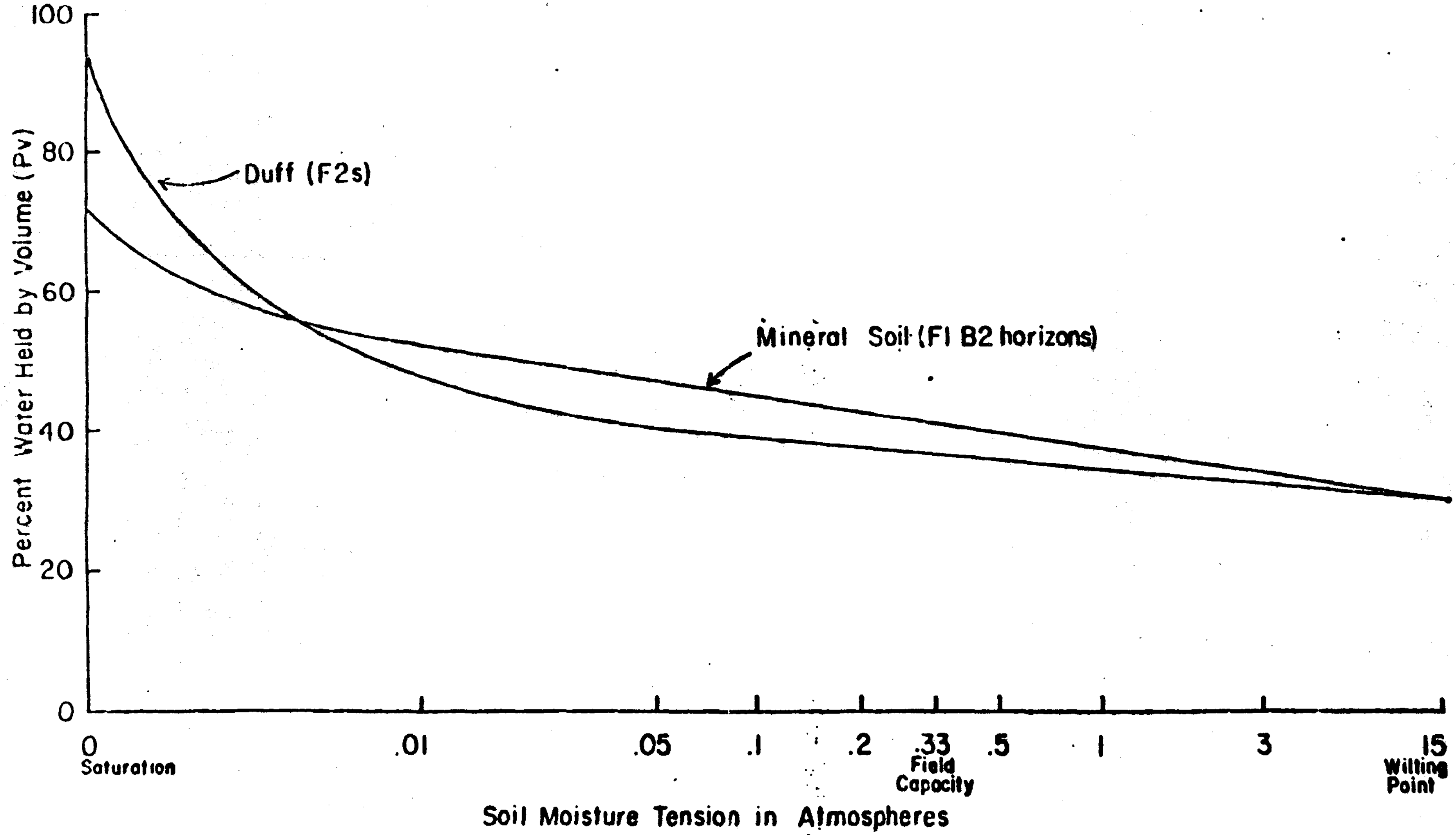


Table 4(3).1. Properties of Lemeta Fl soils. Mean values, standard errors, and numbers of available analyses are shown. Chemical analyses are by the Soil Conservation Service, University of Alaska, and Oregon State University. Physical analyses are by the Soil Conservation Service (clod method) and Institute of Northern Forestry (core samples).

Chemical Properties

Horizon	pH	Carbon	Total Nitrogen (Kjeldahl)	C/N	"Available" Phosphorus	Cation Exchange Capacity (NH_4OAc)
	(n)	Pct (n)	Pct (n)	Ration (n)	p.p.m. (n)	meq per 1[illegible]
O	3.6±0.05(7)	———	1.50±0.030 (4)	———	45±13.0 (7)	115±11.1
A	6.1±0.0[illegible](9)	5.0±0.71 (9)	0.20±0.030 (7)	26±2.7 (7)	3.5±1.40(5)	26±5.0
B21	6.2±0.12(9)	9.[illegible] (8)	0.49±0.069 (8)	19±1.0 (7)	1.7±0.24(5)	50±6.7
B22	6.2±0.1[illegible](8)	5.1±0.74 (8)	0.21±0.035 (8)	25±2.0 (8)	2.9±0.43(4)	30±6.6
B3	6.9±0.09(13)	3.5±0.5[illegible](11)	0.13±0.018 (8)	26±2.4 (7)	2.6±0.53(8)	22±3.6

Physical Properties

Horizon	Bulk density		Moisture Held at Saturation	
	g/cc	(n)	Pct	(n)
O	———		———	
A2	1.02±0.0[illegible]	(4)	———	
B21	0.64±0.0[illegible]	(4)	———	
B22	0.69±0.0[illegible]	(12)	72±0.09	(9)
B3	0.66±0.[illegible]	(4)	———	

carbon and nitrogen contents are both relatively high and carbon: nitrogen ratios are wide. Base saturations are very low, again with the exception of horizons just above calcareous bedrock.

Climax stands are uneven aged, about 75 percent hemlock with the remainder Sitka spruce and western redcedar. Understories have about 50 percent ground cover of vaccinium and menziesia and 20 percent of bunchberry and five-leaved bramble. Young stands after logging or wildfire are about 50 percent each Sitka spruce and western hemlock.

413.11 - F1a. Deep, Freely-drained ash soils, ± 150 site index

These ecosystems are from volcanic ash that was medium textured at the time it was deposited and are low in coarse fragment content. The Kadashan series is the only classified soil of this ecosystem. Soils from originally-coarse textured volcanic ash are in subtype F3a.

413.12 - F1b. Deep, freely-drained soils, ± 150 site index on uplifted beaches

These are on the uplifted beaches that, although not extensive, are common throughout southeast Alaska. They are all close to saltwater. The soils are very gravelly sandy loams to loamy sands. They have three inches to a foot or so of duff, thin dark gray A2 horizons, and very dark gray or black B horizons. The Salt Chuck series is the only classified soil of this ecosystem.

Vegetation is similar to that described for the type, although Sitka spruce usually dominates the overstory, and understory vegetation is usually sparse. Sitka spruce demonstrates high salt tolerance in many of these ecosystems, as they are sometimes flooded by extreme tides.

413.13 - Flc. Deep, freely-drained soils over compact till, ± 150 site index

These ecosystems have compact glacial till substrata at depths of less than 4 feet. The Karta series is the only classified soil of the ecosystem.

413.14 - Fld. Freely-drained soils more than 5 feet deep, ± 150 site index

These ecosystems have at least 5 feet of soil material over consolidated substrata. Soils of the Kupreanof, Ulloa, and Tokeen series occur in these ecosystems.

413.15 - Flf. Deep, freely-drained soils over fine textured deposits, ± 150 site index

These ecosystems have fine textured marine deposits that occur as substrata. The Sitkum series is the only classified soil of this ecosystem.

413.16 - Fln. Normal Fl ecosystems, ± 150 site index

These ecosystems have 10 inches to 5 feet of mineral soil over bedrock. Classified soils include the Tolstoi, Kupreanof, Sarkar, Ulloa, Kaukati, and Tokeen series.

413.17 - Flt. Deep, freely-drained soils on alluvial terraces, ± 150 site index

These ecosystems are on relatively old and high terraces. Their profiles are similar in color to those typical of type Fl, but are often not quite so deep. They are medium textured in the upper profile and overlie gravels and sands. The Tuxekan series is the only classified soil of this ecosystem.

413.20 - F2. Freely-drained soils less than 10 inches deep

This extensive type is on well-drained, shallow-to-bedrock soils that occur from sea level up to about 1,500 feet elevation.

413.21 - F2n. Freely-drained soils, 2 to 10 inches deep, ± 118 site index

Mineral soil depth to bedrock ranges from 2 inches on McGilvery soils up to 10 inches on the very shallow phases of Tolstoi and Sarkar soils.

The soils have three inches to more than a foot of duff. McGilvery soils have 2 to 4 inches of variable mineral soil material over bedrock. Very shallow Tolstoi and Sarkar soils have profiles similar to soils of ecosystem Fl, except they are truncated by bedrock at depths of 4 to 10 inches.

413.22 - F2r. Freely-drained soils 0 to 2 inches to bedrock, ± 90 site index

Table 413.2. Properties of Ecosystem F2r soils. Mean values, standard errors, and numbers of available Analyses are shown. Chemical analyses by Washington State University and the University of Alaska. Physical analyses by the Institute of Northern Forestry (core samples).

Chemical Properties

Horizon	pH		Total Nitrogen (Kjeldahl)		Cation Exchange Capacity (NH_4OAc)	Extractable Cations Calcium	Magnesium	Potassium	Sodium	Base Saturation	
		(n)	Pw	(n)	----------meq per 100 g (n)----------					percent	(n)
O	3.4±0.07(4)		0.88±0.008	(4)	112±3.0 (4)	8.4±1.65 (4)	5.6±1.65(4)	1.9±0.53(4)	1.8±0.44(4)	14±2.7	(4)

Physical Properties

Horizon	Bulk Density		Moisture Held at Saturation		1/3 Atmosphere		15 Atmospheres	
	g/cc	(n)	Pv	(n)	Pv	(n)	Pv	(n)
O	0.12±0.015	(3)	94±2.5	(3)	31±3.9	(3)	27±5.0	(3)

These are on the McGilvery soils, which are essentially just a duff layer over bedrock. Laboratory data for some McGilvery profiles are in Table 413.2. McGilvery soils tend to become drier than the other soils (fig. 413.01), although moisture tensions high enough to materially restrict tree growth have not been recorded.

413.30 - F3. Deep, freely-drained soils, ± 130 site index

This ecosystem type is on deep, freely-drained soils that are similar in gross morphology to those of type F1, but have somewhat lower productivity. They are developed on deep deposits that were coarse textured at "time zero," such as deep, coarse-textured moraines or ash and pumice deposits. At present, however, most of the soils are high in colloids. Vegetation, except for tree growth rates, is similar to ecosystem F1.

413.31 - F3a. Deep, freely-drained soils from sandy volcanic ash and pumice, ± 130 site index

These ecosystems are typical of type F3, except the soils are developed from volcanic ejecta that was coarse textured at "time zero." (Volcanic ash that was medium textured at "time zero" has developed F1 ecosystems). At present, the soils appear similar to those of type F1. They are high in colloids, low in coarse fragments, and many have thin, irregular iron pans. Laboratory data for an F3a soil, classified as the Kruzof series, is in Table 413.3.

413.32 - F3b. Deep, freely-drained soils from uplifted beaches, ± 130 site index

Table 413.3. Properties of an Ecosystem F3a soil. Analyses by the Soil Conservation Service

Chemical Properties

Horizon	pH	Carbon	Total Nitrogen (Kjeldahl)	C/N	Cation Exchange Capacity (NH4OAc)	Extractable Cations: Calcium	Magnesium	Potassium	Sodium	"Free" Iron as Fe
		Pw	Pw	Ratio	meq per 100 g					Pw
O	3.6	51	0.77	65	145	8	15	1.0	1.5	0.2
A2	4.1	5.1	0.08	61	12	0.3	0.4	0.1	0.1	0.3
B21	4.2	18.1	0.44	41	59	0.5	0.4	0.1	0.2	1.1
B22	4.5	17.3	0.34	51	27	0.2	0.2	0.1	0.3	0.4
B3	5.5	4.3	0.14	31	60	0.3	0.1	0.0	0.1	-----

Physical Properties

Horizon	Bulk Density	Moisture Held at 1/3 Atmosphere	15 Atmospheres
	g/cc	Pv	Pv
O	0.17	-------	39
A2	0.86	45	-------
B21	0.37	-------	44
B22	0.30	77	48
B3	0.24	81	---------

This minor ecosystem is on uplifted exposed gravel beaches. The soils, (the Sokolof series), have the normal duff layer over black, very gravelly muck. There is little or no fine mineral soil material between the gravel particles; the voids have been filled, at least partially, with decomposed organic matter in spite of free drainage. Vegetation is similar to ecosystem F3a.

<u>413.33 - F3g. Deep, freely-drained soils derived from very gravelly outwash, ± 130 site index</u>

These soils are similar in gross morphology to those of ecosystem F1, except the dominant mass of the soil (more than 75 percent by volume) consists of gravel, cobbles, and stones with only a minor constituent (perhaps 5 percent or less) of silt and clay. They may have a few inches of sandy soil material as an overlay on the gravels. Topography is gentle, except for terrace excarpments. Vegetation is similar to ecosystem F3a.

<u>413.34 - F3n. Deep, freely-drained soils on moraines</u>

These soils are similar in gross morphology to those of ecosystem F1d, except they are on push moraines. They have, thus far, only been observed at Point Vanderput near Petersburg and in Fish Creek valley near Juneau.

<u>413.35 - F3o. Deep, freely-drained soils derived from sandy outwash, ± 130 site index</u>

These ecosystems are similar to group F3g, except the solum is developed in generally gravel-free sandy soil material. The sandy layers are generally 2 to 3 feet deep over the gravels.

413.40 - F4. Somewhat poorly-drained soils, ± 120 site index

This extensive ecosystem type is on somewhat poorly-drained soils that occur from sea level up to around 1,500 feet elevation. They vary widely in parent material, although all overlie some drainage restriction. Textures range from sandy loam to silt loam with up to 75 percent coarse fragments by volume. They have three inches to a foot or more of duff, a trace to six inches of dark gray A2 horizon, one to six inches of black B21 and up to a foot or two of dark grayish brown B3 horizon.

These soils usually have a seeping water table within 18 inches of the duff. They may occasionally saturate to the point of surface runoff, although we have not observed this.

Climax vegetation and young growth vegetation are similar to that of ecosystem F1, although Sitka spruce percent is generally lower and the cedars make a higher proportion of the overstory. The understories generally have more skunk cabbage and devil's club than those of ecosystem F1.

413.41 - F4a. Somewhat poorly-drained soils from ash, ± 120 site index

These F4 ecosystems are from volcanic ash and pumice, and many have thin dense, irregular iron pans that restrict drainage. Beneath the iron pan, they often have bright colors similar to soils of ecosystem F1. The Shelikof series is the only classified soil of this ecosystem.

413.42 - F4b. Somewhat poorly-drained soils on uplifted beaches, ± 120 site index

These are on the uplifted beaches that, although not extensive, are common throughout southeast Alaska. They are all adjacent to salt-water. The soils are sandier than normal for F4 and usually have an iron-cemented horizon that restricts free drainage.

<u>413.43 - F4c. Somewhat poorly-drained soils over compact till, ± 120 site index</u>

These F4 ecosystems overlie compact glacial till. The Wadleigh series is the only classified soil of this ecosystem.

Laboratory data are in Table 413.43. These soils have lower nitrogen contents than the soils of ecosystem F1.

<u>413.44 - F4d. Somewhat poorly-drained soils on deep, stratified deposits, ± 120 site index</u>

These F4 ecosystems are derived from stratified glacial lake deposits and usually contain irregular iron pans. The Shinaku series is the only classified soil of this ecosystem.

<u>413.45 - F4f. Somewhat poorly-drained soils over fine textured deposits, ± 120 site index</u>

These F4 ecosystems overlie fine-textured marine deposits that occur as substrata. Coarse fragment content is low. The Sloduc series is the only classified soil of this ecosystem.

<u>413.46 - F4r. Somewhat poorly-drained soils over bedrock, ± 120 site index</u>

Table A11.63. Properties of [illegible] Pic soils. Mean values, standard errors, and numbers of available analyses are shown. Analyses by the University of Alaska and Washington State University (O horizons only.)

Chemical Properties

Horizon	pH	(n)	Carbon %	(n)	Total Nitrogen (Kjeldahl) %	(n)	C/N Ratio	(n)	"Available" Phosphorus p.p.m.	(n)	Cation Exchange Capacity (NH_4OAc)	(n)	Calcium	(n)	Magnesium	(n)	Potassium	(n)	Sodium	(n)	Base Saturation percent	(n)	"Free" Iron as Fe %	(
											----------- meq per 100 g (n) -----------													
O	3.9±0.10(4)		-------		1.07±0.04	(4)	-----------		42	(1)	100±6.5	(4)	16.3±1.16(4)		5.0±0.26(4)		2.0±0.38(4)		1.5±0.16(4)		26±3.6	(4)	0.1	(
A2	4.8	(1)	0.9	(1)	0.05	(1)	15	(1)	0	(1)	16	(1)	1.0	(1)	0.4	(1)	0.1	(1)	0.1	(1)	10	(1)	0.1	(
B2	4.6	(1)	2.6	(1)	0.14	(1)	19	(1)	2.3	(1)	43	(1)	1.2	(1)	0.4	(1)	0.2	(1)	0.2	(1)	9	(1)	0.5	(
B3	5.0	(1)	1.7	(1)	0.10	(1)	17	(1)	2.5	(1)	26	(1)	1.0	(1)	0.3	(1)	0.1	(1)	0.3	(1)	6	(1)	0.3	(

These F4 ecosystems overlie bedrock.

413.50 - F5. Poorly-drained soils, ± 73 site index

According to present data, this is the most extensive ecosystem type in southeast Alaska. The soils are organic and occur from sea level up to about 1,500 feet elevation. They have three inches to a foot or more of duff over a layer of black muck or mucky peat, which in turn usually overlies a layer of sedge or sphagnum peat. Beneath the organic soil material is compact till, massive bedrock, fine textured lake or marine sediments, volcanic ash with well-developed iron pans, or some other very slowly permeable deposit. The Maybeso, Karheen, Kaikli, and Sumdum series are classified soils of this type.

These soils usually have a water table within a foot of the base of the duff layer. Rooting is largely restricted to the duff.

Available laboratory data are restricted to duff layers and are in Table 413.5.

Climax stands are ragged and trees are small (often referred to as "scrub"), dominated by western hemlock, Alaska cedar, western red-cedar, mountain hemlock, and only small proportions of Sitka spruce. Understories are similar to those of type F1, except they generally are denser and contain more skunk cabbage and patches of sphagnum. Young stands after logging or wildfire are dominated by western hemlock with small proportions of Sitka spruce and occasionally lodgepole pine.

Table 413.5. Properties of Ecosystem F5 soils (Surface organic horizons only, as rooting is most confined to them.) Mean values, standard errors, and numbers of available Analyses are shown. Analyses by Washington State University and the University of Alaska.

Chemical Properties

pH	Total Nitrogen (Kjeldahl)	Cation Exchange Capacity (NH_4OAc)	Calcium	Extractable Cations Magnesium	Potassium	Sodium	Base Saturation
	Pw (n)	----------	----------	meq per 100 g (n)	----------	----------	Percent (n)
3.5±0.21(3)	0.91±0.12(3)	103±15.6 (3)	9.3±0.70 (3)	3.7±0.53(3)	1.1±0.07(3)	0.8 (2)	15±3.1 (3)

413.51 - F5b. Poorly-drained soils, ± 90 site index on uplifted beaches

These are on the uplifted beaches that, although not extensive, are common throughout southeast Alaska. They are all adjacent to salt-water.

The soils (the Karheen series) have si inches to a foot or more of duff over a shallow layer of black muck overlying saturated, black, mucky gravels. Vegetation is similar to that of the F5 type description, although tree growth is somewhat better.

413.52 - F5d. Poorly-drained, very deep organic soils, ± 73 site index

These F5 ecosystems overlie more than 6 feet of peat (mostly sphagnum peat).

413.53 - F5f. Poorly-drained soils over fine textured deposits, ± 73 site index

These F5 ecosystems overlie fine-textured marine deposits. The Sumdum series is the only classified soil of this ecosystem.

413.54 - F5n. Poorly drained soils over compact till, ash, outwash or other material, ± 73 site index

This is the most extensive known ecosystem subtype.

413.55 - F5r. Poorly-drained soils over bedrock, ± 73 site index

These F5 ecosystems overlie bedrock at 2 to 4 feet depth. The Kaikli series is the only classified soil of this ecosystem.

413.60 - F6. Somewhat poorly-drained soils of the high elevation, poor timber zone

These are the extensive ecosystems that occur just under the alpine zone between about 1,500 and 2,000 feet elevation. The soils are mostly shallow to bedrock. Slopes are gentle to very steep and rock outcrops common. The St. Nicholas series is the only classified soil in this ecosystem. It is a very stony, somewhat poorly-drained mineral soil, similar in gross morphology to those of ecosystem F4r. Other soils from volcanic ash are in these ecosystems near Sitka. Subtypes have not been defined, as little management experience or research data are available.

Open stands of Sitka spruce, mountain hemlock, western hemlock and Alaska cedar make up the overstory. Dense blueberry, copper bush, and menziesia make up the dominant understory, with false hellebore, deer cabbage and other low species similar to those in ecosystem F1.

413.70 - F7. Poorly-drained organic soils of the high elevation, poor timber zone

These ecosystems occur in the same climatic zone as ecosystem F6 and have similar vegetation. However, the soils (the Tunehean series) are black, stony mucks. In addition, they are the only mature forest ecosystem soils that lack duff layers.

413.80 - Fx. Freely-drained soils, site index 40 to 110

These ecosystems have soils with morphology similar to those in ecosystems F1 and F2 that have exceptionally poor tree growth. The reasons for this poor growth are not known, but some elemental toxicity, or possible extreme deficiency, is strongly suspected. Laboratory data for both soils and foliage so far do not explain the problem, although analyses of many micronutrients and possible toxic elements have not been made. The problem has not been explained by analyses of the following elements: N, P, K, Mg, Ca, Na, Mn, Zn, Cu, and Fe.

These ecosystems, luckily, are not extensive. They appear to have a greater than normal proportion of volume in Sitka spruce for the site class. Although many hemlock may be present, they seem to make much less volume growth per stem than the spruce.

414 - Muskeg Ecosystems Family

Muskeg ecoysytems include the very poorly-drained, organic soils that do not support a closed forest canopy. Many of these bogs support scattered, open-grown trees, typically lodgepole pine, mountain hemlock, Alaska cedar and western hemlock. Few soil analyses are available. Some moisture holding data are in Table 414.

414.10 - M1. Sphagnum Muskeg

These are the extensive sphagnum bogs that occur throughout southeast Alaska. They are composed primarily of sphagnum peat and are usually 5 to 15 feet deep to a mineral substratum. The Kogish series is the

Table 414. Bulk density and moisture-tension data from two muskeg soils near Juneau.

Ecosystem and Depth	Bulk Density	Moisture Held at			
		Saturation	0.1 atm.	0.33 atm.	15 atm.
	(g/cc)	(Percent water by volume, Pv)			
M1-					
2"	0.053	97	45	32	23
4"	0.071	97	65	55	44
6"	0.082	98	72	60	41
8"	0.082	98	77	65	52
12"	0.067	99	71	62	50
M2-					
2"	0.137	97	77	73	55
4"	0.189	91	81	75	64
6"	0.173	91	74	69	56
8"	0.177	87	78	74	66
12"	0.176	89	79	75	55
16"	0.260	85	73	67	54

only classified soil of this type. The water table is frequently at the surface, and rarely is more than eight inches from the surface. Soil moisture tensions at 4 inches do not rise above .05 atmosphere. Vegetation is dominated by sphagnum mosses. Stunted individual lodgepole pine, Alaska cedar, and mountain hemlock are frequently present with occasional shrubby western redcedar, western hemlock, and Sitka spruce. The dominant shrubs are crowberry, Labrador tea, bog rosemary, swamp laurel and juniper. Scirpus is the most common forb, with sedges, skunk cabbage, and grasses occupying small areas. Only one subtype is recognized other than the normal.

414.11 - M1d. Very deep sphagnum muskeg

These are similar to the M1 type description, except they occupy filled lakes and are more than 15 feet deep to a mineral substratum. Soils are of the Kogish series.

414.2 - M2. Sedge-slope muskeg

This is probably the most extensive muskeg ecosystem. Organic soil material consists of partially decomposed, firm woody sedge peat that is a usual two to five, but often ten or more feet deep to a mineral substratum. They occur on gently rolling to fairly steep, uneven to smooth slopes. The Kina series is the only classified soil of this type.

The water table is at or above the surface of the ground during rainy periods and seldom drops to more than a foot during dry periods.

A scattered, open stand of lodgepole pine, Alaska cedar, and mountain hemlock is sometimes present with occasional western redcedar, western hemlock, and Sitka spruce. Tree growth is much better than on M1 muskegs, although canopy closure seldom exceeds 20 percent. Common shrubs are Labrador tea, bog rosemary, swamp laurel, crowberry, crab apple, and a few others. Low vegetation is dominated by sedges and scirpus with a fair proportion of sphagnum. Skunk cabbage, bracken fern, grasses and other forbs are usually present.

No subtypes other than the normal are recognized.

<u>414.3</u> - <u>M3. Sedge-flat muskeg</u>

This is the least extensive muskeg ecosystem. It occupies filled lakes, often adjacent to streams. The water table is at or above the ground surface the year around. The upper profile is a loose, poorly-decomposed sedge peat, often with thin layers of sand and gravel. Depth to a firm mineral substratum ranges from a usual five or ten to many feet. The Staney series is the only classified soil of this type.

Vegetation is dominated by a healthy stand of sedges, with minor amounts of grasses, sphagnum, and various forbs.

<u>415</u> - <u>Alpine ecosystems family</u>

These ecosystems extend upward from the upper forest zone, at roughly 2,000 to 2,500 feet elevation, up to the limit of fairly complete vegetative cover. Some trees do occur in this zone, but they are more shrub-like in character and do not assume erect stature.

415.1 - A1. Alpine heath

This is the most extensive ecosystem type in the alpine of southeast Alaska. The soils are mostly black, somewhat poorly-drained mucks with varying amounts of coarse fragments in their lower profiles and are relatively shallow to bedrock, although some better-drained soils have profiles similar to those of ecosystem F2. The Sunnyhay series is the only classified soil of this type. Laboratory data from some Sunnyhay profiles are in Table 415.1.

Vegetation is dominated by low-growing shrubs, such as mountain heath, crowberry, dwarf blueberry, and copper bush, with a wide variety of forbs including deer cabbage, lutkea and lupine. Shrub-like Sitka spruce, mountain hemlock, and lodgepole pine often occur.
Only one subtype other than the normal is recognized.

415.11 - A1a. Alpine heath with ash soils

These ecosystems are similar to the A1 type description, except the soils are from volcanic ash. Soil drainage may be better, and depth to bedrock is often greater.

415.20 - A2. Alpine Sedge

This ecosystem is moderately extensive in the Alpine. The soils (the Hydaburg series) are very poorly-drained, firm sedge peats which are generally one to four feet deep to bedrock.

Vegetation is dominantly low-growing alpine sedge with minor amounts of deer cabbage and sphagnum moss. Small ponds are frequent.
Only one subtype other than the normal is recognized.

Table 6.3.1 Properties of Ecosystem A1 soils. Mean values, standard errors, and numbers of available analyses are shown. Analyses by the Soil Conservation Service.

Chemical Properties

Depth	pH	(n)	Carbon	(n)	Total Nitrogen (Kjeldahl)	(n)	C/N	(n)	Cation Exchange Capacity (NH_4OAc)	(n)	Extractable Cations: Calcium	(n)	Magnesium	(n)	Potassium	(n)	Sodium	(n)	Base Saturation	(n)
inches			Pct	(n)	Pct	(n)	Ratio	(n)	meq per 100 g (n)										percent	(n)
0-7	5.1	(2)	38.8±5.62	(5)	1.66	(2)	23	(2)	66	(2)	0.5	(2)	1.9	(1)	0.6	(2)	0.6	(2)	6	(2)
7-11	6.0	(2)	13.1	(2)	0.65	(2)	20	(2)	65	(2)	0.2	(2)	0.7	(2)	0.1	(2)	0.2	(2)	2	(2)

Physical Properties

Depth	Bulk Density	(n)	Moisture Held at 15 Atmospheres	(n)
inches	g/cc	(n)	Pct	(n)
0-7	0.35	(2)	76	(2)
7-11	0.66	(2)	61	(2)

415.21 - A2a. Alpine sedge with ash soils

These ecosystems are similar to the A2 type description, except the substrata are volcanic ash deposits.

416 - B. Brushy (snowslide) slope ecosystems

There is only one ecosystem type recognized in this family. These ecosystems usually occur on steep slopes. Snow avalanching is a primary reason for the occurrence of most, but not all of them. The soils are freely-drained, and have only a thin litter layer over one to several feet of dark brown, very gravelly silt loam over bedrock or compact till. The Shakan series is the only classified soil of this ecosystem.

Vegetation is dominated by shrubs ranging up to about 20 feet in height. Sitka alder is the dominant plant, along with salmonberry, copperbush, and devil's club. A lush forb layer is often dominated by ladyfern, but nearly every species of forb in southeast Alaska can be found.

417 - Other mature ecosystems

417.1 - X1. Somewhat poorly-drained soils of the low to intermediate elevations with pseudo-alpine vegetation

One known ecosystem type, on the Kah Sheets soils, is fairly extensive on southwestern Kupreanof Island. These soils are usually only about a foot deep over intermediate to acidic volcanic rocks. Otherwise, they resemble the soils in subtype F4r. Laboratory data from one profile are in Table 417.1.

Table 417.1. Properties of an Ecosystem X1 soil.
Analysis by the University of Alaska.

Chemical Properties

Horizon	pH	Total Nitrogen (Kjeldahl)	Cation Exchange Capacity (NH_4OAc)	Extractable Cations: Calcium	Magnesium	Pota
		Pw	meq per 100g	meq per 100g	meq per 100g	meq per 100g
O	3.7	0.29	95	1.7	2.3	0.4
A2	4.0	0.37	27	0.2	0.3	0.2
B2	4.2	0.30	90	0.0	0.1	0.2
C	4.8	0.10	31	0.2	0.0	0.1

The vegetation includes scattered, shrubby Alaska cedar, lodgepole pine, and mountain hemlock growing in clumps and stringers. Ground cover is dominantly heather, crowberry, and deer cabbage, with lesser amounts of swamp laurel, dwarf blueberry, and bunchberry.

417.2 - X2. Freely-drained soils with pseudo-muskeg vegetation

This very minor ecosystem type has soils similar in morphology to those of ecosystems F1 and F2, but supports vegetation similar to ecosystem M1 (sphagnum muskeg). The lack of a characteristic conifer overstory is unexplained, but as in ecosystem Fx, an elemental toxicity is suspected.

The only known soils in this group are on the Totem Volcanics of southern Kupreanof Island. A common feature there is that of animal "licks" — small depressions caused by removal of the surface litter and consumption of fine soil material by animals (mostly deer). No laboratory data are available, but field pH measurements are unusually high — pH 6.0 to 6.5 at 8 inches depth.

Overstory vegetation is sparse, shrubby lodgepole pine with some Alaska cedar and mountain hemlock. Besides sphagnum moss, ground cover includes juniper, crowberry, bog blueberry, Labrador tea, star flower, bracken fern, sedges, and grasses.

420 - Young ecosystems

Young ecosystems are those with relatively rapid rates of change in soils and vegetation, and consequently animal populations. They are undergoing primary succession. Indications are that most ecosystems on mineral soils approach a mature stage in little more than 1,000 years.

421 - flt. Deep, freely-drained young alluvial terrace soils, ± 150 site index

Most streams in southeast Alaska are unstable, reaching flood stage every fall. Most flow across gentle topography in U-shaped valley bottoms. Low terraces are subject to frequent flooding, and as a rule, the more unstable the stream, the more extensive the low terraces with relatively young ecosystems. Only one ecosystem subtype is extensive enough to be recognized as occurring on low terraces.

These ecosystems occur from sea level up to about 1,000 feet elevation. The soils lack well-developed horizons. They have relatively thin 0 horizons, ranging from 1/2 to 4 inches. Beneath the 0 horizon is 8 to 30 inches of dark brown silt loam to fine sandy loam, which overlies several feet or more of grayish, stratified gravels and sands. The Tonowek series is the only classified soil of this ecosystem.

Stands of rather poorly-stocked, large Sitka spruces dominate the overstory of these ecosystems, with considerable red alder and minor amounts of western hemlock. The spruces are usually "stilted," supported by enlarged roots. The original conifer seedbeds were, in most if not all cases, stubs or logs of flood-killed or windthrown trees. After the spruces became established, the seedbeds rotted away, leaving their roots to support their boles.

Dense patches of salmonberry, devil's club, and currant dominate the shrub layer. A wide variety of herbaceous plants occur as ground vegetation, including lady fern, violets, and many other species.

After logging, spruce regeneration is scattered, being mostly confined to stumps and rotten logs and chunks. Alder, salmonberry, devil's club and currant usually dominate the site.

<u>422</u> - <u>V. Young Ecosystems on Erosion Escarpments (V-notches)</u>

Many steep-gradient streams have carved V-shaped incisions into valley slopes and floors. The walls of these "V-notches" are extremely steep, and consequently, geologic erosion is rapid. Water erosion, soil creep, small landslides and ravel are all active and prevent the development of mature ecosystems. This type could readily be subdivided into young brushy slope (bv), young forest (f1v, f2v, f3v, f4v, f6v) and young alpine (a1v) ecosystems, and rock outcrop. However, as most V-notches are small and narrow, subdivisions would usually be too small for practical management purposes. This group of young ecosystems has been subtyped on the basis of soil materials as follows:

Vc - V-notches in compact glacial till.

Vf - V-notches in fine textured deposits.

Vr - V-notches in rock.

<u>423</u> - <u>Young ecosystems in the Yakutat area</u>

In the Yakutat portion of the Tongass, mature ecosystems are restricted to some of the mountainous areas. Moraines 600 years old or less occur from Ocean Cape to Chicago Harbor and form a semicircle south of Russell Fiord from west of Situk Lake to FH10 near old Situk Creek to the mountains a few miles south of Beasley Creek. Moraines, till, and lake sediments 200 years old or less occur along upper Disenchantment Bay, around the entire lengths of Russell and Nunatak Fiords, and down valley from most glaciers in the Yakutat area. Outwash and sand dunes from a few to 600 years old form the parent material or substrate for most of the soils of the Yakutat Foreland.

We have little quantitative data on the ecosystems of the Yakutat area. However, we can describe some of the ecoysytems in a general way. This section will have to be revised and expanded when more data are gathered.

423.1 - f3e. Deep, freely-drained soils on stabilized sand dunes

Stabilized sand dunes are extensive between Dry Bay and the Italio River and northwest of the mouth of the Lost River. Ecosystem observations are limited to the area near the Lost River and are shown in Fig. 423.1. Understory vegetation is sparse under the 100 year old and younger spruce. Under the 500 year-old spruce, the understory appears similar to mature forest ecosystems.

423.2 - f3m. Deep, freely-drained soils on moraines

These are ecosystems that, because they are too well-drained, do not go through an alder stage. The soils are stony and sandy. Those about 600 years old have upper profiles only slightly less well-developed than those of ecosystem F1. Profile development becomes weaker as the soils become younger. Soil physical properties change with age and by 600 years, are similar to mature soils (fig. 423.21, Table 423.2) in the upper profile.

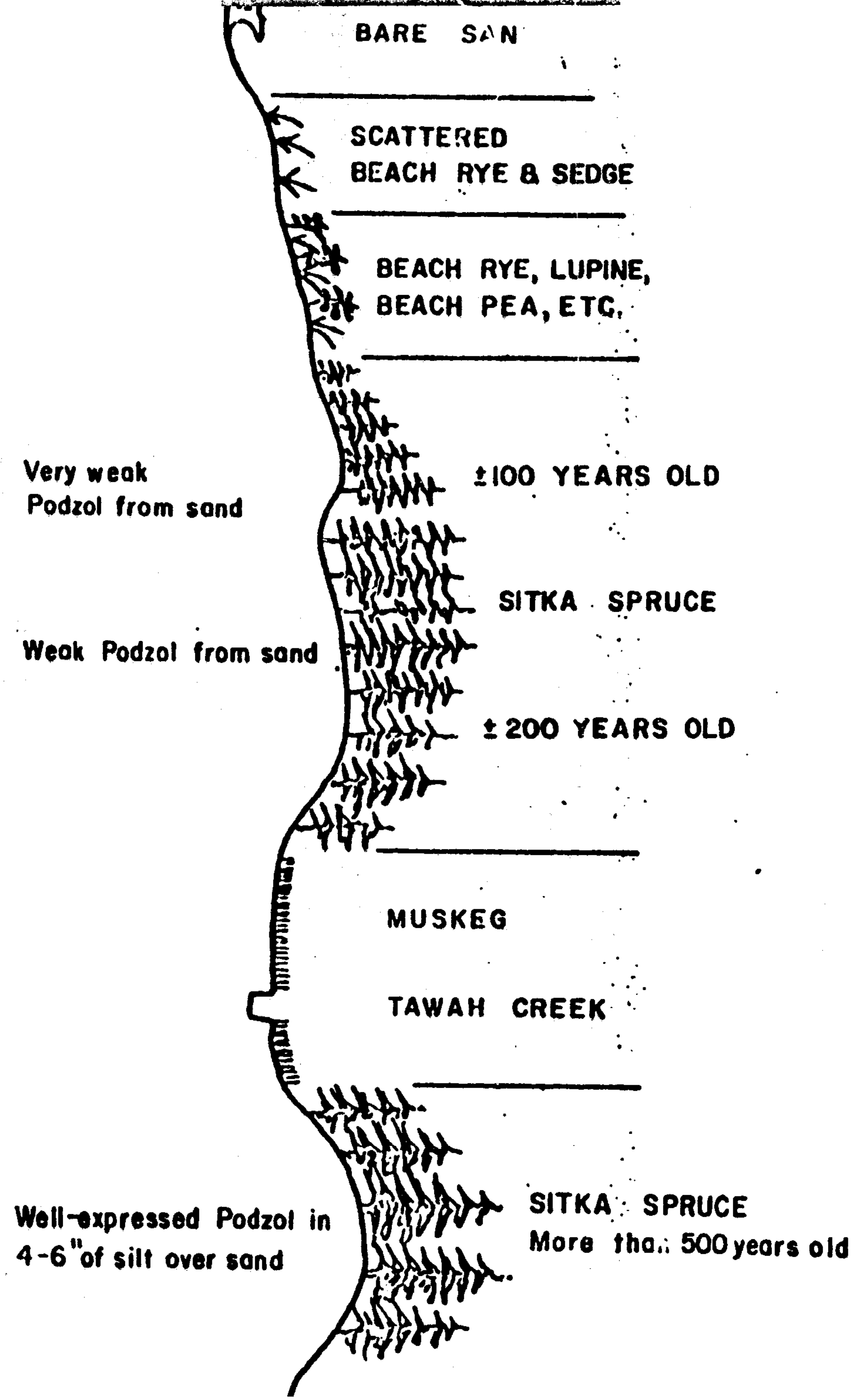
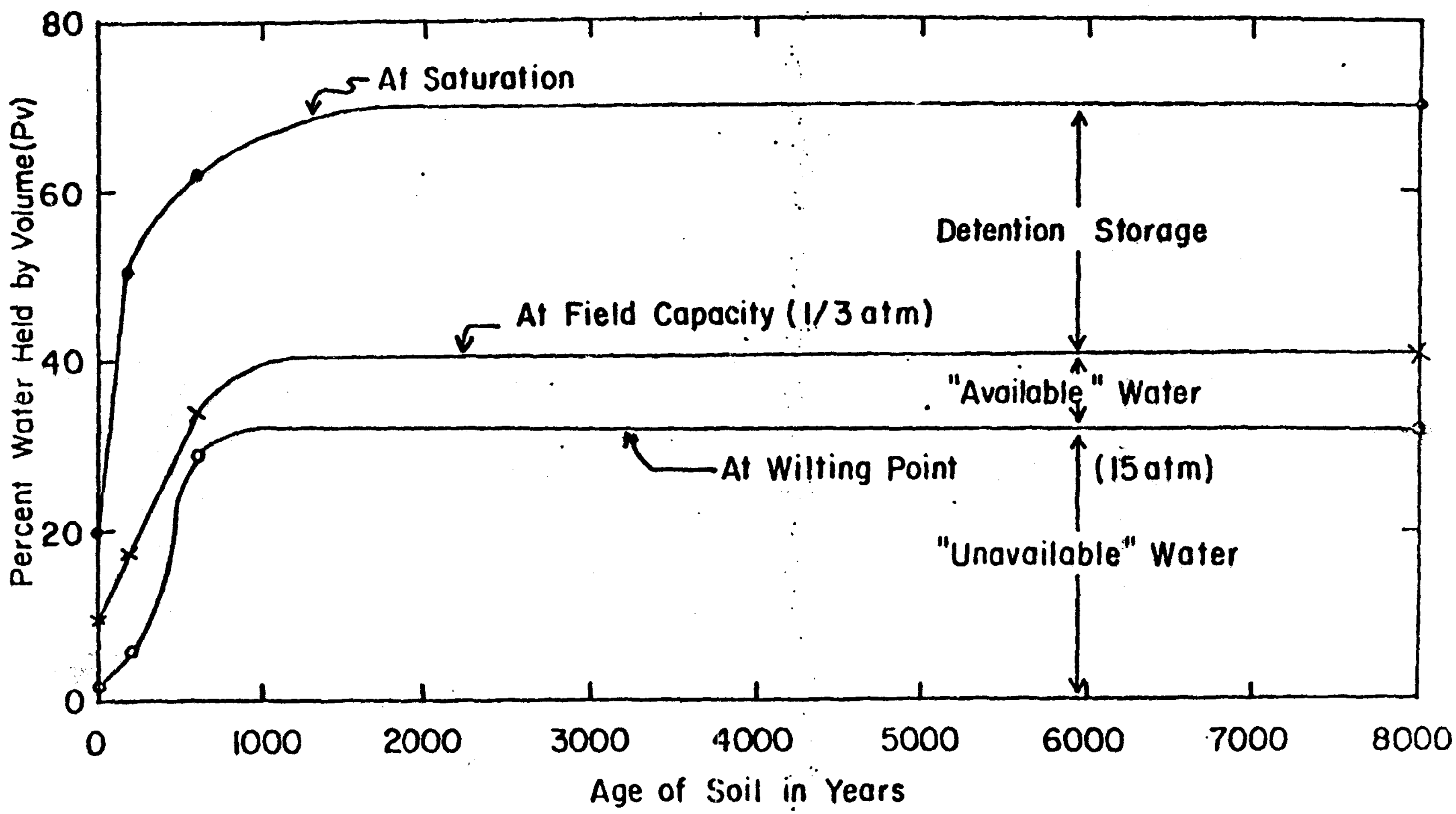


FIGURE 4. GENERALIZED CROSS SECTION SHOWING SOILS AND VEGETATION NEAR THE PACIFIC OCEAN.

Figure 423.21. Development of some B2 horizon soil moisture properties with time in southeast Alaska. Fresh till from the Mendenhall Glacier; 200-year-old f3m soils from the Mendenhall Valley and Glacier Bay; 600-year f3m soils from near Yakutat; and mature FI soils from near Juneau.



Vegetation in the 600 year old ecosystems is near-climax, with a high proportion of western hemlock and understories similar to ecosystem F1. Ecosystems less than 200 years old are dominantly Sitka spruce and cottonwood with willows, lupine and various other shrubs and forbs.

Primary spruce height growth is slow in similar ecosystems near Juneau, reaching about 50 feet at 100 years, but does not decrease appreciably in the older age classes (fig. 423.22). Secondary succession after logging or burning will likely result in better tree growth on the 200 to 600 year old soils.

<u>423.3</u> - <u>f3g. Deep, freely-drained soils from outwash gravels</u>

These extremely gravelly and stony soils are on outwash plains and terraces. Profile development and vegetation cover depends on age. The youngest ecosystems have little profile development and a vegetative cover dominated by willows. Sitka spruce and cottonwood dominate the site within a few hundred years. Soil profiles in 600-year-old ecosystems resemble those of ecosystem F3g, except the B21 horizon is not evident and total solum depth is only about a foot. Laboratory data from one profile are in Table 423.3. Stands are not yet climax, as hemlock occupies only a minor proportion of the volume. Understory vegetation is dominated by blueberry and devil's club.

<u>423.4</u> - <u>f4g. Somewhat poorly-drained soils from outwash gravels</u>

These ecosystems are on outwash plains and terraces that have a water table close to the surface. The 600 year-old soils are much paler than those of ecosystem f3g and frequently have up to a foot of fine sands on top of the gravels. Vegetation is similar to that of ecosystem f3g,

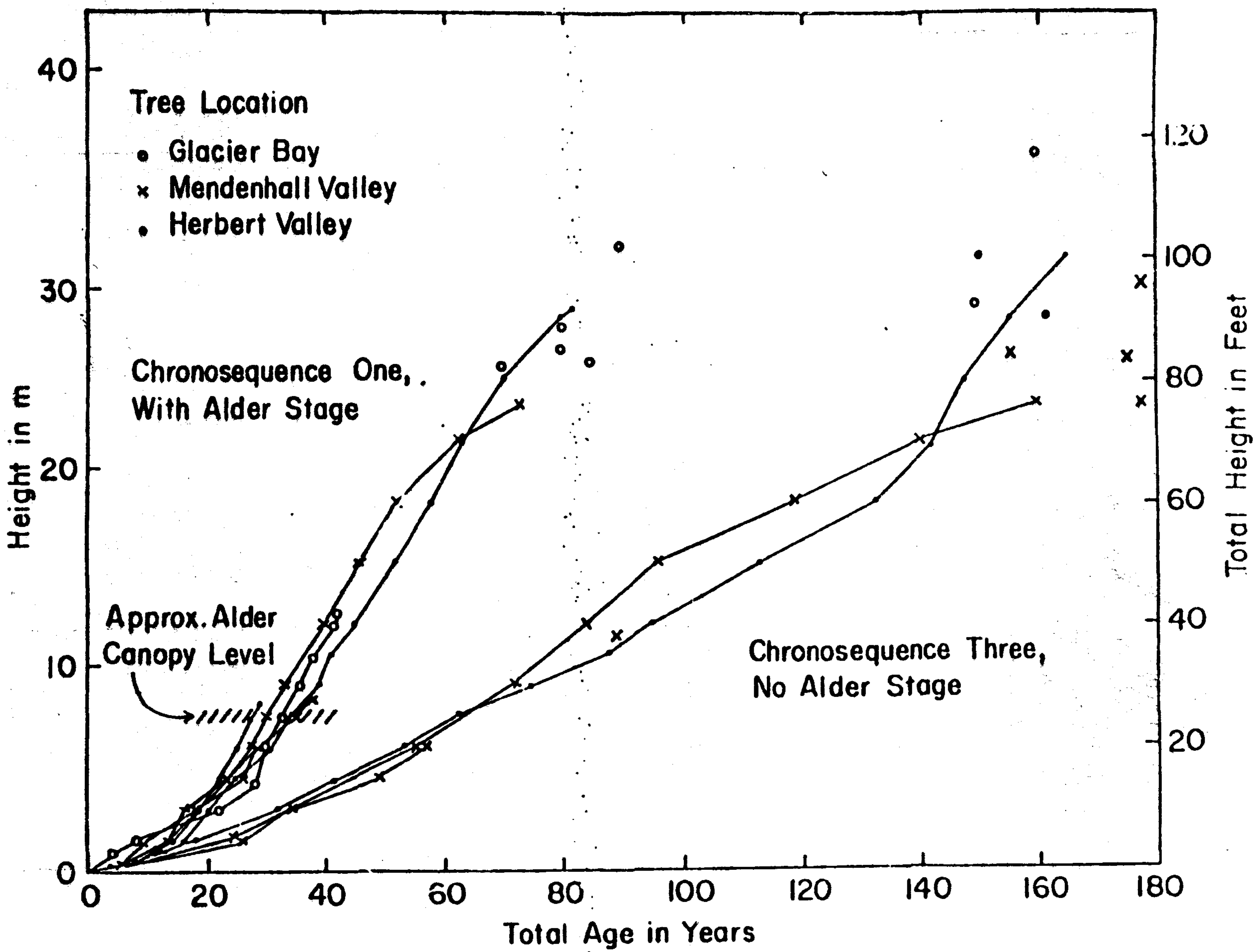


Figure 423.22. Dominant Sitka spruce height growth in primary stands in ecosystem flp (Chronosequence One) -- 1 f3m (Chronosequence Three).

Table 423.3. Properties of a Yakutat Ecosystem f3g soil (about 600 years old). Analysis by the University of Alaska.

Chemical Properties (Of3)

Horizon	pH	Total Nitrogen (Kjeldahl)	Cation Exchange Capacity	Extractable Cations		
				Calcium	Magnesium	Potassium
		Pv	meq per 100 g			
O	3.8	1.42	144	5.6	3.2	0.5
A2	4.2	0.18	106	4.4	2.0	0.5
B2	4.7	0.10	44	0.4	0.1	0.05
B3	3.9	0.06	6	0.2	trace	0.02

Table 423.2 Physical Properties of Yakutat Ecosystem f3m soil (about 600 years old). Analyses by the Institute of Northern Forestry (core samples).

Physical Properties

Horizon	Bulk Density		Moisture held at Saturation		1/3 Atmosphere		15 Atmospheres	
	g/cc	(n)	Pv	(n)	Pv	(n)	Pv	(n)
O	0.15±0.019	(4)	97±1.5	(4)	47±1.4	(4)	41±2.7	(4)
B2	1.17±0.038	(5)	61±0.9	(5)	34±0.6	(5)	29±0.8	(5)

except tree growth is poorer and volumes are less.

423.5 - f5. Poorly-drained organic soils destined to become forested

These ecosystems have thin organic layers overlying wet, gray mineral materials. The water table is seasonally above the surface of the ground. Sedges, grasses, and willows form the dominant vegetation. After 600 years, a scattering of spruce indicates the eventual successional trend toward F5 ecosystems. At this time, we cannot be certain of the "break" between ecosystems f5 and m.

423.6 - m. Young muskegs

These ecosystems have a water table above the surface of the ground most, if not all, of the year. Shallow lakes could theoretically be in this group, but only those ecosystems with land vegetation, dominantly sedges, are included.

The soils are soft, poorly decomposed sedge peats that average about a foot or so to a mineral substratum.

424 - Other young ecosystems

With the exception of Yakutat and the young ecosystems described earlier, young ecosystems are not extensive on the Tongass. They are of many different kinds, and few quantitative data are available for most of them. Consequently, they will not be described in detail. Most of these same ecosystem types occur in the Yakutat area as well. This section will be revised and expanded when data are available. Known kinds of young ecosystems are as follows:

m. Those from glacial till.

f1m. Those with freely-drained soils that go through an alder stage in the succession. Primary spruce growth is shown in Fig. 423.22 and some moisture holding properties in Fig. 423.21.

f2m. Those with freely-drained, very shallow-to-bedrock soils or bare rock that do not go through an alder stage.

f3m. Those with freely-drained soils on moraines that do not go through an alder stage. Primary spruce growth is shown in Fig. 423.22.

f4m. Those with somewhat poorly-drained soils.

f5m. Those poorly-drained young muskegs that are destined to become forested.

m. Young muskegs.

o. Those from outwash gravels and sands. (Similar definitions as above for f1o, f3o, and f4o).

l. Those on landslide tracks.

f1l. Those that go through an alder stage.

f2l. Those that do not go through an alder stage.

430 - Miscellaneous systems

Land areas with little real soil are grouped here. They are included [redacted] mainly because of their extent and hydrologic significance.

431 - R. Rock outcrop

These areas are essentially bare rock, with or without a lichen and moss cover.

432 - I. Ice

Ice fields and glaciers.

CHAPTER 500 - ECOSYSTEM FUNCTIONING

Ecosystems are a complex of living organisms and their environment. Many complicated reactions and interactions are continuously at work. It is convenient to discuss ecosystem functioning in terms of "cycles", such as the energy, hydrologic, carbon, and nitrogen cycles, even though these cycles are interdependent and occurring simultaneously. Each cycle is quite complex, with inputs, outputs, and seasonal variation.

510 - Energy Cycle (To be written)

520 - Hydrologic Cycle (To be written)

530 - Carbon Cycle

The carbon (organic matter) cycle is basic to ecosystem productivity. Plants transform atmospheric carbon (carbon dioxide) into organic matter. Ecosystem productivity depends on how fast this transformation takes place.

Figure 530.1 shows the carbon cycle. Organic matter is the major source of plant nutrients in southeast Alaskan soils. Consequently, organic matter decomposition is critical to ecosystem productivity. Organic matter decomposition depends on the action of soil organisms.

In southeast Alaska, the soils are extremely acid and cool. These factors have important effects on the kinds of soil organisms and their activity.

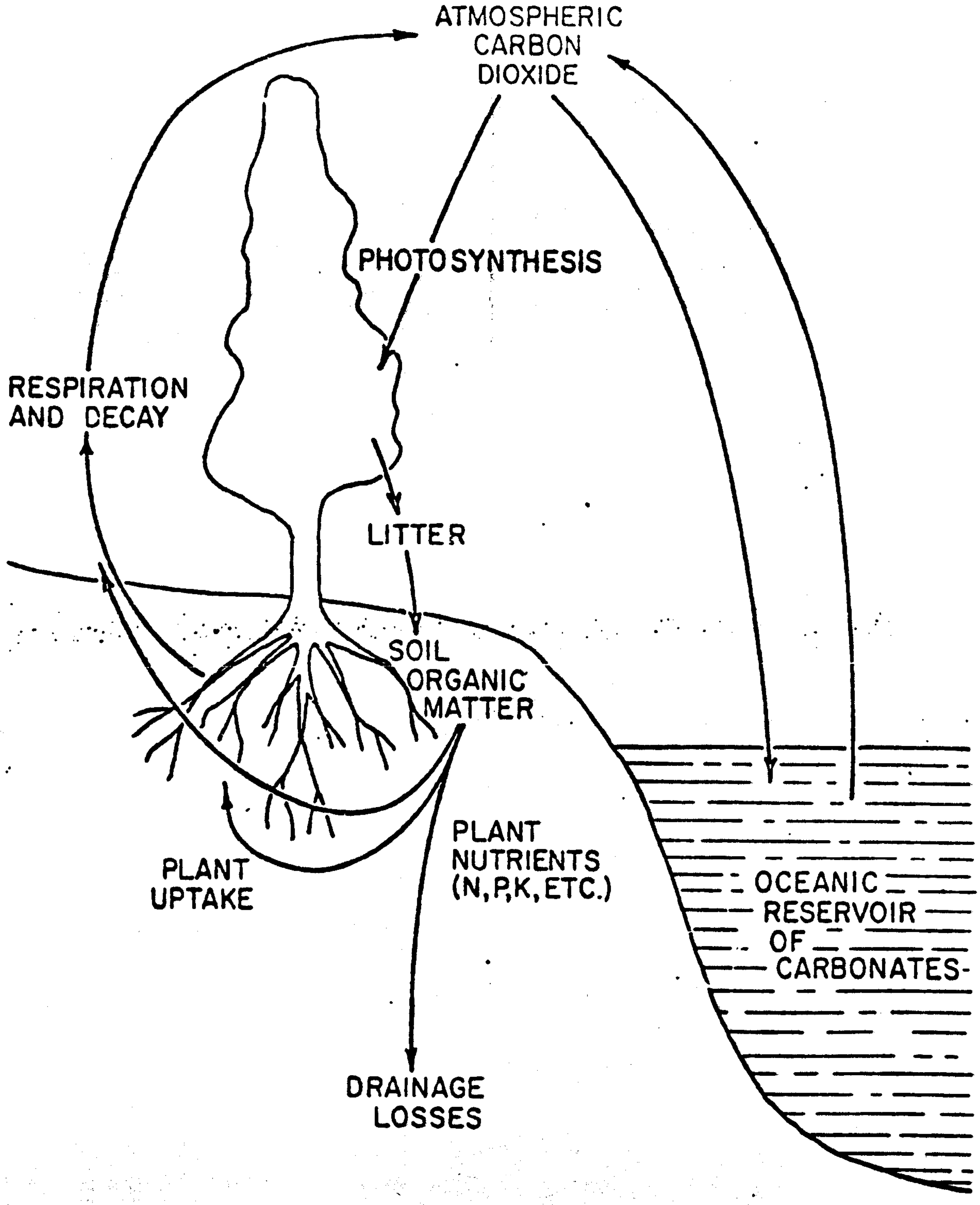


Figure 53(.1 --The carbon cycle

The effects of soil macrofauna are very limited. Earthworms and other soil macrofauna are rare. This may be an important factor in the large accumulations of organic matter on top of the mineral soil. The abrupt transitions between O horizons and mineral soils indicate little or no mixing by macrofauna.

In these soils, fungi are the most numerous and effective organic matter decomposers.

Soil organic matter decomposition rates depend on several factors. Assuming litter from the same species, the major factors are moisture, temperature, and nutrients, especially nitrogen (fig. 530.2).

Decomposition is very slow below 40°F. Generally, the rate doubles for every 10°C. (18°F.) increase in temperature up to about 120°F. Soil temperature in the duff averages about 50° in the growing season, and rarely reaches 70°F. Low soil temperatures are a major reason for the large accumulations of organic matter on and in our better drained forest soils (Table 530.1).

Moisture levels are near optimum for decomposition in our better-drained soils. Decomposition is drastically slowed by either dry or water-logged soils. Lack of oxygen from waterlogging on very poorly-drained sites greatly reduces decomposition rates. This accounts for the extent of muskeg ecosystems in southeast Alaska and their very large accumulations of organic matter.

Soil organisms, like higher plants, need a suitable supply of mineral nutrients. For example, alder leaves decompose much more rapidly than and nutrients on organic matter decomposition and approximate range found in southeast Alaskan Ecosystems

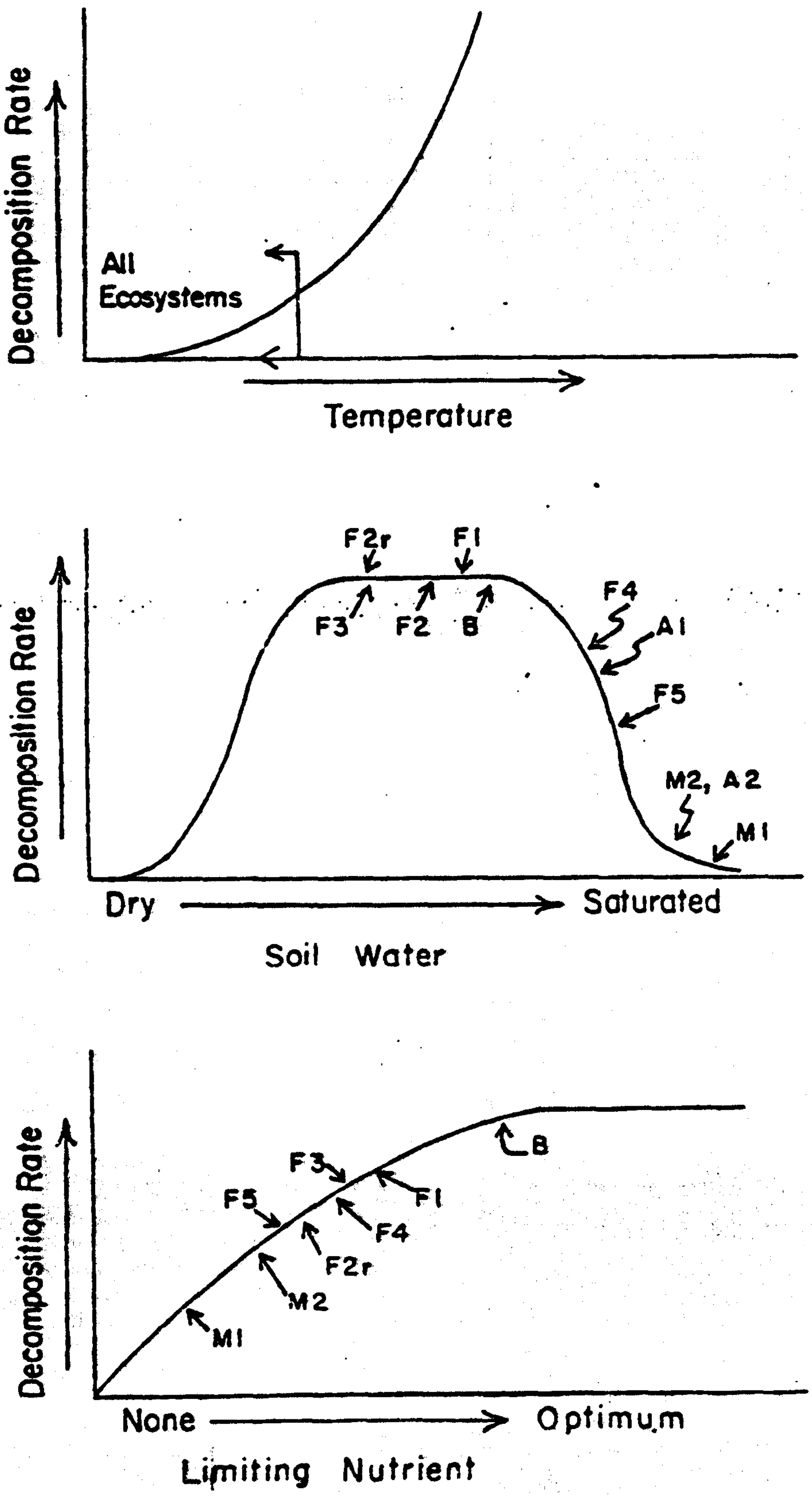


Table 530.1

Total organic matter held on and in the soils of some southeast Alaska Ecosystems.

	O horizons (Duff Layer)		Mineral Soils		Total Soil	
Ecosystem	No. Samples	lb. per acre of organic matter (O.D. Basis)	No. Samples	lb. per acre of organic matter (O.D. Basis)	No. Samples	lb. per ac organic m (O.D. Bas
F1	9	268,417±31,765 1/	4	300,540±47,896	4	541,208±27
F2	2	173,282	-	-	-	-
F2r	4	364,684±78,212	-	-	4	364,684±78
F3	1	351,186	1	392,658	1	743,84
F4	4	361,853±86,948	-	-	-	-
A1	-	-	-	-	2	360,94
M1 (5 feet deep)	-	-	-	-	1	1,060,98
M2 (3 feet deep)	-	-	-	-	1	1,255,78

1/ ± Standard Error

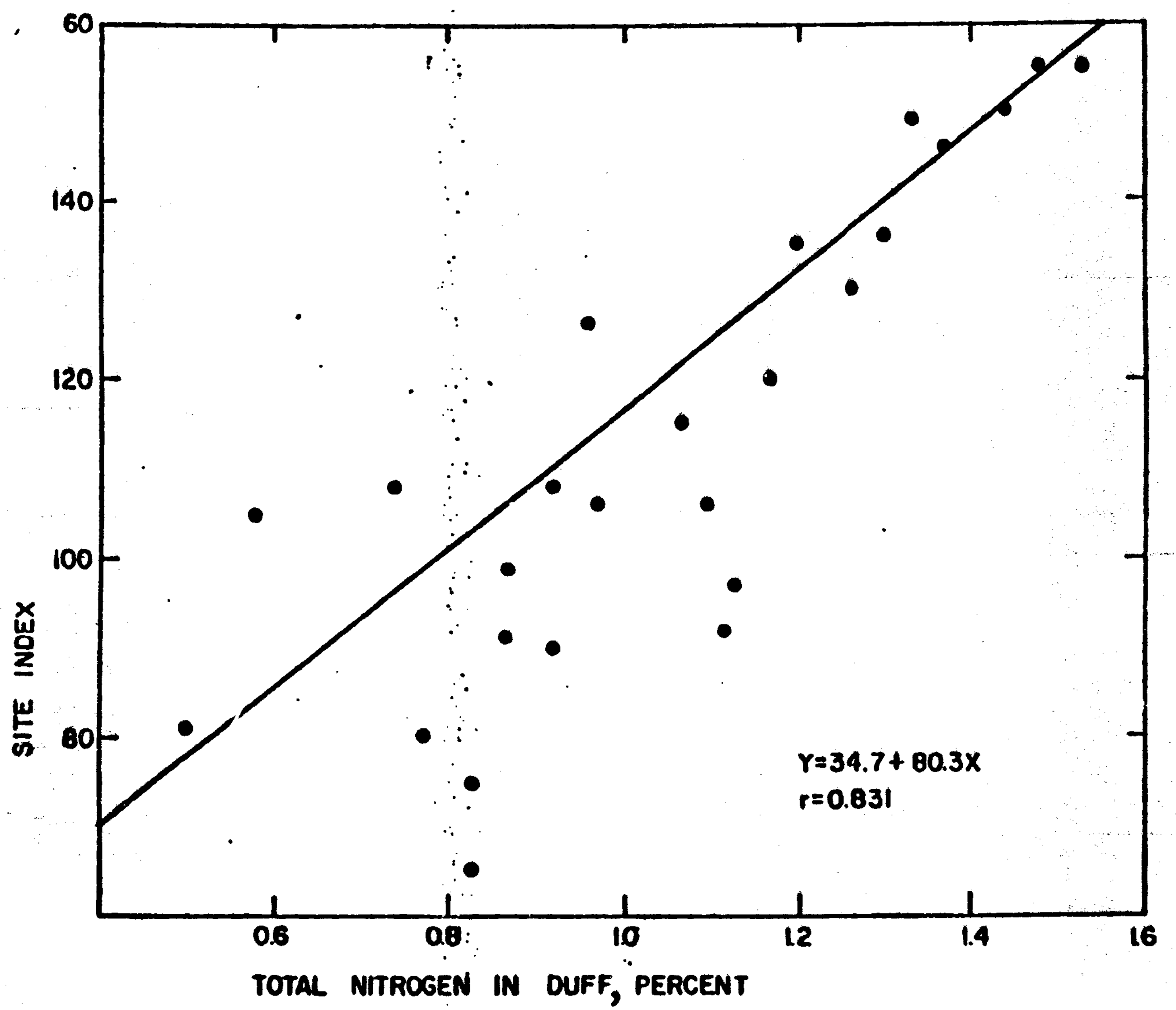
conifer needles, primarily because of their higher nitrogen content. This more rapid decomposition rate is evident in Ecosystem B. In spite of relatively high ecosystem productivity, the soils do not have a thick duff layer, and the mineral soils lack very dark colors indicative of high organic matter content. Decomposition rates can be stimulated by the addition of limiting nutrients, especially nitrogen, to the soil. Increased decomposition rates, in turn, result in increased supplies of available nutrients.

Large quantities of organic matter leach through the soils to streams and the ocean. This is evident in dark-colored water, stained by organic sediments, especially during the fall rains in watersheds with high proportions of muskegs. Further evidence is found in the soils of ecosystems F1 and F2. A black, mucky layer of precipitated organic matter often occurs above compact till, where seepage is almost continual, and above limestone bedrock, where high pH and calcium level cause a change in humus to less soluble forms.

540 - Nitrogen Cycle

Nitrogen is evidently limiting tree growth in many forest ecosystems in the Tongass (fig. 540.1), consequently, special attention to nitrogen in the ecosystem seems deserved. The nitrogen cycle is shown in figure 540.2.

Little or no nitrogen occurs in the rocks that form soil parent materials. There is, however, a large reservoir of nitrogen in the atmosphere, but gaseous nitrogen (N_2) cannot be assimilated by plants. It must be chemically combined with other elements, or "fixed," to an available form.



60
140
120
100
80
SITE INDEX
0.6
0.8
1.0
1.2
1.4
1.6
TOTAL NITROGEN IN DUFF, PERCENT
Y=34.7+80.3X
r=0.831

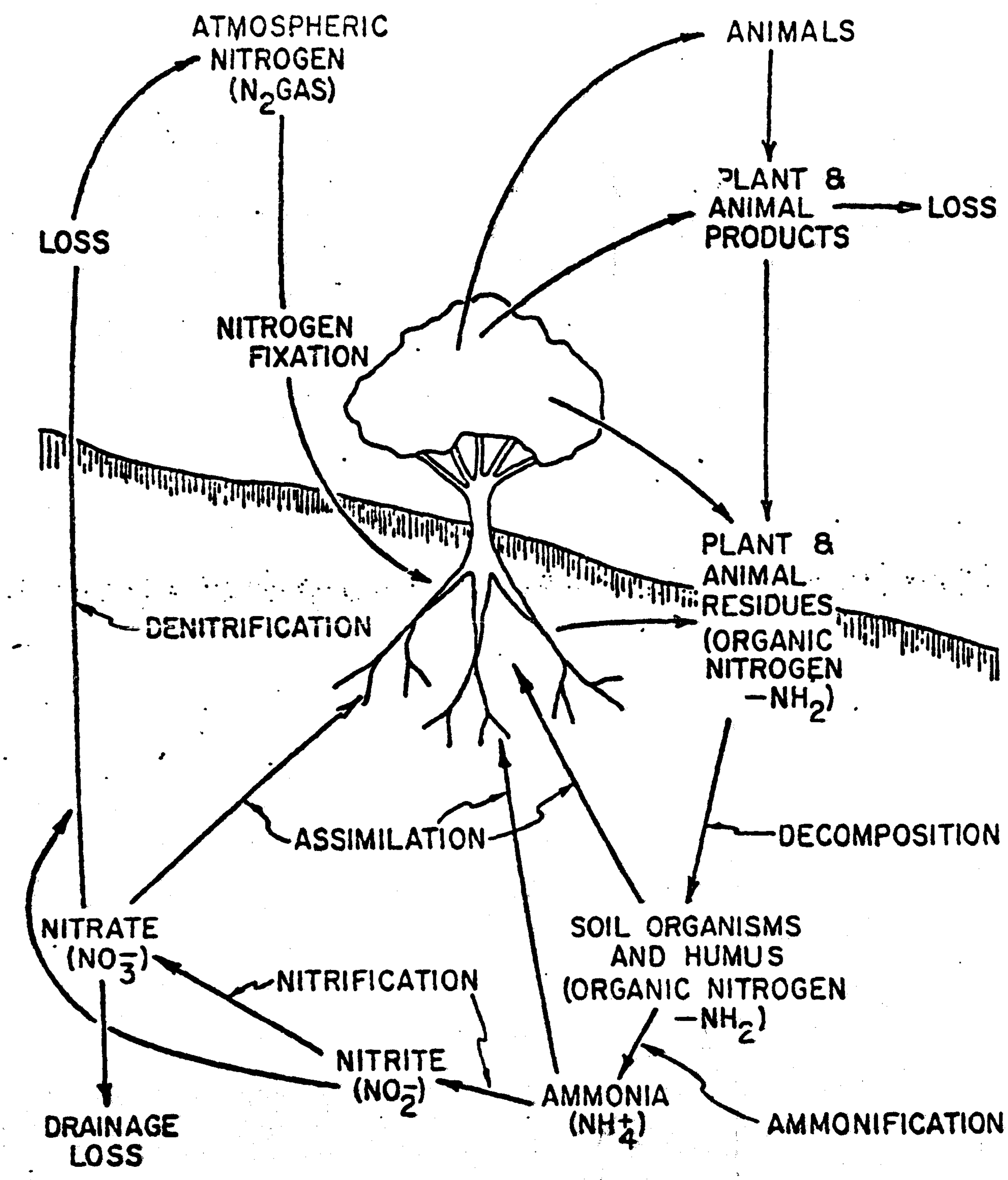


Figure 540.2 --The nitrogen cycle.

Some atmospheric nitrogen is fixed by lightning discharge, and subsequently delivered to the soil in rainfall. There is some evidence that conifers can absorb available nitrogen from the atmosphere. The supply of available nitrogen from precipitation is quite small, probably in the neighborhood of one pound per acre per year. This is only a few percent of the requirement of a healthy vegetative cover. If nitrogen loss by leaching is low, however, this small annual rate can accumulate to a significant total over the 10,000 years of soil formation since deglaciation.

Biological fixation is an important source of ecosystem nitrogen. Alders, some lichens, lupine, vetch, and other species have the ability to symbiotically fix nitrogen. The alders are probably the most efficient nitrogen fixers in our ecosystems. Sitka alder has been shown to contribute about 36 pounds of nitrogen per acre per year to young glacial till soils. In Oregon, the soil under 40-year-old red alder contained 4,000 pounds per acre more nitrogen than the soil under an adjacent 40-year-old conifer stand.

Large amounts of nitrogen are in the living and dead organic matter of our mature ecosystems. In order for organic nitrogen (protein) to become available to plants, it must be broken down by soil organisms. Organic matter decomposition is the primary source of available nitrogen, as well as most other plant nutrients in most of our ecosystems. We have already seen where soil temperature and aeration are critical factors in organic matter decomposition rates. Nitrogen in itself can be limiting to soil organisms, thereby affecting decomposition rates and nitrogen release.

Data on the amounts of nitrogen fixed in and moving through our ecosystems are largely unavailable, except for organic soil nitrogen in some forest ecosystems (Table 540.1). Figure 540.3 shows data of this type for a 35-year-old Douglas-fir ecosystem in Western Washington. Note that about one percent of the soil nitrogen capital is taken up by the trees in the Washington ecosystem. It is likely that uptake in F1 ecosystems is somewhat more, and in F2r ecosystems somewhat less than that of the Washington ecosystem. In terms of percentage of the soil nitrogen capital, yearly uptake in southeast Alaska ecosystems must be only a fraction of one percent.

This illustrates the effect of our cool soil temperatures on organic matter decomposition and nutrient release. Soil nitrogen accumulation has exceeded leaching loss (plus that held by the vegetation) by an average of almost one pound per acre per year since deglaciation, about 10,000 years ago, in and on soils of ecosystem group F1. Actually, the accumulation rate has probably been closer to 0.7 pound per acre per year in F1 soils, as ecosystem f1m soils accumulate about 3,500 pounds per acre during their first 150 years after deglaciation. At any rate, leaching losses in F1 soils must be quite low in order for such large quantities of nitrogen to accumulate.

Table 540.1

Total organic nitrogen held on and in the soils of some southeast Alaskan ecosystems:

	O horizons (duff layers)		Mineral Soils		Total Soil	
Ecosystem	No. Samples	lb. per Acre of N	No. Samples	lb. per Acre of N	No. Samples	lb. per Acre of N
F1	9	3,802±437 1/	7	7,047±1,790	7	10,344±1,639
F2	2	1,889	0	-	0	-
F2r	4	3,207±686		Nil(Bedrock)	4	3,207±686
F3	1	2,716	1	6,000	1	8,716
F4	4	3,909±1,034	1	2,934	1	6,843
F5	2	2,168		Organic. Not rooted below O horizon	0	-
A1	-	-	-	-	2	9,038

1/ ± Standard Error.

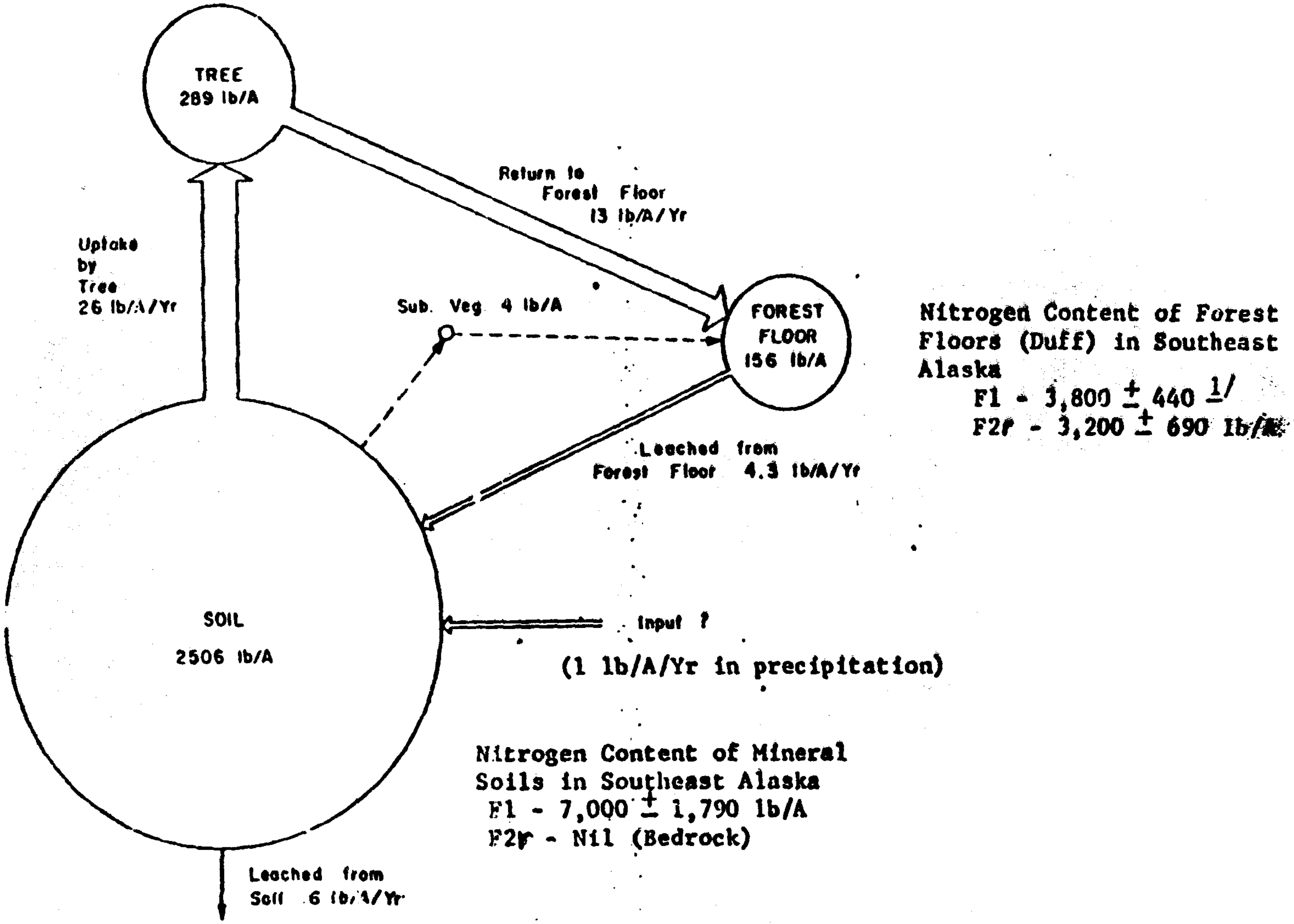


Figure 540.3 Distribution and cycling of nitrogen in a second growth Douglas-fir ecosystem in Washington and comparative soil nitrogen contents of two Southeast Alaska forest ecosystems. Diagram and Douglas-fir ecosystem data from: Cole, Dale W. and Stanley P. Gessel, Cedar River Research, a Program for Studying the Pathways, Rates, and Processes of Elemental Cycling in a Forest Ecosystem. Institute of Forest Products, University of Washington College of Forest Resources. Forest Resources Monograph Contribution No. 4. March 1968. 54 pp. Illus.

Based on accumulated soil nitrogen and inferred evidence, the following statements about the nitrogen cycle in southeast Alaska seem warranted:

1. Large quantities of nitrogen are held in the ecosystems.

2. Only a fraction of one percent of the total soil nitrogen is released annually for uptake by higher plants.

3. Available nitrogen is limiting productivity in many of our forest ecosystems.

4. Nitrogen leaching loss from most of our forest ecosystems must be at a very low level.

5. In most freely-drained soils, increased soil temperature (from clearcutting or thinning) or nitrogen content (from fertilizing) would result in increased organic matter decomposition and nutrient availability to higher plants.

541 - Implications to Fresh Water Ecosystems

"Primary productivity" (the base of the food chain) is at a low level in most fresh water ecosystems in southeast Alaska. In general, the greater their primary productivity, the greater the production of fish that feed for extended periods in fresh waters, such as resident trout, young steelhead, and coho and red salmon. Primary productivity is generally considered unimportant to pink and chum salmon production.

Primary productivity in an aquatic ecosystem varies with many factors. Among these are light, temperature, and the supply of essential elements. Organic staining of many of our waters would appear to limit primary productivity by reducing light available for photosynthesis. Cold water temperatures must also be limiting. However, if temperatures become too warm, salmonids can be adversely affected even though primary productivity is high. Of the essential elements, there are indications that nitrogen is limiting productivity in many freshwater ecosystems as it is in many terrestrial ecosystems.

Data from Kodiak Island indicate the optimum lake primary productivity occurs at levels of at least 0.25 to 0.5 ppm NO_3 and 0.05 ppm PO_4. This level of phosphate is evidently commonly exceeded in southeast Alaska's waters, but data from streams and lakes usually show less than 0.2 ppm of nitrate (Table 541).

Table 541. Nitrates and Phosphates in Some Freshwaters of the Region

Area and Name	Sample Date	General Watershed Ecosystems	NO_3(ppm)	PO_4(ppm)
Southeast				
Big (108) Creek	4/18/67	F(85%) M(8%) R(7%)	0.0	---
Staney Creek	4/19/67	F(77%) M(17%) B(1%) A(1%) R(3%)	0.1	---
Kadashan Creek				
Main Stem	6/25/68	F(62%) M(14%) B(9%) A+R(14%)	0.1	---
Lower "Hook" Creek	6/25/68	F(76%) M(4%) B(5%) A+R(13%)	0.0	---
Upper "Hook" Creek	6/25/68	F(51%) M(8%) B(18%) A+R(23%)	0.2	---
Upper Kadashan Creek	6/25/68	F(52%) M(20%) B(9%) A+R(19%)	0.2	---
"Tonalite" Creek	6/25/68	F(55%) M(14%) B(13%) A+R(17%)	0.3	---
Small Tributaries to Falls Creek				
#1	8/17/68	F (undisturbed)	0.062	0.695
#2	8/17/68	F (undisturbed)	0.063	1.02
#3	8/17/68	F (80% clearcut)	0.076	0.318
#4	8/17/68	F (80% clearcut)	0.087	0.850
#5	8/17/68	F (80% clearcut)	0.120	1.94
Mendenhall Flats				
Moraine Lake	8/16/56	flm (Sitka alder)	0.1	0.00
Glacier Lake	8/16/56	flm (Sitka alder)	0.2	0.00

Nitrogen is evidently limiting primary productivity in most of our fresh water ecosystems. Nitrogen is carried into freshwater aquatic ecosystem with:

1. Precipitation

2. Groundwater (including overland flow from muskegs)

3. Terrestrial detritus (primarily vegetative litter and insects)

4. Anadromous fish

To illustrate the gross magnitude of these sources, consider a hypothetical watershed with the following characteristics:

Watershed area	25,000 acres
Lake	500 acres
Stream courses (including smallest)	500 acres
Salmon run (75,000 pinks, 25,000 chums and cohos)	100,000 salmon.

Yearly nitrogen inputs:

1. Precipitation. Assume one pound per acre.

    1,000 acres of water = 1,000 pounds

2. Groundwater. Assume one pound per acre leached from soil.

    25,000 acres = 25,000 pounds

3. Terrestrial detritus. Assume 25 pounds per acre.

    600 acres of water = 15,000 pounds

4. Anadromous fish. Assume .09 pounds per fish.

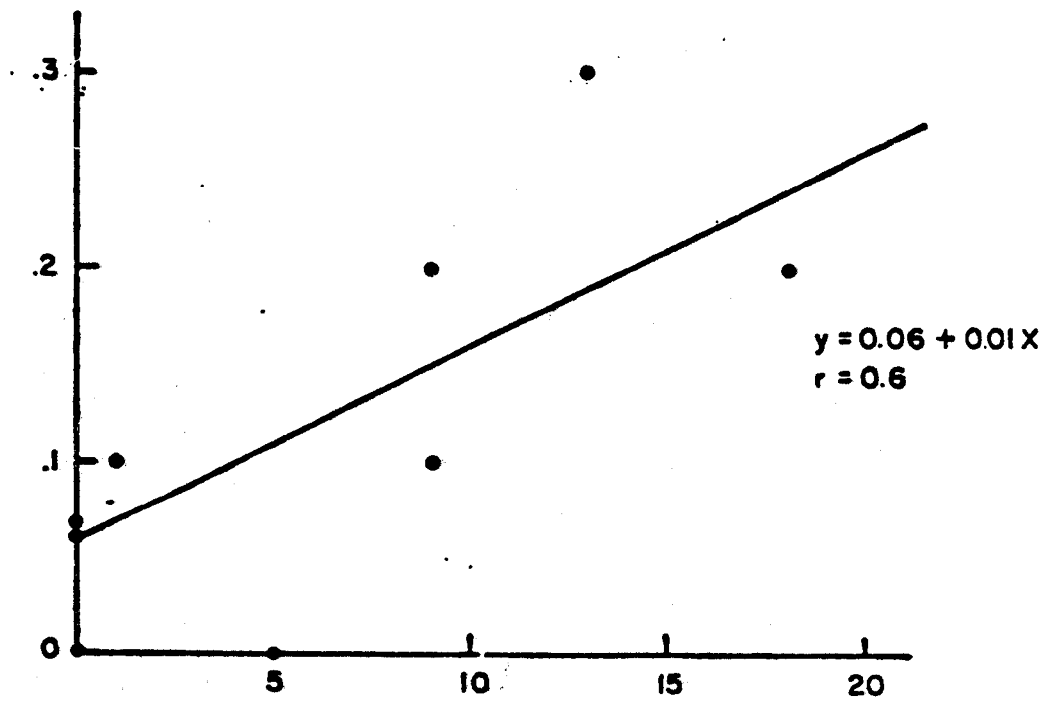
100,000 salmon = 9,000 pounds

This analysis is based on some rather broad assumptions and approximations. However, they should be somewhere near the real order of magnitude found in southeast Alaskan watersheds. The analysis indicates that about half the aquatic nitrogen source is from groundwater, 30 percent from terrestrial detritus, and 20 percent from decomposing salmon carcasses and eggs. The dead salmon source may be less important than indicated, as many carcasses are washed out to saltwater in the fall peak flows.

Of the terrestrial ecosystems, those dominated by alders will have the largest concentration of nitrogen in the groundwater. Although scanty, the data in Table 541 indicate this trend (fig. 541).

Management practices that increase available soil nitrogen supplies (fertilization, increased soil temperature from timber harvest) or reduce vegetative nitrogen uptake (timber harvest, herbicide treatments) should result in increased nitrogen in the groundwater, and consequently, increased freshwater primary productivity. Data in Table 541, from small tributaries to Falls Creek, indicate about a 50 percent increase in nitrate concentration resulted from clearcutting.

Figure 541. Relation of stream nitrate content to proportion of alder-dominated mature ecosystems in the watershed



Percent B ecosystems (SITKA alder slopes) in the watershed

CHAPTER 600 - ECOSYSTEM MAPS AND MAPPING

The location and extent of ecosystems are shown on soil maps. On the Tongass, soil mapping will show ecosystem families, types and subtypes. Mapping unit symbols will be ecosystem symbols, although the stage of vegetative succession is not inferred. This can be seen by the map user on the ground. For instance, recent clearcuts or burns, young growth, climax stands, etc. should be evident to the forester or other map user.

601 - Soil Mapping. Soils are mapped by a combination of on-the-ground investigations and aerial photo interpretation. It is not feasible to visit every delineation, nor is it possible to delineate every small area of soil that differs from the adjacent soil. These practical limitations faced by the soil scientist in preparing soil maps must be understood and recognized by all soil map users. Some of the ramifications of these limitations are discussed in the following sections.

602 - Mapping Units. The basic soil classification unit, corresponding roughly to species in the botanical classification system, is the soil series. The soil series consists of a group of soils with similar characteristics such as color, texture, kind, number and arrangement of horizons. Soil series are named for geographic features near where they were first discovered. Ecosystem types and subtypes often include more than one series that behave similarly ecologically and to management. Similarly, one series may occur in more than one ecosystem type. Ecosystems subtypes are also mapped. These are based primarily on soil materials and slope steepness and shape.

"Ecosystem mapping units" are delineated on the maps. Each mapping unit is a small, rather homogenous landscape. It is usually dominated by one or two ecosystems and occurs repeatedly in the area. These small repetitive landscapes each have a limited range of soils, climate, topography and vegetation. It is usually impossible to delineate mapping units that are "pure" and contain ecosystems of only one subtype. Mapping units, therefore, contain ecosystem types and subtypes differing from the dominant ecosystem. These minor ecosystem areas are called "inclusions."

If the ecosystem pattern is so complex that the map scale will not allow the delineation of mapping units dominated by one ecosystem type, a "complex" is used. An ecosystem complex is an area where two or more kinds of ecosystems occur in a repetitive pattern. The "undifferentiated unit" is used in areas where the ecosystems do not occur in a repetitive pattern, or where management intensity does not justify intensive soil investigations.

The ecosystems being mapped on the Tongass are defined in chapter 400.

<u>603</u> - <u>Ecosystem Symbols</u>. The ecosystem symbols used on the Tongass were designed to infer some of the characteristics of the ecosystems. This will, hopefully, allow the map user to associate certain ecosystem characteristics with the letters used in the symbols.

The first letter indicates the ecosystem family. Capital letters are used for mature ecosystem families and lower case letters for young ecosystem families. The letters used are as follows:

A Alpine

B Brushy slope

D Tide-influenced meadows (deltas)

F Forest

I Ice

M Muskeg

R Rock

V V-notch drainages

X Miscellaneous

A number usually follows the first letter in the ecosystem symbol. The number is to subdivide the ecosystem family into ecosystem types, based on features such as soil drainage, depth to bedrock, etc. that result in significant vegetative differences in terms of productivity or species composition.

Following the number will often be a lower case letter. This indicates a subdivision of the ecosystem type, and usually indicates some kind of soil material difference that is important to management. The letters used for ecosystem subtypes are as follows:

a volcanic ash

b uplifted beach deposits

c compact till

d deep

e sand dunes

f fine textured deposits

g gravel

l landslide

m moraine

n normal

o outwash sands

r rock

t terrace

x miscellaneous

Steep slopes are indicated by underlining the ecosystem symbol; a single underline for steep, smooth slopes and a dashed underline for steep, broken slopes.

604 - Kinds of Mapping Units. The symbol "F1a" (a single ecosystem subtype) indicates that the delineated landscape is dominantly steep F1 ecosystems on ash. However, inclusions of other ecosystems are likely to be found, such as F4a, F2r, etc. Inclusions are almost always present in delineated ecosystem units.

A complex of ecosystems is indicated by two letters or two numbers such as F12, (a complex of F1 and F2 ecosystems) or MF5 (a complex of M2 and FS ecosystems). The major components of ecosystem complexes are defined in the map legend.

Undiferentiated units may be shown by a single capital letter such as A, (undifferentiated alpine ecosystems) or a combination of symbols such as Fflt (an undifferentiated group consisting of Flt and flt). Any one delineation so designated may be dominated by one or the other or both of these ecosystems.

Because of the unavoidable existence of inclusions, <u>on-site investigations are necessary to determine the ecosystem at any point</u>.

<u>605</u> - <u>Correlation of Earlier Soil Reports</u>. Several soil reports with maps have been issued prior to development of this classification. The ecosystem equivalents of the mapping units used are given in this section.

<u>605.1</u>

TO BE WRITTEN

The ecosystems of the Tongass are being used to produce timber, water, wildlife habitat and recreation opportunities. Often these uses occur simultaneously on the same land. However, different ecosystems may have vastly different suitabilities for each of these uses. Ecosystem-management relations are discussed in this chapter.

Information on Tongass National Forest ecosystems and their management has been collected since the start of the Region's soils program in 1961. Ecosystem suitability, productivity and management limitation information is listed in Table 700. The land manager can use the information in this table and the explanations under the various functional subsections to better plan the use of the land. The interpretations in Table 700 and this section are not intended to dictate the use of the land but to evaluate its potential for various uses.

The ratings in Table 700 are by ecosystem classification units, usually by individual ecosystem types or subtypes. These are not the same as mapping units. Mapping units are often complexes of ecosystem classification units and almost all mapping units contain undesignated inclusions (see Chapter 600).

Soil maps may be colored for any of the ratings in Table 700. For example, green could be used for the "best" rating, yellow or orange for "intermediate" ratings and red for the "worst" rating. Sitka spruce site index, for instance, could be color coded for an entire soil map or any part of it. The same could be done for landslide hazard, cont. Table 541. Nitrates and Phosph[illegible]s in Some Freshwaters of the Re[illegible]

Area and Name	Sample Date	General Watershed Ecosystems
Mendenhall Flats		
Glacier Lake	8/31/56	Gfl (Sitka alder)
Glacier Lake	9/12/56	Gfl (Sitka alder)
Glacier Lake	10/13/56	Gfl (Sitka alder)

Table 700. Ecosystem Use and Management Interpretations. [1/]

	Soil Names	Tallest Sitka Spruce Site Index	Susceptibility To Induced Sediment Production	Landslide Hazard	Depth to Seasonal Saturation Level (feet)	Compactibility	Deer Forage Productivity Forbs	Deer Forage Productivity Shrubs	Usual Depth to Bedrock (feet)	Usual Road Construction Problems
A 1	Sunnyhay	-	L	L	0-1/2	H	H	H	1/2-2	Rock
A 1a	Unnamed	-	M	M	1-3	H	H	H	1-5	Cutbank Erosion
A 2	Hydaburg	-	VL	VL	0	H	H	L	2-3	Wetness
A 2a	Unnamed	-	L	VL	0	H	H	L	2-6	Wetness, cut-bank erosion
B	Shakan	-	H	M	1-3	M	H	H	1-6	Cutbank Failures Avalanches
D	Unnamed	-	L	VL	0[4/]	L	H	L	6+	Flooding
E11	Unnamed	125[3/]	VH	?	1/2-3+	H	Var.	Var.	1-6+	Cutbank Failure, Landslides
E1t	Tonowek	150[2/]	M	VL	1-3[5/]	H	H	H	6+	Occasional Floods
F1	Ulloa, Naukati, Tolstoi, Sarkar Kupreanof, Tokeen	150	L	L	2-3+	H	L	H	1-6	Few
F1	"	150	H	H	2-3+	H	L	H	1-3	Cutbank Failures Landslides
F1a	Kadashan	150	M	M	3+	M	L	H	6+	Cutbank Erosion
F1a	" "	150	H	H	3+	M	L	H	2-6+	Cutbank Erosion Landslides
F1b	Salt Chuck	150	L	VL	3+	L	L	H	6+	Few
F1c	Karta	150	M	M	1 1/2-3	M	L	M	4-6+	Cutbank Failures
F1c	" "	150	H	VH	1-2	H	L	H	3-6+	Landslides Cutbank Failures

Table 7. Ecosystem Use and Management Interpretations.

	Soil Names	Tallest Sitka Spruce Site Index	Susceptibility To Induced Sediment Production	Landslide Hazard	Depth to Seasonal Saturation Level (feet)	Compactibility	Deer Forage Productivity Forbs	Deer Forage Productivity Shrubs	Usual Depth to Bedrock (feet)	Usual Road Constructi Problems
F1d	Kupreanof	150	L	L	3+	M	L	M	6+	Cutbank Failures
F1f	Sitkum	150	M	M	1-2	H	L	H	6+	Severly Un stable cut
<u>F1f</u>	" "	150	VH	VH	1-2	H	L	M	6+	Severly Un stable cut Landslides
F1t	Tuxekan	150	L	VL	3+	M	L	M	6+	Few
F2l	Unnamed		M	?	0	L	L	L	0	Rock
F2	Sarkar, Tolstoi Shallow	120	L	L	1/2-3+	M	L	M	1/2-1	Rock
<u>F2</u>	" "	120	H	M	1/2-3+	M	L	M	1/2-1	Rock Cutbank Failures
F2r	McGilvery	90	L	L	1/2-3+	L	L	H	0-1/2	Rock
F3	Unnamed	130	L	L	3+	M	L	M	6+	Few
F3a	Kruzof, Sitka	130	M	M	3+	M	L	M	6+	Cutbank Erosion
<u>F3a</u>	" "	130	H	H	3+	M	L	M	2-6+	Cutbank Erosion Landslides
<u>F3a</u>	" "	130	H	H	3+	M	L	M	2-6+	" "
F3b	Sokolof	130	VL	VL	3+	L	L	M	6+	Few
F3g	Unnamed	130	L	VL	3+	L	L	M	6+	Few
F3o	Unnamed	130	L	VL	3+	L	L	M	6+	Few
F4	Unnamed	120	L	VL	1/2-1	M	M	H	6+	Few

Table 7??. Ecosystem Use and Management Interpretations.

	Soil Names	Tallest Sitka Spruce Site Index	Susceptibility To Induced Sediment Production	Landslide Hazard	Depth to Seasonal Saturation Level (feet)	Compactibility	Deer Forage Productivity Forbs	Shrubs	Usual Depth To Bedrock (feet)	Usual Road Construction Problems
F4a	Snelikof	120	M	H	1/2-1	M	M	H	6+	Cutbank Erosion and Failures
F4a	" "	120	H	H	1/2-1	M	M	H	2-6+	Same plus Landslides
F4b	Unnamed	120	L	VL	1/2-1	M	M	H	6+	Few
F4c	Wadleigh	120	M	M	1/2-1	M	M	H	4-6+	Cutbank Failures
<u>F4c</u>	" "	120	H	VH	1/2-1	M	M	H	2-6+	Same plus Landslides
F4d	Shinaku	120	L	L	1/2-1	M	M	H	6+	Cutbank Failures
F4f	Slodue	120	H	M	1/2-1	M	M	H	6+	Severely unstable cuts
<u>F4f</u>	" "	120	VH	VH	1/2-1	M	M	H	6+	Same plus Landslides
F4r	Woewodski	120	L	L	1/2-1	M	M	H	1-2	Rocks, Cutbank Failures
<u>F4r</u>	" "	120	H	H	1/2-1	M	M	H	1-2	Same plus

	Soil Names	Tallest Sitka Spruce Site Index	Susceptibility To Induced Sediment Production	Landslide Hazard	Depth to Seasonal Saturation Level (feet)	Compactability	Deer Forage Productivity Forbs	Shrub	Usual Depth to Bedrock	Usual Road Problems
F5	Maybeso	75		VL	1/2	M	M	M	4-6+	Wetness
F5	" "	75	L	L	1/2	M	M	M	4-6+	Wetness, cutbank failures
F5b	Karheen	90	VL	VL	1/2	M	M	M	2-6+	Wetness
F5d	Unnamed	75	VL	VL	1/2	M	M	M	6+	Wetness deep Organics
F5f	Sumdum	75	H	L	1/2	M	M	M	6+	Severly unstable cutbanks
F5r	Kaikli	75	VL	VL	1/2	M	M	M	2-4	Wetness, rock
F5r	" "	75	L	L	1/2	M	M	M	2-4	Same plus cutbank failures
F6	St. Nicholas	90 3/	L	L	1/2-1	M	M	M	1/2-3	Rock, wetness
F6	" "	90 3/	H	H	1/2-1	M	M		1/2-3	Same plus Landslides
F7	Tuneneán	70 3/	H	H	0	M	H	L	1/2-3	Same
Fx	Unnamed	40-100	Var.	Var.	2-3+	M	L	M	1/2-6+	Rock cutbank Failures
I	(Ice)	—	VL	—	—	—	L	L	6+	Ice
M1	Kogish	—	VL	VL	0	M	L	L	6+	Wetness
M1d		—	VL	VL	0	H	L	L	15+	Deep organics
M2	Kina	—	VL	L	0	H	M	L	6-10+	Wetness
M2	"	—	L	L	0	H	M	L	4-10+	Wetness, cutbank failures
M3	Staney	—	VL	VL	0	H	M	L	10-15+	Deep Organic Flooding
R	(Rock)	—	VL	L	—	L	L	L	0	Rock
V	(V-notch)	Var.	VH	VH	Var.	M	Var	Var.	Var.	Severe cutbank failure Avalanches Landslides

	Soil Names	Tallest Sitka Spruce Site Index	Susceptibility To Induced Sediment Production	Landslide Hazard	Depth to Seasonal Saturation Level (feet)	Compactability	Deer Forage Productivity Forbs	Shrub	Usual Depth to Bedrock	Usual Road Problems
Va	(V-notch)	Var.	VH	VH	Var.	H	Var.	Var.	Var.	Severe cut bank failu Avalanches Landslides
Vf	" "	Var.	VH	VH	Var.	H	Var.	Var.	Var.	Extremely Unstable
Vr	" "	-	H	H	Var.	L	L	L	0	Rock, Avalanchin
X1	Kah Sheets	-	L	M	1/2-1	H	H	H	1/2-2	Rock
X2	Unnamed	-	L	VL	1/2-2	M	H	L	2-6+	Few

1/ Abbreviations: -, not applicable; Var., Variable, L, Low; M, Moderate; H, High; V, Very.
2/ This ecosystem is usually poorly stocked with Sitka spruce and little hemlock.
3/ Estimated
4/ Flooded by highest tides.
5/ Occasionally flooded during high runoff.

compactibility, deer forage, etc.

Definitions of terms used in Table 700 are in the following sections. The first column in Table 700 lists the ecosystem classification unit. The second, the classified soils that are grouped in the ecosystem types and subtypes. These names are all tentative and subject to change during official Soil Conservation Service correlation. Many ecosystem subtypes do not have named soils, because National Cooperative soil surveys have not yet been made in areas where these soils occur.

The figures given in the column "tallest Sitka spruce site index" are averages as determined in the Soil-Site Index Administrative Study. A few figures are estimated and so indicated by footnotes. A dash indicates the ecosystem is not suited for timber production and "var." indicates highly variable site indexes. These site indexes are, according to present data, about 10 units higher than those shown in Bulletin No. 412.

Ratings under "susceptibility to induced sediment production" are relative within the Tongass National Forest. There are not comparable to other areas. For instance, an ecosystem that rates "high" in the Tongass might rate "low" in California, in terms of tons per acre of sediment reaching the stream after soil disturbance. The classes in Table 700 are as follows:

"Very high" indicates ecosystems on very steep slopes that are most likely to slide or erode when disturbed. These ecosystems contribute large quantities of sediment to streams under natural conditions.

"High" These ecosystems are also on steep slopes, but because of their soil materials and vegetation are less likely to produce damaging stream sediments than those rated "very high." Also included are some ecosystems with soils of fine texture on gentle to moderate slopes.

"Moderate" indicates ecosystems on moderate or short, fairly steep slopes or terraces. These soils are generally stable until disturbed, when erosion, small slides or slumps may occur.

"Low" indicates very shallow mineral soils, soils on gentle slopes, or organic soils on fairly steep slopes that have little sediment-producing hazard.

"Very low" indicates organic soils on gentle slopes.

Landslide hazard gives relative ratings for potential landslide problems of the various ecosystems. Several characteristics are considered in this rating, including soil depth, landform, permeability of the profile, and steepness of slope. Soils occurring on long, smooth, steep slopes with impermeable substrata have the highest landslide hazards. Other soils with high landslide hazards include those with fine textured substrata on steep slopes and those in with extremely steep slopes such as the V-notched drainage ways.

"Depth to seasonal saturation level" in the soil is given in feet to the normal fall water table level. The water table may be a perched, thin water table or the regional ground water table.

Relative ease of soil disturbance from compactive forces is given under "compactibility." These rating are relative for the Tongass forest. For instance, many of the soils rated "low" might be rated moderate or high in other areas of the United States. This rating is based on soil coarse fragment (gravel and stone) content, colloid content, and drainage.

"Deer forage productivity" is given in relative ratings under "forbs" and "shrubs" as found under mature vegetation. Forested ecosystems generally go through a period of high forage productivity after timber removal. However, after 20 or 30 years, productivity becomes almost nil as the young conifer canopy closes. Kinds of forbs and shrubs found in the various ecosystems are given in the ecosystem descriptions.

The last two columns, "usual depth to bedrock" and "usual road construction problems" are primarily for engineering use.

710 - Timber Management. Timber productivity levels vary with individual ecosystems. The soils of the Tongass are rarely dry enough to seriously limit conifer growth (figure 413.01). Cool soil temperatures, excess soil water in soils with restricted drainage, and especially, fertility (figure 540.1) limit tree growth on the Tongass.

The site indexes given in Table 700 are for the tallest Sitka spruce. These are not the same as those used in bulletin 412. Until better information is available, site indexes about 10 units less than those shown in Table 700 can be used to determine yields.

Experience from past logging indicates few problems with natural regeneration, except on ecosystem flt and areas of exposed mineral soil. Alder and brush competition is usually a problem on ecosystem f1t. Bare mineral soil, because of frost heave, has been proven to be a poor seed bed in all ecosystems, except perhaps ecosystem F3b, F3g and F3o. Regeneration is delayed for several years, until a cover of moss and lichens becomes established. Red alder, if a seed source is available, usually dominates the site for many years on exposed mineral soils, except in ecosystems f21, F2r, F3g and F?0. Where the mineral soils on these ecosystems is exposed, however, spruce and hemlock growth is greatly retarded in comparison with the adjacent soil where the duff layer is at least partially intact. Grass seeding and fertilizing has been shown to promote spruce regeneration and growth while retarding red alder growth on exposed mineral soils.

Windthrow hazard is high on all timbered soils, as root systems of spruce and hemlock are generally shallow. Physiography and wind patterns appear to have more to do with windthrow than the soils.

Surface soil erosion from logging operations has been, at worst, only a minor problem. It can occur on swing roads, tractor roads, or other places where mineral soil is exposed. Erosion may be more serious on soils from ash and fine textured deposits. Aerial cable logging systems, well-constructed water bars and immediate revegetation of exposed minerals soils can reduce this hazard.

There is some evidence that landslides are increased by logging susceptible ecosystems. However, landslide concentrations can and do occur in similar ecosystems that have not been logged.

Soil damage from tractor logging is usually serious in all ecosystems except those rated "low" in compactibility.

720 - Watershed Management. Water is essential for man and all living things. An abundance of cool, clear water is required by spawning salmon and trout. The salmon originating in the Tongass are important to the local and regional economy. Water is used for domestic, industrial and hydroelectric purposes. Water is an important product of the Tongass National Forest.

The Tongass forest has an abundance of water, although it varies widely in quality and seasonal availability. This variation is due primarily to the source ecosystems in the watershed. Stream flow is generally unstable with wide ranges in discharge, even though surface runoff occurs only on poorly-drained soils. The soils are highly porous, although many have slowly permeable layers at various depths. Water seeps rapidly through the better-drained soils, over slowly permeable layers, and into streams.

Muskeg and F5 ecosystems contribute large quantities of organic sediments to streams, resulting in typical "muskeg-colored" water. These dark organic matter-stained waters must reduce light availability and primary productivity. Glaciers and ecosystems with high rates of natural geologic erosion (those rated "very high" under "susceptibility to induced sediment production") contribute large quantities of mineral sediments to streams.

The mature soils of the Tongass are very resistant to accelerated erosion. As long as their thick duff layers remain intact, surface soil erosion cannot occur. The mineral soils are high in organic matter and iron and aluminum oxides, factors which contribute to resistance to soil particle detachment. Surface runoff or indications of surface runoff have not been observed on the better-drained mineral soils of the Tongass, except those low-lying soils which are sometimes flooded. The soils are all permeable, at least down to impermeable or slowly permeable layers that may occur as substrata. Therefore most soils do not saturate to the surface. Without surface runoff, surface erosion cannot occur.

Permeable soils over restrictive layers contribute to unstable stream flow, because moisture moves rapidly down through the profile and over impermeable layers into streams. There is evidence that muskegs contribute even more to unstable stream flow. As they are saturated to the surface during periods of high rainfall, surface runoff does occur on these soils. Alpine and F5 ecosystems may also operate in a similar manner. Muskeg soils also contribute to warm summer stream temperatures, as water movement is dominantly in the upper profile which is largely exposed to sunshine.

The manager working with watershed protection and management should refer to columns labeled "susceptibility to induced sediment production", "landslide hazard", "depth to seasonal saturation level" and the various ecosystem decriptions in chapter 400 for quantitative information.

730 - Recreation. The Tongass forest has abundant recreation attractions - fishing, hunting, scenery, photography, etc., and recreation use is increasing rapidly. Many factors other than the ecosystem play a major role in the selaction of sites for recreation developments. The attractions and access factors often outweigh ecosystem factors.

Because of this, recreation sites sometimes have to be established on undesirable soils, thus increasing the cost of both installation and maintenance. In some cases, however, ecosystem characteristics and qualities can be a major consideration in selecting sites for recreation developments.

The recreation manager will be most interested in the columns "depth to seasonal saturation level" and "compactibility" in assessing the desirability of alternate ecosystems for recreation improvements, as these two features are the most wide-spread problems in recreation developments. "Usual depth to bedrock" is also an important feature in some types of recreation installations, such as pit toilets.

740 - Wildlife habitat. The Tongass National Forest provides habitat for large numbers of a variety of mammals, fish, and birds. Some ecological zones are suitable habitat only seasonally, but year-round habitats are available for fish, deer, bear, wolf, goat, moose and many birds and smaller creatures. The wildlife habitat manager will find pertinent information in the ecosystem descriptions (Chapter 400) and in Table 700. The columns under "deer forage pruductivity" contain relative ratings of forage production in natural stands.

The alpine country (A ecosystems and R) is an important summer habitat for deer, volves, bear, mountain goat, ptarmigan and a wide variety of smaller birds and mammals. The open meadows abound with grasses, sedges, forbs and a variety of berries during the summer. Cover is available in the rocks, brush and adjoining forest ecosystems. Streams, ponds and lakes are numerous and water is not limiting to wildlife populations.

The freely-drained forest ecosystems (F1, F2 and F3) provide year around wildlife habitat. Succulent foods are available during spring and summer. Leaves, twigs, and in season, berries of bluberry, elder-berry, etc. are eaten by deer, bear and other animals. Spruce seeds provide food for small mammals and birds. The shrub and evergreen forb species in these ecosystems are vital for the deer's winter survival. Cover and water are generally plentiful in all these ecosystems. Following logging, the low brush and forb vegetation provides an even greater food supply except during periods of heavy snow pack. After about 20 years, however, growing conifer stands shade out almost all the understory plants except moss and fungi.

The relatively wet forest ecosystems (F4 and F5) provide excellent seasonal habitat for wildlife. The "edge" environment between muskeg and adjoining forest is rich with browse species as well succulent skunk cabbage, marsh marigold and other forbs and grasses.

The muskeg ecosystems provide seasonal habitat for deer and bear. Deep snows limit their use during the winter. In the spring, deer and bear eat the succulent grasses, sedges and forbs of these ecosystems. They are also favored nesting areas for many kinds of birds.

The tide-influenced meadow ecosystems are heavily-used by bear and deer in the spring and by waterfowl throughout the year.

The pink, coho, sockeye and chum salmon that spawn in the Tongass are important to the economy of the state as well as to the bear, wolves, and many birds and small furbearers. The streams and lakes also provide year-around and seasonal habitat for other important fish such as the steelhead, cutthroat and rainbow trouts and Dolly Varden. Proper maintenance and improvement of fish habitat depends upon an understanding of the watershed ecosystems.

750 - Engineering. The ecosystems of the Tongass have many characteristics that affect their use for road and trail constructon or building foundations. Experience has shown that most soil materials are not useable for road fill. The ASSHO and Unified ratings serve no useful purpose for the mature soils of the Tongass and are therefore not listed. Because the soils are so high in organic matter and iron and aluminum oxides, and are perpetually moist, only those with ASSHO ratings of A-1-a are useful, and even these must be used with caution. Ecosystems D, f1t, F1b, F1t, F3b, F3g, and F3o may have material in their substrate that is useable for road construction. Young ecosystems from glacial till or outwash frequently have soil material suitable for road fill, but as soil development progresses, colloidal accumulation in the profile makes it unsuitable. Occasionally, mature ecosystems will overlie suitable deposits at great depth where soil formation and weathering have not been effective. Soils with high colloid content (humus and iron and aluminum oxides) are "thixotropic". That is, they tend to have fair to good stability when undisturbed, but become fluid on disturbance. They hold large quantities of water at field capacity and wilting point (fig. 413.02). Therefore, they cannot be dried enough to make them useful for road fill.

Deep organic soils have been a problem to road construction in some areas. Most muskegs are not deep and are favored for overlay road construction as they require little or no clearing. The occasional deep muskeg, however, can become a serious problem if the road "breaks through" the fibrous surface mat of undecomposed organic matter and roots.

The columns "usual depth to bedrock", "usual road construction problems", "depth to seasonal saturation level", "landslide hazard", and "susceptibility to induced sediment production" should be referred to by engineears locating and designing roads. The column "compactibility" is useful to those locating and designing trails. Moderate to heavy use trails will require some sort of protective overlay on ecosystems where compactibility is rated "high."

The mapping and data are somewhat generalized and <u>on-site inspection is necessary prior to design of specific engineering works</u>.