

Air Quality

Goal: Maintain the current air resource condition to protect the Forest's ecosystems from on- and off-Forest air emissions sources.

Objective: Attain national and state ambient air quality standards Forest-wide.

Background: The Forest Plan anticipated localized, temporary, and limited direct effects on air quality from forest management activities within the Tongass National Forest such as dust, vehicle and small boat emissions, permitted incinerators, mineral development, and prescribed fire. Indirect effects were anticipated from off-Forest sources such as large cruise ship emissions, pulp mill emissions, and firewood burning. There are no Class I areas within or adjacent to the Tongass National Forest. All wilderness areas on the Tongass National Forest are considered Class II, as all other lands are considered on the Tongass.

From 1989-1992 eighty permanent baseline plots were established across the Tongass National Forest using lichens for biomonitoring air quality (Geiser et al. 1994). Such monitoring (ideally in combination with instrument monitoring) offers an economical approach that can provide a sensitive overview of air quality, detect fairly small changes in air quality geographically or over time, and identify areas that might need instrument monitoring. Results indicated that most elemental values for the Tongass (concentration or parts per million dry weight) were within expected ranges for non-industrial locations and were comparable to or lower than values available from other national parks or forests. The elements calcium, magnesium, potassium and manganese were slightly higher than other regions, probably due to marine influences. A preliminary study of lichens around the Sitka pulp mill was also initiated, finding elevated concentrations of sulfur, phosphorous, sodium, copper, nickel and cadmium. In 2005, the Forest completed a three-year effort to re-visit a portion of the permanent plots in wilderness to monitor possible changes in air quality through lichen tissue samples and community data. This recent effort also established baseline plots for wilderness areas not visited during the 1989-1992 study.

Juneau's Mendenhall Valley is the only area in Southeast Alaska that is known to have exceeded national ambient air quality standards (EPA 2008). This area, including about 5000 acres of Tongass National Forest, was designated a non-attainment area for PM_{2.5} particulate matter due to wood smoke and road dust in the early 1990s. The same has occurred between the years 2000 and 2006 where the levels have shown an increase greater than 1 µg/m³ (EPA 2008a). The Clean Air Act established regulatory authority for air quality within the Environmental Protection Agency (EPA) and Alaska Department of Environmental Conservation (ADEC 2008). ADEC's monitoring strategy is to focus its limited resources on the highest priority areas and pollutants (i.e. areas and pollutants most likely to exceed a public health standard). For Southeast Alaska, ADEC has focused its efforts on monitoring PM₁₀ and PM_{2.5} and (particulate matter) in Juneau's Mendenhall Valley. The Forest Plan concluded that EPA and ADEC enforcement of applicable regulations would ensure compliance with air quality standards around the Juneau area.

All marine vessels including vessels covered under the State of Alaska's Department of Environmental Conservation (ADEC) Commercial Passenger Vessel Environmental Compliance (CPVEC) program must comply with Alaska's marine vessel emission standard (ADWCD 2008). The vessel smoke stack visible emissions must be no greater than 20%

opacity, except when maneuvering to/from anchor or port. Ports in Juneau, Skagway, Sitka and Ketchikan are near Tongass National Forest boundaries. Extra work is being conducted in Tracy Arm wilderness to monitor visible emissions from cruise ships that visit this wilderness.

Due to concerns about the air quality in downtown Juneau, an ADEC contractor set up ambient air monitors during 2000 and 2001 to measure the level of selected pollutants that are harmful to public health and the environment (i.e. sulfur dioxide, nitrogen dioxide and microscopic particles of PM 2.5). A committee of ADEC scientists, concerned citizens, industry representatives and the U.S. Coast Guard employees selected the air monitor locations. Three downtown ambient air monitoring stations were installed in 2000: Baranof Hotel, Capital Park, and Marine Way. In 2001, three monitoring stations were installed: Wickersham House, Highlands and Marine Way. Data from these monitors were appreciably below the State and national air quality standards in both 2000 and 2001. ADEC concluded that current air pollution concentrations in Juneau would not result in adverse effects on human health or welfare. Due to the levels being low in 2000 and 2001, ADEC decided to discontinue the monitoring. The ADEC has listened to haze concerns made by local residents but they did not begin any more monitoring in 2006 due to lack of funding (ADWCD 2008).

Question 1: Is air quality meeting state and federal ambient air quality standards?

Tongass National Forest Air Quality Monitoring Program and Results:

Lichen Biomonitoring and 2007 Monitoring Results

The results of the most recent biomonitoring initiative using lichens are reported (Dillman et al 2007). Its objectives were to: 1) Establish monitoring sites in wilderness areas that were not part of the baseline monitoring study of 1989-1994 (10- Year Wilderness Stewardship Challenge (10 YWSC), FSM 2580.44), 2) Perform elemental analysis of lichens from wilderness areas that were part of the initial baseline monitoring study to detect possible changes in concentrations of plant nutrients and metal-containing contaminants over time (10YWSC, FSM 2580.44), 3) Determine whether relationships exist between element concentrations in lichens and several physiographic site characteristics, 4) Establish Forest-wide provisional threshold levels for four lichen species and 27 elements (NFMA, FSM 2850.44), 5) Identify areas on the Forest where element concentrations in lichens are elevated above threshold (National Forest Management Act (NFMA)), 6) At locations where thresholds are exceeded, determine whether enhancement is due to anthropogenic or natural sources (10YWSC, NFMA, FSM 2580.44), and 7) Determine patterns of contaminant accumulation in lichens near downtown Juneau on Mt Roberts and at Greens Creek mining facility on Admiralty Island (FSM 2580.44). Monitoring locations outside wilderness near known polluted areas will be used in future modeling of air pollution gradients in the Alaska Region.

To date, 127 biomonitoring plots are established across the Tongass that have provided lichen tissue chemistry data (Figure 1). Of the 127 plots, 54 are in wilderness. Of the 54 plots in wilderness, 13 were revisited during the second monitoring period between 2003 and 2005. Except for the Maurelle Islands, all wilderness areas on the Tongass contain air

quality biomonitoring plots (Dillman et al 2007). Lichen biomonitoring plots were also established at the Greens Creek Mine on Admiralty Island and along an elevational gradient on Mt Roberts in Juneau. Some of the other areas outside wilderness areas where lichen biomonitoring plots have been established are on Baranof, Mitkof, and Revilla Islands, and along Lynn Canal (Figure 1).

From the 1989 to 1992 and 2003 to 2005 data collection periods, threshold levels were determined per lichen species and pollutants from 88 of the 127 biomonitoring plots (Table 1). All of data from the 54 wilderness plots were included. Some of the other plots considered “pristine” are from Pikes Lake Research Natural Area (RNA), Old Toms Creek RNA, Dog Island, Kell Bay, Cape Fanshaw RNA, and Crystal Mountain on Mitkof Island.

Provisional elemental analysis thresholds are levels of elements per lichen species that can be expected at a clean air site on the Tongass National Forest. Levels above threshold might be considered elevated due to anthropogenic or natural processes. Natural processes could be airborne oceanic salt spray or glacial dust. Thresholds were estimated for each element and lichen species by using the non-parametric 97.5% quantile in the lichen tissue data collected from 88 plots considered relatively free of human disturbance and pollution effects. Elemental threshold levels in lichens can be used by land managers to determine if the lichens in an area of concern have elevated levels of pollutants.

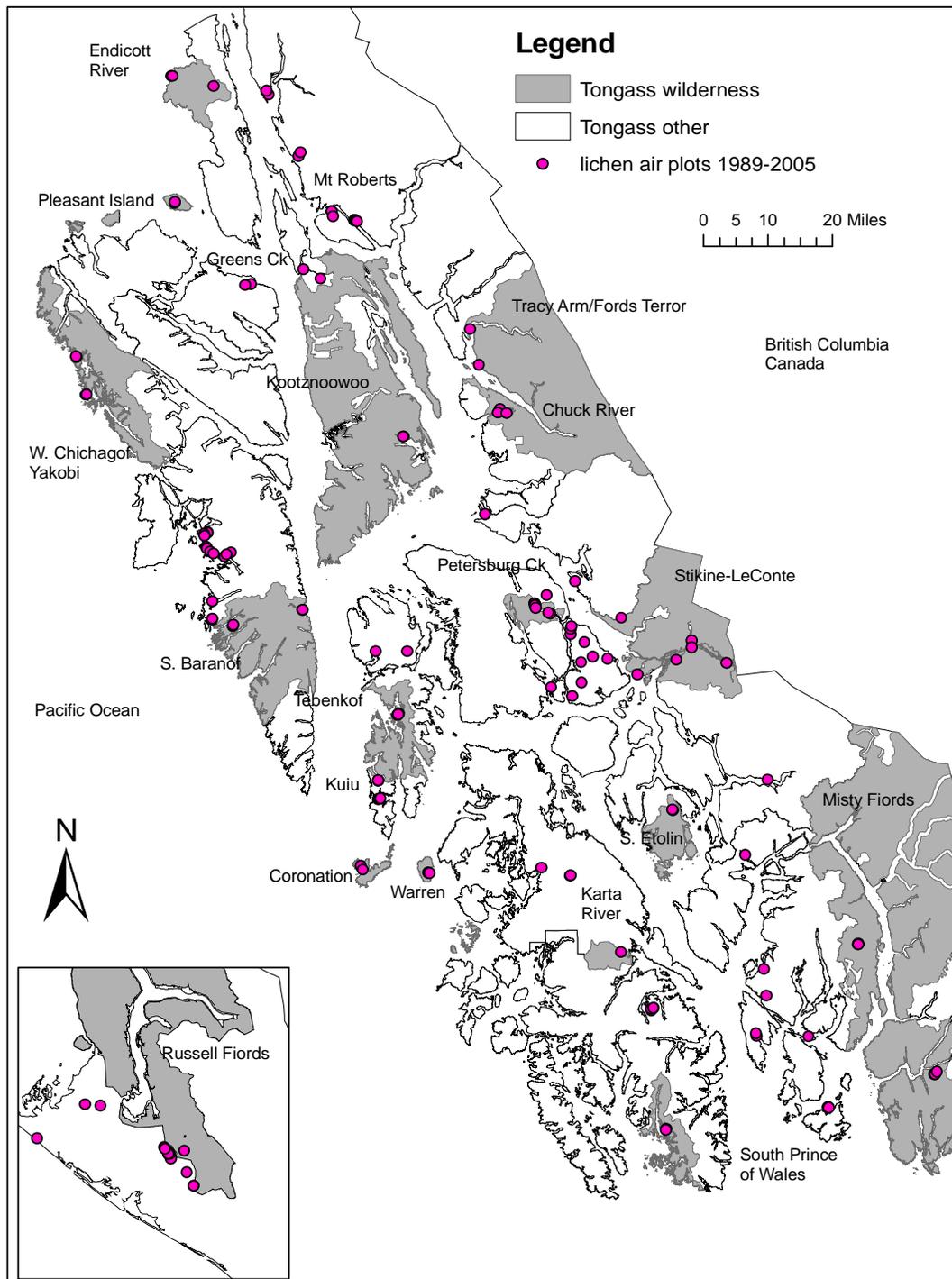


Figure 1. Lichen biomonitoring plots on the Tongass National Forest that contains elemental data.

Table 1. Threshold levels for four lichen species and elements in pristine areas of the Tongass National Forest. All elements, except nitrogen (N) and sulfur (S) are reported in ppm (parts per million). Nitrogen and sulfur are presented in percent (%) of dry weight. Alesar=*Alectoria sarmentosa*, Hypog=*Hypogymnia* species, Lobore=*Lobaria oregana*, Plagla=*Platismatia glauca*.

Al=aluminum, B=boron, Ba=barium, Be=beryllium, Ca=calcium, Cd=cadmium, Co=cobalt, Cr=chromium, Cu=copper, Fe=iron, K=potassium, Li=lithium, Mg=magnesium, Mn=manganese, Mo=molybdenum, Na=sodium, Ni=nickel, P=phosphorus, Pb=lead, Rb=rubidium, Si=silicon, Sr=strontium, Ti=titanium, V=vanadium, and Zn=zinc.

Species	S	N	Al	B	Ba	Be
Alesar	0.06	0.56	56.78	9.33	15.84	0.04
Hypog	0.09	0.88	1126.44	9.47	76.62	0.04
Lobore	0.13	NA	580.03	4.06	16.46	0.04
Plagla	0.08	0.80	1063.57	6.05	53.80	0.04
Species	Ca	Cd	Co	Cr	Cu	Fe
Alesar	9689.25	0.40	0.78	0.73	1.86	55.64
Hypog	24671.17	0.61	1.25	2.38	31.31	1990.78
Lobore	1158.10	0.55	0.83	1.51	10.18	1010.97
Plagla	4104.48	0.32	1.14	3.29	7.55	1773.56
Species	K	Li	Mg	Mn	Mo	Na
Alesar	2413.25	0.40	740.83	188.24	0.54	893.16
Hypog	3284.34	0.71	2127.70	860.85	0.54	929.13
Lobore	8001.57	0.59	735.79	168.00	0.54	394.30
Plagla	2523.88	0.60	1717.08	483.70	0.54	693.21
Species	Ni	P	Pb	Rb	Si	Sr
Alesar	0.96	913.75	5.00	53.00	134.75	33.56
Hypog	4.26	1597.23	10.13	53.00	563.82	61.26
Lobore	1.65	2532.49	3.52	53.00	681.18	6.30
Plagla	2.65	1115.00	3.52	53.00	635.83	28.91
Species	Ti	V	Zn			
Alesar	4.93	0.37	38.06			
Hypog	62.42	2.99	70.20			
Lobore	45.30	2.42	82.93			
Plagla	76.86	3.08	52.85			

Of the 127 monitoring sites, 58 contained at least one lichen species that was at or above the threshold for one or more elements. Twenty of the 58 are in wilderness areas. Most of the elevated concentrations of certain elements in lichens from wilderness areas were likely due to natural variation, possibly enhanced by salt spray in exposed locations (e.g. Ca, Mg, K, S, and Mn), local geology or windblown soils (e.g. Al, Ba, Li, Si, Ni, Ti). Additionally, some lichens from wilderness monitoring sites at beach locations were above threshold for elements such as sulfur and nitrogen (i.e. Coronation, Warren and Tebenkof). Although ocean spray is likely the source for these elements, the bays in these wildernesses are also popular marine vessel anchorages where fossil fuel combustion releases nitrogen and sulfur containing emissions. Most of the wilderness areas that contain lichens elevated above threshold are in locations with exposure to the open ocean or to the interior climates of the mainland (i.e. Tebenkof, Endicott River, Stikine River, Russell Fjords, Coronation, Warren). Mainland areas tend to be drier and contain windblown sands and soils that are continual sources for dry and wet deposition on the lichen thallus. Lichens quickly hydrate during humid conditions and elements are then absorbed into the tissues where they remain until they are leached out over time into the environment. Exposed locations on the beaches are susceptible to incessant salt spray containing naturally occurring elements in sea water (i.e. Ca, S, Mn, and Na). Elements are deposited on lichens from the salt spray and absorbed into the thallus. The use of some bays as anchorages by marine vessels such as Coronation and Warren Islands may also enhance certain contaminants in the beach lichens due to burning of fossil fuels.

Another objective of the recent biomonitoring initiative was to determine patterns of contaminant accumulation in relation to the industrialization of Greens Creek mine and downtown Juneau. Both of these areas contain large machinery and/or vehicles that burn fossil fuels which produce NO_x. Elevated sulfur in these areas is most likely anthropogenic from diesel power and other machinery. Greens Creek and Juneau are not in exposed locations subjected to continual salt spray as are the more pristine places that were elevated in sulfur (i.e. Tebenkof, Coronation).

The three Greens Creek sites contained between 7 and 17 different contaminants elevated above threshold (Table 2). The most common were cadmium, copper, iron, sulfur, lead, zinc, vanadium, and nickel. Several of these contaminants were at the highest levels reported in lichens on the Tongass. Some contaminants were also within ranges considered enhanced due to smelters and mining from worldwide studies. Therefore, the levels of some contaminants from Greens Creek are similar to other sites in industrial locations worldwide with heavy metal air pollution. The tailings pile site contained the most elements above threshold, followed by the site near the entrance to the portal. This indicates that the open tailings pile releases contaminants into the air and surrounding environs through weathering of the exposed ore. These contaminants are mainly from the ore dusts extracted in the mining process.

The five monitoring sites on Mt Roberts in Juneau had at least three elements above threshold from each of the five sites (Table 2). The 175 ft elevation site sampled near the downtown tram contained 13 elements at or above threshold level (Table 2). The most common elements elevated were nitrogen, potassium, phosphorus, sulfur, and zinc. Additionally, Mt Roberts's sampling sites are above the cruise ship docking area where ships

use diesel power when in port. Along with this industry, automobile traffic and wood burning stoves play a role in contributing air pollutants in the downtown area.

Contaminant enhancement in lichens from the Juneau and Greens Creek area are attributed to industrial and urban sources. However, the distance beyond the monitoring sites that the elements have dispersed into the forest or surrounding habitats is unknown. Land managers concerned with air quality in Juneau and Greens Creek should consider implementing a gradient of collection locations radiating from the pollution sources to determine where the levels of certain elements drop below threshold.

Elemental air data can also be compared and contrasted to water quality data to determine if airborne contaminants are eventually leaching into soils and freshwater sources. Air pollution is directly tied to forest health. Deposition of certain pollutants may harm vegetation and soil resources due to changes in pH of the soil water, thus increasing the solubility of certain ions and promoting leaching. These mobilized ions can damage roots and soil biota (CARB 1989).

Elevated contaminants in lichens were more indicative of localized emission and dusts rather than poor regional air quality. Enhanced concentrations of certain elements in lichens are evidence that human activities near and on the Forest generate air pollution and the associated airborne contaminants are being introduced into the ecosystem. However, natural sources of some elements can also be high in lichens. Lichens from polluted and clean areas exist in dynamic equilibrium with the environmental conditions in which they are growing. Certain containments can affect photosynthesis and other metabolic processes in lichens more readily than others, such as sulfur, nitrogen, and some heavy metals. Additional work is needed to combine elemental analysis with the diversity and abundance of expected lichen species. A community analysis of epiphytic lichens would provide a sensitive tool for land managers to detect status and trends in air quality on the Forest in general and around local or stationary source.

Table 2. Summary of air biomonitoring data on the Tongass National Forest. Plots with elemental values above provisional threshold levels are in bold type for an element. *Alectoria sarmentosa* = Alesar; *Lobaria oregana* = Lobore; *Platismatia glauca* = Plagla. All other elements not in bold were at threshold level.

Plot Number	General location	Lichen species and elevated elements	Possible sources
28	Petersburg Creek wilderness	none	
29	Petersburg Creek wilderness	Alesar: Mn, Ni	Natural variation, geology
57	Petersburg Creek wilderness	none	
82	Petersburg Creek wilderness	none	
116	Petersburg Creek wilderness	Alesar: Mn	Natural variation, geology
237	Petersburg Creek wilderness-not permanent plot	none	
145	Pleasant Island wilderness	none	

Plot Number	General location	Lichen species and elevated elements	Possible sources
146	Pleasant Island wilderness	none	
189	Kootznoowoo wilderness-Gambier Bay	Alesar: Cd Hypogymnia: Mn	Natural variation, geology
190	Kootznoowoo wilderness-Gambier Bay	Hypogymnia: Mn	Natural variation, geology
30	Stikine River wilderness-Shakes	none	
31	Stikine River wilderness-main river	Plagla: Mn, Si	Windblown soils
195	Stikine River wilderness-Gut Island	Plagla: B	marine influence, windblown soils
494	Stikine River wilderness-Andrews Slough	none	
495	Stikine River-Flemer cabin	Lobore: Ba, Si, V	Windblown soils
503	Stikine wilderness-Thunder Mt	none	
496	South Etolin wilderness-alpine lake	none	
497	South Etolin wilderness-alpine lake	none	
199	Bradfield area-Harding River	none	
32	Tebenkof wilderness-beach	Alesar: Mg Lobore: P	Marine influence, marine vessels
33	Tebenkof wilderness-beach	Alesar: S, Al, Cu, K, P Lobore: S	Marine influence, marine vessels
500	Tebenkof wilderness-beach	none	
37	Cape Fanshaw	Lobore: Mn	Natural variation, geology
192	Point Agazii-PRD mainland	none	
43	Shrine of St Teresa-Juneau- temporary plot	Hypogymnia: Al	road dust
159	Karta River wilderness	none	
39	Mitkof Island Raven's Roost	none	
40	Mitkof Island, Raven's Roost	none	
42	Mitkof Island Raven's Roost	none	
44	Mitkof Island near Petersburg temporary plot	Hypogymnia: Al	road dust
91	Mitkof Island Crystal mountain-temporary plot	none	
118	Mitkof Island-Froot Rd	Alesar: Cd	Road dust, nearby rifle range

Plot Number	General location	Lichen species and elevated elements	Possible sources
117	Mitkof-3 Lakes Loop Rd- temporary plot	none	
124	Mitkof Island-off 6227 Rd	none	
140	Mitkof Island, Twin Creeks	none	
167	Mitkof Island, Woodpecker	none	
121	Kupreanof Is, Sherman Pk	none	
152	Woewodski Is Harvey Lake- temporary plot	none	
60	Yakutat bunkhouse- temporary plot	none	
64	Yakutat road system- temporary plot	none	
65	Yakutat Pike lakes RNA	none	
66	Yakutat Greens Pond	Alesar:Cr Hypogymnia: Cr Lobore: Cu	road dust
67	Yakutat road 11 mile- temporary plot	Hypogymnia: S Lobore: B	Road dust
69	Yakutat Pikes Lakes RNA	Alesar: Al Plagla: N, Al	Road dust, windblown soils
208	Yakutat Pikes Lakes RNA	none	
209	Yakutat Pikes lake RNA	none	
210	Yakutat Pikes Lakes RNA	none	
211	Yakutat Pikes Lakes RNA	none	
212	Yakutat Pikes Lakes RNA	none	
62	Russell Fiords wilderness	Hypogymnia : Al, Cr, Li, Si, Ti, V Lobore: Al, Co, Cr, Cu, Fe, Li, Ni, Ti Plagla: Cr, Li, Ni, Ti	Road dust, bridge, airstrip, windblown soils from interior, and nearby glaciers
76	Dog Island, near Duke Is.- temporary plot	Alesar: Cd	Geology, natural variation
77	Dog Island near Duke Is.	none	
79	Kuiu Island-Kell Bay isthmus- temporary plot	Hypogymnia: Ca, Mn Lobore: Mn	Salt spray
80	Kuiu Island-Kell Bay isthmus- temporary plot	none	
81	Kuiu Island-Kell Bay isthmus	Alesar: Ca	Salt spray

Plot Number	General location	Lichen species and elevated elements	Possible sources
219	Kuiu Island- Rowan Ck	Alesar: Al, Fe	Road dust
220	Kuiu Island Crane Ck	none	
498	Kuiu wilderness-Malmsberry Lk	none	
499	Kuiu wilderness-Malmsberry Lk	none	
86	Misty Fiords-Hugh Smith	Lobore: K	Natural variation
88	Misty Fiords-Hugh Smith	none	
83	Misty Fiords Manzanita Lk	none	
84	Misty Fiords Manzanita Lk	none	
85	Misty Fiords Manzanita Lk	none	
164	Cleveland Pen.Lk McDonald	none	
98	Chichagof Is. Dry Pass, West Chichagof wilderness	none	
99	Chichagof Is. Dry Pass, West Chichagof wilderness	Alesar: Na	Marine influence
100	Myriad Island-West Chichagof wilderness	Alesar: Mn, V	Marine influence, geology, or natural variation
101	Myriad Island-West Chichagof wilderness	none	
110	Juneau Amalga Tr Yankee Basin	Lobore: Cd	Old mine site, geology or natural variation
102	Baranof Island-Big Bay	none	
105	Baranof Island-Kanga Bay	none	
221	Douglas Island-Eaglecrest Rd	Alesar: Al, Cd, Pb	Nearby road, old mining
112	Douglas Island-Eaglecrest Rd	none	
113	Berners Bay- Cove Pt	Alesar: Co, K, P Hypogymnia: Al	marine influence, old mine nearby, natural variation
114	Berners Bay-Cove Pt	none	
130	Revilla Island, Settlers Cove	Alesar: Ca	Ocean influence
125	Revilla Is. Ward Lake	none	
132	Gravina Is	none	
133	Gravina is	none	
135	Bold Is KMRD	none	
142	Whitestone-Hoonah	Alesar: Na	Natural variation

Plot Number	General location	Lichen species and elevated elements	Possible sources
143	Whitestone-Hoonah	Alesar: Al, Na	Nearby road, natural variation
107	Sitka near Blue lk- temporary plot	Alesar: Ca, Ni, P	Road dust, industry, urban
108	Sitka near Thimbleberry Tr.- temporary plot	Alesar: Al, B, Cd, Cu, Na, Zn Hypogymnia: B, Na	Road dust, industry, urban
236	Sitka Blue Lake rd- temporary plot	Hypogymnia: Cr, Ni, P	Road dust, industry, urban
239	Sitka Hwy- temporary plot	Hypogymnia: S, Cr, Cu, K, Ni, Pb	Road dust, industry, urban
241	Sitka Hwy- temporary plot	Hypogymnia: K, P, Pb	Road dust, industry, urban
240	Sitka Hwy temporary plot	Alesar: S, Al, Cr, Cu, Fe, Ni, Zn	Road dust, industry, urban
242	Sitka Hwy- temporary plot	Hypogymnia: S, Cr, K, Pb, Zn	Road dust, industry, urban
243	Sitka Hwy- temporary plot	Hypogymnia: S, Al, B, Cr, Fe, K, Ni, P, Pb	Road sust, industry, urban
244	Sitka Hwy- temporary plot	Hypogymnia: S, Al, Cr, K, Ni, Pb	Road sust, industry, urban
245	Sitka Hwy- temporary plot	Hypogymnia: B, Cr, Fe, Ni	Road dust, industry, urban
246	Sitka Hwy- temporary plot	Alesar: Cr Hypogymnia: S, B, Cd, Mg Lobore: B, Cr, Cu, Mg, Mn, Pb	Road dust, industry, urban
487	S. Baranof wilderness-West Crawfish	none	
488	S. Baranof wilderness -West Crawfish	none	
489	S. Baranof wilderness-Red Bluff Bay	none	
490	S. Baranof wilderness-Red Bluff Bay	none	
491	Chuck River-mouth of river	none	
492	Chuck River-Taylor Creek	none	
493	Chuck River-Taylor Lake	none	
504	Tracy Arm wilderness-muskeg	none	
505	Tracy Arm wilderness-forest	none	
506	Endicott River wilderness-lower river	Hypogymnia: N, Ca, Zn Lobore: Ca, Zn Plagla: N, Co	Marine influence, marine traffic, geology, natural variation

Plot Number	General location	Lichen species and elevated elements	Possible sources
507	Endicott River wilderness-upper river	Alesar: Ba, Ca Hypogymnia: S	Unknown S source, geology, natural variation
508	Endicott River wilderness-upper river	Alesar: Al, Ba, Fe, K, Si, Ti Hypogymnia: S, Ba, Co, K. Plagla: Ba, Co, P, V	Geology, windblown soils from interior, unknown S source
509	Warren Island wilderness- muskeg	Hypogymnia: Mg	Natural variation or marine influence
510	Warren Island wilderness-Warren Cove	Alesar: S, N, Mg Plagla: K, Mg	Exposed to ocean, marine anchorage
511a	Green Creek mine plot near stream	Plagla: Ba, Cd, Cu, Ni, Pb, V, Zn	Mining activities
511b	Greens Creek mine at portal- temporary plot	Hypogymnia: S, Cd, Cu, K, Pb Plagla: S, Cd, Cr, Cu, Fe, K, Li, Ni, P, Pb, V, Zn	Mining activities
512	Greens Creek mine-tailing pile	Alesar: S, N, Al, Ba, Cd, Cu, Fe, Pb, Si, Ti, V, Zn Hypogymnia: S, Al, Cd, Co, Cu, Fe, Li, Ni, Pb, Si, Ti, V, Zn Plagla: S, Al, Ba, Cd, Co, Cr, Cu, Fe, K, Li, Ni, Pb, Si, Ti, V, Zn	Mining activities
513	Coronation wilderness-Egg Harbor	Alesar: N Hypogymnia: Mg Plagla: S	Exposure to open ocean, marine vessel anchorage
513	Coronation wilderness-Windy Pass	Alesar: Ca	Natural variation, exposure to open ocean
71	POW Old Toms Ck RNA	none	
72	POW Old Toms Ck RNA	none	
73	POW Old Toms Ck RNA	none	
119	POW Coffman Cove	none	
120	POW Coffman Cove	none	
128	POW Naukati	none	
515	S Prince of Wales wilderness-muskeg	none	
516	S Prince of Wales wilderness-beach	Alesar: S, Mg	Marine influence

Plot Number	General location	Lichen species and elevated elements	Possible sources
1000	Mt Roberts 175 ft	Alesar: S, N, Al, Ba, Cu, Fe, Na, Ti, V Plagla: N, Cr, K, Ni, P, Ti, V	urban Juneau, cruise ship dock, old mine
1001	Mt Roberts 600 ft	Plagla: S, K, Ni, P, V	urban Juneau, cruise ship dock, old mine
1002	Mt Roberts 910 ft	Alesar: P, Zn Plagla: S, K, P	urban Juneau, cruise ship dock, old mine
1003	Mt Roberts 1241 ft	Plagla: N, K, P	urban Juneau, cruise ship dock, old mine
1004	Mt Roberts 1750 ft	Alesar: Zn Plagla: N, K, P, Zn	urban Juneau, cruise ship dock, old mine, tourist tram station

IMPROVE 2007 results

In 2003, the Air Executive Committee funded the installation of an Interagency Monitoring of Protected Visual Environment (IMPROVE) aerosol sampler near Petersburg. The IMPROVE program is a cooperative air quality monitoring effort between federal land managers; regional, state and tribal air agencies; and the Environmental Protection Agency (IMPROVE, 2008). Along with a greater understanding of regional patterns of air pollutants, the Petersburg site will provide more information about the trans-Pacific contribution of air pollutants to the loadings seen in the Pacific Northwest and in Alaska. The aerosol data are made publicly available approximately one year after collection. In addition, seasonal and annual data reports, special study data reports, technical publications and other data are prepared from the network of IMPROVE sites nationwide. All of these IMPROVE resources about the Petersburg site can eventually be obtained from the website:

<http://vista.cira.colostate.edu/improve/data/IMPROVE/summary-data.htm>

Data filters were successfully retrieved during the 2007 sampling period. Data filters were sent to the University of California- Davis, Crocker Laboratory. Results for 2007 will not be available for some time, as the lab is at least a year behind in the analysis for the IMPROVE program.

Tracy Arm Cruise Ship Emissions Visual Monitoring 2007

The Forest Service signed an MOU with the ADEC in 2002 to monitor visual emissions from cruise ships in wilderness areas. Cruise ship visits have increased on the Tongass over the past few years, and particularly in Tracy Arm/Fords Terror Wilderness. In 2007, there were 187 cruise ship vessels that entered the narrow Tracy Arm and carried tourists to view the glacier and fiord compared to 2003 with 108 ships. Only 2% of the ships that visited the wilderness received readings compared to 2006 of 5%. There were no readings of interest in the wilderness for 2007.

Western Airborne Contaminants Assessment Project (WACAP) Results

The Western Airborne Contaminants Assessment Project (WACAP) was initiated in 2002 to determine the risk to ecosystems and food webs in western national parks and wilderness areas from the transport of airborne contaminants (NPS 2008). WACAP is designed and implemented by the National Park Service's Air Resources Division in cooperation with many western national parks, U.S. Environmental Protection Agency, U.S. Geological Survey, USDA Forest Service and several universities.

Airborne contaminants can pose serious health threats to wildlife and humans. Some toxic compounds "biomagnify" meaning that small concentrations in air, water, snow and plants can result in larger concentrations at higher levels of the food web like fish and mammals. Biological effects of airborne contaminants include impacts on reproductive success, growth, behavior disease and survival. The contaminants to be detected in this assessment are persistent organic pollutants (POPs), mercury, and semi-volatile organic pollutants (SOCs).

Primary WACAP locations collected samples from lichens, conifers, fish and mammals, and from lake sediments and snow. These primary locations were in ten National Parks across the country including Denali National Park in Alaska. The Tongass National Forest participated in this program as one of ten secondary sampling locations where only the air, lichens, and spruce needles were collected. The geographic position of the Tongass acts as a bridge between interior Alaska and the lower 48 for data collection and interpretation of results.

The final WACAP report is now available on line that fully describes the results for the different parks, including the Stikine-LeConte Wilderness found at http://www.nature.nps.gov/air/studies/air_toxics/wacap.cfm

The analysis of the vegetation (lichens and spruce needles) in Stikine-LeConte concluded that the samples were at or below the median for SOCs such as CUPs (Current Use Pesticides), PCBs (polychlorinated biphenyls) and PAHs (polycyclic aromatic hydrocarbons), and at or above the median for HUPs (Historic Use Pesticides); this pattern was also observed at other high precipitation sites along coastal Alaska (i.e. Wrangell St. Elias and Glacier Bay) (NPS 2008). The dominant SOCs in vegetation were the following: PAHs, endosulfans (pesticide), a-HCH (hexachlorocyclohexane-alpha pesticide), HCB (hexachlorobenzene pesticide) and g-HCH (hexachlorocyclohexane-gamma or lindane pesticide). Also, low concentrations of the pesticides chlorpyrifos, dacthal, and chlordanes were also detected. Nitrogen concentrations in lichens were within background ranges, indicating that nitrogen deposition is not elevated here.

Passive Air Sampling Devices (PASDs) were sampled at sea level, near Bussy Creek at 254 m and at 815 m NW of Bussy Lake. The SOCs that increased in the vegetation with elevation also increased in air, such as current use endosulfans, the HUPs called HCB, a-HCH, g-HCH and chlordanes. Other SOCS were not detected or were at the instrument detection limits. All SOCs ranked low at the lowest elevation, concentrations at the highest elevation ranked moderate to high relative to concentrations at other WACAP parks (NPS 2008).

ADEC and EPA Monitoring Near the Tongass National Forest

Since 1998, the Forest Service has reported an annual summary of ambient air quality monitoring data collected by ADEC in the vicinity of the Tongass National Forest (EPA 2008). During 2007, ADEC analyzed the content of particulate matter (PM₁₀ and PM_{2.5}) in the air in Juneau. Out of the 135 days monitored in 2007, there were 123 days of good Air Quality Values, 10 moderate days, and 2 unhealthy /sensitive days (EPA 2008). The main pollutant was PM_{2.5} (96%) with a small percent of PM₁₀ (4%).

The level of air pollution and the health concerns are greater at higher AQI values. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality. An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy-at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Evaluation of Results

ADEC has continuously analyzed the content of particulate matter in air in Juneau's Mendenhall Valley since 1997. Particulate pollution is in general terms a mixture of solid particulates and liquid droplets found in air. Course particulates are directly emitted from sources such as construction sites, unpaved roads, combustion sources or fires. Other fine particulates form when gases react in the atmosphere such as sulfur dioxide (SO₂) nitrogen oxides (NO_x) and volatile organic compounds (VOCs). These are emitted mostly from power plants, industries, and automobiles (EPA 2008a).

There are two standards for PM_{2.5}: an annual standard (15 µg/m³) and a daily standard (35 µg/m³). The national trends for PM_{2.5} show a steady decline across the country for annual standards. However, between the years 2000 and 2006, the Juneau area showed an overall increase in PM_{2.5} (EPA 2008a). The year 2007 had 12 moderate to poor readings out of 135 days selected. It is very unlikely that this Juneau station could detect particulate matter originating from or affecting the Tongass National Forest. The lichen biomonitoring program has detected high levels of many contaminants along the ridge of Mt Roberts in downtown Juneau and very close to Forest Service lands including sulfur (S) and nitrogen (N) and heavy metals (see Table 2, plots 1000 and 1001). The biomonitoring method should be conducted on Forest Service lands around Juneau to compliment or fill in the gaps where instrument detection cannot reach in this area.

The threshold levels generated for elements found in Tongass lichens are useful tools for land managers to determine if a pollution source is potentially causing high concentrations of certain elements of interest in the surrounding environment. Region 6 Air program has nearly completed a large effort to relate lichen community and thallus N responses in western OR and western WA to 4 measures of N deposition obtained thru IMPROVE, other national monitoring programs, and from on-site measures using passive resin-tube precipitation collectors in the Columbia Gorge NSA. The critical loads for N will range from about 2 -10 kg/ha/yr dependent on precipitation at the site (low precipitation areas have lower CLs, high precipitation areas have high CLs) (Geiser et al. 2008 in prep). This work in Region 6 can

also be completed in Region 10 as the forest continues collaboration with air specialists in other regions and at the national level.

The IMPROVE site in Petersburg is collecting background data on the type of particles that affect visibility and air quality (PM_{2.5}, PM₁₀, organics and elemental carbon, and sulfates, nitrates and chloride ions). Through sample analysis, the particle size, chemical composition, and concentration will be characterized. The Petersburg data is stored at the IMPROVE website, but runs at least one year or more behind collection (IMPROVE 2008). The first quarter results for the year 2005 indicate that the Petersburg station is sensitive to regional pollutants such as smoke from forest fires originating in other areas. No data are available for the remainder of 2005 or 2006 until the end of 2007 and 2008.

Through this monitoring report, WACAP results are being communicated to Forest Service land managers and the public to become aware that herbicide and pesticide chemicals are accumulating in the environment of the Tongass National Forest. With the overall results for the National Park System in Alaska, Tongass managers should be aware that mercury concentrations in the fish sampled routinely exceed piscivorous animal thresholds, and in some parks, human contaminant thresholds were also exceeded (NPS 2008). Fish tissue were not sampled on the Tongass, however, mercury levels in fish should be considered a priority for future monitoring efforts of this element in partnership with other agencies. Although the historic use pesticides are accumulating in plant tissues from the Tongass, they are shown to be decreasing fairly consistently across the country. Therefore, the current use pesticides should be focused on for future work. This type of analysis is very costly and technical, and should be conducted in a partnership with NPS.

Although nitrogen in Stikine-LeConte showed to be below background in the WACAP study, it does appear to be above threshold in many places monitored by lichen biomonitoring (Dillman et al 2007). It has not been detected as being above background in the IMPROVE results from 2005, yet continuing monitoring for nitrogen is important for the detection of trans-Pacific nitrogen that is expected to increase over the coming years. Without trend data, it will not be possible to detect an increase of nitrogen in the future.

Action Plans

No corrective action is recommended with respect to current air resource conditions on the Tongass National Forest.

Direct effects of Forest Plan implementation activities on air quality are likely to be temporary, limited and highly localized. There are no Class I areas within or near the Tongass National Forest. Therefore, the Tongass National Forest is held to the same ambient air quality standards as the rest of Southeast Alaska. ADEC, in consultation with EPA, has a long-term strategy for air quality monitoring that is responsive to emissions and community concerns.

The following specific actions are recommended for consideration with respect to this monitoring question:

1. Continue to summarize the annual data from ADEC and EPA from the areas in proximity to the Tongass National Forest such as Juneau, Ketchikan, and Sitka.

2. Consider incorporating air quality monitoring activities such as biomonitoring with lichens into wilderness air monitoring at the Forest Plan scale, and/or project or program monitoring below or above the Forest Plan scale as appropriate. Thresholds have been established for Tongass lichens for many elements. Managers can use the thresholds for comparison with future lichen samples from areas with pollution concerns. Lichen biomonitoring can detect nitrogen and sulfur levels. These are two pollutants that can cause ecosystem and human health deterioration. *Trends in pollution levels can only be established through regular monitoring every 5 to 10 years.*
3. The IMPROVE site has been in existence since 2004. The results are very far behind in analysis. The annual results from the Petersburg IMPROVE program for evaluation criteria of achieving ambient air quality standards across the Tongass National Forest and for a regional and global perspective of PM_{2.5}, PM₁₀, organics and elemental carbon, and sulfates, nitrates and chloride ions can be used when available. After 2008, the project should be re-evaluated and decisions made to continue or discontinue participation in the program. Nitrogen emissions are expected to increase in Asia over the next 25 years as coal-generated power facilities are built. With this program, the trans-Pacific pollution can eventually be detected if the monitoring continues long enough for trends to be established.
4. Continue smoke-emissions monitoring in Tracy Arm/Fords Terror Wilderness in conjunction with ADEC. Follow the Wilderness Best Management Practices initiative to help determine if cruise ships are following the Marine Vessel Visible Emissions Standards (18 AAC 50-.070).
5. Encourage and continue collaboration with the National Park Service WACAP and cruise ship emission studies in Skagway and Glacier Bay.
6. Recommendations are to review the management of the Tongass National Forest and direction for air quality monitoring as a Forest Plan monitoring activity. Air quality in the Tongass National Forest and Southeast Alaska in general is more likely to be affected by long-range transport and global processes that are much broader in scale than the Forest Plan. Effects on air quality are more appropriately addressed through programmatic baseline monitoring in wilderness and/or by participating in broader regional or national air quality monitoring efforts.

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