11.0 CLASS I IMPACT RESULTS

11.1 OVERVIEW

Comprehensive refined modeling was conducted to assess GREC Class I area air quality impacts in accordance with EPA, Federal Land Managers (FLMs), and FDEP modeling guidance. This section provides the results of the GREC air quality assessment with respect to long-range transport impacts at two PSD Class I areas: the Okefenokee and Chassahowitzka NWAs. Section 9.0 previously addressed GREC air quality impacts in the vicinity of the project Site.

PSD Class I areas located within 300 km of GREC include the Okefenokee, Chassahowitzka, Bradwell Bay, Wolf Island, and St. Marks NWAs. The Everglades National Park is located more than 400 km south of GREC. The nearest PSD Class I areas are the Okefenokee NWA situated approximately 93 km (58 miles) to the north of GREC and the Chassahowitzka NWA situated approximately 110 km (68 miles) southwest of GREC.

11.2 INITIAL SCREENING ANALYSIS

For new sources that will be located at a distance of 50 km or greater from a Class I area, the FLAG 2008 draft guidance on initial screening criteria recommends using the ratio of potential project emission rates divided by the project's distance from a Class I area (i.e., Q/D or 10D Rule) to determine whether an assessment of Class I area AQRVs is necessary. This screening approach is similar to that implemented by EPA as part of its Regional Haze Regulation. Potential project emissions (i.e., Q) include SO_2, NO_2, PM_{10}, and H_2SO_4 mist annual emissions in tpy, based on 24-hour maximum allowable emissions. The distance (i.e., D) is the distance in km from the Class I area. For cases in which the calculated Q/D ratio is 10 or less, a Class I AQRV impact analyses is not required.

The Q/D ratio was calculated for GREC using the BFB boiler stack annual potential emission rates and the nearest distance to each of the five Class I areas located within 300 km of GREC. Table 11-1 summarizes the BFB boiler stack's NO_2, SO_2, H_2SO_4 mist, and PM_{10} potential annual emissions in tpy, the distance to each Class I area (km), and

Table 11-1. GREC PSD Class I Initial Screening Analysis

	NO_x	SO_2	H_2SO_4 Mist	PM_{10} (total)*	Totals
			tpy		
GREC potential emissions (Q)	416.4	243.9	5.9	249.8	916.0

	Okefenokee NWA	St. Marks NWA	Chassahowitzka NWA	Bradwell Bay NWA	Wolf Island NWA
			km		
Distance from GREC (D)	93.4	159.3	110.1	210.9	202.2
			ton/yr-km		
FLAG screening ratio (Q/D)	9.8	5.8	8.3	4.3	4.5

*Filterable and condensable PM.

Source: ECT, 2009.

the calculated Q/D ratio for each Class I area. The calculated Q/D ratios are all below the FLM threshold of 10; therefore, Class I AQRV analyses are not required in accordance with the FLAG guidance.

Based on the initial screening results, the GREC analysis with respect to the PSD Class I increments addressed the two nearest PSD Class I areas; i.e., the Okefenokee and Chassahowitzka NWAs. GREC air quality impacts at the more distant PSD Class I areas will be lower than those predicted for the Okefenokee and Chassahowitzka NWAs. Figure 11-1 provides the locations of the Okefenokee and Chassahowitzka NWAs in relation to GREC.

11.3 CONCLUSIONS

Comprehensive dispersion modeling using the CALMET/CALPUFF/CALPOST modeling suite demonstrates that the GREC will have insignificant air quality impacts for all modeled PSD pollutants and all averaging periods in the PSD Class I areas. Accordingly, a multisource cumulative assessment of air quality impacts with respect to the PSD Class I increments for NO_2, SO_2, and PM_{10} was not required.

11.4 GENERAL APPROACH

The required Class I area impact assessments were conducted using the CALPUFF dispersion model in accordance with the recommendations contained in the Interagency Workgroup on Air Quality Modeling (IWAQM) *Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts*, the FLAG Phase I Report, and EPA's GAQM. In addition, an Air Quality Impact Analysis Modeling Protocol was submitted to FDEP, the U.S. Fish and Wildlife Service (USFWS), and EPA Region 4 in July 2009 for review and comments. The air quality impact analyses conducted for GREC incorporates the comments and suggestions received from these regulatory agencies on the modeling protocol.

The CALPUFF model was employed in a refined mode using 3 years (2001 through 2003) of 4-km resolution CALMET data and Class I area receptor grids as recommended

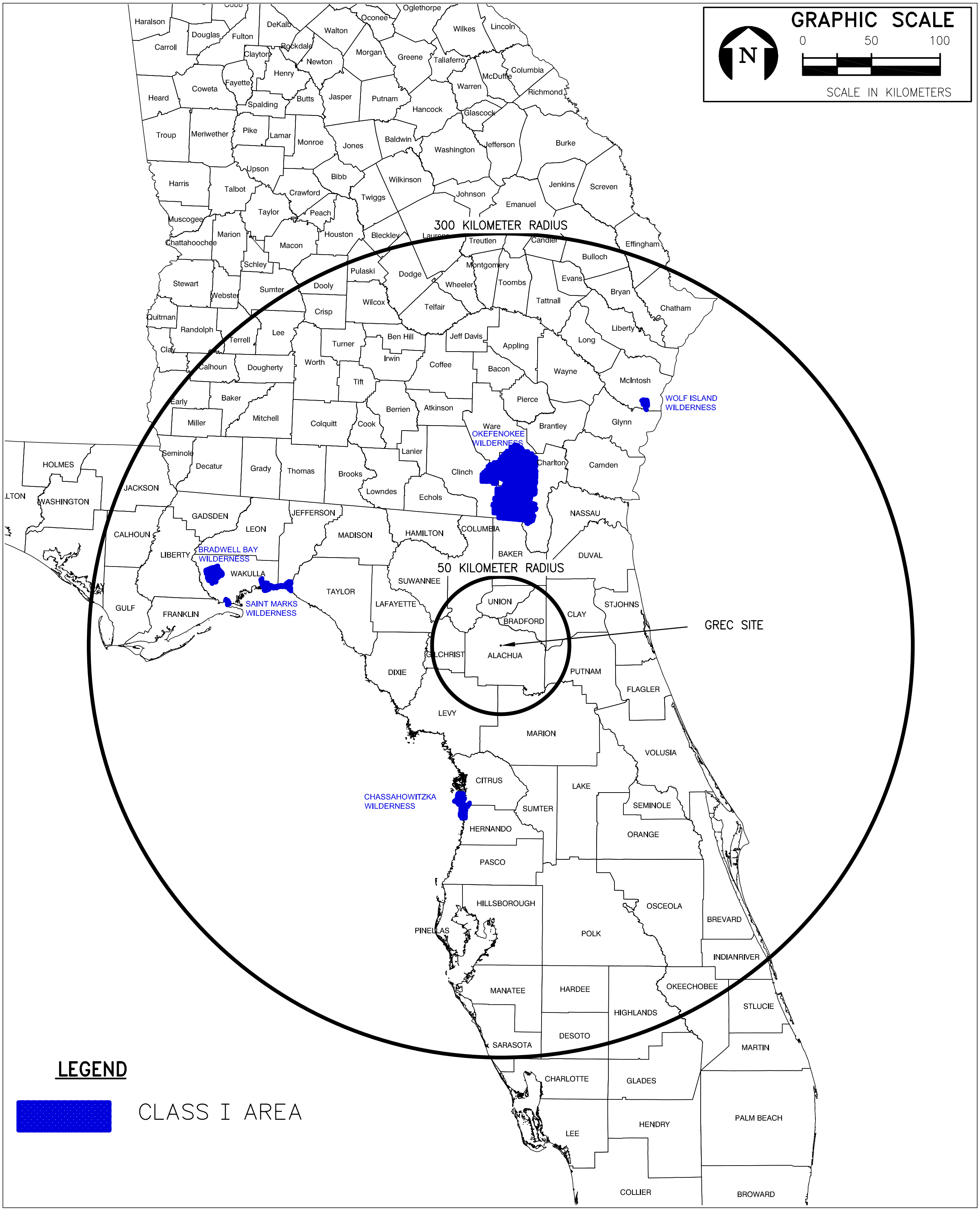

FIGURE 11-1.

CLASS I AREAS WITHIN 300 KM OF THE GREC SITE

Sources: FWS, 2007; USFS, 2007; NPS, 2007; ECT, 2009.

Gainesville Renewable Energy Center
An American Renewables Company

by the National Park Service (NPS). The CALPUFF suite of programs, including the CALPOST postprocessing program, was employed to develop estimates of GREC impacts at the Okefenokee and Chassahowitzka NWAs with respect to the PSD Class I increments.

11.5 MODEL SELECTION AND USE

Steady-state dispersion models do not consider temporal or spatial variations in plume transport direction, nor do they limit the downwind transport of a pollutant as a function of windspeed and travel time. Due to these limitations, conventional steady-state dispersion models, such as AERMOD, are not considered suitable for predicting air quality impacts at receptors located more than 50 km from an emission source.

Because of the need to assess air quality impacts at PSD Class I areas, which are typically located at distances greater than 50 km from the emission sources of interest, EPA and the FLMs initiated efforts to develop dispersion models appropriate for the assessment of long-range transport of air pollutants. The IWAQM was formed to coordinate the model development efforts of EPA and the FLMs.

The IWAQM work plan indicates that a phased approach would be taken with respect to the implementation of recommendations for long-range transport modeling. In Phase 1, the IWAQM would review current EPA modeling guidance and issue an interim modeling approach applicable to projects undergoing permit review. For Phase 2, a review would be made of other available long-range transport models and recommendations developed for the most appropriate modeling techniques.

The Phase 1 recommendation, issued in April 1993, is to use the Lagrangian puff model, MESOPUFF II, for long-range transport air quality assessments. The Phase 2 recommendations, issued in December 1998, are contained in the IWAQM *Phase 2 Summary Report and Recommendations for Modeling Long-Range Transport Impacts*. Additional FLM guidance with respect to the assessment of visibility and deposition impacts is provided in the FLAG Phase I report dated December 2000. The Phase 2 IWAQM recommendation is to apply the CALPUFF Modeling System to assess air quality impacts at distances greater than 50 km from an emission source. In April 2003, EPA designated the CALPUFF model as a preferred model (i.e., a model listed in Appendix A to W of 40 CFR 51, Summaries of Preferred Air Quality Models) for use in assessing the long-range transport of air pollutants.

The EPA GAQM indicates that the CALPUFF modeling system is appropriate for long-range transport (source-receptor distances of 50 to several hundred kilometers) of emissions from point, volume, area, and line sources. All the receptors at the Class I areas evaluated are situated at distances greater than 50 km from GREC.

The EPA-approved version of the CALPUFF modeling suite was used for the GREC Class I area impact assessments. The EPA-approved CALPUFF modeling suite is comprised of the following programs:

- CALMET   Version 5.8   Level: 070623
- CALPUFF   Version: 5.8   Level: 070623
- CALPOST   Version: 5.6394   Level: 070622

These programs were used to assess PSD Class I increments impacts.

The CALPUFF modeling system consists of three main components: CALMET, CALPUFF, and CALPOST. Each of these components is described in the following subsections.

11.5.1 CALMET

CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modeling domain. The meteorological file produced by CALMET for use by CALPUFF also includes two-dimensional parameters such as mixing height, surface characteristics, and dispersion properties.

CALMET requires a number of input data files to develop the gridded three- and two-dimensional meteorological file used by CALPUFF. The specific meteorological data used by the CALMET program include:

- Penn State/National Center for Atmospheric Research mesoscale model gridded, prognostic wind field data (terrain elevation, land use code, sea level pressure, rainfall amount, snow cover indicator, pressure, temperature/dew point, wind direction, and windspeed).
- Surface station weather data (windspeed, wind direction, ceiling height, opaque sky cover, air temperature, relative humidity, station pressure, and precipitation type code).
- Upper air sounding (mixing height) data (pressure, height above sea level, temperature, wind direction, and windspeed at each sounding).
- Surface station precipitation data (precipitation rates).
- Overwater data (air-sea surface temperature difference, air temperature, relative humidity, overwater mixing height, windspeed, and wind direction).
- Geophysical data (land use type, terrain elevation, surface parameters including surface roughness, length, albedo, Bowen ratio, soil heat flux, and vegetation leaf area index, and anthropogenic heat flux).

Further technical discussion of the CALMET model can be found in Section 2 of the User's Guide for the CALMET meteorological model dated January 2000.

VISTAS has developed a 3-year (2001 through 2003) CALMET dataset for a fine, 4-km, subregional domain that covers all of Florida and the adjacent Class I areas of interest to Florida. The VISTAS 2001-2003 meteorological data was recently reprocessed by USFWS using the current EPA regulatory version of CALMET; i.e., Version 5.8, Level: 070623. This reprocessed fine-grid CALMET dataset (containing more than 250 gigabytes of data) was obtained from FDEP and was used in the GREC Class I impact assessments.

11.5.2 CALPUFF

CALPUFF is a transport and puff model that advects puffs of material from an emission source. These puffs undergo various dispersion and transformation simulation processes as they are advected from an emission source to a receptor of interest. The simulation processes include wet and dry deposition and chemical transformation. CALPUFF typically uses the gridded meteorological data created by the CALMET program. CALPUFF, when used in a screening mode, can also use nongridded meteorological data similar to that used by a steady-state dispersion model such as AERMOD. The distribution of puffs by CALPUFF explicitly incorporates the temporal and spatial variations in the meteorological fields thereby overcoming one of the main shortcomings of steady-state dispersion models. Further technical discussion of the CALPUFF model can be found in Section 2 of the User's Guide for the CALPUFF Model dated January 2000.

There are a number of optional CALPUFF input files that were not used for the GREC Class I area impact assessments. These include time-varying emission rates, user-specified deposition velocities and chemical transformation conversion rates, complex terrain receptor and hill geometry data, and coastal boundary data.

CALPUFF generates output files consisting of hourly concentrations, deposition fluxes, and data required for visibility assessments for each receptor. These CALPUFF output files are subsequently processed by the POSTUTIL and CALPOST programs to provide impact summaries for the pollutants and averaging periods of interest.

The various CALPUFF program options are implemented by means of a control file. CALPUFF options selected for the GREC Class I area impact assessments conform to the recommendations contained in the IWQAM Phase 2 report and EPA's GAQM. Key CALPUFF model options selected for the GREC Class I impact assessments are listed:

- CALPUFF domain configured to include the GREC emission sources and all Class I receptors with a minimum 50-km buffer in all directions.
- 4-km spacing meteorological and computational grid.
- Class I receptors as defined by NPS.

- Modeling of six species (SO_2, SO_4, NO_x, nitric acid, nitrate, and PM_{10}).
- Use of the MESOPUFF II chemical mechanism module.
- IWAQM default guidance, including Pasquill-Gifford dispersion coefficients.
- 2001 through 2003 ozone data from CASTNet and AIRS stations.
- Integrated puff sampling methodology.
- No consideration of building downwash.

11.5.3 CALPOST

CALPOST is a postprocessing program used to process the concentration, deposition, and visibility files generated by CALPUFF. The CALPOST program was formulated to average and report pollutant concentrations or wet/dry deposition fluxes using the hourly data contained in the CALPUFF output files. CALPOST can produce summary tables of pollutant concentrations and depositions for each receptor for various averaging times and can develop ranked lists of these impacts. For visibility-related modeling (e.g., regional haze), CALPOST uses the CALPUFF generated pollutant concentrations to calculate extinction coefficients and other related indicators of visibility.

Similar to the CALPUFF program, the various CALPOST program options are implemented by means of a control file. CALPOST options selected for the GREC Class I impact assessments conform to the recommendations contained in the FLAG Phase I report.

11.6 RECEPTOR GRIDS

The GREC Class I area receptor grids included the Okefenokee NWA (500 discrete receptors), and the Chassahowitzka NWA (113 discrete receptors) receptors identified by NPS for these two Class I areas. The Class I receptor locations, which are provided by NPS in geographic (latitude and longitude) coordinates, were converted to Lambert Conformal Conic coordinates consistent with the VISTAS fine 4-km CALMET grid parameters (i.e., two matching parallels, latitude/longitude of the projection origin, and coordinate datum) using the NPS Class I areas conversion program.

All receptors were included in each CALPUFF model run. In CALPOST, only the receptor ranges for the specific Class I areas were processed.

11.7 MODELED EMISSION SOURCES

GREC modeled emission sources included only the main BFB boiler stack. The other GREC point sources, fugitive material handling, and cooling tower emission sources will have minor PM_{10} emission rates and low release heights. Accordingly, these emission sources will have negligible impacts at the distant Class I areas.

Maximum potential emission rates were used for the GREC BFB boiler. Table 11-2 summarizes the GREC BFB boiler stack parameters and emission rates used in the CALPUFF modeling assessments.

11.8 MODEL RESULTS

GREC CALPUFF modeling results for the PSD Class I increments at the two Class I areas evaluated are discussed in the following subsections.

Table 11-3 summarizes the GREC NO_2, SO_2, and PM_{10} impacts with respect to the PSD Class I SILs. This table provides the highest annual average impacts (for NO_2, SO_2, and PM_{10}), highest 3-hour average impacts (for SO_2), and highest 24-hour average impacts (for SO_2 and PM_{10}) for the two Class I areas evaluated.

All impacts are below the PSD Class I SILs for all pollutants and all averaging periods. Accordingly, a multisource cumulative assessment of air quality impacts with respect to the PSD Class I increments for NO_2, SO_2, and PM_{10} was not required.

Table 11-2. CALPUFF Modeling Input Data—GREC BFB Boiler

Parameter	Units	Value
<u>Boiler Stack Units</u>		
Stack height	ft	230
Stack diameter	ft	12
Stack velocity	ft/sec	76.7
Stack temperature	°F	310
SO_2 emissions	lb/hr	55.7
NO_x emissions	lb/hr	95.1
PM_{10} emissions (total)	lb/hr	57.0

Source: ECT, 2009.

Table 11-3. Summary of GREC PSD Class I Air Quality Impacts—NO_x, SO_2, and PM_{10}

Pollutant	Year of Meteorology	Averaging Period	Class I Area Impact (µg/m³) Okefenokee NWA	Chassahowitzka NWA
NO_x	2001	Annual	0.0017	0.0015
	2002		0.0025	0.0013
	2003		0.0023	0.0014
	Maximum		**0.0025**	**0.0015**
PSD SIL			0.1	0.1
% of PSD SIL			2.5	1.5
Exceed PSD SIL (Yes/No)			No	No
SO_2	2001	Annual	0.0017	0.0015
	2002		0.0023	0.0015
	2003		0.0021	0.0014
	Maximum		**0.0023**	**0.0015**
PSD SIL			0.1	0.1
% of PSD SIL			2.3	1.5
Exceed PSD SIL (Yes/No)			No	No
	2001	24-Hour	0.041	0.033
	2002		0.051	0.026
	2003		0.040	0.044
	Maximum		**0.051**	**0.044**
PSD SIL			0.2	0.2
% of PSD SIL			25.4	21.9
Exceed PSD SIL (Yes/No)			**No**	No
	2001	3-Hour	0.157	0.108
	2002		0.231	0.110
	2003		0.173	0.146
	Maximum		**0.23**	**0.15**
PSD SIL			1.0	1.0
% of PSD SIL			23.1	14.6
Exceed PSD SIL (Yes/No)			**No**	No
PM_{10}	2001	Annual	0.002	0.002
	2002		0.003	0.002
	2003		0.002	0.002
	Maximum		**0.0029**	**0.0021**
PSD SIL			0.2	0.2
% of PSD SIL			1.5	1.0
Exceed PSD SIL (Yes/No)			No	No
	2001	24-Hour	0.053	0.049
	2002		0.057	0.031
	2003		0.047	0.051
	Maximum		**0.057**	**0.051**
PSD SIL			0.3	0.3
% of PSD SIL			18.9	17.0
Exceed PSD SIL (Yes/No)			No	No

Source: ECT, 2009.

REFERENCES

Barbo DN, Chappelka AH, Stolte K. 1994. Ozone effects on productivity and diversity of an early successional forest community. Proceedings of the Eighth Biennial Southern Silvicultural Research Council. Auburn, Alabama. Nov 1-3, 291-298.

Barett TW, Benedict HM. 1970. Sulfur dioxide. In: Recognition of air pollution injury to vegetation: A pictorial atlas. J.S. Jacobson and A.C. Hill, editors

Bateman DR, Jarvis G, Carmody. 1994. Mercury concentrations in fishes of the St. Marks National Wildlife Refuge. Publication No. PCFO-EC-94-07. U.S. Fish and Wildlife Service, Panama City Field Office, Panama City, Florida.

Bennett, JH, Hill, AC. 1975. Interactions of air pollutants with canopies of vegetation. In: Responses of plants to air pollution. J.B. Mudd and T.T. Kozlowski, editors.

Bevanger K, Albu O. 1986. Decrease in a Norwegian feral mink (*Mustela vison*) population – a response to acid precipitation? *Biological Conservation* 38: 75-58.

Bindler R. 2003. Estimating the natural background atmospheric deposition rate of mercury utilizing ombrotrophic bogs in southern Sweden. *Environmental science and technology* 37: 40-46.

Blancher PJ, McAuley DG. 1987. Influence of wetland acidity on avian breeding success. *Transactions of the Norht American Wildlife and Natural Resources Converence* 52: 628-635.

Byrd H J, Aydelott DG, Bacon DD, Stone EM. 1961. Soil survey of McIntosh County, Georgia. U.S. Dep. Agric. Soil Conserv. Serv. 98 p.

Davis DD, Skelly JM. 1992. Growth response of four species of eastern hardwood tree seedlings exposed to ozone, acidic precipitation, and sulfur dioxide. *Journal of the Air & Waste Management Association* 42: 309-311

Driscoll CT, Holsapple J, Schofield CL, Munson R. 1998. The chemistry and transport of mercury in a small wetland in the Adirondack region of New York, USA. *Biogeochemistry* 40: 137-146.

Fitzgerald et al., 1996

Florida Fish and Wildlife Conservation Commission. 2001. A conceptual management plan for Chassahowitzka National Wildlife Area 2002-2007. Tallahassee, Florida. Southeast Regional Office. Atlanta, Georgia.

Goldstein, RA et al., 1985. Plant response to SO_2: An ecosystem perspective. In: Sulfur dioxide and vegetation, pp. 403-417. Winner W.E., Mooney HA, Goldstein RA. (eds). Sanford University Press, Sanford, CA.

Gough LP, Shacklette HT, Case AA. 1979. Element concentrations toxic to plants, animals, and man. U. S. Geological Survey Bulletin, Report: B 1466, 80 pp.

Hart R, Webb PG, Biggs RH, Portier KM. 1988. The use of lichen fumigation studies to evaluate the effects of new emission soures on class I areas. *Journal of air poll. Assoc.* 38: 144-147.

Hindawi IJ. 1970. Air pollution injury to vegetation. Raleigh, N. C: U. S. National Air Pollution Control Administration; U.S.Govt.Print.Off., Washington, 1970. 44 pp.

Hogsett WE, Plotcher M, Wildman V, Tingey DT, Bennett JP. 1985. Growth response of two varieties of slash pine seedlings to chronic ozone exposures. *Canadian journal of botany* 63: 2369-23.

Johnson DW, Reuss JO. 1984. Soil-mediated effects of atmospherically deposited sulphur and nitrogen. *Phil. Trans. R. Soc. Lond.* 305: 383-392.

Jones HC, Weber D, Balsillie D. 1974. Acceptable limits for air pollution dosages and vegetation effects: Sulfur dioxide. *Proceedings of the 67th Annual Meeting of the Air Pollution Control Association.*

Jordan DN, Green TH, Chappelka AH, Lockaby BG, Meldahl RS, Gjerstad DH. 1991. Response of total tannins and phenolics in loblolly pine foliage exposed to ozone and acid rain. *Journal of chemical ecology* 17: 505-513.

Krabbenhoft DP, Benoit JM, Babiarz CL, Hurley JP, Andren AW. 1995. Mercury cycling in the Allequash Creek watershed, northern Wisconsin. *Water, Air & Soil Pollution* 80: 425-433.

Llacuna S., Gorriz A., Dufort M., Nadai I. 1993. Effects of air pollution on passerine birds and small mammals. *Arch. Environ. Contam. Toxicol.* **24:** 59-66.

Lawrence GB, Huntington TG. 1999. Soil-calcium depletion linked to acid rain and forest growth in the eastern united states. USGS Water-Resources Investigations Report 98-4267.

LeBlanc F, Rao DN, Comeau G. 1972. The epiphytic vegetation of *Populus balsamitera* and its significance as an air pollution indicator in Sudbury, Ontario. *Can. J. Bot.* 50: 519-528.

LeBlanc F, Rao DN. 1975. Effects of air pollutants on lichens and bryophytes. In: Responses of plants to air pollution. Mudd JB, and Kozlowski TT (eds).

Longcore JR, Ross RK, Fischer KI. 1987. Wildlife resources at risk through acidification of wetlands. *Transactions of the North American Wildlife and Natural Resources Conference* 52: 608-618.

MacLean DC, Delbert DC, BcCune DC, Weinstein LH, Mandl RH, Woodruff GN. 1968. Effects of acute hydrogen fluoride and nitrogen dioxide on citrus and ornamental plants of central Florida. *Enviorn. Sci. and Tech.* 2: 444-449.

Majernik O, Mansfield TA. 1970. Direct effect of SO_2 pollution on the degree of opening of stomata. *Nature* 227: 377-378.

Masson GR, Bowers MD. 1995. Mercury and lead levels in fish of the Okefenokee National Wildlife Refuge. Report by U.S. Fish and Wildlife Service, Environmental Contaminants Division, Brunswick, Georgia. 11 pp.

Middleton JT, Kendrick JB, Schwalm HW. 1950. Smog in the south coastal area of California. *California agriculture* 4: 7-11.

Mortensen L. 1993. Effects of ozone on growth of several subalpine plant species. *Norwegian journal of agricultural science* 7: 91-97.

Mortensen L. 1994. Further studies on the effects of ozone concentration on growth of subalpine plant species. *Norwegian journal of agricultural science* 8: 91-97.

Mortensen L, Nilsen J. 1992. Effects of ozone and temperature on growth of several wild plant species. *Norwegian journal of agricultural science* 6: 195-204.

Mudd JB, Kozlowski TT. 1975. Peroxyacl Nitrates. In: Responses of plants to air pollution. JB Mudd and TT Kozlowski (eds).

Newman JR. 1980. Effects of air emissions on wildlife resources. US Fish and Wildlife Service, Biological Services Program, National Power Plant Team, FWS/OBS-80/40.1 32 pp.

Newman JR, Schreiber RK. 1985. Effects of acidic deposition and other energy emissions on wildlife: A compendium. *Veterinary and human toxicology* 27: 394-401.

Newman, J.R. and R.K. Schreiber. 1988. Air Pollution and Wildlife Toxicology. *Environmental Toxicology and Chemistry*. **7:** 381-390.

Nikonov VV, Koptsik GN (eds.). 1999. Acid Deposition and Forest Soils. Apatity. 325 p. (In Russian).

Porter, E. 2003. Ozone Sensitive Plant Species on National Park Service and U.S. Fish and Wildlife Service Lands: Results of a June 24-25, 2003 Workshop Baltimore, Maryland. Natural Resource Report NPS/NRARD/NRR-2003/01.

Potter L, Foot JP, Caporn SJM, Lee A. 1996. The effects of long-term elevated ozone concentrations on the growth and photosynthesis of *Sphagnum recurvum* and *Polytrichum commune*. *New Phytologist* 134: 649-656.

Prinz B, Brandt CJ. 1985. Effects of air pollution on vegetation. In: Pollutants and their ecotoxicological significance, pp. 67-84. H.W. Nurnberg, editor. John Wiley & Sons, New York.

Pye JM. 1988. Impact of ozone on the growth and yield of trees: A review. *Journal of environmental quality 17:* 347-360.

Rattner BA, Haramis GM, Chu DS, Bunck CM. 1987. Growth and physiological condition of black ducks reared in acidified wetlands. *Canadian Journal of Zoology* 65: 2953-2958.

Reich, PE. 1987. Quantifying the response of plants to ozone: A unified explanation. *Tree phys.* 3: 63-91.

Reiling K, Davison AW. 1992. Effects of a short ozone exposure given at different stages in the development of *Plantago major*. *New Phytologist* 120: 643-647.

Reinert et al. 1975. Plant responses to pollutant combinations. In: Plant responses to air pollution. JB Mudd and TT Kozlowski (eds).

Shanklin J, Kozlowski, TT. 1985. Effect of flooding of soil on growth and subsequent responses of Taxodium distichum seedlings to SO sub(2). *Environ. Pollut. (A Ecol. Biol.)* 38: 199-212.E

Siegel BZ, Lasconia M, Yaeger E, Siegel SM. 1984. The phytotoxicity of mercury vapor. *Water, air and soil pollution* 23: 15-24.

St Louis VL, Rudd JWM, Kelly CA, Beaty KG, Bloom NS, Flett RJ. 1994. Importance of wetlands as sources of methyl mercury to boreal forest ecosystems. *Canadian Journal of Fisheries and Aquatic Sciences* 51: 1065-1076.

Taylor OC et al. 1975. Oxides of nitrogen. In: Responses of plants to air pollution. JB Mudd and TT Kozlowski (eds.).

Taylor OC, MacLean DC. 1970. Nitrogen oxides and peroxyacyl nitrates. In: Recognition air pollution injury to vegetation: A pictorial atlas; pp. E1-E14. JS Jacobsen, editor. Air Pollution Control Association, Pittsburgh, PA.

Thimonier A, Dupouey JL, Bost F, Becker M. 1994. Simultaneous eutrophication and acidification of a forest ecosystem in north-east France. *New Phytologist* 3: 533-539.

Treshow M, Anderson FK. 1989. Plant stress from air pollution, John Wiley and Sons Ltd.

United States Fish and Wildlife Service. 2006(a). Okefenokee National Wildlife Refuge comprehensive conservation plan. Southeast Region. Atlanta, Georgia.

United States Fish and Wildlife Service. 2006(b). St. Marks National Wildlife Refuge comprehensive conservation plan and environmental assessment.

Varshney CK, Garg JK. 1979. Plant responses to sulfur dioxide pollution. CRC Critical Reviews in Environmental Control.

Westman, WF et al. 1985. SO_2 effects on the growth of native plants. In: Sulfur dioxide and vegetation, pp. 264-280. WE Winner et al., editors. Sanford University Press, Sanford, CA.

Wetmore CM. 1983. Lichens of the air quality class I National Parks. Final Report. NPS Contract CX-0001-2-0034.

Winger PW. 1997. Fate of airborne contaminants in Okefenokee National Wildlife Refuge. U.S. Department of the Interior. Geological Survey, Biological Resources Division. University of Georgia, Athens, Georgia.

World Health Organization. 2000. Air quality guidelines for Europe. 2nd edition. 288 pages.

Wright LM, Lockaby SG, Meldahl R, Thornton F, Chappelka AH. 1991. The influence of acid precipitation and ozone on nitrogen nutrition of young loblolly pine. *Water, air, and soil pollution* 5.