ENVIRONMENTAL MONITORING AND BASELINE DATA MANAGEMENT STRATEGIES AND THE FOCUS OF FUTURE RESEARCH IN GREAT SMOKY MOUNTAINS NATIONAL PARK

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INTRODUCTION

This report evolved from an attempt to develop coherent links between the environmental monitoring activities of years past, present monitoring activities, and plans for future efforts in Great Smoky Mountains National Park (GRSM). The major purpose of this report is to provide managers and researchers with summary information on current and past monitoring and research data collected in GRSM as well as to identify some areas of concern in which the available information is inadequate.

The U.S. Man and the Biosphere program produced a bibliography and a history of scientific studies done in GRSM (U.S. MAB Reports Nos. 4 and 5). Published in 1982, they consist primarily of journal articles, theses, and dissertations. By contrast, much of the research cited herein is unpublished. Additionally, research contained in this document is more recent. Finally, many of these data sets have not been fully analyzed. For these reasons, this publication and the MAB publications should be seen as complementary efforts.

Section I of this report lists goals and objectives of the program which have been set up to develop a comprehensive environmental baseline data set and an environmental monitoring program for the park. Specific actions to be taken within the next 2 to 3 years are listed under each of these sets of goals and objectives. The environmental monitoring program for the park will not be completely developed by then, but it is hoped the plan presented in this document will form a nucleus around which an effective and efficient monitoring program, relevant to the needs of NPS management, can evolve. An evironmental monitoring program must have both continuity and flexibility, since there is a need for long-term measurements of environmental parameters which can easily be compromised by constraints of funding and manpower. Keeping this in mind, we have developed an environmental program which is built upon the data from past research and monitoring efforts, including work done by NPS researchers, non-NPS researchers, and interagency programs such as the Look Rock Air Quality Monitoring Station and the National Atmospheric Deposition Program.

Section II begins with an overview of GRSM data sets, which are presented in condensed form. Adequate information is provided for each data set so that any manager or researcher may gain access to the data sets, which in most cases are on file at GRSM. The data set overviews are arranged in such a way that workers in various fields can find data sets of interest to them quickly and easily. For instance, a botanist interested in endangered plant species in the park would simply look in section II, part A, under the heading "Biological Resources," and turn to the section on terrestrial flora.

Part B of section II consists of a series of tables which provide general information about research and monitoring activities for each watershed in the park. The section begins with two maps: one map delineates the various watersheds, each of which is identified by the name of the major stream draining the watershed and an assigned number which is used throughout the rest of the section; the other map shows the positions and names of each of the major streams and rivers in the park. These maps are followed by tables which outline monitoring and research activities in the park by watershed.

Section III is a list of research ideas developed by the science and resources management staffs at GRSM. No priority ranking was attempted in developing these lists, and the lists are far from complete. They are intended to be suggestions for further research but are not intended to place limits on research in the park. There are certainly innumerable research topics in both basic and applied fields that have not been covered.

We would like to invite researchers from other government agencies and academia to come to GRSM and help the NPS solve its many natural resources management problems as well as to continue the quest for basic knowledge of natural ecosystem structure and function. We hope this document will help provide the impetus to to develop such cooperative interaction.

III. FUTURE RESEARCH NEEDS IN GREAT SMOKY MOUNTAINS NATIONAL PARK

This is perhaps the most important section in this report in terms of conveying to researchers in other government agencies and universities the need for cooperation in solving the many and varied natural resource and environmental problems in GRSM. What follows is a far from complete list of ideas for future research in the park. The list includes research ideas that are directly related to natural resources management problems as well as ideas that are more attuned to the gathering and scientific analysis of data that will add to our basic knowledge of natural ecosystems, often a crucial first step in the solution of complex management-related problems. Items listed here go beyond the research priorities documented in the GRSM Resources Management Plan. Projects identified in that document are considered essential to the implementation of the plan and will probably be addressed by the National Park Service. This list will most certainly grow and the need for better understanding of GRSM ecosystems will continue to mushroom. In the meantime, it is essential that we continue to focus our attention on the problems at hand in order to better facilitate the preservation of the Great Smoky Mountains ecosystems.

III.A. Aquatic Ecosystems

Surveys

1. Qualitative survey of selected streams within those watersheds selected for future research to determine numbers and types of species of benthic macroinvertebrates present.

2. Qualitative survey of the periphyton in streams in selected watersheds.

3. Updated survey of fish in streams in selected watersheds.

4. Development of a map showing locations of wetlands, ponds, bogs, and other non-lotic aquatic habitats in the park.

5. Aquatic and semiaquatic herpetofauna (salamanders, frogs, lizards, snakes, turtles) surveys to determine current status of rare and/or endemic species (red-cheeked salamanders, bog turtles, hellbenders, etc.).

Watershed - Stream Relationships

6. Effects of the various dominant vegetation types found in the park on lotic communities via differences in quantity and quality of input of allochthonous detritus.

*7. Effects on the various vegetation/soil/bedrock geology combinations found in the park on stream baseflow and stormflow chemistry.

8. Effects of storm-event related streambed scouring on benthic communities.

*Indicates that studies in these areas are under way.

9. Effects of catastrophic floods on fish and aquatic salamander communities.

10. Consequences of large organic debris loading in streams in virgin watersheds; use of large woody debris and debris dams as habitat by benthic macroinvertebrates.

Other Basic Ecological and Organismal Studies

11. Community structure and dynamics in all streams in selected watersheds, but especially in habitats that have not been studied in other places in the southern Appalachians, to include:

    a. Periphyton)
    *b. Macroinvertebrates) Individually and as a whole stream community
    c. Salamanders)
    d. Fish)

12. Low-flow effects on stream communities during droughts.

*13. Trophic relationships within macroinvertebrate communities.

14. Trophic relationships within whole stream communities.

15. Competition between all native fishes and introduced brown trout and rainbow trout.

16. Life history studies of benthic macroinvertebrates.

17. Studies of genetic diversity in aquatic organisms, including:

    a. Descriptions of any undescribed species of macroinvertebrates in the park.

    b. Description of undescribed species of periphyton in the park.

    c. Continued taxonomic studies of salamanders in the park.

    d. Continued taxonomic studies of fish in the park.

18. Life histories and population dynamics of nonsalmonid game fish species and nongame fish species.

Pollutant Loading and Disturbance Ecology

19. Impact of toxic trace element loading in streams at both baseflow and storm event stages.

20. Effects of increased hydrogen ion loading during storm events in streams along longitudinal/altitudinal gradients.

21. Aluminum chemistry and related effects in streams.

22. Increases in pollutant loading attributable to unusual circumstances such as cloud moisture scavenging at high elevation or due to peculiarities found in certain vegetation/soil/bedrock types.

23. Stream recovery rates from impact of Anakeesta roadfill.

24. Effects of increased loading of organic leachate associated with atmospheric deposition on periphyton communities and consequent effects on aquatic food chains.

25. Impacts on biotic communities from historical preservation practices in Cades Cove.

*26. Use of benthic macroinvertebrates as biological indicators of pollution, including stream acidification and toxic trace elements.

*27. Accumulation of toxic trace elements in the tissues of aquatic organisms.

28. European wild hog effects on wetland areas and headwater streams.

29. Effects of devastation of fir trees by balsam woolly aphids on headwater streams.

30. Visitor impacts on stream ecosystems.

Stream Monitoring

31. Development of a comprehensive stream monitoring program.

32. Development of suitable methods for regularly sampling stream organisms.

Habitat Preservation and Protection of Rare and Endangered Species

33. Development of habitat preservation plan for bog turtles, if and when populations are found in the park.

34. Development of a plan to protect and preserve hellbender populations in larger streams and rivers.

35. Development of a plan to remove introduced grey-cheeked salamanders from the park if research on interspecific competition indicates that they are a threat to native red-cheeks.

*36. Development and implementation of a plan to protect and preserve native brook trout populations and their habitat.

III.B. Terrestrial Ecosystems

Terrestrial Flora

Vegetation-Landscape Relations

1. Heath balds: origin, soil evidence, relation to bedrock, and stability.

*2. Vegetation models: predicting vegetation types from topographic variables using remote sensing data and cartographic data set.

*3. Succession and land use history: old homesites, old pastures, garden plots, hayfields.

4. Revegetation of lower parts of debris avalanches.

5. Grape infestation patches: relationship to disturbance, and effect on succession.

6. Resampling of Miller plots.

7. Resampling of Oosting and Billings spruce-fir plots.

*8. Forest modeling: adapting the FORET growth simulation.

9. Vernal flowering displays: prediction from environmental conditions, effects of disturbance history (logging, farming) and wild hogs; marking of phenology plots

10. Rhododendron:prediction of occurrence, resolution of the disequilibrium problem, effects on tree regeneration.

*11. Grassy balds; monitoring the effects of management.

*12. Natural dynamics of the spruce-fir system (old-aged gap dynamics).

13. Dynamics of the remanant virgin forests: Are the big tree stands breaking up?

Fires, Fuels, and Woody Debris

14. Inputs: landscape model of production.

15. Decay rates.

16. Debris fall: size/frequency analysis of organic matter fall.

17. Interface with aquatic systems: debris dams and litter inputs

*18. Fuel models: typing and recognition in GRSM.

19. Logs as seed beds: their importance in tree regeneration as a function of vegetation type and site

*20. Synergism between disturbances; heavy fuel loadings after balsam woolly aphid, pine beetle, and windstorm, and the potential for catastrophic fires.

Disturbance Ecology

*21. Quantification of natural and human disturbance gradients, frequency, intensity, and magnitude as a function of landscape parameters.

22. The riparian zone: flood scour and flood regime, and interactions with recreational impacts

Exotics

*23. Gypsy moth: monitoring for the insects, collection of baseline data on ecosystem structure and function in susceptible stands.

24. Microstegium: survey of an exotic grass in its invasion phase.

25. Honeysuckle: updated survey for the park and trial of management.

26. Exotic plants at old homesites, inholdings, and analysis of possible future problems.

*27. Overall exotic plant management plan.

28. Native vegetation on kudzu sites: nitrogen fertilization and site rehabilitation.

Rare Plants

29. Species biology and population dynamics: Adlumia fungosa, Synandra hispidula (both biennials with widely fluctuating population levels); Phacelia spp. (winter annuals).

30. Population biology of the three GRSM endemics: Cacalia rugelia, Calamagrostis cainii, Glyceria nubigena.

31. Panax quinquefolius: habitat analysis, population sizes, permanent plot monitoring.

32. Plants and poaching: the energetics and allocation-impact of plant gathering, including whole plant and above-ground picking.

33. Introgressive hybridization in rare species: Gregory Bald azaleas and Roan rattlesnake root.

Other

*34. Upgrading the hardmast survey and monitoring; evaluation of the significance of acorn consumption by wildlife, including wild hogs, in terms of oak tree seedling establishment.

35. Upgrading the campsite monitoring program--summary and reassessment of the program.

36. Biological survey of the Cities Service property.

37. Wetlands management plan for GRSM: establishing baseline data on biotic communities, food regime, and succession.

38. Chestnut blight recovery project.

*39. Expanding the life history data for vascular plants: hog food items, pollutant sensitive genera.

40. Role in forest dynamics: Aesculus octandra, Robinia pseudo-acacia

41. Wildlife habitat: modeling the occurrence of denning trees for black bear.

42. The trailside phenomenon: increased biomass, flowering, and invasion by certain herbs.

43. Dynamics of the Houston Chambers Pond flora.

44. The slowness of succession on the White Oak Sink valley floor.

*45. Survey of the Foothills Parkway management corridor for a natural resources plan.

46. Fate of chestnut logs and reconstruction of the silvics of chestnut.

47. The E-W floristic gradient quantified--presence/absence, hemlock distribution.

Terrestrial Fauna

48. Catalog rare animal species present in the park.

49. Develop a means to monitor deer browse, Cades Cove.

50. Survey small mammals in the park.

51. Develop means to monitor changes in species composition and population levels of mammals and birds in the spruce-fir forest in response to the loss of fir trees.

52. Assess level of recruitment of skunks into campgrounds.

53. Determine whether skunks frequenting campgrounds have higher reproductive rates than non-campground skunks.

54. Develop a means to monitor distribution and movement patterns of coyotes and their effects upon prey species.

55. Develop a computer model to simulate the competitive interaction between European wild hogs and native wildlife species.

56. Determine what effects European wild hogs may have on other game species.

57. Utilize small mammal road kills to monitor general health of these animals as well as major changes in population levels and movement patterns.

58. Develop a means to monitor the effects of human visitation to caves on habitat condition and hibernation of bats.

59. Develop a means to monitor density, distribution, and effects of beavers as they reestablish in the park.

60. Study of competition between introduced grey-cheeked and native red-cheeked salamanders.

III.C. Sociological Studies

1. Evaluate how effectively interpretive programs convey management issues to the public.

*2. Describe behavior patterns in frontcountry and backcountry campsites.

3. Evaluate potential for conflict between hikers and horses.

*4. Evaluate potential for conflict between bikers and automobiles in Cades Cove.

5. Evaluate potential for conflict between tubers and fishermen on streams.

6. Develop interpretive programming for management issues such as air quality, hog control, biosphere reserve management.

7. Evaluate visitor flow patterns.

8. Evaluate the interpretive potential of commercial bus tours.

9. Investigate the extent of the use of drugs in the park.

10. Evaluate impact of tourism development surrounding the park on the local scenic landscape and culture.

11. Further study of human/bear interaction in the back- and front country.

12. Describe social behavior patterns at primary points of interest Newfound Gap, Clingmans Dome, Mount LeConte.

*13. Use of touch screen computers in visitor center.

14. Social behavior at shelters along the Appalachian Trail.