

MONITORING REFERENCES

**A Product of the Hawaii Natural Resources Monitoring Working Group
(a working group of the Secretariat for Conservation Biology)**

<http://www.hear.org/hinrmwg>

DATABASES and SOFTWARE

Borland Paradox for Windows v. 5.0. 1994. Borland International, Inc. Scott's Valley, CA.

A relational database program. Platform for customized Monitoring Database programmed by Philip Thomas (see below).

Jensen, M. E., W. Hann, R. E. Keane, J. Caratti, and P. S. Bourgeron. 1994. ECODATA - A Multiresource Database and Analysis System for Ecosystem Description and Evaluation. In: Jensen, M. E., and P. S. Bourgeron, technical editors. Volume II: Ecosystem Management: Principles and Applications. Eastside Forest Ecosystem Health Assessment. General Technical Report PNW-GTR-318. February 1994. U. S. Dept. of Agriculture, Forest Service. Pacific Northwest Research Station. ECODATA is a term used to describe a set of relational databases and analysis programs developed for environmental assessment and ecosystem analysis.

Gibbs, James P. Monitor: Software for Estimating the Power of Population Monitoring Programs to Detect Trends in Plant and Animal Abundance. Version 6.2. 1995.

Shareware available free from WWW. DOS-based.

The introduction in the User manual (also downloadable) states: This software estimates the statistical power of population monitoring programs relative to (1) the number of plots monitored, (2) the magnitude of counts per plot, (3) count variation, (4) plot weighting schemes, (5) the duration of monitoring, (6) the interval of monitoring, (7) the magnitude and nature of ongoing population trends, (8) the significance level associated with trend detection, and several other factors. The program deals ONLY with COUNT data (e.g. how many plants were counted in a plot, how many birds were seen in a 3 minute period). It does NOT deal with frequency or interval data (e.g. frequency of weeds along a transect, foliar cover values).

Thomas, Philip A. 1996. Hawaiian Natural Resources Monitoring Database. Research Corporation of the University of Hawaii and National Biological Service. Hawaii.

This customized monitoring database was programmed in the Paradox relational database. The program continues to evolve and can be modified by users. It features standardized taxa nomenclature and federal status under the endangered species act. Documentation is available on the world wide web at: www.hear.org/MonitoringDatabase.

TECHNICAL REPORTS and AGENCY MANUALS

Allen, R.B. 1993. *A Permanent Plot Method for Monitoring Changes in Indigenous Forests*. Manaaki Whenua-Landcare Research New Zealand Ltd., Christchurch, New Zealand. UDC 504.064.36(931): 630.9 35 pp.

The management and protection of New Zealand's remaining indigenous forests require techniques for monitoring its status (forest structure, species composition, and distribution). The uses of permanent sample plots are discussed and this manual updates and standardizes the use of the 20 x 20m permanent plot. Keywords: forest, permanent sample plots, forest inventory, forest dynamics, environmental monitoring, forest conservation.

Bolda, Karen, and Bill Meyers. (no date) *Long-term Water Quality Monitoring on the McCloud River, CA*. McCloud River Preserve, P.O. Box 409. McCloud, CA 96057.

2 pp.

This study employed a paired-watershed design which monitored disturbed and undisturbed watersheds with similar physical properties. The results include suspended sediment, turbidity, and peak flows.

Bureau of Land Management, U.S. Department of the Interior. 1997. *Inventory and Monitoring of Special Status Plants*. Manual for Course # 1730-05 held April 14 - 18. Portland, Oregon.

Carpenter, Richard, and James Maragos. 1989. *How to Assess Environmental Impacts on Tropical Islands and Coastal Areas*. East-West Center. Honolulu, Hawaii.

Chambers, Jeanne C., and Ray W. Brown. 1983. *Methods for Vegetation Sampling and Analysis on Revegetated Mined Lands*. General Technical Report INT-151. October 1983. U.S. Dept. of Agriculture, Forest Service. Intermountain Forest and Range Experimental Station, Ogden, UT. 57 pp.

Several vegetation sampling techniques are discussed.

Dunn, Patrick. 1992. *Long-Term Biological Resource and Threat Monitoring of Hawaiian Natural Areas*. Produced for The Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife by The Nature Conservancy of Hawaii. Honolulu, HI.

The basis for most biological monitoring in TNCH preserves and state NARS.

Hawaii Department of Health. 1995. *Draft: Rapid Bioassessment and Habitat Assessment Protocols for Streams in Hawaii: Technical Support for Biological Surveys*. Unpublished draft document prepared by the Stream Bioassessment Program, Environmental Planning Office, Hawaii Department of Health.

State of Hawaii Division of Forestry and Wildlife. 1988. *Natural Area Reserves System Inventory Field Manual*. 1988. Natural Areas Reserve System, Division of Forestry and Wildlife, Department of Land and Natural Resources, State of Hawaii.

A 43 page manual that describes the procedures used to inventory the State's Natural Area Reserves from December 1987-April 1989. The Introduction states: "[It] was designed to gather management-oriented resource information over large and often remote areas within a short time period. It was not meant to be a comprehensive survey." Information collected included: presence/absence of species (both animals and plants); qualitative information about sites (e.g. steep slope, west facing); a cover class code describing foliar cover of weeds and native vegetation (e.g. code 3 = 5-25%); ungulate sign and intensity (e.g. F/M = fresh sign of moderate intensity); and population information about rare plants (e.g. 3 lg plts, 2 in flwr, on steep slope, pig digging nearby).

State of Hawaii Division of Forestry and Wildlife. 1994. *Field Manual for Monitoring Transects. Version 2.0*. Division of Forestry and Wildlife, Kauai District. State of Hawaii. 19 pp.

This manual describes monitoring of native vegetation, weeds, ungulate sign, birds, and erosion along 300 ft long transects. Methodology is discussed and sample data sheets are included. Parameter selection is not discussed, nor is data analysis.

Holt, Alan. 1983. *An Overview of Vegetation Monitoring at Kamakou Preserve, Molokai*. Draft 10/5/83. 5 pp.

This overview deals with the General Vegetation Monitoring System at Kamakou Preserve and is designed for the primary purpose of tracking the status of forest bird/native species habitat. The set of sample plots is intended to track samples of each of the preserve's major native habitats (native vegetation types), primarily focusing on the trends of "per cent nativeness".

Institute of Pacific Islands Forestry, Forest Service, U.S. Dept. of Agriculture. 1992. *East Maui Watershed Monitoring Plan*. Report to State of Hawaii Dept. of Land and Natural Resources, Division of Forestry and Wildlife.

Leslie, Michele, Gary K. Meffe, Jeffrey L. Hardesty, and Diane L. Adams. 1996. *Conserving Biodiversity on Military Lands: A Handbook for Natural Resources Managers*. The Nature Conservancy, Arlington, VA. 241 pp + ~ 100 pp of appendices. Includes background on biodiversity and management of natural resources on military lands. Moves to modeling, management infrastructure, goal setting and strategies for conservation. One section (9 pp) deals with monitoring. Does not deal with methodology, but rather concept behind monitoring. Emphasizes the difference between management and monitoring objectives and defines other types of monitoring. Also mentions the importance of defining clear and appropriate questions before beginning a monitoring program. The handbook gives a nice overview of ecological considerations as they relate to conservation and resource management.

Lewis, T.E., and B. L. Conkling, editors. 1994. *Forest Health Monitoring Southeast Loblolly/Shortleaf Pine Demonstration Interim Report*. EPA/620/R-94/006. U.S. Environmental Protection Agency, Washington, D.C.

The objectives of this study, referred to as the Southeast Loblolly/Shortleaf Pine Demonstration, or SE DEMO, was to test a suite of indicators considered important in assessing forest health. The indicators were evaluated from a statistical and biological perspective to ascertain their suitability in Detection Monitoring. This report identifies problems in data collection, quality assurance and quality control, and acquisition.

Medeiros, A. C., C. G. Chimera, and L.L. Loope. 1996. *Kauhako Crater Botanical Resource and Threat Monitoring, Kalaupapa National Historical Park, Island of Molokai, Hawaii*. Technical Report # 110. Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa. Honolulu, HI.

Describes the monitoring of dryland forest plants and threats in the crater on the Kalaupapa Peninsula. Raw data is included as are management recommendations.

Mitchell, Wilma A., and H. Glenn Hughes. 1995. *Point Sampling*: Section 6.2.1, U.S. Army Corps of Engineers Wildlife Resources Management Manual, Technical Report EL-95-25, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 37 pp. Report discusses point sampling techniques to estimate percentage of ground cover. Topics covered include guidelines for technique selection and study design, preparation for sampling, procedures for data collection, and data analysis. It also describes how to build a point-quadrat frame and a sighting tube for viewing both ground cover and overstory. Deals mostly with range vegetation, not forests.

Mitchell, Wilma A., H. Glenn Hughes, and Larry E. Marcy. 1995. *Prism Sampling*: Section 6.2.3, U.S. Army Corps of Engineers Wildlife Resources Management Manual, Technical Report EL-95-24, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 49 pp.

Report describes prism sampling, also known as variable radius plot sampling or the Bitterlich method. It is a method commonly used by foresters to assess tree basal area, density, volume of useable wood and stand structure of trees. It is most applicable to forests with an open understory such as those in a tree plantation.

Mitchell, Wilma A. and H. Glenn Hughes. 1995. *Fixed Area Plot Sampling for Forest Inventory*: Section 6.2.4, U.S. Army Corps of Engineers Wildlife Resources Management Manual, Technical Report EL-95-27, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 33 pp.

Report describes the use of permanent plots for forest inventory. Species composition, basal area and density are discussed along with data analysis. The methods are based on standard forestry assessment techniques and are designed for use in forests with low species diversity and open understory. The methods are for assessing trees (red timber) only. No herbs, shrubs, or epiphytes are measured.

Mitchell, Wilma A. and H. Glenn Hughes. 1995. *Line Intercept*: Section 6.2.5, U.S. Army Corps of Engineers Wildlife Resources Management Manual, Technical Report EL-95-22, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 25 pp.

Report describes the use of line intercept methods for estimating ground cover in shrublands and arid habitats.

Mitchell, Wilma A. and H. Glenn Hughes. 1995. *Visual Obstruction*: Section 6.2.6, U.S. Army Corps of Engineers Wildlife Resources Management Manual, Technical Report EL-95-23, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 26 pp. Report describes the use of a 2m tall board, painted in 0.5 m increments to assess the percent of vegetation cover at varying heights. Cover estimates are an aggregate of all species, and individual species cover is not distinguished. It is used for vegetation <2m in height only.

Morris, Meredith J. 1967. *Statistical Methods in Grassland Research - An Abstract Bibliography*. Washington, D.C.: Forest Service, U.S. Department of Agriculture. 222 pp.

A bibliography of world literature on statistical methods for scientists working in grassland research. The booklet is organized by subject matter class, which includes measurement of vegetation (plots, lines, point, reconnaissance, forage value, site relations, distribution, root and soil sampling), animal responses, and statistical theory (distributions, hypothesis testing, regression, sampling, design, and experimental design). The abbreviations used for jargon and publications are given. Most of the 1118 bibliographic entries include abstracts prepared by the authors or by an abstracting service.

Keywords: statistics/ bibliography/ grassland/ sampling.

The Nature Conservancy. 1994. *A Strategy for Ecological Monitoring at Parks in Peril Sites*. Submitted by The Monitoring for Management Working Group, Latin America and Caribbean Division, The Nature Conservancy. 15 November 1994.

Summary of the sustainable, iterative process of ecological monitoring for evaluating the progress toward management goals. Importance of monitoring --and distinguishing-- causes and effects of "natural" and anthropogenic changes in biological, abiotic, and socioeconomic processes are stressed due to the idea that without, appropriate management action cannot be taken.

The Nature Conservancy. 1995. *Vegetation Monitoring in a Management Context*. Handbook from a workshop coordinated by The Nature Conservancy and cosponsored by the U. S. Forest Service. June 1995.

The Nature Conservancy of California. 1991. *Natural Diversity Monitoring - A Primer for Volunteers*. Draft - November 19, 1991.

Factors to consider when writing a monitoring plan.

The Nature Conservancy of Hawaii. (no date). *Long-Term Biological Resource and Threat Monitoring of Pelekunu Preserve, Molokai*. 45 pp.

This plan describes the monitoring protocol for Pelekunu Preserve. The plan is based on the protocol suggested in "Long-term biological resource and threat monitoring of Hawaii's natural areas." The plan is organized to give a summary of the monitoring

procedures, the locations of sampling transects and stations, and in-depth descriptions of monitoring protocol. These descriptions include all field procedures, example data sheets, field 'cheat sheets', and examples of typical data and data analysis. There are some errors and ambiguities. Some changes have been made through usage.

The Nature Conservancy of Hawaii. 1996. *East Maui Watershed Monitoring*. The Nature Conservancy of Hawaii, Honolulu, HI.

Summary of a pilot monitoring project in the East Maui Watershed and a proposed monitoring plan for future monitoring of alien species, vegetation, birds and other biological resources.

Keywords: monitoring/ Hawaii/ Maui/ plan/ ecology.

Poiani, Karen. 1996. *Monitoring Change at the Landscape Level*. Talk notes. TNC National Stewardship Conference--Jan/Feb 1996. 4 pp.

Headings: conservation at landscape scales, landscape features, landscape change, monitoring landscape change, patch measures, corridor measures, and whole-landscape measures. References included.

Rolph, David N. 1993. *A Vegetation Monitoring Plan for the Moomomi Preserve, Molokai, Hawaii*. The Nature Conservancy of Hawaii. 142 pp.

This plan describes monitoring of coastal vegetation communities. Included are sections on monitoring native and alien vegetation, vegetation within and outside deer exclosures, rare plants, weather, and methods for photo documentation and weed mapping. There are some errors and ambiguities. Some changes have been made through usage.

Russell, Diane. 1997. *Studying the Social Dimensions of Community-Based Biodiversity Conservation*. Biodiversity Conservation Network, Regional Office, Manila, Philippines. 61 pp.

This is a "no-frills" guidebook designed to help projects, programs and organizations working in biodiversity and conservation. This guide is primarily intended for Biodiversity Conservation Network grantees and partner organizations. This guide is intended to help develop a social research and monitoring program that provides information and feedback to managers and decision-makers at all levels. The social research outlined in this manual combines several activities: baseline research, socioeconomic monitoring, community organizing, analysis and evaluation.

Shopland, Jennifer M. 1992. *Ecological Monitoring in Tropical Reserves: Advances and Opportunities*. Mexico Country Program, The Nature Conservancy, 15 April 1992. 23 pp.

This is a preliminary summary of recent advances in the design and implementation of monitoring programs. The goal of this review was to call out opportunities for TNC to incorporate these new perspectives into work with its Latin American partners in conservation. This review focuses on tropical rather than temperate-zone models.

Shopland, Jennifer M. 1993. *Some Guidelines for Developing an Integrated Ecological Monitoring Program in a Latin American Reserve*. Mexico County Program, The Nature Conservancy, 14 April 1993. 10 pp.

This review offers guidelines for “ecological monitoring” which is a sustainable, iterative process for evaluating progress toward management goals. The guidelines given describe the steps taken towards the collaboration and development of an integrated monitoring plan for the El Triunfo Biosphere Reserve in the Sierra Madre de Chiapas.

Shopland, Jennifer M. 1994. *A Framework for an Integrated Ecological Monitoring Program at the El Triunfo Biosphere Reserve, Chiapas, Mexico*. Mexico Country Program, The Nature Conservancy, Tucson, AZ, USA, 25 January 1994. 47 pp.

This paper discusses the proposal for an integrated monitoring program for the El Triunfo Biosphere Reserve. This Reserve is located in the montane and lower-elevation tropical forest region of the Sierra Madre de Chiapas, Mexico. The focus of this paper is based upon the Reserve’s 8 management goals, the available resources, the analyzing of gaps in information, assessing risks and opportunities, and the suggestion of 12 monitoring projects.

Tallent-Halsell, Nita G., editor. 1994. *Forest Health Monitoring: 1994 Field Methods Guide*. EPA/620/R-94/027. U.S. Environmental Protection Agency. Washington, D.C. 205 pp.

This Field Guide compiled by the partners of the Forest Health Monitoring (FHM) program includes information on the trends in indicators of forest ecosystem condition and indicators of natural and human-caused stressors, including changes in forest extent and distribution. Information is also provided on the health of the nation’s forest ecosystems in annual statistical summaries and periodic interpretive reports. There are some errors in several of the figures.

Tazik, David, Steven D. Warren, Victor E. Diersing, Robert B. Shaw, Robert J. Brozka, Calvin F. Bagley, and William R. Whitworth. 1992. *U. S. Army Land Condition-Trend Analysis (LCTA) Plot Inventory Field Methods*. USACERL Technical Report N-92/03. February 1992. U.S. Army Corps of Engineers.

Report outlines standard methods for collecting and maintaining a permanent LCTA database on the condition of Army land resources. Included are lists of equipment needed for data collection, and detailed procedures for establishing permanent field plots, collecting plant specimens, inventorying wildlife populations, and maintaining the databases by periodic short and long-term monitoring of the field plots.

Wells II, Wade G., and Peter M. Wohlgemuth. 1987. *Sediment Traps for Measuring Onslope Surface Sediment Movement*. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture. 6 Pages. Research Note. Vol. PSW-393.

Two types of small (so-cm aperture) sheet metal sediment traps were developed to monitor onslope surface sediment transport. Traditionally, sediment traps and erosion pins have been used to measure the onslope movement of surficial soil material. While

pins may be appropriate for documenting landscape denudation, traps are more suitable for monitoring downslope transport parallel to the ground surface. Previous investigations used large (3-m aperture) traps to measure sediment transport. However, large aperture traps are cumbersome and require excessive amounts of time and energy for installation, sample collection, and sample processing. These serious logistical constraints make data acquisition difficult and expensive. The small traps were designed to remedy this situation. Field tests of these small traps revealed variable patterns of spatial and temporal surficial debris movement obscured in previous studies. Although these traps are not without limitations, the improved sampling logistics allow greater sample sizes and constitute a marked improvement over other transport measurement techniques.

Keywords: erosion/ surface erosion/ hillslopes/ chaparral/ California/ process/ monitoring .

BOOKS

Barbour, Michael G., Jack H. Burk, and Wanna D. Pitts. 1980. *Terrestrial Plant Ecology*. The Benjamin/Cummings Publishing Company, Inc. Menlo Park, CA.

Bonham, Charles D. 1989. *Measurements for Terrestrial Vegetation*. John Wiley and Sons. New York. 338 pp. QK 911 B57

Standard text on measuring vegetation. Discusses various parameters appropriate for sampling with chapters on Units for Measurements; Statistical Concepts for Field Sampling; Frequency and Cover; Density; Biomass; and a separate chapter on Monitoring and Evaluation. The monitoring section emphasizes the need for clearly defining the purpose for monitoring and the parameters for which one wishes to detect change. Mapping (both from the ground and air), changes in frequency, cover, condition, and biomass are discussed.

Keywords: measurement/ vegetation/ statistics/ ecology.

Cain, Stanley A., and G. M. de Oliveira Castro. 1959. *Manual Vegetation Analysis*. Harper and Bros. New York. QK 911 C3

Cressie, Noel A. C. 1991. *Statistics for Spatial Data*. John Wiley & Sons. New York. 900 pp.

(from the preface) This book is a comprehensive examination of statistics for spatial data for use by scientists and engineers. Part I covers Geostatistics, Part II deals with Lattice data, and Part III covers Point Patterns. The author assumes at least 1 semester of graduate courses in statistical inference and linear models. The book includes generous use of data and models to develop a comprehensive theory and proofs. It is a highly technical book on spatial data.

Keywords: statistics/ geostatistics/ modeling.

Diamond, Jared, and Ted J. Case. 1986. *Community Ecology*. Harper and Row. New York. QH 5541 C644

Falk, Donald A., Constance I. Millar, Margaret Olwell. 1996. *Restoring Diversity*. Island Press. Washington, D.C. QK 86.4 R47

Chapter 10 by Rob Sutter (TNC) is titled "Monitoring".

This chapter deals with monitoring of populations of rare plant species after plants are reintroduced into the wild. Sampling design and parameters to measure are also discussed.

Given, David R. 1994. *Principles and Practice of Plant Conservation*.

Timber Press, Inc. Portland, OR.

Chapter 4 Plant Population Management. Discusses maintenance of plant population characteristics and essential habitat. Monitoring is discussed as a way to assess plant populations over time. The 2 page discussion deals with aspects of demographic and population monitoring that need to be considered in a monitoring plan. References in the text can lead the reader to other sources of information.

Greig-Smith P. 1964. *Quantitative Plant Ecology*. 2nd ed. Butterworth and Co. London. QK 901 G83

A standard text on vegetation sampling. Nothing on monitoring, per se, but rather what parameters are useful when trying to quantify vegetation characteristics. Chapters include Quantitative Description of Vegetation; Sampling and Comparison; Pattern; Association Between Species; Correlation of Vegetation with Habitat Factors; Description, Comparison, Classification and Ordination of Plant Communities; and Quantitative Approach to Plant Ecology.

(from the preface of the first edition) There are 7 chapters in the book. Chapter 1 deals with different methods of quantitative description of vegetation, Chap. 2 with placement and number of samples needed. Chapter 3 contains a discussion the factors that cause placement of plants in communities to depart from random, then chapter 4 considers the relationship between patterns of different species in communities. Chapter 5 deals with correlation between vegetation and environmental factors. Chapter 6 is concerned with assessing the delineation of plant communities and differences between stands of vegetation. Chapter 7 speculates about the values of utilizing quantitative methods in ecological theory and in putting the practice of ecology on a sounder basis through quantitative methods.

Keywords: ecology/ methods/ statistics/ sampling/ modeling.

Hammersley, J. M., and D. C. Handscomb. 1964. *Monte Carlo Methods*. John Wiley & Sons. New York. 178 pp. Methuen's Monographs on Applied Probability and Statistics. Bartlett, M. S., General Editor.

Notes: References (19 pages).

A survey of the state of Monte Carlo methods (in 1964). Applies theory to problems of simulation, sampling, and experimentation. Application to problems concerning physical and chemical phenomena are giving but none are directly applicable to biology. The book includes theory and application of mathematical processes (it assumes an understanding of mathematical theorems).

Keywords: statistics/ theory/ simulation.

Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. 1994. *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press. Washington DC. 364 pp.

Hicks, Charles R. 1964. *Fundamental Concepts in the Design of Experiments*. Holt, Rinehart and Winston. New York. 293 pp.

Extensive examples, statistical tables, chapter problems (some solutions given), short bibliography.

(From Preface) The book presents the fundamental concepts in the design of experiments through the use of simple numerical problems. Emphasis is given to the basic philosophy of design through use of a logical sequence of sample designs in a consistent outline. The author expects the reader to be engaged in experimental work and to have a good background in statistical methods including analysis of variance. A background in calculus is not assumed but some calculus is used to present theory.

Keywords: statistics/ experimental design.

Kershaw, Kenneth A., and John Henry H. Looney. 1985. *Quantitative and Dynamic Plant Ecology*. 3rd ed. Edward Arnold. Baltimore, MD. QK 901 K4

Discusses methods for describing vegetation and concepts about succession, cyclical change, plant interactions, distributions of plants, and plant communities. Does not deal with monitoring per se, but rather how to characterize vegetation.

Krebs, Charles. 1989. *Ecological Methodology*. Harper Row. New York. QH 541.15 S72 K74

An excellent reference on many basic ecological statistics, including species richness and diversity.

Manly, Bryan F. J. 1992. *The Design and Analysis of Research Studies*. Cambridge University Press. New York. R 853 S7 M36

Mueller-Dombois, Dieter and Heinz Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*. John Wiley and Sons. New York. QK 901 M8

Classic text on vegetation classification.

Myers, Wayne L., and Ronald L. Shelton. 1980. *Survey Methods for Ecosystem Management*. John Wiley and Sons. New York. QH 541.15 S95 M93

Discusses survey techniques, not monitoring. Sections on topography, soil, geology, air, water, weather, and vegetation (no animals). Discusses various parameters that are usually measured and brief description on how it is done.

Powell, Thomas M., and John H. Steele, editors. 1995. *Ecological Time Series*. Chapman and Hall. New York. QH 541.15 S72 E26

Primarily an ecology text dealing with methods and concepts of freshwater, marine, and terrestrial ecology. Chapters focus on the analysis and interpretation of ecological

processes that function on varying time scales. Chapter 12 by Thomas Stohlgren titled “Planning Long-Term Vegetation Studies at Landscape Scales” is the most relevant to the type of veg monitoring done in Hawaii.

Scott, J. Michael, Stephen Mountainspring, Fred L. Ramsey, Cameron B. Kepler. 1986. *Forest Bird Communities of the Hawaiian Islands: Their Dynamics, Ecology, and Conservation*. Studies in Avian Biology # 9. Cooper Ornithological Society. Allen Press, Inc. Lawrence, KS.

Spellerberg, Ian F. 1991. *Monitoring Ecological Change*. Cambridge University Press. New York. QH 541.15 M64 S73

A helpful general introduction of issues in monitoring. Includes chapters on biological indicators and indices. Special chapters on monitoring birds and freshwater populations.

Sokal, Robert R. and F. James Rohlf. 1981. *Biometry: The Principles and Practice of Statistics in Biological Research*. 2nd ed. W. H. Freeman and Co. New York.

One of the standard statistical texts for biologists. Doesn't deal with monitoring specifically but rather with hypothesis testing in an experimental setting.

Steel, Robert G. D., and James H. Torrie. 1960. *Principles and Procedures of Statistics*. MacGraw-Hill. New York. QA 276 S82

Statistic reference with, in the words of the authors, special reference to the biological sciences. Primary emphasis is hypothesis testing, not monitoring.

Stoddard, Charles H., and Glenn M. Stoddard. 1987. *Essentials of Forestry Practice*. 4th ed. John Wiley and Sons. New York. 432 pp. SD 373 S79

Turner, Monica G., and Robert H. Gardner. editors. 1991. *Quantitative Methods in Landscape Ecology: The Analysis and Interpretation of Landscape Heterogeneity*.

Springer-Verlag. New York. QH 541.5 L35 Q36

Chapters on remote sensing, GIS, landscape patterns and a large section on landscape modeling.

Zar, Jerrold H. 1984. *Biostatistical Analysis*. 2nd ed. Prentice Hall. Englewood Cliffs, New Jersey. 718 pp.

One of the standard statistical texts for biologists. Doesn't deal with monitoring specifically but rather with hypothesis testing in an experimental setting. Similar to Sokal and Rohlf but a bit more accessible.

JOURNAL ARTICLES and BOOK CHAPTERS

Anderson, J. E. 1991. A conceptual framework for evaluating and quantifying naturalness. *Conservation Biology* 5: 347-352.

Proposes and evaluates several home-grown indices.

Anderson, Stephen J., and Charles P. Stone. 1994. Indexing sizes of feral pig populations in a variety of Hawaiian natural areas. *1994 Transactions of the Western Section of the Wildlife Society* 30: 26-39.

Describes transect-based monitoring of pig activity.

Austin, M. P. 1977. Use of ordination and other multivariate descriptive techniques to study succession. *Vegetatio* 35: 165-175.

Austin, M. P. 1981. Permanent quadrats: an interface for theory and practice. *Vegetatio* 46: 1-10.

Conceptual treatment dealing mostly with succession.

Austin, M. P., and P. C. Heyligers. 1989. Vegetation survey design for conservation: gradsect sampling of forests in north-eastern New South Wales. *Biological Conservation* 50: 13-32.

Sampling vegetation for surveys. Most data was frequency data. Repeat measurements not discussed.

Bourdeau, Philippe F. 1953. A test of random versus systematic ecological sampling. *Ecology* 34 (3): 499-512.

Results from this study indicate that stratified random sampling should be used in ecological work since it will be almost as accurate as systematic sampling, if not more so, and it allows a reliable assessment of sampling error for about the same amount of time spent in the field.

Brand, David G., Donald G. Leckie, and Edward E. Cloney. 1991. Forest regeneration surveys: Design, data collection, and analysis. *The Forestry Chronicle* 67 (6): 649-657. Regeneration surveys have always been looked on as a necessary evil in silviculture. Huge amounts of data have been collected, only to answer simple questions or to be filed and never used. This paper addresses the possibility of changing regeneration surveys from simple legislative requirements, into components of the forestry information system. Current technology allows the development of sophisticated decision support systems, and this changes the whole perspective on information needed from regeneration surveys. Depending on the level of information needed, ground surveys or aerial surveys can be used. The types of information available from different survey systems are described, and two case studies are presented. In one, regenerating stands are assessed using an intensive ground-based survey and, in the second, the MEIS (Multi-spectral, Electro-Optical Imaging Scanner) is used to identify stocking in young plantations. It is concluded that surveys must be designed by working backwards from the decisions to be made, to the information needed to make those decisions, to the data needed to provide that information -- Authors.

Keywords: surveys/ data/ monitoring/ statistics.

Briggs, Mark K., Lisa Harris, Jim Howe, and William Halvorson. 1996. Using long-term monitoring to understand how adjacent land development affects natural areas: An example from Saguaro National Park, Arizona (USA). *Natural Areas Journal* 16 (4): 354-361.

Describes the broad outline of a plan to monitor wildlife and riparian ecosystems via a series of inventories conducted at intervals of 3-5 years over a 20 year time span.

Burnham, Kenneth P., David R. Anderson, and Jeffrey L. Laake. 1980. Estimation of density from line transect sampling of biological populations. *Wildlife Monographs* 72: 1-202.

Cairns, Jr., John, Paul V. McCormick, and B. R. Niederlehner. 1993. A proposed framework for developing indicators of ecosystem health. *Hydrobiologia* 263: 1-44.

Clarkson, Bruce D., and Beverley R. Clarkson. 1994. Vegetation decline following recent eruptions on White Island (Whakaari), Bay of Plenty, New Zealand. *New Zealand Journal of Botany* 32: 21-36.

Vegetation decline following recent (1976-90) eruptions on White Island (Whakaari) was assessed during 1986 and 1990 using historical accounts (1959 and 1967) as a baseline. Probable causes of the marked decline of forest and scrub vegetation as well as the extinction of local species are discussed. Keywords: vegetation decline, volcanic eruption, White Island, pohutukawa, *Metrosideros excelsa*, forest, gannetry vegetation.

Dickinson, K. J. M., A. F. Mark, and W. G. Lee. 1992. Long-term monitoring of non-forest communities for biological conservation. *New Zealand Journal of Botany* 30: 163-179.

Grass/shrubland study using modified point-intercept to estimate cover and describe structure and composition. Repeat measurements with different observers showed high precision.

Davis, Gary E. 1989. Design of a long-term ecological monitoring program for Channel Islands National Park, California. *Natural Areas Journal* 9 (2): 80-89.

Doty, R. D., H. B. Wood, and R. A. Merriam. 1981. Suspended sediment production from forested watersheds on Oahu, Hawaii. *Water Resources Bulletin* 17(3):399-405. Suspended sediment from forested and agricultural water sheds was sampled over a five-year period on the island of Oahu. A variety of storm conditions were sampled, giving a measure of the extreme variability in suspended sediment production. Total annual suspended sediment from all watersheds sampled ranged from 8400 kg/k2 to 617,000 kg/km2. Normally about 90 percent of the total suspended sediment was produced during less than 2 percent of the time. Suspended sediment concentrations rapidly increased during rising stream flow resulting from rain storms. Time to peak of less than two hours is common, with a similarly rapid return to prestorm conditions. The data presented indicate the great variability of suspended sediment yields, making establishment of effective standards difficult.

Keywords: forestry/ water quality/ Hawaii/ storm flow/ sediment/ hydrology/ monitoring.

Dunn, C. P., and R.R. Sharitz. 1987. Revegetation of a *Taxodium-Nyssa* forested wetland following complete vegetation destruction. *Vegetatio* 72: 151-157.

An analysis of vegetation change using ordination techniques.

Eckblad, James W. 1991. How many samples should be taken. *BioScience* 41 (5): 346-348.

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An explanation of the theory and utility of the jackknife procedure is provided. The latter is exemplified by a sampling simulation using ratio-of-means estimation from three forestry populations. A universal reduction in the bias of the ratio estimator was achieved, but of greater importance is the considerably more accurate estimates of its variance that are possible by jackknifing. Another use of the jackknife is provided by the derivation of an estimator of the theoretically complex variance of quadratic mean stem diameter from prism sampling data.

Keywords: statistics/ forestry/ sampling/ geostatistics.

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Appropriate quadrat sizes and efficient allocations of sampling units were determined for frequency sampling of the *Artemisia arbuscula/Festuca Idahoensis* association in southeast Oregon. The theoretical considerations pertinent to these determinations were reviewed. A quadrat 6 to 10 in. sq. is appropriate for frequency sampling of the common spp., and an allocation of 10 to 20 quadrats per transect attained optimum efficiency. A sample of 15 transects, each including 10 9-in. quadrats, was convenient, appropriate, and efficient. This allocation of sampling units is recommended for subsequent frequency sampling of this assoc.

Keywords: Oregon/ sampling/ sagebrush/ Idaho fescue/ statistics.

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A call to differentiate between a statistically significant change and a biologically significant change.

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An adaptation of line transect methodology to circular plot surveys is presented.

Alterations of the methodology are suggested to address two specific features unique to the circular plot: (i) detection probability is higher at intermediate distances because the observer remains in a fixed position for an assignable time period, and (ii) estimation of large distances is poorly done because the circular plot is used in dense habitat and for species 'sighted' by vocal identification. A situation using Poisson variation in counts to simulate animal mobility or population fluctuation reveals that density estimators which rely only on near-station counts can gravely overshoot their mark. A method, based on likelihood ratio testing, is proposed for reducing this possibility.

Keywords: survey/ animals/ Hawaii/ methods/ plots/ statistics .

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Strip transects of 100 contiguous, aligned quadrats were sampled during the spring blooming in a creosotebush (*Larrea tridentata*) semidesert and a chamise (*Adenostoma fasciculatum*) chaparral, with species covers in quadrats recorded. Techniques of pattern analysis included reciprocal averaging ordination of quadrats, measurements of pattern diversity and pattern periodicity, and species association and contagion. In both communities the first ordination axis expressed a strong pattern of differentiation of the herb flora from shrub centers to openings; second and third axes expressed other responses of herb species to shrub species and shrub cover. The pattern axis represents a principal direction of niche difference to which most species responded and along which several pairs of congeners were separated. Pattern periodicities were 6 m (weakly defined) in the semidesert and 9 m in the chaparral; pattern diversities were 1.4 and 1.8 half-changes. Quadrat species richness was highest in the transitions between shrub clumps and openings in the semidesert, but higher in the openings and lower under the shrubs of the chaparral. Overall alpha diversity resulted from roughly comparable contributions of point or small-quadrat diversity, pattern diversity of more common species, and rare species. The importance of biological modification of microsites for population function and niche relationships is suggested by species responses to the primary pattern axis, the responses of some herb species to particular shrub species, and the indicated allelopathic effects in the chaparral.

Keywords: ecology/ chaparral/ creosotebush/ classification/ pattern/ statistics/ Southern California.

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Visual estimates of grass and forb density were compared among 8 observers. Differences varied among observers, with time of day, and with the species being assessed. Results supported the trend away from reliance on visual density estimates of range plants.

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Estimates of mean values of soil properties within small rectangular blocks of land can be obtained by kriging provided the semi-variogram is known. This paper describes optimal rectangular grid sampling configurations whereby estimation variances can be minimized. For linear semi-variograms, square blocks are best estimated by sampling at the nodes of a centrally placed grid with its interval equal to the block side divided by the square root of the sample size. For spherical semi-variograms the same configuration is almost optimal. The estimation variance of a bulked sample can be identical with a kriged estimate where the semi-variogram is linear and equal portions of soil are taken from each node on the optimally configured grid and provided the soil property is additive. For spherical semi-variograms the above is approximately true. Comparisons with estimates that account for known spatial dependence show that true variances can be much less than those apparent using classical theory, and the necessary sampling effort much less. Within block-variances are often needed for planning, an appendix gives two-dimensional auxiliary functions from which they can be calculated for linear and spherical semi-variograms.

Keywords: statistics/ geostatistics/ spatial/ soils/ variance/ landscape variation.

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