LIST OF PLANTS—STANDARDIZED PLANT NAMES (1942)

Common Name	*Latin Name*
paspalum, seashore	*Paspalum vaginatum*
pickerel weed	*Pontederia cordata*
pondweed, leafy	*Pontamogeton foliosus*
rice, common domestic	*Oryza sativa*
rice, red	*Oryza sativa* var.
rosemallow, common	*Hibiscus palustris*
saltgrass, seashore	*Distichlis spicata*
sawgrass	*Cladium jamaicensis*
signalgrass	*Brachiaria platyphylla*
smartweed, Puerto Rico	*Polygonum portoricense*
smartweed, swamp	*Polygonum hydropiperoides*
snow-on-the-prairie	*Euphorbia bicolor*
spikesedge, common	*Eleocharis palustris*
spikesedge, dwarf	*Eleocharis parvula*
spikesedge, Gulfcoast	*Eleocharis cellulosa*
spikesedge, jointed	*Eleocharis equistoides*
spikesedge, squarestem	*Eleocharis quadrangulatus*
stonewort	*Chara* sp.
waterlily, dotleaf	*Nymphaes ampla*
waterlily, American	*Nymphaes odorata*
waterprimrose, floating	*Jussiaea diffusa*
watershield	*Brasenia schreberi*

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CLIPPING STUDY TECHNIQUES IN MARSH ECOLOGY INVESTIGATIONS

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INTRODUCTION

A variety of field study techniques are being employed in the investigation of the northern and central Everglades aquatic plant communities. These include permanent quadrats, belt and line transects, association transects, clipping study quadrats, and transect sample plot methods. Each of these procedures is utilized to serve a specific need. This paper describes the latter two of the aforementioned procedures and discusses some of the problems involved in designing these study methods.

Aquatic communities have probably received less attention than any other natural association concerning the ecologist. This neglect is perhaps explained in part by the usual inaccessibility of these areas, the inconvenient working conditions that are many times prevalent and a feeling by some that the aquatic communities are of negligible importance. Undoubtedly, the wildlife researcher has contributed more, in the way of knowledge and study techniques, to the science of aquatic plant ecology than any other natural science field. The reason is of course apparent. Aquatic communities are an intrinsic and vital facet of the wildlife managers' interest and responsibility. If waterfowl, muskrats, nutria, or any of the other species occupying aquatic environments are to be intelligently managed it is imperative that the biological, chemical and physical forces operative in this environment be understood and properly evaluated.

In October, 1952, a cooperative agreement was entered into between the Florida Game and Fresh Water Fish Commission and the Central and Southern Florida Flood Control District. The latter agency has been given the responsibility of watershed management in 17 south Florida counties. Under the terms of the agreement the Commission accepted the obligation of managing 726,000 acres of seasonally flooded marshland that comprises the Everglades Wildilfe Management Area. This area is composed of two, shallow, water retention units that have been designated as Conservation Areas.

When the Commission took over the management of the wildlife resources of this immense area, it was readily apparent that field investigative procedures had to be formulated that would conform to the unique terrain features of the region. Additionally, techniques would be required to furnish a maximum amount of accurate data with a minimum amount of time and effort expended. This was necessary because of the large acreages involved and because of the urgency to supply construction agencies with information regarding the effects of their activites on the wildlife and vegetation of the area.

Throughout most of the research endeavor, the 136-000-acre Conservation Area 2 has served as the experimental unit. Work has been concentrated in this area because its boundaries are well defined, it will be the first area to be enclosed by a system of levees and water control structures, and it is well covered by a network of continuous water level recording stations. In addition, the plant communities of this area are representative of the northern and central Everglades formation. It was felt, therefore, that information obtained would apply as a reasonable guide to conditions existing over the remainder of the Management Area.

There were, initially, two primary spheres of interest involved in the Everglades studies. This interest was concerned with the effects of water levels on the vegetation as community systems and on a single plant species, sawgrass (*Mariscus jamaicensis*) (Crantz) Britton.

The influence water levels have on the vegetation of the area is not only of vital concern to the Commission, but is similarly important to other public agencies as well, who are responsible for levee design and construction. Interest of construction agencies hinges on the fact that the vegetation of the Conservation Areas, particularly sawgrass which is the principal species, exercises a decided influence upon hurricane wind tides. This factor is a prime consideration influencing levee design.

Initially, a decision had to be made regarding the type of sampling unit that would be utilized. It was felt that a square meter sample would be the most applicable and that total weight of plant material in the sample would constitute the most reliable estimate of stand density. The total weight method was chosen as opposed to stem counts, point quadrats or other such procedures. These latter methods would tend to bias collected data because of variations in size between plants of the same species, unusually rank growth of some species, *e. g.*, sawgrass and cattail, and the difficulty that immediately arises in counting plants that reproduce by tillering or rhizomes in deciding where one individual plant begins and ends. Most plant species in the Glades reproduce vegetatively, making stem count methods impractical and time consuming if conducted on an extensive basis.

In most biological investigations it is usually unwise to attempt to designate a single environmental factor as the primary population value determinant. If a statistical correlation between an environmental force and a population value is contemplated the investigator must be reasonably certain that the biological principles involved are valid, otherwise some very unsound and unrealistic inferences will result.

The writer is aware that, in the Glades, many factors are operative which determine plant community and plant species characteristics. Among the more obvious are water depth, period of inundation, rate of water level fluctuations, water quality, fire, soil type, and southward extension of the frost line. All of these factors are significant but experience has shown that hydrological cycles exert the greatest influence on the vegetation. Therefore, in these studies, hydroperiods have been considered as the major environmental factor affecting plant community composition and density.

Prior to proceeding further with the discussion of field methods, it is perhaps relevant to review some of the ramifications of sample theory involved in these studies.

In almost any survey it is neither practical nor necessary to examine every individual in the population under investigation. The limitations of time, money, and qualified personnel usually preclude this. Required information must therefore be obtained through some type of sampling procedure. It is thus indispensable that a well-planned sampling method be designed. The method should supply desired data at an accuracy level congruous with study objectives. A sampling procedure shrould be formulated, therefore, prior to initiating field operations in order to collect data in such a way that its analysis is facilitated in the most expeditious manner possible.

Perhaps much too often, the wildlife worker rushes into a problem, collects a large volume of data and is then at a loss as to just exactly what should be done with it. In some instances this situation is unavoidable because of the urgent solicitations of other agencies for information and the pressuring of unrelenting sportsmen. This is usually, however, a "hurry up and wait" affair. Under normal conditions many problems that arise in analyzing collected data can be eliminated by first having a clear understanding of objectives, formulating a relevant sampling method and, in essence, designing an applicable analytical procedure.

There are two basic factors affecting the estimate of population values in almost any type of sample technique. These are sample error and bias. As pointed out by Jolly (in Brown, 1954), "Since no sample can resemble accurately in every respect the population from which it is drawn, it follows that an estimate derived from a sample is subject to error." Sample error can be determined and accuracy limits established. If a reduction in sample error is indicated by the data it can usually be achieved by increasing the number of sampling units. It is not normally necessary to alter the sampling procedure. An error resulting from bias, however, can only be eliminated or reduced by modifying the experimental design. Bias is not compensated for by increasing sample size. In some specific instances bias does not always appreciably alter results beyond the degree of accuracy required. This must be determined by the investigator and he obviously can do this only if the presence of bias is recognized in the experiment.

If an effort is being made to estimate a population value, a calculation of the sample error is most useful. Without this, there is generally no valid estimate of accuracy and the investigator can not be sure if the sample he has taken is sufficient to give desired information. In order to calculate the statistical validity of collected data it is necessary that randomness either be inherent in the population or be included in the experimental design. In addition, an adequate number of sampling units must be taken (Jolly, in Brown, 1954).

The controversy between random and systematic sampling is undoubtedly well-founded. Wildlife workers and statisticians very often do not agree on survey methods. This disagreement is due in part to a lack of realization by both factions as to the problems involved. Admittedly, systematic sampling is frequently much more convenient than a random selection of plots. In some cases a completely random choice of samples is neither practical nor possible for the wildlife worker. A systematic system does have certain advantages. It is usually less complicated and per sample unit may be more accurate than a completely random method. Its one disadvantage, however, is that no true estimate of sample error is possible. A random sample will usually require a few more sampling units than the systematic procedure but it permits a mathematical estimate of the real preciseness of the data.

TECHNIQUES AND PROCEDURES

Sawgrass Density Studies: Sawgrass is a large, rank sedge, comprising the major vegetative component in the Florida Everglades. The species attains heights up to four meters and produces, from a rather large fleshy rootstock, numerous long, linear stems approximately 5 mm in width having margins profusely armed with tiny, sharp spicules.

Sawgrass seems to grow best on seasonally flooded sites. Any drastic modification in hydroperiod cycles produces noticeable changes in stand density and seed production. This study was initiated in order that such changes might be accurately estimated. The problem was approached in the following manner.

Three dense stands of sawgrass, ranging in size from two to five acres, were selected. Each stand was located on sites that had been subjected to dissimilar hydroperiods. At each of these sites water stage data were available. In selecting the study plots care was taken to choose sawgrass stands representative of the site under consideration.

At ten-day intervals during the April-June growing season of sawgrass three square meter quadrats are randomly selected in each of the three study plots. All sawgrass occurring in these quadrats is clipped at ground level and weighed to the nearest tenth of a pound. The number of fruiting stems is also recorded. A five-pound sample of fresh plant material was retained from each site, every ten days, the first year of the study. This material was oven-dried to determine moisture loss of the plants.

After completing the collection of field data a population mean expressed in pounds of sawgrass per square meter is calculated. The standard error of the mean is then determined. Confidence limits are calculated at the 5% probability level of t.

A significant difference test is utilized in comparing variations in stand density and number of fruiting stems when the confidence limits of the infinite population values overlap, thus indicating that such a test is necessary. These tests compare individual sites and individual years.

Initially it was realized that if water levels were to be considered as the principal correlative factor it would be necessary to examine other environmental agents. Among the first of these considered was the possible variation in weight between sites as a result of plants on one site being physiologically wetter than those on other sites. This variable was reduced by oven-drying the material. Another consideration of importance was soil nutrients. Representative soil samples were obtained from each site and a determination of available plant nutrients made. Water quality was also considered. After a careful review of these factors it was felt that water levels could be safely utilized in the correlation.

In this analysis, sawgrass density, expressed as total weight, on the various study sites is compared with water levels that have occurred over a specified period of time.

The foregoing outlined procedures are presented as a guide and can of course be modified to meet other types of conditions and needs. It is presumed, however, that if its limitations are recognized the basic procedure is a fairly accurate and rapid method of estimating density, particularly in aquatic communities where pure stands of large, rank-growing plant species occur. In addition, if conducted periodically, it can serve as an estimate of vegetative change.

Transect Sample Plot Studies: Although much observational and general information has been published on the flora of the Everglades the literature is practically devoid of any type of quantitative data. The following outlined study has been formulated to fulfill this need. Primary objectives include a determination of plant community composition and density, and an estimation of extent of major plant community types. Over a period of years this information will provide a valid estimate of vegetative change. Wildlife population data can be correlated with the above data giving a reasonably accurate picture of the relationships existing between the flora and the indigenous fauna.

Details of field methods are presented in the following paragraphs:

The plant community investigation is essentially a transect-sample plot method, designed to examine the marsh vegetation of the 136,000-acre Conservation Area 2. It is basically a clipping study with total weight of plant material being used as the criterion of density.

An airboat is utilized for transportation in the study. The field party consists of two men.

Prior to beginning field operations the study area was divided into five working units or zones. Floristic as well as topographic and cultural features were used in establishing the zone boundaries. This was done in order to aid field orientation and to facilitate the collection and analysis of data. Each working unit is treated as an entity and thus comparisons between various portions of the Conservation Area can be made.

After subdividing the area, north-south transect lines were established, spaced approximately ¾ mile apart. The beginning point of each line was marked for future reference with an iron pipe. The transects were then delineated on a generalized vegetative type base map of the area.

Selection of sample units on the transect lines is accomplished in the following manner. A north bearing is taken with a compass at the beginning point of each transect. A number is then chosen from a table of random permutations of 9. This number designates the distance in hundreds of yards to the first plot. For example, if the random number 6 is selected this indicates a distance of 600 yards to the plot. This procedure is followed in selecting the distance between all plots on the line. The airboat operator concentrates on the direction of the transect line while moving from one plot to the next. The second man in the crew looks behind the boat, while it is in motion, to the location of the previous plot and when he feels that the correct distance, as ascertained from the table of random numbers, has been travelled he signals the operator to stop. By estimating distances behind the boat the possibility of the vegetation influencing the stopping point is eliminated. Once the airboat comes to a complete halt an additional random number is chosen from the table. This number indicates the distance in feet from the airboat to the exact location of the sample plot. This measurement is taken from a different point on the boat at each plot location. By employing the aforementioned method, a random selection of samples is obtained.

Upon ascertaining the plot location, procedures are as follows: First, the general vegetative type and the distance to the previous plot are recorded. Water temperature, depth, and time are noted. A square meter, wooden, quadrat frame is then placed in the water and serves as the sampling unit. All plant species, except shrubs, occurring in the quadrat are clipped at ground level, separated by species, allowed to drain for approximately ten minutes and then weighed in pounds or grams as the case may be. Stem counts are made of shrub species such as wax myrtle, holly and willow.

At every tenth plot a water sample is taken and analyzed for alkalinity, hardness, pH and oxygen concentration.

The study is begun each year in September, prior to the die-back of the annuals and the growth termination period of perennials.

In these studies, a determination of sample size was a prime consideration. No information was available that could be used in estimating, prior to beginning the field work, the approximate number of samples that should be taken. As a result it was necessary to sample one zone, initially, and analyze the information in order to have a guide as to sample size. This was accomplished by taking approximately 30 samples in one working unit and calculating the standard error of the population mean of a selected species. Obviously, this calculation will not indicate the exact number of sample units required but serves merely as a guide.

The type of sampling procedure described will result in supplying a considerable amount of information. First, and perhaps most important, quantitative data regarding plant community composition, species density, and frequency are obtained. These values may be correlated with mean water levels, soil types, wildlife populations, water temperatures and quality, fire and other factors. By recording plant community types at each plot on the transect, intersect lines may be set up on a base map and a generalized vegetative type map of the study area prepared. In addition, the method provides for easy comparison between various portions of the area, between transect lines if desired, and, if conducted periodically, between years.

Analytical procedures are basically similar to those employed in the sawgrass density studies except that in the community investigations population means are calculated for combinations of certain species. For example, the plant species that studies have shown are important deer foods are combined. This results in an estimate of pounds of deer food present per unit in the management area.

All basic data are recorded on mark sense cards. The use of mark sensing greatly facilitated the collection and analysis of data. The writer is grateful for the assistance rendered by Mr. Scott Overton, Florida Game and Fresh Water Fish Commission, in designing the mark sense card.

SUMMARY

In October, 1952, the Florida Game and Fresh Water Fish Commission accepted the wildlife management responsibilities of 726,000 acres of freshwater marsh that comprises the bulk of the Everglades. Because little quantitative data were available relative to the plant communities of this immense area, it was necessary that studies be formulated to meet the need.

This paper describes two techniques presently being employed in studying the Glades communities. Both are sample plot, clipping procedures with weight considered as the estimate of density.

One technique has been designed to investigate the effects of water levels on sawgrass and consists of clipping and weighing the plant material from randomly selected quadrats on three different sites each subjected to different hydroperiod cycles. The study is conducted annually and serves as an estimate of sawgrass stand density fluctuations that are considered to be related to mean water levels.

A transect sample plot method is being employed to study the plant communities over the entire 136,000-acre Conservation Area 2. This method consists of clipping and weighing all plant species occurring in randomly selected sample units located along a predetermined transect line. In both studies a square meter quadrat frame serves as the sample unit.

Data are analyzed by calculating a population mean in pounds of plant material per square meter. The sample error is estimated for the important plant species and confidence limits established at the 95% probability level. The population mean value per square meter is expanded to pounds per acre when applicable. Differences between areas, sites and years are tested for significance.

It is believed that these study techniques are suitable for examining certain aquatic plant communities as methods are designed to give reasonably valid, quantitative data at a minimum expenditure of time and effort.

ACKNOWLEDGMENTS

Study techniques described in this paper have resulted from the suggestions and comments of many individuals to whom much credit is due. The writer would like to particularly thank, however, Mr. H. E. Wallace and Mr. E. B. Chamberlain, Jr. of the Florida Game and Fresh Water Fish Commission for their assistance and cooperation. Dr. Manley Ross, Department of Botany, University of Miami, for his aid in setting up the sawgrass density studies, and Mr. Frank Ligas and Mr. William Ware, Florida Game and Fresh Water Fish Commission, for assistance in the field work. The typing of the manuscript by Miss Anne Baldwin is acknowledged and appreciated.

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