VEGETATIONAL CHANGES ASSOCIATED WITH WATER LEVEL STABILIZATION IN LAKE OKEECHOBEE, FLORIDA

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ABSTRACT

Ecological changes in plant communities in several Florida lakes have been noted by biologists in the past, but rarely have the parameters of these communities been documented for future reference. Soil moisture is an important factor in determining which plants will occur at particular elevations, but more important is the inundation tolerance of the various species. The purpose of this study was to compare the long range effects of water level fluctuation on the marsh vegetation of Lake Okeechobee.

The Florida Game and Fresh Water Fish Commission, in 1956, conducted a vegetational analysis of the lake marsh in order to predict the probable results on vegetation from construction of a levee to contain the lake waters. A subsequent analysis of the same area was conducted by Commission personnel in 1969 to determine what vegetational changes had occurred.

Comparison of the data from the two studies revealed that stabilization of the water level had occurred resulting in perennials replacing annual plants, an increased frequency of submergent species, and a decrease in total number of species present.

INTRODUCTION

Aquatic plant associations and succession of a river marsh has been described by Laessle (1942). He also related effects of water fluctuation on plant communities of fresh water ponds.

The effects of water level fluctuation on aquatic vegetation has been noted in respect to vegetation control (Bennett, 1962; Lantz, Davis, Hughes, and Schafer, 1964). More recently investigation has shown that water levels are the most important factor influencing the distribution of plant species in coastal marshes (Palmisano and Newsom, 1967).

In 1956 the Florida Game and Fresh Water Fish Commission undertook a project to determine vegetational types in relation to contours on the northwest shore of Lake Okeechobee. The primary objective of the project was to determine existing vegetation of the marsh in order to evaluate the effects on wildlife of each of three proposed levee alignments of a flood control project by the Corps of Engineers. The constructed levee would allow a rise in the average lake level from 14.3 feet to 16.4 feet above mean sea level. The project was based on the assumption that "the most decisive factor, within the confines of the climatic region and prevailing edaphic factors, in determining vegetation at any particular elevation in the marsh is its relationship to water. Soil moisture is undoubtedly important in determining vegetation but in this immediate area, which at times is completely inundated, the inundation period at each elevation can be considered the primary factor in determining the vegetation."

In 1969 the Florida Game and Fresh Water Fish Commission undertook a project to rerun the same vegetational transect before the average increase in water level occurred in order to determine what changes, if any, had occurred in the composition of the marsh vegetation from changes in land use or succession within plant communities.

DESCRIPTION OF THE AREA

Lake Okeechobee was once a natural, shallow-basin, fresh water lake which periodically covered a tremendous area of South Florida during wet seasons of the year. However, the lake has been diked by the Corps of Engineers as part of a flood control project for South Florida and is now confined to a basin of about 450,000 acres. On the western shore of the lake is a marsh varying in width from 100 yards to almost 3 miles. Over 150 species of plants are found within this marsh.

MATERIALS AND METHODS

A "point transect" method was used in the previous study and the method was duplicated as nearly as possible in this study. With the point transect method, the vegetation existing at a well defined point in space is recorded. The more accurately the point is defined, the less bias is involved, and the more readily subsequent studies can be made to yield comparable date. The original transect was run five miles south of the Kissimmee River bridge. The total length of the transect was 20,760 feet and between the 9.3 feet contour and the 16.8 feet contour. The sampling device consisted of a horizontal rod 5½ feet in length. A hole was drilled through the rod every 16 inches and 5 smaller rods, 10 inches in length, were attached to the horizontal rod. Thus 5 parallel "needles" projected from the horizontal rod inclined forward at approximately 45 degrees. A handle 2½ feet in length was attached to the center of the horizontal rod in the same plane as the needles. Another rod about 18 inches in length was attached beneath the handle and projected backward and downward. The function of this rod was to counterbalance the weight of the sampler to permit the sampler to stand upright.

A set of the sampler consisting of 5 sample points was taken every 15 feet by pacing. At each set of the sampler the kind of vegetation that had absolute contact within one inch of the lower end of the needles was recorded. Where more than one species was found to be touching the 1 inch tip of the needle, the species closest to the end was the one recorded. When the needle failed to touch any vegetation, the point was recorded as bare ground. The primary limitation of this point transect method is the fact that the method does not sample different species to the same degrees because of difference in growth form. The point transect method of sampling yields frequency data. Relative total abundance may be calculated by multiplying percent frequency by contour width and determining percentage abundance.

Since elevations by 6 inch contours were determined in the 1956 study, it was necessary in this study to determine only the contour of 9.3 feet. Then, by applying the total number of sample points in the order of their occurrence to the previous transect of the contours, (Figure 1) a comparable set of sample points was derived for each contour between the 9.3 feet contour and the base of the constructed levee at the 14.3 feet contour with the exception of the area between the 11.8 and 12.3 feet contours. This particular area consisted of cattails, bulrush, pickerelweed, and torpedo grass, and was inaccessible for sampling due to density of the vegetation and water depth. The assumption was made that no change in contours had occurred in the marsh.

RESULTS

The data obtained in this study were applied to the previous transect data in respect to the succeeding contours and their width by assuming no change in

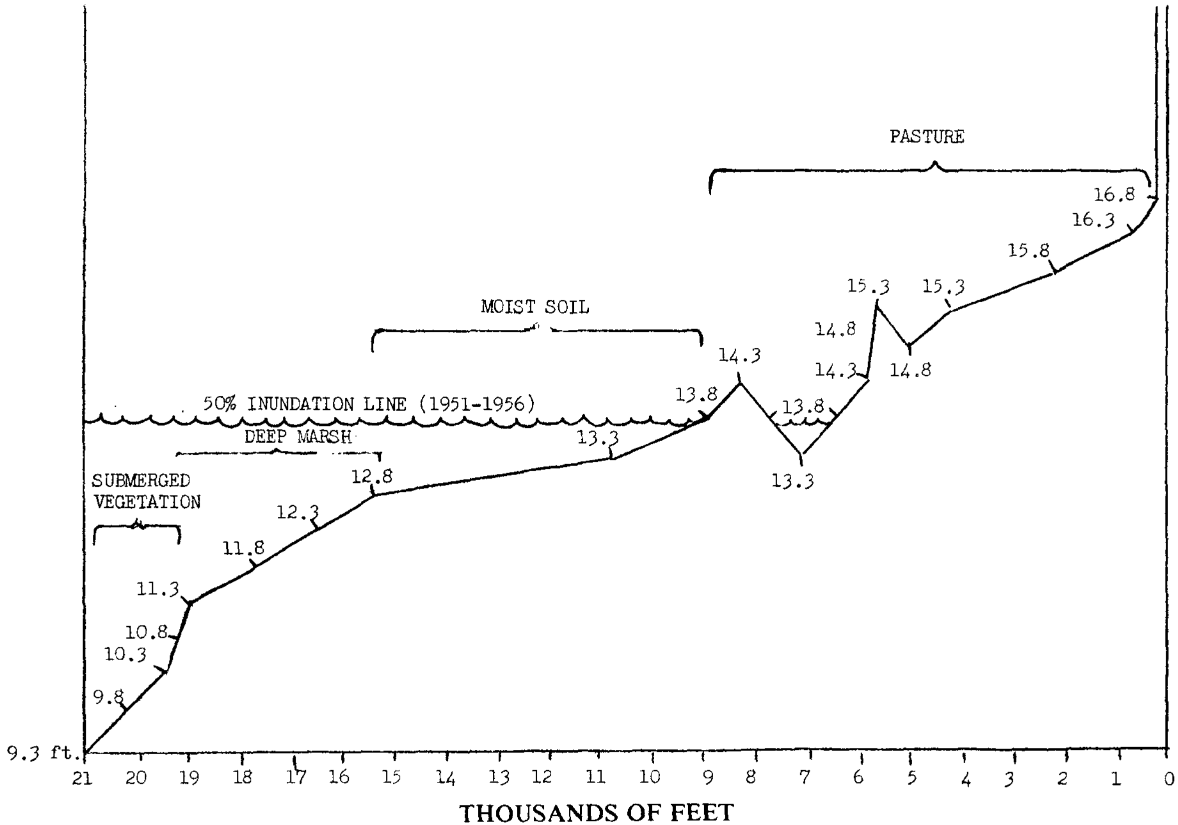

FIGURE 1. Profile of the Northwest shore of Lake Okeechobee five miles south of the Kissimmee River showing vegetation types-1956.

contours or contour width had occurred. Table 1 lists the various species sampled in this transect. A total of 42 species were identified. Unidentified species of grasses were lumped together in a separate category and accounted for 0.37 percent of the total sample points. Torpedo grass, *Panicum repens,* was the most frequently encountered species in the transect occurring at 29.04 percent of the total sample points. Horse grass, *Hydrochloa caroliniensis,* was the second most frequent species encountered occurring at 5.24 percent of the sample points, followed by spikerush, *Eleocharis obtusa* at 3.78 percent, and bladderwort, *Utricularia resupinata,* at 2.62 percent.

Figure 2 presents stage duration curves prior to the study periods and Figure 3 presents average lake stages prior to the studies.

DISCUSSION

In comparison, the two vegetational transects were run at different times of the year. The original transect was run in September of 1956 while the present transect was run in June and July of 1969. This difference in the time might account for differences in percent frequencies of individual species occurring in both transects.

The 1956 study was preceded by exceptionally dry season as illustrated by Figure 3. The present study was preceded by an above average lake stage. From the average lake stages for five years preceding each study, it can be seen that slightly higher lake stages occurred during the late fall through the late spring period preceding the present study. Of significant importance is the change in average lake stages from May through September between the two study periods. Of more recent occurrence, average lake stages at this period have increased at a greater rate than in the previous period illustrated, and to an approximate one foot higher elevation. This difference between lake stage averages has been brought about by more efficient water control by various completed control structures within the overall flood control project on Lake Okeechobee.

These changes in average lake stages affect not only the percent of inundation of the various contours (Figure 2), but also the time or season at which inundation of the contours occur (Figure2). Increased water control has tended to stabilize water fluctuation by generally decreasing maximum lake stages and preventing extreme minimum stages.

Table 2 lists total percent frequency of the various species in both transects for their comparison. Due to the construction of the levee at the 14.3 feet contour, crabgrass, tickseed, marsh fleabane, germanders, and one of the unidentified panic grasses were necessarily eliminated from the present transect. False nettle, pennywort, and marsh purslanes occurred previously as extremely small percent frequencies, therefore the sample method could omit them from the current transect even though they were present. Buttonweed, wild millet, fimbristylis, heliotrope, water primrose, climbing hempweed, smartweed, and cord grass were also absent from the present transect. Wax myrtle, sorrel, and bladderpod occurred only in the present sample and at low percent frequencies, so that, even though they may have been present previously, they may not have occurred in the samples. White-top sedge, southern naiad, white water lily, water purslane, bladderwort, and salvinia occurred in the present transect at significant percent frequencies.

An explanation of these vegetation changes apparently is based on at least two evident changes in water fluctuation. Figure 2 illustrates the change in percent inundation showing stabilization and the more recent higher water levels. Figure 3 illustrates the general change in time at which the rate of increase in water level occurs. It is the writer's opinion that this change in time at which inundation occurs coupled with more stable water level is the primary factor responsible for the absence of important species of plants available to waterfowl previously encountered in the transect as well as the increase in the percent frequencies of submergent vegetation in the present transect.

The effects of cattle grazing on the vegetation of the marsh are unknown. Since the construction of the levee, cattle are confined within the marsh and are no longer able to move to higher elevations when water level increases.

Figure 4 illustrates the profile of the vegetation transect of 1969 showing the four areas of general vegetation types. Carpet-grass, water hyssop, panic grasses, and bahia composed the pasture zone and accounted for 73 percent of the occupied sample points. Spikerush, panic grasses, bladderwort, and horse grass composed the moist soil area accounting for 89 percent of the occupied sample points. The deep marsh was made up of southern naiad, pondweed, bulrush, cattail, wild celery, salvinia, and water hyacinth accounting for 95 percent of the occupied sample points. The submerged vegetation zone consisted of chara, pondweed, and wild celery accounting for 100 percent of the occupied sample points. In comparison with the previous transect (Figure 1), it can be seen that although little change has occurred in vegetation type with respect to contours, these vegetation types are now more defined than previously (Table 2). The pasture zone was composed of broom sedge, carpet-grass, frog-fruit, panic grasses, pigeon grass, and beak-rush. Primary moist soil plants were sedges, wild millet, spikerushes, fimbristylis, horse grass, panic grasses, bahias, smartweed, bald-rush, and beak-rush. The deep marsh zone consisted of sedges, spikerushes, panic grasses, bahia, and cattails. The submerged vegetation zone consisted of chara, pondweed, wild celery, spikerushes, and bulrush. This definition of vegetation types is most likely a result of water level stabilization. This stabilization of water level has generally eliminated annuals (Table 2) as illustrated by the absence of wild millet, fimbristylis, heliotrope, and smartweed. New vegetation in the transect is composed of pernnials (Table 2) such as the white-top sedge, southern naiad, white water lily, and bladderwort.

SUMMARY

In 1956 the Florida Game and Fresh Water Fish Commission undertook a project to determine existing vegetation of the marsh on the northwest shore of Lake Okeechobee in order to evaluate the effects on wildlife of a proposed flood control project by the Corps. of Engineers. In 1969 the Commission undertook a project to rerun the same vegetation transect in order to determine what changes had occurred in the composition of the marsh vegetation before the rise in average lake level occurred.

A "point transect" method was used in the previous study and the method was duplicated as nearly as possible in this study. The transect was located on the northwest shore of the lake five miles south of the Kissimmee River bridge. The primary limitation of the point transect method is the fact that the method does not sample different species to the same degree because of differences in growth form. The point transect method of sampling yields frequency data.

A total of 42 species of plants were identified in the present study compared to 46 species in the 1956 study. Torpedo grass and horse grass were the two most frequently encountered species in both studies.

A significant change in the water fluctuation pattern had occurred since the 1956 study. This difference in lake stage averages has been brought about by the completion of various flood control project structures within the overall flood control project for Lake Okeechobee. This increased water control has tended to stabilize water fluctuation by generally decreasing maximum lake stages and preventing extreme minimum stages.

An explanation of the vegetation changes which have occurred since 1956 is based on at least two evident changes in water fluctuation. The change in time at which inundation occurs coupled with more stable water level are the primary factors responsbile for the reduction of important waterfowl plants as well as the increase in percent frequencies of submergent vegetation. Water level stabilization has brought about greater definition of general vegetation types. The stabilization and change in time at which inundation occurs has tended to eliminate annuals while new vegetation is composed of perennials.

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Table 1. Scientific and common names of plants encountered and the inundation period to which they are adapted, 1969.

Scientific and Common Names	Annual or Perennial	Inundation period in which species occurred
1. *Andropogon scoparius* Broom sedge	Perennial	10 to 65%
2. *Axonopus furcatus* (Flugge) Hitchc. Carpet-grass	Perennial	10 to 65%
3. *Bacopa caroliniana* (Walter) Robinson Water hyssop	Perennial	10 to 80%
4. *Centella asiatica* (L.) Urban Centella	Perennial	10 to 80%
5. *Cephalanthus occidentalis* L. Buttonbush	Perennial	65 to 95%
6. *Chara vulgaris* Muskgrass	Perennial	80 to 100%
7. *Cynodon dactylon* (L.) Pers Bermuda grass	Perennial	65 to 85%
8. *Cyperus spp.* Sedges	Annual or Perennial	10 to 80%
9. *Dichromena colorata* (L.) Hitchcock White-top sedge	Perennial	10 to 65%
10. *Eichornia crassipes* (Martius) Solms Water-hyacinth	Perennial	90 to 100%
11. *Eleocharis intermedia* (Muhl.) Schultes Dwarf spikerush	Perennial	65 to 90%

Table 1. Scientific and common names of plants encountered and the inundation period to which they are adapted, 1969.

Scientific and Common Names	Annual or Perennial	Inundation period in which species occurred
12. *Eleocharis obtusa* (Willd.) R.& S. Spikerush	Annual	70 to 95%
13. *Eupatorium coelestinum* L. Mist-flower	Perennial	10 to 40%
14. *Fuirena squarrosa* Michx. Umbrella-grass	Annual	90 to 95%
15. *Glottidium vesicarium* (Jacquin) Mohr Bladderpod	Perennial or Annual	10 to 20%
16. *Hydrochloa caroliniensis* Beauv. Horse grass	Perennial	10 to 95%
17. *Lippia nodiflora* (L.) Michaux. Frog-fruit	Perennial	10 to 80%
18. *Myrica cerifera* L. Wax Myrtle	Perennial	10 to 40%
19. *Najas quadalupensis* (Spreng) Magnus Southern naiad	Perennial	95 to 100%
20. *Nymphaea ordorata* Aiton White water lily	Perennial	90 to 100%
21. *Oxalis corniculata* L. Sorrel	Perennial	10 to 20%
22. *Panicum repens* Panic grass	Perennial	10 to 95%
23. *Panicum sp.* Panic grass	Annual or Perennial	95 to 100%
24. *Paspalum dissectum* (L.) L. Bahia	Perennial	10 to 70%
25. *Paspalum distichum* L. Bahia	Perennial	10 to 20%
26. *Paspalum notatum* Flugge	Perennial	10 to 20%
27. *Pontederia cordata* L. Pickerelweed	Perennial	70 to 95%

Table 1. Scientific and common names of plants encountered and the inundation period to which they are adapted, 1969.

Scientific and Common Names		Annual or Perennial	Inundation period in which species occurred
28.	*Potamogeton illinoensis* Morong Pondweed	Perennial	100%
29.	*Psilocarya nitens* (Vahl) Gray Bald-rush	Annual or rarely Perennial	40 to 65%
30.	*Rhynchospora tracyi* Britton Beak-rush	Perennial or rarely Annual	10 to 95%
31.	*Sagittaria falcata* Pursh Arrowheads	Perennial	85 to 95%
32.	*Scirpus americanus* Persoon Common three-square	Perennial	85 to 95%
33.	*Scirpus validus* Vahl Giant bulrush	Perennial	95 to 100%
34.	*Sesuvium portulacastrum* L. Water purslane	Annual or Perennial	10 to 40%
35.	*Setaria geniculata* (Lam.) Pigeongrass	Perennial or Annual	80 to 90%
36.	*Salvinia rotundifolia* Willd. Salvinia		95 to 100%
37.	*Typha sp.* Cattail	Perennial	90 to 100%
38.	*Utricularia cornuta* Michaux Bladderwort	Perennial	80 to 95%
39.	*Utricularia purpurea* Walter Bladderwort	Perennial	90 to 95%
40.	*Utricularia resupinata* B. D. Greene Bladderwort	Perennial	70 to 90%
41.	*Utricularia vulgaris* L. Bladderwort	Perennial	85 to 95%
42.	*Vallisneria americana* Marie-Vict. Wild celery	Perennial	100%
	Unknown grasses		10 to 90%

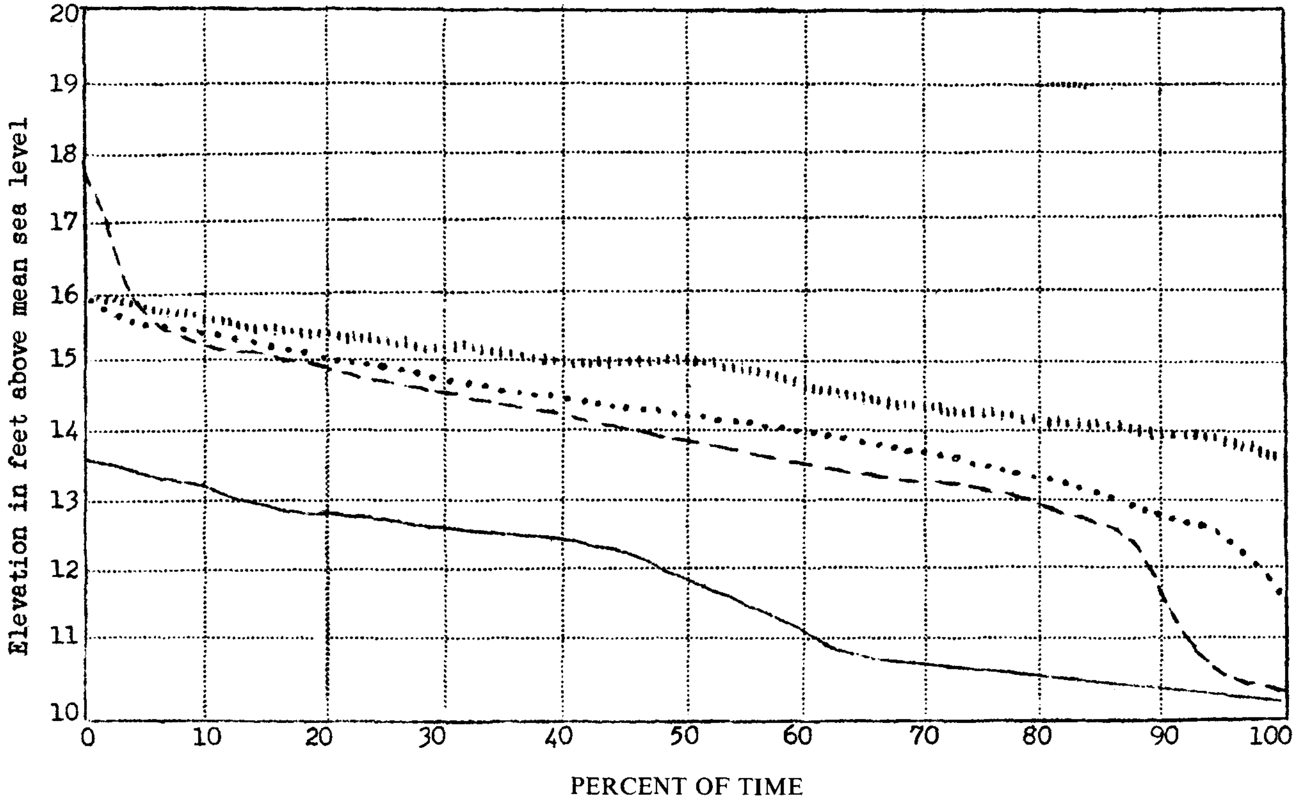

FIGURE 2. Stage duration curves for Lake Okeechobee.
______One year period - October 1955 to September 1956
------Five year period - October 1951 to September 1956
||||||One year period - October 1968 to September 1969
......Five year period - October 1964 to September 1969

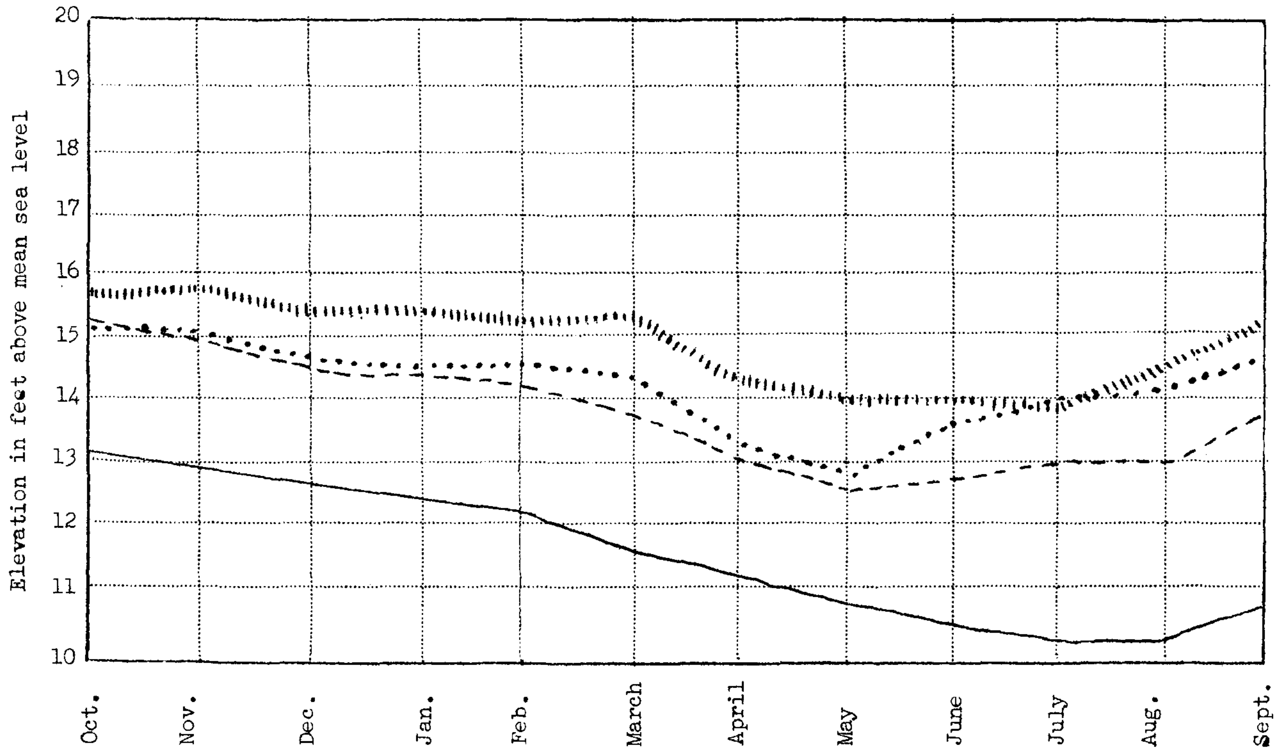

FIGURE 3. Average lake stage hydrographs for pre-study periods.
Stages are those recorded on the last day of each month.

________ Hydrograph for October 1955 through September 1956
\- - - - - - - - Average hydrograph for five year period - October 1951 through September 1956
||||||||||||||||||||| Hydrograph for October 1968 through September 1969
.... Average hydrograph for five year period - October 1964 through September 1969

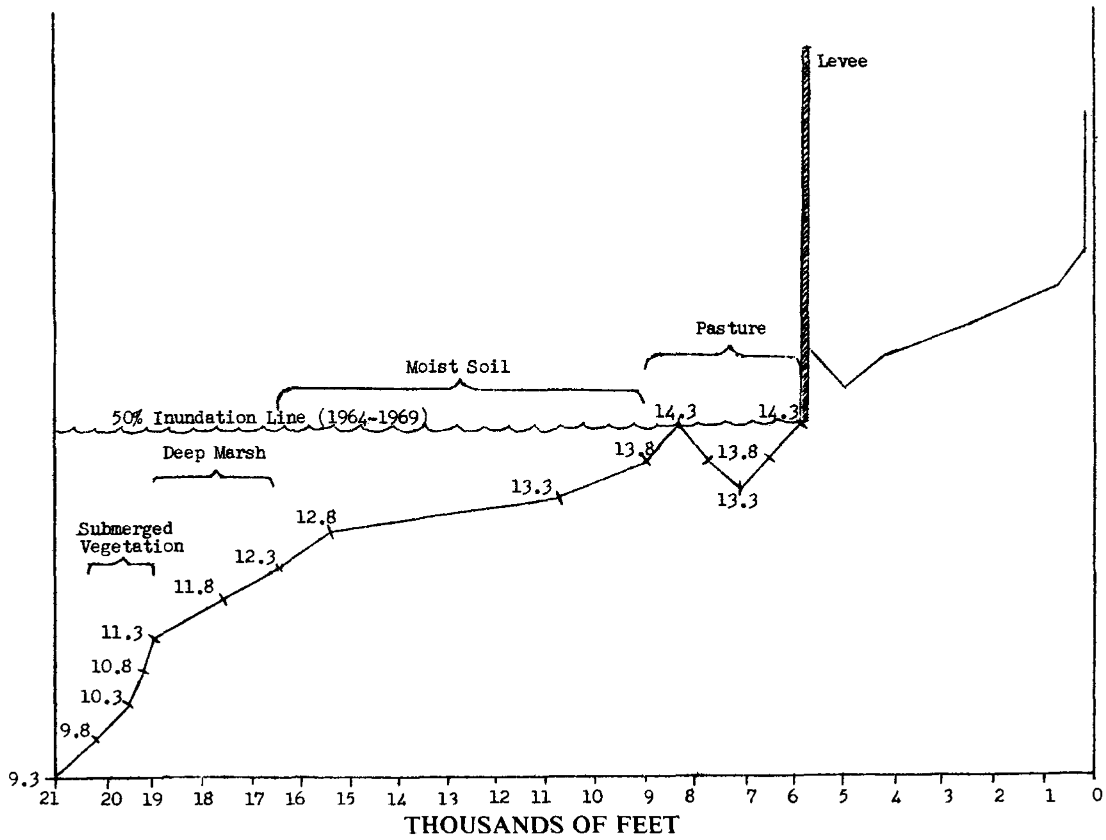

FIGURE 4. Profile of the northwest shore of Lake Okeechobee five miles south of the Kissimmee River showing vegetation types-1969.

Table 2. Species encountered and their combined percent frequencies within vegetational zones.

PASTURE ZONE

1956 Transect Species	Percent Frequencies 3	1969 Transect Species	Percent Frequencies 3
1. Ragweed*	0.08	1. Broom sedge	3.45
2. Broom sedge	2.91	2. Carpet-grass	4.18
3. Carpet-grass	13.35	3. Centella	1.27
4. Centella	2.19	4. Buttonbush	0.18
5. Tickseed *1	0.08	5. Bermuda grass	1.82
6. Bermuda grass 1	1.27	6. Sedges 2	4.73
7. Sedges	0.48	7. White-top sedge *	0.91
8. Crabgrass *1	0.24	8. Dwarf spikerush	0.55
9. Buttonweed *	0.72	9. Mist-flower	1.27
10. Spikerushes	0.08	10. Horse grass	0.36
11. Fimbristylis *	1.12	11. Frog-fruit	2.36
12. Heliotrope *	0.28	12. Wax Myrtle *	0.18
13. Horse grass	1.87	13. Water hyssop	6.36
14. Water hyssop	0.24	14. Sorrel *	0.18
15. Frog-fruit	6.41	15. Panic grasses 2	41.82
16. Panic grasses 2	20.28	16. Bahias 2	7.82
17. Bahias 2	1.75	17. Bald-rush	1.09
18. Marsh fleabane *1	0.12	18. Beak-rush	0.18
19. Bald-rush	0.12	19. Bladderpod *	0.18
20. Beak-rush	5.86	20. Water purslane	0.73
21. Pigeon grass	3.94	21. Unclassified grasses	2.91
22. Cord grass *	0.80		
23. Germanders *	0.08	Total	82.53
24. Unclassified grasses	1.43		
25. Unclassified herbaceous *	0.44		
Total	66.14		

Table 2. Species encountered and their combined percent frequencies within vegetational zones.

MOIST SOIL ZONE

1956 Transect		1969 Transect	
Species	Percent Frequencies 3	Species	Percent Frequencies 3
1. Ragweed *	0.03	1. Water hyssop	0.03
2. Broom sedge	0.03	2. Centella	0.10
3. Carpet-grass	0.03	3. Buttonbush	0.14
4. Centella	0.62	4. Chara	1.42
5. Buttonbush	0.21	5. Bermuda grass	0.07
6. Sedges	1.97	6. Sedges 2	0.38
7. Buttonweed *	0.35	7. Spikerushes 2	6.82
8. Wild millet *	3.45	8. Umbrella grass	0.45
9. Spikerushes	4.21	9. Horse grass	8.24
10. Dogfennels	0.03	10. Frog-fruit	0.03
11. Fimbristylis *	8.32	11. White water lilly *	0.17
12. Heliotrope *	0.31	12. Panic grasses 2	38.06
13. Horse grass	16.06	13. Pickerelweed	0.21
14. Marsh purslanes *	0.03	14. Beak-rush	2.98
15. Frog-fruit	0.52	15. Arrowhead	0.55
16. Panic grasses 2	12.95	16. Common three-square	0.10
17. Bahias 2	8.01	17. Pigeongrass	0.03
18. Smartweed *	0.14	18. Cattail	0.03
19. Pickerelweed	0.14	19. Bladderwort *2	11.00
20. Bald-rush	2.28	20. Unclassified grass	0.03
21. Beak-rush	1.49		
22. Arrowhead	0.86	Total	70.84
23. Common three-square	0.14		
24. Pigeongrass	0.03		
25. Cord grass 8	1.45		
26. Cattail	0.07		
27. Unclassified grass	0.14		
28. Unclassified herbaceous *	0.97		
Total	66.05		

Table 2. Species encountered and their combined percent frequencies within vegetational zones.

DEEP MARSH

1956 Transect		1969 Transect	
Species	Percent Frequencies 3	Species	Percent Frequencies 3
1. False nettle *	0.12	1. Sedges 2	0.44
2. Centella	0.12	2. Southern naiad *	3.30
3. Sedges	15.66	3. White water lily *	1.32
4. Wild millet *	1.45	4. Panic grasses 2	0.44
5. Water hyacinth	1.08	5. Pondweed	8.79
6. Spikerush	8.07	6. Bulrush	7.25
7. Dog fennels	0.12	7. Cattail	10.33
8. Umbrella grass	0.96	8. Wild celery	8.79
9. Horse grass	0.12	9. Salvinia *	3.30
10. Pennywort *	0.24	10. Water hyacinth	2.64
11. Water hyssop	0.24		
12. Water-primrose *	1.69	Total	46.60
13. Frog-fruit	0.36		
14. Climbing hempweed *	0.84		
15. Panic grasses 2	4.22		
16. Bahia 2	5.30		
17. Smartweed *	0.12		
18. Pickerelweed	0.48		
19. Bald-rush	2.29		
20. Arrowhead	1.33		
21. Common three-square	0.12		
22. Bulrush	2.05		
23. Cattail	5.30		
24. Unclassified herbaceous	0.24		
Total	52.52		

Table 2. Species encountered and their combined percent frequencies within vegetational zones.

SUBMERGED VEGETATION

1956 Transect		1969 Transect	
Species	Percent Frequencies 3	Species	Percent Frequencies 3
1. Chara	1.90	1. Chara	4.38
2. Spikerushes	0.29	2. Pondweed	2.19
3. Pondweed	0.29	3. Wild celery	3.94
4. Bald-rush	0.15		
5. Bulrush	0.44	Total	10.51
6. Wild celery	0.58		
Total	3.65		

* Found in one transect but not in the other.

1. Occurred only above the 14.8 feet contour of the 1956 study.
2. The percent frequency of the sum of all individual species within the genera.
3. The percent frequencies of the sum of the species within the designated contours.