WATER QUALITY STATUS OF MILLER LAKE

1973

Ministry
of the
Environment

WATER QUALITY STATUS
OF
MILLER LAKE

1973

by

D.S. Osmond, M.F. Michalski & J.D. Westwood
Biology Section
Water Quality Branch
Ministry of the Environment

TABLE OF CONTENTS

FIGURES

TABLES

SUMMARY

Miller Lake is a small, shallow recreational lake set in Niagara Escarpment dolomite in the Bruce Peninsula. A summer sports fishery exists for smallmouth bass and pike. At present, intensive cottage and resort development is limited to the northwest shoreline of the lake. Further development is imminent at the shallow west end.

A brief study of general water quality in Miller Lake was conducted during July, August and September 1972. Somewhat reduced water clarity appeared to be the result of suspension of loose bottom sediments by wind-induced water movements rather than the production of excessive algae populations. Virtually complete circulation of lake water by prevailing winds was also evinced by the homogeneity of temperature and dissolved oxygen concentrations in surface through bottom waters.

Through comparisons of chlorophyll a data from Miller Lake with values from other recreational lakes, Miller Lake appeared to be at most, moderately enriched. However, recreational activities would not be hampered by present levels of production of phytoplankton and aquatic! weeds. Phosphorus concentrations were found to be low and would not be expected to promote nuisance levels of aquatic plant growth.

This brief study suggests that density of cottages and related recreational pressure are more important than water quality considerations in considering the advisability of further development on Miller Lake.

Utilizing one documented approach for an estimate of the carrying capacity of a recreational lake, it was concluded that with development of areas which have already received provincial approval, Miller Lake has already attained its carrying capacity.

WATER QUALITY STATUS - MILLER LAKE
1972

1. INTRODUCTION

As a result of a request from the Strategic Planning Branch for an assessment of the water quality status of Miller Lake, data from two brief studies by the Biology Section during the summer of 1972 and from two recent lake surveys by the Ministry of Natural Resources (MNR) were reviewed. Information on present and future cottage development on the Lake was obtained from the Private Waste and Water Management Branch.

2. GENERAL DESCRIPTION

Miller Lake is set in Niagara Escarpment dolomite in Lindsay Township, Bruce County. It is small (773 acres) and shallow with its 2 mile length oriented in an east-west direction. Although somewhat sheltered at the east end, the lake is exposed to prevailing winds. A small creek from Britain Lake feeds the lake while it is drained at the opposite (west) end by Spring Creek.

Only one small island is present at the north east end of the lake. Additional physiographic details are listed in Table 1.

Table 1. Physical Characteristics of Miller Lake.

Length :	2 miles	Area:	772 acres
Max. Width :	0.7 miles	Volume:	6374 acre-ft.
Max. Depth :	29 feet	Perimeter:	7.4 miles
Avg. Depth :	8.2 feet		

In a survey of the fishery status of the lake in 1970 by MNR, it was concluded that Miller Lake be managed for a summer fishery of smallmouth bass and pike. The population found could only meet the demands of summer fishing and it was recommended that ice-fishing not be encouraged. The lack of aquatic vegetation, the presence already of two highly competitive species and the lack of previous stocking success were cited as reasons for not introducing additional sports species such as largemouth bass and pickerel.

3. COTTAGE AND RESORT DEVELOPMENT

Through a study of Lindsay Township records in October 1972, the Private Waste and Water Management Branch indicated that a total of 365 cottage lots and 174 licensed campsites have been registered. Also a single church camp is situated on the lake. Based on a rough cottage count conducted during our 1972 survey and upon MNR observations recorded during their fishery study in 1970, dwellings have been constructed on approximately 20 percent of the 365 registered cottage lots. General locations of cottages are indicated on Figure 1.

As of Oct. 23 1972, authorities were aware of plans for future development at two locations on the lake. At Miller Lake Estates on the northwest corner of the lake, 130 cottage lots have been approved. Nearby on the north shore, fifty tent and trailer sites have been proposed but approval has not been granted pending review by the Bruce County Health Unit and the Private Waste and Water Management Branch.

Summer House Camp, a resort located about half-way down the lake on the north shoreline, consists of five cottages and 124 licensed camp sites. Although the owners are considering alterations of waste treatment facilities to rectify pollution problems identified by the Health Unit, application for approval of an alleged sewage lagoon had not been received by the Sanitary Engineering Branch at the end of 1972.

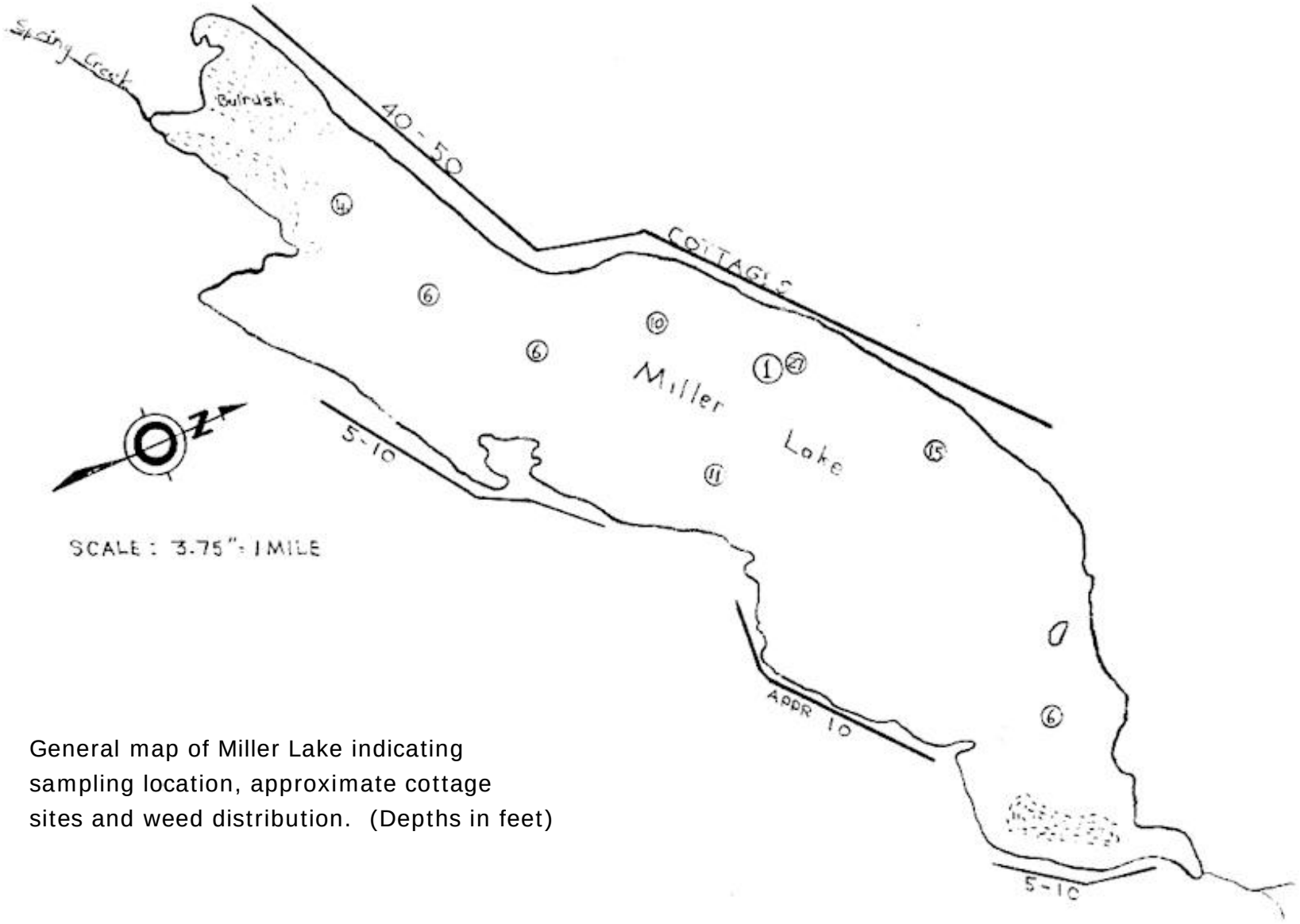

Figure 1: General map of Miller Lake indicating sampling location, approximate cottage sites and weed distribution. (Depths in feet)

4. WATER QUALITY

Methods:

A simple procedure adopted by the Ministry in its 'Self-Help' Program to determine water quality in recreational lakes was followed on Miller Lake with the aid of North Grey and Sauble Valley Conservation Authority staff who collected field data and submitted water samples during July and August 1972. This approach correlates light penetration in a lake with chlorophyll a concentrations which provide a rough measure of algae production. Algae growth is regulated by the physical, chemical and biological properties of the water and thus reflects the 'fertility' of the water body. Further details regarding field and analytical methods are available on request.

On September 22, 1972 a brief study of the lake was conducted. Along with physical and chemical data which were collected at five-foot intervals with depth at one location (Figure 1), observations on cottage development, water depth and occurrence of obvious weed beds were recorded. Similar information for July 9, 1970 was taken from the MNR lake survey report.

Results:

Chlorophyll a concentrations and water clarity data are presented in Table 2. Physical and chemical results of samples collected during the 1972 spot survey may be found in Table 3.

Water clarity values (as measured by a Secchi disc) were as high as 13.5 feet on July 6, and as low as 7.0 feet on numerous occasions throughout the summer. A mean reading of 8.3 feet was achieved. Recently, Vallentyne (1969) suggested that lakes having Secchi disc readings below 9.6 feet are eutrophic or enriched in nature

Table 2: Secchi disc (feet) and chlorophyll a data (parts per billion) collected from Miller Lake during the summer of 1972.

Date	Chlorophyll a (ppb)	Secchi disc
6/7	2.9	13' 6"
12/7	2.6	12' 6"
12/7	1.0	8' 0"
19/7	3.3	7' 0"
19/7	2.3	11' 0"
26/7	3.8	7' 0"
3/8	3.9	10' 0"
3/8	2.7	7' 0"
15/8	1.6	8' 0"
15/8	1.7	7' 0"
17/8	1.8	7' 0"
17/8	2.4	7' 6"
23/8	2.1	7' 0"
23/8	2.6	7' 0"
30/8	2.3	7' 0"
30/8	1.1	7' 0"

while those exceeding 19.2 feet are oligotrophic or un-enriched in status. Lakes having Secchi disc recordings between 9.6 and 19.2 feet would be mesotrophic or moderately productive, that is, they have a moderate supply of nutrients, plant growths and biological production. On the basis of these water clarity guidelines, Miller Lake would be eutrophic (as determined from the mean value for the Lake).

Chlorophyll levels were exceedingly low during the sampling period. Experience has indicated that concentrations between 0 and 5 µg/L are low and indicate low to moderate algal densities, Concentrations between 5 and 10 µg/L, although moderately high, may be considered acceptable for most water-oriented recreational pursuits. Levels between 10 and 15 ppb reflect high algal levels. At these higher levels deterioration of water quality for recreational activities such as swimming and water skiing may be expected; as well as a reduction in aesthetic quality. Vallentyne's (1969) guidelines which indicate that acceptable levels as 5 µg/L while dangerous concentrations occur above 10 µg/L are remarkably similar to our "water-use oriented criteria" determined from experience. As indicated in Table 2, chlorophyll levels in Miller Lake were exceedingly low reflecting good water quality conditions.

Chlorophyll a measures the amount of photosynthetic green pigment in algae while water clarity, which is one of the most important parameters used in defining water quality for recreational use, is determined by means of a Secchi disc. Recently, staff from the Ministry of the Environment have found a near-hyperbolic relationship between chlorophyll a concentrations and Secchi disc readings. Figure 2 illustrates the mathematical relationship between chlorophyll a and Secchi disc for 945 sets of data collected from approximately sixty recreational lakes in Ontario. Points for eutrophic lakes which are characterized by high chlorophyll a concentrations and poor water clarity are situated along the vertical axis of the hyperbola while oligotrophic waters which have low chlorophyll a levels and allow significant light penetration lie among the horizontal limb. Data for mesotrophic lakes would be dispersed about the middle section of the curve.

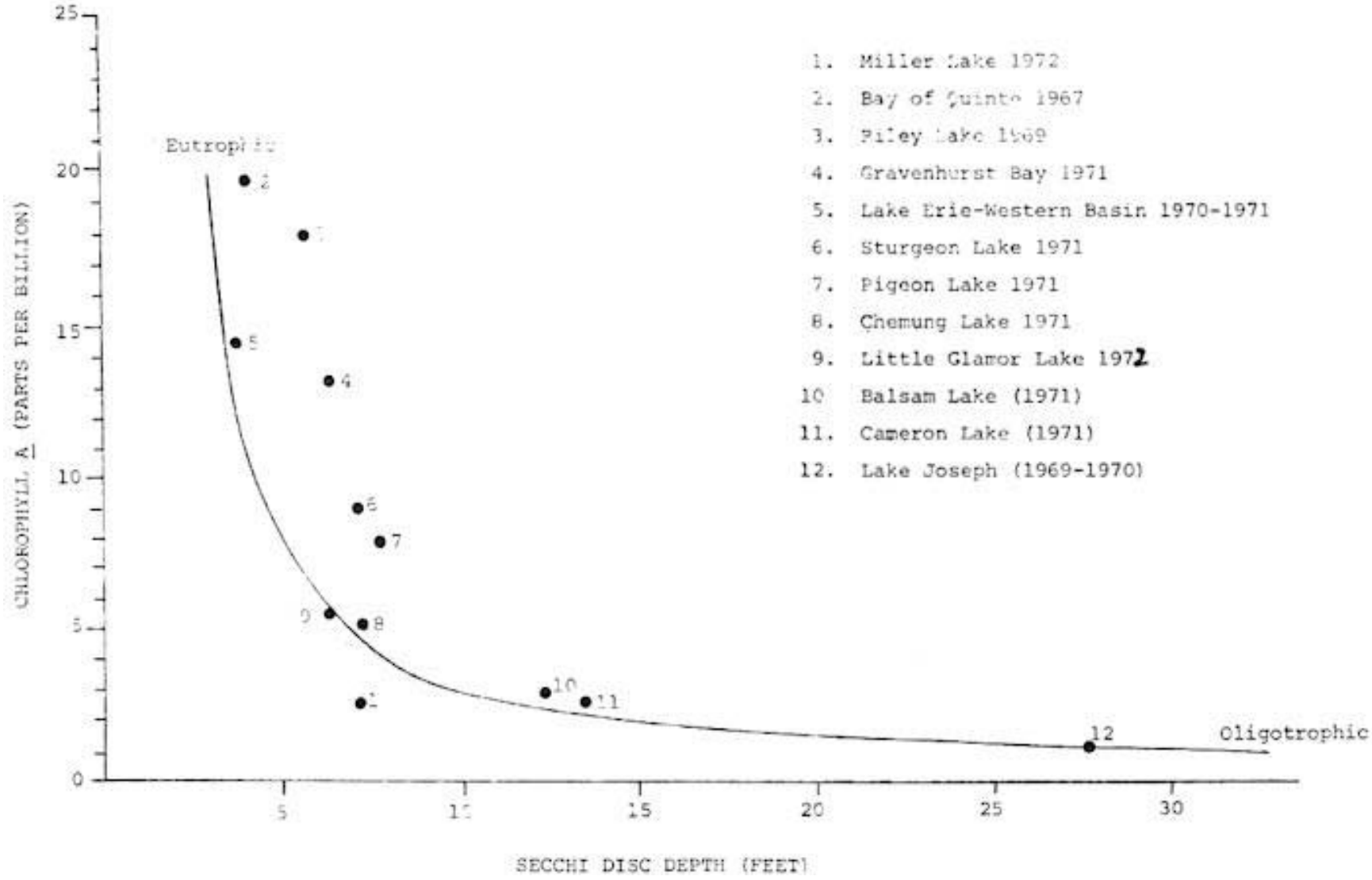

Figure 2: The relationship between chlorophyll a and Secchi disc depth for twelve lakes. Values for each lake are based on mean values collected during the ice-free periods of the listed years.

The fact that chlorophyll a and Secchi disc data for Miller Lake were somewhat below the established relationship suggest that factors other than phytoplankton production (such as colour or suspended material) govern water clarity. However, the chlorophyll a and Secchi disc data when considered independently indicate that Miller Lake is roughly similar to some low to moderately-enriched Kawartha Lakes. It must also be appreciated that Miller Lake was well removed from the highly eutrophic waters of Gravenhurst Bay and the western basin of Lake Erie.

From the physical-chemical information collected on Sept. 22, 1972 it was apparent that Miller Lake at its deepest point did not stratify thermally nor did concentrations of dissolved oxygen vary from surface to three feet above the bottom. Values recorded on July 9, 1970 by MNR confirm this fact. Concentrations of dissolved oxygen were more than adequate for fish and other aquatic life.

Concentrations of other parameters analysed were low. Soluble phosphorus which is of considerable significance for phytoplankton and aquatic weed production occurred at concentrations well below 10 ppb - a level considered by Sawyer (1947) as being capable of producing nuisance algal blooms at the start of the active growing season. The fact that the lake appears well aerated at all depths by wind-induced water movement suggests that sediment transfer of phosphorus would be negligible because of the oxidized nature of the mud surface.

Aside from scattered growths of bulrushes (*Scirpus*) at the east end of the lake and somewhat heavier growth at the west end (Figure 1) aquatic weeds were rarely found. Submerged aquatics were not visible at or from the surface in shallow water and in deeper water only a small specimen of bushy pondweed (*Najas*) was found caught on the anchor. MNR surveys in 1970 and 1971 documented the occasional occurrence of bulrushes and rare finds of Chara and *Potamogeton*. The 1970 MNR lake survey cited the lack of vegetation in Miller Lake as a partial explanation for the lack of success with previous largemouth bass and pickerel introductions.

Table 3. Physical and chemical data collected at a single deep-water station on Miller Lake - Sept.22, 1972. (All results except pH in parts per million unless otherwise indicated).

DEPTH	D.O.	Temp. (°F)	pH	NITROGEN AS N				Phosphorus as P		ALK.	IRON as Fe	Turbidity Units	Conduc-tivity µmhos/cm^3
				Ammonia	Kjel.	Nitrite	Nitrate	Tot.	Sol.				
Surface	9	61											
5	9	61											
10	9	61											
15	9	61											
20	9	61											
23 (3 ft. above bottom)	9	59	8.4	0.02	0.46	0.001	0.01	0.018	0.004	126	<0.05	6	259
Column through photic zone (13ft.)			8.4	0.01	0.42	0.001	0.01	0.022	0.001	122	<0.05	6	259

5. DISCUSSION

To comment on the impact of future development on water quality of Miller Lake would require a more detailed study such as the "Lakealert" procedure devised for Precambrian Lakes. Indeed, it is possible that such a study would indicate that some degree of enrichment from further development may be beneficial by increasing fish production and providing habitat for forage fish and additional game species, thus optimizing use. A careful selection of areas for future development based on such criteria as soil properties and critical environmental areas would minimize or avoid detrimental effects to the lake.

The results of this brief investigation suggest that density of cottages and related recreational pressure are more important than water quality considerations in considering the advisability of further development on Miller Lake. Accepting that its small size most strongly governs development on Miller Lake, it was concluded that the easiest and most meaningful method to determine carrying capacity was to apply the 'Boat Limit System' outlined in the "Lakealert" manual*. Briefly, this approach evaluates recreational capacity according to the most aggressive, space-consuming recreational activity-power boating. Without delving into detailed calculations, it was estimated that at most, 570 acres of the 773 acre area of Miller Lake is suitable for boating without damaging shoreline or endangering users. According to the lakealert formula, this would allow a cottage capacity in the neighbourhood of 170 on Miller Lake. Assuming complete development of Miller Lake Estates, the lake has already attained its carrying capacity.

DSO/cg
Feb. 21/73

---

* Lakealert Phase 2 - Hough, Stansbury & Associates Ltd., 1972.

6. REFERENCES

Ontario Ministry of Natural Resources, 1972. Lakealert, Phase 2 - Methodology. Hough, Stansbury & Associates Ltd.

Ontario Ministry of the Environment, Biology Section, 1972. Water quality evaluation for the Lake Alert Study.

Sawyer, C.N. 1947. Fertilization of lakes by agricultural and urban drainage. J. New England Water Works Ass'n. 61:109.

Vallentyne, J.R. 1969. The process of eutrophication and criteria for trophic state determination. *In:* "Modelling the Eutrophication Process". Proc. of a workshop at St. Petersburg, Fla. Nov 19-21. p. 57-67.