An Evaluation of Topographic Ground Surveys and Aerial Photo Analysis Concerning Satellite Basins and Associated Vegetative Communities in the Peace-Athabasca Delta

by

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I. Introduction

Critical requirements for a functional L.P. model of the ecological relationships on the Peace-Athabasca Delta are (a) accurate topographic data concerning the relationship of perched (or satellite) basins with open drainage systems, (b) the relationship of vegetative communities with basin bottoms and water levels, and (c) the amount of shoreline and water surface loss over a period of three years desiccation. The purpose of this study was threefold: (1) to determine the elevation distribution of spill levels and associated basin bottoms of water bodies satellite to openly drained lakes in the Peace-Athabasca Delta, (2) to assess the vertical relationship of vegetative communities with respect to the basin bottoms and water levels of satellite ponds and, (3) to determine the changes in shoreline length and water surface area of satellite basins after a period of three years desiccation.

II. Description of the Study Area

The major field investigations took place on what appeared to be closed drainage basins located immediately north of Mamawi Lake and Lake Claire on the Peace-Athabasca Delta. A detailed description of the vegetation and wildlife found on the area can be found in Dirschl (1970).

1972

III. Methods

The analysis of topographic data was restricted to those transects running from a known basin bottom or water level through adjacent uplands to a levee top which was assumed to be a "spill-in" level. Occasionally two or more transects had been made on a single basin so in such instances each transect was considered separately in the results. Where only one transect was indicated for a basin, we considered the basin bottom (or water level) and spill level (levee height) as being representative of the entire basin.

All of the basin elevation data were grouped into the vegetative elevation ranges established for the combined "open" basins of "I" and "J" set by Townsend (1971). Those basins having associated spill levels and basin bottom elevation data were initially categorized. These data were then supplemented with information from basins with recorded spill levels but no recorded basin bottom elevations. Average elevations for basin bottoms and spill levels, and the per cent frequency of occurrence of basins within each category were calculated. The total shoreline miles and acreages within each category were subsequently computed by directly applying the per cent frequency of occurrence to the total shoreline miles and acreages of open water and vegetative communities calculated for the satellite basins in the area of Lakes Claire and Mamawi by Ducks Unlimited (Table 1, 1971) and Townsend (1971) respectively. From the data obtained for those basins having recorded basin bottom and spill level elevations, we calculated the per cent of basins having spill levels two or more feet higher than their basin bottoms within each category. In all instances the maximum elevation recorded on a levee adjacent to a basin was assumed

Table 1. Miles of Shoreline Existing in Basins Satellite to Lakes Claire and Mamawi in September 1970.

Edge Type	Small Water Edge (mi.)	Map Measured Edge* (mi.)	Total Edge 1/ (mi.)	Exp. Factor
Water - Mud Flat	434.8	140.5 (28.1)	462.9	3.1
Water - Immature Meadow	714.4	47.8 (9.6)	724.0	14.9
Water - Meadow	1341.3	283.7 (85.1)	1426.4	4.7
Water - Low Shrub	653.6	210.7 (63.2)	716.8	3.1
Water - Tall Shrub	202.3	140.2 (42.1)	244.4	1.4
Water - Deciduous	33.0	11.8 (3.5)	36.5	2.8
Water - Coniferous	9.9	3.3 (1.0)	10.9	3.0
Water - Rock	3.3	0.3 (0.1)	3.4	11.0
Total Water Edge	3392.6	232.7	3625.3	4.4

* Adjusted figures in brackets were used

1/ Total miles of shoreline represented in satellite ponds.

to be the "spill level" of that particular basin unless it was stated otherwise.

Along each transect taken from a basin bottom or water level to a levee top, an attempt was made by the surveyors to document the elevations where obvious plant communities were encountered and where these communities ended so as to provide some idea of the height above basin bottom or water level at which vegetative communities existed as well as the range in elevation that each plant community encompassed.

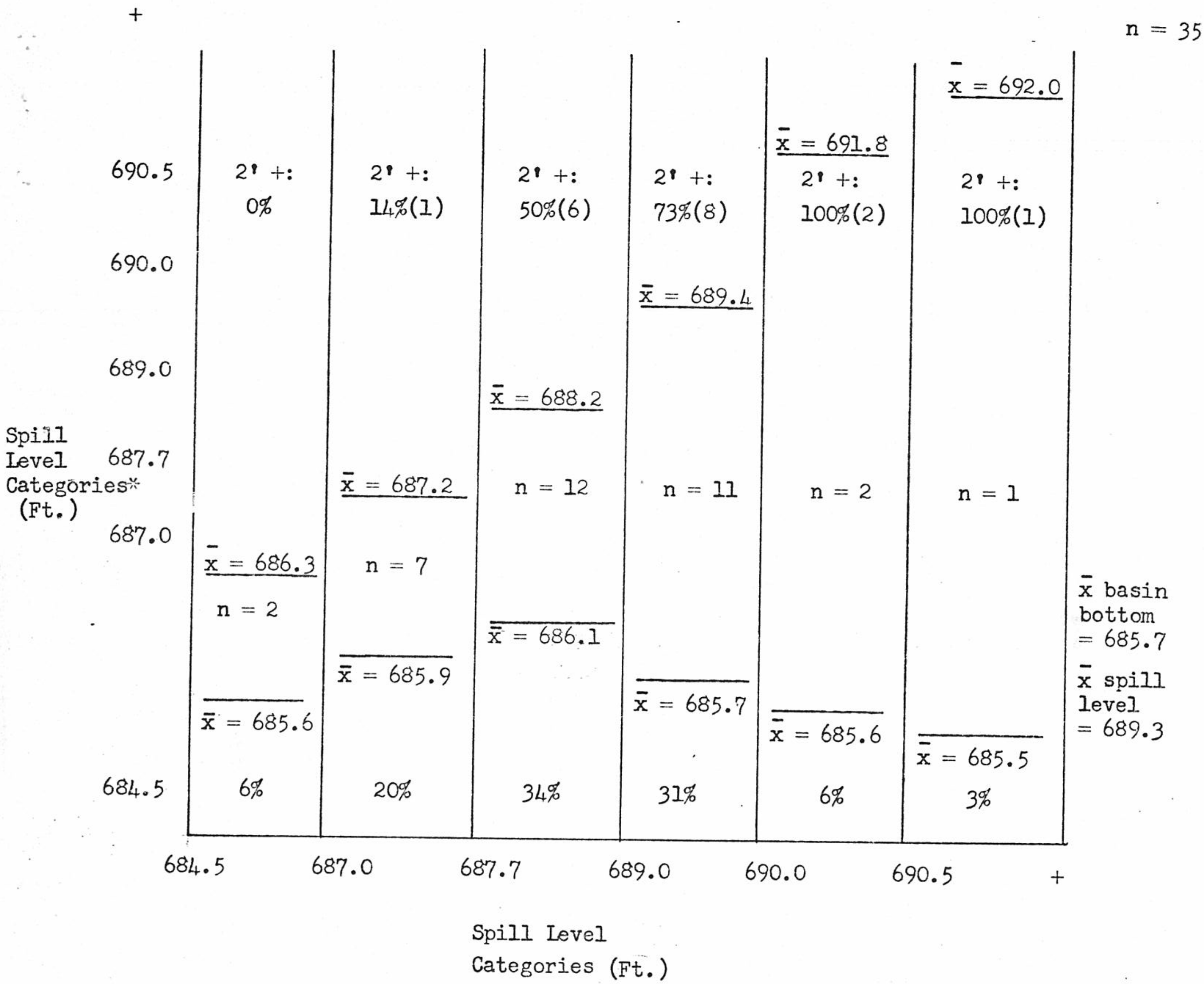
Aerial photographs from the late summers of 1968 and 1971 concerning similar areas (i.e. satellite ponds) peripheral to Lakes Claire and Mamawi were studied to determine the changes in acreages of open water and feet of shoreline that took place from 1968 to 1971. The data obtained are rather questionable due to our lack of knowledge concerning such environmental aspects as: (1) differences in local precipitation that may have occurred annually and seasonally, (2) possible differences in ground water loss from one part of the Delta to another, and (3) differences in rates of transpiration, evaporation, and sublimation that may exist in various parts of the Delta. We calculated the per cent of basins having spill levels at least two feet higher than their bottoms within each category.

IV. Results and Discussion

A. Distribution of Spill Levels and Associated Basin Bottoms

From Figure 1 it appears that as the ranges of spill levels increase from 684.5 feet to 690.5 plus feet the proportion of basins having spill levels at least two feet above basin bottoms also increases within each range. We cannot draw any general conclusion from this, because of the limited sample size and dearth of topographic information. We found

Figure 1. Basins with Recorded Bottoms and Spill Heights



* as established by G. Townsend (1971)

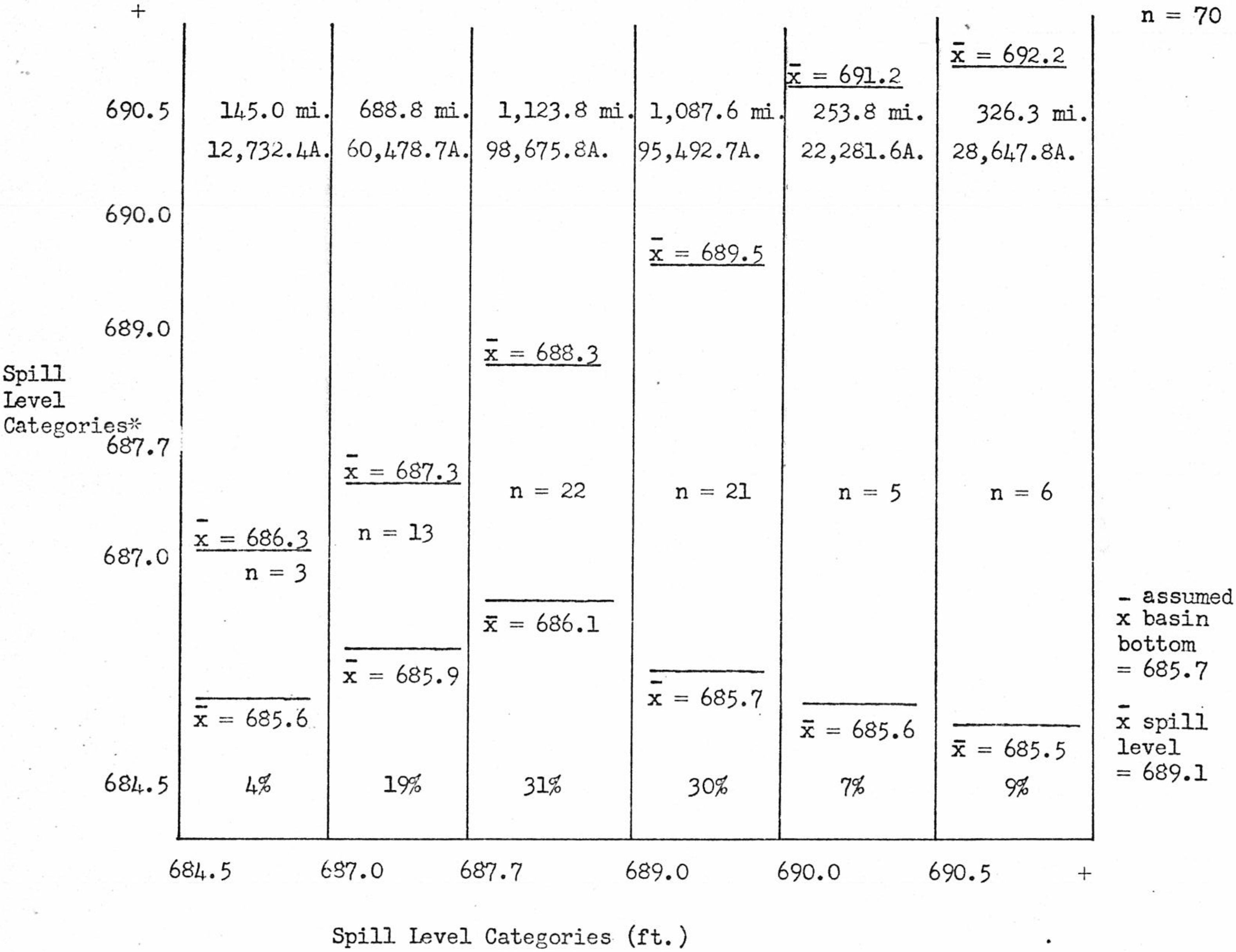
the average basin bottom to be 685.7 feet with the average spill level at 689.1 feet, whereas Dirschl and Townsend considered 679.5 feet as the lower limit of the basin bottom and 690.5 feet as the uppermost limit in their categories. From the graph integrating information from all the basins studied (Figure 2) it appears that 96% of the water bodies recorded have spill levels greater than 687.0 feet. This concurs with the report by D. Nieman (1971) which states that 88% of water bodies investigated in the Lakes Claire and Mamawi area were unaffected by a flood level of 686.0 feet.

According to our information, 54% of the water bodies studied have spill levels between the heights of 684.5 feet and 689.0 feet. If, as Dr. Drischl (1971) suggests, an average water base level of 687.0 feet is maintained on the delta with a temporary raise to 689.0 feet in a summer followed by a decline to 687.0 feet, 46% (i.e. 146,422.1 acres and 1,667.7 shoreline miles) of the water bodies would be unaffected. However, if the water level were temporarily raised to 690.0 feet an added 30% (95,492.7 acres and 1,087.6 shoreline miles) would be affected.

B. Relationship of Vegetative Communities with Elevations from Basin Bottoms and Basin Water Levels

In view of the survey crew's lack of experience in plant taxonomy, many of the terms used in reference to various plant communities are very general and verge on the ambiguous (e.g. "weeds"). Because of this ambiguity, all comments concerning vegetative communities will be centered on the nine categories used in the Canadian Wildlife Service L.P. model of the ecological relationships found on the Peace-Athabasca Delta. The categories are as follows: (1) open water, (2) mud flat, (3) immature fen, (4) <u>Carex atherodes</u> meadow, (5) <u>Calamagrostis</u> spp. meadow, (6) low

Figure 2. Basins with Recorded Bottoms and Spill Heights, and Basins with Spill Heights Only.



total acres = 318,309 total miles = 3,625.3

* as established by G. Townsend (1971)

shrub, (7) tall shrub, (8) deciduous forest, and (9) coniferous forest.

Figures 3 and 4 graphically represent two different situations particularly in the early successional states (i.e. those communities between open water and low shrub). Figure 3 represents elevation data obtained from basins having no water (or very little) present. In other words terrestrial plant succession has occurred throughout the entire basin bottom where there was once an aquatic environment. It should be pointed out that we have no knowledge as to the time span involved when these basins became dry and so we have no idea as to the duration of time that terrestrial plant succession has been occurring.

From examination of Figure 3 the following relationships from the basin bottoms are represented (n = 35): (a) The water surface rose to 0.2 ft. above the basin bottoms; (b) Mud flats occurred from 0.0 ft. (i.e. basin bottom) to 0.3 ft. above the basin bottoms; (c) Immature fen was found from 0.0 ft. to 1.3 ft. above the basin bottoms; (d) Carex atherodes meadow was found to range from 0.0 ft. to 4.0 ft. above the basin bottoms; (e) Calamagrostis spp. meadow ranged from 0.1 ft. to 4.0 ft. above the basin bottoms; (f) Low shrub was not recorded; (g) Tall shrub was found between 4.3 ft. and 7.2 ft. above the basin bottoms; and (h) Deciduous forest was found to range between 7.2 ft. and 8.1 ft. above the basin bottoms. No coniferous forest was recorded.

The fact that water, mud flats, and immature fen were present is probably indicative of some basins being in late stages of desiccation. However, the most interesting relationship exists between the Carex atherodes and Calamagrostis spp. meadows. It is generally accepted that Carex atherodes is more tolerant to aquatic or semi-aquatic conditions than is Calamagrostis

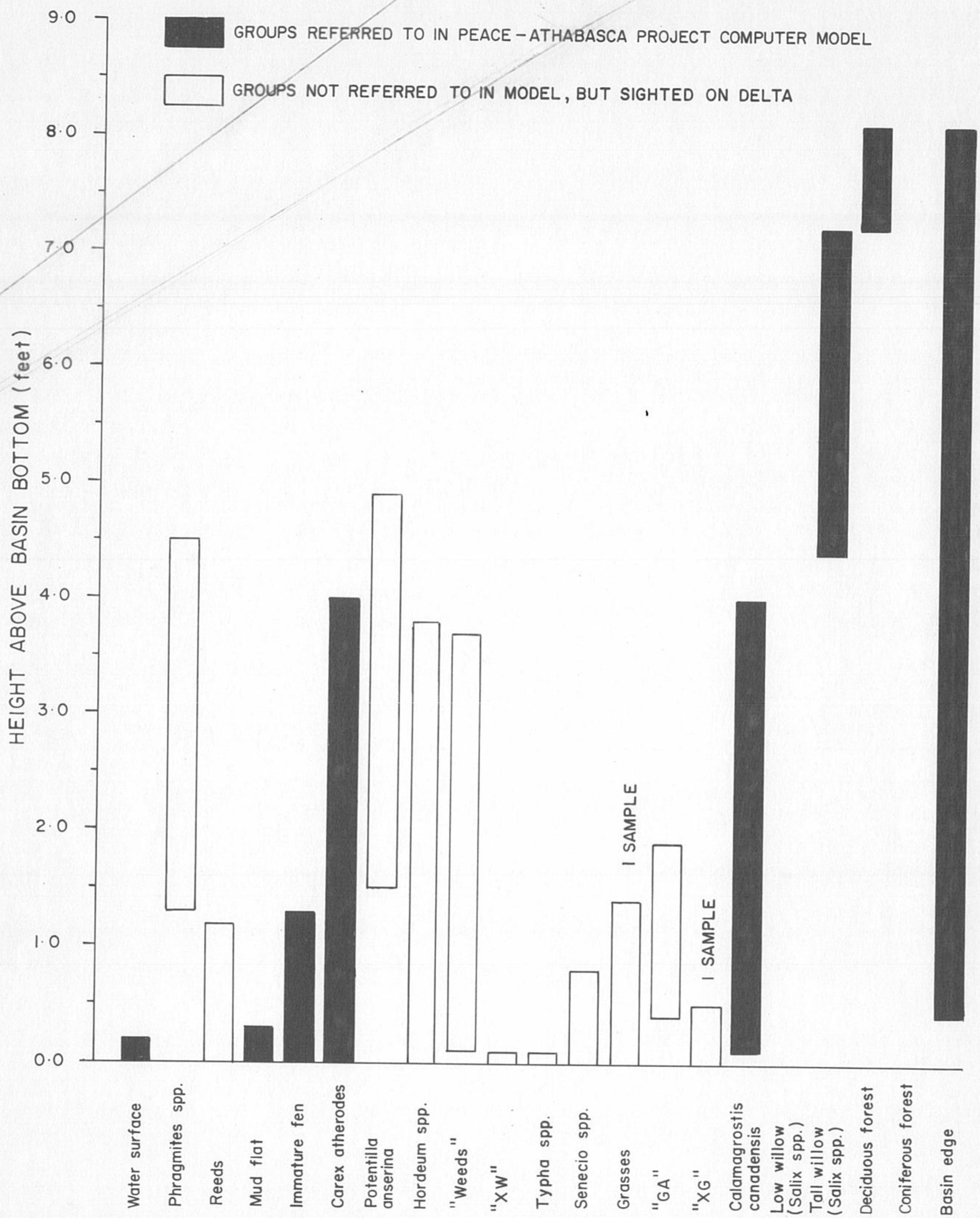


Figure 3 - Plant succession from bottom of basin to levee.

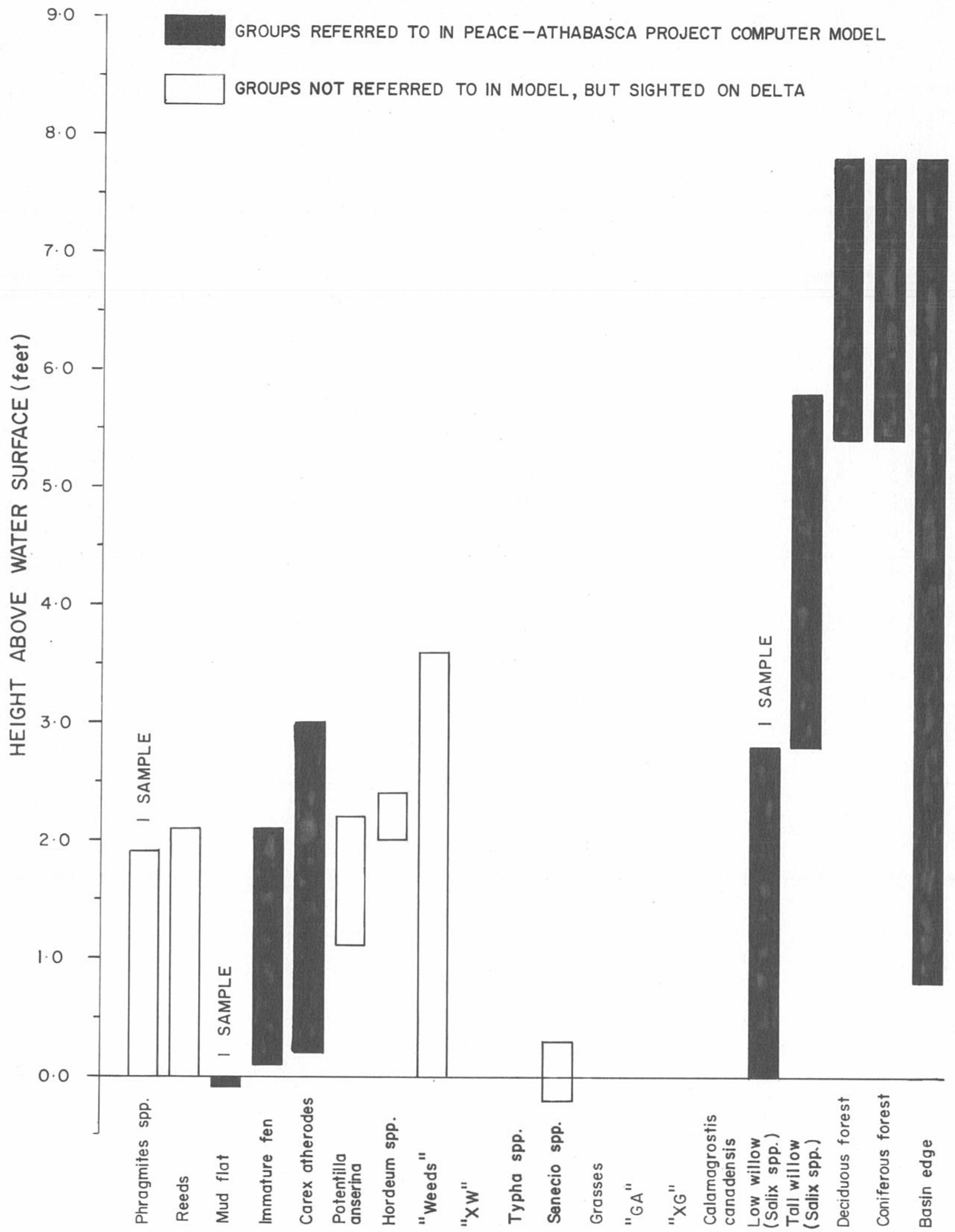


Figure 4 - Plant succession from water surface to levee.

spp. which generally prefers a more xeric environment. However, the data presented in Figure 3 indicates a marked overlap in elevations from basin bottoms where both Carex atherodes and Calamagrostis spp. were found. These data probably indicate two possible qualities of these plant species: Carex atherodes appears to exhibit a much higher tolerance to xeric conditions and/or Calamagrostis spp. appears to exhibit a high tolerance to a moist environment.

To draw any conclusions from this apparent relationship at this point may be rather speculative to say the least. Our lack of data prior to and during the period of basin desiccation prohibits any sound conclusions to be formed on the basis of the data obtained at these sites.

Figure 4 is a graphic representation of the elevation data obtained from plant communities in basins where only the water surface could be measured and no basin bottom elevations were recorded. From the data obtained in these basins, the following elevations with respect to the water surface were recorded: (a) Mud flats were observed at one point, that point being - 0.1 ft. below the water surface; (b) Immature fen was found to occur between 0.1 ft. and 2.1 ft. above the water surface; (c) Carex atherodes meadow was found to range between 0.2 ft. and 3.0 ft. above the water surface; (d) Calamagrostis spp. was not recorded; (e) Low shrub was recorded at one point, this being 2.7 ft. above water surface; (f) Tall shrub was found to range between 2.7 ft. and 5.8 ft. above the water surface; (g) Deciduous forest and Coniferous forest were both found to exist between 5.4 ft. and 7.8 ft. above water surface level.

Table 2. Comparison of Vertical Widths of Open Drainage Vegetation Zones (Townsend 1971) with Data Obtained on Vertical Vegetation Ranges from Basins with Water Present (Figure 4) and those with Basin Bottoms Recorded (Figure 3).

Community	Townsend (1971)	This Study Water Surface (Figure 4)	This Study Basin Bottom (Figure 3)
Carex atherodes	1.3 ft.	2.8 ft.	4.0 ft.
Calamagrostis spp.	0.7 ft.	not recorded	3.9 ft.
Low Shrub	0.8 ft.	one recorded	not recorded
Tall Shrub	1.4 ft.	3.1 ft.	2.9 ft.
Deciduous Forest	1.6 ft.	2.4 ft.	0.9 ft.
Coniferous Forest	0.7 ft.	2.4 ft.	not recorded

The data presented in Table 2 indicates that, in general, the vertical vegetative zones presented by Townsend (1971) are much more restrictive than those obtained from the elevations found in this study. Townsend's estimates can best be described as conservative.

C. Changes in Shoreline Length and Water Surface Area

The 1968 and 1971 aerial photographs of 23 satellite basins in the area north of Lakes Claire and Mamawi were examined during this portion of the study.

The data presented in Table 3 show that over the three year period between 1968 and 1971, a net loss of 28 per cent and 43 per cent occurred in shoreline length and water surface area respectively on the 23 lakes examined. Four (17 per cent) of those 23 lakes were known to have dried up completely during this time period. Although we do not know the rate of shoreline and water surface area loss, the data obtained represent a mean

Table 3. Changes in Feet of Shoreline and Areas of Basins from 1968-1971.

Basin Number	Total Shoreline Change (Feet)	Per Cent Shoreline Change (%)	Total Area Change (Acres)	Per Cent Area Change (%)
A	- 3200	18	-316.8	50
B	-11616	100 Dry-(?70)	-192.0	100 Dry (70)
C	- 3400	16	-194.4	12
D	-14520	100 Dry (71)	-134.4	100 Dry (71)
E	- 6600	100 Dry (71)	- 54.4	100 Dry (71)
F	- 1400	5	- 98.4	10
G	- 4224	42	-108.8	69
H	- 1600	24	- 55.2	33
I	- 200	2	- 6.0	6
J	+ 400	+ 9	- 8.0	11
K	- 200	2	- 8.4	6
L	- 800	10	- 0.4	0.3
M	0	0	- 5.6	10
N	- 2800	25	- 37.2	36
O	- 8600	83	- 34.8	78
P	- 3600	36	- 25.2	28
Q	-16896	96	-182.4	89
R	- 5976	27	-230.8	61
S	- 2600	25	- 15.6	14
T	- 1400	13	- 10.8	13
U	+ 2000	+ 15	-110.4	27
V	-14500	100 Dry (71)	-368.0	100 Dry (71)
W	- 1600	16	-121.2	44
Total	loss: 105,732 gain: 2,400 difference: 103,332	$\bar{x}$ loss = 40.0 $\bar{x}$ gain = 12.0 $\bar{x}$ loss = 28.0	loss: 2319.2 gain: 0 total: 2319.2	$\bar{x}$ loss = 43.3 $\bar{x}$ gain = 0 $\bar{x}$ = 43

annual loss of about 9.3 per cent for shoreline and 14.3 per cent for water surface area.

V. Summary and Conclusions

(1) Eighty-four per cent of the basin spill levels examined in the field surveys were found between 684.5 ft. and 690.0 ft. above sea level. Sixty-one per cent of the basin spill levels were found within the elevation range of 687.7 ft. and 689.0 ft. above sea level.

(2) There was a general increase in the percentage of basins having a difference of greater than two feet between their spill levels and basin bottoms as the spill levels increased.

(3) Based on the data presented in this study, we recommend that if any remedial works are established in the area of Lakes Mamawi and Claire, the structure (or structures) in question should have the capacity to create a short-term flood having a water level elevation of 690.0 ft. Such a flood would likely produce a significant recharging effect on the waters of perched basins in this region.

(4) More extensive topographic information is essential for the management of water regimes in various portions of the Delta. The data presented in this study are representative of only a small portion of the Delta, and the data obtained were analyzed at the exclusion of many influential environmental factors. The field surveys conducted were not meant to replace an accurate topographic survey of the entire Delta.

(5) The vertical widths of vegetative zones obtained from ground surveys in this study are generally wider than those presented by Townsend (1971).

(6) <u>Carex atherodes</u> communities and <u>Calamagrostis</u> spp. communities appeared to have a significant vertical overlap in the basin bottoms studied.

(7) Over a three year period between the summers of 1968 and 1971 there was a net loss of 28 per cent and 43 per cent in the shoreline length and surface water acreage respectively on perched basins in the area north of Lakes Claire and Mamawi. This represented an average annual loss of about 9.3 per cent for shoreline and 14.3 per cent for water surface area.

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