REED CANARYGRASS (*Phalaris arundinacea* L.) IN THE PACIFIC NORTHWEST: GROWTH PARAMETERS, ECONOMIC USES, AND CONTROL

* Study on Nisqually NWR
w/ maps of coverage

by

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an essay
submitted in partial fulfillment
of the requirements for the degree of
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Introduction

Depending upon the situation, Phalaris arundinacea L. can be either a useful or a destructive component of a given ecosystem. It has several characteristics that make it an important species in agriculture, sewage treatment, and stream bank stabilization. Many of these qualities -- high productivity, efficient nutrient uptake, sod-forming rhizomes, and the ability to reproduce both sexually and vegetatively -- make it an aggressive and difficult-to-control invader, especially in marsh and wetland ecosystems. It is only recently that riparian habitat management staff have recognized the invasive qualities of this species and the subsequent need to control it to preserve these habitats in non-successional state. Previously, most research on this species has dealt with increasing productivity, nutrient content, and palatability to make it more valuable as a forage crop.

Also known as reed canarygrass, P. arundinacea L. is a hardy grass that reproduces both by rhizomes (vegetatively) and by seeds (sexually). It is common in northern Eurasia, in Alaska and Canada, and throughout the continental United States except for the extreme southeast and California. It is a perennial species that normally ranges from one to two meters in height, depending on the conditions under which it is growing. It prefers wet, marshy areas but can also grow very well on sites with better drainage. The sturdy, fibrous stems can be up to one centimeter in diameter; individual leaves measure up to two centimeters wide and three decimeters long. Flowers and seeds are borne on culms that stand high above the leaves. The panicles can be up to two decimeters in length (Weinmann et al. 1984 in Naglich).

Shoots of P. arundinacea L. have been observed growing beneath wrack at Lake Sammamish, Washington as early as January (Weinmann et al. 1993, in Naglich). Its growth rate accelerates from about mid-April until seed development peaks in late June or July (Naglich, 1994), although in the southern part of its range this period may be extended somewhat (Abrams, ?). Observations by some researchers have indicated that it varies considerably in height during antithesis, in the size and shape of inflorescence, and in overall coloration; none of these factors could be correlated with geographic distribution or with each other, indicating that there is a high degree of morphological plasticity inherent within the species (Baltensperger and Kalton, 1958, in Apfelbaum, 1987)

One of the main uses of this species is as a forage crop, but P. arundinacea L. again shows itself to have both desirable and undesirable qualities. It is hardy and competitive. Seeded in a mixed stand with a legume, it will completely dominate the stand within three years (Bonin and Tomlin, 1968). Phalaris arundinacea L. contains several alkaloids, usually gramine or one of four substituted tryptamine-carbolines (Kendall and Sherwood, 1975). Since alkaloid content is negatively correlated with the palatability of the grass to ruminant animal species (Marten, et al. 1976), several low-alkaloid varieties have been developed commercially, including Rise, Venture, Palaton, MN-76, and Vantage (Sheaffer et al. 1990 in Naglich). Some researchers have found that bi-directional selection is effective for producing populations that have a high concentration of neutral detergent fiber (which many researchers use as an indicator of the potential that the grass will be eaten voluntarily by livestock).

Other studies with regards to the use of P. arundinacea L. as feed for livestock have dealt mainly with the effects of different times and methods of cutting on factors such as in vitro cellulose digestibility, crude protein content, and dry matter disappearance (all of which are indicators of the nutrient value of the grass), tiller formation, and dry matter yield (the amount of forage produced in a given period). There is evidence to suggest that reed canarygrass harvested at later stages of development is less valuable as forage (Johnson et al. ?). Another study showed that the dry matter yield of Phalaris arundinacea L. decreased with increasing heights of cutting, and increased with advancing maturity at the time of taking the initial harvest (Lawrence and Ashford, 1969). The combined results of these studies seem to implicate that the highest forage yield per season is obtained when the grass is cut at the point when it is less nutritious. The study on tiller formation showed that P. arundinacea L. plants clipped at 4 cm heights produced 46% more tillers by the time of the second harvest; those clipped at 10 cm had 119% more tillers by the time of the second harvest.

P. arundinacea L. has uses other than as a forage crop. The promotion of this species for the stabilization of stream banks probably dates back to the dust bowl (Naglich, 1994). Again, it has a disadvantageous aspect that affects its usefulness. At least one researcher says that P. arundinacea L. "causes a deposition of silt along the inside of ditch banks, limiting the channel capacity (Hodgson, 1968)." P. arundinacea is also extremely effective in the removal of nitrogen from sewage effluent (Pierce, 1979).

Despite the massive amount of research that workers have devoted to this species, there is little information on the effectiveness and necessity of controlling the species when it becomes a nuisance, as it has at the Nisqually Delta National Wildlife Refuge. The managers of the refuge concentrate on preserving habitat diversity rather than species diversity *per se*; hence, they did not notice P. arundinacea L. until it became a problem. Possible strategies for the control of this species include various combinations of burning, shading, haying, and spraying with pesticides. In order to evaluate the effect of haying on the growth and spread of P. arundinacea L., we collected data on the above- and below-ground dry weight biomass of samples taken from areas that have been hayed consistently over the past 15 years with those taken from areas that have not been hayed during this time.

From these data, we were able to formulate a hypothesis on what effects yearly mowing has had on P. arundinacea L. We hypothesized several possible results. Mowing could have either inhibited above-ground production and increased below-ground production or vice versa. It could also have had no noticeable effects on either above- or below-ground production. Finally, mowing could increase or decrease total production. This study will provide new information on the effectiveness of mowing or haying as a method for controlling the spread of P. arundinacea.

Site Description

The Nisqually National Wildlife Refuge lies in the extreme northeast corner of Thurston County, Washington where the Nisqually River drains into Puget Sound. The refuge consists of a number of habitat types, including a large freshwater grasslands and marsh environment within which our biomass experiment was performed.

The freshwater ecosystem lies on the remnants of a salt marsh which was diked and reclaimed in 1904 in order to create pasture and farmland. The transect along which we collected our mowed samples was in an area which has been cut for hay at least anually for the last fifteen years. The elevation difference over the length of the transect was a maximun of 30 to 35 centimenters. The site was well drained and there was no evidence of seasonal flooding or standing water within fifteen meters of the transect. The soil along the transect was of fine silt-like consistency and contained large amounts of fully decomposed plant matter. The ground had less than one centimeter of identifiable *Phalaris* necromasss. The area was completely unshaded.

The unmowed sample site was in an area which refuge records showed had not been mowed or otherwise distrurbed within the last fifteen years. The site contained large amounts of *Phalaris* necromass reaching a depth of approximately ten centimeters. The soil appeared to be of the same type and consistency as along the mowed transect. The soil contained large amounts of dead below ground *Phalaris* biomass, promarily rhizomesand root hairs. This areas showed no evidence of flooding or standing water either. This site was at least fifteen meters from the nearest standing water, unshaded and level.

Materials and Methods

We first measured out a 13.5 meter transect at breast height above our sample communities and then lowered it to ground level. Once the transect tape was on the ground, we made sure that all tillers remained standing and that none were pressed underneath the meter tape. We then measured out twenty-five 20 square centimeter plots along the transect at each sample site using meter sticks. All of these plots were on the same side of the transect and were spaced at two per meter. Each plot was dug to a depth so as no appreciable amont of below ground biomass was excluded.

We then separated the above and below ground biomass and removed any surface necromass. All below ground biomass samples were then divided into smaller pieces using a saw and serrated knife. The samples were then washed using a pressure hose over a fine mesh screen to remove any remaining soil and necromass.

All samples were dried in a drying oven set at 106 degrees Celsius until comletely dry. The samples were then individually weighed using an electronic scale accurate to one one-hundreth of a gram. Between the weighing of each sample we tared the scale in order to maximize accuracy

Results

There were qualitative differences in the morphology of the species on the two sites. The below-ground parts of the unmowed samples had far more fine root hairs, while those of the mowed samples tended to have less root hairs and fleshier rhizomes. The sod layer from which the unmowed samples grew contained mostly the dead growth of previous years in various stages of decay and less clay. The sod beneath the mowed samples, by contrast, contained more clay and was inhabited by more earthworms than the unmowed samples.

The mowed above-ground dry weight biomass (DWB) were more variable than those of unmowed above-ground DWB The mowed above-ground DWB varied from 11.23 grams to 76.96 grams (figure 1), while the unmowed above-ground DWB varied from 3.48 grams to 33.98 grams (figure 2). The average above-ground DWB from the mowed samples was 30.90 grams. This was more than twice the average above-ground DWB of the unmowed samples (14.53 g).

Unmowed below-ground DWB had a greater variability than the mowed below-ground DWB. The mowed below-ground DWB varied from 18.99 grams to 151.92 grams (figure 3); unmowed below-ground DWB varied from 27.89 grams to 265.69 grams (figure 4). The mean below-ground DWB from the mowed samples (46.57 grams) was approximately half that of the below-ground unmowed samples (92.94 grams).

The total DWB varied more widely in the unmowed samples than in the mowed samples (Figures 5, 6): total unmowed DWB varied from 32.08 grams to 280.39 grams while the mowed total DWB varied from 34.69 grams to 228.88 grams. The mean total unmowed DWB of 76.28 grams was 45.86% greater than mean total mowed DWB of 11.3 grams.

The slopes (y/x; below-ground/above-ground) of the best-fit lines were and 1/3, or .33, for the mowed samples (Figure 7) and 3/2, or 1.5 (Figure 8)for the unmowed samples, indicating more above-ground mass per unit below-ground mass for the mowed samples and the opposite for the unmowed samples.

Discussion

It is likely that the greater amounts of above-ground biomass in the samples taken from areas which had been consistently mowed were a result of the removal of the dead growth of previous years. This would make the mowed areas less stressed as the new growth would receive more sunlight and water, although it is possible that the above-ground necromass in the unmowed area could keep the new growth from dehydrating as quickly. The greater production of above-ground biomass may also be a physiological reaction to the repeated stress of mowing. The need to completely replace above-ground growth each year would cause the grass to deplete its rhizomes since, in addition to their reproductive purpose, they serve as reservoirs of starches for the plant. Also, the above-ground necromass that is left on the unmowed areas encourages roots to grow up into it as it falls and rots, because it could be a source of nutrients. In fact, we observed that this was the case - a fine network of root hairs had grown up into the mat of necromass in the unmowed area.

This would indicate that mowing may be effective in inhibiting the rhizomal spread of Phalaris arundinacea L. The need to produce all above-ground parts year after year would prevent the plant from using its energy to spread vegetatively. If the grass is cut before the seeds have matured, then mowing may also be effective in controlling sexual reproduction as well. In considering mowing as a technique for controlling vegetative reproduction of this species, it is important to keep in mind that one study found that reed canarygrass plants produced more tillers when cut (Horrocks & Washko, 1971).

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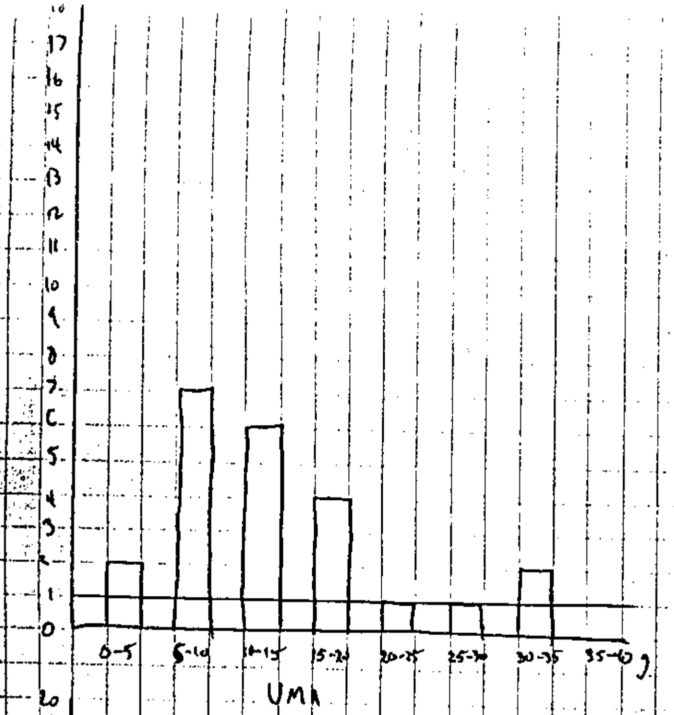
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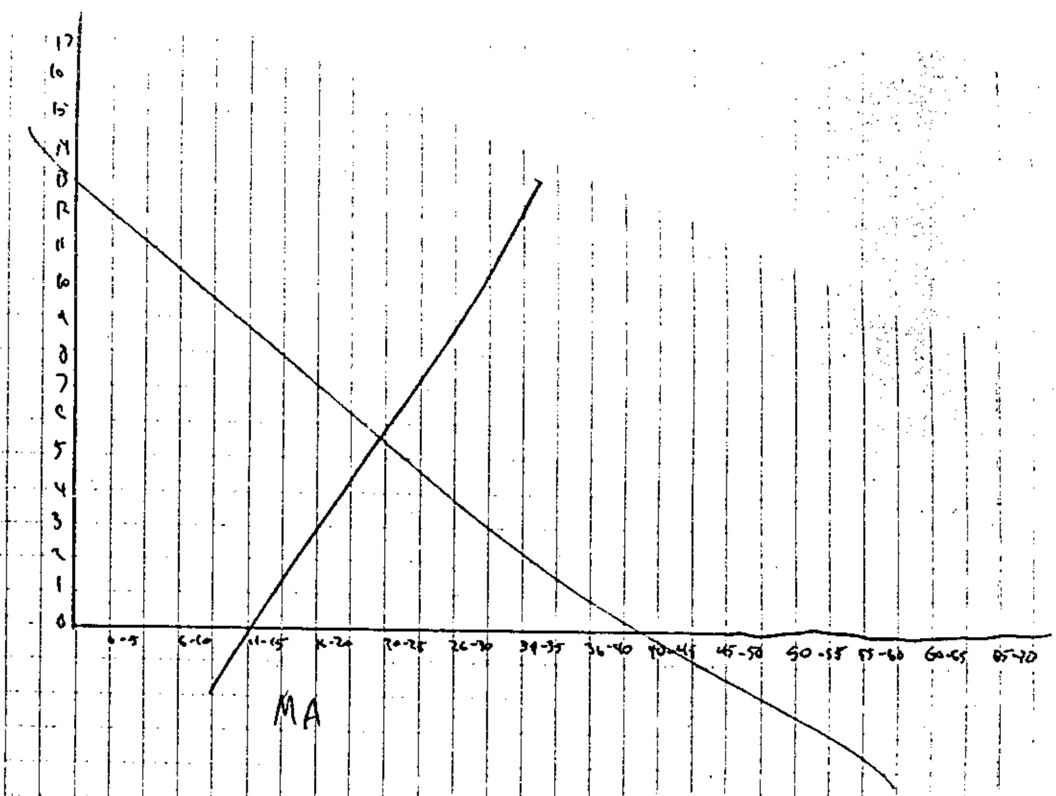
Fig 2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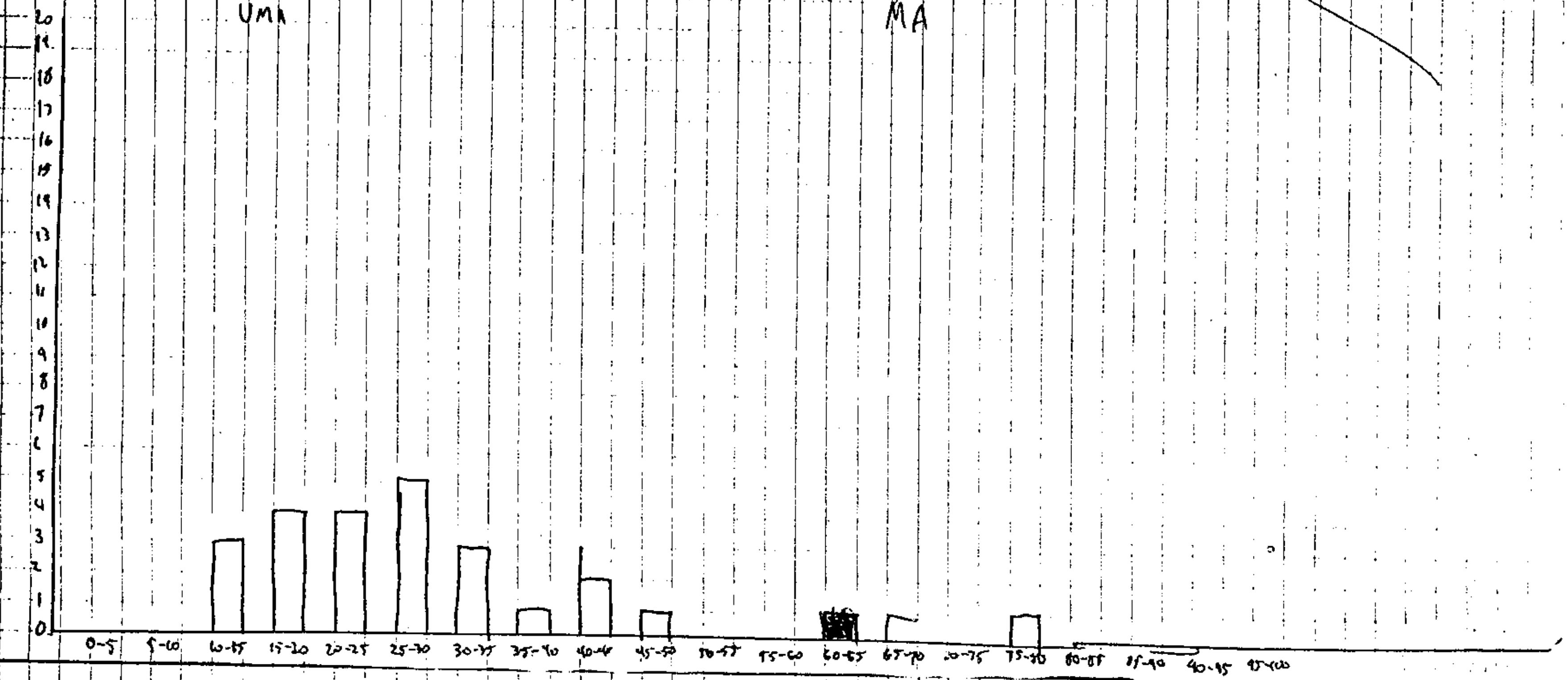
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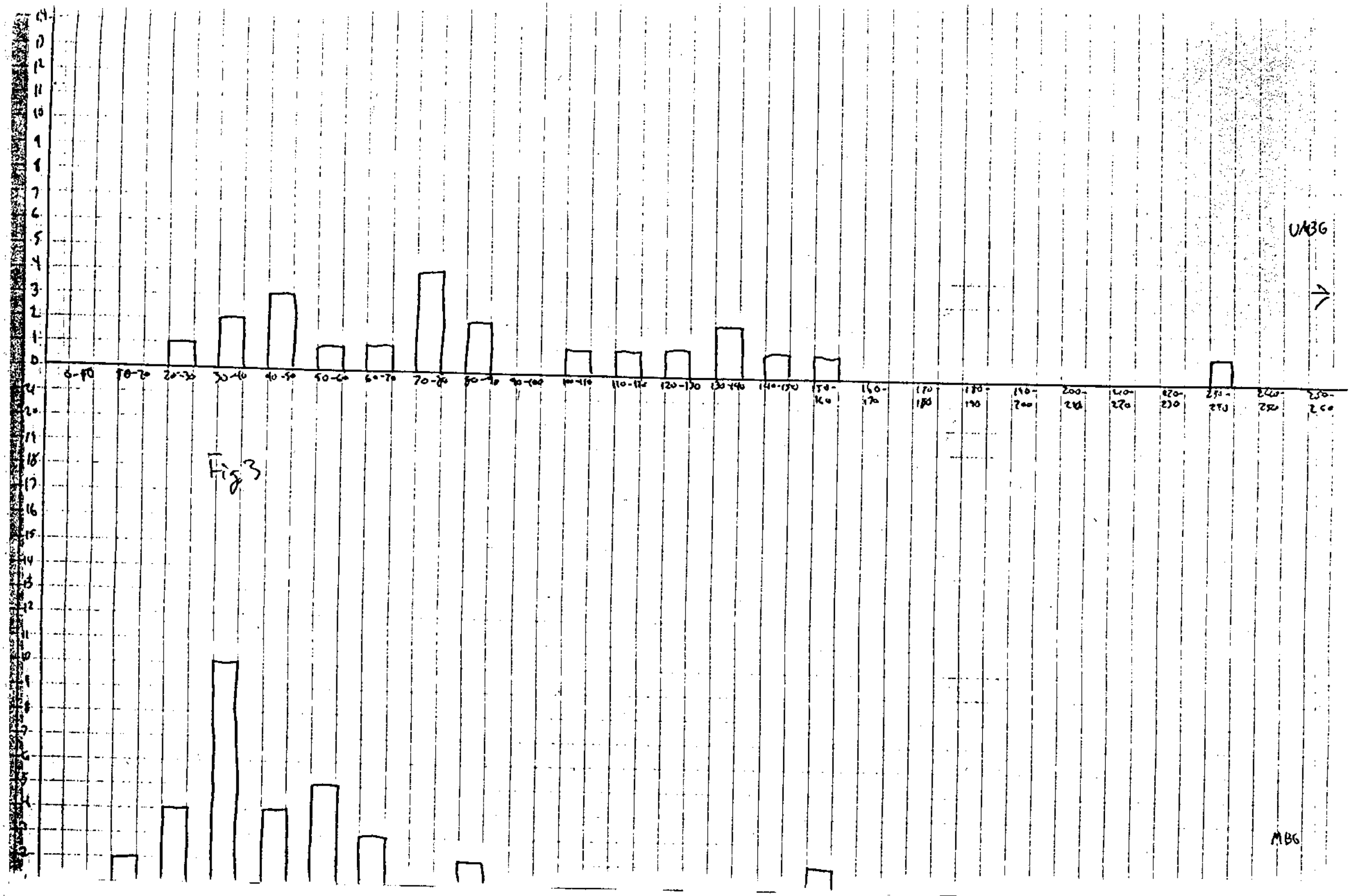
Fig 4



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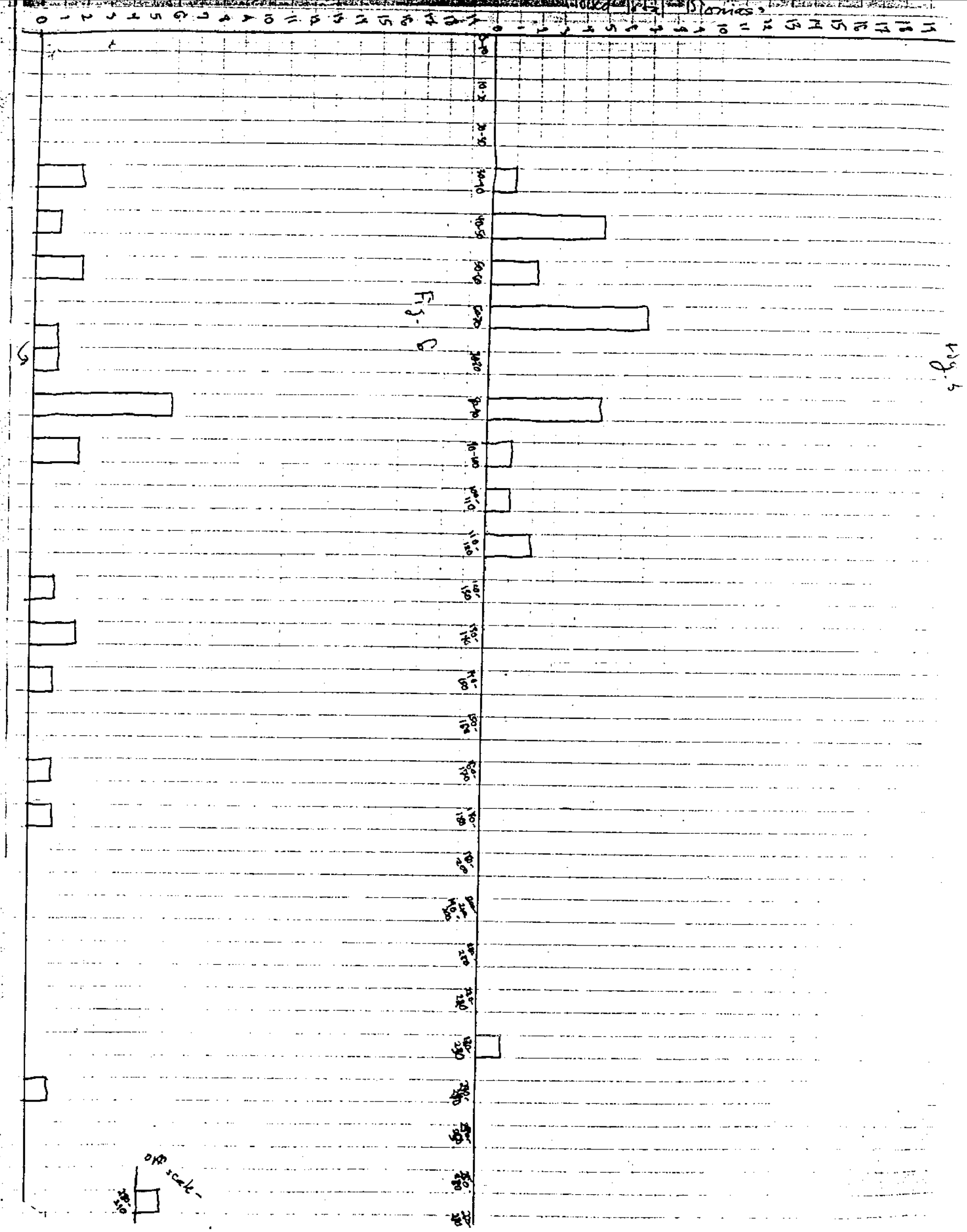

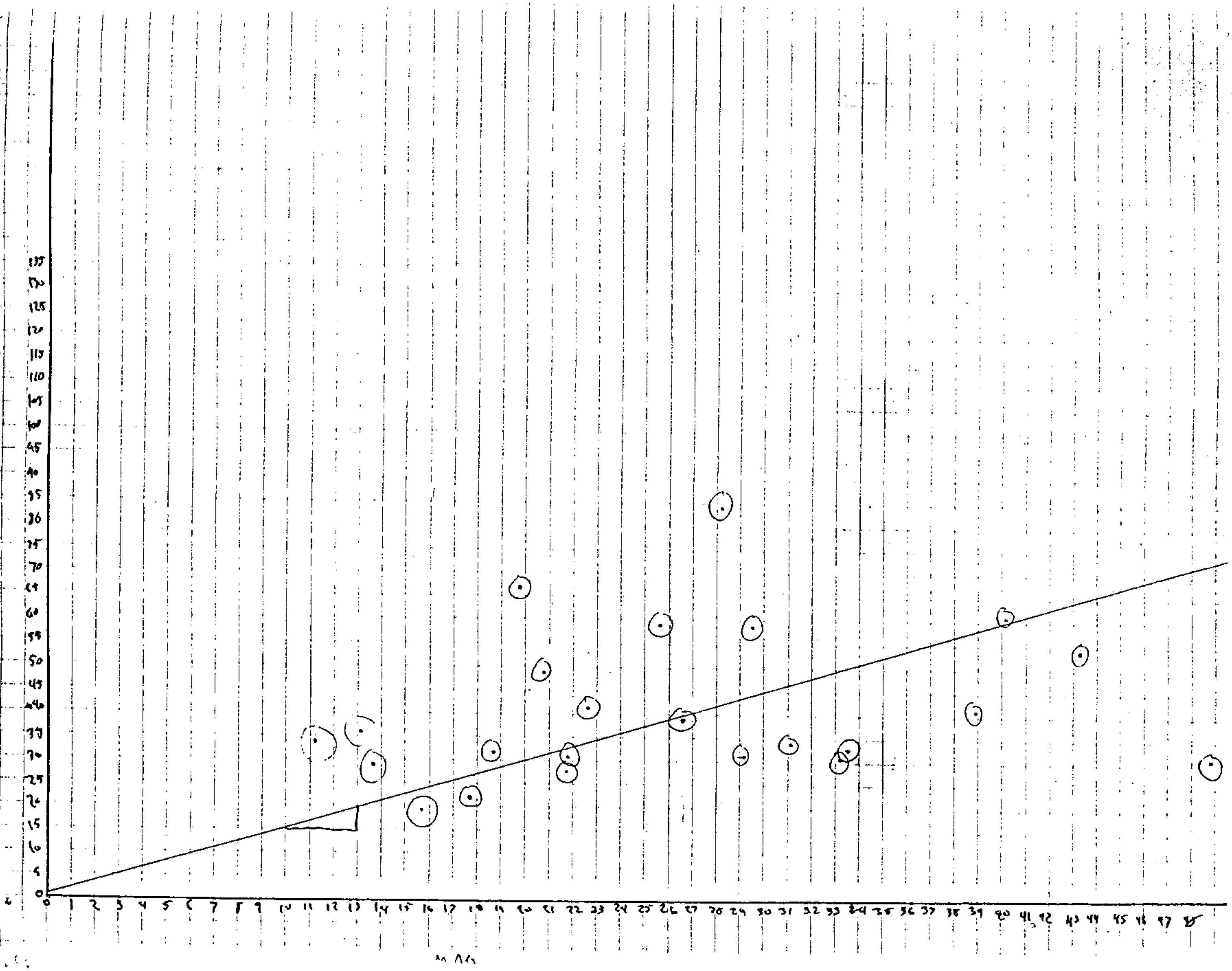

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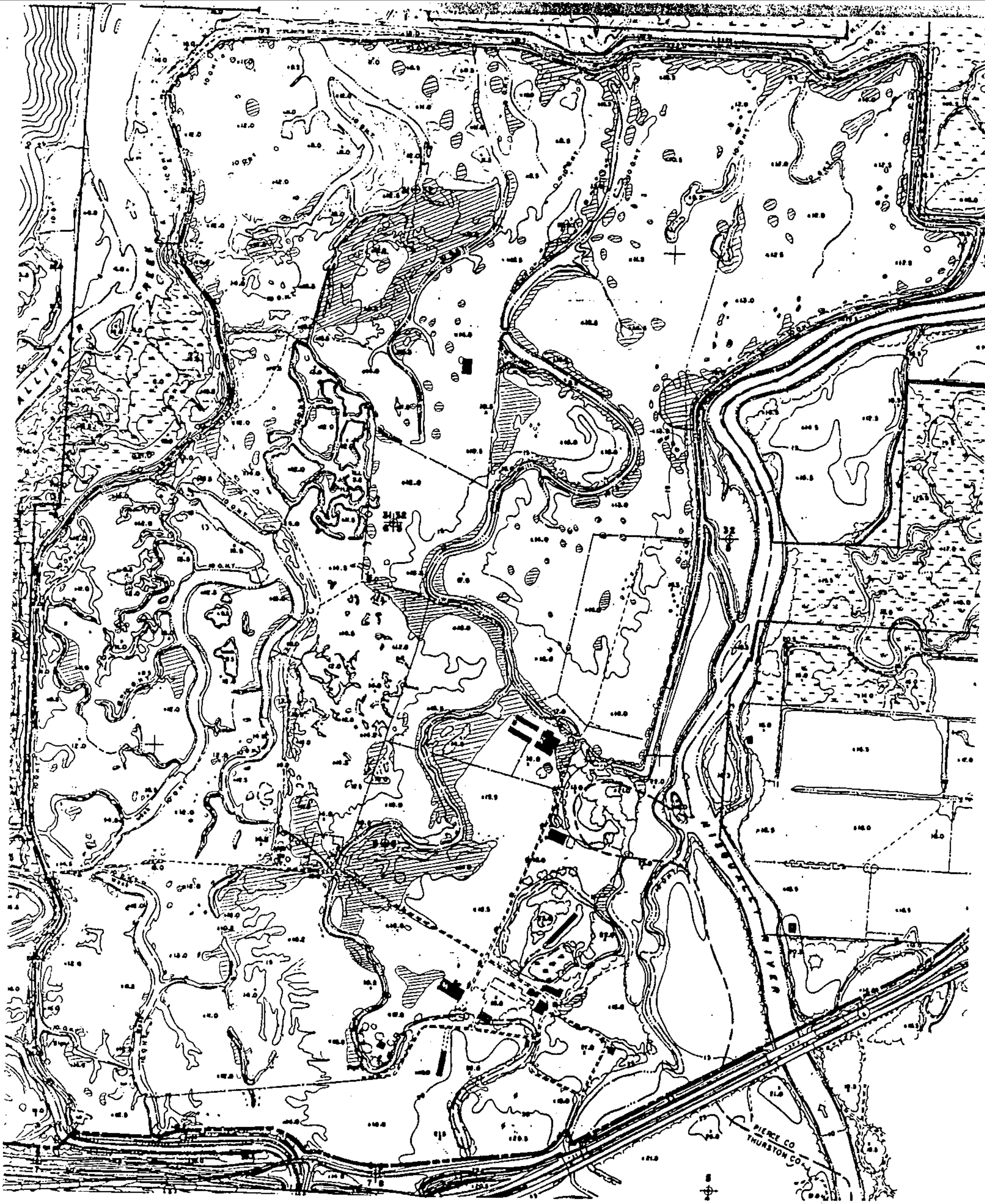
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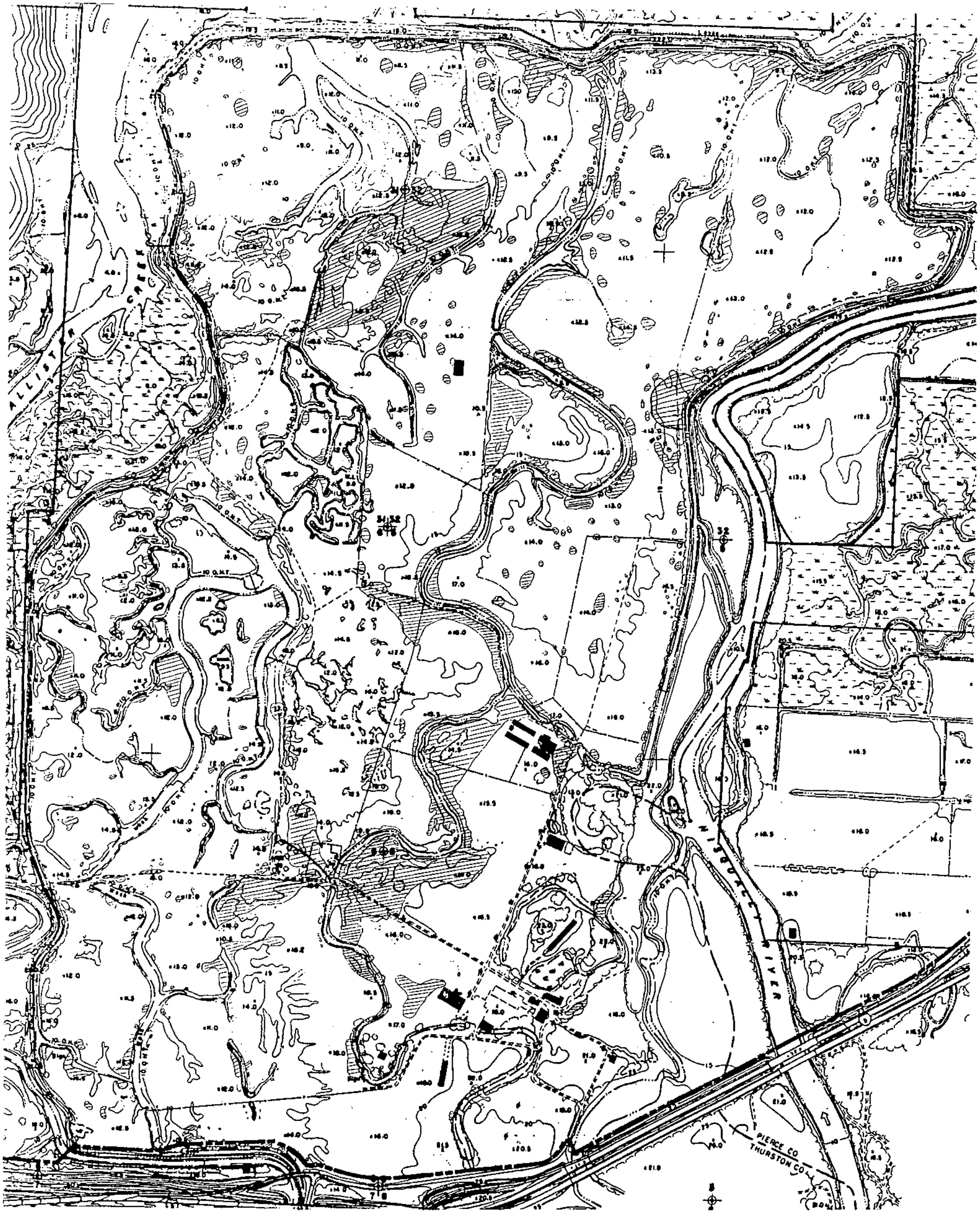

Phalaris arundinacea L. (reed canarygrass) May 1995

Acreage Estimates of Phalaris arundinacea L.
on the
Nisqually National Wildlife Refuge - 5/95

Section #	Total Acreage	Acreage of P. arundinacea
1	11	1
2	42	3
3	32	2.5
4	18	0.1
5	11	0.1
6	23	1.5
7	15	1
8	27	4
9	17	0.33
10	21	0.75
11	10	0.75
12	10	1
13	21	2.25
14	16	2
15	20	12
16	23	10
17	23	1
18	18	2
19	15	2
20	14	2
21	15	6
22	18	1.25
23	22	2.25
24	11	1
25	14	2.25
26	6	0
27	18	3
28	20	2
29	39	6.5
30	18	2.25
31	4	1.5
32	9	0.75
33	29	4
34	34	10
35	23	7
36	21	4.5
37	25	12
38	20	4
39	4	1
40	30	4
41	37	4
42	18	?*
43	28	10
44	21	5
45	15	3
46	26	6
47	37	5
48	12	5

*This area was innaccessible by foot due to flooded sloughs.

	Total Acreage:	162.53**

**Please note that this total only includes the area of the refuge within the Brown Farm Dike.

Mapping and estimations performed by Moon Callison, Alex Cobb, Matthew Fontaine, Jacob Hendrickson, and Michael Spadafora as part of the integrated studies program Humans and Nature in the Pacific Northwest at The Evergreen State College.

Acreage Estimates of <u>Phalaris arundinacea</u> L.
on the
Nisqually National Wildlife Refuge - 5/15

Section #	Total Acreage	Acreage of P. arundinacea
1	11	1
2	42	3
3	32	2.5
4	18	0.1
5	11	0.1
6	23	1.5
7	15	1
8	27	4
9	17	0.33
10	21	0.75
11	10	0.75
12	10	1
13	21	2.25
14	16	2
15	20	12
16	23	10
17	23	1
18	18	2
19	15	2
20	14	2
21	15	6
22	18	1.25
23	22	2.25
24	11	1
25	14	2.25
26	6	0
27	18	3
28	20	2
29	39	6.5
30	18	2.25
31	4	1.5
32	9	0.75
33	29	4
34	34	10
35	23	7
36	21	4.5
37	25	12
38	20	4
39	4	1
40	30	4
41	37	4
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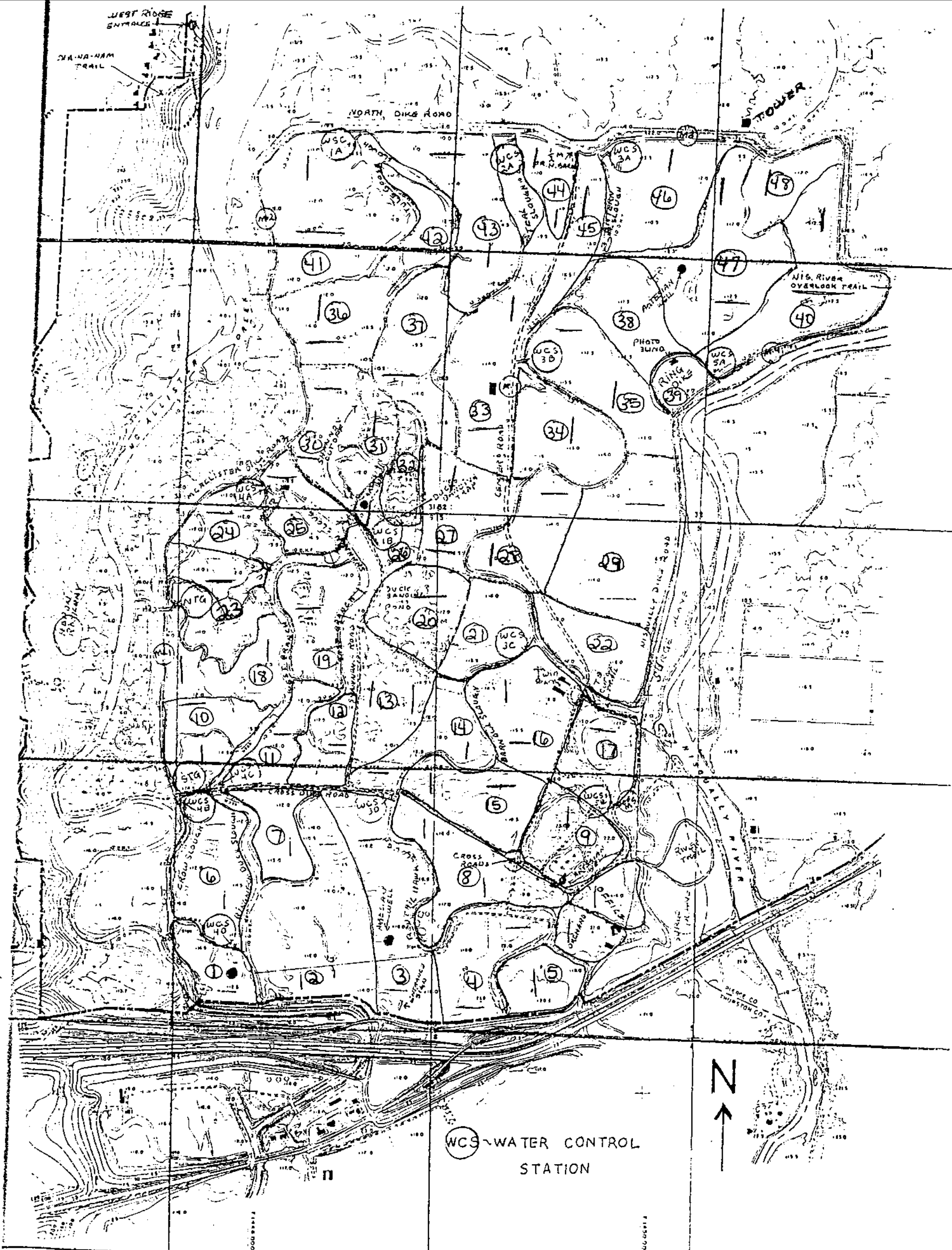

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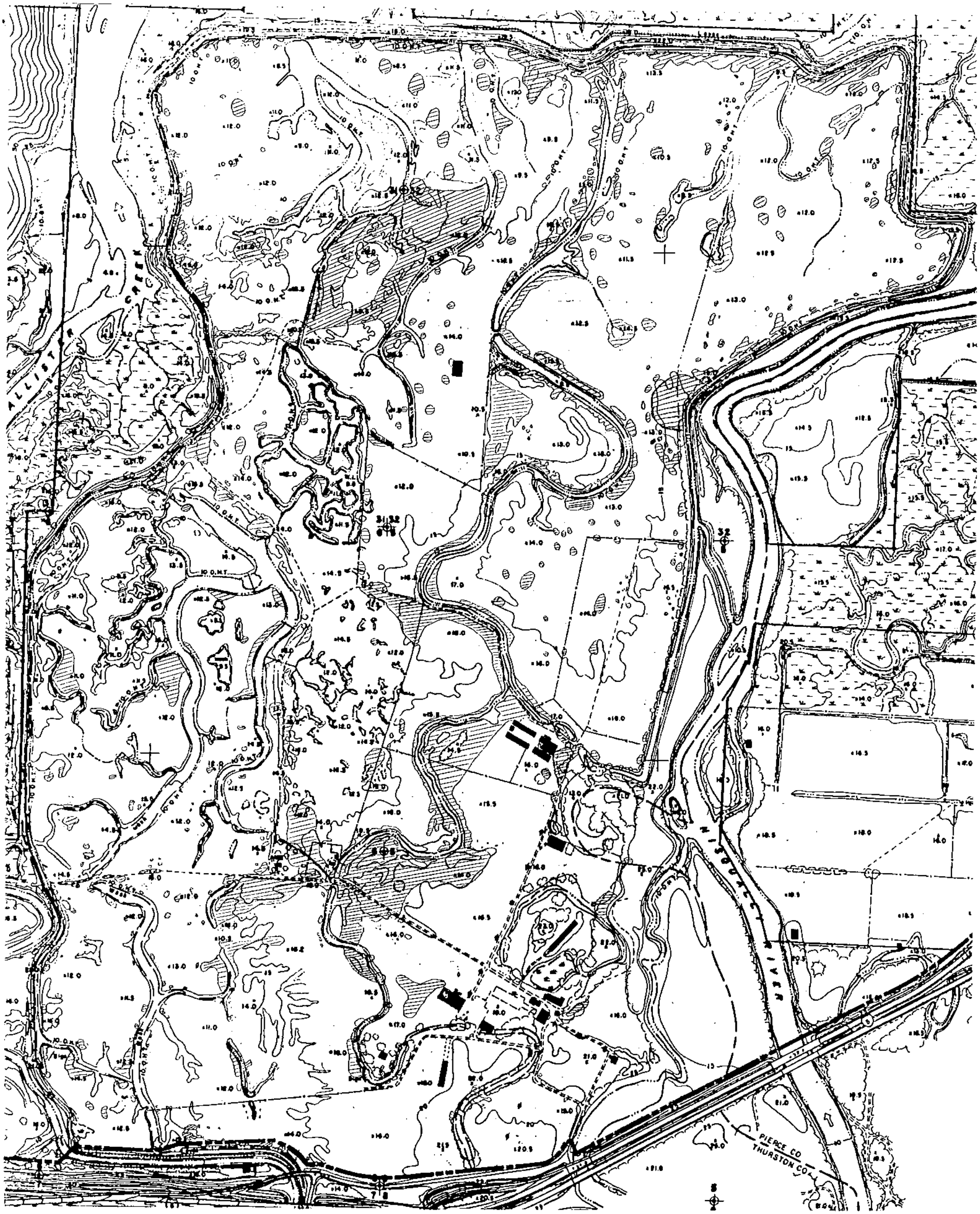
Location of sampling

Map of Nisqually National Wildlife Refuge.



Phalaris arundinacea L. (reed canarygrass) May 1995

Nisqually NWR