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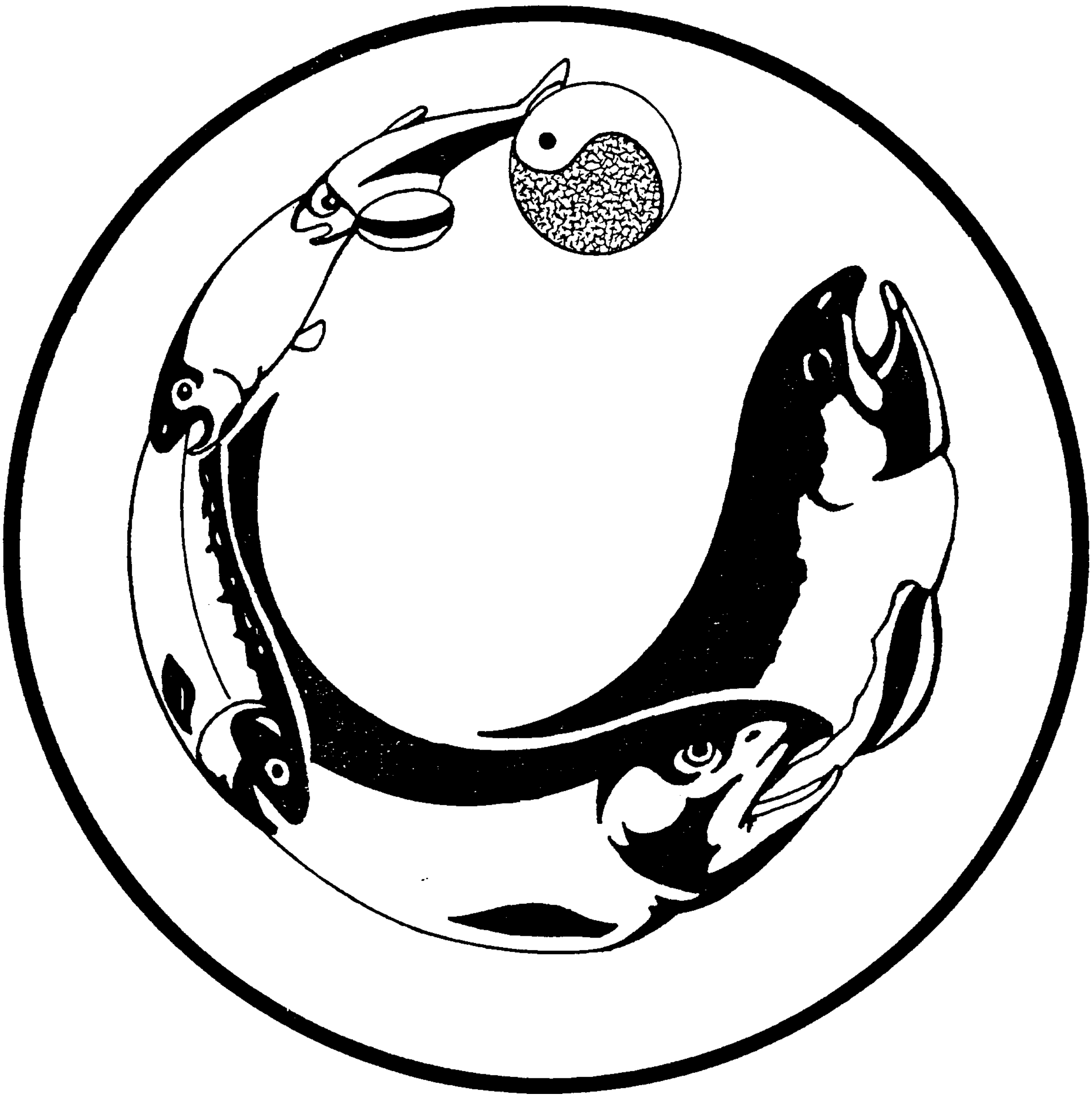

REPORT

of

AQUA CULTURE SURVEY PROJECT

June 1986 - December 1986

A Project Funded by

Saskatchewan Education
(Northern Division)

Department of Regional Industrial Expansion
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(Industrial Research Assistance Program)

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I. PURPOSE OF PROJECT

In this preliminary survey water chemistry data was gathered from several ponds in northern Saskatchewan being used for cage rearing of rainbow trout in order to determine which factors appeared most significant for the viability of commercial operations. Data was also gathered in one pond on the growth-related effectiveness of several varieties of commercial fish feed.

The results of this project will be incorporated into the curriculum of training programs designed to assist northern entrepreneurs establish and maintain fish farming operations.

II. INTRODUCTION

In northern Saskatchewan there are numerous lakes and smaller water bodies which can support a healthy fish population during the summer months. In recent years these water bodies have become popular for fish farming.

The conventional method of fish farming is to stock the water body with fingerlings in early spring. Feeding on natural food in the water, the fingerlings grow throughout the summer. In the fall, the fish are harvested by netting.

The advantages of this type of fish farming, called extensive aquiculture, are low capital and low operating costs. However, the recovery rate of harvestable fish averages only 35%. The losses may be attributed to predators, poor availability of food, oxygen depletion, disease, and insufficient harvesting. Most often, the losses cannot be controlled or minimized.

A more controlled method of fish farming has been gaining popularity in Saskatchewan. In this method, called intensive cage culture, fingerlings are stocked in cages and fed exclusively on trout feed during the growing season. The advantages of using the cage culture method are: higher stocking densities (15 times that of conventional extensive aquiculture), ease of harvesting, and uniform size of fish. With careful monitoring, a recovery rate of 90-100% is possible.

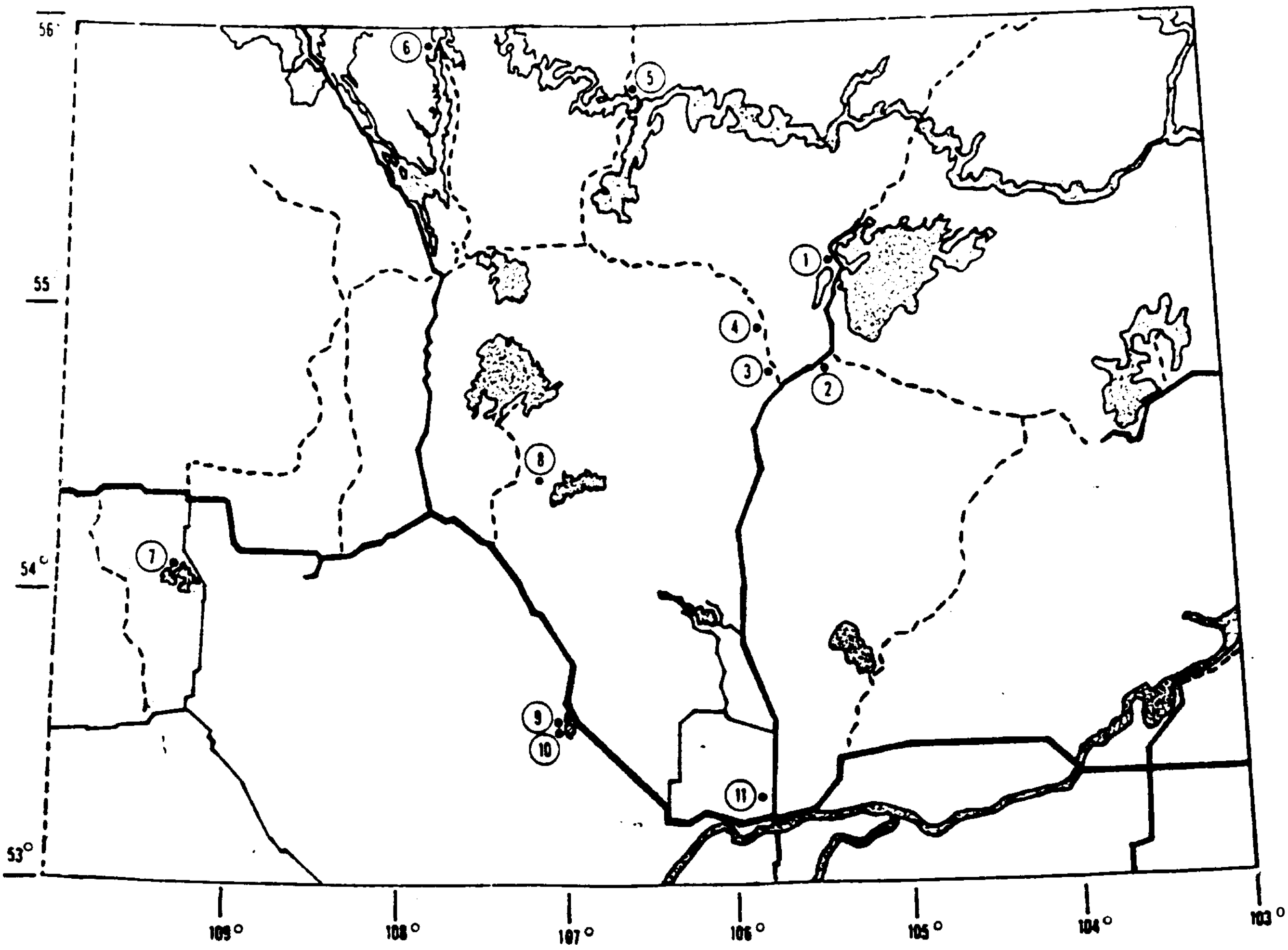
There are, however, several problems inherent in this practice. With large numbers of fish in a confined area, crowding stress is likely to develop. Changes in water conditions such as lowered oxygen level or increased surface temperature can lower the fish's defenses against disease. And if a disease develops, it can spread rapidly throughout the cages.

Recognizing the potential of the intensive cage culture method, representatives from the Saskatchewan Indian Agriculture Program (SIAP) and La Ronge Fish Farm Inc. proposed that Saskatchewan Education - Northern Division work cooperatively with them to develop the curriculum for a training program to inform practicing and potential aquaculturists about the cage culture method.

This report describes the results of a preliminary water chemistry survey and a feed effectiveness trial involving the cage culture rearing of rainbow trout (*SalmoGairdnere*) monitored between June 1986 and December 1986. The study will surely serve as the basis for further research and will also be used to develop a training program for northern aquaculturists, teaching them the proper methods of site selection, monitoring, and feeding.

III. STUDY AREA

Eleven different water bodies in the north-western part of the province were monitored from June to December of 1986. Five of the water bodies, which are within 60 km of La Ronge, are leased and operated by La Ronge Fish Farm Inc.; the remaining water bodies are demonstration sites which were operated by SIAP. The following map shows the location of each site and the number of fish stocked in each pond.



SITE	NAME	NO. OF FISH STOCKED	SIZE WHEN STOCKED
1	Cycloid Lake	10,000	6 cm
2	Highway Pond	3,700	10 cm
3	Lisa Lake	16,400	10 cm
4	Greywater Lake	10,000	10 cm
5	Banana Lake	9,000	10 cm
6	Little Swan Lake	5,000	10 cm
7	Big Whitefish Lake	5,000	10 cm
8	Unnamed Lake	5,000	10 cm
9	Little Loon Lake	5,000	15 cm
10	Unnamed Lake	10,000	6 cm
11	Sturgeon Lake	10,000	10 cm

Figure 1: Location of the Study Areas

IV. REARING METHOD

Rainbow trout were cultured in 4.8 m (16 ft) square cages. Nylon net 1.3 cm (1/2") mesh size was hung inside the cage. Because of the differences in depth at each site, 2.7 m (9 ft) to 4.6 m (15 ft), a deep net was used to ensure proper water circulation.

Initially the fingerlings were stocked at 10,000 per cage. As they reached 10 cm in length, the stocking density was reduced to 5,000 per cage. To allow for different harvest times, three different sizes of fingerlings were used: 6 cm (2 1/2"), 10 cm (4"), and 15 cm (6").

V, FEEDING

The cage cultured fish were fed with pelletized artificial fish feeds. They were hand fed until they reached 11 cm-13 cm (4 1/2"-5") in size. At which tired, they were trained to use demand feeders.

Daily feed requirements depended on three major factors:

1. Size of fish: as the fish grew larger, more feed was required.

2. Water Temperature: an increase in water temperature will increase the metabolic rate, thus more feed was required. A water temperature between 15°C to 22°C gave the best rate of growth.

3. Water oxygen level: feed consumption increased as oxygen levels increased.

The results of the survey indicate that the best growth rate occurred during the months of August and September. Visual observation also indicated that as oxygen levels decreased, feed consumption decreased, and eventually ceased when the oxygen level fell below 5 parts per million (ppm). A detailed daily feed consumption record was kept. Data from the observation of feeding and growth is presented in the Appendix.

VI. WATER CHEMISTRY

The following water chemistry factors were monitored In the survey:

Oxygen

Oxygen is the most important dissolved gas for fish survival. The threshold minimum for trout is 5 ppm. Below 5 ppm a massive die-off occurs. Three factors have been found to affect the oxygen level in the summer: water temperature, aquatic plant growth, and water circulation.

Because cool water can hold more oxygen than warm water, oxygen is most abundant during spring and fall. An average reading of 7 ppm was recorded in July compared with 11 ppm before freeze-up in November.

Because ice and snow cover reduce water circulation and photosynthesis, water bodies will undergo a significantly reduced oxygen level during winter. Winter-kill can occur in many water bodies. In this survey, shortly after freeze-up, oxygen values dropped to 3 ppm for Sites 1 to 6 within two weeks.

Plants such as algae give off oxygen when growing in sunlight. Superoxygenated water (15 ppm at 22°C) was recorded at Site 11 during an algae "bloom" period. However, as algae growth diminishes on hot and cloudy days, the algae can rob oxygen from the water. A stress factor such as oxygen loss can cause summer-kill.

Water circulation is vital to maintain an even distribution of oxygen in a water body. The cage netting should not be blocked by algae or other aquatic plants. The water body should be of sufficient size and depth to allow for adequate storage of oxygen, A surface area of 10 hectares (25 acres) with a depth of 4.6 m (15 ft) is a minimum requirement for intensive cage culture.

Turbidity

The Secchi disk transparency method was used to measure water turbidity" Fine particles in lake sediment can become suspended in the water and absorbed sunlight, making the water look cloudy or murky. Site 5, which is a dark, brownish-colored water body, recorded a constant transparency value of 1 m throughout the year.

Vigorous plant growth, especially of blue-green algae, can decrease the transparency as well as fine particles can. This was shown in Site 11, where transparency decreased from 4 m (12 ft) in June to 0.6 m (2 ft) during the algae "bloom" period. Eventually, as the algae growth collapsed, the water became clear again.

pH

The pH value measures the acidity or alkalinity of a substance. Because soil sediment is the ❑ain factor in determining the pH of a water body. the pH value remains relatively constant throughout the year.

Cage cultured rainbow trout can tolerate a pH range of 4.5 (fairly acid) to 9.0 (fairly alkaline) depending on factors such as temperature, dissolved oxygen, prior acclimation, and ammonia level. Release of humic acid during the decomposition of organic matter may cause the PH to go as low as 4.0 in value.

Water with a low pH ($\leq$ 4.5) has been noted to decrease growth rate of fish. However, trout can tolerate a higher amount of ammonia under mildly acid condition. A tolerance chart is presented in the Appendix.

Ammonia

Three factors contribute to the production of ammonia in a water body: soil nutrient level, decay of fish and their waste material, and the decay of aquatic plants. A portion of the ammonia forms into ions and acts as a weak base, ammonium (NH_4^+); the unionized portion, NH_3 is very toxic to the gill membrane. Formation of ionized NH_4^+ decreases as water temperature or pH increases, leaving most of it in unionized form.

Tests showed lake water at 22° C with a pH of 5.3 and total ammonia level of 0.8 ppm had no effect on fish health at Site 5. However, at Site 11, during an algae collapse period, an ammonia level of 0.8 ppm, coupled with a water pH of 8.3 and a temperature of 22°C, resulted in an 80% fish-kill within seven days.

Specific Conductivity

The concentration of ions dissolved in the water is indicated by its specific conductivity. Soil acidity strongly influences the concentration of mineral ions in the soil by controlling their volubility. Macro-nutrients, nitrogen, phosphorous, and potassium are most available at neutral or slightly alkaline conditions. At Sites 9, 10, and 11 a high pH (8.0-8.5) coupled with agricultural land runoff resulted in a conductivity in the range of 400-600 µmhos. In the northern region however, the conductivity range is usually between 40-100 µmhos.

VII. RECOMMENDATIONS

One of the basic principles of fish husbandry Is the early recognition of health problems. By frequently monitoring water chemistry, trouble can be recognized before it results in severe losses.

Water testing should begin during site selection. Early information is valuable in avoiding conditions which could have costly consequences later.

Aquaculturists should keep in mind the following:

1. Low pH water will result in a slow growth rate. However, the tolerance to ammonia decrease as pH increases. The situation is especially critical during July and August.

2. The water body should be of sufficient depth and size to allow good circulation.

3. Specific conductivity should be tested initially to determine the nutrient level. Nutrient rich water can lead to vigorous plant growth.

4. Oxygen and ammonia must be at acceptable levels before stocking.

5. During the growing season, all tests must be performed regularly. Oxygen levels should be checked both inside and outside of all nets. If differences occur, they may be due to algae blockage. Changing or cleaning the nets can remedy this problem.

6. If the oxygen level decreases steadily, the pond should be aerated or the cage moved out to a fresh location. Oxygen depletion can occur in both summer and winter.

7. A constant record of Secchi disk transparency readings will show the degree of plant growth.

8. 'Ammonia levels should be monitored frequently, especially in an alkaline water body.

9. Feed consumption and fish behavior should also be observed and monitored.

10. To avoid a localized build up of organic matter, the cage should be moved to a different location every month. Nets should be checked regularly for algae and predation. All dead or diseased fish should be removed immediately because they can foul up the water,

VIII. CONCLUSION

This report has shown that water chemistry monitoring is essential in the intensive cage culture method. Results from this survey showed low oxygen, high pH, and high ammonia levels are the three major factors for fish losses.

There were four locations that experienced summer-kill, Sites 4, 6, 9, and 11. At Sites 4 and 6, poor water quality due to shallow water and overcrowding were the main causes. As soon as the stocking density was reduced and the cages were moved out to a fresher spot, losses were reduced.

At Site 9, overcrowding was assumed to be a contributing factor, while at Site 11, high ammonia and low oxygen during an algae collapse period were the likely causes. Oxygen depletion during ice formation resulted in major losses in most of the winter-killed lakes.

Maximum growth rates occurred from mid July to September. All 15 cm (6") and 90% of 10 cm (4") fingerlings reached at least 280 g (10 oz) by October. An experiment has been started to over-winter all undersized stock In non winter-killed lakes.

APPENDIX

Page 1

1. TABLE OF FEED CONSUMPTION DATA (kg/month)
2. TABLE OF WEIGHT GAIN (g/month)
3. TABLE OF FEED EFFECTIVENESS (g/kg) / month
4. TABLE OF FEEDS USED

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1. GRAPH OF FEED CONSUMPTION DATA (kg/month) [by month]

Page 3

1. GRAPH OF FEED CONSUMPTION DATA (kg/month) [by feed]

Page 4

1. GRAPH OF WEIGHT GAIN (g/month)

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1. GRAPH OF FEED EFFECTIVENESS (g/kg) / month

Page 6

1. TABLE OF AMMONIA TOLERANCE

Page 7

1. GRAPH OF AMMONIA TOLERANCE

FEED CONSUMFTION 1986

(kg/month)

	Feed 1	Feed 2	Feed 3	Feed 4
July	59.65	49.30	38.95	70.40
August	89.30	78.40	82.00	120.70

WEIGHT GAIN 1986

(g/month)

	Feed 1	Feed 2	Feed 3	Feed 4
July	34.19	27.'21	30.56	27.03
August	73.93	67.62	56.26	55.05

FEED EFFECTIVENESS 1986

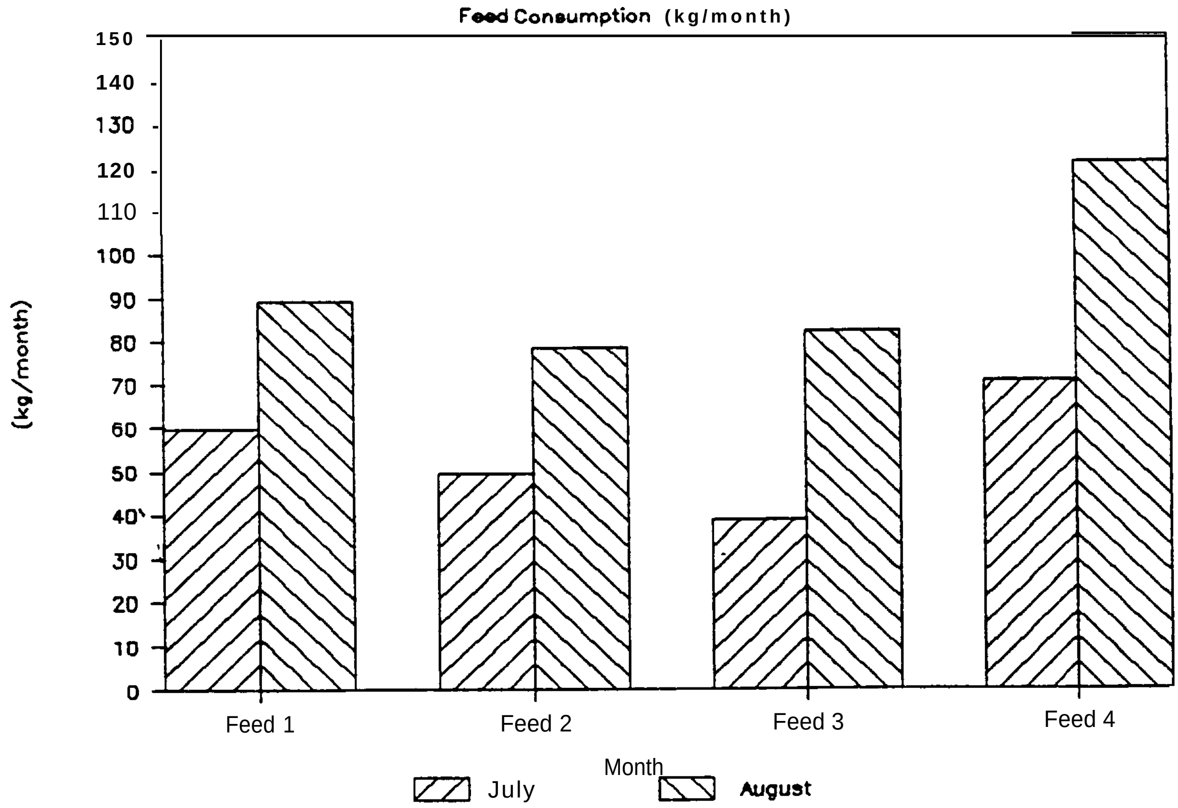
Weight Gained for Feed Consumed(g/kg)/month

	Feed 1	Feed 2	Feed 3	Feed 4
July	0.573	0.552	0.705	0.384
August	0.828	0.863	0.686	0.456

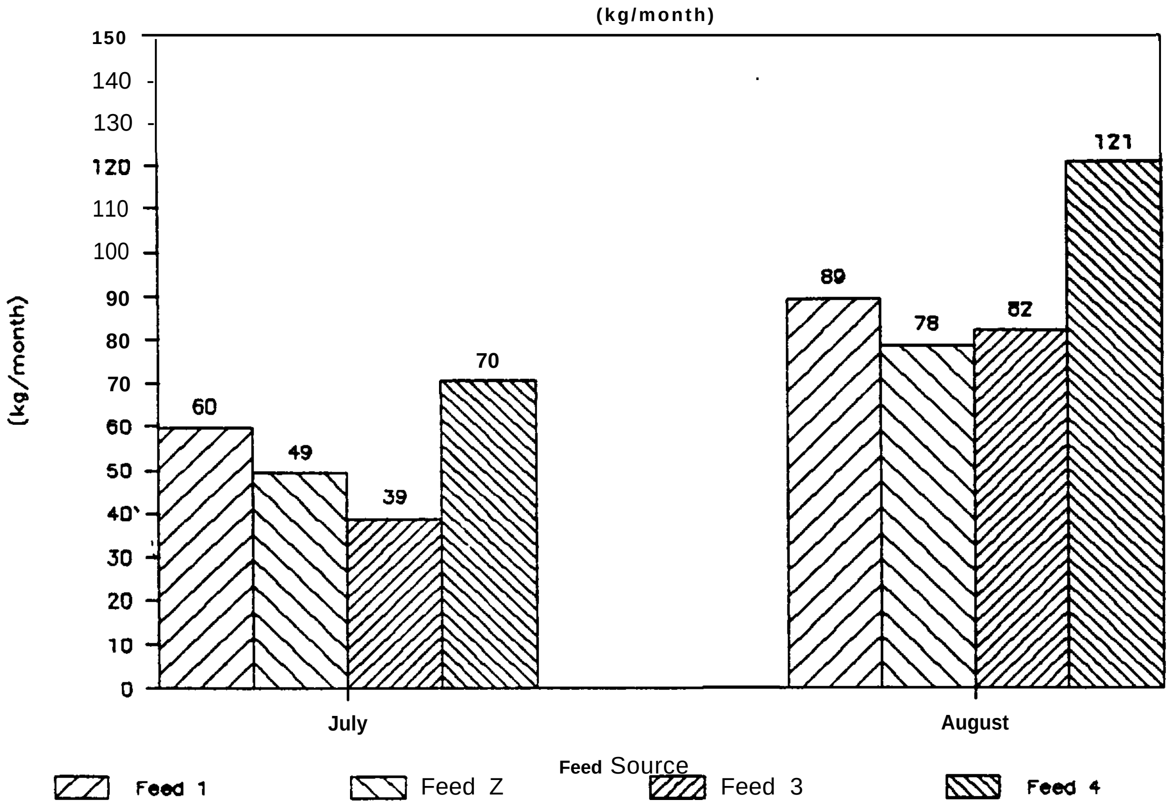
FEED CHART

Feed	Brand
Feed 1	Martin
Feed 2	Payway
Feed 3	Western
Feed 4	Hillcrest

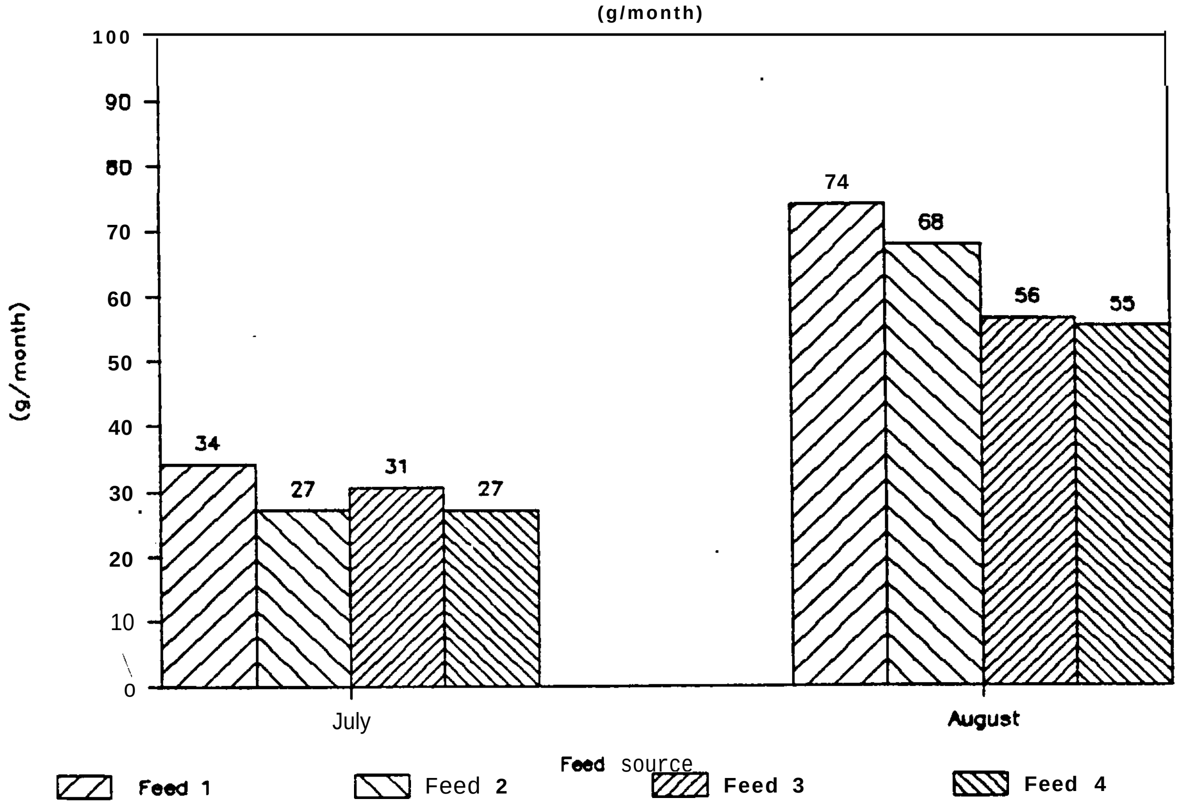
FEED CONSUMPTION 1986



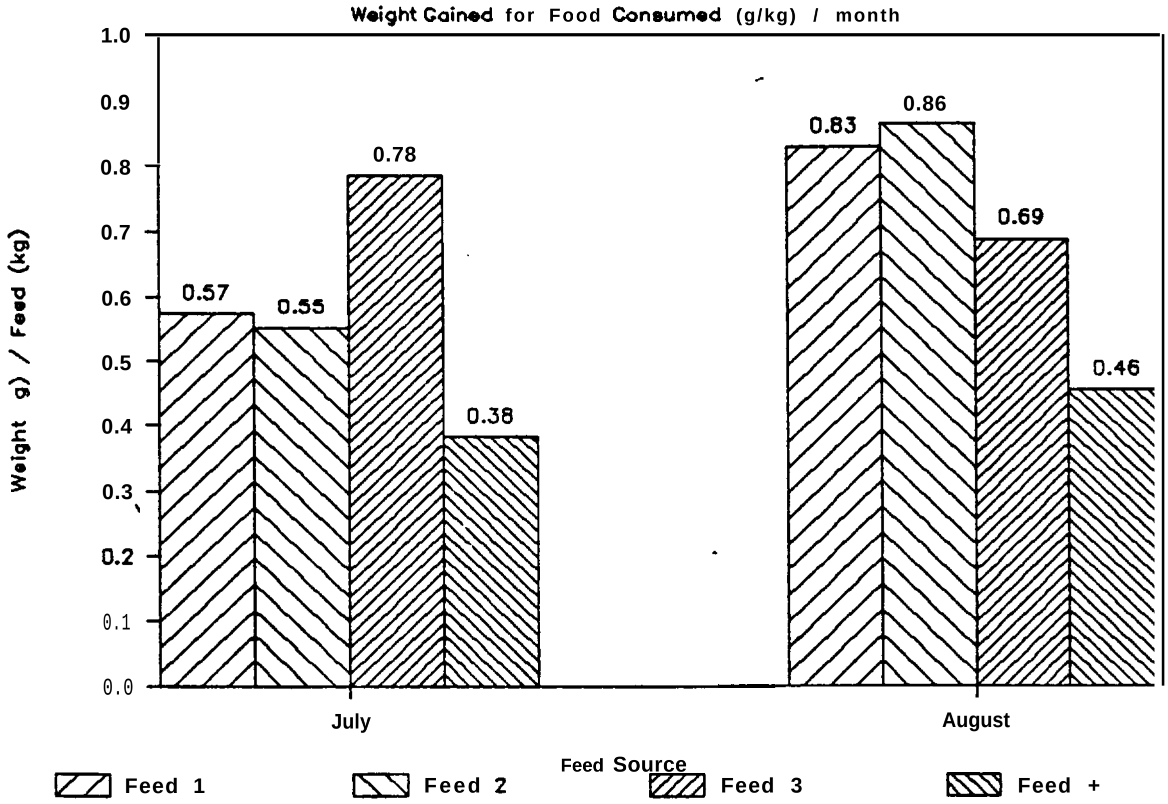
FEED CONSUMPTION 1986



WEIGHT GAIN 1986



FEED EFFECTIVENESS 1986



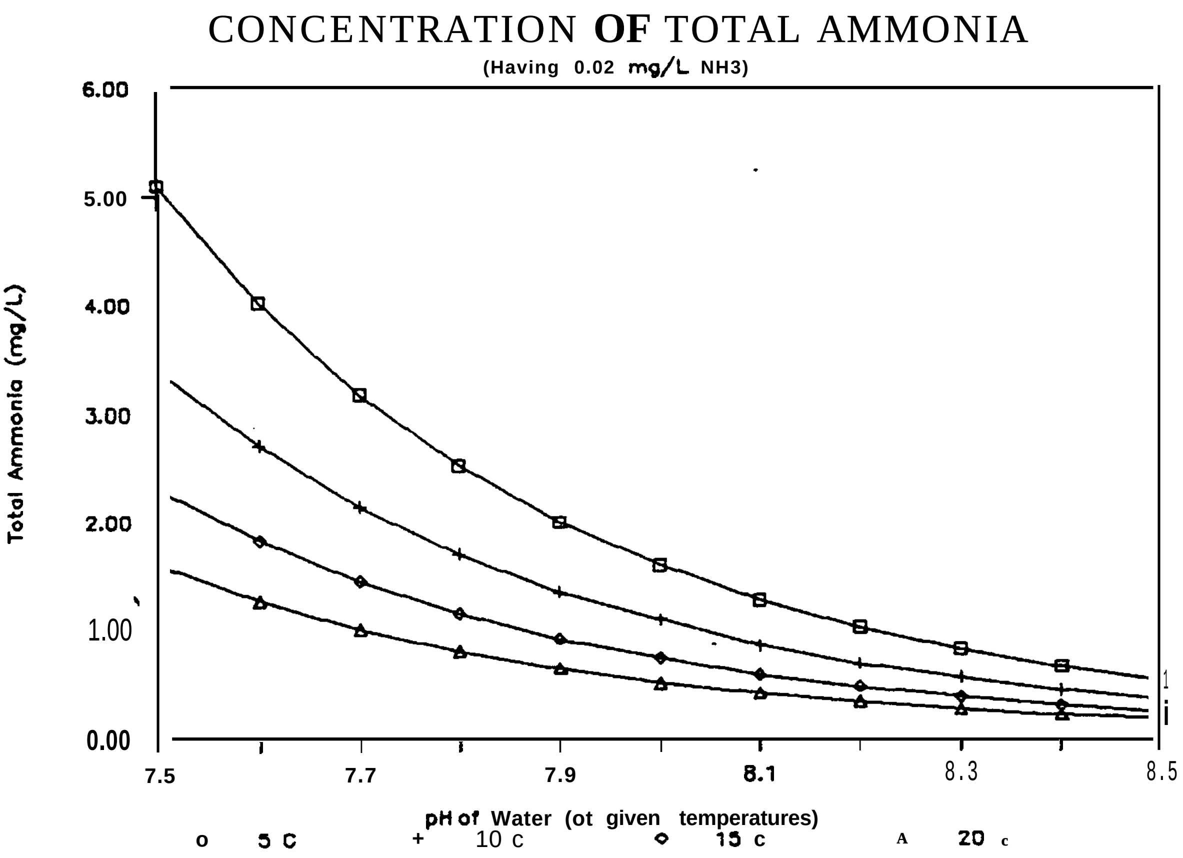
CONCENTRATION OF-TOTAL AMMONIA

HAVING 0.02 MG/L NH_3

Temp.	PH		
C	7.50	0.00	8.50
5 C	5.10	1.60	0.53
10 C	3.40	1.10	0.36
15 C	2.30	0.75	0.2s
20 C	1.60	0.52	0.18

These values ndicate total concentration of ammonia for which NH_3 concentration is 0.02 mg/L.

This level is considered the h ghest HEALTHY level for trout.


CONCENTRATION OF TOTAL AMMONIA
(Having 0.02 mg/L NH3)
Total Ammonia (mg/L)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
7.5
7.7
7.9
8.1
8.3
8.5
pH of Water (at given temperatures)
5 C
10 C
15 C
20 C