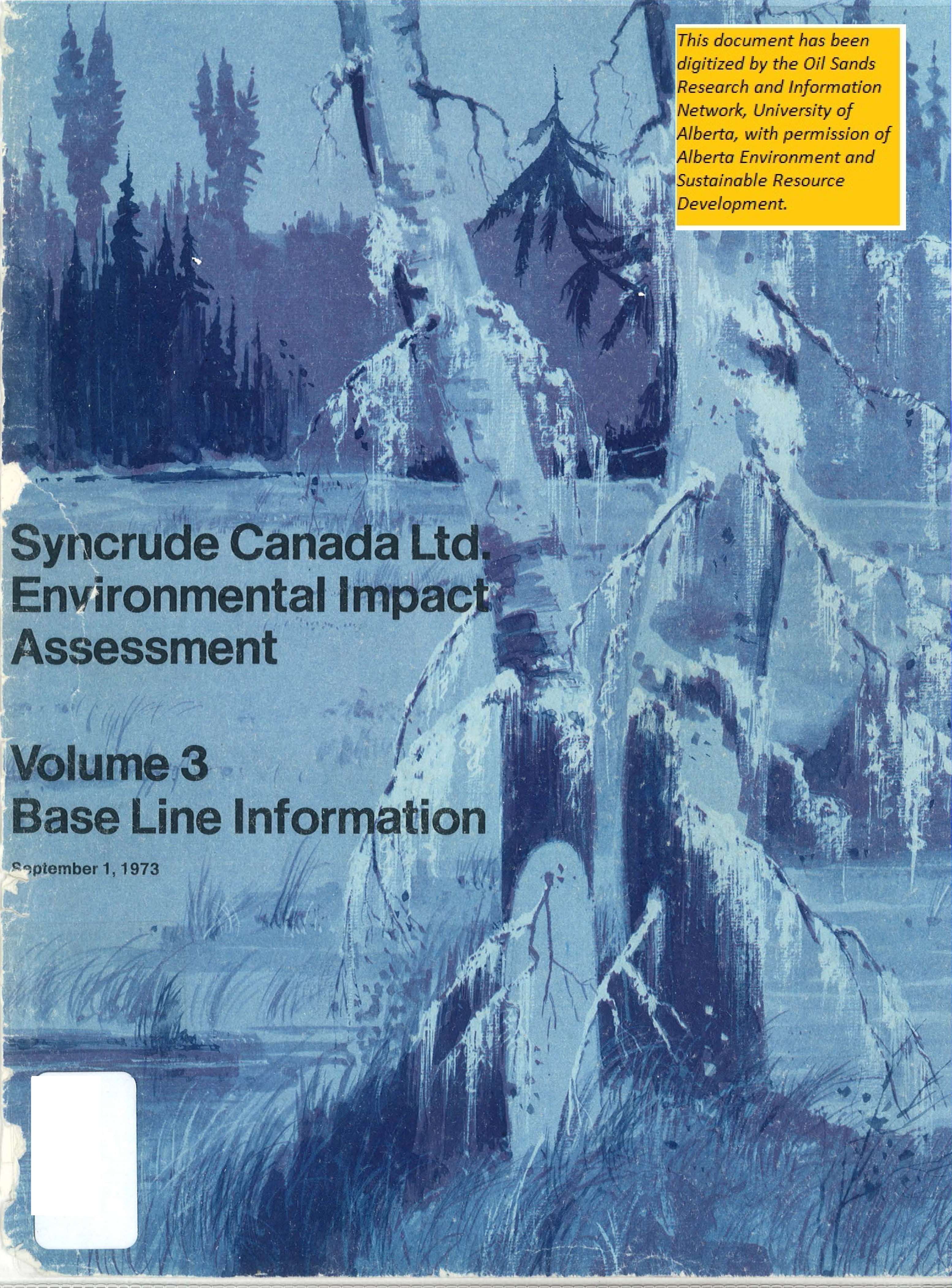

Syncrude Canada Ltd. Environmental Impact Assessment

Volume 3
Base Line Information

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PREFACE

This volume is a supplement to Sections 4, 5 and 6 of Volume I and is comprised of ecological and environmental research reports.

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March, 1973

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ABSTRACT

Syncrude Canada Ltd. Lease 17 is located in the boreal mixedwood forest ecosystem. It lies within an area of moderately-low biological productivity. Thirty per cent of the lease is in the muskeg habitat type. The winter climate is severe. Energy cycling between soils, plants and animals occurs at comparatively slow rates. There are relatively few steps between food-producing organisms and food-consuming organisms, in comparison with temperate zone ecosystems.

Twelve terrestrial and aquatic habitat types exist on the lease. These plant communities offer a variety of cover to wildlife. Terrestrial habitats of mature forest cover are restricted to eastern and southern portions of the lease. Much of the lease has been burned by forest fires prior to our development. The most important winter habitat of moose, based on productivity per unit of area, was riverine association.

Other important winter habitats for moose were boreal mixedwood (spruce-aspen) association and pure aspen consocies. Treed muskeg and older burn (aspen) were of secondary importance. The boreal mixedwood (spruce-aspen) association comprised the most extensive moose winter habitat.

Potential habitat exists on the lease area for deer and caribou, but deer may be limited by snow conditions and competition with moose for saskatoon-berry in pure aspen stands. Some habitat types were suitable for black bear, ruffed grouse, spruce grouse, ptarmigan, and other species. Rabbits utilized all habitat types, causing severe browsing in some areas. Wolves, coyotes and lynx were common to all habitat types.

Areas of key moose wintering habitat determined in this study, and moose distribution on Lease 17 as determined by the big game survey of February 1972, were closely correlated.

Locations of moose in February 1972 were checked on the aerial photos and habitat map (Figure 1). Five moose were distributed on the southwest corner of the lease near the MacKay River, and eight were distributed on the eastern quarter of the lease. Of the five moose near the MacKay River, all were located on aspen-dominated old burns (Type 9) near to willow or open muskegs. Of the eight moose on the eastern portion, three were located in pure aspen (Type 1), three in the spruce-aspen (Type 4A), one in Type 1 or treed muskeg (Type 6), and one in riverine (Type 10). This corresponded fairly well with assessments of these habitat types for wintering moose.

Only one moose was noted in the riverine habitat although this area appeared to be most heavily utilized. Moose were missed in this type in the survey either because of heavy timber cover or because they moved down along the river after February.

No moose were located in the spruce-aspen type that covers a good portion of the south part of the lease.

Aquatic habitats are limited on Syncrude Lease 17. The Beaver Creek drainage is good beaver habitat. Mildred and Horseshoe Lakes offer habitat to waterfowl, especially as feeding areas during migration; summer waterfowl nesting habitat is limited.

CHAPTER ONE

PHYSIOGRAPHY AND DRAINAGE BASINS

CLIMATE

SOILS

Introduction:

The bituminous sands mineral surface leases held by Syncrude Canada Ltd. are all located in the boreal mixedwood forest. Good land management on these leases requires an understanding of the ecosystem or ecological region in which these leases are located, and an evaluation of habitats.

The boreal mixedwood forest in Alberta occupies the northeastern portion of the province. It extends west from the Saskatchewan border to about the Peace River, and from the boreal sub-Arctic lowlands on the north to the aspen parkland ecotone on the south. It encompasses large areas of bog and muskegs, and covers about 80,000 square miles.

Physiography and Drainage Basins

This ecological region begins on the eastern Alberta plains on the south. Proceeding northward, it includes the Lesser Slave Lowlands, the Stony Mountain, and Mostoos Hills Uplands. Continuing north (in the bog-muskeg zone) it includes the Methy Portage Plain, the Algar Plain, the Loon River Lowlands and the Clearwater Lowlands (the location of Lease 17). Prominent heights of land further north include the Buffalo Hills Upland, the Birch Mountain Upland, and the Muskeg Mountain Upland. Surficial deposits on the lowlands are, primarily, outwash, lake deposits, and wind deposits of sand and gravel. Along the Athabasca River the soils change to lacustrine silts and clays, while the uplands of the Birch Mountains are, primarily, ground moraine and hummocky moraine till parent material.

The underlying Cretaceous shales had been glaciated; this has produced a rolling morainal topography. The soil mantle is rich in clay, characteristic of Gray-Wooded soils which have developed on upland terrain. These soils are favourable to the growth of the mixedwood forest community.

The main drainages within this region are the watersheds of the Athabasca, Wabasca, Birch and Peace Rivers.

Bedrock geology studies of this region indicate that most of it lies in the Upper Cretaceous zone. Bedrock is primary shales and minor sandstone of the La Biche group. The Pelican Mountains, and other outliers, are of Upper Cretaceous origin--primarily sandstones, shale and coal of the Wapiti Formation. Of special note is the bedrock geology around Fort McMurray. This is in the Lower Cretaceous zone, and contains shales and sandstones--including the oil sands of the McMurray Formation and the Joli Fou Formation. Adjacent to Ft. McMurray is also an area of Lower Cretaceous sandstones of the Pelican and Grand Rapids Formations. A portion of the river valley in the Athabasca and Clearwater River junction is of Devonian origin, including limestone, shale, dolomite and minor gypsum.

The mixedwood forest region is an area of rolling topography of uplands and heights of land with many low-lying areas. The low-lying areas generally fall into the bog-muskeg or sedge fen classification. The major riverbreak zones in this region are the Athabasca, Wabasca, Birch and

Peace Rivers. The mixedwood forest region is difficult to delineate, as the ecotone (or transition) between aspen parkland and mixedwood forest, along the southern boundary, is extremely irregular. The Birch Mountains in the northeast are known specifically to be an area where permafrost occurs in organic soils.

Climate

The climate in this region is generally dry subhumid, in the lowlands, and moist subhumid in the uplands. Precipitation is higher in the uplands, and noticeably lower in the lowlands along the Athabasca River Valley. Precipitation in the region ranges from 16 - 22 inches. Growing season precipitation (April through August) is approximately 8 - 10 inches. Mean annual snowfall is 60 - 80 inches. Snowfall exceeds 80 inches in the Buffalo Head Hills, the Birch Mountains, and the Highlands southeast of Fort McMurray. The variability of precipitation during the growing season is approximately twenty-five to thirty per cent. This is relatively stable, compared with the rest of the province. The average number of days during which precipitation occurs is approximately 130 days. This is the highest category of precipitation frequency in the province. This region is characterized by comparatively-low average potential evapotranspiration. The actual average evapotranspiration is relatively high, compared to the rest of the province. (Potential evapotranspiration is the measure of heat supply available to evaporate and transpire moisture where soil moisture supplies are not limited. Actual evapotranspiration is a measurement of average soil moisture storage--with capacities of four inches at present. It is a measure of the actual growth potential.) Areas of low values are either cool or dry. The average deficiency, based on areas with limited soil moisture recharge characteristics of the uplands and higher elevations of the region, is 2 - 4 inches (12-inch storage); average moisture deficiency does not exceed 4 inches (4-inch storage).

A climatic summary of the region:

1. Average annual precipitation--14 - 20 inches, increasing with elevation;

2. Growing season precipitation (April through August);

3. Average 9 inches of rain;

4. Average annual snowfall: 60 - 80 inches locally, higher on the uplands;

5. Hours of sunshine for the region--1900, increasing westerly;

6. Percentage of sky covered in March--approximately seventy-five per cent during the daylight hours;

7. Percentage of sky covered in August--sixty to sixty-five per cent;

8. Last spring frost--average between June 1 and 15;

9. Frost-free period: approximately 90 days. Some variability occurs in this date on the uplands in the north of the region. Here, frost may occur in any month of the year;

10. Less than ten winter days when the maximum winter temperature exceeds 40^{o}F;

11. Less than twenty days in the summer where maximum temperature exceeds 80^{o}F;

12. Westerly winds prevail throughout the region. A lack of reporting stations in this region makes it difficult to give more specific data on wind direction and velocity. It can be generally stated

that summer winds are southwesterly 4 - 12 miles per hour, while in the fall and winter the direction switches to northwest--increasing at times to an average of 12 - 20 miles per hour. Wind measurements from Fort Smith at the northeast corner of the province indicate almost uniform variability in direction, and velocities of 4 - 12 miles per hour at most seasons of the year;

13. Temperature inversions can be expected in the major river valleys in the absence of air movement (winds), especially during the mid-winter months.

Soils

This region is situated primarily in the Grey Wooded soil zone of Alberta. However, the region contains large acreages of organic Brown Wooded and acid Brown Wooded, Dark Grey and Dark Grey Wooded soils, and gleisolic soils.

The Dark Grey and Dark Grey Wooded soils are generally located along the ecotone with the parkland region adjacent to the North Saskatchewan River. Solonetzic soils generally do not occur in this region, except in isolated localities.

Organic soils are those which have over 12 inches of peat at the surface. Although some organic soils have more than 10 feet of peat, the average is about three to four feet. Peat is mainly derived from sphagnum moss, although some is derived from sedge vegetation. Peat is acid to moderately-acid in reaction, and has a high water-holding capacity. Very limited acreages of these soils have been cultivated within this region, as they are susceptible to frost. Organic soils on the uplands throughout the region generally have a climafrost or permafrost layer approximately 24 inches below the surface. Most of the organic soils occur in the bog-muskeg land form.

Dark Grey Wooded soils and Grey Wooded soils occur in areas of dry subhumid to subhumid climate where there is fairly continuous tree cover. Also included in this group are the Bisequa Grey Wooded soils. Grey Wooded soils usually have a thin leaf mat on the surface. Under the leaf mat is a black to dark grey surface horizon, three to ten inches thick. Below this, there is often a deep, very light grey horizon. The lime concentration is generally 40 - 60 inches below the surface. Productivity of these soils for agricultural crops is moderate, but is seriously restricted by other climatic factors within this region.

Orthic Grey Wooded soils and their variants within this region follow the characteristic growth potentials as Grey Wooded soils in other portions of the province. The exceptions to the normal pattern are the constraints caused by climate, and lack of available soil moisture during the growing season.

Because of soil characteristics alone, much of the region must be classified as the bog-muskeg land form.

Approximately thirty per cent of Lease 17 lies within the bog-muskeg zone. These areas have numerous environmental constraints. The soils in these areas are, basically: organic and gleisolic soils formed on glacial till, gravelly outwash, alluvial and lacustrine parent material. The extent of well-drained soils is somewhat limited; the lease area is generally characterized by a significant percentage of sphagnum moss bogs (muskegs).

Peat bogs have a regulating effect in maintaining water levels in streams and local water tables, and in preventing erosion of soil when large volumes of water are suddenly spilled into the stream channel.

CHAPTER TWO

THE BOREAL MIXEDWOOD FOREST

General Vegetation:

The Boreal Mixedwood Forest is a mosaic of deciduous poplar and evergreen white spruce stands, interspersed with willow, black spruce and associated muskegs. The understory vegetation in the timber stands contains a diversity of plants and animals, especially in poplar stands. White spruce replaces poplar in older forests, where seed sources are available. Frequent forest fires encourage poplar growth, as poplar reproduction sprouts from surviving root suckers, whereas spruce regenerates from seed. Large and black spruce trees are associated with the vast expanses of muskeg on the poorly-drained lowlands. Muskeg, a generic term, is composed of water-logged moss-peat (sphagnum) or fens (sedges), according to the amount of calcium in the substrate. Jackpine stands occur on well-drained sandy ridges.

La Roi (1967) has divided the boreal mixedwood into two categories: (a) the aspen-dominated mixedwood forest, and (b) the spruce-dominated mixedwood forest. By understanding the environmental controls of each of these sub-types, we can synthesize the inter-relationship between the two communities. The controls are light, soil moisture, solar energy, the timing or photoperiodicity which changes seasonally, and the chemical and physical characteristics of the soil substrate. Deciduous trees have different growth characteristics than evergreen trees. In turn, different overstory trees create conditions on the ground which favour the growth of different shrubs and herbs.

The Aspen-Dominated Mixedwood Forest:

In the trembling aspen stand the living trees are 60 years old and about 80 feet tall. They have smooth, gray-green trunks which retain no branches near the ground and are capped by shallow, convex crowns intermingling to form a stippled summer-green canopy, in which the leaves flutter on the slightest breeze. This canopy intercepts only a moderate amount of sunlight and rainfall, allowing the remainder to fall upon the stand interior. When the leaves drop in autumn, the forest becomes much more open to sun, wind, rain and snow.

Here and there amid the living trees, either fallen or still standing, are dead aspens of assorted smaller sizes in various stages of decomposition. These trees have been eliminated through the quiet but vigorous competition within the aspen population for light, water and nutrients. This struggle began with the establishment of the stand and will continue to its end. Whether this tree or that one survives depends largely on their relative growth rates and the maintenance of a sunny exposure. These two factors, in turn, are strongly influenced by reductions in the photosynthetic output of the leafy crowns, that is, in the use by leaves of sunlight combined with plant nutrients for the manufacture of food. These reductions in photosynthesis can come from insect predation or through damage by wind and ice. Another controlling factor is the relative amount of water and nutrients readily available to the root systems of the competing trees.

Moving into the warm, sun-flecked stand interior, we find that it is difficult to see the ground surface through the profusion of shrubby and herbaceous vegetation. This lush undergrowth consists of numerous shrubs reaching to the waist, even more shrubs and tall herbs reaching the calf, and under these, dense patches of dwarf shrubs and low herbs at ankle height. Pushing aside this leafy growth, we see that the forest floor is matted with moist, rapidly-decaying and nutrient-rich aspen leaves together with a sprinkling of twigs and other detritus and a host of ants, worms and other invertebrate animals. True mineral soil lies about three inches below the litter surface and is crowded with roots. Fallen logs and tree bases rise above this leafy litter, harbouring mixtures of shade-tolerant mosses.

Among the more abundant medium shrubs are the mooseberry, saskatoon, red osier dogwood, red raspberry and, in drier areas, hazel and buffalo-berry. The lower shrubs commonly include prickly rose, red and other currants, bracted honeysuckle and snowberry. With or just below these are large numbers of wild sarsaparilla, hairy lungwort, asters, wild pea, vetch, blue-joint, and in drier openings, pine grass. Of the many dwarf shrub and low herb species the following are most numerous: twin-flower, strawberry, bunchberry, bishop's cap, horsetails, dwarf raspberry and several wintergreens. There are signs of change in this aspen stand. Hidden amongst the shrubs and herbs one finds occasional seedlings and young trees of white spruce; but only rarely do we find young trembling aspen, though the canopy above sends down millions of seeds each year.

It is of historic and geographic interest that half of the plant species and all but one genus listed above occur in similar forests of the Eurasian boreal taiga.[1]

The Spruce-Dominated Mixedwood Forest:

Dr. La Roi continues:

The living trees in the white spruce stand are mostly about 70 years old and 80 feet tall, but the range in age and size is somewhat greater than in the aspen forest. The spruce trunks have thin, ashy-brown scaly bark, retain small dead branches near the ground, and are topped by deep, pyramidal evergreen crowns. These crowns do not intermingle to the same extent as those of aspen, but they are far denser and therefore much more effective absorbers of light. Their needles also catch and return to the atmosphere much of the water in light summer showers, thus strongly reducing precipitation as well as light intensity in the forest interior throughout the year. Evidence of competitive thinning in the maturing spruce forest is similar to that for aspen, except that overtopped and suppressed trees seem to "hang on" longer before capitulating.

As we move into the summer spruce forest, we quickly notice the remarkable change in climate from that outside. The interior is far cooler and the light more subdued than in the aspen forest. The air is humid and still, thick with the scent of sun-warmed spruce needles from above and the distinctive essence of mosses from beneath our feet. Instead of wading through a mass of woody and herbaceous plants, we walk upon soft carpets of "feather" mosses, interrupted only occasionally by localized patches of dwarf shrubs and low herbs, by accumulations of spruce needles around the bases of trees, or by piles of spruce cone scales harvested by red squirrels. Medium and low shrubs are far less numerous here than in the aspen stand; those few present are straggly and bear little or no fruit.

Three feather mosses dominate the forest floor: *Hylocomium splendens, Pleurozium schreberi* and *Ptilium crista-castrensis*. These same three species produce similar carpets throughout the taiga of both North America and Eurasia. The living green part of the moss carpet in our spruce stand is about three inches thick, and is permeated with spruce needles. Below this level the moss parts are clearly discernible though colourless for an inch or so, but then begin to disintegrate along with the spruce needles into a moist, cottony fermentation layer of white or yellow fungal threads. The next two inches consist of a blackish-brown, acidic peat-like material, with a network of roots lying on the gray surface of the mineral soil.

Among the more persistent and successful shrubs rooted in or through the moss carpet are green alder, mooseberry and prickly rose. The most extensive colonies of dwarf shrubs and low herbs are dominated by bunchberry, twin-flower, horsetails, wintergreens, wild lily-of-the-valley, cowberry and northern comandra.

A careful search of the forest floor eventually finds a few very slow-growing white spruce "seedlings", some rooted in the cracks of rotting logs, others growing in places where the mineral soil has been exposed by disturbance of the moss carpet.[2]

* * *

. . . (Environmental conditions in the mixedwood forest) should make it clear that trembling aspen and white spruce trees are as different in their influence on their surroundings as they are in appearance. . . .

The contrasting effects of deciduous broad leaves and evergreen needle leaves are of crucial significance. The amount of solar energy reaching the aspen stand interior is greater at all seasons, and much greater after leaf fall than that percolating through the relatively unchanging spruce canopy. As a result, photosynthetic production and consumer food supply can be far higher among the shrubs and herbs under the aspen trees than is possible for the feather mosses under the spruce canopy. In the spring, direct heating of the aspen forest floor by by the sun quickly melts the snow-pack and warms the soil. In the white spruce stand, the melting and warming process takes longer, since it is caused only by the diffuse light from the sky and the indirect conduction of heat by air and rain. Hence many shrubs and herbs are leafing out and flowering before the aspen canopy forms and before the last trace of snow finally disappears from the shaded moss carpet of the spruce forest.

. . .

Old spruce needles are tough in texture and strongly acid in composition. Very few species of vertebrate or invertebrate animals will eat them. Combined with dead moss parts at the bottom of the cool moss carpet, they do form a suitable energy source for those fungi, termed saprotrophic, which feed on dead organic materials. Even the fungi, however, cannot completely utilize the needle-moss mixture, and the partially decomposed peat-like remains gradually pile up as the spruce forest grows older. As water percolates down through the moss carpet and peaty layer, it picks up free organic acids and carries them into the mineral soil. Here the acids tend to displace and leach away essential nutrient compounds. Meanwhile other nutrients are imprisoned in the substance of the peaty material and are for the most part unavailable for use by green plants. The product of interaction between spruce needles, mosses, fungi, low temperature and water percolation is an acid-rich and nutrient-poor rooting medium, which approaches or exceeds the limits of tolerance of many plant and animal species that thrive in the aspen forest.

In contrast, dead aspen leaves are quite palatable and are therefore readily eaten by many invertebrate animals. By the middle of summer, most of the previous year's leaf fall has been consumed by thousands of detritus-feeders, and the egested wastes passed on to a host of secondary consumers, from earthworms to bacteria. In this way the energy bound up in the litter of the aspen stand is largely captured by consumer and decomposer organisms, and then released as respiratory heat. As a result, the mass of organic matter in the litter declines rapidly as free carbon dioxide is respired to the air. The remaining humus materials are thoroughly mixed with the mineral soil by burrowing animals. The thorough decomposition of the aspen leaves permits a fast and efficient release of nutrient compounds which are quickly absorbed and re-cycled into use by the roots of all green plants in the stand. Thus the interaction between aspen leaves, detritus feeders, decomposer organisms and warm, moist conditions ensures the production and maintenance of a non-acidic and fertile rooting medium for many boreal plants and the organisms which live among, or feed upon them.

. . .

Thus in our "typical" mixedwood upland stand we find small clumps of pure aspen and spruce scattered in a larger area of varying combinations of the two. The subordinate vegetation layers in the centre of the pure clumps closely resemble those of the two stands already described. Layers under mixed canopies are in many respects predictably intermediate or transitional in appearance, but in other ways quite different. For example, certain plant and animal species with only feeble representation in both spruce and aspen stands--such as the ruffed grouse--are much more common in areas where the two trees are intermingled. Other species are present here but missing entirely from spruce and aspen. These facts seem curious.

Part of the explanation appears to lie in what has aptly been called "hybridization of the habitat". There are two aspects to such hybridization--quantitative and qualitative. The former is easily understood, for it simply refers to the production of environmental conditions, light, for example, of which the intensities are between those of either pure aspen or pure spruce. Species better adapted to such intermediate habitats will prosper in them, often at the expense of competing species.

The qualitative aspect refers to the synthesis of different kinds of habitat conditions or components from precursors in the pure spruce and pure aspen stands. A simplified example will illustrate this. Some of the organic products of decomposition in a mixture of decaying aspen leaves and spruce needles do not occur in either unmixed rotting aspen leaves or unmixed old spruce needles. These "new" organic compounds form necessary links in a food chain of decomposer micro-organisms which now proceed to convert the litter into a distinctive kind of humus found only under mixedwood canopies. This "new" humus, in turn, is a favorable rooting medium for several flowering plants which do not occur in either the aspen or the spruce stands. The humus also tilts the competitive balance in favor of certain species which were of only minor importance in the pure stands.[3]

Forest succession follows a sequence. Dr. La Roi states:

> If there are no fires and seed is available from surrounding vegetation, we shall first of all find a slowly-increasing number of shade-tolerant young white spruce trees becoming established in the lower layers of the aspen stand. Because of intense competition for light, water and nutrients with the surrounding herbs, shrubs and trees, the growth rate of the invading spruce population is at first very slow, and many seedlings perish during dry spells or are smothered under a blanket of aspen leaves. As time goes by, however, the young spruce trees begin to overtop and suppress their competition, and begin to alter their surroundings in the manner described earlier.
>
> Meanwhile, the rate of increase in size of the short-lived aspen trees slackens perceptibly. Injuries arising from grazing animals, various insects and the weather continue to provide access to wood-rotting fungi, which subsequently prepare the trees for wind breakage. In this way, the number of healthy aspen declines, and gaps appear in the tree canopy. . . .
>
> The replacement of one distinctive phase of the mixedwood community by another is a long process. The lingering old aspen trees continue to exert great influence on the physical, chemical and biological properties of the developing spruce stand. Even after the last veteran aspen has fallen, many years pass before the soil, flora and fauna of the aspen forest are completely succeeded by those of spruce. It seems, indeed, that the best growth of the spruce forest is made before the relatively high potential production of the aspen habitat has been depleted.[4]

The preceding discussion of ecological succession makes the assumption that the forest has been protected from fire. However, the effect of fire must be taken into consideration as it affects the retardation of ecological succession.

C H A P T E R T H R E E

WILDLIFE

Animals:

The animal component of the mixedwood forest is highly diverse. "In spring and summer thousands of birds wing their way to (the depths of the mixedwood forest) to breed and nest . . . . Waterfowl of many species nest along or near the shores of the multitudinous ponds, sloughs and lakes or in marshy areas . . . . Some birds, like the chickadee, are year-round residents."[5] Most representative of bird life in the boreal mixedwood forest are the ruffed and spruce grouse, the Richardson's owl and the goshawk.

The dominant ungulate is the moose, with mule deer, white-tailed deer and elk indigenous to certain portions of the region. Woodland caribou are found in the northern portions, and aggregate in small pockets. The mixedwood forest is a favorite habitat of the American black bear. Major carnivores are the wolf, coyote, lynx and wolverine. Lesser carnivores are the fisher, weasel, and otter. Lagomorghs are represented by the MacKenzie's varying hare; the rodents, by the Northern red-backed vole. Many of these smaller animals act as "buffer species" between the larger ungulates and major carnivores.

Snow depths are a limiting factor in the distribution of smaller ungulates (deer). A depth of twenty-four inches or more significantly impedes travel by deer, although of less importance to elk and moose. The characteristics of the snow crusting and layering are even more important year by year than snow depth alone. A massive die-off of elk and moose seems to have occurred in two late-nineteenth century winters, due to the effect of severe cold and fluctuating temperatures. This caused crusted snow, which resulted in mechanical injury to lower limbs, and a viral or bacterial epizootic which caused infections and death. This has altered ungulate numbers and distribution, in this region, to the present time.

Settlement patterns around the fringes of this region have in some ways caused a change in animal distribution. Mule deer do not adapt well to areas of intensified cultivation, while white-tailed deer adapt well, as long as sufficient heavy-cover patches remain. Moose in North America do not adapt well in settlement areas, unlike the Scandinavian moose. As settlement encroaches, moose simply move to more solitary habitats in the adjacent heavy cover of river valleys in the mixedwood forest. Ecological relationships of animal population in winter are well described by Dr. William A. Fuller.[6]

Wildlife Common to Most Habitat Types on Lease 17:

Wildlife species which ranged over most of the habitat types included the major predators.

Timber wolves (*Canis lupus*) appeared to be common over the lease area and tracks were observed near Horseshoe Lake and west of the test pit area. A trapper in that area reported that three or four wolves frequented the area over the winter months, while larger packs were noted to pass through.

Coyotes (*Canis latrans*) appeared common over the lease area, and at least six were observed during the course of the study.

Canada lynx (*Lynx canadensis*) appeared common. Four were observed during the course of the study. A local trapper caught fifty-two lynx on the lease area last winter, and it would appear that they have reached peak populations--following an apparent recent peak of rabbits.

Rabbits were the most abundant of all mammals, and utilized almost all habitat types available. Regular rabbit runs criss-crossing muskegs were noticeable from aircraft. Judging by the abundance of remains seen in the woods and by the heavily-browsed condition of shrubs in recent years, it would appear that a rabbit population "crash" occurred last winter (1970 - 1971) and/or the winter before, although rabbits were commonly seen during the field work. Lynx populations usually "crash" about one year after rabbits do.

Trend Index Data--Pellet Plots:

Pellet plots were set up on eastern portions of the lease to compare present utilization of two habitat types on the lease, and to measure trends of moose populations over the years.

The plots are as outlined on Table I. As mentioned previously, pellet plots gave a good comparison of use of two of the key browse wintering habitats: pure aspen and riverine habitat. Comparison corresponded closely to browse measurements. More plots should be set up when time permits as some of the present plots will be eradicated by development.

TABLE I

Plot	Location	Type	Number of Pellet Groups
1	N.E. corner--Mildred Lake	Pure Aspen	4
2	Same	Same	2
3	Same	Same	1
4	Same	Same	3
5	Same	Same	0
6	Flats east of Horseshoe L.	Riverine	7
7	Same	Same	1
8	Same	Same	4
9	Same	Same	2
10	Same	Same	2
11	Syncrude Air Strip	Pure Aspen	1
12	Same	Same	0
13	West side of Beaver Creek	Same	1
14	Same	Same	2
15	Same	Same	4
		TOTAL	34

Average per 1/50 plot = 2.3

TABLE II

Birds observed on the lease area during Spring 1972 (except waterfowl) included:

Snow buntings *(Plectrophenax nivalis)* - Large flocks of migrants

Horned larks *(Eremophila alpestris)* - Large flocks of migrants

Marsh hawk *(Circus cyaneus)* - Resident on lease

Osprey *(Pandion naligetus)* - One at Horseshoe Lake in early May

Robin *(Turdus migratorius)* - Common

Thrush, Gray-cheeked *(Hylocichla minima)*

Thrush, Swainson's *(Hylocichla ustulata)*

Thrush, Hermit *(Hylocichla guttata)*

Red-winged blackbird *(Agelaius phoeniceus)* - Nests around lakes and marshes on lease

Sparrow, white-throated *(Zonotrichia albicollis)*

Common nighthawk *(Chordeiles minor)* - Appear to nest in treed muskeg

Eastern kingbirds *(Tyrannus tyrannus)* - Late arrivals

Ruffed grouse *(Bonasa umbellus)*

Spruce grouse *(Canachites canadensis)*

Great-horned owl *(Bubo virginianus)* - Resident in aspen grove at N.W. corner of Mildred Lake

Downy woodpecker *(Dendrocopos pubescens)*

Solitary sandpipers *(Tringa solitaria)* - Resident along the Beaver River

Black-bellied plovers *(Squatarola squatarola)* - migrants

Lesser-yellowlegs *(Totanus flavipes)* - Common residents

C H A P T E R   F O U R

THE ROLE OF FIRE

Dr. George H. La Roi describes the role of forest fires as an ecological factor in the boreal mixedwood forest:

> . . . the records for 1957 show that more than 20 per cent of the entire boreal forest area, including lowlands, was burned over at least once in the short interval of 15 years. Since white settlement, the frequency of forest fires has risen. Yet there is convincing evidence from burn scars on old trees and charcoal in the soil that lightning, Indians and other agents caused vast conflagrations long before the arrival of the first white explorers, fur trappers and traders.
>
> Fires are usually more frequent and more intense and travel farther in coniferous than broadleaf forests. Crown fires in the highly inflammable spruce forest are extremely hot, and the convection winds which they generate in the lower atmosphere often drive them forward at great speed. Surface fires may or may not accompany or be accompanied by crown fires. When following a period of drought, surface fires frequently consume all litter, the moss carpet and the peat layer down to the mineral soil. Sometimes, however, such fires will dip under wet moss carpets and travel in the dry peat layer, killing rooted plants but sparing the mosses. Hot fires are especially common around the dry, needle and cone-strewn bases of spruce trees.
>
> Few plants or slow-moving animals survive the holocaust which leads to a thoroughly burned spruce forest. But if the exposed mineral soil is a good one, then much of the nutrient materials released from bondage by fire in the form of ash will wash into the soil to produce a very favorable seed-bed. The area will then be rapidly invaded by a succession of fast-growing plant and animal populations. The result will be a mixed "fire-forest" dominated by seed trees of spruce, pine and birch, with occasional aspen and balsam poplar.
>
> Even if all of the organic matter in the original spruce forest was not removed by fire, the increased

illumination and amount of nutrients would encourage the growth of a multitude of plants and animals not found in the original spruce forest. Thus even a moderate fire produces a better rejuvenation than that following temporary breakup of an old spruce canopy with no fire. Barring further disturbance, however, the shade-intolerant pines and birches of the fire forest are slowly replaced by white spruce as the community reverts to the feather moss phase.

The volume of inflammable material is much less in the aspen forest, because decomposition rates usually keep up with accumulation rates, thus preventing the formation of thick litter and duff layers. Crown fires, too, are almost unheard of, for the leaves and branches of aspen are much less readily burned than are those of spruce. As a result, fires do not last long or travel fast in the aspen habitat, even after prolonged drought. Furthermore, after racing through a spruce forest, fires are frequently deflected or halted along the aspen forest margin.

. . .

Significantly enough, white spruce is *not* among those species which are able to regenerate vegetatively from surviving root systems. Thus at any time in the slow process of succession from aspen to spruce, the incidence of fire is disastrous for the spruce and a boon to the aspen.

In the mixedwood mosaic forest, fire may be intense in the pockets of pure spruce but light elsewhere. If so, then the aspen may expand at the expense of spruce, or the spruce may successfully re-establish itself in its old haunts by seed from unburned crowns or from nearby individual spruce trees which escaped the fire because of protection by aspen. We may therefore be pardoned for speculating that the mixedwood forest, the most common upland forest in Alberta's boreal taiga, is an evolutionary adaptation to fire, at the community level of biological organization.[7]

CHAPTER FIVE

HABITATS

Habitat Evaluation:

At least twelve different habitat types are found on Syncrude Lease 17, thus offering a rich variety of plant communities to wildlife (Figure 1).

Moose browse studies were made of these habitat types, with the exception of pure pine (Type 2), pure spruce (Type 3), and marsh (Type 11), which have obviously limited browse production.

Because of lack of time, the line transect study of herbs, forbs and grasses was not done. However, this only slightly limits this habitat analysis because these plants are not of importance in the diet of the important animals at the critical time of the year.

The lease area is discussed here in terms of these habitat types, with special emphasis on presently-utilized or potential habitat for wild ungulates--especially moose (*Alces alces*), but including mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervus canadensis*), woodland caribou (*Rangifer caribou*), and barren ground caribou (*Rangifer tarandus*).

No signs of mule deer were noted on the lease during this field work, although Soper (1964) states their range extends sporadically northward as far as Great Slave Lake. This has apparently occurred within the last 60 years. Men who have worked on the Syncrude lease over recent years described the occasional sightings of mule deer, especially in the autumn.

No caribou are presently found on the lease area. However, woodland caribou once ranged the forest in which the Syncrude lease occurs (Soper, 1964) but presently are restricted to pockets to the east and south of Fort McMurray and northwest of Lake Athabasca. Also, barren-ground caribou once extended their winter migrations as far south as Fort McMurray (Soper, 1964).

Elk also once ranged the area, and probably utilized the aspen groves and semi-open grasslands along the slopes of the Athabasca River.

Soper shows the range of white-tailed deer as extending up the Athabasca River as far north as Fort McMurray. However, they appear totally absent from the Syncrude lease.

In general, limitations of range for deer and elk in this area are probably snow depths and crust conditions, rather than lack of winter forage.

Habitat Study

A terrestrial wildlife habitat study was undertaken in the spring of 1972 as a follow-up to a moose survey of February, 1972, and an ecological impact evaluation of July, 1971 made. The objectives were:

1. To delineate habitat types on Syncrude Lease 17;

2. To assess their importance to wildlife including big game ungulates in the lease area;

3. To identify the critical habitat required by wildlife on the lease area.

Field work was conducted intermittently from April 27 - June 3, 1972. General observations were gathered for all wildlife species. An analysis of different habitat for browse plants was conducted using the Point-Center Quarter Method (Curtis and Cottam, 1959). Transects were run on a compass bearing at randomly-selected locations in representative areas of each habitat type. Four samples were taken at each point on each line every two chains distance. There were a total of 40 point plots or 160 plants per type, except for willow muskeg. The degree of browsing on each shrub species was recorded, using an index system. Only shrub species which ranged from approximate snow accumulation level to the browsing height of a tall moose were included.

The following table (Table 3) indicates the twelve browse species measured, where present.

The relative density, relative dominance, relative frequency and importance value of each species in each habitat type were determined. Relative density is the number of individuals of one species as a percentage of the total number of individuals of all species.

Relative dominance is the total basal area of one species as a percentage of the total basal area of all species.

Relative frequency is the number of points of occurrences of one species as a percentage of the total number of points of occurrences of all species.

Importance value is the relative importance of each species in a community to each other and to the community as a whole, based on the relative density, relative dominance, and relative frequency. Each factor is of equal weight.

A habitat type map (Figure 1) based on vegetation cover of the Lease 17 area was prepared from aerial photos of September, 1967 (Scale: 1:31,680). Stereoscopic identification of habitat types was made from air photos and the area transposed to a base map with a scale of 1:50,000. Spot checks were made in the field to ascertain any significant changes which might have occurred since the original flight was made.

TABLE III

Common Name	Abbreviation*	Latin Name
Saskatoon berry	Amal	*Amelanchier alnifolia*
Willow	SAL	*Salix* spp.
Green alder	Alcr	*Alnus crispa*
Balsam poplar	Poba	*Populus balsamifera*
Aspen (poplar)	Potr	*Populus tremuloides*
Red osier dogwood	Cost	*Cornus stolonifera*
Paper (white) birch	BET	*Betula papyrifera*
Bog birch	BET	*Betula glandulosa*
Mooseberry (cranberry)	Vied	*Viburnum edule*
Honeysuckle	LON	*Lonicera* spp.
Chokecherry	Prvi	*Prunus virginiana*
Balsam fir	Abba	*Abies balsamea*

*Species names are coded using the first two letters of the Latin genus name plus the first two letters of the Latin species name, i.e., alder *(Alnus crispa)* = Alcr. When genus alone is used the first three letters of the Latin genus name appear in capitals, i.e. willow *(Salix* spp.) = SAL.

Twelve habitat types were delineated as follows:

Type 1	Pure aspen consocies
Type 2	Jackpine/lodgepole pine association
Type 3	Pure white spruce consociation
Type 4A	Boreal mixedwood: white spruce-aspen faciation
Type 4B	Boreal mixedwood: pine-aspen faciation
Type 5	Fen muskeg: sedge-willow-birch faciation
Type 6	Treed muskeg (black spruce) faciation
Type 7	Willow-muskeg consocies
Type 8	Recent burn (potentially productive)
Type 9	Old burn--aspen-dominated facies
Type 10	Riverine association
Type 11	Open marsh*

*Habitat types are discussed here as facies or faciations and associes or associations. A faciation is a climax community of one dominant species such as pure spruce; and a facies is a successional stage of a faciation, such as young spruce and mature aspen. An association is a climax plant community of more than one faciation, such as boreal mixedwood; and an associes is a successional stage of more than one facies. A consociation has a single climax dominant species; and a consocies is a successional stage of a consociation.

Key moose wintering range (Types 1, 4A and 10) was designated as well as key waterfowl areas.

Fifteen pellet group plots were set up in areas of intensive use to begin measurements of the trend of moose populations. Rectangular 1/50 acre plots (12' X 72.6') were used and permanently marked. These proved to be better adapted for the vegetation types than 1/100 acre circular plots. The number of pellet groups that have occurred in each plot since last autumn were counted. Pellet groups that were on the borderlines were included.

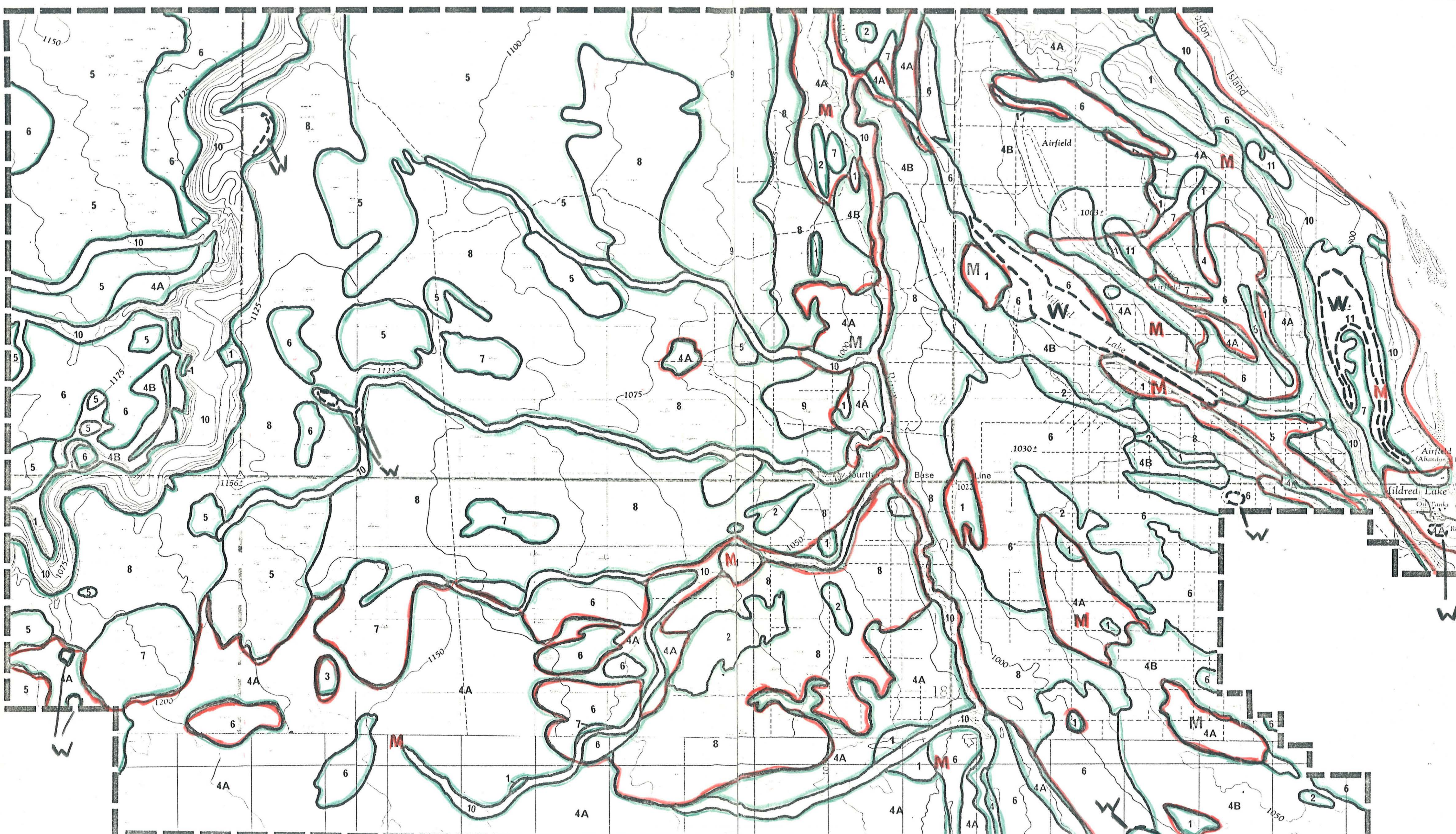

FIGURE 1–Map of Habitat Types (green), Key Moose Winter Range·M·(red), & Key Waterfowl Areas·W·(black) on Lease 17.

Type 1: Pure Aspen Consocies

Stands of larger pure aspen are found scattered on eastern portions of the lease but do not constitute a large area. The oldest stand is found on the northwest corner of Mildred Lake. Stands of small aspen are included under Type 9.

Shrub cover varies from site to site in the pure aspen stands. Species are listed in Table 1. Saskatoon-berry was most abundant on ridges and slopes such as those along-side Mildred Lake, whereas mooseberry and willow were most abundant on damper sites. Other plants noted in these pure aspen stands were buffalo-berry (*Shepherdia canadensis*), cinquefoil (*Potentilla sp.*), choke-cherry, rose (*Rosa spp.*) and red or other currants (*Ribes spp.*) as well as a variety of grasses and forbs.

The browse survey showed that pure aspen stands are important moose wintering areas on the lease--ranking less in importance only to the spruce-aspen association of the mixedwood forest (Type 4A) and the riverine strip (Type 10), in terms of utilization by moose. Pellet plots also gave a similar index of importance. The pellet plots in pure aspen stands showed an average of 1.8 moose pellet groups per plot compared to 3.2 pellet groups per plot for the riverine habitat along the Athabasca River.

Especially important are the stands containing a good understory of saskatoon-berry, which is one of the most preferred browse species in the area. Twenty-six per cent of all the plants measured in pure aspen stands were browsed by moose, and most of these were saskatoon-berry. Thus, while willow and small aspen had a greater importance value than saskatoon-berry, they received far less utilization. Alder, while highest in importance value, was not utilized by moose. It was, however, heavily utilized by the varying hare (*Lepus americanus*).

Pure aspen stands with "broken" edges are generally good habitat for ruffed grouse (*Bonasa umbellus*), but only one bird was observed in this habitat during the course of the field work. Grouse appear to be at a low level of population. Varying hare, which utilized aspen stands in winter, also heavily browsed buffalo-berry, small aspen, and rose--although alder appeared to be their major winter feed.

The pure aspen stands in Lease 17 appear to have a poor potential carrying capacity for deer and elk because of heavy utilization by moose.

Type 2: Lodgepole Pine-Jackpine Association

This type is limited to dry sandy sites to the north and east of Mildred Lake and on southeastern portions of the lease (Figure 1). It is dominated by a varying mixture of lodgepole pine (*Pinus banksiana*) and jackpine (*Pinus contorta*).

Pine forests have very little browse productivity and therefore have little or no value to moose.

Ground cover appeared to follow the two types designated by Moss (1955) where a pine-feather moss (*Hylocomium splendens* and *Calliergonella schreberi*) faciation exists on damper sites, and a pine-heath faciation on drier sites.[8]

Pine forests have limited value to other wildlife, except that lichens and moss, that offer potential feed for caribou. Black bear (*Ursus americanus*) were noted to feed in the early spring on kinnikinnick (*Arctostaphylos uva-ursi*) in a stand of pine on the east side of the Beaver Creek. Only two spruce grouse (*Canachites canadensis*) were noted in this habitat type.

Type 3: Pure White Spruce Consociation

Pure stands of white spruce (*Picea glauca*) are present only on the bottomlands along the Athabasca River along the east side of, and to the north of, Horseshoe Lake. Since these stands have been altered by logging operations in recent years and are limited in size, they are included with the riverine habitat (Type 10). The largest noticeable effect of logging of these stands has been to allow a new growth of shrubs, dominated by red osier dogwood that is heavily utilized by wintering moose.

Type 4: Boreal Mixedwood Association

The boreal mixedwood association on the lease is divided into two faciations: spruce-aspen (Type 4A) and pine-aspen (Type 4B), which cover an area far more extensive than the pure aspen and riverine types (the other two key moose wintering areas on the lease). Spruce-aspen covers a large area along the south boundary of the lease between Beaver Creek and the MacKay River, and large portions on the east side of the lease (Figure 1). Much of the riverine habitat is spruce-aspen in cover but is treated as a separate type, as will be explained under the riverine section.

Pine-aspen mixedwood stands are found extensively to the north of the Syncrude air strip and a few other areas, and are treated separately in the browse study.

In spruce-aspen, the composition varies in terms of the dominant tree species. An area sampled for browse, between Mildred Lake and the Syncrude air strip, is largely dominated by white spruce (*Picea glauca*). The other area sampled, between the Fort MacKay Road and Morton Island on the Athabasca River, is largely aspen-dominated. Also, some pure stands of aspen with a good understory of predominantly saskatoon-berry, and some pure stands of white spruce, form small portions of the spruce-aspen mixedwood.

In the spruce-aspen faciation, saskatoon-berry has a much lower importance value than in the pure aspen type (Table 4). However, willow, mooseberry, and red osier dogwood have higher importance values than in the pure aspen type. More willow and red osier dogwood plants were browsed in spruce-aspen than in pure aspen. Thus spruce-aspen is important moose winter range on the lease area. It also offers good potential winter range to deer and elk. Also, an abundance of grasses and forbs in parts of the spruce-aspen type offers good potential summer range to deer and elk. It also offers good habitat to ruffed grouse.

In contrast to spruce-aspen, the most important shrub in pine-aspen is alder, which is not preferred by moose (Table 4). Clumps of alder in pine-aspen, however, were severely hedged by rabbits. Saskatoon-berry had a higher importance value in pine-aspen than in spruce-aspen, but a lower percentage of plants were browsed by moose. Only 5% of all shrubs in the pine-aspen were browsed by moose. Most of the saskatoon-berry in pine-aspen were small, spindly plants which had been fairly well browsed by rabbits, and therefore largely unavailable to moose. This type is of little importance as moose winter range. However, good mats of kinnikinnick were noted in spots, providing abundant berries for black bear and spruce grouse.

Type 5: Fen Muskeg (Sedge-Willow-Birch) Faciation

This type forms fairly small areas on the lease. The low-lying area to the south of Mildred Lake, near the Fort MacKay road, was sampled as a representative area.

This type is dominated by a low mat of dense clumps of bog birch (*Betula glanulosa*) and willow with some clumps of marsh reedgrass and sphagnum moss and the occasional marsh marigold, Labrador tea (*Ledum groenlandicum*), and other minor species. The occasional bog larch (*Larix laricina*) and black spruce is noted, and a margin of willow forms around the edges of this muskeg.

TABLE IV

SUMMARY OF DATA FOR EACH BROWSE SPECIES AND HABITAT TYPE

Species	Relative Density	Relative Dominance	Relative Frequency	Importance Value	No. of Plants Browsed	Percent Utilization
Map Type: 1 Habitat Type: Pure Aspen						
Amal	21.25	2.48	16.92	13.55	27	79%
SAL	15.00	16.93	21.54	17.82	6	25%
Alcr	19.38	51.00	18.45	29.61	-	-
Poba	2.50	2.81	3.08	2.80	-	-
Potr	21.89	12.53	21.54	18.65	1	3%
Cost	.63	.36	1.54	.84	1	100%
BET	1.25	5.08	3.08	3.14	-	-
Vied	18.13	7.80	13.85	13.26	6	21%
				Total:	41	26%
Map Type: 4 Habitat Type: Boreal Mixedwood Association A. Spruce-Aspen						
Amal	4.50	2.09	5.81	4.13	3	43%
SAL	17.00	31.16	19.77	22.64	10	37%
Alcr	5.85	32.25	8.14	15.41	-	-
Poba	2.50	1.53	4.65	2.89	-	-
Potr	9.70	10.78	11.63	10.70	1	7%
Cost	13.97	3.12	13.95	10.35	14	64%
BET	2.50	1.54	3.49	2.51	1	25%
Vied	43.98	17.53	32.56	31.36	7	10%
				Total:	36	23%
B. Pine-Aspen						
Amal	16.88	1.05	16.46	11.46	2	7%
SAL	6.25	2.72	7.59	5.52	1	10%
Alcr	38.12	77.75	32.91	49.59	2	3%
Poba	1.25	1.42	1.27	1.31	-	-
Potr	27.50	14.54	30.38	24.14	-	-
Vied	2.50	.30	2.53	2.29	3	75%
LON	1.25	.42	2.53	2.10	-	-
Prvi	6.25	1.80	6.33	7.84	-	-
				Total:	8	5%

TABLE IV (Cont.)

Species	Relative Density	Relative Dominance	Relative Frequency	Importance Value	No. of Plants Browsed	Percent Utilization
Map Type: 5 Habitat Type: Fen Muskeg						
Amal	1.88	1.00	1.54	1.47	-	-
SAL	37.49	62.62	41.53	47.21	-	-
Poba	.63	.22	1.54	.80	-	-
Potr	2.50	1.53	1.54	1.86	-	-
BET	56.25	31.10	52.31	46.55	-	-
Vied	1.53	1.53	1.54	1.44	-	-
				Total:	0	0
Map Type: 6 Habitat Type: Treed Muskeg						
SAL	49.38	71.26	48.21	56.28	19	24%
Potr	1.24	.48	3.58	1.77	-	-
BET	49.38	28.26	48.21	41.95	1	1%
				Total:	20	12.5%
Map Type: 7 Habitat Type: Willow Muskeg						
SAL	63.75	52.03	58.06	57.95	12	24%
BET	36.25	47.97	41.94	42.05	-	-
				Total:	12	7.5%
Map Type: 8 Habitat Type: Recent burn (potentially productive)						
SAL	36.25	50.72	41.42	42.80	-	-
Poba	27.50	12.44	30.00	23.31	-	-
Potr	30.00	29.15	21.43	26.86	-	-
Cost	2.50	2.78	1.43	2.24	-	-
BET	2.50	4.56	4.29	3.78	-	-
Vied	1.25	.35	1.43	1.01	-	-
				Total:	0	0

TABLE IV (Cont.)

Species	Relative Density	Relative Dominance	Relative Frequency	Importance Value	No. of Plants Browsed	Percent Utilization
			Map Type: 9 Habitat Type: Older burn (Aspen-dominated)			
Amal	1.25	.04	1.15	.81	1	100%
SAL	28.75	57.88	29.88	38.84	5	11%
Alcr	6.25	11.52	8.05	8.64	2	20%
Poba	18.75	6.87	17.24	14.29	1	3%
Potr	33.13	19.13	27.58	26.61	-	-
Cost	7.50	3.37	8.05	6.31	4	33%
Vied	5.00	1.19	8.05	4.75	4	50%
				Total:	17	11%
			Map Type: 10 Habitat Type: Riverine			
Amal	2.50	.22	2.47	1.73	1	25%
SAL	1.88	7.92	2.47	4.09	2	67%
Alcr	10.63	27.73	9.88	16.08	-	-
Poba	10.63	5.51	13.59	9.91	7	4%
Potr	.63	.16	1.23	.67	1	100%
Cost	43.47	35.53	35.80	38.36	51	73%
BET	3.75	8.14	6.17	6.02	1	17%
Vied	18.74	3.88	19.75	14.12	4	13%
Abba	5.62	9.73	4.94	6.77	-	-
LON	1.25	.30	2.47	1.34	-	-
Prvi	.63	.88	1.23	.91	-	-
				Total:	67	42%

In western portions of the lease these areas were primarily sphagnum-labrador tea associations, but were not sampled.

Table 4 shows that bog birch and willow have very high importance values in this association, whereas saskatoon-berry, aspen, balsam poplar and mooseberry have low values. None of the plants samples were browsed by moose. Indeed, most birch and willow shrub are unavailable to moose because of severe winter hedging by rabbits, which left most plants with dead woody stems and only small leaf buds near the ground. Thus, only the narrow margin of higher willow around the edge of these muskegs is presently available to moose. This type of muskeg seems to be most important habitat for rabbits and their associated predators.

Some ptarmigan may utilize this edge of willow in the winter, feeding on the buds.

The few sandhill cranes (*Grus canadensis*) which nest near the test pit area probably nest in this type of habitat, although the actual nesting area was not determined.

Type 6: Treed Muskeg (Black Spruce) Faciation

Treed muskeg forms extensive areas on southeastern portions of the lease. Two areas were sampled: one between the Fort MacKay road and Morton Island, and the other about one mile west of the present Syncrude pilot plant and camp.

Cover varies from thick stands of black spruce to semi-open areas with black spruce, bog larch, scattered clumps of willow, bog birch, and a few small aspen and balsam poplar.

Willow and bog birch are the most important browse species of this type. Twelve and one-half per cent of all species were browsed, mostly willow. Thus this type has some secondary value as moose winter range.

As in Type 5, there was severe browsing by rabbits on small spruce, larch, aspen, and bog birch. In some instances, small evergreens were chewed down to stubs of one-inch diameter, or the bark had been "ringed." This type may provide winter habitat for spruce grouse and, possibly, ptarmigan (one spruce grouse was noted in the type).

Type 7: Willow-Muskeg Consocies

Type 7 is very limited in area on the eastern, and more accessible, portions of the lease, but forms fairly extensive areas on recently-burned areas of muskeg towards the MacKay River. It is also found along the flats of the Beaver Creek and small tributaries, extensively around the edges of the marsh near the Syncrude air strip, and on the edges of Horseshoe Lake (Figure 1).

Only eighty plants were sampled from this type, on an area near the end of the road that runs up the west side of the Beaver Creek from the Fort MacKay road. This area was a burned-over black spruce muskeg, which had been revegetated with healthy clumps of willow five to fifteen feet high--with a lower shrub cover dominated by bog birch and willow. The dominant ground cover was marsh reed-grass and sedge, with some marsh marigold and other forbs present.

Both willow and bog birch had high importance values. As usual, the bog birch was heavily hedged by rabbits, and thus unavailable to moose. Seven and one-half per cent of all the plants were browsed by moose, and all of these were willow--indicating that willow muskegs have some secondary value as moose wintering habitat.

In general, moose appeared to prefer saskatoon-berry shrubs in aspen groves to patches of willow where both were available. For example, only a few clumps of willow were noted to be browsed around the marsh at the Syncrude air strip but saskatoon bushes in a stand of pure aspen on the edge of the marsh were heavily utilized. Several moose were noted to browse on clumps of willow along the edge of Horseshoe Lake from late April to mid-May. However, an examination of the area showed far heavier browsing on other species adjacent to the willow edge (see riverine type) than on the willows themselves.

Lorraine Allison (personal communication, 1972) noted that moose on the Peace-Athabasca Delta make heavy summer use of willow leaves. While this was not observed on the Syncrude lease, it undoubtedly occurs.

Slight hedging of willow buds by ptarmigan was noted, and the willow muskegs may serve as wintering areas for these birds.

Willow muskegs are of little value to other wildlife.

Type 8: Recent Burn (Potentially Productive)

Recent burns, or areas classified by the Alberta Forest Service as "potentially productive," are found extensively to the southwest of Mildred Lake and on both sides of the Beaver Creek where the test pit area is located. Both of these locations were sampled in the browse study.

These areas appeared to have been burned within the last ten years, and have been invaded by a wide variety of trees and shrubs which varied in density from site to site. Thus, there are white spruce, black spruce, pine, aspen, balsam-poplar, a few bog larch, and an interspersion of many shrub species. Willow has by far the highest importance value, with aspen and balsam-poplar ranking next in order. Red osier dogwood, birch, and moose-berry are relatively unimportant.

Other shrubs noted were rose, currant, labrador tea, honey-suckle, buffalo-berry, and cinquefoil (abundant in places). The latter two shrubs were heavily browsed by rabbits. Other plants noted were kinnikinnick, huckleberry, and a variety of forbs including wild strawberry.

No plants in the line transects were browsed by moose--an indication that these areas have little utilization by wintering moose, although they have good shrub forage available except for saskatoonberry. Lack of sufficient cover may limit use of these areas by wintering moose.

Rabbits browsed heavily on pine. In one site a whole stand of small pine had been killed by rabbits' over-browsing, while small spruce were emerging untouched.

Some signs of black bear were noted, especially where they root for ants in old stumps and fallen trees. A few woodchucks (*Marmota monax*) were noted near the test pit area, but are probably not restricted to this habitat type alone.

Type 9: Older Burn Aspen-Dominated Facies

An older burn, dominated by aspen ten to thirty feet high, forms one of the most extensive areas on the lease--occupying a good portion of the western half. These areas are found extending from the Beaver Creek about one-half mile west of the test pit area to west of the MacKay River.

According to the Fire Protection Officer in Fort McMurray, this burn probably occurred in the late 1940's.

The area sampled for browse species was along the road that runs up the west side of Beaver Creek from the Fort MacKay road.

As with Type 8, willow was the most important shrub species, with an importance value of 38.84. Aspen, which was within reach of moose, was the second-most important, followed by balsam poplar. Following, in order of decreasing importance value, were alder, red osier dogwood, mooseberry and saskatoon berry.

Eleven per cent of all the shrubs sampled were browsed, indicating that this area is of secondary value to wintering moose. Good cover probably accounts for use of this type by moose, compared to more recent burns where there is little cover.

The extensive aspen-covered burn on the western portion of the lease certainly offers the most potentially-productive moose winter range on the lease, once the stands become more mature.

Rabbits appeared to make heavy use of these areas.

Type 10: Riverine Association

This type comprises areas of forest cover which are unique because of their proximity to rivers or creeks (i.e. river edges, flats, and valley slopes).

On the lease area, the riverine type included:

1. The flats and slopes adjacent to the Athabasca River (riverbreak zone);
2. The bottom flats and adjacent slopes of Beaver Creek;
3. Most of the small tributaries of Beaver Creek; and
4. The valley of the MacKay River.

The most productive riverine area is located between Horseshoe Lake and the Athabasca River, including the slopes to the west of Horseshoe Lake. These areas are mainly logged-over white spruce-aspen stands, with small stands of large balsam-poplar adjacent to the Athabasca River. The lower elevation and greater fertility of the soil in parts of the riverine zone is conducive to a richer growth of plant life. For example, red osier dogwood reaches almost tree size along the Athabasca River whereas, in areas of higher elevation, it was typically a low shrub.

The area between Horseshoe Lake and the Athabasca River was sampled during the browse study. Red osier dogwood had an importance value of 38.36 and was 73% browsed--the highest combined index of importance value and browse utilization of any shrub species sampled on any other habitat type.

Alder has an importance value of 14.12 and was 17% browsed. Other shrubs of lower importance that were browsed were saskatoon berry, willow, balsam poplar, aspen and white birch. Balsam fir (*Abies balsamea*) was found on drier sites, but was not utilized. Honeysuckle and chokecherry were of low importance and were not utilized.

Thus, the riverine area along the Athabasca River constitutes the most important moose winter range on the lease, in terms of availability and utilization of browse. This is also reflected in the trend-index data, where pellet plots for this type gave a higher average than in the pure aspen type.

The banks and flats along Beaver Creek also appeared to be fairly important moose winter range because of a good availability of browse, and the natural shelter which the river depression offers from prevailing winter winds. Flats examined upstream from Beaver Creek campgrounds showed a good availability of willow, aspen, balsam poplar, mooseberry, white birch and some saskatoonberry. Some had been well-utilized by wintering moose. Several sites examined farther upstream, towards the Syncrude test pit, showed heavy utilization of saskatoonberry in aspen slopes adjoining the river.

Farther upstream the small tributaries of Beaver Creek have good "edges", or flats, of willow. A brief examination of these determined that they were only lightly used by wintering moose.

The riverine type is good ruffed grouse habitat--especially the areas near Horseshoe Lake, where most ruffed grouse were noted. It is also good black bear habitat.

Type 11: Marsh

Only a few small sedge marshes--with the exception of the ones around Horseshoe Lake--are found on the lease area, and are relatively unimportant as wildlife habitat.

Mildred Lake:

Mildred Lake is the largest lake on the lease--covering approximately 340 acres. It drains northwesterly from its north end into Beaver Creek. The lake appears shallowest towards the north end.

The lake was ice-free by May 8, and the following vegetative analysis was made near the end of May.

Most of Mildred Lake is forested to near the edge with a treed margin of willow, alder, and bog birch, and a narrow ground fringe of marsh reedgrass (*Calamagrostis canadensis*), sedge (*Carex* spp.) with minor plants such as marsh marigolds (*Caltha palustris*) and horsetail (*Equisetum* spp.).

In some areas, dead willows line the shore, or the lake is forested right to the water's edge.

Most of the shoreline has a narrow zone of emergent vegetation ten to thirty feet wide, dominated by cattail (*Typha latifolia*) with some sedges (*Carex atherodes*), common spikerush (*Eleocharis palustris*) and pickerel weed (*Pontederia* sp.). There are some floating hummocks of marsh reedgrass. The north and south ends both have "floating" edges.

Submergent vegetation was briefly examined. The south end, near to shore, has a loose, rich organic bottom with a submerged matt of moss (*Hypnum* spp.), mare's tail (*Hippuris* sp.), hornworts (*Ceratophyllum* sp.), and some green algae growth.

An area on the east side of Mildred Lake, near the middle where the bottom drops off steeply from shore with no margin of cattail, has a three- to four-inch layer of organic mud with submerged bottom plants of water-weed (*Elodea canadensis*), hornworts and moss.

Duckweed (*Lemna minor*), a good duck food, and a "pond scum" of filamentous algae (*Spirogyra* sp.) floated along the edge. A few pond lilies

(*Nymphaea* sp.) were noted.

Towards the end of May, the northern half of the lake became cloudy with a light creamy-brown appearance, suggesting a "bloom" had taken place.

A rich variety of invertebrate life was present, including leeches and snails (*Lymnaea* sp., *Planorbis* sp., and *Trivolvis* spp.).

The variety of insect and plant life on Mildred Lake provides good feed for the numbers of waterfowl that use the area during spring migration. The presence of up to 400 lesser scaup (*Aythya affinis*) on the lake, for a continued period during part of May, suggests that an abundance of submerged vegetation is available at that time. An abundance of snails and other invertebrates provides good feed for common goldeneyes (*Bucephala clangula*) and buffleheads (*Bucephola albeola*), which were common on the lake during the spring.

The narrow margin of shore vegetation limits the value of Mildred Lake as nesting habitat to such ground-nesting species as lesser scaup and widgeon (*Mareca arnericana*). Two or three pairs of common loons (*Gavia immer*) and some red-necked grebes (*Podiceps grisegena*) also appeared to be nesting along the lake. Some bufflehead and common goldeneye appear to nest in holes in dead aspen (*Populus tremuloides*) snags near the shoreline.

A few beaver (*Castor canadensis*) were noted on Mildred Lake but no muskrat (*Ondatra zilbethicus*) were observed. Water shrew (*Sorex palustris*) live along the edge.

Moose (*Alces alces*) probably feed upon aquatic vegetation along Mildred Lake during the late summer, to escape the flies.

Horseshoe Lake:

Horseshoe Lake is located along the bottom of the Athabasca Valley, and is much shallower than Mildred Lake. It is slightly smaller (about 320 acres) but has a much wider shore margin of sedges, grasses, and willow.

The water regime of Horseshoe Lake has been altered by a canal at the north end which drains into the Athabasca River. The canal was built in about 1955 by the oil company then holding the lease. During spring "break-up", water and ice from the Athabasca River flow into Horseshoe Lake via the canal. In mid-May, as the river level recedes, Horseshoe Lake drains out through the canal, and water levels drop sharply. By late summer the lake reaches low levels, and may dry up in very dry years. The fluctuation creates desirable habitat for dabbling ducks such as the mallard.

Horseshoe Lake has a richer growth of aquatic vegetation than any other lake in the area. Growth begins earlier because of the early spring flooding of the lake by water from the Athabasca River, which has been heated by thermal emissions from the Great Canadian Oil Sands Plant.

The bottom of Horseshoe Lake is covered with a mat of moss, hornwort, and other submerged plants. By mid-May the open water is choked with water-lily, duckweeds (*Lemna minor, L. trisulca*) and filamentous algae which form a dense mat on the surface, along the edges.

Marginal vegetation is dominated by cattail, with some hardstem bulrush (*Scirpus validus*) and common spikerush.

Sedge and marsh reedgrass form a wide margin along most of the lake, and a large meadow at the north end.

This lake receives its heaviest use by waterfowl during the first two weeks of spring migration.

In the spring several moose were seen feeding daily along the edge on willows, but they disappeared about mid-May. The moose probably utilize this lake later on in the summer, as pond lilies are good summer moose feed.

A few beaver and their lodges were noted on Horseshoe Lake, but no muskrat were observed. According to local residents, muskrat were once abundant on Horseshoe Lake, before it was drained.

Riverine Habitats:

Beaver Creek, and a number of small tributaries to the west of Syncrude's present test pit area, offer limited habitat to wildlife. The relative abundance of beaver has been discussed in other parts of this discussion.

Some waterfowl utilize beaver dams on Beaver Creek, and its tributaries, during spring migration, but this use is limited.

A ground check of some beaver dams to the west of the present test pit on May 31 showed a good growth of duckweed (*L. minor*) and filamentous algae on the surface, but no ducks were noted.

Some common mergansers (*Mergus merganser*), which are fish-eaters, were noted on Beaver Creek.

The MacKay River, being larger and faster-flowing than Beaver Creek, has little to offer wildlife. Small numbers of migrant ducks were noted along its edges and side channels, immediately after spring break-up.

FOOTNOTES

[1]George H. La Roi, M.Sc., Ph.D., "Taiga" in "The Boreal Forest," Alberta: A Natural History (Edmonton: Canadian Utilities Limited, 1967), pp. 158 - 160.

[2]Ibid., pp. 160 - 161.

[3]Ibid., pp. 161 - 164.

[4]Ibid., p. 165.

[5]Cyril G. Hampson, B.A., Ph.D., "Summer Animals" in "The Boreal Forest," Alberta: A Natural History (Edmonton: Canadian Utilities Limited, 1967), pp. 169 - 170.

[6]William A. Fuller, M.Sc., Ph.D., "Winter in the Northern Forest" in "The Boreal Forest," Alberta: A Natural History (Edmonton: Canadian Utilities Limited, 1967), pp. 172 - 184.

[7]La Roi, Op. Cit., pp. 166 - 169.

[8]E. H. Moss, "The Vegetation of Alberta," The Botanical Review Vol. 21, No. 9, 1955.

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SECTION 1

ECOLOGICAL BASELINE INFORMATION

2. BEAVER CREEK: AN ECOLOGICAL BASELINE SURVEY

February, 1973

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Summary of Results

1) Beaver Creek rated 55% on the calculation of habitat percent of optimum. This value is considered low.
2) Low dissolved oxygen and percent saturation occur in the slackwater area of Beaver Creek.
3) The river is high in total dissolved solids but normal for pH, methyl orange alkalinity and total hardness.
4) Water temperatures are within the tolerance limits for Arctic grayling.
5) Abundance of food organisms is rated as poor on the basis of bottom and drift sampling.
6) Tar sand-rubble substrate may limit production of benthic organisms.
7) Beaver Creek was utilized exclusively by the people of the Ft. McMurray area for recreation purposes during the survey period. Use was associated with existing access points downstream from the Syncrude lease.
8) Angling was the major form of recreation, however picnicking and camping were also important. Recreational use, based on man hours, was low.
9) Beaver Creek is one of twenty-nine streams comprising a total length of 2,308 miles, within a 50-mile radius of the proposed plant site.
10) Lake chub, and suckers, constituted 88% of the total sample, which numbered 659 fish. Arctic grayling accounted for only 8% of the total.
11) Only two creel-sized grayling were taken during the entire sampling period.
12) Young-of-the-year Arctic grayling were collected only in the lower portion of Beaver Creek, between its confluence with the Athabasca River and the Ft. MacKay road. This area is considered to provide the best spawning and rearing habitat.
13) Chub, suckers, and brook stickleback were the only fish species taken from Mildred Lake. No sport fish were taken.

Summary of Conclusions

1) Fisheries habitat for Arctic grayling is considered marginal in Beaver Creek due primarily to habitat restrictions.
2) Arctic grayling (creel size) comprised 0.3% of the total species sampled indicating that the sport fishery capability of the river for this species is extremely low.
3) Possible limiting factors to grayling production include:
   a) Lack of suitable spawning substrate;
   b) Low dissolved oxygen concentrations occurring in the slackwater area;
   c) Low production of benthic organisms in riffle areas thus limiting food supply.
4) The lack of a catchable population precludes any economic analysis based upon the existence of a harvestable fish stock.
5) Data indicate that the creek is used primarily by residents of the Ft. McMurray area with angling only a part of the recreational value. Existing recreation demands on the creek are considered light.
6) While Arctic grayling production is low, evidence indicates that the species utilizes lower Beaver Creek as a spawning and rearing area. The size of the spawning run is unknown. Construction of a dam and retention pond would eliminate this potential spawning area.
7) The impact of the Syncrude development on other species (primarily chub and suckers) in Beaver Creek would be negligible upstream of the development.

I. INTRODUCTION

The tar sands development being contemplated by Syncrude Canada Ltd. will result in ecological disturbances within the lease, especially in the mining areas.

The initial mining area and retention pond will straddle Beaver Creek which flows through the lease to its confluence with the Athabasca River some sixteen miles from the southern lease boundary. The Syncrude development would eliminate the lower reaches of Beaver Creek in the mining and retention pond areas, and modify downstream flows.

The study reported here was initiated on July 26, 1971, to provide ecological baseline information on Beaver Creek. Field surveys were carried out from August 7th to August 24th. Of particular interest to this study was the acquisition of quantitative data on fisheries populations as a means of determining if harvestable populations of sport fish occur in Beaver Creek. Specific objectives of the study were as follows:

1) To conduct a fisheries habitat survey.
2) To conduct systematic sampling of invertebrate fauna.
3) To conduct systematic sampling of the fish populations.
4) To attempt identification of spawning areas.
5) To assess the use made of Beaver Creek by inhabitants of the Fort McMurray area for fishing and other forms of water-oriented recreation.
6) To assess the relative importance of Beaver Creek in a regional context.

II. GENERAL DESCRIPTION

Beaver Creek is located near the town of Ft. McMurray, in northeastern Alberta. Flowing north out of a bog area, it is a tributary of the Athabasca River (Fig. 1). The upper section of the creek is composed almost entirely of slackwater, flowing over a heavily-silted substrate. "Slackwater" in the remainder of this report refers to evenly flowing, smooth-surfaced water in the upper sections of the creek, i.e.; greater than ten miles above the confluence of Beaver Creek and the Athabasca River. In the lower ten miles of the creek the gradient becomes steeper resulting in alternating riffles and long pools.

In the fastwater areas, adjacent banks are steep and heavily-wooded. Black spruce *(Picea mariana)*, bog birch *(Betula glandulosa)*, and balsam poplar *(Populus balsamifera)* are the dominant tree species. Further upstream, willow *(Salix spp.)* gradually replaces birch as the dominant brush species. Throughout all areas, reed canary grass *(Phalaris spp.)* grows along the stream bank and provides both cover and bank stabilization (Fig. 2).

III. METHODS AND MATERIALS

A. Physical Habitat:

An aerial survey of the creek was carried out to ascertain its general habitat characteristics. The aerial survey encompassed the upper reaches of the creek and its tributaries. Ground access to this section was impossible even by all-terrain vehicle.

A series of nine sample stations were set up along the creek at one mile intervals beginning at the south lease boundary. The stations were marked with wooden stakes with the total length of each station comprising 200 feet of stream. Transects of 90^{o} across the stream at the upper, lower, and middle sections of the stations were used for sampling

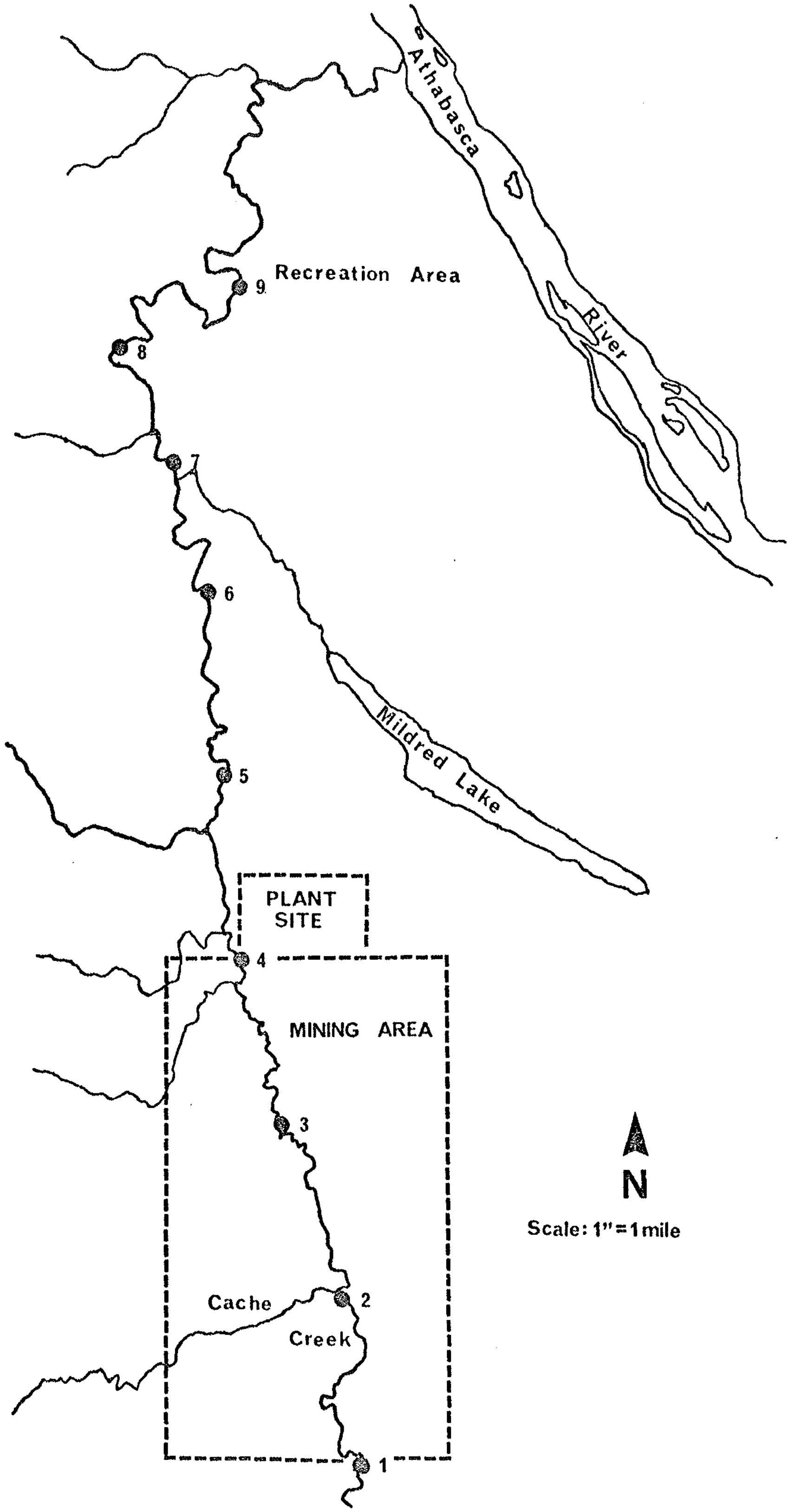

Figure 1: Map of Beaver Creek and Sample Sites, August 1971.

purposes. At each transect, physical and chemical measurements were made. Width was measured to the nearest foot at the existing water line and depth to the nearest inch to assist in determining the average depth of the stream. Pool depth was similarly measured at all sample stations.

Two classes of water surface-pools and riffles were established. The designation of a pool was largely subjective. Pool quality classes were designated on the basis of pool size, water depth and fish shelter as described by Herrington and Dunham (1967).

Six types of bottom material were noted and recorded as follows:

1) Debris
2) Silt
3) Sand
4) Gravel--rocks 0.1 to 2.9 inches in diameter
5) Rubble--rocks 3 to 11.9 inches in diameter
6) Boulder--rocks greater than 12 inches in diameter.

Banks were rated as stable or unstable with 1, 2, or 3 points assigned depending on stability. Bank ratings are subjective and based upon the amount of vegetative cover and fish shelter they provide.

B. Chemical Environment:

Dissolved oxygen, methyl orange alkalinity, total hardness and pH were measured using packaged test kits, and total dissolved solids were measured with a conductivity meter.

Continuous water temperatures were recorded with a maximum - minimum thermometer read every two days. When collecting fish, temperatures were measured with a pocket thermometer.

C. Fish Collection:

Fish collections were made using 30' sections of prima cord explosives. Areas sampled included: the slackwater, pools riffles, beaver dams, and backwaters. Sampling populations by electro-fishing was attempted but had to be discontinued as a result of equipment failures.

Four stream parameters were measured at each sample site to determine the relationship between the density of grayling and measurable habitat characteristics. While these parameters were correlated with other species, emphasis was placed on grayling because of their importance as sport fish. Habitat included stream depth, substrate size, temperature, and water type.

To survey the existing fish fauna of the area, Mildred Lake (Figure 3) was also sampled using prima cord explosives and gill nets. Nets were set overnight and pulled the following morning. The nets used were 50 yards in length with 3½", 4½", and 5½" stretch mesh. Horseshoe Lake was completely choked with aquatic vegetation and could not be sampled.

D. Invertebrate Sampling:

To assess food availability, drifting organisms were sampled in two riffles. Each riffle was sampled with two 1 mm. mesh nets having a mouth size of one foot by two feet. Drift samples were gathered in the nets for 24 hours. Nets were emptied at three hour intervals.

To determine the effect of tar sand substrate on insect production as well as to quantify the production of bottom fauna in the stream, eight 12" by 12" bottom samples were taken. Four samples in rubble-tar sand substrates and four in areas of rubble substrate were taken to allow comparison of the numbers of organisms from the two substrates. This procedure was carried out twice during the study period.

All organisms collected were sorted, classified by order, counted, and their volumes measured.

E. Stream-Oriented Recreation:

Data were tabulated on numbers of anglers who fished the study water. The angler survey was carried out on one weekday and one weekend day each week during the study period. A two-hour count interval was used with counts made from 8:00 a.m. to 8:00 p.m. on the designated days.

F. The Status of Beaver Creek in a Regional Context:

A compilation of numbers, size, and length of other rivers within a 50-mile radius of Beaver Creek was determined from maps of the areas. A mean meander factor was calculated and used to calculate the stream length of all rivers noted.

IV. RESULTS

A. Physical Habitat

From the aerial survey it was observed that Beaver Creek is divided into two major habitat zones. The first, extending from its confluence with the Athabasca River upstream ten miles, is characterized by good riffle-pool separation and generally fast flow. The second, extending from that point to the headwaters, consists almost entirely of slow-moving slackwater. The only exceptions were three small riffle areas approximately 40 miles from the confluence. The upper areas of the river were more open than the lower areas and were heavily populated by beaver as evidenced by the many beaver dams observed (Fig. 4).

Between its confluence and the south lease boundary, the stream is sixteen miles in length, has an average width of 33 feet and an average depth of 28 inches (Table 1). These values represent close to minimum dimensions for this stream since data was collected during the seasonal low flow period.

Pool areas are generally regarded as ideal habitat for most fish species. In the area surveyed, 68% of Beaver Creek was classified as "pool." Seventy-nine percent of the total pools scored as quality Class I (Appendix I)*. Only three percent of the pool areas were assigned to a quality class lower than Class III (Fig. 5).

Silt was the predominant substrate type present, comprising 48% of the total bottom area sampled (Fig. 5). Conversely, ideal spawning habitat for Arctic grayling (i.e. sand and/or gravel) comprised 6% of the total habitat sampled.

The study area included portions of both habitat zones previously mentioned. The upper zone, which includes the creek above the plant site, exhibits a rather uniform gradient consisting of slack-water flowing over heavily-silted substrate. The second zone from the pit area downstream to the Beaver Creek recreational area, has a moderate gradient, generally fast flow and a series of pools and riffles with

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*Quality classes are assigned on the basis of several habitat criteria. These are presented in detail in Appendix II.

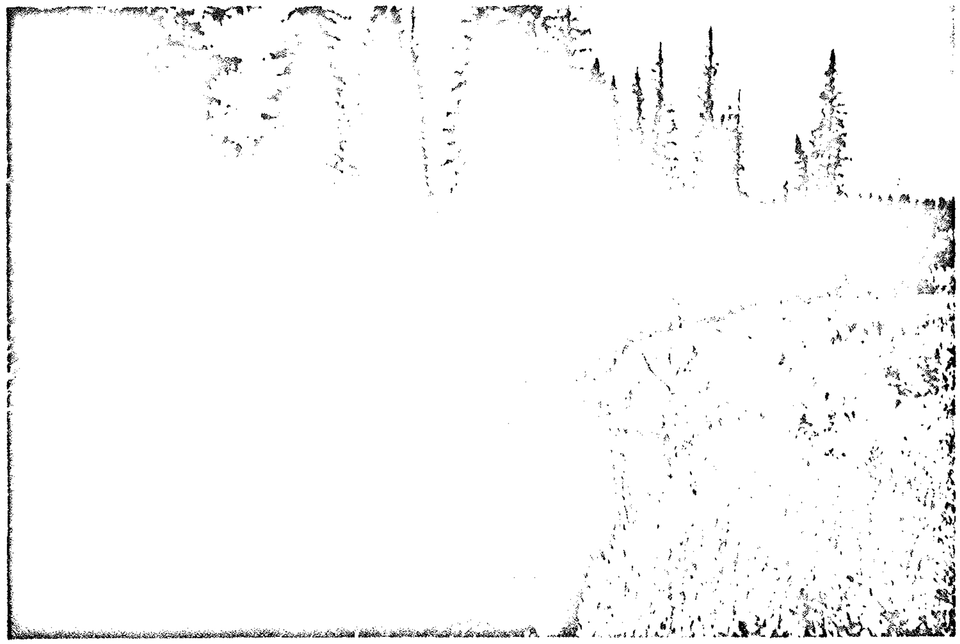

Figure 2: Portion of the Beaver River near Station #5. Note the excellent bank stability and cover. August 1971.

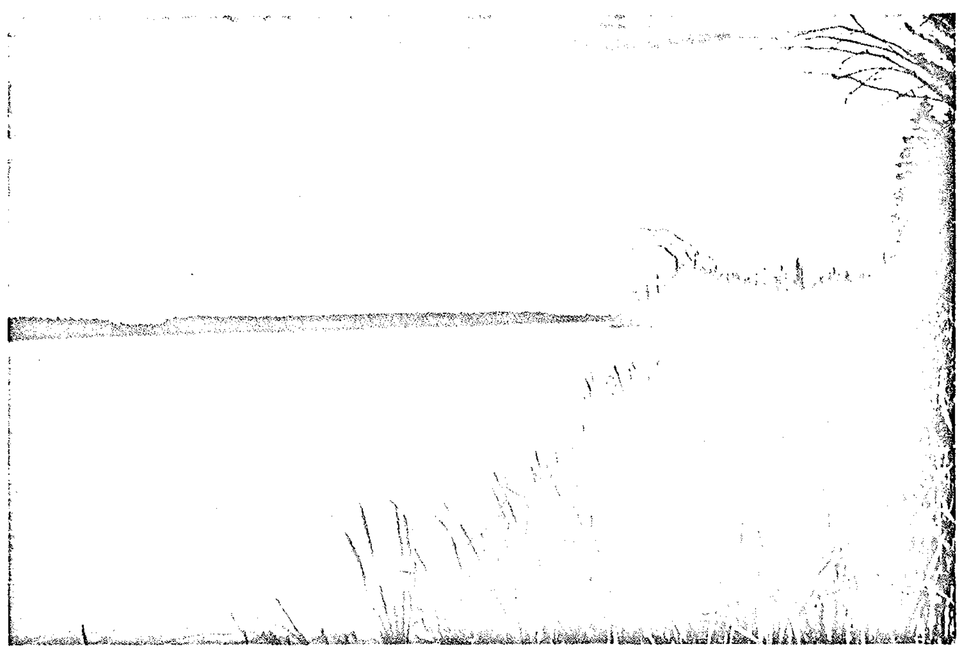

Figure 3: General view of Mildred Lake looking north west.

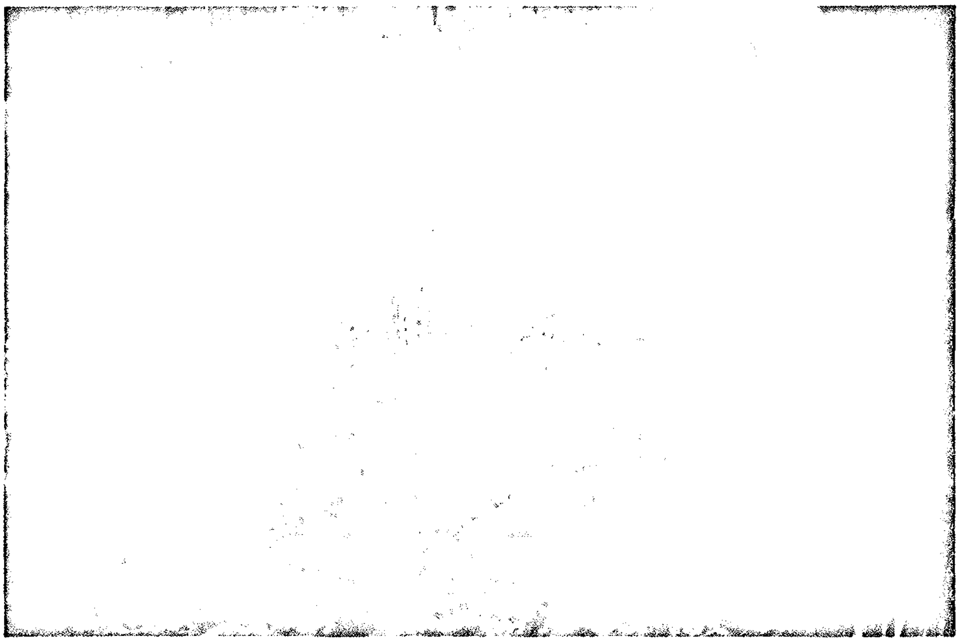

Figure 4: Slackwater area of the Beaver River upstream from the proposed plant site. Note the evidence of beaver activity.

TABLE 1

SUMMARY OF BEAVER CREEK PHYSICAL CHARACTERISTICS, AUGUST 1971

Number of stations	9
Length of stations	200'
Average depth	28"
Average width	33'
Adjusted stream length	16 mi.
Riffle area	32%
Pool area	68%
Total length of pools	1,471'
Maximum possible points for bank observations	36
Total points for bank observations	26
Estimated amount of gravel	30'
Estimated amount of rubble	540'
Streamside Vegetation:	
Forest	24%
Brush	42%
Grass	34%

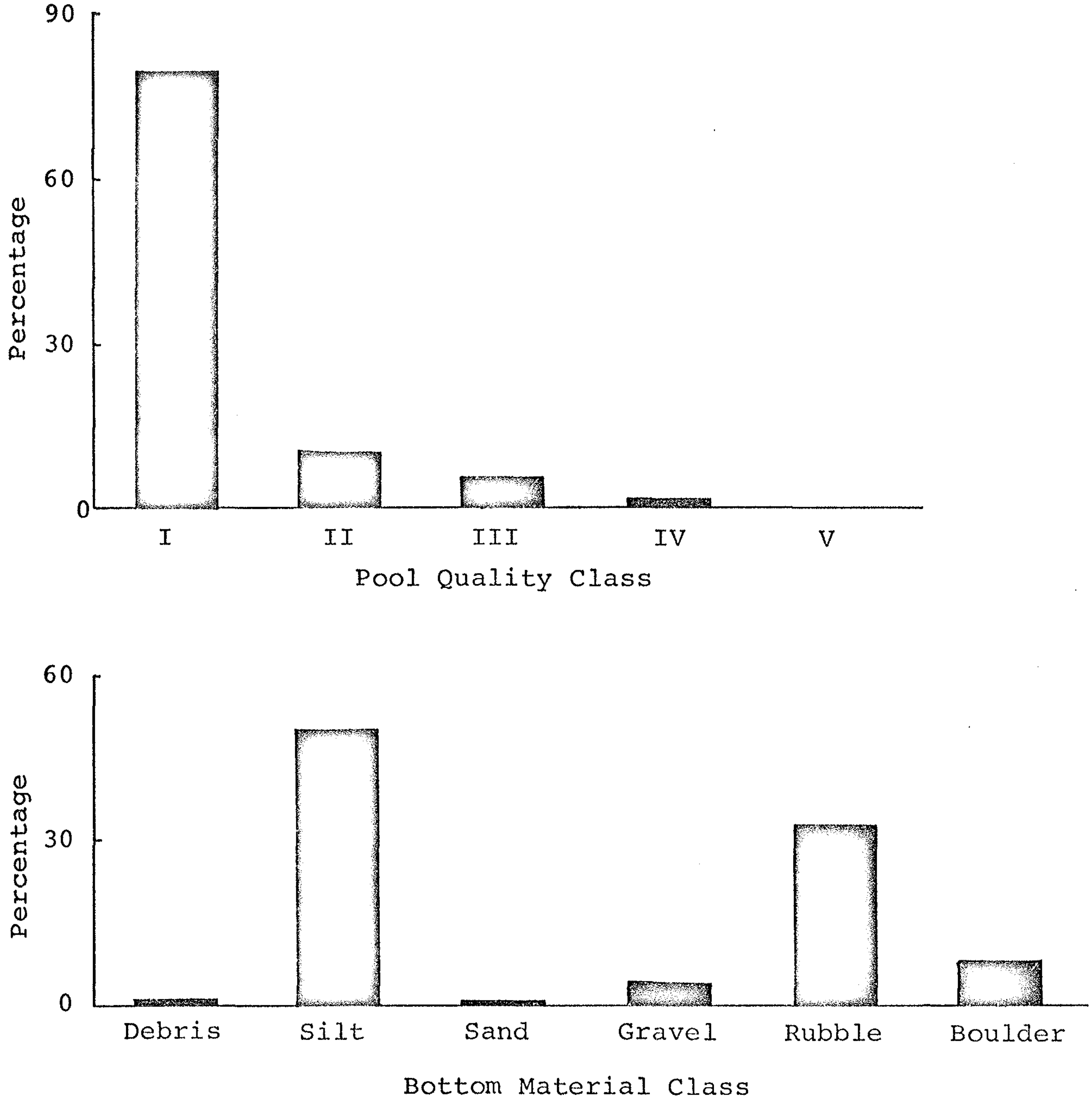

Figure 5: The estimated percentage of pool quality and bottom material classes found in Beaver Creek, August 1971.

boulder and rubble substrates (Fig. 6).

The calculation of habitat percent of optimum is a measure of the suitability of the stream to salmonid production. A perfect score of 100% indicates the stream has a perfect environment for salmonid species. Beaver Creek percent of optimum scored at 55% (Appendix II). This low rating was due primarily to the high proportion of slackwater in the river and scores calculated for stream bottom characteristics. A score of 55% indicates that Beaver Creek is not a good stream for salmonid habitat even though abundant bank cover is present.

B. Water Chemistry:

Total dissolved solids were quite high in spite of their fluctuations through the length of the river. Alkalinity, hardness and pH remained fairly constant while dissolved oxygen fluctuated with the type of water habitat (Fig. 7, 8). In slackwater sections of the creek the oxygen content was low with a saturation of 43% recorded at one point. Values for the lower portions of the stream (more riffle area) increased to a high saturation of 115%. In general, the percent of saturation was low for a stream of this type.

The average recorded water temperature during the study period was 62.8^{o}F. with a maximum recorded temperature of 71^{o}F and a minimum recorded temperature of 57^{o}F. These temperatures are within the tolerance range of salmonid species (Fig. 9).

C. Invertebrate Sampling:

Repeated benthic sampling revealed seven orders of invertebrates present in riffle areas of Beaver Creek (Table 2). The order Trichoptera (Caddis flies) were by far the most numerous followed by the orders Diptera, Coleoptera, and Ephemeroptera.

In Beaver Creek the mean volume for the sixteen bottom samples measured 0.6 c.c. and the average number per square foot 23 indicating that insect production is extremely poor. Two factors which may account for the low insect production observed are:

a) The presence of a tar sand substrate in many of the riffle areas;

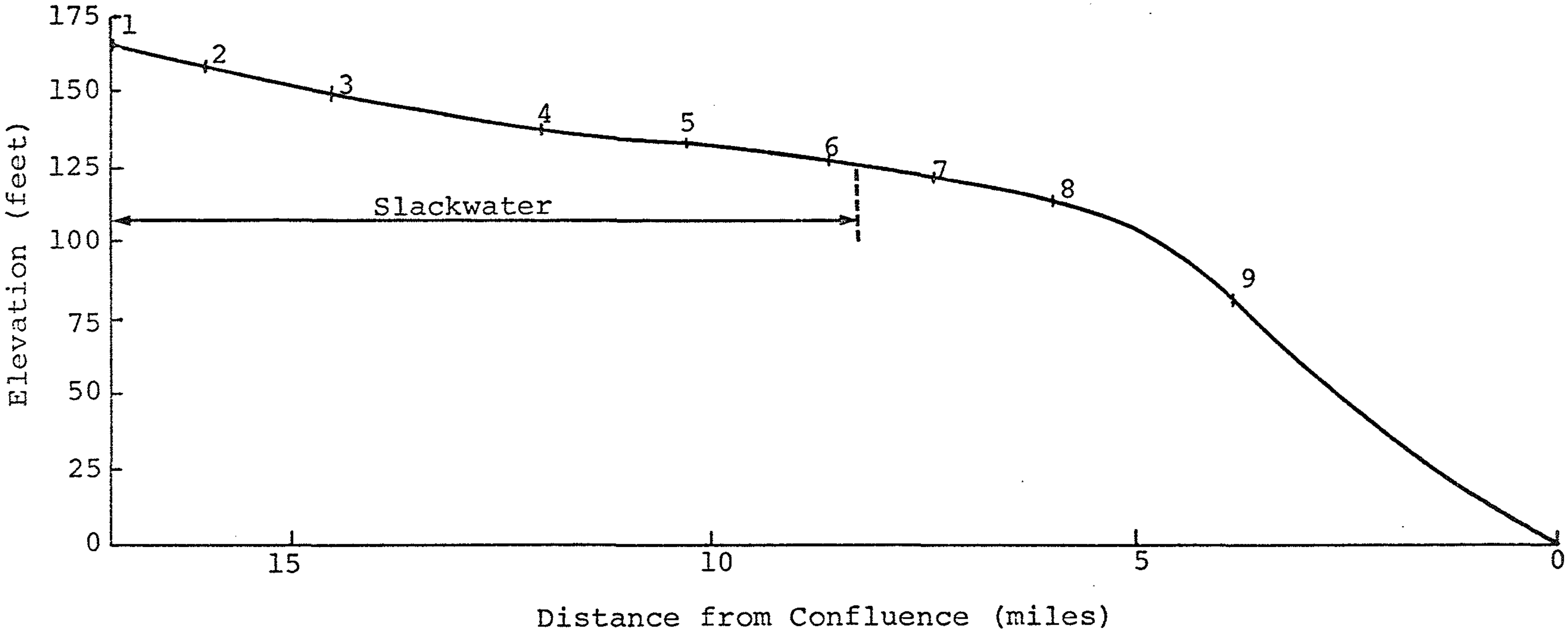

Figure 6: Stream profile of the Beaver Creek Study Area. Numbers indicate the sites of the sample stations. August 1971.

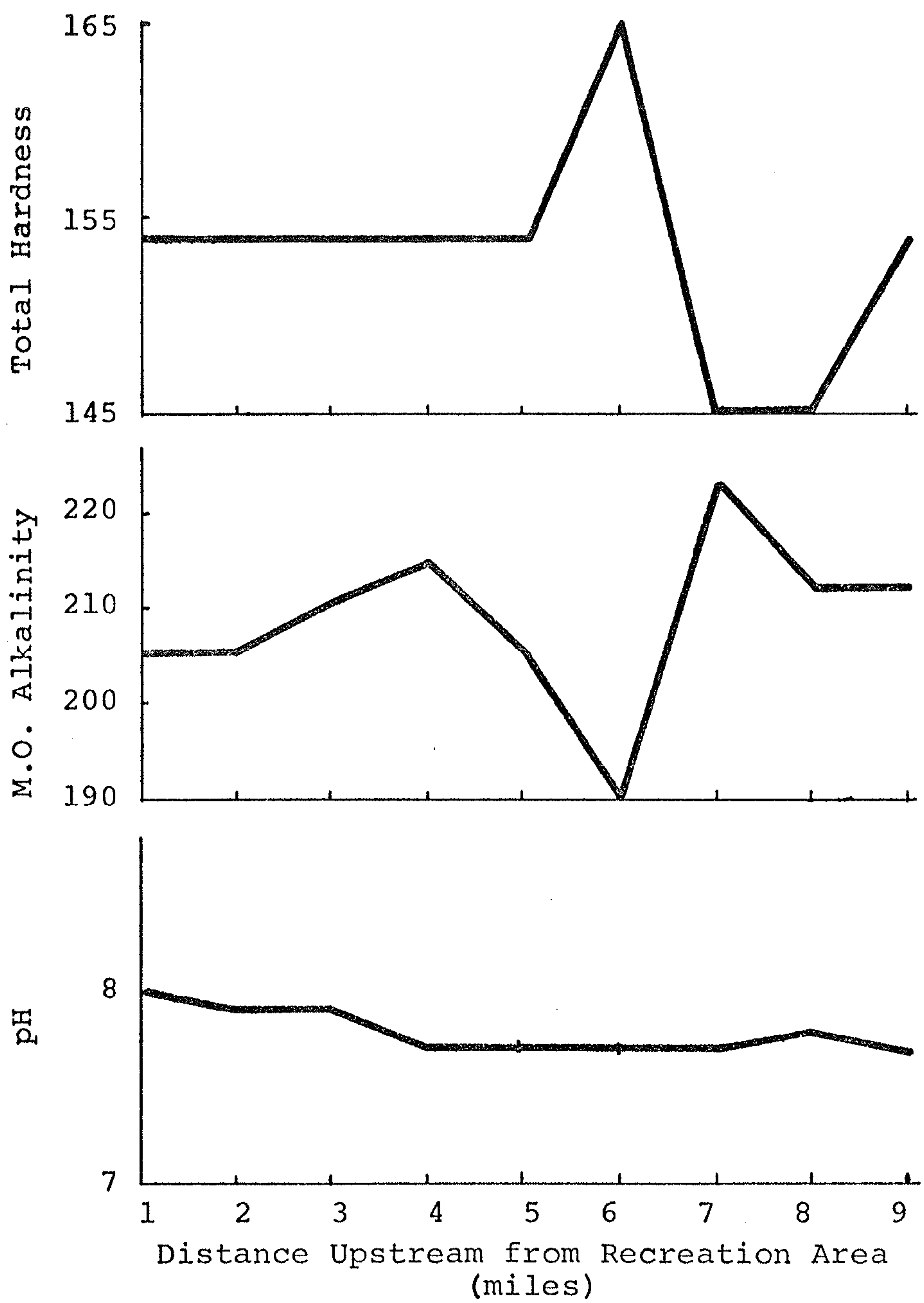

Figure 7: Water Chemistry Analysis of total hardness, methyl orange alkalinity and pH, Beaver Creek, August 1971

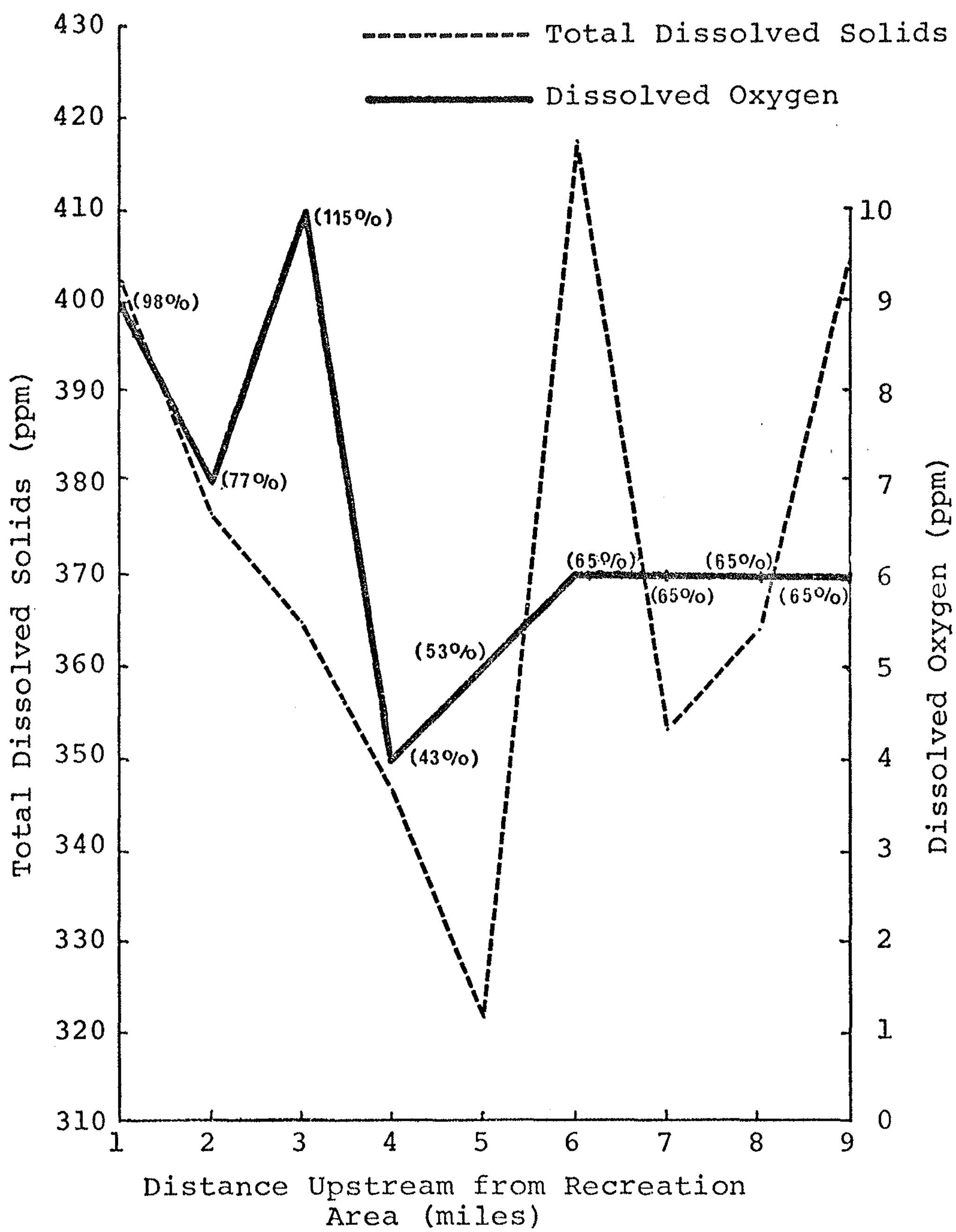

Figure 8: Total dissolved solids (25^{o}C) and dissolved oxygen concentrations in Beaver Creek, August 1971. Percentages indicate the amount of oxygen saturation in the sample.

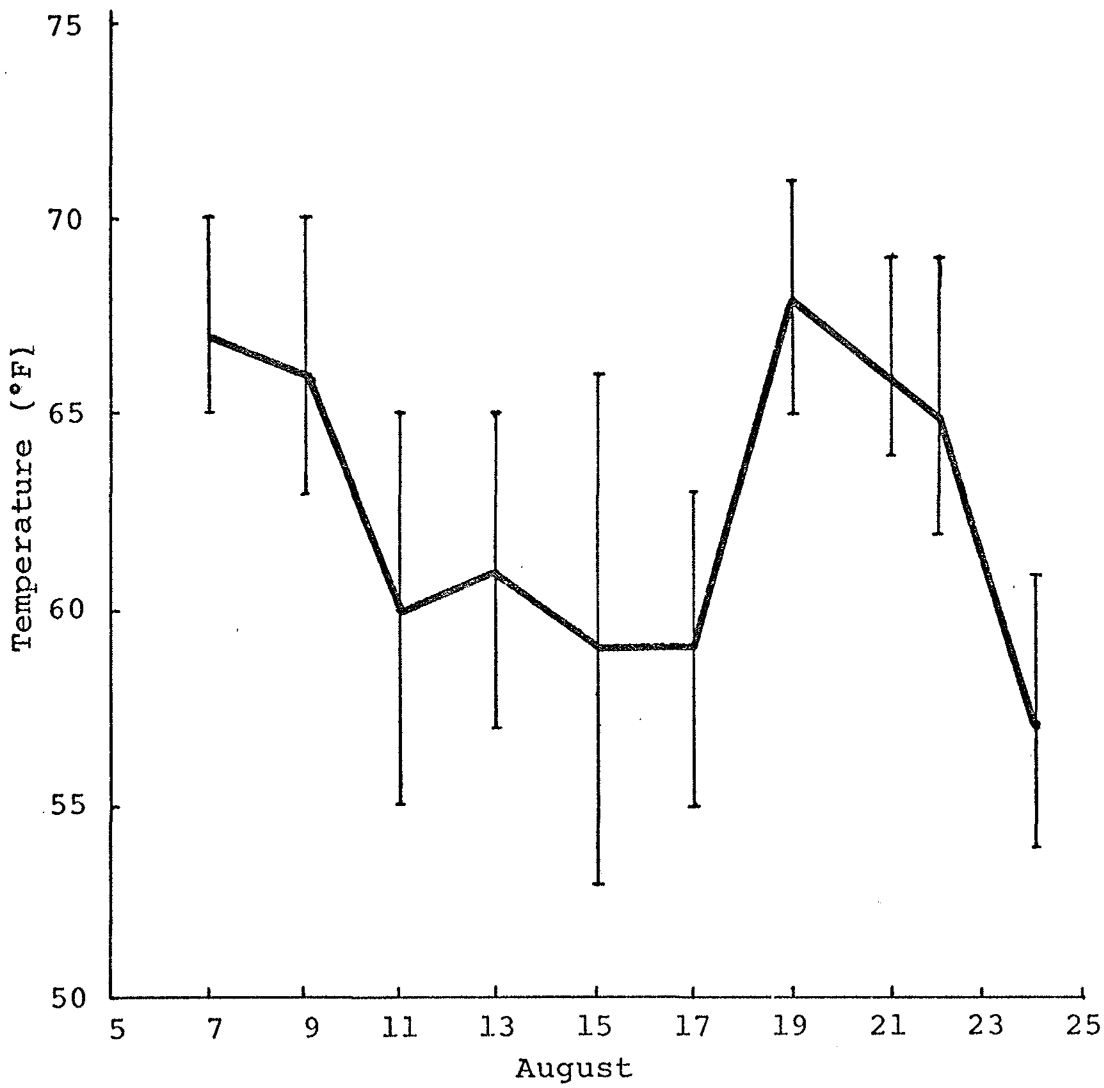

Figure 9: Mean Water Temperature with maximum - minimum values indicated, Beaver Creek, August 1971.

TABLE 2

SUMMARY OF BENTHIC ORGANISMS BY NUMBER IN SIXTEEN SQUARE FOOT BOTTOM SAMPLES FROM BEAVER CREEK, AUGUST 1971

Group Sampled	Number	Number/Square Feet
Order Trichoptera	197	12.3
Order Diptera	51	3.2
Order Coleoptera	46	2.9
Order Ephemeroptera	34	2.1
Order Plecoptera	23	1.4
Class Oligochaeta	13	0.8
Class Arachnida	4	0.3
TOTAL	368	23.0

Numbers alone do not provide an adequate supply; volume is also an important consideration. Standards of richness have been developed as an aid in classification of stream as to food supply (Lagler, 1956). This classification is as follows:

FOOD GRADE I: (Exceptional richness)
Volume $\geq$ 2 cc., numbers $\geq$ 50/sq. ft.

FOOD GRADE II: (Average richness)
Volume 1-2 cc., numbers $\geq$ 50/sq. ft.

FOOD GRADE III: (Poor in food)
Volume $<$ 1 cc., and/or numbers $<$ 50/sq. ft.

b) Heavily silted slackwater stretches.

An average of three times as many organisms were found in riffle areas with rubble substrates compared to riffle areas with a tar sand substrate (Fig. 10). Similar results are shown with volumes of insects (Table 3). The actual proportions of the stream with a tar sand substrate could not be ascertained in the present study.

Five orders of aquatic insects (Coleoptera, Diptera, Plecoptera, Ephemeroptera and Trichoptera) composed an average of 94% of the total drift numbers in a 24-hour drift net set (Table 4). Aquatic insects exhibited the alternans* pattern of nocturnal activity with a major peak in numbers occurring in the 2:00 a.m. sample (Table 3), (Fig. 11). Therefore, the majority of aquatic insects entered the drift nets when they were probably unavailable to actively feeding grayling.

D. Recreational Use of the Creek:

Beaver Creek was utilized solely by the people of the Ft. McMurray area during the survey period. No people from outside the Ft. McMurray area were noted in data collected from the six days of the use count.

Fishing was the major form of recreational use on four of the six days with a mean of twenty-six angler hours per week recorded--all confined to the weekend. Camping and picnicking were the next most important recreational uses. These were observed on both weekdays and weekends (Table 5). It should be noted that present recreational use of the creek is restricted by access to two locations: the first at the recreation area, five miles above the confluence on the road to Ft. McKay; and the second two miles south of the recreation area, near the sample station number seven (Fig. 1).

E. Beaver Creek in a Regional Context:

Map measurements were carried out to ascertain the status of Beaver Creek in a regional context. Data were obtained from both 1:50,000 and 1:250,000 scale maps and provide a generalized perspective of the relationship of Beaver Creek to other streams in the region.

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* Greater activity during dark periods.

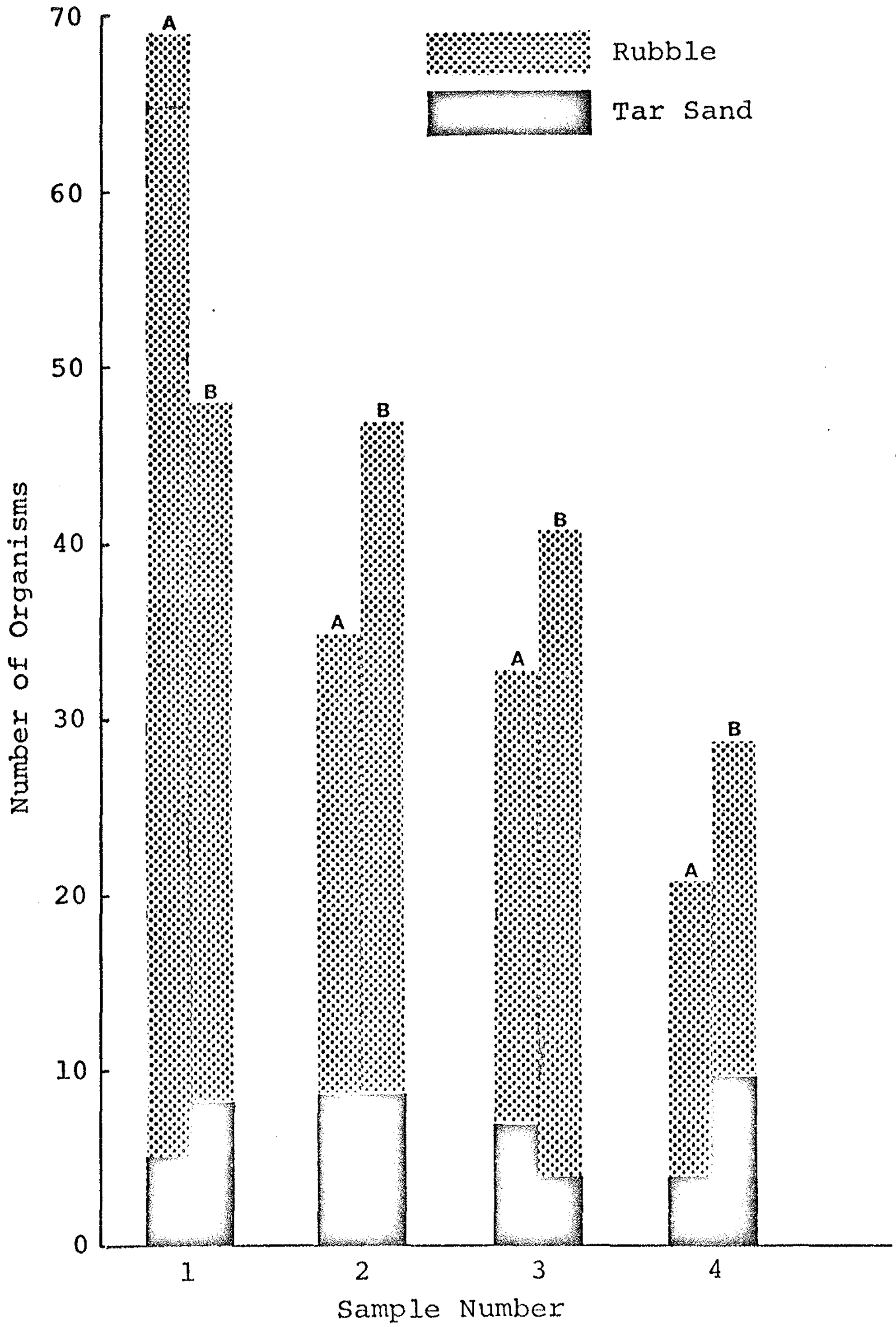

Figure 10: Comparative results of two sets (A & B) of Surber sampling in rubble and rubble-tar sand substrates in Beaver Creek, August 1971.

TABLE 3

SUMMARY OF INSECT SAMPLING VOLUMES (cc.)

BEAVER CREEK, AUGUST 1971

A. Surber Samples (taken August 11th, 20th)

		Tar Sand Substrate (cc. per sq. ft.)	Rubble Substrate (cc. per sq. ft.)
August 11th Samples:			
	1	Trace	1.0
	2	Trace	1.0
	3	0.2	0.4
	4	0.1	0.6
August 20th Samples:			
	1	Trace	1.3
	2	0.1	1.5
	3	Trace	1.1
	4	0.1	0.9

B. Drift Samples (taken August 11th)

Time Sample Taken	Terrestrial Insects	Aquatic Insects	Total
2:00 p.m.	1.4	1.0	2.4
5:00 p.m.	0.4	0.8	1.2
8:00 p.m.	0.9	0.4	1.3
11:00 p.m.	0.6	1.9	2.5
2:00 a.m.	0.1	1.3	1.4
5:00 a.m.	0.4	1.4	1.8
8:00 a.m.	0.6	0.6	1.2
11:00 a.m.	0.4	0.2	0.6

TABLE 4

NUMBER OF DRIFT ORGANISMS TAKEN IN FOUR NETS SET 24 HOURS AND EMPTIED EVERY THREE HOURS, BEAVER CREEK, AUGUST 1971

Terrestrial Orders Occurring in Drift Nets	No.
Hymenoptera;	
Fam. Formicidae	52
Fam. Apidae	2
Diptera	19
Hemiptera	18
Arachnida	5
Lepidoptera	3
Trichoptera (adult)	1
Odonata	4
TOTAL	104

Aquatic Groups Occurring in Drift Nets	No.
Order Coleoptera (adult)	66
Order Trichoptera	51
Order Diptera	41
Order Ephemeroptera	39
Order Plecoptera	25
Order Coleoptera (larvae)	15
Order Hemiptera	7
Order Arachnida	4
Platyhelminthes (Flatworms)	3
Order Odonata	1
Class Hirudinea	1
TOTAL	253

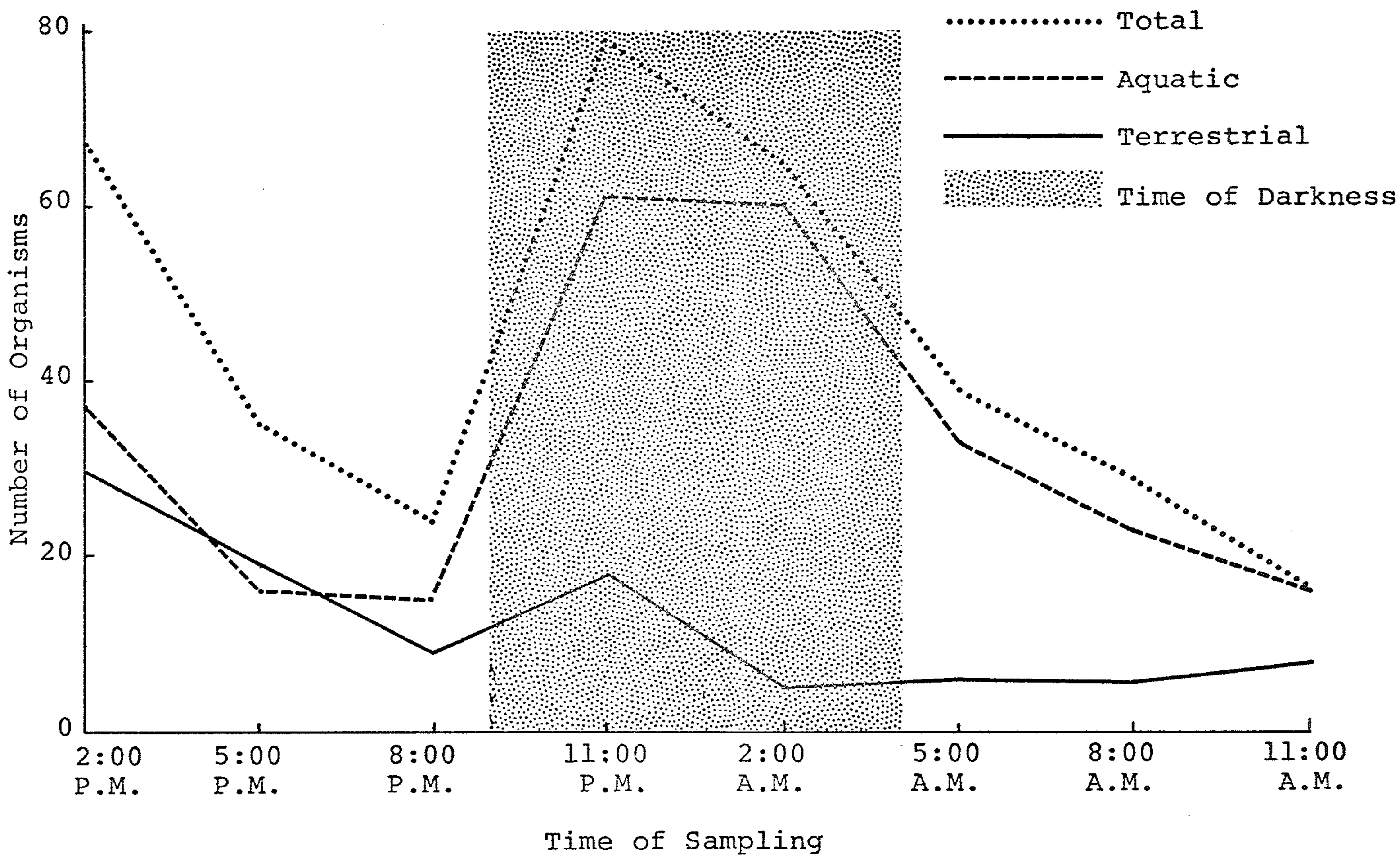

Figure 11: Number of drifting organisms taken every 3 hrs. from 4 drift nets placed in two riffle areas, Beaver Creek, August 1971.

TABLE 5

SUMMARY OF RECREATIONAL USE OF BEAVER CREEK DURING AUGUST, 1971

	Fishing			Other Recreation*		
Sample Week:	1	2	3	1	2	3
Estimated hours on:						
a) Week-ends	22	30	36	14	0	136
b) Week-days	0	0	0	36	0	0
TOTAL HOURS	22	30	36	50	0	136

*Includes camping, picnicking and other outdoor recreation.

TABLE 6

MILES OF STREAM WITHIN A 50-MILE RADIUS OF BEAVER CREEK PROPOSED PLANT SITE

Miles of stream larger than Beaver Creek	792
Miles of stream equal or smaller than Beaver Creek	654
Miles of major tributaries	862
TOTAL MILES OF STREAM	2,308

Within a 50-mile radius of the Syncrude plant site there are twenty-nine rivers, nine of which are accessible by automobile. These rivers constitute a total estimated length of 2,308 miles. Of this amount, 34% are streams larger than Beaver Creek, 28% are approximately the same size and 38% are tributary streams (Table 6). These figures have been corrected by using a meander factor of 1.6 per lineal mile of river measured to obtain actual length. The average meander factor for the larger rivers is 1.6 but it should be considered as the absolute minimum for smaller rivers, creeks, and tributaries.

F. Fish Collection:

Six species of fish were collected during the sampling period. Samples were taken at locations over 16 miles of the creek encompassing the lease area, and downstream.

Species collected were:

Lake Chub, *Couesius plumbeus* (Agassiz)
White Sucker, *Catostomus commersoni* (Lacepede)
Arctic Grayling, *Thymallus arcticus* (Pallas)
Burbot, *Lota lota* (Linnaeus)
Slimy Sculpin, *Cottus cognatus* (Richardson)
Northern Pike, *Esox lucius* (Linnaeus)

The relative abundance of six species of fish sampled by prima cord explosives is indicated in Fig. 12. Lake Chub were the most numerous species, comprising 50% of the total sample. Chub and suckers together constituted 88% of fish collected. The total number of fish sampled was 659. Chub ranged in size from 1½" to 4½" and suckers were from 1½" to 12" long. The majority of suckers were in the smaller size ranges.

Of the five major habitats sampled (slackwater, pools, riffles, backwater, and beaver dams), only two mature grayling* out of a total of 59 specimens were collected. These were taken from pool areas. Chub and suckers occurred in all water types (Fig. 13). Pools were the most productive areas for fish with an average of 25 fish collected per blast (Fig. 14). Backwater areas were least productive with an average of 0.8

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*12" and 13" in size

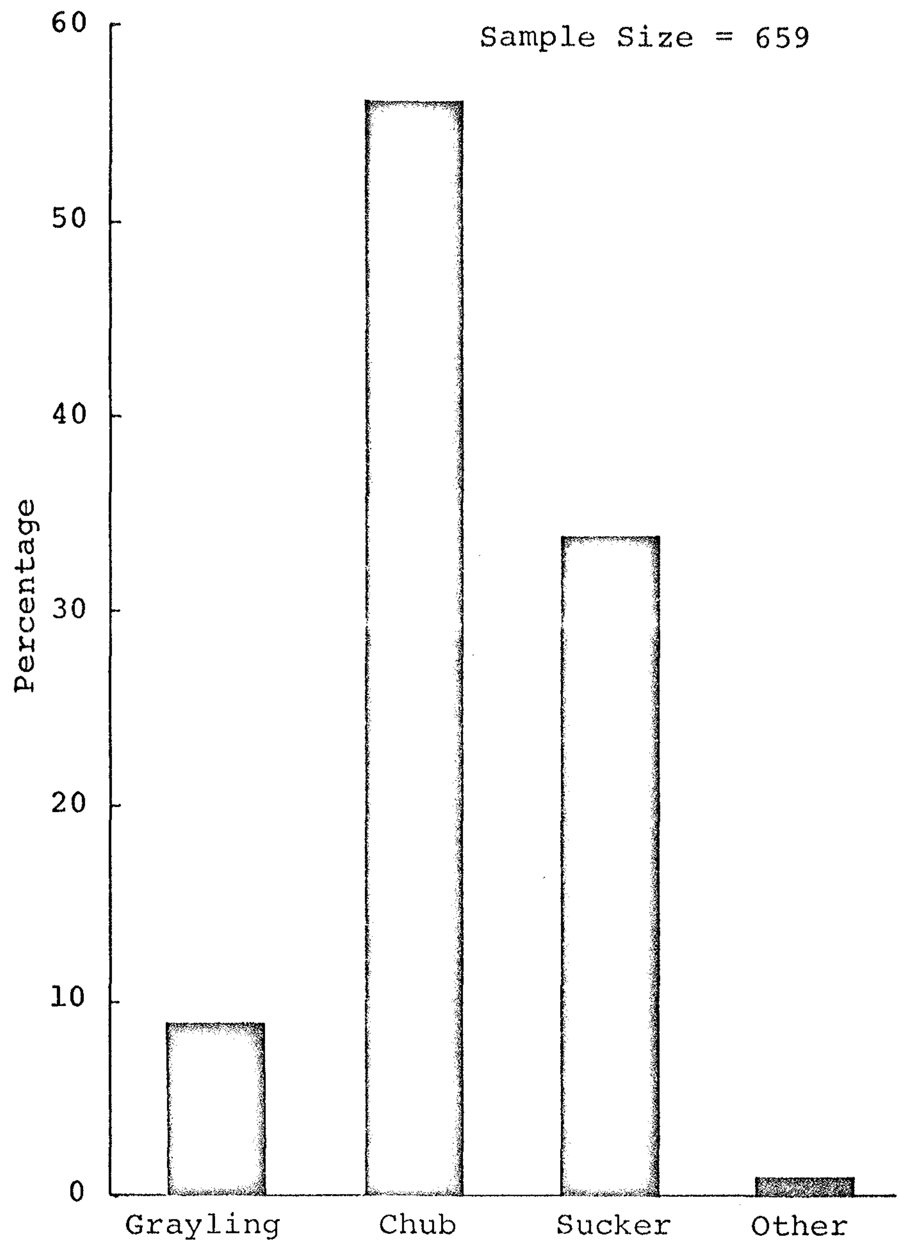

Figure 12: Relative Abundance of species as indicated by prima cord sampling in the Beaver Creek, August 1971.

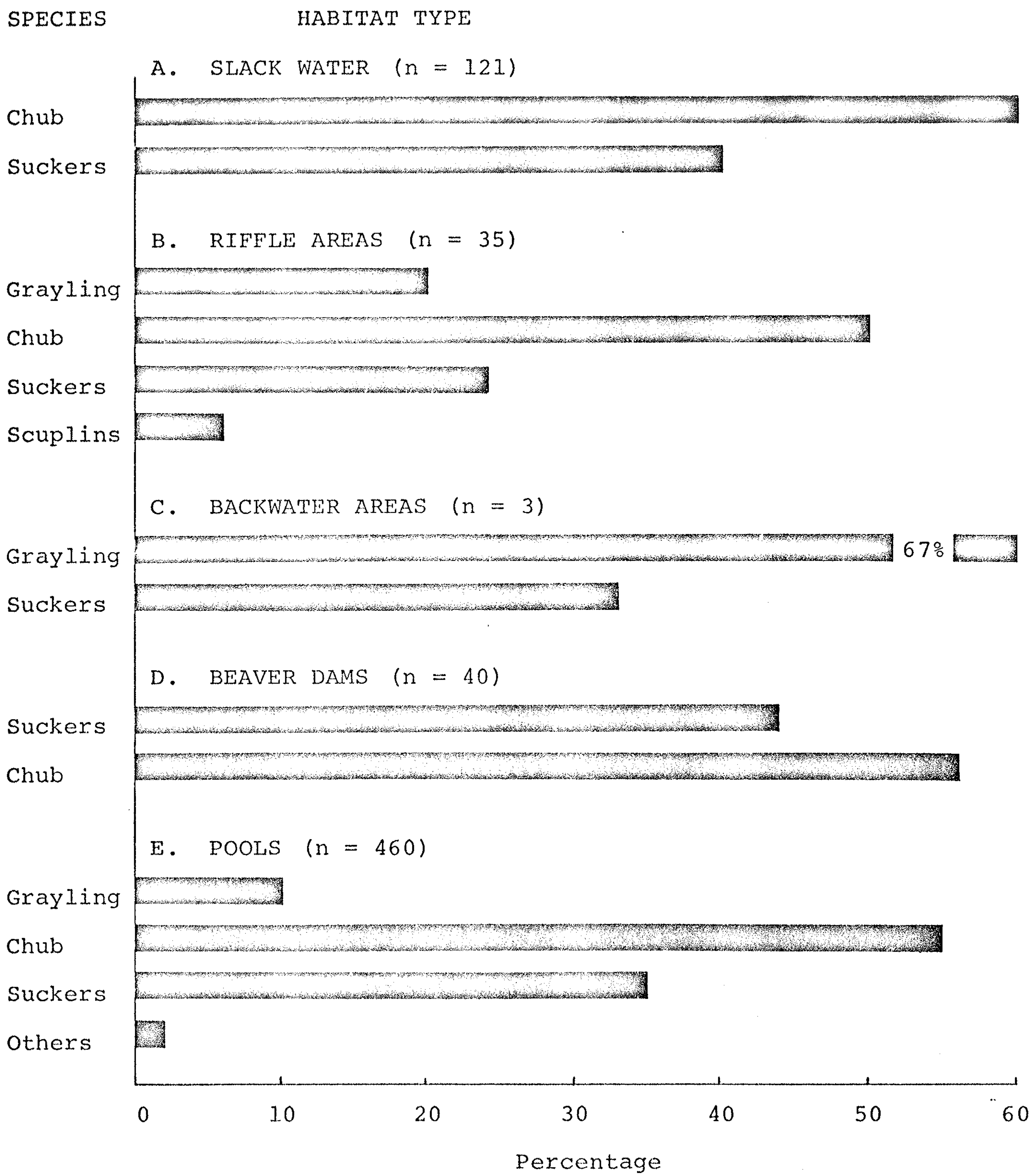

Figure 13: The relative abundance and distribution of species according to water habitat, Beaver Creek, August 1971.

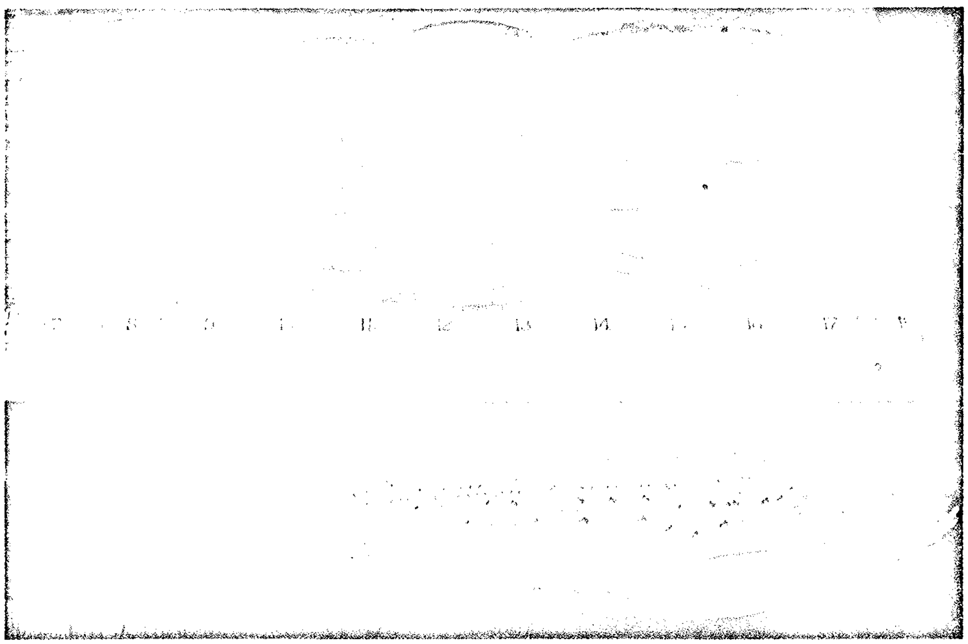

Figure 14: A sample of the fish collected with prima cord explosive from a pool area on the Beaver River, August 19, 1971.

fish per blast.

The density of young-of-the-year and age I+ Arctic grayling is related independently to depth, substrate, and water type when density is related to the individual parameter. Since there is a correlation between parameters, e.g.; rubble substrate associated with riffle, the separation of habitat for individual analysis does not represent the actual pattern of habitat occupancy. However, it allows comparison of immature grayling for each parameter and time. Univariate analysis (i.e.; one independent variable vs. the dependent variable) demonstrates the importance of sand and pools as variables influencing young-of-the-year grayling density in August (Table 7). Brown (1938) and Ward (1951) reported grayling spawned in sand and fine gravel respectively. It is in these areas where most young-of-the-year were found. Grayling of age I+ on the other hand showed a clear preference for rubble substrate but other parameters were not as well defined as to preference.

The length frequencies of immature grayling collected in Beaver Creek formed three distinct modes when plotted (Fig. 15). The modes measured 1½", 3-3/4" and 7" respectively and represented the total lengths of age groups 0+, I+ and II+.

Gillnetting of Mildred Lake resulted in five white suckers being taken in 3½" stretch mesh net. These fish averaged 14" in length. Using prima cord sampling, 197 lake chub (average size 2") and 29 brook stickleback, *Culaea inconstans* (Kirtland) were obtained. In neither instance were sport fish found in Mildred Lake. It is doubtful if sport fish would overwinter in Mildred Lake in any event because of its shallowness. Horseshoe Lake could not be sampled due to the heavy weed growth covering the lake's surface. This made conventional sampling methods impossible.

V. DISCUSSION

A. Beaver Creek as Fisheries Habitat

Results of this study indicate fisheries habitat in the Beaver Creek is marginal for sport fish, in particular Arctic grayling. The river ecosystem appears quite stable and does not appear to have undergone any major changes in the past few years which would affect fish populations.

TABLE 7

OCCURRENCE OF IMMATURE ARCTIC GRAYLING

IN THREE HABITAT PARAMETERS,

BEAVER CREEK, AUGUST 1971

Age Group	Water Type			Depth (feet)					Substrate		
	Backwater	Pool	Riffle	1	2	3	4	5	Sand	Silt	Rubble
0+	1	31	-	4	-	28	-	-	32	-	-
1+	-	9	7	11	1	1	-	3	1	3	12

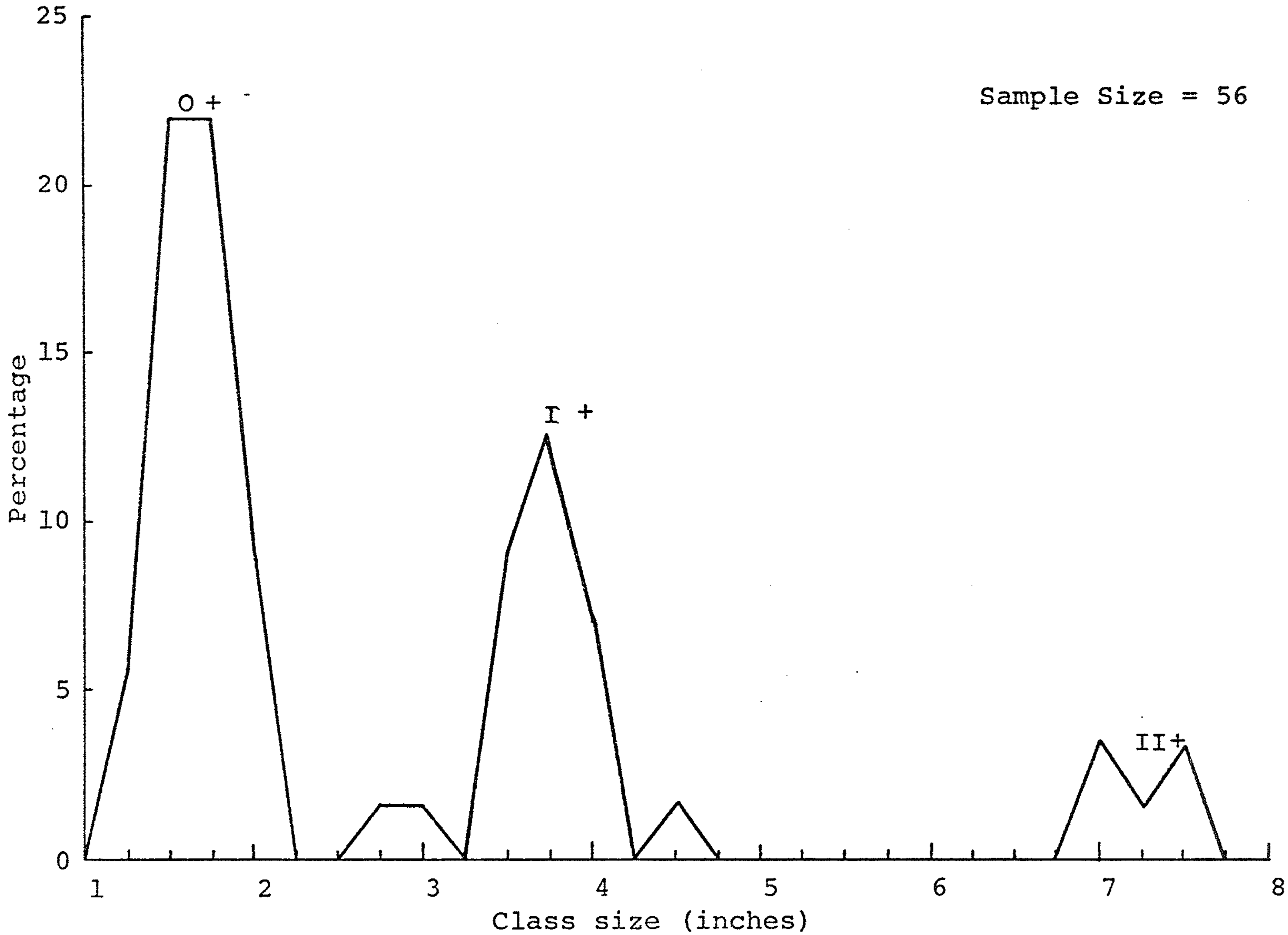

Figure 15: Length - frequency analysis of immature grayling taken from Beaver Creek, August 1971.

Since the habitat rating derived in the present study differs from that presented by Robertson (1970) this aspect warrants separate discussion.

B. Habitat Ratings

The 1970 study established a habitat rating of 70% of optimum and concluded the stream had excellent potential for salmonid production. In contrast, the current study has derived a value of 55%, or low quality rating for salmonid production (Appendix II). The discrepancy is due primarily to the higher pool area (68%) calculated in the present study. More slackwater areas, which are classed as pools, occurred at stations* established in this study, hence a larger pool environment. The lower reaches contain a much more favorable pool to riffle ratio; however, the rating includes the entire area of the river to be altered by the development. The aerial survey revealed slackwater as the predominant habitat type extending some 30 miles upstream from the plant site. However, data presented in this report are accurate only for the study area and the foregoing is a general observation of the major habitat condition upstream on the creek.

We do not feel that difference in flow conditions between the time of the two studies is a significant factor influencing the habitat rating since pool:riffle separation is most evident during low water conditions which prevailed at the time of the survey.

Beaver Creek exhibits streamflow patterns typical of most small streams: high spring discharge, then dropping steadily throughout the summer except during periods of high precipitation when they rise slightly. Fluctuating water levels destroy bottom organisms, lowering the productivity of a stream. However, in general we consider that other factors discussed in this report have a more significant bearing on the fisheries of the stream than does the flow regime.

The chemical environment of the creek appears stable except for dissolved oxygen values which are minimal for salmonids in the slackwater. Total dissolved solids can be considered as a gross measure of the primary production of a stream. Generally, high productivity is associated with high total dissolved solids. Total dissolved solids vary according to many factors and differences in values between the 1970 study and current data can be attributed to the time of year. However, both studies indicate

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*Stations were set at one mile intervals to avoid biases.

SPECIES DISTRIBUTION ACCORDING TO HABITAT TYPES, BEAVER CREEK, AUGUST 1971

A. WATER TYPE

Species	Type				
	Slackwater	Riffle	Backwater	Beaver Dam	Pool
Grayling	0%	12.5%	3.5%	0%	84.0%
Chub	19.0%	5.0%	0%	6.5%	69.5%
Sucker	19.0%	3.5%	0.5%	70.0%	70.0%
Other	0%	25.0%	0%	0%	75.0%

B. WATER DEPTH

Species	Depth				
	1'	2'	3'	4'	5'
Grayling	31.5%	5.0%	58.5%	0%	5.0%
Chub	14.0%	9.0%	74.0%	24.0%	10.0%
Sucker	16.0%	11.5%	57.0%	9.5%	6.0%
Other	37.5%	0%	50.0%	12.5%	0%

C. SUBSTRATE TYPE

Species	Type				
	Silt	Sand	Gravel	Rubble	Boulder
Grayling	17.0%	64.0%	0%	22.0%	17.0%
Chub	35.0%	2.0%	9.5%	43.0%	10.5%
Sucker	27.0%	11.0%	5.0%	37.0%	20.0%
Other	0%	50.0%	12.5%	25.0%	12.5%

relatively high T.D.S. values. These values of potential productivity are not reflected in actual fisheries production. This is attributed to habitat factors such as the pool:riffle ratio, generally low substrate quality and low dissolved oxygen values at certain times of the year.

C. Prima Cord Explosives as a Sampling Tool

The advantage of prima cord as a sampling device is that a collector can obtain more fish, more quickly, over a larger area, than other conventional sampling methods. The species selectivity and lethal range of prima cord is largely unknown, therefore data are subject to possible biases. In most of the blasts conducted, however, size or species selectivity did not appear significant. Some bias can occur depending upon the site chosen for blasting. In pool areas all dead fish do not surface after the blast and may be missed by the collector. On the other hand, blasts set in fastwater results in fish drifting downstream before being collected. Despite these inherent limitations, the prima cord technique has less serious biases than conventional methods and we consider that a representative sample of the fish populations of Beaver Creek was obtained during the survey.

D. Sport Fisheries Potential

Forage and coarse fish are the most abundant species in Beaver Creek. Suckers and chub represent 88% of the total species composition and we conclude that these are the major species present in the stream. Of the fish collected, grayling and pike are considered sport fish. However, both species were negligible in occurrence. Arctic grayling, of catchable size, which can be considered the most desirable species present, represented less than one percent of the fish taken.

Available data are insufficient to quantify factors limiting grayling. However, we believe that a combination of habitat and food restrictions are the main limiting factors.

Arctic grayling require small gravel or sand substrates on which to spawn. This type of substrate on Beaver Creek is estimated at 5% of the total stream bed, confined mainly to the lower reaches. Silt substrates, which are unsuitable for the survival of grayling eggs, are estimated at 50%, mainly occurring 10 - 40 miles upstream where the creek is almost entirely slackwater. Data on water chemistry indicated low dissolved oxygen concentrations occur in the slackwater areas. Concurrent with dissolved oxygen values as low as 4 ppm, saturation values as low as 45% were recorded. The most common condition was 6 ppm and 65% saturation. These low values likely result from a combination of factors including:

a) Abundant streamside cover, (Fig. 2), which may inhibit wind action.
b) The low gradient of the stream in its upper reaches.
c) The presence of numerous beaver dams which would tend to produce low oxygen concentrations.

Composition of benthic invertebrate samples indicate food may be limited in the Beaver River. Robertson (1970) found low numbers of benthic organisms and attributed it to sampling phenomenon. Our sampling also produced low numbers in both rubble and tar sand substrate. Since the two independent samples agree with one another, it is likely that insect production is actually low rather than a sampling phenomenon. Numbers of insects in drift samples support this interpretation. Production of benthic organisms in riffle areas over rubble-tar sand substrates was negligible, while over straight rubble areas, invertebrate numbers increased by a factor of three to five times. However, in terms of volume and numbers, invertebrate production is generally low even in areas of suitable habitat.

E. The Value of Beaver Creek for Sport Fishing

Data obtained in the present study clearly indicate that the occurrence of harvestable sport fish species is negligible in Beaver Creek. An earlier survey of Beaver Creek conducted by the Alberta Fish and Wildlife Division (Robertson, 1970) rated the stream as having an excellent potential for salmonid production but quantitative data on the fisheries of the Creek were not presented in that study. Results presented by Robertson did show that angling was unproductive when attempted during that study.

Discussions with local anglers support the contention that fishing for grayling is poor in the stream. It appears that while occasional creel size grayling and pike occur, these individuals are widely distributed and present in very low numbers through the system.

The lack of a catchable population precludes any economic analysis predicated on the existence of harvestable fish stocks. Any attempt to assign dollar values to the stream based entirely on sport fishing capability would be hypothetical since the basic requirement (sport fish available for harvest) is lacking.

We interpret that present recreational use reflects aesthetic considerations more so than an attraction provided by opportunities to catch fish. The lower reaches of Beaver Creek have desirable aesthetic attributes--scenery, and diverse terrain which contribute to present recreational use. It is significant that a high proportion of activities associated with the river at existing access points are related to recreation apart from angling. While access is presently limited, it appears that existing demands on the area are light. The use survey was conducted during the time of year when outdoor activities are most prevalent, therefore results obtained would reflect the importance of the area to residents of Ft. McMurray.

In summary, the data obtained indicates little basis upon which to place an economic value on sport fishing. The sporadic distribution of suitable species and their low numbers indicates that Beaver Creek has an extremely low capability for sport fishing. The use and significance of the creek to grayling populations is discussed in the following section.

F. The Impact of the Tar Sands Development on Beaver Creek

Evidence collected during this study indicates that Arctic grayling production is low; however, this species utilizes Beaver Creek as a spawning and rearing area. The presence of young-of-the-year fish all taken from similar habitat is evidence of a spawning run. Since grayling are a spring spawning species, no indication of the size of the run could be obtained from our investigation. Presumably adult fish move up Beaver Creek from the Athabasca River in the spring, spawn, and then return gradually to the Athabasca. The majority of the habitat suitable for spawning grayling occurs in the lower ten miles where pool:riffle ratios, cover, and substrate are favorable. The construction of a retention pond and dam upstream of the recreation area would eliminate the main rearing area mentioned and effectively obstruct any spawning migrations into the upper reaches of the creek, thus eliminating any existing grayling population.

The impact on other fish populations would be similar downstream of the dam. In the upper reaches, the impact of Syncrude's proposed development would not likely affect existing populations of suckers and chub.

APPENDIX I

POOL DESIGNATIONS

Quality Class No.	Length or Width	Depth	Shelter[1]
1	Greater than a.c.w.[2]	2' or deeper	Abundant[3]
	Greater than a.c.w.	3' or deeper	Exposed[4]
2	Greater than a.c.w.	2' or deeper	Exposed
	Greater than a.c.w.	Less than 2'	Intermediate[5]
	Greater than a.c.w.	Less than 2'	Abundant
3	Equal to a.c.w.	Less than 2'	Intermediate
	Equal to a.c.w.	Less than 2'	Abundant
4	Equal to a.c.w.	Shallow	Exposed
	Less than a.c.w.	Shallow	Abundant
	Less than a.c.w.	Shallow	Intermediate
	Less than a.c.w.	Less than 2'	Intermediate
	Less than a.c.w.	2' or deeper	Abundant
5	Less than a.c.w.	Shallow	Exposed

[1]Logs, stumps, boulders and vegetation in or overhanging pool, or overhanging banks.

[2]Average channel width.

[3]More than one-half perimeter of pool has cover.

[4]Less than one-quarter of pool perimeter has cover.

[5]One-quarter to one-half perimeter of pool has cover.

APPENDIX II

CALCULATION OF HABITAT PERCENT OF OPTIMUM

Number of square feet of pool = 39,387

Number of square feet of riffle = 18,113

Number of square feet of total sample = 57,500

Therefore, pool area is 68% of total sample area.

Riffle area is 32% of total sample area.

1) Pool Measure:

When total area of pool is this percent of sample total area	Then rating % is:	When total area of pool is this percent of sample total area	Then rating % is:
50	100	25 or 75	50
49 or 51	98	24 or 76	48
48 or 52	96	23 or 77	46
47 or 53	94	22 or 78	44
46 or 54	92	21 or 79	42
45 or 55	90	20 or 80	40
44 or 56	88	19 or 81	38
43 or 57	86	18 or 82	36
42 or 58	84	17 or 83	34
41 or 59	82	16 or 84	32
40 or 60	80	15 or 85	30
39 or 61	78	14 or 86	28
38 or 62	76	13 or 87	26
37 or 63	74	12 or 88	24
36 or 64	72	11 or 89	22
35 or 65	70	10 or 90	20
34 or 66	68	9 or 91	18
33 or 67	66	8 or 92	16
32 or 68	64	7 or 93	14
31 or 69	62	6 or 94	12
30 or 70	60	5 or 95	10
29 or 71	58	4 or 96	8
28 or 72	56	3 or 97	6
27 or 73	54	2 or 98	4
26 or 74	52	1 or 99	2
		0 or 100	0

2) Pool Structure = % rating of pool measure (1 above) X

$$\frac{\text{total ft. of Quality Class 1, 2, 3 rated pools}}{\text{total ft. in pools}}$$

$$= 64 \times \frac{1471}{1800}$$

$$= 52.5\%$$

3) Stream Environment $= \frac{\text{total points of bank observation}}{\text{max. possible points if all forested}} \times 100$

$$= \frac{26}{36} \times 100$$

$$= 72.2\%$$

4) Stream Bottom $= \frac{\text{ft. of gravel and ft. of rubble}}{\text{total ft. in sample}} \times 100$

$$= \frac{30 + 540}{1800} \times 100$$

$$= 31.7\%$$

5) Habitat Percent of Optimum

$$= \frac{\text{pool measure + pool structure + stream bottom + stream environment}}{400}$$

$$= \frac{64 + 52.5 + 31.7 + 72.2}{400}$$

$$= 55\%$$

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SECTION I

ECOLOGICAL BASELINE INFORMATION

3. MIGRATORY WATERFOWL AND THE SYNCRUDE TAR SANDS LEASE: A REPORT

September, 1973

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T A B L E S

F I G U R E S

INTRODUCTION:

Early in its developmental operations on the Athabasca Tar Sands, Syncrude Canada Ltd. has shown concern for the ecological effects of its operations. In the Spring of 1971, the management of Syncrude contacted Renewable Resources Consulting Services regarding assessments of potential ecological impacts on the lease area. As a result, a preliminary investigation of ecological relationships was undertaken in July of 1971. This was followed by other surveys to assess fisheries, wildlife (including waterfowl) and the general ecological conditions of the Boreal Mixedwood Forest Ecosystem in which Lease #17 is located.

An attempt was made to identify potential areas of concern during the preliminary investigation of the development. Assessments of potential conflicts between resource extraction operations and the functioning of ecological relationships on the lease area were initiated. These preliminary investigations were not considered to represent quantitative or qualitative statements of ecological impacts, but were made primarily to determine whether or not significant potential problems existed.

Although many of the principles which govern ecological relationships among organisms living within a physical environment are well known, how these principles apply to the

Athabasca Tar Sands area is not known. Therefore, in order to evaluate the effects and impacts on a particular activity, it is necessary to know the conditions and interrelationships of the "baseline" or undisturbed ecosystem. These baselines must be established to provide a control against which the effects of activities can be measured.

As the ecosystem pertains to wildlife, an analysis of both primary and secondary consumers is required. This means that food chain and food web relationships, based on information from the vegetation survey, must be approximated for each habitat type. The presence, distribution, and population dynamics of all major species and representative minor species should be evaluated over the long term (Ca. 10 years). Preliminary investigation should delineate habitat types and the animals indigenous within the type.

Mapping of key winter ranges is essential to any ecological study. The distribution and cyclic densities of upland game birds should be determined. Requirements for nesting and their relationship to other factors within the community must be understood. Presence and chronology of waterfowl species should be determined. It is essential to know whether observed waterfowl are summer residents or simply migrants within the study area.

The factors of natural environmental resistance and potential productivity must be assessed and estimations made of the population's biotic potentials. In addition to this, the present carrying capacity of the habitat must be determined in order to evaluate the extent of changes brought about by future human action. This report is a first order estimate.

OBJECTIVES:

Objectives of the waterfowl surveys are:

1.) To monitor waterfowl migrations through the Syncrude Lease 17 and general area during all seasons of use.
2.) To establish the locations and intensity of use.
3.) To document the chronology of migration through the area.
4.) To determine the key areas used during the migration.
5.) To further examine the implications of the Syncrude development upon waterfowl.
6.) To suggest mitigative measures, if any, that might be taken.

METHODS:

In October, 1971, two aerial surveys of waterfowl were made to determine the use of the Syncrude lease area by fall migrants. Three hundred and two mallards were observed on Mildred Lake during the first survey and none during the second. In general, it was concluded that the Ft. McMurray region is not a heavily used migration stopover during the late autumn. Waterfowl that had migrated at this time are believed either to have flown non-stop through the area to the south, or flown southeast from the Athabasca Delta through the province of Saskatchewan. The Fish and Wildlife Officer at Ft. McMurray stated that the movement of geese through the area had occurred almost two weeks earlier. However, neither he nor the local residents observed any large migration of ducks through the area.

The survey was undertaken in a Cessna 180 flown by Brandon Zimmerman of Gateway Aviation. Observers were R. D. Jakimchuk, C. Surrendi and K. Baker. The survey began at 9:50 A.M. and travelled from Ft. McMurray north along the Athabasca River. An altitude of approximately 200 feet and speed of 100 m.p.h. was maintained.

All lakes, from Ft. McMurray to McLellan had open water as did the Athabasca River. Visibility was excellent despite an overcast ceiling. There was not snow in the lease area although 30 miles north snow cover was encountered. A considerable amount of fresh snow was observed south of Ft. McMurray. Many of the lakes and marshes between Edmonton and Ft. McMurray were partially or completely frozen.

No birds were observed along the Athabasca River in checkpoints 1 through 4. Checkpoint 4 was a small marsh adjacent to the Athabasca River (Figure 4). Two female moose (a cow and yearling) were observed on an island at checkpoint 3. The plane was then flown over Horseshoe Lake (checkpoint 5) which contained 40 mallards on its southwest end and 40 more mallards on its southest portion. Mildred Lake (checkpoint 6) was occupied by 300 mallards along the east shore, 5 unidentified (probably mallards) on its north end, and 1 pair unidentified, 1 pair mallards and 1 pair of unidentified loons or grebes along the west side.

The survey then progressed to marshy Saline Lake on the east side of the Athabasca River (checkpoint 7). However, no waterfowl were observed at this checkpoint. A small marsh just south of Saline Lake (checkpoint 8) contained one flock of 15 mallards and a second group of eight. Checkpoint 9 (Ruth Lake) contained only 3 common loons. Checkpoints 10 and 11 were small lakes between Ruth Lake and Mildred Lake. These had no waterfowl. From this point the Beaver River was flown to its confluence with the Athabasca River (checkpoint 12). No waterfowl were observed on the Beaver River. Checkpoint 13 (McLelland Lake) to the north and east of Ft. McKay was surveyed next. It was felt that this lake, because of it's large size, might attract large numbers of waterfowl. However, only 1 group of 40 mallards and 1 group of 15 mallards were seen.

Since few waterfowl were seen on the survey, it appeared that the main migration had occurred early. The radio operator at the Ft. McMurray airport was interviewed for additional information. However, he did not know of any large movements of waterfowl through the area. The nearest radar facility is at Cold Lake and data from that area would not be useful in assessing migrations through the Ft. McMurray area.

A second aerial survey was conducted on October 27, 1971 to try to determine the amount of use made by staging waterfowl of the area in and around the Syncrude Lease near Ft. McMurray. The survey was undertaken following a report that freeze-up had occurred in the Peace-Athabasca Delta region, and in anticipation of southward migrations from the delta which might pass through the study area.

This survey was conducted in a Cessna 185 chartered from Contact Airways, Ft. McMurray and flown by Jack Bergeron. The observer was Keith Baker. The survey started at 10:00 A.M. at Ft. McMurray then travelled down the Athabasca River. The sky was overcast but visibility was excellent. An elevation of 200 feet and a speed of 100 m.p.h. were maintained during the survey.

A snow storm that had started around 2:30 P.M. the previous afternoon finished in the early morning leaving one half inch or more of snow on the ground. The last several days had been quite cool and the whole area was starting to freeze up. The Clearwater River was choked with large pieces of ice and the water flowing between the shore and sand bars was completely frozen over. The Athabasca River was also in the above semi-frozen state while most small ponds were completely frozen over.

The waterfowl survey began at the point where Clearwater River meets the Athabasca River and the plane progressed northward along the Athabasca River. Along checkpoints 1 through 3 (Figure 4) no waterfowl were observed and only 15 ravens, all in one flick, were seen. Checkpoint 4, a small marsh on the east side of the Athabasca River, was completely frozen over. A cow moose with twin calves was seen lying on the north end of this marsh. The Survey then progressed to Horseshoe Lake (checkpoint

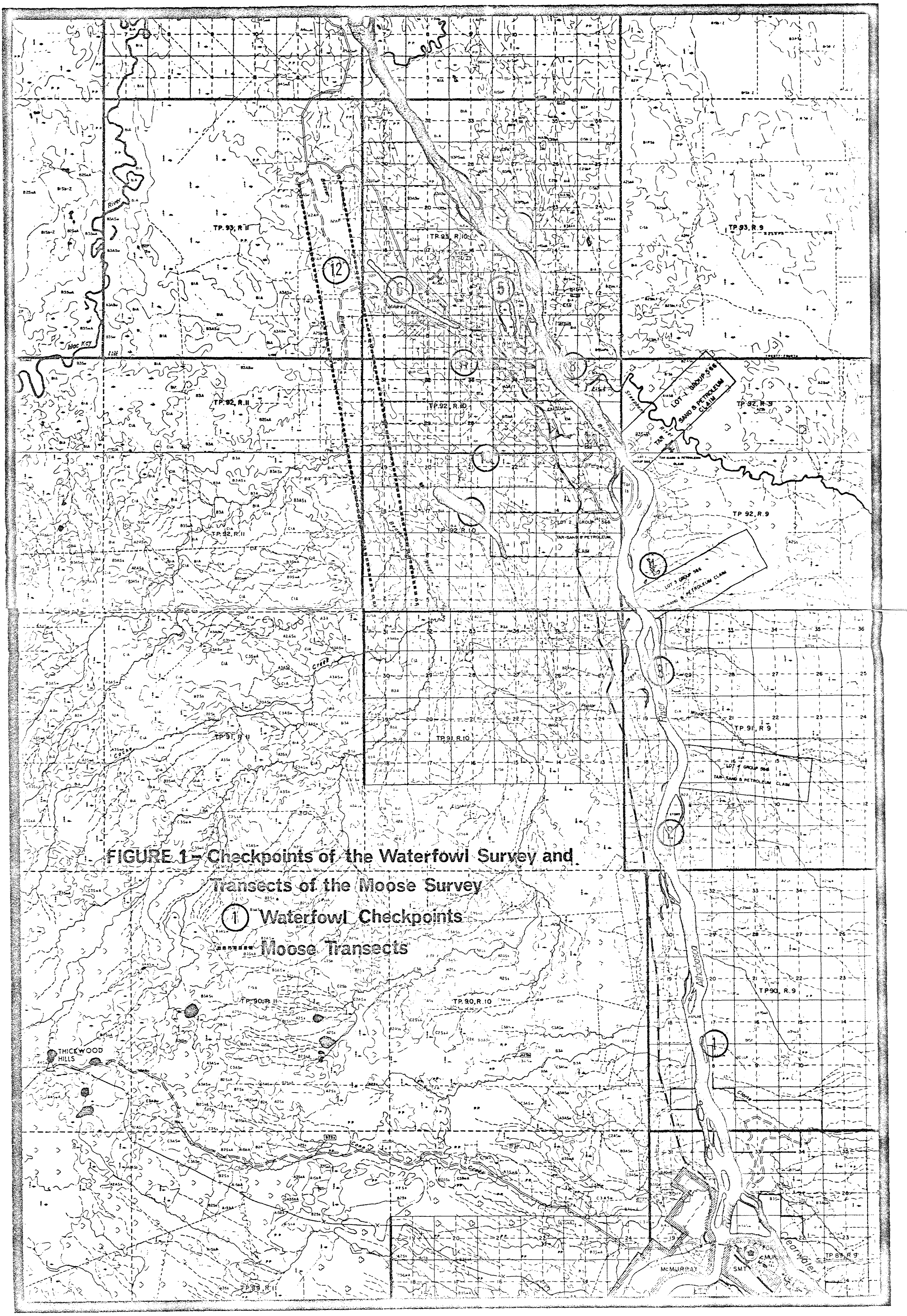


FIGURE 1 - Checkpoints of the Waterfowl Survey and Transects of the Moose Survey

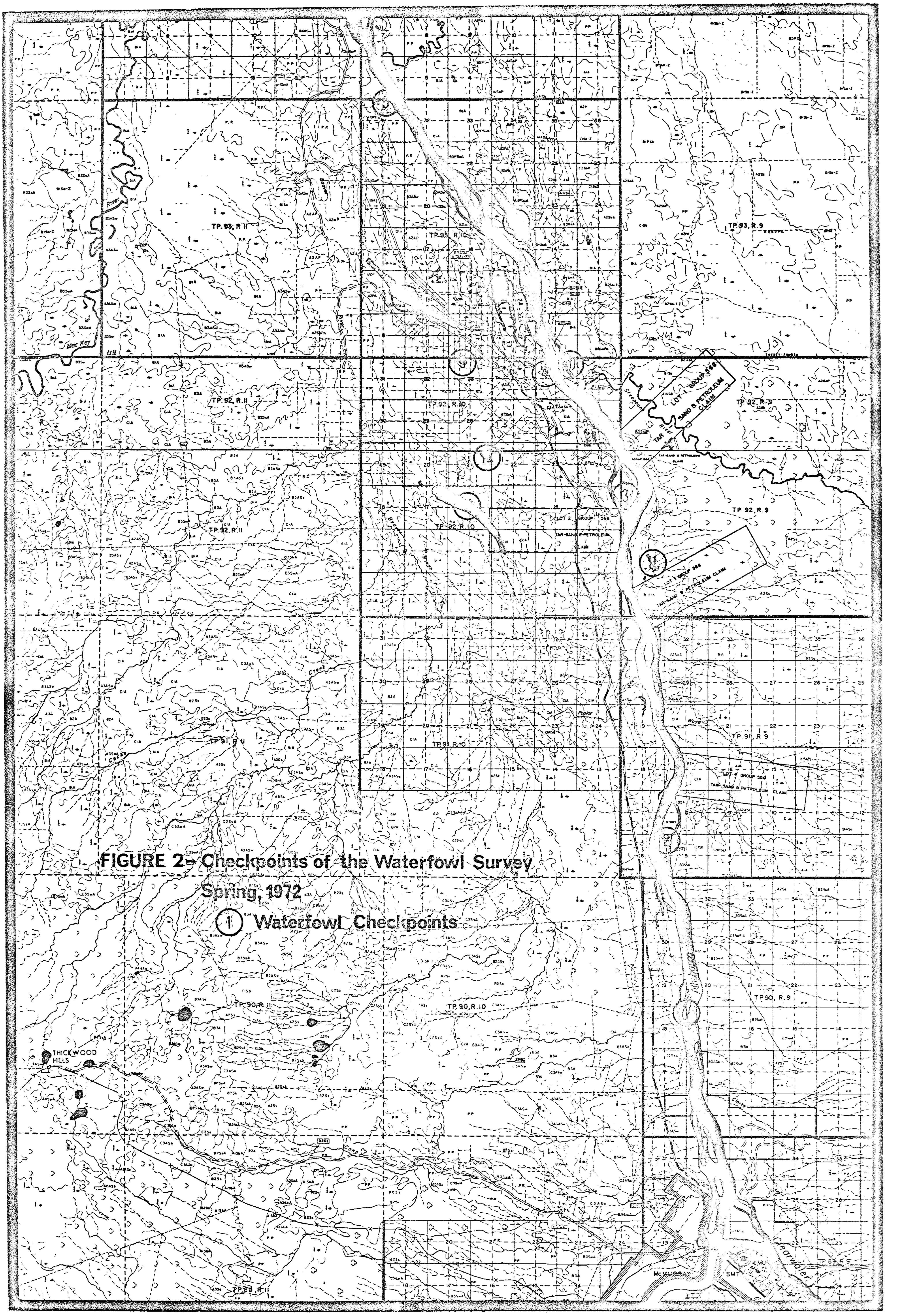


FIGURE 2– Checkpoints of the Waterfowl Survey

Spring, 1972

(1) Waterfowl Checkpoints

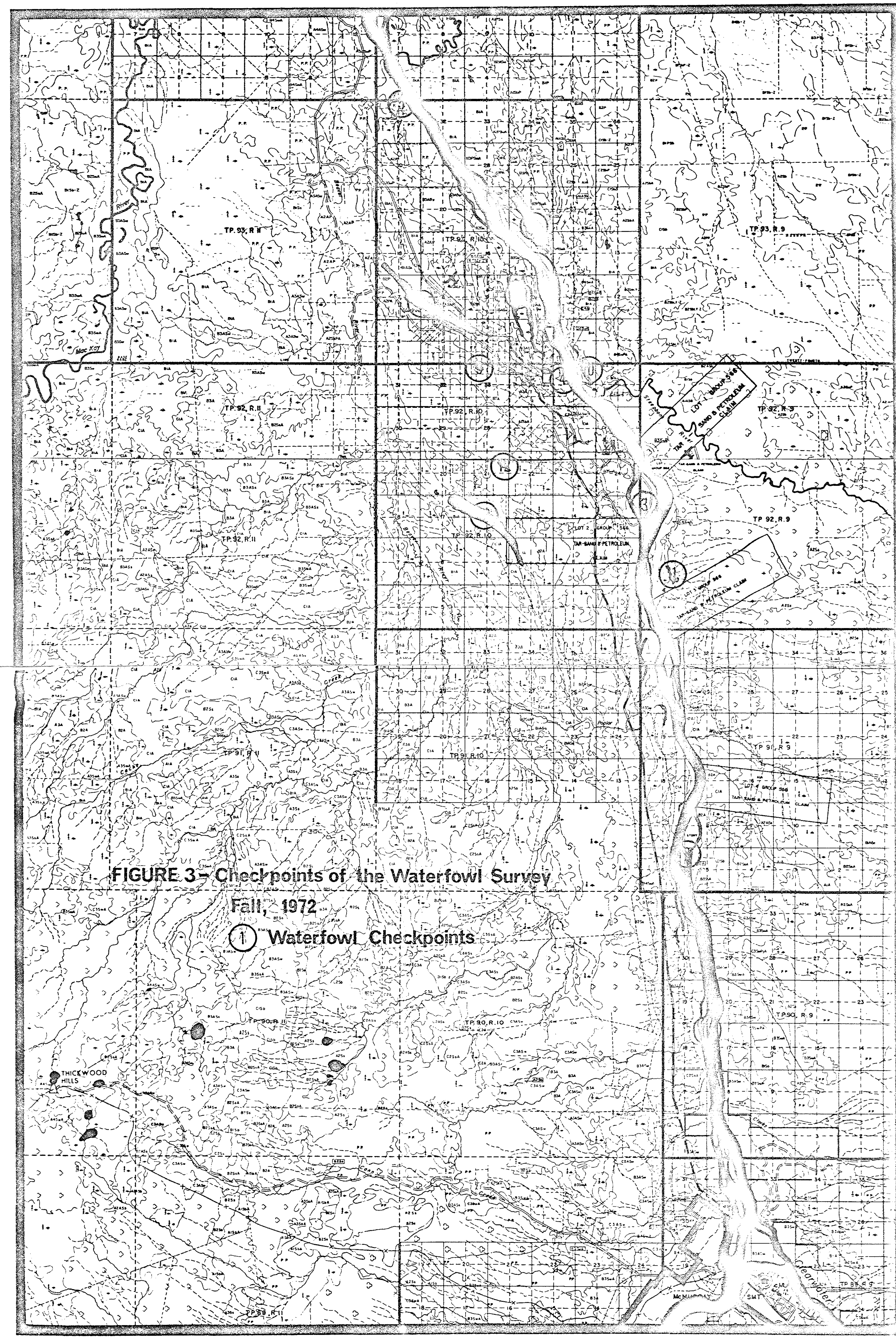


FIGURE 3 – Checkpoints of the Waterfowl Survey
Fall, 1972
1 Waterfowl Checkpoints
TP. 93, R. 11
TP. 93, R. 10
TP. 93, R. 9
TP. 92, R. 11
TP. 92, R. 10
TP. 92, R. 9
TP. 91, R. 11
TP. 91, R. 10
TP. 91, R. 9
TP. 90, R. 11
TP. 90, R. 10
TP. 90, R. 9
TP. 89, R. 11
LOT 2 GROUP 566
TAR-SAND & PETROLEUM CLAIM
LOT 4 GROUP 566
THICKWOOD HILLS


TP. 93, R. 11
TP. 93, R. 10
TP. 93, R. 9
TP. 92, R. 11
TP. 92, R. 10
TP. 92, R. 9
TP. 91, R. 11
TP. 91, R. 10
TP. 91, R. 9
TP. 90, R. 11
TP. 90, R. 10
TP. 90, R. 9
TP. 89, R. 11
LOT 1, GROUP 566 TAR SAND & PETROLEUM CLAIM
LOT 2, GROUP 566 TAR SAND & PETROLEUM CLAIM
LOT 3 GROUP 566 TAR SAND & PETROLEUM CLAIM
LOT 4 GROUP 566 TAR SAND & PETROLEUM CLAIM
THICKWOOD HILLS
FIGURE 4 – Checkpoints of the Waterfowl Survey
Spring, 1973
1 Waterfowl Checkpoints

5) which also was frozen and contained no waterfowl. Checkpoint 6 was Mildred Lake which was frozen over at both ends but open in the middle. Again no waterfowl were observed and the plane was flown to Saline Lake (checkpoint 7). On one of the numerous patches of open water on this lake 9 mallards were observed. Checkpoint 8, the small marsh south of Saline Lake, was almost totally frozen and contained no waterfowl. The Beaver Creek (checkpoint 12) was also almost completely frozen over and no waterfowl were seen on the river.

The waterfowl survey continued to McLelland Lake. The lake was two-thirds frozen and no birds were seen. Since the entire region was largely frozen, and no evidence of significant migrating populations was obtained, aerial surveys for waterfowl were discontinued. Waterfowl that were migrating at this time are believed either to be flying non-stop through the area to the south, or from the Athabasca Delta southeast through Saskatchewan.

In an attempt to get information on waterfowl migrations in the area, Fish and Wildlife Officer, A. Boggs, was contacted and interviewed. He stated that movements of geese through the area had occurred almost two weeks earlier. This was also mentioned by the pilot during the aerial survey. Numbers of geese moving down the river were probably relatively small in 1971, although the pilot indicated large numbers encountered along the river in previous years. No estimate of actual numbers is available. Mr. Boggs and Mr. Bergeron did not notice any large migration of ducks through the area.

A summary of results for both surveys is presented in Table 10.

From April 28 to June 2, 1972, a spring waterfowl study was carried out on Syncrude Lease #17 and surrounding area. This study showed that the Syncrude lease and surrounding area is not a major spring staging area but does have fair use as a stopover for 28 species of ducks.

Few geese, swans, sandhill crances and great blue heron stopped over. The majority of ducks were distributed on Mildred, Ruth, Horseshoe and Saline Lakes and the Athabasca River, proximal to the proposed Syncrude development. Problems involving waterfowl and the Syncrude tailings pond are thus anticipated during spring migration.

In the spring of 1972, intermittent contact was kept with Mr. A. Boggs, Fish and Wildlife Officer at Fort McMurray on any spring movements of waterfowl into that area. Aerial waterfowl counts were begun on April 28. Flights were made intermittently every 3 - 5 days until June 2. A Cessna 185 from Contact Airways at Fort McMurray was used with Wayne McCrory as observer. An altitude of approximately 200 - 300 feet and a speed of 100 m.p.h. was maintained with reduced speeds over areas where concentrations of waterfowl occurred. Flights were usually made in the morning. Records were kept of other wildlife noted during the flight.

The flight route covered the west side of the Athabasca River from Fort McMurray downriver to the mouth of the Beaver River, a distance of 28.5 miles. Lakes and sloughs on the west side of the Athabasca were then surveyed. Then the east side of the Athabasca was covered upriver to Fort McMurray with a survey of lakes and sloughs on the east side of the Athabasca River.

During the fall 1972 survey, aerial waterfowl counts were initiated on September 18th, and carried out twice weekly. Until October 5th, a Cessna 185 floatplane was used. From October 12th onwards, a Cessna 185 on wheels was used. Both aircraft were chartered out of Fort McMurray from Contact Airways.

Chronology of Break-Up And Freeze-Up on Study Area, 1972

CHECKPOINT	NAME	BREAK-UP	FREEZE-UP
1 - 5	Athabasca River	April 28 - Open for 1 - 2 miles below G.C.O.S. plant. May 3 - River broken up and nearly free of ice flows.	October 10 to October 23: 10% frozen, mostly along shore. Some ice floating down river. October 26: 20% frozen.
6	Saline Lake	Partially open on May 3 All ice-free by May 8	20% frozen on October 12 95% frozen on October 26
7	Horseshoe Lake	Partially open by April 27 Nearly all open on May 3	90% frozen on October 12 100% frozen on October 16
8	Mildred Lake	60% open on May 8 100% open on May 9	30% frozen on October 12 99% frozen on October 26
9	Slough near Mildred Lake	Frozen on May 3 Open on May 8	100% frozen on October 12
10	Slough across from Syncrude	Frozen on May 3 Open on May 8	50% frozen on October 12 100% frozen on October 16 97% frozen on October 26
11	Slough across from G.C.O.S.	Frozen on May 3 Open on May 8	100% frozen on October 12
12	Slough near Ruth Lake	Closed on May 8 Open on May 11	100% frozen on October 12
13	Ruth Lake	Partially open on May 8 Open on May 11	95% frozen on October 26

The same study area and checkpoints were used in the Spring '72, Fall '72 and Spring '73 surveys (R.R.C.S., 1972) and are as follows:

Checkpoint 1: Fort McMurray to Poplar Island (5 miles).
" " 2: Poplar Island to Stony Island (4.5 miles).
" " 3: Stony Island to Great Canadian Oil Sands (G.C.O.S.) tailings disposal pond (8 miles).
" " 4: G.C.O.S. to Syncrude river landing (4 miles).
" " 5: Syncrude to mouth of Beaver Creek (7 miles).
" " 6: Saline Lake.
" " 7: Horseshoe Lake (Sometimes included small lake to north).
" " 8: Mildred Lake.
" " 9: Small lake to south of Mildred Lake.
" " 10: Slough across from Syncrude on East side of Athabasca River.
" " 11: Slough upstream from G.C.O.S. on East side of Athabasca River
" " 12: Small lake to north-east of Ruth Lake.
" " 13: Ruth Lake.

Some checkpoints varied from the checkpoints used in the October 1971 study because of a change in the aerial survey route.

Ground observations were made on either Horseshoe Lake or Mildred Lake to correlate with aerial counts and to determine breeding activity.

The study area was initially chosen to cover not only Lease 17 but also the area felt to be within the sphere of influence of developments on the lease. Also a better understanding of migratory patterns of waterfowl along the corridor of the Athabasca River was obtained by selecting a general study area rather than confining the study only to Lease 17.

More difficulty was encountered in identification of certain species during this fall survey than in the spring because many of the birds, expecially the males, had not molted into full autumn plumage. Juvenile birds were also difficult to specify. For example, the white wing speculum of widgeon is one of the most positive means of identification from aircraft. However, during the fall, juvenile widgeon have very little white on their specula.

In addition, fall waterfowl were generally in larger flocks, sometimes composed of a variety of species. Thus, some guess work was necessary in estimating numbers of each species. Occasionally, air turbulence and poor visibility precluded any positive identification of species.

For the purposes of this report it is not thought that errors in identification and biases in estimating numbers would affect the results and conclusions; unless otherwise noted in the text.

No ground counts were made during the fall '72 survey.

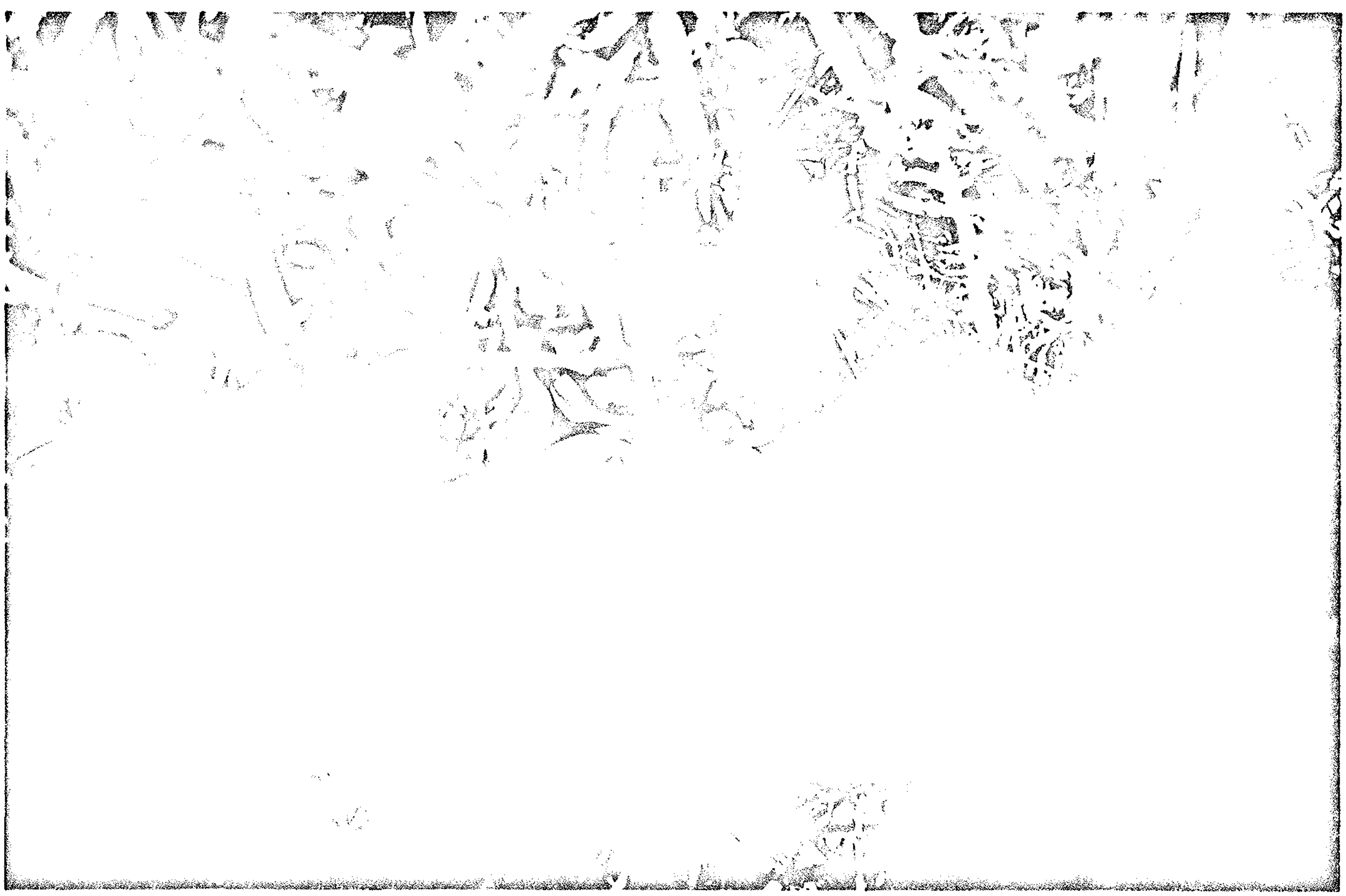
In the spring of 1973, a slightly different approach was taken from that used by the observer of last year. More passes were made over an area when waterfowl were not immediately identifiable. Frequently, waterfowl were concentrated in groups which were composed mainly of one or two species, with a few individuals of other species mixed in. On the first pass, the majority of the waterfowl would be identifiable, and it would be the less common or less easily identified birds that would be enumerated on subsequent passes. This resulted in slightly longer flights and a much lower percentage of unidentified waterfowl.

THE STUDY AREA:

Syncrude Lease #17 is less than 100 miles straight south of the large Athabasca-Peace River Delta waterfowl staging area. Staging area, as used in this report, refers to an area where large numbers of migrant waterfowl build up before moving on. Stopover refers to areas where migrant waterfowl rest and feed but do not build up great numbers. Waterfowl rest and feed but do not build up great numbers. Waterfowl from the four major North American flyways stage extensively in the Delta region. The proxmity of the Syncrude lease to this major staging area has led the present study of waterfowl migration through the area.

Upstream from Fort McMurray the Athabasca River flows through a long section of rapids. Downstream, the river is more slack, flowing through a series of open bars and wooded islands, and thus is more suitable for waterfowl than the upstream portion.

Most of the waterfowl which pass thru the Tar Sands area nest in the Athabasca Delta to the north of Lease 17. This area is one of the major "duck factories" of North America. Careful attention is being paid to the hydrology of the Athabasca River as it affects "the Delta".



Five open sloughs including checkpoints 10 and 11 are found along the river bottom between Fort McMurray and the mouth of Beaver Creek. In addition, four lakes of approximately 300 acres or more (Saline, Horseshoe, Mildred and Ruth) are located within a 3-mile radius of the proposed tailings pond. This is the greatest concentration of small lakes along the Athabasca River for at least 50 miles in either direction from the Syncrude Lease.

Mildred Lake and Horseshoe Lake are located on Lease #17. Horseshoe Lake and Saline Lake, on the east side of the river, are located along the river bottom and are thus open in advance of lakes away from the river bottom. This enhances the attractiveness of the area near the Syncrude Development for early spring use by migrant waterfowl.

Detailed vegetative descriptions of Mildred and Horseshoe Lakes are given in "The Habitat of Syncrude Lease #17" (Syncrude Canada Ltd. 1973). The lakes and sloughs in the study area are far more attractive to waterfowl as stopover areas than as nesting habitat. Horseshoe Lake, part of Saline Lake, and some of the small sloughs along the Athabasca River bottom are fairly shallow and thus offer good stopover habitat for "dabbling" ducks. Ruth Lake, Mildred Lake, and part of Saline Lake are deeper and thus offer good stopover habitat for "diving" or bay ducks.

In addition, Beaver Creek (especially the areas with Beaver dams), the MacKay River, and some minor sloughs offer limited stopover habitat to waterfowl on Lease #17.

DISCUSSION AND RESULTS:

Data obtained on both surveys indicate that the Ft. McMurray region in general is not a heavily used migration stopover during the late autumn. The 302 mallards observed on Mildred Lake in the first survey was the largest number of ducks observed within the area. These birds likely represent a migrating flock since observations made on Mildred Lake during the summer did not reveal any more than a few scattered waterfowl, and these were primarily diving ducks. It is likely therefore that lakes and marshes in the area are used to some extent by migrating waterfowl, which probably originate in the Athabasca Delta. However, present evidence indicates that the area is insignificant as a staging or resting area for these populations. The largest proportion of migrants either overfly the area en route to grain growing areas further to the south or utilize a route southeast from the delta passing through Saskatchewan. Since the area was surveyed immediately following reports of an exodus of waterfowl from the delta following freeze-up, any sustantial use of the area would have been observed.

According to information obtained from a Ducks Unlimited observer at Ft. Chipewyan, in 1971, resident (nesting) waterfowl in the Athabasca delta gradually migrated south during September and October. A build up of populations from the north then occurred in the delta and these birds remained until approximately October 24th when freeze-up was general,

Table 1: List of common names, abbreviations and scientific names of waterfowl and other species of birds observed during spring waterfowl surveys on the Syncrude study area, 1973:

COMMON NAME	ABBREVIATION	SCIENTIFIC NAME
Common Loon	Loon	*Gavia immer*
Red-necked Grebe	R.N.Gre	*Podiceps grisegena*
Pied-billed Grebe	P.B.Gre	*Podilymbus podiceps*
Mallard	Mal	*Anas platyrhynchos*
Gadwall	Gad	*Anas strepera*
Pintail	Pin	*Anas acuta*
Green-winged Teal	G.W.T.	*Anas carolinensis*
Blue-winged Teal	B.W.T.	*Anas discors*
American Widgeon	Wid	*Mareca americana*
Shoveler	Shov	*Spatula clypeata*
Redhead	Red	*Aythya americana*
Ring-necked Duck	Ring	*Aythya collaris*
Canvasback	Can	*Aythya valisineria*
Greater Scaup	Sc	*Aythya marila*
Lesser Scaup	Sc	*Aythya affinis*
Common Goldeneye	C.G.	*Bucephala clangula*
Bufflehead	Buf	*Bucephala albeola*
White-winged Scoter	W.W.Scot	*Melanitta deglandi*
Surf Scoter	S.Scot	*Melanitta perspicillata*
Ruddy Duck	Rud	*Oxyura jamaicensis*
Common Merganser	Mer	*Mergus merganser*
Red-tailed Hawk	R.T.H.	*Buteo jamaicensis*
Marsh Hawk	M.H.	*Circus cyaneus*
Whooping Crane	W. Cr	*Grus americana*
American Coot	Co	*Fulica americana*
Great Blue Heron	G.B.H.	*Ardea herodias*

Table 2: List of common names, abbreviated names and scientific names of waterfowl species observed during fall waterfowl survey on Syncrude study area, 1972.

COMMON NAME	ABBREVIATION	SCIENTIFIC NAME
Mallard	Mal	*Anas platyrhynchos*
Pintail	Pin	*Anas acuta*
Widgeon (Baldpate)	Wid	*Mareca americana*
Gadwall	Gad	*Anas strepera*
Shoverler	Shov	*Spatula clypeata*
Green-winged teal	Teal or GWT	*Anas carolinensis*
Blue-winged teal	Teal or BWT	*Anas discors*
Common Goldeneye	CG	*Bucephala clangula*
Bufflehead	Buf	*Bucephala albeola*
Lesser Scaup	Sc	*Aythya affinis*
Greater Scaup	Sc	*Aythya marila*
Ring-necked Duck	Ring	*Aythya collaris*
Canvasback	Can	*Aythya valisineria*
Redhead	Red	*Aythya americana*
Ruddy Duck	Rud	*Oxyura jamaicensis*
Common Merganser	Mer	*Mergus merganser*
White-winged Scoter	Scot	*Melanitta deglandi*
Common Scoter	Scot	*Oidemia nigra*
Surf Scoter	Scot	*Melanitta perspicillata*
Oldsquaw	Olds	*Clangula hyemalis*
Red-necked Grebe	Gre, Red N.	*Podiceps grisegena*
Horned Grebe	Gre	*Podiceps auritus*
Eared Grebe	Gre	*Podiceps caspicus*
Western Grebe	Gre	*Aechmophorus occidentalis*
Coot	Co	*Fulica americana*
Whistling Swan	Sw	*Olor columbianus*
Canada Goose	Cang	*Branta canadensis*
Unidentified	Unid	

Table 3: List of common names abbreviations and scientific names of waterfowl species observed during spring waterfowl survey on Syncrude study area, 1972.

COMMON NAME	ABBREVIATION	SCIENTIFIC NAME
Mallard	Mal	*Anas platyrhynchos*
Pintail	Pin	*Anas acuta*
Widgeon (Baldpate)	Wid	*Mareca americana*
Gadwall	Gad	*Anas strepera*
Shoveler	Shov	*Spatula clypeata*
Green-winged teal	Teal or GWT	*Anas carolinensis*
Blue-winged teal	Teal or BWT	*Anas discors*
Common Goldeneye	CG	*Bucephala clangula*
Bufflehead	Buf	*Bucephala albeola*
Lesser Scaup	Sc	*Aythya affinis*
Greater Scaup	Sc	*Aythya marila*
Ring-necked Duck	Ring	*Aythya collaris*
Canvasback	Can	*Aythya valisineria*
Redhead	Red	*Aythya americana*
Ruddy Duck	Rud	*Oxyura jamaicensis*
Common Merganser	Mer	*Mergus merganser*
Red-breasted Merganser	Mer	*Mergus serrator*
White-winged Scoter	Scot	*Melanitta deglandi*
Common Scoter	Scot	*Oidemia nigra*
Surf Scoter	Scot	*Melanitta perspicillata*
Oldsquaw	Olds	*Clangula hyemalis*
Red-necked Grebe	Gre, Red N.	*Podiceps grisegena*
Horned Grebe	Gre	*Podiceps auritus*
Eared Grebe	Gre	*Podiceps caspicus*
Western Grebe	Gre	*Aechmophorusoccidentalis*
Common Loon	Loon	*Gavia immer*
Coot	Co	*Fulica americana*
Harlequin Duck	Harl	*Histrionicus histrionicus*
Whistling Swan	Sw	*Olor columbianus*
Sandhill Crane	S Cr	*Grus Canadensis*
Great Blue Heron	GBH	*Ardea herodias*
Unidentified	Unid	

Table 4: Waterfowl and other birds observed during five aerial surveys of the Syncrude study area, 1973.

SPECIES	May 4	May 11	May 18	May 25	June 4	Total	
Common Loon	-	8	8	2	1	19	3.8
Red-necked Grebe	4	6	5	7	1	23	4.6
Pied-billed Grebe	-	-	-	-	-	1	.2
Mallard	154	146	133	143	42	618	123.6
Gadwall	-	2	4	20	8	34	6.8
Pintail	57	6	22	6	3	94	18.8
Green-winged Teal	58	18	4	3	2	85	17
Blue-winged Teal	2	-	7	4	4	17	3.4
American Widgeon	154	161	170	149	54	688	137.6
Shoveler	61	21	37	32	7	158	30.6
Redhead	-	21	1	22	-	44	8.8
Ring-necked Duck	-	-	-	12	14	26	5.2
Canvasback	18	30	5	10	6	69	13.8
Scaup[1]	245	234	294	205	158	1136	227.2
Common Goldeneye	294	177	334	211	63	1079	215.8
Bufflehead	23	35	28	29	24	139	27.8
White-winged Scoter	-	-	2	6	2	10	2
Surf Scoter	-	5	4	6	-	15	3
Ruddy Duck	3	-	-	5	-	8	1.6
Common Merganser	22	-	2	2	1	27	5.4
Red-tailed Hawk	1	-	-	-	-	1	.2
Marsh Hawk	3	-	1	2	-	6	1.2
American Coot	80	268	241	592	279	1460	292
Unidentified Waterfowl	8	1	1	-	3	13	2.6
Great Blue Heron	-	1	-	-	-	1	.2
TOTAL	1187	1140	1303	1469	672	5771	1154.2

[1] Mostly Lesser scaup.

Table 5: Summary of aerial surveys of waterfowl from September 18 to October 26, 1972

	Sept 18	Sept 21	Sept 25	Sept 28	Oct 2	Oct 5	Oct 12	Oct 16	Oct 19	Oct 23	Oct 26	Total	Avg. No. Flight (11 days)
Puddle Ducks:													
Mal	815	337	470	857	910	611	182	2	43	17	19	4263	387.5
Pin	4		95	282		44	20					445	40.5
Wid	257		580	122	103	199	37		12	1		1311	119.2
Gad	12					2						14	1.3
Shov	4				2	4						10	0.9
Teal	8			100	14	13						135	12.3
Diving Ducks:													
CG	2		95	31	50	17			26	5		226	20.5
Buf		60	8		6	2						76	6.9
Sc	508	512	670	1660	536	1	1492	736	1110	84	57	7366	669.6
Ring				3	400	250						653	59.4
Can					30	5			10	2		47	4.3
Red				85		104	20		40			249	22.6
Rud				1			1	2	2	1	2	9	0.8
Mer		18	49	4	17	10		28	16	69	6	217	19.7
Scot	6				17			7	53	2		85	7.7
Olds	10											10	0.9
Gre	1	1			1	2			1	1		7	0.6
Loon													0.0
Co	4				52	6	42		40	10		154	14.0
Harl													0.0
Others:													
Sw		2	2					1	2			7	0.6
S Cr													0.0
GBH													0.0
Cang	88	33	6	20	10	12						169	15.4
Unid	87 (49 Dab)	260 (Dab)		136	89 (55 Dab)	93 (33 Div) (31 Dab)						665	60.4
Total	1806	1223	1975	3301	2237	1375	1794	776	1355	192	84	16,118	1465.3

Table 6: SUMMARY OF AERIAL SURVEYS OF WATERFOWL FROM APRIL 20 to JUNE 2, 1972

SPECIES	*April 29 a.m.	May 3 a.m.	May 8 a.m.	May 8 p.m.	May 11 a.m.	May 11 p.m.	May 15 a.m.	May 18 a.m.	May 22 a.m.	May 25 a.m.	May 30 a.m.	June 2	**Total	Average No/ Day (10 days)
Puddle Ducks:														
Mal	59	113	95	59	128	97	100	148	135	150	162	54	1144	114.4
Pin	8		5		2		8	2	7	14	6		52	5.2
Wid		98	58	78	66	107	91	105	96	99	115	56	784	78.4
Gad									2		5		7	.7
Shov					2	1	10	7	12	16	23	2	72	7.2
Teal	6	18			5	21	42	23	21	24	23	20	182	18.2
Diving Ducks:														
CG	95	33	20	25	57	20	13	12	37	5	21	2	295	29.5
Buf		27	8	2	29	21	33	33	48	60	34	32	304	30.4
Sc[1]	14	57	35	659	777	840	1002	570	128	263	74	29	3349	334.9
Ring								3	2	20	60	14	99	9.9
Can		6	8	4	18	8	12	2	25	1	7	24	110	11.0
Red			5	4						3			8	.8
Rud									20		2	3	25	2.5
Mer[2]		8	14	32	22	47	53	83	107	112	73	94	566	56.6
Scot							12	3	17	3	10	4	49	4.9
Olds										11			11	1.1
Gre[3]			17	22	26	9	10	10	16	13	11	7	110	11.0
Loon[4]		1		3	7	4	10	10	10	11	10	2	62	6.2
Co				2			30		52	28	19	4	133	13.3
Harl											2		2	.2
Sw		2	2	12									14	1.4
S Cr							3				12		15	1.5
GBH			1	1		1	1						4	.4
Unid	±445	±1128	±556	299	161	99	155	106	101	46	86	92	2976	297.6
Total	627	1491	1224	1202	1300	1275	1583	1117	836	879	755	439	10373	1037.3

Footnote:
1. Mostly Lesser Scoup
2. All Common Mergansers except for 2 Red-Breasted Mergansers
3. Mostly Red-Necked Grebes
4. Mostly Common Loons

*On April 28 a.m. total of ±1500 mostly Sc with some Mal, Pin, Teal, CG, and Buff; including 7 Can, 1 Loon, 1 S Cr.

**Excluding May 8 and May 11 p.m. counts triggering a large migration.

In view of the foregoing, periodic use of lakes in the lease could occur during the first prolonged migration. However, there has been no indication of extensive use by large numbers of waterfowl in the area. At present it appears that casual use of the area is made by small flocks for a short period of time.

Since northward spring migrations progress fairly slowly in response to weather conditions, it was recommended that the 1972 spring migration should be monitored to supplement existing survey data. In addition, surveys on fall migrations should be repeated in 1972.

Table 3 lists the 28 different species of ducks that used the study area during spring '72 migration, plus whistling swans, sandhill cranes and great blue herons. A few geese also appeared to use the area at this time.

Table 2 lists the 25 different species of waterfowl that were noted to pass through the study area during fall '72 migration. Species recorded were similar to those of the spring migration except that no red-breasted mergansers, common loons, harlequin ducks, sandhill cranes, and great blue herons were noted. Canada geese were noted this fall but were absent in the Spring '72 survey.

Table 6 summarizes the results of the twelve aerial surveys made in Spring 1972, which are presented in Appendix 1. Appendix II presents the ground observations of waterfowl.

Local weather conditions and the degree of air haziness affected identification of waterfowl. As well, a sample bias was produced by some species being more difficult to identify from the air than others. For example, mallards are easier to identify than teal or ruddy ducks. Additionally, sampling errors were produced in making estimates of large flocks where counts from the air were possible. However, the sample biases and errors are considered to be relatively unimportant to the overall results of the data presented here.

A daily average of 1,037 birds from April 28 to June 2, 1972 indicates that the study area was <u>not</u> a major staging area but rather a stopover area. This daily average is conservative because some ducks hidden in vegetation were certainly missed during aerial surveys. Numbers of waterfowl using the study area would be expected to shift from year to year with fluctuations in duck populations and changes in migratory routes.

Unfortunately, the first aerial survey on September 18th, 1972 was initiated after the onset of fall migration. On that date, 1,800 birds were recorded in the area. Migration from the Peace-Athabasca Delta usually begins in early September (Ed Hennan, pers. comm.).

It is evident that, as in the spring, the study area is not a major staging area, but rather a casual stopover area. The average of the eleven flights was 1,465 birds per flight. However, Canadian Wildlife Service personnel conducting fall waterfowl counts in the area report large numbers of waterfowl staging or stopping on some of the larger lakes south of the Peace-Athabasca Delta especially in the Gordon Lake area, about 50 miles southeast of Fort McMurray. Craig Schick (pers. comm.) reported estimates of up to 100,000 ducks in the Gordon Lake area in September; 75-80% of these were diving ducks. This may account for the higher proportion of diving ducks to dabbling ducks counted in the surveys. Dabblers appear to swing to the east of the study area. Ducks Unlimited data indicates that 80% of dabblers banded on the Delta were recovered in Saskatchewan (Craig Schick, pers. comm.).

Table 1 lists the 25 species of waterfowl and other birds of importance that were noted to use the study area during spring 1973 migration. Species were similar to those seen during the spring of 1972 except that no whistling swans, harlequin ducks, oldsquaw, common scoters, red-breasted mergansers, horned, eared or western grebes were seen. As well pied-billed grebes were seen that were not observed last year.

Table 4 summarizes results of the five aerial surveys made in spring 1973 which are presented in Appendix 1. Unfortunately, the first survey on May 5 was initiated after the onset of spring migration. On that date, 1187 waterfowl were observed. By then the Athabasca River and all the lakes were thawed and many of the dabbling ducks had already reached their peak. It would appear that because of the unusually mild weather in April (average mean temperature of 37.5 F in 1973 as compared to 31.9 in 1972, Government of Canada, Department of Climatology, pers. comm.), spring break-up, and thus migration was about two weeks earlier than in 1972.

By mid-April flocks of Canada geese (*Branta canadesis*) were noted flying over the area. This is approximately when the Athabasca River first started to break up, and probably coincided with the advancement of the 35 F. isotherm which Canada geese are known to follow in spring migration (Lincoln, 1950).

Use of the study area during the period May 4 - June 4 averaged 1154.2 birds per day with a high count of 1469 birds on May 25. Average daily utilization was slightly higher than in 1972, but was probably a reflection of a more protracted migration, lasting into early June.

Comparative use of the study area by different species is illustrated in Figures 5 thru 10. Coots were by far the most common species, followed by scaup (mostly lesser), common goldeneye, American Widgeon, and mallard. Figures 5 thru 10 show the chronology of use of the Syncrude study area by dabbling and diving ducks. These figures illustrate that most waterfowl had already reached good numbers by May 4 and did not increase their numbers substantially after that date. Only the coot shows any marked increase after May 4th.

The results and discussion of results of the study are as follows:

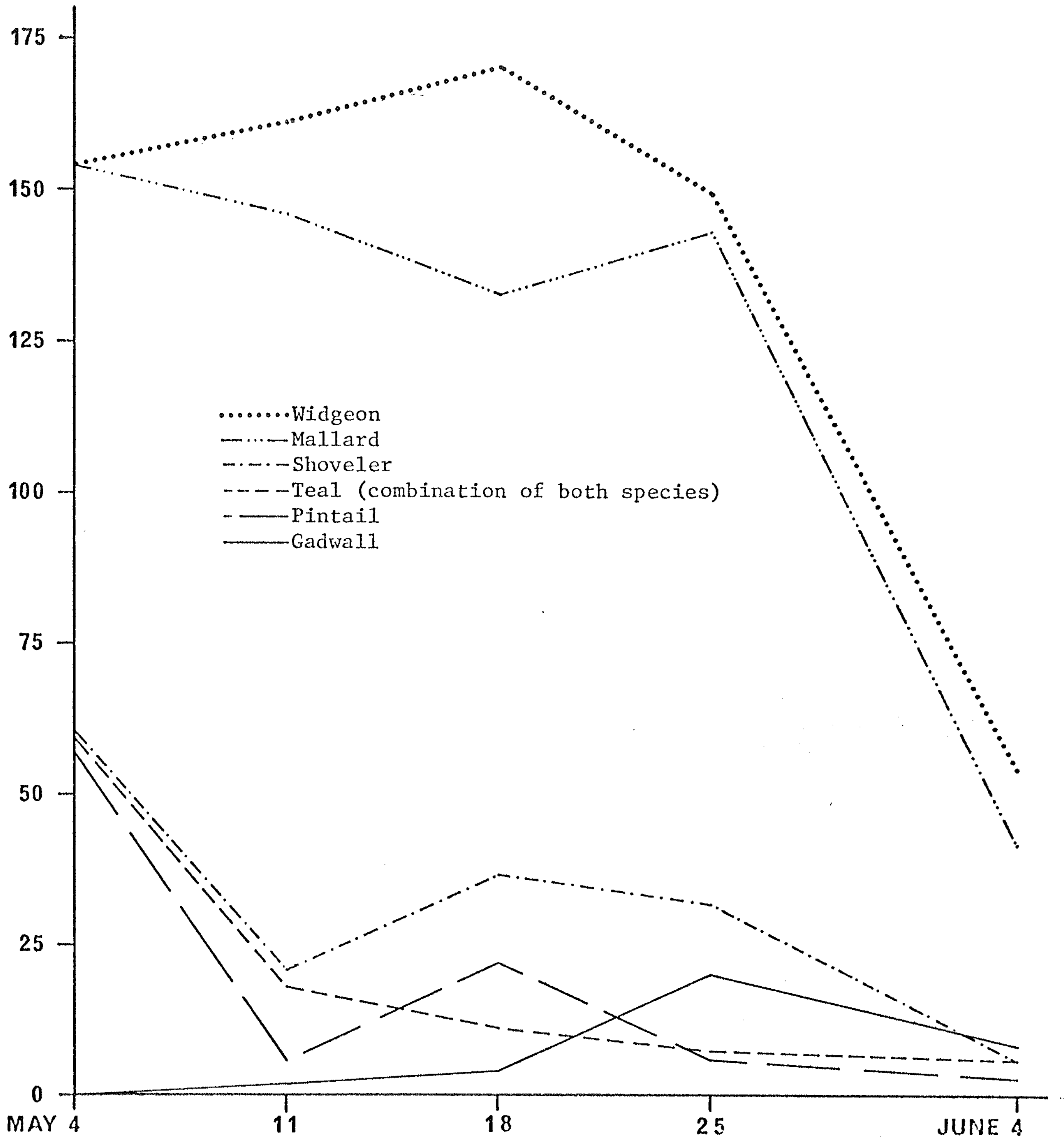


FIGURE 5: Use of Syncrude Study Area by dabbling ducks during spring migration, 1973.

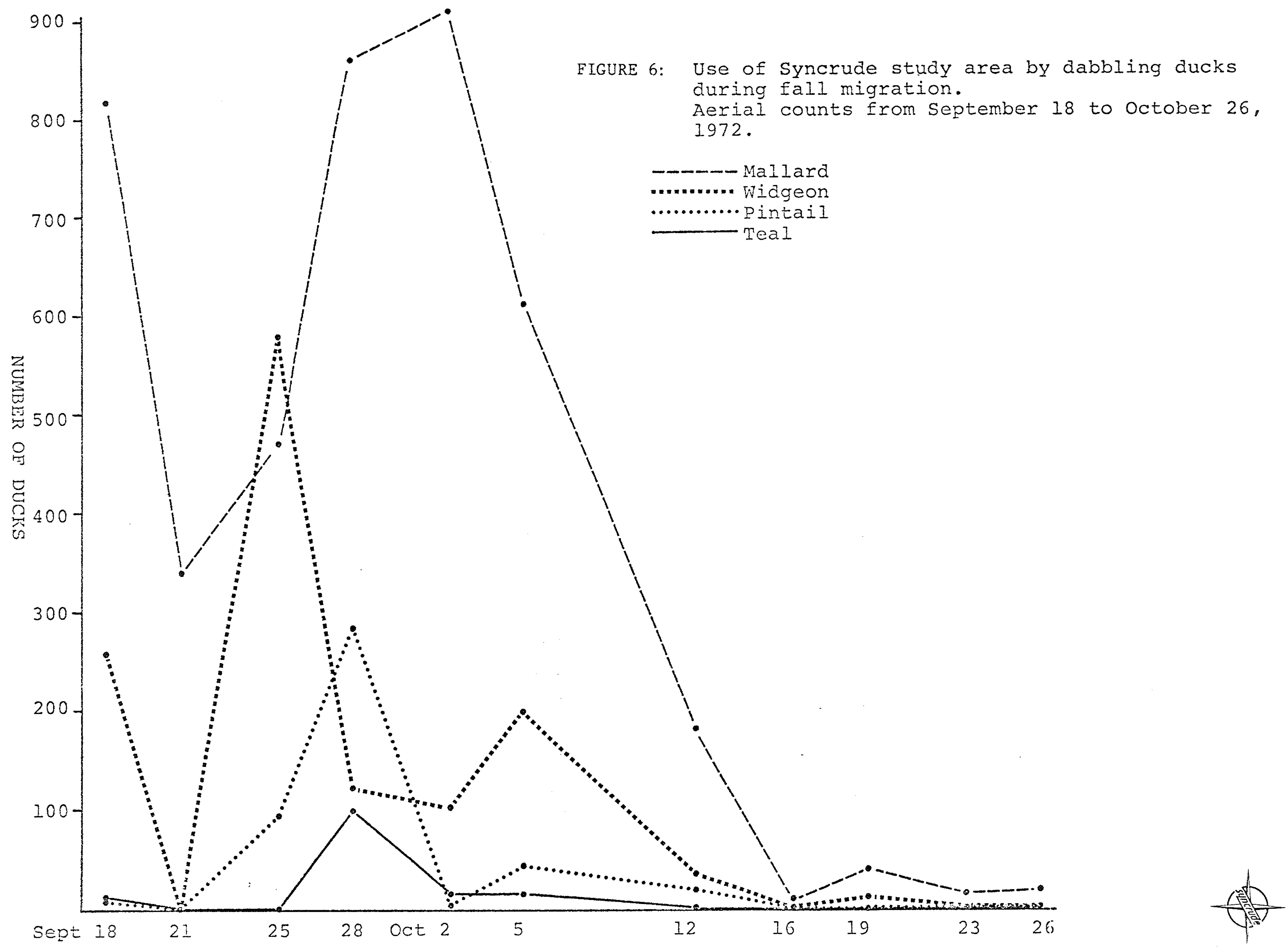
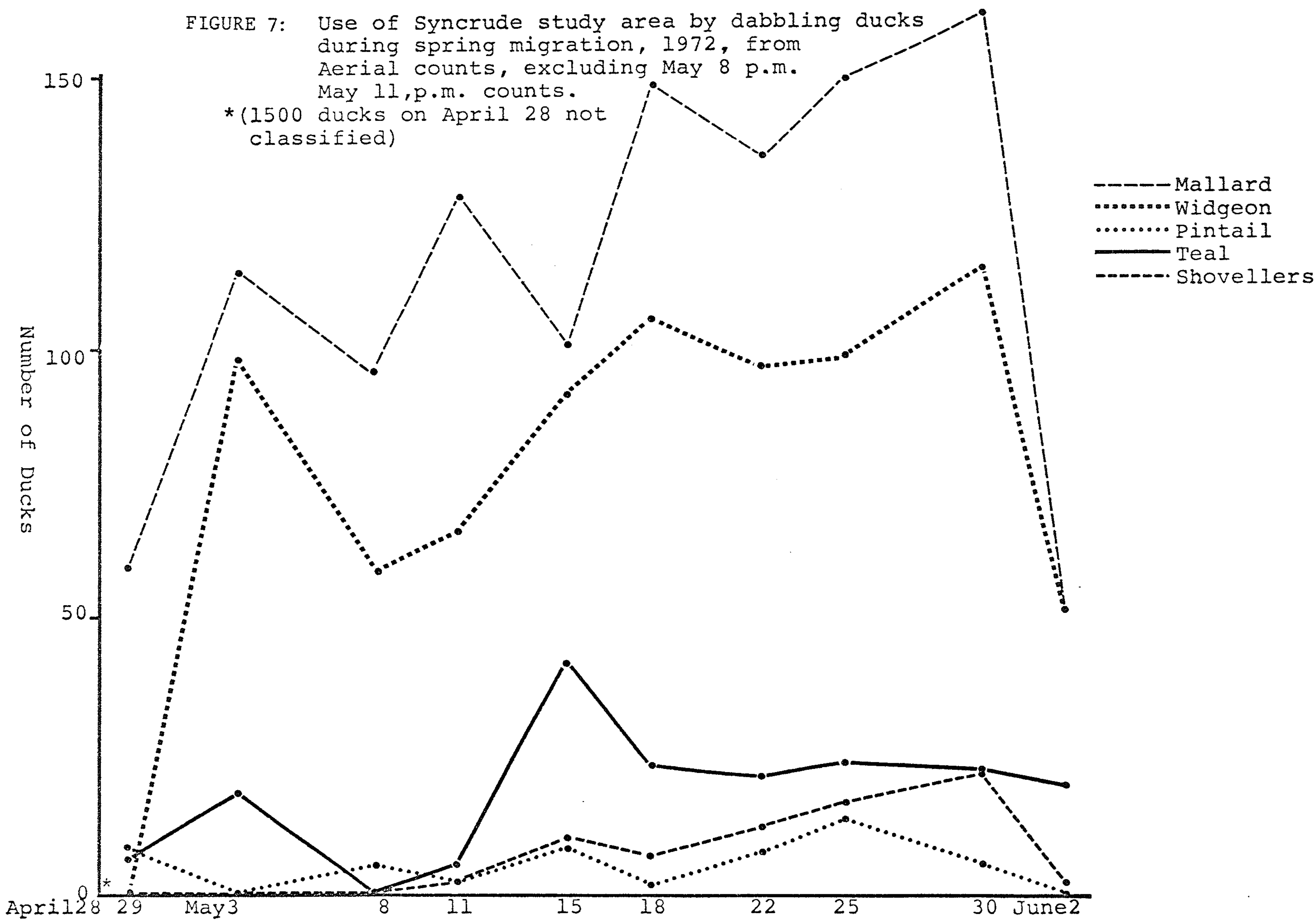


FIGURE 6: Use of Syncrude study area by dabbling ducks during fall migration. Aerial counts from September 18 to October 26, 1972.

FIGURE 7: Use of Syncrude study area by dabbling ducks during spring migration, 1972, from Aerial counts, excluding May 8 p.m. May 11, p.m. counts.
*(1500 ducks on April 28 not classified)



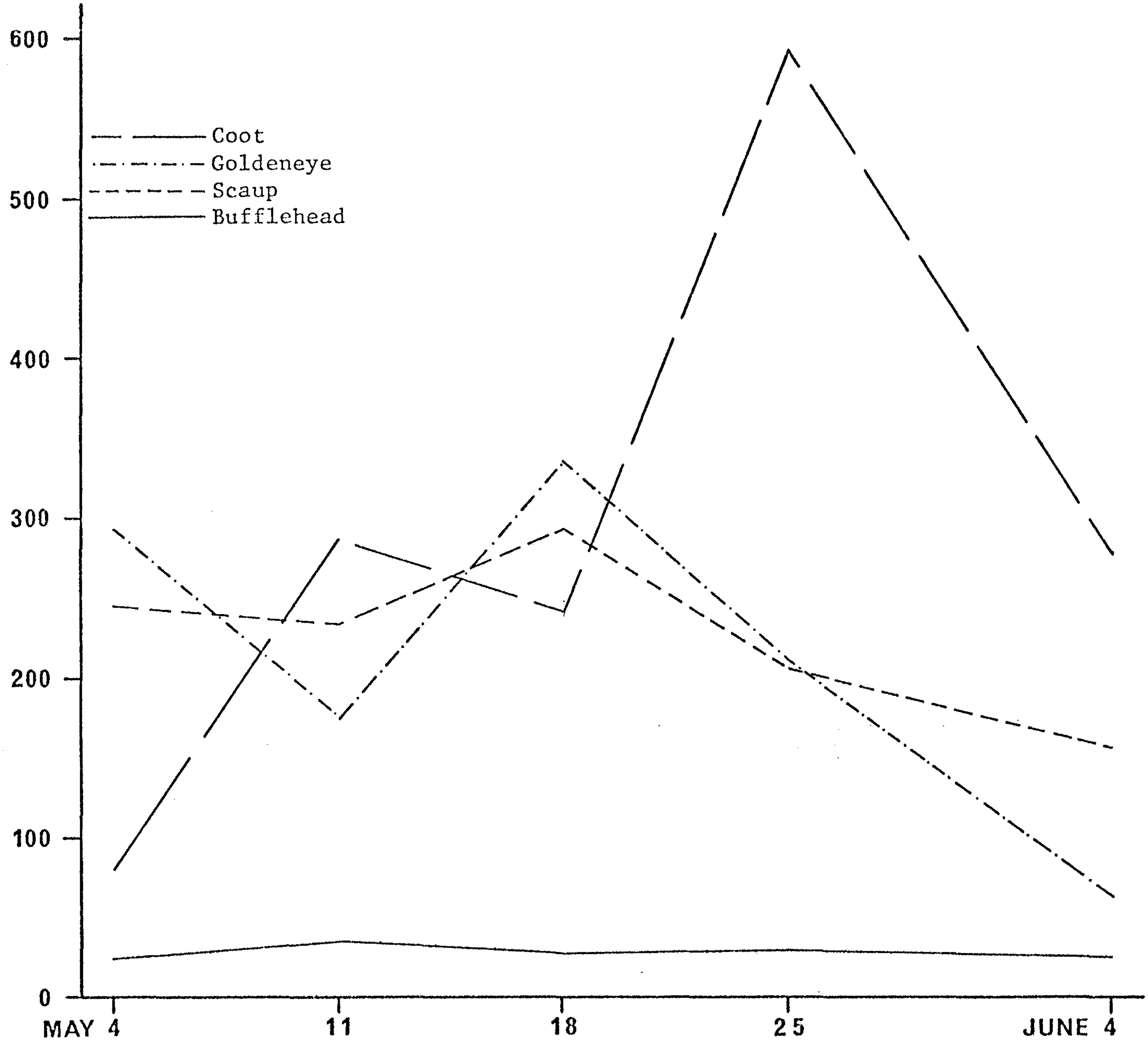


FIGURE 8: Use of Syncrude Study Area by diving ducks during spring migration, 1973, showing major species.

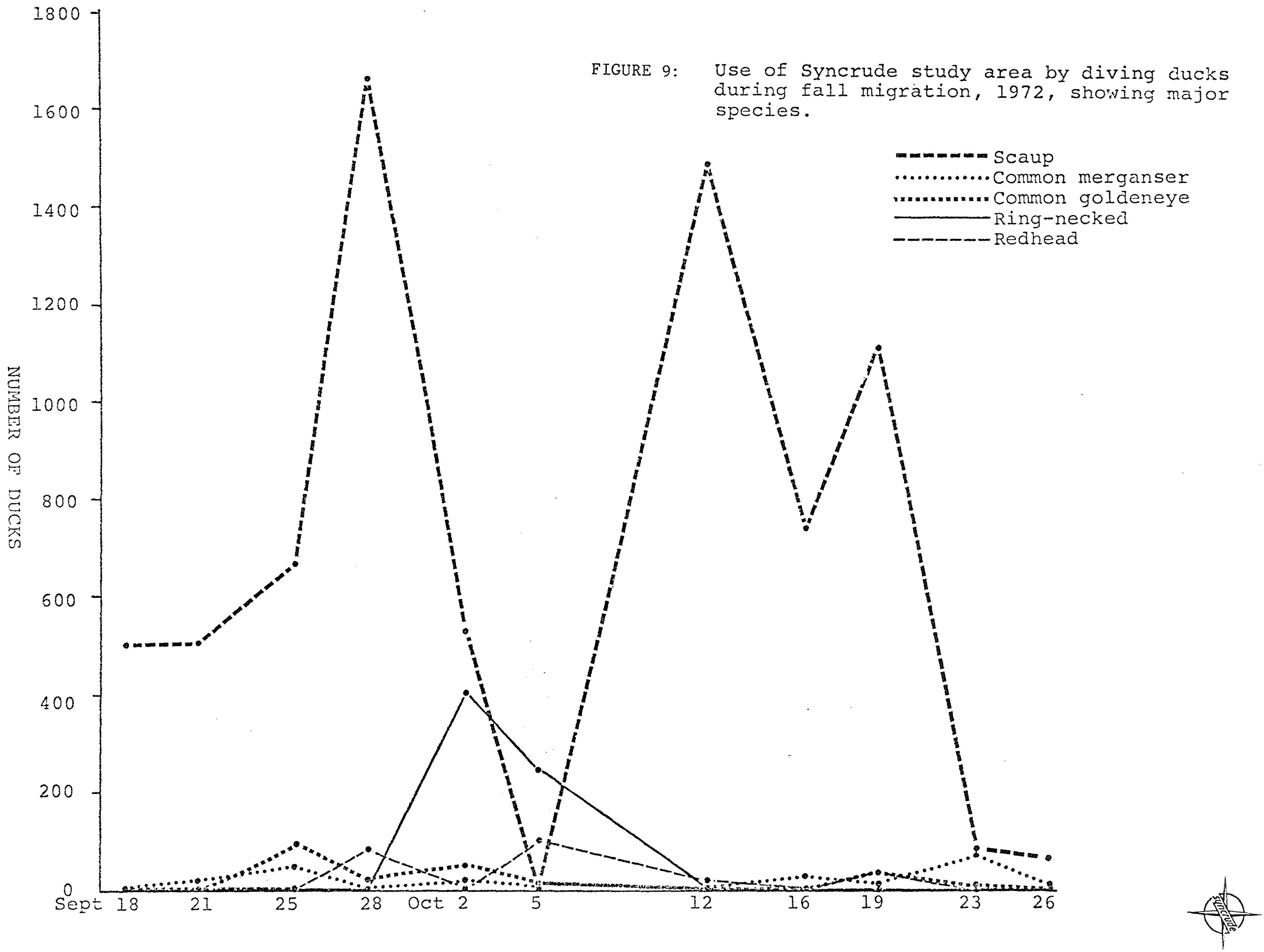
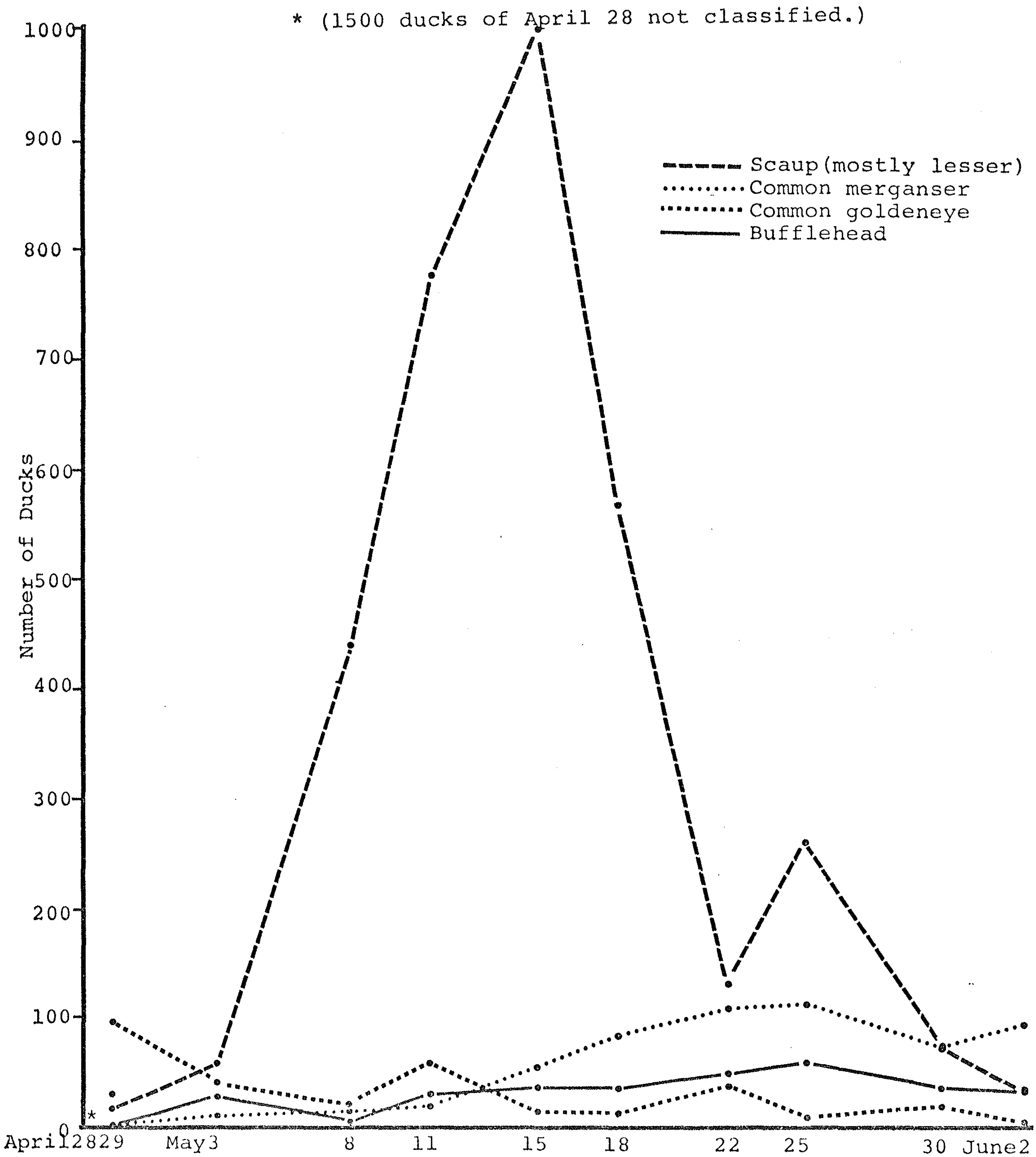


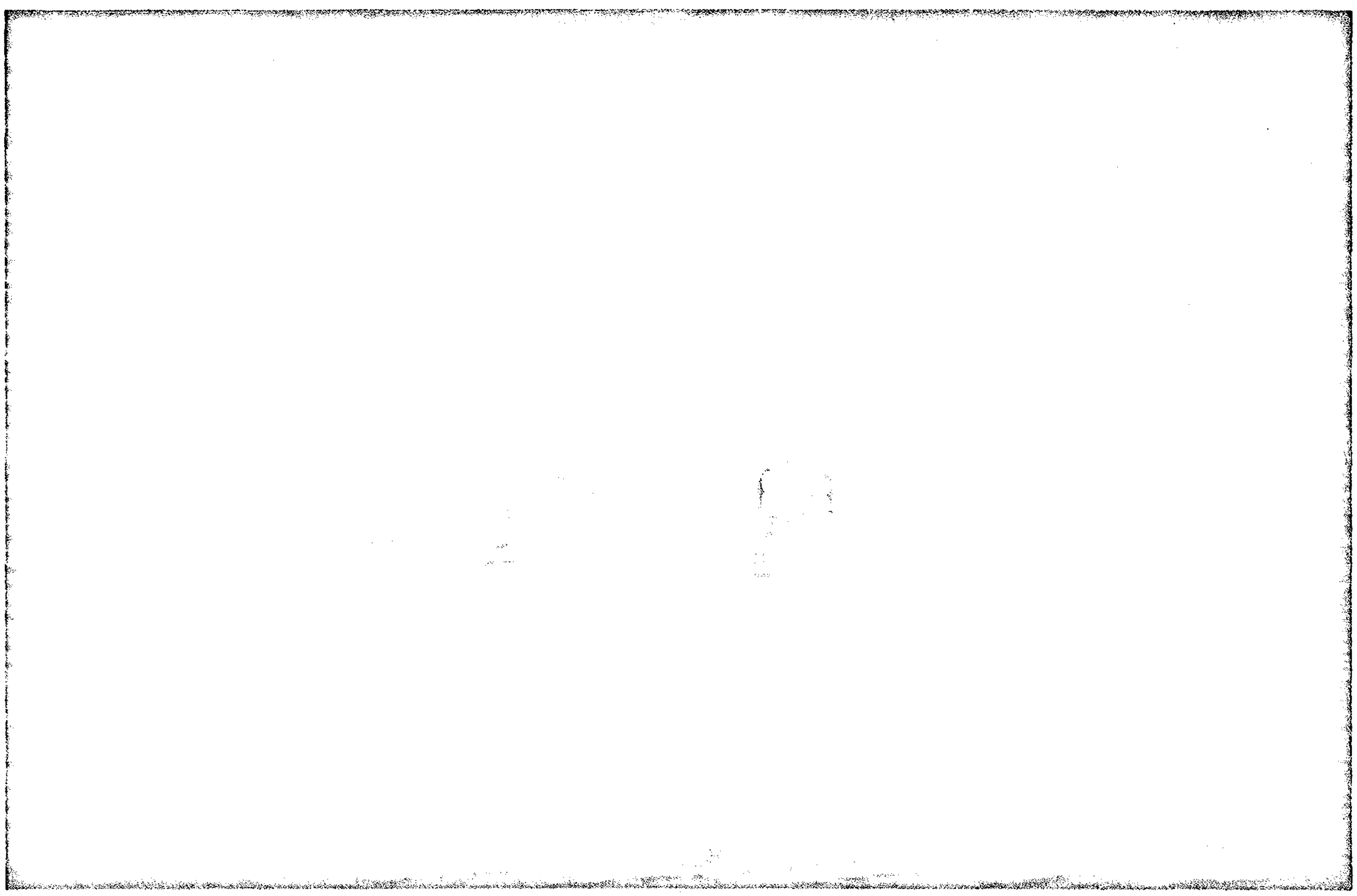
FIGURE 9: Use of Syncrude study area by diving ducks during fall migration, 1972, showing major species.

FIGURE 10: Use of Syncrude study area by diving ducks during spring migration 1972 showing major species. From aerial counts excluding May 8,P.M. and May 11, P.M.



Lesser Scaup are a spring migrant on Lease 17.

It is a diving duck and a late nester. The young almost immediately go to the water after hatching. Lesser scuap usually migrate early in the fall.



Distribution in the Study Area in Relation to Spring Break-up:

The early use of lakes, rivers and sloughs within the study area during spring migration closely follows the sequence of spring "break-up". Ducks use the first patches of water that are available.

According to A. Boggs, Fish and Wildlife Officer at Fort McMurray, no ducks were present before the weekend of April 22-23, 1972 when the first wave of ducks arrived.

During the first aerial survey, on April 28, about 1,500 ducks (mallard, pintail, goldeneye, bufflehead, canvas-back, and scaup) were counted on the patches of open river between the Great Canadian Oil Sands plant and the mouth of Beaver Creek, including about 300 on Horseshoe Lake (Table 6). This stretch of the Athabasca River is open nearly all year round because of hot water emissions from the G.C.O.S. plant. As well, Horseshoe Lake opens prematurely because it receives flow from the Athabasca River through a canal. Thus for this short initial period ducks were concentrated on the Athabasca River, many of them proximal to the Syncrude Lease.

Break-up advanced at a rapid rate, once it began. On April 29, the Athabasca River began breaking up more extensively and ducks dispersed more along its length between Fort McMurray and the Mouth of Beaver Creek (Table 6), mostly flocking on pockets of open water between the ice blocks.

As frozen lakes opened up, ducks made immediate use of them and use of the Athabasca River decreased. Thus by May 3, Saline Lake was partially open and had attracted about 1/3 of all the ducks counted (Table 6).

The ducks were attracted to the freshly thawed lakes because of an obvious greater abundance of acquatic food on the lakes than on the Athabasca River. Mildred Lake had totally thawed by May 8 and Ruth Lake by May 11 and each received immediate use by numbers of ducks. Use of the deeper end of Horseshoe Lake by scaup also diminished as the other lakes thawed. After all the lakes had thawed, use of them continued to be considerably greater than use of the Athabasca River, thus concentrating the waterfowl close to the Syncrude development. Ducks that used the River, after break-up was completed, were mainly scattered pairs of mallards and widgeon and were more abundant between G.C.O.S. and the mouth of Beaver Creek than along upstream sections (Table 6).

Some ducks also used areas of meltwater on frozen muskegs and beaver dams but this use diminished as lakes thawed. Thus, 28 ducks were counted over the lease area on April 29, 60 on May 3 but only 2 on June 2.

Sixteen ducks were noted along the edges of the MacKay River on May 3.

Comparative Use of the Study Area by Waterfowl:

SPRING MIGRATION

Use of the study area during 1972 spring migration averaged 1,037 birds per day with the migration waning at the beginning of June (Table 6). These results are consistent with the general pattern of spring migration where ducks gradually follow the northward occurrence of warm temperatures (the 35^{o} isotherm). Fall migration is more rapid with many birds waiting until freeze-up and then suddenly moving south.

Comparative use of the study area by different species is illustrated in Figure 7. Scaup (mostly lesser) were by far the most abundant species followed by mallards, widgeon, common mergansers, bufflehead, common goldeneye and teal.

For further discussion, ducks are segregated into 2 classes: puddle or dabbling ducks; and diving or bay ducks. Puddle ducks (such as mallards) are typically birds of shallow water and usually feed on the surface. Diving or bay ducks, such as scaup and canvasback, frequent deeper water and feed by diving.

As shown in Figure 7, scaup were the most abundant species counted in the study area followed in sequence of abundance by mallards, widgeon, ring-necked duck, and pintail. The three most abundant species in the fall were in the same relative order of abundance as in the spring.

Other species of lesser importance varied from spring to fall in abundance but were essentially similar in being low in numbers. After October 12, few dabblers were observed, indicating that they had either completed their movement through the area at this time or stopped using it.

Puddle (Dabbling) Ducks:

Mallards were the most abundant dabbler species utilizing the study area during the spring migration. They averaged 114.4 birds per day with a range of 54 to 162 birds per day. Widgeon were the second most abundant averaging 78.4 birds per day with a range of 0 to 115 birds per day. Following in order of decreasing importance were teal (green-winged and blue-winged), shovelers and pintail. Only 7 gadwall were recorded throughout the survey period.

Mallards were the most abundant dabbler species observed on the study area during fall migration. An average of 387 mallards were tabulated per flight with a range of 2 to 910 ducks per flight (Table 8). Widgeon were the second most abundant species. An average of 119 widgeon were tabulated per flight with a range of 1 to 580 ducks per flight. Following in order of decreasing abundance were pintail, teal, gadwall and shoveler.

Some of the minor species were noted to be present with the large flocks of mallards and widgeon and estimates of their numbers are probably conservative.

The sequence of arrival in spring varied from species to species and was in agreement with the general migratory pattern outlined by Kortright (1960) with the exception that widgeon arrived earlier than is usual. Mallards, pintails, and green-winged teal arrived immediately at break-up followed shortly thereafter by widgeon. Blue-winged teal and shovelers were later migrants.

Use by mallards and widgeon was fairly constant throughout, increasing towards the end of May (Figure 7). Initially, most were in pairs, or small flocks of pairs; but as the migration progressed, greater numbers of unpaired drakes appeared. For the mallards, most of the unpaired drakes were probably juveniles in breeding plumage rather than drakes with mates on the nest. For widgeon, the appearance of more drakes towards the end of May probably represented in part the onset of nesting in the area. For example, on June 3, 1972, 11 widgeon drakes were scattered singly on the Athabasca River between Horseshoe Lake and Saline Lake indicating that their mates had begun nesting on these lakes.

Pintails appeared to pass through the area in two waves. The first wave, mostly flocks of pairs, passed through in late April and early May with a very short stopover period. A large number of pintails were noted on the April 28 aerial count but had passed onward by the April 29 A.M. aerial count. One hundred pintails were later counted on the evening of April 29 on Horseshoe Lake but were gone by April 30. The increase in pintails near the end of May appeared to be due to a later migration composed primarily of drakes.

As would be expected the dabblers tended to utilize the shallower waters in the area, i.e., mainly Horseshoe Lake and part of Saline Lake.

Widgeon were the most abundant dabblers observed in the study area in spring, 1973, averaging 137.6 birds per survey with a range of 54 to 170 ducks per survey (Figure 5). Mallards were the second most abundant species. An average of 123.6 mallards were tabulated per survey with a range of 42 to 154 birds per survey. Although mallards were more abundant than widgeon in 1971 the difference in numbers of each of the two species between the two years was not great. Following in order of decreasing numbers were shoveler, teal, pintail and gadwall. The indicated general increase in numbers of these species in 1973 may have been due to more frequent passes over lakes and thus fewer unidentified waterfowl.

Bay or Diving Ducks:

Lesser scaup were by far the most abundant of all species utilizing the study area in spring 1972. They averaged 335 birds per day with a range of 14 to 1,002 birds per day. Many of the 1,500 ducks observed on April 28 were scaup. Peak use by scaup occurred around mid-May; by the beginning of June few remained in the area (Fugure 10).

Common mergansers, which are primarily fish-eaters, were the second most abundant of the diving ducks. They averaged 56.6 birds per day with a range of 0 to 107 birds per day. Common mergansers arrived later than scaup (Figure 10) and tended to concentrate on Saline Lake or downriver from the G.C.O.S. plant. Bufflehead averaged 30.4 birds per day and common goldeneye averaged 29.5 birds per day. Minor numbers of ringneck, canvasback, coots, scoters (mainly surf and a few white-ringed and common), common loons, grebes (red-necked, earned, and horned), and ruddy ducks used the area. A few old-squaw, redhead, and harlequin ducks were also noted (Table 6).

An abundance of duck food on Saline, Horseshoe, Ruth, and Mildred Lakes tended to concentrate these ducks (especially the scaup) in large flocks on these lakes.

Saline Lake was the lake most intensively used by waterfowl in the area. In spring 1973, scaup were the most common diving ducks with an average of 227.2 and range of 158-294 birds per survey (Table 7). Common goldeneye was second in abundance with an average of 215.8 birds per survey and a range of 63 to 335. Following in order of decreasing numbers were bufflehead, canvasback, redhead, common merganser, ring-necked duck, scoters (both surf and white-winged) and ruddy duck.

The common goldeneye was the only diving duck to show a marked increase in number over 1972, increasing by a factor of 7.2 times.

Although the average scaup population per survey was about 2/3 that of last year's (227.2 as compared to 334.9), at the peak it was only 30% that of last year's (294 compared to 1,002). It is quite possible that a build-up did occur this year, but was not observed because of the week lapse between surveys. It is also obvious that this year the build-up at the beginning of migration was missed.

Other Species:

Whistling swans stopped only briefly in the area. Two were seen on Saline Lake on May 3, and twelve on May 8, 1972. Two were also seen at checkpoint 11 on May 8.

A few sandhill cranes appeared to stop briefly while passing through. Also, several large flocks were seen going over high northward.

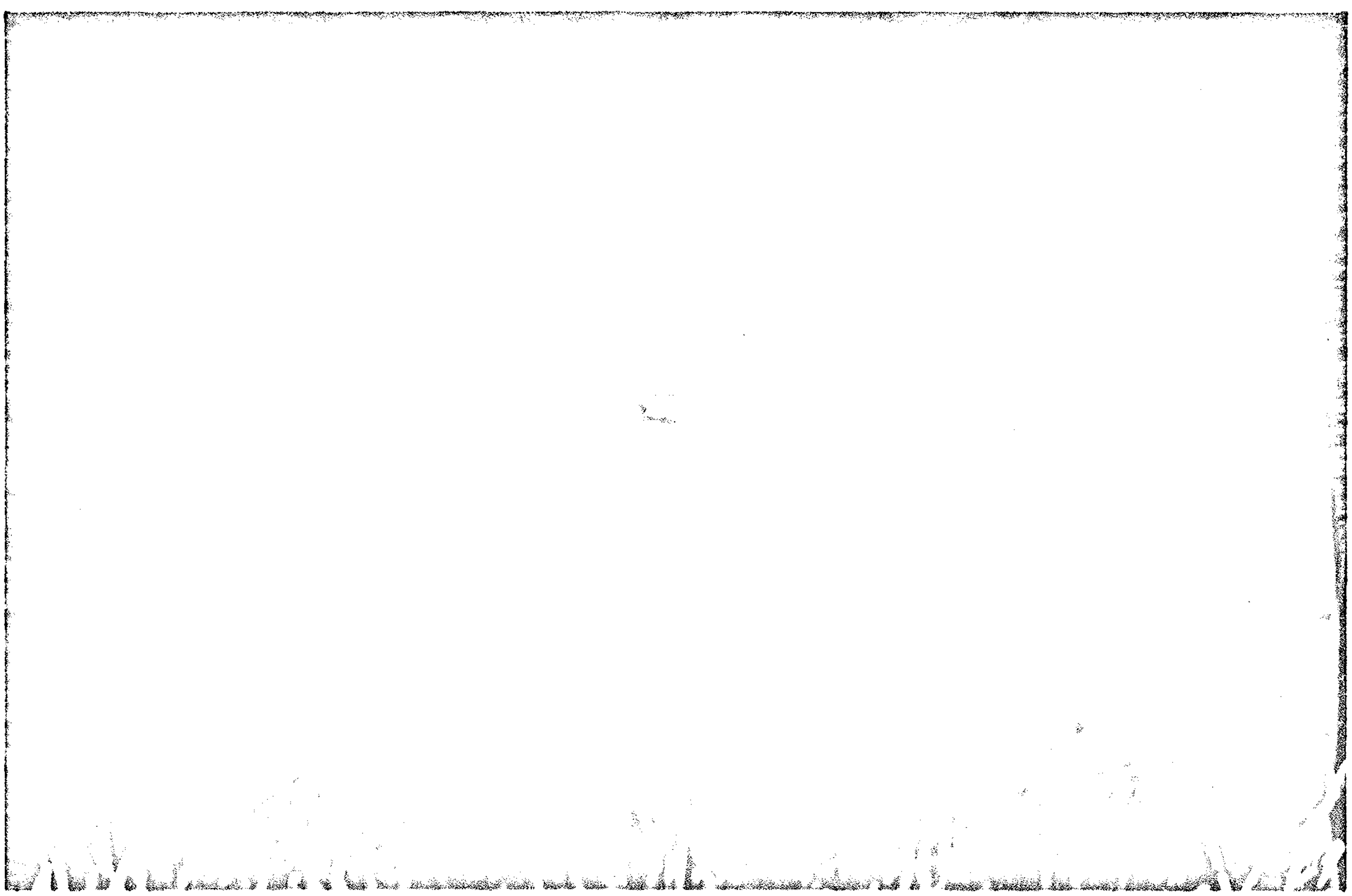
No geese were noted during the field work except that one flock was heard passing over high late at night. Men working at the Syncrude Camp reported the occasional small flock in the vicinity and four Canada geese were reported near the Syncrude test pit area at the end of May. Thus they appear to overfly the area during the spring and the majority probably pass along another route. There was some observations by men who had spent some time in the area that geese do stop on the Athabasca River in the fall when the water is low and utilize the gravel bars which are not exposed during the spring. These sources, however, reported that few geese stopped during the fall of 1971.

A few great blue heron were noted to utilize the area briefly.

Utilization of the study area by shorebirds during the spring appeared minor. Occasional flocks of unidentified shorebirds were noted on Saline Lake or along the Athabasca River while one flock of 100 black-bellied plovers was noted at Saline Lake.

Coots were the most common species and in fact the most common bird of any type using the lakes in the study area (Table 7).

Canvasback ducks are not common on Lease 17 but provide excellent sport. They do not nest on Lease 17 but are occasional spring migrants.



In 1973, an average of 292 birds per survey were counted. Following in order of abundance were red-necked grebe, common loon, marsh hawk, red-tailed hawk, pied-billed grebe and great blue heron. Flocks of Canada geese and a few sandhill cranes (*Grus canadensis*) were observed in the area in mid-April by the R.R.C.S. fisheries biologists investigating spawning activity of fish in Beaver Creek.

Numbers of coots observed in 1973 increased 22 fold over 1972. An adequate explanation for this increase is difficult. Relatively dry conditions in southern Alberta in the spring may have resulted in displacement of coots to more permanent water bodies in northern Alberta. However, if this explanation is correct, it is difficult to explain why dabbling ducks did not respond similarly.

The few loons, grebes and scoters that were observed, appeared to be resident birds that arrived early and occupied specific territories.

Saline Lake received the most intensive use by waterfowl, as it did in 1972, averaging 45% of the total numbers, with a maximum of 59% on June 4. This was due to its close proximity to the Athabasca River, and its attractive habitat for both diving and dabbling ducks. There was an apparent gradual shift of concentration of dabbling ducks and coots from Horseshoe Lake, and the small ponds at Checkpoints 10 and 11 in early May, to Saline Lake by early June. This shift was probably caused by

Horseshoe Lake and the smaller ponds becoming less attractive to these birds as the season progressed. The birds that moved to Saline Lake may have come both from Horseshoe and Checkpoints 10 and 11, and from other lakes and sloughs both in the immediate area and from further south. Movement from further south may have included both post-breeding males and birds which were unsuccessful at breeding because of poor water conditions further south.

By the end of May, waterfowl on Ruth and Mildred Lakes had dropped considerably in numbers, and birds were sometimes seen in the emergent vegetation along the shore. These birds were probably nesting and undoubtedly many of them missed. By this time pond lily (*Nuphar variegatum*) had built up on the shallower lakes and sloughs, particularly Horseshoe Lake, to the point where waterfowl became very difficult to observe.

FALL MIGRATION

Fall migration patterns are shown in Table 5. Mallards and widgeon passed through in two waves, one which was underway on September 18 and one towards the end of September through the beginning of October. This is probably concomitant with the general pattern of southward migration from the Peace-Athabasca Delta. An initial and gradual migration of resident birds takes place from the Delta during early September. Birds from farther north then build-up after the third week in September and move out from that time until freeze-up (Ed Hennan, Pers, comm.). However, these peaks may also reflect a local build-up of numbers due to favorable weather conditions.

Pintail and teal numbers appeared to peak only once near the end of September; unless an earlier wave passed through before the surveys began.

The duration of stay of migrants in the area is impossible to determine unless marking of birds in carried out. Length of stay probably depended on local weather conditions. Ducks probably stay in the area during warm weather and then move south when freezing conditions arrive. For example, the same flock of 60 - 75 widgeon was noted on the slough at Checkpoint 10 on October 2nd and 5th during a spell of mild weather but only 30 widgeon (either part of same flock or a different flock) were noted on October 12 when the slough was half frozen.

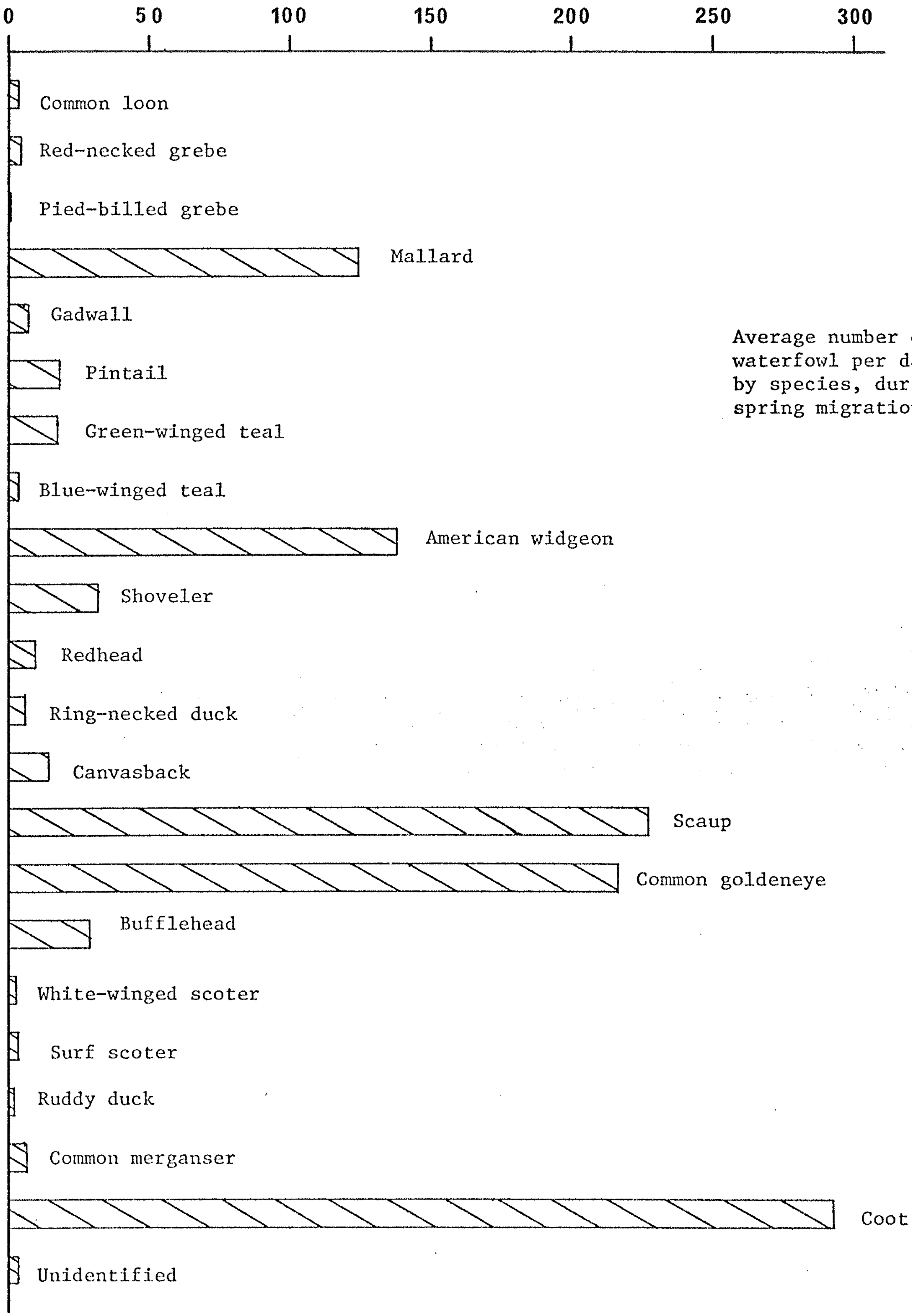
Bay or Diving Ducks:

As with the dabblers, the duration of stay (feeding/ resting) of migrant divers in the area was impossible to ascertain. However, from the fluctuations in numbers of each species and variations in species composition of flocks from date to date, it appears that there was a regular turnover of birds.

Scaup were again the most abundant of the divers migrating through the study area. While most of these were Lesser scaup some Greater scaup were noted. The average number of scaup tabulated per flight was 670 birds with a range of 1 to 1,660 birds. Scaup also showed two distinct peaks of abundance (Table 8) which, as discussed previously, could reflect two waves of southward movements from the Delta. These peaks, however, might

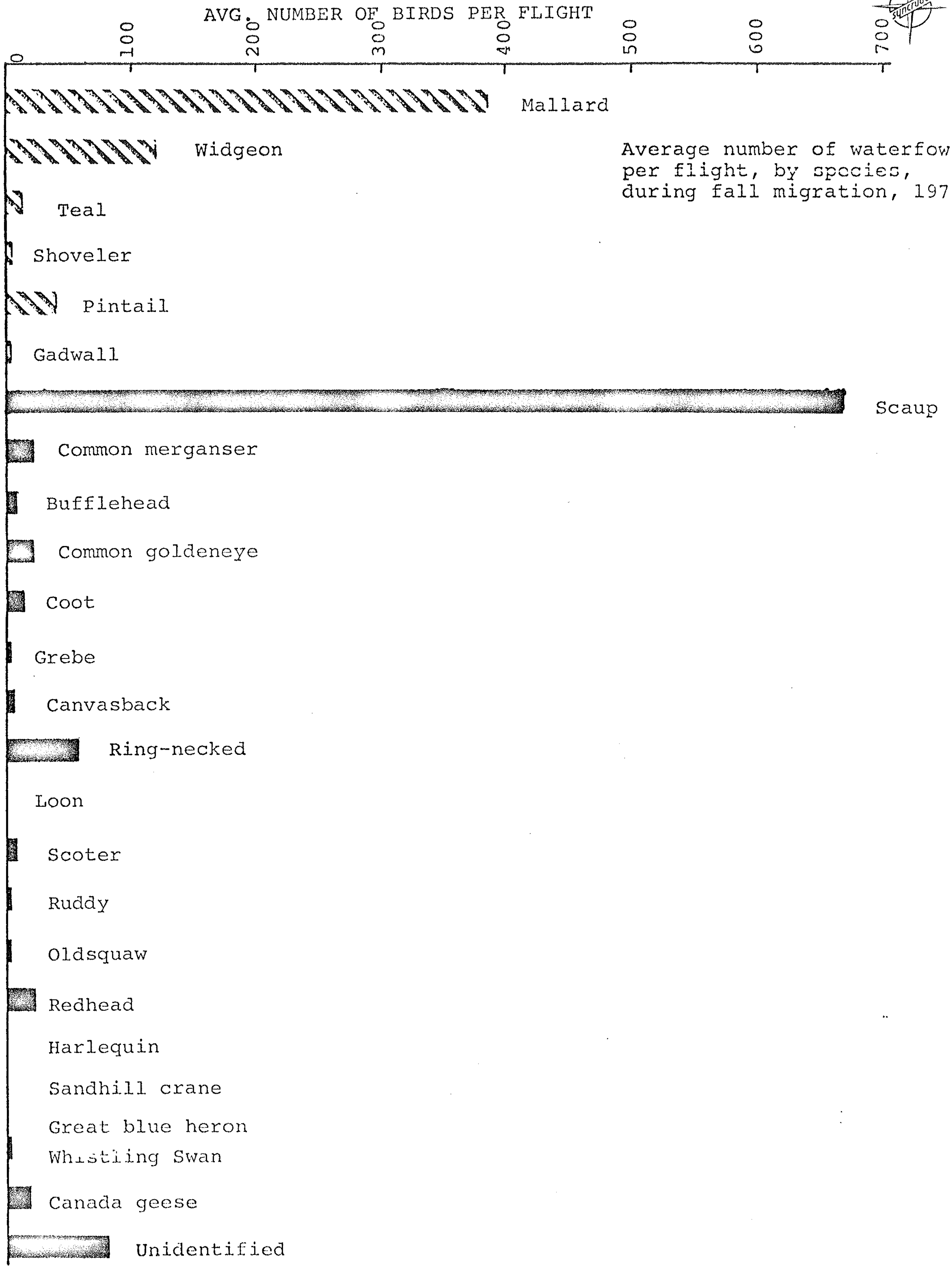
TABLE 7

AVERAGE NUMBER OF WATERFOWL PER DAY



Average number of waterfowl per day, by species, during spring migration, 1973.

TABLE 8



Average number of waterfowl per flight, by species, during fall migration, 1972 also reflect local build-ups in numbers due to favorable weather conditions.

Ring-necked ducks were the second most abundant of the divers. An average of 59 ring-necked ducks were tabulated per flight. Their migration appeared very abrupt as they were noted only on September 28, and October 2 and 5, 1972.

Following in order of decreasing abundance were red-head, common goldeneye, mergansers (mostly common), and coots, minor numbers of bufflehead, canvasback, ruddy duck, scoters, old-squaw and grebes were noted.

No common loons, which nest in the area, were observed. Common loons are usually early migrants. However, three were noted on October 17, 1971, on Ruth Lake (R.R.C.S., 1972).

Other Species:

A few whistling swans were noted throughout the 1971-1972 survey period. One swan was observed to be "frozen in" on Horseshoe Lake on October 19, 1971.

An average of 15 Canada geese per flight was observed during the fall survey. The greatest number counted on a single day was 88. No geese were seen after October 5, 1972.

Few shorebirds were noted during this period (Fall 1972). The majority of shorebirds are very early migrants and would have passed through before the study began. However, a few yellowlegs were noted during the last three surveys.

Of some interest is the fall migration of eagles down the Athabasca River. A total of 2 golden eagles and 22 bald eagles were counted during the 11 surveys. However, some of these were repeated sightings. It appeared that there was an initial migration of immature bald eagles as 5 of the 8 seen on September 25 were immature birds.

On October 19, one adult bald eagle was noted on the ice of Mildred Lake with a dead duck.

Two rough-legged hawks were also noted during the survey.

Comparison of the Habitats Used by Waterfowl:

On September 28, 1972, part of Beaver Creek, the MacKay River, and beaver sloughs to the west of the test pit were flown and checked for waterfowl. Only 12 unidentified ducks were noted and these were on a slough adjacent to the MacKay River. It was concluded that use of sloughs and creeks on Lease 17 during fall migration was negligible.

However, of all the waterfowl counted throughout the survey, the lakes on Lease 17 (Checkpoints 7, 8 and 9) accounted for 43% of the total.

Saline Lake and Ruth Lake accounted for most of the number of waterfowl counted off Lease 17. These lakes are on the margins of the lease. Therefore, in the migration "corridor" of the Athabasca Valley from Beaver Creek to Fort McMurray (25 linear miles) sampled by the study area, the most intensive use by waterfowl is concentrated on the proximal to Lease 17.

Lakes and sloughs on the study area received far greater use than the Athabasca River. As the lakes froze-up however, a greater number of waterfowl used the river, especially towards the latter part of October.

Horseshoe Lake, the shallower and marshier of the larger lakes, as would be expected, received the most intensive and consistent use by dabblers. The largest number of dabblers counted on Horseshoe Lake was 720 on September 28; approximately 570 of these were mallards. After Horseshoe Lake became partially frozen few dabblers were counted in the study area. Saline Lake, Mildred Lake and Ruth Lake received some use by flocks of dabblers, but use was far less than Horseshoe Lake. This was similar to the pattern of use in the spring.

Saline, Ruth and Mildred Lakes, all deeper lakes, received the most intensive use by diving ducks usually in large "rafts". These lakes, being deeper and larger than the others, were the last to freeze-up and therefore accounted for most of the waterfowl observed in the area towards the latter part of October. Nearly all of the 1,350 ducks (mostly scaup) counted on October 19 were on Saline, Ruth and Mildred Lakes.

Canada geese were most frequently noted on the gravel bars and islands along the Athabasca River but also made fairly consistent use of the north end of Horseshoe Lake. On one occasion, a flock of Canada geese was noted on a partially vegetated mud bar between the G.C.O.S. tailings pond dyke and the Athabasca River. This was of interest because of the proximity of geese to heavy industrial activity.

Duration of Stay of Spring Migrants:

In order to attempt to determine the duration of stopover of migrant ducks or rate of population turnover, aerial surveys were made on both the mornings and evenings of May 8 and May 11, 1972. The morning and evening counts of each day showed a marked similarity of composition and distribution for most species (Table 9). This suggested that the ducks stayed at least a day. However, the actual length of stay was indeterminable. Birds would have to be marked for identification in order to obtain accurate data. Length of stopover appears dependent upon weather conditions.

Variations, in aerial counts from date to date, plus ground observations, does suggest that the population is on a continual basis for some species such as mallards and widgeon. The appearance of more drakes in the population towards the end of migration also suggests a turnover of population.

Observations of scaup on Mildred Lake suggests more of a "staging behaviour" for this species in the area than for such species as mallards and widgeon. Ground checks made almost daily from May 9 onwards showed a build-up of scaup to about 400 birds by May 13. These scaup rested and fed in the same location on the lake until May 18. Then they decreased to 200 birds and on May 22 to only a few birds (see Table 9). The seasonal use of the whole area followed a similar pattern (Figure 10), i.e., movement to Mildred Lake.

TABLE 9

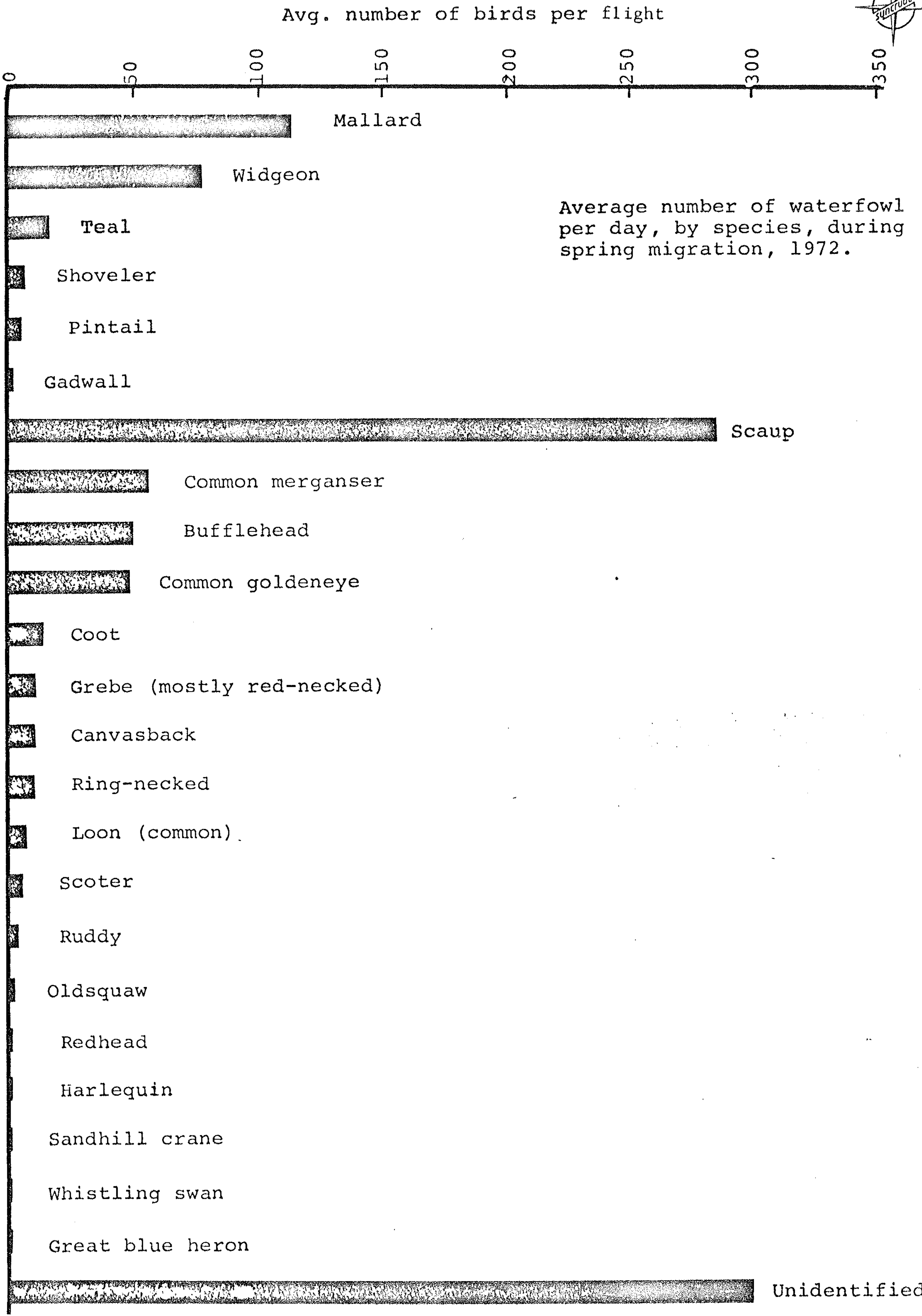

Avg. number of birds per flight
0
50
100
150
200
250
300
350
Mallard
Widgeon
Teal
Shoveler
Pintail
Gadwall
Scaup
Common merganser
Bufflehead
Common goldeneye
Coot
Grebe (mostly red-necked)
Canvasback
Ring-necked
Loon (common)
Scoter
Ruddy
Oldsquaw
Redhead
Harlequin
Sandhill crane
Whistling swan
Great blue heron
Unidentified
Average number of waterfowl per day, by species, during spring migration, 1972.

TABLE 10

SUMMARY OF WATERFOWL SURVEY RESULTS SYNCRUDE LEASE AND ADJACENT AREAS, 1971.

Location		October 17 Survey			October 27 Survey		
		Mallards	Loons	Unidentified	Mallards	Loons	Unidentified
#1							
2							
3							
4							
*5	Horseshoe Lake	80					
*6	Mildred Lake	302		9			
7	Saline Lake				9		
8		23					
*9	Ruth Lake		3		6		
*10							
*11							
*12							
13	McLelland Lake	55					
TOTAL		460	3	9	15	0	0

* Checkpoints within Lease

This suggests a fairly rapid build-up of scaup on other lakes and then a fairly sudden departure.

Spring Migrant and Nesting Populations:

Most of the ducks that stopped in the area appeared to be paired migrants enroute to their breeding grounds farther north. Some breeding activity was noted, especially amongst mallards, widgeon, common goldeneye, and bufflehead and certainly these probably nest in limited numbers in the area. Most of the grebes and loons which were counted throughout the study appeared to be resident birds which arrived early and occupied their tradional territories. Two to three pairs of loons each occupied Ruth and Mildred Lakes shortly after break-up and remained throughout the study. Red-necked grebe nests were noted on Ruth Lake towards the end of May.

According to men working in the test pit area, a few sandhill cranes have nested in that vicinity for the past few years and were present this spring.

Large groups of male and female waterfowl, the changes in population composition from survey to survey and the decrease in total numbers towards the end of May, indicated that most of the waterfowl that stopped in the area were migrants enroute to breeding grounds further north. By June 4, numbers were considerably lower in all areas except Saline Lake, and most birds in these areas appeared to be breeders, particularly mallards, widgeon, scaup, goldeneye, bufflehead and coot. By this time groups of waterfowl were much smaller, and composed mainly of males. Lone drakes were also observed along the shore lines of the lakes and females were occasionally seen in the emergent vegetation.

On Saline Lake larger groups of waterfowl, made up mostly of males where sex was determinable, were seen in the central portions of the lake. These groups consisted mostly of scaup and coot but with some goldeneye, mallards and widgeon among them. Concentrations of male scaup at this time of year could be attributed to birds beginning their postnuptial molt, presumably en route to traditional molting lakes after having completed or given up their reproductive efforts for the year (Hochbaum, 1944 cited by Rogers, 1964). This normally happens in late May and early June (Rogers, 1964).

Effects of Syncrude Development Upon Waterfowl:

The possible effects of the Syncrude development upon waterfowl has already been touched upon.

In the light of the results of the waterfowl study, some aspects were thought worthy of enlarging.

Since the use of Mildred Lake as a fresh water impoundment is planned, some enhancement of Mildred Lake may occur, however, from the increased water level which will enlarge its area. However, if seepage from the tailings pond into Mildred Lake occurs this may introduce change in the water chemistry of Mildred Lake.

The influx of people to work on the Syncrude project will result in increased hunting pressures on waterfowl.

Water diversion will create additional waterfowl habitat on and adjacent to Lease 17. Existing shorelines and habitat are receiving protection in any development plan.

Hunting, regulated by Federal and Provincial legislation, is not considered to be a serious issue.

The most serious potential impact on waterfowl will be from possible oil contamination on the 9.3 square mile tailings pond. Both the spring and fall waterfowl surveys have shown that appreciable numbers and varieties of ducks use lakes on or bordering the Syncrude Lease to rest and feed during migration. The creation of a body of water as large as the tailings pond will undoubtedly attract more waterfowl to the area, particularly as the Syncrude area appears to be on part of a broad flyway for large numbers of waterfowl. Gordon Lake, where an estimated 100,000 ducks staged this fall, is only 75 miles to the southeast. The Peace-Athabasca Delta, which has populations of up to 1.5 million ducks and 300 - 400 thousand geese during staging (Craig Schick, pers. comm.), is only 100 miles to the north.

Some alteration of waterfowl habitat has already occurred on Horseshoe Lake. A drainage canal was built at the north end of the lake in the mid-1950's, thus reducing the water-levels on Horseshoe Lake and altering its nature by the inflow of water from Athabasca River during the peak spring flow. This has probably reduced its attractiveness to waterfowl.

One of the tentative plans is to dam Beaver Creek above the mining areas, creating two detention storage reservoirs. This will create alternate waterfowl habitat in the lease area which may help alleviate the problem expected between waterfowl and the tailings disposal pond, by luring them south, away from the sphere of activity in the plant site area.

Possible Effects of Large Tailings Disposal Pond:

Some species of waterfowl appear more vulnerable to contact with oil than others. Experimental studies on mallards and scaup exposed to oil contamination showed scaup to be far more vulnerable when oil-soaked than mallards. Mallards recovered after cleaning but scaup died because of a loss of buoyancy and an elevation of metabolic rates to compensate for the loss of feather insulation (McEwan, et al, 1972).

The presence of an average of over one thousand ducks per day, many of these scaup, for over a month near the large tailings disposal pond, will undoubtedly lead to problems of oiled ducks. The magnitude of these problems, however, is difficult to predict, and will be expected to vary with the degree of surface pollutants, status of waterfowl populations, and weather conditions.

There is some evidence that water fowl avoid the G.C.O.S. tailings disposal pond. No waterfowl were observed on the pond during aerial flights although fairly large flocks would sometimes be noted along the river immediately below the impoundment dyke. One of the senior officials involved with environmental control at G.C.O.S. stated that in 5 years he has noted only 2 oiled ducks at the plant site. One of these was found dead on the shore of the tailings disposal pond and another was found on the waste water disposal pond. He stated that ducks seem to avoid the G.C.O.S. water containment areas except for the sewage lagoon.

Mr. A. Boggs, Fish and Wildlife Officer at Fort McMurray, has had two oiled waterfowl, both loons, brought to him from the G.C.O.S. tailings pond over the past two years. Mr. Vincent Bouchier, who owns trapline #2565, stated he found two ducks some distance upstream from G.C.O.S. this spring. The ducks were on the bank of the Athabasca River. He "collected" one, a mallard drake, whose wing and breast feathers were matted with oil. The duck was flightless. The other duck escaped into the brush. Thus, it would appear that some ducks may land in the G.C.O.S. pond and take off with their feathers coated with oil, and later suffer after-effects. Mr. Jim Farley, cook at the Syncrude Camp, said he rescued a duck from the Syncrude test plant pond last year but it did not survive.

Problems with waterfowl on the Syncrude tailings disposal pond might be expected to be greater than with G.C.O.S. because:

1) The Syncrude pond will be much larger, about 17 times the size of Mildred Lake. This will create the second largest body of water proximal to the Athabasca River between Fort McMurray and Lake Claire near the mouth of the Athabasca River. It is well-known that large bodies of water attract waterfowl and create shifts in flyways of migratory waterfowl, (e.g., artifical reservoirs in parts of U.S. have changed flight routes of migrant geese.)

2) The Syncrude pond will be much closer to larger concentrations of migrant waterfowl that stop over during the spring.

Problems may also be encountered with Mildred Lake should it become contaminated with pollutants that are harmful to waterfowl. The complexity of the problem is compounded by the fact that Mildred Lake and portions of the Syncrude tailings disposal pond will be available to waterfowl when other bodies of water are frozen - either in late fall or early spring, thus serving as an attrahent - particularly during spring migration.

The most significant aspect of the tailings pond as an attrahent to waterfowl is its large size rather than as habitat. Waterfowl are characteristically attracted to large water bodies during fall migrations because of the security they represent during resting periods. The proposed pond represents an extremely difficult problem since it would be necessary to achieve high use of peripheral areas and maintain the pond in an unattractive state to waterfowl.

Four lakes of 300 acres or more are located within a 3-mile radius of the proposed Syncrude tailings disposal pond. This is the greatest concentration of small lakes along the Athabasca River zone for at least 50 miles in either direction from the Syncrude Lease. This concentration of lakes attracts the greatest number of waterfowl that stop over in the area during spring migration. Lakes on Lease 17 accounted for 43%

of all waterfowl counted throughout the survey. The most intensive use by waterfowl between Beaver Creek and Fort McMurray is concentrated on and proximal to Lease 17.

Use of these lakes occurs immediately after spring breakup and use of the Athabasca River decreases. The Athabasca River between G.C.O.S. and the mouth of Beaver Creek, and Horseshoe Lake, are prematurely open because of hot water emissions from the G.C.O.S. plant. These areas attract the first wave of migrants.

Twenty-eight species of ducks were noted in the 1971-72 studies. Twenty-five species of waterfowl and other birds of importance were noted during five aerial surveys of the Syncrude study area between May 4 and June 4, 1973. During spring '72, most of the ducks appear to be migrants, stopping over in the area for limited periods of time. By early June the birds still in the area included breeders, unsuccessful breeders, non-breeders and post-breeding males. By May 4, 1973, migration was well underway and appeared to be about two weeks advanced over last year's migration. The number of ducks diminished at the beginning of June when migration wanes.

In spring '72, an average of 1,037 ducks per day stopped-over in the area during the month of May. Few geese, swans, sandhill cranes, and great blue herons stopped-over. Results of eleven aerial surveys in spring '73, indicated an average of 1,465 waterfowl per survey flight. In 1972, the most abundant species were lesser scaup, followed by mallards, widgeon, and common mergansers. In 1973, coots were the most common species, followed by scaup, common goldeneye, American widgeon and mallard.

Dabbling ducks preferred Horseshoe Lake and shallow parts of Saline Lake, whereas diving ducks tended to prefer Mildred, Ruth, and deeper parts of Saline Lake. Saline Lake received the greatest use by waterfowl and a shift in concentration of coots and dabbling ducks was noted from other lakes to this lake as the season progressed. By the end of May the few waterfowl left on Ruth Lake and Mildred Lake tended to hide in the emergent vegetation along the shore. This and the build-up of pond-lily (Nuphar) made observations difficult. Utilization by shorebirds appeared minor.

Limited evidence suggests waterfowl avoid the G.C.O.S. tailings disposal pond because of larger area. Mitigation must be undertaken to reduce waterfowl oiling problems.

By mid-September, 1972, considerable numbers of migrant waterfowl were already utilizing the study area which included lakes on Syncrude Lease 17. These waterfowl were mainly resting and feeding birds. Duration of stay in the area was indeterminable. Most of these occurred in large flocks composed of a mixture of species. For mallards and scaup, two general waves of migration were documented. In fall '72, scaup were the most abundant species observed, averaging 670 birds per flight. Mallards were the second most abundant species in the area (averaging 387 species per flight). Ring-necked ducks were the second most abundant diver species averaging 59 per flight. Coots and common goldeneye showed appreciable increases in numbers over 1972, possibly a result of lower water levels further south. Scaup migration was more protracted than in 1972, showing no staging behavior. No common loons were noted.

Few ducks utilized the Athabasca River except late in October when most lakes were frozen or partially frozen. Most dabbler species utilized Horseshoe Lake. However, some flocks utilized other water bodies; primarily Saline, Ruth and Mildred Lakes. Dabblers were infrequent in the area once Horseshoe Lake became largely iced over before October 12, 1972. Divers, mostly scaup, remained later and were still present on October 26. They utilized open water on Saline, Ruth and Mildred Lakes. Canada geese were noted and averaged 15 birds per flight in fall '72. Canada geese utilized gravel bars and islands along the Athabasca River as well as the northern portion of Horseshoe Lake. The MacKay River, Beaver Creek and small sloughs on Lease 17 appeared to receive little or no use by waterfowl during fall migration.

Possible Mitigative Actions:

Careful monitoring will be required during the initial years of the development. Control measures should be initiated if a serious problem develops. Carbide cannons used to discourage waterfowl from crops might be gathered in booms and contained in certain areas.

Horseshoe Lake should be managed to improve its desirability to waterfowl. Horseshoe Lake is the first lake open when migrants arrive in the spring and will help to lure waterfowl away from the open water of the tailings disposal pond at a time when all other lakes are frozen over as well as after melt. The canal at the north end of Horseshoe Lake could be filled in or a wing gate built to control water levels at optimum conditions for good waterfowl habitat.

While it is difficult to predict the magnitude of waterfowl oiling problems, a mitigation study will be initiated while the project is still in the planning stage. Such a stage should include a review of the following factors:

1) Physical characteristics of proposed alteration and/or creation of water bodies and channels on Lease 17.
   - water temperatures and quality
   - volumes
2) Analysis of expected alteration and/or creation of water bodies on Lease 17 and surrounding area in relation to utilization by waterfowl. For example, a clean water reservoir for diversion of Beaver Creek will probably help to divert waterfowl from the tailing pond. Analysis of factors contributing to the attractiveness and unattractiveness of water bodies to waterfowl on migration will be carried out. Results can be

applied to the design of the tailings pond so that as many unattractive features as possible are incorporated. Additional habitat can be created to attract birds from the tailings pond.

3) Analysis of alteration of water bodies proximal to Lease 17: special enhancement of Ruth Lake and creation of new clean water detention storage reservoirs on Beaver Creek by Syncrude.

4) Analysis of above factors in relation to present data on waterfowl in the area so that problems that occur at critical times might be solved.

5) Analysis of all literature available on mitigation of waterfowl - oiling problems.

6) Recommendations for mitigation based on all of the above facets. Examples might be:
Design alteration of the tailings disposal pond to create several smaller initial settling ponds which might confine surface oil to a smaller area rather than to the total surface of the tailings pond.
Distrubance techniques to frighten birds away from tailings pond during the period when there is an influx of waterfowl in the area.

Increased hunting pressure might lead to complications with a mitigation program designed to entice waterfowl to certain ponds. Hunters might drive ducks away from such ponds and it is possible that hunting restrictions would have to be instituted.

Additional waterfowl surveys will be made as a followup to this study including a brood count about mid-July to determine numbers and distribution of the breeding population of waterfowl. This would take only a few days, and while the breeding population would be expected to be small, the data would serve as baseline information. An extensive survey should be made to determine the use of the area during the full period of the fall migration.

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Appendix 1:

Aerial Count of May 4, 1973 — 9:38 - 11:25 A.M.

Visiblity: Good — Weather: Sunny, windy.

Pilot: John Merilees — Observer: T.W. Thormin

	CHECKPOINT					TOTAL	CHECKPOINT								TOTAL
SPECIES	Ft.McM-1	1-2	2-3	3-4	4-5	RIVERS	6	7	8	9	10	11	12	13	LAKES
R. N. Gre	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4
Mal	2	25	16	6	1	52	34	14	21	2	20	2	2	7	102
Pin	-	-	2	-	-	2	4	6	8	-	-	8	-	29	55
G.W.T.	-	34	23	-	-	57	-	-	-	-	1	-	-	-	1
Wid	40	8	24	2	8	32	-	44	4	-	8	4	3	9	72
Shov	-	-	13	-	-	13	-	6	-	-	-	28	-	12	46
Can	-	-	-	-	-	-	8	-	10	-	-	-	-	-	18
Sc	-	-	-	-	-	-	90	10	50	4	-	4	-	87	245
C.G.	-	-	-	2	-	2	208	20	28	-	18	18	-	-	292
Buf	-	-	-	-	-	-	6	2	-	4	3	2	2	4	23
Rud	-	-	-	-	-	-	-	2	-	-	1	-	-	-	3
Mer	-	-	6	4	2	12	-	8	2	-	-	2	-	-	12
R.T.H.	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
M.H.	-	-	-	1	-	1	-	-	1	-	-	-	-	1	2
Co	-	-	-	-	-	-	-	50	-	-	-	30	-	-	80
Unid	-	-	-	4	-	4	-	-	-	-	-	-	-	4	4
TOTAL	42	67	86	20	11	226	350	162	126	10	51	98	7	157	961

GRAND TOTAL: 1,187

Appendix 2:

Aerial Count of May 11, 1973 — 9:10 - 10:55 A.M.
Visibility: Good — Weather: Cloudy
Pilot: Graeme Milne — Observer: T.W. Thormin

SPECIES	CHECKPOINT FT.MCM-1	1-2	2-3	3-4	4-5	TOTAL RIVERS	CHECKPOINT 6	7	8	9	10	11	12	13	TOTAL LAKES
Loon	-	-	-	-	-	-	-	-	2	-	-	-	-	8	8
R.N.Gre	-	-	-	-	-	-	-	-	3	-	3	-	-	-	6
Mal	-	-	4	-	17	21	50	35	13	2	3	14	2	6	125
Gad	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
Pin	-	-	-	-	-	-	-	4	2	-	-	-	-	-	6
G.W.T.	-	2	4	-	-	6	-	6	2	-	2	-	-	2	12
Wid	-	-	12	-	15	27	65	43	2	-	-	22	2	-	134
Shov	-	-	1	-	-	1	-	18	-	-	-	-	-	2	20
Red	-	-	-	-	-	-	21	-	-	-	-	-	-	-	21
Can	-	-	-	-	-	-	27	4	-	-	-	4	-	-	30
Sc	-	-	2	-	-	2	100	6	94	-	5	-	2	25	232
C.G.	-	1	6	14	11	32	104	4	4	-	15	8	1	9	145
Buf	-	-	-	-	2	2	5	5	2	-	5	7	-	9	33
S. Scot	-	-	-	-	-	-	-	-	5	-	-	-	-	-	5
Co	-	-	-	-	1	1	10	153	-	-	-	104	-	-	267
G.B.H.	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Unid	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
TOTAL	1	3	29	14	46	93	377	281	129	2	33	159	7	59	1047

GRAND TOTAL: 1,140

Appendix 3:

Aerial Count of May 18, 1973
Visibility: Good
Pilot: Arnold Schreder

8:40 - 10:35 A.M.
Weather: Sunny
Observer: T.W.Thormin

SPECIES	CHECKPOINT Ft. McM-1	1-2	2-3	3-4	4-5	TOTAL RIVERS	CHECKPOINT 6	7	8	9	10	11	12	13	TOTAL LAKES
Loon	-	-	-	-	-	-	-	-	15	-	-	-	-	3	8
R.N.Gre	-	-	-	-	-	-	-	-	2	-	1	-	-	2	5
Mal	-	-	14	-	11	25	35	28	23	-	6	2	4	10	108
Gad	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4
Pin	-	-	5	-	-	5	12	3	-	-	-	1	-	1	17
G.W.T.	-	-	-	-	-	-	-	3	-	-	-	-	-	1	4
B.W.T.	-	-	4	-	-	4	-	-	-	-	-	3	-	-	3
Wid	2	5	8	1	6	22	73	65	-	-	4	2	-	4	148
Shov	-	-	8	-	-	8	2	15	-	-	6	6	-	-	29
Red	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Can	-	-	-	-	-	-	5	-	-	-	-	-	-	-	5
Sc.	-	-	20	-	14	34	87	4	82	-	5	33	-	49	260
C.G.	-	-	6	1	58	65	200	4	6	-	11	44	2	2	269
Buf	-	-	-	-	-	-	12	1	2	-	7	1	-	5	28
W.W.Sclt	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
S.Scot	-	-	-	-	-	-	-	-	4	-	-	-	-	-	4
Mer	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
M.H.	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C.	-	-	-	-	-	-	79	82	-	-	-	76	-	4	241
Unid	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
TOTAL	3	5	65	2	89	164	513	206	124	1	40	168	6	81	1139

GRAND TOTAL: 1,303

Appendix 4:

Aerial Count of May 25, 1973 — 8:48 - 10:45 A.M.

Visibility: Good — Weather: Clear, windy

Pilot: Arnold Schreder — Observer: T.W. Thormin

SPECIES	CHECKPOINT Ft.McM-1	1-2	2-3	3-4	4-5	TOTAL RIVERS	CHECKPOINT 6	7	8	9	10	11	12	13	TOTAL LAKES
Loon	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
R.N. Gre	-	-	-	1	-	1	-	-	2	-	-	-	-	4	6
P.B.Gre	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Mal	-	1	4	2	6	13	66	23	7	-	-	29	2	3	130
Gad	-	-	-	-	-	-	8	8	-	-	2	-	2	-	20
Pin	-	-	-	-	-	-	4	2	-	-	-	-	-	-	6
G.W.T.	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3
B.W.T.	-	-	-	-	-	-	-	-	2	-	-	2	-	-	4
Wid	-	2	5	1	14	22	62	38	-	-	12	7	-	8	127
Shov	-	-	3	-	-	3	6	9	-	-	-	14	-	-	29
Red	-	-	-	-	-	-	20	2	-	-	-	-	-	-	22
Ring	-	-	-	-	-	-	8	-	-	-	4	-	-	-	12
Can	-	-	-	-	-	-	10	-	-	-	-	-	-	-	10
Sc	-	-	-	-	-	-	96	14	6	-	27	17	5	40	205
C.G.	-	-	2	13	30	45	140	-	6	-	4	14	2	-	166
Buf	-	-	-	-	-	-	13	5	-	-	-	2	-	9	29
W.W. Scot	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6
S. Scot	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6
Rud	-	-	-	-	-	-	-	-	-	-	-	5	-	-	5
Mer	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
M.H.	-	-	-	-	-	-	-	1	-	-	-	1	-	-	2
Co	-	-	-	-	-	-	299	186	-	-	4	103	-	-	592
TOTAL	-	3	14	17	50	84	734	289	25	-	53	197	11	76	1385

GRAND TOTAL: 1,469

Appendix 5:

Aerial Count of June 4, 1973 — 9:55 - 11:25 A.M.

Visibility: Good — Weather: Cloudy, windy

Pilot: Arnold Schreder — Observer: T.W. Thormin

SPECIES	CHECKPOINT Ft.McM-1	1-2	2-3	3-4	4-5	TOTAL RIVERS	CHECKPOINT 6	7	8	9	10	11	12	13	TOTAL LAKES
Loon	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
R.N. Gre	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Mal	-	-	-	1	1	2	30	5	-	-	5	-	-	-	40
Gad	-	-	-	-	-	-	5	-	-	-	-	1	-	2	8
Pin	-	-	-	-	-	-	-	2	-	-	-	-	-	1	3
G.W.T.	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
B.W.T.	-	-	-	-	-	-	-	2	-	-	-	-	-	2	4
Wid	-	-	-	-	4	4	31	7	-	-	3	9	-	-	50
Shov	-	-	-	-	-	-	4	2	-	-	-	-	-	1	7
Ring	-	-	-	-	-	-	-	-	-	-	10	4	-	-	14
Can	-	-	-	-	-	-	4	2	-	-	-	-	-	-	6
Sc	-	-	-	-	-	-	117	6	4	-	9	17	-	5	158
C.G.	-	-	1	1	-	2	57	-	-	-	-	1	-	3	61
Buf	-	-	-	-	-	-	16	1	-	-	4	3	-	-	24
W.W. Scot	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
Mer	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	130	138	-	-	1	9	-	1	279
Unid	1	-	1	-	-	2	-	-	1	-	-	-	-	-	1
TOTAL	1	-	2	2	6	11	396	167	7	-	32	44	-	15	661

GRAND TOTAL: 672

Appendix 6

General Aerial Reconnaisance of April 28, 1972 — 8:00 - 10:00 A.M.
Visibility: Fair — Weather: Intermittent clouds
Pilot: John Merilees. — Observer: Wayne McCrory and Jim Nalbach

Check-Point	
1-5, and 7	±1500 ducks, mostly between checkpoints 3 and 5 with about 300 on checkpoint 7. Most were Sc, Mal, Pin, CG, Buf, and (GWT). Also noted 7 Can, 1 common Loon, and 1 G.B.H. All other checkpoints frozen over. Beaver River and McKay River partially open.

Aerial Count of April 29, 1972 — 8:30 - 9:30 A.M.
Visibility: Fair — Weather: Sunny
Pilot: John Merilees — Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Ft.-1)E.	-	-	-	-	-	-	-	-	-	-	-	-	15	-	15
1-2) side	16	8	-	-	-	37	-	6	-	-	-	-	25	-	92
2-3)	-	-	-	-	-	7	-	-	-	-	-	-	60	-	67
3-5	31	-	6GWT	-	-	18	-	2	-	-	-	-	173	-	230
#7	12	-	-	-	-	33	-	6	-	-	-	-	72	-	123
3-1)W.side	-	-	-	-	-	-	-	-	-	-	-	-	±100	-	100
TOTAL:	59	8	6	-	-	95	-	14	-	-	-	-	445	-	627
Lease Area	15	-	-	-	-	5	-	-	-	-	-	-	8	-	28

Other checkpoints still frozen over.

Appendix 7

Aerial Count of May 3, 1972 | 8:45 - 10:00 A.M.
Visiblity: Poor | Weather: Cloudy
Pilot: John Merilees | Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Ft.-1	5	-	-	-	-	1	-	12	-	-	-	-	32	-	50
1-2	3	-	-	4	-	-	-	-	-	-	-	-	106	-	113
2-3	6	-	-	13	-	3	2	-	-	-	-	-	76	-	100
3-4	21	-	6GWT	20	-	9	-	-	-	-	-	8	±153*	-	217
4-5	51	-	12GWT	44	-	8	13	3	6	-	-	-	±171*	1 loon	309
Total River:	86	-	18	81	-	21	15	15	6	-	-	8	538	1	789
6	11	-	-	-	-	6	8	32	-	-	-	-	±424*	2SW	483
7	16	-	-	17	-	6	4	10	-	-	-	-	±166*	-	218
Total Lakes:	27	-	-	17	-	12	12	42	-	-	-	-	590	2	701
													Grand Total:		1491
Lease area	5	-	-	5	-	-	-	-	-	-	-	-	50	-	60
McKay River	2	-	-	10	-	2	-	-	-	-	-	-	2	-	16

*Mostly Sc with a few Can and others.
Other checkpoints frozen over.

Appendix 8

Aerial Count of May 8, 1972
Visibility: Good
Pilot: John Merilees

8:45 - 10:15 A.M.
Weather: Sunny and warm
Observer: Wayne McCrory

Transect	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M to #1	5	-	-	-	-	3	-	-	-	-	-	-	-	-	8
1-2	3	-	-	-	-	-	-	-	-	-	-	-	26	-	29
2-3	28	-	-	30	-	-	-	-	-	15	-	2	53	-	128
3-4	8	-	-	6	-	-	-	-	-	-	-	4	33	-	50
4-5	19	5	-	8	-	6	-	2	-	-	-	-	27	-	67
Total Rivers:	63	5	-	44	-	9	-	2	-	15	-	6	139	-	283
6.	-	-	-	-	-	-	-	±200	-	-	-	-	±200	-	400
7	11	-	-	6	-	-	6	18	-	2	-	-	45	1 GBH 5 Red	94
8	20	-	-	6	-	6	-	±104	-	-	-	4	66	-	206
9	-	-	-	-	-	-	-	11	-	-	-	-	-	-	11
10	1	-	-	2	-	5	2	-	8	-	-	4	56	-	78
11	-	-	-	-	-	-	-	±100	-	-	-	-	±50	2 Sw	152
Total Lakes:	32	-	-	14	-	11	8	433	8	2	-	8	417	8	941
													Grand Total		1224

Checkpoints 12 and 13 frozen over.

Appendix 9

Aerial Count of May 8, 1972
Visibility: Good
Pilot: John Merilees

8:45 - 10:00 P.M.
Weather: Clear and warm
Observer: Wayne McCrory

Transect	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M. to 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
1-2	4	-	-	-	-	12	-	-	-	-	-	-	18	-	34
2-3	4	-	-	6	-	-	-	-	-	4	-	-	61	-	75
3-4	11	-	-	28	-	-	-	30	-	12	-	18	25	-	124
4-5	3	-	-	8	-	4	-	-	-	-	-	10	5	-	30
Total Rivers:	24	-	-	42	-	16	-	30	-	16	-	28	109	-	265
6	-	-	-	-	-	-	-	300	-	-	-	-	100	12 Sw	412
7	12	-	-	2	5	-	2	55	-	-	2	-	21	1 GBH	100
8	16	-	-	24	2	-	-	44	4	5	-	-	24	1 Loon	119
9	3	-	-	-	-	-	-	30	-	-	-	-	-	-	33
10	2	-	-	10	2	-	-	50	-	-	-	4	30	2 Red	100
11	2	-	-	-	-	-	-	150	-	1	-	-	15	2 Red 2 Loon	172
Total Lakes:	35	-	-	36	9	-	2	629	4	6	2	4	190	20	936

Grand Total: 1202

Checkpoints 12 and 13 frozen over.

Appendix 10

Aerial Count of May 11, 1972
Visibility: Good
Pilot: John Merilees

8:45 - 10:00 A.M.
Weather: Sunny
Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M. to 1	7	-	-	-	-	-	2	-	-	-	-	1	6	-	16
1-2	5	-	-	2	-	-	-	11	-	-	-	-	2	-	20
2-3	16	-	-	6	-	5	-	32	-	-	-	7	1	-	67
3-4	11	-	-	2	-	14	-	8	-	-	-	3	7	-	45
4-5	8	-	-	22	-	21	-	3	-	2	-	9	4	-	69
Total Rivers:	47	-	-	32	-	40	2	54	-	2	-	20	20	-	217
6	31	-	-	16	-	8	12	445	-	3	-	-	61	-	576
7	13	-	-	10	1	3	3	5	1	-	-	-	17	-	53
8	29	2	-	2	-	3	1	216	-	4	-	-	10	4 Loon	271
9	-	-	-	-	-	-	-	6	-	-	-	-	3	-	9
10	3	-	5GWT	6	-	-	-	-	-	3	-	-	7	-	24
11	3	-	-	-	1	1	-	-	3	7	-	-	41	-	56
12	1	-	-	-	-	-	-	-	-	-	-	-	-	1 Loon	2
13	1	-	-	-	-	2	11	51	14	7	-	2	2	2 Loon	92
Total Lakes:	81	2	5	34	2	17	27	723	18	24	-	2	141	7	1083
													Grand Total:		1300

Appendix 11

Aerial Count of May 11, 1972
Visibility: Fair
Pilot: John Merilees

7:30 - 8:45 P.M.
Weather: Clear and warm
Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M. to 1	5	-	-	-	-	1	-	-	-	-	-	-	-	-	6
1-2	6	-	9	3	-	1	-	-	-	-	-	2	-	-	21
2-3	13	-	-	9	-	-	-	40	-	-	-	11	2	-	75
3-4	3	-	7	20	-	4	-	-	-	-	-	3	1	-	38
4-5	12	-	-	12	-	4	4	2	-	-	-	13	10	-	57
Total Rivers:	39	-	16	44	-	10	4	42	-	-	-	29	13	-	197
6	17	-	-	9	-	1	5	292	7	1	-	14	29	1 GBH	376
7	10	-	1	22	1	4	1	30	1	-	-	-	6	-	76
8	16	-	4	13	-	-	1	315	-	1	-	3	7	4 Loon	364
9	-	-	-	-	-	-	-	15	-	2	-	-	-	-	17
10	-	-	-	-	-	3	-	-	-	2	-	-	13	-	18
11	4	-	-	4	-	2	5	46	-	1	-	-	31	-	93
12	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4
13	7	-	-	15	-	-	5	100	-	2	-	1	-	-	130
Total Lakes:	58	-	5	63	1	10	17	798	8	9	-	18	86	5	1078
												Grand Total:			1275

Appendix 12

Aerial Count of May 15, 1972
Visibility: Good
Pilot: John Merilees

7:30 - 8:45 A.M.
Weather: Sunny, light overcast
Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M. to 1	4	-	-	-	-	-	-	-	-	-	-	-	1	-	5
1-2	2	-	-	1	-	2	-	2	-	-	-	1	4	-	12
2-3	10	-	-	8	-	-	-	-	-	-	-	-	-	12 Scot 1 GBH	31
3-4	10	8	2	3	2	2	1	12	-	-	-	10	1	-	51
4-5	19	-	-	14	-	8	2	12	-	-	-	16	10	-	81
Total Rivers:	45	8	2	26	2	12	3	26	-	-	-	27	16	13	180
6	17	-	2	16	-	-	12	395	4	-	30	19	62	3 S Cr	560
7	12	-	14	7	8	-	2	26	2	2	-	-	46	-	119
8	7	-	24	28	-	1	6	421	-	2	-	3	8	4 Loon	504
9	-	-	-	-	-	-	-	4	-	-	-	-	-	-	4
10	2	-	-	-	-	-	2	17	1	5	-	1	-	-	28
11	8	-	-	8	-	-	1	41	-	-	-	1	12	-	71
12	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Loon	2
13	9	-	-	6	-	-	7	72	5	1	-	2	11	4 Loon	117
Total Lakes:	55	-	40	65	8	1	30	976	12	10	30	26	139	13	1403
												Grand Total:			1583

Appendix 13

Aerial Count of May 18, 1972
Visibility: Good
Pilot: John Merilees

7:45 - 9:15 A.M.
Weather: Windy, cloudy and raining
Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M. to 1	1	-	-	-	-	-	-	-	-	-	-	-	4	-	5
1-2	1	-	-	5	-	-	-	-	-	-	-	3	7	-	16
2-3	8	-	-	7	-	6	-	-	-	-	-	8 (C)	-	-	29
3-4	3	-	-	-	2	1	-	-	-	-	-	3 (C)	8	-	17
4-5	6	-	-	46	-	2	-	-	-	-	-	26 (C)	2	-	82
Total Rivers:	19	-	-	58	2	9	-	-	-	-	-	40	21	-	149
6	39	-	-	35	4	2	5	±288	2	-	-	27 (C)	59	-	461
7	55	-	11GWT	8	-	-	3	1	-	1	-	-	11	-	90
8	7	2	12	-	-	-	7	±175	-	4	-	5 (C)	2	6 Loon 3 Scot 3 Ring	226
9	-	-	-	-	-	-	-	6	-	1	-	-	-	-	7
10	-	-	-	-	-	1	-	-	-	3	-	3	8	-	15
11	24	-	-	2	1	-	4	10	-	-	-	8 (C)	3	-	52
12	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Loon	2
13	4	-	-	2	-	-	14	90	-	1	-	-	2	2 Loon	115
Total Lakes:	129	2	23	47	5	3	33	570	2	10	-	43	85	16	968

Grand Total: 1117

*Note similarity of distribution at diff. checkpoints May 15 - 18.

Appendix 14

Aerial count of May 22, 1972
Visibility: Fair
Pilot: Brian Hardy

7:40 - 9:15 A.M.
Weather: Cool, cloudy
Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M. to 1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
1-2	5	-	-	2	-	-	-	-	-	-	-	3C	7	-	17
2-3	2	-	2	8	4	6	-	-	-	-	-	-	8	4 Loon 4 Scot	38
3-4	6	-	-	3	-	-	-	-	-	-	-	23(C) 2RB	-	-	34
4-5	1	-	-	18	-	6	2	6	-	-	-	36C	4	2 Loon	75
Total Rivers:	14	-	2	31	4	12	2	6	-	-	-	64	21	10	166
6	56	6	6	48	-	4	7	47	24	-	8	±40C	46	5 Scot 20 Rud	317
7	40	-	-	2	2	2	10	12	1	-	32	-	10	-	111
8	18	1	7	9	-	4	-	27	-	3	-	2C	6	5 Scot 1 Loon 2 Ring	85
9	-	-	-	-	-	12	-	-	-	-	-	-	-	-	12
10	2	-	2	-	-	-	5	8	-	1	-	-	2	3 Scot	23
11	-	-	1	6	6	1	11	7	-	-	12	1C	12	2 Gad	59
12	-	-	-	-Not checked, but looked like no ducks on it										-	-
13	5	-	3	-	-	4	13	21	-	12	-	-	4	3 Loon	65
Total Lakes:	121	7	19	65	8	25	46	122	25	16	52	43	80	41	670
												Grand Total:			836

Appendix 15

Aerial Count of May 25, 1972.
Visibility: Good
Pilot: Graham Milne

9:25 - 10:45 A.M.
Weather: Low overcast and cold
Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2
1-2	2	-	-	6	-	-	-	-	-	-	-	-	-	-	8
2-3	6	-	-	8	-	-	-	-	-	-	-	-	-	1 Olds	15
3-4	2	-	-	-	4	-	2	-	-	-	-	22	-	-	30
4-5	-	-	-	6	-	-	-	-	-	-	-	2	-	-	8
Total Rivers:	10	-	-	22	4	-	2	-	-	-	-	24	-	1	63
6	85	-	13	39	10	3	29	130	1	4	25	88	11	3 Red H 2 Scot	443
7	35	-	1	12	2	1	2	10	-	2	1	-	2	-	68
8	13	2	-	6	-	-	-	15	-	2	-	-	6	1 Ring 4 Loon	49
9	2	-	-	-	-	-	2	4	-	-	-	-	-	15 Ring	23
10	-	-	-	-	-	1	2	6	-	4	-	-	2	-	15
11	5	12	10	17	-	-	3	69	-	-	-	-	25	-	141
12	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Loon	2
13	-	-	-	3	-	-	20	29	-	1	2	-	-	5 Loon 4 Ring 1 Scot 10 Olds	75
Total Lakes:	140	14	24	77	12	5	58	263	1	13	28	88	46	47	816
													Grand Total:		879

Appendix 16

Aerial Count of May 30, 1972 — 7:30 - 9:10 A.M.

Visibility: Good — Weather: Warm and sunny

Pilot: Brian Hardy — Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Ft.-1	2	-	-	-	-	-	-	-	-	-	-	-	-	3 Scot	5
1-2	12	-	-	-	-	-	-	-	-	-	-	1	6	6 S Cr	25
2-3	12	-	-	12	-	6	-	3	-	-	-	6	4	6 S Cr	49
3-4	-	-	-	3	9	4	-	-	-	-	-	4	-	-	20
4-5	4	-	-	20	-	1	-	-	-	-	-	10	11	-	46
Total Rivers:	30	-	-	35	9	11	-	3	-	-	-	21	21	15	145
6	92	6	5	55	7	-	11	56	6	1	4	52	25	5 Gad 2 Harl	327
7	26	-	17	8	4	8	-	3	-	-	8	-	22	-	96
8	3	-	-	5	-	-	-	2	-	1	-	-	4	2 Scot 4 Ring 5 Loon	26
9	1	-	-	-	-	-	8	2	-	-	-	-	-	16 Ring	27
10	-	-	-	-	2	-	1	-	-	1	-	-	1	2 Scot	7
11	2	-	-	10	-	2	1	4	1	2	7	-	8	2 Rud 30 Ring	70
12	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Loon	2
13	8	-	-	2	1	-	13	4	-	6	-	-	5	3 Scot 10 Ring 3 Loon	55
Total Lakes:	132	6	23	80	14	10	34	71	7	11	19	52	64	86	610

Grand Total: 755

Appendix 17

Aerial Count of June 2, 1972
Visibility: Excellent
Pilot: John Merilees

7:40 - 9:20 A.M.
Weather: Cloudy and gusty
Observer: Wayne McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Ft.-1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
1-2	-	-	-	-	-	1	-	-	-	-	-	-	1	-	2
2-3	-	-	-	3	-	-	-	-	-	-	-	-	2	-	5
3-4	-	-	-	2	-	-	-	-	-	-	-	31	4	-	37
4-5	-	-	-	11	-	-	-	-	-	-	-	-	1	-	12
Total Rivers:	-	-	-	16	-	1	-	-	-	-	-	31	9	-	57
6	38	-	6	32	-	1	11	18	24	2	-	63	57	2 Rud	254
7	5	-	8	7	2	-	6	2	-	-	4	-	11	-	45
8	8	-	6	-	-	-	-	-	-	2	-	-	-	2 Loon 6 Ring	24
9	-	-	-	-	-	-	-	4	-	1	-	-	2	2 Ring	9
10	-	-	-	-	-	-	1	-	-	-	-	-	1	1 Scot 1 Rud	4
11	-	-	-	1	-	-	3	3	-	-	-	-	12	3 Ring 3 Scot	25
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	3	-	-	-	-	-	11	2	-	2	-	-	-	3 Ring	21
Total Lakes:	54	-	20	40	2	1	32	29	24	7	4	63	83	23	382

Grand Total: 439

Appendix 18

Aerial Count of September 18, 1972
Visibility: Fair to poor
Pilot: John Merilees

10:30 - 11:45 A.M. (1.3 hours)
Weather: Overcast 37° - 45°F.
Observer: W. McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M. -1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1-2	-	-	-	-	-	-	-	-	-	-	-	-	-	50 Cang	50
2-3	-	-	-	-	-	-	-	-	-	-	-	-	-	12 Cang	12
3-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4-5	-	-	-	-	-	-	-	-	-	-	-	-	-	20 Cang	20
Total Rivers:	-	-	-	-	-	-	-	-	-	-	-	-	-	82	82
6	10	2	8	2	4	-	-	191	-	-	-	-	49 Dab	10 Olds	276
7	395	-	-	220	-	-	-	-	-	-	-	-	9	6 Cang	630
8	280	-	-	6	-	2	-	15	-	-	-	-	6	10 Gad 6 Scot	325
9	-	-	-	20	-	-	-	12	-	-	-	-	-	-	32
10	-	-	-	2	-	-	-	26	-	1	-	-	3	-	32
11	17	2	-	7	-	-	-	8	-	-	-	-	2	-	36
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	113	-	-	-	-	-	-	256	-	-	4	-	18	2 Gad	393
Total Lakes:	815	4	8	257	4	2	-	508	-	1	4	-	87	34	1724

Grand Total: 1806

Appendix 19

Aerial Count of September 21, 1972
Visibility: Good
Pilot: John Merilees

12:30 - 1:30 P.M. (1.0 hours)
Weather: Cloudy, 1" fresh snow, 32°F.
Observer: W. McCrory, T. Thormin

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	-	-	-	-	-	-	-	-	-	-	-	-	-	25 Cang	25
1-2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
2-3	-	-	-	-	-	-	-	-	-	-	-	11	-	-	11
3-4	-	-	-	-	-	-	-	-	-	-	-	6	-	-	6
4-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Total Rivers:	-	-	-	-	-	-	-	-	-	-	-	18	-	25	43
6	80	-	-	-	-	-	60	130	-	-	-	-	-	-	270
7	200	-	-	-	-	-	-	-	-	-	-	-	240 M,W Few Teal and Shov	2 Sw 8 Cang	450
8	45	-	-	-	-	-	-	30	-	1	-	-	8 Dab	-	84
9	-	-	-	-	-	-	-	60	-	-	-	-	-	-	60
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
11	12	-	-	-	-	-	-	2	-	-	-	-	12 Dab	-	26
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	-	-	-	-	-	-	-	290	-	-	-	-	-	-	290
Total Lakes:	337	-	-	-	-	-	60	512	-	1	-	-	260	10	1180

Grand Total: 1223

Appendix 20

Aerial Count of September 25, 1972
Visibility: Good
Pilot: John Merilees

10:30 - 11:45 A.M. (1.3 hours)
Weather: Cloudy, 27°F.
Observer: T. Thormin

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1-2	70	-	-	20	-	-	-	-	-	-	-	10	-	-	100
2-3	-	-	-	-	-	-	-	20	-	-	-	-	-	-	20
3-4	-	-	-	-	-	-	-	-	-	-	-	10	-	-	10
4-5	30	-	-	-	-	10	8	-	-	-	-	29	-	-	77
Total River:	100	-	-	20	-	10	8	20	-	-	-	49	-	-	207
6	70	-	-	130	-	-	-	150	-	-	-	-	-	-	350
7	130	50	-	220	-	-	-	-	-	-	-	-	-	6 Cang 2 Sw	408
8	50	20	-	100	-	80	-	200	-	-	-	-	-	-	450
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
11	20	-	-	10	-	5	-	-	-	-	-	-	-	-	35
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	100	25	-	100	-	-	-	300	-	-	-	-	-	-	525
Total Lakes:	370	95	-	560	-	85	-	650	-	-	-	-	-	8	1768

Grand Total: 1975

Appendix 21

Aerial Count of September 28, 1972 — 12:00 - 1:40 P.M. (1.6 hours)
Visibility: Excellent — Weather: Sunny, 37°F.
Pilot: John Merilees — Observer: W. McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2-3	-	-	-	-	-	5	-	-	-	-	-	4	-	-	9
3-4	3	-	-	-	-	-	-	-	-	-	-	-	-	20 Cang 8 Red	31
4-5	-	-	-	2	-	16	-	-	-	-	-	-	-	-	18
Total River:	3	-	-	2	-	21	-	-	-	-	-	4	-	28	58
6	102	132	-	8	-	-	-	400	-	-	-	-	100 Dab & Div	1 Rud	743
7	570	50	100	-	-	-	-	30	-	-	-	-	-	-	750
8	82	-	-	-	-	-	-	400	-	-	-	-	-	7 Red	489
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	2	-	-	-	-	-	-	-	-	6	-	8
11	-	-	-	-	-	-	-	-	-	-	-	-	26 Dab	3 Ring	29
12	-	-	-	-	-	-	-	-	-	-	-	-	4	-	4
13	100	100	-	110	-	10	-	830	-	-	-	-	-	70 Red	1220
Total Lakes:	854	282	100	120	-	10	-	1660	-	-	-	-	136	81	3243

Grand Total: 3301

Appendix 22

Aerial Count of October 2, 1972
Visibility: Good
Pilot: John Merilees

9:20 - 11:00 A.M. (1.4 hours)
Weather: Sunny, 30°+F.
Observer: W. McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2-3	-	-	-	9	-	-	-	-	-	1	-	3	3 Dab	-	16
3-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4-5	28	-	-	-	-	30	-	-	-	-	-	-	-	-	58
Total River:	28	-	-	9	-	30	-	-	-	1	-	3	3	-	74
6	83	-	2	-	-	2	2	45	-	-	20	14	46 Dab	200 Ring	414
7	575	-	12	19	-	-	-	-	-	-	-	-	2	10Cang	618
8	209	-	-	-	-	16	4	-	30	-	1	-	20	8 Scot 200 Ring	488
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	3	-	-	75	-	-	-	-	-	-	-	-	-	-	78
11	6	-	-	-	2	-	-	-	-	-	21	-	6 Dab 2		37
12	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
13	6	-	-	-	-	2	-	489	-	-	10	-	10	9 Scot	526
Total Lakes:	882	-	14	94	2	20	6	536	30	-	52	14	86	427	2163

Grand Total: 2237

Appendix 23

Aerial Count of October 5, 1972
Visibility: Good
Pilot: John Merilees

12:00 - 1:00 and 2:00 - 2:15 P.M. (1.4 hours)
Weather: Sunny, 35°+F.
Observer: W. McCrory

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1-2	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6
2-3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
3-4	-	-	-	-	4	-	-	-	-	-	-	-	-	-	4
4-5	7	-	-	-	-	1	-	-	-	-	-	-	2	-	10
Total River:	15	-	-	-	4	1	-	-	-	-	-	-	2	-	22
6	110	44	-	2	-	-	-	-	-	-	-	-	31 Dab	100 Ring	287
7	352	-	13	132	-	-	-	-	-	-	-	-	12 Cang	4 Red 30 M & Red	543
8	104	-	-	5	-	6	2	-	-	-	6	-	30 Div	150 Ring	303
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	60	-	-	-	-	-	-	-	-	-	-	60
11	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Gad	2
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	30	-	-	-		10	-	1	5	2	-	10	-	100 Red	158
Total Lakes:	596	44	13	199	-	16	2	1	5	2	6	10	61	398	1353

Grand Total: 1375

Appendix 24

Aerial Count of October 12, 1972
Visibility: Good
Pilot: G. Milne

11:45 A.M. - 1:30 (1.4 hours)
Weather: Cloudy, Windy, 40^{o}-45^{o}F.
Observer: T. Thormin

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6
1-2	15	-	-	-	-	-	-	-	-	-	-	-	-	-	15
2-3	1	-	-	7	-	-	-	-	-	-	-	-	-	-	8
3-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4-5	-	-	-	-	-	-	-	7	-	-	-	-	-	-	7
Total River:	22	-	-	7	-	-	-	7	-	-	-	-	-	-	36
6	70	20	-	-	-	-	-	650	-	-	40	-	-	1 Rud	781
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8	60	-	-	-	-	-	-	410	-	-	2	-	-	-	472
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	30	-	-	-	-	-	-	-	-	-	-	30
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	30	-	-	-	-	-	-	425	-	-	-	-	-	20 Red	475
Total Lakes:	160	20	-	30	-	-	-	1485	-	-	42	-	-	21	1758
														Grand Total:	1794

Appendix 25

Aerial Count of October 16, 1972
Visibility: Good
Pilot: G. Milne

9:15 - 10:45 A.M. (1.4 hours)
Weather: Cloudy, 20^{o}-25^{o}F.
Observer: T. Thormin

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2-3	1	-	-	-	-	-	-	-	-	-	-	9	-	-	10
3-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Total River:	1	-	-	-	-	-	-	-	-	-	-	9	-	-	10
6	1	-	-	-	-	-	-	206	-	-	-	4	-	1 Sw 4 Scot 3 Scot	219
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8	-	-	-	-	-	-	-	265	-	-	-	-	-	-	265
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
11	-	-	-	-	-	-	-	15	-	-	-	-	-	-	15
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	-	-	-	-	-	-	-	250	-	-	-	15	-	2 Red	267
Total Lakes:	1	-	-	-	-	-	-	736	-	-	-	19	-	10	766

Grand Total: 776

Appendix 26

Aerial Count of October 19, 1972 — 11:15 - 1:15 P.M. (1.7 hours)
Visibility: Good — Weather: Cloudy, 32°-38°F.
Pilot: G. Milne — Observer: T. Thormin

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1-2	2	-	-	-	-	-	-	-	-	-	-	1	-	-	3
2-3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
3-4	-	-	-	1	-	-	-	-	-	-	-	-	-	1 Sw	2
4-5	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Total River:	2	-	-	1	-	1	-	-	-	-	-	2	-	1	7
6	33	-	-	-	-	15	-	450	-	-	40	12	-	20 Scot	
														10 Scot	580
7	-	-	-	-	-	-	-	-	-	-	-	-	-	1 Sw	1
8	8	-	-	-	-	-	-	350	-	-	-	-	30 Red	1 Greb	
													2 Rud	3 Scot	394
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	10	-	-	-	-	-	-	-	-	-	-	10
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	-	-	-	1	-	10	-	310	10	-	-	2	10 Red	15 Scot	
														5 Scot	363
Total Lakes:	41	-	-	11	-	25	-	1110	10	-	40	14	42	55	1348

Grand Total: 1355

Appendix 27

Aerial Count of October 23, 1972
Visibility: Good
Pilot: G. Milne

10:00 - 11:30 A.M. (1.4 hours)
Weather: Cloudy, 38^{o}-43^{o}F
Observer: T. Thormin

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
1-2	12	-	-	-	-	-	-	-	-	-	-	31	-	-	43
2-3	4	-	-	-	-	-	-	1	-	-	-	-	-	-	5
3-4	-	-	-	-	-	-	-	12	-	-	-	-	-	-	12
4-5	-	-	-	-	-	1	-	-	-	-	-	38	-	1 Scot	40
Total River:	17	-	-	-	-	1	-	13	-	-	-	69	-	1	101
6	-	-	-	1	-	2	-	6	-	-	10	-	-	-	19
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8	-	-	-	-	-	-	-	30	-	-	-	-	-	1 Gre	31
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	-	-	-	-	-	2	-	35	2	-	-	-	-	1 Scot 1 Rud	41
Total Lakes:	-	-	-	1	-	4	-	71	2	-	10	-	-	3	91

Grand Total: 192

Appendix 28

Aerial Count of October 26, 1972
Visibility: Poor to Fair
Pilot: G. Milne

12:10 - 1:30 P.M. (1.3 hours)
Weather: Cloudy, 10^{o}F.
Observer: T. Thormin

Check-Point	Mal	Pin	Teal	Wid	Shov	CG	Buf	Sc	Can	Gre	Co	Mer	Unid	Other	Total
Fort M.-1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6
1-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2-3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
3-4	2	-	-	-	-	-	-	1	-	-	-	3	-	-	6
4-5	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Total River:	17	-	-	-	-	-	-	1	-	-	-	3	-	-	21
6	2	-	-	-	-	-	-	2	-	-	-	-	-	1 Rud	5
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8	-	-	-	-	-	-	-	-	-	-	-	-	-	1 Rud	1
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	-	-	-	-	4	-	-	-	-	-	-	4
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	-	-	-	-	-	-	-	50	-	-	-	3	-	-	53
Total Lakes:	2	-	-	-	-	-	-	56	-	-	-	3	-	2	63

Grand Total: 84

Appendix 29

GROUND OBSERVATIONS, SYNCRUDE WATERFOWL STUDY, SPRING, 1972

April 27 - p.m.	Wandering River to Fort McMurray 11 pairs Mal, plus 8 Mal, 4 CG, 1 Buf, 9 GWT (1 drake Mal chasing hen on water)
May 4 - a.m.	Fort McMurray to Wandering River 3 Mal, 7 GWT, 2 CG, 5 Buf, 9 Sc

Horseshoe Lake (Partial counts)

April 28 - p.m.	29 Mal, 21 GWT, 1 Wid, 16 CG, 9 Buf, 2 Pin, 1 GBH, 1 Gre, 12 Shorebirds (Most paired. 1 drake Mal chasing hen)
April 29 - p.m.	10 Mal, 100 Pin, 11 Wid, 30 CG, 3 Buf, 2 Co, 8 Shorebirds (Pintails came into flocks in evening to rest and feed.)
April 30 - p.m.	5 Mal, 6 GWT, 31 Wid, 12 CG, 14 Buf, 7 Sc, 2 Can 1 Rud, 1 Loon (Common) (Male Buf approached female in typical breeding behavior)
May 1 - p.m.	6 Mal, 6 CG, 5 Buf, 20 Co, (14 Scr in V-flock going north, high-up.)
May 2 - a.m. (over 1/2 of Lake counted)	6 Mal, 2 Pin, 28 GWT, 14 Wid, 20 CG, 17 Buf, 36 Sc, 5 Red-necked grebes, 3 Eared-grebes, 1 Horned grebe. (TOTAL: 175)
May 11 - p.m.	2 Mal, 3 drake Shov

May 22 - p.m. — 8 Mal, 7 Wid, 4 BWT, 2 Shov, 3 Ring, 12 Co, 2 Eared grebes (drake Wid with hen chases another drake away.)

<u>Mildred Lake</u>:

May 9 - p.m. — 18 Mal, 8 Pin, 22 Wid, 22 GWT, 2 BWT, 6 CG, 5 Buf, 118 Sc, 6 Can, 4 Old-squaws, 2 White-winged scoters, 1 Surf scoter, 9 Horned grebes, 1 Rednecked grebe, 2 Common loons, 75 unidentified. (Total - 285) (Lake was totally ice-free today, 60% ice-free yesterday. Breeding activity by Mal and CG.)

May 11 - p.m. (Total count) — 8 Mal, 26 Wid, 11 GWT, 2 CG, 2 Buf, Approx. 300 Sc (in same location as a.m. aerial count), 6 Red-necked grebes, 3 Common loons. (Total - 350) (Wid show breeding activity)

May 12 - p.m. (Total count) — 12 Mal, 2 Pin, 12 Wid drakes, 20 Wid, 12 GWT, 2 CG, 8 Buf, ±300 Sc (most in same place as yesterday and apparently same group, about 75% drakes) 2 Can, 2 Red-necked grebes, 3 loons. (Total - 375) (Most Sc resting, some feeding).

May 13 - p.m. (Partial count in middle) — ±400 Sc in middle of lake or same place as yesterday. Same group, but larger, still about 75% male. 3 drake Buf, 4 drake Wid, 1 drake Can.

May 14 - p.m. — Same ±400 Sc in same place.

Appendix 29 (Cont'd)

May 15 - a.m.	Same ±400 Sc in same place, 2 Mal, 3 Western grebes, 2 Buf, 2 Ring, 2 White-winged scoters, 1 loon. (2 Buf showed breeding behavior)
May 17 - p.m.	Only ±200 Sc in same place today. 3 White-winged scoters, 3 Surf, 2 Ring, and a few CG and Buf.
May 18 - p.m.	Count of 200 + Sc in same place. (Most resting, some feeding) 6 Mal, 3 BWT, 2 GWT, 12 CG, 8 Buf, 20 + Ring, 10 Surf scoters. (3 small groups of CG show vigorous breeding behaviour. Mating noted.)
May 19 - p.m.	Quick check showed same ±200 Sc in same place.
May 23 - p.m.	Only 11 Sc in same place as yesterday's aerial count. Note well. 3 Mal, 3 Wid, 4 CG, 5 Buf, 5 Rud, 7 Ring, 6 Surf scoters. (Surf scoters show some breeding behaviour)
May 23 - June 2	Sporadic checks showed small numbers of ducks daily.

Appendix 30

CHRONOLOGY OF BREAK-UP AND FREEZE-UP ON STUDY AREA, 1972

CHECKPOINT	NAME	BREAK-UP	FREEZE-UP
1 - 5	Athabasca River	April 28 - Open for 1 -2 miles below G.C.O.S. plant. May 3 - River broken up and nearly free of ice flows.	October 10 to October 23: 10% frozen, mostly along shore. Some ice floating down river. October 26: 20% frozen.
6	Saline Lake	Partially open on May 3 All ice-free by May 8	20% frozen on October 12 95% frozen on October
7	Horseshoe Lake	Partially open by April 27 Nearly all open on May 3	90% frozen on October 12 100% frozen on October 16
8	Mildred Lake	60% open on May 8 100% open on May 9	30% frozen on October 12 99% frozen on October 26
9	Slough near Mildred Lake	Frozen on May 3 Open on May 8	100% frozen on October 12
10	Slough across from Syncrude	Frozen on May 3 Open on May 8	50% frozen on October 12 100% frozen on October 16 97% frozen on October 26
11	Slough across from G.C.O.S.	Frozen on May 3 Open on May 8	100% frozen on October 12
12	Slough near Ruth Lake	Closed on May 8 Open on May 11	100% frozen on October 12
13	Ruth Lake	Partially open on May 8 Open on May 11	95% frozen on October 26

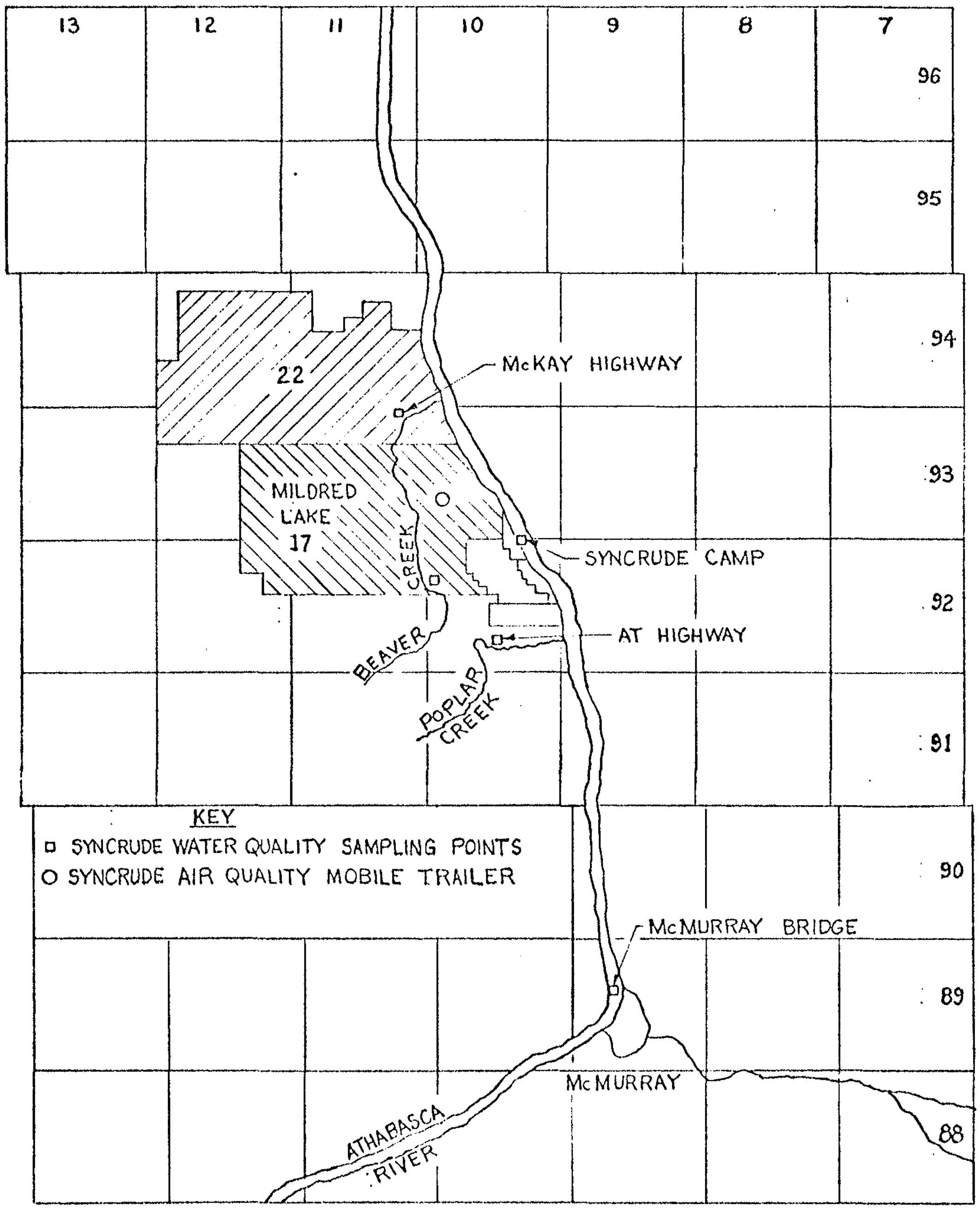
SECTION II

ENVIRONMENTAL BASELINE INFORMATION

1. AIR QUALITY

May, 1973

LOCATION OF SYNCRUDE
AIR AND WATER QUALITY MONITORING POINTS



SUMMARY

A Western Research & Development Ltd. air quality monitoring trailer was operated at the proposed Syncrude plant site in the vicinity of Ft. McMurray during the month of May, 1973.

The trailer was equipped with a Philips sulphur dioxide monitor, a Research Appliance Company hydrogen sulphide tape sampler and a Dominion Instruments wind instrument.

The maximum sulphur dioxide concentration recorded was 0.17 ppm on May 27 at which time the wind was from the southeast. At this time the sulphur dioxide concentration exceeded 0.10 ppm for 3 minutes. There were no average concentrations recorded exceeding 0.20 ppm for 30 minutes, 0.17 ppm for 60 minutes or 0.06 ppm for 24 hours. Hydrogen sulphide concentrations did not exceed zero ppb. During the reporting period the wind was predominantly from the south approximately 42 percent of the time.

INTERPRETATION OF SO_2/H_2S RECORDS

Charts from the sulphur dioxide monitor and tapes from the hydrogen sulphide tape sampler are read by Western Research & Development Ltd.

For each record on the sulphur dioxide charts an average concentration is read plus the total time interval over which the average concentration is taken. For peak readings exceeding 0.10 ppm the peak concentration is read along with the length of time the reading exceeds 0.10 ppm. When the peak concentration of sulphur dioxide exceeds 0.10 ppm or the average sulphur dioxide concentration is 0.05 ppm or greater for 15 minutes it is listed on a separate page. Weighted averages are calculated for the half-hour, hour, day and total period using a digital computer.

Hydrogen sulphide tapes are arbitrarily read in thirty minute intervals. Cumulative thirty minute concentrations of 3 ppb or greater are listed on a separate page. Weighted averages are calculated for the day and total period using a digital computer.

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY, 1973

HALF-HOUR AVERAGE H2S CONCENTRATIONS EXCEEDING 3 PPB

DATE	TIME START	TIME END	H2S AVERAGE CONC. (ppb)	WIND DIR.	WIND VEL. (mph)

no concentrations recorded exceeding limit

SYNCRUDE CANADA LIMITED – FT. MCMURRAY

MAY, 1973

HALF-HOURLY AVERAGE H2S CONCENTRATIONS (PPB)
(PAGE 1)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAGE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY, 1973

HALF-HOURLY AVERAGE H2S CONCENTRATIONS (PPB)
(PAGE 2)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAGE
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***	***	***	***	***	***	***	***	***	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***	***	***	***	***	***	***	***	***	
29	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
30	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
31	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	

*** DESIGNATES NO DATA FOR THAT HALF HOUR

AVERAGE CONCENTRATION FOR THE PERIOD: 0.000 PPB

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY, 1973

SO2 PEAK CONCENTRATIONS EXCEEDING 0.10 PPM
AND AVERAGE SO2 CONCENTRATIONS OF 0.05 PPM OR GREATER FOR 15 MINUTES

	PEAK CONC. (PPM)	TIME EXCEEDING 0.10 PPM (MIN.)	AVERAGE CONC. (PPM)	AVERAGE DURATION (MIN.)	TIME START	TIME END	DATE	WIND DIR.	WIND VEL. (MPH)
	0.11	1	0.06	10	1210	1220	MAY 26	E	**
	0.13	3	0.11	15	1220	1235	MAY 26	E	**
*			0.06	15	1235	1250	MAY 26	E	**
*			0.06	15	1250	1305	MAY 26	E	**
*			0.07	15	1335	1350	MAY 26	E	**
*			0.05	15	1630	1645	MAY 26	SE	**
	0.17	3	0.10	10	1015	1025	MAY 27	SE	**
	0.11	3	0.08	20	1025	1045	MAY 27	SE	**
*			0.06	15	2050	2110	MAY 30	**	**

* INDICATES AVERAGE SO2 CONCENTRATIONS OF 0.05 PPM OR GREATER FOR 15 MINUTES

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY, 1973

30 MINUTE AVERAGE SO2 CONCENTRATIONS EXCEEDING 0.20 PPM

DATE	TIME START	TIME END	SO2 AVERAGE CONC. (ppm)	WIND DIR.	WIND VEL. (mph)

no average concentrations exceeding limit

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY, 1973

60 MINUTE AVERAGE SO2 CONCENTRATIONS EXCEEDING 0.17 PPM

DATE	TIME START	TIME END	SO2 AVERAGE CONC. (ppm)	WIND DIR.	WIND VEL. (mph)

no average concentrations exceeding limit

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY, 1973

24 HOUR AVERAGE SO2 CONCENTRATIONS EXCEEDING 0.06 PPM

DATE	TIME START	TIME END	SO2 AVERAGE CONC. (ppm)	WIND DIR.	VEL. (mph)

no average concentrations exceeding limit

SYNCRUDE CANADA LIMITED - FT. MCMURRAY
MAY, 1973
HALF-HOURLY AVERAGE SO2 CONCENTRATIONS (PPM)
(PAGE 1)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAGE
1	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
2	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
3	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
4	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
5	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
6	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
7	***	***	***	***	***	***	***	***	***	***	***	.0	.0	.0	.0	***	***	.0	.0	.0	.0	.0	.0	.0	****
	***	***	***	***	***	***	***	***	***	***	.0	.0	.0	.0	***	***	.0	.0	.0	.0	.0	.0	.0	.0	
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.0	.0	.0	.0	.00	.0	.0	.00	.0	.0	.0	.001
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.0	.0	.0	.00	.01	.00	.0	.00	.0	.0	.0	.0	
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.01	.01	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.002
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.03	.01	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
10	.0	.0	.0	.0	.0	.0	.0	.01	.0	.0	.0	.00	.01	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.001
	.0	.0	.0	.0	.0	.0	.01	.0	.0	.0	.0	.01	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.01	.0	.0	.0	.0	.000
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.0	.0	.0	.0	.0	
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
14	.0	.0	.0	.0	.0	***	***	***	***	***	.0	.0	.0	.0	.0	.0	.0	***	***	***	***	***	***	***	.0
	.0	.0	.0	.0	.0	***	***	***	***	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	***	***	***	***	
15	***	***	***	***	***	.0	.0	.0	.0	.0	.0	***	.0	.0	.0	.0	.0	.0	.0	.0	.03	.04	.02	.02	.005
	***	***	***	***	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.04	.04	.02	.0	
16	.0	.0	.0	***	***	***	***	***	***	***	***	***	***	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	***	***	***	***	***	***	***	***	***	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	

SYNCRUDE CANADA LIMITED - FT. MCMURRAY
MAY, 1973
HALF-HOURLY AVERAGE SO2 CONCENTRATIONS (PPM)
(PAGE 2)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAGE
17	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
18	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.001
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.0	
19	.02	.0	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.001
	.02	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
20	.0	.0	.0	.0	.0	.01	.01	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.001
	.0	.0	.0	.0	.00	.01	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
21	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.0	.00	.0	.0	***	***	***	.000
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.0	.0	.00	.0	***	***	***	***	
26	***	***	***	***	***	***	***	***	***	***	.02	.02	.07	.05	.0	.0	.00	.00	.0	.0	.0	.0	.0	.0	.012
	***	***	***	***	***	***	***	***	***	.00	.02	.02	.07	.05	.0	.0	.02	.0	.0	.0	.0	.0	.0	.0	
27	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.05	.0	.0	.0	.0	.0	***	.0	.0	.0	.0	.0	.0	***	.002
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.04	.0	.0	.0	.0	.0	***	.0	.0	.0	.0	.0	***	***	
28	***	***	***	***	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	***	***	***	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
29	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	***	***	***	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	***	***	***	***	
30	***	***	***	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.03	.0	.0	.0	.0	.01	.03	.01	.00	.003
	***	***	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.01	.0	.0	.0	.00	.02	.01	.01	.0	
31	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
MEAN	.001		.000		.000		.000		.0		.003		.004		.000		.001		.000		.002		.002		
CONC		.000		.000		.000		.000		.0		.002		.002		.001		.000		.000		.003		.001	

PEAK SO2 CONCENTRATION RECORDED DURING THIS PERIOD   0.17 PPM
MAXIMUM SO2 AVERAGES BASED ON CALENDAR TIME:
HALF-HOURLY 0.07 PPM   HOURLY 0.07 PPM   DAILY 0.012 PPM
AVERAGE CONCENTRATION FOR THE PERIOD .0010 PPM
*** DESIGNATES NO DATA FOR THAT HALF HOUR

SYNCRUDE CANADA LIMITED – FT. MCMURRAY
MAY, 1973
24-HOUR RUNNING AVERAGE SO2 CONCENTRATIONS (PPM)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
2	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
3	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
4	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
5	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
6	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
7	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
8	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
11	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
15	***	***	***	***	***	***	***	***	***	.00	.00	***	***	***	***	***	***	.00	.00	.00	.00	.00	.01	.01
16	.01	.01	.00	.00	.00	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.00	.00	.00	.00
17	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
18	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
19	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
20	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
22	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
23	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
24	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
25	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
26	.00	.00	.00	.00	.00	.00	.00	.00	.00	***	***	***	***	***	***	***	***	***	***	***	***	.01	.01	.01
27	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
31	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

NOTE: WHEN DATA IS AVAILABLE, THE HOURLY AVERAGE CONCENTRATIONS FOR THE TWENTY-FOUR HOURS IMMEDIATELY PRECEDING THE REPORTING PERIOD ARE USED

*** INDICATES MORE THAN TWELVE HOURS OF MISSING DATA IN CALCULATING THE TWENTY-FOUR HOUR AVERAGE

SYNCRUDE CANADA LIMITED – FT. MCMURRAY
MAY, 1973
WIND DIRECTION AND SPEED

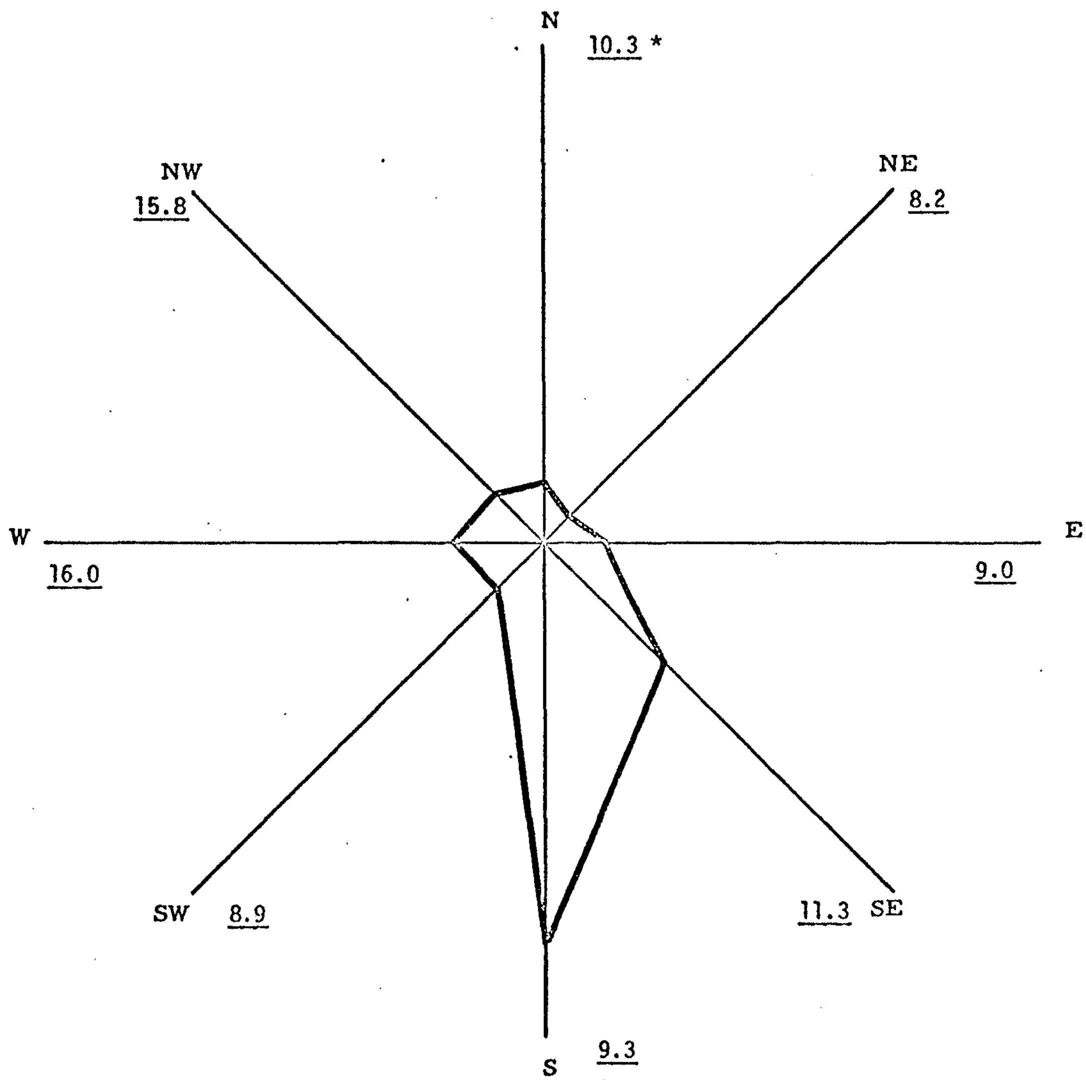
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVERAGE SPEED
1	S 7	S 6	S 4	SW 6	S 7	S 6	S 7	S 7	S 7	S 6	S 8	S13	S15	S15	S15	S14	S13	S11	SW10	SW 9	S 7	S 7	S 7	S10	9.0
2	S10	S 6	S 9	SE 9	SE 8	S 4	E 3	E 4	S 6	SE11	SE12	SE13	SE13	SE15	SE15	SE12	SE13	S11	S12	S12	SE12	SE 9	SE10	SE12	10.0
3	SE 9	SE 8	S 6	SE 4	SE 4	S 4	S 5	S 6	S 4	SW 4	S 5	SE13	SE18	SE17	SE18	SE19	SE18	S14	S15	S 9	SE11	E12	E 9	E11	10.1
4	S 6	SE 8	SE 9	SE 9	SE 8	S 3	SW 3	S 3	SW 3	S 7	S 6	S 8	SE17	SE17	SE14	E15	E15	SE14	SE14	S12	SE10	S 9	S 9	S 8	9.5
5	S 8	S 5	SW 4	S 4	E 4	SE 5	S 9	S 8	S 8	S 7	S 8	S 9	S10	S 7	S 7	S 8	S 8	S 7	S 9	S 8	SE 8	SE 9	S10	S14	7.7
6	S14	S13	S10	S 8	S 9	S 8	S 9	S12	SE13	S13	S14	S15	S15	S15	S15	S14	SE15	SE15	SE16	SE16	SE16	SE17	SE17	**11	13.3
7	** 9	**12	** 8	**11	**15	**17	**20	**18	**18	**19	SW20	SW21	SW24	W24	W20	W18	W19	W17	W17	W14	W11	W 9	S 9	SW11	15.9
8	SW 9	S 8	S 8	S 8	S 4	S 3	S 3	S 4	S 3	S 4	NE 7	E 6	E 7	NE 9	NE12	E15	SE13	SE17	SE14	SE12	SE10	SE 6	NW 6	SW 6	8.1
9	S 8	S 7	S 4	NE 4	N 5	N 4	W 5	NW 6	N 9	N11	E13	SE14	SE13	SE15	SE15	S13	S12	S15	S14	S13	S 8	S13	S10	S11	10.1
10	SE 6	E 6	E 7	E 8	E 8	E 5	E 7	NE 4	N 6	NW 6	N 8	E 8	SE13	S16	S14	S12	S 9	S 8	S 7	SW 6	W 7	SW 5	SW 7	W 6	7.9
11	SW 6	SW 5	S 6	S 6	S 7	S 7	S 6	S 5	S 4	S 5	S 6	SW 7	SW 7	SW 7	S 3	S 6	SW 9	SW11	S 8	SW 9	W11	W11	SW 5	S 6	7.1
12	SW 7	SW 5	SW 5	S 3	S 4	S 3	S 4	S 6	S 5	S 3	S 4	S 5	S 6	SE10	SE 9	SE11	S11	S10	SE10	S10	S 7	S 8	S 7	S 7	6.7
13	SE10	SE11	SE 9	SE 8	SE 8	S 5	S 6	S 6	S13	S14	S14	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	****
14	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	N 8	NE 9	NE 8	N 8	NE 9	N 7	N17	N20	N22	N19	N19	N12	N 5	12.5
15	N 4	N 6	NW 6	N 9	NW 7	NW 9	N12	N 8	N 7	N 8	NE 8	N 9	E 7	NW 7	W 7	S 5	S 4	S 4	S 2	E 6	E 4	SE 3	S 7	S 8	6.5
16	S 7	*****	*****	*****	*****	*****	*****	*****	*****	*****	S 9	S11	SW14	SW14	W23	W24	W29	W30	W30	W30	NW30	NW18	NW14	NW13	19.7
17	W12	W15	W16	W15	W18	W21	W22	NW15	NW22	NW22	NW21	NW20	NW21	NW21	NW17	NW15	NW13	NW11	N 8	SE 4	SE 5	SE 6	N 5	E 8	14.7
18	SE 8	SE12	SE 6	S 9	W 9	W 6	W 7	W 6	W15	W18	W20	NW22	NW23	NW24	NW23	NW24	NW22	NW21	NW20	NW15	N 8	E12	SE 7	S 5	14.3
19	S 5	S 6	S 7	S11	S11	S11	S 8	S 7	S 7	SE 6	S 8	SW12	SW12	SW15	W16	W15	NW21	NW10	S15	S15	SE 8	SE 8	SE 8	S 8	10.4
20	SE 8	NE 4	N 5	NE 6	E10	E 7	NE 9	NE10	E12	NE12	NE11	E12	E13	E14	E13	NE10	N13	N16	N15	N13	N12	N15	N 8	NW 7	10.6
21	NW 8	NE 7	SE 9	SW10	W14	W18	W16	W15	W15	W15	W18	W17	W15	W15	W15	NW13	NW10	E 7	E 9	E 9	E 8	SE 9	SE 8	S 5	11.9
22	S 5	SE 5	S 4	S 2	SW 3	S 5	S 3	S 4	S 9	S 9	S10	S12	S13	S15	S15	S15	S15	S15	S15	SE15	SE15	SE15	SE14	S12	10.2
23	S13	S13	S10	S10	SE13	S10	S 7	S14	S15	S13	S14	S15	S17	S15	S18	S18	S18	S18	S19	S17	S15	S13	S14	S12	14.2
24	S10	SE14	SE12	S12	S12	SE10	SE15	S17	S21	S23	S**	S**	S**	S**	S**	S**	S**	SE**	S**	SE**	SE**	SE**	SE**	SE**	****
25	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	S**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	****
26	SE**	SE**	SE**	S**	SW**	SW**	NW**	N**	N**	N**	E**	E**	E**	E**	SE**	S**	SE**	SE**	SE**	SE**	S**	S**	SE**	SE**	****
27	SE**	SE**	S**	S**	S**	SW**	S**	S**	S**	SE**	SE**	S**	S**	S**	SE**	S**	S**	SW**	W**	NW**	N**	SW**	SW**	W**	****
28	W**	N**	W**	S**	S**	W**	W**	W**	W**	W**	NW**	NW**	N**	N**	NW**	NW**	W**	NE**	S**	NW**	SW**	SW**	W**	W**	****
29	W**	S**	W**	W**	W**	W**	W**	W**	W**	W**	SW**	W**	W**	NW**	NW**	NW**	N**	N**	NW**	*****	*****	*****	*****	*****	****
30	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	S**	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	****
31	*****	*****	*****	SW**	SW**	SW**	S**	S**	S**	S**	SW**	SW**	SW**	W**	W**	W**	W**	W**	W**	SW**	SW**	W**	W**	SW**	****
FAN	8.2		7.5		8.5		8.5		10.1		11.1		13.7		14.4		14.0		13.6		11.0		9.2		
PD		8.3		7.8		7.8		8.4		10.7		12.3		14.3		14.0		13.6		12.5		10.6		8.9	

** DESIGNATES NO DATA FOR THAT HOUR

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

WIND DIRECTION DISTRIBUTION

May, 1973



Wind from direction: (%)

N	NE	E	SE	S	SW	W	NW	Calm
6.8	3.3	6.8	18.0	42.1	6.8	9.3	7.1	0.0

*Average wind speed for the indicated direction

Average wind speed for the reporting period - 10.7 mph

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY. 1973

AVERAGE WIND SPEED AND FREQUENCY DISTRIBUTION

SPEED (MPH)	FREQUENCY (PERCENT)									
	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 4	0.4	0.6	0.8	0.8	5.4	1.0	0.0	0.0	0.0	8.9
5 - 8	3.1	1.0	2.9	4.2	16.4	2.7	1.4	1.5	0.0	33.2
9 - 12	1.4	1.7	1.7	5.4	9.1	1.9	1.2	0.8	0.0	23.2
13 - 16	1.0	0.0	1.4	5.6	9.3	0.6	2.9	1.4	0.0	22.0
17 - 20	0.8	0.0	0.0	1.9	1.5	0.2	2.1	0.8	0.0	7.3
21 - 24	0.2	0.0	0.0	0.0	0.4	0.4	1.0	2.5	0.0	4.4
25 - 28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29 - 32	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.2	0.0	1.0
33+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	6.8	3.3	6.8	18.0	42.1	6.8	9.3	7.1	0.0	
AVE SPD (MPH)	10.3	8.2	9.0	11.3	9.3	8.9	16.0	15.8	0.0	
NO SPEED AVAILABLE (HOURS)	9.0	1.0	4.0	44.0	33.0	18.0	31.0	11.0	0.0	

TOTAL NUMBER OF HOURS USED FOR CALCULATIONS IS 518.
DOES NOT INCLUDE HOURS WHEN SPEED OR DIRECTION ARE NOT AVAILABLE

AVERAGE WIND SPEED FOR THE REPORTING PERIOD IS 10.7 MPH

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY, 1973

CUMULATIVE FREQUENCY DISTRIBUTION
FOR HALF-HOURLY AVERAGE SO2 CONCENTRATIONS

CONCENTRATIONS	NUMBER OF HALF HOURS	PERCENTAGE	CUMULATIVE PERCENTAGE
.000	1001	93.81	93.81
.001 - .049	63	5.90	99.72
.050 - .059	1	0.09	99.81
.060 - .099	2	0.19	100.00
.100 - .169	0	0.0	100.00
.170 - .199	0	0.0	100.00
.200 - .499	0	0.0	100.00
.500 - .999	0	0.0	100.00
1.0+	0	0.0	100.00

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

MAY, 1973

CORRELATION OF WIND DIRECTION
AND SO2 CONCENTRATION DISTRIBUTION

CONCENTRATIONS (PPM)	N	NE	E	SE	S	SW	W	NW	CALM
.000	100.0	88.9	61.3	83.5	96.3	97.6	100.0	100.0	0.0
.001 - .049	0.0	11.1	35.5	16.5	3.7	2.4	0.0	0.0	0.0
.050 - .059	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.060 - .099	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0
.100 - .169	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.170 - .199	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.200 - .499	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.500 - .999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WIND DIRECTION DISTRIBUTION	6.0	3.7	6.4	17.5	33.7	8.6	15.2	9.0	0.0

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

AIR MONITORING INSTRUMENTATION DATA

MAY, 1973

SULPHUR DIOXIDE:

1. Make and model of instrument used: Philips Model PW 9700
2. Minimal detectable limit of instrument 4 ppb
3. Precision of instrument 1 % of measured signal
4. Percentage of time operational 71.7 %
5. Instrument was calibrated on March 27 1973 by the permeation tube method
6. Instrumentation difficulties, if any: Missing data is the result of a missing chart.

HYDROGEN SULPHIDE:

1. Make and model of instrument used: Research Appliance Company G2 SF
2. Percentage of time operational 89.2 %
3. Instrumentation difficulties, if any: Missing data is the result of a chart not being available.

WIND SPEED AND DIRECTION:

1. Make and model of instrument used: Dominion Instruments Windflo
2. Percentage of time operational
   - Direction 89.9 %
   - Speed 71.1 %
3. Instrumentation difficulties, if any: Missing data is the result of inking problems and the recorder pens sticking.

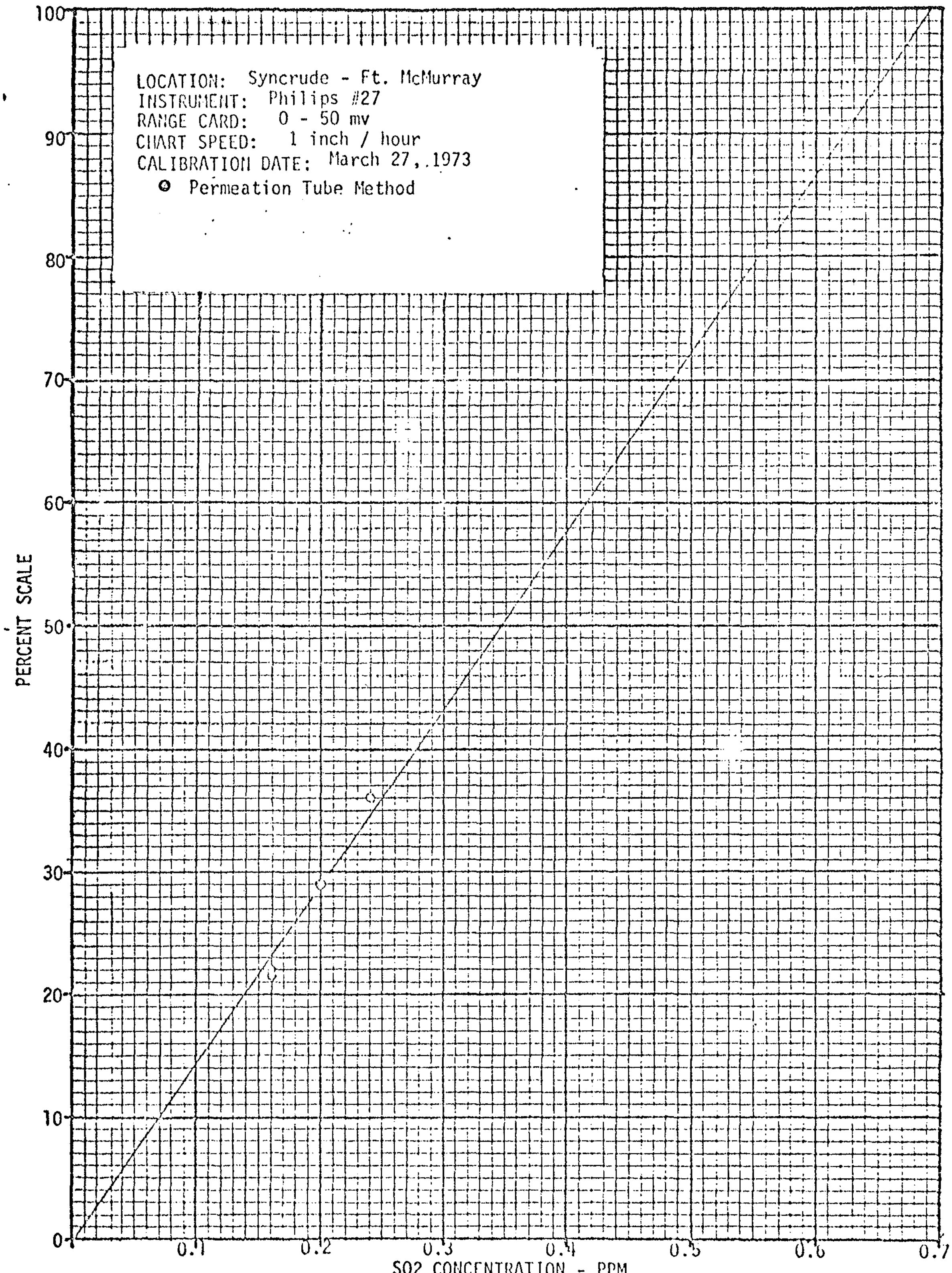
CALIBRATION OF SULPHUR DIOXIDE AIR MONITOR

Western Research & Development Ltd. calibrates the sulphur dioxide air monitors by a dynamic method employing permeation tubes.

The sulphur dioxide permeating from the tubes is mixed with a diluent gas stream, and the resulting mixture supplied to the instrument. The permeation rate of the sulphur dioxide is determined gravimetrically and the total gas stream flow-rate is metered by a calibrated flow control device. During each calibration, four concentrations within the range of the instrument are supplied to the instrument; three up-scale and one down-scale.

In order to assure that the permeation system is operating correctly, and to assure that errors will not occur, the sulphur dioxide concentrations delivered by the permeation tube systems are checked periodically by the modified West-Geake method.

The calibration curve and copy of the chart obtained during the procedure is attached.



LOCATION: Syncrude - Ft. McMurray
INSTRUMENT: Philips #27
RANGE CARD: 0 - 50 mv
CHART SPEED: 1 inch / hour
CALIBRATION DATE: March 27, 1973
Permeation Tube Method
PERCENT SCALE
0
10
20
30
40
50
60
70
80
90
100
0.1
0.2
0.3
0.4
0.5
0.6
0.7
SO2 CONCENTRATION - PPM

.R.&D.

DATE: MAR 27/73
JOB NUMBER : 8339

SO_2 Calibration

Company: SYNCRUDE   Plant Location: FT. McMURRAY

Trailer No. or Location: ______

Instrument: PHILIPS   No.: 27

Range Card: 0 - 50 mV.

Instrument Air Flow: 14B   Reagent Flow: /

Calibration Bottle No.: ______   Permeation Rate: .162

Span: 84 - 10 = 74

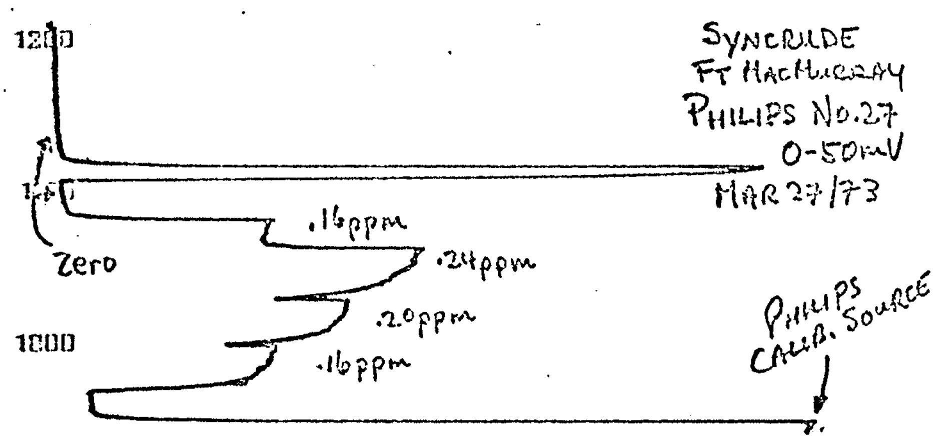
Concentration: ______   Zero: 10-8 % scale

Dynamic Method	SO_2 Input(ppm)	Initial	Span Adjust	Final
1.	.16	30-8 = 22		
2.	.20	37-8 = 29		
3.	.24	44-8 = 36		
4.	.16	29.5-8 = 21.5		

Net span adjust

West Geake Method

Q: ______   Meter Temp.: ______   B.P.: ______



Form #24

SUMMARY

A Western Research & Development Ltd. air quality monitoring trailer was operated at the proposed Syncrude plant site in the vicinity of Ft. McMurray during the month of June, 1973.

The trailer was equipped with a Philips sulphur dioxide monitor, a Research Appliance Company hydrogen sulphide tape sampler and a Dominion Instruments wind instrument.

The maximum sulphur dioxide concentration recorded was 0.43 ppm on June 13 at which time the wind was from the northeast at 5 miles per hour. At this time the sulphur dioxide concentration exceeded 0.10 ppm for 13 minutes. The 30 minute average limit of 0.20 ppm was exceeded once (page 7), this being recorded as 0.21 ppm on June 13 during winds from the east at 10 miles per hour. The 60 minute average limit of 0.17 ppm was also exceeded once (page 8), this being recorded as 0.18 ppm and also occurring on June 13. There were no average concentrations recorded exceeding 0.06 ppm for 24 hours. Hydrogen sulphide concentrations did not exceed zero ppb. During the reporting period the wind was predominantly from the southwest quarter approximately 63 percent of the time.

INTERPRETATION OF SO2/H2S RECORDS

Charts from the sulphur dioxide monitor and tapes from the hydrogen sulphide tape sampler are read by Western Research & Development Ltd.

For each record on the sulphur dioxide charts an average concentration is read plus the total time interval over which the average concentration is taken. For peak readings exceeding 0.10 ppm the peak concentration is read along with the length of time the reading exceeds 0.10 ppm. When the peak concentration of sulphur dioxide exceeds 0.10 ppm or the average sulphur dioxide concentration is 0.05 ppm or greater for 15 minutes it is listed on a separate page. Weighted averages are calculated for the half-hour, hour, day and total period using a digital computer.

Hydrogen sulphide tapes are arbitrarily read in thirty minute intervals. Cumulative thirty minute concentrations of 3 ppb or greater are listed on a separate page. Weighted averages are calculated for the day and total period using a digital computer.

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

HALF-HOUR AVERAGE H2S CONCENTRATIONS EXCEEDING 3 PPB

DATE	TIME START	TIME END	H2S AVERAGE CONC. (ppb)	WIND DIR.	VEL. (mph)

no concentrations recorded exceeding limit

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

HALF-HOURLY AVERAGE H2S CONCENTRATIONS (PPB)
(PAGE 1)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAG
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

HALF-HOURLY AVERAGE H2S CONCENTRATIONS (PPB)
(PAGE 2)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAGE
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

MAXIMUM H2S CONCENTRATION RECORDED DURING THIS PERIOD 0 PPB
AVERAGE CONCENTRATION FOR THE PERIOD 0.0 PPB
*** DESIGNATES NO DATA FOR THAT HALF HOUR

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

SO2 PEAK CONCENTRATIONS EXCEEDING 0.10 PPM
AND AVERAGE SO2 CONCENTRATIONS OF 0.05 PPM OR GREATER FOR 15 MINUTES

	PEAK CONC. (PPM)	TIME EXCEEDING 0.10 PPM (MIN.)	AVERAGE CONC. (PPM)	AVERAGE DURATION (MIN.)	TIME START	TIME END	DATE	WIND DIR.	WIND VEL. (MPH)
*			0.07	15	1315	1330	JUNE 1	SE	**
*			0.06	15	1330	1345	JUNE 1	SE	**
*			0.06	15	1415	1430	JUNE 1	SE	**
*			0.05	15	1430	1445	JUNE 1	SE	**
*			0.06	15	1445	1500	JUNE 1	SE	**
	0.11	1	0.04	30	1915	1945	JUNE 12	E	6
	0.17	15	0.09	30	855	925	JUNE 13	N	3
	0.12	3	0.08	5	925	930	JUNE 13	NE	4
	0.25	16	0.16	20	930	950	JUNE 13	NE	4
	0.13	8	0.10	10	950	1000	JUNE 13	NE	4
	0.43	13	0.16	25	1000	1025	JUNE 13	NE	5
	0.11	5	0.04	20	1110	1130	JUNE 13	E	12
	0.11	3	0.04	25	1805	1830	JUNE 13	E	15
	0.14	29	0.13	30	2050	2120	JUNE 13	SE	9
	0.33	30	0.21	30	2120	2150	JUNE 13	E	10
	0.24	26	0.14	30	2150	2220	JUNE 13	E	10
	0.16	6	0.05	25	1835	1900	JUNE 15	N	13
	0.18	9	0.09	25	1235	1300	JUNE 23	NW	6
*			0.07	15	1045	1100	JUNE 25	W	2

* INDICATES AVERAGE SO2 CONCENTRATIONS OF 0.05 PPM OR GREATER FOR 15 MINUTES

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

30 MINUTE AVERAGE SO2 CONCENTRATIONS EXCEEDING 0.20 PPM

DATE	TIME START	TIME END	SO2 AVERAGE CONC. (ppm)	WIND DIR.	WIND VEL. (mph)
13	2120	2150	0.21	E	10

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

60 MINUTE AVERAGE SO2 CONCENTRATIONS EXCEEDING 0.17 PPM

DATE	TIME START	TIME END	SO2 AVERAGE CONC. (ppm)	WIND DIR.	WIND VEL. (mph)
13	2120	2220	0.18	E	10

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

24 HOUR AVERAGE SO2 CONCENTRATIONS EXCEEDING 0.06 PPM

DATE	TIME START	TIME END	SO2 AVERAGE CONC. (ppm)	WIND DIR.	WIND VEL. (mph)

no average concentrations exceeding limit

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

HALF-HOURLY AVERAGE SO_2 CONCENTRATIONS (PPM)

(PAGE 1)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAG
1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	***	***	.07	.05	.01	.0	.0	.0	.0	.0	.0	.0	.0	.005
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	.04	.05	.01	.0	.0	.0	.0	.0	.0	.0	.0	
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	.0	.0	.0	.0	.0	.0	.01	.02	.0	.0	.001
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	***	.0	.0	.0	.0	.0	.0	.02	.0	.0	.0	
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.0	.0	.0	.0	.0	.000
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
10	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	.03	.01	.0	.0	.0	.0	.0	.0	.0	.001
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	.01	.00	.0	.0	.0	.0	.0	.0	.0	
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	***	***	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	***	***	.0	.0	.0	.0	.0	.0	.0	.0	.0	
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.00	.0	.01	.02	.0	.0	.0	.0	.002
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.0	.00	.00	.02	.0	.0	.0	.0	
13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.09	.16	.03	.02	.0	.0	.0	.0	.0	.03	.0	.01	.16	.09	.0	.022
	.0	.0	.0	.0	.0	.0	.0	.0	.04	.14	***	.0	.0	.01	.0	.0	.0	.0	.0	.00	.07	.18	.0	.0	
14	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
15	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.01	.0	.0	.0	.0	.001
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.04	.0	.0	.0	.0	.0	
16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	

SYNCRUDE CANADA LIMITED – FT. MCMURRAY
JUNE, 1973
HALF-HOURLY AVERAGE SO_2 CONCENTRATIONS (PPM)
(PAGE 2)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAGE
17	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	
18	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
19	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	.0	.01	.0	.0	.0	.0	.0	****
	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	.0	.01	.0	.0	.0	.0	.0	
20	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
21	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.02	.0	.0	.0	.02	.0	.0	.0	.00	.0	.00	.003
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.08	.0	.0	.0	.00	.01	.0	.0	.0	.00	.00	.0	
24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.0	.0	.0	.0	.001
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.0	.0	.00	.0	.0	
25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.04	.01	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.003
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.05	.03	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
27	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
28	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
29	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.01	.0	.0	.0	.0	.0	.00	.01	.0	.0	.0	.0	.0	.001
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.0	.0	.0	.0	.0	.01	.00	.0	.0	.0	.0	.0	
30	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
MEAN CONC	.0	.0	.0	.0	.0	.0	.0	.0	.001	.004	.008	.001	.002	.003	.002	.001	.000	.001	.003	.001	.002	.007	.002	.000	

PEAK SO_2 CONCENTRATION RECORDED DURING THIS PERIOD 0.43 PPM
MAXIMUM SO_2 AVERAGES BASED ON CALENDAR TIME:
HALF-HOURLY 0.18 PPM HOURLY 0.17 PPM DAILY 0.022 PPM
AVERAGE CONCENTRATION FOR THE PERIOD .0016 PPM
*** DESIGNATES NO DATA FOR THAT HALF HOUR

SYNCRUDE CANADA LIMITED – FT. MCMURRAY

JUNE, 1973

24-HOUR RUNNING AVERAGE SO2 CONCENTRATIONS (PPM)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.00	.00	.00	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
2	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.00	.00	.00	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.0	.0	.0	.0	.0	.0
10	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.00	.00	.00	.00	.00	.00	.00	.00
11	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.01	.01	.02	.02	.01	.01	.01	.02	.01	.02	.02	.02	.02
14	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.01	.01	.01	.01	.01	.01	.01	[illegible]	.01	.01	.01	.00	.00	.00
15	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	[illegible]	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
17	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
18	.00	.0	.0	.0	.0	.0	.0	.0	.0	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
19	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
20	***	***	***	***	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
22	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
23	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
24	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
25	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
26	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
27	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

NOTE: WHEN DATA IS AVAILABLE, THE HOURLY AVERAGE CONCENTRATIONS FOR THE TWENTY-FOUR HOURS IMMEDIATELY PRECEDING THE REPORTING PERIOD ARE USED

*** INDICATES MORE THAN TWELVE HOURS OF MISSING DATA IN CALCULATING THE TWENTY-FOUR HOUR AVERAGE

SYNCRUDE CANADA LIMITED - FT. MCMURRAY
JUNE, 1973
WIND DIRECTION AND SPEED

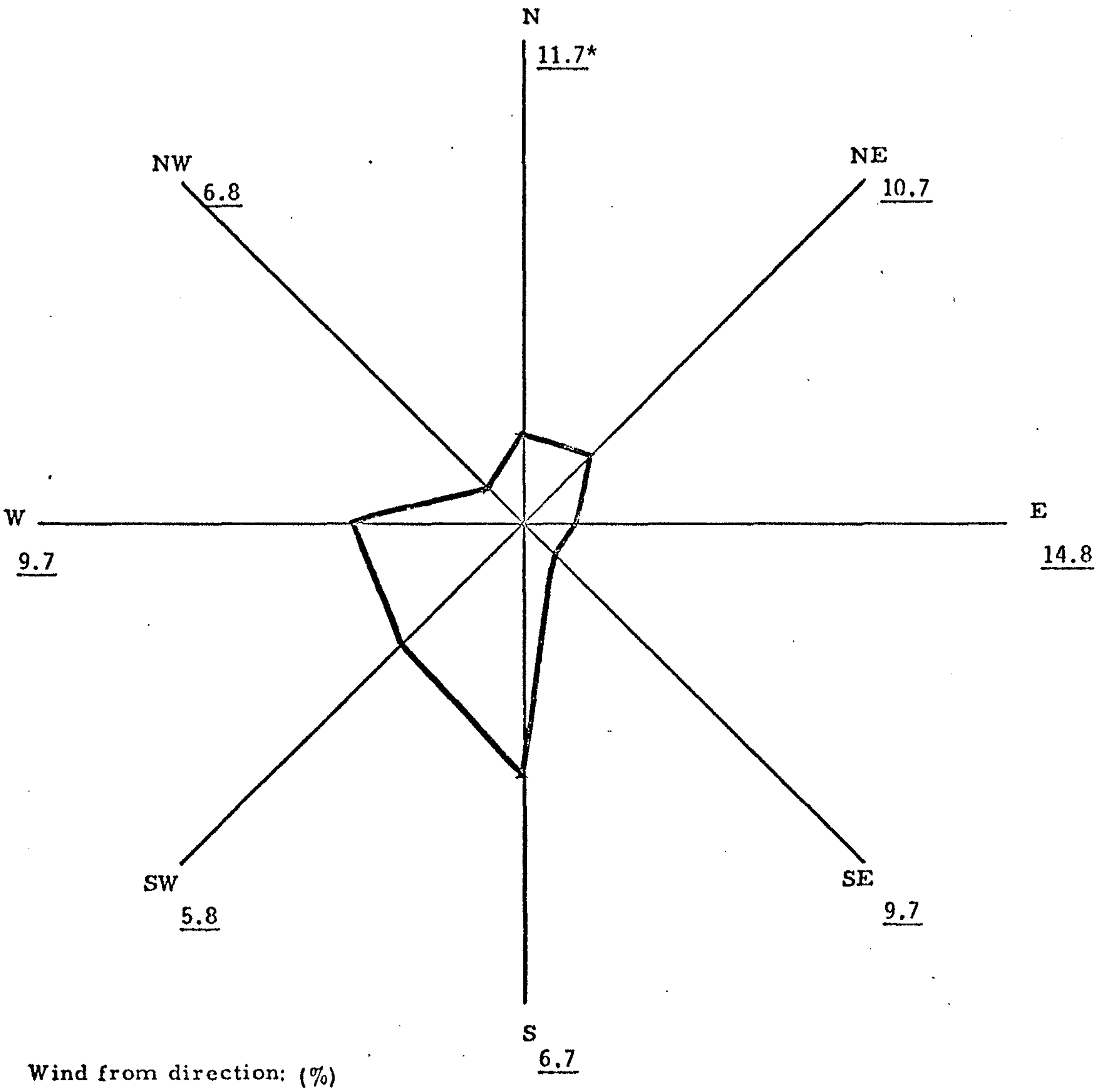
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVERAGE SPEED
1	****	****	****	****	****	****	****	****	****	E**	E**	E**	E**	SE**	SE**	SE**	SE**	SE**	S**	S**	S**	S**	S**	S**	****
2	S**	S**	S**	S**	S**	S**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	S**	S**	SE**	SE**	S**	S**	SE**	SE**	****
3	SE**	SE**	S**	S**	S**	S**	S**	S**	SW**	S**	SW**	W**	W**	NW**	N**	NW**	N**	N**	NW**	W**	W**	NW**	W**	W**	****
4	NW**	W**	W**	W**	W**	W**	W**	W**	W**	W**	NW**	NW**	N**	N**	NW**	NW**	N**	N**	N**	N**	NW**	W**	NW**	NW**	****
5	W**	W**	W**	W**	NW**	N**	N**	N**	N**	NW**	W**	W**	W**	W**	NW**	N**	N**	N**	N**	N**	N**	N**	NE**	SW**	****
6	SW**	SW**	SW**	SW**	SW**	S**	S**	S**	S**	S**	E**	S**	S**	SE**	S**	SE**	SE**	S**	S**	S**	SE**	SE**	SE**	SE**	****
7	SE**	S**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	E**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	SE**	S**	S**	S**	SE**	SE**	S**	****
8	S**	S**	S**	SW**	SW**	S**	SW**	S**	SW**	S**	S**	SW**	SE**	S**	SW**	NE**	NW**	NW**	NW**	NW**	SW**	SW**	S**	SW**	****
9	SW**	SW**	W**	SW**	SW**	SW**	S**	E**	SW**	W**	W**	W**	SW**	SW**	W**	SW**	SW**	SW**	SW**	SW**	S**	S**	S**	S**	****
10	SE**	S**	S**	S**	SE**	S**	S**	NW**	N**	S**	N**	N**	N**	N**	N**	N**	NW**	NW**	W**	SW**	SW**	W**	W**	W**	****
11	W**	W**	W**	NW**	N**	N**	N**	N**	N**	NW**	****	NW 8	NW14	SW 6	W11	N22	NW10	W 5	W 5	W 5	W 5	W 5	W 3	SW 4	7.9
12	NW 2	C 0	S 3	S 3	C 0	S 4	S 3	S 2	SW 1	SW 2	SW 4	S 5	S 8	NW 7	W 3	S 5	NE 6	N 6	NE 5	E 6	NE 6	NE 8	NE 8	E 5	4.3
13	C 0	SW 2	SW 2	SW 1	SW 2	W 2	W 2	NW 4	N 3	NE 4	NE 5	E12	E15	E15	SE11	S12	S12	SE12	E15	E10	SE 9	E10	S11	S 8	7.5
14	S 6	S 3	NE 7	N 3	NE 4	N 6	NW 4	NE 6	E10	NE10	NE14	NE14	NE13	NE10	E14	E15	NE 8	NE 7	NE 6	NE11	NE11	NE10	N 8	N 7	8.6
15	N 6	N 7	N10	N10	N 9	N10	N11	NE14	NE15	NE14	N15	N16	N21	N20	N15	N14	N12	N10	N13	N14	N15	NE11	N10	N 9	12.5
16	N 9	N 9	NE 8	E15	E15	E22	E23	E23	E21	E26	NE25	NE26	NE23	NE18	NE13	NE15	NE19	E19	E21	SE16	SE14	SE14	SE15	SE16	17.7
17	SE15	S14	S12	S11	S10	S14	S12	S15	SW15	SW10	S10	S12	S12	S11	SW 8	S11	S13	S13	SW 4	W 3	N 5	W 2	SW 1	SW 3	9.8
18	W 4	NW 5	SW 3	SW 3	W 4	W 3	W 5	NW 4	N 8	N**	N**	N 9	N**	N**	N**	N**	NE14	NW**	NW**	W**	W 6	W 6	W 4	W 4	5.5
19	SW 3	S 4	S 2	S 4	S 3	S 2	C 0	S 2	W 4	SE 4	SW 3	W 7	W10	N 9	N11	N16	N14	NE 8	SE 9	S 6	SW 5	W11	S 4	SW 6	6.1
20	SW 5	SW 6	S 6	S 7	S 6	SW 6	SW 7	SW 6	SW 9	W17	W16	W17	W19	W18	W16	W19	W23	W24	W22	W19	W15	W12	W12	W13	13.3
21	W15	W14	W11	W10	SW11	SW 7	SW 3	SW 7	W13	W15	W15	W19	W19	W21	**19	**19	**22	**17	**13	**13	** 9	** 6	** 8	** 8	13.1
22	S 7	S 7	S 7	S 4	S 3	S 2	S 6	SW10	SW10	S10	S12	S20	**19	** 8	SW 7	SW 6	S 3	S10	S 9	SE 8	SE11	SE 9	SE 7	S 3	8.3
23	S 3	S 2	S 4	SW 2	C 0	SW 2	W 4	W 2	W 4	NW 6	NW 2	W 4	NW 6	NW 8	**11	**16	**16	**18	**21	**21	**19	**19	**19	**20	9.5
24	**20	N25	N25	E12	S12	SW 5	NW 4	NW 5	S 6	S 2	SW 2	SW 2	SW 2	S 3	S 3	SW 2	W 3	W 3	C 0	NW 2	S 2	S 3	S 5	SE 4	6.3
25	S 5	S 7	S11	S13	S12	S11	N13	N12	NE13	N13	W 2	W 8	W13	W 7	W 3	W 9	W 9	W 9	W11	W12	W 6	SW 7	SW 5	S 9	9.5
26	S 8	S 5	SE 6	S 7	SW 7	SW 7	S 6	S 7	S 7	S 7	S 7	S 8	SW 7	S 6	SW 3	SW 7	SW 8	SW 7	SW10	SW11	SW10	SW 8	SW 8	SW 6	7.4
27	S 9	S 5	S 6	S 9	S 9	S 6	NW13	NW 6	SW 4	S 5	S 3	S 6	S 6	S 4	S 4	S 6	S 8	S 7	S 4	SW 3	SW10	SW 9	SW 7	SW 5	6.4
28	SW 7	W 9	SW11	SW11	SW 9	W 9	W 9	W11	W 9	W 8	W 6	W 8	W 8	W 5	SW 4	S 6	S 8	S 9	S 7	S 6	S 4	S 2	S 7	S 4	7.4
29	SE 6	S 7	SE 6	S 5	SW 5	SW 4	SW 4	SW 9	SW 5	S 2	NE 6	NE11	NE 8	NE12	NW17	NW12	N13	W17	E 9	E 6	SE 8	SW 5	SW 6	SW 6	8.0
30	S 6	S 5	SW 6	SW 8	SW 3	S 3	S 4	SW 4	W 7	NW 6	S 3	S 5	S 5	S 5	S 5	S 5	NW 6	NE 5	NE 5	SE 4	NW 5	N 9	NE 6	NE 9	5.4
MEAN SPD	7.2	7.2	7.7	7.3	6.5	6.6	7.0	7.8	8.6	8.9	8.3	10.8	12.0	10.2	9.9	11.4	11.3	10.8	9.9	9.4	8.8	8.3	7.7	7.4	

** DESIGNATES NO DATA FOR THAT HOUR

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

WIND DIRECTION DISTRIBUTION

JUNE, 1973



Wind from direction: (%)

N	NE	E	SE	S	SW	W	NW	Calm
9.8	10.1	5.3	4.8	27.2	18.3	17.8	5.3	1.4

Average wind speed for reporting period - 8.4 mph

* Average wind speed for indicated direction (mph)

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

AVERAGE WIND SPEED AND FREQUENCY DISTRIBUTION

SPEED (MPH)	FREQUENCY (PERCENT) N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4
1 - 4	0.5	0.5	0.0	0.7	8.5	6.6	4.3	1.6	0.0	22.7
5 - 8	1.8	4.1	0.7	1.4	11.4	8.2	4.3	2.5	0.0	34.6
9 - 12	3.7	2.1	1.4	1.4	5.7	3.2	3.9	0.5	0.0	21.7
13 - 16	2.7	2.3	1.6	1.4	1.4	0.2	2.3	0.5	0.0	12.4
17 - 20	0.2	0.5	0.2	0.0	0.2	0.0	2.1	0.2	0.0	3.4
21 - 24	0.5	0.2	1.1	0.0	0.0	0.0	0.9	0.0	0.0	2.7
25 - 28	0.5	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1
29 - 32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	9.8	10.1	5.3	4.8	27.2	18.3	17.8	5.3	1.4	
AVE SPD (MPH)	11.7	10.7	14.8	9.7	6.7	5.8	9.7	6.8	0.0	
NO SPEED AVAILABLE (HOURS)	38.0	2.0	7.0	49.0	59.0	32.0	37.0	26.0	0.0	

TOTAL NUMBER OF HOURS USED FOR CALCULATIONS IS 437.
DOES NOT INCLUDE HOURS WHEN SPEED OR DIRECTION ARE NOT AVAILABLE

AVERAGE WIND SPEED FOR THE REPORTING PERIOD IS 8.4 MPH

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

CUMULATIVE FREQUENCY DISTRIBUTION
FOR HALF-HOURLY AVERAGE SO2 CONCENTRATIONS

CONCENTRATIONS	NUMBER OF HALF HOURS	PERCENTAGE	CUMULATIVE PERCENTAGE
.000	1267	95.12	95.12
.001 - .049	54	4.05	99.17
.050 - .059	2	0.15	99.32
.060 - .099	5	0.38	99.70
.100 - .169	3	0.23	99.92
.170 - .199	1	0.08	100.00
.200 - .499	0	0.0	100.00
.500 - .999	0	0.0	100.00
1.0+	0	0.0	100.00

SYNCRUDE CANADA LIMITED - FT. MCMURRAY

JUNE, 1973

CORRELATION OF WIND DIRECTION
AND SO2 CONCENTRATION DISTRIBUTION

CONCENTRATIONS (PPM)	N	NE	E	SE	S	SW	W	NW	CALM
.000	92.6	91.1	71.4	89.7	97.7	100.0	97.0	88.4	80.0
.001 - .049	7.4	4.4	25.0	8.8	2.3	0.0	3.0	11.6	20.0
.050 - .059	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
.060 - .099	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.100 - .169	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.170 - .199	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0
.200 - .499	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.500 - .999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WIND DIRECTION DISTRIBUTION	10.7	7.1	4.4	10.7	27.1	16.5	15.9	6.8	0.8

SYNCRUDE CANADA LIMITED - FT. MCMURRAY
AIR MONITORING INSTRUMENTATION DATA
JUNE, 1973

SULPHUR DIOXIDE:

1. Make and model of instrument used: Philips Model PW 9700
2. Minimal detectable limit of instrument 4 ppb
3. Precision of instrument 1 % of measured signal
4. Percentage of time operational 92.6 %
5. Instrument was calibrated on June 11 197 3
   by the permeation tube method
6. Instrumentation difficulties, if any: Missing data is the result of inking problems.

HYDROGEN SULPHIDE:

1. Make and model of instrument used: Research Appliance Company G2 SE
2. Percentage of time operational 100.0 %
3. Instrumentation difficulties, if any: None.

WIND SPEED AND DIRECTION:

1. Make and model of instrument used: Dominion Instruments Windflo
2. Percentage of time operational
   Direction 95.4 %
   Speed 63.9 %
3. Instrumentation difficulties, if any: Missing data is the result of inking problems.

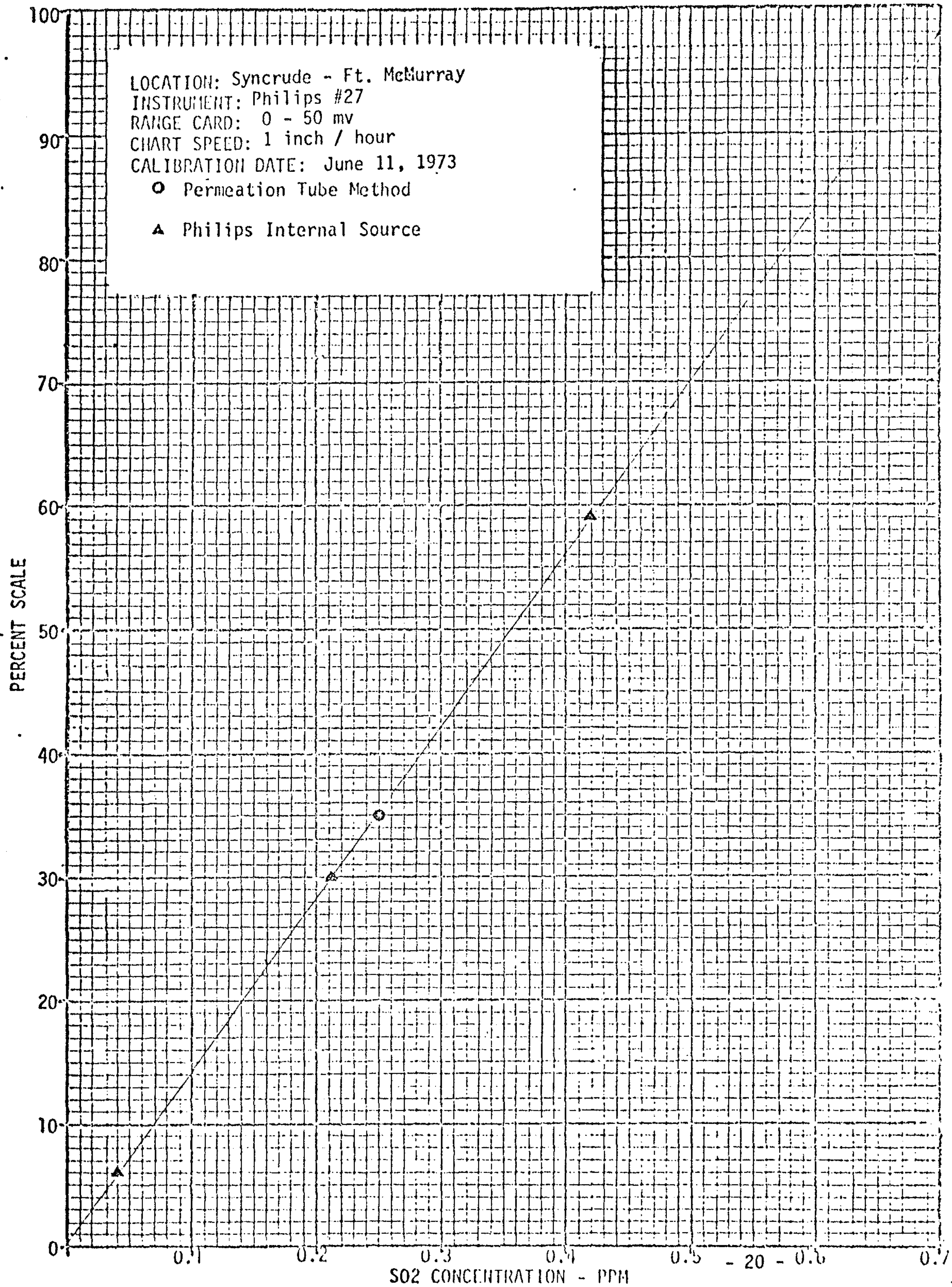
CALIBRATION OF SULPHUR DIOXIDE AIR MONITOR

Western Research & Development Ltd. calibrates the sulphur dioxide air monitors by a dynamic method employing permeation tubes.

The sulphur dioxide permeating from the tubes is mixed with a diluent gas stream, and the resulting mixture supplied to the instrument. The permeation rate of the sulphur dioxide is determined gravimetrically and the total gas stream flow-rate is metered by a calibrated flow control device. During each calibration, four concentrations within the range of the instrument are supplied to the instrument; three up-scale and one down-scale.

In order to assure that the permeation system is operating correctly, and to assure that errors will not occur, the sulphur dioxide concentrations delivered by the permeation tube systems are checked periodically by the modified West-Geake method.

The calibration curve and copy of the chart obtained during the procedure is attached.


LOCATION: Syncrude - Ft. McMurray
INSTRUMENT: Philips #27
RANGE CARD: 0 - 50 mv
CHART SPEED: 1 inch / hour
CALIBRATION DATE: June 11, 1973
O Permeation Tube Method
▲ Philips Internal Source
PERCENT SCALE
100
90
80
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
SO2 CONCENTRATION - PPM

V.R. & D.

DATE: 14 June 11/73

JOB NUMBER : 8339

SO_2 Calibration

Company: Syncrude Plant Location: Ft MacMurray

Trailer No. or Location:

Instrument: Philips No. 27

Range Card: 0-50 mV.

Instrument Air Flow: 148 Reagent Flow:

Calibration Bottle No.: Permeation Rate:

Span:

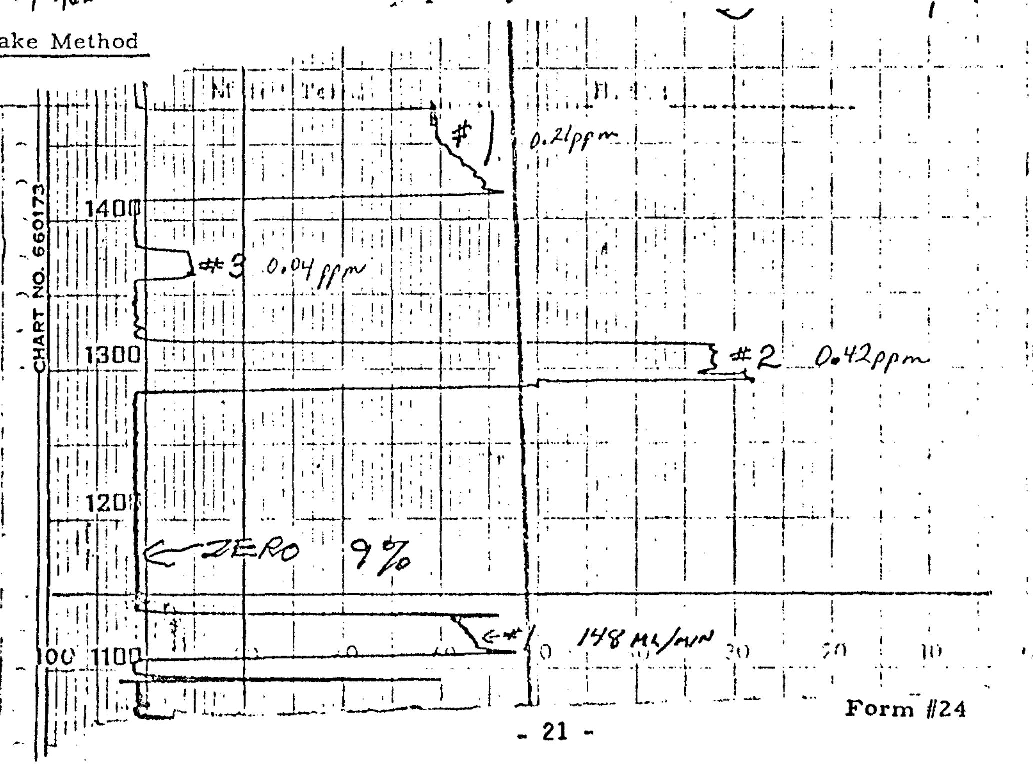
Concentration: Zero: 9 % scale

Dynamic Method	SO_2 Input(ppm)	Initial	Span Adjust	Final
Using Internal Sources Verified by Permeation Tube	1. #1 .21	30%		
	2. #2 0.42	59%		
	3. #3 0.04	6%		
	4. Perm. Tube 25PSIG #57 0.25ppm	55%		

Net span adjust

West Geake Method

Q:



Form #24

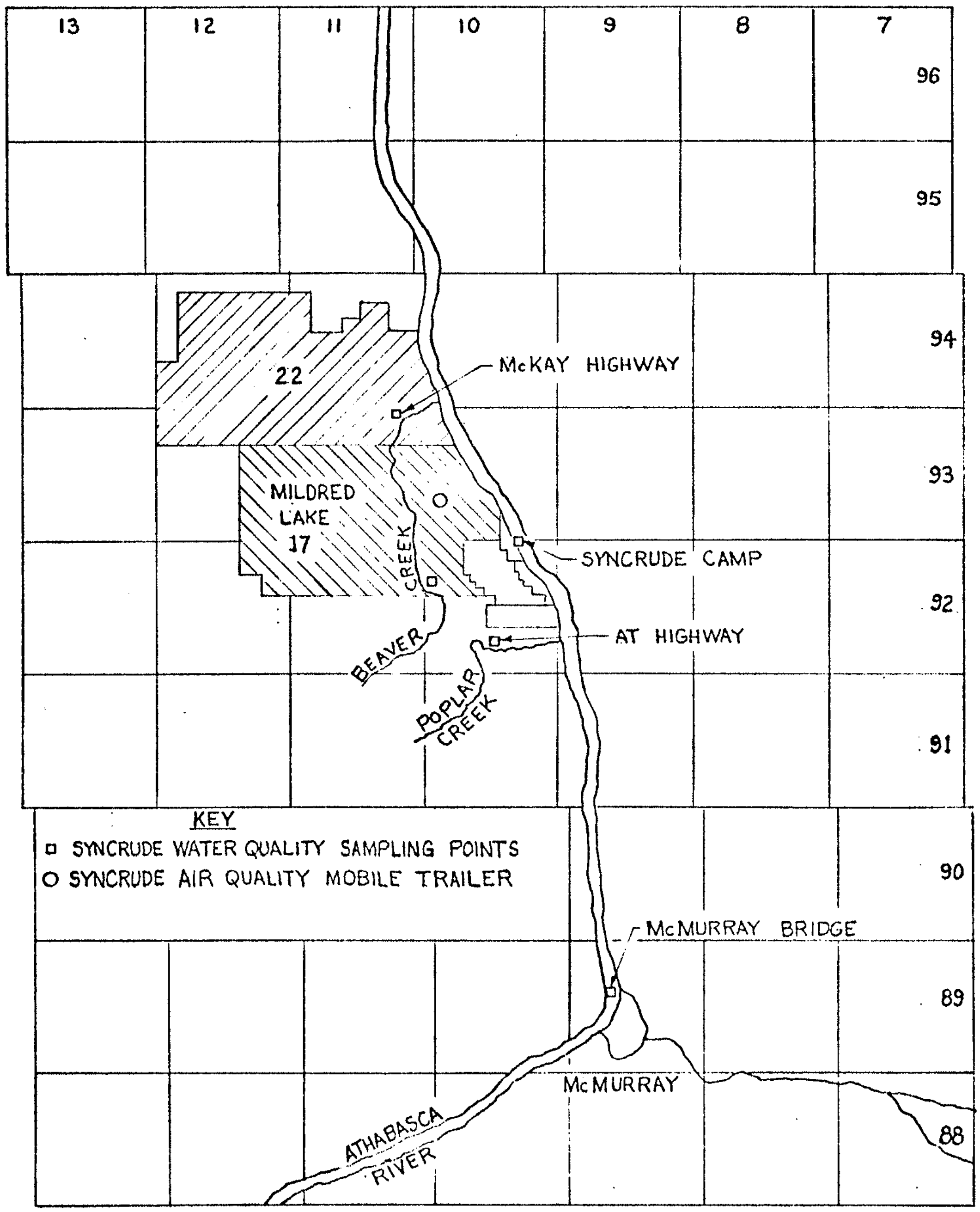
SECTION II

ENVIRONMENTAL BASELINE INFORMATION

2. WATER QUALITY

June, 1973

LOCATION OF SYNCRUDE
AIR AND WATER QUALITY MONITORING POINTS



Surface Water Quality Monitoring on Lease 17

An on-going program to monitor the quality of surface water on or near Syncrude's Lease 17, began several years ago. The raw data obtained to date and remarks on a few relevant details are contained in this report.

No major attempt has been made to interpret the chemistry of the waters in relation to water quality or make comprehensive comparisons against government criteria at this stage of the program. The prime purpose is to collect baseline information recognizing certain limitations such as sampling techniques and accessibility of suitable sampling locations.

In September of 1972, the program was expanded by doing more extensive chemical assays and by adding more sampling points. The field sampling is done by Syncrude personnel and the chemical analyses performed by Chemical and Geological Laboratories in their Edmonton Laboratory. The data obtained is contained in Volume II Section II.

Sampling Locations

Athabasca River - Every two months several samples (the number of samples taken depending on the chemical pretreatment required for sample preservation described below) are taken at two locations: at the McMurray bridge and off the dock at the Syncrude camp. During the winter months, the ice was augered and a weighted bottle was used to obtain a grab sample.

Beaver Creek - Two sample sets are obtained every two months; where the creek crosses lease 17 boundary (upper) and at the government campsite on the Fort McMurray highway. The samples were taken in fast flowing zones and an ice auger used when required. Accessibility to the Upper Beaver Creek sampling point has been difficult and is reached either by hiking in or by snowmobile during the winter.

Poplar Creek - One set of samples are taken every two months before the culvert where Poplar Creek crosses the highway. Sampling was missed during January 1973 because of heavy ice cover.

MacKay River - Sampling was done below the bridge on the Fort McKay highway. This sampling has been discontinued.

Mildred Lake - Surface water was sampled approximately 100 yards off the center of the north shore line. Sampling was started in mid-1973.

Sample Preservation

Special sample box containers were constructed by Chemical and Geological Laboratories Ltd. All samples were taken in glass bottles that had been carefully cleaned particularly when trace metals were to be determined. It is recognized that preservation techniques can only retard chemical and biological changes that inevitably continue.

Thus considerable effort was made to deliver the treated samples to the Chemical and Geological testing laboratory as soon as possible, generally within 24 hours, but frequently within 8-10 hours. The methods of treatment followed (Syncrude personnel applied these treatments in the field) are outlined in Clean Water, Methods for Chemical Analysis of Water and Wastes, 1971, Environmental Protection Agency, Water Quality Office, Analytical Quality Control Laboratory, Cincinnati, Ohio.

TABLE 1

Athabasca River Water Analysis
(Sept. 29/1972 to July 7/1972)

Date: Location:	9/29/72 Syncrude	9/29/72 McMurray Bridge	11/28/72 Sycrude	11/29/72 McMurray Bridge	1/25/73 Syncrude	1/26/73 McMurray Bridge	3/6/73 Syncrude	3/6/73 McMurray Bridge	5/14/73 Syncrude	5/14/73 McMurray Bridge	7/9/73 Syncrude	7/9/73 McMurray Bridge	Gov't Criteria *
Temp (°C)	4	5	0	0			0	0	14	13	18	20	
Dissolved O_2	12.1	11.9							6.8	7.2	5.2	5.5	>5
Calculated Na	11	10					15	12					30-75
Ca	37	37					49	51					
Mg	10	10					13	14					
SO_4	29	28					50	40					
Cl^-	5.2	4.5					5	3			3.5	3.0	
CO_3	Nil	Nil					Nil	Nil					
HCO_3	146	146					182	202					
pH	8.1	8.1					8.0	8.0					6.5-8.5
Dissolved Solids evap.	207	209			410	300	260	258	188	182	184	222	
Ign.	140	131			139	129	182	174	120	116	90	98	
Suspended Solids evap.	10.8	10.8			3.2	1.2	3.2	8.4	293	303	146.4	125.6	
Ign.	10.4	8.0			2.4	0.8	2.4	6.0	254	273	122.0	104.8	
Oil	1.3	2.4	0.5	1.0	0.2	1.8	0.3	1.3	3	4.4	2.0	1.8	15
Phenolics	0.004	0.002			0.009	0.004	<0.001	<0.001	0.007	0.013	<0.002	<0.002	0.005
Sulfides	<0.05	<0.05					<0.02	<0.02	<0.05	<0.05	<0.05	<0.02	0.05
Colornumber	20	15	40	60	20	20	25	25	75	70	75	70	
B.O.D.	6	4			7	2	8	6	14	13	3	6	
C.O.D.	7.6	34.7			18.8	91.6	9	43	46	48	2.6	11.6	
T.O.N.	10	3			80	20	40	20	5	40	10	10	>8
Ammonia Nitrogen	0.18	0.13	0.74	0.30	0.18	0.09	0.27	0.29	0.20	0.07	0.41	0.38	1.0
Nitrate Nitrogen	0.60	<0.5			<0.5	<0.05	<0.5	0.70	<0.5	<0.5	2	0.70	
Total Phosphates	0.05	0.07			0.07	0.07	0.32	0.51	1.8	1.28	0.43	0.43	0.15
Nickel	0.03	0.04					0.04	0.05					
Mn	0.02	0.02					0.04	0.02					0.05
Fe	0.46	0.34			0.33		0.22	0.38	10.6	10.6	4.16	3.84	0.3
Pb	0.03	0.03					0.03	0.03					0.05
Zn	0.02	0.02					0.04	0.06					0.05
Cr	<0.01	<0.01					<0.002	<0.02					0.05
Cu	<0.01	0.01					<0.02	<0.02					0.02
Au	<0.01	<0.01					<0.01	<0.01					0.01
Se	<0.005	<0.005					<0.002	<0.002					0.01
Cd	<0.01	<0.01					<0.02	<0.02					0.01
V	<0.001	<0.001					<0.001	<0.001					
Hg (ppb)	3.28	2.15					<0.1	<0.1					0.1
B	<0.20	<0.02					<0.1	<0.1					0.5
Al	0.70	0.52					0.24	0.24					
Co	0.02	0.01					<0.02	<0.02					
Silica	30	25.7					12.6	11.4					

All results except pH, Color and Odor reported in mg/l
*Provincial Board of Health Regulations, August 1970.

TABLE 2

Beaver Creek Water Analysis
Sept. 28/73 to July 10/73

Date: Location:	9/28/72 Upper	9/28/72 Lower	11/29/72 Upper	11/28/72 Lower	1/26/73 Upper	1/26/73 Lower	3/5/73 Upper	3/6/73 Lower	5/15/73 Upper	5/14/73 Lower	7/10/73 Upper	7/10/73 Lower	Gov't Criteria *
Temp. °C		4			0	-3	0	0.5	14	14	16	18.5	
Dissolved O_2		12.0							7.3	7.0	6	5.4	>5
Calculated Na		66	56				118	98					30-75
Ca^{++}		41	36				42	47					
Mg^{++}		13	12				13	17					
SO_4		16	8				28	40					
Cl^-		9.8	4				6	20			3.5	3	
$CO_3^=$		2.2	Nil				Nil	Nil					
HCO_3^-		325	302				460	403					
pH		8.3	8.2				8.2	7.6					6.5 - 8.5
Dissolved Solids evap		522	448		435	354	488	4.36	207	215	294	328	
Ign		290	272		319	240	364	340	132	142	66	140	
Suspended Solids evap.		3.6	10.0		10.4	6.4	31.6	13.6	28	11	18.4	17.6	
Ign		3.2	6.4		9.2	5.2	27.6	8.0	15	2	14.8	6.8	
Oil & Grease		1.2	0.6	0.1	1.2	2.4	10.8	10	3.0	3.6	1.4	1.2	15
Phenolics		0.012	0.24	0.002	0.019	0.002	<0.001	0.001	0.005	0.011	0.014	0.005	0.005
Sulfides		<0.05	<0.05				<0.02	<0.02	<0.05	<0.05	<0.02	<0.02	0.05
Colornumber		60	140	11.0	30	60	40	45	120	100	250	225	
B.O.D.		6	<1		4	4	10	7	14	16	10	6	
C.O.D.		102.8	314		8.4	10.9	95	71	84	37	138	60.5	
T.O.N.		3	5		10	5	5	20	25	10	5	4	>8
Ammonia Nitrogen		0.14	0.21		0.11	0.08	0.09	0.10	0.08	0.03	0.44	0.24	1.0
Nitrate Nitrogen		<0.5	<0.5		0.08	<0.5	1.1	<0.5	<0.5	<0.5	0.60	0.8	
Total Phosphates		0.12	0.15	0.13	0.32	0.16	0.61	0.32	0.83	1.16	0.28	0.26	0.15
Nickel		0.04	0.04				0.11	0.06					
Mn		0.02	0.05				0.11	0.10					0.05
Fe		0.84	3.28	2.45	2.8	1.45	3.36	1.52	1.5	1.2	1.44	1.42	0.3
Pb		0.04	0.02				0.16	0.32					0.05
Zn		0.03	0.07				0.14	0.06					0.05
Cr		<0.01	<0.01				0.06	<0.02					0.05
Cu		0.01	0.02				<0.02	<0.02					0.02
Au		<0.01	<0.01				<0.01	<0.01					0.01
Se		<0.005	<0.005				<0.002	<0.002					0.01
Cd		<0.01	<0.01				<0.02	<0.02					0.01
V		<0.001					<0.001	<0.001					
Hg		6.75					<0.1	<0.1					0.1
B		<0.02	0.24				0.66	0.38					0.5
Al		0.49	0.24				0.96	0.44					
Co		0.02	0.24				0.02	<0.02					
Silica		20.6	13.2	13.2			31.2	13.2					

All results except pH, Color and Odor reported in mg/l.

* Provincial Board of Health Regulations, August 1970.

BEAVER CREEK WATER ANALYSIS (cont.)

Date:		20/2/66	26/3/66	26/4/66
<u>ANALYSIS</u>:				
Na + K		93	154	24
Ca		80	57	18
Mg		25	12	5
Fe				TRACE
Ca + Mg		105	69	23
$SO_4^=$		26	45	24
Cl		48	15	7
CO_3				
HCO_3		500	558	100
PO_4				
pH		7.5	7.8	7.5
Total Solids:	Evap.	608	680	208
Total Solids:	Ign.	468	510	92
Total Solids:	CHLC.	772	841	178
Sp. Gravity		<1.000	<1.000	<1.000
Resistance		12.59	12.42	55.17

All analyses except pH and resistance (ohm-m) reported in mg/l.

Note:
The analysis of the Beaver Creek was discontinued on April 26, 1966. The program was replaced with more detailed Baseline Water Analyses on Sept. 28/1972. (Table ___) and includes sample from the upper and lower portions of the Creek.

TABLE 3

BEAVER CREEK WATER ANALYSIS
June 6/1964 to April 26/66

Date:	9/6/64	7/7/64	19/9/64	13/12/64	21/1/65	20/2/65	23/4/65	7/6/65	29/8/65	21/1/66
ANALYSIS:										
Na + K	28.6	39.6	47.8	81.6	93.4	158	52	39	65.2	82.8
Ca	30	45	40	46	63.6	37	23	31	42	50.0
Mg	12	17	15	23	34.6	19	9	11	13.5	18.0
Fe	1.6	3.5	2.4	2.8	0.12	1.5	1.76	0.09	0.48	3.94
Ca + Mg	42	62	55	69	98.2	56	32	42	55.5	68
$SO_4^{=}$	10	8	12	71	15.6	35	12	16.4		24.7
Cl	8	15		7	16.0	8	6	2	6	10.6
CO_3									TRACE	19.2
HCO_3^-	210	300	303	425	512	594	166	54	346	368
PO_4	1.8									
pH	7.7	7.8	8.0	7.6	7.5	7.4	7.8	7.6	7.95	8.03
Total Solids: Evap.		420	344	580	476	812	260	226	344	452
Total Solids: Ign.						590		176		200
Total Solids; Calc.	302	428	420	656	735	853	268	156	474	577.2
Sp. Gravity						1.001	1.001	1.001	1.000	1.000
Resistance						10.8				11.27

All analysis except pH and resistance (OHM-M) reported in mg/l.

TABLE 4

MacKay River Water Analyses
June 9/1964 to April 4/1966

Date taken:	9/6/64	7/7/64	17/8/64	20/9/64	13/12/64
Na	14	25	14	20	60
K	1.2	2.8	0.9	1.0	3.9
Ca	23	36	25	32	66
Mg	9	14	8	11	28
Fe	1.8	Nil	0.3	1.1	1.8
Ca + Mg	32	50	33	43	94
SO_4	8	20	10	26	81
Cl	4	4	2	3	24
CO_3	Nil	Nil	Nil	Nil	Nil
HCO_3	160	200	118	154	382
PO_4	Nil	Nil	Nil	Nil	Nil
pH	7.5	8.0	7.8	8.1	7.9
Evap solids		320	198	226	568
Ign solids					
Calc solids	221	302	178	248	647
Sp. gravity					
Resistivity					

Date taken:	21/1/66	20/2/66	26/3/66	20/4/66
Na + K	75.9	87	92	11
Ca	76.0	106	114	19
Mg	26.0	34	24	5
Fe	2.45			Trace
Ca + Mg	102.0	140	138	24
SO_4	91.4	144	112	12
Cl	28.9	53	52	10
CO_3	16.7			
HCO_3	327.0	450	480	80
pH	8.18	7.8	7.9	7.6
Evap solids	520	672	680	147
Ign solids	232	520	538	67
Calc solids	641	874	874	137
Specific gravity	1.000	<1.001	<1.001	<1.001
Resistivity	10.38	11.76	11.51	68.78

All results except pH and resistance (ohm-m) reported in mg/1.

TABLE 4 Mackay River Water Analyses
June 9/1964 to April 5/1966

Date taken:	9/6/64	7/7/64	17/8/64	20/9/64	13/12/64
Na	14	25	14	20	60
K	1.2	2.8	0.9	1.0	3.9
Ca	23	36	25	32	66
Mg	9	14	8	11	28
Fe	1.8	Nil	0.3	1.1	1.8
Ca + Mg	32	50	33	43	94
SO_4	8	20	10	26	81
Cl	4	4	2	3	24
CO_3	Nil	Nil	Nil	Nil	Nil
HCO_3	160	200	118	154	382
PO_4	Nil	Nil	Nil	Nil	Nil
pH	7.5	8.0	7.8	8.1	7.9
Evap solids		320	198	226	568
Ign solids					
Calc solids	221	302	178	248	647
Sp. gravity					
Resistivity					

Date taken:	21/1/66	20/2/66	26/3/66	20/4/66
Na + K	75.9	87	92	11
Ca	76.0	106	114	19
Mg	26.0	34	24	5
Fe	2.45			Trace
Ca + Mg	102.0	140	138	24
SO_4	91.4	144	112	12
Cl	28.9	53	52	10
CO_3	16.7			
HCO_3	327.0	450	480	80
pH	8.18	7.8	7.9	7.6
Evap solids	520	672	680	147
Ign solids	232	520	538	67
Calc solids	641	874	874	137
Specific gravity	1.000	<1.001	<1.001	<1.001
Resistivity	10.38	11.76	11.51	68.78

All results except pH and resistance (ohm-m) reported in mg/l.

Date taken	21/1/65	21/1/65	26/3/65	22/9/65
Na	90.2	102	234	22
K	3.9	4	9	5
Ca	104.9	87	113	24.6
Mg	34.5	43	86	7.2
Fe	1.72	0.7	0.46	.026
Ca + Mg	139.4	130	199	31.8
SO_4	107.8	114	267	16.5
Cl	64.0	56	96	5.9
CO_3	Nil	8	Nil	Nil
HCO_3	520	495	928	122
pH	7.7	8.3	8.05	7.7
Evap solids	710	876	1440	248
Ign solids			800	
Calc solids	927	910	1733	203
Specific gravity				1.001

TABLE 5

Mackay River Water Analysis
Sept 29/73 to Jan 25/73

Date: Location:	9/29/73 Mackay River	11/28/72 Mackay River	1/25/73 Mackay River	Gov't Criteria *
Temp	3			
Dissolved O_2	12.5			5
Calculated Sodium	62			30-75
Ca	46			
Mg	19			
SO_4	60			
Cl^-	20			
CO_3	2.0			
HCO_3	284			
pH	8.4			6.5-8.5
Dissolved Solids evap	406		624	
Dissolved Solids Ign	329		402	
Suspended Solids evap	1.6		6.4	
Suspended Solids Ign	1.2		4.4	
Oil	1.5	0.9	1.8	15
Phenolics	0.003		0.002	0.005
Sulfides	<0.05			0.05
B.O.D.	5		2	
C.O.D.	92.7		60.3	
T.O.N.	20	2	1.0	>8
Ammonia Nitrogen	0.09		0.11	1.0
Nitrate Nitrogen	0.5		0.6	
Total Phosphates	0.15	0.13	0.22	0.15
Nickel	0.03			
Colornumber	80	180	120	
Mn	0.02			0.05
Fe	0.47	1.46	1.45	0.3
Pb	0.04			0.05
Zn	0.03			0.05
Cr	<0.01			0.05
Cu	0.01			0.02
Au	<0.01			0.01
Se	<0.005			0.01
Cd	<0.01			0.01
V	<0.001			
Hg	1.63			0.01
B	0.2			0.5
Al	0.52			
Co	0.02			
Silica	15.3			

All results except pH, color and Odor reported in mg/l.

* Provincial Board of Health regulations August 1970.

TABLE 6

Mildred Lake Water Analyses
March 7/73 to July 16/73

Date: Location:	3/7/73 Mildred Lake	5/16/73 Mildred Lake	7/16/73 Mildred Lake	Government Criteria *
Temp	0	18	18.5	
Dissolved O_2		6.1	6.2	>5
Calculated Sodium	10			30-75
Ca	51			
Mg	19			
SO_4	2			
Cl^-	3		2	
CO_3	Nil			
HCO_3	270			
pH	7.8			6.5-8.5
Dissolved Solids evap	254	174	300	
Dissolved Solids Ign	130	131	120	
Suspended Solids evap	38.8	10	32.8	
Suspended Solids Ing	15.6	3	8.0	
Oil	13.3	2.0	0.40	15
Phenolics	0.008	0.006	0.003	0.005
Sulfides	0.07	<0.05	<0.02	0.05
Colornumber	25	15	25	
B.O.D.	4	6	15	
C.O.D.	114	15	214.8	
T.O.N.	100	10	40	>8
Ammonia Nitrogen	0.80	0.12	0.26	1.0
Nitrate Nitrogen	<0.5	<0.5	0.8	
Total Phosphates	0.54	0.65	0.18	0.15
Nickel	0.04			
Mn	0.13			0.05
Fe	1.22	0.4	0.92	0.3
Pb	0.10			0.05
Zn	0.04			0.05
Cr	< 0.02			0.05
Cu	<0.02			0.02
Au	<0.01			0.01
Se	<0.02			0.01
Cd	<0.02			0.01
V	<0.001			
Hg	<0.1			0.01
B	0.1			0.5
Al	0.3			
Co	<0.02			
Silica	11			

All results except pH, Color and Odor reported in mg/l.

* Provincial Board of Health Regulations, August 1970.

TABLE 7

Poplar Creek Water Analysis
Sept. 30/73 to July 9/73

Date: Location:	9/30/72 Poplar Creek	11/29/72 Poplar Creek	1/26/73 Poplar Creek	3/6/73 Poplar Creek	5/25/73 Poplar Creek	7/9/73 Poplar Creek	Government Criteria *
Temp					11	16.5	
Dissolved O_2					7.5	6.4	>5
Calculated Na	110			554			30-75
Ca	47			82			
Mg	24			27			
SO_4	18			24			
Cl^-	126	85		747		10.5	
CO_3	Nil			Nil			
HCO_3	317			540			
pH	8.2			7.9			6.5-8.5
Dissolved Solids evap	531			1778	254	268	
Dissolved Solids Ign	385			1470	145	140	
Suspended Solids evap	3.2			2.4	11	20.4	
Suspended Solids Ign	2.0			2.0	6	16.4	
Oil	0.4			2.4	0.4	2.8	15
Phenolics		0.003		0.008	0.003	0.002	0.005
Sulfides		<0.05		<0.02	<0.05	<0.02	0.05
Colornumber		120		50	100	225	
B.O.D.	9			3	16	7	
C.O.D.		34.4		52	72	37.9	
T.O.N.	4			10	25	20	78
Ammonia Nitrogen				0.25	0.03	0.41	1.0
Nitrate Nitrogen	0.5			0.8	0.5	0.40	
Total Phosphates	0.06			0.25	0.43	0.18	0.15
Nickel	0.05			0.19			
Mn	0.03			0.22			0.05
Fe	1.25	1.78		1.10	0.09	0.84	0.3
Pb	0.05	0.03		0.66			0.05
Zn	0.03			0.12			0.05
Cr	<0.01			0.02			0.05
Cu	0.01			0.02			0.02
Au	<0.01			0.01			0.01
Se				0.002			0.01
Cd	<0.01			<0.02			0.01
V		<0.001		<0.004			
Hg		0.12		<0.1			0.01
B		<0.2		<0.30			0.5
Al	0.42			<0.32			
Co	0.02			0.11			
Silica	9.4			12.6			

All results except pH, Color and Odor reported in mg/l.

*Provincial Board of Health Regulations August 1970.