NORTHERN TIER

Report No. 2

THE EFFECTS OF LARGE UNDERGROUND PIPELINES ON WILDLIFE

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC
ENERGY DIVISION
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THE EFFECTS OF LARGE-DIAMETER UNDERGROUND CRUDE-OIL PIPELINES ON WILDLIFE

With Emphasis on the Proposed Northern Tier Pipeline in Montana

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CONTENTS

FIGURES

ABBREVIATIONS

ANGTS	Alaska Natural Gas Transportation System
BLM	Bureau of Land Management
c	centigrade
cm	centimeter
DNRC	Department of Natural Resources and Conservation (Montana)
EIS	environmental impact statement
F	farenheit
ft	foot
ha	hectare
in	inch
km	kilometer
kV	kilovolt
l	liter
m	meter
m^3	cubic meter
mi	mile
NTPC	Northern Tier Pipeline Company
NTPS	Northern Tier Pipeline System
TAPS	Trans-Alaska Pipeline System
TVA	Tennessee Valley Authority

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CHAPTER ONE

INTRODUCTION

The following analysis of the effects of a large-diameter, underground crude-oil pipeline on wildlife supplements Montana's Draft EIS on the Proposed Northern Tier Pipeline System, prepared by the Department of Natural Resources and Conservation (DNRC). The Northern Tier Pipeline Company (NTPC) has proposed a 102- to 107-cm-diameter (40- to 42-in-diameter) underground pipeline system to transport crude oil from a tanker port at Port Angeles, Washington, to Clearbrook, Minnesota, traversing approximately 1014 km (630 mi) of Montana en route.

The state's draft EIS discusses the impacts of Northern Tier's proposed route and alternative routes. The U.S. Bureau of Land Management (BLM) has also prepared a draft EIS on the proposed project (USDI 1979).

This report (1) gives a general description of large-diameter, underground, crude oil pipelines (such as the proposed Northern Tier Pipeline System, or NTPS), (2) discusses the impacts on wildlife from construction, operation and maintenance, and abandonment of such a pipeline, (3) identifies ways in which adverse impacts on wildlife could be avoided or prevented, and (4) describes ways that unavoidable losses could be compensated. While the report emphasizes effects on Montana wildlife, the information is generally applicable to study of the impacts a large, underground pipeline would have in other parts of the country where wildlife is similar to that in Montana.

This report is one in a series of six reports prepared in conjunction with the state's draft EIS. The series consists of the following reports:

Report 1	The Effects of Large-Diameter Underground Crude-Oil Pipelines on Soils and Vegetation, with Emphasis on the Proposed Northern Tier Pipeline in Montana
Report 2	The Effects of Large-Diameter Underground Crude-Oil Pipelines on Wildlife, with Emphasis on the Proposed Northern Tier Pipeline in Montana
Report 3	The Effects of Large-Diameter Underground Crude-Oil Pipelines on Aquatic Life and Habitats, with Emphasis on the Proposed Northern Tier Pipeline in Montana
Report 4	Earthquake Hazard to the Proposed Northern Tier Pipeline in Montana
Report 5	The Effects of Large-Diameter Underground Crude-Oil Pipelines on Land Use, with Emphasis on the Proposed Northern Tier Pipeline in Montana

Report 6 Social and Economic Impacts of the Proposed Northern Tier Pipeline in Montana

The reports are available on request from the Montana Department of Natural Resources and Conservation, Energy Division, 32 South Ewing, Helena, Montana 59601, (406) 449-3780.

CHAPTER TWO

A GENERAL DESCRIPTION OF LARGE UNDERGROUND CRUDE-OIL PIPELINES

The following is a summary of the activities typically required to construct, operate and maintain, and abandon a large-diameter, underground, crude-oil pipeline system. The impacts of these activities are then discussed in the chapter of this report titled "The Effects of a Pipeline System on Wildlife." More detailed discussions of pipeline system design and techniques of constructing, operating, and maintaining a pipeline are in chapters two ("Description and Justification of the Project as Proposed by NTPC") and five ("Engineering and Geotechnical Concerns") of DNRC's draft EIS.

SUMMARY OF ACTIVITIES

PIPELINE CONSTRUCTION

The construction of a large-diameter pipeline system would involve the following activities:

1) Making flights over the pipeline route prior to construction

2) Surveying and staking the centerline

3) Clearing vegetation from the construction right-of-way

4) Excavating the pipeline trench

5) Transporting pipe to the trench, welding pipe sections and wrapping pipe with a protective cover (pipe staging)

6) Laying the pipe and backfilling

7) Constructing crossings where a pipeline intersected rivers, streams, canals, roads, utility lines, and other pipelines

8) Testing the soundness of the pipe (hydrostatic testing)

9) Reclaiming sites disturbed by construction

CONSTRUCTION OF FACILITIES ASSOCIATED WITH A PIPELINE

Facility construction would involve:

1) Establishing work camps for construction personnel where existing housing could not accommodate an influx of workers[1]

2) Possibly, constructing access roads to the pipeline and associated facilities[2]

3) Building pump stations and delivery facilities

4) Installing high-voltage electrical transmission lines serving pump stations and delivery facilities, and low-voltage distribution lines serving valves

5) Establishing storage yards for pipe and construction materials

6) Excavating material sites (such as gravel pits)

PIPELINE OPERATION AND MAINTENANCE

The following maintenance activities would take place during operation of a pipeline system:

1) Controlling growth of vegetation within the permanent right-of-way

2) Maintaining pump stations, delivery facilities, and powerlines

3) Possibly, maintaining access roads to the pipeline, pump stations, and delivery facilities

4) Making survey flights over the right-of-way

5) Controlling, containing, and cleaning up oil spills, and reclaiming spill areas

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[1]NTPC has stated that it has no plans to establish work camps; however, contractors may establish camps.

[2]For this report, access roads are defined as any road (including a spur road, right-of-way road, and construction traffic and passing lanes) that would be needed to reach a pipeline corridor or an existing road. Although NTPC has no plans to construct new access roads to its pipeline, new roads might be necessary with any of the alternative NTPS routes, or the route of any other pipeline system that might be proposed through Montana.

PIPELINE ABANDONMENT

The following activities would occur after completion of pipeline operation:

1) Flushing oil from the pipeline with water

2) Collecting and treating the water at wastewater treatment facilities, normally constructed at discharge sites

3) Possibly, removing pipe from the trench; this would involve many of the previously mentioned construction activities, including accommodating construction workers, clearing the right-of-way, excavating the pipeline trench, and reclaiming disturbed areas

ACTIONS AND FACILITIES THAT WOULD POSE THE GREATEST RISK OF DAMAGE TO WILDLIFE

Of the above, right-of-way clearing, controlling growth of vegetation within a permanent right-of-way, pipeline trenching, pipe staging, facilities associated with a pipeline, aerial surveillance, and oil spills would be most likely to affect wildlife; thus, they are described in more detail below.

RIGHT-OF-WAY CLEARING AND CONTROLLING GROWTH OF VEGETATION WITHIN A PERMANENT RIGHT-OF-WAY

The extent of damage to wildlife from a pipeline system would depend largely on the amount of habitat disturbed by the clearing of land for construction and the amount of habitat within which vegetation growth was controlled during pipeline operation.

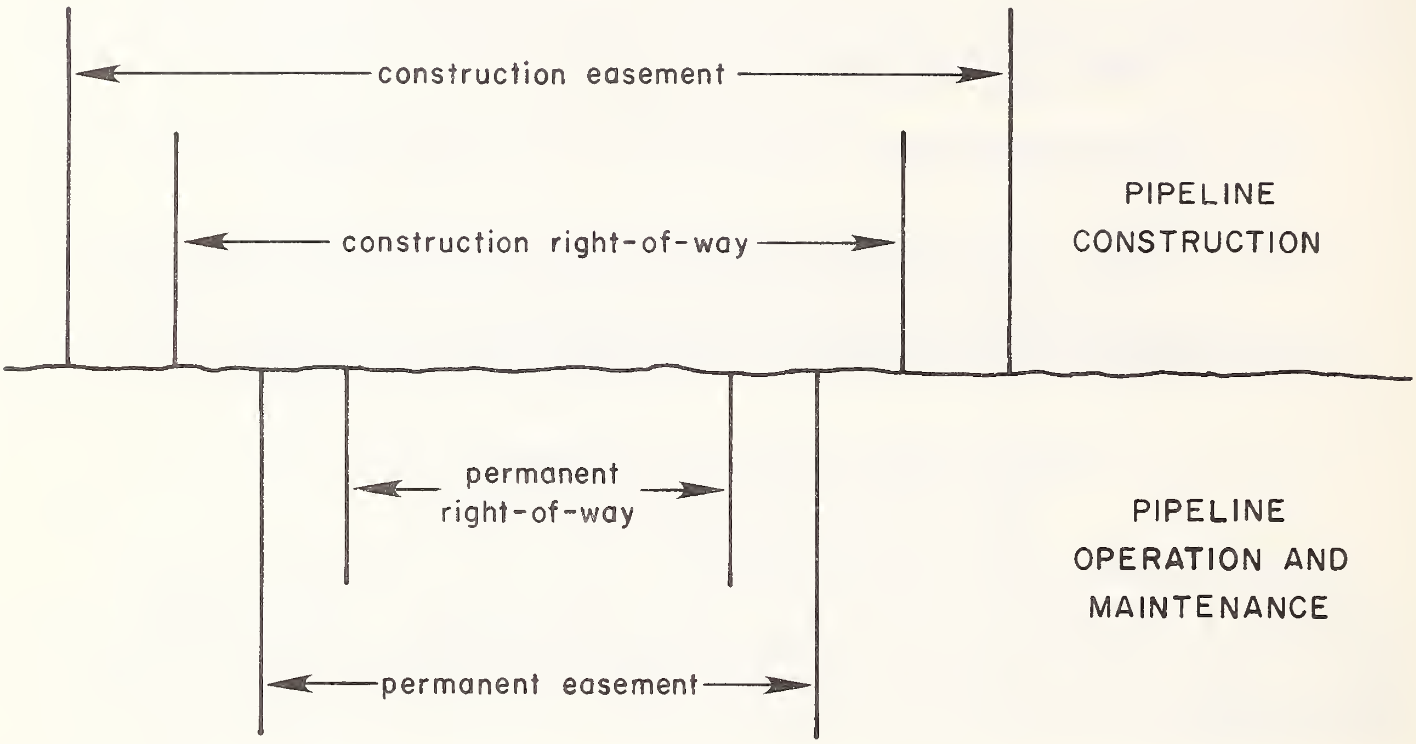
Generally, more land would be required for pipeline construction than pipeline operation and maintenance; thus, a temporary easement for construction usually would be wider than a permanent easement for operation and maintenance. In addition, the amount of land actually used to construct a pipeline could be less than the construction easement, and the land used for operation and maintenance could be less than the permanent easement.

In this report, the strip of land actually used to construct a pipeline is referred to as the construction right-of-way; the strip used for operation and maintenance is referred to as the permanent right-of-way. Figure 1 illustrates the differences between the construction and operation easements, and between the construction and permanent rights-of-way.

Amount of Land Cleared for a Construction Right-of-way

The width of a construction right-of-way would vary, depending on the amount of land required for cut-and-fill slopes, pipeline trenching, spoils

FIGURE 1. Construction and permanent pipeline easements and rights-of-way.

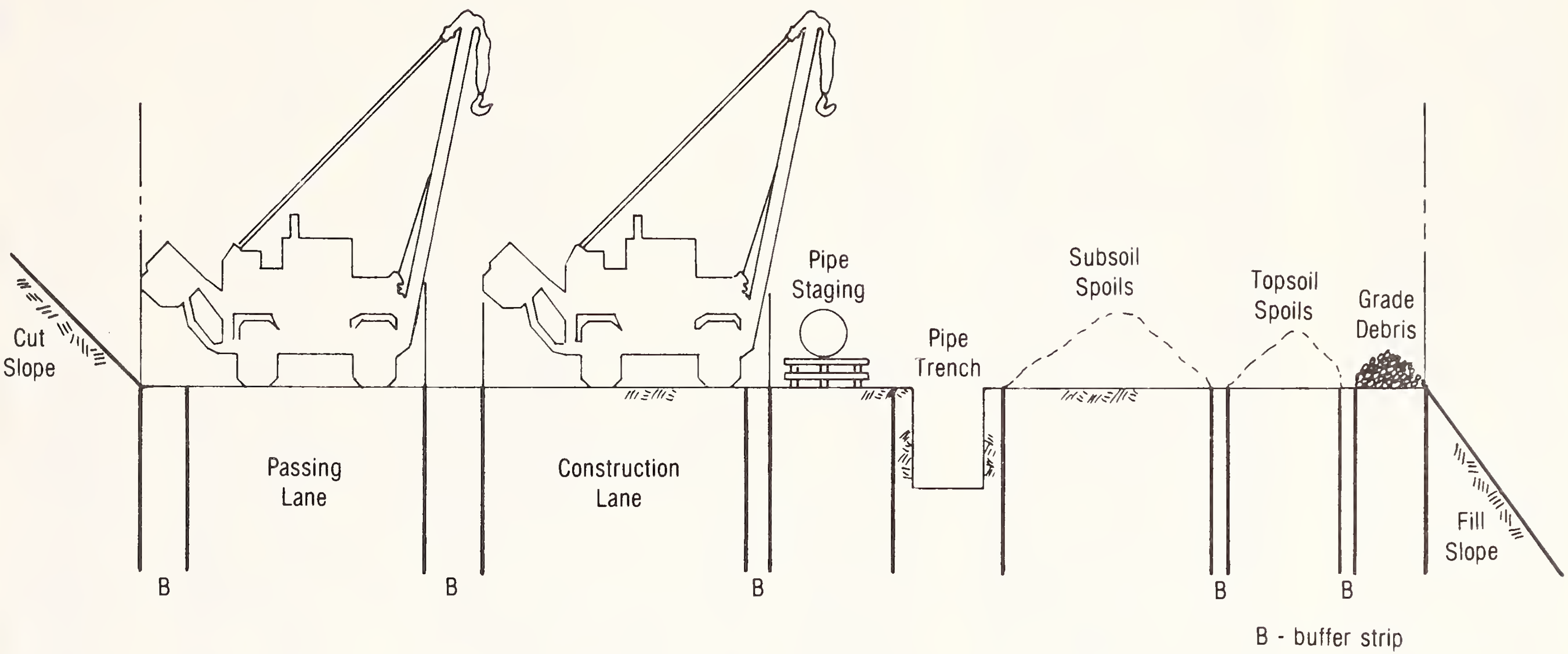


storage, pipe staging, and movement of construction equipment. Figure 2 shows the typical features of a construction right-of-way for a large-diameter, underground pipeline. NTPC has proposed a 27-m-wide (90-ft-wide) construction right-of-way for most of the length of the pipeline, and a wider right-of-way at sites such as river crossings and on steep slopes, where construction would be difficult. The amount of additional land that would be required at difficult sites would be determined during centerline selection.

Cut-and-Fill Slopes. The amount of land required for cut-and-fill slopes would depend on the steepness of the terrain. For pipeline construction to take place efficiently (i.e. quickly and with ease of movement of machinery), a level construction pad would be required. On flat land, no grading would be required to construct a level pad; thus, no land outside the construction right-of-way would need to be disturbed. But on sideslopes, where it would be necessary to cut and fill to construct a level working pad, more land would need to be disturbed.

Pipeline Trenching. The width of a pipe trench would vary, depending on the type of material excavated. For example, in rock and in tight silt or clay soils, where vertical walls could be dug, the trench for a 107-cm-diameter (42-in-diameter) pipe would be about 1.5 m (5 ft) wide. In gravel and other loose material, where walls would have to be excavated at an angle, the top of the trench could be as wide as 3 m (10 ft).

FIGURE 2. Typical features of a construction right-of-way for a large-diameter, underground pipeline.



SOURCE: Prepared by Gulf Interstate Engineering Company, Houston, Texas, for the DNRC Northern Tier Pipeline Project.

Spoils Storage. If topsoil and subsoil removed during trenching were stored in separate piles, about 9 m (30 ft) would be required for storage; this width would include a 0.6 m (2 ft) buffer strip between the piles to prevent mixing of topsoil, subsoil, and grade debris. If the different spoils were piled on top of one another, about 6.1 to 7.6 m (20 to 25 ft) would be required for storage. It would also be possible to store spoils off the construction site; while this would reduce the amount of land required for construction, it would necessitate disturbing land outside the construction area.

Pipe Staging. A strip about 2.4 to 2.7 m (8 to 9 ft) wide adjacent to the pipe trench would be required for pipe staging, which would involve positioning pipe sections parallel to the trench, welding the sections, placing the sections on skids adjacent to the trench, x-ray inspecting the welds, and wrapping the pipe with a protective cover. A 2.4 m (8 ft) staging area would also allow a 0.3 to 0.6 m (1 to 2 ft) buffer at the outside edge of the strip. In areas such as narrow canyons, the amount of land required for staging could be reduced by welding pipe sections off the construction site, then dragging them to the right-of-way and making tie-in-welds; however, this would be practical only along short segments of the pipeline.

Traffic Lanes. The width of the construction right-of-way would also depend on the number and widths of traffic lanes for construction equipment. For optimum construction ease and speed, it would be desirable to have a construction lane adjacent to the pipe staging area and a passing lane adjacent to the construction lane.

A minimum of 5.5 m (18 ft) would be required for a construction lane, which would be used by machinery hauling, welding, coating, and laying pipe. A lane of this width would accommodate the largest piece of construction machinery usually used--the sideboom tractor, which is 5.5 m (18 ft) wide with sidebooms extended.

With a 3.6-m-wide (12-ft-wide) passing lane (a lane the width of a sideboom tractor with the sideboom retracted) immediately adjacent to the construction lane, tractors could squeeze by one another, but passing would be easier if there were a 0.6 to 1.2 m (2 to 4 ft) buffer strip between the lanes. In steep, forested areas, movement would be easier with a second buffer strip about 0.9 m (3 ft) wide on the outside margin of the passing lane, but the strip would not be necessary on cut-and-fill slopes.

By constructing access roads to the construction lane at frequent intervals, logging or county roads outside the right-of-way could serve as a passing lane. However, a passing lane outside the right-of-way would not be as convenient or allow as rapid construction as would one within the right-of-way. Also, construction traffic on logging or county roads could interfere with other traffic.

Construction could take place without a passing lane, but in the absence of a passing lane, only one construction activity could take place at a time, and the operation would be greatly slowed. Additional disadvantages of single-file operation would be: (1) the need to construct access roads at frequent intervals to minimize the length of the segment under construction, (2) damage to vegetation and soils outside the right-of-way if equipment left the construction lane, and (3) a delay in construction if equipment broke down.

An alternative more efficient than single-file operation but less efficient than a passing lane would be the establishment of frequent pullouts along the construction lane; this would allow passing at certain points along a construction segment.

Feasibility of Using Rights-of-way of Different Widths. As the preceding discussion indicates, considerable latitude is possible in the width of a construction right-of-way. Wider widths are preferable in terms of ease of construction, while narrower widths result in less disturbance of land.

In all terrain, a right-of-way 27 m (90 ft) wide would allow ample room for an equipment passing lane and for storage of segregated topsoil and subsoil. In flat terrain, it would be possible to use a 23-m (75-ft) right-of-way and still have room for a passing lane and segregation of spoils. Use of a right-of-way narrower than 27 m (90 ft) would slow construction and make it more difficult because there would be less room for movement of equipment.

If the passing lane were eliminated, the right-of-way could be reduced to 19 m (65 ft); a right-of-way of this width could accommodate storage of segregated spoils on flat land, but might not permit segregation on steep terrain. If both the passing lane and topsoil segregation were eliminated, it would be possible to confine construction to a 16 m (54 ft) right-of-way, the narrowest right-of-way that would allow use of conventional construction techniques.

Any right-of-way narrower than 16 m (54 ft) would require use of special equipment and construction techniques (such as storing spoils and welding pipe off the construction site) and would make construction more expensive than it would be on wider rights-of-way. (The above figures do not include land outside the graded construction pad that would be required to cut and fill slopes on steep terrain, nor do they include the additional land that would be required to construct river crossings.)

Amount of Land on which Vegetation Growth is Controlled for Pipeline Operation

Growth of vegetation within a permanent pipeline right-of-way would be controlled for the life of a project to:

1) Allow visibility of the land above the pipe so that oil spills, leaks, pipeline damage, or hazards to the pipeline could be detected

2) Permit rapid movement of equipment to all points along a pipeline for maintenance, on-the-ground inspection, and emergencies

3) Prevent possible damage to the pipe from tree roots

NTPC had proposed a 23-m-wide (75-ft-wide) permanent easement and right-of-way on state and private land and a 16-m-wide (54-ft-wide) permanent easement and right-of-way on federal land. (The latter width is the maximum allowed by federal law on federal land without special approval from the Secretary of Interior.) However, the amount of land actually cleared for a permanent right-of-way could be less than the amount of land on which clearing would be allowed by the permanent easement, depending on local vegetation cover, land use, and slope, which would influence accessibility.

The pattern of management on many permanent rights-of-way for pipelines and facilities such as powerlines has been: (1) mechanical removal of woody vegetation during construction, (2) seeding with grass during reclamation, and (3) repeatedly spraying regrowth with an herbicide.

DNRC has determined that along most portions of a pipeline, a strip 3 m (10 ft) wide directly above a pipeline must be kept cleared of trees and shrubs. However, trees or shrubs could be planted above a pipeline for short distances if they would not reduce visibility for aerial surveillance. In forested areas, an additional 6 m (20 ft) would be maintained free of timber to serve as an access road. Timber and shrubs could be allowed to reestablish on the remainder of the right-of-way in forested lands, although some regrowth might have to be cleared again if an emergency required use of heavy equipment (for example, to reexcavate pipe).

A cleared strip as narrow as 9 m (30 ft) might be adequate for maintenance and emergencies, but a 15 to 23 m (50 to 75 ft) permanent easement would be more desirable (especially on private land) because the pipeline company would have the legal right to clear and excavate in emergency situations and to prohibit encroachment onto land above the pipeline of structures that might pose a hazard to the line, or hinder maintenance or surveillance.

PIPE TRENCHING

The effect of trenching on wildlife would depend primarily on the width and depth of the trench (see discussion on p. 6), the amount of time and the distance a trench was left open, the time of year trenching took place, the importance of the habitat through which the trench was excavated, and whether a bridge was provided across the trench to allow movement of wildlife.

PIPE STAGING

Pipe is generally trucked to a pipeline trench in 12.2 m or 24.4 m (40 to 80 ft) sections. The pipe sections are then welded, placed on skids, the welds wrapped with a protective coating to inhibit corrosion, and the pipeline lowered into the trench.

The effects of pipe staging on wildlife would depend, to a large extent, on the length of the sections, the distance between unwelded sections, the amount of time sections were left on the ground (before being welded) or on skids (after being welded), the time of year trenching occurred, the wildlife species in the area disturbed by trenching, and the importance of the habitat where trenching took place (for example, if it was an important migration route or watering area).

FACILITIES ASSOCIATED WITH A PIPELINE SYSTEM

Access Roads

To construct and operate a pipeline system, access to the pipeline and related facilities would be needed. In some areas, existing roads could be used; in other areas wildlife could be affected by the establishment of new roads. (See footnote 2 on page 4 for a definition of access roads.) Not all access roads would be permanently maintained. Those needed only for construction might not be maintained, although they could be used for surveillance during pipeline operation or for emergencies, such as oil spill spill cleanup. Others, such as roads to pump stations and delivery facilities and some roads to the pipeline, would be maintained for the life of a project.

Generally, access roads would be designed and constructed to accommodate the heaviest and widest equipment needed. The number and length of access roads required to construct and maintain a pipeline system would largely depend on the location of the pipeline and associated facilities, and the type of construction operation employed.

Other Facilities

The noise and human activity at pump stations, delivery facilities, storage yards, and work camps could also disturb wildlife, and the establishment of these facilities could destroy habitat. Pump stations for a large-diameter pipeline would require about 2 to 2.8 ha (5 to 7 acres) of land; delivery facilities would require 24 ha (60 acres) or more. The size of work camps would vary according to the pipeline work schedule and the availability of existing housing. (See footnote 1 on page 4.)

Pump stations and delivery facilities would require permanent use of land, but disturbance of wildlife from work camps and storage yards would be temporary. Storage yards would probably be abandoned after construction, and restored to their former condition.

AERIAL SURVEILLANCE OF THE RIGHT-OF-WAY

Flights over pipeline rights-of-way might be made prior to construction to obtain low-altitude photographs and during construction to monitor progress. U.S. Department of Transportation regulations would require aerial surveillance of the right-of-way about every two weeks after a pipeline began operating to detect oil spills, leaks, and nearby hazards to the pipeline (such as construction and landslides).

The effect of aerial surveillance on wildlife would depend primarily on the altitude of flights, the time of year they were made, their frequency, and the species affected.

Federal aviation regulations prohibit flight below 152.4 m (500 ft) in the vicinity of populated areas, buildings, or other structures. These restrictions may be waived to permit flights within 70 m (200 ft) of the ground surface for some purposes, including right-of-way surveillance by pipeline companies and other utilities. There are no regulations for minimum flight altitudes in open, lightly populated areas.

OIL SPILLS

Minor oil spills could result from leaking valves or gauges, oil losses at separators, or similar occurrences. Major spills could result from pipeline splits or ruptures caused by defective pipe, imperfect welds, pipe corrosion, landslides, vandalism, sabotage, excavation equipment hitting the pipe, river scour, earthquakes, and operational errors or accidents. (A minor spill would be less than 18 m^3, 5,000 gal; a major spill would be 18m^3, 5,000 gal, or more.)

Large spills should be detected automatically by instruments at pump stations that measure deviations in the pressure and volume of flow. Spills too small to be detected automatically could be discovered during aerial surveillance, or by observation by pipeline employees or the public. If a spill report were based on detection by instruments rather than direct observation, the exact location of the leak would not be known--all that would be known is that the leak was somewhere between two pump stations.

Personnel and equipment for containing and cleaning up a spill might not reach a spill until several days after its discovery. A leak under ice or frozen ground that was not large enough to be detected automatically could go undetected for a longer period of time than would a spill visible above ground. A more detailed discussion of spill risk is in chapter 5 ("Engineering and Geotechnical Concerns") of DNRC's Draft EIS on the Proposed Northern Tier Pipeline System.

CHAPTER THREE

THE EFFECTS OF A PIPELINE SYSTEM ON WILDLIFE

An impact on wildlife may be defined as any alteration of the environment that changes population size or an area's existing carrying capacity. (Carrying capacity is the optimum number of animals the environment can support over a long period of time.) An impact can be either positive or negative. A wildlife population would be adversely affected by a change that: (1) reduced the population size below carrying capacity, (2) increased the population size above carrying capacity, or (3) reduced the area's existing carrying capacity. A species would benefit from a change that: (1) restored a depleted or oversized population of that species to its carrying capacity or (2) increased the area's carrying capacity for that species.

For this study, effects on wildlife were grouped according to population changes or changes in carrying capacity that would result from: (1) habitat alteration, (2) displacement of a population, (3) changes in mortality or natality rates, and (4) stress. Complex relationships exist among the specific impacts that fall within these four groups.

HABITAT ALTERATION

The habitat of an animal may be defined as the locality where an animal could generally be found, and where all essentials for its development and existence are present. Carrying capacity is primarily a function of the quality of habitat: if habitat is altered in such a way that it no longer meets the life requirements of a population, carrying capacity is reduced. The degree to which a species is affected by a reduction in carrying capacity depends largely on its ability to adapt to a variety of available habitats if its preferred habitat is disturbed. Species differ considerably in their ability to adapt to different habitats. Some, like the coyote and white-tailed deer, can exploit a wide variety of habitats. Others, such as the mountain goat, mountain sheep, marten, and lynx are dependent on specific habitats.

"K-selected" species (MacArthur and Wilson 1967), such as the harlequin duck, marten, and wolverine, are especially vulnerable to habitat alteration. K-selected species are those whose survival and productivity are determined by their competitive ability at population densities near the carrying capacity. Such species often inhabit an area only during late successional stages and are generally stenotopic--that is, they are restricted to a narrowly defined range of environmental conditions.

"R-selected species" (such as the deer mouse) have high reproductive rates and the ability to compensate rapidly for population losses. Generally, they are species tolerant of wide extremes in environmental conditions and having a wide range of distribution (eurytopic species). Thus, r-selected species are generally less vulnerable to habitat alteration than are K-selected species.

In forested areas, all trees and brush are generally removed from the pipeline construction right-of-way; additional strips of indefinite widths are cleared for electrical transmission lines serving pump stations and valves. If topsoil is not set aside when a right-of-way is graded, then replaced during reclamation, revegetation with the desired species may fail, resulting in a long-term loss of habitat for wildlife species that inhabited the area prior to construction. Some of the most important effects of habitat alteration are discussed below.

CHANGES IN THE AVAILABILITY OF FOOD AND COVER

Wildlife would be especially affected by changes in the availablility of food and cover resulting from right-of-way clearing, hydrostatic testing, maintenance of a cleared right-of-way, oil spills, and siltation.

Changes Resulting from Right-of-way Clearing

The ecological changes resulting from clearcutting forested habitats for the purpose of timber harvest have been studied extensively and findings are generally applicable to the impacts that would result from right-of-way clearing. However, there are several important differences between clearcutting for timber harvest and for removal of vegetation along a pipeline right-of-way: (1) clearcuts are often nearly as wide as long, while right-of-way clearings are long and very narrow; (2) clearcutting usually require numerous roads (including access roads and skid trails), while right-of-way clearing might require only a few roads; and (3) tree regeneration is encouraged on clearcuts, but generally is impaired or prevented within a permanent pipeline right-of-way.

Where removal of trees along a right-of-way would open a forest canopy, understory vegetation would be altered, especially where dense stands of conifers would be cleared. A change in understory vegetation could represent either a net increase or a net decrease in the availability of food or cover, depending on the animal species affected. Pengelly (1972) summarized the effects of clearcutting on wildlife as follows: "Some clearcut logging benefits some species of wildlife in some areas some of the time."

A commonly cited impact of timber clearing is an increase in the production of shrubs and forbs in the clearing, which may provide food for a variety of herbivores and cover for small mammals and birds. Clearing and burning of some forest types, particularly moist sites with a shrub understory, can increase browse production (Basile 1977, Bramble and Byrnes 1972, Edgerton 1972, Goodwin 1975, Patton no date, Patton 1974, Pengelly 1963, Resler 1972, Warner 1970). However, clearing of drier forest types is likely to produce little additional browse (Daubenmire 1969).

The usefulness of shrub regeneration to large herbivores (such as deer and elk) depends on the food and cover it provides, the habitat preferences and use patterns of animals in the area, the availability of food in surrounding areas, and the amount of disturbance in nearby areas. For example, deer and elk would be likely to benefit from increased forage production on winter ranges, but probably would not benefit from increased forage production on summer-fall ranges, where food is already abundant (Nyquist 1973). While the quality of forage in the fall is extremely important to winter survival of deer and elk, summer-fall range is seldom as scarce as winter range.

The presence of abundant browse would not necessarily mean it would be available to wildlife; if it were in an area inaccessible to animals or near a disturbed area (for example, a pump station or delivery facility) it might not be used by wildlife. The availability of browse to large herbivores is partially dependent on its distance from cover. Elk, in particular, are reluctant to venture far from tree cover into the center of large clearcuts, even if browse is abundant.

Several studies (Goodwin 1975, Resler 1972, Reynolds 1966, Wallo 1969) have shown that in uniform stands of some forest types, removal of trees in narrow strips can be more beneficial to herbivores than removal of timber in large blocks, because the forage is only a short distance from cover. However, another study (Day 1973) indicates the size of a clearcut has little effect on use of forage by elk.

From a study on the distribution of elk and deer pellets inside and outside of clearcuts, Lyon (1973a and 1975) drew the following conclusions about the effect of clearcuts on deer:

1) In an uncut forest, an accumulation of down timber higher than 0.6 m (2 ft) so limits deer distribution that the presence of a clearcut probably would not influence distribution of deer.

2) Where dead and down timber does not limit distribution, deer prefer an opening about 24 ha (60 acres) in size; the acceptable range of size of a clearcut is probably 16 to 32 ha (40 to 80 acres).

3) Deer make only limited use of any opening with vegetation shorter than 0.3 m (1 ft); use increases with vegetation 0.6 m (2 ft) high, and is greatest with 0.9 m (3 ft) of growth. Additional increments of vegetation growth may increase the range of size of openings deer find acceptable to 8 to 40 ha (20 to 100 acres).

4) Within any opening of acceptable size, an accumulation of slash higher than 0.6 m (2 ft) reduces deer use by at least 50 percent.

Lyon drew the following conclusions about elk use of clearcut openings:

1) Elk show less preference for a specific-sized opening than do deer. In an uncut forest where there is no down timber, elk use openings from 8 to 40 ha (20 to 100 acres) in size. But where slash is 0.7 m (2.5 ft) deep, the size of opening elk find acceptable drops to 8 ha (20 acres).

2) Elk use of any opening with vegetation less than 0.3 m (1 ft) tall is limited, but use of larger openings increases with increasing vegetation height (to at least 1.5 m, or 5 ft). The height of vegetation does not affect use of smaller openings.

3) Within any opening elk find acceptable, accumulations of slash in excess of 0.5 m (1.5 ft) reduce elk use by at least 50 percent.

Alteration of habitat that is required by a species, but which is limited in availability, would represent a major impact. Animals most likely to be affected by changes in scarce, required habitat are big game (such as bighorn sheep, moose, elk, and deer) dependent on wintering areas and riparian habitat, and nesting birds (such as osprey, goose, and bald eagle) dependent on riparian habitat. For example, pipeline construction in riparian willow areas during winter could displace moose and destroy food supplies at a time of year when the animal's energy budget is tight. White-tailed deer and, to a lesser extent, mule deer and elk would be similarly impacted by construction along streams.

Recent studies by Beebe (1974), Bull (1975), Conner and Crawford (1974), Jackman (1974), Jackson (1976), and McClelland (1977) document the importance of standing, dead trees to cavity nesting birds, especially woodpeckers. The removal of dead trees from a right-of-way could significantly decrease the availability of nesting habitat for such birds. Snags are also ideal nesting sites for many raptors and some colonial water birds.

Birds dependent on lakes and ponds could also suffer adverse impacts from loss of breeding habitat during pipeline construction. Great blue heron rookeries would be permanently lost if habitat were destroyed.

Changes Resulting from Hydrostatic Testing

Hydrostatic testing of a pipeline would affect wildlife primarily by damaging habitat around water intake and discharge sites. To test a 16 km (10 mi) section of a pipeline 107 cm (42 in) in diameter, an estimated 16.3 million l (4.3 million gal) of water would be drawn from a stream or river. The removal of water could damage food and cover of semi-aquatic furbearers, such as beaver, muskrat, mink, and others. After testing, the water would be expelled from the pipe, possibly at a high velocity.

In flat terrain and where soils could absorb the water, vegetation damage from discharge would be short-term. But in areas where water could not be absorbed because of topography or soils, pools could form, damaging vegetation for a longer period of time. However, in some cases, the creation of ponds could benefit waterfowl temporarily, or even permanently if ponds were managed to create wetland habitat.

Changes Resulting from Maintenance of a Permanent Right-of-way

Undesirable foliage within a right-of-way could be removed by machinery or by applying herbicides. By using machinery, a selected plant species could be removed. Herbicides would damage all broad-leaved vegetation (Weigand 1978, Story 1978, Rosetta 1977); but after a period of time, those species resistant to herbicides (generally slow-growing species) would begin to reestablish within the right-of-way and would need to be removed by some method other than the application of herbicides.

For example, the Tennessee Valley Authority (TVA) used herbicides to control vegetation within its powerline right-of-way for twenty years; but when resistant species grew to a height where they posed a hazard to the line, vegetation was removed by mechanical methods (Fowler et al. 1976). The TVA now uses herbicides only where mechanical clearing is impractical because of topography, or in areas where use of heavy equipment would cause greater environmental damage than herbicides.

Use of herbicides to control regrowth of shrubby vegetation in a cleared right-of-way affects terrestrial animals primarily by temporarily altering habitat. Toxicity from herbicides is seldom reported in terrestrial vertebrates.

Wildlife can benefit from mechanical control of vegetation because it allows invasion of the right-of-way by many species of shrubs and forbs, including buck brush (*Ceanothus* spp.), sagebrush (*Artemisia* spp.), bitterbrush (*Prushia tridentata*), thistle (*Cirsium* spp.), quack grass (*Agropyron repens*), and knapweed (*Centaurea* spp.), (Fowler et al. 1976, Rosetta 1977).

Changes Resulting from Oil Spills and Siltation

Habitat could be altered by contamination of soil and vegetation by oil spills, and fire resulting from an oil spill. Wind-blown dust and sand from the right-of-way and access roads could cover vegetation. Habitat alteration from oil spills, fires, and siltation would generally cause only a short-term loss of food and cover. The effects of oil spills and siltation on vegetation are discussed in greater detail in *Northern Tier Report No. 1*. The effects of oil on wildlife mortality are discussed on page 25 of this report.

CHANGES IN MICROCLIMATE

Changes in microclimates resulting from the removal of forest canopy could have minor effects on some animals (Herrington and Heisler 1973, Hildebrand 1971, Pengelly 1963). Cavanagh et al. (1976) found that the removal of thermal or security cover along a right-of-way precludes use of the cleared area despite an abundance of food and cover. Snow drifts within a right-of-way could bury forage and impede travel of large mammals. Animals could be chilled by increased wind velocities during storms and discontinue use of the right-of-way. The temperatures of the ground within a right-of-way could increase during summer as a result of increased insolation (solar radiation).

EDGE EFFECT

Edges, or ecotones, (the transition zones where different habitats, such as grassland and forest, meet) can be inhabited by a variety of wildlife species because they can support species common to each habitat, as well as species specifically adapted to edge physiognomy. Aldo Leopold (1933) has remarked that wildlife are commonly found where the habitats that provide their food and cover needs meet. Thus, the creation of edge habitat by pipeline right-of-way clearing is of special interest.

In general, species that are adapted to closed-canopy or near-climax forests decrease in number or are eliminated by forest clearing. Species that prefer open-canopy habitat, disturbed areas, ecotones, and seral habitat will increase in number or colonize a cleared area (Bendell and Elliott 1966, Gashweiler 1970, Griffin 1977, Gysel 1957, Hagar 1960, Heath 1973, Madson 1969, Resler 1972, Tevis 1956). The net result is often an increase in the number, diversity, and abundance of wildlife species at the margins of a clearing (Gashweiler 1970, Hagar 1960, Heath 1973, Lay 1938, Schreiber and Graves 1977).

Edges created by right-of-way clearing have received little study so it is difficult to predict what effect the creation of edge along a pipeline right-of-way would have on wildlife.

The mere presence of an edge does not guarantee an increase in the number of wildlife species inhabiting an area. There is evidence that the number of animals in ecotones is determined more by diversity in the composition and distribution of vegetation than by the edge itself (Adams and Barrett 1976, Roth 1976, Winternitz 1976). For example, there would be a greater diversity of wildlife species in an edge with uneven boundaries and with vegetation patches of different sizes and shapes scattered over a broad area than in an abrupt, uniform, edge along a pipeline right-of-way. In addition, animals with large home ranges that are not entirely within the right-of-way are not as likely to benefit from corridor clearing as much as species whose home ranges are entirely within the right-of-way.

Schreiber et al. (1976) noted that edge habitats along powerline rights-of-way supported the greatest numbers of small mammal species of all habitats they studied. However, other studies (Balda 1975, Griffin 1977) show that ecotones may support the same number of species or fewer species than do adjacent communities, and that ecotonal species are often "weed species"--that is, relatively common species having broad ranges of tolerance, the ability to disperse over large areas, and high reproductive rates.

Anderson et al. (1976) studied bird communities on transmission line corridors of four widths (12, 30.5, 61, and 91.5 m; or 39, 100, 200, and 300 ft) in eastern deciduous forest. Typical open-country bird species were found to colonize the wider corridors, but these were primarily summer residents rather than permanent residents, and distances to grassland habitat were unspecified. Although most forest species appeared to be attracted to the corridors, and although the 30.5 m (100 ft) corridor supported a higher density of territorial males than adjacent forest, all four corridors had a lower bird species diversity than undisturbed forest. Of the corridor widths studied, the 30.5 m (100 ft) corridor appeared to show the greatest edge effect; the narrow corridors showed little change and the wider corridors produced a shift toward grassland bird communities.

Artificially created ecotones may function as ecological "traps" by concentrating bird nests, thus increasing predation-caused nest loss. A study by Gates and Gysel (1978) indicated that while nest density increased near ecotones, nest success decreased because of predation.

FRAGMENTATION OF HABITATS

The effects of fragmentation of large blocks of uniform habitat on the number and diversity of animal species have recently been examined in light of MacArthur and Wilson's theory of "island biogeography" (1967), which assumes that the number of species inhabiting a particular habitat area (or island) represents an equilibrium between colonization and extinction rates. According to the theory, large blocks of habitat (or habitat continents) tend to support many more species at equilibrium than do smaller blocks (or habitat islands); the division of a large habitat into a smaller habitat reduces the number of species using the habitat.

Most research indicates that to maintain high species diversity, large blocks of habitat must be preserved (Diamond 1975 and 1976, Forman et al. 1976, Galli et al. 1976, McClintock et al. 1977, Sullivan and Shaffer 1975). However, Simberloff and Abele (1976) argue that small, scattered blocks of habitat may be more beneficial to wildlife than one large block.

Construction of a pipeline right-of-way and associated access roads could fragment a large habitat block into two or more smaller habitat islands. However, a right-of-way or road probably would not inhibit movement of wildlife between the fragmented habitats, except perhaps that of small and sedentary mammals that are reluctant to cross rights-of-way or access roads (Oxley et al. 1974). Schreiber and Graves (1977) studied movements of two species of small mammals in rights-of-way and found that the animals moved freely across clearings as wide as 103.6 m (340 ft). However, birds requiring large, uniform stands of closed canopy forests could be eliminated from areas where a large forest habitat is broken up by roads and clearings (Whitcomb et al. 1977, Whitcomb 1977).

The fragmentation of "unaltered" habitats (habitats not altered by human activities) by construction of a right-of-way and access roads could adversely affect species such as grizzly bear, mountain lion, lynx, marten, and fisher--all of which require habitat where man's influence is not felt. Habitats in undeveloped areas also serve as security areas for big game, especially elk and mule deer.

Impacts on wildlife could extend beyond a right-of-way and access roads to adjacent areas as a result of increased human use (made easier by improved access) or a change in land use in the newly opened area. For example, if 10,000 ha (25,000 acres) of wildland were bisected by a pipeline right-of-way requiring 100 ha (250 acres), the amount of wild habitat that would remain undisturbed would be much less than 9,900 ha (24,460 acres). Right-of-way clearing often opens undeveloped areas to development--including recreational, residential, commercial forest, and agricultural development.

Although fragmentation of habitat by constuction of a pipeline might not result in immediate and obvious changes in wildlife communities, the impacts of repeated fragmentation of habitat are significant and obvious over the long-run.

BARRIERS TO MOVEMENT OF WILDLIFE

Open trenches along the pipeline right-of-way, long stretches of welded pipe left stayed above the ground, and accumulations of slash and other debris along the pipeline corridor could block access to feeding areas and water holes and interfere with big game migration. (See figure 4 in appendix A). The extent of disruption of movement would depend on the length of the barriers, the amount of time they would block movement, and the season in which they blocked movement.

Blockage of access to water holes would be a serious impact during dry seasons or in areas that are normally dry year-round. Blockage of migration routes would be a major impact if seasonal habitats were blocked during the time of migration. In forested areas, snow drifts along the right-of-way also could impede the movement of animals across the right-of-way.

CONSTRUCTION OF ACCESS ROADS

A small amount of wildlife habitat would be permanently altered by construction of access roads to the pipeline corridor. Such loss of habitat generally is not a significant impact unless it is habitat that is limiting to a particular species (for example, willow-bottom moose habitat).

DISPLACEMENT

Displacement, or population redistribution resulting from disturbance or other environmental change, is a special case of habitat alteration that causes animals to avoid an otherwise suitable area.

SHORT-TERM DISPLACEMENT

An influx of workers into construction areas; right-of-way clearing; establishment of work camps; and construction of a pipeline, pump stations, and delivery facilities would create temporary disturbances resulting in displacement of most species of birds and mammals in the disturbed area. Perhaps the most serious of these causes of disturbance would be the influx of people into areas that previously were not heavily used. Displacement resulting from construction would be temporary; in most disturbed areas, carrying capacity would not be permanently reduced and animals that left an area during construction would return, resuming their normal habits, when construction ended.

The distance animals would move from a disturbed area and the amount of time that would pass before they returned would depend on the habits of the displaced species, the type and severity of the disturbance, and the amount of habitat disturbed. Rodents and songbirds would probably move only several meters from a disturbance while large birds and mammals would probably move many kilometers.

The avoidance by large ungulates (particularly elk and moose) of areas where timber is being harvested or roads constructed is well documented (Allen and Looner 1974, Beall 1974, Ream et al. 1972, Allen et al. 1978, Stelfox 1962, Ward 1973a and 1973b). Elk may move as far as 6.4 km (4 mi) from a disturbed site (Lyon 1973a and 1973b, Allen and Looner 1974).

The time of year an area were disturbed would be a major factor in determining the severity of impacts on wildlife. For example, breeding birds (especially raptors and colonial water birds) might abandon eyries or rookeries if displaced early in the breeding season (Baglien 1975, Stahlecher 1975, Werschkul et al. 1976), and sage and sharptail grouse might abandon display grounds they had used for many years. If construction took place during the nesting season, it is likely that all active nests within and adjacent to construction areas would be abandoned; even if breeding sites were not abandoned permanently, young birds could die of exposure or from premature fledging if incubating or brooding adults were flushed from nests.

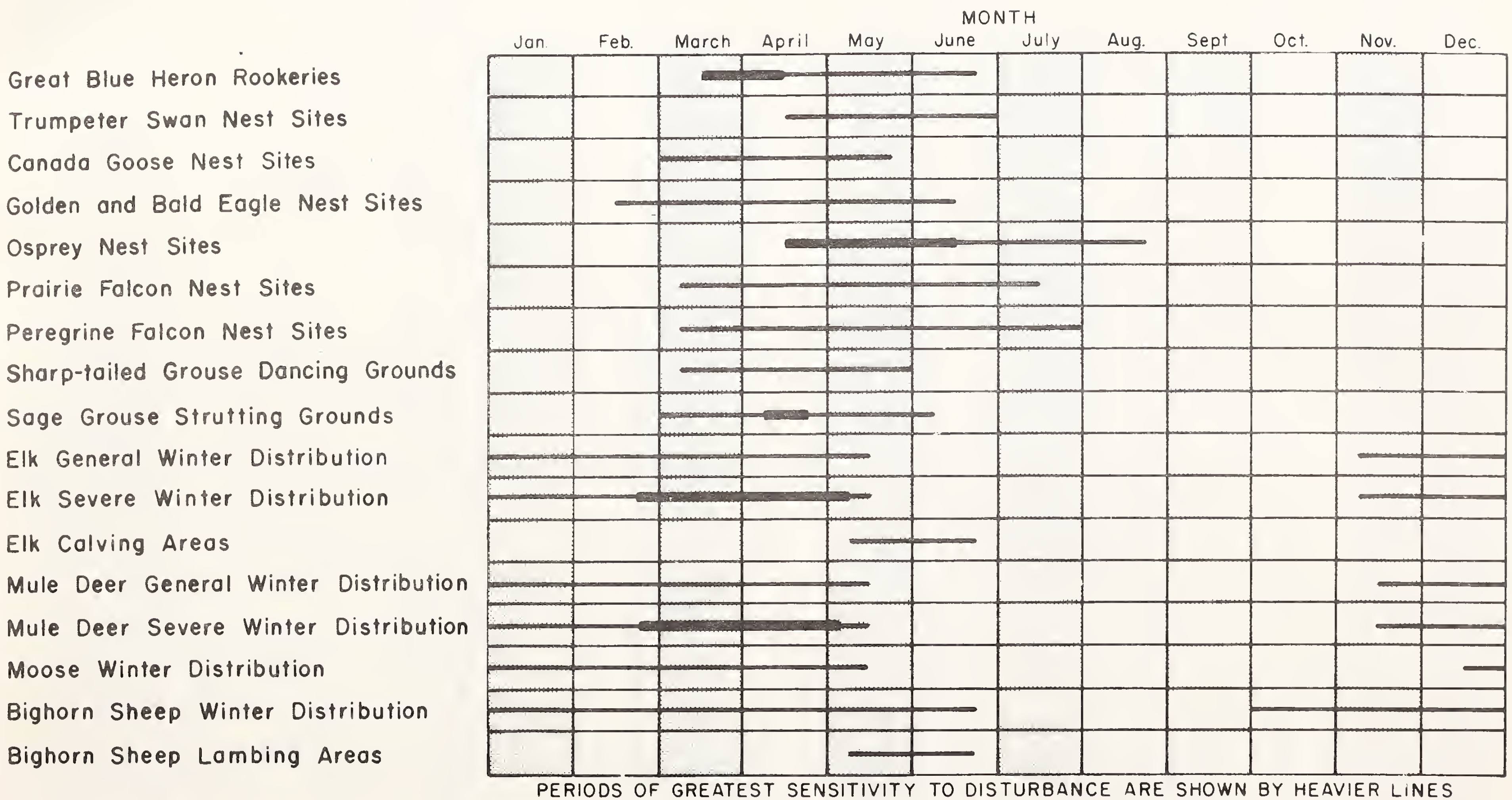
If critical winter habitat were cleared for right-of-way construction during winter, the animals dependent on that habitat would probably be displaced to marginal or submarginal wintering areas, where their food and cover requirements could not be met. Big game species, waterfowl, and wintering bald eagles could all be displaced by loss of winter habitat. Figure 3 indicates the times of the year when selected Montana wildlife species are most sensitive to disturbance of seasonal use sites.

Noise from blasting and the operation of heavy equipment would displace most wildlife species for at least a short period of time. Noise levels from typical construction activities can be as high as 78 to 84 decibels at a distance of 122 m (400 ft) (Golden et al. 1979). The severity of the impact of noise on wildlife would depend on the season in which the noise occurred, animals' tolerance of noise, the nature of the habitat animals were displaced from, and whether the noise bursts were regular or sporadic. Nesting raptors and other birds might abandon nests if noise was too loud or if construction took place too close to nests. This would decrease nesting success and perhaps cause birds to abandon nests. Irregular bursts of noise would inhibit habitation, increasing the severity of impacts from noise.

LONG-TERM DISPLACEMENT

Permanent avoidance of a disturbed area as a result of pipeline construction would represent a much more serious effect on wildlife than temporary avoidance because it would be equivalent to a permanent reduction in its carrying capacity.

FIGURE 3. Periods when selected species are most sensitive to disturbance of seasonal use sites in Montana.



SOURCE: DNRC 1976

Avoidance of Access Roads

Roads built to facilitate pipeline construction are often used for maintenance and inspection of a pipeline during its operation. Even if access road were closed to public use or were not maintained, they would be used by hunters, motorcyclists, snowmobilers, and other recreationists. Such use could lead to long-term displacement of wildlife species that avoid encounters with man and machines.

Elk appear to be among the species most sensitive to vehicle use of roads. Many studies have documented elks' avoidance of roads (Allen 1971, Allen and Lonner 1974, Lyon 1974, Lyon and Janson 1974, Allen et al. 1978, Rost and Bailey 1974, Sundstrom and Norberg 1972). However, one study (Ward 1973b) suggests that freeway traffic has little effect on elk activity beyond 0.3 km (0.2 mi) from the freeway.

An elk's sensitivity to disturbance is largely dependent on the season in which the disturbance occurs and the animal's condition. In addition, a road may be a source of disturbance at one time of day and not another; for example, elk may avoid a logging road during daylight hours when it is traveled, but cross it freely at night when it is not used. Moose, mountain goats, deer, and other big game mammals also avoid roads being used by man.

Elk are affected considerably more than deer or pronghorn antelope by traffic and human activity on highways and roads (Ward et al. 1976). Displacement of elk in the Burdette Creek logging area of western Montana has been found to continue as long as men and machinery are active (Lyon 1973b).

Goodwin (1975) found that the most significant influence a 500 kV transmission line in Idaho had on elk movement resulted from increased hunting along the line's cleared right-of-way and access roads. Hunters tended to concentrate along roads, trails, and clearings, seldom hunting more than 1.6 km (1 mi) from a road or clearing. Elk displaced by the increased hunting pressure moved to areas 0.8 km (0.5 mi) or more away from the right-of-way or access roads.

Dispersed recreation and off-road vehicle travel, especially snowmobile travel, could also displace large ungulates (Baldwin and Stoddard 1973, Goodwin 1975, Hollenbaugh 1974, Wanek 1971, Ward 1973a and 1973b, Ward et al. 1973). Deer can become accustomed to limited amounts of frequent snowmobile use; however, in areas which are used infrequently by snowmobilers, deer react violently to the disturbance. Elk appear less tolerant of snowmobiles than deer, and will move great distances to avoid a disturbance.

There would be no guarantee that wildlife displaced from an area by pipeline construction would return when construction was completed, because the right-of-way and adjacent areas would continue to be disturbed by pipeline maintenance activities and use of access roads. Long-term displacement of big game from disturbed areas would be an especially significant impact if the areas provided habitat for a species during a critical season, and such habitat were scarce. For example, in the northern Rockies, the availability of good winter habitat for big game is limited; use of many areas of winter habitat is already at or in excess of carrying capacity.

Avoidance of Pump Stations and Delivery Facilities

The noise, human activity, yard lights, and vehicle traffic near pump stations and delivery facilities might result in long-term displacement of some wildlife species. According to NTPC (1978), noise levels at pump stations along the propoed NTPS are not expected to exceed 70 decibels at a distance of 31 m (104 ft). Noise-related displacement of wildlife in the vicinity of pump stations is likely to be aggrevated by the noise of helicopters landing there periodically.

HABITUATION

Most mammals and birds can become accustomed to a disturbing and unfamiliar environmental stimulus if it is constant or repeated regularly. For example, an attempt was made to drive elk from cultivated fields in northern Idaho with firecrackers and exploding rockets. Initially, the noise caused elk to flee the fields, but after four to five days, they became conditioned to the disturbance and no longer fled (Goodwin 1975).

Other game species can also become conditioned to constant vehicle traffic--even if traffic is heavy and noise levels are high. For example, big game are often seen feeding near interstate and other major highways in Montana; in western Montana, bighorn sheep winter in an area adjacent to a major highway.. Animals feeding along roads usually move if there is a disruption in the normal traffic pattern--for example, if a vehicle stops suddenly and its occupants get out. Along roads where there is little vehicle travel, animals are more likely to avoid vehicles because they don't become conditioned to traffic.

Big game would probably react to pipeline access roads in a similar manner: near heavily traveled roads, animals would become accustomed to vehicle use and would not be displaced; where there was little traffic (for example, where a pipeline access road traversed a previously unroaded area), animals would not become accustomed to traffic and would be displaced. Thus, construction of access roads in undeveloped areas could result in a reduction in carrying capacity. The amount of available habitat that would be lost from use of an access road would extend beyond the road itself; for example, elk could be displaced from an area extending 0.5 km (0.3 mi) from both sides of a road.

The degree to which wildlife would be adversely affected by long-term displacement along a road would depend on how long the road had been present in the area, the location of previously existing roads, distance to populated centers and developed recreation sites, traffic density, hunting pressure, species present in the disturbed area, and the type and abundance of vegetation bordering the road. If the presence of an access road did not result in increased public use of an area, it is likely that animals displaced during construction would return when construction ended and become habituated to disturbances resulting from pipeline operation and maintenance.

Great blue herons can adapt to routine human activity; for example, herons forage along rivers within 200 m (60 ft) of interstate highways with no apparent regard for travelers, unless there is a departure from the normal pattern of travel (Jackman and Scott 1975). A recent study of great blue heron nests in California (Ives 1972) indicated that construction with heavy equipment 396 m (one-quarter mi) downwind of heron nests did not decrease the birds reproductive success or cause abandonment of nests; however, several herons abandoned their nests when people intruded upon the immediate area of the colony.

CHANGES IN MORTALITY AND NATALITY RATES

Minor variations in the natural mortality rate of a population are normally balanced by over-production of young or, in some cases, by an increase in the natality rate, with the result that most animal populations are maintained at or near carrying capacity. Thus, increased mortality rates or decreased natality rates have a serious impact on population size only when they exceed the potential of the population to recover. If mortality rates increase or natality rates decrease for long periods of time, a species can become locally extinct.

MORTALITY RATES

Small mammals and other r-selected species with high reproductive potentials have high natural mortality rates; very high mortality in populations of these species can often be compensated for in a few months or years.

Species most likely to be adversely affected by increased mortality are those:

1) With a low reproductive potential (such as the grizzly bear, peregrine falcon, trumpeter swan, and most K-selected species)

2) That are already rare or in danger of extinction (such as the black-footed ferret)

3) Living in small isolated colonies that would be easily destroyed (such as the great blue heron)

Following is a discussion of the ways in which a pipeline and associated facilities could contribute to increased mortality rates among some species.

Mortality Resulting From Construction

Construction and maintenance of a pipeline could directly increase mortality of small animals using the area disturbed by vehicles, clearing, and trenching. Construction could indirectly increase mortality rates by:

1) Destroying nests or dens within the proposed right-of-way

2) Disrupting or blocking access to feeding and watering areas

3) Interfering with movements of animals with established territories

4) Increasing physiological stress from increased dust, noise, vehicle traffic, and increased human population densities

5) Destroying vegetation used for forage and cover

6) Increasing predation on animals weakened by displacement

7) Increasing hunting or poaching pressure

Trenching, blasting, and hydrostatic testing would directly kill some ground-dwelling species. Net losses probably would be negligible considering the rapid reproductive potential of most of these species; however, species with limited distribution or numbers would be seriously affected by losses. Blasting in water areas may kill beaver and muskrat. In remote, mountainous areas there may be confrontations between man and bear, which frequently end in the death of the bear. Because the grizzly is a threatened species with an exceptionally low recovery rate, even a small reduction in the population of grizzly would be a particularly serious effect of a pipeline.

Overhead powerlines to valves and pump stations, towers supporting the pipeline at aerially spanned river crossings, communication towers, and access roads could also contribute to increased mortality rates for some species. Mortality of waterfowl and many other birds could increase substantially as a result of collisions with transmission wires and towers; electrocution of raptors, herons, crows, ravens, and wild turkeys perching on low-voltage powerlines is well-documented (Thompson 1978a).

Increased mortality rates resulting from environmental disturbances would have only minor long-term effects on populations of species with high reproductive potentials. For example, r-selected species, such as small mammals and most song birds, typically have high reproductive rates and the ability to compensate for losses. They could be expected to recover relatively rapidly from mortality caused by an environmental disturbance. Recovery of a population would depend on the availability of habitat suitable to sustain a population increase. If a population were reduced by pipeline construction and the amount of suitable habitat were reduced as well, the post-construction population would probably remain lower than the population before construction because of the permanent reduction in habitat.

Changes in Harvest Rates

Pipeline access roads have the potential to alter the distribution of trappers and hunters, and to change the rate of harvest mortality for many game species. Increased hunting access could reduce the availability of already scarce big game security areas and shorten the time it would take to reach harvest quotas. This, in turn, could result in more restrictive hunting regulations and reduce the quality and quantity of hunting opportunities available in a given area. For example, after logging roads were constructed in previously unroaded portions of Montana's Gravelly, Little Belt, and Bitterroot mountains, hunting use increased, leading to more restrictive elk hunting regulations--in particular, a reduction in the number of days of open either-sex hunting (Allen 1971).

Generally, hunting regulations are changed the first year or two after a road is constructed, because of increased hunting (Allen 1971). However, in areas where there is a shortage of natural predators, a lack of hunter harvest can be detrimental to elk populations, resulting in a change in population age structure such as an increase in the number of old animals (Goodwin 1975). In such areas, increased hunting could benefit wildlife.

The relationships among access, hunting pressure, and game populations have been studied by experimentally closing segments of roads in Montana's Ruby and Little Belt mountains to restrict hunting pressure. Allen and Looner (1974) found that a road closure in the Ruby Mountains increased elk use of the restricted area, increased the incidence of elk observation, and increased hunter success, resulting in a more uniform season-long hunting pressure and elk harvest. However, Basile (1977) found a road closure in the Little Belt Mountains had no apparent effect on hunting pressure or elk distribution, although the number of elk seen by hunters increased by nearly 50 percent.

An increase in human activity in a previously inaccessible forested area can result in increased trapping, adversely affecting populations of forest-dwelling furbearers (Kucera 1974) that can be trapped legally, as well as species that cannot be trapped legally, but which could be caught in traps accidentally. Foxes, wolves, marten, fisher, wolverine, and coyotes are often attracted to linear right-of-way edge in densely forested areas, and would be quite vulnerable to increased trapping.

Mortality Resulting from Illegal Shooting

The potential for poaching would be greatly increased along a pipeline corridor because of improved access and increased traffic. Even if firearms were prohibited on a construction spread, shooting by the public and construction workers after work hours could reduce populations of raptors, game species, and other animals.

Mortality Resulting from An Oil Spill

According to Kucera (1974), an oil spill could directly increase wildlife mortality rates as a result of: (1) oil coating animals' fur or feathers, causing hypothermia from lack of insulation; (2) the ingestion of toxic compounds and associated kidney failure; (3) destruction of available forage and subsequent starvation; (4) poisoning from eating contaminated prey or drinking contaminated water; and (5) drowning due to a loss of buoyancy. Another possible effect is the entrapment of animals in pools of standing oil.

The ingestion of oil by consumption of contaminated forage or by licking oil from hair or fur would probably prove harmful to wildlife, either through direct poisoning or through interference with the digestion and absorption of food. The amount of oil that must be ingested to cause acute effects is uncertain; probably it would vary from species to species. Ruminants, whose digestion depends on the action of microorganisms within the digestive tract, would probably have a lower tolerance for ingested crude oil than would carnivores. Herbivores would be exposed to oil-covered food items more than carnivores.

Oil spills would be detrimental to both land and water birds. The degree of impacts to birds from spilled oil would depend on many factors, such as time of year of the spill, its location, and the spill volume. Spills may affect birds directly by coating their feathers and contaminating food, and indirectly by draining into important waterfowl nesting areas.

According to Jacobsen (1964):

> In general, oil mats the plumage and destroys water repellency (Clark 1969), causes waterfowl to lose buoyancy and their ability to fly (Erickson 1963), and diving ducks their ability to dive for food (Chubb 1954). It eliminates heat insulation (Tuck 1960, Butler and Berks 1972), inhibits egg-laying (Hartug 1965), reduces hatchability of eggs (Gross 1950), increases metabolism and accelerates starvation (Hartung 1967), and causes direct mortality due to ingestion (Hartung and Hunt 1966). Mortality is usually highest where temperatures are low and food is not readily accessible (Nelson-Smith 1970).

Birds are attracted to pools of oil on the ground, snow, or ice, mistaking them for water. Oil sumps take a toll of ducks, shore birds, song birds, and raptors (King 1953, Block 1964). Because of the dark color of oil, waters polluted with oil would absorb more sunlight and thaw earlier in spring than nonpolluted waters, attracting early migrants. Birds also may mistake oil on ice and snow for open water; Barry (1970) reported 450 migrating ducks and geese were trapped and killed in a pool of crude oil spilled from a pipeline onto river ice.

Waterfowl are most vulnerable to oil spills when they are concentrated at staging areas during migration or on small ice-free water bodies in winter. Hunt (1961) reported duck mortality in excess of 10,000 on the chronically oil-polluted Detroit River.

Aquatic species such as beaver, muskrat, river otter, mink, and racoon, would be particularly vulnerable to injury or death if oil spilled in riparian areas or in water (Kucera 1974). The effects of oil spills on fish are discussed in Northern Tier Report No. 3.

Mortality Resulting from Oil Spill Cleanup

Oil spill cleanup could have both short- and long-term effects on birds. During spill cleanup, nesting or migrating birds could be displaced by noise and human activity, and nesting or staging habitat could be altered by construction of oil containment structures (such as earthen, straw, and underflow dams). In addition, young birds could be killed by the hosing of banks with water jets or by boats moving oil slicks with booms. If a population could recover quickly from these losses, the effects of cleanup would be short-term. But if critical habitat or a large percentage of a bird population were destroyed, the effects could be long-term.

The severity of impacts on wildlife from spill cleanup would vary, depending on the number of workers and the amount of equipment required to clean up spills of various sizes. In addition, because oil persists a long time in water, mammals and birds could continue to be oil-soaked long after a pipeline break was repaired.

Mortality Resulting from Fire at a Spill Site

An oil spill and the straw and other absorbants used to soak up spilled oil would create a fire hazard. An oil-spill fire would have only short-term impacts on animals and habitat if it could be contained within a small portion of the right-of-way. In western Montana, the right-of-way for the proposed NTPS would be flanked by forest, making spill containment especially critical to fire containment.

NATALITY RATES

Pipeline construction could decrease natality rates by (1) detroying nests, thus inhibiting or halting reproductive activities; (2) displacing individual animals; or (3) producing physiological stress as a result of increased levels of noise, human activity, vehicle traffic, and loss of forage and protective vegetation. Disturbances such as these may cause temporary behavior changes that would result in decreased breeding success. For example, natality could be greatly reduced by an oil spill and cleanup activities near raptor nests or waterfowl nesting and staging areas.

Construction through big game calving, fawning and lambing areas in late May or early June could affect reproductive success for the year of the disturbance. Raptors such as the bald eagle, peregrine falcon, prairie falcon, golden eagle, and osprey sometimes abandon nests when development projects are under way near an eyrie (Snow 1972, 1973a, 1973b, 1974). Peregrine falcons are extremely sensitive to disturbance during nesting (Snow 1972).

PHYSIOLOGICAL STRESS

The effects of stress are sublethal, difficult to identify, and may not result in immediately observable population changes. Three probable sources of stress on wildlife populations resulting from pipeline construction and operation are: (1) displacement, (2) aerial surveillance, and (3) animals eating or being fed garbage.

STRESS RESULTING FROM DISPLACEMENT

Stress on a population may increase as a result of displacement, which can indirectly affect mortality and natality rates. For example, repeated displacement of wintering elk into areas of deep snow would probably not kill animals directly, but it could cause abortion of fetuses or predispose animals to mortality through other causes, such as predation, disease, starvation, or hypothermia. Even slight increases in stress and the expenditure of stored energy (such as would result from displacement and harassment) are important during winter, when most animals are already under severe stress.

STRESS RESULTING FROM AERIAL SURVEILLANCE

According to literature on the effects of aircraft surveillance of wildlife, animals are: (1) affected by surveillance more during winter and spring than fall and summer, (2) most sensitive to aircraft disturbances when flights are below 300 m (1,000 ft) in altitude, and (3) affected more by sporadic flights than by regular flights.

Aerial surveillance of large pipelines generally occurs once every two weeks. The most detrimental effect of this activity on wildlife is the energy a frightened animal expends fleeing an aircraft. According to Klein (1973), the energy loss in wildlife frightened by aircraft must be countered by increased food consumption, or body reserves will be decreased. The impact of decreased body reserves is greatest during winter and spring. Stress from aerial surveillance could also cause animals to abort fetuses (especially if the animal were in deep, crusted snow) or trample the newly born (Geist 1971).

The response of different wildlife species and individual animals to aircraft varies greatly depending on the proximity of the aircraft, the duration of the disturbance, and an animal's previous exposure to such activities (Golden et al. 1979). The physical condition and behavioral characteristics of animals and the season of year flights take place also affect animals' responses to aircraft, as does the type of aircraft used. A study by McCourt et al. (1974) showed that caribou responded inconsistently to aircraft flying at an altitude of 300 m (1,000 ft). Animals in research areas are more accustomed to aircraft than are animals in areas that are not flown over frequently.

Wildlife are generally more disturbed by helicopters than by fixed-wing aircraft (Hinman 1974) because helicopters are louder and vibrate more than fixed-wing aircraft. However, animals in areas flown over regularly by helicopters may become accustomed to the aircraft.

According to Feist et al. (1974), sheep are "markedly disturbed by helicopters at distances up to one mile away." A study by Lenarz (1974) showed 85 percent of sheep exposed to a helicopter flying at a diagonal distance of 90 to 150 m (300 to 500 ft) exhibited panicked running. Kucera (1974) suggested that energy lost when avoiding aircraft may affect sheep survival, natality, and abortions. Black bear, grizzly bear, and moose react to aircraft flying between altitudes 30 and 300 m (100 and 1,000 ft) by walking or running from the disturbance (McCourt et al. 1974, Quimby 1974, Doll et al. 1974).

Waterfowl have been observed to abandon their nest sites or become restless in response to irregular aircraft disturbances. However, Schweinburg et al. (1974) suggest that aircraft disturbance may have little effect on waterfowl regularly or constantly subjected to such flights. According to Jacobson (1974), "disturbance [of waterfowl] could increase stress and alter normal behavior pattern during critical life history phases such as spring migration nesting, molting, or fall migration staging; decrease reproductive success; or cause the birds to desert traditional areas such as molting or nesting sites."

Hancock (1963) conducted a bald eagle nest survey and noted that a helicopter hovering low to the ground caused incubating eagles to flush nests. When Hancock compared the number of young produced from nests that were surveyed by helicopter with those not surveyed by helicopter, he found a 50 percent reduction in the number of young produced from nests that had been flown over. He also found that while only 15 percent of eagle nests used in one year are normally abandoned in the subsequent year, 45 percent of the nests surveyed by helicopter were abandoned the following year. The disturbance was less severe when fixed-wing aircraft were used and when helicopters did not hover. During a golden eagle nest survey, Hickman (1972) found that even repeated passes with aircraft would not flush incubating golden eagles; only close approach of an aircraft would flush eagles from their perches (Boeker and Bolen 1972).

In a survey done in the Yukon and Northwestern territories, helicopters evoked strong reactions from peregrine falcons, but there was some evidence that falcons at established sites could adapt to aircraft flights (USDI, 1976).

STRESS RESULTING FROM ANIMALS FEEDING AT PIPELINE FACILITIES

Animals could also be placed under stress as a result of feeding at work camps, construction sites, and garbage dumps along a pipeline. (While NTPC has no plans to establish camps, camps might be used by NTPC contractors, or for any other pipeline that might be proposed through Montana in the future.)

Continued reliance on human food can lead to nutritional and behavioral problems in wildlife. The human food animals eat consists primarily of carbohydrates, which probably do not satisfy normal nutritional requirements, leaving animals in a weakened physiological state and reducing their chances of survival. The reliance on human food can also cause animals to alter their normal patterns of movement, even to delay migration. Animals that habituate camps, garbage dumps, and roads generally lose their normal fear of people, become pests, and are sometimes destroyed; young animals reared as "garbage animals" lose their normal fear of people. Other problems could arise from reliance on human food; animals' reproductive success could be reduced, and animals could threaten the safety of construction workers.

The situation that developed with animals feeding at facilities along the Trans-Alaska Pipeline System (TAPS) illustrates many of these problems (Hinman 1974). Substantial numbers of black and grizzly bears, wolves, red and arctic foxes, ground squirrels, gulls, and ravens were attracted to camps and construction areas because they were fed by pipeline employees and because food and garbage in camps was improperly handled and disposed of. The animals feeding at camps soon became pests; nuisance animals were trapped and relocated or shot. The Alaska Fish and Game Department's work load increased substantially from dealing with nuisance animals (Hinman 1974).

Temporary feeding of wildlife by construction workers served to artificially increase the population size of some species (particularly the arctic fox) above carrying capacity. When workers left a construction area, removing the artifical food source, unnaturally large predator populations decimated the populations of their prey; predator populations then suffered losses. For example, in the two or three years following pipeline construction, the arctic fox population dropped sharply because populations of its prey were destroyed (Kucera 1974).

Glaucous gulls remained near construction camps north of the Alaskan Brooks Range until late November in 1964, when air temperatures were already below -18° C (0° F); this was well past the usual period of migration and greatly reduced the gulls' chances of survival. Grizzlies in Alaska postponed denning for up to a month due to the abnormal availability of food from humans (Milke 1977). Problems with animals in Alaska have continued during pipeline operation and maintenance, although they appear to have become less severe (Milke 1977).

Problems similar to those that occured with TAPS could arise if a pipeline crossed remote portions of Montana. But few of these problems would result from a pipeline in developed, densely populated portions of the state, where wildlife would be less inclined to seek food at construction sites because they have generally been exposed to humans and human activities and, thus, are wary of man.

THE SIGNIFICANCE OF IMPACTS

Adverse impacts on wildlife could be significant from either the biological or the social point of view. The biological significance of impacts is statistically and objectively definable; social acceptability is purely subjective, and changes from one year to another and from one place to another.

According to Sharma et al. (1975),

> An impact is biologically significant if it results in a change that is measurable in a statistically sound sampling program and if it persists, or is expected to persist, more than several years at the population, community or ecosystem level.

Biological significance can be measured in terms of changes in population size, population age structure, or carrying capacity. Social acceptability, however, is dependent on the degree to which a given impact "flaunts the public's (or portion thereof) system of values" (Sharma et al, 1975).

Thus, while the destruction of a brood of ducklings by an oil spill might not be biologically significant, if brought to the public's attention, it could so outrage people that it would assume a social significance that could not be ignored. Similarly, destruction of a dozen burrowing-owl nest sites by trenching could have a high biological significance, but may be totally ignored by the public. While any impact evaluation should involve consideration of both the biological and social significance of an impact, it is often impossible to predict the magnitude of either with any degree of confidence.

According to Sharma's definition of a biologically significant impact, none of the short-term wildlife impacts described in this chapter would be biologically significant, although they might be highly unacceptable to the public. Of the possible long-term impacts described, those that could be measured would be considered biologically significant. Biologically significant effects would include:

1) Long-term habitat alteration resulting from the prevention of regrowth of trees and shrubs within a permanent right-of-way

2) Intrusion of a right-of-way or access road into an unroaded security area

3) Long-term habitat alteration at pump stations and delivery facilities

4) Permanent abandonment of special-use sites along a pipeline right-of-way, such as raptor nests, sage grouse strutting grounds, sharp-tailed grouse dancing grounds, and large water-bird colonies

5) A major oil spill in a wetland during a period of heavy use by water birds

CHAPTER FOUR

MITIGATING MEASURES

This chapter describes a range of measures that could be taken to reduce the severity of impacts on wildlife from construction, operation and maintenance, and abandonment of a pipeline system. The measures pertain only to wildlife; consequently, some may conflict with measures pertaining to other concerns, such as soils and vegetation, aquatic life and habitats, land use, visual impacts, or pipeline engineering and economics.

To identify the measures that would provide the most effective mitigation of a project's overall impacts (not just its impacts on wildlife), it would be necessary to examine all the possible mitigating measures for all concerns and assess the trade-offs among concerns. Several other factors would influence selection of mitigating measures: the laws, regulations, and policies governing pipeline siting, construction, operation, and maintenance; the statutory authority to ensure implementation of measures; and the cost-effectiveness of mitigation in specific situations. Thus, the mitigating measures for wildlife that would be implemented for a particular project would probably not be identical to all those identified in this chapter.

LOCATION OF A PIPELINE AND RELATED FACILITIES

The following measures would mitigate adverse impacts of a pipeline system on wildlife and wildlife habitat:

1) Identifying environmentally sensitive areas where a pipeline and related facilities (such as access roads, pump stations, and transmission lines) would have a high risk of adversely affecting wildlife. One possible means of identifying such areas is the "impact risk" mapping method (Thompson 1978b), which involves:

    a) Identifying and ranking species of greatest concern

    b) Mapping the habitat of each identified species and rating it according to potential suitability

    c) Mapping the distribution of each species and the areas used during different seasons

    d) Combining the habitat and species distribution maps

    e) Weighing each resultant category according to the numerical ranking of its resident species and its suitability as habitat for those species

2) Making an on-the-ground-inspection of a proposed centerline and the location of pipeline facilities to determine their effects on wildlife. Wherever possible, modifying the centerline or facility locations to avoid damage to sites where there would be a high risk of adversely affecting wildlife.

3) Basing decisions regarding the significance of impacts from different centerlines on (among other variables):

   a) The biological and social importance of the species that would be affected along each corridor

   b) The long-range implications of disturbing different areas

   c) The susceptibility of different species to disturbance

   d) The extent to which impacts could be reduced by taking actions other than relocating the centerline (for example, by carrying out construction during a season when wildlife would be affected least)

4) Preparing (through field investigation) detailed maps of environmentally sensitive areas that could not be avoided in centerline selection or facility siting.

PIPELINE SYSTEM CONSTRUCTION

TIMING OF CONSTRUCTION

Adverse effects that would result from construction during particular times of the year would be mitigated by:

1) In environmentally sensitive areas that could not be avoided, carrying out construction during the time of year when it would cause the least damage (for example, trenching in critical winter habitat during summer).

2) Speeding construction in some environmentally sensitive areas, such as bald eagle nesting sites. Construction could be speeded by working twenty-four hours a day, with double or triple shifts; welding pipe off the construction spread; reducing the length of construction segments; and hiring additional construction workers.

3) Prohibiting trenching and welding in the migration routes of large mammals during periods of migration (especially routes between summer and winter range).

CONSTRUCTION PRACTICES

Adverse effects of construction on wildlife would be further mitigated by:

1) Limiting the width of a construction right-of-way to the minimum that would allow expeditious construction; this would be especially important in forested areas, where right-of-way clearing would generally require removal of timber for the life of a pipeline project. (The second chapter of this report, "A General Description of Large Underground Crude-Oil Pipelines," contains a discussion of factors that would influence the required width of a right-of-way.)

2) Limiting the number of new access roads to the minimum required to construct a pipeline system. (See footnote 2 on page 4 for a definition of access roads.)

3) Designing and constructing the necessary new roads to cover the shortest distance possible without compromising engineering and construction standards (such as erosion control).

4) Operating construction equipment and other vehicles only on roads and within the right-of-way.

5) In certain environmentally sensitive areas (such as nesting sites of raptors), clearing vegetation by hand rather than with machines.

6) Making an on-the-ground inspection to approve clearing boundaries before clearing begins.

7) Clearing only vegetation within the boundaries of a clearing or marking clearing boundaries, except designated trees that would pose a hazard during construction or maintenance.

8) In forested areas that provide important big game habitat, clearing the right-of-way in a manner that would create an irregularly shaped edge boundary rather than a straight line.

9) Disposing of all slash within the right-of-way or along access roads prior to the end of the first winter after clearing.

10) Removing debris generated by clearing and construction that might block wildlife movement.

11) Constructing earthen bridges over a trench at specified intervals during trenching to allow passage of wildlife. (This could be done by leaving narrow strips across a trench undisturbed until pipe is actually laid or by digging the trench, then filling in bridges until the pipe is laid, at which time the bridge would be reexcavated. This process, known as "skip trenching," is illustrated in figure 5, appendix A.)

12) Leaving openings at least 10 m (11 ft) wide at specified intervals between sections of welded pipe left above ground for longer than a few days.

13) Quickly removing (or otherwise disposing of) all garbage generated during construction, operation, maintenance, and abandonment of a pipeline system in a manner that would not attract wildlife.

14) Prohibiting the feeding of animals at construction areas, work camps, and other pipeline facilities.

15) Prohibiting the harrassment of wildlife along a pipeline corridor and at pipeline facilities.

16) Taking steps to mitigate damage to soils and vegetation in wildlife habitat. (See Northern Tier Report No. 1 for mitigating measures for soils and vegetation.)

RECLAMATION AND REVEGETATION OF A CONSTRUCTION RIGHT-OF-WAY

These steps would reduce long-term damage to wildlife and habitat:

1) Reclaiming and revegetating disturbed wildlife habitat as quickly as possible after construction ends, without jeopardizing the success of efforts. The rapid reestablishment of native species would be especially critical in winter range. (See Northern Tier Report No. 1 for discussion of mitigating measures that would encourage successful reclamation and revegetation.)

2) Whenever possible, revegetating the right-of-way in a manner that would maximize benefits to species of concern (for example, by giving priority to reestablishment of browse species important to herbivores in areas where a centerline crossed winter range).

PIPELINE OPERATION AND MAINTENANCE

Adverse effects of operation and maintenance would be mitigated by:

1) In forested or shrubby areas, maintaining a cleared right-of-way only as wide as would be required to allow access for maintenance and clean up of an oil spill.

2) Using mechanical clearing methods rather than herbicides to prevent regrowth of trees and tall shrubs within a permanent right-of-way.

3) Clearing only the minimum amount of vegetation necessary to accommodate operation and maintenance.

4) Clearing mechanically for only a short period of time in areas susceptible to damage from this clearing method.

5) Preparing a plan with detailed provisions for preventing, controlling, and extinguishing fires within and near a permanent right-of-way.

6) Closing pipeline access roads to public use by installing heavy gates.

7) In certain environmentally sensitive areas (especially winter ranges of ungulates and nesting sites of peregrine falcons and bald eagles), making flights over the right-of-way at altitudes above 305 m (1,000 ft).

OIL SPILLS

OIL SPILL CONTINGENCY PLAN

The adverse effects of an oil spill on wildlife would be mitigated by preparing a contingency plan for controlling, containing, and cleaning up oil spills, including provisions for:

1) Steps to be taken in the event of a break, leak, or explosion in the pipeline or related facilities.

2) Notification of the agency responsible for enforcing the plan.

3) Control of oil spills.

4) Immediate action to contain the spill and restore the affected area to its original condition.

5) Approval of materials or devices that would be used to control a spill and techniques of handling oily substances.

6) Identifying emergency access routes for cleanup of an oil spill. (Where possible, pipeline maintenance roads should be used for access to an oil spill.)

7) Techniques and schedules for revegetating forests, grasslands, agricultural lands, bottomlands, and wetlands, based on an area's soils, vegetation, precipitation, and other influential factors.

8) Techniques for rehabilitating oil-soaked birds and mammals and criteria for quickly determining the cost-effectiveness of rehabilitation.

CONTROL, CONTAINMENT, AND CLEANUP OF A SPILL

In the event of a spill, these measures would reduce the impact on wildlife:

1) Controlling, removing, disposing of, and cleaning up spilled oil to the satisfaction of the landowner or managing agency.

2) Rehabilitating oil-soaked birds and mammals immediately following a major oil spill, if rehabilitation would be cost-effective in terms of its overall effect on populations.

3) If rehabilitation would not be cost-effective, quantifying and compensating losses by enhancing habitat or employing some other form of compensation.

4) Quickly restoring the vegetation of a spill area. (Mitigating measures for revegetation of a spill area are discussed in <u>Northern Tier Report 1</u>.)

PIPELINE SYSTEM ABANDONMENT

Measures that would mitigate adverse impacts on wildlife from abandonment of a pipeline are generally the same as those listed under the previous headings "Construction Practices" and "Reclamation and Revegetation of a Construction Right-of-Way."

CHAPTER FIVE

COMPENSATION OF LOSSES

Even if the most successful reclamation techniques and other methods of mitigating adverse impacts on wildlife were employed, a certain amount of damage to wildlife from a large pipeline project might be unavoidable. According to Pengelly (1975), mitigation is an admission that "some loss will occur and that you will try to do as little harm as possible. Unfortunately for wildlife, this is a decision that is being increasingly made with inevitable long term results--a one-way attrition."

However, unmitigated losses of wildlife habitat and populations need not be an unavoidable cost of development; in many cases, such losses can be compensated by enhancing habitat in one area to make up for losses in another area. Enhancement would require alteration of habitat, but unlike alteration resulting from some aspects of pipeline construction and operation, alteration for the purpose of enhancing habitat would be designed to benefit wildlife.

Following are some examples of how habitat altered by pipeline construction could be enhanced through management:

1) Settling ponds, reservoirs or catchment basins created during hydrostatic testing or for the purpose of cleaning up an oil spill could be managed to create permanent wetland habitat.

2) Spoils materials unsuitable for backfill could be used to create nesting islands in reservoirs.

3) Baskets or nest boxes could be installed in ponds and reservoirs to encourage waterfowl to nest.

4) Where a right-of-way passed through forested land, regrowth of seral browse species important to ungulates could be encouraged.

5) Nest boxes could be placed in woodland areas where snags were removed.

6) The edge of the permanent right-of-way could be managed to increase habitat diversity by planting trees and tall shrubs of different shapes (such as conifers, aspens, and birches) on the temporary right-of-way following construction.

7) Diverse microhabitats beneficial to numerous wildlife species could be created by grading ground disturbed during construction into different shapes, then revegetating with a variety of plant species.

8) In prairie land, where cover is scarce, habitat could be enhanced by planting shrubs and trees on the right-of-way after construction.

Other techniques for enhancing habitat are described by Yoakum and Dasmann (1971).

In many cases, compensation would yield greater and more cost-effective benefits to wildlife than would mitigation; for example, rehabilitation of waterfowl damaged by an oil spill during fall migration might cost thousands of dollars, yet save few birds because if they were released during winter, they could die during migration from harsh weather and their weakened physical condition. In such a case, the time, money, and effort that would be spent on mitigation could be better spent on habitat enhancement or management for waterfowl in other areas.

Measures that would compensate losses are:

1) Prior to construction, preparing a right-of-way management plan (a) identifying opportunities for enhancing habitat disturbed by pipeline construction and (b) reflecting the specific wildlife species, habitats, terrain, climate, and other conditions found in particular areas along a pipeline corridor.

2) Monitoring pipeline construction to ensure that all mitigating measures are enforced and to allow documentation of unmitigated losses. Unavoidable losses could then be compensated by: (a) acquiring habitat similar to the damaged habitat, (b) managing areas other than the damaged area for the benefit of the affected species, (c) obtaining easements to manage private land for the benefit of the affected species, or (d) restocking the vacated habitat.

3) Estimating the requirements for compensating habitat losses on the basis of U.S. Fish and Wildlife Service Habitat Evaluation Procedures (Schamberger and Farmer 1978) or a modification of these procedures.

APPENDIX A

MOVEMENT OF WILDLIFE DURING PIPELINE CONSTRUCTION

Figure 4. Tracks of moose whose passage was blocked by a three-quarter mile-long section of continuously welded pipe placed on skids during construction of the Trans-Alaska Pipeline System.

(Photo by Charles Kay.)

Figure 5. Female black bear with her cub crossing a "skip section" during construction of the Trans-Alaska Pipeline System. Leaving sections untrenched at intervals along an open pipeline trench is one technique of mitigating adverse impacts on wildlife during construction.

(Photo by Charles Kay.)

GLOSSARY

biogeography--The science concerned with the distribution of life on the earth.

carrying capacity--The optimum number of organisms which the environment is capable of supporting over the long term.

centerline--The linear center of a pipeline right-of-way as surveyed and staked on the ground.

easement--A legal agreement in which a landowner grants the pipeline company the authority to carry on certain pipeline-related activities within a specified area.

construction easement--A legal agreement in which the landowner grants the pipeline company authority to carry out all activities necessary to install the pipeline. Usually granted for a wider parcel of land than the construction right-of-way.

permanent easement--A legal agreement in which the landowner grants the pipeline company authority to carry out pipeline operation and maintenance activities on the land in proximity to the pipeline. Usually granted for a wider parcel of land than the permanent right-of-way.

ecotone--A transitional community lying between two or more different habitats; an edge habitat.

eminent domain--A government's right to take, or authorize the taking of privately owned land for public use. The owner is compensated.

eurytopic--Tolerating wide extremes in environmental conditions.

eyrie--The nest of an eagle or other bird of prey.

fee ownership--A legal agreement that provides total ownership of land with unrestricted rights to use the land; the ownership is granted in perpetuity. In contradistinction to easements, which are granted for a specified limited use or uses.

habitat--The natural place of abode of a plant or other organism. The locality where the organism may generally be found, and where all essentials for its development and existence are present.

hypothermia--Subnormal body temperature.

K-selection--See r selection.

phenotype--The individual physical makeup or appearance of an organism in contrast to its genetic constitution or genotype.

phenological response--The cyclical behavior of organisms' time of flowering, leafing, and so forth, in relation to the climate or in response to a disruption of climatic conditions.

r and K selection--Alternative expressions of selection of traits that determine fecundity and survivorship to favor rapid population growth at low population density (r) or competitive ability at densities near the carrying capacity (K) (Ricklefs, 1973).

right-of-way--The strip of land appropriated by a pipeline company through easement, condemnation, or fee ownership.

construction right-of-way--The strip of land, appropriated by a pipeline company, that is actually disturbed during construction of a pipeline; usually larger than the permanent right-of-way.

permanent right-of-way--The strip of land, appropriated by a pipeline company to accommodate maintenance activities during operation of the pipeline; usually narrower than the construction right-of-way.

riparian--Pertaining to the banks of a river or stream.

rookery--A breeding place or colony of birds such as herons.

route--The general location of a pipeline right-of-way, subject to adjustments of 1.6 km (1 mi) or more during centerline location.

ruminant--An animal that chews its cud.

seral--Of or pertaining to a series of successional changes in a habitat, leading to a stable state.

siltation--The deposition or accumulation of silt that is suspended throughout a body of water; often includes sedimentary particles ranging in size from colloidal clay to sand.

stenotopic--Relatively intolerant of environmental changes.

succession--Replacement of populations in a habitat through a regular progression to a stable state.

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