REPORT OF THE CARIBOU IMPACT ANALYSIS WORKSHOP, ARCTIC NATIONAL WILDLIFE REFUGE
November 19-20, 1985

Compiled and Edited by

Glenn W. Elison
U.S. Fish and Wildlife Service
Arctic National Wildlife Refuge

Ann G. Rappoport
U.S. Fish and Wildlife Service
Regional Office, Anchorage

and

Gerald M. Reid
U.S. Fish and Wildlife Service
Regional Office, Anchorage

August 1986

United States Department of the Interior
U.S. Fish and Wildlife Service
Arctic National Wildlife Refuge
101 12th Ave., Box 20
Fairbanks, Alaska 99701

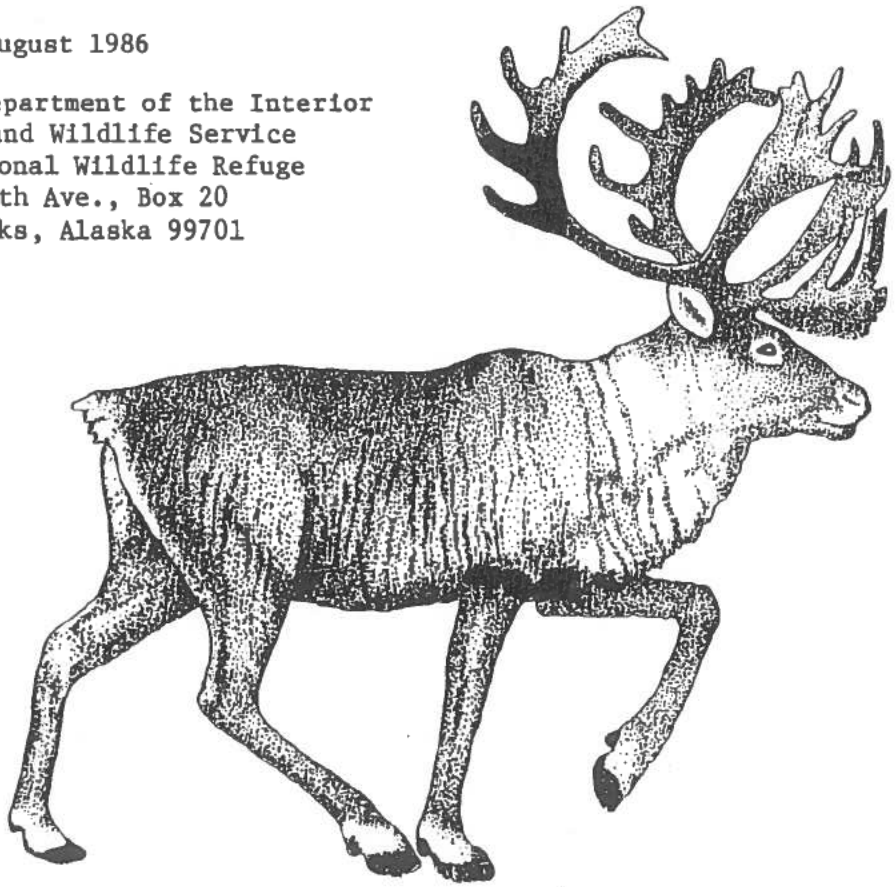


Table of Contents

	Page
Executive Summary	iii
Introduction	1
Results and Discussion	9
Conclusions and Recommendations from the Plenary Session	11
Points of General Consensus	18
Summary	21
References	22
Figures	
1. Map of the 1002 area and hypothetical development scenario	2
2. Porcupine caribou herd concentrated calving areas (1972-1985)	4
3. Porcupine caribou herd insect relief areas	5
4. Central Arctic herd range, calving grounds, and insect relief areas	6
Tables	
1. Draft definitions of effects	8
2. Revised definitions of effects for draft 1002(h) report	19

Table of Contents, continued.

Appendix 1

Workshop participants and their affiliations 24

Meeting agenda 25

Appendix 2

Hypothetical oil development scenario 26

Appendix 3

Other Issues of Concern 29

Appendix 4

Use of the Arctic National Wildlife Refuge coastal plain by the Porcupine and Central Arctic caribou herds. 32

Table A. Size of Porcupine caribou herd calving area 33

Figure A. Migration routes and winter range of the Porcupine caribou herd 34

References 38

EXECUTIVE SUMMARY

Fourteen caribou biologists met to discuss the potential effects on caribou of petroleum development on the coastal plain of the Arctic National Wildlife Refuge. The biologists analyzed a hypothetical development scenario which was representative of the type of petroleum development which may occur on the coastal plain. The group expected the development would produce a negative effect on coastal plain caribou populations and their distributions. However, agreement was not reached on the magnitude of that effect. Greatest concern focused on displacement from traditional calving areas, followed by displacement from, or inhibited access to, habitat used for relief from insect harassment. Many other aspects of caribou biology and effects of petroleum development were also discussed. Mitigation measures focused on reducing disturbance and impacts of the infrastructure associated with petroleum development. Potential mitigation included permanently closing the "core" of the traditional calving area to development, limiting area access to essential personnel only, closing the development area to all hunting, designing pipelines to facilitate caribou passage, consolidating facilities, and implementing time and area closures to minimize disturbances to caribou during their critical life stages. The group was concerned that the scenario did not consider the cumulative effects of potential petroleum development offshore or on adjacent state and private lands.

INTRODUCTION

A workshop to discuss potential effects of oil development on caribou was held in Fairbanks, Alaska, November 19-20, 1985. The workshop was hosted by the U.S. Fish and Wildlife Service (FWS), which was seeking expert opinion on such effects, as part of the environmental analysis portion of the Arctic National Wildlife Refuge (ANWR) coastal plain resource assessment. The Alaska National Interest Lands Conservation Act (ANILCA) section 1002 established the coastal plain study area and directed the assessment be conducted. The study area is referred to in this report as the "1002 area" (Fig. 1). Section 1002(h) of ANILCA required an evaluation of: the oil and gas potential of the 1002 area; fish, wildlife, and their habitats in the area(s) with oil and gas potential; and potential petroleum development effects on those area(s)' fish, wildlife, and habitats. The 1002(h) report is due to Congress by September 2, 1986.

Workshop participation was limited to individuals with experience in studying caribou, particularly studies related to the interaction of caribou with arctic oil development. A list of participants, workshop facilitators, and their affiliations and the meeting agenda are attached (Appendix 1).

Prior to the workshop, participants were sent an information packet containing:

1. Preliminary maps of caribou use areas within the 1002 area and adjacent locations [Porcupine caribou herd (PCH) concentrated calving areas from

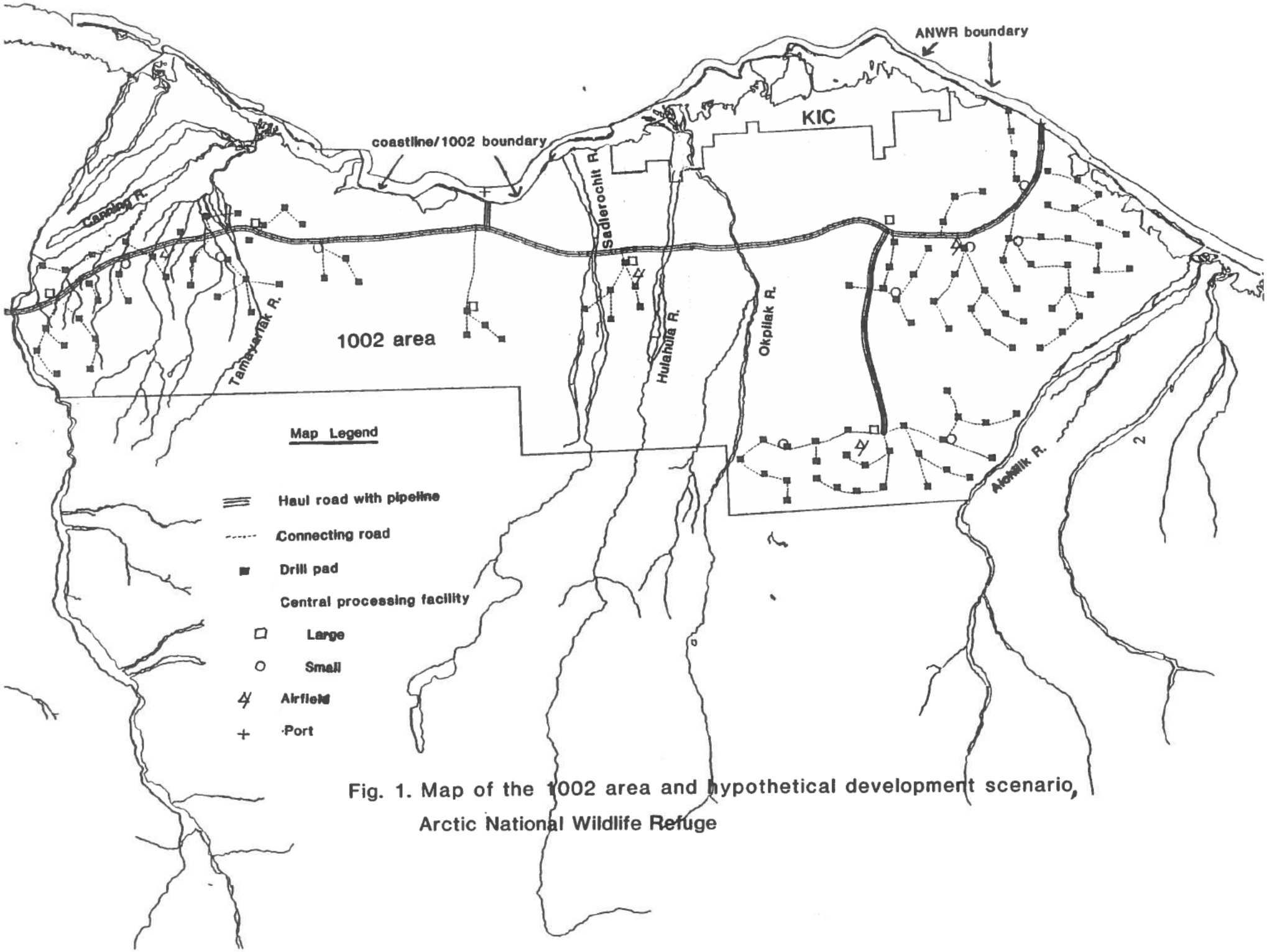


Fig. 1. Map of the 1002 area and hypothetical development scenario, Arctic National Wildlife Refuge

1972-1985 (Fig. 2); PCH insect relief areas (Fig. 3); and Central Arctic caribou herd (CAH) range, calving grounds, and insect relief areas (Fig. 4)];

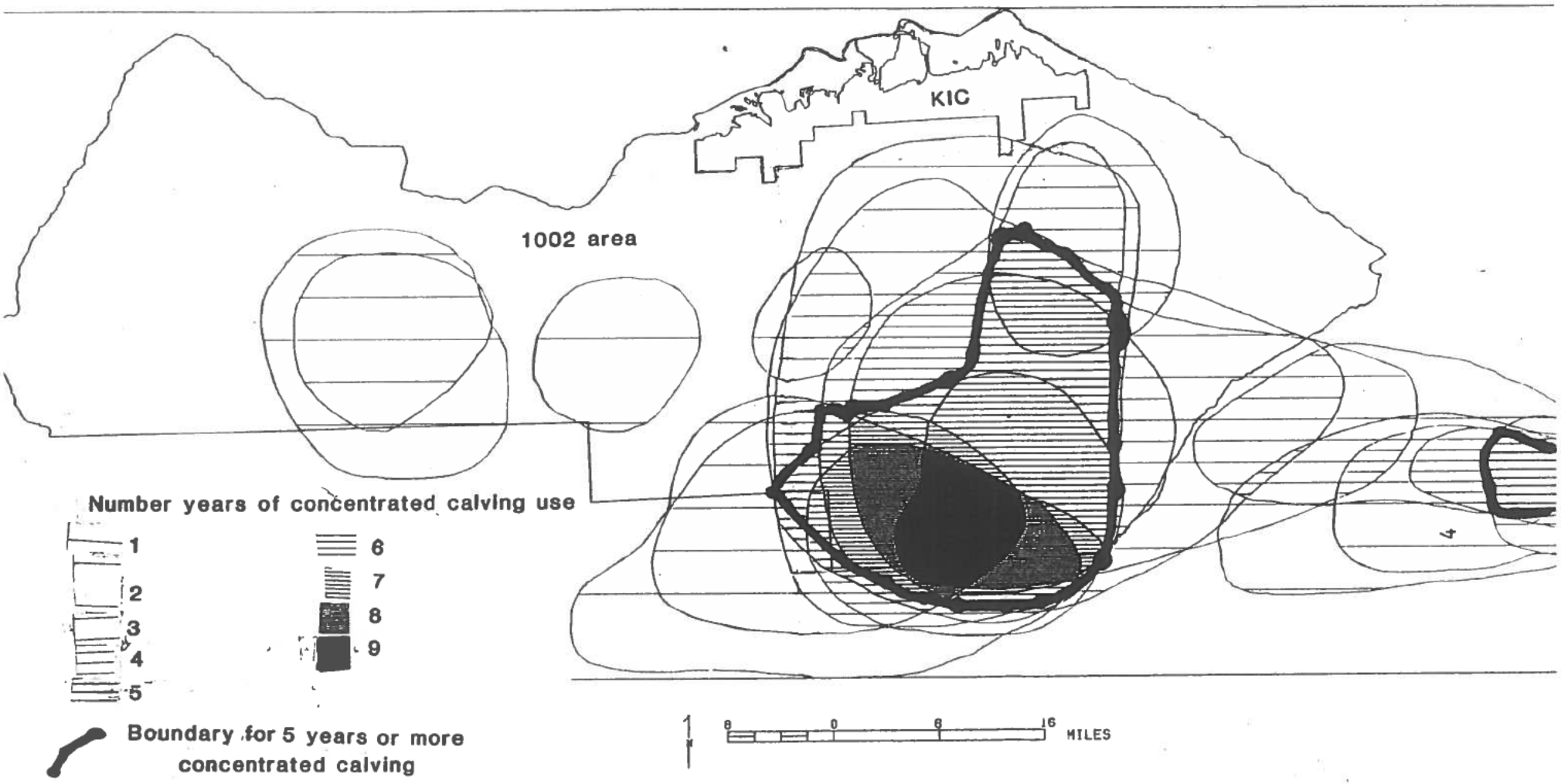
2. A hypothetical oil development scenario describing the scope of facilities, gravel requirements, direct habitat changes, and disturbance factors (Appendix 2);

3. Copies of various reports about caribou from the ongoing FWS Baseline Study (FWS, 1982; Garner and Reynolds, 1983, 1984, and 1985) on the ANWR coastal plain.

A map of the hypothetical development scenario was available at the workshop (Figure 1). The scenario was designed to raise major issues regarding the interaction of caribou with oil development, e.g., development in major calving areas and insect relief habitat, transecting migration routes with infrastructure, and disturbance effects. Participants were requested to focus their attention on the 1002 area because development on adjacent private lands, offshore waters, state lands and in Canada is highly speculative and beyond the scope of the report due to Congress. The FWS recognized that although development in those other areas may have a major influence on caribou as well as other fish and wildlife, the analysis of such impacts was beyond the scope of this workshop. The group was asked to discuss issues by:

1. describing how caribou using the 1002 area would be affected by oil development;

Fig. 2. Porcupine caribou herd concentrated calving area



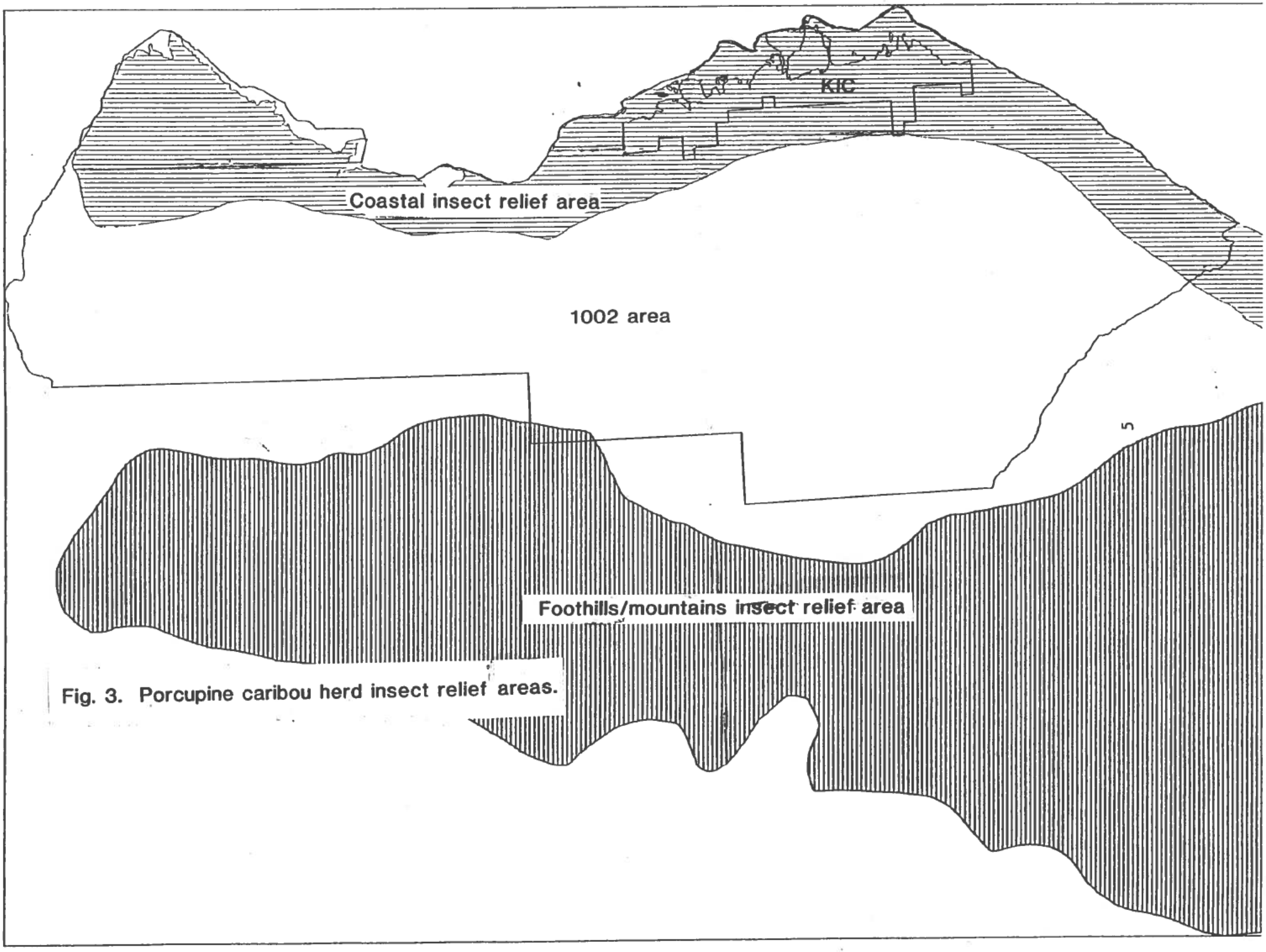


Fig. 3. Porcupine caribou herd insect relief areas.

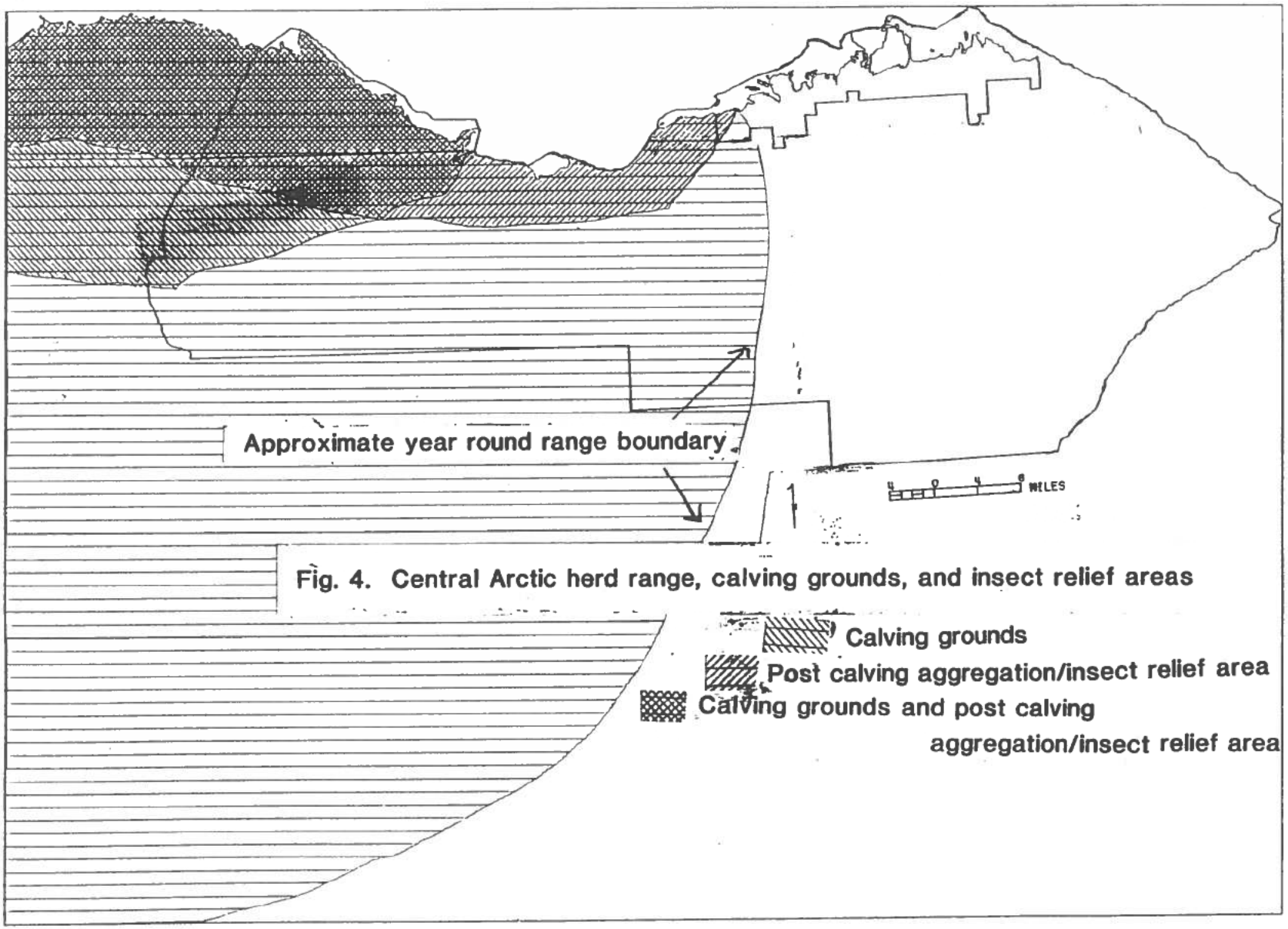


Fig. 4. Central Arctic herd range, calving grounds, and insect relief areas

2. qualitatively describing the magnitude of potential effects (the group was given terms and draft definitions for use in characterizing effects) (Table 1);

3. suggesting mitigation which could reduce negative effects; and

4. identifying any area(s) where negative effects would be of such magnitude, even with mitigation in place, that those area(s) should be closed to development.

The meeting was conducted in three sessions: plenary introduction, breakout work groups, and plenary conclusion. In the introductory session, the meeting purpose, 1002(h) report, hypothetical development scenario, background maps and biological information were described. The FWS presented a synopsis of results of the Baseline Study (FWS, 1982; Garner and Reynolds 1983, 1984, and 1985) which was required by section 1002(c) of ANILCA. The Alaska Department of Fish and Game presented a brief overview of the PCH population status and recent census efforts.

In the breakout session, workshop participants were divided into three groups to enhance discussion and maximize the number of issues and ideas examined. The discussion in each group was facilitated by a member of the FWS Environmental Assessment Team, the team responsible for preparing the analysis of environmental impacts for the 1002(h) report. The facilitators could also answer questions on potential oil development within the 1002 area; they

TABLE 1. Draft definitions of effects to caribou from oil development on the coastal plain of the Arctic National Wildlife Refuge

EFFECT LEVEL	DEFINITION
Major:	A reduction in population and/or habitat availability and quality which may cause a coastal plain population to decline in abundance and/or distribution beyond which natural recruitment does not return it to its former level within several of that species' generations.
Moderate:	A reduction in population and/or habitat availability and quality which may cause a portion of a coastal plain population to change in abundance and/or distribution over more than one of that species' generations but is unlikely to affect the regional population.
Minor:	Short-term, local disruption of population and/or habitat availability and quality for a local species population with recovery within one of that species' generations.
Negligible:	Changes in population and/or habitat availability and quality to a coastal plain population which do not result in detectable changes to that regional population.

and other group members could provide further detailed biological information on other resources of the area.

In the final plenary session, each group presented its conclusions about probable effects of oil development on caribou and recommended mitigation measures. During this plenary session, discussion centered on identifying conclusions for which there was agreement. Key issues for which consensus had not been reached were also identified. Other issues of concern for which time did not permit complete discussion during the plenary session are described in Appendix 3.

Appendix 4 is a brief summary of caribou use of the ANWR coastal plain. It is included for the benefit of readers not familiar with the area.

RESULTS AND DISCUSSION

The PCH quickly became the focus of the workshop because of its size and historic use of the ANWR coastal plain for calving, post-calving activities (including movements between inland foraging areas and coastal insect relief habitats), and post-calving aggregations. Participants agreed that oil development, as presented in the scenario, would have a negative effect on the PCH.

Diverse views were presented on exactly what effects would occur and the expected magnitude of those effects. It was agreed that displacement from the

historic calving area is a major issue. It was believed that such displacement would occur and could result in reduced caribou production. Factors suggested as causing reduced production include a combination of: increased predation, less nutritious forage, later snow melt, and possibly other factors associated with the area(s) to which the PCH would be displaced. Furthermore, calving is the time when maternal cows and their calves are most sensitive to disturbance and also the time when this segment of the PCH is expected to have the greatest interaction with petroleum development, under the given scenario.

Disturbance as a cause of displacement was also a major concern. Hunting near development, traffic, and general activity associated with petroleum development could all displace caribou. Increased predation or harassment by insects, as well as other adverse effects, could occur depending upon where and when displacement occurred.

Other developments which may occur in offshore areas and on adjacent private and state lands could also produce cumulative effects which need to be considered when assessing impacts to North Slope caribou in general. However, the group refused to speculate on the quantitative impact petroleum development would produce on caribou. Interaction of a caribou herd the size of the PCH with the amount of development presented in the scenario is without precedent.

CONCLUSIONS AND RECOMMENDATIONS FROM THE PLENARY SESSION

In the closing plenary session, there was agreement on issues and conclusions listed below. A brief discussion of each issue is followed by specific mitigative recommendations where applicable. Some of the recommendations listed were augmented by the FWS as follow-up to the group's discussions and conclusions and based on input during the more detailed work group discussions.

1. The area of sustained calving use by the PCH was generally identified and subsequently defined by the FWS as the location in which there has been concentrated calving activity in at least 5 of the last 14 years for which detailed records are available (1972-1985). The characterization of concentrated or core calving is subjective. Since 1981, an estimated density of 19 or more caribou per km^2 ($50/mi^2$) has been used to characterize core areas for the PCH during annual monitoring of calving activity by the FWS and ADF&G. Prior to 1981, caribou density in areas identified by other observers as core calving areas is unknown. However the difference in caribou density between core and peripheral calving areas is readily apparent, so it is assumed that use of the term "core" by previous observers reflects densities of similar magnitude.

   Recent work has shown that maternal caribou have been displaced from areas within approximately 3 km of roads associated with North Slope oil development (Dau and Cameron, 1985). Consequently, workshop participants predicted displacement of the PCH from much of its concentrated calving

area, given the likely locations of pads and roads within the 1002 area. Effect of this displacement is expected to be adverse. However, workshop participants would not speculate on where the displaced caribou would go nor the magnitude of the adverse effect. Participants felt that they could not accurately quantify the numbers of caribou to be affected by various aspects of the development scenario, particularly given the general nature of the scenario.

Recommendation: The area of sustained calving use (Fig. 2) should be deleted from leasing. (There was one dissenter from this view).

2. Hunting can be a negative reinforcement which increases sensitivity to disturbance, decreases habituation to development, and prolongs the reaction of caribou to disturbances such as road traffic. Thus, when hunting occurs in the vicinity of development, it can reinforce avoidance behavior by caribou toward other disturbances. As a result, there may be greater reluctance of caribou to cross through developed areas to reach historical use areas and a general avoidance of development.

Recommendation: Developed areas should be closed year-round to all hunting of caribou to prevent the additional disturbance and negative reinforcement that such activity produces. A closure of 8 km (5 mi) on either side of pipelines, road corridors, and developed areas was recommended. Modifying the caribou hunting season (which currently includes July and August) to September 1 through April 30 in

the 1002 area was also suggested as a means of reducing disturbance to the PCH.

3. Ramps have been used with mixed success in facilitating caribou movements across pipelines. Poor success has been associated with placement of ramps in areas not regularly traveled by caribou or with poor ramp design.

   Recommendation: Ramps should be considered where roads and pipelines come together creating artificial funnels affecting caribou movements and for areas of high crossing probability based upon historic migration or movement patterns. Future studies should be designed to identify need, placement and design of ramps.

4. Potential for displacement caused by disturbance will be greatest during the construction phases of oil development, because of the presence of more workers and higher activity levels. Effects on caribou will likely be most acute during the calving period and times of severe insect harassment. Displacement can result in increased predation and energy stress, which may reduce survival. These effects can be avoided or minimized by time and area closures which eliminate or reduce activities in caribou concentration areas, particularly during the sensitive calving period, usually late May to mid-June.

   Recommendation: Time and area closures should be implemented for surface and air traffic to minimize disturbances to caribou, especially calving caribou.

5. Habitat disturbance can be reduced by centralizing facilities.

Recommendation: Facilities should be consolidated and redundant facilities eliminated. Developing only one sea port and one main airport should be considered. Placing marine facilities west of the Hulahula River will reduce potential effects to PCH moving between coastal insect relief habitats and inland feeding areas.

6. Recent research indicates that separating roads from pipelines reduces the avoidance reaction of caribou to those structures (Curatolo and Murphy, 1983; Curatolo and others, 1982; Robus and Curatolo, 1983). The separation distance depends upon traffic level and terrain, but 600-800 feet appears to be an appropriate average distance based upon preliminary findings of research conducted in the central Alaskan arctic.

Recommendation: Separate roads and pipelines transecting caribou use areas. The configuration and separation distance should be determined by further study.

7. Habituation by caribou to development will not likely compensate for negative effects (displacement), although workshop participants agreed they did not know how much habituation would occur over time. Without negative reinforcement (e.g., hunting, harassment from workers, etc.), caribou may partially habituate to development. The PCH would be in contact with development for a relatively brief period annually, and would therefore be less likely to habituate than the CAH. At least part

(less than 10 percent) of the CAH uses the Prudhoe Bay development area year-round and approximately half of the CAH is in contact with development from mid-May to mid-August.

Some habituation has occurred in the CAH but it has been greater in males than females, particularly females with young. PCH females with young are expected to be that segment of the herd having greatest contact with oil development based upon the given scenario and historical use of the area. Because females with young are particularly sensitive to disturbance, the probability of habituation by that portion of the PCH is expected to be low.

8. Direct habitat loss, e.g. gravel mine sites, gravel pads, etc., would be minor if project design is such that facilities are not located in key caribou use areas, e.g. calving and insect relief areas.

   Recommendation: Design project so that facilities are located in least sensitive habitats and use areas.

9. Disturbance to caribou by petroleum development would be directly related to the number of people and vehicles in the 1002 area. Limiting access to project personnel engaged in official activities will minimize the potential for disturbances to caribou.

   Recommendation: Access to the development area should be limited to essential personnel.

10. Several participants expressed concerns over the current piecemeal nature of North Slope oil development. They believed this had led to unnecessary duplication of facilities. Mitigation has been less effective than desired, at least partly because mitigation planning has often been based on incomplete development plans.

Recommendation: A consolidated development/mitigation plan should be formulated for the North Slope.

11. Informing exploration, construction, and production workers of fish and wildlife values and environmentally sensitive operation methods and travel routes, as well as providing full-time monitors can be effective measures for minimizing negative impacts.

Recommendation: Require environmental orientation of all 1002 area workers and on-site environmental monitoring in conjunction with any petroleum exploration and development.

12. The issue of pipeline design generated a substantial amount of discussion. It was agreed that proper pipeline design would result in the highest success of caribou crossings and the least disruption of natural caribou movements and activities. Buried pipelines were viewed as highly effective in allowing free caribou crossing, however, the inherent engineering problems in pipeline burial on the North Slope were

recognized. While the alternative of elevating pipelines on vertical support members (VSM) had unanimous approval, there was not agreement on the appropriate height. Terrain and other factors will affect the optimal height.

Recommendation: Wherever possible, pipelines should be buried. Otherwise, elevated pipelines should be placed on VSM's at least five feet high. Determination of appropriate VSM heights will require additional study.

13. Participants agreed that the magnitude of direct habitat loss from oil development could be reduced by rehabilitating areas no longer in production. Moreover, gravel could be removed from abandoned areas for future development, thus reducing the need to disturb additional habitat for new gravel.

Recommendation: Abandoned development areas should be rehabilitated. Gravel for other development areas should be mined from abandoned roads and pads as the opportunity arises, providing an overall benefit to the environment will occur.

14. The group was concerned that the 1002(h) report would not consider the cumulative effects of development in other potential areas e.g., the Outer Continental Shelf, private lands, State of Alaska waters and State land west of the Canning River. Effects on caribou of development in those areas could be additive to the effects of development in the 1002 area.

Recommendation: The report should address the probability of adjacent developments and potential for additional, cumulative effects on caribou.

POINTS OF GENERAL CONSENSUS

During the plenary session, time did not allow discussion of all issues raised within the work groups. However, discussions in the work groups revealed that there was general, though probably not complete, consensus on the following recommendations and aspects of caribou behavior in relation to likely effects of oil development:

1. Definitions of terms (Table 1) used to qualitatively characterize impacts were considered unsuitable for dealing with all wildlife populations. A two-tier evaluation is needed to characterize effects on those animals using the 1002 area as opposed to effects on the entire animal population. For example, separate evaluations are needed for petroleum development effects (1) on that portion of the PCH using the 1002 area, and (2) on the entire PCH population. Additional improvements to the FWS draft definitions were suggested by workshop participants, although a final consensus on effects definitions was not reached. Based on this input and subsequent internal discussions, the FWS prepared a revised set of definitions (Table 2).

2. The circular and often daily movements of caribou to and from coastal insect relief habitats were discussed. A majority of the biologists

TABLE 2. Revised definition of effects for draft 1002(h) report.

EFFECT LEVEL	DEFINITION
Major:	A widespread, long-term change in habitat availability or quality which would likely modify natural abundance or distribution of species using the coastal plain. That modification will persist at least as long as modifying influences exist.
Moderate:	A widespread, short-term change in habitat availability or quality which would likely modify natural abundance or distribution of species using the coastal plain; or a local modification in habitat availability or quality which would likely modify natural abundance or distribution at least as long as modifying influences exist.
Minor:	Short-term, local change of species' abundance, distribution, habitat availability or habitat quality.
Negligible:	Little or no change in population, habitat availability, or habitat quality.

believed that a 5-8 km (3-5 mile wide) non-development buffer zone should be maintained along the coast to facilitate caribou movements and access to insect relief habitat.

3. Maternal cows at calving and immediately thereafter in company with their calves are the segment of the population which is most susceptible to disturbance. Based on the given development scenario, it is that portion of the PCH which will encounter oil development on the 1002 area.

4. Roads will eventually become public, based on experiences in Canada and with TAPS, regardless of the original intent.

5. Public access to the 1002 area will increase.

6. Disturbance caused by air traffic is generally less of a problem than disturbance by surface traffic.

7. Road kills and other human-caused accidents will occur but will have minor effects on the caribou population.

8. Oil development on adjacent private and State lands or off-shore will confound the ability to predict effects of development on the 1002 area.

SUMMARY

Workshop participants believed there would be a moderate or major decline or displacement of the PCH as a result of the amount of development presented in the scenario. If the area of historic, concentrated calving identified in Fig. 2 is closed to leasing and surface occupancy, the negative effects, e.g., displacement from disturbance, would be substantially reduced. To further reduce disturbance effects on caribou, prohibiting all hunting around developed areas, restrictions on personnel access, traffic controls and other measures were recommended. Past experience with the CAH and the relatively brief period the PCH uses the 1002 area suggest there will be a low degree of habituation, particularly of maternal cows, to the presence of development.

Barriers to free movement of caribou through development areas can be reduced by placing ramps over pipelines, separating roads and pipelines, requiring elevated pipelines, controlling traffic, and limiting human access. Based upon past experience with TAPS and developments in Canada, project roads will eventually become public and use of those roads will increase regardless of the original intent. A final recommendation was to maintain a non-developmental buffer zone of 5-8 km (3-5 mi) wide along the coast to facilitate free movement of caribou and access to insect relief habitat.

Cumulative effects of development on all lands and waters within the PCH and CAH ranges must be considered to realistically assess impacts to caribou.

REFERENCES

Curatolo, J. A., and Murphy, S. M., 1983, Caribou responses to the pipeline/road complex in the Kuparuk oil field, Alaska 1982, final report to ARCO Alaska, Inc., by Alaska Biological Research, Fairbanks, 81pp.

Curatolo, J. A., Murphy, S. M., and Robus, M. A., 1982, Caribou responses to the pipeline/road complex in the Kuparuk oilfield, Alaska, 1981, final report to ARCO Alaska, Inc. by Alaska Biological Research, Fairbanks, 64pp.

Dau, J. R., and Cameron, R. D., 1985, Effects of a road system on caribou distribution during calving. Address at fourth international reindeer/caribou symposium, Whitehorse, Yukon Territory, August 22-25, 1985, p. 18..

Garner, G. W., and Reynolds, P. E., editors, 1983, 1982 update report baseline study of the fish, wildlife, and their habitats section 1002c, Alaska National Interest Lands Conservation Act, U. S. Fish and Wildlife Service, Anchorage, 379pp.

Garner, G. W., and Reynolds, P. E., editors, 1984, 1983 update report baseline study of the fish, wildlife, and their habitats section 1002c, Alaska National Interest Lands Conservation Act, U. S. Fish and Wildlife Service, Anchorage, 614p.

Garner, G. W., and Reynolds, P. E., editors, 1985, 1984 update report baseline study of the fish, wildlife and their habitats section 1002c, Alaska National Interest Lands Conservation Act, U. S. Fish and Wildlife Service, Anchorage, 777p.

Robus, M. A., and Curatolo, J. A., 1983, Caribou movements along the Oliktok Road and in Kalubik Creek Region, Kuparuk Oilfield, Alaska, 1983, final report, ARCO Alaska, Inc., Anchorage, Alaska, 61p.

U. S. Fish and Wildlife Service, 1982, Arctic National Wildlife Refuge coastal plain resource assessment, initial report, baseline study of the fish, wildlife, and their habitats, Anchorage, Alaska, 507pp.

APPENDIX 1. List of workshop participants, facilitators, and their affiliations.

Caribou Workshop Participants

Tom Bergerud, University of Victoria
Ray Cameron, Alaska Department of Fish and Game
Jim Dau, Alaska Department of Fish and Game
Gerald Garner, U.S. Fish and Wildlife Service
Ronald Jakimchuk, Renewable Resources Consulting Service, Inc.
Dave Klein, Alaska Cooperative Wildlife Research Unit
Art Martell, Canadian Wildlife Service
Frank Miller, Canadian Wildlife Service
Steve Murphy, Alaska Biological Research
Larry Pank, U.S. Fish and Wildlife Service
Wayne Regelin, Alaska Department of Fish and Game
Scott Robertson, ARCO Alaska, Inc.
Dick Shideler, Alaska Department of Fish and Game
Ken Whitten, Alaska Department of Fish and Game

Caribou Workshop Facilitators

Glenn Elison, U.S. Fish and Wildlife Service
Ann Rappoport, U.S. Fish and Wildlife Service
Gerald Reid, U.S. Fish and Wildlife Service

APPENDIX 1, continued.

Caribou Workshop Agenda

November 19, 1985

9:00 - 9:15	Welcome, introduction of participants, and administrative details.
9:15 - 9:30	Purpose of the meeting
9:30 - 10:00	Background of the coastal plain resource assessment
10:00 - 10:15	Break
10:15 - 11:30	Review of the Baseline Study concerning caribou Outline of specific objectives to be accomplished Assignment of subgroups
11:30 - 1:00	Lunch
1:00 - 5:00	Subgroups meet

November 20, 1985

8:30 - 10:00	Subgroups meet
10:00 - 10:15	Break
10:15 - 11:30	Subgroups report conclusions and recommendations
11:30 - 1:00	Lunch
1:00 - 4:30	Reconcile disagreements in the subgroups' reports

SUBGROUPS

Elison	Rappoport	Reid
Jakimchuk	Murphy	Garner
Bergerud	Martell	Miller
Shideler	Cameron	Dau
Pank	Whitten	Robertson
	Klein	
	Regelin	

APPENDIX 2. Hypothetical Oil Development Scenerio

Scenario for Potential Oil and Gas Development on the Coastal Plain of Arctic National Wildlife Refuge (ANWR)

If oil and gas developments are authorized on the 1.5 million acre coastal plain of ANWR, the following scenario describes activities that could occur with development.

ACTIVITIES

Further exploration would likely preceed actual development. This would include additional surface geology and seismic exploration to "fill-in" or provide more detailed data in certain areas. Potential effects would be similar to those from such exploration to date, i,e. if exploration is confined to winter when most wildlife species are absent from the coastal plain, effects would primarily be visual tracks and local vegetation and soils disturbances. However, exploration would probably include several exploration wells, similar to the well now being drilled by Chevron on Kaktovik Inupiat Corporation lands.

With full scale development, oilfield facilities would be placed on thick gravel pads that maintain insulation and provide a stable work surface. Pads would be connected by gravel roads of similar construction. Drill pads and roads are typically placed on 5 feet of gravel fill.

The access road could be adjacent to or separated from the elevated pipeline used to transport any oil and gas produced. The main road pipeline system would extend approximately 150 miles from east to west across the coastal plain and adjacent state lands to pump station one of the Trans-Alaska Pipeline System. Multiple wells would be drilled from single, large drill pads evenly spaced about 2 miles apart. In the Prudhoe Bay area, the state originally restricted wells so that there was no more than one well for every 160 acre area. Lately the state has allowed one well per 80 acres; eventually, one well per 40 acre area may be allowed. The Bureau of Land Management has indicated that pad placement can often be flexible within a half-mile radius from the desired spot. Feeder pipelines would connect the well with central processing facilities and the main pipeline. A road system would be associated with those collecting lines and all other facilities. One main airfield would service the area with smaller airstrips likely at each oilfield which may be developed. One or two port sites for barging in supplies would also be associated with oil and gas development on the coastal plain; a road would connect the dock area with the oilfields.

Potential oilfields are scattered across the coastal plain. The number of drill pads would vary from one or two for oilfields of 200-2500 acres to 21 or 23 pads for oilfields of at least 120,000 acres. Pads could range in size from 20 to 35 acres. Total gravel needs for each drill pad could be 160,000 to 285,000 cubic yards. Drill site activities vary from intense and nearly continual during initial construction and expansion to minimal activity during normal operations. During the peak construction period as many as 1500 workers may be on the coastal plain.

Pits to contain drilling muds would be built adjacent to drill sites and cover from 1 to 6 acres each. For each oilfield, there would be one camp and large central processing facility requiring 90 acres (725,000 cubic yards of gravel). Larger fields may require one or two additional smaller central processing facilities of 40 acres each (330,000 cubic yards of gravel).

The main road and pipeline would require a right-of-way totalling 100 feet and approximately 3.3 million cubic yards of gravel. Access roads connecting drill sites to the main road would likely be heavily traveled only during construction, have a crown width of 42 feet, and minimum gravel requirements of 40,000 cubic yards/mi. Most powerlines would be overhead, built during winter, and maintained during summer with rolligons. Total roads, drill pads, and other facilities could cover 7300 acres and require 60 million cubic yards of gravel.

Gravel for the drill sites, roads, pipeline pads and other support facilities would come from pit mines in alluvial floodplains. An additional 1200 acres of coastal plain habitats could be modified by mining for gravel.

DIRECT HABITAT LOSS AND MODIFICATION

In addition to the direct loss of areas covered by oilfield facilities (i.e., drill sites, roads, pipelines, camps, etc.), physical effects can include impoundments, late snowmelt, and gravel spray from traffic, snow clearing or small construction spills. Road and pad activities also generate dust, noise disturbance, and contaminants. Powerlines, ice roads, and off-road vehicles are additional sources of disturbance. Off-road vehicle trails would be most noticeable in wet tundra types. Road maintenance includes snow clearing in winter and dust control during summer. Impoundments and dust from traffic are the other most noticeable impacts from roads. Adjacent to roads, thermokarst may appear as water-filled pits or trenches between polygons.

High levels of dust and noise disturbance are associated with all construction activities. Drainages blocked by drill sites, roads, or gravel pit overburden piles form permanent impoundments with thermokarst forming directly adjacent to the pad. Gravel spray and dust from traffic and intense activities around active gravel mines can affect vegetation adjacent to pads and lead to early snowmelt. In other locations, late-melting snowbanks may form on the west side of pads. They may also occur due to snow deposition during winter maintenance or naturally deposited drifts, depending on road orientation. Mud pits are a potential source of contaminants either through leaching of material through the berm or from pumping of pits. Unless actively filled, gravel mines remain beyond construction and are subject to flooding.

DISTURBANCE

Additional effects include continual noise from compressors and pumps; occasional gas and oil flaring is noisy and emits smoke and other material into the air. Disturbance, interference with wildlife movement routes, the presence of human activities in areas and at a much greater intensity than presently occurs, and alterations in consumptive wildlife uses could be further effects of oil and gas development in the coastal plain of ANWR.

EFFECTS TO CARIBOU

Using the caribou use area maps included here, workshop participants will be asked to interpret how various configurations of potential development may affect coastal plain caribou, given the activities and facilities described above. Estimating the magnitude of these effects should also be a discussion topic. Mitigation measures and the extent to which they can reduce any identified negative effects will also be considered. There will be opportunity to identify areas where negative effects would be sufficient to consider eliminating some area from potential development.

APPENDIX 3. Other Issues of Concern

Many other issues and specific points of caribou biology and interaction with petroleum development were raised within the work groups. Time did not permit discussion of all of those issues in the plenary session. Although one or more work groups reached agreement on some of those issues, it was either not determined if consensus existed or obvious that it did not. Biological factors and developmental effects which were discussed are listed below to demonstrate the range of discussion and, in some cases, conflicting views regarding caribou biology and the interaction of caribou with petroleum development. Some statements reflect individual opinions.

1. Resource decisions affecting the PCH may have a much greater impact than those affecting the CAH because:

    a. The relative size of the PCH is greater (PCH is estimated to total 165,000, CAH totals 12,000-14,000).
    b. Worldwide, one of the largest aggregations of caribou during a specific life stage (e.g. post-calving) occurs in the PCH.

2. Caribou displacement from developed areas will occur as a result of several factors. Human activity, particularly traffic, is the largest displacement/diversion stimulus. Pipelines, depending upon their configuration, may also be a barrier to caribou movements. Another barrier to free movement and a cause of displacement is roads; roads with frequent activity are a greater barrier than roads with minimal activity.

3. Cows with calves are less tolerant of disturbances than single cows or bulls. Cows and calves react when disturbances are further away and once disturbed they are displaced farther.

4. Gathering lines may become a major barrier to caribou movement if the lines are constructed without mitigative measures (e.g., elevated lines with ramps.)

5. Caribou preferentially used ramps to cross pipelines in Kuparak when adjacent VSM's were five feet, however, studies have not shown an increase in crossing success, i.e., caribou show preference but not necessarily a significant increase in success.

6. The PCH has more insect relief habitat options than the CAH. In addition to coastal areas, the PCH has access to insect relief areas in the mountains (wind blown ridges, aufeis fields, and snow banks).

7. The effects on caribou of modifications or disturbances are less critical in insect relief habitat than in calving habitat.

8. Large groups of caribou that form in response to heavy mosquito harassment are less successful moving through industrial areas than are small groups.

9. Aircraft harassment will not likely be a problem.

10. Participants could not agree regarding the effects of petroleum development on energetics. Thoughts expressed included:

    a. Development will result in negligible effects on energetics given current range utilization.
    b. Nutrition effects may interact with other factors.
    c. Predators and insects are driving factors for habitat selection by caribou--not nutrition.

11. Caribou select calving areas as a predator avoidance strategy. Some of the participants believe that predator avoidance is one of many reasons why caribou select a particular calving area.

12. Caribou must be able to disperse at calving. Displacement from normal calving areas may cause clumping in peripheral areas and increase predation.

13. Effects of petroleum development on the PCH (e.g. displacement) could result in a major decrease in the subsistence harvest of caribou, particularly at Kaktovik.

14. Riparian communities may be important feeding areas for caribou and should be protected.

15. Some small caribou herds in British Columbia have been extirpated when their calving grounds were lost to development.

16. Development will produce a major negative effect on the segment of the PCH using the 1002 area.

17. Development will produce a major negative effect on the PCH herd at large.

18. Development will produce no detectable effect on the PCH.

19. Access to PCH calving and insect relief areas west of the potential development will be inhibited.

20. Examining snow melt patterns may help define calving areas.

Mitigation recommendations made in work groups but not fully discussed in the final session included:

1. Bury pipelines, particularly feeder lines, inside the roadbed.

2. Bury pipelines when permafrost free soils are present.

3. Build pipelines from ice roads.

4. Raise pipelines to 7 or 8 feet at VSM's. Caribou need to be able to see under the pipeline to facilitate passage.

5. Reduce traffic speeds.

6. Pulse traffic, e.g. allow traffic to depart a specific point for only ten minutes out of every hour.

7. Align roads parallel to animal movements where appropriate.

8. Establish aircraft corridors to minimize disturbing animals in calving and other high use areas.

9. Establish minimum flight levels (1,000'-2,000' above ground level).

10. Route infrastructure as directly as possible.

11. Route the pipeline corridor along the coast from the eastern portion of the 1002 area to just west of Camden Bay, then move inland to fully avoid the CAH's calving areas and insect relief habitat on the Canning River Delta. A coastal route would be better for the main haul road because an inland haul road could affect a larger portion of the habitat more intensively used by the PCH. The reverse would be true for the CAH within the 1002 area. North-south roads extending to inland work pads will have less traffic than east-west haul roads.

APPENDIX 4. Use of the Arctic National Wildlife Refuge coastal plain by the Porcupine and Central Arctic caribou herds.

Portions of the Porcupine and Central Arctic caribou herds are found within the 1002 area during various times of the year. Each herd has specific distributions, movement patterns, and herd dynamics.

Porcupine caribou herd. The Porcupine caribou herd (PCH) is an international resource, estimated at 165,000 animals in 1985. The herd is increasing and is one of the largest herds in North America (Whitten, 1986). Population estimates for the PCH have ranged from 165,000 (Whitten, 1986) to 101,000 (LeResche, 1972). It is unclear if some of the earlier estimates are lower because of actual reduced abundance, less accurate or less complete survey techniques, or a combination of these factors. Caribou populations appear to fluctuate unpredictably over the long term. The long term maximum and minimum population size of the PCH or the actual carrying capacity of the PCH range is unknown.

The PCH ranges over 96,000 square miles of northeast Alaska and northwest Canada, and constitutes the largest population of large mammals shared between the two nations. Virtually the entire 1002 area is part of the traditional calving grounds of the PCH, extending throughout the Arctic foothills and 1002 area from the Canning River in Alaska to the Babbage River in Canada. The greatest concentration of calving usually occurs between the Hulahula River and the Canadian border. Since 1972 the PCH has calved over approximately 8.9 million acres (Table A). Concentrated calving (greater than 50 caribou/sq. mi.) has occurred within about 2.1 million acres of the 8.9 million acres. Of the 2.1 million acres, about 311,000 acres has been the core calving area during at least 5 of the 14 years from 1972-1985. The 1002 area represents 17 percent of the total calving area, 44 percent of the concentrated calving area, and 78 percent of the core calving area. During postcalving movements, extremely large, dense aggregations of caribou are common in the area. Although rather small in proportion to the herd's entire range, the calving/postcalving area is an important, identifiable habitat that has been repeatedly used by the PCH during these critical life stages.

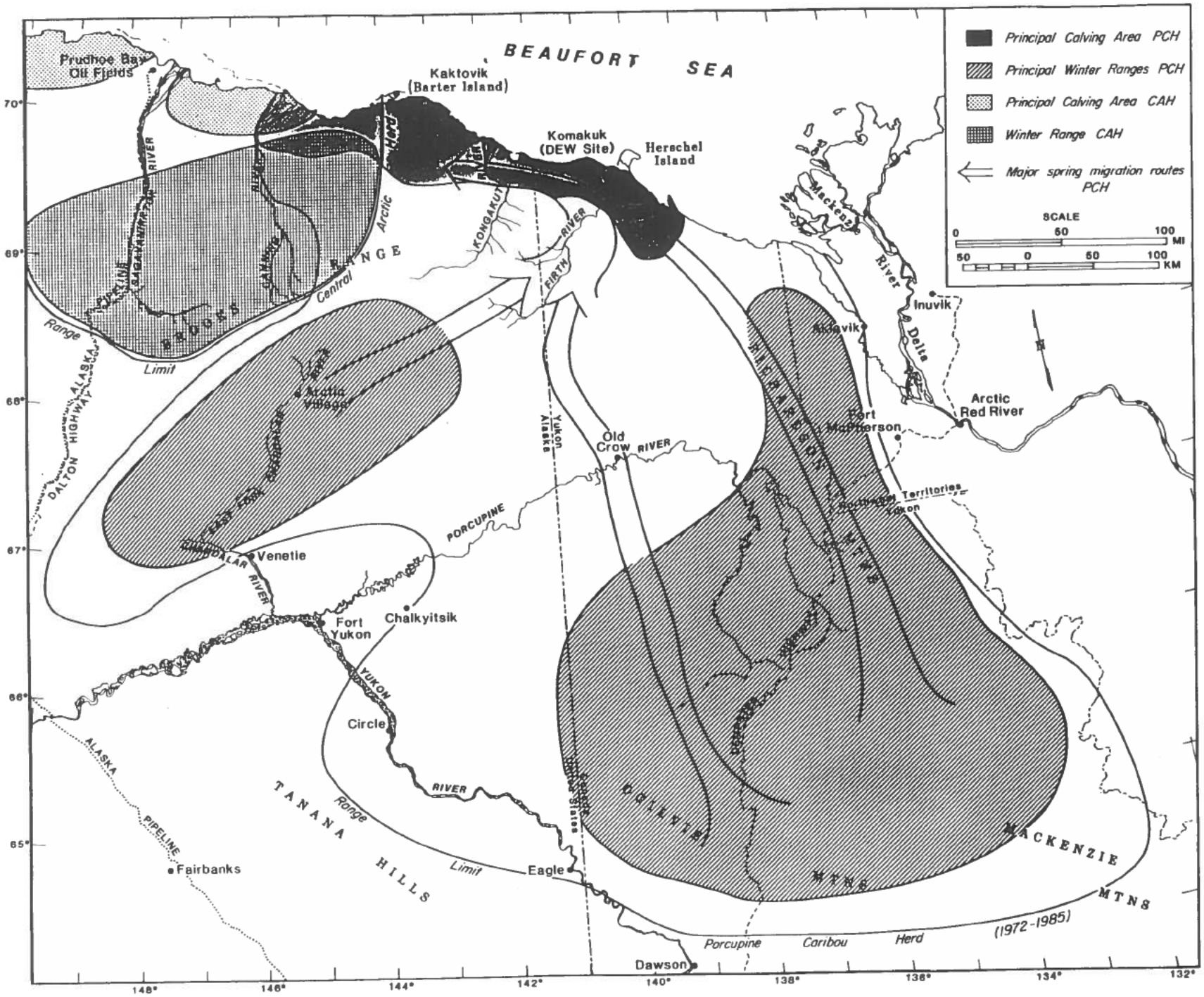
Spring migrations to the calving grounds start in May from winter ranges which are usually south of the Continental Divide in Alaska and in central Yukon Territory and adjacent Northwest Territories in Canada (Fig. A). Timing and routes of migrations vary annually depending on winter distributions, snow conditions, and the onset of spring weather. Most caribou migrate to reach the calving grounds of the 1002 area from Canada, moving westward along the northern foothills of the Brooks Range. In some years many caribou also pass through mountain valleys east of the Aichilik River in Alaska. These areas tend to be the first snow-free areas.

Table A. Size of Porcupine caribou herd calving area[1] in the United States and Canada, 1972-1985.

	U.S.	Canada	Total	1002 area	Percent of total within 1002 area
Core calving area[2]	311,000	0	311,000	242,000	78
Concentrated calving area[3]	1,584,000	533,000	2,117,000	934,000	44
Peripheral calving[4]	2,164,000	4,597,000	6,761,000	558,000	8
Total[5]	3,748,000	5,130,000	8,878,000	1,492,000	17

[1] area in acres
[2] at least 50 caribou/sq. mi. during calving for at least 5 years
[3] at least 50 caribou/sq. mi. during calving in at least one year, includes core calving area
[4] less than 50 caribou/sq. mi. during calving in any year
[5] concentrated and peripheral calving areas

Figure A--Migration routes and winter range of the Porcupine caribou herd.



As spring conditions progress, caribou in the foothills spread northward along a broad front, primarily following the major river corridors and associated terraces where snowmelt has advanced. During years when snowmelt on the coastal plain is early, a broad zone north of the foothills is used for calving. In such years calving concentrations tend to be more northerly and scattered calving extends to the coasts. When spring is late, calving is more southerly and easterly, followed by a distinct movement west and northwest to the traditional calving grounds where there is less directional movement. During and immediately following calving, vegetated riparian habitats as well as tussock uplands are heavily used by foraging caribou. Riparian areas serve as travel corridors as well as important feeding areas in both spring and summer.

From year to year, the distribution of caribou on the calving grounds varies considerably. During the 14 years, 1972-1985, in which major observations were made, major calving concentrations of the PCH were in the foothills and the adjacent coastal lowlands form the Tamayariak River to the Canadian border (Fig. 2). Scattered calving has also occurred throughout the foothills and 1002 area from the Canning River eastward. The percentage of cows using the 1002 area for calving was estimated to be 74 percent in 1983 and 82 percent in 1985. In 1984, 35 percent of the cows calved in the 1002 area; 38 percent calved adjacent to the 1002 area, east of the Achilik River. The latter group moved into the 1002 area within a week of giving birth and joined the cows already in the 1002 area (FWS, unpublished data). These estimates were derived from explorations of locational data on radio-collared cows. Usually caribou begin to arrive on the calving grounds of the ANWR during mid- to late May. The first calves are born during the last week of May, peak calving occurs during June 4-8. Although calving has been observed in a variety of terrain types, most calves are born in snow-free areas of sedge tussock uplands. Predator densities are apparently less in these areas and, subsequently, calf survival is better in the northern parts of the calving grounds which become snow-free when snowmelt is early (U.S. Fish and Wildlife Service, 1982; Mauer and others, 1983; Whitten and others, 1984 and 1985).

In arctic areas, caribou reproduction is highly synchronous. The majority of calving occurs within a 2- to 3-week period, when a single calf is born to most adult females (3 or more years old). Caribou calves are precocious, being able to stand and nurse within 1 hour following birth. They are capable of travel with adults within a week. The first 24 hours of life is critical, when a behavioral bond is formed between the calf and its mother. Disturbance of maternal groups on the calving grounds may interfere with bond formation and increase calf mortality.

After calving, small bands of cows with newborn calves gradually merge into larger groups. Yearlings, barren females, and bulls occupying the southern and eastern periphery of the calving grounds begin to mix with the cows and calves, ultimately forming huge postcalving aggregations. By late June or early July aggregations of 80,000 or more caribou on the 1002 area are common. Dense clumping or aggregations and increased movements occur when weather conditions promote insect harassment. Postcalving movements show considerable annual variation. During insect harassment, caribou groups

usually move rapidly towards the coast seeking relief on points, river deltas, mudflats, aufeis, large gravel bars, and barrier islands and in the shallows of lagoons (Fig. 3). Some groups also move to higher elevations in the mountains for relief. In other years there can be a gradual westward shift across the coastal plain and northern foothills.

The postcalving season is the low point of the annual physiological cycle when energy reserves of parturient cows are especially low. The stresses of winter, pregnancy, migration, birth, lactation, hair molt, antler growth, and insect harassment draw heavily upon this segment of the population (Dauphine, 1976; White and others, 1975). Access to insect-relief habitat and forage resources during this period may be critical to herd productivity. In early July the herds usually move east and south, vacating the 1002 area by mid-July. In certain years, residual groups numbering up to 15,000 animals have remained on the 1002 area and adjacent foothills and mountains through August. Occasionally, remnants of such groups (up to 2,000 animals) have wintered in northern mountains and foothills.

An international agreement for management of the PCH is currently being negotiated between the United States and Canada. The State of Alaska and Yukon Territorial governments as well as local users are active participants in the negotiations. The 1984 Western Arctic Land Claims settlement between Canada and the Inuvialuit in the Yukon removed a major obstacle to development of the agreement.

Harvest of the PCH occurs in both the United States and Canada. The harvest by individual Native villages is highly variable, depending upon herd movements. Recent harvests by the only village adjacent to the 1002 area, Kaktovik, have ranged from 25 to 75 animals from the PCH (Pedersen and Coffing, 1984). Harvest of the PCH throughout its range was estimated to be between 3,000 and 5,000 animals by LeBlond (1979). The harvest varies greatly between villages and between years within the same village. The annual harvest at Arctic Village, Alaska ranges from 200-1,000 (LeBlond, 1979). Annual harvest of the PCH within Canada averaged approximately 1,700 animals between 1963-1985 for the years in which data were available (Yukon Territory Wildlife Branch, unpublished data).

Central Arctic caribou herd. The Central Arctic caribou herd (CAH) has been increasing, and in 1985 numbered about 12,000 to 14,000. Its range is entirely north of the Continental Divide, from the Itkillik and Colville Rivers on the west to the Sadlerochit River on the east. The Trans-Alaska Pipeline, Dalton Highway corridor and Prudhoe Bay-Kuparuk oil fields lie within the herd's range. In July 1983, the herd was comprised of 46 percent cows, 21 percent calves, and 33 percent bulls (Hinman, 1985).

Females of the CAH wintering in the mountains and foothills near the western part of the 1002 area migrate north-northwest across the rolling uplands south of Camden Bay to the calving grounds on or near the Canning and Staines River deltas. A northward movement along the Canning River corridor also occurs.

CAH activity has been concentrated in two areas: the vicinity of the lower Kuparuk River and the Canning River delta. Most years as many as 1,000 females calve on the Canning River delta within the 1002 area (Fig. 4). Scattered, low-density calving extends as far east as the Sadlerochit River. Little or no calving has been observed in the TAPS-Prudhoe Bay oil field area since about 1973 (U.S. Fish and Wildlife Service, 1982; Whitten and Cameron, 1985).

After calving, some CAH caribou move southeastward, to the uplands south of Camden Bay. During the insect season (July) there is often a strong eastward movement along coastal habitats between the Canning River delta and Camden Bay (Fig. 4). An estimated 2,000-3,000 caribou of the CAH use the 1002 area (Canning River delta and coastal habitats along Camden Bay) for postcalving and insect relief. During the summer, an additional 1,000 animals may be scattered west of the Sadlerochit River and north of the Sadlerochit Mountains. Riparian areas are used for travel corridors as well as important spring and summer feeding areas. In late summer and fall CAH caribou are found scattered across the coastal plain south of Camden Bay, in foothills north of the Sadlerochit Mountains, and in uplands south of the Sadlerochit Mountains where they remain for the winter. During most winters, scattered groups of CAH caribou range throughout the 1002 area west of the Katakturak River and adjacent uplands to the south. The number of wintering animals ranges from 100 to 1,000.

The annual harvest of CAH caribou by Kaktovik residents has most recently been estimated to be 25-75 animals (Pedersen and Coffing, 1984). This harvest occurs along the coast during the summer when residents can travel by boat and inland during the fall and spring when snow-machine travel is possible.

REFERENCES

Dauphine, T. C., and R. L. McClure. 1974. Synchronous mating in Canadian barren-ground caribou. Journal of Wildlife Management, 38(1), p. 54-66.

Hinman, R. A., 1985, Annual report of survey-inventory activities, in Caribou survey-inventory progress report, v. XVI: Juneau, Alaska Department of Fish and Game, Aid in wildlife restoration progress report, project W-22-4, 56 p.

LeBlond, N. R., 1979, Porcupine caribou herd: Canadian Arctic Research Commission Research Monograph 3, Yukon Series, 156 p.

LeResche, R. E., 1972, The international herds--Present knowledge of the Fortymile and Porcupine caribou herds, p. 127-134, in Luick, J. R., Lent, P. C., Klein, D. R., and White, R. G., editors: Proceedings of the First International Reindeer and Caribou Symposium: Fairbanks, University of Alaska.

Mauer, F. J., Garner, G. W., Martin, L. D., and Weiler, G. J., 1983, Evaluation of techniques for assessing neonatal caribou calf mortality in the Porcupine caribou herd, p. 201-245, in Garner, G. W., and Reynolds, P. E., editors, 1982 update report, baseline study of the fish, wildlife, and their habitats: Anchorage, U. S. Fish and Wildlife Service, Region 7, 379 p.

Pederson, S., and Coffing, M., 1984, Caribou hunting--Land use dimensions and recent harvest patterns in Kaktovik, Northeast Alaska: Fairbanks, Alaska Department of Fish and Game, Division of Subsistence, 57 p.

U.S. Fish and Wildlife Service, 1982, Initial report, baseline study of the fish, wildlife, and their habitats, Section 1002(c) of the Alaska National Interest Lands Conservation Act: Anchorage, U. S. Fish and Wildlife Service, Region 7, 507 p.

White, R. G., Thomson, B. R., Skoland, T., Person, S. J., Russell, D. E., Holleman D. F., and Luick, J. R., 1975, Ecology of caribou at Prudhoe Bay, Alaska, p. 151-201, in Brown, J., editor, Ecological investigations of the tundra biome in the Prudhoe Bay Region, Alaska: Fairbanks, Biological Papers of the University of Alaska, Special Report 2, 215 p.

Whitten, K. R., 1986, Population status and trend of the Porcupine caribou herd, 1982-1985, in prep., in Garner, G. W., and Reynolds, P. E., editions, 1985 update report, baseline study of the fish, wildlife, and their habitats: Anchorage, U. S. Fish and Wildlife Service, Region 7.

Whitten, K. R., and Cameron, R. D., 1985, Distribution of caribou calving in relation to the Prudhoe Bay oil field, p. 35-39, in Martell, A. M., and Russell, D. E., editors, Caribou and human activity: Ottawa, Proceedings of the First North American Caribou Workshop, Whitehorse, Sept. 28-29, 1983, Canadian Wildlife Service Special Publication, 68 p.

Whitten, K. R., Garner, G. W., and Mauer, F. J., 1984, Calving distribution, initial productivity and neonatal mortality of the Procupine caribu herd, 1983, p. 359-420, in Garner, G. W., and Reynolds, P. E., editors, 1983 update report, baseline study of the fish, wildlife, and their habitats: Anchorage, U. S. Fish and Wildlife Service, Region 7, 777 p.

Whitten, K. R., Mauer, F. J., and Garner, G. W., 1985, Calving distribution, initial productivity, and neonatal mortality of the Porcupine caribou herd, 1984, p. 527-621, in Garner, G. W., and Reynolds, P. E., editors, 1984 update report, baseline study of the fish, wildlife, and their habitats: Anchorage, U. S. Fish and Wildlife Service, Region 7, 777 p.