VOLUME 3

REPORT OF TASK GROUP TWO
Remedial and Mitigative Measures

FOR THE

BEAUFORT SEA STEERING COMMITTEE

April 1991

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REPORT

by

TASK GROUP NUMBER TWO

REMEDIAL AND MITIGATIVE MEASURES

for

BEAUFORT SEA STEERING COMMITTEE

APRIL, 1991

Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

Your file Votre reference

MAR 1 0 1991

Our file Notre reference

Mr. Robert Hornal
Chairman
Beaufort Sea Steering Committee
Hornal Consultants Ltd.
401-1755 West Broadway
Vancouver, B.C.
V6J 4S5

Beaufort Sea Steering Committee: Task Group 2 Final Report

Dear Mr. Hornal:

On behalf of Task Group 2 I am pleased to submit our final report entitled Wildlife and Wildlife Habitat Restoration and Compensation in the Event of an Oil Spill in the Beaufort Sea.

The report examines the issue of mitigative and remedial measures as specified in the Inuvialuit Final Agreement (IFA). It also addresses the need to create a generally acceptable procedure for developing and estimating the cost of a "worst case" oil blowout scenario, as it relates to restoration and compensation. The work is in response to Isserk recommendations #6 and #3 of the March 1990 Workshop on Wildlife Compensation and the Inuvialuit Final Agreement.

A procedure was developed and tested by: applying assessments of vulnerability and sensitivity of valued wildlife species; evaluating the practicality of restoration options (e.g. wildlife deterrents, cleaning and treatment, habitat enhancement and bioremediation); and estimating the costs of these restoration measures. Compensation costs for potential loss of wildlife harvest are also estimated. Definitions are proposed for mitigation, remediation and for other terms in the context of their usage in the Inuvialuit Final Agreement, and a discussion is presented on the issue of " How clean is clean? "

.../2

Canada

The work was managed by Task Group 2 through a joint ESRF/NOGAP contract to several consulting firms led by Michael Lawrence and Stuart Davies of North/South Consultants.

The final report is presented in five parts:

Part I: Background, Scope and Approach;

Part II: Wildlife and Wildlife Habitat Restoration in the Event of an Oil Spill in the Beaufort Sea;

Part III: Wildlife Compensation in the Event of an Oil Spill in the Beaufort Sea;

Part IV: Workshop Discussion Paper; A Review of Wildlife Restoration Options and their Applicability to the Beaufort Sea Area; and

Part V: Workshop Discussion Paper; Compensation Models and Methodologies Employed in the Beaufort Sea Region and Elsewhere.

The task group was very successful in bringing together the varied interests and expertise of the many stakeholders under a demanding schedule. The report reflects excellent work of the consultants, the task group members and those who attended the December 1990 workshop. I believe that the enclosed report takes us a considerable distance forward in our thinking on restoration and compensation in the Beaufort.

Sincerely,

Rick Hurst
BSSC
Task Group 2 Leader

c.c.: Task Group 2 members

attach.

WILDLIFE AND WILDLIFE HABITAT

RESTORATION AND COMPENSATION

IN THE EVENT OF AN OIL SPILL IN THE BEAUFORT SEA

Edited by

M. LAWRENCE
(North/South Consultants Inc.)

BEAUFORT SEA STEERING COMMITTEE

TASK GROUP 2

REMEDIATION AND MITIGATION

FINAL REPORT

March, 1991

BSSC TASK GROUP 2 FINAL REPORT

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BEAUFORT SEA STEERING COMMITTEE
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EXECUTIVE SUMMARY

INTRODUCTION

Section 13 of the Inuvialuit Final Agreement (IFA) under the Western Arctic Claim Settlement Act (1984) among other things addresses the need for wildlife and wildlife habitat restoration in the context of wildlife compensation measures. It also sets forth principles and statements on financial responsibility and liability for those damages.

The objectives of Section 13(1)(b) are:

- if damage occurs, to restore wildlife and its habitat as far as is practicable to its original state and to compensate Inuvialuit hunters, trappers and fishermen for the loss of their subsistence or commercial harvesting opportunities.

Implications of this objective relate in part to the responsibility of the Environmental Impact Review Board (EIRB) under Section 13.(11) to recommend to the government authority empowered to approve the proposed development:

(a) terms and conditions relating to the mitigative and remedial measures that it considers necessary to minimize any negative impact on wildlife harvesting; and

(b) an estimate of the potential liability of the developer determined on a worst case scenario, taking into consideration the balance between economic factors, including the ability of the developer to pay, and environmental factors.

In turn, in Section 13.(16) Canada acknowledges that, where it was involved in establishing terms and conditions for the development, it has a responsibility to assume the developer's liability for mitigative and remedial measures to the extent practicable.

SCOPE

The full scope of Section 13.(1)(b) and Section 13(16) and the potential financial implications have been discussed at some length since the signing of the IFA but have never been addressed in any comprehensive or systematic manner. The present work is an attempt to initiate this.

This report addresses the need to create a generally acceptable procedure for developing and estimating the potential cost of a "worst case" scenario as it relates to restoration and compensation. It also examines the issue of definitions for mitigative and remedial measures as specified in the IFA in order to reach some common understanding of the terms.

METHODS AND PRODUCTS

The work was managed by Beaufort Sea Steering Committee Task Group 2. A contract was awarded to produce discussion papers as background for a workshop (December 1990) at which a number of discipline specialists from governments, university and the private sector undertook to address the restoration issues and the requirements for compensation of harvest loss.

The products include: 1) two workshop discussion papers, a) a review of wildlife restoration options and their applicability to the Beaufort Sea area (Part 4 of this report; Cross et al. 1991), and b) an analysis of compensation models and methodologies employed in the Beaufort Sea Region and elsewhere and recommendations on their applicability to the Inuvialuit Final Agreement (Part 5; Davies and Osler 1990), 2) the development and implementation of a procedure to assess the practicability and costs of restoration that can be integrated with "worst case" oil spill impact assessments [Part 2 of this report; (Lawrence et al. 1991)] and 3) a synopsis of a workshop concerning wildlife compensation in the event of an oil spill on the Beaufort Sea [Part 3 of this report (Davies and Osler 1991)]. Part 1 provides the Background, Scope and Approach (Hurst, 1991).

RESULTS

Definitions are proposed for the terms mitigation and remediation in the context their usage in Section 13 of the IFA. The essential difference between the mitigation and remediation is when the action takes place. Therefore we suggest the following definitions:

Mitigation - A priori efforts to prevent or lessen potential adverse environmental effects that may occur.

Remediation - A posteriori efforts to correct or compensate for any adverse environmental effects that have occurred, and to prevent, lessen, or compensate for any adverse environmental effects that may occur in the future as a result of the environmental damage.

Thus mitigative measures would include design, location, operational processes, timing and the preparation of contingency plans (including countermeasure plans), whereas remedial measures would include the implementation of contingency plans, clean-up, restoration of wildlife and wildlife habitat, and compensation (See Figure 1).

A discussion concerning the issue of "How clean is clean?" is presented. It concluded that among a number of environmental, social and scientific factors which should influence this decision, ultimately the most important influence will be from the coastal residents whose harvest opportunities may be affected, as well as from those parties who have a stake in compensation.

A procedure for estimating the potential restoration costs of a "worst-case" scenario has been developed by applying:

- assessments of the vulnerability and sensitivity of valued wildlife species to oil from a blowout on the Beaufort Sea;
- an evaluation of practicability of restoration options; and
- estimates of the costs of implementing specific measures to aid in the restoration of wildlife species and their habitat.

The procedure was developed and tested using valued wildlife species and elements of select worst-case scenarios. Proponent use of the procedure in a project-specific application will demand certain information prerequisites. These include; a project-specific oil spill scenario, an assessment of the potential impacts on wildlife and habitat, and the predicted effectiveness of countermeasures and clean-up.

Total compensation costs that account for potential loss of harvest of wildlife in the event of a "worst case" oil spill (whether from direct loss due to population reduction, or due to harvest restrictions) were estimated to be $ 12,185,500.00.

RECOMMENDATIONS AND CONCLUSIONS

With respect to wildlife and wildlife habitat restoration are:

1. Focused and planned research and monitoring, to the extent possible prior to a spill occurring (and opportunistic, in the event of a spill happening) is recommended in order to improve the level of confidence in the effectiveness of restoration measures. Our understanding of methods which will accelerate both the restoration of habitat, and population recovery from the effects of an oil spill is not well developed. There are few proven options which have been demonstrated to be effective and practical within the logistical constraints of the Beaufort Sea area.

2. The effectiveness of remedial measures from the perspective of both benefit to wildlife populations and cost decreases with time. The emphasis must be on a priori efforts, i.e., prevention, and also on the a posteriori implementation of offshore and nearshore countermeasures, habitat protection and cleanup. Restoration per se responds to the limitations of oil spill countermeasures and being the "pound of cure" is the least effective measure.

3. Existing rationale and end points for oil cleanup should be revisited from ecosystem as well as social perspectives (e.g. Neither "visibly clean" nor "chemically clean" by themselves are the most suitable criteria).

4. There are two "publics" of concern in the Inuvialuit Settlement Area - the IFA beneficiary and the public of Canada. The legislative scope of the issue is wider than the IFA. Also the expectations may differ and this could influence decisions on practical restoration options (e.g. is $30K cost per bird treated and released a practicable option?).

5. Biological/population research and monitoring is integral to:

   - predicting potential impacts and needs for practical restoration;
   - evaluating impacts and effectiveness of restoration; and
   - determining an end point for restoration (and compensation).

   Effective monitoring requires planning, budgeting and "buying in" by all stakeholders prior to an incident. It is recommended that the BSSC Task Group 4 undertake the development of a framework that addresses this requirement.

With respect to compensation are:

1. The Inuvialuit Harvest Study (IHS) should be formally referenced in the Generic Compensation Agreement as the primary data source to be used in the quantification of claims.

2. Industry should initiate discussions with the Local Working Group of the IHS to identify an iterative mechanism whereby industry could become more involved on an ongoing basis in the Harvest Study. A mutually acceptable form of participation is required to provide industry with a clear understanding of the current methodology and data limitations of the Study.

3. The majority of financial compensation would be related to polar bear and beluga whale losses. These losses may be more a function of closure of the hunt by the regulatory authority than actual damage to the population. A pre-impact valuation for these species should be conducted on an annual basis for the purpose of determining direct cash compensation. This valuation would be conducted by the Inuvialuit Game Council (IGC) and would be forwarded to industry representatives who would then either accept the price list or negotiate changes to that list.

4. A mock compensation program should be conducted with the communities to identify the types of issues that could surface. During the workshop it was stated that this simulation could be included as part of the current "Spill Response Practice". Workshop participants also felt that this program was important enough to conduct as a separate exercise.

5. Despite the reference to "cash compensation as a last resort" in the Inuvialuit Final Agreement, it was recommended that individual harvesters be able to select the type of compensation most suitable to their own needs.

ACKNOWLEDGEMENTS

The names of individuals who participated in the Calgary Wildlife Restoration and Compensation Workshop, held in December 1990 can be found in Appendix 1 of Part 2 and Appendix 2 of Part 3 of this report. The Task Group extends thanks to those many individuals who participated so enthusiastically. We also wish to acknowledge the funding provided through the ESRF in support of the workshop and the preparation of the discussion papers. The Northern Oil and Gas Action Program (NOGAP) provided additional funding for final report preparation. Scientific Authorities were Evan Birchard (Esso) and Rick Hurst (DIAND).

REFERENCES

Cross, W.E., T.L. Hillis and R.A. Davis. 1991. Wildlife and wildlife habitat restoration in the event of an oil spill in the Beaufort Sea. A discussion paper. Report for Beaufort Sea Steering Committee Task Group 2. 45 pp.

Davies, S.L. and C.F. Osler. 1990. Wildlife compensation in the event of an oil spill in the Beaufort Sea. A discussion paper. Report for Beaufort Sea Steering Committee Task Group 2. 24 pp.

Davies, S.L. and C.F. Osler. 1991. Wildlife compensation in the event of an oil spill in the Beaufort Sea. Workshop synopsis. Report for Beaufort Sea Steering Committee Task Group 2. 18 pp.

Lawrence, M., R. Hurst, W.E. Cross and J. Harper. 1991. Wildlife and wildlife habitat restoration in the event of an oil spill in the Beaufort Sea. Report for Beaufort Sea Steering Committee Task Group 2. 39 pp. and Appendices.

Figure 1. Mitigative and Remedial Measures: Effectiveness vs Time

Time

Mitigation

Remedial Measures

Spill

Population
Restored

Project design,
scheduling,
location

well control
marine countermeasures

shoreline protection

shoreline cleanup

wildlife deterrents
wildlife relocation

wildlife cleaning/treatment

bioremediation
habitat enhancement
restocking

harvest restrictions
compensation

Effectiveness

Monitoring

* bold type denotes the mitigative and remedial measures addressed in the present work.

PART I

BACKGROUND, SCOPE AND APPROACH

R. Hurst

BEAUFORT SEA STEERING COMMITTEE

TASK GROUP 2

REMEDIATION AND MITIGATION

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1.0 BACKGROUND

1.1 The Inuvialuit Final Agreement (IFA)

The Inuvialuit Final Agreement (IFA) under the Western Arctic Claim Settlement Act (1984) addresses the need for wildlife and wildlife habitat restoration in the context of wildlife compensation measures, and sets forth definitions, principles, and details on financial responsibility and liability for damages.

The section of the IFA which deals with restoring wildlife and its habitat in the event of an oil spill is embodied in Wildlife Compensation, Section 13 which states that:

13. (1) The objectives of this section are:

(a) to prevent damage to wildlife and its habitat and to avoid disruption of Inuvialuit harvesting activities by reason of development; and

(b) if damage occurs, to restore wildlife and its habitat as far as is practicable to its original state and to compensate Inuvialuit hunters, trappers and fishermen for the loss of their subsistence or commercial harvesting opportunities.

The full scope of Section 13.(1) (b) and the potential financial implications have been discussed at some length since the signing of the IFA but have never been addressed in any comprehensive or systematic manner. The present work is an attempt to initiate this.

The implications relate in part to the responsibility of the Environmental Impact Review Board (EIRB) under Section 13.(11) to recommend to the government authority empowered to approve the proposed development:

(a) terms and conditions relating to the mitigative and remedial measures that it considers necessary to minimize any negative impact on wildlife harvesting; and

(b) an estimate of the potential liability of the developer determined on a worst case scenario, taking into consideration the balance between economic factors, including the ability of the developer to pay, and environmental factors.

In turn, in Section 13.(16) Canada acknowledges that, where it was involved in establishing terms and conditions for the development, it has a responsibility to assume the developer's liability for mitigative and remedial measures to the extent practicable.

One of the primary tasks required to clarify the relevant subsections of Section 13 is to reach some common understanding on terms such as "practicable", 13(1) (b) and 13 (16), "reasonable", 13 (12) and "reasonably practicable" 13 (18), see Table 1 which cites other relevant subsections of the IFA.

1.2 EIRB Recommendations and Follow Up

In November 1989 the EIRB made recommendations following review of the Esso, Chevron et al. Isserk drilling program. The recommendation to the Minister of Indian and Northern Affairs Canada read as follows: "(the Department should) convene meetings of Inuvialuit, industry and government representatives within 90 days to deal with all aspects of compensation and financial responsibility under the IFA."

In March 1990 a workshop was convened in Inuvik to respond to the recommendation. It addressed Wildlife Compensation and the Inuvialuit Final Agreement and made six (6) recommendations for follow up (hereafter referred to as Isserk Recommendations 1-6).

The urgency of implementing these workshop recommendations was underscored in the July, 1990 recommendation by the Environmental Impact Review Board in its review of the Gulf Kulluk drilling program.

2.0 SCOPE

The present work addresses, in some measure, Isserk Recommendations 3 and 6.

Isserk Recommendation #3 is to create a generally acceptable procedure for developing and estimating the potential cost of a "worst case" scenario

Isserk Recommendation #6 is to examine the issue of mitigative and remedial measures as specified in the IFA.

3.0 LINKAGE WITH TASK GROUPS 1 AND 3

The present work addresses Isserk workshop recommendation 6 (Restoration). The results will also be incorporated into separate exercises being undertaken concurrently by Task Group 1 (worst case) and Task Group 3 (Generic Compensation Agreement).

Task Group #1 is working towards determining the cost of a worst case scenario(s) by addressing 5 components (See also Table 2):

1) well control
2) marine countermeasures
3) shoreline cleanup
4) remedial measures (wildlife and habitat restoration)
5) wildlife harvest loss.

The present report addresses components 4 and 5 (to the extent of estimating the potential for harvest loss) and this information will be forwarded to Task Group 1.

Task Group 3 is in part developing a generic wildlife compensation agreement. The efforts of Task Group 2 include an analysis of compensation models and methodologies employed in the Beaufort Sea Region and elsewhere; aspects of models which are most appropriate; and recommendations on their applicability to the Beaufort Sea Area (Davies and Osler 1990) These will be forwarded to Task Group 3. This report also provides estimates of the potential cash compensation for harvest loss, which are being forwarded as well to Task Group #1.

4.0 APPROACH AND PRODUCTS

The work was managed by Task Group 2, composed of 9 representatives of the Inuvialuit, Industry and Government and led by Rick Hurst of Indian and Northern Affairs Canada (Appendix 1.) A contract, jointly funded by the Environmental Studies Revolving Fund (ESRF) and the Northern Oil and Gas Action Program (NOGAP), was awarded to a group of four consulting companies: North/South Consultants, LGL Ltd., ESL Environmental Sciences Ltd. and InterGroup Consultants Ltd. Additional support was provided by Harper Environmental Services.

The products include two background documents prepared for participants of a Workshop held in Calgary on December 11 and 12, 1990. The documents are presented as parts 4 and 5 of this Final Report.

Davies, S.L. and C.F. Osler. December 1990. Wildlife Compensation in the Event of an Oil Spill in the Beaufort Sea. 24 pp.

Cross, W.E., T.L. Hillis and R.A. Davis. February 1991 (revised). Wildlife and Wildlife Habitat Restoration Options in the Event of an Oil Spill in the Beaufort Sea. 45 pp.

The workshop included 31 technical specialists and agency representative divided into subgroups to address the two major tasks:

1. restoration of wildlife and wildlife habitat and;

2. wildlife harvest loss and compensation.

The efforts of the workshop participants (see Appendix 1 of Part 2 and Appendix 2 of Part 2) in undertaking these tasks are gratefully acknowledged.

BSSC TASK GROUP 2
REMEDIAL MEASURES (RESTORATION)

Wildlife Compensation (Section 13 of the IFA)

13(1)(b) If damage occurs to restore wildlife and its habitat as far as is practicable to it's original state.

13(11) (Review board shall recommend to the Government authority:)

a) terms and conditions relating to the mitigative and remedial measures that it considers necessary to minimize any negative Impact on wildlife harvesting; and

b) an estimate of the potential liability of the developer, determined on a worst case scenario, taking into consideration the balance between economic factors, including the ability of the developer to pay and environmental factors.

13(12) (every proposed development will be authorized only after)...due scrutiny of and attention to all environmental concerns and subject to reasonable mitigative and remedial provisions being imposed.

13(18)(c) Any Inuvialuit group or community affected have the right to seek recommendations of the Arbitration board pursuant to section 18 with respect to remedial measures, to the extent reasonably practicable, including cleanup, habitat restoration and reclamation.

13(24) Arbitration Board...shall recommend to that authority appropriate remedial measures.

BSSC TASK GROUPS 1 & 2

LINKAGE*

1) well control
2) marine countermeasures
3) shoreline cleanup
4) remedial measures (wildlife and habitat restoration)
5) wildlife harvest loss

* This report addresses component 4 and part of 5, insofar as it relates to estimating the potential for loss of harvest until wildlife and its habitat is restored.

APPENDIX 1

TASK GROUP 2 MEMBERS

Rick Hurst, Ottawa (Chairman)	Evan Birchard, Calgary
Vic Gillman, Inuvik	Shawn Gill, Ottawa
Mark Hoffman, Whitehorse	Steve Matthews, Yellowknife
Angus Robertson, Yellowknife	Norm Snow, Inuvik
Scott Edwards, Yellowknife	Bill Brakel, Edmonton

PART 2

WILDLIFE AND WILDLIFE HABITAT RESTORATION

IN THE EVENT OF AN OIL SPILL

IN THE BEAUFORT SEA

M. Lawrence,
(North/South Consultants Inc.)

R. Hurst,
(Department of Indian and Northern Affairs)

W.E. Cross,
(LGL Limited)

and

J. Harper
(Harper Environmental Services)

BEAUFORT SEA STEERING COMMITTEE

TASK GROUP 2

REMEDIATION AND MITIGATION

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RECOMMENDATIONS AND CONCLUSIONS

1. Focused and planned research and monitoring, to the extent possible prior to a spill occurring (and opportunistic, in the event of a spill happening) is recommended in order to improve the level of confidence in the effectiveness of restoration measures. Our understanding of methods which will accelerate both the restoration of habitat, and population recovery from the effects of an oil spill is not well developed. There are few proven options which have been demonstrated to be effective and practical within the logistical constraints of the Beaufort Sea area.

2. The effectiveness of remedial measures from the perspective of both benefit to wildlife populations and cost decreases with time. The emphasis must be on a priori efforts, i.e., prevention, and also on the a posteriori implementation of offshore and nearshore countermeasures, habitat protection and cleanup. Restoration per se responds to the limitations of oil spill countermeasures and being the "pound of cure" is the least effective measure.

3. Existing rationale and end points for oil cleanup should be revisited from ecosystem as well as social perspectives (e.g. Neither "visibly clean" nor "chemically clean" by themselves are the most suitable criteria).

4. There are two "publics" of concern in the Inuvialuit Settlement Area - the IFA beneficiary and the public of Canada. The legislative scope of the issue is wider than the IFA. Also the expectations may differ and this could influence decisions on practical restoration options (e.g. is $30K cost per bird treated and released a practicable option?).

5. Biological/population research and monitoring is integral to:

   - predicting potential impacts and needs for practical restoration;
   - evaluating impacts and effectiveness of restoration; and
   - determining an end point for restoration (and compensation).

   Effective monitoring requires planning, budgeting and "buying in" by all stakeholders prior to an incident. It is recommended that the BSSC Task Group 4 undertake the development of a framework that addresses this requirement.

1.0 SCOPE

As stated in Part I, this initiative is predicated entirely by the Inuvialuit Final Agreement. Although it is recognized that there is a host of related and relevant Federal and Territorial legislation, these have generally not been considered.

The present work does address remedial measures after an oil spill incident including:

1)
   - wildlife deterrents
   - wildlife relocation
   - bioremediation

     (for purposes of this task these were included under the umbrella of restoration)

   - restoration options including:
     - wildlife cleaning/treatment
     - restocking wildlife populations
     - habitat enhancement
     - harvest restrictions; and

2) . the practicability, limitations and potential costs involved in applying such techniques in the Beaufort Sea Area.

The present work does not address:

- mitigative measures employed prior to an oil spill incident such as project location, design alternatives, contingency planning or scheduling;

- other remedial measures employed after a spill incident such as well control, marine countermeasures, shoreline protection or shoreline cleanup (these issues were addressed by Task Group #1 - Worst Case Scenario).

- scientific research and monitoring, or compliance monitoring/surveillance (except in so far as some recommendations are made for consideration elsewhere, particularly by Task Group #4 - Research and Science).

2.0 DEFINITIONS

A number of terms are used in the IFA in specific reference to restoration of wildlife and wildlife habitat. These require an acceptable definition so as to understand the scope of the activities described in this report. Some additional definitions of terms used in our analysis are also provided for the sake of clarity. Where necessary some discussion of the underlying rationale for a definition is also provided.

Mitigation - A priori efforts to prevent or lessen potential adverse environmental effects that may occur.

Remediation - A posteriori efforts to correct or compensate for any adverse environmental effects that have occurred, and to prevent, lessen, or compensate for any adverse environmental effects that may occur in the future as a result of the environmental damage.

Thus mitigative measures would include design, location, operational processes, timing and the preparation of contingency plans (including countermeasure plans), whereas remedial measures would include the implementation of contingency plans, restoration of wildlife and wildlife habitat, and compensation (See Figure 1).

Restoration - in the context of this analysis, restoration includes post-spill measures (other than oil containment, recovery and removal) that would enhance recovery of harvested populations to pre-impact levels. These measures include:

- wildlife deterrent activities,
- wildlife relocation activities,
- wildlife cleaning and/or holding,
- restocking wildlife species,
- enhancement of productive capacity of wildlife habitat,
- bioremediation, and
- harvest restrictions

Vulnerability - the probability or potential for contact of the population or its habitat with oil in the environment (after Dickins et al. 1987). There are two aspects to determining the vulnerability of a population to oil exposure: 1) as determined by the habits and habitat of a population, and 2) as determined by the trajectory and fate of oil from an oil spill.

Sensitivity - an indication of the physiological or toxicological effect of oil on an individual (after Dickins et al. 1987).

Population sensitivity, or recovery potential of a regional population - the potential for the population to recover from adverse effects of oil exposure through reproduction or recruitment from outside the regional population (after Dickins et al. 1987).

Risk - the combination of vulnerability, sensitivity and population recovery potential as per Dickins et al. 1987, Table A4).

Practicable - a determination that a treatment or technique is feasible, achieves the intended objectives (in this case harvested population recovery) and is achievable within the logistical constraints of the Beaufort Sea region with known technology.

Effective - in the context of restoration, that there is an acceleration in what would otherwise be a natural rate of population recovery.

Short recovery period - less than one generation of the affected species.

Long recovery period - more than one generation of the affected species.

3.0 HOW CLEAN IS CLEAN?

This discussion is presented here to provide the broader context within which to assess the requirement for clean-up and restoration activities during project planning. Ultimately in the event of a spill, decisions on when and where to clean, and/or undertake restoration activities, would be influenced by the factors briefly examined here.

This report has not attempted to develop these criteria, only to claim an awareness of the factors that should influence the decision making. Factors to be considered for further analysis and perhaps further development of protocols include:

1. Socio-economic importance of the oiled area;
2. Ecological importance of the oiled area and wildlife resources at risk;
3. Predicted persistence of oil, including the nature of the shoreline and wave energy; i.e. potential for natural recovery of habitats;
4. Risk of further ecological damage caused by cleanup efforts, including disposal;
5. Safety of cleanup crew;
6. Allocation of funding for restoration;
7. Public opinion;
8. Criteria used to determine whether the standards developed have been met, e.g., visual assessment or chemical measurements?

To a large extent, the first three factors are treated quantitatively, and factors 4 and 5 are addressed, in the "Environmental Atlas for Beaufort Sea Oil Spill Response" (Dickins et al. 1987). In that document, the environmental sensitivity of each area of the Canadian Beaufort Sea coast is ranked according to human use sensitivity, biological sensitivity, and shore zone oil residence, and those rankings or some equivalent should be used in the development of standards for remediation.

An objective, scientific evaluation of Factor #4, the risk of damage caused by cleanup efforts is critical, especially in view of the opinion of the public (Factor #7), which includes but is not limited to the Inuvialuit. As stated by White and Nichols (1981: 365-366),

"In some situations this latter aspect [pressures exerted by the public, politicians, the media and sectoral interests] will result in a demand for as near total clean-up as is humanly possible, leaving nothing to natural processes. This is not only a labour-intensive operation of diminishing returns, requiring individual rock and stone cleaning in extreme cases, but has to be balanced against the environmental damage it will cause."

Considerable research and monitoring effort has been directed towards natural cleaning processes in recent years, especially following the Exxon Valdez incident, and it is clear that no cleanup is the environmentally sound recourse in some situations (White and Nichols 1981; Baker 1983 and Ganning et al. 1984).

In view of the costs incurred in cleaning oiled birds and otters following the Exxon Valdez spill (e.g., $30,000 for each bird treated and released; see Cross et al. 1991), Factor #6 will require careful consideration. Except in special circumstances, e.g., for endangered species, the amount of money that would be spent on cleaning wildlife might be better spent on other types of restoration (e.g., habitat restoration, restocking of populations) or, as suggested by White and Nichols (1981), used for research, countermeasures, or payment to international environment agencies.

The last factor mentioned above must be considered in view of community acceptance, scientific rigour, and cost-benefit. Among other considerations, the use of rigorous chemical criteria to determine when clean is clean enough would be very costly, not only because of the high cost of hydrocarbon analysis but because a large number of samples would be required. Furthermore, results would not be available in real time, and elaborate chain-of-custody and QC/QA procedures would be required. On the other hand, visual assessment may not be acceptable to scientists or the public.

Ultimately the most important judgements sought as to how clean is clean, should be those of the stakeholders; the coastal residents who rely on the affected resources and those parties who share the liability for compensation for loss of those resources.

In subsequent sections of this report (specifically Section 4.1 and 4.2 which describes the process followed to identify needs for and practicability of restoration action at the population level), the types of criteria that were considered included to some degree all but the last criterion listed.

4.0 METHODS

A workshop procedure for determining the practicability and potential costs of restoration resulting from a "worst-case" scenario was developed. It required that workshop participants:

- determine which wildlife species restoration should be the focus of attention;
- perform assessments of the vulnerability and sensitivity of valued wildlife species to oil from a blowout on the Beaufort Sea;
- evaluate the practicability of restoration options, and;
- estimate the costs of implementing practicable treatments.

These four tasks were performed at a Workshop held in Calgary, Alberta, December 11 and 12, 1990.

4.1 EVALUATING THE NEED FOR RESTORATION OPTIONS

A species-by-species (or species group) approach was used to evaluate needs. The procedure attempted to take into consideration: differences in the value of species to the resource users; differences between species in their vulnerability and sensitivity to oil; differences in response to a proposed restoration technique; and difference in "natural" recovery responses (after Dickins et al. 1987).

4.1.1 Which species to focus on?

The procedure was developed specific to the requirements of the Inuvialuit Final Agreement and was generally limited in its intended application to those harvested species of the Inuvialuit Settlement Region that may be affected by an oil spill in the Beaufort Sea.

4.1.2 Establishing a hierarchy of need: vulnerability and sensitivity

A hierarchy of those wildlife species which may require restoration effort was created. This involved, among other considerations, an assessment of wildlife and wildlife habitat vulnerability and sensitivity (combined, equals risk) to an oil spill (**Figure 2**).

Vulnerability - The vulnerability assessment involved a determination of when the species/species-group would overlap in both space and time with oil from an oil spill incident. There are two components to this:

i) Habitat vulnerability - What is the likelihood that habitat (seasonal or otherwise) of the species would be affected by oil from a spill on the Beaufort Sea? For example a shorebird's nesting habitat may not be vulnerable to oil whereas its feeding habitat may be.

ii) Population vulnerability - Are the species habits (e.g. swimming, consuming carrion) such that it is likely to come in contact with oil?

Sensitivity - This required information concerning the reproductive capability of the species and the opportunity for recovery of the population through emigration from other stocks or populations and the distribution of the population within the region. Two questions concerning species sensitivity to oil were asked and answered (after Dickens et al. 1987):

i) What are the toxicological effects of oil on an individual of the species?, and;

ii) What is the sensitivity at the population level to oil exposure? i.e. Are there attributes of the population that would lead to an expectation of a short recovery period (within one generation) or long recovery period from the effects of an oil spill (e.g. low reproductive capacity)?

4.2 EVALUATING PRACTICABILITY

Evaluations (based on some precedent or experimental evidence where possible) of the effectiveness and feasibility (practicability) of restoration options and their limitations were performed at the Calgary Workshop Dec., 1990. The procedure described in (**Figure 2**) was followed.

4.3 ESTIMATING THE COSTS OF RESTORATION TECHNIQUES

Estimations of the costs associated with deploying equipment and personnel required to implement each restoration technique were made. Input was sought from Calgary Workshop participants and from logistic costs estimates provided by Task Group 1. Where possible some unit of application of the treatment (e.g. cost per hectare of habitat treated or cost per animal treated) was defined. Fixed or base cost assumptions were also identified from a variety of sources.

4.4 PROCEDURE FOR APPLYING RESULTS TO A PROJECT-SPECIFIC OIL SPILL SCENARIO (See Figures 3 & 4)

The "blowout scenario" and fate of oil predictions will normally be specific to each drilling program, and may be expected to be included with a proponent's application. Based upon knowledge of the potential for overlap in space and time of the species population with an oil- contaminated zone (part of an impact assessment), a population and its habitat's vulnerability to a specific oil spill, expressed as a number or a percentage, may be predicted (Figure 3).

The information generated in carrying out tasks described in Sections 4.1 to 4.3, i.e. species' needs for restoration, practicability of restoration techniques and the costs of implementing restoration, can then be applied to a specific oil spill scenario (Figure 4).

5.0 RESULTS

The following sections describe the application of the workshop discussions to the procedures described in Section 4. An example of the application of the procedure to a project-specific worst case oil spill scenario, was not possible however an example of the type of information that would be generated is provided.

5.1 THE NEED FOR RESTORATION: A SPECIES/SPECIES GROUP APPROACH

The list of valued wildlife species was created and subsequently assessments of their vulnerability and sensitivity to oil were examined.

5.1.1 Selected species/species groups

Concern for restoration of wildlife and their habitat was focused on those species that are harvested by the Inuvialuit (Table 1, column 1). The list of "harvested" species was potentially very long (some 50-60 species are routinely recorded in the Inuvialuit Harvest Study Program). Therefore, where appropriate, species were grouped according to their similar habitat requirements, and/or their similar vulnerability and sensitivity to oil, as was done by Dickins et al. (1987) in developing their "Environmental Atlas for Beaufort Sea Oil Spill Response". For example, for assessment purposes a number of species of seabirds were grouped according to their similar likelihood of exposure and/or sensitivity to an oil spill on the Beaufort Sea.

Certain species which are not likely to be harvested, but were nevertheless deemed "important" in an ecological or some other social context were also included in the assessment of the need for restoration. An example of this latter category is the Black Guillemot where it was thought to deserve special protection because of its small numbers in the western Arctic.

5.1.2 Vulnerability and Sensitivity

The assessment of vulnerability and sensitivity to oil, as it applies to wildlife of the Inuvialuit Settlement Region (ISR) was performed using information derived in large part from Dickins et al. (1987), from discussions at the Wildlife Compensation and Wildlife and Wildlife Habitat Restoration Workshop, Calgary, December 11 and 12, 1990 and from Cross et al. (1991). The results are presented in summary form in Table 1, columns 2,3, and 4. (A synopsis of Workshop discussions are contained in Appendix 3.)

5.1.3 Anticipated Natural Recovery Period

The assessment of natural recovery period (Table 1, column 5) was for the most part based on a similar assessment perfomed by Dickens et al. (1987), modified in some cases as a result of discussion at the Calgary Workshop. The recovery period of a population was estimated based on the potential to expose the total population to oil, the size of the population, their reproductive capability and recruitment potential from outside the zone of influence of oil.

For example, the rapid (2 yrs.) recovery of the Kendall Island Snow goose colony after five successive years of no successful production, demonstrates their recovery potential once the source of impacts are removed (T. Barry, pers. com.).

Likewise, Brant, are anticipated to undergo a rapid recovery from even major losses in the ISR because the juveniles (1 and 2 year olds) remain in Alaska, not returning to Canadian Beaufort nesting habitat until their 3rd year. Thus a large portion of the population would always be outside the effects of an oil spill in the Canadian Beaufort Sea.

Thick-billed murres and guillemots, on the other hand, because of there small regional population size and localized nesting habitat would be expected to undergo a slow population recovery.

5.1.4 Potential for Impact on the Human Community

A further assessment of the potential of oil effects on wildlife to impact on the communities was made. This was based on a combination of the vulnerability and sensitivity of a wildlife population along with its importance to the local economy. A population that is highly vulnerable to oil (i.e. has a high probability of contact), is also sensitive to that exposure at both the individual and population level and is prominent in the local economy, was a considered a high priority candidate for some measure of restoration effort (Table 1, column 6).

5.2 EVALUATION OF THE PRACTICABILITY OF RESTORATION OPTIONS

A number of options for restoration of wildlife and their habitat are available and have been used with varying degrees of success in other oil spill circumstances or have been experimentally successful. A review of options for wildlife and wildlife habitat restoration is provided in Cross et al. (1991). Some of these which were given further consideration at the Calgary Workshop are listed below:

- deterrents (chasing animals from an oiled area)
- relocation (removal of animals from an area that is in imminent danger of oiling)
- cleaning/treatment of animals (e.g. polar bears)
- restocking from other populations
- holding (in captivity until risk is reduced)
- enhancement of habitat
- bio-remediation (accelerating biological breakdown)
- captive rearing
- predator control
- harvest restrictions
- others (removal of oiled substrates)

In order to determine whether or not a restoration option was practicable, elements of worst-case oil spill scenarios were generated within which to apply a number of restoration responses. Various attributes of the techniques were explored (see Restoration Workshop Synopsis - Appendix 2) for each species/species group. Conclusions were made as to the practicability and the circumstances under which each restoration technique could be applied. The results are summarized in Table 2. Only those measures which were determined to be practicable are presented there.

5.3 COST ANALYSIS OF PRACTICABLE RESTORATION TECHNIQUES

Determinations of the costs associated with employing each of the practicable habitat restoration techniques were calculated on a unit-of-effort basis; i.e., on a per hectare or per kilometre of beach basis. In some cases the costs of facilities and other infra-structure that may be required in order to implement the restoration technique, were also estimated or assumed. For example, personnel involved in beach restoration activities would require accommodation at a "floatel" facility.

However costs associated with measures employed to deter, hold, clean and relocate animals were found to be more satisfactorily estimated through an examination of what was logistically feasible in a given setting. The constraints imposed by human safety and the regional setting, were more often the factors which determined the appropriate level of effort.

An impact assessment of the "worst case" scenario will provide a semi-quantitative assessment of the likelihood of direct impacts of oil (i.e. oiling or ingestion of oil) on a population of birds or bears etc.). That information is of value in identifying whether there will be a need (based on a predicted percentage of population exposure) to plan for a deterrent, cleaning or holding capability. The consensus among workshop participants was that in most cases, predictions such as numbers of birds oiled, would not drive the restoration effort equation. The prediction of costs of implementing that capability, would be driven by evaluation of the level of effort needed to; a) ensure the recovery of the regional population or b) meet public demands to provide assistance to animals in stress.

Costs associated with providing the capability to implement the various practicable restoration options are shown in Table 3.

As an example, the cost to capture, transport, clean and release birds that were oiled during the EXXON Valdez spill, amounted to $30 000 per bird (Cross et al. 1991). The benefits to the populations of birds that were affected by oil were unlikely to justify the costs. Much of the expenditure was in response to public demands for humanitarian action as opposed to species' population survival. Despite the efforts, there was minimal benefit to the populations of birds that were affected by the spill. The number of birds treated and released represents less than 1% of the birds that were estimated to have been killed by oil (Cross et al. 1991).

5.4 COSTS OF A HYPOTHETICAL WORST CASE SCENARIO

An assessment of the impacts of oil from a worst case oil spill scenario was not performed. The level of effort required to perform such an exercise with sufficient rigour to be meaningful, was not warranted by the benefits of such a "demonstration "exercise.

However annotated example tables which demonstrate the types of information that would be generated from the "restoration" component of such an assessment are provided (Tables 4a and 4b).

It was also concluded that in future, assessments of the need for, and cost of, restoration specific to an oil spill scenario could be integrated into impact assessment procedures (as depicted in Figures 3 and 4).

6.0 ACKNOWLEDGEMENTS

The authors extend many thanks to the Restoration Session Workshop participants who so energetically contributed their time and effort. Thanks also go to the Task Group 2 members for their many useful suggestions and review comments.

7.0 REFERENCES

Baker, J.M. 1983. Impact of oil pollution on living resources. The Environmentalist, Vol. 3. Supplement No. 4. ISSN 0251.1088

Cross, W.E., T.L. Hillis and R.A. Davis. 1991. Wildlife and wildlife habitat restoration in the event of an oil spill in the Beaufort Sea. A discussion paper. Unpub. Report for Beaufort Sea Steering Committee Task Group 2. 32 p.

Dickens, D.L., L. Martin, I. Bjerkelund, S. Potter, D. Erickson, J. Harper, P. Norton, S. Johnson and P. Vonk. 1987. Environmental atlas for Beaufort Sea oil spill response. Environment Canada, Environmental Protection Service. ISBN 0-921623-03-8.

ESSO Resources Canada. 1990. Polar bear protection plan for Isserk I-15.

Ganning, B., D.J. Reish and D.S. Straughan. 1984. Recovery and restoration of rocky shores, sandy beaches, tidal flats and subtidal bottoms impacted by oil spills. In: Restoration of habitats impacted by oil spills. ed. by J. Cairns Jr. and A.L. Buikema Jr. An Ann Arbor Science Book.

Shweinsburg, R.E.,, I. Stirling, M. Shoesmith, F. Juck and R. Englehardt. 1986. Action plan for protection of polar bears in the event of a major oil spill. Unpub. report to Federal/Provincial Polar Bear Administrative Committee.

White, I.C. and J.A. Nichols.1981. The cost of oil spills. Marine Pollution Bulletin 12: 363 - 367.

Figure 1: A flowchart of the steps involved in evaluating the need for restoration measures: a species/species group approach.

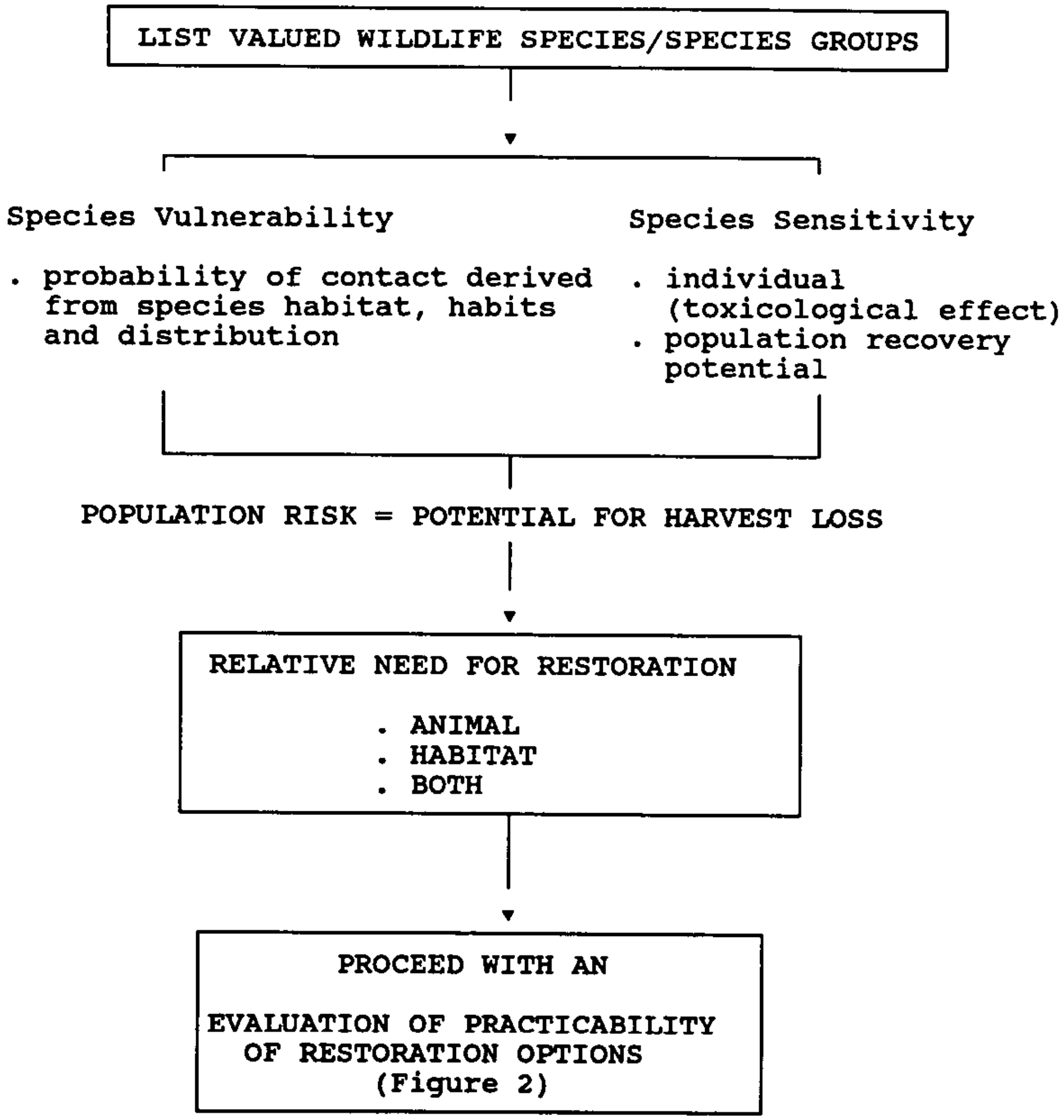


Figure 2. A flowchart of the steps involved in evaluating the practicability of a restoration option.

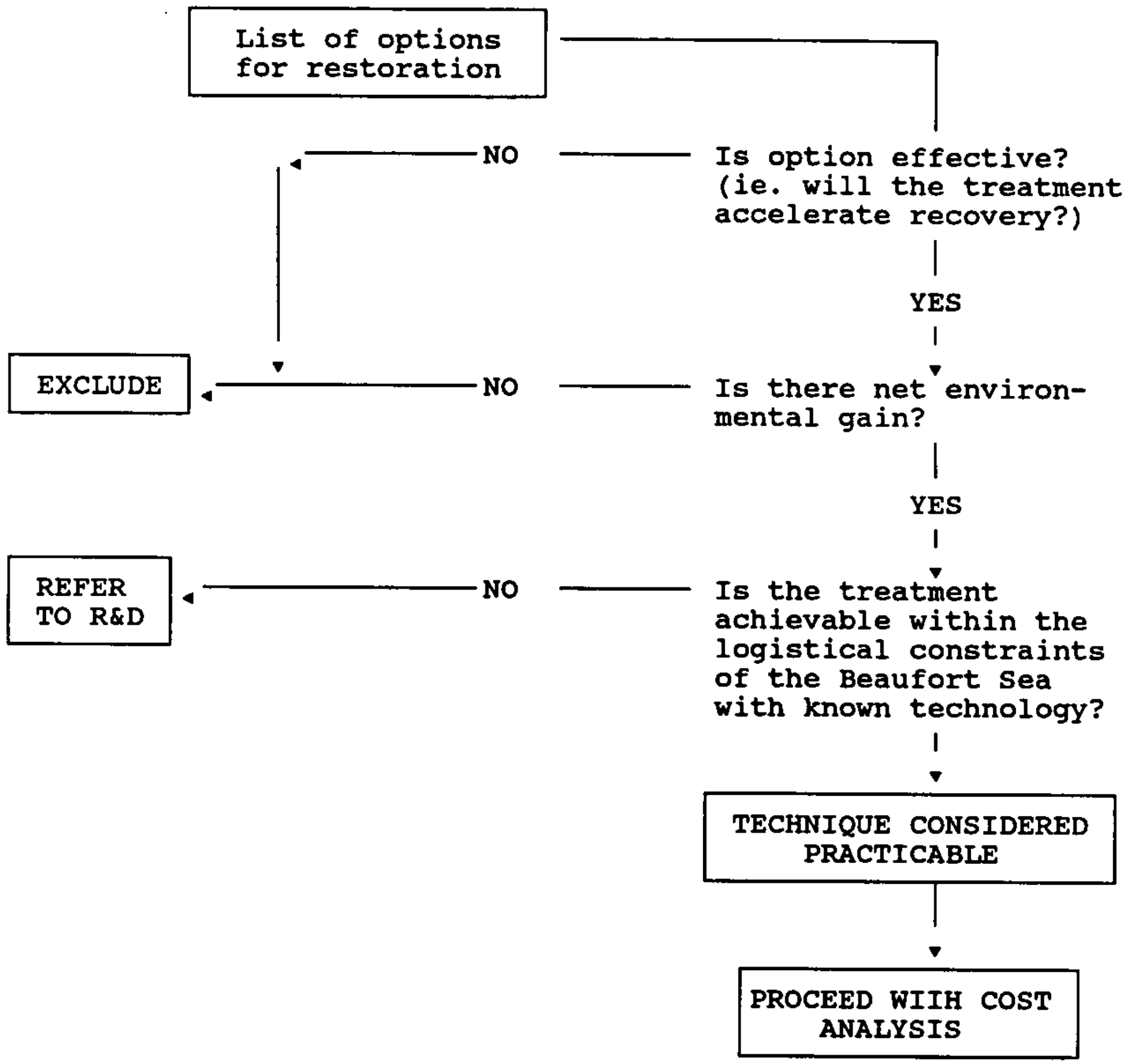
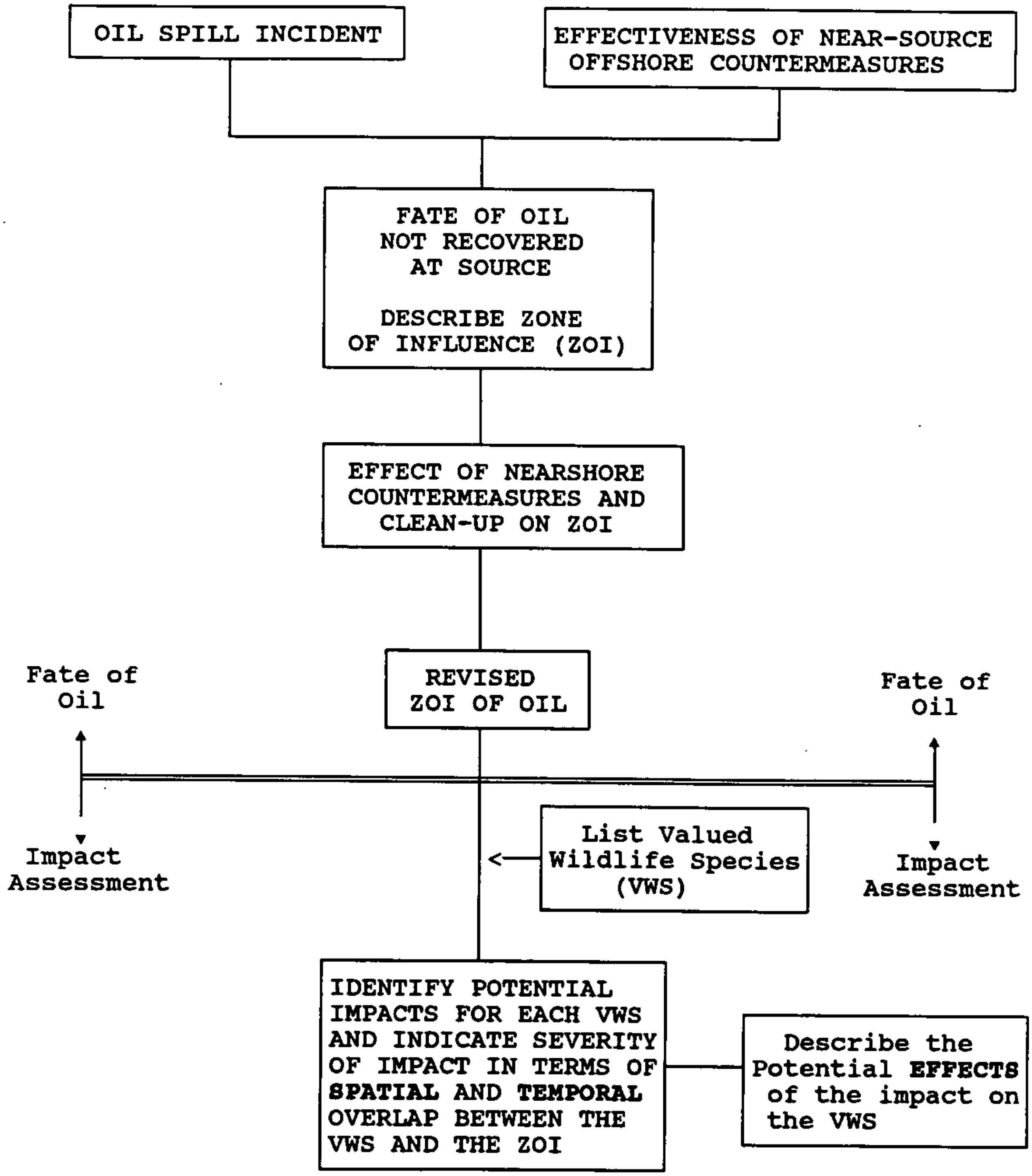


Figure 3. A flowchart of the steps involved in predicting the requirement for restoration measures in the event of an oil spill, based upon an assessment of impacts on populations and their habitat.



continued...

Figure 3 (cont'd.)

Following the evaluation of effects on each VWS of an oil spill impact:

ASSESS THE SIGNIFICANCE OF THE CUMULATIVE EFFECTS OF ALL OF THE OIL RELATED DISTURBANCES TO THE VWS POPULATION AND ITS HABITAT AND DEFINE THE PREDICTED TIME FOR POPULATION RECOVER

Impact Assessment

Impact Assessment

Restoration Needs Assessment

Restoration Needs Assessment

Based upon this determination of potential significance of an oil spill scenario to VWS populations

Evaluate the need for immediate response measures to reduce the exposure of the VWS to oil
e.g.-Deterrents
-Relocation
-Holding
-Cleaning

Evaluate the need for subsequent measures to enhance the recovery of VWS populations to sustain appropriate harvest levels
-captive rearing
-restocking
-predator control
-harvest management
-habitat-bioremediation
-enhancement

Figure 4. Flowchart of steps involved in predicting the restoration costs associated with a project-specific oil spill scenario.

PROJECT-SPECIFIC RISK ASSESSMENT (from Figure 4)

PRACTICABLE RESTORATION OPTION(S) (from Table 3)

- Identification of requirements for population (as opposed to habitat) restoration treatment

X

- cost of acquiring the capability to provide the restoration/ treatment
- incremental costs of implementing the restoration/treatment

and

and

- Potential area of habitat requiring restoration

X

- cost/area of habitat

COST ESTIMATE FOR RESTORATION OPTIONS (Enter into Table 4a & 4b)

Estimate of <u>TOTAL COST</u> of Restoration per Species/Species Group

Repeat for each species/species group

Table 1. Summary of the potential for oiling and for recovery of harvested species in the event of an oil spill on the Beaufort Sea.

Species or Species Group	Oil Effects	Vulnerability[1]	Sensitivity[2]	Anticipated Natural Recovery Period[3]	Potential for Human Community Impact[4]
Alcids - Thick-billed Murres - Black Guillemots	Lethal	High - spring and fall	High - individual High - population	Long	+
Brant	Lethal	High - during fall migration (Nesting habitat is vulnerable to storm surges)	High - individual High - population	Moderate to Short (3 yr.)	++
Loons	Lethal	High	High - individual Population sensitivity may be moderated by wide regional distribution	Long to Moderate (3 yr.) (depending on species)	+
Elders and Oldsquaw	Lethal	High - large numbers of birds in concentrated leads in sea ice	High - individual High to Moderate - population	Long - Short (2 yr.)[5]	++
Shorebirds	Lethal	Moderate	moderate - individual moderate - population	Moderate - Short	+
Diving Ducks	Lethal	Moderate to High	High - individual High - population	Moderate (2 yr.)	+

1. As determined through Steps 1 & 2 (Vulnerability) Section 5.1.1
2. As determined through Steps 1 & 2 (Sensitivity) Section 5.1.1
3. As determined through Dickens et al. (1987) and modified (in some cases) by Workshop participants. Short = <1 generation Long = >1 generation
4. Potential for human community impact = importance (value) of harvest to community x potential for impact
   + = Lowest potential for affecting community interest
   ++++ = Highest potential for affecting community interest
5. The North Pacific drift net fishery is believed to be having considerable negative effect on the Western Arctic populations of Common and King eiders. High losses to the drift nets, coinciding with high oil spill related mortality, would slow down population recovery considerably (T. Barry pers. comm.)

Table I: continued

Species or Species Group	Oil Effects	Vulnerability[1]	Sensitivity[2]	Anticipated Natural Recovery Period[3]	Potential for Human Community Impact[4]
Polar Bears	Lethal - sublethal	High - in presence of leads and fall-winter period Low - in summer open water	High - individual Moderate - population	Moderate - Long	++++
Geese and Swans	Lethal - sublethal	Moderate to Low - colonies not in tidal flats but individuals could be during brood rearing, fall staging (storm surge)	High - individual (less so than other bird species) Moderate - population	Moderate (3 yr.)	++
Coastal Marine Fish - Larvae and Juveniles	Lethal - sublethal	Low to Moderate	High - individuals Low - population	Short	+
Coastal Marine Fish - Adult	Sublethal - lethal	Low to Moderate	Moderate - individuals Low - population	Short	+
Coastal Anadromous Fish - Juveniles	Lethal - sublethal	Moderate - High	Moderate to High - individuals Low to Moderate - population	Short	+
Coastal Anadromous Fish - Adults	Sublethal-lethal	Moderate-High	Moderate - individuals Low - population	Short	+++
Beluga Whales	Sublethal	High - when concentrated in leads Moderate - summer open water	Low - individuals Low - population	Moderate - Short	++++
Bowhead Whales	Sublethal	Moderate	Low - individual Moderate - population	Long - Short	+
Bearded Seals	Sublethal - lethal	Moderate	Low - individual Moderate - population	Moderate - Short	+

Table 1: continued

Species or Species Group	Oil Effects	Vulnerability[1]	Sensitivity[2]	Anticipated Natural Recovery Period[3]	Potential for Human Community Impact[4]
Ringed Seals	Sublethal - lethal	Moderate to high (dependent on concentration areas)	Low to Moderate - individual Low - population	Short	+
Dabbling Ducks	Lethal	Low - nil	High - individual Moderate - population	Short (1 yr.)	+
Arctic Fox	Sublethal - lethal	Moderate	Moderate - individual Moderate to low - population	Short	+
Grizzly Bears	Sublethal - lethal	Low - contact through oiled carrion	High to moderate - individual High - population	Moderate to long	+++
Caribou	Sublethal	Low to Moderate (in bug season)	Low to unknown - individual Low - population	Short	+
Wolves	Sublethal	Low (through caribou)	Unknown	Short	+

1. As determined through Steps 1 & 2 (Vulnerability) Section 5.1.1
2. As determined through Steps 1 & 2 (Sensitivity) Section 5.1.1
3. As determined through Dickens et al. (1987) and modified (in some cases) by Workshop participants. Short = <1 generation Long = >1 generation
4. Potential for human community impact = importance (value) of harvest to community x potential for impact
   + = Lowest potential for affecting community interest
   ++++ = Highest potential for affecting community interest
5. The North Pacific drift net fishery is believed to be having considerable negative effect on the Western Arctic populations of Common and King eiders. High losses to the drift nets, coinciding with high oil spill related mortality, would slow down population recovery considerably (T. Barry pers. comm.)

Table 2. Summary of the potentially successfulrestoration opportunities for Beaufort Sea area species that may be affected by an oil spill.

Species(groups)	Restoration Measure	Recommended Application[1]	Anticipated Success[2]
Polar bear	Deterrents - crackers - noise makers - rubber bullets - snow machines - helicopter	- very localized-depends on adequate light & ice conditions - up to 10-20 km displacement of bears - first course of action to deter approaching bears from spill site	- has proven effective in certain close range situations - depends on previous exposure of bears to noise makers, humans - Churchill experience has demonstrated effectiveness in limited application
	Relocation	- when required to move bears large distances from spill site	- successwill depend upon attractiveness of relocation site to bear, distance of removal, presence/absence of attractantsat spill site
	Holding	- useful when waiting for ice to recede - target on bears "valuable" to population survival - if more than a few bears for more than a few days, then a temporary facility will be required	- high rate of successis anticipated - based on Churchill experience
	Cleaning	- when oiled bears are encountered that are determined to be sufficiently healthy to recover from stress of immobilization, transportand respond to treatment	- successdepends on degree of oiling, immediacy of response, age and condition of bear - cleaning is a viable option and has been performed successfully(Hurst 1982)
	Harvest management	- applicable to all scenarios where bears have been, killed, stressedor relocated as a result of an oil spill	- in conjunction with other active responseswill enhance population recovery
	Habitat restoration - oiled carrion removal - food supplement	- oiled carrion is part of clean-up response - food could be supplemented in cases where seal numbers are locally depleted or habitat to which polar bears have been relocated is not prime seal habitat - food supplement (reindeer)	- effective countermeasure - effectiveness unknown -depends on availability of alternate seal sources and hunters to obtain them - unproven, unknown potential for success

1. Based on Workshop discussionsand Crosset al. (1991)
2. Based on Workshop discussionsand Crosset al. (1991)

Table 2: continued

Species(groups)	Restoration Measure	Recommended Application[1]	Anticipated Success[2]
Beluga whales	Deterrents	- outboard motor driven boats combined with seal bombs, rifles etc. are recommended to deter beluga from entering specific, localized areas - Orca sounds transmitted under water to prevent whales from entering localized oiled areas	- Effective - beluga response to this noise source is well documented - Effective - response to Orca sounds is well documented
	Harvest management	- monitoring and assessment of population status will be required to determine effectiveness. As with polar bears, harvest restrictions would/could be invoked to remove one source of population pressure	- in conjunction with other restoration and countermeasures will enhance population recovery
Bowhead whales	Deterrents	- motorboats used in localized areas - noise and disturbance associated with clean-up activities may be an effective deterrent	- effectiveness questionable, especially if whales are actively feeding - limited displacement is anticipated
Ringed seals	Deterrents - seal bombs, etc.	- localized use around a spill site	- questionable effectiveness due to tendency of seals to converge on areas of human activity
Bearded seals	Deterrents - seal bombs, etc.	- not recommended except on opportunistic basis around a spill site where clean-up activities are being engaged	- may be locally effective
Loons	Deterrents - propane cannons	- site specific, small areas such as oil leads in spring - not recommended in large open-water spill areas - most effective when oil is restricted to confined areas	- technique has proven effective for crop protection, and deterring birds from airport facilities
	- helicopters	- ample lead time will be available for spring deployment - nest and rear young in freshwater - adults do no molt in the Arctic - may be effective in offshore leads in spring	- ineffective because of loon's tendency to dive and to stay separate

Table 2: continued

Species(groups)	Restoration Measure	Recommended Application[1]	Anticipated Success[2]
	Cleaning	- focus on recently oiled birds that show potential for recovery - public relations - clean loons on an opportunistic basis in conjunction with efforts directed at other species	- successful on individual basis - may have some positive effect on population
Loons (cont'd.)	Holding	- not recommended except as opportunity to hold flightless birds avails itself	- effect would be minimal on population survival
	Habitat restoration	- in specific instances where known nesting areas have been oiled or badly disturbed by clean-up activity	- unknown
	Captive rearing	- only if population survival in question - its never been done on any scale	- unknown
Brant	Deterrents	- personnel with shell crackers to deter brant from landing on oil covered water - apply to small areas only	- effective at specific sites where personnel have been strategically located - success depends on availability of suitable alternative habitat
	Cleaning	- public relations - not practical except if there is a danger of losing a large proportion of a breeding colony	- see loon cleaning
	Herding and holding	- a practical means of preventing oil contamination - applies only to flightless brant	- effective means of preventing oiling of some brant
	Habitat restoration	- an important strategy to employ with brant as they are very dependant on specific nesting areas and the attributes they possess	- probably effective but will require specialized expertise
	Predator control e.g.: fox, gulls, jaegers, grizzly bear	- undertake in extreme situations where a major portion of a colony has been affected	- will enhance natural recovery of population
	Harvest management	- if specific colonies are known to have been affected then harvest management should be implemented	- difficult to direct effort at specific colonies

Table 2: continued

Species(groups)	Restoration Measure	Recommended Application[1]	Anticipated Success[2]
Eiders and Oldsquaw	Deterrents	- deploy deterrent devices to prevent migrating eiders from landing in oiled-leads - use deterrent techniques to prevent moulting oldsquaw from entering oiled open-water areas	- unknown
	Cleaning	- not expected to have positive impact on population recovery - public relations - not a species group to focus effort on	- effective on individual basis - will have no positive effect on population
Eiders and Oldsquaw (cont'd.)	Habitat restoration	- no specific habitat restoration beyond clean-up of oil	
	Harvest management	- recommended if loss of large numbers are evident - would require international co-operation as these birds are a shared resource	- will have limited effect because few eiders and oldsquaw are harvested relative to population numbers
Alcids (Thick-billed Murre and Black Guillemots)	Deterrents	- not practical (too few birds), however clean-up activity will have some deterrent effect	
	Cleaning	- higher priority than other species because of relative effect on population survival - highest chance of success if effort is concentrated near colonies	- has potential for significant positive effect on population survival
	Habitat enhancement	- black guillemot nesting areas could be improved by supplying beach debris (driftwood, etc.) to serve as nesting sites and nest boxes (shelving)	- potentially effective
	Habitat restoration	- see above for black guillemots - thick-billed murre nesting habitat is not vulnerable to oiling - not applicable	
	Restocking	- only applicable if both Alaskan and Canadian Western arctic populations survival was in jeopardy	- unknown (very difficult)

Table 2: continued

Species (groups)	Restoration Measure	Recommended Application[1]	Anticipated Success[2]
Geese and Swans	Deterrents	- as per brant	- probably more effective than with brant
	Herding	- flightless geese may be successfully herded into areas where there is sufficient grazing habitat - fencing may be employed to prevent geese from re-entering oiled areas	- effective, especially grazing habitat will not be as limiting as would brant feeding habitat
	Habitat restoration	- applies only to circumstances where oil could be carried into grazing and nesting areas - bioremediation and transplantings should enhance recovery of oiled areas	- effective but will require treatment over several years
Geese and Swans (cont'd.)	Harvest management	- initiate restrictive harvest management in co-operation with other harvest management jurisdictions only if population reduction were evident	- would not be practical unless local restrictions were accompanied by harvest reductions in other areas that harvest the same population e.g. N.Carolina for W. Arctic swans
Dabbling Ducks	None required	- vulnerability to exposure from an offshore oil spill is extremely low	
Diving Ducks	Deterrents	- as per eiders and oldsquaws - apply only on a local scale to keep from imminent danger	- less effective than for eiders; oldsquaws because when diving ducks are in coastal waters they are flightless and hence limited in their capacity to move any distance
	Habitat restoration	- none recommended beyond shoreline clean-up to reduce amount of oil that may re-enter water	- effectiveness depends on shoreline type, state of oil etc.
	Cleaning	- public relations - as per eiders and oldsquaws	
Shoreline birds	Deterrents	- deterrent activities associated with other species may benefit shorebirds (including phalaropes) - no effort should be focused on shorebirds per se	- effective on opportunistic basis

Table 2: continued

Species (groups)	Restoration Measure	Recommended Application[1]	Anticipated Success[2]
	Others	- none recommended beyond clean-up of oil	
Arctic Fox	Habitat restoration	- remove oiled carrion	- effective
Grizzly bears	Deterrent - helicopters - bear monitors	- chase bears away from local spill sites where oiled carrion may be present - required in open-water season immediately following spill	- effective - modest requirement for deterring bears due to relatively low incidence of exposure
	Relocation	- when deterrent activities don't appear effective, immobilize and transport bears away from area	- effective, especially given low incidence of requirement for relocation
	Cleaning	- clean oiled bears - may be required in first year immediately following spill	- effectiveness will depend on immediate availability of a temporary cleaning and holding facility
	Harvest management	- may be applicable if even a few bears are destroyed or relocated	- effective in conjunction with other practices
Caribou	Deterrents	- employ persons to chase herds away from potential contact with free oil in shoreline areas	- effective in localized areas
	Habitat vegetation enhancement	- application of fertilizers and plantings in storm-surge fringe to accelerate growth of vegetation	- effect would be of limited consequence to caribou as the area impacted would be small relative to the range available
Wolves	None		- wolves will receive indirect benefits of efforts directed at caribou
Coastal marine fish	Littoral zone bioremediation	- apply treatment to hasten reduction of intertidal oil concentrations with consequential reductions in sub-tidal concentrations - apply at sites where rapid introduction of carbon sources and nutrients would not result in eutrophication - not recommended for embayments smaller than 1 ha	- effectiveness is uncertain - no benefit in first year of spill, possibly in subsequent years - requires research effort to evaluate effectiveness

Table 2: continued

Species (groups)	Restoration Measure	Recommended Application[1]	Anticipated Success[2]
	Habitat enhancement	- possible on a site-by-site basis to enhance coastal spawning habitat, but not recommended without further data on existing spawning habitat - requires research effort	
Anadromous fish	Bioremediation	- as discussed under coastal marine fish	- as discussed under coastal marine fish
	Beach material removal and disposal	- consider this technique at stream mouths where oil in intertidal beach material may affect movement and survival of migrating fish	- effectiveness of reducing oil contact with fish is good and associated negative impacts will be small if applied carefully to localized critical areas

Table 3: Estimate of costs of implementing restoration measures

Species or Species Group(s)	Restoration Measure	Cost Analysis/Assumptions	Fixed Costs	Incremental Costs
Polar Bears	Deterrent Activities	The most significant costs of bear deterrent activities are associated with the cost of operating twin engine helicopters. Costs of equipment are minimal but may include cost of two or more snow machines. Personnel dedicated to a bear deterrent program would be housed at a shorebase facility, costs of which are not shown here but would be marginally incremental to a clean-up operation.	Equipment and supplies for 2-2 person teams $20,000.	2 helicopters @ $4,000/hr for 1 month (10 hrs/day) = $2,400,000./mo.
	Relocation	The same team that performs deterrent activities would carry out this function. Additional costs are associated with drugs and other specialized equipment for demobilization of bears.	Dartgun, drugs, etc. $2,000.	No additional costs beyond those shown above.
	Holding and Cleaning	Portable (culvert type) facility for holding bears plus equipping de-oiling station. Larger temporary facility located at Tuk. Costs include all laboratory/surgical equipment.	$30,000-50,000. $1,500,000.	Transporting bears @ $4,000/bear - Personnel @ $2,000/bear. Same as above.
	Harvest Restrictions	Cost of compensation for lost harvest		$25,000/bear/year
	Habitat Restoration - Removal of oiled carrion - Polar bear food supplement	Costs of oiled carrion removal are included in clean-up cost analysis Meat for polar bears would either be hunted and/or purchased and transported to the bear site		No incremental cost (included in shoreline clean-up) $200/bear/day
Beluga Whales	Deterrents	Costs are associated with boats, motors and personnel to scare belugas out of a localized area. This activity would persist for up to two months Underwater transmission of Orca sounds	Boat and motor @ $10,000 x 2 = $20,000. for each location Playback equipment @ $20,000/unit	Fuel, wages, noise makers, camp supplies @ $1,000/ day/team Costs of maintaining playback equipment, locating and re-locating would be included in above costs.
	Harvest Restrictions	Cost of compensation for lost harvest		$3,840./whale/year
Bowhead Whales	Deterrents	Costs would be absorbed by countermeasures team. Additional effort would be similar in cost to belugas		$1,000/day/team
Ringed Seals and Bearded Seals	Deterrents	Costs would be minor; associated with cost of cracker shells, shotguns etc. Personnel involved in deterrent activities would be a part of any countermeasures/cleanup team	Shotguns - $2,000.	Personnel - $200/day

Table 3: continued

Species or Species Group(s)	Restoration Measure	Cost Analysis/Assumptions	Fixed Costs	Incremental Costs
Birds	Deterrents Cleaning Herding Holding Predator Control	Costs are highly dependent on season and success of offshore oil spill countermeasures. This cost analysis is independent of any particular scenario, but describes the costs associated with an optimal level of effort in responding to a worst-case scenario. Aircraft - 3 months x 2 medium size helicopters @ $2,000./hr for 10 hrs/day Personnel- 3 months x 50 persons	Bird Treatment Facility - several millions	Helicopters @ $1,200,000/month Personnel (50)/month - $1,000,000. Additional supplies for 1 month - $200,000.
	Captive Rearing and Restocking	The costs of these measures were not specifically assessed, however, costs of handling rearing and transporting birds are assumed to be in the hundreds of '000's range to implement an adequate program	One to several hundred thousand dollars	Included in deterrent, cleaning, etc. program.
	Harvest Restrictions (Brant,Eiders & Oldsquaw, Geese & Swans)	Cost of compensation		$4.50/kg/year
Coastal Fish	Littoral Zone Bioremediation	Based on a crew of 3 people covering 5 km/day - estimate about $1,000 to $10,000 per day. The treatment would be repeated each year for 3 years. Includes accommodation costs of floatel	Sprayers, small equipment - $2,000.	$200-$2,000/km of shoreline each year for three years
	Beach Material - Removal & Disposal	Order of magnitude costs of cleanup were estimated @ $10,000/stream mouth that was oiled. Costs are associated with rental of equipment and personnel wages.	None	$10,000/stream mouth
	Harvest Restrictions	Cost of compensation		$4.00/kg/year
Coastal Beach and Backshore Habitat (Bird nesting, brood rearing, etc.)	Habitat Enhancement	Based on a crew of 3 people covering 5 km/day - estimate about $1,000-$10,000 per day. Three years treatment required.	Sprayers, small equipment	$200-$2,000/km of shore zone each year for three years
Grizzly Bears	Deterrent Activities	A modest effort would be required, i.e. no dedicated helicopter support. Personnel would be accommodated with clean-up crew.		Bear monitors @ $700./day (includes food and accommodation)
	Relocation	Medium size helicopter @ $2,000./hr	Dartgun, drugs, etc. @ $2,000.	$2,000-4,000/bear

Table 3: continued

Species or Species Group(s)	Restoration Measure	Cost Analysis/Assumptions	Fixed Costs	Incremental Costs
	Cleaning	The number of bears expected to require treatment would be small. This, combined with the milder temperatures during summer/fall period suggest that a portable, culvert facility would suffice. If a polar bear cleansing facility is available - then it would be used for cleaning oiled grizzles.	$30,000-50,000. (as per polar bears See Polar bears	$2,000-4,000/bear (transportation) plus personnel @ $2,000/bear Same as above
	Harvest Restrictions	Cost of compensation		$15,000/bear/year
Caribou	Deterrents	Costs were calculated based on having a deterrent team of 2 persons for each 10 km of coastline area where caribou might require protection. Six weeks of activity were assumed to be required	Camp equipment $8,000/camp	$6,000/team/week $5,000/team/week helicopter support $1,000/team additional

Table 4a. Predictions of wildlife population restoration costs associated with a project-specific, oil spill scenario.

Species/Species Group (example)	Population[1] Overlap with Oil	Anticipated[2] Restoration Measure	Magnitude of[3] Effort (#'s, time)	Period of[4] Implementation	Fixed Costs[5] Assumptions	Unit Costs[6] (/animal, /time)	Total Costs[7]
Brant							
Eider							
Oldsquaw							
Grizzly Bear							
Arctic Fox							
Beluga Whale							
Bowhead Whale							
Ringed Seal							
Pacific Herring							
Arctic Cod							

Notes:
1. Derived from the assessment of impacts of the oil spill scenario
2. As per Table 2.
3. Derived from the assessment of impacts of the oil spill scenario and as deemed necessary to ensure population recovery (plus other factors e.g. logistic constraints, safety, "public" concern).
4. When would the measure need to be implemented to be effective?
5. As per Table 3.
6. As per Table 3.
7. Equals: fixed costs + incremental treatment costs (from Table 3).

Table 4b. Predictions of wildlife habitat restoration costs associated with a project-specific, oil spill scenario.

Species/Species Group (example)	Habitat Spatial[1] Overlap with Oil	Anticipated[2] Restoration Measure	Magnitude of[3] Effort (ha, km)	Period of[4] Implementation	Fixed Costs[5] Assumptions	Unit Costs[6] (/ha, /km)	Total Costs per Year[7] (x No. of yrs.)
Brant							
Eider							
Beluga Whale							
Ringed Seal							
Broad Whitefish							
Arctic Cisco							
Pacific Herring							
Arctic Cod							

Notes:
1. Derived from the assessment of impacts of the oil spill scenario.
2. As per Table 2.
3. Derived from the assessment of impacts of the oil spill scenario.
4. When would the measure be implemented and for how long?
5. As per Table 3.
6. As per Table 3.
7. Equals: Fixes Costs + (magnitude of Effort (ha, km) x Unit Costs)

APPENDIX 1

RESTORATION WORKSHOP PARTICIPANTS

W. Duval, Vancouver (Rapporteur)

L. Harwood, Inuvik

J. Hines, Yellowknife

S. Edwards, Ottawa

M. Lawrence, Winnipeg

C. McAllister, Nanaimo

B. Alexander, Calgary

L. Mychasiw, Whitehorse

R. Davis, King City

N. Snow, Inuvik

D. Wright, Ottawa (Facilitator)

R. Hurst, Ottawa

J. Harper, Sidney

A. Desrochers, Edmonton

J. Ward, Calgary

APPENDIX 2. RESTORATION WORKSHOP SYNOPSIS (OPTIONS ANALYSIS)

SPECIES/SPECIES GROUP: Polar Bears

IMPACT SCENARIO EVALUATED: LATE OPEN WATER, HEAVY ICE YEAR

Under this scenario, oil would be trapped under ice and encapsulated in both old ice and newly forming first year ice. The trajectory of the ice will largely determine the fate of the oil. In this case the potential for polar bears coming into contact with oil is very low until the following spring when the oil would melt out of the ice, appearing on the surface of floes and on in leads.

VULNERABILITY: HIGH in late fall and spring; LOW during open water period.

SENSITIVITY: HIGH (individual); MODERATE (population)

Sub-adults may be more susceptible to effects of exposure to oil because of limited fat and the implications of oiled fur and thermo-regulation. The survival of the population would be more sensitive to the effects of oil on adult females.

RESTORATION OPTIONS: DETERRENTS, RELOCATION, HOLDING, CLEANING, HARVEST MANAGEMENT, IMPORT BEARS, HABITAT RESTORATION, HABITAT ENHANCEMENT and HUMANE KILLING

RESTORATION EFFECTIVENESS

DETERRENTS: The success of this measure will depend on successful monitoring over the winter of the location of the oil-in-ice. Because oil in leads is the greatest concern, there would be minimal risk to polar bears until the May period. All deterrent activities will require good visibility, either for flying or travelling over the ice on snow machines. Travel on or over the ice during the spring period is potentially hazardous, so human safety will factor heavily into the success of deterrent activities, which include: use of cracker shells, riot guns, rubber bullets, snow machines and helicopters.

To effectively deter bears from the zone of oiled ice, dedicated helicopters and crews would be required.A considerable amount of helicopter time will be required to locate bears. This as significant cost implications, as fuel will have to be cached at appropriate locations to permit helicopters to work effectively. Bears may be chased out of an oil-contaminated area, however there exists a real danger of chasing a bear into oiled open water. Also it should not be attempted to chase bears more than a few tens (or less) of kilometres. Generally deterrent activities should be restricted to preventing bears from coming into a localized area, not as a means of relocating them to a "safe" area.

RELOCATION: Relocating bears could be tried when hazing or other localized deterrent actions are not adequately minimizing the risk to bears. Relocation efforts will require trained personnel properly equipped, supported by a helicopter with slings. Bears could effectively be moved 100's of kms out of the oiled area.

HOLDING BEARS: Bears could be held while waiting for the ice to recede and would most appropriately be focused on animals of greatest importance to the population (adult females).A temporary facility would be required in which to house and feed the bears while in captivity. The facility could be constructed after a spill event (several months lead time would be available) and could be located in Tuk or could be helicopter transportable. The holding facility would also be used to hold bears that have required cleaning.

CLEANING: First priority for cleaning should be attached to females, especially adult females. Priority should also be given to recently oiled bears as their chance of survival is greatest. However bears would not be selectively cleaned until such time as the size of the facility dictates that preferential treatment should be given to females. The extent of oiling and location of oil on the body are factors in determining the requirement for cleaning. Oil left on a bear's hide will cause hair loss or it may be ingested by the bear. Shaving is an alternate to cleaning if the oiled area is not too large.

The facility required to clean and treat bears could be built over the winter period prior to spring melt. The size of facility required would have to be determined on a case-by-case basis and will largely determine the cost. Constructing a permanent facility is not a reasonable approach.

HARVEST MANAGEMENT: The harvest of bears could be selectively focused towards bears that were oiled or had the greatest potential for being oiled. This did not appear to be too attractive an option given public perception problems and the limited value that may be attached to an oiled bear or "oiled bear hunt".

If evidence shows that an oil spill has resulted in a loss of bears then harvest restrictions would most likely be imposed until such time as the population recovered and could sustain previous hunting pressure. The resulting loss of harvest opportunity would need to be compensated for. Reduction of hunting quotas is not viewed in this context as a substitute for restoration but as an essential measure to assure recovery.

IMPORTING BEARS: This was determined to be an unacceptable measure given the absence of a surplus of bears in any other populations. Only in the most extreme (bizarre) circumstance that the Western Arctic population were wiped out would importing bears from other populations be considered.

HABITAT RESTORATION: Clean-up crews would effectively aid in restoration of habitat by timely removal of any oiled carrion. This would be undertaken on an opportunistic basis as opposed to a specific "carcass collection program".

HABITAT ENHANCEMENT: Food supplements may be necessary to make up for loss of natural food, either as a result of relocation to a less than optimal habitat, or as a result of seal mortality due to oiling. Potential food sources include hunter killed seals or provision of terrestrial mammal carcasses.

HUMANE KILLING: Bears which have been determined by an on-site biologist to have been too severely oiled and stressed to survive treatment, should be humanely killed. The oiled carcass would be properly disposed of.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS, RELOCATION, HOLDING, CLEANING, HARVEST RESTRICTIONS and HABITAT RESTORATION.

Deterrent activities are seen as the first and potentially most effective means of assuring population recovery from the effects of an oil spill. Cleaning is a recommended strategy if deterrent and relocation activities are not entirely successful. The population benefits will for the most part be as a result of cleaning efforts that are directed at adult females.

INFRASTRUCTURE REQUIREMENTS: MAJOR

Infrastructure requirements to meet restoration objectives with respect to polar bears are generally modest except to meet needs for cleaning and holding, in which case they are major.

DETERRENTS: No dedicated prior infrastructure is required. Shorebased and offshore camp and refueling facilities can be coordinated with the clean-up and countermeasures teams. Two medium sized helicopters are the major equipment requirement.

RELOCATION: As per deterrents.

CLEANING and HOLDING: A facility of some size may be required in which to house and clean bears. Depending on the season and expected oil trajectory it may be possible to use portable facilities. The larger temporary facility was estimated to cost $1.26M in $1986 (Action Plan for the Protection of Polar Bears). This would accommodate 30-40 bears. The portable units may cost in the tens of thousands to provide.

HARVEST RESTRICTIONS: No infrastructure requirements.

HABITAT RESTORATION: No infrastructure requirements.

COSTS:

DETERRENTS: Two dedicated twin engine helicopters at a cost of $4000/hr will be required. It was assumed that the helicopters would be available to fly 10 hrs/day. If the threat existed for three months, then helicopter cost would be approximately $7,200,00.

CLEANING AND HOLDING: The cost of a 30-40 bear facility = $1.26M (1986). Additional costs of transporting and treating bears were not calculated, but could be estimated based on the costs of providing the necessary helicopter support.

HARVEST RESTRICTIONS: The cost of harvest restrictions would be determined by the dollar valuation of each bear lost from the harvest.

SPECIES/SPECIES GROUP: Grizzly Bear

IMPACT SCENARIO EVALUATED: OPEN-WATER SEASON

This is the season when grizzlies are along the coast and have the greatest potential to come into contact with the oil.

VULNERABILITY: LOW

The grizzly bear could come into contact by (a) ingestion from eating oiled carcasses, (b) ingestion from grazing in oiled tundra (storm-surge areas) and (c) direct contact with oil either in the water or on the intertidal zone. Although the worst-case scenario produces a significant overlap between oil-impacted coastline and grizzly summer range, only a small part of the bears are located along the coast. In that they are primarily considered a terrestrial mammal, their potential for contact is low.

SENSITIVITY: MODERATE TO HIGH

The sensitivity is not specifically known. It assumed that physiological or toxilogical sensitivity would be similar to that of a polar bear. Reproductive potential is low and the population is small, suggesting that the loss of just a few individuals would be considered significant. As an indication of this sensitivity, the present quota for grizzlies between Tuk and the Anderson River is 11 individuals.

RESTORATION OPTIONS: Deterrents, Relocation, Cleaning

A full discussion of restoration options is provided under the polar bear discussion. Note that it is likely that these techniques would be required only in the first year of the spill when oil is likely to be relatively fluid.

<u>DETERRENTS</u>: planes, helicopters or "bear monitors" could be used to scare bears from potential contaminant zones. Given that there are relatively few individuals of concern, then the technique has the potential of being effective and environmentally sound.

<u>RELOCATION</u>: Individual bears could be temporarily moved until the risk of encountering oil is reduced. Given the few number of individuals involved, this technique is likely to be reasonably effective.

CAPTURE AND CLEANING: bears that were observed to be oiled could be captured, moved to a treatment facility for cleaning and/or holding until the threat of contamination was reduced.

RESTORATION EFFECTIVENESS: See polar bear discussion for a complete review.

RECOMMENDED RESTORATION TECHNIQUES: Deterrents, Relocation, Cleaning (see polar bear discussion for complete review).

COSTS: See polar bear discussion for costs.

OVERALL ASSESSMENT OF RESTORATION: The three techniques outlined are all considered practical in that (a) they are effective, (b) there is a net environmental gain associated with each, (c) they would result in an accelerated population recovery if implemented and (d) can be accomplished with existing technology.

SPECIES/SPECIES GROUP: Caribou

IMPACT SCENARIO EVALUATED: OPEN-WATER SEASON, July-August
This is the season when caribou are on the coast and most likely to come into contact with oil.

VULNERABILITY: LOW to MODERATE

Caribou generally would not come into direct contact with oil as they are a terrestrial mammal. However, their summer range could overlap with the coastal oiling predicted by the worst-case scenario and some individuals could come into direct contact with oil in the water or through ingestion of oiled plant material.

SENSITIVITY: LOW to UNKNOWN

While individual sensitivity might be considered low to moderate (Dickins et al. 1987), the anticipated recovery period is considered short as caribou have a high reproductive capacity and there is also the potential for recruitment.

RESTORATION OPTIONS: BIOREMEDIATION, DETERRENTS, ENHANCEMENT, REMOVAL OF INTERTIDAL SUBSTRATE, TILLING OF INTERTIDAL SUBSTRATE, WASHING

As with other restorative techniques, it is assumed that they follow or are coincident with the cleanup. Cleanup is assumed to remove all "free" oil from either the water surface or from substrate. That is, the risk of oil contact after the cleanup is small as the remaining oil is primarily in the form of residual coats and stains.

RESTORATION EFFECTIVENESS

BIOREMEDIATION: This technique is thought to remove only small amounts of intertidal oil and is not considered effective in terms of reducing the risk to caribou.

DETERRENTS: Deterrents are considered effective during the cleanup phase of the spill. They would be designed to keep large herds away from the coastal areas where potential contact with "free" oil is possible.

ENHANCEMENT: The only means of habitat enhancement considered is the fertilization of oil-impacted vegetation in the storm-surge fringe. The primary goal of the technique is to accelerate vegetation growth as opposed to biodegradation of the oil. Although only a very small proportion of the habitat would be affected in comparison to the total range of the caribou, the coastal areas in which they occasionally congregate during the summer would be restored more quickly.

REMOVAL OF SUBSTRATE; TILLING: Removal of intertidal or supratidal substrate or tilling are possible restorative techniques; removal of oiled material or tilling would reduce the potential for contact. However, in that the cleaning is assumed to have removed most of the free oil and in that these techniques are considered highly disruptive with potential coastal erosion effects, there would be no net environmental gain, and they are, therefore, not considered practical.

HIGH PRESSURE, HOT-WATER WASHING: This technique could be used to remove oil left from the cleanup operation. However, little oil that could come into contact with caribou could be removed and there is the possibility of flushing additional oil into the nearshore. As such, this technique was considered to do little to enhance recovery, has potentially detrimental environmental effects and is therefore considered impractical.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS, POSSIBLY ENHANCEMENT

Deterrents are considered to be the most practical of the possible restoration techniques. With a relatively small expenditure of manpower and effort, caribou could be deterred from reaching the coast.

Enhancement of vegetation growth in oiled tundra areas using fertilizer is considered feasible although only a very small percentage of the caribous' habitat would be treated.

INFRASTRUCTURE REQUIREMENTS: MINIMAL

DETERRENTS: No prior infrastructure is required, although a strategy would have to be developed at the time of the spill, for the deployment of camps along the Yukon coast. It is assumed that local Invialuit would operate these camps and no specialized equipment would be required. Aircraft support would also be required for surveillance and for supplying camps.

ENHANCEMENT: Fertilizer is essentially manually applied with small three-man sized crews. No specialized handling equipment is required and the application is not time critical (i.e., cleaning must be completed first) so there is a period of months to mobilize the relatively simple equipment required.

COSTS:

DETERRENTS: Costs are estimated assuming that about 200 km of coast might require protection. Assuming 10 camps are required (10 km spacing) with 6 weeks of support, then stand-alone, one time costs are about $530,000 (2 people per camp, 42 days, 10 camps, $30,000 helicopter support).

ENHANCEMENT: Based on a crew of 3 people covering 2 km/day, estimate between $1,000 and $10,000 per day (or $200-2,000/km). Assuming the entire coastline between the Alaska/Yukon border and the delta could be oiled (an estimated 428 km; Harper et al. 1985) and that about 15% of this coast might be considered susceptible to storm surges, than about 60 km of shoreline per year would require treatment. Associated costs are in the range of $12,000 to $120,000 per year with a minimum of three years treatment required; a total restoration cost of $36,000 to $360,000 is estimated.

OVERALL ASSESSMENT OF RESTORATION:

DETERRENTS: Deterrents are considered an effective technique for limiting contact. Large numbers of animals stand to benefit from deterrents. The technique can be implemented quickly and can be used for other purposes, e.g., bear deterrent. The technique is considered PRACTICAL and is RECOMMENDED.

ENHANCEMENT: Enhancement is of questionable effectiveness to treat what is at most a modest impact. The links between the treatment and the reproductive success are tenuous. The treatment is not likely to result in any significant increase in reproductive success. As such, the technique is considered of QUESTIONABLE PRACTICABILITY.

SPECIES/SPECIES GROUP: Wolves

In that the distribution of wolves is largely controlled by that of caribou, all the assumptions used for caribou are assumed valid for wolves. That is, restoration techniques used for caribou, such as deterrents, are assumed to benefit wolves indirectly.

SPECIES/SPECIES GROUP: Beluga Whale

IMPACT SCENARIO EVALUATED: OPEN-WATER SEASON BLOWOUT

VULNERABILITY: HIGH TO MODERATE

Belugas are vulnerable to oil on surface and in the water column. The are particularly vulnerable when they may be confined to leads.

SENSITIVITY: LOW

Direct contact of the skin with surface or dispersed oil could cause irritation or discomfort which may displace beluga from those areas. Mortality of whales has not been attributed to past oil spills. Geraci suggests that the only likely condition where there may be impact is when oil is concentrated in leads in spring, especially with relatively fresh oil. There is not likely to be a greater risk to calves, but this is not known.

Risk to the population is relatively low, risk to individuals is highest when oil is either in the estuary or in spring leads.

The harvest of whales could be affected by a perception of tainting and the displacement of whales from traditional hunting areas.

RESTORATION OPTIONS: DETERRENTS, CLEANING, HARVEST MANAGEMENT

Habitat restoration was not considered as the only practical habitat measures were more related to clean-up activities.

RESTORATION EFFECTIVENESS:

DETERRENTS: The estuarine habitat is important to beluga for (among other things) moulting of skin. Therefore it was considered to be unwise to attempt to deter them from entering the estuary in general. Deterrent activities would only be of value in localized situation (small portion of bay, etc. - e.g. Kendall Island area).

A decision to deter whales from an area would have to made by (or have significant input from) the Inuit since deterrent actions could result in keeping the whales out of their harvest areas.

If a decision to deter belugas from a local area seemed wise, then whales could be moved out of an area by the Inuvialuit using outboards, rifles, and seal bombs.

Orca tapes could also be used to deter belugas from entering specific oil-contaminated areas. The effectiveness of this measure has not been demonstrated with beluga.

HARVEST MANAGEMENT: DFO could close the beluga hunt if oil were in the estuary; but likely they would not be harvested anyway because of concern that muktuk would be tainted and boats and gear would be fouled by oil. The loss of opportunity to hunt and obtain muktuk would have to be compensated for.

CLEANING: The workshop participants considered that cleaning would not be an effective option.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS and HARVEST MANAGEMENT

Deterrents are recommended only in a localized context, as it may do more harm than good attempting to exclude beluga from the estuary.
The need for harvest restrictions would have to be evaluated at the time of the spill and would depend upon severity of impacts.

INFRASTRUCTURE REQUIREMENTS: MINIMAL

DETERRENTS: Logistic support necessary for clean-up activities would supply the requirements of small crews that might be engaged in keeping beluga away from localized oil contaminated areas. Operation and maintenance of ORCA sound-making equipment would be performed by small crews housed in shore camps.

HARVEST MANAGEMENT: No physical infrastructure is required. Management decision making framework is in place.

COSTS:

Costs associated with various deterrent options were not evaluated. Level of effort was estimated to be low. Costs of harvest restrictions would equate to compensation costs.

SPECIES/SPECIES GROUP: Bowhead Whale

IMPACT SCENARIO EVALUATED: OPEN-WATER SEASON, July-August.

Bowhead whales enter the southern Canadian Beaufort Sea in mid to late July.

VULNERABILITY: MODERATE

Bowhead remain further offshore than beluga and are not as congregated. They are generally not much confined to leads in the coastal Canadian Beaufort Sea.

SENSITIVITY: LOW to MODERATE

Concerns were expressed about the clogging of baleen with oil if bowhead were to feed in oil contaminated waters. However no mortality of baleen whales has been documented following spills. Sensitivity was assessed as poorly understood, but likely low.

RESTORATION OPTIONS: DETERRENTS

It was suggested that there likely be little need for deterrent activities in the offshore except along the Yukon Coast.

RESTORATION EFFECTIVENESS

DETERRENTS: If whales are feeding, it may be difficult to deter them from an area. However, there may be instances where some deterrent techniques should be attempted - e.g. if substantial amounts of oil occur off the Yukon Coast. The vessels and activity associated with the cleanup response itself, would likely act as a deterrent.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS

Deterrents in localized coastal ares are likely the only practical approach. The best approach is to remove oil form water as soon as possible through cleanup response.

INFRASTRUCTURE REQUIREMENTS: MINIMAL
As per beluga whales.

COSTS:

DETERRENTS: Costs associated with deterring bowhead from oiled areas were not evaluated. Much of the support costs would be absorbed by the countermeasures teams.

SPECIES/SPECIES GROUP: Ringed Seal

IMPACT SCENARIO EVALUATED: LATE OPEN-WATER SEASON, September

Oil is expected to be trapped and encapsulated in landfast ice.

VULNERABILITY: MODERATE

Vulnerability of ringed seals would not be as high as with belugas. Exposure to oil in spring will depend on the location and stability of ice, which in turn will determine its importance as seal pupping habitat.

SENSITIVITY: LOW to MODERATE

Experiments suggest that oil contact does not effect ringed seals much. However repeated contact near breathing holes could transfer oil to pups during March-April. This is a concern because fur as opposed to blubber provides insulation for pups at this time. Although pups don't go in water (birth lairs) they could be oiled by contact with their mothers. It is unlikely that there would be much mortality of seals; even though they could be fouled and could ingestion some oil. Because of the large natural fluctuations in ringed seal populations, it will be difficult to detect changes in population numbers that are attributable to oil spills.

RESTORATION OPTIONS: DETERRENTS AND CLEANING

Supplemental feeding was considered to be an unlikely requirement. No other restoration options were considered appropriate or relevant. Clean-up of the offshore and landfast ice habitat were considered to be the most effective means of ensuring ringed seal population recovery.

RESTORATION EFFECTIVENESS:

DETERRENTS: Deterrent activities might prove effective on a localized basis during the open-water season. However activity could actually work against effort by attracting these normally curious seals.

CLEANING: Cleaning was considered impractical because it is too difficult to capture seals.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS

INFRASTRUCTURE REQUIREMENTS: MINIMAL

DETERRENTS: Personnel involved with deterrent activities would most likely be part of, or closely associated with, the offshore countermeasures team.

COSTS:

DETERRENTS: Costs associated with deterring ringed seals from oiled areas were not evaluated. Much of the support costs would be absorbed by the countermeasures teams.

SPECIES/SPECIES GROUP: Bearded Seals

IMPACT SCENARIO EVALUATED: LATE OPEN-WATER SEASON, September

Oil is expected to be trapped and encapsulated in landfast ice.

VULNERABILITY: MODERATE

Bearded seals are not as widespread as ringed seals. They feed on bottom and so are more restricted to shallower areas. They are not generally concentrated and tend to be found in transition zone ice during winter and spring. However they can be found in fast ice areas but are generally further offshore in this habitat than are ringed seals. The relatively sedentary nature of these seals compared to ringed seals could may increase their vulnerability.

SENSITIVITY: LOW to MODERATE

Bearded seals were assumed to possess similar individual sensitivity to oil exposure as ringed seals. However their smaller population size combined with a high natural variability in population size pose a potentially greater risk to bearded seals. Major population shifts in bearded seals have been documented and oil could have more pronounced effects on already stressed seals.

RESTORATION OPTIONS: DETERRENTS

Cleanup of oil should be priority as with ringed seals and whales.

RESTORATION EFFECTIVENESS:

DETERRENTS: Deterrent use was considered to be less practical than for ringed seals. However if the occasion arose it may be effective to deter bearded seals from entering oil contaminated areas during the open water season.

RECOMMENDED RESTORATION TECHNIQUES: NONE RECOMMENDED

Deterrents could be employed on an opportunistic basis.

INFRASTRUCTURE REQUIREMENTS: MINIMAL (as per ringed seals)

COSTS: (as per ringed seals)

SPECIES/SPECIES GROUP: Arctic Fox

IMPACT SCENARIO EVALUATED: LATE OPEN WATER SEASON, end of September.

VULNERABILITY: MODERATE

Arctic foxes are less vulnerable than bears.Oil exposure would result primarily from eating oiled carrion in offshore areas during spring. They do not enter the water.

SENSITIVITY: MODERATE

Sensitivity was assumed to be similar other carrion eaters.

RESTORATION OPTIONS: OILED CARRION REMOVAL

Removal of oiled carrion from spill site and other oil-contaminated habitat was considered to be the only practical restoration measure.

RESTORATION EFFECTIVENESS

OILED CARRION REMOVAL: Removal of oiled carrion is considered a component of normal habitat clean-up operations and was assessed as being the most effective means of minimizing contact.

RECOMMENDED RESTORATION TECHNIQUES: OILED CARRION REMOVAL

INFRASTRUCTURE REQUIREMENTS: MINIMAL (covered under clean-up)

COSTS: (covered under clean-up)

SPECIES/SPECIES GROUP: Birds - numerous species and most restoration questions apply to all species groups:

1. loons
2. brant
3. eiders and oldsquaw
4. alcids
5. diving ducks

6. geese and swans
7. dabbling ducks
8. shorebirds

IMPACT SCENARIO EVALUATED: LATE SEASON OPEN WATER

Oil becomes encapsulated in the ice over winter and is released onto the ice and water surfaces the following spring.

VULNERABILITY: HIGH to LOW (species dependant)

SENSITIVITY: HIGH to MODERATE (species dependant)

RESTORATION OPTIONS: DETERRENTS, HERDING, CLEANING, HOLDING, HABITAT RESTORATION, HUMANE KILLING, CAPTIVE REARING, HABITAT ENHANCEMENT, PREDATOR CONTROL and HARVEST MANAGEMENT

RESTORATION EFFECTIVENESS:

DETERRENTS: Deterrents are probably most effective because once birds become oiled there is little opportunity to effectively deal with the problems associated with capturing and cleaning.

The effectiveness of propane canisters will depend on the species. Propane canisters have been used to keep birds away from crops and may be effective on a local scale in keeping birds from landing in oil contaminated leads during spring migration. They could also be used in coastal staging areas.

Deterrents would not be as effective if there is a large amount of open water that was oiled. Satellite imagery could be used to help predict the location of most effective deployment of noise-makers.

In the worst case event (late open water spill) there would be several months lead time to mount a deterrent effort to protect spring-migrating birds.

People armed with pyrotechnics (i.e. not a passive response) may be more effective than unmanned propane canisters.

Helicopters could also be used to chase birds from oiled areas. This may be a practical option when the amount of habitat that birds want to use is restricted (e.g. in spring migration).

HERDING: In conjunction with shoreline response activities, birds could be herded using helicopters during the moulting period. One difficulty is that you couldn't stop birds from feeding while moving them to an uncontaminated area. Herding would work with terrestrial species (e.g. geese).

CLEANING: Bird cleaning was generally not a recommended priority of this group, particularly when other restoration techniques may be more practical and cost effective and achieve restoration in shorter periods.

The success of bird cleaning has not been high historically, at least with batch spills (e.g. tanker spills) where there is no time for preparation. In the case of a late summer blowout there would be a need for immediate action until free oil became encapsulated in ice or flowed under the ice. In this latter case there would be several months to make preparations for treating birds that could become oiled in the following spring.

Workshop participants emphasized the crucial importance of getting birds as early as possible after oiling and emphasized the need to focus treatment efforts on lightly-oiled birds that had a chance of recovering.

The big expense involved in cleaning is keeping the birds after cleaning rather than costs of detergents and hot water.

Their was no confidence expressed that cleaning would be of benefit to populations of birds. Cleaning is of limited biological value except for endangered species and special cases. In general cleaning was not viewed as a practical approach except for colonial species where cleaning might be the only successful restoration technique (e.g. brant colony). Even in this case one would still prefer to scare adults brants out of the area (even if there were a loss of an entire year's production).

It was reported that from the Inuvialuit perspective cleaning is a misplaced activity; that it would be better to destroy birds humanely. However it was expected that some effort would have to be directed to cleaning birds because of a public view of the importance of the benefits to individual birds of rescue and cleaning (as opposed to population benefits).

<u>HOLDING BIRDS</u>: Holding birds is not an option except during moulting period (or flightless young) when thy could be more easily captured. There could be special circumstances where this approach could be used, (e.g.could be tried in conjunction with herding) but in general this would not be practical.

<u>HABITAT RESTORATION</u>: Restoration of tundra habitat would benefit birds that use these areas for nesting.Nesting colonies would be a priority. Care must be taken to ensure that restoration practices do create more negative impact than the oil itself, either through disturbance of nesting birds or use of inappropriate techniques. In general it would be rare that nesting habitat were affected by oil, except as a result of storm surges transporting oil

inland. Areas where effort would be focused (i.e. major nesting and moulting habitat) are for the most part already identified and documented.

HUMANE KILLING and REMOVAL of OILED BIRDS: Heavily oiled and stressed birds should be humanely killed and removed to approved disposal site. Likewise dead oiled birds would be removed to reduce risk to scavenging animals. Counts of dead and destroyed birds should be recorded towards establishing as accurate a record as possible of population losses.

CAPTIVE REARING and STOCKING: This could be practical with certain species. The success of efforts would depend largely on our understanding of rearing methods or the ability to develop techniques.Capture and transport of flightless young to rearing facilities would be the most likely segment of any population to focus on. There is no evidence of successful rearing of colonial nesters; the birds which are most in jeopardy from a spill.

HABITAT ENHANCEMENT: Enhancing existing habitat and creating new habitat would be viable for some species (Black guillemots) and situations.

PREDATOR CONTROL: Control of predators could be an effective means of increasing reproductive success (and decreasing recovery time) of colonial nesting bird colonies.

HARVEST MANAGEMENT: Harvest restrictions should be considered in some cases.

COSTS: ALL BIRDS

Costs will be highly dependent on the oil spill scenario and will be very dependent on amount of helicopter time that is available (necessary).

Aircraft

Up to 3 months x 2 dedicated medium-sized helicopters (Bell 204 or S-76)
Cost of response = (90 x 10h x $2000) = $1,800,000.

Personnel

90 day response x $700 (includes support and wages) x 50 people = $3,150,000. These personnel costs do not include costs associated with habitat restoration efforts.

TOTAL COSTS of BIRD RESTORATION (includes transportation, personnel and equipment = $ 10M

INFRASTRUCTURE REQUIREMENTS:

RECOMMENDED RESTORATION TECHNIQUES: SPECIES DEPENDANT

1. LOONS

VULNERABILITY: HIGH

Loons dive to feed therefore are highly vulnerable. Since they move to water several times a day, the likelihood of oil contact is high. In terms of the populations; red-throated are most vulnerable. Pacific loons are also vulnerable - moderate to high. However since they are distributed along the coast only a portion of the population would be affected in most instances.

SENSITIVITY: HIGH

All birds are highly sensitive to oil exposure.

RESTORATION EFFECTIVENESS:

DETERRENTS: It would be difficult to deter any number of loons from an oiled area as they are not in as concentrated groups as are eiders. It may be a feasible option during spring migration.

It would be difficult to chase loons from an oiled area because their typical response is to dive rather than take flight. Deterring loons is not likely an effective option.

CLEANING: Not considered an option. Loons are difficult to handle and if oiled they will be severely oiled.

HABITAT RESTORATION: Loons are easy to disturb, therefore there is considerable risk of increasing impact on loons if they move off their nests.

PREDATOR CONTROL: Since loons are a predatory species, predator control is not considered practical.

CAPTIVE REARING: This may be the best course of action if a loon population is in jeopardy. Its success is unknown however as this has not been attempted on any scale.

RECOMMENDED RESTORATION TECHNIQUES: CAPTIVE REARING, HABITAT RESTORATION

No restoration techniques are recommended specifically for loons. However loons would benefit from techniques directed at other species. The best course of action is considered to be that of enhancing natural production.

2. BRANT

VULNERABILITY: HIGH

During fall migration brant move along coast and are susceptible to oil. They are colonial nesters, nesting near the shore, therefore their vulnerability would be high if there were a storm surge.

SENSITIVITY: HIGH

RESTORATION EFFECTIVENESS:

DETERRENTS: Deterrents could be effective with this species. Deterrent efforts must involve people and be focused (e.g. use of shell crackers). Timing is critical and would depend on events at the time. Priority areas could be selected at which to deploy deterrent techniques. Deterring brant may have adverse implications to other species therefore site-specific considerations must be taken into account. Whether people are sufficiently trained to use deterrents may pose a problem in implementing this technique. An ESRF study will re-visit this technique. In part the success of deterring brant (or other species depends on the availability of alternate habitats. Generally deterrents will be effective for small areas only. A concern lies in the lack of information on their effects on other species.

CLEANING: Brant are easier to clean and keep in captivity. Cleaning would only be used if there were a danger of losing a large proportion of a breeding colony; it is not practical in other instances.

HOLDING and HERDING: Practical and one of a mix of techniques to prevent oil contamination; would be only used with flightless birds.

HABITAT RESTORATION: is important because brant are very dependent on specific local habitat in areas where they nest.

PREDATOR CONTROL: In an extreme situation where a brant colony has been affected, then predator control may be advised to help reproduction success.

HARVEST RESTRICTIONS: The effectiveness of harvest restrictions would be limited if they were intended to assist recovery of a specific colony.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS, CLEANING, HERDING and HOLDING, HABITAT RESTORATION

3. EIDERS AND OLDSQUAW

VULNERABILITY: HIGH

There are large numbers of both species and in the spring their habitat is restricted to open leads in the sea ice. A high proportion of the Western Arctic population could be exposed within a relatively small area.

SENSITIVITY: HIGH

Vulnerability and Sensitivity

RESTORATION EFFECTIVENESS:

DETERRENTS: Deterrents could be used in certain circumstances (e.g. open water areas). One would want to attempt the use of deterrents but there is no indication of success. Oldsquaw concentrate in areas to moult and so deterrents cold be attempted and may be successful.

CLEANING: Given the large numbers of these birds and the history of relatively poor success of this technique it was considered not to be practical to focus any cleaning effort at these species. There would be little if any population benefit.

HABITAT RESTORATION: As their offshore habitat is similar to whales and seals, no specific habitat restoration techniques other than cleanup is recommended.

PREDATOR CONTROL, RESTOCKING and CAPTIVE REARING: Not recommended.

HARVEST RESTRICTIONS: Since the numbers of these species which are harvested in Beaufort area are small in relation to the population size, harvest restrictions would probably have relatively small effect on population recovery. Generally restrictions are not recommended unless there were a loss of large proportion of the population or other population stresses were also apparent (Pacific drift netting effects). As these are internationally shared populations, management would involve other jurisdictions.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS, HARVEST RESTRICTIONS

4. ALCIDS: Thick billed murre - single colony at Cape Parry (700 birds)
Black Guillemot - 2 areas (Herschel Island and Cape Parry)

VULNERABILITY: HIGH

Alcids are most vulnerable during their fall migration in which they are swimming during first portion. They are also highly vulnerable during their spring migration.

SENSITIVITY: HIGH

RESTORATION EFFECTIVENESS:

DETERRENTS: There are too few birds to be practical, however clean up activities that coincide with the location of alcid colonies will have some deterrent effect.

CLEANING: Cleaning may be a higher priority than with other species. However they may be difficult to reach before damage is extensive. It was recommended not to mount a program specifically for alcids, but they would be given high cleaning priority if collected with other species. There would be a higher chance of success if birds were collected near their colonies. A single cleaning facility at Tuktoyaktuk was assumed.

HABITAT ENHANCEMENT: Beach nesting habitat could be improved for guillemots using artificial substrates and driftwood.

HABITAT RESTORATION: Nesting habitat of murres (cliffs) is not in areas where oiling will occur. Storm surges could lead to contamination of nests of guillemots. Cleanup will remove oil and lead to habitat restoration.

RESTOCKING: This is possible but is advised only if both Alaskan and Canadian populations were wiped out.

RECOMMENDED RESTORATION TECHNIQUES: CLEANING, HABITAT ENHANCEMENT, HABITAT RESTORATION (Guillemots only), RESTOCKING

5. GEESE and SWANS

VULNERABILITY: LOW to MODERATE

Colonies do not nest on tidal flats, but could be both species could be in these habitats during brood rearing.

SENSITIVITY: MODERATE to HIGH

RESTORATION EFFECTIVENESS:

DETERRENTS, HERDING and HOLDING: As per brant, except their vulnerability is not as high and they are easier to work with and could be herded further inland. Geese and swans would also be easier to hold. There is more grazing habitat available and so options for moving are improved. Geese could easily be moved away from shore zone and placed in fenced areas so long as the area were still in the species' feeding habitat.

HABITAT RESTORATION: If oil was transported into tundra areas that serve as grazing and nesting areas for geese then there may be some need for habitat restoration. Swans nesting habitat is less vulnerable being further from the coast.

HARVEST RESTRICTIONS: There would have to be significant reduction in either populations to justify harvest restrictions.These species are managed on a multi-jurisdictional basis and so harvest limits imposed in one region would not be practical unless accompanied by reductions in other areas. It would be possible and perhaps effective locally to reduce harvest near colonies as a restoration measure. It is unlikely that snow geese would be severely impacted and therefore unlikely that harvest restrictions would be necessary. At present there are no quotas.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS, HERDING, HOLDING, HABITAT RESTORATION (Geese) and HARVEST MANAGEMENT

6. DABBLING DUCKS

These ducks are numerous but do not occur in areas where oil impacts could occur (they are further inland). Therefore no restoration requirement is foreseen.

7. DIVING DUCKS (other than eiders and oldsquaw)

VULNERABILITY: MODERATE to HIGH

Large moulting concentrations occur in nearshore in late July and August.

SENSITIVITY: HIGH

RESTORATION EFFECTIVENESS:

DETERRENTS: Generally, the restoration techniques applied to eiders and oldsquaw would also apply to diving ducks. Because these ducks are flightless when in costal waters, deterrents would only be effective on a local scale.

HABITAT RESTORATION: Shoreline clean up would be of benefit.

CLEANING: Cleaning is not considered practical, but might be employed on an opportunistic basis.

RECOMMENDED RESTORATION TECHNIQUES: DETERRENTS and HABITAT RESTORATION

8. SHOREBIRDS

VULNERABILITY: HIGH to LOW

There are only two vulnerable species (i.e. only the species that swim and migrate offshore in spring and fall) - Phalaropes (Moderate-High). Other species have a LOW vulnerability.

SENSITIVITY: HIGH

RESTORATION EFFECTIVENESS: No restoration techniques are considered practical. Natural recovery would be the best option (in conjunction with shoreline cleanup). Although it would not be a priority for restoration, deterrent activities for other species may benefit shorebirds.

If an Eskimo Curlew (may be extinct) were oiled the population would benefit from its cleaning and recovery. However as they are found in upland areas, they are unlikely to come in contact with oil.

SPECIES/SPECIES GROUP: COASTAL MARINE FISH

This group includes those fish that spend their entire life in coastal marine and estuarine waters and may spend a significant proportion of their life cycle in shallow, nearshore areas. Pacific herring was chosen as a representative indicator species for this group of fish because: (a) it is an important subsistence use species and possible commercial-use species, (b) it has ecological significance as an element in the food chains of the coastal environment (c) it overwinters in coastal embayments (i.e., 9 months of the year spent in this area) and (d) it spawns in the embayments. The length of time the fish spends in the nearshore is representative of other coastal/marine fish and the larvae of herring, which are known to be sensitive to oil, are also concentrated in embayments.

IMPACT SCENARIO EVALUATED: LATE, OPEN-WATER SEASON BLOW-OUT

Oil would come ashore, possibly relatively fresh (a few days weathering), would be encapsulated within the ice during freeze-up and would then be released during spring melt. High concentrations of oil on the shoreline would serve as contaminant sources to the nearshore, benthic substrate.

Cleanup is assumed to remove all "free oil"; that is oil that could easily to remobilized. As such, oil movement from the beach areas is assumed to take place as a particulate movement of oil attached to fine sediment particles (e.g., oil adsorption).

The scenario assumes high oil concentrations reach bays. However, as noted within impact assessments of this scenario, there is the potential to prevent oil from reaching a very significant proportion of these embayments.

Note that results from the BIOS experiment are directly applicable to this scenario.

VULNERABILITY: FOR ADULTS, LOW; FOR EGGS and LARVAE, MODERATE

Pacific herring overwinter and spawn in deep bays of the outer Mackenzie Delta and to the east of the Mackenzie Delta along the Tuk Peninsula and in Liverpool Bay. Specific areas of concentrations are not well known. Areas of spawning concentration are unknown. There is significant overlap of population and the oil impact zone (that is, the west coast of the Tuk Peninsula).

Because oil is encapsulated in the ice during most of the over-wintering period, the potential contact with adults is low. Food web effects for adults are also considered to be low.

Larvae and eggs could come into contact with oil in the water column or in benthic sediments. Oil in the water column would be released during spring melt. Oil in the benthic sediments in the range of 1-10 micro-grams per gram might be expected initially, increasing up to 400 micro-grams per gram in the top 2cm (Boehm et al 1987) over the next few years, followed by a gradual decrease in oil concentrations (N. Snow, pers. comm., 1990). Although oil is likely to be concentrated within fine sediments and the spawning areas are principally gravel, fine materials do occur within the gravels and contact is possible. As such larvae and eggs were conservatively estimated to have a moderate vulnerability. The distribution of spawning habitat and rearing areas for pacific herring is not well known.

SENSITIVITY: FOR ADULTS, LOW to MODERATE; FOR EGGS AND LARVAE, MODERATE TO HIGH

Larvae especially are known to be sensitive to low oil concentrations. The risk of tainting of adults is possible during the first year when there could be oil in the water column; the possibility of tainting is considered remote and short-term.

RESTORATION OPTIONS:

FOR FISH - CLEANING, DETERRENTS, RESTOCKING
FOR HABITAT - BIOREMEDIATION, ENHANCEMENT, REMOVAL OF INTERTIDAL SUBSTRATE, TILLING OF INTERTIDAL SUBSTRATE, HIGH PRESSURE/HOT-WATER WASHING, SEDIMENT CAPPING

RESTORATION EFFECTIVENESS:

FISH CLEANING: there is no known method for cleaning fish and the technique was not considered further.

FISH DETERRENTS: deterrents involves the exclusion of fish from areas of elevated hydrocarbon concentrations. In that Pacific herring are believed to demonstrate some degree of "site fidelity" (i.e., instinct to return to the same wintering or spawning ground), exclusion would not likely result in alternative site use. Also there is the practical problem of exclusion techniques (nets, solid fill dikes, etc.). For these reasons, deterrents were judged to be of limited effectiveness and possibly detrimental, and they were not considered further.

<u>FISH RESTOCKING</u>: restocking could be accomplished by moving fish stocks from uncontaminated sources (e.g. Liverpool Bay). However since this would probably occur naturally at a greater rate than forced re-stocking, restocking was not considered to be effective or practical.

<u>HABITAT BIOREMEDIATION</u>: bioremediation is a treatment where application of nutrients, e.g. fertilizers, can be used to increase the effectiveness of oil-degrading bacteria. The concept considered is that reduction of intertidal oil concentrations would reduce subtidal oil concentrations and therefore the risk of future oil contact with eggs or larvae.

The effectiveness of bioremediation is uncertain, however (Dave Kennedy, NOAA HAZMAT, Seattle, pers. comm., 1990) and of unknown benefit; further information may be forth-coming from the EXXON Valdez work within the near future. In addition, there are numerous links between the application of fertilizers in the intertidal zone and the subsequent improvement of reproductive success. There are no benefits in year one and questionable benefits later on.

There are concerns that the introduction of nutrients to small, enclosed embayments - could trigger adverse effects such as eutrophication, algal blooms, etc. Based on the approach used in the EXXON Valdez incident, Use would not be recommended in bays with areas less than 10,000 sq. metres.

The unknown effectiveness of the technique coupled with the numerous links between cause and effect make effectiveness to habitat restoration uncertain. It was RECOMMENDED that the R&D Task Group #4 consider this technique.

HABITAT ENHANCEMENT: increasing the spawning habitat area by introduction of gravel sediments is a possible enhancement technique. It is viable and has been used in other areas. However, the potential increase to overall spawning area is probably small. It was RECOMMENDED the R&D Task Group#4 consider the identification of spawning habitat as a research project.

The technique was considered possible on a site-by-site basis but not particularly practical. If more specific information on spawning habitat becomes available, potential effectiveness should be re-evaluated.

BEACH REMOVAL AND DISPOSAL: oil concentrations in nearshore benthic sediments might be reduced by removal of intertidal sediments with high oil concentrations.

Disposal of contaminated material is a significant problem as there are no permanent disposal sites located within the Beaufort Sea region and public acceptance would be problematic. There are potential adverse effects on shoreline stability; removal of intertidal sediments could cause coastal erosion, and terrain disturbances during removal could trigger thermal erosion.

The technique is considered feasible only on a very-small localized scale. Lack of disposal options and potential detrimental effects, e.g., erosion concerns, limit potential use. The technique was not considered further with respect to coastal, marine fish.

BEACH TILLING: subsurface oil may remain in intertidal sediments after cleanup and could serve as a potential contaminant source to nearshore benthic sediments. Shallow tilling could be used to enhance natural wave cleaning action of the intertidal sediments.

As this technique does not remove any oil, the benefits are questionable and possibly even detrimental - it could result in an even higher flux rate of oil to the nearshore. It was not recommended for further consideration.

HIGH-PRESSURE/HOT-WATER WASHING: the use of high pressure, hot-water washing can be used to remove additional oil not removed by standard cleanup, which is assumed to use manual pickup and low-pressure, cold-water washing). The additional component of oil removed by this technique in comparison to "standard techniques" is unknown. There is the potential to increase the particulate transfer of oil to the nearshore - high pressure blasts particulates downslope into the subtidal area. The use of hot water would also trigger thermal erosion, an undesirable impact.

Because of the unknown effectiveness of the technique, the general lack of "washable" substrate and the potential to increase the flux of oil to nearshore with potential detrimental effects, this technique was not considered effective.

BEACH CAPPING: contamination sources are often "capped" in onshore situations to prevent leaching of contaminants to surround areas. The technique has not been used for beaches and would be highly disruptive; an onshore source of capping material would be required, terrain disturbance at the source site and placement site is possible and geotextile material would probably be required to prevent wave erosion of the cap.

Because of the unknown effectiveness and the associated disruptive nature of the technique, it was judged to be impractical.

RECOMMENDED RESTORATION TECHNIQUES: POSSIBLY BIOREMEDIATION

Depending on R&D information on effectiveness of the technique and subject to limitations for use in small, restricted embayments, this technique may be feasible.

BIOREMDIATION INFRASTRUCTURE REQUIREMENTS: MINIMAL

Fertilizer is essentially manually applied with small three-man sized crews. No specialized handling equipment is required and the application is not time critical (i.e., cleaning must be completed first) so there is a period of months to mobilize the relatively simple equipment required.

BIOREMEDIATION COSTS: Based on a crew of 3 people covering 5km/day, estimate between $1,000 and $10,000 per day (or $200-2,000/km). Assuming the entire Tuktoyaktuk Peninsula could be oiled (an estimated 700km; Harper et al 1985) and that about 50% of this coast might be considered "embayment" coast, then about 350km of shoreline per year would require treatment. Associated costs are in the range of $70,000 to $700,000 per year with a minimum of three years treatment required; a total restoration cost of $210,000 to $2.1 million is estimated.

OVERALL ASSESSMENT OF RESTORATION: Bioremediation is of questionable effectiveness to treat what is at most a modest impact. The links between the treatment and the reproductive success are tenuous. The treatment is not likely to result in any significant increase in reproductive success. As such, the technique is considered of QUESTIONABLE PRACTICABILITY. However, should recommended R&D studies indicate substantial effectiveness of the technique in reducing intertidal oil concentrations, practicability should be reassessed.

SPECIES/SPECIES GROUP: ANADROMOUS FISH

This group includes fish that spawn in freshwater but occupy the coastal estuarine areas during some part of the year. Some populations (or segments of them also overwinter in the fresher inner estuary or in the Mackenzie River Delta. Broad whitefish was chosen as the indicator species of this group because (a) it is an important subsistence resource, (b) much of the open-water season is spent in shallow nearshore areas where elevated hydrocarbon concentrations may be present and (c) a significant component of its diet is from benthic infauna, which could have elevated hydrocarbon contents (Cross et al, 1987).

IMPACT SCENARIO EVALUATED: LATE, OPEN-WATER SEASON BLOW-OUT

The same impact as scenario as that used for coastal, marine fish was considered.

VULNERABILITY: MODERATE for ADULTS; LOW POST-LARVAE and JUVENILES

Direct water column effects are not considered important in this analysis as they are short-term and patchy.

Tainting is possible through ingestion of contaminated infauna by adults.

SENSITIVITY: MODERATE for ADULTS; HIGH for POST-LARVAE and JUVENILES

RESTORATION OPTIONS: SAME AS COASTAL/MARINE FISH

All options discussed under coastal/marine fish are relevant.

Bioremediation is considered possibly effective for habitat improvement as per the coastal/marine fish discussion.

Beach removal and disposal is also considered appropriate for use where spawning stream channels cross oiled intertidal sediments. Removal of the oiled sediments is practical and desirable to eliminate the potential for direct oil/fish contact in the stream channels. Oiled logs might also be removed where re-release of oil from logs is possible. The small selective nature of the treatment is considered to have minimal impact.

RECOMMENDED RESTORATION TECHNIQUES: BEACH REMOVAL AND DISPOSAL; POSSIBLY BIOREMEDIATION

See previous discussion on bioremediation limitations and costs.

Oiled sediment removal at stream mouths is recommended because effectiveness of reducing oil contact with fish is good and long term adverse impacts are not expected. The technique was used at the EXXON Valdez incident where subsurface oiling posed a potential contaminant source to the streams; the removal was highly localized and involved the volumes in the range of only a few tens of cubic metres of material in the entire cleanup program.

In that sediment removal and disposal was assumed to be a non-standard clean-up technique, it was considered a "restoration" technique for purposes of this discussion.

SEDIMENT REMOVAL DISPOSAL INFRASTRUCTURE REQUIREMENTS: MINIMAL

The treatment area is considered to be of small-scale extent and could be conducted manually or mechanically. No additional equipment beyond that available in the cleanup program would be anticipated.

Disposal is a potential problem but because anticipated disposal volumes are very small, this problem is not considered to be a limitation to the use of the technique.

SEDIMENT REMOVAL/DISPOSAL COSTS: Order of magnitude costs of cleanup were estimated at $10,000 per stream mouth; significant problems with disposal options might double this cost (e.g., debris incinerator cleaned or transported to hazardous waste disposal site in southern Canada). Treatment applied to 20-50 sites would result in a total, one time cost in the range of $400,000 to $1 million.

If this program were considered as part of the cleanup, cost effectiveness would be improved, probably resulting in a very small incremental cost to that program.

OVERALL ASSESSMENT OF RESTORATION: As per the previous discussion, bioremediation is of questionable practicality.

Localized sediment removal/disposal at stream mouths is considered effective and practical and is recommended.

PART 3

WILDLIFE COMPENSATION IN THE EVENT OF AN OIL SPILL IN THE BEAUFORT SEA

SYNOPSIS OF THE COMPENSATION WORKSHOP

CALGARY, DEC. 11 AND 12, 1990

by

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BEAUFORT SEA STEERING COMMITTEE

TASK GROUP 2

REMEDIATION AND MITIGATION

FINAL REPORT

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SUMMARY OF RECOMMENDATIONS AND CONCLUSIONS

1. The Inuvialuit Harvest Study (IHS) should be formally referenced in the Generic Compensation Agreement as the primary data source to be used in the quantification of claims.

2. Industry should initiate discussions with the Local Working Group of the IHS to identify an iterative mechanism whereby industry could become more involved, on an ongoing basis, with the Harvest Study. A mutually acceptable form of participation is required to provide industry with a clear understanding of the current methodology and data limitations of the Study.

3. The majority of financial compensation would be related to polar bear and beluga whale losses. These losses may be more a function of closure of the hunt by the regulatory authority than actual damage to the population. A pre-impact valuation for these species should be conducted on an annual basis for the purpose of determining direct cash compensation. This valuation would be conducted by the Inuvialuit Game Council (IGC) and would be forwarded to industry representatives who would then either accept the price list or negotiate changes to that list.

4. A mock compensation program should be conducted with the communities to identify the types of issues that could surface. During the workshop it was stated that this simulation could be included as part of the current "Spill Response Practice". Workshop participants also felt that this program was important enough to conduct as a separate exercise.

5. Despite the reference to "cash compensation as a last resort" in the Inuvialuit Final Agreement, it was recommended that individual harvesters be able to select the type of compensation most suitable to their own needs.

1.0 SCOPE

The Wildlife Compensation Task Group initiated discussions through review of the Wildlife Compensation Discussion Paper (Davies and Osler 1990). Following this review, the Task Group decided that the workshop would focus on the "quantification of loss issue". This issue was discussed under the following headings:

1) Data base requirements
2) Quantification methodology
3) Future requirements
4) Compensation process/model

Definitions of discipline terminology used in this document are provided in Appendix 1.

2.0 DATA BASE REQUIREMENTS

The Task Group concluded/recommended the following:

a) that the IHS be the primary data base used in the quantification of claims. It was recommended that the use of these harvest data for compensation purposes be formally referenced in the Generic Compensation Agreement. It was also noted that long-term data bases on polar bear harvests could be accessed from the NWT Government;

b) that procedures be initiated to allow for review of the IHS summary data on an annual basis by the Hunters and Trappers Associations (HTAs) and industry. If these data were acceptable to both the HTAs and industry, the two parties would certify that the data base would be used for the purpose of determining compensation;

c) that industry become involved with the Local Working Group of the IHS. It was stressed that this be conducted in a fashion that does not challenge the confidentiality of the data collected from individual harvesters;

d) that the current data base be expanded to include information on the use of animals harvested i.e. were they harvested for domestic food or as an economic activity such as guiding sport hunters;

e) that harvest levels can often be maintained through increased effort on the part of the harvester. It was recommended that the collection of effort data be initiated and continued on an ongoing basis to reflect changes in harvesting activity and level of effort. If harvesting effort increased, but harvest remained unchanged, the Claimant would be compensated for the increase in effort;

f) that in some instances the IHS data base would not be adequate to determine compensation, especially in cases where harvesting was market driven i.e. fur prices. It was concluded that compensation be based on a regression showing relationship between market price and historical harvest data. Long-term data bases available from regulatory agencies would be used for this purpose.

The Task Group felt that the IHS was possibly the most comprehensive data base on subsistence harvesting in North America and, considering its applicability to the compensation issue (among others), stressed the importance of continuing this study.

3.0 QUANTIFICATION METHODOLOGY

Factors that would affect compensation for each species or group of species were examined. These factors, along with other issues and recommendations, are provided below. At the end of each section a rough estimate of potential compensation (based solely on replacement cost) is provided.

A. POLAR BEARS

- with a worst case scenario oil spill, the regulatory authority would remove the quota, resulting in a 100% harvest loss;

- the loss would occur for a minimum of three years, which is the time required to re-assess the population. Loss could occur for as long as 20 years due to the slow recovery rate of this species;

- re-assessment of the population would cost approximately $400,000. to $600,000. It was recommended that population surveys be conducted on a priority basis due to the importance of the species to the Inuvialuit and to minimize compensation payments;

- the Proponent would compensate annually for loss of the entire quota for the duration of the closure. Once the quota is re-established no further claims would be entertained;

- individual hunters are provided with a licence to hunt polar bears by the community. Compensation would be paid to the HTAs as individual hunters could not be identified for the year of loss;

- compensation would have to be a direct cash payment because all polar bear populations are currently being harvested at their maximum sustainable yield;

- for the portion of the quota that is hunted for subsistence use, compensation would equal the cost of replacing the edible portion of the carcass plus the value of the fur and associated parts (e.g., gall bladder);

- for the portion of the quota that is used for guiding sport hunters, compensation would equal the sum of the net income generated from guiding plus the cost of replacing the edible portion of the carcass and associated parts. The loss of a bear utilized for guiding sport hunters results in a significantly higher level of compensation than a bear hunted for domestic use;

- it was estimated that compensation for polar bears would be the largest loss category.

- a rough estimate of potential compensation was arrived at from the following calculations:

<u>SPORT HUNTING</u>

# of bears potentially hunted for sport	30/yr.
Cost of hunt	$25,000./bear
Value of domestic food and associated parts	$1,000./bear
Total value of a sport hunted bear	$26,000./bear
Potential Annual Compensation	$750,000.

DOMESTIC HUNTING

# of bears potentially harvested	30/yr.
Value of fur ($100/linear foot) and associated parts	$2,000./bear
Value of domestic food	$1,000/bear
Total value of a domestically harvested bear	$3,000.
Potential Annual Compensation	$90,000.
Possible Duration of Impact	10 years
Total Potential Compensation	$8,700,000.

B. GRIZZLY BEAR

- compensation would be substantially lower for grizzly bears because lower prices are paid to hunt these bears for sport and because fewer bears are harvested;

- payment for losses would be made to HTAs for the same reasons discussed in the polar bear section;

- compensation for grizzly bear losses would be calculated using the same methodology developed for polar bears;

- based on an estimated 10 bears being harvested for sport annually; a maximum value of $15,000/bear; and a 5 year duration of impact; the total compensation was estimated at $750,000.

C. BELUGA WHALES

- although beluga harvests are currently not regulated, it was suggested that after an oil spill the FJMC could recommend that the regulatory agency impose a quota or hunt closure for a specified period of time;

- harvest loss would equal the difference between the highest number of beluga harvested in any of the three years preceding the spill and the annual harvest after the spill;

- it was predicted that the harvest would be reduced by 100% for the first two years and 50% in the third year;

- a rough estimate of compensation was calculated as: maximum of 160 whales harvested x 480 kg edible weight/whale x $8.00/kg x 2.5 years = $1,536,000.

- compensation for reduced beluga harvests was second only to polar bears and the combined loss from these harvests represents the majority of total potential compensation. In both cases, compensation would be driven by closure of the hunt by the regulatory authority. The requirement for timely scientific assessments to minimize the duration of compensation was once again stressed.

D. FUR BEARERS (FOX/WOLF)

- pelt prices vary dramatically, even within a six month period, complicating the determination of compensation levels;

- long-term data bases available from the regulatory authority would be used to determine the relationship between market price and the number of animals harvested. The relationship would then be related to the current market price to determine harvest loss;

- long-term data bases would also be required to differentiate between market induced effects, modernization effects (i.e., is there a general trend away from commercial trapping in favour of wage employment), and losses resulting from the impact;

- net value of harvest loss would approximate gross value due to low capital and operating costs associated with the activity;

- compensation would be paid to individual harvesters unless otherwise requested.

- a rough estimate of maximum compensation for the fox harvest was calculated as: 2,000 pelts x \$60./pelt = \$120,000. This was considered to be a conservative estimate as only a portion of the 2,000 animals would be lost;

- a rough estimate of maximum compensation for wolf harvest was calculated as: 20 wolf pelts x \$150./pelt = \$3,000. This was again considered a conservative estimate as only those wolves harvested within the zone of impact would be affected;

- total compensation for fur harvest was estimated at \$120,000. (fox) + \$3,000. (wolves) = \$123,000./year.

E. FISH

- three loss categories (domestic, sport, and commercial) were identified, but only domestic losses were dealt with due to the limited activity currently taking place in the other categories;

- reductions in domestic fish harvest could result from loss of access, displacement of fish species, or from tainting of fish flesh;

- concern was raised over quantification of long-term losses. For example, destruction of eggs or larval fish could result in the loss of a year class that may not affect the harvest for several years. The need for comprehensive biological studies was stressed to provide a basis for differentiating between project induced impacts and natural variation. It was suggested that the requirement for these studies be written into the Generic Compensation Agreement;

- it was recommended that tainting problems be addressed immediately after the impact and that they be dealt with in a manner that ensures long-term problems do not occur;

- the fisheries component was identified as an area where alternate locations could be found to enable individual harvesters to continue their traditional harvesting practices. While continued harvesting was identified as a priority under the IFA, it was suggested that the Claimant be given the choice between relocation of harvesting activities and direct cash payments;

- compensation payments would be made directly to individual harvesters unless otherwise directed;

- a rough estimate of compensation was calculated as follows: 200,000 kg of fish harvested/yr. X $4.00/kg = $800,000./year. Although this calculation is based on retail costs, it is stressed that domestic fishing is an activity where relocation is both practicable and preferable.

F. WATERFOWL

- the Inuvialuit Settlement Region (ISR) provides significant breeding and staging areas for large populations of migratory birds. If local populations were severely reduced, lost harvest opportunity may occur as a result of hunters having to access more remote or non-traditional hunting sites;

- payments would be made to individual harvesters unless otherwise directed;

- it was generally accepted that the importance of waterfowl to the communities would not be adequately reflected by the amount of compensation that could potentially be paid;

- a rough estimate of compensation was calculated as: potential loss of 17,000 kg of harvested waterfowl X 1 year x $4.50/kg = $76,500;

- the Task Group stated that alternate waterfowl harvesting sites could be identified and that relocation of hunters to these areas was both practicable and preferable.

G. SEALS

- seal harvesting, although considered a domestic activity, is affected by commercial fur prices;

- commercial harvesting enterprises have been proposed by several communities and should be included in the Generic Compensation Agreement;

- it was noted that seals tend to avoid oil and, when exposed, are not extremely vulnerable. The potential for loss was not considered high and was not expected to be a factor for more than three years;

- a rough estimate of compensation was calculated as: the reduction in actual harvest x edible weight of the carcass x replacement cost of the meat. The net value of the pelts was added to this total;

- estimates of compensation (based on different data sets and assumptions) varied from $5,000./year to $200,000./year. To provide a worst case scenario, the estimate of $200,000./year has been used.

During the review of the loss categories it became apparent that a pre-impact valuation of each species would greatly facilitate the settling of claims. This valuation would determine the net value animals for each type of utilization. In the case of polar bears the following information would be provided:

. for sport hunting
    - net value of the guiding activity
    - value of the edible portion of the carcass and associated parts (e.g., gall bladder)

. for domestic hunting
    - value of the edible portion of the carcass and associated parts (e.g., gall bladder)
    - value of the fur

It was suggested that the valuation be conducted by the IGC and, after review by industry, that it be certified by both parties. These valuations would then would be used in determining cash compensation. The process would be repeated on an annual or semi-annual basis.

H. TOTAL ESTIMATED COMPENSATION

. polar bear losses	$8,700,000.
. grizzly bear losses	750,000.
. beluga whale losses	1,536,000.
. fur harvest losses	123,000.
. domestic fish losses	800,000.
. waterfowl losses	76,500.
. seal losses	200,000.
Total Estimated Compensation	$12,185,500.

The above table is based on a one year loss of fur, domestic fish, waterfowl, and seal harvests. The Task Group agreed that polar bear losses should be calculated over a ten year period although there is some possibility that, losses could occur for up to 20 years. In the event that impacts on any of these components lasted longer than estimated, compensation would have to be adjusted accordingly. Due to the above, it is suggested that a range of $12,000,000. to $18,000,000. be used as a conservative estimate of compensation under a worst case scenario.

It is important to note that potential compensation has been calculated strictly on the basis of replacement costs. Lifestyle issues are not adequately covered by replacement costs. The amount of compensation required to address lifestyle issues therefore, remains outstanding.

4.0 FUTURE REQUIREMENTS

Throughout the workshop, the requirement for a framework that could expediently settle claims was stressed. It was felt that the lack of such a process would foster ill will between the parties and lead to future problems. It was also noted that the current focus on the worst case scenario fails to provide a framework for the processes that would be required in the majority of impact scenarios. It was suggested that the IGC develop a framework for settling claims and that industry buy into the process. It is recognized that while the IGC may develop the initial framework in isolation, that a dialogue would have to be established between the IGC and industry, to ensure that the framework was acceptable to both parties.

With the establishment of an initial framework for settling claims, it was suggested that a mock compensation run be conducted with the communities. To be effective, this simulation should incorporate as many real life variables as possible. For example, the worst case scenario oil spill should be described to the community with little or no advance warning. The day after the worst case scenario is described, circumstances should be altered to reflect the uncertainties associated with this type of event.

The mock compensation exercise should test: a) the need for the community to have professional or legal representation to determine appropriate levels of compensation; b) the relationships between impacts, compensation, and lifestyle issues; and c) the facility with which compensation, other than direct cash payments, can be dealt with, i.e., relocation to alternate hunting and fishing areas.

Throughout the mock compensation run, the focus should be on the inter-relationship between the harvester and industry. Potential conflicts could be tested where the hunter requests compensation for unwarranted claims, and where the company refuses to pay justifiable claims.

This simulation would familiarize harvesters with the compensation process and identify potential problems. Resolution of these problems prior to an oil spill would help to develop the process and ensure its applicability in the event of an actual spill.

The provision of a formula that the parties could agree to prior to a spill was identified as a priority recommendation. It was suggested that this be conducted within the next 12 to 18 months and that it form part of the current "Spill Response Practice". During discussions with the Task Group after the workshop, it was also stated that the mock compensation program was sufficiently important to be conducted as a separate task.

The first task after the impact occurs will be to determine the types of loss categories and the extent of the loss. The data bases that will be accessed at this time are the IGC harvest data and long-term data bases from regulatory authorities. An obvious requirement is that both data sets be maintained in a fashion that will provide ready access to current data.

To determine the temporal extent of the loss it will be necessary to develop adequate pre-impact data bases and to initiate appropriate monitoring studies and scientific assessments immediately following the spill. The importance of re-instating quotas and harvest levels immediately upon recovery of the population was stressed by both the proponent (to minimize compensation) and the harvester (to minimize disruption of traditional activities).

In the case of property loss or damage, compensation would be paid on the basis of replacement cost. Compensation for harvest loss can be conducted in three ways:

a) relocation of harvesting activity;
b) reimbursement in kind and;
c) direct cash compensation.

The desirability of relocating harvesting activity to an area unaffected by the impact is stressed in the IFA. In many instances, however, (polar bears, whales) there are no surplus stocks to harvest in other areas and this method of compensation becomes non-practicable.

Reimbursement in kind is recommended as the second alternative under the IFA. This method is effective in ensuring that country food consumption is maintained, and that young children are able to acquire a taste for items such as muktuk. The purchase of country foods in quantities necessary to maintain historic consumption levels may, however, be difficult to obtain over the long-term. In some instances, (i.e. polar bears), replacement is not feasible, as a surplus is not available in other communities.

Cash compensation is identified as a last resort under the IFA due to its negative impact on lifestyle. However, direct cash payments may be required for losses that cannot be mitigated through either relocation of harvest activity or reimbursement in kind. When this type of compensation is provided, the level of payment will be determined from the previously described species valuation list.

A comment was made by several individuals at the workshop that despite the "cash compensation as a last resort" clause, that individual harvesters should be able to select the type of compensation most suitable to their needs.

As compensation will be determined and paid on an annual basis (according to actual harvest loss), future loss was seen as more of a restoration than a compensation issue. It was concluded that compensation paid for a long-term reduction in harvest potential from habitat would essentially result in "double billing" as the actual loss was already being compensated. This issue was therefore left to the Working Group dealing with Restoration.

5.0 ACKNOWLEDGEMENTS

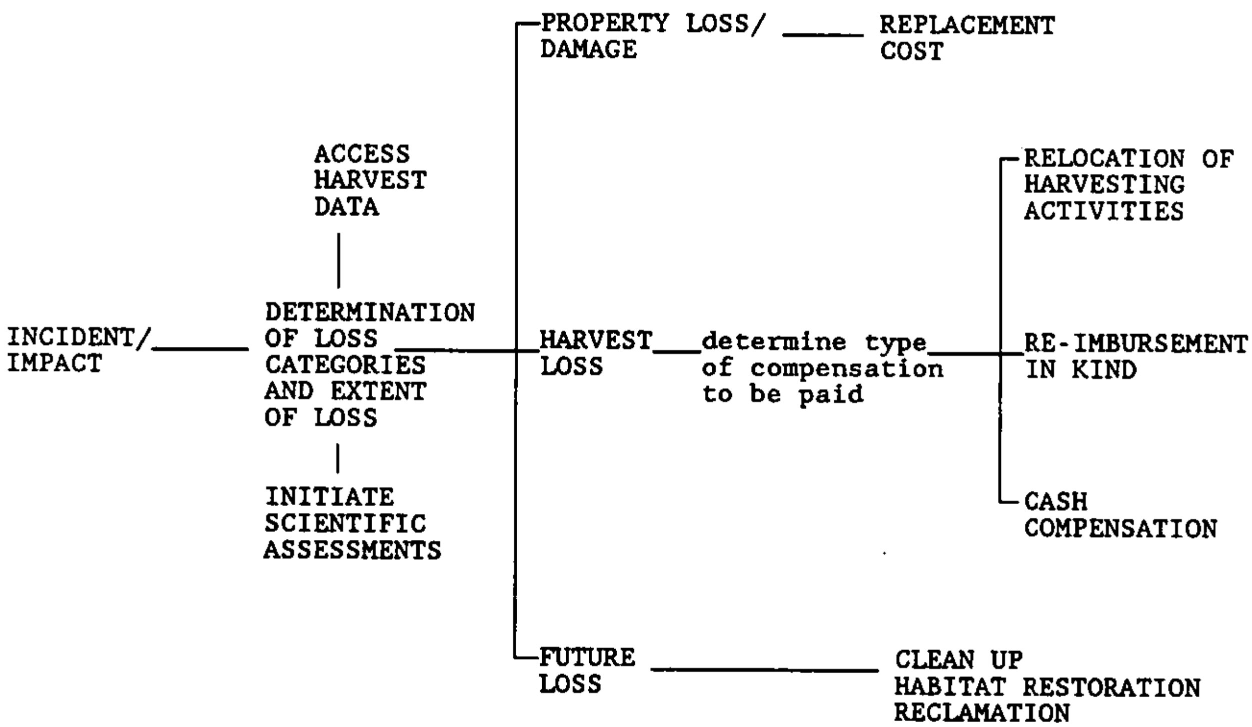
We extend our thanks to the participants of the Compensation Workshop Session for their active discussions and participation. Our thanks also go to the Task Group 2 members for their review comments and suggestions.

6.0 REFERENCES

Davies, S.L., and C.F. Osler. 1990. Wildlife compensation in the event of an oil spill in the Beaufort Sea. Unpub. Report for Beaufort Sea Steering Committee.

7.0 OVERVIEW OF THE COMPENSATION MODEL.

The following flow chart illustrates the series of events and decision points in the model:



APPENDIX 1. DEFINITIONS

Harvest is defined as the total amount of game killed and retrieved. Harvest is generally lower than number of animals killed as not all animals killed are retrieved but is larger than consumption due to spoilage and surplus.

Harvest effort is defined as the amount of time, gear, and cash expenditures required to conduct the harvest.

Modernization effects are defined as the effects of culture changes on traditional lifestyle and harvesting activities. Education, increased wage employment, and availability of store bought foods are examples of modernization effects which could decrease the long-term harvesting of country foods.

Replacement cost is defined as the cost of purchasing the same food item, or a similar food item, (e.g., poultry to replace waterfowl) to replace an item that can no longer be harvested.

Restoration was defined by Task Group 2 as the post-spill measures (other than oil containment, recovery, and removal) that would enhance recovery of harvested populations to pre-impact levels.

APPENDIX 2.

COMPENSATION WORKSHOP PARTICIPANTS

W. Brakel, Edmonton

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PART 4

WILDLIFE AND WILDLIFE HABITAT RESTORATION IN THE EVENT OF AN OIL SPILL IN THE BEAUFORT SEA
A DISCUSSION PAPER

by

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15 February 1991

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1.0 INTRODUCTION

The Environmental Impact Review Board (EIRB) which was established under the Inuvialuit Final Agreement (IFA) has recently reviewed two applications for exploratory drilling in the nearshore Beaufort Sea. The public phases of the reviews of Isserk I-15 in November 1989 and the Kulluk DPA in June 1990 involved much discussion of the IFA, particularly section 13: Wildlife Compensation. The objectives of section 13 are (a) to prevent damage to wildlife and its habitat ...; and (b) *if damage occurs, to restore wildlife and its habitat as far as is practical to its original state* .... The restoration of wildlife and wildlife habitat is a fine objective, but it begs the question of what restoration is possible with current techniques and can restoration capabilities be improved with further research?

This document is a discussion paper to be used as the basis for a workshop in Calgary on 11-12 December 1990 to address the issues of wildlife and wildlife habitat restoration. The paper is designed to summarize the available literature that is relevant to the situation in the Beaufort Sea if a major oil spill occurs. To orient the reader, the paper begins with a review of the species that would be at risk from a spill and a brief summary of the effects of oil on those species. The paper examines the techniques and the relative merits of cleaning and treating oil-exposed wildlife, restocking depleted wildlife populations, and restoring wildlife habitat to its original state. In conjunction with the workshop in December, it is directed towards estimating the practical opportunities and limitations involved in using such techniques in the Canadian Beaufort Sea Region.

This discussion paper distinguishes between standard shoreline cleanup techniques and habitat restoration techniques. The former are essential elements of an overall restoration strategy but they are addressed by other panels of the Beaufort Sea Steering Committee. This paper is concerned with techniques to be used after, or in conjunction with, standard shoreline cleanup. Also, the paper does not consider the suite of techniques that could be used to prevent animals from becoming oiled. Rather, it concentrates on methods that can be used to restore oiled wildlife, oiled habitat, and reduced populations.

2.0 SOURCES OF INFORMATION

The primary sources of information used in preparing this discussion paper included Arctic Marine Oilspill Program (AMOP) Technical Seminar Proceedings (yearly, 1978- 1989); American Petroleum Institute Oil Spill Conference Proceedings (biannual, 1979- 1989); Baffin Island Oil Spill (BIOS) Project Study Reports, 1981-1984, and associated documents; Marine Pollution Bulletin, 1977; LGL Limited's reprint library; and the Oiled Bird Workshop, sponsored by Environment Canada at the Canadian Centre for Inland Waters, Burlington, Ontario, 14-15 November 1990.

A number of people kindly provided information during the preparation of this discussion paper. These individuals included Terrie M. Williams, Co-Director, International Wildlife Research, Kailua, Hawaii; Jay Holcomb (Director), Jan White, and R. Van Vlack, International Bird Rescue and Research Center, Berkeley, California; Mitchell Taylor, Polar Bear Biologist, Renewable Resources, Government of Northwest Territories; Gary Zikovitz, Head, Spills Action Centre, Ontario Ministry of the Environment, Toronto; Phil Smith, Consultant to BP Exploration, Anchorage, Alaska; Bob Pollard, LGL Alaska Research Associates Inc., Anchorage, Alaska; Cal Sikstrom, Esso Resources Canada Ltd., Calgary; and Jim Bunch, Arctic Biological Station, DFO.

This discussion paper was prepared under a subcontract from North/South Consultants, Inc., Winnipeg. Michael Lawrence of North/South supervised the project and provided input to the background paper. Task Group Leader for the BSSC was Rick Hurst who provided many helpful comments on the report.

3.0 BACKGROUND

3.1 Species and Habitats at Risk

This section is designed to provide the reader with a brief overview of the principal species that are at risk from an oil spill in the Beaufort Sea. The overview is intended to orient the reader rather than be a detailed description of resources at risk.

3.1.1 Birds

Detailed reviews of the distribution and biology of birds in the Beaufort Sea have been prepared recently by S.R. Johnson in Dickins *et al.* (1987), Alexander *et al.* (1988), and Johnson and Herter (1989). The groups that are most at risk from oil are loons, waterfowl (swans, geese and ducks), shorebirds, gulls and terns, and alcids.

Loons

Four species of loons (red-throated, Pacific, common, yellow-billed) nest in coastal ponds and lakes and feed, loaf and migrate through nearshore waters of the Beaufort Sea. The Pacific and red-throated are the most common loons being widely distributed in all coastal waters.

Waterfowl

The tundra swan is the largest and most conspicuous of the waterfowl in the area. Small numbers frequent coastal mudflats and estuarine waters in fall but for the most part swans would not be affected by an offshore blowout or spill. Several species of geese are common in the region. The brant is a marine goose that occupies coastal habitats and is vulnerable to oil at migration staging areas and coastal nesting and feeding areas. Other species such as lesser snow goose, greater white-fronted goose and Canada goose occur in large numbers in the Beaufort Sea area. These species are most at risk from storm surges that might carry oil into coastal nesting and brood-rearing areas. In addition, these geese often use coastal lagoons during moulting and migration.

The most common ducks in the areas are common eider, king eider and oldsquaw. About 800,000 king eiders migrate past Point Barrow in spring and follow a direct broad front offshore path to Banks Island and Cape Bathurst. Offshore leads are used for resting. About 150,000 common eiders and 240,000 oldsquaws follow major flaw leads that parallel the Beaufort Sea coast in spring. All three species frequently land in leads and polynyas and are, therefore, vulnerable to oil that might concentrate there. Male and sub-adult eiders undertake major moult migrations westward across the southern Beaufort Sea to Alaska in mid summer. These moult migrations involve several hundred thousand birds that could be vulnerable to offshore oil. Male oldsquaws congregate in flocks at specific coastal areas to moult. Ducks are flightless during moult and thus particularly at risk if oil reaches important moulting areas. Brood-rearing oldsquaws remain inland on ponds and lakes, whereas female common eider and many king eiders raise their young in coastal marine waters.

Several other species of ducks commonly use nearshore marine waters for moulting. These include greater scaup, lesser scaup, surf scoter, white-winged scoter, black scoter (small numbers), and red-breasted mergansers. Some of these species also use coastal waters on fall migration.

Shorebirds

Over 20 species of shorebirds regularly nest in the Beaufort Sea region. During post-breeding dispersal and fall migration, shorebirds frequent mudflats, spits and lagoons in the littoral zone. Coastal concentrations are variable but can involve large numbers of birds. The red-necked phalarope and red phalarope are among the most common shorebirds in the region. They differ from other shorebirds in that they swim in coastal and nearshore waters and migrate through these and offshore waters. Because of this habit of swimming, phalaropes are particularly vulnerable to surface oil. The highly endangered eskimo curlew is thought to nest in the Anderson River area but it is not known if it is vulnerable to oil in this region.

Jaegers, Gulls and Terns

Three species of jaegers (pomarine, parasitic, and long-tailed) are common in the Beaufort region. These marine species spend their lives at sea coming ashore only during the breeding season. Little is known about their migration routes and offshore distribution in the Beaufort Sea. The glaucous gull is the most widespread coastal gull in the region. It is found along all coasts and is often found tens of kilometres offshore. During late summer and fall, there is a little known movement of black-legged kittiwakes into offshore waters of the Beaufort Sea. At this time, kittiwakes are dispersed over large areas in moderate numbers in at least some years. Other marine gulls such as Sabine's gull, ivory gull, and Ross' gull may frequent offshore waters of the Beaufort Sea on some occasions.

The arctic tern nests on coastal tundra and in small colonies on barrier islands. Some of these nests would be vulnerable to storm-surges that carried spilled oil. Of much greater concern is the fact that arctic terns feed, rest and migrate through marine waters of the Beaufort Sea where they could encounter oil from a blowout.

Alcids

Two species of alcid nest in the Beaufort Sea area. There is a single colony of 700 thick-billed murres at Cape Parry in southwest Amundsen Gulf. Murres are cliff-nesting seabirds that come ashore only to lay eggs; they feed their young with marine fish from nearshore and offshore waters. The early stages of the fall migration of the thick-billed murre is accomplished by swimming since the young leave the colony before they can fly and the adults are moulting. The black guillemot nests among beach debris and in old buildings at Herschel Island (83 adults) and in the Cape Parry area (37). The guillemot is also a seabird, but it tends to be somewhat more coastal than the murres.

3.1.2 Marine Mammals

Whales

The beluga or white whale migrates through offshore leads in the pack ice en route to the west coast of Banks Island in May and June. Many of those animals move south into Amundsen Gulf and west to the Mackenzie River estuary. When the ice bridge off the mouth of the Mackenzie breaks, the belugas move into the estuarine waters where they are harvested by the Inuvialuit in July. Up to 7000 belugas use the estuary at one time (Fraker and Fraker 1982). The overall population is thought to number at least 11,500 (Davis and Evans 1982). After leaving the estuary, belugas feed in the offshore waters of the Beaufort Sea and Amundsen Gulf. The westward fall migration occurs primarily in September and probably far offshore along the edge of the pack ice.

The bowhead whale winters in the Bering Sea and migrates into the Beaufort Sea in May and June. It also moves through offshore leads, although virtually nothing is known about its distribution until it enters Amundsen Gulf and nearshore shelf waters of the Beaufort Sea in late July and August. Large concentrations of subadult whales occur along the Yukon coast in some years. The westward fall migration occurs in September and October with most bowheads returning to Alaskan waters by mid October. An estimated 7,000+ bowheads are present in Canadian waters during the summer.

Seals

Ringed seals and bearded seals are common in the Beaufort Sea. The ringed seal is more abundant, occurring throughout the area in most water depths. It is more or less evenly spaced when living under the ice in winter, but loose feeding aggregations occur during the open-water season (Harwood 1989). Bearded seals are bottom-feeders and tend to be restricted to relatively shallow areas. They are common in certain areas such as off southern Banks Island and in the transition zone ice in winter and spring.

Polar Bear

The polar bear is a marine mammal that lives on the sea ice where it hunts both ringed and bearded seals. Females and cubs hunt along coastal fast ice after emerging from coastal denning sites. Males and non-breeding animals feed along ice edges and in the transition zone where non-breeding ringed seals and bearded seals concentrate. Bears readily enter water and could contact oil if leads were contaminated. In summer, bears tend to remain with the multi-year pack ice which usually, but not always, retreats to the north in summer (Stirling *et al.* 1975, 1981).

Other Species

Other mammals are of some concern regarding an offshore blowout. The arctic fox spends much time scavenging along coasts and could ingest oiled prey. Some arctic foxes also spend much time on the sea ice feeding on the remains of seals killed by bears and preying upon newborn ringed seal pups which they dig out of birth lairs (Smith 1976; Eberhardt *et al* 1983). Foxes normally do not swim voluntarily; thus, they may not be very vulnerable to oiling.

Grizzly bears and wolves scavenge along the Yukon coast and on islands of the outer Mackenzie delta. In those situations, they could ingest oiled carcasses that wash up on shore or they could contact oil along the shore.

Barren-ground caribou frequent coastal areas to obtain relief from insects. Concern has been expressed that they could become oiled by wading in shallow waters or they could be somehow affected by storm surges that carry oil inland.

3.1.3 Fish

Anadromous Fish

Anadromous species, which include the coregonids (whitefishes and ciscos), rainbow smelt and Arctic charr, spend a part of their life in the estuarine environment and part in the freshwater environment of the Mackenzie River, or other coastal watersheds. Arctic charr are not found along the Tuktoyaktuk Peninsula due to a lack of suitable riverine spawning habitat.

During the open-water period, between the onset of break-up and the beginning of freeze up, coregonids and smelt inhabit the coastal waters. Their distribution along the coast is determined by the extent and degree of influence of the Mackenzie River plume along the coast, and to a lesser extent the fresh water inputs of the Babbage and Anderson rivers and numerous small streams. The degree of salt tolerance of these species varies. Ranked in order of increasing preference for fresher water among the coregonids are: arctic cisco, least cisco, broad whitefish, lake whitefish and inconnu (Reist and Bond 1988). Consequently arctic cisco, which are well adapted to the highly variable salinity regimes of the estuary, are distributed widely throughout the nearshore waters of the region. The remaining species are more restricted to fresher waters of the estuary; whether for feeding; for access to coastal stream/lake systems for feeding and/or overwintering; or for access to spawning locations in the Mackenzie River and its tributaries.

Rainbow smelt which have a coastal distribution that is similar to the least cisco, may be more restricted to less saline waters, not so much because of intolerance to high salinities, but because they feed upon those juvenile fish which themselves prefer fresher water.

Marine/Estuarine Fish

The estuarine species which inhabit the nearshore coastal area have adapted to an environment which exhibits a wide range (both spatially and temporally) in temperature and salinity. They are classified as euryhaline species and include Pacific herring, starry and arctic flounders, saffron cod and fourhorn sculpin. Arctic cod and capelin are more truly marine species, preferring colder, more saline water.

Arctic cod, especially juveniles, are abundant and widely but perhaps patchily distributed outside (or at the periphery of) the freshwater plume of the Mackenzie River. Where cold, saline waters intrude coastward, arctic cod may also be plentiful. Arctic cod spawn locally in winter (Ratynski 1984), but it is likely that the regional abundance of this species is more dependant on spawning activity outside the region.

Capelin have a sporadic distribution in the southern Beaufort Sea. Information on this species is sparse, being limited to a few reports of spawning aggregations at Herschel Island and also at Baillie Island.

Important Coastal Habitat

There is little doubt about the importance of the Beaufort Sea coastal embayments to fishes (Craig 1984). Numerous coastal embayments and stream mouths between Herschel and Ballie Islands provide favourable oceanographic conditions important for feeding, overwintering, spawning and/or nursery grounds of marine and anadromous fish.

Euryhaline marine species are abundant in the nearshore zone the entire year. During summer the nearshore zone is important for feeding and as nursery grounds, while during winter fish utilize the nearshore as temperatures are more favourable. Fourhorn sculpin, arctic flounder and saffron cod spawn in the nearshore embayments during winter. Pacific herring congregate in coastal embayments in the fall, overwinter at these locations and subsequently spawn in June at the onset of break-up. Starry flounder spawn in these embayments shortly after break-up in late June or early July (Bond 1982; Gillman and Kristoffersson 1984; Lawrence *et al.* 1984; Ratynski 1984). During the open-water season, embayments which are closer to the Mackenzie River and are more likely to have 'fresher' water, provide important feeding and nursery habitat to coregonids.

Anadromous species which are less tolerant of higher salinities (inconnu and whitefishes) are more restricted in their distribution, both regionally and within the embayments which they inhabit. They tend to remain in the nearshore parts of bays, whereas ciscos and rainbow smelt are as likely to be found in the mid waters of the bays, as are Pacific herring and other marine species.

A number of coastal embayments provide important overwintering habitat for both marine species and arctic cisco (Percy 1975). Marine fish are thought to overwinter in the coastal embayments because of the relatively warmer water which exists there *vs.* cold offshore water. Many marine species also spawn at these locations.

3.2 Potential Effects of Oil

Brief descriptions of the types of effects that crude oil can have on arctic wildlife are included in the following sections.

3.2.1 Birds

Studies conducted on the effects of oil contamination on birds are numerous; recent reviews include Clark (1978); Leighton (1983, 1990); Clark (1984); Piatt *et al.* (1989); and Fry (1990). Reported effects vary with the type of oil, species of bird, weather, time of year, and duration of the spill. General categories of the effects of oil on birds include behavioural, internal and external changes that take place during the course of a spill (Frink 1987). Birds that are contaminated by oil frequently do not survive because (1) diving and resurfacing in a spill of heavy oil (e.g. Prudhoe Crude or Bunker C) causes feathers to bind to the body, hampering flight or buoyancy (Lambert and Peakall 1981; Clark 1984); (2) the insulative capabilities of feathers are lost, resulting in hypothermia and death (Clark 1984; Leighton 1990; Piatt 1990); and (3) the toxicity of the oil affects birds through ingestion or inhalation (Leighton 1983; Frink 1990; J. White pers. comm.). Although some birds may survive these immediate effects, long-term physiological changes (condition and reproduction) may occur as a result of thermal changes and/or oil ingestion (Ainley *et al.* 1981; Williams 1985; Frink and White 1990; Fry 1990; J. White pers. comm.).

It is now a well-accepted fact that birds are the group that is most at risk from a marine oil spill or blowout. Diving species such as loons, eiders, oldsquaws, scoters, mergansers, guillemots and murres are considered to be the most susceptible to the effects of surface slicks. However, other species such as phalaropes, gulls (including kittiwakes) and terns can be vulnerable to contacting oil because individuals feed over wide areas with frequent contact with the water's surface.

3.2.2 Marine Mammals

The effects of oil contamination on marine mammals are of concern not only because marine mammals are used as a traditional renewable resource, both as subsistence and as a cash income (Freeman 1976), but also because they play vital roles in the ecosystem they inhabit (Engelhardt 1985). Mammals that may be impacted during an oil spill in the Beaufort Sea include bowhead and beluga whales, ringed and bearded seals, polar bears and arctic fox.

Only anecdotal incidences of oiled mammals have been recorded in the wild (Richardson *et al.* 1989); the majority of studies conducted on the effects of oil on marine mammals have taken place in captivity (e.g., Geraci and Smith 1976; Kooyman *et al.* 1977; Øritsland *et al.* 1981; Hurst and Øritsland 1982; Geraci and St. Aubin 1990). Overall, ingestion of oil appears to be the most significant impact of an oil spill; all marine mammals studied showed some response to ingested oil. The importance of external effects varies among species (Engelhardt 1983).

Studies conducted on the effects of oil on hair seals (e.g., ringed, bearded) show that they suffer no deleterious thermal effects during an oil spill because of the insulative blubber layer that reduces the exchange of heat at the skin/fur interface (Geraci and St. Aubin 1980; St. Aubin 1990b). Immediately after birth, hair seal pups depend on fur (lanugo) for insulation until the blubber layer develops; thus, newborn pups would be susceptible to heat loss because of oiling (Geraci and Smith 1976). Other external effects, including oil plugged external nares and eye irritation have been reported, but the effects were minor and improvement was noticed within 3 hours of being placed in clean water (Geraci and Smith 1976; Richardson *et al.* 1989; St Aubin 1990b). St. Aubin (1990b) reported little evidence of serious internal effects in seals, although absorption of oil did occur, with the highest levels found in the liver and blubber. The oil absorbed was removed from the system in approximately 1 month (Engelhardt 1985).

There has been much speculation about possible detrimental effects of oil on whales, but there are few data. Geraci (1990) reviewed the available literature and concluded that previous oil spills have not been shown to have detrimental effects on whales in open ocean situations. However, Geraci points out that bowheads and belugas may be more vulnerable in leads and along ice edges in arctic waters where both oil and whales may be concentrated.

Few studies have been conducted on the effects of oil on polar bears; the results indicate that polar bears are seriously affected by oil, both externally and internally (Øritsland *et al.* 1981; Hurst *et al.* 1982). Thermal changes that resulted from oil contamination indicate that heat transfer increases up to 5 times the normal rate because the oil affects the physical characteristics of the natural oil coating as well as the heat load at the skin surface (Frisch *et al.* 1974; Øritsland *et al.* 1980; Øritsland *et al.* 1981; Hurst and Øritsland 1982; St. Aubin 1990a). Vomiting, anorexia and tremors were observed in bears that had ingested oil, although serious effects were apparent only 2-4 weeks after contact with oil (Øritsland *et al.* 1981; Richardson *et al.* 1989; St. Aubin 1990a). Ingestion of oil was caused mainly by the bear's efforts to clean the oil from its coat. Specific studies on the effects of oil ingestion by grizzly bears have not been conducted. It is reasonable to assume that effects would be similar to those in polar bears. No studies have been conducted on the impact of oil on the arctic fox or wolf, it may also be reasonable to expect that effects would be similar to those observed in polar bears.

3.2.3 Fish

Generally, effects of oil on fish can include mortality of adults, mortality of the more sensitive early life stages including eggs, and sublethal effects including tainting. There have been few reports of widespread effects of oil spills on adult fish, probably because of their mobility and ability to avoid oil. For example, even in large crude oil spills such as the *Argo Merchant* and *Amoco Cadiz*, effects on fish stocks have been negligible (McIntyre 1982). Eggs and larvae are about 10 times more sensitive than adult fish (Moore and Dwyer 1974), and are also vulnerable to oil because they are not sufficiently mobile to avoid oil exposure and because many develop at or near the surface where the risk of exposure to oil is greatest. In the Beaufort Sea, the spawning areas of most valued fish species would not be affected by spilled oil, but Pacific herring spawn on the bottom in shallow waters of a number of bays in the Beaufort Sea, and eggs and larvae of arctic cod float. Pacific herring embryos exposed to <1 ppm Prudhoe Bay crude oil were affected after 12 hours in experiments conducted by Smith and Cameron (1979). It should be pointed out, however, that natural mortality of fish eggs and larvae is very high, and that even larval losses of 50% or more may have little effect on an adult population (Longhurst 1982) unless the mortality is additive to the natural mortality.

Where oil concentrations or exposures are not high enough to kill fish, a variety of sublethal effects may occur. Fish readily take up components of oil into their tissues from water, food organisms, and sediment (e.g., Lee 1977; Varanasi and Malins 1977). Once accumulated, many hydrocarbon components can be metabolized by enzymes that are activated by the presence of hydrocarbon, and then excreted (e.g., Payne 1977; Stegman 1978). Reported sublethal effects include changes or damage to a variety of organs; physiological changes such as altered respiration, changes in blood parameters and on concentrations, and decreased energy reserves; and behavioural effects such as decreased ability to locate food or react to fright stimuli, disorientation, and changes in schooling behaviour.

Of particular concern where subsistence or commercial fisheries are involved is the tainting of flesh (defined as a change in appearance, texture, odour, or taste) that can result from the uptake of hydrocarbons from water, food, or sediments. Tainting may result from very low environmental concentrations of petroleum (e.g., 0.01-0.02 ppm hydrocarbons in sediment; Sidhu *et al.* 1972). Furthermore, public opinion may affect fish marketability even when fish are not tainted; for example, the price of fish dropped markedly in Paris after the *Torrey Canyon* spill, although few fish sold there were caught near the spill site (Nelson-Smith 1972). An oil spill may also lead to regulatory closures of fisheries even in the absence of tainting. In the Beaufort Sea, all anadromous fish, particularly broad whitefish, could be vulnerable to tainting because they feed close to shore during the open-water season.

At least some fish have the ability to detect and avoid oil. For example, pink salmon fry can detect and avoid oil concentrations of about 1% of the lethal dose (Rice 1973). However, fish may be highly motivated to migrate to a specific area even if they have to move through a polluted area (Rice 1985); this might apply to Arctic charr returning to their natal rivers in late summer, although appropriate experiments have not been conducted. There is also some concern that an oil spill might interfere with salmon homing, as the final stages of the homing migration are guided by olfactory cues (Brannon *et al.* 1986).

4.0 WILDLIFE RESTORATION TECHNIQUES

4.1 Birds

4.1.1 Restoration Techniques

The rescue, cleaning, and rehabilitation of oiled birds has been practised in several parts of the world for a number of years (Clark 1984). Although success rates of early methods of cleaning were not reported, cleaning commonly left the birds in a condition that did not allow them to survive in the wild (Berkner 1979). Early techniques included (1) use of a mild white soap and drying with a stream of compressed air directed at the feathers, (2) mixtures of corn oil, neatsfoot oil, detergent, waxes, solvent, and water that were applied to the bird, which than preened the substance from its feathers, and (3) the application of powdered chalk, fuller's earth, mascara remover, butter, lard, detergents, castor oil, mineral oil, and waterless handcleaner (Berkner 1979). The development of cleaning techniques reached its technological zenith with the immersion of oiled ducks in an ultrasonic cleaning device that was filled with a detergent solution (Berkner 1979).

The major problems with all of the early techniques were that the cleaned birds were not waterproof and that moulting often occurred, thereby delaying release by several weeks (Berkner 1979; Clark 1984; Kerley *et al.* 1985; J. White, IBRRC, pers. comm.). One approach was to induce an oiled bird to moult its oiled feathers and replace them with new clean feathers. This approach was halted when the stress of moulting in combination with the stress of captivity resulted in low survival (Clark 1978; Berkner 1979; Clark 1984). Attempts to synthesize the natural waterproofing of the bird led to the testing of preen waxes, e.g., Larodan 127 and spermaceti and lanolin in hexane. All substitutes failed to produce waterproofing; as the bird preened, it removed the wax and exposed the detergent residues (Clark 1978, 1984; Berkner 1979; J. Holcomb, IBRRC, pers. comm.).

As research into the use of oil dispersants began, the National Wildlife Health Association began testing the use of organic solvents (Gulfsol 10 & 20, Shellsol 71, Basic H, liquid concentrates) for cleaning oiled birds. Birds were washed in a series of warm solvent baths and dried using forced warm air. Although the use of solvents showed adverse toxic effects to both the bird and the handler (Berkner 1979; Clark 1984; Frink 1987), some success was observed. After a spill in the Halton (Ontario) area, 61 of 65 oiled birds that were treated with a solvent cleaner were released (G. Kirkovitz, MOE, pers. comm.).

In the mid 1970's, the International Bird Rescue Research Center was established and an initial study of 14 detergents was conducted (Berkner *et al.* 1977). It was found that an industrial strength biodegradable detergent (Lux Liquid Amber) was capable of removing most oils without leaving surfactant residues (Berkner 1979; Williams 1983; Clark 1984; Frink 1987; Frink and White 1990; J. Holcomb, IBRRC, pers. comm.). With the establishment of detergent cleaners, post-cleaning mortalities declined; in 1978, 32% of 423 birds contaminated during a spill in Virginia were released, and 24 of 28 puddle ducks oiled in Lake Simcoe were rehabilitated and released (Berkner 1979; J. Wernaart, HCA, pers. comm.). Detergents proved to be the most effective, safe, and available technique for cleaning birds. Using a 1% solution in water at 40°C, oil is removed effectively; it is not absorbed by the feathers and can be rinsed off thoroughly (Clark 1978; Berkner 1979; Randall *et al.* 1980; Williams 1985; Frink 1987; Bryndza *et al.* 1990; J. Holcomb, IBRRC, pers. comm.). During the *Exxon Valdez* incident in Alaska, workers from the International Bird Rescue Research Center found that by increasing the temperature of the wash water by approximately 2-3°C, the solution became more effective and the birds were not exposed to thermal shock (Frink and White 1990). The majority of failures in rehabilitating oiled birds now result from unsuitable conditions for maintaining birds before and after cleaning (Clark 1978; Frink and White 1990).

Williams (1985) established a set of guidelines for rehabilitation of oiled birds. These include (1) stabilize the bird before washing, (2) remove the oil from feathers, (3) remove cleaning agent from the feathers, (4) restore the waterproofing, and (5) acclimate the bird for release. With the advent of this protocol, the success rate for oiled birds has increased dramatically (Williams 1985). Release rates vary with species, type of oil, and the speed of retrieval of oiled birds during a spill, but the protocol is effective and results are good. Using this method, 90% of Anseriformes (Canada and snow geese, mallards), 73% of diving ducks and grebes, 50% of Gaviformes (loons) and 68% of the penguins affected by an oil spill on St. Croix Island, South Africa, were rehabilitated to the wild (Randall *et al.* 1980; Frink 1987).

4.1.2 Applicability to the Beaufort Sea

The applicability of the technique of Williams (1985) to an arctic situation is indicated by the results of its use in the bird recovery effort following the *Exxon Valdez* incident in 1988. Of a total of about 36,000 oiled birds collected, 1630 (<5%) were rescued alive and treated (J. Holcomb, IBRRC, pers. comm.). Survival rates varied among the treatment centres: 581 of 849 birds (68%) treated at the Seward base were released, 102 of 368 birds (28%) treated at the *Valdez* base were released, 89 of 221 birds (40%) treated at the Kodiak base were released, and 55 of 192 birds (29%) treated at the Homer base were released (J. Holcomb, IBRRC, pers. comm.). Overall, the success rate for cleaning living birds was 51%.

The infrastructure and logistic support available to respond to the *Exxon Valdez* spill was much greater than would be available in the Beaufort Sea. Even so, only about 800 of the 36,000 birds recovered were successfully rehabilitated and returned to the wild in the Alaska spill. Furthermore, this 2% recovery rate greatly overestimates the overall effectiveness of the cleaning efforts. Piatt *et al.* (1990) have estimated that 100,000 to 300,000 birds were killed by oil from the *Exxon Valdez*. Therefore, the massive rescue attempts associated with the *Exxon Valdez* spill managed to save only 0.3 to 0.8% of the birds that were potentially fatally oiled by the spill.

Rescue attempts in the Beaufort Sea would suffer from a much more rudimentary infrastructure. On the other hand, a major spill in the Beaufort would come from a long-running blowout rather than an instantaneous release from a tanker accident. Thus, much more time would be available to establish treatment centres and a higher proportion of the retrieved birds would be freshly oiled. These characteristics might counter-balance the lower logistics support in the Beaufort.

Approximate costs associated with the *Exxon Valdez* cleanup are discussed later.

4.1.3 Restocking Bird Populations

Although recovery rates for oiled birds have increased with improved cleaning techniques, the official policy of groups such as the Royal Society for the Prevention of Cruelty to Animals and the Royal Society for the Protection of Birds is that oiled birds should be humanely destroyed (Clark, 1984). Conservation measures can then be implemented, for example restocking.

Although no efforts to restock birds in areas suffering from major oil spills have been conducted, there have been several programs to reintroduce birds into abandoned parts of their ranges. These have usually involved endangered species such as peregrine falcons and trumpeter swans. A variety of techniques have been tried. These include releasing captive-reared fledgling birds at natural or artificial nest sites (e.g., hacking of peregrine falcons), placing eggs from nests in one part of the range (or from captive birds) into nests of similar species in the areas of concern (e.g., peregrine eggs into prairie falcon nests, whooping crane eggs into sandhill crane nests, trumpeter swan eggs into mute swan nests, yellow-headed blackbird eggs into red-winged blackbird nests), and releasing juvenile and adult birds into selected receiving areas (e.g., Atlantic puffins off the Maine coast and along the Brittany coast, and Canada geese in many areas).

These efforts have met with variable success. They all involve much planning and the programs are multi-year efforts that require a long-term commitment of manpower and resources. None of these programs has been attempted with arctic marine species. The most relevant case involves the successful reestablishment of colonies of Atlantic puffins in New England and France (Duncombe and Reille 1980; Clark 1984). Puffins are alcids and are close relatives of the thick-billed murre and black guillemot, that nest in the Beaufort Sea region. However, the puffins nest in burrows, whereas murres are cliff-nesters and guillemots nest among rocks and coastal debris. Thus, colonies of arctic alcids would be more difficult to re-establish.

4.1.4 Enhancement Techniques

There are a few techniques which can be employed to increase bird populations that remain after a spill. The nesting success of some species can be improved by manipulation of nesting habitat. For example, common eider females nest preferentially in well-protected areas near logs and among driftwood and rocks (Johnson and Herter 1989). Thus, the numbers of nesting sites can be increased by adding and rearranging driftwood along coasts and on barrier islands (S.R. Johnson, LGL Ltd., pers. comm.). Similarly, it should be possible to enhance the nesting habitat for black guillemots in the Herschel Island area where it nests among beach debris, much of it man-made. Artificial nesting structures have been used to create the largest guillemot colony (450 adults) in Alaska on Cooper Island off the Alaskan Beaufort Sea coast (Johnson and Herter 1989).

One option for enhancing recovery of depleted species is to eliminate hunting of that species, if it is a hunted species. Depending upon the severity of the situation, hunting could be curtailed locally within the Beaufort Sea area or on a wider basis. Of course, local closures of hunting would have implications for wildlife compensation programs.

4.2 Marine Mammals

4.2.1 Restoration Techniques

Few studies have been conducted on the rehabilitation of oiled marine mammals. The majority of recent work has concentrated on the rehabilitation of sea otters which are the most vulnerable marine mammal to oil (Costa and Kooyman 1981; Williams and Davis 1990; Geraci and Williams 1990; T.M. Williams, I.W.R., pers. comm.). Sea otters do not occur in the Beaufort Sea.

Since seals show no active avoidance of oil slicks (Geraci and Smith 1976), and free-ranging polar bears have been reported to consume small quantities of petroleum from installations or camps in the arctic (Engelhardt 1981; M. Taylor, GNWT, pers. comm.), it is reasonable to believe that some of these animals will become oiled during a spill. To our knowledge, cleaning of oiled hair seals has not been attempted. In studies conducted on ringed seals, Geraci and Smith (1976) found that seal pelage cleaned itself from a 100% coating of oil after one day of swimming in clean sea water (Engelhardt 1981, 1987). Rehabilitation techniques, therefore, may not be necessary for hair seals.

While conducting work on the effects of oil on polar bears, Øritsland *et al.* (1981) noticed that the fur became discoloured and that matting oil was present at the base of the hairs. Treatment with solvents removed all of the discolouration and matting oil residues (Engelhardt 1981). Although it is theoretically possible to clean oiled bears, there are very significant logistics problems in finding oiled bears and then tranquillizing and transporting them to some well-built, heated holding facilities for treatment and subsequent release. One of the major concerns is that oiled bears immediately try to lick the oil off of their fur (Stirling 1990). During this process, they could ingest substantial amounts of oil which could eventually prove fatal to the bear (*cf.* St. Aubin 1990a for a review). Thus, any rescue attempt would only be successful if the bears were captured soon after oiling. In addition, there is a possibility that bears that are stressed by oil may not survive the tranquillizing process.

There are no known methods for capturing and cleaning free-ranging whales nor is it clear that such efforts are necessary. The stress, social disruption, and possibility for accidents during capture attempts would probably cause more damage to the whales than would the oil.

No experiments or observations have been reported on oiled foxes or wolves. Similarities in hair structure would suggest that techniques applied to bears would probably be applicable to foxes.

4.2.3 Restocking Marine Mammals

The potential for restocking oil-affected marine mammal populations is unknown. Polar bears are the species of most concern since they could suffer substantial mortality from a major spill. Polar bears have large home ranges; furthermore, polar bear cubs remain with their mothers for up to three years, thereby learning about the large ranges (M. Taylor, GNWT, pers. comm.). These behaviour patterns suggest that bears transplanted to the Beaufort might have difficulty surviving in the unfamiliar terrain. Attempts have been made to relocate nuisance bears in Churchill, Manitoba, but the bears usually returned to the area they were taken from in a relatively short time (M. Taylor, GNWT, pers. comm).

The most important problem, however, is that reservoir populations of polar bears are not known (M.Taylor, GNWT, pers. comm.). Even if such reservoirs of surplus bears could be demonstrated, transplant programs may have questionable value. Prevention and deterrents are undoubtedly more valuable than restoration where bears are involved.

4.3 Fish

4.3.1 Restoration Techniques

To our knowledge, there have been no attempts made to clean oiled fish. Fish that become tainted by hydrocarbon exposure will lose the taint naturally after a period of time in an uncontaminated environment; detailed information is lacking, but depuration may take weeks or months (Tidmarsh *et al.* 1985).

4.3.2 Restocking

Eggs and larvae are the fish life stages that are most at risk from oil. In the event that Pacific herring eggs were to suffer massive mortality, it might be possible to restock the Beaufort Sea population or specific subpopulations within the Beaufort Sea. Eggs could be moved from one Beaufort Sea spawning location to another, or from areas outside the Beaufort Sea to affected spawning locations. To our knowledge, attempts to restock herring populations have not been made.

Collection of herring eggs is feasible because the eggs are deposited on and adhere to macrophytic algae; temperature control and oxygen supply would be two main considerations during transport. Some success in collecting and transporting herring eggs for use in experiments has been reported. Smith and Cameron (1979) collected eggs of Pacific herring together with the macroalgae to which they were attached (*Thalassiophyllum clathrus*) near Tatitlick, Alaska, 2-3 days after spawning, and transported them the same day by float plane to the Seward Marine Station. Before the experiments began, the eggs were maintained for three days in seawater at 3.5 to 6.0°C, a temperature range chosen to insure that little embryo development took place. Subsequently, the eggs hatched after 12-17 days at 9°C; hatching success was from 39-83%.

Because the eggs of Arctic cod are pelagic, it is likely that restocking is neither be feasible nor necessary. Only a massive oil spill would deplete cod populations through egg mortality. Natural restocking of Beaufort Sea populations would be possible, although it is probable that many different stocks or semi-discrete populations of arctic cod exist (e.g., Bradstreet *et al.* 1986:30).

5.0 WILDLIFE HABITAT RESTORATION TECHNIQUES

Standard shoreline clean-up techniques are not considered in this report. Only those techniques that could be used after, or in conjunction, with shoreline clean-up to attempt to return wildlife habitat to its original state are considered. Included are rehabilitation of oiled tundra and enhancement of biodegradation of oil on the shoreline.

5.1 Tundra Restoration

Oil from a blowout could be transported onto coastal tundra by storm surges driven by strong winds. The range of techniques available to clean or restore oil-contaminated arctic tundra is limited because of the fragile nature of the environment. Techniques that have been described for tundra include (1) allowing the area to recover naturally (Bliss and Wein 1972), (2) reseeding or revegetation of native or non-native plants (Younkin 1976; McKendrick and Mitchell 1978a; Chapman and Chapman 1980; Brendel and Bragaw 1985), (3) application of fertilizers (McKendrick and Mitchell 1978a; Walker *et al.* 1978; Chapman and Chapman 1980; Brendel and Bragaw 1985), (4) manual labour if the oil is lumpy and is contained in a small area, (5) mechanical cleaning if the spill is large-scale (McKendrick and Mitchell 1978a; Logan *et al.* 1975; Pope *et al.* 1982; Brendel and Bragaw 1985), (6) use of bacteria and covering the site with clean soil (Brendel and Bragaw 1985), and (7) the use of fire (McKendrick and Mitchell 1978b).

Experimental work conducted on tundra plants in the Mackenzie Delta and Arctic Archipelago by Bliss and Wein (1972), Freedman and Hutchinson (1976), and Walker *et al.* (1978) indicated that crude oil does affect tundra species, but that natural recovery occurred fairly quickly. During an experimental spill of crude oil, the leaves of all plants present were killed. Impacts of oil were most detrimental during October and in wet sedge communities in the summer; effects of winter spills were reduced because the oil evaporated and lost some of its toxicity between the time of the spill and the time of contact with the plant tissue (Freedman and Hutchinson 1976). Regrowth in some of the woody species (Labrador tea, dwarf birch) occurred the same summer, and additional species showed regrowth during the second summer. In lichens and mosses, no regrowth was recorded in the short term. Full recovery of vegetation (lichens, sedges and grasses, vascular plants) to pre-spill ground cover, however, took approximately seven years, and full recovery of plant biomass took 10-15 years (Freedman and Hutchinson 1976; Walker *et al.* 1987).

The application of fertilizers to oil-damaged sites appears to enhance regrowth immensely in the Beaufort Sea region (McKendrick and Mitchell 1978a). Monitoring of vegetation after an accidental spill in Prudhoe Bay showed that moss cover became re-established during the first growing season after application of phosphorous fertilizer. Grasses and sedges not killed by oil also showed enhanced growth when phosphorus was applied. Applications of nitrogen and potassium fertilizers, separately and together, produced no significant response by resident and seeded plant species in the spill area (McKendrick and Mitchell 1978a). Similar responses to fertilizers have occurred in later studies, although full recovery of native species to an above-ground biomass equal to that of an undisturbed site takes between 5-10 years (Chapin and Chapin 1980; Brenel and Bragaw 1985).

The Foundation of Technical and Industrial Research at the Norwegian Institute of Technology (SINTEF) has conducted a number of experiments on the use of fertilizers to treat oiled vegetation of the supralittoral zone of arctic and sub-arctic beaches. Halmo (1985) reported results of in situ experiments on the effects of two different fertilizers--a water-soluble commercial grade fertilizer and an oil-soluble fertilizer, consisting of urea in a microemulsion of oleic acid--on the vegetated supralittoral zone of a low energy beach at 63.5°N latitude on the Norwegian coast. Test plots were oiled at a rate of 20 L/m^2 with weathered Statfjord crude oil emulsified with equal parts of seawater. During the first summer (June-September), fertilizers increased oil biodegradation significantly; 45 to 85% of paraffins were decomposed, as compared with 10 to 25% decomposition of paraffins in plots containing oil alone. One year later, paraffins had degraded completely in the fertilized plots, whereas 20 to 30% of paraffins remained in the unfertilized plots. There were no significant differences between the two fertilizers tested.

Sendstad (1980) and Sendstad *et al.* (1984) applied a commercial agricultural fertilizer to the vegetated supralittoral zone of a low energy beach on Spitsbergen that had been oiled two years previously with unweathered Forcados crude at a rate of 10 L/m^2. Most of the vegetation, dominated by the grass *Puccinellia phryganoces* and the moss *Bryum* sp., died within three days of oiling, and densities of the dominant invertebrates in the soil (*Collembola*) were reduced to less than 1% of pre-oiling densities. Fertilizers increased heterotrophic soil respiration 3X in the first year and 2X in the second year; thereafter, there were no apparent differences between fertilized and unfertilized plots. After four years, 2.3% and 1.8% of the oil remained in the top layer of soil in unfertilized and fertilized plots, respectively. Fertilizers also increased recovery of soil invertebrates: *Collembola* numbers were 2% and 42% of pre-oiling numbers in unfertilized and fertilized plots, respectively. Seven years after oiling, vegetation in the unfertilized plot was still dead, whereas the fertilized plot was colonized by moss. Results in the two years after treatment indicate that fertilizer should be applied more than once.

Manual and mechanical cleanup apparently cause far more damage than just leaving the oil on the tundra (Bliss and Wein 1972; Rickard and Brown 1974; Logan *et al.* 1975; Pope *et al.* 1980; Brendel and Bragaw 1985). Removal of the oiled material causes thermal erosion (Brendel and Bragaw 1985), and the necessity of disposing of contaminated material and the impact that results from trampling (Freedman and Hutchinson 1976; McKendrick and Mitchell 1978a) make this method a doubtful technique. Damage to the tundra is particularly severe if ice lenses or a thin active layer are present. Throughout the recent 'Environmental Atlas for Beaufort Sea Oil

Spill Response', Dickins *et al.* (1987) emphasized that heavy mechanical shoreline equipment must not be used on tundra shorelines, and that only small scale mechanical cleanup should be considered.

Brendel and Bragaw (1985) attempted to break up spilled oil along the Trans-Alaskan Pipeline and increase microbial activity by seeding with bacteria and covering the oiled area. The availability of clean fill close to the spill site was the major problem with the cover technique. More field work is necessary to evaluate the usefulness of the application of bacteria, although the results of the study indicate that without the addition of fertilizer and aeration of the soil, the technique is of doubtful merit (Brendel and Bragaw 1985).

The use of fire as a method of restoring oiled habitat has been examined by McKendrick and Mitchell (1978b), who studied the effects of fire on six habitat types, including mesic and wet arctic tundra, in the Matanuska Valley, Fairbanks, and Prudhoe Bay. Fires were set immediately after application of oil to the habitat and three weeks after oiling. Attempts were also made to use fire to remove warm oil applied to snow-covered tundra. The results from the study indicated that fires could only be lit immediately after oil was spilled; otherwise, the volatile fractions had evaporated and oil had been incorporated into the spongy soil layer. Results on the vegetation showed that oiling plus burning appeared to cause more damage than oil alone; grass survival was reduced and sedges were eliminated (McKendrick and Mitchell 1978b). Natural fires on unoiled tundra, on the other hand, cause increased nutrient levels and increased depth of the active layer, which in turn causes rapid regrowth in woody species, grasses and sedges; lichens and mosses, however, are completely destroyed by fire (Bliss and Wein, 1972; G.M. Courtin and P.J. Beckett, pers. comm.).

A technique has been developed and tested in the Prudhoe Bay Oilfield to minimize further damage to oil-affected areas, while stimulating regrowth. The steps included (1) pumping oil-covered water areas into reserve pits where mop machines were used to recover the oil, (2) applying sorbents to areas that could not be pumped, (3) using manual labour to trim the tundra close to the ground surface, (4) raking to provide increased aeration and mixing of natural vegetation and root mats, and (5) keeping the number of personnel in an area down to 1 or 2 people and using boardwalks and ramps for equipment (Pope *et al.* 1982). Results from test plots showed that revegetation began three weeks after the application of the restoration technique (in May). New growth was approximately 1 to 5 inches in height and covered over 50% of the affected area. By October, 80% of the affected area was covered (Pope *et al.* 1982). When compared to previously described techniques, where revegetation usually requires several years to obtain 80% coverage (e.g., Bliss and Wein 1972), this method allows for restoration of the natural environment within the first season. This technique alleviates subsequent work on the site, reduces costs, and requires only periodic monitoring (Pope *et al.* 1982). However, the technique may more be appropriate for site-specific spills rather than major incursions caused by storm surges.

5.2 Enhancement of Biodegradation on Shorelines

The Norwegian Institute of Technology (SINTEF) has conducted experiments on the use of fertilizers to treat oiled arctic beaches. Sveum (1987, 1989) tested an oil-soluble fertilizer developed by Elf Aquitaine, INIPOL EAP22, on oiled shorelines on Spitsbergen, Norway. Virtually no biodegradation was observed in one set of experiments, where the fertilizer was applied on an ebb tide to fine-grained sediments on a lagoon shoreline to which 6 L/m^2 of oil had been applied. On coarser grained sediments, however, biodegradation was enhanced markedly by the application of fertilizer: on sandy sediments oiled with Statfjord A+B crude at 10 L/m^2, fertilization increased biodegradation by 60%, and on a gravel beach accidentally oiled with marine gas, enhancement reached 90% during the summer of fertilizer application.

As a part of the Baffin Island Oil Spill (BIOS) Project, common agricultural fertilizers were tested on the backshore of a high energy beach at Cape Hatt, near Pond Inlet on Baffin Island (Sendstad *et al.* 1982; Eimhjellen and Josefsen 1984). Test plots were oiled with a 1:1 weathered Lago Medio crude:seawater emulsion at a rate of 20 L/m^2, and three different fertilizer treatments were applied: 0.04 kg/m^2, 0.4 kg/m^2, and 0.4 kg/m^2 with mixing with a garden tiller. In the same summer that the plots were established, high tides and heavy waves covered the plots with 5-20 cm of sand and gravel, and the plots remained buried throughout the experiment. It was concluded that 1-2 years were required to observe any significant change in composition or amount of oil in the sediment under those conditions, that heterotrophic respiration of oil could be enhanced up to 5X, and that a combination of fertilization and mechanical mixing of the oil and fertilizer provided the highest rates of biodegradation.

Following the *Exxon Valdez* spill, small-scale experiments were conducted by adding nitrogen and phosphorous nutrients to an oiled rocky beach; levels of oil-degrading micro-organisms were 30-100X higher than in untreated areas. Based on the success of that experiment, EPA approved Exxon's proposal to apply nutrients to a 5800 yard oiled shoreline on Green and Seal Islands in Prince William Sound. Two types of fertilizer were applied: an oleophilic and a slow-release soluble fertilizer. Slow release briquettes were placed in herring nets offshore and nutrients were released and distributed to the beach surface by rain or tidal action. The oleophilic fertilizer was sprayed directly onto the beach. Two types of beaches were tested, cobblestone and sand and gravel beach. Significant changes were observed in both beach types two weeks after the oleophilic fertilizer was applied. Oil on the rock surface was removed, although oil remained in the mixed gravel below the rocks. Similar results were observed for the sand and gravel beach, however, visual disappearance of oil was less apparent in sand and gravel. The beaches fertilized with the briquettes were relatively unchanged (C. Sikstrom pers. comm.). No adverse effects of the fertilizers were found (C. Sikstrom pers. comm.), making this application a safe and efficient technique.

Efforts to seed oiled sediments with bacteria have met with limited success (J. Bunch, DFO, pers. comm.). The most promising approach to enhancing the biodegration of oil is through periodic replenishment of nutrients after the indigenous microflora have adapted to the contaminated sediments (Lee and Levy 1987).

6.0 POTENTIAL RESTORATION COSTS

It was beyond the scope of this discussion paper to attempt to determine the costs of various restoration techniques. However, during the course of the preparation of this document, some interesting data on costs associated with the *Exxon Valdez* spill were obtained.

Information on wildlife restoration costs for the *Exxon Valdez* incident in 1988 were provided by personnel from the International Bird Rescue and Research Center and International Wildlife Research. The total cost of wildlife restoration for the Prince William Sound spill to Exxon Corporation was $45 million (US)--$1.4 million for eagles, $25.3 million for other birds, and $18.3 million for sea otters. A rough operational break-down is as follows: $21 million for wildlife search and rescue boat charter, $12 million for personnel, $2 million in aircraft costs, and $10 million for rescue centres. This represents a cost of more than $15,000 for each bird treated (or more than $30,000 for each bird released), and more than $51,000 for each sea otter treated (or more than $82,000 for each otter released).

The high restoration costs incurred during the *Exxon Valdez* incident were partly a result of poor planning and attempts at public relations; for example, fishing boats that could not fish and normally chartered for $500/day were chartered for $3000/day to rescue oiled wildlife. It is estimated that the same operation could have been conducted for less than 1/2 of the $45 million (J. Holcomb, pers. comm.).

Restoration costs in the Beaufort Sea might be higher than those incurred in Prince William Sound because there is a relative absence of infrastructure in the Beaufort Sea region. Much of the existing facilities and logistics capabilities will be directed toward relief well efforts and offshore oil contaminant and recovery. Therefore, the incremental costs of restoration efforts in the Beaufort might be very high.

7.0 CONCLUSIONS

Because this is a background discussion paper for a workshop, we have not attempted to reach specific conclusions since this is the purpose of the workshop. It is clear, however, that the restoration of arctic wildlife and its habitat is not a well-developed science. Apart from the direct clean-up of oil, there has been virtually no research on the subject.

8.0 LITERATURE CITED

Ainley, D.G., C.R. Grau, T.E. Roudybush, S.H. Morrell and J.M. Utts. 1981. Petroleum ingestion reduces reproduction in Cassin's Auklets. Marine Poll. Bull. 12(9):314-317.

Alexander, S.A., T.W. Barry, D.L. Dickson, H.D. Prus and K.E. Smyth. 1988. Key areas for birds in coastal regions of the Canadian Beaufort Sea. Rep. by Can. Wildl. Serv., Edmonton. 146 p.

Berkner, A.B. 1979. Wildlife Rehabilitation techniques: Past, Present, and Future. p. 127-133 *In*: Proceedings of the 1979 U.S. Fish and Wildlife Service Pollution Response Workshop. St. Petersburg Florida.

Berkner, A.B., D.C. Smith and A.S. Williams. 1977. Cleaning agents for oiled wildlife. p. 411-415 *In*: Proceedings of the 1977 Conf. on the Prevention and Control of Oil Pollution. Am. Petrol. Inst., Washington. D.C.

Bliss, L.C. and R.W. Wein. 1971. Plant community responses to disturbances in the western Canadian Arctic. Can. J. Bot. 50:1097-1109.

Bond, W.A. 1982. A study of the fish resources of Tuktoyaktuk Harbour, southern Beaufort Sea coast, with special reference to life histories of anadromous coregonids. Can. Tech. Rep. Fish. Aquat. Sci. 1119:vii. 90 p.

Bradstreet, M.S.W., K.J. Finley, A.D, Sekerak, W.B. Griffiths, C.R. Evans, M.F. Fabijan, and H.E. Stallard. 1986. Aspects of the biology of Arctic cod (*Boreogadus saida*) and its importance in arctic marine food chains. Can. Tech. Rep. Fish. Aquat. Sci. No. 1491. viii + 193 p.

Brannon, E.L., T.P. Quinn, R.P. Whitman, A.E. Nevissi and R.E. Nakatani. 1986. Homing of adult chinook salmon after brief exposure to whole and dispersed crude oil. Trans. Amer. Fish. Soc. 115:823-827.

Brendel, J. and S. Bragaw. 1985. Revegetation of arctic tundra after an oil spill : a case history. p. 315-318 *In*: Proceedings of the 1985 Oil Spill Conference, Los Angles California. 651 p.

Bryndza, H.E., J.P. Foster, J.H. McCartney, J.C. Lober and B. Lundberg. 1990. Surfactant efficiency in removal of petrochemicals from feathers. *In*: The effects of oil on wildlife: Research, Rehabilitation and general concerns. Presented by International Wildlife Research, Tri-State Bird Rescue and Research, Inc. and International Bird Rescue Research Center. Washington.

Chapin III, F.S. and M.C. Chapin. 1980. Revegetation of an arctic disturbed site by native tundra species. Jour. Appl. Ecol. 17:449-456.

Clark, R.B. 1978. Oiled seabird rescue and conservation. J. Fish. Res. Board Can 35:675-678.

Clark, R.B. 1984. Impact of oil pollution on seabirds. Envirn. Poll. 33:1-22.

Costa, D.P. and G.L. Kooyman. 1981. Oxygen consumption, thermoregulation and the effect of fur oiling and washing on the sea otter, *Enhydra lutris*. Can. J. Zool. 60:2761-2767.

Craig, P.C. 1984. Fish use of coastal waters of the Alaskan Beaufort Sea: A review. Trans. Amer. Fish. Soc. 113:265-282.

Davis, R.A. and C.R. Evans. 1982. Offshore distribution and numbers of white whales in the eastern Beaufort Sea and Amundsen Gulf, summer 1981. Rep. by LGL Ltd., Toronto, Ont., for Sohio Alaska Petroleum Company, Anchorage, AK, and Dome Petroleum Ltd., Calgary, Alta. 78 p.

Dickins, D., I. Martin, I. Bjerkelund, S. Potter, D. Erickson, J. Harper, P. Norton, S. Johnson, P. Vonk. 1987. Environmental Atlas for Beaufort Sea Oil Spill Response. D.F. Dickins Assoc. Ltd., and ESL Environmental Sciences Ltd., Vancouver British Columbia. 182 p.

Duncombe, F. and A. Reille. 1980. Experience de transplantation de macareau. Courrier de la Nature:13-17.

Eberhardt, L.E., R.A. Garrott and W.C. Hanson. 1983. Winter movements of arctic foxes, *Alopex lagopus*, in a petroleum development area. Can. Field-Nat. 97:66-70.

Eimhjellen, K. and K. Josefsen. 1984. Microbiology 2: Biodegradation of stranded oil-1983 results. Baffin Island Oil Spill Project Working Rep. 83-6. Environmental Protection Service, Environment Canada, Ottawa. 58 p.

Engelhardt, F.R. 1981. Oil pollution in polar bears : exposure and clinical effects. p. 139-179 *In*: Proceedings of the 4th AMOP Technical Seminar, Edmonton Alberta. 741 p.

Engelhardt, F.R. 1983. Petroleum effects on marine mammals. Aquatic Toxicology 4:199-217.

Engelhardt, F.R. 1985. Effects of petroleum on marine mammals. p. 217-243 *In*: F.R. Engelhardt (ed.), Petroleum effects in the Arctic Environment. Elsevier Applied Science Pub. London.

Engelhardt, F.R. 1987. Assessment of the vulnerability of marine mammals to oil pollution. p. 101-338 *In*: J. Kuiper and Van den Brink W.J. (eds.), Fate and effects of oil in marine ecosystems. Maratinus Niijhoff Publ., Netherlands.

Fraker, P.N. and M.A. Fraker. 1982. The 1981 white whale monitoring program, Mackenzie estuary. Rep. by LGL Ltd., Sidney, B.C. for Esso Resources Canada Ltd., Calgary. 74 p.

Freedman, W. and T.C. Hutchinson. 1976. Physical and biological effects of an experimental crude oil spill on low arctic tundra in the vicinity of Tuktoyaktuk, N.W.T. Canada. Can. J. Bot. 54(19):2219-2230.

Freeman, M.R. (ed.). 1976. Inuit land use and occupancy project. Vol. 1 & III. Thorn Press Limited, Ottawa. 153 p.

Frink, L. 1987. An overview: Rehabilitation of oil contaminated birds. p. 479-482 *In*: Proceedings of the 1987 Oil Spill Conference: Prevention, Behaviour, Control, Cleanup. Baltimore, Maryland. 634 p.

Frink, L. and J. White. 1990. A perspective on the effects of oil on birds. *In*: The effects of oil on wildlife: Research, rehabilitation and general concerns. Presented by International Wildlife Research, Tri-State Bird Rescue and Research, Inc. and International Bird Rescue Research Center. Washington.

Frisch, J., N.A. Øritsland and J. Krog. 1974. Insulation of furs in water. Comp. Biochem. Physiol. 47A:403-410.

Fry, D.M. 1990. Oil exposure and stress effects on avian reproduction. *In*: The effects of oil on wildlife: Research, rehabilitation and general concerns. Presented by International Wildlife Research, Tri-State Bird Rescue and Research, Inc. and International Bird Rescue Research Center. Washington.

Geraci, J.R. 1990. Physiologic and toxic effects on cetaceans. p. 167-197 *In*: J.R. Geraci and D.J. St. Aubin (eds.), Sea mammals and oil: confronting the risks. Academic Press, San Diego. 282 p.

Geraci, J.R. and T.G. Smith. 1976. Direct and Indirect effects of oil on ringed seals, Phoca hispida, of the Beaufort Sea. J. Fish. Res. Board Can. 33:1976-1984.

Geraci, J.R. and D.J. St. Aubin. 1980. Offshore petroleum resource development and marine mammals: a review and research recommendations. Mar. Fish. Rev. 42(11):1-12.

Geraci, J.R. and D.J. St. Aubin (eds.). 1990. Sea mammals and oil: confronting the risks. Academic Press, San Diego. 282 p.

Gillman, D.V. and A.H. Kristoferrson. 1984. Biological data on Pacific herring (*Clupea harengus pallasi*) from Tuktoyaktuk harbour and Liverpool Bay area, N.W.T., 1981 to 1983. Can. Data Rep. Fish. Aquat. Sci. 485:iv + 22 p.

Halmo, G. 1985. Enhanced biodegradation of oil. Proc. 1985 Oil Spill Conf. Amer. Petrol. Inst., Publ. No.4385:531-537.

Harwood, L.A. 1989. Distribution of ringed seals in the southeast Beaufort Sea during late summer. M.Sc. Thesis, Univ. Alberta, Edmonton. 131 p.

Hurst, R.J. and N.A. Oritsland. 1982. Polar bear thermoregulation: effect of oil on the insulative properties of fur. J. Therm. Biol. 7 : 201-208.

Johnson, S.R. and D.R. Herter. 1989. The birds of the Beaufort Sea. BP Exploration (Alaska) Inc., Anchorage. 372 p.

Kerley, G.I., T. Erasmus, and R.P. Mason. 1985. Effect of moult on crude oil load in Jackass Penguin, *Spheniscus demersus*. Mar. Poll. Bull. 16(12):474-476.

Kooyman, G.L., R.W. Davis and M. Castellini. 1977. Thermal conductance of immersed pinniped and sea otter pelts before and after oiling with Prudhoe Bay crude. p. 151-157 *In*: D.A. Wolfe (ed.), Fate and effects of petroleum hydrocarbons on marine ecosystems and organisms. Pergamon Press, Oxford.

Lambert, G. and D.B. Peakall. 1981. Thermoregulatory metabolism in mallard ducks exposed to crude oil and dispersant. p. 181-194 *In*: Proceedings of the 4th AMOP Technical Seminar, Edmonton Alberta. 742 p.

Lawrence, M.J., G. Lacho and S. Davies. 1984. A survey of the coastal fishes of the southeastern Beaufort Sea. Can. Tech. Rep. Fish. Aquat. Sci. 1220:x + 178 p.

Lee, K. and E.M. Levy. 1987. Enhanced biodegradation of a light crude oil in sandy beaches. p. 411-416 *In*: Proc. 1987 Oil Spill Conf., Am. Petrol. Inst. Publ. No. 4452. Washington.

Lee, R.F. 1977. Accumulation and turnover of petroleum hydrocarbons in marine organisms. p. 60-70 *In*: D.A. Wolfe (ed.), Fate and effects of petroleum hydrocarbons in marine ecosystems and organisms. Pergamon Press, Oxford.

Leighton, F.A. 1990. The effects of petroleum oils on birds: an overview and perspectives on current knowledge. *In*: The effects of oil on wildlife: Research, rehabilitation and general concerns. Presented by International Wildlife Research, Tri-State Bird Rescue and Research, Inc. and International Bird Rescue Research Center. Washington.

Leighton, F.P. 1983. The pathophysiology of petroleum toxicity in birds: A review. *In*: The Effects of oil on Birds : Physiological Research, Clinical Applications and Rehabilitation. Rosie, D.G. and S.A. Barnes (eds.), Wilmington Press, Deleware.

Logan, W.J., D.E. Thornton, and S.L. Ross. 1975. Oil Spill Countermeasures for the Southern Beaufort Sea. Beaufort Sea Technical Report # 31b. Department of the Enivronment Victoria British Columbia. 126 p.

Longhurst, A. 1982. Consultation on the consequences of offshore oil production on offshore fish stocks and fishing operations. p. 195 *In*: Can. Tech. Rep. Fish. Aquatic. Sci. Rep. No. 1096, Fisheries and Oceans, Ottawa.

McIntyre, A.D. 1982. Oil pollution and fisheries. Philos. Trans. Roy. Soc. London, Ser. B. 279:217-225.

McKendrick, J.D. and W.W. Mitchell. 1978a. Fertilizing and seeding oil-damaged arctic tundra to effect vegetation recovery Prudhoe Bay, Alaska. Arctic 31(3):296-304.

McKendrick, J.D. and W.W. Mitchell. 1978b. Effects of burning crude oil spilled onto six habitat types in Alaska. Arctic 31(3):227-295.

Moore, S.F. and R.L. Dwyer. 1974. Effects of oil on marine organisms: A critical assessment of published data. Deep-Sea Res. 8:819-827.

Nelson-Smith, A. 1972. Oil pollution and marine ecology. Elek Science, Ltd., London. 260 p.

Øritsland, N.A., R. Hurst and P.D. Watts. 1980. Temperature effects of oil on polar bears. Northern Environmental Protection Branch, DIAND. Ottawa. 78 p. + appendices.

Øritsland, N.A., F.R. Engelhardt, F.A. Juck, R.J. Hurst and P.D. Watts. 1981. Effect of crude oil on polar bears. Northern Affairs Program, Ottawa. 268 p.

Payne, J.F. 1977. Mixed function oxidases in marine organisms in relation to petroleum hydrocarbon metabolism and detection. Mar. Pollut. Bull. 8:112-116.

Percy, R. 1975. Fishes of the outer Mackenzie Delta. Beaufort Sea Proj. Tech. Rep. No. 8. 114 p.

Piatt, J. F. 1990. Effects of oil spills on marine bird populations. *In*: The effects of oil on wildlife: Research, Rehabilitation and general concerns. Presented by International Wildlife Research, Tri-State Bird Rescue and Research, Inc. and International Bird Rescue Research Center. Washington.

Piatt, J.F., C.J. Lensink, W.Butler, M. Kendziorek and D.R. Nysewander. 1990. Immediate impact of the Exxon Valdez oil Spill on marine birds. The Auk 107: 387-397.

Pope, P.R., S.O. Hillman and L. Safford. 1983. Arctic coastal plains tundra restoration : a new application. p. 93-108 *In*: Proceedings of the 5th AMOP Techn. Seminar, Edmonton Alberta. 618 p.

Randall, R.M., B.M. Randall and J. Bevan. 1980. Oil pollution and penguins - is cleaning justified? Marine. Poll. Bull. 11:234-237.

Ratynski, R.A. 1984. Mid-summer ichthyoplankton populations of Tuktoyaktuk Harbour, N.W.T. Can. Tech. Rep. Fish. Aquat. Sci. 1218:iv + 21 p.

Reist, J.D. and W.A. Bond. 1988. p. 133-144 *In*: Life history characteristics of migratory coregonids of the lower Mackenzie River, Northwest Territories, Canada. Finnish Fish. Res. 9 p.

Rice, S.D. 1973. Toxicity and avoidance tests with Prudhoe Bay oil and pink salmon fry. p. 667-670 *In*: Proceedings, 1973 Oil Spill Conference, American Petroleum Institute, Washington, D.C.

Rice, S.D. 1985. Effects of oil on fish. p. 157-182 *In*: F.R. Engelhardt (ed.), Petroleum Effects in the Arctic Environment. Elsevier Applied Science Publishers, New York.

Richardson, W.J., C.R. Greene, J.P. Hickie, R.A. Davis, D.H. Thomson. 1989. Effects of offshore petroleum operations on cold water marine mammals: a literature review. LGL Limited for Health and Environmental Science Depart. King City Ontario. 385 p.

Rickard, W.E., JR. and J. Brown. 1974. Effects of vehicles on arctic tundra. Environ. Cons. 1:55-62.

Sendstad, E. 1980. Accelerated biodegradation of crude oil on arctic shorelines. Proc. 3rd AMOP Tech. Sem.:402-416.

Sendstad, E., T. Hoddo, P. Sveum, K. Einhjellen, K. Josefson, O. Nilsen, and T. Sommer. 1982. Enhanced oil biodegradation on an arctic shoreline. Proc. 5th AMOP Tech. Sem.:331-340.

Sendstad, E., P. Sveum, L.J. Endal, I. Brattbakk, and O.I. Ronning. 1984. Studies on a seven years old seashore crude oil spill on Spitsbergen. Proc. 7th Ann. AMOP Tech. Sem. 60-74.

Sidhu, G.S., G.L. Vale, J. Shipton and K.E. Murray. 1972. A kerosene-like taint in mullet (*Mugil cephalus*). p. 546-550 *In*: M. Ruivo (ed.), Marine Pollution and Sea Life. Food Agric. Organ. (UN), Fishing News Ltd., Surrey, England.

Smith, R.L. and J.A. Cameron. 1979. Effect of water soluble fraction of Prudhoe Bay crude oil on embryonic development of Pacific herring. Trans. Amer. Fish. Soc. 108:70-75.

Smith, T.G. 1976. Predation of ringed seal pups, *Phocida hispida*, by the arctic fox, *Alopex lagopus*. Can. J. Zool. 54:1610-1616.

St. Aubin, D.J. 1990a. Physiological and toxic effects on polar bears. p. 235-239 *In*: J.R. Geraci and D.J. St. Aubin (eds.), Sea mammals and oil: confronting the risks. Academic Press Toronto. 282 p.

St. Aubin, D.J. 1990b. Physiological and toxic effects on pinnipeds. p. 103-127 *In*: J.R. Geraci and D.J. St. Aubin (eds.), Sea mammals and oil: confronting the risks. Academic Press Toronto. 282 p.

Stegman, J.J. 1978. Influence of environmental contamination on cytochrome P-450 mixed-function oxygenases in fish: implications for recovery in the Wild Harbour Marsh. J. Fish. Res. Board Can. 35:668-674.

Stirling, I. 1990. Polar bears and oil, ecological perspectives. p. 223-234 *In*: J.R. Geraci and D.J. St. Aubin (eds.), Sea mammals and oil: confronting the risks. Academic Press San Diego. 282 p.

Stirling, I., D. Andriashek and W. Calvert. 1981. Habitat preferences and distribution of polar bears in the western Canadian arctic. Rep. for Dome Petroleum Ltd., Esso Resources Canada Ltd. and Can. Wildl. Serv., Edmonton. 49 p.

Stirling, I., D. Andriashek, P. Latour and W. Calvert. 1975. The distribution and abundance of polar bears in the eastern Beaufort Sea. Beaufort Sea Tech. Rep. No. 2. Can. Dept. Environment, Victoria, B.C. 59 p.

Sveum, P. 1987. Accidentally-spilled gas-oil in a shoreline sediment on Spitsbergen: Natural fate and enhancement of biodegradation. Proc. 10th AMOP Tech. Sem.:177-192.

Sveum, P. 1989. Biodegradation of oil in the Arctic: enhancement by oil-soluble fertilizer application. Proc. 1989 Oil Spill Conf. American Petroleum Institute Publ. No. 4479:439-446.

Tidmarsh, W.G., R. Ernst, R. Ackman, and T. Farquharson. 1985. Tainting of fishery resources. Environmental Studies Revolving Funds Rep. No. 021. Ottawa. xix + 174 p.

Varanasi, U. and D.C. Malins. 1977. Metabolism of petroleum hydrocarbons: accumulation and biotransformation in marine organisms. p. 175-270 *In*: D.C. Malins (ed.), Effects of petroleum on arctic and subarctic marine environments and organisms, Vol. II. Academic Press, N.Y.

Walker, D.A., P.J. Webber, K.R. Everett and J. Brown. 1978. Effects of crude and diesel oil spills on plant communities at Prudhoe Bay, Alaska and the derivation of oil spills sensitivity maps. Arctic 31(3):242-259.

Walker, D.A., D. Cate, J. Brown and C. Racine. 1987. Disturbance and recovery of arctic Alaskan tundra terrain. CRREL Report 87-11 Alaska.

Williams, A.S. 1985. Rehabilitating oiled seabirds. *In*: J. Burridge and M. Kane (eds.), A field manual. International Bird Rescue Research Center, Berkely California. 79 p.

Williams, T.M. and R.W. Davis. 1990. Sea Otter Rehabilitation Program 1989 Exxon Valdez Oil Spill. Int. Wildl. Res., Kailua Hi. 201 p.

Younkin, W.E. 1976. Revegetation Studies in the northern Mackenzie valley region. Arctic Gas Report Series 38.

PART 5

WILDLIFE COMPENSATION IN THE EVENT OF AN OIL SPILL IN THE BEAUFORT SEA

A DISCUSSION PAPER

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Task Group 2

December 3, 1990

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1.0 BACKGROUND

In November 1989, the Environmental Impact Review Board (EIRB) reviewed the Esso/Chevron et al., Isserk drilling program and recommended that the Minister of Northern Affairs Canada "convene meetings of Inuvialuit, industry and government representatives within 90 days to deal with all aspects of compensation and financial responsibility under the IFA".

The meeting recommended above was convened in Inuvik in March 1990. The following six recommendations were formulated at the meeting:

1) To proceed towards a generic wildlife compensation agreement, generally applicable to all oil and gas operators in the Inuvialuit Settlement Area.

2) Review the existing oil spill contingency plans in light of any new information and with the intent of maximizing Inuvialuit input. Focus on relationships between industry, community and Inuvialuit spill response plans.

3) Create a generally acceptable procedure for developing, and estimating the potential cost of a "worst case" scenario.

4) Re-examine the issue of financial capability including the type and level of financial instruments presently available under all relevant legislation including the AWPPA, OGPCA and Inuvialuit Final Agreement.

5) Encourage the creation or the reactivation of a scientific response team capable of conducting useful research in direct and immediate response to a Beaufort Sea oil spill.

6) Examine the issue of mitigative and remedial measures as specified in the IFA.

This discussion paper has been prepared in response to Recommendation #1 and concerns itself with an examination, and possible resolution of, certain compensation issues. This information will be forwarded to Task Group #3 which is responsible for developing the Generic Compensation Model as specified in Recommendation #1.

In July 1990 the EIRB reviewed Gulf's 1990-1992 Kulluk Drilling Program and recommended that the program not be approved. The time frame for resolving the above stated recommendations is therefore of some urgency.

2.0 TERMS OF REFERENCE

The Terms of Reference (Appendix 1) states that the work required include, but not necessarily be limited to, the following:

> "Review and analyze compensation models and methodologies employed in the Beaufort Sea Region and elsewhere (eg. BC and Manitoba Hydro among others). Identify aspects of models which are most appropriate, and make recommendations on their applicability to the Beaufort Sea Region."

The recommendations are to be:

> "applicable and practical, and designed to provide the Environmental Impact Screening Committee and Environmental Impact Review Board, the environmental and renewable resource management agencies, and industry with the necessary information to recommend appropriate wildlife compensation models ..."

An additional task required under the Terms of Reference is the calculation of the estimated total liability under a worst case scenario. Michael Fabjian has agreed to provide sufficient resource harvesting data to allow this estimate to be made. The Scientific Authority has been advised however, that as Task Group #3 is responsible for developing the Generic Compensation Model, that Task Group #2 may not be able to supply an estimate without that model.

In the likely event that the above calculations can not be made at the workshop, it is recommend that Workshop #2 attempt to evaluate calculations of liabilities under different scenarios and different assumptions or models.

3.0 INUVIALUIT FINAL AGREEMENT

The Inuvialuit Final Agreement has been given approval by Parliament under the Western Arctic (Inuvialuit) Claims Settlement Act (WAICSA) which states that the beneficiaries under the Agreement shall have the rights, privileges and benefits set out in the Agreement, and that the Act and the Agreement prevail over any inconsistent law applying in the Northwest Territories.

The progressive nature of the Inuvialuit Final Agreement facilitates the construction of a compensation model. The IFA establishes processes and procedures that provide a framework for wildlife compensation in the area. Aspects such as the procedures for making claims, time frames for reporting of claims and settlement, mediation and arbitration are specifically detailed in Sections 13 (19) to 13 (24) and Section 18 of the Agreement. The IFA also includes provision, under Section 10, for Participation Agreements with parties who want access on and across Inuvialuit lands, and such agreements may include provisions for wildlife compensation, restoration, mitigation etc.

The development of a compensation model must, as stated in the Terms of Reference, encompass the scope of the Inuvialuit Final Agreement (IFA).

The objectives of the Inuvialuit Final Agreement, as stated in that document, are:

a) to preserve Inuvialuit cultural identity and values within a changing northern society;

b) to enable Inuvialuit to be equal and meaningful participants in the northern and national economy and society; and

c) to protect and preserve the Arctic wildlife, environment and biological productivity

Principles (a) and (c) form the basis of Sections 13 (Wildlife Compensation) and Section 14 (Wildlife Harvesting and Management) respectively of the Inuvialuit Final Agreement. These two principles should be reflected in any compensation package developed. It should be noted that the IFA does not set limits to the liability that may be incurred to provide compensation with respect to wildlife impacts from development.

The IFA, and its relation to the development of a Generic Compensation Model, is discussed in Section 4.0 below.

4.0 GENERIC COMPENSATION MODEL - OVERVIEW OF OTHER EXPERIENCES

This section provides an overview of what has been learned from other experiences and identifies specific issues for discussion at the workshop. A list of documents reviewed is provided in Appendix I.

The IFA situation is distinct relative to other compensation applications that we have reviewed to date. This distinctiveness relates to the following:

a) the nature of the developments being considered (petroleum spills vs hydro or forestry): each project differs in specific impact linkages to the environment, duration of impacts, and direct threats to traditional harvesting activities;

b) the extent to which the parties involved have established a basic legal framework in advance of development (in many instances the development occurred first and compensation followed at some later date, in contrast to the IFA where a legal framework exists in regards to compensation processes;

c) the specific desire of parties to remove "compensation risks and uncertainties" through refinement of procedures (here again the IFA situation is distinct to other experiences in Canada)

The majority of compensation experiences reviewed relate to hydro-electric developments. For these developments, it is known in advance that the environment will be permanently and radically changed, and the focus of impact analysis and potential compensation can therefore be directed towards specifics that (in theory) should be clearly anticipated in advance. In contrast, the major concerns raised with respect to IFA area development by petroleum interests, deals with the threat of a "worst case" oil spill or some other infrequent, but serious event. Under ideal circumstances, the event may never occur. If it occurs, its extent, duration, and impacts may be similar to, or quite different from, those presently anticipated.

The current expectations, however, tend to focus on the "worst case" scenario, involving the specific 5 to 10 year period of major impacts which may or may not have implications for some significant elements of traditional livelihood. The "worst case", as presently described, is obviously very different from that associated with many of the hydro projects and their respective compensation programs.

Nevertheless, review of the hydro experience helps to underline the range of problems associated with trying to define compensation after the fact. The Grand Rapids project experience is perhaps an ideal example of this point. Despite fairly extensive pre-Project studies, and even agreements in principle being in place prior to the flooding, the recent compensation settlements (Chemawawin/Moose Lake) have demonstrated the seriousness of the unresolved problems which remained for several decades.

The duration of time and money that has been spent trying to reach a definitive settlement with NFA bands ,and the community of South Indian Lake (SIL), also underlines this point. The following are noted as highlights from this experience with respect to the compensation model issue:

a) earlier attempts to deal with this issue simply ignored the idea of wildlife compensation, except to suggest that managers of the resource would do their best to look after everybody's interests, e.g. Grand Rapids Letters of Intent which provided, among other things, a ten year period to deal with uncertainties

b) compensation programs emerged in response to debris or other specific problems, focusing on compensation for nets, boats, motors, etc.

c) in the case of South Indian Lake, the unpredicted impacts on the fishery led to the evolution of compensation to deal with other factors, eg. volume and value of the harvest (change in fish quality), increased harvesting costs etc.; compensation programs, however, for fishermen and trappers continued to be on an annual basis (although negotiations began to provide a shift from an ex post to an ex ante framework)

d) eventually Manitoba Hydro moved, in the mid 1980's, back towards attempts to settle compensation on a "once and for all" basis with respect to fishermen or trappers, e.g. Chemawawin/ Moose Lake settlements and commercial fishing and commercial trapping settlements at SIL. In the case of SIL, sufficient money was purported to be granted to "buy out" the future value of the commercial fishery based upon the apparent loss of harvest values

e) even under the NFA, specific items were occasionally settled through provision of infrastructure, e.g. a sports complex was built at Cross Lake as settlement for domestic fishing losses. In the case of domestic fishing settlements, the decline in domestic consumption was charged against the project using local retail store values: future harvest losses, however, were limited to a specified time period with attempts to install specific programs aimed at redeveloping elements of the lost domestic fishery.

f) the achievement of a "global" settlement of the NFA has proven to be elusive, as well as potentially very expensive (hundreds of millions of dollars are now on the table, without resolution of the issue, compared with the initial discussions some 15 years ago involving tens of thousands of dollars, at most)

g) the inability of the scientific community to predict all major impacts has also been underlined by both the experience with mercury from flooding as well as the specific problems which emerged at the SIL fishery (quality changes).

The fact that a commercial fishing settlement has been achieved without any domestic fishing settlement also highlights the comparative difficulties associated with these two different issues.

A major aspect which emerges from this review is the extensive range of problems that occur if an appropriate framework is not available upon which the parties can work together in response to a problem. It is very difficult to establish good faith on an "after the fact" basis - particularly in a court room. It is also difficult to retain any sense of good faith once the serious problems emerge, particularly if accountants, lawyers and others are focused primarily on controlling the flow of funds and proving (on some specified basis) liabilities, responsibilities and quantums for compensation.

The compensation model itself has, in some cases, negatively affected the existing problem. The extent to which legal processes and scientific studies become the dominant forces; and the extent to which this becomes fed by the way in which funding is provided must be kept in focus. The Beaufort Sea situation will be "successful" with respect to its compensation policy if it is able to cope with major problems without running into serious settlement and loss of faith issues which have unfortunately been typical in the context of hydro development examined above.

Two key documents to consider, in developing a Generic Compensation Model for the Beaufort Sea area, are the 1987 Wildlife Compensation Agreement between the Inuvialuit Game Council (IGC) and Gulf and the 1989 Wildlife Compensation Agreement between the IGC and Esso Resources Canada Limited. It is suggested that as both of these agreements were signed by the Proponent and the IGC that they form the basis upon which a more comprehensive Generic Model be developed.

The Esso Agreement was, to a large extent, developed from the Gulf Agreement. Key features of the Gulf Agreement and areas where Gulf deviated from the Esso Agreement, as detailed by Munro et al. (1987), include the following:

a) increased number of definitions to provide greater precision;

b) inclusion of the "Dependant Harvester" definition;

c) clarification that guiding and outfitting losses are compensable;

d) clarification that "net income loss" is compensable (as distinct from "income");

e) specific exclusion of cultural or lifestyle or "trivial" impacts, or the pleasure or recreation component of an activity: Section 3.2 of the Esso Agreement explicitly deviates from the Gulf Agreement and refers to the "non-economic components of resource harvesting";

f) comments about including "increases in income" in determining net losses are noted;

g) priority on replacement, restoration, etc., may be noted, but it is not clear in practice how it would be applied: the Esso Agreement in Section 3.5 excludes the wording in the Gulf Agreement relating to property and equipment being replaced or repaired;

h) Munro et al. (1987) state that the procedure and arbitration provisions have been simplified and improved, relative to the IFA;

i) Munro et al. (1987) note concerns about the degree to which "onus of proof" may be stricter than is desirable for small, individual claims : lack of detail on the mediation process was also highlighted, and suggestions are made to further improve and simplify the process;

j) Munro et al. (1987) highlight uncertainties relating to overlapping regimes that could be clarified by agreement of the parties and;

k) both Agreements provide minimal clarification as to "rules" for compensation in terms of detailed principles and procedures for actually establishing loss and estimating damage.

In both the Gulf and Esso documents effort has been directed towards maintaining simplified, workable agreements. The importance of providing a workable, yet comprehensive compensation model is highlighted by the fact that the majority of the settlements reviewed are the result of negotiations which lasted twenty and in some cases thirty years. The complexity of the Northern Flood Agreement for example, has resulted in a cumbersome, slow and extremely expensive process which has been unable to provide any major settlements to date. The type of model required to facilitate settlement is identified as a topic for discussion at the workshop.

The following provides a review of compensation models on a topic basis and identifies issues which will require discussion at the workshop.

4.1 LEGAL SCOPING ISSUES

4.1.1 Onus of Proof

An essential element of any compensation agreement is the development of specific guidelines to differentiate between Project induced impacts versus impacts from other activities including natural causes. In this regard the IFA states:

13. (15) Where it is established that actual wildlife harvest loss or future harvest loss was caused by development, the liability of the developer shall be absolute and he shall be liable without proof of fault or negligence for compensation to the Inuvialuit and for the cost of remedial and mitigative measures as follows:

a) where the loss was caused by one developer, that developer shall be liable;

b) where the loss was caused by more than one developer, those developers shall be jointly and severally liable; and

c) where the loss was caused by development generally, but is not attributable to any developer, the developers whose activities were of such nature and extent that they could reasonably be implicated in the loss shall be jointly and severally liable.

When contrasted with other agreements the above statements appear comprehensive. One aspect requiring discussion however, is how to determine if "actual wildlife harvest loss or future harvest loss was caused by development". The linkage, of loss to impact, is often tenuous and is one of the most contentious issues in the settlement of claims. Discussion of this aspect could perhaps focus on article 23.2 of the Northern Flood Agreement (NFA) which states:

> "The onus shall be on Hydro (the Proponent) to establish that the projects did not cause nor contribute to an adverse effect, where any claim arises by virtue of an actual or purported adverse effect of the Project."

While this clause provides a high level of comfort to the potential claimant it has the obvious, reverse effect on the Proponent. The appropriateness of including such a clause in the Generic Compensation Agreement will provide an area for discussion at the workshop.

The NFA also makes Manitoba Hydro responsible for paying for lawyers, consultants, etc., to assist the local Bands to evaluate the situation and prepare their case. The IFA contradicts this approach; however, in the future, this could be a major consideration in dealing with complicated legal and scientific issues, and the matter should therefore be discussed.

The IFA states in Section 13. (23) that:

> "...The claimant shall, as far as reasonable in the circumstances, mitigate his damages and should subsequent events, including the effect of any mitigative or remedial measures, materially affect the claim, any part to the original proceedings may cause the hearing to be reopened in order that the decision may be rescinded or appropriately varied."

With the exception of the Gulf and Esso Agreements this clause has not been found elsewhere. A possible area of discussion for the workshop includes the definition of "as far as is reasonable in the circumstances".

4.1.2 Description of Worst Case Scenario

Section 13.(11) (b) of the IFA states that where a proposal is referred to the Review Board, it shall recommend to the government authority empowered to approve the development:

> "an estimate of the liability of the developer, determined on a worst case scenario, taking into consideration the balance between economic factors, including the ability of the developer to pay, and environmental factors."

A description of the worst case scenario will be determined by Task Group I. Based on the worst case scenario, the Generic Compensation Model will be used to provide an estimate of maximum liability in terms of compensation.

If a Generic Compensation Model had been developed and utilized prior to Manitoba Hydro initiating the Churchill River Diversion it would not have identified the increase in mercury levels in fish which became one of the most significant impacts of the Project. In order to ensure that these aspects are covered the Northern Flood Agreement provides the following statement:

> " Uncertainty as to the effects of the Project, with respect not only to the Project as it exists at the date of this agreement but also as it may develop in the future, as such that it is not possible to foresee all the adverse results of the Project nor to determine all those persons who may be affected by it, and, therefore it is desirable to establish through the offices of a single arbitrator a continuing arbitration instrument, to which any person adversely affected may submit a claim, and as well as to fully empower such arbitrator to fashion a just and appropriate remedy;"

While the inclusion of such a statement in a compensation agreement is of obvious benefit to the Claimant it often creates unmanageable problems for the Proponent. This is generally dealt with by the Proponent after the fact through a negotiated settlement for damages incurred, including a Full and Final Release for all retroactive and future losses.

The appropriateness, and implications, of including such a clause in a Generic Compensation Model is identified as an issue requiring discussion.

4.1.3 Limits of Liability

Section 13 (15) of the IFA states that:

> "...the liability of the developer shall be absolute and he shall be liable without proof of fault or negligence for compensation to the Inuvialuit and for the cost of mitigative and remedial measures as follows:"

A contentious issue identified by Task Group 3 is the interpretation of the above whereby the term "absolute" and the phrasing "liable without proof of fault or negligence..." may or may not apply "for the cost of mitigative and remedial measures". The Generic Compensation Model will require a clear interpretation of Section 13 (15) as the degree of remedial work conducted will directly influence the type and degree of compensation warranted.

Further to the liability question, Section 13 (16) of the IFA states that:

> "Canada acknowledges that, where it was involved in establishing terms and conditions for the development, it has a responsibility to assume the developers liability for mitigative and remedial measures to the extent practicable".

This clause provides the "backstop provision" whereby Canada assumes the liability of the Proponent. The liability of the Proponent for remedial works under the Arctic Waters Pollution Prevention Act (AWPPA) is $40 million which in turn sets Canada's liability, if it were to assume that of the Proponent, at $40 million. In light of the costs associated with the cleanup of the Exxon Valdez, the EIRB has questioned the sufficiency of this liability. Task Group 3 is currently dealing with this aspect and it will subsequently not require discussion at this workshop.

In terms of financial resources to meet the worst case scenario neither the Gulf nor Esso Agreements were required to prove capability. This is another aspect that is being examined by Task Group #3 and which may not require discussion at the upcoming workshop.

4.1.4 Compliance with Other Legislation

Compensation agreements generally contain a clause which states that the Agreement is not intended to conflict with Federal or Territorial (Provincial) legislation binding upon the parties and, that where a conflict does occur, that the legislation be applied and that the remainder of the Agreement remain in effect. Both the Gulf and Esso Agreements contain this clause, but do not clarify the relevance of this statement in respect to the IFA.

The extent to which the IFA takes precedence over all other acts is an issue requiring discussion at the workshop. This issue has been raised by Munro et al. (1987), wherein the opinion was given that the WAICSA ensures that the IFA prevails over any inconsistent law applying in the Northwest Territories. Munro et al. (1987) also suggested that the WAICSA makes the IFA binding on developers in the area. Both of these areas require discussion and might be appropriate for inclusion (in order to clarify the resolution) in the Generic Compensation Agreement.

Additional aspects regarding legal scoping issues which should be discussed at the workshop include:

a) The applicability of any Generic Compensation Model pursuant to the IFA with respect to non-Inuvialuit (particularly those with whom the Inuvialuit enter into mutually beneficial harvesting rights agreements).

b) The extent to which the Generic Compensation Model will cover all direct and indirect impacts from development by the Proponent, including: impacts from developments that the Proponent conducts outside of Inuvialuit lands; disruption due to noise or other activities disturbing wildlife habitat and/or migration patterns and; impacts associated with changes in lifestyle which may (in part) derive from new employment or other opportunities associated with development.

c) To the extent that it is not covered above, the limit of liability issue should clearly define what is "practicable", or anticipated, with respect to environmental protection measures and (after a problem emerges) remedial work. This is a likely area for major dispute, in that the costs for such measures may well exceed (by many orders of magnitude) the costs for compensation. The present wording provides comfort where, in practice, real problems may emerge. This is considered a legal scoping issue to the extent that it establishes principles or standards governing what is anticipated to occur in the future.

4.2 REPORTING OF CLAIMS, MEDIATION AND ARBITRATION

During the settlement of claims it must be determined whether or not the individuals are negotiating on a "level playing field". If claims are settled by individual harvesters who do not make use of legal or professional advice, future problems may result. In the event that Full and Final Settlements are negotiated the legitimacy of these settlements may be questioned leaving the potential for "residual obligations and/or responsibilities".

To ensure this does not occur Proponents often request that the injured party receive professional counsel, and offer to provide funds, for that counsel. The applicability of detailing the approach for settlement of claims outside of arbitration is an issue requiring discussion during the upcoming workshop.

The procedures for reporting claims, mediation and arbitration are described in Section 13.(17) and 13.(19) to 13.(20) of the IFA. The Gulf and Esso Agreements handle these aspects in a clear and concise fashion. These aspects do not appear to have been contentious to date but a detailed review of arbitration methodology as set out in the NFA is recommended prior to finalization of a Generic Compensation Agreement.

4.3 COMPENSATION

4.3.1 Compensation vs Rehabilitation

The IFA stresses the need for mitigation and rehabilitation, with compensation only being provided when it is not practicable to return the environment to its original state. Section 13.(1) (a) of the IFA states:

> "if damage occurs, to restore wildlife and its habitat as far as is practicable to its original state ..." .

Similar references are found in other agreements such as Article 24.8 of the NFA which states:

> Because mitigatory and/or remedial measures are more likely to have a lasting beneficial effect on the viability of a community and/or on individual residents than monetary compensation, such matters shall be preferred and only where mitigatory and/or remedial measures are not feasible or fail in

> effectiveness shall monetary compensation be ordered in lieu thereof in respect of any adverse effect.

The cost of rehabilitation may, in some instances, be several orders of magnitude greater than the cost of compensation. In order to determine potential liability under a worst case scenario the point at which direct compensation replaces rehabilitation must be determined. The discussion paper on the feasibility / advisability of restoration measures will assist in providing definition to the term "practicable" and will guide workshop participants in identifying the point at which compensation replaces or is complementary to rehabilitation.

4.3.2 Loss Categories

It is understood that a list of potential loss categories is being assembled by Task Group #3 and will consequently not be detailed in this document.

Several references to the rights of the Inuvialuit in regards to the development of resource oriented tourist operations are made in the IFA. Section 14 (42) states:

> "The Inuvialuit shall have first priority in the Western Arctic Region for guiding, outfitting or other commercial activities related to wildlife as authorized by governments from time to time."

Although this statement is qualified to some degree in Section 14(43), significant, resource based, opportunities are granted. The Esso/IGC Agreement also provides clarification that guiding and outfitting losses are compensable.

The loss of future development opportunities, either through direct loss of the resource or through loss of aesthetics, could occur through project related disturbances. The degree of compensation, if any, required to mitigate potential losses of opportunities requires discussion.

4.3.3 Cash Payment vs Payment in Kind

The IFA provides a fairly detailed list of the types of compensation which can be claimed in respect to income generating harvest activities, as stated in Section 13.(18):

> "... The types of compensation that may be claimed include the cost of temporary or permanent relocation, replacement of equipment, reimbursements in kind subject to harvestable quotas, provision of such wildlife products as may be obtainable under existing Acts and regulations, payment in lump sum or by instalments or any reasonable combination thereof. The claimant will be entitled to indicate his preference as to type of compensation in making his claim, but the compensation award shall be subject to subsections (22) and (23)"

The above clause is also repeated for subsistence harvesting which clearly states that cash payments in lump sum or by instalments should only be considered as a last resort.

The IFA addresses the continuation of traditional practices. The Esso and Gulf Agreements provide a basis for payment of direct losses but do not address lifestyle issues which would be affected by resource losses. Review of the Chemawawin/Easterville and Moose Lake cases demonstrates the importance of these issues in both maintaining the general well being of the community and avoiding future claims. Lack of appropriate care in handling compensation issues has resulted in several documents referring to the "Devastation of the Cree".

The concept of "lifestyle impacts" should be addressed in the context of defining the requirements to provide compensation / remedial activities versus cash payment. In practice, it may often be far cheaper (over the short term) for proponents to provide compensation rather than relocation, income in kind, remedial works or other measures. The short term benefits to the Proponent in terms of cost savings, and to the Claimant in terms of rapid payment, may be far out weighed by long term losses. The comfort currently provided by the IFA may be short lived in the event of an oil spill unless terms such as "last resort" are clearly defined before the impact occurs.

A discussion on the appropriateness, implications and methodology required to include lifestyle issues in the Generic Compensation Model is identified as a critical element requiring discussion at the workshop.

5.0 SUMMARY

The following topics have been identified as areas for discussion at the workshop. As noted previously, some of these will have been dealt with by other working groups prior to the workshop, and discussion will therefore focus on its application to a Generic Compensation Model.

- relationship between the IFA, which states that the Act and the Agreement prevail over any inconsistent law applying in the N.W.T., and the AWPPA, OGPCA etc.;

- limits of liability, ability of the Proponent to pay, and applicability of the "backstop provision" whereby Canada assumes the Proponents liability;

- definition of a worse case scenario, in terms of compensation, including time frame for compensation and remedial methods;

- methodology for handling unpredicted impacts i.e. mercury at South Indian Lake;

- legal framework for differentiating between Project induced impacts and impacts from other activities including natural causes;

- mitigation of impacts by the Claimant and definition of "as far as is reasonable in the circumstances";

- applicability to individuals other than the Inuvialuit, especially in regards to the IFA (Section 10) provisions for Participation Agreements;

- the extent to which the Generic Compensation Model is to cover all direct and indirect impacts i.e. changes in lifestyle which may derive from new employment or other opportunities associated with the development;

- definition of what is "practicable" or anticipated with respect to environmental protection measures and remedial work;

- differences between compensation models for domestic versus commercial activities;

- methodology for calculating replacement costs for country foods;

- methodology for processing claims by individuals whereby a "level playing field" is ensured;

- consideration of a compensation fund to facilitate rapid payment of claims;

- degree of compensation, if any, for loss of opportunity;

- methodology required to include lifestyle issues into the Generic Compensation Model: implications of not addressing lifestyle issues and;

- design of a framework capable of addressing major impacts but simple enough to facilitate quick resolution of claims.

6.0 REFERENCES

MUNRO, E., H. RUEGGEBERG and A.R. THOMPSON. 1987. Liability and compensation for wildlife harvesting: Regimes that apply to the proposed Amauligak extended production testing project in the Inuvialuit Settlement Region. Unpub. report for Government of Northwest Territories.

APPENDIX A

Compensation settlements and/or compensation agreements which were reviewed include the following:

- the Ontario Hydro/Whitedog/ Canada Settlement for impacts related to the Caribou Falls Generating Station (1989)
- the Saskatchewan Power/Cumberland House Settlement for impacts related to the Squaw Rapids Generating Station (1988)
- the Whitedog and Grassy Narrows Settlement for impacts related to mercury contamination from the Reed Inc. pulp and paper mill in Ontario (1985)
- Manitoba Hydro Registered Trapline Program (1975)
- Chemawawin-Easterville/ Manitoba Hydro Settlement for impacts related to the Grand Rapids Generating Station (1990)
- Moose Lake/ Manitoba Hydro Settlement for impacts related to the Grand Rapids Generating (1990)
- Northern Flood Agreement (1977) related to Lake Winnipeg Regulation and Churchill River Diversion Projects. Signatories to the Agreement are The Government of Manitoba; the Manitoba Hydro-electric Board; Nelson House, Split Lake, Cross Lake, Norway House, and York Factory; and The Government of Canada.
- Wildlife Compensation Agreement between the IGC and Esso Resources Canada Limited (1989)
- Wildlife Compensation Agreement between the IGC and Gulf (1987)