

**DISCUSSION OF QUESTIONS RELATED TO ENVIRONMENTAL IMPACTS AND MANAGEMENT**

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Paul Scott provided a summary of the following paper

**FEDERAL ENVIRONMENTAL ASSESSMENT AND  
WEST COAST OFFSHORE OIL AND GAS DEVELOPMENT**

**Notes for a Presentation to Exploring the Future of Offshore Oil and Gas  
Development in B.C.**

**Simon Fraser University - May 18, 2000**

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Introduction

In the early 1980's, consideration was given by the federal and provincial governments to a lifting of their respective moratoriums on offshore exploration. In 1983, a Memorandum of Agreement was signed between the governments of Canada and B.C. that established the basis for a joint review of renewed offshore oil and gas exploration should the moratoriums be lifted. Under the Agreement, the two Ministers of the Environment established an independent environmental assessment panel to conduct a public review of the potential environmental impacts associated with any renewed offshore exploration program. The offshore area subject to the panel review was the coastal waters from northern Vancouver Island to the B.C./Alaska border.

Panel Review Process

A five member independent panel was appointed in June, 1984. The panel's terms of reference asked it "to examine the environmental and directly related socio-economic effects of offshore petroleum exploration, and to present recommendations on the terms and conditions under which offshore petroleum exploration could proceed in a safe and environmentally responsible manner". It is worth noting that in interpreting its terms of reference, the panel defined exploration to include seismic surveying, exploratory drilling and the delineation drilling that would occur to establish favorable conditions for the development and production programs to be proposed. The panel did not include in its review a consideration of impacts associated with production scenarios.

At the beginning of the review, both Petro Canada and Chevron were involved and information prepared by these companies served as a starting point for the review. The panel's Terms of Reference named both Chevron and Petro Canada as proponents. During the course of the review, Petro Canada decided to withdraw citing other priorities. For the remainder of the review, Chevron served as the only project proponent.

During the early stages of its review, in late 1984, the panel held public information meetings in 15 north coast area communities as well as Vancouver and Victoria. These meetings introduced the panel to area residents and other interested stakeholders and

helped to panel to understand the issues of concern and to finalize the information requirements for the review. In December, 1984, the panel released a document outlining the additional information it needed from government and industry in order to complete its review. Following the preparation by Chevron and federal and provincial governments of the additional information requested and once the panel was satisfied that it had sufficient information to complete its review, it held a series of public hearings, both technical and non-technical, in most of the same communities in which the information meetings had been held. These hearings were held in the fall of 1985. At the end of its review, the panel produced a report (dated April, 1986) to the federal and provincial governments summarizing the results of the review, including its conclusions and recommendations.. The panel report included a total of 92 recommendations.

The two governments responded to the panel report and the panel recommendations in June, 1987. In this response, the governments accepted most of the panel recommendations subject to a number of conditions.

#### Panel Conclusions and Recommendations

The panel concluded that terms and conditions could be put in place that would allow the moratoriums to be lifted. Other important conclusions and recommendations included:

- Exploratory drilling should not take place within an exclusion zone of 20 km from any point of land to minimize potential impacts on sensitive nearshore areas from routine operations or from an oil well blowout.
- Exploratory drilling outside of a specified 20 km exclusion zone should initially be confined to the months of June to October at least until further operating experience is obtained and weather forecasting improved.
- A two year airgun seismic survey program could proceed providing certain terms and conditions were met. The panel concluded that further seismic programs should not be permitted until monitoring results from the initial program were analyzed to better determine the effects of airguns on fish eggs, larvae and juvenile fish.
- Additional information leading to a better understanding of the environment of the exploration area and the potential impacts of the exploration program should be gathered and provided to the regulatory authorities prior to the commencement of the drilling. Some of the panel's other recommendations provided details on what additional information was needed.
- The major source of socio-economic impact is likely to arise from the limited ability of residents of the areas, including First Nation people, to participate in decisions relating to the management of the area's resources.
- An effective ongoing environmental management structure should be put in place that would be capable of managing decisions relating to the environmental and socio-economic considerations of offshore exploration and of possible development and production as it may evolve.



- An effective compensation program that applies to all losses and damages resulting from an oil blowout or from routine operations should be established before the start of any offshore drilling.

Some other important considerations that arose during the panel review include:

- Land claims and, at the time of the panel review, the lack of any meaningful progress on land claims, were brought forward during the review by the First Nation people in the area.
- There was, and presumably still exists, some question about the jurisdiction over the West Coast offshore area. Is it federal or provincial? The panel review was carried out “without prejudice to resource ownership and jurisdiction, to any future agreement which may be reached on sharing of revenues from offshore oil and gas activity”.
- Numerous issues were raised in connection with the environmental acceptability of the risks associated with offshore exploration and, in particular, the risks associated with the possibility of a major oil blowout.
- Panel concerns and recommendations relating to seismic exploration were based on the understanding that most seismic survey work would be done using airguns. There was, at that time, limited knowledge about the impacts of airguns on fish eggs, larvae and juveniles and about the distribution of these organisms in the review area. Has this knowledge increased in the intervening years? There were also concerns expressed about the impacts of airguns on whale migration. The panel recommended against the use of explosives for seismic surveys.
- Concerns were expressed about the potential impact of adverse weather conditions on the exploration programs and uncertainty was expressed about the accuracy of forecasts of adverse weather conditions.
- The panel believed that means should be found to ensure that area residents have an effective role in decisions relating to the management of offshore exploration and its possible effects.
- The panel recommended that offshore operators establish a preferential hiring policy for employing local residents assuming equivalent skills and the operators ensure that contractors follow the same policy.
- The panel made a number of recommendations relating to blowout prevention and control and how to deal with a blowout situation should one occur.
- The panel made recommendations on areas of research and investigation that should be carried out to increase knowledge about issues such as impacts of oil on birds and fish.

#### Follow-up to Panel Report and Recommendations

In June, 1987, the governments of Canada and B.C. together issued a formal response to the panel’s report and recommendations. The governments accepted the intent of most of

the panel's recommendations. In fact, the governments accepted the intent of 80 of the panel's 92 recommendations. For 46 of these accepted recommendations, the timing and the manner of implementing the objectives were not detailed. Nine of the recommendations were rejected (none were critical recommendations) and no response was possible for 3 recommendations because the topics were then under policy review.

Although the panel report and recommendations along with the government response to the report seemed to open the door to having the moratoriums lifted, no further action with regard to the moratoriums was taken. This appeared to be due, at least in part, to lack of active interest by the oil and gas industry in renewing exploration activities off the west coast. It is really only in the last few years that interest, driven largely by north coast communities, in lifting the moratoriums has again been kindled.

#### Future Federal Environmental Assessment Requirements

The basis for the federal involvement in the 1980's panel review was the *Environmental Assessment and Review Process*. This non-legislated federal environmental assessment process was replaced in 1995 with the new *Canadian Environmental Assessment Act*(CEAA).

Under CEAA, whenever a federal authority has a specified decision-making responsibility in connection with a project, it takes on an obligation to ensure that an environmental assessment is carried out that meets the requirements of the Act. There are four areas of federal decision-making that trigger assessments under CEAA:

1. federal proponent;
2. federal funding;
3. federal lands; or
4. federal regulatory authority.

The most likely triggers for any new federal environmental assessment of renewed plans for offshore exploration and/or development would be in connection with federal regulatory authorities. A few areas of regulatory decision-making that would likely trigger a new CEAA review are National Energy Board authorizations under the *Canada Oil and Gas Operations Act*, authorizations under Section 32 and/or Section 35(2) of the *Fisheries Act*, and permits under the *Navigable Waters Protection Act*.

Once a CEAA trigger was confirmed in connection with an identified offshore project, then the responsible authority(ies) would have to ensure that an environmental assessment was completed that met the requirements of the Act. It is too early to speculate on the nature of such an assessment. However, two factors should be kept in mind:

1. any new CEAA assessment of offshore exploration activities would be obligated to take into consideration the results of the previous panel review; and

2. if a review under the B.C. *Environmental Assessment Act* were also required, the Canada-B.C. Agreement for Environmental Assessment Cooperation would ensure that the two levels of government would work together on a single assessment process.

**The Status of Environmental Assessment Review of Westcoast Offshore Hydrocarbon Exploration: what is (and isn't) needed to warrant the lifting of the moratorium on Westcoast offshore hydrocarbon explorations.**

**Jon Sexter**

*Sector Environmental Resources Consultants, Victoria, BC*

My contention is that the stage is set for the lifting of the moratorium. That particular assertion is based on a number of premises, several overriding and several intrinsic. The primary premise is that there will be and has to be the entering in good faith of tripartite negotiations between Canada British Columbia and the Haida Nation, Canada British Columbia and the Tsimshian Nation, and Canada British Columbia and the Heltsuik Nation, with reconciliation of resource sharing and resource revenues and benefits from this particular resource. That can go on concurrently with a variety of things and I will go as far as to say that that should go on separately and apart from the existing treaty negotiation process.

With that said there is another premise. I was surprised that no one yesterday mentioned this, and that is that somewhere out there, there is an industrial proponent that wishes to make a play here. We have to make that assumption, because without a proponent there are not going to be projects of exploration of various forms and perhaps even production one day. In addition, I would emphasize the fact that even though the geological presentation yesterday emphasized the whole coast, based on our Panel's findings some fifteen years ago, every time I think about offshore exploration on the west coast, it starts and stops north of Vancouver Island. I would not think of it happening in Johnstone Straits, Georgia Strait or off the West Coast of Vancouver Island. The geological evidence is where I assume that the proponents will focus.

Through the work of LUCO (Lands Use Coordination Office) a CD-ROM will be soon be issued by the province of British Columbia - it is a coastal resource and oil spill response atlas which is both iterative and very interactive. The first one is for Vancouver Island. Because its focus is coastal resource management it is also very useful for oil spill response and planning. The data is already in place for a similar atlas for Haida Gwaii, there is an ongoing program collecting data for the Central Coast, and the process is about to get underway on the North coast. LUCO's overall program of coastal resource mapping is one thing the Panel called for and it is indeed well underway.

The point about the focus of the Panel being not *whether to* per se is in fact correct, but implicit in everything the Panel said and did was if there was reason, in their collective and respective opinions to recommend not going ahead with the lifting of the moratorium either on social grounds (and they did a great deal of things social from the communities) or on technical grounds, they would have said so. In fact, they filed their recommendations and it has been sitting, following the government's review of it, for a good number of years.

The intrinsic premises that I talked about are as follows. These are the premises of my assertion that the stage is set. The stage is set and in fact is waiting for mechanisms and implementation; for the appropriate things to make it happen right, from a social point of view, economic point of view and environmental point of view. The premises are that the Panel in fact, fifteen years ago, thoroughly and responsibly covered the range of applicable issues.

The second thing is that the technology and the will are present to assure the implementation of the recommendations and safeguards.

And notwithstanding the pressures on the resource that we talked about yesterday, we all know that the ecosystem in general is basically out there and requires the same safeguards, with appropriate technological advances, as were there were fifteen years ago. What I am basically saying is that we don't need to go and visit the *what to* again. The *what to* is on the stage — it is the *how to* that we need - the *how to* do it right.

***The Panel's Recommendations***

Of the 89 recommendations from the Panel this is how they break down from the implementation point of view. Four pertain to general environmental assessment processes. Twenty-five need to be implemented during offshore

exploration. Nine are things that have to be investigated and or mechanisms and structures that have to be put into place before seismic exploration. Thirty-five are things that need to be undertaken or produced prior to exploratory drilling. Eleven items deal with compensation, and among those that were not formally accepted are the compensation recommendations, and five items are related to a coordinating committee and management authority to oversee this.

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### *The Panels Recommendations*

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- 4 pertain to general environmental assessment processes;
  - 25 are operational / procedural conditions to be required and implemented during offshore exploration;
  - 9 are items to be undertaken or produced and in place prior to the commencement of seismic exploration;
  - 35 are items to be undertaken or produced prior to the commencement of exploratory drilling;
  - 11 items deal with compensation for damages and loss to environmental resources as a result of offshore exploration activity; and
  - 5 items relate to a coordinating committee and management authority to oversee Westcoast offshore petroleum exploration.
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The Panel was very adamant that a focussed authority needed to be established, because other agencies have their own agendas, their own priorities, their own budgets and things of this sort.

The key recommended items that are required prior to commencing with seismic exploration are listed below. Bear in mind, however, that the wording is fifteen years old and reflect the times and processes that were on hand (these were the days before treaty process and before truly focussed community consultations). For example, the recommendation (#8) to ensure participation by the regional public can be interpreted in any way appropriate to today. The same is true with the recommendation (#9) nine to ensure aboriginal people involvement. Recommendation #20 for the production of fisheries booklets, to my knowledge still has to happen. For the recommendation #23 for improved knowledge of current movements, many programs are completed and include all sorts of advances. Things like funding of community monitoring — that is monitoring of the effects on both community and its own area resources have yet to be put into place as is the case for the recommendation (#46) for a local supplier policy.

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### *Key Recommendations*

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- #8 ensure participation by the regional public: *current information programs to be expanded and formalized*
  - #9 ensure aboriginal people involvement : *as for 8 above*
  - #20 produce fisheries booklets: *to be developed*
  - #23 improved knowledge of current movements : *this and related hydrographic and oceanographic programs are completed (reference: websites of Dr Bill Crawford of CHS-DFO)*
  - #21 seismic operators meet with fishing industry :*to be arranged*
  - #41 funding of community monitoring: *to be arranged*
  - #42 public information and education programs: *as for 8 and 9*
  - #46 local supplier policy: *to be developed*
  - #57 improve information on native food fishery: *programs underway*
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For the four items needed to be put into place before exploratory drilling my colleagues at Canadian Wildlife Services advise me that the requisite bird surveys have been undertaken on the mid and north coasts. The data gaps regarding modelling of fisheries, and regarding currents and oceanography, and sensitive mapping for the areas of the coast we are talking about are underway.

- #33 Bird Disturbance Guidelines : required bird surveys have been undertaken on the mid and north coast by CWS.
- #53 Reduce Data Gaps re Modeling of Fisheries Impacts : required research in this area has been undertaken and is ongoing
- #59 Sensitivity Mapping — General: programs in the subject areas are well advanced
- #60 Sensitivity Mapping - Food Fishery and Resource Harvesting: programs in the subject areas are underway

## ***Legislation***

With regard to the acknowledged applicable legislation I will only refer to some of the key points. My examination of the situation, both as a student and practitioner of the system, suggests that the Canadian Environmental Assessment Act is not necessarily applicable to seismic exploration. It is certainly applicable to exploratory drilling — via the permits, if not other things, that are required for structures. This is not a direct federally sponsored activity. The primary trigger lies in the specific permits that are required from federal agencies to authorize an aspect of an activity and depending on where it is and what permits the federal government does or does not allow there may be no trigger for the Environmental Assessment Act for seismic exploration. Having said that, my contention is that even if there are no formal broad environmental process requirements, I use the term 'environmental assessment' as the planning tool that proponents use to do the environmental planning for their project and through that they acquire their regulatory permits. What Paul Scott does in his office is the review of that — and his environmental assessment (it used to be called a review process) reviews what a proponent these days should be and probably is doing. It is a subtlety but we don't want the public, or yourselves, to be caught up by the fact that unless there is a process there won't be any environmental assessment. There will all sorts of environmental assessment, both in the sense of the things that any proponent who emerges knows he has to do, because the Panel has basically laid out a number of conditions, or because he knows that if he goes out and scores in any part of the world he has to do these things, and these things will be overseen by whatever the body is and through the mechanisms that I am advocating be established.

## ***What is NOT needed?***

In my view, you do not need another Panel hearing on the *whether to*. There is a taking of the pulse going on now. There are going to be focussed consultations — the northern commissioner is examining what I call the pulse on northern residents' views on offshore oil ( <http://www.ndc.gov.bc.ca/> ). To proceed, it is my view that public consultations in a formal sense are not needed in the *whether to* issue — the stage is set. Further, an Environmental Assessment Review Panel on seismic exploration is not needed. When you are thinking about these things, the question you should ask is: What additional information will this add or shed light on to the situation? If someone could convince me that there is additional information at these levels, I could be convinced there is a need for such a review panel. At this point I am not. Also, I do not think you need protracted hearings on *how to*; instead you need focussed consultations on *how to* - those are very different constructs in my mind.

In summary, in my mind, given the premises I described at the very outset, there are four things that need to be done, to give the two cabinets of the senior governments a comfort factor to enable them to lift the moratorium. Those in appropriate positions need to show that the mid-1980s Panel satisfactorily addressed the barriers and safeguards and conditions/issues; show that there are mechanisms to implement these properly and put them into place; show that these steps are going into place or are in place to proceed with the Panel's recommendations; take the public pulse with regard to acceptability (and it is my understanding that Mr. Backhouse efforts are doing that); and undertake focussed public consultations on the *how to* level in relation to a declared intention to lift the moratorium.

## **Environmental Impacts, Assessment and Management**

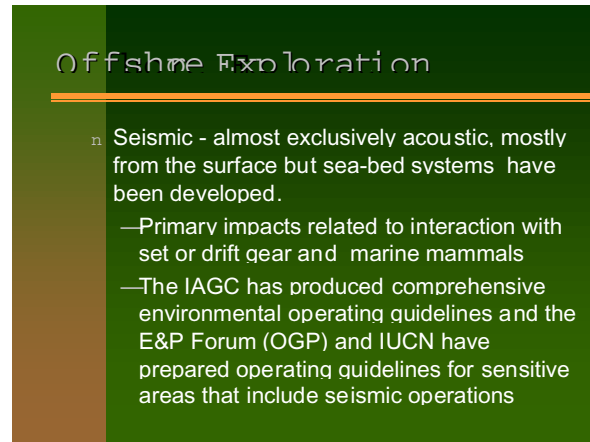
### **Wishart Robson**

***Canadian Occidental Petroleum Ltd., International Manager, Environment, Health and Safety, Calgary, AB***

Canadian Occidental does not hold any offshore exploration leases or acreage in Canada. The reason I was invited to give this presentation is for the experience that I have had working with a number of people in this room in activities on the west coast, the Arctic and most recently when I was with Petro Canada looking at the Terra Nova project and going through the environmental assessment process and the panel review. I will be talking about some of the changes that have taken place in the industry over the last ten years in the development process, in the technological sense, and in the process and management sense. I will present my views on the environmental assessment process and some of the challenges that a proponent, the company, has. As Jon Sector mentioned there

wouldn't be reviews unless there were proponents. I will finish up with observations, primarily based on some of the work I do overseas, on the role of oil and gas development as it pertains to environmental justice and ethics and equity.

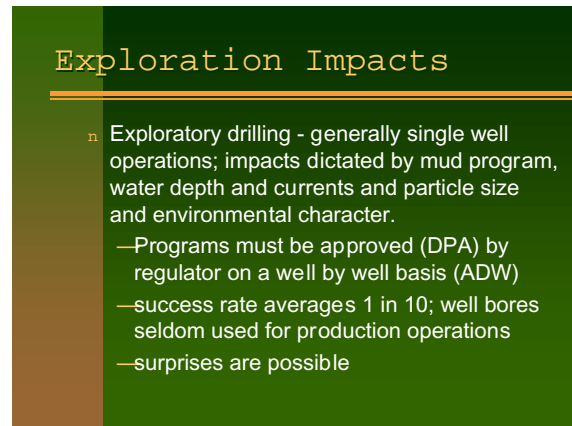
### *Offshore Exploration*



For those of you who are not familiar with the world of offshore exploration, seismic exploration is the process for trying to determine the location of the reservoirs that you might want to drill into to see if they contain hydrocarbons. That used to be done through the use of explosives, which was very destructive especially in terms of fisheries and marine mammals but that was a long time ago and as you heard yesterday from Bevin Ledrew, they have progressed to newer technology, with much cleaner signals that do not have those sorts of impacts, although there still are concerns about marine mammals and perhaps some species, or particular lifecycles, of fish. Strat Canning yesterday talked about some of the physical interactions between seismic exploration and the fishery particularly with respect to set gear, whether it is nets or traps. We work hard with the fishing industry wherever we are, whether in Canada or overseas, to make sure that those impacts are minimized through communication or through timing.

In the last ten years there has been a lot of work done by the industry, and by the industry's contractors, as well as by a number of international environmental groups to come up with operating guidelines that will effectively improve the way we do our business and minimize the impacts that we might have. The International Association of Geophysical Contractors (IAGC) has produced an excellent set of operating guidelines that is meant to minimize those impacts and interactions with other marine users. The E and P Forum of the Office of Global Programs (OGP), an organization of oil companies based in the United Kingdom, and the International Union for the Conservation of Nature (IUCN), a world wide conservation organization based in Geneva, have come up with operating guidelines for particularly sensitive environments, including mangroves and coral reefs, in the marine setting. The communication of those practices and those guidelines are referenced now in our contracts and the operators, the seismic contractors, are required to meet these terms as a requirement of our contract and they are audited on this during the course of our work, particularly where we have identified that there are some sensitivities.

## Exploration Impacts

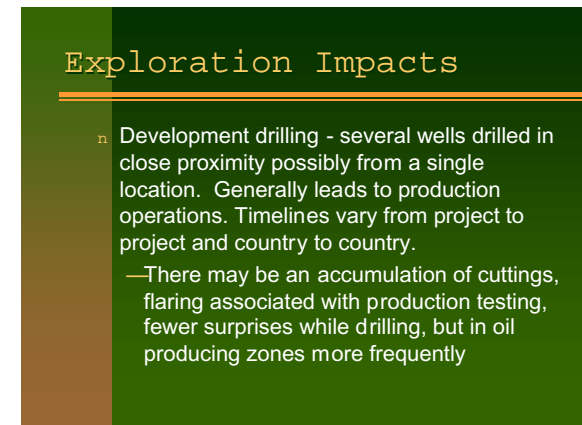


Exploration Impacts

- n Exploratory drilling - generally single well operations; impacts dictated by mud program, water depth and currents and particle size and environmental character.
  - Programs must be approved (DPA) by regulator on a well by well basis (ADW)
  - success rate averages 1 in 10; well bores seldom used for production operations
  - surprises are possible

Exploratory drilling is generally done with single wells and the wells are drilled at quite a large spacing — if you have a large prospect and you have identified a couple of targets you could be looking at tens of miles or more between the exploratory well locations. The impacts might be dictated by the mud program. Mud in this case, the drilling mud that we use, is to lubricate the bed and also to get the cuttings from the bottom of the well to the surface so that you can continue to drill in the paths of some of those muds. The muds contain things like diesel fluid that would lubricate the bed. Going back over the past 20 or 30 years since the time that diesel was used, we are now talking about two and three different technological generations of product.

The impacts from exploratory drilling are dictated by the kind of mud program and chemicals you use as well as the water depth. The greater the water depth, generally the less the impact is on the seabed. Impacts are also determined by currents, that is, how strong the currents are, with respect to the distribution of the cuttings that might come from that well, as well as particle size of the cuttings, and the environmental character of the area.



Exploration Impacts

- n Development drilling - several wells drilled in close proximity possibly from a single location. Generally leads to production operations. Timelines vary from project to project and country to country.
  - There may be an accumulation of cuttings, flaring associated with production testing, fewer surprises while drilling, but in oil producing zones more frequently

In most countries, using the terms from the east coast of Canada, the operator must submit the program that he has when he has successfully bid on a piece of land and acquires it. This program describes what he intends to do in the whole block during that exploratory phase (DPA). They also have to submit requests for approval (ADW) on a well by well basis. And both those applications have to contain some level of environmental information about the site and what the proponent intends to do to minimize the impacts. For your information, the success rate for exploration wells worldwide, ones that might uncover hydrocarbons, and that doesn't necessarily mean commercial hydrocarbons, might be one in ten. The well borers for those exploration wells are seldom used for production. The exploration wells are generally abandoned and if a discovery has been made they go on to drill a well that will be used in the production operation. Surprises are possible because you are drilling into formations and reservoirs that

you don't know. Therefore, when the drilling is done on exploratory wells it is done a little differently than it is when it is done in a development sense — you are not drilling to make time and reduce costs that way — you are drilling to ensure that the well integrity is maintained throughout the whole program

If you have been lucky enough, one in ten or one in fifteen, or one in twenty, you may get into development drilling, which is determined in part by what it is that you have found, both to the extent of volume and area, as well as quality of oil and quantity of oil. That could be several wells drilled in close proximity - sometimes if you are interested in minimizing the footprint of the impact, you might drill a number of wells in one location and pad. This generally leads to production operations. However, the timelines between the exploration activity, development drilling and production can be years. For example, on the east coast of Canada, it was between eighteen and twenty years (we heard yesterday) between the discovery and the commercial production of the hydrocarbon. And in the north, in the Arctic, where there have been commercial quantities found, it is going to be even longer than that because of the issues around where that gas can be marketed. So in a development drilling sense, the impacts could be associated with an accumulation of cuttings or flaring associated with testing the fluid to determine what the flow rates will be. There could be definitely fewer surprises than well drilling because you have identified what you are drilling through. When you are in the producing zone, therefore there is an incremental risk of having some form of problem that might result in the release of hydrocarbons.

### ***Development Drilling***



With respect to development drilling, there are now ways to minimize the number of wells that are drilled, including, coming off at different locations through directional drilling, or through other processes where you only have to have one central well bored and you take off and drill multiple laterals off that. All of these are in attempt to try to reduce the number of well heads you might have to have on the seafloor and also the number of holes that you have to drill to the surface. I mentioned earlier that there have been new drilling mud systems developed because of the concerns about the older types of drilling muds used which included diesel, or low toxicity mineral oils. They have now developed some synthetic muds, five or six different types, and they are all designed to meet the safety and well integrity issues as well as to reduce their environmental impact. It is possible that in larger fields where you have a lot of drilling going on you can drill a special well and you can inject the cuttings from other wells into that well bore - this is called annular injection. This type of injection has been tested and tried but is not widely used because there are still a number of technical issues to be dealt with. Further, as Bevin Ledrew mentioned yesterday, there are now shore-based cleaning systems that have been developed whereby cuttings can be transported to shore and the cuttings can be cleaned of whatever hydrocarbons are in them either in the formation or the drilling mud and then the cuttings can either be used in a land farm or they can be used in some other process. Again this would probably be tied to a very large program with lots of wells in a certain area.

### ***Production impacts***

The physical process of separating oil and gas really hasn't changed that much over the years. However, gas conservation regulations and a new generation of generators and other drivers with low air emission qualities have certainly improved the air quality.

## Production Impacts

- n Production operations - the physical process of producing gas or oil has changed little; however gas conservation regulations and new generation generators and compressors have reduced emissions to the air. Produced water is generally treated sequentially in the process to meet disposal requirements. There have been improvements in separation technology.

Produced water, water produced with the oil and then separated from it before you ship the oil off to market, is generally treated sequentially in the process now to the extent that we have new separation technology and we can produce water that has a lower content of oil that we were able to do ten years ago. The issue of produced water was certainly one of the more topical issues on the hearings on Terra Nova, as it is in most places where there are those sorts of forums to discuss the development of oil and gas. During the courses of the Terra Nova hearings, there was a lot of discussion about produced water and the question came up about taking the produced water that you generate and re-injecting it into the formation — because a lot of the formations don't naturally flow to the surface so you need to put water down there (you may need to put gas down there) to lift the oil to drive it out of the reservoir into the well bore and take it up to the surface for production. In the case of Terra Nova, for example, they were going to be doing some water flooding, and the question arose as to why you can't take that produced water and put it into the reservoir.

## Production Impacts

- n Produced water can be re-injected but not generally for enhanced recovery. To date the cost/benefit of injection leads to treatment and disposal.
  - NORM may be present (older fields) and can not be treated.
- n The trend to Floating Production will reduce impacts associated with the abandonment of fixed platforms.

There are a number of reasons for this. They mostly have to do with the quality of the water that you get to put down there, even after you have treated it, and the possibility that it might cause a problem in the reservoir, particularly if you have bacteria in it and the bacteria start to grow in the reservoir and produce hydrogen sulphide. This could sour your formation pretty quickly. Therefore, there are a lot of concerns about why and how we would do this, and generally today, in almost all the producing areas of the world, the produced water is still treated to some level set by the regulators, generally 20—40 ppm and then discharged overboard. In the Gulf of Mexico they have found in some of the older portions that have been in production for 40— 50 years, something called naturally occurring radioactive material (NORM) — it is a natural product generated in the reservoir and it is my understanding that it cannot be treated.

The trend to Floating Production gets away from some of those issues, but it also has some of its own problems that I will describe below. The other aspect, sometimes not an aspect which oil companies become directly involved in, is the case of transportation. In the case of pipelines, the pipelines from production operations to shore-based storage facilities, there have been a number of issues associated with their construction, their operation and their decommissioning. Floating Production and storage onsite eliminates some of the concerns, but in this case it has its own concerns associated with both the storage and transfer operations. During the preparation work that we did for the Terra Nova hearings we did quite an extensive review from about fifteen years of experience with these systems in the North Sea and elsewhere, and it turned out that they actually have a very good record of safety. We could only find two incidents where the loading lines had parted between the tanker that was producing and the tanker that was offloading in hundreds of thousands of operations. At the time that the Hibernia platform was built, they went through the environmental assessment process, and they did look at Floating Production. However, at that time, in the early 1980s, technology was not sufficiently advanced to do the things that we are doing today. Twenty years, even ten years, have brought significant changes.

## Transportation Impacts

- n Pipelines from production operations to shore-based terminals have been the standard with attendant issues for construction, operation and abandonment.
- n Storage on-site eliminates those concerns but has its own risks associated with transfer operations under a range of conditions.

### *The Precautionary Principle*

One of the issues that came up in the context of the Terra Nova environmental assessment review and that has also come up since the matter of oil and gas development on the west coast is Principle 16 from the Earth Summit in Rio, the Precautionary Principle. It says that "where there are threats of serious or irreversible damage, lack of full scientific certainty must not be used as a reason for postponing cost effective measures to prevent environmental degradation". This is an interesting principle to look at in the context of offshore oil and gas development anywhere in the world, but certainly in Canada, because it talks about 'serious', which is a difficult term to define, and about 'cost effective' and the question is for both of these terms, who determines what that is.

Clearly, industry is going to have a serious voice in what 'cost effective' means with respect to the money that we are going to spend, and we would hope that we have a say in determining the 'serious' component as well. This is one of the principle premises that a lot of the intervenors in the Terra Nova hearings came in with, both the NGOs and the regulators, both the federal fisheries and environment departments. When you think about the Precautionary Principle and put it in the context of risk-based decision making (which is what we do in the industry all the time; for example, you heard Ben Poblete talk about it yesterday), it doesn't just extend to safety, it extends to environment and to people.

## The Precautionary Principle

- n Principle 16 from the Rio Declaration of on Environment and Development states:

Where there are threats of serious or irreversible damage, lack of full scientific certainty must not be used as a reason for postponing cost effective measures to prevent environmental degradation

We do have some information that we can bring to try and answer some of those questions. What is cost effective? and What is serious? I think that everybody accepts that if it is determined to be irreversible, that is just not going to be an issue for debate.

With offshore oil and gas, there are analogue producing basins, with more than twenty years of data, and there are offshore producing basins with more than forty years of offshore production. The data over the last twenty years is much better than the data that was collected in the first twenty years of some of those fields. We now have analogue producing basins in the North Sea, the Gulf of Mexico, southeast Asia, and Australia. We can refer to these and try and do analogues on where we think we are going to be operating, and identify what the issues would be based on what the experience has been elsewhere. The interesting thing when you are following this process though, is that when you look at the older data, you are looking at data that was derived, or impacts that may have been derived, from operations that were materially different from those that are operating today. If you are looking at an operation that was started 30 years ago, you are probably looking at something that might have had diesel fuel as the additive for lubrication and you might be looking at chemicals used then that are no longer in use today. This makes it very difficult to do some of that extrapolation.

## Impact Assessment

- n The Precautionary Principle and Risk-Based decision making
  - There are analogue producing basins with more than 20 years of data
  - Improved Operating practices/products
  - Monitoring programs are better designed
  - The impacts of new technology/practices may not always be obvious

The newer fields like Hibernia and some of the fields in the North Sea with newer monitoring are starting to provide data that allows us to really look at whether we have to be concerned about the Precautionary Principle, and just what 'full scientific certainty' means. There are improved operating practices and products and monitoring programs are better designed. But we also have to be concerned or should be aware at least, that the impacts of new technology are always not what we think they are going to be. Earlier I mentioned synthetic muds being developed in the North Sea - there was a lot of hope that they would resolve some of the outstanding issues between the industry and the regulators and other interested parties. However, it turns out that some of the synthetics are not as good as others, and in cold water they are not delivering the benefits that we had hoped for.

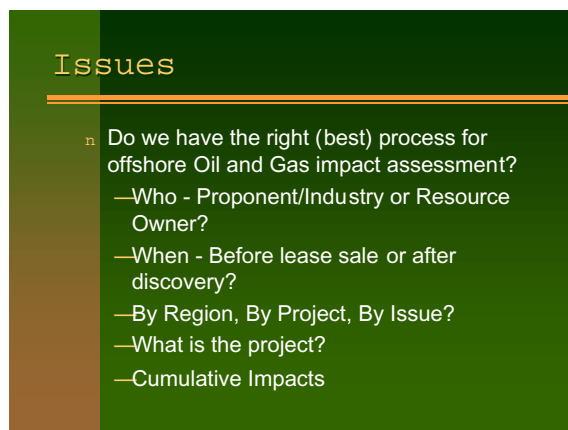
### ***Routine operations***

## Impacts

- n Routine Operations
  - significant changes in Regulatory requirements, Operator standards, Contractor standards and Industry/NGO standards for unique or sensitive environments
- n Accidents
  - High profile accidents have a low frequency but, continue to challenge the industry, undermining the credibility of all Operators

For routine operations, to summarize it, there have been significant changes in the regulatory requirements and in the role of the regulator. As an operator I can say that I would much rather work in an environment with a really informed effective regulator — it makes my life a lot easier. It also makes it easier within the company and it makes it easier within the context of the communities you operate in, if they know and trust that the regulatory system is effective. Operator standards have changed, in part, because corporate standards are changing in all respects, whether it is in social or environmental issues. Contractors have improved their performance. There is a better relationship in some respect between industry and NGOs when it comes to the cooperative efforts I mentioned earlier. And after saying all that, I have to admit that our industry has been plagued by some high profile, low frequency, accidents, that continue to call into question the ability of industry to be an effective operator, particularly in the challenging frontier of the offshore area.

### Issues



Issues

- n Do we have the right (best) process for offshore Oil and Gas impact assessment?
  - Who - Proponent/Industry or Resource Owner?
  - When - Before lease sale or after discovery?
  - By Region, By Project, By Issue?
  - What is the project?
  - Cumulative Impacts

Probably one of the most significant incidents that has taken place since offshore oil and gas development was considered in British Columbia, was the loss of the Piper Alpha platform in the North Sea four years ago. That was an unfortunate set of circumstances that resulted in the death of 167 people (220 or 230 people were on the platform). That led to, among the things that Ben Poblete discussed yesterday, the Cullin Report, the development of the safety case concept, and the principle of reducing the risk to as low as is reasonably practical. Those are all things that came out of the Cullin report — they are very technical in most respects. That is why we have people like Ben Poblete at Lloyds Register to provide us with guidance on these issues.

But it is a very personal issue as well — Piper was operated by a company that used to be our parent company, Occidental Petroleum — and there were a number of people in our company who actually worked in the Piper operations based out of Aberdeen. This may just be a big faceless industry to a lot of people but to us it is an industry of people. And we do care. It is an event like this that drives us to improve our performance as companies and as individuals. We do operate in rough areas and do some things that people don't agree with but we do care about our people and we care about the environment and we do want to do a good job in producing the energy that people demand from us day in and day out.

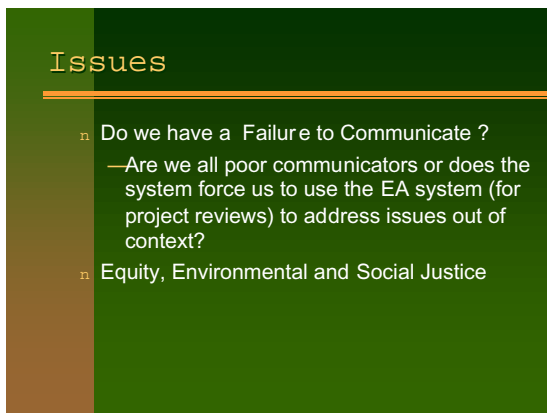
Do we have the right or the best process in Canada for offshore oil and gas impact assessment? Before I talk about *who*, I will talk about *when*. If the company wants to explore offshore the process is: the government puts up lands for bid and you bid a certain amount of work. It could be a seismic program, or it could be a seismic program and drilling operation of one or two wells. That costs a certain amount of money — it might be \$40 million, it might be \$90 million. Each of these wells is expensive; \$20 to \$40 or \$50 million per well drilled offshore in Canada. Then after you make a discovery you drill a few more wells and after that you have to determine whether or not you have a commercial discovery, and whether or not you can produce it or whether or not you need new technology such as in deep water. By this time you have probably spent 300-400 million dollars and you still don't have the environmental assessment to develop the deal. In addition, there are other jurisdictions where those issues about are we going to allow oil and gas in this particular area are sorted out before the lands are leased. And then it becomes

more of a site specific concern about how is that operator going to develop that particular aspect to minimize the concerns around safety and environment and social impact. So for example, with Terra Nova we have spent \$375 million and still have to go through the approval process to build the project.

Who should do that? Should a company do the environmental impact assessment and then have to defend it to the public, and to the resource agencies, most of whom have the information we have to take to develop it, or should the resource owners and their other agencies, sister and brother agencies in government, be the ones that do that at the early stages before the industry leases that land - so that we can go in and know that that has been looked after and we do what we do best, which is to find and produce oil and gas? Should we do it by region, by project, by issues? For example, when the environmental process was being done for Terra Nova, the one for Sable was going on at the same time. Concurrently, we talked about whether we should be using oil-based drilling muds, about what we should do with produced water, and a lot of the questions were about whether or not we should be having oil and gas development in these areas. That means that Mobil and their team and Petro Canada and their team were doing the same things and having to address the same issues. To my mind each issue should have been dealt with separately, not in the context of one project that has to defend all these issues.

Other issues that come up are: What is the project, what are the boundaries? For example, the issue of transportation at Terra Nova - Is the tanker at Terra Nova different from the tanker that comes from the North Sea filled with crude going into Montreal or Quebec City? It turns out that they probably are — but once it gets into the shipping lane are they any different?

Another issue is that of cumulative impacts. As an operator we know what is there — we can talk about that - but we don't know what's coming in the future. To most of the proponents that seems to be something the government should be addressing rather than the individual company.



### ***Lessons learned from Frontier operations***

I have come to the conclusion that a lot of the conflict or difference of opinion that I as an operator have with community organizations and other stakeholders is because we frequently get put in a position of defending an action that the resource owner has made. You can think about the oil and gas company in many respects, and as a contractor to the government. We contract with them or they contract with us to produce oil that we are going to get paid a certain amount for and after we recover our costs. We do not like being put in a position where we have to be at odds with the NGOs and the communities because we think we do a good job of trying to communicate with them — but often we are put in the position of having to address issues that are beyond our ability to provide answers for and it is a very frustrating experience.

### ***Equity and environment and social justice***

I would like to provide a little different perspective on environmental justice — mostly drawn from the work that I do overseas. There are a lot of third world countries that look at the developing world and they are critical of the fact that we have oil and gas resources here, but we want to go and develop them there because then we do not have deal

with the risks here. They say "you want to come and explore our oil and gas so you do not have to do it in your backyard". I have to say that we operate in difficult environments all over the world. It is difficult here, with lots of different values, and native title issues, and other concerns, but these are also true for a lot of the countries that I currently operate in. It is no different operating in Indonesia and Nigeria in that respect than it is operating in Canada on the west coast.

Finally, I will leave you with the thought that everybody has something in their backyard that they like — here are some of the places that I have been that fit that category. These are special places that demand and require special attention from the operators that produce oil and gas. Here in Alaska, the MacKenzie Delta, and the Arctic (Innuvik and Tuktiaktuk) all with oil and gas operations — there is no production but production from analogue operations. Here is Sable Island and a very special operating area just off the Gully, Newfoundland's fledgling oil and gas industry, primarily on the Grand Banks but also off Labrador, the West coast of Greenland, and where there is no production yet but exploration, in the highest Arctic. This is Yemen — an extremely difficult region. What are the environmental issues there? Groundwater — this is the most valuable resource in this area - if you contaminate that you will have more impact on people's lives than you can imagine. On the west coast of Africa — two million barrels/day are produced, most of it offshore. Here is Botswana, and the middle of a game farm in the Amazon, and this is Colombia with its very sensitive freshwater swamps but again oil and gas production/operations are going on there. Then there are the mangroves in SE Asia, and a large coral reef. The offshore oil and gas industry is in all of these areas and they operate with special operating guidelines in each area. They are different from each other — all have special challenges — but they are all unique to the people that use them and live there day to day.

## **SYNOPSIS OF DISCUSSIONS FOLLOWING THE ENVIRONMENTAL IMPACTS AND MANAGEMENT SESSION**

### *What about oil spills?*

A participant asked what percentage of oil for offshore operations could be expected to be recovered if there was a spill. The panellists replied that you would be doing well to recover twenty percent and if you had adverse conditions, five percent would be a success — that is, for the oil remaining after it evaporates.

A participant asked if there has ever been a case with a large spill — where it has been successfully contained. The presenters responded that mostly what you are talking about with large spills are tanker spills and it is these large instantaneous releases that cause problems. They noted that if they are not instantaneous releases, rather slower release, then the success rate would be much higher. They noted however, that each spill has its own specific challenges.

One participant noted that incidents of minor spills has increased in the United Kingdom and noted that the presenters did not show slides of suffocating seals and birds. She would like to have heard from the people of the countries affected by oil spills.

Susan Sherk made the point that the largest oil discharges have to do with bilge discharge of oily water and noted that this is a very serious problem all over Atlantic Canada. It is not related at all to the oil industry and it is not related to tankers that are carrying the oil, but it is a serious problem worldwide. She stressed that when we talk about 'oil spills' we should be clear about the source of the spill.

### *Is there a process for violations?*

The question about the process for violations was posed. The panelists noted that companies operate under licence to government and that the government has legislation that allows for certain penalties against operators. In Canada, for example, under the Fisheries Act, operators are required to post a bond. It is possible that your licence could be lifted if you had a spill or that you might only be able to operate, subject to specific conditions.

### *What changes have been brought in with the new act?*

Charlie Bellis complimented the federal government for bringing in the process of environmental assessment and noted that, unlike some countries, Canada is lucky to have such a process in place. However, he questioned whether since the new Act has come out if the proponents were more liable to be involved or could they walk away from the table like Petro Canada did. He noted that he sees this as a potential weakness in the system. Paul Scott answered that under the new Act the proponents cannot walk away. He also noted that under the new Act there may not have been an assessment like the one they had fifteen years ago because it was not considered a specific project. It was a plan to assess the moratorium and a review of the environmental implications of potentially lifting it, without actually having a particular project. Therefore, under the new Act, it is unlikely that you could have a Panel such as the one they had fifteen years ago and now you may have to wait until there is a particular proponent that wants to build or operate a particular well before you can put such a process into place. However, this is not to say that today there would not be a government review of lifting the moratorium; rather that there would probably not be such a review under the current Act and instead it would probably have to be done under some other authority. He noted that once you get into a review of a project the only way the proponent could withdraw is to abandon the project — and they wouldn't be allowed to proceed with any activity if they didn't participate in the assessment. He noted also that they are now at the point where they are starting to recover the cost for the review from the proponents as well thereby not only requiring them to participate but also to contribute some of the cost.

*What are the requirements to consult with neighbouring nations?*

Bob Hill noted that there was a lot of emphasis on the consultation process and asked: What are the requirements globally to consult with neighbouring nations? He used the example of the US and the use of the Hecate Strait and Dixon Entrance and the AB line and the military activity that is carried out there by the US government. He also referred to the standards of the federal government regarding operating in this region and noted that the standards of the First Nations in this area exceed those of the government of Canada. He asked: What standards do you have to follow?

The panel responded that activity in British Columbia waters would clearly have a potential impact on Alaska and that that would be a consideration so that Alaskan interests would be invited and encouraged to take part in the federal and provincial environmental assessment.

*Whose standards would be used?*

Referring to Georges Bank and Cook Inlet Bob Hill wondered how the US interest, the AB line and the boundary, would be considered in terms of the environmental assessment process — whose standards would be used for the environmental assessment, but beyond that how would the resources be shared between the two countries?

*Should a different question be asked?*

Another point raised was: If it was understood that the Panel could have said *no*, why was that not in the terms of reference which clearly read "under what conditions should the moratorium be lifted"? The participant made the statement that the question regarding whether the moratorium should be lifted has never been asked and noted that it has to be asked and addressed by all the people involved.

*What about Marine Protected Areas?*

A question was raised about compensation for exploration/development in Marine Protected Areas. The response was that the process/negotiations would take into account what is nearby and what rights in the legal sense are being encroached upon and this would be expected to be sorted out before the MPAs are established. The three or four MPAs currently being proposed for British Columbia do not interfere directly with leasehold areas involved with oil and gas reserves or with other specific subsea minerals.

*Has a proponent come forth?*

A question was raised about whether or not a proponent has come forth regarding development of offshore oil and gas in British Columbia.. The response from the panel was at this point there is no identified proponent for offshore oil and gas on the west coast; however, there clearly is interest on the part of north coast communities, and a variety

of British Columbians, in this particular resource development opportunity. There is also a lot of interest in what the implications are with going ahead with the development and *if* it is going to go ahead how it should be done properly. Up until this point petroleum companies have been keeping away from the west coast because there is a moratorium in place. And it appears that it is not in their interest economically and timewise to play on the west coast until they have some indication that the moratorium will be lifted. The supposition is that if that happens, then perhaps a proponent will be interested — and perhaps the markets and conditions in the petroleum industry in the world are such that they will not be interested. It was pointed out that despite being invited to attend, there is no identified proponent participating in this meeting.

**Peter Taylor**  
*Scientist, Environment Australia*

I am on a short assignment from the Australian government with the Canadian government with the Department of Fisheries and Oceans. This is a good opportunity to provide a very short update on what we are doing with our Marine Protected Area program in Australia. In the course of this we do have significant interactions with the Australia oil and gas industry. I will briefly summarize the work that we are doing and some of the stories I have to tell about some of our experiences.

For those of you who are not familiar with some of the issues that we need to deal with, the white line on this map indicates our marine jurisdiction. Unlike some other countries, our state or provincial governments have responsibility for the waters legislatively out to about 3 nautical miles and the federal government has responsibility for waters beyond that out to the limit of our EEZ. We are also signatories to the Law of the Sea Convention. We have made claim to 42% of Antarctica as well, and through to MacDonal Island and Macquarie Island, Norfolk Island, Christmas Island, and Ashmore Reef. So it is quite a large marine responsibility.  
(<http://www.environment.gov.au/marine/mpa/commonwealth/cthmpa.html> (see map))

What I will try to do is give you some sense of the policy context that the Australian federal government is working on in relation to Marine Protected Areas and also about what we mean by multiple use. And I will describe what our broad policy position is in relation to our interactions with the oil and gas industry and some of the experiences.

With regard to the policy context that we operate in, the federal government launched a federal Oceans Policy at the end of 1998. This provides us with an overall umbrella and a mandate to be able to work very closely with all sectors that have responsibilities in the marine environment. And the overall (simplified) aim of the Oceans Policy is to ensure that the different sectors that work in the marine environment are able to work in a more integrated way so that one industry doesn't negatively impact on others.

I am slightly embarrassed to tell you how much money is involved in funding when you consider the expenditure on ocean related activities in this part of the world. But in the budget, we have been given for the next 3 years funding (federal government — cross agency responsibility) for a range of marine environment protection initiatives. These initiatives get 21% of the funding; 14% goes to the development of commonwealth or federal MPAs and there is the administrative cost for an Oceans office that we have and the advisory processes and so forth. For the implementation, we have divided the country up into six regional provincial scale type marine regions. For the next three years we will be concentrating on the SE region to establish integrative regional plans which will also encompass MPAs. I will have to say that the Oceans policy and the national representative system of Marine Protected Areas are significant top down driven policy mandates, as being directed by the federal government with the support of the state governments. We have a national representative system for Marine Protected Areas that has taken several years to bring to agreement with each of the states. Each of the state governments has their own region a specific base for establishing Marine Protected Areas within their jurisdictional waters out to three nautical miles. We have national agreement about what a national representative system for Marine Protected Areas is, and the state legislation for the established MPAs tends to differ according to the needs and desires for each of the states. You have much more conservative approaches in some states and more liberal approaches in other states.

At the commonwealth level, we have just recently designated three sections under the new program: the waters around Macquarie Island Marine Park, have sixteen million hectares of which six million hectares is a 'no take' component; some extinct volcanoes south of Tasmania, a fairly small reserve there; and in the Great Australian Bight in 1998, about two million hectares.

We are currently working on three more — a small island in the Indian Ocean, Cartier Island, the waters around Lord Howe Island in the Pacific, Heard Island and MacDonal Island just slightly north of Antarctica. This map shows (<http://www.environment.gov.au/marine/mpa/commonwealth/cthmpa.html>) where we have our federal marine protected areas. Ashmore Reef, and hopefully shortly Cartier Island, a focal point for illegal immigration that comes from Indonesia and Middle East, a small reserve called Mermaid, and then Ningaloo which is over 200 km long, and the Great Australian Bight and the Sea Mounts off Tasmania, and Macquarie Island, Lord Howe Island, and of course a separate authority which deals with the Great Barrier Reef Marine Park Authority which encompasses a very substantial part of the Queensland coastline. That is under a separate Act and is administered by a federal agency with the state government of Queensland.

When it came to embracing the notion of multiple use and when I first came along and was asked to set up this program I had a look and saw that the federal department really had no strategic relationship with groups outside government and it was a problem. In the marine environment to make a meaningful Marine Protected Area you need to take a really large ecosystem based approach. We decided that it was really important that in order to do that you are better off having strategic alliances with industry groups and the marine users. If you did not do that you were immediately inviting conflict. And your chances of getting large or meaningful ecosystem based MPAs would be virtually impossible. So we worked very hard to come up with a set of principles for the maintenance of ecosystem integrity which is our primary objective under Commonwealth law, wealth generation and resource use, equity across industry and a participatory framework to ensure that those affected are engaged in the process.

I should mention too that Australia is a member of the IUCN (International Union for the Conservation of Nature). Under our new very powerful environment legislation that comes into effect in July of this year, the Environment Protection Biodiversity Conservation Act, we have embraced the IUCN categories for management. There are six categories: absolute no take (1), multiple use (6) and range of categories in between. This is the international standard that is recognized throughout most of the countries that have a robust Marine Protected Area network.

I have to say that when we first started engaging industry — once we made the decision to get out and actually work with stakeholders- the first thing that happened was that I was described in the media (when we were trying to negotiate with the fishing industry a two million hectare ecosystem based MPA) as a work-shy ecowarrior.

It was really important that we came face to face with the reality of decision-making particularly with regional communities that were going downhill badly economically. What we really needed to face was — well if we are going to establish a Marine Protected Areas regime, it needs to be relevant, and we need to have substantial buy-in in order for the communities that are affected by these decisions to actually own and feel that this is important for them. That meant a system of compromises, on both sides — trade-offs, deals, negotiations in order to get something that had genuine integrity from an ecosystem biodiversity conservation perspective but at the same time minimized any conflict and any loss of livelihood.

When it comes to the oil and gas industry — 60% of Australian petroleum needs comes from the waters off Australia — we realized that the oil and gas industry is a very significant industry — it is probably our most wealthy marine industry. We thought the best thing to do would be to walk right into Australia's Petroleum Industry Association and form some sort of strategic alliance to ensure that we had the basis for communicating with the oil and gas industry. That resulted in us developing a substantial agreement between the Australian Petroleum Production/Exploration Association (the PEC Association) and Environment Australia, or our department. That has led to some outstanding examples about what you can achieve through cooperation — we have had dollars contributed to marine conservation from industry, we have had staff secondments both ways, and we are also working on a voluntary conservation agreement in the Northwest shelf of Australia, now our hottest area of commercial oil and gas activity.

Here are a couple of examples — the Great Australian Bight that I mentioned earlier, if you can picture it, is in the very southern part of Australia, a very important whale migration area and calving area for the southern right whale, at the head of the Bight, and the sedimentology of the Great Australian Bight is very significant. There have never

been any river or water systems flowing out into the Bight and so the sedimentology in a global sense is unique. We took a representative sample, that the oil and gas industry is particularly interested in doing some work on. We decided that we shouldn't shift that somewhere else — rather we would embrace it and should there be an argument for the oil and gas industry to be drilling, rather exploring, in the park we have provided for a pathway or a process for that to be examined in our management. It is also enshrined within our Act that there is equity with any industry groups — it depends on our objectives. In this particular case, it has been very controversial. We have not won any friends in the conservation movement in Australia because they believe that we should lock out the oil and gas industry, full stop. However in this case, the oil and gas industry, should they pose an argument to be drilling inside or near the park, will have to go through extremely rigorous environmental impact assessments and processes and the companies may decide it may not be worth going through that process. It is possibly unlikely indeed that there would ever be any activity inside the area but it is not 100% absolutely ruled out — I would be interested to see if it happens, but at least there is a process for industry to go through.

This one example does not involve oil and gas but I will show it as a demonstration of the processes that we need to go through in order to trade off and get innovative outcomes. The Sea Mounts, extinct volcanoes, virtually wiped out by the fishing industry except for a group of them that were quarantined some time ago — that has been declared a Marine Protected Area. In the process of designing and negotiating with fisheries we found that this is 2000 meters of water, that there was occasionally some bluefin tuna caught in the top 500 meters of the water. Quite frankly our chances of getting this as an MPA were zero unless we had some way of being able to work with the fishing industry on this. At the end of the day, we used the IUCN categories from the seabed to within 500 meters of the surface (about 1500 meters of water) encompassing all of the Sea Mounts in a category of absolute 'no take' — and the fishing industry were prepared to work with us on that. The top 500 meters is a category 6 under the IUCN and some fishing is allowed.

To finish, the conservation agreement that we are negotiating with the oil and gas industry has been a very exciting project, and very innovative. If we can get an agreement, that is not necessarily an MPA, with the oil and gas industry, it means that we have enormous capacity to be able to influence the industry over conservation related activities including whale/cetacean monitoring. This is a very exciting project

The lessons we have learned from all this is the value of 'buy-in' including the contributions to conservation; it is also the sense that marine conservation is everyone's responsibility, it is not just the role of government. As a consequence of the 'buy-in' and the multiple use you will eventually be guaranteed of getting larger more ecosystem-based MPAs. With regards to the relationship between science and politics - decisions are made through politics rather than pure science. It is a tricky game meeting the needs of the electorate and the minister and at the same time making sure that we get something that makes sense.

Among the challenges we face for the future include: moving beyond personalities — there are personalities in different industries that make things happen and we need to institutionalize these positive initiatives beyond the personalities; maintaining political interest — we have a minister who is very committed to MPAs and drives the agenda very strongly. What happens when he goes? Fortunately we still have a strong policy mandate; and managing cultural change inside organizations is a very difficult thing to do.

## **A brief overview of global change and energy**

**Robie MacDonald**

*Research Scientist, Institute of Ocean Science, DFO, Sidney, BC*

Climate change has occurred for eons and will continue to do so. Recent human activities have the potential to alter climate but it is not yet clear what influence they might have. Whatever the changes are, they are not likely to be manifest as a rosy, warmer future for all humans. It is clear that climate change will be delivered differently to different regions — drought in some places, more rain in others, warmer in some places and cooler in others. There will be winners and there will be losers. A major reason why we are not yet able to construct accurate predictions of, for example, the impact of CO<sub>2</sub> increase in the atmosphere is that we do not understand all of the pathways involved in climate. Models are helping us to understand how climate might be changed and long-term proxy records from ice and sediments are helping us to view the present in terms of a highly variable past.

Two factors contribute to human encroachment on climate 1) Population explosion where humans have gone from less than a million in the distant past to 6 billion at the end of the 20<sup>th</sup> century and 2) Increase use of energy by each of us so that present requirements are about 100 times what they were during the stone age. One clear, unequivocal result of human activities is the increase of greenhouse gases (GHG) in the atmosphere (CO<sub>2</sub>, CH<sub>4</sub>, CFCs). Physical behaviour of these gases, which is well known, tends to reduce heat loss from the earth to space and so leads to warming.

Data from ice cores going back as much as 400,000 years show that climate has changed by extraordinary amounts in the past — four ice ages have occurred during which atmospheric temperatures have swung by more than ten centigrade degrees and humans have lived on earth throughout this period. The last ice age ended about 10,000 to 15,000 years ago and has been followed by one of the most stable periods during the past half-million years as far as atmospheric temperature is concerned. Indeed, some climatologists are asking why we have not started to enter the next ice age! These long-term records strongly suggest that gases like CO<sub>2</sub> and CH<sub>4</sub> are implicated in global change either as initiators or as amplifiers. No matter how GHGs operate in the climate system, human activities have enhanced their atmospheric concentrations beyond any recorded in glacial ice from the past 400,000 years. Other observations are that the past several years and even the past 50 years have been warmer than previously: the oceans and atmosphere contain more heat (are warmer), glaciers have retreated in many places, ice has thinned in the Arctic and sea level has been rising. These various phenomena are very likely related to one another but we do not yet know for sure how much they are due to human activities or whether they are simply part of a long-term cycle in global temperatures. One of the difficulties in assessing our impacts on climate is that the climate system is complex and contains a number of poorly understood feedback components including clouds and the organic carbon cycle. For this latter, the amounts of carbon stored in reservoirs (atmosphere, ocean, sediments) and the rates of transfer between reservoirs are large and variable making the estimate of human impacts on the cycle difficult to measure. Nevertheless, a recent report on climate change (Houghton et al., 1995) concluded that the balance of evidence suggests that enhanced warming due to human activities is probably occurring and that we are just emerging from the noisy climate background.

Historical trends of GHGs together with projected use of fossil fuels suggest that our activities will impact climate in detectable ways over the next two decades. Models and hypotheses suggest that some of those changes might occur much faster than we previously believed possible. In particular, evidence from Greenland ice cores suggests that climate in that region has changed within times measured in decades and that the change may be caused by alteration of global ocean circulation (shutting down the ocean conveyor belt). Therefore, it is not so much a gradual warming of the globe that climate scientists worry about; rather, it is the unexpected feedbacks on atmospheric and oceanic circulation and changes in the hydrological cycle than can lead to catastrophic change in short time periods.

In the Kyoto Agreement, Canada contracted to reduce its CO<sub>2</sub> emissions such that by 2008-2012 our emissions would be six percent less than the estimated emission in 1990. So far we are not progressing very well. In 2000, our emissions in Canada were perhaps fifteen to twenty percent *higher* than in 1990 and are projected to be as much as 30-40% *higher* 2020 (in BC our total GHG emissions climbed from about 50\*10<sup>6</sup> tonnes/yr to over 60\*10<sup>6</sup> tonnes/yr). Even were we to live up to the Kyoto Agreement (along with all the other parties who signed on) the activity of reducing our emissions will only buy us time — perhaps a decade. This is because the effect of GHGs on climate depends predominantly on the cumulative release during the phase in which gases are accumulating in the atmosphere.

Would the decision to produce or not produce oil from the Queen Charlotte Sound and Hecate Strait regions have any effect on climate? Not really. The important control of human impact on climate is set by the global demand from increasing population hungry for increasing energy, and in this equation our coastal reserves are minuscule. If we are to effect change, it has to be done in the way we use energy as opposed to how we extract it. For example switching to alternate energy sources (solar, wind, tidal), using hydrogen or natural gas (CH<sub>4</sub>) instead of liquid fuel oils or coal which produce larger amounts of CO<sub>2</sub>, or using less energy especially in personal transportation would be far more effective ways of reducing our "climate forcing". Finally, oil has an irreplaceable value as a starting material in the chemical industry. Delay in oil production, therefore, might preserve oil for this purpose while alternatives are developed for combustion uses (heating, transport).

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<http://www1.tor.ec.gc.ca/ccrm/bulletin/>  
<http://www.ec.gc.ca/climate/fact/greenhou.html>  
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## **Oil and Gas Issues in Alaska: Lessons Learned about Long-term Toxicity Following the Exxon Valdez Oil Spill**

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### **Abstract**

The *Exxon Valdez* oil spill, which occurred in March 1989, was and still is the largest oil spill to occur in U.S. waters. Although not the largest spill in world history, the extensive documentation of birds and mammals deaths in the first year, coupled with evidence of damage to fish and fish habitat makes it one of the most-studied spills in history. The detection of significant pockets of residual oil in several sensitive habitats a decade later, coupled with evidence of long-term damage has altered public perceptions about the dangers of oil contamination in the nearshore environment. Although our knowledge of spill effects has increased significantly in the ensuing decade since the spill, exactly what the impact of these subtle and delayed impacts may be on the ecosystem remains unknown. This spill has changed our view of the damages resulting from an oil spill, causing us more concern for the long-term persistence and long-term damages.

### **Need for oil**

Supporting year-round economic activity is a struggle in northern environments, and the petroleum industry adds much-needed jobs and tax dollars to an otherwise shaky state economy. Royalties and taxes from oil production are the primary support for the state of Alaska government, and much of the infrastructure of the state is derived directly or indirectly from these funds. But, energy development it is not without social and environmental costs. Oil and coal have been produced in Alaska for nearly 100 years, significantly accelerating with the discoveries of reserves in Cook Inlet and, a few years later, of even larger reserves in Prudhoe Bay. Social changes, both positive and negative, began with the initial exploration; whereas, most environmental risks occurred later with production and transport. Alaska has produced about 20% of the U.S. domestic oil production since the 1970s, from several fields in the Cook Inlet and Prudhoe Bay regions. Over the past 30 years, there have been numerous small spills, including a continuing chronic discharge of oil-contaminated treated ballast water (a price one pays for exporting oil), and one very large oil spill in 1989. Fisheries, tourism, and oil production are the mainstays of the Alaska economy, industries that maintaining an uneasy co-existence in regions where they occur together.

### ***Brief history of the spill***

The spill occurred on Good Friday, 1989, when the *Exxon Valdez* deviated from its normal course to avoid an iceberg, but failed to return to course. It was a human error. About 43 million liters of Alaska Northslope crude oil was released, about 20% of the cargo (Spies et al. 1996). Winds were initially calm, but timely reaction to the spill was hindered by the remoteness of Alaska, residual winter conditions, and the availability of equipment. Equally daunting was the 200 million liters still on board, which needed to be removed to prevent an even worse spill. After 3 days, freezing 70 knot northerly winds stopped all activities and spread the oil beyond the immediate vicinity of the ruptured vessel. Preventing spread of the spill was no longer an option. Fisheries were suspended for the spring and summer in the spill-affected areas. Exxon would spend two summers and about \$2 billion dollars cleaning the oil from several hundreds of kilometers of beaches, inside and outside Prince William Sound. Coincident with initial cleanup activities, both sides, state/federal governments and Exxon, began litigation-sensitive (secret) damage assessment activities. In 1991, a settlement of about \$1 billion was reached between Exxon and the state and federal governments for criminal negligence and for the damages to the natural resources. Civil damages to Natives and fishers in the spill area went to trial several years later to pursue civil damage proceedings against Exxon, resulting in a judgement against Exxon for \$5 billion--a judgement that is still under appeal 11 years after the spill.

### ***Exxon Valdez oil spill- Unique, most studied***

Before the spill, Prince William Sound was a pristine environment, with few people (less than 10,000 in two villages and three communities). The largest of these communities, Port Valdez, was the southern terminus of the 800-mile Alaska oil pipeline, and the marine terminal was where tankers like *Exxon Valdez* took on the crude oil loads. Fishing was the primary commercial employer of the region, centred in Cordova. Cordova was often ranked as one of the top 10 U.S. ports in value of commercial catch landed. Subsistence harvest, particularly fishing, was a dominant way of life for the two Native villages in the Sound. Lacking any industry, Prince William Sound had one of the most ecologically sound and chemically clean environments in the world. Baseline measurements for chemicals confirmed the cleanliness of the Sound before the spill (Karinen et al. 1993), and biological baselines had tracked populations of several commercial species before the spill.

Subsequently, the *Exxon Valdez* oil spill became the most-studied spill in history. Approximately \$100 million was spent between 1989 and 1991 to determine the immediate impacts of the spill; the results of which were the basis for the settlement. These studies ranged from counting carcasses of birds and mammals to determining the contamination loads in intertidal and subtidal sediments. Since the settlement, approximately \$100 million has been spent assessing the long-term persistence of oil and the long-term effects of this residual oil. These studies have ranged from species-specific studies to ecosystem studies. No other spill has been studied so intensely, particularly its long-term consequences. From the *Exxon Valdez* oil spill, many lessons were learned. In particular, 1) there are immediate effects to fish and habitat, even if not always visible 2) oil is persistent in some nearshore habitats 3) oil is far more toxic than previously believed 4) oil and gas development in certain species/habitat combinations can have serious consequences, and 5) a precautionary approach needs to be adopted toward the interaction of fisheries and oil development.

### ***Lessons learned- immediate impacts***

As in most spills, human errors seem to eventually happen. Oil and water do not mix, and once oil is spilled, it is very difficult to clean up. Shorelines are often heavily impacted. Birds and mammals are always hit hard in the beginning of a spill. Damage to fish has seldom been documented following a spill, but with the *Exxon Valdez*, damages to pink salmon and herring have been documented. The immediate effects of the spill have been covered in two symposium proceedings. The Exxon contractors published their first reports in the ASTM proceeding; the *Exxon Valdez* Trustee researchers published their first reports in the American Fisheries Society. The *Exxon Valdez* experience makes clear the need for prevention.

While immediate effects of a spill can be obvious for many species and habitats, particularly the surface species, the significance and magnitude of these effects can always be debated. Table 1 demonstrates the range in deaths from the spill that were estimated for four species, and can serve as our model to demonstrate the debates surrounding spill damage. The impacts to birds and otters were based on the collection of thousands of carcasses, with

expansion to estimate the uncollected carcasses. The number of dead adult birds and otters cannot be disputed, and was hard data showing a direct impact on a population. The immediate impacts are seldom disputed with the surface animals- the visual evidence is usually strong. The length of time to full recovery is often disputed and depends in part on the health and recovery of the ecosystem, making it a complex task to calculate given the many factors that are seldom fully understood. Given that there were not a series of oil spills in Prince William Sound prior to the Exxon Valdez spill, predicting recoveries was not based on a series of previous observations. Therefore, estimating times to recovery was not based on a reality-based model but had to be extrapolated experimentally. This led to debate over government estimates of recovery times.

In contrast, subsurface species are more difficult to see and study, and their impacts to these species are less understood. The case for damage to fish populations is certainly not supported by the hard visual evidence of carcasses like with the birds and mammals. Estimation of damages are more open to controversy, beginning with the estimates of initial damage. In a fish population, high mortality rates in eggs and larvae are expected, and it is very difficult to tease out the mortalities caused by a spill event from the mortalities caused by natural processes. Adult carcasses of pink salmon or herring were not found or collected, but egg or juvenile life-stage impacts were detected found by the Trustee researchers, and estimates of damage were made from these observations. The numbers estimated can be staggering- Brown et al. (1996) estimates 13 billion herring larvae did not survive the early stages of the spill. Exxon disputes the damage to these life stages, saying they were no more significant than natural deaths, and that populations were not affected.

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**Table 1.** Deaths of birds, otters, pink salmon, and herring as estimated by EVOS Trustee researchers.

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Species	Estimated Mortalities	Reference
Otters	2,800	Garrott et al. 1993
Birds	250,000	Piatt and Ford 1996
Pink salmon	1,900,000	Geiger et al. 1996
Herring	12,980,000,000	Brown et al. 1996

***Lessons learned- oil persists for a long time***

About 40% of the spilled oil was beached within Prince William Sound, driven by a high-energy storm shortly after the spill. Subsequently, the oil settled into the interstices of beach gravel. In some locations, this process resulted in deposits of oil that were more than two metres deep (Weidmer and Fink 1996). About two percent of the original spilled mass remained in the beaches by fall 1992 (Wolfe et al. 1994), despite considerable cleanup efforts (\$2 billion worth) and the physical forces of three winters. After more than ten years, oil can still be found in the intertidal reaches of some salmon streams, and on cobble beaches armored with large boulders, and underlying mussel beds on soft sediments.

*Persistence of oil in pink salmon spawning habitat:* Pink salmon spawn in the intertidal reaches of streams in Prince William Sound, and like other intertidal zones, streams were impacted by the beached oil. This habitat is important to pink salmon: 75% of the spawning occurs within the intertidal reaches of streams within Prince William Sound. At first, the freshwater outflow of streams was presumed by many to give adequate protection from direct oiling of the stream beds (and for the most part, it did), and it was hoped that the indirect oiling of spawning gravel from the streams sides would not be significant. To avoid harming the critical spawning habitat, cleaning of the stream deltas was left to natural processes. Studies in the mid 1990s continued to show persistence of oil in the spawning habitat and studies measuring elevated salmon embryo mortalities provided information that the decision not to clean may have been in error.

In 1989, sampling of more than 170 stream deltas revealed broad-scale contamination of the intertidal stream banks (Murphy et al. 1999), but there was little direct visual evidence of oil in these stream beds. However, in streams

flowing through contaminated sediment for two years after the spill, elevated enzymes indicative of oil exposure were evident in the incubating larvae (Weidmer and Fink 1996). In 1995, there were still measurable levels of oil in stream bank sediments of 12 oiled streams (Murphy et al. 1999). In 1999, evidence for continued leaching of polynuclear aromatic hydrocarbons (PAH) from oil into stream water was collected by our laboratory using oil-collection devices placed in salmon redds, indicating continued exposure of salmon eggs and risk. In hindsight, these findings were not surprising given that these habitats were never cleaned after the spill.

*Persistence of oil in armored beaches:* Other habitats in Prince William Sound also retained significant reservoirs of oil in sediments, such as the armored beaches of Latouche and Evans Islands. Armored beaches are in a high energy environment, and consist of large cobble overlain with boulders; these beaches were pounded in 1989 with storm waves and oil, driving the oil well into and below the surface. These beaches were cleaned extensively in 1989 and 1990, but subsurface oil could not be removed. In 1997, these beaches were re-cleaned. Initially, efforts to clean the exposed sections of the beach appeared successful, but winter storms re-arranged the boulders on the beach, revealing a large number of newly exposed oil patches in 1998 (Brodersen et al. 1999). Exposed oil on the surface often had a very thick weathered consistency, while the exposed oil immediately underneath was fluid and mobile, and thus readily re-solubilized.

*Persistence of oil in mussel beds on soft sediments:* The highest concentrations of oil in beach sediments after cleaning have been found in soft sediments underlying mussel beds in Prince William Sound (Babcock et al. 1996, 1998). In contrast to the high energy environments of armored beaches, some mussel beds rest on soft sediment low gradient beaches, often within sheltered bays. Many of these habitats were not cleaned in 1989 or 1990, because the habitats were judged to be sensitive and would have been destroyed by cleaning. In these protected habitats, nature has often been less effective at natural cleaning and restoration. In the late 1990s, these habitats have been suspected as possible sources of hydrocarbon exposure to higher vertebrates, such as harlequin ducks and juvenile sea otters. Some of these species use mussel beds for foraging at different seasons and stages of their life cycle. The retention of hydrocarbons in sediments underlying mussel beds coupled with the potential for long-term exposure should result in a close re-examination of the non-cleaning decision in future spills.

*Composition of weathered oil:* The process of weathering removes the lighter aromatic hydrocarbons at a faster rate than the heavier compounds. The remaining oil has a higher proportion of 3-4 ring aromatic hydrocarbons (PAH), compounds which are more toxic (to aquatic organisms) than the smaller aromatic hydrocarbons. While the volume of oil may be reduced with weathering, the toxicity on a volume basis actually increases. These reservoirs of toxic oil can remain untouched in sediments for years until disturbed (Brodersen et al. 1999, Murphy et al. 1999, Babcock et al. 1996, 1998; Carls et al. in press;).

### ***Lessons Learned: oil can be toxic over a long time period***

In addition to initial deaths attributable directly to oil effects, a number of marine vertebrate species continued to be affected for many years after the spill, including sea otters, harlequin ducks, herring and pink salmon.

*Long-term damage in sea otters and sea ducks:* The age distribution of sea otters whose carcasses were recovered between 1976 and 1998 indicates a persistent effect of the spill on the survival of otters alive in 1989 (Monson et al. 2000). In addition, sea otters born in contaminated areas after the spill also had greater mortality than expected. It is thought that these otters continued to be exposed to oil residues and that their pups were affected by both direct and maternal exposure to oil (Monson et al. 2000). In harlequin ducks, winter survival 6-8 years after the spill was lower in the oiled part of Prince William Sound than in un-oiled parts of the sound (Esler et al. 2000), but no direct effect of the spill was identified. In another study, induction of P450 1A enzymes in harlequin and Barrow's goldeneye sea ducks was found from 1996-1998 in the oiled areas of Prince William Sound, and the authors concluded that remaining oil was still constraining full recovery for these two species (Trust et al. 2000). Both species show evidence of continued oil exposure, and both have feeding strategies that are tied to the nearshore, where pockets of oil still remain. The linkage is suspected but not yet proven.

*Field evidence of long term damage in pink salmon:* There were measurable increases in the number of dead eggs in intertidal portions of pink salmon streams in oiled areas of Prince William Sound for four years after the *Exxon Valdez* oil spill (Bue et al. 1996, 1998). Many presumed that these intertidal spawning areas were protected from oiling effects, since there was no visual evidence of direct oiling. Long-term damage to eggs is believable when the

evidence of persistence of oil alongside the stream is combined with the emerging evidence that oil is especially toxic to eggs in the stream gravels. Exxon contractors have disputed these elevated egg mortalities, but the statistical power of the Bue et al. studies far exceeds the power in the tests conducted by the Exxon contractors (more streams, more transects, more eggs examined, more years examined). Long-term damage such as this from an oil spill have rarely been documented.

*Laboratory evidence of part per billion (ppb) toxicity to pink salmon embryos:* Since 1993, a series of long term-low level exposures has been conducted with pink salmon embryos, with effects measured in the 1-20 ppb range. In these studies, artificially weathered oil was deposited as thin films on gravel substrate. Seawater was passed through the rock just as it would if the oil were beached, exposing fish eggs to the resulting solutions. The exposures were long (up to 8 months), and some juveniles were tagged and released to the wild environment to test their fitness after exposure (these experiments were possible because salmon return to their natal streams to spawn). In embryos and larvae, there were obvious abnormalities and impacts on survival by the end of the exposure (Marty et al. 1997, Heintz et al. 1999). Most surprising, however, were the delayed impacts on growth and on numbers of returning adults (Heintz et al. 1996); adults returned about sixteen months after the exposures ended and were evaluated for growth and survival. Because these effects accrue across life stages, exposure of eggs to these low levels (20 ppb) eventually killed half the fish before they could reproduce. Adverse effects appeared at total PAH concentrations near 1 ppB, indicating that the practice of setting water quality standards at 1% of the acute toxicity levels is not sufficiently conservative.

The response of herring eggs and larvae to the type of oil solutions used in the pink salmon experiments was similar to pink salmon response, though the picture is not as complete. Field observations in 1989 indicated significant failure of larvae in the oiled areas of Prince William Sound (Brown et al. 1996). Laboratory tests with herring embryos and larvae also indicated their extreme sensitivity (Carls et al. 1999). Herring eggs exposed to solutions as low as 0.4 ppB of PAH in seawater for as few as four or as many as sixteen days exhibited a variety of adverse effects (Carls et al. 1999). Effects included increased mortality and abnormalities, and reductions in swimming ability, incubation time, and length at hatch. Several of these effects suggest structural and genetic impacts from oil rather than simple toxicity. Herring do not home to Natal areas like pink salmon, hence the evidence of long term exposure and damage is less clear after the first one-to-two years of the spill. Herring populations crashed in 1993, due to disease that cannot be tied directly to the oil spill, although many suspect there is a linkage. Troubling, there was also a crash in pink salmon in Prince William Sound in the same year, and no other region in the state had a herring crash in standing biomass or a crash in pink salmon.

How can such low concentrations be toxic in the long-term? Once released from sediment, the toxic fractions are taken up by the lipid-rich eggs. Eggs, which develop slowly, incorporate these compounds into their tissues, and these compounds may alter how the fish larvae develop. Thus, low-level oil poisoning is insidious because most of the effects are delayed, and each different symptom is hard to detect, but the cumulative effect may be substantial. Ominously, most of the toxicity associated with this mode of action appears to be associated with the larger and more environmentally persistent oil fractions (Carls et al. 1999; Heintz et al. 1999). In addition, ultraviolet light can increase PAH toxicity by several orders of magnitude, and is most effective on the large persistent PAH (Pelletier et al. 1997). Genetic damage that is passed on to successive generations is currently under study.

### ***Implications of Oil Pollution for Fish Natal and Rearing Habitats***

The threat is not just from acutely toxic concentrations that result in immediate fish kills, but also in the more subtle effects of low-level oil pollution to sensitive life stages. Incubating embryos are very sensitive to long-term exposure to PAH because they may sequester toxic hydrocarbons from low or intermittent exposures into lipid stores for long periods, and because developing embryos are highly susceptible to the toxic effects of pollutants (Marty et al. 1997; Carls et al. 1999; Heintz et al. 1999). PAH in weathered oil can be persistent, biologically available for a long time, and very toxic to sensitive life stages. The result is that fewer juvenile fish survive, so that recruitment from the early life stages is reduced, and adult populations are not replaced at sustainable levels. Eventually, adult populations may gradually decline to extinction.

Streams and estuaries play host to the vulnerable early developmental life stages of many fish species and are also the recipients of the bulk of chronic hydrocarbon discharges. Herring spawn their eggs in areas of reduced salinities, salmon use both stream and estuary for much of their first year of life, and the embryos-larvae-juveniles of many

marine species use the estuaries for nursery grounds. The very qualities of these natal and rearing habitats that provide protection from predators also make both the habitat and, by extension, the species vulnerable to pollution. The soft sediments of salmon streams and many nearshore estuaries can harbor oil for extended periods with slow release.

Fish natal and rearing habitats are clearly vulnerable to oil poisoning from chronic discharges under the current regulatory framework, because regulations are based on *acute toxicity models* which, seldom account for long term low level toxicity to vulnerable life stages or for habitat differences in retaining contaminants. Water- quality standards are often based on acute toxicity results for more-tolerant life stages, which may seriously underestimate cumulative adverse effects, even when presumably conservative safety factors of 1% are applied. These water-quality standards need to be revised to protect these habitats. This is a daunting task. In the United States, the equivalent of an Exxon Valdez oil spill is produced every year by each 50 million people as urban runoff (Eganhouse et al. 1981, Hoffman et al. 1983). No single event is notable, and mass fish kills with floating carcasses are rare. Instead, there is continued habitat contamination, erosion of populations and, when coupled over time with other events such as hard winters, other habitat loss, increases in predators or fishing, decreases in food availability at a critical life stage, etc. Such chronic pollution may eventually result in extinction of the population. Species with life history strategies that rely on streams or estuaries for reproduction are most vulnerable.

Prince William Sound is recovering from the EVOS, and although oil can still be found in selected habitats 11 years after the spill, less oil is bioavailable each year. The spill is now more analogous to chronic low level pollution from the remaining pockets of oil. In contrast, most urban environments have a complex mixture of pollutants that add to the stress of other physical habitat perturbations. Unless protection of water quality and physical habitats is secured, many natal and rearing habitats of fish near urban areas will continue to degrade and will lose their ability to support sensitive life stages.

#### ***A precautionary approach to risk assessment should be adopted***

A precautionary approach to oil and gas development and the attendant risks to marine organisms seems advisable in the face of mounting evidence that oil is far more pernicious in the nearshore environment than previously believed, and that early life stages of fish are very vulnerable to toxic pollutants. We are no longer surprised at embryo sensitivities when humans are exposed (e.g. fetal alcohol syndrome; thalidomide); we should not be surprised that low level environmental pollutants can have devastating effects on fish embryos and their subsequent poor recruitment into the adult population. While the oil companies, like big Tobacco, continue to remind the public that very little can be rigorously proven, the public is becoming increasingly aware that oil and gas development can have a major impact on fish and wildlife habitat. Up until now, it has been the government's responsibility to prove the potential for harm before greater regulatory controls would be placed on oil development and transport. In the light of the results of the Exxon Valdez oil spill, the public is requiring more caution from its regulators. Drug manufacturers are required to prove that a given drug has a very low risk before it can be sold, but in environmental regulation the burden of proving risk rests with the government. Like ripples from a pebble in a pond, each of the effects of oil on fish reproduction is cumulative. Oil development and transportation will continue to be needed and valued, but each aspect needs to be viewed in terms of risk to developing embryos and sensitive habitat, rather than the acute toxicity models relevant to more tolerant life stages.

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## SYNOPSIS OF DISCUSSION FOLLOWING THE ENVIRONMENTAL IMPACTS AND MANAGEMENT SESSION:

*Is anyone tracking pink salmon through the food chain?*

A lot of work is being done on pink salmon and the results suggest that they are really important to the ecosystem in terms of the carcass nutrients and how they move up the food chain. A further question was raised that regarding whether any of those studies have been initiated in Prince William Sound, and tracking those nutrients, PAHs and other contaminants associated with oil up the food chain.

The response was that the studies to date have been with sockeye taking PCB's — with a lake that does not have an anadromous run and the PCBs have come from the ocean. Where they had another lake immediately adjacent to it that did not have an anadromous fish run, the PCB's were not present.

*Is there legislation on how oil tankers are constructed and maintained?*

We have been hearing a lot about the rules and regulations — now we have been hearing about oil spills. I live on Strait of Georgia and see oil tankers going back and forth. Is there legislation in place or can it be in place to dictate how the tankers are constructed so they are safe enough to go around the world, and how they are maintained, and how long they can be in service before they are scrapped.

Jeep Rice replied from the US perspective. The Oil Spill Pollution Act came in a year after the Exxon Valdez — and it says that you will change to double hulls or the equivalent, for example, within about twenty years. We are looking at that going down the road. Robie MacDonald noted that in terms of a comment made earlier about hydrocarbons coming into the Strait of Georgia system, about 50% or more of them are coming from run off from land. He noted also that combustion of PAHs around Vancouver are showing up in the sediments thus continually adding to the load of the land run off.

*Can we affect what passes by our coast?*

Jeep Rice noted that for the USA the transport vessels have to be USA registered vessels and so there is some level of control. He noted the biggest polluters in Alaska right now are the international flag tourist boats — they occasionally run on the rocks, spill oil, dumping their trash, have poor quality smoke emissions. In the south there is a shared traffic corridor through Juan de Fuca and Puget Sound so regulations have to fit both the USA and Canada.

*How are the indigenous people of that area doing after that spill?*

Jeep Rice noted that they are not doing very well — there are two villages and one did not get directly impacted from the oil spill, the other closest ones were pretty hard hit. He mentioned that this is also the area that was hardest hit by the 1964 earthquake that uplifted in exactly the same area as the oil spill. So even if a beach is certified as clean they still will not use it. For us, it would be like saying this sewer outlet here is certified to be clean - and the biggest and juiciest clams and oysters are 100 feet away and they still are not going to eat it. That is what has happened to the village — so their whole subsistence lifestyle has not only been interrupted, it has actually been stopped and they now go some pretty significant distances to do their foraging.

*Moot question- how did Alaska let the Exxon Valdez spill happen?*

With the Exxon Valdez accident having such an impact on our decision making now on the North coast of British Columbia, with the due diligence that we would hope to have been in place in Alaska, how did the state and federal government allow a vessel to leave the terminal with an impaired skipper, no pilot, no vessel escorts hitting an unmarked reef.

Jeep Rice responded that the reef well marked — on all maps, but not on the beacon. He noted that they are going to "shut the barn door after the horse got out". One of the problems that Alaska has is that the oil industry drives the economy- not by a small margin but a huge margin. He noted that the watch dog agencies, have basically been gutted over the last ten years and it is the private interest groups, the independent groups that are the watchdogs now.