Sense and Nonsense- The Environmental Impacts of Exploration on Marine Organisms Offshore Cape Breton

by

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Introduction

The Oil and Gas industry proposals to explore and drill for hydrocarbons offshore Cape Breton are an assault on the senses of man and marine organisms and even defy good sense. Not only are the Corridor Resources and Hunt Oil tracts some of the largest tracts issued in Nova Scotia, they are the closest to shore and both are adjacent to the unspoiled Highlands National Park. Together these blocks appear larger than Cape Breton Island itself. Moreover, while the risk of finding some hydrocarbons next to wells which already had gas indications are relatively low, the blocks were obtained with by far the lowest (on a per hectare basis) work commitments. After a thorough review of the following environmental risks to the natural resources of Cape Breton it will be up to the Public Review Commission to decide whether these bargain basement prices justify these significant potential hazards.

The environmental impacts of the Oil and Gas Industry's exploration operations are pervasive. No country or province which has been exposed to a prolonged history of offshore hydrocarbon exploration has been left untouched by the inevitable accidents and unforeseen consequences of the petroleum industry.

The fishing industry is usually the first sector to be impacted by these exploration activities. This normally occurs when fishermen are told to remove their boats and gear from an area so that a seismic vessel can begin generating noises. Although thousands of kilometers of seismic were already acquired through the 1980's, hundreds and probably thousands more are planned by Cape Breton leaseholders. This cycle repeats itself every few years whenever better technology is introduced or another company takes an interest in prospects. This means that fishermen's activities have been increasingly disrupted by seismic and drilling activities.

By far the loudest noises generated by the offshore petroleum industry are those produced by seismic survey equipment. This equipment is designed to create very loud noises, the echoes of which reflect off geological strata deep within the seabed and are used to locate likely places for drilling wells. The sounds were at one time made by explosives, which could kill fish at a range of some hundreds of meters, but the almost universal seismic equipment now used offshore is an array of "airguns".

In assessing the environmental effects of underwater sound, the first task is to determine at what range that sound would be audible to marine animals and fish. "Sound exposure levels of 150 to 160dB are where potential reactions might occur for large whales and fish. On the Scotian shelf these noise thresholds are reached at distances of 4.5 to 14.5 km. depending on the specific location." (Tsui. 1998) Similar ranges would be expected at the same depths off Cape Breton.

"Broadband sounds at or above 180 dB would be experienced within 1500 m of the array. Stationary fish would be exposed to this level or greater for about 20-25 minutes." Unfortunately, "it is not yet possible to establish unequivocal criteria for determining the zone of influence around a noise source. Sound waves are created by the explosive release of compressed air from an array of air guns towed behind seismic vessels (specialized ships), firing every 5 - 12 seconds. Streamers can be up to 6 km long and are stored on a large winch[1]" (Exploring for Offshore Oil and Gas number 2 of a series of papers on energy and the offshore November, 1998)

Seismic Effects on Fish and Marine Mammals

Experiments on the effects of seismic shooting on abundance and catch of cod and haddock were conducted in the Barents Sea. The Norwegian studies (Engas 1993) looked at the effects of an airgun using a combination of scientific-survey and commercial-fishing techniques. The fish survey work extended across a circle 40 nautical miles in diameter (a maximum range of some 33 km from the airgun survey area) and continued until five days after the seismic work was completed. It had been supposed that this study would extend far enough and long enough to delimit the area and time affected by the airgun's sounds "Acoustic density of cod and haddock decreased over the entire study area by 45% during the shooting and 64% during the 5 d period after shooting ceased. More than 90% of the catch was cod. During shooting, catch in the shooting area decreased by 60% and catch in the other areas (up to 18 km from the exploration area) decreased by 45-50%. Catch rates did not recover during the 5 day period after shooting ended. The longline catch decreased by 45% in the exploration area, but the decline was smaller with increasing distance from the exploration area; with no reduction in catch at distances of 16-18 nautical mi. from it. Catches increased after cessation of shooting." (Tsui. 1998)

It may therefore be expected that a seismic survey on the shelf will cause many fish to move some tens of kilometres away from the airgun, substantially depressed commercial catch rates in the vicinity for at least several days during and after the survey, though it should not injure or kill any adult fish (except those very few that approach within a few metres of the airgun). This degree of disturbance could be very significant to fishermen working near the survey area. Indeed, if the fish were forced away from their spawning ground, or even a prime feeding area, there could be some significant loss to the resource. Seismic surveys are not innocuous to the fish or the fisheries.

In a later Norwegian study (Engås 1996), longline "catch was reduced by 55%-80% within the seismic survey area and there was some reduction in catch to a distance of 5 Km." In the same area, "trawls were made before and during shooting. Cod catches during shooting were reduced by 79-83% compared to pre-shooting levels within the exploration area and within 9 km of it." (Tsui. 1998). Large fish, both cod and haddock, showed more response to the shooting than smaller ones did. There was no recovery over the following few days. Thus, the lower levels after the seismic survey ended represent a failure of the fish to return following gradual decline, rather than continued movement out of the study area.

The merits and shortcomings of the Norwegian studies have been endlessly debated and can never be fully resolved. What has been missing from these controlled experiments until recently is the experience and first-hand knowledge of qualified and objective observers. Since the fall of the Iron Curtain, information has begun to flow out about the Russian experience with decades of exploration activity in the Caspian and Barents Seas. These reports differ markedly from the rather subdued observations in Western Bloc countries. Dr Stanislav Patin in his 1999 book entitled *"Environmental Impacts of the Offshore Oil and Gas Industry"* recalls a catastrophic ecological situation in the Caspian Sea in the 1960's. "I was a member of the Special Government Committee on this issue and witnessed firsthand the dramatic ecological consequences of the explosive use, including mass mortality of Caspian sturgeons (up to 200,000 large specimens)."

This report is not viewed as a serious threat to large groundfish from modern seismic sources in Canada, but rather as a reminder that harmful effects of exploration activities have been recorded in many other countries for years with little coverage from Western sources.

In a fishing experiment on rockfish in California, catch per unit effort (CPUE) declined by an average of 52.4% when air gun pulses were emitted at levels of 186 to 191 dB. Skalski et al (1992) speculated in an area where sound had caused the fish to disperse, a lowered CPUE might persist.

"With the exception of the California studies of rockfish, investigators did not measure received noise levels. Thus, it is not possible to say, with any certainty, what sound levels could cause reduction in catchability cod and haddock." However, regarding dispersal, "There may be some situations in which movement to other areas will not detrimentally affect the population. However the safest assumption is that population occupies optimum habitat and movement away from the habitat is likely to be detrimental, at least if the animals are displaced for more than a brief period" (Tsui.1998)

Herring is also relatively sensitive to sound. At 50-1200 Hz its hearing threshold is about 75-80 dB. Yolk sac larvae (2 day old) showed peak pressures of 217-220 dB (75- 100 kPa) had detrimental effects on anchovy. A 50% mortality for 2 day and 4 day old larvae occurred at this level.

"Peak pressures of 217-220 dB (75- 100 kPa) had detrimental effects on anchovy. Adult anchovy also experienced swim bladder damage in this range". Also "In one study, the fish [Herring] changed direction and moved away from the source, but schooling behavior was not affected. The fish reacted to sounds of 144 dB." (Tsui.1998)

Early life stages of fish are particularly vulnerable. Pulses from an airgun damaged larvae mainly with a radius of 5m. Eggs of the anchovy, the most sensitive species experienced some damage at this distance. (Kostyuchenko 1973). According to the Georges Bank Review Panel Report 1999, "A consultant to the petroleum industry stated that fish eggs and larvae are susceptible to seismic damage, and that seismic pressure waves within a distance of about 1 _ to 6 metres from the airgun could cause mortality of the eggs and larvae."

"There are no data on behavioral effects of seismic pulses on fish eggs and larvae…A small change in the survival rate of larvae can have a large effect on recruitment to the adult population." (Assessment of the Possible Environmental Impacts of Exploratory Activities on Georges Bank Aquatic Resources. DFO. November, 1998)

According to Patin 1999, "Mechanisms and manifestations of biological effects of high energy waves of seismic signals on living organisms can differ. They range from damage of orientation and food search to physical damage of organs and tissues, disturbance of motor activity and death. Early stages of fish development – larvae fry and probably developing eggs – are especially vulnerable."

Although many complex computer models have been applied to calculate the radius of mortality in the vicinity of an airgun, the results of these models should never replace common sense and practical observations. The fact is that there are no adequately reported measurements of the sound pressure directly above an airgun. Airguns are typically towed at a depth of 6m below the surface. This leaves very little room above the airguns which is not potentially lethal. Although the oil companies insist that the energy from the airguns is directed downward, they continue to use spherical models to calculate dispersal. This suggests that the energy is propagated upwards as well as downwards.

There are also no reported studies of impacts on organisms located above the airguns. Perhaps this is because the water above the airgun has been observed to be forcibly expelled in the air as the bubbles break the surface. A reasonable person might conclude that survival of eggs and larvae is limited in this zone, but reportedly the industry has no data to examine these effects.

The one fact that all researchers can agree on is that there has been little or no examination of the impacts of seismic airgun sources on spawning activity. This is surprising, considering that millions of kilometers of offshore seismic have been acquired in major global spawning areas such as the coast of Africa, Asia, Russia, Australia and many other regions. Each of these areas increasingly require their own versions of environmental impacts assessment and investigation into fishing consequences. In each area, when questions are raised about disruption of spawning activity the industry claims it has no data on these effects. However, it is well known that many species of fish and marine mammals require auditory signals for successful mating behavior. In short, propagation of many species may depend on undisturbed reproductive activity. How many more years will the Oil and Gas Industry claim that the consequences of exploration seismic on spawning activity is entirely unknown? The coast of Cape Breton contains established spawning and nursery areas for Cod, Winter Flounder, Grey sole, Snow Crab, Scallop, Hake, Plaice, Halibut, Herring, Yellowtail, Mackerel, Lobster, Sea Urchin and Shrimp. There is virtually no time of the year when the area is ice-free when spawning in this critical habitat is not occurring.

Sound Pressure Levels

Confusion over sound reference standards has sparked much debate recently concerning the potential effect of seismic on marine mammals. Sound pressure levels are measured in decibels (dB). The decibel is measured on a logarithmic scale comparing a measured sound pressure to a reference sound pressure. Since sound reference pressures differ between air and water, a correction factor of 26 dB must be added to an air reference when compared to a water reference. When comparing sound power levels, an additional 35 dB must be added to an air reference to compare sound power levels to a water reference to account for the physical differences between water and air as propagation media. Therefore, approximately 61 dB must be added to an airborne sound to compare it to a waterborne sound. Seismic proponents believe that power rather than pressure level is the more relevant comparison because power levels reflect the change in energy through a given medium over a specified area while pressure levels do not.

The effects of these sounds on marine mammals are even less well known. Detonation of the airgun arrays used in seismic survey has the potential for structurally damaging marine animals. Whales, primarily bowheads, have been reported in the scientific literature as showing reactions of various kinds to seismic surveys at distances of 5 to 10 km, while there is even a report of sperm whales altering their behavior in response to the sound of a survey some hundreds of kilometers away. One recent study has suggested that dolphins show a similar tendency to avoid seismic vessels, though some individuals were observed within 2 km of the airguns. It does seem, however, that while such surveys disturb (and perhaps even cause pain to) cetaceans, possibly reducing their feeding opportunities or exposing juveniles to predation, they do not directly injure or kill at any reasonable range.

Dr Rob McCauley from Curtin University in Australia (APPEA 2001 Activity Report) found that the wavelength and amplitude of the sound produced by seismic equipment are almost identical to the sound characteristics of humpback whales breaching. The results of the Curtin University work also indicate that seismic activities are likely to cause an avoidance response in humpback whales within 3 kilometres from the seismic source. Obviously this could have a detrimental effect on whale reproductive behavior. In some instances Dr McCauley found whales were initially attracted to the sources of seismic activities before swimming away. Could this behavior potentially cause damage to whales?

It is interesting to note that the Nova Scotia Offshore Area Petroleum Geophysical Operations Regulations clearly state, " During a geophysical operation, no air gun shall be test-fired while the air gun is in the water if there are divers within 1,500 m of the air gun. If this is considered a safe distance for humans in the water when airguns are firing we can only speculate what would be a safe distance for marine mammals with far better developed hearing?

The DFO has stated (Boudreau et al 1999) that "seismic exploration has been known to give rise to the following impacts such as:

- a decreased catch rates due to scaring of the fish;
- interference with fish spawning
- space conflicts with existing fishing activities
- mortalities in a number of species and a number of life stages and ,
- possibly change marine mammal movements

A typical seismic shoot would fire an airgun approximately every 10 seconds. These programs are conducted 24 hrs a day and (for a 2D program) might operate as much as 70% of the time considering maintenance and weather. This results in more than 25,000 shots over a very minimal 10-day seismic schedule. These lines are normally shot adjacent to each other, so it is likely that some organisms would be within earshot of these sources for hours, if not days. It is hard to argue that these impacts are not significant when they occur over a wide survey area and extend for such periods of time. No one knows for certain what overall impact these disturbances have on spawning stocks, survival of eggs and larvae in the near surface, marine mammals and critical migration routes. All of these issues directly impact the health and reproductive success of fragile stocks in Nova Scotia.

Exploration Drilling

Despite industry claims, the companies do not yet know for certain which type of hydrocarbon (oil, gas, condensate or a combination of these fluids. will be encountered). Vintage seismic data from the 1980's cannot accurately distinguish between oil and gas and geochemistry, if available, is often difficult to interpret. Before drilling, the companies will conduct a hazard survey primarily to reduce the chances of encountering shallow gas which could be disastrous.

Shallow seismic surveys of the upper few hundred meters of the seabed are often carried out to determine the structure of the sediments and scan for potential hazards to drilling (e.g., shallow gas pockets). These hazards will be described in greater detail in the section on shallow gas blowouts.

The Drilling Phase
Under normal circumstances, the predominant discharges during drilling, would be the "cuttings"; small chips of rock cut by the drill in forming the well, and the "muds" used in the drilling process to cool and lubricate the drill, carry the cuttings out of the hole and counter-balance the pressure of gas, when that is reached. These discharges, their fates and their environmental effects have been the most intensively studied (and argued) aspect of the offshore petroleum industry's environmental effect. It has generally been

thought that drill muds cause the greatest harm, other than that resulting from major accidents.

Aside from the limited amount of information from (mostly exploratory) drilling in the northwest Atlantic, only Georges Bank and the North Sea developments offer much documented experience relevant to the Cape Breton situation.

Cuttings from drilling can have an adverse effect on the benthic community, the effects of cuttings being substantially greater, at least when multiple wells are drilled. Beneath the platform, these effects are mainly due to physical burial of the natural seabed. In the North Sea early studies showed that major deleterious effects were confined within 500 m of the platform, where recovery is likely to be slow. Lesser biological effects, detected as changed community parameters, extended to 1000 m or, with stronger currents and more drilling, 2000 m from a platform, and elevated hydrocarbon levels can extend as much as 4 km down-current.

A much more appropriate environmental effects monitoring program was designed for the exploratory drilling on Georges Bank in 1981-82. It included monitoring of barium (a tracer of drilling mud, which contains a high percentage of barite) at a wide array of stations. The studies showed (Backus 1987) that the barium concentration in fine sediment (sieved from samples of seabed sediments) at a monitoring station 35 km east of the drill sites doubled during the period of drilling. The same index at a station 65 km to the westward of the wells (down the residual current) rose by as much as six times. In the opinion of the scientists involved, the likely reason that barium increases were not found at still more distant sites was that the natural sediments at the sampling points chosen were muddy, diluting any barium-rich mud from the drilling to undetectable levels.

In the early 1990s, a research team from the Bedford Institute of Oceanography undertook some field studies around the COPAN platform on Sable Island Bank. Having noted the crudity of the conceptual models being used in designing environmental impact studies around offshore installations, this team had developed advanced sampling gear that would allow study of more complex environmental mechanisms. In 1993, following seven months of drilling, this equipment was deployed on Sable Island Bank and showed that the seabed around the rig was covered with light flocs, composed of a mixture of biotic material and drilling wastes. Substantial amounts of this material were found as far as 2 km from the platform, with some at more distant stations even the most distant one sampled, 15 km from the platform though natural flocs have since been seen on Sable Island Bank and those observed beyond 2 km from the COPAN platform may not have been drilling-related. (Muschenheim 1995,1996)

In the ocean, our ability to measure change is so weak that gross damage could be done to resource productivity without anybody being aware of the fact. If, for example, the groundfish of the Cape Breton shelf suffered a one-time 25% or even 50% die-off, it is most unlikely that anyone would ever know for certain that that had happened since we have almost no ability to even estimate average rates of non-fishing mortality, let alone to measure their inter-annual changes. Sustained annual "natural" (i.e. non-fishing) death rates could rise from about 20% (their likely normal level) to well over 30% and yet the possibility of that change would only be argued over years later when the resulting errors in management caused another collapse of the fisheries.

Similarly, year-to-year variations in the numbers of young recruits to each fish stock are so large that a one-time loss of 90% or more of the young-of-the-year would only be noticed as another "naturally" poor year. Even a sustained 50% reduction in recruitment would not be clearly recognizable for a decade or more, no matter how precisely the numbers of recruits could be documented. Reduction of growth rates of the fish would be rather more detectable than these changes in recruitment and death rates, though 10% changes might still pass unnoticed and, even if detected, it would be all but impossible to establish the cause of the decline.

Since Nova Scotia's fisheries have annual landed values around half a billion dollars and overall values to the Provincial economy are several times higher still, it would be possible for some of these changes to take a billion or so dollars out of the Provincial economy annually. Such an effect would most certainly be "significant", in a social and economic sense, despite remaining undetectable at the resource level.

Mud and Cuttings Discharges
Water Based Muds (WBMs)

Besides their intended constituents, drill muds, both Water Based Muds (WBMs) and Oil Based Muds (OBMs), often contain high levels of heavy metal contamination. WBMs, despite their water base, also often contain appreciable amounts of oil: under some circumstances, it is necessary to add a "pill" of oil to the circulating WBM and this is usually left in the mud, gradually being dispersed through it and ultimately discharged with it.

All drill muds circulate in the well when in use and they are routinely, re-conditioned and re-used; the cuttings being extracted from the circulation as the drilling proceeds. In time, however, the muds become unsuitable for further use and have to be replaced. The universal practice with WBMs offshore seems to be the discharge, direct to the sea, of all such waste mud, either as a more-or-less steady stream or as a short, high-volume "bulk discharge". Inevitably, some WBM is also discharged with the cuttings produced by the drilling.

The overall quantities of WBM discharged can be high. While the water naturally disperses into the ocean, the other constituents represent substantial contamination. The eight exploratory wells drilled with WBM on Georges Bank in 1981-2, for example, resulted in some 4000 tons of barite and 1500 tons of bentonite clay being discharged.

The WBM itself, both that lost routinely with the cuttings and that released in bulk discharges, would contain the many noxious and toxic components described above. Most of them would only be released in very small quantities and would be rapidly dispersed in the water column. They are, therefore, generally ignored in discussions of the impacts of WBM drilling. Clearly, this is inappropriate and potentially dangerous, though the wide variety of possible materials and the lack of study of their effects makes any more detailed treatment impossible.

Water-Based Mud

The composition of drilling mud may be changed often during drilling in response to conditions encountered. In practice, this usually means that mud weight is gradually increased by adding barite and other chemicals to control the natural pressure increase with depth. When this happens suddenly, the mud is dumped in bulk and a new batch is mixed (often with heavier properties in anticipation of increased pressure). Analysis of the drilling waste scenario data (volume density and weight) could yield a likely composition. It is indeed strange that adult scallops are highly sensitive to barite but show relatively low sensitivity to used water based mud cuttings. This strongly suggests that the samples analyzed came from the upper part of the hole where the concentration of barite would be at a minimum.
[Offshore Production, Storage and Transportation Number 3 of a series of papers on energy and the offshore, November 1998]

Moreover, the time has passed when scientists can simply drag out the same old reworked oil and gas environmental studies from the North Sea and Gulf of Mexico showing inconclusive results due to a lack of pristine base-line conditions. What about the hundreds of thousands of wells drilled offshore in other regions? Why do these brief compilations of available data rarely even mention scientific investigations conducted in other regions?

Furthermore, dozens of organisms have already been subjected to varying compositions of drilling mud and the toxicity results are known and well reported. Of 415 acute lethal bioassays lasting 48-144 hrs with 68 drilling muds involving 70 species, 8% showed 50% mortality (LC50) below 10,000 ppm. The 96-hour LC50 test and the sublethal tests (Neff 1987) revealed the most sensitive species were as follows:

Copepods- 5500 ppm in 96 hrs (LC_{50})
Lobster Larvae- 2000 ppm (increase in larval development by 3 days)
  Stage IV 8 ppm (partial inhibition of molting, delayed detection of food cues)
  Stage IV-V - 1-4 mm layer (altered burrow behavior delays in construction)
  Stage V - 5000 ppm (LC_{50})
Lobster Adults- 10 ppm Decreased response of walking leg chemosensors to food cues)
1-2mm layer for 4 days- inhibition of feeding behavior
Scallops
  Juveniles and embryo's -
  Scallop larvae - 49ppm (decreased rate of shell growth)
    2 day larvae -100 ppm in 96 hrs (significant inhibition of shell formation)

Ecosystem Impacts

"There is concern that the routine discharge of wastes during drilling for oil and gas could impact valuable fishery resources. Recent studies have indicated that intensive drilling efforts in the North Sea have caused detrimental effects in adult and larval fish and benthic invertebrates at greater distances from drilling platforms than previously envisaged"[8]. (Neff 1987)

Abundance of benthic organisms near one N.J. rig site plunged from 8011 animals /sq m. before drilling to 1729 animals /sq m. during drilling. One year after drilling was completed, the number had risen to only 2638 animals /sq m. Diversity was also impacted from 70 to 38 species /0.02 sq m rebounding only to 53 species /0.02 sq m one year afterwards. [8] (Neff 1987)

In the Gulf of Mexico, the benthic fauna is "decidedly reduced relative to other studies and that the majority of the benthos in an offshore Ecology Investigation (OEI) study area is composed of two species, both of which have been documented as precise individuals of severely polluted environment." [6](Howarth 1987)

Discharges and Shellfish

Laboratory experiments have shown barium uptake, from WBM-contaminated sediments and foods, by both flounder and lobster juveniles but there does not seem to be any evidence for its biomagnification up the food chain. In the experimental setting, the contaminants suppressed growth of both species and enhanced lobster mortality but this was with concentrations of 9 g barium per kilogram of sediment and a 98 or 99-day exposure concentrations unlikely to be found offshore for such a prolonged period.

The final fate of the WBM bentonite would, perhaps, be similar to that of barite. Certainly, its finer grain size should ensure that it is at least as mobile as the barite and probably more so. Recent research has shown that scallops are peculiarly susceptible to barite and bentonite, prolonged exposure to even concentrations as low as 10 mg.l-1 (less than 10 ppm) being fatal, while levels as low as 2 mg.l-1 can affect scallop growth.

What is known is that sediment concentrations in the lowest levels of the benthic boundary layer of the water column (levels in which scallops live and from which they draw their food) can be 100 times higher than those only a few meters above the bottom. In one survey, around a COPAN site at which drilling had been proceeding for seven months, tidally-resuspended bentonite was found at detectable levels even at the most distant station sampled, 8 km from the platform, though the concentrations there seem to have been around 0.01 ppm and so should not have been high enough to affect scallops.

All of these firmly established numbers may, however, conceal a greater problem for scallops. The research to date has, for obvious reasons, examined the effects of bentonite/barite on adult scallops finding it to be more harmful than many would have expected. What has yet to be considered, however, is the impact of bentonite/barite, lying on the seabed or suspended in the benthic boundary layer, on settling scallop larvae ("spat"). Scallops, like most marine benthic species, have planktonic larvae that must, at a short and critical phase in their life cycles, select a point on the seabed where they will settle. While no definite information is available, it is likely that these scallop spat and their selection activities are more vulnerable to the impacts of contaminants than are adult scallops. Thus, it is possible that the bentonite distributed about active drilling operations would reduce scallop recruitment for some kilometers around the wells, in the year of the drilling. The degree of any such reduction can only be a matter for speculation at the present time.

Recent studies of Scallop impacts from drilling activities on the Scotian Shelf have been carefully documented. "Much of the observed growth loss [in scallops] was due to retarded gonad development and not adductor muscle. Therefore it is likely that drilling wastes would have more effect on spawning potential (An impact not apparent in the fishery until reduced recruitment in future years) than on muscle size." The net effect might be reproductive loss which could affect strength of future year classes. (Assessment of the Possible Environmental Impacts of Exploratory Activities on Georges Bank Aquatic Resources. DFO. November, 1998)

The benthic boundary layer transport (bblt) and mortality studies on scallops have the following limitations and are inadequate for predicting the biological impacts of drilling discharges. Therefore estimates of lost growth days and safe distances from rigs are invalid

1. Scallops were exposed only intermittently for 12 hrs each day for up to 68 days. Even the hypothetical well was projected to be drilled 24 hrs per day for 93 days with wastes released on 59 of those days. There is no evidence that the benthic concentrations of barite would decrease significantly during the brief periods when mud and cuttings were not actually being discharged.

2. "The biological effects predicted apply only to adult scallops (4-5 years old)" Known impacts on eggs and larvae were not incorporated.

3. "For these applications, drilling waste concentrations were averaged for the bottom 10 cm of the water column." The concentrations obviously would increase at the sediment water interface.

4. No safe level of barite was experimentally determined for adult scallops. Both the "zero growth concentration" threshold and the "no effects concentration" threshold were estimates not supported by experimental results. Zero growth occurred at the lowest concentration tested (0.5 milligrams/L and could actually have been much lower. The "no effects" threshold could easily have been in micrograms or even nannograms per liter but was arbitrarily set at 0.1 milligrams/L

The actual ratio of barite to bentonite averaged over the total depth of the eight Georges Bank exploratory wells ranged from 47 to 77% (avg. 66%) [8][Neff 1987]. This ratio also increases with depth to compensate for increasing pressures. Increased mud densities result in higher settling velocities.

"The predicted near-bottom concentrations are very sensitive to the effective settling velocities of drilling wastes. Those at the higher velocity are about an order of magnitude greater than those at the lower velocity." [5] (Assessment of the Possible Environmental Impacts of Exploratory Activities on Georges Bank Aquatic Resources. DFO. November, 1998)

"The expected range of settling velocities was estimated using measured drilling waste concentration profiles around the Copan site [on Sable Island], but it appears that these did not fully resolve the dense mats seen in video images. Thus higher settling velocities and hence near bottom concentrations are possible but considered unlikely to occur under the tidally energetic conditions on Georges Bank. If they were to occur on the Bank, near bottom concentrations and scallop loss could be increased by several fold above the present model predictions." [5] (Assessment of the Possible Environmental Impacts of Exploratory Activities on Georges Bank Aquatic Resources. DFO. November, 1998)

"As mush as 90% of the discharged solids settle directly to the bottom. (Brandsma 1980). The remaining 10% including clay-sized particles and soluble materials is diluted by the current and dispersed over large areas[8]. " Furthermore "during the entire [one well] scenario a total of 468 MT of drilling mud and 2569 MT of cuttings are released to the marine environment. [5] (Assessment of the Possible Environmental Impacts of Exploratory Activities on Georges Bank Aquatic Resources. DFO. November, 1998)

"Studies examining the effects of exploratory drilling on the U.S. portion of Georges Bank found that small amounts of some drilling muds (in particular the weighting agent barite) had been transported as much as 60 km from the well site." [11] [Exploring for Offshore Oil and Gas number 2 of a series of papers on energy and the offshore November, 1998]

There is the potential of some suppression of production, through reduced growth and increased death rates, of this resource within a few kilometers of each platform while drilling is in progress. The fate of crabs and lobsters exposed to this level of contaminants are largely unknown.

Now that it has been shown that drilling eight wells spread detectable levels of barite over much of Georges Bank, the COPAN drilling near Sable Island spread flocculant material some kilometers from the source, Norwegian oil production has affected benthic communities over some 100 sq km around major platforms and that background sediment hydrocarbon levels seem to be rising in the United Kingdom sector of the North Sea, the relevance of such impacts can no longer be ignored.

Shallow Gas Blowouts

If, as the company's claim, there is little potential for oil on the leases then one of the greatest risks to the environment during the exploration phase is a shallow gas blowout. This is particularly true if the flow is associated with a condensate discharge which frequently occurs.

"Shallow gas flows are a critical issue because field experience and mathematical modeling have shown that it is difficult, and almost impossible, to control or stop a flow with existing rig equipment once it begins. Once flow has started, it is almost inevitable that a blowout will occur. The response time based on field experience is low or virtually non-existent in many cases. Sufficient time does not exist in most cases to recognize the situation, dose the diverter, and begin the kill operation before the flow becomes uncontrollable[2]." (Adams 1991, World Oil" (May and June 1991)

"Diverter system failures occur at such an alarming rate during shallow gas blowouts that contingency plans probably should be based on their anticipated failure rather than an expectation that they will function effectively. Previously published studies show that failure rates range from 50 to 70% of all applications."

"Many operators and contractors now design diverter systems for the primary purpose of providing time to evacuate the rig. They do not plan to remain on the rig and attempt to control shallow gas blowouts".

With shallow gas blowouts, "Flow outside casing usually results in severe situations such as a damaged well and rig or platform loss. Also, flow can exit to the surface through fault planes or around poorly cemented casing."

"Cratering occurs when flow outside the casing displaces large volumes of surface sediment. The eruptive force of blowouts can be dramatic and has been documented as lifting large boulders weighing several hundred pounds into the air and dropping them as much as 150 ft from the well site.

Their areal extent can be large. One well had a crater with dimensions of 1,300 ft x 250 ft x 300 ft deep. However, the actual depths of craters are not easily determined. Large rigs and platforms have been lost in craters without any evidence of the rig remaining at the surface.

"Records show that if a shallow gas blowout does not bridge within the first one to two days, then the well will probably continue to blow for an extended period of time, i.e., weeks or months. Some have continued for years[2]."

"Shallow gas flow rates have generally been grossly under estimated. Bends, bore size changes and flow path discontinuities produce high particle impact angles and local increases in velocity.

Adams includes a chart condensed from a database of 950 shallow gas blowouts. Of the 56 rigs listed more than half suffered extensive damage or the total loss of the rig. (after Adams 1991, How to Prevent or Minimize Shallow Gas Blowouts (parts 1 &2). World Oil-May and June.

The truth is that the biological impacts of gas and condensate spills have been poorly studied until recently. Even the Uniacke gas blowout which released condensate in 1984 was not evaluated for biological impacts. Gas blowouts such as occurred in India in 1999 are poorly reported and not studied in detail. It is ludicrous for the industry to argue that gas wells have little impact on the ecosystem when they have not looked carefully at the marine organisms effected and no long-term studies on productivity or reproductive success following exposure are known to exist.

Conclusion

In summary, according to the RAP document (DFO 2001 draft) "Any impacts from oil and gas exploration [documented above] will be amplified due to the small, shallow, enclosed nature of the environment and the high biomass and diversity year-round."

The industry proposals as outlined on their websites are designed basically to refine existing prospects; they are not shooting in the dark. Make no mistake, if the seismic programs proceed, drilling will follow. Such is the nature of these exploration cycles. The companies are not attempting to find gas in this case; they are only concerned with how much. They have little concern for the costs to the fishermen, the communities or the Province as long as they make a profit.

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