White's Cove Quarry Blasting:
Potential Impacts on American Lobster

By

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Regulatory Background and Acoustic Study

The latest DFO guidelines regarding explosives and their impact on biota and habitat are presented in Wright and Hopky (1998) and Wright (2002) (S. Kuehnemund, Habitat Evaluation Biologist, DFO St. John's NL, pers. comm.) and are summarized in Tables 1 to 3. Based on acoustic modeling, Hannay and Thomson (2003) concluded that White's Cove Quarry blasting would likely result in peak sound pressure levels in the water column at the water-land interface of less than 50 kPa at ordinary high tide and less than 25 kPa within three hours of low tide. Both of these levels are less than the DFO guideline level of 100 kPa (Wright and Hopky 1998). Burial depths and setback distances for various size explosive charges that would satisfy the 100 kPa guideline are presented in Tables 1 and 2. Table 1 applies to usual construction and demolition applications with single blasts (i.e., White Cove Quarry) and Table 2 applies to geophysical survey explosions with multiple blasts. The planned setback distance for the 45.5 kg charge to be used at White's Cove Quarry is 76 m, well beyond the relevant guideline distance indicated in Table 1 and even beyond the distance indicated in Table 2 for geophysical applications. Hannay and Thomson (2003) also presented the ground vibration levels predicted by modeling (CONWEP). The quarry blasting will involve a different type of explosive (ANFO) than was used to derive the DFO guidelines (TNT). ANFO has a lower yield per equivalent weight than TNT. The model predicted a peak ground velocity of approximately 13 mm/s at the ordinary high tide mark (upper limit of the intertidal zone) located 76 m from the closest shot hole. Vibrations in the water column would be well below those specified in the DFO guidelines (Table 3). At White's Cove Quarry, setback distance from the low tide mark would be approximately 164 m, greater than the minimum distance required for a 100 kg charge (Table 3). The predicted 0-P noise level at 500 m from the charge is approximately 186 dB re 1µPa (Hannay and Thomson 2003).

Table 1. Setback distance (m) from center of detonation of a confined explosive to fish habitat to achieve 100 kPa guideline criteria for various substrates.

SUBSTRATE TYPE	**WEIGHT OF EXPLOSIVE CHARGE (KG)**							
	0.5	**1.0**	**2.0**	**5.0**	**10.0**	**25.0**	**50.0**	**100.0**
Rock	3.6	5.0	7.1	11.0	15.9	25.0	35.6	50.3
Frozen soil	3.3	4.7	6.5	10.4	14.7	23.2	32.9	46.5
Ice	3.0	4.2	5.9	9.3	13.2	20.9	29.5	41.8
Saturated soil	3.0	4.2	5.9	9.3	13.2	20.9	29.5	41.8
Unsaturated soil	2.0	2.9	4.1	6.5	9.2	14.5	20.5	29.0

Source: Table 1 in Wright and Hopky (1998)

Table 2. Proposed minimum depth of burial or setback distance (m) of an explosive charge from fish habitat as it applies to geophysical surveys.

Substrate Type	**Weight of Explosive Charge (kg)**							
	0.5	**1.0**	**2.0**	**5.0**	**10.0**	**25.0**	**50.0**	**100.0**
Rock	7.2	10.0	14.2	22.0	32.0	50.0	71.0	100.0
Frozen soil	6.5	9.5	13.0	21.0	32.0	46.0	66.0	93.0
Ice	6.0	8.5	12.0	18.5	26.5	42.0	60.0	84.0
Saturated soil	6.0	8.5	12.0	18.5	26.5	42.0	60.0	84.0
Unsaturated soil	4.0	6.0	8.2	13.0	18.5	29.0	41.0	58.0

Source: Table 2 in Wright (2002)

Table 3. Setback distance (m) from center of detonation of a confined explosive to spawning habitat to achieve 13 mm/s guideline criteria for all types of substrate.

Weight of Explosive Charge (kg)						
0.5	**1.0**	**5.0**	**10.0**	**25.0**	**50.0**	**100.0**
10.7	15.1	33.7	47.8	75.5	106.7	150.9

Source: Table 2 in Wright and Hopky (1998)

Recent results of seismic exploration using explosives in the Northwest Territories indicated that DFO's guidelines (Wright and Hopky 1998) might require revision due to the unpredictability of IPC (Instantaneous Pressure Change). Cott (submitted) reported that setback distance guidelines in Wright and Hopky (1998) were followed but subsequent monitoring of charges revealed that many IPCs were higher than 100 kPa.

Potential Interactions Between Blasting and American Lobsters

Characteristics of the marine substrate off White's Point are consistent with the preferred habitat types of the American lobster (*Homarus americanus*). Organisms known to be preferred prey of lobsters (crabs, sea stars, sea urchins and sea cucumbers) are found throughout this area. Lobsters in the White's Point area occur from one meter below low tide to the deeper subtidal region. The horizontal distance between the waterline at one meter below ordinary low tide and the shot hole nearest the shoreline is approximately 170 m (White's Point EA, In prep).

In a 1998 DFO assessment, less than 10% of lobster landings in Lobster Fishing Area (LFA) 34 were made from waters around Digby Neck. Most of the landings were made in the more sheltered waters south of Digby Neck than in the waters of Bay of Fundy proper (Pezzack et al. 2001). From the DFO assessment it is known that egg-carrying females occur in the White's Cove area. Over 1,000 egg-carrying females were V-notched in waters on the north side of Digby Neck during 1998-1999, including the waters off White's Cove. Fewer female lobsters were V-notched in 1999-2000. During both lobster seasons, most V-notchings were done during the springtime (Pezzack et al. 2001).

American lobsters typically exhibit seasonal inshore-offshore movements. They tend to move into shallower areas in the summer and back to deeper areas in the winter. The extent of this seasonal movement depends on various factors including available habitat, degree of bottom slope, water temperature, and degree of exposure to wave energy. Distance of movement can range from a few hundred meters to hundreds of kilometers. Molting, mating, egg extrusion and fertilization, and larval hatch by American lobsters generally occur during the summer months when the animals are in the shallower areas closest to shore (Pezzack et al. 2001).

Based on these known behaviourial traits, the lobsters at White's Cove would be closest to shore during the summer and would therefore be exposed to the highest levels of pressure and vibration during this time. Since some of the lobsters would be undergoing molting and reproduction during the summer, fertilized eggs and larvae would also be exposed to the highest pressure and vibration levels during this time. Juvenile and adult lobsters would likely only occur downslope of the low tide mark while the larvae and early benthic stages could possibly occur in the intertidal area. However, based on the CONWEP modeling (Hannay and Thomson 2003), all lobster stages would not be exposed to peak pressure levels exceeding 210-216 dB re 1 μPa. While there has been scientific research on the sensitivities of various decapod crustaceans to acoustic stimuli and waterborne vibrations (Wiese 1976; Tautz and Sandeman 1980; Heinisch and Wiese 1987; Breithaupt and Tautz 1990; Goodall et al. 1990), it is very limited in nature and does not pertain specifically to the American lobster. In terms of physical and/or behavioural impact of sound energy on decapod crustaceans, research of this nature is also limited. Pearson et al. (1994) reported no statistically significant acute or chronic effects on Dungeness crab larvae exposed to peak pressures as high as 231 dB re 1 μPa from a seismic air gun array. Christian et al. (2004) conducted a study of the effects of seismic energy on snow crabs (*Chionoecetes opilio*) in Newfoundland. The following section provides some results of that study.

Study of Effects of Seismic on Snow Crab Health and Catchability

Snow crabs of varying carapace width (75 to 115 mm) were exposed to various levels of seismic energy. Each exposure session consisted of 200 shots delivered at a rate of one shot every 10 seconds (i.e., sessions were approximately 33 minutes in duration). Received broadband levels (0-peak) ranged from just over 197 dB re 1 μPa to about 220 dB re 1 μPa. A single fertilized egg mass in its second year of development was also exposed to seismic energy, approximately 220 dB re 1 μPa (Christian et al. 2004).

Exposed and control animals were examined for acute effects of seismic energy on their health. Tissues examined included haemolymph, hepatopancreas, heart, and statocysts. No significant differences were found between the exposed and control crabs. Investigations of chronic effects of seismic energy on snow crabs are now in progress (Christian et al. 2004).

With respect to effects of seismic energy on the fertilized eggs, there was the suggestion that those eggs exposed to 0-P received levels of approximately 220 dB re 1 μPa were affected. Over 2,000 eggs from each of the control and exposed masses were assessed for mortality and development stage. There were significantly more dead eggs in the exposed mass and the live control mass eggs were significantly more advanced in development than those in the exposed egg mass. These results should be considered preliminary given that only one fertilized egg mass was exposed to seismic energy at a single received level (Christian et al. 2004).

According to Hannay and Thomson (2003), peak sound pressure levels in the water column near the White's Cove Quarry are expected to be less than 50 kPa (210 to 216 dB re 1 µPa; $_{0\text{-P}}$) at ordinary high tide and less than 25 kPa (204 to 210 dB re 1 µPa; $_{0\text{-P}}$) if blasting is performed within 3 hours of low tide. Both scenarios result in peak sound pressure levels less than those measured when the snow crab fertilized eggs were exposed to seismic energy. In addition, quarry blasting consists of explosions less than 0.5 s in duration compared to the 33 minutes of seismic exposure experienced by the crab eggs.

There is some evidence that noise may affect catch rates of crustaceans near White's Cove Quarry. Experimental commercial snow crab fishery results in Christian et al. (2004) suggested that snow crabs receiving less than 182 dB re 1 µPa $_{0\text{-P}}$ were more catchable than those receiving more than 185 dB re 1 µPa $_{0\text{-P}}$. These preliminary findings were based on approximate distances between the commercial traps and the seismic source (Christian et al. 2004). There could be a temporary effect on lobster catchability but this is only supposition. The explosion may temporarily affect lobster activity patterns, thereby resulting in less lobster movement and lower catches.

Conclusion

Based on the acoustics modeling results (Hannay and Thomson 2003) and preliminary research on other decapod crustaceans, the quarry blasting would likely have negligible physical effects on the lobsters in the White Cove area. There could be temporary effects on the behaviour of the animals but considering the short duration and infrequency of the blasts, these possible behavioural effects would most likely be negligible.

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