THE POSSIBLE IMPACTS OF MILITARY ACTIVITY ON CETACEANS IN WEST SCOTLAND

E.C.M. Parsons[1], I. Birks[2], P.G.H. Evans[3], J.C.D. Gordon[4], J.H. Shrimpton[1] and S. Pooley[1]

[1]*Hebridean Whale and Dolphin Trust, 28 Main Street, Tobermory, Isle of Mull, Argyll PA75 6NU, UK.*
[2] *Sail Gairloch, Tigh-na-Bruach, Strath, Gairloch, Ross-shire IV21 2BT, UK.*
[3] *Seawatch Foundation, 11 Jersey Road, Oxford OX4 4RT, UK*
[4] *3 Alma Terrace, Newport-on-Tay, Dundee DD6 8HZ, UK.*

INTRODUCTION The waters of western Scotland are one of the most important cetacean habitats in Europe with 24 species recorded from the region (Parsons *et al.*, 1999) ranging from the harbour porpoise in coastal waters to the blue whale and mysticetes in offshore waters. The region is also a major area for military exercises and activities (Figure 1) including:

- submarine exercises;
- torpedo testing;
- firing ranges; and
- training exercises.

SUBMARINE EXERCISES There are several submarine exercise grounds off the west coast of Scotland including areas of the Firth of Clyde, Sea of Hebrides and the Minches (Figure 1). A summary of the amount of submarine activity in the various regions of western Scotland is presented in Table 1. The concern, with respect to cetaceans and submarine traffic is the latter's use of sonar. Several studies have voiced concern over the potential impacts of sonar use upon cetaceans. Vonk and Martin (1989), Simmonds and Lopez-Jurado (1991) and Frantzis and Cebrian (1999) have all suggested that the testing of sonar may have caused a mass stranding of Cuvier's beaked whales in the Canary Islands and the Ionian Sea. Moreover, sperm whales and long-finned pilot whales have both demonstrated changes in vocal behaviour in response to the use of military sonar (Watkins *et al.*, 1985; Rendell & Gordon, 1999).

Sonar systems usually emit short pulses of sound and are designed to focus as much energy as possible in narrow ranges of direction. Simple sonar systems target this sound in just one direction, although, more complicated systems may emit beams of sound in multiple directions. Frequencies commonly used by sonar systems and their source levels are summarised in Table 2. However, the exact acoustic frequencies and sound sources of military sonar are usually classified and some systems may use frequencies which are lower or louder that the summarised data. In addition to sonar, submarine-to-submarine communications systems are also a substantial source of submarine sound: 5-11kHz at source levels of 180-200 dB (Richardson *et al.*, 1995). Table 3 summarises the range of acoustic frequencies used by cetaceans occurring in the Hebrides. This data clearly shows that military sonar uses frequencies that cetaceans would be sensitive to. Considering the high source levels of military sonar, the possible impact of these systems upon cetaceans is, therefore, substantial.

TORPEDO TESTING The Ministry of Defence British Underwater Test and Evaluation Centre (BUTEC) is situated near the Kyles of Lochalsh in the western Highlands (Figure 1). The waters adjacent to BUTEC are used as a torpedo testing range. Some 130 squares miles of the Sound of Raasay are considered to be a danger area to shipping because of the use of explosives in this region. However, this area is also an important habitat for cetaceans, notably the harbour porpoise and, on occasions, the northern bottlenose whale.

Torpedoes have been documented to be a cause of cetacean mortality. Gardner (1996) stated that during hostilities between British and Argentine forces in the 1982 Falkland's conflict "a large number of whales were attacked by torpedoes and depth chargers". Therefore, the use of torpedoes on the BUTEC range would not only be expected to disturb cetaceans but could also be physically damaging to individual animals in many cases.

FIRING RANGES A missile firing range is situated on the island of South Uist, which fires ordinance westwards out to sea. The west coast of South Uist receives a large number and variety cetacean strandings every year, suggesting that the adjacent waters possess a diverse cetacean population (Sheldrick, 1989; Bones & Maclennan, 1994a,b). Military artillery produce noise levels in excess of 180dB. However,

the main impact of the South Uist range would not be acoustic disturbance as such, but the potential of physical trauma from falling and fragmenting ordinance.

Live-firing exercises also occur in the waters of western Scotland. These exercises are restricted to the southern approaches to the Firth of Clyde and Cape Wrath- a known area of high cetacean abundance. Apart form the direct physical injury caused by live ordinance, they are substantial sound sources producing broadband frequencies at a source level in excess of 270dB. Such sound sources could cause auditory damage to cetaceans at distances of several kilometres from the sound source and could cause disturbance to cetaceans at a distance of tens of kilometres.

MILITARY TRAINING EXERCISES Since 1946, NATO has conducted the Joint Maritime Course (JMC) military training exercise in the coastal waters and in deeper waters to the North and West of Scotland. The JMC occurs three times a year in March, June and November. Military jets, submarines, warships (including minesweepers and sub-hunters), landing craft, power boats and sonobouys are utilised during these exercises. The noise levels produced by the various craft used in these exercises are listed in Table 4. Many of the exercises involve the use of active sonar, the impacts of which have been discussed above. In 1998, concerns were voiced by tour operators running cetacean-watching trips near the Small Isles and Gairloch. The tour operators had noted a marked decrease in cetacean sightings for the duration of the JMC. When sightings data was plotted of the two commonest cetacean species occurring in these regions (minke whale, *Balaenoptera acutorostrata* and harbour porpoise, *Phocoena phocoena*) this decrease was clearly visible (Figures 2-9). A subsequent analysis of minke whale sightings data demonstrated that the decrease observed in 1998 was statistically significant (ANOVA on log transformed data: $F=4.6$; $p<0.005$).

DISCUSSION The amount of military activity in western Scotland is considerable, and so the potential for lethal and sub-lethal impacts upon cetacean populations in this region is high. Due to the classified status of much military activity in this area and equipment used (especially sonar), it is impossible to determine precise impacts on cetaceans without input from UK Ministry of Defence (MOD). Concerns over the impacts of military activities upon cetaceans in West Scotland, in particular the impacts of the 1998 JMC, led to the formation of a joint agency forum to discuss these concerns. The forum consisted of representatives of the MOD, Scottish Natural Heritage (Scotland's statutory body with responsibility for nature conservation), environmental NGOs and concerned wildlife tour operators. As a result of this forum a code of conduct for military vessels in the vicinity of cetaceans was produced (Table 4) and a more open forum for discussion created. However, as yet, very little progress has been made to address the real issues of concern. To date, no research has been undertaken to evaluate the impacts of military activities upon cetacean populations in the Hebrides, and cetacean conservation bodies in the UK should consider this issue a priority.

REFERENCES

Bones, M. & Maclennan, D. (1994a). Cetacean strandings in the Western Isles in 1992. *Hebridean Naturalist*, **12**, 47-50.

Bones, M. & Maclennan, D. (1994b). Cetacean strandings in the Western Isles in 1993. *Hebridean Naturalist*, **12**, 51-54.

Evans, P.G.H. and Nice, H. (1996). *Review of the Effects of Underwater Sound generated by Seismic Surveys on Cetaceans*. Report to UKOOA. Seawatch Foundation, Sussex.

Frantzis, A. & Cebrian, D. (1999). A rare mass stranding of Cuvier's beaked whales: cause and implications for the species biology. *European Research on Cetaceans*, **12**, 332-335.

Gardner, W.J.R. (1996). *Anti-submarine Warfare*. Brassey's Sea Power Series, London.

Parsons, E.C.M., Shrimpton, J. & Evans, P.G.H. (1999). Cetacean conservation in Northwest Scotland: perceived threats to cetaceans. Pp. 128-133. In: *European Research on Cetaceans* – 13, Proc. 13th Ann. Conf. ECS, Valencia, Spain, 5-8 April 1999. (Eds. P.G.H. Evans, J.A. Raga and J. Cruz). European Cetacean Society, Valancia, Spain.

Perry, C. (1998). A review of the impact of anthropogenic noise on cetaceans. *Paper presented to the Scientific Committee at the 50th Meeting of the International Whaling Commission, 1998*. SC/50/E9.

Rendell, L.E. & Gordon, J.C.D. (1999). Vocal responses of long-finned pilot whales (*Globicephala melas*) to military sonar in the Ligurian Sea. *Marine Mammal Science*, **15**, 198-204.

Richardson, W.J., Greene, C.R., Mame, C.I. & Thomson, D.H. (1995). *Marine Mammals and Noise.* Academic Press Inc, San Diego, USA.

Simmonds, M. & Lopez-Jurado, L.F. (1991). Whales and the military. *Nature*, **337**, 448.

Sheldrick, M.C. (1989). Stranded whale records for the entire British coastline, 1967 - 1986. *Investigations on Cetacea*, **22**, 298-329.

Vonk, R. & Martin, V. (1989). Goosebeaked whales *Ziphus cavirostris* mass strandings in the Canary Isles. *European Research on Cetaceans*, **3**, 73-77.

Watkins, W.A., Moore, K.E. and Tyack, P. (1985). Sperm whales acoustic behaviour in the Southeast Caribbean. *Cetology*, **49**, 1-15.

Table 1. Naval activity in the Hebrides during 1998
(NB. Figures are in ship days and high figures reflect multiple vessel exercises)

LOCATION	SUBMARINE ACTIVITY	SURFACE ACTIVITY
Rona North	52 days	45 days
Rona South	52 days	209 days
Rona West	59 days	2 hours
Raasay	58 days	543 days
Tiumpan	46 days	6 hrs
Stoer	38 days	6 hrs
Shiant	48 days	41 days
Ewe	40 days	34 days
Portree	--	195 days
Trodday	55days	1 day 1 hour
Lochmaddy	59 days	2 hours
Dunvegan	76 days	1 day 1 hour
Ushenish	60 days	1 day
Neist	63 days	8 days
Canna	33 days	--
Bracadale	33 days	--
Rhum	9 hours	--
Sleat	--	219 days
Barra	56 days	--
Hawes	44 days	3 hours 29 minutes
Tiree	47 days	3 days
Ford	75 days	5 days
Boyle	72 days	4 days
Place	77 days	6 days
Staffa	34 days	3 days
Eigg	9 hours	2 hours 30 mins
Colonsay	33 days	2 days
Mull	22 days	156 days
Sound of Jura	6 days	17 days
Linnhe	--	30 days
Blackstone	51 days	16 days
Mackenzie	36 days	3 days
Orsay	80 days	9 days
Islay	57 days	9 days
Otter	81 days	26 days
Gigha	30 days	35 days
Earadale	24 days	20 days
Kintyre	70 days	12 days

Source: C. Wheatley, MOD Conservation Officer pers. comm.

Table 2. The acoustic properties of active sonar systems (Richardson *et al*., 1995; Perry, 1998)

SONAR TYPE	FREQUENCY RANGE (KHZ)	AV. SOURCE LEVEL (dB re 1 uPa/1 a)
Search and surveillance	2-57	230+
Mine & obstacle avoidance	25-200	220+
Weapon mounted sonar	15-200	200+
Low Frequency Active Sonar (LFAS) used by NATO.	0.25-3.0?	230+

Table 3. Acoustic frequencies utilised by cetaceans occurring in the Hebrides (Evans & Nice, 1996).

SPECIES	SOUND TYPE	FREQUENCY RANGE (kHz)	DOMINANT FREQUENCIES (kHz)
Harbour porpoise	pulses	41.0	--
	clicks	<100-160	125-140
White-beaked dolphin	squeals	--	8.0-12.0
Risso's dolphin	whistles	--	3.5-4.5
	rasp/pulse burst	0.1- 8.0+	2.0-5.0
Common dolphin	barks	--	<0.5-3.0
	whistles	4.0 -16.0	--
	chirps	--	8.0-14.0
	clicks	10.0-110	26, 90, 110
Bottlenose dolphin	barks	0.20-16.0	--
	whistles	0.80-24.0	3.5-14.5
	clicks	0.10-300	15.0-130
Killer whale	whistles	1.50-18.0	6.0-12.0
	pulsed calls	0.50-25.0	1.0-6.0
	clicks	0.10-80.0	12.0-25.0
Long-finned pilot whale	whistles	0.50-8.0	1.6-6.7
	clicks	0.10-18.0	--
Atlantic white-sided dolphin	whistles	--	6.0-15.0
Northern bottlenose whale	whistles	3.0-16.0	--
	clicks	0.5-26.0+	--
Sperm whale	clicks	0.10-30.0	2.4, 10-16
Minke whale	down sweeps	0.06-0.13	--
	moans, grunts	0.06-0.14	0.06-0.14
	ratchet	0.85-6.00	0.85
	clicks	3.30-20.0	less than 12
	thump trains	0.19-2.0	0.1-0.2
Fin whale	moans	0.03-0.75	0.02
	chirps, whistles	1.5-5.0	1.5-2.5
	clicks	10-31	--
	rumble	0.01-0.03	--
	constant call	0.02-0.04	--
Sei whale	pulses	2.5-3.5	3
Northern right whale	tonal moans	0.03-1.25	0.16-0.50
	pulses	0.03-2.20	0.05-0.50
Blue whale	moans	0.012-0.39	0.16-0.25
	clicks	6-8, 21-31	6-8, 25
Humpback whale	song components	0.03-8.0	0.12-4.0
	moans	0.02-1.80	0.035-0.36
	grunts	0.12-1.90+	--
		0.10-2.0	--

Table 4. MOD guidelines for minimising cetacean disturbance
(Source: Appendix 14 to Annex A to Operations Plan 73701, Exercise Northern Light 99, Dated 15 June 99)

The sea areas off the North West of Scotland, the Minches and the Sea of Hebrides are known cetacean breeding grounds, the principal mating season for these marine mammals falls within the period July-September. Units operating in these areas during this period should, where possible, observe the following guidelines when encountering cetaceans-
a. On encountering cetaceans, continue on your intended route making progress at a slow, steady, no wake speed. This will present predictable movements and thus minimise the risk of disturbance to, or collision with, the animals. Avoid erratic movements or sudden changes in course and speed.
b. To minimise the risk of disrupting mother-calf bonds give cetaceans with young a wide berth and avoid coming between a mother and calf.
c. Allow groups of cetaceans to remain together. Proceeding slowly on a steady course will enable cetaceans to remove themselves from the path of a vessel as a group. Avoid deliberately passing through, or between, groups of cetaceans.
d. On sighting cetaceans, fast planing vessels should gradually slow down to a slow, no wake speed. A suggested speed is less than 5 knots. Wait until well clear of cetaceans before resuming speed.
e. Be aware of, and attempt to minimise, possible sources of noise disturbance.

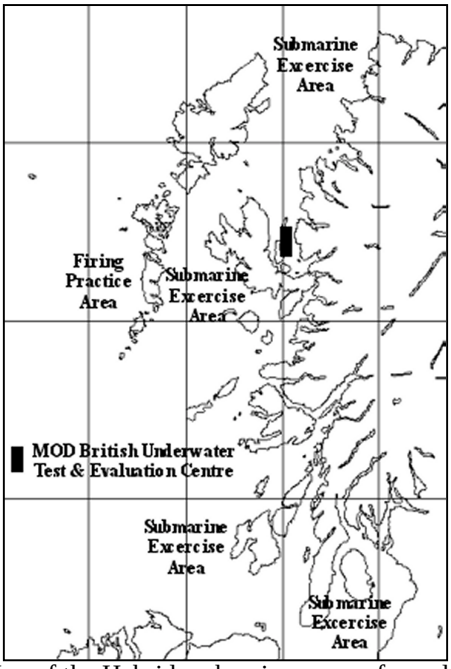

Figure 1. Map of the Hebrides showing areas of naval activity.

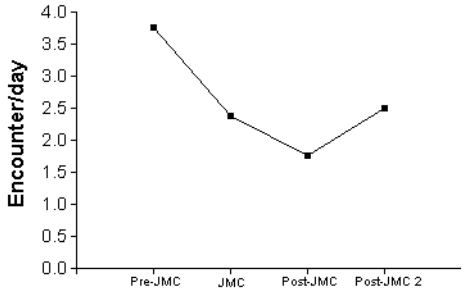

Figure 2. Minke whale sighting rates near the Small Isles before, during and after the 1999 Joint Maritime Course (JMC).

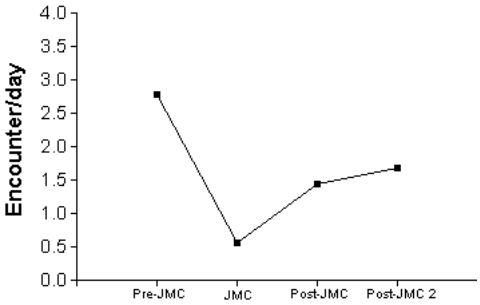

Figure 3. Minke whale sighting rates near the Small Isles before, during and after the 1998 Joint Maritime Course (JMC).

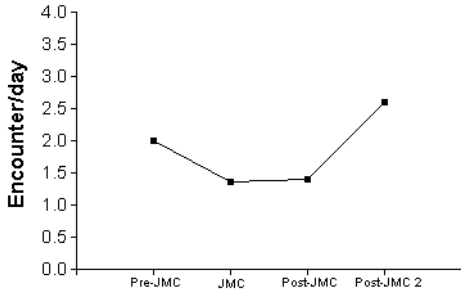

Figure 4. Minke whale sighting rates near the Small Isles before, during and after the 1997 Joint Maritime Course (JMC).

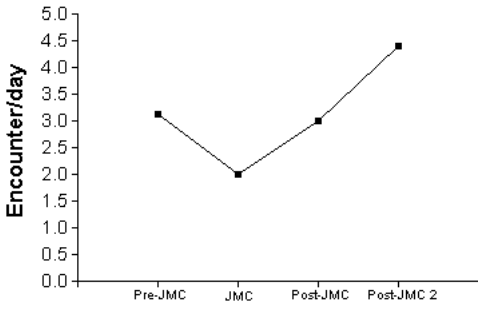

Figure 5. Porpoise sighting rates near the Small Isles before, during and after the 1999 Joint Maritime Course (JMC).

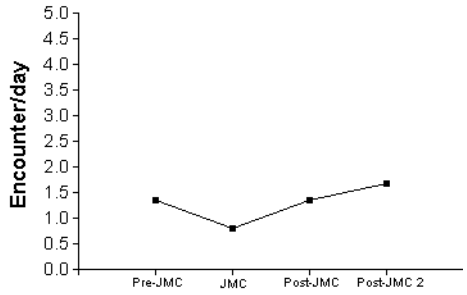

Figure 6. Porpoise sighting rates near the Small Isles before, during and after the 1998 Joint Maritime Course (JMC).

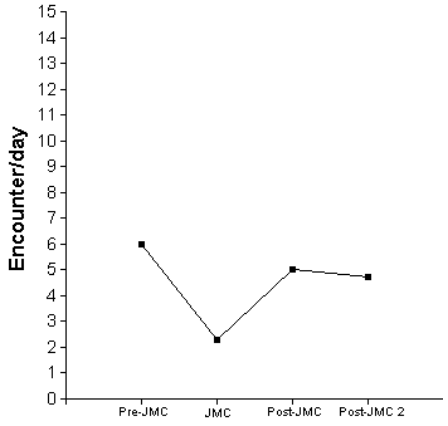

Figure 7. Porpoise sighting rates in Gairloch before, during and after the 1999 Joint Maritime Course (JMC).

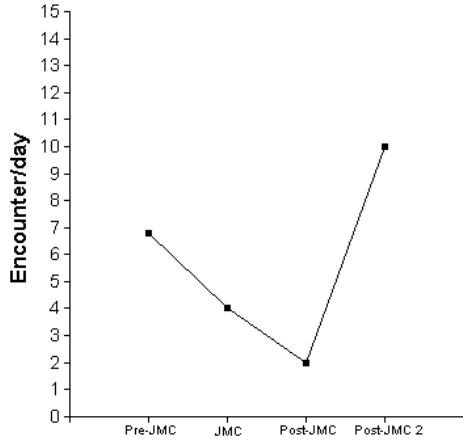

Figure 8. Porpoise sighting rates in Gairloch before, during and after the 1998 Joint Maritime Course (JMC).

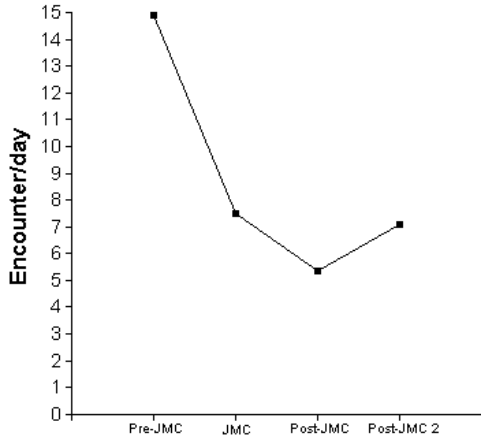

Figure 9. Porpoise sighting rates in Gairloch before, during and after the 1997 Joint Maritime Course (JMC).