

Use of the ADD calculation spreadsheet “ADD sound zones v2.4”

Separate calculations should be done for each cage group. Detailed instructions are given in the "Cage group calculation" sheet. A table of the calculated results is provided in the "Output summary" sheet. This can be printed or copied and saved. New ADD devices can be added to the spreadsheet and new cage group location details can be defined in the "Source data" sheet. Most cells in the spreadsheet are locked to prevent accidental modification.

Area of potential disturbance: Since disturbance relates to the audibility of ADDs, the spreadsheet takes the loudest device on the site and determines the 120dB threshold radius of that device. Some manufacturers are considering allowing their units to be synchronised in which case the total of all the synchronised devices is used.

The disturbance threshold radius is likely to be several kilometres and so may overlap with those of other cage groups. In this case the threshold radii centred on the centre of each cage group should be drawn on a map and the total area within the envelope calculated. Areas of land and should be removed from the total area. Sound shadows caused by the coast or islands (but not small rocky outcrops) can be removed from the area. Areas affected by two cage groups do not need to be double counted. The resulting total area should be used to calculate the number of mammals affected.

By coordinating applications with neighboring cage group owners as recommended by Marine Scotland, any overlapping areas of disturbance can be removed. This will reduce the overall calculated impact of ADDs on animals in the zone. I am told that decisions on the acceptability of disturbance will be made on a zonal basis.

Area of potential PTS injury: For this calculation the spreadsheet adds together the sound energy of all the devices on a cage group and ascribes it to a point at the centre of the cage group. A single PTS threshold radius is calculated for the cage group. Any areas of land or shadow zones within this area can be discounted but if there are areas of overlap with other cage groups, these areas should not be discounted.

In this spread sheet the devices are combined rather than calculated individually. This is most appropriate approach where the threshold radii are similar to, or larger than, the separation are the devices. Where threshold radii are smaller than the device separations, then consideration of the devices as separate units could be justified. This results in a slightly smaller area of effect however it is significantly more work, the difference in total area is likely to be only a few percent and where these areas are small, the importance of the result is relatively low.

The area of potential injury calculation assumes a worst case scenario with the devices being used for 24 hours per day. If potential PTS injury is a significant problem for a cage group and 24 hour operation is never used then this can be modified for you.

Submissions:

EPS applications should probably be accompanied by a copy of this spread sheet in order to meet the requirement that methodology is clearly identified.

Comparison with use of the Maine Scotland tables: Marine Scotland have seen and confirmed the calculations of this spread sheet. However Marine Scotland also provide a table of threshold radii for single notional ADD devices which you are permitted to use. The areas of potential PTS injury resulting from data in the current version of this document (December 2020 version 4) differ from the spread sheet calculations for reasons that are unclear. I am not aware of any device that resembles ADD1 (195dB), but if you have such a unit then use of the

Marine Scotland figures would be advantageous for the PTS calculation. The table below shows the PTS threshold areas calculated from the Marine Scotland table as a percentage of those areas calculated by this spreadsheet.

Differences in the area of potential PTS injury due to differences in calculation method.

	LF	HF	VHF
ADD1	6%	10%	8%
ADD2	530%	662%	712%
ADD3	530%	660%	712%
ADD4	157%	180%	192%
ADD5	182%	204%	145%

Calculation Instructions

ADD sound zones V3.0

only cells in green can be altered
 cells in red contain key model outputs
 Alternative ADD data in the yellow cells is generated by adding new ADD data in sheet "Source data"
 This alternative ADD data can be used in the yellow cells or copied into available green cells using paste special - values

1. Enter the site name and location using the Marine Scotland zone codes G - T.
2. Check that all the required ADD devices are shown column A, lines 25-36.
 (Characteristics of all commercial devices should be verified against test information)
3. Use "Source data" sheet to create data for alternative devices. This appears in the yellow cells.
4. If more than one additional device is needed then copy the values from the yellow cells into green cells using paste special - values
5. Enter the numbers of each type of ADD device on a farm site in column B
6. If multiple ADDs are fired simultaneously set simultaneous to YES otherwise NO
 (example: if there are 6 RT1 units on site of which 2 fire simultaneously create two RT1 lines one with 4 units and one with 2 simultaneous units)
7. Using a site map determine the area of land within the threshold radius and enter the value in the green cells
8. The output of this sheet is summarised in sheet "Output summary"
9. Where applications are made for multiple adjacent cage groups plot the disturbance threshold circles on a map and report the total sea area enclosed within the envelope. Neglect significant sound shadow zones caused by the coast shape but not by small rock outcrops
10. Do not combine or discount PTS (injury) zones for different sites even if they seem to overlap

Marine Scotland zones



Potential disturbance and injury calculation

farm name and cage group	Clachnessie Bay - Oldenay pen group
farm location	Minch

ADD devices in use	number	simultaneous	Adjustment		Single ADD level (disturbance) & weighted SEL (PTS injury)			
			SPL	SEL	Disturbance	PTS: LF	PTS: HF	PTS: VHF
ADD1	0	NO	0	0	195.0	233.3	218.3	212.6
ADD2 and Motin Aquac	0	NO	0	0	198.0	242.4	241.4	238.6
ADD3 and Gaelforce	0	NO	0	0	198.0	245.4	244.4	241.6
OTAQ and ADD4	0	NO	0	0	189.0	231.4	230.5	227.7
OTAQ patrol and ADD5	0	NO	0	0	165.0	201.9	201.0	198.2
Genuswave Salmonsafe	0	NO	0	0	180.0	215.3	187.6	179.5
Aice Aquatec RT1 flex [S1]	0	NO	0	0	182.0	218.3	191.2	183.0
Aice Aquatec RT1 ring [S2]	0	NO	0	0	180.0	216.3	192.8	185.2
Aice Aquatec US3	8	NO	0	0	181.0	215.6	214.1	211.2
Aice Aquatec other	0	NO	0	0	100.0	122.7	125.1	126.4
total SPL or weighted SEL (dB)					181	215	213	220
threshold radius (m)					2194	25	24	379
area of which is land or sound shadow (sq km)					9.1	0.0	0.0	0.0
affected area (sq km)					5.44	0.00	0.00	0.42
percentage of zone area					0.04%	0.000%	0.000%	0.003%

mammals potentially affected	Disturbance	PTS injury
Minke whale [LF]	0.1	0.00004
Harbour porpoise [VHF]	0.0	0.16749
Bottlenose dolphin [HF]	0.0	0.00000
Risso Dolphin [HF]	0.0	0.00000
Common Dolphin [HF]	0.0	0.00000
White-sided Dolphin [HF]	0.0	0.00000
White-beaked Dolphin [HF]	0.0	0.00000

Calculation of combined farm site disturbance area



for further information on this spread sheet contact



this file is secured with EPSCalc

Calculation Instructions

ADD sound zones V3.0

only cells in green can be altered
 cells in red contain key model outputs
 Alternative ADD data in the yellow cells is generated by adding new ADD data in sheet "Source data"
 This alternative ADD data can be used in the yellow cells or copied into available green cells using paste special - values

1. Enter the site name and location using the Marine Scotland zone codes G - T.
2. Check that all the required ADD devices are shown column A, lines 25-36.
 (Characteristics of all commercial devices should be verified against test information)
3. Use "Source data" sheet to create data for alternative devices. This appears in the yellow cells.
4. If more than one additional device is needed then copy the values from the yellow cells into green cells using paste special - values
5. Enter the numbers of each type of ADD device on a farm site in column B
6. If multiple ADDs are fired simultaneously set simultaneous to YES otherwise NO
 (example: if there are 6 RT1 units on site of which 2 fire simultaneously create two RT1 lines one with 4 units and one with 2 simultaneous units)
7. Using a site map determine the area of land within the threshold radius and enter the value in the green cells
8. The output of this sheet is summarised in sheet "Output summary"
9. Where applications are made for multiple adjacent cage groups plot the disturbance threshold circles on a map and report the total sea area enclosed within the envelope. Neglect significant sound shadow zones caused by the coast shape but not by small rock outcrops
10. Do not combine or discount PTS (injury) zones for different sites even if they seem to overlap

Marine Scotland zones



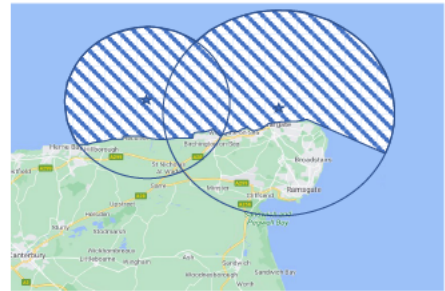
Potential disturbance and injury calculation

farm name and cage group	Clachnessie Bay - Oldenay pen group
farm location	Minch

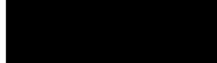
ADD devices in use	number	simultaneous	Adjustment		Single ADD level (disturbance) & weighted SEL (PTS injury)			
			SPL	SEL	Disturbance	PTS: LF	PTS: HF	PTS: VHF
ADD1	0	NO	0	0	195.0	233.3	218.3	212.6
ADD2 and Motin Aquac	0	NO	0	0	198.0	242.4	241.4	238.6
ADD3 and Gaelforce	0	NO	0	0	198.0	245.4	244.4	241.6
OTAQ and ADD4	0	NO	0	0	189.0	231.4	230.5	227.7
OTAQ patrol and ADD5	0	NO	0	0	165.0	201.9	201.0	198.2
Genuswave Salmonsafe	0	NO	0	0	180.0	215.3	187.6	179.5
Aice Aquatec RT1 flex [S1]	6	NO	0	0	182.0	218.3	191.2	183.0
Aice Aquatec RT1 ring [S2]	0	NO	0	0	180.0	216.3	192.8	185.2
Aice Aquatec US3	0	NO	0	0	181.0	215.6	214.1	211.2
Aice Aquatec other	0	NO	0	0	190.0	222.7	225.1	226.4
total SPL or weighted SEL (dB)					182	226	199	191
threshold radius (m)					2443	30	1	9
area of which is land or sound shadow (sq km)					12.2	0.0	0.0	0.0
affected area (sq km)					6.53	0.00	0.00	-0.03
percentage of zone area					0.02%	0.000%	0.000%	0.000%

mammals potentially affected	Disturbance	PTS injury
Minke whale [LF]	0.1	0.00006
Harbour porpoise [VHF]	0.0	-0.01340
Bottlenose dolphin [HF]	0.0	0.00000
Risso Dolphin [HF]	0.0	0.00000
Common Dolphin [HF]	0.0	0.00000
White-sided Dolphin [HF]	0.0	0.00000
White-beaked Dolphin [HF]	0.0	0.00000

Calculation of combined farm site disturbance area



for further information on this spread sheet contact



this file is secured with EPSCalc

Data and calculation of weighted SEL levels

Change only the contents of green cells

- This sheet sets the model and data provided by Marine Scotland and NOAA
- This sheet allows new ADD data to be introduced to the calculation on using green cells and tests the development of MMPA compliance
- The sheet allows new ADD data to be introduced to the calculation on using green cells 125-134

Box 1 ADD types	Mohm Area (7)	Gaelfo ce (7)	Oras (7)	Oras pat ol (7)	GenusWave (7)
Marine Scotland TABLE 2	ADD1	ADD2	ADD3	ADD4	ADD5
sound level @ 1m dB re 1µPa	195	198	198	189	165
lowe f equency bound kHz	1	8	8	9	9
uppe f equency bound kHz	5	12	12	11	11
duty cycle	8%	50%	100%	32%	9%

sound level	Ace Aquatic RT1 flex (S1)	Ace Aquatic RT1 ng (S2)	Ace Aquatic US3	Ace Aquatic 100
lowe f equency	0.9	1	8	10
uppe f equency	1.4	2	11	20
duty cycle	5%	5%	5%	1%
MMPA	TRUE	TRUE	TRUE	TRUE

Box 2 Marine mammal sensitivity	LF Mammals (eg m rike)	HF Mammals (eg dolph ns)	VHF Mammals (eg Po po se)
Marine Scotland TABLE 1	7Hz - 35kHz	150Hz - 160kHz	175Hz - 160 kHz
d stur bance dB(flat)	120	120	120
nju y dB(we ghted)	199	198	173

MMPA compl ance dete m nes whethe f sh can be expo ted to the USA see https://imlondon.sh.nyosos.com/NMFSAcousticCheck_enWebTool/ fo MMPA ce t cat on

Box 3 Marine Mammal density (animals/sq km)	A	H	I	J	K	S	T	cal
Marine Scotland TABLE 6	G yllf	zone H	M rch	Heb des west coast	No th coast west	O th coast & O kney	Shetland	
total a ea (sq km)	15122	18364	13979	35099	32505	40383	65417	100
M rike whale (LF)	0.027	0.008	0.02	0.018	0.009	0.01	0.032	1
His bou po po se (VHF)	0.336	0.09	0.397	0.058	0.308	0.152	0.402	2
Bottlenose dolph n (HF)	0.121	0.003				0.004		3
R sso Dolph n (HF)		0.029		0.192	0.014			4
Common Dolph n (HF)				0.133				5
Wh te-s ded Dolph n (HF)							0.021	6
Wh te-beaked Dolph n (HF)		0.316		0.053	0.217	0.021	0.037	7

Box 4 d stance attenuation factor	RL=SL-18 3Log(met es)
	18.3

Box 5 Frequency Weighting coefficients	LF	HF	VHF
NOAA Table E52			
a	1	1.5	1.8
b	2	2	2
f1	0.2	8.8	12
f2	19	110	140
c	0.13	1.2	1.36
k	1.79	177	152

ADD 4	divis on of ADD spectrum into 12 equal octave bands	F equency band	lowe kHz	uppe kHz	cent e (kHz)	unwe ghted	LF we ghted	HF we ghted	VHF we ghted	cal
Band 1	0.9	0.9	0.9	0.9	171.2	171.1	140.9	132.3	132074E 17	1.29302E 17
Band 2	0.9	1.0	1.0	1.0	171.2	171.1	141.4	132.9	132074E 17	1.29674E 17
Band 3	1.0	1.0	1.0	1.0	171.2	171.1	141.9	133.5	132074E 17	1.30016E 17
Band 4	1.0	1.0	1.0	1.0	171.2	171.2	142.4	134.0	132074E 17	1.30377E 17
Band 5	1.0	1.1	1.1	1.1	171.2	171.2	142.9	134.6	132074E 17	1.3061E 17
Band 6	1.1	1.1	1.1	1.1	171.2	171.2	143.4	135.2	132074E 17	1.30866E 17
Band 7	1.1	1.2	1.1	1.1	171.2	171.2	143.9	135.7	132074E 17	1.31096E 17
Band 8	1.2	1.2	1.2	1.2	171.2	171.2	144.4	136.3	132074E 17	1.31301E 17
Band 9	1.2	1.3	1.2	1.2	171.2	171.2	144.9	136.9	132074E 17	1.31481E 17
Band 10	1.3	1.3	1.3	1.3	171.2	171.2	145.4	137.5	132074E 17	1.31637E 17
Band 11	1.3	1.3	1.3	1.3	171.2	171.2	145.9	138.0	132074E 17	1.31771E 17
Band 12	1.3	1.4	1.4	1.4	171.2	171.2	146.4	138.6	132074E 17	1.31882E 17
total we ghted level dB Leq					182.0	182.0	154.8	146.7		
Calculation result Th s data is passed to ye low cells in sheet "Cage group calculation"									MMPA compl ant?	TRUE
total f equency we ghted SEL (dB)					218.3	191.2	183.0			

f (te values fo	MMPA compl ance calculat on
0.9	199 0988064 228.5605707 212.183
0.933755064	199 0857588 228.0544149 211.6097
0.968776132	199 0738126 227.5486775 211.0377
1.005110688	199 062912 227.0438977 210.4659
1.042807993	199 0530055 226.5388561 209.8945
1.08191916	199 0440463 226.0342995 209.3233
1.122492716	199 0359177 225.5305714 208.7525
1.164597177	199 028803 225.0274421 208.1821
1.208276124	199 0224455 224.5249557 207.612
1.253592716	199 0168886 224.0231596 207.0424
1.300610077	199 0121054 223.5210105 206.4733
1.349390273	199 0080725 223.0218445 205.9046
1.4	199 0047705 222.5243478 205.3365

ADD 4	divis on of ADD spectrum into 12 equal octave bands	F equency band	lowe kHz	uppe kHz	cent e (kHz)	unwe ghted	1.3006100772462	1.2768852916199	171 208187539524 we ghted	
Band 1	1.0	1.1	1.0	1.0	169.2	169.2	140.5	132.1	8.33333E 16	
Band 2	1.1	1.1	1.1	1.1	169.2	169.2	141.3	133.0	8.33333E 16	
Band 3	1.1	1.2	1.2	1.2	169.2	169.2	142.1	133.9	8.33333E 16	
Band 4	1.2	1.3	1.2	1.2	169.2	169.2	142.9	134.8	8.33333E 16	
Band 5	1.3	1.3	1.3	1.3	169.2	169.2	143.6	135.7	8.33333E 16	
Band 6	1.3	1.4	1.4	1.4	169.2	169.2	144.4	136.6	8.33333E 16	
Band 7	1.4	1.5	1.5	1.5	169.2	169.2	145.2	137.5	8.33333E 16	
Band 8	1.5	1.6	1.6	1.6	169.2	169.2	146.0	138.4	8.33333E 16	
Band 9	1.6	1.7	1.6	1.6	169.2	169.2	146.8	139.2	8.33333E 16	
Band 10	1.7	1.8	1.7	1.7	169.2	169.2	147.5	140.1	8.33333E 16	
Band 11	1.8	1.9	1.8	1.8	169.2	169.2	148.3	141.0	8.33333E 16	
Band 12	1.9	2.0	1.9	1.9	169.2	169.2	149.1	141.9	8.33333E 16	
total we ghted level dB Leq					180.0	180.0	156.4	148.8		
Calculation result Th s data is passed to ye low cells in sheet "Cage group calculation"									MMPA compl ant?	TRUE
total f equency we ghted SEL (dB)					216.3	192.8	185.2			

f (te values fo	MMPA compl ance calculat on
1.0	199 0643608 227.1133192 210.5451
1.094663094	199 0490364 226.3215004 209.6486
1.127462048	199 0392182 225.5309998 208.7523
1.189207115	199 0250923 224.7419736 207.8583
1.259921005	199 0161894 223.9545496 206.9646
1.334839854	199 0091833 223.1690607 206.0702
1.414213562	199 0039902 222.3855834 205.1807
1.498307077	199 0005482 221.6044034 204.2908
1.587401052	198 9988169 220.8257863 203.4025
1.681792831	198 9987768 220.0500263 202.516
1.78179436	199 0004297 219.2774488 201.6315
1.887748625	199 0037983 218.5084132 200.7492
2	199 008927 217.7433153 199.8694

ADD 4	divis on of ADD spectrum into 12 equal octave bands	F equency band	lowe kHz	uppe kHz	cent e (kHz)	unwe ghted	1.7817974362806	1.7310731220122	169 208187539524 we ghted	
Band 1	8.0	8.1	8.1	8.1	170.2	168.9	166.0	162.5	1.0491E 17	
Band 2	8.2	8.4	8.3	8.3	170.2	168.8	166.1	162.7	1.0491E 17	
Band 3	8.4	8.7	8.5	8.5	170.2	168.7	166.3	163.0	1.0491E 17	
Band 4	8.7	8.9	8.8	8.8	170.2	168.7	166.5	163.3	1.0491E 17	
Band 5	8.9	9.1	9.0	9.0	170.2	168.6	166.7	163.6	1.0491E 17	
Band 6	9.1	9.4	9.3	9.3	170.2	168.5	166.9	163.8	1.0491E 17	
Band 7	9.4	9.6	9.5	9.5	170.2	168.4	167.0	164.1	1.0491E 17	
Band 8	9.6	9.9	9.8	9.8	170.2	168.3	167.2	164.3	1.0491E 17	
Band 9	9.9	10.2	10.0	10.0	170.2	168.2	167.4	164.6	1.0491E 17	
Band 10	10.2	10.4	10.3	10.3	170.2	168.1	167.5	164.8	1.0491E 17	
Band 11	10.4	10.7	10.6	10.6	170.2	168.0	167.7	165.0	1.0491E 17	
Band 12	10.7	11.0	10.9	10.9	170.2	167.9	167.8	165.3	1.0491E 17	
total we ghted level dB Leq					181.0	179.2	177.8	174.8		
Calculation result Th s data is passed to ye low cells in sheet "Cage group calculation"									MMPA compl ant?	TRUE
total f equency we ghted SEL (dB)					215.6	214.1	211.2			

f (te values fo	MMPA compl ance calculat on
8.0	200 2902481 202.3560972 180.8822
8.215144594	200 3612147 202.1590904 180.5989
8.436075088	200 4353356 201.9670885 180.3204
8.662947083	200 5129293 201.7801134 180.0469
8.895920362	200 5938316 201.59881 179.7784
9.135159001	200 6784174 201.4212972 179.5151
9.38083152	200 7667564 201.2494671 179.257
9.633110919	200 8589567 201.0826856 179.0042
9.892174886	200 9551426 200.9209422 178.7567
10.158205808	201 0554388 200.7642204 178.5147
10.43139127	201 1599698 200.6124974 178.2782
10.71192345	201 2688598 200.4657475 178.0472
11	201 3822322 200.32329 177.8217

ADD 4	divis on of ADD spectrum into 12 equal octave bands	F equency band	lowe kHz	uppe kHz	cent e (kHz)	unwe ghted	10 431391266338	10.2938923690871	170 208187539524 we ghted
Band 1	10.0	10.6	10.3	10.3	89.2	87.1	86.5	83.8	83333333.3
Band 2	10.6	11.2	10.9	10.9	89.2	86.9	86.8	84.3	83333333.3
Band 3	11.2	11.9	11.6	11.6	89.2	86.6	87.1	84.8	83333333.3
Band 4	11.9	12.6	12.2	12.2	89.2	86.3	87.4	85.2	83333333.3
Band 5	12.6	13.3	13.0	13.0	89.2	86.0	87.7	85.7	83333333.3
Band 6	13.3	14.1	13.7	13.7	89.2	85.7	87.9	86.1	83333333.3
Band 7	14.1	15.0	14.6	14.6	89.2	85.3	88.1	86.4	83333333.3
Band 8	15.0	15.9	15.4	15.4	89.2	84.9	88.3	86.8	83333333.3
Band 9	15.9	16.8	16.3	16.3	89.2	84.5	88.4	87.1	83333333.3
Band 10	16.8	17.8	17.3	17.3	89.2	84.1	88.6	87.4	83333333.3
Band 11	17.8	18.9	18.3	18.3	8				