OCS Study
MMS 2004-064

Explosive Removal Scenario Simulation Results

Final Report

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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DISCLAIMER

This report was completed under the project entitled "Technical Consulting Services to Apply the Acoustic Integration Model (AIM) for Three-Dimensional Acoustic Propagation and Marine Mammal Movement Modeling to Estimate 'Take' of Marine Mammals Incidental to Gulf of Mexico (GOM) Explosive Removal Activities." This report was prepared based on acoustic impact criteria established by the National Oceanic and Atmospheric Administration's Fisheries (NOAA-F) Office and was commissioned by the Minerals Management Service (MMS) for incorporation into a programmatic National Environmental Policy Act (NEPA) document regarding the environmental impacts of decommissioning operations. Readers of this document should be aware that the "take" estimates presented within this report are theoretical and do not take into account "take-negating" factors such as programmatic and/or site-specific mitigation requirements.

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Introduction

The Minerals Management Service (MMS) is petitioning the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service for incidental take of marine mammals in the Gulf of Mexico. There is concern about the potential effects of seismic exploration using airgun arrays and the explosive removal of offshore structures (EROS). Therefore it is desirable to predict the degree of impact of operation of these sources.

For a given scenario, the Acoustic Integration Model © (AIM) can make predictions of received sound levels for an animal. AIM is a Monte Carlo model that operates by considering the acoustic source characteristics, and then calculates the sound field of the particular physical environment. Within that environment, numerous virtual animals ("animats") are moved in three dimensions and time, thereby simulating the real movement patterns of real animals. AIM then convolves the model-predicted sound field with the animal movements to predict the exposure of each animat. This exposure history can be compared to regulatory thresholds to determine the number of animals that will be affected or "taken" by the proposed activity.

The accurate modeling of movement behavior is important because it affects the exposure levels that the animal is likely to receive. For example, in estimating the effects from explosions on or below the bottom of the ocean, deep diving species are more likely to receive high exposure levels than shallow diving species. AIM uses a set of behavioral parameters derived from a wide number of scientific papers to reproduce animal movements (Appendix A, Frankel et al. 2002).

In addition to the movement patterns of the animals being properly simulated, the propagation of the sound from the explosion to the animals needs to be accurately modeled. The analysis of explosive propagation is a complex undertaking with multiple variables. MMS supported Applied Research Associates (ARA) in the development of a model to predict the effective source level and propagation of an explosion taking place below the mudline, as well as when contained within pipes of varying diameters and wall thicknesses (Dzwilewski and Fenton 2003). The ARA model was therefore chosen for this application, and was interfaced to AIM. The result was the capability to perform comprehensive integrated three-dimensional modeling of the effect of explosive removals upon marine mammals.

The work reported here is for 24 EROS simulations occurring over ten sites selected to represent existing offshore structure locations and areas of likely cetacean concentration. The take criteria were established in consultation with MMS and are based on the criteria developed for the U.S. Navy *Seawolf* shock trials, i.e. exceeding 182 dB re 1 μPa^2-secec in the loudest third octave band and/or 12-psi peak pressure.

Methods

Criteria Used

Impulsive sources are, by their nature, broadband (*i.e.*, they simultaneously produce a wide spectrum of frequencies, ranging from tens to thousands of Hertz). However, the energy produced across this frequency band is not uniform. The energy density from impulsive sources generally peaks at a relatively low frequency and then decreases rapidly as frequency increases. This document uses the exposure criteria developed for the *Seawolf* Final Environmental Impact Statement (FEIS) (Department of the Navy 1998) to determine the potential impacts of impulsive sources on marine mammals.

The *Seawolf* FEIS established that an animal would be considered 'taken' if its exposure exceeded either of two criteria. The first criterion is a received level of 182 dB re 1 μPa^2-sec in the appropriate 1/3-octave band. The appropriate 1/3 octave band is above 10 Hz for mysticetes, and above 100 Hz for odontocetes. The second is the 12-psi peak pressure criterion. The ARA model that was incorporated into AIM calculated the received levels for both of these criteria.

Simulation Locations and Parameters

A set of 10 sites was chosen to encompass the shelf, slope and abyssal regions in the three MMS Gulf of Mexico Region planning areas. Sites were selected to represent existing structure locations and areas of likely cetacean concentration, such as areas with high primary productivity or predominant cyclonic activity.

The final set of 24 explosive removal scenarios was developed in cooperation with MMS. The scenarios were developed to encompass the range of possible activities in different planning areas and species regimes (*i.e.*, coastal, slope and abyssal).

Table 1

Location of the Runs and Their Environmental Regimes are Presented

Site Number	Lat Deg	Lat Min	Long Deg	Long Min	Planning Area	In/Off Shore	Species Density Province
1	27	52.7	96	16	W	In	Coastal
2	26	20.4	96	3.8	W	Off	Slope
3	28	51.0	93	56	W	In	Coastal
4	27	27.3	93	52	W	Off	Slope
5	28	40.7	91	34	C	In	Coastal
6	28	26.1	88	55	C	Off	Slope
7	27	27.3	88	29	C	Off	Abyssal
8	25	52.7	89	43	C	Off	Abyssal
9	27	55.5	87	40	E	Off	Abyssal
10	28	20.7	87	43	E	Off	Abyssal

C – Central, E – Eastern, and W – Western.

Multiple explosive removal scenarios were envisioned for some of the sites. At these sites a variety of different types of offshore structures exist which would require different removal methods. Each scenario was simulated with an individual model run. Each explosive removal was considered an explosive event, and each model run predicted the exposure from a single event. The specific characteristics of each run are presented in Table 2. The characteristics include the water depth, charge weight, charge location, pile diameter and pile wall thickness. Due to the required time delay between charges to prevent the summation of energy, scenarios involving multiple charges were modeled with a single charge. The ranges to the 182 dB re 1μPa^2-sec and 12 psi isopleths are also presented. These are the ranges for which mitigation efforts would be needed, if this scenario where to be enacted. Figure 1 depicts the input and setup screens in the AIM program, illustrating how these parameters were input into AIM.

Propagation Modeling

The Underwater Shockwave/sound Propagation model developed by ARA (Dzwilewski and Fenton 2003) was incorporated into AIM. It was used to estimate the received pressure level at an animal, both in the 1/3 octave band of maximal energy of the source (dB re 1 μPa^2-sec) as well as the total peak pressure (psi). The original model was developed for a range of charge weights between 25 and 100 lbs. Several of the scenarios identified by MMS specified charge weights in excess of the range of explosive weights considered in the original model (25-100 lbs). However, the implementation of the ARA model interfaced to the AIM model accepts and accounts for these larger charge weights. This implementation is based on the observation that the processes are mathematically linear as suggested in the original ARA modeling report (Dzwilewski and Fenton 2003). Thus, a linear extrapolation approach was used to modify the original ARA model to accommodate the larger charge weights shown in Table 2. The particular 200-lb scenarios modeled where both open water, and a single scenario with a charge inside a pile. The calculated explosive efficiency for this simulation falls within the range of values included in the original ARA model and is therefore a valid prediction (Dzwilewski, pers. comm.). However, all of the parameters for the 500-lb charge scenarios exceed the original ARA modeling parameter ranges in charge weight, pile diameter and wall thickness. The calculated explosive efficiencies for these scenarios exceed 90%, thereby approaching the level of an open-water explosion. These estimates are based upon the best available science. Additional modeling for the larger (500 lbs) parameters would refine these estimates. The take estimates might decrease, but they could only increase by a maximum of 10% (Dzwilewski, pers. comm.).

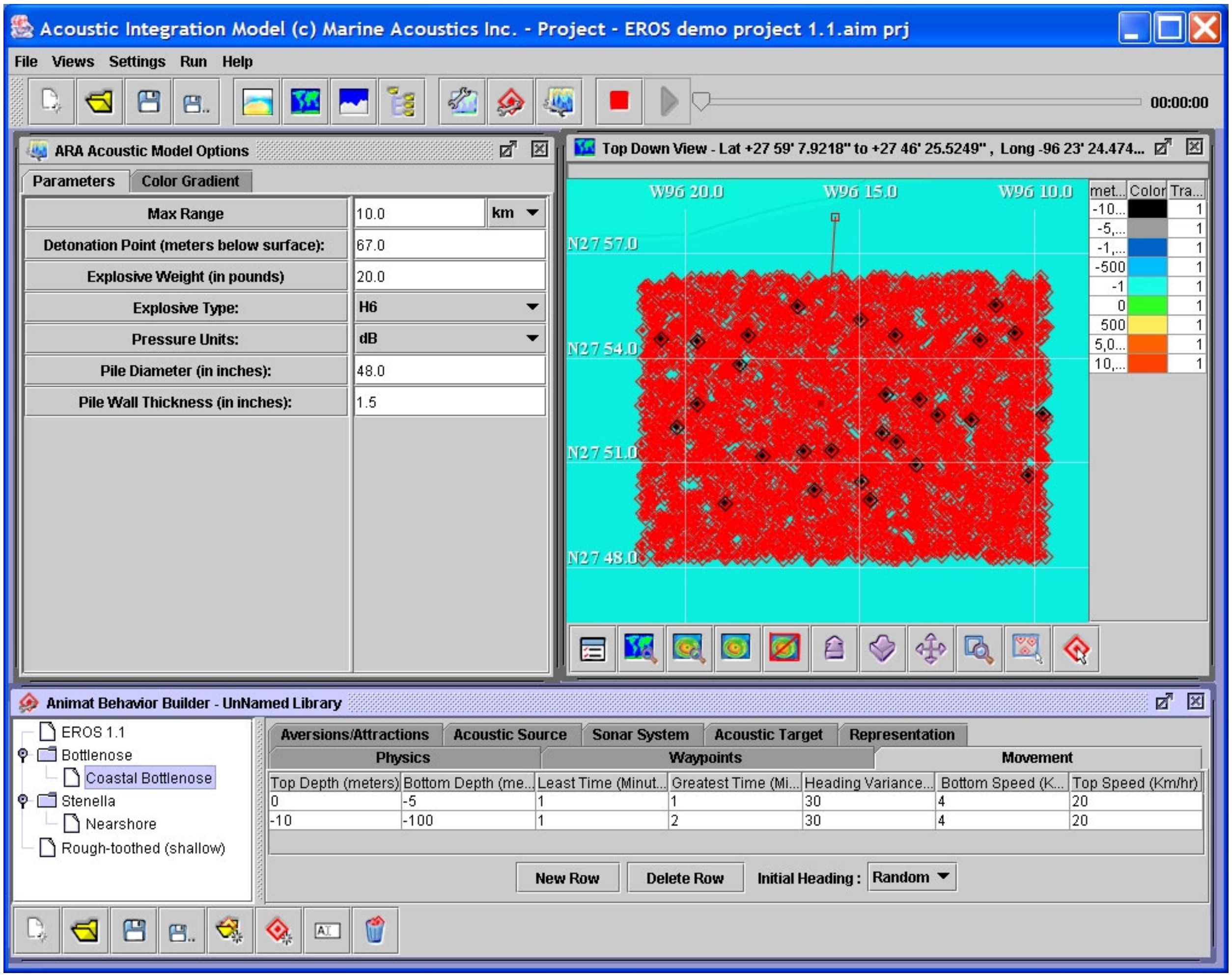
Table 2

Specific Characteristics of Each Scenario Simulation

(The values indicate the site and run numbers, where it is located, the depth of ocean and the explosive parameters. Open Water Modeling indicates that the charge was simulated as being exploded outside of a pile, rather than inside one. The ranges to the 182 dB re 1μPa2-s and 12 psi peak pressure levels are indicated as well.)

Site #	Planning Area	Run #	Water Depth (m)	Charge Wt (lb)	Above or Below Mudline	Open Water Modeling?	Number of Piles	Pile Diameter (in)	Wall Thickness (in)	182 dB isopleth (m)	12 psi isopleth (m)
1	W	1	57	20	BML	No	1	48	1.5	154	377
1	W	2	57	80	BML	No	4	48	1.5	343	646
1	W	3	57	80	AML	Yes				470	830
2	W	4	806	80	BML	Yes				470	830
2	W	5	806	200	BML	Yes				781	1126
3	W	6	24	20	AML	Yes				250	522
3	W	7	24	80	AML	No	6	36	0.75	365	674
3	W	8	24	80	BML	No	1	64	2	343	646
3	W	9	24	200	BML	No	8	36	1.25	622	966
3	W	10	24	500	BML	No	1	96	3.5	1269	1564
4	W	11	893	80	BML	No	1	24	0.75	343	646
4	W	12	893	200	AML	Yes				781	1126
5	C	13	28	20	BML	No	3	30	1.5	152	373
5	C	14	28	20	AML	Yes				250	522
5	C	15	28	80	BML	No	6	36	1.75	326	624
5	C	16	28	200	BML	No		76	3	599	941
5	C	17	28	500	BML	No	4	68	3	1172	1481
6	C	18	1196	20	AML	Yes				250	522
6	C	19	1196	80	BML	Yes				470	830
7	C	20	2201	200	BML	Yes				781	1126
8	C	21	3226	80	BML	Yes				470	830
9	E	22	2794	20	AML	Yes				250	522
9	E	23	2794	80	BML	Yes				470	830
10	E	24	2446	20	AML	Yes				250	522

C- Central, E – Eastern, W – Western, AML – Above Mudline, BML – Below Mudline



Max Range	10.0	km
Detonation Point (meters below surface):	67.0	
Explosive Weight (in pounds)	20.0	
Explosive Type:	H6	
Pressure Units:	dB	
Pile Diameter (in inches):	48.0	
Pile Wall Thickness (in inches):	1.5	

met...	Color	Tra...
-10...	■	1
-5,...	■	1
-1,...	■	1
-500	■	1
-1	■	1
0	■	1
500	■	1
5,0...	■	1
10,...	■	1

Top Depth (meters)	Bottom Depth (me...	Least Time (Minut...	Greatest Time (Mi...	Heading Variance...	Bottom Speed (K...	Top Speed (Km/hr)
0	-5	1	1	30	4	20
-10	-100	1	2	30	4	20

Initial Heading : Random

Figure 1. AIM model screen showing input of run parameters. (The upper left hand panel is where EROS source parameters are input for the ARA model. The upper right panel shows the geographic location of the simulation; the red and black icons represent different marine mammal species. The Red icons represent the "overpopulated" number of animals present in the simulation. The Black icons represent a random distribution based on real-world densities. The lower panel shows how the animal movement parameters are input into AIM.)

Species Modeled

Densities

Species densities are based upon two recent reports specified as the preferred data sources by MMS for describing cetacean distribution and abundance in the Gulf of Mexico. Fulling et al. (2003) analyzed data collected between 1998 and 2001 to determine the distribution and density of different species in the 20-200 m water depth range. Mullin and Fulling (in press) analyzed ship survey data from 1996 to 2001. They reported densities for all species in slope region (200-2,000 m water depth) the NW (Western and Central Planning Areas), the NE (Eastern Planning

Areas) as well as the abyssal region (depth > 2,000 m). The density estimates presented here were taken from these papers and are summarized in Tables 3-5.

Dive Behavior

Parameters describing species' diving behavior were taken from the existing MAI database. Documentation for this database is provided in Appendix A.

Table 3

Western and Central Shelf (20-200 m) Species Density
(data from Fulling et al. 2003)

Species	Density (animals/km^2)
bottlenose dolphin	0.095
Atlantic spotted dolphin	0.026
rough-toothed dolphin	0.006

Table 4

Western and Central Slope Area (200-2,000 m) Species Densities
(data from Fulling et al. 2003 and Mullin and Fulling in press)

Species	Density (animals/km^2)	Species	Density (animals/km^2)
Bryde's whale	0.00003	Fraser's dolphin	0.00067
sperm Whale	0.0043	Risso's dolphin	0.0063
Kogia spp.	0.0020	bottlenose dolphin	0.0025
Cuvier's beaked whale	0.0050	rough-toothed dolphin	0.0014
Mesoplodon spp.	0.0005	Atlantic spotted dolphin	0.0014
killer whale	0.0004	pantropical spotted dolphin	0.1351
Globicephala spp.	0.0185	Clymene dolphin	0.0482
Melon-headed wh	0.0267	striped dolphin	0.0251
false killer whale	0.00011	spinner dolphin	0.0010
pygmy killer whale	0.00037		

Table 5

Abyssal (>2,000 m) Species List and Densities
(data from Mullin and Fulling in press)

Species	Density (animals/km^2)	Species	Density (animals/km^2)
sperm whale	0.0037	Risso's dolphin	0.0043
Kogia spp.	0.0021	spinner dolphin	0.0042
Cuvier's beaked whale	0.0001	rough-toothed dolphin	0.0014
Mesoplodon spp.	0.0008	pantropical spotted	0.2983
pygmy killer whale	0.0022	Clymene dolphin	0.0583
false killer whale	0.0037	striped dolphin	0.0147
killer whale	0.0005		

Definition of "Take" within the Model Context

The exposures of simulated animals within each simulation were calculated every minute during a one hour simulation, in which the simulated animals were moving according to their programmed behavioral parameters. This ensured that each animal moved through its entire dive cycle. Therefore, 60 exposure levels were calculated for each animal. The reported exposure value for each animal was the highest of the 60 estimates calculated for each animal. A simulated animal was considered to have been "taken" if the exposure exceeded either the 182 dB re 1µPa^2-sec (within the appropriate 1/3 octave band) or the 12 psi peak criteria. The number of takes in each model run was scaled with the ratio of modeled and real-world animal densities to produce the Take Estimate per Event (TEPE).

Simulation Construction and Take Estimation

Each simulation was initiated with an "over-populated" model density of 10 animals/km^2. This density exceeds the actual value of number per km^2 of any species, but the linear "overpopulation" method helps to ensure that a reasonable distribution density of values will be obtained, i.e. a smoother and more continuous distribution curve with well-defined tails. This model density is corrected to the actual density when calculating takes, as explained below. The simulated animals were distributed in a 5 km square box around the source of the explosion. The ARA model was set to run out to 10 km, to insure that each animal received the signal. The model was set to run at 60-second intervals and each simulation lasted one hour. This was done in order to insure that each animal moved through a least one full dive cycle during the simulation.

Once the simulation was run, the maximum received level was calculated for each animal. The resulting distribution of received levels was plotted as a histogram. The number of animals exposed to received levels exceeding the criteria was determined. These were the “model” take numbers for each species and simulation. Both the 182 dB re 1μPa^2-sec and 12 psi ‘take’ numbers were reported. The larger of the two values was used as the modeled take for each species. These modeled ‘take’ values were then scaled to reflect the real-world density of the animals. This was calculated with the following formula:

Take Estimate per Event = number of “model” takes * (real / modeled density)

The simulation of an EROS event might produce 19 “modeled” takes for a given species. In this example, the density of animals was 0.095/km^2 (Table 6, Column 3), and the take value of 19 is scaled with the ratio of 0.095 / 10 (real / modeled densities) to produce a Take Estimate per Event (TEPE) of 0.18 animals for this simulation (Table 6, Column 7). Because this calculation is based upon animal densities, and those densities are not exact, we used the reported variation in the density numbers to calculate upper and lower bounds of the TEPE. These bounds were determined by multiplying the TEPE by the coefficient of variation (CV) (Table 6, Column 4) for each animal’s density estimate. The product was then added or subtracted from the TEPE to produce the upper and lower bounds (Table 6, Columns 8 and 9). To illustrate, the TEPE for this example was 0.18 and the CV was 0.30. Therefore, the upper and lower bounds of the take probability are 0.13 and 0.23, respectively.

Finally, the number of EROS events needed to produce a take was calculated by taking the inverse of the upper bound of the Take Estimate per Event (Table 6, Column 11). In this example, 1/0.23 = 4.3333, indicating that if four removals of this type took place, a single take would probably have occurred. A five year forecast of the number of predicted removals by planning areas and depth regime has been produced (Kaiser et al. 2002) and may be applicable to generate total number of takes.

Table 6

Example of Take Estimation Calculations

Run	Species	Density (animals/ sq. km)	C.V. of Den-sity	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
0	bottlenose dolphin	0.095	0.30	0.10	0.18	0.18	0.13	0.23	10.0	4

Results

Table 8 displays those examples of scenarios and species where the upper bound of the Take Estimate per Event exceeded 1.00. These examples were summarized here to illustrate the combinations of location, charge weight, and species that are most likely to generate takes. Four nearshore (shelf) examples involving bottlenose dolphins produced TEPE greater than one with small (20 lb) charges. All of the remaining 22 (out of 26) high-take scenarios resulted from the use of charges greater than 50 pounds. The TEPE are listed for all species and scenarios in Tables 9-22.

These tables list the Take Estimates per Event. In order to determine the total number of animals predicted to be taken for a year, or five year period, the total number of explosive removals that correspond to each scenario needs to be determined. Consider if there were 120 removals scheduled to be conducted in a five-year period that correspond to Scenario 3. The total five-year take would then be calculated as follows.

Number of Takes = Take Estimate per Event * Number of Events

In addition, the coefficient of variation for each species density can be used to estimate the upper and lower bounds of the total take estimate. This is achieved by multiplying the number of events by upper and lower bounds of the Take Estimate per Event, respectively. For this example, the take estimate for bottlenose dolphins would be 103 (C.I. 72-133), Atlantic spotted dolphins would be 25 (C.I. 15-36) and rough-toothed dolphins would be 6 (C.I. 0-11). The details of these calculations are shown in Table 7.

Table 7

Example Take Calculation for a Five-Year Period

Species	Density (animals/ sq. km)	C.V. of Density	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Number of Events	Total Takes	Lower Bound	Upper Bound
bottlenose dolphin	0.095	0.30	0.39	0.86	0.86	0.60	1.11	120	103	72	133
Atlantic spotted dolphin	0.026	0.42	0.13	0.21	0.21	0.12	0.30	120	25	15	36
rough-toothed dolphin	0.006	0.98	0.02	0.05	0.05	0.00	0.09	120	6	0	11

Table 8

Scenarios that Produced Takes with a Single Explosive Removal

(Note that all examples are with charge weights greater than 50 lbs, with the exception of some nearshore cases with bottlenose dolphins.)

Loc-ation	Run	Charge Wt	Species	Density (animalsper sq. km)	C.V. of Den-sity	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
4	11	80	pantropical spotted dolphin	0.1351	0.84	3.28	0.53	6.04	41.7	1
5	17	500	bottlenose dolphin	0.095	0.30	2.63	1.84	3.42	10.0	1
3	10	500	bottlenose dolphin	0.095	0.30	2.34	1.64	3.04	10.0	1
2	5	200	pantropical spotted dolphin	0.1351	0.84	2.24	0.36	4.13	41.7	1
4	12	200	pantropical spotted dolphin	0.1351	0.84	2.01	0.32	3.70	41.7	1
5	16	200	bottlenose dolphin	0.095	0.30	1.70	1.19	2.21	10.0	1
3	9	200	bottlenose dolphin	0.095	0.30	1.43	1.00	1.86	10.0	1
1	3	80	bottlenose dolphin	0.095	0.30	1.35	0.94	1.75	10.0	1
4	11	80	Clymene dolphin	0.0482	0.73	1.17	0.32	2.03	64.3	1
5	15	80	bottlenose dolphin	0.095	0.30	1.17	0.82	1.52	10.0	1
3	7	80	bottlenose dolphin	0.095	0.30	1.02	0.71	1.32	10.0	1
2	4	80	pantropical spotted dolphin	0.1351	0.84	1.01	0.16	1.86	41.7	1
1	2	80	bottlenose dolphin	0.095	0.30	1.00	0.70	1.30	10.0	1
3	8	80	bottlenose dolphin	0.095	0.30	0.98	0.68	1.27	10.0	1
5	14	20	bottlenose dolphin	0.095	0.30	0.98	0.68	1.27	10.0	1
1	1	20	bottlenose dolphin	0.095	0.30	0.86	0.60	1.11	10.0	1

Table 8 (continued)

Scenarios that Produced Takes with a Single Explosive Removal
(Note that all examples are with charge weights greater than 50 lbs, with the exception of some nearshore cases with bottlenose dolphins.)

Loc-ation	**Run**	**Charge Wt**	**Species**	**Density (animalsper sq. km)**	**C.V. of Den-sity**	**Take Est. per Event**	**Lower Bound**	**Upper Bound**	**Pod Size**	**Number of Events Needed to Produce a Take**
2	5	200	Clymene dolphin	0.0482	0.73	0.80	0.22	1.38	64.3	1
3	6	20	bottlenose dolphin	0.095	0.30	0.78	0.55	1.01	10.0	1
5	17	500	Atlantic spotted dolphin	0.026	0.42	0.72	0.42	1.03	15.6	1
4	12	200	Clymene dolphin	0.0482	0.73	0.72	0.19	1.24	64.3	1
3	10	500	Atlantic spotted dolphin	0.026	0.42	0.71	0.41	1.01	15.6	1
5	13	20	bottlenose dolphin	0.095	0.30	0.68	0.48	0.89	10.0	1
4	11	80	melon-headed whale	0.0267	0.55	0.63	0.28	0.98	65.0	1
4	12	200	melon-headed whale	0.0267	0.55	0.63	0.28	0.98	65.0	1
4	11	80	striped dolphin	0.0251	0.67	0.61	0.20	1.02	53.6	1
2	5	200	melon-headed whale	0.0267	0.55	0.44	0.20	0.69	65.0	1

Table 9

Take Estimates for Location 1 and Scenarios 1-3

Run	Species	Density (animals per sq. km)	C.V. of Den-sity	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
1	bottlenose dolphin	0.095	0.30	0.39	0.86	0.86	0.60	1.11	10.0	1
1	Atlantic spotted dolphin	0.026	0.42	0.13	0.21	0.21	0.12	0.30	15.6	3
1	rough-toothed dolphin	0.006	0.98	0.02	0.05	0.05	0.00	0.09	14.0	11
2	bottlenose dolphin	0.095	0.30	0.54	1.00	1.00	0.70	1.30	10.0	1
2	Atlantic spotted dolphin	0.026	0.42	0.17	0.25	0.25	0.15	0.36	15.6	3
2	rough-toothed dolphin	0.006	0.98	0.03	0.05	0.05	0.00	0.11	14.0	9
3	bottlenose dolphin	0.095	0.30	0.85	1.35	1.35	0.94	1.75	10.0	1
3	Atlantic spotted dolphin	0.026	0.42	0.27	0.34	0.34	0.20	0.48	15.6	2
3	rough-toothed dolphin	0.006	0.98	0.05	0.08	0.08	0.00	0.16	14.0	6

Table 10

Take Estimates for Location 2 and Scenario 4

Run	Species	Density (animals per sq. km)	C.V. of den-sity	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produced a Take
4	Bryde's whale	0.00003	0.61	0.00	0.00	0.00	0.00	0.00	2.0	3,106
4	sperm whale	0.0043	0.37	0.00	0.03	0.03	0.02	0.05	1.8	21
4	*Kogia* spp.	0.002	0.49	0.00	0.01	0.01	0.01	0.02	2.2	60
4	Beaked Whale	0.0005		0.00	0.00	0.00				
4	Cuvier's beaked whale	0.0003	0.82	0.00	0.00	0.00	0.00	0.01	4.0	137
4	*Mesoplodon* spp.	0.0005	0.54	0.00	0.00	0.00	0.00	0.01	1.2	162
4	killer whale	0.0004	0.67	0.00	0.00	0.00	0.00	0.00	2.0	272
4	blackfish	0.0267		0.00	0.26	0.26				
4	*Globicephala* spp.	0.0185	0.48	0.00	0.18	0.18	0.09	0.27	34.2	4
4	melon-headed whale	0.0267	0.55	0.00	0.26	0.26	0.12	0.40	65.0	2
4	false killer whale	0.00011	0.71	0.00	0.00	0.00	0.00	0.00	28.5	548
4	pygmy killer whale	0.00037	0.60	0.00	0.00	0.00	0.00	0.01	9.5	174
4	Fraser's dolphin	0.00067	0.70	0.00	0.00	0.00	0.00	0.01	117.0	128
4	Risso's dolphin	0.0063	0.47	0.00	0.06	0.06	0.03	0.09	8.1	11
4	bottlenose dolphin	0.0025	0.95	0.00	0.02	0.02	0.00	0.04	5.6	25
4	rough-toothed dolphin	0.0014	1.00	0.00	0.02	0.02	0.00	0.04	15.0	27
4	*Stenella*	0.1351		0.00	1.01	1.01				
4	Atlantic spotted dolphin	0.0014	1.04	0.00	0.01	0.01	-0.04	2.07	15.0	1
4	pantropical spotted dolphin	0.1351	0.84	0.00	1.01	1.01	0.16	1.86	41.7	1
4	Clymene dolphin	0.0482	0.73	0.00	0.36	0.36	0.10	0.63	64.3	2
4	striped dolphin	0.0251	0.67	0.00	0.19	0.19	0.06	0.31	53.6	3
4	spinner dolphin	0.0085	0.71	0.00	0.06	0.06	0.02	0.11	164.0	9

Table 11

Take Estimates for Location 2 and Scenario 5

Run	Species	Density (animals per sq. km)	C.V. of Density	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produced a Take
5	Bryde's whale	0.00003	0.61	0.00	0.00	0.00	0.00	0.00	2.0	1,553
5	sperm whale	0.0043	0.37	0.00	0.05	0.05	0.03	0.07	1.8	14
5	*Kogia* spp.	0.002	0.49	0.00	0.02	0.02	0.01	0.03	2.2	34
5	beaked whale	0.0005		0.00	0.01	0.01				
5	Cuvier's beaked whale	0.0003	0.82	0.00	0.00	0.00	0.00	0.01	4.0	161
5	*Mesoplodon* spp.	0.0005	0.54	0.00	0.01	0.01	0.00	0.01	1.2	114
5	killer whale	0.0004	0.67	0.00	0.00	0.00	0.00	0.01	2.0	136
5	blackfish	0.0267		0.03	0.44	0.44				
5	*Globicephala* spp.	0.0185	0.48	0.02	0.31	0.31	0.16	0.45	34.2	2
5	melon-headed whale	0.0267	0.55	0.03	0.44	0.44	0.20	0.69	65.0	1
5	false killer whale	0.00011	0.71	0.00	0.00	0.00	0.00	0.00	28.5	320
5	pygmy killer whale	0.00037	0.60	0.00	0.01	0.01	0.00	0.01	9.5	102
5	Fraser's dolphin	0.00067	0.70	0.00	0.01	0.01	0.00	0.01	117.0	83
5	Risso's dolphin	0.0063	0.47	0.02	0.10	0.10	0.05	0.15	8.1	7
5	bottlenose dolphin	0.0025	0.95	0.01	0.04	0.04	0.00	0.07	5.6	14
5	rough-toothed dolphin	0.0014	1.00	0.00	0.03	0.03	0.00	0.05	15.0	19
5	*Stenella*	0.1351		0.50	2.24	2.24				
5	Atlantic spotted dolphin	0.0014	1.04	0.01	0.02	0.02	-0.09	4.57	15.0	1
5	pantropical spotted dolphin	0.1351	0.84	0.50	2.24	2.24	0.36	4.13	41.7	1
5	Clymene dolphin	0.0482	0.73	0.18	0.80	0.80	0.22	1.38	64.3	1
5	striped dolphin	0.0251	0.67	0.09	0.42	0.42	0.14	0.70	53.6	1
5	spinner dolphin	0.0085	0.71	0.03	0.14	0.14	0.04	0.24	164.0	4

Table 12

Take Estimates for Location 3 and Scenarios 6-10

Run	Species	Density (animals per sq. km)	C.V. of Den-sity	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
6	bottlenose dolphin	0.095	0.30	0.22	0.78	0.78	0.55	1.01	10.0	1
6	rough-toothed dolphin	0.006	0.98	0.02	0.05	0.05	0.00	0.10	14.0	10
6	Atlantic spotted dolphin	0.026	0.42	0.12	0.24	0.24	0.14	0.34	15.6	3
7	bottlenose dolphin	0.095	0.30	0.46	1.02	1.02	0.71	1.32	10.0	1
7	rough-toothed dolphin	0.006	0.98	0.04	0.07	0.07	0.00	0.14	14.0	7
7	Atlantic spotted dolphin	0.026	0.42	0.17	0.29	0.29	0.17	0.41	15.6	2
8	bottlenose dolphin	0.095	0.30	0.43	0.98	0.98	0.68	1.27	10.0	1
8	rough-toothed dolphin	0.006	0.98	0.04	0.06	0.06	0.00	0.13	14.0	8
8	Atlantic spotted dolphin	0.026	0.42	0.15	0.28	0.28	0.16	0.40	15.6	3
9	bottlenose dolphin	0.095	0.30	0.85	1.43	1.43	1.00	1.86	10.0	1
9	rough-toothed dolphin	0.006	0.98	0.06	0.10	0.10	0.00	0.21	14.0	5
9	Atlantic spotted dolphin	0.026	0.42	0.30	0.41	0.41	0.24	0.59	15.6	2
10	bottlenose dolphin	0.095	0.30	1.95	2.34	2.34	1.64	3.04	10.0	1
10	rough-toothed dolphin	0.006	0.98	0.14	0.16	0.16	0.00	0.32	14.0	3
10	Atlantic spotted dolphin	0.026	0.42	0.58	0.71	0.71	0.41	1.01	15.6	1

Table 13

Take Estimates for Location 4 and Scenario 11

Run	**Species**	**Density (animals per sq. km)**	**C.V. of Density**	**182 dB Takes**	**12 psi Takes**	**Take Est. per Event**	**Lower Bound**	**Upper Bound**	**Pod Size**	**Number of Events Needed to Produce a Take**
11	Bryde's whale	0.00003	0.61	0.00	0.00	0.00	0.00	0.00	2.0	N/A
11	sperm whale	0.0043	0.37	0.06	0.07	0.07	0.05	0.10	1.8	10
11	*Kogia* spp.	0.002	0.49	0.02	0.03	0.03	0.02	0.05	2.2	22
11	beaked whale	0.0005		0.01	0.01	0.01				
11	Cuvier's beaked whale	0.0003	0.82	0.00	0.00	0.00	0.00	0.01	4.0	116
11	*Mesoplodon* spp.	0.0005	0.54	0.01	0.01	0.01	0.00	0.01	1.2	82
11	killer whale	0.0004	0.67	0.01	0.01	0.01	0.00	0.01	2.0	86
11	Blackfish	0.0267		0.00	0.63	0.63				
11	*Globicephala* spp.	0.0185	0.48	0.00	0.44	0.44	0.23	0.65	34.2	2
11	melon-headed whale	0.0267	0.55	0.00	0.63	0.63	0.28	0.98	65.0	1
11	false killer whale	0.00011	0.71	0.00	0.00	0.00	0.00	0.00	28.5	225
11	pygmy killer whale	0.00037	0.60	0.00	0.01	0.01	0.00	0.01	9.5	72
11	Fraser's dolphin	0.00067	0.70	0.00	0.01	0.01	0.00	0.02	117.0	54
11	Risso's dolphin	0.0063	0.47	0.00	0.14	0.14	0.08	0.21	8.1	5
11	bottlenose dolphin	0.0025	0.95	0.00	0.06	0.06	0.00	0.12	5.6	8
11	rough-toothed dolphin	0.0014	1.00	0.00	0.03	0.03	0.00	0.07	15.0	15
11	*Stenella*	0.1351		2.59	3.28	3.28				
11	Atlantic spotted dolphin	0.0014	1.04	0.03	0.03	0.03	-0.13	6.70	15.0	1
11	pantropical spotted dolphin	0.1351	0.84	2.59	3.28	3.28	0.53	6.04	41.7	1
11	Clymene dolphin	0.0482	0.73	0.93	1.17	1.17	0.32	2.03	64.3	1
11	striped dolphin	0.0251	0.67	0.48	0.61	0.61	0.20	1.02	53.6	1
11	spinner dolphin	0.0085	0.71	0.16	0.21	0.21	0.06	0.35	164.0	3

Table 14

Take Estimates for Location 4 and Scenario 12

Run	Species	Density (animals per sq. km)	C.V. of Density	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
12	Bryde's whale	0.00003	0.61	0.00	0.00	0.00	0.00	0.00	2.0	1,553
12	sperm whale	0.0043	0.37	0.04	0.05	0.05	0.03	0.07	1.8	15
12	*Kogia* spp.	0.002	0.49	0.01	0.02	0.02	0.01	0.03	2.2	36
12	beaked whale	0.0005		0.00	0.01	0.01				
12	Cuvier's beaked whale	0.0003	0.82	0.00	0.00	0.00	0.00	0.01	4.0	173
12	*Mesoplodon* spp.	0.0005	0.54	0.00	0.01	0.01	0.00	0.01	1.2	123
12	killer whale	0.0004	0.67	0.00	0.00	0.00	0.00	0.01	2.0	146
12	blackfish	0.0267		0.25	0.44	0.44				
12	*Globicephala* spp.	0.0185	0.48	0.00	0.44	0.44	0.23	0.65	34.2	2
12	melon-headed whale	0.0267	0.55	0.00	0.63	0.63	0.28	0.98	65.0	1
12	false killer whale	0.00011	0.71	0.00	0.00	0.00	0.00	0.00	28.5	225
12	pygmy killer whale	0.00037	0.60	0.00	0.01	0.01	0.00	0.01	9.5	72
12	Fraser's dolphin	0.00067	0.70	0.00	0.01	0.01	0.00	0.01	117.0	85
12	Risso's dolphin	0.0063	0.47	0.06	0.10	0.10	0.05	0.15	8.1	7
12	bottlenose dolphin	0.0025	0.95	0.03	0.04	0.04	0.00	0.08	5.6	13
12	rough-toothed dolphin	0.0014	1.00	0.01	0.02	0.02	0.00	0.04	15.0	26
12	*Stenella*	0.1351		1.08	2.01	2.01				
12	Atlantic spotted dolphin	0.0014	1.04	0.01	0.02	0.02	-0.08	4.11	15.0	1
12	pantropical spotted dolphin	0.1351	0.84	1.08	2.01	2.01	0.32	3.70	41.7	1
12	Clymene dolphin	0.0482	0.73	0.39	0.72	0.72	0.19	1.24	64.3	1
12	striped dolphin	0.0251	0.67	0.20	0.37	0.37	0.12	0.62	53.6	2
12	spinner dolphin	0.0085	0.71	0.07	0.13	0.13	0.04	0.22	164.0	5

Table 15

Take Estimates for Location 5 and Scenarios 13-17

Run	Species	Density (animals per sq. km)	C.V. of Density	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
13	bottlenose dolphin	0.095	0.30	0.18	0.68	0.68	0.48	0.89	10.0	1
13	Atlantic Spotted dolphin	0.026	0.42	0.06	0.15	0.15	0.09	0.21	15.6	5
13	rough-toothed dolphin	0.006	0.98	0.01	0.03	0.03	0.00	0.07	14.0	15
14	bottlenose dolphin	0.095	0.30	0.41	0.98	0.98	0.68	1.27	10.0	1
14	Atlantic spotted dolphin	0.026	0.42	0.07	0.21	0.21	0.12	0.30	15.6	3
14	rough-toothed dolphin	0.006	0.98	0.02	0.05	0.05	0.00	0.10	14.0	10
15	bottlenose dolphin	0.095	0.30	0.56	1.17	1.17	0.82	1.52	10.0	1
15	Atlantic spotted dolphin	0.026	0.42	0.11	0.27	0.27	0.16	0.38	15.6	3
15	rough-toothed dolphin	0.006	0.98	0.03	0.06	0.06	0.00	0.12	14.0	9
16	bottlenose dolphin	0.095	0.30	1.15	1.70	1.70	1.19	2.21	10.0	1
16	Atlantic spotted dolphin	0.026	0.42	0.22	0.43	0.43	0.25	0.61	15.6	2
16	rough-toothed dolphin	0.006	0.98	0.06	0.09	0.09	0.00	0.17	14.0	6
17	bottlenose dolphin	0.095	0.30	2.10	2.63	2.63	1.84	3.42	10.0	1
17	Atlantic spotted dolphin	0.026	0.42	0.54	0.72	0.72	0.42	1.03	15.6	1
17	rough-toothed dolphin	0.006	0.98	0.12	0.14	0.14	0.00	0.29	14.0	3

Table 16

Take Estimates for Location 6 and Scenario 18

Run	Species	Density (animals per sq. km)	C.V. of Density	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
18	Bryde's whale	0.00003	0.61	0.00	0.00	0.00	0.00	0.00	2.0	N/A
18	sperm whale	0.0043	0.37	0.00	0.01	0.01	0.01	0.02	1.8	61
18	*Kogia* spp.	0.002	0.49	0.00	0.00	0.00	0.00	0.00	2.2	559
18	Beaked Whale	0.0005		0.00	0.00	0.00				
18	Cuvier's beaked whale	0.0003	0.82	0.00	0.00	0.00	0.00	0.00	4.0	366
18	*Mesoplodon* spp.	0.0005	0.54	0.00	0.00	0.00	0.00	0.00	1.2	433
18	killer whale	0.0004	0.67	0.00	0.00	0.00	0.00	0.00	2.0	N/A
18	Blackfish	0.0267		0.00	0.00	0.00				
18	*Globicephala* spp.	0.0185	0.48	0.00	0.00	0.00	0.00	0.00	34.2	N/A
18	melon-headed whale	0.0267	0.55	0.00	0.00	0.00	0.00	0.00	65.0	N/A
18	false killer whale	0.00011	0.71	0.00	0.00	0.00	0.00	0.00	28.5	N/A
18	pygmy killer whale	0.00037	0.60	0.00	0.00	0.00	0.00	0.00	9.5	N/A
18	Fraser's dolphin	0.00067	0.70	0.00	0.00	0.00	0.00	0.00	117.0	1176
18	Risso's dolphin	0.0063	0.47	0.00	0.00	0.00	0.00	0.00	8.1	N/A
18	bottlenose dolphin	0.0025	0.95	0.00	0.00	0.00	0.00	0.00	5.6	N/A
18	rough-toothed dolphin	0.0014	1.00	0.00	0.00	0.00	0.00	0.01	15.0	139
18	*Stenella*	0.1351		0.00	0.04	0.04				
18	Atlantic spotted dolphin	0.0014	1.04	0.00	0.00	0.00	0.00	0.08	15.0	12
18	pantropical spotted dolphin	0.1351	0.84	0.00	0.04	0.04	0.01	0.07	41.7	13
18	Clymene dolphin	0.0482	0.73	0.00	0.01	0.01	0.00	0.03	64.3	40
18	striped dolphin	0.0251	0.67	0.00	0.01	0.01	0.00	0.01	53.6	79
18	spinner dolphin	0.0085	0.71	0.00	0.00	0.00	0.00	0.00	164.0	229

Table 17

Take Estimates for Location 6 and Scenario 19

Run	Species	Density (animals per sq. km)	C.V. of Density	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
19	Bryde's whale	0.00003	0.61	0.00	0.00	0.00	0.00	0.00	2.0	N/A
19	sperm whale	0.0043	0.37	0.00	0.00	0.00	0.00	0.00	1.8	N/A
19	*Kogia* spp.	0.002	0.49	0.00	0.00	0.00	0.00	0.00	2.2	N/A
19	beaked whale	0.0005		0.00	0.00	0.00				
19	Cuvier's beaked whale	0.0003	0.82	0.00	0.00	0.00	0.00	0.00	4.0	N/A
19	*Mesoplodon* spp.	0.0005	0.54	0.00	0.00	0.00	0.00	0.00	1.2	N/A
19	killer whale	0.0004	0.67	0.00	0.00	0.00	0.00	0.00	2.0	N/A
19	blackfish	0.0267		0.00	0.00	0.00				
19	*Globicephala* spp.	0.0185	0.48	0.00	0.00	0.00	0.00	0.00	34.2	N/A
19	melon-headed whale	0.0267	0.55	0.00	0.00	0.00	0.00	0.00	65.0	N/A
19	false killer whale	0.00011	0.71	0.00	0.00	0.00	0.00	0.00	28.5	N/A
19	pygmy killer whale	0.00037	0.60	0.00	0.00	0.00	0.00	0.00	9.5	N/A
19	Fraser's dolphin	0.00067	0.70	0.00	0.00	0.00	0.00	0.00	117.0	N/A
19	Risso's dolphin	0.0063	0.47	0.00	0.00	0.00	0.00	0.00	8.1	N/A
19	bottlenose dolphin	0.0025	0.95	0.00	0.00	0.00	0.00	0.00	5.6	N/A
19	rough-toothed dolphin	0.0014	1.00	0.00	0.00	0.00	0.00	0.00	15.0	N/A
19	*Stenella*	0.2482		0.00	0.00	0.00				
19	Atlantic spotted dolphin	0.0014	1.04	0.00	0.00	0.00	0.00	0.00	15.0	N/A
19	pantropical spotted dolphin	0.1351	0.84	0.00	0.00	0.00	0.00	0.00	41.7	N/A
19	Clymene dolphin	0.0482	0.73	0.00	0.00	0.00	0.00	0.00	64.3	N/A
19	striped dolphin	0.0251	0.67	0.00	0.00	0.00	0.00	0.00	53.6	N/A
19	spinner dolphin	0.0085	0.71	0.00	0.00	0.00	0.00	0.00	164.0	N/A

Table 18

Take Estimates for Location 7 and Scenario 20

Run	**Species**	**Density (animals per sq. km)**	**C.V. of Den-sity**	**182 dB Takes**	**12 psi Takes**	**Take Est. per Event**	**Lower Bound**	**Upper Bound**	**Pod Size**	**Number of Events Needed to Produce a Take**
20	sperm whale	0.0037	0.32	0.02	0.03	0.03	0.02	0.04	2.3	25
20	*Kogia* spp.	0.0021	0.44	0.01	0.02	0.02	0.01	0.03	1.7	34
20	beaked whale	0.0008		0.00	0.01	0.01				
20	Cuvier's beaked whale	0.0001	0.75	0.00	0.00	0.00	0.00	0.00	1.0	749
20	*Mesoplodon* spp.	0.0008	0.58	0.00	0.01	0.01	0.00	0.01	1.0	104
20	blackfish	0.0037		0.03	0.05	0.05				
20	false killer whale	0.0022	1.00	0.02	0.03	0.03	0.00	0.06	65.0	16
20	pygmy killer whale	0.0037	0.60	0.03	0.05	0.05	0.02	0.09	9.5	12
20	killer whale	0.0005	0.66	0.01	0.01	0.01	0.00	0.01	2.7	71
20	Risso's dolphin	0.0043	0.66	0.00	0.00	0.00	0.00	0.01	7.8	126
20	rough-toothed dolphin	0.0014	0.84	0.00	0.00	0.00	0.00	0.01	25.0	113
20	*Stenella*	0.2983		0.00	0.00	0.00				
20	spinner dolphin	0.0042	0.64	0.00	0.00	0.00	0.00	0.01	70.0	127
20	pantropical spotted dolphin	0.2983	0.21	0.00	0.00	0.00	0.00	0.01	62.8	172
20	Clymene dolphin	0.0583	0.94	0.00	0.00	0.00	0.00	0.01	121.9	107
20	striped dolphin	0.0147	0.62	0.00	0.00	0.00	0.00	0.01	81.7	129

Table 19

Take Estimates for Location 8 and Scenario 21

Run	Species	Density (animals per sq. km)	C.V. of Den-sity	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
21	sperm whale	0.0037	0.32	0.00	0.00	0.00	0.00	0.00	2.3	N/A
21	*Kogia* spp.	0.0021	0.44	0.00	0.00	0.00	0.00	0.00	1.7	N/A
21	beaked whale	0.0008		0.00	0.00	0.00				
21	Cuvier's beaked whale	0.0001	0.75	0.00	0.00	0.00	0.00	0.00	1.0	N/A
21	*Mesoplodon* spp.	0.0008	0.58	0.00	0.00	0.00	0.00	0.00	1.0	N/A
21	blackfish	0.0037		0.00	0.00	0.00				
21	false killer whale	0.0022	1.00	0.00	0.00	0.00	0.00	0.00	65.0	N/A
21	pygmy killer whale	0.0037	0.60	0.00	0.00	0.00	0.00	0.00	9.5	N/A
21	killer whale	0.0005	0.66	0.00	0.00	0.00	0.00	0.00	2.7	N/A
21	Risso's dolphin	0.0043	0.66	0.00	0.00	0.00	0.00	0.00	7.8	N/A
21	rough-toothed dolphin	0.0014	0.84	0.00	0.00	0.00	0.00	0.00	25.0	N/A
21	*Stenella*	0.2983		0.00	0.00	0.00				
21	spinner dolphin	0.0042	0.64	0.00	0.00	0.00	0.00	0.00	70.0	N/A
21	pantropical spotted dolphin	0.2983	0.21	0.00	0.00	0.00	0.00	0.00	62.8	N/A
21	Clymene dolphin	0.0583	0.94	0.00	0.00	0.00	0.00	0.00	121.9	N/A
21	striped dolphin	0.0147	0.62	0.00	0.00	0.00	0.00	0.00	81.7	N/A

Table 20

Take Estimates for Location 9 and Scenario 22

Run	Species	Density (animals per sq. km)	C.V. of Den-sity	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
22	sperm whale	0.0037	0.32	0.00	0.00	0.00	0.00	0.00	2.3	N/A
22	*Kogia* spp.	0.0021	0.44	0.00	0.00	0.00	0.00	0.00	1.7	N/A
22	beaked whale	0.0008		0.00	0.00	0.00				
22	Cuvier's beaked whale	0.0001	0.75	0.00	0.00	0.00	0.00	0.00	1.0	N/A
22	*Mesoplodon* spp.	0.0008	0.58	0.00	0.00	0.00	0.00	0.00	1.0	N/A
22	blackfish	0.0037		0.00	0.00	0.00				
22	false killer whale	0.0022	1.00	0.00	0.00	0.00	0.00	0.00	65.0	N/A
22	pygmy killer whale	0.0037	0.60	0.00	0.00	0.00	0.00	0.00	9.5	N/A
22	killer whale	0.0005	0.66	0.00	0.00	0.00	0.00	0.00	2.7	N/A
22	Risso's dolphin	0.0043	0.66	0.00	0.00	0.00	0.00	0.00	7.8	N/A
22	rough-toothed dolphin	0.0014	0.84	0.00	0.00	0.00	0.00	0.00	25.0	N/A
22	*Stenella*	0.2983		0.00	0.00	0.00				
22	spinner dolphin	0.0042	0.64	0.00	0.00	0.00	0.00	0.00	70.0	N/A
22	pantropical spotted dolphin	0.2983	0.21	0.00	0.00	0.00	0.00	0.00	62.8	N/A
22	Clymene dolphin	0.0583	0.94	0.00	0.00	0.00	0.00	0.00	121.9	N/A
22	striped dolphin	0.0147	0.62	0.00	0.00	0.00	0.00	0.00	81.7	N/A

Table 21

Take Estimates for Location 9 and Scenario 23

Run	Species	Density (animals per sq. km)	C.V. of Density	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
23	sperm whale	0.0037	0.32	0.00	0.00	0.00	0.00	0.00	2.3	N/A
23	*Kogia* spp.	0.0021	0.44	0.00	0.00	0.00	0.00	0.00	1.7	N/A
23	beaked whale	0.0008		0.00	0.00	0.00				
23	Cuvier's beaked whale	0.0001	0.75	0.00	0.00	0.00	0.00	0.00	1.0	N/A
23	*Mesoplodon* spp.	0.0008	0.58	0.00	0.00	0.00	0.00	0.00	1.0	N/A
23	blackfish	0.0037		0.00	0.00	0.00				
23	false killer whale	0.0022	1.00	0.00	0.00	0.00	0.00	0.00	65.0	N/A
23	pygmy killer whale	0.0037	0.60	0.00	0.00	0.00	0.00	0.00	9.5	N/A
23	killer whale	0.0005	0.66	0.00	0.00	0.00	0.00	0.00	2.7	N/A
23	Risso's dolphin	0.0043	0.66	0.00	0.00	0.00	0.00	0.00	7.8	N/A
23	rough-toothed dolphin	0.0014	0.84	0.00	0.00	0.00	0.00	0.00	25.0	N/A
23	*Stenella*	0.2983		0.00	0.00	0.00				
23	spinner dolphin	0.0042	0.64	0.00	0.00	0.00	0.00	0.00	70.0	N/A
23	pantropical spotted dolphin	0.2983	0.21	0.00	0.00	0.00	0.00	0.00	62.8	N/A
23	Clymene dolphin	0.0583	0.94	0.00	0.00	0.00	0.00	0.00	121.9	N/A
23	striped dolphin	0.0147	0.62	0.00	0.00	0.00	0.00	0.00	81.7	N/A

Table 22

Take Estimates for Location 10 and Scenario 24

Run	Species	Density (animals per sq. km)	C.V. of Density	182 dB Takes	12 psi Takes	Take Est. per Event	Lower Bound	Upper Bound	Pod Size	Number of Events Needed to Produce a Take
24	sperm whale	0.0037	0.32	0.00	0.00	0.00	0.00	0.00	2.3	N/A
24	*Kogia* spp.	0.0021	0.44	0.00	0.00	0.00	0.00	0.00	1.7	N/A
24	beaked whale	0.0008		0.00	0.00	0.00				
24	Cuvier's beaked whale	0.0001	0.75	0.00	0.00	0.00	0.00	0.00	1.0	N/A
24	*Mesoplodon* spp.	0.0008	0.58	0.00	0.00	0.00	0.00	0.00	1.0	N/A
24	blackfish	0.0037		0.00	0.00	0.00				
24	false killer whale	0.0022	1.00	0.00	0.00	0.00	0.00	0.00	65.0	N/A
24	pygmy killer whale	0.0037	0.60	0.00	0.00	0.00	0.00	0.00	9.5	N/A
24	killer whale	0.0005	0.66	0.00	0.00	0.00	0.00	0.00	2.7	N/A
24	Risso's dolphin	0.0043	0.66	0.00	0.00	0.00	0.00	0.00	7.8	N/A
24	rough-toothed dolphin	0.0014	0.84	0.00	0.00	0.00	0.00	0.00	25.0	N/A
24	*Stenella*	0.2983		0.00	0.00	0.00				
24	spinner dolphin	0.0042	0.64	0.00	0.00	0.00	0.00	0.00	70.0	N/A
24	pantropical spotted dolphin	0.2983	0.21	0.00	0.00	0.00	0.00	0.00	62.8	N/A
24	Clymene dolphin	0.0583	0.94	0.00	0.00	0.00	0.00	0.00	121.9	N/A
24	striped dolphin	0.0147	0.62	0.00	0.00	0.00	0.00	0.00	81.7	N/A

Discussion

The take predictions presented here are based upon the current dual criteria of 182 dB re 1 μPa^2-sec in a 1/3 octave band or the 12 psi peak pressure limit. These values are intended to correspond to the approximate onset of temporary threshold shift. It should be noted that there are indications that smaller, behavioral reactions may occur at larger ranges (Finneran et al. 2000). Nevertheless, these results indicate a low take number for each of these activities when considered independently. Most of the simulations that produced a Take Estimate per Event estimate greater than or equal to 1.0 were based upon charge weights greater than 50 pounds. The only small charge weight simulations that produced a take estimate per event equal to or greater than one were the shallow water runs, with the numerous bottlenose dolphin.

The Take Estimates per Event are statistical predictions and are valid for large numbers of events. The actual number of takes is a product of the take probabilities and the number of explosive removals forecast to be performed over a year or five-year period. It is important to understand the differences between these statistical predictions and the actual results of a single EROS event. The actual take of any single given event is likely to be either zero (no animals within range of the explosion) or greater than the statistical prediction, because the animals naturally occur in groups. Nevertheless the statistical predictions are valid for a large number of events.

To illustrate, the statistical prediction might be 1.0 animal taken per removal. If twenty such removals were conducted then the predicted take would be twenty animals. However, the density values used in these calculations are in terms of single animals per square kilometer. In reality, most of the species occur in groups of varying size. For our example animals, the pod size is 10. Therefore the probability of a pod being present during a single event is given by the Take Estimate per Event divided by the pod size. Therefore the Take Estimate per Event FOR A GROUP is 0.1. Over the course of twenty events, the probable take is 2.0, or 2 pods (multiply by 10 animals/pod), or twenty animals. The number of takes is the same given either method over the total number of events.

Other Potential Effects

Turtles are known to be attracted to offshore platforms, which apparently function as artificial reefs (Gitschlag and Herczeg 1994). It is suspected that these platforms may function to attract marine mammals. This is based upon observations of biologists working from oil and gas platforms (Weller, pers. comm.). However, there are no published data documenting such an effect. A survey in the northwestern Atlantic found no differences in cetacean abundance before and after oil structures were installed (Sorensen et al. 1984). If there was such an aggregative effect, it would probably be due to the structures acting as fish aggregating devices (FADs). Such stationary structures are known to support localized ecosystems that may serve as sources of prey for marine mammals (Fréon and Dagorn 2000; Castro et al. 2001). Should any attractive effect of the structures be found, then the take estimates should be adjusted upward.

Effect of Mitigation

All of these results are calculated without consideration of the potential effect of mitigation. Table 2 listed the site scenario ranges to the 182 dB re 1µPa^2-sec and 12 psi isopleths around the charges. These isopleths range between 152 and 1,564 meters. Only those simulations using 500 lb charges produced ‘take’ ranges greater than the current standard (941 meters) for aerial visual surveys (Kaiser et al. 2002). The existing mitigation procedures are likely to reduce the take numbers for some species. This is further reinforced by noting that most of the “high take” scenarios listed in Table 8 include dolphin species that are relatively easy to detect visually.

There are three basic mitigation procedures that can be used. The first is visual monitoring of the area. The effectiveness of visual monitoring is dependent upon the sightability of the animals, which varies between species (Clarke 1982). Some species, such as bottlenose dolphins are relatively easy to visually detect, occurring in medium sized groups and surfacing often. Sperm whales have long submergence times (Papastavrou et al. 1989), making them less likely to be detected visually. However, sperm whales produce frequent clicks that can be detected and tracked over long distances (Watkins and Moore 1982; Whitehead and Weilgart 1990). Passive acoustic monitoring is an extremely effective technique for vocal species such as sperm whales. There are some cryptic species, such as most beaked whales, that are difficult to detect visually and do not vocalize often. The most effective approach for mitigating the effects of EROS activities on these species would be the use of an active ‘whale-finding’ sonar.

Conclusion

These results indicate that the majority of EROS activities have a very low probability of actually taking an animal. Effective mitigation techniques can probably reduce the actual takes and may be able to reduce this activity to a “no effects” status. This is especially likely when charge size is limited to 50 pounds or less.

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Appendix A

Marine Mammal Behavioral Analysis for Minerals Management Service Analyses

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Introduction

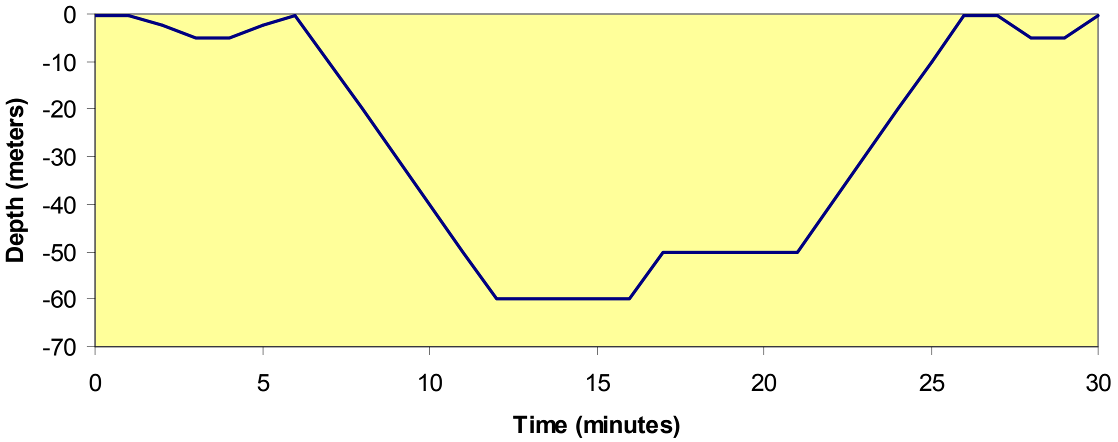
It is a general characteristic of any model that the quality of the results is dependent upon the quality of the inputs to the model. The Acoustic Integration Model © (AIM) is built around the realistic modeling of 1) acoustic sources and propagation and 2) the accurate modeling of animal behavior. Both of these are necessary in order to realistically predict the exposure of marine mammals to an acoustic source, because the complicated nature of acoustic propagation makes the depth of an animal as important as its range from the source.

The AIM model has been used to predict exposures of different species to different acoustic sources. In order to properly conduct these simulations, the behavioral parameters for different species have been gleaned from repeated literature searches. The results of these searches have been tabulated into a growing database of species behavioral characteristics. This document is intended to summarize these behavioral values and provide references to the original sources that were reviewed to construct this database.

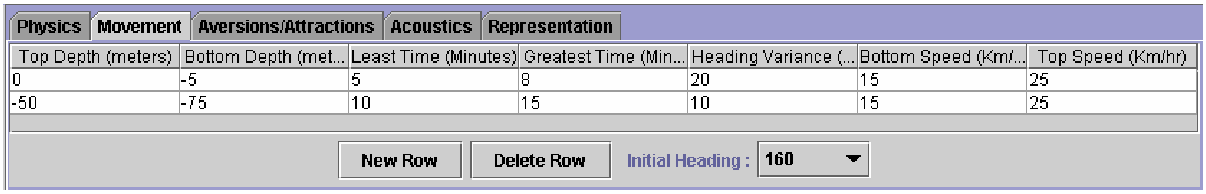
Model Parameters

Movement

Animals move through four dimensions: three-dimensional space and time. Several movement parameters are used in the model to produce a simulated movement pattern that accurately represents real animal movements. A typical dive pattern is shown below. It consists of two phases; the first is a shallow respiratory sequence, which is followed by a deeper, longer dive.



These two phases are represented in the model with the values as input into the box below.



Top Depth (meters)	Bottom Depth (met...	Least Time (Minutes)	Greatest Time (Min...	Heading Variance (...	Bottom Speed (Km/...	Top Speed (Km/hr)
0	-5	5	8	20	15	25
-50	-75	10	15	10	15	25

The top row has the values for the shallow, respiratory dive. The animal dives from the surface to a maximum depth of 5 meters. It is followed by the second line, which describes the second phase of the dive. In this phase the animal dives to a depth between 50 and 75 meters. In this example, the animal spends time at both 60 and 50 meters before surfacing. The pattern then repeats.

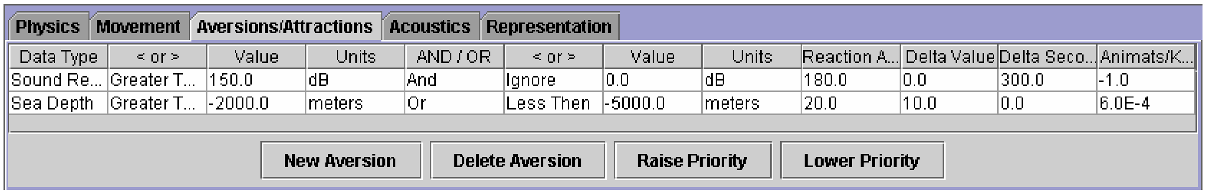
The horizontal component of the course is handled with the 'heading variance' term. It allows the animal to turn up to a certain number of degrees at each movement step. In this case, the animal can change course 20 degrees on the surface, but only 10 degrees underwater. This example is for a narrowly constrained set of variables, appropriate for a migratory animal.

Heading Variance

There is little data that summarizes movement in terms of heading variance, or the amount of course change per unit time. Therefore the default value used in the modeling is 30 degrees. Exceptions are made for migratory animals, which tend to have more linear travel, therefore these animals typically are assigned a value of 10 degrees. Foraging animals tend to have less linear travel, as they may be trying to remain within a food patch. Therefore foraging animals are assigned a higher heading variance value, typically 45 to 60 degrees.

Aversions

In addition to movement patterns, the animats can be programmed to avoid certain environmental characteristics. For example, this can be used to constrain an animal to a particular depth regime. The example below constrains the animal to waters between 2000 and 5000 meters deep.



Data Type	< or >	Value	Units	AND / OR	< or >	Value	Units	Reaction A...	Delta Value	Delta Seco...	Animats/K...
Sound Re...	Greater T...	150.0	dB	And	Ignore	0.0	dB	180.0	0.0	300.0	-1.0
Sea Depth	Greater T...	-2000.0	meters	Or	Less Then	-5000.0	meters	20.0	10.0	0.0	6.0E-4

Baleen Whales

Sei/Bryde's Whale

There is a paucity of data for these species. Since they are similar in size, data for both species have been pooled to derive parameters for these two species.

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance	Min Speed (km/h)	Max Speed (km/h)	Depth Limit/ Reaction Angle
Sei/Bryde's whale	1	2	50	150	2	11	30	2	20	50/135

Dive Depth

Inferred from other species

Dive Time

Dive times ranged between 0.75 and 11 minutes, with a mean duration of 1.5 minutes (Schilling et al. 1992). Most of the dives were short in duration, presumably because they were associated with surface or near-surface foraging. The same paper reported surface times that ranged between 2 second and 15 minutes.

Heading Variance

Observations of foraging sei whales found that they had a very high reorientation rate, frequently resulting in minimal net movement (Schilling et al. 1992).

Speed

A tagging study found an overall speed of advance for sei whales was of 4.6 km/h (Brown 1977). The highest speed reported for a Bryde's whale was 20 km/h (Cummings 1985).

Habitat

Sei whales are known to feed on shallow banks, such as Stellwagen Bank (Kenney and Winn 1986). Therefore Sei and Bryde's whales are allowed to move into shallow water.

Large Odontocetes

Sperm Whale

Currently, sperm whales are modeled with a single animat. In the future, we should create separate animats for males and females, since their behavior is so different.

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h) (s/d)	Max Speed (km/h) (s/d)	Depth Limit/ Reaction Angle
Sperm whale	6	11	300	1400	20	65	20	0/3	3/8	480/135

Dive Depth

The maximum, accurately measured, sperm whale dive depth was 1,330 meters (Watkins et al. 2002). Foraging dives typically begin at depths of 300 meters (Papastavrou et al. 1989).

Dive Time

Sperm whale dive times average 44.4 min in duration and range from 18.2-65.3 minutes (Watkins et al. 2002).

Speed

Sperm whales are typically slow or motionless on the surface. Mean surface speeds of 1.25 km/h (Jaquet et al. 2000) and 3.42 km/h (Whitehead et al. 1989). Their mean dive rate ranges from to 8.04 km/h (Lockyer 1997).

Habitat

Sperm whales are found almost everywhere, but they are usually in water deeper than 480 meters (Davis et al. 1998).

Beaked Whales

Data on the behavior of beaked whales is sparse. Therefore, all beaked whale species have been pooled into a single animat.

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h) (s/d)	Max Speed (km/h) (s/d)	Depth Limit / Reaction Angle
Beaked whale	3	5	120	1453	16	70	30	3	6	253/135

Dive Depth

The minimum and maximum dive depth measured for a beaked whale was 120 and 1453 meters respectively (Hooker and Baird 1999).

Dive Time

The minimum and maximum dive time measured was 16 and 70.5 minutes respectively (Hooker and Baird 1999).

Speed

Dive rates averaged 1 m/s or 3.6 km/h (Hooker and Baird 1999). A mean surface speed of 5 km/h was reported by (Kastelein and Gerrits 1991).

Habitat

The minimum sea depth in which beaked whales were found was 253 meters (Davis et al. 1998).

Dwarf and Pygmy Sperm Whales (Kogia spp.)

Data on dwarf and pygmy sperm whales are rare, and these species are very similar, so data for these two species have been combined.

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h) (s/d)	Max Speed (km/h) (s/d)	Depth Limit/ Reaction Angle
Kogia spp.	1	2	200	800	5	12	30	0	11	176/135

Dive Depth

In the Gulf of Mexico, Kogia were found in waters less than 1000 meters, along the upper continental slope (Baumgartner et al. 2001). Therefore the dive limits of 200-800 meters were chosen based on similar species diving deeply to feed, and within the physical constraints of the environment. It should be noted that Kogia have been seen in water almost 2000m deep (Davis et al. 1998), but they may not be diving to the bottom.

Dive Time

Maximum dive time reported for Kogia is 12 minutes (Hohn et al. 1995).

Speed

Tracking of a rehabilitated pygmy sperm whale found that speeds range from 0 to 6 knots (11 km/h) with a mean value of 3 knots (Scott et al. 2001).

Habitat

The minimum depth that Kogia was found in the Gulf of Mexico was 176 meters (Davis et al. 1998).

Blackfish: False Killer Whale, Melon-headed Whale, Pilot Whale

Studies describing the movements and diving patterns of these animals are rare and sparse. Therefore, they have been combined into a single "blackfish" category. As more data become available, these species will be split into separate animats.

Model Parameters

	Min. Surface Time (min)	**Max Surface Time (min)**	**Min Dive Depth (m)**	**Max Dive Depth (m)**	**Min Dive Time (min)**	**Max Dive Time (min)**	**Heading Variance (surf/dive)**	**Min Speed (km/h)**	**Max Speed (km/h)**	**Depth Limit/ Reaction Angle**
Blackfish	2	5	200	1000	2	12	30	2	22.4	200/135

Dive Depth

Long-finned pilot whales in the Mediterranean were observed to display considerable diurnal variation in their dive depths. During the day they never dove to more than 16 meters. However, at night, they dove to a maximum depth of 648 meters (Baird et al. 2002).

Dive Time

Only one study has TDR data on pilot whales (to date). (Baird et al. 2002) reported on dives of two individuals, and dive times varied between 2.14 and 12.7 minutes.

Speed

Maximum speed recorded for false killer whales was 8.0 m/s (28.8 km/h) (Rohr et al. 2002), although the typical cruising speed is typically 20-24% less than the maximum speed (Fish and Rohr 1999). This "typical" maximum of 6.24 m/s (22 km/h) was used for AIM.

Shane (1995) reported a minimum speed of 2 km/h and a maximum of 12 km/h for pilot whales. It is believed that the Rohr et al. (2002) value is more accurate for maximum speed.

Habitat

The minimum water depth that pilot whales were seen in the Gulf of Mexico was 246 m (Davis et al. 1998).

Killer Whale

There is a remarkable paucity of quantitative data available for Killer whales, considering their coastal habitat and popular appeal. Nevertheless, most data from "blackfish" were used to model orca, with the exception of dive depth. The different feeding ecology of these species makes very deep dives apparently unnecessary. When additional data allow, we need to develop separate animats for "resident" and "transient" killer whales.

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h)	Max Speed (km/h)	Depth Limit / Reaction Angle
Killer whale	1	5	10	180	1	10	30	6	10	25/135

Dive Depth

Killer whales feeding on herring were observed to dive to 180 meters (Nøttestad et al. 2002). Killer whales are found in at least two "races", transients and residents. Transients feed primarily on marine mammals whereas residents feed primarily on fish. Residents were reported to dive to the bottom (173m) (Baird 1994). Baird (1994) also reported that while residents dive deeper than transients, the transients spent a far greater amount of time in deeper water. Resident killer whales in the Pacific northwest dove to a maximum depth of 201 meters (Baird et al. 1998).

Dive Time

No data on dive times available – data from other species used.

Speed

No data available – data from other species used.

Habitat

Killer whales are known to occur in very shallow water (e.g. rubbing beaches) as well as cross open ocean basins. However, they are usually coastal and most often found in temperate waters.

Small Odontocetes

Risso's Dolphin

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h)	Max Speed (km/h)	Depth Limit/ Reaction Angle
Risso's dolphin	1	3	150	1000	2	12	30	2	12	150/135

Dive Depth

Dive depths of 150-1000 meters were inferred from its squid-eating habits, and from similar species.

Dive Time

No data on divetimes could be found. The values for blackfish, which have a similar ecological niche, were used.

Speed

Risso's dolphins off Santa Catalina Island were reported to have speeds that range between 2 and 12 km/h (Shane 1995).

Habitat

Risso's dolphins were seen in water deeper than 150 meters in the Gulf of Mexico (Davis et al. 1998). In the Gulf of Mexico they were most often observed between 300 and 750 meters. Off Chile they were seen in waters deeper than 1000 meters. In all cases this association seems to be driven by the local oceanographic upwelling conditions that increase primary productivity.

Bottlenose Dolphin

In many environments there can be coastal and pelagic stocks of bottlenose dolphins. This is certainly the case off the east coast of the United States, however defining the range of offshore form is difficult (Wells et al. 1999). Regardless of the genetic differences that may exist between these two forms, they frequently occur at different densities, and so they are split into two animat categories.

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h)	Max Speed (km/h)	Depth Limit/ Reaction Angle
Bottlenose (coastal)	1	1	15	98	1	2	30	4	30	10/80
Bottlenose (pelagic)	1	1	15	200	1	2	30	4	30	101/1,226

Dive Depth

The maximum recorded dive depth for wild bottlenose dolphins is 200 meters (Kooyman and Andersen 1969). A satellite tagged dolphin, in Tampa Bay had a maximum dive depth of 98 meters (Mate et al. 1995). This value was used as the maximum dive depth for the coastal form of bottlenose.

Dive Time

Measured surface times ranged from 38 seconds to 1.2 minutes (Lockyer and Morris 1986; Lockyer and Morris 1987; Mate et al. 1995).

Speed

Bottlenose dolphins were observed to swim, for extended period, at speeds of 4 to 20 km/h, although they could burst at up to 54 km/h (Lockyer and Morris 1987). A more recent analysis found that maximum speed of wild dolphins was 5.7 m/s (20.5 km/h), although trained animals could double this speed when preparing to leap (Rohr et al. 2002).

Habitat

In the Gulf of Mexico, bottlenose where observed in water depths between 101 and 1,226 meters (Davis et al. 1998), However tagged animals have been observed to swim into water 5,000 meters deep (Wells et al. 1999).

Stenella: Clymene, Spinner, Spotted, and Striped Dolphins

Most *Stenella* species have strong diurnal variation in their behavior. We should build separate daytime and nighttime animats for this species, which requires a new ability in AIM. A temporary approach would be to populate the area with both types of animats, and then scale them by the local photoperiod.

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h)	Max Speed (km/h)	Depth Limit/ Reaction Angle
Stenella	1	1	10	400	1	4	30	2	20	100

Dive Depth

Spinner dolphins feed during the night, and rest inshore during the daytime. At night they dive to about 400 meters to feed (Dolar et al. 2003).

Pantropical spotted dolphins off Hawai‘i also dive deeper at night than during the day. The maximum daytime depth was 122 meters, whereas the nighttime maximum was 213 meters (Baird et al. 2001).

Dive Time

Pantropical spotted dolphins off Hawai‘i had a mean dive duration of 1.95 min (SD=0.92) (Baird et al. 2001), so a three minute dive time maximum was used for modeling purposes. An Atlantic spotted dolphin tagged with a satellite linked TDR had a maximum dive time of 3.5 minutes (Davis et al. 1996).

Speed

The mean speed of striped dolphins in the Mediterranean was 6.1 knots (11 km/h), and were observed to burst to 32 kts (Archer and Perrin 1999). A maximum speed of 20 km/h was chosen as a typical (non-burst) maximum speed.

Habitat

In the Gulf of Mexico, spinner dolphins were seen in water deeper than 526 meters, striped dolphins were seen in water deeper than 570 meters and spotted dolphins were seen in water deeper than 102 meters(Davis et al. 1998). Spinner dolphins in Hawai’i are known to move into shallow bays during the day (Norris and Dohl 1980).

Fraser's Dolphin

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h)	Max Speed (km/h)	Depth Limit/ Reaction Angle
Fraser's dolphin	1	1	10	600	1	4	30	2	20	100

Dive Depth

Fraser's dolphins dive to about 600-700 meters to feed, much deeper than spinner dolphins (Dolar et al. 2003). All other behavioral parameters are taken from *Stenella* species, since there are no direct data for Fraser's dolphin.

Rough-toothed Dolphin

Model Parameters

	Min. Surface Time (min)	Max Surface Time (min)	Min Dive Depth (m)	Max Dive Depth (m)	Min Dive Time (min)	Max Dive Time (min)	Heading Variance (surf/dive)	Min Speed (km/h)	Max Speed (km/h)	Depth Limit/ Reaction Angle
Rough-toothed dolphin	1	3	50	600	3	15	30	5	20	194/135

Dive Depth

No dive depth data is available; depths are based upon other species.

Dive Time

The maximum dive time reported for rough-toothed dolphins was 15 minutes (Miyazaki and Perrin 1994). A more typical range was 0.5 to 3.5 minutes (Ritter 2002).

Speed

Bow-riding *Steno* were observed at 16 km/h (Watkins et al. 1987). Porpoising *Steno* off the Canary Islands were tracked at ">3 knots" (Ritter 2002).

Habitat

Rough-toothed dolphins were seen in water deeper than 194 meters (Davis et al. 1998). Dolphins off the Canary Islands were most often seen in water 100-1000 m deep, with occasional shallow water sightings, and one group was seen in water 2500 m deep (Ritter 2002).

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The Department of the Interior Mission

MARCH 3, 1849

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.

MMS Securing Ocean Energy &
Economic Value for America