

## **APPENDIX B: MARINE ANIMAL STRIKE PROBABILITY ASSESSMENT**

### **Introduction**

An approach was used to determine the expected number of marine animals that could be struck by the separation and jettison or drop of various spent stages and payload fairings from licensed launches in the U.S. For this approach, the data were based on 50 projected launches, which is a conservative value for annual launches. The greatest number of U.S. licensed launches occurred in 1998 with 22 launches.

### **Assumptions**

Various assumptions were applied to the launch rate data to estimate the number of items jettisoned/dropped that could potentially hit marine animals. Each number of the total is a worst case for the payload capacity size (e.g., a Delta II is used as an example of an intermediate launch vehicle, because more parts are jettisoned than an Atlas). Conservative total launch numbers have been developed for each of the four payload capacity types.

- Small, Land-based - 7
- Small, Air-based - 5
- Medium/Intermediate - 31
- High - 7

The launches were further separated into launches over the Atlantic Ocean and over the Pacific Ocean. Thus, the launch total was divided in half and distributed as noted in Table B-1. Because there is an odd number for each type of launch, the number for each type was divided in half with one ocean having one more launch than the other (e.g., Small, Land-based (total: 7) was projected to be 4 over the Atlantic and 3 over the Pacific). The launches were distributed so that the total for each ocean was 25 launches.

During the launch process, up to four stages, up to nine SRMs, and a payload fairing can be jettisoned/dropped. The four stages are: Stage 0, Stage 1, Stage 2, and Stage 3. The following assumptions were made:

- None of the stages or payload fairings are burned up or broken apart during the descent.
- All the stages and payload fairings (including Stage 3 parts) fall back to the Earth intact, while taking into consideration the widest possible trajectory over the oceans.
- A jettisoned payload fairing breaks up into three equal pieces upon impact with the ocean surface.
- For each applicable stage, there is one part jettisoned, however it is not the case for the Medium/Intermediate and High capacity launches for Stage 0.
  - Nine SRMs are jettisoned during ascent on every Delta II vehicle for a Medium/Intermediate Capacity launch.
  - Two SRMs are jettisoned during ascent on every Titan III vehicle for a High Capacity launch.

These assumptions are applied to the probability assessment to obtain the worst case scenario for predicting contact between jettisoned spacecraft and marine animals during the launch period. For example, it is conservative to assume that all the stages and payload fairings fall back to the Earth intact, because this is the breakup configuration that appears to have the most potential for damage to marine animals. For example, several very large pieces have the greatest potential for inflicting damage to marine animals than many smaller pieces. Thus, the breakup configuration involving the largest number of very large pieces was used.

## Methodology

The various stages and payload fairings that are jettisoned have a certain length that is used to calculate an “effective” area. The effective area for any one component is the region within which any marine animal present will be struck. When the stage-specific effective areas (in square kilometers) are multiplied by the species-specific densities (number of animals per square kilometer), one obtains the expected (average) number of animals for any one species that would be in the effective area of any one stage of each separation. Multiplying those numbers by the total number of components of each stage or payload fairing to be jettisoned in a year yields the total expected number of animals of each species that would be hit. Summing over the different stages and the different species of marine animals yields the total expected number of marine animals struck. These calculations and results are shown in Extended Tables B-2 and B-3 at the end of this appendix.

This approach makes some simplifying assumptions that in most cases are conservative and tend to over-estimate the expected number of animals struck. The main assumptions include:

- The entire range of any given species is considered to be susceptible to the stages and payload fairing releases. This assumption is implicit in using the average densities for the calculations, because it is assumed that all the animals are at risk from any one component. This approach ignores the fact that, in the stage’s hazard area, there may be no animals of a given species present at the time of a stage release. In order to simplify the analysis, this assumption also ignores the possibility that there may be more than one animal hit by a single stage.
- This analysis ignores the possibility that effective areas of two or more stages jettisoned during a single launch may overlap, potentially overestimating the total effective area.
- The analysis assumes a uniform density for all marine animals throughout the respective ocean. For the Atlantic Ocean, densities are derived from the highest seasonal density in a continental shelf area (which has higher densities than the open ocean for many species, especially migratory ones such as turtles).
- The fractional probabilities are summed across all marine species. So, for example, if a probability of hit was 0.2 for 5 different species, the methodology would report that as 1.0 animals. Note that the highest probability for an individual species is less than 0.02. Thus, by combining improbable events for several species, the probability of a “hit” is inflated.

Given the assumptions listed above, this approach can estimate the expected (average) number of animals struck for any combination of stages or payload fairing, species of concern, and numbers of stages jettisoned.

## **Conclusions**

The results are documented in Table B-4 and B-5. They show that the total expected number of marine animals struck is potentially 0.078 annually in the Atlantic Ocean and 0.297 annually in the Pacific Ocean. Therefore, the total number of animals at risk is less than 0.4 annually. These results signify that the risk to marine animals is extremely low from launch activities in the U.S.

**TABLE B-1**  
**DISTRIBUTION OF JETTISONED MATERIAL INTO ATLANTIC AND PACIFIC OCEAN**

| Launch Vehicles                      | Stage 0         |                | Stage 1         |                | Stage 2         |                | Stage 3         |                | Payload Fairing (# per launch) |                | Total Number of Objects    |
|--------------------------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|--------------------------------|----------------|----------------------------|
| Length (effective radius)            | ft              | Sq km          | ft                             | Sq km          |                            |
| Small Land                           | 29.59           | 0.009019       | 29.1            | 0.00887        | 8.92            | 0.002719       | 4.39            | 0.001338       | 5.65                           | 0.001722       |                            |
| Small Air                            | ---             | ---            | 29.1            | 0.00887        | 11.7            | 0.003566       | 4.39            | 0.001338       | 14.5                           | 0.00442        |                            |
| Medium/Intermediate                  | 42.5            | 0.012954       | 85.6            | 0.026091       | 19.6            | 0.005974       | 6.7             | 0.002042       | 26                             | 0.007925       |                            |
| High                                 | 90.4            | 0.027554       | 78.6            | 0.023957       | 32.7            | 0.009967       | 11              | 0.003353       | 42.6                           | 0.012984       |                            |
| <b>Area (km<sup>2</sup>)</b>         |                 |                |                 |                |                 |                |                 |                |                                |                |                            |
| Small Land                           | ---             | 0.000255       | ---             | 0.000247       | ---             | 2.32E-05       | ---             | 5.62E-06       | ---                            | 9.31E-06       |                            |
| Small Air                            | ---             | ---            | ---             | 0.000247       | ---             | 3.99E-05       | ---             | 5.62E-06       | ---                            | 6.13E-05       |                            |
| Medium/Intermediate                  | ---             | 0.000527       | ---             | 0.002138       | ---             | 0.000112       | ---             | 1.31E-05       | ---                            | 0.000197       |                            |
| High                                 | ---             | 0.002384       | ---             | 0.001802       | ---             | 0.000312       | ---             | 3.53E-05       | ---                            | 0.000529       |                            |
| <b>Number/year</b>                   | <b>Atlantic</b> | <b>Pacific</b> | <b>Atlantic</b> | <b>Pacific</b> | <b>Atlantic</b> | <b>Pacific</b> | <b>Atlantic</b> | <b>Pacific</b> | <b>Atlantic</b>                | <b>Pacific</b> |                            |
| Small Land<br>(7 launches)           | 4               | 3              | 4               | 3              | 4               | 3              | 4               | 3              | 12                             | 9              | 7 per launch<br>49 total   |
| Small Air<br>(5 launches)            | 2               | 3              | 2               | 3              | 2               | 3              | 2               | 3              | 6                              | 9              | 6 per launch<br>30 total   |
| Medium/Intermediate<br>(31 launches) | 135a            | 144a           | 15              | 16             | 15              | 16             | 15              | 16             | 45                             | 48             | 15 per launch<br>465 total |
| High<br>(7 launches)                 | 8b              | 6b             | 4               | 3              | 4               | 3              | 4               | 3              | 12                             | 9              | 8 per launch<br>56 total   |

b: Two SRMs on every Titus III vehicle are jettisoned during ascent

**TABLE B-2**  
**ANIMALS AT RISK IN THE ATLANTIC OCEAN**

**SMALL LAND**

| Marine Animals                | Density  | Stage 0         |                  |              | Stage 1         |                  |              | Stage 2         |                  |              |
|-------------------------------|----------|-----------------|------------------|--------------|-----------------|------------------|--------------|-----------------|------------------|--------------|
|                               |          | Area<br>(sq km) | One<br>Component | Total (4/yr) | Area<br>(sq km) | One<br>Component | Total (4/yr) | Area<br>(sq km) | One<br>Component | Total (4/yr) |
| Atlantic spotted dolphin      | 1.28E-03 | 2.554E-04       | 3.269E-07        | 1.308E-06    | 2.470E-04       | 3.162E-07        | 1.265E-06    | 2.321E-05       | 2.971E-08        | 1.188E-07    |
| Atlantic white-sided dolphin  | 1.19E-02 | 2.554E-04       | 3.039E-06        | 1.216E-05    | 2.470E-04       | 2.939E-06        | 1.176E-05    | 2.321E-05       | 2.762E-07        | 1.105E-06    |
| Blue whale                    | 1.71E-04 | 2.554E-04       | 4.367E-08        | 1.747E-07    | 2.470E-04       | 4.224E-08        | 1.689E-07    | 2.321E-05       | 3.969E-09        | 1.588E-08    |
| Bottlenose dolphin            | 4.59E-02 | 2.554E-04       | 1.172E-05        | 4.689E-05    | 2.470E-04       | 1.134E-05        | 4.535E-05    | 2.321E-05       | 1.065E-06        | 4.261E-06    |
| Common dolphin                | 1.78E-01 | 2.554E-04       | 4.546E-05        | 1.818E-04    | 2.470E-04       | 4.397E-05        | 1.759E-04    | 2.321E-05       | 4.131E-06        | 1.653E-05    |
| Cuvier's beaked whale         | 1.71E-04 | 2.554E-04       | 4.367E-08        | 1.747E-07    | 2.470E-04       | 4.224E-08        | 1.689E-07    | 2.321E-05       | 3.969E-09        | 1.588E-08    |
| Dwarf sperm whale             | 1.71E-04 | 2.554E-04       | 4.367E-08        | 1.747E-07    | 2.470E-04       | 4.224E-08        | 1.689E-07    | 2.321E-05       | 3.969E-09        | 1.588E-08    |
| Fin whale                     | 1.23E-02 | 2.554E-04       | 3.141E-06        | 1.257E-05    | 2.470E-04       | 3.038E-06        | 1.215E-05    | 2.321E-05       | 2.855E-07        | 1.142E-06    |
| Harbor porpoise               | 1.56E-03 | 2.554E-04       | 3.984E-07        | 1.594E-06    | 2.470E-04       | 3.853E-07        | 1.541E-06    | 2.321E-05       | 3.621E-08        | 1.448E-07    |
| Humpback whale                | 4.98E-04 | 2.554E-04       | 1.272E-07        | 5.088E-07    | 2.470E-04       | 1.230E-07        | 4.920E-07    | 2.321E-05       | 1.156E-08        | 4.623E-08    |
| Long-finned pilot whale       | 6.51E-02 | 2.554E-04       | 1.663E-05        | 6.651E-05    | 2.470E-04       | 1.608E-05        | 6.432E-05    | 2.321E-05       | 1.511E-06        | 6.044E-06    |
| Mesoplodon spp. beaked whales | 4.22E-04 | 2.554E-04       | 1.078E-07        | 4.311E-07    | 2.470E-04       | 1.042E-07        | 4.169E-07    | 2.321E-05       | 9.795E-09        | 3.918E-08    |
| Minke whale                   | 5.54E-04 | 2.554E-04       | 1.415E-07        | 5.660E-07    | 2.470E-04       | 1.368E-07        | 5.474E-07    | 2.321E-05       | 1.286E-08        | 5.143E-08    |
| North Atlantic right whale    | 2.77E-04 | 2.554E-04       | 7.075E-08        | 2.830E-07    | 2.470E-04       | 6.842E-08        | 2.737E-07    | 2.321E-05       | 6.429E-09        | 2.572E-08    |
| Pygmy killer whale            | 1.71E-04 | 2.554E-04       | 4.367E-08        | 1.747E-07    | 2.470E-04       | 4.224E-08        | 1.689E-07    | 2.321E-05       | 3.969E-09        | 1.588E-08    |
| Pygmy sperm whale             | 1.71E-04 | 2.554E-04       | 4.367E-08        | 1.747E-07    | 2.470E-04       | 4.224E-08        | 1.689E-07    | 2.321E-05       | 3.969E-09        | 1.588E-08    |
| Risso's dolphin               | 7.00E-02 | 2.554E-04       | 1.788E-05        | 7.151E-05    | 2.470E-04       | 1.729E-05        | 6.916E-05    | 2.321E-05       | 1.625E-06        | 6.499E-06    |
| Sei whale                     | 1.71E-04 | 2.554E-04       | 4.367E-08        | 1.747E-07    | 2.470E-04       | 4.224E-08        | 1.689E-07    | 2.321E-05       | 3.969E-09        | 1.588E-08    |
| Short-finned pilot whale      | 6.51E-02 | 2.554E-04       | 1.663E-05        | 6.651E-05    | 2.470E-04       | 1.608E-05        | 6.432E-05    | 2.321E-05       | 1.511E-06        | 6.044E-06    |
| Sperm whale                   | 1.24E-03 | 2.554E-04       | 3.167E-07        | 1.267E-06    | 2.470E-04       | 3.063E-07        | 1.225E-06    | 2.321E-05       | 2.878E-08        | 1.151E-07    |
| Striped dolphin               | 2.92E-02 | 2.554E-04       | 7.458E-06        | 2.983E-05    | 2.470E-04       | 7.212E-06        | 2.885E-05    | 2.321E-05       | 6.777E-07        | 2.711E-06    |
| Green sea turtle              | 1.71E-04 | 2.554E-04       | 4.367E-08        | 1.747E-07    | 2.470E-04       | 4.224E-08        | 1.689E-07    | 2.321E-05       | 3.969E-09        | 1.588E-08    |
| Kemp's Ridley sea turtle      | 1.71E-04 | 2.554E-04       | 4.367E-08        | 1.747E-07    | 2.470E-04       | 4.224E-08        | 1.689E-07    | 2.321E-05       | 3.969E-09        | 1.588E-08    |
| Leatherback sea turtle        | 1.88E-03 | 2.554E-04       | 4.802E-07        | 1.921E-06    | 2.470E-04       | 4.644E-07        | 1.857E-06    | 2.321E-05       | 4.363E-08        | 1.745E-07    |
| Loggerhead sea turtle         | 5.25E-02 | 2.554E-04       | 1.341E-05        | 5.363E-05    | 2.470E-04       | 1.297E-05        | 5.187E-05    | 2.321E-05       | 1.219E-06        | 4.874E-06    |
|                               |          | <b>Totals:</b>  | 0.000138         | 0.000551     |                 | 0.000133         | 0.000533     |                 | 0.000013         | 0.000050     |

**TABLE B-2**  
**ANIMALS AT RISK IN THE ATLANTIC OCEAN (Continued)**

**SMALL LAND**

| Marine Animals                | Stage 3         |                  |              | Payload Fairing |                |               | Total Across Species |           |
|-------------------------------|-----------------|------------------|--------------|-----------------|----------------|---------------|----------------------|-----------|
|                               | Area<br>(sq km) | One<br>Component | Total (4/yr) | Area<br>(sq km) | One<br>Fairing | Total (12/yr) | One                  | All       |
| Atlantic spotted dolphin      | 5.622E-06       | 7.196E-09        | 2.878E-08    | 9.312E-06       | 1.192E-08      | 1.430E-07     | 6.919E-07            | 2.863E-06 |
| Atlantic white-sided dolphin  | 5.622E-06       | 6.690E-08        | 2.676E-07    | 9.312E-06       | 1.108E-07      | 1.330E-06     | 6.432E-06            | 2.662E-05 |
| Blue whale                    | 5.622E-06       | 9.614E-10        | 3.845E-09    | 9.312E-06       | 1.592E-09      | 1.911E-08     | 9.243E-08            | 3.825E-07 |
| Bottlenose dolphin            | 5.622E-06       | 2.580E-07        | 1.032E-06    | 9.312E-06       | 4.274E-07      | 5.129E-06     | 2.481E-05            | 1.027E-04 |
| Common dolphin                | 5.622E-06       | 1.001E-06        | 4.003E-06    | 9.312E-06       | 1.658E-06      | 1.989E-05     | 9.622E-05            | 3.981E-04 |
| Cuvier's beaked whale         | 5.622E-06       | 9.614E-10        | 3.845E-09    | 9.312E-06       | 1.592E-09      | 1.911E-08     | 9.243E-08            | 3.825E-07 |
| Dwarf sperm whale             | 5.622E-06       | 9.614E-10        | 3.845E-09    | 9.312E-06       | 1.592E-09      | 1.911E-08     | 9.243E-08            | 3.825E-07 |
| Fin whale                     | 5.622E-06       | 6.915E-08        | 2.766E-07    | 9.312E-06       | 1.145E-07      | 1.374E-06     | 6.649E-06            | 2.751E-05 |
| Harbor porpoise               | 5.622E-06       | 8.770E-09        | 3.508E-08    | 9.312E-06       | 1.453E-08      | 1.743E-07     | 8.432E-07            | 3.489E-06 |
| Humpback whale                | 5.622E-06       | 2.800E-09        | 1.120E-08    | 9.312E-06       | 4.637E-09      | 5.565E-08     | 2.692E-07            | 1.114E-06 |
| Long-finned pilot whale       | 5.622E-06       | 3.660E-07        | 1.464E-06    | 9.312E-06       | 6.062E-07      | 7.275E-06     | 3.519E-05            | 1.456E-04 |
| Mesoplodon spp. beaked whales | 5.622E-06       | 2.372E-09        | 9.490E-09    | 9.312E-06       | 3.930E-09      | 4.716E-08     | 2.281E-07            | 9.439E-07 |
| Minke whale                   | 5.622E-06       | 3.115E-09        | 1.246E-08    | 9.312E-06       | 5.159E-09      | 6.191E-08     | 2.995E-07            | 1.239E-06 |
| North Atlantic right whale    | 5.622E-06       | 1.557E-09        | 6.229E-09    | 9.312E-06       | 2.579E-09      | 3.095E-08     | 1.497E-07            | 6.196E-07 |
| Pygmy killer whale            | 5.622E-06       | 9.614E-10        | 3.845E-09    | 9.312E-06       | 1.592E-09      | 1.911E-08     | 9.243E-08            | 3.825E-07 |
| Pygmy sperm whale             | 5.622E-06       | 9.614E-10        | 3.845E-09    | 9.312E-06       | 1.592E-09      | 1.911E-08     | 9.243E-08            | 3.825E-07 |
| Risso's dolphin               | 5.622E-06       | 3.935E-07        | 1.574E-06    | 9.312E-06       | 6.518E-07      | 7.822E-06     | 3.784E-05            | 1.566E-04 |
| Sei whale                     | 5.622E-06       | 9.614E-10        | 3.845E-09    | 9.312E-06       | 1.592E-09      | 1.911E-08     | 9.243E-08            | 3.825E-07 |
| Short-finned pilot whale      | 5.622E-06       | 3.660E-07        | 1.464E-06    | 9.312E-06       | 6.062E-07      | 7.275E-06     | 3.519E-05            | 1.456E-04 |
| Sperm whale                   | 5.622E-06       | 6.971E-09        | 2.789E-08    | 9.312E-06       | 1.155E-08      | 1.386E-07     | 6.703E-07            | 2.773E-06 |
| Striped dolphin               | 5.622E-06       | 1.642E-07        | 6.566E-07    | 9.312E-06       | 2.719E-07      | 3.263E-06     | 1.578E-05            | 6.531E-05 |
| Green sea turtle              | 5.622E-06       | 9.614E-10        | 3.845E-09    | 9.312E-06       | 1.592E-09      | 1.911E-08     | 9.243E-08            | 3.825E-07 |
| Kemp's Ridley sea turtle      | 5.622E-06       | 9.614E-10        | 3.845E-09    | 9.312E-06       | 1.592E-09      | 1.911E-08     | 9.243E-08            | 3.825E-07 |
| Leatherback sea turtle        | 5.622E-06       | 1.057E-08        | 4.228E-08    | 9.312E-06       | 1.751E-08      | 2.101E-07     | 1.016E-06            | 4.205E-06 |
| Loggerhead sea turtle         | 5.622E-06       | 2.952E-07        | 1.181E-06    | 9.312E-06       | 4.889E-07      | 5.867E-06     | 2.838E-05            | 1.174E-04 |
|                               | <b>Totals:</b>  | 0.000003         | 0.000012     |                 | 0.000005       | 0.000060      | 0.000291             | 0.001206  |

**TABLE B-2**  
**ANIMALS AT RISK IN THE ATLANTIC OCEAN (Continued)**

**SMALL AIR**

| Marine Animals                | Density  | Stage 0         |                  |              | Stage 1         |                  |              | Stage 2         |               |              |
|-------------------------------|----------|-----------------|------------------|--------------|-----------------|------------------|--------------|-----------------|---------------|--------------|
|                               |          | Area<br>(sq km) | One<br>Component | Total (0/yr) | Area<br>(sq km) | One<br>Component | Total (2/yr) | Area<br>(sq km) | One Component | Total (2/yr) |
| Atlantic spotted dolphin      | 1.28E-03 | --              | --               | --           | 2.470E-04       | 3.162E-07        | 6.323E-07    | 3.993E-05       | 5.111E-08     | 1.022E-07    |
| Atlantic white-sided dolphin  | 1.19E-02 | --              | --               | --           | 2.470E-04       | 2.939E-06        | 5.879E-06    | 3.993E-05       | 4.752E-07     | 9.503E-07    |
| Blue whale                    | 1.71E-04 | --              | --               | --           | 2.470E-04       | 4.224E-08        | 8.447E-08    | 3.993E-05       | 6.828E-09     | 1.366E-08    |
| Bottlenose dolphin            | 4.59E-02 | --              | --               | --           | 2.470E-04       | 1.134E-05        | 2.267E-05    | 3.993E-05       | 1.833E-06     | 3.666E-06    |
| Common dolphin                | 1.78E-01 | --              | --               | --           | 2.470E-04       | 4.397E-05        | 8.793E-05    | 3.993E-05       | 7.108E-06     | 1.422E-05    |
| Cuvier's beaked whale         | 1.71E-04 | --              | --               | --           | 2.470E-04       | 4.224E-08        | 8.447E-08    | 3.993E-05       | 6.828E-09     | 1.366E-08    |
| Dwarf sperm whale             | 1.71E-04 | --              | --               | --           | 2.470E-04       | 4.224E-08        | 8.447E-08    | 3.993E-05       | 6.828E-09     | 1.366E-08    |
| Fin whale                     | 1.23E-02 | --              | --               | --           | 2.470E-04       | 3.038E-06        | 6.076E-06    | 3.993E-05       | 4.911E-07     | 9.823E-07    |
| Harbor porpoise               | 1.56E-03 | --              | --               | --           | 2.470E-04       | 3.853E-07        | 7.706E-07    | 3.993E-05       | 6.229E-08     | 1.246E-07    |
| Humpback whale                | 4.98E-04 | --              | --               | --           | 2.470E-04       | 1.230E-07        | 2.460E-07    | 3.993E-05       | 1.989E-08     | 3.977E-08    |
| Long-finned pilot whale       | 6.51E-02 | --              | --               | --           | 2.470E-04       | 1.608E-05        | 3.216E-05    | 3.993E-05       | 2.599E-06     | 5.199E-06    |
| Mesoplodon spp. beaked whales | 4.22E-04 | --              | --               | --           | 2.470E-04       | 1.042E-07        | 2.085E-07    | 3.993E-05       | 1.685E-08     | 3.370E-08    |
| Minke whale                   | 5.54E-04 | --              | --               | --           | 2.470E-04       | 1.368E-07        | 2.737E-07    | 3.993E-05       | 2.212E-08     | 4.424E-08    |
| North Atlantic right whale    | 2.77E-04 | --              | --               | --           | 2.470E-04       | 6.842E-08        | 1.368E-07    | 3.993E-05       | 1.106E-08     | 2.212E-08    |
| Pygmy killer whale            | 1.71E-04 | --              | --               | --           | 2.470E-04       | 4.224E-08        | 8.447E-08    | 3.993E-05       | 6.828E-09     | 1.366E-08    |
| Pygmy sperm whale             | 1.71E-04 | --              | --               | --           | 2.470E-04       | 4.224E-08        | 8.447E-08    | 3.993E-05       | 6.828E-09     | 1.366E-08    |
| Risso's dolphin               | 7.00E-02 | --              | --               | --           | 2.470E-04       | 1.729E-05        | 3.458E-05    | 3.993E-05       | 2.795E-06     | 5.590E-06    |
| Sei whale                     | 1.71E-04 | --              | --               | --           | 2.470E-04       | 4.224E-08        | 8.447E-08    | 3.993E-05       | 6.828E-09     | 1.366E-08    |
| Short-finned pilot whale      | 6.51E-02 | --              | --               | --           | 2.470E-04       | 1.608E-05        | 3.216E-05    | 3.993E-05       | 2.599E-06     | 5.199E-06    |
| Sperm whale                   | 1.24E-03 | --              | --               | --           | 2.470E-04       | 3.063E-07        | 6.126E-07    | 3.993E-05       | 4.951E-08     | 9.903E-08    |
| Striped dolphin               | 2.92E-02 | --              | --               | --           | 2.470E-04       | 7.212E-06        | 1.442E-05    | 3.993E-05       | 1.166E-06     | 2.332E-06    |
| Green sea turtle              | 1.71E-04 | --              | --               | --           | 2.470E-04       | 4.224E-08        | 8.447E-08    | 3.993E-05       | 6.828E-09     | 1.366E-08    |
| Kemp's Ridley sea turtle      | 1.71E-04 | --              | --               | --           | 2.470E-04       | 4.224E-08        | 8.447E-08    | 3.993E-05       | 6.828E-09     | 1.366E-08    |
| Leatherback sea turtle        | 1.88E-03 | --              | --               | --           | 2.470E-04       | 4.644E-07        | 9.287E-07    | 3.993E-05       | 7.507E-08     | 1.501E-07    |
| Loggerhead sea turtle         | 5.25E-02 | --              | --               | --           | 2.470E-04       | 1.297E-05        | 2.594E-05    | 3.993E-05       | 2.096E-06     | 4.193E-06    |
|                               |          | <b>Totals:</b>  | 0.000000         | 0.000000     |                 | 0.000133         | 2.663E-04    |                 | 0.000022      | 0.000043     |

**TABLE B-2**  
**ANIMALS AT RISK IN THE ATLANTIC OCEAN (Continued)**

**SMALL AIR**

| Marine Animals                | Stage 3         |                  |              | Payload Fairing |             |              | Total Across Species |           |
|-------------------------------|-----------------|------------------|--------------|-----------------|-------------|--------------|----------------------|-----------|
|                               | Area<br>(sq km) | One<br>Component | Total (2/yr) | Area<br>(sq km) | One Fairing | Total (6/yr) | One                  | All       |
| Atlantic spotted dolphin      | 5.622E-06       | 7.196E-09        | 1.439E-08    | 6.133E-05       | 7.850E-08   | 4.710E-07    | 4.530E-07            | 1.220E-06 |
| Atlantic white-sided dolphin  | 5.622E-06       | 6.690E-08        | 1.338E-07    | 6.133E-05       | 7.298E-07   | 4.379E-06    | 4.211E-06            | 1.134E-05 |
| Blue whale                    | 5.622E-06       | 9.614E-10        | 1.923E-09    | 6.133E-05       | 1.049E-08   | 6.292E-08    | 6.051E-08            | 1.630E-07 |
| Bottlenose dolphin            | 5.622E-06       | 2.580E-07        | 5.161E-07    | 6.133E-05       | 2.815E-06   | 1.689E-05    | 1.624E-05            | 4.375E-05 |
| Common dolphin                | 5.622E-06       | 1.001E-06        | 2.001E-06    | 6.133E-05       | 1.092E-05   | 6.550E-05    | 6.299E-05            | 1.696E-04 |
| Cuvier's beaked whale         | 5.622E-06       | 9.614E-10        | 1.923E-09    | 6.133E-05       | 1.049E-08   | 6.292E-08    | 6.051E-08            | 1.630E-07 |
| Dwarf sperm whale             | 5.622E-06       | 9.614E-10        | 1.923E-09    | 6.133E-05       | 1.049E-08   | 6.292E-08    | 6.051E-08            | 1.630E-07 |
| Fin whale                     | 5.622E-06       | 6.915E-08        | 1.383E-07    | 6.133E-05       | 7.544E-07   | 4.526E-06    | 4.353E-06            | 1.172E-05 |
| Harbor porpoise               | 5.622E-06       | 8.770E-09        | 1.754E-08    | 6.133E-05       | 9.567E-08   | 5.740E-07    | 5.521E-07            | 1.487E-06 |
| Humpback whale                | 5.622E-06       | 2.800E-09        | 5.600E-09    | 6.133E-05       | 3.054E-08   | 1.833E-07    | 1.762E-07            | 4.746E-07 |
| Long-finned pilot whale       | 5.622E-06       | 3.660E-07        | 7.320E-07    | 6.133E-05       | 3.993E-06   | 2.396E-05    | 2.304E-05            | 6.205E-05 |
| Mesoplodon spp. beaked whales | 5.622E-06       | 2.372E-09        | 4.745E-09    | 6.133E-05       | 2.588E-08   | 1.553E-07    | 1.493E-07            | 4.022E-07 |
| Minke whale                   | 5.622E-06       | 3.115E-09        | 6.229E-09    | 6.133E-05       | 3.398E-08   | 2.039E-07    | 1.961E-07            | 5.280E-07 |
| North Atlantic right whale    | 5.622E-06       | 1.557E-09        | 3.115E-09    | 6.133E-05       | 1.699E-08   | 1.019E-07    | 9.803E-08            | 2.640E-07 |
| Pygmy killer whale            | 5.622E-06       | 9.614E-10        | 1.923E-09    | 6.133E-05       | 1.049E-08   | 6.292E-08    | 6.051E-08            | 1.630E-07 |
| Pygmy sperm whale             | 5.622E-06       | 9.614E-10        | 1.923E-09    | 6.133E-05       | 1.049E-08   | 6.292E-08    | 6.051E-08            | 1.630E-07 |
| Risso's dolphin               | 5.622E-06       | 3.935E-07        | 7.871E-07    | 6.133E-05       | 4.293E-06   | 2.576E-05    | 2.477E-05            | 6.672E-05 |
| Sei whale                     | 5.622E-06       | 9.614E-10        | 1.923E-09    | 6.133E-05       | 1.049E-08   | 6.292E-08    | 6.051E-08            | 1.630E-07 |
| Short-finned pilot whale      | 5.622E-06       | 3.660E-07        | 7.320E-07    | 6.133E-05       | 3.993E-06   | 2.396E-05    | 2.304E-05            | 6.205E-05 |
| Sperm whale                   | 5.622E-06       | 6.971E-09        | 1.394E-08    | 6.133E-05       | 7.605E-08   | 4.563E-07    | 4.388E-07            | 1.182E-06 |
| Striped dolphin               | 5.622E-06       | 1.642E-07        | 3.283E-07    | 6.133E-05       | 1.791E-06   | 1.075E-05    | 1.033E-05            | 2.783E-05 |
| Green sea turtle              | 5.622E-06       | 9.614E-10        | 1.923E-09    | 6.133E-05       | 1.049E-08   | 6.292E-08    | 6.051E-08            | 1.630E-07 |
| Kemp's Ridley sea turtle      | 5.622E-06       | 9.614E-10        | 1.923E-09    | 6.133E-05       | 1.049E-08   | 6.292E-08    | 6.051E-08            | 1.630E-07 |
| Leatherback sea turtle        | 5.622E-06       | 1.057E-08        | 2.114E-08    | 6.133E-05       | 1.153E-07   | 6.918E-07    | 6.653E-07            | 1.792E-06 |
| Loggerhead sea turtle         | 5.622E-06       | 2.952E-07        | 5.903E-07    | 6.133E-05       | 3.220E-06   | 1.932E-05    | 1.858E-05            | 5.004E-05 |
|                               | <b>Totals:</b>  | 0.000003         | 0.000006     |                 | 0.000033    | 0.000198     | 0.000191             | 0.000514  |

## MEDIUM/INTERMEDIATE

**TABLE B-2**  
**ANIMALS AT RISK IN THE ATLANTIC OCEAN (Continued)**

| Marine Animals                | Density  | Stage 0         |                  |                | Stage 1         |                  |                  | Stage 2         |                  |               |
|-------------------------------|----------|-----------------|------------------|----------------|-----------------|------------------|------------------|-----------------|------------------|---------------|
|                               |          | Area<br>(sq km) | One<br>Component | Total (135/yr) | Area<br>(sq km) | One<br>Component | Total<br>(15/yr) | Area<br>(sq km) | One<br>Component | Total (15/yr) |
| Atlantic spotted dolphin      | 1.28E-03 | 5.269E-04       | 6.744E-07        | 9.105E-05      | 2.138E-03       | 2.736E-06        | 4.104E-05        | 1.121E-04       | 1.435E-07        | 2.152E-06     |
| Atlantic white-sided dolphin  | 1.19E-02 | 5.269E-04       | 6.270E-06        | 8.465E-04      | 2.138E-03       | 2.544E-05        | 3.815E-04        | 1.121E-04       | 1.334E-06        | 2.001E-05     |
| Blue whale                    | 1.71E-04 | 5.269E-04       | 9.010E-08        | 1.216E-05      | 2.138E-03       | 3.655E-07        | 5.483E-06        | 1.121E-04       | 1.917E-08        | 2.875E-07     |
| Bottlenose dolphin            | 4.59E-02 | 5.269E-04       | 2.418E-05        | 3.265E-03      | 2.138E-03       | 9.811E-05        | 1.472E-03        | 1.121E-04       | 5.145E-06        | 7.718E-05     |
| Common dolphin                | 1.78E-01 | 5.269E-04       | 9.379E-05        | 1.266E-02      | 2.138E-03       | 3.805E-04        | 5.707E-03        | 1.121E-04       | 1.995E-05        | 2.993E-04     |
| Cuvier's beaked whale         | 1.71E-04 | 5.269E-04       | 9.010E-08        | 1.216E-05      | 2.138E-03       | 3.655E-07        | 5.483E-06        | 1.121E-04       | 1.917E-08        | 2.875E-07     |
| Dwarf sperm whale             | 1.71E-04 | 5.269E-04       | 9.010E-08        | 1.216E-05      | 2.138E-03       | 3.655E-07        | 5.483E-06        | 1.121E-04       | 1.917E-08        | 2.875E-07     |
| Fin whale                     | 1.23E-02 | 5.269E-04       | 6.481E-06        | 8.749E-04      | 2.138E-03       | 2.629E-05        | 3.944E-04        | 1.121E-04       | 1.379E-06        | 2.068E-05     |
| Harbor porpoise               | 1.56E-03 | 5.269E-04       | 8.220E-07        | 1.110E-04      | 2.138E-03       | 3.335E-06        | 5.002E-05        | 1.121E-04       | 1.749E-07        | 2.623E-06     |
| Humpback whale                | 4.98E-04 | 5.269E-04       | 2.624E-07        | 3.542E-05      | 2.138E-03       | 1.064E-06        | 1.597E-05        | 1.121E-04       | 5.583E-08        | 8.374E-07     |
| Long-finned pilot whale       | 6.51E-02 | 5.269E-04       | 3.430E-05        | 4.631E-03      | 2.138E-03       | 1.392E-04        | 2.087E-03        | 1.121E-04       | 7.298E-06        | 1.095E-04     |
| Mesoplodon spp. beaked whales | 4.22E-04 | 5.269E-04       | 2.224E-07        | 3.002E-05      | 2.138E-03       | 9.020E-07        | 1.353E-05        | 1.121E-04       | 4.731E-08        | 7.096E-07     |
| Minke whale                   | 5.54E-04 | 5.269E-04       | 2.919E-07        | 3.941E-05      | 2.138E-03       | 1.184E-06        | 1.776E-05        | 1.121E-04       | 6.210E-08        | 9.316E-07     |
| North Atlantic right whale    | 2.77E-04 | 5.269E-04       | 1.460E-07        | 1.970E-05      | 2.138E-03       | 5.921E-07        | 8.881E-06        | 1.121E-04       | 3.105E-08        | 4.658E-07     |
| Pygmy killer whale            | 1.71E-04 | 5.269E-04       | 9.010E-08        | 1.216E-05      | 2.138E-03       | 3.655E-07        | 5.483E-06        | 1.121E-04       | 1.917E-08        | 2.875E-07     |
| Pygmy sperm whale             | 1.71E-04 | 5.269E-04       | 9.010E-08        | 1.216E-05      | 2.138E-03       | 3.655E-07        | 5.483E-06        | 1.121E-04       | 1.917E-08        | 2.875E-07     |
| Risso's dolphin               | 7.00E-02 | 5.269E-04       | 3.688E-05        | 4.979E-03      | 2.138E-03       | 1.496E-04        | 2.244E-03        | 1.121E-04       | 7.847E-06        | 1.177E-04     |
| Sei whale                     | 1.71E-04 | 5.269E-04       | 9.010E-08        | 1.216E-05      | 2.138E-03       | 3.655E-07        | 5.483E-06        | 1.121E-04       | 1.917E-08        | 2.875E-07     |
| Short-finned pilot whale      | 6.51E-02 | 5.269E-04       | 3.430E-05        | 4.631E-03      | 2.138E-03       | 1.392E-04        | 2.087E-03        | 1.121E-04       | 7.298E-06        | 1.095E-04     |
| Sperm whale                   | 1.24E-03 | 5.269E-04       | 6.534E-07        | 8.820E-05      | 2.138E-03       | 2.651E-06        | 3.976E-05        | 1.121E-04       | 1.390E-07        | 2.085E-06     |
| Striped dolphin               | 2.92E-02 | 5.269E-04       | 1.539E-05        | 2.077E-03      | 2.138E-03       | 6.242E-05        | 9.362E-04        | 1.121E-04       | 3.273E-06        | 4.910E-05     |
| Green sea turtle              | 1.71E-04 | 5.269E-04       | 9.010E-08        | 1.216E-05      | 2.138E-03       | 3.655E-07        | 5.483E-06        | 1.121E-04       | 1.917E-08        | 2.875E-07     |
| Kemp's Ridley sea turtle      | 1.71E-04 | 5.269E-04       | 9.010E-08        | 1.216E-05      | 2.138E-03       | 3.655E-07        | 5.483E-06        | 1.121E-04       | 1.917E-08        | 2.875E-07     |
| Leatherback sea turtle        | 1.88E-03 | 5.269E-04       | 9.906E-07        | 1.337E-04      | 2.138E-03       | 4.019E-06        | 6.028E-05        | 1.121E-04       | 2.107E-07        | 3.161E-06     |
| Loggerhead sea turtle         | 5.25E-02 | 5.269E-04       | 2.766E-05        | 3.734E-03      | 2.138E-03       | 1.122E-04        | 1.683E-03        | 1.121E-04       | 5.885E-06        | 8.828E-05     |
|                               |          | <b>Totals:</b>  | 0.000284         | 0.038345       |                 | 0.001152         | 0.017284         |                 | 0.000060         | 0.000906      |

**TABLE B-2**  
**ANIMALS AT RISK IN THE ATLANTIC OCEAN (Continued)**

**MEDIUM/INTERMEDIATE**

| Marine Animals                | Stage 3         |                  |               | Payload Fairing |             |               | Total Across Species |           |
|-------------------------------|-----------------|------------------|---------------|-----------------|-------------|---------------|----------------------|-----------|
|                               | Area<br>(sq km) | One<br>Component | Total (15/yr) | Area<br>(sq km) | One Fairing | Total (45/yr) | One                  | All       |
| Atlantic spotted dolphin      | 1.136E-05       | 1.677E-08        | 2.515E-07     | 1.972E-04       | 2.524E-07   | 1.136E-05     | 3.823E-06            | 1.459E-04 |
| Atlantic white-sided dolphin  | 1.056E-04       | 1.559E-07        | 2.338E-06     | 1.972E-04       | 2.347E-06   | 1.056E-04     | 3.554E-05            | 1.356E-03 |
| Blue whale                    | 1.517E-06       | 2.240E-09        | 3.360E-08     | 1.972E-04       | 3.372E-08   | 1.517E-06     | 5.107E-07            | 1.948E-05 |
| Bottlenose dolphin            | 4.073E-04       | 6.013E-07        | 9.019E-06     | 1.972E-04       | 9.051E-06   | 4.073E-04     | 1.371E-04            | 5.230E-03 |
| Common dolphin                | 1.580E-03       | 2.332E-06        | 3.498E-05     | 1.972E-04       | 3.510E-05   | 1.580E-03     | 5.317E-04            | 2.028E-02 |
| Cuvier's beaked whale         | 1.517E-06       | 2.240E-09        | 3.360E-08     | 1.972E-04       | 3.372E-08   | 1.517E-06     | 5.107E-07            | 1.948E-05 |
| Dwarf sperm whale             | 1.517E-06       | 2.240E-09        | 3.360E-08     | 1.972E-04       | 3.372E-08   | 1.517E-06     | 5.107E-07            | 1.948E-05 |
| Fin whale                     | 1.092E-04       | 1.611E-07        | 2.417E-06     | 1.972E-04       | 2.426E-06   | 1.092E-04     | 3.674E-05            | 1.402E-03 |
| Harbor porpoise               | 1.384E-05       | 2.044E-08        | 3.065E-07     | 1.972E-04       | 3.076E-07   | 1.384E-05     | 4.659E-06            | 1.778E-04 |
| Humpback whale                | 4.419E-06       | 6.524E-09        | 9.786E-08     | 1.972E-04       | 9.821E-08   | 4.419E-06     | 1.487E-06            | 5.675E-05 |
| Long-finned pilot whale       | 5.777E-04       | 8.528E-07        | 1.279E-05     | 1.972E-04       | 1.284E-05   | 5.777E-04     | 1.944E-04            | 7.418E-03 |
| Mesoplodon spp. beaked whales | 3.745E-06       | 5.528E-09        | 8.292E-08     | 1.972E-04       | 8.322E-08   | 3.745E-06     | 1.260E-06            | 4.809E-05 |
| Minke whale                   | 4.916E-06       | 7.257E-09        | 1.089E-07     | 1.972E-04       | 1.092E-07   | 4.916E-06     | 1.655E-06            | 6.313E-05 |
| North Atlantic right whale    | 2.458E-06       | 3.629E-09        | 5.443E-08     | 1.972E-04       | 5.462E-08   | 2.458E-06     | 8.273E-07            | 3.156E-05 |
| Pygmy killer whale            | 1.517E-06       | 2.240E-09        | 3.360E-08     | 1.972E-04       | 3.372E-08   | 1.517E-06     | 5.107E-07            | 1.948E-05 |
| Pygmy sperm whale             | 1.517E-06       | 2.240E-09        | 3.360E-08     | 1.972E-04       | 3.372E-08   | 1.517E-06     | 5.107E-07            | 1.948E-05 |
| Risso's dolphin               | 6.212E-04       | 9.170E-07        | 1.376E-05     | 1.972E-04       | 1.380E-05   | 6.212E-04     | 2.091E-04            | 7.976E-03 |
| Sei whale                     | 1.517E-06       | 2.240E-09        | 3.360E-08     | 1.972E-04       | 3.372E-08   | 1.517E-06     | 5.107E-07            | 1.948E-05 |
| Short-finned pilot whale      | 5.777E-04       | 8.528E-07        | 1.279E-05     | 1.972E-04       | 1.284E-05   | 5.777E-04     | 1.944E-04            | 7.418E-03 |
| Sperm whale                   | 1.100E-05       | 1.624E-08        | 2.437E-07     | 1.972E-04       | 2.445E-07   | 1.100E-05     | 3.704E-06            | 1.413E-04 |
| Striped dolphin               | 2.591E-04       | 3.825E-07        | 5.738E-06     | 1.972E-04       | 5.758E-06   | 2.591E-04     | 8.721E-05            | 3.327E-03 |
| Green sea turtle              | 1.517E-06       | 2.240E-09        | 3.360E-08     | 1.972E-04       | 3.372E-08   | 1.517E-06     | 5.107E-07            | 1.948E-05 |
| Kemp's Ridley sea turtle      | 1.517E-06       | 2.240E-09        | 3.360E-08     | 1.972E-04       | 3.372E-08   | 1.517E-06     | 5.107E-07            | 1.948E-05 |
| Leatherback sea turtle        | 1.668E-05       | 2.463E-08        | 3.694E-07     | 1.972E-04       | 3.707E-07   | 1.668E-05     | 5.615E-06            | 2.142E-04 |
| Loggerhead sea turtle         | 4.659E-04       | 6.878E-07        | 1.032E-05     | 1.972E-04       | 1.035E-05   | 4.659E-04     | 1.568E-04            | 5.982E-03 |
|                               | <b>Totals:</b>  | 0.000007         | 0.000106      |                 | 0.000106    | 0.004784      | 0.001610             | 0.061426  |

**TABLE B-2**  
**ANIMALS AT RISK IN THE ATLANTIC OCEAN (Continued)**

**HIGH**

| Marine Animals                | Density  | Stage 0         |                  |              | Stage 1         |               |              | Stage 2         |                  |              |
|-------------------------------|----------|-----------------|------------------|--------------|-----------------|---------------|--------------|-----------------|------------------|--------------|
|                               |          | Area<br>(sq km) | One<br>Component | Total (6/yr) | Area<br>(sq km) | One Component | Total (3/yr) | Area<br>(sq km) | One<br>Component | Total (3/yr) |
| Atlantic spotted dolphin      | 1.28E-03 | 2.384E-03       | 3.051E-06        | 1.831E-05    | 1.802E-03       | 2.307E-06     | 6.920E-06    | 3.119E-04       | 3.992E-07        | 1.198E-06    |
| Atlantic white-sided dolphin  | 1.19E-02 | 2.384E-03       | 2.837E-05        | 1.702E-04    | 1.802E-03       | 2.145E-05     | 6.434E-05    | 3.119E-04       | 3.712E-06        | 1.113E-05    |
| Blue whale                    | 1.71E-04 | 2.384E-03       | 4.076E-07        | 2.446E-06    | 1.802E-03       | 3.082E-07     | 9.245E-07    | 3.119E-04       | 5.333E-08        | 1.600E-07    |
| Bottlenose dolphin            | 4.59E-02 | 2.384E-03       | 1.094E-04        | 6.565E-04    | 1.802E-03       | 8.272E-05     | 2.482E-04    | 3.119E-04       | 1.432E-05        | 4.295E-05    |
| Common dolphin                | 1.78E-01 | 2.384E-03       | 4.243E-04        | 2.546E-03    | 1.802E-03       | 3.208E-04     | 9.624E-04    | 3.119E-04       | 5.552E-05        | 1.666E-04    |
| Cuvier's beaked whale         | 1.71E-04 | 2.384E-03       | 4.076E-07        | 2.446E-06    | 1.802E-03       | 3.082E-07     | 9.245E-07    | 3.119E-04       | 5.333E-08        | 1.600E-07    |
| Dwarf sperm whale             | 1.71E-04 | 2.384E-03       | 4.076E-07        | 2.446E-06    | 1.802E-03       | 3.082E-07     | 9.245E-07    | 3.119E-04       | 5.333E-08        | 1.600E-07    |
| Fin whale                     | 1.23E-02 | 2.384E-03       | 2.932E-05        | 1.759E-04    | 1.802E-03       | 2.217E-05     | 6.650E-05    | 3.119E-04       | 3.836E-06        | 1.151E-05    |
| Harbor porpoise               | 1.56E-03 | 2.384E-03       | 3.719E-06        | 2.231E-05    | 1.802E-03       | 2.811E-06     | 8.434E-06    | 3.119E-04       | 4.866E-07        | 1.460E-06    |
| Humpback whale                | 4.98E-04 | 2.384E-03       | 1.187E-06        | 7.123E-06    | 1.802E-03       | 8.975E-07     | 2.692E-06    | 3.119E-04       | 1.553E-07        | 4.660E-07    |
| Long-finned pilot whale       | 6.51E-02 | 2.384E-03       | 1.552E-04        | 9.312E-04    | 1.802E-03       | 1.173E-04     | 3.520E-04    | 3.119E-04       | 2.030E-05        | 6.091E-05    |
| Mesoplodon spp. beaked whales | 4.22E-04 | 2.384E-03       | 1.006E-06        | 6.036E-06    | 1.802E-03       | 7.605E-07     | 2.282E-06    | 3.119E-04       | 1.316E-07        | 3.949E-07    |
| Minke whale                   | 5.54E-04 | 2.384E-03       | 1.321E-06        | 7.924E-06    | 1.802E-03       | 9.984E-07     | 2.995E-06    | 3.119E-04       | 1.728E-07        | 5.184E-07    |
| North Atlantic right whale    | 2.77E-04 | 2.384E-03       | 6.603E-07        | 3.962E-06    | 1.802E-03       | 4.992E-07     | 1.498E-06    | 3.119E-04       | 8.640E-08        | 2.592E-07    |
| Pygmy killer whale            | 1.71E-04 | 2.384E-03       | 4.076E-07        | 2.446E-06    | 1.802E-03       | 3.082E-07     | 9.245E-07    | 3.119E-04       | 5.333E-08        | 1.600E-07    |
| Pygmy sperm whale             | 1.71E-04 | 2.384E-03       | 4.076E-07        | 2.446E-06    | 1.802E-03       | 3.082E-07     | 9.245E-07    | 3.119E-04       | 5.333E-08        | 1.600E-07    |
| Risso's dolphin               | 7.00E-02 | 2.384E-03       | 1.669E-04        | 1.001E-03    | 1.802E-03       | 1.262E-04     | 3.785E-04    | 3.119E-04       | 2.183E-05        | 6.550E-05    |
| Sei whale                     | 1.71E-04 | 2.384E-03       | 4.076E-07        | 2.446E-06    | 1.802E-03       | 3.082E-07     | 9.245E-07    | 3.119E-04       | 5.333E-08        | 1.600E-07    |
| Short-finned pilot whale      | 6.51E-02 | 2.384E-03       | 1.552E-04        | 9.312E-04    | 1.802E-03       | 1.173E-04     | 3.520E-04    | 3.119E-04       | 2.030E-05        | 6.091E-05    |
| Sperm whale                   | 1.24E-03 | 2.384E-03       | 2.956E-06        | 1.774E-05    | 1.802E-03       | 2.235E-06     | 6.704E-06    | 3.119E-04       | 3.868E-07        | 1.160E-06    |
| Striped dolphin               | 2.92E-02 | 2.384E-03       | 6.961E-05        | 4.177E-04    | 1.802E-03       | 5.262E-05     | 1.579E-04    | 3.119E-04       | 9.107E-06        | 2.732E-05    |
| Green sea turtle              | 1.71E-04 | 2.384E-03       | 4.076E-07        | 2.446E-06    | 1.802E-03       | 3.082E-07     | 9.245E-07    | 3.119E-04       | 5.333E-08        | 1.600E-07    |
| Kemp's Ridley sea turtle      | 1.71E-04 | 2.384E-03       | 4.076E-07        | 2.446E-06    | 1.802E-03       | 3.082E-07     | 9.245E-07    | 3.119E-04       | 5.333E-08        | 1.600E-07    |
| Leatherback sea turtle        | 1.88E-03 | 2.384E-03       | 4.482E-06        | 2.689E-05    | 1.802E-03       | 3.388E-06     | 1.016E-05    | 3.119E-04       | 5.864E-07        | 1.759E-06    |
| Loggerhead sea turtle         | 5.25E-02 | 2.384E-03       | 1.252E-04        | 7.509E-04    | 1.802E-03       | 9.462E-05     | 2.838E-04    | 3.119E-04       | 1.637E-05        | 4.912E-05    |
|                               |          | <b>Totals:</b>  | 0.001285         | 0.007711     |                 | 0.000972      | 0.002915     |                 | 0.000168         | 0.000504     |

**TABLE B-2**  
**ANIMALS AT RISK IN THE ATLANTIC OCEAN (Continued)**

**HIGH**

| Marine Animals                | Stage 3         |                  |              | Payload Fairing |             |               | Total Across Species |           |
|-------------------------------|-----------------|------------------|--------------|-----------------|-------------|---------------|----------------------|-----------|
|                               | Area<br>(sq km) | One<br>Component | Total (3/yr) | Area<br>(sq km) | One Fairing | Total (12/yr) | One                  | All       |
| Atlantic spotted dolphin      | 3.530E-05       | 4.518E-08        | 1.356E-07    | 5.294E-04       | 6.776E-07   | 8.132E-06     | 6.480E-06            | 3.469E-05 |
| Atlantic white-sided dolphin  | 3.530E-05       | 4.201E-07        | 1.260E-06    | 5.294E-04       | 6.300E-06   | 7.560E-05     | 6.025E-05            | 3.225E-04 |
| Blue whale                    | 3.530E-05       | 6.036E-09        | 1.811E-08    | 5.294E-04       | 9.053E-08   | 1.086E-06     | 8.657E-07            | 4.635E-06 |
| Bottlenose dolphin            | 3.530E-05       | 1.620E-06        | 4.861E-06    | 5.294E-04       | 2.430E-05   | 2.916E-04     | 2.324E-04            | 1.244E-03 |
| Common dolphin                | 3.530E-05       | 6.283E-06        | 1.885E-05    | 5.294E-04       | 9.423E-05   | 1.131E-03     | 9.012E-04            | 4.825E-03 |
| Cuvier's beaked whale         | 3.530E-05       | 6.036E-09        | 1.811E-08    | 5.294E-04       | 9.053E-08   | 1.086E-06     | 8.657E-07            | 4.635E-06 |
| Dwarf sperm whale             | 3.530E-05       | 6.036E-09        | 1.811E-08    | 5.294E-04       | 9.053E-08   | 1.086E-06     | 8.657E-07            | 4.635E-06 |
| Fin whale                     | 3.530E-05       | 4.342E-07        | 1.303E-06    | 5.294E-04       | 6.512E-06   | 7.814E-05     | 6.227E-05            | 3.334E-04 |
| Harbor porpoise               | 3.530E-05       | 5.507E-08        | 1.652E-07    | 5.294E-04       | 8.259E-07   | 9.910E-06     | 7.898E-06            | 4.228E-05 |
| Humpback whale                | 3.530E-05       | 1.758E-08        | 5.274E-08    | 5.294E-04       | 2.636E-07   | 3.164E-06     | 2.521E-06            | 1.350E-05 |
| Long-finned pilot whale       | 3.530E-05       | 2.298E-06        | 6.894E-06    | 5.294E-04       | 3.446E-05   | 4.136E-04     | 3.296E-04            | 1.764E-03 |
| Mesoplodon spp. beaked whales | 3.530E-05       | 1.490E-08        | 4.469E-08    | 5.294E-04       | 2.234E-07   | 2.681E-06     | 2.136E-06            | 1.144E-05 |
| Minke whale                   | 3.530E-05       | 1.956E-08        | 5.867E-08    | 5.294E-04       | 2.933E-07   | 3.519E-06     | 2.805E-06            | 1.502E-05 |
| North Atlantic right whale    | 3.530E-05       | 9.778E-09        | 2.933E-08    | 5.294E-04       | 1.466E-07   | 1.760E-06     | 1.402E-06            | 7.508E-06 |
| Pygmy killer whale            | 3.530E-05       | 6.036E-09        | 1.811E-08    | 5.294E-04       | 9.053E-08   | 1.086E-06     | 8.657E-07            | 4.635E-06 |
| Pygmy sperm whale             | 3.530E-05       | 6.036E-09        | 1.811E-08    | 5.294E-04       | 9.053E-08   | 1.086E-06     | 8.657E-07            | 4.635E-06 |
| Risso's dolphin               | 3.530E-05       | 2.471E-06        | 7.413E-06    | 5.294E-04       | 3.706E-05   | 4.447E-04     | 3.544E-04            | 1.897E-03 |
| Sei whale                     | 3.530E-05       | 6.036E-09        | 1.811E-08    | 5.294E-04       | 9.053E-08   | 1.086E-06     | 8.657E-07            | 4.635E-06 |
| Short-finned pilot whale      | 3.530E-05       | 2.298E-06        | 6.894E-06    | 5.294E-04       | 3.446E-05   | 4.136E-04     | 3.296E-04            | 1.764E-03 |
| Sperm whale                   | 3.530E-05       | 4.377E-08        | 1.313E-07    | 5.294E-04       | 6.565E-07   | 7.877E-06     | 6.278E-06            | 3.361E-05 |
| Striped dolphin               | 3.530E-05       | 1.031E-06        | 3.092E-06    | 5.294E-04       | 1.546E-05   | 1.855E-04     | 1.478E-04            | 7.914E-04 |
| Green sea turtle              | 3.530E-05       | 6.036E-09        | 1.811E-08    | 5.294E-04       | 9.053E-08   | 1.086E-06     | 8.657E-07            | 4.635E-06 |
| Kemp's Ridley sea turtle      | 3.530E-05       | 6.036E-09        | 1.811E-08    | 5.294E-04       | 9.053E-08   | 1.086E-06     | 8.657E-07            | 4.635E-06 |
| Leatherback sea turtle        | 3.530E-05       | 6.636E-08        | 1.991E-07    | 5.294E-04       | 9.953E-07   | 1.194E-05     | 9.518E-06            | 5.096E-05 |
| Loggerhead sea turtle         | 3.530E-05       | 1.853E-06        | 5.560E-06    | 5.294E-04       | 2.779E-05   | 3.335E-04     | 2.658E-04            | 1.423E-03 |
|                               | <b>Totals:</b>  | 0.000019         | 0.000057     |                 | 0.000285    | 0.003425      | 0.002729             | 0.014611  |

**TABLE B-3**  
**ANIMALS AT RISK IN THE PACIFIC OCEAN**

**SMALL LAND**

| Marine Animals              | Density  | Stage 0         |                  |              | Stage 1         |               |              | Stage 2         |                  |                 |
|-----------------------------|----------|-----------------|------------------|--------------|-----------------|---------------|--------------|-----------------|------------------|-----------------|
|                             |          | Area<br>(sq km) | One<br>Component | Total (3/yr) | Area<br>(sq km) | One Component | Total (3/yr) | Area<br>(sq km) | One<br>Component | Total<br>(3/yr) |
| Beaked whales               | 1.50E-03 | 2.554E-04       | 3.831E-07        | 1.149E-06    | 2.470E-04       | 3.705E-07     | 1.112E-06    | 2.321E-05       | 3.482E-08        | 1.044E-07       |
| Blue whale                  | 1.00E-04 | 2.554E-04       | 2.554E-08        | 7.662E-08    | 2.470E-04       | 2.470E-08     | 7.410E-08    | 2.321E-05       | 2.321E-09        | 6.963E-09       |
| Bottlenose dolphin          | 1.23E-02 | 2.554E-04       | 3.141E-06        | 9.424E-06    | 2.470E-04       | 3.038E-06     | 9.114E-06    | 2.321E-05       | 2.855E-07        | 8.564E-07       |
| Common dolphin              | 1.16E+00 | 2.554E-04       | 2.954E-04        | 8.863E-04    | 2.470E-04       | 2.857E-04     | 8.572E-04    | 2.321E-05       | 2.685E-05        | 8.055E-05       |
| Dall's porpoise             | 3.20E-02 | 2.554E-04       | 8.173E-06        | 2.452E-05    | 2.470E-04       | 7.904E-06     | 2.371E-05    | 2.321E-05       | 7.427E-07        | 2.228E-06       |
| Fin whale                   | 2.00E-04 | 2.554E-04       | 5.108E-08        | 1.532E-07    | 2.470E-04       | 4.940E-08     | 1.482E-07    | 2.321E-05       | 4.642E-09        | 1.393E-08       |
| Gray whale                  | 1.08E-02 | 2.554E-04       | 2.758E-06        | 8.275E-06    | 2.470E-04       | 2.668E-06     | 8.003E-06    | 2.321E-05       | 2.507E-07        | 7.520E-07       |
| Harbor porpoise             | 6.00E-03 | 2.554E-04       | 1.532E-06        | 4.597E-06    | 2.470E-04       | 1.482E-06     | 4.446E-06    | 2.321E-05       | 1.393E-07        | 4.178E-07       |
| Humpback whale              | 1.20E-03 | 2.554E-04       | 3.065E-07        | 9.194E-07    | 2.470E-04       | 2.964E-07     | 8.892E-07    | 2.321E-05       | 2.785E-08        | 8.356E-08       |
| Killer whale                | 2.00E-04 | 2.554E-04       | 5.108E-08        | 1.532E-07    | 2.470E-04       | 4.940E-08     | 1.482E-07    | 2.321E-05       | 4.642E-09        | 1.393E-08       |
| Minke whale                 | 3.00E-04 | 2.554E-04       | 7.662E-08        | 2.299E-07    | 2.470E-04       | 7.410E-08     | 2.223E-07    | 2.321E-05       | 6.963E-09        | 2.089E-08       |
| North right whale           | 1.00E-04 | 2.554E-04       | 2.554E-08        | 7.662E-08    | 2.470E-04       | 2.470E-08     | 7.410E-08    | 2.321E-05       | 2.321E-09        | 6.963E-09       |
| North right whale dolphin   | 8.07E-02 | 2.554E-04       | 2.061E-05        | 6.183E-05    | 2.470E-04       | 1.993E-05     | 5.980E-05    | 2.321E-05       | 1.873E-06        | 5.619E-06       |
| Pacific white-sided dolphin | 4.61E-01 | 2.554E-04       | 1.176E-04        | 3.528E-04    | 2.470E-04       | 1.137E-04     | 3.412E-04    | 2.321E-05       | 1.069E-05        | 3.206E-05       |
| Risso's dolphin             | 1.23E-01 | 2.554E-04       | 3.129E-05        | 9.386E-05    | 2.470E-04       | 3.026E-05     | 9.077E-05    | 2.321E-05       | 2.843E-06        | 8.530E-06       |
| Sperm whale                 | 3.40E-03 | 2.554E-04       | 8.684E-07        | 2.605E-06    | 2.470E-04       | 8.398E-07     | 2.519E-06    | 2.321E-05       | 7.891E-08        | 2.367E-07       |
|                             |          | <b>Totals:</b>  | 0.000482         | 0.001447     |                 | 0.000466      | 0.001399     |                 | 0.000044         | 0.000132        |

**TABLE B-3**  
**ANIMALS AT RISK IN THE PACIFIC OCEAN**  
**SMALL LAND**

| Marine Animals              | Stage 3         |                  |              | Payload Fairing |             |              | Total Across Species |           |
|-----------------------------|-----------------|------------------|--------------|-----------------|-------------|--------------|----------------------|-----------|
|                             | Area<br>(sq km) | One<br>Component | Total (3/yr) | Area<br>(sq km) | One Fairing | Total (9/yr) | One                  | All       |
| Beaked whales               | 5.622E-06       | 8.433E-09        | 2.530E-08    | 9.312E-06       | 1.397E-08   | 1.257E-07    | 8.108E-07            | 2.516E-06 |
| Blue whale                  | 5.622E-06       | 5.622E-10        | 1.687E-09    | 9.312E-06       | 9.312E-10   | 8.381E-09    | 5.405E-08            | 1.678E-07 |
| Bottlenose dolphin          | 5.622E-06       | 6.915E-08        | 2.075E-07    | 9.312E-06       | 1.145E-07   | 1.031E-06    | 6.649E-06            | 2.063E-05 |
| Common dolphin              | 5.622E-06       | 6.504E-06        | 1.951E-05    | 9.312E-06       | 1.077E-05   | 9.695E-05    | 6.253E-04            | 1.941E-03 |
| Dall's porpoise             | 5.622E-06       | 1.799E-07        | 5.397E-07    | 9.312E-06       | 2.980E-07   | 2.682E-06    | 1.730E-05            | 5.368E-05 |
| Fin whale                   | 5.622E-06       | 1.124E-09        | 3.373E-09    | 9.312E-06       | 1.862E-09   | 1.676E-08    | 1.081E-07            | 3.355E-07 |
| Gray whale                  | 5.622E-06       | 6.072E-08        | 1.822E-07    | 9.312E-06       | 1.006E-07   | 9.051E-07    | 5.838E-06            | 1.812E-05 |
| Harbor porpoise             | 5.622E-06       | 3.373E-08        | 1.012E-07    | 9.312E-06       | 5.587E-08   | 5.028E-07    | 3.243E-06            | 1.007E-05 |
| Humpback whale              | 5.622E-06       | 6.746E-09        | 2.024E-08    | 9.312E-06       | 1.117E-08   | 1.006E-07    | 6.487E-07            | 2.013E-06 |
| Killer whale                | 5.622E-06       | 1.124E-09        | 3.373E-09    | 9.312E-06       | 1.862E-09   | 1.676E-08    | 1.081E-07            | 3.355E-07 |
| Minke whale                 | 5.622E-06       | 1.687E-09        | 5.060E-09    | 9.312E-06       | 2.794E-09   | 2.514E-08    | 1.622E-07            | 5.033E-07 |
| North right whale           | 5.622E-06       | 5.622E-10        | 1.687E-09    | 9.312E-06       | 9.312E-10   | 8.381E-09    | 5.405E-08            | 1.678E-07 |
| North right whale dolphin   | 5.622E-06       | 4.537E-07        | 1.361E-06    | 9.312E-06       | 7.515E-07   | 6.763E-06    | 4.362E-05            | 1.354E-04 |
| Pacific white-sided dolphin | 5.622E-06       | 2.589E-06        | 7.767E-06    | 9.312E-06       | 4.288E-06   | 3.859E-05    | 2.489E-04            | 7.725E-04 |
| Risso's dolphin             | 5.622E-06       | 6.887E-07        | 2.066E-06    | 9.312E-06       | 1.141E-06   | 1.027E-05    | 6.622E-05            | 2.055E-04 |
| Sperm whale                 | 5.622E-06       | 1.911E-08        | 5.734E-08    | 9.312E-06       | 3.166E-08   | 2.849E-07    | 1.838E-06            | 5.704E-06 |
|                             | <b>Totals:</b>  | 0.000011         | 0.000032     |                 | 0.000018    | 0.000158     | 0.001021             | 0.003168  |

**SMALL AIR**

**TABLE B-3**  
**ANIMALS AT RISK IN THE PACIFIC OCEAN (Continued)**

| Marine Animals              | Density  | Stage 0         |                  |              | Stage 1         |                  |              | Stage 2         |                  |              |
|-----------------------------|----------|-----------------|------------------|--------------|-----------------|------------------|--------------|-----------------|------------------|--------------|
|                             |          | Area<br>(sq km) | One<br>Component | Total (0/yr) | Area<br>(sq km) | One<br>Component | Total (3/yr) | Area<br>(sq km) | One<br>Component | Total (3/yr) |
| Beaked whales               | 1.50E-03 | --              | --               | --           | 2.470E-04       | 3.705E-07        | 1.112E-06    | 3.993E-05       | 5.990E-08        | 1.797E-07    |
| Blue whale                  | 1.00E-04 | --              | --               | --           | 2.470E-04       | 2.470E-08        | 7.410E-08    | 3.993E-05       | 3.993E-09        | 1.198E-08    |
| Bottlenose dolphin          | 1.23E-02 | --              | --               | --           | 2.470E-04       | 3.038E-06        | 9.114E-06    | 3.993E-05       | 4.911E-07        | 1.473E-06    |
| Common dolphin              | 1.16E+00 | --              | --               | --           | 2.470E-04       | 2.857E-04        | 8.572E-04    | 3.993E-05       | 4.619E-05        | 1.386E-04    |
| Dall's porpoise             | 3.20E-02 | --              | --               | --           | 2.470E-04       | 7.904E-06        | 2.371E-05    | 3.993E-05       | 1.278E-06        | 3.833E-06    |
| Fin whale                   | 2.00E-04 | --              | --               | --           | 2.470E-04       | 4.940E-08        | 1.482E-07    | 3.993E-05       | 7.986E-09        | 2.396E-08    |
| Gray whale                  | 1.08E-02 | --              | --               | --           | 2.470E-04       | 2.668E-06        | 8.003E-06    | 3.993E-05       | 4.312E-07        | 1.294E-06    |
| Harbor porpoise             | 6.00E-03 | --              | --               | --           | 2.470E-04       | 1.482E-06        | 4.446E-06    | 3.993E-05       | 2.396E-07        | 7.187E-07    |
| Humpback whale              | 1.20E-03 | --              | --               | --           | 2.470E-04       | 2.964E-07        | 8.892E-07    | 3.993E-05       | 4.792E-08        | 1.437E-07    |
| Killer whale                | 2.00E-04 | --              | --               | --           | 2.470E-04       | 4.940E-08        | 1.482E-07    | 3.993E-05       | 7.986E-09        | 2.396E-08    |
| Minke whale                 | 3.00E-04 | --              | --               | --           | 2.470E-04       | 7.410E-08        | 2.223E-07    | 3.993E-05       | 1.198E-08        | 3.594E-08    |
| North right whale           | 1.00E-04 | --              | --               | --           | 2.470E-04       | 2.470E-08        | 7.410E-08    | 3.993E-05       | 3.993E-09        | 1.198E-08    |
| North right whale dolphin   | 8.07E-02 | --              | --               | --           | 2.470E-04       | 1.993E-05        | 5.980E-05    | 3.993E-05       | 3.222E-06        | 9.667E-06    |
| Pacific white-sided dolphin | 4.61E-01 | --              | --               | --           | 2.470E-04       | 1.137E-04        | 3.412E-04    | 3.993E-05       | 1.839E-05        | 5.516E-05    |
| Risso's dolphin             | 1.23E-01 | --              | --               | --           | 2.470E-04       | 3.026E-05        | 9.077E-05    | 3.993E-05       | 4.891E-06        | 1.467E-05    |
| Sperm whale                 | 3.40E-03 | --              | --               | --           | 2.470E-04       | 8.398E-07        | 2.519E-06    | 3.993E-05       | 1.358E-07        | 4.073E-07    |
|                             |          | <b>Totals:</b>  | 0.000000         | 0.000000     |                 | 0.000466         | 0.001399     |                 | 0.000075         | 0.000226     |

**SMALL AIR**

**TABLE B-3**  
**ANIMALS AT RISK IN THE PACIFIC OCEAN (Continued)**

| Marine Animals              | Stage3          |                  |              | Payload Fairing |             |              | Total Across Species |           |
|-----------------------------|-----------------|------------------|--------------|-----------------|-------------|--------------|----------------------|-----------|
|                             | Area<br>(sq km) | One<br>Component | Total (3/yr) | Area<br>(sq km) | One Fairing | Total (9/yr) | One                  | All       |
| Beaked whales               | 5.622E-06       | 8.433E-09        | 2.530E-08    | 6.133E-05       | 9.200E-08   | 8.280E-07    | 5.308E-07            | 2.144E-06 |
| Blue whale                  | 5.622E-06       | 5.622E-10        | 1.687E-09    | 6.133E-05       | 6.133E-09   | 5.520E-08    | 3.539E-08            | 1.430E-07 |
| Bottlenose dolphin          | 5.622E-06       | 6.915E-08        | 2.075E-07    | 6.133E-05       | 7.544E-07   | 6.789E-06    | 4.353E-06            | 1.758E-05 |
| Common dolphin              | 5.622E-06       | 6.504E-06        | 1.951E-05    | 6.133E-05       | 7.095E-05   | 6.385E-04    | 4.094E-04            | 1.654E-03 |
| Dall's porpoise             | 5.622E-06       | 1.799E-07        | 5.397E-07    | 6.133E-05       | 1.963E-06   | 1.766E-05    | 1.132E-05            | 4.575E-05 |
| Fin whale                   | 5.622E-06       | 1.124E-09        | 3.373E-09    | 6.133E-05       | 1.227E-08   | 1.104E-07    | 7.078E-08            | 2.859E-07 |
| Gray whale                  | 5.622E-06       | 6.072E-08        | 1.822E-07    | 6.133E-05       | 6.624E-07   | 5.961E-06    | 3.822E-06            | 1.544E-05 |
| Harbor porpoise             | 5.622E-06       | 3.373E-08        | 1.012E-07    | 6.133E-05       | 3.680E-07   | 3.312E-06    | 2.123E-06            | 8.578E-06 |
| Humpback whale              | 5.622E-06       | 6.746E-09        | 2.024E-08    | 6.133E-05       | 7.360E-08   | 6.624E-07    | 4.247E-07            | 1.716E-06 |
| Killer whale                | 5.622E-06       | 1.124E-09        | 3.373E-09    | 6.133E-05       | 1.227E-08   | 1.104E-07    | 7.078E-08            | 2.859E-07 |
| Minke whale                 | 5.622E-06       | 1.687E-09        | 5.060E-09    | 6.133E-05       | 1.840E-08   | 1.656E-07    | 1.062E-07            | 4.289E-07 |
| North right whale           | 5.622E-06       | 5.622E-10        | 1.687E-09    | 6.133E-05       | 6.133E-09   | 5.520E-08    | 3.539E-08            | 1.430E-07 |
| North right whale dolphin   | 5.622E-06       | 4.537E-07        | 1.361E-06    | 6.133E-05       | 4.949E-06   | 4.454E-05    | 2.856E-05            | 1.154E-04 |
| Pacific white-sided dolphin | 5.622E-06       | 2.589E-06        | 7.767E-06    | 6.133E-05       | 2.824E-05   | 2.542E-04    | 1.630E-04            | 6.583E-04 |
| Risso's dolphin             | 5.622E-06       | 6.887E-07        | 2.066E-06    | 6.133E-05       | 7.513E-06   | 6.762E-05    | 4.335E-05            | 1.751E-04 |
| Sperm whale                 | 5.622E-06       | 1.911E-08        | 5.734E-08    | 6.133E-05       | 2.085E-07   | 1.877E-06    | 1.203E-06            | 4.861E-06 |
|                             | <b>Totals:</b>  | 0.000011         | 0.000032     |                 | 0.000116    | 0.001042     | 0.000668             | 0.002700  |

**TABLE B-3**  
**ANIMALS AT RISK IN THE PACIFIC OCEAN (Continued)**

**MEDIUM/INTERMEDIATE**

| Marine Animals              | Density  | Stage 0         |                  |                | Stage 1         |                  |               | Stage 2         |                  |               |
|-----------------------------|----------|-----------------|------------------|----------------|-----------------|------------------|---------------|-----------------|------------------|---------------|
|                             |          | Area<br>(sq km) | One<br>Component | Total (144/yr) | Area<br>(sq km) | One<br>Component | Total (16/yr) | Area<br>(sq km) | One<br>Component | Total (16/yr) |
| Beaked whales               | 1.50E-03 | 5.269E-04       | 7.904E-07        | 1.138E-04      | 2.138E-03       | 3.206E-06        | 5.130E-05     | 1.121E-04       | 1.682E-07        | 2.690E-06     |
| Blue whale                  | 1.00E-04 | 5.269E-04       | 5.269E-08        | 7.587E-06      | 2.138E-03       | 2.138E-07        | 3.420E-06     | 1.121E-04       | 1.121E-08        | 1.794E-07     |
| Bottlenose dolphin          | 1.23E-02 | 5.269E-04       | 6.481E-06        | 9.332E-04      | 2.138E-03       | 2.629E-05        | 4.207E-04     | 1.121E-04       | 1.379E-06        | 2.206E-05     |
| Common dolphin              | 1.16E+00 | 5.269E-04       | 6.095E-04        | 8.777E-02      | 2.138E-03       | 2.473E-03        | 3.956E-02     | 1.121E-04       | 1.297E-04        | 2.075E-03     |
| Dall's porpoise             | 3.20E-02 | 5.269E-04       | 1.686E-05        | 2.428E-03      | 2.138E-03       | 6.840E-05        | 1.094E-03     | 1.121E-04       | 3.587E-06        | 5.740E-05     |
| Fin whale                   | 2.00E-04 | 5.269E-04       | 1.054E-07        | 1.517E-05      | 2.138E-03       | 4.275E-07        | 6.840E-06     | 1.121E-04       | 2.242E-08        | 3.587E-07     |
| Gray whale                  | 1.08E-02 | 5.269E-04       | 5.691E-06        | 8.194E-04      | 2.138E-03       | 2.309E-05        | 3.694E-04     | 1.121E-04       | 1.211E-06        | 1.937E-05     |
| Harbor porpoise             | 6.00E-03 | 5.269E-04       | 3.161E-06        | 4.552E-04      | 2.138E-03       | 1.283E-05        | 2.052E-04     | 1.121E-04       | 6.726E-07        | 1.076E-05     |
| Humpback whale              | 1.20E-03 | 5.269E-04       | 6.323E-07        | 9.105E-05      | 2.138E-03       | 2.565E-06        | 4.104E-05     | 1.121E-04       | 1.345E-07        | 2.152E-06     |
| Killer whale                | 2.00E-04 | 5.269E-04       | 1.054E-07        | 1.517E-05      | 2.138E-03       | 4.275E-07        | 6.840E-06     | 1.121E-04       | 2.242E-08        | 3.587E-07     |
| Minke whale                 | 3.00E-04 | 5.269E-04       | 1.581E-07        | 2.276E-05      | 2.138E-03       | 6.413E-07        | 1.026E-05     | 1.121E-04       | 3.363E-08        | 5.381E-07     |
| North right whale           | 1.00E-04 | 5.269E-04       | 5.269E-08        | 7.587E-06      | 2.138E-03       | 2.138E-07        | 3.420E-06     | 1.121E-04       | 1.121E-08        | 1.794E-07     |
| North right whale dolphin   | 8.07E-02 | 5.269E-04       | 4.252E-05        | 6.123E-03      | 2.138E-03       | 1.725E-04        | 2.760E-03     | 1.121E-04       | 9.046E-06        | 1.447E-04     |
| Pacific white-sided dolphin | 4.61E-01 | 5.269E-04       | 2.426E-04        | 3.494E-02      | 2.138E-03       | 9.843E-04        | 1.575E-02     | 1.121E-04       | 5.162E-05        | 8.260E-04     |
| Risso's dolphin             | 1.23E-01 | 5.269E-04       | 6.455E-05        | 9.295E-03      | 2.138E-03       | 2.618E-04        | 4.190E-03     | 1.121E-04       | 1.373E-05        | 2.197E-04     |
| Sperm whale                 | 3.40E-03 | 5.269E-04       | 1.791E-06        | 2.580E-04      | 2.138E-03       | 7.268E-06        | 1.163E-04     | 1.121E-04       | 3.811E-07        | 6.098E-06     |
|                             |          | <b>Totals:</b>  | 0.000995         | 0.143295       |                 | 0.004037         | 0.064590      |                 | 0.000212         | 0.003387      |

**TABLE B-3**  
**ANIMALS AT RISK IN THE PACIFIC OCEAN (Continued)**  
**MEDIUM/INTERMEDIATE**

| Marine Animals              | Stage 3         |                  |               | Payload Fairing |             |               | Total Across Species |           |
|-----------------------------|-----------------|------------------|---------------|-----------------|-------------|---------------|----------------------|-----------|
|                             | Area<br>(sq km) | One<br>Component | Total (16/yr) | Area<br>(sq km) | One Fairing | Total (48/yr) | One                  | All       |
| Beaked whales               | 1.310E-05       | 1.965E-08        | 3.144E-07     | 1.972E-04       | 2.958E-07   | 1.420E-05     | 4.480E-06            | 1.823E-04 |
| Blue whale                  | 1.310E-05       | 1.310E-09        | 2.096E-08     | 1.972E-04       | 1.972E-08   | 9.466E-07     | 2.987E-07            | 1.215E-05 |
| Bottlenose dolphin          | 1.310E-05       | 1.611E-07        | 2.578E-06     | 1.972E-04       | 2.426E-06   | 1.164E-04     | 3.674E-05            | 1.495E-03 |
| Common dolphin              | 1.310E-05       | 1.515E-05        | 2.425E-04     | 1.972E-04       | 2.281E-04   | 1.095E-02     | 3.455E-03            | 1.406E-01 |
| Dall's porpoise             | 1.310E-05       | 4.192E-07        | 6.707E-06     | 1.972E-04       | 6.310E-06   | 3.029E-04     | 9.558E-05            | 3.889E-03 |
| Fin whale                   | 1.310E-05       | 2.620E-09        | 4.192E-08     | 1.972E-04       | 3.944E-08   | 1.893E-06     | 5.974E-07            | 2.431E-05 |
| Gray whale                  | 1.310E-05       | 1.415E-07        | 2.264E-06     | 1.972E-04       | 2.130E-06   | 1.022E-04     | 3.226E-05            | 1.313E-03 |
| Harbor porpoise             | 1.310E-05       | 7.860E-08        | 1.258E-06     | 1.972E-04       | 1.183E-06   | 5.679E-05     | 1.792E-05            | 7.293E-04 |
| Humpback whale              | 1.310E-05       | 1.572E-08        | 2.515E-07     | 1.972E-04       | 2.366E-07   | 1.136E-05     | 3.584E-06            | 1.459E-04 |
| Killer whale                | 1.310E-05       | 2.620E-09        | 4.192E-08     | 1.972E-04       | 3.944E-08   | 1.893E-06     | 5.974E-07            | 2.431E-05 |
| Minke whale                 | 1.310E-05       | 3.930E-09        | 6.288E-08     | 1.972E-04       | 5.916E-08   | 2.840E-06     | 8.960E-07            | 3.646E-05 |
| North right whale           | 1.310E-05       | 1.310E-09        | 2.096E-08     | 1.972E-04       | 1.972E-08   | 9.466E-07     | 2.987E-07            | 1.215E-05 |
| North right whale dolphin   | 1.310E-05       | 1.057E-06        | 1.691E-05     | 1.972E-04       | 1.591E-05   | 7.639E-04     | 2.410E-04            | 9.808E-03 |
| Pacific white-sided dolphin | 1.310E-05       | 6.033E-06        | 9.652E-05     | 1.972E-04       | 9.081E-05   | 4.359E-03     | 1.375E-03            | 5.597E-02 |
| Risso's dolphin             | 1.310E-05       | 1.605E-06        | 2.568E-05     | 1.972E-04       | 2.416E-05   | 1.160E-03     | 3.659E-04            | 1.489E-02 |
| Sperm whale                 | 1.310E-05       | 4.454E-08        | 7.126E-07     | 1.972E-04       | 6.705E-07   | 3.218E-05     | 1.016E-05            | 4.132E-04 |
|                             | <b>Totals:</b>  | 0.000025         | 0.000396      |                 | 0.000372    | 0.017877      | 0.005641             | 0.229545  |

**TABLE B-3**  
**ANIMALS AT RISK IN THE PACIFIC OCEAN (Continued)**

**HIGH**

| Marine Animals              | Density  | Stage 0         |                  |              | Stage 1         |                  |              | Stage 2         |                  |              |          |
|-----------------------------|----------|-----------------|------------------|--------------|-----------------|------------------|--------------|-----------------|------------------|--------------|----------|
|                             |          | Area<br>(sq km) | One<br>Component | Total (8/yr) | Area<br>(sq km) | One<br>Component | Total (4/yr) | Area<br>(sq km) | One<br>Component | Total (4/yr) |          |
| Beaked whales               | 1.50E-03 | 2.384E-03       | 3.576E-06        | 2.861E-05    | 1.802E-03       | 2.703E-06        | 1.081E-05    | 3.119E-04       | 4.679E-07        | 1.871E-06    |          |
| Blue whale                  | 1.00E-04 | 2.384E-03       | 2.384E-07        | 1.907E-06    | 1.802E-03       | 1.802E-07        | 7.209E-07    | 3.119E-04       | 3.119E-08        | 1.248E-07    |          |
| Bottlenose dolphin          | 1.23E-02 | 2.384E-03       | 2.932E-05        | 2.346E-04    | 1.802E-03       | 2.217E-05        | 8.867E-05    | 3.119E-04       | 3.836E-06        | 1.535E-05    |          |
| Common dolphin              | 1.16E+00 | 2.384E-03       | 2.758E-03        | 2.206E-02    | 1.802E-03       | 2.085E-03        | 8.339E-03    | 3.119E-04       | 3.608E-04        | 1.443E-03    |          |
| Dall's porpoise             | 3.20E-02 | 2.384E-03       | 7.628E-05        | 6.103E-04    | 1.802E-03       | 5.767E-05        | 2.307E-04    | 3.119E-04       | 9.981E-06        | 3.992E-05    |          |
| Fin whale                   | 2.00E-04 | 2.384E-03       | 4.768E-07        | 3.814E-06    | 1.802E-03       | 3.604E-07        | 1.442E-06    | 3.119E-04       | 6.238E-08        | 2.495E-07    |          |
| Gray whale                  | 1.08E-02 | 2.384E-03       | 2.575E-05        | 2.060E-04    | 1.802E-03       | 1.946E-05        | 7.786E-05    | 3.119E-04       | 3.369E-06        | 1.347E-05    |          |
| Harbor porpoise             | 6.00E-03 | 2.384E-03       | 1.430E-05        | 1.144E-04    | 1.802E-03       | 1.081E-05        | 4.325E-05    | 3.119E-04       | 1.871E-06        | 7.486E-06    |          |
| Humpback whale              | 1.20E-03 | 2.384E-03       | 2.861E-06        | 2.289E-05    | 1.802E-03       | 2.163E-06        | 8.651E-06    | 3.119E-04       | 3.743E-07        | 1.497E-06    |          |
| Killer whale                | 2.00E-04 | 2.384E-03       | 4.768E-07        | 3.814E-06    | 1.802E-03       | 3.604E-07        | 1.442E-06    | 3.119E-04       | 6.238E-08        | 2.495E-07    |          |
| Minke whale                 | 3.00E-04 | 2.384E-03       | 7.152E-07        | 5.721E-06    | 1.802E-03       | 5.407E-07        | 2.163E-06    | 3.119E-04       | 9.357E-08        | 3.743E-07    |          |
| North right whale           | 1.00E-04 | 2.384E-03       | 2.384E-07        | 1.907E-06    | 1.802E-03       | 1.802E-07        | 7.209E-07    | 3.119E-04       | 3.119E-08        | 1.248E-07    |          |
| North right whale dolphin   | 8.07E-02 | 2.384E-03       | 1.924E-04        | 1.539E-03    | 1.802E-03       | 1.454E-04        | 5.818E-04    | 3.119E-04       | 2.517E-05        | 1.007E-04    |          |
| Pacific white-sided dolphin | 4.61E-01 | 2.384E-03       | 1.098E-03        | 8.782E-03    | 1.802E-03       | 8.299E-04        | 3.320E-03    | 3.119E-04       | 1.436E-04        | 5.745E-04    |          |
| Risso's dolphin             | 1.23E-01 | 2.384E-03       | 2.920E-04        | 2.336E-03    | 1.802E-03       | 2.208E-04        | 8.831E-04    | 3.119E-04       | 3.821E-05        | 1.528E-04    |          |
| Sperm whale                 | 3.40E-03 | 2.384E-03       | 8.105E-06        | 6.484E-05    | 1.802E-03       | 6.127E-06        | 2.451E-05    | 3.119E-04       | 1.060E-06        | 4.242E-06    |          |
|                             |          | <b>Totals:</b>  |                  | 0.004502     | 0.036018        |                  | 0.003404     | 0.013615        |                  | 0.000589     | 0.002356 |

**TABLE B-3**  
**ANIMALS AT RISK IN THE PACIFIC OCEAN (Continued)**

**HIGH**

| Marine Animals              | Stage 3         |                  |              | Payload Fairing |             |              | Total Across Species |           |
|-----------------------------|-----------------|------------------|--------------|-----------------|-------------|--------------|----------------------|-----------|
|                             | Area<br>(sq km) | One<br>Component | Total (4/yr) | Area<br>(sq km) | One Fairing | Total (9/yr) | One                  | All       |
| Beaked whales               | 3.530E-05       | 5.295E-08        | 2.118E-07    | 5.294E-04       | 7.941E-07   | 7.147E-06    | 7.594E-06            | 4.865E-05 |
| Blue whale                  | 3.530E-05       | 3.530E-09        | 1.412E-08    | 5.294E-04       | 5.294E-08   | 4.765E-07    | 5.063E-07            | 3.243E-06 |
| Bottlenose dolphin          | 3.530E-05       | 4.342E-07        | 1.737E-06    | 5.294E-04       | 6.512E-06   | 5.860E-05    | 6.227E-05            | 3.989E-04 |
| Common dolphin              | 3.530E-05       | 4.084E-05        | 1.633E-04    | 5.294E-04       | 6.124E-04   | 5.512E-03    | 5.857E-03            | 3.752E-02 |
| Dall's porpoise             | 3.530E-05       | 1.130E-06        | 4.518E-06    | 5.294E-04       | 1.694E-05   | 1.525E-04    | 1.620E-04            | 1.038E-03 |
| Fin whale                   | 3.530E-05       | 7.060E-09        | 2.824E-08    | 5.294E-04       | 1.059E-07   | 9.529E-07    | 1.013E-06            | 6.487E-06 |
| Gray whale                  | 3.530E-05       | 3.812E-07        | 1.525E-06    | 5.294E-04       | 5.718E-06   | 5.146E-05    | 5.468E-05            | 3.503E-04 |
| Harbor porpoise             | 3.530E-05       | 2.118E-07        | 8.472E-07    | 5.294E-04       | 3.176E-06   | 2.859E-05    | 3.038E-05            | 1.946E-04 |
| Humpback whale              | 3.530E-05       | 4.236E-08        | 1.694E-07    | 5.294E-04       | 6.353E-07   | 5.718E-06    | 6.075E-06            | 3.892E-05 |
| Killer whale                | 3.530E-05       | 7.060E-09        | 2.824E-08    | 5.294E-04       | 1.059E-07   | 9.529E-07    | 1.013E-06            | 6.487E-06 |
| Minke whale                 | 3.530E-05       | 1.059E-08        | 4.236E-08    | 5.294E-04       | 1.588E-07   | 1.429E-06    | 1.519E-06            | 9.730E-06 |
| North right whale           | 3.530E-05       | 3.530E-09        | 1.412E-08    | 5.294E-04       | 5.294E-08   | 4.765E-07    | 5.063E-07            | 3.243E-06 |
| North right whale dolphin   | 3.530E-05       | 2.849E-06        | 1.139E-05    | 5.294E-04       | 4.272E-05   | 3.845E-04    | 4.086E-04            | 2.617E-03 |
| Pacific white-sided dolphin | 3.530E-05       | 1.626E-05        | 6.502E-05    | 5.294E-04       | 2.438E-04   | 2.194E-03    | 2.331E-03            | 1.494E-02 |
| Risso's dolphin             | 3.530E-05       | 4.324E-06        | 1.730E-05    | 5.294E-04       | 6.485E-05   | 5.837E-04    | 6.202E-04            | 3.973E-03 |
| Sperm whale                 | 3.530E-05       | 1.200E-07        | 4.801E-07    | 5.294E-04       | 1.800E-06   | 1.620E-05    | 1.721E-05            | 1.103E-04 |
|                             | <b>Totals:</b>  | 0.000067         | 0.000267     |                 | 0.001000    | 0.008998     | 0.009561             | 0.061254  |

**TABLE B-4**  
**ANIMALS AT RISK-ATLANTIC OCEAN**

| <b>Launch Vehicle</b>  |               | <b>Small Land</b> | <b>Small Air</b> | <b>Medium/<br/>Intermediate</b> | <b>High</b> | <b>Total</b> |
|------------------------|---------------|-------------------|------------------|---------------------------------|-------------|--------------|
| <b>Stage 0</b>         | One Component | 0.000138          | 0                | 0.000284                        | 0.001285    |              |
|                        | Total         | 0.000551          | 0                | 0.038345                        | 0.007711    |              |
| <b>Stage 1</b>         | One Component | 0.000133          | 0.000133         | 0.001152                        | 0.000972    |              |
|                        | Total         | 0.000533          | 0.000266         | 0.017284                        | 0.002915    |              |
| <b>Stage 2</b>         | One Component | 0.000013          | 0.000022         | 0.00006                         | 0.000168    |              |
|                        | Total         | 0.00005           | 0.000043         | 0.000906                        | 0.000504    |              |
| <b>Stage 3</b>         | One Component | 0.000003          | 0.000003         | 0.000007                        | 0.000019    |              |
|                        | Total         | 0.000012          | 0.000006         | 0.000106                        | 0.000057    |              |
| <b>Payload Fairing</b> | One Component | 0.000005          | 0.000033         | 0.000106                        | 0.000285    |              |
|                        | Total         | 0.00006           | 0.000198         | 0.004784                        | 0.003425    |              |
| One Component Total    |               | 0.000291          | 0.000191         | 0.00161                         | 0.002729    | 0.004821     |
| All Components Total   |               | 0.001206          | 0.000514         | 0.061426                        | 0.014611    | 0.077757     |

**TABLE B-5**  
**ANIMALS AT RISK-PACIFIC OCEAN**

| <b>Launch Vehicle</b>  |               | <b>Small Land</b> | <b>Small Air</b> | <b>Medium/<br/>Intermediate</b> | <b>High</b> | <b>Total</b> |
|------------------------|---------------|-------------------|------------------|---------------------------------|-------------|--------------|
| <b>Stage 0</b>         | One Component | 0.000482          | 0                | 0.000995                        | 0.004502    |              |
|                        | Total         | 0.001447          | 0                | 0.143295                        | 0.036018    |              |
| <b>Stage 1</b>         | One Component | 0.000466          | 0.000466         | 0.004037                        | 0.003404    |              |
|                        | Total         | 0.001399          | 0.001399         | 0.06459                         | 0.013615    |              |
| <b>Stage 2</b>         | One Component | 0.000044          | 0.000075         | 0.000212                        | 0.000589    |              |
|                        | Total         | 0.000132          | 0.000226         | 0.003387                        | 0.002356    |              |
| <b>Stage 3</b>         | One Component | 0.000011          | 0.000011         | 0.000025                        | 0.000067    |              |
|                        | Total         | 0.000032          | 0.000032         | 0.000396                        | 0.000267    |              |
| <b>Payload Fairing</b> | One Component | 0.000018          | 0.000116         | 0.000372                        | 0.001       |              |
|                        | Total         | 0.000158          | 0.001042         | 0.017877                        | 0.008998    |              |
| One Component Total    |               | 0.001021          | 0.000668         | 0.005641                        | 0.009561    | 0.016891     |
| All Components Total   |               | 0.003168          | 0.0027           | 0.229545                        | 0.061254    | 0.296667     |