

REVIEW

# Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis

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*Endang Species Res* 7:125–136 (2009)

**Supplement 1.** Accounts of individual marine cetacean species. Unless otherwise stated, information on current species range, habitat preferences and temperature preferences comes from Rice (1998) and Kaschner et al. (2006). CWL: cooler water-limited species; CWWL: cooler and warmer water-limited species; WWL: warmer water-limited species — for details of climate categories see 'Materials and methods'

## TOOTHED WHALES

### Sperm whales:

#### **Sperm whale** *Physeter macrocephalus*:

*Current range:* Polar to tropical waters of the world.

*Water temperature preferences:* Polar, sub-polar, temperate, sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* Cosmopolitan.

*Likely effect of increases in water temperature on species/population range(s):* As a species with a cosmopolitan range, it is unlikely that the range of this species will be greatly affected by increases in water temperature resulting from climate change. However, groups of females and juveniles are limited to tropical, sub-tropical and, in some places, warm temperate waters and the range of these age-sex classes are likely to expand polewards.

*Conservation implication:* Unchanged.

#### **Pygmy sperm whale** *Kogia breviceps*:

*Current range:* Sub-tropical and tropical waters of the world, with the exception of the Mediterranean. Possible occurrence in warm temperate waters in some regions, but exact species range remains poorly known (Caldwell & Caldwell 1989).

*Water temperature preferences:* Sub-tropical and tropical, with possible occurrence in warm temperate waters.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* As a WWL species, the range of the pygmy sperm whale is likely to expand polewards in all oceans. This may also include colonisation of the Mediterranean, but the reason for its lack of occurrence in this sea is unknown.

*Conservation implication:* Favourable.

#### **Dwarf sperm whale** *Kogia sima*:

*Current range:* Sub-tropical and tropical waters of the world, with the exception of the Mediterranean. Possible occurrence in warm temperate waters, but thought to occur in warmer waters than the pygmy sperm whale (Caldwell & Caldwell 1989).

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* As a WWL species, the range of the pygmy sperm whale is likely to expand polewards in all oceans. This may also include colonisation of the Mediterranean, but the reason for its lack of occurrence in this sea is unknown.

*Conservation implication:* Favourable.

### Beaked whales:

#### **Cuvier's beaked whale** *Ziphius cavirostris*:

*Current range:* Warm temperate to tropical waters of the world (Heyning 1989, MacLeod et al. 2006).

*Water temperature preferences:* Warm temperate, sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* As a WWL species, the range of Cuvier's beaked whale is likely to expand polewards in all oceans. However, a poleward expansion in the North Pacific may be limited by the large, shallow expanse of the Bering Sea. In addition, a poleward shift in the southern limit in the southwest Atlantic and the southeast Pacific may lead to a mixing (or increased mixing depending on the exact location of the current southern range limit) between these previously isolated populations.

*Conservation implication:* Favourable/unchanged in North Pacific.

#### **Arnoux's beaked whale** *Berardius arnuxii*:

*Current range:* Polar to cold temperate waters of the southern Hemisphere (Balcomb 1989, MacLeod et al. 2006).

*Water temperature preferences:* Polar, sub-polar and cold temperate. *Habitat:* Oceanic waters.

*Climatic category:* CWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWL species, the range of Arnoux's beaked whale is likely to contract polewards and decline in geographic extent.

*Conservation implication:* Unfavourable.

#### **Baird's beaked whale** *Berardius bairdii*:

*Current range:* Sub-polar to temperate waters of the North

Pacific (Balcomb 1989, MacLeod et al. 2006).

*Water temperature preferences:* Sub-polar and temperate.

*Habitat:* Oceanic waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, it might be expected that the range of Baird's beaked whale would shift northwards as water temperatures increase. However, the northern limit of its current range coincides with the southern extent of the shallow waters of the Bering Sea. This bathymetric barrier of unsuitable habitat is likely to limit the ability for Baird's beaked whale to shift its northern limit poleward in response to increases in water temperature. As a result, the range of this species is likely to contract rather than shift northwards.

*Conservation implication:* Unfavourable.

**Shepherd's beaked whale** *Tasmacetus shepherdi*:

*Current range:* Poorly known, but probably limited to sub-polar and cold temperate waters temperate waters of the southern hemisphere (Mead 1989a, MacLeod et al. 2006).

*Water temperature preferences:* Probably sub-polar and cold temperate.

*Habitat:* Oceanic waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species would be expected to shift polewards as waters warm. Depending on the southern limit of the current range, this could lead to mixing between populations previously separated by the land mass of South America. However, more information is needed about the current range of this poorly known species to confirm if South America really does provide a barrier to mixing between these populations at present.

*Conservation implication:* Potentially unfavourable.

**Longman's beaked whale** *Indopacetus pacificus*:

*Current Range:* Tropical to sub-tropical waters of the Indian and Pacific Oceans (MacLeod et al. 2006).

*Water temperature preferences:* Tropical and sub-tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* As a WWL species, the range of this species is likely to expand polewards in all oceans where it currently exists. However, this poleward expansion in the northern Indian Ocean will be limited by the land mass of Asia. While this species is not currently recorded in the tropical and sub-tropical Atlantic, these waters would appear suitable, and its occurrence here may be limited by a lack of sufficiently warm waters connecting its current range to the warmer waters of the South Atlantic around southern Africa (Fig. 2). Increasing water temperatures have the potential to weaken or remove this cool-water barrier and could result in Longman's beaked whale colonising the warmer waters of the Atlantic, leading to a greatly increased geographic range for this species. Given that the current southern limit of this species in the Indian Ocean is close to the Cape of Good Hope (MacLeod et al. 2006), only a relatively small increase in water temperature could result in the dissolution of the current cool-water barrier between the Atlantic and the Indian Ocean in terms of the range of Longman's beaked whale.

*Conservation implication:* Favourable.

**Northern bottlenose whale** *Hyperoodon ampullatus*:

*Current range:* Polar to temperate waters of the North Atlantic (Mead 1989b, MacLeod et al. 2006).

*Water temperature preferences:* Polar, sub-polar and temperate.

*Habitat:* Oceanic waters.

*Climatic category:* CWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWL species, it would be expected that the range of this species would contract northwards as water temperatures increase, reducing the geographic area occupied by this species. However, as sea ice cover in the Arctic Ocean declines in response to climate change, a relatively large area of suitable oceanic habitat may open up into which this species could expand its range. Cold water beaked whale species from the North Pacific may be prevented from similarly expanding into this region by the large expanse of shallow waters in the Bering Sea. Therefore, the northern bottlenose whale is likely to encounter few potential competitors for such a colonisation of much of the Arctic Ocean, from which it is currently excluded by the presence of sea ice, as water temperatures increase.

*Conservation implication:* Unfavourable, but favourable if species greatly expands its range in the Arctic Ocean.

**Southern bottlenose whale** *Hyperoodon planifrons*:

*Current range:* Polar to temperate waters of the southern Hemisphere (Mead 1989b, MacLeod et al. 2006).

*Water temperature preferences:* Polar, sub-polar and temperate.

*Habitat:* Oceanic waters.

*Climatic category:* CWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWL species, the range of the southern bottlenose whale is likely to contract polewards and decline in geographic extent.

*Conservation implication:* Unfavourable.

**Hector's beaked whale** *Mesoplodon hectori*:

*Current range:* Probably limited to sub-polar to cold temperate waters of the southern hemisphere (although the exact species range remains poorly known - Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences:* Sub-polar and cold temperate.

*Habitat:* Oceanic waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of Hector's beaked whale is likely to shift polewards. However, more information is required on the species range in relation to water temperature to infer the exact extent of such a shift.

*Conservation implication:* Potentially unfavourable.

**True's beaked whale** *Mesoplodon mirus*:

*Current range:* Temperate waters of the North Atlantic and southern hemisphere (although the exact species range in the southern hemisphere remains poorly known - Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences:* Temperate.

*Habitat:* Oceanic waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of True's beaked whale is likely to shift polewards. However, more information is required on the species range in relation to water temperature to infer the exact extent of such a shift, particularly in the southern hemisphere where the distribution of this species remains poorly known.

*Conservation implication:* Unfavourable.

**Gervais' beaked whale** *Mesoplodon europaeus*:

*Current range*: Sub-tropical to tropical waters of the Atlantic (although the exact species range in the South Atlantic remains poorly known - Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences*: Sub-tropical and tropical.

*Habitat*: Oceanic waters.

*Climatic category*: WWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a WWL species, the range of Gervais' beaked whale is likely to expand polewards in both the North and South Atlantic. In addition, as water temperatures warm, this species may colonise the Mediterranean where this species currently does not occur.

*Conservation implication*: Favourable.

**Sowerby's beaked whale** *Mesoplodon bidens*:

*Current range*: Sub-polar to temperate waters of the North Atlantic (Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences*: Sub-polar and temperate.

*Habitat*: Oceanic waters.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a CWWL species, the range of Sowerby's beaked whale is likely to shift polewards in the North Atlantic. As with the northern bottlenose whale, this could include the potential to colonise large areas of deep water in the Arctic Ocean if they became ice-free, greatly increasing the geographic range of the species.

*Conservation Implication*: Unfavourable, but favourable if species colonises much of the Arctic Ocean.

**Gray's beaked whale** *Mesoplodon grayi*:

*Current range*: Sub-polar to temperate waters of the southern hemisphere (Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences*: Sub-polar and temperate.

*Habitat*: Oceanic waters.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a CWWL species, the range of Gray's beaked whale is likely to shift polewards throughout the southern hemisphere.

*Conservation Implication*: Unfavourable.

**Pygmy beaked whale** *Mesoplodon peruvianus*:

*Current range*: Sub-tropical to tropical waters of the eastern Pacific (MacLeod et al. 2006).

*Water temperature preferences*: Sub-tropical and tropical.

*Habitat*: Oceanic waters.

*Climatic category*: WWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a WWL species, the range of the pygmy beaked whale is likely to expand polewards in the eastern Pacific. Whether this species will also expand westward into the western Pacific remains unclear as the exact reason why it does not occur in this region (and whether it is in any way related to water temperature) is unknown.

*Conservation implication*: Favourable.

**Andrew's beaked whale** *Mesoplodon bowdoini*:

*Current range*: Sub-polar to temperate waters of the southern hemisphere (Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences*: Sub-polar and temperate.

*Habitat*: Oceanic waters.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a CWWL species, the range of Andrew's beaked whale is likely to shift polewards. This may lead to mixing (or increased mixing) between southwest Atlantic and southeast Pacific populations that are

currently isolated from each other by the land mass of South America as the current southern limit of this species appears to be close to the southern tip of South America.

*Conservation implication*: Unfavourable.

**Spade-toothed beaked whale** *Mesoplodon traversii*:

*Current range*: This species is currently known from three incomplete specimens from the southern hemisphere. As a result, its range at sea is unknown, but may be limited to cooler waters in the southern hemisphere - MacLeod et al. 2006).

*Water temperature preferences*: Unknown.

*Habitat*: Unknown but presumed to be oceanic waters.

*Climatic category*: Unknown.

*Likely effect of increases in water temperature on species/population range(s)*: Unknown.

*Conservation implication*: Unknown.

**Hubbs' beaked whale** *Mesoplodon carlhubbsi*:

*Current range*: Temperate waters of the North Pacific (Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences*: Temperate.

*Habitat*: Oceanic waters.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a CWWL species, the range of this species is likely to shift polewards in the North Pacific.

*Conservation implication*: Unfavourable.

**Ginkgo-toothed beaked whale** *Mesoplodon ginkgodens*:

*Current range*: Sub-tropical and tropical and possibly warm temperate water of the Indian and Pacific Oceans, although the full range of this species remains poorly understood (Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences*: Sub-tropical and tropical and possibly warm temperate.

*Habitat*: Oceanic waters.

*Climatic category*: WWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a WWL species, the range of this species is likely to expand polewards. However, a northward expansion in the northern Indian Ocean will be limited by the land mass of Asia. More information on the true range of this species is required to fully assess how this species' range may change in response to increasing water temperatures

*Conservation implication*: Potentially favourable.

**Stejneger's beaked whale** *Mesoplodon stejnegeri*:

*Current Range*: Sub-polar and temperate waters of the North Pacific (Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences*: Sub-polar and temperate.

*Habitat*: Oceanic waters.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a CWWL species, it might be expected that the range of Stejneger's beaked whale would shift northwards as water temperatures increase. However, as with Baird's beaked whale, the northern limit of its current range coincides with the southern extent of the shallow waters of the Bering Sea. This topographic barrier of unsuitable habitat is likely to limit the ability for this species to shift its northern limit poleward in response to increases in water temperature. As a result, the range of this species is likely to contract polewards rather than shift northwards.

*Conservation implication*: Unfavourable.

**Strap-toothed whale** *Mesoplodon layardii*:

*Current range*: Polar to cold temperate waters of the southern hemisphere (Mead 1989c, MacLeod et al. 2006).

*Water temperature preferences*: Polar, sub-polar and cold temperate.

*Habitat:* Oceanic waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of the strap-toothed whale is likely to shift polewards throughout the southern hemisphere.

*Conservation implication:* Unfavourable.

**Blainville's beaked whale** *Mesoplodon densirostris*:

*Current range:* Sub-tropical to tropical waters of the world with the exception of the Mediterranean (Mead 1989, MacLeod et al. 2006).

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* As a WWL species, the range of Blainville's beaked whale is likely to expand polewards in all oceans where it currently occurs. However, the land mass of southern Africa may currently separate populations in the south eastern Atlantic and the south western Indian Ocean. Increasing water temperatures may result in a weakening or disappearance of this barrier as the southern limit of the species move polewards and lead to a mixing of these previously isolated populations. In addition, waters of the eastern Mediterranean would appear suitable for this species and cooler waters around the Straits of Gibraltar may currently prevent this species colonising this region. This barrier may also decrease or disappear as temperatures warm, leading to a colonisation of the deep waters of the Mediterranean by this otherwise ubiquitous warm-water species.

*Conservation implication:* Favourable.

**Perrin's beaked whale** *Mesoplodon perrini*:

*Current range:* This species is currently known from a small number of stranded specimens from temperate waters to the west of California. As a result, its range at sea is unknown, but may be limited to temperate waters in this region (MacLeod et al. 2006).

*Water temperature preferences:* Unknown.

*Habitat:* Unknown but presumed to be oceanic waters.

*Climatic category:* Unknown.

*Likely effect of increases in water temperature on species/population range(s):* Unknown.

*Conservation implication:* Unknown.

#### River dolphins:

Of the six species of river dolphins, only one (the franciscana – *Pontoporia blainvillei*) is marine. The rest are restricted to individual or groups of river systems and, therefore, beyond the scope of this study of how the ranges of marine cetacean species are likely to be affected by increases in water temperature.

**Franciscana** *Pontoporia blainvillei*:

*Current range:* Warm temperate to sub-tropical waters of coastal/estuarine Atlantic waters of South America.

*Water temperature preferences:* Sub-tropical and warm temperate.

*Habitat:* Coastal shelf and estuarine.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to shift southwards along the coast of South America as the range expands at its southern edge and contracts its northern edge as temperatures increase.

*Conservation implication:* Unfavourable.

#### Monodontids:

**Beluga** *Delphinapterus leucas*:

*Current range:* Polar to sub-polar waters of the northern hemisphere.

*Water temperature preferences:* Polar and sub-polar.

*Habitat:* Oceanic and shelf waters.

*Climatic category:* CWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWL species, the range of the beluga might be expected to contract as water temperatures increase. However, this contraction may not be a simple affair. Beluga distribution is divided into a number of non-contiguous areas in northern polar and sub-polar waters. In addition, there is a reliance on shallow coastal areas in summer months. As a result, their ability to move their range poleward as water temperatures increase and ice coverage decreases may be limited by the absence of suitable shelf and coastal waters further north in the Arctic Ocean. In addition, isolated populations at the southern edge of the current species range, such as in the Gulf of St. Lawrence, may be limited in their ability to shift their range northward and these populations may become extinct as a result of changes in water temperature.

*Conservation implication:* Unfavourable/potentially high risk for some populations.

**Narwhal** *Monodon monoceros*:

*Current range:* Polar waters of the northern hemisphere.

*Water temperature preferences:* Polar.

*Habitat:* Shelf and oceanic waters

*Climatic category:* CWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWL species, the range of the narwhal is likely to contract poleward, particularly in response to a decrease in ice coverage which is important habitat for this species. However, a decrease in ice coverage may result in a mixing of distinct populations that are currently separated by the land mass of Greenland and the permanent sea ice to its north.

*Conservation implication:* Unfavourable, but high risk if Arctic sea ice disappears.

#### Dolphins:

**Commerson's dolphin** *Cephalorhynchus commersonii*:

*Current range:* Cold temperate to sub-polar waters around South America and the Kerguelen Islands in the southern Indian Ocean.

*Water temperature preferences:* Cold temperate and sub-polar.

*Habitat:* Shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* In general, the range of Commerson's dolphin would be expected to shift southward as water temperatures increase. However, possible range shifts are complicated by the fact that this species is restricted to shelf waters. There are no suitable shelf waters to the south of the southern tip of South America or the Kerguelen Islands, limiting the ability of this species to shift its range southward. As a result, the range of this species is likely to decline as its northern edge contracts southwards in response to increases in water temperature in response to climate change. This could potentially lead to the extinction of the Kerguelen Island population and a decline in the size of the population in the shelf waters

around South America as its geographic range declines in area.

*Conservation implication:* High risk.

**Chilean dolphin** *Cephalorhynchus eutropia*:

*Current range:* Cold temperate to sub-polar waters of the South Pacific around South America.

*Water temperature preferences:* Cold temperate and sub-polar.

*Habitat:* Shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As with Commerson's dolphin, changes in the range of this species in response to increases in water temperature are likely to be complicated by its occurrence in shelf waters. In particular, there are no similar shelf waters to the south of the southern tip of the Americas into which this species could move. As a result, the range of this species is likely to contract rather than shift polewards as might be generally expected of a CWWL species.

*Conservation implication:* High risk.

**Havside's dolphin** *Cephalorhynchus heavisidii*:

*Current range:* Cold temperate waters of the South Atlantic coasts of Africa.

*Water temperature preferences:* Cold temperate.

*Habitat:* Shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As with other *Cephalorhynchus* species that are limited to cooler shelf waters in the southern hemisphere, the ability of this species to shift its range southward is greatly limited by a lack of suitable shelf waters to the south of its current range. Therefore, the range of this species is likely to contract rather than shift southwards. Given the relatively narrow range of water temperatures in which this species appears to occur, even a relatively small change in water temperature could have a large impact on the viability, and therefore conservation, of this species, leading to its extirpation from much or all of its current range.

*Conservation implication:* High risk.

**Hector's dolphin** *Cephalorhynchus hectori*:

*Current range:* Temperate waters of New Zealand.

*Water temperature preferences:* Temperate.

*Habitat:* Shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species would be expected to shift southward. However, its preference for shelf waters will limit its ability to shift southwards as there are few areas of suitable shelf waters to the south of its existing range. As a result, the range of this species is likely to contract, rather than shift, southwards.

*Conservation implication:* High risk.

**Atlantic humpbacked dolphin** *Sousa teuszi*:

*Current range:* Tropical to sub-tropical waters of the Atlantic coasts of Africa.

*Water temperature preferences:* Tropical and sub-tropical.

*Habitat:* Shelf waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* Little is known about the true range of this species. However, given its current distribution, it is likely that its range will expand northward and southward along the shelf waters of western Africa. It is possible that a southward expansion of the range of this

species and a similar expansion of the range of the Pacific humpbacked dolphin could result in a mixing between these two currently allopatric sister species. Whether these two species could retain their distinctiveness as a result of such mixing remains unclear.

*Conservation implication:* Favourable but potentially high risk if populations of the two *Sousa* species mix.

**Indo-Pacific humpbacked dolphin** *Sousa chinensis*:

*Current range:* Tropical to sub-tropical waters of the Indian and western Pacific Ocean.

*Water temperature preferences:* Tropical and sub-tropical.

*Habitat:* Shelf waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* As a WWL species, the range of this species would be expected to expand northwards in response to increases in water temperature. However, this expansion may be limited to specific sections of its existing range. For example, a northward expansion throughout the northern Indian Ocean will be limited by the land mass of Asia. However, an expansion in species range is possible northwards along the east coast of Asia and southward along the east and west coasts of Australia. Finally, this species may currently be prevented from colonising otherwise suitable coastal waters of the tropical and sub-tropical west coast of Africa by an area of relatively cool water around the west coast of South Africa and Namibia (Fig. 2). An increase in water temperatures may result in this barrier to the distribution of the Indo-Pacific humpback dolphin becoming breached or disappearing, and a mixing between the currently separated ranges of the two *Sousa* species, with unknown consequences for their genetic uniqueness and, therefore, their conservation.

*Conservation implication:* Favourable but potentially high risk if populations of the two *Sousa* species mix.

**Tucuxi** *Sotalia* spp.:

*Current range:* Tropical to sub-tropical waters of coastal/estuarine Atlantic waters of South America.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Coastal shelf and estuarine.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species may expand polewards along the coasts of South America as water temperatures increase, with a particularly noticeable poleward shift of the southern edge of the species range.

*Conservation implication:* Favourable.

**Bottlenose dolphin** *Tursiops* spp.:

*Current range:* The genus *Tursiops* probably represents a species complex and its exact species composition remains unclear in much of the world. However, as a genus, *Tursiops* has a range that encompasses all warm temperate to tropical waters of the world.

*Water temperature preferences:* Warm temperate, sub-tropical and tropical.

*Habitat:* Shelf and oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand northwards as temperatures increase in response to climate change. However, it is unclear how the ranges of individual populations/species within this genus may change as divisions between them are not always clear cut.

*Conservation implication:* Favourable.

**Rough-toothed dolphin** *Steno brenadensis*:

*Current range:* Sub-tropical to tropical waters of the world, excluding the Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Primarily oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* As a WWL species, as temperatures increase in response to climate change the range of this species is likely to expand polewards in all oceans. With sufficient increases in water temperature, it is possible that mixing will occur between populations that were previously separated by the land mass of southern Africa. In addition, if the range of this species expands sufficiently in the eastern North Atlantic, it may be able to colonise the otherwise suitable waters of the eastern Mediterranean.

*Conservation implication:* Favourable.

**Pan-tropical spotted dolphin** *Stenella attenuata*:

*Current range:* Sub-tropical to tropical waters of the world, excluding the Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Primarily oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand polewards as temperatures increase in response to climate change. With sufficient increases in water temperature, it is possible that mixing will occur between populations that were previously separated by the land mass of southern Africa. In addition, if the range of this species expands sufficiently in the eastern North Atlantic, it may be able to colonise the otherwise suitable waters of the eastern Mediterranean.

*Conservation implication:* Favourable.

**Striped dolphin** *Stenella coeruleoalba*:

*Current range:* Sub-tropical to tropical waters of the world, with occasional occurrence in warm temperate waters in some regions.

*Water temperature preferences:* Sub-tropical, tropical and to a lesser extent warm temperate.

*Habitat:* Primarily oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand polewards as temperatures increase in response to climate change. With sufficient increases in water temperature, it is possible that mixing will occur between populations that were previously separated by the land mass of southern Africa.

*Conservation implication:* Favourable.

**Atlantic spotted dolphin** *Stenella frontalis*:

*Current range:* Sub-tropical to tropical waters of the North Atlantic excluding the Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Primarily oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand polewards as temperatures increase in response to climate change. With sufficient increases in water temperature, it is possible that this species could colonise otherwise suitable habitats in the Indian Ocean that it is currently prevented from accessing due to the cooler waters along southwest coast of Africa (Fig. 2). In addition, if the range of this species expands sufficiently in the eastern North Atlantic, it may be able to colonise the otherwise suitable waters of the eastern Mediterranean.

*Conservation implication:* Favourable.

**Spinner dolphin** *Stenella longirostris*:

*Current range:* Sub-tropical to tropical waters of the world, excluding the Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Primarily oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* As a WWL species, as temperatures increase in response to climate change the range of this species is likely to expand polewards in all oceans. With sufficient increases in water temperature, it is possible that mixing will occur between populations that were previously separated by the land mass of southern Africa. In addition, if the range of this species expands sufficiently in the eastern North Atlantic, it may be able to colonise the otherwise suitable waters of the eastern Mediterranean.

*Conservation implication:* Favourable.

**Clymene dolphin** *Stenella clymene*:

*Current range:* Sub-tropical to tropical waters of the Atlantic, excluding the Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Primarily oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand polewards in the Atlantic as temperatures increase in response to climate change. If the range of this species expands sufficiently in the eastern North Atlantic, it may be able to colonise the otherwise suitable waters of the eastern Mediterranean (Fig. 2). Similarly, with sufficient increases in water temperature, it is possible that this species could colonise the warmer waters of the Indian Ocean, an event which is currently prevented by the presence of an area of cooler water around the southwest of Africa (Fig. 2).

*Conservation implication:* Favourable.

**Common dolphin** *Delphinus spp.*:

*Current range:* A complex of two or three species that occur in warm temperate to tropical waters of the world.

*Water temperature preferences:* Warm temperate, sub-tropical and tropical.

*Habitat:* Oceanic and shelf waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this genus is likely to expand polewards as temperatures increase in response to climate change. However, the ranges of individual species within the genus *Delphinus* remain unclear and, therefore, it is unclear how they may respond to increases in water temperature.

*Conservation implication:* Favourable.

**Fraser's dolphin** *Lagenodelphis hosei*:

*Current range:* Sub-tropical to tropical waters of the world, excluding the Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand polewards as temperatures increase in response to climate change. With sufficient increases in water temperature, it is possible that mixing will occur between populations that were previously separated by the land mass of southern Africa. In addition, if the range of this species expands sufficiently in the eastern North Atlantic, it may be able to colonise the otherwise suitable waters of the eastern Mediterranean.

*Conservation implication:* Favourable.

**White-beaked dolphin** *Lagenorhynchus albirostris*:

*Current range:* Cold temperate to sub-polar waters of the North Atlantic.

*Water temperature preferences:* Cold temperate and sub-polar.

*Habitat:* Shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, it might be expected that the range of this species would shift northwards. However, this species primarily occurs in shelf waters and the distribution of waters less than 200 m deep may have a strong effect on how the range of this species will change in response to increases in water temperature (MacLeod et al. 2008). In particular, the ability for populations that currently occur in shelf waters around northwest Europe are likely to decline as there are few areas suitable shelf waters north of about 61°N in this region.

*Conservation implication:* Unfavourable but high risk for population around northwest Europe.

**Atlantic white-sided dolphin** *Lagenorhynchus acutus*:

*Current range:* Temperate to sub-polar waters of the North Atlantic.

*Water temperature preferences:* Temperate and sub-polar.

*Habitat:* Primarily oceanic waters (although occurs in non-coastal shelf waters on some occasions and in some regions).

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species is likely to shift northwards.

*Conservation implication:* Unfavourable.

**Pacific white-sided dolphin** *Lagenorhynchus obliquidens*:

*Current range:* Temperate of the North Pacific.

*Water temperature preferences:* Temperate and sub-polar.

*Habitat:* Primarily oceanic waters (although occurs in shelf waters on some occasions).

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species is likely to shift northwards.

*Conservation implication:* Unfavourable.

**Dusky dolphin** *Lagenorhynchus obscurus*:

*Current range:* Temperate waters of the southern hemisphere.

*Water temperature preferences:* Temperate.

*Habitat:* Primarily shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species is likely to shift southwards. However, the ability of dusky dolphin populations to shift their range southwards in response to increases in water temperature is likely to be limited by the distribution of suitable shelf habitats. In particular, there are few areas of suitable shelf habitat to the south of much of the existing species range. As a result, the range of this species is likely to decline rather than shift polewards. Of particular concern here is the population that is current found in temperate waters of southwest Africa where even relatively small increases in water temperature could result in all shelf waters in this area becoming too warm for this species.

*Conservation implication:* Unfavourable but high risk for southern African population.

**Peale's dolphin** *Lagenorhynchus australis*:

*Current range:* Cold temperate waters of South America.

*Water temperature preferences:* Cold temperate.

*Habitat:* Shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species is likely to shift southwards. However, any movement in the species range in this direction is likely to be limited by the distribution of suitable shelf habitats around South America. As a result, the range of this species is likely to decline rather than shift polewards.

*Conservation implication:* High risk.

**Hourglass dolphin** *Lagenorhynchus cruciger*:

*Current range:* Sub-polar to polar waters of the southern hemisphere, with occurrence in cold temperate waters in some areas.

*Water temperature preferences:* Primarily sub-polar and polar waters

*Habitat:* Primarily oceanic waters.

*Climatic category:* CWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWL species, the range of this species is likely to contract southwards in response to increases in water temperature.

*Conservation implication:* Unfavourable.

**Northern right whale dolphin** *Lissodelphis borealis*:

*Current range:* Temperate to sub-polar waters of the North Pacific.

*Water temperature preferences:* Temperate and sub-polar.

*Habitat:* Primarily oceanic waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species is likely to shift northwards.

*Conservation implication:* Unfavourable.

**Southern right whale dolphin** *Lissodelphis peronii*:

*Current range:* Temperate to sub-polar of the southern hemisphere.

*Water temperature preferences:* Temperate and sub-polar.

*Habitat:* Oceanic waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species is likely to contract southwards in response to increases in water temperature.

*Conservation implication:* Unfavourable.

**Risso's dolphin** *Grampus griseus*:

*Current range:* Warm temperate to tropical waters of the world.

*Water temperature preferences:* Warm temperate, subtropical and tropical.

*Habitat:* Oceanic and shelf waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of Risso's dolphin is likely to expand polewards as temperatures increase in response to climate change.

*Conservation implication:* Favourable.

**Melon-headed whale** *Peponocephala electra*:

*Current range:* Sub-tropical to tropical waters of the world, with the exception of the eastern Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand polewards as temperatures increase in response

to climate change. There is the potential for this species to colonise the Mediterranean if water temperatures increase sufficiently in the eastern Atlantic for the range of this species to encompass the Straits of Gibraltar.

*Conservation implication:* Favourable.

**Pygmy killer whale** *Feresa attenuata*:

*Current range:* Sub-tropical to tropical waters of the world, with the exception of the eastern Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand polewards as temperatures increase in response to climate change.

*Conservation implication:* Favourable.

**False killer whale** *Pseudorca crassidens*:

*Current range:* Warm temperate to tropical waters of the world, with the exception of the Mediterranean.

*Water temperature preferences:* Warm temperate, sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of the false killer whale is likely to expand polewards as temperatures increase in response to climate change.

*Conservation implication:* Favourable.

**Long-finned pilot whale** *Globicephala melas*:

*Current range:* Temperate to sub-polar waters of the North Atlantic and southern hemisphere.

*Water temperature preferences:* Temperate and sub-polar.

*Habitat:* Primarily oceanic waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, the range of this species is likely to shift polewards. However, in the Mediterranean, a northward shift in the species range will be limited by the landmass of Europe and it is possible that long-finned pilot whales will become extirpated from this sea.

*Conservation implication:* Unfavourable but high risk for Mediterranean population.

**Short-finned pilot whale** *Globicephala macrorhynchus*:

*Current range:* Warm temperate to tropical waters of the world, with the exception of the Mediterranean.

*Water temperature preferences:* Warm temperate, sub-tropical and tropical.

*Habitat:* Oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this species is likely to expand polewards as temperatures increase in response to climate change. This may include a colonisation of the Mediterranean.

*Conservation implication:* Favourable.

**Killer whale** *Orcinus orca*:

*Current range:* Polar to tropical waters of the world.

*Water temperature preferences:* Polar, sub-polar, temperate, sub-tropical and tropical.

*Habitat:* Oceanic and shelf waters.

*Climatic category:* Cosmopolitan.

*Likely effect of increases in water temperature on species/population range(s):* As a species with a cosmopolitan range, it is unlikely that the range of this species will be greatly affected by increases in water temperature resulting from climate change.

*Conservation implication:* Unchanged.

**Irrawaddy dolphin** *Orcaella* spp.:

*Current range:* Sub-tropical to tropical waters of the eastern Indian Ocean and western Pacific that may be divided into two species (*O. brevirostris* and *O. heinsohni*) by the deep waters along the Wallace Line (Beasley et al. 2005).

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Shelf waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* The range of this genus is likely to expand polewards in coastal waters of east Asia and Australia. However, within the Bay of Bengal, the species range is unlikely to change as any northward shift is limited by the land mass of Asia.

*Conservation implication:* Favourable.

### Porpoises:

**Harbour porpoise** *Phocoena phocoena*:

*Current range:* Temperate to sub-polar waters of the northern hemisphere.

*Water temperature preferences:* Temperate and sub-polar

*Habitat:* Shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, it might be expected that the range of this species would shift northwards. However, this species primarily occurs in shelf waters (Read 1999) and the distribution of waters less than 200 m deep may have a strong effect on how the range of this species will change in response to increases in water temperature. In particular, the ability for populations that currently occur in shelf waters around northwest Europe are likely to decline as there are few areas suitable shelf waters north of about 61°N in this region.

*Conservation implication:* Unfavourable but high risk for northwest European populations.

**Vaquita** *Phocoena sinus*:

*Current range:* Sub-tropical waters of the northern Gulf Of California.

*Habitat:* Shelf waters.

*Water temperature preferences:* Sub-tropical waters.

*Climatic category:* Possibly CWL.

*Likely effect of increases in water temperature on species/population range(s):* It is currently unclear why this species is limited to the shelf waters of the northern Gulf of California and why it does not occur in neighbouring shelf waters further south in this region. If this restricted range is related to water temperature and this species is warm water-limited, this has major implications for the effect of climate change on this species. Due to the presence of land to the north of its current range, there is no possibility of the range shifting northward. Therefore, the vaquita is potentially 'trapped' in the Gulf of California and its range may contract substantially as water temperatures increase. Indeed, given sufficient warming, its apparent preferred temperature range within the Gulf of California could disappear entirely. Therefore, given the current restricted range of this species, it is possible that climate change may provide the final straw for this already critically endangered species. However, more information is required on whether the range of this species is indeed temperature limited.

*Conservation implication:* Potentially high risk.



**Burmeister's porpoise** *Phocoena spinnipinnis*:

*Current range*: Temperate waters of South America.

*Water temperature preferences*: Temperate.

*Habitat*: Shelf waters.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a CWWL species, it might be expected that the range of this species would shift southwards. However, this species primarily occurs in shelf waters and the distribution of waters less than 200 m deep may have a strong effect on how the range of this species will change in response to increases in water temperature. In particular, there are no contiguous areas of shelf waters to the south of the current range. As a result, the range of this species is likely to contract rather than shift southwards in response to increases in water temperature resulting from climate change.

*Conservation implication*: High risk.

**Spectacled porpoise** *Phocoena dioptrica*:

*Current range*: Cold temperate to sup-polar waters of the southern hemisphere.

*Water temperature preferences*: Cold temperate and sub-polar.

*Habitat*: Shelf waters.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: As with Burmeister's porpoise, while this species may be expected to shift its range southwards in response to increasing water temperatures, its preference for shelf waters will limit its ability to track waters of its preferred temperatures southwards as there are few contiguous shelf areas to the south of the shelf waters where it currently occurs. As a result, the range of this species is likely to contract rather than shift southwards in response to increases in water temperature resulting from climate change. This may result in its extirpation from some areas that are at the northern edge of its current range such as Tasmania.

*Conservation implication*: High risk.

**Finless porpoise** *Neophocaena phocaenoides*:

*Current range*: Sub-tropical to tropical waters of the eastern and central Indian Ocean and western Pacific north of the deep waters of the Wallace Line.

*Water temperature preferences*: Sub-tropical and tropical.

*Habitat*: Shelf waters (and some estuarine/freshwater river systems).

*Climatic category*: WWL.

*Likely effect of increases in water temperature on species/population range(s)*: The range of this species is likely to expand polewards in coastal waters of east Asia as water temperatures increase. However, within the Indian Ocean, the species range is unlikely to change as any northward shift is limited by the land mass of Asia.

*Conservation implication*: Favourable

**Dall's porpoise** *Phocoenoides dalli*:

*Current range*: Temperate to polar waters of the North Pacific.

*Water temperature preferences*: Temperate, sub-polar and polar.

*Habitat*: Oceanic and shelf waters.

*Climatic category*: CWL.

*Likely effect of increases in water temperature on species/population range(s)*: As a CWL species, it might be expected that the range of this species would contract northwards in response to increases in water temperature resulting from climate change.

*Conservation implication*: Unfavourable.

**BALEEN WHALES****Bowhead whale** *Balaena mysticetus*:

*Current range*: Pack ice zone of Arctic Ocean.

*Water temperature preferences*: Polar.

*Habitat*: Oceanic and shelf waters.

*Climatic category*: CWL.

*Likely effect of increases in water temperature on species/population range(s)*: Decrease in range as southern limit contracts northward following a decline in sea ice, resulting in a reduction in geographic range size. Potential mixing between populations that are currently separated by areas of permanent sea ice (e.g. East Greenland stock and those west of Greenland). However, the population within the northern Sea of Okhotsk is likely to be prevented from contracting its range northward due to the land barriers to the east, west and north of the current range and the existence of unsuitable warmer waters to the south. As a result, this population may decline and eventually become extirpated, rather than altering its range, as water temperatures increase as a result of climate change.

*Conservation implication*: Unfavourable but high risk for Sea of Okhotsk population.

**Northern right whales** (*Balaena glacialis* and *B. japonica*):  
*Current range*: Sub-polar to sub-tropical waters of the North Atlantic (*glacialis*) and North Pacific (*japonica*).

*Water temperature preferences*: Sub-polar, temperate and sub-tropical.

*Habitat*: Primarily shelf waters, but also oceanic waters on occasions.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: Northward shift of species range in both oceans as both northern and southern limits move poleward in response to increasing water temperatures. However, the northern limit, which is likely to be determined by feeding habitat and the distribution of preferred prey, may shift to a greater extent than southern limit, which may be determined by locations of ancestral calving grounds. As a result, this may lead to an increased length of migrations.

*Conservation implication*: Unfavourable.

**Southern right whale** *Balaena australis*:

*Current range*: Sub-polar to sub-tropical waters of the southern hemisphere.

*Water temperature preferences*: Sub-polar, temperate and sub-tropical.

*Habitat*: Primarily shelf waters, but also oceanic waters on occasions and during migration.

*Climatic category*: CWWL.

*Likely effect of increases in water temperature on species/population range(s)*: Southward shift of species range as both northern and southern limits move poleward in response to increasing water temperatures. However, the southern limit, which is likely to be determined by feeding habitat and the distribution of preferred prey, may shift to a greater extent than northern limit, which may be determined by locations of ancestral breeding/calving grounds. As a result, this may lead to an increased length of migrations. In addition, this species appears to require sheltered coastal areas for breeding and calving. If there is a poleward shift in the northern limit of this species, the population that currently breeds/calves around southern tip of Africa may be at risk of extinction as there are no similar suitable sheltered coastal waters to the south of the current breeding/calving grounds. While populations that

breed/calve in other areas may be affected in a similar way, there are greater areas of alternative sheltered coastal habitats to the south of their current northern limit which they could utilise, and therefore they are likely to face a lower risk of extinction due to range shifts resulting from climate change.

*Conservation implication:* Unfavourable, but high risk for population that breeds in coastal waters of South Africa.

**Pygmy right whale** *Caperea marginata*:

*Current range:* Poorly known but possibly sub-polar to sub-tropical waters of the southern hemisphere.

*Water temperature preferences:* Possibly sub-polar, temperate and sub-tropical.

*Habitat:* Poorly known, but possibly cosmopolitan.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* As a CWWL species, there is likely to be a southward shift of species range as both northern and southern limits move poleward in response to increasing water temperatures.

*Conservation implication:* Unknown.

**Grey whales** *Eschrichtius robustus*:

*Current range:* Sub-polar to tropical waters of the North Pacific.

*Water temperature preferences:* Sub-polar, temperate and sub-tropical.

*Habitat:* Primarily shelf waters.

*Climatic category:* CWWL.

*Likely effect of increases in water temperature on species/population range(s):* Northward shift of species' range as both northern and southern limits move poleward in response to increasing water temperatures. However, the northern limit, which is more likely to be determined by feeding habitat and the distribution of preferred prey, may shift to a greater extent than southern limit, which may be determined by locations of ancestral calving grounds. As a result, this may lead to an increased length of migrations. With a sufficiently great increase in water temperature, it is possible that the cold water/sea ice barrier that currently prevents this species from accessing the North Atlantic through the Northwest Passage could be breached leading to a recolonisation of this region (where a previous population is thought to have become extinct by the 1700s). However, given the facts that the northern limit of this species is only occupied during summer months and the following of traditional migratory routes may limit movements through the Northwest Passage even if it were to come suitable for this species.

*Conservation implication:* Unchanged.

**Humpback whale** *Megaptera novaeangliae*:

*Current range:* All polar to tropical waters of the world, with the exception of the Mediterranean.

*Water temperature preferences:* Polar, sub-polar, temperate, sub-tropical and tropical.

*Habitat:* Shelf and oceanic waters.

*Climatic category:* Cosmopolitan.

*Likely effect of increases in water temperature on species/population range(s):* As a species with a cosmopolitan range, it is unlikely that the range of this species will be greatly affected by increases in water temperature resulting from climate change.

*Conservation implication:* Unchanged.

**Northern minke whale** *Balaenoptera acutorostrata*:

*Current range:* Polar to tropical waters of the northern hemisphere, with the exception of the eastern Mediterranean.

*Water temperature preferences:* Polar, sub-polar, temperate, sub-tropical and tropical.

*Habitat:* Shelf and oceanic waters.

*Climatic category:* Cosmopolitan.

*Likely effect of increases in water temperature on species/population range(s):* As a species with a cosmopolitan range, it is unlikely that the range of this species will be greatly affected by increases in water temperature resulting from climate change.

*Conservation implication:* Unchanged.

**Dwarf minke whale** *Balaenoptera acutorostrata* sub-species:

*Current range:* Sub-polar to tropical waters of the southern hemisphere.

*Water temperature preferences:* Sub-polar, temperate, sub-tropical and tropical.

*Habitat:* Shelf and oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* Potential for expansion of range into higher latitudes in the southern oceans.

*Conservation implication:* Favourable.

**Antarctic minke whale** *Balaenoptera bonaerensis*:

*Current range:* Polar to tropical waters of the southern hemisphere.

*Water temperature preferences:* Polar, sub-polar, temperate, sub-tropical and tropical.

*Habitat:* Shelf and oceanic waters.

*Climatic category:* Cosmopolitan.

*Likely effect of increases in water temperature on species/population range(s):* As a species with a cosmopolitan range, it is unlikely that the range of this species will be greatly affected by increases in water temperature resulting from climate change.

*Conservation implication:* Unchanged.

**Bryde's whale** *Balaenoptera edeni*:

*Current range:* Sub-tropical to tropical waters throughout the world, with the exception of the Mediterranean.

*Water temperature preferences:* Sub-tropical and tropical.

*Habitat:* Shelf and oceanic waters.

*Climatic category:* WWL.

*Likely effect of increases in water temperature on species/population range(s):* Poleward expansion of the species range as water temperatures increase. This may lead to increased mixing between Indian and Atlantic populations as water temperatures around the southern tip of Africa increase and the species' range expands south of this current barrier to mixing. In addition, the waters of the eastern Mediterranean appear to be suitable for this species given their current water temperatures. However, this species may currently be prevented from colonising this area by the cooler waters between its current northern limit in the eastern North Atlantic and the eastern Mediterranean. With increases in water temperature and a poleward expansion of this species range, it is possible that this cool water barrier may disappear and that this species may colonise the eastern Mediterranean and indeed other areas of this sea.

*Conservation implication:* Favourable.

**Fin whale** *Balaenoptera physalus*:

*Current range:* Polar to tropical waters of the world, with the exception of the eastern Mediterranean.

*Water temperature preferences:* Polar, sub-polar, temperate, sub-tropical and tropical.

*Habitat:* Primarily oceanic waters.

*Climatic category:* Cosmopolitan.

*Likely effect of increases in water temperature on spe-*

*cies/population range(s)*: As a species with a cosmopolitan range, it is unlikely that the range of this species will be greatly affected by increases in water temperature resulting from climate change.

*Conservation implication*: Unchanged.

**Blue whale** *Balaenoptera musculus*:

*Current range*: Polar to tropical waters of the world, with the exception of the Mediterranean.

*Water temperature preferences*: Polar, sub-polar, temperate, sub-tropical and tropical.

*Habitat*: Primarily oceanic waters.

*Climatic category*: Cosmopolitan.

*Likely effect of increases in water temperature on species/population range(s)*: As a species with a cosmopolitan range, it is unlikely that the range of this species will be greatly affected by increases in water temperature resulting from climate change.

*Conservation implication*: Unchanged.

**Sei whale** *Balaenoptera borealis*:

*Current range*: Sub-polar to tropical waters of the world, with the exception of the eastern Mediterranean.

*Water temperature preferences*: Sub-polar, temperate, sub-tropical and tropical.

*Habitat*: Primarily oceanic waters.

*Climatic category*: WWL.

*Likely effect of increases in water temperature on species/population range(s)*: Expansion into higher latitudes bordering on the existing species range.

*Conservation implication*: Favourable.

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