# Coordinated research framework to assess the national conservation status of Australian snubfin dolphins (*Orcaella heinsohni*) and other tropical inshore dolphins

Department of the Environment

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This Research Framework was developed through consultation with, and contributions from, leading cetacean researchers, statisticians, indigenous representatives and other stakeholders (see DSEWPaC 2013).

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## Executive Summary

Australian snubfin dolphins (*Orcaella heinsohni;* hereafter snubfin dolphin) are found throughout coastal waters of northern Australia. They live in small populations of approximately 50-100 individuals, inhabit shallow inshore and estuarine waters, exhibit fine-scale population structure and have relatively small home ranges. These biological characteristics render the snubfin dolphin vulnerable to anthropogenic threatening processes, including habitat degradation, fishery bycatch and vessel strike.

Globally, snubfin dolphins are listed as 'Near Threatened' by the International Union for Conservation of Nature (IUCN), listed in Appendix I of the Convention on International Trade in Endangered Species (CITES) as 'most Endangered', and listed on Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). As a result of being listed under the CMS they are included on the list of migratory species under the *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act).

Past efforts to nominate snubfin dolphins as a Threatened Species under the EPBC Act have been unsuccessful because the Threatened Species Scientific Committee concluded that a paucity of information precludes an assessment under the listing criteria of the EPBC Act.

The first step in developing this Research Framework was to determine which criteria would be most suitable for assessing the status of snubfin dolphins under the EPBC Act. The review ranked Criterion 3(B) as the highest priority for research. This criterion requires an estimate of the total number of mature individuals within the population; an indication of a continued decline and an assessment of the precariousness of the geographic distribution. Continued decline can be inferred or projected based on a number of indices including area of occupancy, number of locations and extent of suitable habitat. Research informing Criterion 1(A3) and Criterion 2 (see Appendix 1) could also be informative for an assessment but was considered a lower priority.

Given the outcome of the review this Research Framework aims to guide the delivery of the necessary information required for a future assessment of the snubfin dolphin under Criterion 3(B) of the EPBC Act. It should also serve to ensure that as funding sources arise they will be directed towards a planned, coordinated and strategic research strategy for this species. The Framework identifies three specific Research Objectives:

*Objective 1.* To conduct a broad-scale assessment of the extent of occurrence and area of occupancy of snubfin dolphins. This should include: a compilation of existing data sources; the development of an indigenous engagement and knowledge sharing strategy; the development of a temporally or spatially replicated presence/absence boat survey covering a large geographic range.

*Objective 2.* To conduct dedicated multi-year studies of the distribution, abundance and habitat use of snubfin dolphin at selected sites across northern Australia with differing levels of threatening processes. The studies would provide a plausible estimate of rate of change within sites and by extension, across the entire range.

*Objective 3.* To undertake a spatial and temporal risk assessment of current and projected threatening processes that impact snubfin dolphins.

The Research Objectives and associated Actions described within this Framework may also apply to other tropical dolphin species such as Indo-Pacific humpback dolphins (*Sousa chinensis*) and Indo-

Pacific bottlenose dolphins (*Tursiops aduncus*) which are also likely to be affected by similar anthropogenic threatening processes as snubfin dolphins.

It is recognised these ambitious objectives will require multiple funding sources and be conducted by many groups with varying and overlapping timeframes. Therefore to ensure adequate coordination and cooperation a Project Steering Committee will need to be established and supported to guide issues such as project funding, survey design, indigenous engagement, data sharing, data management, project reviews and communication. Such a committee would require support similar to that provided to Threatened Species Recovery Teams.

In addition to the establishment of the Steering Committee the following actions should be a priority: the establishment of a Methods Working Group to guide survey design; the development of an Indigenous Engagement Strategy in consultation with representatives of the Indigenous Advisory Committee, Ranger groups and other indigenous stakeholders; and the development of a Data Management Strategy.

## Abbreviations used

| | |
|---|---|
| CITES | Convention on International Trade in Endangered Species |
| CMS | Conservation of Migratory Species of Wild Animals |
| DSEWPaC | Department of Sustainability, Environment, Water, Population and Communities |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) |
| EPBC Regulations | *Environment Protection and Biodiversity Conservation Regulations 2000* |
| GIS | Geographic Information System |
| IAC | Indigenous Advisory Council |
| IUCN | International Union for Conservation of Nature |
| NAILSMA | Northern Australian Indigenous Land and Sea Management Alliance |
| PAM | Passive Acoustic Monitoring |
| TSSC | Threatened Species Scientific Committee |

# Introduction

## a) Species information

**Description**

The Australian snubfin dolphin, *Orcaella heinsohni,* hereafter 'snubfin dolphin', was described as a separate species in 2005 (Beasley et al., 2005). Previously it had been regarded as an unnamed population of Irrawaddy Dolphin (*Orcaella brevirostris*). The characteristics of snubfin dolphins on surfacing include a robust, low, rounded melon; a virtually beakless appearance with straight mouth line angled upwards; a long flexible neck often with a clear neck crease; and a smooth back. The dorsal fin, set on the mid-back, is small, triangular and slightly falcate with a pointed tip (Shirihai and Jarrett, 2006).

**Distribution and habitat**

Australian snubfin dolphins are potentially found throughout coastal waters of northern Australia, including Queensland, Northern Territory and Western Australia (Parra and Ross, 2009; Robertson and Arnold, 2009; Allen et al., 2012). The current estimate of extent of occurrence for snubfin dolphins is 93,070 $km^2$ comprised of: 38,400$km^2$ for Queensland, 33,050$km^2$ for Northern Territory, and 21,620$km^2$ for Western Australia (WWF 2011 snubfin dolphin nomination).

**Figure 1: An indicative distribution map of the present distribution of the species based on best available knowledge (Department of the Environment)[1,2].**

**Ecology, population status and threats**

Information on the ecology and population status of snubfin dolphins is scarce, with detailed information only available for a few selected areas along Queensland's east coast (Corkeron et al., 1997; Parra and Corkeron, 2001; Parra et al., 2004; Chilvers et al., 2005; Parra, 2006a; Parra et al., 2006a; Parra et al., 2006c; Parra, 2007; Parra and Jedensjö, 2009; Parra and Ross, 2009; Cagnazzi et al., 2011; Parra et al., 2011), Northern Territory (Palmer et al., 2008; Palmer, 2009; Palmer, 2010; Palmer et al., 2011) and Western Australia (Thiele, 2005; Thiele, 2008; Thiele, 2010a; Thiele, 2010b). For a comprehensive review of the state of knowledge of inshore dolphins in northern Australia see Beasley et al. (2012a). Evidence from these studies indicates that snubfin dolphins live in small

[1] It is recognised that snubfin dolphins have been positively identified outside this indicative range and research conducted under the auspices of this Research Framework should take these into account when designing surveys.

[2] A digital map that can be searched at finer scales will be produced by the Scientific Methods Working Group.

populations of approximately 50-100 individuals (Parra et al., 2006a; Cagnazzi et al., 2011), inhabit mainly shallow inshore and estuarine waters (Parra et al., 2004; Parra, 2006a; Parra et al., 2006c), feed on a wide variety of fish and cephalopods associated with these inshore habitats (Parra and Jedensjö, 2009), exhibit genetic population structure and low gene flow between populations (Cagnazzi, 2010; Parra et. al. unpublished), and have relatively small home ranges (Parra, 2006b; Cagnazzi, 2010; Cagnazzi et al., 2011). In general, snubfin dolphins appear to exist as a metapopulation; a group of spatially separated populations (subpopulations) which interact at some level. However, it also appears that there are relatively isolated local populations (Cagnazzi, 2010).

The biological features discussed above, render the Australian snubfin dolphin particularly vulnerable to anthropogenic threatening processes, including habitat degradation caused by coastal zone development and pollution, injury or mortality caused by gillnetting, and vessel strike (for examples refer to Figure 2).

**Conservation status**

Globally, snubfin dolphins are listed as 'Near Threatened' by the International Union for Conservation of Nature (IUCN), listed in Appendix I of the Convention on International Trade in Endangered Species (CITES) as 'most Endangered', and listed on Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). As a result of being listed under the CMS they are included on the list of migratory species under the EPBC Act.

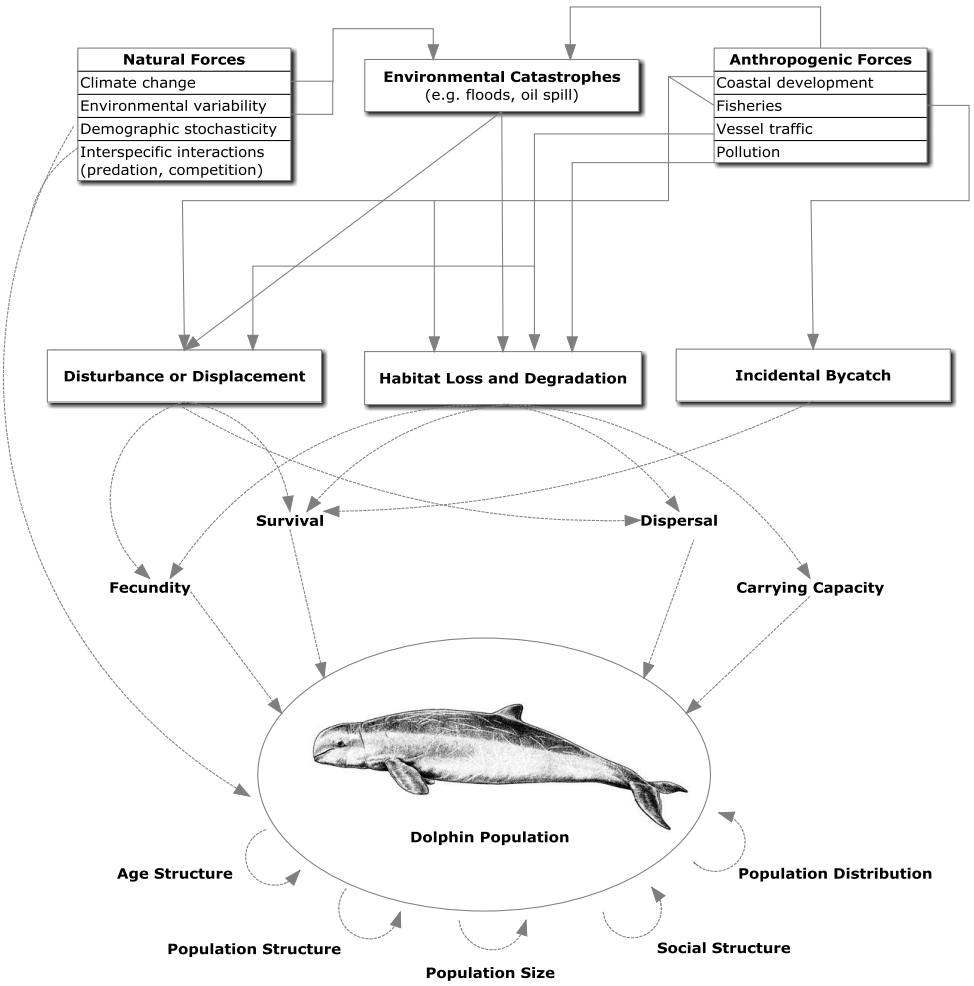


**Figure 2: Draft conceptual model of the multi-scale factors influencing the population dynamics of snubfin and humpback dolphins (Parra et al., 2012).**

## b) The need for a Research Framework

Concerns about the conservation and management of snubfin dolphins have been raised due to the species' vulnerability to anthropogenic threats and the rapid development of the coastline throughout much of species' range (Parra et al., 2006b; Cagnazzi, 2010; Bejder et al., 2012). Despite these concerns, the assessment of snubfin dolphins' national conservation status is currently constrained by the lack of adequate information on distribution, population size and trend.

Past efforts to nominate snubfin dolphins for listing as 'Vulnerable' under Criteria 1 and 2 of the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) in 2011 were unsuccessful. The Threatened Species Scientific Committee decided there was currently insufficient information to assess the species against the listing criteria of the EPBC Act (see Appendix 1; Beasley et al., 2012b).

The conservation status of Threatened Species under the EPBC Act reflects the species' risk of extinction. This risk is assessed using information on the species' population dynamics (population size and trends, population structure) and the key biological and environmental factors influencing those dynamics (distribution, behaviour, life history, habitat use, and the effects of human activities). Why dolphin populations increase or decrease is complex and involves many variables; Figure 2 presents a conceptual model of the multi-scale factors influencing the population dynamics of snubfin dolphins (Parra et al., 2012).

Addressing the information gaps in snubfin dolphin ecology and population dynamics requires a coordinated, structured, hierarchical, large-scale research effort that is 1) spatially comprehensive; 2) rigorous in the treatment of sampling error; and 3) sustainable over the time scales necessary to detect population trends or changes in distribution. However, given the snubfin dolphins' small, isolated populations, their large distribution geographical (including throughout remote northern Australia); their inconspicuous surfacing behaviour; and the limited financial resources available to carry out comprehensive monitoring, there are considerable challenges to obtain this information. The collection of will data require significant financial and logistical resources and a coordinated, strategic approach to long term monitoring of snubfin dolphin populations guided by a set of priority objectives and actions, hence the development of this research framework.

## c) Scope of the coordinated research framework

The scope of this Research Framework is to stimulate and guide research aimed at the provision of information required to assess the conservation status of Australian snubfin dolphins (*Orcaella heinsohni*) under the EPBC Act. Nevertheless, other tropical inshore dolphins such as Indo-Pacific humpback dolphins (*Sousa chinensis*) and Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) have similar life history traits and may also be impacted by similar threatening processes as those affecting snubfin dolphins. Therefore, when appropriate, any research conducted under the auspices of this framework should also opportunistically collect information on other tropical inshore dolphin species.

## Appropriate criteria for listing snubfin dolphins under the EPBC Act (1999)

A review of the EPBC listing criteria for an assessment of snubfin dolphins was undertaken during a two-day workshop held in Melbourne, 10-11 December 2012 (DSEWPaC 2013). This workshop assessed the likelihood of being able to provide the necessary information to apply one or more of the five listing criteria within a reasonable timeframe given the likely logistical and financial constraints of studying this species. The ranked criteria for an assessment of snubfin dolphins is presented in Table 1.

The workshop agreed Criterion 3(B) was the most likely criterion under which an assessment could be completed. This criterion specifies that a species is eligible for listing if the estimated total number of mature individuals is determined to be very low, low or limited and evidence suggest that either the number will continue to decline at a very high to substantial rate, or the number is likely to continue to decline and the species' geographic distribution is precarious for its survival. Precariousness is judged on a case by case basis with regard to the degree of threat operating on the species (see Appendix 1).

Criterion 3(B) was considered most suitable for targeted research because it is logistically feasible, (although still very challenging) to: assess the geographic extent and occupancy of snubfin dolphins; the threats to the species' habitat and survival; and to derive an index or order of magnitude of the total number of mature adults. The latter may be possible through calibration of sighting rates at sites surveyed for presence/absence or occupancy against sighting rates at more intensively studied sites. This would require mark-recapture studies to follow a transect design that allows the area surveyed and number of sightings per length of transect to be derived (see Appendix 2).

Monitoring snubfin dolphins throughout their range in Australia in order to estimate abundance and changes in abundance over time would be extremely difficult. However, it may also be possible to document or project a decline for snubfin dolphins over its entire range if declines were observed at intensively studied focal sites and the threatening processes underlying these declines shown to operate over a large spatial scale (Brooks et al., 2014). Therefore, Criteria 1 (A3) was deemed to be medium priority because with new data from focal study sites it may be possible to argue a suspected decline within the next 10 years if these dolphins are shown to be vulnerable to expanding anthropogenic threats. Similarly, Criterion 2, which relates to declines in geographic distribution, was also ranked as a medium priority because in time it may be possible to document changes in the area of occupancy (B2).

Criteria 4 (total number of mature individuals) and 5 (probability of extinction) were deemed to be low priority for research because snubfin dolphins are unlikely to qualify under the former (<1000 adults) and our understanding of the biology of snubfin dolphins is too poor to construct a quantitative population viability analysis for the latter.

Given the outcome of the review of listing criteria, research conducted under this Research Framework should focus on collecting data to inform an assessment of snubfin dolphins under Criterion 3(B) with the understanding that information could also be used to assess snubfin dolphins against Criteria 1(A3) and 2.

**Table 1: Criteria for listing under the EPBC Act (1999) and their research priority for a future assessment of snubfin dolphins (*cf*. Appendix 1)**

| Criteria | Content | Priority for research |
|---|---|---|
| **Criterion 1 Reduction in numbers** | A1 – An observed, estimated, inferred or suspected population size reduction over the last 10 years or 3 generations where causes are reversible and understood and ceased, based on any of the following:<br>a) Direct observation<br>b) An index of abundance appropriate to the species<br>c) A decline in area of occupancy, extent of occurrence and/or quality of habitat<br>d) Actual or potential levels of exploitation<br>e) The effects of introduced species, hybridization, pathogens, pollutants, competitors or parasites | Low |
| | A2 – An observed, estimated, inferred or suspected population size reduction over the last 10 years or 3 generations where causes may not be reversible or not understood or not have ceased, based on any of a) to e) above. | Low |
| | A3 – A population size reduction projected or suspected to be met within the next 10 years or 3 generations, based on any of b) to e) above. | Medium |
| | A4 – An observed, estimated, inferred or suspected population size reduction over the last 10 years or 3 generations where time period must include both past and future and where reduction or its causes may not have ceased or may not be understood or may not be reversible, based on any of a) to e) above. | Low |
| **Criterion 2 Geographic distribution** | B1 Extent of occurrence<br>B2. Area of occupancy<br><br>Geographic distribution is precarious based on at least two of a) to c).<br>a) Severely fragmented or known to exist at a limited location<br>b) Continuing decline, observed, inferred or projected, in any of the following:<br>i. extent of occurrence<br>ii. area of occupancy<br>iii. area, extent and/or quality of habitat<br>iv. number of locations or subpopulations<br>v. number of mature individuals<br>c) Extreme fluctuations in any of the following:<br>i. extent of occurrence<br>ii. area of occupancy<br>iii. number of locations or subpopulations<br>iv. number of mature individuals | Medium |
| **Criterion 3 Total number of mature individuals** | Number of mature individuals is < 10,000 and either (A) or (B) is true:<br>(A) Rate of continued decline (see Appendix 1) **or**<br>(B) Continued decline **and** geographic distribution is precarious, based on at least two of a) to c):<br>a) Severely fragmented or known to exist at a limited location.<br>b) Continuing decline, observed, inferred or projected, in any of the following:<br>i. extent of occurrence<br>ii. area of occupancy<br>iii. area, extent and/or quality of habitat<br>iv. number of locations or subpopulations<br>v. number of mature individuals<br>c) Extreme fluctuations in any of the following:<br>i. extent of occurrence<br>ii. area of occupancy | **High**<br>**PRIMARY CANDIDATE** |

| Criteria | Content | Priority for research |
|---|---|---|
| | iii. number of locations or subpopulations<br>iv. number of mature individuals | |
| **Criterion 4 Total number of mature individuals only** | The estimated total number of mature individuals is < 1,000 | Low |
| **Criterion 5 Probability of extinction** | Probability of extinction in the wild (see Appendix 1) | Low |

## Prioritised research objectives and associated actions required for the assessment of the conservation status of snubfin dolphins under the EPBC Act (1999)

To obtain sufficient data to assess snubfin dolphins under Criterion 3(B) will require coordinated research over a large spatial area and over several years of effort. Therefore, it is important to set realistic objectives that take into account the likely logistical, analytical and financial constraints of monitoring this species.

There will need to be broad scale surveys to elucidate the distribution and occupancy of snubfin dolphins and estimate the total number of mature adults; fine-scale studies to investigate snubfin dolphin abundance, life history parameters, habitat preferences and vulnerability to anthropogenic disturbance; and a review of the current and projected distribution of threatening processes that impact snubfin dolphins.

Therefore, three objectives have been identified:

> **Objective 1.** Conduct a broad-scale assessment of the extent of occurrence and area of occupancy of snubfin dolphins in Australia (Timeframe: 3-5 years).
>
> **Objective 2.** Conduct dedicated multi-year studies of the distribution, abundance and habitat use of snubfin dolphins at selected focal sites across northern Australia (Timeframe: 5-8 years).
>
> **Objective 3.** Undertake a spatial and temporal risk assessment of the threatening processes to snubfin dolphins (Timeframe: 1 year).

These three objectives and the actions required against each are discussed in detail below.

## Objective 1: Conduct a broad-scale assessment of the extent of occurrence of snubfin dolphins in Australia (Timeframe: 3-5 years)

### a) Background and challenges

The paucity of data currently available on the distribution, abundance and population dynamics of snubfin dolphins is a major constraint to a formal assessment of their conservation status under

EPBC criteria. Indeed, the lack of adequate information on these aspects was a key factor in the Threatened Species Scientific Committee's (TSSC) decision to not recommend it be included on the Proposed Priority Assessment List in 2011.

A major challenge associated with collecting information to assess snubfin dolphin conservation status using Criterion 3(B), or indeed Criteria 1(A3) and 2, is that we currently have a poor understanding of the actual spatial distribution of snubfin dolphins. Snubfin dolphins are thought to be widely distributed along the northern Australian coastline but no dedicated wide-scale surveys have been conducted. At present, their distribution is inferred primarily from local studies, strandings, museum records and aerial surveys for other species. This precludes an accurate estimation of their *extent of occurrence* (i.e. area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy) and *area of occupancy* (i.e. area within its 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy). Both measures are essential for assessing a decline in population size, extent of occurrence, area of occupancy, and extent of habitat; and for assessing the precariousness of the snubfin dolphin's geographic distribution under Criterion 3(B) (as well as Criteria 1(A3) and 2.

A second major challenge is that, at present, there are no national population estimates or indices of abundance available for snubfin dolphins. Population estimates are only available for a few selected locations along Queensland's east coast. Moreover, snubfin dolphins appear to occur in relatively small populations rendering the detection of any population changes and trends extremely difficult and unacceptable as a key population assessment strategy (i.e. power analyses indicate that by the time population decline is detected populations would be at extremely low numbers (Parra et al., 2012).

Nevertheless, in order to address Criterion 3(B) or 1(A3) some estimate or index of abundance is necessary. Formal abundance estimation at all sites where snubfin are found to occur is not feasible given the effort and expense required to sample for this over the whole range. Moreover, survey platforms that would allow the coverage of large areas, such as aerial surveys, have proven inefficient due to problems of species identification in either turbid waters or lack of 'closing-mode' protocols (i.e. survey effort suspended to circle back animals sighted) to confirm species identification[3]. However, it may be possible to derive an index of abundance through calibration of sighting rates at sites surveyed (by boat) for presence/absence or occupancy against sighting rates during carefully designed transect surveys at focal study sites (see Objective 2), where formal abundance estimates are available. It may also be possible to derive abundance estimates for some sites (where dolphin density or sampling effort are greater) from a broad scale occupancy study that uses information on the number of sightings on transect segments rather than simply the observation that there was either at least one or none (N-Mixture models, Royle, 2004). Both Criteria 3(B) and 1(A3) also allow inferences about population trends to be derived using measures of habitat quality, rather than being restricted to direct estimates of population number and direct observation of trends.

## b) Recommended actions

*1.1. Compile and map (GIS) all snubfin dolphin location data available throughout their range from, e.g., previous, dedicated aerial and boat surveys, stranding databases, whale*

[3] It is recognised that the dedicated use of aerial surveys for snubfin dolphins has proven successful in some areas (e.g. Port Alma and Port Curtis; Isabel Beasley personal communication), and helicopter surveys can be used to assess hotspots.

*watching tours, published literature, Environmental Impact Assessment reports, and wildlife management agencies databases, and use the results (alongside those from Action 3.1) to inform Action 1.5.*

Given the huge extent of occurrence and area of occupancy of snubfin dolphins (Beasley et al. 2012a), there is a clear need to compile existing information and subsequently mount a carefully designed, dedicated survey effort that, where possible, engages indigenous Ranger programs. Data on the sighting locations of snubfin dolphins for different areas along their distribution are currently available from different data sources and survey platforms. However these data are in different formats and collated in disparate databases. Data from these different sources should be brought together into a single Geographic Information System (GIS) database for display, storage, and analysis. This data set can provide a baseline for the estimation of the actual extent of occurrence and area of occupancy of snubfin dolphins at a coarse-scale across northern Australia. Both are key parameters for assessing the conservation status of the species.

1.2. *Develop an indigenous engagement strategy and conduct a series of community mapping and knowledge sharing workshops in both remote and urban regions to record the knowledge of traditional owners and other stakeholders on tropical inshore dolphins.*

1.3. *Investigate the utility of the Indigenous Tracker Program (I-Tracker; NAILSMA) to assist with Actions 1.1 and 1.5; and*

1.4. *Engage with Rangers, community members and research groups to conduct structured surveys to obtain information on occupancy to contribute to Actions 1.1 and 1.5. An agreement on data sharing arrangements will be required.*

Information on the occurrence of snubfin dolphins in the northern region of Australia is scarce due to the large spatial extent and remoteness of this area. A collaborative and integrative approach is required in these remote regions, and others, that harness the capacity of indigenous communities and other stakeholders (e.g. local fishers) to monitor marine wildlife using their knowledge and logistical capacity, in conjunction with scientific techniques. Thus, a series of community mapping and knowledge sharing workshops should be conducted in both remote and urban regions throughout the dolphins' range to record the indigenous knowledge of traditional owners and other stakeholders. This knowledge can then be used to design and conduct dedicated surveys in collaboration with local Ranger groups as well as provide communities with information that assists their sea management activities. A process to collect such data has already been tested (Marsh et al., 2010; Grech et al., in review) and refinements and expansion of these methods to other areas are currently underway (Isabel Beasley, personal communication).

1.5. *Design (based on the results of Action 1.1.) and conduct temporally or spatially replicated presence/absence, boat-based surveys over large-scale areas in both remote and urban regions of Australia*.

Uncertainty in the estimation of extent of occurrence and area of occupancy can be minimised through temporally or spatially replicated presence/absence sampling effort in both remote and urban regions of Australia. Dedicated boat-based surveys should be conducted to monitor presence/absence or occupancy of snubfin dolphins, in collaboration with adequately trained and assisted Rangers and/or community members. Data on the environmental characters of the habitats sampled should also be collected during the surveys to inform our understanding of the probability of occupancy and/or precariousness of geographic distribution based on environmental information such as habitat quality. Efforts should be made to include a range of habitats of varying quality in the

study. Although logistically difficult and expensive to implement, such broad-scale surveys are urgently needed to address information gaps and to provide data that can also assist in meeting Objectives 2 and 3.

1.6. *Explore the use of new techniques, e.g. Passive Acoustic -Monitoring (PAM), alongside boat-based surveys for broad-scale assessment of snubfin dolphin occurrence.*

The use of Passive Acoustic Monitoring (PAM) alongside boat-based surveys should be explored to aid the broad scale assessment of snubfin dolphin occurrence. PAM can add a temporal dimension to presence/absence/occupancy and is especially useful in areas where data are currently lacking. However, careful consideration would be required as PAM needs to be conducted in areas with low levels of ambient noise.

## Objective 2: Conduct dedicated multi-year studies of the distribution, abundance and habitat preferences of snubfin dolphins at selected focal sites across northern Australia (Timeframe: 5-8 years for)

### a) Background and challenges

Criterion 3 (B) (and Criterion 2) recognises that a decrease in the number of locations or subpopulations (as well as extent of occurrence, area of occupancy and abundance) is indicative of decline. Evidence suggests that snubfin dolphins are likely to exist as a metapopulation (small groups of interconnected subpopulations). For example, recent genetic studies demonstrated that snubfin dolphin populations along the urban coast of Queensland are genetically differentiated into at least three distinct clusters (northern, central and south Queensland) and that there appear to be low migration rates between these clusters (Cagnazzi, 2010; Parra et. al. unpublished data). This renders each subpopulation susceptible to extinction if rates of dispersal between subpopulations are adversely affected (Tilman et al., 1994; Hanski, 1998) or if there is a loss of genetic variation in populations with abnormally low immigration and small population sizes (Forney and Gilpin, 1989; Frankham, 1995; Bouzat et al., 1998; Bouzat, 2000), leading to serious concerns about the conservation and long-term survival of snubfin dolphins.

Research conducted under Objective 2 should focus on providing abundance estimates for selected focal study sites (see Action 2.1) that can then be used in concert with information collected under Objective 1 to derive local abundance estimates as well as information on metapopulation structure, dispersal and fragmentation. This information can then be used to derive an estimate of the total abundance across the species' entire range.

The collection of biopsy samples from snubfin dolphins, although feasible, has proven to be time consuming because of their inconspicuous surfacing behaviour, boat-avoidance behaviour and low population densities. However, quantifying the genetic variability and gene flow, or lack thereof, among wild populations of snubfin dolphins throughout their geographical range, and subsequently estimating the isolation/connectivity of their populations, could aid an assessment snubfin dolphin conservation status. Therefore, the collection of biopsy samples alongside focal site surveys should occur if it does not compromise the effectiveness and efficiency of the actions outlined below.

### b) Recommended actions

2.1 *Estimate abundance and assess population dynamics at strategically selected sites across the range of snubfin dolphins.*

The selection of sites should ensure that there is adequate representation of the habitat types across the range of snubfin dolphins. It should also ensure that a range of impact levels are also considered. Information derived from Objective 1 should be used to inform site selection where possible. Sites for which snubfin dolphin data already exist (cf. Parra et al., 2012) may be preferable to allow continued research on population demography, trends and habitat characteristics. Some of the focal study sites selected should be subject to coastal development, while others should remain relatively undisturbed (as quasi-controls). This will allow an assessment the vulnerability of snubfin dolphin populations to various threatening processes that are likely to be operating across the range of the species.

*2.2 Employ a photo-identification mark-recapture approach at the selected sites.*

There are two main methods for assessing cetacean abundance: 1) mark–recapture methods in which estimates of abundance are generated based on re-sightings of naturally or artificially marked individuals through photo-Identification (Hammond et al., 1990) and, 2**)** sighting surveys in which individual animals or groups of animals are counted and density estimates generated using distance sampling and/or spatial modelling techniques (Buckland et al., 2001). Mark-recapture methods have been used successfully in the past for estimating the abundance of snubfin dolphins at small spatial scales (Parra et al., 2006b; Cagnazzi et al., 2011) and a similar boat-based transect-design, mark-recapture approach should be followed at the focal sites over multiple years. Data on the environmental characters of the habitats sampled should also be collected during the surveys. It is critical that the methods should be coordinated and standardised across sites so that data are easily comparable. Particular care should be taken to design and implement a sampling strategy that links the focal studies undertaken under Objective 2 with the broad-scale studies conducted under Objective 1.

*2.3 Investigate the feasibility of using occupancy as a surrogate for abundance estimation.*

Decline in area of occupancy can also be used to assess the population status of snubfin dolphins. A positive relationship between estimates of the probability of occupancy and the average density of individuals has been found in a wide variety of taxa (Gaston et al., 2000), including cetaceans (Hall et al., 2010). This is particularly valuable for species occurring at very low densities, such as snubfin dolphins, where it may be prohibitively expensive to estimate their actual abundance, particularly over large spatial scales. Determining whether snubfin dolphins are present at a sampling location may be much less costly than collecting the relevant information for estimating abundance through mark-recapture or sightings surveys. Moreover, distinct from presence/absence approaches, occupancy modelling accounts for imperfect detection by simultaneously estimating the probability of occurrence and the probability a species is detected (through multiple visits to sampling sites or surveying a set of spatial replicates – sub-sites) as a function of environmental variables (Mackenzie et al., 2002). Thus, occupancy modelling can also provide important information on species-habitat relationships, their stability over time and the potential drivers behind current trends. Direct ways to estimate occupancy and its changes in time have been developed (Mackenzie et al., 2002; Mackenzie and Nichols, 2004; Mackenzie and Royle, 2005). The implementation of these models to the study of snubfin dolphins should be explored by a Methods Working Group (see below).

## Objective 3: Undertake a spatial and temporal assessment of the threatening processes and risks to snubfin dolphins (Timeframe: 1 year)

### a) Background and challenges

In addition to the lack of information on the distribution, abundance, population structure and dynamics, and life history of snubfin dolphins, the impact of human activities remains largely unknown. The main reasons for this are the lack of: 1) a broad quantitative account of the extent of snubfin dolphin habitat and the extent potentially affected/altered by coastal development, 2) assessment of risks to snubfin dolphins from anthropogenic activities associated with coastal zone developments and 3) the lack of adequate impact studies. This information is required in order to make predictions about future reductions in population size, distribution (extent of occurrence, area of occupancy, area, extent and/or quality of habitat) and population structure (number of locations or subpopulations, and number of mature individuals).

Parra et al. (2012) suggested the biggest challenges in assessing the effects of human activities on snubfin dolphin populations to be: difficulties in obtaining accurate data on activities already known to have had a direct impact on populations (i.e. bycatch from incidental entanglements in gillnets and shark nets set for bather protection); and the lack of baseline data on the status of most populations before an impact takes place. Moreover, given the complexity of ecological and environmental variability in marine ecosystems separating the effects of human activities on coastal dolphins from natural ecological and environmental variability is difficult.

An effective assessment of human impacts on snubfin dolphins will depend on: distinguishing change due to ecological and environmental variability from that associated with human activities; robust statistical assessment of the impact; and assessments of the biological/ecological significance of the impact. Some of these challenges can be overcome through the implementation and design of appropriate impact studies and improvement of collection of information (e.g. the number of interactions between fishing gear and dolphins). Data generated under Objective 2 should be used to inform the work conducted under Objective 3 and vice versa.

## b) Recommended actions

3.1. *Identify the areas of snubfin dolphin habitat likely to be impacted by threatening processes*[4] *and link this to the information collected in Action 1.1 to map the current knowledge of snubfin distribution.*

The use of Geographic Information Systems (GIS) to integrate spatially explicit data on anthropogenic activities (e.g. gill-net fishing, vessel traffic, coastal zone development) and intrinsic factors (e.g. abundance, site fidelity, ranging patterns) that affect the vulnerability of cetaceans have been used to define the vulnerability of cetacean habitats to human activities (Grech and Marsh, 2008; Cubero-Pardo et al., 2011). These approaches are particularly valuable in large geographic regions where information is limited and where experimental designs to assess the response of cetaceans to the development of human activities are hard to implement or require long-term studies.

A spatial and temporal assessment of the threats facing snubfin dolphin populations should be undertaken based on recent, past and proposed activities, developments and leases. All relevant agencies should be encouraged to collate spatial information about current and projected coastal development because the impacts of such development extend beyond snubfin dolphins to other marine species.

[4] Threatening processes include but are not limited to, coastal development, port development and coastal/undersea mining (includes habitat modification, noise, water quality) impacts; gill and shark nets; vessel strikes.

3.2. *Where appropriate, conduct sensitivity analyses to assess the vulnerability of each snubfin dolphin population.*

The mapping of patterns in cumulative human-use impacts to marine ecosystems (e.g. Halpern et al., 2008) allows sensitivity analyses to be conducted and estimations of 'plausible impact' to be made. Information such as this may prove useful in assessing the conservation status of snubfin dolphins under Criteria 3, 1(A3) and 2 of the EPBC Act, in particular in assessing precariousness of the species' geographic range and inferring potential population declines as for Action 3.1.

## Coordination, timelines and indicative costs

The Actions described above will be undertaken by a range of institutions, organisations and groups including researchers and indigenous communities. It is anticipated that this work will be undertaken over a period of five to ten years. Funding will come from a variety of private, industry and government sources. To ensure that work undertaken under the framework is efficiently and effectively delivered, and does not duplicate work already completed, a Project Steering Committee must be established. The Project Steering Committee will include representatives from indigenous communities, State, Territory and Commonwealth governments, research organisations, and NGOs. A Committee of this nature will require support of a similar nature to Threatened Species Recovery Teams. The committee will oversee the following:

1. *Methods Working Group*

An underlying premise of broad-scale and fine-scale surveys is that their design is simple and indicator variables are straightforward, unambiguous and replicable. Appendix 2 provides a detailed report of a Methods Working Group set up to make recommendations for robust, survey designs and statistical approaches for assessing the conservation status of snubfin dolphins over different scales. In order to deliver against framework there will need to be additional development of specific methodologies, a statistical approach and survey designs required to meet each of the prioritised objectives. Survey designs and research protocols should continue to be developed by a Methods Working Group and the information generated shared between all those involved in the broader project.

2. *Data management*

To be able to undertake the analysis of data collected across the range of snubfin dolphin there will need to be processes that will allow for the sharing of data or preferably a central repository for all data. The Project Steering Committee will need to oversee the development of a data management strategy in close consultation with the Methods Working Group.

3. *Stakeholder engagement*

The delivery of work under the framework will involve a variety of organisations with one of the most importation groups being traditional owners. To facilitate good working relationships between researchers and indigenous communities one of the first actions for the project coordination committee must be the development of an Indigenous Engagement Strategy.

4. *Financial management*

Funding for the framework will likely come from a number of sources. It has been suggested that some could come in the form of offset payments from projects approved under the EPBC Act. It would be desirable to explore options for receiving and dispersing funds paid in this way. In addition the Project Steering Committee must also update the estimated costs of actions under the framework.

*5. Monitoring and review*

As Actions are addressed there needs to be a periodic review of progress against the overall objectives of the framework. This will ensure that adjustments to methods or engagement activities are made when necessary.

The timelines and estimated costs of each objective within the Research Framework are presented in Table 2. These require detailed refinement based on methodological development and stakeholder engagement.

**Table 2: Indicative costs for prioritised objectives**

| Objective | Items | Cost (AUD) |
|---|---|---|
| **1 – Conduct a broad scale assessment of the distribution of snubfin dolphins in Australia** | Existing data and ongoing programmes<br>Collecting new data (5 year research effort)<br><br>Start up planning and documents:<br>• Indigenous Engagement Strategy<br>• Centralised data repository (basic; photo ID and survey)<br>• Centralised data repository (sophisticated including online photo ID catalogue)<br>• Annual meeting of steering group | 100,000<br>5 million<br><br><br>30,000<br>60,000<br><br>700,000<br><br>30,000 |
| **2 – Abundance and demography at selected sites** | 18 days, two boats, twice per annum, 3 personnel per boat for at least 3 regions (with representative habitat differences) and 3 impact levels, over 5 years. | 200,000 per year per site |
| **3 – Undertake a spatial assessment of the threatening processes and risks to snubfin and humpback dolphins** | • Desk exercise, 1 person over 1 year | 100,000 |

## Conclusions and general remarks

The objectives and actions recommended in this Research Framework are not exhaustive, but serve as a guide for prioritising the research required to assess the conservation status of snubfin dolphins under the EPBC Act.

The scope of this Research Framework is the provision of information required to assess the conservation status of snubfin dolphins under the EPBC Act, specifically Criterion 3(B). Nevertheless, the recommendations herein are also applicable to Indo-Pacific humpback dolphins and other tropical inshore species because of their similar life history traits and the similar challenges associated with collecting information about them. Therefore, any research conducted under the auspices of this Research Framework should also endeavour to collect information about Indo-Pacific humpbacks and other inshore dolphin species.

This Research Framework acknowledges that indigenous cultural heritage values may be relevant to sites occupied by snubfin dolphins, and that it is important to work in partnership with traditional owners and indigenous communities to ensure that cultural heritage values are supported and protected.

## Acknowledgements

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## References

Allen SJ, Cagnazzi DDB, Hodgson AJ, Loneragan NR, Bejder L, 2012. Tropical inshore dolphins of north-western Australia: Unknown populations in a rapidly changing region. Pacific Conservation Biology 18.

Beasley I, Allen S, Parra GJ, 2012a. Current status of inshore dolphins in Northern Australia. In: Final report to DSEWPaC.

Beasley I, Allen S, Parra GJ, 2012b. Review of Australian snubfin dolphin nomination for listing as threatened species under the EPBC Act. In: Final report to DSEWPaC.

Bejder L, Hodgson AJ, Loneragan NR, Allen SJ, 2012. Coastal dolphins in north-western Australia: The need for re-evaluation of species listings and short-comings in the Environmental Impact Assessment process. Pacific Conservation Biology 18.

Bouzat JL, 2000. The importance of control populations for the identification and management of genetic diversity. Genetica 110:109-115.

Bouzat JL, Cheng HH, Lewin HA, Westemeier RL, Brawn JD, Paige KN, 1998. Genetic evaluation of a demographic bottleneck in the greater prairie chicken. Conservation Biology 12:836-843.

Brooks L, Carroll E, Pollock KH, 2014. Proposed sampling and statistical methods for assessment of the conservation status of Australian snubfin (*Orcaella heinsohni*) and other inshore dolphins. In: Unpublished report, Australian Marine Mammal Centre, Dept of the Environment; 11.

Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers, D.L., Thomas L, 2001. Introduction to distance sampling: Estimating abundance of biological populations. Oxford: Oxford University Press.

Cagnazzi D, 2010. Conservation Status of Australian snubfin dolphin, *Orcaella heinsohni*, and Indo-Pacific humpback dolphin, *Sousa chinensis*, in the Capricorn Coast, Central Queensland, Australia (PhD Thesis). Lismore: Southern Cross University.

Cagnazzi DDB, Harrison PL, Ross GJB, Lynch P, 2011. Abundance and site fidelity of Indo-Pacific Humpback dolphins in the Great Sandy Strait, Queensland, Australia. Marine Mammal Science 27:255-281.

Chilvers BL, Lawler IR, Macknight F, Marsh H, Noad M, Paterson R, 2005. Moreton Bay, Queensland, Australia: an example of the co-existence of significant marine mammal populations and large-scale coastal development. Biological Conservation 122:559-571.

Corkeron PJ, Morissette NM, Porter LJ, Marsh H, 1997. Distribution and status of hump-backed dolphins, *Sousa chinensis*, in Australian waters. Asian Marine Biology 14:49-59.

Cubero-Pardo P, Donovan C, Urbán-Ramírez J, 2011. A proposal to define vulnerability of cetacean areas to human development: variables and analysis procedures applied to the Gulf of California. Aquatic Conservation: Marine and Freshwater Ecosystems 21:433-447.

DSEWPaC, 2013. Report of the technical workshop on the research strategy to assess the status of the Australian snubfin dolphin (*Orcaella heinsohni*) and other inshore dolphins. In: Melbourne, Australia, December 2012.

Forney KA, Gilpin ME, 1989. Spatial structure and population extinction: a study with *Drosophila* flies. Conservation Biology 3:45-51.

Frankham R, 1995. Inbreeding and extinction: A threshold effect. Conservation Biology 9:792-799.

Gaston KJ, Blackburn TM, Greenwood JJD, Gregory RD, Quinn RM, Lawton JH, 2000. Abundance–occupancy relationships. Journal of Applied Ecology 37:39-59.

Grech A, Marsh H, 2008. Rapid Assessment of Risks to a Mobile Marine Mammal in an Ecosystem-Scale Marine Protected Area. Conservation Biology 22:711-720.

Grech A, Parra GJ, Beasley I, Bradley J, Johnson JE, Whiting S, Ii-Anthawirriyarra Sea Rangers, Yanyuwa families, Marsh H, in review. A process incorporating Indigenous Knowledge and Western Science to inform the management of marine wildlife in northern Australia. Ecology and Society.

Hall K, MacLeod CD, Mandleberg L, Schweder-Goad CM, Bannon SM, Pierce GJ, 2010. Do abundance–occupancy relationships exist in cetaceans? Journal of the Marine Biological Association of the United Kingdom 90:1571-1581.

Halpern B, Walbridge S, Selkoe K, Kappel C, Micheli F, D'Agrosa C, Bruno J, Casey K, Ebert C, Fox H, Fujita R, Heinemann D, Lenihan H, Madin E, Perry M, Selig E, Spalding M, Steneck R, Watson R, 2008. A Global Map of Human Impact on Marine Ecosystems. Science 319:948-952.

Hammond PS, Mizroch SA, Donovan GP, 1990. Individual recognition of cetaceans: use of photo-identification and other techniques to estimate population parameters. Report of the International Whaling Commission Special Issue 12:440 pp.

Hanski I, 1998. Metapopulation dynamics. Nature 396:41-49.

Mackenzie DI, Nichols JD, 2004. Occupancy as a surrogate for abundance estimation. Animal Biodiversity and Conservation 27:461-467.

MacKenzie DI, Nichols JD, Lachman GB, Droege S, Royle JA, Langtimm CA, 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83:2248-2255.

Mackenzie DI, Royle JA, 2005. Designing occupancy studies: general advice and allocating survey effort. Journal of Applied Ecology 42:1105-1114.

Marsh H, Bradley J, Parra GJ, Grech A, Whiting S, Beasley I, Johnson S, Barrett D, Fitzpatrick N, Friday G, Johnston A, Keighran F, Miller R, Norman L, Norman L, Pracy D, families Y, 2010. Yarrbanthawu ki-Miriyiyu: Looking for Dolphins. Developing a decision process based on expert knowledge to inform the management of dugongs and coastal dolphins in Northern Australia: The Yanyuwa sea country in the Northern Territory as a case study. In. Townsville: School of Earth and Environmental Sciences, James Cook University; 44.

Palmer C, 2009. Ecology of the Australian snubfin *Orcaella heinsohni* and Indo-Pacific humpback *Sousa chinensis* dolphins in Kakadu National Park. In: Department of Natural Resources, Environment, Arts and Sport. Unpublished Interim Report 3; 16.

Palmer C, 2010. Darwin Harbour coastal dolphin project. In: Department of Natural Resources, Environment, Arts and Sport. Unpublished Interim Report; 11.

Palmer C, Fitzgerald P, Wood A, McKenzie A, 2008. Final Report: Monitoring and assessment of inshore dolphins in Cobourg Marine Park. Conservation Assessment of Priority Non-Fish Marine Threatened Species in the NT: Project no. 2007/134. Unpublished report. In; 21.

Palmer C, Murphy SA, Thiele D, Parra GJ, Robertson KM, Beasley I, Austin CM, 2011. Analysis of mitochondrial DNA clarifies the taxonomy and distribution of the Australian snubfin dolphin (*Orcaella heinsohni*) in northern Australian waters. Marine and Freshwater Research 62:1303-1307.

Parra GJ, 2006a. Resource partitioning in sympatric delphinids: Space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins. Journal of Animal Ecology 75:862-874.
Parra GJ, 2006b. Resource partitioning in sympatric delphinids: space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins. J Anim Ecol 75:862-874.
Parra GJ, 2007. Observation of an Indo-Pacific humpback dolphin carrying a sponge: object play or tool use? Mammalia 71:147-149.
Parra GJ, Beasley I, Allen S, Brooks L, Pollock KH, 2012. Draft coordinated research strategy to collect information required to assess the national conservation status of Australian topical inshore dolphins. In: Report to DSEWPaC.
Parra GJ, Corkeron PJ, 2001. Feasibility of using photo-identification techniques to study the Irrawaddy dolphin, *Orcaella brevirostris* (Owen in Gray 1866). Aquatic Mammals 27:45-49.
Parra GJ, Corkeron PJ, Arnold P, 2011. Grouping and fission–fusion dynamics in Australian snubfin and Indo-Pacific humpback dolphins. Animal Behaviour 82:1423-1433.
Parra GJ, Corkeron PJ, Marsh H, 2004. The Indo-Pacific humpback dolphin, *Sousa chinensis* (Osbeck, 1765), in Australian waters: a summary of current knowledge. Aquatic Mammals 30:197-206.
Parra GJ, Corkeron PJ, Marsh H, 2006a. Population sizes, site fidelity and residence patterns of Australian snubfin and Indo-Pacific humpback dolphins: Implications for conservation. Biological Conservation 129:167-180.
Parra GJ, Corkeron PJ, Marsh H, 2006b. Population sizes, site fidelity and residence patterns of Australian snubfin and Indo-Pacific humpback dolphins: Implications for conservation. Biol Conserv 129:167-180.
Parra GJ, Jedensjö M, 2009. Feeding habits of Australian Snubfin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphins (*Sousa chinensis*). In. Cairns: Project Report to the Great Barrier Reef Marine Park Authority, Townvsille and Reef & Rainforest Research Centre Limited; 22.
Parra GJ, Ross GJB, 2009. Humpback Dolphins: *S. chinensis* and *S. teuszii*. In: Encyclopedia of Marine Mammals (Second Edition) (Perrin WF, Bernd W, Thewissen JGM, eds). London: Academic Press; 576-582.
Parra GJ, Schick RS, Corkeron PJ, 2006c. Spatial distribution and environmental correlates of Australian snubfin and Indo-Pacific humpback dolphins. Ecography 29:396-406.
Robertson KM, Arnold PA, 2009. Australian Snubfin Dolphin: *Orcaella heinsohni*. In: Encyclopedia of Marine Mammals Second Edition (Perrin WF, Würsig BH, Thewissen H, eds). San Diego, CA.: Academic Press; 62-64.
Royle JA, 2004. N-Mixture Models for Estimating Population Size from Spatially Replicated Counts. Biometrics 60:108–115.
Shirihai H, Jarrett B, 2006. Whales, dolphins and seals: A field guide to the marine mammals of the world. London, UK: A&C Black.
Thiele D, 2005. Report of an opportunistic survey for Irrawaddy dolphins, *Orcaella brevirostris*, off the Kimberley coast, northwest Australia. In: Working paper presented at the 57th International Whaling Commission annual meeting, Small Cetaceans Scientific Committee (IWC/SC57/SM2), Ulsan, Republic of Korea.
Thiele D, 2008. Ecology of inshore and riverine dolphin species in northwestern Australian waters. Kimberley coast Orcaella project. Summary of current knowledge – EPBC listed inshore dolphin species on the Kimberley Coast. In: Unpublished background report to DSEWPaC.
Thiele D, 2010a. Collision course: snubfin dolphin injuries in Roebuck Bay. Unpublished Report. In: WWF - Australia; 15.
Thiele D, 2010b. Iconic marine wildlife surveys. In: Unpublished final report to WWF.
Tilman D, May R, Lehman C, Nowak M, 1994. Habitat destruction and the extinction debt. Nature 371:65-66.

**Appendix 1.** Criteria for listing as CRITICALLY ENDANGERED, ENDANGERED OR VULNERABLE under the EPBC Act and indicative thresholds (obtained from: www.environment.gov.au)**.**

| | | Critically Endangered | Endangered | Vulnerable |
|---|---|---|---|---|
| **Criterion** | **Matters considered** | **Indicative Thresholds** | | |
| | | **Very severe** | **Severe** | **Substantial** |
| **1**<br>**Reduction in numbers**<br><br>Based on any of A1 – A4 | A1. An observed, estimated, inferred or suspected population size reduction over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:<br>a) direct observation<br>b) an index of abundance appropriate to the species<br>c) a decline in area of occupancy, extent of occurrence and/or quality of habitat<br>d) actual or potential levels of exploitation<br>e) the effects of introduced species, hybridization, pathogens, pollutants, competitors or parasites. | ≥90% | ≥70% | ≥50% |
| | A2. An observed, estimated, inferred or suspected population size reduction over the last 10 years or three generations, whichever is the longer**,** where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible**,** based on (and specifying) any of (a) to (e) under A1. | ≥80% | ≥50% | ≥30% |
| | A3. A population size reduction, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1. | ≥80% | ≥50% | ≥30% |
| | A4. An observed, estimated, inferred, projected or suspected population size reduction over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1. | ≥80% | ≥50% | ≥30% |

| | | Critically Endangered | Endangered | Vulnerable |
|---|---|---|---|---|
| **Criterion** | **Matters considered** | **Indicative Thresholds** | | |
| **2**<br><br>**Precarious geographic distribution** | B1. Extent of occurrence estimated to be less than:<br><br>B2. Area of occupancy estimated to be less than: | **Very restricted**<br><br>100 $km^2$<br><br>10 $km^2$ | **Restricted**<br><br>5,000 $km^2$<br><br>500 $km^2$ | **Limited**<br><br>20,000 $km^2$<br><br>2,000 $km^2$ |
| | **AND Geographic distribution i precarious for the survival of the species (based on at least two of a) to c).**<br><br>a) Severely fragmented or known to exist at a limited location<br>b) Continuing decline, observed, inferred or projected, in any of the following:<br>i. extent of occurrence<br>ii. area of occupancy<br>iii. area, extent and/or quality of habitat<br>iv. number of locations or subpopulations<br>v. number of mature individuals<br>c) Extreme fluctuations in any of the following:<br>i. extent of occurrence<br>ii. area of occupancy<br>iii. number of locations or subpopulations<br>iv. number of mature individuals | Geographic distribution considered to be **precarious*** for the species' survival | Geographic distribution considered to be **precarious*** for the species' survival | Geographic distribution considered to be **precarious*** for the species' survival |
| **3**<br><br>**Precarious geographic distribution** | Estimated total number of mature individuals<br><br>**AND** either of (A) or (B) is true | **Very low**<br><br><250 | **Low**<br><br><2,500 | **Limited**<br><br><10,000 |
| | A. Rate of continued decline | **Very high**<br><br>25% in 3 years or 1 generation (up to 100 years), whichever is longer | **High**<br><br>20% in 5 years or 2 generations<br><br>(up to 100 years), whichever is longer | **Substantial**<br><br>10% in 10 years or 3 generations (up to 100 years), whichever is longer |

| Criterion | Matters considered | Critically Endangered | Endangered | Vulnerable |
|---|---|---|---|---|
| | | Indicative Thresholds | | |
| | **OR** B. Continued decline and geographic distribution is precarious (based on at least two of a – c):<br><br>a) Severely fragmented or known to exist at a limited location.<br>i. Continuing decline, observed, inferred or projected, in any of the following:<br>ii. extent of occurrence<br>iii. area of occupancy<br>iv. area, extent and/or quality of habitat<br>v. number of locations or subpopulations<br>vi. number of mature individuals.<br>b) Extreme fluctuations in any of the following:<br>i. extent of occurrence<br>ii. area of occupancy<br>iii. number of locations or subpopulations<br>iv. number of mature individuals | Geographic distribution considered to be **precarious*** for the species' survival | Geographic distribution considered to be **precarious*** for the species' survival | Geographic distribution considered to be **precarious*** for the species' survival |
| ***4***<br><br>***Small population size*** | Number of mature individuals | **Extremely low** | **Very low** | **Low** |
| | | < 50 | < 250 | < 1,000 |
| **5**<br><br>**Probability of extinction in the wild** | Based on a quantitative analysis which shows the species is likely to become extinct in the wild within:<br><br>(Note: probability must be at least 50% for critically endangered, 20% for endangered, 10% for vulnerable) | **Immediate future** | **Near future** | **Medium-term future** |
| | | 10 years or three generations, whichever is the longer (up to a maximum of 100 years) | 20 years or five generations, whichever is the longer (up to a maximum of 100 years) | 100 years |

** **Precariousness** is judged on a case-by-case basis, having regard to the degree of threat operating on the species*

**Appendix 2.** Brooks L, Carroll E, Pollock KH, 2013. Proposed sampling and statistical methods for assessment of the conservation status of Australian snubfin (*Orcaella heinsohni*) and other inshore dolphins. In: Unpublished report, Australian Marine Mammal Centre, Dept of the Environment.