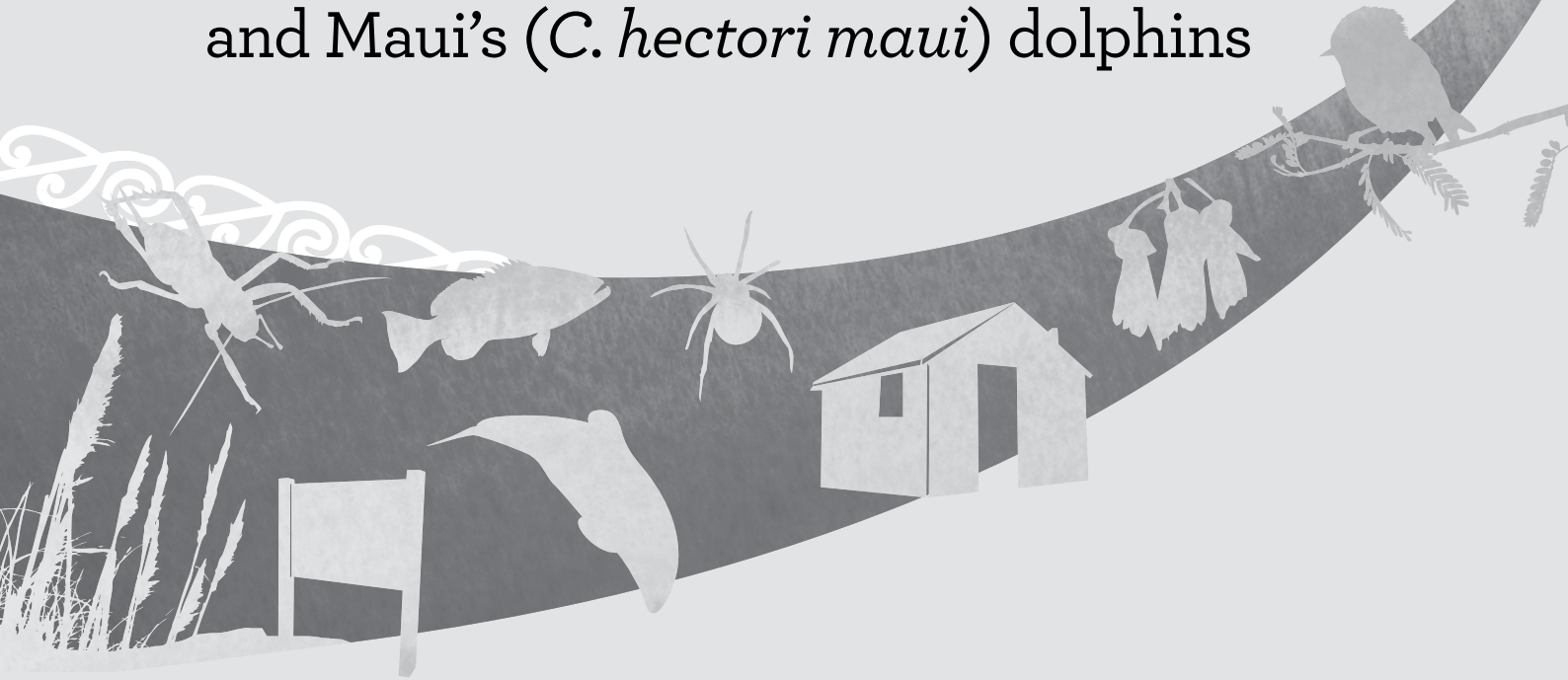




An updated, annotated bibliography for Hector's (*Cephalorhynchus hectori hectori*) and Maui's (*C. hectori maui*) dolphins



DOC RESEARCH AND DEVELOPMENT SERIES 332

Sam du Fresne, Daniel Burns and Emma Gates

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Abstract

In July 2003, a selective, annotated bibliography for Hector's dolphin (*Cephalorhynchus hectori hectori*) was published. Since then, this species has been redefined as two subspecies—Hector's dolphin (*C. h. hectori*) and Maui's dolphin (*C. h. maui*). This report presents an updated bibliography for the two subspecies, building on an informal (unpublished) update produced in 2008. In total, 39 peer-reviewed publications, 11 graduate theses (seven PhD and four MSc), and 26 reports (published and unpublished) have been produced since 2003. As with the original bibliography, some reports that were not solely focussed on Hector's or Maui's dolphins are included; in addition, unlike the 2003 bibliography, some unpublished reports have also been included. Every attempt has been made to include all relevant material, and any omissions are inadvertent.

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1. Introduction

A selective, annotated bibliography of Hector's dolphin (*Cephalorhynchus hectori hectori*) was published in July 2003 (Martinez & Slooten 2003). In 2008, an informal, unpublished update was produced. The present document seeks to provide a formal update to the 2003 bibliography, and is intended to be read in conjunction with it.

Since the first bibliography was produced, a draft Threat Management Plan (TMP) for Hector's dolphin has been produced (MFish & DOC 2007¹) and it has become widely accepted that Hector's dolphin comprises two subspecies—Hector's dolphin (*C. h. hectori*), which has an almost entirely South Island distribution, and Maui's dolphin (*C. h. maui*), which has an entirely North Island distribution (Baker et al. 2002; Hamner et al. 2012).

The motivation for this update to the bibliography is upcoming reviews of the TMP. At the time of writing, the Maui's dolphin TMP is due for review in 2012, and the Hector's dolphin review is due in 2013.

2. Methods

Reports published since 2008 (when the unpublished bibliography update was compiled) were identified using standard internet searches, primarily with Google and Google Scholar. New Zealand Cetacean Research Progress Reports to the International Whaling Commission (IWC 60–63: Childerhouse 2008; Donoghue 2009; Chilvers 2010, 2011) were consulted for reports of published and unpublished literature. The authors also consulted with a variety of researchers and staff of other government departments in New Zealand and other countries. During these searches, a number of unpublished reports were identified that have subsequently been published in the peer-reviewed literature. In these cases, the peer-reviewed publication has been included; the unpublished reports generally have not.

The references are listed alphabetically by authors, and then chronologically. The exceptions to this are Slooten (2007a), Middleton et al. (2007), and Slooten (2007b). These papers appear sequentially because Middleton et al. (2007) is a comment, and Slooten (2007b) is a reply to the comment on the Slooten (2007a) paper.

The format of this bibliography differs from that of the original 2003 bibliography. Each entry is structured as follows:

1. **Full citation** in Department of Conservation (DOC) publications format (listed alphabetically and chronologically)
2. **Focus:** The main focus of the report selected from the following general subject areas: abundance; distribution; general biology; genetics; behaviour; threats, impacts and management.
3. **Summary:** Text under each of the following headings, to standardise across each publication:
Aim
Methods
Results

¹ The draft TMP provided Ministers (of Fisheries and Conservation at that time) with advice on appropriate management and protection measures for Hector's and Maui's dolphins. The TMP was only ever released as a draft for consultation; subsequently a number of other documents were released to advise of the TMP outcomes (e.g. Fisheries Final Advice Paper).

4. Other details:

Who (organisation type (in italics, selected from *Academic, Government, Research Organisation, Independent Researcher, Consultant*) and name)

Type of publication (peer-reviewed journal; DOC peer-reviewed; DOC not peer-reviewed; thesis—honours, masters, doctoral; unpublished report)

TMP (status with respect to TMP. Pre- or post-TMP; if post-TMP, then details of key information are provided)

Every attempt has been made to present results, recommendations, and conclusions in an abbreviated format that is consistent with the original documents and standardised across all entries. No critical analysis is offered by the authors of this update; and unpublished reports are clearly identified as such.

3. Results

The addition of the following peer-reviewed publications, university theses and departmental reports to the bibliography is an indication of the continuing high-quality research being carried out on both the Hector's and Maui's dolphin subspecies.

Included in this update are publications that were 'in press' when the original bibliography was finalised (Bräger et al. 2003; Burkhart & Slooten 2003). These documents are included here so that their full and final citations can be recorded. For reasons unknown, there are also three publications from 2002 (two DOC reports and one MSc thesis) that did not appear in the Martinez & Slooten (2003) bibliography. Additionally, there are several 2003 DOC publications that were not in Martinez & Slooten (2003); it is likely that these publications were not finalised and therefore not available in time to be included in the 2003 bibliography.

In total, 39 peer-reviewed publications, 11 graduate theses (seven PhD and four MSc), and 26 reports (combination of published and unpublished) have been produced since July 2003.

4. Bibliography

Abraham, E.R.; Berkenbusch, K.N.; Richard, Y. 2010: The capture of seabirds and marine mammals in New Zealand non-commercial fisheries. *New Zealand Aquatic Environment and Biodiversity Report No. 64*. 52 p.

Focus Threats, impacts, and management.

Summary

Aim Conduct a literature review of studies of incidental capture of protected species, with a particular focus on non-commercial catches; carry out a boat-ramp survey to obtain first-hand information from fishers (focussing on seabirds).

Methods A range of databases were used to conduct the literature review, in addition to contacting authors directly. Boat ramp surveys were carried out during May–December 2007, and again during the summer of 2007/08. Eight North Island and three Otago coast locations were targeted for surveys.

Results (Hector's and Maui's dolphins only) Most recorded incidents (407) occurred between 1980 and 2007. Of these, 116 were recorded as setnet mortalities. For nearly half of these ($n = 51$) it was unknown whether the net was commercial or recreational. A total of 44 were confirmed from commercial nets, and 22 from recreational. The highest number of overall catches occurred in the Canterbury region ($n = 68$), followed by the West Coast (South Island; $n = 31$).

Who Consultancy (Dragonfly).

Type Published report.

TMP Post-TMP.

Information added Comprehensive summary of Hector's dolphin incidental mortality, with a focus on non-commercial catches.

Abraham, E.R.; Thompson, F.N. 2011: Summary of the capture of seabirds, marine mammals, and turtles in New Zealand commercial fisheries, 1998–99 to 2008–09. *New Zealand Aquatic Environment and Biodiversity Report No. 80*. 172 p.

Focus Threats, impacts, and management.

Summary

Aim Summarise the capture of seabirds, marine mammals, and turtles during trawl, longline, and setnet fishing in New Zealand waters.

Methods Ministry of Fisheries observers on commercial fishing vessels recorded captures of protected species, which were subsequently entered into a Centralised Observer Database (COD). For some species, Bayesian models were constructed to estimate total captures, allowing for non-representivity of observer coverage.

Results (Hector's and Maui's dolphins only) One Hector's dolphin was caught in a setnet near Kaikoura in the 2008–09 season. Additionally, two other Hector's dolphins had been reported in earlier seasons, also during setnet fishing operations off the South Island's east coast. No estimate was made of the total captures of Hector's dolphin.

Who Consultancy (Dragonfly).

Type Published report.

TMP Post-TMP.

Information added Comprehensive summary of fisheries observer data, including some captures of Hector's dolphin.

Baker, C.S.; Chilvers, B.L.; Constantine, R.; Du Fresne, S.; Mattlin, R.H.; van Helden, A.; Hitchmough, R. 2010: Conservation status of New Zealand marine mammals (suborders Cetacea and Pinnipedia), 2009. *New Zealand Journal of Marine and Freshwater Research* 44(2): 101–115.

Focus Abundance; distribution; threats, impacts, and management.

Summary

Aim Reappraisal of the conservation status of all New Zealand marine mammals, including Hector's dolphin and Maui's dolphin.

Methods Desktop study using recent publications, public submissions and expert opinion to assign a risk category to each taxon. Threat levels based on total population size, population trend, geographical range, and whether taxon had been affected either directly or indirectly by humans.

Results Hector's dolphin listed as 'Nationally Endangered' and Maui's dolphin as 'Nationally Critical'.

Who *Academic* (University of Auckland, Oregon State University); *Government, NZ* (DOC); *Consultant* (Sea Mammal Research Unit, Marine Wildlife Research); *Research Organisation* (Museum of New Zealand Te Papa Tongarewa).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Confirmed status of Hector's and Maui's dolphins through rigorous and transparent review process.

Information gap filled None.

Information gap identified None, but highlighted importance of planned fisheries restrictions.

Bleazard, R.H. 2002: Observations of set-net and inshore trawl fishing operations in the South Canterbury Bight, 2001. *DOC Science Internal Series 85*. Department of Conservation, Wellington. 20 p.

Focus Behaviour; threats, impacts, and management.

Summary

Aim Observer programme funded by the Conservation Services Levy (CSL²) to record interactions between Hector's dolphins and setnet and trawl fisheries operating in the South Canterbury region.

Methods Three trawl and 20 setnet events were observed during 7 weeks in 2001. Attendance and behaviour of Hector's dolphins were recorded.

Results No incidental captures of Hector's dolphins were observed during this programme, though there were observations made of Hector's dolphins while vessels were between setnetting locations. The report also described the use of acoustic pingers on setnets. No dolphins were observed during the setnet events when pingers were used.

Who *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP

² The Conservation Services Programme (CSP) uses levies recovered from the commercial fishing industry to fund research on marine protected species. The goal of this research is to enable commercial fishing activities to continue in such a way that does not compromise the protection and recovery of protected species in New Zealand fishing waters. Thus, CSP-funded research focusses on understanding the impacts of fishing activities on protected species and developing effective mitigation solutions.

Bräger, S.; Harraway, J.A.; Manly, B.F.J. 2003: Habitat selection in a coastal dolphin species (*Cephalorhynchus hectori*). *Marine Biology* 143: 233–244.

Focus Distribution.

Summary

Aim Quantification of habitat used by Hector's dolphins.

Methods Preference of dolphins for warm and turbid waters was tested using eight models.

Results Abiotic factors (water depth, water clarity, sea surface temperature) and the study area explained dolphin presence to a significant degree. Habitat selection by dolphins differed between study area, particularly between east and west coasts, as well as in summer (December to February) and in winter (June to August). Dolphin abundance appeared to change seasonally in some study areas, possibly due to the more offshore distribution of their prey in the winter. In summer (the main reproductive season), dolphins tended to occupy shallow and turbid waters, whereas in winter this habitat was less used.

Who Academic (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

Burkhart, S.M.; Slooten, E. 2003: Population viability analysis for Hector's dolphin (*Cephalorhynchus hectori*): a stochastic population model for local populations. *New Zealand Journal of Marine and Freshwater Research* 37: 553–566.

Focus Abundance; threats, impacts, and management.

Summary

Aim Use population viability analysis (PVA) to assess the survival prospects of Hector's dolphins over a range of maximum population growth rates, entanglement rates and fishing effort levels in a stochastically varying environment.

Methods Hector's dolphins were modelled as 16 discrete, closed populations corresponding to the 16 fisheries management areas.

Results Increases to either the entanglement rate or fishing effort significantly increased the risk of population decline. Ten of the 16 populations were likely to decline under current fishing levels, five were indefinite, and only one was likely to increase (population partly protected by a marine mammal sanctuary created in 1998). The authors recommend urgent conservation measures to protect the highly threatened North Island populations.

Who Academic (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

Carraher, C.J.F. 2004: Comparative mitogenomics of the Southern Hemisphere dolphin genus *Cephalorhynchus*. MSc thesis. School of Biological Sciences, University of Auckland. 161 p.

Focus Genetics.

Summary

Aim Assess the phylogenetic status of the dolphin genera *Cephalorhynchus* and *Lagenorhynchus*; assess the level of mtDNA divergence between the four *Cephalorhynchus* species; date the divergence times within *Cephalorhynchus*, and the split between this and genus *Lagenorhynchus*.

Methods Long Polymerase Chain Reaction (PCR) techniques were used to sequence the entire protein coding region of the mtDNA for ten southern hemisphere dolphin species, as well as three samples from Maui's dolphins.

Results Consistent with other studies, there was no variability between the three Maui's dolphin samples. There were comparatively low levels of genetic difference between species belonging to genus *Cephalorhynchus*. The genus was found to have diverged ~3 Ma.

Who *Academic* (University of Auckland).

Type Thesis.

TMP Pre-TMP.

Childerhouse, S.; Rayment, W.; Webster, T.; Scali, S.; du Fresne, S. 2008: Offshore aerial survey of Maui's dolphin distribution 2008. Final report to Auckland Conservancy, Department of Conservation. Du Fresne Ecology Ltd, Nelson. 6 p.

Focus Distribution.

Summary

Aim Investigate Maui's dolphin distribution off the west coast of the North Island.

Methods Aerial line-transect surveys were conducted on the northern west coast of the North Island in May 2008.

Results Six sightings of Maui's dolphins were made over seven survey flights: six lone animals; and one pair. One sighting was made outside the 4 nautical mile (n.m.). protected area offshore boundary, at 4.30 n.m. All sightings were in water <50 m deep. Three sightings of lone animals were also made within the offshore boundary during 'off effort' parts of flights. Five sightings were north and four sightings south of Manukau Harbour. The authors highlight that the existing protected area does not fully encompass the offshore range of Maui's dolphins.

Who *Consultant* (Du Fresne Ecology Ltd); *Government, NZ* (DOC).

Type Unpublished report.

TMP Post-TMP.

Information added Confirms that Maui's dolphin offshore distribution exceeds existing protection boundary.

Information gap filled As above.

Information gap identified Future survey effort should focus south of the protected area as far as Cape Egmont.

Clement, D.M. 2005: Distribution of Hector's dolphin (*Cephalorhynchus hectori*) in relation to oceanographic features. Unpublished PhD Thesis. Department of Marine Science, University of Otago, Dunedin. 270 p.

Focus Distribution.

Summary

Aim Identify specific habitat requirements of Hector's dolphin.

Methods Monthly dolphin surveys at locations within the Banks Peninsula Marine Mammal Sanctuary (BPMMS) were combined with oceanographic sampling using a CTD (Conductivity Temperature Depth) profiler. Geographical weighted regression (GWR) models were then used to examine possible relationships between oceanographic features and aggregations of Hector's dolphins within the BPMMS.

Results Four hotspots of dolphin distribution around the South Island were identified: Te Waewae Bay; Banks Peninsula; on the west coast between Okarito Lagoon and Arnott Point; and between Karamea and Hokitika. The latter three regions were found to contain over half of the current South Island population. Monthly GWR models suggested that the seasonal presence and strength of local oceanographic fronts influenced dolphin distribution. Specifically, dolphin aggregations coincided with the steepest gradients between water masses along eastern regions of Banks Peninsula. The study recommends long-term monitoring within

the three main stronghold areas identified. Furthermore, and in light of the thesis's findings, future management strategies should consider why Hector's dolphins are preferentially using certain regions.

Who *Academic* (University of Otago).

Type Thesis (PhD).

TMP Pre-TMP.

Clement, D.; Mattlin, R.; Torres, L. 2011: Abundance, distribution and productivity of Hector's (and Maui's) dolphins. Final Research Report on PRO2009-01A. Ministry of Fisheries (Wellington, NZ). 50 p.

Focus Abundance; distribution.

Summary

Aim Estimate the distribution of the south coast South Island Hector's dolphin sub-population in both winter and summer; the work for this sub-project was subsequently extended to include the data collection necessary to estimate abundance.

Methods Aerial line-transect surveys were completed between Puysegur Point (Fiordland) and Nugget Point (Otago) during March and August 2010. Double observer team methods were used to facilitate mark-recapture distance sampling (MRDS) analysis for abundance estimates. Additional observations to estimate surface availability of dolphins were carried out from a helicopter. ArcGIS Spatial Analyst was used to calculate relative densities; habitat models were constructed using Generalised Additive Models (GAMs); and abundance estimates were calculated using Program Distance.

Results Abundance for the total area was estimated as 628 dolphins (95% CI = 301-1311); higher densities were observed in March than in August (when animals tended to be more dispersed); habitat models suggested that water temperatures may be an important determinant for distribution in winter months, and that proximity to river mouths (possibly correlated with prey activity and availability) was also important.

Who *Research organisation* (Cawthron); *Consultant* (MWR Ltd); *Research organisation* (NIWA).

Type Unpublished report.

TMP Post-TMP.

Information added Updated, comprehensive survey of dolphins along this section of the South Island.

Information gap identified Additional surveys needed to assess variability in distribution and to validate model predictions, while also increasing sample sizes for abundance estimates. Suggested occupancy approaches for further surveys.

Conroy, M.J.; Barker, R.J.; Dillingham, P.W.; Fletcher, D.; Gormley, A.M.; Westbrooke, I.M. 2008: Application of decision theory to conservation management: recovery of Hector's dolphin. *Wildlife Research* 35: 93-102.

Focus Threats, impacts, and management.

Summary

Aim Demonstration of a framework for incorporating existing knowledge, data, and scientific understanding to make the best possible conservation management decisions.

Methods Theoretical construction of a decision model based on structured decision making (SDM) and adaptive resource management (ARM) principles, using the recovery of Hector's dolphin as an example.

Results Demonstrated the process of building an SDM/ARM framework and how it can be used for Hector's dolphin conservation.

Who *Academic* (University of Georgia; University of Otago); *Government, NZ* (DOC).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added New method for assessing management options, incorporating interactions between uncertainty and potentially conflicting objectives.

Information gap filled None.

Information gap identified Highlights importance of on-going monitoring.

Davies, N.; Bian, R.; Starr, P.; Lallemand, P.; Gilbert, D.; McKenzie, J. 2008: Risk analysis of Hector's dolphin and Maui's dolphin subpopulations to commercial set net fishing using a temporal-spatial age-structured model. National Institute of Water and Atmospheric Research Limited (NIWA). 113 p.

Focus Threats, impacts, and management.

Summary

Aim Carry out a risk analysis of the Hector's and Maui's dolphin sub-populations.

Methods A Bayesian, age-structured, temporally and spatially stratified population model was fitted to data from the Pegasus/Canterbury Bight Hector's dolphin subpopulation (BP model). The model was projected to the four sub-populations under five alternative strategies for managing set net commercial effort.

Results High parameter and structural uncertainty for the BP model made it difficult to draw conclusions on the predicted outcomes of management strategies in terms of absolute risk; therefore, broad qualitative inferences were drawn. For status quo management, it was more probable that the three Hector's dolphin sub-populations would decline than increase. West Coast North Island Maui's and South Coast South Island Hector's dolphins were vulnerable to decline in population sizes where extinction risk is very high, due to depensation processes. Population increases were highly probable under zero fishing effort and management that closes inshore areas to fishing effort during the summer period. However, the probability that Maui's dolphins would decline was roughly equal to the probability of increase, even with inshore fishing exclusions.

Who *Consultant* (Starrfish Ltd); *Research Organisation* (NIWA); *Industry* (SeaFIC).

Type Unpublished report.

TMP Post-TMP.

Information added Extended model of risk analysis to include new information on seasonal dolphin distribution, age at first reproduction, historical effort, total survival rate, and incidental catch.

Information gap filled Provided further and up-to-date model results for management.

Information gap identified More data required on sub-adult distribution, age at first reproduction, total survival rate, and scientific observer coverage of set net operations in the four sub-populations. Integration of Bayesian and mark-recapture models needed.

Dawson, S.M. 2008: *Cephalorhynchus* dolphins *C. heavisidii*, *C. eutropia*, *C. hectori*, and *C. commersonii*. Pp. 191–196 in Perrin, W.F.; Wursig, B.; Thewissen, J.G.M. (Eds): *Encyclopedia of marine mammals*. Academic Press, San Diego, USA.

Focus Abundance; distribution; general biology; genetics; behaviour; threats, impacts, and management.

Summary

Review chapter briefly summarising current knowledge about dolphins of the genus *Cephalorhynchus*, including Hector's and Maui's dolphins.

Who *Academic* (University of Otago).
Type Peer-reviewed journal or book chapter.
TMP Post-TMP.
Information added None.
Information gap filled None.
Information gap identified None.

Dawson, S.; Slooten, E. 2005: Management of gillnet bycatch of cetaceans in New Zealand. *Journal of Cetacean Research and Management* 7(1): 59–64.

Focus Threats, impacts, and management.

Summary

Aim Evaluate the successfulness of cetacean bycatch management in New Zealand.

Methods Particular emphasis is placed on dusky dolphin (*Lagenorhynchus obscurus*) bycatch in Kaikoura; and Hector's and Maui's dolphin bycatch in Canterbury and on the North Island west coast, respectively.

Results The paper highlights the difficulties encountered in trying to implement effective and statistically robust observer programmes, noting that the Hector's dolphin bycatch estimate of 17 animals from the 1997–98 Canterbury observer programme was clearly unsustainable. The authors also discuss the use of pingers, and conclude that evaluating their effectiveness was not possible due (in part) to poor coverage in observer programmes. Additionally, pingers were introduced together with several other operational changes to the fisheries, making it impossible to tease out the effects of individual factors. The authors argue that fisheries area closures are the most reliable way of mitigating bycatch of Hector's dolphins; however, they note that due to its size and compliance difficulties, the Banks Peninsula Marine Mammal Sanctuary may currently be insufficient to protect that population of dolphins.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

Dawson, S.; Slooten, E.; Du Fresne, S.; Wade, P.; Clement, D. 2004: Small-boat surveys for coastal dolphins: line-transect surveys for Hector's dolphin (*Cephalorhynchus hectori*). *Fishery Bulletin* 102(3): 441–451.

Focus Abundance.

Summary

Aim Update the abundance estimate for Hector's dolphin between Farewell Spit and Long Point (Foveaux Strait).

Methods This paper combined three previously published DOC client reports (Dawson et al. 2000; Clement et al. 2001—see Martinez & Slooten 2003 for details; du Fresne et al. 2001) to provide the updated abundance estimate.

Results Hector's dolphin abundance in the coastal zone to 4 n.m. offshore was calculated at 1880 individuals (CV = 15.7%, log-normal 95% CI = 1384–2554).

Who *Academic* (University of Otago); *Government, US* (National Marine Fisheries Service).

Type Peer-reviewed journal.

TMP Pre-TMP.

Dawson, S.; Wade, P.; Slooten, E.; Barlow, J. 2008: Design and field methods for sighting surveys of cetaceans in coastal and riverine habitats. *Mammal Review* 38(1): 19–49.

Focus Abundance.

Summary

Aim This paper offers advice on survey methodology for estimating dolphin population abundance and trends, including examples from studies of Hector's dolphin.

Methods Outlines design and field methods for conducting line-transect surveys of coastal and riverine dolphins, including both vessel-based and aerial-based surveys.

Results Provides guidance about the type of survey to be conducted (e.g. line- or strip-transect; boat- or aircraft-based), survey design, avoiding bias, and increasing precision using robust, low-cost methods, including a case study on Hector's dolphin.

Who *Academic* (University of Otago); *Government, US* (National Marine Mammal Laboratory; National Marine Fisheries Service).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added A synthesis paper offering advice on the best methods for designing abundance surveys in coastal and riverine environments. Relevant to Hector's and Maui's surveys, and surveys reported in Dawson et al. (2004) are used as one of the case studies (out of two).

du Fresne, S. 2005: Conservation biology of Hector's dolphin. Unpublished PhD thesis. Department of Marine Science, University of Otago, Dunedin. 152 p.

Focus General biology; threats, impacts, and management.

Summary

Aim The main aim of this PhD thesis was to provide updated and statistically robust estimates of the adult survival rate of Hector's dolphins.

Methods Photographic identification (photo-ID) surveys were carried out within the BPMMS over a 3 year period, contributing to the existing Hector's dolphin dataset. The resulting 18 years of mark-recapture data were analysed using Programme MARK. Analyses utilised the Arnason-Schwarz multi-state model. Covariates were developed to model heterogeneity in capture probability, which results from spatial and temporal variability in sampling effort, and sightings of known individuals.

Results An overall estimate for adult survival of 0.9042 resulted from the most parsimonious model. There was little support for models with time-varying (annual) survival estimates, suggesting that any changes in survival over the study period were insignificant and non-detectable. A model was also developed that estimated survival separately for juvenile and adult animals. Crucially, overall survival was found to be lower than the threshold thought to be necessary for population growth to occur, suggesting that the population may still be declining, most likely as a result of continued bycatch.

Who *Academic* (University of Otago).

Type Thesis (PhD).

TMP Pre-TMP.

du Fresne, S. 2010: Distribution of Maui's dolphin (*Cephalorhynchus hectori maui*): 2000–2009. *DOC Research & Development Series 322*. Department of Conservation, Wellington. 24 p.

Focus Distribution; threats, impacts, and management.

Summary

Aim Synthesise Maui's dolphin distribution data into one document to aid management via protected area design.

Methods Summarised results from systematic offshore surveys, opportunistic and alongshore surveys, verified sightings by members of the public, and passive acoustic monitoring studies.

Results Maui's dolphin was regularly found between Kaipara Harbour to the north, and Kawhia Harbour to the south, with occasional sightings further south including near New Plymouth. Dolphins have been reliably sighted outside the 4 n.m. setnetting restricted area boundary, especially (but not exclusively) during winter periods. Dolphins have been reported in North Island harbours, including Kaipara, Raglan, and Manukau Harbours. Passive acoustic monitoring of Manukau Harbour suggested a regular use of areas near or beyond the current protected area of the outer harbour. Proposals for protected areas need to consider offshore and alongshore areas that are occasionally visited, as well as core home ranges.

Who *Consultant* (Du Fresne Ecology Ltd); *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Post-TMP.

Information added None, but see below.

Information gap filled Synthesis of recent distribution data for management; identified areas without adequate protection.

Information gap identified More data required to determine the southern extent of Maui's dolphins on the west coast of the North Island.

du Fresne, S.; Fletcher, D.; Dawson, S. 2006: The effect of line-transect placement in a coastal distance sampling survey. *Journal of Cetacean Research and Management* 8(1): 79–85.

Focus Abundance.

Summary

Aim Investigate the effect of different survey design strategies in conducting line-transect surveys for coastal cetaceans.

Methods A number of simulations were carried out, based on data from the 1997/98 Banks Peninsula line-transect survey for Hector's dolphin (Dawson et al. 2000, 2004).

Results The study found that systematic placement of lines provided more precise abundance estimates, with a reduction in the coefficient of variation (CV) of abundance. The paper also discusses practical advantages conferred by systematic designs, including more uniform spatial coverage.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

du Fresne, S.; Mattlin, R. 2009: Distribution and abundance of Hector's dolphin (*Cephalorhynchus hectori*) in Clifford and Cloudy Bays. Final report for NIWA project CBF07401. Marine Wildlife Research Ltd, Nelson. 28 p.

Focus Abundance; distribution.

Summary

Aim Establish baseline information regarding the distribution and abundance of the Hector's dolphin population in Clifford and Cloudy Bays. This work was carried out as part of permitting conditions for a large, offshore mussel farm to be constructed in Clifford Bay.

Methods Seasonal aerial line-transect surveys were carried out four times a year (summer, autumn, winter, spring) from July 2006 to March 2009. Double-observer methods and MRDS analytical approaches were used. Data on surface availability were gathered during supplementary helicopter surveys. The survey area extended from Robertson Point (in the north) to Cape Campbell (south) and out to the 100 m depth contour.

Results Dolphins were widely distributed throughout the survey area during summer surveys, regularly being seen as far out as the 100 m depth contour. Highest numbers were seen during summer and autumn, with winter and spring having correspondingly fewer sightings. Summer abundance was estimated as 951 animals (95% CI = 573–1577); representing a considerable increase from previous boat-based line-transect surveys in the area (see Dawson et al. 2004).

Who Consultancy (MWR Ltd).

Type Unpublished report.

TMP Post-TMP.

Information added Detailed distribution and abundance surveys for the northern part of the ECSI population; distribution patterns inconsistent with previous studies at Banks Peninsula.

Information gaps identified Possible that the offshore extent of this population is not fully defined. More work required to tease out seasonal abundance estimates, and to understand seasonal distribution shifts.

Duignan, P.J. 2003a: Disease investigations in stranded marine mammals, 1999–2002. *DOC Science Internal Series 104*. Department of Conservation, Wellington. 32 p.

Focus General biology; threats, impacts, and management.

Summary

Aim Collect comprehensive information on stranding events, pathological findings, and life history of stranded marine mammals.

Methods Between June 1999 and June 2002, a total of 137 stranded or beached marine mammals were examined post mortem by Massey University.

Results Hector's dolphins were found to contain less halogenated dimethyl bipyrroles (HDBPs) than ecologically similar species in the northern hemisphere—a result consistent with other studies. Hector's dolphins tested negative for morbillivirus, indicating that they may be susceptible to infection. Dolphin pox—characterised by tattoo lesions on the skin—was also identified in Hector's dolphin, but it was noted that this virus is rarely the cause of significant disease in cetaceans.

Who Academic (Massey University); Government, NZ (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Duignan, P.J. 2003b: Part 1: Autopsy report for 1997/98. Pp. 5–28 in Duignan, P.J.; Gibbs, N.J.; Jones, G.W. 2003: Autopsy of cetaceans incidentally caught in fishing operations 1997/98, 1999/2000, and 2000/01. *DOC Science Internal Series 119*. Department of Conservation, Wellington. 66 p.

Focus General biology; threats, impacts, and management.

Summary

Aim Part 1 of a volume containing three separate cetacean autopsy reports.

Methods For the 1997/98 reporting period, a total of 12 Hector's dolphins were autopsied.

Results Three of the Hector's dolphins had been incidentally caught in commercial fishing operations. The remainder had either been retrieved from setnets ($n = 3$) or found beach-cast along the Canterbury coast. Three of the beach-cast dolphins had lesions indicative of probable net entanglement, with a further two bearing lesions that suggested possible entanglement; and one had lesions that suggested asphyxiation. As with previous reports of stranded or incidentally caught Hector's dolphins, immature (i.e. non-reproductive) animals were over-represented. The reproductive status of the animals was consistent with previous studies.

Who *Academic* (Massey University); *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Duignan, P.J.; Gibbs, N.J.; Jones, G.W. 2003a: Part 2: Autopsy report for 1999/2000. Pp. 29–46 in Duignan, P.J.; Gibbs, N.J.; Jones, G.W. 2003: Autopsy of cetaceans incidentally caught in fishing operations 1997/98, 1999/2000, and 2000/01. *DOC Science Internal Series 119*. Department of Conservation, Wellington. 66 p.

Focus General biology; threats, impacts, and management.

Summary

Aim Part 2 of a volume containing three separate cetacean autopsy reports.

Methods For the 1999/2000 reporting period, a total of 16 Hector's dolphins were autopsied.

Results One Hector's dolphin had been incidentally caught in commercial fishing operations. Of the remaining 15, one was retrieved from a recreational set net. The rest were found beach-cast on the South Island west coast ($n = 3$) or east coast ($n = 7$). One North Island Hector's dolphin was found beach-cast at Kawhia. Once again, immature animals were over-represented. The sex ratio was equal. Of the 15 dolphins that were beach-cast, seven had lesions indicative of net entanglement, while a further two had lesions consistent with trauma and sudden death; two were too decomposed to establish cause of death; one was a neonate that may have died as a result of separation; and one had severe trauma unrelated to bycatch.

Who *Academic* (Massey University); *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Duignan, P.J.; Gibbs, N.J.; Jones, G.W. 2003b: Part 3: Autopsy report for 2000/01. Pp. 47–66 in Duignan, P.J.; Gibbs, N.J.; Jones, G.W. 2003: Autopsy of cetaceans incidentally caught in fishing operations 1997/98, 1999/2000, and 2000/01. *DOC Science Internal Series 119*. Department of Conservation, Wellington. 66 p.

Focus General biology; threats, impacts, and management.

Summary

Aim Part 3 of a volume containing three separate cetacean autopsy reports.

Methods For the 2000/01 reporting period, a total of 18 Hector's dolphins were autopsied.

Results Three of the Hector's dolphins were retrieved from recreational setnets. Six dolphins were beach-cast on each of the South Island west and east coasts, and three were Maui's dolphins beach-cast south of Auckland. The age distribution was similar to previous reports. Nine of the beach-cast dolphins had lesions indicative of entanglement; three had lesions consistent with trauma and sudden death; two were too decomposed to establish cause of death; and one had died of natural disease.

Who *Academic* (Massey University); *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Duignan, P.J.; Gibbs, N.J.; Jones, G.W. 2004: Autopsy of cetaceans incidentally caught in commercial fisheries, and all beachcast specimens of Hector's dolphins, 2001/02. *DOC Science Internal Series 176*. Department of Conservation, Wellington. 28 p.

Focus General biology; threats, impacts, and management.

Summary

Aim Cetacean autopsy reports from the 2001/02 reporting period.

Methods A total of ten Hector's dolphin carcasses were retrieved and autopsied during the 2001/02 reporting period.

Results Three of the Hector's dolphins were retrieved from setnets (it is not specified if these were commercial or recreational nets, but it may be assumed they were recreational). Two of these were North Island Hector's/Maui's dolphins. An additional North Island dolphin was found floating at sea. Five animals were beach-cast on the South Island's west coast; one on the east coast. Of the seven beach-cast animals, one had lesions indicative of net entanglement; two had lesions consistent with trauma, asphyxiation, and sudden death; two were too decomposed to establish cause of death; and two were neonates that may have died as a result of separation from their mothers.

Who *Academic* (Massey University); *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Duignan, P.J.; Jones, G.W. 2005: Autopsy of cetaceans including those incidentally caught in commercial fisheries, 2002/03. *DOC Science Internal Series 195*. Department of Conservation, Wellington. 22 p.

Focus General biology; threats, impacts, and management.

Summary

Aim Cetacean autopsy reports from the 2001/02 reporting period.

Methods A total of 11 Hector's and one Maui's dolphin carcasses were retrieved and autopsied during the 2001/02 reporting period.

Results One Hector's dolphin was incidentally caught in a commercial fishing net. Of the remaining dolphins, one was retrieved from a recreational set net at Kaikoura; and seven were beach-cast on the South Island's west coast, and two on the east coast. The single Maui's dolphin was also found beach-cast. Two of the beach-cast Hector's dolphins had lesions indicative of entanglement; two may have died as a result of parasitic pneumonia; one died from acute blunt trauma; and four were too decomposed to determine cause of death. The single Maui's dolphin died from complications associated with a lung infection.

Who *Academic* (Massey University); *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Fairfax, D.P. 2002: Observations of inshore trawl fishing operations in Pegasus Bay and the Canterbury Bight, 2002. *DOC Science Internal Series 86*. Department of Conservation, Wellington. 12 p.

Focus Behaviour; threats, impacts, and management.

Summary

Aim A DOC report describing a Conservation Services Levy (CSL)-funded observer programme in the Canterbury region.

Methods Nine inshore trawl events were monitored on six observer days in early 2002. Activities of sighted marine mammals were recorded.

Results No incidental captures of Hector's dolphin were observed during this programme; however, several interactions with Hector's dolphin and fishing operations are described. It was noted that, as in previous years, observer coverage was low, hampering a reliable estimate of interactions between the fisheries and protected species such as Hector's dolphin.

Who Government, NZ (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Fletcher, D.; Lebreton, J.D.; Marescot, L.; Schaub, M.; Gimenez, O.; Dawson, S.; Slooten, E. 2012: Bias in estimation of adult survival and asymptotic population growth rate caused by undetected capture heterogeneity. *Methods in Ecology and Evolution* 3: 206–216.

Focus Abundance; threats, impacts, and management.

Summary

Aim Methodological paper aimed at determining the effects of capture heterogeneity on estimates of adult survival and maximum population growth rate using mark-recapture techniques. Uses Hector's dolphin as one example.

Methods Major focus on effects of capture heterogeneity for estimating adult survival and maximum population growth rate in mark-recapture analyses of photo-identification data.

Results Suggests that ignoring capture heterogeneity in photo-identification data may result in underestimation of adult survival probability and maximum population growth rate. This has the potential to affect management decisions if undetected bias is ignored.

Who Academic (University of Otago); Research Organisation (Centre d'Ecologie Fonctionnelle et Evolutive, Swiss Ornithological Institute).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Methods to improve estimates of survival and population growth rates from photographic-identification studies.

Information gap filled None.

Information gap identified None.

Gormley, A. 2002: Use of mark-recapture for estimating abundance of four marine mammal species in New Zealand. Unpublished MSc thesis. University of Otago, Dunedin. 105 p.

Focus Abundance.

Summary

Aim Master's thesis focussing on the utility of natural markings for estimating abundance via mark-recapture.

Methods Photographic identification (photo-ID) of natural markings was used to derive abundance estimates for Hector's dolphin (*Cephalorhynchus hectori*) at Banks Peninsula,

sperm whales (*Physeter macrocephalus*) at Kaikoura, bottlenose dolphins (*Tursiops truncatus*) in Doubtful Sound, and New Zealand sea lions (*Phocarctos hookeri*) on Otago Peninsula.

Results See Gormley et al. (2005) for further description.

Who Academic (University of Otago).

Type Thesis (Masters).

TMP Pre-TMP.

Gormley, A.M. 2009: Population modelling of Hector's Dolphins. Unpublished PhD thesis. University of Otago, Dunedin. 214 p.

Focus Abundance; general biology; threats, impacts, and management.

Summary

Aim Produce a population viability analysis (PVA) for Hector's dolphins around Banks Peninsula.

Methods Annual survival rates were estimated from capture-recapture analysis of 20 years of photo-ID data from around Banks Peninsula. Reproductive parameters were estimated using integrated hierarchical modelling. A stage-structured matrix model was specified in order to estimate the rate of increase for the population around Banks Peninsula. The probability of population decline was also estimated from population projections that included environmental and demographic stochasticity and parameter uncertainty.

Results Mean annual survival was estimated to be higher after the establishment of the Banks Peninsula Marine Mammal Sanctuary. Population growth was estimated at 0.99 (95% CI = 0.952-1.029). Population decline was estimated at probabilities between 0.70 and 0.73. The actual rate of decline may be severe, with a 0.22 probability of a decrease of at least 80%, and a 0.48 probability of a decrease of at least 50% in the next 50 years. This suggests that the species should be classified as Endangered under the IUCN risk categories. Management to eliminate by-catch is the best option to minimise the overall expected loss. However, under this management option, there is still a 0.33 probability that the population would decline by at least 30% after 50 years. Greater protection is suggested in light of this predicted decline.

Who Academic (University of Otago).

Type Thesis (PhD).

TMP Post-TMP.

Information added More precise fecundity estimates; refined survival rate estimates (also see Gormley et al. 2012); reduced uncertainty in population growth; management implications and options.

Information gap filled Efficacy of Banks Peninsula Marine Mammal Sanctuary proven quantitatively.

Information gap identified Need for further work to estimate fecundity, which is believed to be a large contributor to overall post-sanctuary population growth rates.

Gormley, A.; Dawson, S.; Slooten, E.; Bräger, S. 2005: Capture-recapture estimates of Hector's dolphin abundance at Banks Peninsula, New Zealand. *Marine Mammal Science* 21(2): 204-216.

Focus Abundance.

Summary

Aim Describe a mark-recapture abundance estimate of Hector's dolphin within the Banks Peninsula Marine Mammal Sanctuary.

Methods Photo-ID data gathered between 1989 and 1997 were used to estimate abundance via the program MARK. A total of 180 individuals were identified from distinct nicks and notches on their dorsal fins.

Results Overall mark-rate (proportion of identifiable animals) was estimated at 12.5%. The 1996 population was estimated at about 1100 (CV = 0.21), which was in close agreement with the 1997–98 line-transect estimate of roughly 900 (CV = 0.28). There was no evidence of population change over the period during which these data were collected. An advantage of the capture-recapture approach stems from the inherent versatility of photo-ID data. The authors argue that line-transect estimates are easier to interpret, however, because the sampling design is explicit; in contrast, mark-recapture is conducted over a much longer time period and will include animals that occasionally stray into the study area. A further benefit is that line-transect surveys may be designed to provide random or equal survey effort, whereas during mark-recapture studies of cetaceans the survey vessel will typically stop to photograph individuals, during which time other animals may approach. Thus, effort is neither random nor equal.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

Gormley, A.M.; Slooten, E.; Dawson, S.; Barker, R.J.; Rayment, W.; du Fresne, S.; Brager, S. 2012: First evidence that marine protected areas can work for marine mammals. *Journal of Applied Ecology* 49: 474–480.

Focus Abundance; threats, impacts, and management.

Summary

Aim Test whether reduced gillnetting pressure would result in increased adult survival rate and improved population growth of Hector's dolphin in the Banks Peninsula Marine Mammal Sanctuary.

Methods Used capture-recapture modelling of 21 years of photo-identification data collected along standardised transects from 1986 to 2006 to compare pre- and post-sanctuary mean annual survival rates.

Results Estimated a 90% probability that survival improved between the pre-sanctuary and post-sanctuary periods, resulting in a 6% increase in mean annual population growth.

Who *Academic* (University of Otago); *Research Organisation* (Landcare Research; The Whale Museum); *Consultant* (Blue Planet Marine).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Refined survival and population growth estimates.

Information gap filled Efficacy of Banks Peninsula Marine Mammal Sanctuary proven quantitatively, through estimates in survival and also population growth.

Information gap identified Need for further work to estimate fecundity, thought to be large contributor to overall post-sanctuary population growth rates.

Green, E. 2003: Population biology and the effects of tourism on Hector's Dolphins (*Cephalorhynchus hectori*), in Porpoise Bay, New Zealand. Unpublished MSc thesis. Department of Zoology, University of Otago, Dunedin.

Focus Abundance; behaviour; distribution; threats, impacts, and management.

Summary

Aim Collect data on the effects of tourism, estimate abundance, quantify distribution and alongshore range, and provide recommendations for the management of a small population of Hector's dolphin in Porpoise Bay.

Methods Photo-ID data were gathered during the summers of 2001/02 and 2002/03. Nineteen dolphins were identifiable from natural markings.

Results Abundance was estimated at 43 animals (95% CI = 40–48). This was lower than an earlier abundance estimate of 48 (95% CI = 45–55; Bejder & Dawson 2001), but the difference was not significant (overlapping confidence intervals). Overall distribution was similar to previous studies, with dolphins showing a preference for a small area in the southern part of the bay. Time spent by dolphins in the presence of boats and swimmers increased from 24% to 33% over a five-year period. Behavioural budgets differed in the presence of tourism (boats and swimmers), and dolphins appeared to show less interest in swimmers over time. Implications for management and potential future research are discussed.

Who *Academic* (University of Otago).

Type Thesis (Masters).

TMP Pre-TMP.

Green, E. 2004: Preliminary boat-based surveys to investigate distribution of Hector's dolphin in Te Waewae bay, Southland. Southland Conservancy, Department of Conservation, Invercargill. 28 p.

Focus Abundance; distribution.

Summary

Aim Gain a better understanding of the Hector's dolphin population in Te Waewae Bay (Southland) by investigating their distribution within the bay and establishing a photo-ID catalogue.

Methods Boat-based photo-ID surveys of Te Waewae Bay were carried out from April to June 2004, following the coast in one direction then following one of three transects running parallel to the coast at distances of 5, 10, and 15 km offshore.

Results Density maps standardised by search effort showed that dolphins were concentrated within 1 km of the coast, with especially high concentrations of animals off the Waiau River and west of Rowallen Burn. In particular, many groups of dolphins were sighted just behind the surf zone. Few animals were seen on transects. A photo-ID catalogue of 65 animals was developed as a first step in obtaining mark-recapture abundance estimates of the population. The discovery curve of dolphins appeared to level off in latter stages of the surveys, suggesting the population may be 'closed' (i.e. minimal immigration or emigration).

Who *Government, NZ* (DOC).

Type DOC (not peer-reviewed).

TMP Pre-TMP.

Green, E.; Charteris, C.; Rodda, J. 2007: Te Waewae Bay Hector's dolphins: abundance, distribution and threats. Southland Conservancy, Department of Conservation, Invercargill. 54 p.

Focus Abundance; distribution; threats, impacts, and management.

Summary

Aim Report of the first intensive study of Hector's dolphin in Te Waewae Bay (see also Green 2004). Aimed to provide an accurate abundance estimate and document dolphin distribution within the bay.

Methods Boat-based photo-ID surveys following coastal and offshore transects were carried out during April–June 2004; December 2004; and January–February 2005. Mark-recapture analysis applying a Robust Design model in the program MARK was used to estimate abundance.

Results Mark-recapture analysis of sightings of 29 distinctive animals (from an overall catalogue of 70) provided an autumn abundance estimate of 251 (95% CI = 183–343), compared with a summer estimate of 403 (95% CI = 280–488). Sightings were concentrated near shore, but

were sighted less often at the western and eastern extremes of the bay. The abundance estimate is not considered by the authors to be definitive, and is expected to be refined with additional sampling. Observation was made that the threat posed by potential fisheries bycatch may be high, and that boat strike is a risk.

Who *Government, NZ (DOC).*

Type DOC (peer-reviewed).

TMP Post-TMP.

Information added New abundance and distribution information on a small, isolated population of Hector's dolphins.

Information gap filled South coast (Te Waewae Bay) population of Hector's dolphin previously unstudied, though was included in the Dawson et al. (2004) population estimate.

Information gap identified Further data required to better estimate seasonal movements; population definition; anthropogenic threats; abundance; and survival of this population.

Hamner, R.M. 2008: Population structure, gene flow and dispersal of Hector's dolphins (*Cephalorhynchus hectori hectori*) around the South Island of New Zealand. Unpublished MSc Thesis. School of Biological Sciences. University of Auckland, Auckland. 146 p.

Focus Genetics.

Summary

Aim Improve understanding of population structure, gene flow, and dispersal of South Island Hector's dolphins.

Methods Used mtDNA, bi-parentally inherited microsatellites, assignment tests based on microsatellite genotypes, and clustering analyses. Samples came from 101 stranded/beach-cast dolphins, 106 live biopsied dolphins, and 128 skin-swabbed dolphins from 1988 to 2007.

Results Long-term restrictions in gene flow between the east, west and south coast regions were confirmed, supporting previous studies. Geographic sampling locations corresponded to genetically distinct regional populations. Low levels of differentiation were found for the local populations within the west and east Coasts. One potential intra-regional migrant was identified in the east coast, three in the west coast, and two in the south coast; all were between adjacent local populations. Evidence of male-biased dispersal was found for the west and east coasts. The two South Coast populations of Te Waewae Bay and Toetoe Bay displayed significant population differentiation. Stepwise gene flow around the South Island, with a gap between the east and south Coasts, was supported. The east coast, west coast, Te Waewae Bay, and Toetoe Bay populations of Hector's dolphins met criteria for designation as partial Evolutionary Significant Units, and should be managed independently.

Who *Academic (University of Auckland).*

Type Thesis (Masters).

TMP Post-TMP.

Information added Genetic differentiation of South Island populations; male-biased dispersal; population migration.

Information gap identified Further biopsy sampling needed, especially in Porpoise Bay; focussing on the role of temporary dispersal between adjacent local populations.

Hamner, R.M.; Oremus, M.; Stanley, M.; Brown, P.; Constantine, R.; Baker, C.S. 2012: Estimating the abundance and effective population size of Maui's dolphins using microsatellite genotypes in 2010–11, with retrospective matching to 2001–07. Auckland Conservancy, Department of Conservation, Auckland. 44 p.

Focus Abundance; distribution; genetics; threats, impacts, and management.

Summary

Aim In addition to completing the profiling and archiving of recently collected Maui's dolphin tissue samples, this study had a number of aims relating to movements, migrations, abundance, and trends of Maui's dolphin.

Methods Dedicated small-boat surveys were conducted during the summers of 2009/10 and 2010/11. A total of 73 dart-biopsy samples were collected during these periods. Genotypic profiling was used to identify individual Maui's dolphins and Hector's dolphin migrants; movement of individuals was calculated using a simple straight-line distance between sampling locations of the same individual; subspecies confirmation was achieved via a Bayesian haplotype assignment procedure; abundance and trend estimation was completed via various mark-recapture models; and, finally, effective population size was estimated via the linkage disequilibrium method.

Results Movement data confirmed previously identified patterns of site fidelity and local movements across the Manukau Harbour entrance and the mouth of the Waikato River; the largest movement recorded was just over 80 km. Abundance estimate of animals >1 year old was 55 (95% CL = 48–69); with a suggested (but unconfirmed) decline of 3% per year.

Who *Academic* (Oregon State University; University of Auckland); *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Post-TMP.

Information added Revised abundance estimate; effective abundance estimate; movements; large-scale migrations; management implications.

Information gap filled First evidence of West Coast South Island to West Coast North Island movement.

Information gap identified Will Hector's migrants remain with and successfully breed with Maui's dolphins?

Hamner, R.M.; Pichler, F.P.; Heimerier, D.H.; Constantine, R.; Baker, C.S. 2012: Genetic differentiation and limited gene flow among fragmented populations of New Zealand endemic Hector's and Maui's dolphins. *Conservation Genetics*. DOI 10.1007/s10592-012-0347-9.

Focus Genetics.

Summary

Aim Examine genetic diversity, gene flow, and migration between Hector's and Maui's dolphins, as well as among regional and local populations of Hector's dolphins.

Methods Tissue samples ($n = 438$) collected between 1988 and 2007 using a number of methods, including sampling (using biopsy darts or skin swabs) of free-ranging, beachcast, and bycaught dolphins. Mitochondrial DNA and microsatellite genotypes used to investigate genetic differentiation and migration.

Results Results confirmed the reproductive isolation of Maui's from Hector's dolphins; and independent evolutionary trajectories were supported for Hector's dolphin populations of the east coast, west coast, Te Waewae Bay and Toetoe Bay. Genetic diversity within east and west Coast populations of Hector's dolphins were shown to be maintained through step-wise gene flow; but the two south coast populations exhibited a high degree of differentiation given their close proximity (c. 100 km).

Who Academic (Oregon State University; University of Auckland).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Increased coverage of distribution of genetic samples; inclusion of Toetoe Bay population.

Information gap filled Contributed to greater understanding of corridors for gene flow, necessary to preserve genetic diversity and maintain local populations.

Heimeier, D. 2009: Comparative diversity at the Major Histocompatibility Complex in two dolphin species. Unpublished PhD Thesis. School of Biological Sciences, University of Auckland, Auckland. 228 p.

Focus Genetics.

Summary

Aim Investigate diversity of three genes (class I, *DQA*, and *DQB*) of the Major Histocompatibility Complex (MHC) in Hector's dolphin (*C. h. hectori*), Maui's dolphin (*C. h. maui*) and long-finned pilot whale (*Globicephala melas*).

Methods MHC genes were amplified from cDNA derived from blood samples from two live-captured Hector's dolphins. *DQA* and *DQB* diversity in Hector's and Maui's dolphins was analysed from previously collected stranding and biopsy samples ($n = 233$), representing three populations from the South Island and the Maui's dolphin population from the North Island.

Results Hector's dolphin showed a surprisingly large number of alleles at both loci ($DQA = 4$, $DQB = 6$), considering their small population size and compared with other cetacean populations with larger population sizes. Maui's dolphin showed a relatively high nucleotide diversity for *DQB* ($\pi = 4.5\%$), based on only three alleles that have been retained in the sub-species, representing the most divergent of all six alleles. All populations showed strong geographic differentiation at both loci, with the greatest differentiation between the South Island population and the North Island Maui's dolphin. Comparison with mitochondrial and microsatellite diversity suggested the influence of stochastic genetic drift, although the pressure of balancing selection acting on *DQB* over an evolutionary time period was also evident.

Who Academic (University of Auckland).

Type Thesis (PhD).

TMP Post-TMP.

Information added Population and species-level genetic diversity.

Information gap filled Comparative genetic diversity of Hector's dolphin with Maui's dolphin and other cetacean species.

Heimeier, D.; Baker, C.S.; Russell, K.; Duignan, P.J.; Hutt, A.; Stone, G.S. 2009: Confirmed expression of MHC class I and II genes in the New Zealand endemic Hector's dolphin (*Cephalorhynchus hectori*). *Marine Mammal Science* 25(1): 68–90.

Focus Genetics.

Summary

Aim Functional diversity of the Major Histocompatibility Complex (MHC) immune genes determines the scope of a population's ability to detect foreign antigens, with low diversity at these genes resulting in possibly higher susceptibility to disease. This paper aimed to describe the expression of three MHC genes in samples from Hector's dolphins.

Methods Total RNA and DNA were extracted from blood and skin samples taken from two South Island Hector's dolphins at Banks Peninsula. These samples were analysed to describe the expression of three MHC genes in these dolphins.

Results A small number of surviving divergent alleles were detected in the MHC genes of the two Hector's dolphins sampled, suggesting the potential for a 'divergent allele' advantage. The small sample size for this study highlights the need to consider the results preliminary.

Who *Academic* (University of Auckland); *Government, Ireland and NZ* (Department of Agriculture, Food and the Marine; DOC); *Research Organisation* (New England Aquarium).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Suggestive of a 'divergent allele' advantage (which potentially confers immunological advantages).

Information gap identified Similar studies would be beneficial with the Maui's dolphin population, given the extremely small population size.

Jonker, F.; Ferreira, S.M. 2004: Can echolocation devices be used to define harbour use by Maui's dolphins? *DOC Science Internal Series 161*. Department of Conservation, Wellington. 21 p.

Focus Distribution.

Summary

Aim Pilot study undertaken between 1 April and 30 June 2003 to investigate the distribution and movement of Maui's dolphins within Manukau Harbour, using porpoise detection devices (PODs). The main focus of this study was to calibrate PODs and determine their usefulness in studying Maui's dolphins.

Methods Controlled POD tests were carried out on recorded Hector's dolphin sounds and in different waterbodies in the Manukau Harbour, with POD tests also conducted for dolphins actually sighted outside the Harbour region.

Results Only two attempts were made to log Maui's dolphin vocalisations using PODs. In the first, the POD was not fully functional and no data were obtained. In the second, vocalisations were logged from a single animal during a forty-five-minute period. Attempts to log dolphin recordings played back underwater were similarly unsuccessful.

Who *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

King, R.; Brooks, S.P. 2004a: Bayesian analysis of the Hector's Dolphin data. *Animal Biodiversity and Conservation 27(1)*: 343–354.

Focus General biology; threats, impacts, and management.

Summary

Aim Determine the effect of the Banks Peninsula Marine Mammal Sanctuary on the survival rate of Hector's dolphin.

Methods Analysis of Hector's dolphin photo-ID data from Banks Peninsula (1985–1993) was undertaken within a Bayesian framework.

Results The model with most support has constant survival over time, suggesting that the introduction of the marine mammal sanctuary had no impact on the survival rates of dolphins. The second most probable model places a change point at the time the sanctuary is introduced; however, results indicate a slowly decreasing trend in survival since 1987.

Who *Academic* (University of St. Andrews; University of Cambridge).

Type Peer-reviewed journal.

TMP Pre-TMP.

King, R.; Brooks, S.P. 2004b: A classical study of catch-effort models for Hector's dolphins. *Journal of the American Statistical Association* 99(466): 325–333.

Focus General biology.

Summary

Aim This paper uses Akaike's information criterion and an extension of the simulated annealing algorithm to investigate a variety of models that correspond to different assumptions regarding Hector's dolphin survival rates.

Methods Analysis is based on photo-ID data gathered within the Banks Peninsula Marine Mammal Sanctuary between 1985 and 1993.

Results The authors advocate the inclusion of catch-effort data, because such models provide better fit to the data, and therefore better prediction and ultimately better management. Their results indicated that pre-sanctuary (pre-1989) survival was 0.944, compared with a post-sanctuary estimate of 0.827.

Who *Academic* (University of St. Andrews; University of Cambridge).

Type Peer-reviewed journal.

TMP Pre-TMP.

Kyhn, L.A.; Tougaard, J.; Jensen, F.; Wahlberg, M.; Stone, G.; Yoshinaga, A.; Beedholm, K.; Madsen, P.T. 2009: Feeding at a high pitch: source parameters of narrow band, high-frequency clicks from echolocating off-shore hourglass dolphins and coastal Hector's dolphins. *Journal of the Acoustical Society of America* 125(3): 1783–1791.

Focus General biology; behaviour.

Summary

Aim Describe the source parameters (i.e. acoustic characteristics) of echolocation clicks from hourglass dolphins and Hector's dolphins.

Methods A hydrophone array was used to record hourglass dolphins in Drake Passage and Hector's dolphins at Banks Peninsula, and comparisons were made of the source parameters for echolocation clicks of the two species.

Results Both species produce narrow-band, high-frequency echolocation clicks, with hourglass dolphins producing clicks at higher source levels, allowing them to detect prey at more than twice the distance compared with Hector's dolphins. This may be a result of the cluttered coastal environment inhabited by Hector's dolphins compared with the pelagic habitat of hourglass dolphins.

Who *Academic* (University of Aarhus); *Research Organisation* (Fjord & Baelt; New England Aquarium; Woods Hole Oceanographic Institution).

Type Peer-reviewed journal.

TMP Post TMP.

Martinez, E. 2003: A pre-disturbance study of Hector's dolphins (*Cephalorhynchus hectori*) prior to a dolphin-watching operation at Motunau, New Zealand. Unpublished MSc Thesis. University of Otago, Dunedin.

Focus Behaviour; threats, impacts, and management.

Summary

Aim Gather pre-disturbance data on a small population of Hector's dolphin for which a marine mammal-watching permit had been granted.

Methods Land-based observations and theodolite tracking were carried out during the summers of 2000 and 2001. Dolphin behaviours, occupancy, and short-term responses to vessels were assessed.

Results Behaviour associated with feeding peaked in the morning (0600–1000 h) and again in the afternoon (1400–1800 h). Rates of aerial, play, and sexual behaviours all increased as the day progressed. Dolphins were found further away from shore in March and during the middle of the day (1000–1400 h). Dolphins formed tighter pods in the presence of boats, but otherwise displayed no significant attraction to or avoidance of vessels. It is noted, however, that sample size was often too small to have sufficient statistical power to detect subtle changes.

Who *Academic* (University of Otago).

Type Thesis (Masters).

TMP Pre-TMP.

Martinez, E. 2010: Responses of South Island Hector's dolphins (*Cephalorhynchus hectori hectori*) to vessel activity (including tourism operations) in Akaroa Harbour, Banks Peninsula, New Zealand. Unpublished PhD Thesis. Massey University, Auckland. 316 p.

Focus Behaviour; threats, impacts and management.

Summary

Aim Evaluate the impacts of tourism disturbance on Hector's dolphin in Akaroa Harbour.

Methods Occurrence and demographics of Hector's dolphins and vessel traffic were documented from land-based platforms during three consecutive austral summers from 2005. Focal-group follows from land and analyses using Markov chain models determined behavioural budget effects. The response of dolphins to swim attempts and auditory stimulants was assessed from commercial tourism vessel trips.

Results An inshore-offshore migration was confirmed, with higher density patterns between the Kaik hills and harbour entrance. Most groups consisted of adults only (91.2%, $n = 2000$), with 2–5 individuals (83.2%). Group size was largest when socialising. Dolphins were not in the presence of vessels for only 14% of their day. Most vessel traffic was recreational (72.9%), but 70.4% of observed encounters were with commercial vessels, which interacted with dolphins for twice as long as recreational vessels. No displacement was evident, suggesting an adjustment of the dolphins' behavioural budget to compensate for the high presence of vessels. Vessel presence affected activity budget, with diving and travelling significantly disrupted by vessel interactions. Behaviour was correlated to method of approach, swimmer placement, number of successive attempts, dolphin group size, and initial behaviour. The use of stones by swimmers to create a noise and attract dolphins led to greater probability of close and sustained approaches by dolphins. Some sensitisation to seasonally high levels of vessel interactions was detected. Resighting rates of individual dolphins via photo-ID surveys suggested that frequent users of the harbour were likely to be exposed to more tourism pressure, but unlikely to discontinue use of the harbour. A moratorium on new permits and reduction in daily trip numbers was suggested.

Who *Academic* (Massey University, Auckland).

Type Thesis (PhD).

TMP Post-TMP.

Information added Effect of tourism and vessel disturbance on a high concern population.

Information gap identified In addition to recommending on-going studies of this nature (photo-ID inside and outside Akaroa Harbour; studies of interactions between dolphins and tourism activities—preferably using experimental design to tease out different effects), a further recommendation was that studies of the effects of anthropogenic noise on dolphin prey species be carried out.

Martinez, E.; Orams, M.B.; Pawley, M.D.M.; Stockin, K.A. 2011: The use of auditory stimulants during swim encounters with Hector's dolphins (*Cephalorhynchus hectori hectori*) in Akaroa Harbour, New Zealand. *Marine Mammal Science*. DOI: 10.1111/j.1748-7692.2011.00528.x.

Focus Threats, impacts, and management.

Summary

Aim Investigate the effects of human-induced noise (e.g. banging stones together) on Hector's dolphin behaviour during swim-with-dolphin encounters.

Methods Opportunistic observations were conducted from onboard a commercial swim-with-dolphin vessel in Akaroa Harbour in November and December 2008.

Results Swimmers were significantly more likely to be approached, experience longer interaction times, and have dolphins in closer proximity when they used stones to attract dolphins than when they did not. Dolphins also approached closer and interacted for longer with active swimmers compared with non-active swimmers.

Who *Academic* (University of Aarhus); *Research Organisation* (Fjord & Baelte; New England Aquarium; Woods Hole Oceanographic Institution).

Type Peer-reviewed journal.

TMP Post-TMP.

Information gap filled First study of use of auditory stimulants during swim encounters with Hector's dolphins.

Information gap identified Acoustic properties of auditory stimulants and their relevance to echolocation and communication clicks.

Martinez, E.; Orams, M.B.; Stockin, K.A. 2011: Swimming with an endemic and endangered species: effects of tourism on Hector's dolphins in Akaroa Harbour, New Zealand. *Tourism Review International* 14: 99–115.

Focus Threats, impacts, and management.

Summary

Aim Assess the effects of swim-with-dolphin encounters on Hector's dolphins, including vessel approach and swimmer placement strategies.

Methods Opportunistic vessel surveys were conducted to record characteristics and dolphin responses to swim-with-dolphin encounters conducted by five ecotourism vessels at Banks Peninsula from November 2005 to March 2006.

Results Milling groups of Hector's dolphins had significantly increased interaction times with swimmers compared with diving, socialising, and travelling groups, and larger groups of dolphins interacted for longer than smaller groups. The authors suggest no further swim-with-dolphin permits should be granted in Akaroa Harbour and that management authorities consider reducing the level of tourism activities to which this population is exposed.

Who *Academic* (Massey University; AUT University).

Type Peer-reviewed journal.

TMP Post-TMP.

Information gap filled Quantitative basis for decisions regarding dolphin exposure to tourism activities in Akaroa Harbour.

Martinez, E.; Stockin, K.A. 2011: Report on the usefulness of information collected from marine mammal permittees in the form of data sheets in Akaroa Harbour, New Zealand. Final report for Canterbury Conservancy, Department of Conservation, Christchurch. 40 p.

Focus Threats, impacts, and management.

Summary

Aim Assess the usefulness of data collected by marine mammal permittees; compare against those data collected by dedicated researchers; determine whether data can be used for management; suggest improvements to data sheets.

Methods A standardised data sheet was provided to tour operators (permittees) in 2006. Data sheets were collected up until 2008 (between November and March of each year). A number of comparative statistical tests were carried out on the resulting data.

Results The nature of the data precludes rigorous robust assessment of tourism on animal behaviour, particularly since a large percentage of data sheets were not completed by operators. Additionally, data were not consistent or reliable enough to assess permit compliance, or to be of use for other management purposes. Suggested amendments to the data sheets were provided, which may improve the quality and usefulness of data in the future.

Who *Academic* (Coastal-Marine Research Group; Massey University).

Type Unpublished report.

TMP Post-TMP.

Information added First attempt at standardising data recording by tour operators in Akaroa Harbour.

McElderry, H.; McCullough, D.; Schrader, J.; Illingworth, J. 2007: Pilot study to test the effectiveness of electronic monitoring in Canterbury fisheries. *DOC Research and Development Series 264*. Department of Conservation, Wellington. 27 p.

Focus Threats, impacts, and management.

Summary

Aim Electronic monitoring (EM) systems were tested on inshore trawl and set net vessels (one and four vessels, respectively) in the Canterbury region between October 2003 and January 2004.

Methods EM systems consisted of two closed circuit television cameras, a GPS receiver, hydraulic and winch sensors, and onboard data storage.

Results The systems proved highly reliable, although some imagery (14%) was lost post-fishing trip. The analysis method used to examine imagery for protected species took about one-third of the time needed for detailed catch enumeration, and successfully detected two Hector's dolphin entanglements (both appeared to be released alive). EM systems offer numerous advantages over traditional observer programmes, including logistical efficiency (e.g. labour savings), fleet suitability (some vessels are too small to carry observers), and industry acceptance.

Who *Consultant* (Archipelago Marine Research Ltd).

Type DOC (peer-reviewed).

TMP Pre-TMP.

MFish (Ministry of Fisheries); DOC (Department of Conservation) 2007: Hector's dolphin threat management discussion document. Ministry of Fisheries and Department of Conservation, Wellington. 154 p.

Focus Threats, impacts, and management.

Summary

Aim Provide background information for regional stakeholder discussions on threats and management options for Hector's dolphins, to help develop the Threat Management Plan.

Methods The document is structured to provide information at a national and regional level.

Results The document provides a comprehensive description of the current biological status of Hector's dolphins, documented threats, and management measures available to avoid, remedy or mitigate human-induced threats in each region where Hector's dolphins are found.

Who *Government, NZ* (DOC; MFish).

Type Unpublished report.

TMP Pre-TMP.

Rayment, W.J. 2008: Distribution and ranging of Hector's dolphins: implications for protected area design. Unpublished PhD Thesis. University of Otago, Dunedin. 206 p.

Focus Distribution; threats, impacts, and management.

Summary

Aim Identify distribution and movements of Hector's dolphins to improve the design of the Banks Peninsula Marine Mammal Sanctuary (BPMMS).

Methods Aerial surveys for dolphins were made around Banks Peninsula and the South Island's west coast over 3 years. Boat surveys (2002–2006) were carried out to continue the long-term photo-ID dataset. Acoustic dataloggers (T-PODs) were deployed at Banks Peninsula to monitor the dolphins' inshore habitat use.

Results On average, 19% of dolphins were sighted outside the BPMMS's offshore boundary in summer, and 56% in winter; sightings were made up to 19 n.m. offshore. On the west coast, all dolphins were sighted within 6 n.m. with no seasonal change in distribution. Distribution was most strongly defined by water depth, with all sightings within the 90 m isobath. The alongshore home range of the 20 most frequently sighted dolphins over 22 years was estimated at a mean of 49.69 km (SE = 5.29), 60% higher than previous estimates. 15% of these individuals' home ranges extended beyond the BPMMS northern boundary. Dolphins were detected by T-PODs more than twice as often per day in the summer than in winter. Implications for protected area design are discussed.

Who *Academic* (University of Otago).

Type Thesis (PhD).

TMP Post-TMP.

Information added Distribution related to water depth; temporal distribution varies with population and location; revised estimate of alongshore home range; revised suggestions for management.

Information gap filled Distribution outside the BPMMS boundaries; first trial of T-PODs with Hector's dolphins.

Information gap identified Further research into Hector's dolphin prey to better understand seasonal changes in distribution; more photo-ID effort to determine appropriate BPMMS boundaries; use of T-PODs to monitor potentially harmful activities and the efficacy of protected areas.

Rayment, W., Clement, D.; Dawson, S., Slooten, E.; Secchi, E. 2011: Distribution of Hector's dolphin (*Cephalorhynchus hectori*) off the west coast, South Island, New Zealand, with implications for the management of bycatch. *Marine Mammal Science* 27(2): 398–420.

Focus Distribution; threats, impacts and management.

Summary

Aim Investigate Hector's dolphin distribution to inform protected area management.

Methods Line transect aerial surveys were carried out to investigate the alongshore distribution and abundance on the South Island's west coast in December 2000. Further surveys in summer and winter 2003 focussed on offshore distribution from the identified central zone of high density (Kohaihai Bluff to Ross).

Results Dolphin density decreased with increasing distance offshore. No dolphins were sighted more than 6 n.m. from the coast or in waters >60 m deep. There was no significant temporal effect on offshore distribution. Distribution was best explained by distance from the coast. Small (c. 5 km) and medium (c. 50 km) patterns of density in the central zone were consistent, suggesting year-round residency. Current commercial gillnetting restrictions up to 2 n.m. offshore therefore protect 60% or less of the population for 3 months per year.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added West-coast-specific population distribution data and management implications.

Information gap filled First data of this type for the west coast South Island population of Hector's dolphin.

Information gap identified Further surveys needed to confirm results.

Rayment, W.; Dawson, S.; Scali, S.; Slooten, E. 2011: Listening for a needle in a haystack: passive acoustic detection of dolphins at very low densities. *Endangered Species Research* 14: 149–156.

Focus Abundance; distribution.

Summary

Aim Investigate distribution of Maui's dolphins within harbours and assess whether current protection measures are sufficient.

Methods T-PODs were deployed in four harbours on the North Island's west coast between 2005 and 2008. Decision rules were developed to minimise the risk of false positive detections.

Results Over 3211 'T-POD days' of acoustic monitoring, 38 Maui's dolphin click trains were detected in Manukau Harbour and 1 in Kaipara Harbour. The number of detections varied temporally. Models were also used to estimate how often dolphins could have been present yet undetected at monitored locations. Maui's dolphins in North Island harbours were found to remain at risk from gillnet bycatch. The challenges of passive acoustic monitoring of rare species are discussed.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added At the time of survey, Maui's dolphins were distributed outside the areas of protection, and therefore remained at risk. This may still be the situation.

Information gap filled Passive acoustic monitoring is possible for small delphinids.

Information gap identified Made a number of recommendations to improve future acoustic monitoring projects.

Rayment, W.; Dawson, S.; Slooten, L. 2009: Trialling an automated passive acoustic detector (T-POD) with Hector's dolphins (*Cephalorhynchus hectori*). *Journal of the Marine Biological Association of the United Kingdom* 89(5): 1015–1022.

Focus Distribution; behaviour.

Summary

Aim Test the performance of the T-POD acoustic datalogger for detection of Hector's dolphin echolocation clicks.

Methods Simultaneous T-POD recordings and visual surveys were conducted at Flea Bay, Banks Peninsula, including use of a theodolite to measure the distance between dolphins and the T-POD.

Results Detection probability and click train detection rates decreased with distance. No detections were made beyond 500 m. The T-POD effectively detected all dolphin groups within an estimated radius of 198–239 m.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added First rigorous trial of T-PODs as an acoustic monitoring tool for Hector's dolphins.

Information gap filled Determined T-PODs' range of detection radius for Hector's dolphins.

Rayment, W.; Dawson, S.; Slooten, L. 2009: Use of T-PODs for acoustic monitoring of *Cephalorhynchus* dolphins: a case study with Hector's dolphins in a marine protected area. *Endangered Species Research* 10: 333–339.

Focus Distribution; behaviour.

Summary

Aim Evaluate the T-POD acoustic datalogger's capacity for addressing habitat use questions relevant to the management of Hector's dolphins.

Methods Three T-PODs were deployed during summer and winter months to detect Hector's dolphins at Banks Peninsula from June 2004 to February 2006. Acoustic data were analysed to determine the number of detection-positive minutes per day.

Results No significant difference was found between acoustic detection rates during the night or day; however, three times as many minutes with dolphin detections were recorded in summer compared with winter.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added First evaluation of using T-PODs to investigate habitat preferences of Hector's dolphins.

Information gap identified Made a number of recommendations for further studies to investigate dolphin habitat use; e.g. the proportion of time dolphins spent echolocating should be investigated.

Rayment, W.; Dawson, S.; Slooten, E. 2010: Seasonal changes in distribution of Hector's dolphin at Banks Peninsula, New Zealand: implications for protected area design. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20: 106–116.

Focus Distribution; threats, impacts, and management.

Summary

Aim Investigate seasonal changes in the distribution of Hector's dolphin around the Banks Peninsula Marine Mammal Sanctuary (BPMMS).

Methods Aerial line-transect surveys were carried out up to 20 n.m. offshore from Banks Peninsula, in each austral summer and winter of 2002, 2004, and 2005.

Results Dolphin sightings were concentrated closer to shore in shallow water in summer, and more evenly distributed throughout the study area in winter. More dolphins were sighted outside the BPMMS 4 n.m. offshore boundary in winter than in summer (mean = 56% and 19%, respectively). Distance offshore had the strongest effect on dolphin presence; depth had a strong effect in summer only. An extension of gillnet restrictions and the offshore boundary of the BPMMS are suggested.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Distribution related to water depth; temporal distribution.

Information gap filled Distribution outside the BPMMS boundaries.

Rayment, W.; Dawson, S.; Slooten, E.; Brager, S.; du Fresne, S.; Webster, T. 2009: Kernel density estimates of alongshore home range of Hector's dolphins at Banks Peninsula, New Zealand. *Marine Mammal Science* 25(3): 537–556.

Focus Distribution; behaviour; threats, impacts and management.

Summary

Aim Determine the ranging behaviour of Hector's dolphins in the Banks Peninsula Marine Mammal Sanctuary (BPMMS).

Methods Photo-ID surveys of Hector's dolphins were conducted in the BPMMS from 1985 to 2006. Data were analysed to obtain univariate kernel density estimates of the alongshore home range for 20 individuals.

Results The mean estimate for the alongshore home range was 49.69 km and for core portions of coastline where dolphins concentrated their activity was 17.13 km. Four distinct hubs where core areas of different individuals coincided were apparent. Three dolphins had home ranges that extended beyond the northern boundary of the BPMMS.

Who *Academic* (University of Otago); *Research Organisation* (German Oceanographic Museum (DMM)); *Consultant* (Du Fresne Ecology Ltd).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Revised home-range estimate using expanded dataset and new analytical methods. Study identified core-use areas that were broadly in agreement with those identified in other studies.

Rayment, W.; Dawson, S.; Slooten, E.; Childerhouse, S. 2006: Offshore distribution of Hector's dolphin at Banks Peninsula. *DOC Research & Development Series* 232. Department of Conservation, Wellington. 23 p.

Focus Distribution; threats, impacts, and management.

Summary

Aim Investigate seasonal distribution patterns of Hector's dolphin in and around the Banks Peninsula Marine Mammal Sanctuary (see also Slooten et al. 2006b).

Methods Aerial surveys were carried out in summer and winter 2004. The primary set of transect lines were at 45° to the coast at 4 n.m. intervals, and extending 15 n.m. offshore. A second set of five lines extended between 15 and 20 n.m. offshore.

Results In summer, most Hector's dolphin groups were observed close to shore in waters <20 m deep. In winter, they were seen more often in waters 20–50 m deep. The deepest sightings were in waters approximately 70 m deep in the summer and 80 m deep in the

winter. In winter, there was a noticeable offshore shift in distribution, with dolphins seen at the offshore limits of the survey area. During summer, 93% of groups seen were within the 4 n.m. boundary of the sanctuary, compared with 43% in the winter. During the summer survey, encounter rates were particularly clumped in the 0–2 n.m. zone. In winter, sighting rates were spread more evenly from the coast to 18 n.m. offshore. The report raised concerns that the sanctuary is not currently big enough to adequately protect the dolphin population.

Who *Academic* (University of Otago); *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Rayment, W.; du Fresne, S. 2007: Offshore aerial survey of Maui's dolphin distribution 2007. Final report to Auckland Conservancy, Department of Conservation. Du Fresne Ecology Ltd, Nelson. 6 p.

Focus Distribution.

Summary

Aim Investigate Maui's dolphin distribution.

Methods Aerial line-transect surveys were conducted up to 10 n.m. offshore between Muriwai and Carter's Beach just north of Raglan, North Island, in October 2007.

Results Thirteen Maui's dolphin sightings were made during 11 survey flights, comprising nine single animals and four pairs. One sighting was made outside the 4 n.m. protected area offshore boundary, at 4.05 n.m. All sightings were at depths of <40 m. Four sightings of Maui's dolphins (three individuals, one pair) were also made within the offshore boundary whilst planes were travelling 'off effort'. The majority of sightings were between Manukau Harbour and Port Waikato, and within 3 n.m. of the coastline. However the authors raise concern that the current protected area boundary does not fully encompass the offshore range of Maui's dolphins.

Who *Consultant* (Du Fresne Ecology Ltd); *Government, NZ* (DOC).

Type Unpublished report.

TMP Post-TMP.

Information added Maui's dolphin offshore distribution exceeds existing protection boundary.

Information gap identified Further data required from seasonal offshore surveys.

Rayment, W.; Webster, T. 2009: Observations of Hector's dolphins (*Cephalorhynchus hectori*) associating with inshore fishing trawlers at Banks Peninsula, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 43: 911–916.

Focus Threats, impacts, and management.

Summary

Aim Presents observations about the influence of inshore fishing trawlers on group size and behaviour of Hector's dolphins.

Methods Observations of dolphins associating with trawlers were made during photo-ID surveys conducted at Banks Peninsula from November 2003 to February 2007.

Results Dolphins following trawlers were found in larger groups and typically exhibited more aerial and sexual behaviours than those observed in groups away from trawlers. Trawlers are likely to increase prey availability for Hector's dolphins, but also increase their risk of being caught in trawl nets.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Quantified the attraction of Hector's dolphins to working inshore trawlers; suggested that aggregations were related to feeding behaviour.

Information gap identified Unknown how feeding behaviour and success would be influenced by changes in fishing effort or distribution.

Reeves, R.R.; Dawson, S.M.; Jefferson, T.A.; Karczmarski, L.; Laidre, K.; O'Corry-Crowe, G.; Rojas-Bracho, L.; Secchi, E.R.; Slooten, E.; Smith, B.D.; Wang, J.Y.; Zhou, K. 2000: *Cephalorhynchus hectori* ssp. *maui*. In: IUCN 2011: IUCN Red List of Threatened Species, Version 2011.2. www.iucnredlist.org.

Focus Abundance; distribution; general biology; threats, impacts, and management.

Summary

Aim Assess conservation status of Maui's dolphin.

Methods Used available information relevant to species threat risk.

Results The North Island subspecies of Hector's dolphin is considered to be Critically Endangered. This is due to an estimated rate of decline over three generations (c. 39 years; Slooten et al. 2000), from 1970 to 2009, of 93% (Slooten 2007; also see Martien et al. 1999; Burkhart & Slooten 2003). The single subpopulation size is estimated at 111 individuals (95% CI: 48–252; Slooten et al. 2005); the proportion of mature individuals is estimated at 50% (Slooten et al. 2000; Taylor et al. 2007). A continuing decline is inferred since the principal purported cause of decline (gillnet fisheries bycatch) remains in parts of the subspecies' range. Trawling also continues through parts of the subspecies' range. The distribution is highly fragmented; 90% of individuals are found within a 22 n.m. strip of coast between the Manukau Harbour and Port Waikato. Further information is required on geographic range declines.

Who *Research organisation* (International Union for Conservation of Nature (IUCN)).

Type Internet resource.

TMP Pre-TMP.

Reeves, R.R.; Dawson, S.M.; Jefferson, T.A.; Karczmarski, L.; Laidre, K.; O'Corry-Crowe, G.; Rojas-Bracho, L.; Secchi, E.R.; Slooten, E.; Smith, B.D.; Wang, J.Y.; Zhou, K. 2008: *Cephalorhynchus hectori*. In IUCN 2011: IUCN Red List of Threatened Species, Version 2011.2. www.iucnredlist.org.

Focus Abundance; distribution; general biology; threat, impacts, and management.

Summary

Aim Assess the conservation status of Hector's dolphin.

Methods Used available information relevant to species threat risk.

Results The species is considered to be Endangered due to an ongoing and projected decline of greater than 50% over three generations (c. 39 years; Slooten et al. 2000). Hector's dolphin has the most limited range of any marine cetacean other than the vaquita (*Phocoena sinus*). In a population viability analysis, the estimated rate of decline was 74% over three generations, from 1970 to 2009 (Slooten 2007). The main cause of population decline is considered to be ongoing bycatch in fisheries.

Who *Research organisation* (International Union for Conservation of Nature (IUCN)).

Type Internet resource.

TMP Post-TMP.

Information added Updated conservation status evidence.

Ross, P.S.; Barlow, J.; Jefferson, T.A.; Hickie, B.E.; Lee, T.; MacFarquhar, C.; Parsons, E.C.; Riehl, K.N.; Rose, N.A.; Slooten, E.; Tsai, C.-Y.; Wang, J.Y.; Wright, A.J.; Yang, S.C. 2011: Ten guiding principles for the delineation of priority habitat for endangered small cetaceans. *Marine Policy* 35: 483–488.

Focus Threats, impacts, and management.

Summary

Aim Produce guidelines for the delineation of priority habitat boundaries for small, at-risk cetaceans.

Methods A step-by-step scientific approach to priority habitat delineation is taken, that is applicable to practical management concepts.

Results Ten guiding principles are outlined: food; habitat features; habitat size; external connections; nurseries; social and behavioural considerations; temporal patterns; threat description; precaution; adaptive management. Priority habitat protection should augment other wider protective measures.

Who *Academic* (George Mason University; National Environmental Research Institute, Aarhus University; Trent University; University of Otago); *Consultant* (Changhua Environmental Protection Union; Clymene Enterprises; Humane Society International; FormosaCetus Research and Conservation Group; Wild at Heart Legal Defence Association); *Government, Canada and US* (Fisheries and Oceans Canada; Southwest Fisheries Science Center, NOAA National Marine Fisheries Service).

Type Peer-reviewed journal.

TMP Post-TMP.

Information gap filled Guiding principles for managers adopting endangered species laws.

Rowe, S.J. 2007: A review of methodologies for mitigating incidental catch of protected marine mammals. *DOC Research & Development Series 283*. Department of Conservation, Wellington. 47 p.

Focus Threats, impacts, and management.

Summary

Aim Presents results from a global review of mitigation methods aimed at reducing mortalities of marine mammals, and is therefore highly relevant to Hector's dolphin.

Methods Assesses the application of mitigation methods to New Zealand fisheries, makes fisheries management recommendations, and identifies areas for further research.

Results The report concludes that while pingers (acoustic warning devices placed on nets) have successfully reduced bycatch of Harbour porpoises, concerns remain over their long-term efficacy, potential to displace cetaceans from preferred habitat, and ability to prevent bycatch of other species. Further research into this and other mitigation techniques such as gear modifications is recommended. Modifying the acoustic properties of nets has given inconsistent results but warrants further research. The report highlights the need to understand the mechanisms that lead to bycatch, to successfully develop mitigation methods.

Who *Government, NZ* (DOC).

Type DOC (peer-reviewed).

TMP Pre-TMP.

Secchi, E.R. 2006: Modelling the population dynamics and viability analysis of Franciscana (*Pontoporia blainvillei*) and Hector's Dolphins (*Cephalorhynchus hectori*) under the effects of bycatch in fisheries, parameter uncertainty and stochasticity. University of Otago, Dunedin. 254 p.

Focus Abundance; general biology; threats, impacts, and management.

Summary

Aim Model the population dynamics and conduct a viability analysis for Franciscana and Hector's dolphins.

Methods A stage-specific population model was constructed for Hector's dolphin.

Results The estimated low growth rate of this species is thought to be insufficient to compensate for current levels of fishing-related mortality, which appears to be driving population decline in some local populations. For example, the Banks Peninsula population was predicted to decrease below its initial size in 74% of simulations. In comparison, the west coast (South Island) population of Hector's dolphin grew, even under current levels of fishing effort.

Who *Academic* (University of Otago).

Type Thesis (PhD).

TMP Pre-TMP.

Slooten, E. 2007a: Conservation management in the face of uncertainty: effectiveness of four options for managing Hector's dolphin bycatch. *Endangered Species Research* 3(2): 169–179.

Focus Threats, impacts, and management.

Summary

Aim Investigate how to manage bycatch of Hector's dolphin in commercial gillnets.

Methods Catch rate from a single, commercial fisheries observer programme was used to estimate past and future population sizes of Hector's dolphins within a population viability analysis (PVA) framework.

Results Using the total current estimated population size of 7873, the 1970 population was estimated at nearly 30 000. A major expansion in gillnetting since then is blamed for the decrease to just 27% of this population today. Current management is not sufficient to halt population declines. The total population is predicted to decrease to 5475 by 2050; however, the creation of four strategically placed protected areas would allow population recovery towards 1970 levels. Slooten concludes that reducing fisheries mortality to levels approaching zero shows the strongest promise of meeting national and international guidelines for managing dolphin bycatch.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

Slooten, E.; Davies, N. 2012: Hector's dolphin risk assessments: old and new analyses show consistent results. *Journal of the Royal Society of New Zealand* 42(1): 49–60.

Focus Threats, impacts, and management.

Summary

Aim Review previous risk assessment work that focussed on Hector's dolphin bycatch; present new analyses; discuss uncertainty involved in all models.

Methods Earlier assessments utilised Leslie Matrix, Schaefer, and Bayesian model structures; Potential Biological Removal was also reviewed. Using new data, a new Bayesian model was constructed using the statistical package R.

Results Before 2008, an estimated total of 110–150 dolphins were caught annually; the authors estimated that 23 Hector's dolphins were caught off the east coast of the South Island (ECIS)

between 1 May 2009 and 30 April 2010. Different risk assessments displayed a high level of agreement, demonstrating (for example) that populations could recover substantially in the next 50 years in the absence of fisheries-related mortality. However, all analyses also indicated that recovery is unlikely under current protection measures.

Who *Academic* (University of Otago); *Government, New Caledonia* (Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia).

What Peer-reviewed journal.

TMP Post-TMP.

Information added Comprehensive review of previous population models and risk assessments; presentation of new assessment results; showed consistency in results despite differing approaches; also showed continual threat of fisheries-related mortalities post-TMP and new management measures.

Information gap filled First attempt to assess efficacy of management measures introduced post-TMP.

Slooten, E.; Dawson, S.M. 2008: Sustainable levels of human impact for Hector's dolphin. *The Open Conservation Biology Journal* 2: 37–43.

Focus Threats, impacts, and management.

Summary

Aim Determine bycatch levels likely to cause Hector's dolphin population decline.

Methods The Potential Biological Removal (PBR) was calculated for Hector's dolphin populations.

Results PBRs for most populations were <1 individual per year. Total PBR for the whole species was <10 per year. Current estimated bycatch was in the order of 10–35 times higher than these PBRs. This was consistent with Population Viability Analyses that indicate that Hector's dolphin populations are declining rapidly under current management. Management changes in line with a precautionary approach are suggested.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information gap filled Potential Biological Removal of Hector's and Maui's dolphins.

Information gap identified Additional fisheries bycatch data are required.

Slooten, E.; Dawson, S.M. 2010: Assessing the effectiveness of conservation management decisions: likely effects of new protection measures for Hector's dolphin (*Cephalorhynchus hectori*). *Aquatic Conservation: Marine and Freshwater Ecosystems* 20(3): 334–347.

Focus Abundance; threats, impacts, and management.

Summary

Aim Assess the potential impact of new fisheries management regulations on Hector's dolphin populations.

Methods A population viability analysis was carried out, using estimated catch rates in commercial gillnets from an observer programme. The impact of the fishery was predicted under three scenarios: status-quo management (Option A); new regulations announced by the Minister of Fisheries in 2008 (Option B); and total protection (Option C). Sensitivity analyses also examined the effect of variation in catch rate and displacement of fishing effort.

Results The current Hector's dolphin population was estimated to be at 27% of the 1970 population. Projections to 2050 under Options A and B predicted the total population is likely to continue declining. For Option B, this was mainly driven by continuing bycatch on

the South Island west coast, where protection measures are weaker. Under total protection (Option C), all populations were projected to increase, with total population reaching just over half the 1970 population size by 2050. The new 2008 protection measures were an improvement over previous management, but fall short of ensuring the species' recovery and meeting conservation goals.

Who Academic (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added New (2008) fisheries management regulations do not meet conservation goals for the population recovery of Hector's and Maui's dolphins..

Information gap identified More information required on population size and growth rate, and the number of dolphins by-caught by amateur gillnetters and trawl fisheries.

Slooten, E.; Dawson, S.M.; Rayment, W.J. 2004: Aerial surveys for Hector's dolphins: abundance of Hector's dolphins off the South Island west coast, New Zealand. *Marine Mammal Science* 20(3): 477–490.

Focus Abundance.

Summary

Aim Reports results from an aerial survey carried out on the South Island's west coast to estimate abundance of Hector's dolphins.

Methods Surveys were carried out in December 2000 using two independent observer pairs in a fixed-wing plane. Additional observations were carried out from a helicopter to record dive times and hence estimate the proportion of time that dolphins could be seen at or near the water surface (and therefore 'available' to be counted). Used two observer teams to establish a mark-recapture experiment to allow for estimation of the proportion of available sightings on the transect lines that were actually counted.

Results The average availability of dolphins (i.e. at or near the surface) was 46.3%, and 96.2% of dolphins at the surface and on the trackline were seen. The total abundance for the South Island west coast, corrected for visibility and availability, was 5388 (CV = 20.6%). Combined with results from Dawson et al. (2004), this gives an overall South Island abundance estimate of 7270 (CV = 16.2%).

Who Academic (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

Slooten, E.; Dawson, S.M.; Rayment, W.J.; Childerhouse, S.J. 2005: Distribution of Maui's dolphin, *Cephalorhynchus hectori maui*. New Zealand Fisheries Assessment Report 2005/28. Ministry of Fisheries, Wellington. 21 p.

Focus Distribution; threats, impacts, and management.

Summary

Aim Examine the risk posed to Maui's dolphin by fishing activities by comparing summer and winter dolphin distribution.

Methods Aerial surveys were carried out during summer (January) and winter (June–July) 2004 to assess the distribution of Maui's dolphin off the west coast of the North Island. Additionally, previous survey data were reviewed and re-analysed to allow for comparison with the 2004 survey data.

Results The geographic range of Maui's dolphin extends at least as far north as Maunganui Bluff and at least as far south as New Plymouth, with highest densities between Manukau Harbour and Port Waikato. Maui's dolphins use at least three of the five west coast harbours (Manukau, Raglan and Kaipara). No sightings were made beyond the 4 n.m. offshore boundary of the protected area. Maui's dolphin were more dispersed and found in deeper waters during

winter. Concern was raised over the potential overlap of Maui's dolphins and gillnet fisheries within the harbours and to the south of the protected area. Trawling is also highlighted as a potential source of further mortality, as is illegal recreational gillnetting within the protected area.

Who *Academic* (University of Otago); *Government, NZ* (DOC).

Type Government report.

TMP Pre-TMP.

Slooten, E.; Dawson, S.; Rayment, W.; Childerhouse, S. 2006: A new abundance estimate for Maui's dolphin: what does it mean for managing this critically endangered species? *Biological Conservation* 128(4): 576–581.

Focus Abundance.

Summary

Aim Assess distribution and abundance of Maui's dolphin.

Methods Aerial surveys were carried out between 14 and 28 January 2004 between Maunganui Bluff in the north and New Plymouth to the south on the North Island west coast (also see Slooten et al. 2005). Field and analytical methods were broadly similar to those applied in Slooten et al. (2004).

Results Population size for this critically endangered subspecies was estimated at 111 (95% CI = 48–252). Using the Potential Biological Removal (PBR) method, a sustainable level of human-caused mortality would be just one dolphin every 6.4 years.

Who *Academic* (University of Otago); *Government, NZ* (DOC).

Type Peer-reviewed journal.

TMP Pre-TMP.

Slooten, E.; Rayment, W.; Dawson, S. 2006: Offshore distribution of Hector's dolphins at Banks Peninsula, New Zealand: is the Banks Peninsula Marine Mammal Sanctuary large enough? *New Zealand Journal of Marine and Freshwater Research* 40: 333–343.

Focus Distribution; threats, impacts, and management.

Summary

Aim Carry out a population viability analysis to evaluate the effectiveness of the Banks Peninsula Marine Mammal Sanctuary.

Methods Aerial line-transect surveys were carried out in and around the Banks Peninsula Marine Mammal Sanctuary in February and June 2002.

Results In summer, the proportion of sightings made inside the 4 n.m. sanctuary boundary was 79%, which dropped to just over 35% in winter. Suggestions were made for offshore and alongshore extensions to the sanctuary boundary that would potentially reduce fisheries mortality to a sustainable level (based on the PBR method).

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

Middleton, D.A.J.; Starr, P.J.; Gilbert, D.J. 2007: COMMENT—Modelling the impact of fisheries bycatch on Hector's dolphin: comment on Slooten (2007). *Endangered Species Research* 3: 331–334.

Focus Threats, impacts, and management.

Summary

Aim Comment on Slooten (2007a) paper.

Methods The authors question several aspects of the modelling choices made by Slooten.

Results The authors argue that fishing effort is overestimated for the period 1970 to 1982, which inflates the model estimate of historical population size. They also argue that the catch-rate estimate used is inappropriate as it includes no spatial or temporal variability, or overall uncertainty. Middleton et al. question whether the population trajectories and implied bycatch levels inferred by Slooten's model are realistic, based on reported mortalities. Middleton et al. are also critical of the level of detail provided in the methodology, which makes confirmation of results difficult.

Who *Industry* (New Zealand Seafood Industry Council); *Research Organisation* (NIWA).

Type Peer-reviewed journal.

TMP Pre-TMP.

Slooten, E. 2007b: REPLY COMMENT—Criticism is unfounded: reply to Middleton et al. (2007). *Endangered Species Research* 3: 335–339.

Focus Threats, impacts, and management.

Summary

Aim Response to criticism by Middleton et al. (2007) on Slooten et al. (2007a).

Methods Slooten counters the criticisms made by providing further detail and rationale behind her model.

Results Slooten concludes by arguing that we know Hector's dolphins have been depleted by bycatch in gillnet fisheries, and that all risk analyses carried out by a variety of researchers make the same conclusions: continued population decline can be expected under current management regimes; population recovery could occur if fishing impacts are removed.

Who *Academic* (University of Otago).

Type Peer-reviewed journal.

TMP Pre-TMP.

Stockin, K.A.; Law, R.J.; Roe, W.D.; Meynier, L.; Martinez, E.; Duignan, P.J.; Bridgen, P.; Jones, B. 2010: PCBs and organochlorine pesticides in Hector's (*Cephalorhynchus hectori hectori*) and Maui's (*Cephalorhynchus hectori maui*) dolphins. *Marine Pollution Bulletin* 60: 834–842.

Focus General biology; threats, impacts, and management.

Summary

Aim Determine the levels of polychlorinated biphenyls (PCBs) and organochlorine (OC) pesticides in Hector's and Maui's dolphins.

Methods PCBs and a range of OC pesticides were determined from blubber samples collected from 30 stranded and incidentally by-caught Hector's ($n = 27$) and Maui's ($n = 3$) dolphins from 1997 to 2009.

Results The OC pesticides dieldrin and dihydrodiphenyltrichlorethane (DDT) and the DDT metabolites DDE and DDD were present at the highest concentrations. Placental transmission of summed DDTs and summed PCBs was estimated at 5.7% and 4.3%, respectively. Concentrations of OC pesticides were higher than previously reported for Hector's dolphins, reflecting New Zealand's legacy of historic DDT usage. The vulnerability of coastal dolphins to toxins was discussed.

Who *Academic* (Massey University).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added Current levels of pollutants; placental transmission.

Information gap filled Hector's and Maui's dolphins have high similar pollutant burdens.

Information gap identified Trace elements and emerging contaminants require investigation.

Stone, G.; Hutt, A.; Duignan, P.; Teilmann, J.; Cooper, R.; Geschke, K.; Yoshinaga, A.; Russell, K.; Baker, A.; Suisted, R.; Baker, S.; Brown, J.; Jones, G.; Higgins, D. 2005: Hector's dolphin (*Cephalorhynchus hectori hectori*) satellite tagging, health and genetic assessment. Department of Conservation, Auckland. 77 p.

Focus Behaviour; distribution; general biology; genetics.

Summary

Aim Provide results of a trial to evaluate the efficacy and safety of satellite tagging Hector's dolphins, and summarise results from a health and genetic assessment project conducted at the same time.

Methods Three Hector's dolphins were caught in the waters around Banks Peninsula in March 2004 and were released following the attachment of satellite transmitters. Prior to release, a complete assessment of their health was carried out.

Results All three tags transmitted for more than 3 months. There was no evidence of deleterious impacts on the dolphins as a result of the tag attachment, nor were the dolphins observed exhibiting unusual behaviours. The study concluded that Hector's dolphin would be a suitable animal for a tagging programme. A number of viral and bacterial tests were carried out, with one dolphin testing positive for Brucellosis. Otherwise, all the animals appeared to be in good condition.

Who Government, NZ (DOC); Research Organisation (New England Aquarium).

Type DOC (not peer-reviewed).

TMP Pre-TMP.

Travis, G.-R. 2008: Boat preference and stress behaviour of Hector's dolphin in response to tour boat interactions. Unpublished PhD thesis. Lincoln University, Christchurch. 317 p.

Focus Behaviour; threats, impacts, and management.

Summary

Aim Investigate stress-induced behaviour of Hector's dolphins resulting from tour boat interactions.

Methods Shore-based theodolite tracking observed dolphin behaviour with and without the presence of tour boats in and around Lyttelton and Timaru Harbours during October–March 2000/01 and 2001/02. Observations during 2005 were used in some of the analyses. Quadrant preference, swimming direction, and behaviour were observed over 6 years from the Black Cat tour boat.

Results Generic behaviours indicative of stressed individuals in cetaceans may not all apply to Hector's dolphins. Some stress-related behaviours, such as increased swimming speed to open ocean and grouping behaviour, were observed in the presence of boats. Dolphins preferred to approach and depart from the bows of boats rather than stern. It was suggested that low-level tourist boat activity is not placing undue stress on the population. Behaviour changed in response to the presence of the tourist boat from neutral in the second year, to positive in the third year, to avoidance in the seventh year of boat activity.

Who Academic (Lincoln University).

Type Thesis (PhD).

TMP Post-TMP.

Information gap filled Short- and long-term responses of Hector's dolphin to tourism activity in Lyttelton and Timaru Harbours.

Information gap identified Suggests a need for further studies investigating the effects of tourism on these populations; highlights difficulties in quantitatively defining and studying 'stress' in free-ranging marine mammal populations.

Webster, T. 2008: Demographics and social structure of Hector's dolphin (*Cephalorhynchus hectori*) at Banks Peninsula, New Zealand. Unpublished MSc Thesis. University of Otago, Dunedin. 140 p.

Focus General biology.

Summary

Aim Examine demographics and social structure of Hector's dolphin using novel non-invasive tools.

Methods A laser photogrammetry system was used to obtain dorsal fin measurements in the field. An underwater pole-camera was used to determine dolphin gender. Group size and mother-calf groups were examined.

Results Dorsal fin length obtained from laser-metric photographs was found to be a better predictor of total length than fin height. Age categories (juvenile, intermediate, and adult) were assigned to the 33 identifiable individuals measured using this technique; the method therefore showed promise for determining approximate age of Hector's dolphins. Underwater pole-camera use increased the rate of sexing marked individuals. Data supported the hypothesis of a 1:1 sex ratio in the population. There was a high degree of gender segregation. Nursery groups preferred certain areas, which has implications for management.

Who Academic (University of Otago).

Type Thesis (Masters).

TMP Post-TMP.

Information added Demographics; social structure; distribution.

Information gap filled First use of laser photogrammetry and underwater pole-cameras with Hector's dolphins.

Information gap identified More research required on nursery group distribution and anthropogenic impacts.

Webster, T.A.; Dawson, S.M.; Slooten, E. 2009: Evidence of sex segregation in Hector's dolphin (*Cephalorhynchus hectori*). *Aquatic Mammals* 35(2): 212–219.

Focus General biology.

Summary

Aim Document sex segregation in Hector's dolphin.

Methods An underwater pole-camera was used to sex 43 groups (group size <5).

Results 91% of groups containing 2–5 individuals ($n = 32$) were either all male or all female. In an additional seven groups with calves, all adults associating with mothers and their young were female. Large groups (>5 individuals) and aggregations occurred less frequently than small groups (17% of the time), and tended to be of mixed sex, likely for feeding or sexual activities. The high level of sex segregation may have implications for reproduction, including difficulty finding a mate as populations decline.

Who Academic (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information added A 1:1 sex ratio was supported by the results.

Information gap filled Minimal disturbance method to classify sex; Hector's dolphins are highly sex segregated.

Webster, T.; Dawson, S.; Slooten, E. 2010: A simple laser photogrammetry technique for measuring Hector's dolphins (*Cephalorhynchus hectori*) in the field. *Marine Mammal Science* 26(2): 296–308.

Focus General biology.

Summary

Aim Develop a non-invasive method to measure and age free-ranging Hector's dolphins.

Methods A simple photogrammetric system was developed using two parallel lasers and a digital camera. Laser dots projected onto the fin of free-ranging dolphins provided a scale alongside simultaneous photo-ID. Errors due to angle and measurement were quantified via photography of a fiberglass Hector's dolphin model. Allometric measurements and age data were collected from 233 autopsied Hector's dolphins.

Results Fin length was a better predictor of total length than fin height. Gompertz age/length growth curves were used to provide three broad age categories. Linear regressions estimated the total length for 34 individuals, from their laser-metrically estimated fin base length. The system shows promise as a non-invasive method to measure individuals whilst providing simultaneous photo-ID information. These measurements have several applications.

Who Academic (University of Otago).

Type Peer-reviewed journal.

TMP Post-TMP.

Information gap filled The development of a non-invasive method to measure and age free-ranging Hector's dolphins.

5. Other information sources

While it cannot be included in the bibliography, the authors note that the DOC Hector's and Maui's dolphin Incident Database³ offers a useful source of information. Other resources available online from DOC include the Maui's dolphin sightings database⁴.

6. Works in progress

Several publications were identified as being 'in review' (i.e. submitted; but not yet accepted for publication), or 'in prep' (planned for submission sometime during or after compilation). In addition, at least one PhD thesis had (at the time of compilation) been submitted, but not yet accepted. It is therefore recommended that prior to the next stage of the TMP review (expected to occur in 2013), another update is made to the bibliography.

³ <http://www.doc.govt.nz/conservation/native-animals/marine-mammals/dolphins/hectors-dolphin/docs-work/hectors-dolphin-incident-database/>

⁴ <http://www.doc.govt.nz/upload/documents/conservation/native-animals/marine-mammals/hectors-maui-incidents/mauis-dolphin-database.pdf>

7. References

- Baker, A.; Smith, A.N.H.; Pichler, F.B. 2002: Geographical variation in Hector's dolphin: recognition of new subspecies of *Cephalorhynchus hectori*. *Journal of the Royal Society of New Zealand* 32(4): 713–727.
- Bräger, S.; Harraway, J.A.; Manly, B.F.J. 2003: Habitat selection in a coastal dolphin species (*Cephalorhynchus hectori*). *Marine Biology* 143: 233–244.
- Burkhart, S.M.; Slooten, E. 2003: Population viability analysis for Hector's dolphin (*Cephalorhynchus hectori*): a stochastic population model for local populations. *New Zealand Journal of Marine and Freshwater Research* 37: 553–566.
- Childerhouse, S. 2008: New Zealand progress report on cetacean research, April 2007 to March 2008, with statistical data for the calendar year 2007. IWC. 16 p.
- Chilvers, L. 2010: New Zealand progress report on cetacean research April 2009 to April 2010. IWC. 19 p.
- Chilvers, L. 2011: New Zealand progress report on Cetacean Research, April 2010 to March 2011. IWC. 20 p.
- Donoghue, M. 2009: New Zealand progress report on cetacean research April 2008 to April 2009. IWC. 11 p.
- Hamner, R.M.; Pichler, F.B.; Heimeier, D.; Constantine, R.; Baker, C.S. 2012: Genetic differentiation and limited gene flow among fragmented populations of New Zealand endemic Hector's and Maui's dolphins. *Conservation Genetics*, 13(4): 987–1002.
- Martinez, E.; Slooten, E. 2003: A selective, annotated bibliography for Hector's dolphin (*Cephalorhynchus hectori*). *DOC Science Internal Series* 124. Department of Conservation, Wellington. 40 p.
- MFish (Ministry of Fisheries); DOC (Department of Conservation) 2007: Hector's dolphin threat management discussion document. 154 p.
- Middleton, D.A.J.; Starr, P.J.; Gilbert, D.J. 2007: COMMENT—Modelling the impact of fisheries bycatch on Hector's dolphin: comment on Slooten (2007). *Endangered Species Research* 3: 331–334.
- Slooten, E. 2007a: Conservation management in the face of uncertainty: effectiveness of four options for managing Hector's dolphin bycatch. *Endangered Species Research* 3(2): 169–179.
- Slooten, E. 2007b: REPLY COMMENT—Criticism is unfounded: reply to Middleton et al. (2007). *Endangered Species Research* 3: 335–339.

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