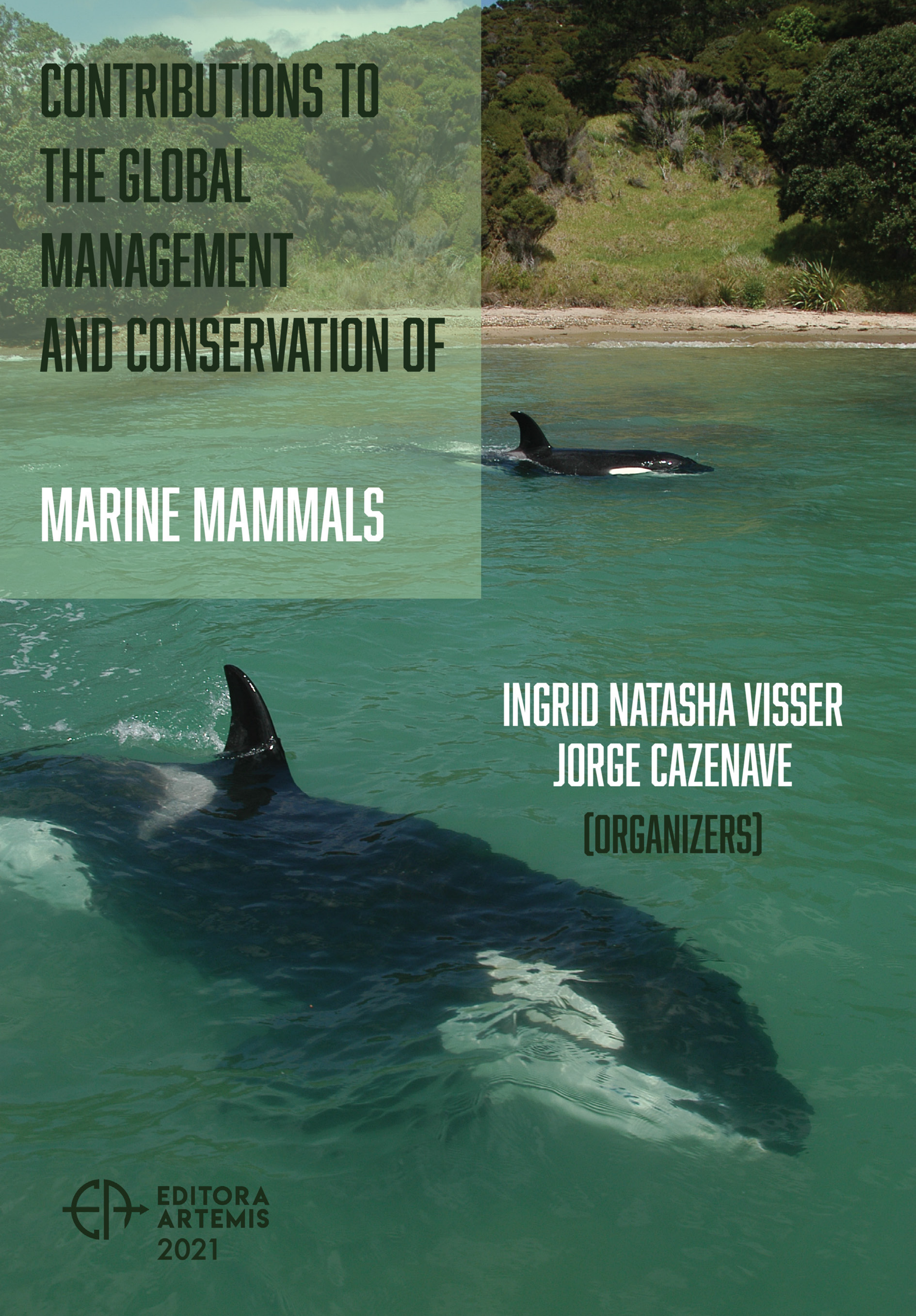

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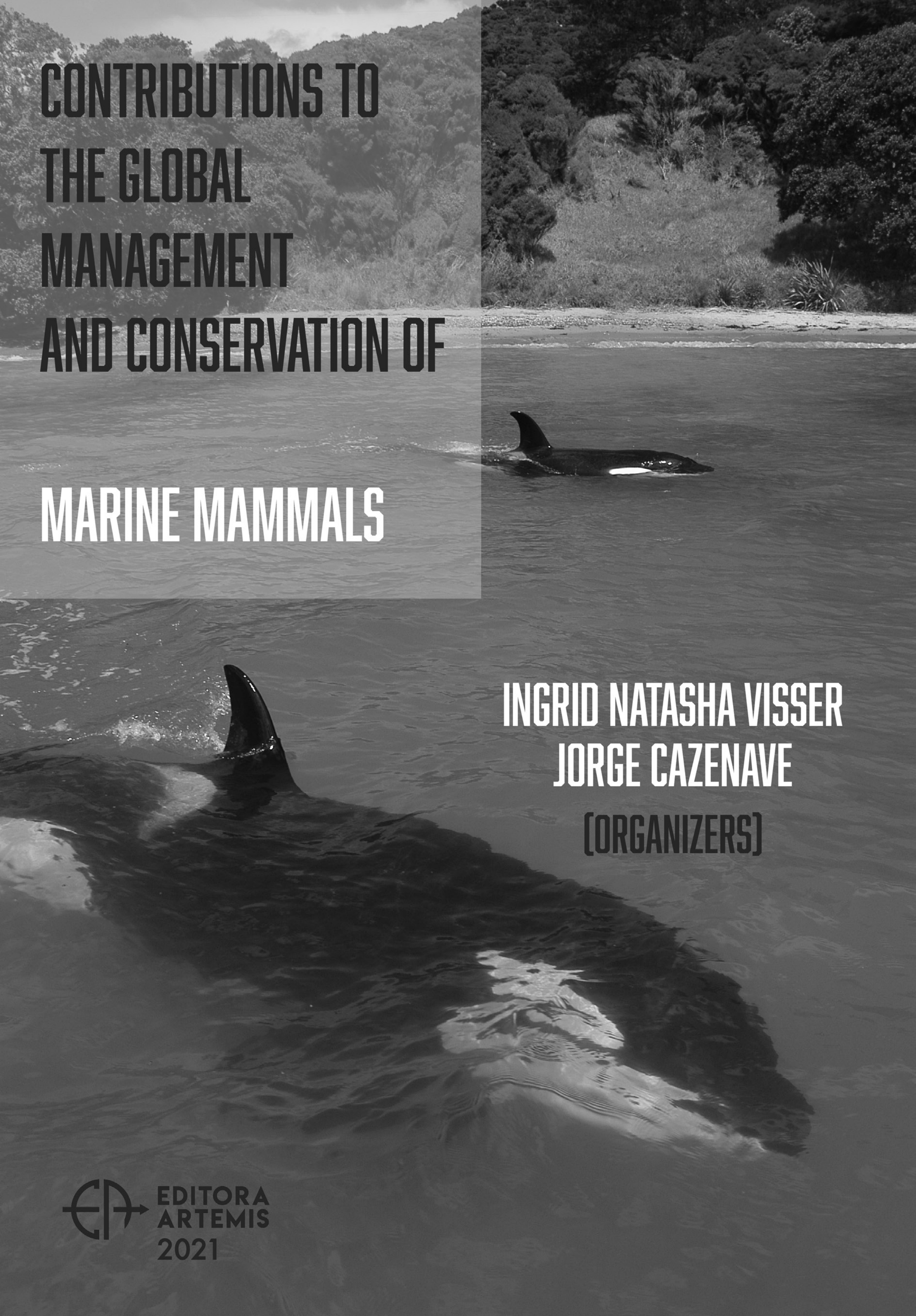

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PREFACE

Contributions to the Global to Management and Conservation of Marine Mammals.

I write the introduction to this book after just having returned from a day out researching wild orca along the New Zealand coastline. During that encounter I had the opportunity to not only see the orca hunting for rays in the shallow waters, but an adult male orca, known to me since he was born, became stranded as he followed his family over a sand bank. His calm demeanour was indicative to me that he had experienced such an event before. Whilst stranded, he patiently tested the water depth, and his ability to get off the sand bank, by gently rolling from side to side every 10 mins or so. During the time that he was stranded our team poured water over him in order to prevent his skin drying out. Eventually the tide had returned enough for him to focus all his energy into getting off and into deeper water. Within minutes of freeing himself he was back with his family and within an hour he was catching rays again. It struck me as I was watching him, that he was around 30 years old, older than I was when I started studying his family. The changes he had seen in his lifetime are changes that I've documented too. Encroachment into his habitat with new marinas, wharfs, reclamation and dredging. Exclusion from prime hunting area from all of these man-made features as well as aquaculture farms expanding so fast it is hard to document them all. He has seen the numbers of vessels increase exponentially and the volume of noise pollution expand with it. He has experienced raw sewage flowing around him when he has entered into harbours and he has swum past floating garbage and viewed sunken junk discarded in his home. He has seen members of his social network drown when entangled, die when stuck on a beach and suffer from severe wounds when hit by boats. It is a wonder he has survived as long as he has with all this and more that he must contend with. But, despite all these negative aspects, there is some hope; New Zealand now has more than 30 marine reserves (protected areas to prevent fishing and habitat destruction). Although they are comprised of only a tiny part of the entire coastline, they are a start. I also see a growing number of scientists, lawyers, researchers and field biologists interested in contributing towards conservation and management issues. My hope is that this volume will provide a platform for some of those studies to reach a wide audience and to make a difference for individual cetaceans, their populations and the habitats that they not only live in but require to survive. The book is arranged by author, rather than, species, region or topic as the first two categories ranged across multiple species and around the globe and yet at times also overlapped, whilst the topics were just as diverse.

Ingrid N. Visser (PhD), New Zealand

In December 2019, the Society for Marine Mammalogy (SMM) and the European Cetacean Society (ECS) jointly hosted the World Marine Mammal Conference in Barcelona, Catalonia, Spain. That conference, the starting point for gathering the authors of this book, was the largest gathering of marine mammologists that had ever occurred, with over 2,700 registered attendees, from more than 90 countries. It was only the second World Marine Mammal Conference, with the first being in 1998 in Monte Carlo, Monaco (and where approximately 1,200 people from 50 countries attended). With the Covid-19 pandemic now rampant across the globe it may be many years before such a similar gather occurs again. Regardless, the work of all those conference attendees will continue and this volume is just one of the many published works that are resulting from ongoing research.

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CHAPTER 6

TRIALS AND TRIBULATIONS: THE CONSERVATION IMPLICATIONS OF AN ORCA SURVIVING A STRANDING AND BOAT STRIKE. A CASE STUDY.

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ABSTRACT: Although thousands of stranded cetaceans have been rescued in the past few decades, evidence of the outcomes from these interventions is not abundant. There is a paucity of comprehensive case studies, even though management and conservation strategies are often based on evidence of effective results. We present details of the successful rescue of a male orca who stranded on the New Zealand coast and who has now been documented for more than 23 years. Nearly 1.5 years after his rescue he was hit by a boat and his dorsal fin was severely cut. He recovered from both incidents and has since been documented travelling with conspecifics, cooperatively and independently hunting for rays and sharks, food sharing with conspecifics (an important social bonding aspect for this species) and alloparenting. He has been photographed 98 times, from which the minimum distance he has travelled can be calculated. He has travelled ~37,700 km (of which >36,600 km were in the 22 years after the boat strike). The three highest average daily distances he travelled were 145, 170 and 193 km. The scars he sustained at his stranding were still visible 7,831 days (i.e., 21 years, 5 months, 10 days) later, setting a new record for scar longevity on orca.

KEYWORDS: Stranding, boat strike, *Orcinus orca*, killer whale, survival, intervention.

RESUMEN: Aunque se han rescatado miles de cetáceos varados en las últimas décadas, la evidencia de los resultados de estas intervenciones no es abundante. Hay una escasez de estudios de caso completos, aunque las estrategias de manejo y conservación a menudo se basan en evidencia de resultados efectivos. Presentamos detalles del exitoso rescate de un macho de orca que quedó varado en la costa de Nueva Zelanda y que ahora ha sido documentado por más de 23 años. Casi un año y medio después de su rescate, fue golpeado por un

bote y su aleta dorsal fue cortada severamente. Se recuperó de ambos incidentes y desde entonces ha sido documentado viajando con conespecíficos, cazando de manera cooperativa e independiente rayas y tiburones, compartiendo alimentos con conespecíficos (un aspecto importante de la vinculación social para esta especie) y aloparentalidad. Ha sido fotografiado 98 veces, a partir de las cuales se puede calcular la distancia mínima que ha recorrido. Ha nadado ~37,700 km (de los cuales > 36.600 km fueron en los 22 años posteriores al choque con el barco). Las tres distancias diarias promedio más altas que nadó fueron 145, 170 y 193 km. Las cicatrices que sufrió en su varamientos aún eran visibles 7.832 días (es decir, 21 años, 5 meses, 10 días) más tarde, estableciendo un nuevo récord de longevidad de cicatrices en orca.
PALABRAS CLAVE: varamiento, colisión con barco, *Orcinus orca*, supervivencia, intervención.

1. INTRODUCTION

Cetacean strandings have been occurring for thousands of years (De Smet, 1996; Aaris-Sørensen et al., 2010), but it is only relatively recently that government authorities, marine mammal scientists, stranding networks, animal welfare communities and other stakeholders have made concerted efforts to rescue them when they are ashore (Zimmerman, 1991; St. Aubin et al., 1996; Geraci & Lounsbury, 2005). Other issues such as entanglements and boat strikes have been more recent issues for cetaceans to contend with and trained disentanglement teams and mitigation techniques are also relatively newly developed (Moore et al., 2013; Cates et al., 2017).

In New Zealand (NZ), which has a relatively long coastline (between 15-18,000 km, Gordon et al., 2010), at least 38 of the world's 90 cetacean species have been documented (Baker, 1983; Jefferson et al., 2015). Within those 38, one species, the orca (*Orcinus orca*, also known as killer whale), has five different ecotypes (distinct populations) which have been recorded in NZ waters; Antarctica Type B, Type C, Subantarctic or Austral (also known as Type D), Pelagic and NZ Coastal (Visser, 1999a; Visser & Mäkeläinen, 2000; Dwyer & Visser, 2011; Lauriano et al., 2015; Visser & Cooper, 2020a, 2020b).

As part of the research conducted by the Orca Research Trust (ORT) (www.orcaresearch.org), orca are photographed and identified individually (photo-ID) using congenital and acquired pigmentation, scars and marks. They are then assigned numbers in a catalogue (see Visser, 2000 for specific details). The population is small, with fewer than 200 individuals catalogued in nearly three decades of research (Visser, 2000; Visser & Cooper, 2020a). Yet, despite such relatively low numbers, the NZ orca have one of the highest rates of both strandings and boat strikes (Visser, 1999c, 2000, 2013; Visser & Hupman, 2018).

Within NZ, the species is listed as 'Nationally Critical' (Baker et al., 2019) which is one of the three 'Acutely Threatened' categories and the highest threat ranking given by the NZ Government (Townsend et al., 2008). In 2004, the NZ Government implemented its first (and only) 'Marine Mammal Action Plan' to cover the years 2005-2010 (Suisted & Neale, 2004). That Action Plan included comments such as *"Stranded killer whales can be successfully refloated"* and that the Department of Conservation (DOC), who are the legally mandated authority for the protection of NZ cetaceans *"... aims to focus management on: seeking to mitigate the disturbance of killer whales by recreational vessels in northern New Zealand"* and *"maintaining effective stranding and incident response."*

The conservation implications of rescuing stranded cetaceans or providing other assistance such as disentanglement can be diverse and produce mixed results (Zagzebski et al., 2006). In the USA, 69 cases involving 10 species of odontocetes, were evaluated to assess postintervention survival (Wells et al., 2013). The longest duration an individual was documented to have survived was 132 days (Wells et al., 2013). Their data set did not include any cases of orca or their survival rates.

Herein, the long-term survival of a male NZ Coastal orca (catalogue # NZ101, also known as Ben), who stranded and was successfully rescued and then was subsequently run over by a boat, is discussed. Although the original details from these events were described in Visser & Fertl (2000), the intervening 20 years provide an extended dataset, delivering what we believe to be the longest postintervention survival documented for this species globally.

2. METHODS

In order to better understand if NZ101 exhibited long-term effects from his stranding and/or if he was hampered by his injury, we assessed and compared subsets of data delimited by time and by event. The time data sets were comprised of (A) 1996-1999 (i.e., covered by Visser & Fertl, 2000) and (B) 2000-2020 (i.e., the 'current' dataset). Period (A) was punctuated by two events (a stranding and a boat strike) resulting in four subsets of data; (1) pre-stranding, (2) post stranding, (3) between stranding and boat strike and (4) post boat strike. However, as the post stranding and post boat strike data continued to be collected during the 20 years after period (A), two subsets of that data (1 and 3) fell exclusively within time (A); and two (2 and 4) overlapped between (A) and (B).

In addition to field research, we collated photo-ID records of NZ101 from a range of sources *inter alia*; citizen scientists, cetacean watching companies, coastguard, marine police, navy, ferries and members of the public (e.g., beach walkers). However, with the very distinctive appearance of NZ101, we also recorded sightings where photographs were unavailable. In some instances, the observer was familiar with NZ101 (e.g., a dolphin watching boat skipper who had encountered him before). We questioned observers with non-leading questions such as *'can you describe the dorsal fin?'* and *'did the orca have any specific features that would allow you to identify it?'*. Descriptions of NZ101 from observers included aspects such as having a *"split fin with one section hanging over on the left side".*

The complete data set consisted of 152 sightings, of which a number were repeat sightings in the same general area, therefore we standardised the latitude and longitude of each and refer to them as a 'location'. When the location was a harbour/fjord/sound or similar, we chose the narrowest section of the entrance of each, as the standardised waypoint for that location. However, we note that at times NZ101 may have been documented 10's of kilometres inside the waterway from the waypoint.

We then used 'aquaplot' (https://www.aquaplot.com/) a software application that calculates the distances (by sea and using navigable ships channels) between two locations. Although we recognise that orca do not typically travel such a track (and instead NZ orca tend to 'hug the coastline' e.g., to enter small bays, harbours and estuaries) (Visser, 1999b, 2000), the program standardised the measurements and removed human bias/error. We emphasise that the distances calculated are absolute minimum distances.

We then assessed;

(i) resighting durations

(ii) average daily distances travelled

(iii) minimum overall distances travelled

(iv) minimum distances between sightings

(v) association/social networks and behaviour with conspecifics

(vi) foraging behaviour (*inter alia*, prey types, cooperative hunting, food sharing)

The data from (ii) were at times heavily skewed, given that there may have been significant timeframes between consecutive sightings (i.e., during long periods it is reasonable to assume that NZ101 had travelled to other locations, but was not documented between any two temporally distant sightings).

We noted (v) & (vi) to ascertain if NZ101 could be considered a long-term candidate for successful reintegration into his social network and if he was able to sustain himself despite his injury (i.e., he was not a 'burden to society').

We also considered the entire dataset within the framework of results from other cetaceans of various species who were also provided some form of intervention.

3. RESULTS

A. CASE STUDY HISTORY

On 14 June 1997, NZ101 was found stranded on a sandy beach near Mangawhai, east coast of the North Island, NZ (Figure 1). He remained on the beach for approximately 21 hours and, with assistance (Figure 2), he was successfully refloated. Effectively, for cetaceans the pectoral fin is not adapted to cope with the impact of a stranding as *"in the terrestrial sense the flipper* [pectoral fin] *is non-weight-bearing"* (Felts, 1966) and the scapula-humerus joints are orientated in such a way that articulation is limited (Felts & Spurrell, 2005). The typical angles of the pectoral fins when an orca is free swimming (i.e., hanging at approximately 45° from the body) are illustrated in Figure 3 compared to the sternum (i.e., where the animal would lie if stranded). Therefore, to avoid damage, species-specific rescue techniques were applied – such as digging pits in the sand (Figure 2) in order to alleviate the pressure on the scapula-humerus joints and his pectoral fins were positioned outside of the rescue mats (Figure 2) to ensure that the joints were not compromised during the moving process.

On the fifth post stranding sighting (16 October 1998), NZ101 was observed with substantial damage to his dorsal fin, caused by a boat strike. Details of wound healing and sightings are chronicled in Visser & Fertl (2000), however, for direct comparison we reproduce some details here. After the boat strike and prior to the publication of Visser & Fertl (2000), NZ101 was resighted 11 times with their last record on 15 October 1999 (see their Table 1 for details and Table 1 herein for summary information).

NZ101 was documented 18 times in Visser & Fertl (2000) over a period of 1,136 days (or 3 years, 1 month, 11 days, between 04 September 1996 and 15 October 1999). During this period, he was documented in nine different locations (Figure 1) and two of those (Bay of Islands and Whangarei Harbour), he visited three or more times. Since the publication of Visser & Fertl (2000), but within the same time period (i.e., 1996-1999), two additional historic sightings have been collected, resulting in a total of 20 records at 11 locations for period (A), with all sightings off the northern North Island (see Table 1 in Visser & Fertl, 2000 and Table 1 herein).

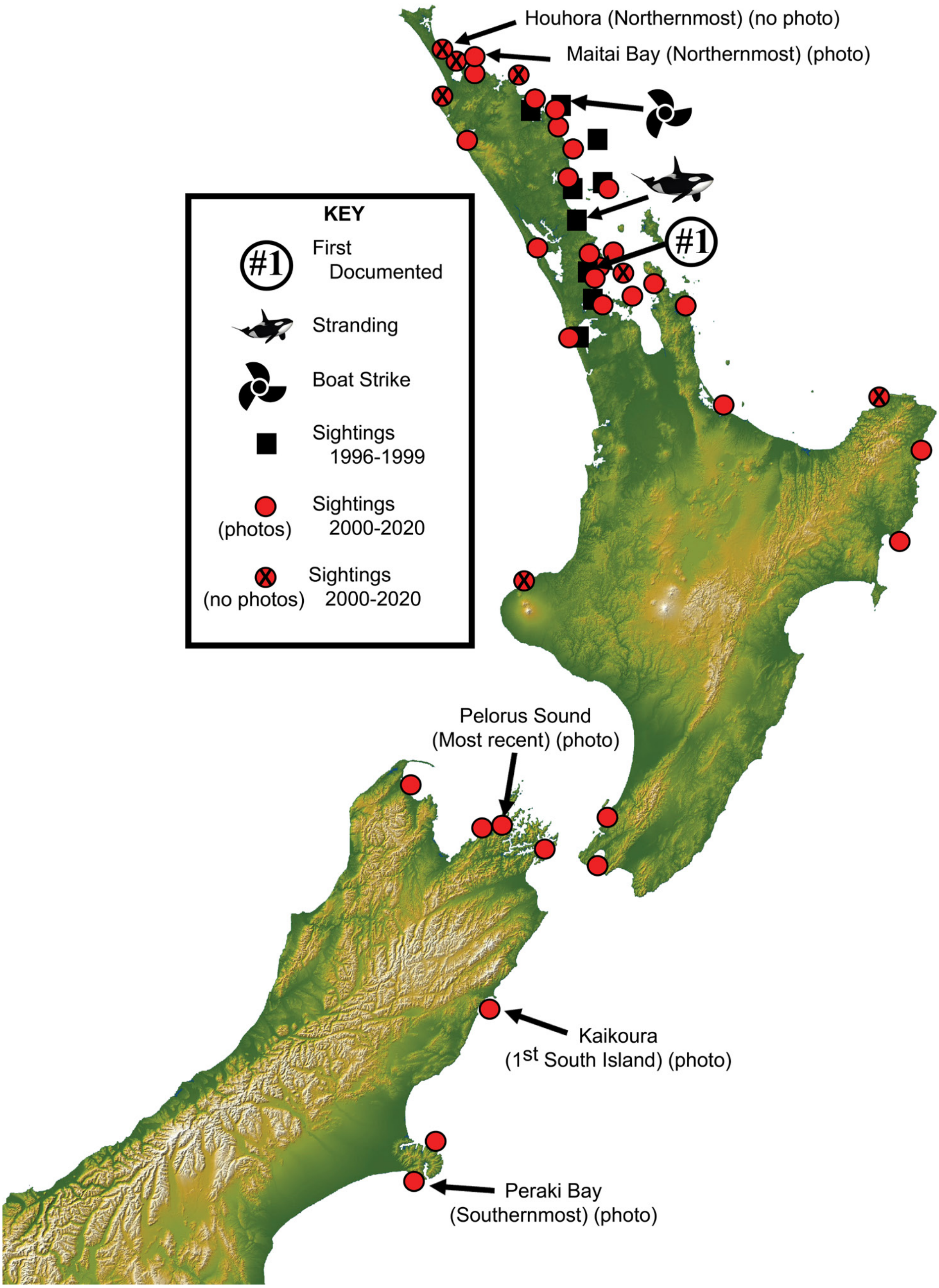

Figure 1. Sighting locations of NZ101 (Ben), a male orca who stranded (orca icon) on 14 June 1997 and has been resighted 152 times. His most recent sighting, 05 December 2020 (Pelorus Sound), was 8,574 days (i.e., 23 years, 5 months 20 days) after he was refloated. The black squares indicate locations from Visser & Fertl (2000) and the red circles indicate locations where he has since been documented (note that multiple resightings occurred at some locations from within both the Visser & Fertl (2000) and current data sets).

Figure 2. As part of the rescue of NZ101, he was cared for on the beach overnight. Assistance included covering him with sheets and keeping him wet (top left). Holes were dug for his pectoral fins to alleviate the pressure on his scapula-humerus joints (top right & bottom). To return him to the water, mats were placed under him and 'spreaders' were used to ensure that he was not excessively compressed during the lifting process. Note that his pectoral fins were kept outside the mats to prevent damage to them and the scapula-humerus joints. His dorsal fin was leaning to his left side (top left), which caused a pressure blister during the stranding and may have contributed to the direction the posterior portion of his fin collapsed after he was hit by a boat propeller, Figures 4, 5, 7-13). Photos © Top, Ingrid N. Visser, bottom Terry M. Hardie.

B. CASE STUDY UPDATE

Sightings, Resightings & Photo-ID of NZ101

Between when NZ101 was first documented on 04 September 1996 and his most recent sighting on the 05 December 2020 (i.e., periods (A) and (B) combined), he was observed a total of 152 times (Table 2), 145 of those since his rescue and of those 140 since the boat strike. Despite his distinctive appearance, the first sighting of NZ101 in period (B) was not until 214 days after he was last reported in period (A). That resighting occurred on 16 May 2000 in the Bay of Islands and although NZ101 was documented by a cetacean watching company with guides familiar with him, he was not photographed. The first time he was photographed after period (A) was on 15 November 2000, in Whitianga Harbour, 397 days (1 year and 1 month) after he was previously photographed (Table 1).

Since the last sighting in period (A), NZ101 has been documented over a period of 7,722 days (or 21 years, 1 month, 20 days between 15 October 1999 and 05 December 2020) and documented in 48 locations (including all of those locations documented in Visser & Fertl, 2000). In period (B), NZ101 visited three locations (Bay of Islands, Whangarei Harbour and Hauraki Gulf) more than 10 times and he visited another two locations (Tauranga Harbour and Kaikoura) seven and nine times respectively, the latter being the only location off the South Island where he was photographed more than once.

In the period (B) dataset, NZ101 was documented 136 times off the North Island (in 40 locations, 34 off the east coast, five off the west and one off the south). His northernmost sighting (no photograph) was on the east coast at Houhora Harbour, whilst his northernmost sighting (with a photo) is Maitai Bay (Table 1). That location is only 5 km south of Houhora Harbour (but is situated 30 km to the east) and Maitai Bay is approximately 80 km north of the Bay of Islands, his northernmost location in period (A).

On 16 March 2003, NZ101 was reported (and photographed) for the first time off the coast of the South Island (at Kaikoura, Figure 1, Table 1). He has since been photographed off the South Island 15 times; with a further eight encounters in the Kaikoura area. His most recent sighting on 05 December 2020, in Pelorus Sound, is also off the South Island (Figure 1, Table 1). NZ101's southernmost sighting was when he was photographed at Peraki Bay, on the south coast of Banks Peninsula on 27 December 2011 (Figure 1, Table 1).

Irrespective of the size of the data set, there remain noticeable gaps between the distribution of both sightings and locations; for example, there are no sightings/locations south of Banks Peninsula on the east coast or anywhere on the west coast of the South Island. As NZ101 typically forages in close to the shore (Visser & Fert (2000), ORT, unpublished data), he likely traversed the coastline between the clusters of sightings. But, as described in Visser (2000), observer bias may be influencing the data for NZ101, e.g., the comparative number of people living/boating along parts of the NZ coastline where there are few/no sightings is lower than the northern part of the North Island and therefore the potential for sightings/data collection is lower.

Additionally, there were instances where NZ101 was documented consecutively in the same location but there may have been days, months or even years between these sightings (Table 3). For example, in period (A) he was sighted in the Bay of Islands on 06 and 16 October 1997 (i.e., 10 days apart) and there were no other sightings between these. Five days later he was photographed in the Waitemata Harbour. NZ101 then returned to the Bay of Islands on 11 November 1998 and again on 04 May 1999 (i.e., 174 days apart) with no sightings between these two.

Similar instances occurred in period (B), where NZ101 was photographed in the Bay of Islands on 24 May 2002 and again on 08 October 2002 (137 days apart) with no sightings between these two. Given that the Bay of Islands has high boat traffic, that there were at least three whale/dolphin watching companies operating in the area during both periods (A) and (B) and that we have never documented an orca remaining in any one location for longer than three days (unless injured or compromised in some way, e.g., Visser et al., 2017), the probability that NZ101 remained in the Bay of Islands between these dates is negligible. This again emphasises that the distances documented herein are absolute minimums.

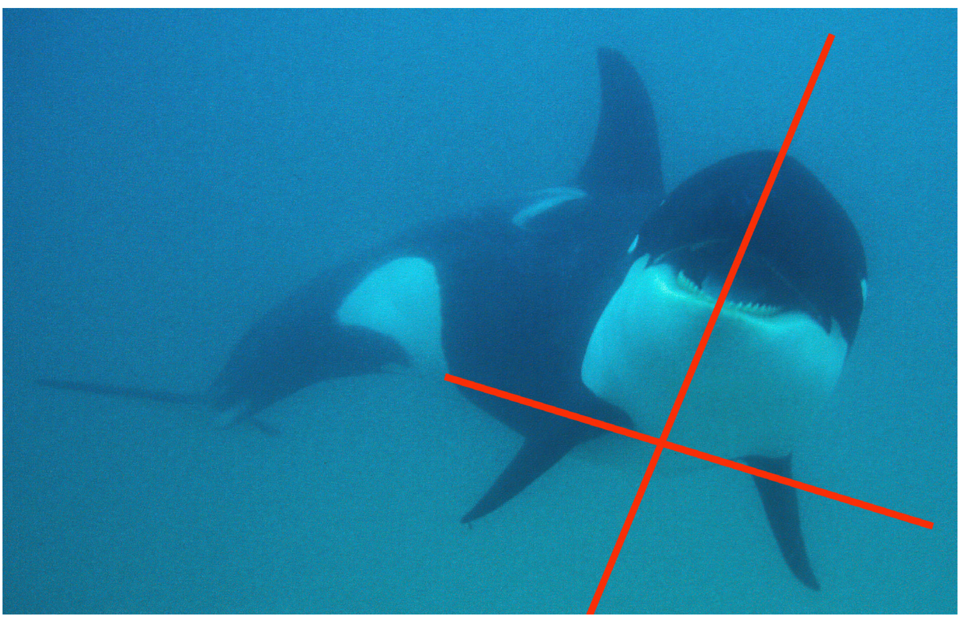

Figure 3. A juvenile female orca, showing the typical 45° angle for the species' pectoral fins, when compared to a medial line and an approximate 'base line' of her sternum. The potential damage to the scapula-humerus joints increases in sub-adult and adult males, due to their larger pectoral fins. Species-specific protocols should always be implemented when intervening (e.g., see Figure 2). Photo © Ingrid N. Visser.

Table 1. Key events and dates for NZ101 who has been resighted 152 times. Of those, 145 sightings were since his rescue and of those 140 were since the boat strike. Only a selection of key dates from the Visser & Fertl (2000) data (white rows) and the current set (grey rows) are listed. See Table 2 for details durations and distances and Figure 1 for locations. N/A = not applicable, ORT = via Orca Research Trust, TEC = Tracy E Cooper, V & F (2000) = Visser & Fertl (2000). Distances are calculated using www.aquaplot.com and sightings with & without photos.

Date yyyymmdd	Event Details	Location	Days since first documented	Days post rescue	km's post rescue	Days post boat strike	km's post boat strike	Source
19960904	First record in database (photo)	Kawau Channel	0	N/A	N/A	N/A	N/A	V & F (2000)
19970614	Stranded (photo)	Mangawhai Heads	283	N/A	N/A	N/A	N/A	V & F (2000)
19970615	Rescued (refloated) (photo)	Mangawhai Heads	284	1	N/A	N/A	N/A	V & F (2000)
19970616	First resighting after rescue (video)	Hen & Chicken Islands	285	2	28	N/A	N/A	V & F (2000)
19971006	Northernmost sighting, first documentation of white scar at base of dorsal fin (photo)	Bay of Islands	397	113	198	N/A	N/A	V & F (2000) (see Fig. 4)
19981016	Boat strike (photo)	Bay of Islands	772	488	766	N/A	0	V & F (2000)
19981024	First resighting after boat strike (photo)	Manukau Harbour	780	496	1,340	8	603	V & F (2000)
19991015	Last sighting in V & F (2000) (photo)	Hibiscus Coast	1,136	852	2,759	364	2,022	V & F (2000)
20000516	First resighting after V & F (2000) (214 days since previous sighting) (no photo)	Bay of Islands	1,350	1,066	3,020	578	2,283	J. Halliday
20001115	First photo-ID after V & F (2000) (397 days) (photo)	Whitianga Harbour	1,533	1,249	3,357	761	2,620	ORT
20030316	First sighting South Island (photo)	Kaikoura	2,384	2,100	6,290	1,612	5,374	S. Lock
20030531	Northernmost sighting (photo)	Maitai Bay	2,460	2,177	11,493	1,688	10,756	N. Scott
20111227	Southernmost sighting (photo)	Peraki Bay, Banks Peninsula	5,592	5,308	36,150	4,820	35,413	E. Slooten & S. Dawson
20190316	Most recent documentation of white scar (duration scar visible = 7,831 days, i.e., 21 years, 5 months, 10 days) (photo)	Kaikoura	8,228	7,945	52,940	7,456	52,203	TEC & Dolphin Encounter Kaikoura (see Fig. 8)
20200606	Northernmost sighting (no photo)	Houhora Harbour	8,676	8,392	54,932	7,904	54,016	ORT
20201205	Most recent resighting (photo) (from first photo = 8,858 days i.e., 24 years, 3 months, 1 day) (from rescue = 8,574 days i.e., 23 years, 5 months, 20 days) (from boat strike = 8,086 days i.e., 22 years, 1 month, 19 days)	Pelorus Sound	8,858	8,5754	55,831	8,086	54,915	N. Howard

Durations & Distances

From when he was first documented, until his most recent sighting, NZ101 was resighted over a period of 8,858 days (24 years, 3 months, 1 day) during which he was documented 152 times (Tables 1 & 2). He was resighted 136 times off the North Island and 16 off the South Island. He was resighted most frequently in the Bay of Islands, where he was observed on 18 occasions (Table 2).

During the entire time that NZ101 has been recorded the longest duration between sightings was 360 days, where NZ101 travelled a minimum of 255 km between the Waitemata Harbour and the Bay of Islands (Figure 1 & Table 1), with the average distance <1 km per day. In the latter encounter he was first documented with injuries from the boat strike. The following sighting was in the Manukau Harbour, eight days later and in all three locations photographs were taken, confirming his presence. The minimum distance between the Manukau Harbour and the Bay of Islands was 603 km, giving an average distance per day of 75 km.

The maximum distance between sightings (with photo-ID at both locations) was 1,219 km when NZ101 was sighted first off Waitemata Harbour and then 95 days later off Kaikoura (Table 2). The shortest distance between locations was 0 km, when NZ101 was resighted in the same location on consecutive sightings (e.g., the Hauraki Gulf to Hauraki Gulf example in Table 3, but we note that these two sightings were 111 days apart). In contrast, there were 16 instances where NZ101 was photographed between consecutive sightings at locations which were more than >1,000 km apart. The timeframe between these was never less than 34 days and up to 186 days, with the resulting average daily distances calculated as low as 5 km and never more than 35 km. Such lower daily rates are likely skewed due to the extended timeframes between consecutive sightings and lack of documentation of his movements during those timeframes. This becomes more apparent when comparing distances where NZ101 was photographed only one day apart (*n*=6) which were 145, 136, 71, 43, 28 and 0 km, with zero kilometres occurring when he was resighted in Whangarei Harbour (Table 3) and 28 km occurring when he was first resighted the day after his refloating.

In contrast, NZ101 has been documented travelling an average of 193 km per day (Table 2), over a period of five days (with a total distance with 964 km between the two sightings and with photo-ID at both locations). The next two highest daily distances were 145 and 136 km. All three of these relatively high daily distances occurred after the boat strike, indicating that although the injury was extreme, it has not severely impacted his ability to swim large distances in short periods of time.

Table 2. Summary data for the male orca NZ101 (Ben). Records are presented as two subsets; 'with or without' and 'with' photo-ID at sightings. Distances were calculated using aquaplot (www.aquaplot.com).

WITH or WITHOUT photo-ID at sightings	
SIGHTINGS	
Total number of sightings	152
Number of sightings since refloating	145
Number of sightings since boat strike	140
Number of locations sighted off North Island	40
Number of locations sighted off South Island	8
Maximum number of sightings in one location	18 (Bay of Islands)
DURATIONS	
Duration between first and most recent sighting	8,858 days (24 years, 3 months, 1 day)
Duration between refloating & most recent sighting	8,574 days
Duration between boat strike & most recent sighting	8,086 days
Maximum duration between two sightings	360 days
DISTANCES (minimum)	
Distance between all sightings	55,814 km
Distance between refloating & most recent sighting	55,635 km
Distance between boat strike & most recent sighting	54,898 km
Maximum distance between two sightings	1,219 km
Maximum daily distance (calculated)	193 km
Maximum daily distance (single day)	170 km
WITH photo-ID at sightings	
SIGHTINGS	
Number of sightings	98
Number of sightings since refloating	90
Number of sightings since boat strike	86
Number of locations sighted off North Island	33
Number of locations sighted off South Island	7
Maximum number of sightings in one location	12 (Whangarei)
DURATIONS	
Duration between first and most recent sighting	8,858 days
Duration between refloating & most recent sighting	8,574 days
Duration between boat strike & most recent sighting	8,086 days
Maximum duration between two sightings	360 days
DISTANCES (minimum)	
Distance between photographed sightings	37,772 km
Distance between refloating & most recent sighting	37,593 km
Distance between boat strike & most recent sighting	36,856 km
Maximum distance between two sightings	1,219 km
Maximum daily distance (calculated)	193 km
Maximum daily distance (single day)	145 km

Furthermore, with the standardised locations and the direct line measurements, the distances are likely to be much greater than indicated from these calculations. For example, from our experience watching the NZ coastal orca in the Bay of Islands, we know that they utilise an area that covers a minimum of 200 km^2 within this one complex embayment. Within that area they are often found 10 or more kilometres from the 'standardised' location in the Bay of Islands, e.g., at the north end of the Te Puna Inlet (13km away), or the south-eastern end of the Waikare Inlet (15 km away). Also, the minimum distance calculations do not take into account the highly dynamic movements of orca, who not only conduct vertical dives but also typically travel along the coastline, entering into small bays and estuaries when foraging.

Over the total period that NZ101 has been documented (i.e., 24 years, 3 months, 1 day), the minimum distance that he travelled was 55,814 km (Table 2). If only those instances where NZ101 was photographed are used to calculate the distance he travelled, the minimum distance was 37,772 km (37,593 km of those were post his stranding and 36,856 km of those were post the boat strike injury) (Table 2).

White Blister Scar & Pigmentation

NZ101 was observed on 6 October 1997, i.e., 113 days after his rescue and refloating, with a white (depigmentation) scar on his left side just below his dorsal fin (Figure 4), presumed to be the result of a large pressure blister that occurred during the stranding (Visser & Fertl, 2000). That white scar was still visible 375 days after his rescue on 16 October 1998, when NZ101 was first documented with severe injuries from a boat strike (Figure 5). The white scar has remained visible in subsequent encounters see (Figures 7-12), including during one of the most recent sightings in which his left side was photographed (see Figure 8). This sets a new record for scar longevity on orca at 7,831 days, (i.e., 21 years, 5 months, 10 days), where the previous records for depigmentation scars on orca were rake marks which were documented for a minimum of 1,529 days (or 4 years, 2 months, 7 days) and a cookie cutter shark bite scar which was visible for 4,090 days (or 11 years, 2 months, 12 days) (Visser et al., 2020).

Pressure blisters are typically considered a minimally invasive and superficial injury (Kutlu & Svedman, 1992). Greenwood (2013), a cetacean veterinarian, suggested that the previous severity of a healed wound can be assessed based on depigmentation alone when he stated;

> "[the captive orca] *carried numerous fine linear scars from previous interactions with other whales, but these were all long since healed. None of these scars had caused depigmentation, indicating that the wounds had been superficial."*

Yet, in the case of NZ101 the superficial blister had caused depigmentation and the extreme trauma from the boat strike, which resulted in a severe laceration and splitting of his dorsal fin, resulted in no depigmentation (Figures 7- 13). Additionally, when NZ101 later received wounds to the anterior portion of his dorsal fin (Figure 11), these were significant enough to have gaping wide lesions and necrotic tissue, yet they healed leaving no depigmentation areas. These two examples call into question retroactive assessment of wound severity based solely on depigmentation (such as conducted by Greenwood).

When NZ101 was first photographed on 16 October 1998 with boat strike wounds, his right saddle patch was 'rounded' and 'smooth' (Figure 13 and see Sugarman (1984) for examples of saddle patch types). By 27 September 2010, his saddle patch had changed shape, in that it then had a 'hard angle' below the cut (arrow, Figure 13). This appears to have resulted from tension applied to his skin and body from his damaged dorsal fin as it creates drag and pressure as NZ101 moves through the water (see *'Injury & Hydrodynamics'* below). This is the first instance that we could find of a saddle patch changing shape in an orca (albeit that saddle patches develop as a calf matures).

Injury & Hydrodynamics

Cetaceans do not have bones in their dorsal fins (Cozzi et al., 2016) and as such the appendage is only supported by fibrous tissue such as ligamentous layers of collagen bundles (Felts, 1966; Pavlov, 2003). From the first day that NZ101 was cut by a propeller, the posterior portion of his dorsal fin leaned towards his left and over time it collapsed (Figure 9). A year after the boat strike the posterior portion had arched over and was impacting his hydrodynamics as evidenced by the water disturbance he was causing when at the surface (e.g., see Figures 7-13) and apparent cavitation when submerged underwater (ORT, unpublished data). The posterior portion of his fin has grown 'longer' (rather than taller as would be expected for an upright dorsal fin) resulting in a larger proportion of the fin dragging as he has aged (e.g., compare Figure 7 with Figures 8-13). Also, the distal end of the posterior portion of his fin has begun to 'roll under' itself (Figures 7-12). With his dorsal fin dragging in the water in such an unnatural manner, there is significant tension on the base of the fin (red arrows, Figure 12). This has created a ridge of raised tissue, visible as a darker line through his left saddle patch (yellow arrows, Figure 12).

As of 2021, NZ101 is approximately 40 years old and his dorsal fin should not grow any 'longer', since his adolescent growth spurt and subsequent 'filling out' as an adult should have finished by the time he was 20 years old, when compared to other male New Zealand coastal orca (ORT, unpublished data) or by 18 years old when compared to Pacific Northwest orca (Olesiuk et al., 2005).

Figure 4. On 06 October 1997, the first day NZ101 was resighted and photographed after his rescue and refloating on 15 June 1997, a white scar (white arrow) from the blister that formed at the base of his dorsal fin, was visible. The black arrow indicates a dark scar that straddles the spinal ridge. See subsequent Figures for comparisons. Photo © Ingrid N. Visser.

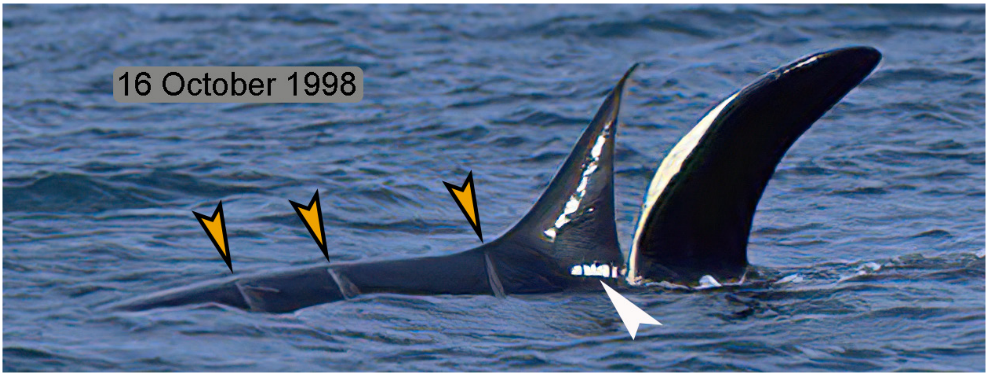

Figure 5. On 16 October 1998, NZ101 was photographed with injuries from a boat strike. Parallel wounds on his dorso-thorax (orange arrows) and extensive damage to his dorsal fin were apparent. The leading edge of the open wound on his dorsal fin exposed the connective tissue and appeared bright white. At the base of his dorsal fin, the white scar remained visible (white arrow), 1 year and 10 days after it was first documented. Another area of white (on the anterior upright part of his fin) was from light reflecting off his fin and was not depigmentation. See subsequent Figures for comparisons. Photo © Ingrid N. Visser.

Table 3. Examples of locations where NZ101 was photographed, with minimum distances and average daily distances (calculated using www.aquaplot.com). Four categories of examples are presented; (A) sightings one day apart, (B) sightings 2 days apart, (C) repeat sightings between locations and (D) sightings at locations >1,000 km apart. Cells in grey indicate maximum durations or distances. These examples are representative of the data for NZ101, but are not an exhaustive list of each category.

Sighting Category	Locations	# of Days between	Distance between (km)	Average Daily distance (km)
A (1 day)	Hen & Chicken Islands (Northland) – Bay of Islands (Northland)	**1**	**170**	**170**
	Whangarei Harbour (Northland) – Mahurangi Harbour (Auckland region)	1	145	145
	Mimiwhangata (Northland) – Whangarei Harbour (Northland)	1	71	71
	Cavalli Islands (Northland) – Bay of Islands (Northland)	**1**	**32**	**32**
B (2 days)	Bream Bay (Northland) – Cavalli Islands (Northland)	**2**	**196**	**98**
	Ahipara (Northland) – Rangaunu Harbour (Northland)	2	187	94
	Whangarei Harbour (Northland) – Waitemata Harbour (Auckland region)	**2**	**174**	**87**
C (repeat)	Hauraki Gulf (Auckland region) – Hauraki Gulf (Auckland region)	**111**	**0**	**0**
	Whangarei Harbour (Northland) – Whangarei Harbour (Northland)	17	0	0
	Hen & Chicken Islands (Northland) – Hen & Chicken Islands (Northland)	7	0	0
	Whangarei Harbour (Northland) – Whangarei Harbour (Northland)	1	0	0
D (>1,000 km)	Whangarei Harbour (Northland) – Kaikoura (South Island)	**160**	1,182	7
	Mercury Bay (Coromandel) – Kaikoura (South Island)	109	1,020	9
	Kaikoura (South Island) – Hauraki Gulf (Auckland region)	105	**1,185**	11
	Kaikoura (South Island) – Whitianga Harbour (Coromandel)	83	1,024	**12**

The injury to NZ101 illustrates the physical ramifications that a boat strike can have on a cetacean. Although the population of NZ Coastal orca is relatively small it has one of the highest rates of boat strikes in the world (Visser & Hupman, 2018). It therefore stands to reason that there must be factors influencing such a high rate, such as large numbers of vessels and their operating zones overlapping critical habitat for the orca. In Figure 6, just one aspect of vessel traffic around the NZ coastline, i.e., commercial ships, is illustrated. Of note is that although this only shows data for ships *"... recreational craft use in NZ is significant, with the country being recorded as having one of the highest boat ownership rates per head of population in the world."* (Riding et al., 2016). These smaller pleasure craft, like the ships, overlap areas where NZ101 has been documented (see Figure 1 for comparison of distribution of NZ101 sightings).

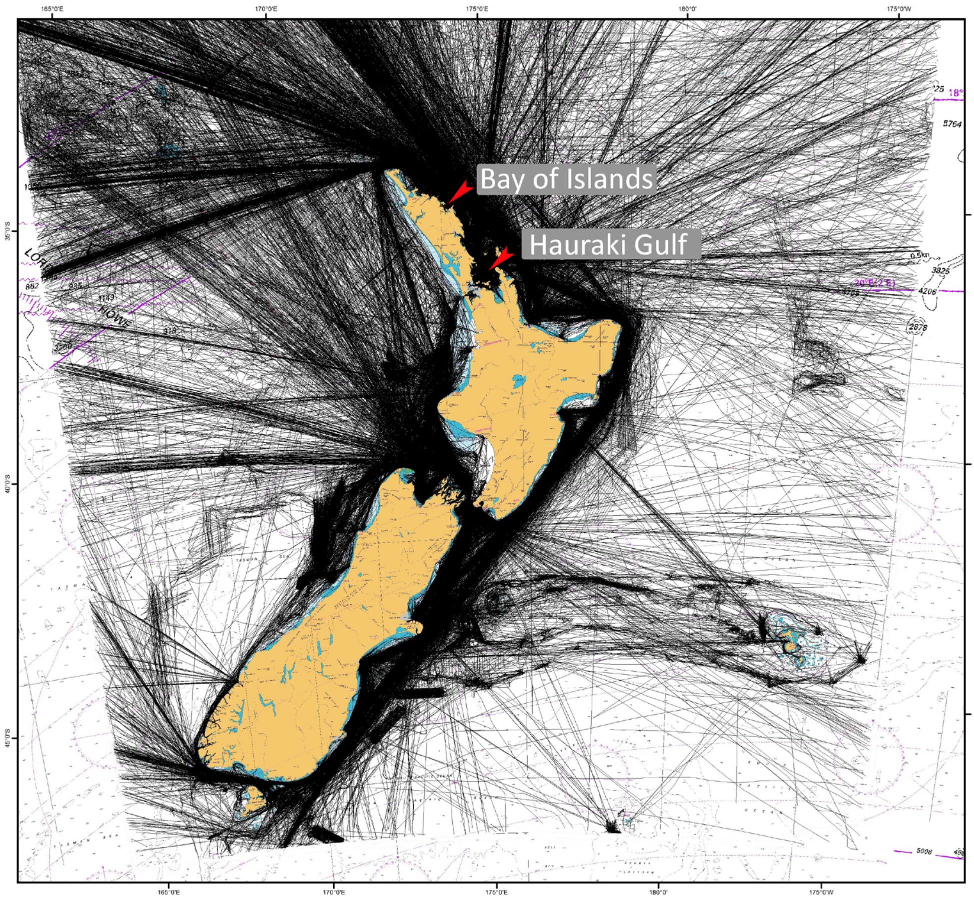

Figure 6. Tracking data of commercial ships from July 2014 to June 2015, extracted from Riding et al., (2016). Although the data in is now six years old, the extent of the exposure is significant. It is of note that this figure does not include commercial tour operators such as whale and dolphin watching, diving tours, ecotours or similar. Nor does it include private vessels/pleasure craft and such smaller vessels are typically concentrated around areas of high human habitation/recreation such as the Bay of Islands and the Hauraki Gulf (arrows), which are also two areas where NZ101 has been sighted the most often. NZ101 was struck by a vessel in the Bay of Islands.

Associations

Visser & Fertl (2000) documented NZ101 travelling with orca prior to his stranding and after both the stranding and the boat strike and there were a number of individuals that he was repeatedly seen with during that period. The social networking pattern for NZ101 has remained comprehensive during the entire time he has been documented. For example, NZ101 travelled with at least 26 orca in the ORT catalogue during period (A) prior to his boat strike including with NZ4, an adult female (he was photographed with her *n*=9 times), NZ6, an adult male (*n*=11) and NZ63, an adult female (*n*=9) and he was therefore presumed to have a strong association with those individuals. He was subsequently documented with each of these orca in period (B).

Other key individuals he was sighted with in period (A) e.g., NZ1 and NZ9, adult females and NZ8 and NZ21, both males, where NZ8 was a juvenile when first documented with NZ101 in 1996 and NZ21 was an adult male when first documented with NZ101 in 1999, have also been recorded travelling with him in period (B). After his boat strike, he was documented with 33 orca in the ORT catalogue. Of these, he has been seen with some individuals multiple times such as NZ1, an adult female (*n*=9), NZ3, an adult male (*n*=8) and NZ68 (*n*=7), who was a juvenile when first sighted with NZ101 but is now an adult male (ORT, unpublished data).

However, as time has progressed NZ101's association network has shifted as, although he may have continued to associate with some individuals listed in the 2000 publication, others are now presumed dead (e.g., NZ3, was last documented travelling with NZ101 on 30 December 2005 and has not been documented at all since November 2007 and NZ4, was last photographed travelling with NZ101 on 20 August 2006 and has not been documented at all since January 2007). As part of his social interactions, NZ101 has been documented alloparenting/babysitting young orca and engaged in other social interactions with conspecifics (e.g., male-male interactions, play behaviour and foraging).

Foraging Behaviour

NZ101 has been documented feeding on rays in both periods (A) and (B). He has been documented feeding on and cooperatively hunting for short-tailed stingray (*Dasyatis brevicaudata*), long-tailed stingray (*Dasyatis thetidis*) and eagle ray (*Myliobatis tenuicaudatus*). In both periods he has also been documented food sharing (an important social bonding interaction in this species), with both males and females (of all age classes except neonates who are not yet taking solid food). In period (B) he was documented cooperatively hunting and killing a broadnose sevengill shark (*Notorhynchus cepedianus*).

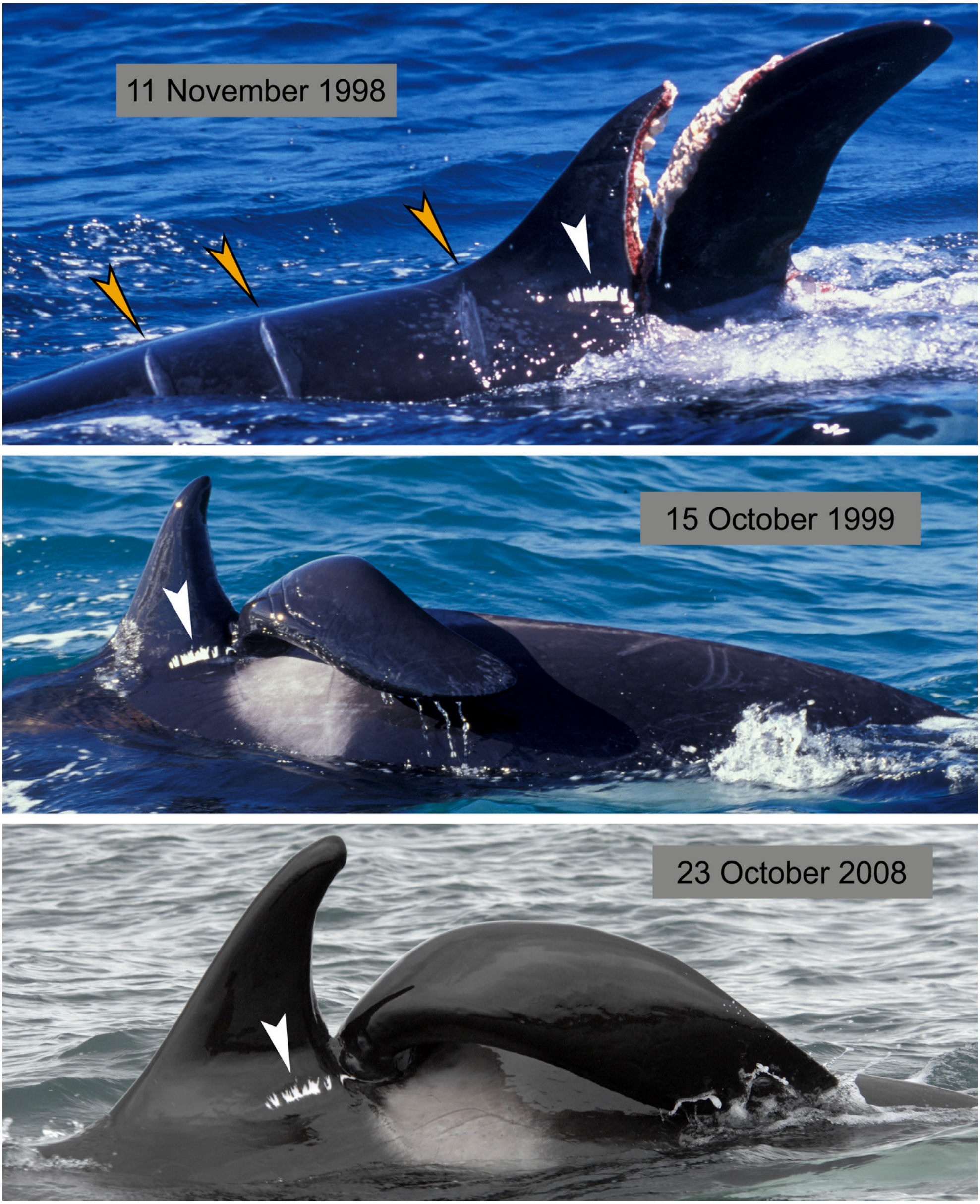

Figure 7. Photographs of the left side of NZ101 show the progression of collapse of the posterior portion of his dorsal fin. Shallow cuts on his dorso-thorax area from the propeller strike are visible one month after they were inflicted (orange arrows, top panel and compare to Figure 5). The wound slicing his dorsal fin had healed by 15 October 1999 (middle panel), including re-pigmentation of the skin. This is in contrast to the persistence of the depigmentation creating a white scar from a pressure blister (white arrows, all panels). Photos © Ingrid N. Visser.

Figure 8. NZ101 was photographed off Kaikoura on 05 February 2019. Over time, the posterior portion of his dorsal fin has been swept further back and 'rolled under' due to water flow as he swims. The white scar at the base of the anterior portion of his fin (white arrow) is still visible (see Figure 4, 06 October 1997 for first documentation). This is the longest duration a depigmentation scar has been documented on an orca, at 7,831 days (i.e., 21 years, 5 months, 10 days). A scar (just on the shadow line, black arrow, insert) that indents and straddles the spinal ridge, was also visible in 1997 (see Fig. 4). The insert was post-processed using TopazLabs Stabilize AI and Gigapixel AI software. Photo © Tracy E. Cooper/Dolphin Encounter.

Table 4. Some examples of the distances which orca have been documented travelling, in order of duration of tracking. Tagging data typically gives a daily 'waypoint' (although some tags provide more frequent location data), whereas photo-ID only gives data at each location where the photo was taken. Neither method accounts for any deviations from a minimum straight-line distance between datapoints. N/D = Not documented.

Time Frame (days)	Distance as Direct line (km) or Area covered (km^2)	Daily Distance Average (km)	Daily Distance Maximum (km)	Notes	Source
28	49,351 km^2	56.8 ± 31.8	114.3	Satellite tag, Ross Sea, Antarctica	Andrews et al., (2008)
48	4,717 km	98	N/D	Satellite tag, Norway	Dietz et al., (2020)
77	3,267 km	42.4	N/D	Photo-identification, Kodiak, Alaska – Monterey, California, USA	Dahlheim et al., (2008)
90	>5,400 km	159.4 ± 44.8	252	Satellite tag, Canadian Arctic and into the North Atlantic	Matthews et al., (2011)
104	7,608 km	73	N/D	Satellite tag, Norway	Dietza et al., (2020)
109	9,392 km (in 42 days)	N/D	N/D	Satellite tag Antarctica – South America return	Durban & Pitman (2011)
8,858	37,772 km	Variable	193	Photo-identification New Zealand	This study

Figure 9. When NZ101 was photographed swimming towards the camera on 16 October 1998 (left), the anterior portion of the fin was upright whilst the posterior portion began to collapse to his left, the same direction it had started to collapse during the stranding a year and half prior. On 25 October 2010 (right), the anterior portion remained upright, whilst the degree to which the posterior portion of the fin was compromised is obvious. The white scar can also be seen in both photos (white arrows). Photos © Ingrid N. Visser.

Figure 10. When NZ101 was photographed swimming away from the camera on 21 May 2007 (left), the collapse of his fin is clearly visible. By 25 October 2010, the posterior distal end of the collapsed portion was beginning to 'roll under'. See Figure 8 for comparison to 2019. The black arrows (also see inserts) indicate a small dark scar that is an indent which straddles the spinal ridge (see Figures 4, 11 & 13 for comparison). Photos © Ingrid N. Visser.

Figure 11. On 20 August 2006, NZ101 was photographed with two wounds on the anterior section of his dorsal fin (top & insert). The aetiology of these is unclear, but by 03 September 2015 (bottom) they had completely healed and like the rest of the skin on his dorsal fin, there was no depigmentation. A dark scar is visible across his spinal ridge (upper image, black arrow, also see Figures 4, 8, 10 & 13). Photos Top; © Ingrid N. Visser (2006), Bottom © Terry M. Hardie (2015).

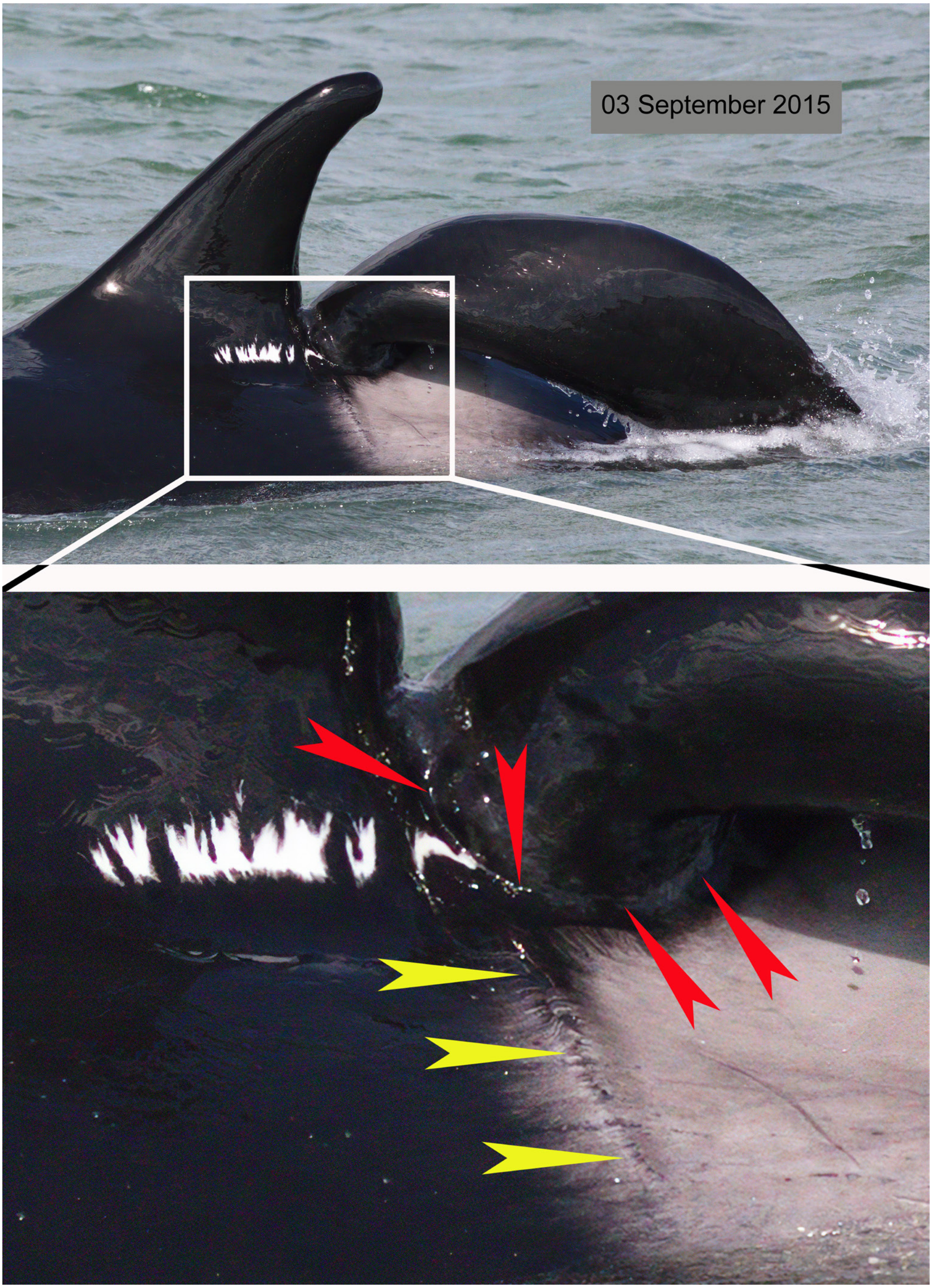

Figure 12. NZ101 photographed on 03 September 2015. The posterior portion of his dorsal fin hanging in the water creates drag and disturbs water flow. This in turn creates a significant amount of pressure on the base of the dorsal fin, as evidenced by the raised ridge and scar (yellow arrows) and the pressure ridge around the base of the fin, noting that this ridge continues around and 'into' the split of the fin (red arrows). The white depigmented scar from a pressure blister is still clearly visible (also see Figures 4, 5, 7-9). Photo © Ingrid N. Visser.

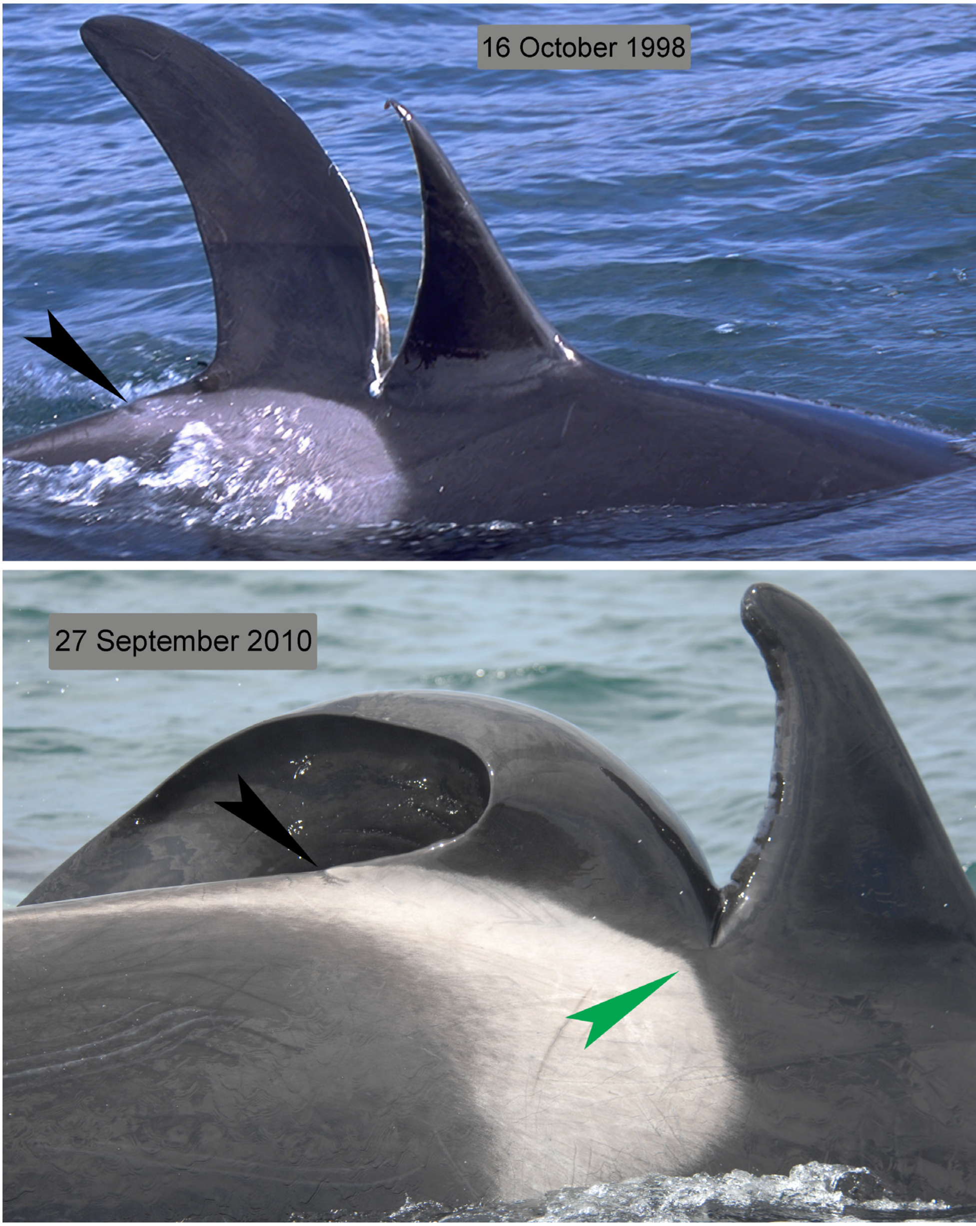

Figure 13. The right side of NZ101 was photographed 16 October 1998 (top), and on 27 September 2010 (bottom). A small scar, straddling his spinal ridge (black arrows) is visible in both images (also see Fig. 8). Of note is that the grey area of his saddle patch has changed shape; originally it was rounded near the apex of the cut (top) whilst in the bottom image it had an angled 'corner' to it (green arrow). This is likely due to the pressure of his dorsal fin as it is dragged through the water, distorting his skin on his right side. Photos © Ingrid N. Visser.

C. ONE OF THESE IS NOT LIKE THE OTHER

We have become aware of another orca who has a remarkably similar injury to NZ101 (Figure 14). That individual, a female, was photographed off the east coast of Australia, but has never been documented outside of that area. Although similar, there are some differences between the wounds on the two orca (see Figure 14 caption for details). By 2003 the dorsal fin of NZ101, a growing male, was hanging much further into the water than the Australian female orca.

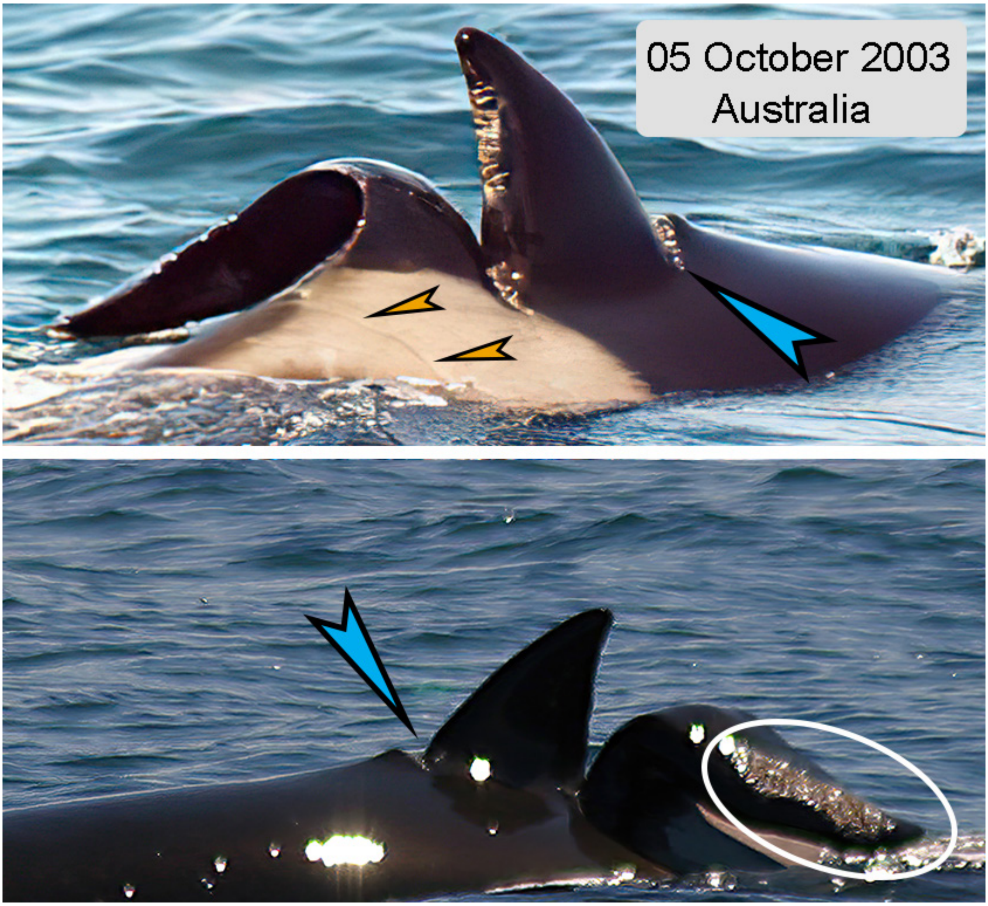

Figure 14. A female orca, photographed on 05 October 2003 at Twofold Bay, New South Wales Australia, shows remarkably similar boat strike wounds to NZ101. However, her injuries differed from his in that she had a deeper cut from the propeller anterior to her dorsal fin (blue arrows), the portion of her dorsal fin that remained upright was more triangular and the cut which sliced her dorsal fin extended down into the pale grey area of her saddle patch (upper panel). Additionally, she had a shallow healed scar on her right saddle patch (orange arrows, upper panel) which was spaced a similar distance to the other deeper cuts and was therefore indicative that the propeller strikes occurred along her right side (see Figures 5 & 7 for similar shallow wounds on NZ101). Furthermore, this female had no white blister scar (rather, the bright white areas in the lower panel are from the sun reflecting off her wet skin). She also had some type of growth or external infestation, perhaps of cyamids, on the posterior portion of her fin (circled, lower panel). Photos © Amy Hellrung.

D. OTHER CETACEANS POSTINTERVENTION

Wells et al., (2013), when evaluating survival rates of cetaceans who had been provided assistance, noted that;

> *"Stranded beached cetaceans were less successful than free-swimming rescued animals. Rehabilitated animals were less successful than those released without rehabilitation. Mass stranded dolphins fared better than single stranded animals."*

Geraci & Lounsbury (2005) stated in their book '*Field Guide for Strandings*', that a cetacean which;

> *"... has come ashore in a mass stranding, ... may have a better chance than a singly stranded animal which is more likely to be sick and debilitated."*

Based on both of these statements, NZ101 had a reduced chance of survival as he filled at least two of the 'less successful' categories; (1) he was stranded on the beach and (2) he stranded as a single animal and furthermore he was 'debilitated' due to his potentially broken shoulder joint. Perhaps to his advantage, he was not rehabilitated in a facility, as intervention at that level was found to hinder a successful rescue of a cetacean (Wells et al., 2013).

In NZ, where there are high rates of orca strandings (Visser, 2013), most events involve single stranded animals who are in good health, but who strand as a result of their method of foraging in shallow waters for rays (Visser, 1999b). Towers et al., (2020a) also believed that the strandings of another orca ecotype (Bigg's) were *"accidental out-comes resulting from the intent to capture prey"* and in those cases the prey were marine mammals. Likewise, (Shelden et al., 2003) describes at least three events where orca stranded in association with hunting marine mammals and one adult male orca *"regurgitated a large chunk of beluga blubber and a harbor seal paw"* whilst stranded.

We reviewed a range of other published studies to assess the duration that cetaceans were resighted postintervention. However, we could find only four cetacean species which have been documented for more than 100 days after they were rescued/ released; long-finned pilot whale (*Globicephala melas*), in which two individuals were satellite tagged post stranding and tracked for 127 and 132 days (Nawojchik et al., 2003); humpback whale (*Megaptera novaeangliae*), in which an individual was biopsied during and after a stranding, 2,826 days (7 years, 8 months, 27 days) apart (Neves et al., 2020) and a number of bottlenose dolphin (*Tursiops truncatus*), many of whom were disentangled from fishing gear. The bottlenose dolphin with the longest duration postintervention, was resighted 12,826 days (35 years, 1 month and 12 days) (McHugh et al., 2021).

For orca, we could find few examples outside of NZ where intervention was applied to help rescue an individual and where the resighting data was longer than

100 days. One event involved a female (catalogue # A73, known as 'Springer'), from the Northern Resident population found off the west coast of North America. She was separated from her family after her mother was presumed to have died. A73 became emaciated and intervention involved taking her into short-term (31 days) captivity in a sea pen for rehabilitation (Norberg et al., 2003; Hewlett & Francis, 2007; Schroeder et al., 2007) where she was provisioned and administered medication. She was photo-ID'd (not tagged) and released and has been resighted numerous times, travelling with her extended family (Hewlett & Francis, 2007). She has subsequently given birth twice (in 2013 and in 2017 see Towers et al., 2020b) with her most recent resighting in July 2020 (G. Ellis & J. Towers, pers. comms. to Visser).

Another event involved a juvenile of unknown sex (catalogue # T068C1), from the British Columbia, Canada Bigg's ecotype population. It stranded and was assisted by keeping it cool with bucketed water and as the tide rose around the orca, it required further assistance;

> "... [the orca] *had difficulty lifting its blow-hole above the surface to breathe due to its tail end being positioned higher on the rock than the head. Two oars were quickly acquired and placed between the pectoral fins and upper abdomen to leverage the whale into deeper water. During this effort, the whale began pumping its fluke and became free of the rock after about 4 h of being stranded. At first, T068C1 rolled upside down and became motionless for approximately 2 min. It then righted itself, took a breath, and joined the other two whales in the distance."* and *"T068C1 was next documented 65 d later off the west coast of Vancouver Island. Between this date and the end of 2019, T068C1 appeared healthy on 12 occasions when photo-identified with kin between Juan De Fuca Strait, British Columbia, and Glacier Bay, Alaska"* Towers et al. (2020)

We compared the example of NZ101 to records of other NZ orca who have also received intervention and note that nine have been resighted over a duration of more than 100 days (six examples with the longest durations postintervention are listed in Table 5, including NZ101). The longest duration between an incident and resighting was 9,686 days (26 years, 6 months, 6 days) for a female (NZ63 'Miracle') who stranded when she was a juvenile. She has since had two calves which have survived (Table 5).

Although there are other examples of orca surviving strandings and being resighted more than 100 days after refloating, typically these events involve little or no intervention. For example, Towers et al., (2020a) describe a resighting of two orca (an adult female and her adult male offspring) who stranded in 2011 and were resighted 119 times afterwards (prior to the end of 2019), but there was no intervention applied (other than a single bucket of water). Shelden et al. (2003) describe an adult male orca who survived a stranding in 1991 and was resighted in 1993, but they do not discuss any assistance that was given to the orca.

In comparison, there are a number of orca in NZ who have stranded and received no intervention – and who have also since been resighted, for example NZ21 (aka 'Roundtop'), who has stranded twice whilst foraging for rays and been documented with NZ101 on a number of occasions. He first stranded on the 27 July 2006 and then restranded again on 09 April 2010, with his most recent resighting on 09 June 2020, i.e., the total duration between his first stranding and his most recent sighting was 5,066 days (13 years, 10 months, 13 days) and there were 3,714 days (10 years, 2 months) between his second stranding and his most recent sighting.

Likewise, there are other NZ Coastal orca who have survived boat strikes, without intervention. For example, a female orca (catalogue # 142, aka 'Striker') has a series of at least seven cuts from a propeller strike, running from her dorsal fin to her caudal peduncle (Figure 15). She was first photographed with the boat strike wounds on 19 December 2017, off Kaikoura (her southernmost sighting). At that point the wounds were already healed and therefore we have no indication of where she was injured. She has been documented as far north as the Bay of Islands and has travelled from there to Wellington (a distance calculated by aquaplot as 1,100 km) in 14 days (averaging 79 km per day). In all instances that she has been photographed she was travelling with NZ1, an adult female who has also been documented with NZ101 on numerous occasions in both periods (A) and (B).

Figure 15. A female orca, photographed on 30 August 2019 at the Hen & Chicken Islands, exhibits seven healed wounds (orange arrows) from a boat strike. Photo © Ingrid N. Visser.

A young female orca (catalogue #125, aka 'Anzac') was documented on 25 April 2004 with a cut in her caudal peduncle and in her right tail fluke, that later resulted in her losing part of her fluke. The wounds not only injured her, but appeared to also impact her, either through changing her style of swimming as she would often lift her tail flukes out of the water, or due to irritation (perhaps itching or pain) as she would often tail slap (see

Figure 16 for some examples of this behaviour). She has been resighted every year since the injury and has subsequently produced a calf (ORT, unpublished data).

Figure 16. Injuries from a boat strike have resulted in modified swimming style (tail lifting) and behaviour (tail slapping on the water surface) of NZ125. Photo © Ingrid N. Visser.

Yet another NZ Coastal female orca (known as 'Prop', catalogue # NZ25), has a series of four very deep propeller cuts along her spinal ridge, posterior to her dorsal fin and extending all the way along her caudal peduncle (Visser, 1999c). She was first documented off the North Island in February 1982 when she was an adult and at that point the boat strike wounds had already healed. She has most recently been documented off the South Island in September 2020 and therefore, she has survived at least 38.5 years after the injury. During that time she has been documented with NZ101 on a number of occasions, off both the North and South Islands.

4. DISCUSSION

Recognising and assessing the risks for any endangered population of animals is an important part of their conservation and management. When individuals are exposed to situations where intervention can help their survival, the option to intervene is ethically logical. However, an evaluation of the costs and benefits is often applied to determine if a rescue should be conducted and the calculated outcome typically influences the decision-making process. In those cases, part of that calculation must include case studies that provide evidence of outcomes (survival rates as well as benchmark milestones for thriving). We have endeavoured to provide a comprehensive case study here, with other examples for comparison, to provide evidence to support intervention as well as, at times, 'hands-off' approaches.

NZ101 was involved in two significant incidents; a stranding which he would not have survived without assistance and a boat strike for which he received no intervention. The distances that NZ101 has travelled, after his stranding and after his boat strike injury attest to his successful recovery from both incidents. Comparison to examples of distances which other orca have travelled (Table 4), illustrates that the maximum daily distance of 193 km for NZ101 is not excessive, neither is it an under representation of what an uninjured orca can (and does) travel. In contrast, the low average daily distances for some of the examples are likely a facet of four key factors; (1) the minimum distances calculated between any two locations are not 'real-world' distances, as NZ Coastal orca typically follow the coastline; (2) the long periods between some sightings indicates that NZ101 would have in fact travelled elsewhere; (3) repeat sightings at the same location (when separated by time) are also indicative that he would have travelled to other locations and; (4) the relatively infrequent number of times he has been documented limit our knowledge (i.e., had more data been collected, we would be more aware of the distances he has travelled). Combined, these factors clearly illustrate that the calculations are underestimates. Furthermore, they do not factor in the distances NZ101 covered during vertical travel (i.e., diving) which is relevant when it is understood that orca have been documented diving to over 1,000 m (Towers et al., 2018) and that in NZ they regularly dive to the sea floor when foraging for rays (Visser, 1999b).

The new resighting data herein adds 7,722 days (21 years, 1 month, 20 days) to the last recorded sighting in Visser & Fertl (2000). Now, the total duration between stranding and his most recent sighting is 8,574 days (23 years, 5 months, 20 days). The only other record for orca that we could find, which is comparable in duration for postintervention, was for the female A73 ('Springer') who has been resighted 18 years after rehabilitation and release (G. Ellis & J. Towers, pers. comms. to Visser). Therefore, the data from NZ101, is as best as we can establish, a global record for resighting of an orca postintervention.

One of the early records of tracking a cetacean after a stranding was conducted on a pilot whale, which was monitored for 95 days after it was released and during that period it was documented numerous times with conspecifics (Mate, 1989). Nawojchik et al., (2003) considered the postintervention release of two long-finned pilot whales a success when the two whales, who were released together, were tracked by satellite for 127 and 132 days. They were thought to remain together during that tracking period. Although NZ101 stranded alone, Visser & Fertl (2000) noted that;

> *"At dawn, on the morning of the release, a single unidentified killer whale was sighted from a cliff top near the stranding location, and seen about 7.5 km offshore, swimming parallel with the beach. At 1010 h, when the stranded animal was placed in the water, the killer whale offshore turned and headed towards the coast. An hour after release, the previously stranded killer whale joined up with the unidentified killer whale..."*

In each of the subsequent 145 sightings after his rescue, NZ101 was documented with other orca, including at least 10 of which he was seen with prior to his stranding. This behaviour, combined with the fact that he has also been recorded food sharing with conspecifics, which is considered an important social bonding aspect for the species (Wright et al., 2016), fulfil criteria for 'socially reintegrated', after his rescue and release. Collectively, this all illustrates that NZ101 has not only survived but that he has thrived.

However, originally his life had been in danger, not only from the stranding but also due to management decisions. On the day of his stranding in June 1997, the ORT was alerted that the DOC (i.e., the NZ Government Department legally mandated to protect cetaceans) were going to euthanise NZ101. They stated at the time that this decision was made because NZ101 had a small amount of blood coming from an external cut in the crease of his pectoral fin insert. The ORT team therefore chartered a helicopter to arrive on site before the DOC Marine Ranger could conduct the shooting. The following day, as NZ101 was being prepared for return to the ocean Visser & Fertl (2020) noted that;

> *"Inspection in daylight revealed the left pectoral fin joint could have been broken, since it hung at a different angle from the right fin. The joint was bleeding slightly from the cut running parallel to the body. Standard whale stranding procedures in New Zealand do not cater for rehabilitation in captivity, as there are no suitable facilities. Hence, the whale, although possibly injured, was refloated ready for release."*

The evidence presented here supports that decision to rescue and release him, rather than euthanise. A year later, when NZ101 was first photographed with the boat strike injury to his dorsal fin and then again when he was photographed 26 days later, the tissue surrounding the wound was deteriorating and his fin was beginning to collapse (see Figure 7), and the prognosis for his survival was not high. Although consultations were conducted with regards to potential intervention (including to perhaps administer medication), NZ101 was not relocated until 174 days later and by then the wound had healed over.

Based either on his presumed broken shoulder joint, or the severe trauma from the propeller cuts, rehabilitation in captivity may have been an option had an appropriate sea pen facility been available. However, the added trauma of a capture, along with the forced separation from his family members would have caused significant stress (Marino et al., 2019). Collectively, this may have impeded his recovery rather than enhanced it, as Wells et al., (2013) have noted when evaluating 169 cetacean cases where intervention was applied, that rehabilitation in a facility reduced survival.

The graphic nature of the boat strike injury, compared to the perceived benign nature of a pressure blister, is not reflected in the fact that the white scar from the blister has remained visible for nearly 21.5 years and the wounds on his dorsal fin healed with no depigmentation. Scars on orca appear to have much longer duration when they create a contrasting pigment (in this case white on black, but also see Visser et al., (2020) where cookie cutter shark bite marks were visible when black on grey). The white blister scar on NZ101 was also helpful in providing another identifying feature of NZ101 when the boat strike injury occurred, as he was not lifting his head out of the water high enough to document his white eye patches, which are unique for each individual orca (Visser & Mäkeläinen, 2000).

Table 5. Resightings of some of the NZ coastal orca who were involved in one or more incidents and received intervention. Date format is yyyymmdd.

NZ Coastal Orca Catalogue # & Name	♂/♀ Age class during 1st incident	1st Incident	Resighting post 1st incident & (# days since 1st incident)	2nd Incident [days since 1st incident]	Resighting post 2nd incident [days since 1st incident]	Most Recent Resighting	Days since 1st incident until most recent resighting [2nd incident until most recent resighting]	Comment
NZ63 "Miracle"	♀ juv	19930823 (stranding)	19950818 (725 days)	20190201 (stranding) [9,293 days or 25 years, 5 months, 9 days]	20190209 [8 days]	20200229	9,686 days or 26 years, 6 months, 6 days [393 days or 1 year, 28 days]	1st calf 2001, 2nd calf 2009 Both stranded with her in 2019
NZ101 "Ben"	♂ sub-adult	19970614 (stranding) 19970615 (release)	19971027 (134 days)	19981016 (boat strike) [489 days or 1 year, 4 months, 2 days	19981016	20201205	8,574 days or 23 years, 5 months, 20 days	This Chapter
NZ126 "Putita"	♂ juv	20030702 (stranding)	20040722 (386 days)	20100525 [2,519 days]	20100530 (5 days)	20201017	6,317 days or 17 years, 3 months, 15 days [3798 days or 10 years, 4 months, 22 days]	Presumed brother of NZ91 who stranded in 2003
NZ91 "Rua"	♂ adult	20030711 (stranding)	20060906 (1153 days)	-	-	20201017	6,308 days or 17 years, 3 months, 6 days	Presumed brother of NZ126 who stranded in 2003 & 2010
NZ20 "Double Dent"	♀ adult	20041123 (stranding)	20041123 (same day)	-	-	20201127	5,848 days or 16 years, 4 days	Stranded with presumed son, NZ24, new calf in Oct 2010
NZ24 "Rudie"	♂ adult	20041123 (stranding)	20041123 (same day)	-	-	20201127	5,848 days or 16 years, 4 days	Stranded with presumed mother NZ20 & younger sibling

With regards to the boat strike incident, NZ101 is not the only orca to have extensive injuries from vessels. In a database of 907 ship strikes, orca were the odontocete species with the third highest incident rate (after sperm whales (*Physeter macrocephalus*) and bottlenose dolphins, where the latter were recorded with only one more incident than orca (Winkler et al., 2020). NZ also ranked as the country with the third highest boat strikes (of any cetacean species) after USA and Canada (Winkler et al., 2020). Visser & Hupman (2018) documented 10 boat strike incidents involving orca in NZ waters and since then at least two other individuals from this population have been hit by boats (ORT unpublished data). Even in locations where boat traffic is severely restricted, such as the UNESCO Heritage site of Península Valdés, Argentina, orca have been documented with injuries from propellers (Copello et al., 2021, Chapter 1 this volume).

In a strategic plan specifically written to mitigate the impacts of ship strikes on cetacean populations, Cates et al., (2017) were addressing larger whale species, however their statement is equally applicable to other species and certainly relevant with respect to the NZ Coastal orca;

> *"... it was noted that human-induced mortality caused by ship strikes can be an impediment to cetacean population growth. Populations of whales in the low hundreds of individuals are at risk of continuing declines even if only a small number of ship strikes occur per year. Therefore, it is important to identify populations that are small, are in decline, or for which human activities result in whale deaths or injuries and to monitor these populations to evaluate the extent to which ship strikes are a threat..."*

Despite the large distances that NZ101 has been documented swimming, it is unclear what, if any overall impact the injury has had on his diving ability, his hydrodynamics and/or if the tension from the drag of his fin has had an impact on his skeletal or muscle structures. Although he has been documented travelling relatively large distances, finer aspects such as his ability to turn whilst pursuing prey may be impacted and can be hard to monitor. It has been shown that an orca can turn within 4% of its body length (Fish & Rohr, 1999), which is one of the most efficient turning radii of cetaceans. The morphological characteristics of cetacean appendages influence locomotion and manoeuvrability, with a fine balance having evolved (Fish, 2002). Logically, one would expect that deviations from the optimal placement and design of control surfaces of those appendages would impact efficiency and ultimately the potential survival of an individual. Yet, despite the gross destabilising injury NZ101 has sustained, he has continued to travel widely around NZ. In fact, his range may have extended since the incident, as he had never been documented in the waters around the South Island prior to his injury. However, we do recognise that he may have frequented these locations earlier, but the distinctive nature of his appearance now increases the likelihood of him being documented and reported.

Although the injury to NZ101's dorsal fin makes him very distinctive, there is a small chance of mis-identification – for example when comparing his injury to that of the female orca off the east coast of Australia (see Figure 14), in that both individuals have had their dorsal fin sliced by a propeller and the posterior section has collapsed to their left in both cases. Regardless, we are confident that the sightings we documented were of NZ101, as no other orca has been documented in NZ waters with a similar injury. Likewise, no NZ Coastal orca have ever been documented in Australian waters (ORT, unpublished data).

But the fact that two orca have recovered from similar injuries does speak for the ability of these animals to survive horrendous wounds. Comparable in duration in terms of survival, is a female bottlenose dolphin who, as a calf, was captured to remove fishing gear and was released directly without any further intervention such as rehabilitation. That dolphin has been observed for 35 years postintervention and has successfully produced calves (McHugh et al., 2021). These examples highlight the importance of monitoring individuals during and post both incidents and interventions, in order to document not only their survival but also their ability to thrive. McHugh et al., (2021) stated;

> *"... given the costs associated with interventions, it is important to understand the benefits of these endeavors not only to save individuals, but also to establish if and how saved individuals contribute to social functioning, survival and reproduction within small, resident populations facing multiple concurrent threats."*

We emphasise that it was only possible to confirm that NZ101 survived both events due to photo-ID being conducted at the original stranding event. As such, we note that high-quality photo-ID of each cetacean should be an absolute priority at all rescue events. *Inter alia*, congenital marks and scars (Auger-Méthé et al., 2010) and anomalous pigmentation (Stockin & Visser, 2005; Jefferson et al., 2015), should all be documented. In addition to standard features such as the shape of the dorsal fin, special attention should be paid to species-specific details such as; for orca, saddle patches (Sugarman, 1984) and eye patches (Visser & Mäkeläinen, 2000); for common dolphins, dorsal fin pigmentation (*Delphinus delphis*) (Neumann et al., 2002) and for right whales, callosities (*Eubalaena* sp.) (Vernazzani et al., 2013).

Furthermore, photo-ID of the other orca present during encounters with NZ101 also allowed for his social network to be determined prior to his stranding as well as after both the stranding and his boat strike. Social network studies on bottlenose dolphins in Florida have shown a reduction in associations between individuals for two years after sustaining human-induced injuries (Greenfield et al., 2021). However, the social networking pattern for NZ101 has remained comprehensive during the entire time he has been documented. For example, NZ101 travelled with at least 26 orca in the ORT catalogue prior to his boat strike and after the boat strike, he was documented with 33 orca in the catalogue.

Visser & Fertl (2000) stated;

> *"Successful return to the wild can be assessed on survival and re-incorporation into social groups (Wells et al., 1998). Based on these criteria, NZ101 is considered to be successfully returned to the wild, since he survived for at least 28 months after stranding and was resighted with individuals he was known to associate with prior to stranding."*

And McHugh et al., (2021), when assessing 27 cases of intervention for bottlenose dolphins, stated;

> *"Survivorship rates did not decline substantially between 1 and 5 years post-rescue, meaning survival beyond 1 year may be a useful benchmark of long-term success."*

For NZ101, we have documented him for more than two decades and calculated that he has swum (at an absolute minimum) over 37,700 km since he was refloated. His rescue can be considered nothing short of significant for a plethora of reasons. For example, the conservation implications of rescuing NZ101 include the potential for him to have contributed to the gene pool of the Nationally Critical NZ Coastal orca population, which is comprised of fewer than 200 individuals (Visser, 2000; Visser & Cooper, 2020b). Given that reproductive success for male orca appears to increase with age (Ford et al., 2011) and the fact that NZ101 is now estimated to be approximately 40 years old, the likelihood of him fathering offspring is predicted to increase.

Additionally, NZ101 has been seen to participate actively in alloparenting and food-sharing, as well as cooperative and independent hunting. These factors also contribute positively towards the success of the individuals within his social network. Nonetheless, we recognise that it is likely that during the timeframe immediately following his boat strike injury he may have been more of a burden on the group(s) he accompanied, than an asset, as they may have had to provide him protection and/or provision him. However, we counter this with the sightings data that we have collated for the time shortly afer the boat strike – for example, only eight days after he was documented in the Bay of Islands (where the boat strike occurred on the east coast of the North Island), he was documented a minimum of 600 km away, (i.e., he travelled an average of ~75 km per day), in the Hokianga Harbour on the west coast of the North Island. Two days later he was documented a minimum of 230 km away (an average of ~60 km/day) in the Manukau Harbour, also on the west Coast of the North Island. In both instances he was photographed with conspecifics. These travel distances are not a typical for NZ coastal orca and they are consistent with data collected on NZ101's travels years later. Therefore, although severely injured, NZ101 appeared to place little restriction on his conspecifics with regards to their travel.

Another conservation implication that NZ101 has contributed to is raising awareness of boat strike issues for cetaceans in NZ and at a global level. Images of his injury have appeared in reports to the NZ Government, for the NZ Environmental Court and International Courts, in educational presentations, brochures, ID guides and posters, in various peer-reviewed scientific papers and in a range of books and magazines. He is now an iconic individual and his contributions to education about boat strike (e.g., as a 'poster child') cannot be underestimated, even if it is difficult to ascertain the influence that his story may have had on changing boater behaviour.

Disturbingly, more than 30 NZ orca have died in the past decade primarily due to boat strikes, entanglements and due to ineffective or inappropriate intervention by Government Authorities (e.g., see Visser et al., 2017). And yet, when experienced personnel from species-specific NGO's are involved with interventions the success rate for release/refloating is near 99% (Visser, 2013). This pattern, after nearly three decades of data gathering, is undeniable. The case study of NZ101 perfectly illustrates how an NGO's intervention prevented the death of this individual and contributed to his rescue. The evidence presented here also demonstrates that it is worth the commitment of time, money and effort to provide appropriate intervention and long-term monitoring for orca.

From multi-year studies such as this, science can directly help advise conservation and management actions, such as boat speed restrictions and boater education (Visser, 2008). As negative human influences on the marine environment continue to grow, we should prioritise the mitigation of these, particularly where there are accumulative impacts on critical habitats for keystone species such as orca. Reducing risks, eliminating, restricting, or preventing encroaching infrastructures that cause habitat loss, or exclusion from habitats are all vital areas that need addressing. For example salmon farms have high vessel traffic that impacts cetaceans (Bedriñana-Romano et al., 2021) and mussel and/or mussel spat farms can have 100's of kms of plastic rope, thereby increasing the risks of entanglement (e.g., see rope calculations for a proposed spat farm in Lampen, 2020).

In NZ, the Resource Management Act was introduced in 1991 with specific regulations for the marine environment implemented in 2010, under the NZ Coastal Policy Statement (NZCPS) (Department of Conservation, 2010). Although Policy 11 of the NZCPS was developed *"To protect indigenous biological diversity in the coastal environment"*, the Policy restricts its level of protection by adding inter alia, the following caveats;

> *(a) avoid adverse effects of activities on:*
> *(i) indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists;*
> *(ii) taxa that are listed by the International Union for Conservation of Nature and Natural Resources as threatened;*

(iii) indigenous ecosystems and vegetation types that are threatened in the coastal environment, or are naturally rare;
(iv) habitats of indigenous species where the species are at the limit of their natural range, or are naturally rare;
(b) avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on:
(ii) habitats in the coastal environment that are important during the vulnerable life stages of indigenous species;
(iv) habitats of indigenous species in the coastal environment that are important for recreational, commercial, traditional or cultural purposes;
(v) habitats, including areas and routes, important to migratory species; and
(vi) ecological corridors, and areas important for linking or maintaining biological values identified under this policy.

As such, orca and their habitats should fall under the protection of the NZCPS as they are listed under the NZ Threat Classification System. However, exploitation of a wide range of their habitat persists at a rapid pace and is expanding almost unabated. In fact, the NZ Government has an official 'Aquaculture Strategy' to increase the output of annual sales generated by NZ aquaculture from ~$600 million to $3 billion per year, and to increase that within just 15 years. Yet that scheme has no clear mitigation paths or acknowledgement of protection for any marine mammals, or their habitats (New Zealand Government, 2019). That is in spite of the NZCPS Policy 11*(b)(iv)* specifically highlighting the potential conflict of interest between commercial interests and indigenous threatened wildlife. Likewise, the NZCPS requires that commercial use of the marine region must *"avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities"*. The overlap between NZ101's sightings and the core areas for NZ aquaculture is almost all-encompassing – with only one of the six aquaculture hotspots (New Zealand Government, 2019) currently not inside areas that would be considered critical habitat for him (and by default, also the rest of the NZ Coastal orca population).

This case study of NZ101 reveals that the NZ law, Government strategies, policies and 'Action Plans' do not necessarily act as shields for the animals. Rather, they are applied as swords by industry (and the NZ Government) to enable commercial use of the marine environment at breakneck speed. It is therefore often up to local communities to challenge over-exploitation through the legal system, in order to safeguard coastal areas and the animals who live in them (Visser, 2020). We therefore hope that the evidence presented here provides a strong backbone for such undertakings by grassroots groups and thereby helps increase protection for this unique orca ecotype.

If one inspects NZ101's sightings distribution and his patterns of travel, and overlays those with the various commercial industries that he is exposed to, it becomes apparent that the potential risks are accumulative and not minor. From oil exploration and extraction, overlapping habitat use with various marine industries such as fisheries and aquaculture, high concentrations of vessel traffic, noise pollution, destruction of habitat through reclamation and removal of mangroves and foreshore for human developments (ports, marinas etc), raw sewage discharge from cities into the marine environment, overfishing of prey, as well as a myriad of other impacts, it becomes apparent that these are aspects he and his conspecifics face on a daily basis.

Yet despite all these challenges, NZ101 has travelled the equivalent of once around the earth (the circumference of the earth is approximately 40,000 km, NASA, 2018). In light of the distance data presented here and noting that Wells et al., (2013) has evaluated that rehabilitation in a facility can hinder the success of a cetacean intervention, the ability of any rehabilitation facility to be able to provide adequate space for a cetacean should be considered during any intervention decision-making. The small sizes of these facilities are likely one of the contributing factors to reduced success as realistically, no facility will ever be able to meet the daily travel requirement of any cetacean. For example, the largest tank holding orca in captivity is in the USA, at SeaWorld Texas, and it is only 70 m long (Harrison et al., 2017). It is used for commercial shows for the public display of orca, not for rehabilitation. Even if used for rehabilitation, it is approximately 250 km from the ocean and would require at least 2.5 hours of overland transport from the nearest beach.

In light of this assemblage of data, if rehabilitation is required for any cetaceans, we recommend the use of genuine seaside sanctuaries with sea pens, which would not only provide a more natural environment for the animals once their triage period and critical care is over, but also are built with larger areas than any concrete tanks currently provide. At the very least, genuine sanctuaries should be used for the rehabilitation transition period prior to release. Although we recognise that there are only a few sanctuaries for cetaceans currently in operation around the world, more are at various stages of development.

5. CONCLUSIONS

Within NZ, the effectiveness of rescuing stranded orca has been hugely successful, often eclipsing results elsewhere in the world. Yet, despite these encouraging examples, we have seen multiple events transpire since the rescue of NZ101, in which decisions to euthanise (or a disturbing trend of apathy) have prevailed, not only for orca but also for other cetacean species who require assistance at stranding, entanglements and other incidents. There are a number of key points that NZ101 and these other successfully rescued individuals illustrate and, although these should not be the only aspects considered during any intervention, they should feature in the decision-making process and influence the welfare for the animal(s) and the successful outcome of intervention;

1. Rescues should be conducted with the immediate and long-term welfare of the individual(s) given the utmost priority. To facilitate that, these events should be supervised by experienced personnel, while ensuring that species-specific experts are consulted and collaborated with at all times.

2. Euthanasia should only be conducted when it would be in the best interests for the animal and where there are no alternatives (i.e., not because of convenience or costs or other human-orientated aspects).

3. Cetaceans can be inflicted with extensive injuries and yet survive (and thrive) to have lives that reach milestones and achieve benchmarks (e.g., reaching maturity and producing offspring). Such injuries should not be the only determining factor regarding a decision to euthanise. Where feasible, intervention could instead include medication (e.g., pain killers and/or antibiotics).

4. Photo-ID should be a high priority at all incidents. Success or failure of interventions can only be determined through confirmation that individuals have survived. Photo-ID should also be conducted if an animal has died, as it may be possible to 'back-match' to an already known animal and thereby increase our understanding of the population.

5. Where possible, non-intrusive DNA sampling should be conducted during interventions (e.g., skin scrapings), as this may also help confirm later identification of individuals in instances where photographs are not suitable (e.g., a decomposed carcass).

6. Incidents should be reported as soon as possible to researchers to enable them to assist at events, advise on species-specific protocols and to facilitate the on-going monitoring of an individual, as well as to ascertain if there are any matches to known individuals.

7. Non-invasive tagging (such as suction-cup attachments, cotton tape around tail stocks, non-toxic paint) can be helpful for post-intervention monitoring. Although we recognise the value of data collected from longer-term tags (e.g., satellite tags attached with invasive methods such as bolts through dorsal fins), if the animal is already compromised during an intervention, such invasive methods may be the 'last straw' for the animal perhaps further compromising their already stressed systems. Therefore, we recommend that invasive type tagging be a last option and generally only applied after an animal is fully recovered from an incident.

For NZ specifically, at a country-wide and all-species level, it is apparent that the NZ Government's DOC should urgently update their Marine Mammal Action Plan (which is now more than 10 years out of date). To ensure robust, effective and appropriate actions are included and due diligence is applied, thorough consultations and collaborations with all stakeholders, including species-specific experts, should be incorporated. Our view is that DOC should be working urgently and closely with other Government Departments who oversee aquaculture and other habitat encroaching industries, in order to mitigate risks and better protect cetaceans, as per the requirements of Policy 11 of the NZCPS (which was published by the DOC).

Finally, the contributions to marine mammal research from stakeholders such as whale and dolphin watching companies, citizen scientists, Iwi (Māori tribes), NGO's, other operators on the water, as well as the public, is vital. Those contributions have immense value in platforms-of-opportunity research (Hupman et al., 2015), in targeted research (this chapter) and in long-term monitoring of individual animals and populations (e.g., Berghan & Visser, 2001; Hupman et al., 2019). As such, we strongly encourage contributors to take high-resolution (e.g., RAW files) images which improve the chances of matching individuals (Urian et al., 2014; Visser et al., 2020). As technology improves, the outcomes from such collaborations will continue to expand and therefore the information we can derive together will yield increasingly robust and compelling data.

We are confident that the case-study of NZ101 (aka Ben) is inspiring, as despite having stranded and also being a severely injured individual, he has not only survived but he has thrived as a member of the endangered NZ orca population. It is our belief that Ben has become part of a legacy that illustrates the values of rescues and of long-term data sets. His boat strike injury is a warning flag for the risks that these animals face, but as he has overcome these wounds, his story remains encouraging. As such, we are hopeful that Ben's life and what he has overcome will continue to raise awareness and to generate better protection for orca and their habitats, not only in NZ but also worldwide.

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REFERENCES

Aaris-Sørensen K., Rasmussen K.L., Kinze C.C. & Petersen K.S. 2010. **Late Pleistocene and Holocene whale remains (Cetacea) from Denmark and adjacent countries: Species, distribution, chronology, and trace element concentrations**. Marine Mammal Science. 26(2):253-281.

Andrews R.D., Pitman R.L. & Ballance L.T. 2008. **Satellite tracking reveals distinct movement patterns for Type B and Type C killer whales in the southern Ross Sea, Antarctica.** Polar Biology. 31:1461-1468.

Auger-Méthé M., Marcoux M. & Whitehad H. 2010. **Nicks and notches of the dorsal ridge: Promising mark types for the photo-identification of narwhals.** Marine Mammal Science. 26:663-678.

Baker A.N. 1983. **Whales and dolphins of New Zealand and Australia: An identification guide.** 1st ed. Victoria University Press, Wellington, New Zealand. 133 pp.

Baker C.S., Boren L., Childerhouse S., Constantine R., van Helden A., Lundquist D., Rayment W. & Rolfe J.R. 2019. **Conservation status of New Zealand marine mammals, 2019.** Department of Conservation, Wellington, New Zealand. 22 pp.

Bedriñana-Romano L., Hucke-Gaete R., Viddi F.A., Johnson D. & Zerbini A.N. 2021. **Defining priority areas for blue whale conservation and investigating overlap with vessel traffic in Chilean Patagonia, using a fast-fitting movement model.** Scientific Reports. 11(2709):1-16.

Berghan J. & Visser I.N. 2001. **Antarctic Killer Whale Identification Catalogue.** 14th Biennial conference on the biology of marine mammals; Page 22. Vancouver, Canada. November 28 - December 3, 2001.

Cates K., DeMaster D.P., Brownell R.L., Silber G.K., Gende S., Leaper R., Ritter F. & Panigada S. 2017. **Strategic plan to mitigate the impacts of ship strikes on cetacean populations: 2017-2020.** International Whaling Commission. 17 pp.

Copello J.M., Bellazzi G., Cazenave J. & Visser I.N. 2021. Chapter 1, **Argentinean orca (*Orcinus orca*) as an umbrella species: Conservation & management benefits.** In: Carvelho Mocellin V, Editor. Contributions to the global management and conservation of marine mammals. Editora Artemis, Curitiba, Brazil, 1-27.

Cozzi B., Huggenberger S. & Oelschlager H. 2016. **Anatomy of dolphins: Insights into body structure and function.** 1st ed. Academic Press, Amsterdam, Boston, Heidelberg, London, New York, Oxford, Paris, San Diego, San Francisco, Singapore, Sydney, Tokyo.

Dahlheim M.E., Shulman-Janiger A., Black N.A., Ternullo R.L., Ellifrit D.K. & Balcomb K.C. 2008. **Eastern temperate North Pacific offshore killer whales (*Orcinus orca*): Occurrence, movements, and insights into feeding ecology.** Marine Mammal Science. 24(3):719-729.

De Smet W.M.A. 1996. **Five centuries of sperm whale strandings along the Flemish coast**. Bulletin de l'Institut Royal Des Sciences Naturelles de Belgique Biologie. 67:11-14.

Department of Conservation. 2010. **New Zealand Coastal Policy Statement 2010 (under the Resource Management Act 1991).** Department of Conservation. Wellington, New Zealand. p. 28.

Dietz R., Rikardsen A.H., Biuw M., Kleivanee L., Lehmkuhl Noer C., Staldera D., van Beest, Floris M, Rigét F.F., Sonne, Christian, Hansen, Martin, Strager H. & Olsen M.T. 2020. **Migratory and diurnal activity of North Atlantic killer whales (*Orcinus orca*) off northern Norway.** Journal of Experimental Marine Biology and Ecology. 533:1-13.

Durban J.W. & Pitman R.L. 2011. **Antarctic killer whales make rapid, round-trip movements to subtropical waters: evidence for physiological maintenance migrations?** Biology Letters.(0875,):1-4.

Dwyer S.L. & Visser I.N. 2011. **Cookie cutter shark (*Isistius* sp.) bites on cetaceans, with particular reference to killer whales (orca) (*Orcinus orca*).** Aquatic Mammals. 37(2):111-138.

Felts W.J.L. 1966. Chapter 14, **Some functional and structural characteristics of cetacean flippers and flukes.** In: Norris KS, Editor. Whales, Dolphins and Porpoises. University of California, California, 255-396.

Felts W.J.L. & Spurrell F.A. 2005. **Structural orientation and density in cetacean humeri.** American Journal of Anatomy. 116(1):171 - 203.

Fish F.E. 2002. **Balancing requirements for stability and maneuverability in cetaceans.** Integrative and Comparative Biology. 42(1):85-93.

Fish F.E. & Rohr J.J. 1999. **Review of dolphin hydrodynamics and swimming performance.** United States of America Navy. Technical Report 1801. 193 pp.

Ford M.J., Hanson M.B., Hempelmann J.A., Ayres K.L., Emmons C.K., Schorr G.S., Baird R.W., Balcomb K.C., Wasser S.K., Parsons K.M. & Balcomb-Bartok K. 2011. I**nferred paternity and male reproductive success in a killer whale (*Orcinus orca*) population.** Journal of Heredity. 102(5):537-553.

Geraci J.R. & Lounsbury V.J. 2005. **Marine mammals ashore. A field guide for strandings.** 2nd ed. National Aquarium in Baltimore, Inc, Baltimore, USA. 371 pp.

Gordon D.P., Beaumont J., MacDiarmid A., Roberston D.A. & Ahyong S.T. 2010. **Marine biodiversity of Aotearoa New Zealand.** PLoS ONE. 5(8):e10905 (pages 10901-10917).

Greenfield M.R., McHugh K.A., Wells R.S. & Rubenstein D.I. 2021. **Anthropogenic injuries disrupt social associations of common bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida.** Marine Mammal Science. 37(1):1-16.

Harrison L.E., Wolf J. & Visser I.N. 2017. **Orca Tanks. The mathematics of scale.** Orca Research Trust, Tutukaka, New Zealand. 1 pp.

Hewlett G. & Francis D. 2007. **Operation Orca. Springer, Luna and the struggle to save West Coast killer whales.** Harbour Publishing, 280 pp.

Hupman K., Visser I.N., Fyfe J., Cawthorn M.W., Forbes G., Grabham A.A., Bout R., Mathais B., Benninghaus E., Matucci K., Cooper T., Fletcher L. & Godoy D. 2019. **From Vagrant to Resident: Occurrence, residency and births of leopard seals (*Hydrurga leptonyx*) in New Zealand waters.** New Zealand Journal of Marine and Freshwater Research. 54(1):1-23.

Hupman K., Visser I.N., Martinez E. & Stockin K.A. 2015. **Using platforms of opportunity to determine the occurrence and group characteristics of orca (*Orcinus orca*) in the Hauraki Gulf, New Zealand.** New Zealand Journal of Marine and Freshwater Research. 49(1):132-149.

Jefferson T.A., Webber M.A. & Pitman R.L. 2015. **Marine mammals of the world. A comprehensive guide to their identification.** 2nd ed. Academic Press (Elsevier), Amsterdam. 608 pp.

Kutlu N. & Svedman P. 1992. **The superficial dermal microcirculation in suction blister wounds on healthy volunteers.** Vascular Surgery. 26(3):200-212.

Lampen F. 2020. **Evidence of Fraser Lampen on behalf of Appellant. Dated 25 September 2020.** Before the Environment Court Auckland Registry. ENV-2020-AKL-000051. In the matter of the Resource Management Act 1991 (the Act) and the in the matter of an appeal under section 120 of the Act between Warwick Sutherland Wilson Appellant and Waikato Regional Council Respondent and Ohinau Aquaculture Limited Applicant. 8 pp. + Appendices.

Lauriano G., Eisert R., Panigada S., Ovsyanikova E., N, Visser I.N., Ensor P.H., Currey R., Sharp B. & Pinkerton M. 2015. **Activity, seasonal site fidelity, and movements of Type-C killer whales between the Ross Sea (Antarctica) and New Zealand.** 19-30 October. Convention on the Conservation of Antarctic Marine Living Resources; Hobart, Tasmania , Australia.

Marino L., Rose N.A., Visser I.N., Rally H.D., Ferdowsian H.R. & Slootsky V. 2019. **The harmful effects of captivity and chronic stress on the well-being of orcas (*Orcinus orca*).** Journal of Veterinary Behavior. 35: 69-82.

Mate B.R. 1989. **Satellite-monitored radio tracking as a method for studying cetacean movements and behaviour.** Reports of the International Whaling Commission. 39:389-291.

Matthews C.J., Luque S.P., Petersen S.D., Andrews R.D. & Ferguson S.H. 2011. **Satellite tracking of a killer whale (*Orcinus orca*) in the eastern Canadian Arctic documents ice avoidance and rapid, long-distance movement into the North Atlantic.** Polar Biology. 34(7):1091-1096.

McHugh K.A., Barleycorn A.A., Allen J.B., Kim B.-H., Lovewell G.N., Boyd D., Panike A., Cush C., Fauquier D.A., Mase B., C L.R., Greenfield M.R., Rubenstein D.I., Weaver A., Stone A., Oliver L., Morse K. & Wells R.S. 2021. **Staying alive: Long-term success of bottlenose dolphin interventions in Southwest Florida.** Frontiers in Marine Science. 7:1-16.

Moore M., Andrews R., Austin T., Bailey J., Costidis A., George C., Jackson K., Pitchford T., Landry S., Ligon A., McLellan W., Morin D., Smith J., Rotstein D., Rowles T., Slay C. & Walsh M. 2013. **Rope trauma, sedation, disentanglement, and monitoring-tag associated lesions in a terminally entangled North Atlantic right whale (*Eubalaena glacialis*).** Marine Mammal Science. 29(2):E98-E113.

NASA. 2018. **Solar system exploration. Earth by the numbers.** Planetary Science Division. Online multimedia. https://solarsystem.nasa.gov/planets/earth/by-the-numbers/
(Archived Feb 2021; https://archive.is/47bLF).

Nawojchik R., St. Aubin D.J. & Johnson A. 2003. **Movements and dive behaviour of two stranded, rehabilitated long-finned pilot whales (*Globicephala melas*) in the Northwest Atlantic.** Marine Mammal Science. 19(1):232-239.

Neumann D.R., Leitenberger A. & Orams M.B. 2002. **Photo-identification of short-beaked common dolphins (*Delphinus delphis*) in the north-east New Zealand: A photo-catalogue of recognisable individuals.** New Zealand Journal of Marine and Freshwater Research. 36:593-604.

Neves M.C., Neto H.G., Cypriano-Souza A.L., da Silva B.M.G., de Souza S.P., Marcondes M.C.C. & Engle M.H. 2020. **Humpback whale (*Megaptera novaeangliae*) resighted eight years after stranding.** Aquatic Mammals. 46:483-487.

New Zealand Government. 2019. **The New Zealand Government Aquaculture Strategy.** Ministry for Primary Industries NZ. Wellington, New Zealand. 20pp.

Norberg B., Barre L., Whaley J., Rowles T., Joyce M., Foster J., Wright C., Jeffries S. & Maynard D. 2003. **Rescue, rehabilitation and release of a wild orphaned killer whale calf in the Pacific Northwest.** NOAA Fisheries, Canada. 40 pp.

Olesiuk P.F., Ellis G.M. & Ford J.K.B. 2005. **Life history and population dynamics of northern resident killer whales (*Orcinus orca*) in British Columbia.** Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, British Columbia, Canada. Report Number 2005/045. 1-81 pp.

Pavlov V.V. 2003. **Wing design and morphology of the harbour porpoise dorsal fin.** Journal of Morphology. 258:284-295.

Riding H., Priovolos G. & Roberts J. 2016. **New Zealand hydrographic risk assessment - Synopsis.** Report Number 15NZ326-D. Issue No. 2. Marico Marine, Wellington, New Zealand. 44 pp.

Schroeder J.P., Wood B. & Bain D.E. **2007. A73/ Springer health evaluation, November, 2007.** Global Research and Rescue, Seattle, Washington. 13 pp.

Shelden K.E.W., Rugh D., Mahoney B.A. & Dahlheim M.E. 2003. **Killer whale predation on belugas in Cook Inlet, Alaska: Implications for a depleted population.** Marine Mammal Science. 19(3):529-544.

St. Aubin D.J., Geraci J.R. & Lounsbury V.J. 1996. **Rescue, rehabilitation, and release of marine mammals: An analysis of current views and practices.** Proceedings of a Workshop held in Des Plaines, Illinois, 3-5 December 1991. 68 pp.

Stockin K.A. & Visser I.N. 2005. **Anomalously pigmented common dolphins (*Delphinus* sp.) off northern New Zealand.** Aquatic Mammals. 31(1):43-51.

Sugarman P. 1984. **Field guide to the orca whales of Greater Puget Sound and Southern British Columbia.** The Whale Museum, Friday Harbor, Washington. 26 pp.

Suisted R. & Neale D. 2004. **Department of Conservation marine mammal action plan for 2005-2010.** Department of Conservation, Wellington, New Zealand. 89 pp.

Towers J.R., Keen E.M., Balcomb-Bartock K., Vonick J. & Davis D. 2020a. **Live strandings of Bigg's killer whales (*Orcinus orca*) along the West Coast of North America.** Aquatic Mammals. 46(5):466-477.

Towers J.R., Pilkington J.F., Gisborne B., Wright B.M., Ellis G.M., Ford J.K.B. & Doniol-Valcroze T. 2020b. **Photo-identification catalogue and status of the Northern Resident killer whale population in 2019.** Canadian Technical Report of Fisheries and Aquatic Sciences. Report Number 3371. 77pp.

Towers J.R., Tixier P., Ross K.A., Bennett J., Arnould J.P.Y., Pitman R.L. & Durban J.W. 2018. **Movements and dive behaviour of a toothfish-depredating killer and sperm whale.** ICES Journal of Marine Science. 76(1):1-14.

Townsend A.J., de Lange P.J., Duffy C.A.J., Miskelly C.M., Molloy J. & Norton D.A. 2008. **New Zealand threat classification system manual.** Department of Conservation, Science & Technical Publishing, Wellington, New Zealand. 35 pp.

Urian K., Gorgone A., Read A., Balmer B., Wells R.S., Berggren P., Durban J.W., Eguchi T., Rayment W. & Hammond P.S. 2014. **Recommendations for photo-identification methods used in capture-recapture models with cetaceans.** Marine Mammal Science. 31(1):298-321.

Vernazzani B.G., Cabrera E. & Brownell R.L.J. 2013. **Eastern South Pacific southern right whale photo-identification catalog reveals behavior and habitat use patterns.** Marine Mammal Science. 30(1):389-398.

Visser I.N. 1999a. **Antarctic orca in New Zealand waters?** New Zealand Journal of Marine and Freshwater Research. 33:515-520.

Visser I.N. 1999b. **Benthic foraging on stingrays by killer whales (*Orcinus orca*) in New Zealand waters.** Marine Mammal Science. 15(1):220-227.

Visser I.N. 1999c. **Propeller scars and known migration of two orca (*Orcinus orca*) in New Zealand waters.** New Zealand Journal of Marine and Freshwater Research. 33(4):635-642.

Visser I.N. 2000. **Orca (*Orcinus orca*) in New Zealand waters.** PhD Thesis. Auckland: University of Auckland, 194 pp.

Visser I.N. 2008. **Boats around orca.** February 2008. Boating New Zealand. New Zealand. p. 88-90.

Visser I.N. 2013. **Long-term survival of stranded & rescued New Zealand orca (*Orcinus orca*).** Society of Marine Mammalogy; 9-13 December; Dunedin, New Zealand.

Visser I.N. 2020. **Evidence of Ingrid Natasha Visser on behalf of Appellant.** Dated 28 September 2020. Before the Environment Court Auckland Registry. ENV-2020-AKL-000051. In the matter of the Resource Management Act 1991 (the Act) and the in the matter of an appeal under section 120 of the Act between Warwick Sutherland Wilson Appellant and Waikato Regional Council Respondent and Ohinau Aquaculture Limited Applicant. 55pp + Appendices.

Visser I.N. & Cooper T.E. 2020a. **It's not black and white: Orca ecotypes in New Zealand.** 5th World Conference on Marine Biodiversity; 13-16 December 2020; Auckland, New Zealand.

Visser I.N. & Cooper T.E. 2020b. **Orca Research Trust Guide to New Zealand Orca.** Black and White Fish Publications, Tutukaka, New Zealand. 40 pp.

Visser I.N., Cooper T.E. & Grimm H. 2020. **Duration of pseudo-stalked barnacles (*Xenobalanus globicipitis*) on a New Zealand Pelagic ecotype orca (*Orcinus orca*), with comments on cookie cutter shark bite marks (*Isistius* sp.); can they be used as biological tags?** Biological Diversity. 11(4):1067-1086.

Visser I.N. & Fertl D.C. 2000. **Stranding, resighting and boat strike of a killer whale (*Orcinus orca*) off New Zealand.** Aquatic Mammals. 26(3):232-240.

Visser I.N., Halliday J., Foster J., Foster K. & Cooper T. 2017. **Welfare vs Politics. Lone orca calf denied humane intervention: A New Zealand case study.** 3rd International Compassionate Conservation Conference; Blue Mountains, Sydney, Australia.

Visser I.N. & Hupman K. 2018. **High incidence of boat strikes on orca (*Orcinus orca*) in New Zealand waters.** Society of Conservation Biology (Oceania); Wellington, New Zealand.

Visser I.N. & Mäkeläinen P. 2000. **Variation in eye-patch shape of killer whales (*Orcinus orca*) in New Zealand waters.** Marine Mammal Science. 16(2):459-469.

Wells R.S., Fauquier D.A., Gulland F.M.D., Townsend F., I & DiGiovanni R.A.J. 2013. **Evaluating postintervention survival of free-ranging odontocete cetaceans.** Marine Mammal Science. 29(4):E463-E483.

Winkler C., Panigada S., Murphy S. & Ritter F. 2020. **Global numbers of ship strikes: An assessment of collisions between vessels and cetaceans using available data in the IWC ship strike database.** Report to the International Whaling Commission, IWC/68/SC HIM09. 33 pp.

Wright B., Ford J.K.B., Ellis G.M. & Stredulinsky E. 2016. **Kin-directed food sharing promotes lifetime natal philopatry of both sexes in a population of fish-eating killer whales, *Orcinus orca*.** Animal Behavior. 115:81-95.

Zagzebski K.A., Gulland F.M.D., Haulena M., Lander M.E., Greig D.J., Gage L.J., Hanson M.B., Yochem P.K. & Stewart B.S. 2006. **Twenty-five years of rehabilitation of odontocetes stranded in Central and Northern California, 1977 to 2002.** Aquatic Mammals. 32(3):334-345.

Zimmerman S. 1991. **A history of marine mammal stranding networks in Alaska, with notes on the distribution of the most commonly stranded cetacean species, 1975 - 1987.** Marine mammal strandings in the United States: Proceedings of the 2nd Marine Mammal Stranding Workshop; Miami, Florida.

ABOUT THE ORGANIZERS

Ingrid N. Visser

Ingrid has had a passion for cetaceans since she was a child. She gained her first University degree, in Zoology, after having spent her teenage years sailing around the world. This was soon followed by a Masters degree also in Zoology. When she started her PhD in Environmental and Marine Science, with the topic of the New Zealand coastal orca, she founded the Orca Research Trust. That non-profit continues to this day and is the foundation for the data collected in Chapter 6. Her research has featured in a number of documentaries, for companies such as BBC, National Geographic, Discovery Channel. Ingrid has observed more than half of the worlds marine mammals and visited all seven continents in her quest to learn more about these fascinating animals. She has published more than 30 scientific articles, along with numerous popular-style articles for wildlife magazines and children's books and an autobiography. Since 2010 she has divided her time between working with wild cetaceans and advocating for those in captivity (see Chapter 5). As part of that work, Ingrid has observed 15 different species of cetaceans (plus other marine mammals; i.e., pinnipeds, sirenians, marine otters and polar bears), in 50 facilities around the world. She has appeared as an expert witness in Environmental and High Courts, as well as before Governments who are investigating the issues of keeping marine mammals in captivity. As part of her conservation work, she has founded (or co-founded) seven non-profit organisations, all with a focus on marine mammals, such as Punta Norte Orca Research (Chapter 1) and Whale Rescue (Chapter 6).

Jorge Cazenave

Jorge started his professional career as a lawyer in Argentina, however after 10 years in this field he switched to tourism. He co-founded (and was President of) Agricultural Tour Operators International and was on the board of the National Tour Association, both whilst photographing wildlife. As an experienced naturalist, he currently guides guests to view and photograph wildlife around the world, specialising in apex predators such as puma, jaguar and orca. His expertise is sought after by documentary making companies such as the BBC, ZED and National Geographic. Since 2001, Jorge has been photographing the unique orca of Punta Norte on the remote Península Valdés, Argentina (see Chapter 1), who exhibit a range of unique behaviours including intentionally stranding to capture sea lion pups. His work with conservation extends to include collaboration with several projects in different regions of Argentina, including Punta Norte Orca Research, of which he is a board member.

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