

# To move or not? Tourists' perceptions and management considerations of a beached whale carcass in a South African national park and marine protected area

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The handling of beached cetacean carcasses requires social, legal, financial, ecological and logistical considerations. However, limited research on the topic hinders informed decision-making. A large humpback whale carcass that washed ashore at a South African marine protected area (MPA) provided an opportunity to gain insight into tourists' perspectives on carcass management within a national park and MPA setting. Eighty tourists were interviewed, and a thematic analysis approach was adopted to identify key themes and quantify the responses. Chi-square tests of independence were used to determine (i) whether the respondents' views on cetacean carcass management were dependent on their knowledge of the site's MPA designation, and (ii) whether the provision of contextual information would influence the respondents' perceptions. Tourists had mixed responses to whale carcass management, with half the respondents indicating that the carcass should be left to decompose naturally. Viewpoints were significantly influenced when context and information on the decision-making process were provided, with more respondents stating that no management intervention should be necessary. We propose a simple flow-diagram as a decision-support tool, which, in combination with spatial zonation maps to identify applicable management options, will help guide decision-making for management authorities. Inclusivity, transparency and consultation with experienced role-players from multiple agencies will provide legitimacy to the final management decisions.

**Keywords:** coastal management, decision support, interviews, marine mammal disposal, *Megaptera novaeangliae*, social-ecological research, Tsitsikamma MPA

## Introduction

Baleen whales (Mysticeti) and sperm whales *Physeter macrocephalus* are collectively known as the 'great whales' of generally >10 m in length and weighing between 5 and >160 tonnes. These marine mammals consist largely of lipids and proteins (Smith 2006), and when dead are a rich source of nutrients in the marine or coastal environment. Most whale carcasses typically sink to the seafloor (Smith 2006), providing large pulses of organic enrichment and supporting diverse and dynamic biotic assemblages (Lundsten et al. 2010). Carcasses that wash up onto shorelines transport marine biomass to the sea–land interface (Roman et al. 2014) and are a potential source of food for both marine and terrestrial scavengers (e.g. Polis and Hurd 1996; Schlacher et al. 2013; Laidre et al. 2018). However, given that some whale populations have been recovering from commercial whaling and exploitation over the last century (Meyer et al. 2011; Tulloch et al. 2018), whale carcass management is becoming an increasingly important concern for coastal management authorities (Tucker et al. 2018).

The beaching of cetacean (whale, dolphin or porpoise) carcasses is a naturally occurring phenomenon and an

integral component of coastal ecosystems, which provides an array of ecosystem services (Moleón et al. 2014; Quaggiotto et al. 2022). However, an increase in coastal development and use (Neumann et al. 2015) has resulted in a concomitant increase in community pressure for carcass removal owing to various health and safety concerns (Tucker et al. 2018). Issues include the potential transfer of communicable diseases (Waltzek et al. 2012), possible increased shark activity in the adjacent surf zone, and the unpleasant sight and smell associated with decaying carcasses (Tucker et al. 2018). The management of stranded carcasses depends on multiple factors which can become complex, since various technical, social, economic and environmental aspects must be considered (Olbers et al. 2017; Tucker et al. 2018). However, limited research on the topic hinders informed decision-making, with management authorities relying more on anecdotal evidence and social pressures (Tucker et al. 2018). Additionally, each instance of a beached carcass requires a unique set of factors to be considered depending on the location, conditions and relevant management authority.

In remote locations and areas where public health risks are minimal, allowing natural decomposition *in situ* is generally advocated (Olbers et al. 2017; Tucker et al. 2018; Quaggiotto et al. 2022). Similarly, enabling natural processes like decomposition and scavenging to occur is preferable within proclaimed marine protected areas (MPAs). However, pressure for management intervention could occur if an MPA is bordered by municipal land or when the carcass washes up in an area zoned for tourism activities. A large whale carcass that washed up at Tsitsikamma MPA on the south coast of South Africa illustrated this point and provided an opportunity to gain a greater understanding of tourists' perspectives on whale carcasses and whale carcass management within a national park and MPA setting. Specific objectives included: (i) determining the perceptions of tourists in relation to carcass management; (ii) measuring the influence of additional information and context on visitor perspectives; and (iii) developing a decision-support tool to assist management decisions based on experiences learned during the event. In addition, the duration of the decomposition process was observed and recorded as a key component for managing the disruption of tourism activities.

The results of this study provide unique insight into the complex stakeholder interactions required following the beaching of a large marine mammal. Covering ecological, economic and social perspectives, the proposed generic decision-support tool is intended to help guide management authorities in a range of contexts.

## Materials and methods

### Context

On 27 September 2019, a dead adult humpback whale *Megaptera novaeangliae* washed ashore within the Tsitsikamma MPA in the vicinity of the Storms River mouth (Figure 1). Falling within the Garden Route National Park under the management of South African National Parks (SANParks), this area encompasses various tourist facilities, including campsites and chalets, a restaurant, parking area, day-picnic area, and a popular coastal hiking trail that includes a suspension bridge traversing the Storms River mouth. Furthermore, an adventure company holds a concession to run various water-based activities, including snorkelling, SCUBA diving, and kayak and lilo trips.

As soon as the carcass washed ashore, SANParks tourism management and the concessionaire raised concerns about the potential negative impact on tourism and a consequent decrease in tourism revenue. Even though much of the debate revolved around potential disruption to tourism, no formal complaints or concerns were raised by tourists at the time.

Following a site assessment undertaken by SANParks (scientific services, park and tourism management representatives), management options were considered with input from the concessionaire and several other relevant stakeholders, including: a local marine stranding network; national government through the Department of Forestry, Fisheries and the Environment (DFFE): Branch Oceans and Coasts; and local representatives from the National Sea Rescue Institute (who are often requested to tow

whale carcasses offshore if they pose a risk to humans). The carcass (~11–12 m long, weighing ~22–25 tonnes) (cf. Best 2007) was found wedged in a rocky gully but was being rolled by wave action. Removal by sea was deemed hazardous, while the steep terrain, forest vegetation, slippery rocks and surf meant it was not feasible to either cut up, remove by land or burn the carcass. A collective decision was made to therefore monitor the carcass and leave it to decompose naturally. Owing to safety concerns regarding increased shark activity, recommendations to the concessionaire included that: (i) diving and snorkelling tours should be temporarily halted; (ii) an observer should be placed at a strategic vantage point to look for signs of shark activity during any kayak trips; and (iii) the kayak trips should start from above the Storms River suspension bridge and proceed up the gorge to circumvent kayaking on the open ocean adjacent to the carcass (Figure 1).

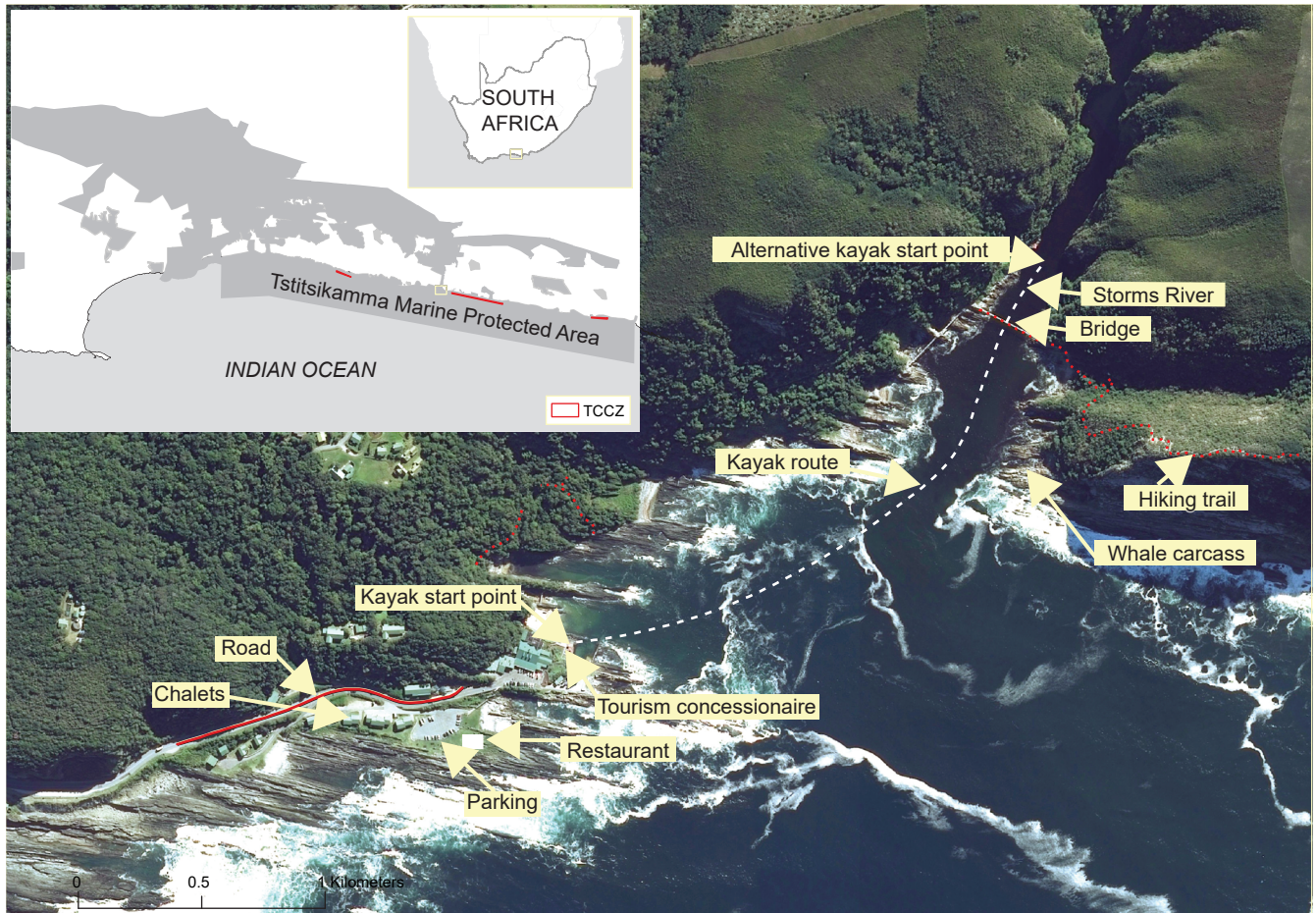
### Tourist interviews

Interviews were conducted over 3 days, within one week of the carcass washing ashore. Most interviews were undertaken at the start of the hiking trail (Figure 1), but to increase the representation of overnight visitors a survey clerk also moved through the Storms River rest camp. Tourists were randomly selected and approached, and the study was explained. Consent forms were signed prior to any questions being asked. No minors (age <18 years) were approached, and all interviews were confidential, voluntary and anonymous, with no personal data recorded. Although only one person was approached at a time, occasionally an interviewee's companion would be in attendance and would also offer an opinion. In these situations, only the responses from the individual initially approached were noted although it is possible that these were influenced by the companion. The unexpectedness of the event and the short time-frames available meant that a pilot study of the interviews (as recommended by White et al. [2005]) could not be conducted. Interviews consisted of a set of 12 questions and included both Yes/No responses and open-ended qualifications. Care was taken to ensure that questions were asked in an identical manner and could be freely answered with no prompt or influence by the questioner, and were accurately captured. To assess whether the provision of more information and greater context around the whale carcass influenced tourists' views, interviewees were asked about their viewpoints on carcass management both before and after being provided with a one-page flyer describing the situation, steps taken, and rationale for the current management option (Appendix). A total of 80 interviews were conducted, involving 62 day-time and 18 overnight visitors; 55 were international visitors and 25 were from South Africa (national).

Later, after the whale carcass had disintegrated, the concessionaire was asked to provide feedback on: (i) how the carcass had impacted the business and tourism product experience; and (ii) engagement with the management authority and how the process could have been handled differently.

### Analysis

For each of the open-ended questions, a thematic analysis approach was adopted based on Braun and



**Figure 1:** Location of the beached humpback whale carcass at Tsitsikamma Marine Protected Area on the southeast coast of South Africa, shown in relation to different tourism infrastructure and activities. TCCZ = Tsitsikamma Coastal Control Zone

Clarke (2006). Briefly, response themes were first identified, and then independently quantified based on the number of times a particular response theme was reported. The primary researcher (MKSS) and third author (MMM) initially coded the themes independently. Any differences in coding were then discussed between all authors and a consensus was reached. A Chi-square test of independence was used to determine: (i) whether respondents' views on carcass management options were related to their awareness of the MPA, with respondent views coded as 'intervene' (remove the carcass), 'no intervention' (allow natural process), 'both' (indicating that both no intervention and intervention could occur) or 'don't know' (unsure or no opinion); (ii) whether respondents' views on carcass management options changed when they were provided with more contextual information, with changes in response placed into one of eight categories: 1 = 'no intervention' to 'intervene'; 2 = 'no intervention' remained 'no intervention'; 3 = 'intervene' to 'no intervention'; 4 = 'intervene' remained 'intervene'; 5 = 'both' remained 'both' (context specific); 6 = 'don't know' to 'no intervention'; 7 = 'don't know' remained 'don't know'; 8 = 'intervene' to 'don't know'. Chi-square tests of independence were undertaken using the R Statistical

Software base package 4.1.2 (R Core Team 2021). Statistical significance was set at  $p < 0.05$ .

#### **Carcass decomposition**

Notes on the state of the carcass, its position, associated avifauna and any other prominent observations were recorded on nine occasions over a 70-day period. Avifauna observations were undertaken on approach to the carcass and from a short distance away to minimise disturbance. Observation days were not evenly spaced but occurred on an opportunistic and *ad hoc* basis.

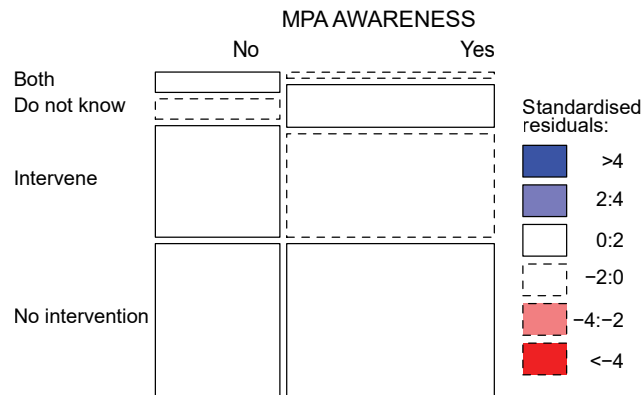
#### **Decision-support tool development**

A simple decision-support tool was developed to assist authorities in managing the beaching of a large whale carcass. This was developed by considering recommendations in the published literature (i.e. Tucker et al. 2018; Quaggiotto et al. 2022), relevant South African governance documents, and the experience gained from the humpback whale stranding in the Tsitsikamma MPA dealt with in this study. The flow-diagram should enable responders to follow correct procedures and allow all factors to be considered when determining the correct course of management action.

**Results**

**Awareness of MPA and additional information on tourists' views of carcass management**

Of the 80 respondents, 73% knew what an MPA was and 62% were aware they were visiting an MPA. The Chi-square test of independence indicated that respondents' views on whether park management should intervene and remove the carcass were not significantly affected by their knowledge or awareness of the National Park-MPA ( $\chi^2_{(3, 80)} = 2.023, p = 0.568$ ) (Figure 2).



**Figure 2:** Mosaic plot showing the relationship between respondents' awareness of the Tsitsikamma Marine Protected Area (MPA) and whether the park officials should intervene or not in removing a beached whale carcass. Plot widths and lengths are proportional to the respondents' MPA awareness and support for intervention, respectively, whereas colours represent positive (blue) and negative associations (red). We found no significant relationship in this analysis. 'Both' refers to respondents who expressed views that the carcass should be left unless there were mitigating factors for its removal (e.g. "Leave it, but if tourists have a problem, then move it")

Half the participants (50%) initially said that no intervention should take place and that the carcass should be left for natural processes to occur, 11% were unsure (with one respondent indicating they would leave the decision to experts), and three participants said it would depend on the context, citing both no intervention and intervention as an option (Tables 1, 2). Of the 35% that indicated management should intervene (removal of some sort), the top-three reasons given were for purposes of research, the carcass eliciting negative emotions, and an aversion to the smell generated during decomposition.

After providing the participants with background information and explaining the decision-making process required for management (see Appendix), 54% of participants who had previously indicated management should intervene changed their opinion to 'no intervention' (Table 2). Observed responses were significantly different to expected responses ( $\chi^2_{(12, 80)} = 56.401, p < 0.001$ ) after participants had read the background information, indicating that it had a significant influence on their views about whale carcass management (Figure 3). More participants were initially unsure ('don't know') and remained unsure (category 7) than was expected by chance, although more than expected changed their view to 'no intervention' (category 6). For those who thought management should intervene, there were more participants that (i) changed from 'intervene' to 'no intervention' (category 3), and (ii) still thought the park should intervene after more context was provided than was expected by chance. Lastly, more participants than would be expected by chance, who initially stated that no intervention was necessary, still chose 'no intervention' after more context was provided.

**Tourists' sentiments towards the carcass**

Most tourists (83%) were unaware of the dead whale at the time of the interview. While 98% indicated that knowledge of the whale carcass would not have influenced their decision to

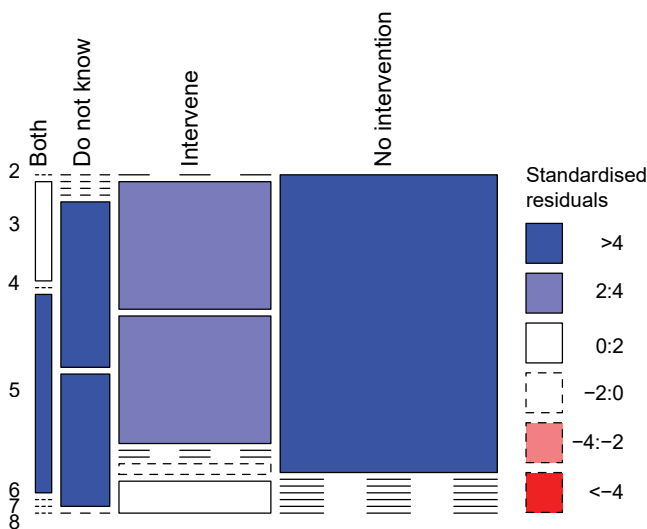
**Table 1:** Categories used when coding respondents' views on cetacean carcass management in the Tsitsikamma Marine Protected Area, South Africa

Category	Before providing context	After providing context	Change in opinion
1	No intervention	Intervene	Yes
2	No intervention	No intervention	No
3	Intervene	No intervention	Yes
4	Intervene	Intervene	No
5	Both intervention and no intervention	Both intervention and no intervention	No
6	Don't know	No intervention	Yes
7	Don't know	Don't know	No
8	Intervene	Don't know	Yes

**Table 2:** Proportion of respondents who changed their response after context was provided regarding management of a whale carcass washed ashore at Tsitsikamma MPA, South Africa

Type of management action required	Proportion pre-context	Proportion post-context
Both intervention and no intervention actions are applicable	3.75%	2.5%
Don't know/unsure	11.25%	10%
Intervene	35%	15%
No intervention	50%	72.5%

## CHANGE IN VIEWS AFTER EXPLAINING THE CONTEXT



**Figure 3:** Mosaic plot showing the relationship between respondents' viewpoints on whale carcass management prior to, and after receiving more information (context). Plot widths and lengths are proportional to respondents' views before and after they were provided with additional information, respectively; colours represent positive (blue) and negative (red) associations

visit, there were some caveats, with respondents indicating that should the carcass have washed out directly in front of the rest camp or restaurant their plans to visit or stay might have changed. Just over half the respondents (53%) were interested in seeing the carcass out of 'curiosity', and in particular they expressed 'a desire to see the size of the whale' as their main motivation. Sample responses were: "Just to see it close up. Get a perception of the real length and size"; "Would be interesting, impressive to see something so big"; and "Not just to see the carcass, but to understand the size". For those who were not interested in seeing the carcass (41%), the majority of reasons revolved around negative emotions associated with or aversion to seeing dead animals; for example "I don't like to see dead animals"; "Sad to see a whale carcass"; and "I don't want to see dead animals or animals in distress".

After being shown a photograph (Figure 4a) of the whale carcass, 66% of respondents indicated negative feelings (e.g. feeling sad or bad), 33% indicated they wanted to know more (in particular the cause of death), 15% said they felt no particular feeling as it was natural for animals to die, 5% indicated positive feelings (e.g. fascinating or good), and 4% were unsure of their feelings. Some respondents had multiple sentiments, such as "Bit sad, never nice to see dead things. Want to know what happened".

### Concessionaire

Regarding the change in the tourist product experience, the concessionaire indicated that only a few complaints from clients were received, largely related to them not being able to participate in the ocean kayaking experience. However, once the situation was explained to the clients, they seemed understanding and accepting of the alternative

Storms River trip. The concessionaire's main concern had been the length of time it would take the carcass to break up/decompose, but they were pleasantly surprised by how rapidly this occurred (see section below). Finally, the concessionaire commended the management authority for early and regular engagement throughout the process and appreciated being included in the decision-making process. No alternatives on how the process could have been handled were offered.

### Decomposition

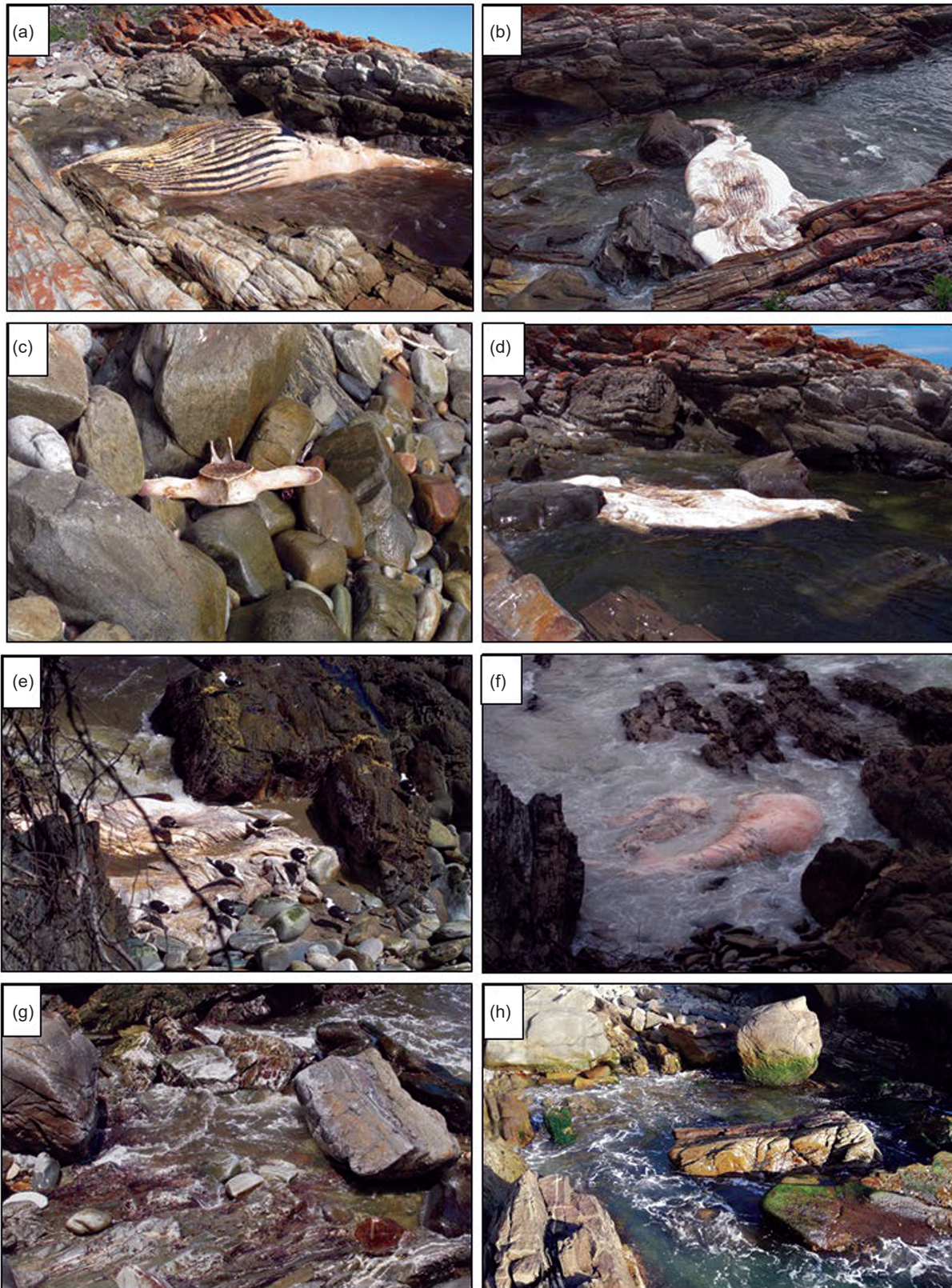
When the carcass washed ashore (day 0) it was intact and the whale was considered to have died recently because of no smell, intact skin and minimal bloating. Carcass deterioration was monitored *ad hoc* over a period of 70 days (Table 3). Between days 1 and 7, deterioration was minimal; but by day 20, bones were washing up on the adjacent shoreline, and although the body retained its shape, including the pectoral fins and tail flukes, it resembled that of a very large 'calamari tube' (i.e. squid body), moulding around the rocks as the waves moved it (Figure 4b). Over the next 18 days, the carcass deteriorated more rapidly, and pieces of bone (Figure 4c) and baleen washed out farther from the carcass (~100 m). On day 29, a large shoal of fish was noted feeding in the gully where the carcass was lying. No fish were caught, but were visually identified as belonging to the family Mugilidae. It was clear that the fish were feeding on floating particles, which we assume included pieces of the carcass. Between days 29 and 32 (Figure 4e), the carcass was moved by wave action to an adjacent gully, following which minimal change occurred between days 32 and 38 (Figure 4f). Unfortunately, no further observations were undertaken until 10 December 2019 (70 days after beaching), at which point time bones were the only remaining evidence of the whale carcass. This was also the first time that green algae were observed growing on the rocks that had been covered in white fatty deposits from the decomposing whale (Figure 4g,h).

### Decision-support tool flow-diagram

Based on our experience regarding the complexity of dealing with a large whale carcass in an MPA in South Africa, the proposed simple flow-diagram is a decision-support tool that aims to streamline and guide decision-making in a similar situation (Figure 5). The process begins with identifying whether the carcass falls within a protected area, as the legislation and governance structures in South Africa differ greatly from non-protected areas as well as among provinces and municipalities. Subsequently, the proximity to populated areas must be determined, followed by a site assessment and risk analysis involving various situation-specific factors. These are broadly grouped into technical, economic, legislative, social and environmental considerations. Early involvement of relevant stakeholders enables a shared learning experience and is encouraged. The factors listed in Figure 5 are not exhaustive and will vary depending on the specific situation.

### Discussion

Increasingly, beached whale carcasses require some form of management intervention with carcasses being removed,



**Figure 4:** Photographs relating to the decomposition of a humpback whale carcass washed ashore at the Tsitsikamma MPA on 27 Sep 2019: (a) the carcass on 2 Oct and (b) 18 Oct 2019; (c) bones washed up on the shoreline directly above the carcass (18 Oct); (d) carcass on 24 Oct; (e) carcass on 1 Nov after having shifted to a different gully; (f) last piece of the whale carcass, recorded on 7 Nov; (g) the original gully where the whale had washed up, showing the white residue of lipids on the rocks and a lack of green algal growth; (h) green algae growing on the rocks that were initially bare but with white residue

**Table 3:** Timeline with notes on the decomposition of a large humpback whale *Megaptera novaeangliae* that washed ashore in the Tsitiskamma Marine Protected Area, South Africa, in 2019. (Observations were completed on an *ad hoc* basis owing to travel distances)

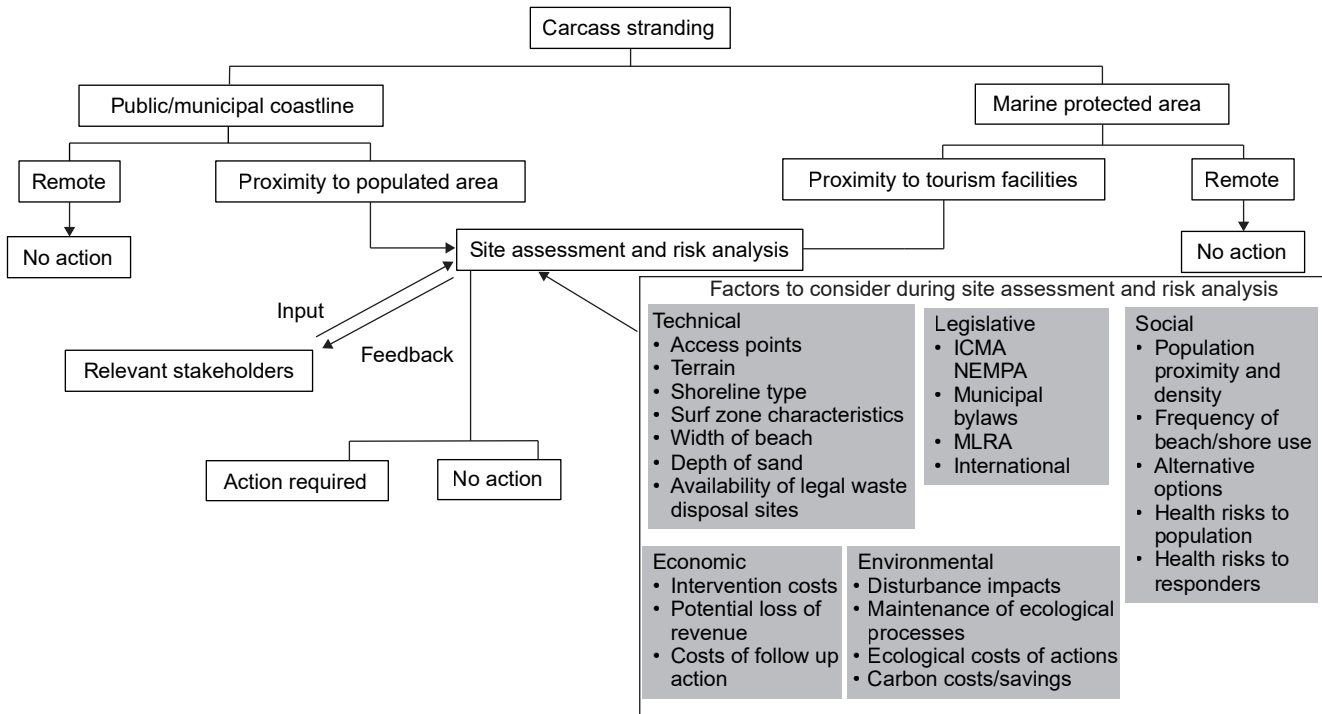
Date	Days after beaching	Observations
29 Sep	0	Whale carcass washed up in the vicinity of Storms River mouth.
2 Oct	4	Whale carcass intact, but a few shark bite marks observed; lying on its dorsal side in a gully and rolling slightly in the swell. Estimated length 11–12 m; estimated weight: 22–25 tonnes. Very little smell, only noticeable when standing above and downwind of the carcass. Avifauna observed: 4 kelp gulls <i>Larus dominicanus</i>
5 Oct	7	Whale carcass still intact; not much physical change and not much smell while standing near the carcass. Avifauna observed: 45 kelp gulls; 2 white-breasted cormorants <i>Phalacrocorax carbo</i> .
18 Oct	20	Noticeable physical deterioration of the carcass, but still not much smell. Some bones lying on the rocky shoreline directly above the carcass. Carcass still retains its whale shape, including tail flukes and fins, but resembles a ‘calamari’ tube. More movement from the swells and waves has caused the carcass to mould around the rocks. Avifauna observed: 2 African black oystercatchers <i>Haematopus moquini</i> ; 4 kelp gulls; 1 white-breasted cormorant.
24 Oct	26	More deterioration of the carcass has caused it to lose its shape; no tail or fin shapes left. Carcass floating on the high tide. A few bones seen on a pebble beach near the suspension bridge. Avifauna observed: 5 kelp gulls.
27 Oct	29	Some large pieces of the carcass seen floating in the original location and immediate vicinity, with pieces still breaking off. Carcass still floating in the original gully. Gully full of fish, which appear to be mullet ( <i>Mugilidae</i> ). More bones seen at the ‘beach’ near the suspension bridge, including vertebrae and rib bones. Avifauna observed: 3 kelp gulls.
1 Nov	32	Further disintegration of the carcass, which the currents and tides have shifted one gully closer to the suspension bridge. Carcass lying on boulders (not floating), but still being splashed with water during low tide. Avifauna observed: 15 kelp gulls; 1 sub-Antarctic skua <i>Stercorarius antarcticus</i> .
7 Nov	38	Not much change to the carcass since previous visit. Lying in same gully, but floating and washing around the rocks. Doesn’t appear to be much change in size of the partial carcass remaining, though it appears slightly smaller and is mainly blubber from throat area, with the roqual grooves still discernible. No avifauna observed.
10 Dec	70	Only remaining signs of carcass are bones washed out on the coastline – within 100 m of the original beaching site. Intertidal rocks that were initially white and covered with whale blubber are now covered with green algae.

by various methods, from the shoreline (Tucker et al. 2018) or buried on site (Bui 2009). Human health and safety concerns around possible transmission of communicable diseases and shark attraction increasingly drive the decision-making process despite very little information being available on the severity of these risks (Tucker et al. 2018, 2019; Quaggiotto et al. 2022). This study has demonstrated that within an MPA setting, where natural processes are generally promoted, concerns for tourists and tourism revenue may place internal and external pressure on management authorities for proactive marine mammal carcass management. In this study, although direct pressure from tourists was lower than expected, with half of all respondents indicating that no intervention was necessary, we also show that peoples’ views may be influenced by the situational context, particularly the proximity of the carcass to tourist accommodation units.

Tourism is a significant funding source for protected area management agencies (e.g. Whitelaw et al. 2014; Smith et al. 2021). Furthermore, the provision of recreational opportunities is an important goal for many MPAs

(Lubchenco et al. 2003; Velando and Munilla 2011; Day et al. 2015). However, evaluating trade-offs between multiple objectives is frequently required in MPA management (Brown et al. 2001). In a literature review, Quaggiotto et al. (2022) showed that cetacean carcasses provide a wide range of ecosystem services. Provisioning services, with the carcass used as a source of meat and oils, were historically more important, but as societies developed, cultural services, particularly those around research and education, have increased (Quaggiotto et al. 2022). One of the dominant themes identified through our work was a desire by tourists for the carcass to be used for research and to understand why the animal had died (e.g. “For scientific reasons – establish why it died” and “To see what we can learn from it and prevent further ones [strandings]”). There was an interesting undertone in that it would be more acceptable for the carcass to be left alone if it had died of natural causes rather than of a clear/noticeable anthropogenic cause.

The provision of information has been shown to influence tourists’ experiences and may sway attitudes and behaviour



**Figure 5:** A decision-support tool devised to assist with the management of large cetacean carcasses washed ashore in South Africa. ICMA = Integrated Coastal Management Act; MLRA = Marine Living Resources Act; NEMPA = National Environmental Management: Protected Areas Act

(Mearns and Botha 2018). Providing extra information to the respondents (Appendix) not only significantly influenced perceptions around whale carcass management, but, even when tourists' views were unchanged, the information was well received and appreciated, with nine respondents specifically stating the information was "interesting and useful". It is recommended that a communication plan targeting tourists should be an integral component of marine mammal carcass management within MPAs, thereby taking advantage of the educational ecosystem services associated with dead cetaceans. Providing context and background on the management decision eventually taken and the ecosystem services and disservices provided when cetacean carcasses wash ashore may reduce negative attitudes towards these decisions (Quaggiotto et al. 2022). In terrestrial settings, carcasses are thought of positively in conservation terms owing to the free ecosystem services that they provide (Barton et al. 2013). For example, in raptor conservation, mammal carcasses contribute to the conservation of vultures and other birds of prey (Dupont et al. 2012; Peisley et al. 2017). In some instances, the provision of mammal carcasses is even encouraged at defined sites (termed "vulture restaurants") in both protected and unprotected systems (Fielding et al. 2014).

Tourists encounter nature in a multisensory manner (Hill et al. 2014), and although this is primarily visual (Urry 1990), the senses of hearing, touch, smell and taste are also important (Gibson 2010). In this study, the smell of a decomposing whale was a stronger motivating factor for requesting the whale carcass to be removed than direct

human health concerns. Although the whale carcass generated interest and curiosity with tourists expressing a desire "to actually see a whale close up" and to "get a perception of its real length and size", the death of a large charismatic mammal also generated some negative emotional responses, such as "it's sad and I would prefer to see a live one" or "I am here for beauty, this [dead whale] is not beautiful". Differences in the emotional significance of seeing a whale carcass would be expected based on the diversity of individual tourists' values (Hill et al. 2014) and highlights the complexities of ecosystem services and disservices.

South Africa, like other countries that are signatories to the International Convention for the Regulation of Whaling (1946), has national legislation to protect marine mammals, including their remains. As such, official permissions (provided by DFFE) are required to handle live-stranded cetaceans or their carcasses, with specific stakeholders being responsible for intervention. These can include representatives of local municipalities, conservation authorities, museums, stranding networks and nongovernmental organisations. The development of spatial zonation maps identifying remote and urban areas where different management options would be applicable, along with a set of protocols to guide and facilitate carcass management, would be beneficial. For example, the National Parks and Wildlife Service of New South Wales in Australia has developed a checklist to guide land managers when disposing of cetacean carcasses (National Parks and Wildlife Service 2020). In South Africa, the City of Cape Town has developed a Large Marine



Animal Stranding Policy and Protocol (City of Cape Town 2009), while the KwaZulu-Natal provincial conservation authority (Ezemvelo KwaZulu-Natal Wildlife) has developed guidelines for the disposal of large marine animal carcasses (Olbers et al. 2017). Dealing with large, beached-whale carcasses requires a collective, coordinated and organised response by various responsible authorities, with decision-making accounting for multiple factors (Figure 5), including balancing ecological, financial, legal and public health aspects (Tucker et al. 2018; Quaggiotto et al. 2022). Technical components include physical site characteristics at the point of stranding (e.g. ease of access, rocky or sandy shore, size of the whale, beach characteristics, transport logistics), while economic considerations include the cost of intervention and the potential loss of revenue. Environmental components include the benefits of enabling natural processes to occur, while also being cognisant of the environmental costs of any intervention—for example, the travel distance and hence carbon costs required to transport the carcass to a suitable landfill site. Social components include the proximity to human settlements, popularity or frequency of beach use, and potential health risks to society. Our experience also highlights the need to account for the health and safety of those tasked with dealing with the carcass and the direct risks they may face. In this case, owing to the carcass still being within the intertidal area with sharp, slippery rocks combined with the angle of swell, the direct risk of injury to the responders was considered relatively high. Importantly, our results indicate that not only is local context important, but the manner in which the decision-making process is undertaken can influence the level of acceptance among diverse stakeholders. Being honest, transparent and inclusive with all relevant stakeholders from an early stage and throughout the process enabled a co-learning opportunity, with different knowledge bases and experiences shared and incorporated into the final decision.

Whale carcasses generally decompose over a long period, with whale-fall carcasses on the deep-sea floor lasting decades (Smith and Baco 2003). Relatively few scavengers were noted around the carcass in our study, and the rapid disintegration of this carcass (<70 days) (Table 2) was probably due to the constant water movement pushing the carcass against the rocky shoreline. Surprisingly few studies have been conducted on the decomposition rates of cetacean carcasses on different shoreline types (rocky versus beach) or on the ecological impacts (either positive or negative). These are topics that require more attention, especially within marine protected areas that serve as ideal outdoor laboratories to undertake such studies when opportunities arise.

## Conclusions

Our results highlight that the context of each cetacean carcass stranding is important, with management authorities needing to assess various technical, social, economic and legislative components. Guidance in the form of spatial maps delineating appropriate coastal areas for different management actions, along with generic guidelines and protocols as recommended by previous authors (e.g.

Tucker et al. 2018), will assist in determining the correct course of action. Here, we build on this by demonstrating that an inclusive and transparent approach, incorporating the perspectives and knowledge of relevant stakeholders, enabled a co-learning experience, improved the legitimacy of management decisions, and strengthened relationships between management authorities and tourists. Furthermore, we advocate that a communications plan should be part of marine mammal carcass management, and that management authorities should use these events as opportunities to engage and share information on novel situations to develop individual solutions. Lastly, we support Tucker et al. (2018) and Quaggiotto et al. (2022) in that more social–ecological research is needed to help guide cetacean carcass management.

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**Ethical considerations** — All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki Declaration and the principles incorporated into the Belmont Report. Written informed consent was obtained from all respondents.

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## Appendix

The following photograph and accompanying text was provided to each respondent as part of the questionnaire survey. The photograph shows the position of the humpback whale carcass wedged in a gully and lying in the intertidal zone. The text provides some background on this carcass, the debate about removing a marine mammal carcass from the coastline versus leaving it for natural processes to occur, and a brief explanation on the management decision to leave this particular carcass to decompose naturally.



“Whale carcasses wash out along South Africa’s coastline each year. This is an adult humpback whale *Megaptera novaeangliae*. These whales spend their summer feeding in Antarctica but migrate north to overwinter in tropical and subtropical breeding grounds. We do not know why this whale died but it was already dead when it washed up at Storms River. This carcass has washed up in the middle of a marine protected area. National parks management approach in terrestrial parks would be to let nature take its course. However, when megafauna wash up along the coastline there is often a strong push towards removal of the carcass. This has been likened by some to ‘sanitising’ the beaches and preventing important ecological process to occur. These carcasses are a food source for many different species, including birds, sharks and invertebrates. The push to remove carcasses is generally due to aesthetics (including smell) and safety of beach users due to the carcass attracting sharks.

As this whale washed up in our tourism hotspot, SANParks evaluated potential carcass removal options, but the size of the animal (~20–25 tonnes) and its location in a rocky gully meant that none of the options (burial, towing away, burning) were deemed feasible. The decision was taken to let natural decomposition occur.”