

Pitman, Robert L., Deecke, Volker B. ORCID: <https://orcid.org/0000-0003-2781-5915> , Gabriele, Christine M., Srinivasan, Mridula, Black, Nancy, Denkinger, Judith, Durban, John W., Mathews, Elizabeth A., Matkin, Dena R., Neilson, Janet L., Schulman-Janiger, Alisa, Shearwater, Debra, Stap, Peggy and Ternullo, Richard (2016) Humpback whales interfering when mammal-eating killer whales attack other species: mobbing behavior and interspecific altruism? *Marine Mammal Science*, 33 (1). pp. 7-58.

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1 Humpback whales interfering when mammal-eating killer whales attack other species:
2 Mobbing behavior and interspecific altruism?

3

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26

27

Abstract

28

29 Humpback whales (*Megaptera novaeangliae*) are known to interfere with attacking killer
30 whales (*Orcinus orca*). To investigate why, we reviewed accounts of 115 interactions
31 between them. Humpbacks initiated the majority of interactions (57% vs. 43%; $n=72$),
32 although the killer whales were almost exclusively mammal-eating forms (MEKWs,
33 95% vs. fish-eaters (5%; $n=108$). When MEKWs approached humpbacks ($n=27$), they
34 attacked 85% of the time and targeted only calves. When humpbacks approached killer
35 whales ($n=41$), 93% were MEKWs, and $\geq 87\%$ of them were attacking or feeding on prey
36 at the time. When humpbacks interacted with attacking MEKWs, 11% of the prey were
37 humpbacks and 89% comprised 10 other species, including 3 cetaceans, 6 pinnipeds, and
38 1 teleost fish. Approaching humpbacks often harassed attacking MEKWs ($\geq 55\%$ of 56
39 interactions), regardless of the prey species, which we argue was mobbing behavior.
40 Humpback mobbing sometimes allowed MEKW prey, including nonhumpbacks, to
41 escape. We suggest that humpbacks initially responded to vocalizations of attacking
42 MEKWs without knowing the prey species targeted. Although reciprocity or kin selection
43 might explain communal defense of conspecific calves, there was no apparent benefit to
44 humpbacks continuing to interfere when other species were being attacked. Interspecific
45 altruism, even if unintentional, could not be ruled out.

46

47 Key Words: humpback whale, interspecific altruism, killer whale, *Megaptera*
48 *novaeangliae*, mobbing behavior, *Orcinus orca*, predation

49

50 Introduction

51

52 Anecdotes have been passed down for centuries about dolphins at sea coming to
53 the aid of distressed conspecifics, as well as other species, including humans (Caldwell
54 and Caldwell 1966, Connor and Norris 1980, Whitehead and Rendell 2015). However,
55 more recent observations, including popular accounts (*e.g.*, Dolphin 1987, D’Vincent *et al.*
56 1989, Pitman and Durban 2009) and videos posted on the internet (Appendix 1),
57 suggest that a baleen whale - the humpback whale (*Megaptera novaeangliae*) – also
58 approaches marine vertebrates in distress, most notably, when they are being attacked by
59 killer whales (*Orcinus orca*). This seems particularly maladaptive for the humpbacks
60 because they themselves are attacked by killer whales (Whitehead and Glass 1985,
61 Jefferson *et al.* 1991, Reeves *et al.* 2006, Ford and Reeves 2008, Saulitis *et al.* 2015).

62 It is generally accepted that, due to their enormous size, large whales have no
63 significant natural predators except, possibly, mammal-eating killer whales (MEKWs -
64 *vs.* fish-eating forms; Jefferson *et al.* 1991, Reeves *et al.* 2006). The prevalence and
65 overall ecological impact of MEKW predation on large whales, however, remains
66 contentious and unresolved (*e.g.*, Doak *et al.* 2006, Reeves *et al.* 2006, Springer *et al.*
67 2006, Trites *et al.* 2007).

68 Much of the uncertainty about killer whale predation on large whales is because
69 attacks have been so rarely reported (Jefferson *et al.* 1991, Pitman *et al.* 2001, Springer *et*

70 *al.* 2008, Ferguson *et al.* 2010). Although some have argued that this lack of observations
71 is evidence that killer whales are *not* important predators of large whales (*e.g.*, Clapham
72 2001, Mizroch and Rice 2006), this ‘absence of evidence’ could also be a legacy of 20th
73 Century industrial whaling (Tønnessen and Johnsen 1982, Clapham *et al.* 2008, Rocha *et*
74 *al.* 2014), which means that most living humans have never experienced oceans that were
75 not already depleted of large whales. Within this “shifted baseline” (Pauly 1995) nearly
76 all large whale species are still in various stages of recovery, making it is impossible to
77 assess the historical impact of MEKW predation on their populations (Doak *et al.* 2006,
78 Kareiva *et al.* 2006, Springer *et al.* 2006, Pitman *et al.* 2015). Furthermore, by the time
79 commercial whaling ended, any populations of killer whales that might have previously
80 preyed upon large whales would almost certainly have either declined, become
81 extirpated, or been forced to switch to alternative prey (Springer *et al.* 2003, Branch and
82 Williams 2006, Doak *et al.* 2006; but see Wade *et al.* 2007 for an opposing view).
83 Consequently, MEKW populations around the world could also be in various stages of
84 recovery, albeit at a lagged and slower rate than large whales (Pitman *et al.* 2015). Only
85 if and when these species recover will we have a chance to view predator/prey
86 interactions as they once were (Kareiva *et al.* 2006).

87 For humpback whales, it is generally assumed that their most important non-
88 human predators are MEKWs (Jefferson *et al.* 1991, Paterson and Paterson 2001, Ford
89 and Reeves 2008). Until very recently, however, based on the relatively few documented
90 attacks (Chittleborough 1953, Whitehead and Glass 1985, Dolphin 1987, Jefferson *et al.*
91 1991, Flórez-González *et al.* 1994, Ford and Reeves 2008), MEKW predation on
92 humpbacks had been considered to be a rare (and almost never fatal) event and therefore

93 of limited ecological impact (Jonsgård 1968, Jefferson *et al.* 1991, Clapham 2001,
94 Mizroch and Rice 2006, Mehta *et al.* 2007, Ford and Reeves 2008).

95 There is, however, mounting evidence to suggest that killer whales may in fact
96 regularly attack humpbacks, and that calves and juveniles are the main targets
97 (Chittleborough 1953, Katona *et al.* 1980, Whitehead and Glass 1985, Jefferson *et al.*
98 1991, Paterson and Paterson 2001, Baird *et al.* 2006, Reeves *et al.* 2006, Ford and Reeves
99 2008, Saulitis *et al.* 2015). In three separate studies (Naessig and Lanyon 2004, Mehta *et*
100 *al.* 2007, Steiger *et al.* 2008), images from humpback whale photo-identification catalogs
101 compiled from various studies around the world were analyzed for MEKW tooth rake
102 marks on the flukes and used to infer the prevalence of killer whale attacks (keeping in
103 mind that marked whales represent only the survivors of such attacks – Clapham 2001).
104 Although the frequency of rake-mark occurrences in some populations ranged as high as
105 20%-40%, in the largest study (Mehta *et al.* 2007) less than 7% of whales acquired
106 additional rake marks after the first time they were photographed. Based on similar
107 findings, all three studies concluded that killer whales regularly attacked humpback
108 calves and juveniles but rarely adults (Naessig and Lanyon 2004, Mehta *et al.* 2007,
109 Steiger *et al.* 2008). Furthermore, these attacks could result in significant calf mortality.
110 When Gabriele *et al.* (2001) compared the number of individually-identified humpback
111 mothers with calves on their North Pacific breeding grounds, with those found later
112 *without* calves in the feeding areas, calf mortality during the first year of life was
113 estimated to be approximately 18% (15%-24%), although the specific causes or locations
114 of that mortality could not be identified.

115 In addition to overt predation, even just the threat of MEKW attack could
116 significantly influence behavioral decisions made by large whales, with potential
117 population-level consequences (Creel and Christianson 2008, Wirsing *et al.* 2008). For
118 example, many baleen whale species undertake extensive seasonal migrations between
119 high-latitude feeding grounds and often prey-deficient, low-latitude breeding areas, but
120 there is no consensus as to why they make these energetically costly movements (Stevick
121 *et al.* 2002, Stern 2009). Some authors have suggested that migration allows calves to be
122 born in lower latitudes where there are fewer killer whales and a reduced risk of
123 predation (Corkeron and Connor 1999, Connor and Corkeron 2001; see also Cartwright
124 and Sullivan 2009). Others (*e.g.*, Clapham 2001, Rasmussen *et al.* 2007), however, are
125 not convinced that the threat of killer whale attack could provide the impetus for what is
126 (or at least was, prior to the advent of global industrial whaling) arguably the largest
127 seasonal movement of animal biomass on Earth. Observations from Western Australia
128 also indicate that migrating humpback cows with calves take longer, more inshore routes
129 compared to nonbreeders, presumably to reduce the risk of MEKW attack (Pitman *et al.*
130 2015). This suggests that the threat of predation could be influencing not only *why*, but
131 *how* humpbacks migrate.

132 Clearly, MEKW predation, even if rarely observed and targeting mainly calves
133 and subadults, represents a threat to humpbacks that is persistent, widespread, and
134 perhaps increasing (Houghton *et al.* 2015, Pitman *et al.* 2015; see also Discussion). As
135 such, humpbacks could be expected to show some specific anti-predator behaviors, and
136 indeed some have been suggested. Ford and Reeves (2008) summarized the defensive
137 capabilities of baleen whales faced with killer whale attack, and they identified two

138 general categories of response. Balaenopterid rorquals (*Balaenoptera* spp.) use their high
139 speed and hydrodynamic body shape to outrun killer whales and were classified as *flight*
140 species. The generally more rotund and slower-swimming species - right whales
141 (*Eubalaena* spp.), bowhead whale (*Balaena mysticetus*), gray whale (*Eschrichtius*
142 *robustus*), and humpback whale - apparently rely on their bulk and powerful, oversized
143 appendages (tail and flippers) to ward off attackers. This group was categorized as *fight*
144 species. As part of their fight response, humpbacks have also been reported exhibiting
145 group defense against killer whale attack (*e.g.*, Whitehead and Glass 1985, Dolphin 1987,
146 D'Vincent *et al.* 1989), and humpback cow/calf pairs are sometimes accompanied by an
147 escort that will also help defend the calf from attack (Chittleborough 1953, Pitman *et al.*
148 2015).

149 As is evident above, most reports describing humpback interactions with MEKWs
150 have emphasized humpback defensive behaviors, but there is a growing body of evidence
151 to suggest that humpback anti-predator behavior may have evolved beyond just basic
152 defense, possibly including humpbacks deliberately interfering when MEKWs are
153 attacking other humpbacks and even other species. To investigate the nature and scope of
154 these interactions, we reviewed published and unpublished sources and compiled
155 observations of 115 separate encounters between humpbacks and killer whales from
156 around the world. From these, we identified two general categories of interactions, with
157 each species responding either offensively or defensively, depending on which species
158 approached the other. Herein, we describe these interactions and discuss the adaptive and
159 ecological significance of these behaviors for both species.

160

Methods

161

162

163 We compiled published and unpublished observations of interactions between humpback
164 whales and killer whales, recorded over a 62-yr period (1951-2012), by at least 54
165 different observers from around the world. Nearly all of the observations were made
166 either opportunistically (usually by passengers or naturalists on whale-watching boats), or
167 by researchers studying killer whales or humpbacks (mainly photo-identification studies).
168 Because the observations were recorded by scientists, naturalists, and laymen alike, they
169 vary widely in accuracy, detail, and interpretation. The accounts are presented largely in
170 their entirety in Appendix 2 and summarized in Table 1. For transparency, we have kept
171 the accounts largely unedited and indicated in brackets any editorial comments or
172 changes made for clarity. Collectively, we believe that these narratives offer new insights
173 into the nature and prevalence of humpback/killer whale interactions (Bates and Byrne
174 2007).

175 Killer whale communities, at least within the continental shelf zone of much of
176 the North Pacific (Ford *et al.* 1998, Ford 2011) and in Antarctica (Pitman and Ensor
177 2003), comprise sympatric populations of mammal- and fish-eating prey specialists
178 ('ecotypes'). Distinguishing among these ecotypes clearly has important implications for
179 understanding their interactions with humpbacks. In the text and table, Bigg's killer
180 whales (Ford 2011; often referred to as 'transient killer whales' or 'transients'), refers to
181 a mammal-eating ecotype from the eastern and central North Pacific. 'Residents' and
182 'offshores' are fish-eating ecotypes from the same area. Similarly, in Antarctica, in
183 addition to mammal-eating killer whale ecotypes (type A and large type B [B1]), there is

184 at least one fish-eating form (type C) from eastern Antarctica and another possible fish-
185 eater (small type B [B2]) found in Antarctic Peninsula waters (Pitman and Ensor 2003,
186 Durban *et al.* 2016). The killer whales listed in Table 1 were classified as mammal-eating
187 killer whales (MEKWs) if they were identified in the Appendix 2 accounts as
188 “transients;” if they were attacking a marine mammal at the time of the observation, or if
189 the encounter occurred in tropical or subtropical waters. Killer whales in lower latitudes
190 tend to have unspecialized diets that include marine mammals (Baird *et al.* 2006). Killer
191 whales were classified as fish-eating ecotypes if they were identified as such by
192 experienced observers or from photo-identification matches to known types. Killer
193 whales that could not be categorized were classified as ‘ecotype unknown.’

194 From the accounts in Appendix 2, we classified interactions between humpbacks
195 and killer whales based on which species approached the other (*i.e.*, which species
196 initiated the interaction) or as ‘unknown’ if a determination could not be made (*i.e.*, the
197 interaction was already in progress when the observer arrived) or was unrecorded (Table
198 1). Based on our interpretation of the duration and intensity of the approaches and the
199 specific comments in the Appendix 2 accounts, we further categorized MEKW
200 approaches to humpbacks as either a ‘test’ (sometimes described in the narratives as a
201 brief harassment), an attack, or unknown. Tests usually lasted 5 min or less and often
202 were little more than a brief pass-by; attacks lasted more than 5 min and involved direct
203 contact with the targeted species.

204 When possible, humpbacks were also noted as being either with or without a calf.
205 If a calf was not specifically identified, humpbacks were recorded ‘without calf,’
206 although small calves may have been overlooked and larger calves can be difficult to

207 distinguish from other adults. The sex of individual humpback whales was sometimes
208 determined, either genetically (through the analysis of tissue biopsies or sloughed skin) or
209 from photographs of the genital area. An animal was also inferred to be female if it was
210 closely and consistently attended by a calf at some time.

211 The term ‘escort’ is usually used to indicate an adult male humpback that
212 accompanies a female with a calf on the breeding grounds (Herman and Antinoja 1977,
213 Tyack and Whitehead 1983, Clapham 2000). However, as is clear from the accounts in
214 Appendix 2 and Pitman *et al.* (2015), cow/calf pairs are sometimes accompanied by
215 another humpback also during migration and on the feeding grounds. Therefore, although
216 deviating somewhat from current usage, for this paper we define ‘escort’ as any
217 humpback that accompanies a humpback cow/calf pair anytime or anywhere, including
218 on the breeding or feeding grounds, or during migration. ‘Group size’ for killer whales
219 and humpbacks refers to the total number of individuals directly involved in an individual
220 interaction and within one humpback body length (*ca.* 15 m) of other conspecifics at
221 some time during the interaction.

222 ‘Bellowing’ is the term we use for the very loud exhalations humpbacks make
223 when they are excited (Whitehead and Glass 1985, Dolphin 1987). These sounds are
224 variously referred to in Appendix 2 as “trumpeting,” “trumpet blowing,” “wheezing
225 blows,” “snorting,” “exhaling loudly,” *etc.* ‘Mobbing behavior’ is defined as one or more
226 humpbacks approaching MEKWs and doing one or more of the following: charging or
227 chasing after the MEKWs, bellowing, and/or slapping or slashing their flipper or tail. As
228 an additional cue, when humpbacks were mobbing, MEKWs actively fled from them or

229 avoided them. Unless otherwise indicated, numbered references in the text (usually in
230 parentheses) refer to the specific numbered events in Appendix 2 and Table 1.

231

232 Results

233

234 Appendix 2 (summarized in Table 1) provides details of 108 encounters between killer
235 whales and humpback whales; six of these encounters (Appendix 2: #16, 39, 48, 49, 58,
236 87) included a further 1-2 interactions with additional groups of humpbacks, which were
237 treated as separate events, giving a total of 115 interactions. Although these events were
238 recorded at widely scattered locations around the world (Fig. 1), by far the majority was
239 recorded in the eastern North Pacific Ocean including Monterey Bay, California (48
240 interactions; 42% of total) and Southeast Alaska (27 interactions; 23%).

241 Interactions between humpbacks and killer whales were usually agonistic and
242 sometimes protracted, but which species behaved offensively, and which defensively,
243 depended largely on the ecotype of the killer whales involved, and which species initially
244 approached the other. Humpback whales interacted almost exclusively with mammal-
245 eating killer whales (MEKWs) vs. fish-eating forms: of the 115 killer whale groups
246 observed interacting with humpbacks, 108 (94%) were identified to type, and these
247 included 95% MEKWs and 5% known or suspected fish-eaters (Table 1).

248 Overall, humpbacks approached MEKWs more often than MEKWs approached
249 humpbacks: of 103 interactions, MEKWs approached humpbacks 27 times (26%),
250 humpbacks approached MEKWs 38 times (37%), and the approaching species was
251 unknown 38 times (37%). When the approaching species was known ($n = 65$),

252 humpbacks initiated 58% of these interactions and MEKWs 42%. Among the 43
253 humpback/killer whale interactions for which the approaching species was not known, 38
254 (88%) included groups of MEKWs and 5 (12%) involved unidentified killer whale types.

255 Below we describe the behavioral responses of humpbacks and killer whales
256 during their interactions based on which was the approaching species. We also provide
257 some quotes from Appendix 2 from people who observed these interactions.

258

259 *Killer Whales Approached Humpbacks*

260 Killer whale groups that approached humpbacks ($n = 31$) were almost exclusively
261 MEKWs (at least 27 groups; 87%). The remainder comprised fish-eaters (6%, $n = 2$) and
262 unidentified types (6%, $n = 2$; Table 1). Among the identified ecotypes, MEKWs
263 comprised 93% of the total. On the two occasions when fish-eaters approached
264 humpbacks, the interactions were relatively benign: 1) a group of ‘resident’ killer whales
265 apparently ‘harassed’ a lone adult male humpback for 5 min before leaving it (#6), and 2)
266 suspected fish-eaters in Antarctica (type B2; Pitman and Durban 2010, Durban *et al.*
267 2016) caused a group of humpbacks to become briefly agitated. Other humpbacks
268 converged on the site, but then the killer whales traveled with the humpbacks for a while
269 afterward without incident (#49).

270 When MEKWs approached humpbacks ($n = 27$), no other potential prey species
271 were observed, although it is possible that small prey, such as a pinniped, could have
272 been overlooked (see, for example, #87). Humpback calves were present during at least
273 17 (63%) of the approaches, and MEKWs attacked during at least 16 (94%) of those. In
274 at least 12 of the 16 (75%) attacks with a calf present, it was reported (or suspected) that

275 the calf was specifically targeted (#30, 33, 34, 36, 37, 39, 40, 42, 43, 45, 47, 48), and in
276 the other 4 cases, calves were likely targeted as well (#31, 35, 38, 41).

277 When MEKWs attacked humpbacks and no calf was reported, there was,
278 nonetheless, evidence that younger animals were in fact targeted in most and perhaps all
279 cases. On the 10 occasions when MEKWs approached humpbacks and a calf was not
280 reported, 7 resulted in attacks of which at least 6 (86%) appeared to target nonadults,
281 including two possible calves (#2, 16), two single juveniles (#14, 58), a possible juvenile
282 (#10), and a lone subadult (#21). The remaining attack was on an animal of unknown age
283 (#1). During the three MEKW approaches when no humpback calves were seen and no
284 attack was reported, MEKWs were described as “testing” or “harassing” (*i.e.*, possibly
285 attacking) humpbacks of unknown age on one occasion (#3), and on two other occasions
286 MEKWs approached single humpbacks that were identified as adults (#13, 28), engaged
287 them briefly, and then left.

288 Although interaction times were infrequently noted, when MEKWs approached
289 humpbacks the interaction lasted longer if the humpback was with a calf. Six interactions
290 with calves present lasted 20, 20, 26+, 45+, 150+, and 390+ min (#33, 40, 34, 47, 48, and
291 41, respectively). When MEKWs approached humpbacks and calves were definitely not
292 present, typically there was a brief bout of bellowing or surface-active behavior by the
293 humpback(s), and the MEKWs moved on (#13, 28; these two interactions lasted an
294 estimated 5 and 2 min, respectively).

295 Although MEKWs purportedly killed one humpback calf (#36) and possibly
296 another (#10; neither kill was confirmed), no adult humpbacks were reported killed or
297 seriously wounded during any of the interactions. Observers sometimes reported seeing

298 exposed flesh, minor bleeding, or bits of skin and blubber floating on the surface during
299 some of the attacks (#2, 3, 34, 47), but there was no evidence to suggest that any adult
300 humpbacks sustained life-threatening wounds.

301

302 *Humpbacks Approached Killer Whales*

303 The killer whales that humpbacks approached were almost exclusively mammal-eating
304 forms: among the groups identified to ecotype, 38 of the 41 (93%) were MEKWs; the
305 remaining 3 (7%) were known or suspected fish-eaters (Table 1).

306 Humpback approaches to fish-eating killer whales were relatively uneventful. In
307 Alaska, humpbacks followed a group of known fish-eaters for over 2 h without incident
308 (#15); in Antarctica, a lone humpback followed a group of suspected fish-eaters (#29).
309 Also in Antarctica, suspected fish-eaters caused a group of humpbacks to become
310 agitated, and several nearby humpbacks moved in among them, but nothing happened
311 and the humpbacks dispersed (#49b).

312 Although infrequently noted, the distance humpbacks traveled to approach
313 MEKWs was sometimes considerable. The six observer accounts that included estimated
314 travel distances included: 200 m, >300 m, “several hundred meters”, >1 mile (>1.6 km),
315 *ca.* 1.8 km, and 2 miles (3.2 km; #92, 96, 78, 4, 59 and 77, respectively). On another
316 occasion (#55), one humpback observed among a group of attacking MEKWs had been
317 photographed feeding 2.7 h earlier, 3.5 nmi (6.5 km) away; a second had been
318 photographed feeding 2.5 h earlier, 3.6 nmi (6.7 km) away, and a third humpback among
319 this group had been photographed feeding 6.1 h earlier, 4.1 nmi (7.6 km) away. During
320 each of these events, the MEKWs were attacking or feeding on prey when the

321 humpback(s) arrived. The killer whale prey included a harbor seal (*Phoca vitulina*), an
322 ocean sunfish (*Mola mola*), a California sea lion (*Zalophus californianus*), a humpback
323 (no calf reported), a Steller sea lion (*Eumetopias jubatus*), another California sea lion,
324 and a gray whale calf, respectively.

325 When humpbacks approached MEKWs ($n = 38$), at least 87% were attacking or
326 feeding on prey at the time, and at least 3 of the other 5 MEKW groups may also have
327 been with prey. Two groups (#87, 99) were suspected of having prey, and in one event
328 (#108) MEKWs were “playing, jumping,” which they often do after a kill (Ford and Ellis
329 1999, Matkin *et al.* 1999; Table 1). When humpbacks approached attacking MEKWs,
330 among the prey identified ($n = 29$) were at least 10 species of large marine vertebrates,
331 including humpbacks (17%) and other species (83%), the latter including 4 cetaceans, at
332 least 5 pinnipeds, and 1 teleost fish. During an additional 43 interactions between
333 MEKWs and humpbacks when the approaching species was not known, at least 23 (56%)
334 of the MEKW groups were reported attacking or feeding on 8 different prey species
335 (including other humpbacks). Overall, humpbacks interacted with MEKWs that were
336 attacking a total of 11 different prey species: other humpbacks ($n = 6$; 2 with calf, 4
337 without); gray whales ($n = 5$), common minke whale (*Balaenoptera acutorostrata*; $n = 1$),
338 Dall’s porpoise (*Phocoenoides dalli*; $n = 1$), Steller sea lions ($n = 13$), California sea lions
339 ($n = 14$), Weddell seals (*Leptonychotes weddellii*; $n = 1$), crabeater seals (*Lobodon*
340 *carcinophaga*; $n = 1$), harbor seals ($n = 3$), northern elephant seals (*Mirounga*
341 *angustirostris*; $n = 2$), ocean sunfish ($n = 2$), and unidentified (but nonhumpback) prey (n
342 = 7; Table 1, Fig. 2). In summary, when humpbacks interacted with attacking MEKWs
343 (*i.e.*, humpbacks approached killer whales or the approaching species was unknown), and

344 the prey were identified ($n = 56$), 11% were humpbacks and 89% were species other than
345 humpbacks.

346 The sex of humpbacks that approached MEKWs was determined for 15
347 individuals from 9 events and included both males and females (one male was recorded
348 twice – see below). Among humpbacks that approached attacking MEKWs, the sex was
349 known for five individuals from three events: a single male and a single female
350 (apparently initially unassociated) responded to an attack on a Steller sea lion (#65); an
351 adult female with two adults of unknown sex approached MEKWs that were with a
352 Steller sea lion kill (#70), and an adult female with 2-6 adult humpbacks of unknown sex,
353 and an adult male with three other adult humpbacks of unknown sex approached
354 MEKWs that killed a gray whale calf (#55). The sex of an additional 10 humpbacks from
355 6 events where the approaching species was not known included 8 males and 2 females: 2
356 single males interacted with MEKWs attacking a Steller sea lion (#60) and a harbor seal
357 (#91); at least 2 of 4 humpbacks present at a Steller sea lion attack (#61) were males; 2
358 previously-unassociated males each responded to an attack on a Steller sea lion (#62); an
359 adult male and another adult of unknown sex interacted with MEKWs at a Steller sea lion
360 kill (#69); and one of a pair of humpbacks at a Weddell seal attack in Antarctica (#88)
361 was genetically identified as a male. In addition, on at least two occasions, cow/calf pairs
362 were among other humpbacks that approached during MEKW attacks on a Steller sea
363 lion (#59) and a California sea lion (#74), respectively. The single male in event #60 was
364 also photo-identified as one of the two males in event #62; both events involved MEKW
365 attacks on single Steller sea lions in Icy Strait, Alaska, one in September 1988 and one in
366 September 2003 - 15 years apart!

367 When humpback whales interacted with MEKWs, they generally showed the
368 same behavioral responses regardless of whether they approached MEKWs, or MEKWs
369 approached them (*i.e.*, the same behaviors were used offensively and defensively), and
370 regardless of whether the MEKWs were harassing or attacking them, their calves, other
371 humpbacks, or other species of marine animals (Table 1). The most commonly reported
372 behaviors for humpbacks interacting with MEKWs, regardless of the approaching species
373 ($n = 103$), included: slapping their flukes at the surface (“lob-tailing”) or slashing them
374 from side-to-side (37 interactions; 36%), bellowing (26%), pursuing behavior (21%), and
375 flipper slapping (14%). When humpbacks pursued MEKWs ($n = 22$), regardless of the
376 initially-approaching species, they were variously described as just following the killer
377 whales (#52, 55, 57, 59, 66, 69, 88, 89, 91, 100, 102, 104, 107), chasing them (#2, 39, 50,
378 55, 86, 94, 96, 105), or charging at them (#19, 31, 55, 77). We categorized as ‘mobbing
379 behavior’ (see Discussion) whenever humpbacks used any of these behaviors offensively
380 (*i.e.*, whenever humpbacks approached attacking MEKWs, or when the approaching
381 species was not known and humpbacks were interacting with MEKWs attacking a third
382 species or another humpback). Based on these criteria, humpbacks exhibited mobbing
383 behavior during at least 31 out of 56 ($\geq 55\%$) interactions with attacking killer whales.

384 Observers sometimes reported that approaching humpbacks appeared to affect the
385 outcome of the attack, and were reportedly responsible for the escape of at least two
386 humpbacks (#16, 39), two gray whales (#52, 53), probably a Weddell seal (#87), and an
387 unrecorded number of sea lions (#53). When humpbacks approached MEKWs attacking
388 humpbacks ($n = 5$; 2 with calves), 4 of the attacks were unsuccessful and the outcome of
389 the other was unknown. Furthermore, the approaching humpbacks were described as

390 coming to the aid (#4) or defense (#58) of the attacked whales, and in two other cases
391 (#16 and 39) they reportedly drove off the attackers. When humpbacks approached
392 MEKWs that were attacking pinnipeds ($n = 18$), the prey was killed on at least 13 (72%)
393 occasions. It was not always possible to determine exactly when the pinniped died, but on
394 at least five of those occasions (#65, 73, 78, 86, 92) the prey was probably already dead
395 when the humpback(s) arrived.

396 What follows are quotes from Appendix 2 by three different observers, which
397 offer some insights into the behaviors of humpbacks that approached attacking MEKWs.

398 “‘We observed the harassment of a humpback whale by [about 15] killer whales
399 once; during the attack, other humpback whales rapidly converged on the attackers and
400 appeared to drive the killer whales away” (#16).

401 [After being attacked by a group of approximately 15 killer whales, a humpback
402 cow/calf pair joined a trio of humpbacks] “and for the next few minutes we could see
403 what clearly looked like the three Humpback whales chasing off the Orcas! The Orcas
404 left the scene completely, all the time with the three Humpbacks behind them” (#39).

405 “[W]e had traveled quite a distance to observe a group of killer whales attacking
406 a gray whale mother and calf pair and out of NOWHERE, a humpback whale came
407 trumpeting in followed by another and then another until we had about 5 or
408 more humpbacks in the immediate area. It was strange because during the entire journey
409 with several observers on effort, not a single humpback whale had been observed. It
410 seemed quite clear that the KW/gray whale interaction had attracted the humpbacks,
411 though I cannot say whether it was motivated by curiosity, playfulness or an act of
412 benevolence. The result however was that the gray whale cow/calf pair was able

413 to escape. [On other occasions] I also personally observed several sea lions
414 surviving predation attempts as a result of humpback whales distracting killer whales”
415 (#53).

416

417 *Additional Biological Observations*

418 The overall median number of MEKWs present during each individual interaction with
419 humpbacks was 6 ($n = 97$; range 1-17), and the median was the same regardless of
420 whether they approached humpbacks ($n = 26$; range 1-17), or humpbacks approached
421 them ($n = 33$, range 2–16). The overall median group size for the total number of
422 humpbacks present in each interaction was 2 ($n = 92$; range 1-16), also regardless of
423 whether they approached MEKWs ($n = 36$; range 1–16), or MEKWs approached them (n
424 = 23; range 1–3).

425 The duration of interactions between humpbacks and attacking MEKWs was
426 variable but often protracted and ranged from 15-437+ min (Table 1). Using data only
427 from sightings observed from start to finish, humpback/MEKW interactions lasted an
428 average of 59 min ($n = 10$, range 15-124). Longer events, however, were rarely observed
429 in their entirety, usually because observers arrived after the event was already in progress
430 or departed before it was over. If we also include events where the approaching species
431 was unknown, there were 13 partially-observed interactions that lasted 60 min or longer.
432 The longest occurred during a gray whale calf kill where humpbacks were present for a
433 minimum of 437 min (#55).

434 When lone humpback cow/calf pairs were attacked ($n = 6$), the mother was
435 sometimes able to drive off the MEKWs by herself (# 35, 42, 45, 46; killer whale group

436 size during these attacks was 1, 7, 6, and 2, respectively). When humpback cow/calf pairs
437 were accompanied by an escort, the escort at times appeared to defend the calf as
438 vigorously as the mother, although even their combined efforts apparently were not
439 always successful (#36). Escorts were reported accompanying cow/calf pairs on the
440 feeding grounds (#33, and probably 58), on the breeding grounds (#34, 37, 43), and on
441 migration (#31, 36).

442 Attacking MEKWs often tried to separate the humpback calf from its mother
443 (#34, 43, 45, 47), and the humpbacks took specific countermeasures. A lone mother
444 raised her calf out of the water on her back and head (#46). Mothers and escorts
445 sometimes responded by flanking the calf (#33, 36, 43, and probably 58), and during one
446 attack, a mother and an escort flanked a calf and partly raised it out of the water with
447 their flippers (#33). If there were more than two adult humpbacks present, they
448 sometimes surrounded the calf or calves (#38, 44).

449 In addition to mothers and escorts protecting calves from attacking MEKWs,
450 other unassociated humpbacks in the area sometimes assisted in driving away the
451 attackers (#4, 16, 39, 48, 49). For example, “in a harassment observed in 1988 in
452 Chatham Strait [Alaska], humpbacks came from over a mile away to the aid of the
453 victim” (#4). In another, 15 MEKWs attacked the smaller of three humpback whales, and
454 an hour into the attack, three other humpbacks “rapidly converged on the attackers and
455 appeared to drive the killer whales away” (#16). In an encounter in Antarctica, a
456 humpback cow/calf pair under attack swam in among three adult humpbacks and the trio
457 apparently chased off the killer whales (#39). In another case, killer whales were

458 attacking a humpback calf, and 30 min later 13 humpbacks “swam up to the injured calf”
459 and the killer whales left the area (#48).

460 Overall, regardless of the approaching species, a minimum of 38 prey animals
461 were reported killed during the humpback/killer whale interactions, including humpback
462 whales (2 calves/juveniles; kill(s) likely but not confirmed), gray whales (2; including at
463 least one calf), minke whale (1), Steller sea lions (10), California sea lions (10), Weddell
464 seal (1), harbor seals (3), northern elephant seals (2), and unidentified prey (7). One,
465 possibly two ocean sunfish were attacked and probably killed, also. When humpbacks
466 interacted with MEKWs that were attacking other humpbacks ($n = 17$), the fate of the
467 prey was recorded 7 times (41%) and there were no kills. These included 2 groups with
468 calves and 5 without. The fate of the prey was unrecorded 10 times (59%). When
469 humpbacks interacted with MEKWs that were attacking nonhumpback prey ($n = 53$), the
470 fate of that prey was recorded 44 times (83%): of those 36 (82%) were killed, and at least
471 8 (18%) were seen (or suspected) to escape (#51, 52, 53, 57, 72, 79, 87, 89).

472

473 *Observer Comments*

474 Some observers were clearly puzzled about why humpbacks would approach attacking
475 MEKWs, and a number of possible explanations were included in the accounts. For
476 example, it was suggested that the humpbacks might have been merely curious (#53, 75,
477 89), and others suggested that the humpbacks were also trying to kill or injure the prey
478 that the MEKWs were attacking, by swatting them with their flippers or flukes (#61, 64,
479 65, 91). Although humpbacks in some of the accounts reportedly struck killer whale prey
480 with their flippers or flukes, including in one case when the prey was apparently already

481 dead (#65), it was unclear whether this contact was intentional, or at least in some cases,
482 whether the purported contact actually occurred. For example, “three adult humpbacks
483 participated [in a Steller sea lion kill] by lobtailing on or near the sea lion 15 times,
484 making physical contact with it a minimum of 10 times” (#61). However, after a careful
485 review of the video that this account was based on, RLP has concluded that the
486 humpbacks remained in close proximity to the sea lion and were swatting only when the
487 killer whales made close passes, and that there was no confirmed contact with the
488 carcass¹.

489 The following is an example of observer confusion as to whether humpbacks were
490 attempting to strike the prey with their appendages or were targeting the killer whales. “It
491 definitely looked like the humpback was slashing, with its pectoral fins, at the [Steller]
492 sea lion. We were astonished and thought at the time that the humpback was participating
493 in the kill. I remember noticing that the pectoral fin slashes were "late", a few beats
494 behind as the Steller swam on the surface alongside the humpback, with orcas
495 following...It's quite possible that the humpback was actually slashing at the orcas
496 following the sea lion. Perhaps the animal wasn't late with its slashes, it might have been
497 right on time!” (#64).

498 Other observers specifically stated that the aggressive behavior of the humpbacks
499 was in fact directed at the attacking killer whales and not their prey (#19, 58, 68, 77, 86).
500 According to one: “I remembered thinking that humpbacks can be fearsome if necessary.
501 The trumpeting noise and quick forceful movements, directly at the Orcas, was

¹ Based on this same video footage, some of the co-authors (VBD, CMG, DRM, and JLN) thought that the

502 impressive” (#19). Another wrote that the humpbacks were “swatting killer whales with
503 their flukes!” (#77). Despite the numerous accounts of humpbacks slapping or slashing
504 their appendages in the presence of attacking killer whales ($n = 38$; Table 1), there were
505 no confirmed reports of humpbacks actually striking MEKWs, although it could have
506 happened (*e.g.*, #55, 59). And finally, some observers interpreted the humpbacks’
507 behavior as attempts to rescue, guard or protect the prey (#52, 53, 55, 60, 68, 88).

508

509

Discussion

510

511 It is clear from these results that killer whales and humpback whales regularly
512 approached each other but for entirely different reasons. Killer whales that approached
513 humpbacks were almost exclusively mammal-eating forms (*vs.* fish-eaters), and they
514 appeared to be looking for calves or juveniles to attack (see also Pitman *et al.* 2015,
515 Saulitis *et al.* 2015). When humpbacks approached killer whales, they were selective
516 about the type of killer whale that they interacted with and the circumstances: 93% of the
517 killer whale groups that they approached were MEKWs, and at least 84% (and perhaps
518 100%) of those were attacking or feeding on prey at the time (Fig. 2). Although the threat
519 of injury to an approaching adult humpback was probably minimal (see below), these
520 interactions did come at a cost to the humpbacks. In addition to disruption of their normal
521 behaviors (*e.g.*, feeding, resting, socializing), they sometimes traveled distances >2 km to
522 approach killer whales. They often responded vigorously and aggressively and sometimes
523 for extended periods of time: interactions regularly lasted >1 h and up to almost 7 h.
524 Particularly puzzling was the fact that when humpbacks approached attacking MEKWs,

525 and the species of prey was identified ($n = 33$), 85% of the time it was a species other
526 than a humpback whale, but the approaching humpbacks often continued their
527 interactions or harassment regardless of the prey species. Below, we discuss the adaptive
528 significance and implications of these interactions for both species, and we comment on
529 how and why humpbacks may be willing to confront MEKWs, even when they were
530 attacking species other than humpbacks.

531

532 *Survival of the Biggest*

533 Our review supports previous conclusions that healthy adult humpback whales, because
534 of their much larger size, sometimes combative nature, and robust appendages (see
535 below), are probably immune to killer whale predation (Whitehead and Glass 1985,
536 Jefferson *et al.* 1991, Mehta *et al.* 2007, Ford and Reeves 2008, Steiger *et al.* 2008,
537 Pitman *et al.* 2015). Even lone humpbacks sometimes deliberately approached and
538 interacted with groups of 10 or more MEKWs that were attacking various prey species
539 (Table 1), and when MEKWs approached adult humpbacks without calves, the MEKWs
540 left almost immediately. This confirms that any putative absence of predation pressure on
541 humpback whales by MEKWs (Clapham 1996, 2001; Clapham and Mead 1999; Mehta *et*
542 *al.* 2007) pertains only to healthy adult humpbacks, which presumably allows them to
543 approach attacking MEKWs largely with impunity.

544 Although adult humpbacks may be safe from MEKW predation, subadults,
545 juveniles, and especially calves are vulnerable to attack, and this probably applies to all
546 species of large whales (Melnikov and Zagrebin 2005; Reeves *et al.* 2006; Ford and
547 Reeves 2008; Pitman *et al.* 2007, 2015; Barrett-Lennard *et al.* 2011). As Scammon

548 (1874) commented about killer whales, “it is but rarely these *carnivora* of the sea attack
549 the larger Cetaceans, but chiefly prey with great rapacity upon their young.”

550

551 *Armed Response*

552 The humpback whale is, to our knowledge, the only cetacean that deliberately approaches
553 attacking MEKWs and can drive them off, although southern right whales (*Eubalaena*
554 *australis*) may also group together to fend off MEKWs attacking other right whales
555 (Sironi *et al.* 2008). The adult humpback’s enormous body size certainly contributes to its
556 apparent invulnerability, but there are other, larger whale species that are not known to
557 deliberately approach MEKWs. We suggest that the evolution of the humpback’s massive
558 pectoral flippers may have given it an advantage over killer whales and perhaps altered
559 the balance of power in their interactions.

560 Humpback flippers (Fig. 3) can measure up to 5 m long, one third of their total
561 body length (Woodward *et al.* 2006), and can weigh over 1 ton (1,016 kg, Tomilin 1967).
562 Although they are by far the largest cetacean flippers, both relatively and absolutely, they
563 are quite flexible and maneuverable, and humpbacks can wield them adroitly (Edel and
564 Winn 1978). Furthermore, in addition to sheer impact power, each flipper has a knobby
565 leading edge often encrusted with large, sharp, sessile barnacles (*Coronula* spp.) that can
566 tear the flesh of their opponents (Pierroti *et al.* 1985, Ford and Reeves 2008). These
567 formidable appendages provide protection at the anterior end of the whale, and, when
568 used in concert with the flukes, afford humpbacks with fore and aft, offensive and
569 defensive weaponry - a capability that is unique among living baleen whales. When
570 humpbacks are agitated by killer whales, they appear to randomly flail their flippers and

571 flukes without specifically targeting individual attackers. Nevertheless, killer whales
572 appear to recognize the danger and normally remain ‘at arm’s-length’ when interacting
573 with humpbacks (RLP pers. obs.)

574 Various other functions have been suggested for the humpback’s over-sized
575 flippers, including prey herding, visual and acoustic signaling, temperature regulation,
576 ‘coital clasping’ during mating, and increased swimming proficiency and
577 maneuverability (Edel and Winn 1978, Fish and Battle 1995, Woodward *et al.* 2006).
578 These massive flippers can be especially important during the breeding season, when
579 adult male humpbacks participate in aggressive contests for access to breeding females.
580 During these bouts, vying males engage in charging behavior, flipper- and tail-slapping,
581 and bellowing (Tyack and Whitehead 1983, Baker and Herman 1984, Glockner-Ferrari
582 and Ferrari 1985) – the same behaviors that both sexes use during aggressive interactions
583 with killer whales (Pitman *et al.* 2015, this study). Regardless of the initial evolutionary
584 impetus for enlarged flippers in humpback whales, or any additional functions they may
585 have acquired over time, it is clear that they currently have important survival value as
586 weaponry against killer whales and for calf protection, and they may also be a major
587 reason why humpbacks are able to confront and drive off MEKWs.

588

589 *Humpback Whale Anti-predator Behaviors*

590 Among the *fight* baleen whale species described by Ford and Reeves (2008; see
591 Introduction), mothers with calves will often seek refuge in their physical environment
592 when they are attacked. This includes gray whales and right whales moving into
593 shallower waters (Ford and Reeves 2008, Sironi *et al.* 2008, Barrett-Lennard *et al.* 2011),

594 and bowhead whales using sea ice as protection from killer whales (Nerini *et al.* 1984,
595 Philo *et al.* 1993). Although humpback mothers and calves also retreat to shallow waters
596 when threatened (Pitman *et al.* 2015) or around structures such as boats (#37) or oil
597 platforms (#41), they appear to require less shelter overall, which Ford and Reeves
598 (2008) suggested might be due to the proficiency of adult humpbacks in fending off
599 attacking MEKWs.

600 In addition to mothers retreating to shallow waters, the *fight* species described by
601 Ford and Reeves (2008) also share a number of other behavioral responses to attacking
602 MEKWs. For example, southern right whales respond with tail- and flipper-slapping
603 when attacked and have been reported to strike killer whales with their flukes (Ford and
604 Reeves 2008, Sironi *et al.* 2008). Right whales also exhibit group defense with nearby
605 whales coming in to help defend calves from attacking killer whales. There are also
606 reports of right whales protecting a calf from attack by using their bodies to enclose the
607 calf in a circle or ‘rosette,’ with their heads pointed in and tails out (Ford and Reeves
608 2008, Sironi *et al.* 2008).

609 Cooperative defense by humpbacks during killer whale attacks has, however,
610 received relatively little attention. Clapham (2000) made no mention of it in his
611 comprehensive review, but more recently Ford and Reeves (2008) listed several instances
612 when humpback mothers and calves were attacked by MEKWs, and nearby humpback
613 adults approached and acted aggressively toward the killer whales (Fig. 4; see also
614 Whitehead and Glass 1985, Dolphin 1987, D’Vincent *et al.* 1989). According to Ford and
615 Reeves (2008), the approaching humpbacks sometimes “displayed apparently defensive
616 or protective behaviour” as they positioned themselves closely around the calves.

617 From the Appendix 2 accounts, we identified two separate humpback responses to
618 MEKWs attacking other humpbacks: 1) when (apparently) unassociated humpbacks
619 approached other humpbacks that were being attacked (*e.g.*, Fig. 4), and 2) when one or
620 more escorts traveling with a cow/calf pair responded aggressively toward attacking
621 MEKWs. As examples of the former, on one occasion four adult humpbacks ‘grouped
622 tightly’ around a calf, and the circling MEKWs left after 10 min (#44). On another
623 occasion, humpbacks near Hawaii formed a rosette (heads in, tails out) around an
624 unspecified number of calves to shield them from attacking MEKWs (#38). The latter
625 and Acevedo-Gutiérrez (2009) are, to our knowledge, the only reports of rosette-
626 formation by humpback whales.

627 Herman and Antinaja (1977) first used the term “escort” to describe a whale
628 accompanying a mother/calf pair on the breeding grounds, and they suggested that
629 escorts might have a protective role. Herman and Tavorga (1980) subsequently suggested
630 that the escort might also be a male waiting for the female to come into estrus. Later work
631 confirmed that escorts on breeding grounds are almost always males and the current
632 consensus is that their main function is to mate with the escorted female if the
633 opportunity arises (Clapham 2000). Although the protective role of escorts have been
634 dismissed (*e.g.*, Darling 2001), there have been numerous recent observations from
635 Ningaloo, Western Australia, of escorts accompanying cows with calves during migration
636 to the breeding grounds and vigorously defending the calf when killer whales attack
637 (Pitman *et al.* 2015, see also Chittleborough 1953). Combined with some of the Appendix
638 2 accounts (*e.g.*, #34, 36, 37, 43), these observations suggest that calf defense by
639 humpback escorts is a temporally and spatially widespread anti-predator measure. Future

640 research that identifies the relatedness of humpback escorts to the mothers and calves that
641 they accompany, and the duration of their associations, will be important for further
642 understanding the social and anti-predator roles of the escort.

643

644 *The Other “Killer Whales”*

645 In addition to MEKWs, other species in the cetacean subfamily Globicephalinae (*i.e.*,
646 “blackfish”), including false killer whales (*Pseudorca crassidens*) and pilot whales
647 (*Globicephala* spp.), are also known or suspected predators of other cetaceans, including
648 calves of large whales, and humpbacks have at times shown similarly aggressive
649 responses toward them also.

650 False killer whales have been known to attack large whales, including sperm
651 whales (*Physeter macrocephalus*, Palacios and Mate 1996) and humpbacks (Dolphin
652 1987, Naessig and Lanyon 2004), and reportedly killed and ate a humpback calf in
653 Hawaii (Mazzuca *et al.* 1998). Hoyt (1983) reported “an apparently aggressive episode
654 between humpbacks and false killer whales” in Hawaii: “Snorkeling in the water,
655 [Graeme] Ellis was watching five false killers quietly share a fish when ‘a humpback
656 came out of nowhere, charged into the middle of them and scattered them like bowling
657 pins.’ The false killers were emitting high-pitched squeaks as they sped away.”

658 Pilot whales have also been known to act threateningly toward large whales – this
659 includes short-finned pilot whales (*G. macrorhynchus*) interacting with sperm whales
660 (Weller *et al.* 1996) and long-finned pilot whales (*G. melas*) with humpbacks (Ciano and
661 Jørgensen 2000). In addition, Siebert (2009) describes an account of a pod of 40-50 short-
662 finned pilot whales attacking a pair of gray whales off Baja California, Mexico, and a

663 nearby humpback came in and drove off the attackers. Although it is unclear if this was
664 an actual predation attempt by the pilot whales or just harassment, the humpback
665 appeared to recognize them as a potential threat and showed the same aggressive
666 responses that some humpbacks have shown to attacking MEKWs.

667

668 *Where Do Attacks Occur?*

669 There have been a number of speculations about where (geographically) MEKWs attack
670 humpback whales, *i.e.*, where do the calves acquire their tooth rake marks. The three
671 areas considered are the feeding grounds, the breeding grounds, or along the migratory
672 corridors that link them, and all have been suggested as likely venues.

673 Clapham (2000) noted that although as many as 33% of the humpbacks in the
674 western North Atlantic had killer whale tooth rake marks on their flukes, during two
675 decades of humpback research in the Gulf of Maine there had been few killer whale
676 sightings and no reported attacks on humpbacks, and that during 16 seasons of field work
677 on the West Indies breeding grounds, no killer whales had ever been sighted (but see
678 #30). From this it was concluded that calves were probably attacked mainly while en
679 route to high-latitude feeding grounds during their first migration (Clapham 2000, 2001;
680 Mehta *et al.* 2007). McCordic *et al.* (2014) reported significant differences in tooth-rake
681 marks among populations of humpbacks sampled from five different feeding grounds in
682 the North Atlantic, and because nearly all North Atlantic humpbacks breed in the West
683 Indies, they concluded that attacks probably occurred either during migration or on the
684 feeding grounds. When Steiger *et al.* (2008) analyzed tooth rake marks on humpbacks in
685 the eastern North Pacific, they concluded that calves were attacked mainly on the

686 breeding grounds. More recently, Pitman *et al.* (2015) documented MEKWs attacking
687 humpback neonate calves during their northbound migration to breeding grounds off
688 northwestern Australia, and estimated that at least dozens were taken annually.

689 Assuming that humpback calves wean only after they are large enough to defend
690 themselves against killer whales, they are probably vulnerable to attack anytime and
691 anywhere that they still accompany their mother. Since calves normally stay with their
692 mothers for about 1 yr (one entire migratory cycle; Clapham and Mayo 1990), this
693 suggests that attacks could potentially occur anywhere within their migratory range, and
694 our records confirm this: humpback calves have been attacked on or near breeding
695 grounds in the West Indies (#30), Colombia (#34), Ecuador (#43), Hawaii (#10, 38),
696 Tonga (#37), South Africa (#35), and West Africa (#41); on the feeding grounds in
697 Alaska (#33, 40, 42, 46, 47), California (#44, 48), and Antarctica (#39), and during
698 migration off Australia (#31, 36, see also Pitman *et al.* 2015).

699 It is still not clear where the majority of these attacks occur because the feeding
700 and breeding grounds of humpbacks both offer advantages and disadvantages for both
701 predator and prey. On the high-latitude feeding grounds, MEKWs are much more
702 abundant (Forney and Wade 2006), but humpback calves there will have grown
703 considerably larger by the time they reach those areas and would be more challenging to
704 kill. By contrast, MEKWs are much less common on the low-latitude breeding grounds,
705 where humpback calves are much smaller and more vulnerable to predation. Perhaps, as
706 suggested by the disparate results and conclusions from the different rake-mark studies
707 cited above, important attack areas may vary with region.

708

709 *Do Humpbacks Respond to Killer Whale Attack Vocalizations?*

710 Another question concerns how humpbacks were able to detect attacking MEKWs that
711 were sometimes over 1 km away. We propose that they were responding to acoustic cues
712 - cues from the MEKWs and not their prey.

713 Unlike fish-eating killer whales, MEKWs in the North Pacific, and probably
714 globally, are mostly silent when they hunt, presumably because their mammalian prey
715 species all have acute hearing capabilities (Barrett-Lennard *et al.* 1996; Deecke *et al.*
716 2005, 2011; Riesch and Deecke 2011). For example, it has been shown that when gray
717 whales, harbor seals, belugas (*Delphinapterus leucas*), and sperm whales are exposed to
718 playback calls of MEKWs, they respond with various anti-predator behaviors (Cummings
719 and Thompson 1971, Fish and Vania 1971, Deecke *et al.* 2002, Curé *et al.* 2013).
720 Humpbacks in the eastern Atlantic also appear to avoid MEKW vocalizations (Curé *et al.*
721 2015).

722 Once MEKWs have detected potential prey, however, they often become vocally
723 active, during and after attacks (Morton 1990, Guinet 1992, Goley and Straley 1994,
724 Barrett-Lennard *et al.* 1996, Deecke *et al.* 2005, Ford *et al.* 2005, Deecke *et al.* 2011,
725 Riesch and Deecke 2011). As Reeves *et al.* (2006) suggested, “active sound processing
726 presumably becomes allowable, and perhaps functionally important, once contact with
727 the prey has been established.” The reason(s) for vocalizing in this context is not
728 currently understood, but it could be important for coordinating attack behavior, or for
729 calling in other killer whales - either to assist in the attack, to share in the kill, or for
730 socializing (Deecke *et al.* 2005).

731 We suggest, therefore, that when humpback whales approached attacking
732 MEKWs, they were responding to the attackers' vocalizations. Four observations support
733 this notion: 1) MEKWs and fish-eating killer whales occur sympatrically in the NE
734 Pacific, and presumably elsewhere. They have type-specific vocalizations (Ford and
735 Fisher 1982, Riesch and Deecke 2011), which humpbacks should be able to distinguish
736 (Deecke *et al.* 2002); 2) humpbacks approached MEKWs (*vs.* fish-eaters) in the large
737 majority of cases (93%; $n = 41$), and when they did, at least 84% ($n = 32$) of the MEKW
738 groups were already attacking or feeding on various prey species; 3) although
739 infrequently reported in Appendix 2, the distances that some of the humpbacks traveled
740 when they approached killer whales were obviously well beyond the visual range of
741 humpbacks. For example, on four occasions humpbacks reportedly traveled 1.6 and 7.6
742 km before approaching MEKWs that were attacking a humpback whale, a gray whale, a
743 Steller sea lion, and a California sea lion (#4, 55, 59, 77, respectively); and 4) on two
744 occasions, observers with hydrophones specifically recorded MEKWs vocalizing at an
745 attack site before the humpbacks arrived (#90, 97).

746 As additional evidence that humpbacks can recognize and respond to MEKW
747 vocalizations, at least in a defensive way, Curé *et al.* (2015) showed that humpbacks in
748 the eastern Atlantic displayed strong negative reactions (*i.e.*, immediate changes in
749 feeding behavior, diving patterns, avoidance behavior, *etc.*) in response to playbacks of
750 MEKW vocalizations (recorded in the North Pacific). We do not have any information on
751 how often humpbacks may actively avoid vocalizing MEKWs, and the Curé *et al.* (2015)
752 sample size ($n = 8$) may have been too small to record the full range of humpback
753 responses to their playbacks.

754 Little is known about nonsong vocalizations of humpback whales (Silber 1986,
755 Clapham 2000, Dunlop *et al.* 2008, Zoidis *et al.* 2008, Wild and Gabriele 2014),
756 including whether or not they have an alarm call; if they do, it would be difficult to
757 explain why they responded when other species were being attacked. Furthermore, it
758 seems unlikely that humpbacks would respond to acoustic signals from nonhumpback
759 prey. On at least three occasions (#58, 59, 66), however, observers with hydrophones
760 reported that humpbacks among attacking MEKWs made “a variety of sounds”
761 underwater and that they regularly bellowed when they interacted with killer whales
762 (Table 1; see also Whitehead and Glass 1985, Dolphin 1987). The purpose of the
763 bellowing is unknown - it may only indicate a heightened level of excitement, or it could
764 signal aggression. As mentioned previously, humpback males on the breeding grounds
765 often bellow loudly during aggressive, competitive interactions with other males (Tyack
766 and Whitehead 1983), but during interactions with killer whales and depending on how
767 far this sound carries through the water, bellowing or other vocalizations could also serve
768 as signals to summon or alert other humpbacks in the area. Therefore, we infer that
769 humpbacks were reacting to calls of attacking killer whales and not to the calls of their
770 prey, which meant that approaching humpbacks probably did not know which species of
771 prey was being attacked until they arrived at the scene.

772 Although we assume that approaching humpbacks were responding primarily to
773 MEKW vocalizations, once among the MEKWs, humpbacks showed various responses
774 depending on the circumstances and, possibly, the demeanor of the individual humpback.
775 If another humpback was being attacked, the approaching humpback(s) always acted
776 aggressively towards the MEKWs, sometimes driving them off. But when a species other

777 than a humpback was being attacked, the approaching humpback(s) showed a range of
778 responses, including: moving away, staying on the periphery of the action as if curious,
779 or aggressively confronting the attackers. This could be due to individual responses
780 reflecting differences in, for example, sex, size, age, reproductive status, kinship,
781 individual history with killer whales, or personality of the approaching humpback (e.g.,
782 Briffa and Weiss 2010, Highfill and Kuczaj 2010). Another possibility, testable through
783 play-back experiments, is that the variation in the humpback responses could also reflect
784 changes in the vocal behavior of the killer whales: if humpbacks are attracted to attack
785 vocalizations of killer whales, then if MEKWs stop vocalizing when humpbacks
786 approach, it might prevent humpbacks from interfering.

787

788 *Mobbing Behavior in Humpback Whales*

789 When a potential prey species detects a predator, the prey can show a range of responses,
790 and although most animals seek to avoid predators and retreat to avoid detection,
791 individuals of some species will, under certain circumstances, deliberately approach and
792 even confront their predators (see review by Caro 2005). The resulting interaction
793 typically falls into one of two general categories. *Predator inspection* is when a prey
794 species approaches a predator, but maintains a safe distance and avoids direct interaction
795 - it merely observes and sometimes follows the predator. *Mobbing behavior* (also known
796 as ‘predator harassment’) is when a prey species closely approaches, often harasses, and
797 sometimes even attacks a predator, often while calling to alert or summon conspecifics
798 (Curio 1978, Berger 1979, Dugatkin and Godin 1992). Whether the predator is inspected

799 from a distance or harassed at close range normally depends on the level of vulnerability
800 of the inspecting/mobbing animal or its brood (Berger 1979, Dugatkin and Godin 1992).

801 Predator inspection has been reported among a variety of fishes, birds, and
802 terrestrial mammals, the latter including mainly ungulates, squirrels and primates
803 (Owings and Coss 1977, Curio 1978, Pitcher *et al.* 1986, Loughry 1988, Tamura 1989,
804 FitzGibbon 1994, Caro 2005, Graw and Manser 2007). Although predator inspection can
805 be dangerous and occasionally even fatal for the inspector (Sordahl 1990, Dugatkin and
806 Godin 1992, FitzGibbon 1994), numerous overriding benefits have been proposed: it
807 exposes the presence and location of a predator to conspecifics and kin; it lets stalking
808 predators know that they have been detected, often causing them to move out of the area;
809 it allows potential prey to monitor predator movements, and it may also provide an
810 opportunity, especially for younger animals, to learn about predators (Curio 1978,
811 Dugatkin and Godin 1992, FitzGibbon 1994, Caro 2005, Graw and Manser 2007).

812 Mobbing behavior is also a widespread anti-predator response. Although
813 especially common among birds, it is also found among insects, fishes, and terrestrial
814 mammals (Curio 1978, Dugatkin and Godin 1992, Ostreiher 2003, Caro 2005). There
815 have also been numerous explanations proposed for this seemingly counterintuitive, and
816 sometimes dangerous (*e.g.*, Denson 1979), anti-predator strategy, but the consensus is
817 that it serves many of the same functions suggested for predator inspection, *i.e.*, to alert
818 stalking predators that they have been detected; to bring the predator to the attention of
819 kin and other conspecifics, and to summon in others to assist in the mobbing and driving
820 off the predator. The main difference between inspection and mobbing is in the level of
821 engagement. Mobbing involves harassment at close range, often with the mobbers

822 making bodily contact and sometimes even killing the predator (Caro 2005). The main
823 benefit of mobbing (*vs.* inspecting) is that it can be more effective in driving off potential
824 predators.

825 Although more difficult to observe in the marine environment, predator mobbing
826 has been reported for a variety of marine mammal species. Among pinnipeds, Galápagos
827 fur seals (*Arctocephalus galapagoensis*), Galápagos sea lions (*Zalophus wollebaeki*), and
828 Australian fur seals (*A. pusillus doriferus*) have been reported to mob sharks (Barlow
829 1972, Trillmich 1996, Kirkwood and Dickie 2005). Steller sea lions have been reported
830 “harassing” (possibly mobbing) killer whales on at least two separate occasions (Heise *et*
831 *al.* 2003), although the specific details (including ecotype of killer whales) were lacking.
832 Matkin *et al.* (2007) reported 6 accounts of groups of 3-50 Steller sea lions approaching
833 MEKWs and following them from distances of 50-100 m; in all but one case, the sea
834 lions outnumbered the MEKWs, and on each occasion the MEKWs swam away from the
835 sea lions.

836 Among cetaceans, mobbing behavior and possible predator inspection have
837 previously been reported only for odontocetes (toothed whales and dolphins). Dolphins
838 have been reported to mob sharks (Essapian 1953, Wood *et al.* 1970, review by Connor
839 2000) and possibly killer whales. For example, Saayman and Tayler (1979) described
840 how three Indo-Pacific humpback dolphins (*Sousa chinensis*; length of adults < 3 m) off
841 South Africa broke from a group of 10 others and pursued an unidentified 4-5 m shark.
842 The dolphins ‘forced’ the shark into two separate coves before driving it off to the open
843 ocean, after which the dolphins returned to their original group. Off Southern California,
844 14 adult bottlenose dolphins (*Tursiops truncatus*, 3-4 m) raced toward a white shark (<3

845 m). They rammed it, breached on it, and drove it toward the nearby beach before it
846 disappeared². Long-finned pilot whales were reported as possibly mobbing killer whales
847 off Norway (Curé *et al.* 2012), and de Stephanis *et al.* (2015) described “mobbing-like”
848 behavior by long-finned pilot whales toward killer whales in the Strait of Gibraltar. In
849 New Zealand, small groups of dusky dolphins (*Lagenorhynchus obscurus*) were observed
850 to approach killer whales and briefly swim around them before departing moments later
851 at high speed (Srinivasan and Markowitz 2009) in what may have been an example of
852 predator inspection.

853 We suggest that at least some of the humpback responses to attacking MEKWs
854 were clear examples of mobbing behavior. When Curio (1978) described mobbing in
855 birds, he stated that they “assemble around a stationary or moving predator (potentially
856 dangerous animal), change locations frequently, perform (mostly) stereotyped wing
857 and/or tail movements and emit loud calls.” This description is almost identical to several
858 of the Appendix 2 accounts that describe humpback whales fluke- and flipper-slapping,
859 charging behavior, and bellowing during their interactions with attacking MEKWs.
860 Although predator mobbing typically involves a smaller, more agile prey species
861 harassing a larger predator, there are also cases of larger species mobbing smaller
862 (usually pack-hunting) predators. For example, adult African elephants (*Loxodonta*
863 *africana*), due to their extreme size and aggressive communal defense, are normally safe
864 from predators, but their one important predator – the lion (*Panthera leo*) – can prey on
865 elephant calves (Joubert 2006). When elephant calves are threatened, herd members will
866 respond by mobbing (and sometimes killing) their considerably smaller attackers

²Eric Martin, Manhattan Beach Roundhouse Aquarium, P.O. Box 1, Manhattan Beach, CA 90266, pers. comm., Jan 2015.

867 (McComb *et al.* 2011). Also, although mobbing species usually detect their predators
868 visually, auditory cues from a predator are also known to elicit strong mobbing
869 responses, especially among taxa that rely heavily on acoustic signals, including birds
870 (McPherson and Brown 1981, Chandler and Rose 1988), and possibly, as we suggest
871 above, humpback whales.

872

873 *Altruism in Humpback Whales?*

874 Reports of mobbing behavior by cetaceans have been rare, and the 31 accounts presented
875 here are more than all previous reports, for all other cetacean species combined, and the
876 first for a baleen whale. Not only was this behavior far from rare, but it occurred in
877 widely scattered locations, across a wide range of years, and this raises some interesting
878 questions. Why, for example, would humpback whales deliberately interfere with
879 attacking killer whales, spending time and energy on a potentially injurious activity,
880 especially when the killer whales were attacking other humpbacks that may not be
881 related, or even more perplexingly, as in the majority of cases reported, when they were
882 attacking other *species* of prey? Mobbing presumably provides individual and/or
883 inclusive fitness benefits and would be expected to persist if these benefits outweigh the
884 costs. Below, we consider three possible drivers of mobbing behavior in humpbacks: kin
885 selection, reciprocity, and altruism, and we discuss their possible fitness benefits.

886 Kin selection occurs only among related individuals; for unrelated individuals,
887 reciprocity can occur if there is a stable social unit (Trivers 1971, Connor and Norris
888 1982). Many cetaceans live in stable social groups that include related individuals, which
889 could allow for either kin selection or reciprocity, and some odontocete species are

890 famously known for coming to the aid of threatened or injured conspecifics, as well as
891 other species, including humans (Caldwell and Caldwell 1966, Connor and Norris 1982,
892 Whitehead and Rendell 2015). A concise definition of altruism is: “a behavior that
893 increases the recipient’s fitness at the cost of the performers” (de Waal 2008). To date,
894 purported altruism among cetaceans has been attributed almost exclusively to smaller
895 odontocetes (Caldwell and Caldwell 1966, Connor and Norris 1982, Wang *et al.* 2013),
896 but has also been reported for killer whales (Albert Prince of Monaco 1898, Mikhalev *et*
897 *al.* 1981) and sperm whales (Pitman *et al.* 2001, Whitehead 2003). The few instances of
898 possible altruistic behavior among baleen whales have mostly involved individuals
899 responding to calves or other associates that had been harpooned by whalers or were
900 otherwise injured (Caldwell and Caldwell 1966, Deakos *et al.* 2010).

901 Although direct evidence for kin selection or reciprocity is generally lacking for
902 humpbacks, they have several features that could promote the development of either,
903 including some semblance of social structure as well as site fidelity. Humpbacks are
904 usually characterized as occurring in small, unstable groups (Connor 2000, Clapham
905 2009), but some studies have found relatively stable associations on the feeding grounds
906 that span different seasons (Weinrich 1991, Ramp *et al.* 2010) or even decades
907 (Pierszalowski 2014), which could foster reciprocity. Maternally-mediated philopatry
908 among humpbacks could also allow for either reciprocity or kin selection. As mentioned
909 previously, humpback calves typically stay with their mothers for about 1 yr
910 (occasionally 2; Clapham and Mayo 1990) - long enough for the calf to complete an
911 entire migration circuit and learn their mother’s feeding and breeding grounds (Weinrich
912 1998). After weaning, calves often exhibit maternally-directed site fidelity (Clapham

913 1996, Baker *et al.* 2013, Barendse *et al.* 2013), with annual rates of return to their
914 mother's feeding area up to 90% (Clapham 2000, Pierszalowski 2014). In addition, Baker
915 *et al.* (2013) reported evidence of strong natal fidelity by humpbacks to their breeding
916 grounds, although several feeding stocks sometimes mix within a single breeding area.
917 This consistent evidence for site fidelity on the feeding and breeding grounds (Darling
918 and Jurasz 1983; Baker *et al.* 1990, 2003; Weinrich 1991, 1998; Calambokidis *et al.*
919 2001; Weinrich *et al.* 2006; Witteveen *et al.* 2011) increases the likelihood that individual
920 humpbacks are more related to, or long-term associates with, neighboring conspecifics
921 than they are to individuals in the population at large, thus laying a foundation for either
922 kin selection or reciprocity.

923 More often though, humpbacks approached MEKWs that were attacking prey
924 species that were clearly not humpbacks (*e.g.*, a gray whale calf with its mother, a seal
925 hauled out on an ice floe, a sunfish), and although the humpbacks faced little risk of
926 serious injury, they also gained no obvious benefits for their time and energy spent.
927 However, if the net effect for mobbing humpbacks was an increase in their individual or
928 inclusive fitness through kin selection or reciprocity, then this behavior could persist even
929 if it inadvertently benefitted other species sometimes. This would be an example of what
930 Norris and Dohl (1980) described as “‘spillover’ of an intraspecific pattern into the
931 domain of more distant [*i.e.*, interspecific] relationships.” We suggest that humpbacks
932 providing benefits to other potential prey species, even if unintentional, could be a focus
933 of future research into possible genetic or cultural drivers of interspecific altruism.

934

935

Acknowledgments

936

937 We received invaluable assistance in the field from D. Allan, D. Anderson, and K. Jeffs,
938 as well as J. Poncet and D. Poncet of the *Golden Fleece*. Additional sightings information
939 and field assistance were kindly provided by S. Anna, C. Bane, S. Benson, L. Beraha, A.
940 Borker, E. Bowlby, J. Collins, K. Cummings, M. de Roos, M. Donoghue, D. Ellifrit, G.
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944 Straley, J. Totterdell, T. van Wyck, J. Williams, and H. Yurk. Important comments on
945 earlier drafts of this paper were provided by L. T. Ballance, D. J. Boness, P. J. Clapham,
946 J. Darling, S. Mesnick, B. Würsig and three anonymous reviewers. Genetic
947 identifications were courtesy of K. Robertson, SWFSC, La Jolla, CA. T. J. Moore
948 produced Fig. 1. Research by R. Pitman and J. Durban was supported by US NOAA
949 Fisheries, the BBC Natural History Film Unit and a grant from National Geographic
950 Society, and was conducted under ACA Permit No. 2009-013M#1, and MMPA No. 774-
951 1714-08 issued to NOAA Fisheries, Southwest Fisheries Science Center.

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1542 Table 1. Summarized observations of interactions between humpback whales and killer
1543 whales (see Appendix 2 for complete accounts). Individual events where killer whales
1544 initially approached humpbacks or other species, and then other humpbacks subsequently

1545 approached those killer whales, are treated as separate events and are indicated by the
1546 same event numbers followed by ‘a’, ‘b’, and ‘c’.

1547

1548 Figure 1. Locations and numbers of recorded interactions between humpback and killer
1549 whales described in Appendix 2 and summarized in Table 1; the number in each circle is
1550 the number of interactions from the general area.

1551

1552 Figure 2. Examples of humpback whales interacting with mammal-eating killer whales
1553 attacking various prey species: A) large type B killer whales attacking a crabeater seal
1554 hauled out on an ice floe with an agitated (bellowing) humpback in the foreground;
1555 January 2009, Western Antarctic Peninsula, Appendix 2 account #89; photo by J.
1556 Durban; B) Bigg’s killer whales attacking a gray whale calf (gray whale mother on left;
1557 wounded calf in center) with a humpback whale in the background; May 2012, Monterey
1558 Bay, CA, #55; photo E. Robinson courtesy Monterey Bay Whale Watch; C) Bigg’s killer
1559 whales attacking a Steller sea lion with humpback in the immediate background; 21 Aug
1560 2010, Vancouver Island, Canada, #67; photo by R. Frank; D) Bigg’s killer whales
1561 attacking a harbor seal (below trailing edge of killer whale dorsal fin; the seal has a
1562 transmitter mounted on its head) and a humpback in the background; June 2005, Glacier
1563 Bay, AK, #91; photo by M. de Roos.

1564

1565 Figure 3. A mother humpback whale and newborn calf photographed off Baja California,
1566 Mexico, Oct 2009. When necessary, the mother will use her massive pectoral flippers to

1567 defend her small calf from attacking predators, especially killer whales. Photo: M. Lynn,
1568 NOAA, Southwest Fisheries Science Center.

1569

1570 Figure 4. In the Aleutian Islands, Alaska, 17 Bigg's killer whales (in the background)
1571 attacked a large humpback calf accompanied by its mother and an escort in July 2003;
1572 three other adult humpbacks joined in and helped drive off the killer whales. (This record
1573 arrived too late to be included in Appendix 2). Photo: © Flip Nicklin/Minden Pictures.

1574

1575

Table 1

Event No. (from Appendix)	Species interacting with killer whales	No. of killer whales	No. of humpback whales	Killer whales			Humpback whale behavior				Duration of interaction (mins)	Comments ¹
				Ecotype ²	Behavior ²	Prey killed? ²	Pursued killer whales	Below	Flipper slap or slash	Fluke slap or slash		
a) Killer whales approached humpbacks												
1	Humpback(s) without calf	3	1	MEKW	A	U						KW jumped on head and tail of HB
2	Humpback(s) without calf	10-12	3	MEKW	A	N	x	x				KW attacking HB on feeding grounds, attacked threesome may have included a calf
3	Humpback(s) without calf	17		MEKW	U	N						KWs attacking or perhaps testing scattered HB
6	Humpback(s) without calf	6	1	FEKW	T	N			x	x		Resident KWs (identified by G. Ellis) harass(?) lone adult male HB for 5 min
10	Humpback(s) without calf	5	3	MEKW	A	Y						KWs apparently killed and ate what appeared to be a juvenile HB (possibly a calf)
13	Humpback(s) without calf	6	1	MEKW	T	N						Transient KWs - one female tests' adult HB, then leaves
14	Humpback(s) without calf	3	1	MEKW	A	N						Juvenile HB wounded on wintering ground
16a	Humpback(s) without calf	15	3	MEKW	A	N						Transient KWs attacked 3 HB, smaller animal possibly a calf - see #16b
21	Humpback(s) without calf	4	1	MEKW	A	N						Unsuccessful attack by KW on a subadult HB
28	Humpback(s) without calf	10	1	MEKW	T	N		x	x	x		2 large type B KWs from a group of 10 briefly harass an adult HB
58b	Humpback(s) without calf	5	1	MEKW	A	N						KWs attack juv HB from #58a (HB possibly a calf of #58c)
30	Humpback(s) with calf	2	2	MEKW	A	U						KWs attack HB calf (with mother) on breeding ground - outcome unknown
31	Humpback(s) with calf	4	3	MEKW	A	N	x					KWs attack 3 HBs (2 adults, 1 calf), an apparent HB escort drove off KWs
32	Humpback(s) with calf	6	2	UnE	U	N						KWs (ecotype unknown) spent 12 mins as close as 15 m to HB cow w calf - no responses
33	Humpback(s) with calf	2	3	MEKW	A	N						20 KWs targeted HB calf; 2 HB adults flanked calf, KWs left
34	Humpback(s) with calf	10	3	MEKW	A	U		x		x		26+ KWs attack 3 HBs (2 adults, 1 calf) - result of attack unknown
35	Humpback(s) with calf	1	2	MEKW	A	N						KW (1) attacks cow/calf - unsuccessful
36	Humpback(s) with calf	7	3	MEKW	A	Y						KWs attack 3 HBs (2 adults, 1 calf) - calf reportedly killed
37	Humpback(s) with calf	2	3	MEKW	A	N						KWs attack 3 HBs (2 adults, 1 calf) - unsuccessful
38	Humpback(s) with calf	5	2	MEKW	A	U						In response to KW attack, 13-16 HB form rosette with calves in the middle
39a	Humpback(s) with calf	15	2	MEKW	A	N						Large type B KWs attack HB cow/calf; other HBs chased off KWs - see #39b
40	Humpback(s) with calf	5	2	MEKW	A	N						Transient KWs harassed HB calf w cow, near a group of feeding HBs
41	Humpback(s) with calf	10	2	MEKW	A	U				x		10 KWs harass cow/calf HB for over 6.5 hr next to oil platform - outcome unknown
42	Humpback(s) with calf	7	2	MEKW	A	N						Transient KWs apparently attack HB calf after a sea lion kill; displaced by cow HB
43	Humpback(s) with calf	2	3	MEKW	A	N				x		KWs attack HB calf with mother and companion on breeding ground - whalewatchers break it up
44	Humpback(s) with calf	5	5	UnE	T	N						4 adult HBs huddle to protect 1 calf; KWs depart after circling 10 min
45	Humpback(s) with calf	6	2	MEKW	A	N		x		x		KWs harass HB calf; cow apparently drives them off
46	Humpback(s) with calf	4	2	MEKW	A	Y						KWs approach HB cow/calf; cow apparently drives them off
47	Humpback(s) with calf	7	7	MEKW	A	N						3 adult HBs successfully defend a HB calf from attacking KWs
48a	Humpback(s) with calf	6	1	MEKW	A	U						150+ 6 KWs attack apparent calf HB; 13 + 2 HBs join calf and KWs leave (see also #48b)
49a	Humpback(s) with calf	30-40	4	FEKW	U	N		x	x	x		35 small type B Antarctic KWs (fish-eaters?) moved in among group of HBs - HBs initially agitated but no incidents (see #49b)
b) Humpbacks approached killer whales												
4	Humpback(s) without calf			MEKW	A	U					> 1 mile (1.6 km)	HBs come from 'over a mile away' to aid another HB attacked by KWs
15	Humpback(s) without calf	18	2	FEKW	U	N						2 HBs follow 18 fish-eating KWs for at least 2 hrs without incident in AK
29	Humpback(s) without calf	50-70	2	FEKW	U	N						Single HB follows KW group (Antarctic small type B - fish-eaters?) - foraging together?
48b	Humpback(s) without calf	6	15	MEKW	A	N			x			6 transient KWs attack and injure HB calf (see #48a); 13 + 2 HB swim up to injured calf; KWs leave
58c	Humpback(s) without calf	6	2	MEKW	A	N						2 adult HB come to defence of juv HB in #58b - possibly a calf of one of the adults
16b	Humpback(s) with calf	15	3	MEKW	A	N						Transient KWs attacking 3 HBs (#16a) joined by 3 other HBs and appeared to drive KW away
39b	Humpback(s) with calf	15	3	MEKW	A	N	x					3 adult HBs drove off large type B KWs that were attacking HB cow/calf pair - see #39a
49b	Humpback(s) with calf	35	6	FEKW	U	N						HBs w calves joined agitated group from #49a - group dispersed without incident while small type B KWs stayed among them
51	Gray whale	4	1	MEKW	A	N						KWs attack (test?) GW briefly; humpback swims close by; no interaction
52	Gray whale	5-6	1	MEKW	A	N	x		x	x		Transient KWs attack GW calf w cow; HB appears to help calf escape
53	Gray whale	>5		MEKW	A	N		x	x	x		Transient KWs attack GW calf with ; 5 + HB come in to drive off KWs
55	Gray whale	11	16	MEKW	A	Y	x	x	x		3.5 mile (5.6 km); 3.6 mile (6.7 km)/4.1 mile (7.6 km)	Transient KWs kill gray whale calf; 2 HBs present; and at least 14 others join in and apparently interfere with attack and feeding by KWs
56	Minke whale	13	1	MEKW	A	Y						Transient KWs chase MW to boat; a demonstrative HB approaches but MW killed
57	Dall's porpoise	2	1	MEKW	A	N	x	x				Transient KWs chase DP; HB follows following
58a	Steller sea lion	1	1	MEKW	A	Y						Juv HB approaches KWs attacking SSL; SSL presumably killed (see #58b, c)
59	Steller sea lion	5-6	9	MEKW	A	U	x	x	x	x	1.8 km	105 KWs attacking SSL when HBs including a cow/calf pr intrude; 'excited' HBs stay 4+ h
65	Steller sea lion	4	2	MEKW	A	Y						6 transient KWs attack and injure HB calf (see #48a); 13 + 2 HB swim up to injured calf
66	Steller sea lion	10	7	MEKW	A	Y	x	x				Transient KWs kill SSL; up to 7 HB move in close and follow KWs
67	Steller sea lion	10	1	MEKW	A	Y						39+ KWs attacking SSL; approached by HB - SSL 'very lively' killed
68	Steller sea lion	16	1	MEKW	A	Y		x	x	x		KWs attack and kill a SSL; HB makes a 'big fuss' in an apparent 'rescue attempt'
70	Steller sea lion	4	3	MEKW	A	Y				x		3 HBs joined 4 KWs that had just killed a SSL; HBs agitated
73	California sea lion	7	8	MEKW	A	Y						Transient KWs kill CSL - "2 + 2 + 2" HBs "in area"
77	California sea lion	8	2	MEKW	A	U	x			x		Transient KWs attack CSLs; HB approach from 2+ miles, "swatting KW w their flukes"
78	California sea lion	pod	2	MEKW	A	Y					several hundred m	KWs kill CSL; 2 HBs approached kill site from 'several hundred meters', following
80	California sea lion	7	2	MEKW	A	Y						Transient KWs taking CSLs; 2 HBs surface in the middle of the KWs
82	California sea lion	5-6	3	MEKW	A	U						Transient KWs kill CSL; 2 + 1 HBs approach and stay over an hour
86	California sea lion	8	7	MEKW	A	Y	x					Transient KWs carrying juv SL; 2 HB 'actually chasing' and 'harass' KW; 2 + 1 + 2 more HB arrive
87b	Weddell seal	10	2	MEKW	U	N		x	x	x		Large type B KWs; a pr of HB joins pr of HB from #87a during possible WS attack
89	Crabbeater seal	10	2	MEKW	A	N	x	x				Large type B KWs attack CS on ice; pr of HBs from #87a appear to follow then interfere with attack
90	Harbor seal	5	1	MEKW	A	Y						Transient KWs attack and apparently kill an HS; single HB approaches then departs
92	Harbor seal	6	2	MEKW	A	Y					200 m	Transient KWs attacking a HS approached by 2 HBs
94	Northern elephant seal	5	1	MEKW	A	Y	x					Transient KWs kill NES - HB shows up and chases KWs
96	Ocean sunfish	8-12	2	MEKW	A	Y			x		>300 m	Transient KWs attacking a sunfish; one 'mobbed' by 3 HBs
97	Unidentified prey	8-12	2	MEKW	A	Y						26 Transient KWs vocalizing with und kill; pr of HB approach and may have scattered KWs
99	Unidentified prey	6	1	MEKW	A	Y						74+ Transient KWs "killed something?" - "1 HB close by"
100	Unidentified prey	6	7	MEKW	A	Y	x					18+ Transient KWs "killed something"; joined by up to 7 HB, several of which follow the KW
102	Unidentified prey	6	7	MEKW	A	Y	x					Transient KWs "killed something" - 2 + 3 + 2 HB join and follow KWs
104	No prey observed	5-6	2	MEKW	U	U			x			73 Transient KWs, possibly with prey, approached by 2 HB, which stayed with them over 1 h
105	No prey observed	11	11	MEKW	U	U	x					124 2 + 3 + 6 HBs following 5 + 6 KWs; HBs 'friendly' with boat
107	No prey observed	5	4	MEKW	U	U	x					"5 KWs followed by 4" HB
108	No prey observed	4	3	MEKW	U	U						HBs approach transient KWs that were 'playing, jumping'
c) Approaching whale(s) unknown												
5	Humpback(s) without calf	12-14	1	MEKW	U	U		x	x			45 Agitated HB surrounded by transient KWs; [KW(s) possibly after other prey?]
7	Humpback(s) without calf	3	1	MEKW	T	U						Transient KWs 'harass' 1 HB
8	Humpback(s) without calf	2	1	MEKW	U	N						Two KWs 'harassing' HB; possible test or attack
9	Humpback(s) without calf	4	1	MEKW	T	U						Transient KWs 'harass' 1 HB
11	Humpback(s) without calf	5	>1	MEKW	T	U						3 Transient KWs 'harass' HBs
12	Humpback(s) without calf	3	1	UnE	U	U						3 KWs passed within 25 m of 1 HB with no interaction
17	Humpback(s) without calf	4-5	1	MEKW	A	N			x	x		KWs attacked lone HB - attackers apparently repelled
18	Humpback(s) without calf	3-4	2	MEKW	U	U						3-5 KWs circled pr of adult HBs for over 1 h; HB tail-slapping
19	Humpback(s) without calf	12	4	MEKW	U	N	x	x				30+ Group of HB charge at group of KWs and scatter them
20	Humpback(s) without calf	4-5	4	MEKW	U	U				x		4-5 KWs in immediate area of tight group of 4 tail-slapping HBs
22	Humpback(s) without calf	4-5	3	UnE	U	U			x			Agitated HBs (2 adult male and 1 unidentified) swim away from group of milling KW
23	Humpback(s) without calf	8	1	UnE	U	U			x	x		'harassed' HB adult apparently repels KW with appendage slaps
24	Humpback(s) without calf	4	>1	MEKW	U	U						4 KWs "with HBs"
25	Humpback(s) without calf	3	3	MEKW	U	U						Transient KWs; no interaction recorded
26	Humpback(s) without calf	5	3	UnE	U	U						No specific interaction recorded
27	Humpback(s) without calf	8	1	MEKW	U	U			x	x		180+ 8 KWs spent over 3 hrs with agitated HB
50	Humpback(s) with calf	15	5	UnE	U	N	x					HBs chasing KWs for 30 min; HB cow/calf broke off early
64	Gray whale	15	7	MEKW	A	Y						15 KWs at GW kill - "3 + 4 HBs" present
60	Steller sea lion	4	1	MEKW	A	Y						65+ KWs attacking SSL with a lone male HB acting 'protective' of SL
61	Steller sea lion	6	4	MEKW	A	Y		x	x	x		50 Transient KWs kill SSL; HBs demonstrative around carcass, touch it with flippers
62	Steller sea lion	4	2	MEKW	A	U		x				KWs attacking SSL; 2 adult male HBs converge, 'agitated' they stay close to SL
63	Steller sea lion	8	3	MEKW	A	Y						Transient KWs kill SSL; 2-3 HB 'toraled' by adult male KW during kill
64	Steller sea lion	6	1	MEKW	A	U			x	x		60+ Transient KWs attacking SSL; lone HB possibly slapping at KWs (or prey) with flippers and flukes
69	Steller sea lion	3	7	MEKW	A	Y	x	x	x		1/2 mile (0.8 km)	30+ Transient KWs kill SSL; agitated HBs closely follow and possibly 'harass' KWs
71	California sea lion	3	5	MEKW	A	Y						102+ Several HB 'near' as transient KWs attack CSLs; kill and eat one; no interactions noted
72	California sea lion	6	2	MEKW	U	N				x		40+ Transient KWs appear to be hunting CSLs; possible 'interference' by pair of HB
74	California sea lion	3	3	MEKW	A	Y						Transient KWs attack CSL; 3 HB (including cow/calf) 'interacted' with KW
75	California sea lion	3	2	MEKW	A	Y						109+ Transient KWs kill CSL; 2 HB "involved, curious?"
76	California sea lion	5	>1	MEKW	A	Y		x				Transient KWs kill CSL; HB "interfering" with KW and carcass
79	California sea lion	15	12	MEKW	A	Y						69 Transient KWs chasing SLs; at least 5 HBs 'present'
81	California sea lion	6	4	MEKW	A	U						63+ Transient KWs chasing SLs; 4 HBs 'present'
83	California sea lion	6	4	MEKW	A	Y						Transient KWs kill CSL - "2 + 2 HB in area"
84	California sea lion	6	2	MEKW	A	Y						46+ Two HBs in among transient KWs for at least 46 min as they attack kill a CSL
85	California sea lion	12	3	MEKW	U	U						9+ Transient KWs with 3 HBs and CSLs present - no interactions recorded
87a	Weddell seal	10	2	MEKW	U	N		x	x	x		

1577
Figure 1

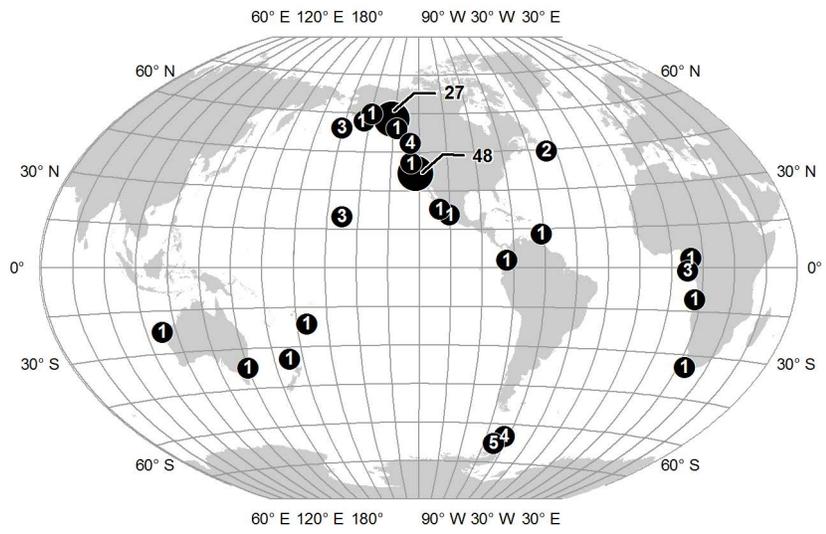


Figure 2

1578



A



B



C



D

1579 Figure 3

1580



1581 Figure 4

1582



1583 Appendix 1. Links to video footage of humpbacks interacting with killer whales attacking
1584 various species of prey; numbers in parentheses refer to event numbers in Appendix and
1585 in Table 1. All links accessed on 18 May 2016.

1586 <https://www.youtube.com/watch?v=K1ZLTqn1WKg&feature=youtu.be> (#61)

1587 <https://www.youtube.com/watch?v=fgnj9QxFoh8&feature=youtu.be> (#61)

1588 <https://youtu.be/SFYAD5ECRXA> (#61)

1589 http://www.youtube.com/watch?v=8Rwak1_YS7c (#101)

1590 <https://www.youtube.com/watch?v=zQXOCIAxh0M&feature=youtu.be> (#94)

1591 <https://www.youtube.com/watch?t=1&v=acU5dBF2nHo> (#55)

1592 https://www.youtube.com/watch?v=-lw8_SAtX8o (#55)

1593 <https://www.youtube.com/watch?v=SWIda-OUdg0> (#55)

1594 <http://www.bbc.co.uk/programmes/p00s7tkj> (#55)

1595 https://www.youtube.com/watch?v=O_LEa6o0XTo

1596 <https://www.youtube.com/watch?v=-2XBwDNoQ9U>

1597 <https://www.youtube.com/watch?v=0OL73ChbRj8&app=desktop>

1598 <https://www.youtube.com/watch?v=yrKtxVHQQnE>

1599

1600 Appendix 2: Accounts of humpbacks interacting with killer whales. We have tried to
1601 retain as much of the original wording of these accounts as possible; any subsequent
1602 rewording, clarification or comments are included in brackets. The Appendix is arranged
1603 chronologically by the species of prey targeted by killer whales and, for humpbacks,
1604 whether or not they were with calves. The event numbers correspond to numbers
1605 provided in the text and in Table 1; mammal-eating killer whales in the NE Pacific are

1606 referred to as either “transients” or “Bigg’s” killer whales; for information on Antarctic
1607 killer whale types see Pitman (2011) and Durban *et al.* (2016).

1608

1609 Humpback whale (*Megaptera novaeangliae*)

1610 A. Humpbacks without calves:

1611 1. Dec 1961; North Cape, New Zealand; Visser (1999). Three “orca seen to attack a
1612 humpback, orca ‘jumped’ onto head and tail of humpback”.

1613

1614 2. 4 July 1982; Grand Bank, Newfoundland; Whitehead and Glass (1985). “we saw 10 to
1615 12 orcas attacking humpbacks...” “About 20-30 humpbacks, in groups of 2-4 animals
1616 were concentrated in an area of approximately 10 km².

1617 “The orcas included three adult males (6-8 m in length), recognizable by their
1618 prominent dorsal fins, and 7-9 smaller (4-6 m in length) whales of unknown age or sex.
1619 Adult males generally milled about alone or, infrequently, in pairs, whereas groups of 2-3
1620 smaller orcas remained together over periods of at least a few minutes.

1621 “Typically, a single adult male, or 2-3 smaller animals, harassed a humpback at
1622 one time. The orcas rushed towards the humpback at about 11-15 km/h (Fig. 1). On four
1623 occasions we saw the humpback turn its belly toward the approaching orca, thrashing
1624 with its flukes. Fluke thrashing, turning, and rolling were common responses to orca
1625 attack. Directly after such an encounter, the orca retreated, frequently pursued for several
1626 meters by one or more of the humpbacks. Throughout our observations, the humpbacks
1627 generally moved slowly (less than 6 km/h).

1628 “While being attacked by orcas, the humpbacks, made loud “wheezing” blows.
1629 These are rarely heard from humpbacks in normal circumstances.

1630 “During the early part of the encounter, the orcas moved about among various
1631 groups of humpbacks, but after several hours they seemed to concentrate on one group of
1632 3 animals. These 3 stayed in close association about 4 m apart. This is closer than the
1633 usual inter-animal distance of grouped humpbacks off Newfoundland...”

1634 “The humpbacks were seen with open wounds: one on the dorsal fin, one on the
1635 caudal peduncle, and one on the lower jaw. Many lumps of stringy blubber (*ca.* 1 kg),
1636 with small pieces of flesh attached, were seen floating in the water. These were the first
1637 such lumps that we had observed during 28 months of humpback research off
1638 Newfoundland, Greenland, and in the West Indies.” [Humpback calves not specifically
1639 mentioned but may have been present, especially in group of 3.]

1640

1641 3. 25-26 June 1983; Grand Bank, Newfoundland; Whitehead and Glass (1985). “we
1642 observed about 17 orcas, including about 3 large males and 2 small calves, attacking
1643 humpbacks...” “The behaviour, groupings, speeds, and sounds of the orcas and the
1644 humpbacks were very similar to those of the previous sighting [#2]. However, there were
1645 differences between the observations of 25 June 1983 and 26 June 1983. On 25 June the
1646 groups of humpbacks were closely packed, with less than 100 m between adjacent
1647 groups. Vigorous attacks by the orcas were countered by violent fluke thrashes from the
1648 humpbacks. In contrast, on 26 June, the humpbacks were much more dispersed, with
1649 groups approximately 500 m apart. The orca attacks were less vigorous, and the
1650 humpbacks’ defensive measures appeared almost leisurely. During the encounter no

1651 lumps of blubber were sighted, and only one small flesh wound was seen on a
1652 humpback's fluke.

1653 “During both encounters we had the definite impression that the orcas had no
1654 immediate intention of attempting to kill a humpback. The orcas may have been simply
1655 attempting to obtain mouthfuls of humpback flesh. Alternatively, they might have been
1656 testing the humpbacks to single out animals which, perhaps on account of disability,
1657 sickness, or age, could then be killed by a greater number of orcas acting cohesively.”

1658

1659 4. 1988; Chatham Strait, AK; D'Vincent *et al.* (1989). “In every encounter we have
1660 observed between killer whales and humpbacks, either in playful harassment or
1661 determined effort, other humpbacks have come to the aid of the jeopardized animal [*i.e.*,
1662 humpback], whether it be an adult or a juvenile. In a harassment observed in 1988 in
1663 Chatham Strait, humpbacks came from over a mile away to the aid of the victim. Such
1664 altruistic behavior is probably the humpbacks' best defense against the killer whale.”

1665

1666 5. 24 June 1994; Chatham Strait, AK; J. Straley in Ford and Reeves (2008). “Adult
1667 humpback surrounded by killer whales reacted by splashing vigorously with flippers,
1668 shaking head, ‘trumpet’ blowing and exhaling underwater. Killer whales ended
1669 harassment after 45 min.” J. Straley³ reported: “12 [transient] killer whales reported 5 nm
1670 south of Yasha Island in Chatham Strait. Killer whales were circling in the area. 1545-
1671 1645 we approached and photographed the killer whales and one humpback whale dorsal
1672 fins. Humpback was not fluking. The killer whales surrounded a very agitated

³Jan Straley, University of Alaska Southeast, 1332 Seward Ave., Sitka, AK 99835 USA, pers. comm. 12 Jan 2010.

1673 humpback whale. The humpback was shaking, exhaling underwater, moving quickly up
1674 and down in the water with the flippers creating breaking waves (white water), no
1675 vocalizations heard but it was very windy, SE 20K+, and choppy 3+foot seas. The killer
1676 whales were divided into two groups of 6-7 whales each with the groups alternating
1677 presumably attacking the humpback. When one group was not near the humpback the
1678 killer whales were off 1/4 nm breaching, charging around, doing head flips and showing
1679 flukes. The humpback disappeared and moved off while we were observing the killer
1680 whales. The groups were composed of a male, calf, 4-5 females or juveniles. Eventually 2
1681 males separated from the others. We did not approach close to minimize our
1682 disturbance. Unknown if the killer whales actually made contact with the humpback, no
1683 blood or damage to the humpback on the dorsal surface was observed. There could
1684 possibly have been a calf or another humpback submerged that was the target of the
1685 attack but a second whale was never seen.”

1686

1687 6. 3 July 1995; Point Carolus, Glacier Bay, AK; C. Gabriele; Glacier Bay National Park
1688 Annual Whale Report 1995. “4 humpbacks were feeding on shallow prey near Point
1689 Carolus when a group of approximately 20 killer whales (*Orcinus orca*) came into the
1690 area. Three of the humpbacks immediately disappeared from the area, and the fourth
1691 animal (male #118) remained. After the killer whales had milled in the area for about 5
1692 minutes, a sub-group of approximately 6 killer whales surrounded whale #118 and
1693 appeared to ‘harass’ him. While he was surrounded, whale #118’s respirations were
1694 wheezy and he repeatedly slashed his pectoral fins and tail from side to side. The killer
1695 whales stayed with the humpback for about 5 minutes, which remained on the surface

1696 throughout the incident. The humpback then resumed feeding nearshore, and the killer
1697 whales eventually headed north into Glacier Bay. Identification photographs of the killer
1698 whales were taken, and later identified as resident-type AG pod, (Graeme Ellis, pers.
1699 comm.).”

1700

1701 7. 26 Aug 1995; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 3 transient
1702 killer whales “harassing a humpback whale.”

1703

1704 8. 12 Jan 1998; West Hawaii, Hawaiian Islands; Baird *et al.* (2006). 2 killer whales
1705 ‘harassing humpback whale’.

1706

1707 9. 19 Nov 2000; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 4 transient
1708 killer whales “harassed 1 [humpback whale].”

1709

1710 10. 20 March 2001; Kaua’i, Hawaiian Islands; Baird *et al.* (2006). 5 killer whales
1711 “feeding on humpback whale”. C. Bane⁴ reported: 15 May 2011. “The day we saw the
1712 Orca killing and eating the humpback we never saw the Humpback except for the pieces
1713 that were being brought up and displayed (for lack of a better word). There was a lot of
1714 dorsal slaps by the biggest adult male right next to the boat as well as some charges/head
1715 slaps 10' from the boat before he'd dive under our boat. And, of course lots of blood.
1716 About 2-3 miles north were over 10 HBs that for lack of a better word seemed to be
1717 "climbing" over each other as to get out of the water. I had first saw the Orca, went over

⁴ Chris Bane, 1601 Harmonys Place, Sooke, BC V9Z 0T1 Canada, pers. comm. 15 May 2011.

1718 to the area, waited a few minutes, looked NE and saw a bunch of activity (spouts,
1719 splashes and bodies), so I headed up there and saw the mayhem. We didn't see any Orca
1720 so I headed back to the spot of the Orca sightings and that's when we started to see the
1721 Orca getting active on the surface (basically getting lots of breaths and going back down).
1722 The first thing we saw was what looked to be a tongue, around 8' long very pale red in
1723 the mouth of the largest male. Within 10 minutes of that we saw the blood come up then
1724 the male had a circular piece of belly meat in his mouth (around 6-8' in diameter). He
1725 showed it to us long enough to see the ventral pleats, layer of fat and muscle with what
1726 looked like tendons/arteries and such hanging off. After that we saw no more feeding,
1727 just the male getting aggressive when we would drift too close. It's kind of hard to say if
1728 it was a small adult or a large juvenile, but the pleats were rather too large to be a baby.”

1729

1730 11. 29 May 2001; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 5 transient
1731 killer whales “harassed [humpback whales].”

1732

1733 12. 30 Aug 2001; Gabon, West Africa; Weir *et al.* (2001). 3 “Killer whales passed within
1734 25 m of a single adult humpback without obvious direct interaction”.

1735

1736 13. 8 July 2002; off Kodiak Island, AK; R. Pitman unpubl. notes. “While we were with [a
1737 group of 6 transient killer whales] an adult [humpback whale] showed up ahead of us;
1738 one of the females [killer whales] broke off and went over and tested the whale. There
1739 was some tail flailing by the [humpback] and the [killer whale] broke off. Seemed more

1740 of an annoyance for the [humpback] than a real threat.” [Total duration of event: 5
1741 minutes]
1742
1743 14. 28 December 2002; Bahia de Banderas, Mexico; Ford and Reeves (2008). “Juvenile
1744 humpback attacked and wounded by [3] killer whales struck at predators with tail flukes
1745 on several occasions.
1746
1747 15. 21 July 2003; off Unalaska Island, Alaska; R. Pitman and J. Durban field notes. A
1748 pair of humpback whales followed a group of an estimated 18 fish-eating (‘resident’)
1749 killer whales around for at least 2 h; nothing happened.
1750
1751 16a-b. 30 July 2003; Akutan Island, Eastern Aleutians, Alaska; C. Matkin *et al.* (2007).
1752 “We observed the harassment of a humpback whale by [15] killer whales once; during
1753 the attack, other humpback whales rapidly converged on the attackers and appeared to
1754 drive the killer whales away.” C. Matkin pers. comm. 26 Feb 2010: “There were
1755 originally three humpback whales with about 15 KWs that were attacking the smaller of
1756 the trio. Some bloody rake marks on humpback fluke. An hour into the attack three other
1757 HW joined. KWs aborted the attack about 30 minutes later.” [We assume the humpbacks
1758 were a cow/calf pair with an escort].
1759
1760 17. 15 August 2003; Langara Island, British Columbia; Ford and Reeves (2008). “Single
1761 humpback rolled, thrashed tail flukes and flippers, and ‘trumpeted’ in response to attack.”
1762 [4-5 killer whales involved]; no kill.

1763

1764 18. 3 Sept 2003; Gabon, West Africa; Weir *et al.* (2010). “a group of three to four killer
1765 whales circled a pair of adult humpback whales for over an hour. One humpback whale
1766 was seen to repeatedly tail-lob and tail swipe. The humpback pair always dived together,
1767 with the killer whales circling above and then diving to follow. No direct interactions
1768 were observed, but the pattern persisted until the observations ceased due to deteriorating
1769 sea conditions.

1770

1771 19. 3 May 2005; Monterey Bay, CA; K. Newton and S. Benson unpubl. notes. “I don't
1772 believe there were any pinnipeds in the mix. There were 4-5 humpbacks...one seemed
1773 smaller than the others, but I wouldn't say it was a calf. It appeared that the humpbacks
1774 were coalesced by the approaching Orcas. The humpbacks came out of the huddle and
1775 charged the Orca group. Humpback blows were forceful and created a loud trumpeting
1776 sound. After the humpbacks passed through the Orcas, they huddled-up again before
1777 aligning themselves for another pass (reminiscent of a bullfight). This sequence of events
1778 continued for a couple more passes. The Orcas became more scattered with each
1779 subsequent pass. I remembered thinking that humpbacks can be fearsome if necessary.
1780 The trumpeting noise and quick forceful movements, directly at the Orcas, was
1781 impressive.” [SB] “I remember the humpbacks and orcas charging back and forth at each
1782 other. I also do not recall any pinnipeds. I just looked through the few photos we have
1783 from the event and I didn't see any pinnipeds. We watched the event for about a half an
1784 hour (from 12:30 - 1pm) before departing to resume our line transect survey. The event

1785 occurred May 3, 2005 in Monterey Bay (36.796N -122.021W). We recorded 4
1786 humpbacks and 12 orcas (my notes indicate a best of 12, high 15, low 10).” [KN]
1787
1788 20. 13 Aug 2005; Gabon, West Africa; Weir *et al.* (2010). 4-5 killer whales; “No direct
1789 interaction observed. The four adult humpback whales maintained a tight group structure
1790 and exhibited tail-swiping, but it was unclear whether this was directed at the killer
1791 whales or whether one or both species was feeding on the numerous sardine (*Sardinella*
1792 sp.) shoals in the region.
1793
1794 21. 8 June 2006; Sitka Sound, AK; Ford and Reeves (2008). “Four killer whales attacked
1795 subadult humpback by swimming onto its back in apparent attempt to submerge it.
1796 Humpback reacted by rolling vigorously at the surface to dislodge killer whales. Killer
1797 whales left after 20 min.”
1798
1799 22. 3 October 2007; Point Adolphus, Icy Strait, AK; C. Gabriele; Glacier Bay National
1800 Park Annual Whale Report 2007. “On October 3 we observed three humpback whales
1801 (adult male #186, adult male #1244 and an unidentified individual) wheeze blowing next
1802 to a group of four or five killer whales. Soon after, the humpback whales began to travel
1803 away while the killer whales began milling approximately 500 m away. We did not detect
1804 a killer whale predation event associated with this interaction and we do not know the
1805 significance of the behavior we observed.”
1806

1807 23. 2 November 2007; Tenakee Inlet, AK; Ford and Reeves (2008). “Adult-sized
1808 humpback harassed by [8] killer whales responded by repeatedly slashing with tail flukes
1809 and pectoral flippers, often while lying with ventrum to the surface.”
1810

1811 24. 30 May 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 4 KWs
1812 “with MNs”.
1813

1814 25. 13 August 2008; Monterey Bay, CA; R. Ternullo unpubl. notes. 3 transient killer
1815 whales (same group killed a California sea lion in same area day before; see #74, 75); “3
1816 [humpbacks] present”.
1817

1818 26. 23 August 2008; Monterey Bay, CA; anonymous report to R. Ternullo. 5 killer
1819 whales with 3 humpback whales.
1820

1821 27. 13 Sept 2008; Angola, West Africa; Weir *et al.* (2010). “No direct interaction
1822 observed. However, the [8] killer whales spent over 3 hours in direct proximity to a
1823 single adult humpback whale which was seen maneuvering tightly in various directions
1824 and exhibiting some longer dives with frequent belly-up rolls, headstands, tail-thrashing
1825 and flipper-slapping.”
1826

1827 28. 17 January 2009; Laubeuf Fjord east of Adelaide Is, West Antarctic Peninsula,
1828 Antarctica; R. Pitman and J. Durban unpubl. notes. “This evening we also saw a
1829 [humpback whale] swimming in the opposite direction to the [type B killer whales] and

1830 the latter could not help themselves and had to harass the lone animal. It rolled on its side
1831 several times, swatted its tail, thrashed its flippers and bellowed loudly as one of the
1832 sprouters and the ragged female [from a group of 10] harassed it at close quarters.
1833 Perhaps it was to test for a possible predation attempt or maybe just some bad boys
1834 flexing their muscles.” [the killer whales departed after approximately 2 min with the
1835 adult humpback unharmed].

1836

1837 29. 23 Jan 2012, Gerlache Strait, Antarctic Peninsula, Antarctica; R. Pitman field notes.
1838 “We pulled into a group of 50-70 small type B killer whales (possibly a fish-eating
1839 ecotype in Antarctica). “Right at the first there was a MENO [humpback whale] in
1840 among them and several OROR [killer whale] were flanking it – it looked like it could
1841 have been an attack on the larger whale. But as we stayed with them it was clear that the
1842 OROR weren’t particularly interested in the MENO and that the MENO was actually
1843 trying to keep up with the OROR that were traveling fairly fast. One of the OROR would
1844 drop back to the MENO on occasion and swim alongside it – what that was about was not
1845 clear. Also, the MENO on a couple of occasions stopped and fluked up. So, just as we
1846 saw BABN [Antarctic minke whale] and fur seals swimming along with small type B
1847 OROR, we have now seen MENO do the same thing. A fur seal was also seen among this
1848 group at one time – the person who first noticed the fur seal thought it was being
1849 attacked, much as people thought that the MENO was being attacked. My guess is that
1850 these are fish-eating OROR and the camp followers are tagging along to see what
1851 opportunities might arise. Also, there was a large flock of [Southern Giant Petrels] sitting
1852 on the water in a tight bunch and it looked like there may have been some recent feeding

1853 going on but no sign of what the food might have been. This group of OROR might be
1854 after fish that shoals around the high spot here just off Useful Island”.

1855

1856 B. Humpbacks with calves:

1857 30. Undated (pre-1988); Lesser Antilles, Caribbean; Katona *et al.* (1988). “Bequia
1858 whalemens recounted an (undated) attack by a small group of (perhaps 5) orcas on a
1859 humpback calf accompanied by its mother. The killer whales breached repeatedly onto
1860 the calf, perhaps attempting to drown it.”

1861

1862 31. October 1951; Exmouth Gulf, Western Australia; Chittleborough (1953). “Mr. J.
1863 Perkin observed in Exmouth Gulf four or five killer whales attacking a group of
1864 humpback whales consisting of two adults and a calf. One adult humpback (presumably
1865 the cow) kept the calf very close, while the other adult (possibly a bull) charged the killer
1866 whales, beating them off with its flukes. A very similar incident occurred off Point
1867 Cloates in the 1952 season. In neither case were the killer whales seen to be successful in
1868 their attacks.”

1869

1870 32. 3 August 1983; Frederick Sound, AK; Dolphin (1987). “Between 1110 h and 1915 h
1871 on 3 Aug 1983, 15 Humpback Whales were dispersed over an area of 5.5 km². A cow
1872 (12-13 m in length) and an accompanying 7 m calf were apparently feeding near a steep
1873 ridge approximately 0.4 km from the nearest other humpback (a single 13 m adult which
1874 we had under observation). At 1415 a pod of six Killer Whales (two adult males, three
1875 females, and one subadult) fed briefly near the surface approximately 0.5 km from the

1876 cow and calf and 0.8 km distant from us: splashing, rapid surface rushes, and
1877 “porpoising” behavior were seen. The Killer Whales changed direction by approximately
1878 45 degrees and swam slowly as a unit toward the cow and calf humpbacks, reaching them
1879 at 1426 h. The pod of Killer Whales then dispersed. Individual Killer Whales often swam
1880 to within 15 m of the humpbacks. The humpback cow made no discernible attempt to
1881 move the calf or herself out of the area, nor were there any detectable changes in
1882 respiration or behavior patterns. The Killer Whales remained in the vicinity of the
1883 humpbacks for approximately 12 minutes. By 1440 h the pod had regrouped and was
1884 slowly traveling off. The cow and the calf humpback continued feeding in the area until
1885 at least 1510 h.” [possibly fish-eating killer whales?]

1886

1887 33. Summer 1987; Chatham Strait, AK; D’Vincent *et al.* (1989). “Two killer whales
1888 suddenly appeared in the midst of a pod of humpbacks during a cooperative lunge feed.
1889 They targeted a calf for attack, but two adult humpbacks immediately sandwiched the
1890 calf between them, so forming a protective barrier. The calf was repeatedly raised
1891 partially out of the water by the flippers of the adults, who maintained this defensive
1892 formation for nearly 20 minutes until the killers departed. It appeared that the killers
1893 caught the humpbacks off guard, by using the humpbacks feeding vocalization to mask
1894 their approach. When banded together in large cooperative feeding groups such as this
1895 one, humpbacks appear to be more vulnerable to surprise attack. The loud feeding
1896 vocalizations and surface commotion of the cooperative groups can easily attract the
1897 attention of killer whales. When these animals move in to investigate a lunge feeding

1898 pod, our observations suggest that the typical humpback response is to stop feeding at
1899 once and disperse.”

1900

1901 34. 15 September 1991; off Gorgona Island, Colombia (Pacific); Flórez-González *et al.*
1902 (1994). “The group of killer whales comprised two adult males (8-9 m long), four calves
1903 (2-3 m long) and four females or immature males (6-7 m long).” “While following the
1904 killer whales, we also observed three humpback whales approximately 200 m in the
1905 distance, consisting of two adults (15-18 m in length), apparently a mother and escort,
1906 and a calf (approximately 6-7 m in length).

1907 “At 1500 h the group of killer whales swam directly towards the humpbacks. The
1908 killer whale females and calves separated the humpback calf from the adults while the
1909 two mature male killer whales paralleled the course of the adult humpbacks, preventing
1910 them from coming near the calf.

1911 “Periodically, the two male killer whales rapidly swam perpendicularly to and
1912 along the sides of the adult humpbacks, causing erratic movements in addition to forceful
1913 exhalations and snorting by the humpback whales.” “Fourteen minutes after the attack
1914 had commenced (1514 h); we saw an open bite anterior to the dorsal fin on one of the
1915 adult humpbacks. White blubber was clearly visible, but the injury was not bleeding. The
1916 humpback whales did not appear to attempt evasive actions or to flee rapidly from the
1917 area...”

1918 “As the male killer whales attacked the adult humpback whales, the group
1919 consisting of eight killer whale females (or immature males) and the calves surrounded
1920 the humpback calf, separating it from the adults by approximately 200 m. The killer

1921 whales, notably the calves, swam quickly around the humpback calf which remained at
1922 the surface, shaking and slashing its tail flukes, only submerging for periods of less than
1923 one minute.

1924 “The attack...was brief (only 26 min), and the mature male killer whales
1925 concentrated their attack on the adult humpback whales, who did not attempt to escape.
1926 The killer whale females and the calves were the main participants in attacking the
1927 humpback calf.” [The whales were all lost in heavy seas and it was not known if the calf
1928 was killed].

1929

1930 35. 21 November 1991; False Bay, South Africa; Ford and Reeves (2008). “Single killer
1931 whale harassed humpback adult with calf. Presumed mother repeatedly struck sea surface
1932 with flukes, and killer whale left.”

1933

1934 36. 16 November 1998; near Eden, New South Wales, Australia; Naessig and Lanyon
1935 (2004). “At 1030 hours, fishermen in the area reported observing this group of killer
1936 whales [7 individuals including 1 adult male, 1 juvenile male, 4 adult females and a calf]
1937 attacking a pod of humpback whales consisting of two adults and one calf. These
1938 witnesses stated that the killer whales attacked the tail of the calf. At one point, the calf
1939 was positioned between the two adult whales. The calf was then observed diving below
1940 the surface for an extended period, and resurfacing between the two adults. At one stage
1941 the calf dived, but was not seen again.” [The calf was apparently killed - chunks of flesh
1942 and a section of its lower jaw were subsequently observed in the immediate area].

1943

1944 37. *Ca.* 2000; Fatamanga Island, Tonga; M. Donoghue⁵. “About 10 years ago, I
1945 witnessed an attempt by an adult male orca and one presumed mature female to take
1946 down a humpback calf accompanied by mother and escort in deep water off the island of
1947 Fatamanga, in the Vava'u group of islands, Kingdom of Tonga. I was at the wheel of a
1948 40-foot sailboat under engine, and approached the interaction. When we got within about
1949 70 metres, the adult male orca charged the boat, thought the better of making contact and
1950 gave us a very close examination before diving. The putative female also dove. We
1951 approached the humpbacks, who took up station about 30 metres off our port quarter.
1952 We intended to escort the group to shallower water with a coral backdrop, and we set off
1953 at about 4 knots. The calf remained at the surface and each adult took turns to submerge.
1954 After about 5 minutes, as I looked back at the whales, the adult on the surface nearest to
1955 the vessel changed direction towards the boat, and about 2
1956 seconds later the head of the adult male orca exploded out of the water by the humpback.
1957 The orca attempted to grab the pectoral flipper, but missed. He slid down the body and
1958 clamped onto the humpback's tail fluke. For two or maybe three thrashings of the tail,
1959 the orca hung on, but there was so much power in the humpback's tail that it released its
1960 hold and we didn't see the orcas again. The humpbacks stuck with us for the best part of
1961 an hour until we separated. I have always assumed that the orca was intending to attack
1962 the calf from underneath, and that the adult put itself in harm's way.”
1963

⁵ Mike Donoghue, Threatened and Migratory Species Adviser, SPREP, Apia, Samoa, pers. comm. 9 Aug 2010.

1964 38. Ca 1998; 3 miles off the NE side of Lehua Rock, Hawaii; C. Bane⁶. 15 May 2011. “a
1965 group of orca (maybe 5-6...) that had a group of humpbacks surrounded There were a
1966 few babies/juveniles in the middle with some large whales with their heads pointed
1967 inward/tails out in a circle and on the outside of all this was a few males "patrolling".
1968 When we got close the orca dove and the larger whales were acting aggressive towards
1969 the boat, approaching the boat blowing bubbles near us, making some heavy breathing
1970 sounds from their blow-holes like when you put our lips together and let them flap as you
1971 exhale w/ tail and peduncle slaps.” “I'd have to guess there was probably 4-5
1972 babies/juveniles on the inside 5-6 on the surface and the largest adults (don't know if they
1973 were male or female, didn't get that close) on the outside patrolling were 4-5. In
1974 retrospect I wish I had a camera (digitals just came out then) and I wish I would have
1975 hung around longer and taken notes.”

1976

1977 39a-b. 8 Feb 2003; Gerlache Strait, Antarctic Peninsula, Antarctica; M. Jørgensen⁷.
1978 “Loose groups of feeding Humpback whales were seen in the distance (approximately 9
1979 individuals in all). The ship was turned to bring us closer, and already from a distance
1980 Orcas (dorsal fins) were seen in with the Humpbacks. We approached the scene, and soon
1981 found ourselves right before a mother and calf pair of Humpback whales together with
1982 approximately 15 Orcas. The other Humpbacks were scattered a little further away. My
1983 first impression/thought was, there must be really good feeding here, since the two
1984 species of whale are that close together, and with all the birds around too. Then I realized

⁶ Chris Bane, 1601 Harmonys Place, Sooke, BC V9Z 0T1 Canada, pers. comm. 15 May 2011.

⁷Morten Jørgensen, Broagergade 1, 3.th., 1672 København V, DK - Denmark, pers. comm. 18 Apr 2003.

1985 that something more was happening. The behaviour of the Humpbacks indicated stress
1986 and distress, the female was thrashing about in the water, throwing it's fluke and body
1987 back and forth, and both it and the calf were sounding irregularly, seemingly trying to
1988 stay only briefly at the surface. The Orcas were on all sides of the Humpbacks, regularly
1989 showing very close to the whales. On a couple of occasions it seemed that the female was
1990 trying to position herself between the Orcas and the calf. Whenever the Orcas were
1991 visible from the surface on one side of the pair, the mother seemed to try to get in
1992 between them and her calf. It was my very clear impression that the Orcas were after the
1993 calf. As the Humpback whales moved, quite rapidly, from the area (we turned the ship to
1994 follow), the Orcas were obviously following them, it looked like a classic chase scene.
1995 What then happened was quite interesting too: The mother and calf succeeded in
1996 swimming towards and up to a group of three adult Humpback whales. Very quickly,
1997 upon the pairs' getting practically in among these three whales, the scene reversed. The
1998 direction of the following pod of Orcas changed, they swerved approximately 90 degrees
1999 from what had been their following course, and for the next few minutes we could see
2000 what clearly looked like the three Humpback whales chasing off the Orcas! The Orcas
2001 left the scene completely, all the time with the three Humpbacks behind them, and soon
2002 after we turned the ship away and left as well.

2003 “On a least two occasions we saw, floating on the surface, large chunks of skin
2004 and blubber. The giant petrels [*Macronectes* sp.] were feeding on this (tugging and
2005 pulling), and the storm-petrels [*Oceanicus oceanicus*] were dancing around them. There
2006 was no doubt in our minds that we were seeing pieces of skin and blubber that had been

2007 torn off the Humpbacks whale (probably the calf). The largest piece was perhaps 15 by 6
2008 inches, the other piece that I recall a bit smaller.”
2009
2010 40. 24 July 2003; Pt. Augusta, Southeast AK; J. Collins⁸. *Ca.* “5 [killer whales] harassed
2011 humpback calf with cow. Cow/calf humpback stayed with feeding group of other
2012 humpbacks (just calf harassed).” “This group of transients put a humpback calf to a very
2013 strong test of strength/will. The calf was with mother humpback and cow/calf were
2014 'acting' like they were doing 'escort duty' to a pod of 6-7 Humpbacks who were actively
2015 bubble net feeding, while traveling south down Chatham Strait.” “Killer Whales first
2016 approached humpbacks... Interaction was maybe 20 minutes... Definitely the humpbacks
2017 defended with tail slapping”.
2018
2019 41. 21 Oct 2003; Cameroon, West Africa; Weir *et al.* (2010). “video footage provided by
2020 oil industry divers from a platform off Cameroon, showing a group of ten killer whales
2021 harassing a humpback whale and its young calf for over 6.5 hours. The humpbacks swam
2022 within metres of the platform in an apparent evasive attempt, and appeared to perceive
2023 the killer whales as a threat. The adult humpback was observed thrashing its tail through
2024 the water although whether this was directed at the boat containing the divers or at the
2025 killer whales was unclear. The outcome of the interaction is not known.”
2026
2027 42. 20 June 2004; Saginaw Channel, near Juneau, AK; V. Deecke unpubl. notes.

⁸ Jim Collins, Po Box 211609 Auke Bay AK 99821 USA, pers. comm. 12 Oct 2010.

2028 “transients T065A, T065A2, T086A, T101, T101A, T101B and T102 attacked and
2029 probably killed a Steller sea lion in Saginaw Channel (near the Barlow Pt. light buoy?) at
2030 approximately 11:00hrs. While still milling after the kill and exhibiting surface-active
2031 behaviour, members of the group apparently attacked a nearby humpback whale calf at
2032 around 12:30hrs. The attack apparently included chasing and breaching by the transients,
2033 but the killer whales backed off once the calf's mother approached.”

2034

2035 43. 18 Aug 2005; Tonsupa, Ecuador; J. Denkinger unpubl. notes. “at 10.34h [2 adult
2036 killer whales] swam very fast and straight to a humpback whale group of mother, calf and
2037 escort. [This group] with the calf in the center increased speed in a Northward direction.
2038 At 10.39h both orcas closed up to [the] Humpback group and while Orca male 1 breached
2039 on the calf and Orca 2 tried to push one of the adults away from the calf. Then they took
2040 turns in breaching on the calf and pushing the adults. The humpback whales tried to
2041 maintain the calf in their center and frequently tail-slapped until at 10.44h another
2042 whalewatching boat approached and divided the Orcas from the humpback whales. We
2043 tried to keep them off, but the captain wanted to save the humpback whale calf and
2044 succeeded. The orcas disappeared at 10.50h towards the coast in a south easterly
2045 direction.”

2046

2047 44. 30 August 2005; off Eureka, California; Ford and Reeves (2008). “Four adult
2048 humpbacks grouped tightly around single calf as killer whales circled closely for *ca.* 10
2049 min before departing.”

2050

2051 45. 1 July 2006; Pleasant Island, Icy Strait, AK; S. Anna; Glacier Bay National Park
2052 Annual Whale Report 2006. “observers reported seeing a group of approximately 20
2053 killer whales off southwest Pleasant Island and then approximately six adult females and
2054 immature killer whales began milling around a humpback whale cow/calf pair. The killer
2055 whales leaped over the calf and temporarily separated it from its mother. The mother
2056 slashed her flukes and produced wheeze blows when the killer whales were close and her
2057 entire body shook when she surfaced. Eventually, the killer whales appeared to lose
2058 interest and departed the area, at which time the observers believed that the humpback
2059 whale mother and calf reunited.”

2060

2061 46. 22 July 2006; Point Adolphus, Icy Strait, AK; J. Williams; Glacier Bay National Park
2062 Annual Whale Report 2006. “two male killer whales were seen traveling rapidly
2063 approximately 200 meters from Point Adolphus and then approached what appeared to be
2064 a humpback whale cow/calf pair. Shore-based observers reported that the “adult
2065 humpback began tail lobbing quiet violently for two to three minutes. Shortly after this, it
2066 appeared that the humpback was holding the calf out of the water with her head/back for
2067 about 30 seconds. The [killer whales] were visible one more time then vanished. The
2068 humpback and calf traveled west...and appeared to be swimming and diving normally.”

2069

2070 47. 20 July 2007; off Seward, AK; T. Evans⁹. “At first we were just looking at the
2071 Humpback Whales before we realized that the killer whales were attacking something.
2072 The captain of the boat was very accommodating and allowed us to observe the whales

⁹ Thomas Evans, U.S. Fish and Wildlife Service, Marine Mammals Management, 1011 E. Tudor Rd., Anchorage, Alaska 99503 USA, pers. comm. 12 November 2009.

2073 for about an hour. With whales (both species) diving repeatedly and staying under water
2074 for varying amount of time, it was difficult to tell what exactly was going on at first. It
2075 became evident that there was a calf with the 3 adult humpbacks, two of which looked
2076 big and another one almost as big as the other two. There were 7 killer whales in the pod
2077 and they took turns diving under the water and seemed intent on taking the calf. The calf
2078 would appear periodically on the surface usually with one adult close by. I didn't see any
2079 injuries - torn flukes, lacerations in the side, blood from the blow hole, or any other
2080 behavioral signs that would indicate obvious signs of injury. The calf, estimated to be
2081 18-20 ft (not quite half of the adult whales), was obviously stressed and had to have
2082 longer bouts on the surface before diving again as the attack went on but after about 45
2083 minutes the killer whale pod swam away and the calf seemed ok although there could
2084 have been some internal injuries that would manifest themselves later. I know the killer
2085 whales often go for the tongue but I am not sure if that is a method of kill or what they
2086 eat after they mortally injure other whale species that they prey upon. As we watched this
2087 event unfold it was interesting that at first it seemed like there were only 5 killer whales 2
2088 smaller males and 3 females (which were diving repeatedly) for the first 15 minutes or so.
2089 Then suddenly a large male surfaced along with another large female. My guess is that
2090 these two were harassing the calf or trying to distract the adult humpbacks while the other
2091 ones attempted to separate the calf from the adults. I assume the killer whales would
2092 either drown and/or mortally injure the calf by tearing up the flippers or flukes or
2093 ramming it causing internal damage. The tag team attack by the killer whales seemed
2094 somewhat organized and initially I thought they would get the calf as there were more of
2095 them and eventually they would wear down the calf and/or the adults. Initially the attack

2096 started further offshore (approx. 0.5 miles) and it seemed to me that it was fortunate for
2097 the humpbacks to have ended up at or found the cliff so they only had to defend 3 sides.
2098 The humpbacks didn't do any tail slapping or jumps but would surface just long enough
2099 to get air and dive again. We didn't see any attacks on the surface thus assume most of
2100 the attack was occurring underwater. The killer whales (except for the two that seemed to
2101 stay under longer) seemed to come to the surface more frequently to get air than the
2102 humpback whales although this was variable during the struggle although it was not
2103 possible to tell if the humpbacks got air each time they surfaced (the killer whales did
2104 seem to get air each time they surfaced). As far as I could tell there were no injuries to
2105 any of the killer whales. There was some fresh blood on the right pectoral fin of one of
2106 the adult humpbacks. Without being able to see what was going on under water, a lot of
2107 this is my interpretation based on what we could see from the activities on the surface.
2108 There were some vocalizations by the calf when it surfaced which sounded like it was in
2109 stress (literally fighting for its life) but I didn't take any notes and cannot remember
2110 enough to describe the sounds." Also – "I once watched 3 humpback whales defend a calf
2111 from a pod of killer whales. The humpbacks backed themselves (or at least that is where
2112 they ended up) next to a cliff in Resurrection Bay (Seward, Alaska) and successfully
2113 saved the calf. The killer whales gave up after trying for about 45 minutes."
2114
2115 48a-b. 23 Aug 2008; Monterey Bay, CA; R. Ternullo unpubl. notes. 1019 - 6 KWs
2116 "attacking MN calf?"; 10:49 – "13 MN swam up to injured calf"; 11:10 – "attack on MN
2117 resume, trumpet blows, no sign of blubber or oil"; 1230 – "KW move W, MN stay and

2118 mill”; 12:33 – “2 more MN”; 1244 – “KW make 5+ min dives”; 1249 – “KW
2119 spyhop/mill, end?”.

2120

2121 49a-b. 28 Feb 2010; Southern Bransfield Strait, Antarctic Peninsula, Antarctica; R.
2122 Pitman field notes. “The MENO [humpbacks] were blowing hard and kicking up a bit of
2123 a fuss and then we saw some [30-40] OROR [killer whales] among them – these were
2124 small Type B killer whales, including some we saw last week further south. The OROR
2125 were swimming right in among the MENO and seemed to be checking them out – there
2126 were some fairly small calves among the MENO. The MENO were bellowing, raising
2127 their flukes and flippers in the air and charging around a bit. While we were there for the
2128 first 45 min or so, other MENO came into the area [total 10]. The OROR didn’t seem too
2129 interested and moved on – the MENO followed along after them but seemed to lose
2130 interest and most of the group went their own ways. We continued to stay with the
2131 OROR as they appeared to be foraging among and staying with the MENO – the MENO
2132 seemed less concerned all the time. The OROR, mainly females and calves, seemed to
2133 stay with individual MENO and were diving and turning as they dove right among them
2134 – they seemed to be foraging and it looked like maybe there were fish associated with the
2135 MENO that the OROR were after. The guess here is that the MENO panicked when the
2136 first saw the OROR and sent out an alarm call that lots of other MENO heard and
2137 responded to – mobbing. Once they figured out either these were not the bad OROR, or at
2138 least these were not attacking OROR, the MENO dispersed and went their separate ways.
2139 Must be some kind of fish around here that these guys are after.” [small type B killer
2140 whales are suspected fish-eaters; Pitman (2011)]

2141

2142 50. 14 Aug 2010; Frederick Sound, AK; J. Katakura unpubl. notes. “When I found the
2143 blow and approached the group, humpbacks had already run after the orcas. Humpbacks
2144 were 5 individuals including 1 calf. 3 adults were running after the orca considerably
2145 positively. Their movement was like mating of the breeding area. 1 adult and 1 calf were
2146 swim after their, and have parted somewhere at once [a cow/calf pair were also chasing
2147 the killer whales but they departed almost immediately]. Orcas were about 15 individuals
2148 including 2 or 3 calves and 4 or 5 males. They hardened like the group, escaped from the
2149 humpbacks, and were swimming fast. Both of them surfacing senses were about 3
2150 minutes. Humpbacks chased orcas about 30 minutes. After the chase, humpbacks group
2151 and orcas group had parted. The orcas and the humpbacks have surfaced sideward soon
2152 about my boat many times. But I was not able to take a lot of photographs because I was
2153 scary. And unfortunately, I did not have a video camera. Do you believe this story? I
2154 think only that the humpbacks were angry because orcas approached their calf.”

2155

2156 Gray whale (*Eschrichtius robustus*)

2157 51. 8 June 2001; Icy Strait, AK; anonymous report to D. Matkin. “4 [killer whales] attack
2158 gray whale briefly. Single humpback swam by close, kept going – no interaction.”

2159

2160 52. 22 April 2008; Monterey Bay, CA; M. Srinivasan, R. Ternullo, and N. Black unpubl.
2161 notes 2 Nov 2009. “At 1611 hours, we started recording behavior and location
2162 information at 10-minute intervals. We also took photographs of all animals involved in
2163 the activity for later identification.

2164 “We observed approximately 5 killer whales, including an adult male seen earlier
2165 in the morning. The killer whales were within 10-15 meters of the gray whale mother/calf
2166 pair. The gray whale calf had already sustained attack marks and appeared bruised. Two
2167 adult humpback whales were also spotted in the vicinity (~ 100 meters) of the killer
2168 whales. Around 1626 hours, a humpback whale was spotted within 10 meters of the gray
2169 whale calf with a male killer whale (CA20) surfacing directly in front of the calf,
2170 appearing to block its movement. Occasionally, the humpback whale would raise its tail
2171 flukes near the killer whale. During this time period, the mother gray whale was nearby
2172 (~ 15 m) but not beside the calf. The humpback whale was closest to the gray whale calf
2173 at this time.

2174 “At 1635 hours, we observed only the humpback whale surfacing with the gray
2175 whale calf (side by side). The humpback whale engaged in lob-tailing and occasionally
2176 raised its pectoral flippers or flukes near the killer whales. However, at 1636 hours only
2177 killer whales were observed, surfacing frequently at the same location. At 1637 hours, the
2178 gray whale calf surfaced alone followed by a 2-3 killer whales (~ 25 meters away), in
2179 turn followed by the humpback whale (~25 meters). The calf was alone and was
2180 surfacing roughly in 12-15 sec intervals. The killer whales followed the calf closely and
2181 engaged in repeated dives with short surface intervals of 2-3 minutes apart.

2182 “At 1642 hours, we observed the mother gray whale and calf surface next to each
2183 other; the pair had been separated for 10 minutes, last seen side by side at about 1632
2184 hours. The calf appeared injured with one pectoral flipper bleeding. The killer whales
2185 made repeated dives of less than a minute and surfaced directly in front of or beside the
2186 gray whales. During this period both mother and calf appeared motionless at the surface

2187 and were positioned on their sides touching each other. The calf was jolted from below
2188 by the killer whales at least 3 or 4 times causing it to buckle and rise above the water
2189 surface. One killer whale leapt and fell directly over on top the gray whale calf. The
2190 male killer whale CA20 was not observed near the gray whales during these actual
2191 attacks on the calf. The three adult female killer whales were most involved and worked
2192 as a team. There was also no sign of the humpback whale and was last seen at 1640
2193 hours.

2194 “Around 1644 hours, at a depth of 10-15 meters, the gray whales managed to get
2195 away from the killer whales and then suddenly dove. After which, we did not detect the
2196 gray whales again. We observed no surface blows or behavior to indicate gray whale
2197 presence. The humpback whale was also not visible at the surface.

2198 “After the failed attack, the killer whales took off at high speed in the opposite
2199 direction, heading west. Perhaps depth was a factor in their decision to give up further
2200 attack. Notably, all animals were first observed at a depth of 60 meters. Throughout the
2201 attack phase, the gray whales continued to move into the shallows, assuming a straight
2202 track towards shallower waters. It is also interesting to note the smaller group size of the
2203 attacking killer whales, which could have limited their ability to hunt effectively and
2204 quickly?

2205 “As we followed the killer whale pod, we observed a second group of killer
2206 whales ahead of our group. Both groups were porpoising and heading west. At 1722, we
2207 lost track of both groups of killer whales.

2208 “...humpback whale roles in such predation events may have protective or
2209 disruptive functions. Thus, they may either directly harass/confront killer whales

2210 (disruptive) or block killer whale access by staying close to the gray whale calf
2211 (protective). The latter maneuver was the preferred option for the humpback whale in the
2212 April 22nd interaction described above. However, it will require sustained surface and
2213 underwater observations combined with species-specific data to explain the precise
2214 nature of this unique multi-species interaction.”

2215

2216 53. [undated]; Monterey Bay, CA; L. Beraha¹⁰. “it did appear to me on various occasions
2217 that the humpbacks were coming to the rescue of both sea lions and gray whales. As
2218 described in your paper [Pitman and Durban 2009], at first we thought perhaps the killer
2219 whales were harassing the humpbacks when we observed increased activity at the
2220 surface. However it soon became apparent that the humpbacks were not intimidated by
2221 the KW but appeared to be pursuing them. It was also quite uncanny the way one day
2222 we had traveled quite a distance to observe a group of killer whales attacking a gray
2223 whale mother and calf pair and out of NOWHERE, a humpback whale came trumpeting
2224 in followed by another and then another until we had about 5 or more humpbacks in the
2225 immediate area. It was strange because during the entire journey with several observers
2226 on effort, not a single humpback whale had been observed. It seemed quite clear that the
2227 KW/gray whale interaction had attracted the humpbacks, though I cannot say whether it
2228 was motivated by curiosity, playfulness or an act of benevolence. The result however was
2229 that the gray whale cow/calf pair was able to escape. I also personally observed several
2230 sea lions surviving predation attempts as a result of humpbacks whales distracting killer

¹⁰ Lori Beraha, P.O. Box 1554, Santa Cruz, CA 95061 USA, pers. comm. 4 Nov 2009.

2231 whales.” [A number of these events are probably described elsewhere in this Appendix
2232 but this offers a different observer’s point of view.]
2233
2234 54. 3 May 2009; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 10:44 – 15
2235 KWs and “3 + 4 MN”; 11:37 – “confirm ER [gray whale] kill”; 15:41 – “MN move off
2236 W”.
2237
2238 55. 3 May 2012; Monterey Bay, CA; A. Schulman-Janiger and N. Black unpubl. notes.
2239 [When they arrived at 12:35, on the Pt. Sur Clipper, 10 Bigg’s killer whales were
2240 attacking a gray whale cow/calf pair and 2 humpbacks were initially present. Humpback
2241 whale photo-identification images taken during this nearly 7-h encounter indicated that at
2242 least 16 different humpbacks were involved; we had encountered three of them earlier,
2243 feeding at different locations.] “The gray whale calf was rolling and bleeding; its mother
2244 was holding calf up. We saw the gray whale calf take at least 6 breaths within one
2245 minute; killer whales were jumping on top of it. We saw the killer whale calf dive right
2246 where the gray whale cow/calf pair went down – followed by one humpback whale,
2247 which dove in this same location. There was a second humpback whale very close to this
2248 action. We heard the humpback whales trumpet blow. (Note: Trumpet blows often
2249 occurred throughout this encounter, although the frequency dropped off with time. They
2250 occurred much more often than noted specifically here).
2251 1238: The mother gray whale milled around for about seven minutes, making a few
2252 dives in the vicinity of her missing calf. A humpback whale surfaced right next to her. A

2253 few killer whales briefly escorted her toward our boat. The gray whale calf disappeared
2254 underwater; we did not see it again.

2255 1245: The gray whale mom escaped, swimming under our boat and off towards the shore.
2256 There were also two highly agitated humpback whales that had been present during the
2257 attack, surfacing as close as one body length from the killer whales. (They may have been
2258 trying to intervene in the attack). They were trumpet blowing and thrashing their flukes.
2259 A few black-footed albatross circled over the scene.

2260 1248: The two humpbacks followed or chased the killer whales. Within 10 minutes after
2261 the kill, three more humpbacks came into the area, joining with the original two; two
2262 additional humpbacks later joined them.

2263 1300: A slick appeared on the water. The gray whale calf was dead, but the humpbacks
2264 continued to remain in the area where the calf was last seen.

2265 [1300 onward: The killer whales came together as a pod and circled the area where the
2266 humpbacks were. They broke up into subgroups. Occasionally they approached the
2267 humpbacks - spyhopping and breaching a few times. More often, humpbacks approached
2268 the killer whales.]

2269 1306: A SMALL SEA LION lay motionless in the water nearby; it did NOT approach
2270 the slick.

2271 1307: One humpback whale did a headstand

2272 1313: Humpbacks thrashed their tails; more humpbacks followed the killer whales.

2273 1316: Humpbacks huddled in a tight group of seven, facing killer whales

2274 1323: A humpback slashed its long pectoral flipper through the water

2275 1324: A humpback whale-fluked and partially rolled (next to another fluking
2276 humpback); its fluke matched that of a surface feeding humpback we had encountered
2277 this morning (at 1056). This humpback had been at its feeding area 2 hours 28 minutes
2278 earlier, 3.6 nautical miles from our current location

2279 1325: The humpbacks followed the killer whales.

2280 1330: A humpback rolled onto its side; one killer whale was VERY close to the
2281 humpback, and the humpback's flipper may have made minor contact with the killer
2282 whale.

2283 1331: A humpback approached the male killer whale - raising its flukes high up next to
2284 at least 3 killer whales.

2285 1332: A humpback whale came up directly behind three killer whales, fluked high, and
2286 then tail slashed toward the killer whales. The humpback whale's fluke matched that of a
2287 surface feeding humpback that we had encountered earlier this morning (at 1052). This
2288 humpback was the last one that we had photographed before turning around to search for
2289 killer whales; we received the call about this attack just over an hour later. We were then
2290 about 6 miles away from the attack scene; it took us 30 minutes to arrive at the scene.

2291 This humpback had been at its feeding area 2 hours 40 minutes earlier - 3.5 nautical
2292 miles from our current location – and had left its feeding site and moved to the gray
2293 whale attack site.

2294 1338: A humpback turned on its side, thrashing – then turned upside-down. This
2295 humpback was missing its left pectoral flipper, and was confirmed through photo-id and
2296 biopsy to be a male.

2297 1345: Noticeably more black-footed albatross have moved into the area, along with some
2298 gulls.

2299 1346: The male killer whale passed about 25 meters from three humpbacks; the
2300 humpbacks rolled onto their sides.

2301 1349: The male and female killer whale passed the humpbacks; one humpback rolled
2302 onto its side,

2303 1350: The killer whales moved together in a tight group – including the killer whale
2304 cow/calf pair.

2305 1351: The humpbacks moved away from killer whales.

2306 1352: The killer whales surfaced near three humpbacks; the furthest humpback rolled on
2307 its side and tail-slashed, the middle humpback logged as it faced the passing killer
2308 whales, while the third humpback surfaced WITH the male killer whale – no more than a
2309 few meters away from him. As the killer whales milled, the humpbacks turned, tail-
2310 slashed, and produced trumpet-blows.

2311 1353: One humpback rolled onto its side, and released a MASSIVE DEFECATION;
2312 then it turned upside-down as a killer whale passed perhaps 10 meters away.

2313 1355: The killer whale cow/calf pair surfaced nearby. Other killer whales surfaced near
2314 us, as the humpbacks logged outside of the killer whales – facing the opposite direction.

2315 1358: Three humpbacks surfaced together.

2316 1400: Eight killer whales – including the calf – surfaced very close to us. – in the slick.
2317 They passed very close to the humpbacks – going in the opposite direction. As the large
2318 male killer whale passed them, one humpback tail-thrashed. Humpbacks continued to

2319 fluke and tail-thrash as the killer whales moved away. One humpback rolled onto its side,
2320 then turned upside-down. One humpback tilted its chin up.

2321 1402: One humpback fluked near the killer whales and the gray whale calf carcass; this
2322 was the same humpback that we had photographed earlier at its feeding site [1332]. This
2323 humpback's distinctive fluke bore many healed killer whale tooth scars, acquired during
2324 a previous encounter. The single-flipped humpback is seen again.

2325 1411: Killer whales turned and passed by again; four humpbacks huddled close together,
2326 rolling, tail-slashing, and trumpet-blowing.

2327 1422: An albatross sat on the slick. One humpback spyhopped; all four humpbacks
2328 stayed tight together.

2329 1440: One killer whale did a headstand in the slick (likely feeding on the gray whale calf
2330 carcass). Six other killer whales stayed in a tight group – including the calf – at the edge
2331 of the slick. The killer whale calf was tucked into the middle of the chorus line. A male
2332 and female killer whale traveled together, separated a bit from the main group.

2333 1455: The killer whale subgroup passed close by, followed by humpback whales,
2334 including a large, flop-finned female [had been photographed with a calf on previous
2335 occasions].

2336 1459: Two humpback whales surfaced and closely approached the male and female
2337 killer whales' right sides at a 90 degree angle (the most common humpback whale
2338 approach angle), submerging just feet away.

2339 1500: Many birds were circling over the growing slick. Phalaropes gathered (krill-
2340 eaters). Killer whales milled in different directions.

2341 1502: Two humpbacks approached the killer whales' left sides (at 90 degree angle).

2342 1506: The killer whales milled in subgroups – one on the edge of the slick, and one in
2343 the slick. The humpbacks stayed tight together between the subgroups. More birds flew
2344 in and settled on the slick, while others flew over the slick.

2345 1507: One killer whale breached twice. The slick has grown MUCH larger.

2346 1508: The killer whale calf sub-pod passed close by us, diving into main slick; the
2347 humpbacks surfaced and dove in the same area. The killer whales surfaced again and
2348 dove in the same area. The male killer whale surfaced and dove. One humpback raised its
2349 chin; others arched, tail-slashed, and released trumpet-blows. Sooty shearwaters flew
2350 close to the water, inspecting it.

2351 1513: The male and female killer whale pair surfaced very close to us.

2352 1516: One humpback raised its flukes especially high. The humpbacks and killer whales
2353 surfaced together – heading in opposite directions – less than 7 meters apart. When the
2354 humpbacks surfaced again, they were facing the same direction as the killer whales.

2355 1519: The killer whales milled around the gray whale calf kill. THE HUMPBACKS
2356 PRODUCED MANY TRUMPET BLOWS. ABOUT SEVEN HUMPBACKS WERE
2357 NOW PRESENT. One humpback appeared to consistently guard the gray whale calf
2358 carcass – trumpeting and tail-slashing as one killer whale repeatedly approached it and
2359 fed on it. The slick is now over 200 meters across. (Blubber is NOT visible).

2360 1522: The killer whales surfaced near the Sea Wolf II; ~10 albatross sat in the large
2361 slick, which has grown to more than 200 meters across; others flew above it. Humpbacks
2362 logged at the surface, facing the opposite direction as the killer whales.

2363 1523: There were still about 10 albatross in this area, sitting on the slick or flying fly. A
2364 few small sea lions may have been spotted nearby. The killer whale(s) had torn a few
2365 pieces of flesh off of the gray whale carcass.

2366 1528-15:40: **A young female killer whale repeatedly dove into the slick, obviously
2367 feeding - tearing pieces off of the gray whale calf's carcass. A juvenile killer whale
2368 stayed by her side, appearing to also feed. Other killer whales came into the slick
2369 (including the killer whale calf), but most of the active feeding appeared to be from these
2370 two killer whales.

2371 1538: Three humpbacks approached the killer whales within 30 meters (from a 90 degree
2372 angle) then followed them at about 10 meters.

2373 1540: One killer whale turned on its side as it dove; a humpback whale charged up high
2374 out of the water at that location, releasing an underwater blow and trumpet blow as it
2375 spyhopped/lunged.

2376 1541: Two humpbacks dove, rolled, and closely followed the milling killer whales.
2377 Other humpbacks were still in sight near the slick area. Scraps of tissue from the gray
2378 whale calf carcass floated up onto the water's surface in the slick above the feeding killer
2379 whales. MANY albatross and gulls landed in the slick and picked up scraps of flesh

2380 1545: Two humpback whales logged at the surface as the killer whales moved away.

2381 1553: Two humpbacks suddenly did surface lunge-feeding once - right in front of us.
2382 (This was the ONLY time we saw any of the humpbacks in the gray whale calf kill area
2383 stop to feed on the very abundant surface krill; there were an estimated 100+ surface
2384 feeding humpback whales within five miles of our location).

2385 1559: There were MANY circling birds. One killer whale did a headstand on the gray
2386 whale calf's carcass: a large quantity of blood appeared in the water

2387 1600: The killer whales tore loose a HUGE section of the gray whale calf's grooved
2388 throat area; it floated on the water's surface. Seven albatross landed and fed on this flesh,
2389 squabbling noisily. The killer whale tore a smaller piece off; it floated up to the surface,
2390 and five albatross landed on the water and fed on it – joined by killer whales that took
2391 this throat section away. 3 humpbacks in area. The slick from the carcass now covers ½
2392 mile of water.

2393 1608: A second slick formed about ¼ mile away. Birds flew over to that spot and started
2394 to circle over it. We spotted an eleventh killer whale, a male not yet seen today: CA217,
2395 AKA "CHOPFIN", "STUMPY", "STUBBY".

2396 1615: The slick is still about ½ mile diameter. Three humpbacks milled over the area of
2397 the gray whale calf carcass. Our boat was about ¼ mile from the slick. Some birds are
2398 flying away from slick.

2399 1617: Some of the killer whales pulled pull more pieces of the gray whale calf's throat to
2400 surface, away from the humpbacks. Pieces of the calf's throat floated at the water's
2401 surface. (The birds in the area did not fly near the humpbacks).

2402 1624: A humpback whale fluked nearby; its fluke matched that of a surface feeding
2403 humpback that we had encountered earlier this morning (at 1017). This humpback had
2404 been at its feeding area 6 hours 7 minutes earlier - 4.1 nautical miles from our current
2405 location.

2406 1625: The killer whales split into 2 groups, separated by about 1/4 mile: ~6 killer whales
2407 were in the first slick (CA45s, CA46s, CA113s); ~5 killer whales in 2nd slick (CA216s,
2408 CA217-CHOPFIN).

2409 The humpbacks tail-slashed in the first slick – directed toward the killer whales.
2410 The humpbacks exhaled underwater, and followed the male killer whale. The humpbacks
2411 were scattered over ½ mile – even further; birds fed in the slick area.

2412 1626: The killer whales dove at the edge of the slick; the blood from the gray whale
2413 calf's carcass was visible in front of one killer whale as many birds circled overhead.

2414 1627: Two humpbacks surfaced – trumpet-blowing and tail slashing – right behind the
2415 killer whales and the calf's carcass; the humpbacks moved from right to left,
2416 perpendicular to the killer whales. The humpback closest to the carcass directed its tail-
2417 slashes toward that feeding killer whale – just a meter away.

2418 1632: The gray whale calf carcass surfaced. Three humpbacks were still mixing in with
2419 the killer whales. ~10 black-footed albatross and 60 gulls were in the area of the carcass.

2420 The killer whales were still in 2 groups: CA45s/CA46s/CA113s - with 3 humpbacks;
2421 CA217-Chopfin-CA216s (1/4 mile away).

2422 1642: One killer whale did a headstand on the gray whale calf's carcass. Scraps of tissue
2423 surfaced; the albatross fought over them (squawking and lunging).

2424 1649: The same killer whale did another headstand on the gray whale calf's carcass. An
2425 extremely grooved section from the gray whale calf's throat came up to the surface, torn
2426 loose by the killer whale.

2427 1650 – 1653: The same killer whale did another headstand on carcass: a smaller grooved
2428 section from the gray whale calf's throat came up to the surface, torn loose by the killer

2429 whale. The same killer whale did another headstand on the gray whale calf's carcass: she
2430 comes up holding a piece of flesh in her mouth. Albatross landed and fed – MANY birds
2431 were in this area.

2432 1655: The humpbacks followed the male killer whale closely. The killer whales dove
2433 into the slick, feeding. The humpbacks also dove into the slick, near where killer whales
2434 submerged (seeming to follow them).

2435 1701: Many birds were sitting on the water. Several humpbacks tail-slashed.

2436 1703: Albatross fed on a floating piece of blubber; the killer whales surfaced, came over
2437 to that piece of blubber and also fed.

2438 1713: A humpback laid on its side, as a killer whale surfaced quickly behind (and about
2439 10 meters beyond) its fluke; birds circled over the killer whale. Two humpback whales
2440 surfaced and approached a group of killer whales – including Chopfin.

2441 1715: Albatross ate scraps of the gray whale calf's carcass that were floating on the
2442 water. Two pairs of humpbacks produced trumpet-blows and tail-slashed, as more scraps
2443 of flesh surfaced around them. One humpback turned on its side as flesh scraps continued
2444 to surface around it; birds dove right next to it – picking up the scraps.

2445 1718: The humpbacks tail-slashed right next to the killer whales that had just dove
2446 underwater in the carcass area.

2447 1721: The killer whales combined into one larger group, feeding in the slick and milling.

2448 1733: The killer whales followed the humpbacks; then the humpbacks followed the killer
2449 whales.

2450 1742: The male killer whale Chopfin surfaced ½ mile away from the rest of the killer
2451 whales; (we haven't noted his presence for nearly 30 minutes).

2452 1746: Chopfin surfaced by himself; 4-5 other killer whales followed ~100 meters behind
2453 him.

2454 1750: Phalaropes were everywhere here, as were heavy patches of surface krill.

2455 1754: Chopfin and the CA216s approached very close to our boat.

2456 1756: Chopfin CLOSE approached our boat by himself; the other killer whales were in 2
2457 groups, ¼ mile away.

2458 1800: A killer whale spyhopped twice and breached once; they may have stopped
2459 feeding on the carcass. (Humpbacks possibly interfered with the killer whales feeding).

2460 1805: The larger male killer whale surfaced VERY close to our boat. A sprouter male
2461 killer whale close approached the left side of a diving humpback.

2462 1810: The killer whales milled and dove in the slick, with albatross sitting nearby.

2463 1812: A humpback dove into the slick where the killer whales had been feeding.

2464 1816: Chopfin surfaced ¼ mile away from the first sub-pod. (in a slick with no birds
2465 present), which was ¼ mile from the other sub-pod of killer whales Humpbacks followed
2466 them out. Killer whales were spread over 1/2 mile (three groups of killer whales).

2467 Chopfin stopped milling. The killer whales were moving slower now, with few birds over
2468 them.

2469 1821: The killer whales were diving longer and spreading out.

2470 1826: Three or four humpbacks surfaced close to us (including the flop-finned female),
2471 with the killer whales surfacing further away.

2472 1830: Three to four humpbacks surfaced together.

2473 1831: Most of the killer whales – including the cow/calf pair - surfaced very close to our
2474 boat.

2475 1834: Chopfin closely approached our boat.

2476 1837: One killer whale breached twice nearby.

2477 1841: One humpback rolled onto its side.

2478 1842: At least two humpbacks dove right where killer whales had just submerged.

2479 1843: A killer whale and two humpback whales surfaced simultaneously in the same

2480 area; the killer whale headed slightly away. One surfacing humpback rolled onto its side

2481 after the killer whale submerged.

2482 1845: One killer whale turned onto its side and did a tail-slash!

2483 1848: The larger male killer whale lobtailed and raised his flukes high. The killer whales

2484 headed southwest in two groups, 200 meters apart.

2485 1853: The cow/calf killer whales surfaced nearby, right on the edge of the slick.

2486 1856: A humpback whale surfaced and logged, facing three surfacing killer whales that

2487 were within 7 meters of it; as the killer whales submerged, the humpback tail-slashed.

2488 1858: A male killer whale did a prolonged headstand nearby.

2489 1859: The same male killer whale dove. A nearby humpback rolled onto its side, then

2490 turned upside-down. Two or three other humpbacks surfaced on their sides; all

2491 humpbacks rolled tightly together.

2492 1902: The killer whales milled. Two humpbacks followed the killer whales, moving back

2493 and forth.

2494 1904: The cow/calf killer whale pair surfaced next to a humpback that was on its side;

2495 the humpback did a tail-slash as the cow/calf pair dove right next to it; Another

2496 humpback raised its fluke toward a killer whale (that was accompanying the cow/calf

2497 pair), and slashed it toward a fourth diving killer whale in that subgroup that was

2498 departing. An albatross sat on the water right next to the humpbacks. Birds dove into the
2499 surrounding water.

2500 1906: One humpback lay on the surface near the killer whales, as another humpback
2501 fluked right next to it; the fluke waved about and nearly touched the humpback that was
2502 at the surface. (The gray whale calf carcass possibly surfaced right between the two
2503 humpbacks, abutted against the humpback that was logging at the surface). An albatross
2504 sat on the water right next to the humpbacks; a few killer whales circled the humpbacks
2505 on the edge of the slick, a short distance away.

2506 1911: The killer whales milled with the humpbacks. Three humpbacks rolled onto their
2507 sides in the slick, and tail-slashed near the killer whales – loudly trumpet-blowing. An
2508 albatross sat on the slick.

2509 1914: One humpback lay on its side near the killer whales, raising a half-fluke up toward
2510 the killer whales. When we left, at 1914, the killer whales were still feeding and
2511 socializing; most of the humpbacks were further off but still hanging around, still trumpet
2512 blowing - although not as often as before. One humpback was still diving in the area of
2513 the gray whale calf carcass as we left.

2514 SUMMARY (1300 onward): The killer whales came together as a pod and circled the
2515 area where the humpbacks were. Both species broke up into sub-groups. Occasionally the
2516 killer whales approached the humpbacks - spyhopping and breaching a few times. Nearly
2517 always, it was the humpbacks that approached the killer whales and followed (and even
2518 possibly chased) them. Most of the tail-slashing shown by humpbacks seemed directed to
2519 either the killer whale who was actively feeding on the gray whale carcass, or to the
2520 larger male; in both types of situations, the humpback whale was especially close to the

2521 killer whale – and often released very loud trumpet-blows. The seven humpbacks initially
2522 stayed in a tight group, later sometimes breaking up into subgroups, then returned to tight
2523 formation. Sometimes they approached the killer whales, trumpeting and tail-slashing,
2524 flipper waving, spyhopping; they often closely followed the killer whales. They
2525 repeatedly dove into the slick area where the calf was last seen. Occasionally they
2526 surfaced within a few feet of a killer whale. The closest encounters involved a humpback
2527 that turned on its side or back; one humpback raised its head up toward a surfacing male
2528 killer whale – keeping it up for some time. A few more humpbacks came in toward the
2529 end of our encounter.” [A BBC film crew was on board and photographed much of this
2530 incident.]. J. Mayer¹¹, captain of SeaWolf, reported: “At 12:00pm I spotted an area of
2531 splashing and disturbance in the water. Upon further examination it was clear that there
2532 were many animals thrashing about within close range of each other. There was Transient
2533 Killer Whales, two Humpback Whales, and cow and calf Gray Whales. The Killer
2534 Whales were clearly attacking the Gray Whale calf as the cow tried to fend away the
2535 Killer Whales. Within very close distance of the attack was the two Humpback Whales
2536 they appeared to follow the attack as the attack was moving about. Often the Humpback
2537 Whales would charge up next to the Killer Whales and ‘trumpet blow’, ‘Tail Slash’, or
2538 rollover on their side. It seemed clear that the behavior of the Humpback Whales was
2539 unsettled and aggravated perhaps even aggressive toward the Killer Whale attack. It
2540 could easily be interpreted that the Humpback Whales may have been acting instinctively
2541 toward the Killer Whales as to protect the Gray Whale calf or disrupting the attack. The

¹¹ John Mayer, 605 Williams Ave., Seaside, CA 93955 USA, pers. comm. 3 May 2012.

2542 Humpback Whales were relentless in keeping close proximity to the attack the entire time
2543 it lasted.”

2544

2545 Minke whale (*Balaenoptera acutorostrata*)

2546 56. 27 July 1996; near Glacier Bay, AK; Andy Spear and D. Matkin; Ford *et al.* (2005).

2547 “a group of 13 transient killer whales in close high-speed pursuit of an adult-sized minke

2548 whale. As the transients and minke drew near to the boat, the minke slowed and

2549 approached closely alongside the boat as if it was attempting to hide from the attacking

2550 whales. At this point, the transients caught up to the minke, and the adult male T63 began

2551 ramming it repeatedly from beneath. Individual transients positioned themselves in front

2552 of the minke to block its forward path and prevent it from diving. On two occasions, a

2553 humpback whale approached to within 50 m of the scene of the attack. Each time, T63

2554 left the minke and rammed the side of the humpback several times. The humpback

2555 responded by rolling over and thrashing its tail flukes towards the killer whale, which

2556 then returned to the minke attack.” D. Matkin: “the minke died and sank to the

2557 bottom. The killer whales stayed in the area for a couple hours afterwards, diving and

2558 feeding on the carcass. The minke bloated and surfaced belly-up three days later.”

2559

2560 Dall’s porpoise (*Phocoenoides dalli*)

2561 57. 14 Sept 2008; Monterey Bay, CA; anonymous report to R. Ternullo. 2 transient killer

2562 whales “chasing murrens [*Uria* sp.] and auklets [*Ptychoramphus aleutica*]; 2 PD [Dall’s

2563 porpoise] flee 0.5 km ahead; [KW] chasing PD [for 8 min]; escape; 1 MN [humpback]

2564 follows...trumpet blowing.”

2565
2566 Steller sea lion (*Eumetopias jubatus*)
2567 58a-c. August 1983; Frederick Sound, AK; D'Vincent *et al.* (1989). "A juvenile
2568 humpback swam directly through an area where killers were attacking a bull Steller sea
2569 lion. The sea lion was badly wounded, with large bleeding gashes from the killer whale's
2570 teeth. The killers appeared to be more interested in tormenting the sea lion than in
2571 actually eating it, for they were tossing the 1200-pound bull around as if it were a ball,
2572 and only occasionally taking a chunk out of it. At this point, a juvenile humpback
2573 appeared, and foolishly approached close enough to distract the killers from the sea lion.
2574 Immediately they closed in on the humpback, charging toward it with tremendous speed,
2575 veering off, then charging in once again. Next, two adult humpbacks [cow and escort?]
2576 swam in to join the juvenile; they flanked it on both sides and defended it by slashing
2577 their flukes at the killer whales. The humpbacks also rolled over, so that their stomachs
2578 were above the water, perhaps to protect that delicate region from attack. They also lifted
2579 their flukes and chins out of the water simultaneously, possibly because the flukes,
2580 tongue and lips are reputedly favored by the killer whales. This is a posture which we
2581 have also seen assumed by other humpbacks when in the presence of killer whales.
2582 Throughout the attack, we had a hydrophone in the water and recorded some humpback
2583 vocalizations and a great many killer whale sounds. One noteworthy sound was a very
2584 loud crash that we heard repeatedly. We believe that this occurred when a killer whale
2585 made contact with a humpback underwater, but we were unable to determine this
2586 conclusively. Eventually the killer whales divided up so that the bulls patrolled around
2587 the attack, while the females and young moved in to strike. When striking, a killer would

2588 leap into the air and come down on the whale, thrashing its tail violently, much as a shark
2589 does when tearing flesh. We did not at any time see blood or wounds on the humpbacks,
2590 yet there is no question that the killers repeatedly made contact.” [The “juvenile”
2591 humpback described here may have been the calf of one of the adults]

2592

2593 59. 13 August 1983; Frederick Sound, AK; Dolphin (1987). [What follows are two
2594 accounts independently written by witnesses to the same event but on different boats.]

2595 “at 1225 h a pod of six Killer Whales (three adult females, one subadult male, one
2596 unsexed juvenile, and one calf) were observed harassing a single medium-sized Steller
2597 Sea Lion (*Eumatopias jubatus*), charging the animal singly or in groups of twos and
2598 threes. The sea lion was, on a number of occasions, struck by the tail of a Killer whale
2599 with force sufficient to throw it several meters across the water surface (see Figure 1).

2600 We were initially attracted to the scene by splashing visible at a distance greater than 3.5
2601 km.

2602 “At 1445 h a pair of 13-14 m Humpback Whales were observed approaching from
2603 approximately 1.8 km, and were within 50 m of the Killer Whales and sea lion at 1455 h.

2604 The humpbacks moved directly into the midst of the commotion where they then
2605 separated. The humpbacks were obviously very excited, as were the Killer Whales, all
2606 swimming rapidly at the surface on their sides, striking the flippers against the water
2607 surface, lobtailing, and lashing their flukes horizontally. Respiration rates of the
2608 humpbacks were significantly increased over the usual pattern and loud in-air
2609 vocalizations (“wheezes” and “trumpets”) were emitted from their blowholes. Frequently
2610 the Humpback and Killer whales were in close proximity if not in actual physical contact.

2611 “They were joined at 1526 by a small (10-11 m) single Humpback Whale; two
2612 additional singles and a pair joined within the next 40 minutes. At 1619 h (1 h 24 min
2613 after joining with the Killer Whales) three of the humpbacks moved off and apparently
2614 began to feed at a depth of 40-60 m, based on Sonar and ventil[at]ion patterns. Three
2615 other humpbacks moved off individually shortly thereafter. At approximately 1630 h a
2616 cow and calf humpback joined the Killer Whales, remaining in their midst for 1 h 45 min,
2617 until 1745 h. During this period there were three humpbacks with the Killer Whales: the
2618 cow and calf, and a small single who joined at 1526 and remained during the entire
2619 observation. The sea lion was no longer visible.

2620 “We stayed with two of the three humpbacks which had left at 1619 h for 2 h and
2621 09 min, until 1928 h, always within sight of the Killer Whales who continued to produce
2622 occasional bursts of activity and associated splashing. At 1930 h we reapproached the
2623 Killer Whales; there were now five Humpback Whales within 0.1 km with still no sign of
2624 the sea lion. At no time was there any indication of feeding by a humpback in the
2625 immediate vicinity of the Killer Whales. We left the area at 1945 h.

2626 B. Mathews unpubl. notes, 13 Aug 1983: “At 15:17 we arrived in the area just off
2627 Gambier Island where “Hval Fisken” had reported that killer whales were ‘working over’
2628 a sea lion. There were 5 orca in the group – 4 adults plus one calf. From the dorsals and
2629 composition of the pod it was obvious that this was the same pod that we’d observed
2630 circling Round Rock on July 30. ‘Hval Fisken’ ...was still in the area. Three
2631 humpbacks... had joined the group by the time we arrived. What we observed follows:
2632 (also my ‘impressions’ about the incident). 15:17: A juvenile male Steller sea lion was
2633 floating and bobbing with its hind flippers up and limp. At first it appeared to be dead,

2634 but later we did see movements which indicated that it was still alive, or at least
2635 responding in a manner which indicated that it was not yet physiologically dead. It
2636 seemed to stay inverted too long without breathing to be alive, but since I didn't record
2637 every apparent breath (deduced from head raising movement ...) no quantification of this
2638 subjective perception is possible. Dan [McSweeney] dropped the hydrophone to record
2639 the sounds at 15:19. We could hear the sounds even through his headphones as he
2640 indicated that multitude of sounds were being produced. Mainly there were sounds from
2641 the killer whales, but the humpbacks were definitely producing a variety of sounds as the
2642 animals surfaced and dove around the sea lion. Some of the recorded noises may have
2643 come from the HBs or KWs.

2644 “The killer whales were leaping over and into the bobbing sea lion. Several times
2645 two of the KWs would race up to the SL and breach into the body one after the other. Full
2646 head over fluke breaches were seen. During these aerial displays there was no indication
2647 that the O. orca were grasping or attempting to bite at the Steller's SL. In between some
2648 of the aerial bouts the sea lion would either disappear, or appear to be dragged along from
2649 below. When it did disappear, it would reappear in a different location. – Dan noted this
2650 movement which must have been caused by the killer whales dragging the animal
2651 beneath the surface. Most of the breaching was by the adults (or juv), although the KW
2652 calf was right in there with them.

2653 “When we arrived at 15:17 we could see the 3 humpbacks surfacing in close,
2654 +parallel formation and about 50 ft from the seal lion. By this time the entrails were
2655 extruding from the inguinal region of the sea lion. A 4th HB came and joined the group at
2656 15:42 [whale #4]. This whale ... was one we'd identified earlier... [and] must have

2657 moved about 3-4 miles between 14:58 and 15:42. [#4] came in close to the sea lion and
2658 killer whales and at 15:42 rolled over so that we could see its ventral surface. It was
2659 approximately 80-100 ft from the sea lion. The killer whales were surfacing close by. The
2660 HB rolled rather slowly on its side again and did not appear to have any forward or lateral
2661 motion. At 15:48 it repeated this slow roll, again close to (*ca.* 50 ft) the sea lion. After
2662 this 2nd roll it arched its head up and held it out of the water for almost a ½ minute. The
2663 throat pleats did not appear to be extended, but I can't say for sure whether they were or
2664 weren't. In any event, the movement did not resemble the vertical or angled forward
2665 closes of the mouth that I've seen when whales surface creating a bubble net (BN) or
2666 during other episodes where feeding is likely. Mainly the motions were slower and then
2667 held longer than similar feeding activities. After raising its rostrum in this manner, [#4]
2668 did a slow shallow sink/dive, without tipping flukes (they were parallel to the water
2669 surface so the underside was never shown).

2670 “During the time that [#4] was rolling and finally sank, the killer whales were
2671 spread out with 3 appearing close to, or surfacing rapidly and crashing into the sea lion.
2672 Around 16:04 2 humpbacks not including [#4] surfaced together in tight formation and
2673 were heading back toward the sea lion. At 16:09 one of the killer whales...breached 2
2674 times in a row – this time not onto the sea lion but about 25 ft from it. Then two other
2675 killer whales (possibly including the original breacher) breached in near synchrony...
2676 Soon after, all 5 KWs surfaced near one another. The breaches seemed to be in response
2677 to the approaching HBs since all previous aerial displays were directed onto or close to
2678 the sea lion.
2679 16:10 – a different HB fluking, heading toward the area.

2680 16:11 -...the humpbacks have gone down again and are again oriented toward the sea
2681 lion.

2682 16:13 - ... HB surfaced. At 16:16 HB [#4] rolled slowly over onto its side – similar to the
2683 rolling earlier, but this time only onto its side. The left [pectoral flipper] was visible and
2684 remained limp and motionless – unlike the active rolling and [pectoral fin] slapping that
2685 we often see in other contexts. At 16:30 the same whales surfaced near and directly
2686 toward the sea lion. On the next surfacing it was right over the spot where the sea lion
2687 was and it rolled slowly on its side, again with the [pectoral fin] draped at the surface. It
2688 appeared that the whale’s [pectoral fin] was carried over the sea lion in a very slow
2689 movement. Because the sea lion disappeared from sight it is impossible to say where it
2690 was when the humpback passed over. The impression that I had though, was that there
2691 was either contact or close contact. The HB then continued on in the same direction and
2692 the sea lion did not return to the surface in the same spot. Instead it was a few minutes
2693 later that Dan noticed that the killer whales were at the surface about 100 ft from the
2694 previous location of the SL and that the sea lion was now with them.

2695 “At 16:36 the KWs were still making close passes and leaps near or onto the sea
2696 lion. Once again, the sea lion’s head came to the surface as [before]. Perhaps the animal’s
2697 head was pushed up from below by one of the killer whales – making it appear that the
2698 sea lion had lifted its head. Because the sea lion had been bobbing upside down and
2699 abused for such a long time (at least 4 hours – “Hval Fisken’ had arrived at 12:45 and the
2700 harassment had already begun), I find it hard to believe that it could still have been alive
2701 at this time.

2702 16:39 – blows from another HB from the south heard.

2703 16:43 – Killer whales still passing close, but fewer aerial displays.
2704 16:43 – HB surfaces near S. lion again (I believe this was whale [#4] still – there were 2
2705 others in the area also). At 16:47 2 new HBs surfaced heading away from the SL and just
2706 after they dove Dan noted that the KWs were echolocating – apparently in response to the
2707 diving whales. As it turned out, this was a cow and calf. We weren't absolutely sure, but
2708 from the dorsal sketches, it looked like [a pair] that we'd just seen east of this area about
2709 3-4 miles and about 2 hours earlier. The cow and calf first surfaced quite close to the
2710 killer whales and we could not detect any response other than the increased echolocating
2711 that Dan had noted upon their arrival. That is, the killer whales did not move toward the
2712 cow and calf from what we could tell on the surface. The calf surfaced alone shortly after
2713 16:47. At 16:48 the cow surfaced heading now toward the killer whales and sea lion, and
2714 about 180° from her first surfacing. On the next surfacing the calf (alone again at the
2715 surface) was also re-oriented toward the KW/SL group. At 16:55 the cow and calf
2716 surfaced together and still moving toward the killer whales. The calf surfaced at 16:57
2717 alone. By 17:02 both cow and calf surfaced together heading NE – away from the
2718 KW/SL area...The cow and calf continued off away from the commotion after being in
2719 the area just 15 minutes.

2720 “Around 17:30 we left the area to I.D. humpbacks...At 18:30 we returned to the
2721 scene where we found the killer whales and 2 humpbacks, but no sign of the sea lion or
2722 remains. Dan listened for sounds and recorded intermittently...The humpbacks and killer
2723 whales surfaced close together. At first I didn't see the calf in any of the three surfacings.
2724 It did appear on the 4th surfacing which was very close to our boat. The killer whales had
2725 come closer to our boat, moving away from the humpbacks. At 18:39 they circled the

2726 boat (more or less) and at 18:40 on the HBs surfaced with a killer whale just 10-15 ft
2727 away from it. The HB did a moderate tail lash as it arched and lunged forward. At the
2728 distance I couldn't tell for sure but the lash did seem to be directed toward the area where
2729 the KW had most recently surfaced.

2730 18:42 – Blows from a different humpback to the east. The whale closest to us and with
2731 the killer whales now surfaced on its side rapidly and was turning to the right. It seemed
2732 that the humpback was now following, or at least surfacing behind, the killer whales for 3
2733 or 4 surfacings as they all headed south. Two new, or rejoining humpbacks surfaced near
2734 the group at 18:59 – blowing forcefully.”

2735

2736 60. 12 September 1988; Point Adolphus, Icy Strait, AK; J. Straley¹². [text in parenthesis
2737 was added by JS at a later date for clarification]. “As I approached Pt. Adolphus at ~0930
2738 I observed breaching and ‘commotion’ off the Pt. I found 4 killer whales (a male KW
2739 and 3 females/ juveniles), 1 wounded (Steller) sea lion and MD (humpback whale - #157
2740 nicknamed MD, a male, who is typically solitary) in the tide rip. The sea lion was still
2741 alive waving a flipper but floating with visible wounds (I remember seeing intestines
2742 extruding from the body). I did not get close to the sea lion, because all whales were
2743 circling with the smaller killer whale breaching and tail slashing on top of the sea lion.
2744 All whales including MD were circling and appeared to guard the sea lion. I left to
2745 observe other (humpback groups) and returned ~30 min later. Same activity but (whales
2746 were) further east (drifted with current). MD seemed even more ‘protective’ of sea lion,
2747 mixing right in (with the killer whales). Maybe schooling fish were under the sea lion

¹² Jan Straley, University of Alaska Southeast, 1332 Seward Ave., Sitka, AK 99835 USA, pers. comm. 12 Jan 2010.

2748 but all whales seemed to have the sea lion as their object of attention. I departed at 1035
2749 (to approach other groups of whales in the area and the humpback and killer whales were
2750 still drifting east)”.
2751
2752 61. 29 August 1999, Icy Strait, AK; D. Matkin *et al.* (2007). “The longest close
2753 interaction of humpback and killer whales in Icy Strait occurred during a [Steller] sea lion
2754 kill by six transients. For 50 minutes, three [later determined from video to be 4] adult
2755 humpbacks participated by lobtailing on or near the sea lion 15 times, making physical
2756 contact with it a minimum of 10 times. The transients did not attack the humpbacks, and
2757 the humpbacks left the area together.” Also, D. Matkin¹³: “It is fascinating, as it was one
2758 of the cases when the humpbacks lobtailed slowly on the dying [Steller] sea lion, and one
2759 humpback actually reach over and touched it with its pectoral flipper. They did this at
2760 times that the killer whales had temporarily moved off a ways. When the killer whales
2761 returned and vigorously lobtailed repeatedly on the sea lion, the humpbacks exhaled
2762 loudly and slashed their flukes from side-to-side as they [the killer whales] moved away.”
2763 [Humpbacks later identified as “adult male #221 (age unknown), adult male #352 (born
2764 1984; age 15) and two unidentified humpback whales presumed to be adults based on
2765 body size” – CMG. [This account is from video footage taken by C. Kellogg from a
2766 commercial whalewatching boat. A subsequent review of the footage by CMG and JN
2767 found only a single incidence of a humpback making contact with the sea lion with its
2768 fluke. Another review by RLP and JWD found no convincing evidence that the

¹³ Craig Matkin, North Gulf Oceanic Society, 3430 Main Street, Suite B1, Homer, AK 99603 USA, pers. comm. 26 Feb 2010.

2769 humpbacks made contact with the sea lion, but were in fact directing their tail slaps at the
2770 killer whales; see main text]

2771

2772 62. 22 September 2003; Icy Strait, AK; C. Gabriele; Glacier Bay National Park Annual
2773 Whale Report 2003. “we observed two adult male humpbacks (#157 and #118) interact
2774 closely with a group of four killer whales (*Orcinus orca*) that were attacking a Steller sea
2775 lion (*Eumetopias jubatus*) in Icy Strait. The killer whales hit, leapt over and generally
2776 harassed the sea lion while it remained passive and stationary at the surface. The two
2777 humpbacks, which had been separate just prior to the start of the killer whale attack,
2778 joined together and stayed very close to the sea lion, especially when the killer whales
2779 were charging at or leaping over the sea lion. The humpbacks appeared agitated –
2780 wheeze-blowing, laterally swishing their tails and rolling on their sides near the sea lion –
2781 and stayed at the surface most of the time. Due to daylight limitations we had to leave
2782 before this multi-species interaction ended.”

2783

2784 63. 27 May 2004; off Olympic Peninsula, Washington; E. Bowlby¹⁴. “During one of our
2785 NOAA Ship *McArthur II* surveys in OCNMS we encountered a pod of [*ca.* 8] transients
2786 toying with an adult Steller sea lion. We stopped to film it (an hour of video), in which
2787 the young orcas were apparently given the freedom to make periodic rushes at the
2788 obviously stressed and partially immobilized sea lion. But during this hour, the adult
2789 orcas, especially one bull, kept [*ca.* 3] humpback whales corralled in a larger perimeter
2790 while the sea lion was being harassed. After the sea lion was eaten and just before the

¹⁴ Ed Bowlby, 133 Fencebird Lane, Sequim, WA 98382 USA, pers. comm. 2 Nov 2009

2791 ship had to resume our survey trackline, the orcas began to attack the whales. I wish we
2792 had the time to linger to see the conclusion but we had to leave.”

2793

2794 64. 6 July 2006; Frederick Sound, AK; T. van Wyck¹⁵. “I witnessed a humpback
2795 interacting with a pod of 6 transients attacking a stellar sea lion. I was very curious about
2796 what was going on, as I had never seen this behavior (but witnessed several transient kills
2797 with humpbacks nearby in the area) off of southwestern Vancouver Island. In Frederick
2798 Sound, Alaska, though, the humpback was slapping the water with its pectoral fin right
2799 by the sea lion, and lobtailing quite a bit as well. When we arrived on scene, I thought at
2800 first the orcas were attacking the humpback, but the sea lion managed to get away and
2801 shelter under our boat.

2802 “By that time the humpback left the area, and the 6 transients were left circling
2803 our vessel, with the Stellar sheltering between the two zodiacs towed at the stern of the
2804 vessel. It was quite an unusual situation!

2805 “When we arrived in 2006 on the 70 foot sailing yacht in Frederick Sound, the
2806 humpbacks, stellar and orcas where already mixed up. As experienced whale watchers,
2807 the captain and I thought that the orcas were harassing or attacking the lone humpback.
2808 Transient kills are of course fascinating and riveting and a good example of "nature, red
2809 in tooth and claw", so we stood about 150 m off, and got ready for an amazing
2810 experience. However, as we began to look closer, we noticed the humpback thrashing
2811 around (as I said before, pectoral fin slapping and slashing, and tail lobbing).

2812 “It definitely looked like the humpback was slashing, with its pectoral fins, at the

¹⁵ Thomas van Wyck, Box 1115, 601 Gibson St, Tofino BC, 0R 2Z0 Canada, pers. comm. 4 Nov 2009.

2813 sea lion. We were astonished and thought at the time that the humpback was participating
2814 in the kill. I remember noticing that the pectoral fin slashes were "late", a few beats
2815 behind as the Stellar swam on the surface alongside the humpback, with orcas following.

2816 "It's quite possible that the humpback was actually slashing at the orcas following
2817 the sea lion. Perhaps the animal wasn't late with its slashes, it might have been right on
2818 time!

2819 "I can't say much more definitive than that, I wish I had some pictures but as the
2820 mate, I was running the deck at the time. But I have a clear memory of at least 3
2821 humpback pectoral fin slashes, I remember the sea lion getting "air" at least once from an
2822 attack coming up below the surface and the sea lion porpoising towards the two trailing
2823 dinghies and parking itself right there. I can also say that I don't recall any vocalizations
2824 in the air, and missed the hydrophone because the action was pretty fast and furious.”

2825

2826 65. 31 August 2007; Point Adolphus, Icy Strait, AK; D. Matkin and J. Neilson; Glacier
2827 Bay National Park Annual Whale Report 2007. “On August 31 we observed a group of
2828 four transient killer whales attacking a Steller sea lion (*Eumetopias jubatus*) near Point
2829 Adolphus in Icy Strait. Several hours later, near the end of the kill, two humpback whales
2830 approached the kill site wheeze blowing and tail slashing at the remains of the dead sea
2831 lion. Based on dorsal fin photographs taken by killer whale researcher Dena Matkin, we
2832 identified the humpback whales as adult male #166 and whale #1907 (age class and sex
2833 unknown).” [#1907 was later identified as an adult female based on 2008 sighting with
2834 calf].

2835

2836 66. 14 Oct 2008; Swiftsure Bank, off Southern Vancouver Island, British Columbia; B.
2837 Gisborne and V. B. Deecke unpubl. notes 20 Dec. 2009. “We encountered this group [of
2838 10 transient killer whales] as they were attacking a large juvenile or adult female Steller
2839 sea lion. It is not sure how long the attack had been going on, but the sea lion was still
2840 alive for the first 45 min of the encounter. At some point during the encounter, a second
2841 sea lion joined the one being attacked resting close next to it for about 10 min. There had
2842 been several humpbacks in the general area when we first encountered the whales.
2843 Several humpbacks approached the killer whales closely at about 11:00 hrs and between
2844 4 and 7 humpbacks remained around the killer whales until the killer whales moved away
2845 at about 12:00 hrs, long after the Steller sea lion was dead. Killer whales and humpbacks
2846 were often within a body length of each other and in general it was the humpbacks
2847 following the movements of the killer whales rather than vice versa. We did not observe
2848 any physical contact between humpbacks and killer whales or between humpbacks and
2849 the prey in this encounter. The humpbacks trumpeted frequently. We recorded
2850 underwater sound from 10:59 to 11:30. There was almost constant vocal behaviour from
2851 humpbacks and killer whales with vocalizations from both species often overlapping.
2852 There were also many prey handling sounds presumably generated by the killer whales
2853 breaking up the sea lion carcass.”
2854
2855 67. 21 Aug 2010; west coast of Vancouver Island, British Columbia, Canada; Rod Palm
2856 pers. comm. 10 Bigg’s killer whales attacking a Steller sea lion were approached by a
2857 single humpback; interaction lasted at least 39 min; sea lion “very likely” killed.
2858

2859 68. 11 Aug 2011; Clayoquot Sound, British Columbia, Canada; R. Palm pers. comm.
2860 “Randy Frank (whale watch driver/interpreter) was watching Ted's gang (T041 [Bigg's
2861 killer whales]) in the company of two other gangs (16 animals in all) in the process of
2862 making a sea lion kill when in comes a Humpy trying to position itself between the
2863 [Steller sea] lion and the Killer Whales. He was making a big fuss with tail and pectoral
2864 thrashing. Sad, for the lion, this apparent rescue attempt was unsuccessful as the Killer
2865 Whales eventually enjoyed their meal. This behaviour has been observed on many
2866 occasions throughout the Pacific Northwest and is very curious in that Humpys are, on
2867 occasion, targets for the Kawkawin [killer whales].”

2868

2869 69. 31 August 2012; Icy Strait, AK; C. Gabriele and R. Gordon unpubl. notes.
2870 “Interpretation Ranger Rebecca Gordon and I were on the Sand Lance in Icy Strait, doing
2871 a humpback whale photo-ID survey. Viewing conditions were good, with flat seas and
2872 sunshine. We had spent an hour with a widely dispersed pod of resident-type killer
2873 whales and were just beginning to approach the numerous humpbacks about $\frac{3}{4}$ mile
2874 offshore, west of Point Adolphus. Around 10:50 AM, while we were photographing two
2875 single humpbacks, one of them, adult male #117, was wheezing for no apparent reason as
2876 he swam West. Rebecca noticed a sea lion leaping, and some killer whales (KWs) about
2877 $\frac{1}{2}$ mile further West of us, in the opposite direction from where the resident KWs had
2878 been. At 11:06 we approached them and found a mother, calf and adult KW circling and
2879 diving in one area (*i.e.* typical postkill milling behavior) and two agitated adult humpback
2880 whales (HWs #1306 and #2315, both adults of unknown sex) wheezing and closely
2881 following the KWs. The KW group included transient-type KW #T086A and others.

2882 No sea lion was sighted, but we presume that it had been killed and was being eaten by
2883 the KWs underwater.

2884 “The KWs were diving for 2 to 4 minutes, closely followed by the HWs, who
2885 dove and surfaced with the KWs. The KWs would surface for about 1 minute, seeming to
2886 travel in a West to East line at the surface, then dive. While at the surface, the HWs
2887 would wheeze and roll at the surface, doing pectoral fin extensions and tail swishes. We
2888 did not see the HWs come into physical contact with the KWs at the surface. The KWs
2889 exhibited no signs of visible distress and did not hasten to leave the area. Subjectively, it
2890 looked like the HWs were harassing the KWs but not successfully driving them away.
2891 However, there was a net westward movement of the group over the 30 minute
2892 encounter. It is not clear whether this is explained by tidal currents or if the KWs were
2893 purposely moving. The TIDES program predicts that there was a 3.2 knot flood tidal
2894 current, which would seem to have pushed a passively drifting group East rather than
2895 West, so perhaps the movement is best explained by active swimming.

2896 “At 11:30, we found and photographed a floating glob of blubber and muscle with
2897 short hairs mixed in that was being scavenged by gulls, which are consistent with a sea
2898 lion kill. The killer whales were about 250 m away at the time, and we were alerted by
2899 black-legged kittiwakes and glaucous-winged gulls (GWGU) that were looking for
2900 scraps. After we photographed the sample (later sent to NOAA Southwest Fisheries
2901 Science Center to confirm species), we collected a small sample and put it back in the
2902 water. Not long afterward, a juvenile GWGU landed near it, vocalized and then gulped
2903 down the impressively large glob in one mouthful (photos) and flew away. At 1135 we
2904 left the group to continue our work with the humpbacks.

2905 “While we were with the KWs, there were many nearby HWs within ½ mile of
2906 the scene, and none were observed to join. However, at 12:04 when the KWs were about
2907 ½ mile West of us, we were approaching a group of 4 HWs (Pod 4a = #1088-female,
2908 #1474-male, #1244-male, #1904-unknown and #351-male) for photography when the
2909 two HWs that had been with the KWs (#2315 and #1306) were suddenly with the group.
2910 There was a lot of wheezing and interaction among the humpbacks. We tried to stay with
2911 the group (Pod 4B containing all 5 whales) assuming they would maintain their previous
2912 behavior pattern (milling and feeding) but on their next surfacing, the entire group had
2913 sprinted West to where it appeared the larger group had resumed harassing the KWs.
2914 Wheezing could be heard and commotion was seen at the sea surface from a distance. We
2915 did not re-approach the KWs to confirm this impression we had from a distance.
2916 Subjectively, it appeared that the pair of HWs who were initially with the KWs came and
2917 rounded up extra help and rejoined the KWs.

2918 “We continued to photograph HWs in the area, and found many of these
2919 individuals in a large shoal of whales East of Point Adolphus by 13:00. We had left the
2920 area where the KWs were last seen, so we did not have any further sightings of them.”
2921 [humpback #1306 was later genetically identified as a male; the prey sample was
2922 genetically identified as Steller sea lion].

2923

2924 70. 10 Oct 2012; Icy Strait, AK; C. Gabriele unpubl. notes. “I was on the National Park
2925 Service research vessel *Sand Lance* in Icy Strait, southeastern Alaska doing a humpback
2926 whale photo-ID survey in good viewing conditions with flat seas and partly cloudy skies.

2927 There were probably 30-50 humpbacks (HW) within 2 miles of the Sand Lance as I sat
2928 about 500 m from the nearest whales and made audio recordings to see if I could pick up
2929 a singer, from 13:25-13:54. There were many HW vocalizations heard, but no killer
2930 whale (KW) vocalizations. While I was drifting to record, several humpbacks that had
2931 been in a few large groups to the west of me paraded eastward by the Sand Lance one or
2932 two at a time starting at 13:35. This is not that unusual, as HWs do relocate as tidal
2933 conditions and prey availability (apparently) change, but it is possible that the HWs were
2934 moving because of the KWs. At 13:45, still drifting, I saw four killer whales also
2935 traveling east right toward and under the boat. I heard no KW vocalizations or
2936 echolocation clicks although the KWs came directly toward the hydrophone and bumped
2937 or vocalized on it as they swam by (elapsed time 5:20 on the recording). At 13:59, after I
2938 finished recording, I got underway and approached the KWs for photo-ID (transient
2939 #T124A1, a medium-sized calf and two other adult sized animals); they were traveling
2940 eastward at about 4 knots with 6 minute dive times and had no visible interaction with the
2941 many HWs feeding in the area. The KWs passed within 100 m of several HWs with no
2942 sign of interaction.

2943 “At 15:00, I resumed approaching HWs because there were several to the east of
2944 me that I had not yet photographed. At 15:19, I approached a group of three HWs (Pod
2945 16: 58.29108 N, 135.77777 W) that I had seen east of Point Adolphus for the past hour.
2946 When I approached them, they immediately began wheezing, and I was unsure if it was a
2947 sign of disturbance from my approach. However, on their next surfacing they joined the
2948 KWs, which had slowed greatly and were loitering in the area. I did not see any marine
2949 mammals nearby. There was a lot of wheezing from the HWs although I had seen no sign

2950 that the KWs had made a kill (I was more than 200 m from the KWs and no longer
2951 watching them since 14:34). The KWs breached a few times and tail slapped.

2952 “At 15:28, I began to record with the hydrophone, but the recorder stopped
2953 recording 2 seconds later (!) so there were no recordings until 15:35 when I repositioned
2954 the boat because the combined group continued to travel southeastward. Many KW
2955 vocalizations were evident, and the HW wheezing was audible. There may be a few quiet
2956 HW growls, squeaks and clucks on the recording. No distant HW sounds were heard –
2957 the background ambient was quiet.

2958 “At 15:45, I stopped underwater sound recording to approach the HWs for ID and
2959 got dorsal fin and partial fluke photos of #1813 (age and sex unknown; first sighted
2960 2004, described as small to medium in size in 2004-2006), #2316 (age and sex unknown;
2961 first sighted 2009 and described as small in size) and #1832 (adult female). The HWs
2962 stayed close together and close to the KWs while all were at the surface. The HWs did
2963 many peduncle lifts, lateral tail swishes, tail throws and tail extensions near or at the
2964 KWs, but no physical contact was observed. All whales dove underwater for
2965 approximately 3 minute dive times. The KWs seemed to head toward the HWs at the
2966 surface (or maybe the HWs were directly over the unseen submerged carcass and the
2967 KWs were simply coming back toward it to keep feeding).

2968 “At 15:50, the presence of Glaucous-winged gulls alerted me to prey remains in
2969 the water near the boat. I collected a small fragment of blubber from the water (later sent
2970 to NOAA Southwest Fisheries Science Center to determine species), and the gulls
2971 quickly ate the other scraps (see photos). The sample was blubber only, and smelled like
2972 other cetacean samples I have observed, so likely came from a harbor porpoise. I saw no

2973 sign that the (presumed) porpoise was alive during any part of the interaction between the
2974 KWs and the HWs.

2975 “At 16:02, I concluded my observation and left the area to return back to Bartlett
2976 Cove due to the late hour. At last observation, the HW and KW whales were continuing
2977 to interact and travel southeastward.” [Prey sample was genetically identified as Steller
2978 sea lion.]

2979

2980 California sea lion (*Zalophus californianus*)

2981 71. 17 Nov 2000; Monterey Bay, CA; A. Schulman-Janiger unpubl. notes. Sighting from
2982 1300-1442 (102 min); “5 [humpbacks] (3 + 2) near [3 transient] KW (NO REACTION);
2983 3 [humpbacks], lots of [California sea lions] VERY close; [KW] breached on [sea lions]:
2984 hundreds flee, porpoising... ca. 30 [sea lions] headed directly toward KW, who breached
2985 on some of them. These appeared to be juvenile [sea lions]; these [killer whales] killed
2986 and ate at least one [sea lion]. NO REACTION from the nearby [humpbacks]. ”

2987

2988 72. 15 August 2006; Monterey Bay, CA; A. Schulman-Janiger unpubl. notes. Sighting
2989 from 1125-1205; “As we were approaching the [killer] whales, I saw a pair of surface-
2990 active humpbacks very close to them; at 1123, one humpback whale breached one time,
2991 and the other did at least one tail slash.” “We arrived at the sighting at 1125, and saw that
2992 the [6 transient] killer whales were with porpoising [California] sea lions, VERY close to
2993 these two humpbacks. I did not see any active behaviors from these humpback whales
2994 once we arrived - just slow surfacing. There did not appear to be a sea lion kill.” “At
2995 1132-1134 [the killer whales] milled and closely passed another pair of 2 [humpbacks] in

2996 the area. At 1137 they passed another pair of [humpbacks] ; at 1142 they CLOSELY
2997 passed 2 thermoregulating [California sea lions]. At 1145 the [KWs] split up (4+2) (3 +
2998 3)". The KW pair stayed very close to us, while the subpod of 4 (a matriarch and her 3
2999 juveniles) headed over to the nearby whalewatch boat and one group "very closely
3000 approached [humpbacks]; NO REACTIONS from several groups of [humpbacks],
3001 including a pair and a single whale (2 + 1: slow surfacing, swimming, slow fluking – no
3002 trumpet blows). At the same time, *ca.* 50 sea lions went porpoising past us: a few sea
3003 lions approached our boat and stopped, pressed against the boat...seemingly 'trying to
3004 hide' against our boat. At 1149 our [KW] pair closely passed one sea lion, at 1152 closely
3005 passed 8 more sea lions. At 1158 the group of four [KWS] approached us again, at 1159
3006 they passed 2 single humpbacks – including one that was VERY close to the killer
3007 whales – NO REACTION. At 1200 one of our earlier humpback pairs (from 1137) fluked
3008 near the killer whales – NO REACTION. WE DID NOT OBSERVE ANY SEA LION
3009 KILLS. passed 50 [sea lions], 2 + 1 [humpbacks]; pass 1 [sea lion], pass 8 [sea lions];
3010 passed 1 + 1 [humpbacks]; 1 humpback – very close to killer whales – NO REACTION;
3011 end of sighting". A. Schulman-Janiger: "There VERY LIKELY WAS INTERFERENCE
3012 on the part of the humpback whales in this sighting. There were 2 humpback whales with
3013 the killer whales and the sea lions – there was a lot of splashing and thrashing before we
3014 arrived at this sighting, and we witnessed some of that surface activity by the
3015 humpbacks."
3016

3017 73. 14 May 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 09:52 – 7
3018 KWs “attack adult CSL”; 10:11 – “CSL dead”; 10:30 – “6 more KW 2km NW”; 10:44 –
3019 “2 + 2 + 2 MN in area”; 11:37 – “2 + 6 MN”.

3020

3021 74. 12 August 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 3
3022 “transients: predation on [California] sea lion: humpbacks (3 – including [a cow with a
3023 calf]) interacted with KW.” [see #25,75]

3024

3025 75. 12 August 2008; Monterey Bay, CA; R. Ternullo unpubl. notes. Sighting from 1018-
3026 1207 h; 3 transient killer whales “kill [California sea lion], not much pounding [with
3027 flukes]; 2 [humpbacks] involved, curious?” [same killer whale group as #74, but different
3028 event; see also #25]

3029

3030 76. 13 August 2008; Monterey Bay, CA; R. Ternullo unpubl. notes. 5 transient killer
3031 whales “killed [California] sea lion; humpbacks trumpeting, interfering with [killer
3032 whales] and [sea lion] carcass.”

3033

3034 77. 13 Sept 2008; Monterey Bay, CA; S. Johnston¹⁶. 8 transient killer whales “charged 3
3035 young CA sea lions; 2 humpbacks came fr/2 miles away, surfaced in middle, swatting
3036 KW w/ their flukes!” Also: “Watched 6 transients in Monterey Bay have some odd
3037 interactions with 3 young California Sea Lions and 2 huge Humpback Whales! The sea
3038 lions seemed to be watching the Orcas swimming in some very relaxed synchronized

¹⁶ Steve Johnston, 940 Peach Ct., Hollister, CA 95023 USA, pers. comm. Sept 2008.

3039 exercises that would make Olympic athletes jealous. They didn't appear injured or
3040 concerned, just curious. After we had watched for over a half hour, however, things
3041 changed. The Orcas began to charge the sea lions and bat them around, but not bite
3042 them; it appeared that they might be teaching the young one in the group how hunting
3043 worked. There was no blood, and the sea lions showed no external wounds when they
3044 swam close. After nearly another half hour two humpbacks that had been a couple miles
3045 away suddenly appeared right in the middle of things! They seemed to be actually
3046 swimming right at the Orcas and occasionally trying to swat them with their tails.
3047 Periodically they would dive and be down for 3-5 minutes, then come back up right in the
3048 middle of things again.”

3049

3050 78. 9 October 2008; Monterey Bay, CA; J. Scarff¹⁷. “a couple of humpbacks came from
3051 several hundred meters away to where a pod of orcas has apparently just killed a
3052 California sea lion. The sea lion was underwater, so I never saw the carcass. The
3053 humpbacks were blowing hard, almost trumpeting, and dove at exactly the spot where the
3054 orcas had dived. The orcas and humpbacks alternated surfacing and diving at the same
3055 spot, with the humpbacks continuing to spout very loudly. The humpbacks and orcas
3056 were never at the surface at the same time. After 4-5 minutes, the humpbacks
3057 disengaged, came over to our whale-watching boat, and hung around as friendly whales
3058 for another 5+ minutes before heading off. While they were around our boat they seemed
3059 much more relaxed and blowing much quieter.”

3060

¹⁷ Jim Scarff, 1807 Martin L. King Jr Way #D, Berkeley, CA 94709 USA, pers. comm. 5 Nov 2009.

3061 79. 11 Oct 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. Observed
3062 for 69 min; 5 transient killer whales and “3 + 2 [humpback whales] present; lots of
3063 [California sea lions] in area;” second group of 10 killer whales moves in; “+ 2 + 3 + 2
3064 [humpbacks];” [killer whales] “chase [sea lion], escapes.”
3065
3066 80. 18 Oct 2008; Monterey Bay, CA; R. Ternullo unpubl. notes. 7 transient killer whales
3067 and “2 [humpbacks] present; kill multiple [California sea lions] all day?” K.
3068 Cummings¹⁸: “Today we encountered around six transients about three miles west of
3069 Moss Landing hunting sea lions. If I took this picture a second earlier you would be able
3070 to see the sea lion in the whale's mouth! We watched the pod hunt and kill one, possibly
3071 two sea lions when we saw two humpbacks approaching from the other side of our boat.
3072 Once the humpbacks got close, they dove under our boat and reappeared in the middle of
3073 all the killer whales. They hung around for about 15 minutes until they trailed off.” P.
3074 Stap unpubl. notes: 11:02 [4 transient killer whales, 2 females and 2 calves, killed a
3075 California sea lion]; 12:07 [group starts porpoising, traveling at 6.5-6.7 kts]; 13:01
3076 [joined by another killer whale]; 13:21 “Had lost them but they were behind us. There is
3077 blood in the water and birds are swarming above. Three or four sea lions in the area.
3078 Calves are showing flukes - grayish orange in color. 50 plus birds. Two adults are tail
3079 slapping off about 100 yards from other orcas.” 13:41 “Breach”. 13:42 “Brought kill to
3080 the surface in its mouth-spy hop; at this point 2 others approximately 1000 yards away”
3081 13:45 “Saw blood; They went under the boat.” 13:53 “Saw it in the calve's mouth just
3082 below the surface. Blood slick on surface. Two humpbacks approximately 500 yards.”

¹⁸ Kate Cummings, 367 Archer Street, Monterey, CA 93940 USA, pers. comm. 18 Oct 2008

3083 14:10 “Humpbacks nearing; orca surfaces with kill on head.” 14:12 “Humpbacks came
3084 up right next to the orcas approximately 50 yards (Boat in neutral)”. [time not recorded]
3085 “Engine off. Humpbacks within 10 feet of 3 orca group (close group).” 14:27 “there are
3086 now 3 [additional humpbacks] 600-700 yards northwest”. 14:32 [another killer whale has
3087 joined]; 14:43 [killer whale] “Tossed something in air with fluke”; 14:57 “Humpback
3088 surfaced right next to us (50 yards) approximately 200 sea lions jumping.” 15:21 [killer
3089 whale] “Tail slaps/surfaces right of us; humpbacks [present]”; 15:38 “Small group [of
3090 killer whales] surfaced near us; spy hop; playing? Splashing”; 15:41 [7 killer whales now
3091 present]. 16:00 “Sea lion tried to use the boat as shield from killer whales. They circled.
3092 A sea lion bumped the underside of the boat. We moved.” 16:12 “Humpback surfaced
3093 directly behind killer whale breach.” 16:16 “Engine off. Humpbacks within 10 yards of
3094 us; sea lions in area.” 16:26 “Killer whales went under boat and circled; sea lions in
3095 area.” [time not recorded] “Double humpback breach.” 16:34 [2 humpbacks] “North of
3096 boat approximately 1 mile away (port); 2 more approximately 200 yards away at 120°
3097 (east of us).” 16:46 “Two humpbacks to the right; 3 killer whales in front; 2 killer whales
3098 in back”; 16:49 “The group of 3 [killer whales] that we've been following picked up
3099 speed.” 17:05 [killer whales] “Milling; then held up and came up to the boat”; 17:22
3100 [same group, swimming at] “Approximately 2 mph; at 17:25 then held up again”; 17:26
3101 [Killer whales] “Spy hop up to pect fin 3 times (1/2 way out of water)”; 17:28
3102 [humpback(s)] “Came up behind us. Could be same as S#4 but no pics so gave it a
3103 separate sighting number. Does not have number of animals in sighting on log.” 17:33
3104 [killer whale] “Porpoised on port side.” 17:34 [killer whales] “Picked up speed, heading
3105 in same direction; 400 yards from boat.” [boat returned to dock after this].

3106

3107 81. 20 Oct 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. Observed
3108 for 63 min; 6 transient killer whales with “2 [humpback whales]; [KW] chasing
3109 [California sea lions] and common murrens [*Uria aalge*]; KW intensely social; 4
3110 [humpbacks] present.”

3111

3112 82. 21 Oct 2008; Monterey Bay, CA; P. Stap unpubl. notes. 15:35 “A Sea lion was 30 yds
3113 from boat and headed right towards us. Sea lion is bleeding and tried to jump on the boat.
3114 He succeeded on landing on the gunnel on the port side. Martijn grabbed the net and I
3115 jumped behind the helm. Martijn pushed the sea lion back in water and when it was clear
3116 of the prop on boat I moved slowly away from Sea lion as killer whales were starting to
3117 circle around the boat in a wide circle. Called [NMFS agent] Joe Cordaro immediately
3118 after the incident to report the incident and asked him if there was a better way to handle
3119 the situation but he said no since we felt in danger with the large bull sea lion.” 16:02
3120 “Put boat in neutral; [2 humpbacks] came within 50 yards of boat between us and Killer
3121 Whales.” 16:02 [5-6 transient killer whales present]; 16:16 “Humpbacks went right
3122 toward killer whales so we could not move in neutral.” 16:17 “Humpbacks went to the
3123 other side of killer whales.” 16:37 [pair of humpbacks] “Went to killer whales”; 16:38 [3
3124 humpbacks] “are with Orcas.” 17:14 [killer whales] “Threw sea lion.” 17:24 “Killer
3125 Whales on a 90° heading” [traveling 4-5 kts; last seen 18:06].

3126

3127 83. 22 Oct 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 10:37 – 6
3128 KW “2 + 2 MN in area”; 11:16 – KW “attack adult male CSL”; 12:20 – “kill CSL.”

3129

3130 84. 22 Oct 2008; Monterey Bay, CA; P. Stap unpubl. notes. 17:26 “2 humpbacks with
3131 killer whales; killer whales attacking sea lion.” 17:45 [Killer whales] “Bite into sea lion;
3132 100 birds.” 18:03 “odor very strong from sea lion.” 18:12 “2 [humpbacks] came up to
3133 boat; birds picking up scraps; 100+ birds” [killer whales travel slowly NW but
3134 humpbacks do not follow].

3135

3136 85. 29 Oct 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. Observed
3137 for 9 min; 12 transient killer whales with “3 [humpbacks] present; pass 50 [California sea
3138 lions].”

3139

3140 86. 26 Nov 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. Observed
3141 for 29 min; 8 transient killer whales “carrying juv [California sea lion]?; attract 2
3142 [humpbacks]; [humpbacks] actually chasing KW; [humpbacks] get friendly with boat;
3143 [humpbacks] harass KW; 2 + 1 + 2 [humpbacks] arrive.”

3144

3145 Weddell seal (*Leptonychotes weddellii*)

3146 87a-b. 15 Jan 2009; Laubeuf Fjord, east of Adelaide Is, West Antarctic Peninsula,
3147 Antarctica; Pitman and Durban (2009) and unpubl. notes. We located a group of 10 type
3148 B killer whales comprised of one adult male, two sub-adult males, four adult females, one
3149 juvenile, and two calves. When we initially approached the group, they appeared to be
3150 harassing a pair of adult-sized humpback whales that they had surrounded. The
3151 humpbacks were bellowing and thrashing the surface with their flukes and pectoral

3152 flippers. Two of the killer whales, including the adult male, were close in among the
3153 humpbacks but they were not acting aggressive from what we could see. This impression
3154 was reinforced by the fact that most of the other killer whales were straying off away
3155 from the humpbacks and spyhopping [*i.e.*, lifting their heads out of the water], looking
3156 for seals on the ice floes. After approximately 30 min of this interaction between the
3157 killer whales and the humpbacks, another pair of humpbacks came in and joined the first
3158 pair. After more bellowing and splashing by both pairs of humpbacks, the killer whales
3159 seemed to lose interest and moved on. At the time, this did not appear to be a serious
3160 attack, and we inferred that perhaps the killer whale were just harassing or testing the
3161 humpbacks. Later on, however, we viewed some video footage of the encounter taken by
3162 a BBC cameraman on board the vessel, and we saw for the first time that there was a
3163 Weddell seal in among the humpbacks. We concluded that the seal may have sought
3164 refuge there and the humpbacks just agitated by the incidental attention they were getting
3165 from the killer whales. Based on what we saw the seal escaped unharmed.

3166

3167 88. 24 Jan 2009; Laubeuf Fjord east of Adelaide Is., West Antarctic Peninsula,
3168 Antarctica; Pitman and Durban (2009) and unpubl. notes. “we came upon a group of 11
3169 [killer whales] (1 adult male, 6 adult females, 4 juveniles) attacking a Weddell seal on an
3170 ice floe. There was a pair of humpbacks present when we first arrived [one was
3171 determined to be a male from a biopsy sample]; from photographs we were able to
3172 determine that the humpbacks were not the same as [in events #87 and #89].” “We saw 4
3173 attacks and three kills - all Weddell seals. The one that got away probably benefitted from
3174 our presence. Perhaps the most amazing thing was a pair of humpbacks that were present

3175 right from the start. In the first kill they came in right among the killer whales and at one
3176 point the killer whales broke up a small bergy bit that the seal was on. When it headed
3177 out into open water, it went straight toward the [humpbacks]. One of the [humpbacks]
3178 rolled over onto its back and the seal was [swept up] onto its chest. In the video footage,
3179 the humpback [quite clearly] uses its flipper to nudge the seal onto its chest. My guess is
3180 it [was] trying to protect the seal from the predatory actions of the killer whales... The
3181 seal spent a few seconds on the chest (I think it was probably freaked out by the
3182 humpbacks attentions - if that's what they were) and then swam over to another bergy bit
3183 (the seal was eventually killed and eaten). During the next couple hours of killer whales
3184 taking Weddell seals the humpbacks stayed right with us and the killer whales. They
3185 were often [bellowing] and clearly agitated although the killer whales were not paying
3186 much attention to them. During the second and third kills, the [humpbacks] were with the
3187 third [seal] before it was killed but broke off to go over and join the [killer whales]
3188 feeding on the second seal - perhaps they heard vocalizing associated with the feeding.
3189 They were [approximately] a quarter mile away and went over to [bellow] and be around
3190 where the feeding was going on. As things picked up at the kill number 3 site, they broke
3191 off and went over there. They repeatedly circled back among the attacking killer whales
3192 although the seal was in among the ice the whole time and the humpbacks could never
3193 have seen it or heard it.”

3194

3195 Crabeater seal (*Lobodon carcinophaga*)

3196 89. 15 Jan 2009; Laubeuf Fjord east of Adelaide Is, West Antarctic Peninsula, Antarctica;

3197 Pitman and Durban (2009) and unpubl. notes. After the type B killer whale group from a

3198 previous encounter (#87) moved away from the area, they fanned out and began hunting
3199 [*i.e.*, spyhopping around ice floes looking for hauled out seals; Pitman and Durban 2012].
3200 Two of the humpbacks from that previous encounter followed them for a mile or so, but
3201 then appeared to fall behind. Shortly afterward, the killer whales detected a crabeater seal
3202 on a large ice floe. The swam in unison and created a wave that broke up the floe into
3203 smaller bits but when they went in to take a closer look at the seal the same pair of
3204 humpbacks moved in and started swimming around the floe between the killer whales
3205 and the seal. The humpbacks began spyhopping, lunging aggressively and bellowing
3206 loudly; they were “right in there with the [killer whales] and seemed to be curious more
3207 than anything else but also seemed to be getting in the way and maybe irritating the
3208 [killer whales]”. Although the humpbacks appeared agitated, they had moved in among
3209 the killer whales of their own volition. After several minutes of rather spirited interaction,
3210 the killer whales and then the humpbacks all swam away leaving the crabeater unharmed
3211 on the small floe. Our speculation at the time was that the humpbacks were ‘mobbing’ the
3212 killer whales much the way small birds do larger birds of prey. [We subsequently
3213 determined that the killer whales were not interested in taking crabeater seals and only
3214 wanted Weddell seals – Pitman and Durban 2012].

3215

3216 Harbor seal (*Phoca vitulina*)

3217 90. 7 July 2000; East of Point Gustavus, Icy Strait, AK; Harald Yurk and V. Deecke
3218 unpubl notes. “at 13:56 hrs, we encountered a group of 14 killer whales travelling south
3219 in Sitakaday Narrows.” “We followed the animals south to Pt. Carolus and then east to
3220 Pt. Gustavus. At approximately 16:15 hrs, the animals split into two subgroups off Pt.

3221 Gustavus and we remained with the trailing subgroup (presumed to be T063, T065,
3222 T065A, T065A1, and T065B). At approximately 16:24 the animals started milling on the
3223 Gustavus Flats just east of Pt. Gustavus and became vocal. At approximately 16:45 hrs
3224 we first noticed a humpback whale approaching the killer whales as they surfaced
3225 repeatedly over the same spot. The humpback whale stayed within 50 to 100 m of the
3226 transients, often remaining upside down with the tail flukes visible above the surface for
3227 several minutes. Shortly after 16:58 hrs, one killer whale tossed a harbour seal through
3228 the air. The killer whales remained at the same spot until 17:08 hrs, when they resumed
3229 travelling southeast in Icy Strait. We lost track of the humpback about 15 min after it was
3230 first seen.”

3231

3232 91. 27 June 2005; North Marble Island, Glacier Bay, AK; V. Deecke and M. de Roos;
3233 Glacier Bay National Park Annual Whale Report 2005; photos on file at Glacier Bay
3234 National Park. “observed adult [humpback] whale #1795 follow and remain in close
3235 proximity to four transient killer whales while the killer whales attacked a harbor seal for
3236 over one hour near North Marble Island. They observed several tail swipes from whale
3237 #1795 and it appeared that some of them were directed at the seal.” [Whale #1795 has
3238 subsequently been genetically identified as a male. An acoustic recording made at the
3239 time of the observation recorded “distinctive bone-crunching noises” and the seal was
3240 presumed to have been killed]

3241

3242 92. 22 Oct 2008; Monterey Bay, CA; P. Stap unpubl. notes. 15:28 - 6 transient KWs “Just
3243 attacked another sea lion or harbor seal - it was still alive.” 15:48 “Harbor seal still in

3244 orca's mouth." 16:15 "2 humpbacks 500-600 yards." 16:17 "2 humpbacks 200 yards;
3245 coming in; 2 orcas separated from humpbacks." 16:34 "Killer whales bearing 160°
3246 [traveling slowly]; went in opposite direction of humpbacks." N. Black and R. Ternullo
3247 unpubl. notes: 15:45 – 6 KW "toss PV about 30 ft in air"; 15:57 – "feed"; 16:19 – "mill,
3248 feed"; 16:25 – "2 MN swim toward KW"; 16:28 – "MN move away"; 16:32 "MN back";
3249 16:36 – "MN move away".

3250

3251 Northern elephant seal (*Mirounga angustirostris*)

3252 93. 14 May 2008; Monterey Bay, CA; P. Stap unpubl. notes. 10:50 2 humpbacks seen;
3253 11:07 "Orcas ... are tail slapping, breaching. There are 8 orcas plus 2 males separate
3254 from group of 8." 11:39 "As orcas went by, the [humpbacks] changed their direction 180
3255 degrees toward area orcas went by". 12:29 "Orcas have possibly a harbor seal... Then an
3256 orca did a tail slap next to seal and seal was gone from surface." 12:38 "5 gulls and 3
3257 albatross eating pieces of something at surface." [boat stayed with killer whales until
3258 15:41 and the humpbacks apparently weren't seen again; prey later identified from photos
3259 as northern elephant seal].

3260

3261 94. 4 June 2009; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes; L. Beraha
3262 video. 11:07 – 5 KWs "catch MA juv"; 11:19 – "MN shows up, friendly"; 11:28 – 2
3263 California sea lions show up, "MN chases KW"; 11:55 "MA killed, MN moves off NW";
3264 12:05 – "MN returns". [video link in Appendix 1 shows humpback apparently chasing
3265 killer whales].

3266

3267 Ocean sunfish (*Mola mola*)
3268 95. 24 Oct 1999; Monterey Bay, CA; D. Shearwater unpubl. notes. 15 transient killer
3269 whales “associated with 5-6 [humpback whales] and 2 [Pacific white-sided dolphins
3270 *Lagenorhynchus obliquidens*]. Ate a *Mola* [*mola*]?”
3271
3272 96. 27 September 2009; Monterey Bay, CA, D. Shearwater unpubl. notes and A.
3273 Borker¹⁹. “From the get-go, the orcas were tail-lobbing and splashing quite a bit,
3274 thrashing all around. ... Finally, as they approached our vessel, we were able to see that
3275 they appeared to be trying to kill an ocean sunfish, (*Mola mola*)! I've seen an adult male
3276 orca kill a Blue Shark, but never a Sunfish. The spyhopping, breaching and tail lobbing
3277 continued. Once, they went after a common murre ... Then suddenly, some humpback
3278 whales appeared at our 10 o'clock. The orcas were at the 2 o'clock. Unbelievably, the
3279 three humpback whales made their way, keeping their ranks extremely close to each
3280 other, toward the orcas! It was hard to believe what we were seeing. I have seen orcas
3281 killing and chasing large baleen whales. But, this was the other way around! The
3282 humpbacks were chasing and bearing down on the killer whales! It was as if the
3283 humpbacks were acting like passerines that mob an owl. They seemed quite intent on
3284 their pursuit of the killer whales and came incredibly close to them. At least one of the
3285 humpbacks was making a racket with its blowing. ...Alas, as they approached, the entire
3286 scene was engulfed in fog.” D. Shearwater unpubl. notes: “I've been wanting to ask you
3287 about this interaction of killer whales apparently killing an ocean sunfish, and then, these
3288 humpback whales coming in, and practically running down the orcas!... It was as if the

¹⁹ Abraham Borker, UCSC Center for Ocean Health, 100 Shaffer Road, Santa Cruz, CA 95060 USA, pers. comm. 30 Nov 2009

3289 humpbacks "mobbed" the orcas! Prior to the arrival of the hump[back]s, the orcas did a
3290 lot of displays-- breaching, spyhopping, swimming belly up, *etc.* It was positively
3291 spectacular. When we first approached the orcas, their behavior reminded me of every
3292 time I've ever seen them on a kill, or having just recently killed an animal. In this case, it
3293 was the mola." [DS estimated 5-6 killer whales] Also, A. Borker⁹: "we spotted about 6-7
3294 orcas and when we approached found them to be biting and presumably killing a sunfish.
3295 They dragged it through the water, but then lost interest. The orcas pod was rolling and
3296 breaching around the boat. At one point an orca made a pass at a common murre at the
3297 surface." "We then spotted two humpbacks about 300 m away and closing in on our
3298 location. They were on the opposite side of our vessel (65'). I think the captain had us
3299 slowly moving alongside the orcas, and the humpbacks came behind the boat, and then
3300 behind the orcas." "The humpbacks stayed very close together, and at the surface swam
3301 towards the orca pod. Myself and others, qualitatively (and perhaps biased) thought that
3302 the frequent blows were very loud and raspy." "As far as I could tell the Humpbacks
3303 never got closer than ~30 meters from the orcas, the orcas did seem to be pushed forward
3304 or "chased" off by the two humpbacks." "Fog rolled in and we left after ~45 minutes
3305 observing the orca pod." "We first spotted the orcas at 10:44 am, first observed the
3306 humpbacks ~11 am and left the scene at 11:36 am. I've attached a photo of the three
3307 humpbacks." [Length of the sunfish was estimated to be 1-1.5 m – A. Borker⁹; killer
3308 whales identified as Bigg's from photos by J. Durban]
3309
3310 Unidentified Prey

3311 97. 3 May 2005; Monterey Bay, CA; P. Stap unpubl. notes. 10:52 “Hydrophone in [the
3312 water] and Oo’s [8-12 transient killer whales] really vocalizing/echolocating. Oo's just
3313 milling then moving a little more West.” 11:22 “Oo's still milling & vocalizing.” 11:31
3314 “Slick now at surface & can smell blubber scent. 8 gulls & 2 albatross. Oo's were milling
3315 but now slowly moving to West.” 11:50 “There are 2 Mn's [humpbacks].” 11:55 “Mn's
3316 went down - Oo's scattered.” 12:05 “Both Mn's came right at Oo's.” 12:10 “Mn's coming
3317 toward us, rolling at surface, raised pec[toral fin] with 4 to 5 Oo's about 200 yds SW of
3318 [the boat]. 12:13 “Mn's now heading toward Oo's.” 12:15 “2 Mn's now turning south &
3319 both fluked & Oo's heading West.” 12:16 “Oo's about 250 yds apart from Mn's. [Killer
3320 whale] CA137 usually stayed out 100 yds but came in once by Mn's. There was usually
3321 only 4 to 5 Oo's but once 6 Oo's by Mn's. Oo's on 317 degree heading & Mn's 88 degree
3322 heading.” [end of encounter]. 14:07 “Captain on [a whalewatch boat] said after we left
3323 Oo's there was 5 Mn's together with Oo's circling Mn's.”

3324

3325 98. 3 June 2006; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 3 transient
3326 killer whales “eating something, test [humpback whale(s)].”

3327

3328 99. 25 May 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 11:06 - 6
3329 KWs “killed something?”; 11:20 – “1 MN close by, killed something?”; 12:20 – “end”.

3330

3331 100. 10 Sept 2008, Monterey Bay, CA; R. Ternullo unpubl. notes. Observed 18 min.; 6
3332 transient killer whales “killed something, 2 [humpbacks] join; 3 [humpbacks] join, leave,
3333 then follow [killer whales], 2 more [humpbacks] join.”

3334

3335 101. 12 Sept 2008; Monterey Bay, CA; K. Cummings²⁰. [4-5 transient killer whales]
3336 “interacting with several [3 in video] humpback whales” and “a lot of trumpet blowing.”
3337 [a short video segment of this encounter in Appendix 1 shows 3 humpbacks milling close
3338 by and the killer are circling and diving in a large slick area – apparently a kill had taken
3339 place].

3340

3341 102. 9 Oct 2008; Monterey Bay, CA; R. Ternullo unpubl. notes. 10:10 – 6 KW “killed
3342 something, 2 MN join”; 10:18 – “3 MN join, leave, then follow KW, 2 more MN join”;
3343 10:45 – “end”.

3344

3345 103. 11 Nov 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. Observed
3346 for 68 min; 3 transient killer whales “killed something; pester[ed] 3 [California sea lions];
3347 4 [humpbacks have] excited interaction with [killer whales]; [later, the killer whales] pass
3348 2 [California sea lions].” P. Stap unpubl. notes: 09:55 [3 transient] “killer whales killed
3349 something.” 10:01 “50-60 gulls in area; picked up flinging prey.” 10:14 “70 birds in area;
3350 [whalewatch boat] in area and 1 killer whale moved off to the east.” 10:17 [1 humpback
3351 in area]; 10:26 “Engine off; male killer whale harassing humpbacks, humpbacks
3352 trumpeting; killer whales moved to west.” 10:46 “Sea lion in area; engine off; humpbacks
3353 have been mugging boat.” 12:32 “humpbacks engaged boat; engine off.” 12:40 “Lost
3354 killer whales as they moved off when humpbacks came within 100 yds of boat so turned
3355 engine off.” [killer whales were found again and finally lost at 13:21].

²⁰ Kate Cummings, 367 Archer Street, Monterey, CA 93940 USA, pers. comm. 18 Oct 2008

3356

3357 No Prey Observed

3358 104. 1 May 2008; Monterey Bay, CA; P. Stap unpubl. notes. 09:33 “When first arrived
3359 we shut off engines. [5-6 transient] Orca's came next to boat. One Orca blew bubbles
3360 under the boat starting from the stern to the bow.” 09:42 “down time approx. 5 minutes.”
3361 09:48 “Orca's came next to boat - engines still off.” 10:00 “We were with the orca's and
3362 the engines were off. We were concentrating on the orca's which were on our port side
3363 when 2 Mn's [humpbacks] surface about 75 to 100 yds on our starboard side. Never saw
3364 them coming so do not know their behavior. The orcas went down when the Mn's
3365 surfaced. Then orca's spy hopped, one raised tail fluke in air.” 10:11 “One Orca in picture
3366 just after Mn Dorsal. Could not see which Orca blew bubbles that came to surface & did
3367 a bubble bursts heading towards Mn's.” 10:18 “3 Orca's that had been together were
3368 harassing the Mn's. One Mn did a couple trumpet blows. Mn's & Orca's were about 200
3369 yds apart and then they all headed toward each other.” 10:32 “Mn's & Oo's about 200 yds
3370 apart but now Mn's heading toward the Oo's. Turned engines back on.” 10:45 “2-3 Orca's
3371 were north of this position by 200 yds and were tail slapping. The Mn's came up about
3372 150 yds east of this position with 1 Orca just west of them by approx 25 yds and Mn's
3373 were heading toward it.” 10:48 “The 2 Mn's & the 1 Orca are together by 10:48. One Orca
3374 came up after the Mn's went down. Mn's are not fluking.” 10:51 “2 Orca's went under the
3375 boat toward the 2 Mn's that are 200 yds east of this position. Then the orca's including a
3376 small Orca were close to Mn's. Mn's are not fluking. One Mn did fluke earlier but they
3377 are just rounding out to go down.” 11:06 “Orca's all together now with Mn's 200 yds NE
3378 of our position.” 11:13 “Mn's came to the Orca's.” 11:22 “3 Orca's (1 with a calf) in this

3379 position & Mn's 250 yds south of this position & at least 1 Orca 100 yds north of this
3380 position.” [killer whales and humpbacks not seen together after this]
3381
3382 105. 23 May 2008; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 10:17 - 5
3383 KWs “with 2 MN following, then get friendly with the boat”; 10:42 – “3 more MN”;
3384 10:46 – “6 more MN”; 11:11 – “MN still follow”; 11:29 – MN get friendly with other
3385 boats”; 11:39 – 6 more KWs present; 12:21 – “end”. [Bigg’s KWs; no potential prey
3386 identified]
3387
3388 106. 31 Oct 2008; Monterey Bay, CA; P. Stap unpubl. notes. 14:18 [5 transient killer
3389 whales milling and] “2 humpbacks in the area 100 yards north”; 14:25 “2 humpbacks
3390 chasing behind us chasing killer whales”; [boat followed killer whales until 15:24; no
3391 further interactions seen].
3392
3393 107. 19 Aug 2009; Monterey Bay, CA; N. Black and R. Ternullo unpubl. notes. 5 KWs
3394 “followed by 4 MN”. [Bigg’s KWs; no prey identified]
3395
3396 108. 27 Sept 2009; Monterey Bay, CA; S. Johnston²¹. 4 Bigg’s killer whales observed
3397 “playing, jumping; 3 humpback whales showed up, came to KW: 2 MNs surfaced w/2
3398 KWs right in front of their heads.”

3399

3400

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