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# Tooth damage in captive orcas (*Orcinus orca*)

John Jett[a,*], Ingrid N. Visser[b], Jeffrey Ventre[c], Jordan Waltz[d], Carolina Loch[e]

[a] Biology Department, Stetson University, 421 N. Woodland Blvd., DeLand, FL, 32723, United States
[b] Orca Research Trust, P.O. Box 402043, Tutukaka, Northland, 0153, New Zealand
[c] Virginia Mason Memorial, Lakeview, 1470 N. 16th Avenue, Yakima, WA, 98902, United States
[d] 171 Pier Ave. #234, Santa Monica, CA 90405, United States
[e] Department of Oral Sciences, Sir John Walsh Research Institute, Faculty of Dentistry, University of Otago, Dunedin 9054, New Zealand

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ABSTRACT

*Objectives:* Tooth damage as a result of oral stereotypies is evident in captive orca, yet little research on the topic exists. This study examines the associations between dental pathology, sex, facility, duration of captivity and other factors in captive orca.

*Design:* We evaluated mandibular and maxillary teeth from dental images of 29 captive orca owned by a US-based theme park. Each tooth was scored for coronal wear, wear at or below gum line and bore holes. Fractured and missing teeth were also noted. Summary statistics described the distribution and severity of pathologies; inferential statistics examined how pathologies differed between sexes, between wild-captured and captive-born orcas and between captive orca at four facilities. We also evaluated how dental pathology and duration of captivity were related.

*Results:* Approximately 24% of whales exhibited “major” to “extreme” mandibular coronal tooth wear, with coronal wear and wear at or below gum line highly correlated. More than 60% of mandibular teeth 2 and 3 exhibited fractures. Bore holes were observed primarily among anterior mandibular teeth, with more than 61% of teeth 2 and 3 bearing evidence of having been drilled. Four of five orca with the highest age-adjusted tooth pathology indices were captive-born.

*Conclusions:* Various dental pathologies were observed across all whales, with pathologies beginning at a young age. Oral stereotypies exhibited by captive orca contributed to the observed dental damage. By making dental and health records of captive whales publicly available, the theme park industry is uniquely positioned to provide further insight into dental pathology and resultant health consequences in captive orca.

## 1. Introduction

The dental morphology of most modern cetaceans – whales, dolphins and porpoises – suggest that their teeth have evolved to primarily capture and hold prey rather than to masticate or process food items (Ungar, 2010). As exceptions to this, both free-ranging Amazon River dolphins (*Inia geoffrensis*) and free-ranging orca (*Orcinus orca*; also referred to as killer whales) may also, depending on prey type, use their teeth to mechanically reduce their live prey for eventual consumption (Werth, 2000). While dental wear is a physiological phenomenon common in many free-ranging mammals, dental pathology is uncommon in toothed cetaceans (odontocetes), which include orca (Loch, Grando, Kieser, & Simões-Lopes, 2011; Loch & Simões-Lopes, 2013). Poor dentition may present serious health consequences to odontocetes as they have a monophyodont dentition, or one set of teeth throughout life (Ishiyama, 1987).

Generalized tooth wear may be associated with increasing age among some odontocetes (Foote, Newton, Piertney, Willerslev, & Gilbert, 2009; Loch & Simões-Lopes, 2013; Perrin & Myrick, 1980; Ramos, Di Beneditto, & Lima, 2000); however, advanced tooth deterioration among free-ranging orca is generally rare, with feeding behavior and prey type thought to play prominent roles. For example, when evaluating the dentition of three orca ecotypes (Offshore, Transient and Resident), Ford et al. (2011) proposed that the abrasive skin of sleeper sharks (*Somniosus pacificus*), a known prey of Offshore orca, is perhaps implicated in their pronounced dental wear. Among Offshore orca, chronic tooth abrasion may, over time, expose pulp cavities and eventually cause wear to the gum line. Similarly, Foote et al. (2009) attributed the significant tooth wear of some North Atlantic orca to suction feeding behavior. Dahlheim et al. (2008) pointed out that the extensive tooth wear seen in Offshore ecotypes was absent from Transient orca skulls from museum collections, and

* Corresponding author.
*E-mail addresses:* jjett@stetson.edu (J. Jett), ingrid@orca.org.nz (I.N. Visser), jmventre@gmail.com (J. Ventre), carolina.loch@otago.ac.nz (C. Loch).

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similarly, Ford et al. (2011) reported that Resident (fish-eating) and Transient (mammal-eating) orca exhibited much less coronal tooth wear than their Offshore counterparts. In an earlier study describing the advanced tooth wear of several deceased free-ranging orca, Caldwell and Brown (1964) attributed wear to permanent mandible misalignment secondary to prior injury or temporary misalignment during high velocity feeding. Morin et al. (2006) later ascertained that two of the specimens that Caldwell and Brown (1964) described as having advanced coronal wear were of the Offshore ecotype.

Unlike free-ranging orca which hunt live prey, orca in captive settings are fed exclusively a diet of dead fish, dead squid and gelatin (the latter administered to mitigate chronic dehydration). These food items are placed into the posterior region of the oral cavity by facility workers and the items are subsequently swallowed, with taking making minimal, if any, contact with the food. Despite the absence of contact with food items, captive orca teeth commonly exhibit extensive wear and other dental pathologies such as fractures and exposed pulp cavities (Jett & Ventre, 2012; Ventre & Jett, 2015; Visser & Lisker,2016). In the United States of America (US), the severity and prevalence of dental pathology among captive orca has prompted animal welfare complaints to be filed in 2015 with the US Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS), the agency charged with administering the Animal Welfare Act. Onsite USDA investigations of those orca, owned by a US-based theme park, confirmed poor dentition, which included exposed pulp cavities from severe dental wear (supporting document 1; obtained through a Freedom of Information Act (US) request).[1]

Both the captive orca diet and feeding method are insufficient to dislodge food and other debris that accumulates in an exposed tooth cavity (Graham & Dow, 1990; J. Jett & J. Ventre, *personal observation*) and this accumulation can become a locus for infection (Dahlheim & Heyning, 1999; Graham & Dow,1990). In an effort to both treat active abscesses and prophylactically avoid infection and health complications, captive orca at theme parks often undergo a modified pulpotomy procedure. In this procedure, staff core-drill diseased or threatened teeth, with the primary objectives of pus drainage, removal of diseased pulp tissue and clearing of impacted food and debris (Ventre & Jett, 2015; see supporting document 2 for more detail).[2] However, contrasting the common dental protocol for humans (e.g., Soncini, Maserejian, Trachtenberg, Tavares, & Hayes, 2007) and some other mammal dentistry (e.g., Holmstrom, Fitch, & Eisner, 2004), the bore holes in captive orca teeth are not typically sealed with amalgam or composite resins.

Like other dental pathologies, tooth fractures are problematic among a variety of spatially-confined mammals. Zoo mammals living in communal conditions, such as dolphins and orca, tend to have a higher proportion of broken teeth and subsequent extractions secondary to aggression among conspecifics (Glatt, Francl, & Scheels, 2008). Spatially-confined zoo and other mammals can also exhibit dental pathology as a result of stereotypical behaviors. Stereotypies are described as a repetitive pattern of activity having no outwardly obvious goal or function (see Mason, 1991 for review; Mason & Latham, 2004) and their occurrence is typically considered a manifestation of poor welfare (Mason & Latham, 2004). Tooth injury as a result of stereotypical behavior has been identified by zoo personnel as a significant problem in zoo settings (Glatt et al., 2008). Mason and Latham (2004) estimated that 82% of wild carnivores held in zoos express stereotypical behavior, and owing to their prevalence and potential for serious health implications, oral stereotypies have been particularly well described in captive terrestrial mammals (see Bergeron, Badnell-Waters, Lambton, & Mason, 2006 for a review) and more recently in captive orca (Jett & Ventre, 2012; Ventre & Jett, 2015; Visser, 2012; Visser & Lisker, 2016).

There is an obvious need to better understand the causes, health effects and potential treatments of dental pathology exhibited by zoo animals; however, despite the prominent role that dentition plays in overall health (e.g., Sheiham, 2005), few studies have focused on the dental consequences of captivity for orca (see Graham & Dow, 1990; Jett & Ventre, 2012; Ventre & Jett, 2015; Visser & Lisker,2016), and none have attempted to quantify the problem across multiple facilities. The aim of this paper is therefore to examine the extent and severity of tooth damage among a captive population of orca owned by a US-based theme park and housed across four different facilities. Specifically, this study evaluates the prevalence and extent of dental wear, fractured and missing teeth and the presence of bore holes in the teeth of captive orca. The paper also examines the association between dental pathology, sex, facility, duration of captivity and other factors among captive orca.

## 2. Materials & methods

### 2.1. Image acquisition and sample

High resolution digital images of 29 captive orca were taken from public viewing areas at each facility between 2013 and 2015 and during normal operating hours. Images were shot opportunistically when an animal's teeth were exposed and in total, 318 images were selected to represent the whales held at the four facilities. Based on the coloration patterns and other morphological attributes unique to individual orca, each animal was identified by an experienced examiner and confirmed by another. Selected images were then named to identify the animal and the mouth quadrant represented. When multiple images were available for a particular whale, the clearest and most recent images were used for analysis. Each animal's duration of captivity (DOC), sex, source (wild-captured or captive-born) and facility were noted. Animal DOC was determined by information contained within the Marine Mammal Inventory Report (MMIR), maintained by the US Department of Commerce's National Marine Fisheries Service, as described in Jett and Ventre (2015). The facility was documented at the time each image was captured and the location of each animal was re-confirmed via the MMIR. In addition to the whales held in the three facilities situated in the US (Florida, Texas and California), we also evaluated orca held at a theme park in the Canary Islands, Spain. As with the rest of our sample, all captive orca at the theme park in Tenerife are owned by the same US-based theme park. In order to analyze the most current dentition, all animals were alive when images were captured as well as when the images were evaluated, although two animals have subsequently died prior to publication.

### 2.2. Tooth evaluations and statistical analyses

Dental pathology and anomalies were evaluated based on Ford et al. (2011) and Loch and Simões-Lopes (2013). Dental pathology was assessed on a quadrant-tooth basis for both mandible and maxilla (Fig. 1), with images zoomed in to the extent necessary to facilitate evaluation. Following Ford et al. (2011), coronal wear on tooth crowns was scored as an estimated percentage of flattening of the tooth relative to the base diameter at the gum line (Fig. 2). Each tooth was additionally assessed for wear down to or below the gum line, the presence of fractures (which included teeth with jagged edges or other obvious breakage characteristics), the presence of bore holes and missing teeth. A tooth was scored as "not applicable" and was not counted in a specific pathology category when it was broken beyond the ability to determine coronal wearing or if the fracture obscured the possible presence of a borehole. Any tooth fractured down to or below the gum line was not only scored as fractured but was also scored positive for wearing down to gum line. When a tooth was noted as missing, it was not assessed for

[1] Accessed Oct 2015 through USDA, APHIS Animal Care: https://www.dm.usda.gov/foia/.

[2] Cornell (2011). Ontario Superior Court of Justice. Docket Number 52783/11. SeaWorld Parks & Entertainment v. Marineland of Canada. Cornell Affidavit (pp. 16–18): Canada, Ontario.

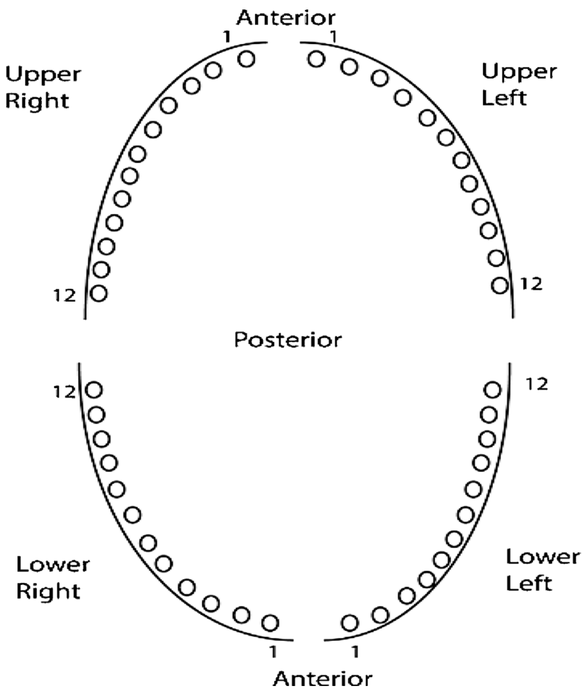


**Fig. 1.** Graphical layout (dental charting) of orca teeth. Numbers represent anterior to posterior ordering.

any other pathology.

Coronal wear scores for individual teeth in a specific quadrant were summed and a mean coronal wear score was calculated for each whale. Similarly, coronal wear scores for each quadrant-tooth among all whales were summed to create a mean coronal wear score for each tooth-position. Dichotomous scores (absence = 0 and presence = 1) for individual teeth in a specific quadrant for each of the other tooth pathology categories (i.e., worn down to or below the gum line, fractures, bore holes and missing) were summed and the percentage of teeth exhibiting that specific pathology was calculated for each whale. As with coronal wear, the number of teeth exhibiting a particular dichotomous tooth pathology was summed on a quadrant-tooth basis among all whales to determine the percentage of a specific tooth-position exhibiting that pathology.

Coronal wear scores ranged from 0 to 4 and were based on an estimation of the amount of tooth worn relative to the diameter of a tooth at the gum line (0 = negligible or < 10%; 1 = minor or 11–25%; 2 = moderate or 26–50%; 3 = major or 51–75%; 4 = extreme or 76–100%), whereas the other category scores were dichotomous. Consequently, mean coronal scores of the mandible and maxilla separately, and percentages for dichotomous scores of the mandible and maxilla separately, for each animal, were converted to z-scores and a tooth pathology index (*PI*) was calculated for each animal for both mandible and maxilla (e.g., $PI_{\text{mandible}} = z_{\text{coronal wear mandible}} + {}_{\text{gumline mandible}} + z_{\text{fracture mandible}} + z_{\text{borehole mandible}} + {}_{\text{missinmandible}}$). As dental wear may be concomitant with age, we generated an age-adjusted pathology index (*API*) for each animal by dividing their *PI* values by their DOC. An overall, age-adjusted pathology index ($PI_{AO}$) for each whale across all categories was also calculated ($PI_{AO} = (PI_{\text{mandible}} + P_{\text{maxilla}})/\text{DOC}$). Summary and inferential statistics employed both unadjusted and age-adjusted pathology indices.

To calibrate our scoring methodology, we first evaluated the teeth of a specific animal to establish agreement on how individual teeth would be scored within each pathology category. We then independently assessed each tooth across all categories and for all whales. A two-way mixed, average-measures, inter-class consistency analysis on the resultant *PI* values was then performed, with inter-class consistency value (0.94) demonstrating high agreement in our scoring. Our scoring methodology was therefore considered suitable for the analyses presented in the study.

Once each tooth was evaluated within each category of tooth pathology and summary statistics were generated, an independent-samples Mann-Whitney *U* test was performed to determine if $PI_{\text{mandible}}$, $API_{\text{mandible}}$, $PI_{\text{maxilla}}$, $API_{\text{maxilla}}$ and $PI_{A\text{o}}$ differed between sexes and between wild-captured and captive-born orca. Independent-samples Kruskal-Wallis test with Bonferroni multiple comparisons was employed to evaluate differences in $PI_{\text{mandible}}$, $API_{\text{mandible}}$, $PI_{\text{maxilla}}$, $API_{\text{maxilla}}$ and $PI_{A\text{o}}$ between orca held at the four facilities. In addition, a related-samples Wilcoxon Signed Rank test was performed to evaluate differences in coronal wear, fractures, wear at or below gum line and missing teeth among age-adjusted, raw pathology scores for mandibular and maxillary teeth. We employed linear regression to determine if DOC served as a predictor of non-age-adjusted dental pathology. We then subsequently divided DOC into quartiles and performed an independent-samples Kruskal-Wallis test with Bonferroni multiple comparisons to evaluate whether non-age-adjusted *PI* values differed between the DOC quartile groups. In addition, Pearson-r correlations were performed on raw, non-age adjusted scores within each pathology category to evaluate how closely associated the scores within each category may be related to those in other categories. All analyses were evaluated at the 0.05 level of significance.

### 2.3. Affiliation & animal ethics

The authors are not affiliated with the US-based theme park company nor the Spanish offshore breeding facility, although both J. Jett and J. Ventre were previously employed by one of the facilities in the US. The dental damage documented herein is not part of any scientific experiment that the authors were involved in, or are aware of, but instead appears to be a consequence of various factors associated with captivity. Therefore, no animal ethics guidelines were required for the study.

## 3. Results

### 3.1. Description of sample

Of the 29 captive orca examined, seven were housed in the Florida facility, five in Texas, 11 in California and six in the Canary Islands (Spain). Forty one percent of the animals were male and 59% female (Table 1). Among the whales evaluated, 21% were of wild-capture origin while 79% were captive-born. Mean DOC was 18.8 yr for females and 17.9 yr for males. Of the teeth that were assessed, 55% were mandibular and 45% maxillary. In total, 713 of the 1127 (63.3%) teeth (mandibular and maxillary teeth combined) evaluated for coronal wear exhibited varying degrees of the pathology; 142 of 1116 (12.7%) teeth exhibited fractures; 234 of 1154 (20.3%) teeth were worn to or below the gum line; 158 of 1056 (15%) teeth were positive for bore holes; and 22 of 1130 (2%) teeth were missing. Differences in number of teeth evaluated within each category occurred when a particular tooth exhibited a pathology feature (e.g., a missing tooth) that reduced or prevented clear evaluation of that tooth for other pathologies. Tooth damage was observed in all whales.

### 3.2. Dental pathologies in mandible and maxilla

Highest mean coronal wear was observed among mandibular teeth, with combined lower left (LL) and lower right (LR) mean scores at or greater than 2.40 among teeth 1–4, with the distribution of combined mean coronal wear differing markedly between teeth in the mandible and maxilla (Fig. 3). For example, mandibular teeth 9–10 presented with the lowest mean coronal scores (1.05 and 1.04, respectively), whereas maxillary teeth 9–11 exhibited the highest coronal wear (0.64, 0.85, and 0.91, respectively). Mean coronal wear scores among

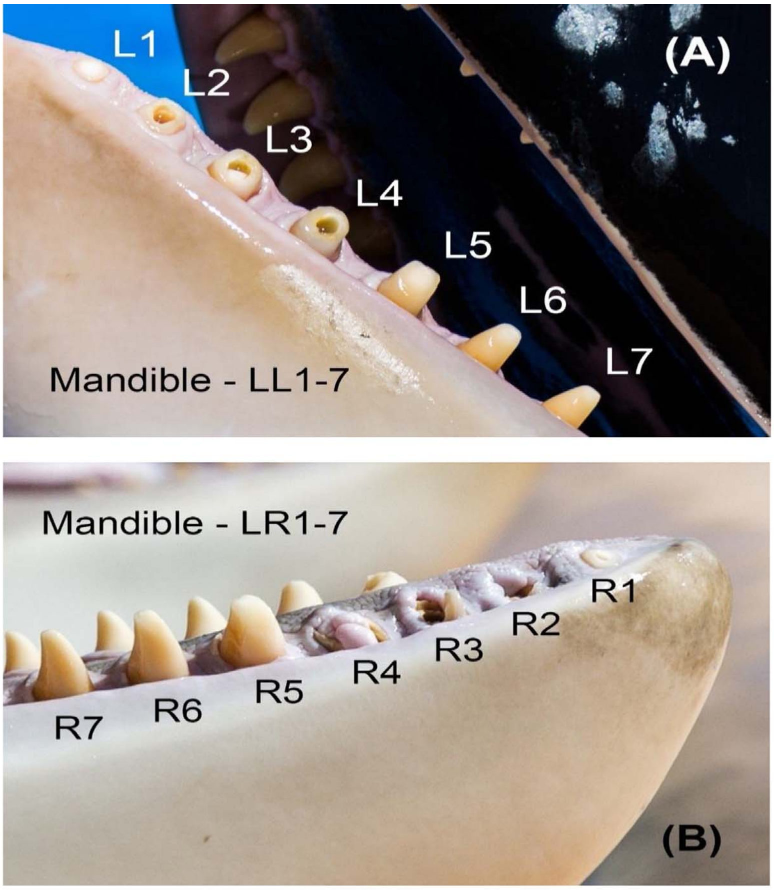


**Fig. 2.** Cropped images of the lower left (LL) (A) and lower right (LR) (B) (i.e., mandibular) teeth of two male captive orcas, with alpha numerical tooth identifiers above or beneath each tooth. Animal (A) was 15.5 yr old at the time he was photographed; animal (B) was 20.8 yr old. The associated table provides examples of how individual teeth were scored. Note that for animal (B) LR 2–4 would not be scored for coronal wear or bore holes. No missing teeth are depicted. Photographs: I. N. Visser.

| Pathology | Score | Tooth meeting criteria |
|---|---|---|
| Coronal wear | 0 (Negligible: <10% of tooth diameter) | LL7; LR5-7 |
| | 1 (Minor: 10-25% of tooth diameter) | LL6 |
| | 2 (Moderate: 26-50% of tooth diameter) | LL5 |
| | 3 (Major: 51-75% of tooth diameter) | LL4 |
| | 4 (Extreme: 76-100% of tooth diameter) | LL1-3; LR1 |
| Worn to or below gum line | 0 (No) | LL3-7; LR5-7 |
| | 1 (Yes) | LL1-2; LR1-4 |
| Fracture | 0 (No) | LL1-3 & LL6-7; LR1 & LR5-7 |
| | 1 (Yes) | LL4-5; LR2-4 |
| Bore holes | 0 (No) | LL1 & LL5-7; LR5-7 |
| | 1 (Yes) | LL2-4; LR1 |
| Missing | 0 (No) | LL1-7; LR1-7 |
| | 1 (Yes) | None |

mandibular teeth ranged from 3.72 for tooth 1 to 1.04 for tooth 10. Mean coronal wear scores among maxillary teeth ranged from 0.35 for tooth 4 to 0.91 for tooth 11. All 29 orca evaluated exhibited some tooth degradation, although two captive-born female calves housed in the California facility (1.9 and 3.8 yrs of age) were observed with only minimal coronal wear in mandibular tooth 1 and no other pathology. One female calf at the Texas facility (2.96 yrs of age) exhibited major mandibular coronal wear in tooth 1 and moderate to minor coronal wear in teeth 2 and 3, respectively. The female was also observed with five bore holes in 20 (25%) of the mandibular teeth evaluated; no other pathologies were observed.

The highest percentage of fractured mandibular teeth was observed in teeth 8–9 (25.45 and 22.64%, respectively) and tooth 12 (30%) (Fig. 4). The highest percentages of mandibular teeth exhibiting wear at or below the gum line occurred in teeth 1–5 (85.96, 61.40, 41.82, 32.14, and 26.32%, respectively) and tooth 12 (28.57%). As with mandibular fractured teeth, an abrupt increase in the percentage of teeth worn at or below the gum line was observed from tooth 11 (16.67%) to tooth 12 (28.57%). Highest percentages of mandibular teeth with bore holes occurred in teeth 2–4 (61.82, 62.26, and 47.27%, respectively); while no bore holes were observed in teeth 10–12. The highest percentages of missing mandibular teeth occurred in teeth 3 and 4 (5.17% and 5.18%, respectively). No missing teeth were observed among mandibular teeth 6 and 8–12.

Overall, maxillary teeth generally presented fewer pathologies than mandibular teeth across categories, although more fractures were observed in maxillary teeth 1 and 2 (3.92 and 19.61%, respectively) than mandibular teeth 1 and 2 (1.79 and 14.29%, respectively). Similarly, a higher percentage of missing teeth were observed in maxillary teeth 1 and 5–8 (2.04, 3.92, 3.94, 4, and 2.22%, respectively) than mandibular teeth 1 and 5–8 (1.72, 1.72, 0, 1.72, and 0%, respectively) (Fig. 5). In maxillary teeth, the highest percentage of fractures was observed in teeth 2–4 and tooth 9 (19.61, 11.53, 9.61, and 9.52%, respectively). The highest percentage of maxillary teeth exhibiting wear at or below

**Table 1**
Summary of whales sampled, by facility, sex, source (wild-captured or captive-born) and mean Duration of Captivity (DOC). Some teeth exhibited a pathology that prevented its assessment in another category (e.g., a missing tooth could not be additionally evaluated for coronal wear, wear at or below gum line and bore holes). Therefore, the mean number of teeth assessed across all pathology categories in the mandible and maxilla is presented.

| Facility & number of orca | Sex | Number of individuals (wild-captured; captive-born) | Mean DOC (yr) | Mean number of teeth assessed over all pathology categories (mandible; maxilla) |
|---|---|---|---|---|
| Florida, US (n = 7) | *male* | 1; 2 | 17.0 | 65.2; 56.4 |
| | *female* | 1; 3 | 21.5 | 86.2; 82.4 |
| Texas, US (n = 5) | *male* | 0; 2 | 21.2 | 42; 38 |
| | *female* | 0; 3 | 11.7 | 59.8; 41.4 |
| California, US (n = 11) | *male* | 1; 3 | 19.5 | 82.8; 51.2 |
| | *female* | 2; 5 | 23.6 | 142.2; 115 |
| Canary Islands, Spain (n = 6) | *male* | 0; 3 | 14.5 | 64.4; 62.2 |
| | *female* | 1; 2 | 11.3 | 65.4; 61.6 |
| Total facilities (n = 4) | *male* | 2; 10 | 17.9 | 63.6; 51.9 |
| Total orcas (n = 29) | *female* | 4; 13 | 18.9 | 88.4; 75.1 |
| | *combined* | 6; 23 | 18.5 | 76; 63.5 |

the gum line was observed in teeth 1 and 2 (12.00 and 11.53%, respectively) and 9–12 (9.30, 9.52, 8.57, and 9.09%, respectively). Missing teeth in the maxilla were observed primarily between teeth 4–8 (3.85, 3.92, 3.92, 4.00, and 2.22%, respectively). No bore holes were observed in the maxilla.

### 3.3. Pathology between sexes, origin and facilities

Males generally exhibited more severe dental pathology than females ($PI_{mandible}$ (0.45), $API_{mandible}$ (−0.06), $PI_{maxilla}$ (0.39), $API_{maxilla}$ (−0.03) and $PI_{Ao}$ (−0.09) (Table 2). However, Independent-samples Mann-Whitney *U* tests of dental pathology indices revealed that the observed difference between sexes was not statistically significant.

Independent-samples Mann-Whitney *U* tests demonstrated a significant difference between wild-captured ($PI_{maxilla}$ = 1.55) and captive-born ($PI_{maxilla}$ = −0.25) orca in non-age-adjusted maxillary pathology (U = 3.72; p = 0.047). Although wild-captured orca generally exhibited more severe dental pathology than captive-born orca ($PI_{mandible}$ (1.28), $API_{mandible}$ (−0.01), $API_{maxilla}$ (0.01), and $PI_{Ao}$ (−0.00)), these pathology summaries did not differ significantly between the two cohorts. Independent-samples Mann-Whitney *U* tests between individual, age-adjusted raw pathology scores of coronal wear, fractures, wear at or below gum line and missing teeth in both the mandible and maxilla demonstrated that the differences between wild-captured and captive-born orca were not statistically significant.

Captive-born animals had significantly lower DOC (M = 14.65 yr; SD = 8.22) than wild-captured whales (M = 33.01 yr; SD = 13.72; U = 3.61; $p < 0.01$), while the mean percentage of mandibular teeth with bore holes was higher among captive-born (29.89%) than wild-captured whales (13.96%). However, the difference in the percentage of mandibular bore holes between the two groups was not statistically significant. The youngest orca at the Spanish facility (captive-born male, 6.1 yrs of age) demonstrated the second highest non-age-adjusted, raw pathology index at that facility, and was observed to have eight of 19 (42%) mandibular teeth bored, seven teeth (37%) with coronal wear scored as extreme and seven worn at or below the gum line. The two youngest whales at the Florida facility (captive-born male, 6.2 yrs of age; captive-born female 9.7 yrs of age) demonstrated the second and fourth highest non-age-adjusted, raw pathology index at that facility, respectively, with the younger of the two observed to have 14 of 22 (64%) mandibular teeth bored, 11 (50%) with coronal wear scored as extreme and 10 (45%) worn at or below the gum line.

More severe mandibular and overall dental pathology indices were observed among orca held in Florida than in the other theme parks ($PI_{mandible}$ (1.87), $API_{mandible}$ (0.11) and $PI_{Ao}$ (−0.04)), although these differences were not statistically significant. Similarly, more severe maxillary teeth pathology indices were generated for whales held in the Texas facility ($PI_{maxilla}$ (0.54) and $API_{maxilla}$ (−0.06)), although the values between facilities did not differ statistically.

### 3.4. Pathology between mandible and maxilla

Related-samples Wilcoxon Signed Rank test for age-adjusted, raw pathology scores between mandibular and maxillary teeth differed statistically for coronal wear ($z = -4.70$; $p < 0.01$), fractures ($z = -2.91$; $p < 0.01$), and wear at or below the gum line categories ($z = -3.96$; $p < 0.01$). These values indicated more severe pathology for teeth in the mandible than in the maxilla. No statistically significant difference between missing teeth in mandible and maxilla was found. Differences in bore hole percentages were not evaluated as no bore holes were observed in the maxilla.

### 3.5. Linear regression: DOC and dental pathology

Linear regression demonstrated that DOC was a significant predictor of overall dental pathology, explaining 39% of the variance in non-age-adjusted, overall dental pathology ($R^2 = 0.39$, $F(1,27) = 17.30$,

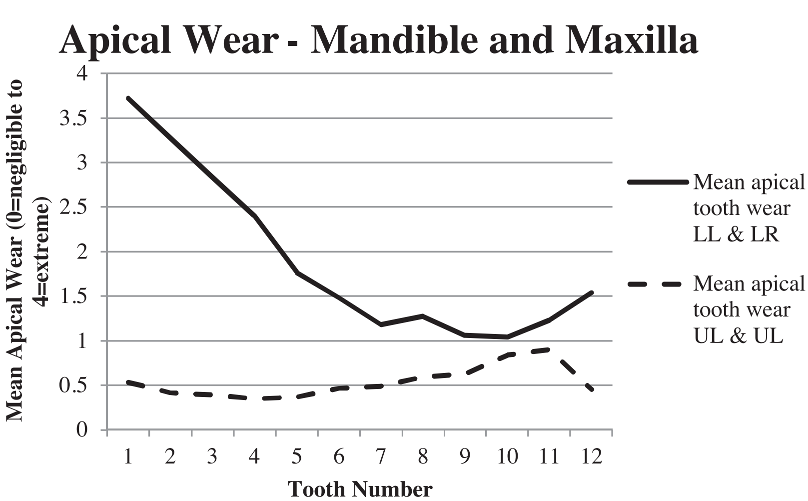


**Fig. 3.** Mean coronal wear for mandible (n = 605 teeth evaluated) and maxilla (n = 522 teeth evaluated). Values depict combined scores for a particular tooth on both the left and right side of the mandible and maxilla of all orcas from all facilities.

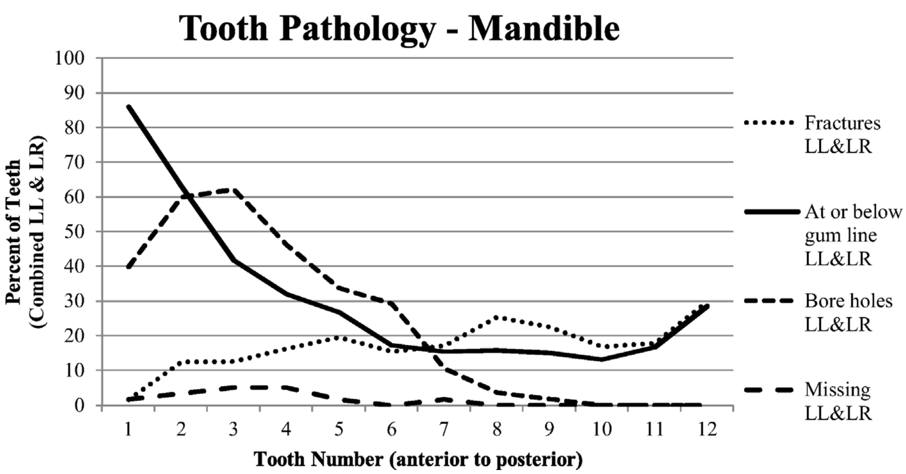


**Fig. 4.** Percentages of fractures (n = 607 teeth evaluated), teeth at or below gum line (n = 619 teeth evaluated), bore holes (n = 589 evaluated) and missing teeth (n = 621 evaluated) in mandible. Indicated as lower left (LL) and lower right (LR). Differences in the numbers of teeth evaluated within each category is due to a tooth's pathology (e.g., missing tooth) preventing its assessment in another category (e.g., coronal wear). Values depict combined percentages for a particular tooth on both the lower left (LL) and lower right (LR) side of the mandible of all orcas from all facilities.

$p < 0.01$). DOC values ranged from 1.97 yr to 46.29 yr (median = 15.22 yr), and as DOC was a statistically significant predictor of overall pathology, we divided DOC values into quartiles to evaluate how groups may differ (group 1 = 1.97 to 9.40 yr; group 2 = 9.41 to 15.22 yr; group 3 = 15.23 to 26.67 yr and group 4 = > 26.68 yr). An independent-samples Kruskal-Wallis test with Bonferroni multiple comparisons performed on non-age-adjusted $PI_o$ values confirmed that groups differed significantly ($\chi^2(3) = 14.34$; $p < 0.01$), with group 1 (M = −1.21; SD = 1.25) differing significantly from group 2 (M = −0.14; SD = 0.28) ($p = 0.05$), group 3 (M = 0.08; SD = 0.25) ($p < 0.01$) and group 4 (M = 0.13; SD = 0.12) ($p < 0.01$). Multiple comparisons between groups 2, 3 and 4 did not differ significantly.

### 3.6. Linear correlations

Pearson-r correlation analyses performed between raw non-age-adjusted pathology values demonstrated that mandibular coronal wear was strongly associated with the proportion of mandibular teeth worn at or below the gum line ($r = 0.93$; $p < 0.01$), with the proportion of mandibular teeth with bore holes ($r = 0.69$; $p < 0.01$) and with maxillary coronal wear ($r = 0.56$; $p < 0.01$) (Table 3). The proportion of fractured mandibular teeth was strongly associated with the proportion of fractured maxillary teeth ($r = 0.58$; $p < 0.01$). The proportion of mandibular teeth worn at or below the gum line was strongly associated with both the proportion of bore holes in the mandible ($r = 0.58$; $p < 0.01$) and coronal wear in maxilla ($r = 0.64$; $p < 0.01$). Similarly, the proportion of fractured teeth in the maxilla was strongly correlated with the proportion of maxillary teeth worn at or below gum line ($r = 0.64$; $p < 0.01$).

## 4. Discussion

From the images of the 29 captive orca evaluated, we found tooth damage present in all whales and the various pathologies were common across animals with different durations of captivity, across both sexes, in captive-born and wild-captured whales, as well as whales kept in each facility. Dental pathology begins early in a whale's captive life and worsens with age. Dental pathology was especially prominent for mandibular teeth.

In our sample, 13 animals (45%) exhibited moderate mandibular coronal tooth wear (at or above index 2), with an additional seven (24%) exhibiting major (index 3) to extreme (index 4) wear. Mean coronal wear in mandibular teeth followed a general gradient of declining severity from tooth 1 at the anterior part of the jaw (M = 3.72) to tooth 10 towards the posterior end (M = 1.03). However, an increase in mean coronal wear severity from tooth 10 to tooth 12 (M = 1.54) was also observed. Mean maxillary coronal tooth wear was generally less severe and the wear pattern was somewhat opposite of that for the mandible. Despite the divergent patterns of dental pathology, significant positive correlations between raw, non-age-adjusted coronal wear values suggested that coronal wear in the mandible is likely to coincide with coronal wear in the maxilla. Not surprisingly, the percentage of teeth worn to or below the gum line was strongly correlated with mean coronal wear in the mandible and, to a lesser extent, mean coronal wear in the maxilla. The pattern of mean coronal wear and the percentage of teeth worn to the gum line were similar, with the majority of teeth worn to or below gum line occurring in the

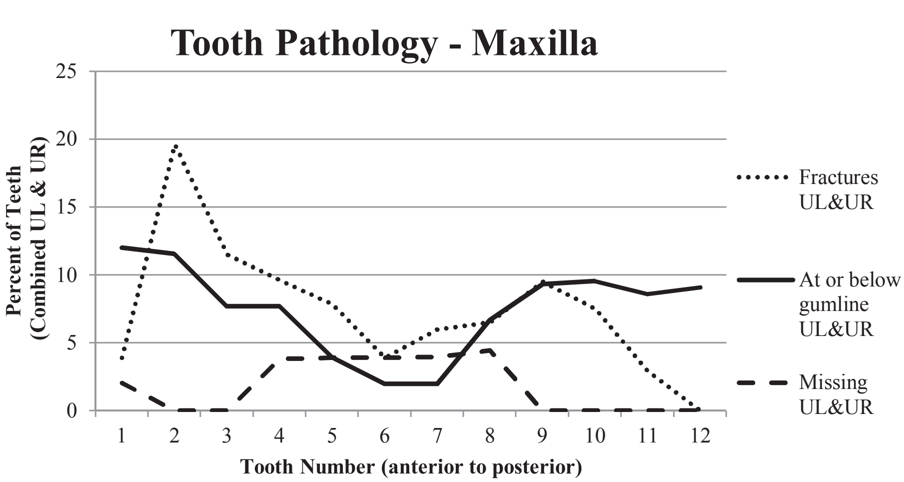


**Fig. 5.** Percentages of fractures (n = 509 teeth evaluated), teeth at or below gum line (n = 535 teeth evaluated), bore holes (n = 467 evaluated) and missing teeth (n = 509 evaluated) in maxilla, indicated as upper left (UL) and upper right (UR). Differences in the numbers of teeth evaluated within each category is due to a tooth's pathology (e.g., missing tooth) preventing its assessment in another category (e.g., coronal wear). Values depict combined percentages for a particular tooth on both the upper left (UL) and upper right (UR) side of the maxilla of all orcas from all facilities. No bore holes were observed in maxillary teeth.

**Table 2**
Summary of z-score pathology indices (*PI*), age-adjusted pathology indices (*API*) and overall, age-adjusted pathology indices ($PI_{Ao}$), with larger z-scores representing increased severity. Also shown are the results of the independent-samples Mann-Whitney *U* tests for sex and origin, and independent-samples Kruskal-Wallis test for each facility.

| Attribute | Pathology Summary | Mean (z scores) | Standard Deviation | Significant |
|---|---|---|---|---|
| Sex (male; female) | $PI_{\text{mandible}}$ | 0.4538; −0.3202 | 3.638; 3.368 | ns |
| | $API_{\text{mandible}}$ | −0.0613; −0.2799 | 0.4664; 0.7656 | ns |
| | $PI_{\text{maxilla}}$ | 0.3855; −0.0660 | 2.452; 2.522 | ns |
| | $API_{\text{maxilla}}$ | −0.0283; −0.1201 | 0.1549; 0.2435 | ns |
| | $PI_{Ao}$ | −0.0896; −0.4001 | 0.4734; 0.9826 | ns |
| Origin (wild-captured; captive-born) | $PI_{\text{mandible}}$ | 1.283; −0.3347 | 4.028; 3.287 | ns |
| | $API_{\text{mandible}}$ | −0.0066; −0.2371 | 0.1792; 0.7212 | ns |
| | $PI_{\text{maxilla}}$ | 1.553; −0.2529 | 2.476; 2.366 | $p = 0.047$ |
| | $API_{\text{maxilla}}$ | 0.0064; −0.1052 | 0.1364; 0.2256 | ns |
| | $PI_{Ao}$ | −0.0002; −0.3423 | 0.2889; 0.8948 | ns |
| Facility (Florida; Texas; California; Spain) | $PI_{\text{mandible}}$ | 1.823; −0.9217; −0.2498; −1.071 | 3.098; 3.301; 4.401; 0.7527 | ns |
| | $API_{\text{mandible}}$ | 0.1025; −0.3008; −0.3777; −0.1050 | 0.1849; 0.6006; 0.9640; 0.1022 | ns |
| | $PI_{\text{maxilla}}$ | 0.1859; −0.1262; 0.6180; −0.7588 | 2.563; 2.935; 2.369; 2.557 | ns |
| | $API_{\text{maxilla}}$ | −0.0597; −0.1622; −0.0512; −0.1069 | 0.1442; 0.3301; 0.2299; 0.1673 | ns |
| | $PI_{Ao}$ | 0.0428; −0.4630; −0.4289; −0.2117 | .1975; 0.9166; 1.161; 0.2550 | ns |

anterior part of the mandible.

Mandibular tooth fractures demonstrated a pattern somewhat opposite of coronal tooth wear. Unlike the generally declining gradient of coronal wear from mandibular teeth 1 to 10, the percentage of fractures generally increased from tooth 3 (12.72%) through tooth 12 (30%). However, evidence of dental fractures likely decreases as teeth become worn over time. Thus, the low percentage of mandibular fractures in anterior teeth is likely a function of the substantial coronal wear we observed in those teeth. Conversely, in maxillary tooth fractures, there was a simultaneous low mean coronal wear in anterior teeth and a higher percentage of fractures among teeth 1 and 2. Similarly, mandibular teeth 8, 9 and 12 exhibited the highest percentages of fractures (25.45, 22.64 and 30%, respectively), while concomitantly having relatively low mean coronal wear (1.27, 1.05 and 1.53).

Bore holes were observed primarily within anterior mandibular teeth, with 61.1% of teeth 2 and 3 and 47.27% of tooth 4 bearing evidence of having undergone the modified pulpotomy procedure. Perhaps due to the difficulty associated with drilling teeth in orca (i.e., particularly for posterior teeth where there is little room to place or maneuver a drill, or maxillary teeth where the angle may be difficult), no bore holes were observed beyond mandibular tooth 10 and none were observed in the maxilla. As with fractures, it is probable that additional mandibular teeth had been drilled in the past, but the evidence for those holes has since been obscured by fractures, severe coronal wear or other pathologies. Conversely, despite the fact that we scored a tooth positive for the presence of a bore hole only if there was a discreet hole discernible, some teeth could have been scored as bored when instead they showed a hole as a result of being worn or fractured to the point of exposing the pulp cavity. In humans, the removal of dental tissues during drilling is associated with a loss of structural integrity and a greater risk of future mechanical failure (Reeh, Messer, & Douglas, 1989; Trabert, Caputo, & Abou-Rass, 1978). The drilling of captive orca teeth seems likely to also increase susceptibility to tooth chipping, fracturing, and other progressive and acute dental events. The public release of accurate drilling records by the theme parks would help shed light on both the use and consequences of the modified pulpotomy procedure in captive whales.

Missing teeth were observed most often in mandibular teeth 4 and 5 (> 5.0% in both teeth), whereas in the maxilla they were most common among teeth 4–8 (range from > 4.0% to > 9.0%). Missing teeth can occur due to mechanical extraction or trauma, the latter of which can be sufficient to break a tooth off below the gum line leaving the root extended into the mandible. At least one female whale at the Florida facility (deceased 1996; not included in this study) had two teeth extracted by facility personnel due to dental intrusion from conspecific aggression (Astrid van Ginneken *personal communication*). Regardless of whether an acute event or chronic process lead to the tooth loss we observed, missing mandibular teeth followed an anterior-posterior gradient.

Both males and wild-captured whales generally exhibited more severe dental pathology than females or captive-born whales, although the differences were not statistically significant. Captive-born orca had a significantly lower DOC (M = 14.78 yr) than wild-captured orca (M = 33.01 yr), yet simultaneously exhibited a higher percentage of mandibular bore holes (29.89%) than wild-captured whales (13.96%). Overall, dental pathology was found to worsen significantly between the first DOC quartile group (1.97–9.44 yr) and second quartile group (9.41–5.22 yr), and with one exception, quartile groups 1 (n = 7) and 2 (n = 8) only included captive-born animals. In addition, three of five captive orca with the highest non-age-adjusted pathology indices, and four of five orca with the highest age-adjusted pathology indices, were captive-born. Substantial dental pathology was also evident in several of the youngest whales in our study. For example, one captive-born calf at the Texas facility (female, 2.96 yrs of age) already exhibited major mandibular coronal wear in tooth 1, moderate to minor coronal wear in teeth 2 and 3, respectively, as well as bore holes in 25% of her mandibular teeth. The youngest orca at the Spanish facility (captive-born male, 6.1 yrs of age) was observed to have 42% of his mandibular teeth bored and 37% of mandibular teeth with extreme coronal wear. Similarly, the youngest whale at the Florida facility (captive −born male, 6.2 yrs of age) exhibited bore holes in 64% of his mandibular teeth and 50% of his mandibular teeth demonstrated extreme coronal wear.

It is known that cetaceans engage in observational learning and mimicry in captive environments (Pace, 2000; Tayler & Saayman, 1973; J. Jett & J. Ventre, *personal observation*), so it is not surprising that young captive orca inflict damage to their teeth when they mimic the oral stereotypies exhibited by the older animals inhabiting their tanks. It is also known that in mammalian models, pathogens and pathogenic byproducts associated with periodontal disease can reach and circulate within a developing fetus and its amniotic fluid, adversely affecting a developing fetus in a variety of ways (e.g., Madianos, Bobetsis, & Offenbacher, 2013). Given the prevalence and severity of dental pathologies in the captive-born individuals we observed, etiologies stemming from the in-utero environment cannot be ruled out, especially among the offspring of mothers with poor dentition.

Consistent with our overall findings, poor dentition has been previously noted in USDA investigations of captive orca owned by the US-based theme park housing the whales studied here (supporting document 1). While a minority of free-ranging orca have also been noted to have dental issues (e.g., Foote et al., 2009; Ford et al., 2011; Loch & Simões-Lopes, 2013), the etiologies leading to dental pathology

**Table 3**
Pearson-r correlation matrix between raw, non-age-adjusted pathology values for mandibular and maxillary teeth.

| Pathology Category | Coronal Wear Mandible | Proportion Fractured Mandible | Proportion at or Below Gum line Mandible | Proportion with Bore Hole Mandible | Proportion Missing Mandible | Coronal Wear Maxilla | Proportion Fractured Maxilla | Proportion at or Below Gum Line Maxilla | Proportion Missing Maxilla |
|---|---|---|---|---|---|---|---|---|---|
| Coronal Wear Mandible | – | **0.402*** | **0.925**** | **0.685**** | 0.082 | **0.555**** | 0.234 | 0.265 | −0.100 |
| Proportion Fractured teeth Mandible | **0.402*** | – | **0.371*** | −0.044 | 0.214 | 0.306 | **0.589**** | 0.374 | 0.069 |
| Proportion teeth at or Below Gum line Mandible | **0.925**** | **0.371*** | – | **0.582**** | 0.073 | **0.635**** | 0.200 | **0.388*** | −0.027 |
| Proportion teeth with Bore Hole Mandible | **0.685**** | −0.044 | **0.582**** | – | −0.046 | 0.074 | −0.286 | −0.165 | 0.035 |
| Proportion Missing teeth Mandible | 0.082 | 0.214 | 0.073 | −0.046 | – | −0.069 | 0.307 | 0.011 | 0.088 |
| Coronal Wear Maxilla | **0.555**** | 0.306 | **0.635**** | 0.074 | −0.069 | – | 0.173 | **0.454*** | −0.138 |
| Proportion Fractured teeth Maxilla | 0.234 | **0.589**** | 0.200 | −0.286 | 0.307 | 0.173 | – | **0.639**** | −0.007 |
| Proportion teeth at or Below Gum Line Maxilla | 0.265 | 0.374 | **0.388*** | −0.165 | 0.011 | **0.454*** | **0.639**** | – | −0.051 |
| Proportion Missing teeth Maxilla | −0.100 | 0.069 | −0.027 | 0.035 | 0.088 | −0.138 | −0.007 | −0.051 | – |

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

between free-ranging and captive orca are markedly different. Although mostly limited to specific ecotypes, free-ranging orca may exhibit extensively worn teeth theorized to be a result of suction feeding behavior (Foote et al., 2009) or consumption of abrasive food items (Ford et al., 2011). However, unlike their ocean-dwelling counterparts, captive orca teeth are never exposed to abrasive or otherwise potentially injurious live prey as they are fed only dead fish, squid and gelatin (Visser & Lisker, 2016; Authors, *personal observation*). Instead, as an oral stereotypy, biting and chewing of hard tank surfaces by captive orca seems to factor prominently in their dental pathology (Graham & Dow, 1990; Jett & Ventre, 2012; Ventre & Jett, 2015; Visser, 2012; Visser & Lisker, 2016). Oral stereotypies by captive orca therefore result in a pathological scenario in which the rate of tooth wear exceeds the rate of secondary dentine deposition along the pulp chamber (see Rose & Ungar, 1998). Even though free-ranging orca may exhibit worn teeth, tooth wear is generally matched by secondary dentine deposition such that pulp exposure is uncommon (Foote et al., 2009; Loch & Simões-Lopes, 2013), although not undocumented (Ford et al., 2011). Additionally, although broken teeth are rarely observed in free-ranging odontocetes (I.N. Visser, *personal observation*; Colin MacLeod, *personal communication*), fractures were observed in 12.7% of the orca in the present study, and the distribution of broken teeth varied considerably between the mandible and maxilla.

Graham and Dow (1990) reported that chewing on tank surfaces by a captive orca had resulted in multiple teeth worn down to the gum line and pulp cavity, with dead, infected, or hyperplastic exposed dental pulps. Due to the health implications of the observed dental pathology, Graham and Dow (1990) reported that the focus animal was also lethargic, leukocytic and suffered a risk of ensuing osteomyelitis, gingival cellulitis and systemic infection. Of note is that in the present study, the whale with the second highest non-age-adjusted pathology index died of a bacterial respiratory infection on Jan 6, 2017 (wild-captured male; Florida facility), and the whale with the 12th highest non-age-adjusted pathology index was euthanized due to a bacterial respiratory infection on Aug 15, 2017 (wild-captured female; California facility). At present, the MMIR attributes a large number of captive orca deaths to various infections and respiratory diseases such as pneumonia. Among humans, poor dentition is associated with a variety of systemic disorders such as cardiovascular ailments (e.g., Tonetti & Van Dyke, 2013), poor pregnancy outcomes (Madianos et al., 2013), respiratory diseases such as bacterial pneumonia (e.g., Bansal, Khatri, & Taneja, 2013) and others. Given the generally poor dentition observed in the present study, there is an obvious need to better understand how dental pathology may be related to morbidity and mortality among captive orca.

It is known that zoo mammals living in communal conditions have a higher proportion of fractured teeth and subsequent extractions secondary to aggression between conspecifics (Glatt et al., 2008). As a sign of aggression, captive orca may engage in a threat display referred to as 'jaw popping' in which whales snap their mouths closed at high speed, as described for free-ranging bottlenose dolphins (Scott, Mann, Watson-Capps, Sargeant, & Connor, 2005). While it is not known if free-ranging orca fracture their teeth from similar aggressive displays, jaw popping has been observed to result in fractures when captive orca teeth make contact with steel segregation gates or other solid tank surfaces (Jett & Ventre, 2012; J. Jett & J. Ventre*, personal observation,*). More specifically, the horizontal components of segregation gates can facilitate dental damage from chewing and jaw popping (see Visser & Lisker, 2016). Jaw popping can result in a tooth fracturing to the point where tooth sections break off and can then occasionally be found on the tank floor (J. Jett & J. Ventre, *personal observation*). Conspecific aggression is an important factor to address if dental pathologies are to be minimized in orca held in captive environments.

Stereotypies certainly contributed to the dental pathology observed in the present study. Stereotypical behavior is described as a repetitive pattern of activity associated with sub-optimal living conditions, frustration, stress, fear, and a lack of physical or mental stimulation, with much of the research indicating adverse health consequences to the animals (see Mason & Latham, 2004; Mason, 1991). Owing to their potential for serious health implications, oral stereotypies have been particularly well described in captive terrestrial mammals (see Bergeron et al., 2006 for a review) such as confined horses (McBride & Hemmings, 2009; Nicol et al., 2005), sows (e.g., Cronin, Wiepkema, & van Ree, 1985) and caged bears (e.g., Li, 2004; Wenker, Hermann, Muller, & Lussi, 1999). Stereotypies are a likely function of stress (Mason & Latham, 2004), and both acute and chronic stress is thought to cause disorders of the autonomic and endocrine systems in mammals (Koob, 1999; Tanaka, Yoshida, Yohoo, Tomita, & Tanaka, 1998). Along these lines it is known that oral behaviors such as biting, gnawing and chewing serve to suppress stress-activated dopamine metabolism and corticotropin-releasing factor in rat models (Gómez et al., 1999; Hori, Yuyama, & Tamura, 2004). Further evidence of the role that oral behaviors may play in coping with stress is found in reduced plasma cortisol levels following stereotypical crib-biting in, for example, confined horses (Briefer Freymond et al., 2015; McBride & Hemmings, 2009).

The MMIR lists gastric ulceration and other gastrointestinal disorders as the cause of death for several captive orca and it is not uncommon for captive orca to be medicated for stomach conditions such as gastric ulcers (Hargrove & Chua-Eoan 2015; J. Jett & J. Ventre, *personal observation*). In a similar scenario, crib-biting behavior in equines is associated with gastric ulceration and general stomach disorders (e.g., Moeller, McCall, Sliverman, & McElhenney, 2008; Nicol et al., 2005). It is therefore feasible that an association exists between gastric illnesses and stereotypical biting and chewing in captive orca, although no published research exists on the topic. Additionally, there is a recognized relationship between a confined animal's propensity to engage in stereotypical behavior and the size of their natural home range (Clubb & Mason, 2003, 2007). If this also holds true for orca, then given the enormous home ranges of free-ranging orca (see Dahlheim et al., 2008; Matthews, Luque, Petersen, Andrews, & Ferguson, 2011; Visser, 1999), the generally poor dentition observed in captive whales may not be surprising.

Finally, captivity-induced dental pathology among orca has been evident since at least the late 1980s (J. Ventre, *personal observation*) and early 1990s (Graham & Dow 1990; Authors, *personal observation*), and those visiting the facilities in the present study can observe, in-situ, the dental pathologies described here. However, despite the animal welfare implications of tooth damage in captive orca, limited empirical research on the topic exists. While the present study elucidates several of the most obvious dental consequences and potential health effects in confined orca, the theme park industry is in a unique position to provide further insight into this phenomenon in captive orca and other odontocetes. By making dental and health records publicly available for captive whales, future management and husbandry practices may be better informed.

## Conflict of interest

None.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.archoralbio.2017.09.031.

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USDA

Animal Care

## USDA, APHIS, Animal Care
# ANIMAL WELFARE COMPLAINT

| Complaint No. | Date Entered | Received By |
|---|---|---|
| AC15-503 | 13-Aug-15 | MAJ |

| Referred To | Reply Due |
|---|---|
| Howard | 14-Sep-15 |

## Facility or Person Complaint Filed Against

| Name | Customer/License/Registration No. |
|---|---|
| Sea World Of Texas | 74-C-0180/4858 |

Address
10500 SEA WORLD DR

| City | State | Zip |
|---|---|---|
| SAN ANTONIO | TX | 78251 |

## Complainant

Address
NA

| City | State | Zip |
|---|---|---|
| NA | NA | NA |

How was complaint received?
Email

**Details of Complaint:** SEE ATTACHED

**Results:** A focused inspection was conducted at Sea World of Texas to address the complaint.

a) Orcas with rake marks indicate intra group aggression and or unsafe enclosures :

Orcas were brought up for close observation by USDA inspector at time of inspection on 8/26/15. Several old rake marks were noted on Kyuquot and Takara. These have been seen on past inspections. Medical records reviewed this date did not indicate any recent injuries to the animals. Trainers were questioned about compatibility of the Killer Whales and said that there had been no serious aggression seen. Enrichment for the Killer Whales has been increased and several new items are being introduced to them.

There were no areas in or around the pool that would indicate the enclosure is not safe for the animals.

b) Orcas with severe dental trauma, creating a severe vulnerability to serious infection :

All Killer Whales were brought up for close view of teeth during the inspection. Several animals were observed to have some teeth which are worn with the pulp cavity exposed. Veterinary treatment for this condition involves opening the cavity enough to flush the cavity to prevent infection. A tom cat catheter is used to flush the area with

USDA

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are

# USDA, APHIS, Animal Care

# ANIMAL WELFARE COMPLAINT

| Complaint No. | Date Entered | Received By |
|---|---|---|
| AC15-504 | 14-Aug-15 | T Gerkin |
| Referred To | | Reply Due |
| Dr Gaj | | 15-Sep-15 |

## Facility or Person Complaint Filed Against

| Name | | Customer/License/Registration No. | |
|---|---|---|---|
| Sea World of Florida | | 3108/58-C-0077 | |
| Address | | | |
| 7007 Sea World Drive | | | |
| City | State | Zip | Phone |
| Orlando | FL | 3 28 821 | ( 4 3637-2351 |

## Complainant

| Name | | Organization | |
|---|---|---|---|
| Jared S. Goodman | | PETA Foundation | |
| Address | | | |
| 1536 16th St. NW | | | |
| City | State | Zip | Phone No./Email address |
| Washington | DC | 2 0 06 3 | jaredg@petaf.org |

How was complaint received?

## Details of Complaint: SEE ATTACHED

## Results:

I will answer this complaint based upon my recent inspection of SeaWorld which took place July 21-23, 2015 and follow-ups.

I will address the complainant's concerns as they appear on her complaint:

1A Dolphin Skin Conditions:

Many of the cetaceans do have pox virus. This is not a zoonotic disease and does not possess a health risk to humans. SeaWorld is doing some clinical trials to reduce this by raising the water temperature in one of the back pools by 4-6 degrees. The results look promising. This raise in temperature seems to help in fading the lesions. If this study is successful it might be extended to all cetacean pools.

I did not observe any ulcerations, lesions, papules, or other clinically significant skin abnormalities (with the exception of Pox Virus) in any of the dolphins.

1.5 % hydrogen peroxide. This is done twice a day seven days a week as part of routine husbandry. Veterinary records for all Killer Whales were reviewed and dental issues appear to be properly addressed and appropriately treated when they do occur.

c) Sea Lions prone to ocular disease confined to an enclosure without shade and forced to look into the sun when begging for food : Sea Lion pool was recently renovated and now includes a roofed area which extends over the edge of the pool. This area provides shade to the animals during times of public feeding. At time of the inspection (near mid-day), there were many shaded areas around the pool. There were no ocular issues noted in any animal observed during the inspection.

d) Death of the 3 week old Beluga Calf
There were 2 necropsy reports from 2 different pathologists for the Beluga calf. Both had the same diagnosis of septicemia/premature birth as cause of death. Records reviewed indicate that the calf was born at least 3 weeks premature and had aspirated meconium during birth. The calf failed to gain weight during its short life despite 24 hour monitoring and many daily supplemental feedings. Records reviewed indicate the calf did receive proper veterinary care.

**Other animals were crowded in back section of the pool while Beluga and calf had larger pool: At times, the Beluga and calf were housed in the main show pool. However, I was told they were rotated to other pools so the other Belugas were not housed in back pool areas for long periods of time. The back Beluga pool dimensions and water volumes were reviewed and space calculated for 8 Beluga and were found to be in compliance at time of the inspection.

Application packet provided? Yes ☐
No ☐

| | |
|---|---|
| INSPECTOR<br>E Pannill DVM VMO | DATE<br>27-Aug-15 |
| REVIEWED BY<br>Tami L Howard, DVM, SACS | DATE<br>16-Sep-15 |

1B Contact with Dolphins:

As I explained in the last complaint, SeaWorld has changed how they do the dolphin encounters at Key West. For an additional charge, small numbers of people line up and are divided into small groups each with a trainer in the immediate area. There is no longer any public feeding anywhere in the Key West exhibit. Only the trainers feed. The public does have the opportunity to touch the dolphins under direct supervision in this paying area. There is still a small circumference of the pool where the public can come up to the pool for free. Since there is no feeding of any kind in this particular area, I observed the dolphins to be less interested in this area than in the other areas where they know that they will get fish. This free public area is still always monitored by at least one employee who has direct visual contact with the public at all times.

I repeatedly asked if any member of the public was injured in any way during the interactions that occur throughout SeaWorld. Their answer was always "no-not to their knowledge", but allegedly there were articles that were published that indicated that there were.

There are no skin conditions which pose a health risk to humans (or the animals) in Key West. There are wash stations in the area for the public to wash their hands. I have heard announcements that hand washing is recommended, but it is not an absolute SeaWorld requirement and it is not enforced by them. There is no AWA regulation or standard that states that the public must wash their hands after touching animals (but I always encourage it).

1C Incompatibility of Dolphins:

Throughout the 25 years that I have inspected SeaWorld I have observed a fair share of rake marks on the dolphins. These rakes were most often clinically insignificant and rarely (if ever) require any type of treatment or intervention. The numbers of rake marks tend to increase during breeding season. SeaWorld is not unique in having rake marks among dolphins, as many other facilities experience this also. All marine mammals were being held in pools which exceed all of our space requirements.

On all of the necropsies that I looked at in the past, there was either no mention of rake marks or the pathologist indicated that the rake marks observed were not clinically significant. As the complainant states the rake marks heal fairly quickly.

1D Dolphins Overcrowded in Shallow Water Exhibit:

At the time of the inspection there were 2.6 dolphins in the Dolphin Nursery exhibit. The complainant observed 4 females and 4 calves (but did not list the sexes of the calves).

This pool is oval with an island in the center that has been in operation for at least 25 years. It is one of the original pools left at SeaWorld and is smaller than the majority of other dolphin exhibits. The MHD is 30', the SA is 3,945 sq. ft., the Volume is 29,587 cu ft., and the depth is 7'6". This pool meets the 6 foot depth requirements & the 24 foot MHD requirements for atlantic bottlenose dolphins.

Even with 8 dolphins in that pool, the volume requirement would be 2712.96 cu ft. (for the 1st 2) + 4578 cu ft. for the next 6 for a total of 7291.08 cu ft. of water. The cu ft. of required volume of water is only about 25 % of the total cu ft. available and is well within compliance for volume of water. The SA required for 8 dolphins is 95.38 sq. ft. x 8 for a total of 763.04 sq. ft. which is only about 20% of the total surface area available and is also well with compliance for SA.

SeaWorld calculated that they could actually hold as many as 35 dolphins in this pool but has never even come anywhere close to that number.

According to our current standards for space of group 1 cetaceans, this pool meets and exceeds the minimum space required. These 8 dolphins are not overcrowded. I did not observe any aggression or abnormal behaviors during my inspection. The dolphins in this pool do not spend their entire lives there anyway and are eventually transferred to the Key West exhibit or other exhibits. While the exhibit is smaller than the others it is nonetheless compliant for all space requirements.

2A Orcas with Dental Trauma:

As the complaint alleges the orcas do have long standing dental issues and wearing of their teeth. These problems have been observed by me for many years. SeaWorld constantly monitors this and does treat & flush their teeth as the veterinarians clinically determine. Some of these orcas have had their teeth drilled in the past as the complainant alleges. They now try to get away from cutting the teeth and drilling into the pulp cavity. SeaWorld consults with both a human dentist and a board certified veterinary dentist who suggested that cutting & drilling to expose the pulp cavity should be avoided.

When the animal fractures or grinds down a tooth and the pulp cavity gets exposed, the animals then produce an "epithelial cap" over the defect which then protects the pulp cavity from infections and debris. This "epithelial cap" is now thought to be more beneficial than interference by drilling and exposing the pulp cavity to treat these dental issues. The last resort for a fractured tooth is extraction. All dental work is performed under local anesthesia. Interestingly, I have been told that studies have suggested that no nerve tissue can be found in the pulp cavity. SeaWorld is actively increasing the amount of enrichment and trainer interactions in an effort to prevent dental issues. I did observe several enrichment toys in the pools on my last inspection.

2B Orca Rake Marks:

Yes like the dolphins, the orcas (to a lesser extent) have rake marks, but these rake marks are also not clinically significant. They appear as light old rakes that have healed up completely. These rakes were also most often clinically insignificant and rarely (if ever) require any type of treatment. All orca pools exceed our space requirements.

I have not observed any aggressive activity in Shamu Stadium during the inspection

2C Injured Orca:

I was informed that Trua spends most of his time housed with Tillicum. The complainant might have observed him alone because Tillicum was doing a show, they were shifting animals, training, vet care, etc. Trua has not had any injuries in several years. The veterinarian did not know of any stereotypic behaviors and I did not observe any either during the inspection.

Some of the orcas have various notches on their fins. Some of the orcas were born that way, others have had them for many years, some were acquired in that condition, and still in others it may have been due to ischemia in the general area which can occur in orcas which creates these notches. In all cases these occurrences have not been clinically significant and rarely (if ever) require any veterinary care.

3 Walrus:

The Wild Artic exhibit exceeds our space requirements. The exhibit alone can hold a minimum of 14 walrus (not including the off exhibit pools) depending on the sex mix. There have never been close to that. They have 2. I looked at the video. On my inspections I have observed similar behaviors when the walrus swim up to the glass as the complainant alleges, but I do not consider this as necessarily a stereotypic behavior or non-compliant. In addition to the exhibit area they have access to the off exhibit pools also. The exhibit is not just a plain pool of water, but is a complex themed design which probably provides some additional enrichment for these animals.

A walrus that is floating is also not necessarily a non-compliance. The veterinarian indicated that both walrus were normal. When I observed these animals they appeared to be normal as well.

Application packet provided? Yes ☐ No ☒

| INSPECTOR | DATE |
|---|---|
| R. Brandes, D.V.M. | 21-Aug-15 |
| REVIEWED BY | DATE |
| Gregory S. Gaj, SACS | 21-Aug-15 |

Court File No. 52783/11

*ONTARIO*
SUPERIOR COURT OF JUSTICE

BETWEEN:

SEAWORLD PARKS & ENTERTAINMENT LLC
("SeaWorld")

Applicant

- and -

MARINELAND OF CANADA INC.
("Marineland")

Respondent

**AFFIDAVIT OF DR. LANNY CORNELL**
**(sworn March 28, 2011)**

I, Dr. Lanny Cornell, of the City of San Diego, in the State of California, MAKE OATH AND SAY:

1. I am a doctor of veterinary medicine and have been actively practising in the field of marine mammal medicine for over 45 years. For the past 20 years I have been an external veterinary consultant to Marineland. As a result, I have knowledge of the matters deposed in this affidavit. Where facts are stated to be on information and belief, I believe such facts to be true.

2. I am currently the President and CEO of Pacific Research Laboratories Inc., located in San Diego, California. Pacific Research Laboratories is a corporation dedicated to providing veterinary care and vitamin supplements to marine mammals and exotic animals worldwide. It is also dedicated to research on marine mammals.

3. I have been involved in the care and treatment of marine mammals since 1965. Over that period of time, I have worked in private practice and as a consultant to various marine mammal theme parks. Specifically, I was employed at SeaWorld from 1973-1987, holding the positions of Corporate Curator, Vice President-Research/Veterinary Husbandry and Senior Vice President/Zoological Director.

4. Over the course of my career, I have acquired a great deal of experience in the medical care and treatment of killer whales. Indeed, I designed and implemented a reproduction system which resulted in the first successful birth of a captive killer whale in the world. I have also designed and implemented marine mammal transport equipment and methods, including the original SeaWorld transport units for whales and dolphins.

5. Moreover, I have authored articles published in various reputable journals, and have given presentations on a variety of topics relating to killer whales including: live capture techniques, transport, restraint, marking, reproduction in captivity, as well as observations on population structure and dynamics of killer whales in the wild. I have attached a copy of my C.V. to this affidavit as Exhibit "A".

6. I am currently or have been licensed to practice veterinary medicine by the Board of Examiners for the states of Colorado, Kansas, New Mexico, Oregon and California.

**History with John Holer**

7. While I was employed at SeaWorld in the 1970s and 1980s, I had the opportunity to work with John Holer, the owner and founder of Marineland.

8. After I retired from SeaWorld, I worked as a general consultant to Holer and Marineland, and have done so on a monthly retainer for the past 20 years.

9. I was initially involved in the transaction between Holer and August Busch III ("Busch"), principal of Anheuser-Busch and Busch Entertainment Corporation ("BEC"), in that I approached Keith Kasen, former President and Chairman of the Board of BEC ("Kasen"), with the general idea that Marineland and SeaWorld might be interested in trading whales. I initially approached Kasen in San Diego in 2003 as a friend of both Marineland and SeaWorld to present to him what I saw as an opportunity for both facilities to benefit from each other. It was my understanding that SeaWorld had a desire to obtain captive-born beluga whales and Marineland provided that opportunity.

10. At the time, I offered Kasen a trade of three captive-born beluga whales from Marineland for one killer whale from SeaWorld.

11. It is my understanding that my initial discussions with Kasen led to the eventual deal between Busch and Holer of the exchange of four captive-born beluga whales for one killer whale (the "Deal").

**<u>Ikaika's Selection</u>**

12. Having had experience in the transport of whales across the Canada - United States border, I am aware of the procedure involved in obtaining permits from the National Marine Fisheries Service ("NMFS").

13. In September, 2006, I was asked by Holer to attend at SeaWorld, San Diego to examine a male killer whale that SeaWorld had proposed be traded to Marineland as part of

the Deal. I attended at SeaWorld, San Diego and examined the proposed male killer whale, but declined this whale for health reasons.

14. Approximately two months later, I travelled with Holer to SeaWorld, Orlando on November 11, 2006 to select the killer whale which was to be traded to Marineland. I examined three male killer whales that SeaWorld had proposed. We rejected each of these whales for health reasons. John and I ultimately selected Orcinus Orca, SWF00o-0201 ("Ikaika"). Ikaika was not yet of breedable age. However, it was my understanding that the male killer whale that we selected was to thereafter belong to Marineland pursuant to the Deal.

15. From my experience, I note the following facts with respect to breedable killer whales:

a. A female killer whale requires a 17 month gestation period, followed by a 3 year nursing period in which it must remain with its calf. Thus, at a minimum, a female killer whale requires over four and a half years in order to effect a proper birth and nursing period.

b. Male killer whales, like Ikaika, are breedable when they reach the age of 7 to 9 years of age. Ikaika was a 4 year old male at the time he was selected and transported. Ikaika would not have been a viable breedable whale until approximately late 2010.

**Health and Well-Being of Ikaika at the time of Transfer in 2006**

16. At the time of his transfer to Marineland in 2006, Ikaika exhibited one major health issue: a chronic dental problem with which he still has difficulties today. Due to the nature of the dental problem, Ikaika's teeth will always be subject to infection.

17. Ikaika's problem is with the roots of various teeth in his mouth. These roots are open, allowing bacteria to enter and cause infections. The infections typically cause his white blood cell count to climb. The normal course of treatment is to flush his teeth consistently, numerous times daily, and treat him with antibiotics and pain medications.

18. In fact, on November 14, 2006, four days prior to his transfer to Marineland, Ikaika had an infection in his teeth which was treated before and after his transport to Marineland. I have attached to this affidavit as Exhibit "B" a copy of Ikaika's veterinary notes from November 14, 2006.

19. Ikaika's dental infection of November 14, 2006 was not his first. His medical records and behavioural chart confirm that Ikaika has had dental infections in or around September 2005, November 2005, and April 2006, (the "Previous Dental Incidents"), all during Ikaika's time at SeaWorld. At times of infection, Ikaika's white blood cell count tended to spike to the area of 8,000 – 10,000, indicative of an infection. When suffering from an infection, Ikaika would exhibit certain characteristic symptoms and behaviours, which were observed by his veterinarians and trainers. Specifically, Ikaika would exhibit redness and swelling in the area around the infected tooth, would have less energy and would be less willing to eat. The infections were always treated quickly and Ikaika would return to normal health. I have

attached to this affidavit as Exhibit "C" Ikaika's medical records and veterinary notes related to the Previous Dental Incidents.

20. On November 18, 2006, Ikaika was transferred to Marineland via cargo plane. I travelled on the plane with Ikaika, along with Dr. Jim McBain, who was at the time the Senior Corporate Veterinarian for SeaWorld. In addition, Thad Lacinak, a SeaWorld trainer, stayed at Marineland for a few days to assist with Ikaika's acclimatization. He also informed the Marineland trainers and veterinarians with respect to the care of Ikaika's teeth, as well as the whale's activities and behaviours.

**Veterinary Care and Trainers at Marineland**

21. Marineland has an experienced and qualified veterinary staff. Dr. June Mergl, a veterinarian, has been an employee/consultant of Marineland since 1991. Dr. Mergl has been practising veterinary medicine since 1985. She has been a consultant/attending veterinarian at Marineland since 1991 and became the head veterinarian and marine mammal supervisor in 2005. Dr. Mergl has been actively involved in the medical care and treatment of marine mammals, including killer whales, throughout her tenure at Marineland. I have attached a copy of Dr. Mergl's C.V. as Exhibit "D".

22. In addition, Marineland hired Dr. Erica Gehring in August, 2006, as a full-time veterinarian. Dr. Gehring regularly speaks with Dr. Mergl and with me about the marine mammals at Marineland. I have attached a copy of Dr. Gehring's C.V. as Exhibit "E".

23. As noted in her C.V., Dr. Gehring has been practicing veterinary medicine since 2006. As further noted in her C.V., as part of her training, she participated in a veterinary internship

at SeaWorld, San Antonio where she participated in animal husbandry, clinical rounds and veterinary diagnostic and surgical procedures, while observing first hand the inner workings of the operations at a marine mammal theme park.

24. Marineland regularly monitors and takes bloodwork from all of the marine mammals on site. Each time bloodwork is taken from Ikaika, the results are, and have been, forwarded to Dr. McBain, who is now a veterinary consultant to SeaWorld.

25. All major decisions with respect to the medical care and treatment of Ikaika are made by Dr. Mergl and Dr. Gehring. If they require any assistance, Dr. Mergl will contact me or others. It is common practice for veterinarians to consult with one another outside and inside of facilities such as SeaWorld and Marineland. I encourage Drs. Mergl and Gehring to contact and consult Dr. McBain, Dr. Christopher Dold, Vice President of Veterinary Services at SeaWorld, as well as myself and many others in the research and laboratory fields to ensure that all the available options are canvassed.

26. However, since Ikaika's transfer to Marineland in 2006, neither Dr. McBain nor Dr. Dold has been responsible for the vetting of any medical decisions relating to Ikaika.

27. I am confident that Marineland has the necessary veterinary skill and expertise to care for a killer whale such as Ikaika.

28. In addition, I am advised by Holer and believe that Marineland employs approximately 18 full-time trainers on-site. Some of these trainers have years of experience in the care and training of marine mammals and are fully capable of handling and training Ikaika. Nick Hayne, Marineland's head trainer, has over 15 years of experience in training

marine mammals, including killer whales. Tom Western and Pete Forrester, full-time trainers at Marineland, have over 70 years of experience between them in the care and training of killer whales. Indeed, Brad Andrews, Vice President of Zoological Operations of SeaWorld ("Andrews") commented on the experience of Mr. Western in handling the transport of a killer whale to SeaWorld, California in 1992. Attached to this affidavit as Exhibit "F" are letters from Andrews to Holer and Mr. Western thanking Mr. Western for his assistance with the transport.

**Marineland's Investment in a Slide Out Scale**

29. I note from reviewing the Affidavit of Dr. Dold, filed in this matter, that he is concerned that Marineland has yet to purchase a "slide-out scale", which is used to weigh large marine mammals.

30. I have been assisting Marineland in investigating opportunities to purchase a slide-out scale to increase its ability to care for its whales. The preferred design of these scales has very recently changed from stainless steel to titanium load devices. Because the titanium design is preferable (due to the effects of salt water corrosion on the steel assemblies), Marineland has been considering purchasing a scale. We have been waiting for the titanium load scales to be ready for market. Attached to this affidavit as Exhibit "G" is an email dated December 28, 2010 discussing Marineland's interest in purchasing a slide-out scale. Attached as Exhibit "H" is an email dated January 18, 2011 regarding the same subject.

31. A slide-out scale is used to weigh marine mammals in order to properly determine the amount of medicine to be administered. While such scales can be helpful, experienced veterinarians, such as myself, Dr. Mergl and Dr. Gehring are able to accurately estimate an

animal's weight and thereby determine the amount of medicine that is appropriate. This practice is standard in the industry. Therefore, while a slide-out scale is a helpful tool, it is by no means a requirement for the health and well-being of the whales.

32. It is important to note that such scales have only been readily available for a few years. Prior to that, whales were weighed by placing them on stretchers and lifting them by means of a crane scale or by measuring water displacement in a device such as a transport unit.

33. I believe that the facilities at Marineland are among the best in the world for killer whales and beluga whales. SeaWorld personnel have made many trips to Marineland to observe and study these facilities and, in fact, have asked for and received the designs and specifications for these facilities.

**Ikaika's Current Health and Well-Being**

34. Aside from his dental problem, Ikaika is a healthy killer whale.

35. Ikaika's dental problem is slightly worse than it was when he arrived at Marineland approximately four and a half years ago. However, this is simply a normal progression of a chronic health problem. I believe that Ikaika's teeth are in the same condition at Marineland that they would have been in had he remained at SeaWorld.

36. Moreover, as mentioned above, when Ikaika arrived at Marineland in 2006, Lacinak showed Marineland trainers and veterinarians how to flush and properly care for Ikaika's teeth. Marineland trainers and veterinarians have continued to follow Lacinak's instructions and have treated Ikaika as per Lacinak's instructions whenever an infection has presented. I believe that Ikaika is being cared for by Marineland veterinarians in accordance with best

veterinary practices, and in any event, in accordance with the instruction provided by SeaWorld.

37. Recently, in bloodwork developed in or around February [illegible]4, 2011, Ikaika showed signs of another dental infection. Ikaika's white blood cell count rose to the 8,000 – 10,000 range and Ikaika exhibited behavioural signs consistent with that of a dental infection. In accordance with Marineland's standard practice, these blood results were provided to Dr. McBain. Ikaika was treated by Marineland veterinarians and has returned to normal health.

38. As recently as March 3, 2011, I had the opportunity to personally examine Ikaika and found him to be in good health. Moreover, I saw him moving readily between the various pools.

**Ikaika's Behavioural Tendencies**

39. I believe that Ikaika is a socially well-adapted male killer whale that shows no greater aggressive tendencies at Marineland than he would at any other facility.

40. I have been informed by Dr. Mergl and believe that Ikaika has exhibited certain aggressive tendencies towards the female killer whale at the Marineland facility. This can be seen via the various rake marks on the skin of the female whale. However, these are natural tendencies of male killer whales both in captivity and in the wild. Indeed, Ikaika showed similar tendencies while at SeaWorld in both 2005 and 2006. In 2006, Ikaika raked a young calf with his teeth and had to be given tranquilizers by the SeaWorld staff. Attached to this affidavit as Exhibit "I" is a copy of Ikaika's veterinary notes from 2005 and 2006 which refer to these incidents.

41. Simply because Ikaika has exhibited aggressive tendencies in the past does not mean that Ikaika's social environment is not meeting his needs. Although Ikaika has, in the past, had problems with the female killer whale at Marineland, Ikaika has since been re-introduced into a controlled environment where he constantly interacts with the female killer whale and has not exhibited any aggressive tendencies beyond those that would be expected in a normal male killer whale.

42. In addition, Ikaika has the ability to move between the various pools at the Marineland facility, as described in the Affidavit of Chuck Tompkins. Moreover, Ikaika has shown a willingness and ability to move consistently between the pools, at times sharing space with the female killer whale.

**SeaWorld's Suggestion Regarding the Urgency of Preparing Ikaika for Transfer**

43. There is no need for SeaWorld veterinarians and trainers to have immediate access to Ikaika.

44. Further, there is no urgent need for SeaWorld to undertake a lengthy training program to prepare Ikaika for transfer.

45. I believe that I, as well as the trainers and veterinarians at Marineland, have the necessary experience and capability to safely transport Ikaika if that becomes necessary. Not only was I involved in the transfer of Ikaika to Marineland in 2006, but from 1973 to 1987 I personally transported or oversaw the transport of all SeaWorld killer whales, as well as other

whales and dolphins. Moreover, I designed and oversaw construction of the transport devices which SeaWorld uses today.

46. Should it be necessary to transfer Ikaika, I would be able to facilitate such a transfer within a period of hours.

47. Accordingly, a lengthy training program is not required and as a result, SeaWorld's trainers do not need immediate access to Ikaika.

**SeaWorld Has No Room For Ikaika**

48. It is my understanding that SeaWorld is currently at capacity for adult mature male killer whales. Accordingly, I believe that Ikaika could not be safely located in a SeaWorld facility.

SWORN BEFORE ME at the City of San Diego, in the State of California on March 30, 2011.

Commissioner for Taking Affidavits

Larry H. Cornell D.V.M.

G. HORTON
Commission No. 1791003
NOTARY PUBLIC - CALIFORNIA
SAN DIEGO COUNTY
My Comm. Expires March 4, 2012
CNB1

G. HORTON
Commission No. 1791003
NOTARY PUBLIC - CALIFORNIA
SAN DIEGO COUNTY
My Comm. Expires March 4, 2012
CNB1 CNB1

This is Exhibit......B.........referred to in the
affidavit of......................................
sworn before me, this.........2?.............
day of........March...............20..11

A COMMISSIONER FOR TAKING AFFIDAVITS

EARS

# Clinical Notes Report

**Ikaika / SWF Oo-0201 / Resident**

**Killer whale — Orcinus orca — Male**

8/25/2006 5:00:00 PM — Christopher Dold — normal

**Subjective:** Animal is BAR and gave blood under voluntary control today. Recheck blood was collected because on previous screening bloodwok his SAP and iron were low.

**Objective:** Blood shows return to normal range for iron but SAP is still low for this animal's age bracket. Dr. Chittick working with staff to increase Ike's ration. Recent increase will go into effect this weekend (?)

**Assessment** Under fed.

**Plan:** Dr. Chitlck to review. Strong words to encourage increase in ration.

9/13/2006 6:30:00 PM — Michael Walsh — Physical exam, immune panel

**Subjective:** No problems noted byt the training staff and appears to be doing well.

**Objective:** His iron levels are decreased and his alk phos is still at the same levels as the last blood sample.

**Assessment** Dr. Chittick has been pushing his food intake as a result of the lower alk phos.

**Plan:** Monitor food intake and awaiting immune panel results.

9/27/2006 3:30:00 PM — Michael Walsh — sedation for calf management

**Subjective:** Currently Ikaika and Taku have been showing some agression to Tina's calf. Ikaika was breaking off from the group and attempting to breed the calf.

**Objective:** Nursing has decreased between Tina and the new calf. She appears to be responding more to Taku and her swimming speed and attitude toward the calf are not favorable. Diazepam has been given to Taku and Tina already.

**Assessment** Since Ikaika is also part of the problem we will try to mellow him as well to try to take pressure off of the calf.

**Plan:** Diazepam 80 mg Bid

11/3/2006 4:00:00 PM — Michael Walsh — nursing and behavior update

**Subjective:** Ikaika was given 80 mg of diazpam 1.5 hours befrore the stretcher test. There was some level of excitement when being handled and he required about 6 people to hold him.

**Objective:**

**Assessment** The dose of diazepam could be increased slightly to improve the handling procedure for the transport if desired.

**Plan:**

11/14/2006 2:15:00 PM — Christopher Dold — Tooth- abscess, Blood Analysis - routine

**Subjective:** Animal is BAR. Immune bloods were collected this morning, as well as CBC and chemistry. Animal is slated for transport this coming Saturday. Animal trainers reported heat around rostral mandibular teeth. Pulp is protruding from third left mandibular canine, and there is purulent exudate exuding from the second left

# Clinical Notes Report

mandibular tooth.

| | |
|---|---|
| Objective: | Applied local anesthesia to the effected teeth, first topical bupivicaine, followed by injectable lidocaine. After teeth were anesthetised, cored affected pulp cavities with hand drill bits. Purluent exudate exuded from both teeth. Animal held for full procedure under voluntary control.<br>Drilling was followed by dilute betadine flush.<br>Hematology is unremarkable, but FBGN is mildly increased, and SAP is chronically low. |
| Assessment | Abscessed pulp cavities on left rostral mandibular teeth. |
| Plan: | Disp cephalexin at 14 g po tid for 7-10 days. Pursue addn'l drilling tomorrow to increase diameter of hole to ~1/4" |

11/15/2006 2:30:00 PM Christopher Dold Tooth, abscess

| | |
|---|---|
| Subjective: | Animal is BAR, and eating well today. Exhibiting normal enclosure behaviors. Trainers performed to more drilling sessions today under local anesthesia. Incresed diameter of cored wholes to 3/16". |
| Objective: | . |
| Assessment | Good management of problem. Animal is still okay for transport. |
| Plan: | CPM. |

| DATE | 7/12/05 | 8/2/05 | 8/25/05 | 9/3/05 | 9/4/05 | 9/13/05 | [illegible] |
|---|---|---|---|---|---|---|---|
| TIME | 1000 | 1100 | 1000 | 1030 | 1030 | 1030 | [illegible] |
| TECH | BB | BB | H | M | SD | BB | |
| HEMOGLOBIN g/dL | 14.6 | 14.6 | 14.7 | 14.7 | 14.8 | 14.1 | 14 |
| HEMATOCRIT % / PCV% | 45 | 44 | 45 | 43 | 43/40 | 41 | |
| RBC 10⁶/ mm³ | 3.92 | 3.89 | 3.94 | 3.79 | 3.85 | 3.62 | [illegible] |
| MCV fL | 115 | 114 | 114 | 113 | 113 | 113 | |
| MCH pg | 37 | 37 | 37 | 39 | 38 | 39 | [illegible] |
| MCHC g/dL | 32 | 33 | 33 | 34 | 34 | 34 | |
| RDW % | 13.7 | 12.5 | 12.8 | 13.4 | 13.3 | 14.0 | [illegible] |
| PLATELETS 10³/ mm³ | 180 | 170 | 168 | 162 | 179 | 176 | [illegible] |
| MPV fL | 15.6 | 15.7 | 17.2 | 16.2 | 17.4 | 16.8 | [illegible] |
| N RBC/100WBC | 0 | 0 | 0 | 0 | 0 | 0 | |
| RETICULOCYTE % | 0.6 | 1.6 | 1.0 | 0.6 | 0.6 | 1.3 | |
| RBC MORPHOLOGY | N | N | N | N | N | N | [illegible] |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| WBC mm³ | 6400 | 6200 | 6800 | 8300 | 6,600 | 8900 | [illegible] |
| BANDS % | 0 | 2 | 3 | 5 | 3 | 3 | [illegible] |
| NEUTROPHILS % | 76 | 76 | 72 | 80 | 72 | 81 | [illegible] |
| LYMPHOCYTES % | 13 | 20 | 23 | 8 | 15 | 15 | 7 |
| MONOCYTES % | 7 | 2 | 1 | 7 | 7 | 1 | [illegible] |
| EOSINOPHILS % | 4 | 0 | 1 | 0 | 3 | 0 | [illegible] |
| BASOPHILS % | 0 | 0 | 0 | 0 | 0 | 0 | |
| ESR mm / 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 60 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| FIBRINOGEN mg/dL | 300 ✓ | 306 | 220 | 249 | 302 | 255 | [illegible] |
| TOTAL SOLIDS | | | | | | | |
| SERUM | ST | ST | ST | sl. Hem. | sl hem. | ST | ST |
| | | | | | | | |
| GLUCOSE mg/dL | 107 | 110 | 113 | 110 | 115 | 107 | [illegible] |
| BUN mg/dL | 38 | 40 | 43 | 41 | 43 | 42 | [illegible] |
| CREATININE mg/dL | 1.2 | 1.2 | 1.0 | 1.0 | 1.0 | 1.0 | [illegible] |
| BILIRUBIN T/D mg/dL | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | |
| CHOLESTEROL mg/dL | 214 | 173 | 167 | 157 | 164 | 159 | [illegible] |
| TRIGLYCERIDES mg/dL | 143 | 105 | 93 | 74 | 104 | 90 | [illegible] |
| T PROTEIN gm/dL | 6.5 | 6.4 | 6.9 | 6.8 | 7.1 | 6.8 | |
| ALBUMIN/GLOBULIN gm/dL | 3.7/2.8 | 3.6/2.8 | 3.6/3.3 | 3.6/3.2 | 3.7/3.4 | 3.5/3.3 | [illegible] |
| ALKALINE PHOS U/L | 536 | 435 | 396 | 405 | 403 | 393 | [illegible] |
| ALT U/L | 13 | 15 | 15 | 13 | 13 | 12 | |
| AST U/L | 36 | 37 | 32 | 41 | 43 | 40 | [illegible] |
| GGT U/L | 6 | 7 | 7 | 6 | 6 | 5 | |
| CK II U/L | 146 | 146 | 166 | 170 | 156 | 162 | [illegible] |
| LD U/L | 326 | 324 | 301 | 320 | 344 | 327 | [illegible] |
| CALCIUM mg/dL | 9.1 | 8.8 | 8.8 | 2.7 | 8.8 | 9.0 | [illegible] |
| PHOSPHOROUS mg/dL | 6.4 | 6.2 | 5.8 | 6.6 | 6.4 | 6.3 | [illegible] |
| SODIUM mEq/L | 154 | 153 | 153 | 154 | 151 | 154 | [illegible] |
| POTASSIUM mEq/L | 3.6 | 3.6 | 3.6 | 3.9 | 3.6 | 3.8 | [illegible] |
| CHLORIDE mEq/L | 119 | 121 | 118 | 118 | 118 | 124 | [illegible] |
| $CO_2$ mEq/L | 27 | 28 | 27 | 25 | 27 | 26 | [illegible] |
| IRON mcg/dL | 109 | 101 | 127 | 115 | 74 | 107 | [illegible] |
| URIC ACID mg/dL | | | | | | | |
| PROGESTERONE pg/mL | | | | | | | |
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| COMMENTS | | | MC | MC | Fu | | |
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| LOCATION | | | | | | | |
| LENGTH | | | | | | | |
| WEIGHT | | | | | | | |

This is Exhibit [illegible] referred to in the affidavit of [illegible] sworn before me, this [illegible] day of March 2011

A COMMISSIONER FOR TAKING AFFIDAVITS

ANIMAL NAME/SEX Kaika ID# 0

SeaWorld Hematology/Chemistry

G. HORTON
Commission No. 1791003
NOTARY PUBLIC - CALIFORNIA
SAN DIEGO COUNTY
My Comm. Expires March 4, 2012
CNB1

| DATE | REMARKS | TREATMENT | D.C. |
|---|---|---|---|
| 9/13/05 | Hx - Recheck. Current food base. | | |
| | S/O - BAR. NAF. | | |
| | Dx - CBC, Chem. | | |
| | A - Alk. phos sl. improved, iron sl. low, white count increased with ↑ bands (note all killer whales had 4-5% bands today). | | |
| | P - Recheck tomorrow (leukocytosis.) Get blow, fecal cultures & thermography & consider antibiotics if white count elevations persist. | | |
| 9/14/05 | Recheck bloodwork. No clinical issues seen. CBC/chem: WBC and band % ↓, fibrinogen up slightly and iron decreased. AP increased slightly. Dr. Chittick to Nowell | | |
| 9-16-05 | Thermogram of mouth shows some heat around lower open rooted tooth - no problems noted at present | | |
| 7/13/05 | Hx - Routine physical, immune panel. | | |
| | Dx - CBC, chemistry, immune panel. | | |
| | A - White count increased again - R/O teeth inflammation, muscle inflammation (recent fighting noted between whales, Ikaika may have been caught in fray) Low alk phos still, though iron improved. ESR, fibrinogen WNL. | | |
| | P - Monitor teeth with thermography. Recheck blood in 2 days | | |
| 7/15/05 | Thermography of mouth done by D. Walsh. | | |
| 7/15/05 | Hx - Recheck bloodwork | | |
| | S/O - BAR. NAF. | | |
| | Dx - CBC, chemistry | | |
| | A - White count improved but still sl. elevated. Alk phos hovering ~400 range. ESR sl. elevated. Inflammation may be related to teeth/jaw or muscle trauma. | | |
| | P - Monitor closely. Increase food base more. | | |

SeaWorld. ADVENTURE PARK Orlando

SEA WORLD
HEALTH RECORD

ANIMAL NAME/SEX Ikaika ID#

000086

# Leukocyte Immunophenotyping Report

Report Date: Mar 23, 2006

| ANIMAL # : IKAIKA | 2871 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Accession Prefix : | KWSWFL | | | | | | | | | |
| Draw Date : | 12/1/2004 | 12/14/2004 | 1/3/2005 | 3/8/2005 | 5/3/2005 | 7/12/2005 | 9/13/2005 | 11/8/2005 | 1/17/2006 | 3/14/2006 |
| Animal ID# : | 216402871 | 616342871 | 216672871 | 216302871 | 416302871 | 216802871 | 216802871 | 216592871 | 616262871 | 2871 |
| Accession Suffix : | 110-06 | 111-05 | 112-08 | 114-01 | 116-01 | 117-08 | 118-01 | 120-04 | 123-01 | 126-07 |
| AGE: | 2.3 | 2.3 | 2.4 | 2.5 | 2.7 | 2.9 | 3.1 | 3.2 | 3.4 | 3.6 |
| Stat (S) / Routine (R) : | R | R | R | R | R | R | R | R | R | R |
| Total WBC's : | 4,800 | 5,500 | 5,700 | 5,200 | 5,000 | 6,400 | 8,900 | 7,700 | 7,600 | 7,000 |
| PMN's (Abs.) : | 3,696 | 4,565 | 4,560 | 4,212 | 4,000 | 5,120 | 7,476 | 6,699 | 6,004 | 5,880 |
| Monocytes (Abs.) : | 48 | 110 | 285 | 104 | 250 | 448 | 356 | 154 | 380 | 420 |
| Lymphocytes (Abs.) : | 1,056 | 825 | 855 | 884 | 750 | 832 | 1,335 | 847 | 1,216 | 700 |
| PMN's (%) : | 77% | 83% | 80% | 81% | 80% | 80% | 84% | 87% | 79% | 84% |
| Monocytes (%) : | 1% | 2% | 5% | 2% | 5% | 7% | 4% | 2% | 5% | 6% |
| Lymphocytes (%) : | 22% | 15% | 15% | 17% | 15% | 13% | 15% | 11% | 16% | 10% |
| Flow Cytometry | | | | | | | | | | |
| Permeability Grade : | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| CD19 (B Cells) % : | 40% | 35% | 69% | 29% | 29% | 17% | 26% | 31% | 27% | 29% |
| CD21 (B Cells) % : | 33% | 27% | 36% | 33% | 20% | 17% | 27% | 39% | 30% | 34% |
| CD2 (T Cells) % : | 66% | 74% | 62% | 63% | 76% | 77% | 71% | 56% | 66% | 59% |
| Total % B + T Lymphs : | 99% | 101% | 98% | 95% | 96% | 94% | 98% | 95% | 95% | 93% |
| CD19 Mean Density : | 142 | 132 | 120 | 123 | 130 | 138 | 130 | #DIV/0! | 134 | 139 |
| CD19 (B Cells) Abs # : | 424 | 287 | 589 | 260 | 219 | 144 | 350 | 261 | 323 | 203 |
| CD21 (B Cells) Abs # : | 348 | 220 | 308 | 289 | 153 | 140 | 364 | 328 | 362 | 236 |
| CD2 (T Cells) Abs # : | 699 | 611 | 533 | 555 | 568 | 645 | 942 | 474 | 798 | 414 |
| T : B Cell Ratio (CD2 : CD21) : | 2.0 | 2.8 | 1.7 | 1.9 | 3.7 | 4.6 | 2.6 | 1.4 | 2.2 | 1.8 |
| Naive T Cells % : | 44% | 51% | 41% | 45% | 54% | 55% | 48% | 32% | 41% | 35% |
| Naive T Cells Abs # : | 464 | 420 | 350 | 396 | 402 | 457 | 639 | 272 | 498 | 243 |
| Memory T Cells % : | 21% | 22% | 20% | 18% | 22% | 22% | 22% | 23% | 24% | 22% |
| Memory T Cells Abs : | 226 | 185 | 170 | 160 | 166 | 186 | 293 | 198 | 292 | 154 |
| Naive : Memory Ratio : | 2.1 | 2.3 | 2.1 | 2.5 | 2.4 | 2.5 | 2.2 | 1.4 | 1.7 | 1.6 |
| CAM-D %PMN HI Density : | 67% | 72% | 69% | 69% | 69% | 65% | 76% | 61% | 59% | 64% |
| MHCII (L3) % Lymphs : | 97% | 95% | 92% | 95% | 97% | 96% | 99% | 93% | 97% | 98% |
| MHCII (L3) Abs # : | 1,019 | 784 | 790 | 836 | 728 | 801 | 1,315 | 788 | 1,183 | 685 |

Abs # = Absolute #     #DIV/0! = No Data Available

Permeability Grade : Indicates changes in cell permeability of Lymphocytes
CD19 Mean Density: The density of this protein on the surface of B lymphocytesis indicative of B cell activity. An increase in density indicates the B cells are being activated and a decrease indicates a stress response. Values >160 or <120 are flagged (bold and/or larger font) .
CAM-D PMN HI Density : Under conditions of health, all PMN's express a hi density of this adhesion protein. An animal undergoing an inflammatory response (probably an infection) will have PMN's that express a lower density of this protein (% will decrease). Values <60% and/or out of range for this animal are flagged.

| DATE | 9/23/05 | 9/30/05 | 10/14/05 | 10/17/5 | 11/8/05 | 11/11/05 | 11/18/05 | 12/16/05 |
|---|---|---|---|---|---|---|---|---|
| TIME | 1030 | 0900 | 1100 | 10:15 | 1030 | 0930 | 10:30 | 1000 |
| TECH | PSB | M | M | MC | PSB | M / | M | M |
| HEMOGLOBIN g/dL | 14.2 | 14.2 | 14.1 | 14.1 | 13.6 | 13.6 | 13.6 | 13.9 |
| HEMATOCRIT % / PCV% | 41 | 42 | 41 | 42 | 40 | 39 | 40 | 40 |
| RBC $10^6$/ $mm^3$ | 3.66 | 3.62 | 3.62 | 3.74 | 3.46 | 3.44 | 3.47 | 3.52 |
| MCV fL | 113 | 113 | 114 | 114 | 114 | 114 | 114 | 114 |
| MCH pg | 39 | 39 | 39 | 39 | 39 | 40 | 39 | 40 |
| MCHC g/dL | 34 | 34 | 34 | 34 | 34 | 35 | 34 | 35 |
| RDW % | 13.4 | 12.8 | 13.6 | 13.6 | 12.9 | 13.1 | 12.8 | 13.6 |
| PLATELETS $10^3$/ $mm^3$ | 187 | 186 | 212 | 212 | 199 | 187 | 192 | 194 |
| MPV fL | 15.2 | 15.8 | 16.3 | 17.1 | 16.7 | 13.6 | 13.7 | 14.2 |
| N RBC/100WBC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RETICULOCYTE % | 1.1 | 0.6 | 1.3 | 1.8 | 1.0 | 1.3 | 1.1 | 2.7 |
| RBC MORPHOLOGY | N | N | N | N | N | N | TR PC | N |
| | | | | | | | | |
| | | | | | | | | |
| WBC $mm^3$ | 11500 | 7000 | 8200 | 7300 | 7700 | 7900 | 7900 | 7300 |
| BANDS % | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 1 |
| NEUTROPHILS % | 80 | 77 | 85 | 82 | 84 | 84 | 69 | 76 |
| LYMPHOCYTES % | 14 | 17 | 12 | 15 | 11 | 11 | 25 | 15 |
| MONOCYTES % | 2 | 4 | 3 | 3 | 2 | 5 | 3 | 8 |
| EOSINOPHILS % | 1 | 0 | 0 | 0 | 3 | 0 | 3 | 0 |
| BASOPHILS % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESR mm / 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 1 | 0 | 1 | 1 | 2 | 0 | 1 | 1 |
| FIBRINOGEN mg/dL | 300 ✓ | 286 | 234 | 235 | 266 | 353 | 263 | 279 |
| TOTAL SOLIDS | | | | | | | | |
| SERUM | ST | ST | ST | St | St | Colorless clear | Colorless Clear | 2+ Hem |
| GLUCOSE mg/dL | 125 | 129 | 102 | 120 | 127 | 113 | 127 | 127 |
| BUN mg/dL | 40 | 39 | 37 | 40 | 38 | 40 | 36 | 38 |
| CREATININE mg/dL | 1.0 | 0.9 | 1.0 | 1.0 | 1.0 | 0.9 | 1.0 | 1.0 |
| BILIRUBIN T/D mg/dL | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| CHOLESTEROL mg/dL | 177 | 174 | 178 | 192 | 184 | 184 | 187 | 184 |
| TRIGLYCERIDES mg/dL | 93 | 96 | 111 | 118 | 91 | 102 | 104 | 122 |
| T PROTEIN gm/dL | 7.0 | 7.0 | 7.2 | 7.6 | 7.6 | 7.5 | 7.6 | 7.3 |
| ALBUMIN/GLOBULIN gm/dL | 3.6/3.4 | 3.5/3.5 | 3.5/3.7 | 3.6/4.0 | 3.5/4.1 | 3.5/4.0 | 3.5/4.1 | 3.5/3.8 |
| ALKALINE PHOS U/L | 409 | 428 | 451 | 458 | 472 | 474 | 469 | 513 |
| ALT U/L | 12 | 12 | 13 | 14 | 10 | 12 | 12 | 13 |
| AST U/L | 38 | 39 | 43 | 44 | 43 | 41 | 45 | 47 |
| GGT U/L | 5 | 5 | 6 | 6 | 5 | 6 | 5 | 5 |
| CK II U/L | 157 | 127 | 173 | 171 | 161 | 160 | 176 | 177 |
| LD U/L | 336 | 323 | 358 | 362 | 352 | 335 | 362 | 366 |
| CALCIUM mg/dL | 8.9 | 8.7 | 8.8 | 8.9 | 8.6 | 8.8 | 8.6 | 8.6 |
| PHOSPHOROUS mg/dL | 6.5 | 6.3 | 6.6 | 6.7 | 6.1 | 6.5 | 6.2 | 7.0 |
| SODIUM mEq/L | 151 | 148 | 151 | 153 | 153 | 150 | 151 | 149 |
| POTASSIUM mEq/L | 3.8 | 3.5 | 3.8 | 3.7 | 3.7 | 39 | 3.8 | 3.9 |
| CHLORIDE mEq/L | 124 | 122 | 119 | 121 | 124 | 120 | 120 | 121 |
| $CO_2$ mEq/L | 25 | 26 | 28 | 28 | 24 | 28 | 28 | 28 |
| IRON mcg/dL | 92 | 109 | 101 | 103 | 95 | 111 | 104 | 112 |
| URIC ACID mg/dL | | | | | | | | |
| PROGESTERONE pg/mL | | | | | | | | |
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| | | | | | | | | |
| COMMENTS | | MC | MC | | V | MC | MC | MC |
| | | | | | | | | |
| | | | | | | | | |
| LOCATION | | | | | | | | |
| LENGTH | | | | | | | | |
| WEIGHT | | | | | | | | |

ANIMAL NAME/SEX Ikaika ID# 00-0201

SeaWorld Adventure Park Orlando Hematology/Chemistry

AC1411

| DATE | REMARKS | TREATMENT | D.C. |
| --- | --- | --- | --- |

10/14/05 History - Recheck blood & thermography.

Average food base information from Patty Clark.

August 2005 - Capelin 50.3 lb (56.8%)
herring 36.9 lb (41.7%)
sardines 1.3 lb (1.5%)
88.5 lb. avg.
body weight 2160 lb

September 2005 - capelin 49.3 lb (50.7%)
herring 43 lb (44.2%)
sardines 5 lb (5.1%)
97.3 lb avg.
body weight 2250 lb

S/O - BAR. No obvious abrasions over mandible or in mouth. Open rooted LR1-3 & LL1-3, no discharge or smelling.

Px - CBC, chemistry

oral thermography - focal heat along inside of rostral mandible extending ventrally from LR1. No heat associated w/ LL 1-3.

A - Alk phos, cholesterol, triglycerides improving. White count somewhat elevated. Some heat signature on lower right mandible - associated around LR 1 & 2 area - this is a shift from heat signature seen before near LL 1-3. No heat seen around LL1-3 today. Improved weight gain.

P - Monitor oral thermography, CBC. chem

10.17.05 (SO) Routine blood sample, thermogram jaw

· WBC ↓, Fibrin ↓ slightly, iron holding, cholesterol ↑, alk phos ↑

Slight ↑ LDH

Thermogram - small amount of heat present in LR teeth but does not appear to be increased, need to compare to previous thermograms

(A) no change

(P) continue to monitor

11.7.05 (SO) Immature animals. Thermogram oral cavity.

LL #5 showing pulp, circular heat signature associated w/ teeth but no heat trail lingually, iron ↓ slightly

Alk Phos ↑, Dr. Chittick will follow up with further evaluation

SeaWorld ADVENTURE PARK Orlando SEA WORLD HEALTH RECORD ANIMAL NAME/SEX Ikaika ID# 00-0201

| DATE | REMARKS | TREATMENT | D.C. |
|---|---|---|---|
| 11/[illegible]/05 | Update on weight / monthly food base – wt = 2360 lb. October 2005 – capelin 51.8 lb (52.1%) herring 42.7 lb. (42.9%) sardines 5.0 lb (5%) 99.5 lb. avg | | |
| | Plan on tooth inflammation – recheck bloodwork, thermogram tomorrow, will likely start antibiotics if low grade inflammation, increased WBC count persists. (initials) | | |
| 11/11/05 | Hx – Recheck. Appetite, behavior WNL. S/O – BAR. PE WNL except lower rostral teeth worn/fractured. Dx – CBC, Chemistry – persistently increased white count (mild), no ESR today, mildly increased fibrinogen, improved/sl. low iron. A – Suspect low grade leukocytosis & inflammation is related to tooth damage +/- superficial skin trauma from playing w/ conspecifics. P – Monitor oral cavity closely (at least weekly) with thermography for now. Discussed case w/ Dr. McBain who has seen increased white counts in younger killer whales w/ pox lesions. No pox lesions noted w/ Ikaika. Consider antibiotic therapy if oral heat signatures suggest tooth infection or worsening condition. (initials) | | |
| 11/18/05 | Hx – Recheck. Attitude, behavior, appetite WNL. S/O – BAR. Worn or fractured rostral lower teeth. Otherwise PE WNL. Dx – CBC, chemistry – thermography – focal heat on LL2, LL3, & LL6 (above gumline); sl. heat signature radiating toward mandible or medial aspect of jaw ventral to LL2 area. A – Chronic mild leukocytosis & ESR increase. Focal heat not seen in LL4 today, but noted in tooth above gumline in LL6. P – Hold on antibiotic therapy for now. Monitor jaw closely. (initials) | | |
| 12/15/05 | Hx – Tongue scrape noted. Hx of chronic regurgitation/playing w/ regurgitated food. BAR/acting normal otherwise. S/O BAR. Several linear scrapes through roughened sl. raised central tongue area. Dx – Thermography – ↑ heat signature associated w/ central raised tongue area | | |

SeaWorld. ADVENTURE PARK Orlando

SEA WORLD HEALTH RECORD

ANIMAL NAME/SEX Ikaika ID# 00-0201

000090

# Leukocyte Immunophenotyping Report

Report Date: Sep 26, 2006

| ANIMAL # : IKAIKA | 2871 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accession Prefix : | KWSWFL | | | | | | | | | | | |
| Draw Date : | 12/14/2004 | 1/3/2005 | 3/8/2005 | 5/3/2005 | 7/12/2005 | 9/13/2005 | 11/8/2005 | 1/17/2006 | 3/14/2006 | 5/1/2006 | 7/11/2006 | 9/12/2006 |
| Animal ID# : | 616342871 | 216672871 | 216302871 | 416302871 | 216802873 | 216802871 | 216592871 | 616262871 | 2871 | 2871 | 2871 | 2871 |
| Accession Suffix : | 111-05 | 112-08 | 114-01 | 116-01 | 117-08 | 118-01 | 120-04 | 123-01 | 126-07 | 128-03 | 133-06 | 136-06 |
| AGE: | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| Stat (S) / Routine (R) : | R | R | R | R | R | R | R | R | R | R | R | R |
| Total WBC's : | 5,500 | 5,700 | 5,200 | 5,000 | 6,400 | 8,900 | 7,700 | 7,600 | 7,000 | 7,000 | 6,300 | 5,400 |
| PMN's (Abs.) : | 4,565 | 4,560 | 4,212 | 4,000 | 5,120 | 7,476 | 6,699 | 6,004 | 5,880 | 5,670 | 5,166 | 3,834 |
| Monocytes (Abs.) : | 110 | 285 | 104 | 250 | 448 | 356 | 154 | 380 | 420 | 630 | 378 | 540 |
| Lymphocytes (Abs.) : | 825 | 855 | 884 | 750 | 832 | 1,335 | 847 | 1,216 | 700 | 700 | 756 | 1,026 |
| PMN's (%) : | 83% | 80% | 81% | 80% | 80% | 84% | 87% | 79% | 84% | 81% | 82% | 71% |
| Monocytes (%) : | 2% | 5% | 2% | 5% | 7% | 4% | 2% | 5% | 6% | 9% | 6% | 10% |
| Lymphocytes (%) : | 15% | 15% | 17% | 15% | 13% | 15% | 11% | 16% | 10% | 10% | 12% | 19% |
| Flow Cytometry | | | | | | | | | | | | |
| Permeability Grade : | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| CD19 (B Cells) % : | 35% | 69% | 29% | 29% | 17% | 26% | 31% | 27% | 29% | 24% | 38% | 30% |
| CD21 (B Cells) % : | 27% | 36% | 33% | 20% | 17% | 27% | 39% | 30% | 34% | 26% | 41% | 30% |
| CD2 (T Cells) % : | 74% | 62% | 63% | 76% | 77% | 71% | 56% | 66% | 59% | 70% | 54% | 67% |
| Total % B + T Lymphs : | 101% | 98% | 95% | 96% | 94% | 98% | 95% | 95% | 93% | 95% | 95% | 97% |
| CD19 Mean Density : | 132 | 120 | 123 | 130 | 138 | 130 | #DIV/0! | 134 | 139 | 139 | 132 | 145 |
| CD19 (B Cells) Abs # : | 287 | 589 | 260 | 219 | 144 | 350 | 261 | 323 | 203 | 171 | 284 | 305 |
| CD21 (B Cells) Abs # : | 220 | 308 | 289 | 153 | 140 | 364 | 328 | 362 | 236 | 179 | 309 | 310 |
| CD2 (T Cells) Abs # : | 611 | 533 | 555 | 568 | 645 | 942 | 474 | 798 | 414 | 487 | 408 | 690 |
| T : B Cell Ratio (CD2 : CD21) : | 2.8 | 1.7 | 1.9 | 3.7 | 4.6 | 2.6 | 1.4 | 2.2 | 1.8 | 2.7 | 1.3 | 2.2 |
| Naive T Cells % : | 51% | 41% | 45% | 54% | 55% | 48% | 32% | 41% | 35% | 44% | 26% | 46% |
| Naive T Cells Abs # : | 420 | 350 | 396 | 402 | 457 | 639 | 272 | 498 | 243 | 307 | 198 | 477 |
| Memory T Cells % : | 22% | 20% | 18% | 22% | 22% | 22% | 23% | 24% | 22% | 26% | 28% | 21% |
| Memory T Cells Abs : | 185 | 170 | 160 | 166 | 186 | 293 | 198 | 292 | 154 | 184 | 215 | 212 |
| Naive : Memory Ratio : | 2.3 | 2.1 | 2.5 | 2.4 | 2.5 | 2.2 | 1.4 | 1.7 | 1.6 | 1.7 | 0.9 | 2.3 |
| CAM-D %PMN Hi Density : | 72% | 69% | 69% | 69% | 65% | 76% | 61% | 59% | 64% | 67% | 65% | 59% |
| MHCII (L3) % Lymphs : | 95% | 92% | 95% | 97% | 96% | 99% | 93% | 97% | 98% | 98% | 90% | 97% |
| MHCII (L3) Abs # : | 784 | 790 | 836 | 728 | 801 | 1,315 | 788 | 1,183 | 685 | 683 | 683 | 992 |

Abs # = Absolute # #DIV/0! = No Data Available

Permeability Grade : Indicates changes in cell permeability of Lymphocytes
CD19 Mean Density: The density of this protein on the surface of B lymphocytesis indicative of B cell activity. An increase in density indicates the B cells are being activated and a decrease indicates a stress response. Values >160 or <120 are flagged (bold and/or larger font).
CAM-D PMN Hi Density : Under conditions of health, all PMN's express a hi density of this adhesion protein. An animal undergoing an inflammatory response (probably an infection) will have PMN's that express a lower density of this protein (% will decrease). Values <60% and/or out of range for this animal are flagged.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DATE | 4/25/06 | 4/26/06 | 4/27/06 | 4/28/06 | 4/29/06 | 5/1/06 | 5/4/06 | 5/8/06 |
| TIME | 1000 | 0500 | 1000 | 10^00 | 10:00 | 1100 | 1000 | 1000 |
| TECH | PSB | PSB | PSB | VIL | M | PSB 20 | PSB | M |
| HEMOGLOBIN g/dL | 13.8 | 13.4 | 13.7 | 13.6 | 13.2 | 13.5 | 13.6 | 14.0 |
| HEMATOCRIT % / PCV% | 40 | 39/39 | 40 | 40 | 39/ | 40 | 40 | 42 |
| RBC $10^6$/ mm³ | 3.49 | 3.41 | 3.47 | 3.44 | 3.40 | 3.47 | 3.48 | 3.60 |
| MCV fL | 115 | 116 | 116 | 116 | 116 | 115 | 115 | 115 |
| MCH pg | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 |
| MCHC g/dL | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| RDW % | 13.3 | 13.7 | 13.1 | 12.4 | 12.9 | 13.2 | 12.7 | 13.1 |
| PLATELETS $10^3$/ mm³ | 184 | 192 | 170 | 169 | 180 | 199 | 192 | 203 |
| MPV fL | 15.2 | 16.6 | 13.9 | 15.7 | 13.6 | 17.4 | 14.7 | 14.6 |
| N RBC/100WBC | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| RETICULOCYTE % | 1.7 | 0.8 | 1.3 | 1.2 | 0.5 ✓ | 1.3 | 0.8 | 1.8 |
| RBC MORPHOLOGY | N | N | N | N | N | N | N | N |
| | | | | | | | | |
| | | | | | | | | |
| WBC mm³ | 7400 | 10400 | 7500 | 8,300 | 7,600 | 7000 | 7200 | 6900 |
| BANDS % | 1 | 2 | 3 | 3 | 0 | 3 | 1 | 1 |
| NEUTROPHILS % | 70 | 72 | 74 | 76 | 79 | 76 | 81 | 79 |
| LYMPHOCYTES % | 26 | 21 | 21 | 18 | 10 | 10 | 14 | 14 |
| MONOCYTES % | 2 | 3 | 1 | 2 | 10 | 9 | 4 | 5 |
| EOSINOPHILS % | 1 | 2 | 1 | 1 | 1 | 2 | 0 | 1 |
| BASOPHILS % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESR mm / 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 2 | 0 | 2 | 1 | 1 | 1 | 0 |
| 60 | 3 | 4 | 4 | 4 | 4 | 5 | 3 | 2 |
| FIBRINOGEN mg/dL | 405 ✓ | 368 | 362 | 368 | 348 | 371 | 323 | 241 |
| TOTAL SOLIDS | | | | | | | | |
| SERUM | St | St | St | St | 2+Hem | St | St | St |
| | | | | | | | | |
| GLUCOSE mg/dL | 135 | 112 | 105 | 116 | 106 | 98 | 118 | 108 |
| BUN mg/dL | 35 | 39 | 39 | 38 | 37 | 36 | 40 | 41 |
| CREATININE mg/dL | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 | 1.1 |
| BILIRUBIN T/D mg/dL | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| CHOLESTEROL mg/dL | 163 | 165 | 160 | 172 | 162 | 167 | 175 | 180 |
| TRIGLYCERIDES mg/dL | 77 | 87 | 118 | 133 | 94 | 112 | 119 | 111 |
| T PROTEIN gm/dL | 7.4 | 7.3 | 7.1 | 7.5 | 7.3 | 7.3 | 7.3 | 7.4 |
| ALBUMIN/GLOBULIN gm/dL | 3.5/3.9 | 3.4/3.9 | 3.4/3.7 | 3.6/3.9 | 3.5/3.8 | 3.5/3.8 | 3.5/3.8 | 3.5/3.9 |
| ALKALINE PHOS U/L | 465 | 456 | 464 | 483 | 447 | 469 | 479 | 491 |
| ALT U/L | 13 | 10 | 11 | 11 | 12 | 10 | 13 | 11 |
| AST U/L | 44 | 35 | 37 | 36 | 44 | 35 | 33 | 37 |
| GGT U/L | 4 | 5 | 6 | 5 | 5 | 5 | 3 | 5 |
| CK II U/L | 190 | 168 | 167 | 171 | 172 | 156 | 168 | 163 |
| LD U/L | 343 | 317 | 335 | 348 | 404 | 323 | 313 | 327 |
| CALCIUM mg/dL | 8.6 | 8.8 | 8.8 | 8.9 | 8.6 | 8.7 | 8.8 | 8.8 |
| PHOSPHOROUS mg/dL | 7.0 | 7.3 | 6.9 | 7.1 | 7.3 | 7.2 | 6.8 | 7.2 |
| SODIUM mEq/L | 152 | 154 | 153 | 150 | 152 | 155 | 152 | 152 |
| POTASSIUM mEq/L | 4.1 | 3.8 | 4.0 | 3.8 | 4.0 | 3.9 | 3.7 | 4.0 |
| CHLORIDE mEq/L | 121 | 122 | 123 | 123 | 120 | 121 | 119 | 121 |
| $CO_2$ mEq/L | 27 | 26 | 25 | 28 | 26 | 25 | 29 | 28 |
| IRON mcg/dL | 27 | 43 | 60 | 70 | 61 | 76 | 80 | 105 |
| URIC ACID mg/dL | | | | | | | | |
| PROGESTERONE pg/mL | | | | | | | | |
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| COMMENTS | | | | | | | | MC |
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| LOCATION | | | | | | | | |
| LENGTH | | | | | | | | |
| WEIGHT | | | | | | | | |

ANIMAL NAME/SEX Kaka ID# 00 0201

SeaWorld ADVENTURE PARK Orlando Hematology/Chemistry

AC1411

| DATE | REMARKS | TREATMENT | D.C. |
|---|---|---|---|

4/11/06 Hx - Routine exam. Doing alright clinically.
S/O - BAR. NAF.
Dx - CBC, Chemistry
A - Alk phos. sl. higher than last week but not in 600's.
Fish analysis from recent herring diets showed herring was ↑ in calories & explains animals' slowing down on food on old base amts. Newer herring is going to be lower calorie than what herring we fed this winter, so will have to watch weights/alk phos's closely in juveniles like Ikaika.
P - Monitor Recheck weight. (CB)

4/23/06 Weight history (last 4 weight):
4/1/06 - 2580 lb
4/5/06 - 2620 lb
4/21/06 - 2660 lb
4/22/06 - 2620 lb.
Plan - Get on weekly weight schedule. Recheck blood this coming week. (BD)

4/25/06 Recheck bloodwork per Dr. Chittick. Clinically doing well.
CBC/Chemistries: CBC indicates slight rise in WBC count.
Fibrinogen elevated as is ESR. AP decreased.
Fe moderately to severely lower. CK & LDH high.
Reevaluate blood tomorrow to monitor trend.

4/26/06 Recheck.
CBC chem - WBC improved to 6400 with 2% bands.
ESR up slightly and fibrinogen decreased somewhat.
Fe better today as is CK.
Possible convalescence from trauma (?)
Recheck again tomorrow.
Thermography camera back from BGT - would should check for heat signature / signs of trauma?

4/27/06 Blood recheck - see results.

| DATE | REMARKS | TREATMENT | D.C. |
|---|---|---|---|

4/28/06 Hx- Clinically normal but bloodwork abnormal the last few days. Recheck.

S/O -

Dx - CBC, Chemistry
Oral thermography

A - Bloodwork shows an increasing white count & band fraction. ESR & fibrinogen elevated. Mild anemia. Alk phos low for age but improving over last couple days. Iron still low but improving. Chronic tooth wear / inflammation - Currently inflammatory bloodwork could be associated w/ tooth problems or GI problems (ulcer?).

P- Recheck blood tomorrow - if leukocytosis / inflammation not improving, will try a course of antibiotics & GI protectants. Increase food base - yesterday, spoke to M Kordowski & asked that Ikaika's base be raised back to 100 lbs. or ↑ caloric intake - new herring is less calorically dense.

4/29/06 Hx - Doing alright, appetite good. Recheck. Base raised to 100 lbs (50/50 herring/capelin)

S/O - BAR. NAF other than lower front tooth wear.

Dx - CBC, Chemistry

A - White count, fibrinogen, ESR still elevated. Iron & alk phos low. Mild anemia. R/O tooth problem, G.I. problem.

P - Start treatment & see if blood parameters improve. Recheck blood EOD for now.

Doxycycline 2000 mg PO BID
Nystatin 100 ml PO TID
Vitamin E 125 mg PO BID
Cimetidine 1500 mg PO SID (PM)

5/1/06 Hx - Routine exam, immune panel

S/O - BAR. WNL per Dr. Gearhart

Dx - CBC, chemistry, immune panel.

A - Sl. improvement in white count but still have mild elevations in fibrinogen & ESR. Iron still sl low but improved. Clinically, WNL.

P - CWCT. Recheck in 2-3 days.