

**Photo-Identification and Skin Lesion Prevalence of  
Bottlenose Dolphins (*Tursiops erebennus*) in  
the Waters of New York and New Jersey  
Supplemental Materials**

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## Descriptions of Skin Lesion Categories

Tattoo lesions are grey, black, or yellow in coloration, with a stippled surface and often with a dark border (Flom & Hock, 1979; Geraci et al., 1979; Van Bresseem & Van Waerebeek, 1996; Van Bresseem et al., 2003, 2009, 2015, 2017; Fury & Reif, 2012; Hart et al., 2012; Toms et al., 2020; Hawkins et al., 2022). Lunar lesions are also variable in color and can be black, grey, blue-grey, and/or white. They have a raised and pitted appearance with distinct borders (Wilson et al., 1997; Bearzi et al., 2009; Maldini et al., 2010; Hart et al., 2012; Toms et al., 2020). Dark fringe lesions, which have also been called ring lesions and pin lesions, are pale and circular, surrounded by a dark halo (Wilson et al., 1997; Bearzi et al., 2009; Hart et al., 2012; Toms et al., 2020; Hawkins et al., 2022). White fringe lesions are characterized by pale halos surrounding circles of dark or normal-colored skin (Wilson et al., 1997; Bearzi et al., 2009; Hart et al., 2012; Toms et al., 2020; Hawkins et al., 2022). Cloudy white spot lesions, also called cloudy lesions (Wilson et al., 1997), are circular areas of hypopigmentation that are either flush with the skin or appear as a slight depression (Baker, 1992; Wilson et al., 1997; Hart et al., 2012; Toms et al., 2020). Spotted lesions have a “cauliflower-like” appearance, with clusters of hypopigmented circles that appear flush with the skin (Hart et al., 2012; Toms et al., 2020). Vesicular lesions are characterized by cutaneous nodules, pustule, or ulcerated dermatitis

(Van Bresseem et al., 1999, 2015; Hart et al., 2012; Duignan et al., 2020; Toms et al., 2020; Hawkins et al., 2022). Dark spot lesions are small circular areas of hyperpigmented skin that could be numerous or a single spot (Toms et al., 2020; Hawkins et al., 2022). Orange hue lesions are characterized by orange coloration with diffuse edges that are typically seen on the body flank (Wilson et al., 1997; Toms et al., 2020). Orange patches are similar in color to orange hue lesions but have distinct edges (Wilson et al., 1997; Maldini et al., 2010; Van Bresseem et al., 2015; Toms et al., 2020; Hawkins et al., 2022). White amorphous lesions have also been referred to as white lesions (Wilson et al., 1997) and are pale and amorphous with rounded edges (Wilson et al., 1997; Hart et al., 2012; Toms et al., 2020). White freckle lesions are small and numerous circular white spots with distinct borders (Toms et al., 2020). Mottled light and mottled dark lesions are scattered flecks of hypopigmented or hyperpigmented skin, respectively, that are irregularly shaped (Hart et al., 2012; Toms et al., 2020). Black amorphous lesions are non-circular patches of hypopigmented skin with either diffuse or distinct edges, and are either flush with skin or slightly depressed (Wilson et al., 1997; Hart et al., 2012; Toms et al., 2020). Discolored head/nuchal patch lesions are characterized by a melon that is either hypo- or hyperpigmented compared to the rest of the body (Toms et al., 2020).

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**Table S1.** Metrics of agreement were determined using the *epi.kappa* function in the ‘epiR’ package and were used to assess inter-rater reliability for overall lesion presence, each lesion category, and each lesion group. Asterisks denote statistical significance (\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\*  $p < 0.001$ ). Cohen’s Kappa (K) is used to indicate agreement (K:  $< 0.2$  = slight,  $0.2$  to  $0.4$  = fair,  $0.4$  to  $0.6$  = moderate,  $0.6$  to  $0.8$  = substantial,  $0.8$  to  $1.0$  = almost perfect). A combination of these metrics, including % agreement, K, the probability of chance agreement, the prevalence index (PI), the bias index (BI), and the prevalence-adjusted bias-adjusted K (PABAK) and  $K_{max}$ , was used to determine the reliability of the agreement among raters. Lesion categories are italicized, while lesion groups and lesion presence are not. NaNs occurred when there were no recorded occurrences of a particular lesion category or group. RMA = rake mark-associated.

Rater 1 vs Rater 2									
Lesion presence, category, or group	% agree	Cohen’s Kappa (K)	z test statistic	Probability of chance agreement	Prevalence index (PI)	Bias index (BI)	PABAK	$K_{max}$	Reliability
<i>Presence</i>	88.5	0.747	15.41***	0.543	0.298	0.05*	0.769	0.842	Strong
Tattoo	92.8	0.704	9.55***	0.756	-0.716	-0.005	0.858	0.848	Strong
Lunar	99.0	0.828	6.86***	0.943	-0.942	0	0.981	1.00	Strong
Dark fringe	96.6	0.793	10.31***	0.837	-0.822	-0.03**	0.933	0.944	Strong
White fringe	98.1	0.740	5.75***	0.926	-0.923	-0.01	0.962	0.992	Good
Cloudy white spots	90.9	0.664	9.05***	0.728	-0.678	-0.06**	0.817	0.808	Strong
Spotted	99.5	0.665	1.98*	0.986	-0.986	-0.005	0.99	1.00	Good
Vesicular	99.5	0	0	0.995	-0.995	0.005	0.99	1.00	Poor
Dark spots	93.8	0.663	7.34***	0.814	-0.793	-0.02	0.875	0.841	Good
<i>Potentially pathogenic</i>	84.6	0.688	13.56***	0.507	-0.135	-0.06	0.692	0.787	Strong
RMA tattoo	97.1	0.558	3.13***	0.935	-0.933	0.02	0.942	0.906	Moderate
RMA lunar	99.0	0.662	2.78**	0.972	-0.971	0	0.981	1.00	Good
RMA dark fringe	99.5	0.855	5.90***	0.967	-0.966	0.005	0.99	1.00	Strong
RMA white fringe	98.1	0.491	1.95*	0.962	-0.962	-0.01	0.962	0.985	Poor
RMA cloudy white spots	94.7	0.534	3.91***	0.886	-0.880	-0.03*	0.894	0.802	Moderate
RMA spotted	99.5	0.665	1.99*	0.986	-0.986	0.005	0.99	1.00	Moderate
RMA vesicular	100.0	NaN	NaN	1.00	-1.00	0	1.00	NaN	Inconclusive
RMA dark spots	96.2	0.535	3.32***	0.917	-0.913	0	0.923	0.851	Moderate
<i>RMA potentially pathogenic</i>	91.3	0.659	8.57***	0.746	-0.702	-0.01	0.827	0.81	Strong
Orange hue	98.6	0.762	5.59***	0.939	-0.938	0.01	0.971	1.00	Good
Orange patches	100.0	NaN	NaN	1.00	-1.00	0	1.00	NaN	Inconclusive
<i>Orange</i>	98.6	0.762	5.59***	0.939	-0.938	0.01	0.971	1.00	Good
White amorphous	94.2	0.803	14.5***	0.707	-0.644	-0.02	0.885	0.911	Strong
White freckles	99.0	0	0	0.990	-0.990	0.01	0.981	1.00	Poor
Mottled light	97.6	0.694	5.13***	0.922	-0.918	-0.01	0.952	0.959	Good
<i>Hypopigmentation</i>	91.8	0.837	13.7***	0.658	-0.563	-0.02	0.837	0.870	Strong
Black amorphous	98.6	0.564	2.23*	0.967	-0.966	-0.005	0.971	1.00	Moderate
Mottled dark	100.0	NaN	NaN	1.00	-1.00	0	1.00	NaN	Inconclusive
<i>Hyperpigmentation</i>	98.6	0.564	2.23*	0.967	-0.966	-0.005	0.971	1.00	Moderate
<i>Discolored head/Nuchal patch</i>	100.0	NaN	NaN	1.00	-1.00	0	1.00	NaN	Inconclusive
<i>Other</i>	96.6	0.449	2.20*	0.939	-0.938	0.03**	0.933	0.850	Moderate
Rater 1 vs Rater 3									
<i>Presence</i>	88.0	0.752	16.2***	0.516	0.188	-0.06*	0.760	0.843	Strong
Tattoo	92.8	0.704	9.55***	0.757	-0.716	-0.005	0.856	0.848	Strong
Lunar	99.0	0.795	5.52***	0.953	-0.952	0.01	0.981	1.00	Good
Dark fringe	96.6	0.703	6.37***	0.887	-0.880	0.02	0.933	0.919	Good

White fringe	97.6	0.694	5.13***	0.922	-0.918	-0.01	0.952	0.959	Good
Cloudy white spots	86.5	0.456	4.76***	0.753	-0.712	-0.03	0.731	0.643	Moderate
Spotted	99.0	0.496	1.40	0.981	-0.981	-0.01	0.981	1.00	Poor
Vesicular	99.0	0.496	1.40	0.981	-0.981	-0.01	0.981	1.00	Poor
Dark spots	92.3	0.577	5.67***	0.818	-0.799	-0.02	0.846	0.776	Good
<i>Potentially pathogenic</i>	81.7	0.618	11.0***	0.523	-0.212	0.01	0.635	0.727	Good
RMA tattoo	96.6	0.447	2.17*	0.939	-0.938	0.02	0.933	0.850	Poor
RMA lunar	99.5	0.855	5.90***	0.967	-0.966	-0.005	0.990	1.00	Strong
RMA dark fringe	99.0	0.662	2.79**	0.972	-0.971	0.01	0.981	1.00	Good
RMA white fringe	99.0	0.496	1.40	0.981	-0.981	0.01	0.981	1.00	Poor
RMA cloudy white spots	97.1	0.489	2.38*	0.944	-0.942	0.03	0.942	0.892	Poor
RMA spotted	99.0	0	0	0.990	-0.990	0.01	0.981	1.00	Poor
RMA vesicular	100.0	NaN	NaN	1.00	-1.00	0	1.00	NaN	Inconclusive
RMA dark spots	96.6	0.353	1.47	0.948	-0.947	0.03**	0.933	0.824	Poor
<i>RMA potentially pathogenic</i>	91.3	0.550	5.42***	0.808	-0.788	0.08***	0.827	0.748	Good
Orange hue	98.1	0.790	7.61***	0.908	-0.904	-0.02*	0.962	0.994	Good
Orange patches	100.0	NaN	NaN	1.00	-1.00	0	1.00	NaN	Inconclusive
<i>Orange</i>	98.1	0.790	7.61***	0.908	-0.904	-0.02*	0.962	0.994	Good
White amorphous	91.8	0.698	9.93***	0.730	-0.678	0.01	0.837	0.835	Strong
White freckles	99.0	0	0	0.990	-0.990	0.01	0.981	1.00	Poor
Mottled light	97.6	0.694	5.13***	0.922	-0.918	-0.01	0.952	0.959	Good
<i>Hypopigmentation</i>	88.9	0.654	9.61***	0.680	-0.601	0.01	0.779	0.787	Good
Black amorphous	99.0	0.745	4.16***	0.962	-0.962	-0.01	0.981	1.00	Good
Mottled dark	99.5	0	0	0.995	-0.995	-0.005	0.990	1.00	Poor
<i>Hyperpigmentation</i>	98.6	0.660	3.39***	0.957	-0.957	-0.01	0.971	1.00	Good
<i>Discolored head/Nuchal patch</i>	100.0	NaN	NaN	1.00	-1.00	0	1.00	NaN	Inconclusive
<i>Other</i>	97.6	0.724	5.95***	0.913	-0.909	0.005	0.724	0.963	Poor

**Table S2.** Each generalized additive model iteration for investigating the relationship among lesion prevalence, month, and year. The optimal model (Model 9) with the lowest AIC and fewest covariates is highlighted in bold.

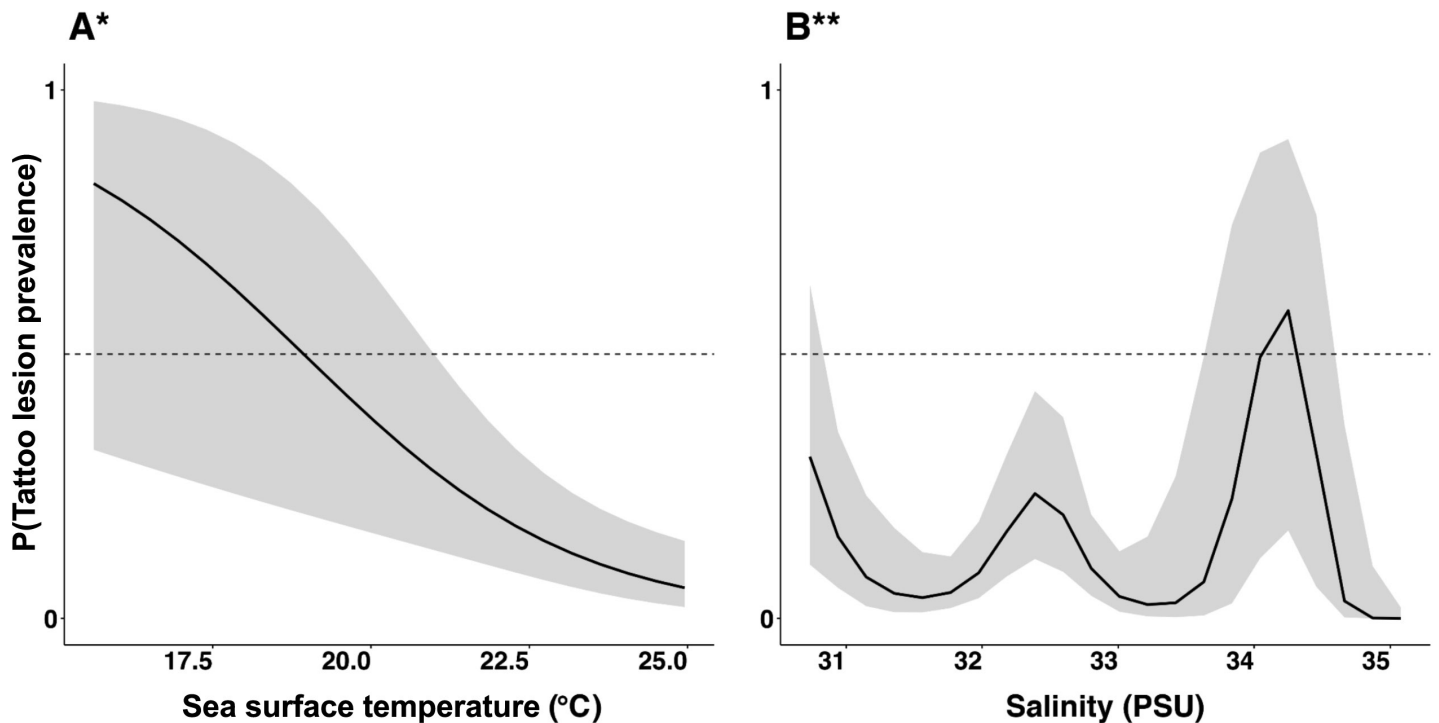
Model number	Terms included	Deviance explained (%)	AIC
1	PropLesions ~ s(month) + s(year) + s(month, by year)	65.9	72.03
2	PropLesions ~ s(month) + s(year)	31.4	75.12
3	PropLesions ~ s(month)	30.9	75.95
4	PropLesions ~ s(year)	32.7	75.65
5	PropLesions ~ s(month, by year)	51.8	72.94
6	PropLesions ~ s(month) + s(month, by year)	51.8	72.94
7	PropLesions ~ s(year) + s(month, by year)	59.0	73.50
8	PropLesions ~ s(month) + s(year) + s(year, by month)	78.3	68.35
<b>9</b>	<b>PropLesions ~ s(month) + s(year, by month)</b>	<b>78.3</b>	<b>68.35</b>
10	PropLesions ~ s(year) + s(year, by month)	49.8	76.85
11	PropLesions ~ s(year, by month)	48.7	77.10

**Table S3.** Each generalized additive mixed model iteration for investigating the relationship between lesion prevalence and environmental variables. The optimal model (Model 2) with the lowest AIC and fewest covariates is highlighted in bold.

Model number	Terms included	AIC	R <sup>2</sup>
1	WeeklyProportionLesions ~ s(week) + s(SST) + s(salinity)	75.24	0.31
<b>2</b>	<b>WeeklyProportionLesions ~ s(SST) + s(salinity)</b>	<b>71.95</b>	<b>0.31</b>
3	WeeklyProportionLesions ~ s(week) + s(SST)	77.59	-0.03
4	WeeklyProportionLesions ~ s(week) + s(salinity)	75.52	0.30
5	WeeklyProportionLesions ~ s(salinity)	92.48	0.18
6	WeeklyProportionLesions ~ s(week)	77.23	0.10
7	WeeklyProportionLesions ~ s(SST)	76.07	0.08

**Table S4.** Each generalized additive model iteration for investigating the relationship between tattoo lesion prevalence and environmental variables. The optimal model (Model 2) with the lowest AIC and fewest covariates is highlighted in bold.

Model number	Terms included	Deviance explained (%)	AIC
1	PropTattoo ~ s(week) + s(SST) + s(salinity)	57.6	59.9
<b>2</b>	<b>PropTattoo ~ s(SST) + s(salinity)</b>	<b>54.5</b>	<b>59.3</b>
3	PropTattoo ~ s(week) + s(SST)	26.2	64.6
4	PropTattoo ~ s(week) + s(salinity)	62.7	63.4
5	PropTattoo ~ s(week)	24.3	64.8
6	PropTattoo ~ s(SST)	0.15	69.77
7	PropTattoo ~ s(salinity)	59.0	59.42



**Figure S1.** Predicted prevalence of tattoo lesions in relation to sea surface temperature (A) and salinity (B). Gray shaded regions show the 95% confidence interval and dark gray points indicate the raw data. The dashed line indicates 50% skin lesion prevalence. Asterisks denote statistical significance (\*p < 0.01, \*\*p < 0.05).