

Island: Hawaii

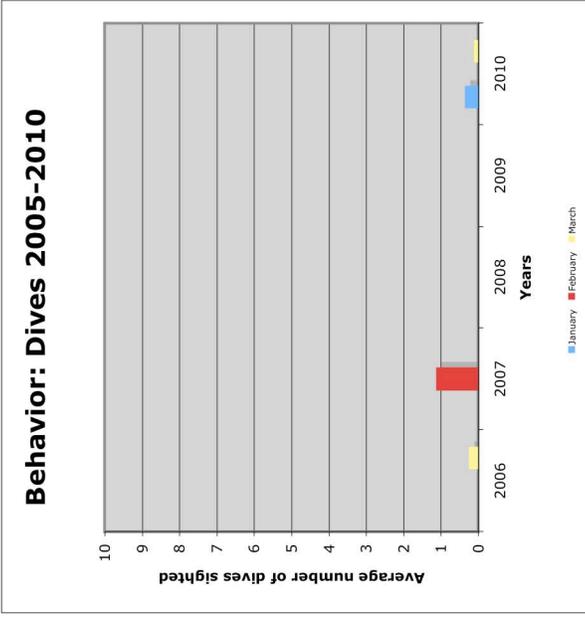
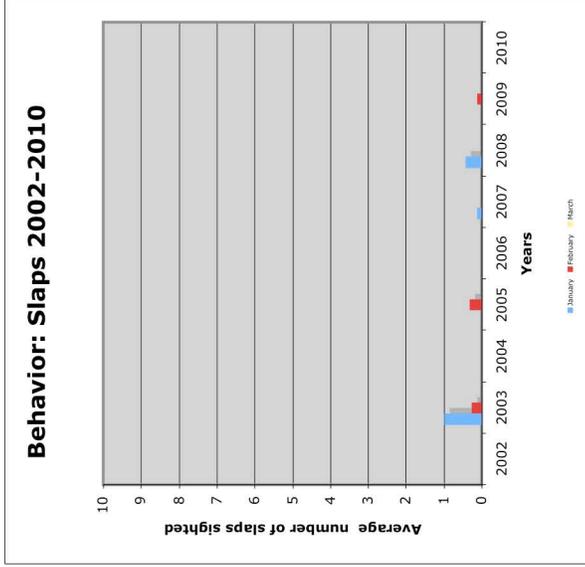
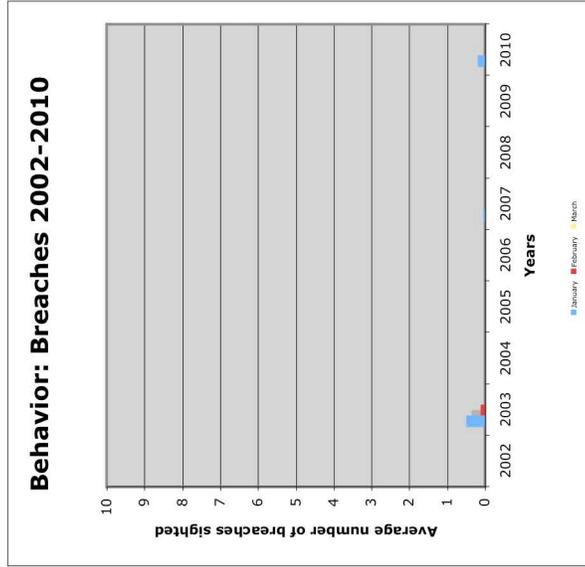
Site #4: Hookena Beach Park

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	NA	NA	NA
2003	0.5	0.12	NA
2004	0	NA	NA
2005	NA	0	NA
2006	0	0	0
2007	0.06	0	0
2008	0	0	0
2009	0	0	0
2010	0.19	0	0

	Slaps		
	January	February	March
2002	NA	NA	NA
2003	1	0.27	NA
2004	0	NA	NA
2005	NA	0.33	NA
2006	0	0	0
2007	0.13	0	0
2008	0.44	0	0
2009	0	0.13	0
2010	0	0	0

	Dives		
	January	February	March
2006	0	0	0.25
2007	0	1.13	0
2008	0	0	0
2009	0	0	0
2010	0.37	0	0.13



Above: Average number of breaches and slaps sighted per whale by volunteers at Hookena Beach Park on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

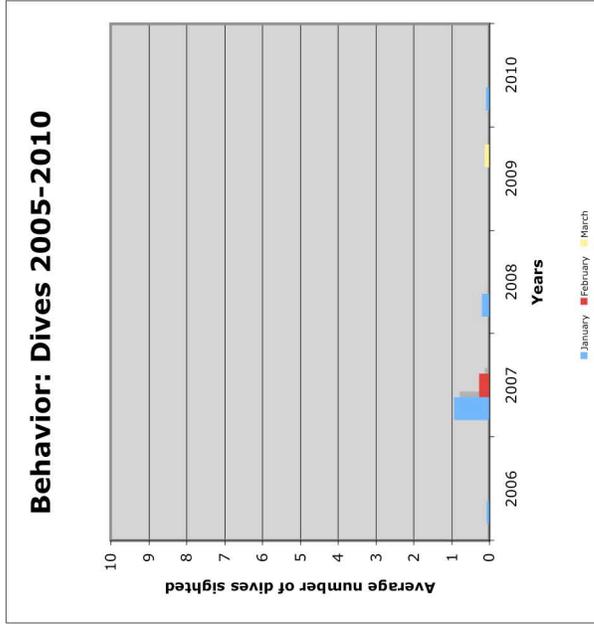
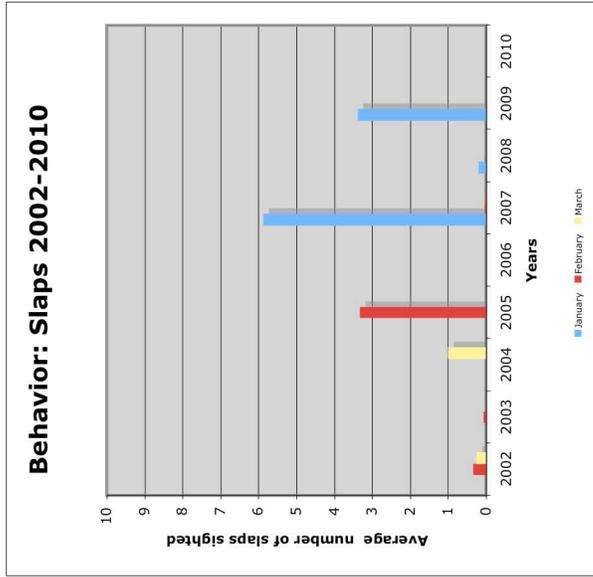
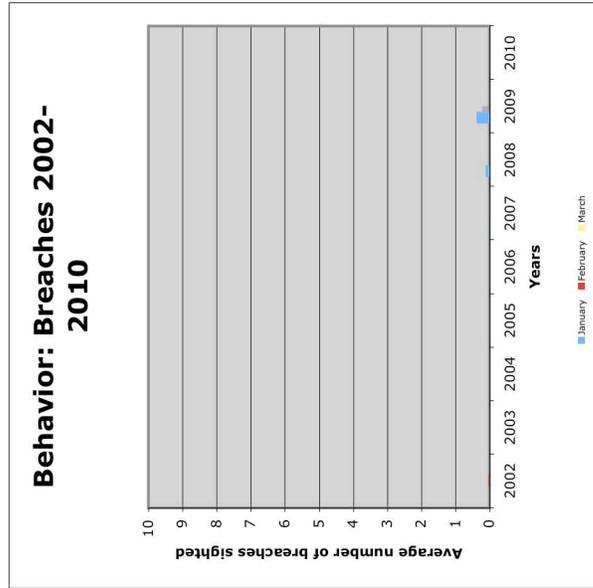
Site #5: Honaunau

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	NA	0.05	0
2003	NA	0	NA
2004	NA	NA	0
2005	0	0	NA
2006	0	0	0
2007	0.03	0	0
2008	0.13	0	0
2009	0.38	0	0
2010	0	NA	0

	Slaps		
	January	February	March
2002	NA	0.35	0.25
2003	NA	0.08	NA
2004	NA	NA	1
2005	0	3.33	NA
2006	0	0	0
2007	5.88	0.03	0
2008	0.2	0	0
2009	3.38	0	0
2010	0	NA	0

	Dives		
	January	February	March
2006	0.08	0	0
2007	0.93	0.28	0
2008	0.21	0	0
2009	0	0	0.13
2010	0.09	NA	0

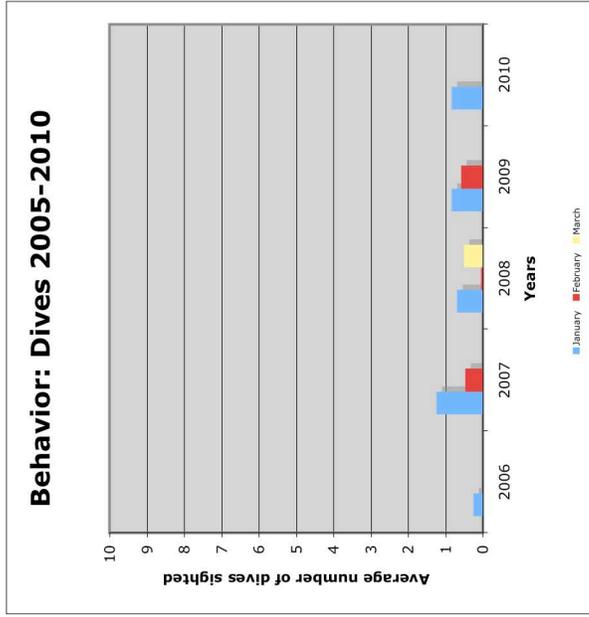
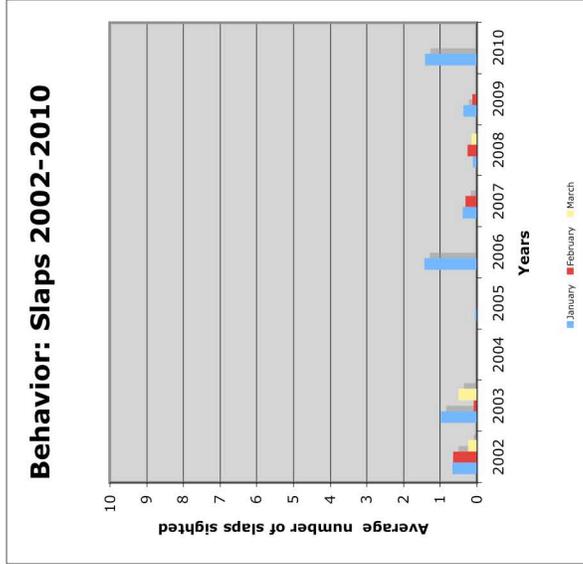
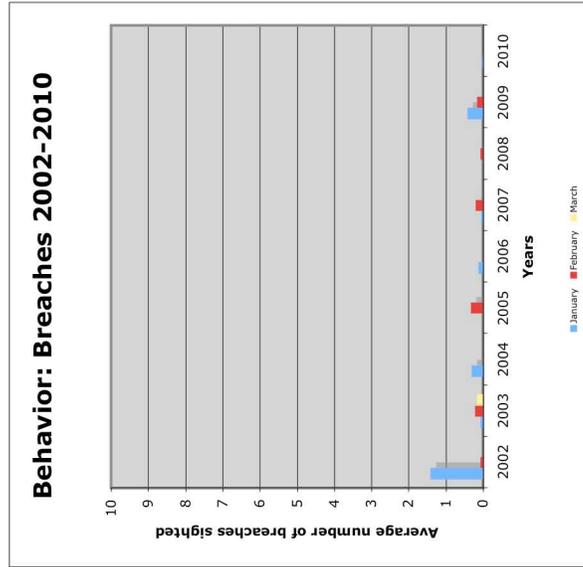


Above: Average number of breaches and slaps sighted per whale by volunteers at Honaunau on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

	Breaches		
	January	February	March
2002	1.41	0.07	0
2003	0.08	0.23	0.17
2004	0.32	NA	0
2005	0	0.33	NA
2006	0.13	0	0
2007	0.06	0.21	0
2008	0	0.07	0
2009	0.42	0.17	0
2010	0.03	0	0

	Slaps		
	January	February	March
2002	0.67	0.66	0.25
2003	0.99	0.1	0.5
2004	0	NA	0
2005	0.06	0	NA
2006	1.44	0	0
2007	0.4	0.32	0
2008	0.11	0.26	0.15
2009	0.38	0.13	0
2010	1.41	0	0

	Dives		
	January	February	March
2006	0.25	0	0
2007	1.25	0.48	0
2008	0.69	0.06	0.51
2009	0.84	0.58	0
2010	0.85	0	0



Above: Average number of breaches and slaps sighted per whale by volunteers at Keahou Scenic Lookout on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

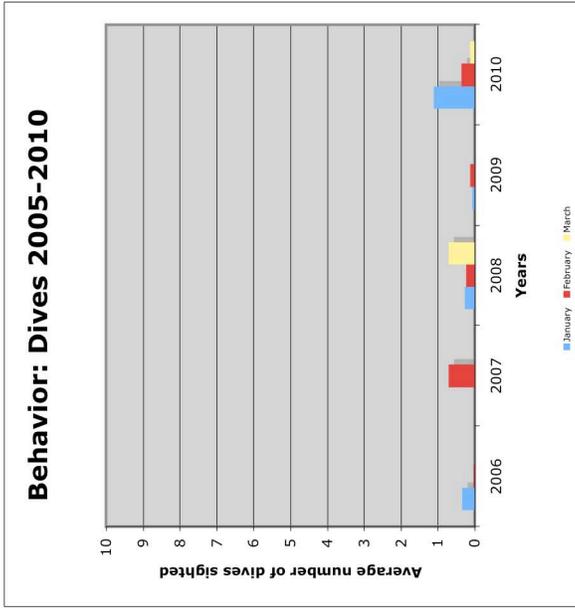
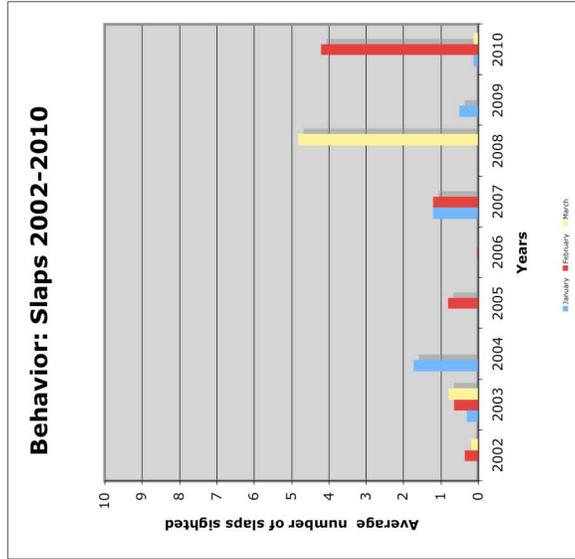
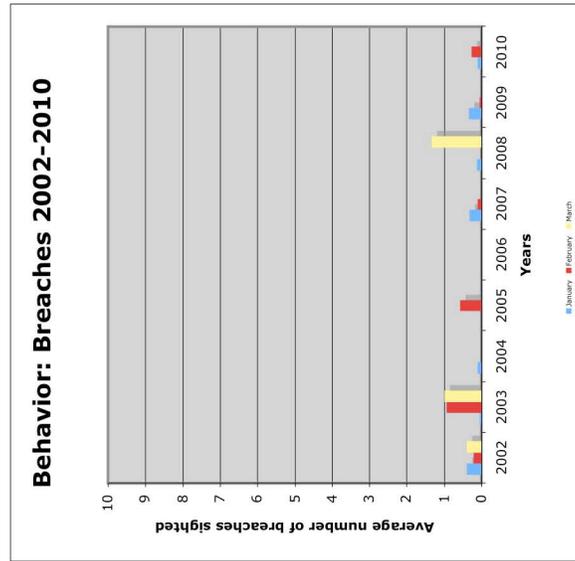
Site #7: Keahole Point

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	0.4	0.22	0.4
2003	0.05	0.94	1
2004	0.11	NA	NA
2005	0	0.57	NA
2006	0	0	0
2007	0.32	0.1	0
2008	0.13	0	1.34
2009	0.35	0.06	0
2010	0.1	0.28	0

	Slaps		
	January	February	March
2002	0	0.36	0.19
2003	0.31	0.66	0.8
2004	1.74	NA	NA
2005	0	0.81	NA
2006	0	0.03	0
2007	1.22	1.21	0
2008	0	0	4.83
2009	0.5	0	0
2010	0.13	4.21	0.13

	Dives		
	January	February	March
2006	0.34	0.03	0
2007	0	0.72	0
2008	0.27	0.24	0.71
2009	0.07	0.13	0
2010	1.12	0.36	0.13



Above: Average number of breaches and slaps sighted per whale by volunteers at Keahole Point on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

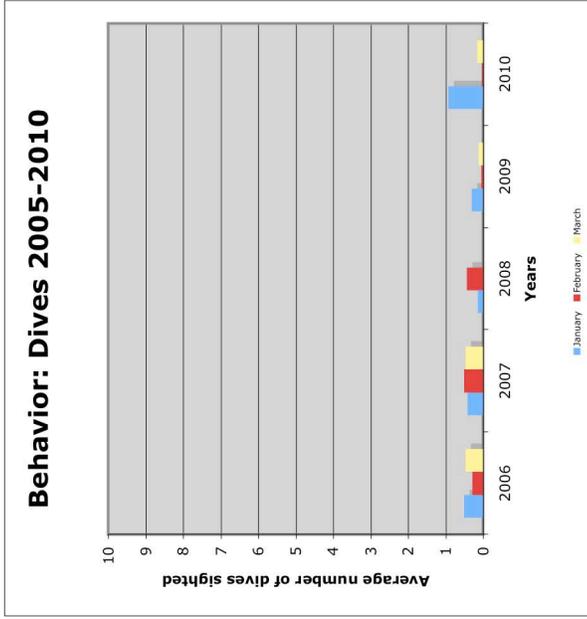
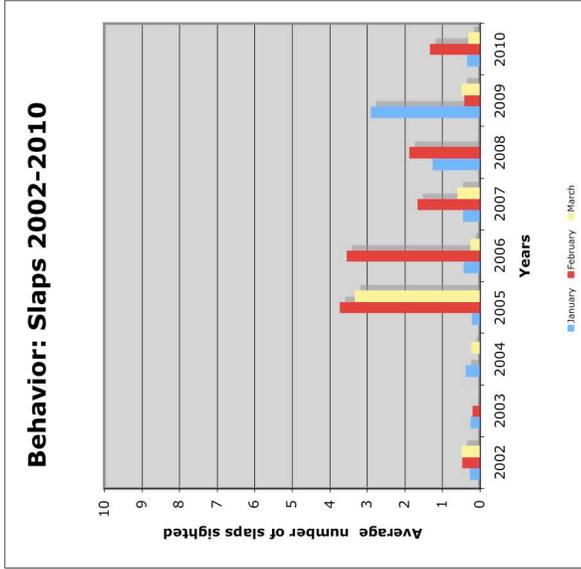
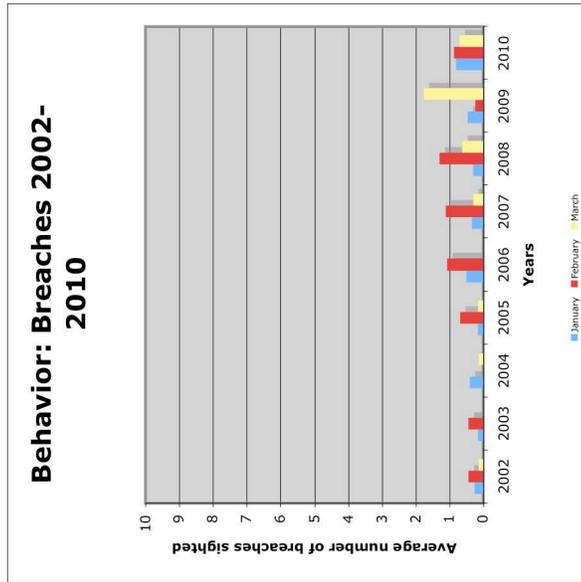
Site #8: Hualalai

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	0.26	0.44	0.15
2003	0.16	0.44	NA
2004	0.41	NA	0.15
2005	0.16	0.7	0.17
2006	0.5	1.08	0
2007	0.34	1.11	0.3
2008	0.3	1.3	0.63
2009	0.47	0.24	1.77
2010	0.82	0.88	0.71

	Slaps		
	January	February	March
2002	0.27	0.48	0.5
2003	0.25	0.21	NA
2004	0.38	NA	0.23
2005	0.22	3.73	3.33
2006	0.44	3.55	0.26
2007	0.45	1.66	0.61
2008	1.27	1.88	0
2009	2.91	0.43	0.5
2010	0.35	1.33	0.31

	Dives		
	January	February	March
2006	0.51	0.29	0.48
2007	0.42	0.51	0.47
2008	0.14	0.44	0
2009	0.32	0.05	0.13
2010	0.93	0.04	0.16



Above: Average number of breaches and slaps sighted per whale by volunteers at Hualalai on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

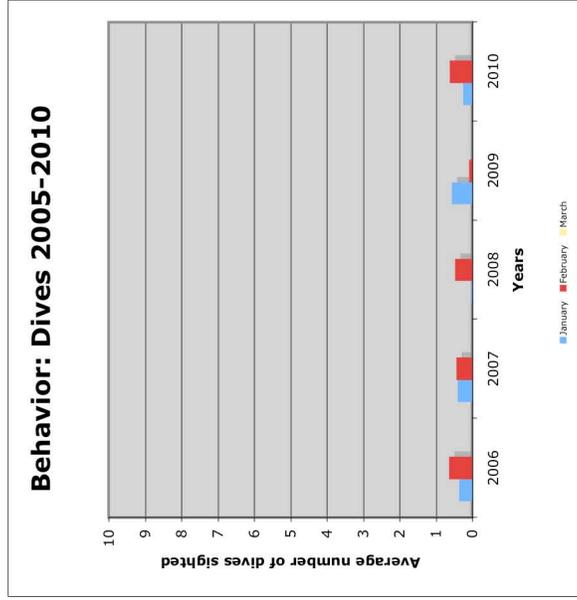
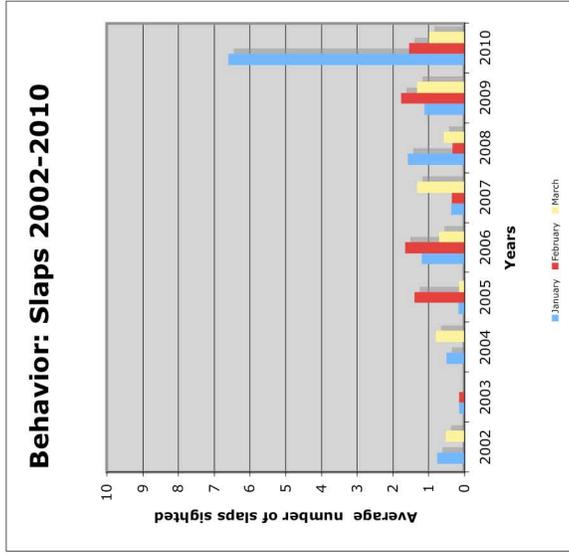
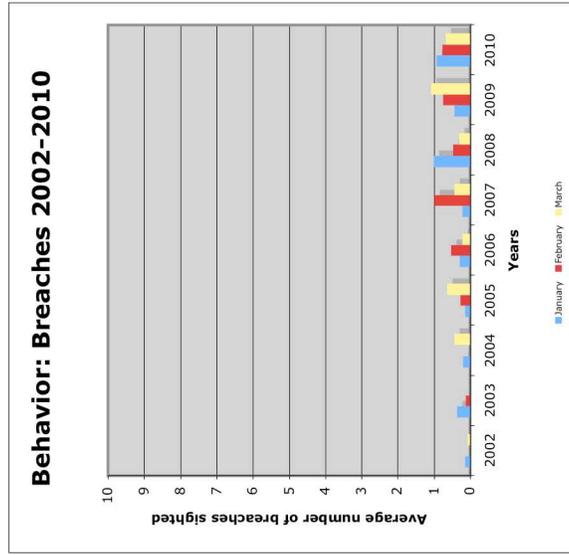
Site #9: Puukohola Heiau National Park

Behavioral Data Analysis

Breaches			
	January	February	March
2002	0.14	NA	0.07
2003	0.36	0.13	NA
2004	0.2	NA	0.44
2005	0.14	0.28	0.64
2006	0.29	0.54	0.22
2007	0.23	1	0.44
2008	1.01	0.47	0.32
2009	0.44	0.75	1.09
2010	0.94	0.78	0.68

Slaps			
	January	February	March
2002	0.76	NA	0.52
2003	0.14	0.15	NA
2004	0.5	NA	0.81
2005	0.16	1.4	0.14
2006	1.19	1.66	0.71
2007	0.37	0.35	1.32
2008	1.58	0.34	0.57
2009	1.12	1.77	1.32
2010	6.6	1.55	0.99

Dives			
	January	February	March
2006	0.36	0.21	0.64
2007	0.4	0.53	0.44
2008	0.03	0.23	0.48
2009	0.57	0.04	0.09
2010	0.26	0.13	0.62



Above: Average number of breaches and slaps sighted per whale by volunteers at Puukohola Heiau National Park on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

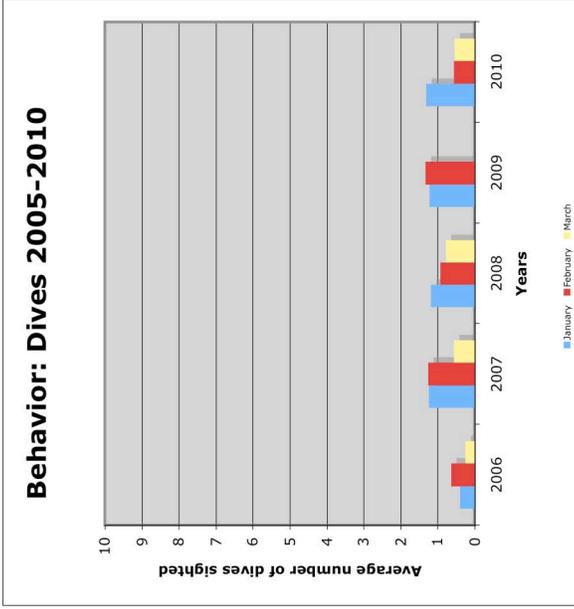
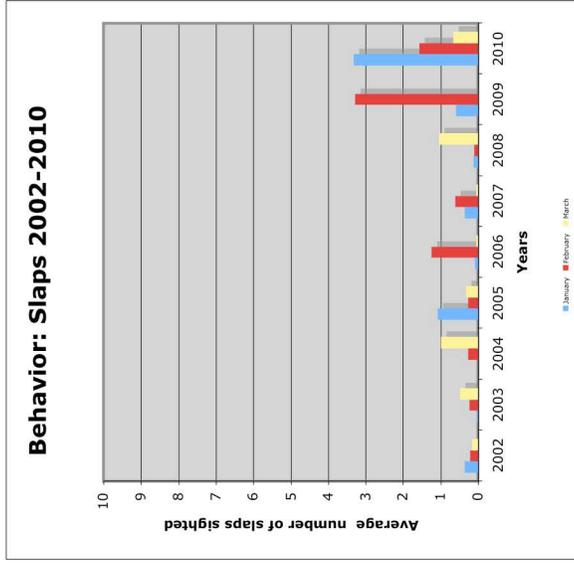
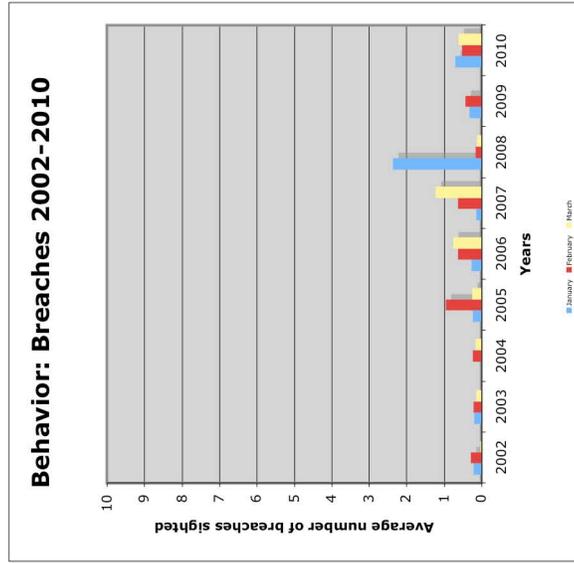
Site #10: Mile Marker 7

Behavioral Data Analysis

Breaches			
	January	February	March
2002	0.22	0.29	0.04
2003	0.2	0.21	0.14
2004	NA	0.23	0.17
2005	0.23	0.95	0.26
2006	0.28	0.63	0.76
2007	0.15	0.64	1.23
2008	2.36	0.16	0.12
2009	0.33	0.43	NA
2010	0.71	0.53	0.61

Slaps			
	January	February	March
2002	0.36	0.21	0.17
2003	0.03	0.24	0.48
2004	NA	0.27	1
2005	1.08	0.28	0.32
2006	0.09	1.24	0.06
2007	0.37	0.61	0.05
2008	0.12	0.11	1.05
2009	0.6	3.29	NA
2010	3.32	1.57	0.67

Dives			
	January	February	March
2006	0.41	0.64	0.265
2007	1.24	1.26	0.56
2008	1.19	0.93	0.79
2009	1.23	1.33	NA
2010	1.32	0.57	0.55



Above: Average number of breaches and slaps sighted per whale by volunteers at Mile Marker 7 on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

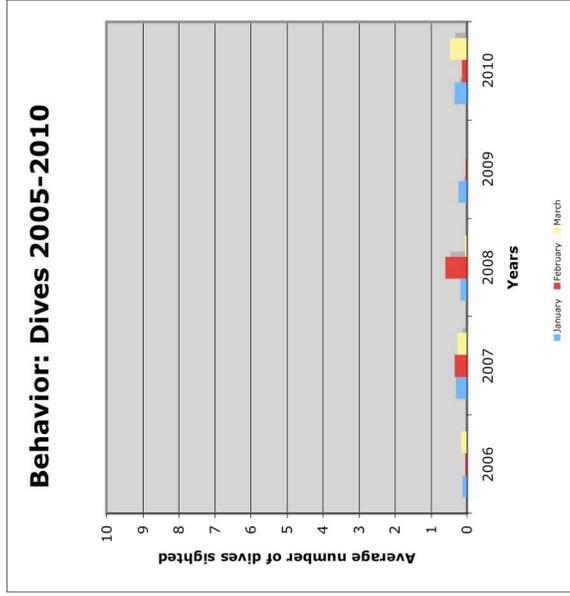
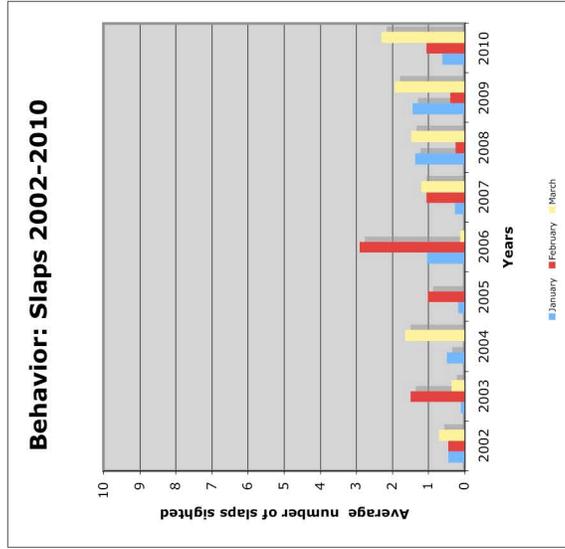
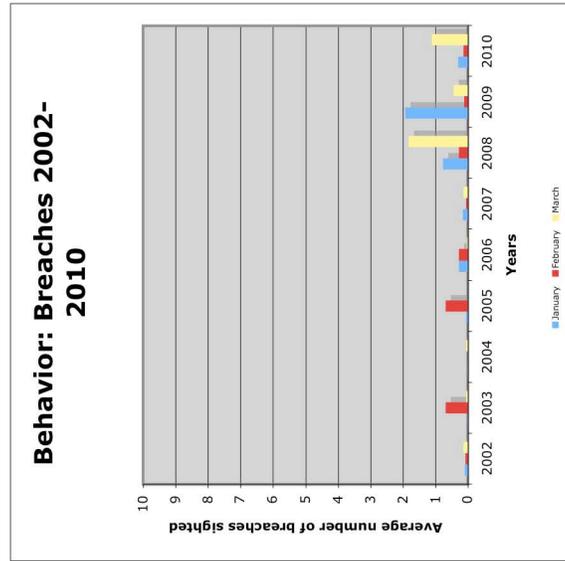
Site #11: Lapakahi State Historical Park

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	0.11	0.09	0.15
2003	0.02	0.69	0.06
2004	0.03	NA	0.06
2005	0.07	0.7	NA
2006	0.29	0.28	0.04
2007	0.16	0.06	0.14
2008	0.77	0.29	1.84
2009	1.94	0.12	0.45
2010	0.3	0.14	1.13

	Slaps		
	January	February	March
2002	0.45	0.46	0.72
2003	0.11	1.51	0.37
2004	0.49	NA	1.65
2005	0.19	1.03	NA
2006	1.04	2.92	0.13
2007	0.27	1.06	1.21
2008	1.37	0.26	1.49
2009	1.45	0.41	1.94
2010	0.62	1.06	2.31

	Dives		
	January	February	March
2006	0.13	0.05	0.17
2007	0.32	0.34	0.28
2008	0.18	0.6	0.06
2009	0.23	0.03	0
2010	0.35	0.14	0.48



Above: Average number of breaches and slaps sighted per whale by volunteers at Lapakahi State Historical Park on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

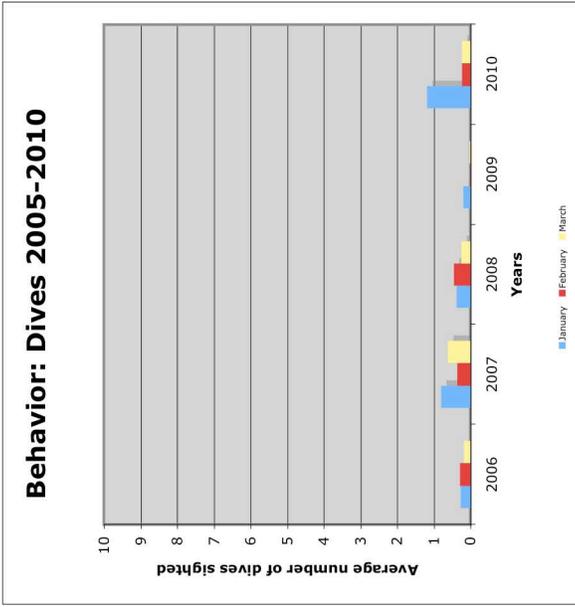
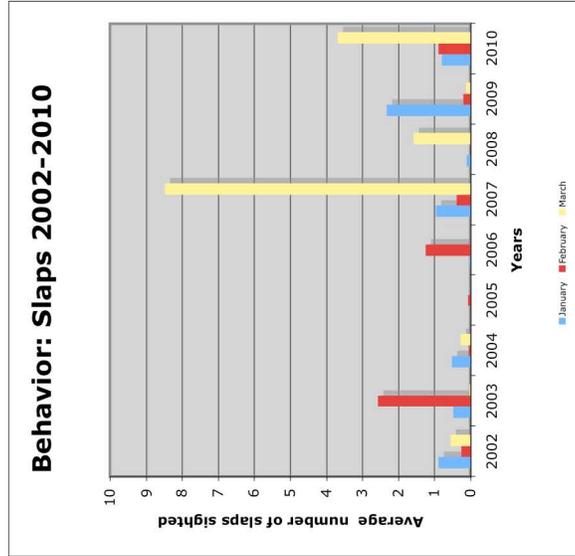
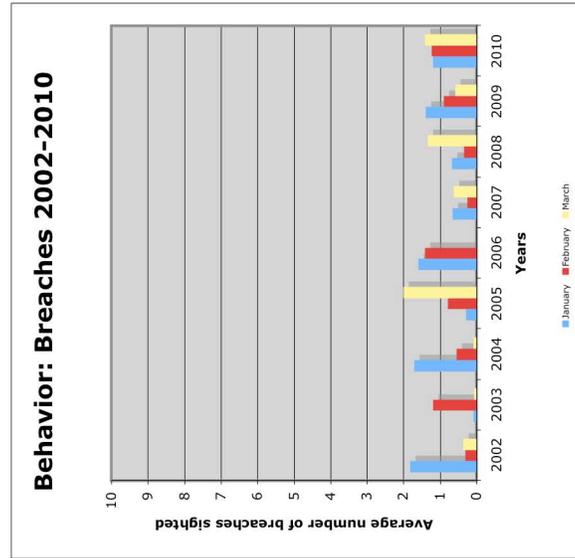
Site #12: Kapaa Beach Park

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	1.83	0.32	0.37
2003	0.09	1.19	0.08
2004	1.72	0.55	0.1
2005	0.29	0.8	2
2006	1.61	1.41	0
2007	0.67	0.25	0.62
2008	0.68	0.35	1.35
2009	1.4	0.91	0.59
2010	1.19	1.23	1.41

	Slaps		
	January	February	March
2002	0.9	0.27	0.56
2003	0.49	2.57	0.03
2004	0.52	0.05	0.28
2005	0	0.07	0
2006	0.03	1.25	0
2007	0.97	0.4	8.49
2008	0.11	0.01	1.59
2009	2.34	0.2	0.13
2010	0.8	0.9	3.69

	Dives		
	January	February	March
2006	0.28	0.3	0.19
2007	0.81	0.36	0.62
2008	0.39	0.46	0.26
2009	0.2	0.02	0.03
2010	1.19	0.23	0.23



Above: Average number of breaches and slaps sighted per whale by volunteers at Kapaa Beach Park on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

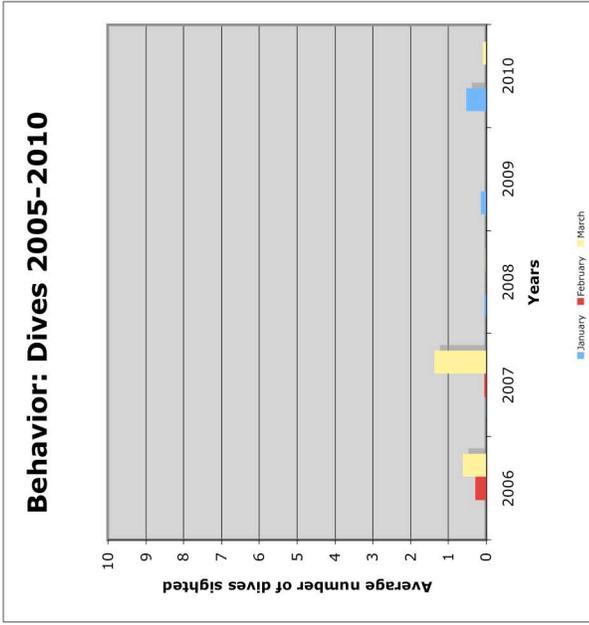
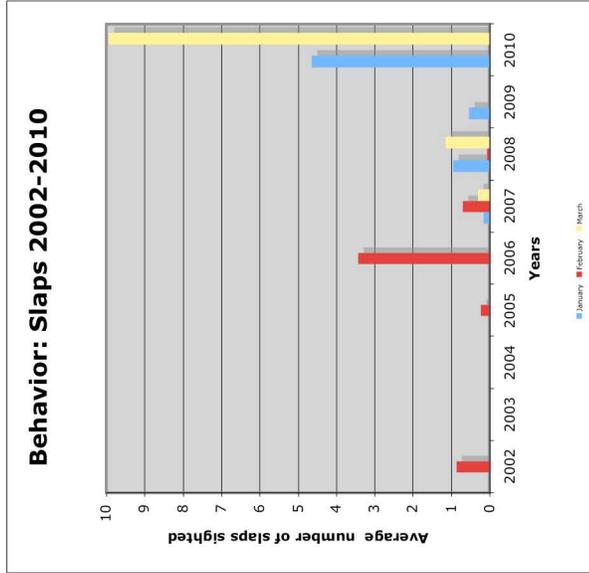
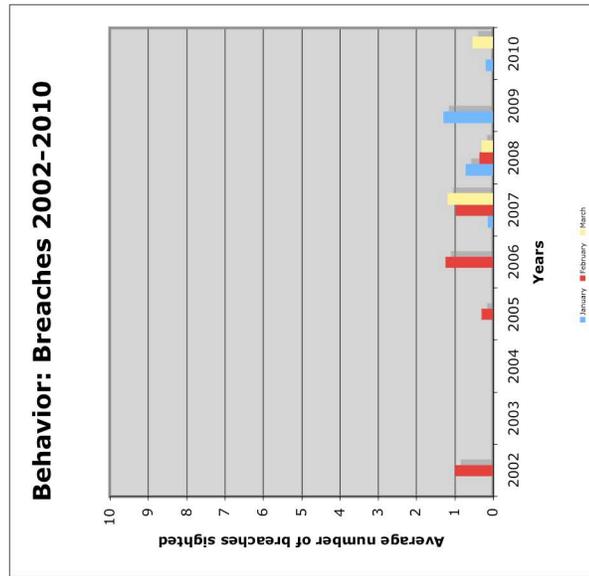
Site #13: Old Coast Guard Road

Behavioral Data Analysis

Breaches			
	January	February	March
2002	NA	0.99	NA
2003	NA	NA	NA
2004	NA	NA	NA
2005	NA	0.3	NA
2006	NA	1.24	0
2007	0.14	0.98	1.19
2008	0.73	0.37	0.3
2009	1.3	NA	NA
2010	0.19	NA	0.55

Slaps			
	January	February	March
2002	NA	0.87	NA
2003	NA	NA	NA
2004	NA	NA	NA
2005	NA	0.24	NA
2006	NA	3.44	0
2007	0.16	0.71	0.3
2008	0.95	0.08	1.16
2009	0.55	NA	NA
2010	4.64	NA	9.95

Dives			
	January	February	March
2006	NA	0.29	0.63
2007	0.02	0.05	1.38
2008	0.05	0	0.01
2009	0.14	NA	NA
2010	0.53	NA	0.09



Above: Average number of breaches and slaps sighted per whale by volunteers at Old Coast Guard Road on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

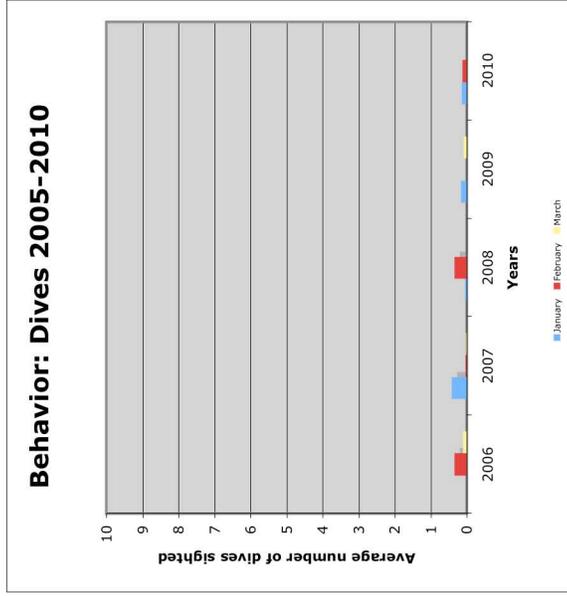
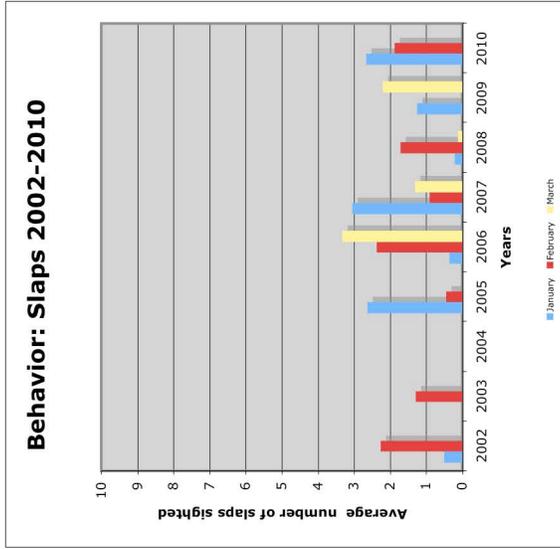
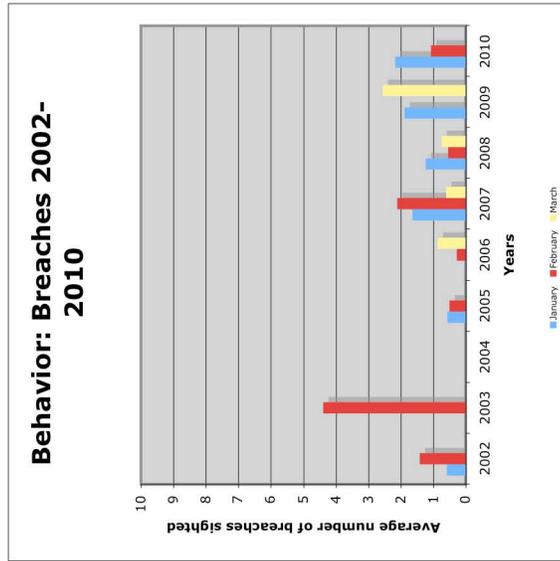
Site #14: Upolu Point

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	0.59	1.42	NA
2003	NA	4.39	NA
2004	NA	NA	NA
2005	0.58	0.5	NA
2006	0.03	0.29	0.88
2007	1.65	2.12	0.62
2008	1.24	0.56	0.75
2009	1.9	NA	2.56
2010	2.18	1.07	NA

	Slaps		
	January	February	March
2002	0.51	2.27	NA
2003	NA	1.3	NA
2004	NA	NA	NA
2005	2.64	0.46	NA
2006	0.36	2.39	3.33
2007	3.06	0.92	1.31
2008	0.22	1.73	0.13
2009	1.27	NA	2.22
2010	2.67	1.88	NA

	Dives		
	January	February	March
2006	0	0.35	0.11
2007	0.42	0.04	0.04
2008	0.05	0.35	0
2009	0.17	NA	0.09
2010	0.15	0.13	NA



Above: Average number of breaches and slaps sighted per whale by volunteers at Upolu Point on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

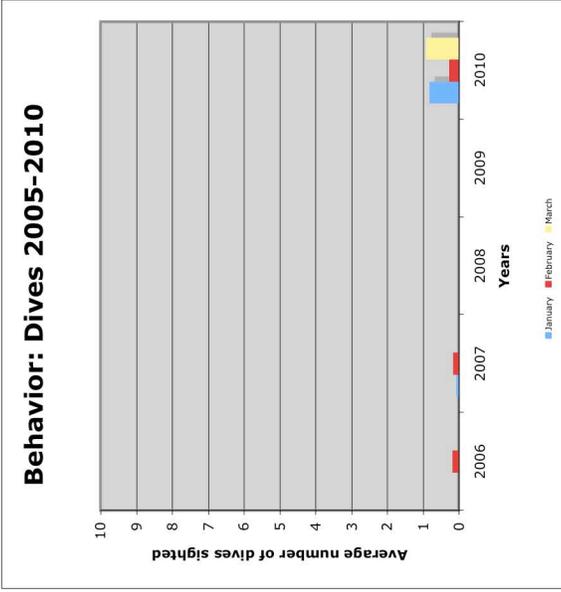
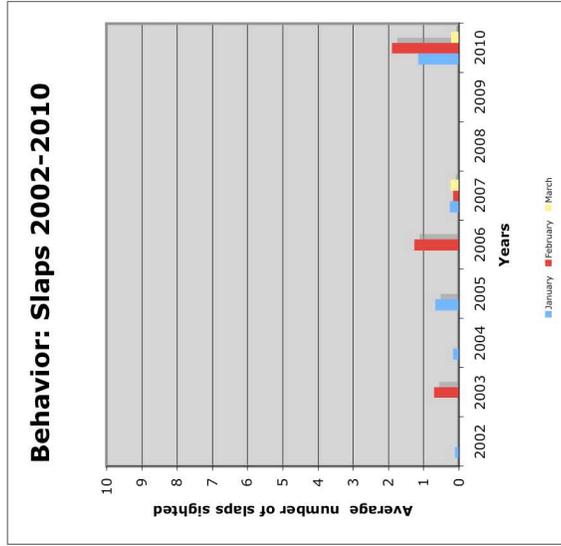
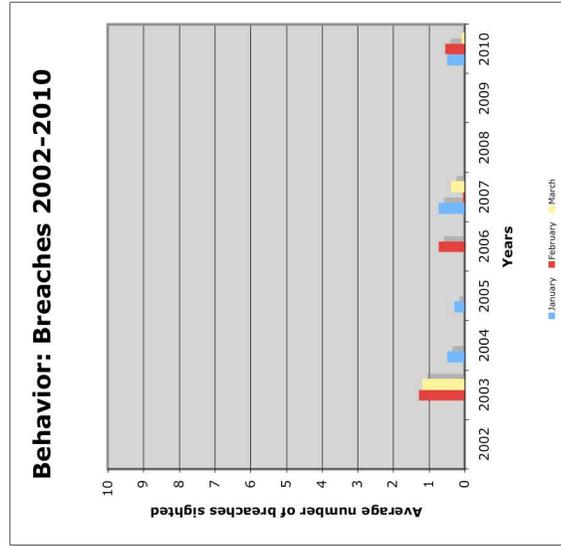
Site #15: Waipio Valley Lookout

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	0	NA	NA
2003	NA	1.29	1.2
2004	0.5	NA	NA
2005	0.29	0	NA
2006	0	0.73	0
2007	0.74	0.06	0.38
2008	NA	NA	NA
2009	0	0	0
2010	0.5	0.55	0.09

	Slaps		
	January	February	March
2002	0.11	NA	NA
2003	NA	0.71	0
2004	0.17	NA	NA
2005	0.67	0	NA
2006	0	1.27	0
2007	0.26	0.16	0.25
2008	NA	NA	NA
2009	0	0	0
2010	1.15	1.9	0.22

	Dives		
	January	February	March
2006	0	0.18	0
2007	0.08	0.16	0
2008	NA	NA	NA
2009	0	0	0
2010	0.82	0.28	0.91



Above: Average number of breaches and slaps sighted per whale by volunteers at Waipio Valley Lookout on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

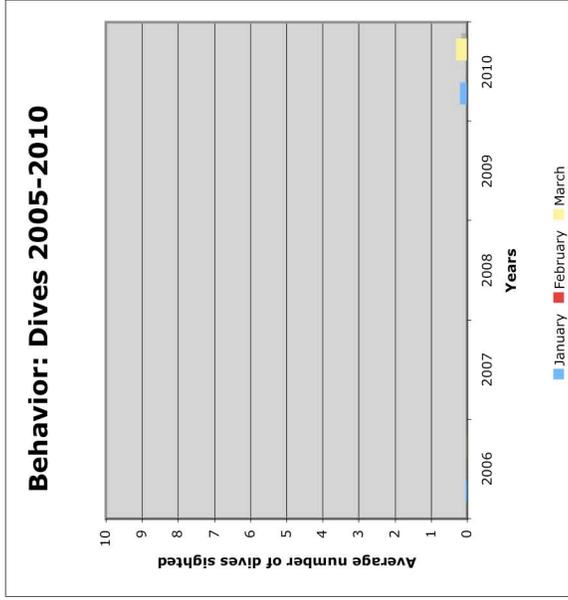
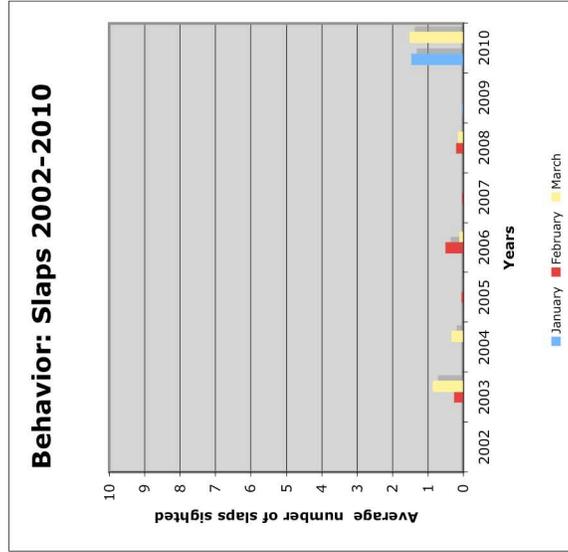
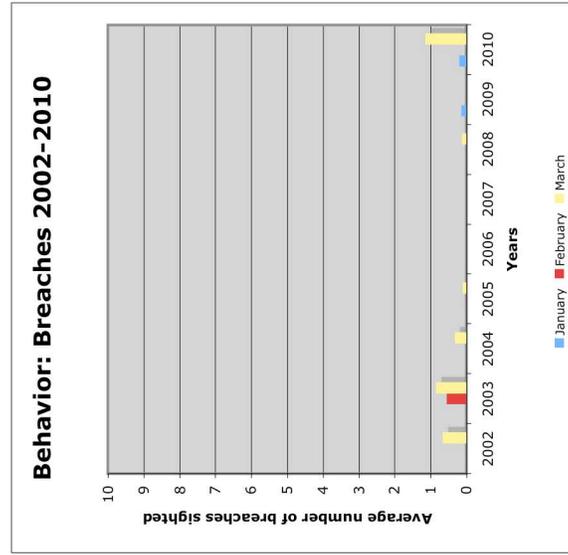
Site #16: Lauahoehoe Scenic Lookout

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	NA	NA	0.67
2003	NA	0.55	0.86
2004	0	NA	0.33
2005	0	0.01	0.12
2006	0	0	0
2007	0	0	0
2008	0	0	0.13
2009	0.14	0	0
2010	0.21	NA	1.16

	Slaps		
	January	February	March
2002	NA	NA	0
2003	NA	0.27	0.86
2004	0	NA	0.33
2005	0	0.05	0
2006	0	0.51	0.12
2007	0	0.04	0
2008	0	0.21	0.16
2009	0.04	0	0
2010	1.46	NA	1.52

	Dives		
	January	February	March
2006	0.05	0	0.02
2007	0	0	0
2008	0	0	0
2009	0	0	0
2010	0.2	NA	0.31



Above: Average number of breaches and slaps sighted per whale by volunteers at Lauahoehoe Scenic Lookout on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

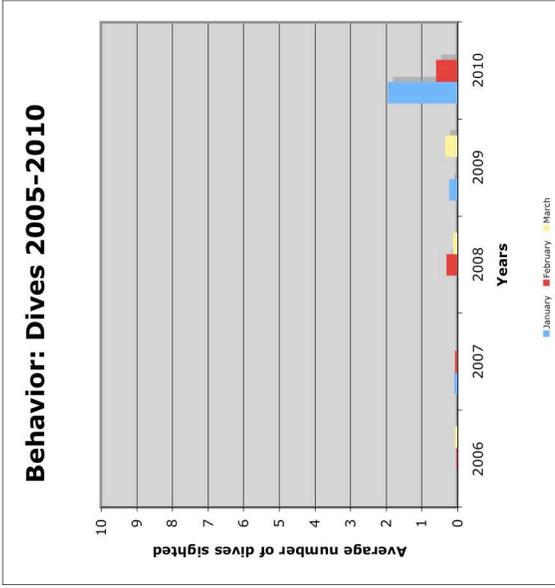
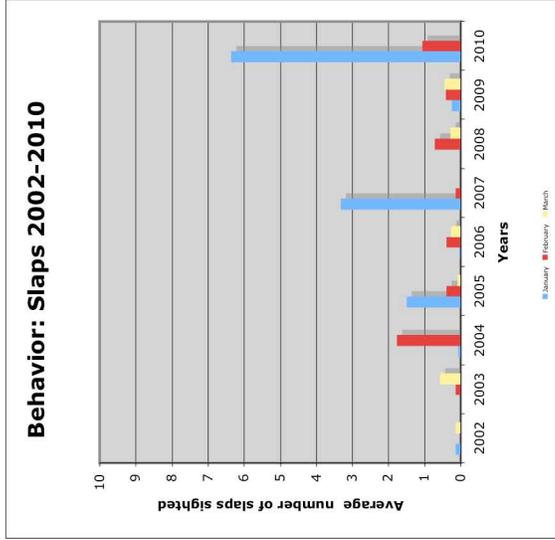
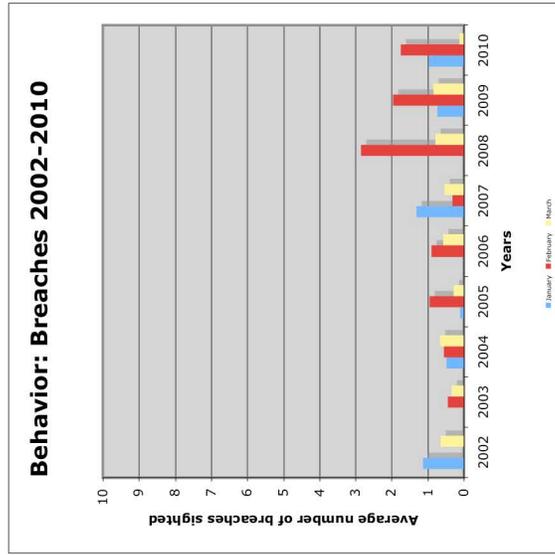
Site #17: Onekahakaha Beach Park

Behavioral Data Analysis

Breaches			
	January	February	March
2002	1.14	NA	0.66
2003	NA	0.46	0.35
2004	0.48	0.56	0.67
2005	0.11	0.95	0.29
2006	0.02	0.91	0.57
2007	1.32	0.32	0.54
2008	0	2.85	0.8
2009	0.75	1.98	0.85
2010	0.97	1.76	0.13

Slaps			
	January	February	March
2002	0.14	NA	0.15
2003	NA	0.14	0.57
2004	0.08	1.78	0
2005	1.5	0.4	0.09
2006	0.04	0.39	0.27
2007	3.33	0.15	0
2008	0	0.73	0.29
2009	0.25	0.41	0.45
2010	6.37	1.06	0

Dives			
	January	February	March
2006	0	0.03	0.07
2007	0.09	0.07	0
2008	0	0.32	0.13
2009	0.24	0	0.34
2010	1.96	0.6	0



Above: Average number of breaches and slaps sighted per whale by volunteers at Onekahakaha Beach Park on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

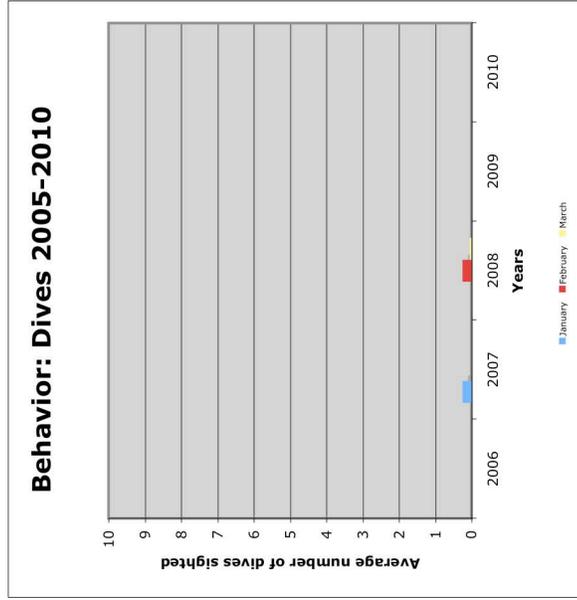
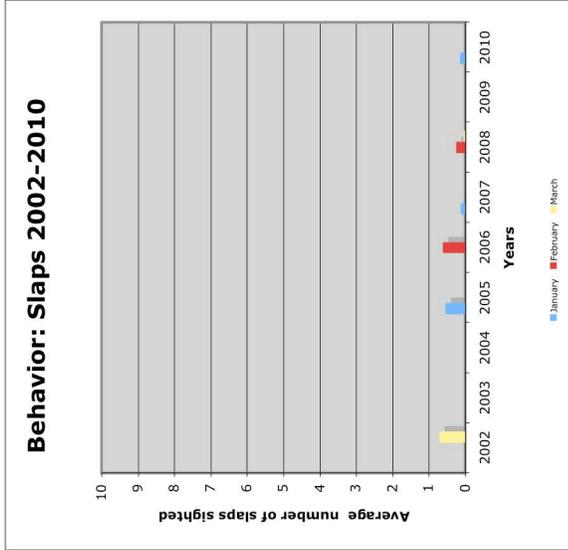
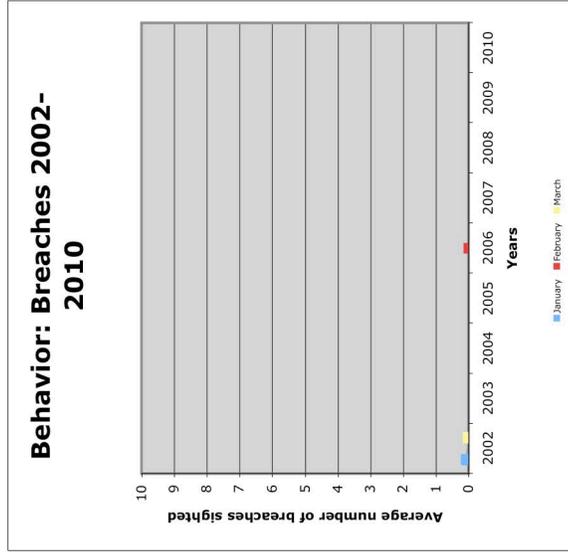
Site #18: Kumukahi Lighthouse

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	0.25	NA	0.18
2003	0	NA	NA
2004	NA	NA	NA
2005	0	0	NA
2006	0	0.17	0
2007	0	0	0
2008	0	0	0
2009	NA	0	0
2010	0	0	0

	Slaps		
	January	February	March
2002	0	NA	0.71
2003	0	NA	NA
2004	NA	NA	NA
2005	0.55	0	NA
2006	0	0.63	0
2007	0.13	0	0
2008	0	0.25	0.06
2009	NA	0	0
2010	0.15	0	0

	Dives		
	January	February	March
2006	0	0	0
2007	0.25	0	0
2008	0	0.25	0.06
2009	NA	0	0
2010	0	0	0



Above: Average number of breaches and slaps sighted per whale by volunteers at Kumukahi Lighthouse on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

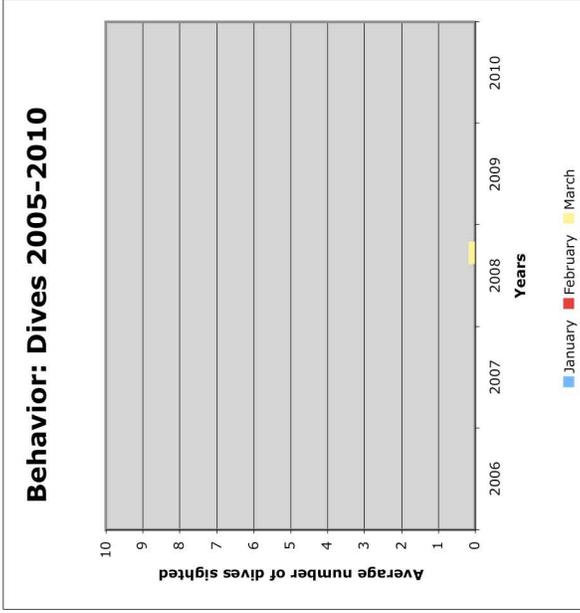
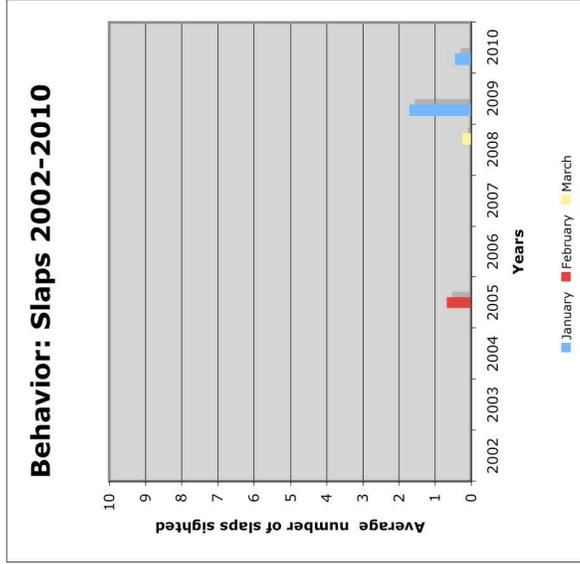
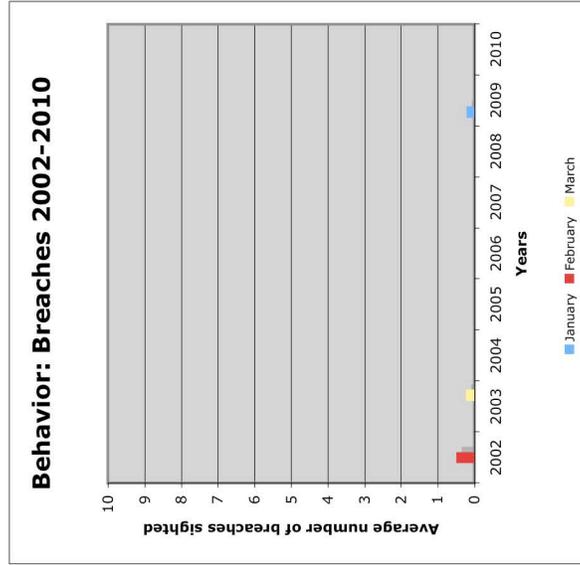
Site #19: Kehena Lookout

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	NA	0.5	NA
2003	NA	NA	0.25
2004	NA	NA	NA
2005	0	0	NA
2006	NA	0	0
2007	0	0	NA
2008	0	0	0
2009	0.23	0	0
2010	0	NA	0

	Slaps		
	January	February	March
2002	NA	0	NA
2003	NA	NA	0
2004	NA	NA	NA
2005	0	0.67	NA
2006	NA	0	0
2007	0	0	NA
2008	0	0	0.25
2009	1.71	0	0
2010	0.45	NA	0

	Dives		
	January	February	March
2006	NA	0	0
2007	0	0	NA
2008	0	0	0.19
2009	0	0	0
2010	0	NA	0



Above: Average number of breaches and slaps sighted per whale by volunteers at Kehena Lookout on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Island: Hawaii

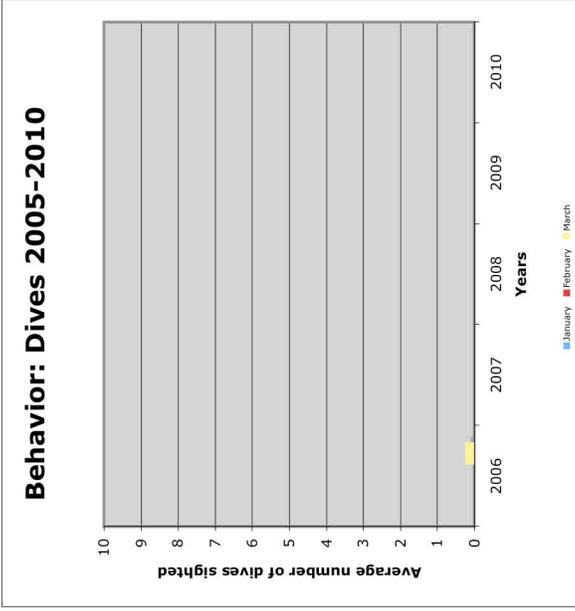
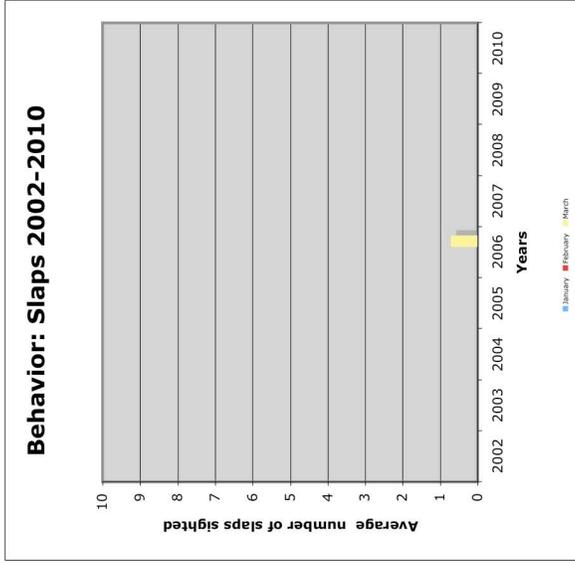
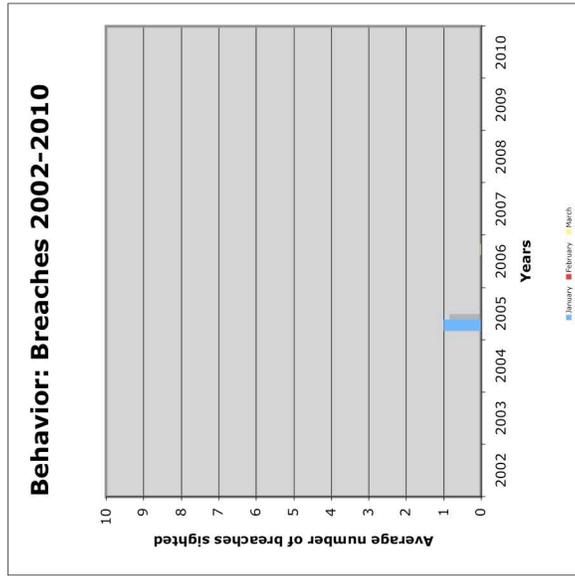
Site #20: Kaena Point

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	NA	NA	NA
2003	NA	NA	NA
2004	0	NA	NA
2005	1	NA	NA
2006	0	0	0.04
2007	NA	NA	NA
2008	NA	NA	NA
2009	NA	NA	NA
2010	NA	NA	NA

	Slaps		
	January	February	March
2002	NA	NA	NA
2003	NA	NA	NA
2004	0	NA	NA
2005	0	NA	NA
2006	0	0	0.73
2007	NA	NA	NA
2008	NA	NA	NA
2009	NA	NA	NA
2010	NA	NA	NA

	Dives		
	January	February	March
2006	0	0	0.25
2007	NA	NA	NA
2008	NA	NA	NA
2009	NA	NA	NA
2010	NA	NA	NA



Above: Average number of breaches and slaps sighted per whale by volunteers at Kaena Point on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

*Site not used after March 2006

Island: Hawaii

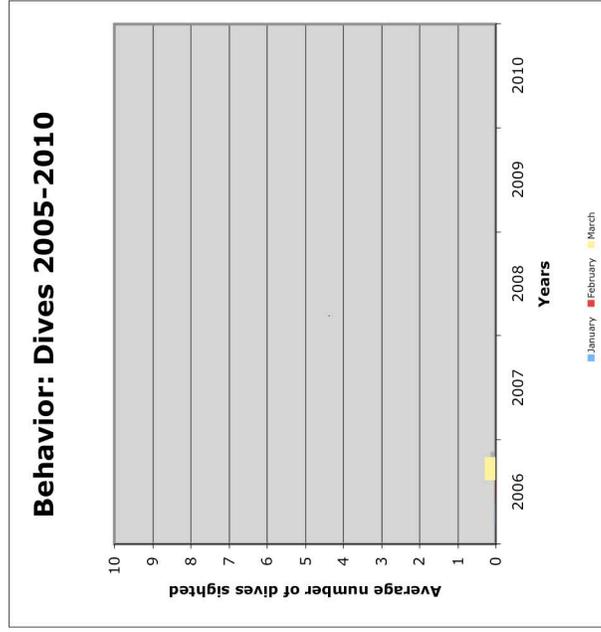
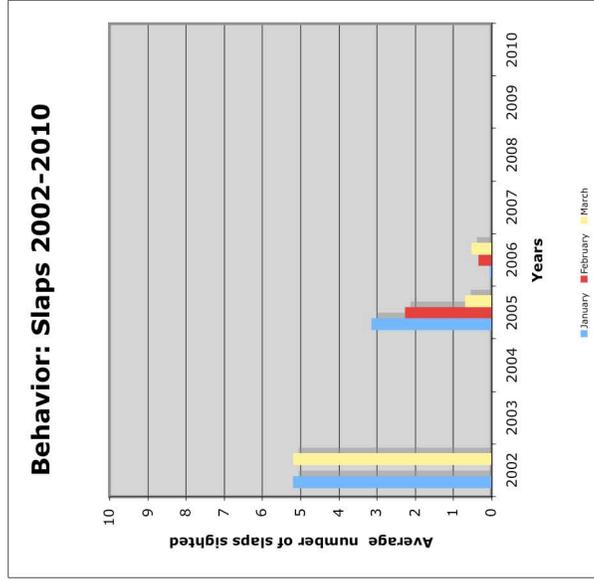
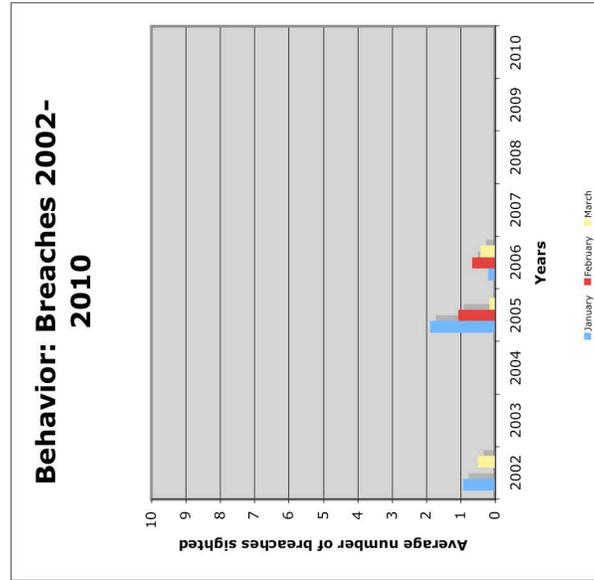
Site #21: Paukaa Point

Behavioral Data Analysis

Breaches			
	January	February	March
2002	0.94	NA	0.5
2003	NA	NA	NA
2004	NA	NA	NA
2005	1.89	1.07	0.17
2006	0.21	0.68	0.42
2007	NA	NA	NA
2008	NA	NA	NA
2009	NA	NA	NA
2010	NA	NA	NA

Slaps			
	January	February	March
2002	5.2	NA	5.2
2003	NA	NA	NA
2004	NA	NA	NA
2005	3.15	2.28	0.7
2006	0.05	0.35	0.54
2007	NA	NA	NA
2008	NA	NA	NA
2009	NA	NA	NA
2010	NA	NA	NA

Dives			
	January	February	March
2006	0.02	0.02	0.29
2007	NA	NA	NA
2008	NA	NA	NA
2009	NA	NA	NA
2010	NA	NA	NA



Above: Average number of breaches and slaps sighted per whale by volunteers at Paukaa Point on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

*Site not used after March 2006

Island: Hawaii

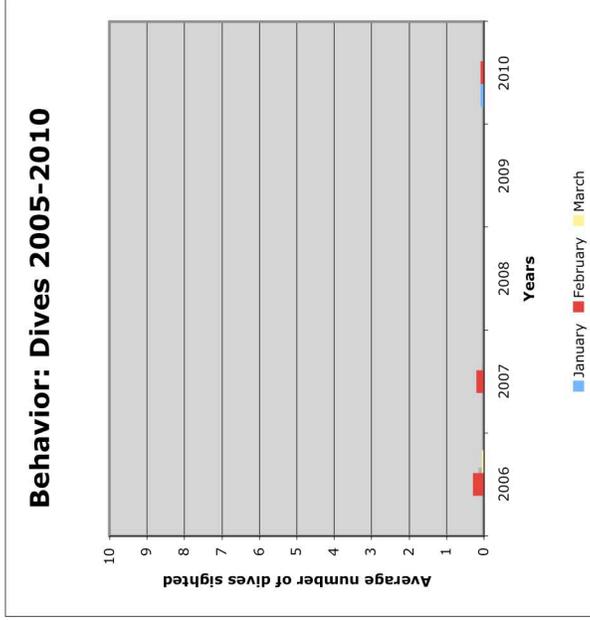
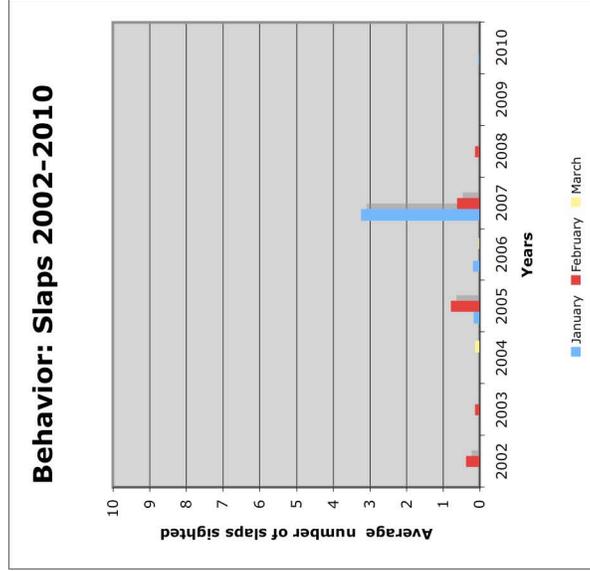
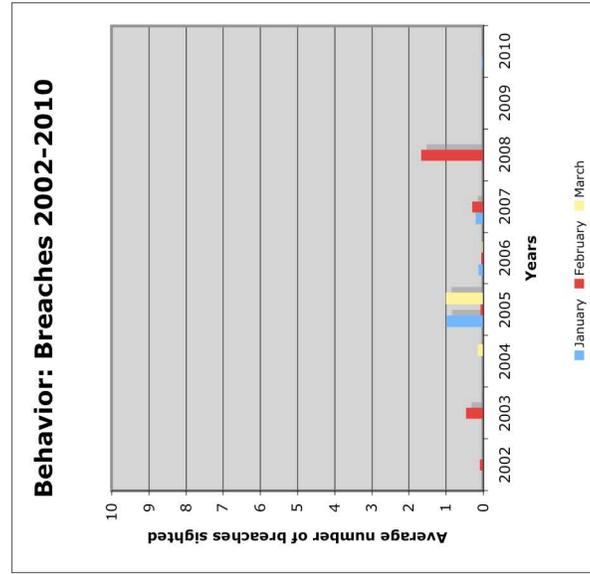
Site #22: Ookala

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	NA	0.1	NA
2003	NA	0.46	NA
2004	0	NA	0.14
2005	0.98	0.08	1
2006	0.13	0.06	0.04
2007	0.21	0.29	0
2008	0	1.68	0
2009	0	0	0
2010	0.04	0	0

	Slaps		
	January	February	March
2002	NA	0.37	NA
2003	NA	0.14	NA
2004	0	NA	0.14
2005	0.17	0.79	0
2006	0.19	0	0.04
2007	3.24	0.63	0
2008	0	0.13	0
2009	0	0	0
2010	0.04	0	0

	Dives		
	January	February	March
2006	0	0.29	0.06
2007	0	0.21	0
2008	0	0	0
2009	0	0	0
2010	0.1	0.09	0



Above: Average number of breaches and slaps sighted per whale by volunteers at Ookala on Hawaii for the years 2002-2010. Dives were only recorded from 2006-2010.

Kahoolawe

Behavioral Data Analysis by Site

January, February and March

Breaches: 2002-2010

Slaps: 2002-2010

Dives: 2006-2010



Doug Perrine/ HWRF/
Seapics.com/NOAA Fisheries
Permit # 882



Doug Perrine/ HWRF/
Seapics.com/NOAA Fisheries
Permit # 882



Flip Nicklin/ Minden
Picutres/NOAA Fisheries
Permit # 987

Island: Kahoolawe

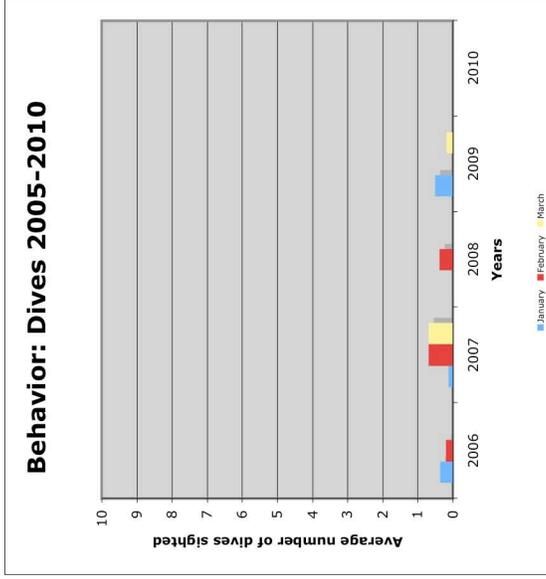
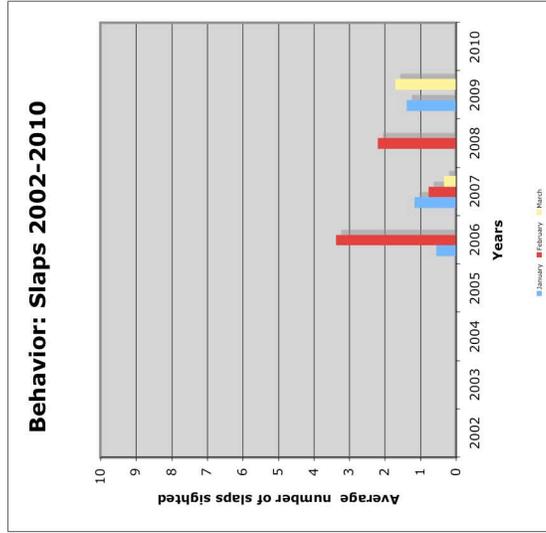
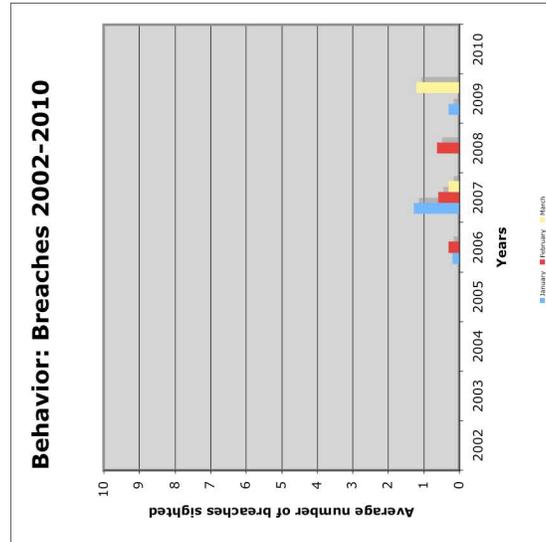
Site #1: Lua Kealia Luna

Behavioral Data Analysis

	Breaches		
	January	February	March
2002	NA	NA	NA
2003	NA	NA	NA
2004	NA	NA	NA
2005	NA	NA	NA
2006	0.19	0.3	NA
2007	1.28	0.59	0.3
2008	NA	0.64	NA
2009	0.31	NA	1.22
2010	NA	NA	NA

	Slaps		
	January	February	March
2002	NA	NA	NA
2003	NA	NA	NA
2004	NA	NA	NA
2005	NA	NA	NA
2006	0.56	3.38	NA
2007	1.17	0.78	0.35
2008	NA	2.21	NA
2009	1.4	NA	1.72
2010	NA	NA	NA

	Dives		
	January	February	March
2006	0.37	0.2	NA
2007	0.13	0.7	0.7
2008	NA	0.39	NA
2009	0.51	NA	0.19
2010	NA	NA	NA



Above: Average number of breaches and slaps sighted per whale by volunteers at Lua Kealia Luna on Kahoolawe for the years 2002-2010. Dives were only recorded from 2006-2010.

Chapter 7: Conclusions

The following summarizes the findings by question.

Question A: Does the Sanctuary Ocean Count census data from 2002-2010 at each site reflect a 5-7% annual increase in population growth for the North Pacific stock of humpback whales as reported by whale researchers?

Researchers report that the Hawaii sub-population of humpback whales has increased at an annual rate of 5-7 percent. The census summary for the ocean count data reflects a gradual overall population increase over the census period. However, the data does not appear to fully reflect the 5-7% annual population increase reported by whale researchers. The highly variable census counts from year to year can be partially attributed to weather and its affect on visibility conditions.

A trend noted in the ten-year census summary analysis indicated consistently higher sightings in January and February than in March. A possible explanation for lower whale counts in March is that some whales may have began their migration back to the feeding grounds in Alaska by the time of the March census. The census summary by island suggest that volunteers on Kauai saw the most whales over the five-year period in January and February while volunteers on Oahu counted the highest average in March. The islands of Kauai and Hawaii also have similar average census counts for each month with the volunteers on Oahu saw lower average counts.

In the census summary by year, volunteers on Kauai counted the most humpback whales on average in every year but 2010. This could be because in 2010, Kauai experienced numerous site closures due to bad weather, presence of a submarine around the island, as well as rescheduling the February count due to a tsunami warning. In the year 2007, all the islands have relatively close census averages (a difference of 0.67) as to suggest suitable viewing conditions on each island, each count period.

Question B: Which ocean count sites on each island are humpback whales sighted consistently from year to year?

The four most consistent sites on every island could help track the population more reliably and accurately around the three islands in upcoming years because of the consistency in the census data for the first ten years of the Sanctuary Ocean Count project. The following are the four most consistent ocean count sites on each island.

Kauai	Oahu	Hawaii
Kilauea Lighthouse	Laie Point	Puukohala Heiau
Crater Hill	Halona Blowhole	Mile Marker 7
Makahuena Point	Lanai Lookout	Lapakahi State Park
Poipu Beach Park	Hanauma Bay	Kapaa Beach Park

Question C: Are there similarities in the census data results among ocean count sites along the same coastline?

Kauai

Anecdotal evidence suggested that March, and more recently February, were considered the peak of whale season on Kauai. Surprisingly, for sites on three of the coastlines, South, East and West Shore, January had the largest average amount of humpback whale sightings followed by February and March's average. The North Shore had a higher average in February with its lowest average in March. For all the coastlines, the month of March had the lowest overall average of humpback whale sightings as to support the earlier claim that many of the whales have left the breeding area by late March.

This comprehensive ten-year analysis depicts different results than Dr. Maldini's original 2002 annual report. Dr. Maldini reported that in January, February and March, the volunteers at East Shore sites counted the highest overall average number of humpback whale sightings (Maldini 88,90,92). However, in the ten-year summary analysis (2002-2010), which is the focus of this report, it appears in January, South Shore saw the highest average. In February and March, Kauai's North Shore had the overall highest average of humpback whale sightings.

Interestingly, North Shore contains the most sites with the highest elevation on the island. However, volunteers at these sites did not always count the most humpback whale sightings as Kauai's South Shore, with elevations below 50 ft. Further analysis would need to be done to see how elevation levels effect the overall ocean count census. However, from the ten-year summary on Kauai, it seems to suggest that sites at higher elevations do not necessarily always see the most humpback whales.

Oahu

The average number of humpback whale sightings varied between the coastlines of Oahu. The four main coastlines are as follows: Waianae, South Shore, North Shore and Windward Coast. Waianae Coast encompasses 3 ocean count sites, South Shore encompasses 4 ocean count sites, and both North Shore and Windward Coast encompass 9 ocean count sites.

For sites along three of the coastlines, Waianae, South Shore and North Shore, February had the largest average amount of humpback whale sightings followed closely by January's average. The Windward Coast had a higher average in March with its lowest average in January.

In comparison with results found by Dr. Daniela Maldini in her annual 2002 report (one of the first Ocean Count census taken), there are similarities and differences in which coastline had the most average number of humpback whales. In both the 2002 and the comprehensive ten-year analysis between 2002 and 2010, the North Shore of Oahu had the highest average in January. In February, North Shore had the highest average while in the 2002 analysis, South Shore had the highest number of average sightings. In March 2002, it was found that volunteers at South Shore sites counted on average more humpback whales (Maldini 88,90,92). In the comprehensive analysis of 2002-2010, Windward Coast saw on average the most whales of all four coasts on Oahu in March.

Hawaii

As with the island of Kauai, for sites along three of the coastlines, South Shore, Kona Coast and Kohala Coast, January had the largest average amount of humpback whale sightings. The Hamakua Coast had an overall higher average in February with its lowest average number of sightings in March. In fact, all the coastlines around the island of Hawaii had the lowest average count of humpback whale sightings in March.

Hawaii's comprehensive ten-year analysis illustrates different results than Dr. Maldini's original 2002 coastline comparison report. She found that in both January and February, sites along the Kona Coast had the highest overall average of humpback whale sightings. In March, she reported that the Hilo Coastline had the highest average (Maldini 88,90,92). However, in the ten-year summary analysis (2002-2010), it appears that in January, February and March, Kohala Coast had the highest overall average every month.

Coastline comparison similarities between the islands of Oahu, Kauai and Hawaii

Interestingly, when comparing all three islands coastline comparison graphs, the trends are rather similar. Three out of four coastlines on every island have the highest overall average of humpback whale sightings fall within one particular count month with one coastline being different. Both Oahu and Hawaii tend to have similar looking graphs with January and February averages being closely related for most of the coastlines. Finally, every coastline, with the exception of Windward Coast on Oahu, have there lowest averages of humpback whale sightings in the month of March. Researchers have hypothesized and speculated that the peak breeding season for humpback whales is over by late March and many of the whales have left the main Hawaiian Islands by the time of the last sanctuary ocean count. Thus, the comprehensive ten-year analysis of the ocean count data seems to support this claim.

Question D: How does the proportion of calves vary between the islands of Kauai, Oahu and Hawaii for the years 2002, 2007-2010?

For the 2002, 2007-2010 analysis, the proportion of calves does vary between the three islands with a greatest overall difference of about 7%. The current analysis shows Kauai had the least overall percentage at about 10% followed by Hawaii at about 15% and then Oahu at 17% relative to the total number of whales sighted. The year 2002 was included in the analysis to compare the earliest ocean count research with the present percentage of calves sighted. On the basis of the current analysis, a higher proportion of calves are sighted on Oahu, followed by the island of Hawaii. Future analysis using the proportion of calves for each ocean count site could yield vital information as to possible calving and/or nursery areas.

Interestingly, whale researchers had announced that the island of Kauai has fewer calves than the other two islands and that the overall percentage is around 10%. The Sanctuaries Ocean Count project seems to be yielding the same results using there trained volunteers from the fifteen shore-based sites around the island.

Question E: For the three selected surface whale behaviors (breaches, slaps and dives), how do the sites on every island compare in the number of sightings of each particular behavior from 2002-2010 in January, February and March?

The overall average per whale for each island was rather close for each particular behavior. Some preliminary conclusions drawn from the behavioral summary by island analysis include for Oahu, volunteers in the month of March saw the overall highest average for all three behaviors. For Hawaii, slaps and dives and the highest count averages in January, and with dives, March had the lowest overall average number of sightings. For Kauai, no real pattern emerged between the three behaviors but less variability was found between January, February and March's averages for each particular behavior. For Kahoolawe, March had the highest average number of sightings for both the breach and dive behaviors.

For breaches, Hawaii had the highest average for January ($x=.390$) and February ($x=.416$) while Oahu had the highest for March ($x=.329$). For slaps, Kauai had the highest in February ($x=.684$) and March ($x=.800$) while Hawaii had the highest average for January ($x=.802$). For dives, Kauai had the highest average in January ($x=.272$), February ($x=.270$) and March ($x=.365$).

Formal behavioral conclusions using the Sanctuary Ocean Count data are beyond the scope of this project and further indepth, specialized analysis is needed to see how the whales use the behaviors.

Chapter 10: Recommendations

The following recommendations for further study are proposed.

Humpback Whale Census Analysis

- Further data analysis is needed to better refine the trends indicated by the census data.
- In addition, more work is needed to correlate ocean count data with population studies conducted by whale researchers.
- This internship project did not investigate how visibility conditions affected the census data. Therefore, further examination into this variable is needed.

Major Coastline Comparison

- Further analysis by a geographer or surveyor is needed to see how elevation levels affect the overall ocean count census.

Proportion of calves

- Expand this analysis to the raw data for 2003-2006 to all islands.
- Future analysis using the proportion of calves computed for each ocean count site could yield vital information leading to the identification of more calving and nursery areas.

Humpback Whale Behavior Analysis

- In depth analysis of the behavioral and any implications they may have on how various ocean count sites may be used by humpback whales is beyond the scope of this internship project and is best left to humpback whale researchers.

Maps

- This internship project did not analyze the ocean count maps. These require analysis and could prove important.

Chapter 11: Bibliography and Acknowledgements

Maldini, Daniela, and Peter Nilsson. "Distribution Patterns and Behaviors of Humpback Whales around Oahu, Kauai, Hawaii and Kahoolawe." (2006): 18-28.

Maldini, Daniela. "Year 2002 Sanctuary Ocean Count Results." (2002): 88,90,92.

Darling, Jim. *Hawaii's Humpbacks Unveiling the Mysteries*. 1. Vancouver BC, Canda: Granville Island Publishing Ltd., 2009. 28-29, 40, 96-99.

Calambokidis, J., E.A.Falcone, T.J. Quinn, A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M.Gabriele, R.LeDuc, D. Mattila, L. Rojas-Bracho, J.M. Straley, B.L.Taylor, J.Urban, D. Weller, B.H. Witteveen, M.Yamaguchi, A.Bendlin, D. Camacho, K. Flynn, A.Havron, J. Huggins, N. Maloney. 2008. SPLASH: structure of populations, levels of abundance and status of humpback whales in the North Pacific. Final Report for Contract AB133F-03-RP-00078. Prepared by Cascadia Research for U.S.Department of Commerce, Western Administrative Center, Seattle, WA. 57pp

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