

## **Hawaiian Islands National Wildlife Refuge and Midway Atoll National Wildlife Refuge- Annual Nest Counts through Hatch Year 2007**

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The Northwestern Hawaiian Islands serve as breeding sites to ~96% of the world's Black-footed Albatross (*Phoebastria nigripes*) and ~99.9% of the world's Laysan Albatross (*Phoebastria immutabilis*). The majority of these birds nest on lands managed by the US Fish and Wildlife Service including 7 of the 8 units of the Hawaiian Islands National Wildlife Refuge and all three islands at Midway Atoll National Wildlife Refuge. The State of Hawaii Department of Land & Natural Resources Division of Forestry and Wildlife manages the colonies at Kure Atoll. Smaller groups of primarily Laysan Albatross nest in the main Hawaiian Islands and in Mexico and both species nest in small numbers at some island groups in Japan.

Recognizing the conservation concerns surrounding all albatross species the National Wildlife Refuge staff has made a particular effort to maintain population monitoring data for these two species including recording breeding chronology, numbers of active nests established each year, and reproductive performance at selected sites where we have year-round presence. The Office of Migratory Birds with technical assistance from USGS BRD have built upon the thousands of albatrosses that have been banded through the years and designed a mark recapture study that will make it possible to monitor survivorship and provide other data necessary for estimating survivorship and other parameters necessary for population modeling efforts.

The counts and estimates of active nests presented here have been conducted using standardized techniques since 1980 at French Frigate Shoals, since 1991 at Midway Atoll, and since 1992 at Laysan Island. There are earlier population counts and estimates for all these sites but here we report only those data collected using the standardized techniques described below. This document summarizes only the counts done in the refuges since we standardized the techniques. For reviews of earlier population estimates and counts at these sites see McDermond and Morgan (1993), Cousins and Cooper, eds. (2000), Fefer et al. (1984) and Tickell (2000). A formal status assessment of both species is in review right now.

All values without confidence limits are the result of a direct count of active nests and stated as number of pairs. Abandoned eggs are also counted but cannot be attributed to species because most colonies are mixed. At Midway Atoll, Laysan Island, and French Frigate Shoals all albatrosses of both species are counted each year during the month of December after egg-laying is complete. The counts are initiated when the asymptote of total eggs is reached in a sample plot for that species. This typically occurs near the middle of December each year and counts are finished by the end of the first week of

January. Counts at these three sites represent a complete count of active nests during the early incubation period of approximately 77% of the world population of Black-footed Albatrosses each year and 93% of the world's Laysan Albatross. At other sites where we do not have a winter field camp (Table 1) we count chicks in the spring and correct for egg and chick loss prior to the count by using the reproductive performance rate measured at our more intensively monitored breeding sites. Table 1 shows the most recent count available for each breeding site known for the species and total world population of birds breeding based on the most recent numbers available. None of these counts include breeders that may have not returned that year, did not lay an egg that year, or birds that have not yet reached breeding age. All chicks produced at Tern have been banded since 1979 and all unbanded adults have been banded and all bands have been read since 1997 so this effort should allow population ecologists to produce better estimates for the unknown values using mark-recapture models. Until 1997, Black-footed and Laysan Albatross populations at Laysan Island were estimated by measuring density of eggs in ~200 quadrats (representing about 5% of the total land area) and multiplying the result by total habitat area. We continue that techniques for Laysan Albatrosses today but have switched to complete active nest counts for Black-footed Albatrosses at Laysan Island. Breeding Laysan Albatrosses at Midway have been completely counted 8 times in the last 14 years because the size of the population (~400,000 pairs) makes this job prohibitively expensive at more frequent intervals. The actual dates of the initiation of the counts are listed in Table 1 whereas the hatch-year of the birds counted is used in the graphs. This means that the values for Midway, Laysan, and French Frigate Shoals listed as 2006 in Table 1 because the eggs were counted in December of 2006 are values for 2007 in the graphs because those eggs hatched in 2007.

Table 1. Most recent population count or estimate of breeding pairs for all known breeding sites.

**ALBATROSS POPULATION (SUMMATION OF CURRENTLY BEST FIGURES FOR EACH SITE)  
NUMBER OF BREEDING PAIRS**

Breeding site	Black-footed Albatross	Laysan Albatross
<b>Kure Atoll</b> 28°25' N, 178°10'W	2020* (2000)	3899*(2000)
<b>Midway Atoll</b> 28°12'N, 177°20'W	(2006) 24887	(2006) 398529
<b>Pearl &amp; Hermes Reef</b> 27°55'N, 175°45'W	6116* (2003)	6912* (2003)
<b>Lisianski I.</b> 26°02'N, 174°00'W	2126* (2006)	26,500(1982)
<b>Laysan I.</b> 25°42'41"N, 171°44'06" W	(2006) 21456	(2006) 149513 ± 25780
<b>French Frigate Shoals</b> 23°45'N, 166°15'W	5725 (2006)	3899(2006)
<b>Necker I.</b> 23°35'N, 164°42'W	112* (1995)	500*(1995)
<b>Nihoa I.</b> 23°06'N, 161°58'W	31* (1994)	0(1995)
<b>Kauai</b> 22°14'N, 159°24'W	0 (2004)	160 (2005)
<b>Lehua I.</b> 22°01'N, 160°06'W	25 (2006)	61(2006)
<b>Niihau</b> 21°55'N, 160°14'W	?	190 (2002)
<b>Kaula</b> 21°40'N, 160°32'W	0 (1998)**	63
<b>Oahu</b>	0 (2002)	60 (2006)
<b>Senkaku Islands</b>	56 *(2002)	0 (2002)
<b>Bonin Is.(Chichijima)</b>	405 (2003)	30 (1992)
<b>Izu Is. (Torishima)</b>	1560* (2003)	0 (2003)
<b>Guadelupe Is.</b>	0 (2003)	337 (2005)
<b>Mexican Is.</b>	0 (2003)	69 (2003)
<b>Total</b>	64519	590722

#Breeding suspected but not confirmed.

\*indicates an extrapolation to total eggs from chicks counted later in the season (assumes 75% reproductive success).

\*\*survey at Kaula was done 16-17 November, 1998 - slightly early to rule out that eggs were laid after that. Nine birds present on island.

### Black-footed Albatross (*Phoebastria nigripes*)

French Frigate Shoals provides us with the longest time series (hatch year 1980 to present) but the land use history at this site must be considered when evaluating changes in population there. The US Fish and Wildlife Service took possession of the station at Tern Island in 1979. Previous to that the Navy and then the US Coast Guard had occupied both East and Tern Islands for many years at the atoll. They had an active program to discourage nesting on Tern Island because they were using it to land C-130 aircraft. This activity changed abruptly when USFWS took over and numbers of all species of breeding seabirds increased at the site subsequently over the next several years. Figure 1 shows results of annual nest counts of Black-footed Albatross at all islets at French Frigate Shoals between hatch year 1980 and hatch year 2007. Counts were not done in hatch year 2006 because there were not two Department of Interior certified boat operators at the atoll during the count period.

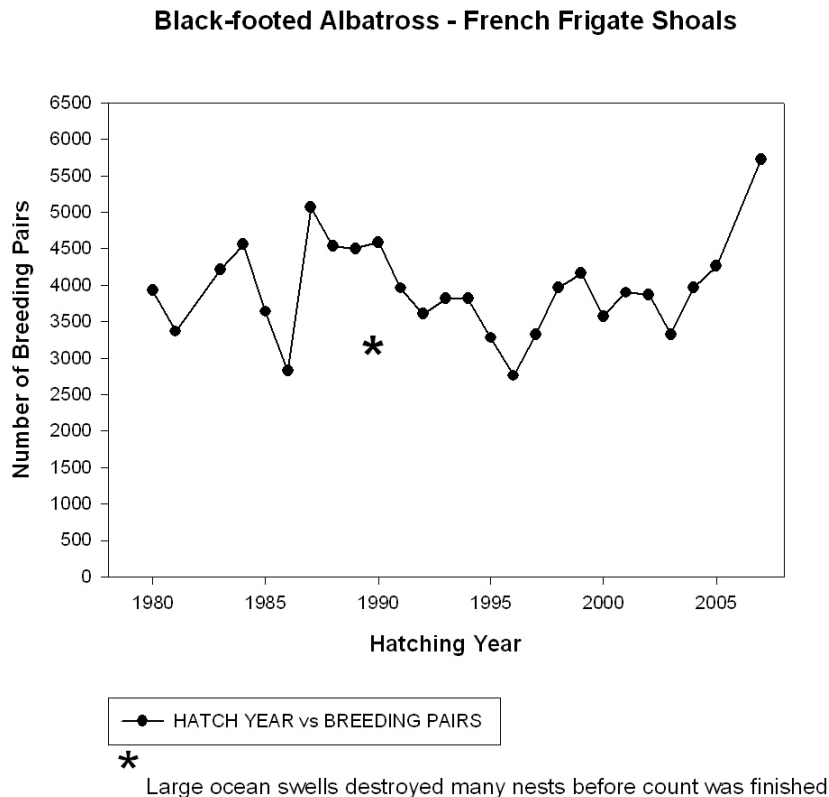


Figure 1. Black-footed Albatross active nests at French Frigate Shoals.

Table 2 Black-footed Albatross active nests at French Frigate Shoals for hatch years 1980-2007

HATCH YEAR	BREEDING PAIRS - FFS BFAL
1980	3926
1981	3366
1983	4214
1984	4561
1985	3637
1986	2823
1987	5067
1988	4535
1989	4501
1990	4588
1991	3960
1992	3608
1993	3817
1994	3816
1995	3280
1996	2760
1997	3321
1998	3964
1999	4164
2000	3573
2001	3899
2002	3869
2003	3328
2004	3966
2005	4259
2007	5725

Figure 2 illustrates breeding population size of Black-footed Albatrosses at Laysan Island between hatch year 1992 and hatch year 2007. This is the period over which we have had a year-round field camp at the site with staff engaging in an ecological restoration of the site. There were no known island habitat or disturbance based factors that would affect albatross populations at Laysan during the years immediately prior to these counts. In 1997 we started doing a direct count of all Black-footed Albatross nests in addition to the estimates based on measured density in quadrats multiplied by total albatross nesting area. Table 3 summarizes these numbers. Figure 3 shows the comparison between the changes in breeding population of Black-footed Albatrosses and Laysan Albatrosses at Laysan Island.

### Black-footed Albatross - Laysan Island

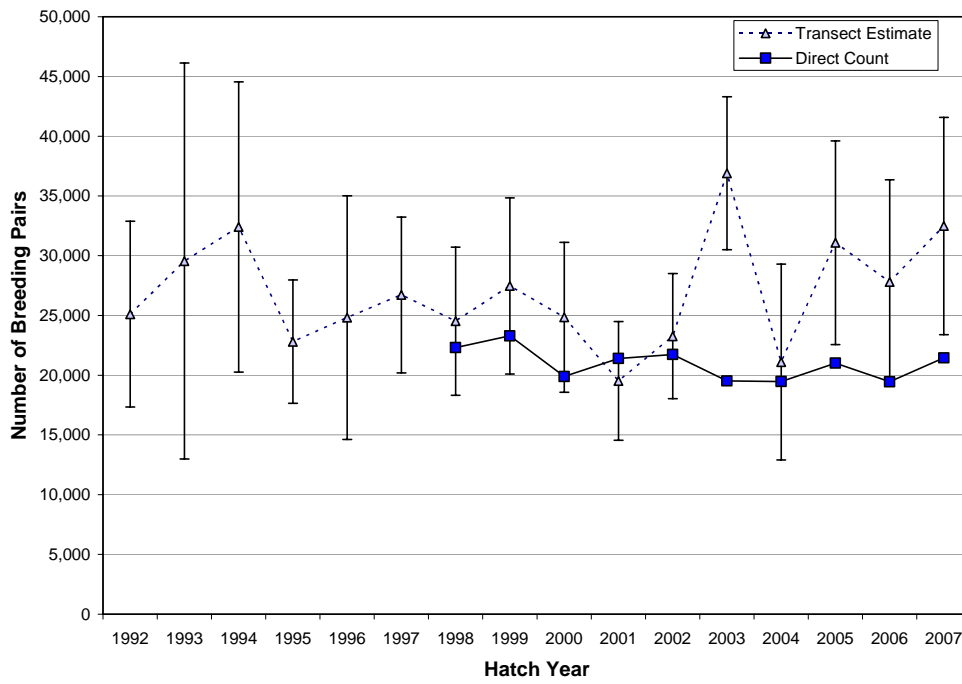


Figure 2. Black-footed albatross populations at Laysan Island assessed using 2 methods.

### Albatross populations - Laysan Island

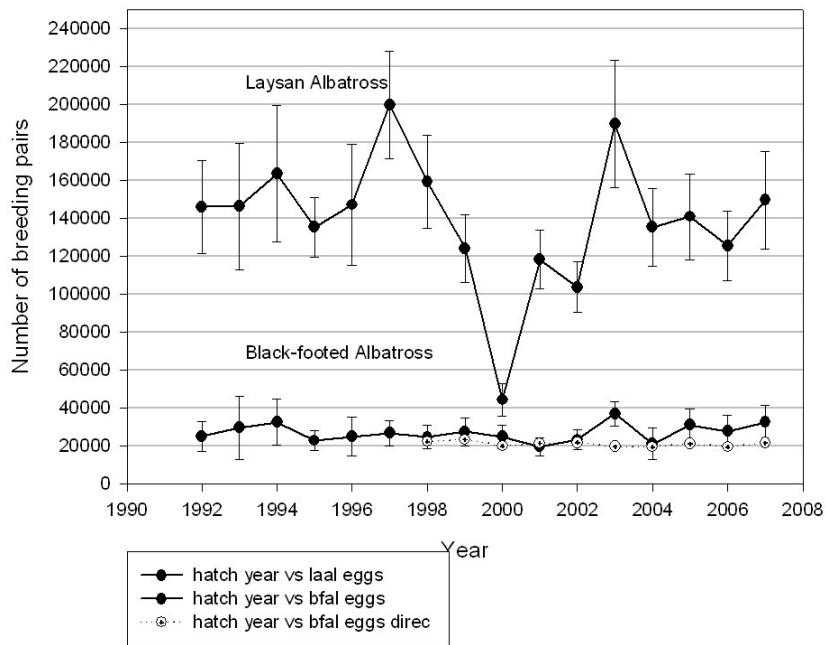


Figure 3. Population sizes of 2 species of breeding albatrosses at Laysan Island.

Table 3. Laysan Island albatross counts and estimates for hatch years 1992 – 2007.  
 BFAL = Black-footed Albatross and LAAL = Laysan Albatross.

hatch year	LAAL eggs	95% CI	BFAL eggs	95% CI	BFAL eggs direct count
1992	145947	24309	25109	7766	
1993	146220	33388	29558	16566	
1994	163553	35870	32414	12143	
1995	135252	15598	22805	5166	
1996	147065	32052	24813	10201	
1997	199724	28477	26723	6520	
1998	159195	24674	24519	6200	22314
1999	124113	17931	27472	7375	23297
2000	44186	8569	24855	6276	19900
2001	118125	15465	19519	4975	21389
2002	103689	13276	23262	5239	21737
2003	189610	33567	36896	6401	19520
2004	135269	20442	21098	8190	19472
2005	140861	22660	31088	8532	21006
2006	125484	18511	27816	8540	19456
2007	149513	25780	32488	9087	21456



Staff has counted Black-footed Albatrosses at Midway Atoll since hatch year 1992. The refuge was created as an overlay on Midway Naval Air Station in 1988 and first staffed year-round in 1990. Figure 4. illustrates Black-footed Albatross pairs for hatch years 1992 through 2007. Table 4. shows count numbers. Disturbance levels have declined since the peak of human population sizes that occurred in the early 1970's.

### Midway Atoll, Black-footed Albatross

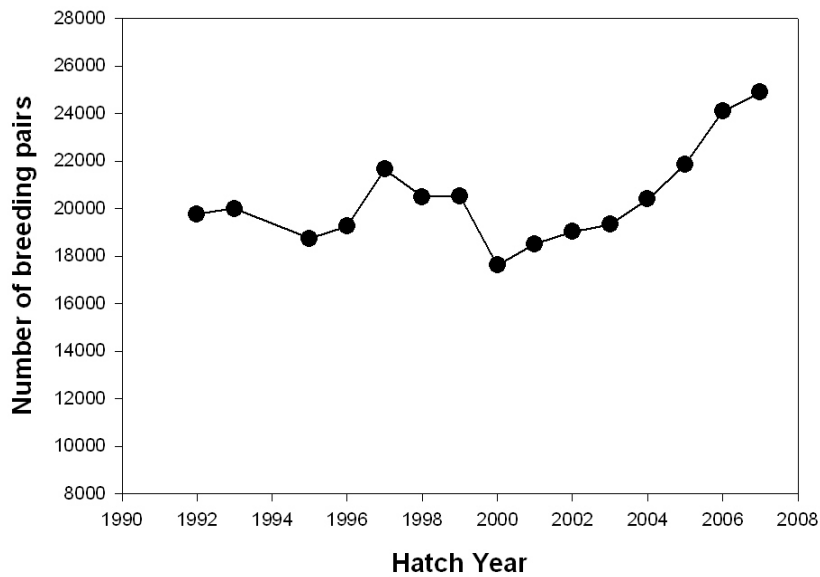


Figure 4. Numbers of active nests of Black-footed Albatrosses at Midway Atoll.

Table 4. Numbers of active nests of Black-footed Albatrosses at Midway Atoll from hatch years 1992 to 2007.

hatch year	active BFAL nests
1992	19757
1993	19994
1995	18731
1996	19255
1997	21645
1998	20490
1999	20510
2000	17617
2001	18493
2002	19012
2003	19331
2004	20393
2005	21829
2006	24085
2007	24887

Figure 5 is a composite of the 3 colonies in which we count all Black-footed Albatross pairs each year and this group represents approximately 76% of the world population of the species if you do not consider the Japanese populations separately.

**Black-footed Albatross**  
**Midway-Laysan-FFS (76 % World population)**  
**+/- 95% CI**

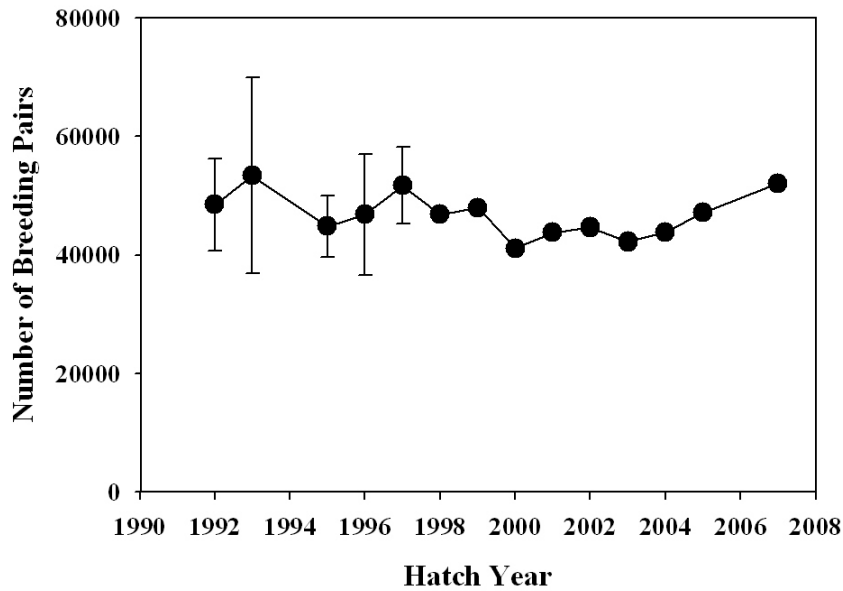


Figure 5. Composite counts of breeding pairs of Black-footed Albatross at Midway, French Frigate Shoals, and Laysan Island.

Table 5. Composite of annual active nest counts of Black-footed Albatross at Midway Atoll, Laysan Island, and French Frigate Shoals.

Hatch year	BFAL nests 3-sites	95%CI
1992	48474	7766
1993	33691	6566
1995	44816	5166
1996	46828	10201
1997	51689	6520
1998	46768	
1999	47971	
2000	41090	
2001	43781	
2002	44618	
2003	42179	
2004	43831	
2005	47094	
2007	52068	

### **Laysan Albatross (*Phoebastria immutabilis*)**

Figure 6 depicts the time series of counts of active nests of Laysan Albatross at French Frigate Shoals since 1982. Table 6 shows the data. Increases in the years immediately following the cessation of Coast Guard activity may reflect a response to reduced hazing and more available nest habitat.

## Laysan Albatross - French Frigate Shoals

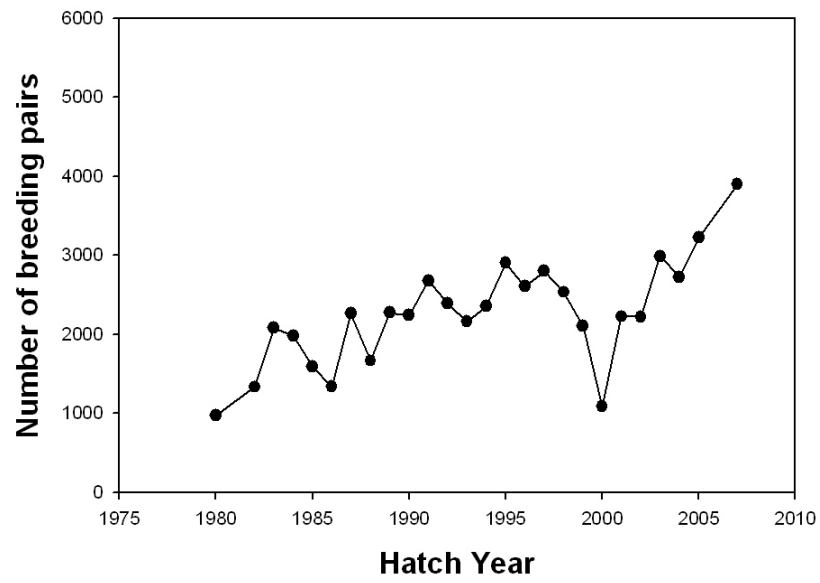


Figure 6. Population of Laysan Albatross active nests at French Frigate Shoals hatch years 1980 to 2007.

Table 6. Population of Laysan Albatross active nests at French Frigate Shoals in hatch years 1980 to 2007.

Hatch Year	No. Breeding Pairs
1980	973
1982	1334
1983	2081
1984	1985
1985	1588
1986	1339
1987	2263
1988	1666
1989	2275
1990	2243
1991	2679
1992	2392
1993	2162
1994	2358
1995	2906
1996	2607
1997	2800
1998	2534
1999	2105
2000	1088
2001	2226
2002	2225
2003	2988
2004	2726
2005	3226
2007	3899

### Laysan Albatross - Laysan Island

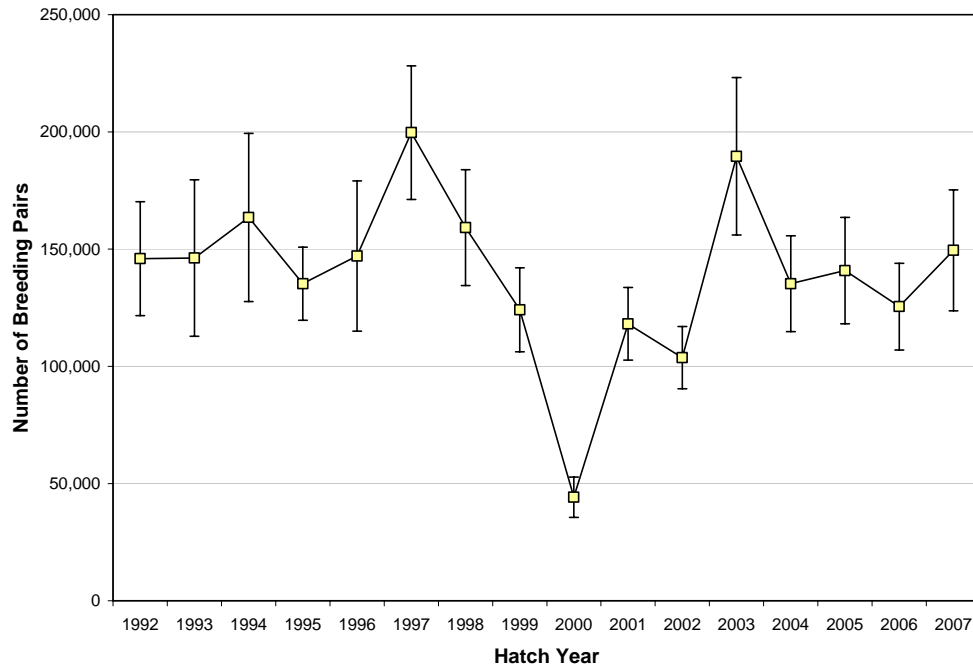


Figure 7. Estimates of Laysan Albatross breeding pairs at Laysan Island 1992 to 2007. See Table 3 for values of each point.

Figure 7 illustrates Laysan Albatross populations at Midway Atoll. Due to the large colony size there we have done whole atoll counts less frequently there than at the other monitoring sites. The 1992 count includes a 95% confidence interval because Eastern Island populations were in part estimated using density samples in quadrats and multiplied by area.

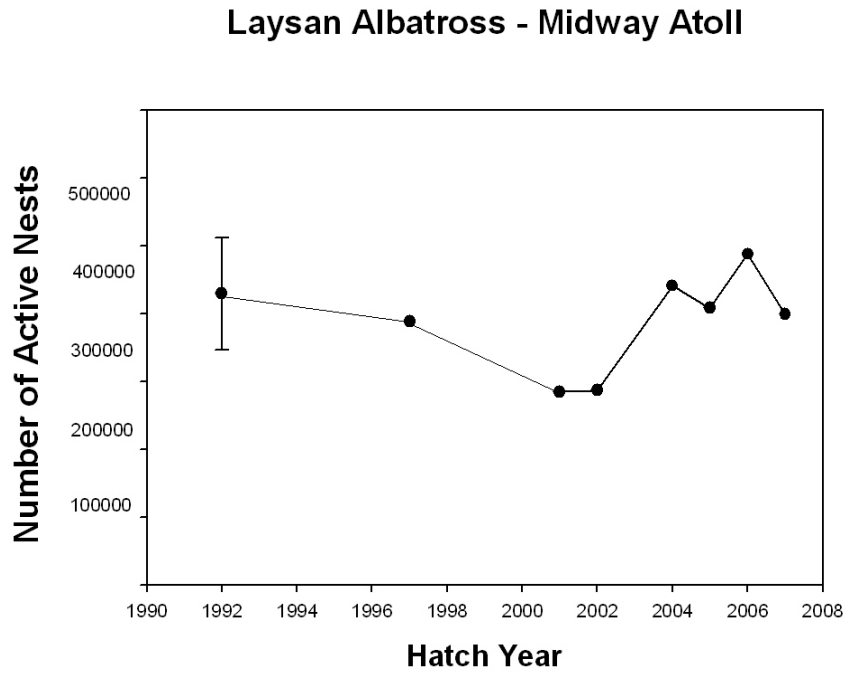


Figure 7. Laysan albatross breeding pairs at Midway Atoll.

Table 7. Laysan Albatross population of active nests during selected hatch years 1992 to 2007.

Hatch Year	Midway LAAL Pairs	95%CI
1990		
1991		
1992	429300	83000
1993		
1994		
1995		
1996		
1997	387854	
1998		
1999		
2000		
2001	284600	
2002	286662	
2003		
2004	441178	
2005	408133	
2006	487527	
2007	398529	



Figure 8. is a composite of counts and estimates of active nests of Laysan Albatrosses at French Frigate Shoals, Laysan Island, and Midway Atoll for years during which all three colonies were surveyed in December. This value represents approximately 93% of the world population.

**Laysan Albatross**  
**Midway-Laysan-FFS (~93 % World Population)**  
**+/- 95% CI**

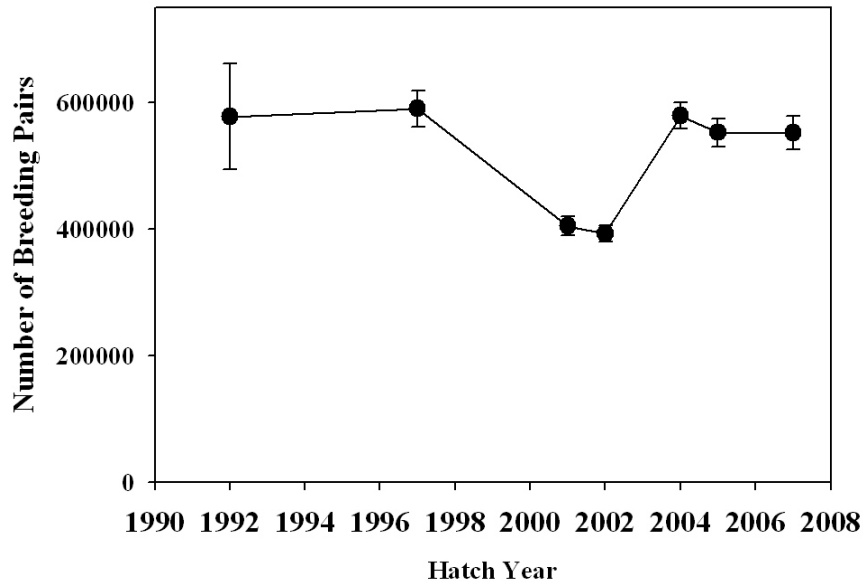


Figure 8. Composite nest count and estimates of Laysan Albatross at Midway, French Frigate Shoals, and Laysan Island.

Table 8. Laysan Albatross active nests at French Frigate Shoals, Laysan Island, and Midway Atoll in hatch years between 1992 and 2007.

Hatch year	LAAL active nests	95% CI
1992	577639	83067
1997	590378	28477
2001	404951	15465
2002	392576	13275
2004	579173	20442
2005	552220	22660
2007	551941	25780

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## **Appendix I. Evaluation of Error in direct count method**

### **Sampling for Observer Error – Atoll-wide Albatross nest count at Midway**

Protocol: Review 100 active nests in a randomly selected area in each of 10 completed plots (five on Sand and four on Eastern), and determine ratio of marked to unmarked nests.

General comments/potential problems:

1. We conducted the 100-nest sampling on plots that were counted as recently as possible. We restricted these audits to areas without high burrow densities to minimize more burrow crushing and because counters were trained to count nests without marking them when the risk of destroying burrows was high
2. Some nests are marked as active when occupied by a bird sitting on a rock, shell, a previously abandoned (and half-buried) egg, or nothing at all. In many cases, those birds spring to their feet when their “nest” is marked, the counter notes the absence of a viable egg, and adjusts her/his tally accordingly. When we encountered false nests that had been marked, we didn’t include them in the 100 nests sampling.
3. The 100-nest sampling method doesn’t assess the observer error of double-counting nests. Complete plot re-counts might shed light on this source of error, but three re-counts done in 2006 did not suggest double-counting was a problem in those three plots.
4. Any method of assessing observer error should be employed as soon as possible after a plot is counted, ideally the same or the following day, to minimize confounding factors such as loss of paint marks and nest abandonment.

Table 8. Observer Error Sampling 100-nest sample results in Hatch Year 2007 count. Auditors were Jim Waddington Cindy Waddington, Beth Flint, Jenny Johnson, and Richard Johnson. 1.76 % error observed.

Plot	Habitat	Number unmarked nests	Total	Auditor
Eastern 2	Verbesina	1	100	RJ
Eastern 3	Verbesina	1	100	RJ
Eastern 5	Verbesina	3	100	CW
Eastern 5	Verbesina	1	100	JW
Sand 5	Casuarina	6	100	CW
Sand 4	Casuarina	3	100	CW
Sand	Grass	0	100	C&JW
Sand	Grass	1	100	BF
Sand	Grass/Verbesina	1	100	BF
Sand	Casuarina	2	100	JW
Sand	Grass/Verbesina	2	100	C&JW
Sand	Grass	0	100	BF
Sand	Grass	0	100	BF
Sand	Grass/Verbesina	4	100	JW
Sand	Verbesina	1	100	R&JJ
Sand	Grass	1	100	CW
Sand	Grass	3	100	R&JJ