

Results of Allen Cays Iguana study (*Cyclura cychlura inornata*)

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ALLEN CAYS

This year was the 29th year of our studies of the Allen Cays iguanas in the Bahamas. The weather for our field work in May this year was much warmer than normal, and no rain fell on us during our entire trip. As a result we captured a respectable 422 Allen Cays iguanas this year (including 9 carcasses; Table 1). We captured 289 iguanas (85% of them recaptures) on Leaf Cay, 114 (82.5% recaptures) on U Cay, and 5 on Allen Cay (including two skeletons and 1 recapture). We have now accumulated 5797 iguana captures in the Allen Cays over the past 29 years!

The decline in numbers of large males on the main beach areas of both Leaf and U Cay is continuing (see previous reports). For example, of 9 large males (> 40 cm in body [SVL] length) captured on U Cay in 2005, only 2 were recaptured this year (an annual survival rate of only 61%). In addition, of the 7 large males captured along just the North (landing) Beach on U Cay in 2005, only 2 were recaptured in May (an annual rate of 66%). These survival rates are well below the long-term annual male survivorship rate (89%) on U Cay over the first 25 years of our work. Similarly, of 9 large males captured in 2005 on the main landing beach on Leaf Cay, only 3 were captured this year (an annual survival rate of 69%). This rate is likewise well below the long-term annual survivorship of males on Leaf Cay (88%). Interestingly, the carcass of one of the missing U Cay large males (#153A; pit tag intact) was found just above the high tide line on Leaf Cay! Whether this was a natural death and waif dispersal or the result of devious human behavior is unknown. However, we believe that the rapid loss of large males from the landing beaches of both Leaf and U Cays over the past 8 years is attributable to mischievous human activity. These cays desperately need educational signage.

Table 1. Recapture information by year for Allen Cays iguanas. Abbreviations are caps (captures), recaps (recaptures), and Cum (cumulative). Total number of captures for U Cay is 1913 (492 + 1421) lizards, and for Leaf Cay it is 3476 (1093 + 2383). All trips for 1980 through 2000 were in mid-March. Trips in 2001 and 2002 were in mid-May and mid-June to mid-July. Censuses in 2003-2008 were also in mid-May.

Year	U Cay					Leaf Cay				
	Total caps	Total recaps	% recaps	Cum. # w/ marks	Cum. # recaps	Total caps	Total recaps	% recaps	Cum. # w/ marks	Cum. # recaps
1980	30	0	0	30	0	14	0	0	14	0
1982	43	9	21	64	9	50	3	6	61	3
1983	48	25	52	87	34	51	26	51	86	29
1986	75	37	49	125	71	79	19	24	146	48
1988	111	58	52	178	129	109	59	54	196	107
1990	113	83	74	208	212	136	81	60	251	188
1992	124	89	72	243	301	148	102	69	297	290
1993	34	33	97	244	334	94	73	78	316	363
1994	150	94	63	300	428	204	110	54	410	473
1995	123	106	86	317	534	150	125	83	435	598
1996	113	86	76	344	620	177	126	71	486	724
1998	95	79	83	360	699	205	150	73	541	874
2000	169	124	73	405	823	254	175	69	620	1049
2001 ^a	140	110	79	435	933	284	220	77	679	1274
2001 ^b	40	34	--	441	967	209	89	--	799	1363
2002 ^c	143	118	83	460	1085	350	266	76	880	1629
2002 ^d	37	34	--	463	1118	147	72	--	945	1701
2003 ^e	102	95	93	470	1213	214	204	95	955	1905
2004 ^f	124	112	90	482	1325	376	257	69	1074	2162
2005 ^g	108	96	89	492	1421	246	221	90	1093	2383
2008 ^h	114	94	82	512	1515	289	245	85	1137	2628

^a Excludes 1 additional capture on Allen Cay.
^b Excludes 6 additional captures (including 1 recapture) on Allen Cay.
^c Excludes 6 additional captures (including 3 recaptures) on Allen Cay.
^d Excludes 1 additional capture (a recapture) on Allen Cay.
^e Excludes 7 additional captures (including 4 recaptures) on Allen Cay.
^f Excludes 9 additional captures (including 7 recaptures) on Allen Cay.
^g Excludes 6 additional captures (including 5 recaptures) on Allen Cay; and 3 new captures on second small cay north of Leaf Cay.
^h Excludes 3 additional captures (including 1 recapture) on Allen Cay; also includes captures in March by Chuck Knapp.

Iguana sex ratios are becoming increasingly female biased, presumably because of the disturbing loss of large males. 136 sexable females and 126 sexable males were captured on Leaf Cay (not significantly different from 1 to 1), and 67 sexable females and 42 sexable males were captured on U Cay (significantly different from unity at $P = 0.01$). Tail break frequencies remain quite low for these iguanas (Leaf Cay females, 8.8%; Leaf Cay males, 7.9%; U Cay females, 11.9%; U Cay males, 21.4%); however, the rate for U Cay males this year is three times that for our last census in 2005 (7.0%)! This may be further evidence of human foul play on at least this cay.

This year we implanted an additional 106 electronic identification (PIT) tags in iguanas, and have now PIT-tagged a total of 740 lizards (Table 2). We had two PIT tag failures this year. However, the failure rate of PIT tags has been quite low over our 15 years of using them, as has been the failure rate of toe clips due to natural toe loss. We will continue to PIT-tag 70-100 additional animals each year as funds allow (\$7 per tag). This winter we plan to do a comparative analysis of our PIT tag success rate versus our toe clip success rate.

Table 2. Tally of PIT (passive integrated transponder) tags deployed and their success rates for Allen Cays iguanas. Abbreviations are Recaps (recaptured lizards), Cum (cumulative), True tag failures (tags palpable under skin, but no signal), and Other tag failures (tags not palpable and no signal). Data for 2001-08 are for May captures only.

Year	U Cay					Leaf Cay				
	Number newly tagged	Cum total tagged	Recaps with tags	True tag failures	Other tag failures	Number newly tagged	Cum total tagged	Recaps with tags	True tag failures	Other tag failures
1993	5	5	0	--	--	11	11	0	--	--
1994	13	18	3	0	0	3	14	5	0	0
1995	52	70	10	0	0	19	33	8	0	0
1996	56	126	36	0	0	56	89	19	0	1
1998	0	126	57	0	3	77	166	49	1	2
2000	29	155	74	0	1	55	221	80	0	2
2001	24	179	75	0	0	14	235	93	1	2
2002 ^a	6	185	65	0	0	20	255	65	2	0
2003 ^b	14	199	58	0	0	52	307	66	3	1
2004 ^c	15	214	65	0	0	51	358	106	1	0
2005 ^d	10	224	50	0	1	52	410	105	0	1
2008 ^e	32	256	27	0	0	74	484	100	0	2

^a Excludes pit tags placed in 3 iguanas on Allen Cay.

^b Excludes pit tags placed in 5 iguanas on Allen Cay.

^c Excludes pit tags placed in 3 iguanas on Allen Cay; also excludes 7 carcasses (2 on U; 5 on Leaf) still bearing tags.

^d Excludes pit tag placed in 1 iguana on Allen Cay (total now with tags = 15); also excludes 1 of 6 carcasses (on Leaf Cay) still bearing tags.

^e Excludes pit tags placed in 2 iguanas on Allen Cay (total now with tags = 17); also excludes 3 of 9 carcasses still bearing tags.

We once again this year recorded the capture location of nearly every iguana. As has been the recent pattern, most captures were made on the big west (landing/tourist feeding) beach of Leaf Cay (only ca. 2% of the total island area), with 68% being made there (44% in 2002; 58% in 2003; and 47% in 2004 and 56% in 2005). On U Cay, 75% were made along or immediately adjacent to the north beach where nearly all visitors land, a substantial increase from the 35% rate in 2005. The attraction of the iguanas to the feeding beaches is obvious.

A few of us were also able to walk the entire length of Allen Cay on 13 May. We found two unidentified iguana skeletons and captured three large iguanas, including two (a male and a female) not previously captured. We have now recorded a total of 19 iguanas on Allen Cay (including the two recent introductions from Leaf Cay; see 2004 Report), and we are confident that no more than 20 total animals occur on the cay (barring further introductions). We have never seen a juvenile iguana on the cay, presumably because of the lack of nesting sites.

FLAT ROCK REEF CAY

Iguanas were introduced by humans to this 5.3 ha cay in about 1996 (see previous reports), and the population has grown rapidly to a current size exceeding 100 iguanas. We spent one day (15 May) on Flat Rock Reef Cay (FRRC) and captured 37 iguanas (51%, or 19 being recaptures). We also found four dead iguanas, the first mortalities we have verified on the island. After noticing a distinct smell of rotting flesh along the east coastline, we pinpointed the odor as emanating from a large blue 50-gallon plastic drum just above the high tide line. When cut in half, the barrel contained three medium-sized iguanas (ca. 14, 20, and 21 cm body length) in similar states of decomposition. None of them was marked, and the precise cause of death was uncertain. However, we speculate that the three iguanas may have been using the drum as a retreat, and it may have been moved by the wind or tide such that the iguanas could not escape, and they overheated and died. This was a very unfortunate accident, but it demonstrates just one more negative impact of humans and their products on the environment.

While on the island in May we excavated the iguana nests that Kirsten Hines and I had identified in July of 2007. We found that the six nests had contained 24 eggs and that 18 (75%) of these had hatched successfully. This compares to seven nests identified in July of 2006 in which 24 of 30 eggs hatched and emerged (80%). Tidbit data loggers placed in two nests revealed that incubation temperatures (1 July to 30 September) in a nest in the open sand at a depth of 17.5 cm averaged 31.0°C and exhibited daily fluctuations of 3-4°C, whereas one 20 cm deep in a small opening in a dense patch of sea oats averaged 31.5°C but fluctuated only about 1.5 to 2°C each day.

Kirsten Hines and I returned to FRRC from 12 to 18 July for our third year of nesting studies on FRRC. Despite hot temperatures (maximum under our tarp in the bush in mid-day, 112°F!) and a storm with near hurricane-force winds, we captured 56 iguanas (38 recaptures, 17 previously unmarked, and one carcass [passed to Sandra Buckner]; Table 3).

Table 3. Recapture information by year for Flat Rock Reef Cay iguanas.

Sample Year (month)	Total captures	Total recaptures	Percent recaptures	Sex ratio (M/F)	Cumulative # w/ marks	Cumulative # recaptures
2001 (May)	2	0	0	2/0	2	0
2003 (May) ^a	3	0	0	1/2	5	0
2005 (May)	7	0	0	5/2	12	0
2006 (March)	38	5	13	19/13	45	5
2006 (July)	26	13	50	11/14	58	18
2007 (Jun-Jul)	19	14	74	11/8	63	32
2008 (May) ^b	37	19	51	16/14	81	51
2008 (July) ^c	55	38	69	23/27	98	89

^a Includes 1 individual originally marked on Leaf Cay.

^b Excludes 4 carcasses.

^c Excludes 1 carcass.

We also located seven nests this year. Each was excavated, and the eggs measured and reburied with a digital temperature logger. Mean clutch size in this year's nests was 4.1 (range 3-5), similar to that for six nests found there last July (mean 4.0; range 2-5). We will excavate these in May of 2009 to determine nest success and incubation temperatures.

Through July we have now marked a total of 98 iguanas (42 males, 39 females, 17 unsexed) on FRRC (58 with PIT tags) and tallied 89 recaptures. Simple Peterson population estimates of adults >20 cm SVL for just the 2007 versus 2008 samples suggest that 33 females, 32 males, and 35 juveniles (100 total) inhabited FRRC in 2007. When the analysis was repeated for just the May and July 2008 samples, the estimates were 35 females, 31 males, and 47 juveniles (113 total) occupying the island in May 2008. Although crude, these estimates confirm our subjective observations that the population is growing rapidly and now well exceeds 100 individuals. Preliminary analyses of growth rates among recaptured iguanas also suggest that on average they are growing faster than on the native Leaf and U Cays.

We intend to excavate this year's nests in May of 2009 and possibly to return to FRRC again next July for the final year of nesting studies there. After that we will be preparing a manuscript comparing growth and reproduction of the introduced Flat Rock Reef Cay population with those same parameters for Leaf and U Cay.

BUSH HILL CAY

For the sixth year (2002-2008, except 2006) we visited Bush Hill Cay at the northern limit of the Exuma Cays Land and Sea Park to census the introduced population of Acklins iguanas (*Cyclura rileyi*) there. We captured and processed iguanas in the afternoon of 17 May and the morning of 18 May. This year we caught only 80 iguanas (29 males, 44 females, 6 unsexed, 1 skeleton; 14 new, 65 recaptures). We have now marked a total of 293 iguanas on Bush Hill and recorded 240 total recaptures (Table 4).

Table 4. Capture information by year for Acklins iguanas introduced to Bush Hill Cay. All trips 2002-2005 were for 24 hours or less in mid-May. The trips in 2007 and 2008 were for 1.5 days in late June and mid-May, respectively.

Year	Total captures	Total adults ^a	Total juveniles	Total recaptures	Percent recaptures	Cumulative # with marks	Cumulative number recaptures
2002	75	75	0	--		75	--
2003	72	69	3	16	22	131	16
2004 ^b	104	103	1	42	40	194	58
2005	106	105	1	59	56	241	117
2007 ^b	96	93	3	58	60	279	175
2008 ^b	79	73	6	65	82	293	240

^a includes all individuals 20 cm SVL or larger (the size when the juvenile pattern begins to fade)

^b excludes single carcass found

Although we spent about the same length of time on Bush Hill Cay this year, and with a similar group of students as in 2004 (104 captures), 2005 (106 captures), and 2007 (96 captures), we captured only 79 iguanas (plus one skeleton). Very warm temperatures during our visit may have contributed to the lower numbers, but it was our subjective impression that fewer iguanas were evident on the south end and the interior of the island compared to previous years. We found only a single partial skeleton on the island, so natural mortality seems unlikely. However, our preliminary survival analyses indicate that male “mortality” (loss) has been increasing in recent years (Table 5). Although it is likely that weather conditions and increased wariness by the lizards were responsible for the lower capture numbers this year, we will monitor numbers very closely next year to be sure that there is no evidence of illegal removal by humans.

We also noticed that many iguanas captured this year weighed less than they did when captured last June (2007). A more complete comparison of every iguana caught both in June of 2007 and May of 2008 confirmed that all 23 such males decreased in body mass by 2 to 27% (mean 12.5%). However, of 17 such females, ten lost 1 to 24% in body mass, and seven gained 1 to 13%; across all females mean weight change was a negligible -0.5%. We hypothesize that the difference is related to male territorial behavior during the May mating period in 2008. Presumably males were spending less time feeding, and more time defending territories and courting females, and hence lost weight during May.

Table 5. Annual survivorship of Bush Hill iguanas based on recapture data analyzed by program MARK. Survival for the last interval in the data (2007-2008) cannot be estimated with this analysis. Note the apparent decline in male survival rate.

Interval	Males	Females
2002-2003	0.79	1.00
2003-2004	0.91	0.79
2004-2005	0.88	1.00
2005-2007	0.62	0.89

Tail break frequency on Bush Hill Cay this year (64% in females; 62% in males) was nearly the same as last year (60.0% in females and 64.0% in males in 2007), but higher than in previous years (e.g., 53.0% in females and 50.0% in males in 2005). The cause of the increase between 2005 and 2007 is not clear, especially when the rate is already over five times that in the Allen Cays. The abundance of broken tails (including forked tails on three), bite marks, and naturally missing digits in males, females, and juveniles suggests very high levels of aggression. This aggression may also explain the statistically significant female-biased sex ratio. For example, the sex ratio of this year's sample was 0.66 (29 males to 44 females) and that of the previous five annual samples together was 0.73 (193 males to 264 females). However, it might also be true that females are easier to capture than males.

All of our Bush Hill Cay data have been forwarded to Drs. Bill Hayes and Ron Carter (Loma Linda University) for comparison with their work on this species in its natural range. A copy also has been sent to Sandra Buckner for archival purposes.

FUTURE PLANS

I plan to return to the Allen Cays and Bush Hill Cay with students in May of 2009 for 8-10 days of survey work, and if possible, to return to Flat Rock Reef Cay for nesting studies in July of 2009.

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