Population Demographics and Health Parameters of Nesting Leatherback and Juvenile Hawksbill and Green Sea Turtles in St. Kitts

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Presented to the WIDECAST
Annual Meeting 2019

Reported Species

Eretmochelys imbricata
Hawksbill

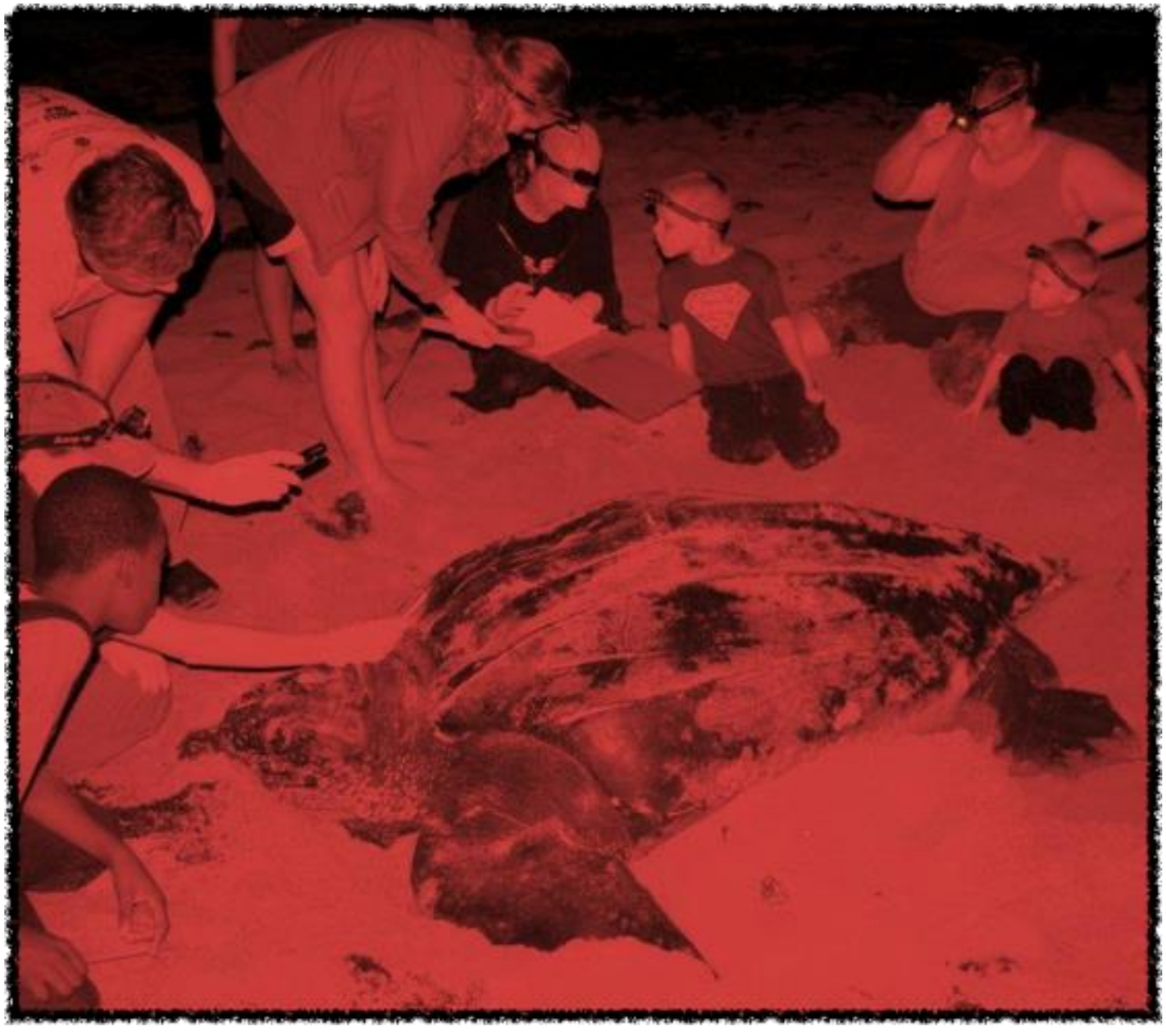
Dermochelys coriacea
Leatherback

Chelonia mydas
Green

Caretta caretta
Loggerhead

Background

Methods



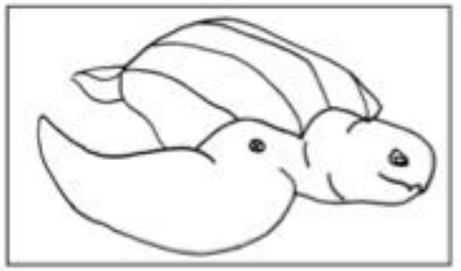


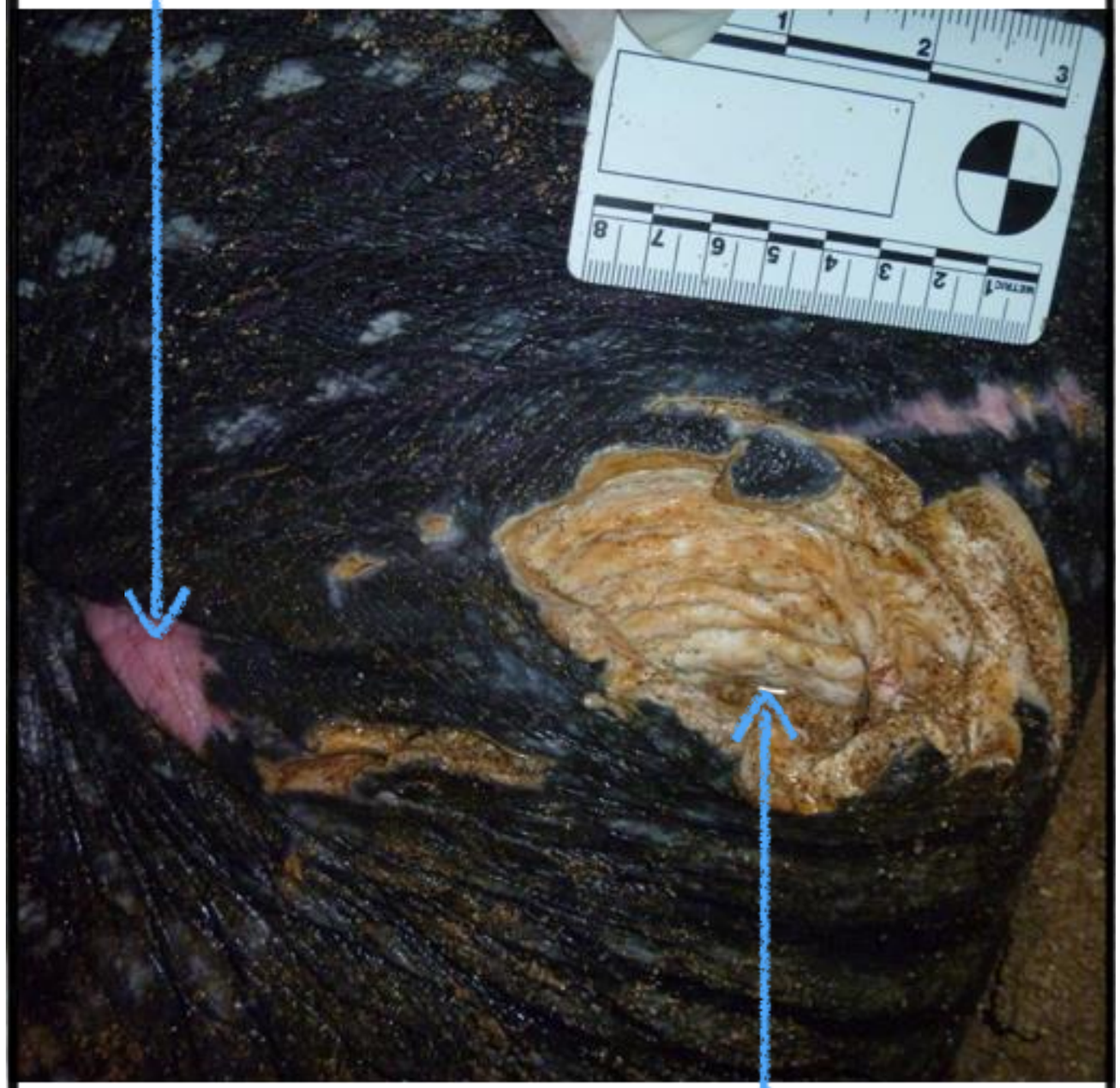
Figure 14. Recommended PIT tagging site for Caribbean leatherback turtles. Photo: Matthew Godfrey, with schematic from Dutton and McDonald (1994).

Neophyte = previously untagged turtle

Remigrant = previously tagged turtle

New Remigrant = turtle previously tagged elsewhere

Remodeling



Proliferative

Notch

Partial amputation

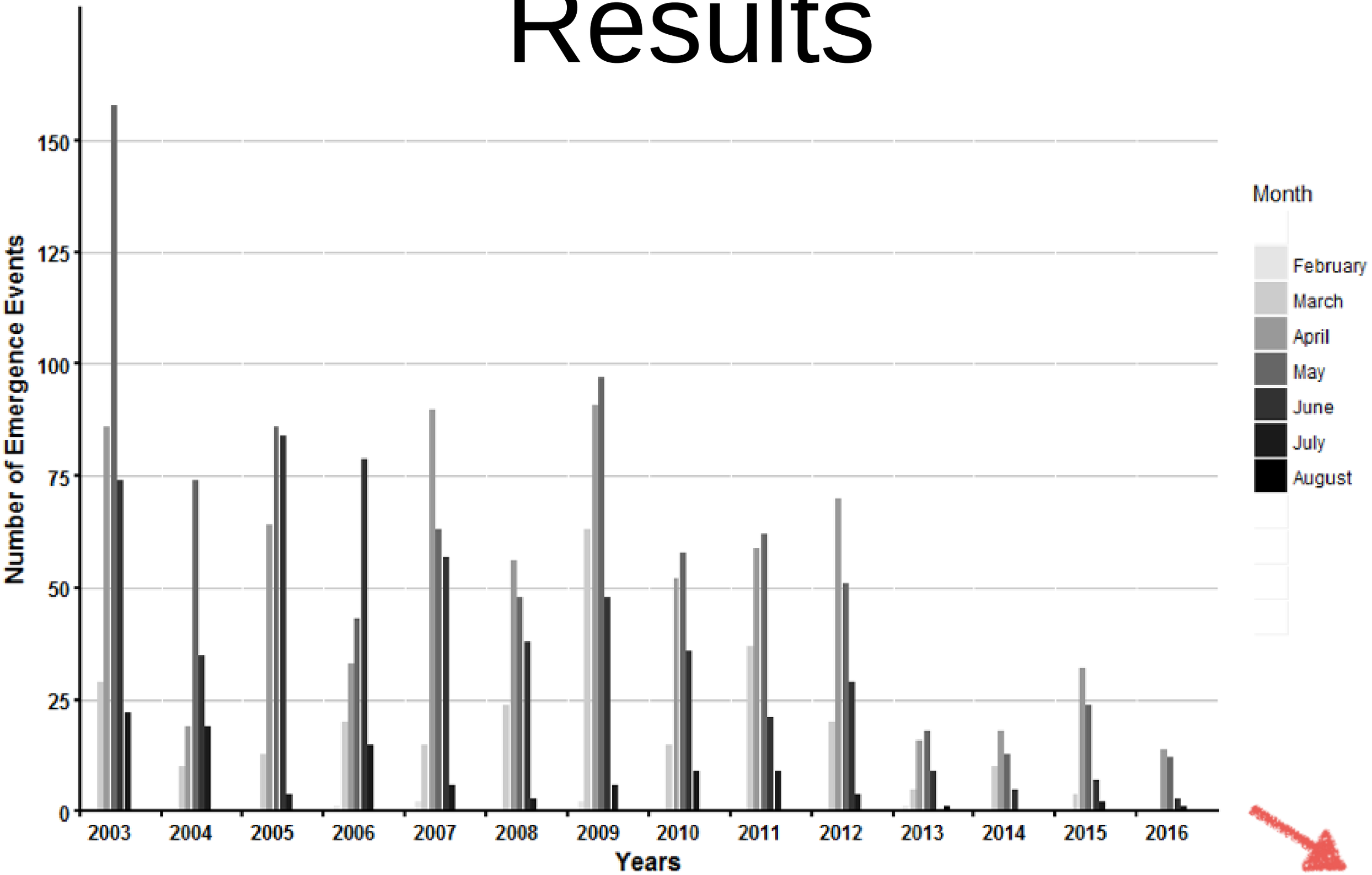

Gary Buckles St Kitts Turtles (SKSTM


HOBO® Pro v2
temp/RH
onset
www.onsetcomp.com
Part No. U23-001

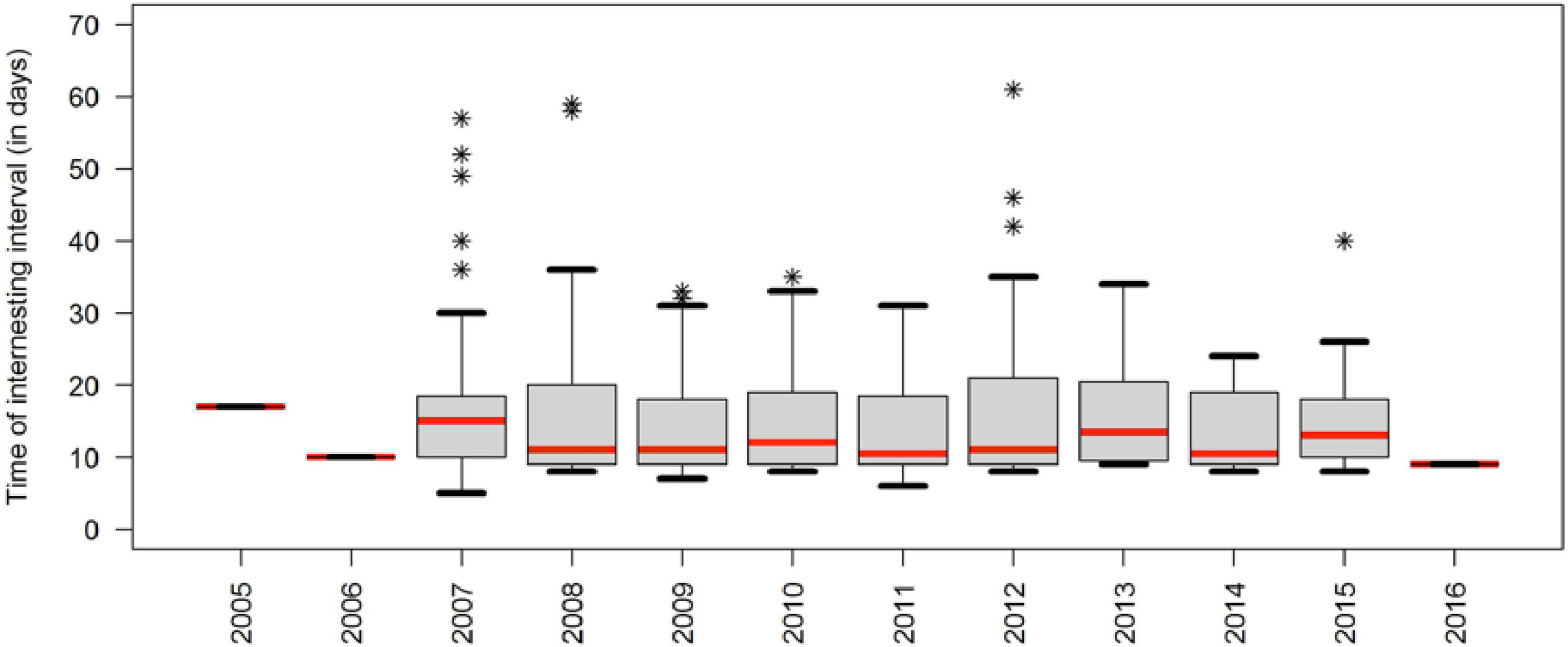
Histopathology

- Excavation, open to stage embryo death, PM's on embryos and dead in nest hatchlings process for histology, take cultures

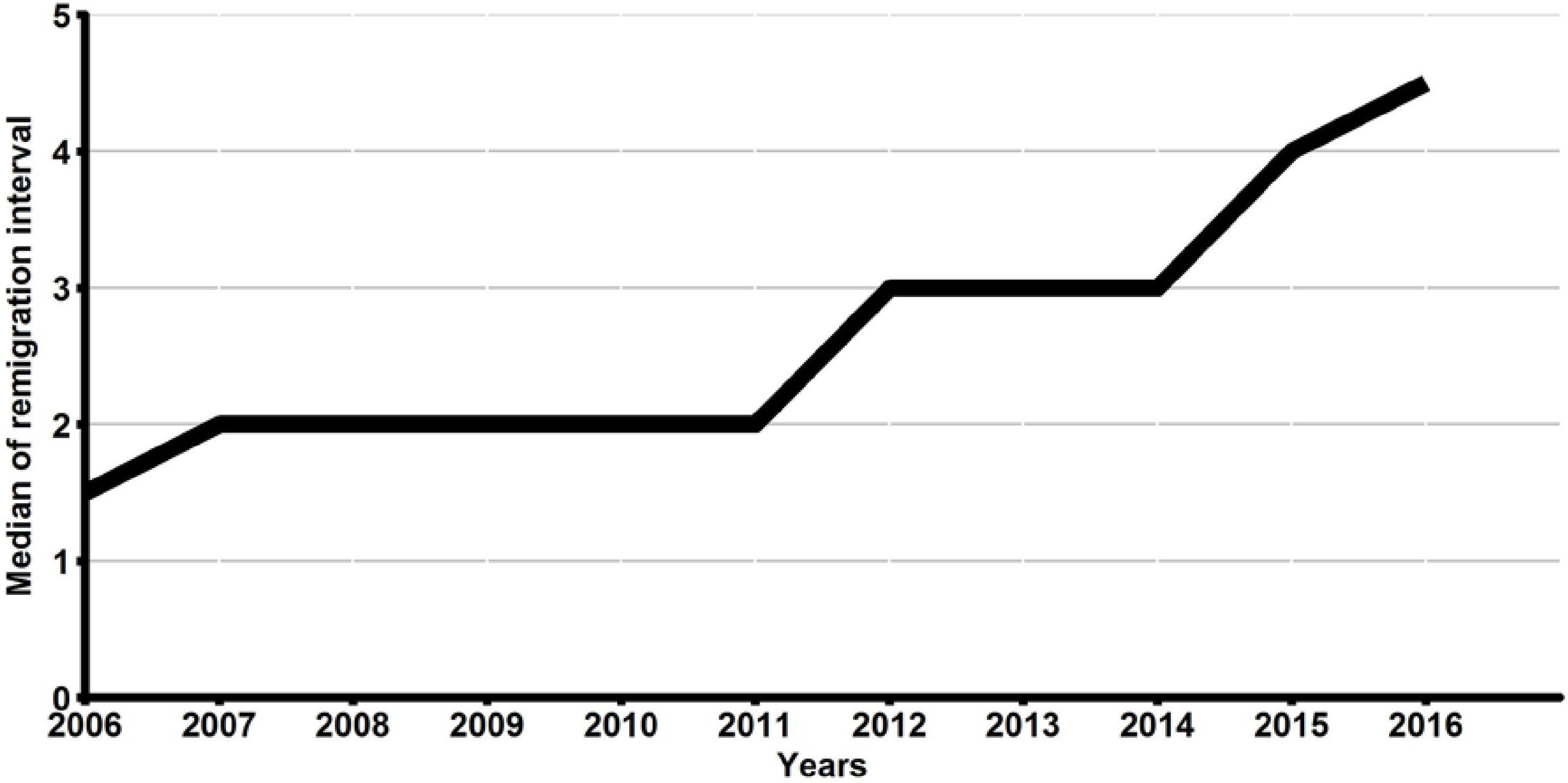
Results



Adult Female Leatherback Emergence Events by Month on Keys and North Friars Beaches, St Kitts, 2003-2016



Yearly Distribution of the Internesting Interval for Leatherback Females Observed on Night Patrols, St Kitts, 2005-2016



Yearly Median Remigration Interval for Leatherback Females Observed on Night Patrols, St Kitts, 2005 -2016

Number of Neophytes, Remigrants, & New Remigrants Documented Annually, St Kitts, 2003-2016

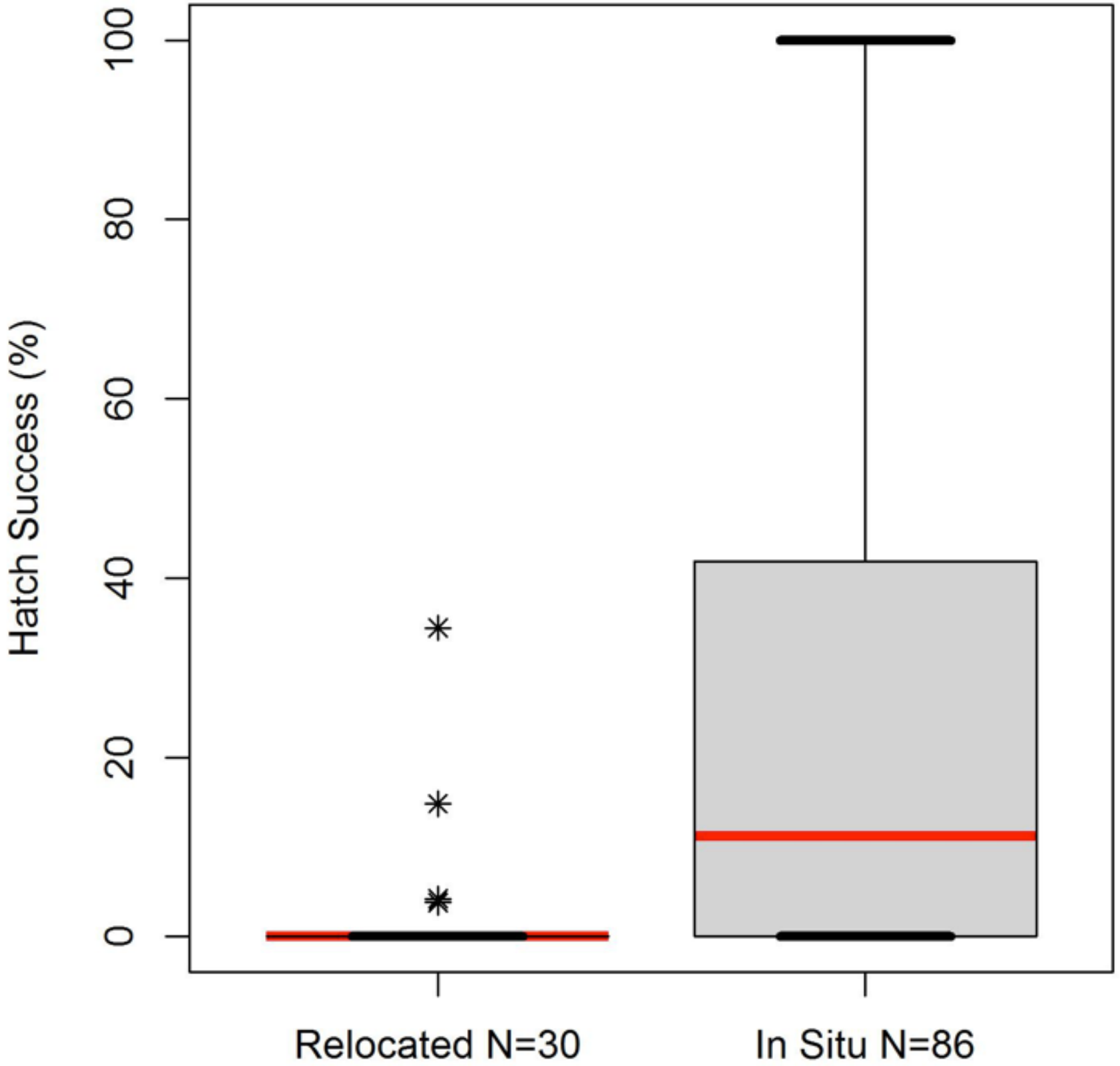
Year	Number of emergence events without ID	Number of neophytes	New remigrants	Number of remigrants
2003	369	0	0	0
2004	157	0	0	0
2005	244	18 100 %	0	0
2006	179	10 91 %	0	1 9 %
2007	113	46 92 %	1 2%	3 6 %
2008	71	32 80 %	1 2.5%	7 17.5 %
2009	116	44 65 %	3 4%	21 31 %
2010	64	26 65 %	1 2.5%	13 33.5 %
2011	108	21 58 %	2 6%	13 36 %
2012	95	15 43 %	1 3%	19 54 %
2013	28	11 79 %	1 7%	2 14 %
2014	21	7 46.7%	1 6.6%	7 46.7 %
2015	29	9 41 %	1 5%	12 55 %
2016	16	7 70 %	1 10%	2 20 %

Average Clutch Size, Yolked, and Yolkless Eggs for Leatherback Females from 2005-2016, St Kitts

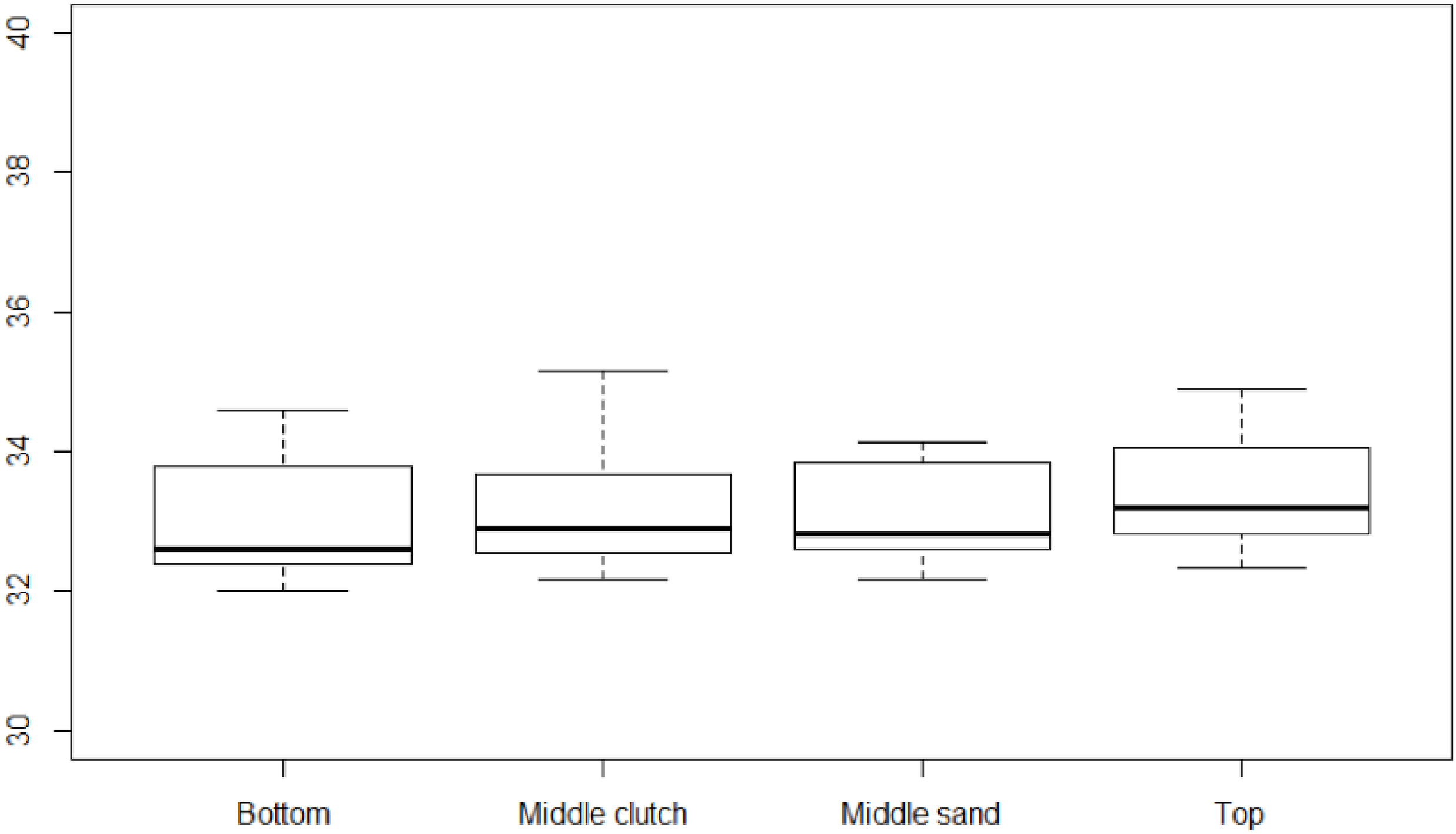
	Number of events	Minimum	Mean	Standard deviaton	Maximum
Number laid	385	16	113	19.5	157
Yolked	387	8	83.5	19.9	142
Yolkless	386	0	29.3	15.4	77

Hatch Success for Leatherback Nests Excavated on Keys and North Friars, St Kitts, 2003-2016

	N	Minimum	Mean	SD	Maximum
All	116	0	18.7	27.5	100
Keys	57	0	6.4	16.1	75.9
North Friars	55	0	31.3	31.2	100



Hatch Success in In Situ Versus Relocated Leatherback Nests in St. Kitts, 2003-2016



Distribution of Temperature in Incubating Nests, n=12

nerback Nests with Evidence of Poaching Activity & Sandmining Damage, 2003-201

Beach	Year	Total Number	Poached (%)	Sandmining (%)g damage (%)
Keys	2003	297	45 (15.2 %)	2 (0.7 %)
	2004	152	24 (15.7 %)	0
	2005	199	11 (5.5 %)	0
	2006	189	3 (1.6 %)	1 (0.5 %)
	2007	200	0	0
	2008	144	1 (0.7 %)	0
	2009	221	0	1 (0.5 %)
	2010	124	0	2 (1.6 %)
	2011	117	2 (1.7 %)	1 (0.8 %)
	2012	102	0	1 (1.0 %)
	2013	42	0	0
	2014	32	0	0
	2015	46	0	0
	2016	14	0	0
	Total	1880	86 (4.6 %)	8 (0.4 %)
North Friars	2003	72	2 (2.8 %)	0
	2004	5	0	0
	2005	64	0	0
	2006	1	0	0
	2007	25	0	0
	2008	25	0	0
	2009	71	1 (1.4 %)	0
	2010	30	0	0
	2011	39	1 (2.6 %)	0
	2012	50	0	0

Lesion Location Frequency, 2005-2016

	Absolute Frequency	**Relative Frequency (%)**
Axillary (L)	59	2.4
Axillary (R)	60	2.5
Carapacial	530	21.7
Front Flipper (L)	514	21.0
Front Flipper (R)	420	17.2
Head (dorsal)	65	2.7
Head (L lat)	47	1.9
Head (dorsal, L)	1	0.04
Head (R lat)	41	1.7
Head (dorsal, R)	1	0.04
Inguinal (L)	10	0.4
Inguinal (R)	6	0.2
Neck (dorsal)	34	1.4
Neck (L)	36	1.5
Neck (R)	29	1.2
Neck (Ventral)	8	0.3
Rear Flipper (L)	266	10.9
Rear Flipper (R)	255	10.4
Tail (dorsal)	34	1.34
Tail (L lateral)	2	0.1
Non documented/NA	29	1.2

Lesion Type Frequency, 2005-2016

	Absolute Frequency	**Relative Frequency (%)**
Abscess	59	2.4
Amputation	12	0.5
Barnacles	202	8.3
Circumferential	48	2.0
Concavity	24	1.0
Deformity	1	0.04
Linear	835	34.1
Malalignment	6	0.2
Nodule	47	1.9
Notch	1009	41.2
Paresis/Paralysis	18	0.7
Partial Amputation	120	4.9
Tag Abscess	1	0.04
Tag Lesion	30	1.2
Unknown/missing value	35	1.4

Frequency of Stage of Healing for Lesions and Barnacle Loads, 2005-2016

	Absolute Frequency	**Relative Frequency (%)**
Acute	109	4.5
Heavy	22	0.9
Mild	102	4.2
Moderate	64	2.6
Proliferative	218	8.9
Remodeling	1719	70.2
Other	2	0.1
Unknown/Missing Values	211	8.6

Hematological Parameters Reported for St. Kitts

Analyte	n	Mean	Med	SD	Range
PCV	96	33	33.3	7.4	12-64
TP	137	3.9	4.0	0.7	2.2-5.5
WBC ($X10^3$/ml)	155	10.213	9.200	4.402	3.800-32.200
Heterophils ($X10^3$/ml)	154	4.046	3.665	2.222	0.416-14.274
Lymphocytes ($X10^3$/ml)	154	4.4.401	3.780	3.196	0.646-27.370
Eosinophils ($X10^3$/ml)	154	0.327	0.134	0.526	0-3.100
Monocytes ($X10^3$/ml)	154	1.462	1.012	1.541	0-8.316
Basophils ($X10^3$/ml)	154	0	0	0	0

Biochemical Parameters Reported for St. Kitts

Analyte	n	Mean	Med	SD	Range
TP	137	3.9	4	0.7	2.2-5.5
AST	142	101.6	101.5	38.9	13-197
CK	97	145.1	5.5	25.9	0-2.167
Alb	126	1.7	1.7	0.4	1.1-2.7
Glob	126	2.3	2.3	0.4	1.1-3.6
Ca+	132	8.9	9	2.2	4.4-15.1
PHOS	142	9.9	20.2	2.4	2.9-15.2
K+	141	4.1	4	0.7	2.6-6.3
Na+	142	142.3	142	6.5	118-163
UA	45	0.4	0.4	0.09	0.3-0.6
Glu	142	81.9	82	12.4	50-120

Evolution of Nesting Leatherback Female Hematological Parameters Over a Nesting Season

	Median[A]	Median[B]	P-value*
White Blood Cell Count	8,500	10,200	0.02
Heterophils			0.2
Lymphocytes			0.7
Eosinophils			0.7
Monocytes	558	1,277	0.01
Basophils			NA

*Paired Wilcoxon Test
[A] Median first sample
[B] Median last sample

Evolution of Nesting Leatherback Female Biochemical Parameters Over a Nesting Season

Analyte	Median[A]	Median[B]	P-value*
Packed Cell Volume			0.1
Total Solids	5.4	4.4	0.0007
Aspartate aminotransferase			0.07
Creatine kinase			0.9
Glucose			0.3
Calcium	9.9	8	0.007
Phosphorus			0.9
Total protein	4.3	3.8	0.008
Albumin	1.8	1.5	0.002
Globulin			0.6
Potassium			0.5
Sodium			0.1
Uric acid			1

*Paired Wilcoxon Test

[A] Median first sample

[B] Median last sample

Hatchling Pathology

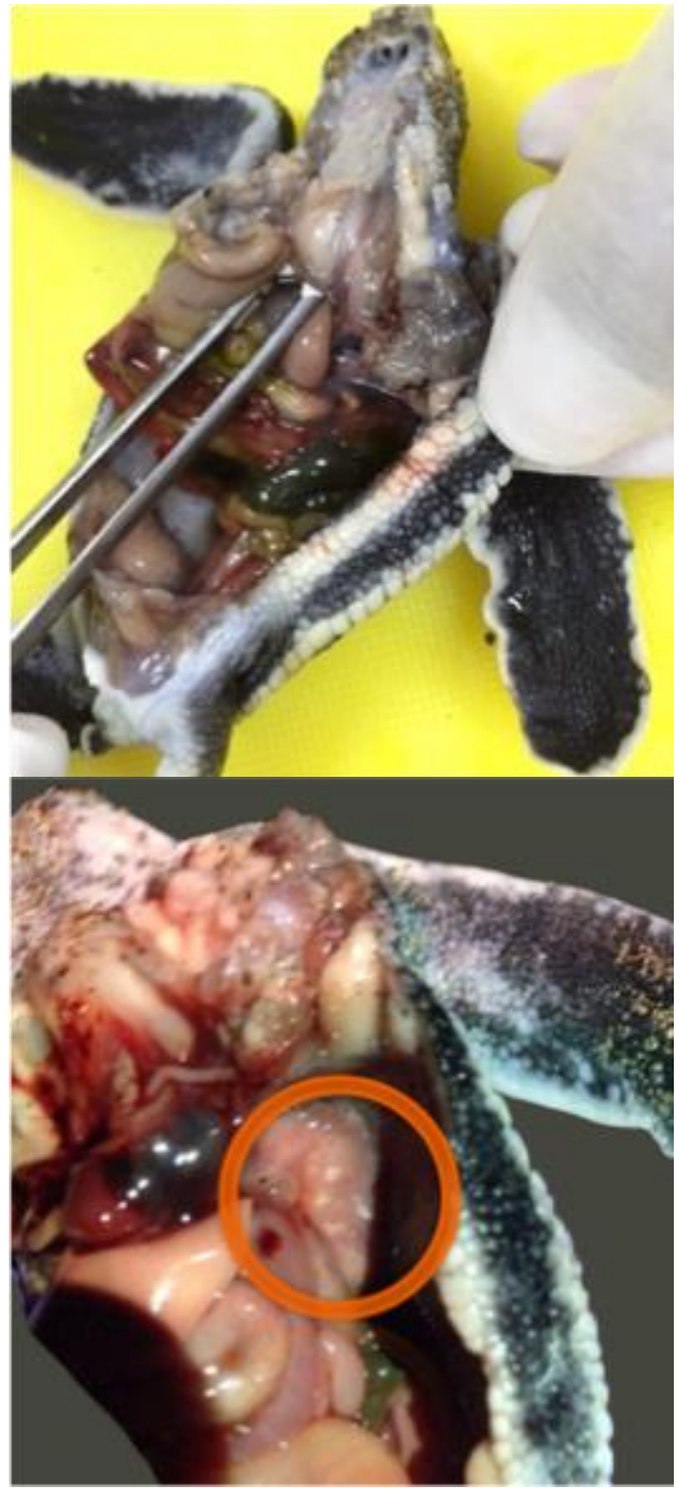
St. Kitts – 38-45% individuals, 50-67% nests (2015-2018)

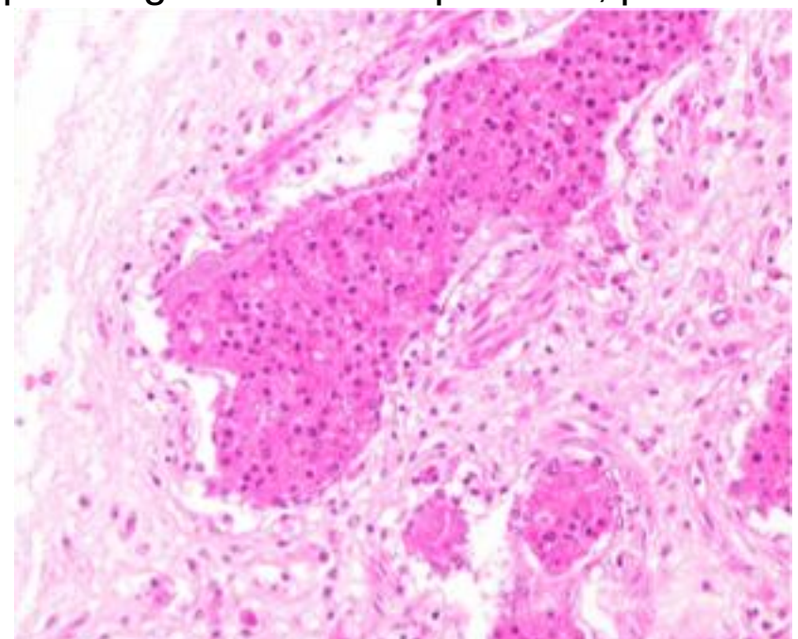
Grenada – 44% individuals, 47% nests (2017)

Reference - Michelle Dennis

Bacterial pneumonia

- Prevalence
  - St. Kitts = 12% individuals, 40% nests
  - Grenada = 6% individuals
- Observed in nests from many different mothers
- Hatchlings >> late stage embryos
- Grossly evident pulmonary nodules in 50% of affected turtles
- Gram negative rods in every case
- ID of bacteria? Pseudomonas and Ralstonia were frequently cultured, but also present in turtles without pneumonia
- Route of infection appears to be inhalation – role of decomposing nest environment?
- Immunosuppressing factors? Temperature, pollutant exposure?

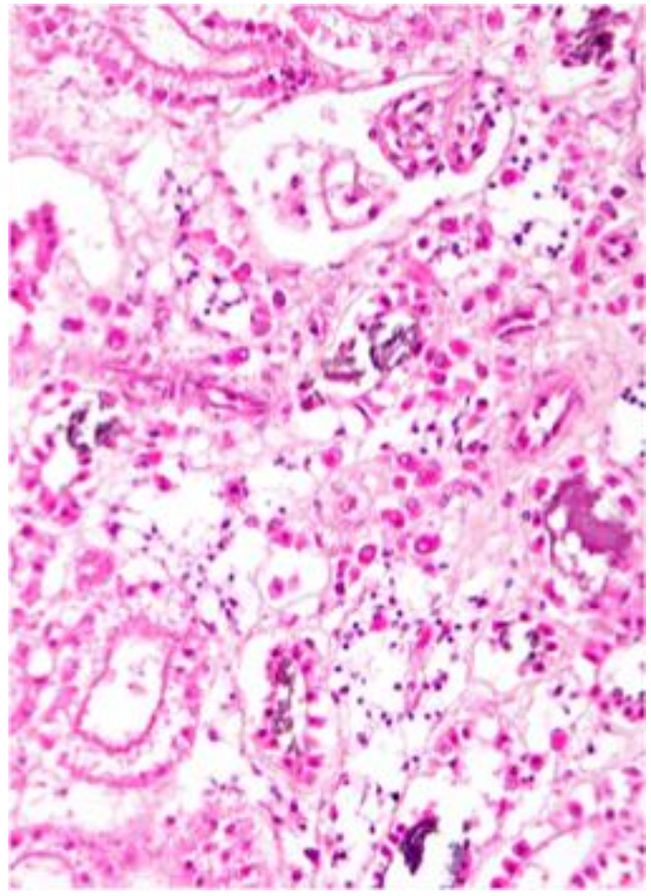


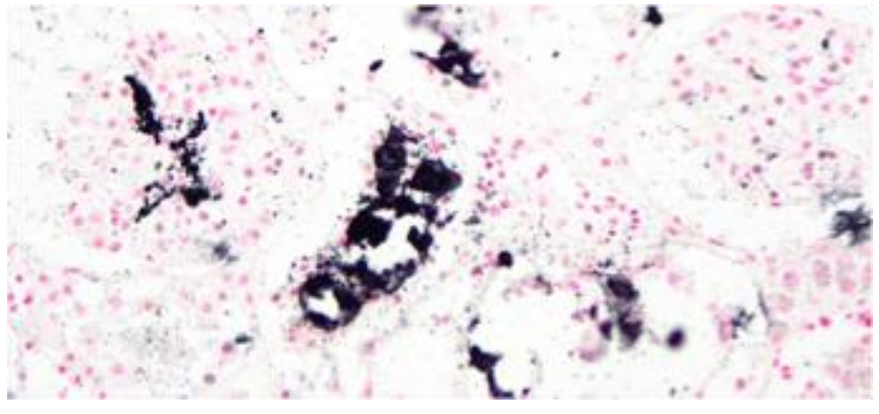


Reference - Michelle Dennis

Renal Tubular Mineralization

- Prevalence
  - St Kitts = 6-24%
  - Grenada = 4%
- Observed in nests from many different mothers
- Seen in early and late embryos, hatchlings
- Associated with cardiac calcification, suggestive of hypercalcemia
- Maternal hypercalcemia?
- Dry nest environment?

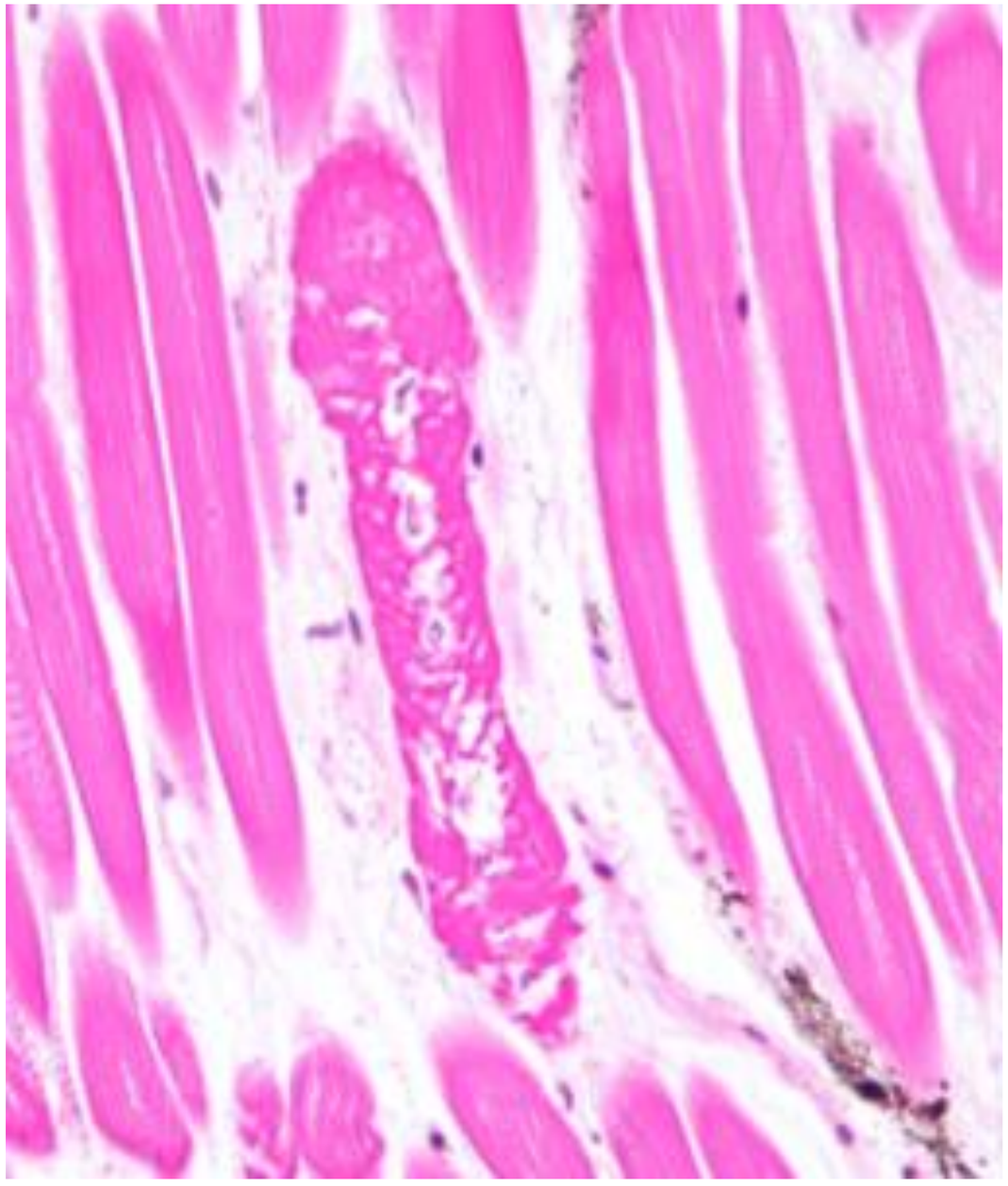




Reference - Michelle Dennis

Skeletal Muscle Necrosis

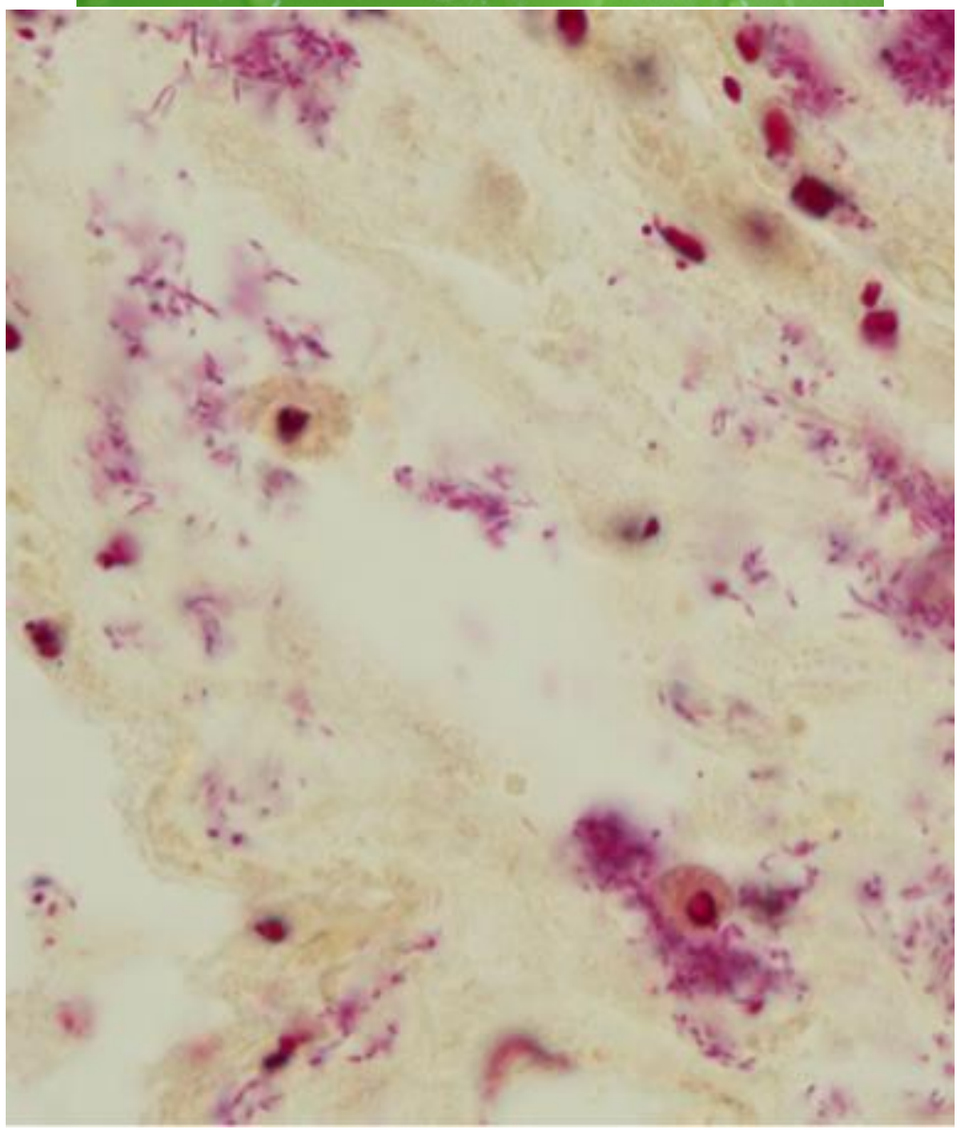
- Prevalence
  - St. Kitts = 7-22%
  - Grenada = 17%
- Seen in hatchlings and late stage embryos
- Usually mild
- Has been reported in hatchlings and selenium deficiency was a suspected etiology
- Hyperthermia? Exertion?



Reference - Michelle Dennis

Inflammation of Chorioallantoic Membranes

- Prevalence
  - St Kitts = 0-10%
  - Grenada = 13%
- Mainly caused gram negative bacilli apparently penetrating egg shell
- Seen in early and late embryos, pipped hatchlings
- Same predisposing factors to consider as for bacterial pneumonia



Reference - Michelle Dennis

Mycotic Dermatitis

- Prevalence
  - St Kitts = 0%
  - Grenada = 5%
- Only in late stage embryos (pathogen penetrating egg shell)
- Identity unknown; morphology similar in all cases but nonspecific
- Could be consistent with Fusarium spp. – several studies implicating as an emerging pathogen in sea turtle eggs[2-4], but fungi not a major etiology in our studies

[2]Sarmiento-Ramírez, J. M., Abella, E., Martín, M. P., Tellería, M. T., Lopez-Jurado, L. F., Marco, A., and Diéguez-Uribeondo, J. 2010. Fusarium solani is responsible for mass mortalities in nests of loggerhead sea turtle, Caretta caretta, in Boavista, Cape Verde. FEMS microbiology letters 312(2): 192–200.

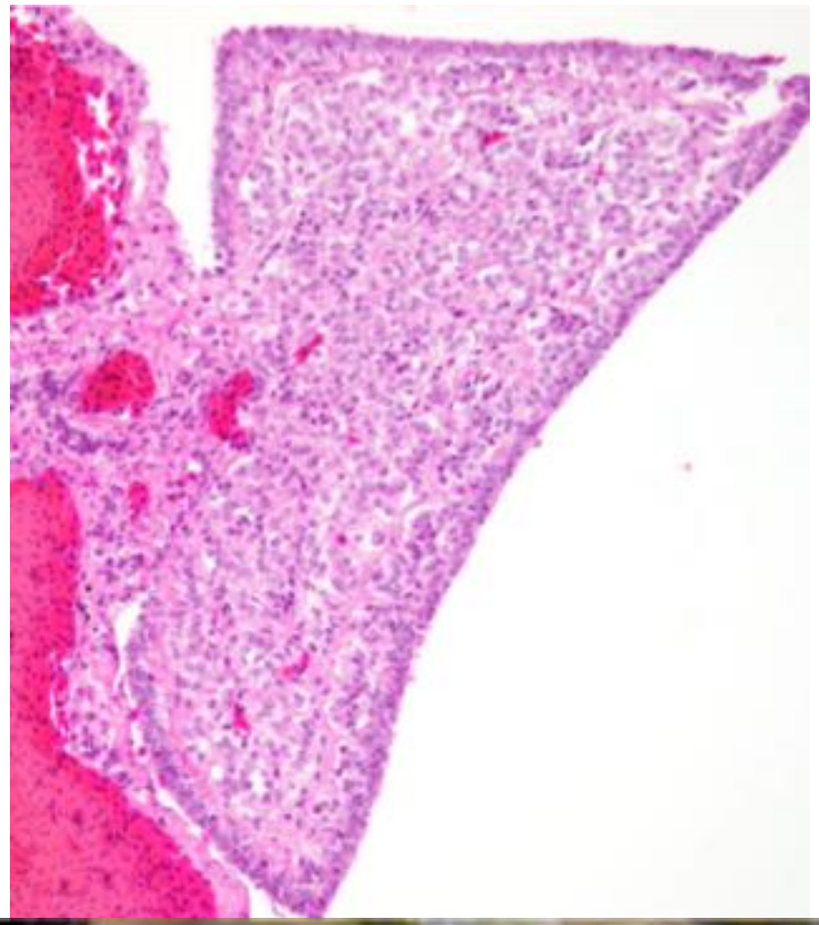
[3]Sarmiento-Ramírez, J. M., Abella-Pérez, E., Phillott, A., Sim, J., van West, P., Martin, M. P., Marco, A., and Diéguez-Uribeondo, J. 2014. Global distribution of two fungal pathogens threatening endangered sea turtles. PLoS ONE 9(1)

[4]Rosado-Rodríguez, G., Maldonado-Ramírez, S.L. (2016) Mycelial fungal diversity associated with the leatherback sea turtle (Dermochelys coriacea) nests from western Puerto Rico. Chelonian Conservation and Biology 15:265-272.

Reference - Michelle Dennis

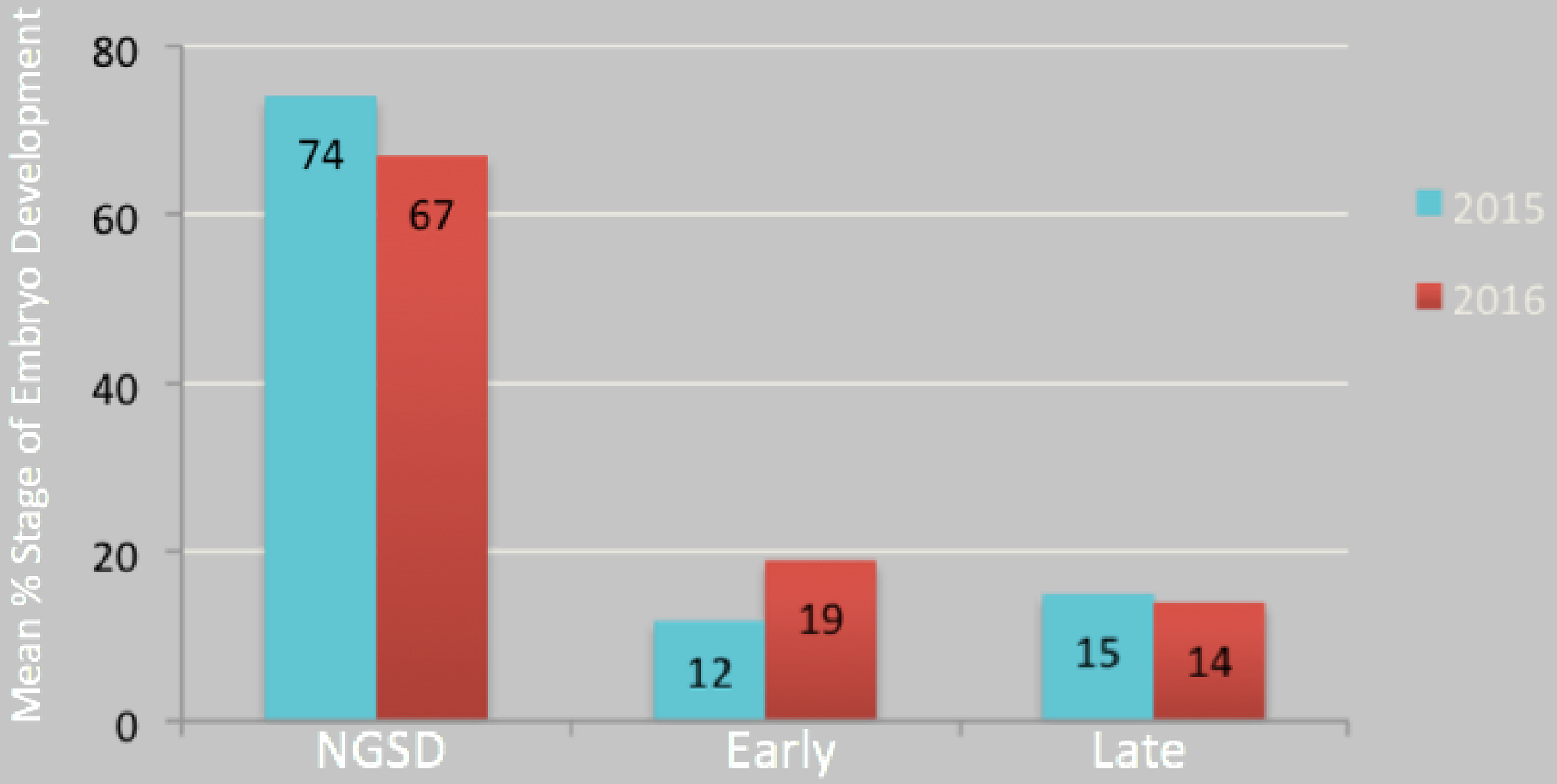
Gonad Development

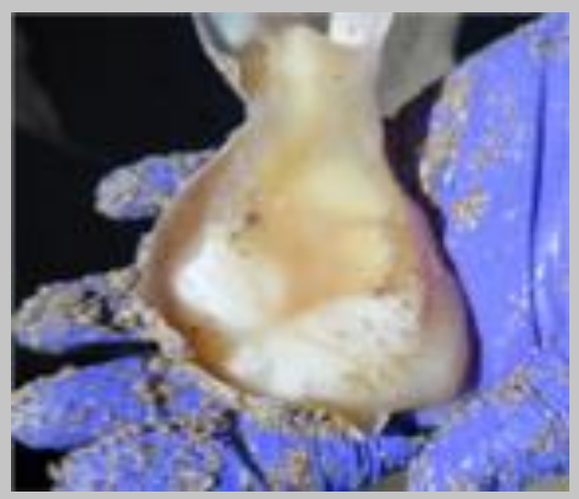
- Sex ratios:
  - St. Kitts – 100% female (2015-2018)
  - Grenada – 100% female (n=60, 2017)
- Related to high nest temperature? Endocrine disrupting chemicals?
- St. Kitts mean temp 33.2C (temps >30C in middle third of development influence female sex)
- Implications for the population?



Reference - Michelle Dennis

Stage of Embryo Development in Unhatched Eggs





Reference Michelle Dennis

Reported Species

Eretmochelys imbricata
Hawksbill

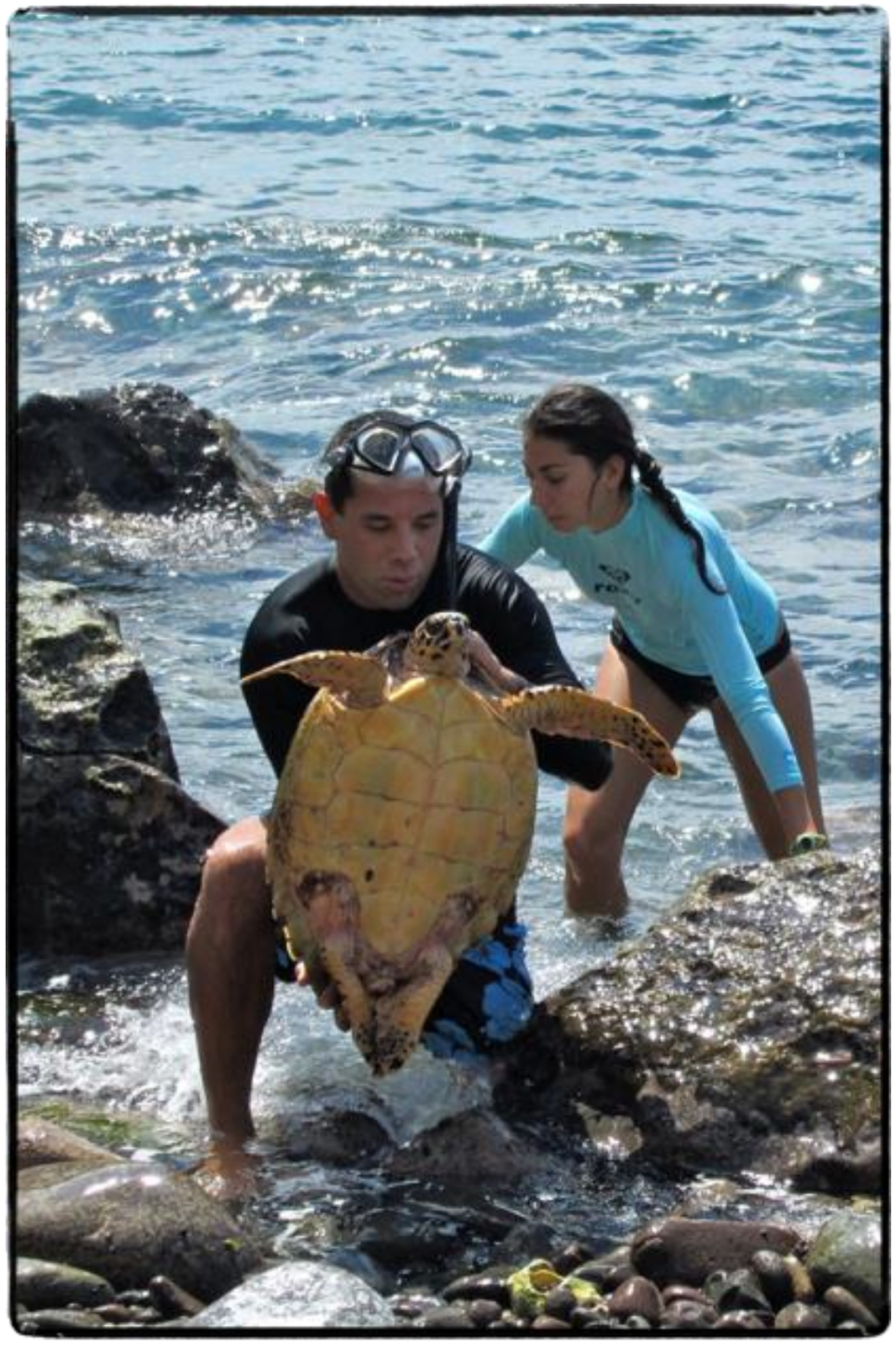
Dermochelys coriacea
Leatherback

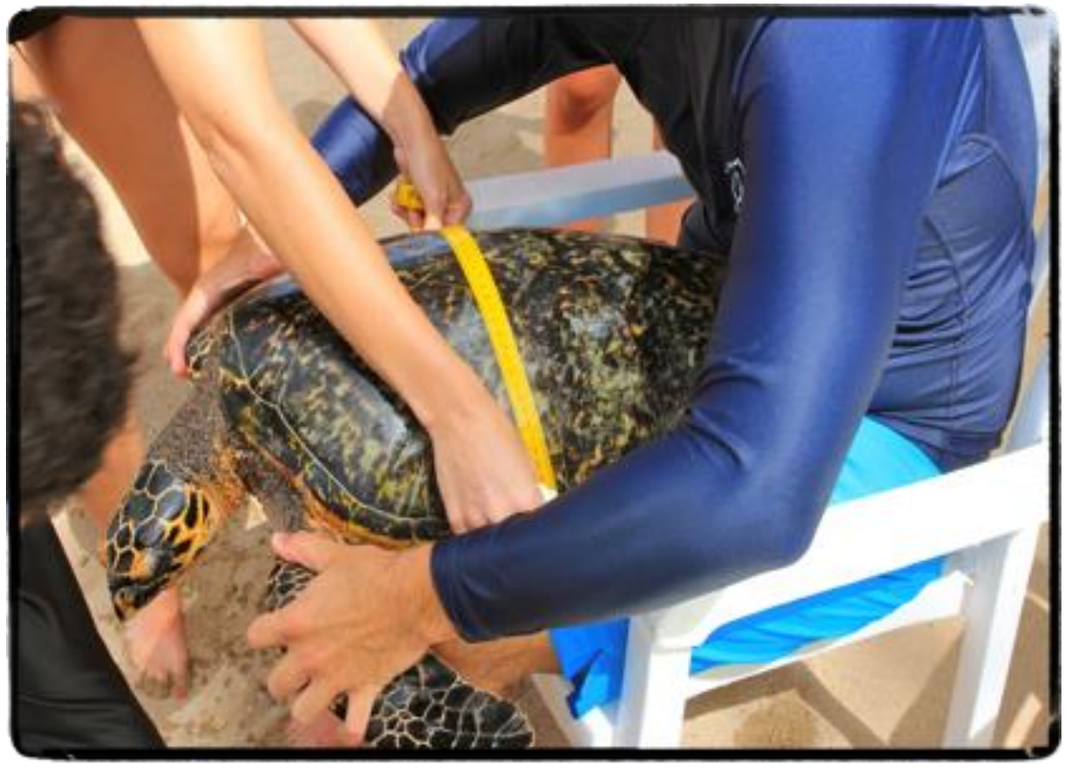
Chelonia mydas
Green

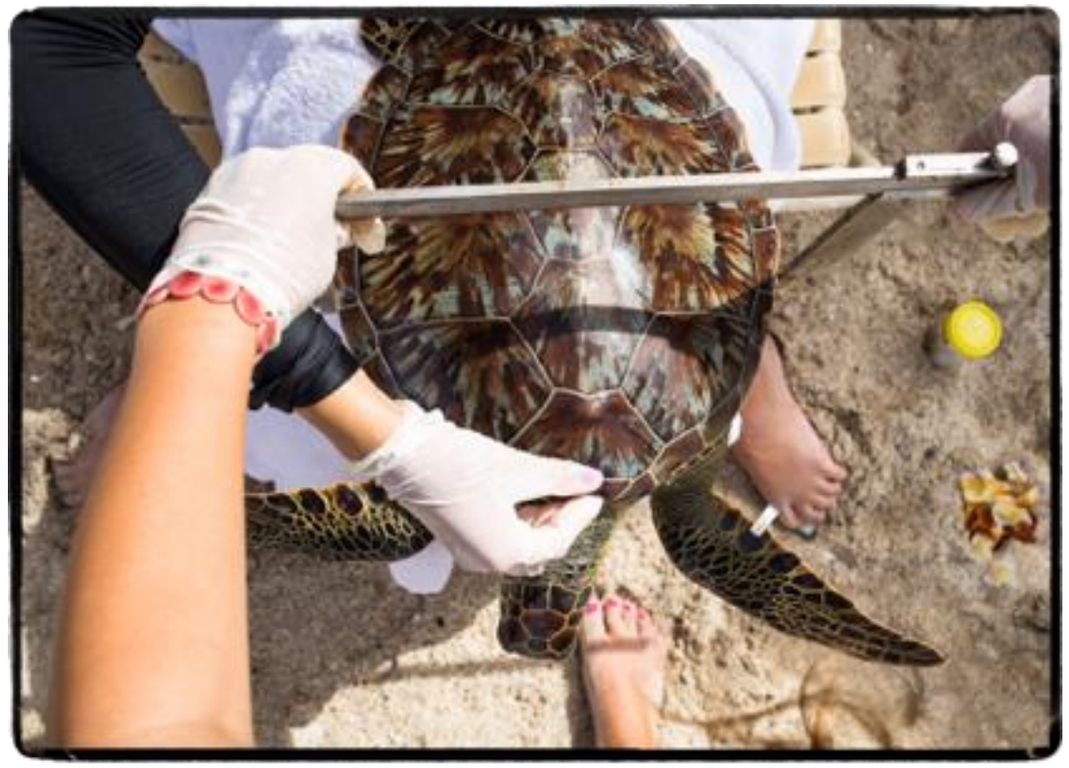
Caretta caretta
Loggerhead

Methods


Dieppe Bay
Pump Bay
Old Road Bay
Bird Rock Bay
Potato Bay
Timothy Bay
South Friars Bay
Whitehouse Bay
Ballast Bay
Shitten Bay
Caribbean Sea
N
E
W
S
Atlantic Ocean
Half Moon Bay
Sandy Bank Bay
Mosquito Bay
Cockleshell Bay
Majors Bay
Banana Bay







42 BCI = [weight (kg)/straight carapace length (cm3)] X 10,000


IMPORTANT

Morphometric Measurements for Juvenile Sea Turtles Captured Around St. Kitts

Parameter	Species	Median	10-90%	Min-Max
CCL Notch-Notch (cm)	Hawksbill	40.5	28.5-51.0	21.5-80.0
	Green	48.7	33.9-64.0	32.0-75.0
CCL Notch-Tip (cm)	Hawksbill	41.7	30.2-54.0	22.0-82.0
	Green	49.7	34.4-64.5	32.0-74.0
CCW (cm)	Hawksbill	36.0	26.5-46.0	17.0-71.0
	Green	42.5	31.1-58.7	25.0-67.0
Notch-Notch SCL (cm)	Hawksbill	35.0	22.4-47.8	18.2-48.0
	Green	47.0	34.3-57.8	30.6-65.0
Notch-Tip SCL (cm)	Hawksbill	38.0	23.3-50.5	19.2-50.8
	Green	47.2	34.6-58.2	30.9-64.0
SCW (cm)	Hawksbill	26.0	16.3-36.6	12.5-38.0
	Green	38.0	27.0-50.8	25.0-54.0
Weight (kg)	Hawksbill	7.9	2.7-16.0	1.3-19.5
	Green	11.1	4.4-22.4	4.0-33.8

Differences in hematologic and biochemistry data noted between species

Parameter	Species	Median	10-90%	Min-Max
BCI	Hawksbill	1.58	1.41-1.87	0.76-2.10
	Green	1.47	1.31-1.64	1.25-1.64
PCV	Hawksbill	32.0	26.2-38.0	17.0-57.0
	Green	27.0	16.2-34.1	6.0-37.0
AST	Hawksbill	84.0	43.8-136.8	27.0-361.0
	Green	169.0	116-252.6	109.0-283.0
Glucose	Hawksbill	94.0	78.8-109.2	56.0-134.0
	Green	70.0	55.0-85.0	53.0-89.0
Phosphorus	Hawksbill	5.3	3.2-7.1	1.0-11.7
	Green	6.7	4.8-10.3	2.9-12.0
Albumin	Hawksbill	1.2	1.0-1.4	0.9-1.7
	Green	1.4	1.0-1.6	1.0-1.8
Sodium	Hawksbill	154.0	149.0-165.0	144.0-167.0
	Green	150.0	143.0-161.8	142.0-168.0
WBC	Hawksbill	7,000	4,000-12,600	2,400-15,000
	Green	13,100	7,100-19,700	4,400-20,000
Heterophils	Hawksbill	1,083	445.2-2,818.2	288-5452
	Green	1,655	514.8-5,588.2	0-5698
Monocytes	Hawksbill	2,016	1,142-4,248	672-7,384
	Green	5,732	2,062-13,240	2,016-13,600

Acknowledgements

ST. KITTS SEA TURTLE MONITORING NETWORK
STKITTSTURTLES.ORG

GEORGIA SEA TURTLE CENTER
JEKYLL ISLAND

Ocean Spirits

Silver Reef
ST. KITTS

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