Challenges in Monitoring and Managing Large Marine Fishes: Lessons from the Galápagos Archipelago

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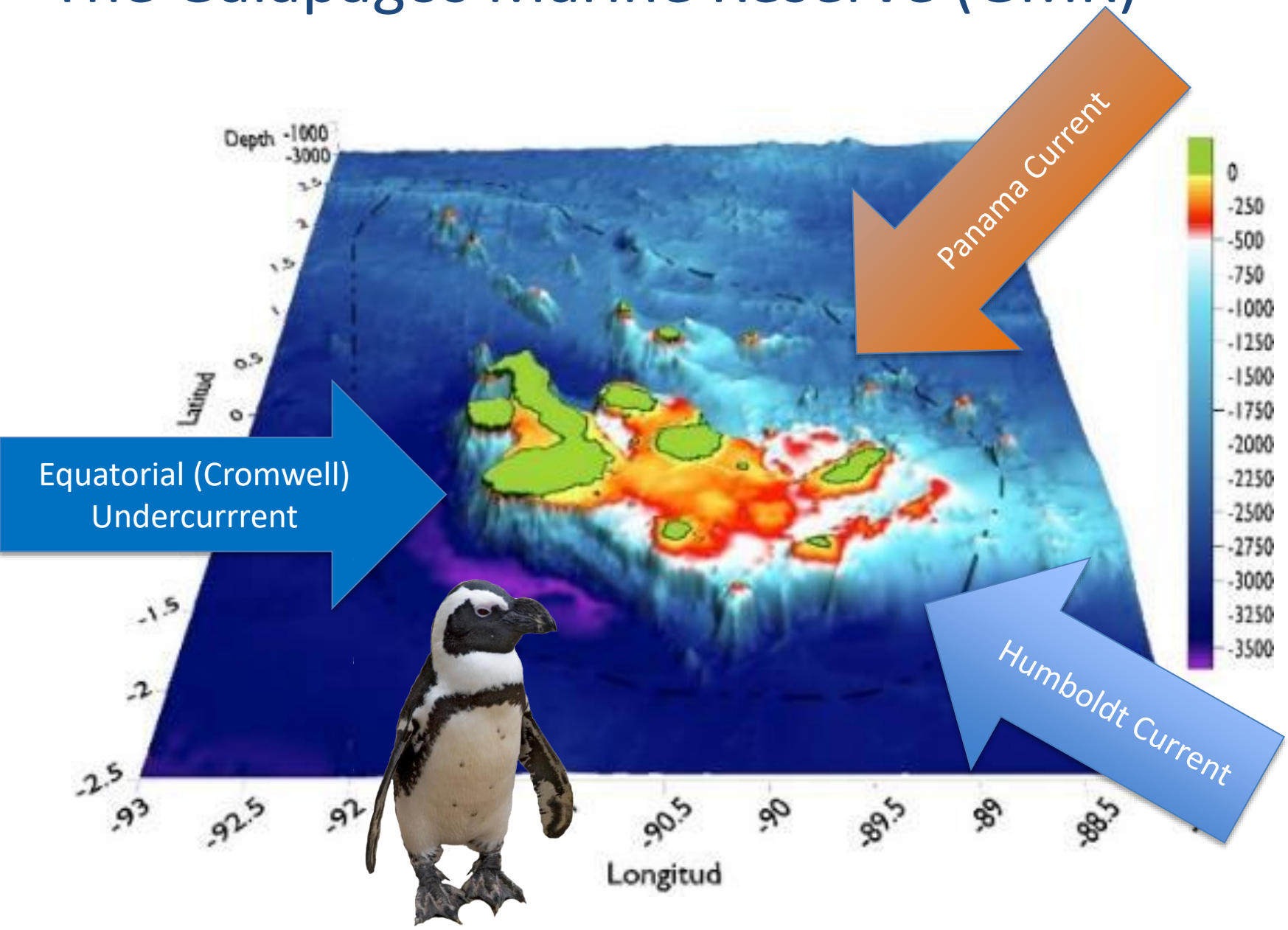
Fundación Charles Darwin

The Galápagos Marine Reserve (GMR)



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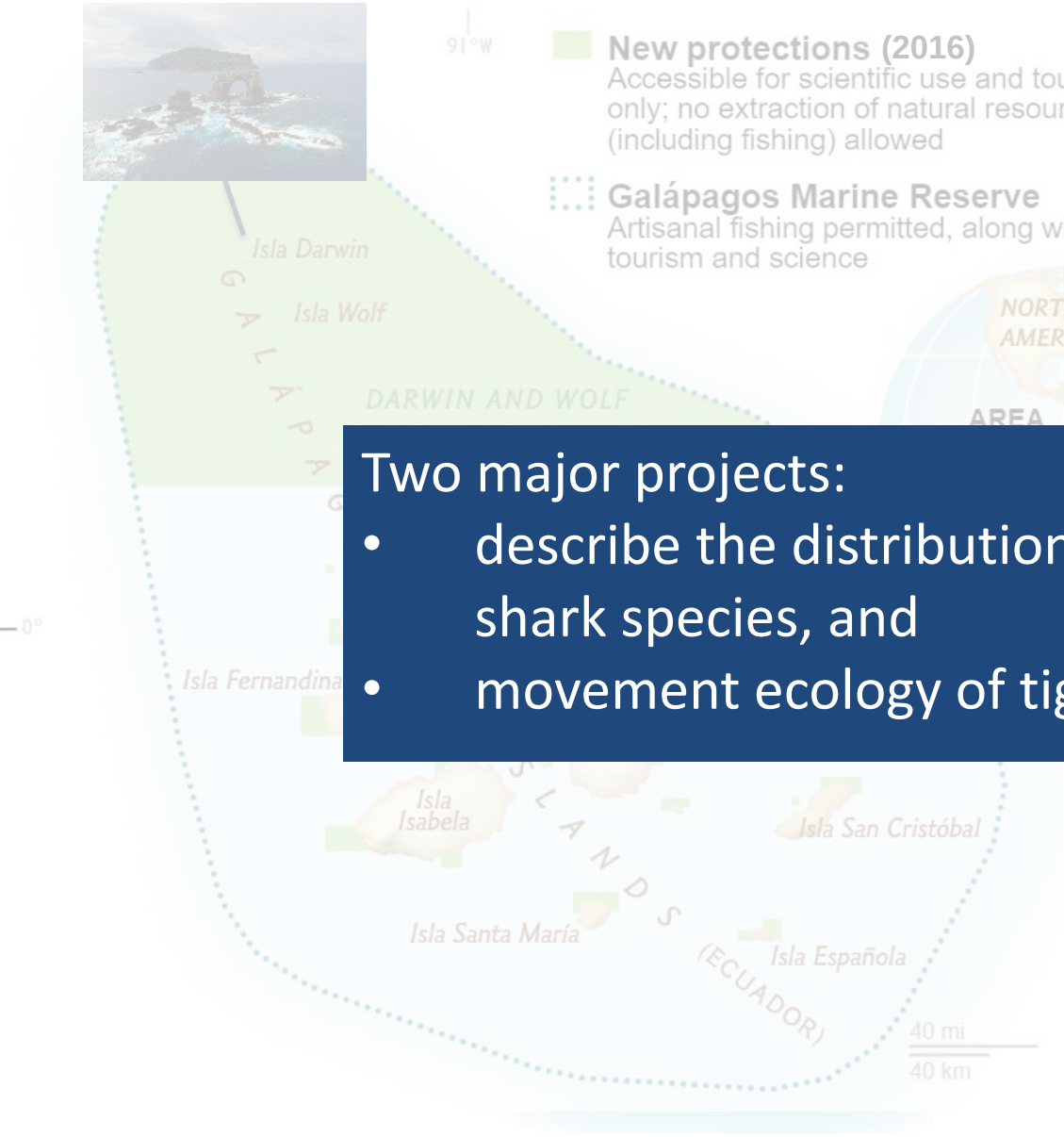


GMR multi-use zonal management since 1989

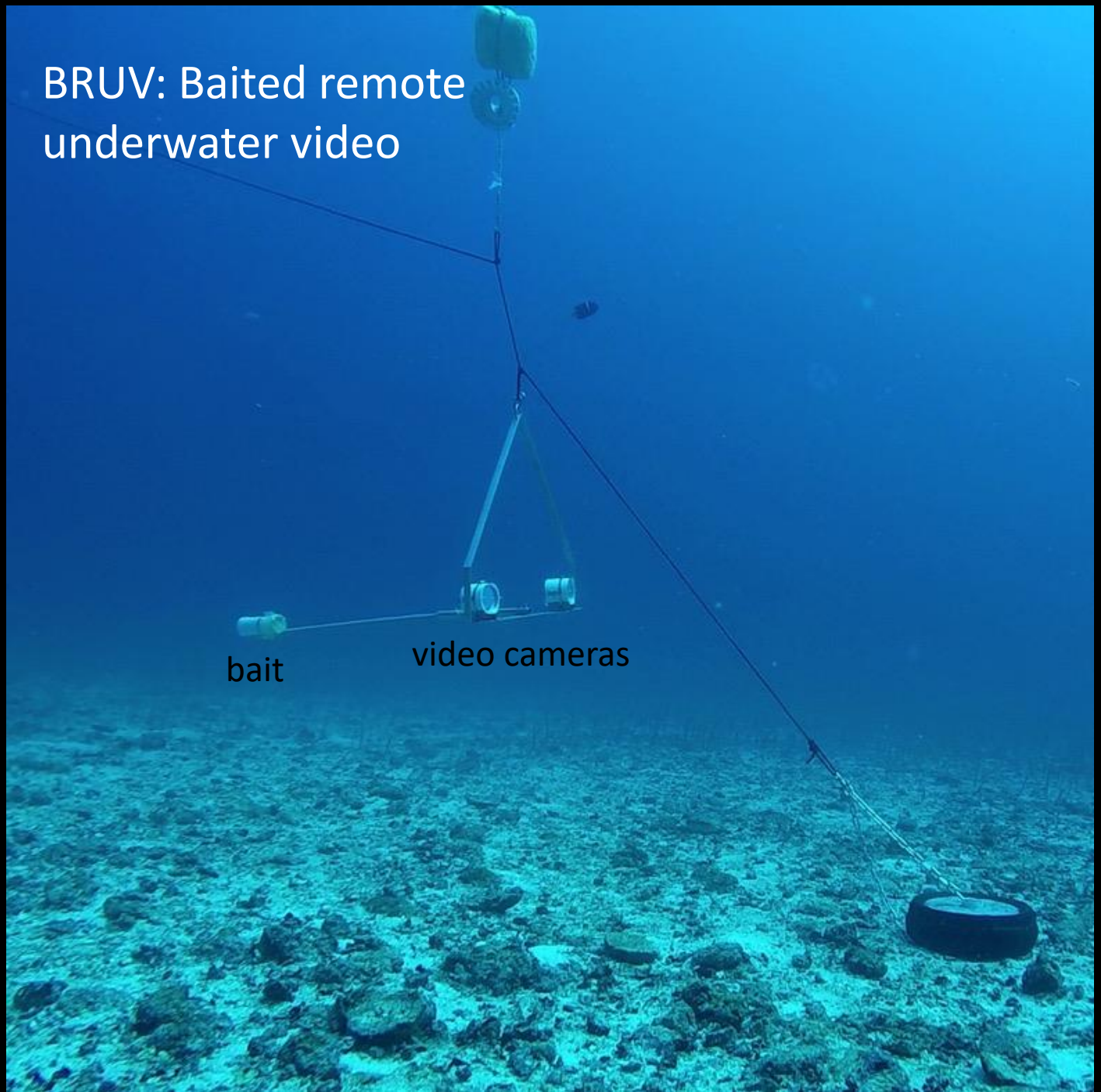
UNESCO world site 2001

Two major projects:

- describe the distribution and diversity of shark species, and
- movement ecology of tiger sharks.

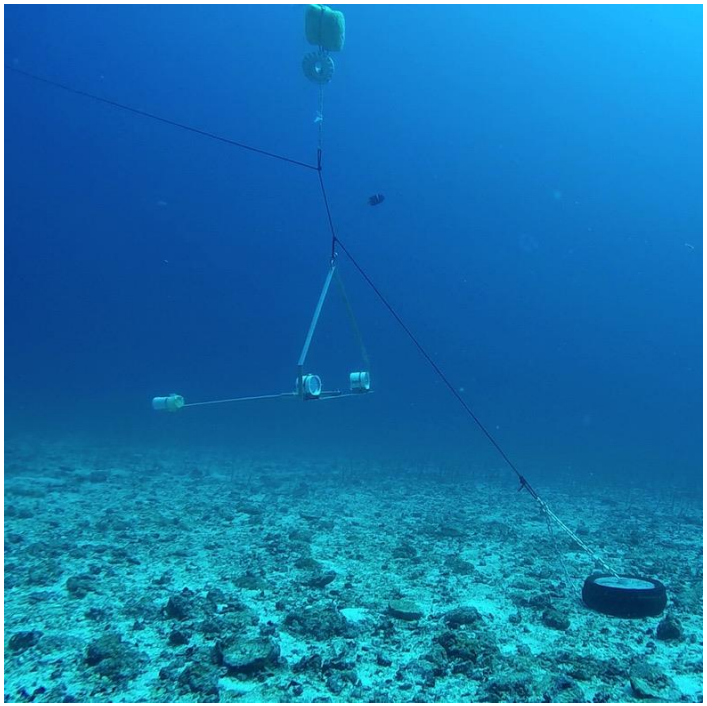
ected in the GMR, yet sightings declined until recently.

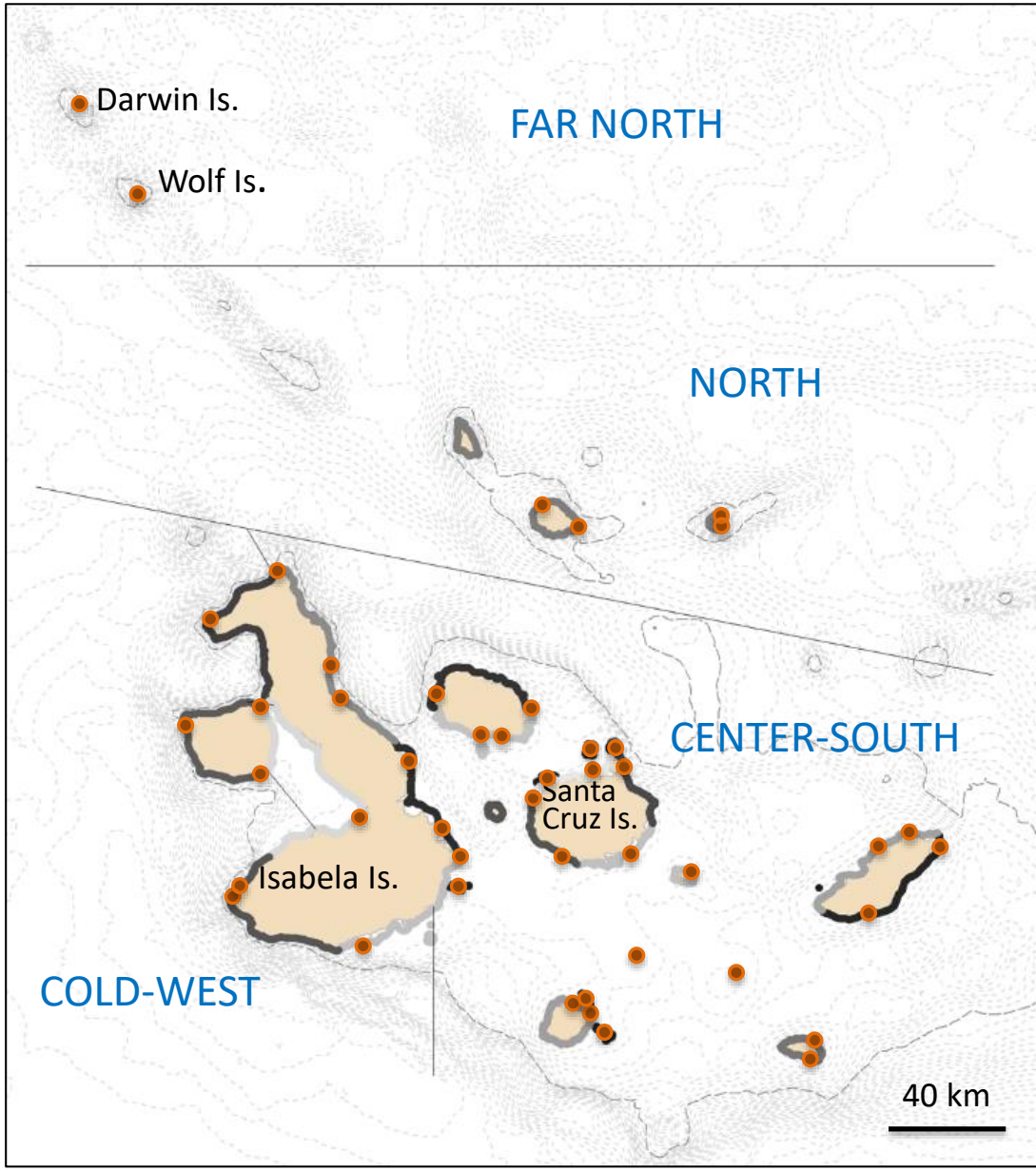
Global hotspot for sharks

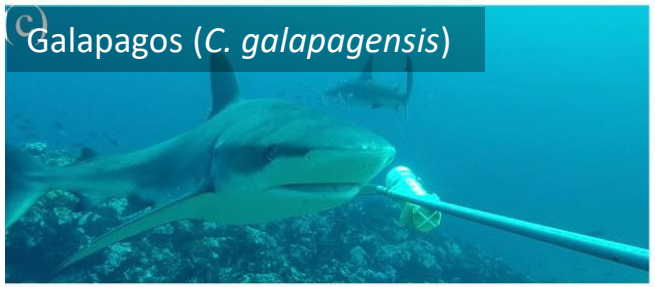

BRUV: Baited remote underwater video
bait
video cameras

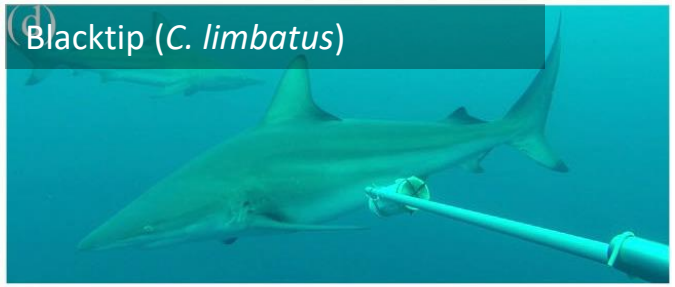
Sampling an archipelago

- 21 strata in 4 bioregions
- 45 sites, randomly selected
- 8 replicates per site
  (4 at 15 m; 4 at 25 m)
- 2 seasons









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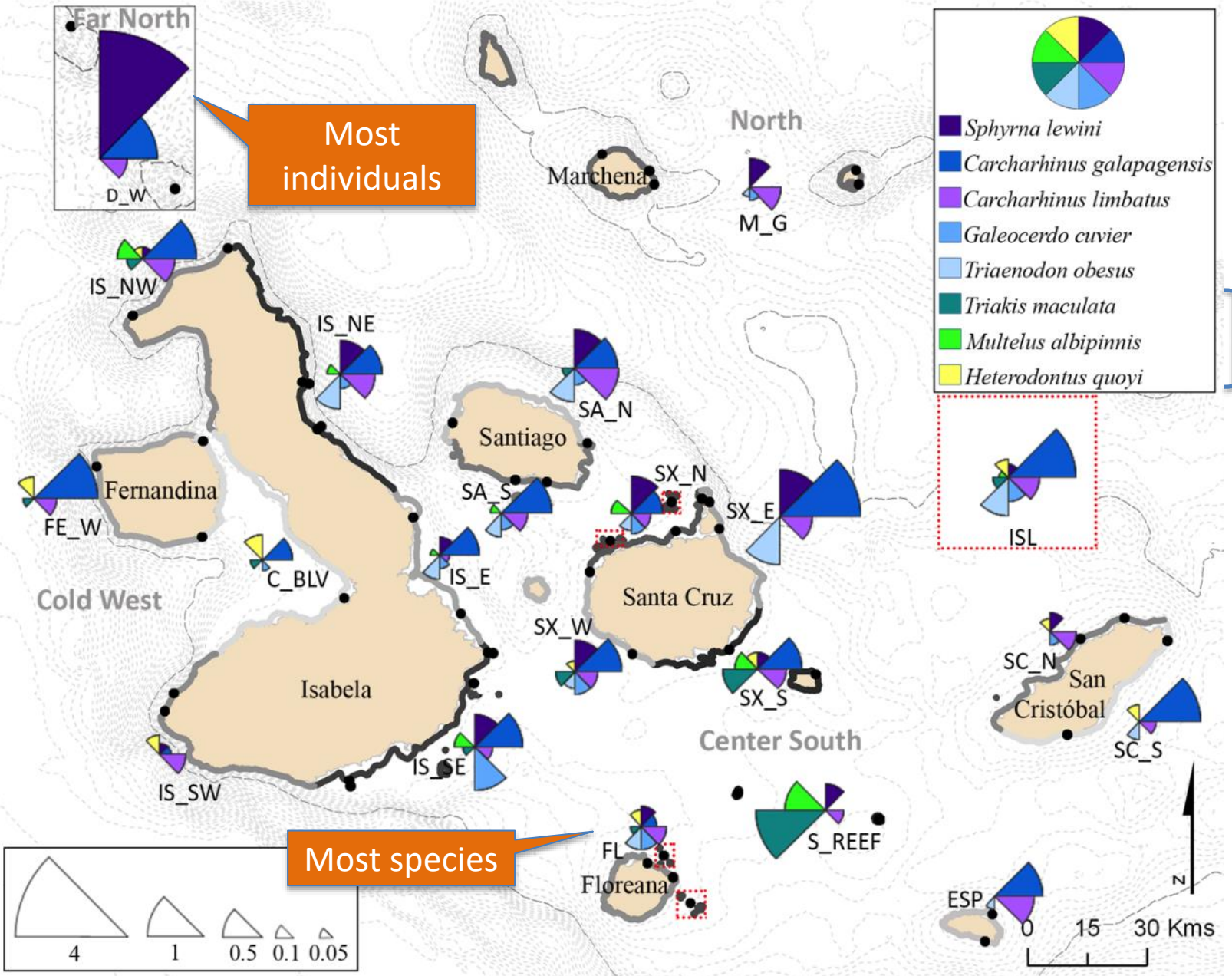
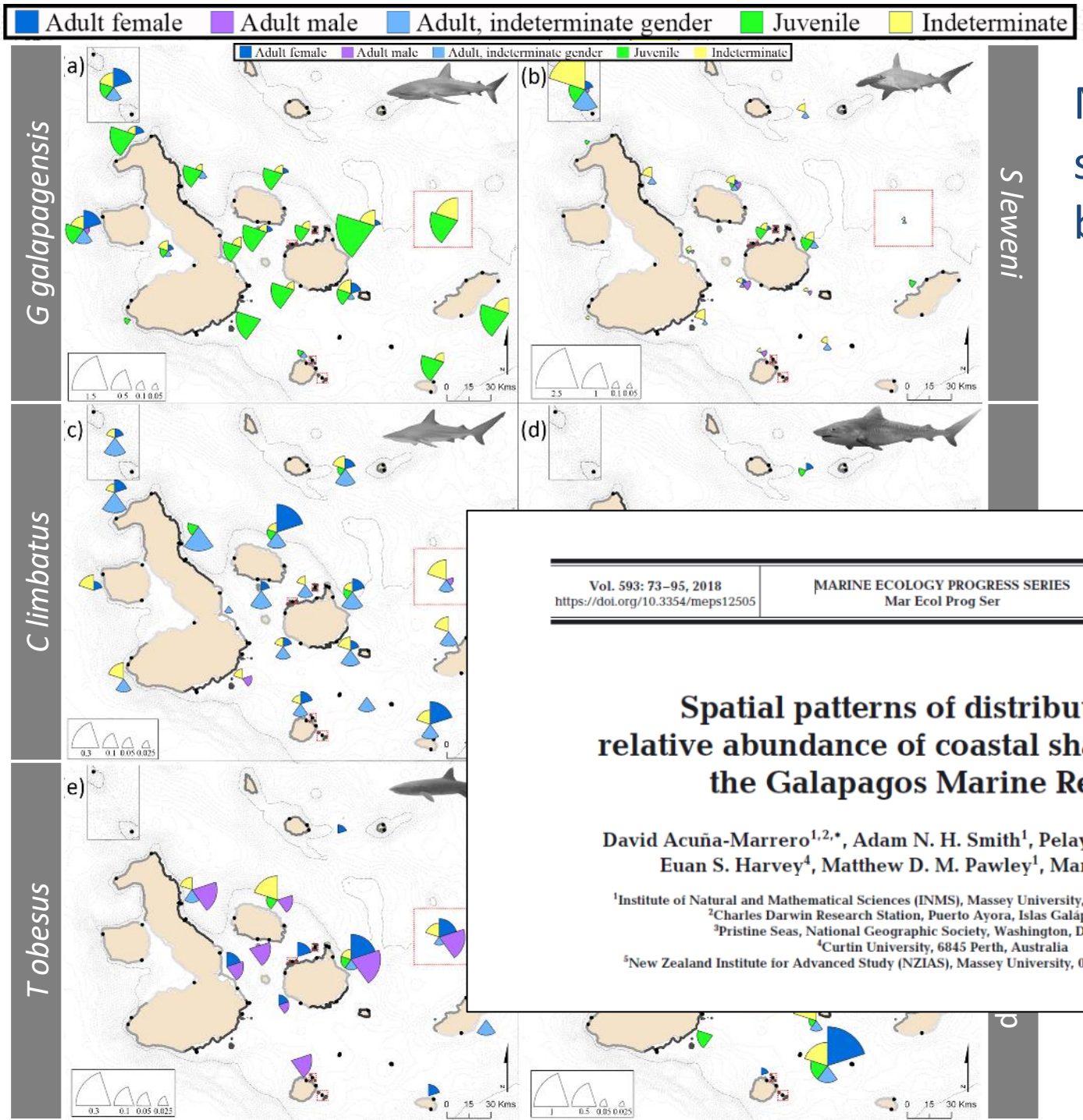
629 deployments in total

Sharks
877 individuals in total
Up to 26 individuals per deployment
10 species in total
Up to 4 species per deployment

62,955 records of other macrofauna

Spatial patterns in shark distributions





Many shark species segregated by size and sex

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Spatial patterns of distribution and relative abundance of coastal shark species in the Galapagos Marine Reserve

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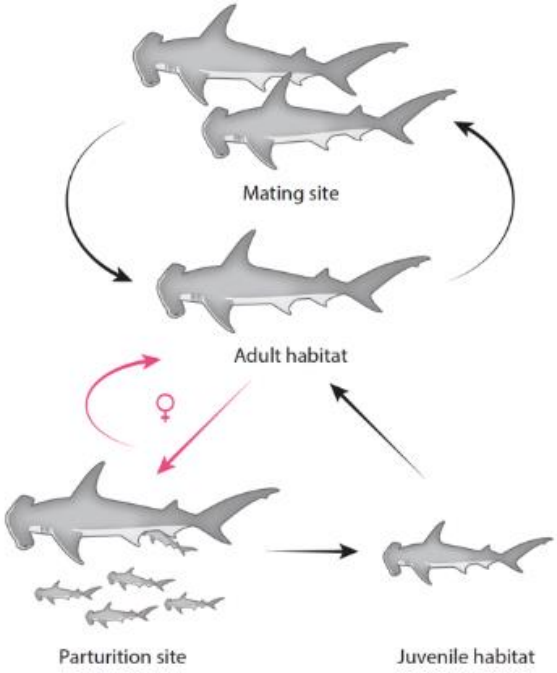
[2]Charles Darwin Research Station, Puerto Ayora, Islas Galápagos, Ecuador
[3]Pristine Seas, National Geographic Society, Washington, DC 20036, USA
[4]Curtin University, 6845 Perth, Australia
[5]New Zealand Institute for Advanced Study (NZIAS), Massey University, 0745 Auckland, New Zealand

Tiger shark (*Galeocerdo cuvier*)

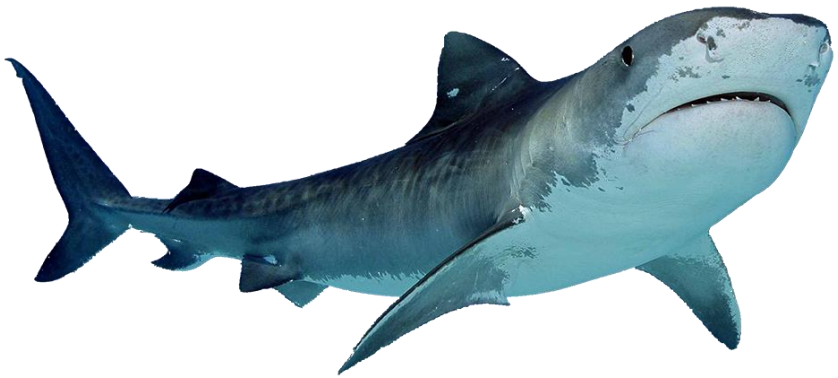
- Highly migratory elsewhere (100s of km)
- Life-history and migration complicates conservation
- Juveniles are nocturnal bottom feeders; adults hunt larger prey, especially turtles



Chapman *et al.* 2015

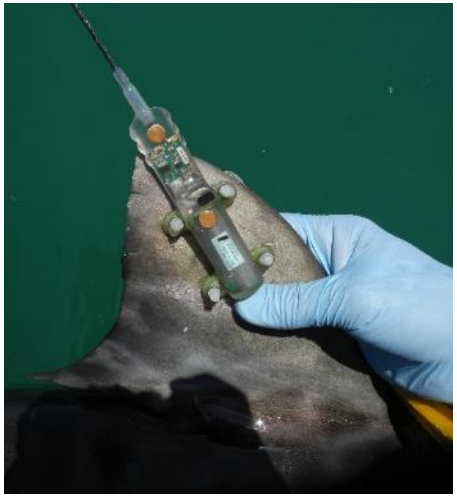
Research questions:

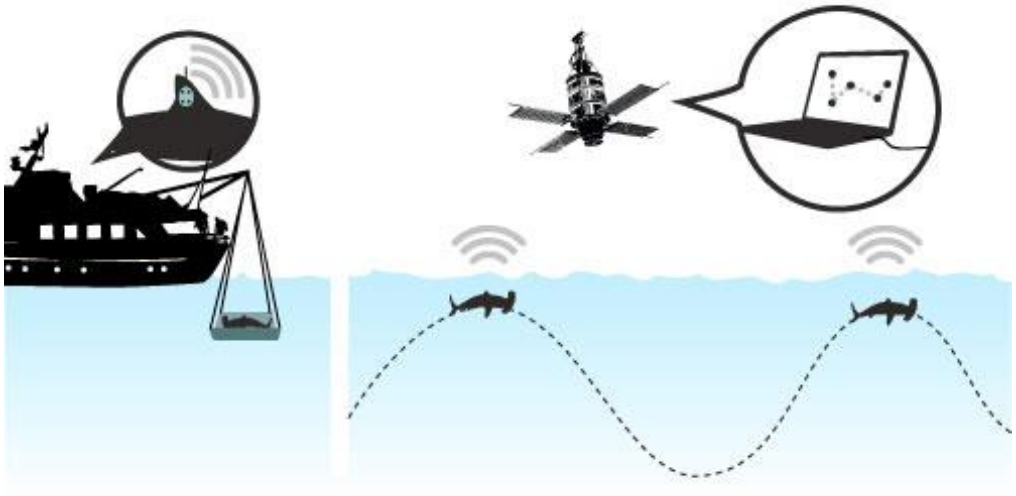
- What are the movement patterns of tiger sharks in and around the Galápagos MR?
- What habitats/food resources are tiger sharks using during their different life-history stages?



Internal acoustic tagging

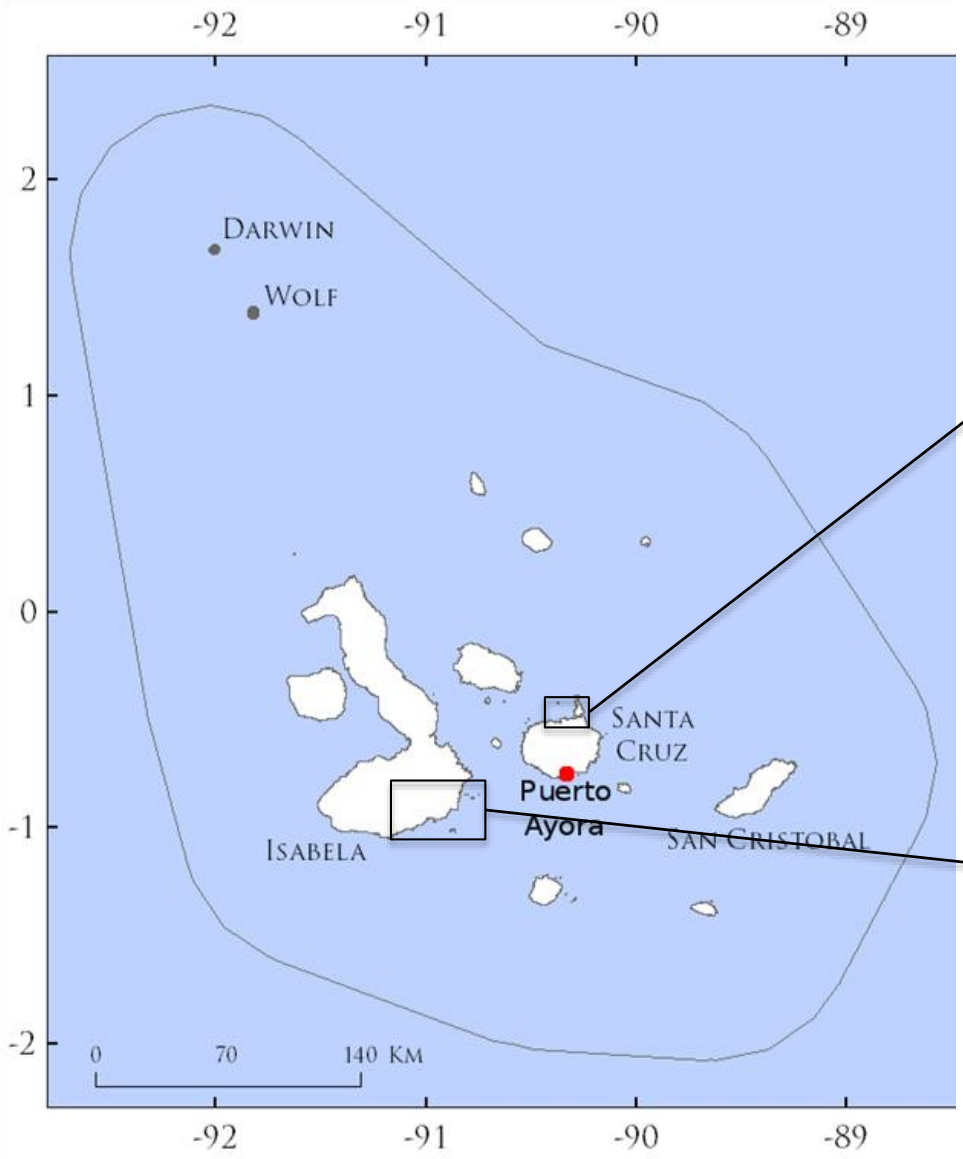
Fin-mounted satellite tags (SPOT5)

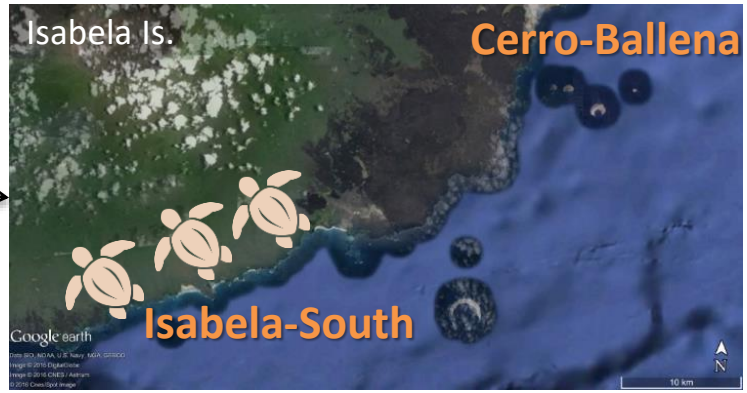




Three study sites

(two important turtle-nesting grounds)



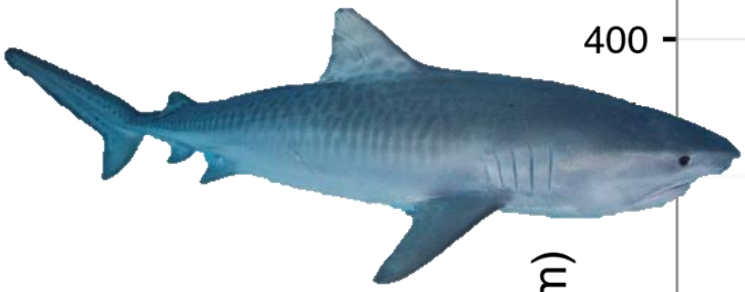


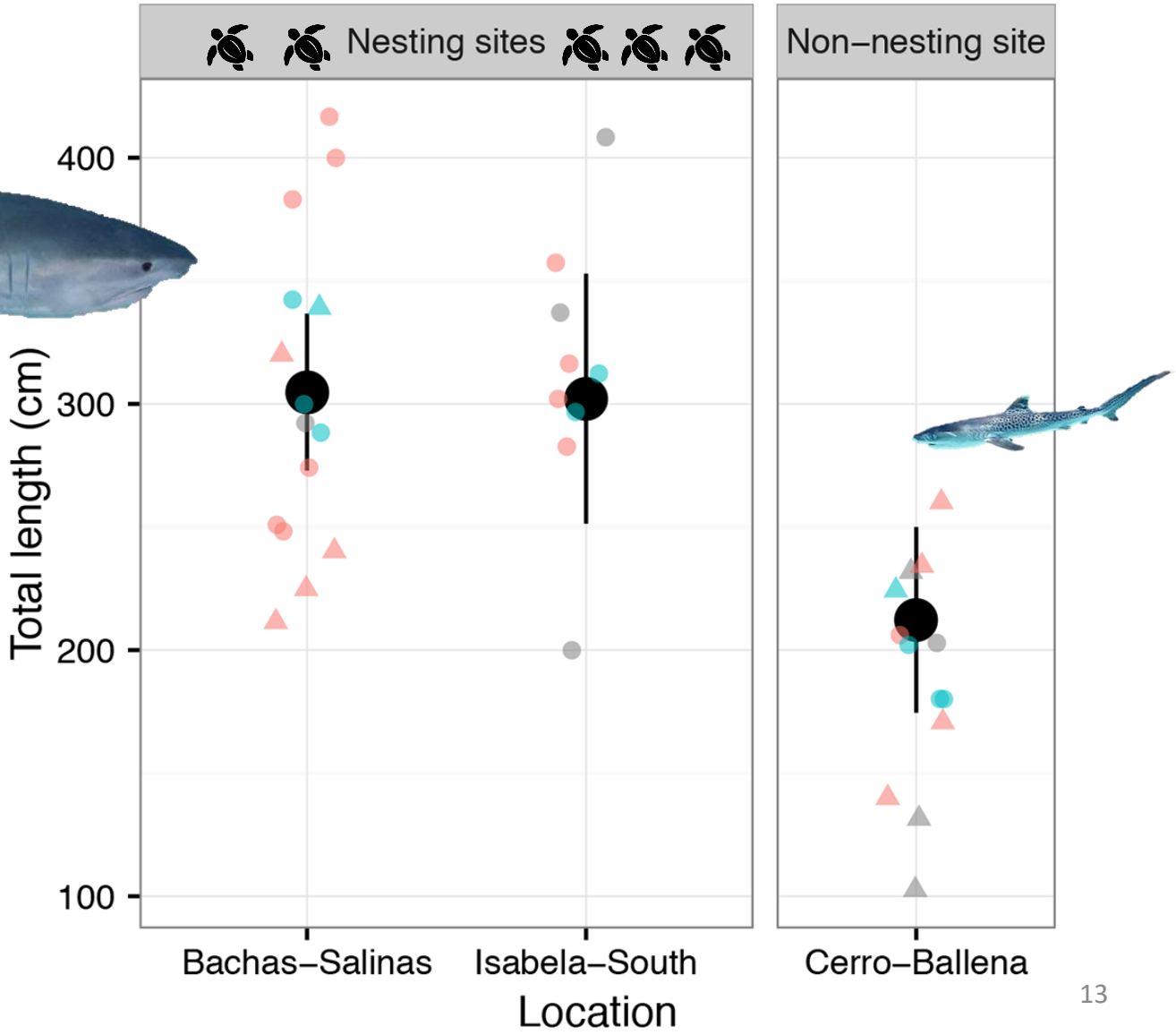
At turtle-nesting sites, tiger sharks were

- seen more often in the turtle nesting season

At turtle-nesting sites, tiger sharks were

- seen more often in the turtle nesting season
- larger

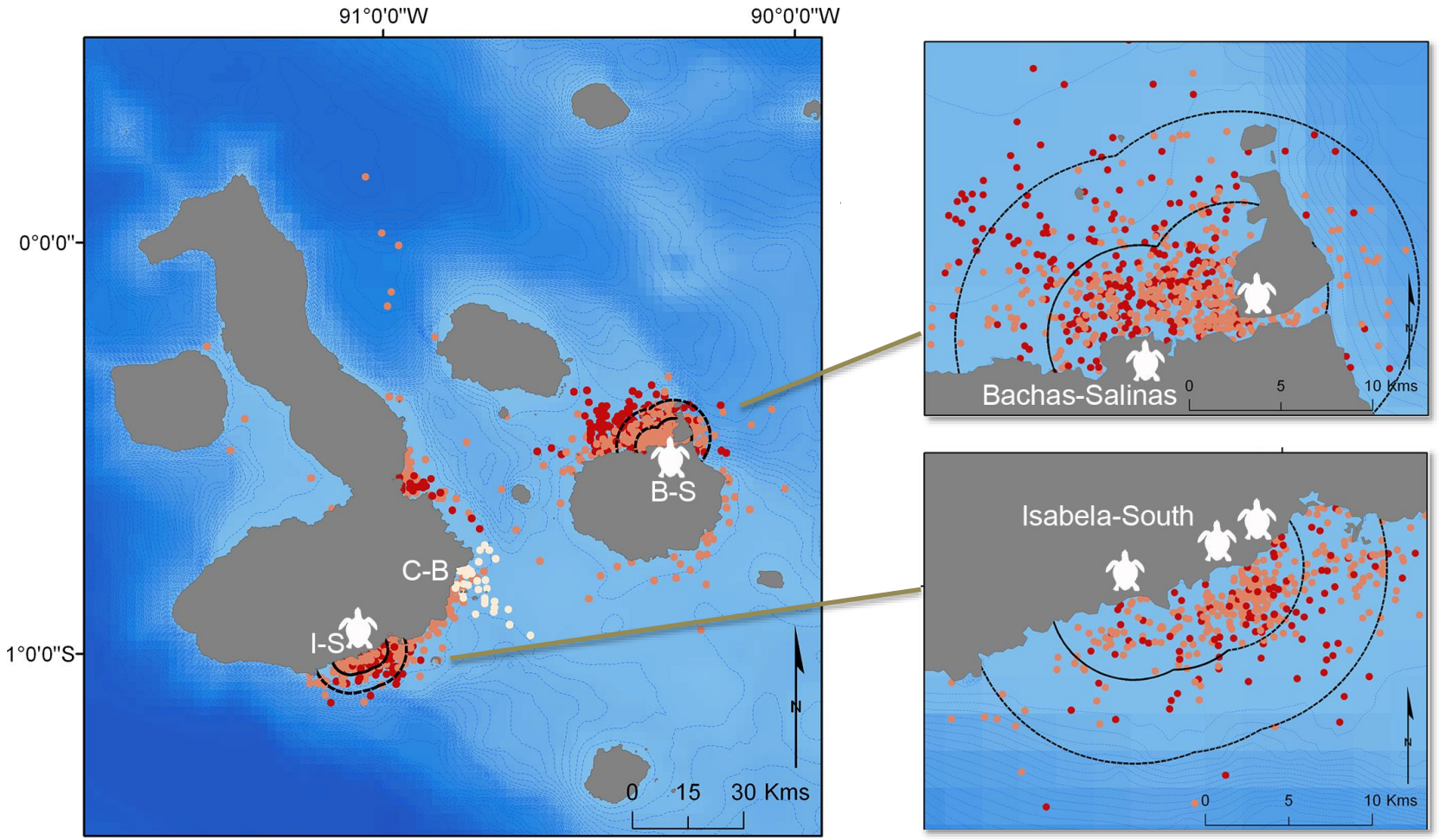




20 sharks captured: 13 females, 7 males. 11 successfully sat. tagged.

Medium-to-large sharks (orange and red) spent most of their time within 5-10 km of the turtle-nesting beaches.

Small sharks (white) stayed near Cerro-Ballena where they were tagged.



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Medium-to-large sharks (orange and red) spent most of their time within 5-10 km of the turtle-nesting beaches.

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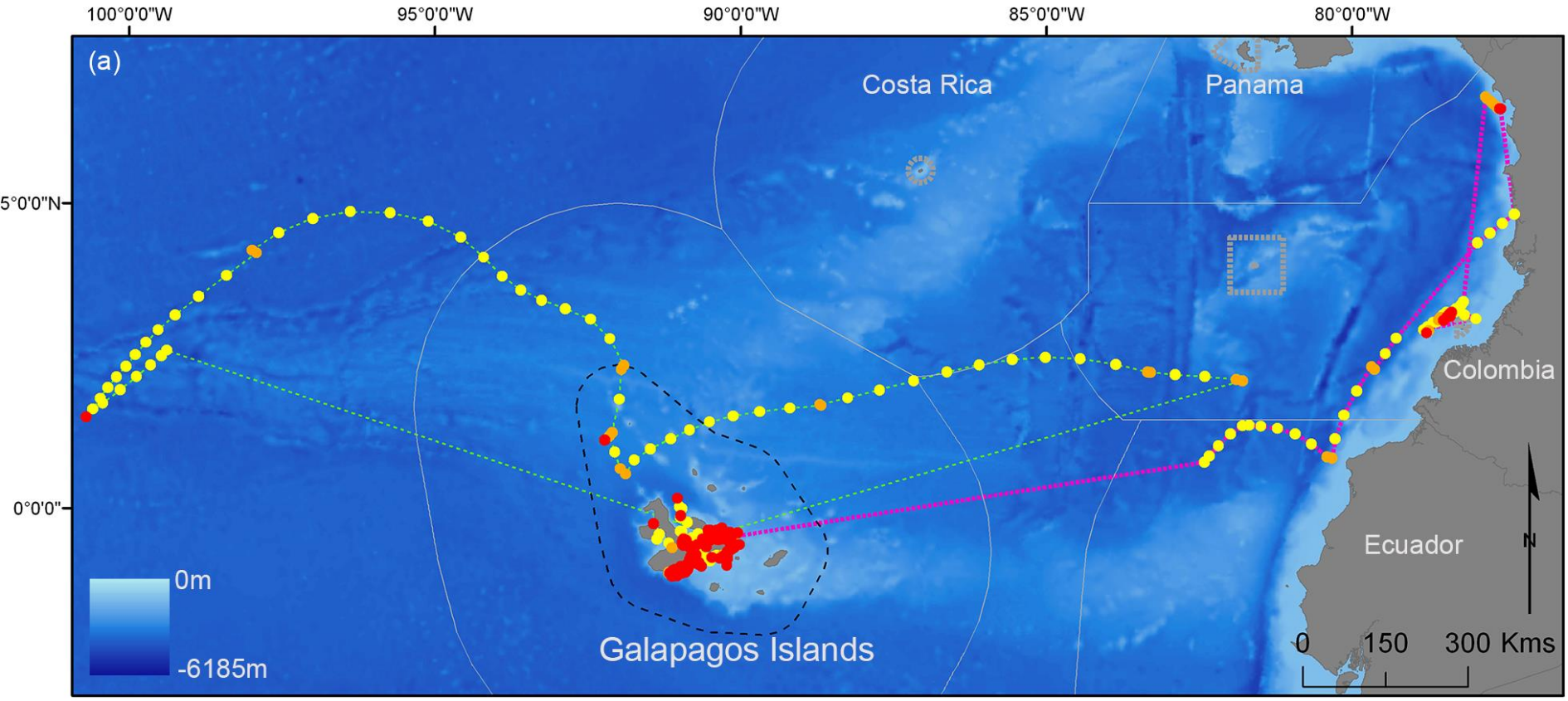
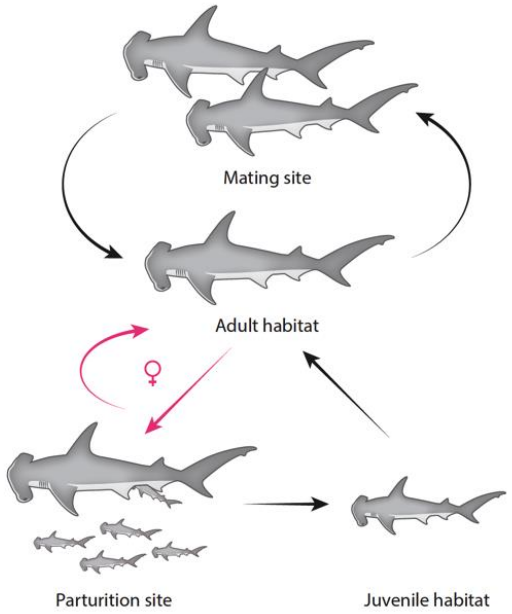
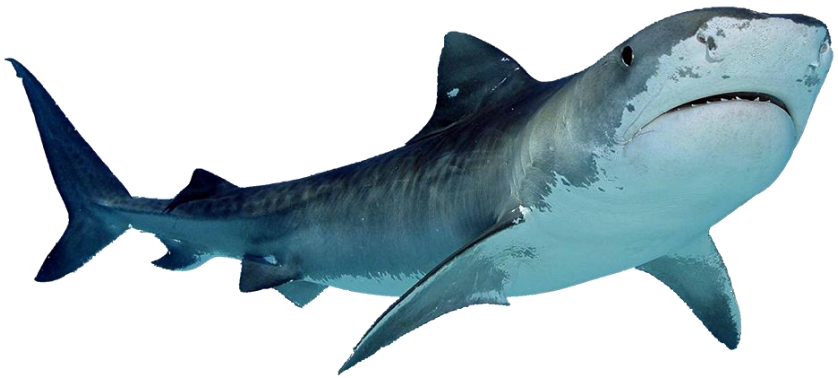
Two female sharks left the GMR; both returned for turtle season.



Tiger sharks at the Galápagos

- Galápagos provides
  - suitable habitats for all life history stages and reproduction
  - Abundant prey year-round, and especially in turtle nesting season
- Most tiger sharks were resident year-round. Those that left returned for turtle season.
- Galápagos Marine Reserve is a highly valuable site for tiger shark conservation





Tiger sharks at the Galápagos

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PLOS ONE

RESEARCH ARTICLE

Residency and movement patterns of an apex predatory shark (*Galeocerdo cuvier*) at the Galapagos Marine Reserve

David Acuña-Marrero[1,2]*, Adam N. H. Smith[2], Neil Hammerschlag[3,4], Alex Hearn[5], Marti J. Anderson[6], Hannah Calich[3], Matthew D. M. Pawley[2], Chris Fischer[7], Pelayo Salinas-de-León[1]

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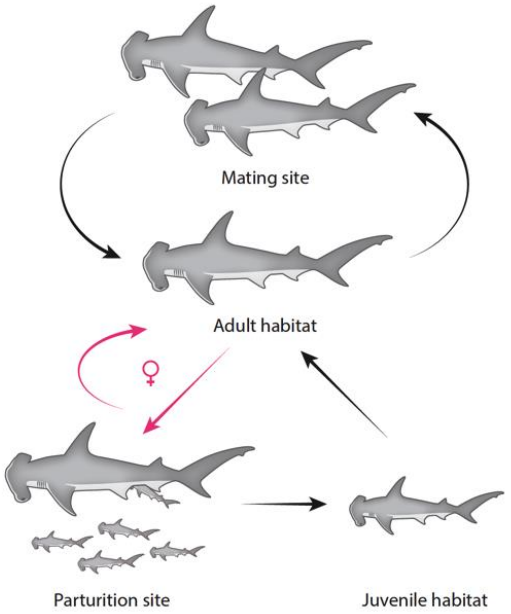

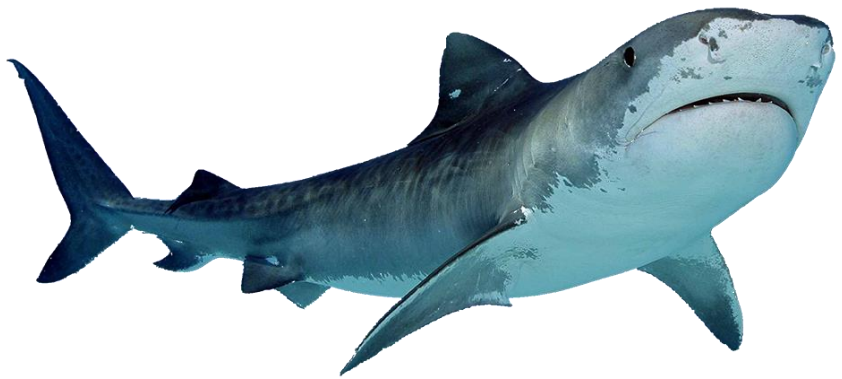

Acknowledgements

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- Neil Hammerschlag, Hannah Calich, *Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida, USA*
- Chris Fischer, *OCEARCH*
- Ian Jonsen, *Macquarie University, NSW, Australia*
- *Galapagos National Park Directorate, Ecuador*
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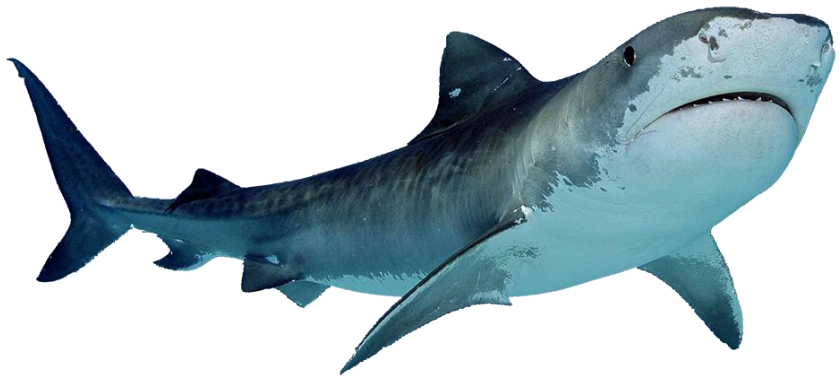
  - Save Our Seas Foundation
  - Lindblad Expeditions
  - National Geographic
  - IWC-Schaffhausen
  - OCEARCH



				Satellite			Acoustic		
Shark ID	Tagging date	TL (cm)	Sex	days transm	% residency time	Days monitored	Days transm	No. detections	RI* (per tagging site)
Bachas-Salinas									
TS1	30-Jan-2014	274	F	116	90.48	307	152	761	0.50
TS2	30-Jan-2014	251	F	210	74.83	79	19	150	0.24
TS3	30-Jan-2014	248	F	127	99.02	-	-	-	-
TS4	30-Jan-2014	383	F	333	82.78	262	111	438	0.42
TS5	11-Jun-2015	225	F	-		104	71	482	0.68
TS6	11-Jun-2015	240	F	67	98.48	104	47	185	0.45
	avg =	270.17 ± 23.49							
Cerro Ballena									
TS7	23-Jul-2014	140	F	-	-	180	41	140	0.23
TS8	23-Jul-2014	224	M	25	87.50	303	68	510	0.22
TS9	24-Jul-2014	234	F	26	100.00	271	16	82	0.06
TS10	24-Jul-2014	171	F	21	100.00	286	45	399	0.16
TS11	24-Jul-2014	260	F	115	100.00	-	-	-	-
TS12	7-Oct-2014	180	M	-	-	113	23	376	0.20
TS13	7-Oct-2014	180	M	-	-	195	93	1183	0.48
TS14	21-Feb-2015	206	F	58	78.12	74	10	23	0.14
TS15	21-Feb-2015	202	M	84	98.30	177	16	99	0.09
	avg =	199.67 ± 12.14							
Isabela-South									
TS16	22-Feb-2015	378	F	128	100.00	-	-	-	-
TS17	22-Feb-2015	282	F	14	100.00	58	1	1	-
TS18	22-Feb-2015	324	M	45	100.00	118	2	2	-
TS19	23-Feb-2015	286	M	66	95.61	-	-	-	-
TS20	23-Feb-2015	242	M	37	100.00	68	1	1	-
	avg =	302.40 ± 22.93							