

## Whale Shark (*Rhincodon typus*)

**Table 1.** Population trend data for Whale Shark (*Rhincodon typus*) subpopulations.

Area	Description	Index at start	Index at end	Data type	Start Year	End Year	Inferred cause	References
<b>Atlantic subpopulation</b>								
Belize	Anecdotal decrease in sightings by divers (1998 - 2015)	4-6 sharks per day	0 sharks per day	Daily whale shark sightings by dive guides at Gladden Spit	1998	2015	Unclear - poorly managed tourism?	Graham and Roberts 2007, Graham 2007, R. Graham pers. comm. 2016
Azores	Expanding distribution due to climate change (1998 - 2013)	4 sharks p.a.	~90 sharks p.a.	Sightings recorded from observers on pole-and-line tuna fishing vessels	1998	2013	Northward extension of 22C isotherm	Afonso <i>et al.</i> 2014

Area	Description	Index at start	Index at end	Data type	Start Year	End Year	Inferred cause	References
Western Africa	Broad-scale ~70% overall decrease in SPUE from tuna fleet (1980 - 2010)	~0.05	~0.01	SPUE from tuna fleet, and raw data	1980	2010	Unclear	Sequeira <i>et al.</i> 2014
<b>Indo-Pacific subpopulation</b>								
Tofo, Inhambane, Mozambique	Localised 79+% decline in SPUE (2005 - 2016)			Modelled sighting data	2005	2011 (ongoing to 2016)	Unclear	Rohner <i>et al.</i> 2013; S Pierce unpubl. data.
Western & Central Indian Ocean	Broad-scale increase in sightings to 2000; decrease to 2007. Significant decrease (~66%) overall (1991 - 2007)			SPUE from tuna fleet, and raw data	1991	2007	Unclear	Sequeira <i>et al.</i> 2013
Maldives	National decrease in CPUE (early 1980s to 1993)	30 caught per annum (one major fishing location)	20 or less (whole country)	Fishery catches	Early 1980s	1993	Overfishing	Anderson and Ahmed 1993
Andaman Sea, Thailand	Localised ~92% decline in SPUE (1992 - 2001)	1.58	0.13	Sightings per dive trip	1992-1993	2000-2001		Theberge and Dearden 2006

Area	Description	Index at start	Index at end	Data type	Start Year	End Year	Inferred cause	References
Ningaloo Reef, Western Australia	Declining mtDNA diversity (2007 - 2012)			Declining mtDNA diversity	2007	2012	Unclear	Vignaud <i>et al.</i> 2014
Ningaloo Reef, Western Australia	(Controversial) 40% decline in SPUE; 1.6 m decline in mean TL (1995 - 2004)			SPUE from tourism vessels	1995	2004		Bradshaw <i>et al.</i> 2008
Ningaloo Reef, Western Australia	Small increase in number of 'returning' sharks over time. Decline in mean TL due to recruitment of smaller individuals (1995 - 2008)			Individual data from mark-recapture models	1995	2008		Holmberg <i>et al.</i> 2009
Philippines – Pamilican	Local ~60% decline in CPUE (1993 - 1997)	4.44	1.7	CPUE	1993	1997	Active fishery	Alava <i>et al.</i> 2002
Philippines – Guiwanon	Local ~60% decline in CPUE (1993 - 1997)	10	3.8	CPUE	1993	1997	Active fishery	Alava <i>et al.</i> 2002
Taiwan – Hongchun Harbour	Local ~80% decline in CPUE (mid-1980s - 1995)	50-60	>10	Fishery catches	Mid-1980s	1995	Active fishery	Chen and Phipps 2002
Taiwan	National ~50+% decrease in CPUE (1997 - 2002)	272 (p.a.)	113 (over 15 months)	Fishery catches	1997	2001-2002	Active fishery	Chen and Phipps 2002

Area	Description	Index at start	Index at end	Data type	Start Year	End Year	Inferred cause	References
Taiwan	National decrease in mean TL of landed sharks (2002 - 2007)	~4.6 m	~4.4 m	Decline in mean TL of landed sharks	2002	2007	Active fishery	Hsu <i>et al.</i> 2012
China	National decrease in mean TL of landed sharks (prior to 2004 - 2011)	8.27 m	6.3 m	Decline in mean TL of landed sharks	Prior to 2004	2008-2011	Active fishery	Li <i>et al.</i> 2012
Western Central Pacific	Broad-scale 50% decrease in SPUE from tuna fleet (2003 - 2012)	~1%	~0.5%	Occurrence in purse-seine sets	2003	2012	Unclear	Harley <i>et al.</i> 2013
Western Central Pacific	Weak evidence for increasing SPUE from tuna fleet (2000 - 2010)	0.003	0.012	SPUE from tuna fleet. Note - poor model performance.	2000	2010	Unclear	Sequeira <i>et al.</i> 2014

## References

- Afonso, P., McGinty, N. and Machete, M. 2014. Dynamics of whale shark occurrence at their fringe oceanic habitat. *PloS ONE* 9(7): e102060.
- Alava, M.N.R., Dolumbaló, E.R.Z., Yaptinchay, A.A. and Trono, R.B. 2002. Fishery and trade of whale sharks and manta rays in the Bohol Sea, Philippines. pp. 132-148. In: S.L. Fowler, T.M. Reed & F.A. Dipper (eds), *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop*. Sabah, Malaysia, July 1997. *Occasional paper of the IUCN Species Survival Commission* No. 25.
- Anderson, R.C. and Ahmed, H. 1993. *The shark fisheries in the Maldives*. FAO, Rome, and Ministry of Fisheries, Male, Maldives.

- Bradshaw, C.J., Fitzpatrick, B.M., Steinberg, C.C., Brook, B.W. and Meekan, M.G. 2008. Decline in whale shark size and abundance at Ningaloo Reef over the past decade: the world's largest fish is getting smaller. *Biological Conservation* 141: 1894-1905.
- Chen, V.Y. and Phipps, M.J. 2002. Management and trade of whale sharks in Taiwan. TRAFFIC East Asia, Taipei, Taiwan.
- Graham, R.T. 2007. Whale sharks of the Western Caribbean: an overview of current research and conservation efforts and future needs for effective management of the species. *Gulf and Caribbean Research* 19: 149-159.
- Graham, R.T. and Roberts, C.M. 2007. Assessing the size, growth rate and structure of a seasonal population of whale sharks (*Rhincodon typus* Smith 1828) using conventional tagging and photo identification. *Fisheries Research* 84: 71-80.
- Harley, S., Williams, P. and Rice, J. 2013. Spatial and temporal distribution of whale sharks in the western and central Pacific Ocean based on observer data and other data sources. Western and Central Pacific Fisheries Commission, Pohnpei.
- Holmberg, J., Norman, B. and Arzoumanian, Z. 2009. Estimating population size, structure, and residency time for whale sharks *Rhincodon typus* through collaborative photo-identification. *Endangered Species Research* 7: 39-53.
- Hsu, H.H., Joung, S.J. and Liu, K. 2012. Fisheries, management and conservation of the whale shark *Rhincodon typus* in Taiwan. *Journal of Fish Biology* 80: 1595-1607.
- Li, W., Wang, Y. and Norman, B. 2012. A preliminary survey of whale shark *Rhincodon typus* catch and trade in China: an emerging crisis. *Journal of Fish Biology* 80: 1608-1618.
- Rohner, C.A., Pierce, S.J., Marshall, A.D., Weeks, S.J., Bennett, M.B. and Richardson, A.J. 2013. Trends in sightings and environmental influences on a coastal aggregation of manta rays and whale sharks. *Marine Ecology Progress Series* 482: 153-168.
- Sequeira, A.M.M., Mellin, C., Delean, S., Meekan, M.G. and Bradshaw, C.J. A. 2013. Spatial and temporal predictions of inter-decadal trends in Indian Ocean whale sharks. *Marine Ecology Progress Series* 478: 185-195.
- Sequeira, A.M.M., Mellin, C. and Floch, L. 2014. Inter-ocean asynchrony in whale shark occurrence patterns. *Journal of Experimental Marine Biology and Ecology* 450: 21-29. DOI: 10.1016/j.jembe.2013.10.019.
- Theberge, M.M. and Dearden, P. 2006. Detecting a decline in whale shark *Rhincodon typus* sightings in the Andaman Sea, Thailand, using ecotourist operator-collected data. *Oryx* 40: 337-342.
- Vignaud, T.M., Maynard, J.A., Leblois, R., Meekan, M.G., Vázquez-Juárez, R., Ramírez-Macías, D., Pierce, S.J., Rowat, D., Berumen, M.L., Beeravolu, C., Baksay, S. and Planes, S. 2014. Genetic structure of populations of whale sharks among ocean basins and evidence for their historic rise and recent decline. *Molecular Ecology* 23: 2590-2601.