BIOL3110 Evolutionary and Conservation Genetics 2022

Wildlife Forensics: a case study

100 million sharks killed per year (Worm et al. 2013 Marine Policy)

Credit: Dr Paolo Momigliano

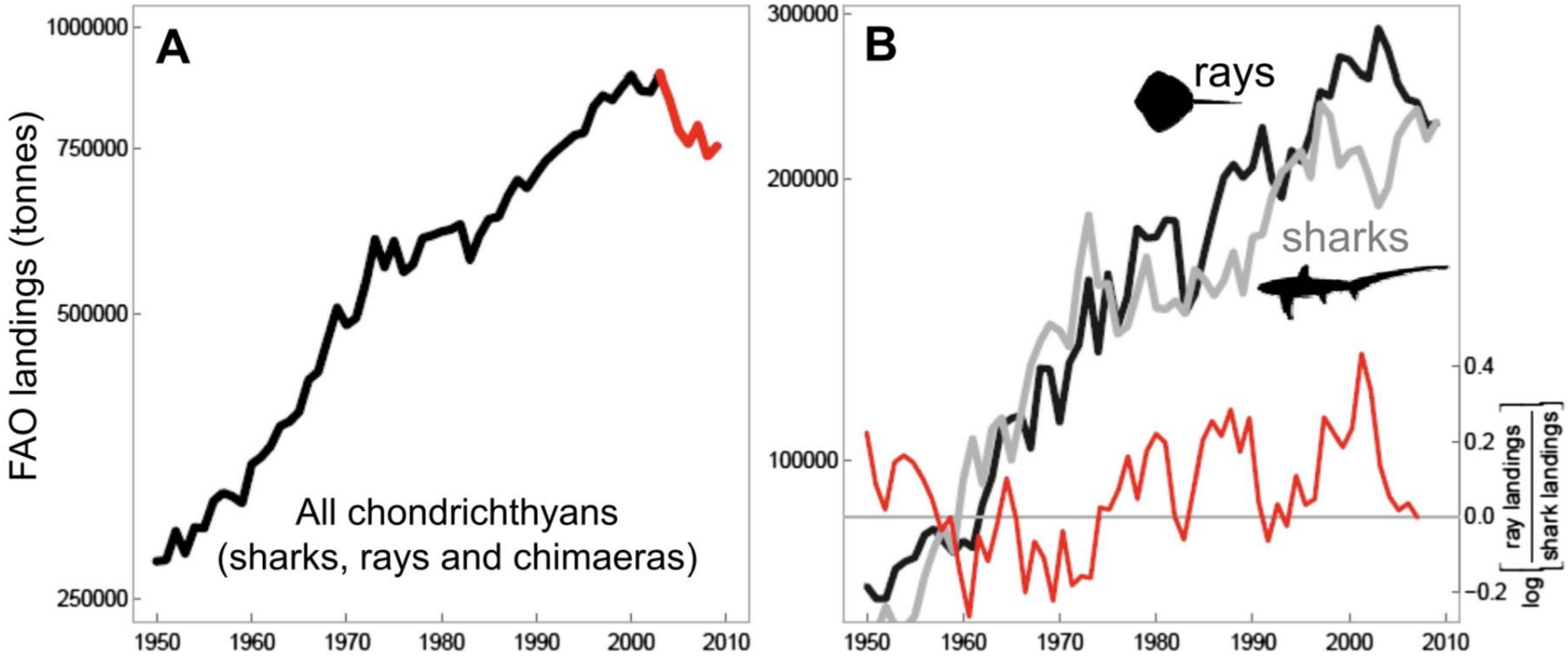
25% of species threatened with extinction (IUCN)

500,000 tonnes of shark fin traded annually

(FAO)

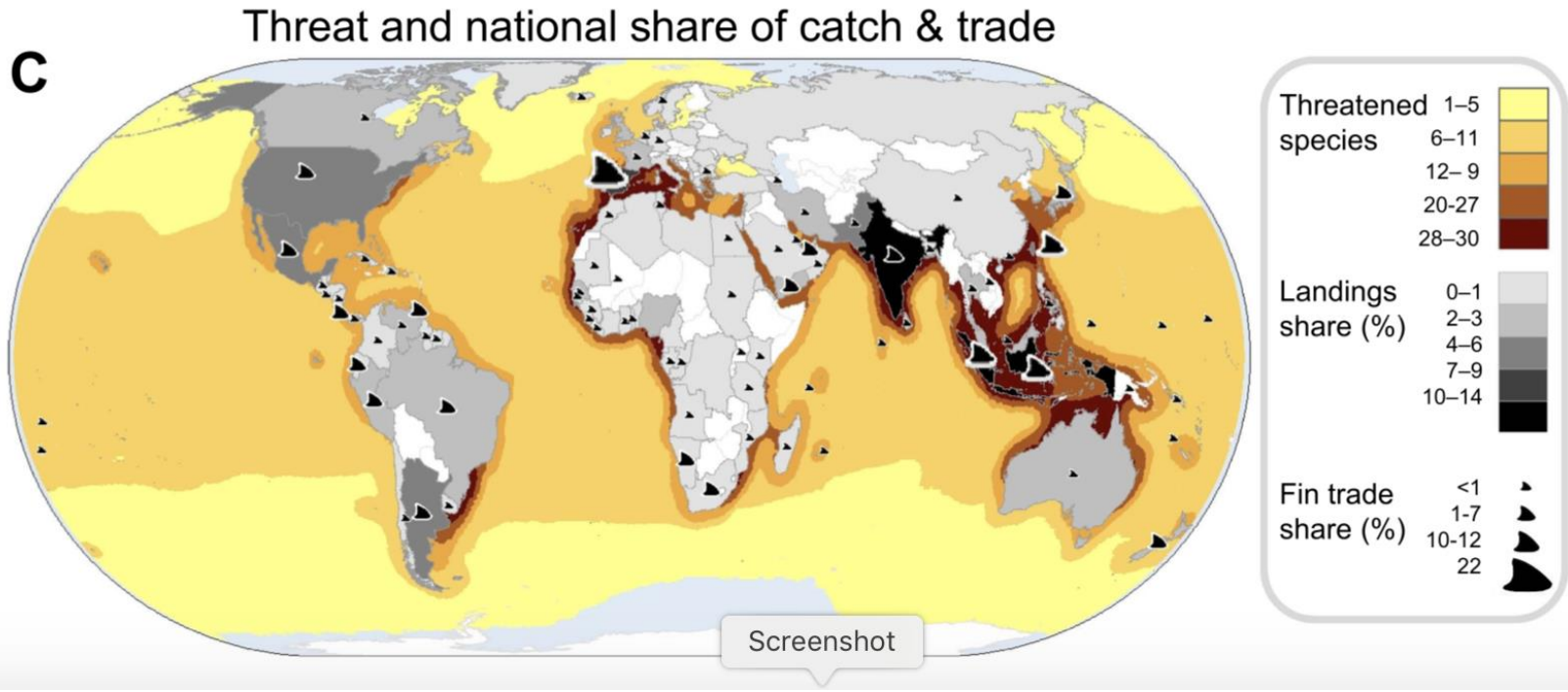
Credit: Dr. Jessica Boomer

US$1 billion at the peak catch in 2003, dropped to US$800 million as catch has declined



Dulvy et al. 2014

Australia – moderate shark fishery combined with relatively high number of threatened species



Dulvy et al. 2014

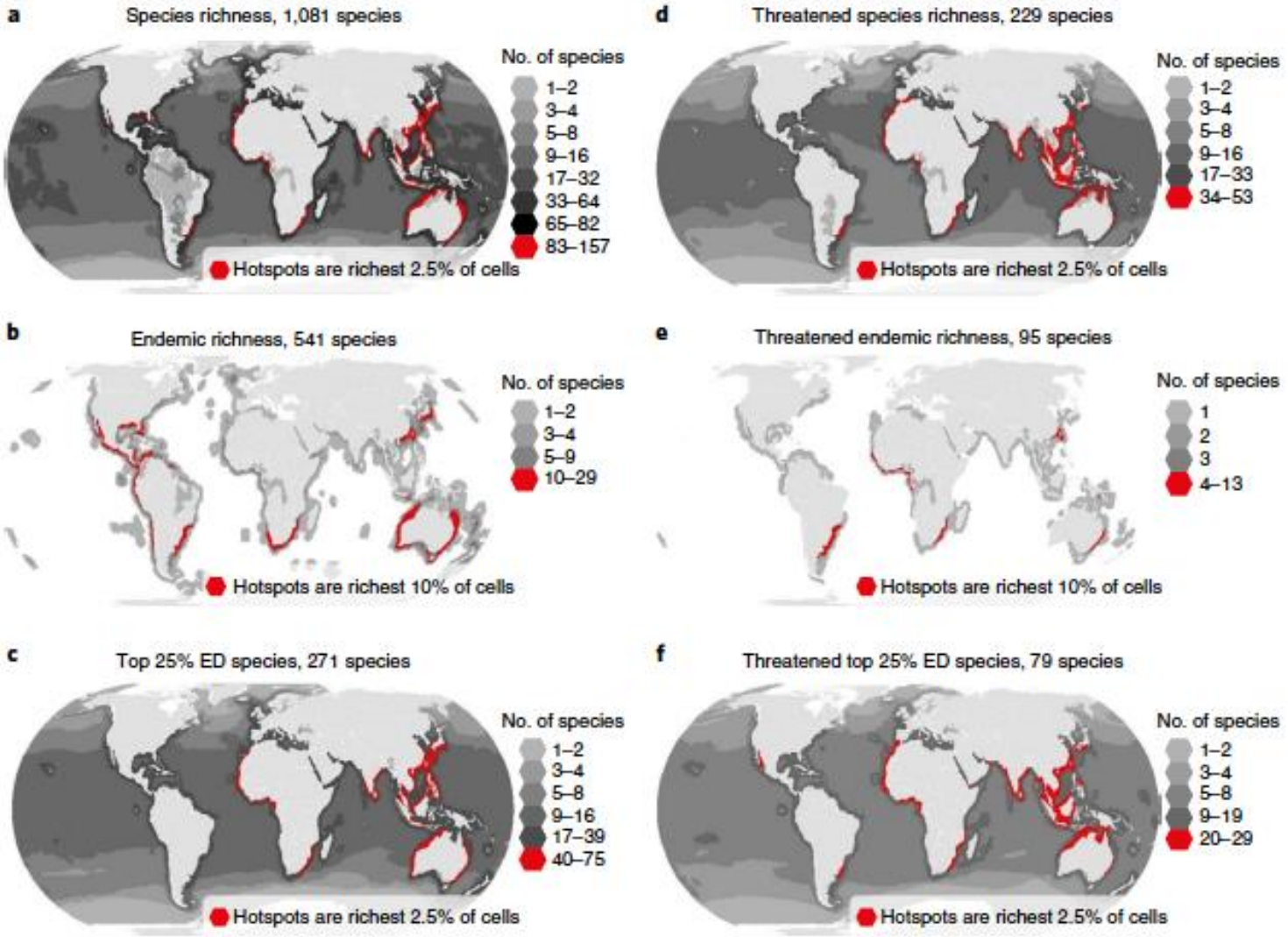


Fig. 5 | Species richness, endemism and ED patterns. a–c, For all chondrichthyan species. **d–f**, For threatened chondrichthyan species only. Hottest hotspots are depicted in red.

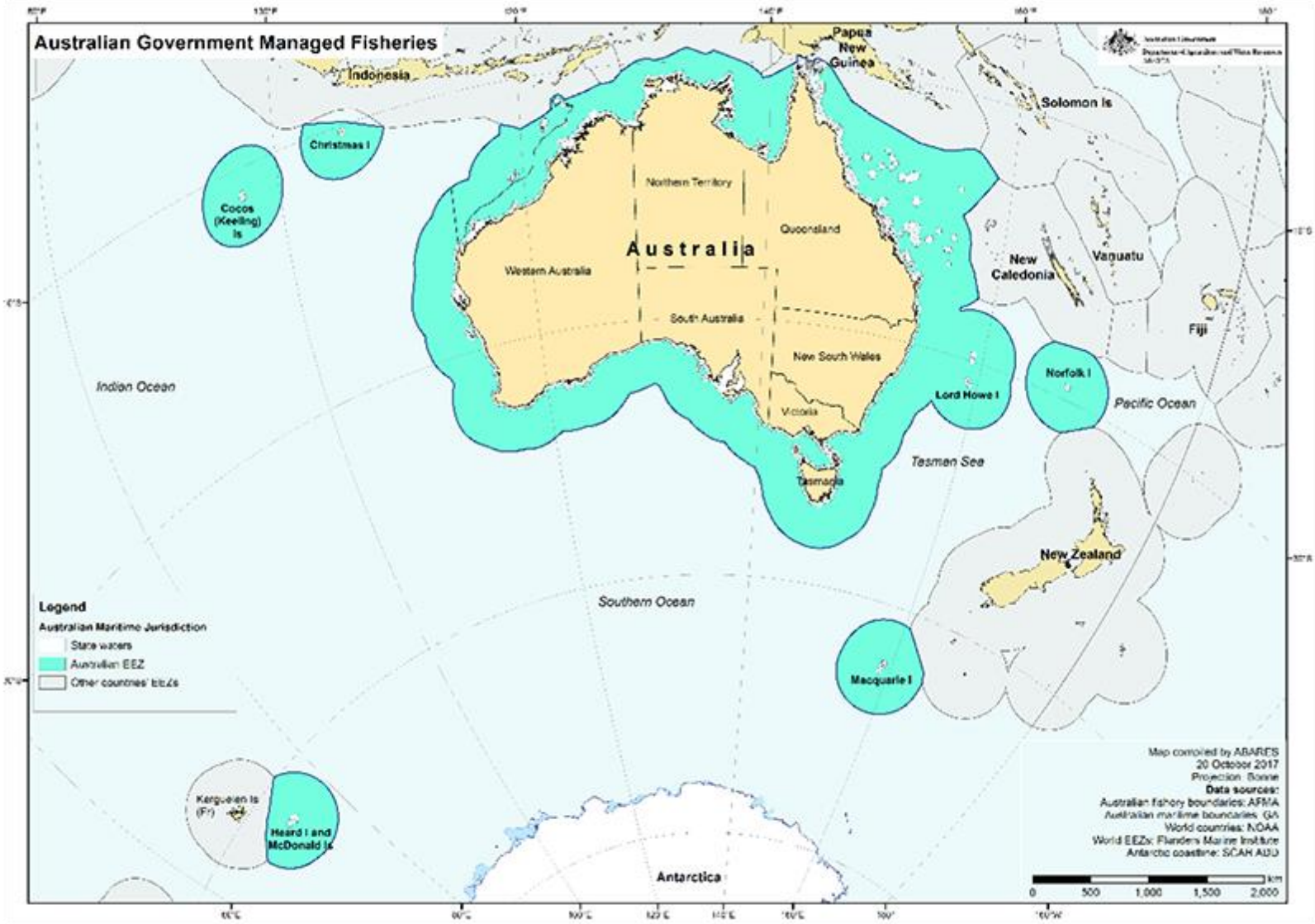
Stein et al. 2018, Nature Ecology and Evolution

Australian Fishing Zone

Australian Government
Department of Agriculture and Water Resources
ABARES

Shark assessment report 2018

James Woodhams and Cher Harte
Research by the Australian Bureau of Agricultural and Resource Economics and Sciences
November 2018



~6-9k tonnes of commercial shark catch reported

Table 1 Reported commercial shark catch, by jurisdiction, 2006–07 to 2014–15

Jurisdiction	2006–07 (tonnes)	2007–08 (tonnes)	2008–09 (tonnes)	2009–10 (tonnes)	2010–11 (tonnes)	2011–12 (tonnes)	2012–13 (tonnes)	2013–14 (tonnes)	2014–15 (tonnes)
Commonwealth a	3,969	4,316	3,959	3,714	3,692	3,344	3,555	3,446	3,597
New South Wales	747	602	314	356	330	321	273	247	205
Victoria	63	56	42	38	49	49	46	43	42
Queensland	1,672	1,417	1,289	899	702	582	551	585	592
South Australia	159	197	236	342	258	273	210	206	136
Western Australia	1,574	1,899	1,608	1,226	1,013	912	946	995	1,044
Tasmania	35	24	21	16	17	16	13	10	12
Northern Territory	838	822	885	665	853	795	442	127	123
Total b	9,057	9,333	8,354	7,257	6,914	6,291	6,035	5,659	5,750

a Commonwealth catch includes discards where data were available. b Reporting of catch by jurisdiction varies according to the state of processing. Some jurisdictions report whole weight; others report processed weight. This information should only be used to make indicative comparisons between years and jurisdictions.

Source: Data supplied by jurisdictions.

Australian Government
Department of Agriculture and Water Resources
ABARES

Shark assessment report 2018

James Woodhams and Cher Harte

Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

November 2018

Table 5 Export destination, value and volume

Country	Value ($)	Volume (kg)
Hong Kong	728,270	50,912
Singapore	103,296	2,000
Taiwan	91,574	109,569
Philippines	86,884	33,254
Malaysia	48,796	4,500
China	22,906	65,896
New Zealand	22,376	1,857
Japan	2,640	49
United States	496	50
Thailand	316	48
Total	**1,107,554**	**268,135**

Australian Government
Department of Agriculture and Water Resources
ABARES

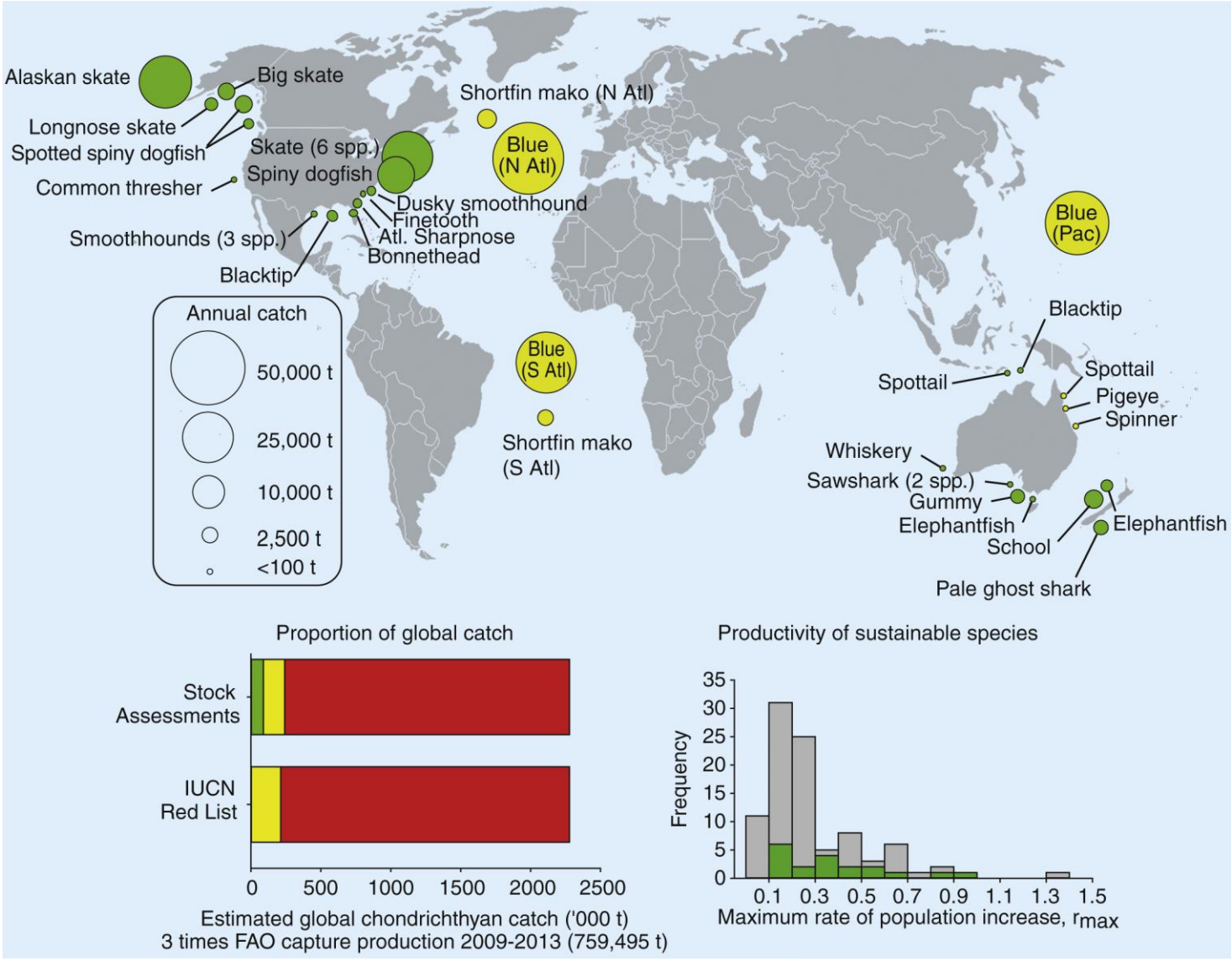
Shark assessment report 2018

James Woodhams and Cher Harte

Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

November 2018

Australian gummy shark fishery sustainable



Simpfendorfer & Dulvy 2017

Table 2 Top 10 shark species caught by jurisdiction, 2006–07 to 2014–15

Jurisdiction	Top 10 species by catch volume	Proportion of total catch (%)
Commonwealth	Gummy, school, sawshark (*Pristiophorus spp.*), ornate angelshark (*Squatina tergocellata*), common sawshark (*Ristiophorus cirratus*), elephantfish (*Callorhinchus milii*), shortfin mako (*Isurus oxyrinchus*), Australian angelshark (*Squatina australis*), platypus (mixed species) and broadnose shark (*Notorynchus cepedianus*).	85
New South Wales	Shovelnose rays (family Rhinobatidae), unspecified shark, gummy, fiddler rays (Trygonorrhina), angel shark (*Squatina spp)*, blacktip (Carcharhinus spp), sandbar (*C. plumbeus*), sawshark (*Pristiophorus spp.*), wobbegong (Orectolobidae) and bronze whaler (*C. brachyurus*).	78
Victoria	Gummy, skate, southern eagle ray (*Myliobatis australis*), elephantfish, angelshark, blue (*Prionace glauca*), school, bronze, seven gilled and unspecified shark.	97
Queensland	Unspecified whaler (Carcharhinus spp), Australian blacktip, hammerhead, blacktip, unspecified shark, spot-tail, scalloped hammerhead (*Sphyrna lewini*), pigeye and bullshark (grouped) and spinner shark (*Carcharhinus brevipinna*).	91
South Australia	Gummy, school, bronze and dusky whaler, wobbegong, port jackson (*Heterodontus portusjacksoni*), elephantfish, saw shark and other.	100
Western Australia	Gummy, bronze, whiskery (*Furgaleus macki*), sandbar, hammerhead, copper whaler, spinner, wobbegong, blacktip and pigeye.	94
Tasmania	Gummy, elephantfish, draughtboard (*Cephaloscyllium laticeps*), school, seven gilled (Hexanchidae), sawshark, thresher (Alopias spp.), mako (Isurus spp.), unspecified shark and wobbegong.	99
Northern Territory	Australian blacktip (*C. tilstoni*), hammerhead (Sphyrna spp.), spottail (*C. sorrah*), pigeye (*C. amboinensis),* bull (*C. leucas*), lemon (*Negaprion acutidens*), tiger (*Galeocerdo cuvier*), winghead (*Eusphyra blochii*), dusky and milk shark (*Rhizoprionodon acutus*).	99

Source: Data supplied by jurisdictions

Traceability can be difficult e.g. Non-descript trade and catch codes

Table 4 Trade codes for shark products

Code type	Trade code	Product description
Import	0302650024	Dogfish and other sharks, fresh or chilled (excluding fish fillets and other fish meat of 0304, livers and roes)
	0302810040	Fresh or chilled dogfish and other sharks (excluding fillets and other meat of HS 0304 and livers and roes)
	0303750019	Dogfish and other sharks, frozen (excluding fish fillets and other fish meat of 0304, livers and roes)
	0303810070	Frozen dogfish and other sharks (excluding fillets and other meat of HS 0304 and livers and roes)
	0305590025	Dried shark fins (excluding smoked)
	0305710091	Shark fins, dried, salted, in brine or smoked, whether or not cooked before or during the smoking process
Export	03026500	Dogfish and other sharks, fresh or chilled (excluding fish fillets, other fish meat, livers and roes)
	03037500	Dogfish, and other sharks, frozen (excluding fish fillets, other fish meat, livers and roes)
	03038100	Frozen dogfish and other sharks (excluding fillets and other meat of HS 0304 and livers and roes)
	03057100	Shark fins, dried, salted, in brine or smoked, whether or not cooked before or during the smoking process
Import and export	0304	Fish fillets and other fish meat (whether or not minced), fresh, chilled or frozen

Source: ABS

Australian Government
Department of Agriculture and Water Resources
ABARES

Shark assessment report 2018

James Woodhams and Cher Harte

Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

November 2018

- Live shark finning, the practice of cutting fins from live sharks and dumping their bodies, is illegal in all jurisdictions in Australia
- allows imports of shark fins that cannot be traced to their source.
- Data for shark fin imports to Australia has only been available for the past couple of years.
- Australia imported 23 tonnes in 2013 and 18 tonnes in 2014

Could be coming from places where live finning is still allowed.

- 70% of seafood in Australia is imported

For consumers to be informed, labelling standardised and compulsory and include:

Species
Country of origin
Method of farming or capture

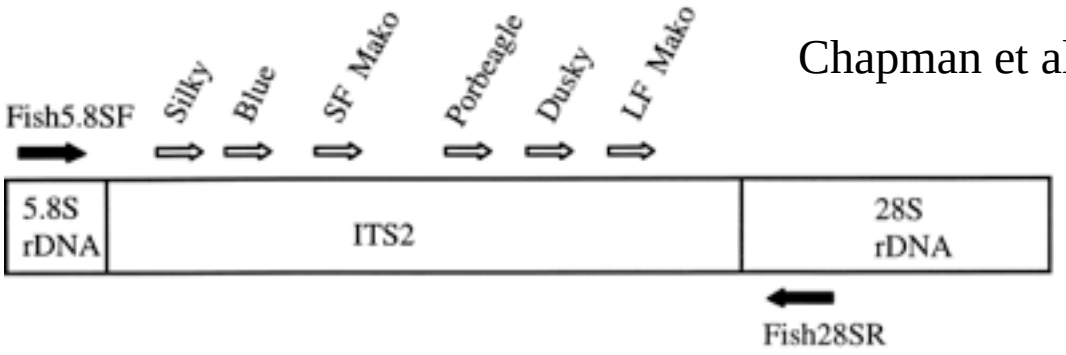
When purchasing uncooked seafood, check the AMCS Sustainable Seafood Guide
https://www.sustainableseafood.org.au/
And look for the Marine Stewardship Council (MSC) tick

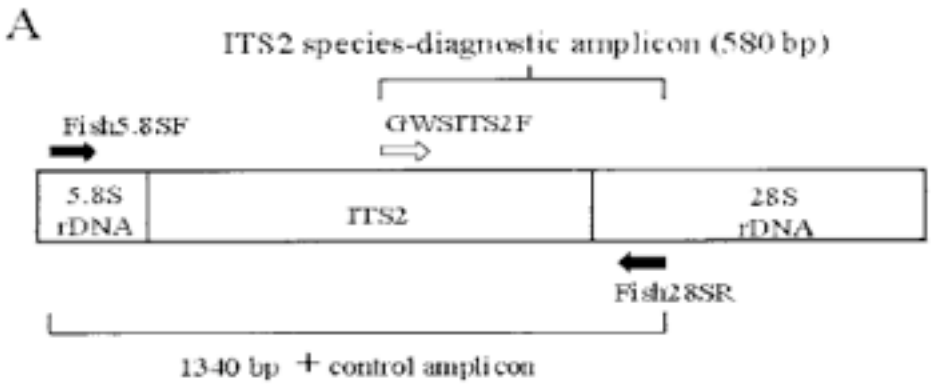
Unclear labelling - Australia

- Fisheries Research and Development Corporation (FRDC) suggested around 100 different species, including some on IUCN Red List
- FRDC fish naming standard = voluntary & not mandated under Food Standards Code.
- But Australian Competition & Consumer Commission (ACCC) can call out deceptive labelling.
- Overall not good for food safety or traceability – consumers want to know
- Much of the seafood industry is in support of better labelling.

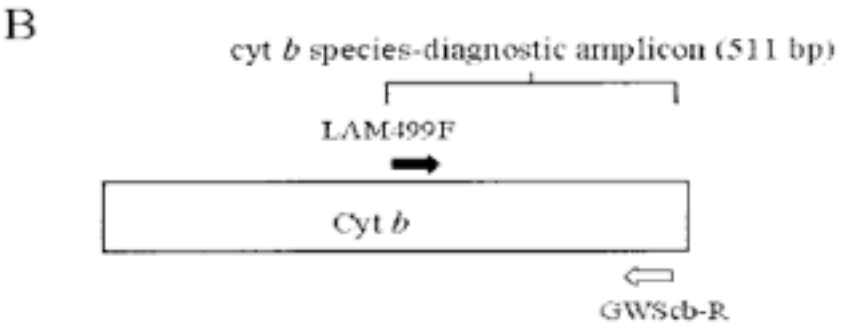
Species specific screening

Chapman et al. 2003

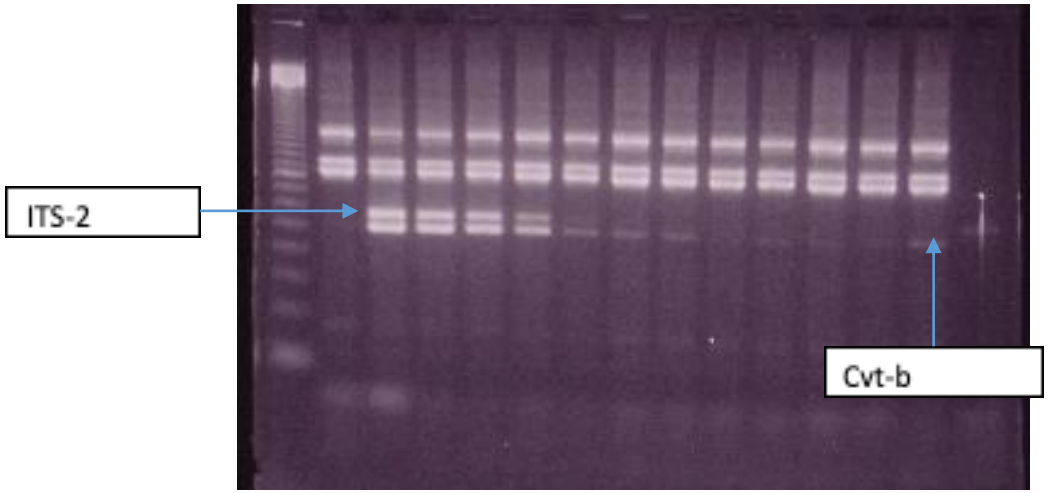




Shivji *et al.* (2001)



White shark sensitivity test



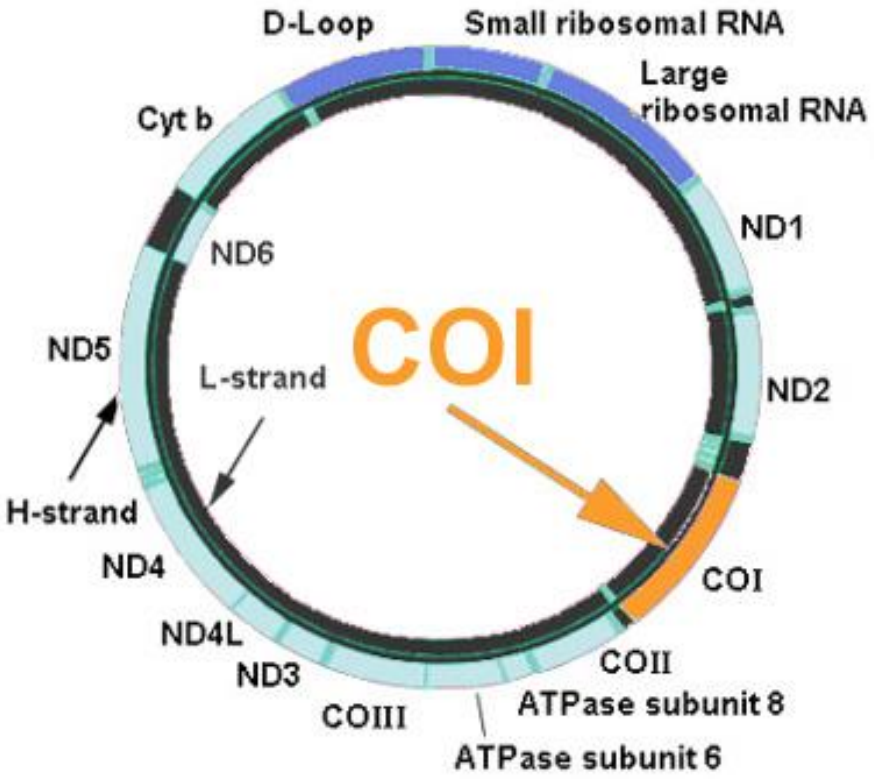
Lane	Concentration	Lane	concentration
1	Unspiked	8	10^{-7}
2	10^{-1}	9	10^{-8}
3	10^{-2}	10	10^{-9}
4	10^{-3}	11	10^{-10}
5	10^{-4}	12	10^{-11}
6	10^{-5}	13	10^{-12}
7	10^{-6}	14	Negative control

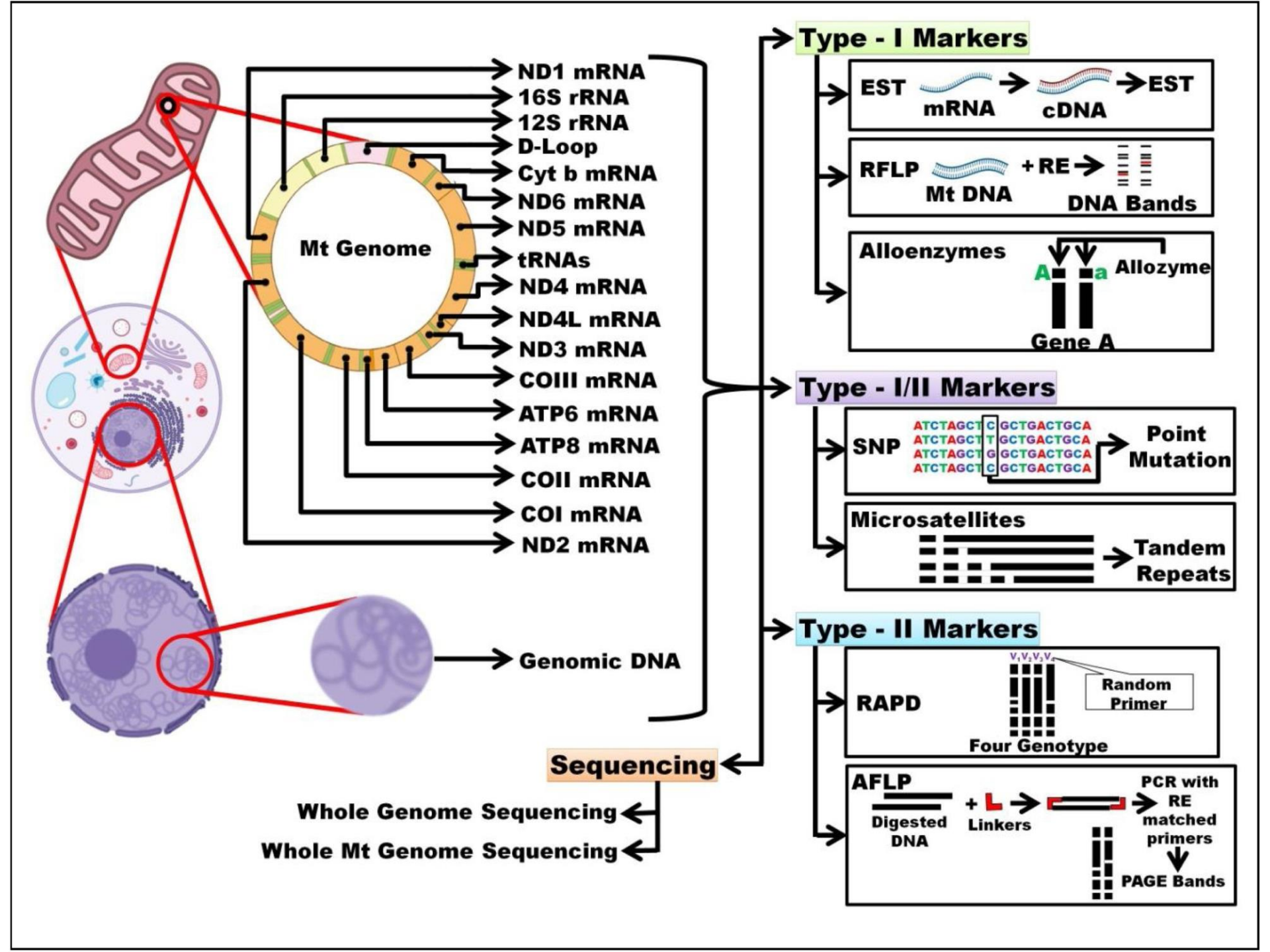
Species	Species
Smooth Hammerhead	Great White (S.Africa)
Scalloped Hammerhead	Grey Nurse (S.Africa)
Bull	Grey Nurse
Bronze Whaler	Dwarf Wobbegong
Tiger	Ornate Wobbegong
Java	
Black Tip	
Dusky	
Grey Nurse	

barcoding

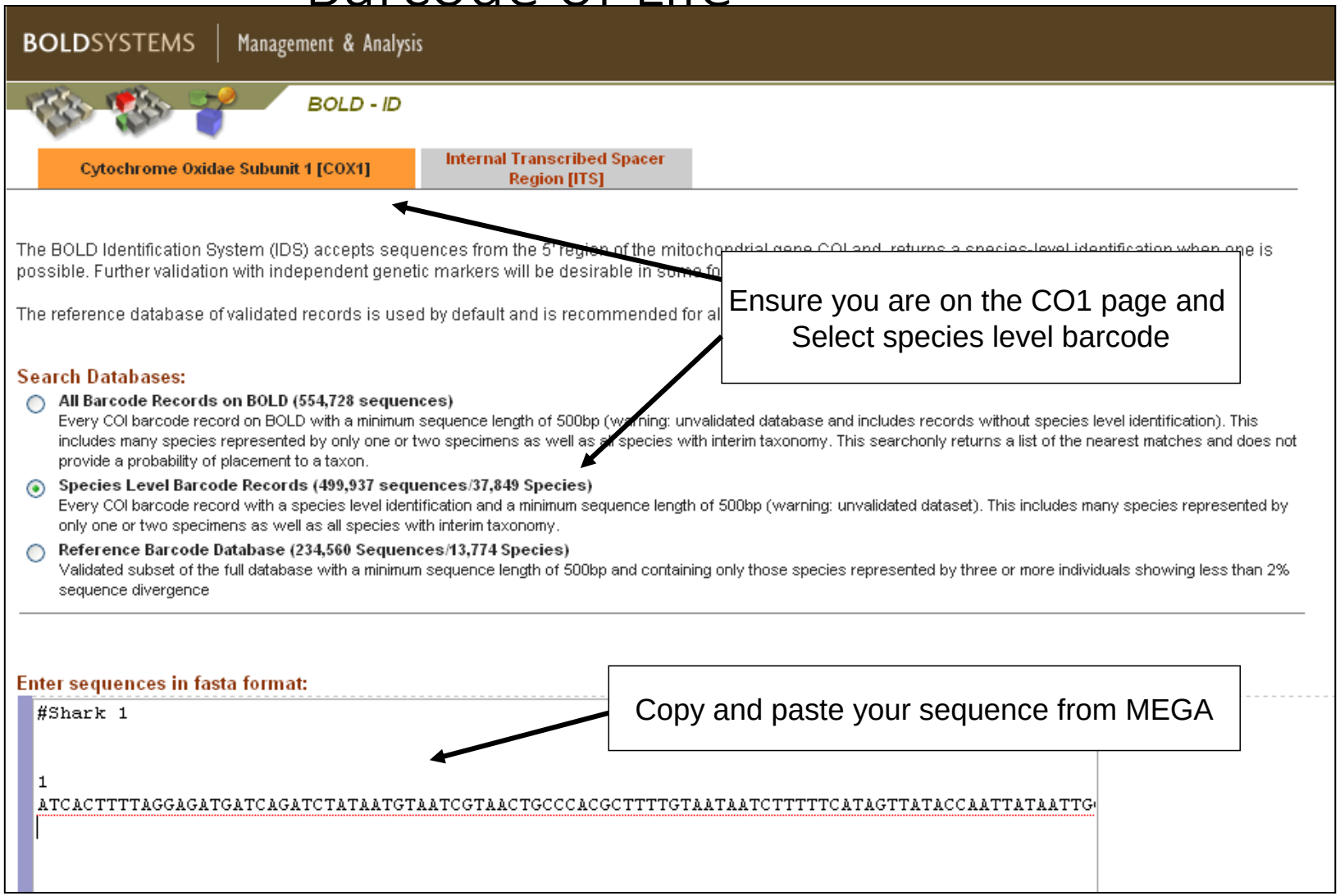
Source: Banksy

- Identify species from similar genetic signatures
- The cytochrome oxidase I gene (COI) is one of 13 mitochondrial genes




ND1 mRNA
16S rRNA
12S rRNA
D-Loop
Cyt b mRNA
ND6 mRNA
ND5 mRNA
tRNAs
ND4 mRNA
ND4L mRNA
ND3 mRNA
COIII mRNA
ATP6 mRNA
ATP8 mRNA
COII mRNA
COI mRNA
ND2 mRNA
Mt Genome
Genomic DNA
Sequencing
Whole Genome Sequencing
Whole Mt Genome Sequencing
Type - I Markers
EST
mRNA
cDNA
EST
RFLP
Mt DNA
+RE
DNA Bands
Alloenzymes
A
a
Allozyme
Gene A
Type - I/II Markers
SNP
ATCTAGCT C GCTGACTGCA
ATCTAGCT T GCTGACTGCA
ATCTAGCT G GCTGACTGCA
ATCTAGCT C GCTGACTGCA
Point Mutation
Microsatellites
Tandem Repeats
Type - II Markers
RAPD
Random Primer
Four Genotype
AFLP
Digested DNA
+
Linkers
PCR with RE matched primers
PAGE Bands

Barcode of Life

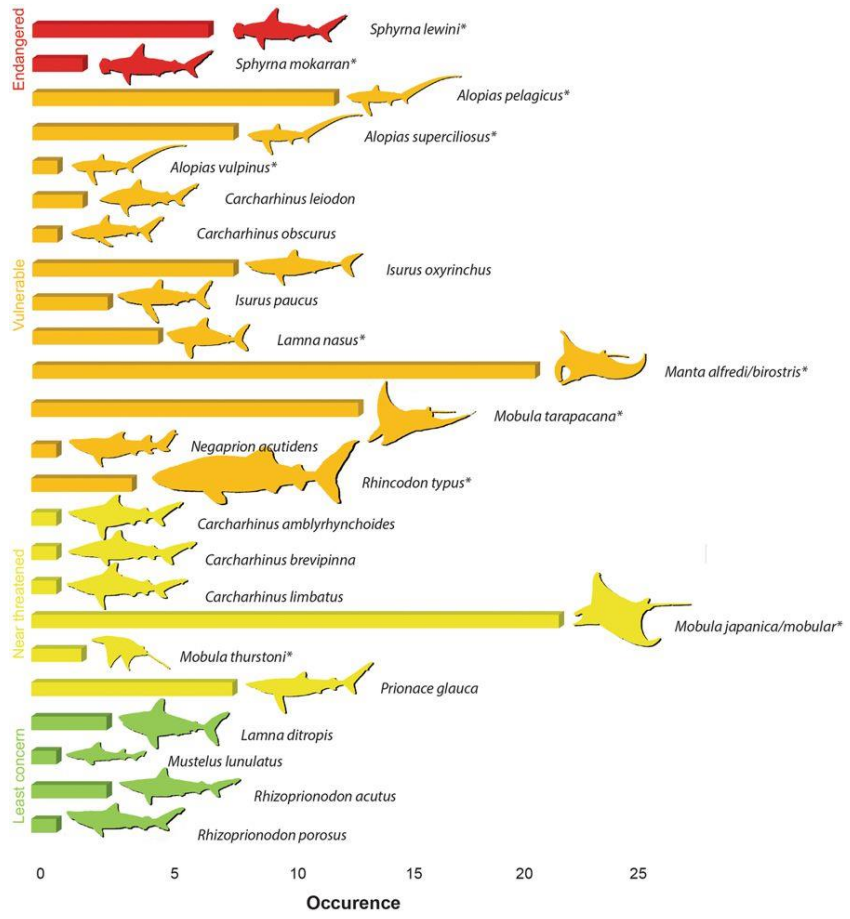


DNA analysis of traded shark fins and mobulid gill plates reveals a high proportion of species of conservation concern

Dirk Steinke[1], Andrea M. Bernard[2,3], Rebekah L. Horn[2,3], Paul Hilton[4], Robert Hanner[5] & Mahmood S. Shivji[2,3]

SCIENTIFIC REPORTS

2017



Obtained from Canada, China, Sri Lanka – around half IUCN Endangered or Vulnerable categories

Figure 1. Species identifications for 134 dried shark fin and Mobulidae ray gill plate samples. Bar length represents abundance; colour and order (Y-axis) correspond to IUCN Red List status. Species currently listed or that will be listed in CITES appendices in 2017 are marked with CITES logo.

Unclear seafood labelling

Table 1
Examples of reported cases of mislabelling by country.

Country	Notes	Source
Australia	23.2% of seafood products mislabelled	Anonymous. Food Standards Australia New Zealand
Canada	41.2% of seafood products mislabelled	Hanner et al., 2011
Ireland	25% of cod and haddock products mislabelled;	Miller & Mariani, 2010
Ireland	28.2% of cod mislabelled	Miller et al., 2012
Italy	77% of 'palombo' shark products substituted;	Barbuto et al., 2010
Italy	32% seafood products mislabelled	Filonzi, Chiesa, Vaghi, & Marzano, 2010
Italy	79% jellyfish products mislabelled	Armani et al., 2013
South Africa	50% of seafood products mislabelled	Von der Heyden et al., 2010
South Africa	31% fish seafood mislabelled	Cawthorn et al., 2012
Spain	20% of hake sampled found to be mislabelled	Machado-Schiaffino, Martinez, & Garcia-Vazquez, 2008
United States	77% of red snapper mislabelled	Marko et al., 2004

Lamedin et al. 2015

- UK up to 78% of some species mislabeled
- Preliminary Australian results show high proportion (~ 30-40%) of gummy shark mislabeled from Melbourne vendors (Greenpeace 2015).

Takeaway 47% labelled ‘Rock’; 56% Fishmonger ‘Huss’

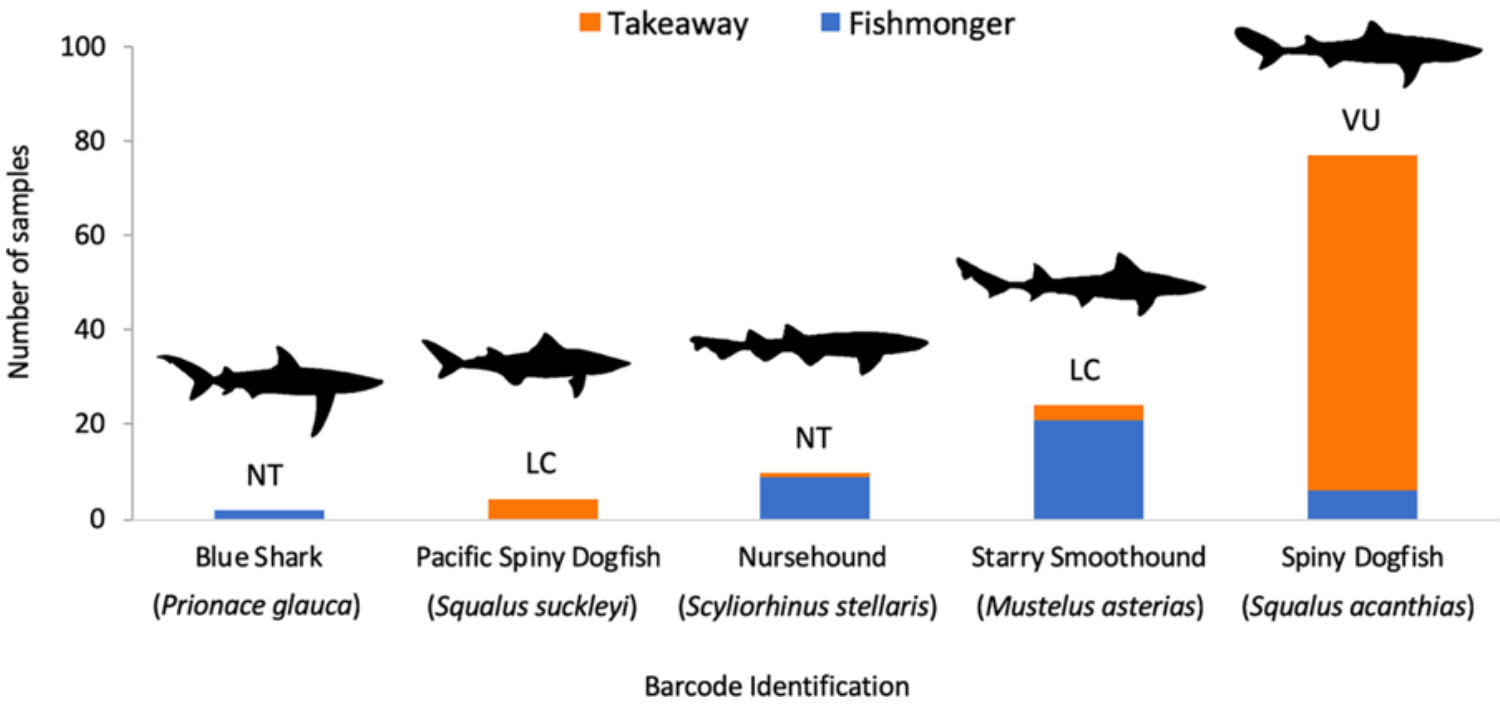
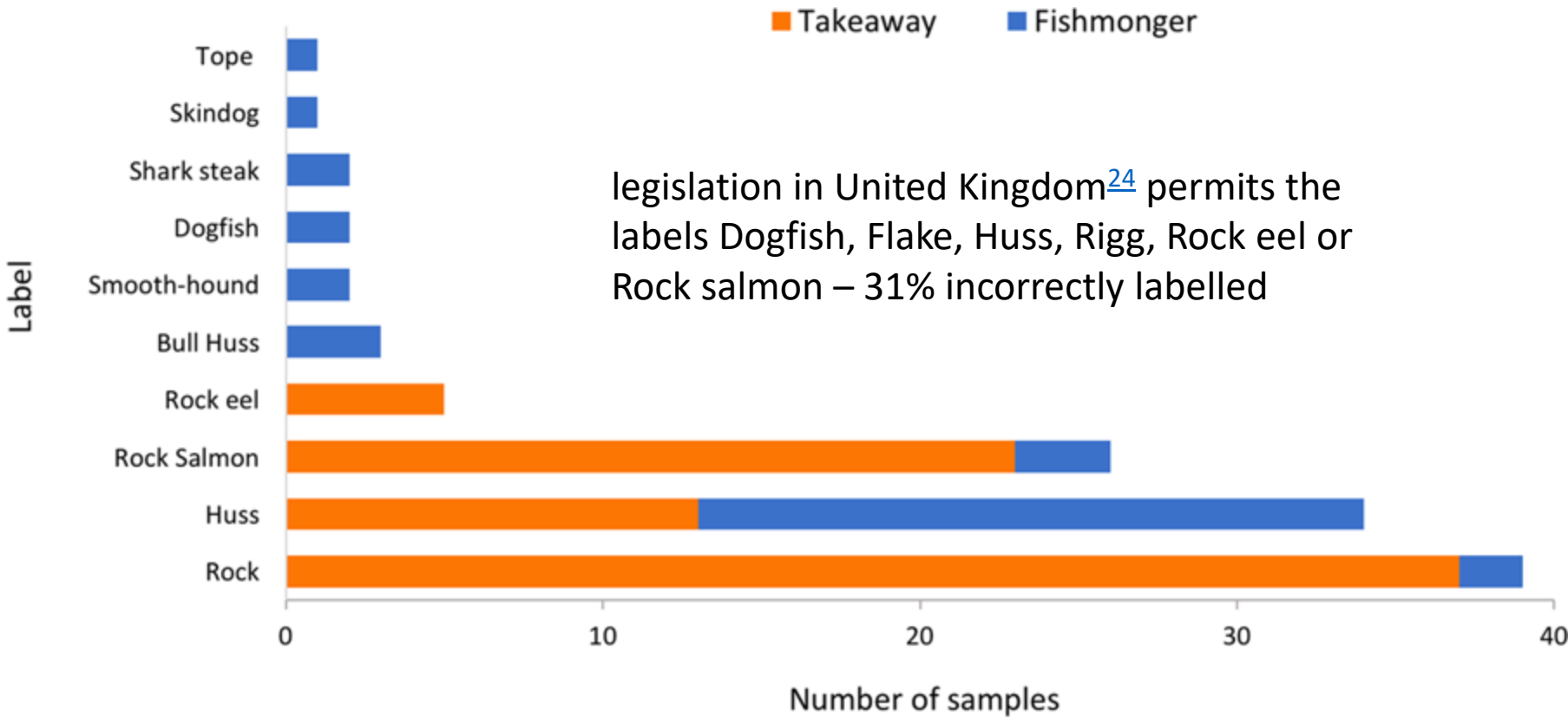


Figure 2

Using DNA Barcoding to Investigate Patterns of Species Utilisation in UK Shark Products Reveals Threatened Species on Sale

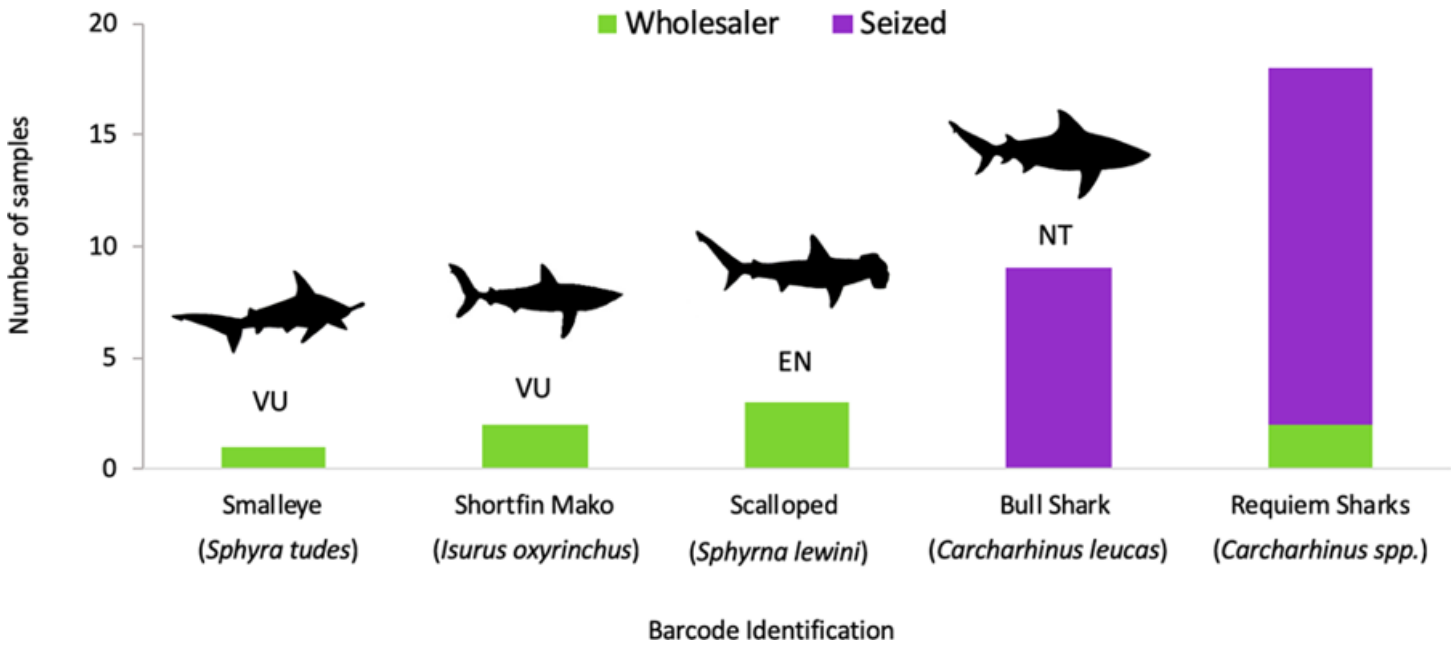
Hobbs et al. Scientific Reports 2019



legislation in United Kingdom[24] permits the labels Dogfish, Flake, Huss, Rigg, Rock eel or Rock salmon – 31% incorrectly labelled

Variation in labels used by retailers (n = 115; Takeaway = 78, Fishmonger = 37, in two cases products were not labelled).

No species information given at sale



Bar chart of species identities assigned to shark fins. Bars are divided according to the source of the fins and the global IUCN Red List conservation status of each species is highlighted (NT: Near Threatened, VU: Vulnerable and EN: Endangered).

Meta-barcoding – large scale monitoring

- DNA based identification and high-throughput DNA
- Sequencing. Using universal PCR primers to mass-amplify DNA Barcodes from mass collections of samples

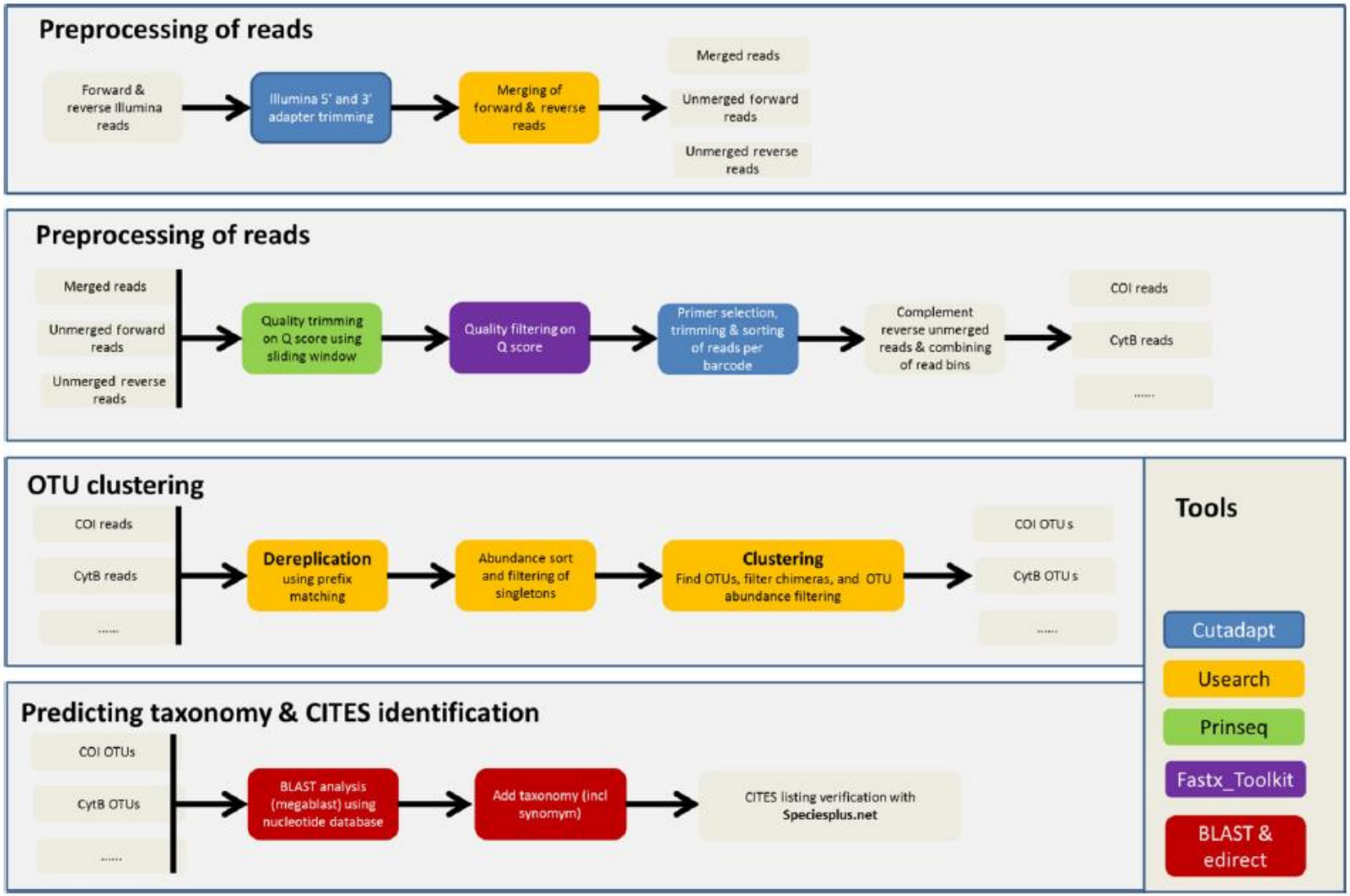


Figure 1: Schematic representation of the CITESspeciesDetect pipeline.

Next Lecture:

Modes of Speciation/ Wrap UP