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Supplementary Materials for

Overfishing and habitat loss drives range contraction of iconic marine fishes to near extinction

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Supplementary text

Habitat availability

To characterize ecological carrying capacity, we compared the performance and predictive accuracy of using coastline length, a proxy of the total habitat availability, versus continental shelf area. We measured coastline length (acquired from Natural Earth free database) as the coastline found within the distribution maps; for example, the coastline length of the USA was measured as the south-eastern coast [see Fig. 2A; (*23*)]. We measured continental shelf area using the species-specific depths reported by the IUCN Red List of Threatened Species: *Pristis pectinata* (88m), *P. zijsron* (70m), *P. clavata* (20m), and *Anoxypristis cuspidata* [40m; (*26*)]. Because *P. pristis* has no reported depth limit on the IUCN Red List, we considered a previously reported depth limit of 25m [shelf area (shallow); (*65*)] and the maximum lower depth limit of 100m [shelf area (deep); (*23*)] separately. Both the shallow and deep shelf area were highly correlated with coastline length (r = 0.87 and 0.88, respectively; Fig. S2). We used Boosted Regression Trees (BRT) to individually compare the performance of shelf area (shallow), shelf area (deep), and coastline length on the predictive accuracy of sawfish occurrence. Using 100 bootstrapped models, the cross-validated median of the area under the curve (AUC) of the receiver operating characteristic (ROC) curve was lowest for shelf area deep (AUC = 0.79) and equal for coastline length and shelf area shallow (AUC = 0.83). However, shelf area shallow explained more of the deviance in the test set (27.1%) compared to coastline length (6.0%). Consequently, we used shelf area shallow (km^2) as the measurement of total habitat available for sawfishes.

Species	Residential and commercial development	Energy production and mining	Transportation and service corridors	Natural system modifications	Pollution	Climate change and severe weather	Biological resource use
Largetooth Sawfish *Pristis pristis* 							
Smalltooth Sawfish *P. pectinata* 							
Green Sawfish *P. zijsron* 							
Dwarf Sawfish *P. clavata* 							
Narrow Sawfish *Anoxypristis cuspidata* 							

Fig. S1. Reported threats for sawfishes from the IUCN Red List of Threatened Species. Coloured boxes indicate listed threats affecting each species of sawfish. Blue boxes denote threats affecting habitat quality and quantity (i.e., ecological carrying capacity) and boxes in red denote threats derived from fishing (i.e., fishing pressure). Red silhouettes denote species that are listed as Critically Endangered and orange silhouettes denote species that are listed as Endangered. Note that although these are published with the Red List Assessments, the total number of threats impacting each species is not limited to this list. In practice, all five species are vulnerable to all the listed threats to a degree, but may differ in the magnitude by which they are affected.

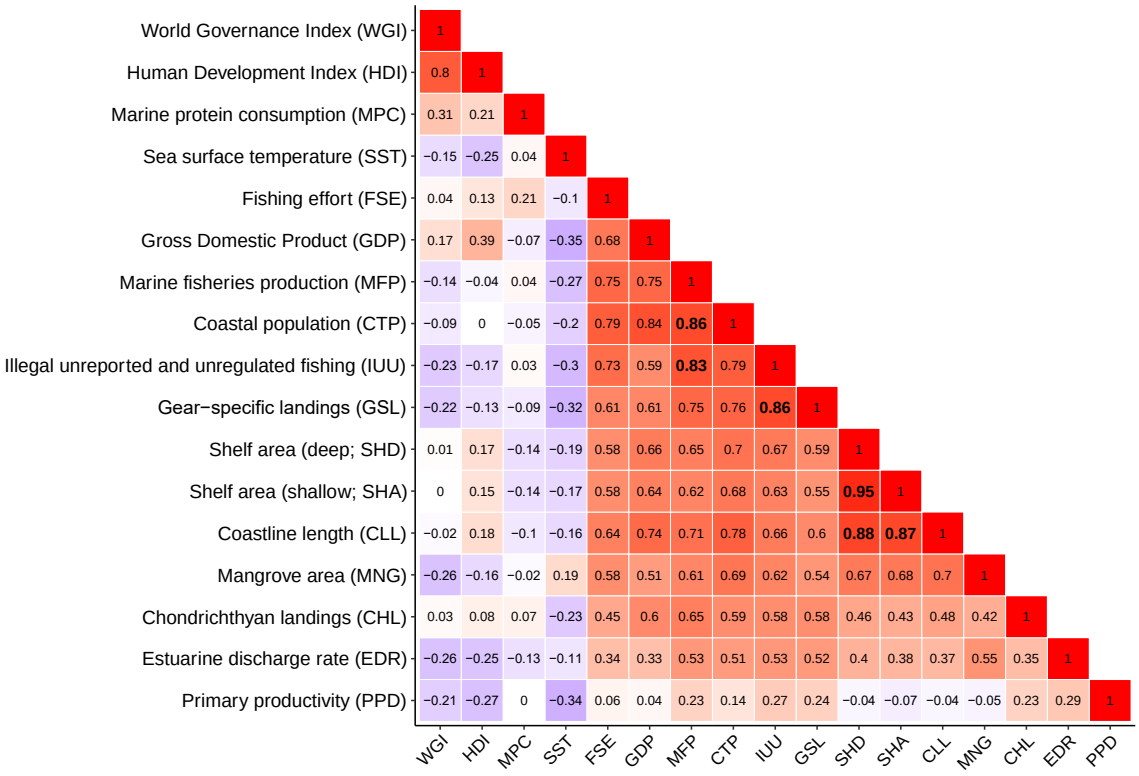

Fig. S2. Pearson's correlation table for variables initially considered for analysis. Values highlighted in red represent positive correlations, purple boxes are negative correlations. Illegal unreported and unregulated fishing (IUU), marine fisheries production (MFP), coastline length (CLL), and shelf area (deep; SHD) were dropped from further analyses due to high collinearity with more than a single variable (collinear values are bolded).

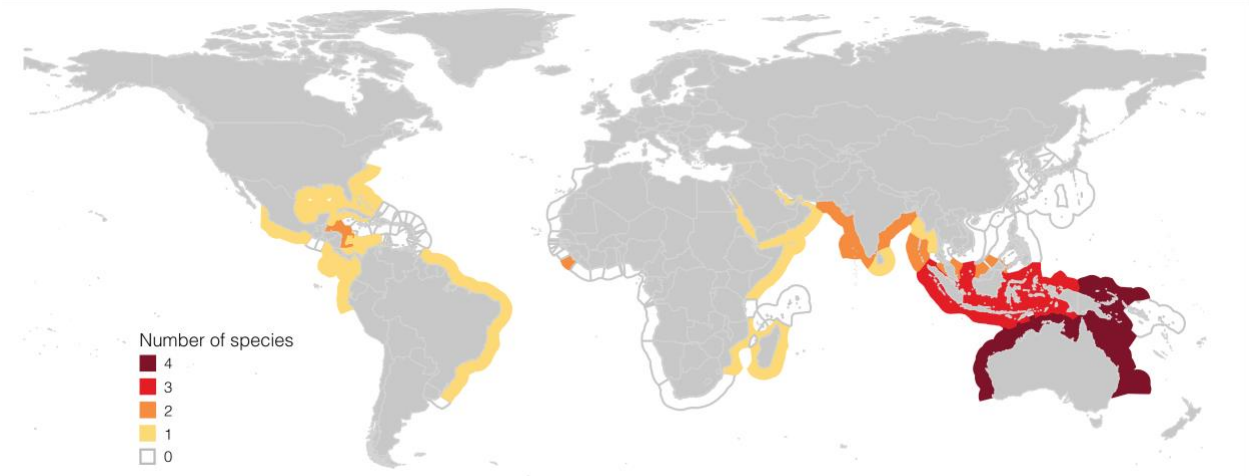

Fig. S3. Current distribution of sawfishes. The total number of sawfish species that are Extant in each nation. Statuses are coloured in the Exclusive Economic Zone (EEZ) of each nation's coastal waters and where higher species richness is denoted by the warmer colours; no colour means that there are no confirmed Extant species in that nation (although at least one species of sawfish historically occurred in each EEZ shown).

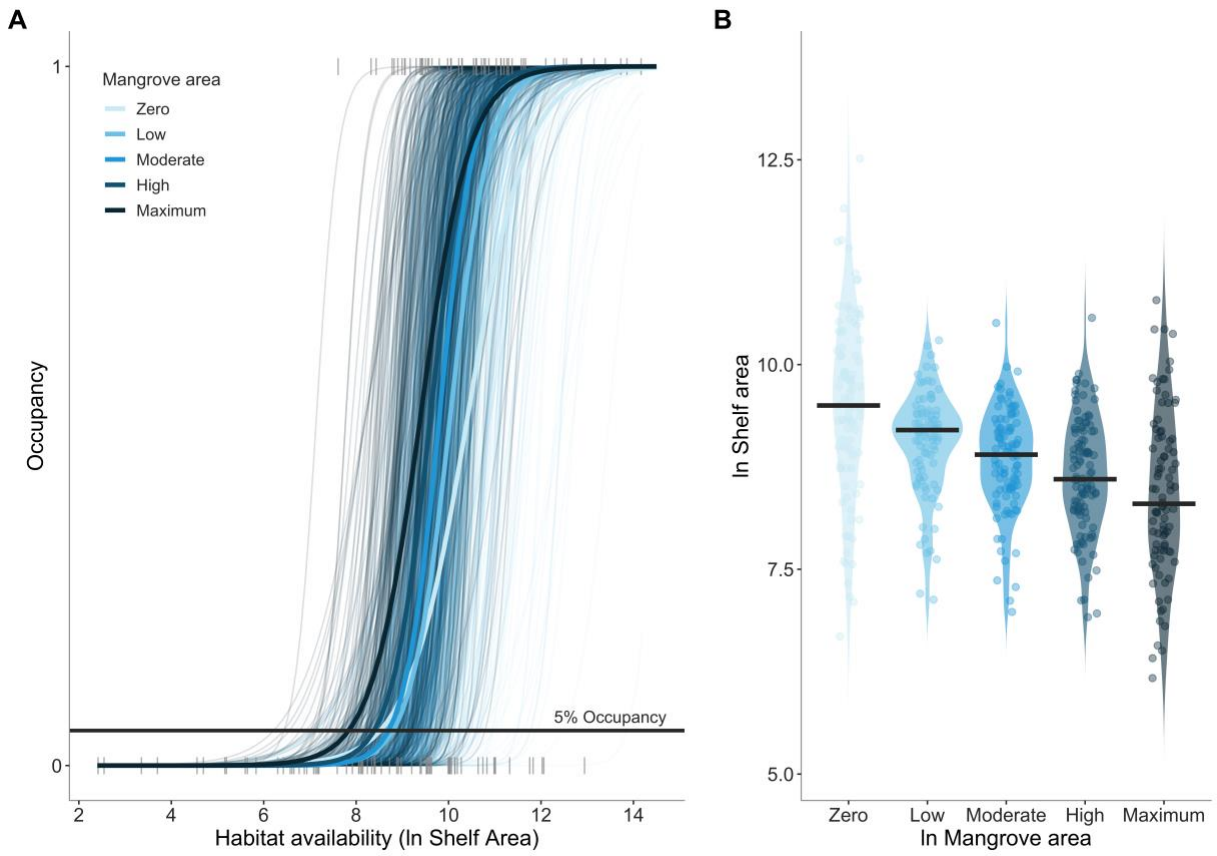

Fig. S4. Predicted changes in occupancy and habitat availability with changes in mangrove area. The effects of increasing mangrove area on the occupancy of sawfishes. (**A**) Logistic regression where the light grey ticks show the raw data, the thin curves show draws from the posterior distribution, and the thick coloured curves are the mean posterior estimates. Curves are coloured and predicted by levels of mangrove area where fishing pressure is held at its mean: the colour darkens with the total area of mangrove, namely the darkest blue represents the maximum mangrove area. The thick grey line shows the intersection where 5% occupancy occurs. (**B**) Estimated habitat required to have 5% occupancy from the posterior distribution through different levels of mangrove area. Violin plots and points show the spread of the posterior draws and the thick lines show the median value. Points have been jittered for ease of interpretation.

Table S1. Variable importance of all models in Boosted Regression Trees (BRT). Median, minimum, and maximum variable importance calculated from 1,000 bootstrapped BRT models for all variables.

Variable	Median (%)	Minimum (%)	Maximum (%)
Indirect fishing pressures			
ln marine protein consumption	9.38	7.96	10.9
ln coastal population	4.82	3.70	6.18
Direct fishing pressures			
ln gear-specific landings	14.5	13.0	17.3
ln chondrichthyan landings	4.86	3.20	5.92
ln fishing effort	2.22	1.09	3.26
Management capacity			
World Governance Index	7.18	6.04	8.41
ln Gross Domestic Product	5.66	2.50	7.04
Human Development Index	3.67	2.61	4.63
Ecological carrying capacity			
ln continental shelf area	25.0	22.8	28.6
ln mangrove area	14.8	13.0	17.0
ln estuarine discharge rate	3.06	1.91	4.09
ln marine primary productivity	2.10	1.15	3.08
Sea surface temperature	1.52	0.69	2.35
Species			
Green Sawfish (*Pristis zijsron*)	0.42	0	0.78
Smalltooth Sawfish (*P. pectinata*)	0.54	0.19	1.00
Largetooth Sawfish (*P. pristis*)	0.21	0.02	0.45
Narrow Sawfish (*Anoxypristis cuspidata*)	0	0	0.01
Dwarf Sawfish (*P. clavata*)	0	0	0

Table S2. Predicted probability of extinction. Predicted probability of extinction from Boosted Regression Trees (BRTs) of Presence Uncertain nations shown as the median, minimum, and maximum predicted values of 1,000 bootstrapped samples. Presence Uncertain nations include nations where either the current presence of all sawfishes is unknown (*), or although the presence of some species can be confirmed, the presence of others is unknown.

Country	Median (%)	Minimum (%)	Maximum (%)
Jamaica	94.8	87.3	98.1
Brunei*	88.2	73.1	97.6
Singapore	86.9	75.5	95.3
Djibouti*	85.9	79.1	90.3
Guinea	85.7	73.6	94.2
Taiwan*	85.4	75.1	92.3
Cambodia	85.2	77.3	93.2
Oman	84.8	81.0	88.6
El Salvador*	84.4	76.1	92.3
Timor-Leste*	83.4	16.7	91.3
Japan*	81.9	71.5	89.6
Haiti*	81.8	73.9	87.3
Iraq*	81.8	77.8	85.4
China*	80.8	70.5	88.7
Thailand	79.7	69.4	87.0
Guyana	73.9	60.7	86.2
Egypt*	73.4	58.8	89.0
South Korea*	71.9	64.1	78.4
Dominican Republic*	70.8	64.5	77.3
Vietnam	66.6	60.5	74.8
Venezuela	63.4	56.1	72.1
Iran	62.0	56.5	67.5
Kenya	58.9	50.5	66.0
Myanmar	42.9	26.0	53.7
India	42.7	31.5	51.0
Costa Rica	42.0	19.7	59.8
Yemen	38.6	23.6	49.3
Kuwait*	33.4	19.2	46.2
Somalia	30.3	18.3	42.5
Bangladesh	30.2	19.2	44.1
French Guiana	30.2	21.0	38.4
Suriname	26.2	16.9	37.3
Bahamas	25.3	17.1	34.1
Solomon Islands*	24.9	19.0	32.2
Sri Lanka	18.6	6.2	38.9
Mexico	18.6	9.6	32.2
Brazil	18.0	10.3	30.6
Panama	15.5	7.0	30.3
Madagascar	13.3	6.9	24.1
Colombia	12.6	7.2	23.9
Tanzania*	12.2	5.8	23.9
Cuba	9.4	4.0	21.7