Supplemental Material

Table S1. Exposure and consequence (resilience and sensitivity) tables for each site.

Exposure

GEARS	Dugong (JOHR)	Dolphin (KGBR)	Dolphin (TRAT)	Dolphin (KUCG)	RATING SCHEME
1) Nets					
Spatial overlap	Calculated for each grid cell and region by the ByRA model ----------------------------------				<enter (3) > 30% of species range overlaps with stressor, (2) 10-30% overlap, (1) 0-10% overlap, (0) no score>
Intensity	Calculated based on fishing effort / gear type densities --------			0	<enter (3) high, (2) medium, (1) low, (0) no score>
Likelihood of species-threat interaction	Calculated based on habitat suitability model --				<enter (3) high, (2) medium, (1) low habitat suitability, (0) no score>
Temporal overlap	2	3 | 2	3	3 | 2	<enter (3) gear and species interact all year (12 months), (2) most of year (4- 11 mo), (1) occasional (1-3 mo), (0) no score>
Likelihood of capture by gear	3	3	3	3	<enter (3) high, (2) medium, (1) low, (0) no score>
Current status of management actions	2	3 | 2	2	3	<enter (3) no strategy identified, (2) mgmt strategy identified, (1) mgmt strategy identified and implemented, (0) no score>
2) Longlines					
Spatial overlap	Calculated for each grid cell and region by the ByRA model ----------------------------------				<enter (3) > 30% of species range overlaps with stressor, (2) 10-30% overlap, (1) 0-10% overlap, (0) no score>
Intensity	Calculated based on fishing effort / gear type densities --------			0	<enter (3) high, (2) medium, (1) low, (0) no score>
Likelihood of species-threat interaction	Calculated based on habitat suitability model --				<enter (3) high, (2) medium, (1) low habitat suitability, (0) no score>
Temporal overlap	2	2	2	2	<enter (3) gear and species interact all year (12 months), (2) most of year (4- 11 mo), (1) occasional (1-3 mo), (0) no score>
Likelihood of capture by gear	3	1	1	1	<enter (3) high, (2) medium, (1) low, (0) no score>
Current status of management actions	2	3 | 2	1	3	<enter (3) no strategy identified, (2) mgmt strategy identified, (1) mgmt strategy identified and implemented, (0) no score>
3) Pots & Traps					
Spatial overlap	Calculated for each grid cell and region by the ByRA model ----------------------------------				<enter (3) > 30% of species range overlaps with stressor, (2) 10-30% overlap, (1) 0-10% overlap, (0) no score>
Intensity	Calculated based on fishing effort / gear type densities --------			0	<enter (3) high, (2) medium, (1) low, (0) no score>
Likelihood of species-threat interaction	Calculated based on habitat suitability model --				<enter (3) high, (2) medium, (1) low habitat suitability, (0) no score>
Temporal overlap	3	3	3	3	<enter (3) gear and species interact all year (12 months), (2) most of year (4- 11 mo), (1) occasional (1-3 mo), (0) no score>
Likelihood of capture by gear	1	1	3	1	<enter (3) high, (2) medium, (1) low, (0) no score>
Current status of management actions	2	3 | 2	2	3	<enter (3) no strategy identified, (2) mgmt strategy identified, (1) mgmt strategy identified and implemented, (0) no score>
4) Trawls					
Spatial overlap	Calculated for each grid cell and region by the ByRA model ----------------------------------				<enter (3) > 30% of species range overlaps with stressor, (2) 10-30% overlap, (1) 0-10% overlap, (0) no score>
Intensity	Calculated based on fishing effort / gear type densities --------			0	<enter (3) high, (2) medium, (1) low, (0) no score>
Likelihood of species-threat interaction	Calculated based on habitat suitability model --				<enter (3) high, (2) medium, (1) low habitat suitability, (0) no score>
Temporal overlap	2	2	2	2	<enter (3) gear and species interact all year (12 months), (2) most of year (4- 11 mo), (1) occasional (1-3 mo), (0) no score>
Likelihood of capture by gear	2	2	3	2	<enter (3) high, (2) medium, (1) low, (0) no score>
Current status of management actions	3 | 2	3 | 2	2	3 | 1	<enter (3) no strategy identified, (2) mgmt strategy identified, (1) mgmt strategy identified and implemented, (0) no score>
5) Hook & Line					
Spatial overlap	Calculated for each grid cell and region by the ByRA model ----------------------------------				<enter (3) > 30% of species range overlaps with stressor, (2) 10-30% overlap, (1) 0-10% overlap, (0) no score>
Intensity	Calculated based on fishing effort / gear type densities --------			0	<enter (3) high, (2) medium, (1) low, (0) no score>
Likelihood of species-threat interaction	Calculated based on habitat suitability model --				<enter (3) high, (2) medium, (1) low habitat suitability, (0) no score>
Temporal overlap	2	3	3	3 | 2	<enter (3) gear and species interact all year (12 months), (2) most of year (4- 11 mo), (1) occasional (1-3 mo), (0) no score>
Likelihood of capture by gear	1	1	1	1	<enter (3) high, (2) medium, (1) low, (0) no score>
Current status of management actions	2	3 | 2	3	3	<enter (3) no strategy identified, (2) mgmt strategy identified, (1) mgmt strategy identified and implemented, (0) no score>

Consequence-Sensitivity

GEARS	Dugong (JOHR)	Dolphin (KGBR)	Dolphin (TRAT)	Dolphin (KUCG)	RATING SCHEME
1) Nets					
Mortality / Severity	3	3	3	3	<enter (3) lethal, (2) sublethal, (1) negligible, (0) no score>
Life stages affected by gear	0	0	0	2	<enter (3) adults only, (2) mixed (1) juveniles only, (0) unknown>
2) Longlines					
Mortality / Severity	3	2	1	1	<enter (3) lethal, (2) sublethal, (1) negligible, (0) no score>
Life stages affected by gear	2	0	0	0	<enter (3) adults only, (2) mixed (1) juveniles only, (0) unknown>
3) Pots & Traps					
Mortality / Severity	2	1	2	2	<enter (3) lethal, (2) sublethal, (1) negligible, (0) no score>
Life stages affected by gear	0	0	0	0	<enter (3) adults only, (2) mixed (1) juveniles only, (0) unknown>
4) Trawls					
Mortality / Severity	2	3	3	3	<enter (3) lethal, (2) sublethal, (1) negligible, (0) no score>
Life stages affected by gear	2	0	0	0	<enter (3) adults only, (2) mixed (1) juveniles only, (0) unknown>
5) Hook & Line					
Mortality / Severity	1	2	1	1	<enter (3) lethal, (2) sublethal, (1) negligible, (0) no score>
Life stages affected by gear	0	0	0	0	<enter (3) adults only, (2) mixed (1) juveniles only, (0) unknown>

Consequence-Resilience

	Dugong (JOHR)	Dolphin (KGBR)	Dolphin (TRAT)	Dolphin (KUCG)	RATING SCHEME
SPECIES ONLY CRITERIA					
Age of maturity	3	3	3	3	<enter (3) > 4 years, (2) 2-4 years, (1) < 2 years, or (0) no score>
Reproductive strategy	3	2	2	2	<enter (3) long calving interval / high parental investment, (2) medium calving interval / high parental investment, (1) short calving interval / short to medium parental investmentl, (0) no score>
Population connectivity	2	3	2	3	<enter (3) negligible movement/exchange between the focal regional population and other populations (a DPS or ESU), (2) occasional movement/exchange between the focal regional population and other populations, (1) regular movement/exchange between the focal regional population and other populations (not a DPS or ESU), or (0) no score>
Local status of the species	3	3	3	3	<enter (3) endangered, (2) threatened or of concern, (1) low concern, or (0) no score>

Table S2. Risk percentages for each gear category per fieldsite.

TRAT

Net Type	% of Bycatch Risk		
	Dry Season		Wet Season
	Top		Muang Trat
Pots/Traps	26.98	Pots/Traps	34.47
Trawlers	24.62	Nets	35.52
Nets	27.90	Longline	30.01
Hook/Line	20.50	Trawlers	0.00
	Middle		Khlong Yai
Pots/Traps	25.78		34.34
Trawlers	25.17		32.76
Nets	26.58		0.00
Hook/Line	22.48		32.90
	Bottom		
Pots/Traps	26.63		
Trawlers	22.53		
Nets	28.12		
Hook/Line	22.71		

KUCHING

Net Type	% of Bycatch Risk		
	Post-Monsoon	Dry Season	Pre-Monsoon
	Santubong-Buntal		
Pots/Traps	33.80	48.85	37.77
Trawlers	0.00	0.00	0.00
Nets	36.94	51.15	42.42
Hook/Line	29.27	0.00	29.71
	Santubong-Salak		
Pots/Traps	32.31	29.67	32.82
Trawlers	0.00	24.69	0.00
Nets	36.27	32.96	40.36
Hook/Line	31.41	29.13	37.75
	Salak Telaga Air		
Pots/Traps	30.81	31.51	0.00
Trawlers	0.00	0.00	0.00
Nets	38.53	37.98	53.09
Hook/Line	30.66	30.51	46.91
	Bako-Buntal		
Pots/Traps	0.00	0.00	0.00
Trawlers	32.06	32.44	0.00
Nets	36.19	36.81	100.00
Hook/Line	31.75	30.77	0.00

SIBU-TINGGI ISLANDS		**KIEN GIANG BIOSPHERE RESERVE**			
Net Type	% of Bycatch Risk	Net Type	% of Bycatch Risk		
	Zone		Zone		Zone
	1		1		5
Pots/Traps	23.67	Pots/Traps	22.23	Pots/Traps	19.54
Trawlers	24.00	Trawlers	23.81	Trawlers	21.65
Nets	28.82	Nets	25.13	Nets	23.78
Hook/Line	23.51	Hook/Line	17.79	Hook/Line	17.62
		Longline	19.94	Longline	17.43
	2		2		6
Pots/Traps	23.27	Pots/Traps	24.13	Pots/Traps	19.35
Trawlers	24.19	Trawlers	26.20	Trawlers	34.41
Nets	28.32	Nets	27.28	Nets	37.44
Hook/Line	24.21	Hook/Line	0.00	Hook/Line	18.84
		Longline	22.40	Longline	18.13
	3		3		7
Pots/Traps	23.66	Pots/Traps	23.09	Pots/Traps	0.00
Trawlers	23.94	Trawlers	24.37	Trawlers	28.95
Nets	29.37	Nets	29.64	Nets	31.93
Hook/Line	23.02	Hook/Line	0.00	Hook/Line	27.41
		Longline	22.90	Longline	23.03
	4		4		8
Pots/Traps	24.29	Pots/Traps	22.53	Pots/Traps	29.24
Trawlers	25.15	Trawlers	26.37	Trawlers	34.14
Nets	27.43	Nets	28.80	Nets	36.62
Hook/Line	23.12	Hook/Line	0.00	Hook/Line	0.00
		Longline	22.29	Longline	0.00

Habitat modeling

We used Maxent to calculate the relative occurrence rate (ROR) of either dugongs or Irrawaddy dolphins for each grid cell of the habitat suitability maps, and estimate the predicted relative habitat conditions within each site (Trat, Kuching Bay, Sibu-Tinggi Islands). Maxent is a flexible software allowing the use of numerous settings and complex models with a high number of parameters (Elith et al. 2011). Among the settings to be chosen, the user needs to decide which features to use as an expanded set of transformations of the original variables from among the six available: linear (L) , quadratic (Q), product (P), threshold (T), hinge (H) and categorical (C) (Phillips et al 2006, Elith et al 2011). Users can also decide on the value of the regularization parameters, which are used to smooth the distributions and reduce overfitting (Phillips et al 2006, Elith et al 2011). Once the best model was identified, we decided on a threshold value of predicted variability to transform the distribution into a range of high to medium to low habitat suitability.

Feature selection

The choice of the best model depends on the ability of the model to predict independent test data (Phillips & Dudík 2008), as the complexity of the model is not considered. Consequently, Maxent is known to overfit the data (Warren et al. 2010; Warren & Seifert 2011; Muscarella et al. 2014). This issue of overfitting was highly possible in our case as we only had a few environmental covariates for a potentially high number of MaxEnt parameters. To help identify the best parameters and avoid overfitting, we used the R tool package ENMeval (Muscarella et al. 2014). This package automatically executes MaxEnt several times across a range of different settings (feature and regularization parameters) and aids in identifying and balancing model fit and predictive ability (Muscarella et al. 2014; Rhoden et al. 2017). For each model tested, ENMeval quantified five evaluation metrics: 1) the Akaike information criterion (AIC) corrected for small sample size, 2) the area under the Receiver Operating Curve (ROC) for the test occurrence data (mean Area Under the Curve (AUC), 3) the difference between the train and test AUC (mean.AUC diff) and two different threshold-based omission rates for the test occurrences (Muscarella et al. 2014, Warren & Seifert 2011).

For this analysis, we ran ENMeval with different sets of environmental covariates for each field site, depending on the data available. For each site, ENMval tested regularization factors ranging from 0.5 to 4 with a step of 0.5. Once the best parameters were identified by comparing AICc and AUC values for the test data (Warren & Seifert 2011), those parameters were used to run a cross validation model in Maxent. We used the K-fold option with a 10-fold cross validation (Muscarella et al. 2014, Briscoe et al. 2014). The K-fold method allowed us to estimate errors around fitted functions and predictive performance on the K-(K-1) held-out data (Elith et al. 2011) K times. A jackknife test was conducted for each selected model to identify the importance of the different environmental covariates within the model. If after analyzing ENMeval outputs, it was not possible to identify one best set of parameters, all the models with the smallest AICc were re-run in MaxEnt and outputs were compared.

Feature selection results

For the Trat province and the Kuching Bay data, models with either the combination of linear, quadratic, hinge, product and threshold features or the linear, quadratic, hinge and product features always had the same smaller AIC values. Depending on the environmental variable used, or the season, the optimal regularization parameter varied. So, for the datasets of those two sites, two models were tested in Maxent for each combination of environmental variable and season. For the Sibu-Tinggi Islands the model with the lowest AICc was the model with all the features and a parameterization value of 3.5. The measured environmental data (pH, turbidity, tide, salinity, chlorophyll-a, temperature) in Trat and Kuching Bay generated a very low resolution map because of the low number and uneven distribution of points. Also, when used in Maxent, they were the least significant covariates.

Model selection

The outputs of the EnMeval analysis resulted in 10 models for testing in Maxent for Trat, six models for Kuching Bay and two for the Sibu-Tinggi Islands (Tables S3-S6). The final model selection resulted in identifying the model that had the best compromise between the highest AUC value and the most realistic habitat distribution. We then ran T-tests between the AUC values of each Maxent model with the same environmental variables to detect if the differences observed across the 10 K-fold of those values were significant or not (Tables S3 to S6). Then the Maxent ouputs were discretized into three categories to match the categorization of the other ByRa parameters. The discretization was based on the Relative Occurrence Rate (ROR). The Maxent output is considered a relative occurrence rate because the presence data are proportional but not equal to occurrence (Rhoden et al. 2017). The lowest category ranged from the smallest logistic value associated with one of the observed species localities, also called the lowest presence threshold (LPT = minimum training presence threshold of Maxent software;) for each dataset (Rhoden et al. 2017; Wisz et al. 2008).

The values of the presence threshold that defined the three categories of low, medium and high habitat suitability differed between sites. For both sites in Malaysia (Sibu-Tinggi Islands and Kuching), there was more specific knowledge of the habitat used based on local geography, near seagrass beds for the former, and within rivers for the latter. In these cases, we set thresholds that were more restrictive. The low habitat suitability category ranged from the LPT to 10% of the maximum ROR of the species of interest. The medium category ranged from 10% of the maximum ROR to 50% of the maximum ROR. The third category ranged from 50% of the maximum ROR to the maximum ROR. This category was identified as the predicted highly habitat for these two species.

In Trat the survey area was larger and more open. We created less restrictive thresholds, also considering the results of other research on Irrawaddy dolphins (Rhoden et al. 2017). The low suitability category ranged from the LPT to 50% of the maximum ROR. The medium suitability category ranged from 50% of the maximum ROR to 75% of the maximum ROR for the Irrawaddy. The third category, which included the predicted highly suitable habitat, ranged from 75% of the maximum ROR to the maximum ROR.

Model selection results

For most models, a significant ($p<0.05$) difference in AUC was observed between the model that contains the Maxent threshold features and the model without it. However, Maxent will always try to maximize the AUC values to the detriment of a fragmented suitable habitat. In most cases, the models with the significantly higher AUC values were the models with all the feature parameters included. However, the resulting habitat suitability maps for those models tended to be pixelized and not a concise representation of the real distribution range of cetaceans. Given that even if the difference between AUC was significant in most cases, the smallest AUC was still high (>85% for all models, and >88% for most of them). As mentioned before, we chose the model with the most realistic habitat distribution according to expert opinion vs. a slightly smaller AUC. The models selected are bolded in Tables S3-S6.

Table S3. Summary of MaxEnt outputs for Irrawaddy dolphin occurrence data in Trat during the dry season, and the environmental variables used (R=distance to river mouth, L=distance to land, D=depth, S=slope) with their average contribution rates and standard deviations in brackets. The variable with the larger contribution is distance to river mouth. The MaxEnt features are L=Linear, Q=Quadratic, P=Product, H=Hing and T=Threshold. The average AUC values are from the test data with standard deviations in brackets. * indicates a significant difference between models with the same environmental covariates. The model selected is bolded.

		Trat RLDS 1	Trat RLDS 2	Trat RLDS 3	Trat RLD 1	Trat RLD 2	Trat RLD3
Environmental Variable Contributions (%)	Distance to River Mouth	**78.59 (1.47)**	76.64 (2.37)	58.07 (4.97)	62.87 (1.20)	63.20 (1.78)	58.42 (4.70)
	Distance to Land	**8.74 (2.36)**	8.34 (1.37)	18.53 (4.61)	22.32 (1.78)	21.98 (2.37)	19.57 (4.14)
	Depth	**12.47 (1.51)**	14.33 (2.19)	21.49 (2.41)	14.82 (1.19)	14.83 (1.29)	22.00 (2.52)
	Slope	**0.19 (0.29)**	0.68 (0.42)	1.91 (0.48)			
MaxEnt Features	MaxEnt Features	**LQH**	LQHP	LQHPT	LQH	LQHP	LQHPT
	Regularization factor	**2.5**	2.5	2.5	2	2	2
MaxEnt Validation Statistics	Mean Test AUC	**85.05 (0.04)**	85.30 (0.04)	87.02* (0.02)	86.06 (0.02)	86.06 (0.02)	87.79* (0.02)

Table S4. Summary of MaxEnt outputs for occurrence data in Trat during the monsoon season, and the environmental variables used (R=distance to river mouth, L=distance to land, D=depth, S=slope) with their average contribution rate and standard deviation (). The variable with the larger contribution is distance to river mouth. The MaxEnt features include L=Linear, Q=Quadratic, P=Product, H=Hing and T=Threshold. * indicates a significant difference with other models with the same environmental covariates. The model selected is bolded.

		Trat_Wet RLDS1	Trat_Wet RLDS2	**Trat_Wet RLD1**	Trat_Wet RLD2
Environmental Variable Contributions (%)	Distance to River Mouth	62.29 (1.82)	62.11 (2.90)	**63.41 (2.42)**	66.02 (2.51)
	Distance to Land	3.47 (0.42)	2.47 (1.68)	**4.64 (1.40)**	2.60 (1.76)
	Depth	30.12 (1.91)	28.98 (1.84)	**31.93 (2.43)**	31.38 (2.07)
	Slope	6.90 (0.86)	6.45 (1.00)		
MaxEnt Features	MaxEnt Features	LQHP	LQHPT	**LQHP**	LQHPT
	Regularization Factor	2	2	**2**	2
MaxEnt Validation Statistics (%)	Mean Test AUC	86.54 (0.03)	88.85 (0.03)	**85.85 (0.03)**	88.23* (0.03)

Table S5. Summary of MaxEnt outputs for Irrawaddy dolphin occurrence data in Kuching Bay for each season, and the environmental variables used (R=distance to river mouth, L=distance to land, D=depth, S=slope) with their average contribution rates and standard deviations (). The variables with the larger contributions are distance to land in the post-monsoon and dry season, and distance to river mouth in the pre-monsoon. The MaxEnt features include L=Linear, Q=Quadratic, P=Product, H=Hing and T=Threshold. * indicates a significant difference with other models with the same environmental covariates. The models selected are bolded.

		Post_1	Post_1	**Dry_1**	Dry_2	**Pre_2**	Pre_2
Environmental Variable Contributions (%)	Distance to River Mouth	**31.71 (1.88)**	26.87 (1.15)	**55.26 (2.18)**	49.98 (1.57)	**48.68 (2.94)**	**45.23 (2.73)**
	Distance to Land	**47.42 (2.00)**	**49.87 (1.19)**	**22.13 (1.93)**	25.50 (1.29)	**23.82 (2.11)**	28.27 (2.52)
	Depth	**20.86 (0.98)**	23.25 (1.17)	**22.61 (0.68)**	24.52 (0.81)	**27.94 (1.51)**	26.50 (1.62)
MaxEnt Parameters	MaxEnt Features	**LQHP**	LQHPT	**LQHP**	LQHPT	**LQHP**	LQHPT
	Regularization Factor	**1.5**	1.5	**1.5**	1.5	**3.5**	3.5
MaxEnt Validation Statistics (%)	Mean Test AUC	**88.54 (0.03)**	91.43* (0.02)	**94.02 (0.01)**	95.68* (0.01)	**87.48 (0.04)**	87.55 (0.04)

Table S6. Summary of MaxEnt outputs for dugong occurrence data in the Sibu-Tinggi Islands, and the environmental variable used (R=distance to river mouth, L=distance to land, D=depth, S=slope) with their average contribution rates and standard deviations (). The variable with the largest contribution is distance to river mouth. The MaxEnt features include L=Linear, Q=Quadratic, P=Product, H=Hing and T=Threshold. The model selected is bolded.

		Sibu-Tinggi_1	Sibu-Tinggi_1
Environmental Variable Contributions (%)	Distance to River Mouth	**40.09 (0.96)**	40.45 (1.06)
	Distance to Land	**34.96 (0.95)**	35.20 (1.20)
	Depth	**24.78 (0.86)**	24.36 (0.55)
	Slope	**0.16 (0.03)**	
MaxEnt Parameters	MaxEnt Features	**LQHPT**	LQHPT
	Regularization Factor	**3.5**	3.5
MaxEnt Validation Statistics (%)	Mean Test AUC	**88.48 (0.01)**	88.47 (0.01)

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