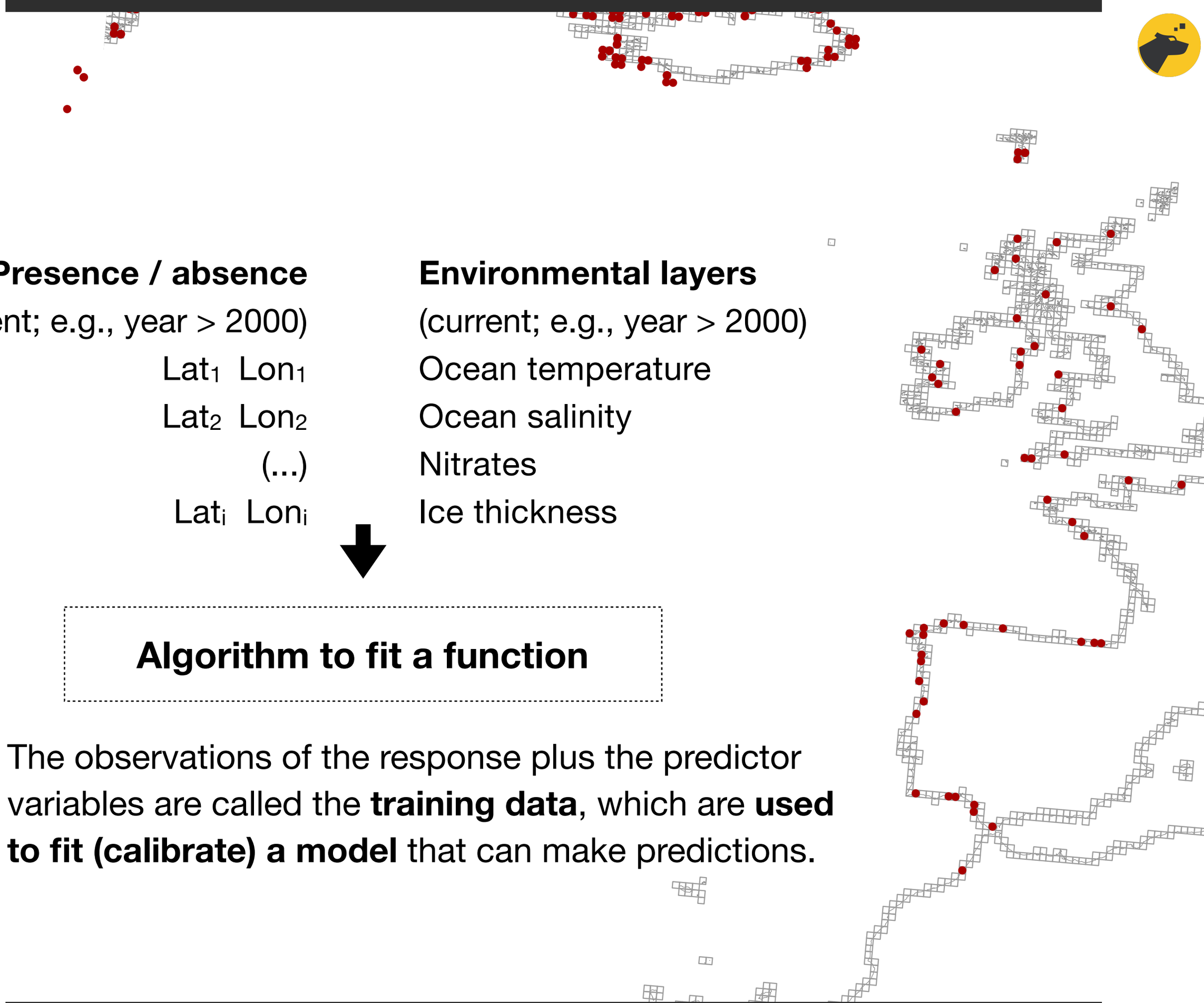
Marine Ecological Modelling Global Climate Change

Model fitting and transferability in space and time

Jorge Assis, PhD // jmassis@ualg.pt // jorgemfa.medium.com
2020, Centre of Marine Sciences, University of Algarve



Presence / absence

(current; e.g., year > 2000)

Lat_1 Lon_1

Lat_2 Lon_2

(...)

Lat_i Lon_i

Environmental layers

(current; e.g., year > 2000)

Ocean temperature

Ocean salinity

Nitrates

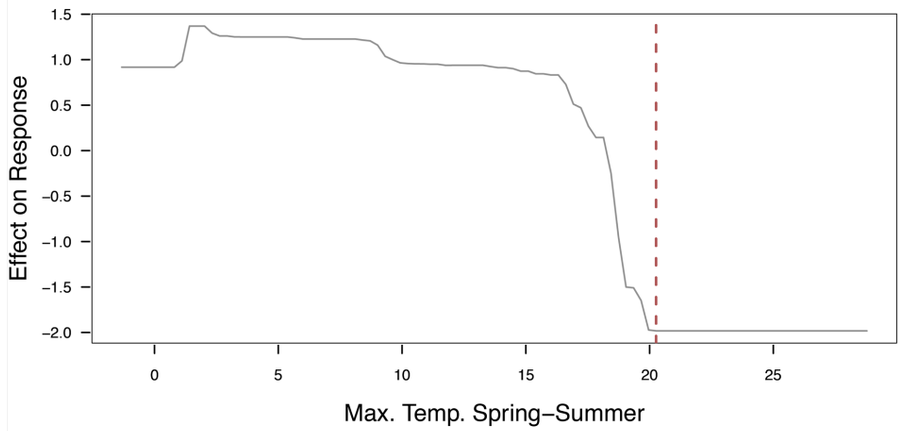
Ice thickness

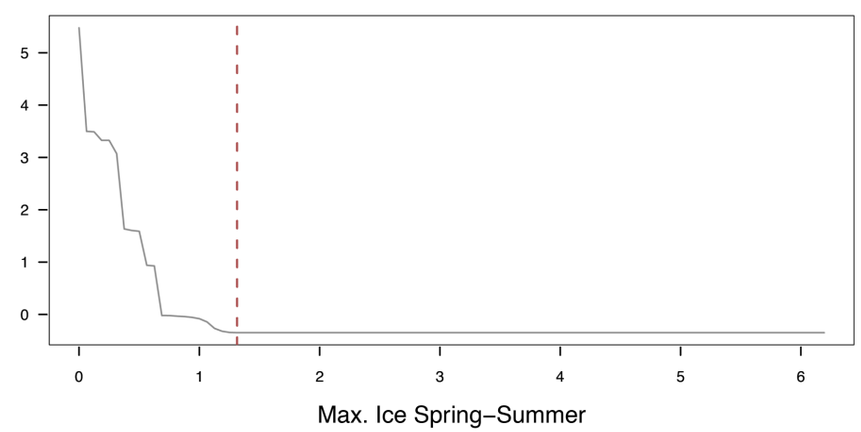
Algorithm to fit a function

The observations of the response plus the predictor variables are called the **training data**, which are **used to fit (calibrate) a model** that can make predictions.

Model transferability to other places or times (forecast or hindcast distributions; response to environmental changes).

Fitted functions





Layers past → Past distribution

Layers present → Present distribution

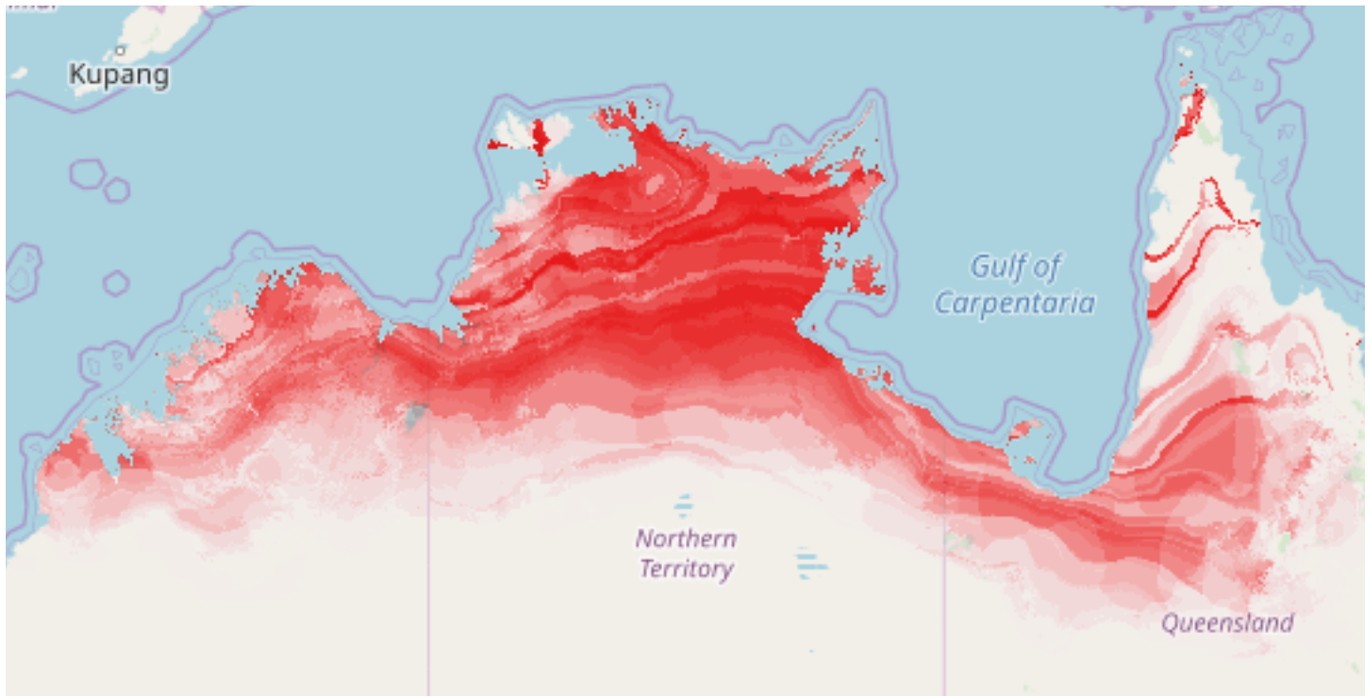
Layers future → Future distribution

Predictions result in continuous surfaces (probability or suitability; 0 to 1).

Regardless of the time period / region, **all layers must be included in the transferability process.** The **availability of layers for climate scenarios also determines the choice of environmental layers for model fitting.**

Predicted distribution :: Map

One of the outputs of ecological niche models are **maps showing the current predicted / potential distribution of species (baseline)**.

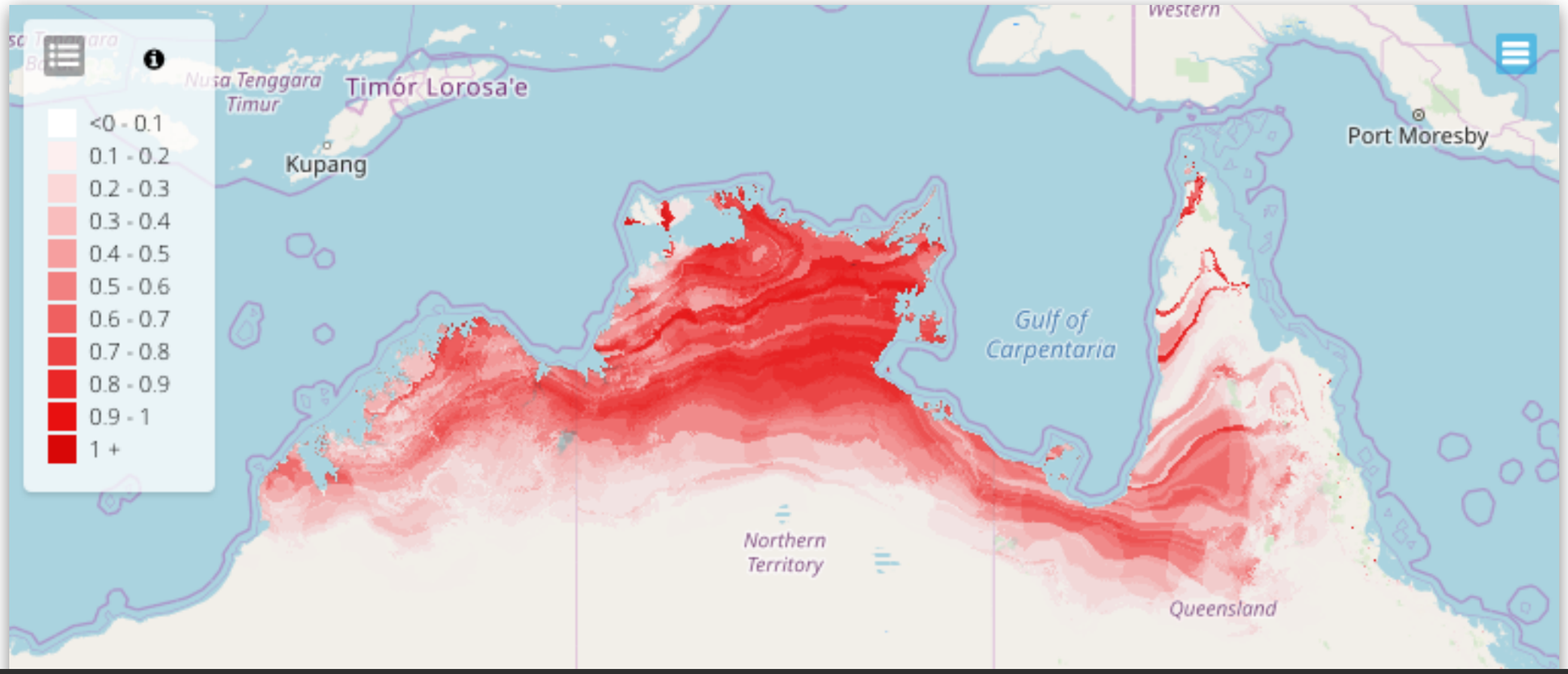


These maps **do not show a prediction of where species occur, but rather the distribution of suitable habitats** as defined by the environmental variables included in the model. Also useful to assess potential invasive process considering current conditions.

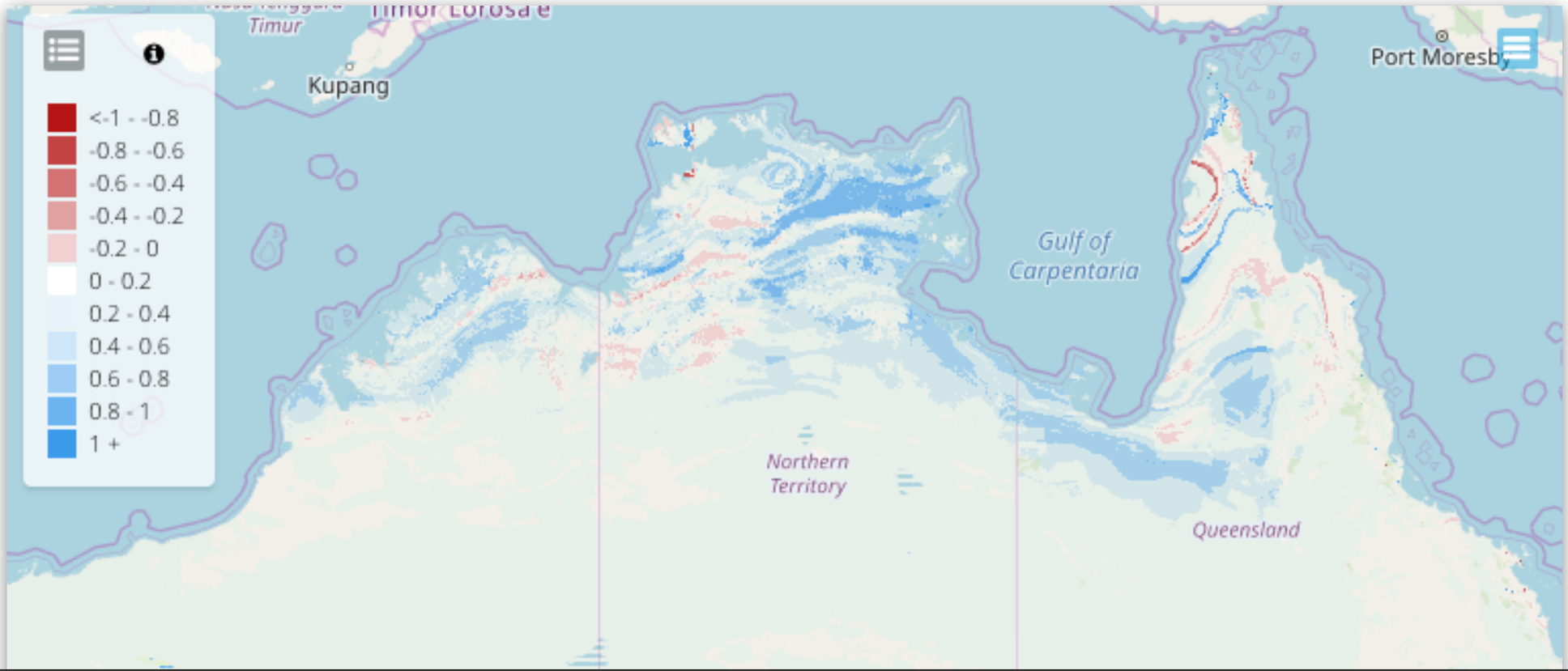
Model transferability :: Map

Model transferability to layers of different climate scenarios can be analysed (per cell) with different approaches:

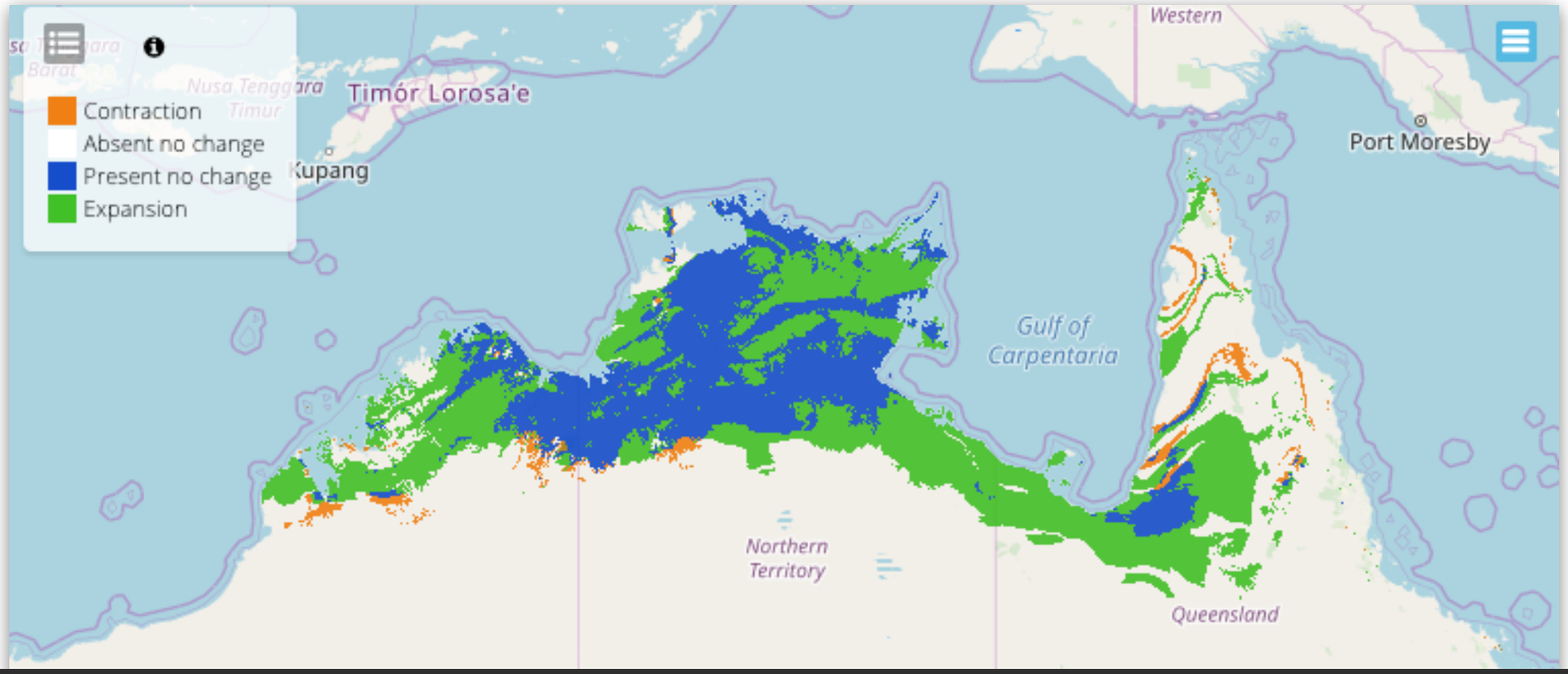
(1) **predicted probability under different conditions** than those where the model fitted (baseline);



(2) **change in probability**, determined as the **difference in the predicted probability between the transferred model and the baseline model**; The map scale from -1 to 1, where negative refers to lower suitable conditions and positive higher suitability.



(3) **change in species distributional range**, generated with binary maps (i.e., 0 or 1). Comparing maps can indicate **no change** of presence or absence, **decrease in range**, when there is presence in the baseline model and absence in climate change model, and **increase in range** when there is absence in the baseline and presence in the climate change model.



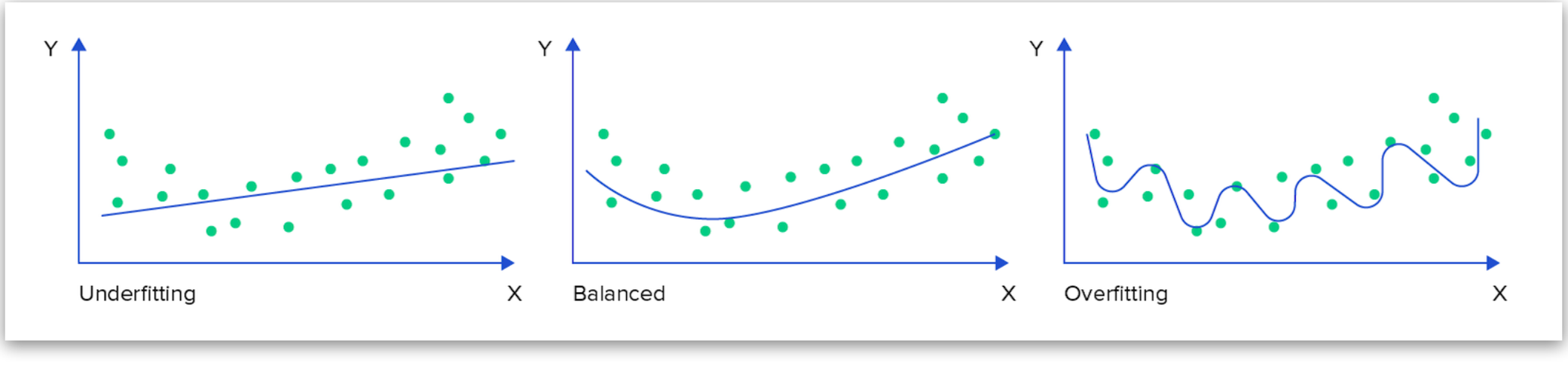
Change in species distributional range :: Table

The change in species range table shows the **number and percentage of grid cells for each of the categories in the species range change map**. The areas of gain and loss of habitats can also be shown.

	no_grid_cells	%_grid_cells	area_km2
Contraction	23016.000	0.876	27432.611
Blank	2073696.000	78.951	2407924.832
No Change	220815.000	8.407	264582.092
Expansion	309024.000	11.765	368386.172

The fit of ecological niche models

The potential for proper transferability is conditioned when the models **overfit** or **underfit** the data.



Underfitting occurs when a model is too simple, which makes it inflexible in learning from the dataset (few records and predictors).

Overfitting occurs when a model fits the quirks and noise of data and not the overall trend separating presences from absences. Reduced generality reduces performance outside the original dataset - unable to transfer a model to other conditions.

There is the need to evaluate predictive performances and set proper decision thresholds.