



# **Marine Ecological Modelling Global Climate Change**

**Model fitting and transferability in space and time**

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**Presence / absence**  
(current; e.g., year > 2000)

Lat<sub>1</sub> Lon<sub>1</sub>

Lat<sub>2</sub> Lon<sub>2</sub>

(...)

Lat<sub>i</sub> Lon<sub>i</sub>

**Environmental layers**

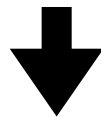
(current; e.g., year > 2000)

Ocean temperature

Ocean salinity

Nitrates

Ice thickness

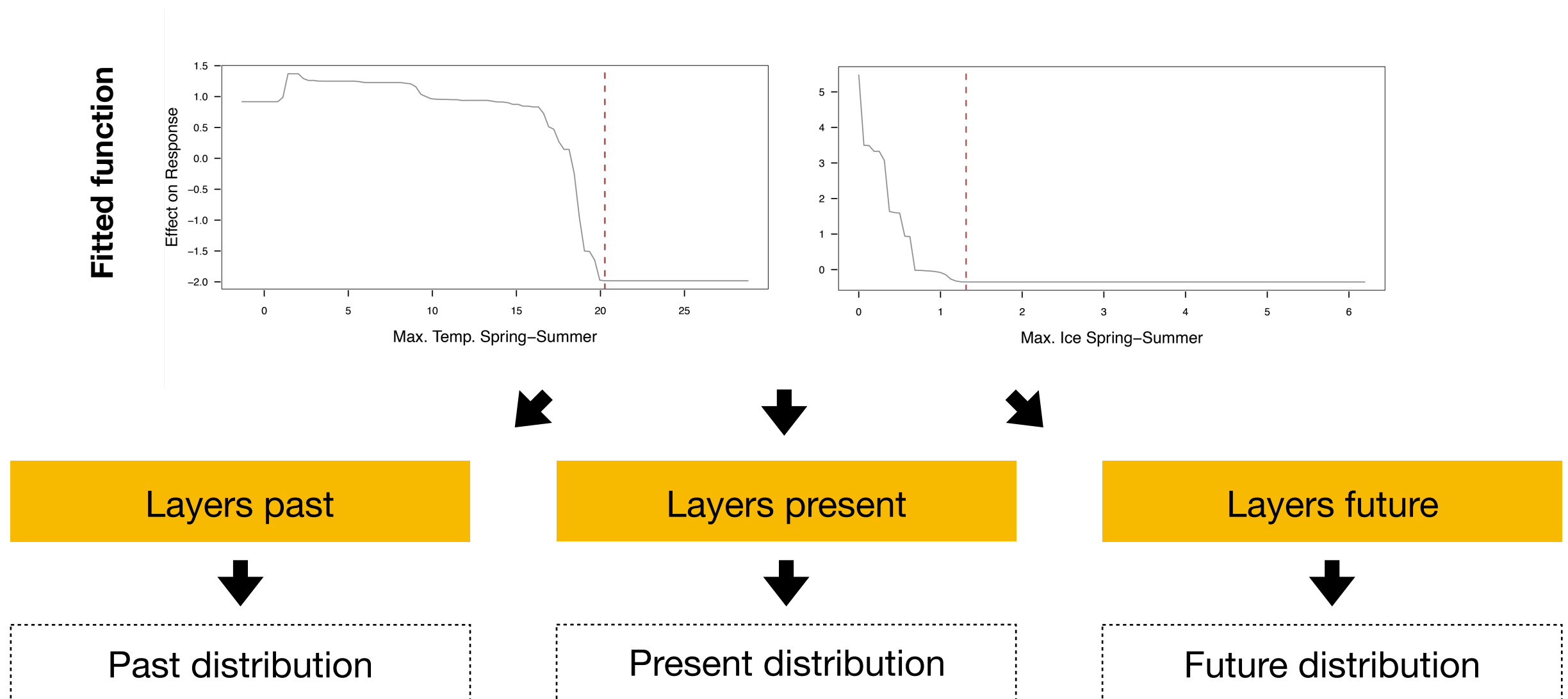


**Algorithm to fit a function**

The observations of the response and 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).



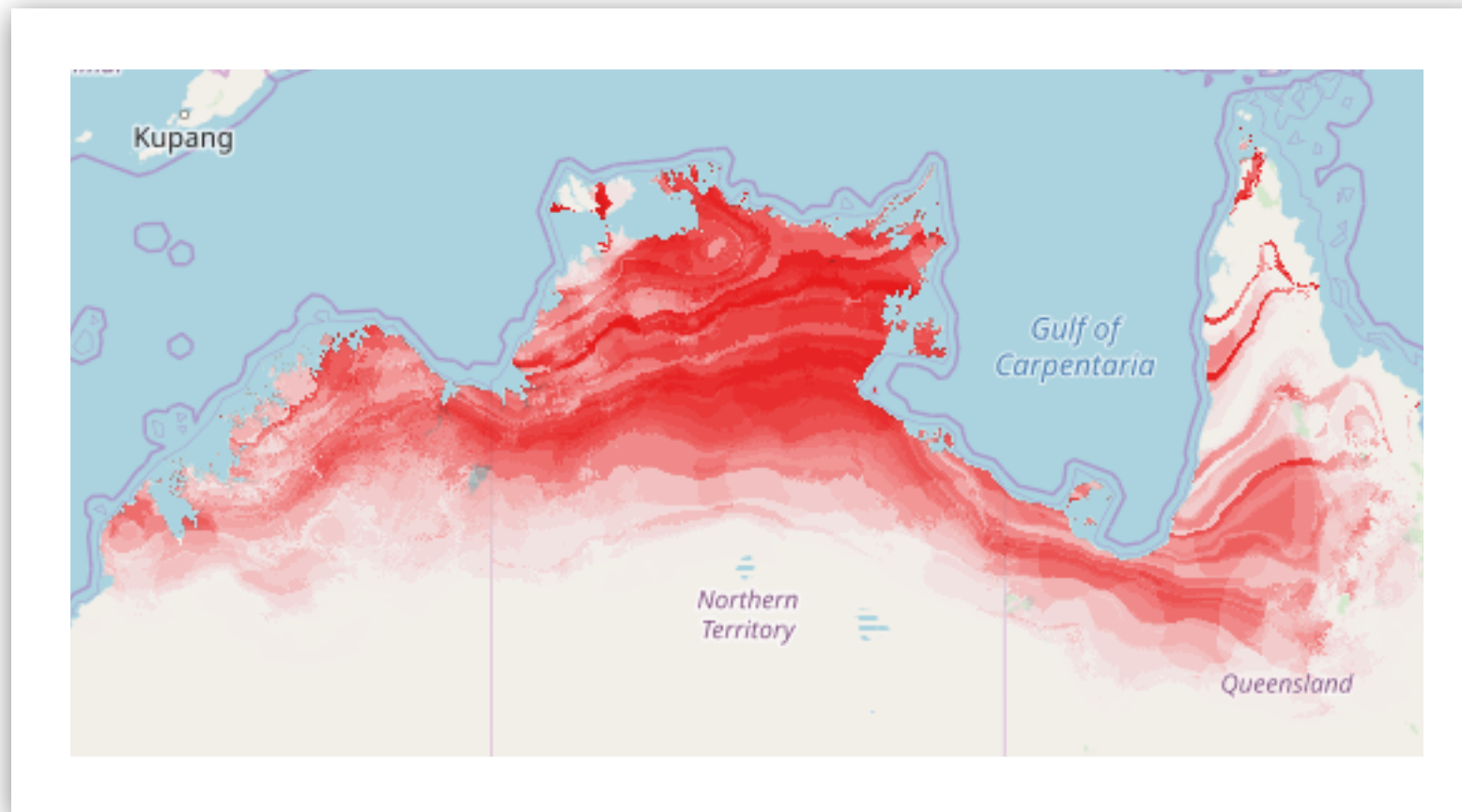
Predictions result in continuous surfaces (probability or suitability; 0 to 1).

Regardless 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 distribution of species (baseline)**.



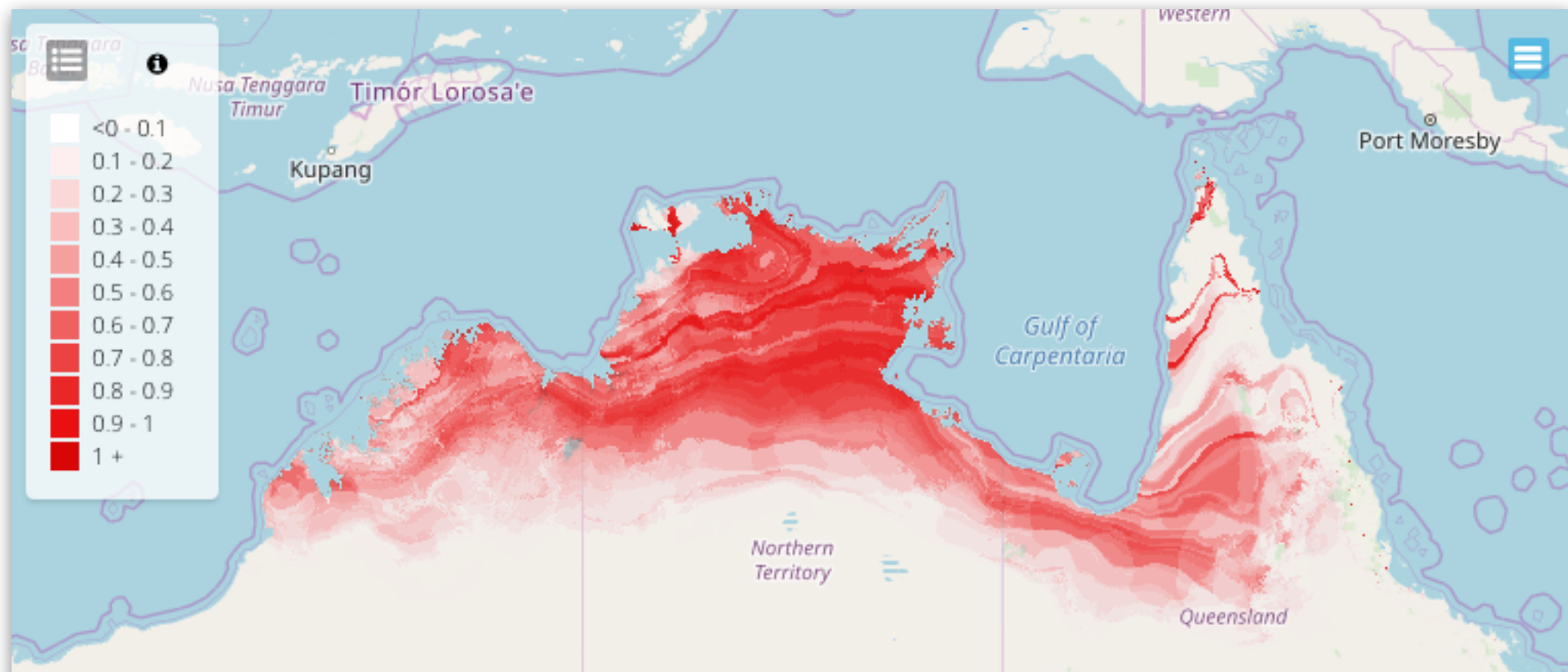
These maps **do not show a prediction of where species occur, but rather the distribution of suitable habitats** as defined by the environmental variables included in the model. Also useful to assess potential invasive process considering current conditions.



## Change in species :: 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);

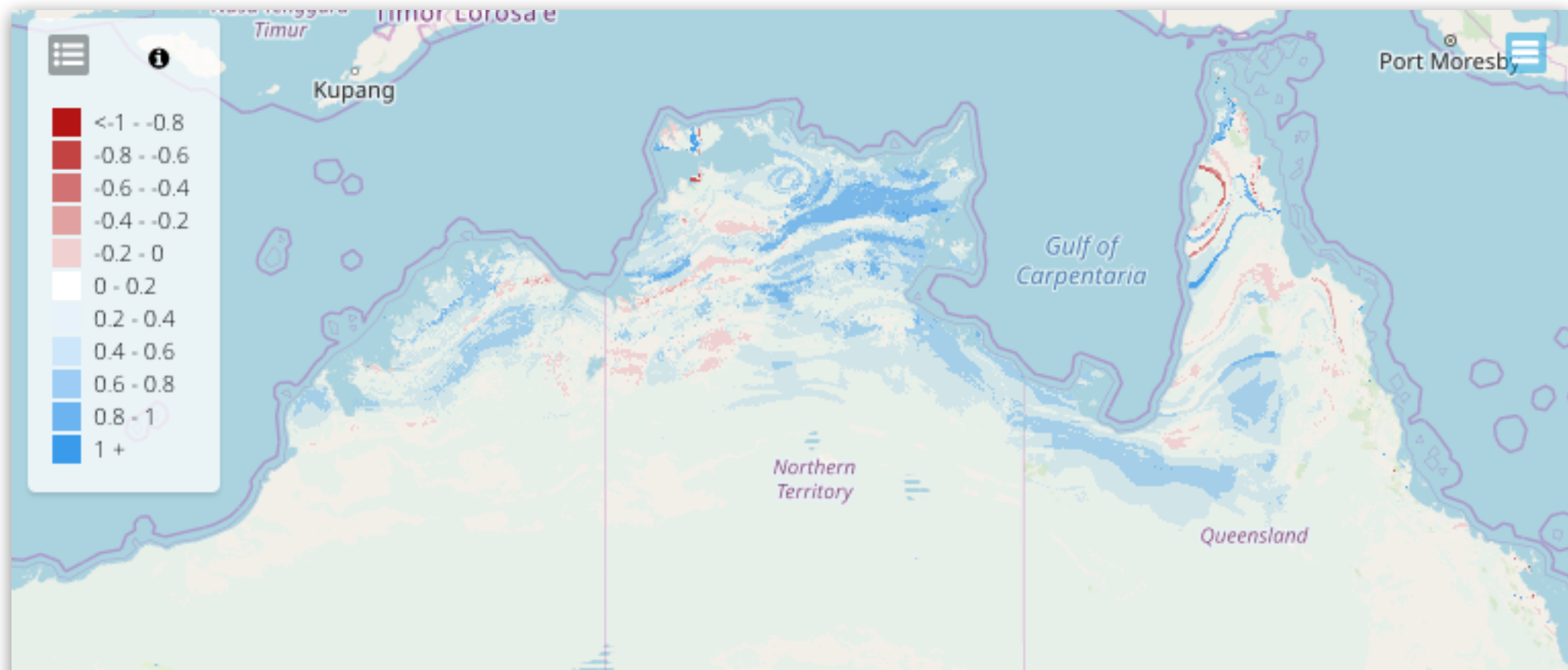




## Change in species :: Map

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

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



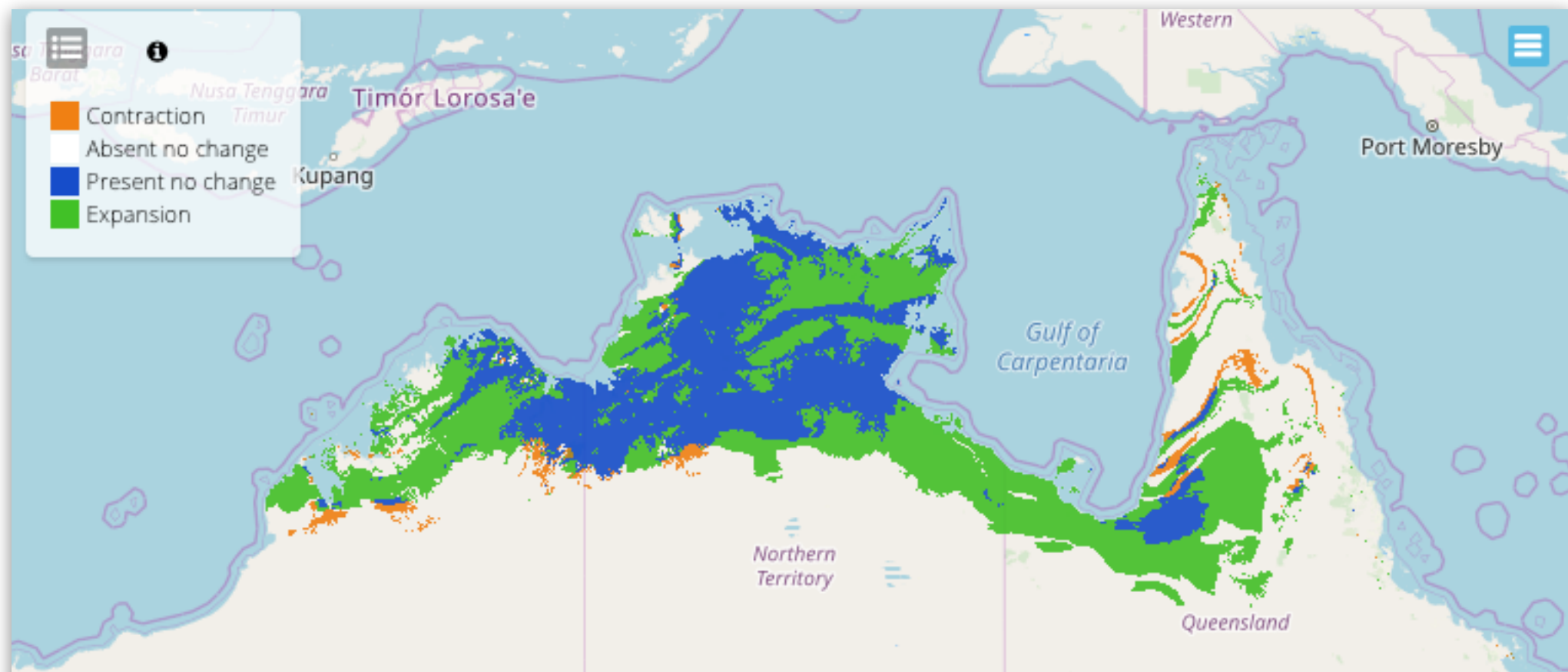




# Change in species :: Map

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

(3) **change in species range map**, 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 :: 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.

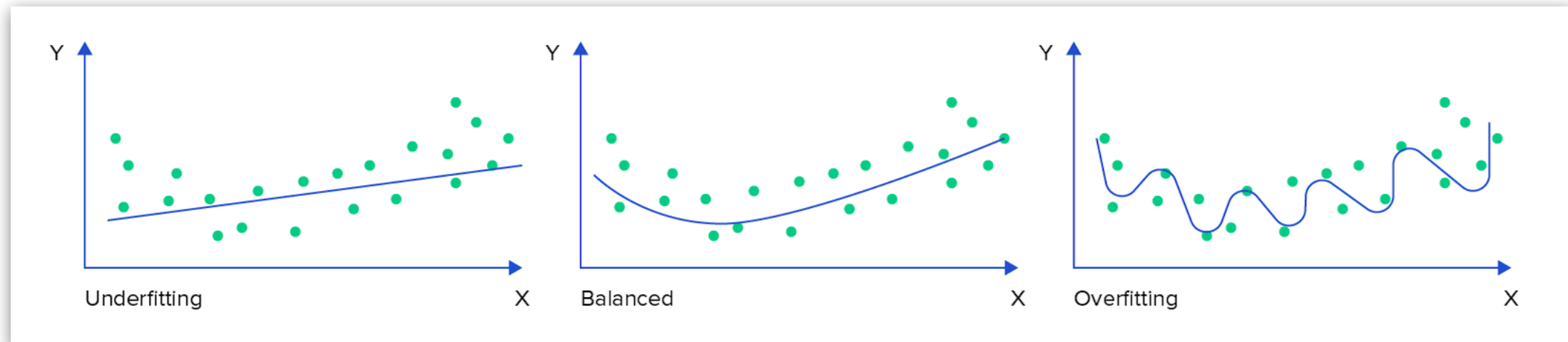
	no_grid_cells	%_grid_cells	area_km2
Contraction	23016.000	0.876	27432.611
Blank	2073696.000	78.951	2407924.832
No Change	220815.000	8.407	264582.092
Expansion	309024.000	11.765	368386.172





# 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.