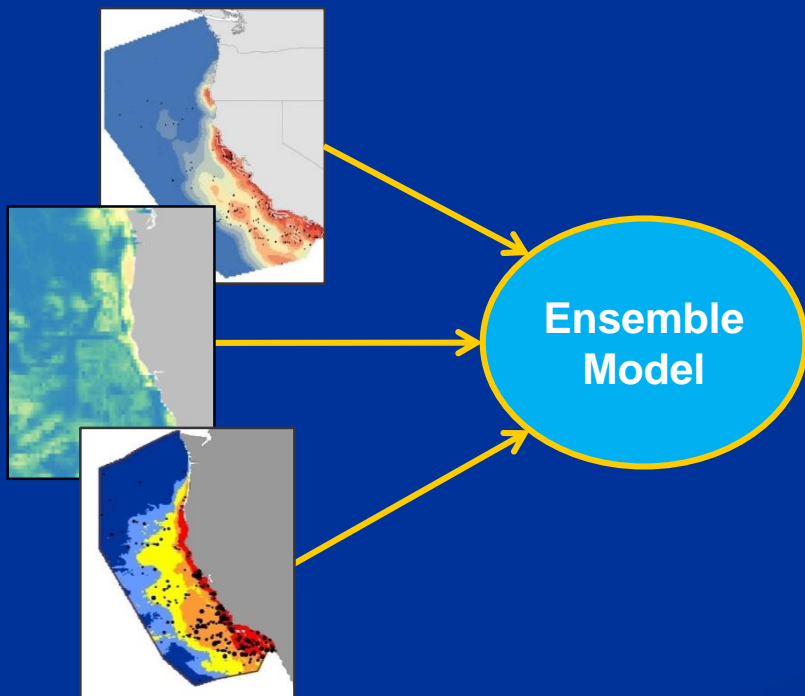




NMFS Protected Species Toolbox Mini-Symposium II  
March 1-2, 2018  
Alaska Fisheries Science Center, Seattle WA



**eSDM:** An ensemble tool for species  
distribution models  
(*Spatial Analysis Theme*)



NOAA/SWFSC Project Team:  
*Karin Forney, Sam Woodman,  
Jessica Redfern, Elizabeth Becker*

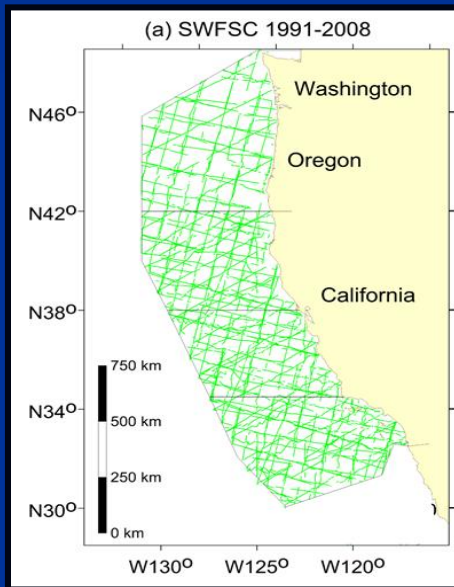
with contributions from  
*Elliott Hazen (SWFSC)  
Daniel Palacios (Oregon State Univ)  
Monica DeAngelis (US Navy)*

For questions, please contact  
[Karin.Forney@noaa.gov](mailto:Karin.Forney@noaa.gov)

# Why Ensemble Modeling?

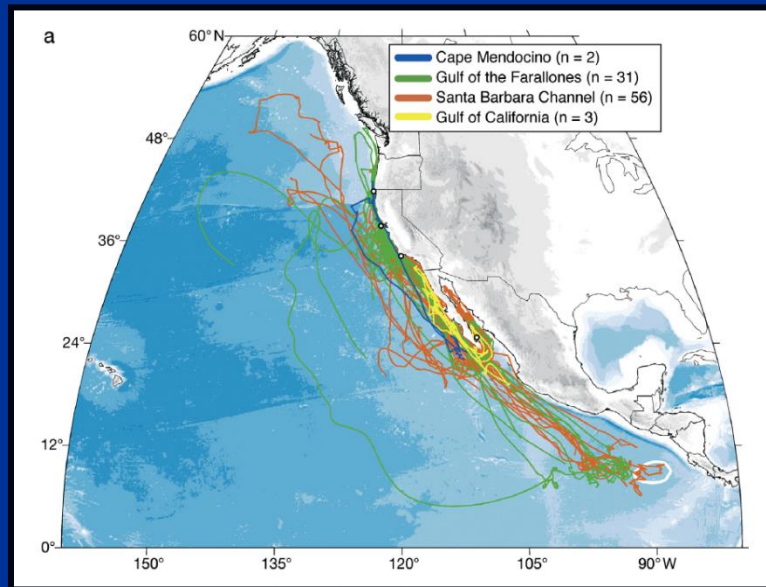
- A variety of sampling techniques have been used to develop species distribution models, with varying strengths & limitations.

## Systematic surveys



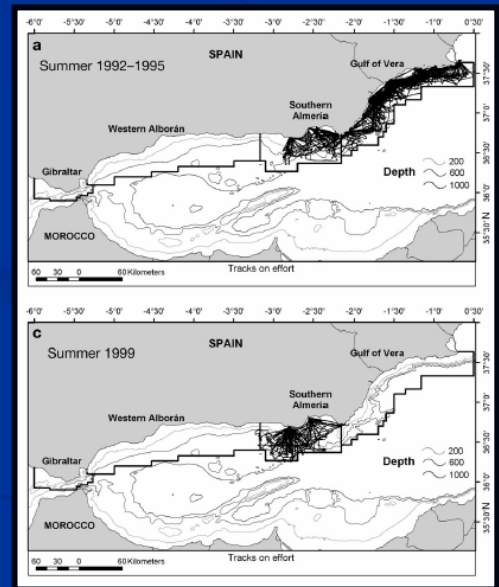
*Becker et al. 2016*

## Telemetry studies



*Bailey et al. 2009*

## Opportunistic surveys



*Cañadas and Hammond 2006*

- No single model is correct at all times, in all areas and at all scales

## Example: West Coast blue whales

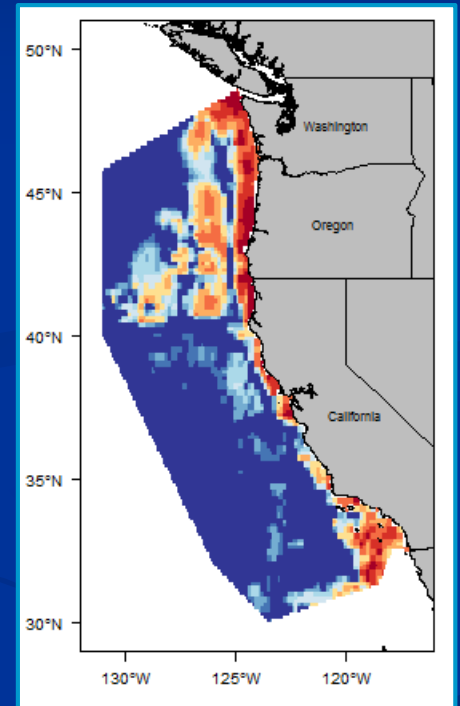
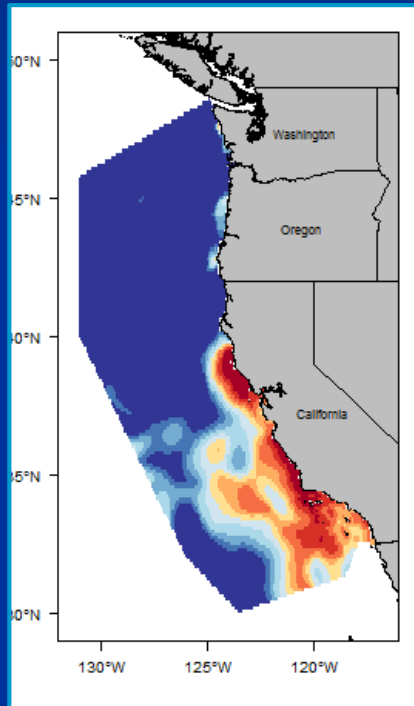
NMFS Large Whale Workshop (September 2014)

Organized by Monica DeAngelis (formerly NOAA West Coast Region)  
to look at the availability of large whale models off U.S west coast

Source	Data	Model type	Region
Pardo et al. 2015	SWFSC LT (CCE & ETP)	Bayesian hierarchical	CCE/E TP
Becker et al. 2016	SWFSC LT (CCE)	GAM	CCE
Hazen et al. 2016	Tagging	GAMM/BRT	ENP
Redfern et al. 2017	SWFSC LT (CCE & CCE/ETP)	GAM	CCE
Dransfield et al. 2014	ACCESS LT	Neg. Bin. Regression	Central CA
Irvine et al. 2014	Tagging	Kernel density	US EEZ
Širović et al.	Passive acoustics	GAM	SCB
Monnahan et al.	Passive acoustics	GAMLSS	ENP

# West Coast blue whales

Multiple, published blue whale models off the U.S. West Coast created challenges for management and assessment of local risks (e.g. entanglements, ship strikes).



May 2015: Joint NMFS-IWC workshop to examine blue whale models and develop a plan for evaluating/combining diverse models

# How can we combine information from multiple studies to get a better spatial model?

---

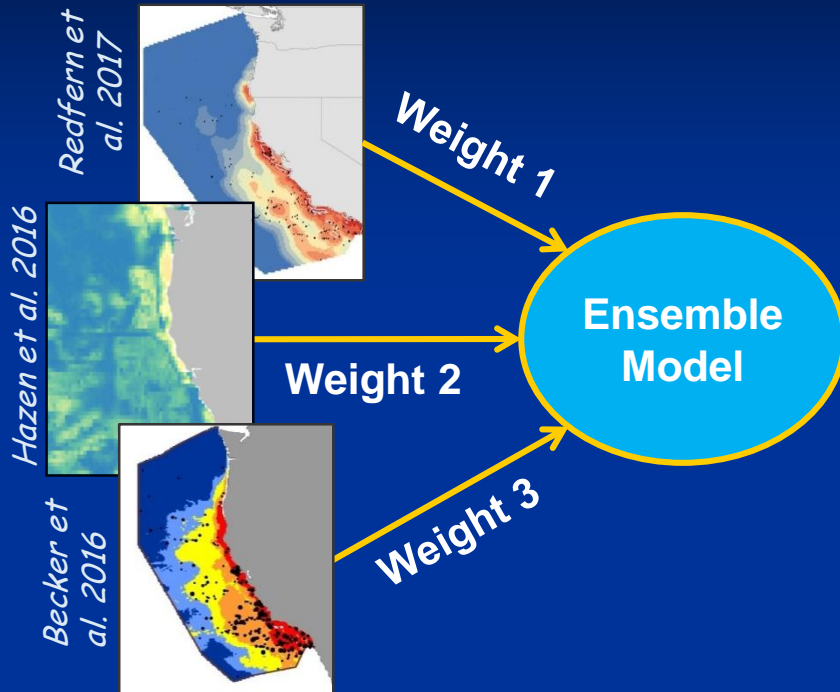
**OPTION 1:** Integrate diverse data within a single analysis framework (e.g. Bayesian hierarchical models).

Challenges can include...

- ... data ownership
- ... computational limitations
- ... analytical expertise required

**OPTION 2:** Combine model *outputs* to create a single ensemble model

# Ensemble Modeling



Predictions from a set ('ensemble') of models often yield more robust predictions and allow evaluation of uncertainties.

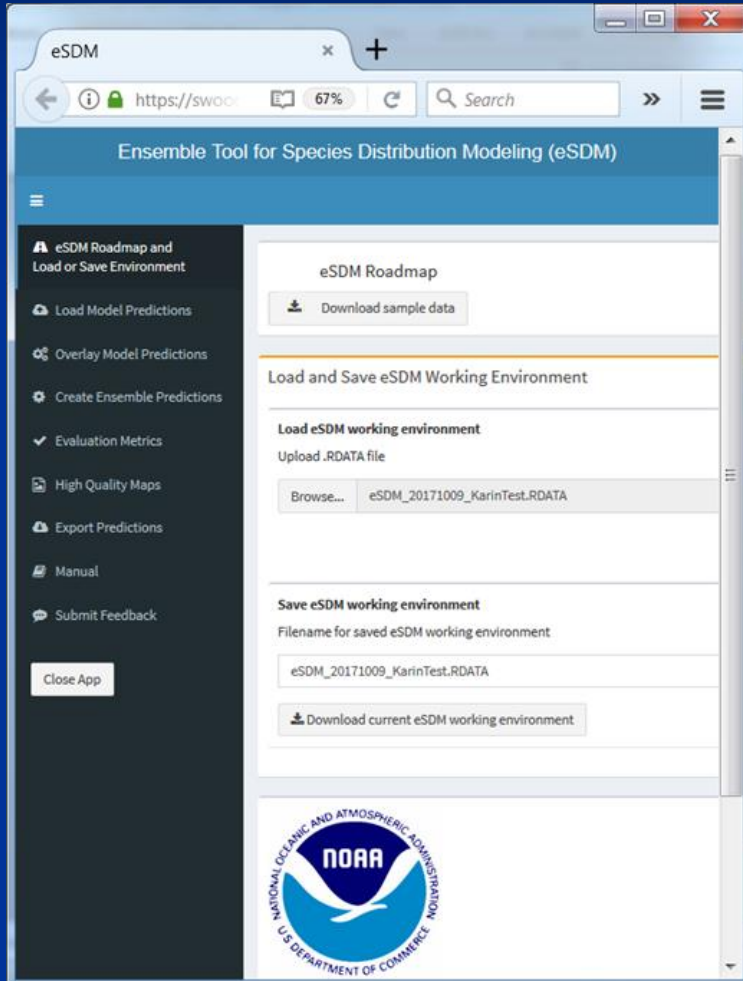
*Wintle et al. 2003,  
Johnson and Omland 2004,  
Araújo and New 2007,  
Thuiller et al. 2008,  
Gritti et al. 2013*

## Advantages:

- Requires only model outputs (not original data)
- Computationally more straightforward
- Can be done by end-users/resource managers



# NOAA Fisheries Science & Technology Protected Species Spatial Toolbox Project: **eSDM**

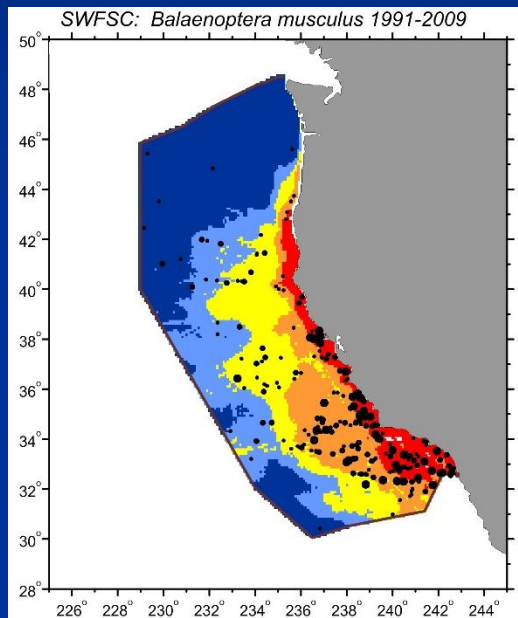


- **Goal:** Develop a user-friendly R tool (**eSDM**) for creating and exploring ensemble models from *existing* spatial models (e.g. provided in GIS or CSV files).
- **Purpose:** Enhance and facilitate management decision-making
- **Approach:** Use published blue whale models as a case study to explore ensembling methods; solicit input from Science Centers, Regions and other end-users during development and testing.
- **Today's presentation:** Provide overview of this project and introduce the draft ('beta version') of **eSDM**.
- **Tomorrow:** Hands-on demo for anyone interested in trying the **eSDM**

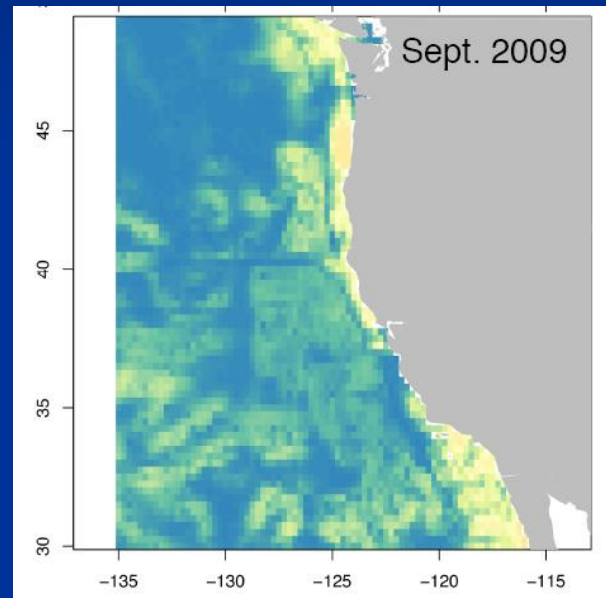
# Blue Whale Case Study

Initially focused on three models of absolute density for the entire California Current Ecosystem study area

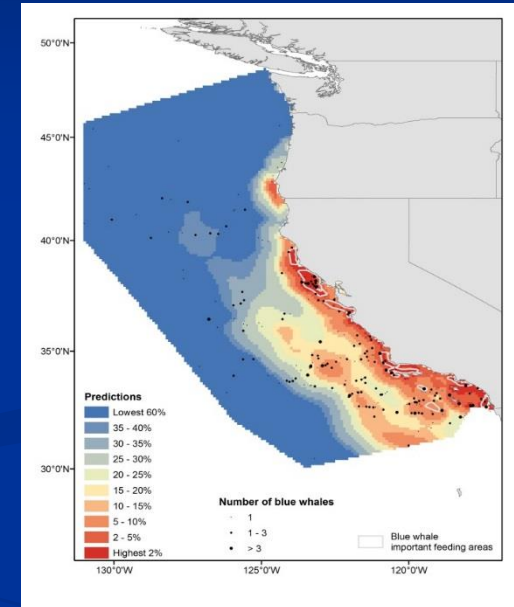
*Becker et al. 2016*



*Hazen et al. 2016*



*Redfern et al. 2017*



## 1991-2009 shipboard line-transect survey

Contemporaneous 8-day ROMS covariates

~10 x 10 km prediction grid

## 1994-2008 blue whale satellite telemetry data

Contemporaneous satellite-derived covariates

~25 x 25 km prediction grid

## 1991-2009 shipboard line-transect survey

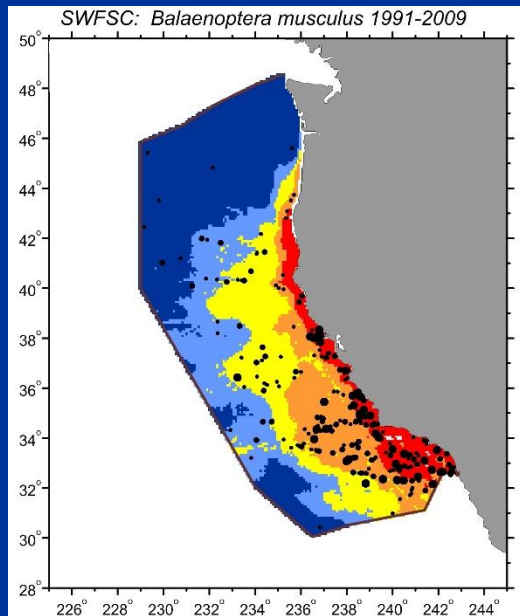
Climatological SODA covariates

10 x 10 km prediction grid

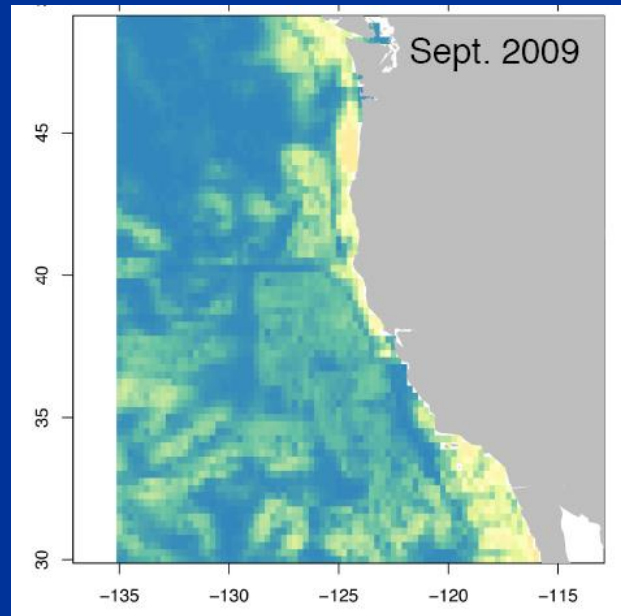


# Creating a common grid

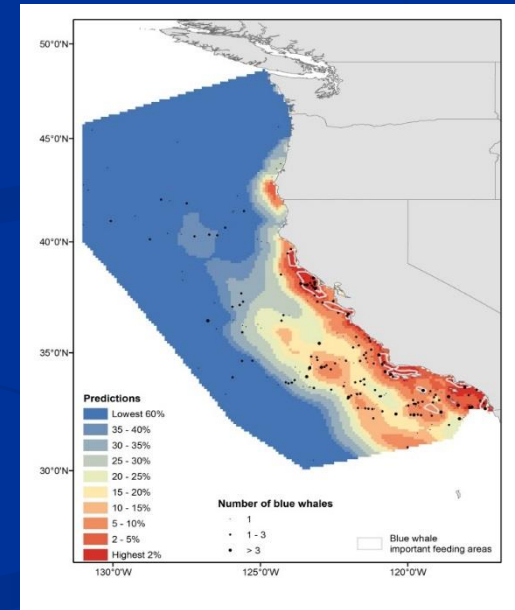
- Models predictions were made using different spatial resolutions and grid patterns (equal area vs. equal degrees), etc.
- Models need to be re-scaled to a common unit if they are not all the same data types (absolute/relative animal density, probability of occurrence, etc).



*Becker et al. 2016*



*Hazen et al. 2016*

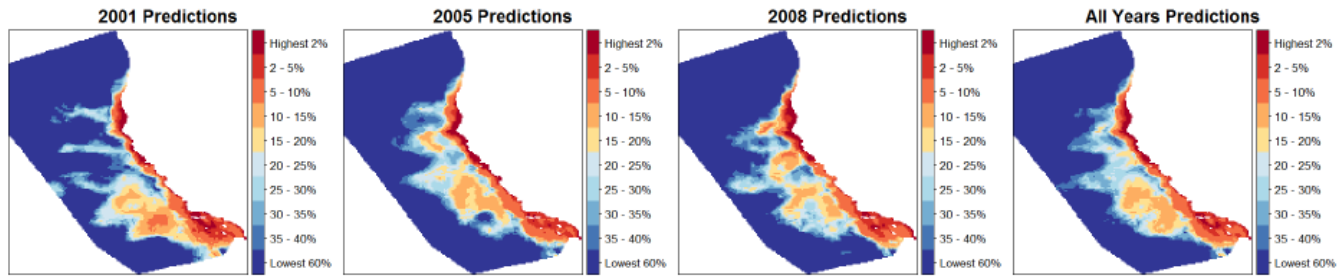


*Redfern et al. 2017*

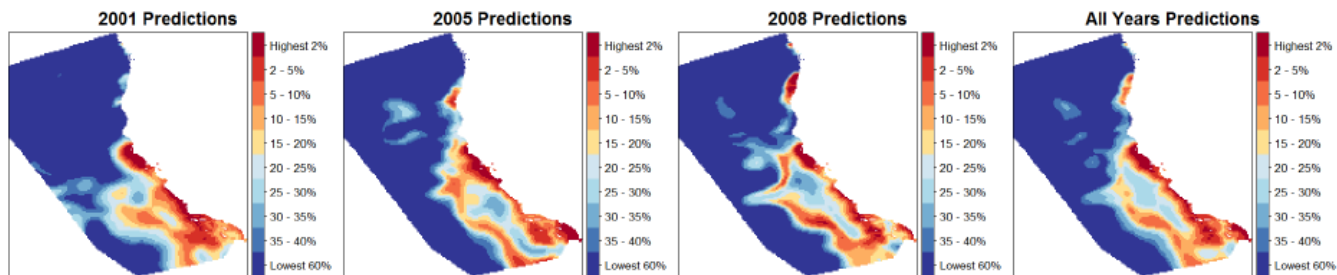
# Estimates for summer/fall, 2001, 2005, and 2008

## OVERLAID MODELS (cont) – Cylindrical Equal Area Projection

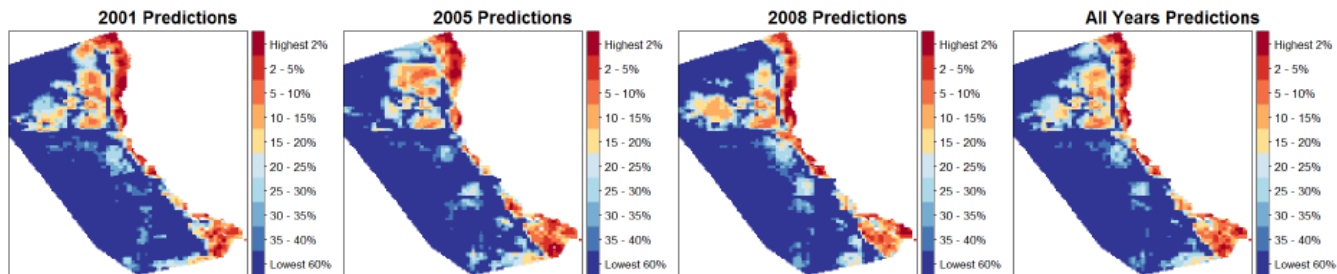
EAB



JVR

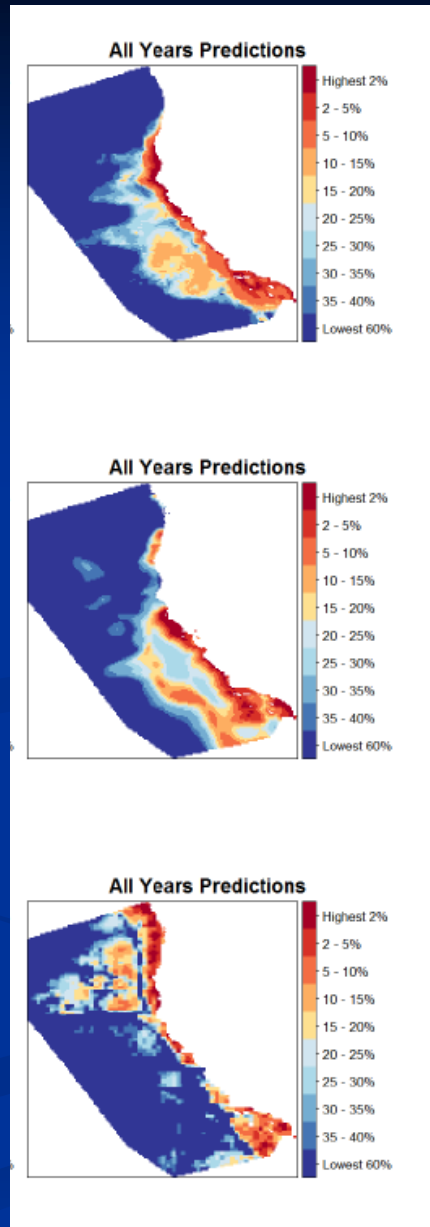


WW



# Evaluation and Weighting of Models

- Evaluation of model performance relative to validation data sets:
  - AUC: Receiver operating characteristic curve (*Fawcett 2006*)
  - TSS: true skill statistic (*Allouche et al. 2006*)
  - RMSE: Root mean squared error
- Development of weighting schemes:
  - User-provided errors/weights
  - Performance-based weights (e.g. AUC)
  - Regional/global weights?
  - Down-weighting for models based on same underlying data?



# Validation data sets for blue whale case study

We used presence and absence points based on 5-km survey segments from NOAA/SWFSC cruises, home range areas from blue whale telemetry study, and both combined.

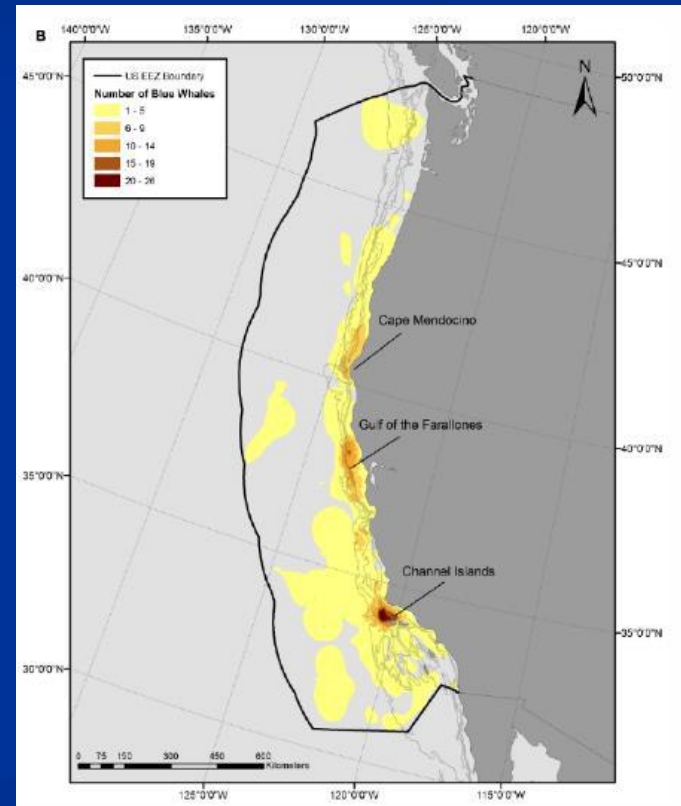
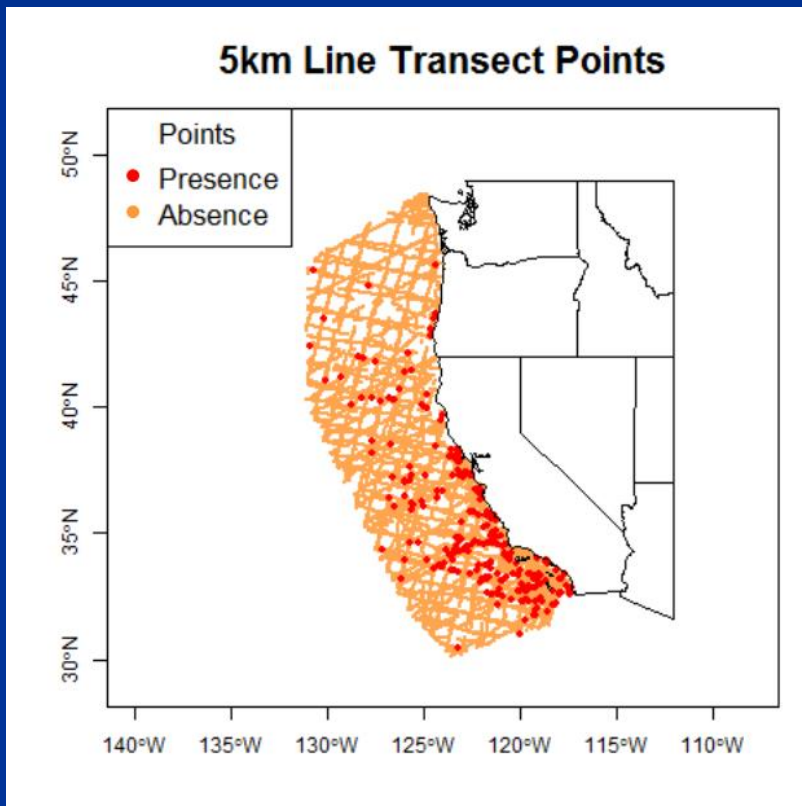
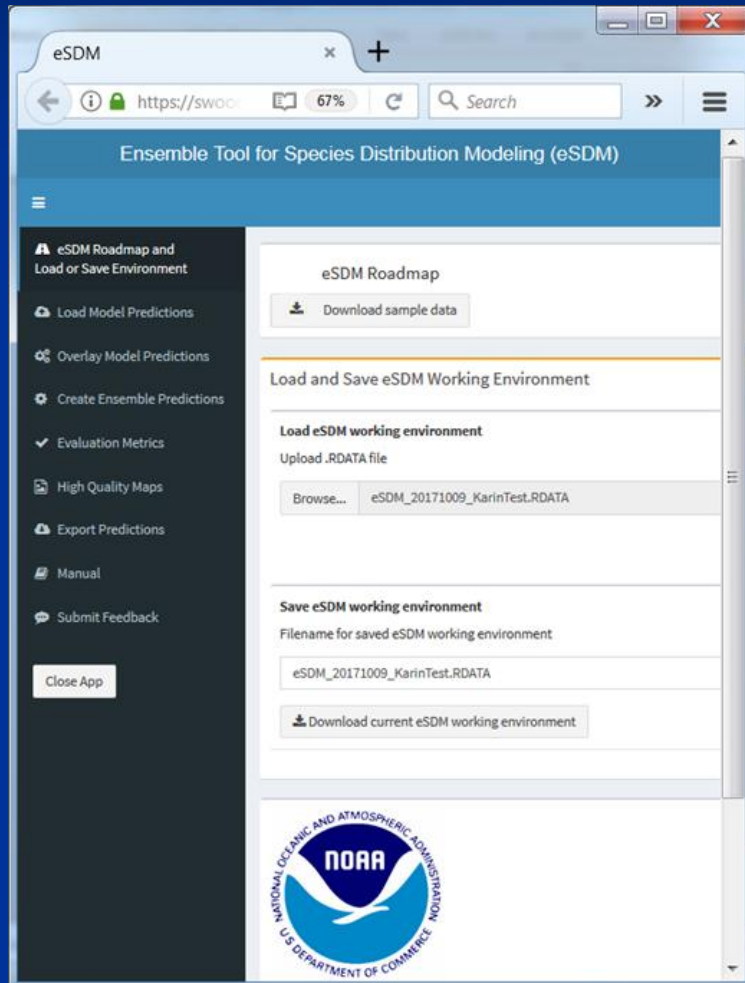


Figure 2b from Irvine et al. (2014)

# eSDM Ensemble Tool

<https://jmlondon.shinyapps.io/eSDM/>



Draft tool includes features that were explored and determined to be useful for blue whale case study (*Redfern et al., in prep*):

- Import options for .CSV and GIS files
- User-specified weights (for whole model, regions, individual pixels)
- AUC & TSS evaluation and weighting
- Scaling to absolute abundance or relative densities
- Validation of individual and ensemble models with external data sets
- Plotting tools
- Model export capabilities



# eSDM Overview: Tabs for each step of ensembling process

The image shows a screenshot of the eSDM web application interface. The main content area displays the 'eSDM Roadmap and Load or Save Environment' tab, which includes an overview of the tool and a list of steps: 1) Load SDM predictions, 2) Overlay and create ensembles, 3) Evaluate, produce maps of, and export predictions, and 4) Manual and eSDM feedback. The sidebar on the left contains a list of tabs: eSDM Roadmap and Load or Save Environment, Load Model Predictions, Overlay Model Predictions, Create Ensemble Predictions, Evaluation Metrics, High Quality Maps, Export Predictions, Manual, and Submit Feedback. A yellow arrow points from the 'Evaluation Metrics' tab in the sidebar to the 'Evaluation Metrics' section in the main content area. Another yellow arrow points from the 'Context-specific tips and brief instructions' text to the 'eSDM Roadmap and Load or Save Environment' tab in the main content area.

**eSDM Roadmap and Load or Save Environment**

**Overview:** The Ensemble Tool for Species Distribution Models (eSDM) is a user-friendly spatial tool with a web-based interface that allows users to import spatial density model (SDM) layers and create and explore ensemble predictions to inform management and explore spatial uncertainties. This section is intended to provide you a roadmap that gives a brief overview of the eSDM and the order in which you can use the sections of the app. This section is NOT intended to explain inputs or replace the manual in any fashion.

**1) Load SDM predictions:** The main function of the eSDM is to load in SDM predictions, overlay them onto the same grid, and then create ensemble predictions. Thus, the first step is to either load SDM predictions in the 'Load Model Predictions' tab or load a saved working environment from a previous eSDM session in the 'Load eSDM working environment' section. You cannot use any of the other functionality in the app until you perform one of these two steps.

If you do not have any SDM predictions on hand but still want to use the eSDM, you can download a zip file with sample model predictions that you can use in the eSDM by clicking the *Download sample data* button below.

**2) Overlay and create ensembles:** Next, you can overlay your loaded SDM predictions in the 'Overlay Model Predictions' tab. Note that you should use the 'same-grid' overlay process if all of your loaded SDM predictions are already on the same grid. This will give you the same result as using the 'standard' overlay process, but in much less time. After creating the overlaid predictions, you can move on to the 'Create Ensemble Predictions' tab to create your ensemble predictions.

**3) Evaluate, produce maps of, and export predictions:** Once you have loaded at least one set of SDM predictions into the eSDM, you can use the 'Evaluation Metrics', 'High Quality Maps', and 'Export Predictions' tabs to calculate evaluation metrics using validation data, produce high quality maps, or export any of the loaded predictions or predictions created with the eSDM, respectively.

**4) Manual and eSDM feedback:** You can view and/or download the eSDM manual in the 'Manual' tab. The manual is divided into sections corresponding to the tabs and their boxes, and provides detailed information about the input format requirements and what exactly is happening during certain steps such as the overlay process. Depending on the browser you are using, the manual may automatically open in a separate window rather than being displayed within the eSDM.

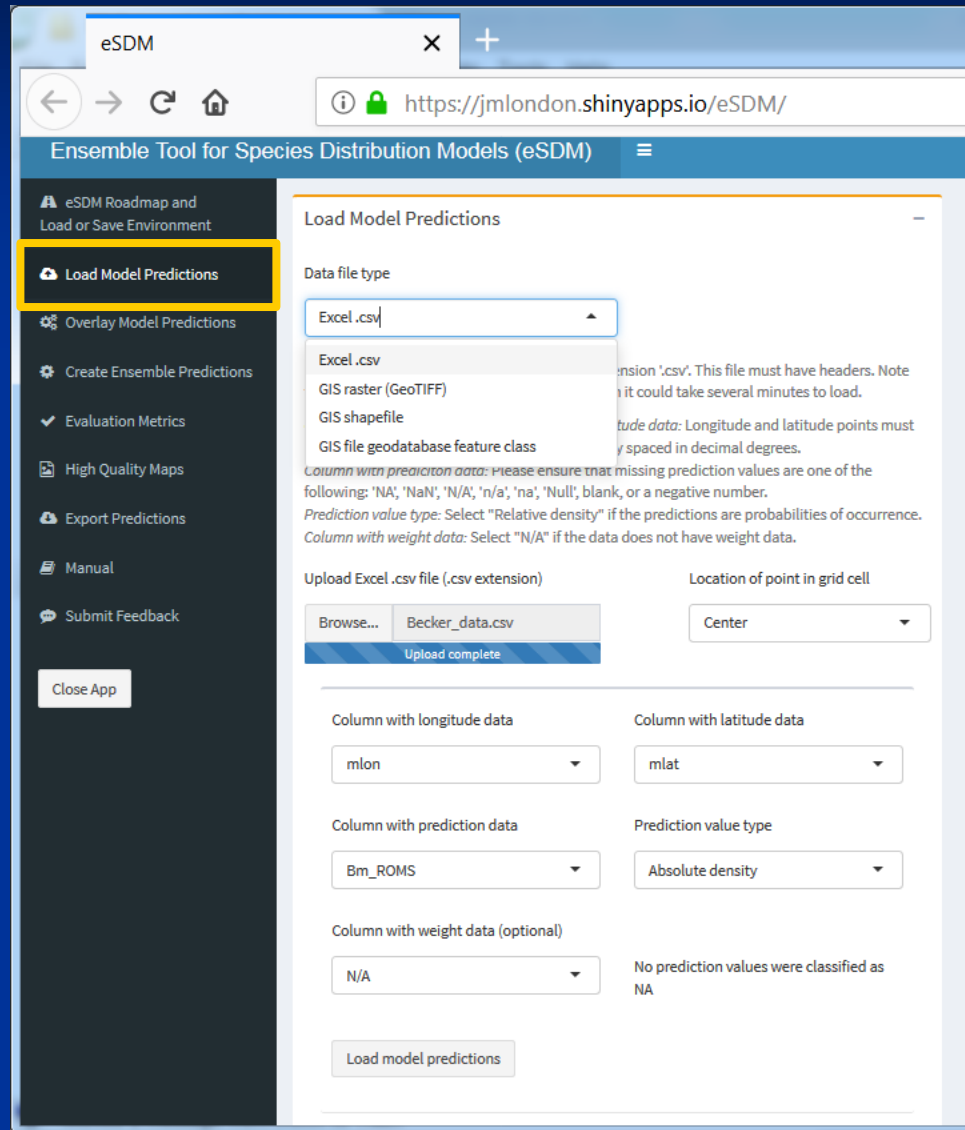
The eSDM is a prototype and still under development. If you encounter an error while using your data with the app or have comments on any facet of the eSDM, please use the 'Submit Feedback' tab to submit your feedback so that we can address your concerns in future versions of the eSDM.

**Run the eSDM locally:** One of the benefits of R Shiny applications such as the eSDM is that they can be hosted online so that users do not have to run them through R themselves. However, running the R Shiny apps locally can be faster than running from them from a server. Thus, you can download the eSDM code from GitHub at [this link](#) and run the eSDM locally. See the 'Run the eSDM locally' section of the manual for instructions on how to run the eSDM locally.

**Context-specific tips and brief instructions**



# eSDM Overview: Load Model Predictions



The screenshot displays the eSDM web application interface. The browser address bar shows the URL <https://jmlondon.shinyapps.io/eSDM/>. The application title is "Ensemble Tool for Species Distribution Models (eSDM)". A yellow arrow points to the "Load Model Predictions" option in the left sidebar. The main panel is titled "Load Model Predictions" and contains the following fields and controls:

- Data file type:** A dropdown menu with "Excel .csv" selected. A tooltip is visible for "Excel .csv" stating: "Excel .csv extension '.csv'. This file must have headers. Note it could take several minutes to load."
- Upload Excel .csv file (.csv extension):** A "Browse..." button and a text input field containing "Becker\_data.csv". Below these is a blue "Upload complete" button.
- Location of point in grid cell:** A dropdown menu with "Center" selected.
- Column with longitude data:** A dropdown menu with "mlon" selected.
- Column with latitude data:** A dropdown menu with "mlat" selected.
- Column with prediction data:** A dropdown menu with "Bm\_ROMS" selected.
- Prediction value type:** A dropdown menu with "Absolute density" selected.
- Column with weight data (optional):** A dropdown menu with "N/A" selected.
- No prediction values were classified as NA:** A text label.
- Load model predictions:** A button at the bottom of the form.

Additional text in the main panel includes: "Column with prediction data: Please ensure that missing prediction values are one of the following: 'NA', 'NaN', 'N/A', 'n/a', 'na', 'Null', blank, or a negative number." and "Prediction value type: Select 'Relative density' if the predictions are probabilities of occurrence. Column with weight data: Select 'N/A' if the data does not have weight data."

- Import options for .CSV and GIS files
- Can specify pixel-specific weights during loading
- Allows for absolute density or relative density values

# eSDM Overview: Load Model Predictions

## Model summary stats and preview

eSDM

← → ↺ 🏠

🔒 https://jmlondon.shinyapps.io/eSDM/ 67% ... 🔍 Search

Ensemble Tool for Species Distribution Models (eSDM)

⚠️ eSDM Roadmap and Load or Save Environment

➡️ Load Model Predictions

🗺️ Overlay Model Predictions

⚙️ Create Ensemble Predictions

✓ Evaluation Metrics

🖨️ High Quality Maps

📄 Export Predictions

📖 Manual

💬 Submit Feedback

Close App

Load Model Predictions

Data file type  
GIS shapefile

Browse to and open all files (.shp, .dbf, etc.) associated with the GIS shapefile. Note that if this file is large (greater than ~50 Mb), then it could take several minutes to load.  
  
Column with prediction data: Please ensure that missing prediction values are one of the following: 'NA', 'NaN', 'N/A', 'n/a', 'na', 'NULL', blank, or a negative number.  
Prediction value type: Select "Relative density" if the predictions are probabilities of occurrence.  
Column with weight data: Select "N/A" if the data does not have weight data.

Upload GIS shapefile files  
Browse... 4 files  
Upload complete

Column with prediction data: pred  
Prediction value type: Relative density

Column with weight data (optional): N/A  
41 prediction values were classified as NA

Load model predictions

Model predictions loaded from GIS shapefile

Loaded Model Predictions

Select loaded model predictions with which to perform an action: Click on row(s) in the table below to select or deselect the model predictions. You can only select or deselect row(s) when Display additional information is unchecked.

	SDM filename	Resolution	Cell count	Prediction count	Abundance	Long, lat range
Original 1	Becker_data.csv	0.09 degrees	14807	14807	1662	-131, -117, 30, 49
Original 2	PredCCE_ModelCCE_shp	10 km	11419	11378	N/A	-131, -117, 30, 49

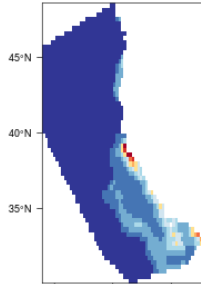
☒ Display additional information  
If 'Resolution' data begins with a '-', then the predictions are irregularly spaced in their provided coordinate system and the provided value is an approximation

Action to perform with selected model predictions  
☒ Plot preview  
☐ Download preview  
☐ Remove from app

Action option(s)  
Units  
☐ Percentages  
☒ Values  
Preview selected model predictions

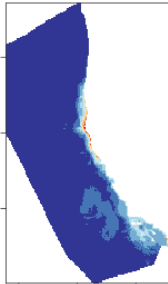
Preview

pred  
PredCCE\_ModelCCE\_shp



0.01778  
0.01601  
0.01423  
0.01245  
0.01067  
0.00889  
0.00711  
0.00534  
0.00356  
0.00178

Bm\_ROMS  
Becker\_data.csv



0.02225  
0.02003  
0.0178  
0.01558  
0.01335  
0.01113  
0.00891  
0.00668  
0.00446  
0.00224

## eSDM Overview: Overlay Model Predictions

The overlay process is the backbone of this tool, as it allows you to create ensemble models for grids developed with different coordinate systems and/or spatial resolutions.

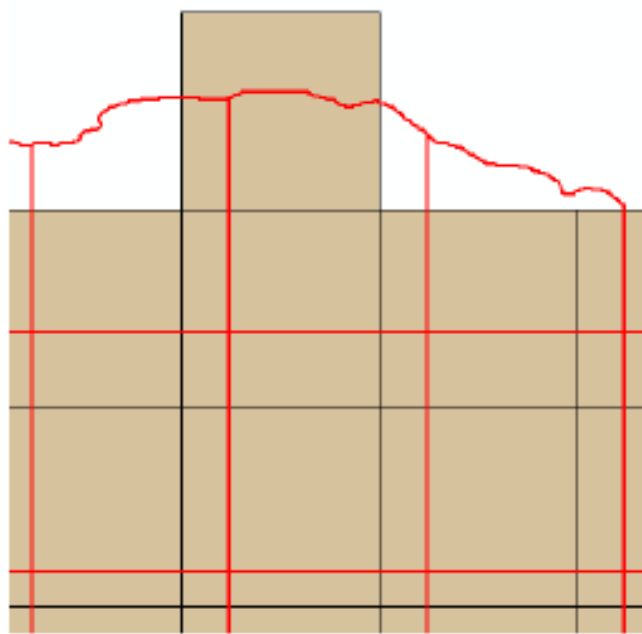
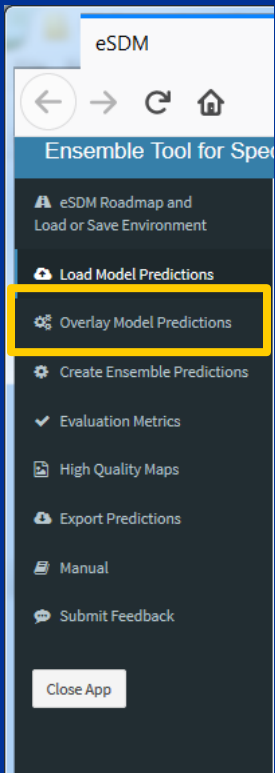


Figure 1

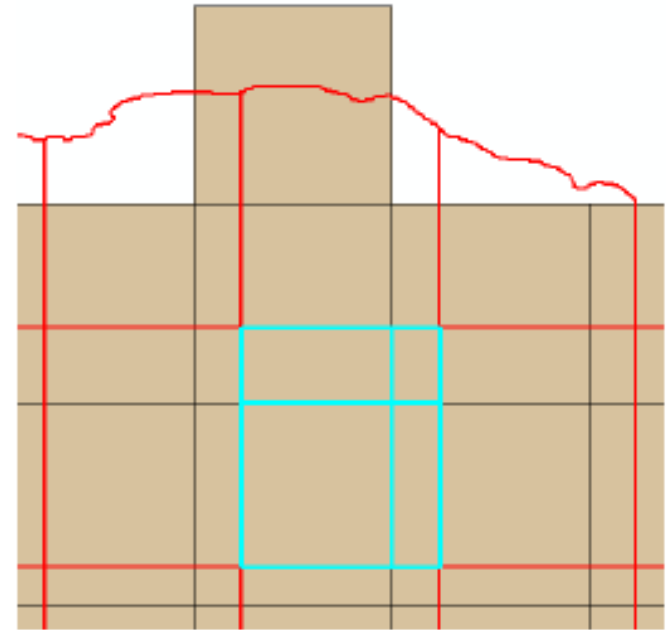
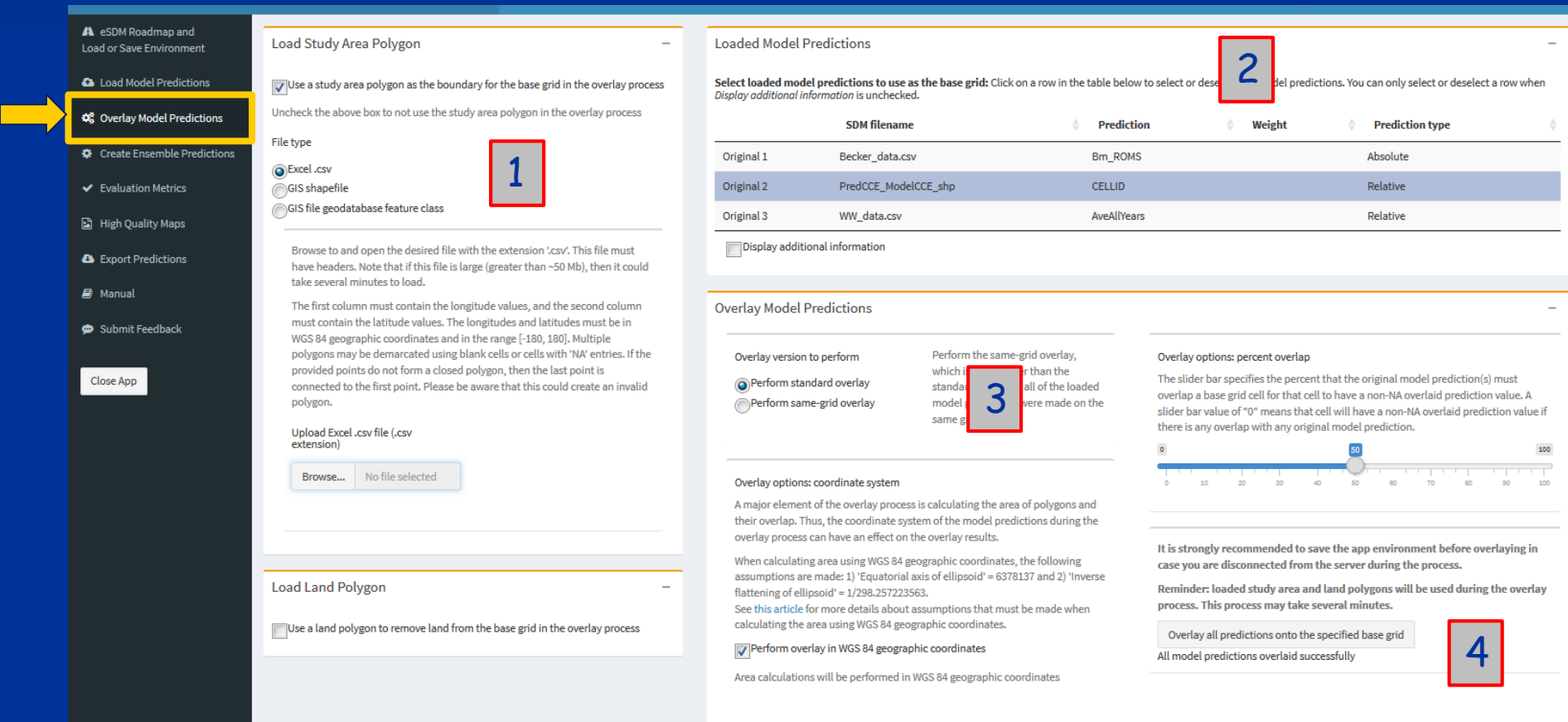


Figure 2

# eSDM Overview: Overlay Model Predictions

1. Load any land or other study area polygons (e.g. to clip model to smaller area)
2. Select the model to use as the base grid
3. Choose *Perform standard overlay* (or *Perform same grid overlay* if grids same)
4. Click on *Overlay predictions onto specified base grid* (can take a while)



**Load Study Area Polygon**

☒ Use a study area polygon as the boundary for the base grid in the overlay process

Uncheck the above box to not use the study area polygon in the overlay process

**File type**

☒ Excel .csv **1**

☐ GIS shapefile

☐ GIS file geodatabase feature class

Browse to and open the desired file with the extension '.csv'. This file must have headers. Note that if this file is large (greater than ~50 Mb), then it could take several minutes to load.

The first column must contain the longitude values, and the second column must contain the latitude values. The longitudes and latitudes must be in WGS 84 geographic coordinates and in the range [-180, 180]. Multiple polygons may be demarcated using blank cells or cells with 'NA' entries. If the provided points do not form a closed polygon, then the last point is connected to the first point. Please be aware that this could create an invalid polygon.

Upload Excel .csv file (.csv extension)

**Load Land Polygon**

☐ Use a land polygon to remove land from the base grid in the overlay process

**Loaded Model Predictions**

Select loaded model predictions to use as the base grid: Click on a row in the table below to select or deselect a row when Display additional information is unchecked. **2**

	SDM filename	Prediction	Weight	Prediction type
Original 1	Becker_data.csv	Bm_ROMS		Absolute
Original 2	PredCCE_ModelCCE_shp	CELLID		Relative
Original 3	WW_data.csv	AveAllYears		Relative

☐ Display additional information

**Overlay Model Predictions**

**Overlay version to perform**

☒ Perform standard overlay **3**

☐ Perform same-grid overlay

Perform the same-grid overlay, which is faster than the standard overlay. All of the loaded model predictions were made on the same grid.

**Overlay options: percent overlap**

The slider bar specifies the percent that the original model prediction(s) must overlap a base grid cell for that cell to have a non-NA overlaid prediction value. A slider bar value of "0" means that cell will have a non-NA overlaid prediction value if there is any overlap with any original model prediction.

0 10 20 30 40 50 60 70 80 90 100

**Overlay options: coordinate system**

A major element of the overlay process is calculating the area of polygons and their overlap. Thus, the coordinate system of the model predictions during the overlay process can have an effect on the overlay results.

When calculating area using WGS 84 geographic coordinates, the following assumptions are made: 1) 'Equatorial axis of ellipsoid' = 6378137 and 2) 'Inverse flattening of ellipsoid' = 1/298.257223563. See [this article](#) for more details about assumptions that must be made when calculating the area using WGS 84 geographic coordinates.

☒ Perform overlay in WGS 84 geographic coordinates

Area calculations will be performed in WGS 84 geographic coordinates

**Overlay all predictions onto the specified base grid** **4**

All model predictions overlaid successfully

# eSDM Overview: Create Ensemble Predictions

1. Select models to combine in ensemble (default is All)
2. Choose options for weighting and re-scaling

The screenshot displays the eSDM web application interface. On the left, a dark sidebar contains navigation links: 'eSDM Roadmap and Load or Save Environment', 'Load Model Predictions', 'Overlay Model Predictions', 'Create Ensemble Predictions' (highlighted with a yellow box and an arrow), 'Evaluation Metrics', 'High Quality Maps', 'Export Predictions', 'Manual', and 'Submit Feedback'. A 'Close App' button is at the bottom of the sidebar.

The main content area is divided into two sections. The top section, 'Overlaid Model Predictions', includes a text instruction: 'Select overlaid model predictions to ensemble: All overlaid model predictions will be used when creating ensemble predictions. You can select specific sets of overlaid model predictions to ensemble when Create ensemble using a subset of the overlaid model predictions is checked.' Below this is a table with the following data:

	SDM filename	Prediction	Weight	Prediction type	Resolution	Cell count	Prediction count	Abundance	Long, lat range
Overlaid 1	Becker_data.csv	Bm_ROMS		Absolute	10 km	11419	11377	1618	-131, -117, 30, 49
Overlaid 2	PredCCE_ModelCCE_shp	CELLID		Relative	10 km	11419	11419	N/A	-131, -117, 30, 49
Overlaid 3	WW_data.csv	AveAllYears		Relative	10 km	11419	11326	N/A	-131, -117, 30, 49

Below the table is a checkbox labeled 'Create ensemble using a subset of the overlaid model predictions'. A red box with the number '1' is placed to the right of the table.

The bottom section, 'Create Ensemble Predictions', contains two main configuration areas. The 'Ensembling method' section has radio buttons for 'Unweighted' and 'Weighted' (selected). Under 'Weighted', there are radio buttons for 'Manual entry' (selected), 'Evaluation metric', 'Pixel-level spatial weights', and 'Polygon(s) with weights'. A text box for 'Ensemble weights' contains the value '1.0, 1.0, 1.0'. A red box with the number '2' is placed to the right of this text box. The 'Rescaling method' section has radio buttons for 'Abundance' (selected), 'Normalization', 'Standardization', and 'Sum to 1'. Below this is a text box for 'Abundance to which to rescale predictions' with the value '0'. A 'Create ensemble' button is located at the top right of this section. A description at the bottom states: 'Description: For each model, rescale predictions so that the predicted abundance is the value entered above'.

# eSDM Overview: Create Ensemble Predictions

After creating ensemble model(s), scroll down to select and preview individual ensemble models

eSDM

← → ↺ 🏠

📌 eSDM Roadmap and Load or Save Environment

☁️ Load Model Predictions

⚙️ Overlay Model Predictions

⚙️ Create Ensemble Predictions

✓ Evaluation Metrics

🗺️ High Quality Maps

☁️ Export Predictions

📖 Manual

💬 Submit Feedback

Close App

☒ Manual entry

the following format: 'weight, weight, ..., weight'.

Ensemble weights

1.0, 1.0, 1.0

☐ Evaluation metric

☐ Pixel-level spatial weights

☐ Polygon(s) with weights

Normalization

☐ Standardization

☐ Sum to 1

Abundance to which to rescale predictions

1618

Description:

For each model, rescale predictions so that the predicted abundance is the value entered above

Created weighted ensemble

Created Ensemble Predictions

Select ensemble model predictions with which to perform an action: Click on row(s) in the table below to select or deselect the model predictions.

	Ensembling method	Weights	Rescaling method	Overlaid models used
Ensemble 1	Weighted	1.0, 1.0, 1.0	Abundance: 1618	All

Action to perform with selected ensemble predictions

☒ Plot preview

☐ Download preview

☐ Remove from app

☐ Calculate predicted abundance

Action option(s)

Units

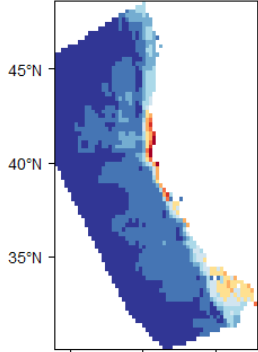
☐ Percentages

☒ Values

Preview selected ensemble predictions

Ensemble Preview

Weighted | Abundance: 1618 | All





# eSDM Overview: Evaluation Metrics

1. Select original models or overlaid models created previously
2. Load external validation data sets (if desired)
3. Select AUC, TSS, RMSE (can then be applied as weights)

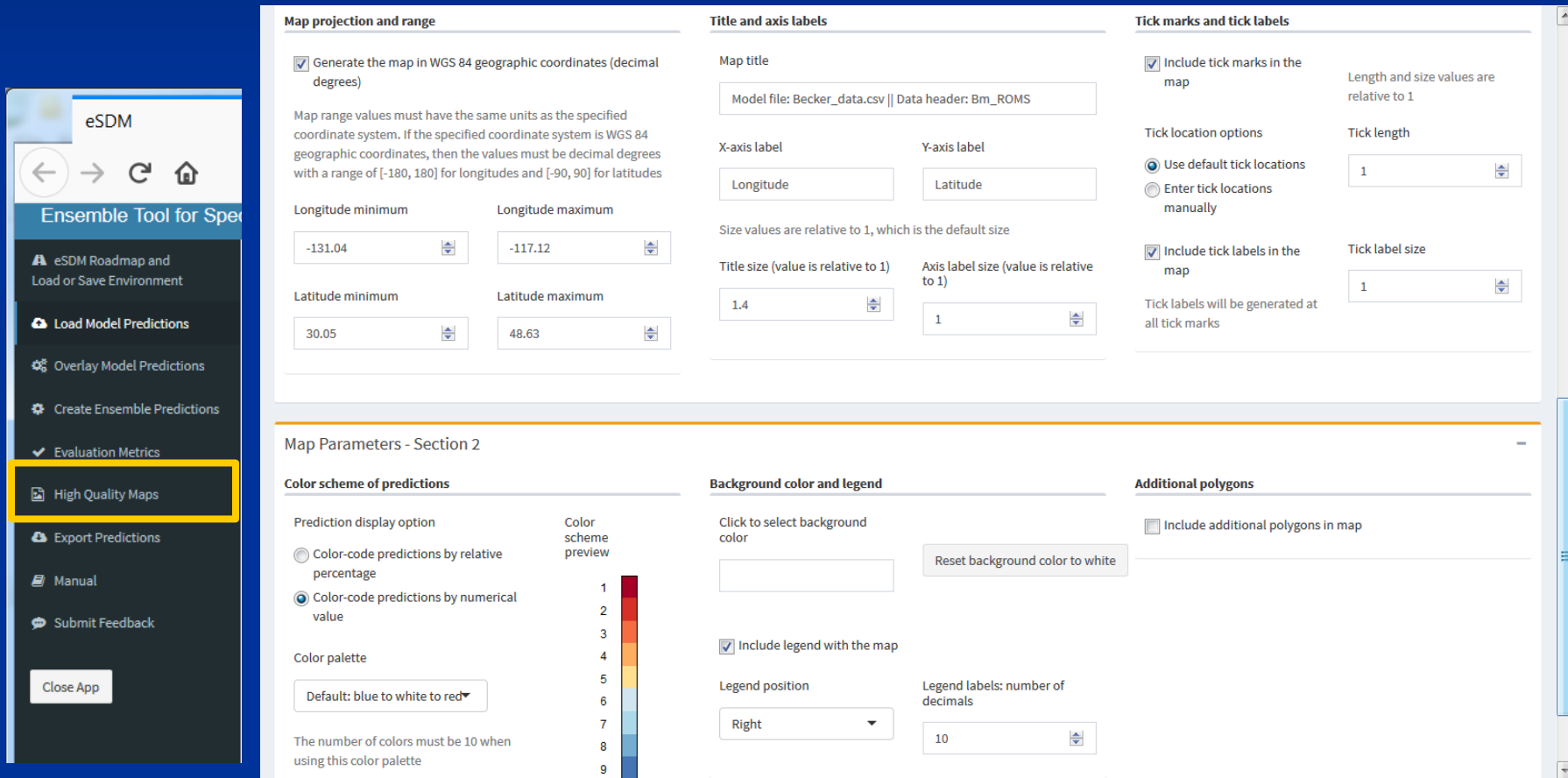
The screenshot displays the eSDM web application interface. The left sidebar contains a menu with the following items: eSDM Roadmap and Load or Save Environment, Load Model Predictions, Overlay Model Predictions, Create Ensemble Predictions, **Evaluation Metrics** (highlighted with a yellow box and an arrow), High Quality Maps, Export Predictions, Manual, and Submit Feedback. A 'Close App' button is located at the bottom of the sidebar.

The main content area is divided into several panels:

- Select Predictions to Evaluate**: This panel contains a table with columns 'SDM filename', 'Prediction', and 'Weight'. It lists three original models and three overlaid models. A red box with the number '1' highlights the instruction: 'Select model predictions to evaluate: Click on row(s) in the table below to select or deselect the model predictions.'
- Load Validation Data**: This panel contains options for 'Validation data file type' (Excel .csv, GIS shapefile, GIS file geodatabase feature class) and 'Validation data type' (Counts (numerical), Presence or absence). A red box with the number '2' highlights the title. Below these options is a text area for instructions and a file upload section with a 'Browse...' button and 'No file selected' text.
- Calculate Metrics**: This panel contains the text 'Load validation data in order to calculate metrics'.
- Metric Descriptions and References**: This panel contains radio buttons for 'Area under the curve (AUC)', 'True Skill Statistic (TSS)', and 'Root mean squared error (RMSE)'. A red box with the number '3' highlights the 'AUC description' text, which states: 'The Area Under the Curve of the ROC plot is a threshold independent metric that evaluates the percentage of the time a random selection from the positive group will have a score greater than a random selection from the negative class (Deleo 1993). See Fielding and Bell 1997 for more information.'

# eSDM Overview: High Quality Maps

Can customize map dimensions, colors, and plotting options to create a high-resolution map (e.g. for publications)



The screenshot displays the eSDM web application interface. On the left, a sidebar contains navigation options: 'eSDM Roadmap and Load or Save Environment', 'Load Model Predictions', 'Overlay Model Predictions', 'Create Ensemble Predictions', 'Evaluation Metrics', 'High Quality Maps' (highlighted with a yellow box and an arrow), 'Export Predictions', 'Manual', and 'Submit Feedback'. A 'Close App' button is at the bottom of the sidebar.

The main content area is divided into several panels:

- Map projection and range:** Includes a checkbox for 'Generate the map in WGS 84 geographic coordinates (decimal degrees)'. Below, it explains that map range values must have the same units as the specified coordinate system. It provides input fields for Longitude minimum (-131.04), Longitude maximum (-117.12), Latitude minimum (30.05), and Latitude maximum (48.63).
- Title and axis labels:** Includes a 'Map title' field with the text 'Model file: Becker\_data.csv || Data header: Bm\_ROMS'. It has input fields for 'X-axis label' (Longitude) and 'Y-axis label' (Latitude). It also includes 'Title size' (1.4) and 'Axis label size' (1) fields, with a note that size values are relative to 1.
- Tick marks and tick labels:** Includes a checkbox for 'Include tick marks in the map' and a 'Tick length' input field (1). It has radio buttons for 'Use default tick locations' (selected) and 'Enter tick locations manually'. It also includes a checkbox for 'Include tick labels in the map' and a 'Tick label size' input field (1).
- Map Parameters - Section 2:** This section is divided into three sub-panels:
  - Color scheme of predictions:** Includes a 'Prediction display option' with radio buttons for 'Color-code predictions by relative percentage' and 'Color-code predictions by numerical value' (selected). It features a 'Color palette' dropdown set to 'Default: blue to white to red' and a vertical color bar with 9 color swatches. A note states: 'The number of colors must be 10 when using this color palette'.
  - Background color and legend:** Includes a 'Click to select background color' field and a 'Reset background color to white' button. It has a checkbox for 'Include legend with the map' (checked) and a 'Legend position' dropdown set to 'Right'. It also includes a 'Legend labels: number of decimals' input field (10).
  - Additional polygons:** Includes a checkbox for 'Include additional polygons in map'.

# eSDM Overview: Export Predictions

All models in the eSDM can be exported as .CSV files, GIS shapefiles or as Google Earth .KML or KMZ files

Ensemble Tool for Species Distribution Models (eSDM)

eSDM Roadmap and Load or Save Environment

Load Model Predictions

Overlay Model Predictions

Create Ensemble Predictions

Evaluation Metrics

High Quality Maps

**Export Predictions**

Manual

Submit Feedback

Close App

Select Predictions to Export

Select model predictions to export: Click on a row in the table(s) below to select or deselect the model predictions.

	SDM filename	Prediction	Weight
Original 1	Becker_data.csv	Bm_ROMS	
Original 2	PredCCE_ModelCCE_shp	CELLID	
Original 3	WW_data.csv	AveAllYears	

	SDM filename	Prediction	Weight
Overlaid 1	Becker_data.csv	Bm_ROMS	
Overlaid 2	PredCCE_ModelCCE_shp	CELLID	
Overlaid 3	WW_data.csv	AveAllYears	

	Ensembling method	Weights	Rescaling method	Overlaid models used
Ensemble 1	Weighted	1.0, 1.0, 1.0	Abundance: 1618	All

Export Predictions

Format in which to export predictions

Excel .csv file

☒ Export predictions in WGS 84 geographic coordinates

Predictions will be exported in WGS 84 geographic coordinates

Description: For predictions to be exported as an Excel .csv file, the centroid is determined for each prediction polygon. The exported .csv file consists of columns with the longitude and latitudes of these centroids, as well as the prediction, and weight values for each of those points.

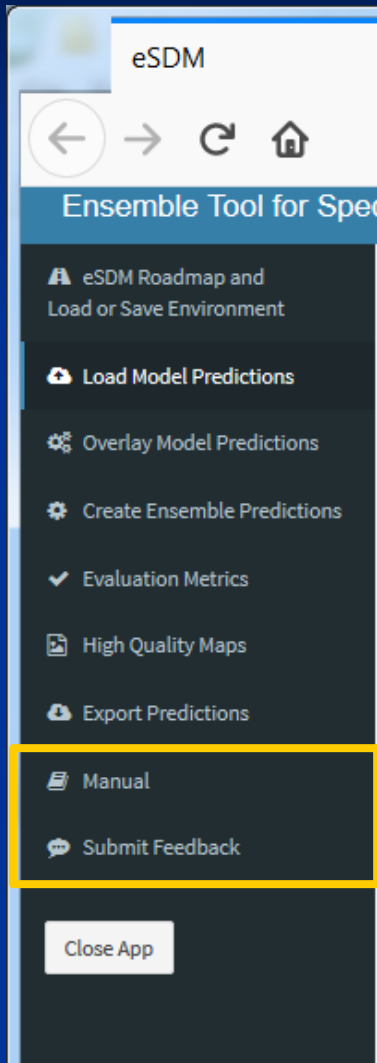
Filename: Extension must be '.csv'.

Filename

eSDM\_PredCCE\_ModelCCE\_shp\_\_CELLID\_\_overlaid

Export predictions

# eSDM Overview: User Manual, Feedback, Next Steps



- Each page has dynamic tips and instructions, but there is also a full user manual (PDF), which loads automatically when the **eSDM** opens. It can also be accessed via the 'Manual' tab
- Below this tab, there is a link to submit feedback and report bugs (**Please!?!)**
- Sam Woodman will return from the field at the end of April 2018 and will make fixes, improvements, and release the revised **eSDM** tool and a supporting paper (target date: September 2018).
- We hope that the **eSDM** will be broadly useful to scientists and managers to explore models, model uncertainty, and inform future management decisions.

# Acknowledgments

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  - Office of Science and Technology  
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- International Whaling Commission
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THANK YOU!

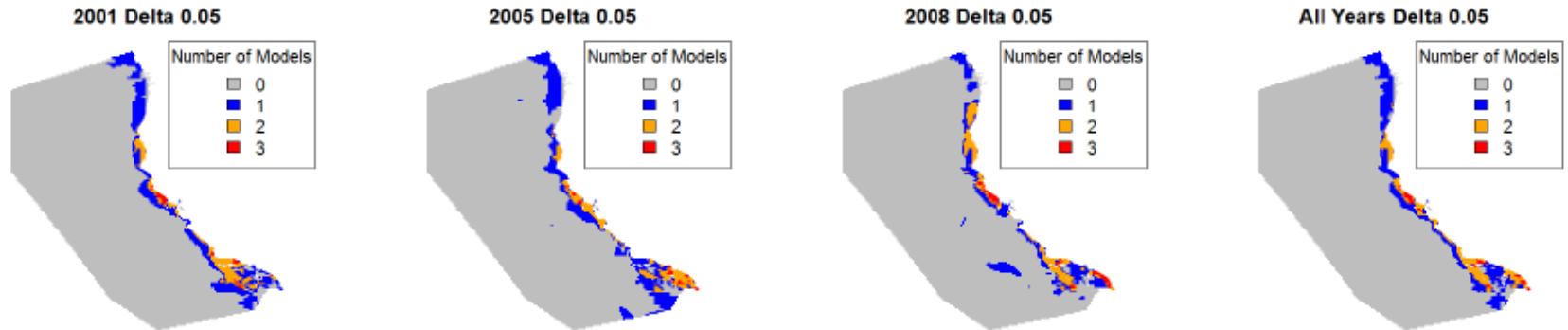




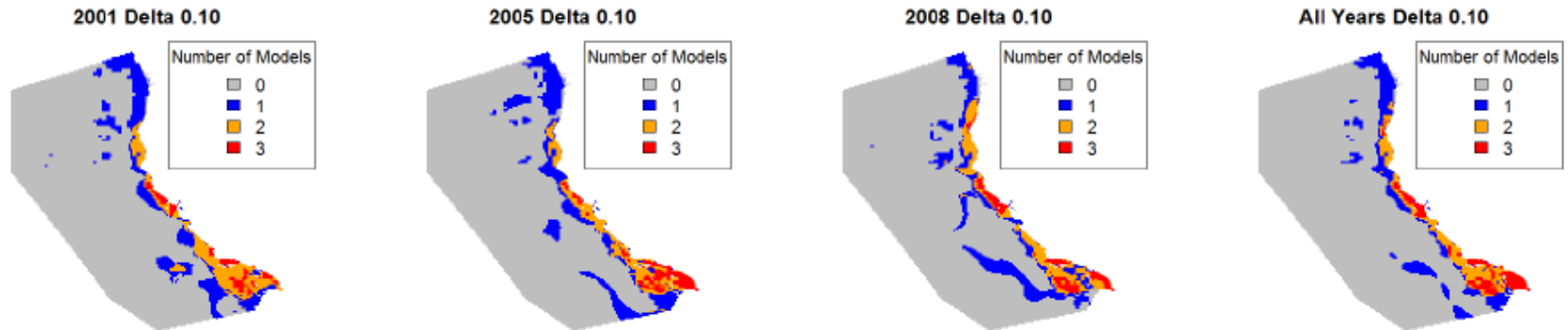
# Delta plots

This PDF was later amended to make the document 508 compliant.

## Overlap of highest 5% of predictions



## Overlap of highest 10% of predictions



Only one model has high predicted densities north of 40° latitude – suggests we need an objective method of evaluating and weighting models geographically