MODELLING SEABIRD COLLISION RISK WITH OFF-SHORE WINDFARMS

M. Mateos, G.M. Arroyo, J.J. Alonso del Rosario

UCA
Universidad de Cádiz

Objectives

To develop a stochastic model of avian collision risk at wind farms

A case study

To obtain probabilities of collision risk

Factors

To estimate mortality rates

Objectives

To develop a stochastic model of avian collision risk at wind farms

A case study

To obtain probabilities of collision risk

Factors

To estimate mortality rates

THE MODEL

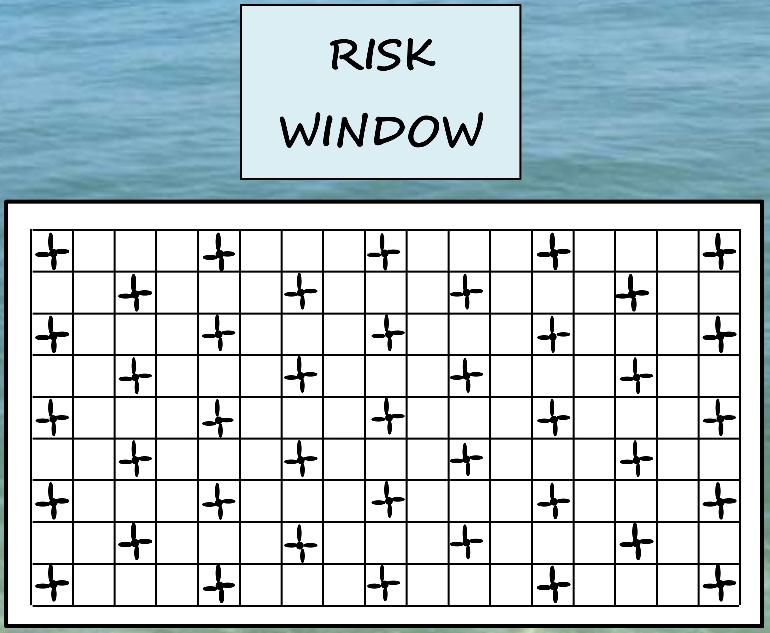
Stochastic character,

based on Montecarlo simulation

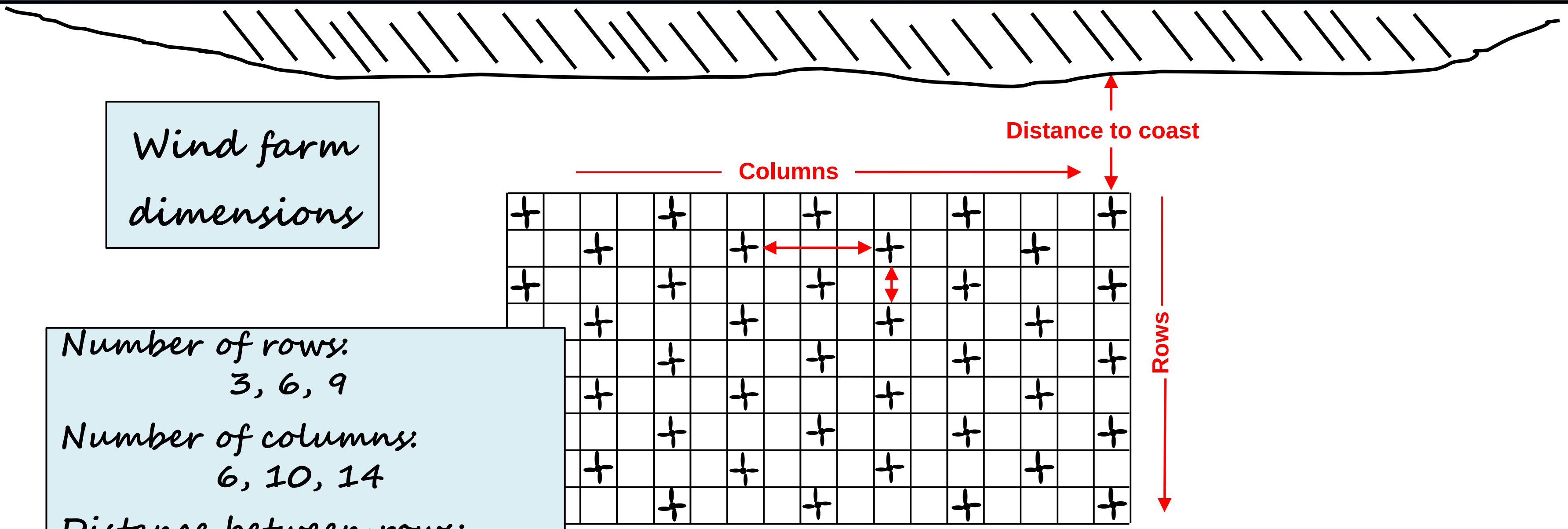
Case study: The Strait of Gibraltar

Case study: The Strait of Gibraltar

THE MODEL: The wind farm as a risk window



THE MODEL: The wind farm as a risk window



Wind farm dimensions

Number of rows:
3, 6, 9

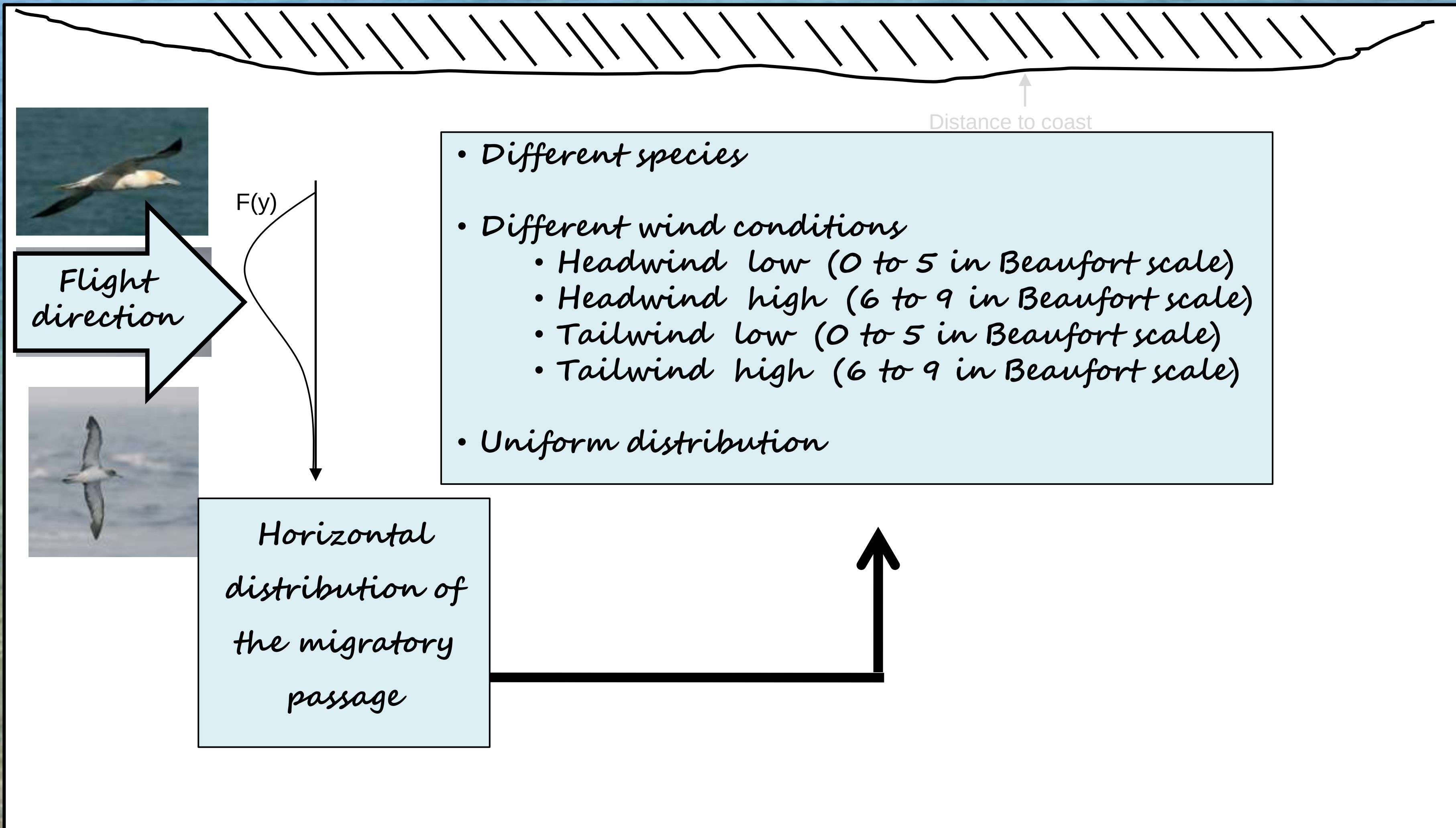
Number of columns:
6, 10, 14

Distance between rows:
400, 700, 1000 m

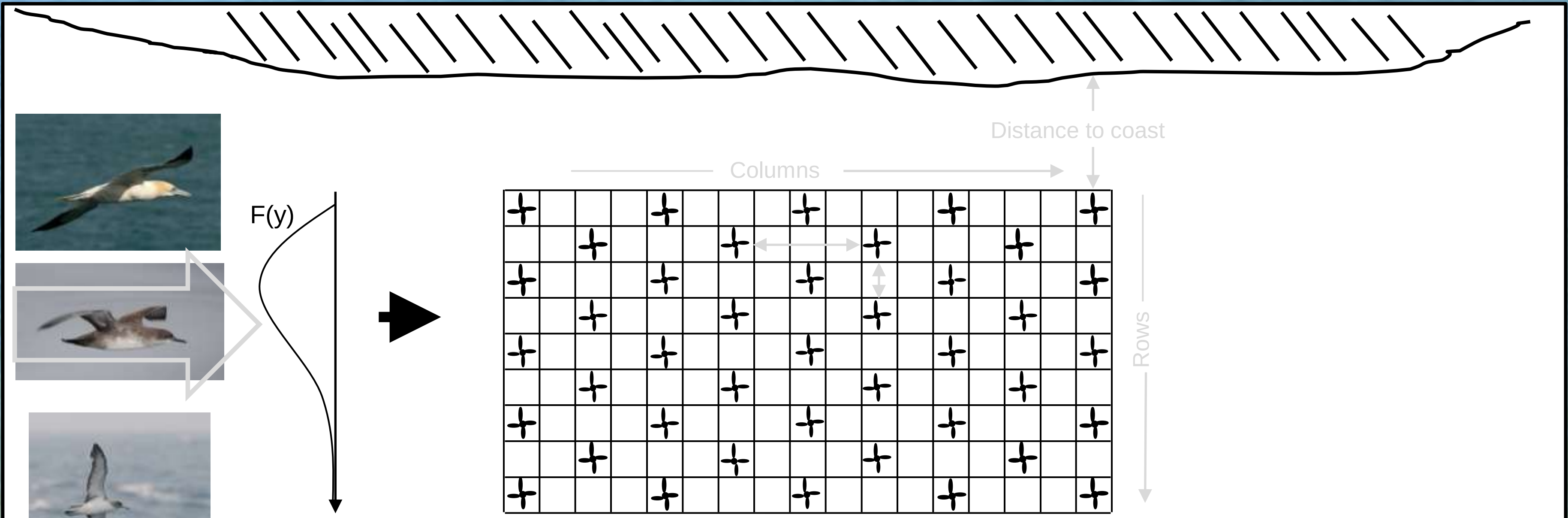
Distance between columns:
300, 600, 900m

Distance to coast:
1, 5, 10 km

THE MODEL: The wind farm as a risk window

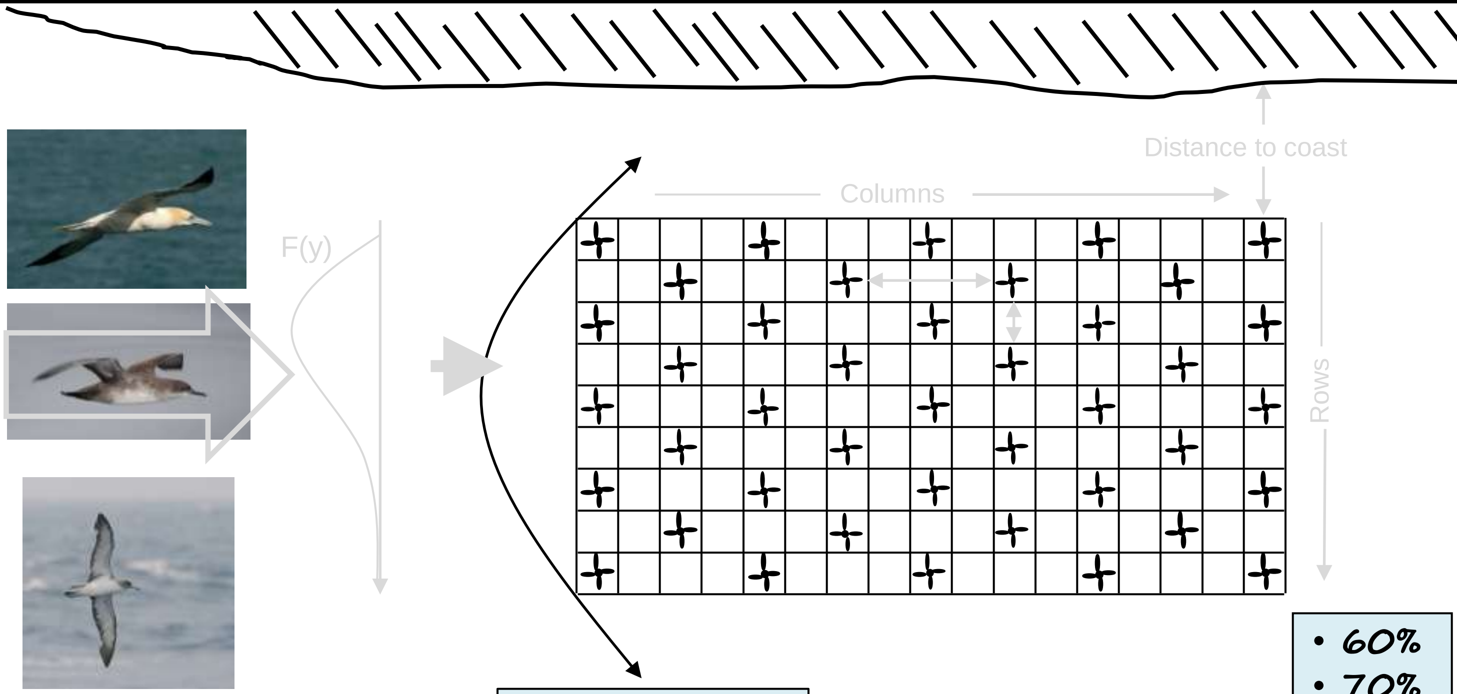


THE MODEL: The wind farm as a risk window



Montecarlo simulation

THE MODEL: The wind farm as a risk window



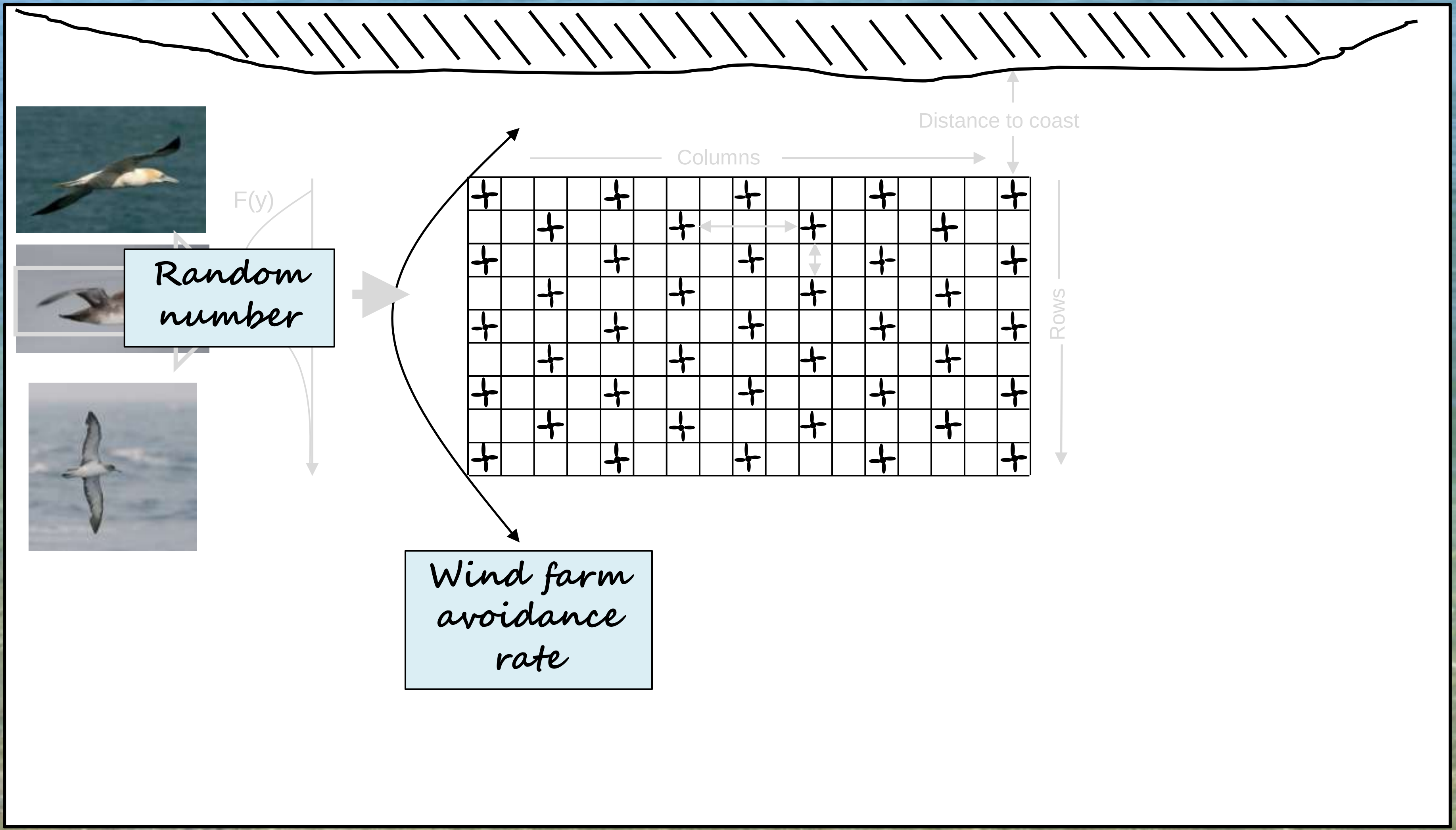
Avoidance rate of the wind farm as a whole

Wind farm avoidance rate → Based on literature →

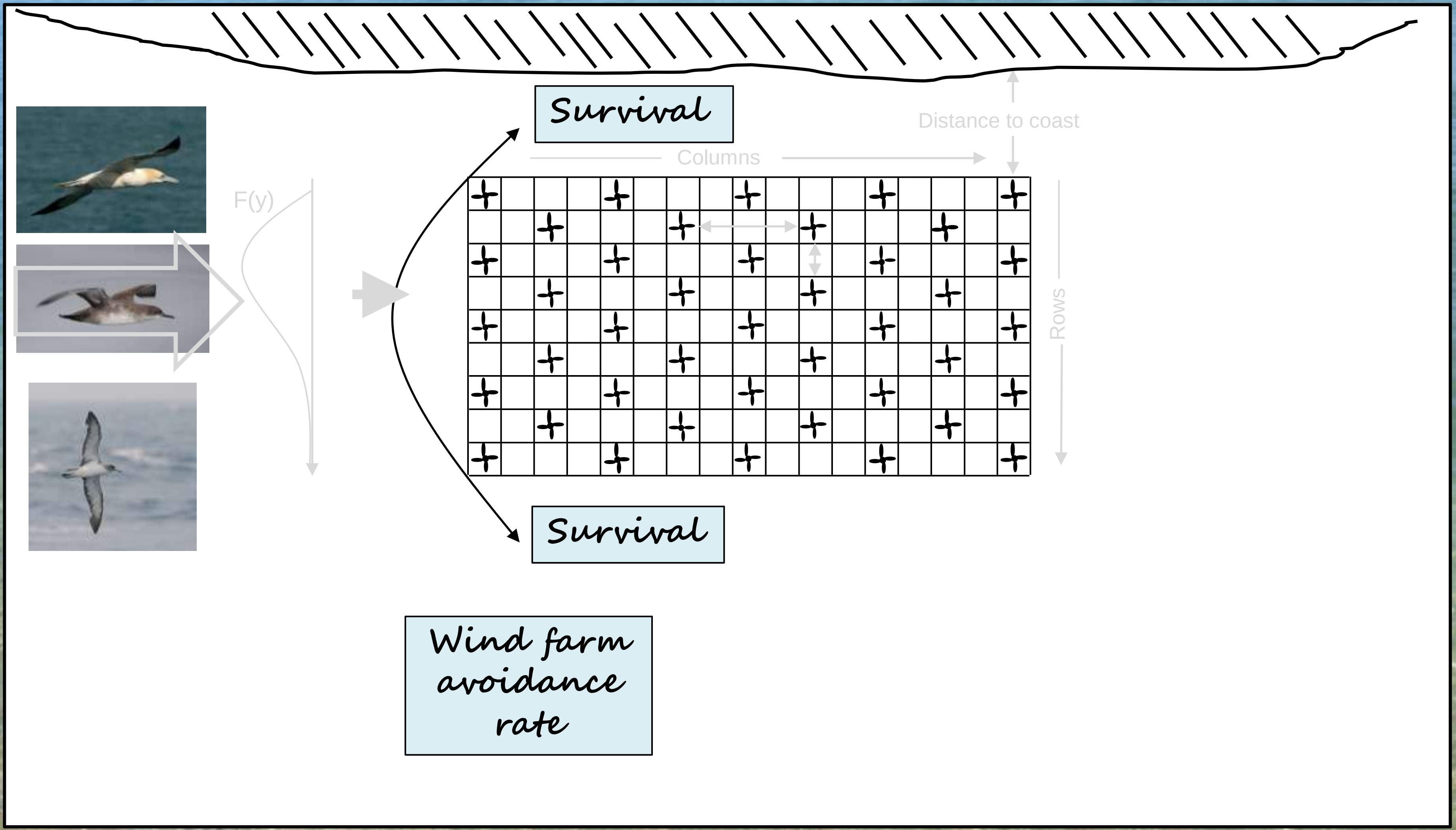
- 60%
- 70%
- 80%
- 90%
- 0%

Species	Avoidance rate		From
Common Eiders	WFAR	82%	Desholm and Kahlert 2005

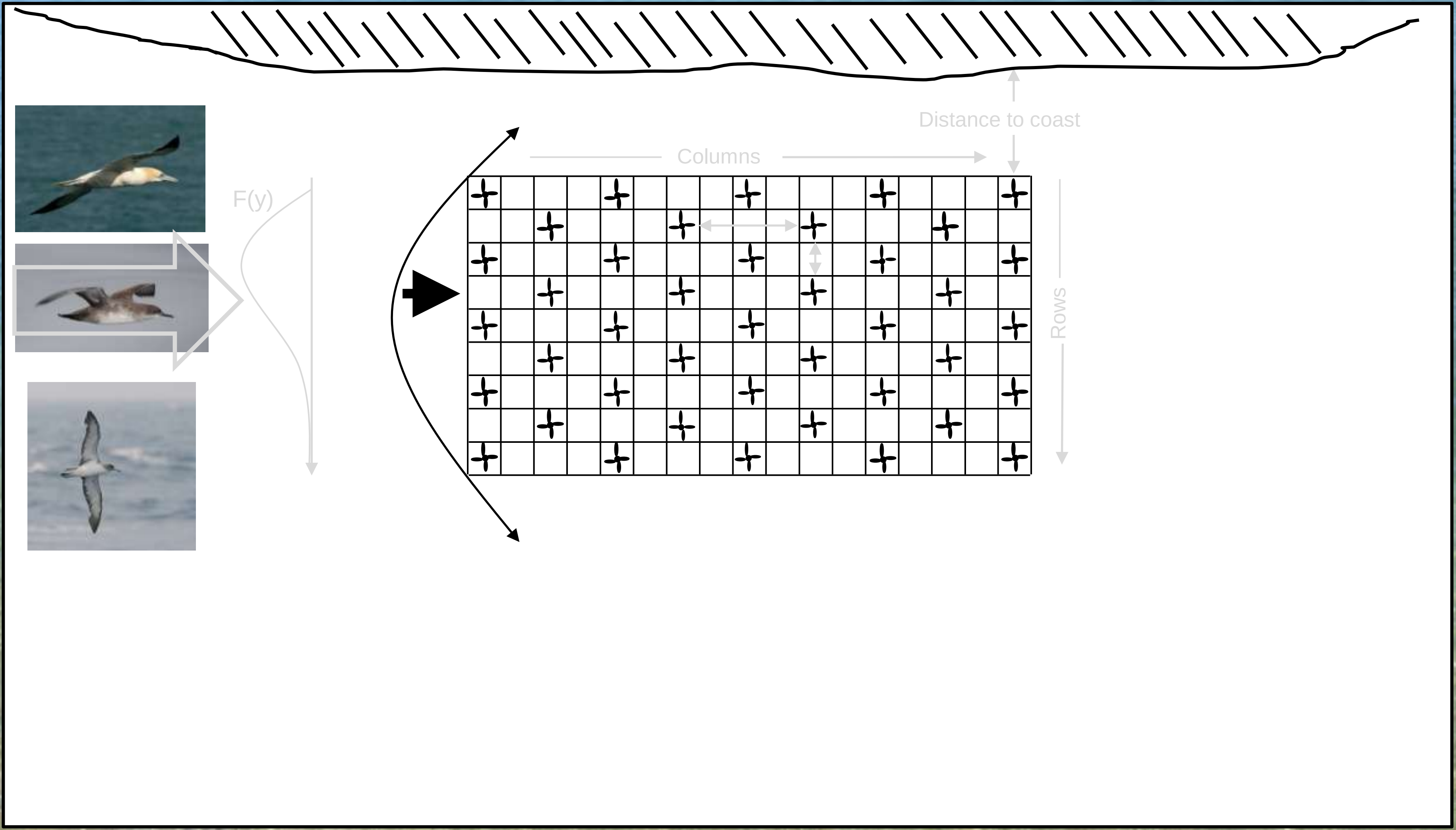
THE MODEL: The wind farm as a risk window



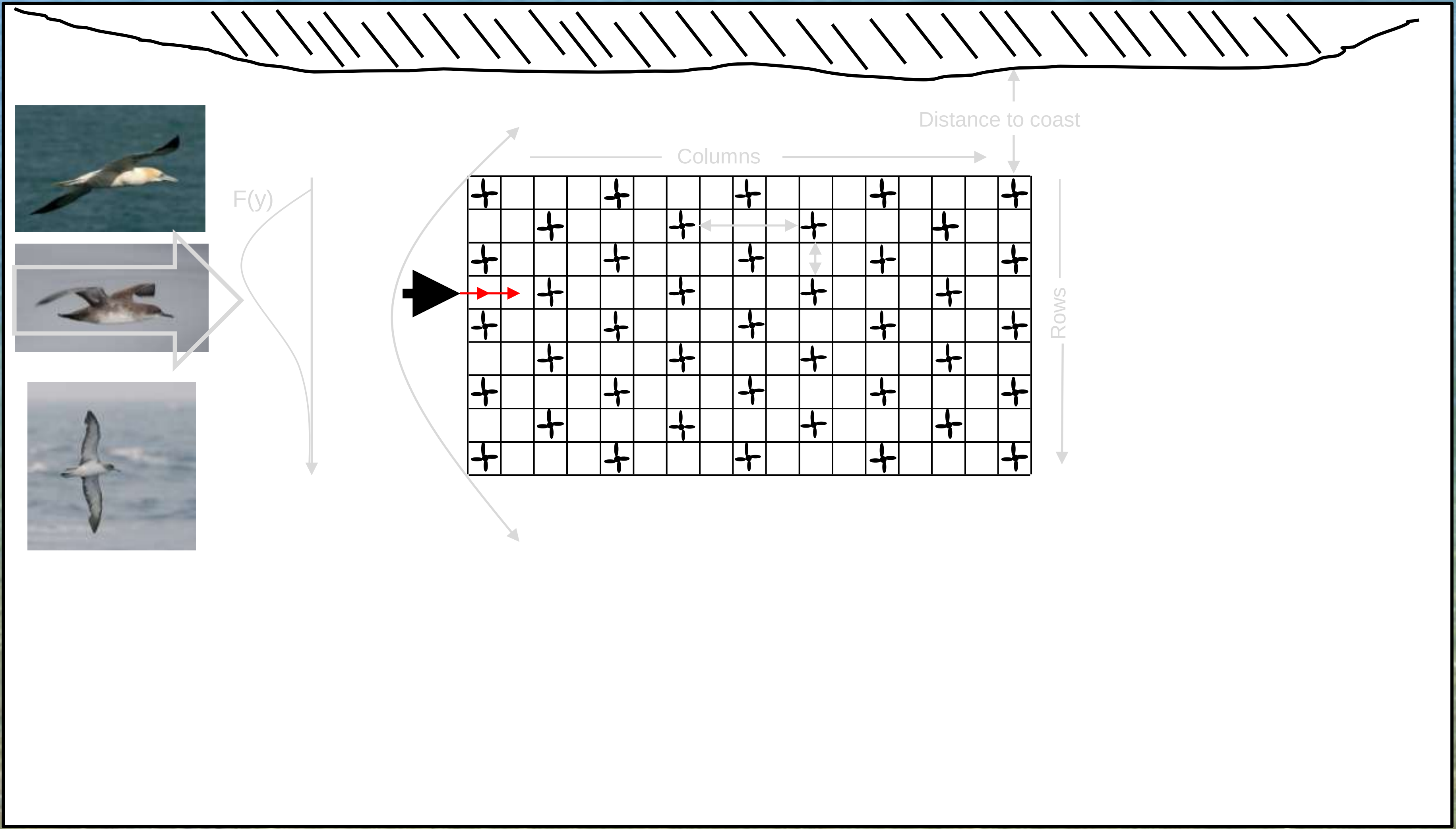
THE MODEL: The wind farm as a risk window



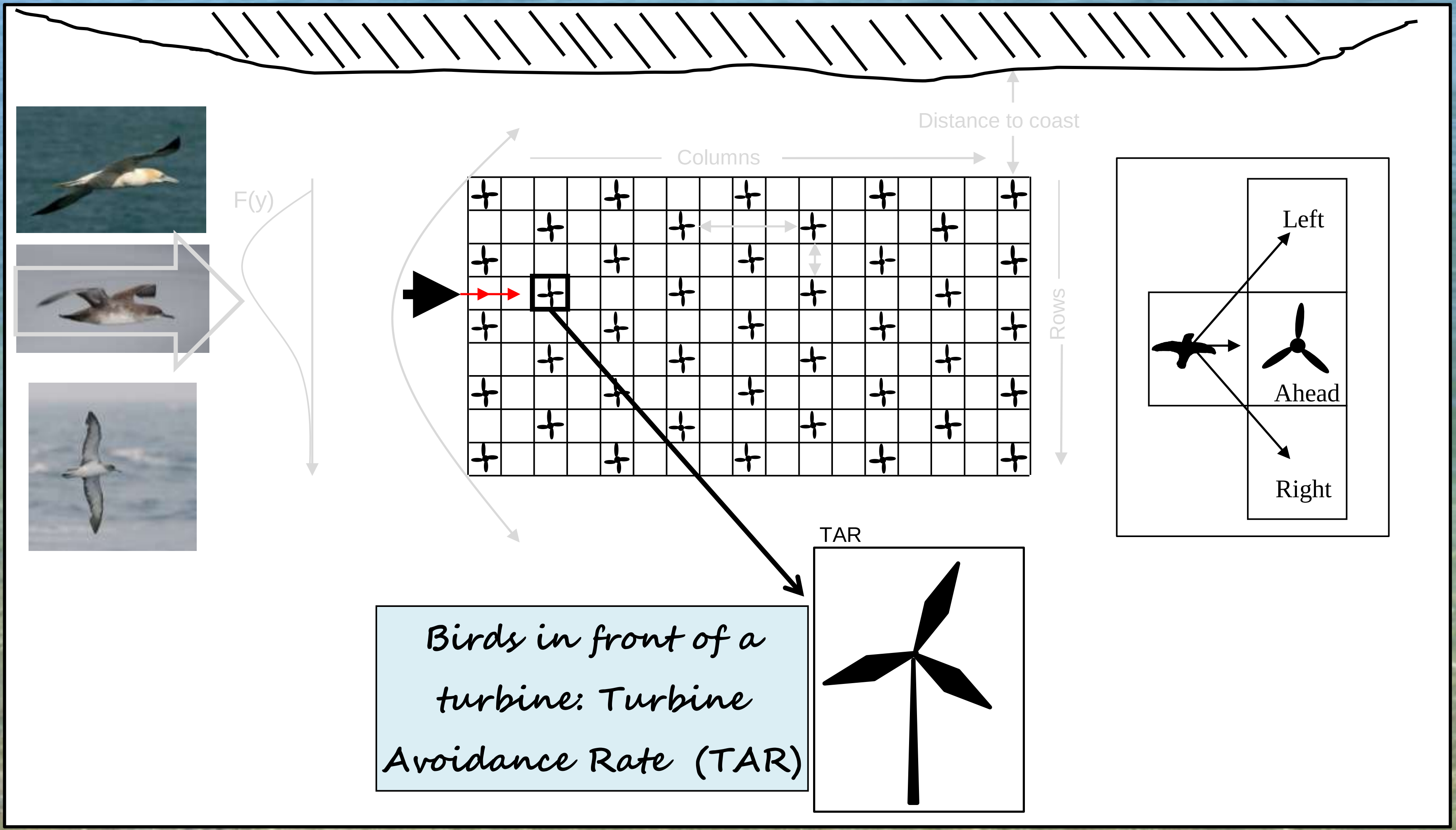
THE MODEL: The wind farm as a risk window



THE MODEL: The wind farm as a risk window

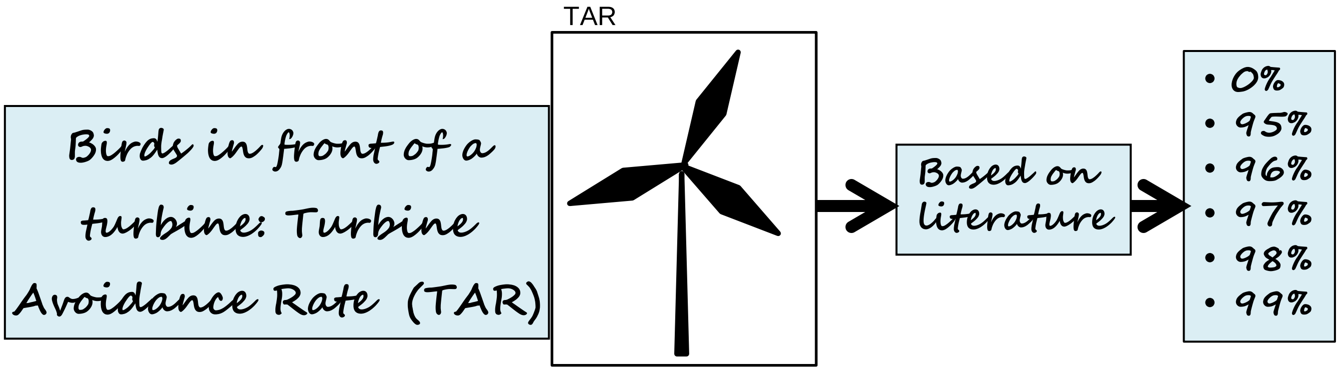


THE MODEL: The wind farm as a risk window

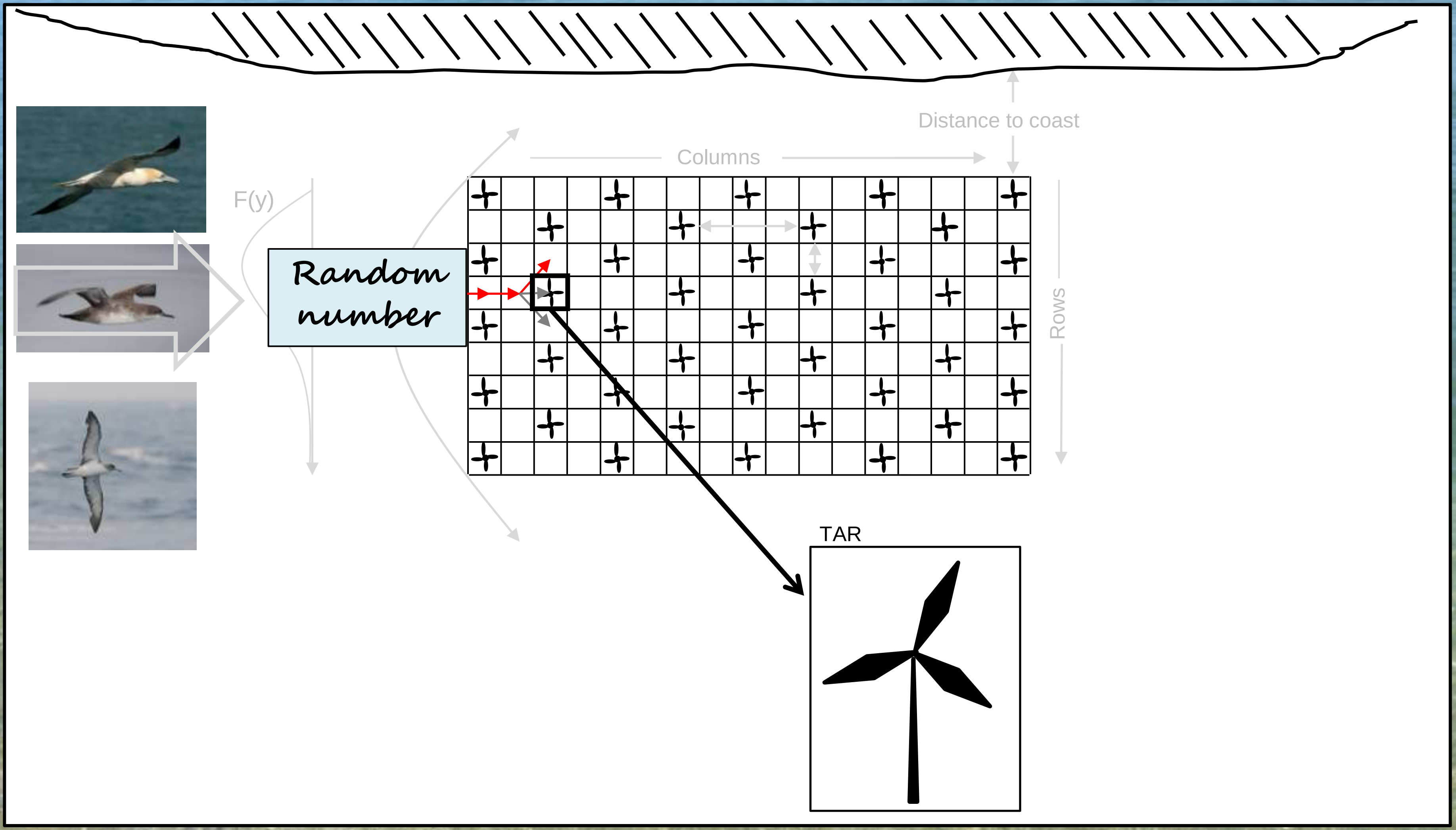


THE MODEL: The wind farm as a risk window

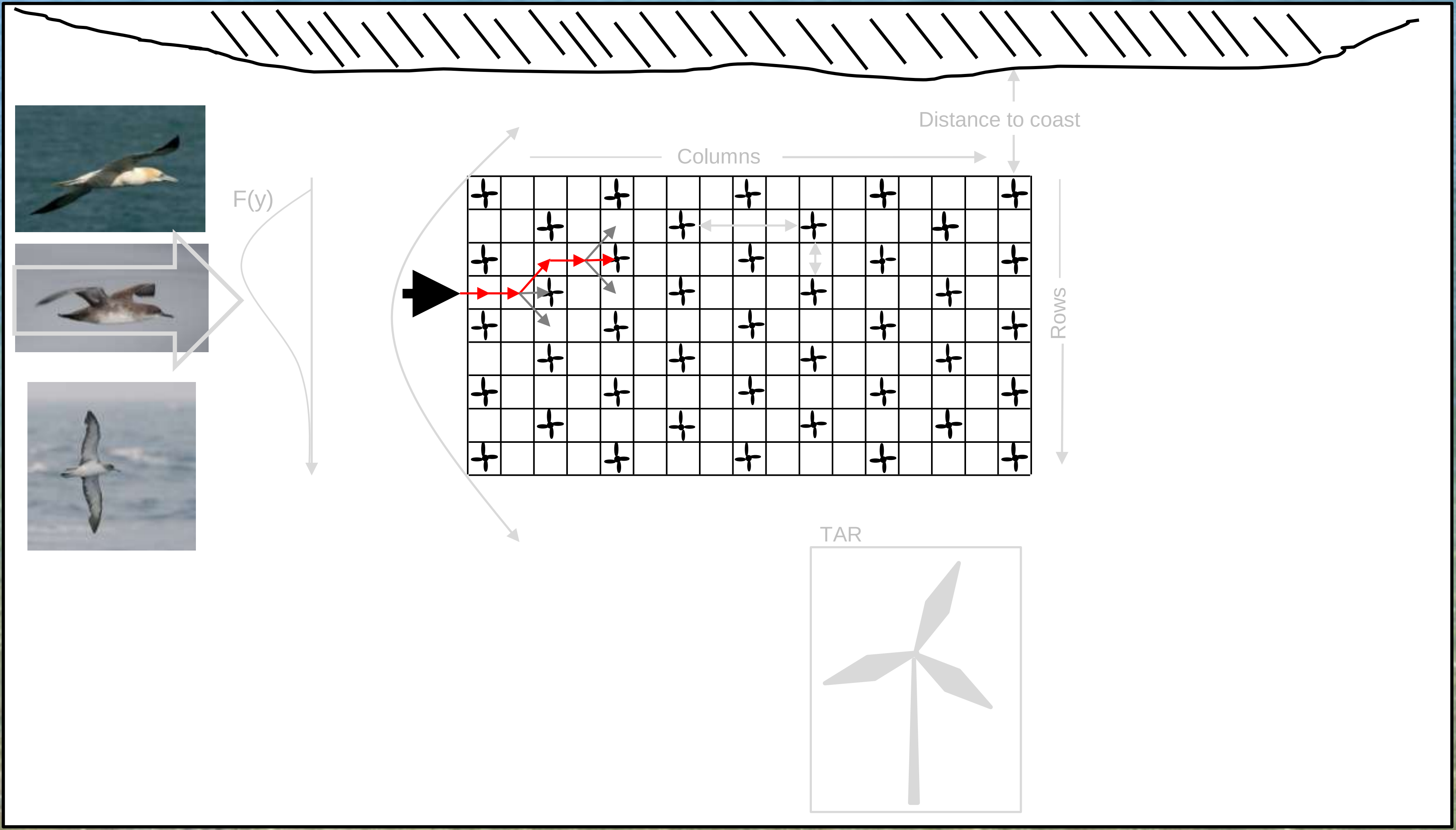
Species	Avoidance rate	From
Common Eiders	94.6%	Desholm and Kahlert 2005
Waterfowl and waders	97.5%	Winkelman 1992, 1994
Gulls, waders	97%	Winkelman 1985
Bewick's Swan	99.5%	Percival 2004
Gulls	99.9%	Everaert et al. 2002
Common terns	99.8%	Everaert et al. 2002
Barnacle, Greylag, White-fronted Geese	100%	Percival 1998



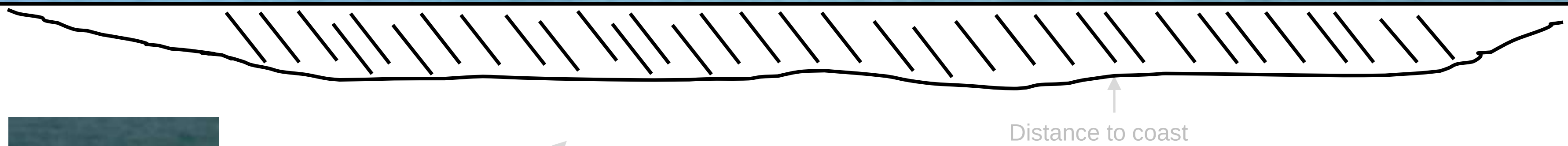
THE MODEL: The wind farm as a risk window

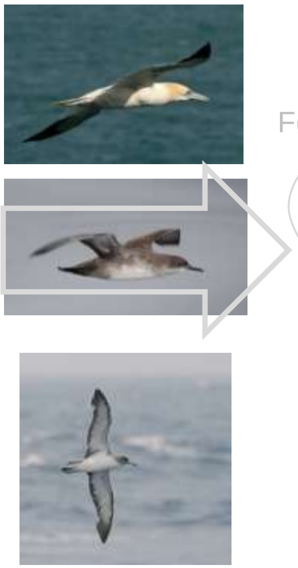


THE MODEL: The wind farm as a risk window



THE MODEL: The wind farm as a risk window

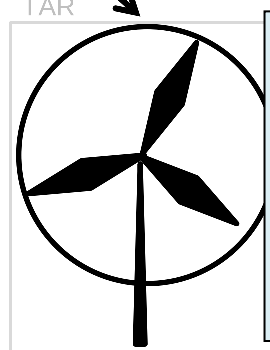




Following Band et al. 2007:

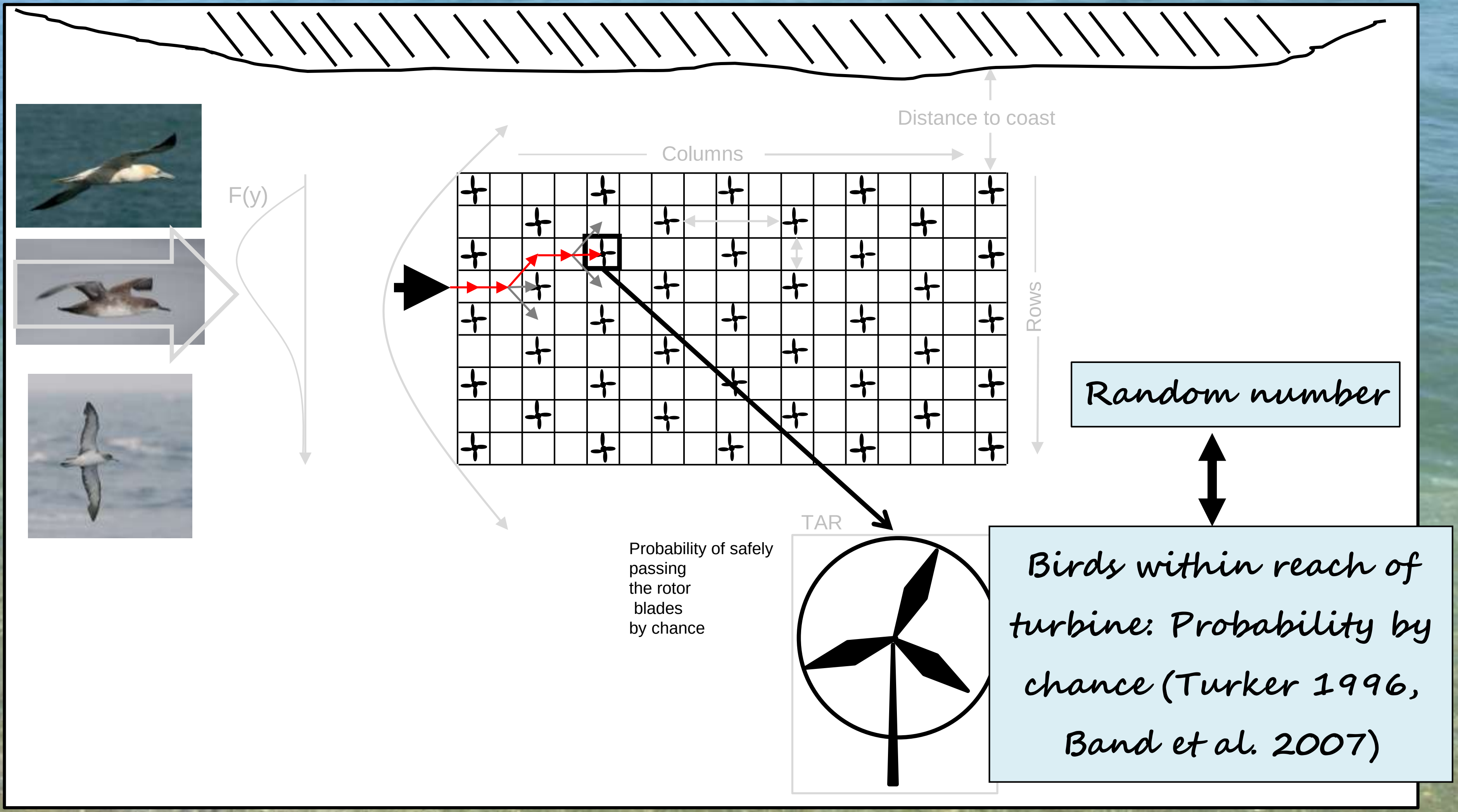
- Different species
- Different wind conditions
  - Headwind low (0 to 5 in Beaufort scale)
  - Headwind high (6 to 9 in Beaufort scale)
  - Tailwind low (0 to 5 in Beaufort scale)
  - Tailwind high (6 to 9 in Beaufort scale)

Probability of safely passing the rotor blades by chance

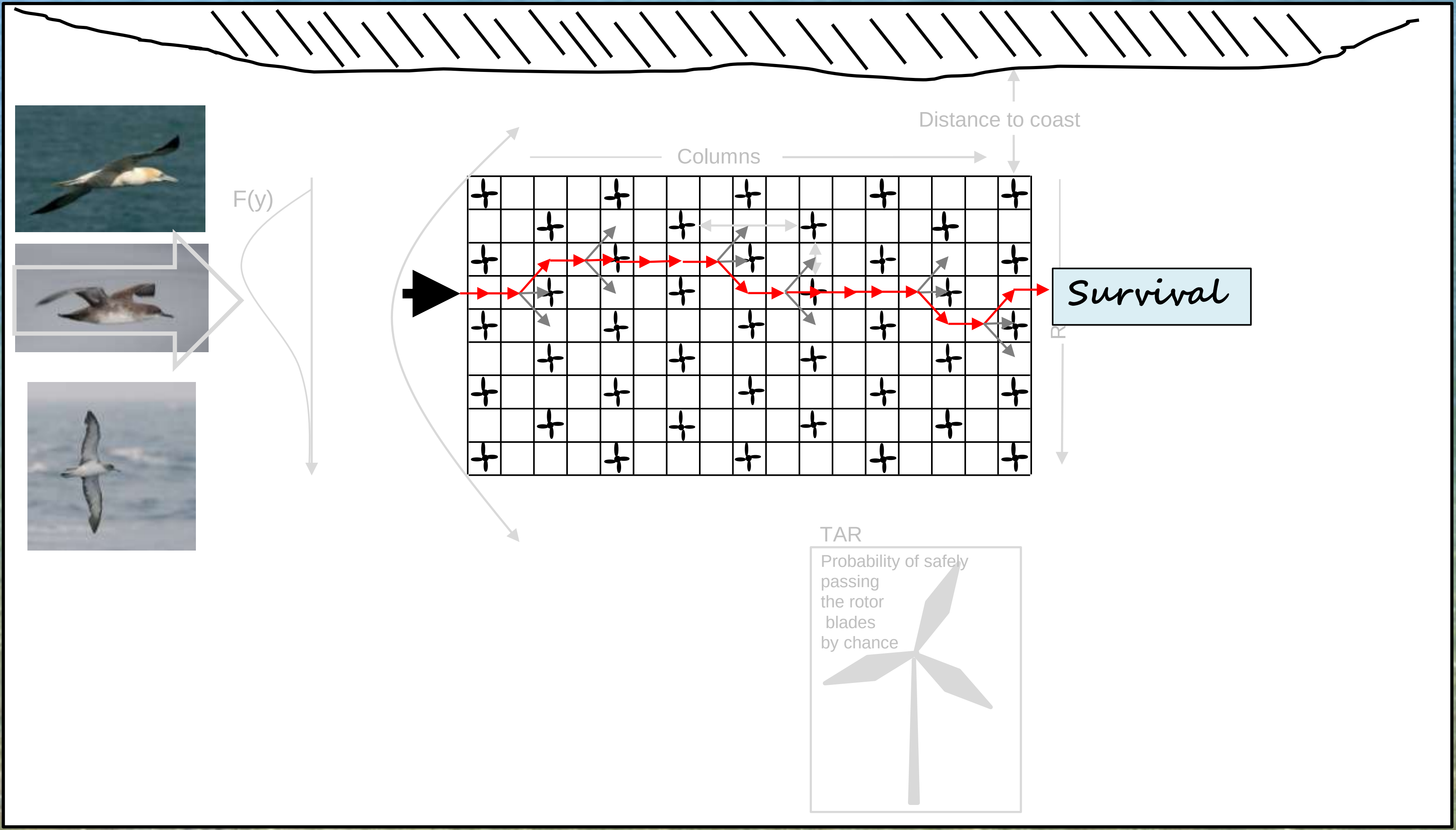


Birds within reach of turbine: Probability by chance (Turker 1996, Band et al. 2007)

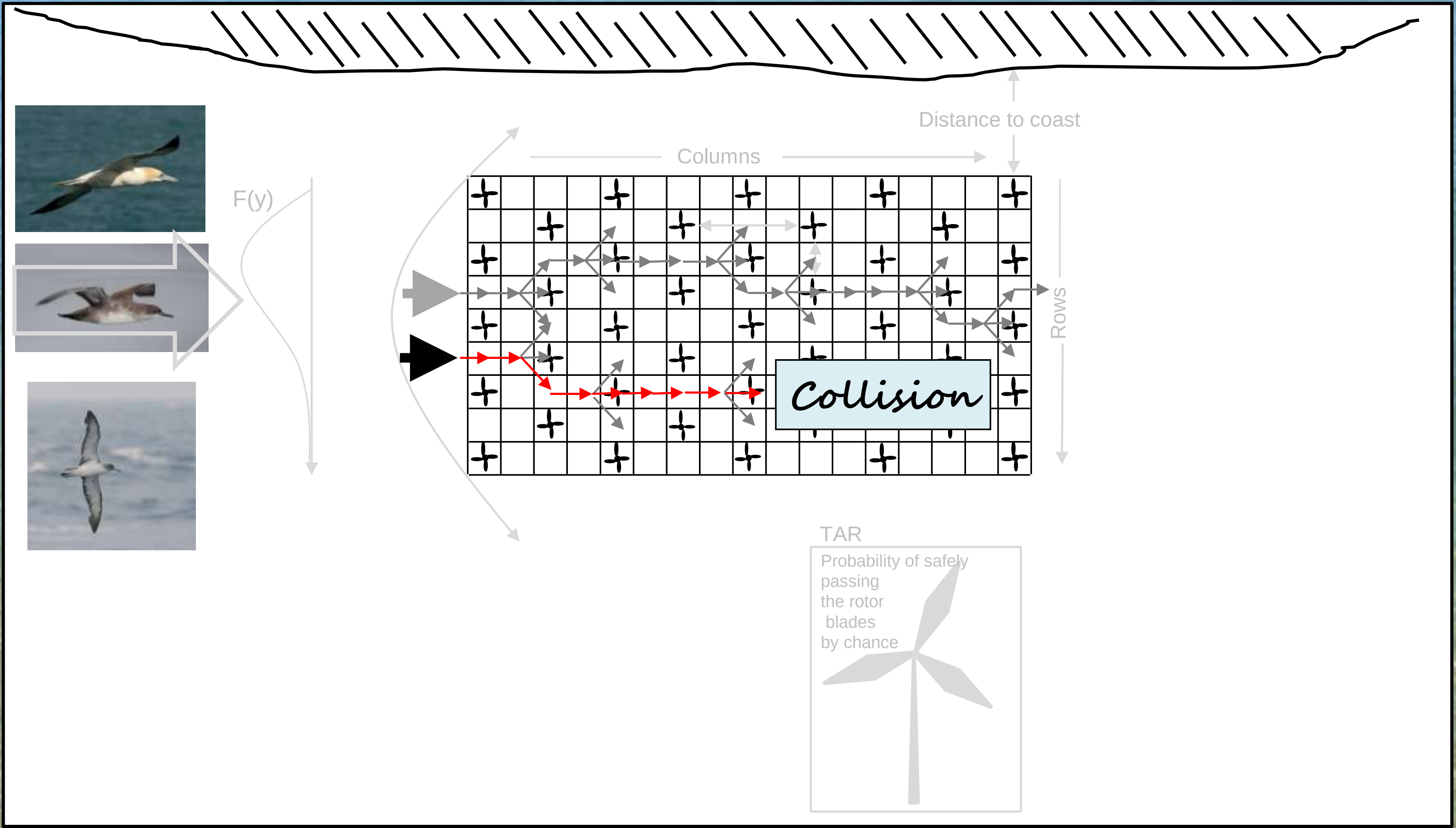
THE MODEL: The wind farm as a risk window



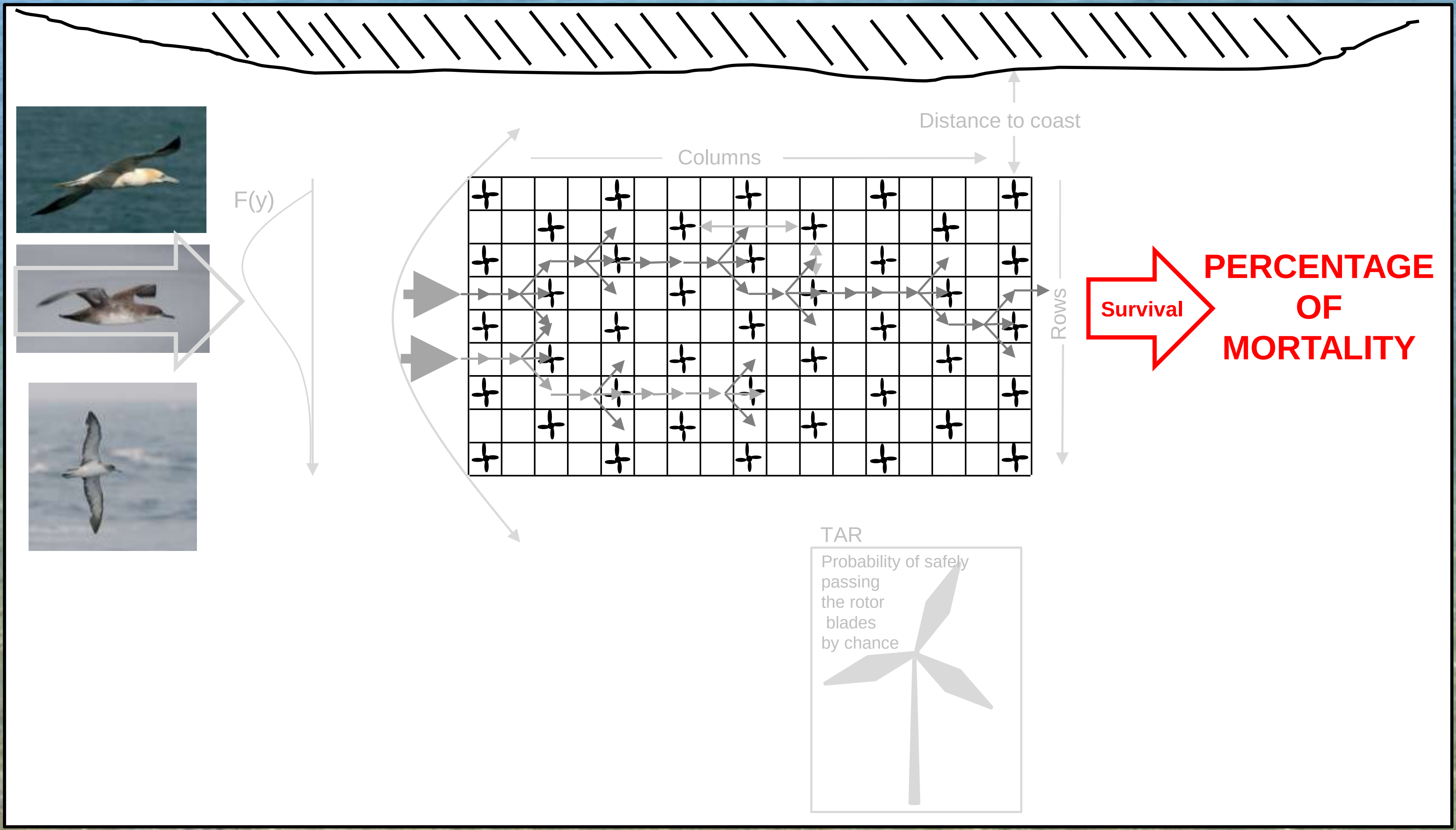
THE MODEL: The wind farm as a risk window



THE MODEL: The wind farm as a risk window



THE MODEL: The wind farm as a risk window



Objectives

To develop a stochastic model of avian collision risk at wind farms

A case study

To obtain probabilities of collision risk

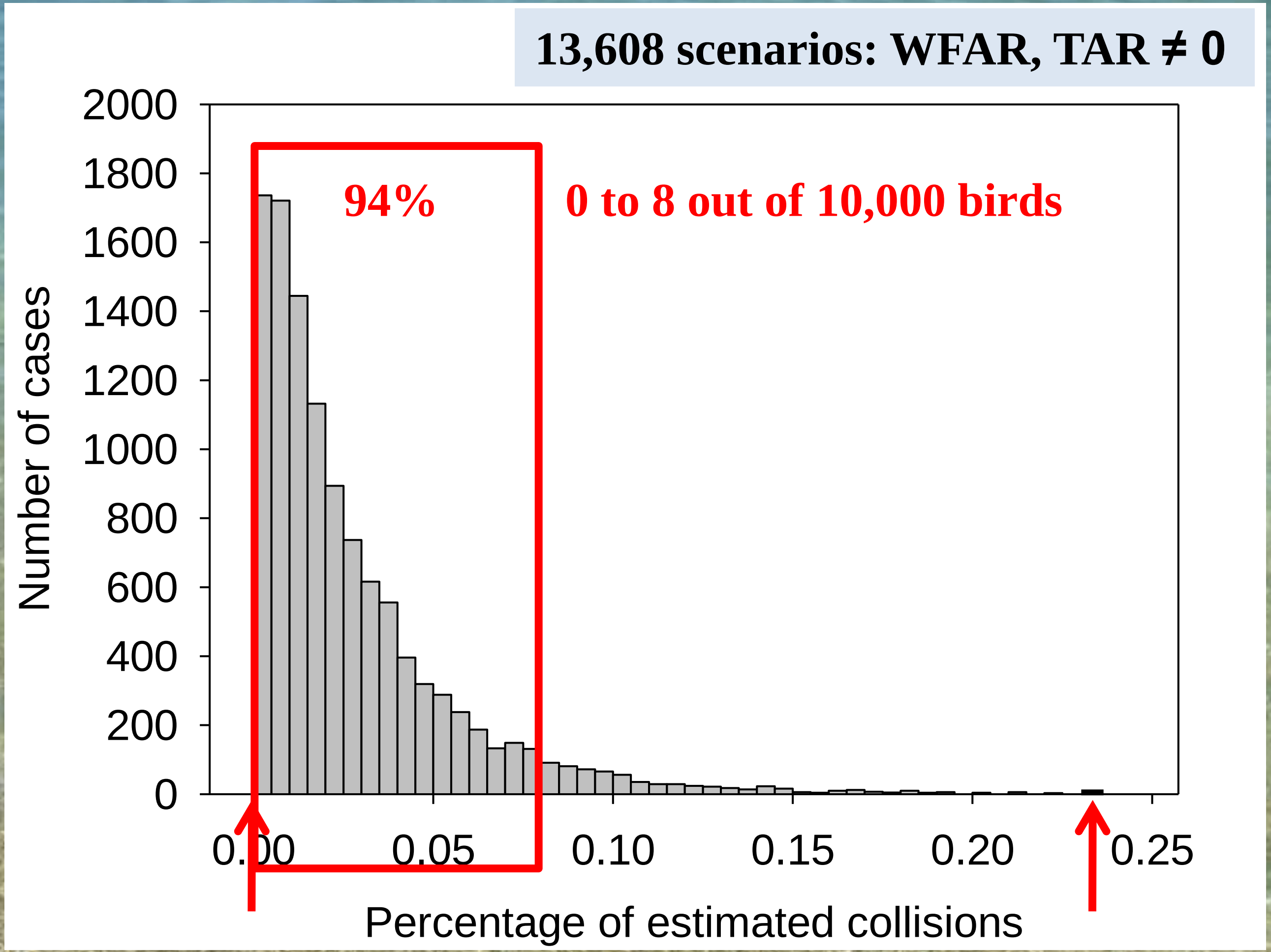
Factors

To estimate mortality rates

Factors

27,216 scenarios (also WFAR, TAR = 0)

1,000,000 events per scenario



Objectives

To develop a stochastic model of avian collision risk at wind farm

A case study

To obtain probabilities of collision risk

Factors

To estimate mortality rates

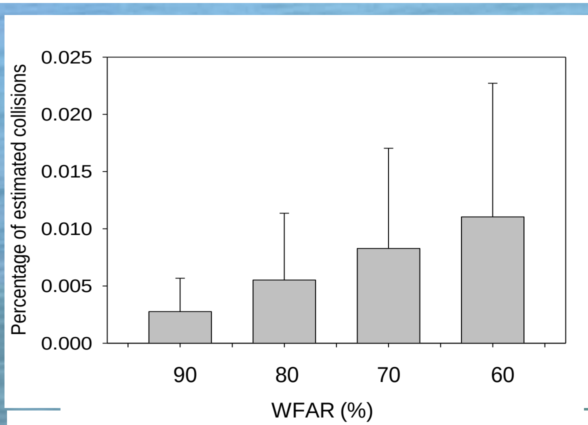
Factors

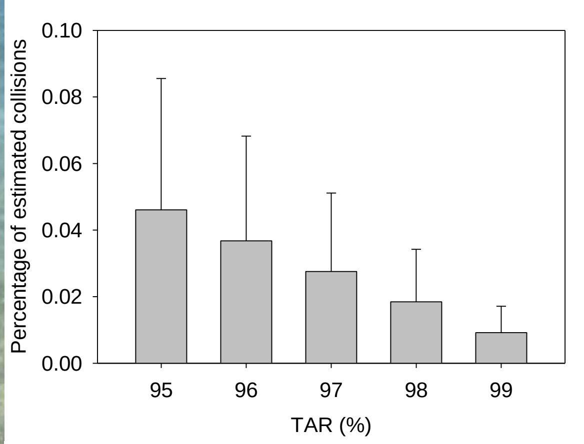
To assess the weighted importance of the different input variables in collision predictions

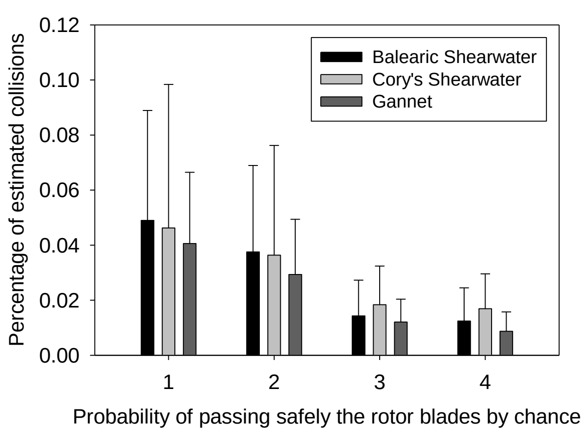
↓

Generalized Additive Model

Factors



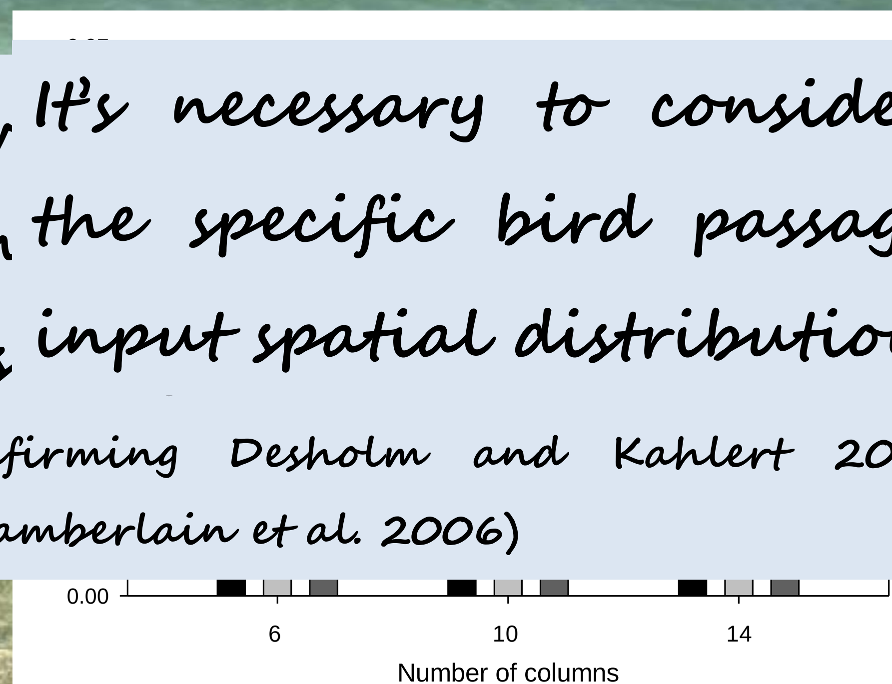




- WFAR: 20%
- TAR: 23.5%
- Probability by chance : 20.8%

- Spatial distribution of the birds entering passage: 18.4%

- Wind farm dimensions: 5.9%



Av It's necessary to consider t
im the specific bird passage,
ris input spatial distribution s
confirming Desholm and Kahlert 2005, Chamberlain et al. 2006)

Objectives

To develop a stochastic model of avian collision risk at wind farm

A case study

To obtain probabilities of collision risk

Factors

Bird volume

Flight altitude

To estimate mortality rates

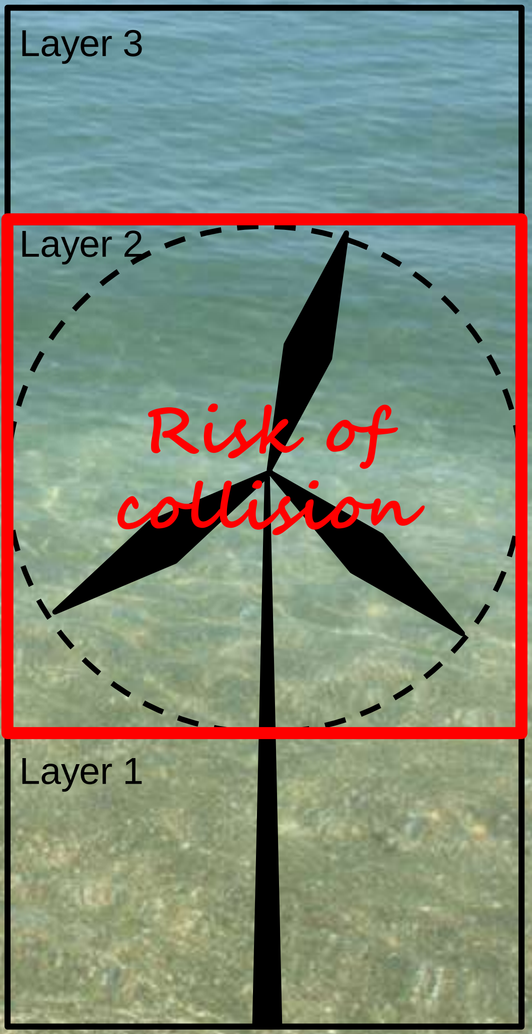
Number of birds collided per time period

Estimating the mortality rates: FLIGHT ALTITUDE

BIRD VOLUME

Autumn migration volume in the north side of the Strait of Gibraltar

FLIGHT ALTITUDE



Following Krüger and Garthe 2001,

We obtained the proportion of birds flying in each height layer for:

- Different species
- Different wind conditions

Estimating the mortality rates

Estimated number of collided birds per autumn season

30 4 5

	Non-evasive scenario	+ TAR	+ WFAR	+ Flight Altitude
	1,340 ± 433	46 ± 15	11.6 ± 3.7	2.3 ± 0.8

	Percentage of Cory's Shearwater flying at			
	Layer 1	Layer 2	Layer 3	n
E1	99.1%	0.6%	0.2%	2,160
E2	99.4%	0.6%	0.0%	36
W1	94.6%	5.3%	0.1%	3,262
W2	100.0%	0.0%	0.0%	1,195

Estimating the mortality rates

Estimated number of collided birds per autumn season

13

	Non-evasive scenario	+ TAR	+ WFAR	+ Flight Altitude
	1,340 ± 433	46 ± 15	11.6 ± 3.7	2.3 ± 0.8
	306 ± 73	11 ± 3	2.6 ± 0.6	$\boxed{0.2 \pm 0.1}$
				0.6 ± 0.1

	Percentage of Balearic Shearwater flying at			
	Layer 1	Layer 2	Layer 3	n
E1	99.7%	0.3%	0.0%	1,518
E2	100.0%	0.0%	0.0%	25
W1	97.8%	2.1%	0.1%	849
W2	100%	0%	0%	20

Estimating the mortality rates

Estimated number of collided birds per autumn season

3

	Non-evasive scenario	+ TAR	+ WFAR	+ Flight Altitude
	203 ± 43	7 ± 2	1.8 ± 0.4	$\boxed{0.6 \pm 0.1}$

	Percentage of Northern Gannet flying at			
	Layer 1	Layer 2	Layer 3	n
E1	90.5%	8.4%	1.1%	577
E2	97.2%	2.8%	0.0%	156
W1	76.4%	20.6%	3.0%	718
W2	91.2%	8.3%	0.6%	223

Conclusions: THE CASE STUDY

Avoidance rates are the most important factors assessing the risk of bird collision

Altitudes of migration → strongly influence the probability of collision

These parameters should be considered as priorities to be addressed in post-construction studies

Fatalities seems to be low → To consider the **synergistic effect** of installing different wind farms along the same migratory route

Other hazards exist to birds by the construction of off-shore wind farms, in addition to collision risk

Conclusions: THE MODEL

A collision model considering the wind farm area as a risk window was constructed for avian migrants.

Due to its very fast run velocity, it is possible to test a huge number of scenarios in a relatively short period of time.

The possibility of testing so many cases, linked to its stochastic character and its high flexibility, give to the estimated probabilities of collision a high level of statistical confidence.


THANKS VERY MUCH FOR YOUR ATTENTION