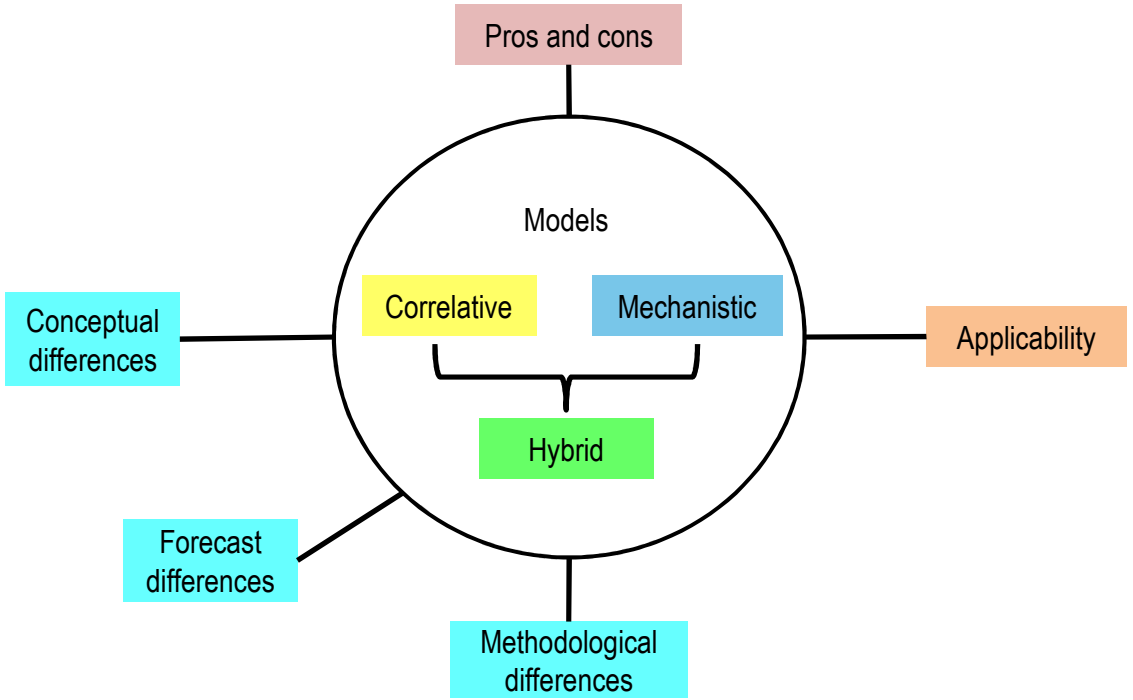
Worcester shad symposium

Shad range-shift response to climate change: a multi-model approach

Géraldine Lassalle, Patrick Lambert and collaborators
(INRAE)

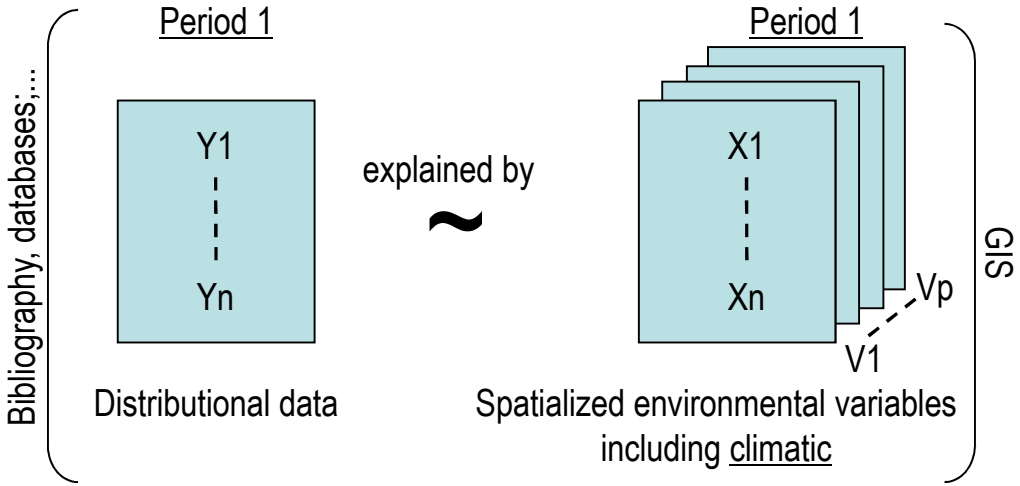
Species distribution model diversity (Tourinho, pers. comm.; Tourinho and Vale, 2022)

Compromise between realism and model complexity



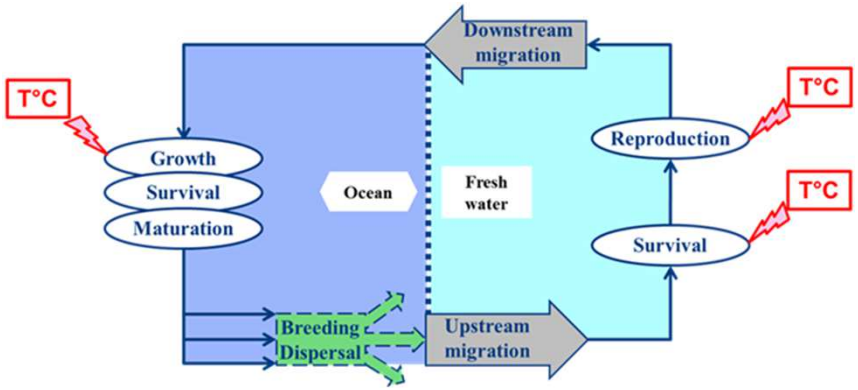
Species distribution model diversity (Guisan and Zimmermann, 2000; Thuiller et al., 2003; Chuine and Régnière, 2017)

Correlative



Probabilities of a habitat to be suitable for a given species under present/past conditions

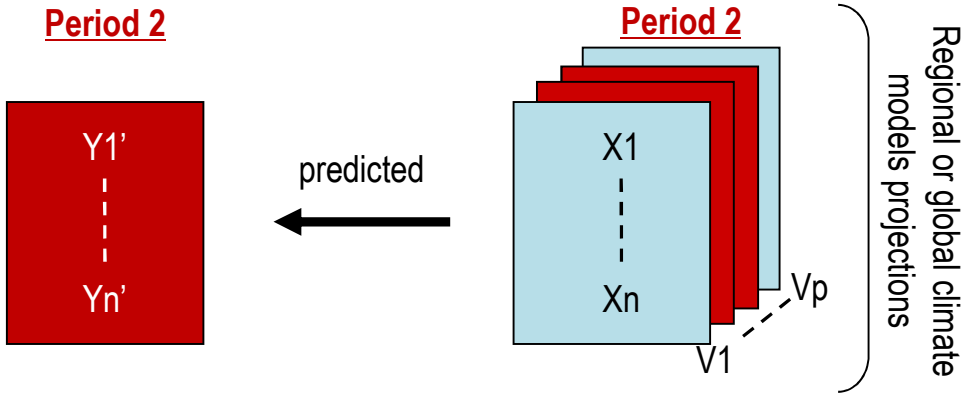
Mechanistic



Probability of a habitat to sustain a stable/functional population for a given species under present/past conditions

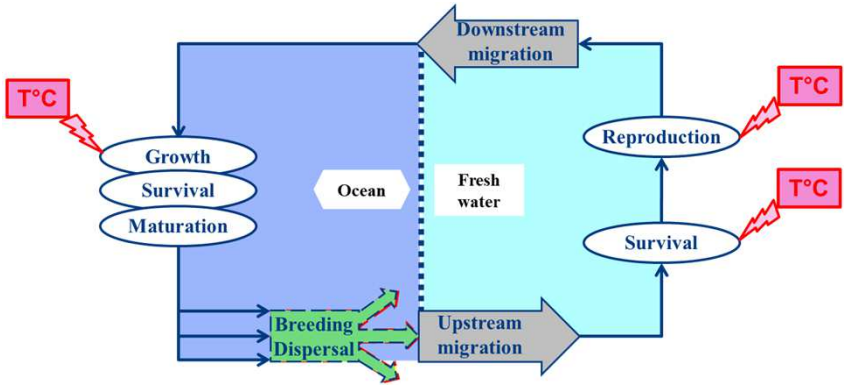
Species distribution model diversity (Guisan and Zimmermann, 2000; Thuiller et al., 2003; Chuine and Régnière, 2017)

Correlative



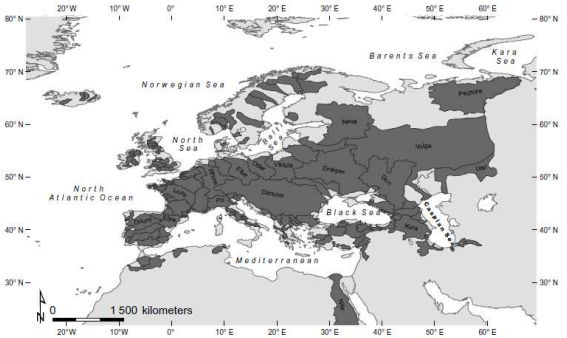
Probabilities of a habitat to be suitable for a given species under future conditions

Mechanistic

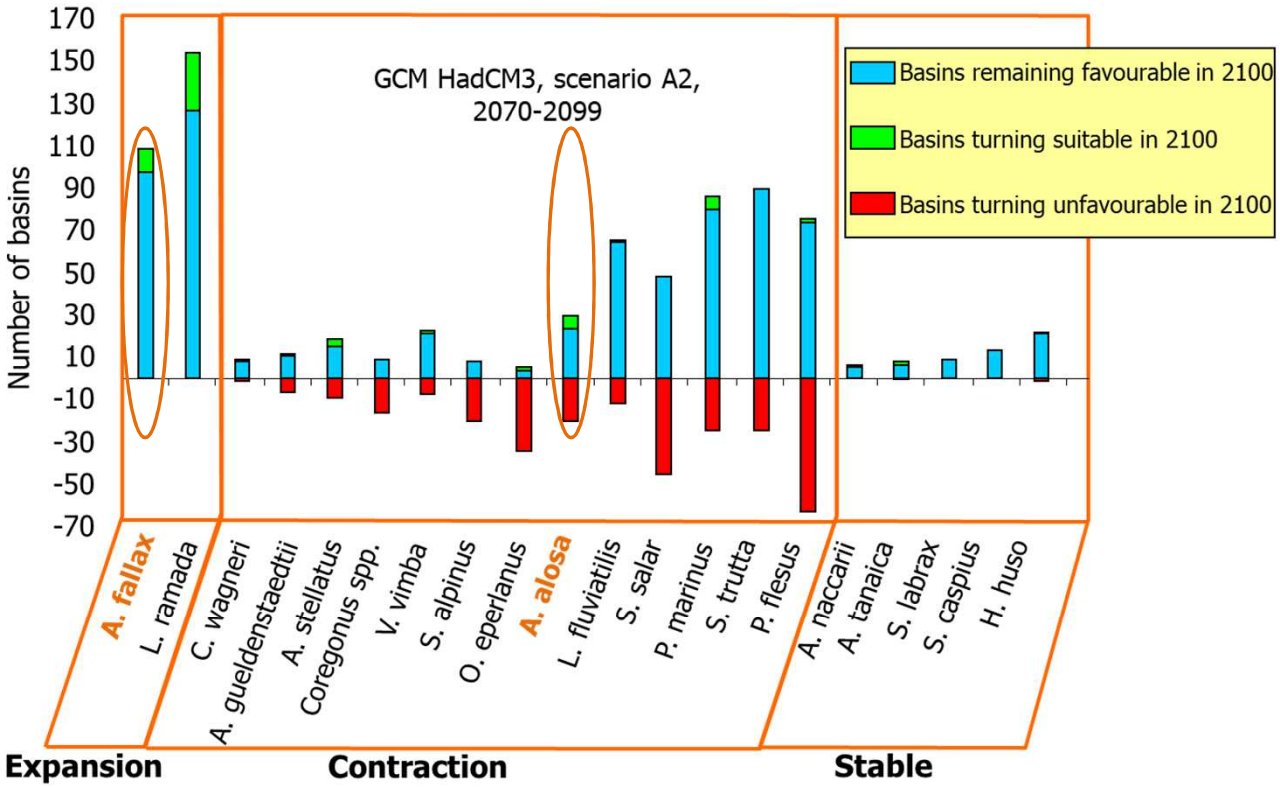


Probability of a habitat to sustain a stable/functional population for a given species under future conditions

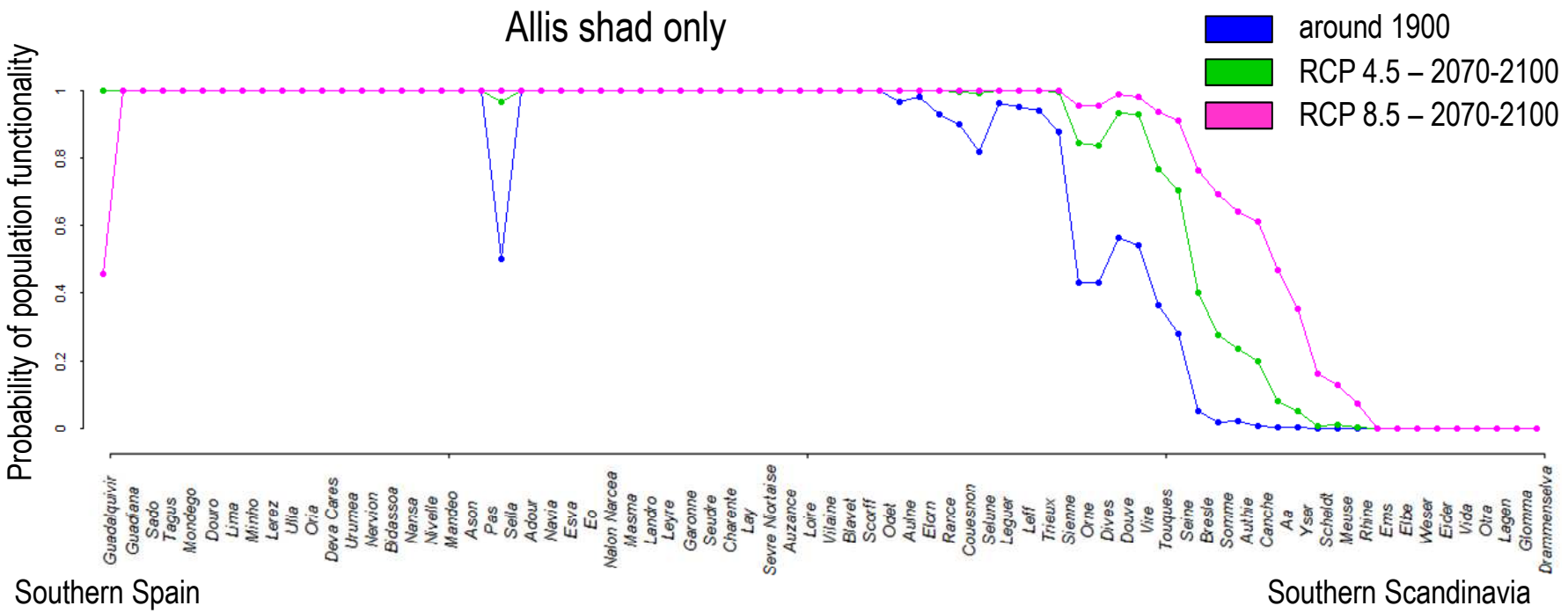
Correlative approach in catchments (Lassalle et al., 2008)



Only temperature changed; precipitations were not retained



Mechanistic approach with GR3D (Rougier et al., 2014; 2015)



Key messages on shads' distributions

- Both species not threatened by a rise in temperature

↳ Importance of considering other climate-related variables such as discharge for aquatic organisms

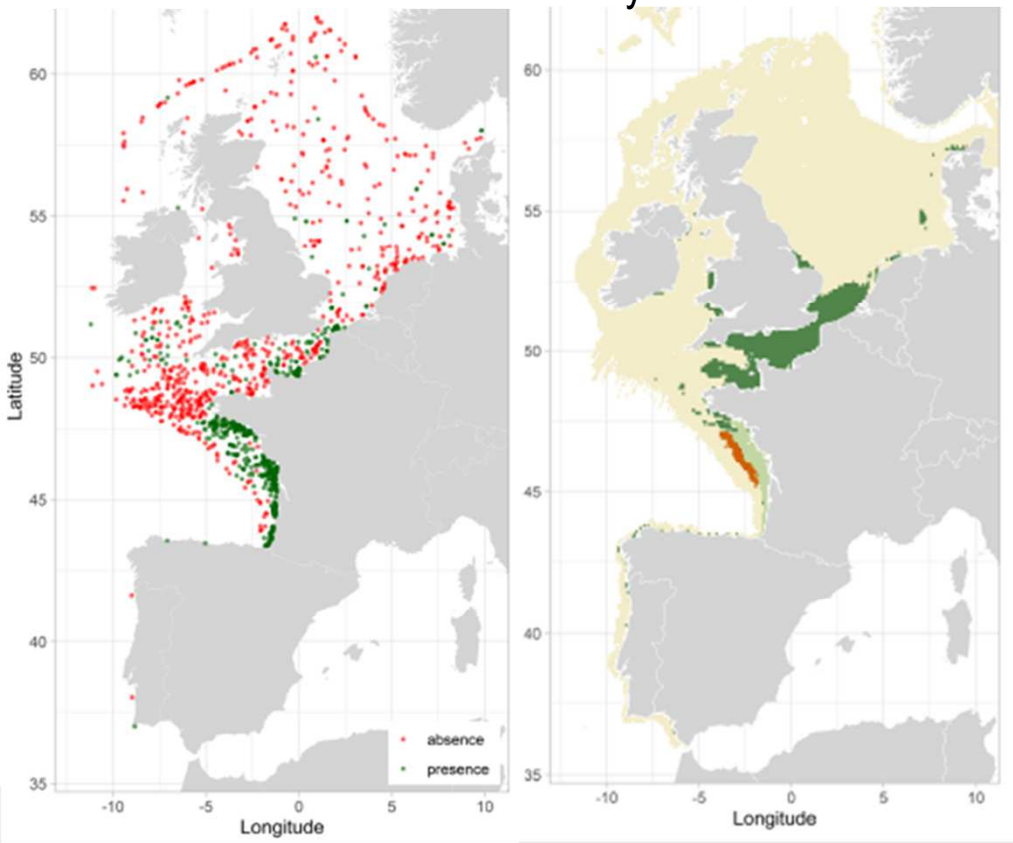
Correlative approach at sea (Navarro et al., in prep; Navarro, 2022; Elliott et al., under review)

2006-2010 versus 2095-2099 under RCP8.5

Net Primary Production, Temperature, Salinity

- Stable unsuitable
- Stable suitable
- Gain of suitable habitats
- Loss of suitable habitats
- Absences in MigrenMer database
- Presences in MigrenMer database

Allis shad only



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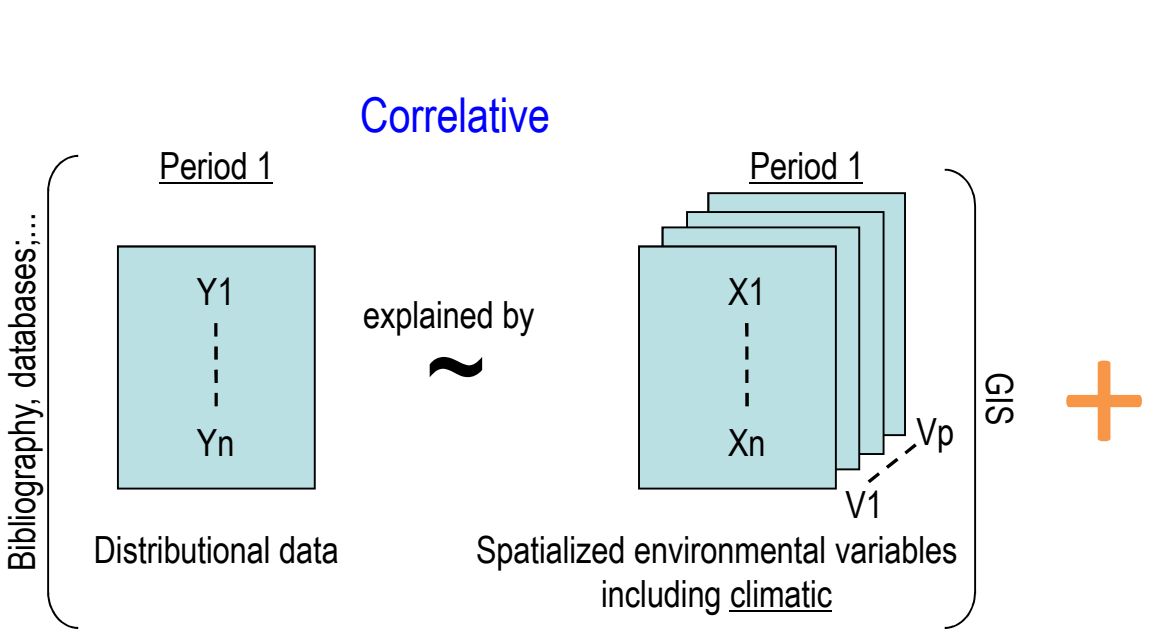
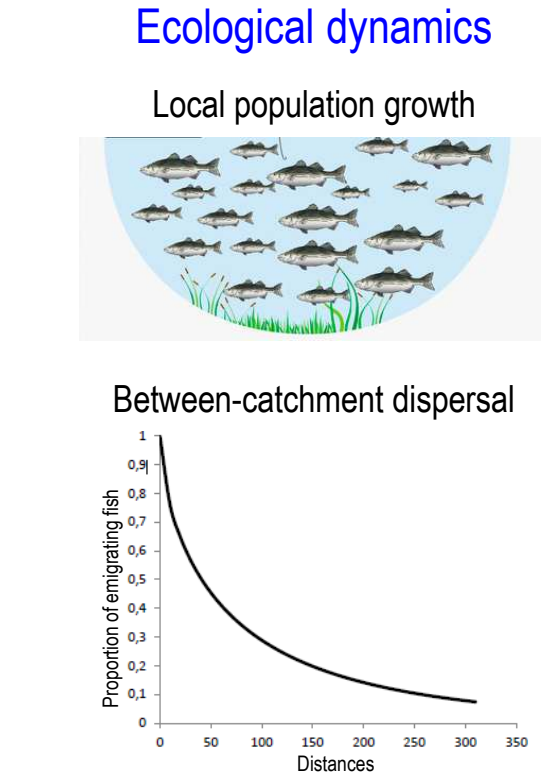
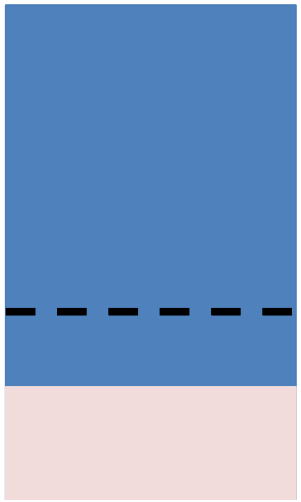
  ↳ Necessity of considering other country declarations in terms of diadromous species catch and bycatch in modelling works

Species distribution model diversity (De Cáceres and Brotons 2012; Singer et al., 2016)





Hybrid approach with HyDiaD (Barber-O'Malley et al., 2022a,b)

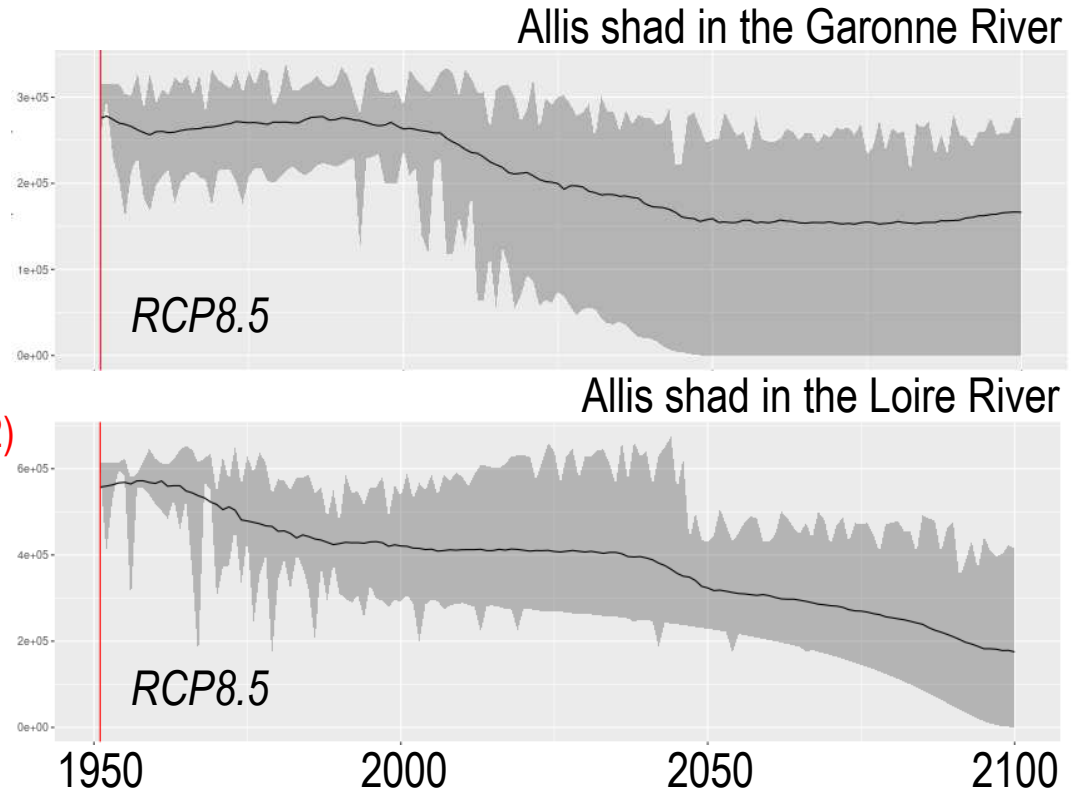


$1 \times D_{max} \times A$, with $HSI_{max} = 1$

$HSI_{i,t} \times D_{max} \times A$ (Eq. 1)

$\text{Min}(HSI_{i,t} \times D_{max} \times A; B_{i,t} \times r)$ (Eq. 2)

Saturation rate (SR) in catchment *i* at time *t* is equal to Eq (2)/Eq. 1



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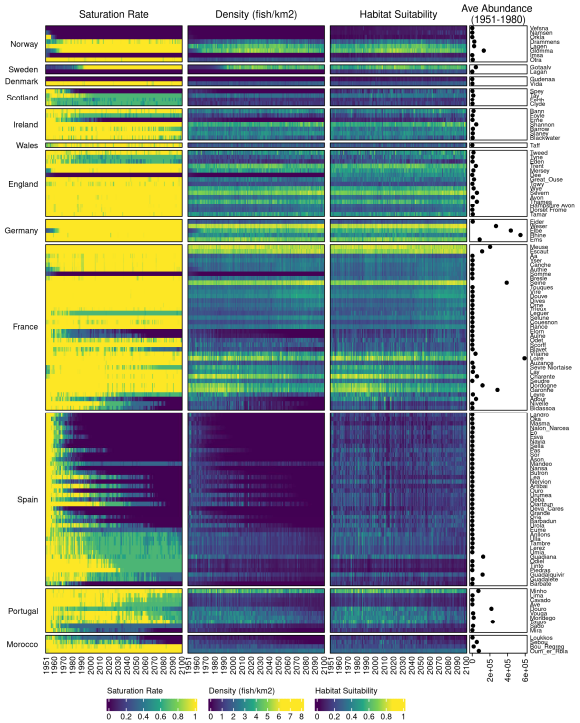
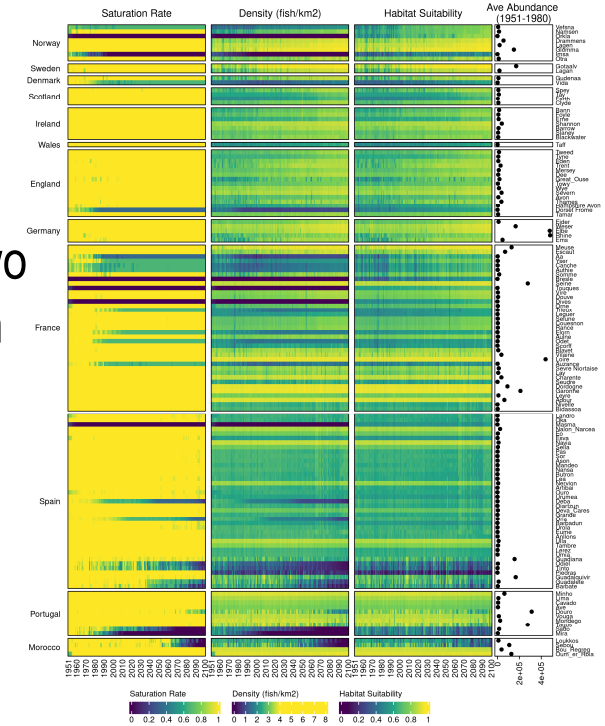
Allis shad



Not the same story for the two species; in accordance with correlative approaches

Twaite shad



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  ↳ Necessity of considering other country declarations in terms of diadromous species catch and bycatch in modelling works

- Twaite shad confirmed as being positively affected by a rise in temperature

  ↳ Importance of monitoring twaite shad populations at the northern distribution edge (e.g. eDNA tracking)

Land-sea continuity multi-model approach

(Dambrine et al., in prep; Elliott et al., under review; Frans et al., 2018)

EuroDiad 4.0 database (Barber-O'Malley et al., 2022a)

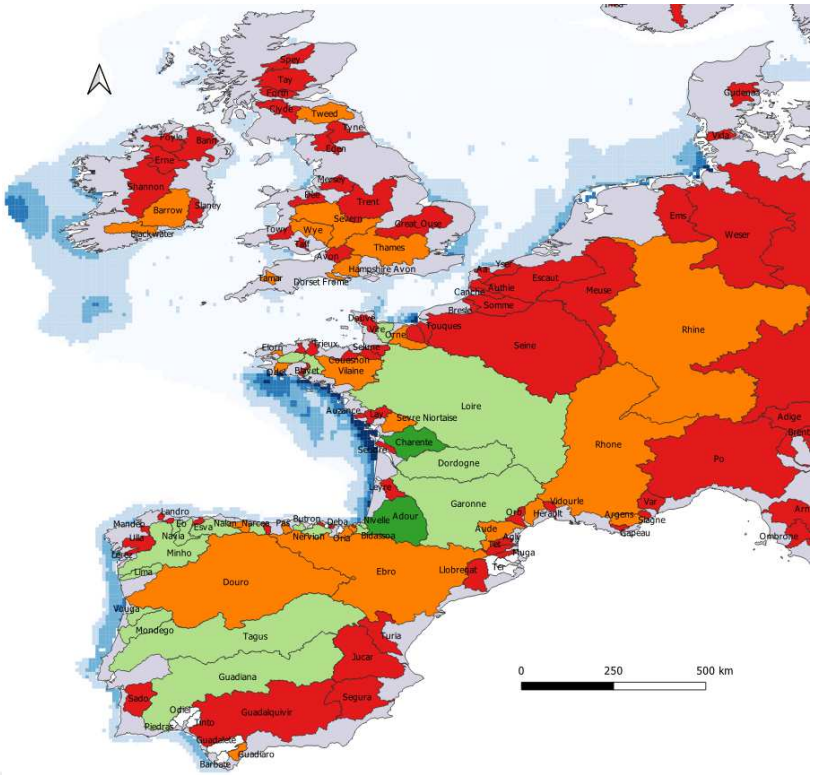
Observations "2010-present"

- Absent
- Rare
- Common
- Abundant

Sea SDM **projections** (Elliott et al., under review)

Period 2006-2019

- 0 – 0.2
- 0.2 – 0.4
- 0.4 – 0.6
- 0.6 – 0.8
- 0.8 – 1



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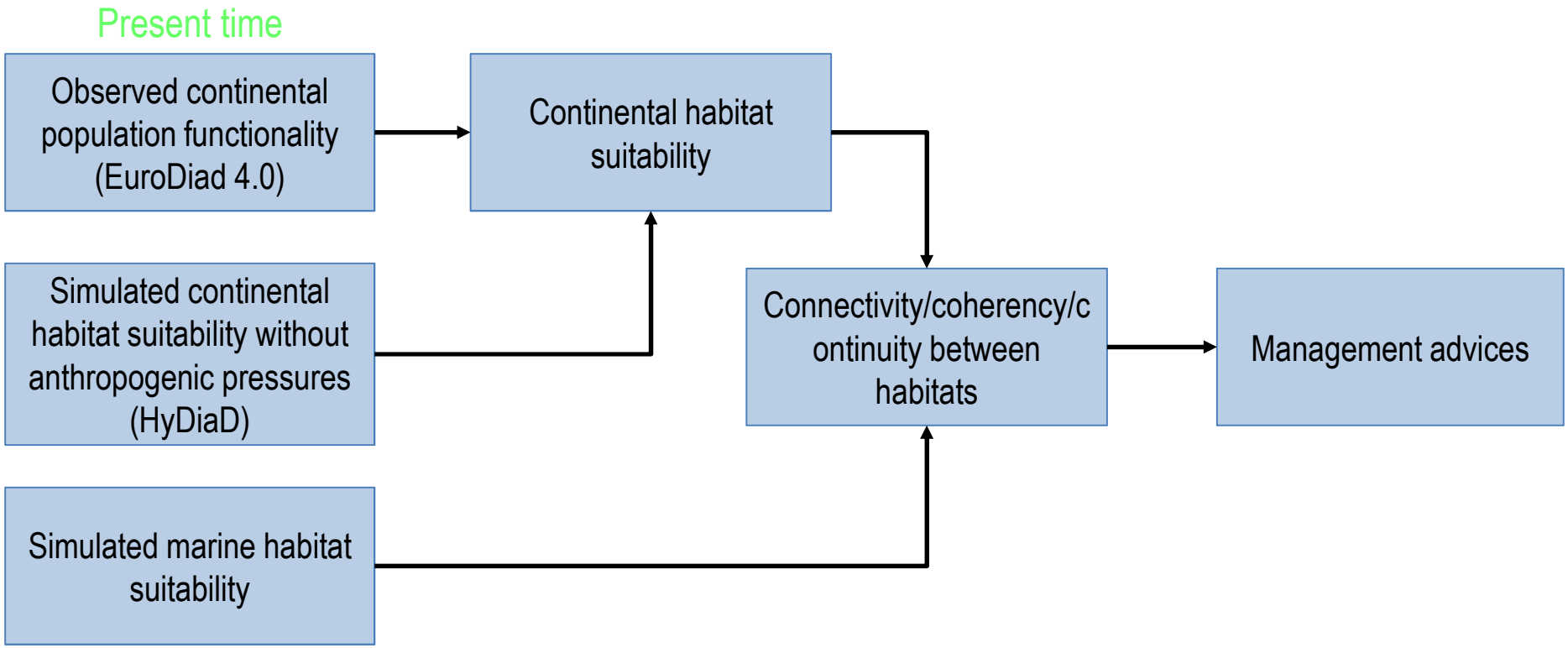

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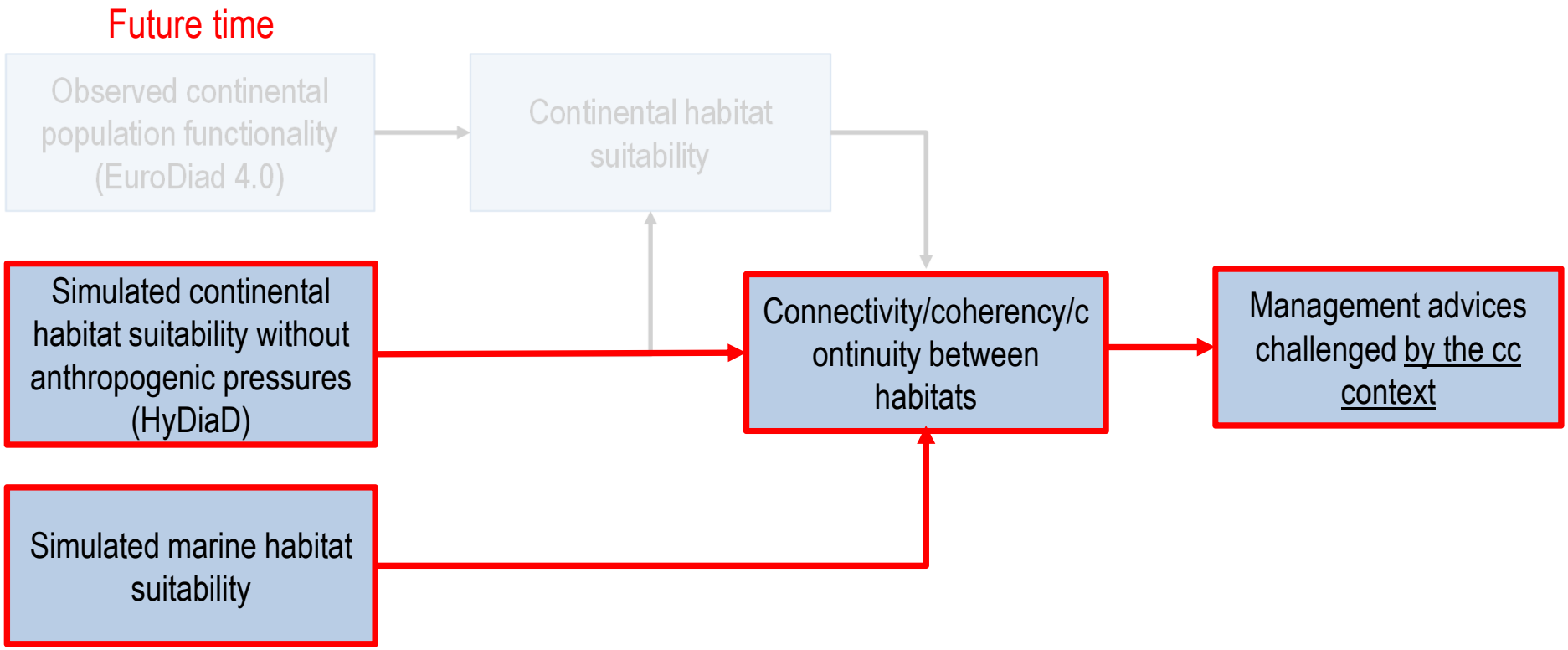

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- How to integrate human pressures indices in large-scale modelling works?

Thanks for your attention

Gironde estuary, STURAT sampling campaign
(Picture: Marie-Laure Acolas)

Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION
DiadES

References

Barber-O'Malley B., Lassalle G., Lambert P. & Quinton E. (2022a) Dataset on European diadromous species distributions from 1750 to present time in Europe, North Africa and the Middle East. Data in Brief, 40: 107821.

Barber-O'Malley B., Lassalle G., Chust G., Diaz E., O'Malley A., Paradinas Blazquez C., Portoles Marquina J. & Lambert P. (2022b) HyDiaD: A hybrid species distribution model combining dispersal, multi-habitat suitability, and population dynamics for diadromous species under climate change scenarios Ecol. Model. 470.

Chuine I., & Régnière J. (2017) Process-Based Models of Phenology for Plants and Animals. Annu Rev Ecol Evol Syst. 48:1, 159-182

De Cáceres M. & Brotons L. (2012) Calibration of hybrid species distribution models: the value of general-purpose vs. targeted monitoring data. Divers. Distrib. 18, 977-989.

Dambrine C., Lambert P., Elliott S., Poole R., Raposo de Almeida P., Vanoverbeke J. & Lassalle G. (In prep) Linking continental and marine habitats of diadromous species by crossing suitability predictions with observations of population functionality to improve management prioritization.

Elliott S.A.M., Beaulaton L., Acou A., Guitton J., Reveillac E. & Rivot E. (Under review) Modelling the distribution of threatened diadromous fish at sea from fisheries dependent and independent data. Biol Conserv.

Frans V.F., Augé A.A., Edelhoff H., Erasmi S., Balkenhol N. & Engler J.O. (2018) Quantifying apart what belongs together: A multi-state species distribution modelling framework for species using distinct habitats. Methods Ecol. Evol. 9, 98-108.

Guisan A & Zimmermann NE (2000) Predictive habitat distribution models in ecology. Ecol. Model. 135: 147-186.

Lassalle G., Béguer M., Beaulaton L. & Rochard E. (2008) Diadromous fish conservation plans need to consider global warming issues: An approach using biogeographical models. Biol. Conserv. 141: 1105-1118.

Navarro C., Dambrine C., Janc A., Lassalle G. & Lambert P. (In prep) Modelling diadromous species marine distributions: emphasis on the temporal scale in the definition of suitable habitat patches.

Navarro C. (2022) Modelling the marine habitats of Allis shad (*Alosa alosa*) and European flounder (*Platichthys flesus*) and their potential evolution in the context of climate change using an ensemble species distribution modelling approach. Master thesis, University of Rennes (France).

Rougier T., Drouineau H., Dumoulin N., Faure T., Deffuant G., Rochard E., et al. (2014) The GR3D model, a tool to explore the Global Repositioning Dynamics of Diadromous fish Distribution. Ecol. Model. 283: 31-44.

Rougier T., Lassalle G., Drouineau H., Dumoulin N., Faure T., et al. (2015) The combined use of correlative and mechanistic species distribution models benefits low conservation status species. PLOS ONE 10(10): e0139194.

Singer A., Johst K., Banitz T., Fowler M.S., Groeneveld J., et al. (2016) Community dynamics under environmental change: How can next generation mechanistic models improve projections of species distributions? Ecol. Model. 326, 63-74.

Thuiller W., Lafourcade B., Engler R. & Araújo M.B. (2009) BIOMOD – a platform for ensemble forecasting of species distributions. Ecography 32: 369-373.

Tourinho L. & Vale M.M. (2022). Choosing among correlative, mechanistic, and hybrid models of species' niche and distribution. Integrative Zoology 00, 1– 17.

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