Maintaining functional connectivity is essential for reducing negative effects of climate change on endangered species

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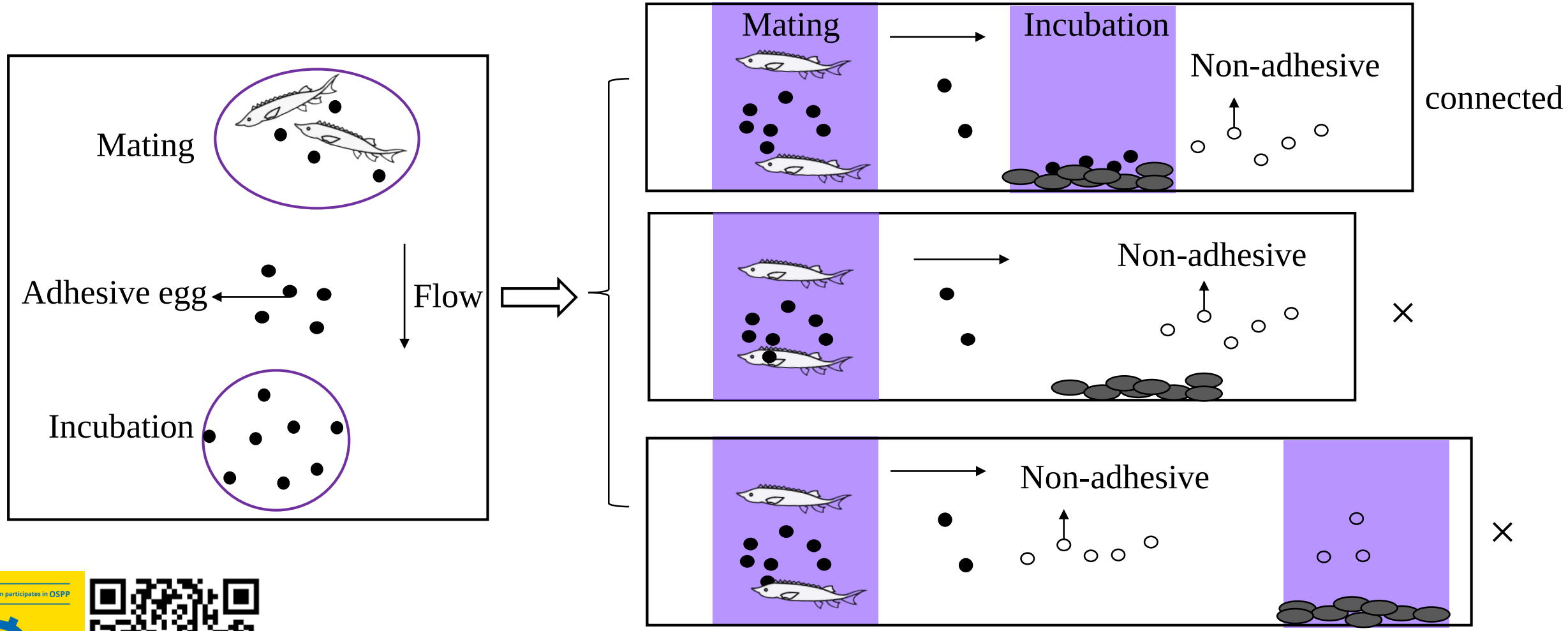
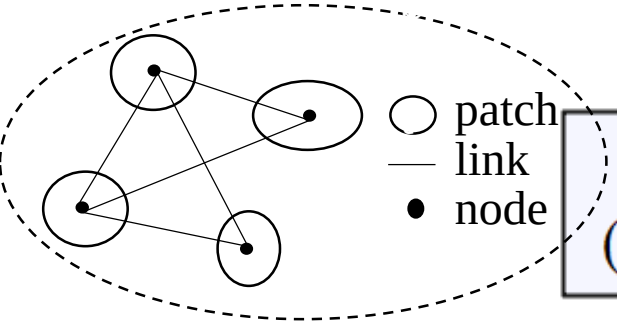
One page Introduction & Objectives

Question: How fine-scale function connectivity influence spawning activities?



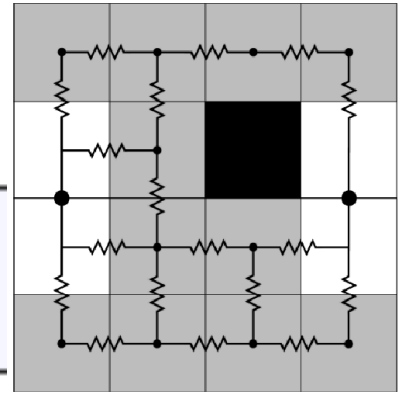
Methodologies: Limitations

Functional connectivity prediction



Graph theory (river ecosystem)

Matrix-based model (terrestrial ecosystem)



- focuses on **large-scale longitudinal** connectivity
- cannot consider **fine-scale** habitat features
- focuses on **landscape** ecology
- **Technical** challenge

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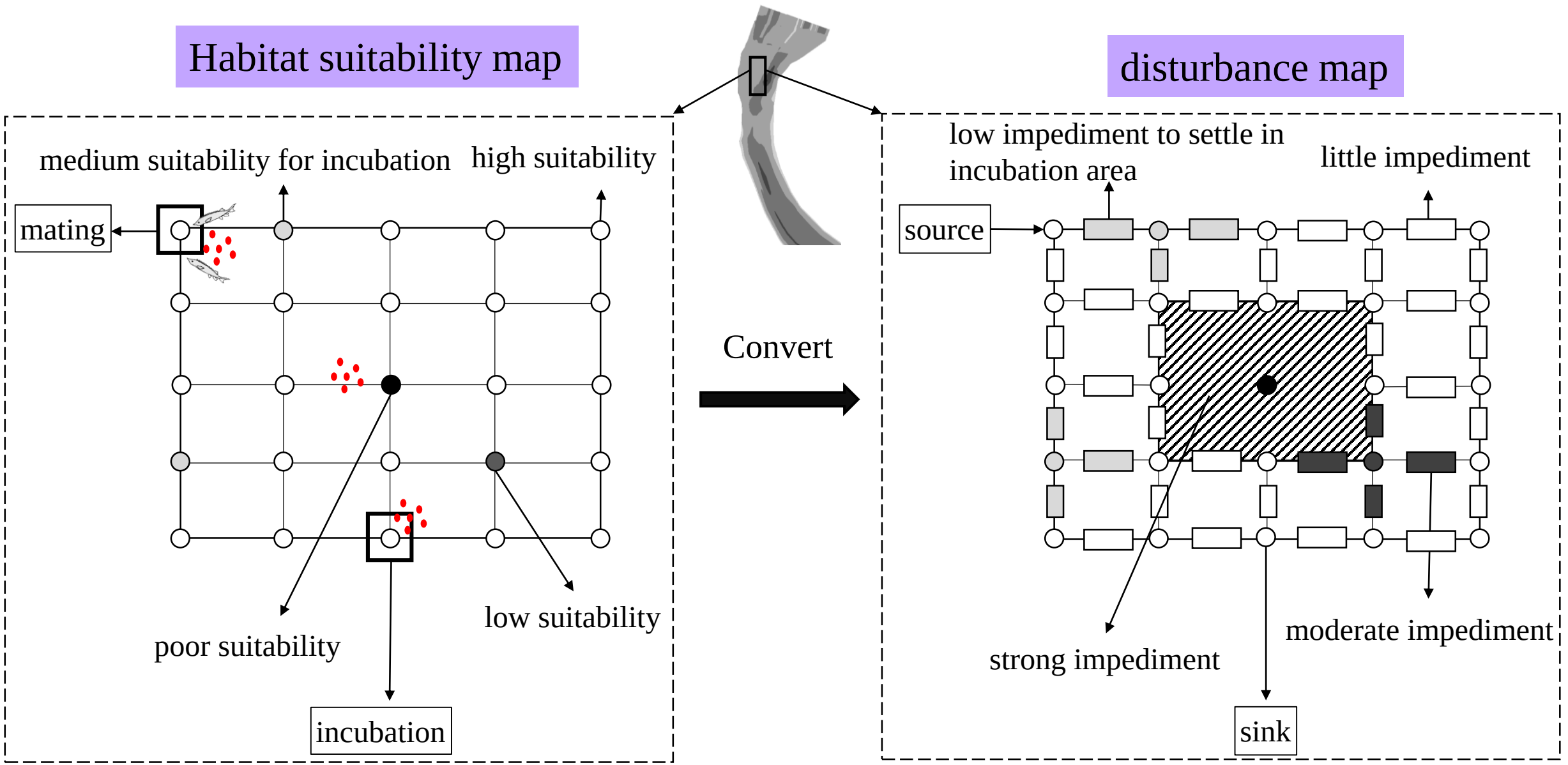
Limitations

Methodologies: functional connectivity modelling for aquatic habitats



Methodologies: functional connectivity modelling for aquatic habitats

Framework

$$\frac{\partial u_i}{\partial x_i} = 0 \qquad \frac{\partial u_i}{\partial t} + u_j \frac{\partial u_i}{\partial x_i} = F_i - \frac{1}{\rho}\frac{\partial p}{\partial x_i} + \nu \frac{\partial^2 u_i}{\partial x_i \partial x_j} - \frac{\partial \overline{u_i' u_j'}}{\partial x_i}$$

$$\frac{\partial(\rho k)}{\partial t} + \frac{\partial(\rho k u_i)}{\partial x_i} = \frac{\partial}{\partial x_j}\left(a_k \mu_{eff} \frac{\partial k}{\partial x_j}\right) + G_k + \rho\varepsilon$$

$$\frac{\partial(\rho\varepsilon)}{\partial t} + \frac{\partial(\rho\varepsilon u_i)}{\partial x_i} = \frac{\partial}{\partial x_j}\left[\alpha_\varepsilon \mu_{eff} \frac{\partial \varepsilon}{\partial x_j}\right] + \frac{C_{1\varepsilon}^* \varepsilon}{k} G_k - C_{2\varepsilon}\rho \frac{\varepsilon^2}{k}$$

Hydrodynamic modelling

$$HSI_i^1 = \prod_{j=1}^{k} V_{ij}$$

$$HSI_i^2 = \prod_{j=1}^{k} V_{ij}$$

Habitat suitability modelling (depth, velocity, substrate)

$NR = HCD$ (habitat connectivity degree)

$\sum HCD \times Area_{cell} = WCA$ (weighted connected area)

$$\sum N_i = 0 \qquad \sum HCD_{cell} = 0$$

Mapping functional connectivity between spawning habitat

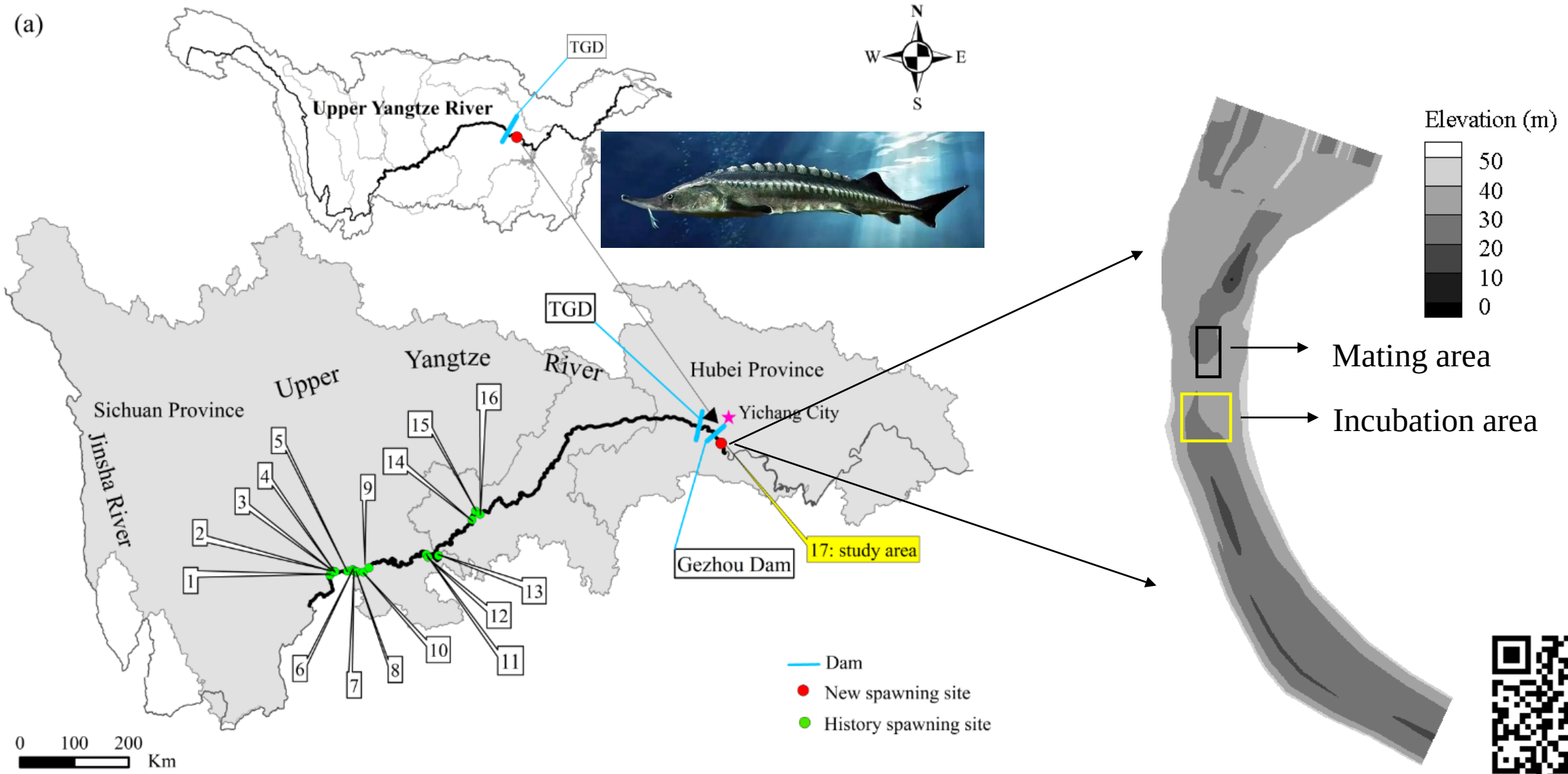
$$R_{ij} = \frac{2}{HSI_i^2 + HSI_j^2}$$

Generate disturbance map

Target species and study area

Target species: Chinese sturgeon

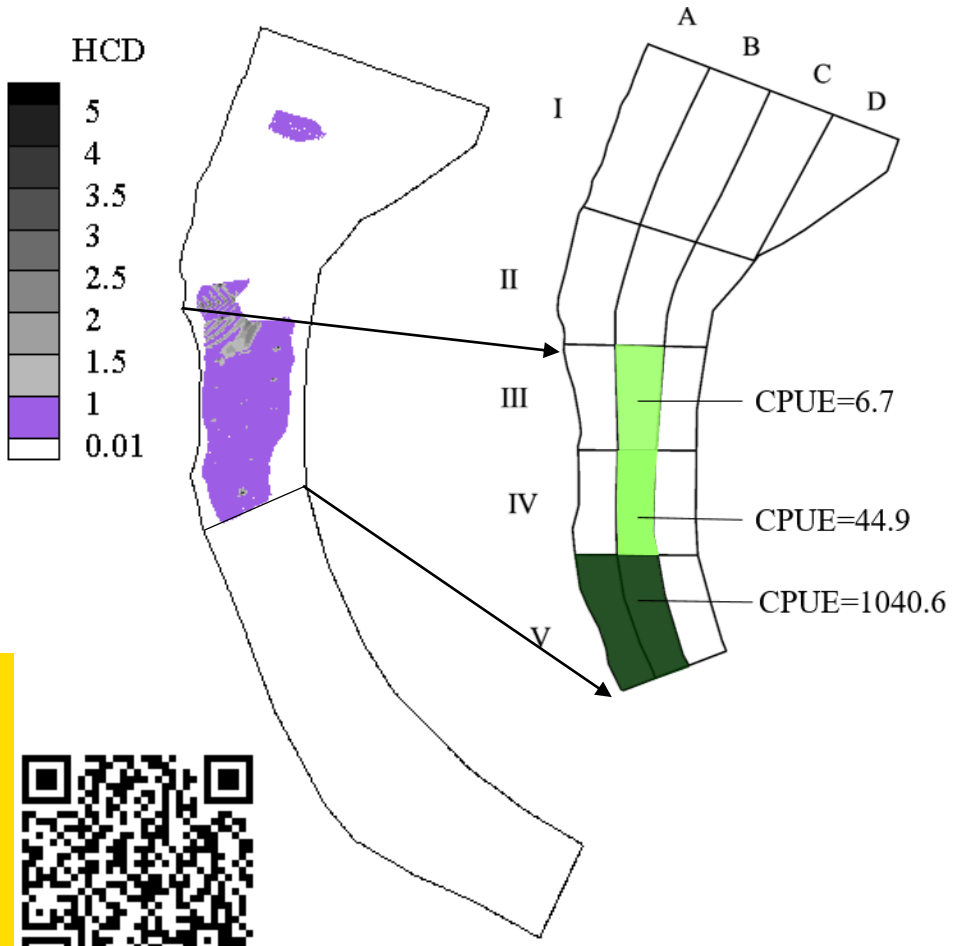
Study area: Yichang spawning ground



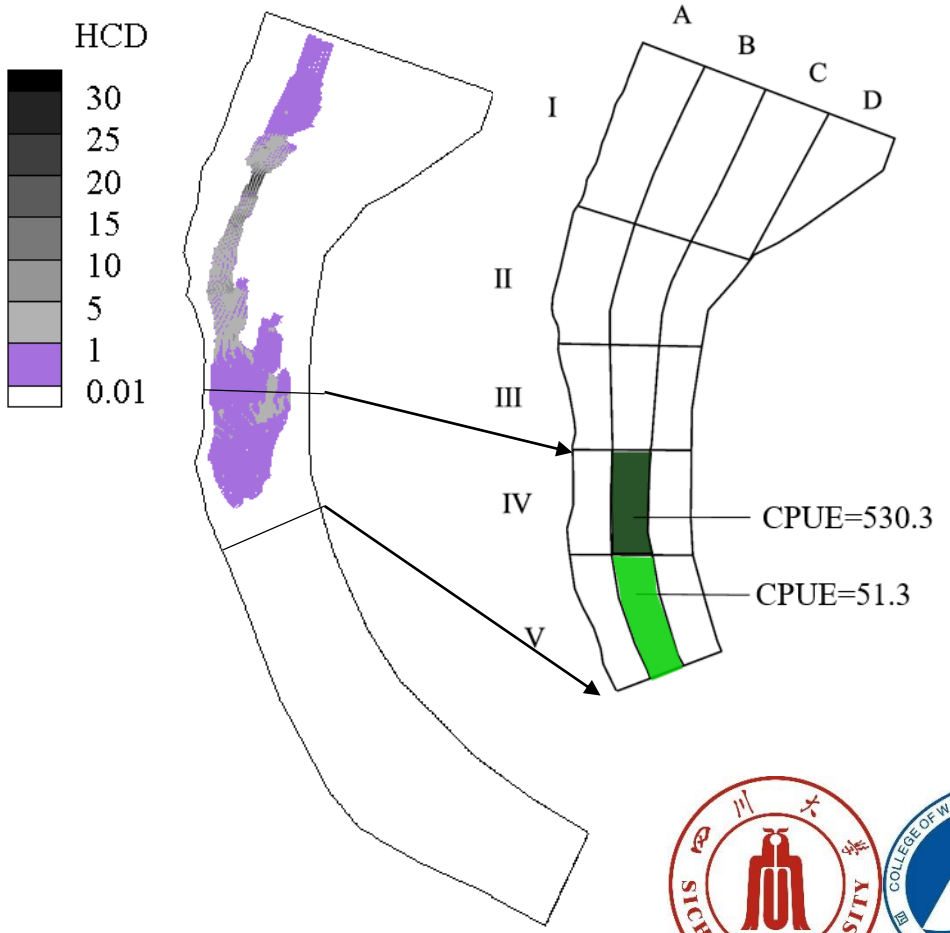
Result 1: Model Performance

- HCD is negatively correlated with functional connectivity.
- Model accuracy based on machine learning: AUC: 0.911>0.9; TSS: 0.809>0.8; F_1 score: 0.870.

(a) 1998

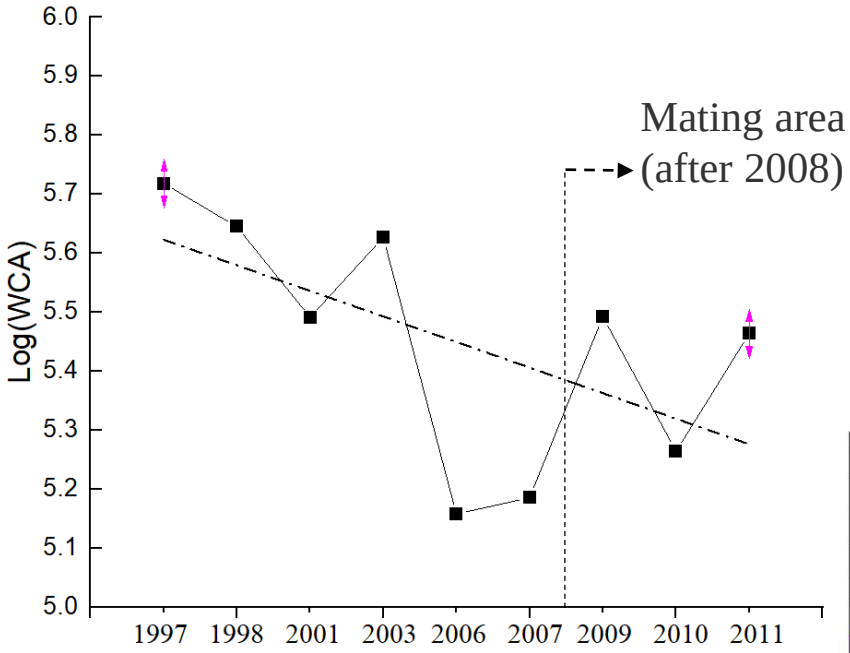


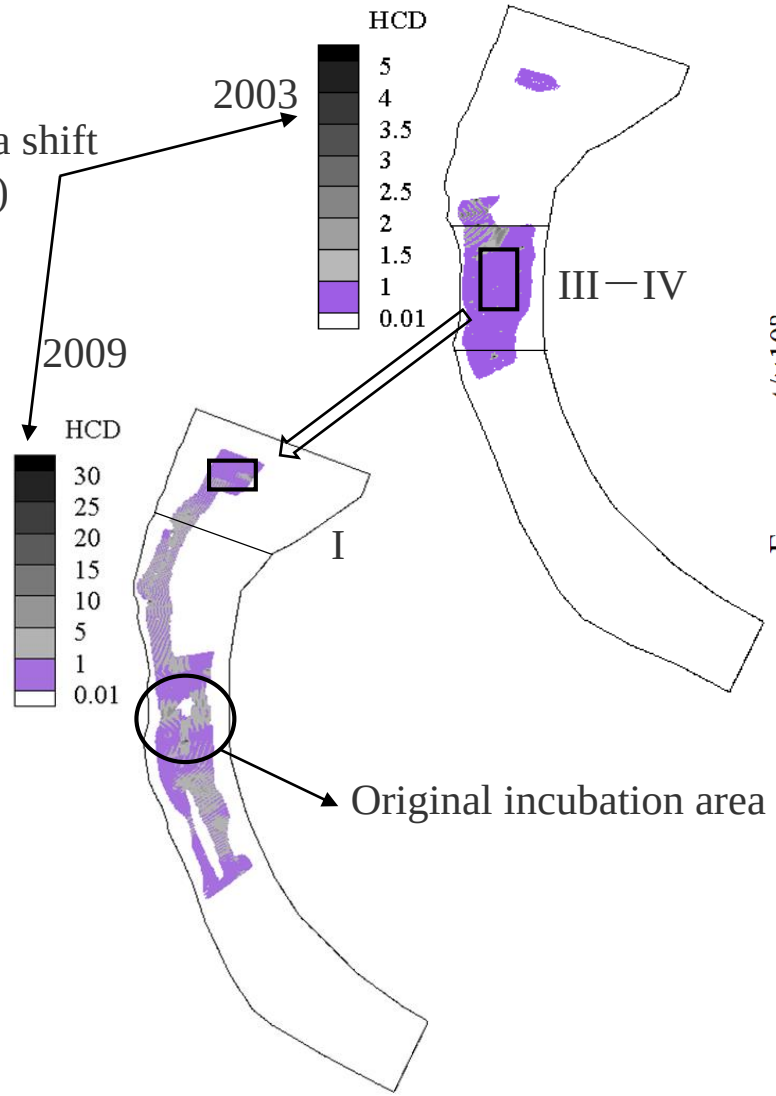
(b) 2003

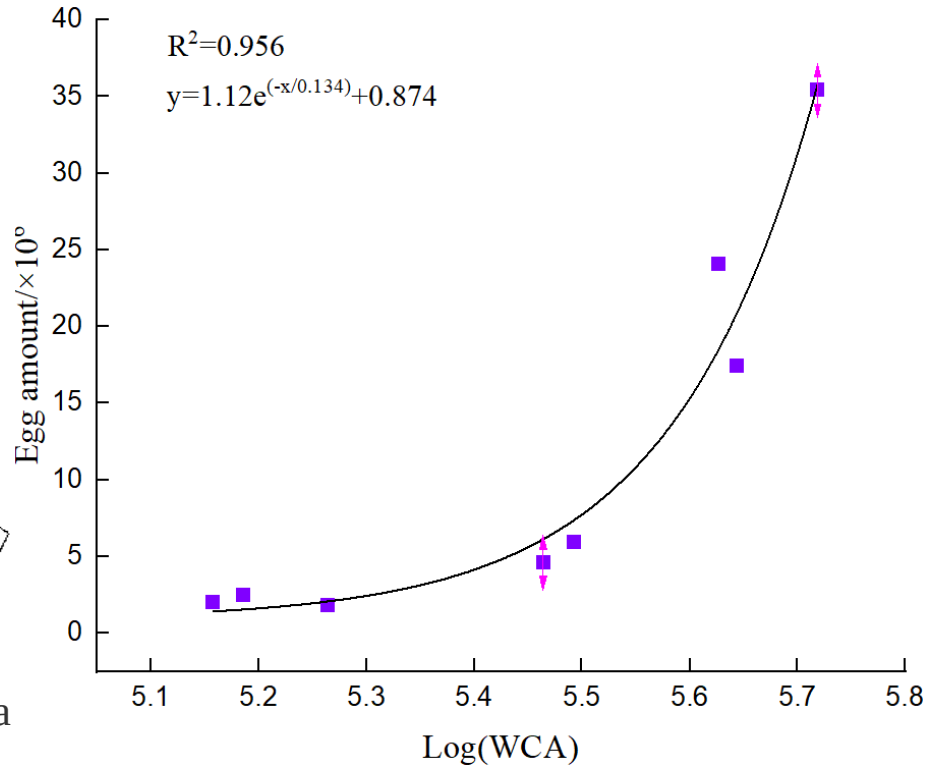


Result 2: The variation of functional connectivity

- The mating areas shifts to upstream as functional connectivity decreases .
- WCA has a strong correlation with egg production.







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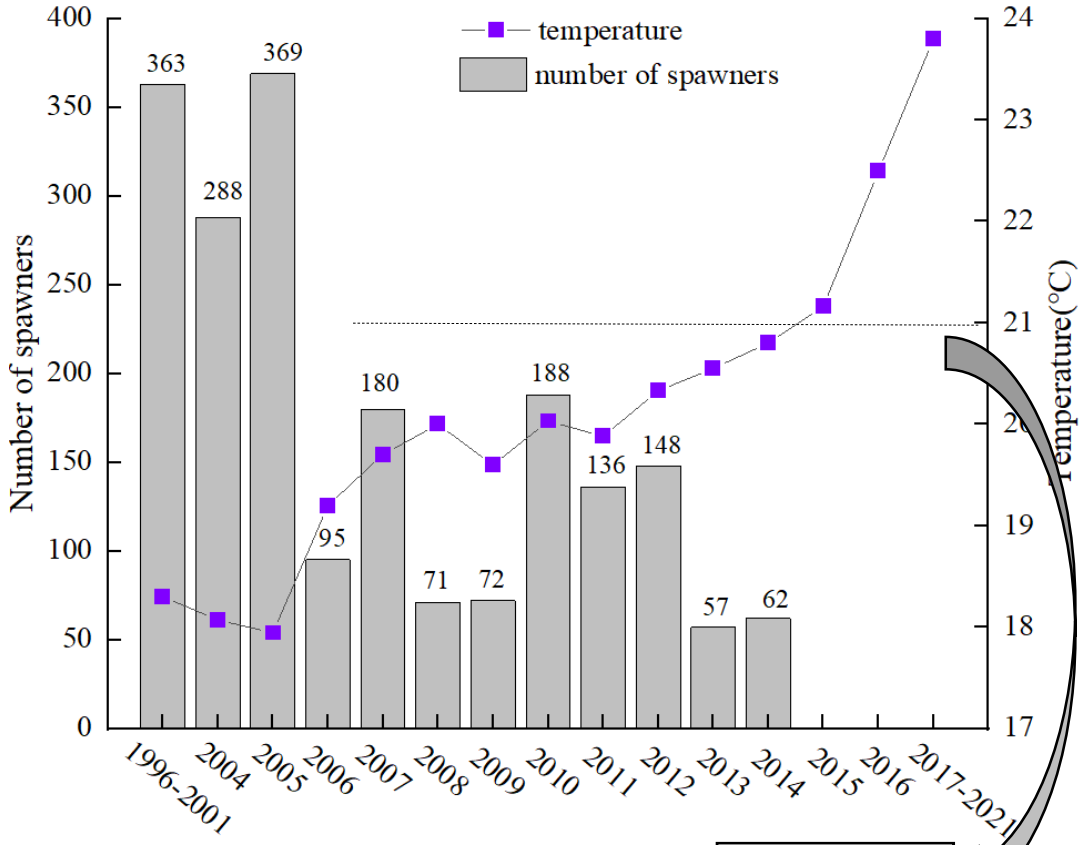
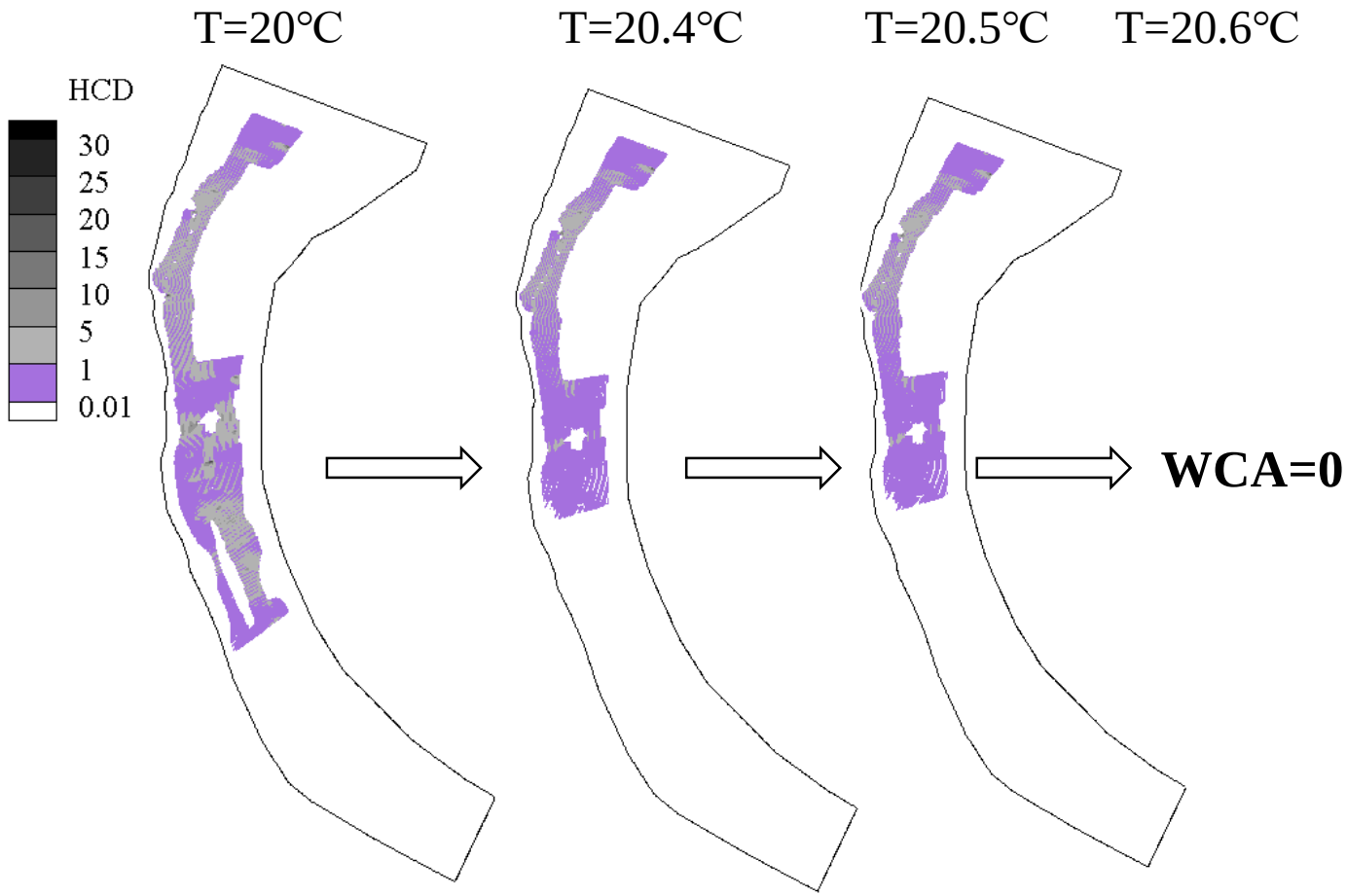
Result 3: The effect of climate changes on functional connectivity

- Functional connectivity dramatically decreases when water temperature > 20℃.
- Chinese sturgeon spawning is likely to cease at 20.6 ℃.



Suitable temperature for spawning: 18—20.2℃

Suitable temperature for incubation: 17—21℃



Conclusions

- Functional connectivity predicting should be incorporated in aquatic habitat quality assessments.
- Functional connectivity between spawning habitats can influence the mating location, as well egg production.
- Functional connectivity of Chinese sturgeon spawning ground would be greatly damaged when the water temperature > 20.5℃.

Thanks for listening !

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