

# Seeing the trees as well as the forest for the relationship between habitat spatial complexity and mangrove ecosystem services

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**Mangroves present as spatially complex habitats:**

- **Protection from predators for juvenile nekton → nursery value**
  - **Shelter from extreme physical conditions → energetic advantage**
  - **Attenuation of water flow → coastal protection role**
  - **Promote trapping of sediments and OM → C sequestration**
- Key ecosystem services**





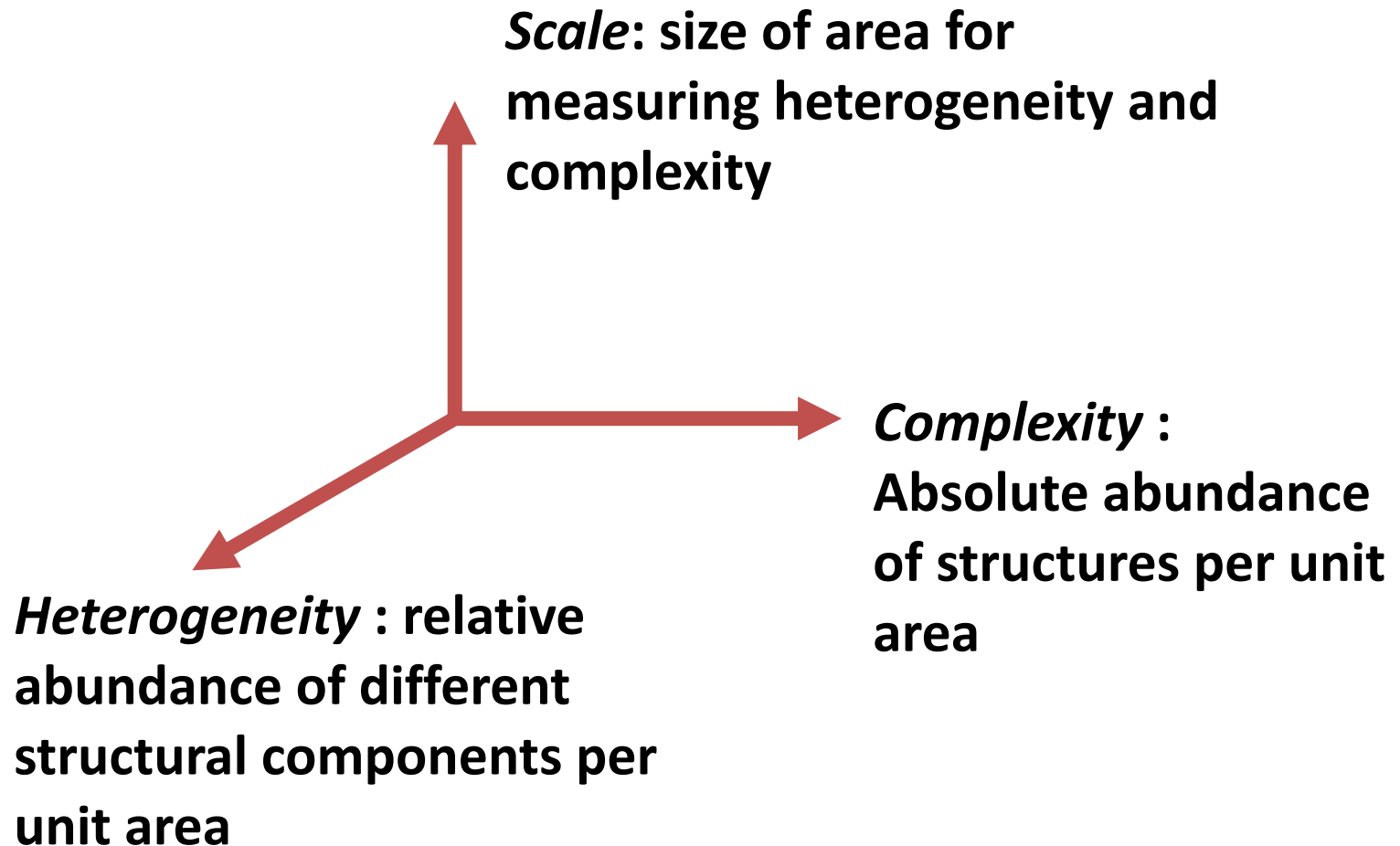
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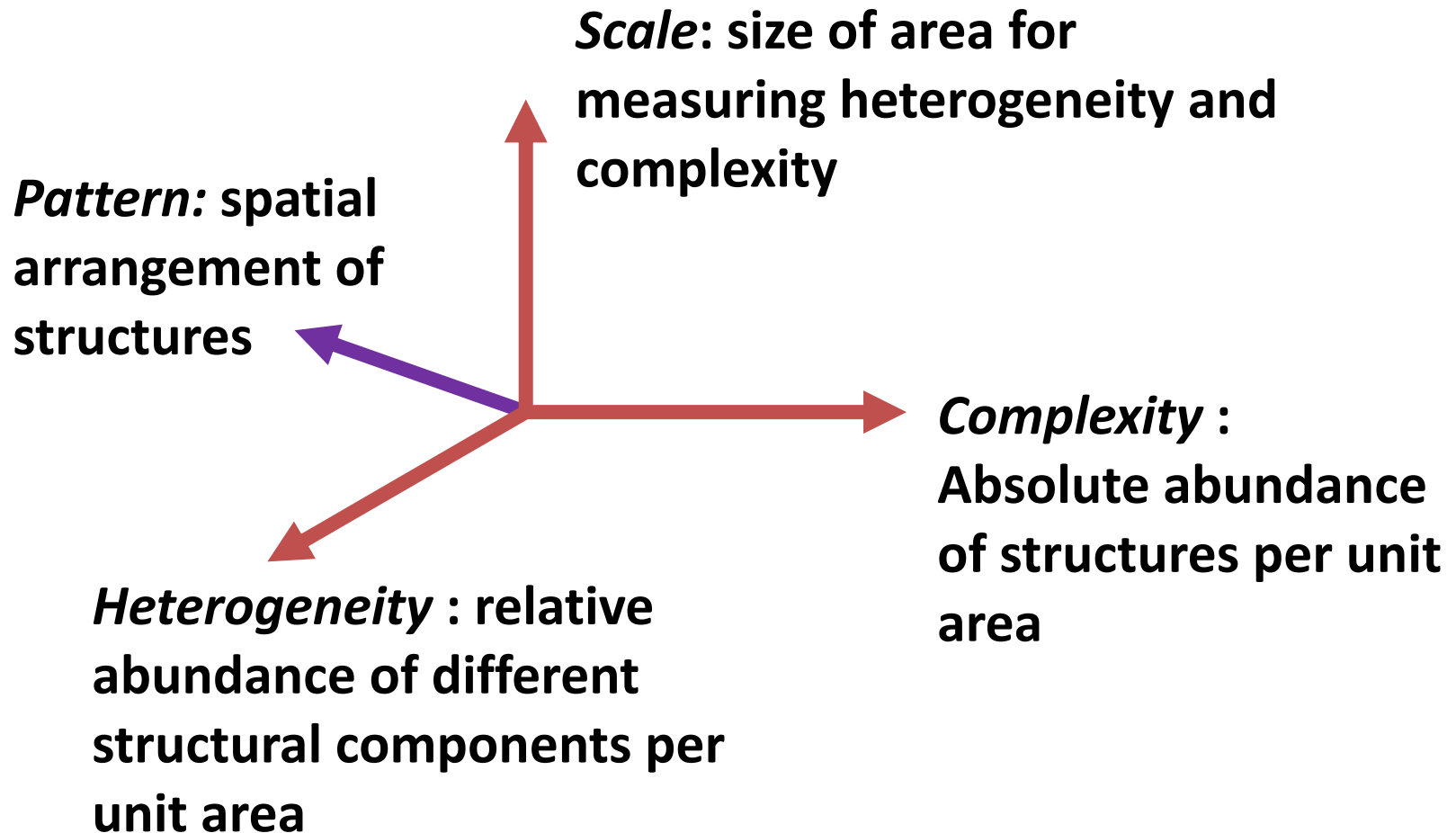
**→ Key ecosystem services**

***No quantitative assessment of relationship between complexity and function: No satisfactory/practical metric of complexity***

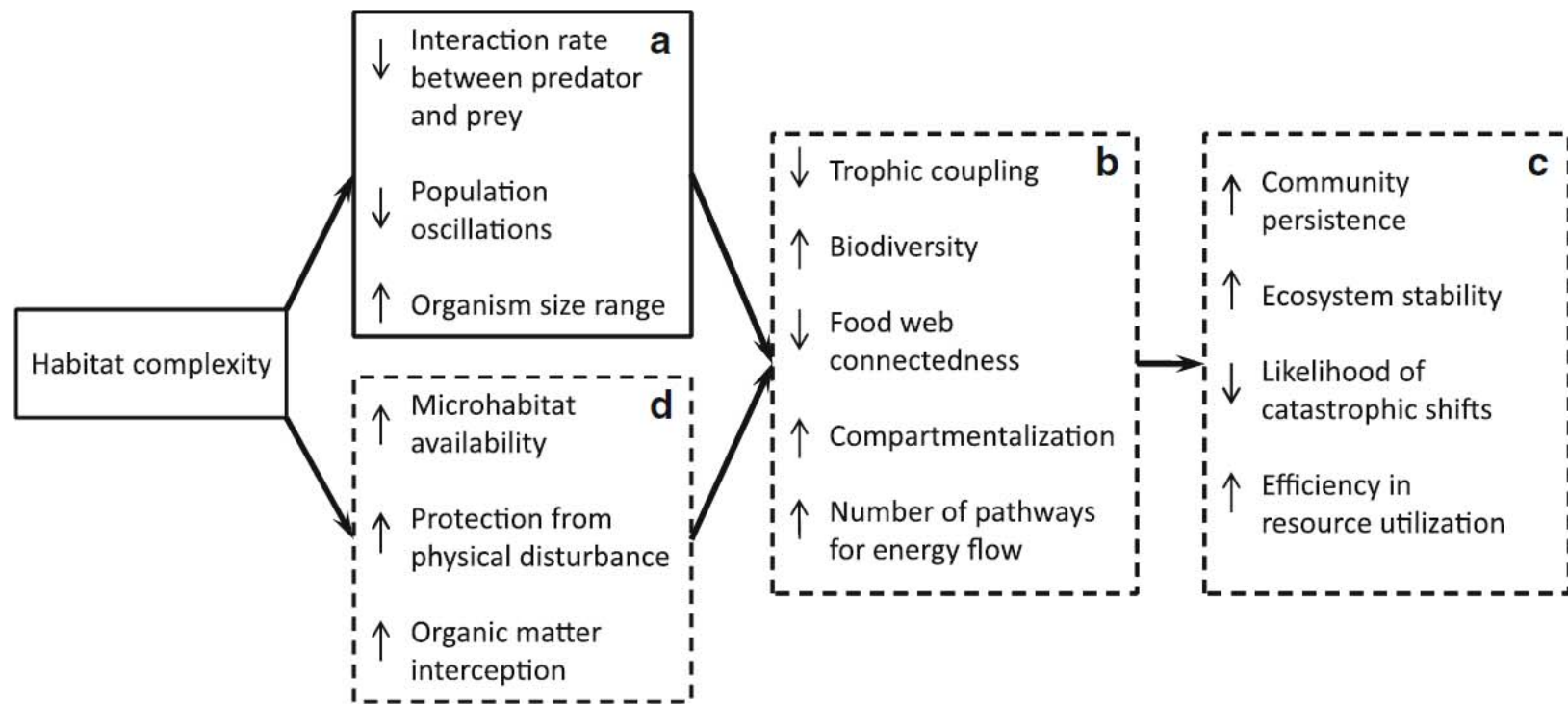
# Components of habitat structure



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# How habitat complexity may influence ecology of populations, communities and ecosystems



**Fig. 2** Whereas effects of habitat complexity on population-level attributes (*a*) are well-documented, little is known about the ensuing effects on community and ecosystem attributes (*b*,

with exception of biodiversity), their emergent properties (*c*), and potential underlying mechanisms (*d*)

Figure 3. The relationship between mangrove areas in the Philippines and the annual yields of penaeid shrimp (adapted from Pauly and Ingles, in press).

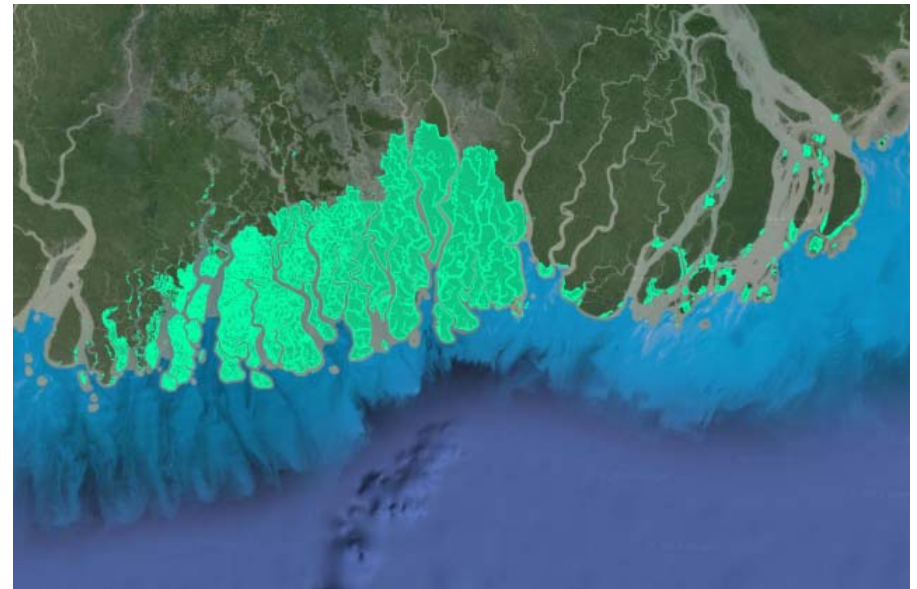
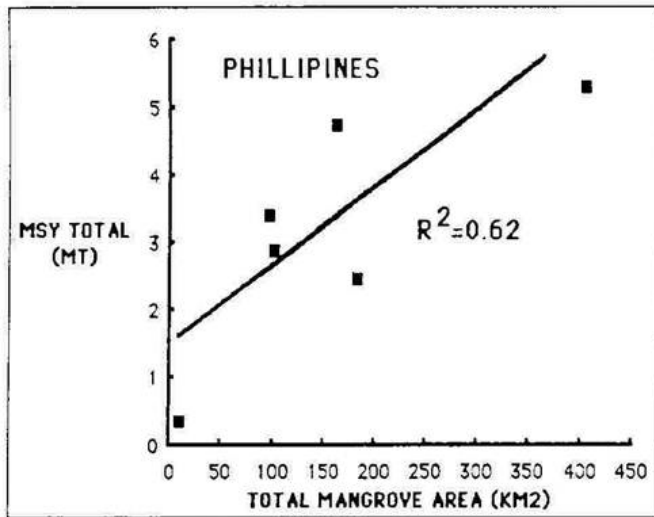
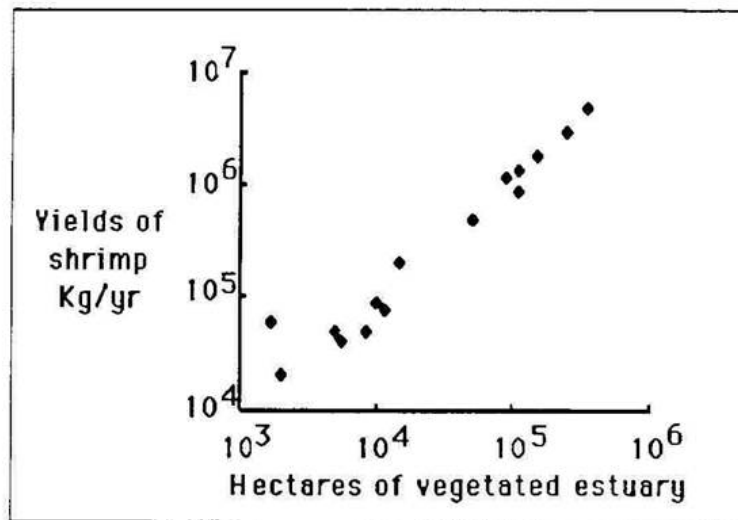
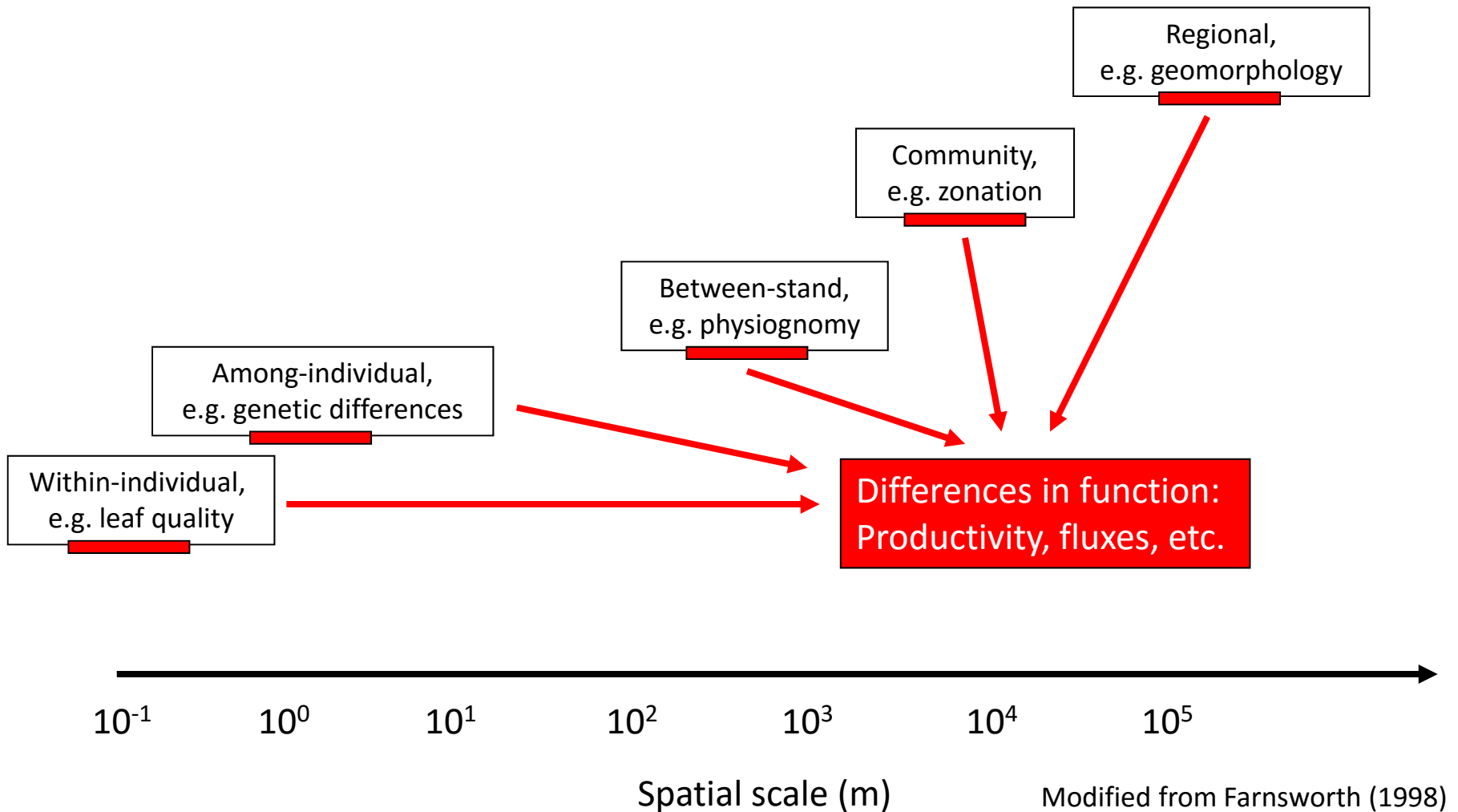


Figure 4. The relationship between intertidal vegetation and penaeid shrimp yields from the estuaries of the northern Gulf of Mexico (from Boesch and Turner, 1985).

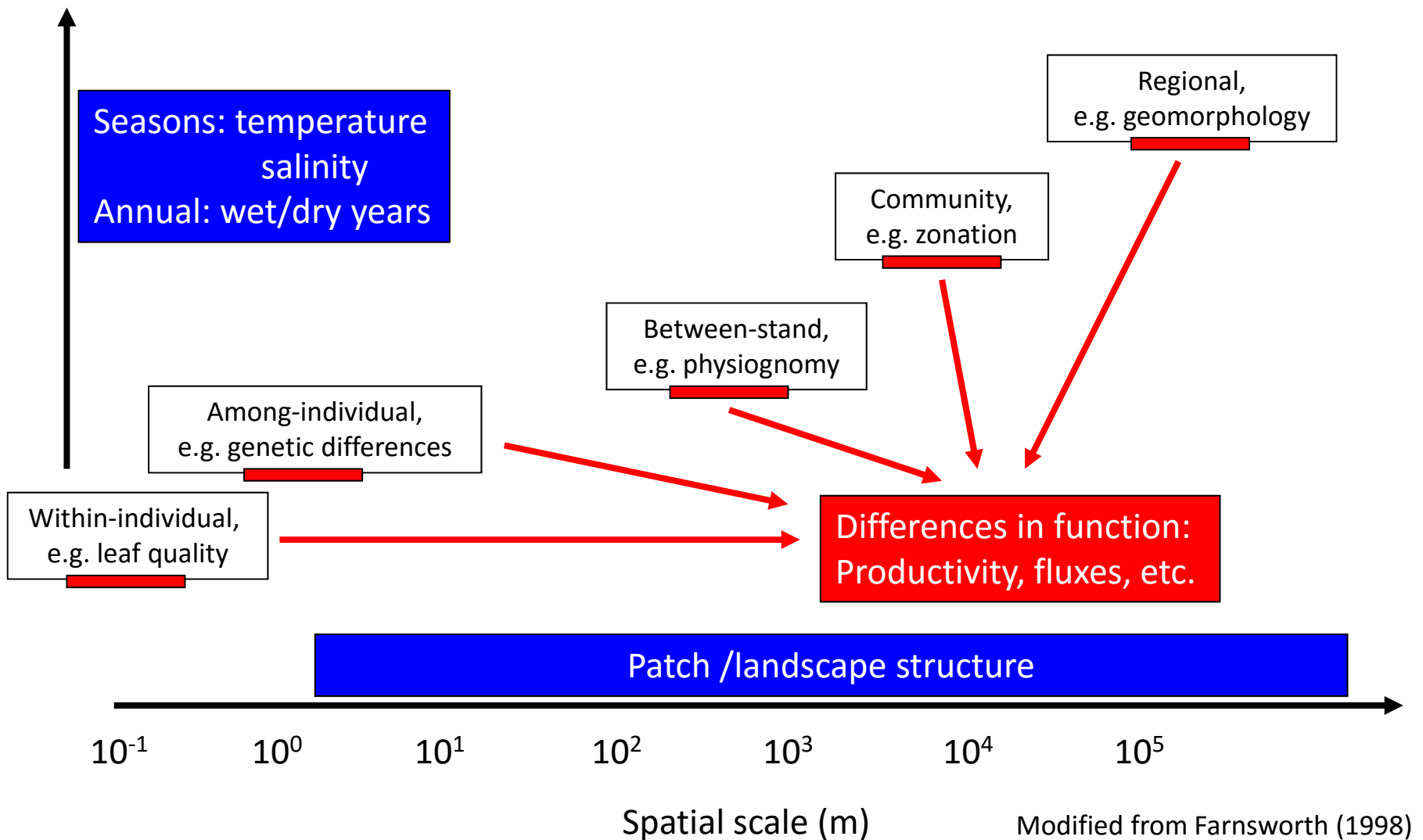


# Sources of mangrove heterogeneity influencing function

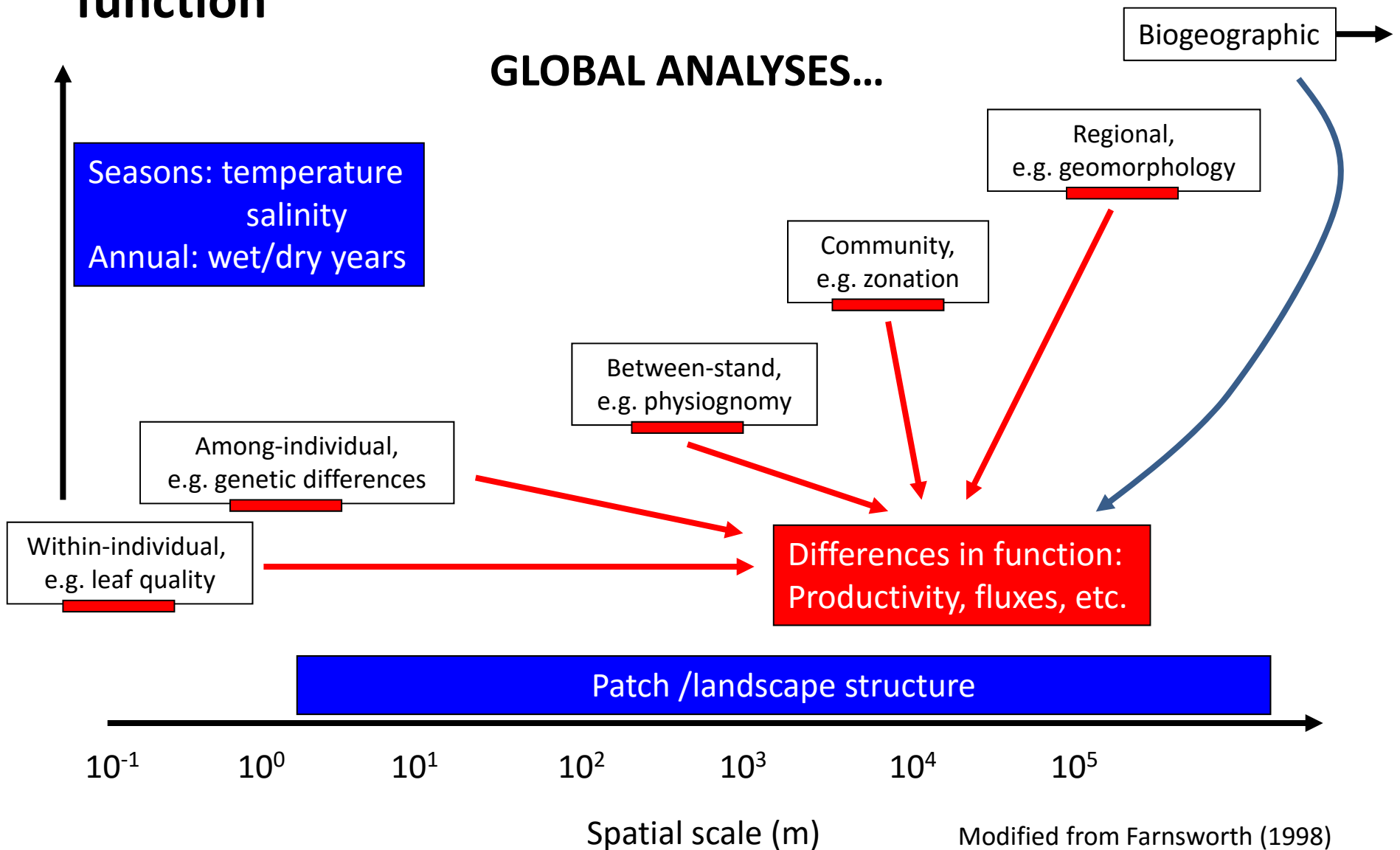




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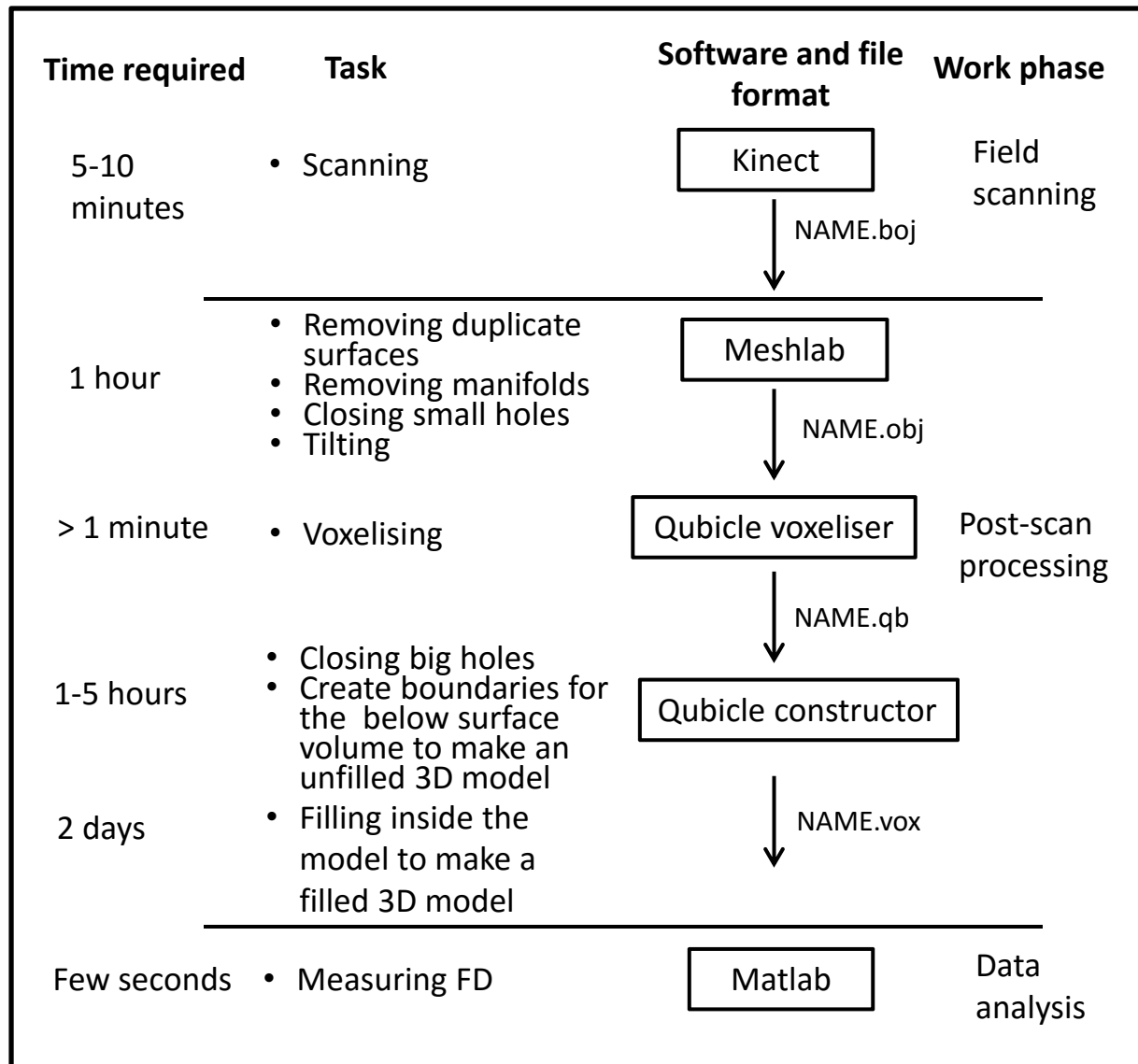


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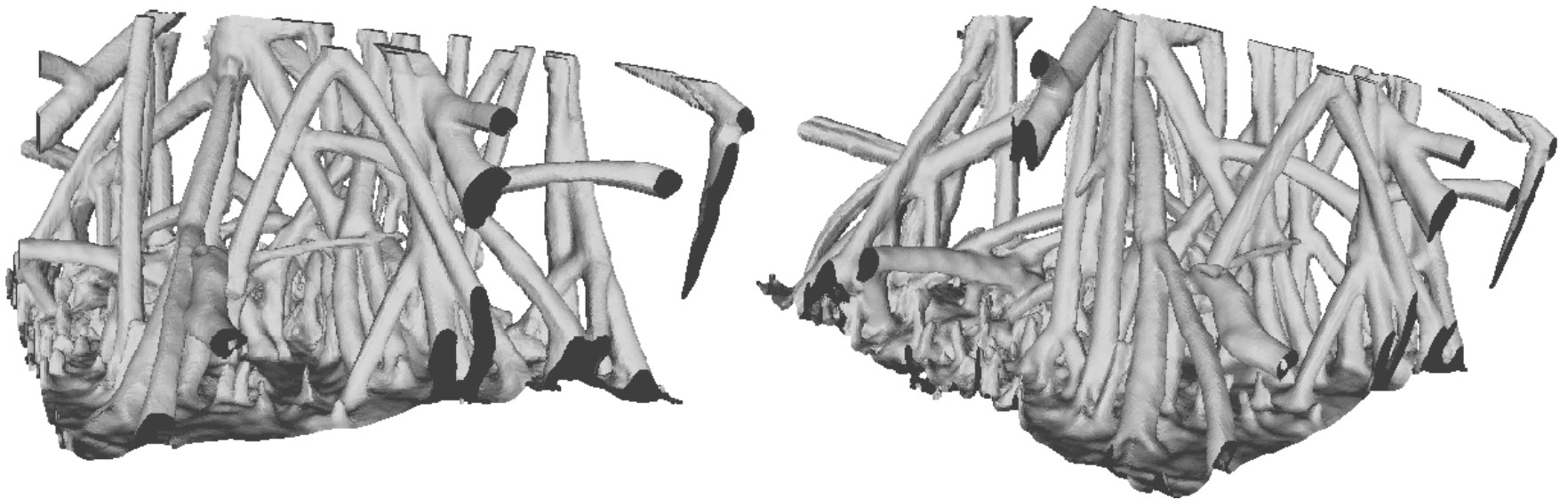




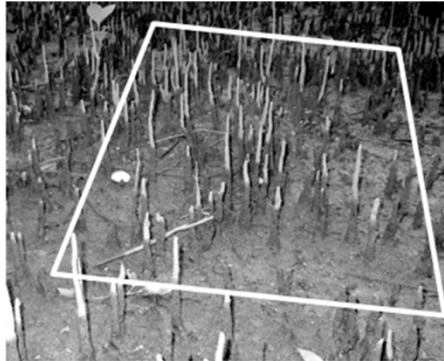
**Assessing the three-dimensional structure of mangrove roots**  
**Kamal et al. (2014) *Methods in Ecol Evolut***



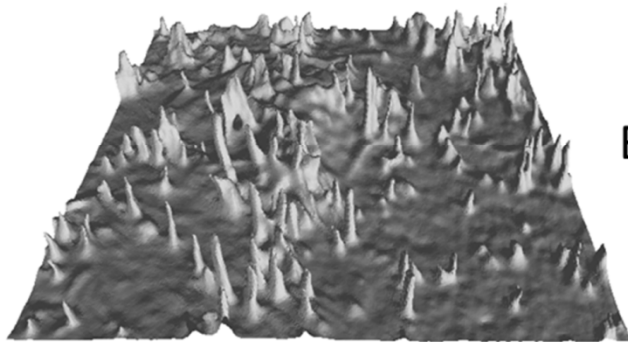
**Steps involved in the scanning and analysis process**



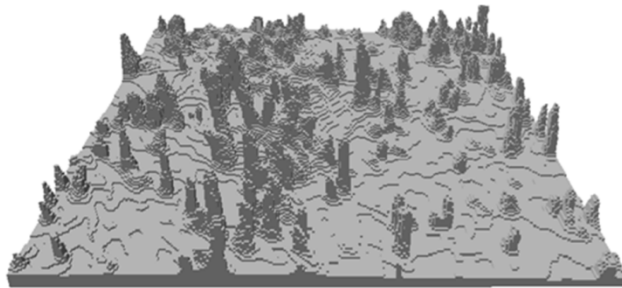
3D model can be manipulated for viewing within Meshlab



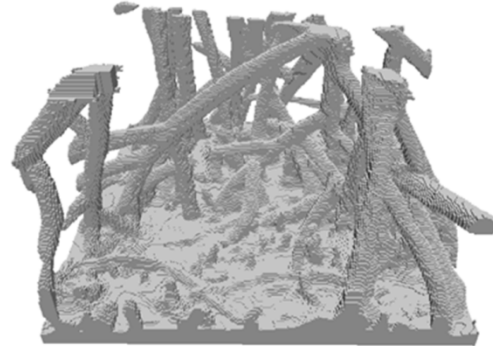
A



B



C



KINECT  
for XBOX 360.

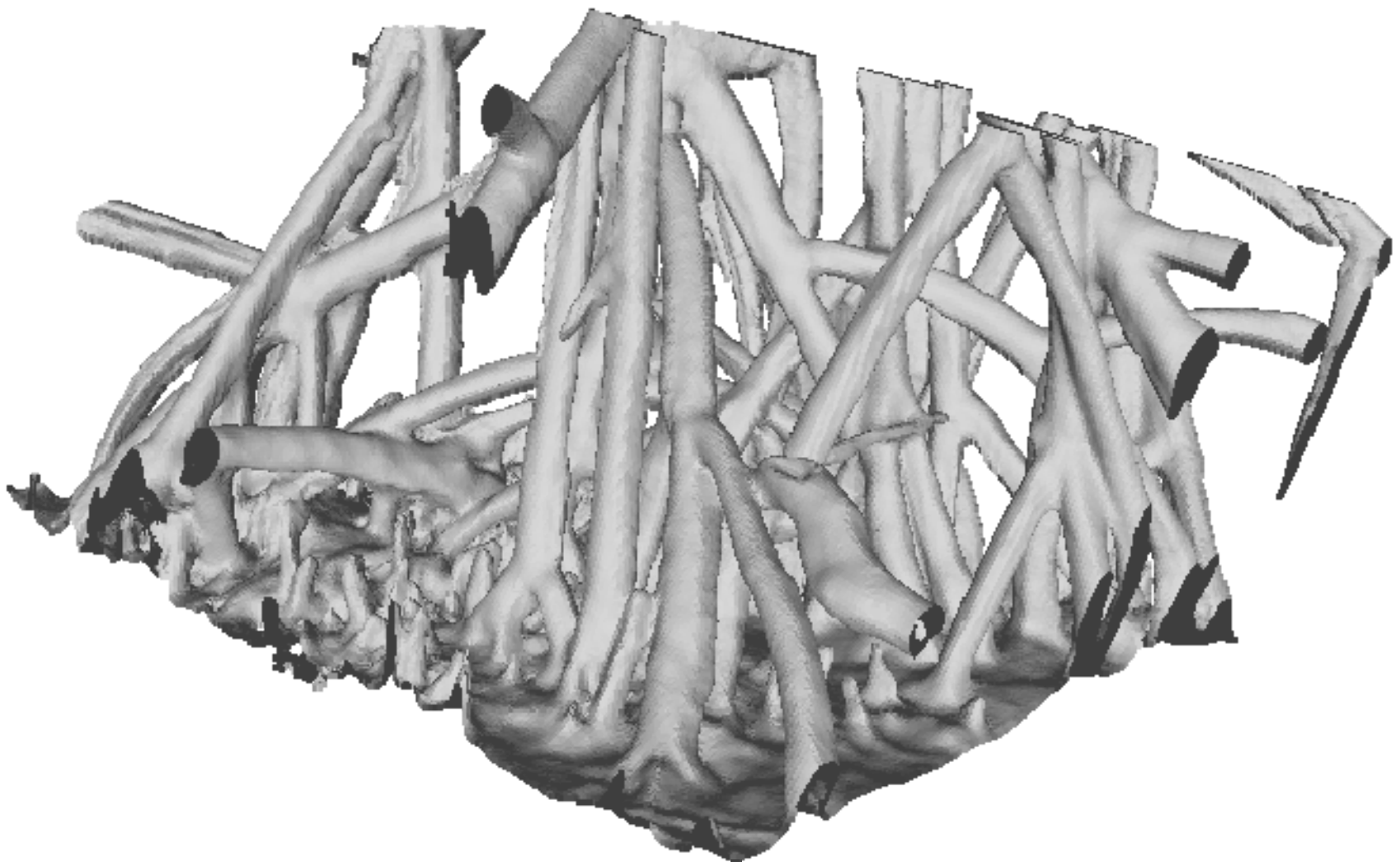
Kamal et al. (in review)

**Digitising the 3-d structure of mangrove roots for analysis**



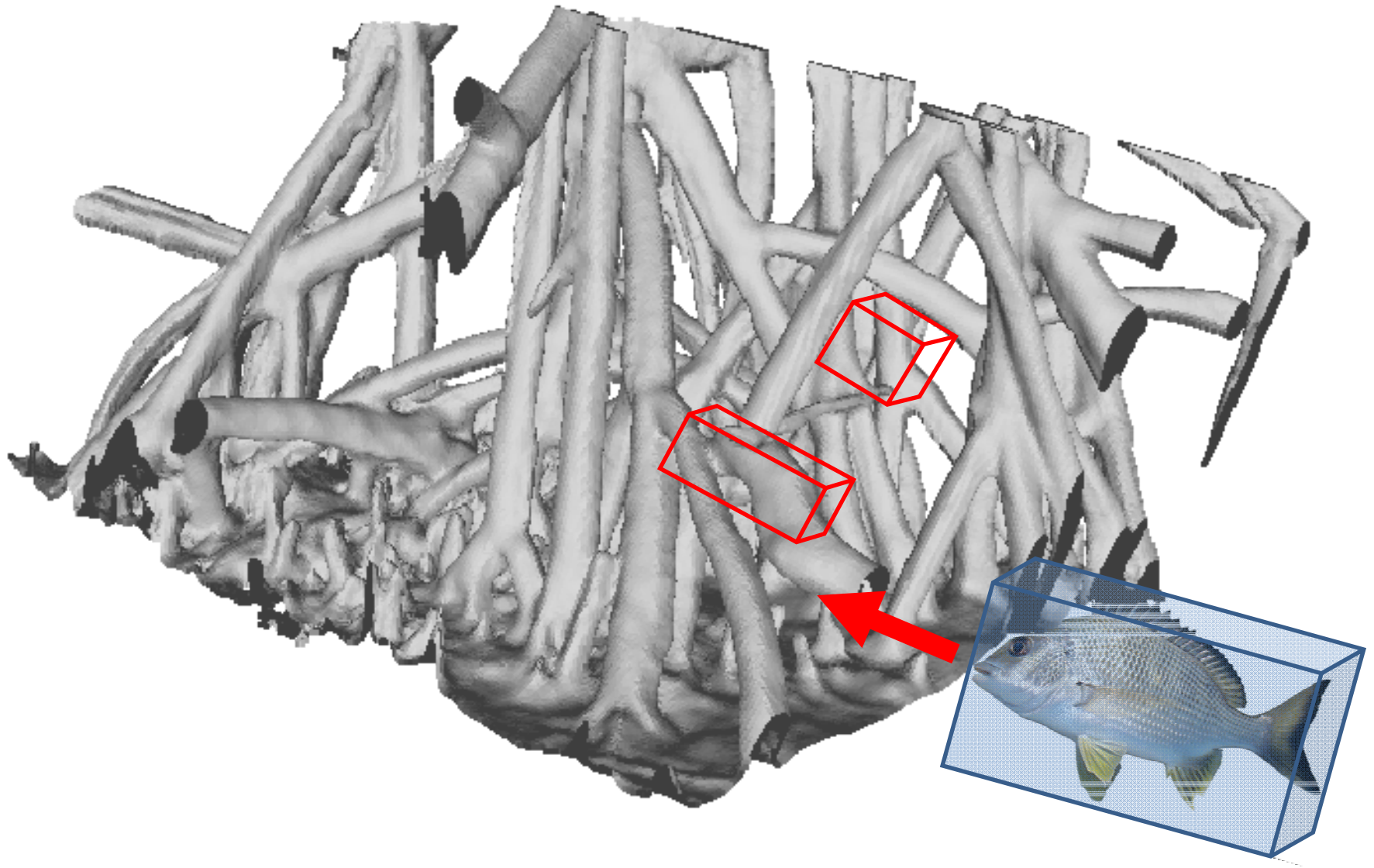
Nexus between habitat structural complexity and mangrove ecosystem function and services unclear – lack of cost-effective tools





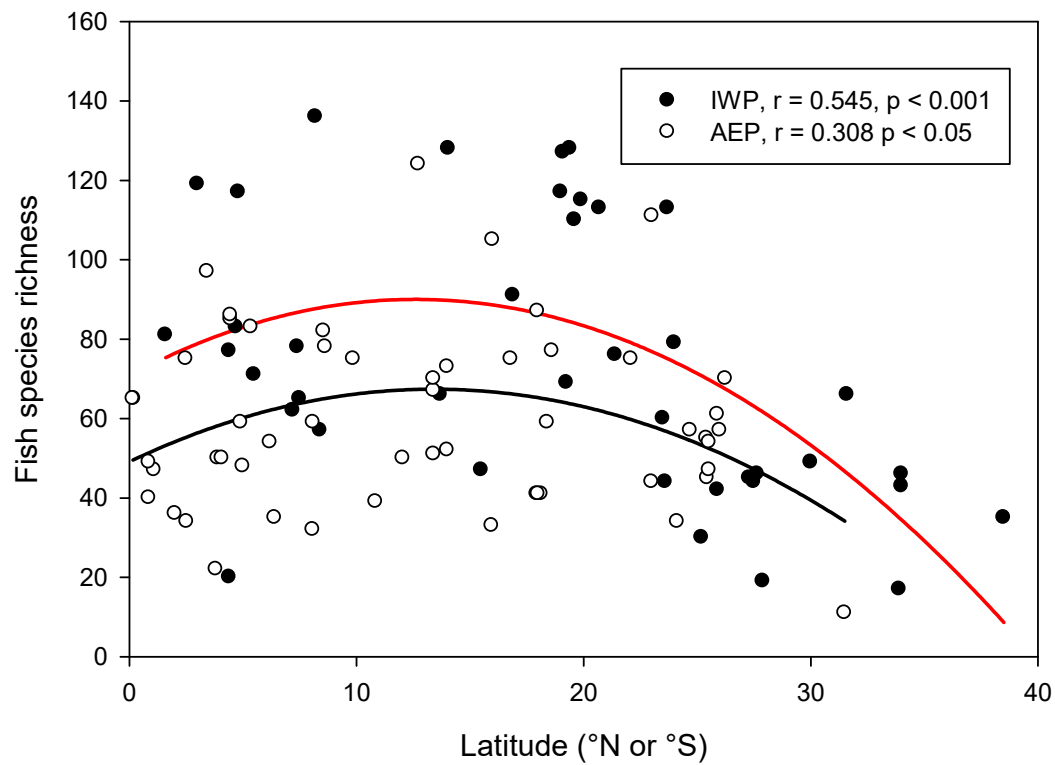


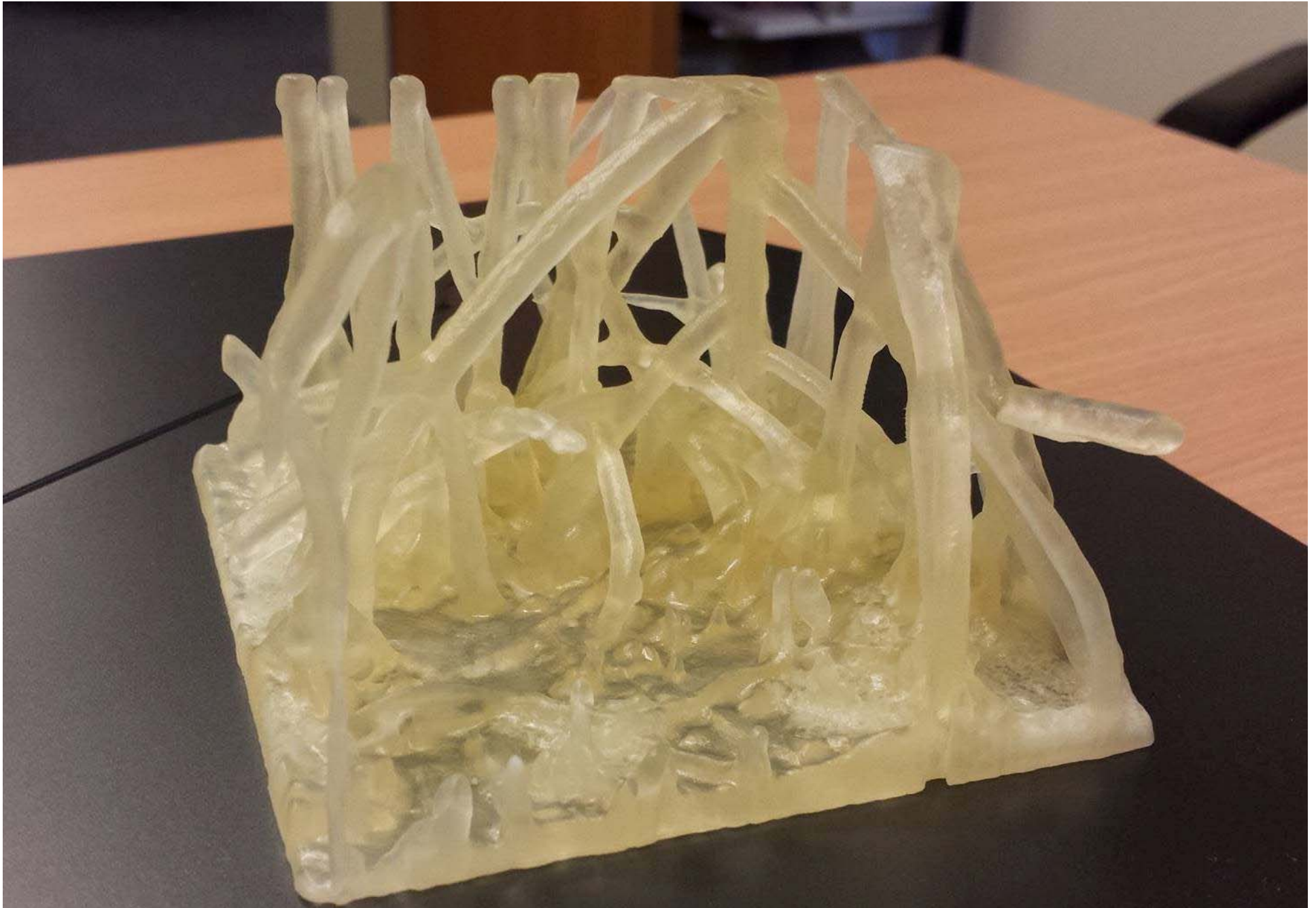
**Assessing habitat complexity from the 'fish point of view' – calculating fractal dimension of habitat using cube/prism counting method**



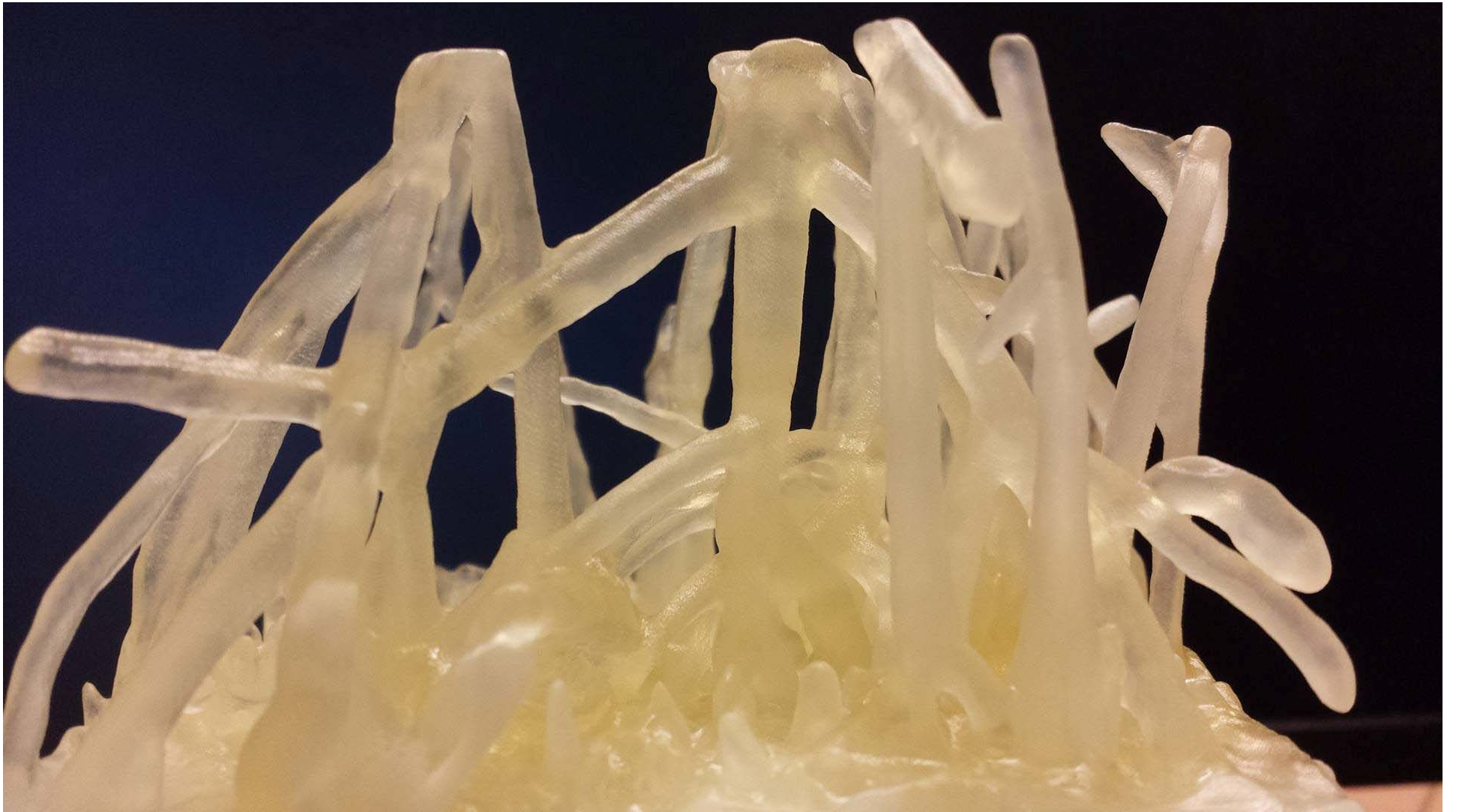
# How may small-scale habitat complexity influence mega-patterns in mangrove ecosystem structure and function?

(Lee et al. in press)

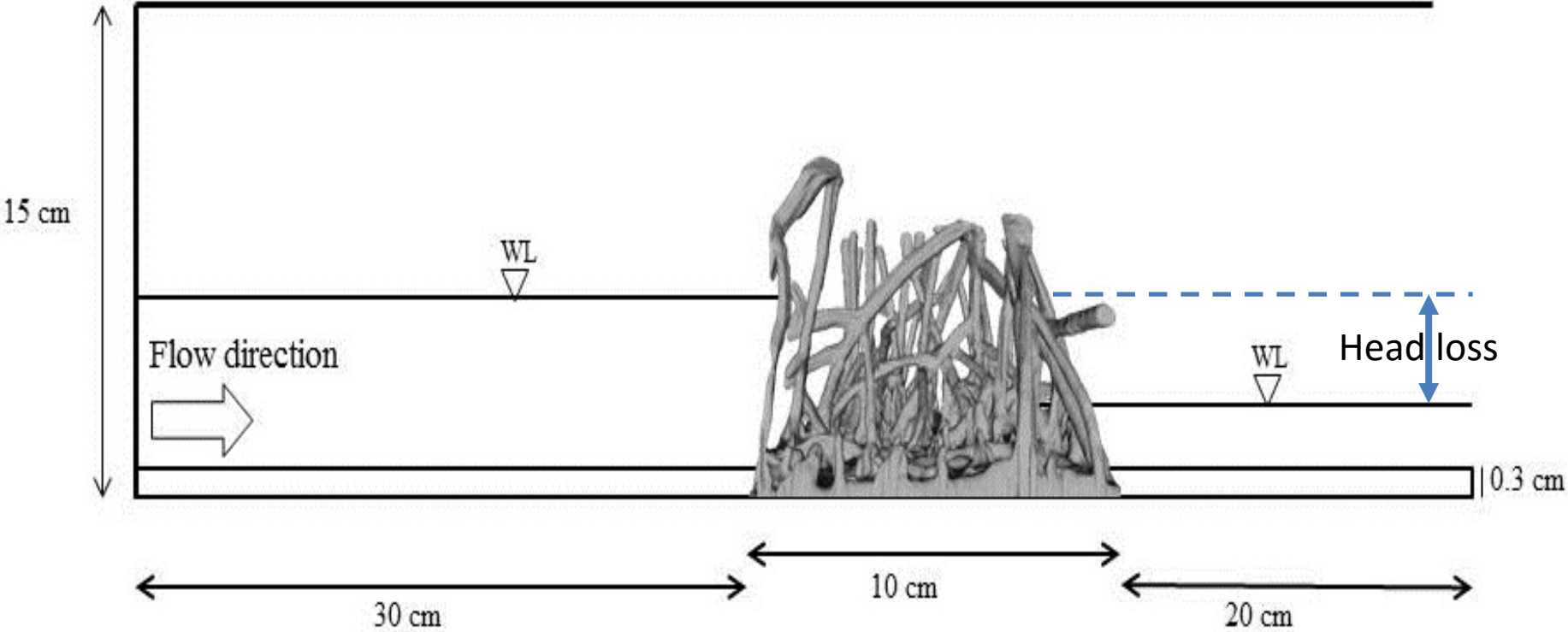




Testing the importance of 3-D complexity to key ecological processes – printed roots



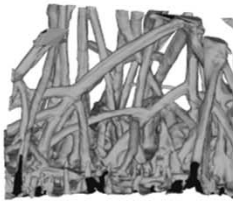
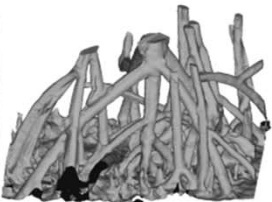



# Measurement of the relationship between mangrove root complexity and water flow using 3D-printed models



## Manipulating the 3D-model to change the level of complexity

3D mesh models of the scanned *Rhizophora stylosa* stilt roots, their AVR and the average of submerged roots AVR values.

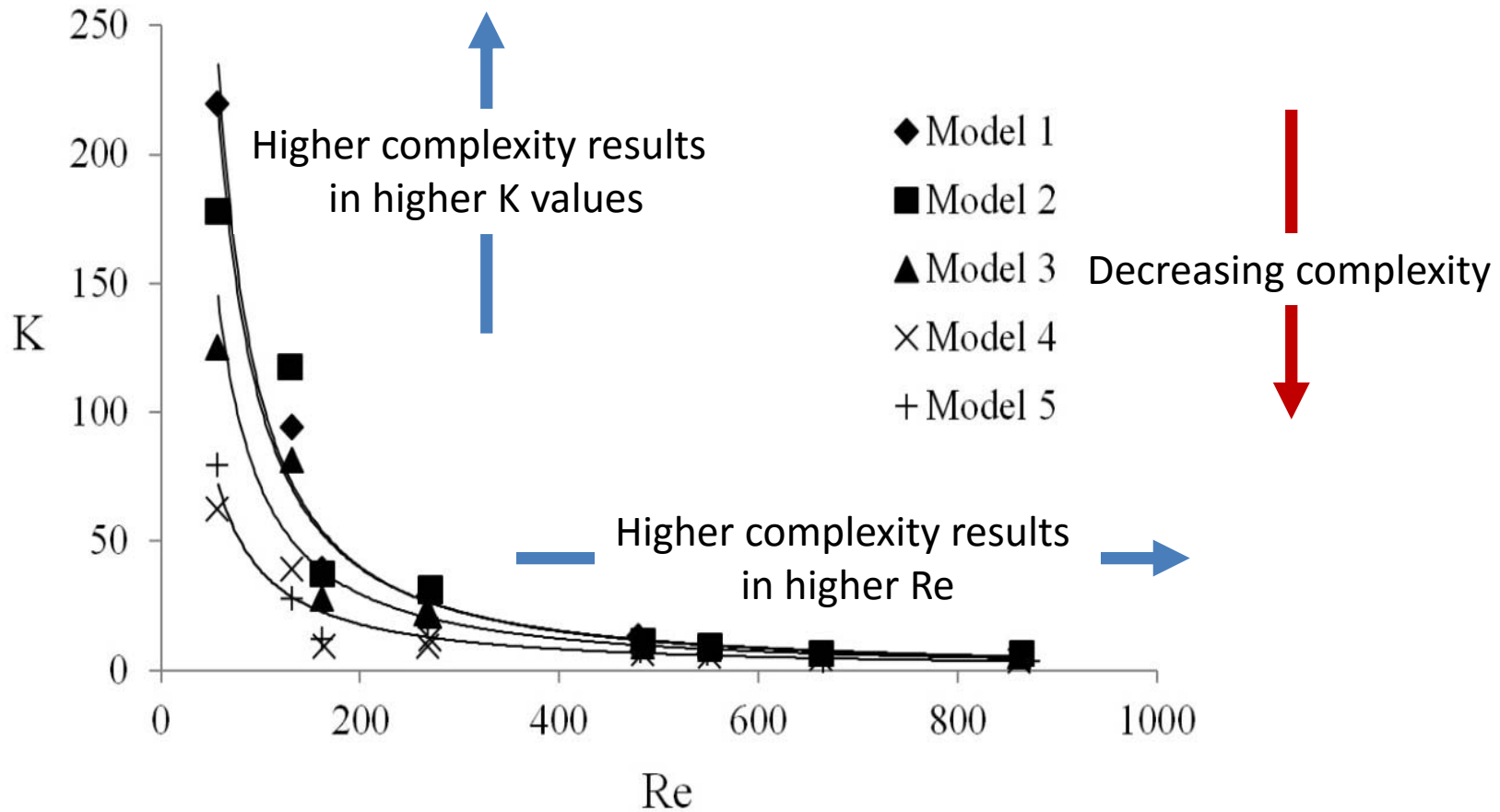
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	1	2	3	4	5
Models					
AVR	79.8	69.8	57.8	40.2	33.4
Submerged root AVR	151.7	148.9	138.3	127.5	126.4

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K is proportional to water head loss

Re should become larger with more complex structures



Relationship between Pressure change coefficient (K) and Reynolds number (Re) for the five root models of different complexity.



**Olaf Meynecke**



**V C Chong**



**Charles Lemckert**



**Norm Duke**



**Brian Fry**



**Hanh Bui**



**Rod Connolly**



**Shafagh Kamal**

**Jan Warnken**



**Xiaoguang Ouyang**

**Funding from:**

**Queensland Government**

**Australian Research Council**

**CSIRO, Australia (Flagship Collaboration Fund & Carbon Cluster)**

**Gold Coast City Council**

**Coastal Cooperative Research Centre**

**Sea World, Australia**

**Fisheries R&D Corporation, Australia**

**Australian Academy of Science**

**Griffith University**

# ***Acknowledgements***