Marine Protected Areas as a tool for long-term monitoring of marine biota: Separating climate from anthropogenic influence

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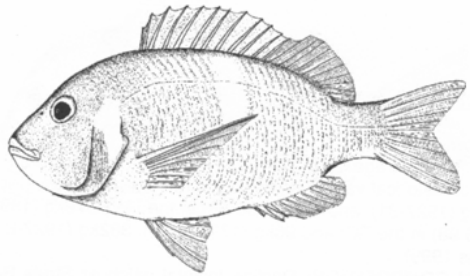
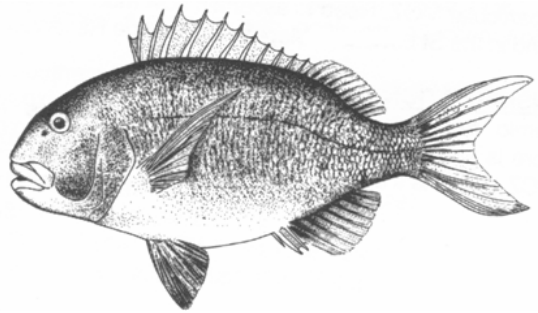
Why Marine Protected Areas (MPAs)?

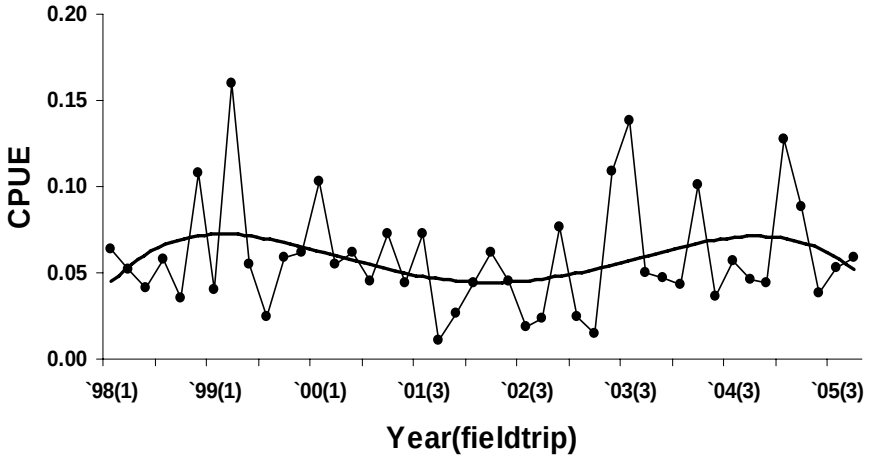
- Anthropogenic influence and natural variability (including climate change) are superimposed

  → Large and well established MPAs are mostly free of anthropogenic influence

  → Measure of natural variability (short-term) and climate change (long-term) as baseline for exploited areas



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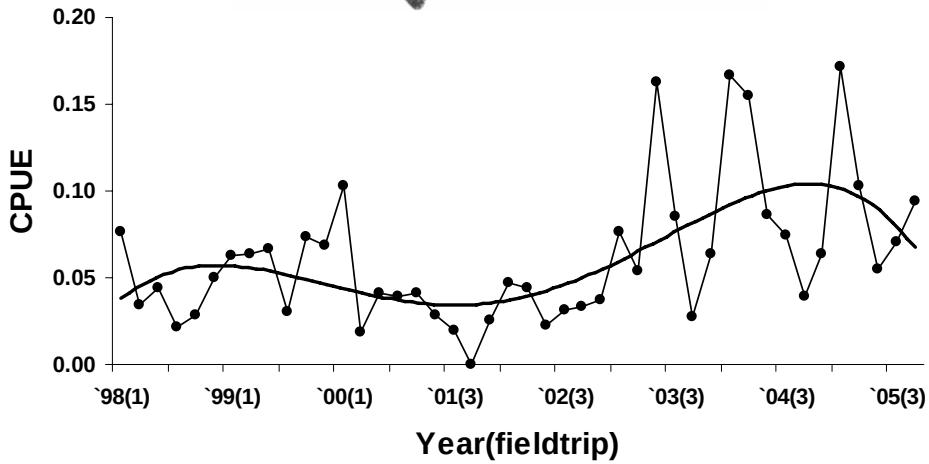
Year(fieldtrip)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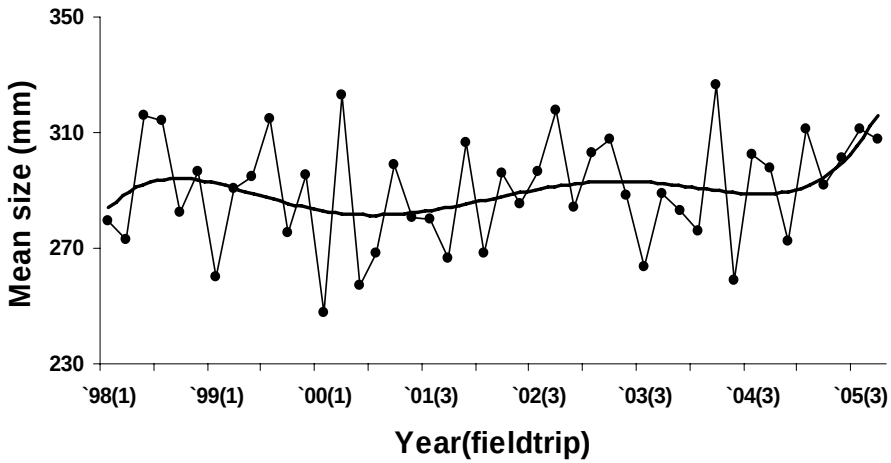
Year(fieldtrip)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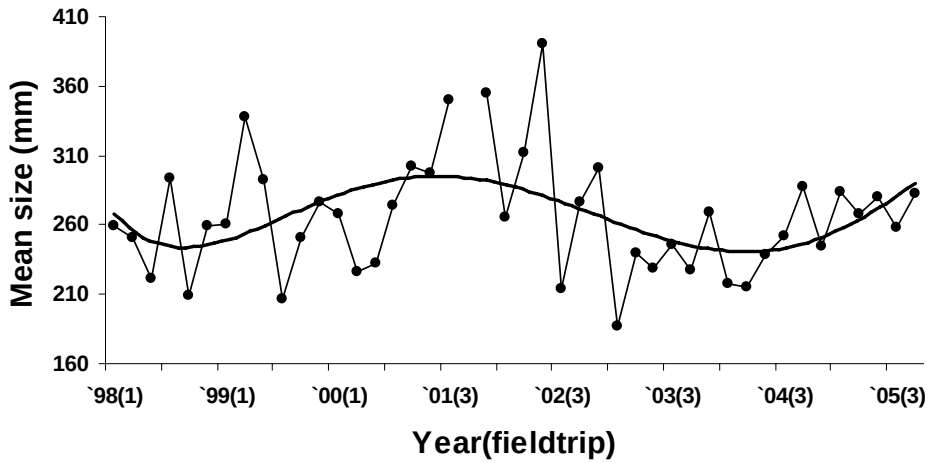
Year(fieldtrip)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Year(fieldtrip)

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- Do MPAs work? (in South Africa)

  → Movement behavior of species

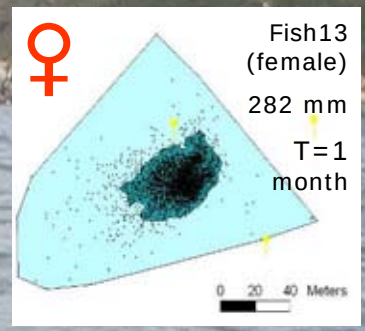
Red Roman *Chrysoblephus laticeps*, SPARIDAE

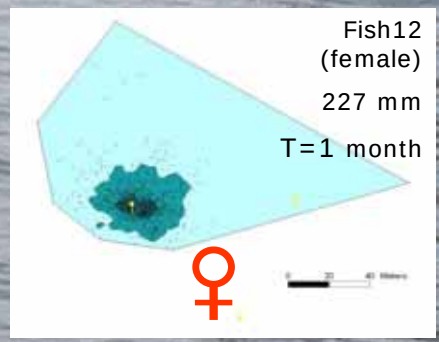
Protogynous Hermaphrodite

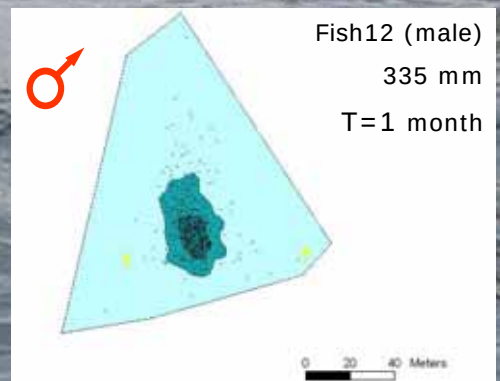
Movement behavior of Roman

Outside spawning season:

- Small home ranges (~1200 m^2 95% fixed kernel)



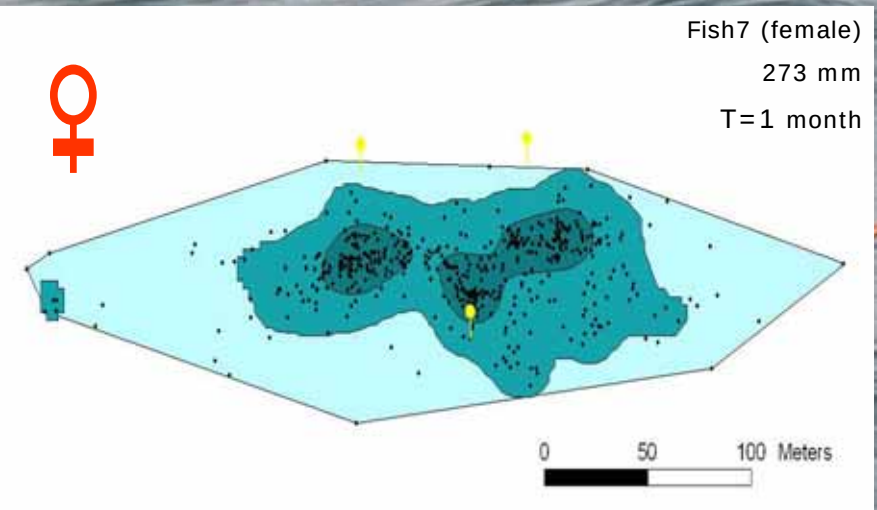


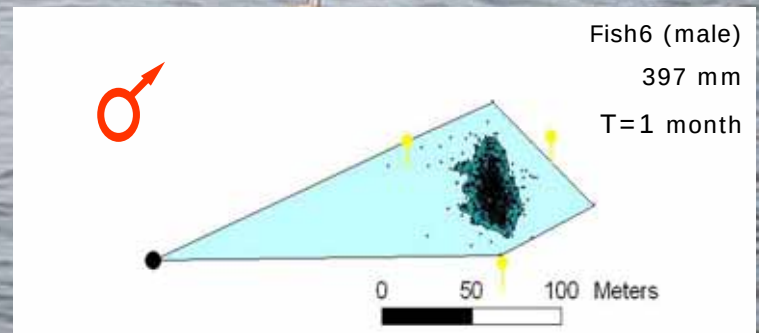


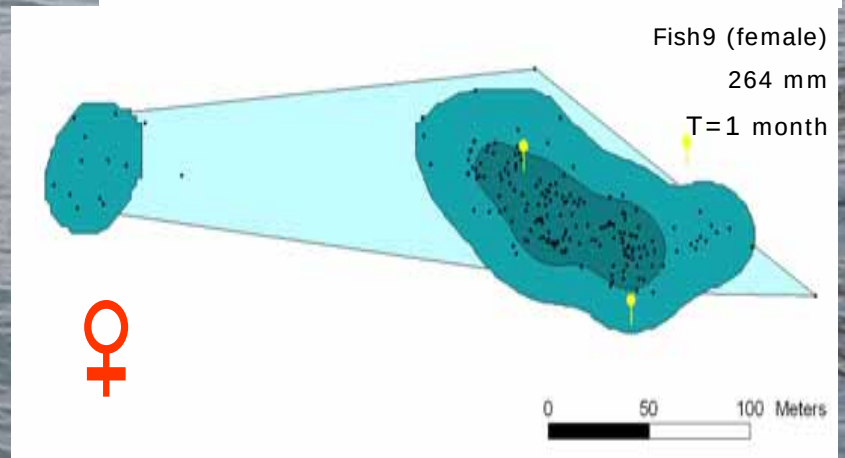
Movement behavior of Roman

Spawning season:

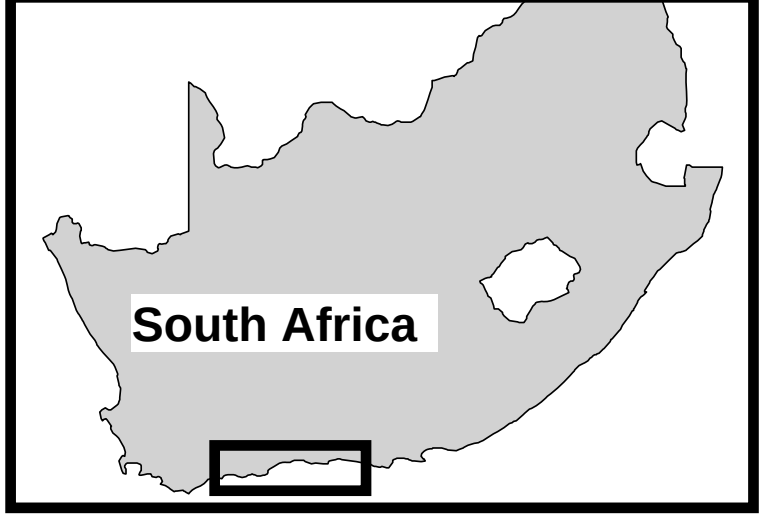
- Females extend home range (~10000 m^2 95% fixed kernel)
- Females engage in aggressive behavior (spawning related)
- No change in male home range, no male aggression

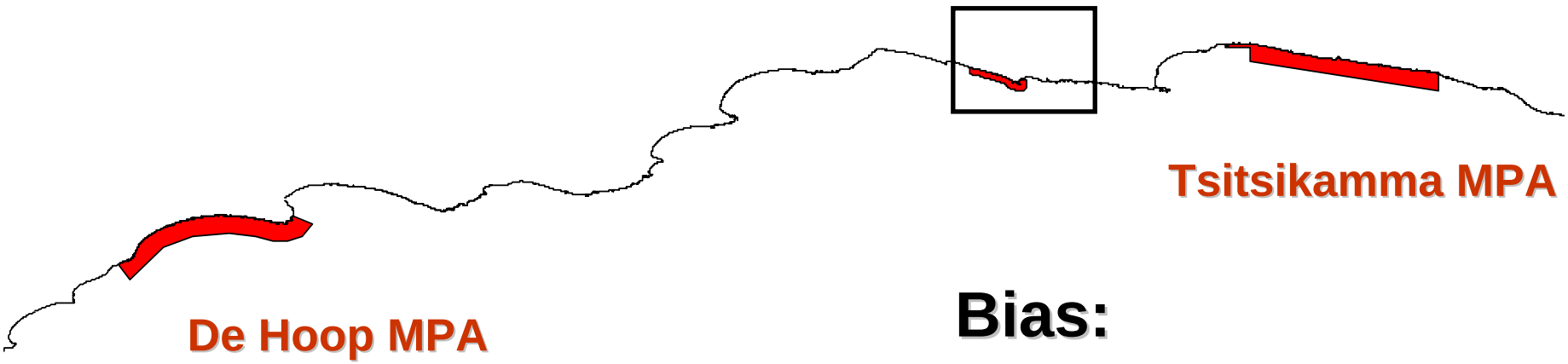






Marine reserves: Sizes





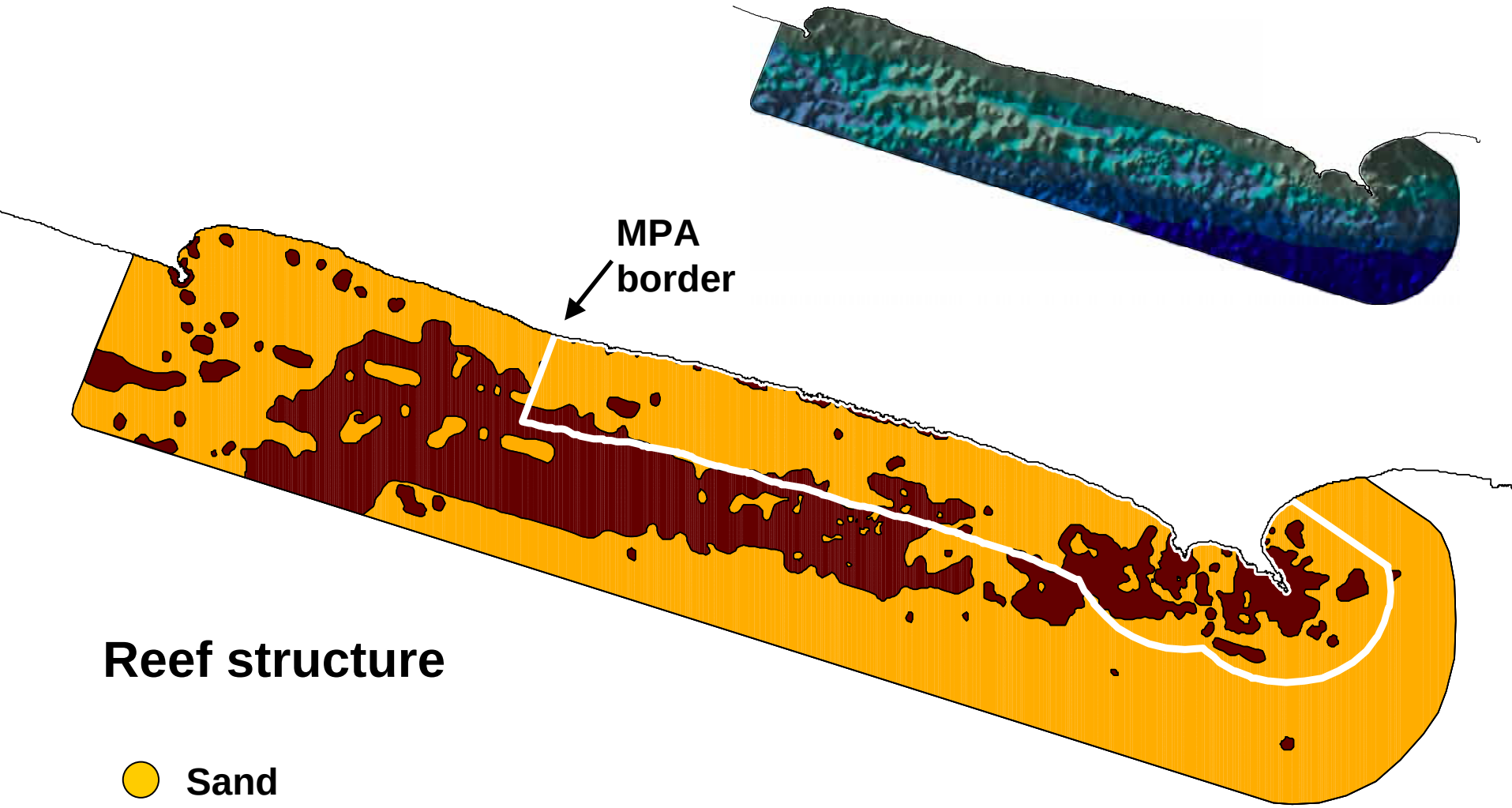
Bias:

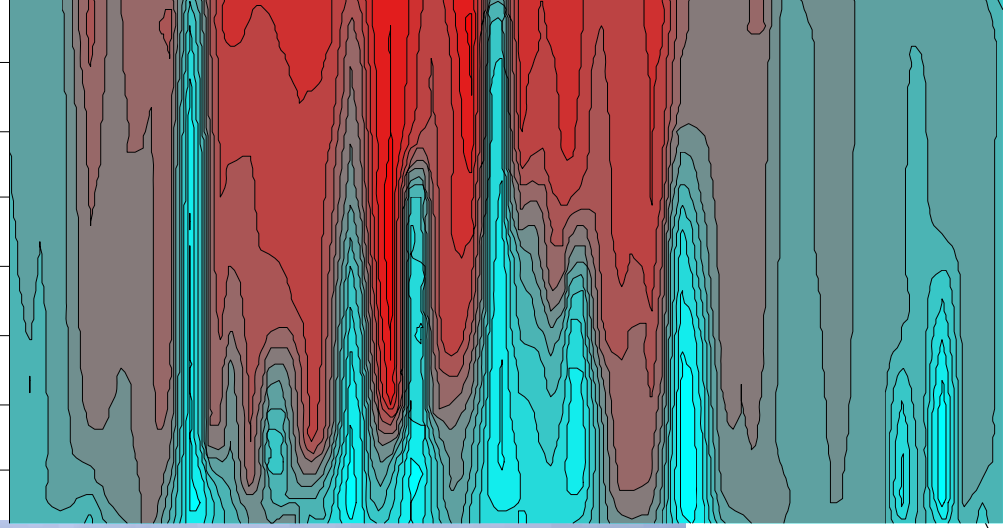
- **habitat**
- **oceanopgraphy**
- **population**

Sampling design

- **Oceanographic survey**

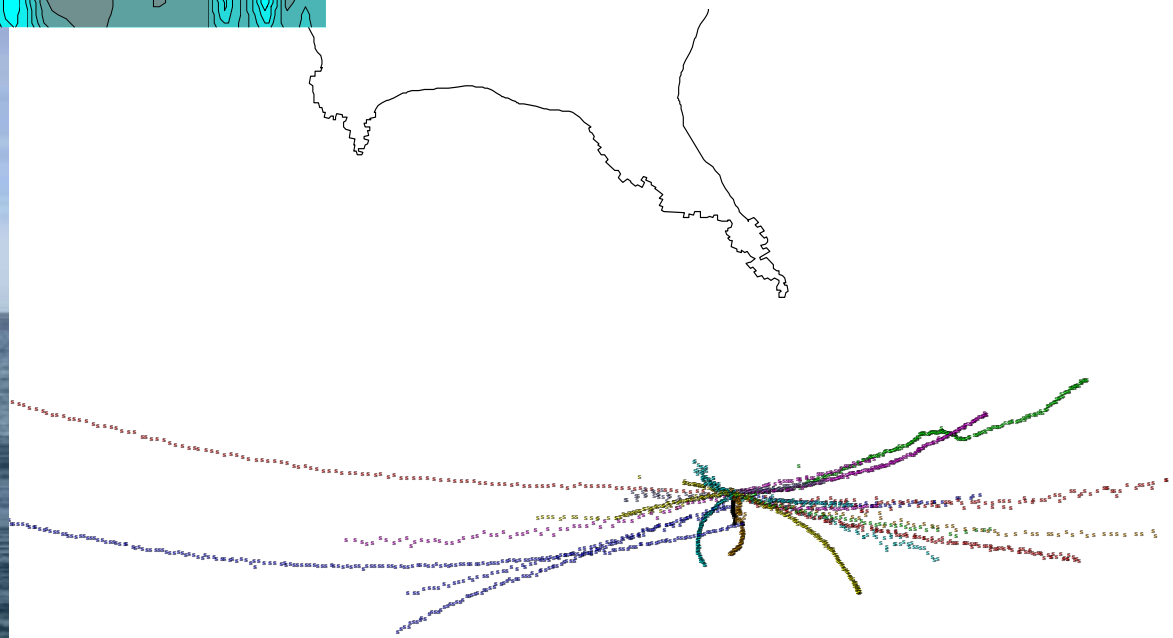
Oceanography

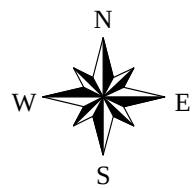




Oceanography

- Temperature
- Turbidity
- Current



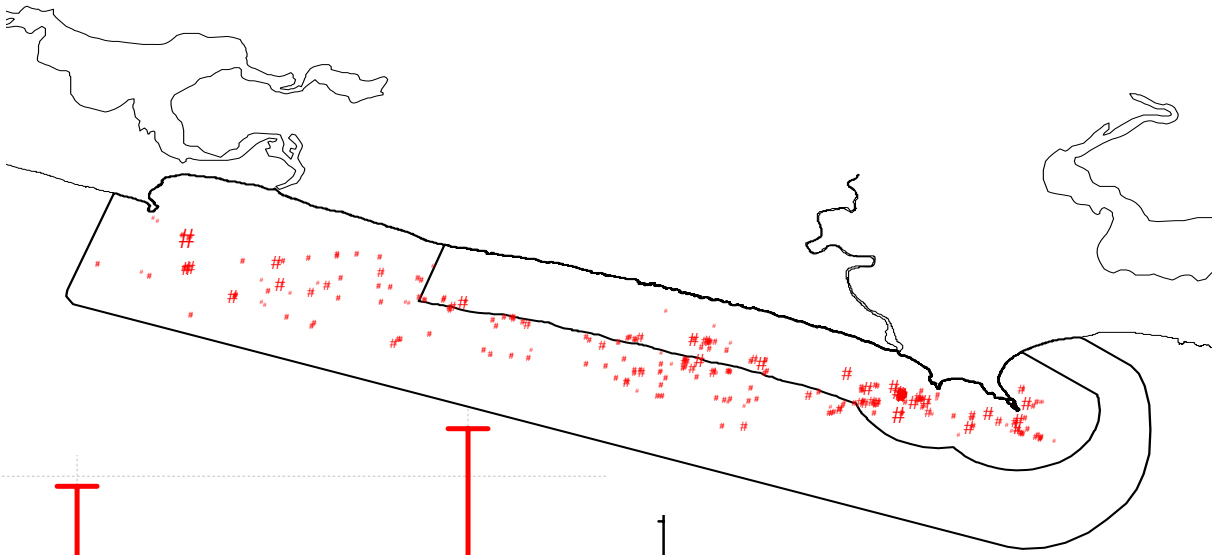


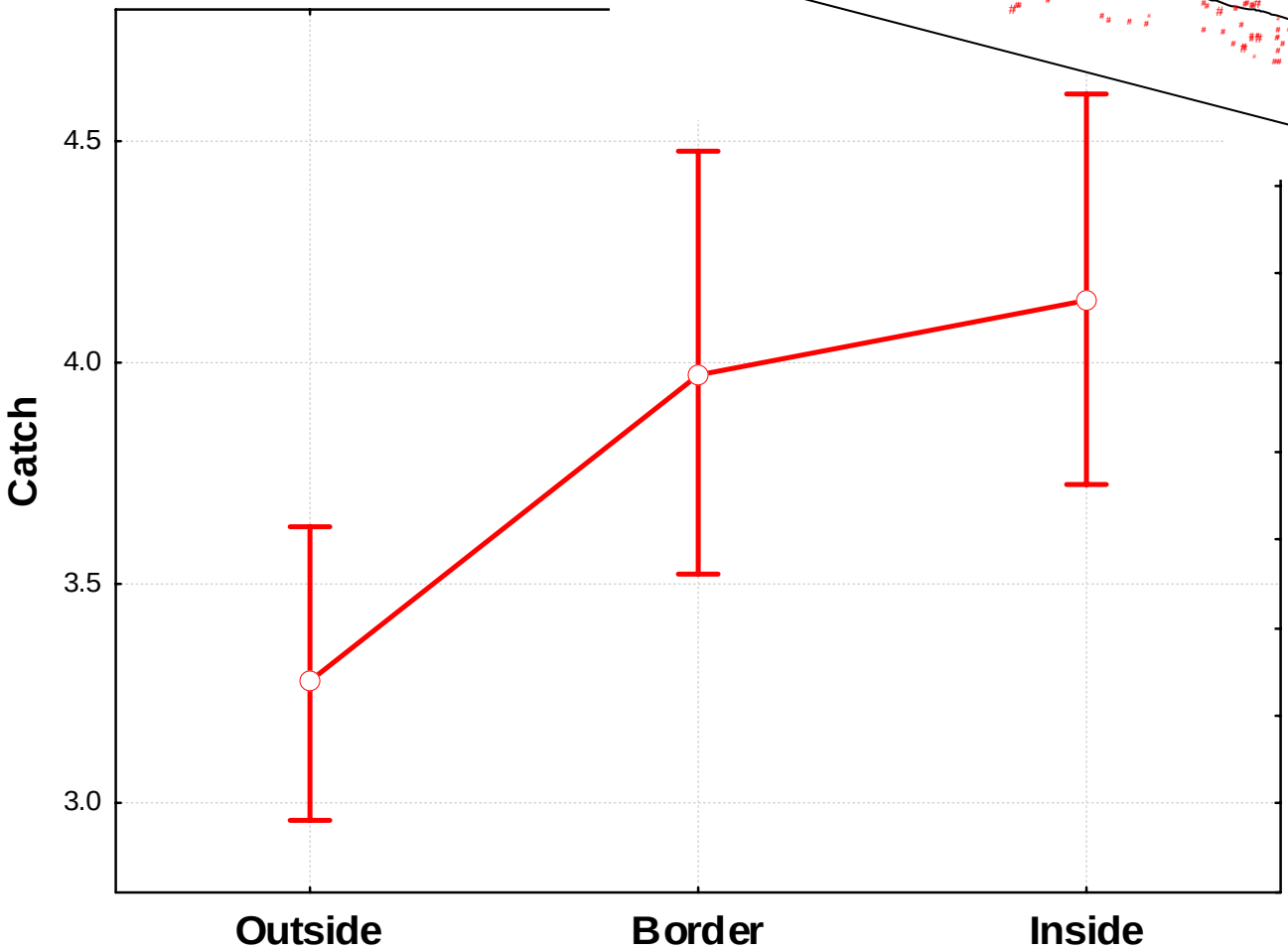
Sampling design

- Oceanographic survey
- Density
- Size

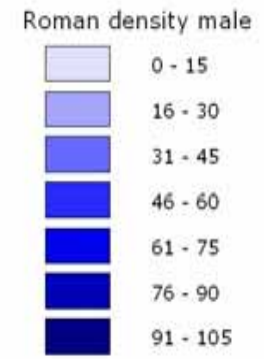
} Controlled angling and UVC

Roman – density

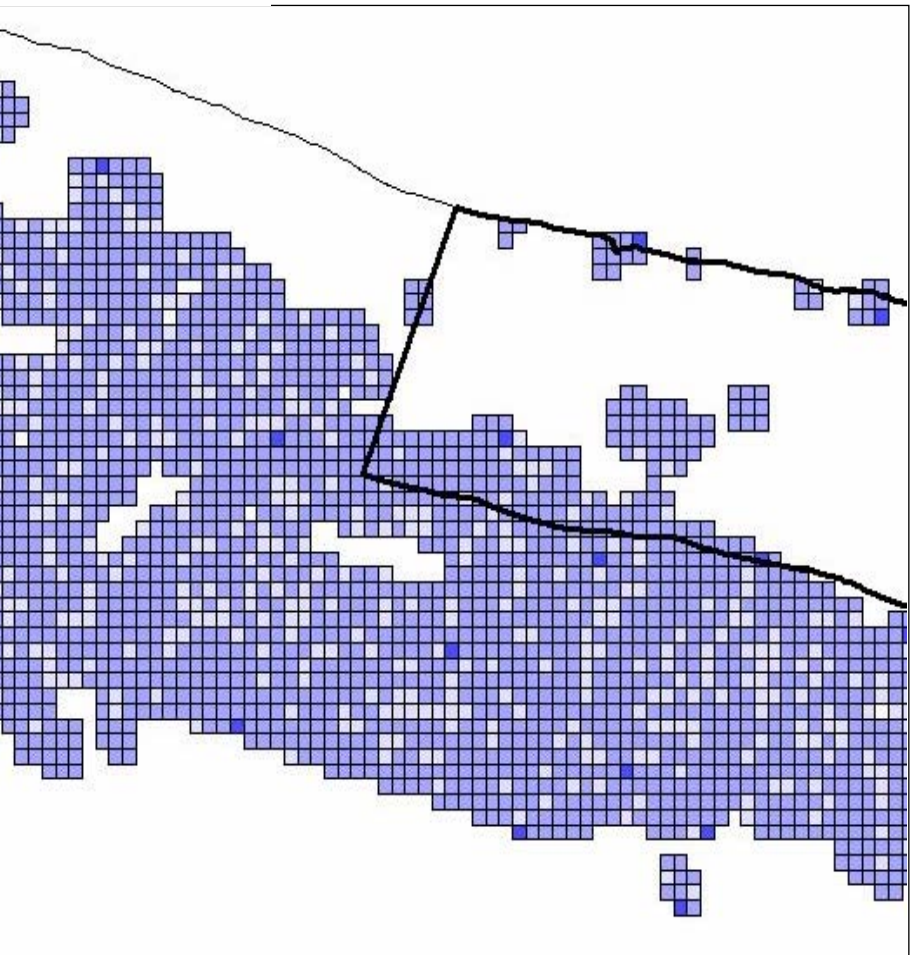


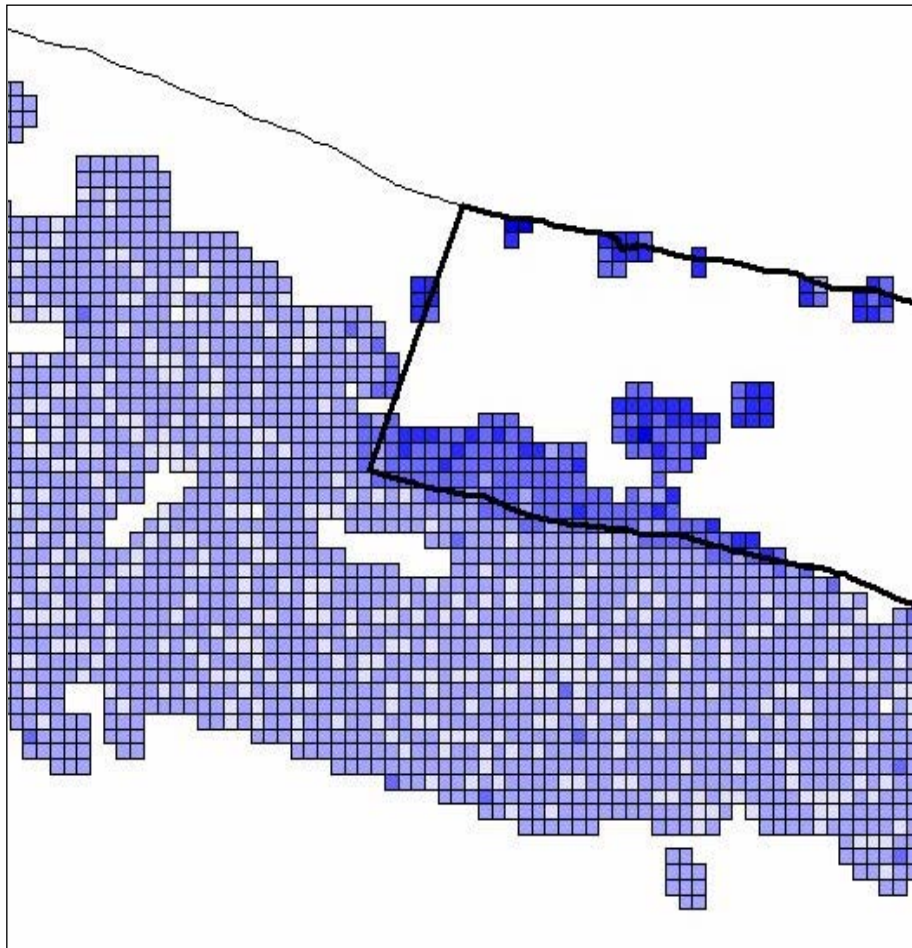


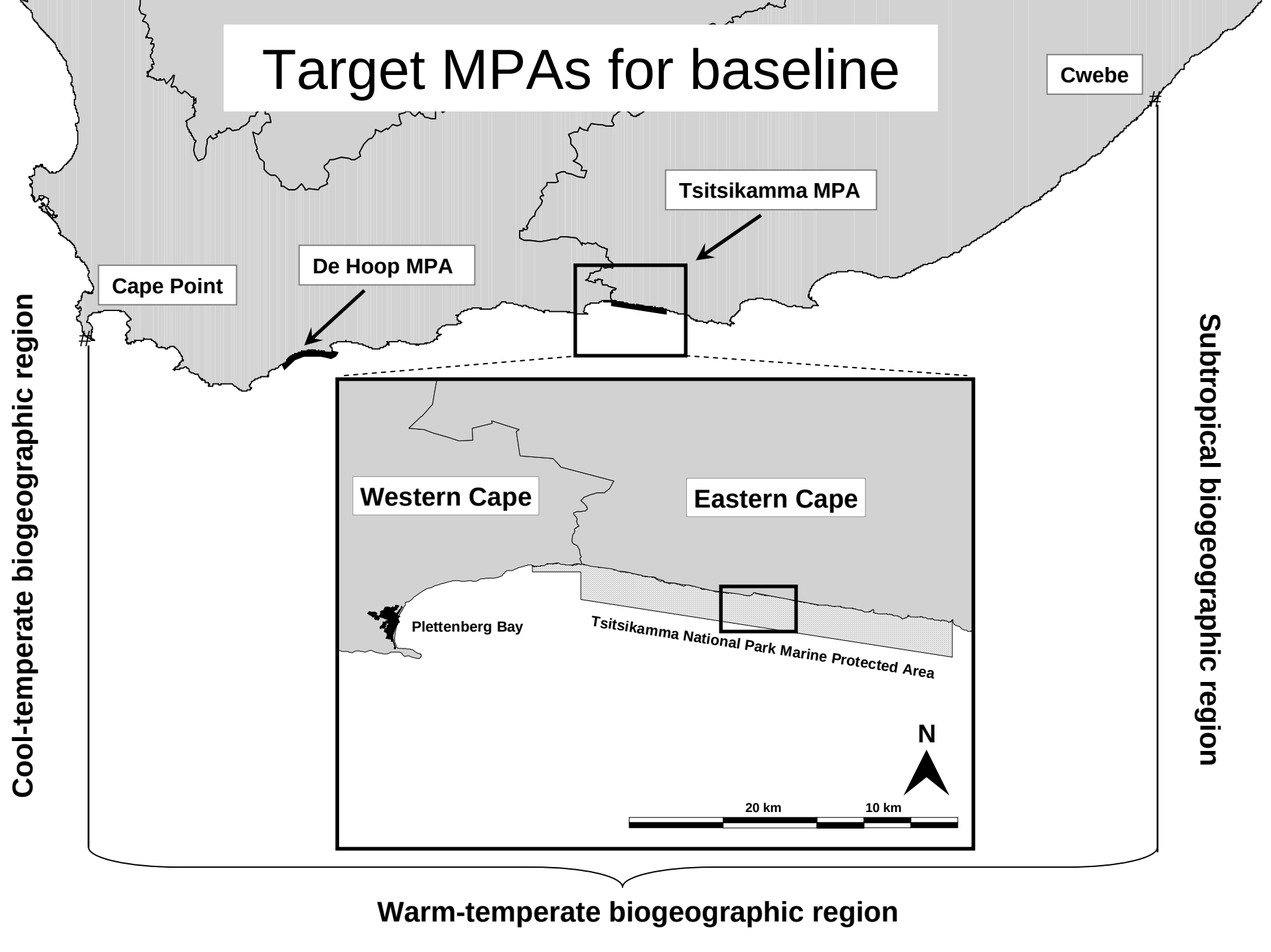
Simulation of Goukamma MPA using individual-based model (IBM)



18 Years after MPA implementation



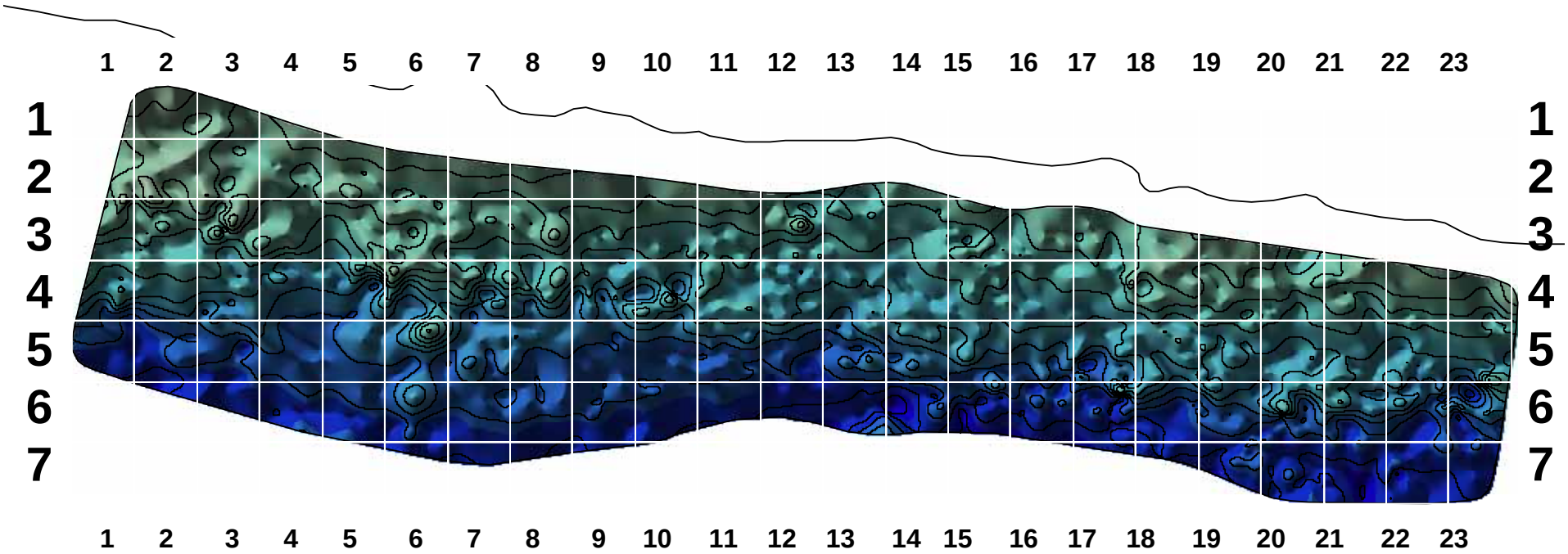



Target MPAs for baseline
Cwebe
Tsitsikamma MPA
De Hoop MPA
Cape Point
Western Cape
Eastern Cape
Plettenberg Bay
Tsitsikamma National Park Marine Protected Area
N
20 km
10 km
Cool-temperate biogeographic region
Subtropical biogeographic region
Warm-temperate biogeographic region

Sample area size: fixed site vs. spatial sampling

- **Low variability;**
- **Difficult to relocate (low visibility);**
- **Trampling effects (mortality, habitat destruction, behavior; Vos *et al.* 2000);**
- **Chance disturbances (pollution, sedimentation, wave action; Nowlis and Friedlander 2004);**
- **Lack of representativity (habitat complexity, benthos patchiness);**
- **Non-randomness (more biased&weaker statistical methods; Vos *et al.* 2000);**
- **Pseudo-replication (benthos and resident fish).**

Randomly stratified approach



Strata:
Depth & Profile
Time of day & Season

Grid cell size & number:
Accuracy of targeting
Power analysis

Selection & analysis:
Random number generator
Generalized Linear Models

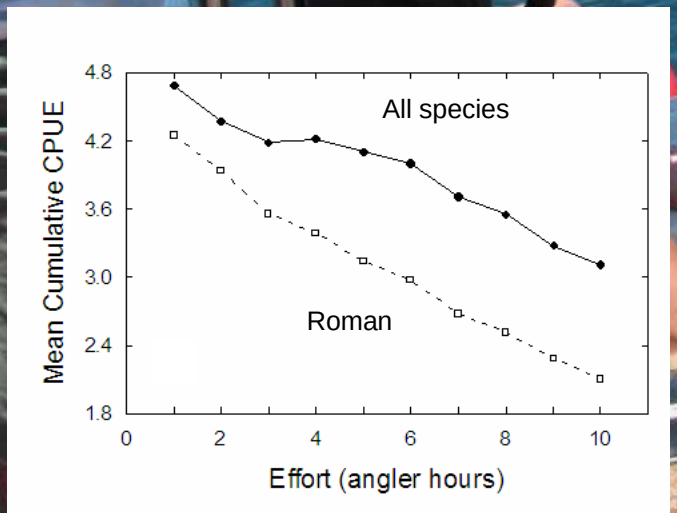
Test of suitability of methods

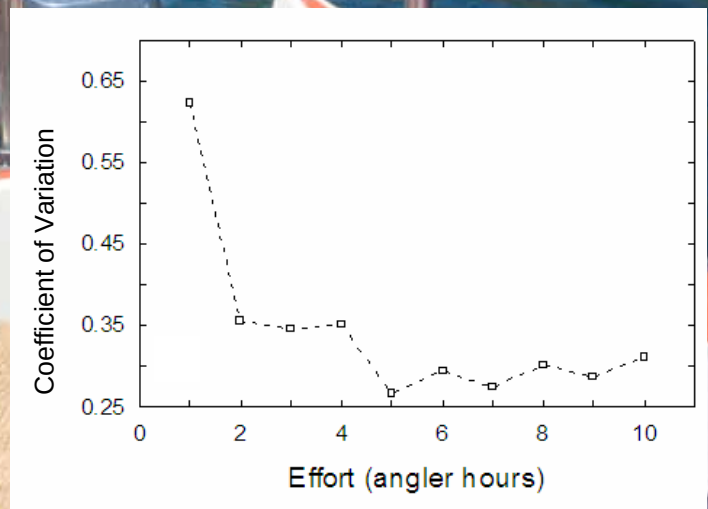
Fish community:

- **Controlled angling**
- **UW counts**

Controlled angling

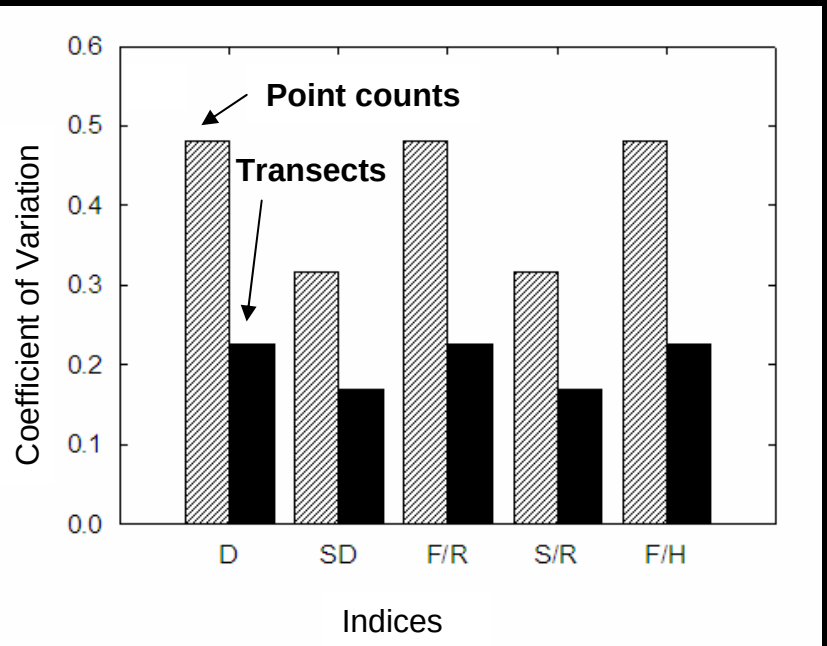
Two years of biannual (seasonal) fieldtrips
Fishing on same site for up to 10 hours





UW counts:

Two years of biannual fieldtrips
Survey of same site using transects and point counts

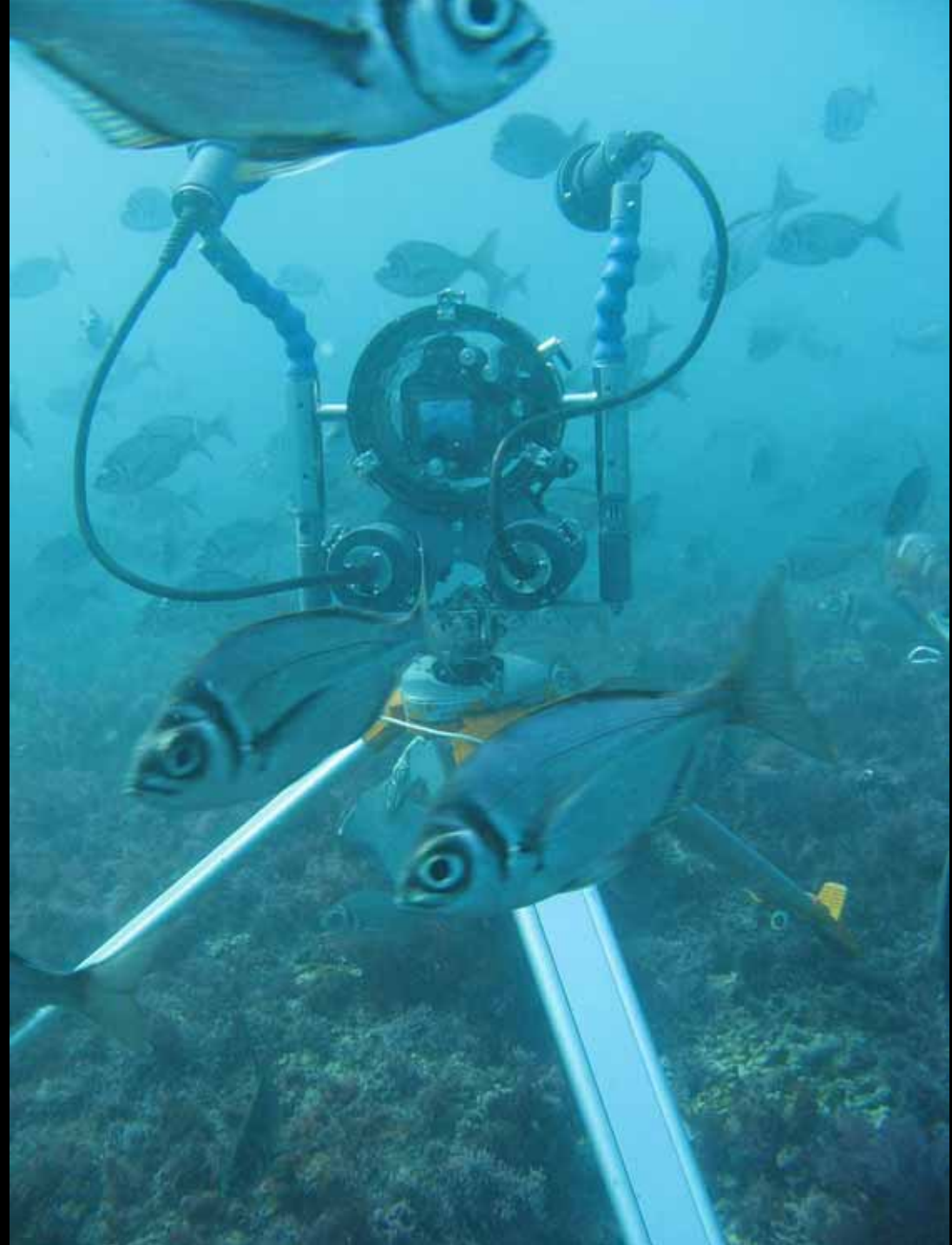


Test of additional methods

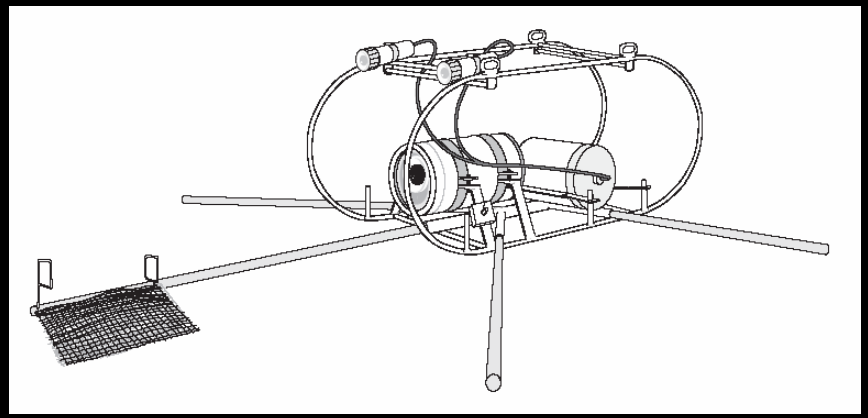
- **Observer bias**
- **Noise over bias approach (Vos *et al.* 2000)**

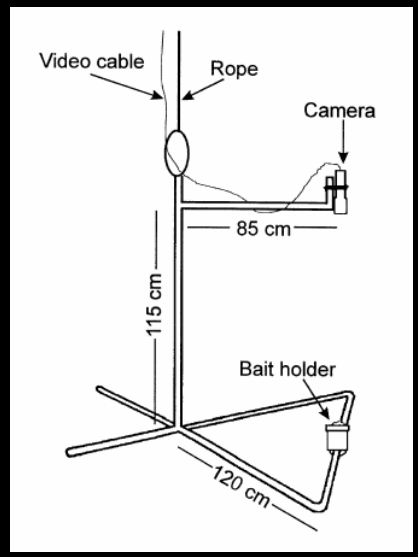
  => digital UW footage: observer bias free & noise reduced

Digital UW footage

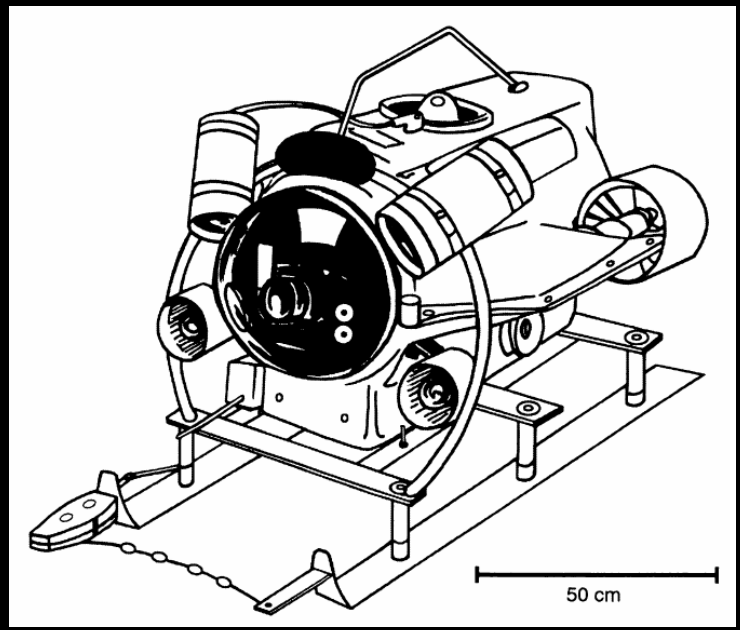


Baited Remote Underwater Video (BRUV)





Remotely Operated Vehicle (ROV)



Benthic invertebrates (intertidal and subtidal)

Public participation (test of observers)

Develop a long-term monitoring strategy for South African near-shore reef biota

⇒**Standardized protocols with tested & cost-effective methods**

⇒**Baseline sites in all biogeographic zones**

⇒**Network of sites for resource monitoring in exploited areas**

Thanks!