Dispersal and spatial dynamics in marine populations: predicting MPA effectiveness through examination of local-scale recruitment patterns.

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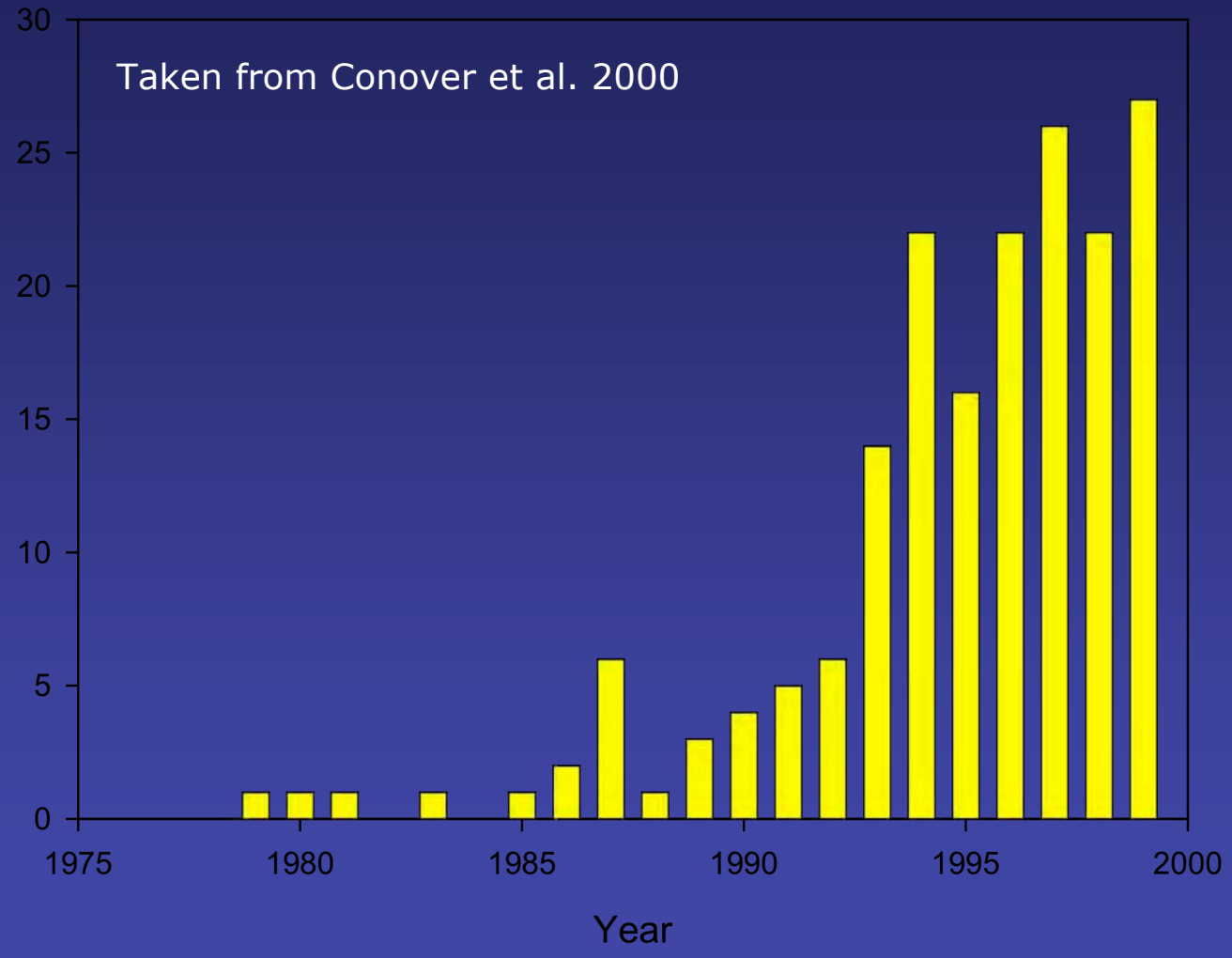
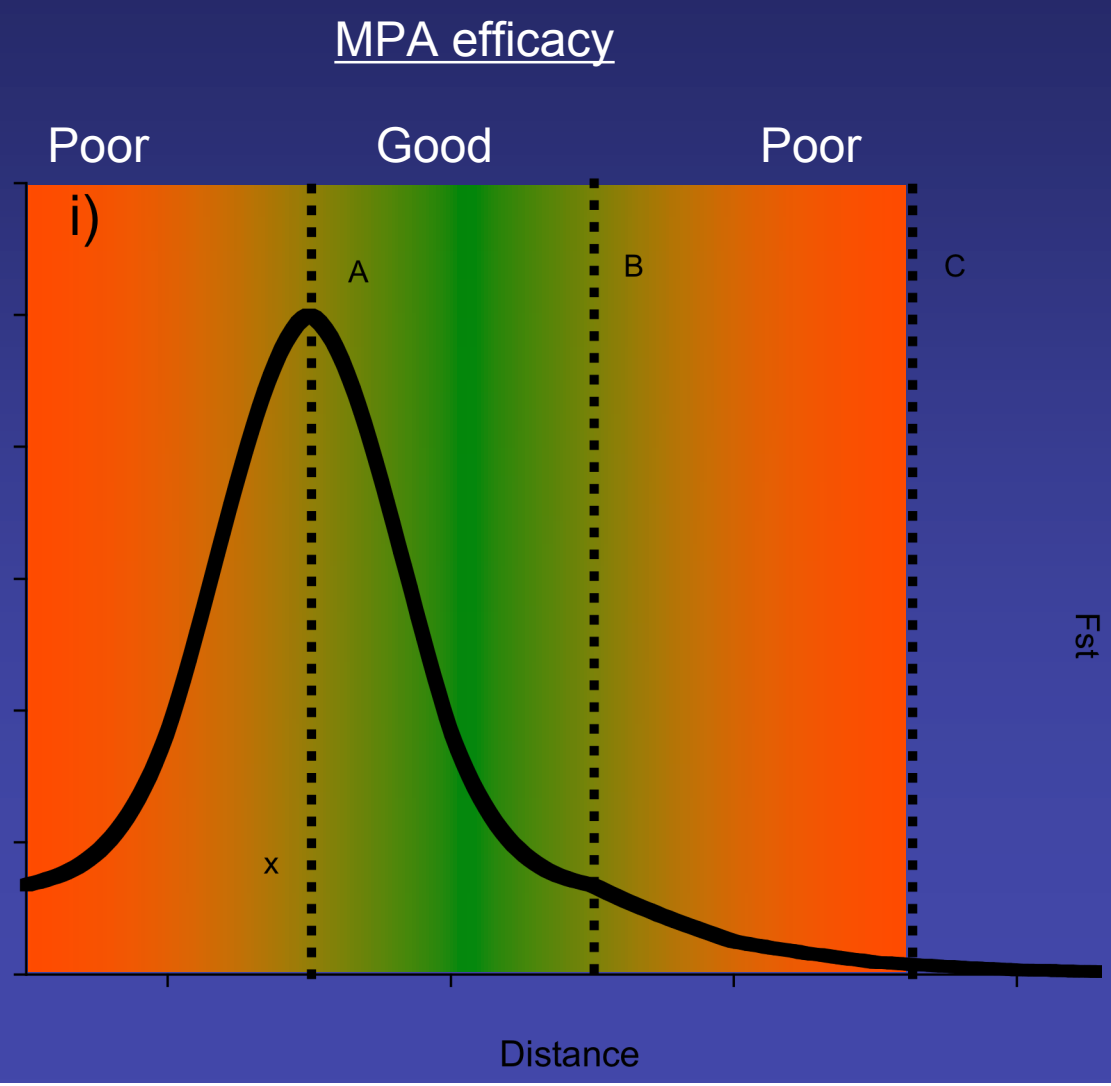
MPA Publications on Marine Reserves 1973-1999

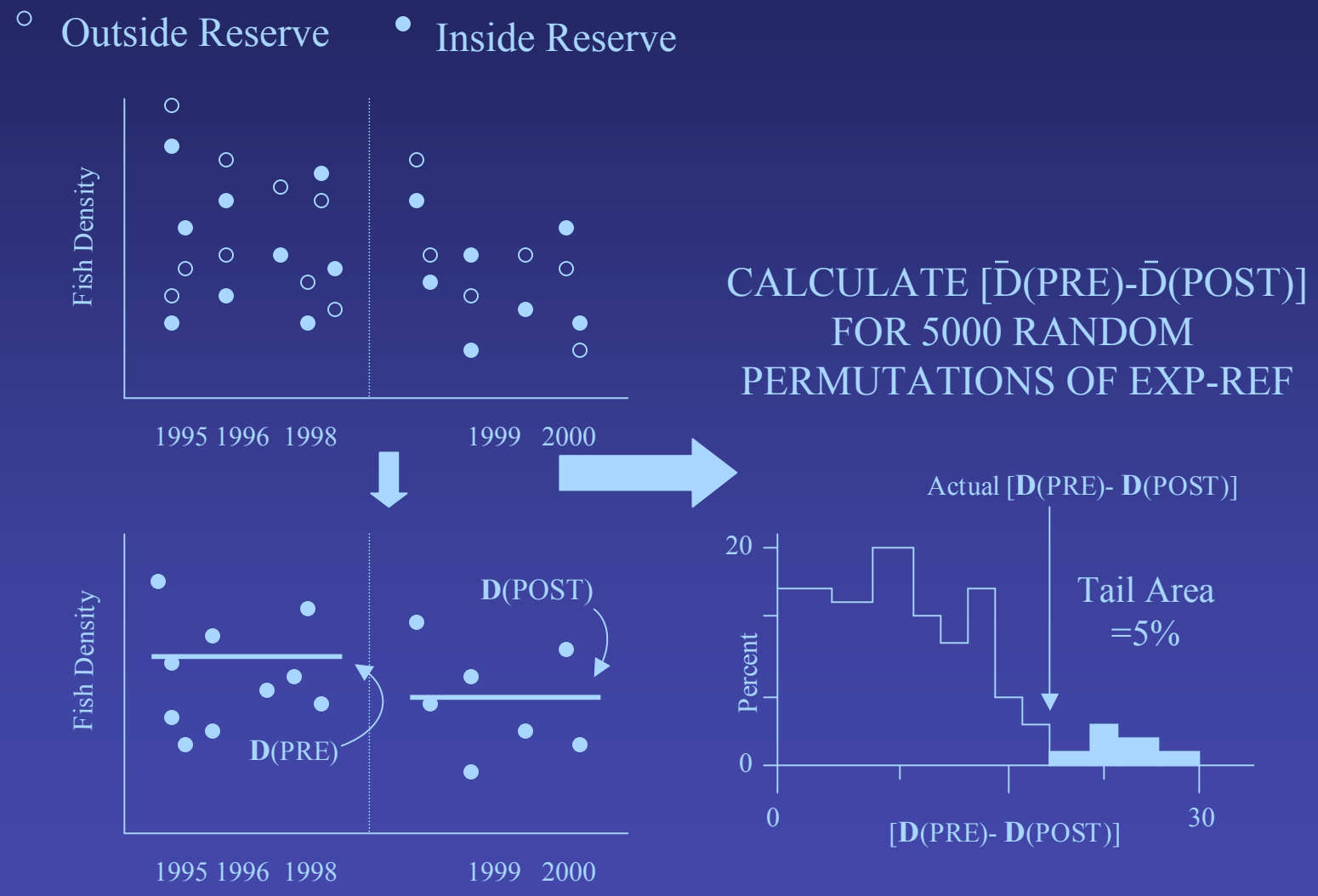


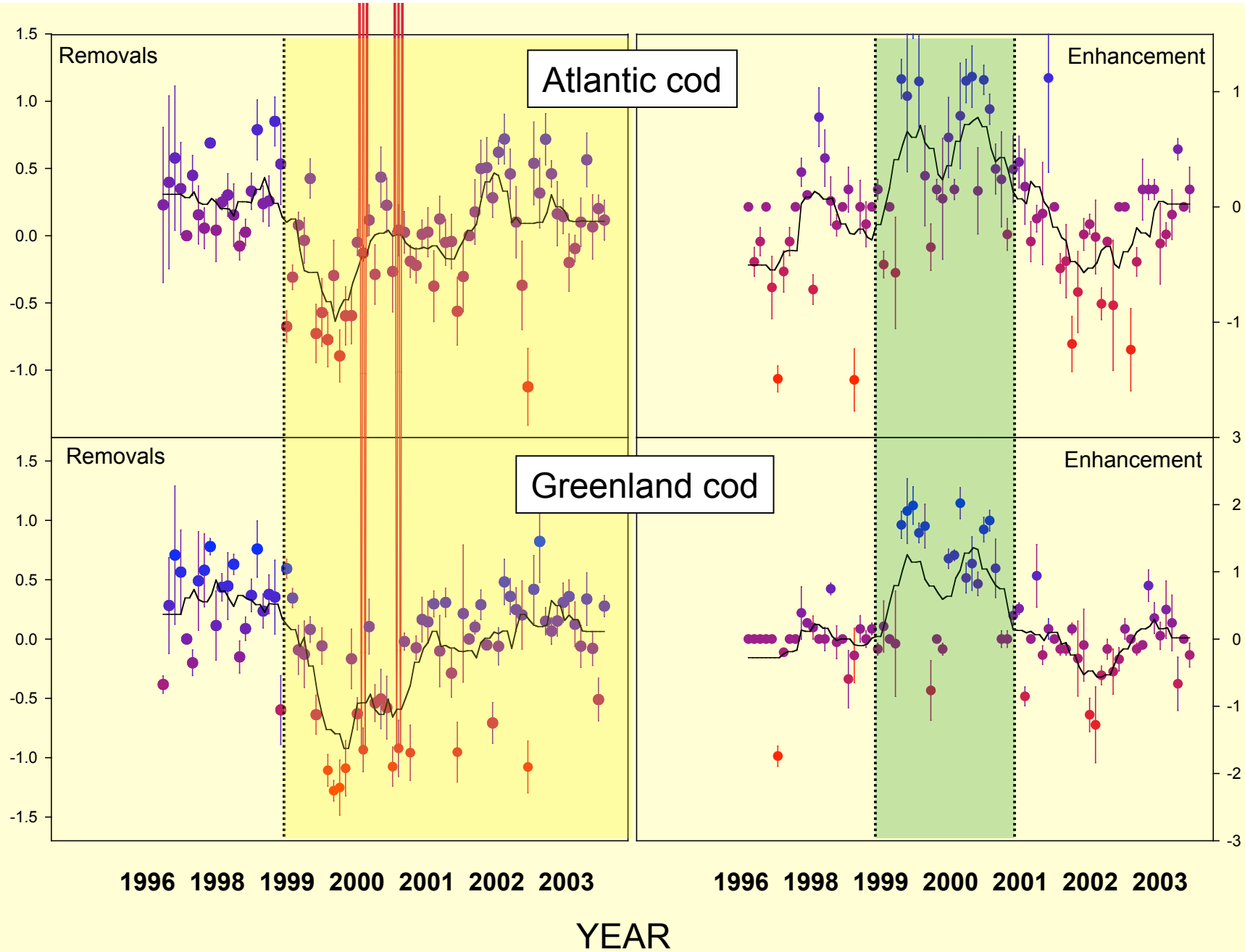
MPA Design- The dispersal range of organisms ultimately determines efficacy



But how do we quantify efficacy?

Evaluating MPAs using BACI methods: Randomized Intervention Analysis (RIA; Carpenter et al 1989)

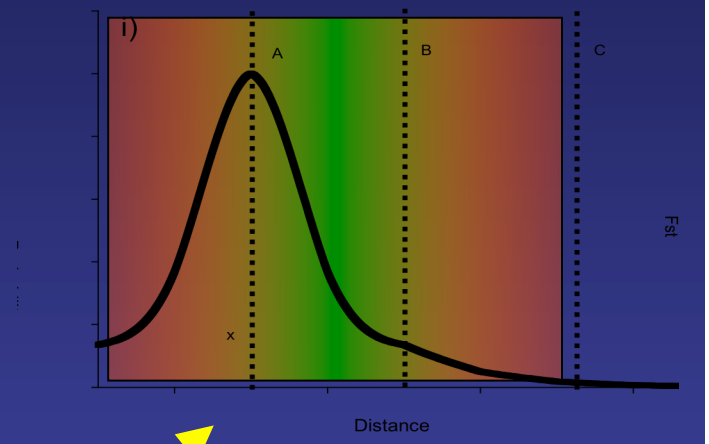




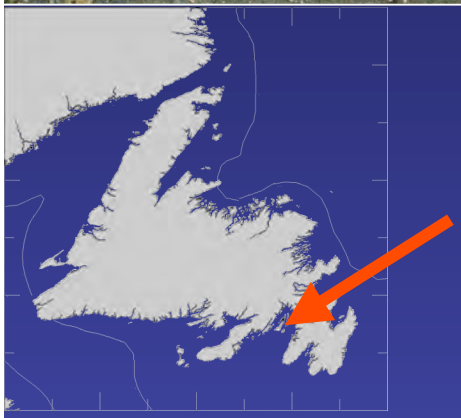
(Laurel et al. 2003b).

Baseline data for BACI analysis often absent

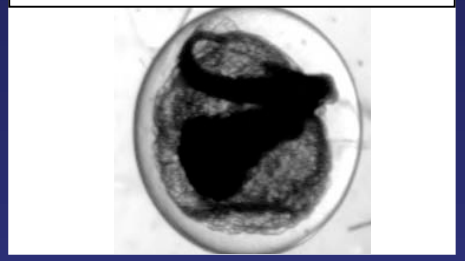
- Need tools measure MPA efficacy *post hoc*
- Measuring dispersal will indicate what proportion of the population is protected by the reserve boundaries and consequently an indication of effectiveness
- How is this done?

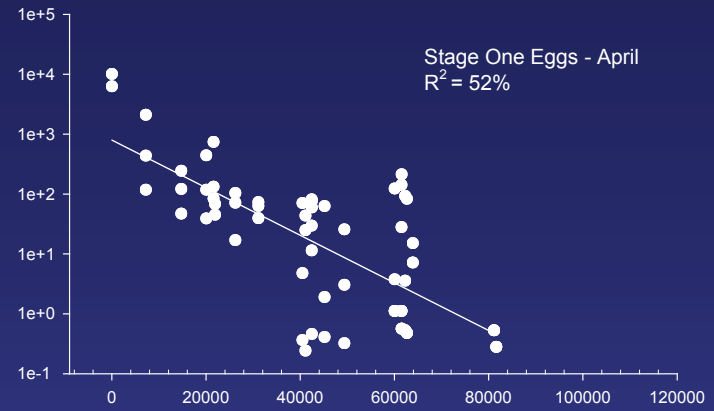


Direct measures of dispersal

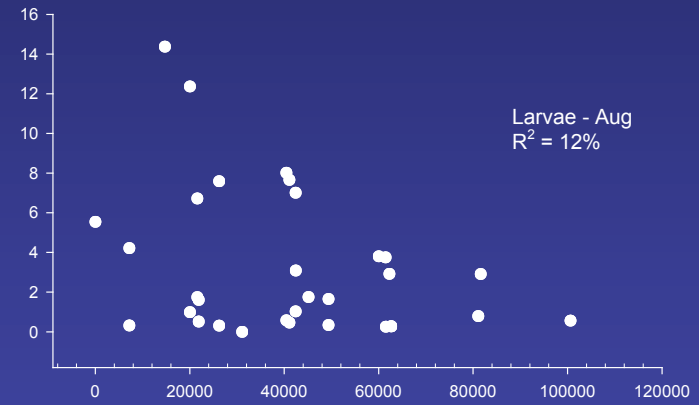


Eggs

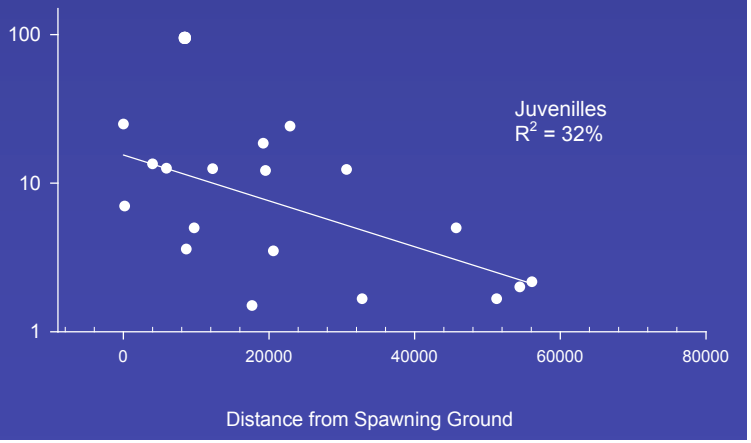




Larvae

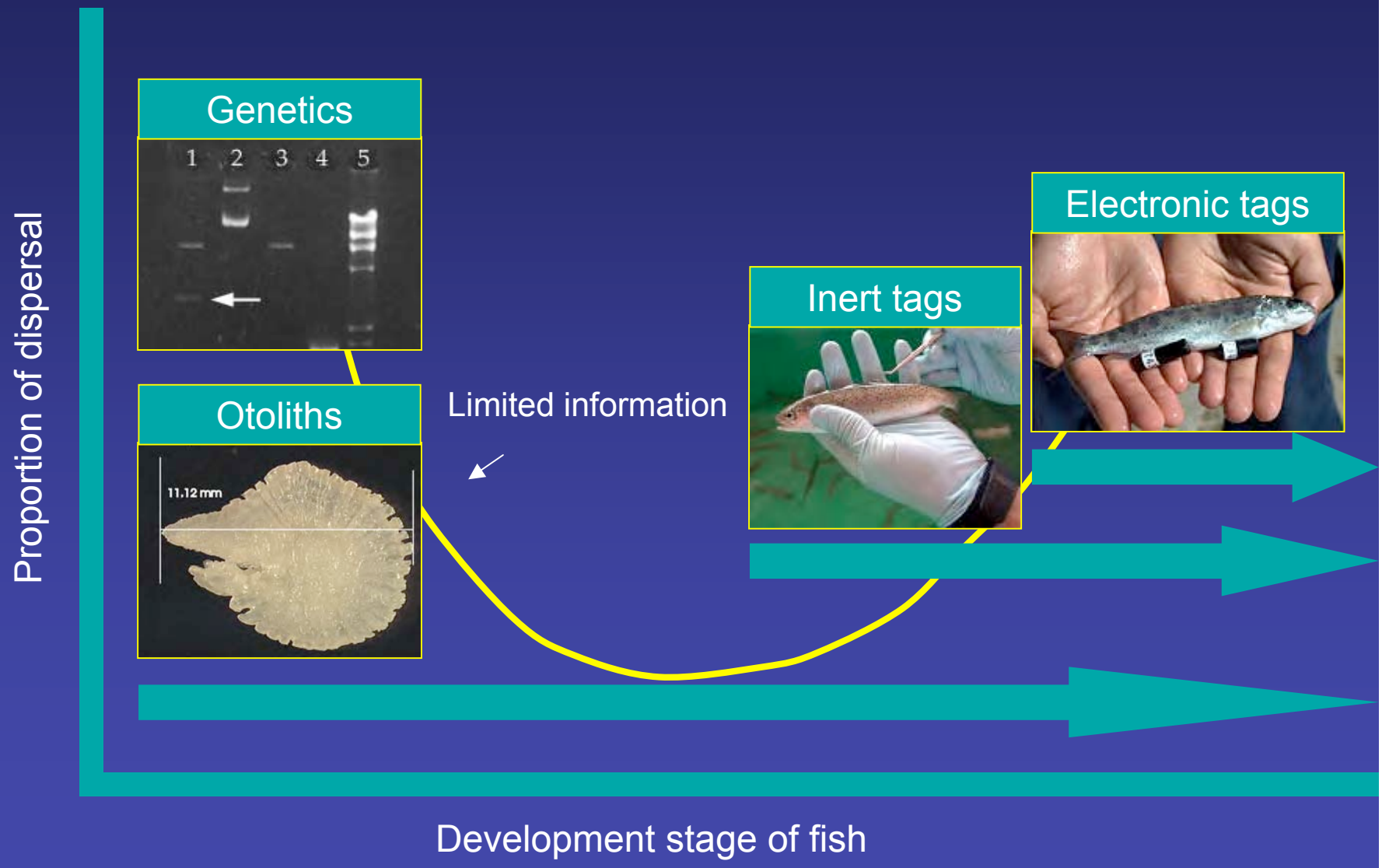


Juveniles



Rare example where direct measures of abundance provide an indication of dispersal

Measuring dispersal in the marine environment using tags



Measuring dispersal to determine MPA efficacy

- Dispersal can be measured directly and indirectly
- Direct measures (e.g., trace elements, chemical tags and measuring abundance) are ideal but information is rare and limited
- Genetic methods albeit less ideal is more readily available and can be combined with modelling studies to estimate dispersal

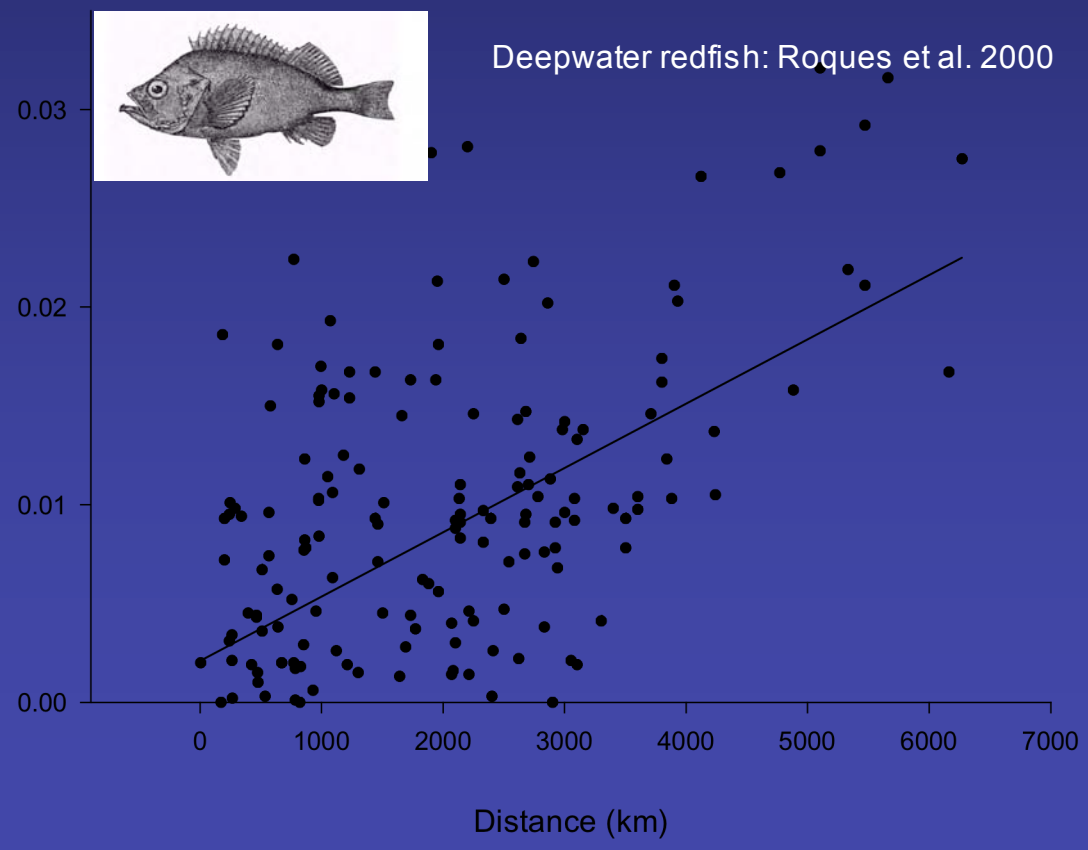
Using genetics to measure dispersal

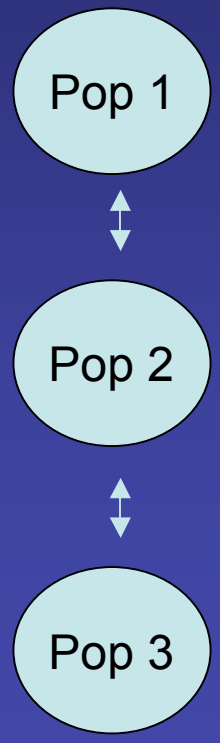
$$F_{st} = \frac{Var(p)}{\bar{p}(1-\bar{p})}$$

where *Var(p)* is the variance among populations in the allele frequency *p* of some allele

F_{st} is a standardized measure by which to examine gene flow among populations

Isolation by Distance (IBD) relationships provide indirect measures of dispersal



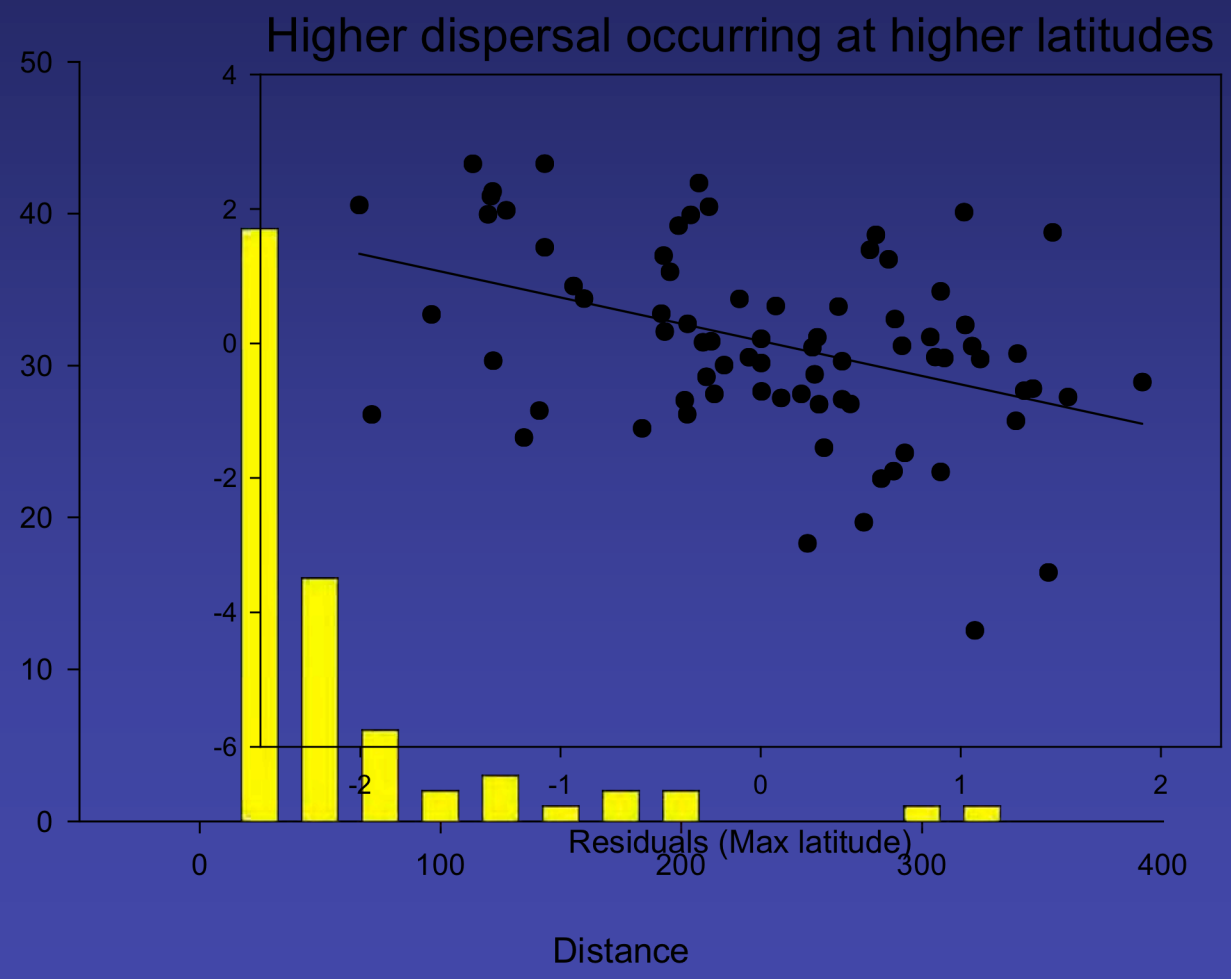


Genetic database

Species	Common Name	Source	Marker	# subpops	Pairwise Fst comparisons $(N^2 - N)/2$
Gadus macrocephalus	Pacific cod	Grant et al 1987	Allozyme	11	55
Sebastes borealis	Alaskan shortraker rockfish	Matala et al 2004	Microsatellites	8	23
Lethrinus miniatus	Red throat emperor	Herwerden et al 2003	Microsatellites	6	15

= 97 total marine fish species

Dispersal distance estimated for 97 IBD relationships for marine fish collected from the literature



Conclusions

- *Post hoc* analyses of MPA efficacy are needed. Dispersal potentials of various marine organisms serve as ‘performance indicators’
- Dispersal can be estimated with incomplete data using available genetic-geographic relationships (IBD)
- MPA efficacy can be measured as the relative proportion of recruits of the total population settling within reserve boundaries or within the network of reserves.

Acknowledgements

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