Precious *CORALLIUM* species

Widely distributed in tropical, subtropical and temperate oceans

ATLANTIC AND PACIFIC

C. secundum
C. elatius
C. konjoi
C. japonicum
C. lauuense
C. kishinouyei
C. ducale
C. regale
C. ...

COMMERCIALY HARVESTED

MEDITERRANEAN

C. rubrum

POPULATION GENETICS OF *CORALLIUM* SPECIES

C. lauuense
C. secundum
C. konojoi

8 - 11 sites in the Pacific
385-535 meter depth 6 Micro

Baco et al (Mol Ecol Notes, 2006)
Baco (Deep-Sea Biology Symposium, 2006)
Uda et al (J Exp Mar Biol Ecol, 2013)

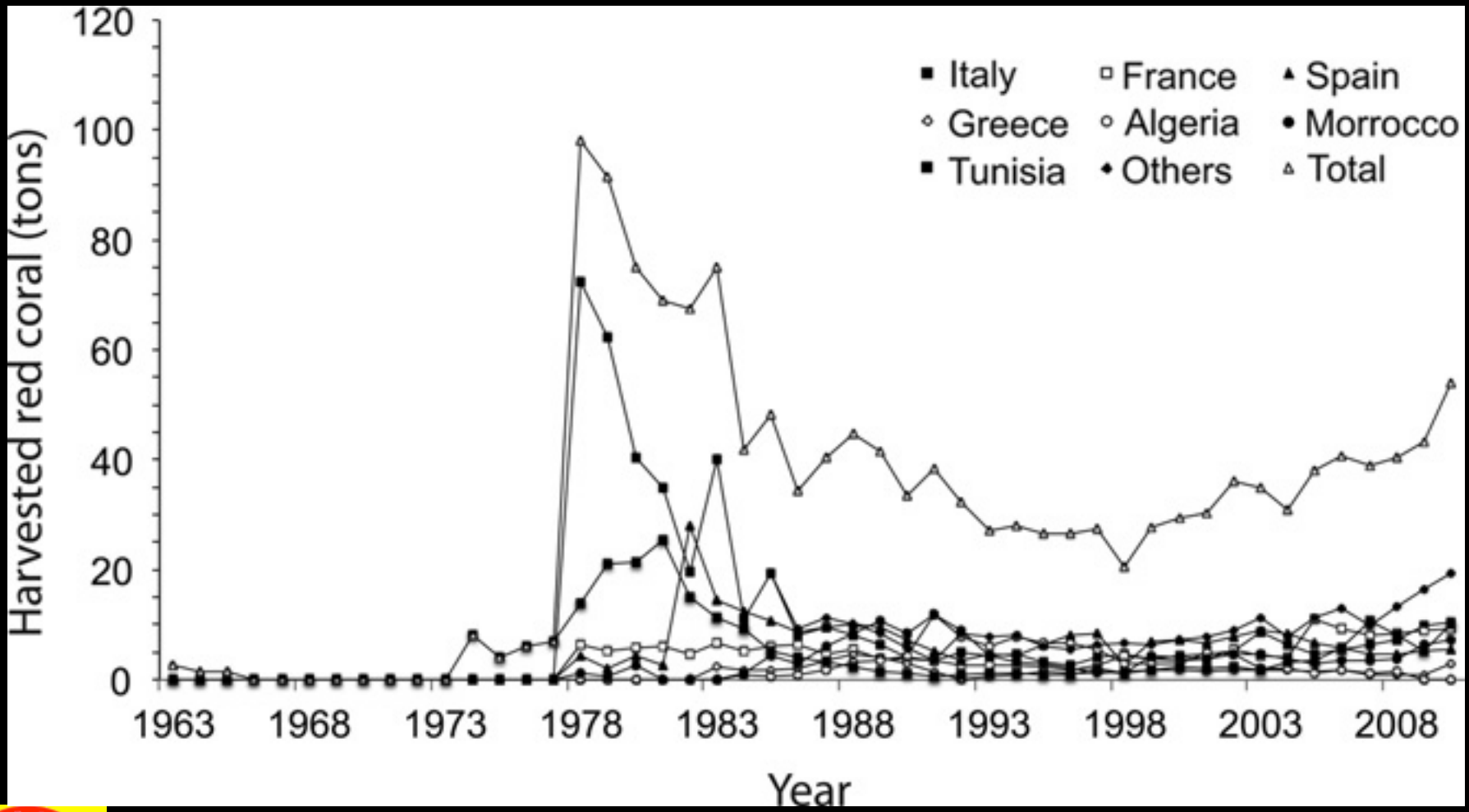
30 sites in the Med
10-819 meter depth
Micro/ITS/MSH/CR

C. rubrum

Abbiati et al (Mar Ecol Prog Ser, 1993)
Aurelle Ledoux (Cons Gen, 2013)
Costantini et al. (Mol Ecol, 2007)
Costantini et al. (Mar Ecol Prog Ser, *2007)*
Costantini et al. (Coral Reefs, 2011)
Costantini et al. (PlosOne, 2013)
Ledoux et al. (Mol Ecol, 2010)

CORALLIUM RUBRUM HARVESTING

FISHING TRENDS IN THE MED SEA



Tsounis et al, Mar Pol, 2013

CORALLIUM RUBRUM HARVESTING

There is still people that uses the term 'sustainable' referring to red coral harvesting

HOWEVER

a biological resource characterised by

- **slow growth rate (commercial size reached in about 40 y)**
- **low recruitment (no recruitment has been detected in deep commercial banks)**
- **patchy distribution in deep waters**

<u>can not be harvested sustainably</u>

Boom and bust harvesting has been the role in the past and led to the collapse of the resource in shallow waters

Santangelo & Abbiati Aq Cons 2001

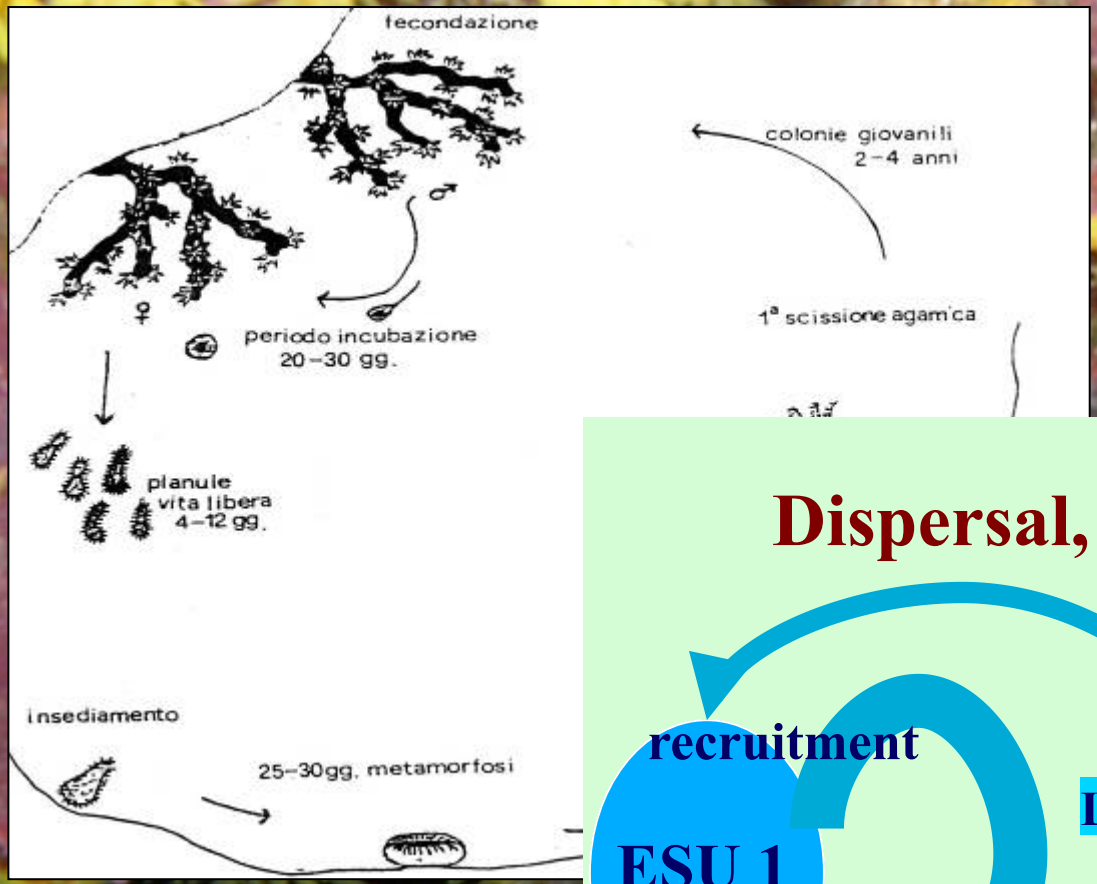
Connectivity and management of *Corallium rubrum* commercial banks

ABBIATI MARCO, COSTANTINI FEDERICA, RUGIU LUCA, CARLESI LORENZO

Research Centre for the Environmental Sciences

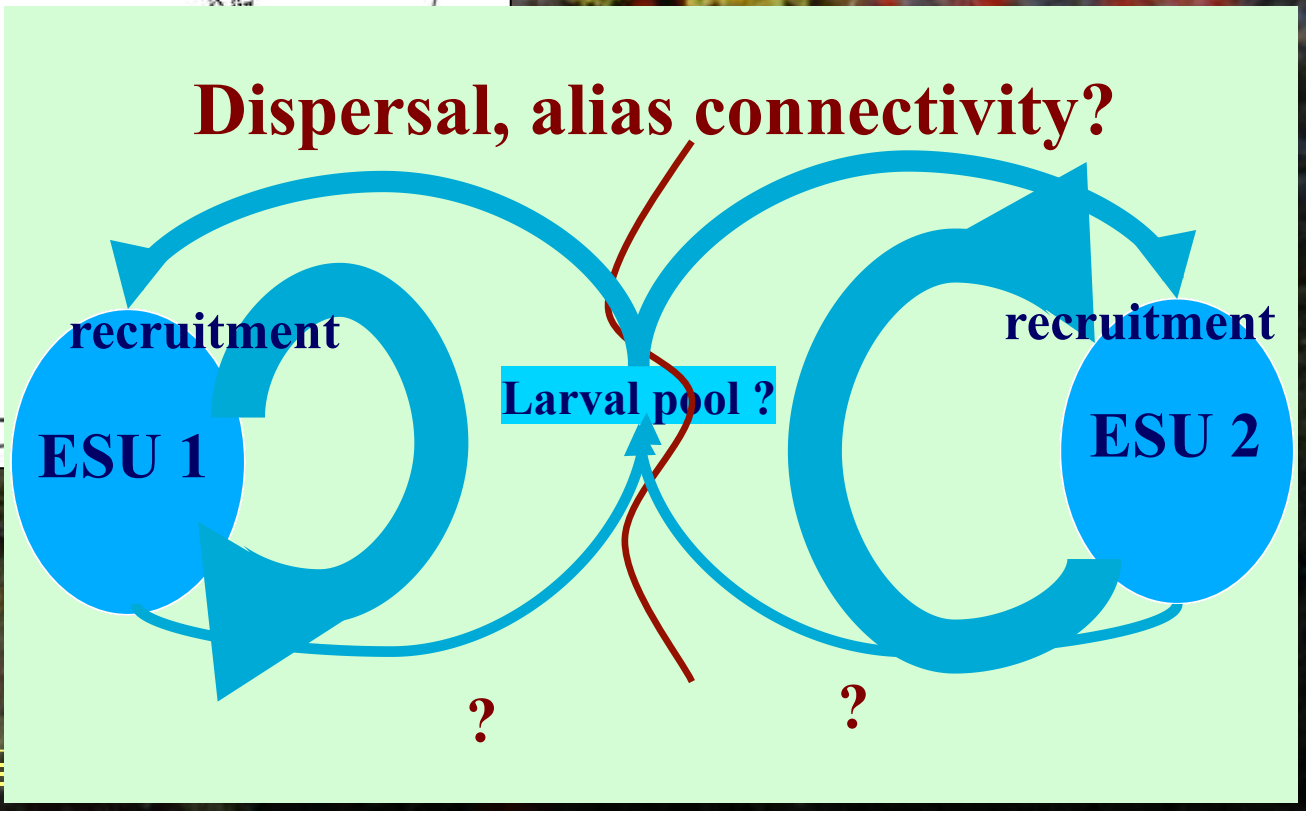
University of Bologna – Ravenna Campus

LIFE HISTORY OF *C. RUBRUM* - SETTLEMENT PROCESS



LIFE CYCLE

EFFECTIVE DISPERSAL



CORALLIUM RUBRUM - GENETIC VARIABILITY AT MEDITERRANEAN SCALE

Micro +

ITS1 sequences

20-50 ind./ sample

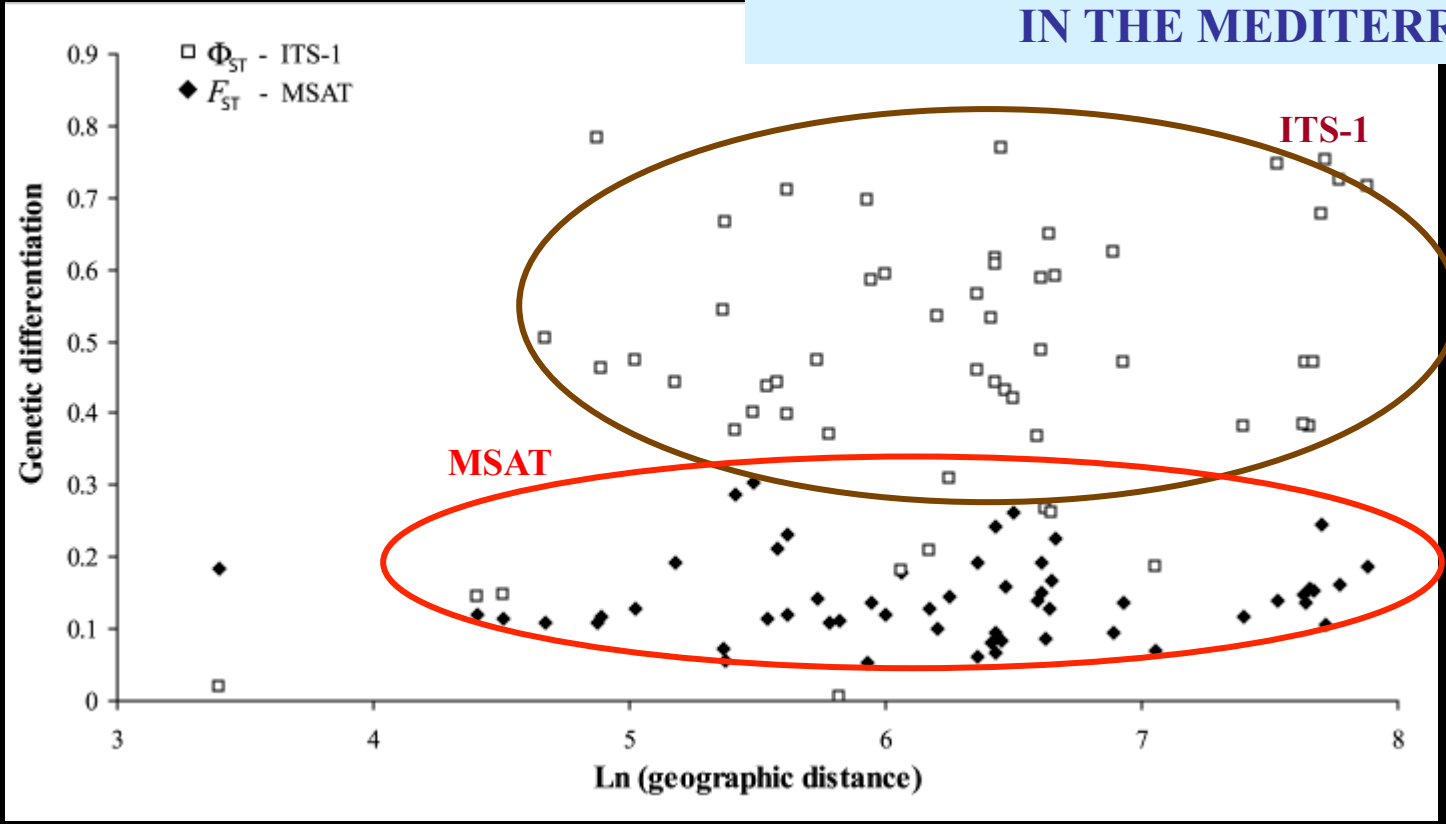
15–50m depth

Costantini et al Mol Ecol, 2007; see also Ledoux et al Mol Ecol, 2010

PATTERNS OF GENETIC STRUCTURING

F_{ST} significantly different from zero

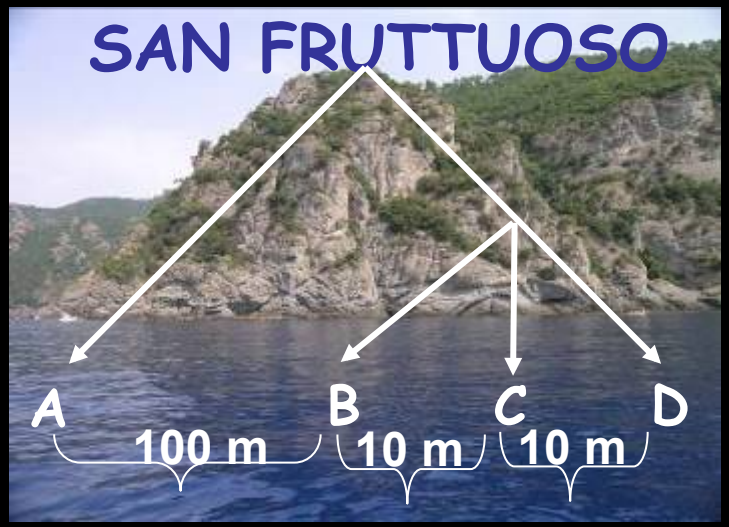
***CORALLIUM RUBRUM* IS HIGHLY STRUCTURED IN THE MEDITERRANEAN**

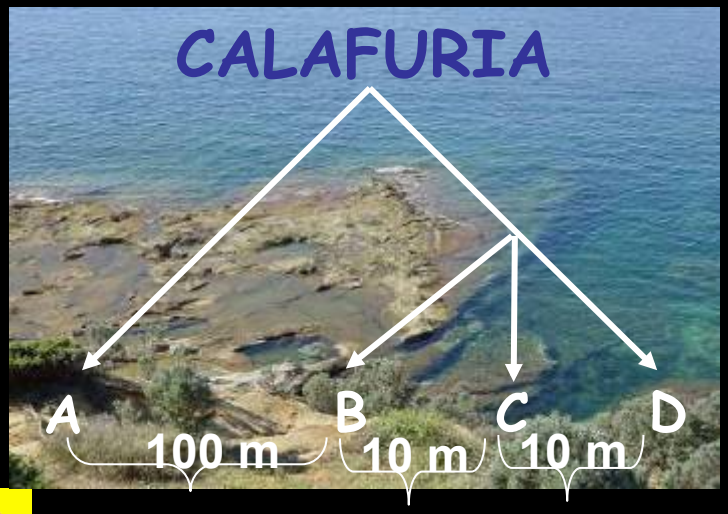


P(IBD) = NS

NO RELATIONSHIP BETWEEN GENETIC STRUCTURING AND GEOGRAPHIC DISTANCE

FINE-SCALE GENETIC STRUCTURING

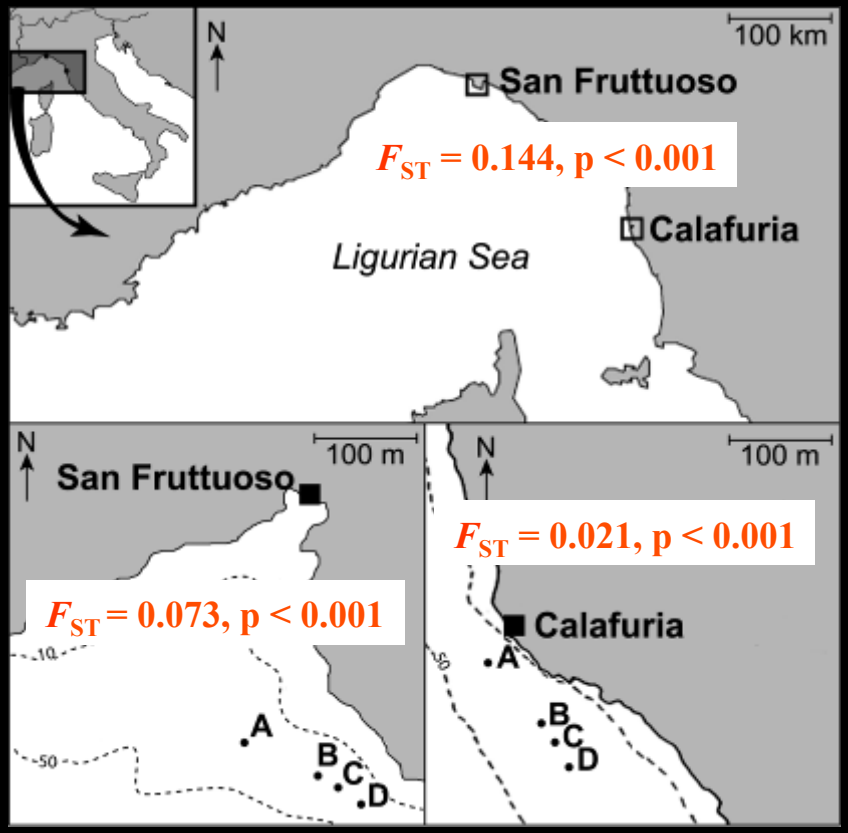




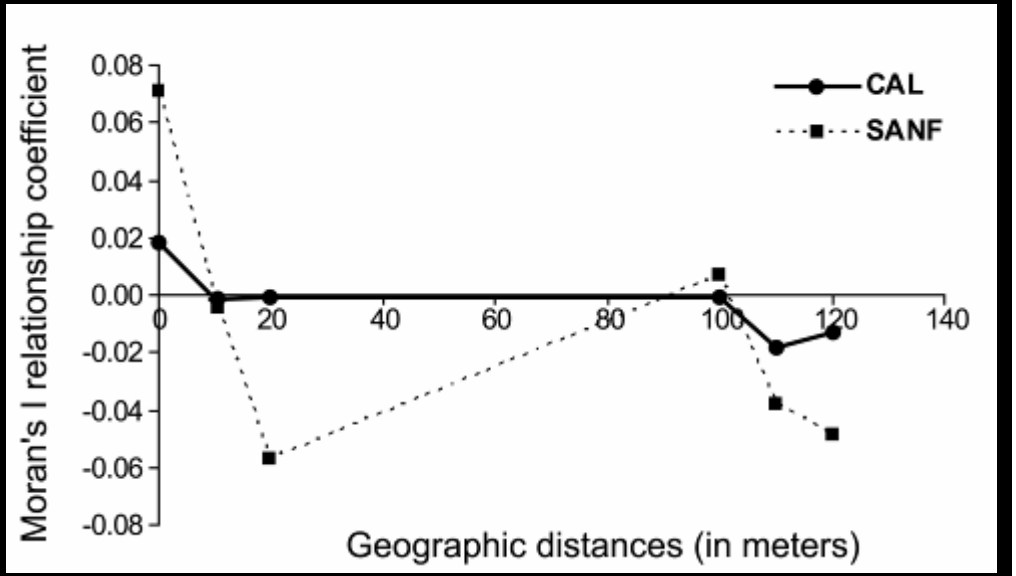
Microsatellites
50 individuals per site

Costantini et al, 2007, *MEPS*

FINE-SCALE GENETIC STRUCTURING

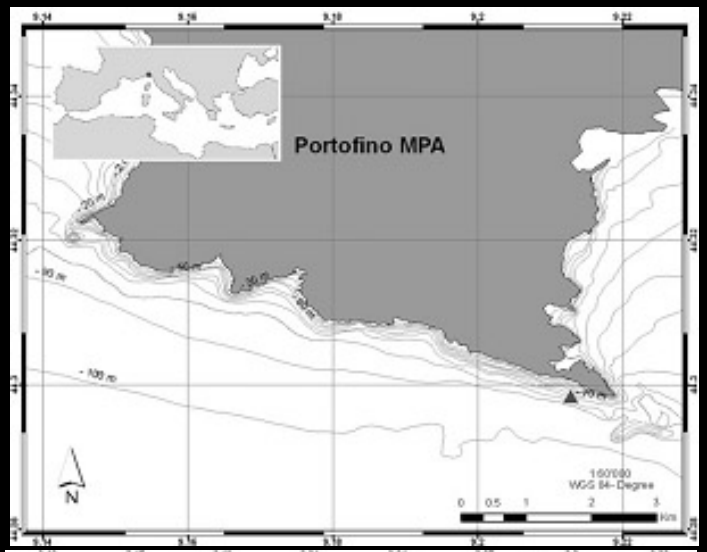


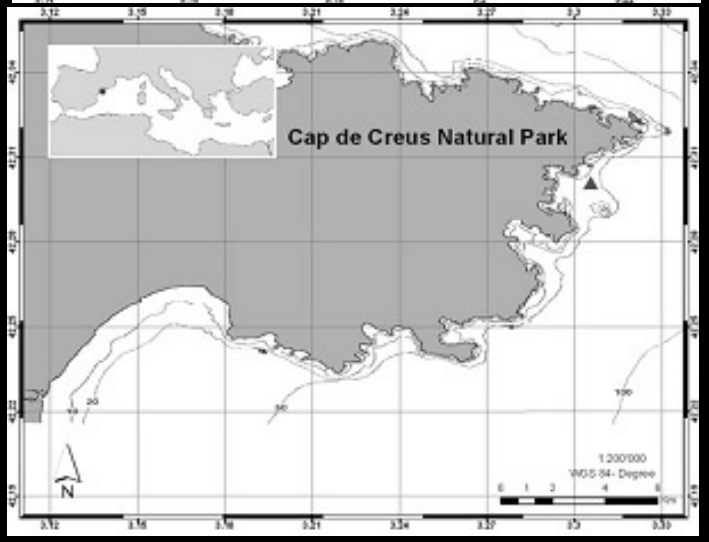
Significant genetic differentiation between samples



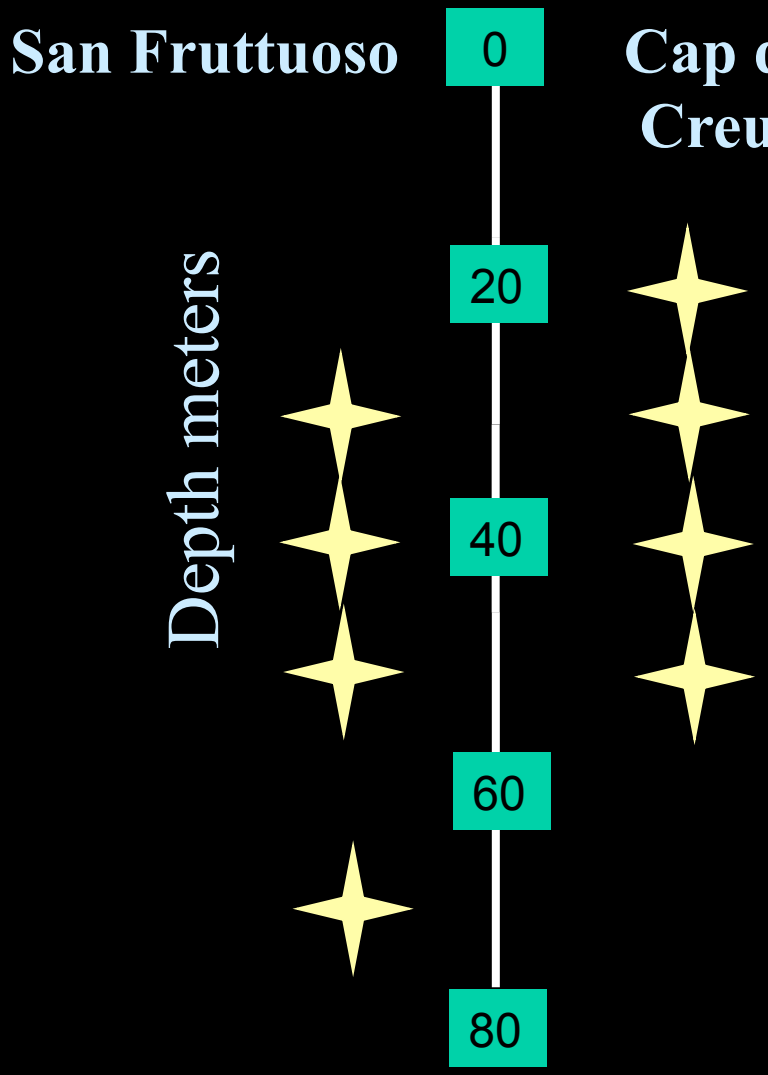
Genetic patch size 10 meters

STRUCTURING ALONG A DEPTH GRADIENT





REPLICATED LOCATIONS



Costantini et al, Coral Reefs, 2011

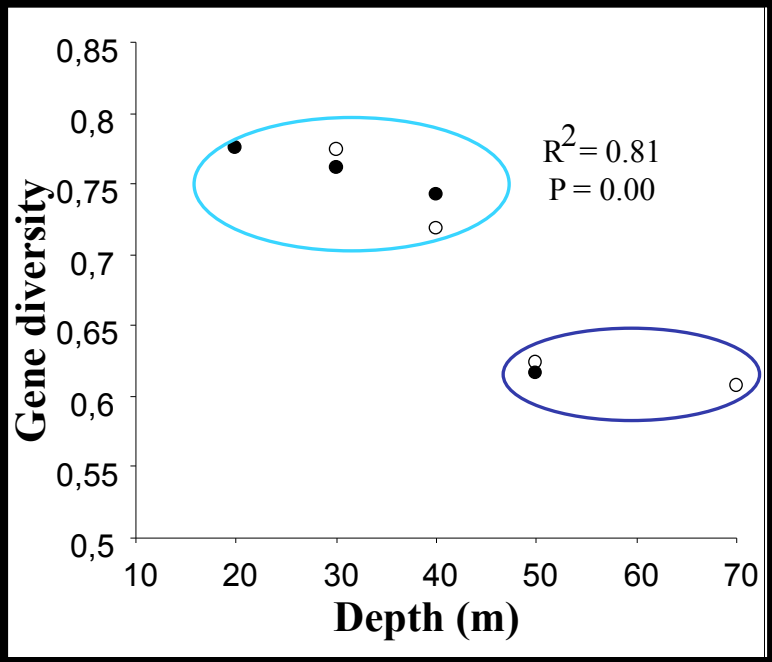
STRUCTURING ALONG A DEPTH GRADIENT

PARWISE *FST* COMPARISON ALL SIGNIFICANT p<0.001

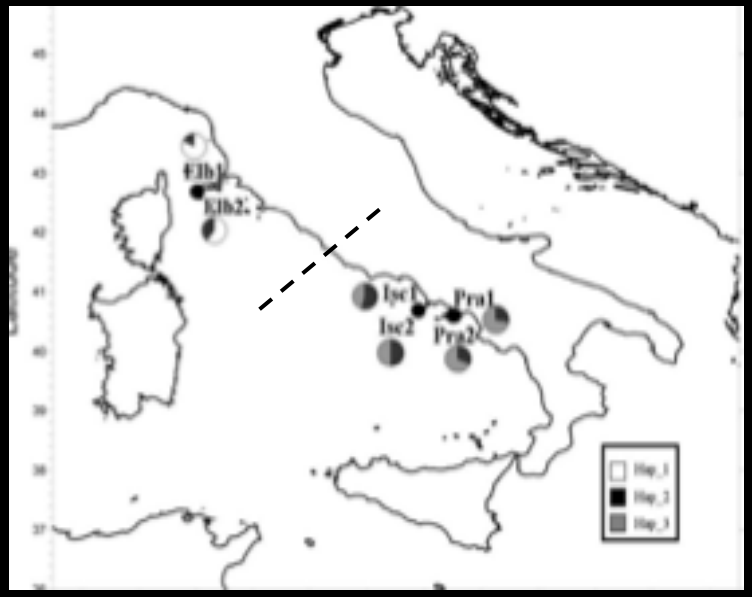
	Port30	Port40	Port50	Port70	Cap20	Cap30	Cap40
Port40	0.03						
Port50	0.10	0.03					
Port70	0.11	0.06	0.06				
Cap20	0.08	0.08	0.11	0.12			
Cap30	0.11	0.10	0.13	0.14	0.02		
Cap40	0.10	0.08	0.13	0.12	0.06	0.04	
Cap50	0.21	0.20	0.20	0.26	0.15	0.13	0.16

REDUCTION OF GENE DIVERSITY ALONG THE DEPTH GRADIENT

A DROP ACROSS 40-50M DEPTH



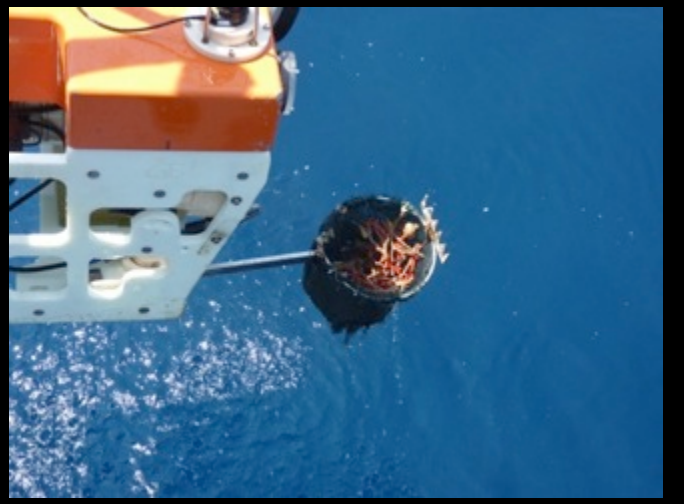
STRUCTURING IN MESOPHOTIC HABITAT

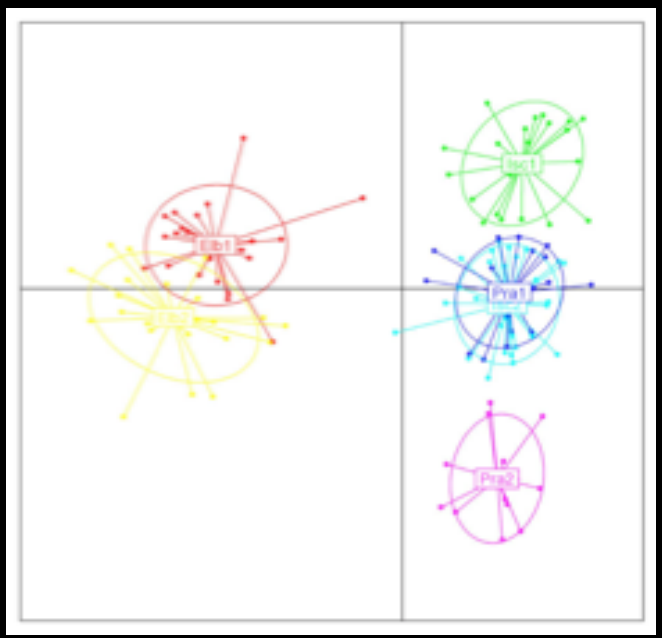


68-118 m depth;

135 specimens

Markers:
MtMSH - CR - Micro





Genetic structuring at all spatial scales

Genetic structuring between the Northern and Southern Tyrrhenian

Costantini et al, PlosOne, 2013

GENETIC STRUCTURING IN *C. RUBRUM*

- ✓ "Chaotic genetic structuring" at Mediterranean scale
- ✓ Strong pattern of genetic divergence at small (meters) geographic and bathymetric scales

Genetic data support the assumption that population are 'closed' (relevant to the population dynamic studies) and therefore vulnerable

Habitat features together with life history traits favour the structuring in "Evolutionarily Significant Units" at local scales

IMPLICATION FOR MANAGEMENT

- **Genetic data provided a strong scientific basis for the recommendation made by GFCM-FAO to ban *Corallium rubrum* harvesting above 50 m depth**
- **Patterns of structuring in mesophotic populations (50-150m depth) stress the need for conservative management: strict rules on colony size, number of colonies, daily quotas must be imposed**

IMPLICATION FOR MANAGEMENT

Genetic data suggest

- No-take zones have to be established on deep sea commercial banks to preserve local larval production
- Evolutionary Units → Management Units: coral harvesting grounds require individual management strategy

A rotating harvesting scheme could be implemented on single harvesting ground

Management strategies at Regional-Mediterranean scale will lead to the collapse of the species

MEDITERRANEAN SUBTIDAL BIOGENIC REEFS – THE CORALLIGENOUS

UNIVERISTY OF BOLOGNA – Dept of Biological, Geological and Environmental Sciences

MEDITERRANEAN SUBTIDAL BIOGENIC REEFS – THE CORALLIGENOUS

UNIVERISTY OF BOLOGNA – Dept of Biological, Geological and Environmental Sciences

MEDITERRANEAN SUBTIDAL BIOGENIC REEFS – THE CORALLIGENOUS

UNIVERISTY OF BOLOGNA – Dept of Biological, Geological and Environmental Sciences

LINK WITH CORALLIGENOUS REEFS

- Durable harvesting has to foresee a network of no-take zones on deep red coral harvesting ground
- Limited connectivity reduces the resilience of many coralligenous species, including red coral
- Off-shore MPAs will help conservation of these unique and fragile habitats

Acknowledgement

I would like to thank all the master and PhD students that contributed to these studies; colleagues form the lab; G. Santangelo – Pisa; L Bramanti – Banyuls Sur Mer; S Rossi, JM Gili – Barcellona; C Cerrano – Ancona; JG Harmelin for the great underwater pictures.

This research has been supported by funding from EU projects, Italian Ministry of Environment, University of Bologna research grants, the Italian Society of Ecology and Brusarosco Foundation


Thank you for your attention!