THE IMPORTANCE OF DEMOGRAPHIC APPROACH TO CONSERVATION AND MANAGEMENT OF MEDITERRANEAN RED CORAL (*Corallium rubrum)*

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CONSERVATION BIOLOGY AND DEMOGRAPHY

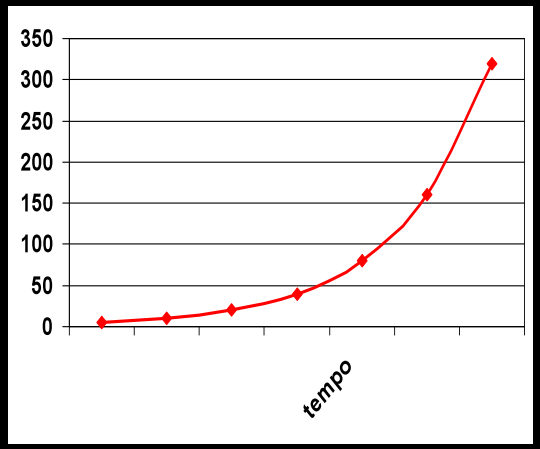
CONSERVATION BIOLOGY :
CONSERVATION OF NATURE AND NATURAL RESOURCES.

ENDANGERED POPULATION: THE NUMBER OF NEW BORN DOES NOT REPLACE THE NUMBER OF DEAD ONES.

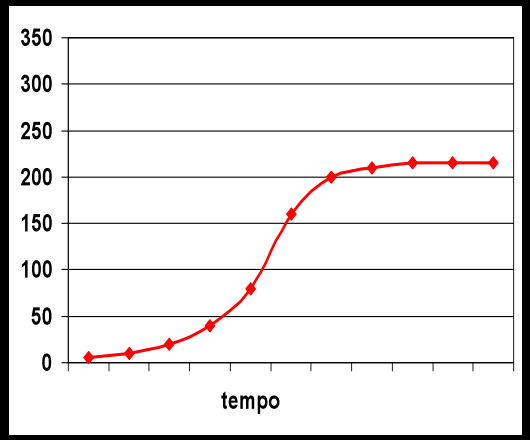
DEMOGRAPHY: SYSTEMATIC STUDY OF THE RELATIONSHIP BETWEEN BIRTH, DEATH AND MIGRATION.

APPLICATION OF DEMOGRAPHY: GROWTH MODELS

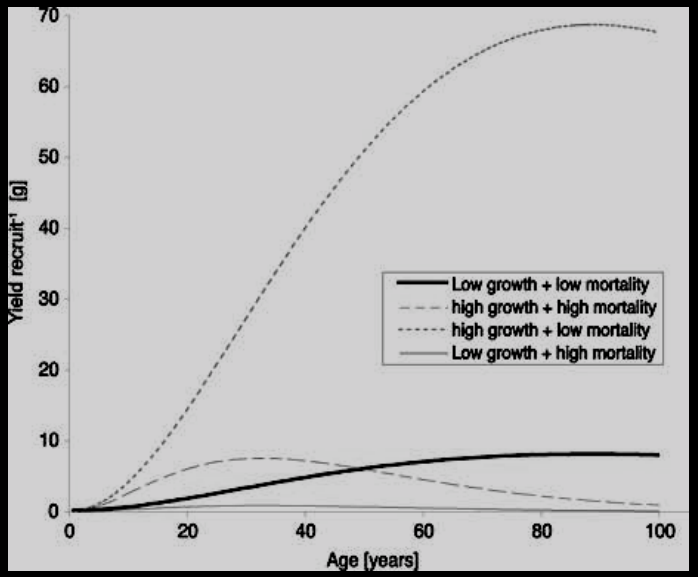
1798 MALTHUS.
ESPONENTIAL MODEL.
INDEFINITE GROWTH OF THE POPULATIONS.



1838 VERHULST. LOGISTIC NON LINEAR MODEL.
GROWTH UP TO A THRESHOLD SATURATION LEVEL.



1957 BEVERTON AND HOLT.
APPLICATION OF LOGISTIC EQUATION TO FISHERY



Tsounis et al., 2007, Ecosystems

MATRIX POPULATION MODELS

TAKE INTO ACCOUNT THE REPRODUCTION OF THE ENTIRE POPULATION

POPULATIONS WITH PARTIALLY OVERLAPPING GENERATIONS

1. ASSESS POPULATION PERFORMANCE
2. DIAGNOSE THE CAUSES OF POOR PERFORMANCE
3. PRESCRIBE MANAGEMENT INTERVENTIONS
4. MAKE PROGNOSES OF POPULATION VIABILITY

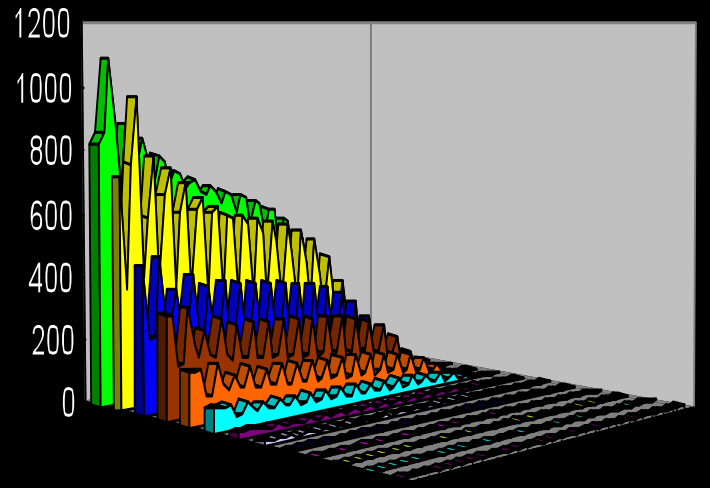
APPLICATION OF DEMOGRAPHIC MODELS TO NATURAL ENDANGERED POPULATIONS

Masami Fujiwara & Hal caswell

Nature Vol. 414 29 November 2001

Crouse D.T., Crowder L.B., Caswell H. (1987)

Ecology 68: 1412-1423



Corallium rubrum (L. 1758)

MODULAR ORGANISM

ENDEMIC TO MEDITERRANEAN AND NEIGHBOURING ROCKY SHORES

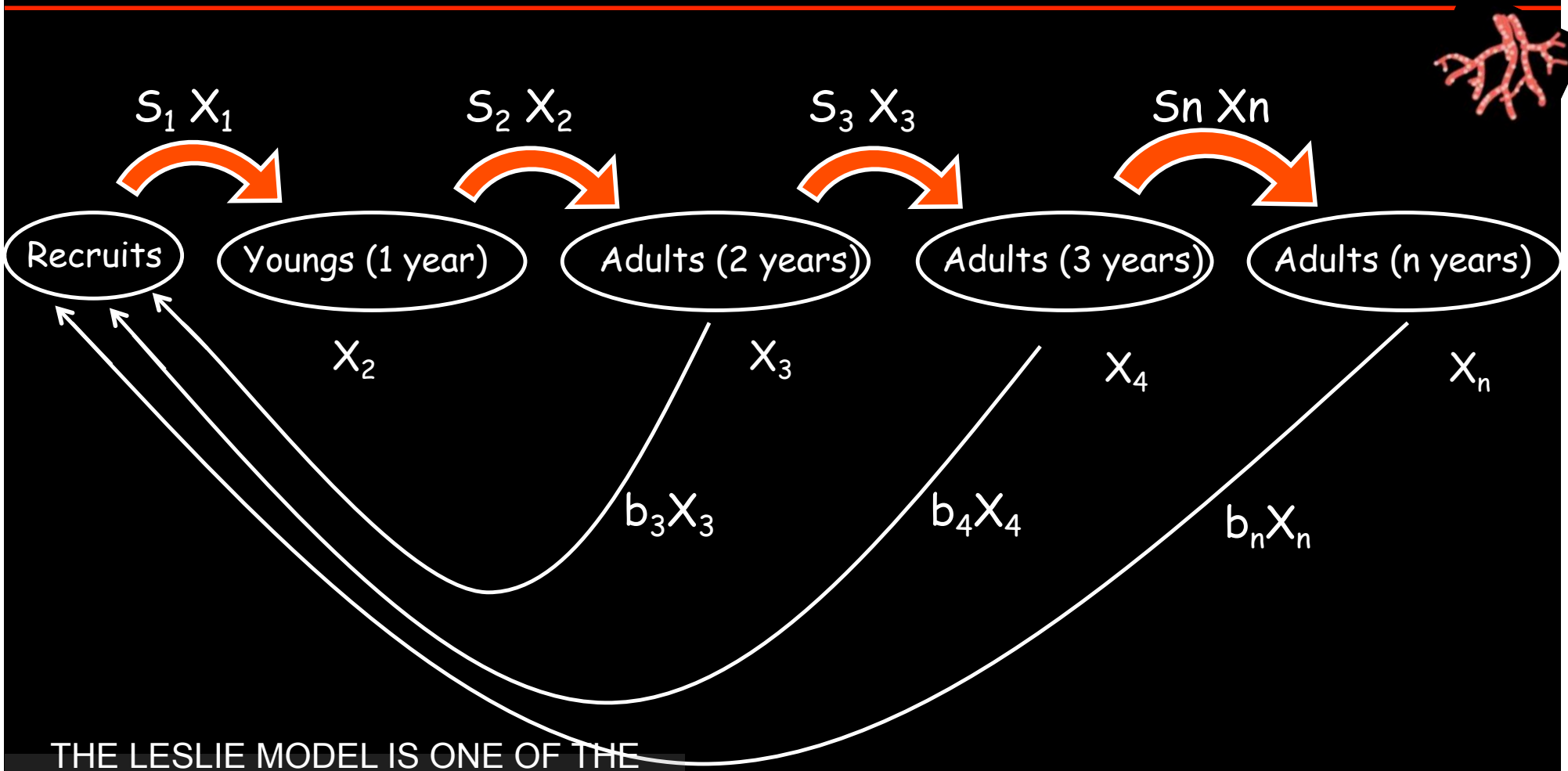
BATHIMETRIC RANGE : 10M – 600M

GONOCHORIC SEXUAL REPRODUCTION

ITEROPAROUS WITH PARTIALLY OVERLAPPING GENERATIONS

ISOLATED AND SELF-SEEDING GENETICALLY DIFFERENTIATED POPULATIONS

THE MODEL



THE LESLIE MODEL IS ONE OF THE MOST USED IN POPULATION ECOLOGY. IT IS A DISCRETE-TIME MODEL OF AN AGE-STRUCTURED POPULATION WHICH DESCRIBES DEVELOPMENT, MORTALITY, AND REPRODUCTION OF ORGANISMS.

X_i = n° individuals in class "i"

S = survival during the passage from the class i to the class i+1

Santangelo et al., 2007. Journal of Theoretical biology

DIFFERENT POPULATIONS

SHALLOW POPULATIONS

- 10 – 50 m DEPTH
- HIGH DENSITIES
- SMALL DIMENSIONS
- LOW COMMERCIAL VALUE
- HIGH TURISTIC/NATURALISTIC VALUE

DEEP POPULATIONS

- MORE THAN 50 m DEPTH
- LOWER DENSITIES
- BIG SIZE
- HIGH COMMERCIAL VALUE

Rossi et al., 2008. Marine Biology

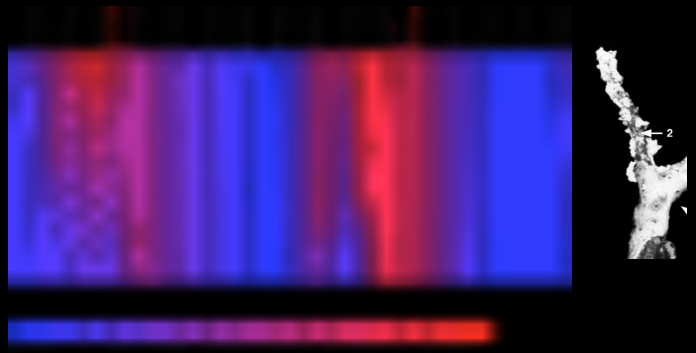
THREATS FOR SHALLOW POPULATIONS

HARVESTING/POACHING

Tsounis et al 2007; Santangelo et al., 2004

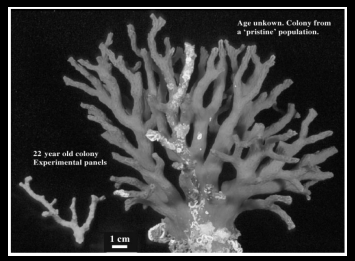
GLOBAL WARMING INDUCED MORTALITIES

Bramanti et al., 2005; Garrabou et al., 2009



A SHIFT IN COLONY SIZE HAS BEEN NOTICED IN MARSEILLE (FRANCE) POPULATION

(*Garrabou and Harmelin, 2002*)



A SHIFT IN POPULATION STRUCTURE HAS BEEN RECORDED IN COSTA BRAVA (SPAIN) POPULATIONS

(*Tsounis et al, 2007*)

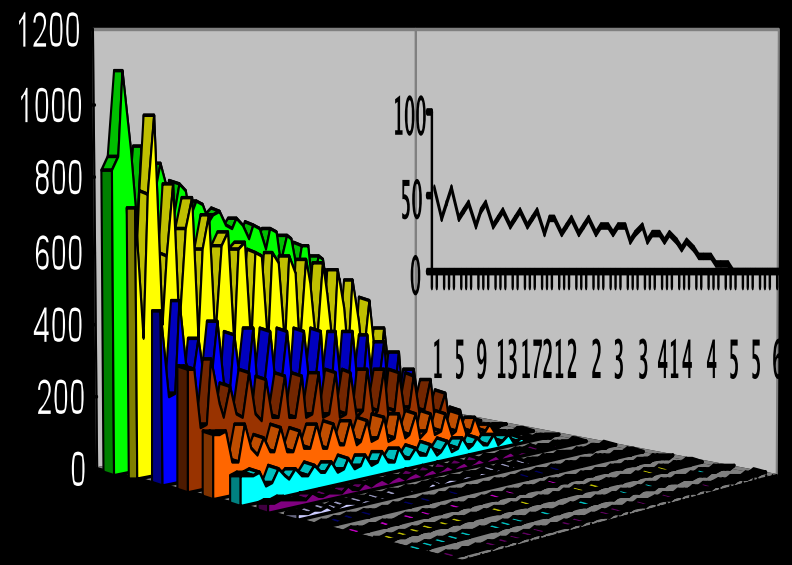
DEMOGRAPHIC STUDIES

- **POPULATION LIFE HISTRORY TRAITS** (fertility, sex ratio, growth rate, popualtion age structure)

- **DEMOGRAPHIC PARAMETERS** (density, recruitment, mortality, reproduction)

- **LIFE TABLES** (describe the demographic structure of a population)

- **MATHEMATICAL MODELS** (allow to perform projections and simulations to undertand population dynamics)



Santangelo, Bramanti, Iannelli 2007 JTB

SIMULATION

A PROGRAM REPRODUCING A MODEL OF A SYSTEM REGULATED BY MATHEMATICAL AND/OR LOGICAL LAWS.

THE USER CAN INTERACT WITH THE PROGRAM BY VARYING SOME PARAMETERS AND OBSERVING THE VARIATIONS INDUCED ON THE MODEL.

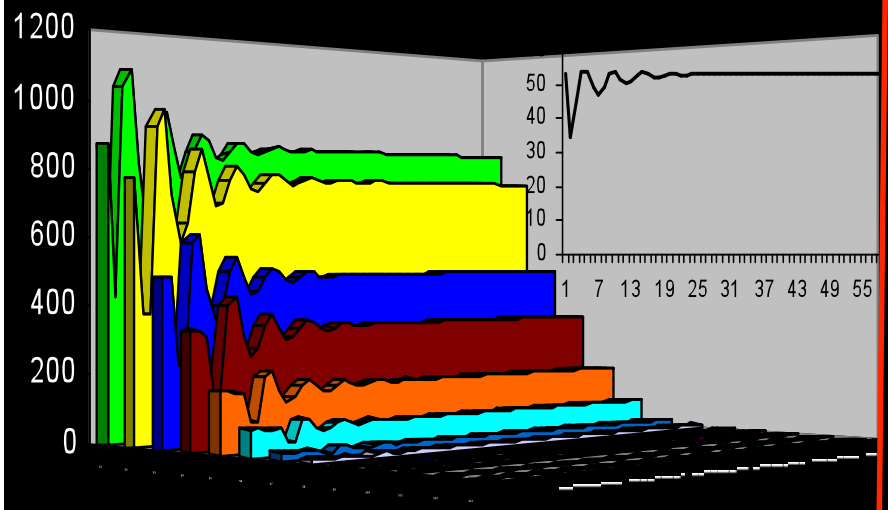
IT CAN BE USEFUL TU USE SIMULATIONS EVERY TIME WE NEED TO OBSERVE: PHENOMENA THAT ARE **FAR IN TIME** OR WHEN HAPPENS TOO FAST OR **TOO SLOWLY**.

APPLIED SIMULATIONS

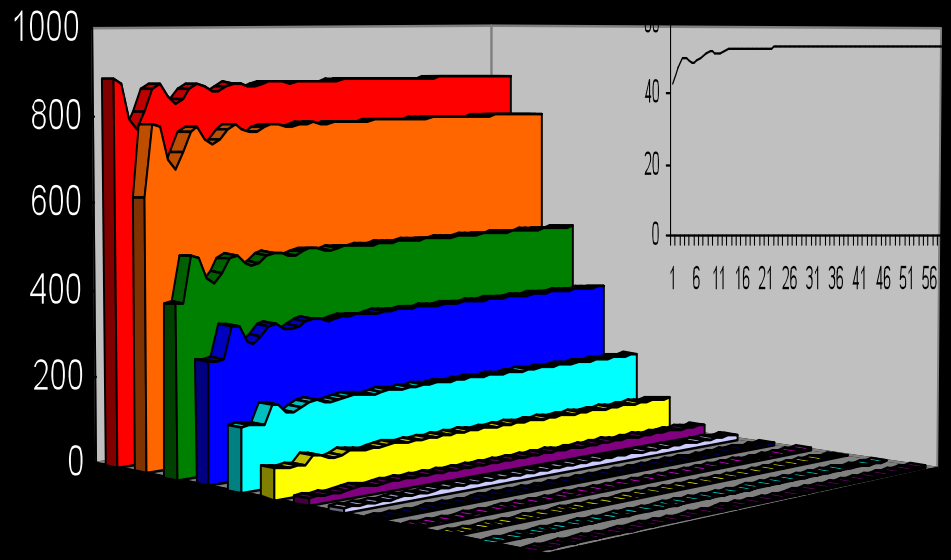
- MORTALITY EVENTS (SINGLE AND REPEATED) APPLIED ON DIFFERENT POPUALTIONS
- HARVESTING
- COMBINED EFFECT
- LIFE SPAN INCREASING
- SURVIVAL OF CLASSES INCREASING

SINGLE MORTALITY EVENT

“CALAFURIA TYPE” MORTALITY

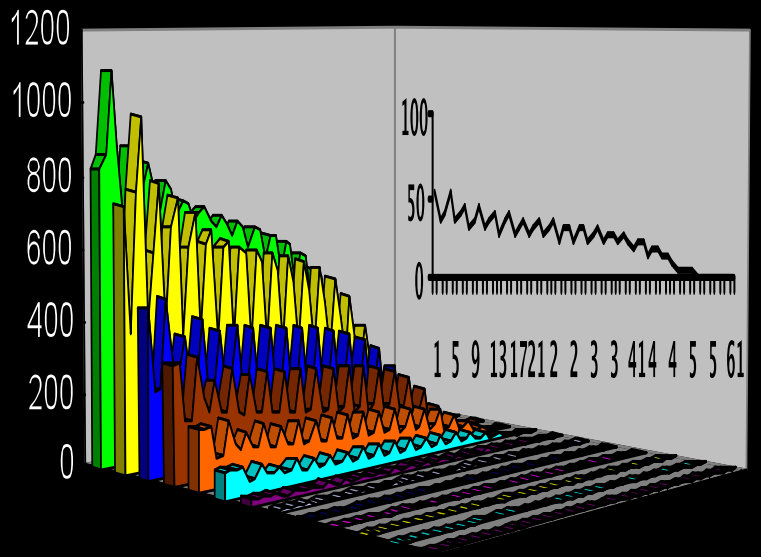


“MARSEILLE TYPE” MORTALITY

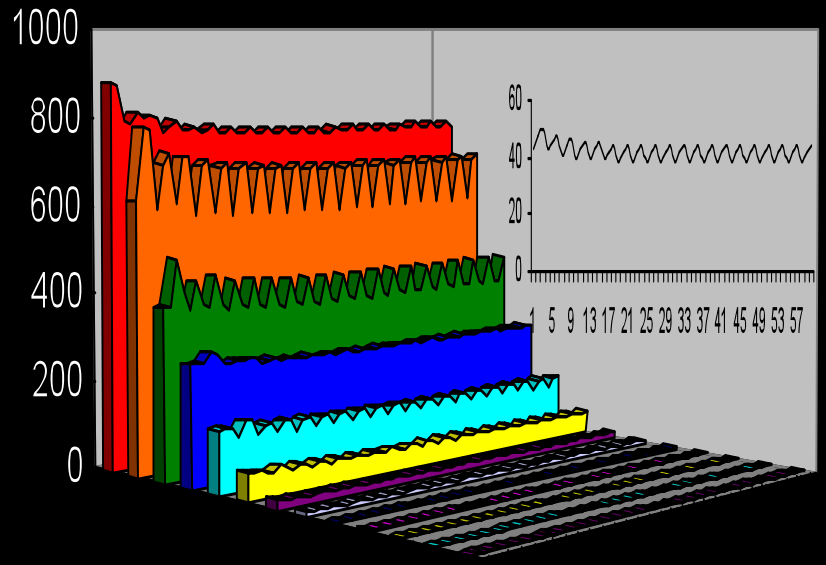


IMPULSE OF MORTALITY EVENTS (PERIOD 3 YEARS)

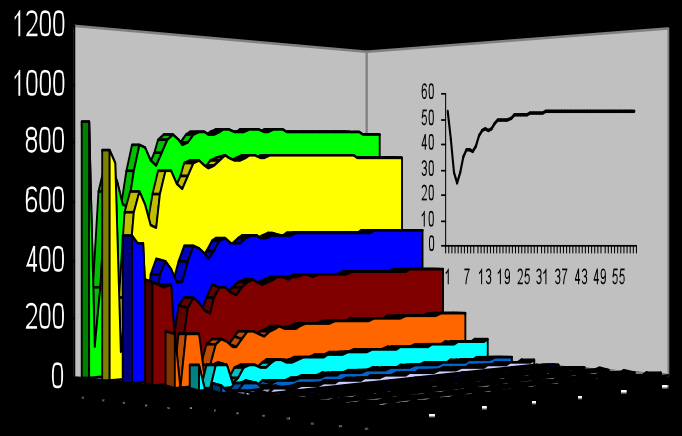
"CALAFURIA TYPE" MORTALITY



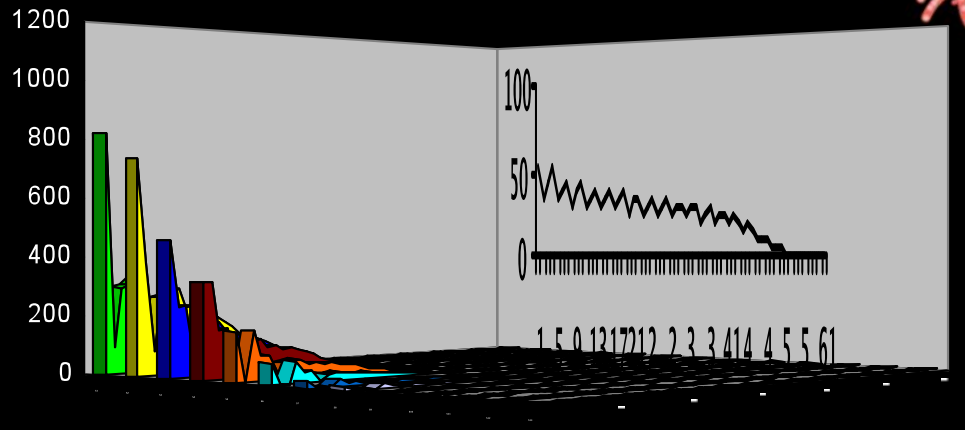
"MARSEILLE TYPE" MORTALITY



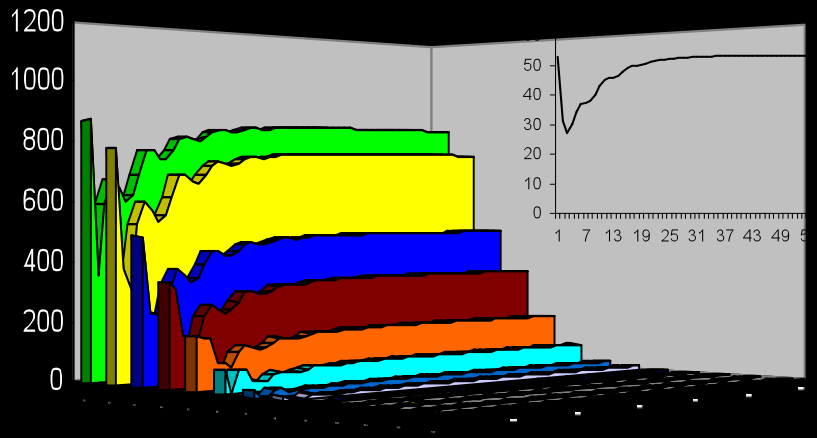
COUPLING EFFECT EXPLOITATION / MORTALITY



EXPLOITATION OF CLASSES 4 – 13



SINGLE EVENT COUPLED WITH 4 – 13 EXPLOITATION

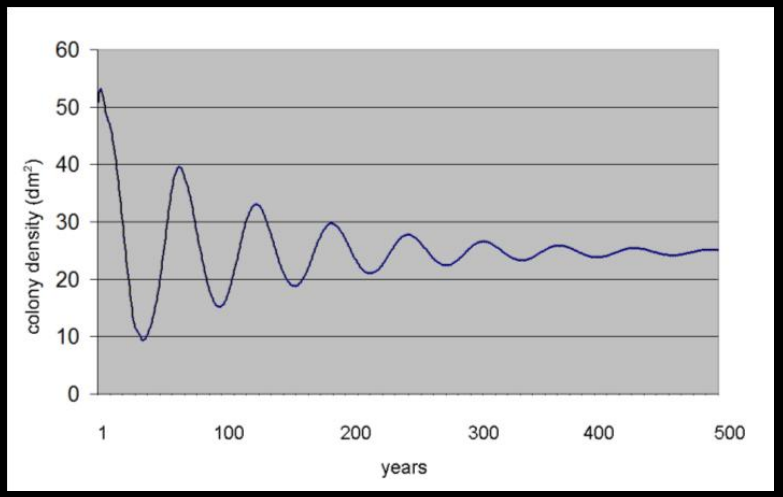


SINGLE EVENT COUPLED WITH 5 – 13 EXPLOITATION

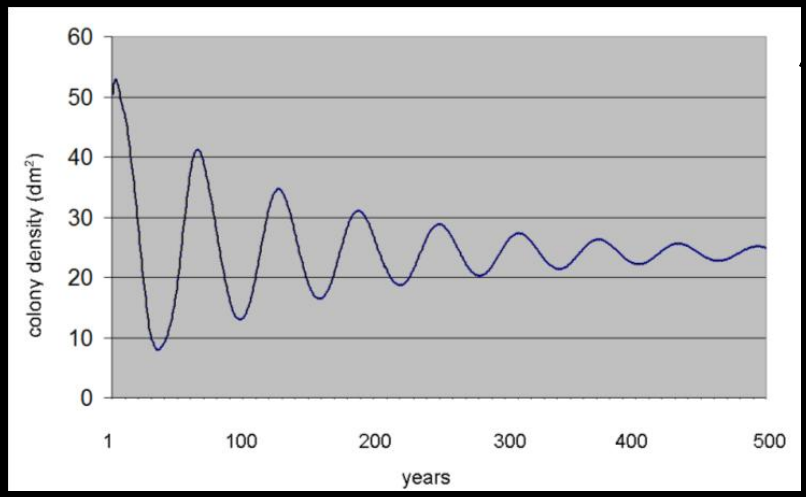
LIFE-SPAN INCREASED FROM 13 TO 40 YEARS

Bramanti et al., 2009. Ecological modelling

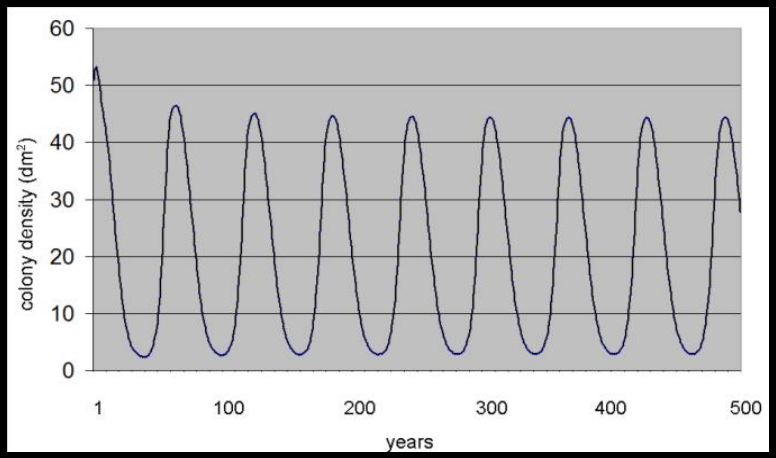
SURVIVAL INCREASED (CLASS 6, 8 AND 11)



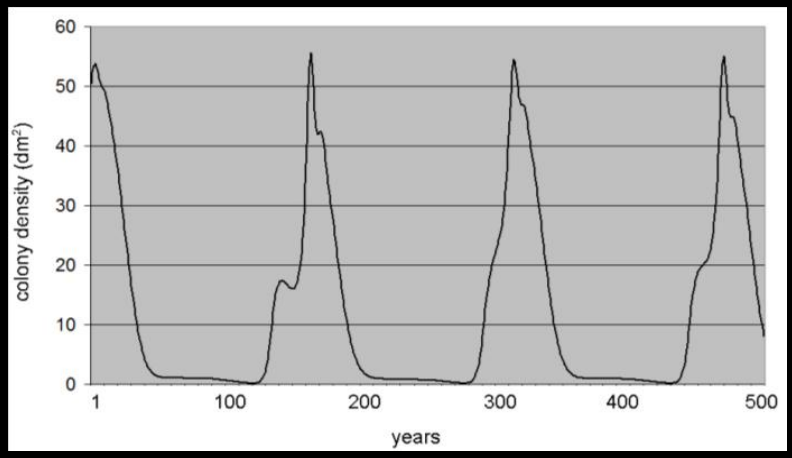
•SURVIVAL OF **CLASS 6** INCREASED (FROM 0.29 TO 0.50)
•LIFE-SPAN IS INCREASED FROM 13 TO 40 YEARS.



•SURVIVAL OF **CLASS 8** IS INCREASED (FROM 0.33 TO 0.50)
•LIFE-SPAN IS INCREASED



•SURVIVAL OF **CLASS 6, 8** IAND 11 (0.33 TO 0.50) NCREASED
•LIFE-SPAN INCREASED



LIFE SPAN INCREASED TO 100 YEARS
SURVIVAL OF CLASSES 14-100 = 100).

SIMULATION COMMENTS

ACCORDING TO THE MODELTHE POPULATION CAN RECOVER FROM A SINGLE MORTALITY EVENT BUT IF THE EVENT IS PERIODICALLY REPEATED POPULATION GOES TO EXTINCTION

THE POPULATION CAN RECOVER FROM AN EXPLOITATION BUT WHEN IT IS COUPLED WITH A MORTALITY EVENT POPULATION GOES TO EXTINCTION.

AN INCREASE OF SURVIVAL AND LIFE-SPAN LEADS THE POPULATION TO A DAMPED OSCILLATING BEHAVIOUR, WHICH OSCILLATIONS INCREASE BOTH WIDTH AND PERIODICITY ACCORDING TO SURVIVAL INCREASE UNTILL DEEP OSCILLATIONS WITH CONSTANT PERIODICITY

A MORTALITY DECREASE LEADS TO AN OSCILLATION INCREASE, BUT THE INCREASED DENSITY OF BIGGER-OLDER COLONIES (WHICH DENSITY-DEPENDENCE EFFECT IS PECULIAR OF A MODULAR ANIMAL, DEPENDING ON THE NUMBER OF MODULES) CONTROLS SUCH OSCILLATIONS PREVENTING THUS POPULATION EXTINCTION.

SHALLOW TO DEEP STRUCTURE SHIFT

CHANGES IN THE RATIO BETWEEN THE AGE CLASSES LEADS TO SCENARIOS IN WHICH SMALL-YOUNG CROWDED COLONIES OR FEW, SPARSE OLDER COLONIES IN TURN DOMINATE THE POPULATION.

AS BOTH POPULATION STRUCTURES ARE PRESENT IN NATURE WE SUPPOSE THAT OVERHARVESTING, INCREASING THE MORTALITY OF BIGGER-OLDER COLONIES, COULD HAVE SHAPED THE POPULATIONS WHICH ACTUALLY DWELL IN SHALLOW AREAS.

CONCLUSIONS

LONG TERM DEMOGRAPHIC DATA ALLOW THE DEVELOPMENT OF MODELS BASED ON TRANSITION MATRICES. ONE OF THIS MODEL HAS BEEN APPLIED TO A RED CORAL **SHALLOW** POPULATION ON THE BASIS OF DEMOGRAPHIC DATA.

SIMULATIONS SHOW A GOOD RESILIENCE CAPABILITY TO MORTALITY EVENTS (TYPICAL OF SPECIES WHITH EARLY SEXUAL MATURITY, OVERLAPPING GENERATIONS, HIGH REPRODUCTION RATES AND SLOW GROWTH). A SPORADIC NEGATIVE REPRODUCTIVE EVENT COULD HAVE A LIMITED EFFECT BUT THE RISK OF EXTINCTION EXISTS IF SUCH MORTALITY EVENTS WILL OCCUR MORE FREQUENTLY OR ARE COUPLED WITH EXPLOITATION.

A REDUCTION OF DENSITY-DEPENDENT MORTALITY LEADS POPULATIONS TO OSCILLATING BEHAVIOURS WHICH CAN INCREASE IN WIDTH AND FREQUENCY LEADING EVEN TO CHAOTIC BEHAVIOURS AND POPULATION EXTINCTION.

DEMOGRAPHIC MODELS BASED ON TRANSITION MATRIXES REPRESENT A POWERFULL TOOL FOR THE MANAGEMENT OF MEDITERRANEAN RED CORAL. THE APPLICATION OF THEES EMODELS TO A SHALLOW POPULATION SHOWED THE CAPABILITIES OF THE INSTRUMENT NEVERTHELESS DEMOGRAPHIC DATA ON DEEP COMMERCIAL POPULATIONS ARE NEEDED FOR THE APPLICATION OF THE MODEL TO THAT POPULATIONS.

2009 - 2010: ROAD MAP TO PROTECTION/MANAGEMENT OF RED CORAL

International Workshop on Corallium Science, Management and Trade. Hong Kong Marzo 2009

Workshop internazionale Corallo rosso. Napoli Ottobre 2009

Summit FAO. Roma, Dicembre 2009

CITES (Convention of International Trade of Endangered Species). Qatar, Marzo 2010

Transversal Workshop on red coral. Alghero 16-17 september 2010

RECOMMENDATIONS

BAN OF SHALLOW WATER POPULATIONS HARVESTING (50 M LIMIT)

IMPROVED LOCAL ENFORCEMENT.

IMPROVED LANDINGS RECORDING OF THE FISHERIES.

REVISION OF MINIMUM SIZE LIMITS, QUOTAS AND LICENSES IN DIFFERENT GEOGRAPHIC REGIONS ON THE BASIS OF DEMOGRAPHIC STUDIES.

ONGOING SCIENTIFIC MONITORING AND COSTANT FEEDBACK BETWEEN RESEARCH AND DECISION MAKERS.

LARGE MARINE PROTECTED AREAS COMPREHENSIVE OF A FRACTION OF DEEP POPULATIONS.

IDENTIFICATION AND PROTECTION OF VIRGIN POPULATIONS FOR RESEARCH.

RESTORATION PLANS FOR DEPLETED POPULATIONS.


THANK YOU FOR THE
ATTENTION