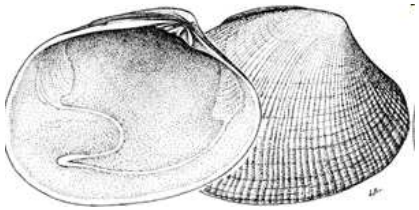
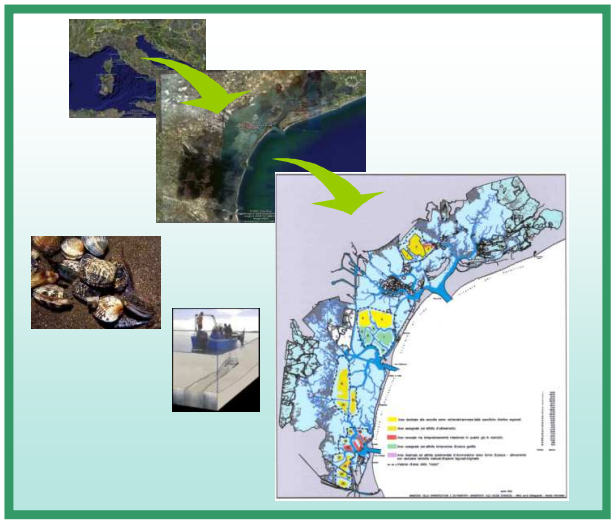
ECSA '09

Towards a sustainable clam farming in the Lagoon of Venice



D. Melaku Canu[1]; P. Campostrini[2]; S. Dalla Riva[2]; L. Rossetto[3]; R. Pastres[4]; G. Cossarini[1], C. Solidoro[1].

1. OGS Istituto Nazionale Ocenografia e Geofisica Sperimentale. Trieste. Italy
2. CORILA Venezia, Itay
3. TESAF University of Padua, Italy
4. Dipartimento Chimica Fisica University of Venezia, Italy

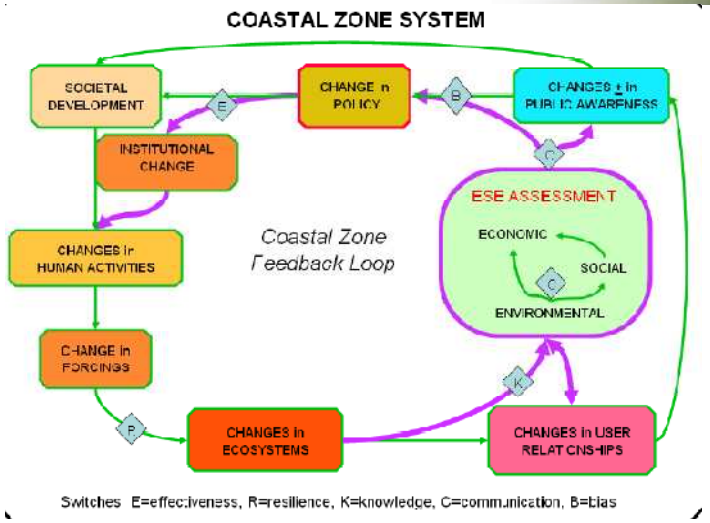


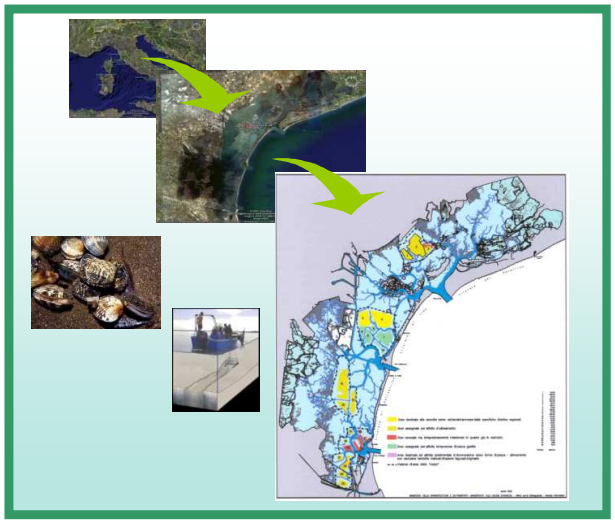
http://cordis.europa.eu/fp6/dc

SPICOSA

Science and Policy Integration for COastal System Assesment

http://ec.europa.eu/sustainable





Issue

Aquaculture of *Tapes philippinarum*

goal

Sustainable use of Lagoon Ecosystem *and* *Tapes philippinarum* stock.

exploring the sensitivity of the system to:

Changes in biological parameters (density, mortality rate)

- Changes in economic parameters (external costs, fishing strategies)
- Size and location of the areas under concession
- Changing Climate Scenarios

STUDY SITE 7.15 Venice Lagoon

Sustainable management of the clam *Tapes philippinarum* in the Lagoon of Venice

History

- **1983**: *Tapes philippinarum* introduction
- **1983-1990** clam colonisation
- **From1990**: fishermen started to fish in **open access regime/ social tensions/poor quality** (fished also in prohibited area)
- **1999**: catches decline
- **2001**: allocation of aquaculture concessions
- **2005**: extension of aquaculture concessions
- **2009**: revision of aquaculture concessions

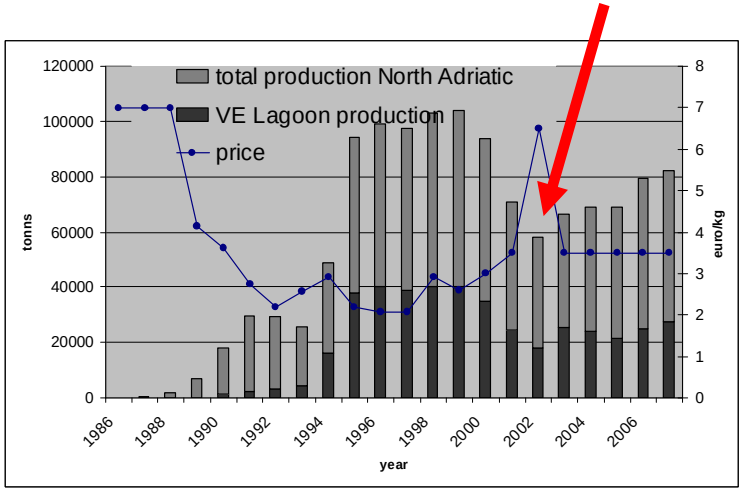
- **Negative impacts**: sediment resuspension, benthic habitat alteration

Clam production Lagoon of Venice

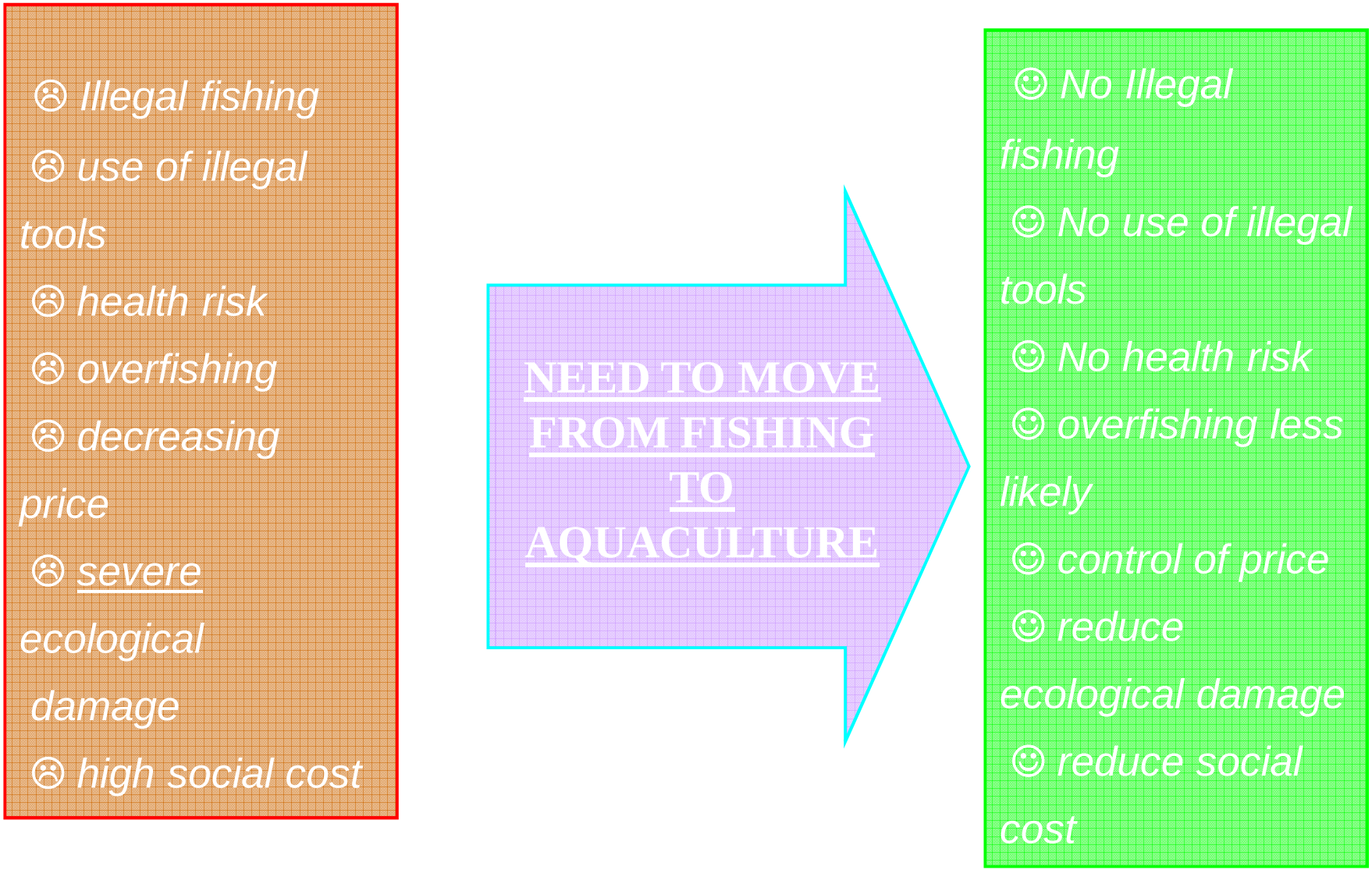
year	Lagoon of Venice	Italy	% Venice over total
1986	4	31	12.9
1987	10	285	3.5
1988	14	1937	0.7
1989	16	7117	0.2
1990	1300	16709	7.8
1991	2400	27116	8.9
1992	3000	26434	11.3
1993	4500	21448	21.0
1994	16000	32723	48.9
1995	38000	56045	67.8
1996	40000	59100	67.7
1997	39000	58401	66.8
1998	40000	62960	63.5
1999	40000	63970	62.5
2000	35000	58635	59.7
2001	24400	46188	52.8
2002	17700	40200	44.0
2003	25500	40863	62.4
2004	23800	44981	52.9
2005	21500	47377	45.4
2006	25000	54452	45.9
2007	27500	54723	50.3

Economic Relevance: around 50% of national production
Number of fishermen: around 1000;
estimated gross annual production: 180 Million Euro

Decrease!!!



Fonte: Zentilin A., Pellizzato M., Rossetti E., Turolla E.. La venericoltura in Italia a 25 anni dal suo esordio. Il Pesce. Numero 3, Anno 2008



Social problems

(15 years later….)

Local Newspaper, 2008

4 people charged for illegal fishery

Quotidiano — **IL GAZZETTINO** Venezia — 09-MAG-2008

Direttore: Roberto Papetti — da pag. 10

Controlli della Polizia provinciale nella zona tra le foci del Naviglio Brenta a Fusina e l'area prospiciente Marghera

Pesca abusiva, 4 denunciati

Solimini: «Stroncare queste attività con provvedimenti che impediscano di ripetere il reato»

Chioggia

Tre azioni coordinate di controllo contro la pesca abusiva di vongole in acque precluse della Laguna hanno fatto emergere in questi giorni quel fenomeno di "abusivismo professionale" del quale in molti avevano certezza, pur senza prove concrete. La zona è sempre la stessa, quella tra le foci del Naviglio Brenta a Fusina e l'area prospiciente Marghera; la tecnica di pesca è sempre quella dei piccoli barchini equipaggiati con potenti motori e rasca a "grattare" il fondo lagunare. In tre diverse occasioni negli ultimi quindici giorni le pattuglie della Polizia Provinciale hanno sequestrato tre carichi di vongole tra i 150 ed i 250 chili ciascuno: le persone identificate e denunciate all'autorità giudiziaria sono complessivamente quattro e fanno parte di uno stesso gruppo di pescatori. Tutte risiedono a Chioggia e nessuno aveva nemmeno la licenza di pesca.

"Gli agenti della nostra Polizia - spiega l'assessore alla Pesca, Luigi Solimini – svolgono continui controlli in Laguna e avevano già avuto modo di incrociare queste persone, magari senza coglierle sul fatto. È come se per qualcuno la pesca abusiva non fosse percepita come un reato. È come se la stessa fuga all'alt della polizia non configurasse una sorta di resistenza ad un pubblico ufficiale. Se accadesse in autostrada che un automobilista non si fermasse davanti ad una pattuglia della polizia, sarebbe perseguibile penalmente. Ma in Laguna qualcuno interpreta questa situazione come fosse parte del rischio di questo mestiere. Che poi è il mestiere della pesca abusiva: dobbiamo arrivare a stroncarla con provvedimenti che impediscano la ripetizione del reato. Per questo abbiamo concordato procedure che permetteranno, oltre al sequestro dell'imbarcazione e dell'attrezzatura, la successiva confisca di questi strumenti da parte della Procura privando il pescatore dei mezzi utilizzati per l'illecito. Quel che comunque deve essere certo per questi pescatori è che i controlli della Polizia Provinciale continueranno con costanza e che colpiremo con continuità ogni comportamento illegale in Laguna".

Fishery meeting ended in a fight

Quotidiano — **IL GAZZETTINO** Venezia — 09-MAG-2008

Direttore: Roberto Papetti — da pag. 1

Tensione nel corso di un incontro nella sede del Gral tra vongolari e i gestori dell'allevamento

Il vertice sulla pesca finisce a pugni

Rissa tra rappresentanti delle marinerie. La polizia interviene per sedare gli animi

Il presidente della Provincia: «Se non si cambia metodo, sciolgo l'ente»

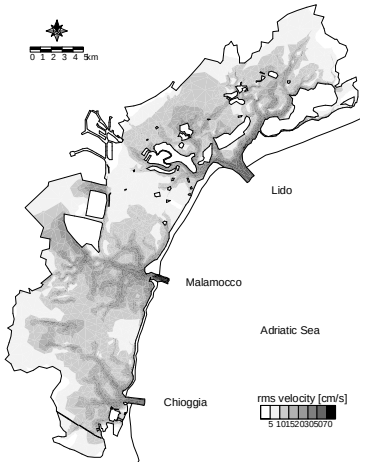
Venezia

È finita in rissa la riunione nella sede del Gral tra pescatori e l'ente che ha in concessione gli specchi di laguna destinati all'allevamento delle vongole. Alcuni dei 60 rappresentanti delle marinerie si sono presi prima a insulti e poi a pugni, tanto che è dovuta intervenire la polizia. L'episodio ha fatto andare su tutte le furie il solitamente imperturbabile presidente della Provincia, Davide Zoggia. «Vedo che in questi giorni - ha esordito Zoggia - il Gral è sottoposto all'attacco non solo da parte dei pescatori ma anche degli enti che hanno competenze sulla laguna. A questo gioco al massacro io non ci voglio stare: se il Gral è il problema, lo togliamo di mezzo. Ho già scritto al Prefetto di convocare al più presto una riunione fra tutti gli enti. Se in quella sede non ci sarà una chiarificazione e un appoggio unitario cominceremo immediatamente le procedure per la messa in liquidazione della società. La Provincia continuerà a svolgere le attività che deve fare per legge, come la sorveglianza, e per il resto i pescatori andranno a bussare alla porta di chi ha le vere colpe. Almeno tutti si prenderanno le proprie responsabilità».

Fulin a pagina IV

Impacts

	year 2000
number of boats	600
time h/month	75
month/year	10
dredging speed (m/h)	750
lengh dredging system, r	1.2
tot fish time, h	450000
glob fish lenght, m	337500000
glob surface, mq	405000000
sediment mobilised mc	40500000
sediment settled	36450000
sediment loss	4050000



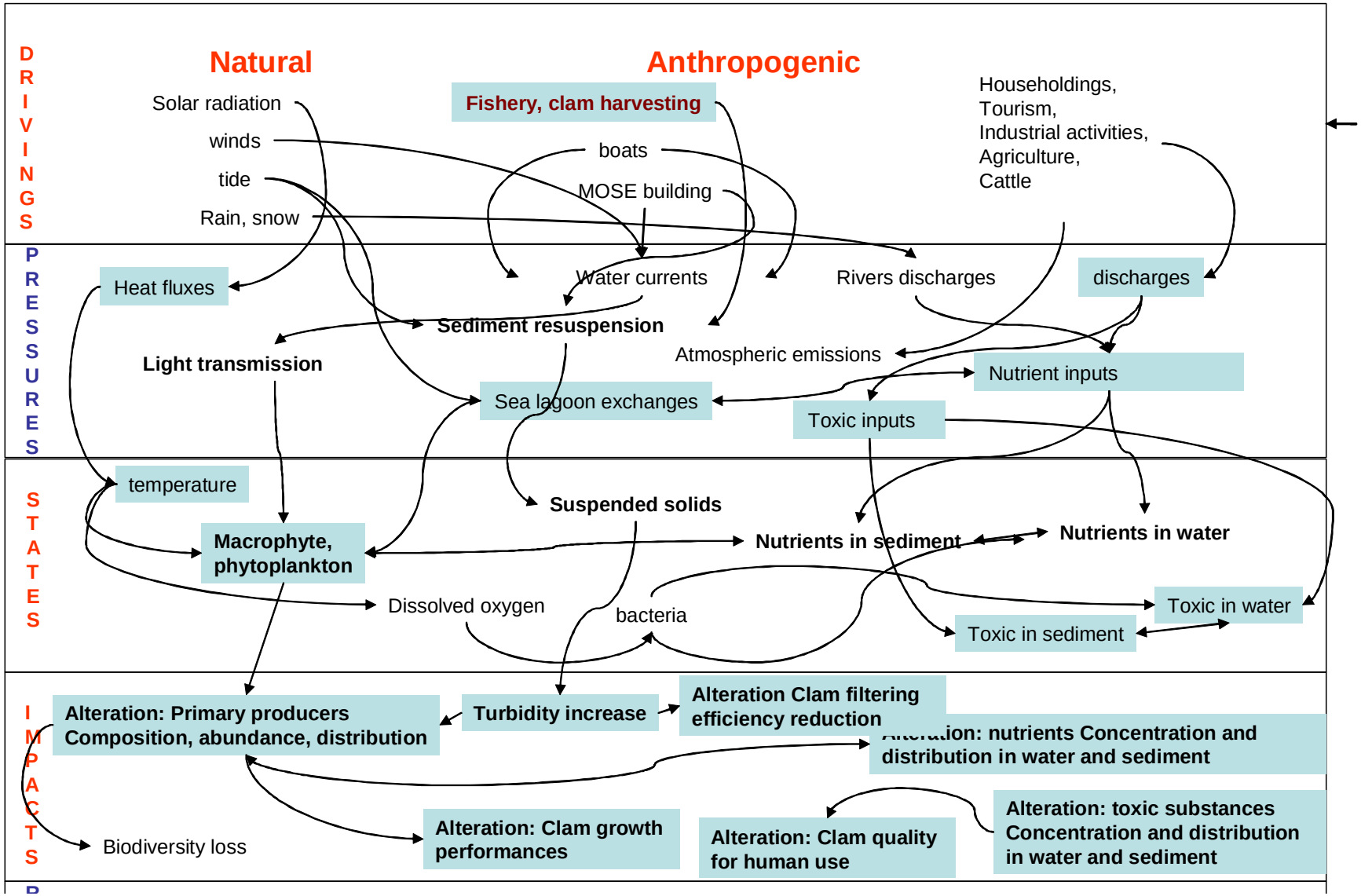
sediment loss	
mc/mq	0.01
euro price/mc	70
1 hectare	10000
impact/h, euro	7000

Using same parameters
Sediment loss estimated
impact: 7000 euro/h

Harvesting Return time
influence on sediment
resuspension impacts

From **Orel G., Boatto V., Sfriso A., Pellizzato M., Piano per la gestione delle risorse alieutiche delle lagune della Provincia di Venezia. Provincia di Venezia, 2000.**

•DPSIR



Methods:

- Modelling tools:
- *Tapes philippinarum* bioenergetic and bioeconomic model
- 0D and 2D application coupling with TDM (biogeochemical model)

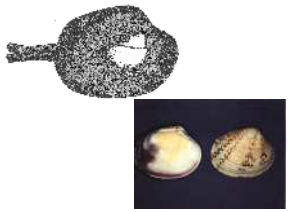
State variables identification

Description of the growth process using few variables.

These variables should be easily measured in field works.

denominazione	**abbreviazione**	**misura**	**strumento**	**precisione**
Lunghezza (detta anche larghezza)	L	dimensioni asse maggiore	calibro	0.1mm
altezza	h	dimensioni asse minore	calibro	0.1 mm
spessore	sp	spessore	calibro	0.1 mm
Peso umido totale	W	peso totale individuo vivo dopo sgocciolamento e asciugatura su carta assorbente	bilancia manuale	0.05g
Peso fresco parti molli	Pm	peso carni	bilancia	1 mg
Peso secco	Ps	peso carni essiccate in muffola a 90°per 48 h	bilancia	1mg
Peso secco senza ceneri	Ws	peso secco meno peso ceneri ottenute ponendo le parti molli in muffola per 4 h a 470°	bilancia	1 mg
Peso conchiglia	Pc	peso conchiglia senza parti molli, asciugata	bilancia	0.05 g

Environmental conditions



From literature:

Growth of *Tapes philippinarum*

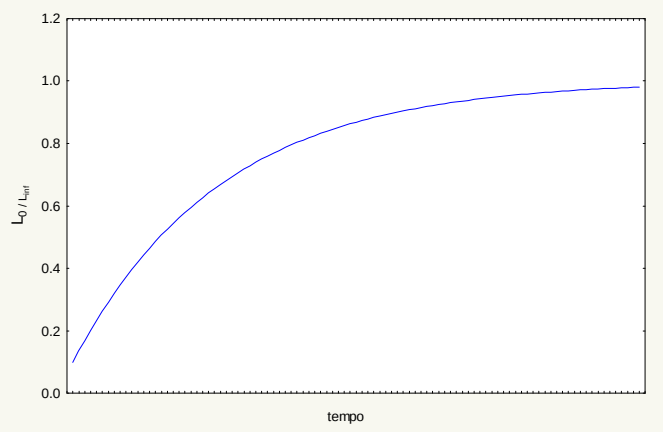
Fitoplancton	. (Tenore et al., 1973, Maitre Allain, 1982, Bodoy et al., 1980, Rossi, 1996, Laing, 1987, Fonda Umani et al 1994, Sorokin e Giovanardi, 1995, Goulletquer, 1989)
Temperatura	(Breber, 1991, Maitre Allain, 1982, Bodoy et al)
Sedimento	(Turolla, 1995, Rossi, 1996)
Turbolenza	(Wildish et al, 1987, Eckman et al 1989 in Cole et al. 1992, Rossi, 1996)
Saturazione di O2	(Breber, 1996, Parache, 1982)
Salinita'	(Breber, 1991, Riva, 1976)
Torbidita'	(Breber 1991)
Densita'	(Ohba, 1956, Turolla, 1995, Rossi, 1996)

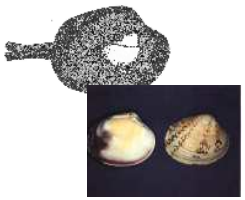
Identification of correlations

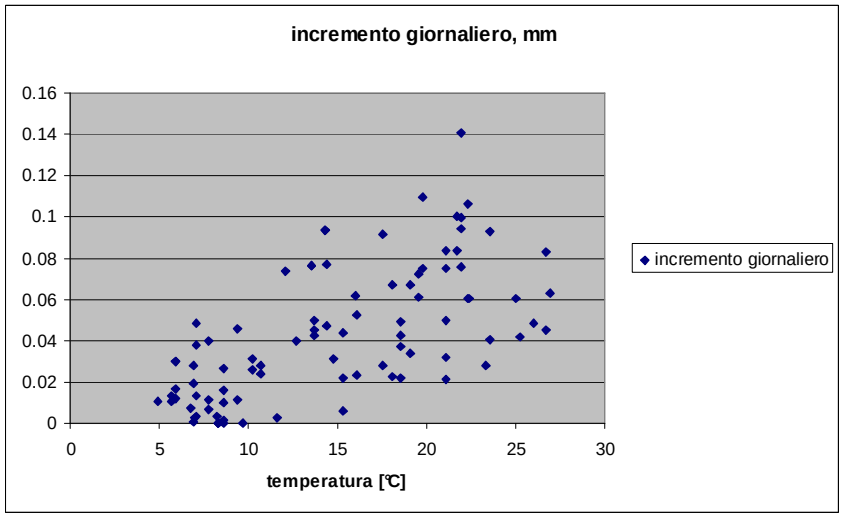
From data

data	area campo	durata	temp.sp	sal.sp	tipo sed.	tipo idr.	tgspo.mm	%O2 sat	Chlmed/g.	Tmed	densità num/mq	densità g/mq	mort.fin.	incremento	incremento/gg
incremento/gg	**0.025715**	**0.380435**	**0.454128**	**-0.266842**	**0.614328**	**0.371285**	**-0.429612**	**0.427368**	**0.406978**	**0.61875**	**-0.516044**	**-0.711354**	**-0.36554**	**0.8319837**	**1**
incremento totale	-0.117322	0.709625	0.223832	0.095077	0.387992	0.052199	-0.354883	-0.063537	0.314979	0.334459	-0.371427	-0.537001	-0.207385	1	0.8286313
mort.fin.	-0.580976	-0.273554	-0.582013	-0.270889	-0.510795	-0.523882	-0.299954	0.118922	-0.516355	-0.613315	0.896969	0.748532	1		
densità	-0.477167	-0.406352	-0.393742	0.143496	-0.401146	-0.3382	0.235675	0.453653	0.23997	-0.422053	0.865513	1			
densità	-0.459301	-0.315271	-0.252717	0.308042	-0.281227	-0.253487	0.019852	0.500951	0.213466	-0.324873	1				
Tmed	0.421404	0.257914	0.933276	0.546833	0.48759	0.586705	0.509036	0.725307	0.944351	1					
Chlmed/g.	0.56146	0.201388	0.864799	0.421246	0.327898	0.492846	0.639826	0.633923	1						
%O2 sat	0.769144	0.724925	0.879876	0.889517	0.772868	0.839321	0.890336	1							
tgspo.mm	0.371706	0.488234	0.714715	0.838861	0.578047	0.545911	1								
tipo idr.	0.413467	0.401686	0.684537	0.741148	0.825148	1									
tipo sed.	0.209998	0.592592	0.679084	0.79388	1										
sal.sp	0.819327	0.920906	0.879102	1											
temp.sp	0.34133	0.649497	1												
durata	0.390231	1													
area campo	1														

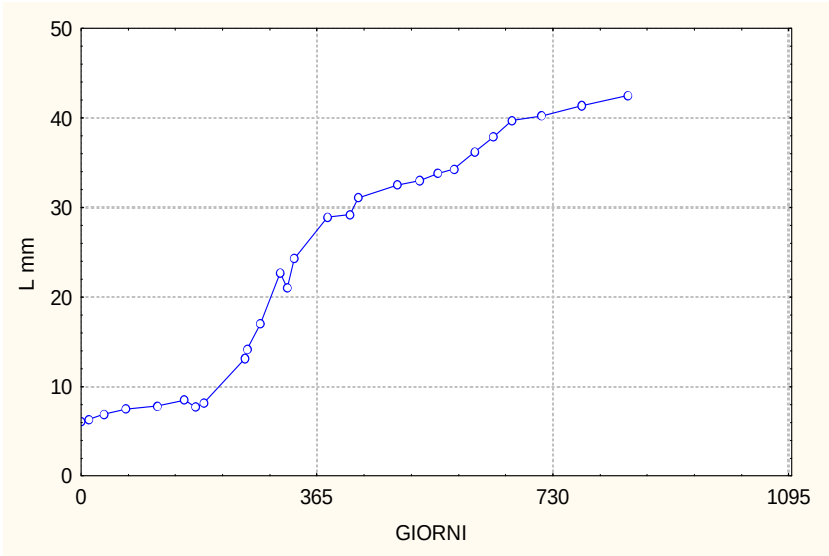
Growth:Seasonal variability





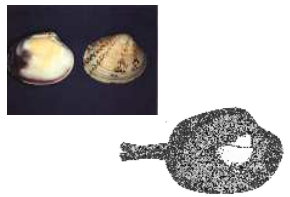


Daily growth and temperature dependance (dati Rossi, 1996)



Growth curve Marano (dati Zentilin A. , 1997)

Model identification



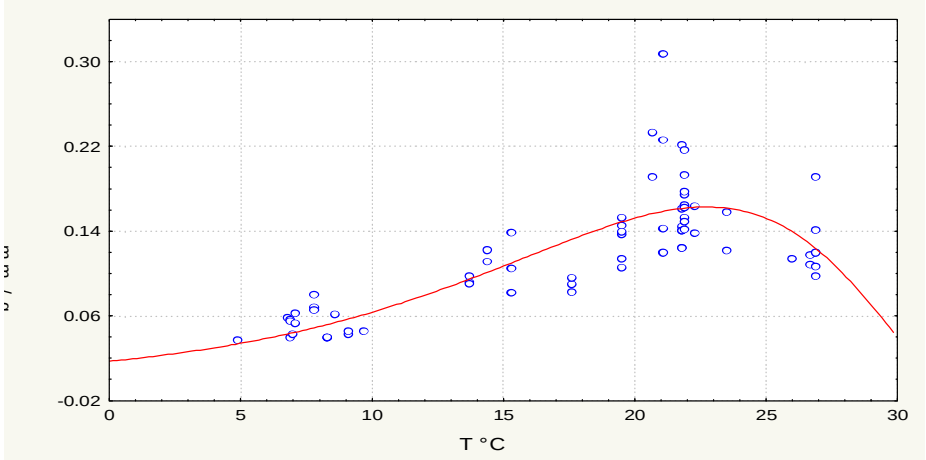
$$\frac{dw}{dt} = k_1 f(T) f(F) w^{2/3} - k_2 g(T) w \qquad (2.14)$$

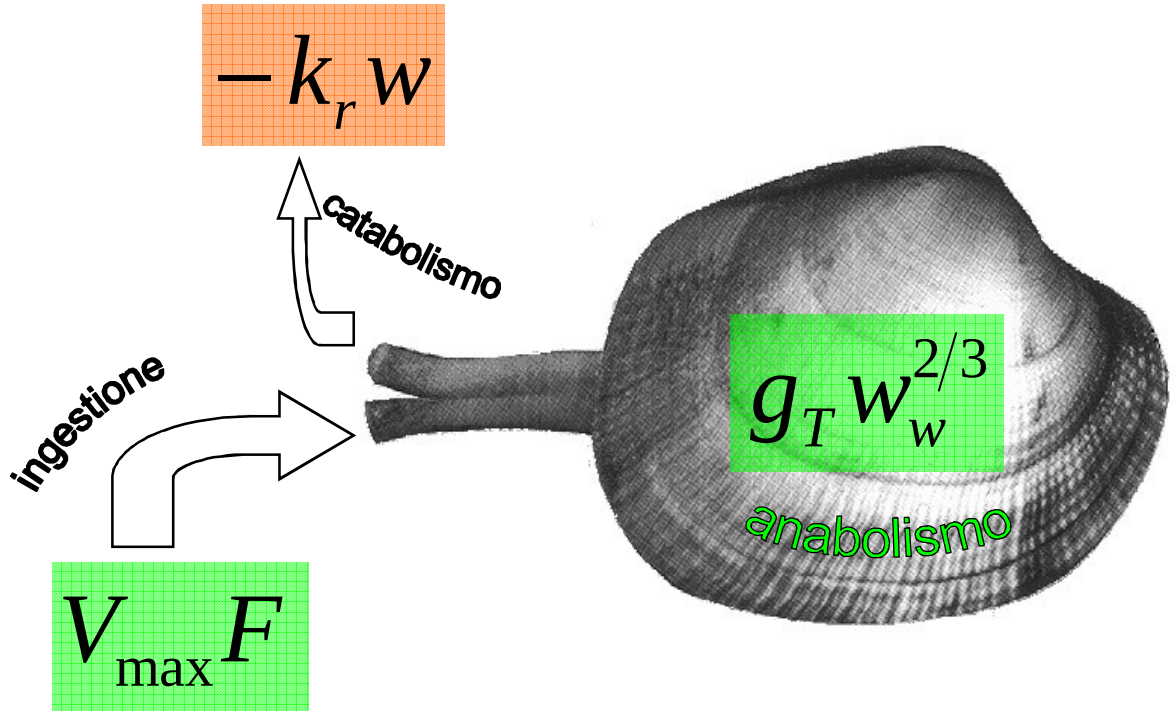
con

$$f(T) = g_{max} \{ [(T_{max}-T)/(T_{max}-T_{ott})]^{\beta(Tmax-Tott)} \} e^{[\beta T(nd)-Tott)]} \qquad (2.15)$$

$$g(T) = r_{max} \{ [(T_{maxr}-T)/(T_{maxr}-T_{ottr})]^{\beta r(Tmaxr-Tottr)} \} e^{[\beta rT(nd)-Tottr)]} \qquad (2.16)$$

(empirical functions -Lassiter & Kearns- optimised using field data from Goro and Venezia)

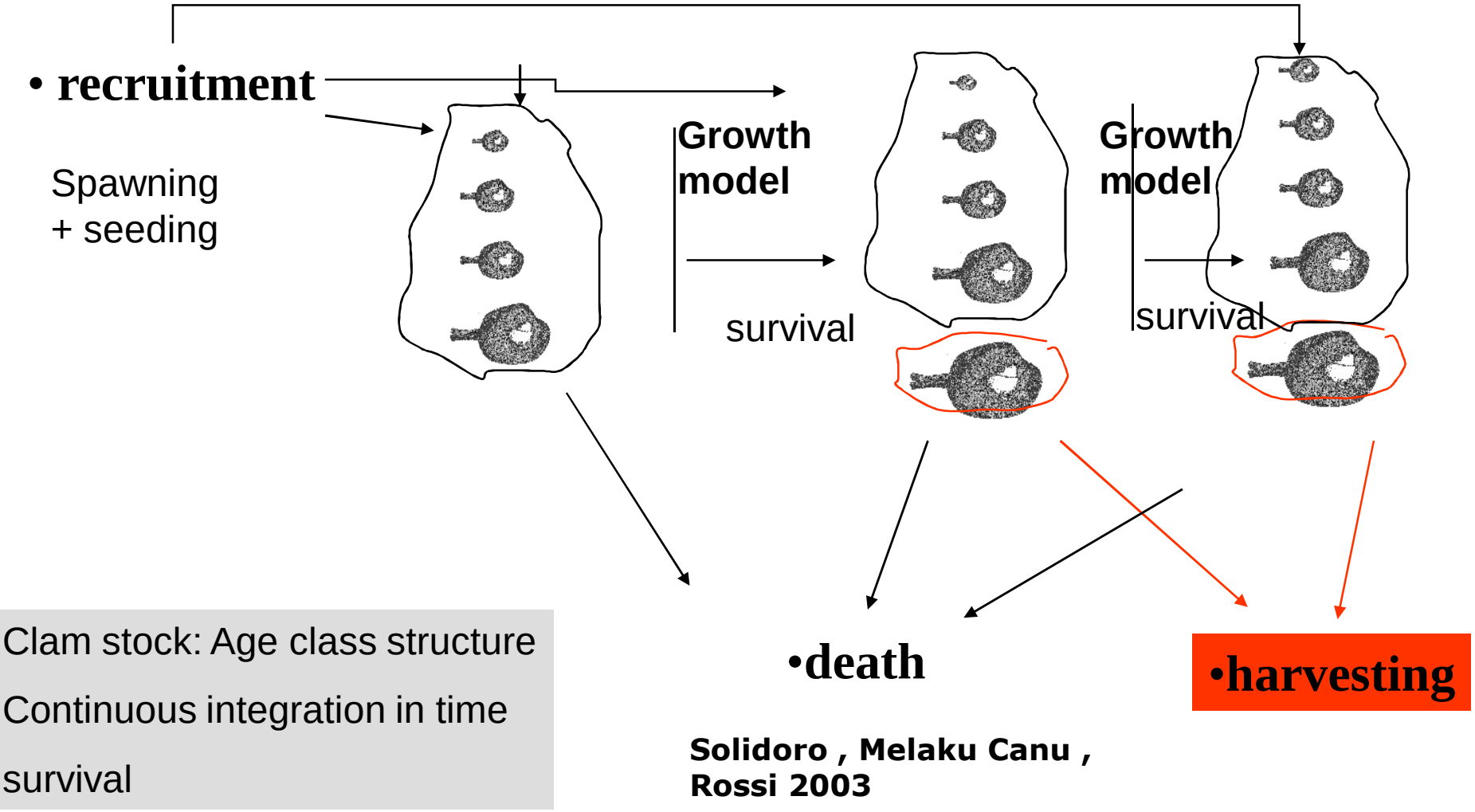




$$\dot{w} = \min\left(V_{\max} F \, , \, g_T w_w^{2/3} \right) - k_r w$$

$\varepsilon_f / \varepsilon_T$

Population Dynamic model

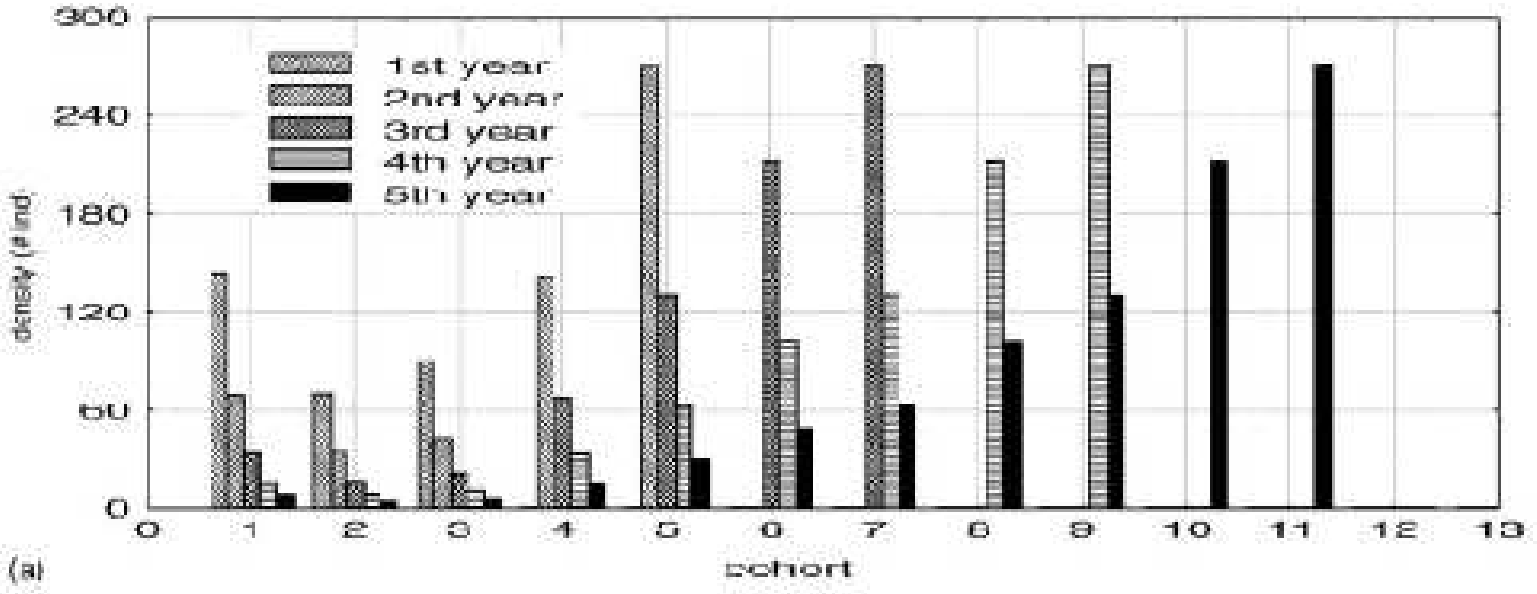


Clam stock: Age class structure

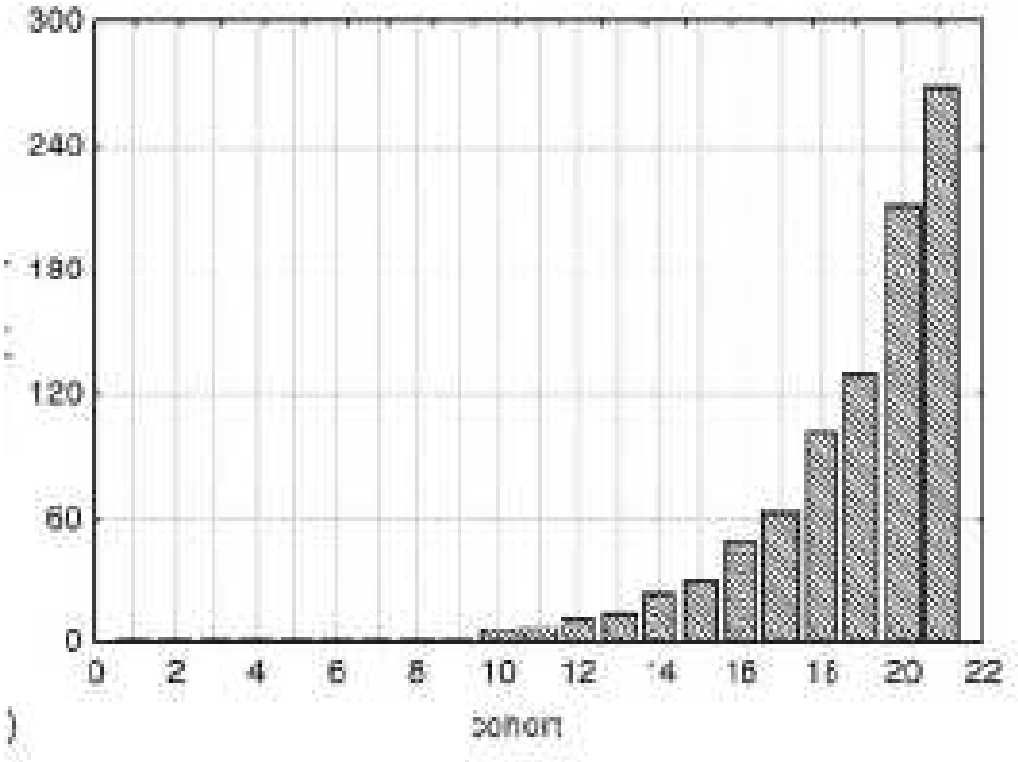
Continuous integration in time

survival

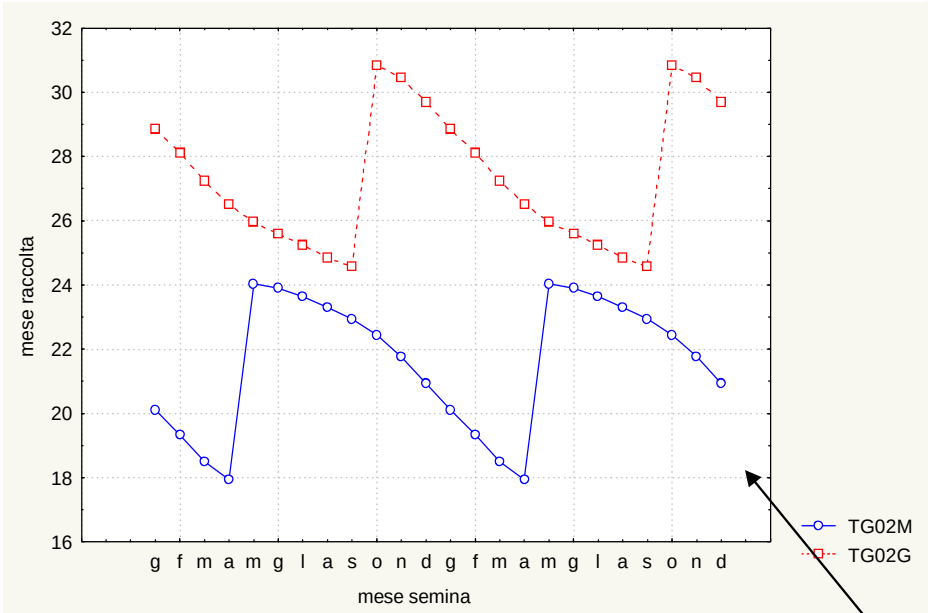
Solidoro , Melaku Canu , Rossi 2003

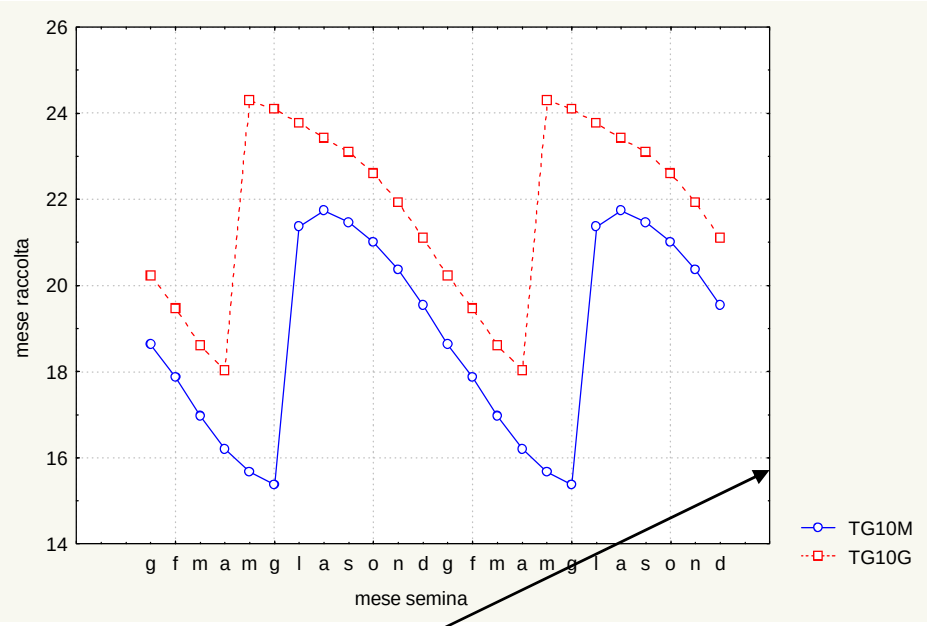


5 years long time course of clam population with no harvesting



Steady state





.Fig 4.2 d *time to harvest small and big clams varying seeding month –from jan to dec- and seeding size -10 and 20 mm-.*

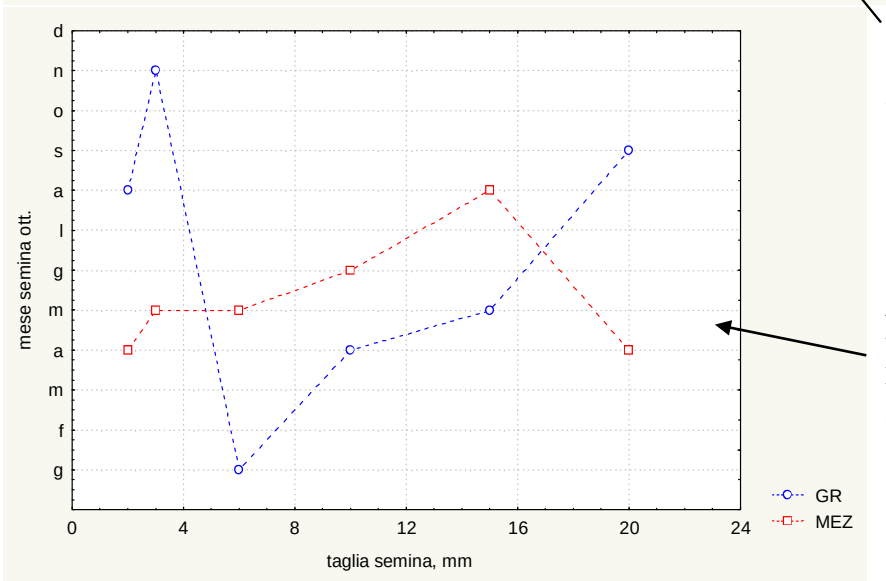
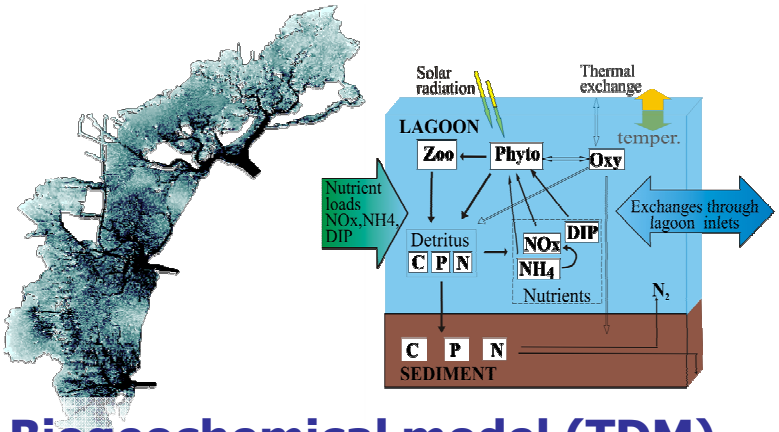


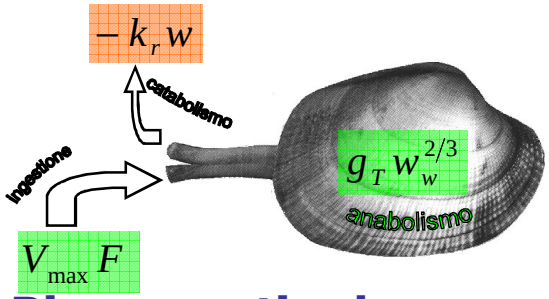
Fig.4.3. identification of the seeding month which minimizes time to harvest.
different lines refer to different seeding size

Methods.1



Biogeochemical model (TDM)

+



Bioenergetic clam model

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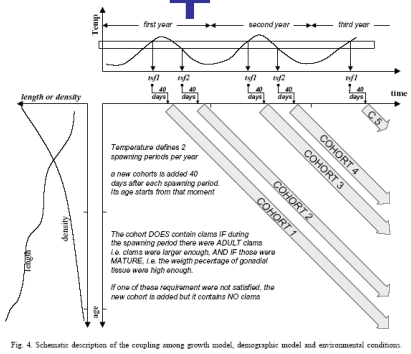
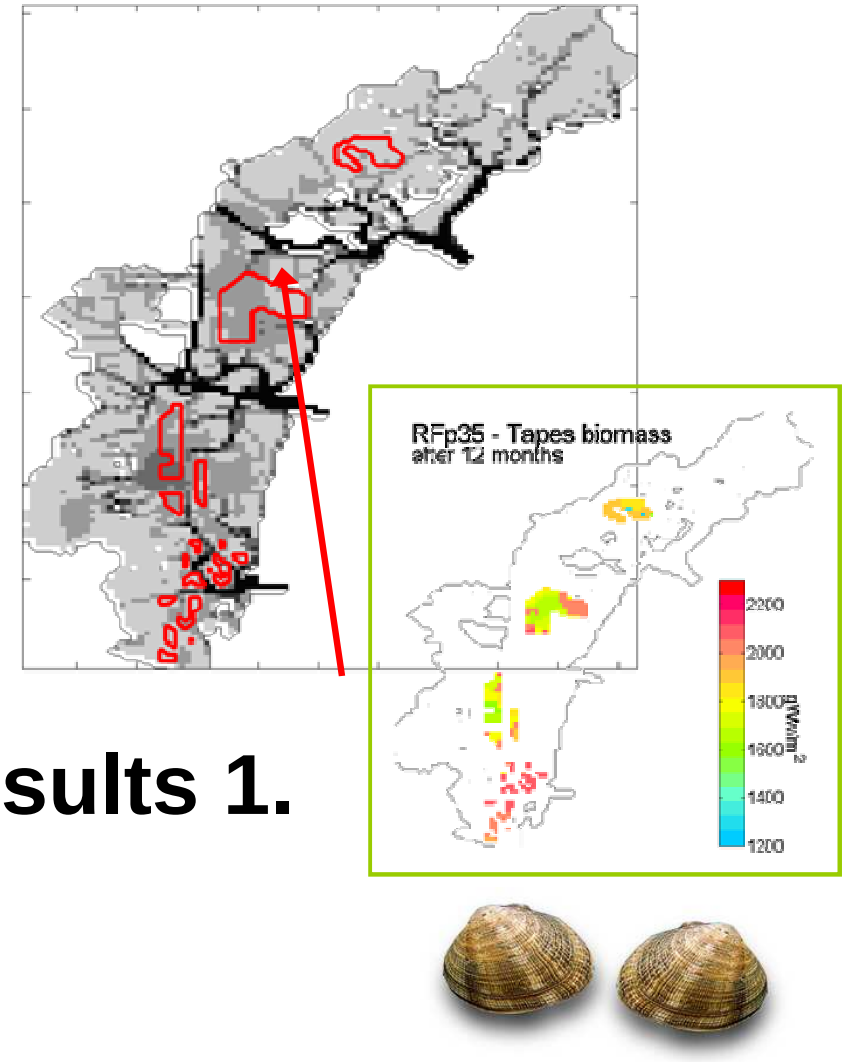


Fig. 4. Schematic description of the coupling among growth model, demographic model and environmental conditions.

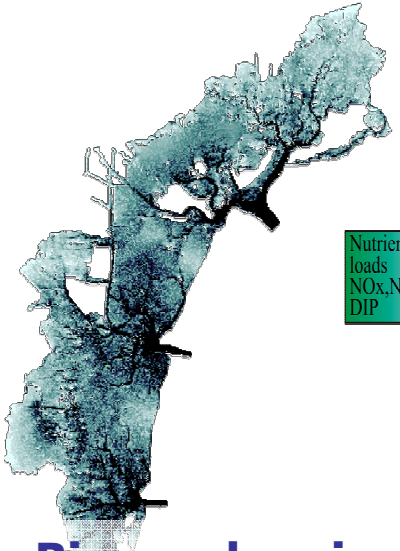
Demographic clam model

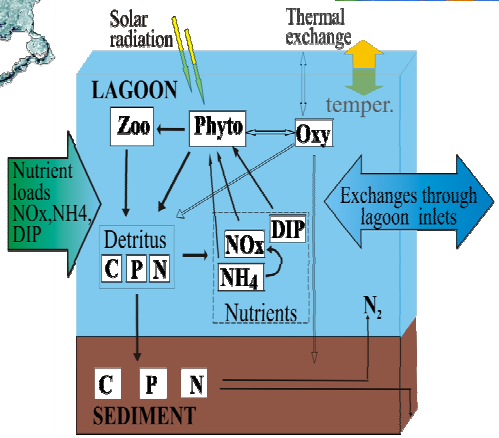


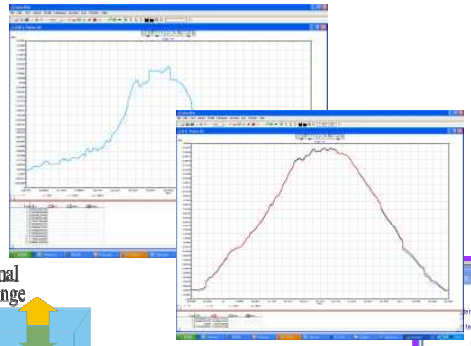
Results 1.

Solidoro et al 2000, 2003 Pastres et al 2001

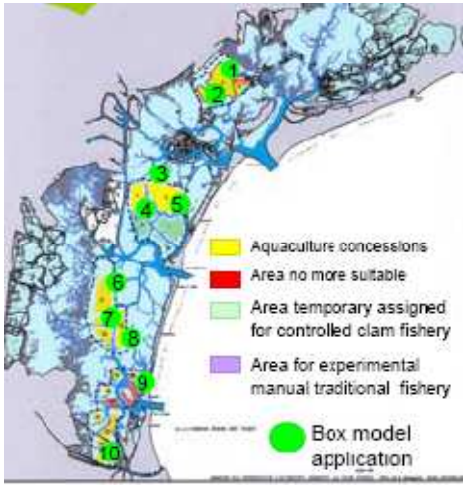
Methods.2

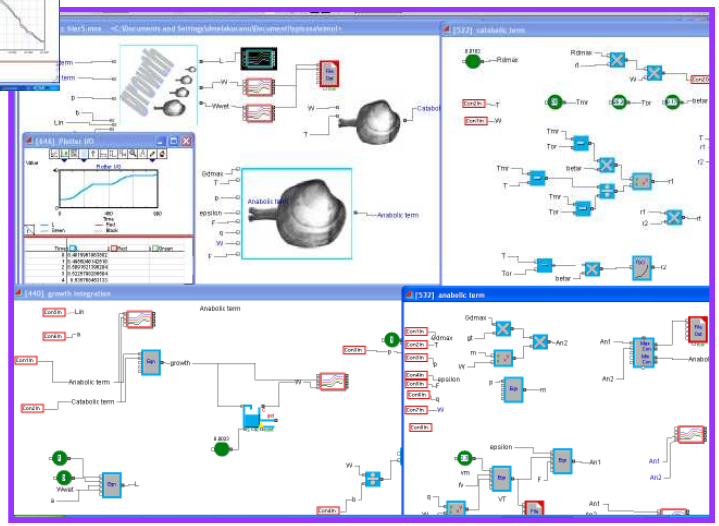






Biogeochemical model (TDM)





EXTEND clam model

EXTEND economic model

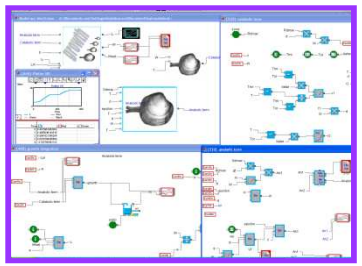
Solidoro et al 2000, 2003 Pastres et al 2001

EXTEND economic model

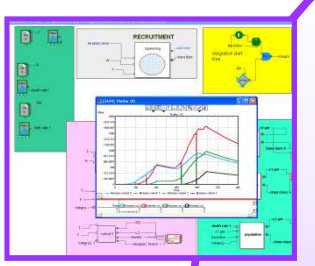
- Computes variable costs such as seeding costs, monitoring costs, gasoline costs, labour costs)
- Computes average revenue and yearly revenue for each fishing unit (boat)

EXTEND Model structure

Individual growth model



Population dynamic model

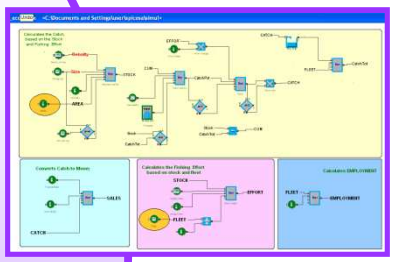


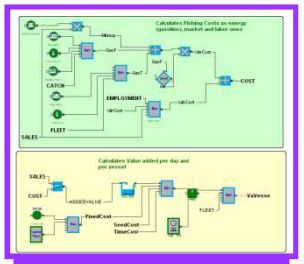
INTEGRATION, First Results:

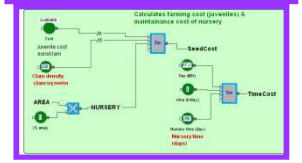
evolution of Catch, Sales, Cost and Added Value.

Varying the schedule of seeding, from january to december

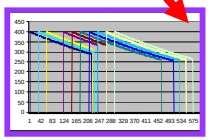
Economic model



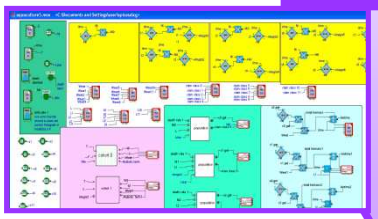




Aquaculture: biomass curves varying seeding time

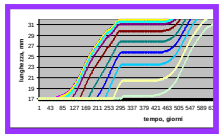


Aquaculture model

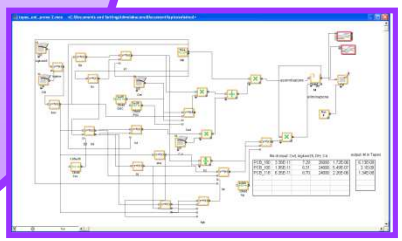


Profitable choice!!!

Aquaculture: growth curves varying seeding time

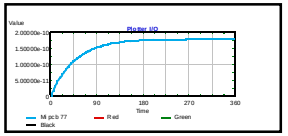


Quality model

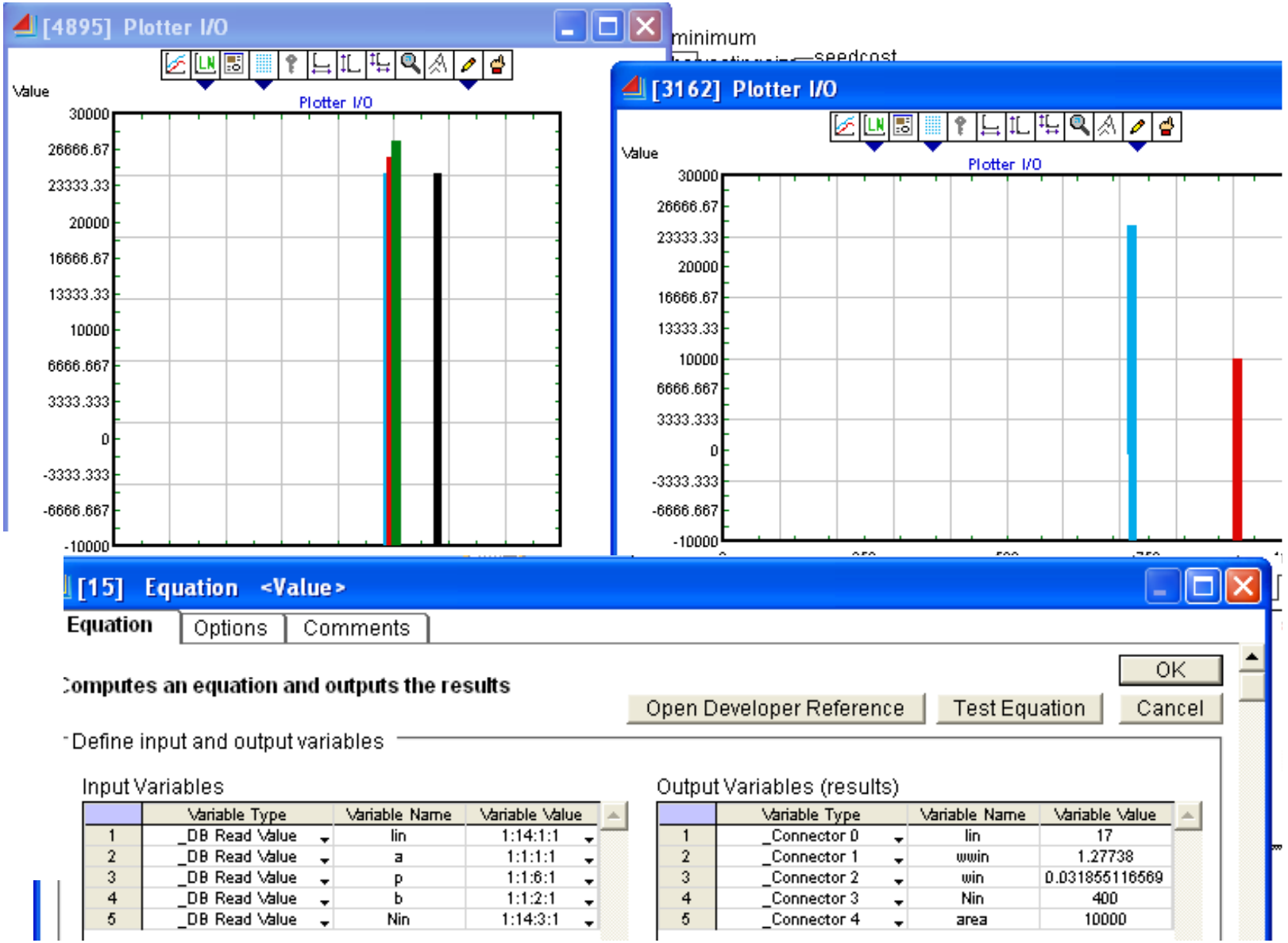


Forcings: pcb 77 in water ($3.38\ 10^{-12}$ g/l)

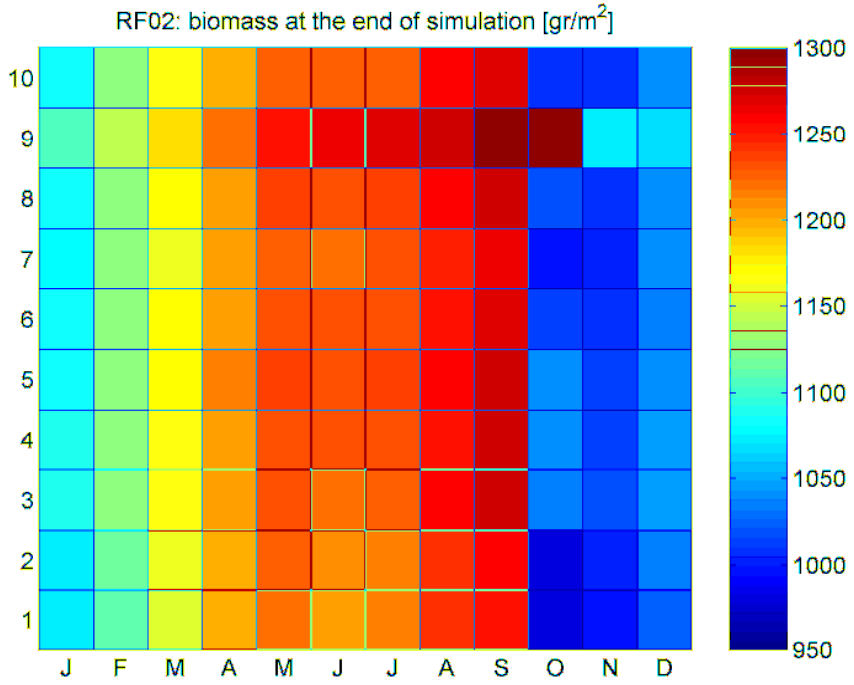
pcb 77 in sediment ($2.70\ 10^{-8}$ g/l);

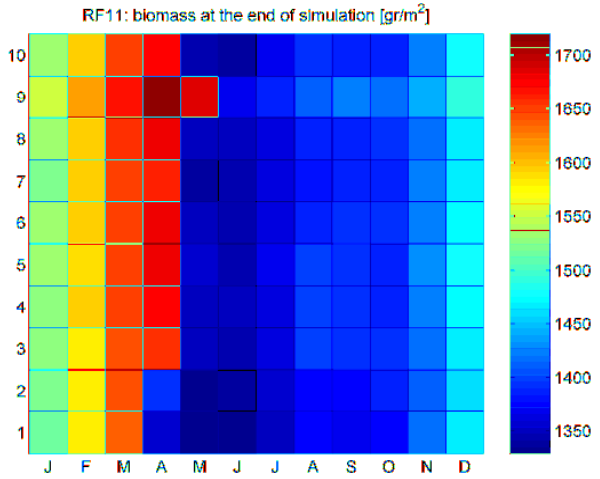


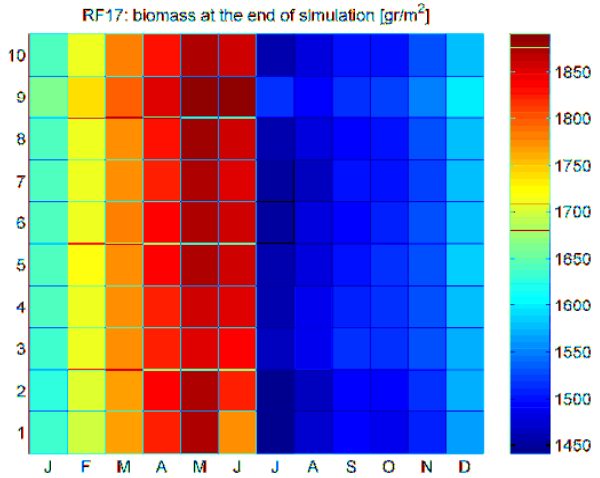
seeding month	income/year/boat march	april	may	june	september	october
euro/year/10000mq	24188.65	25577.71	27154.88	27075.15	24145.90708	9563.153



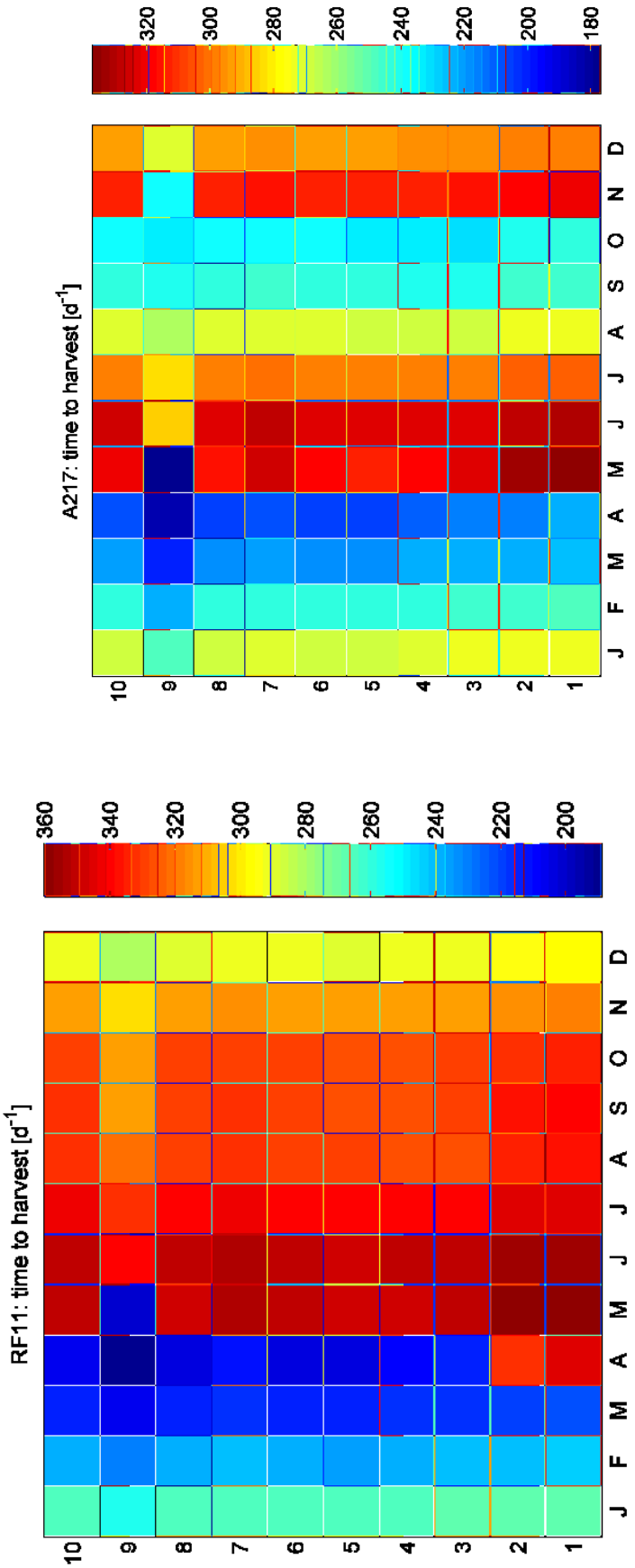
Total Biomass







Time to harvest



Scenario results

sensitivity to price change

				PRICE- 27%	PRICE -17%	PRICE +33%
		1	**2**	**3**	**4**	**5**
seeding month may		may	aprile	may	may	aprile
seeding size, mm		17	17	17	17	17
harvesting size, mm		**34**	**28**	**34**	**34**	**28**
seeding density ind/mq		400	400	400	400	400
seeding cost total euro		32000	32000	32000	32000	32000
seeding price unit		0.008	0.008	0.008	0.008	0.008
PRICE euro/kg		**3**	**2**	**2.2**	**2.5**	**3**
seed day		120	90	120	120	90
harvesting lenght, days		106	92	106	106	92
total yeld, kg		26050	22406	26050	26050	22406
area, ha		1	1	1	1	1
start harvesting, day		516	236	516	516	236
finish harvesting, day		622	328	622	622	328
time to harvest		396	146	396	396	146
rev/year		**35685**	**18572**	**15773**	**23239**	**77614**
variation revenue%		0	-47.955724	-55.7993555	-34.877399	117.497548
return time dredging		449	192	449	449	192
impact/ha euro	7000	3500	7000	3500	3500	7000
revenue-sediment impact		32185	11572	12273	19739	70614
% revenue change (sediment impact)		**-19.616085**	**-37.691148**	**-44.3796361**	**-30.121778**	**-9.018991419**

Additional impacts due to increasing of return time is pressure on juvenile stock and on the nursery area (not quantified here, but see Zucchetta et al *ECSA 09*)

Scenario Results 2.

sensitivity to mortality parameter variation

selling big clams (34 mm) at 3 euro/kg

% variation paramet	-50	0	50	25
mortality rate	*0.00075*	*0.0015*	*0.00225*	*0.001875*
may	**63307**	**35685**	**14282**	**24145**
% change rev/year	77.4050722	0	-59.97758	-32.33852

selling small clams (28 mm) at 2 euro/kg

% variation parame	**-50**	**0**	**50**	**25**
mortality rate	*0.00075*	*0.0015*	*0.00225*	*0.001875*
may	**36056**	**18572**	**487**	**9768**
% change rev/year	94.1417187	0	-97.37777	-47.4047

conclusions

- Bioeconomic model of *Tapes philippinarum*
- *Sensitivity analysis to changes in price and mortality rate suggests that higher level of uncertainty induce fishermen to increase pressure on resource, decreasing the harvesting size, increasing pressure on environment and impacts.*
- *Need of management strategies to avoid price fluctuations such as ‘labelling’ and ‘certification’ in order to prevent overexploitment of Lagoon resource, and of nursery productivity.*

Thank you