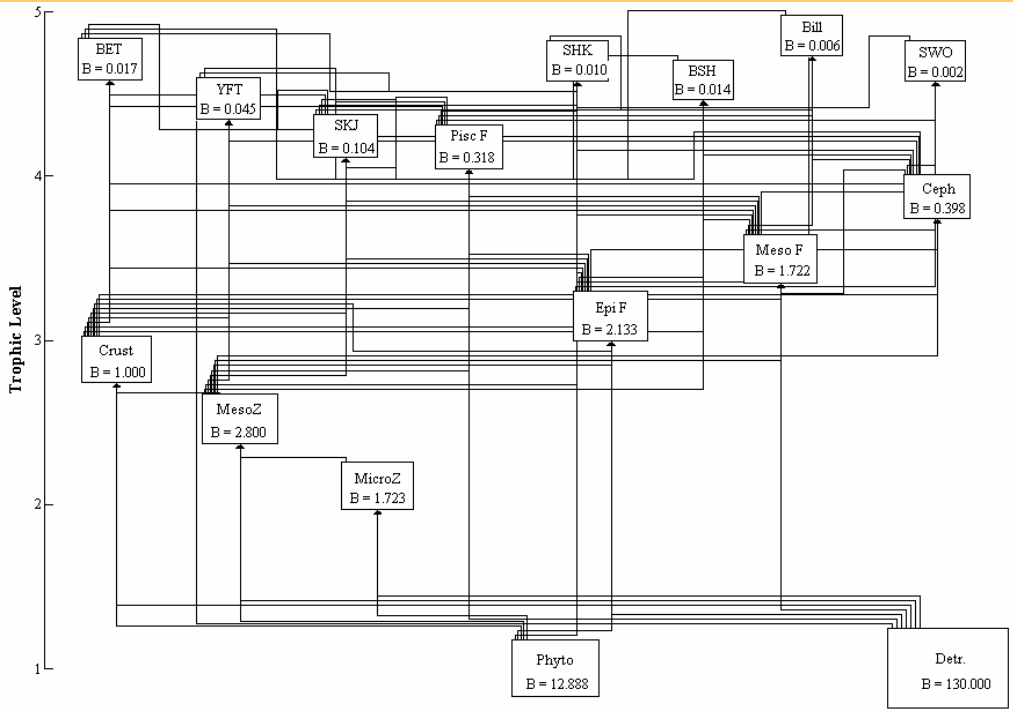
Western and Central Pacific Fisheries Commission

1st Scientific Committee meeting
Noumea, New Caledonia
8-19 August 2005

Ecopath model of the pelagic ecosystem of the Western and Central Pacific Ocean

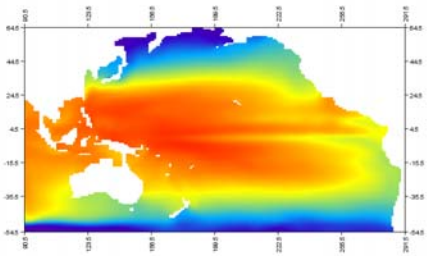


Valerie ALLAIN

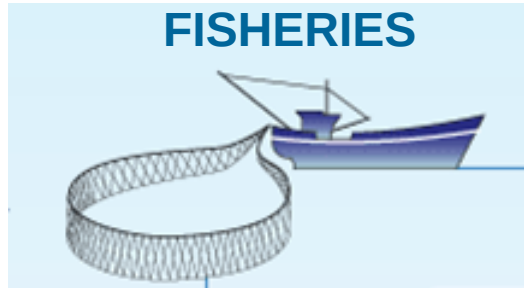
Oceanic fisheries programme
Programme pêche hauturière

Ecosystem approach of fisheries management

ENVIRONMENT



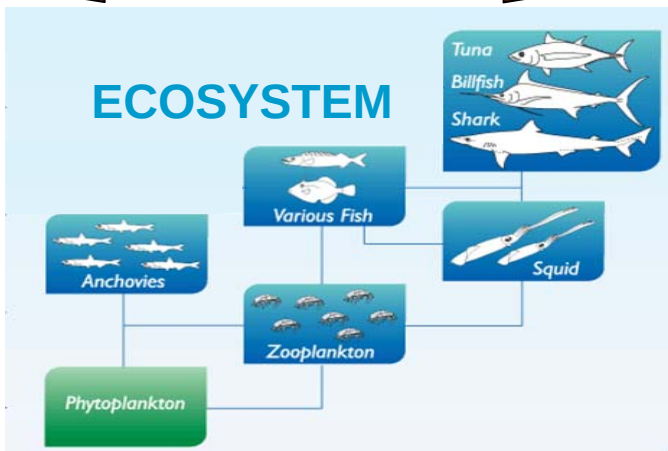
FISHERIES



IMPACT

To help ***understand*** interactions between ecosystem components

To ***investigate impact*** of fisheries and environmental factors on all the components of the ecosystem (target and non-target species)



Development of ecosystem modelling

ECOPATH WITH ECOSIM

Ecopath is a mass-balanced model

based on food-web analysis
assuming steady state in the system

Mass-balance

Production = catch + predation mortality + biomass accumulation + net migration + other mortality

Conservation of matter

Consumption = production + respiration + unassimilated food

Ecosystem components

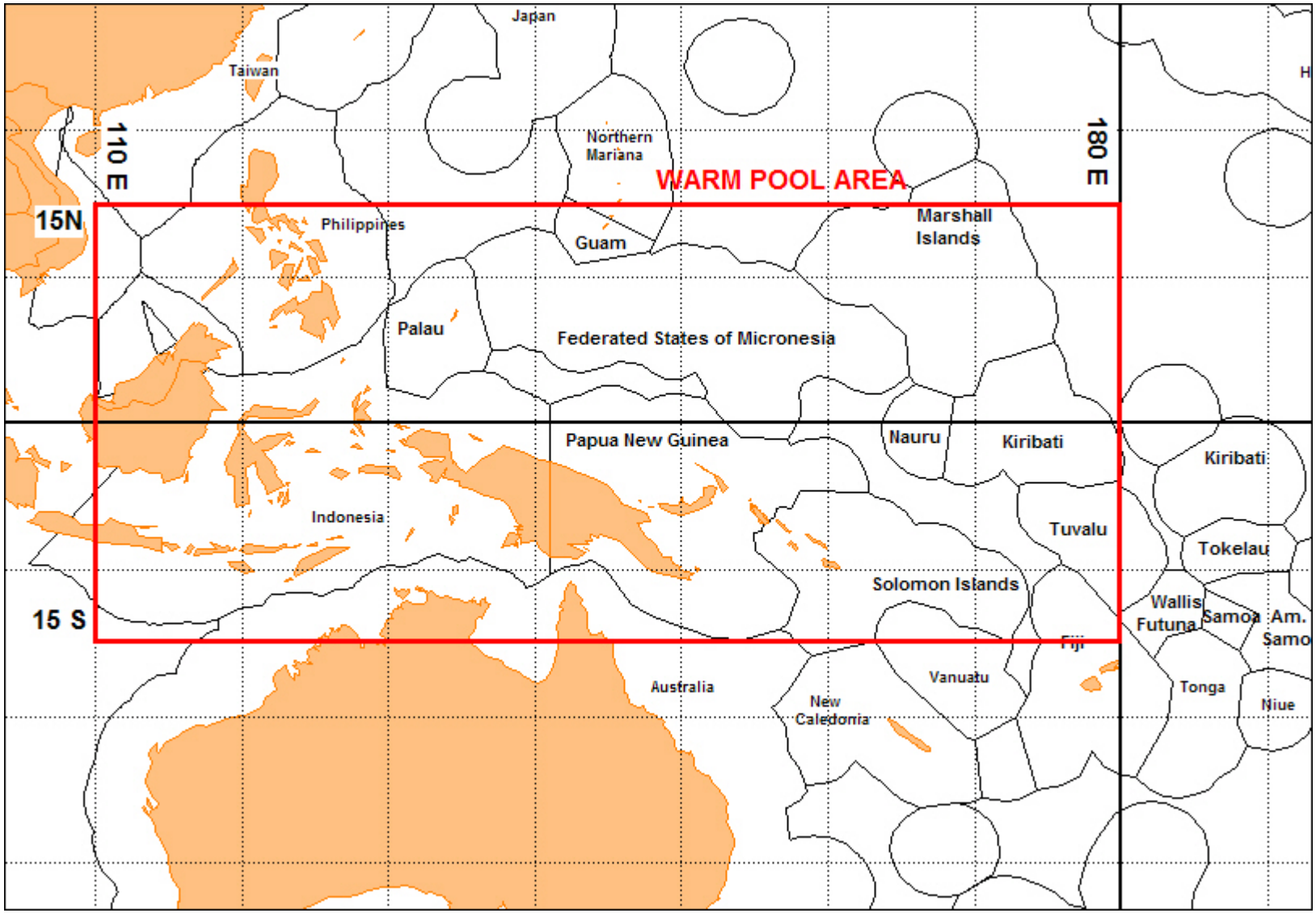
Tuna
Sharks
Marlins
Forage
Plankton …

Catch
Diet composition

Biomass
Production/biomass
Consumption/biomass
Ecotrophic efficiency
(Production used in the model)

3 out of 4

STUDY AREA


Japan
Taiwan
110 E
180 E
Northern Mariana
WARM POOL AREA
15N
Philippines
Guam
Marshall Islands
Palau
Federated States of Micronesia
Papua New Guinea
Nauru
Kiribati
Kiribati
Indonesia
Tuvalu
Tokelau
Solomon Islands
15 S
Wallis Futuna
Samoa
Am. Samo
Fiji
Vanuatu
Tonga
Australia
New Caledonia
Niue

INPUT PARAMETERS

ECOSYSTEM COMPONENTS	CATCH	DIET	BIOMASS	PRODUCTION	CONSUMPTION
SWORDFISH	SPC 2004				
OTHER BILLFISH	SPC 2004				
BLUE SHARK					
OTHER SHARKS					
BIGEYE TUNA	SPC 2004	DIET 2005	MULTIFAN-CL 2005	MULTIFAN-CL 2005	
YELLOWFIN TUNA	SPC 2004	DIET 2005	MULTIFAN-CL 2005	MULTIFAN-CL 2005	BIOENERGETIC 2005
SKIPJACK TUNA	SPC 2004	DIET 2005	MULTIFAN-CL 2005	MULTIFAN-CL 2005	BIOENERGETIC 2005
PISCIVOROUS FISH					
SMALL BIGEYE TUNA	SPC 2004	DIET 2005	MULTIFAN-CL 2005	MULTIFAN-CL 2005	
SMALL YELLOWFIN TUNA	SPC 2004	DIET 2005	MULTIFAN-CL 2005	MULTIFAN-CL 2005	BIOENERGETIC 2005
SMALL SKIPJACK TUNA	SPC 2004	DIET 2005	MULTIFAN-CL 2005	MULTIFAN-CL 2005	BIOENERGETIC 2005
SMALL BILLFISH					
SMALL SHARKS					
EPIPELAGIC FORAGE			SEAPODYM 2005	SEAPODYM 2005	
MIGRANT MESOPELAGIC FORAGE			SEAPODYM 2005	SEAPODYM 2005	
MESOPELAGIC FORAGE			SEAPODYM 2005	SEAPODYM 2005	
Highly migrant bathypelagic forage			SEAPODYM 2005	SEAPODYM 2005	
MIGRANT BATHYPELAGIC FORAGE			SEAPODYM 2005	SEAPODYM 2005	
BATHYPELAGIC FORAGE			SEAPODYM 2005	SEAPODYM 2005	
MESOZOOPLANKTON					
MICROZOOPLANKTON					
LARGE PHYTOPLANKTON					
SMALL PHYTOPLANKTON					
DETRITUS					

DIET STUDIES

MULTIFAN-CL ESTIMATES

SPC CATCH ESTIMATES

BIOENERGETIC MODEL

SEAPODYM ESTIMATES

24 COM

Other data are estimated based on literature review of similar studies in the Pacific, when available

FIRST RUN OF THE MODEL

Group name	Trophic level	Biomass (t/km²)	Prod./ biom. (/year)	Cons./ biom. (/year)	EE
SWO	5.23	0.002	0.4	5.2	0.313
Other billfish	5.44	0.005	0.4	5.3	0.219
BSH	4.86	0.014	0.3	2.5	0.041
Other Shark	5.22	0.01	0.35	4.8	0.141
Adult BET	5.3	0.00148	1.026	14.5	0.807
Adult YFT	4.85	0.0112	1.446	16.14	0.444
Adult SKJ	5.38	0.103	2.046	33.475	0.136
Small billfish	5.16	0.011	0.9	9.3	0.124
Small Shark	5.17	0.012	0.5	5.2	0.137
Small SKJ	4.46	0.0288		69.288	51.605
Small BET	5.27			18	1.238
Small YFT	4.75	0.00953	1.936	18.009	1.392
Piscivorous Fish	5.09	0.0394	1	9	0.95
Forage epipelagic	3.48	0.339	3.691	13.9	5.292
Forage migrant mesopelagic	4.12	0.417		13.9	2.772
Forage mesopelagic	4.3				5.976
Forage H migrant bathypelagic	4.16			13.9	3.482
Forage migrant bathypelagic	4.37	0.343	1.338	13.9	7.207
Forage bathypelagic	4.36	0.759	0.845	13.9	3.499
Mesozooplankton	2.44	4	33	110	0.311
Microzooplankton	2	1.724	100	300	0.944
Large Phytoplankton	1	1.989	134	-	0.251
Small Phytoplankton	1	11.271	94.6	-	0.485
Detritus	1	130	-	-	0.184

JUVENILE TUNAS

FORAGE COMPONENTS

BALANCING THE MODEL

- Modification of parameters to try and reach the balance
- Biomass, production and consumption are less subject to variation than diet
- Modification of the diet matrix to reduce the predation on juvenile SKJ
  - by modifying adult SKJ diet composition which represent a high biomass and high predation as initially 90% of its determined diet is juvenile SKJ
  - and other diet modifications
- After many modifications
  - juvenile SKJ EE was reduced from 51 to 9
  - EE of the 6 forage components were also reduced
  - but piscivorous fish EE increased
- Balance could not be reached

MORE WORK TO BE DONE

- ECOPATH model could not be balanced and simulations to test fisheries and environment impact on the ecosystem could not be run

- More work is needed on the parameterization of the model, and the first model allowed to identify the parameters that need improvement

- Introducing variability into diet matrix and other parameters
  to help balance the model
  to include some variability into the model

- Improve data (biomass estimates) on critical components
  - forage components
  - piscivorous fish

CONCLUSION

- Ecopath is still potentially an interesting tool to try and understand how the ecosystem works

- Concerning the use of this type of models for management issue, at this stage, Ecopath with Ecosim cannot probably be considered as a management tool because of many uncertainties and approximations

- However it is a complement of single-species models as it provides information on the non-target species of the ecosystem

- Even if the results emerging from simulations can be highly speculative because of important uncertainties in the model, Ecopath and Ecosim still provide a documented valuable information on the impact on the ecosystem