Ciências ULisboa

STEADY STATE MODELS

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MESTRADO BIOLOGIA DA CONSERVAÇÃO

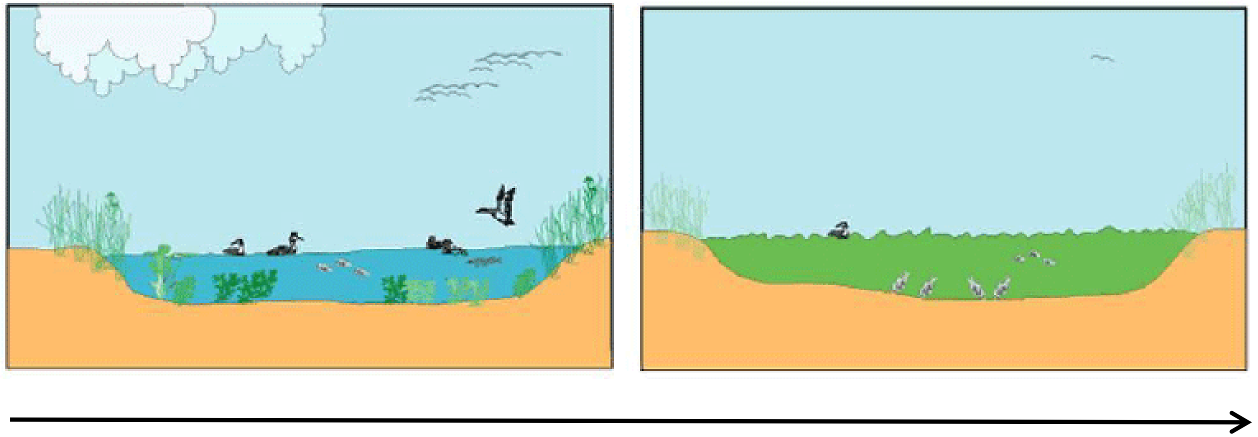
MODELAÇÃO ECOLÓGICA

Prof. Tiago Marques

2018

STEADY STATE MODELS

- Modeled components are **stable** - do not change over time
- Gives information about **average values** of the modelled components or about certain conditions when the ecosystems are in equilibrium
- Phytoplankton-dominant and vegetation dominant states in shallow lake
- Critical implications for management



Phosphorus (μ/L)

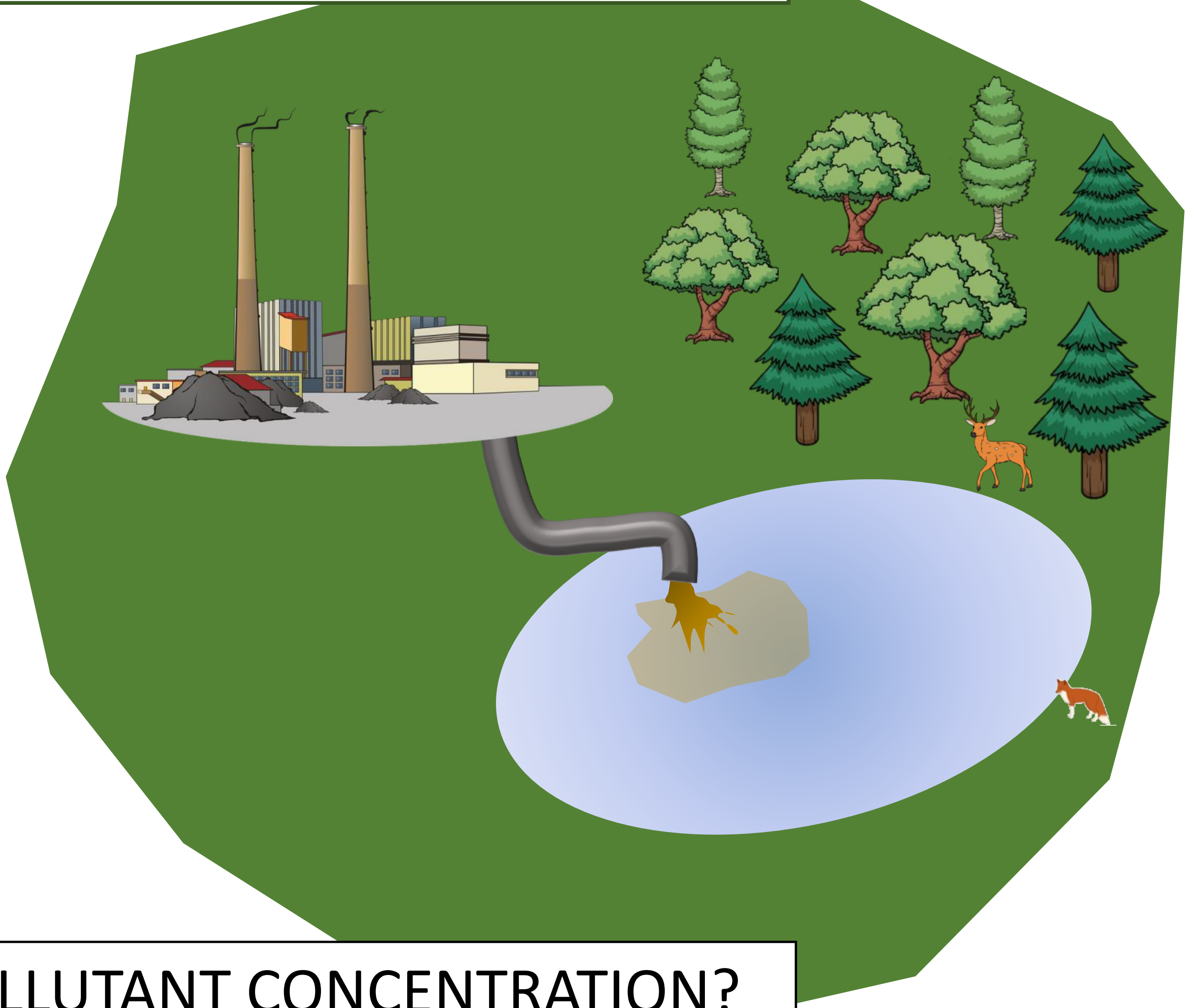
There are different approaches

- Chemostat model
- Ecopath model
- Ecological Network Analysis

$$Dc/dt = (\text{input} - \text{output} - \text{decomposition} - \text{settling} - \text{evaporation})/V = 0$$

- Wastewater volume
- Pollutant concentration in the wastewater
-Half-life of the pollutant
-Volume of the lake
…

Chemostat

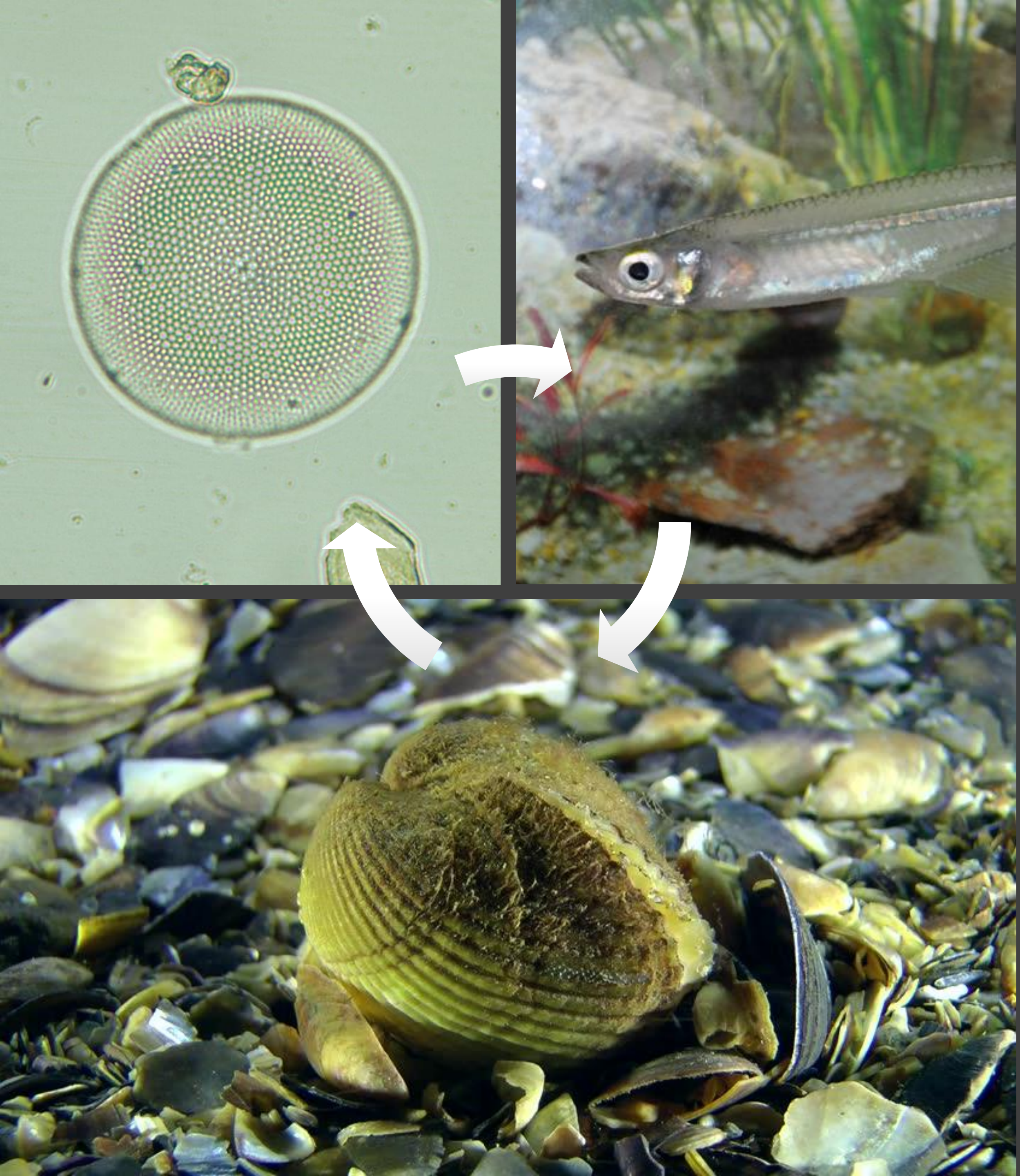


POLLUTANT CONCENTRATION?

Modeling trophic flows in the wettest mangroves of the world: the case of Bahía Málaga in the Colombian Pacific coast

Castellanos-Galindo GA, Cantera J, Valencia N, Giraldo S, Peña E, Kluger LC, Wolff M.

2017



Represent the interactions between the different components of the mangrove ecosystem

A model was created using Ecopath and its main equations:

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

Consumption = production + respiration + unassimilated food

For each of the components there was an associated function based on several parameters

The source of this parameters were many:

- Published and unpublished research
- Data relative to relatively nearby and similar mangroves
- Calculated parameters

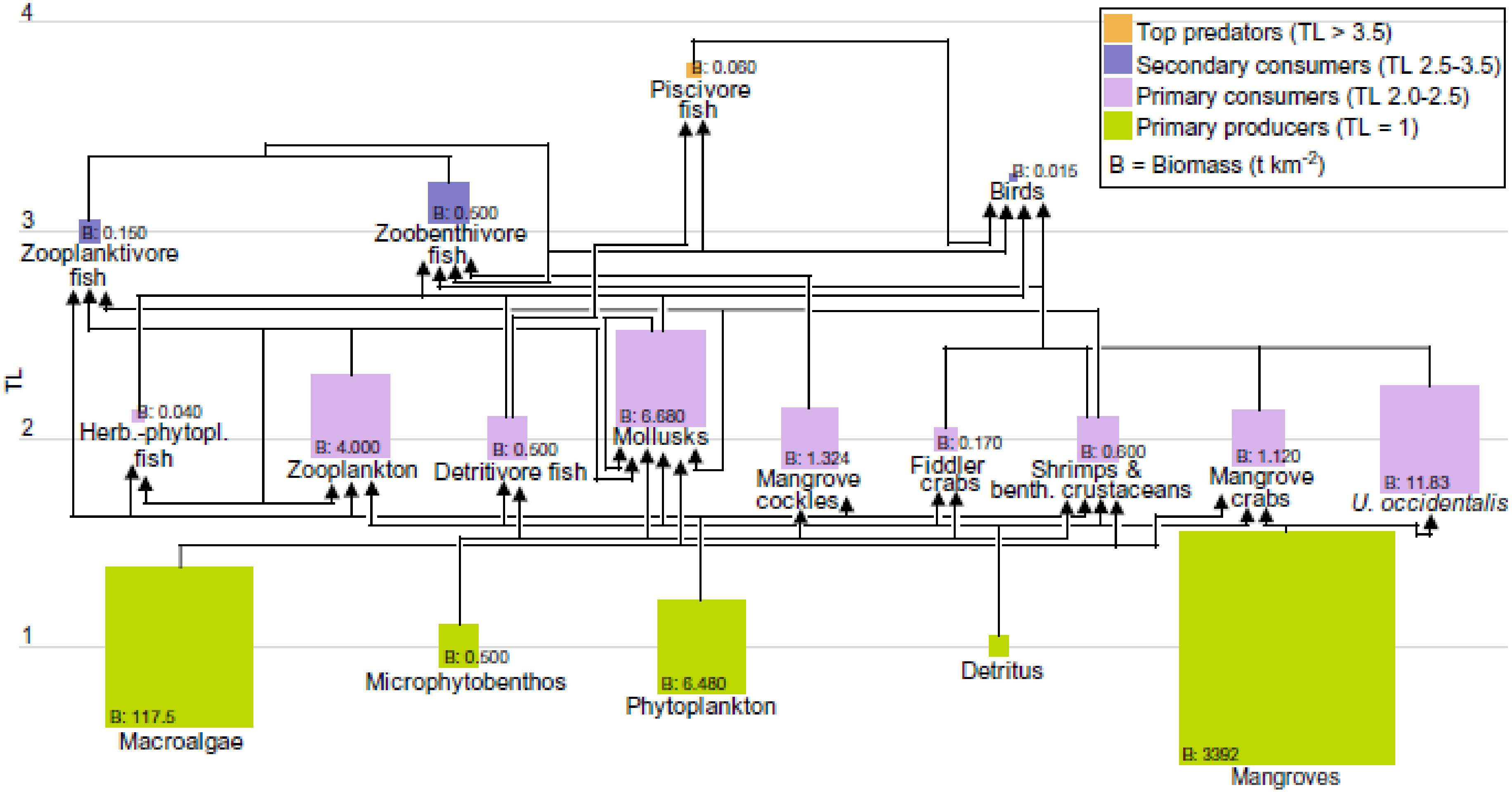


Fig. 3 Flow diagram of the estuarine mangrove system of Bahía Málaga in the Tropical Eastern Pacific as represented by its functional groups. The area of functional group's boxes is scaled to the group's biomass (B), and the *y*-axis describes the trophic level (TL) as calculated by EwE

After the model creation, many indexes were estimated

These were then used to compare with other mangrove ecosystems

The results reveal a surprisingly low productive system that at the same time has very little human interventions.

Table 6 System characteristics and ecological network analysis (ENA) indices of mangrove ecosystems for which Ecopath models have been produced in the Neotropics

System characteristics	Bahía Málaga, Colombia	Gulf of Nicoya, Costa Rica	Golfo Dulce, Costa Rica	Caeté Estuary, Brazil	Terminos Lagoon, Mexico	Huizache-Caimanero Lagoon, Mexico
Biogeographic region	Eastern Pacific	Eastern Pacific	Eastern Pacific	Western Atlantic	Western Atlantic	Eastern Pacific
Tidal regime	Macrotidal	Mesotidal	Mesotidal	Macrotidal	Microtidal	Microtidal
Size (km^2)	160	1,530	750	220	2,500	175
Mangrove area (km^2)	50	135.16	20	99	1,270	4.28
Rainfall (mm $year^{-1}$)	8,000	2,126	3,000–5,000	2,500	1,200–2,000	800–1,200
Funtional groups	18	21	20	20	20	26
Mean trophic level of the catch	2.16	4.06	5.3	2.08	3.6	2.5
Mean transfer efficiency (%)	3.5	14.9	15	9.8	7	8.3
Finn cycling index (FCI)	1.43%	5.5%	18.9%	17.9%	7.0%	9.9%
Relative ascendancy (A/C)[a]	46.5%	26.1%	32.2%	27.4%	51.1	29.4%
Relative overhead (O/C)[a]	53.5%	73.9%	67.8%	69.6%	48.9%	70.7%
Redundancy[a]	%	56%	46.2%		36.1%	
Total system throughput (TST)[a]	7,042.9	3,049.3	1,404.6	10,558.6	3,709.5	6,668.6
Primary production/TST[a]	0.47	0.38	0.27	0.30	0.44	0.57
Consumption/TST[a]	0.13	0,38	0.48	0.35	0.11	0,31
Export/TST[a]	0.39	0.16	0.05	0,21	0.38	0.001
Total biomass of the community[a]	3,542.9	132.1	10.43	13,132.2	263.6	486.3
Reference	This study	Wolff et al. (1998)	Wolff et al. (1996)	Wolff et al. (2000)	Manickchand-Heileman et al. (1998)	Zetina-Rejón et al. (2003)

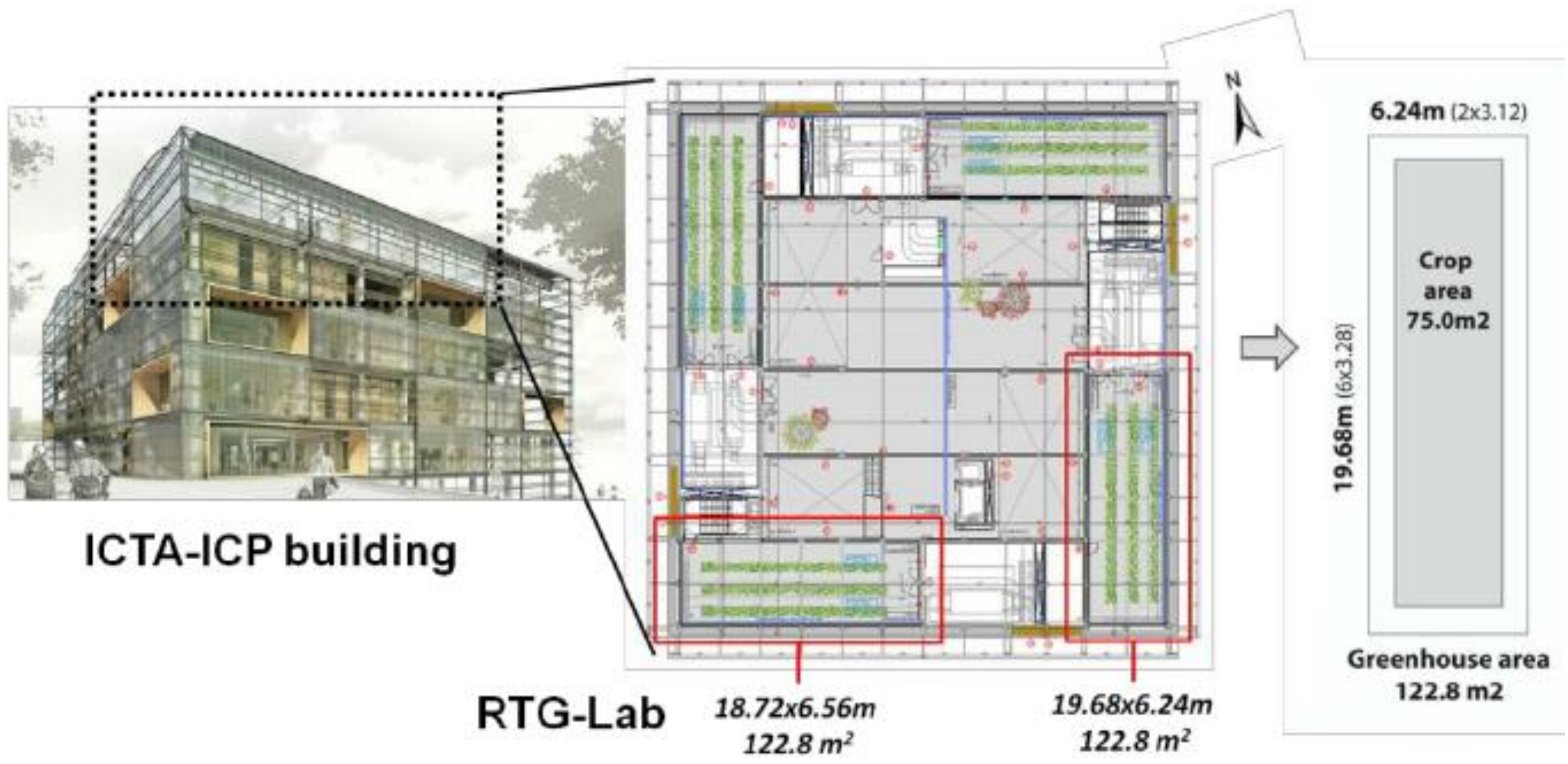
[a] Identified in Heymans et al. (2014) as robust to model construction

Ecological network analysis of growing tomatoes in an urban rooftop greenhouse

Piezer K, Petit-Boix A, Sanjuan-Delmás D, Briese E, Celik I, Rieradevall J, Gabarrell X, Josa A, Apul D.

2019

Objective: to create a sustainable rooftop greenhouse that produces beef-tomatoes based on the Ecological Network Analysis (ENA) model



Traditionally it is use the Life Cycle Assessment (LCA) and the input-output (IO) tables as tools – overview of the material and energy flows trough systems.

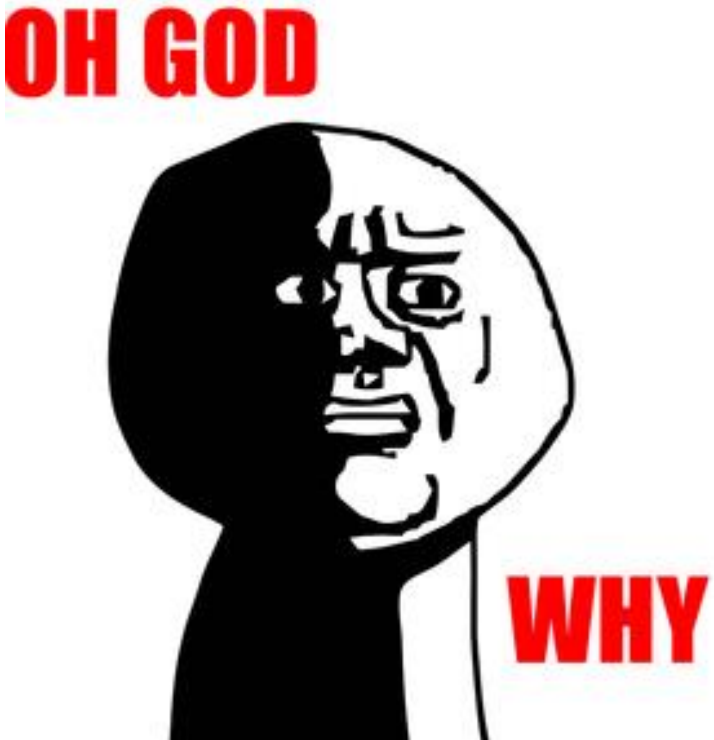
Ecological Network Analysis (ENA)

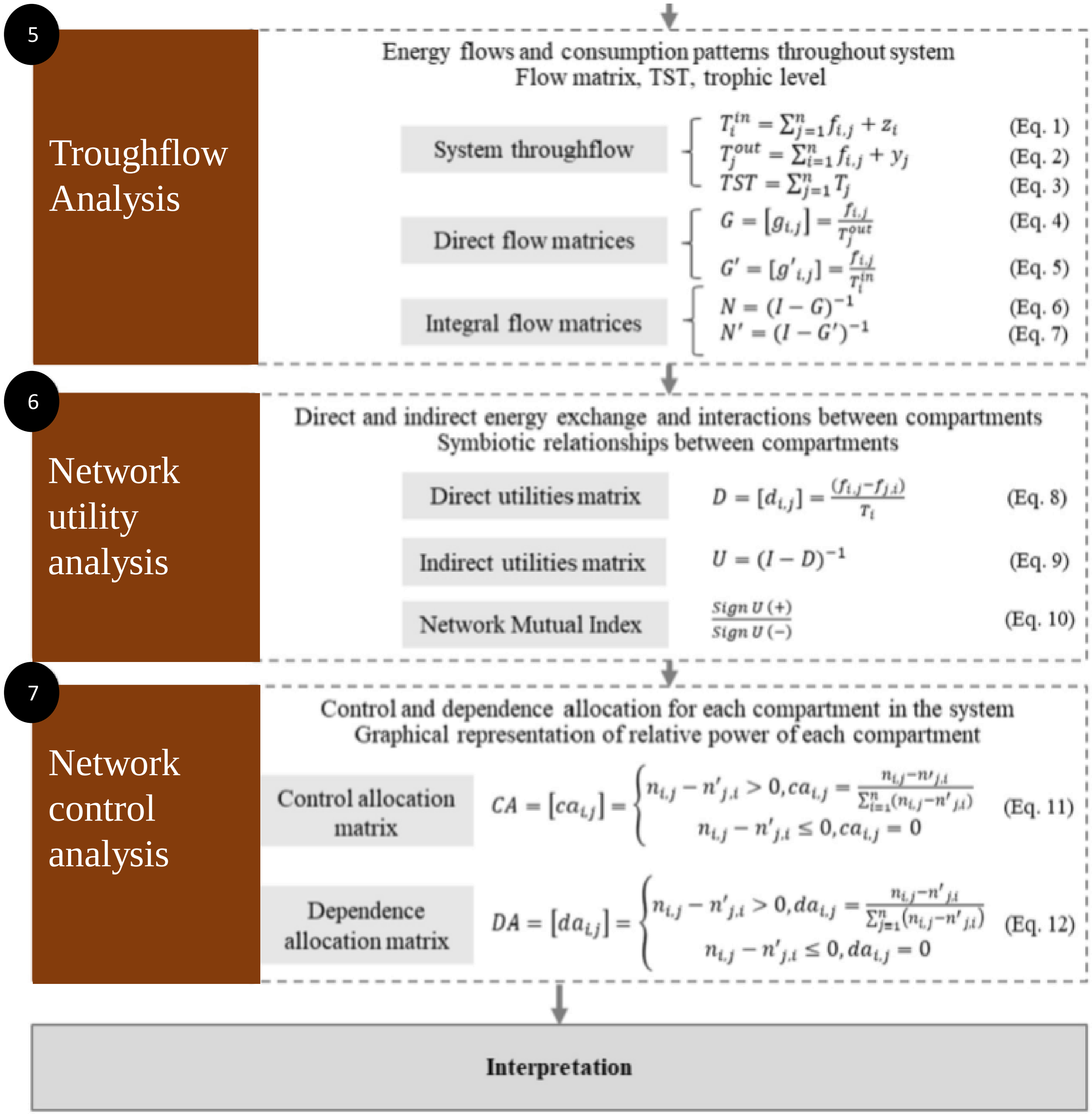
How the hell does it work???

Truly, we don´t know ;(but after maaaany readings we think it is like this…

1. **Goal and scope definition** — Definition of functional unit, system boundaries
2. **Inventory analysis** — Experimental and theoretical measurements, quantification of life cycle flows and processes, definition of network connections
3. **Impact assessment** — Life cycle impact indicator accounted as unit of currency (*e.g., primary energy demand*) ??
4. **Network Balance** — Steady state balance model

Model calculations





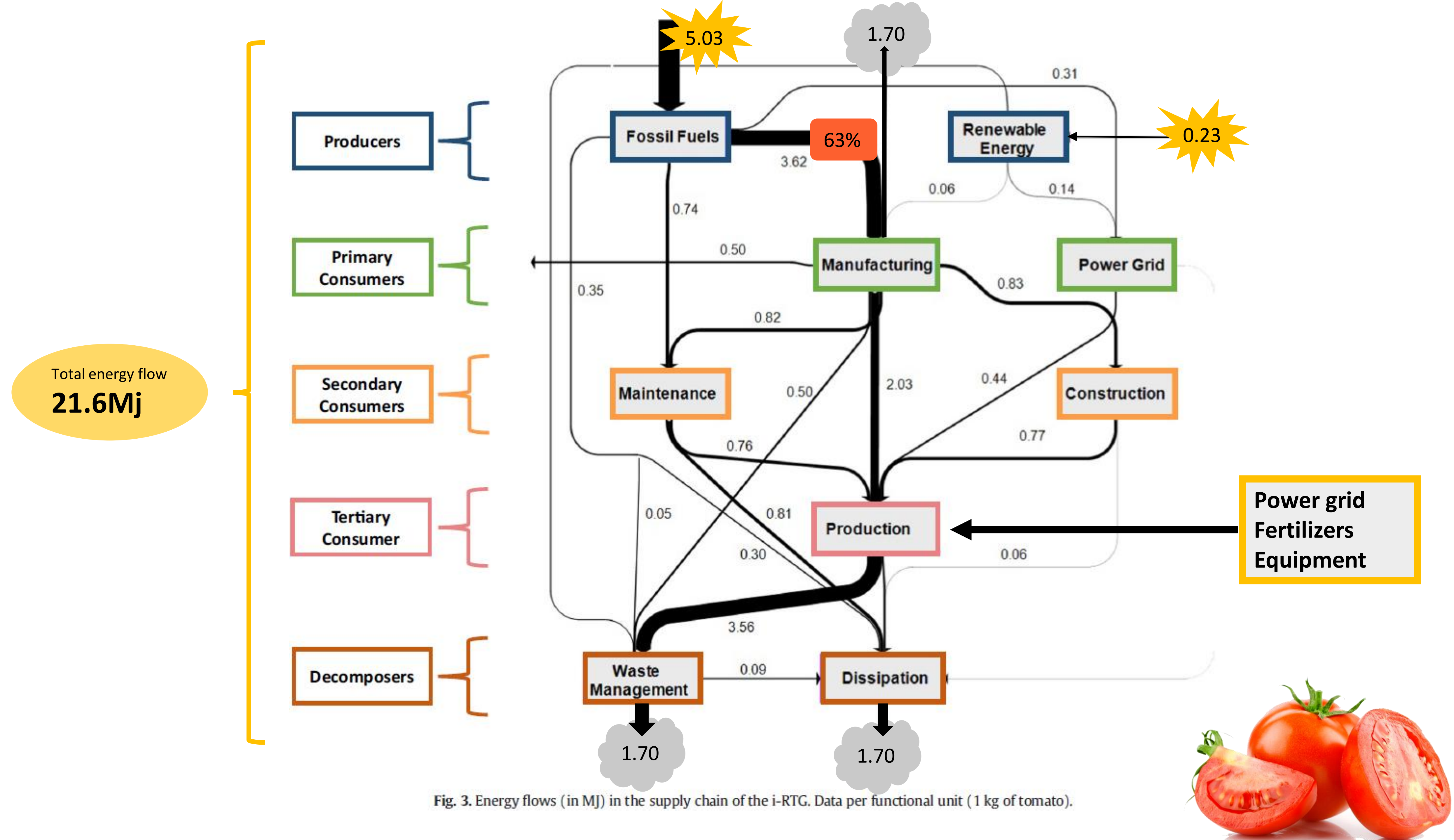
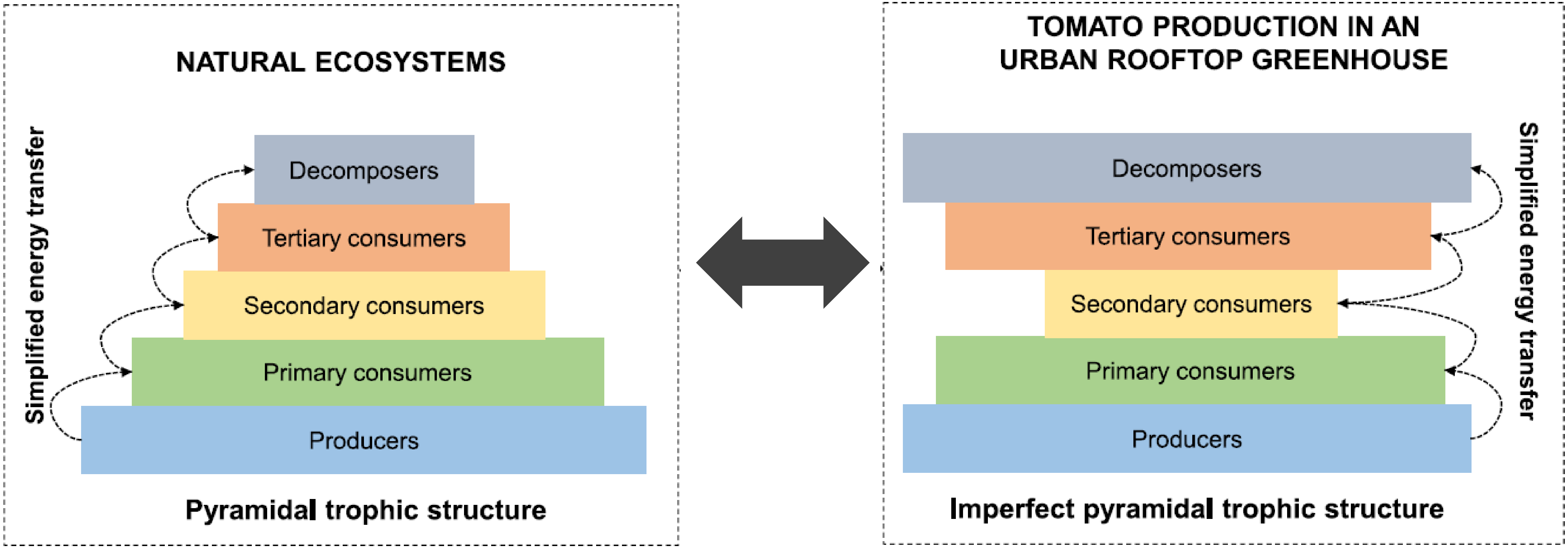


Fig. 3. Energy flows (in MJ) in the supply chain of the i-RTG. Data per functional unit (1 kg of tomato).

Conclusions

1. Identify the energy structure of an urban agricultural setting

2. Future → make improvements on the system and also to predict future behaviors



Natural Ecosystem vs Urban Agriculture System

Conclusions

1. Identify the energy structure of an urban agricultural setting

2. Future → make improvements on the system and also to predict future behaviors

OVERVIEW

	Ecological Network Analysis		Ecopath
Name		≠	
Assumptions and Inputs		=	
Type of questions answered		=	

Basically the same thing…

OVERVIEW: Constraints

- Assumes a “closed” system
- Doesn’t recognize ontogeny

  But!
  Can be fixed by using diferente age classes
- Based on means and average values
- May under or overestimate the impact of harvest

OVERVIEW: Why you want to use them!

- Whole system snapshot view
- Complex interactions between trophic groups
- Role of each component in the system
- Quantification of trophic interactions, harvest rates and impacts and productivity
- Great potential to model aquatic ecosystems

Thank you ☺