

# Bioenergetics

PhD. student

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**6- What drives growth**

**7- The nature of growth in fish**

## What drives growth

# What drives growth ?



**Environment**

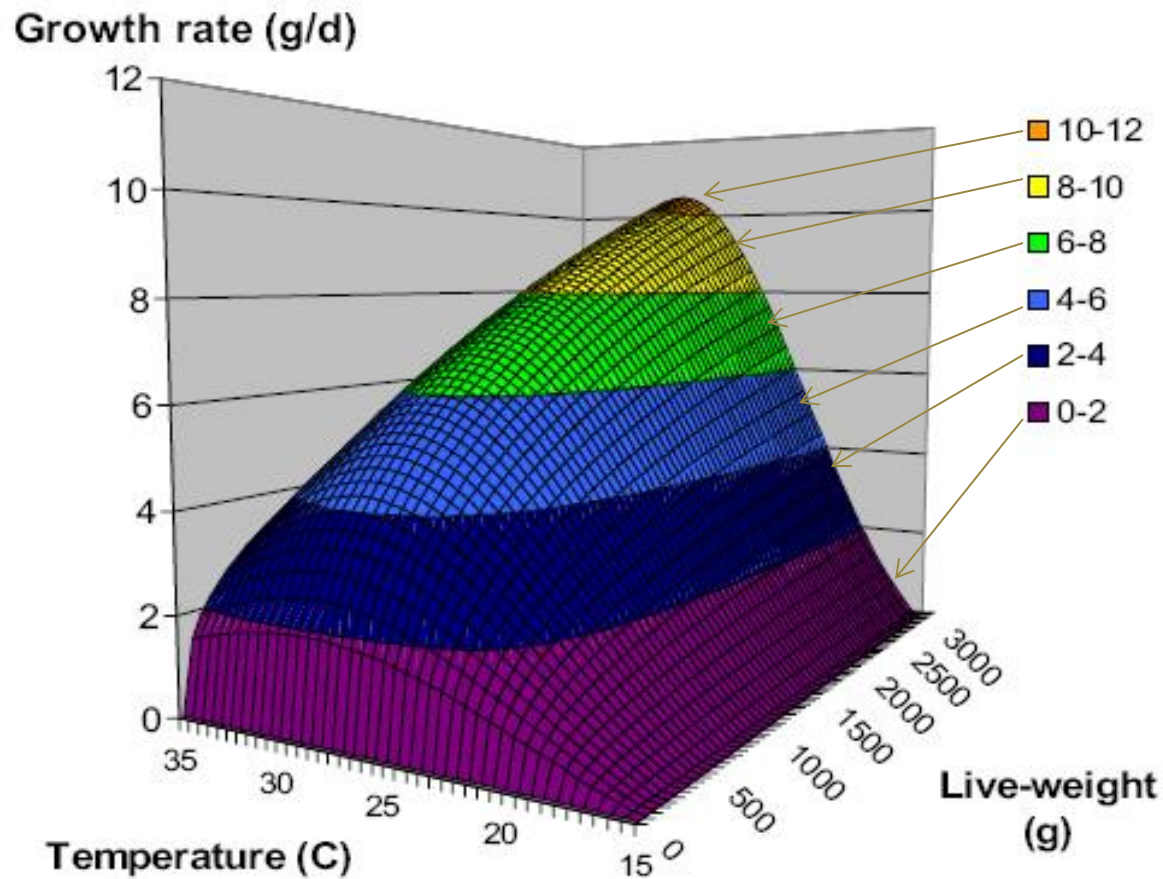


**Genetics**

- **Temperature**
- **Oxygen**
- **Dietary nutrients**
- **Dietary energy**
- **Pathogens**

# What drives growth

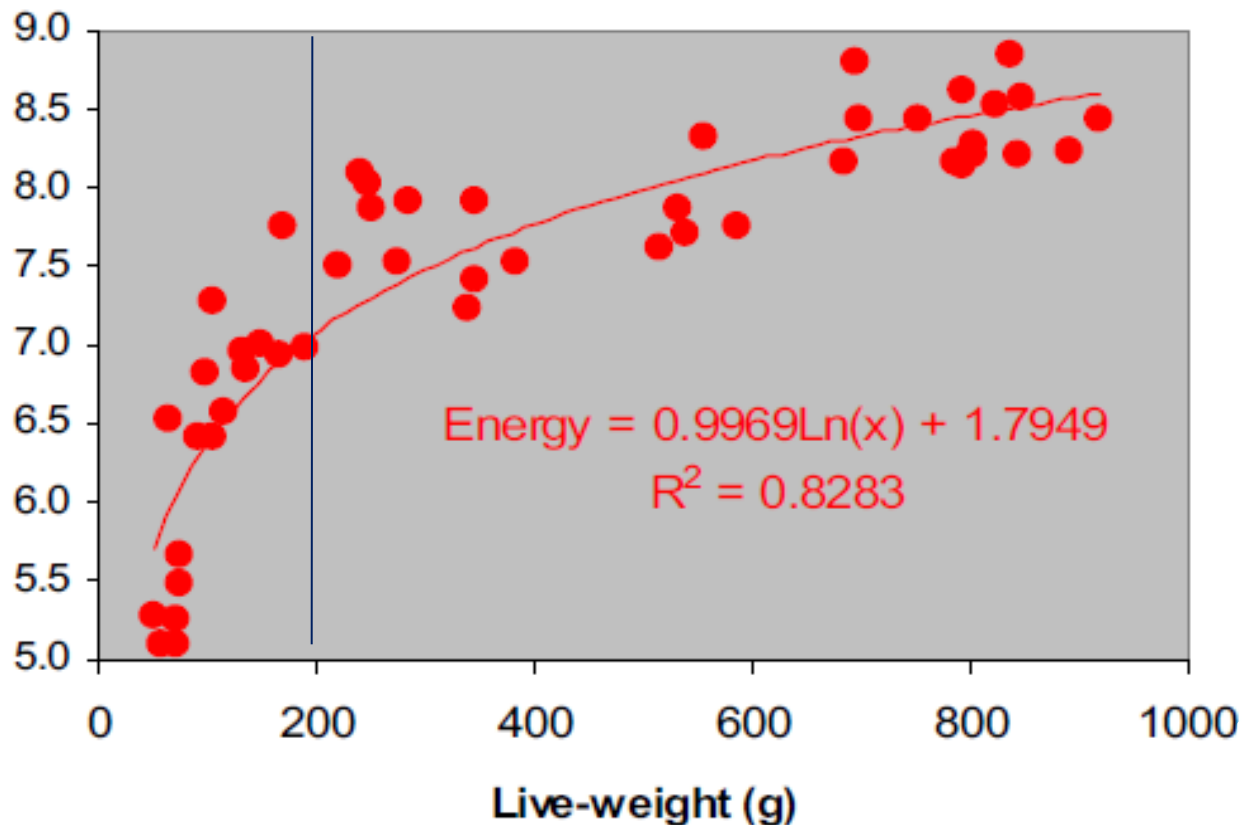
## Predicting fish growth



# What drives growth

## Retained Energy

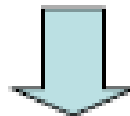
Gross energy content  
(MJ/kg live-weight)



## What drives growth

# Energy gain with growth

**With known Fish size (g) and water temperature (°C)**



**Estimate weight gain (g/d)**



**Estimate energy gain (kJ/d)**

**=**

**RETAINED  
ENERGY DEMAND**

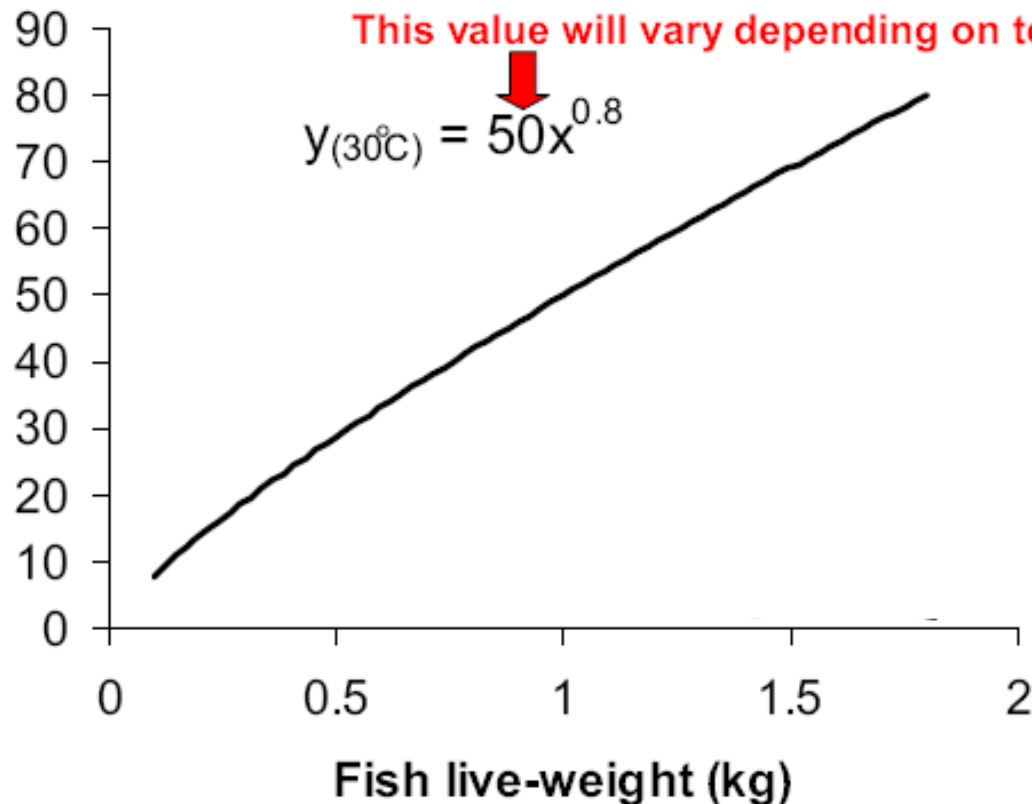
# What drives growth

- All animals have a need for both dietary nutrients and ENERGY
- Nutritional budgets can be described in terms of energy flows
  - Protein = 23.6 MJ/kg
  - Lipid = 39.5 MJ/kg
  - Carbohydrates = 17.3 MJ/kg
- Energy use by fish can be of many forms:
  - *Retained energy (tissue deposition)*
  - *Metabolic (maintenance) energy*
  - *External work energy*
  - *Faecal energy losses*
  - *Urinary energy losses*

# What drives growth

## Maintenance Energy Demands

Energy loss rate (kJ/d)



## What drives growth

# Energetic cost of growth

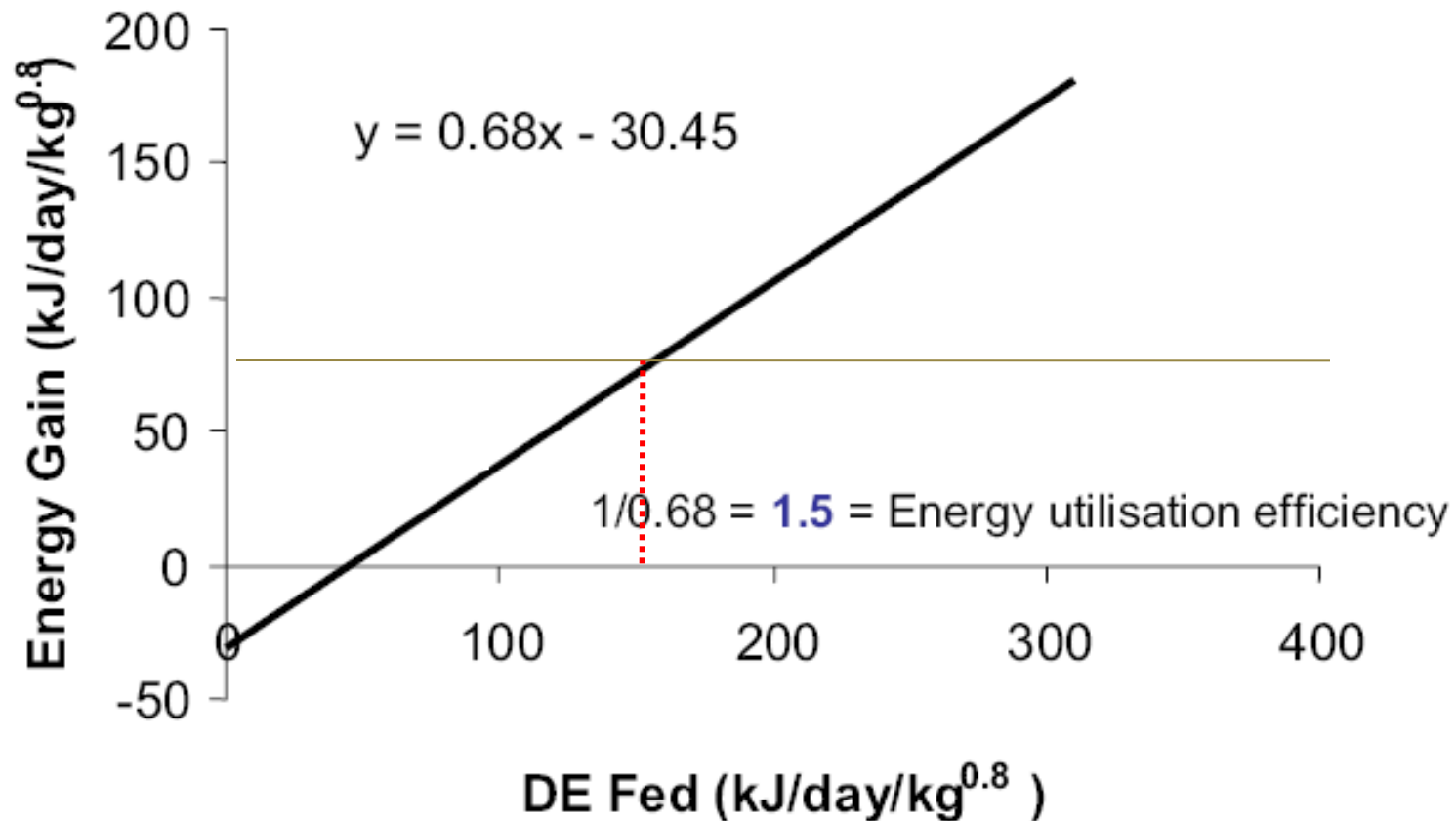
- The process of growth by animals has certain inefficiencies
- The nature of these inefficiencies of energy use appear to be species specific\*
- These account for the cost of conversion of dietary energy to retained energy



# What drives growth

## Utilisation Efficiencies

$$y_{(30^{\circ}\text{C})} = 50x^{0.8}$$



## What drives growth

# Energy needs for fish...

**Retained Energy Demand (RE)**

(body composition)

+

**Non-Retained Energy Demand**

(maintenance, activity, heat-loss)

=

**TOTAL ENERGY NEEDS**

# What drives growth

## Bringing this together...

**Fish weight (g)**

Growth (g/d)

*Energy requirement*

Metabolic BW (kg)<sup>0.8</sup>

DE<sub>maint</sub> (kJ/fish/d)

Energy gain (kJ/fish/d)

DE<sub>growth</sub> (kJ/fish/d)

DE<sub>total</sub> (kJ/fish/d)

	10	100	1000
Growth (g/d)	0.96	2.50	6.52
Metabolic BW (kg) <sup>0.8</sup>	0.03	0.16	1.00
DE <sub>maint</sub> (kJ/fish/d)	1.43	9.02	56.91
Energy gain (kJ/fish/d)	4.37	15.84	57.35
DE <sub>growth</sub> (kJ/fish/d)	6.43	23.29	84.33
DE <sub>total</sub> (kJ/fish/d)	7.86	32.31 =	141.24

$0.1^{0.8}$

X50 (Temp.)

x1.5

DE total (kJ/g/d)

0.786

0.3231

0.14124

Total Digestible Energy (DE) Intake required to achieve growth