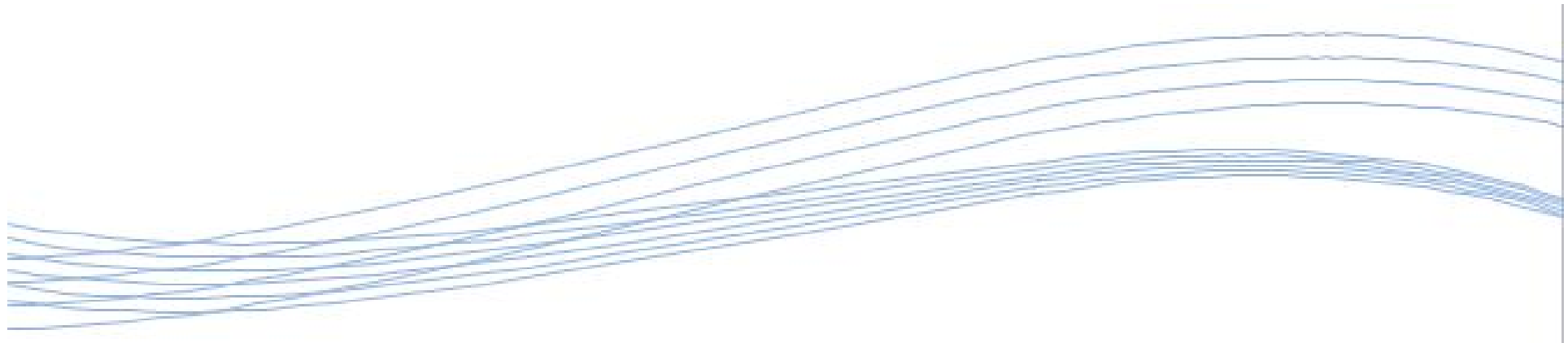


# Increased meat consumption and its effect on municipal wastewater treatment

David J. I. Gustavsson and Susanne Tumlin



# Challenges for WWTPs in Sweden

Increased demands  
of nutrient removal

*Focus on nitrogen*

Combined sewers

Nutrient recovery

Removal of  
micropollutants

Solutions

Source control and source separation  
and/or

End-of-pipe solutions

# Increase nitrogen removal capacity

Due to

- More stringent effluent discharge limits
- Increased load

How?

- Increased volume
- Increased energy usage
- Decreased biogas production
- Increased need of external carbon source



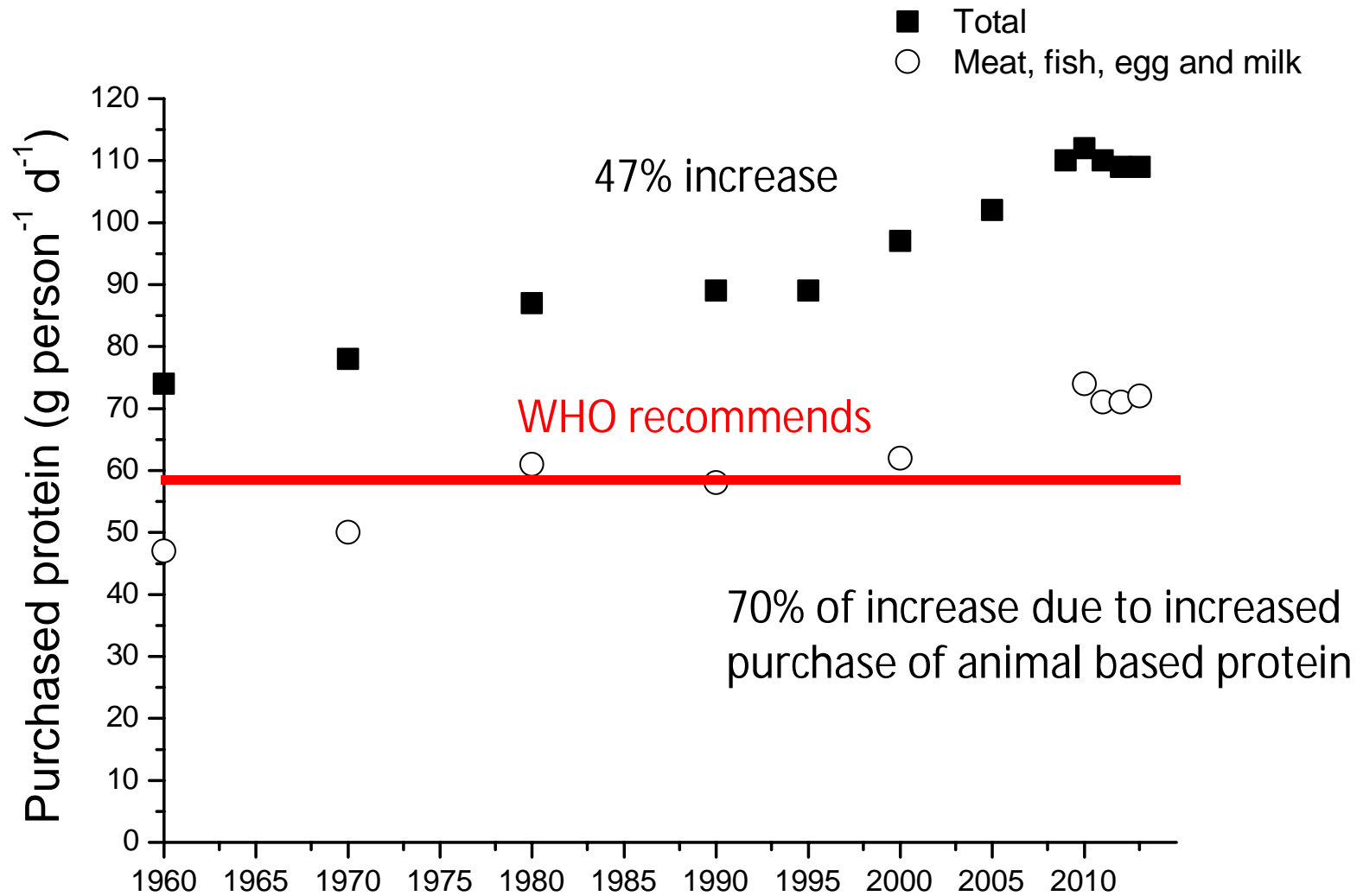
Increased costs and increased environmental impact

# Increased nitrogen load

Due to

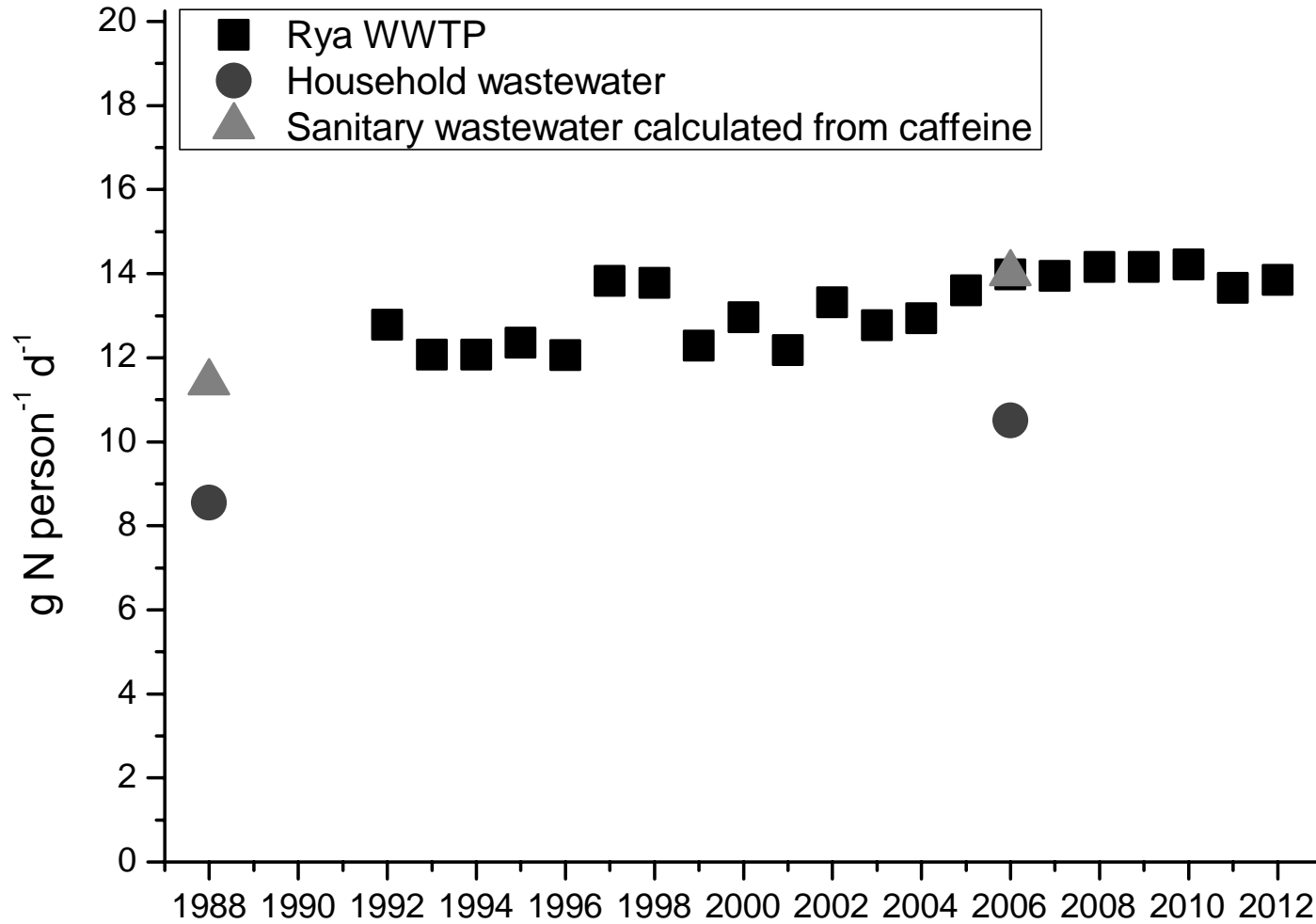
- Population growth
- Increased protein consumption!

# Increased purchased protein

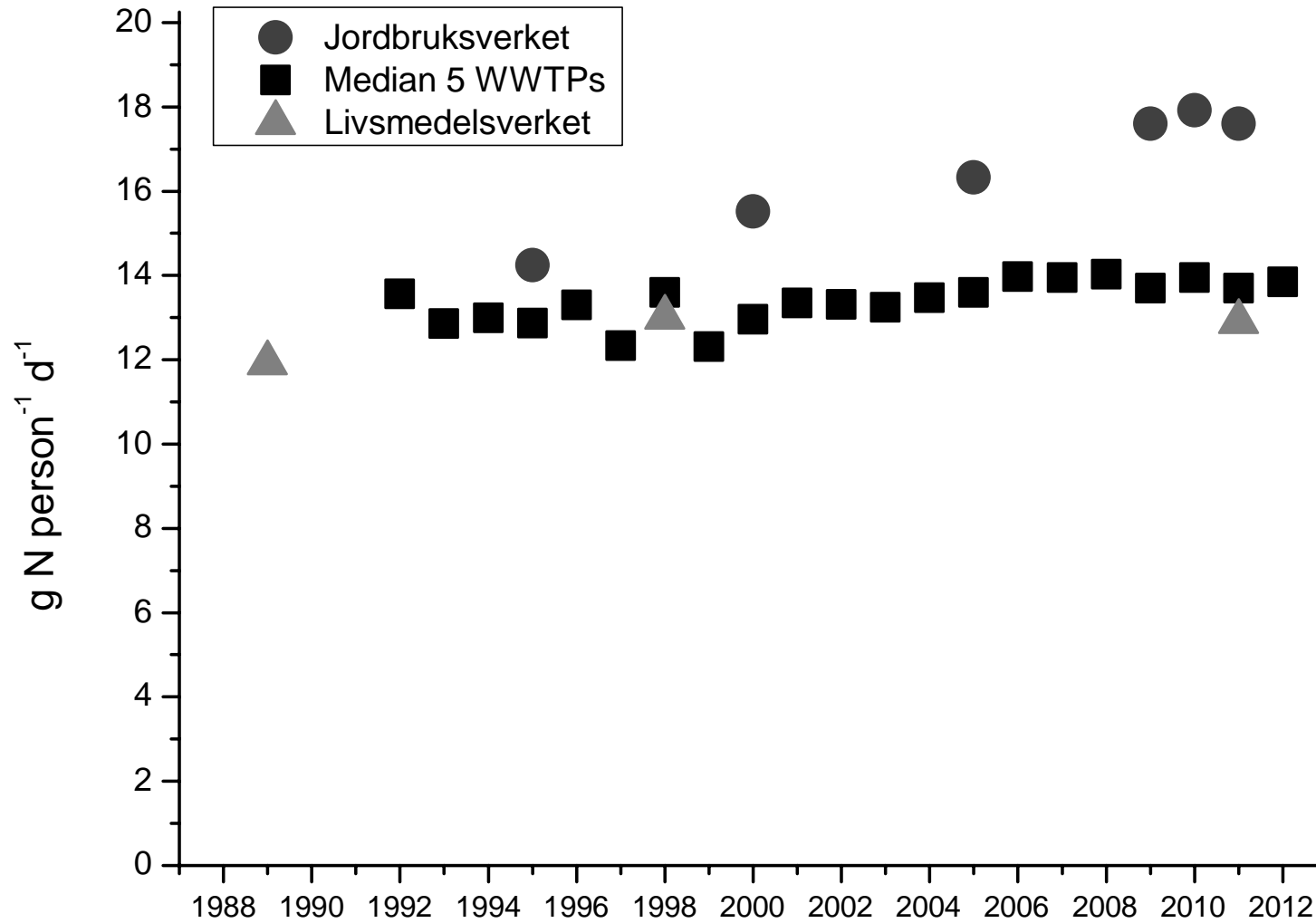


Swedish Board of Agriculture (2014)

# Gothenburg



# Five WWTPs



Jordbruksverket = Swedish Board on Agriculture  
Livsmedelverket = National Food Agency, Sweden

*Tumlin & Mattsson (2013)*

# This means...

- Design rules: rather 14 than 12 g N person<sup>-1</sup> d<sup>-1</sup>



# What does this mean for a large WWTP?

- WWTP with 100,000 connected persons
- Increase from 12 to 14 g N person<sup>-1</sup> day<sup>-1</sup> → 73,000 kg N extra per year
- Low cost 3.2 Euro kg<sup>-1</sup> N
- Extra: approx. 240,000 Euro per year
  
- Assumed cost for nitrogen removal if investment needed 11 Euro kg<sup>-1</sup> N
- Extra: approx. 830,000 Euro per year

# This means...

- Design rules: rather 14 than 12 g N person<sup>-1</sup> d<sup>-1</sup>
- Increase of nitrogen in receiving waters during wet-weather flow conditions and combined sewer overflows.
- Carbon footprint of WWTP increases, and carbon footprint of chicken meat is increased by ca 10% of total footprint (Mattsson *et al.*, 2014).

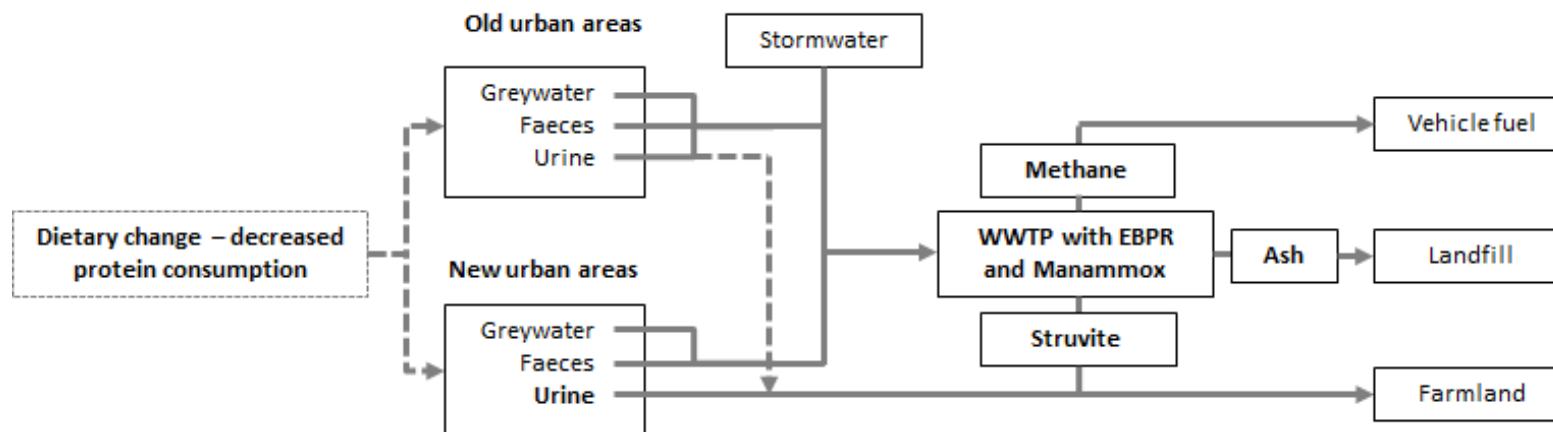
# Why more protein?

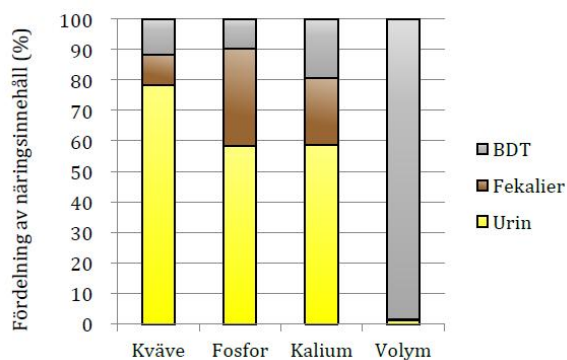
- 1990-2006
  - Meat prices decreased 12 %
  - Other food increased 5 %



# How to decrease the nitrogen load?

*Transition in Wastewater Treatment towards a Sustainable Future with Urine Separation in the Catchment*





Jönsson *et al.* (2005)



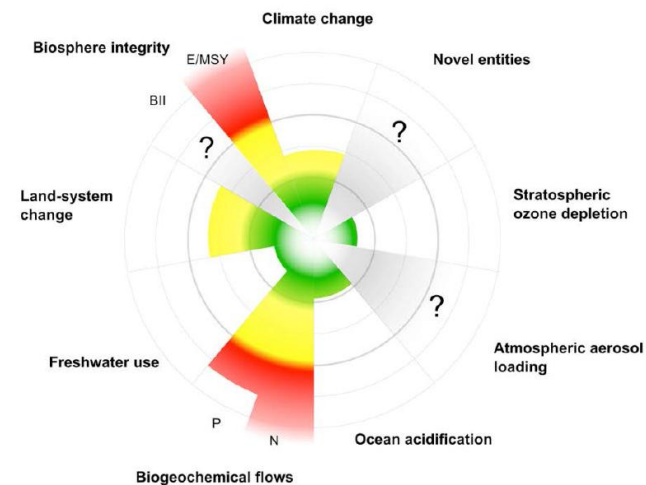
**Fakta. Fler näringsämnen än fosfor i avloppet**

● De olika växtnäringsämnena har jämförts avseende ekonomiskt värde \*, samt minskade tillverkningsutsläpp av växthusgaser om mineralgödseln ersätts av toalettavlopp eller avloppsslam.

	Kväve	Fosfor	Kalium	Svavel	Totalt
<b>Värde (milj kr/år)</b>					
Toalettavlopp	413	79	140	6	638
Avloppsslam	28	98	12	4	143
<b>Resursens ändlighet (antal år)</b>					
Reserv vid nuvarande användning	64**	372	257	<72	
<b>Potentiellt minskade växthusgasutsläpp (ton CO2-ekv/år)</b>					
Toalettavfall	196500	2500	4500	-	203500
Avloppsslam	13500	3000	500	-	17000

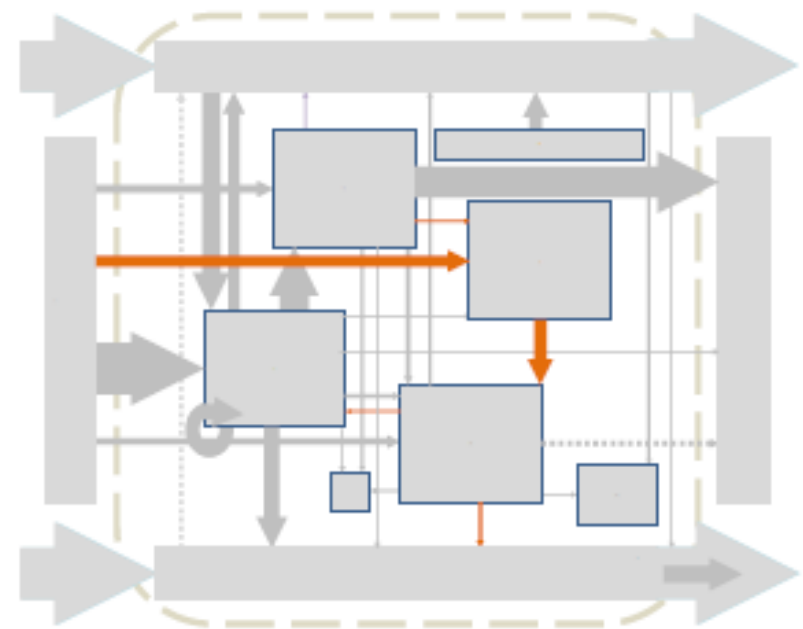
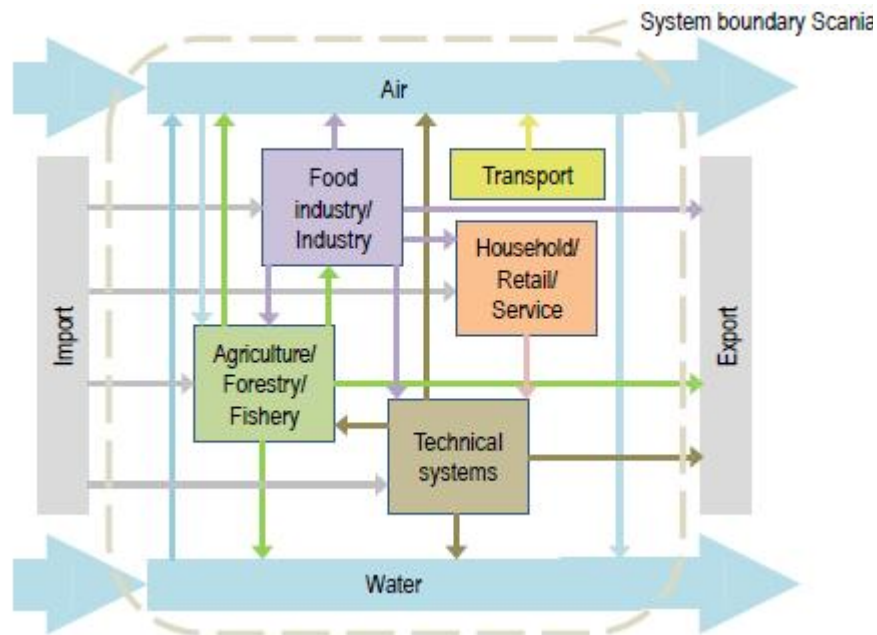
\* Beräknat från USGS, 2012 (Mineral Commodity Summaries, United States Geological Survey) samt BP, 2012 (BP Statistical Review of World Energy June 2012). \*\* Naturgas

Jönsson *et al.* (2012)

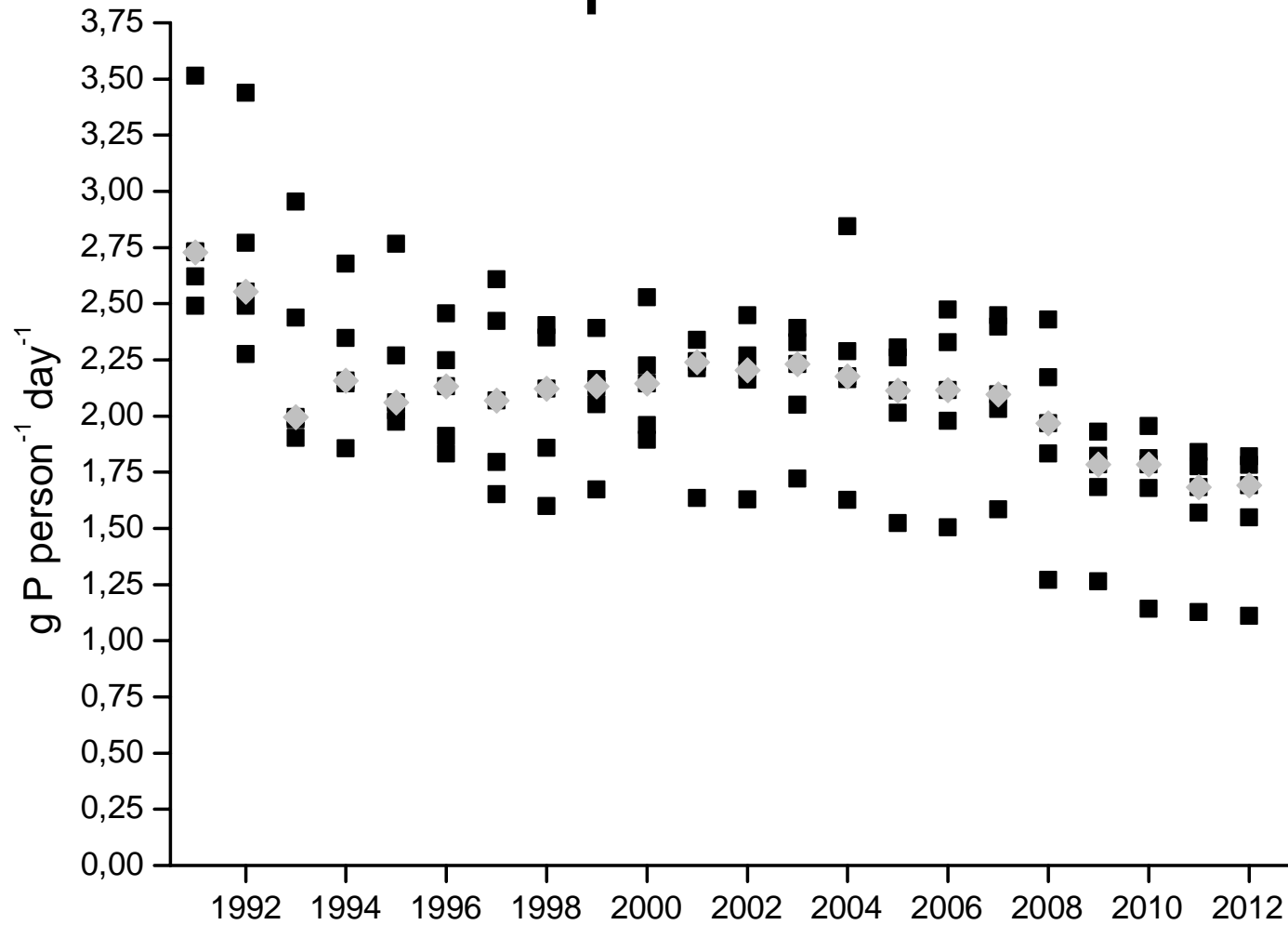


Steffen *et al.* (2015)

# Nitrogen flows in Scania



# Phosphorus?



Swedish people consume double amount of P needed



Thank you for your  
attention!

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