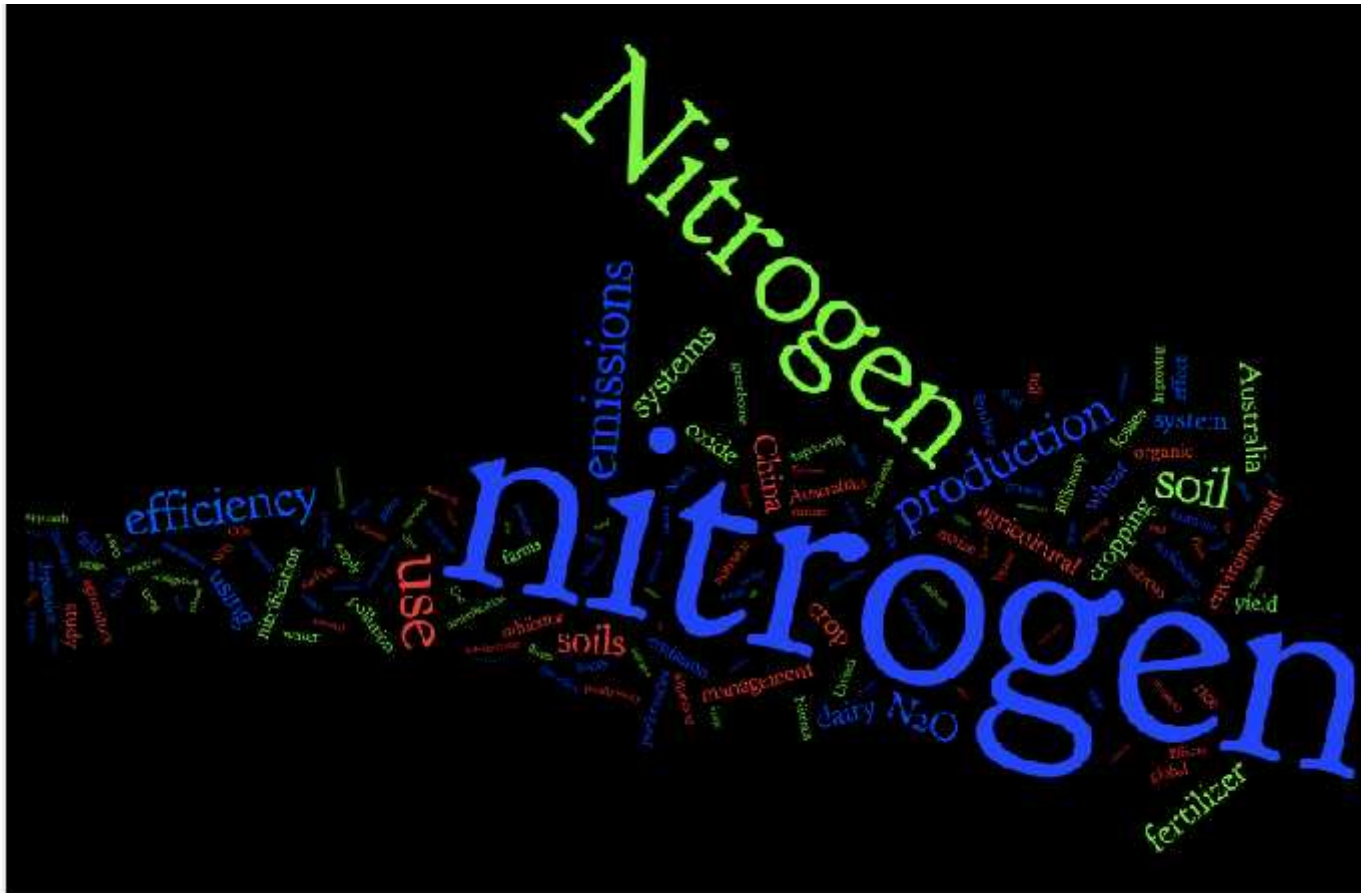


# The Words of our Conference



# The Words of our Conference



# Nitrogen: The historical progression from ignorance to knowledge, with a view to future solutions

**James Galloway**

and



**Jan Willem Erisman**



**Allison Leach**



**Albert Bleeker**

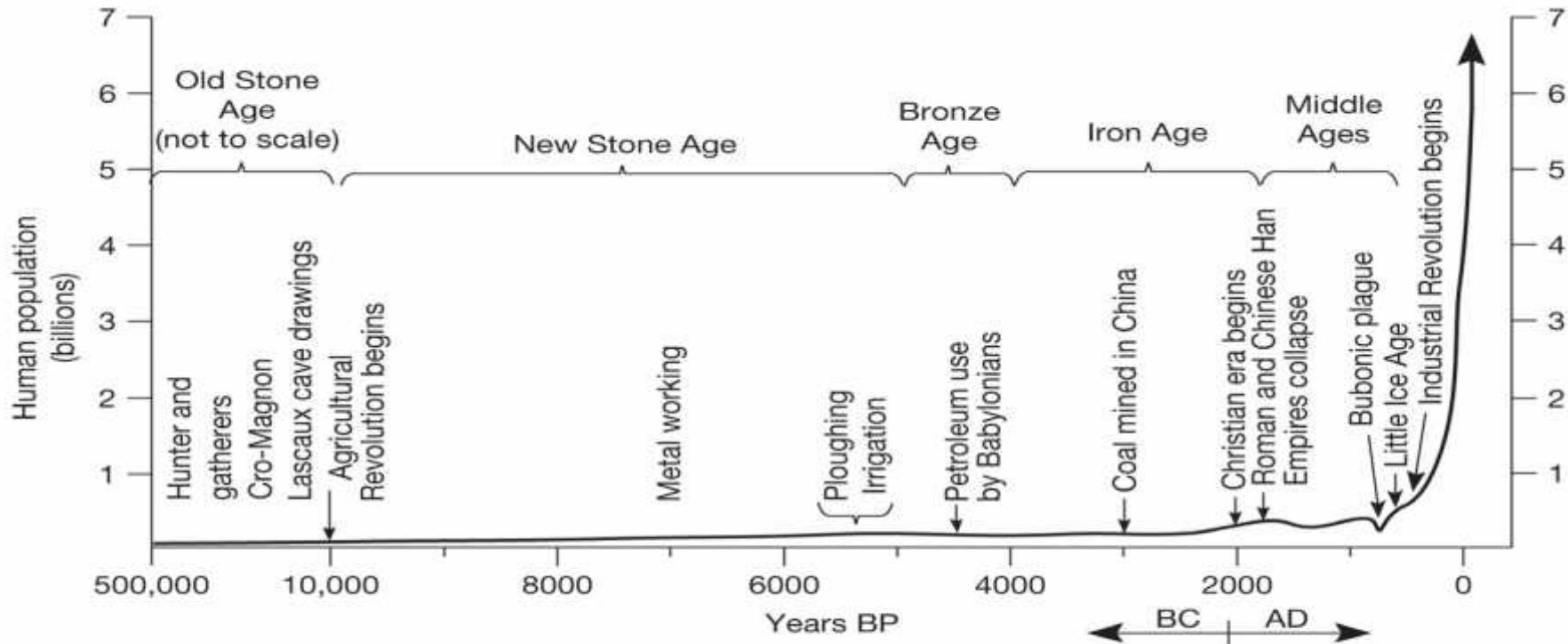
*7<sup>th</sup> International Nitrogen Conference, Melbourne, Australia  
December 4 – 8, 2016*

# The Main Topics

- The Era of Ignorance
  - Food without N knowledge
- Knowledge about N: Part I
  - Microbes and agriculture
- Knowledge about N: Part II
  - Environmental push back
- Perspective on the past
  - What if?
  - Lessons for the future.
- Scenarios for the future
  - We have opportunity for influence!
  - Let's start at INI-2016!

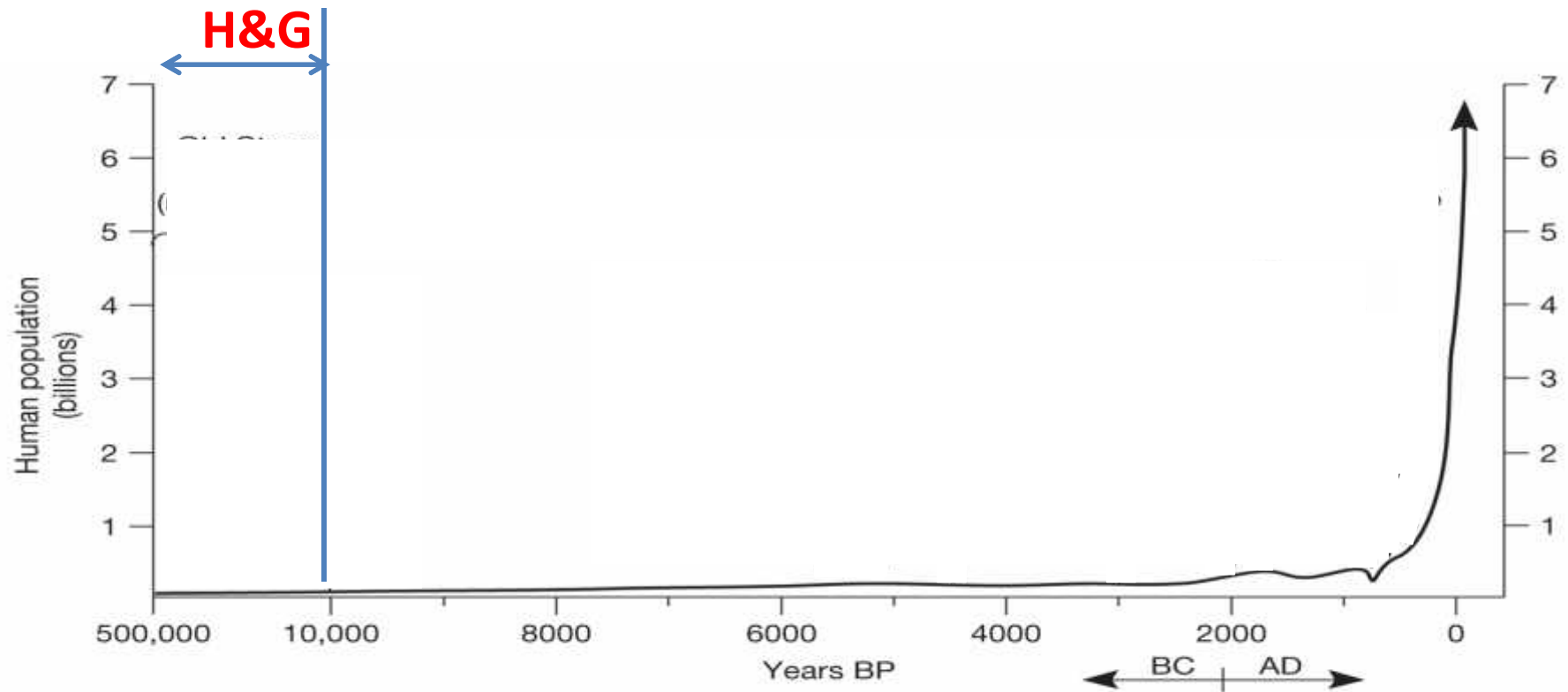
# A Long History of Population

## *Significant Cultural Events*



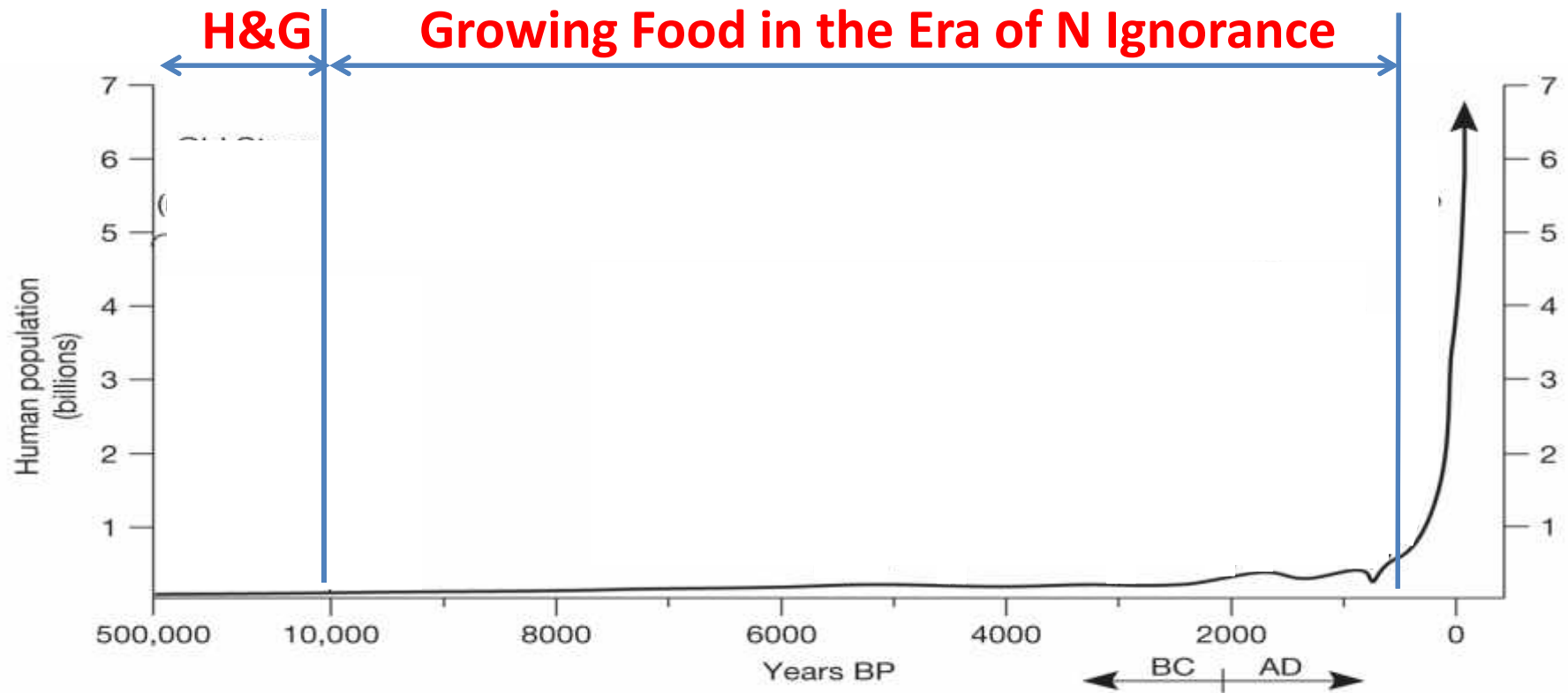
# A Short History of Nitrogen

## *Significant Events*



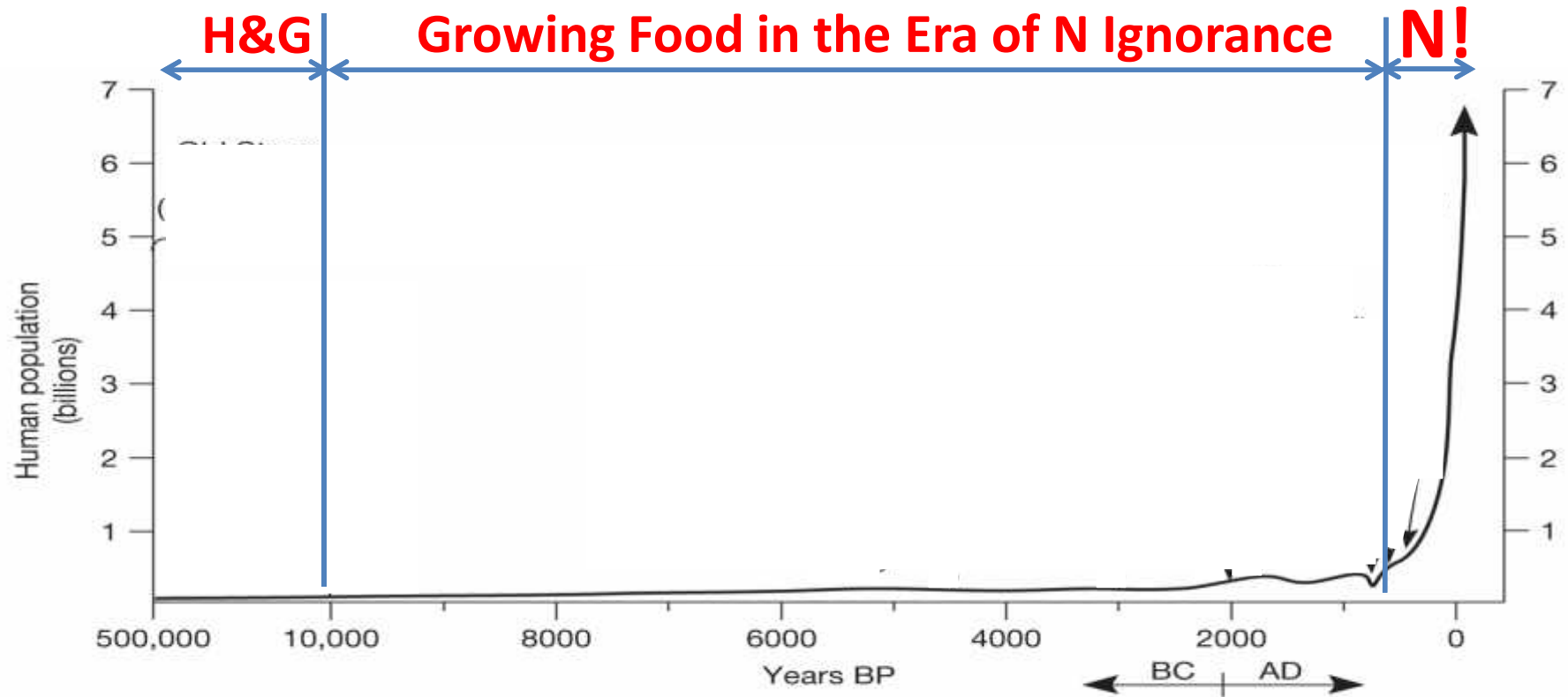
# A Short History of Nitrogen

## *Significant Events*



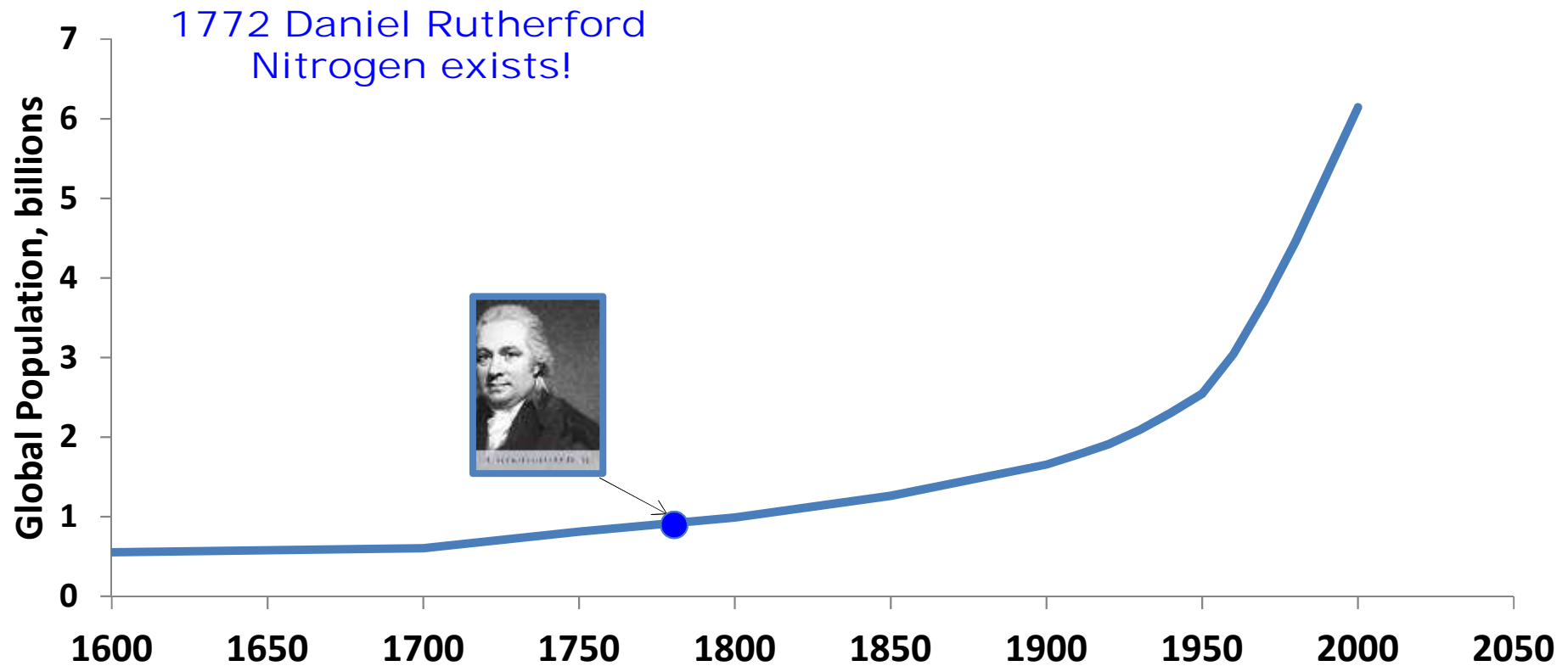
# A Short History of Nitrogen

## Significant Events

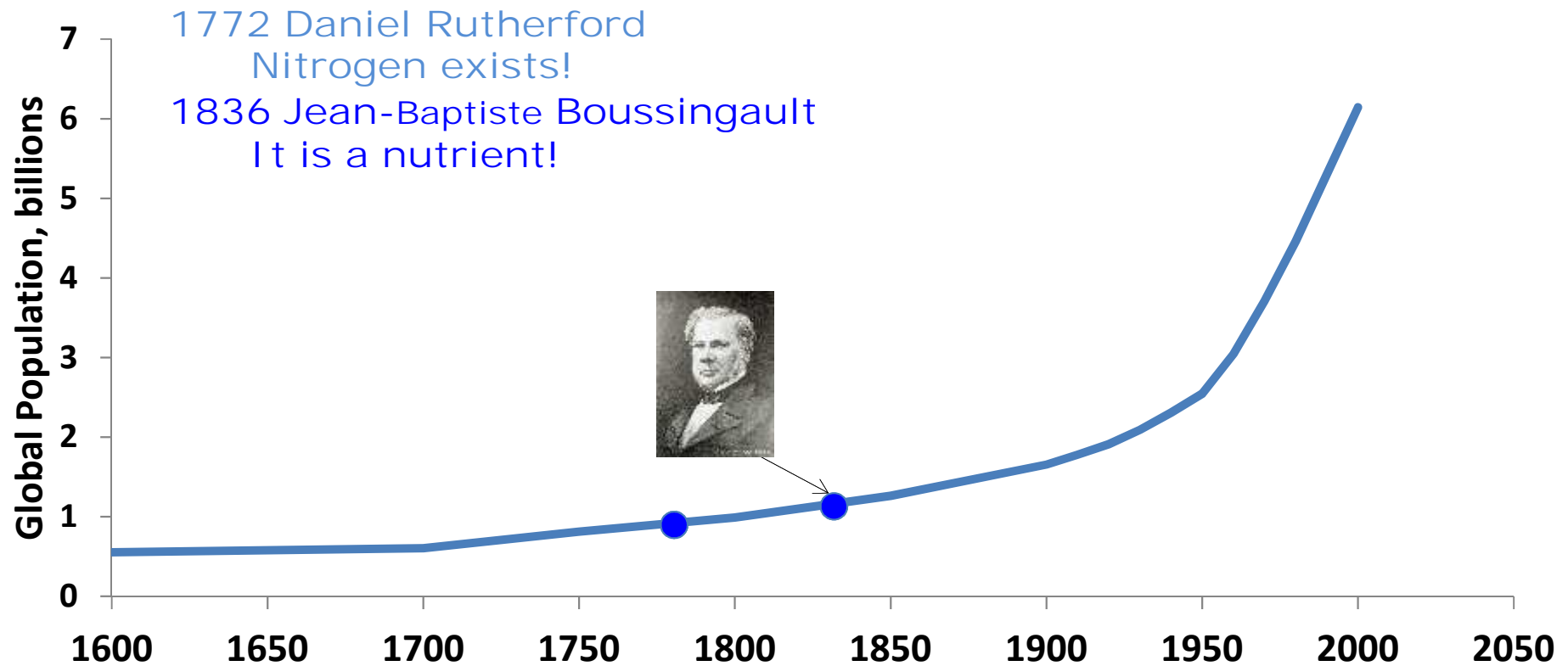




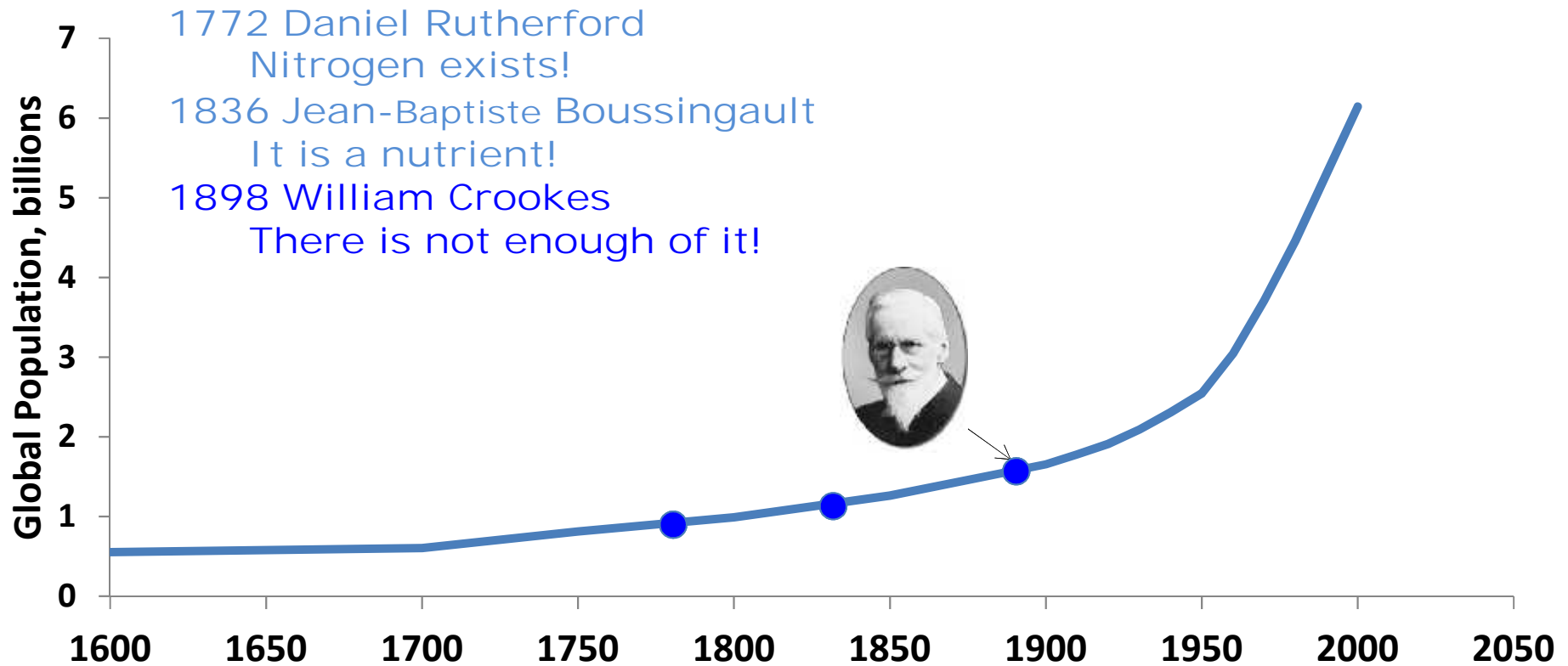
# The Growth of Nitrogen Knowledge



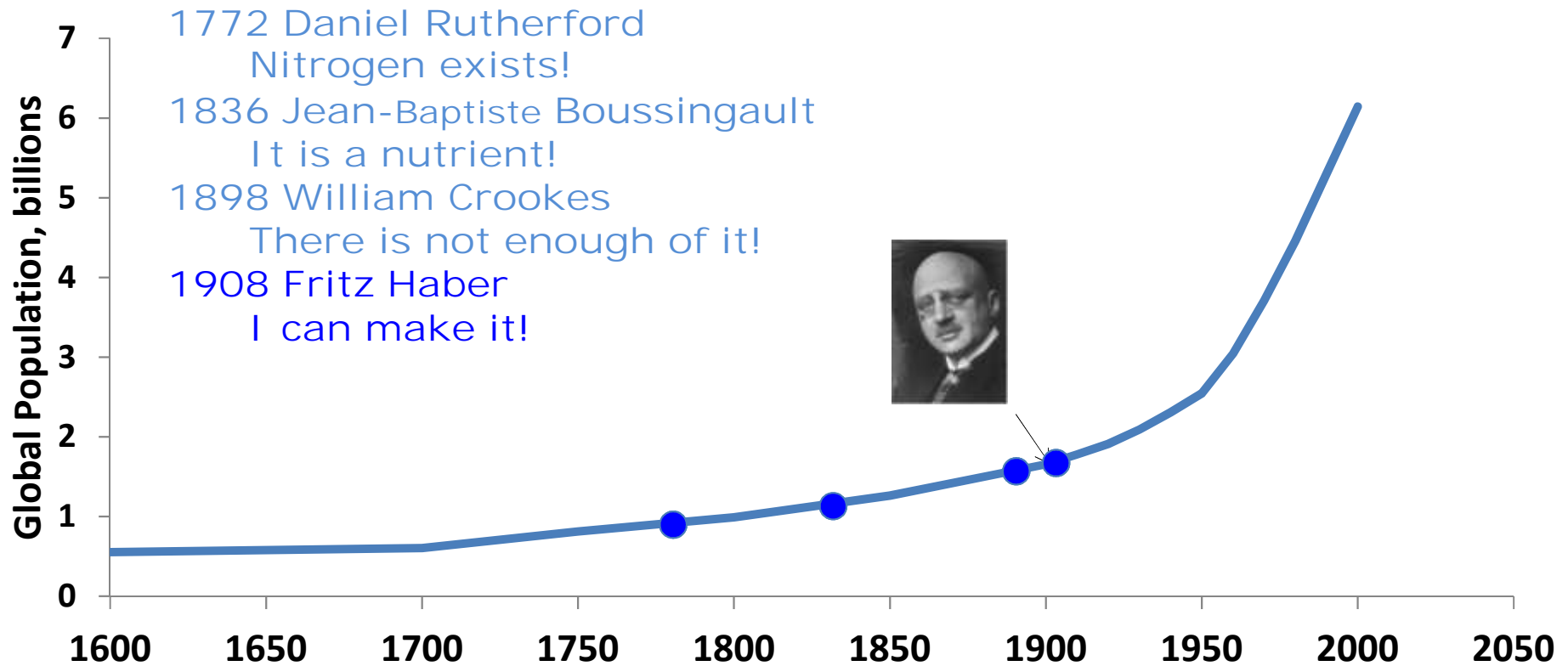
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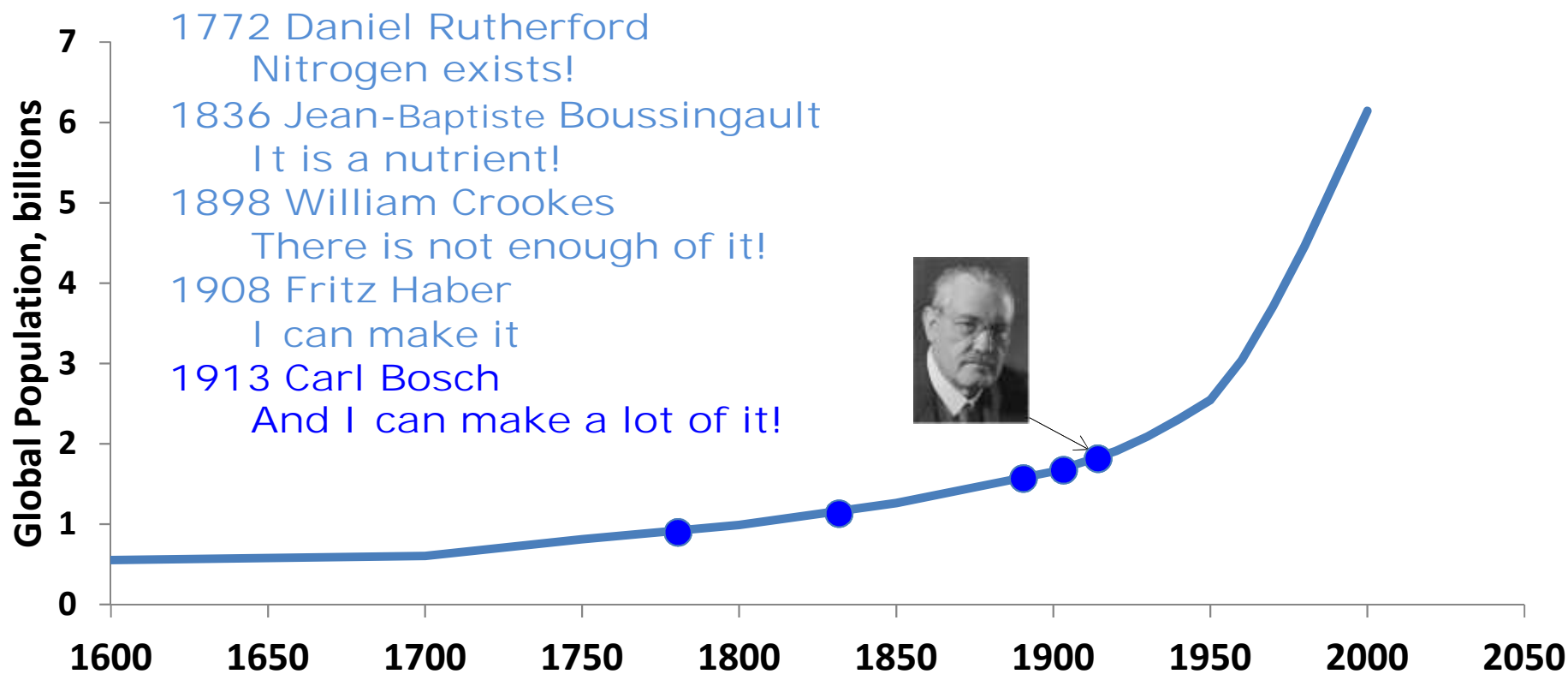
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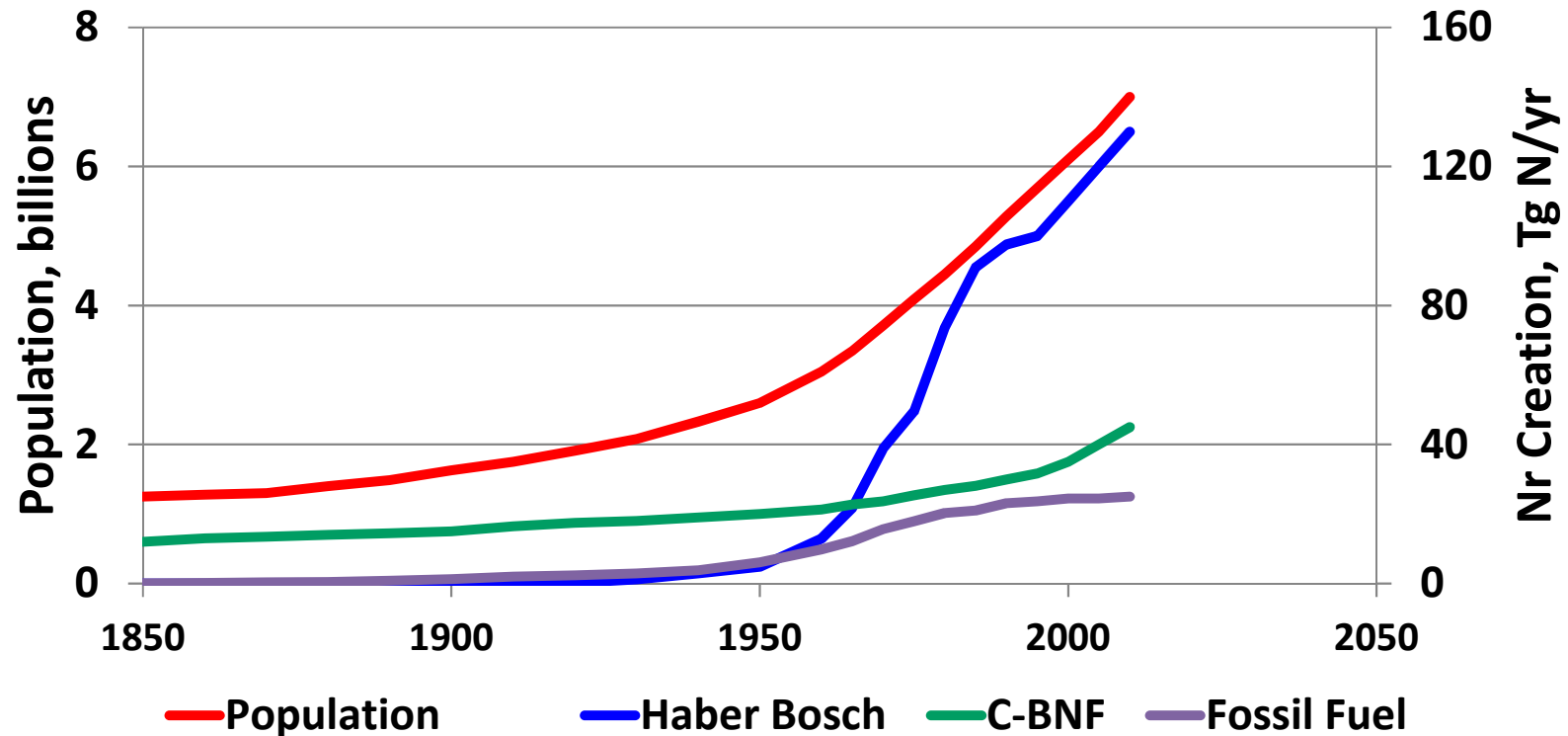
# The Growth of Nitrogen Knowledge



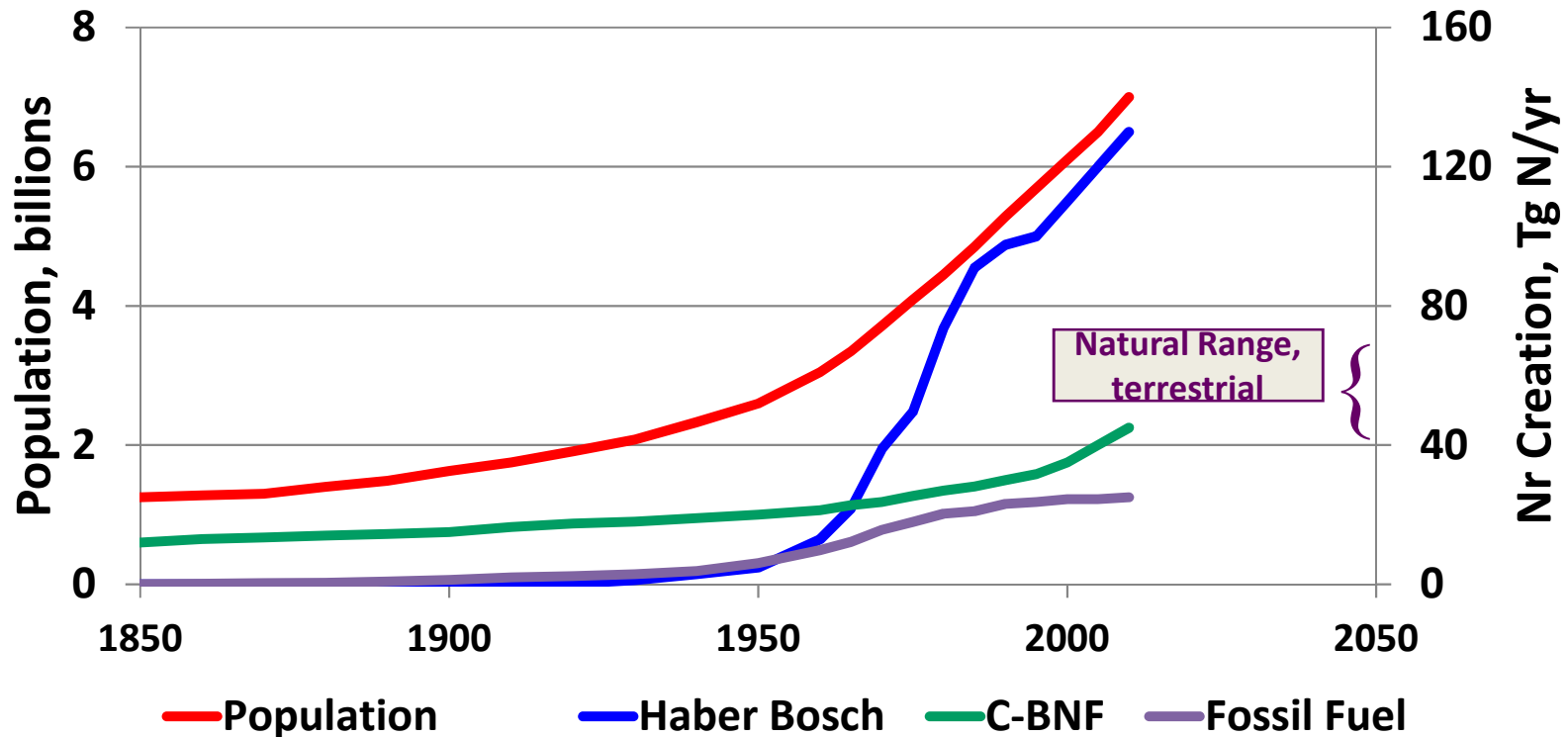
# The Growth of Nitrogen Knowledge



# Global Rates of Nr Creation by Humans in contrast to nature



# Global Rates of Nr Creation by Humans in contrast to nature



# N From People—Sources



**Energy**  
*by accident*

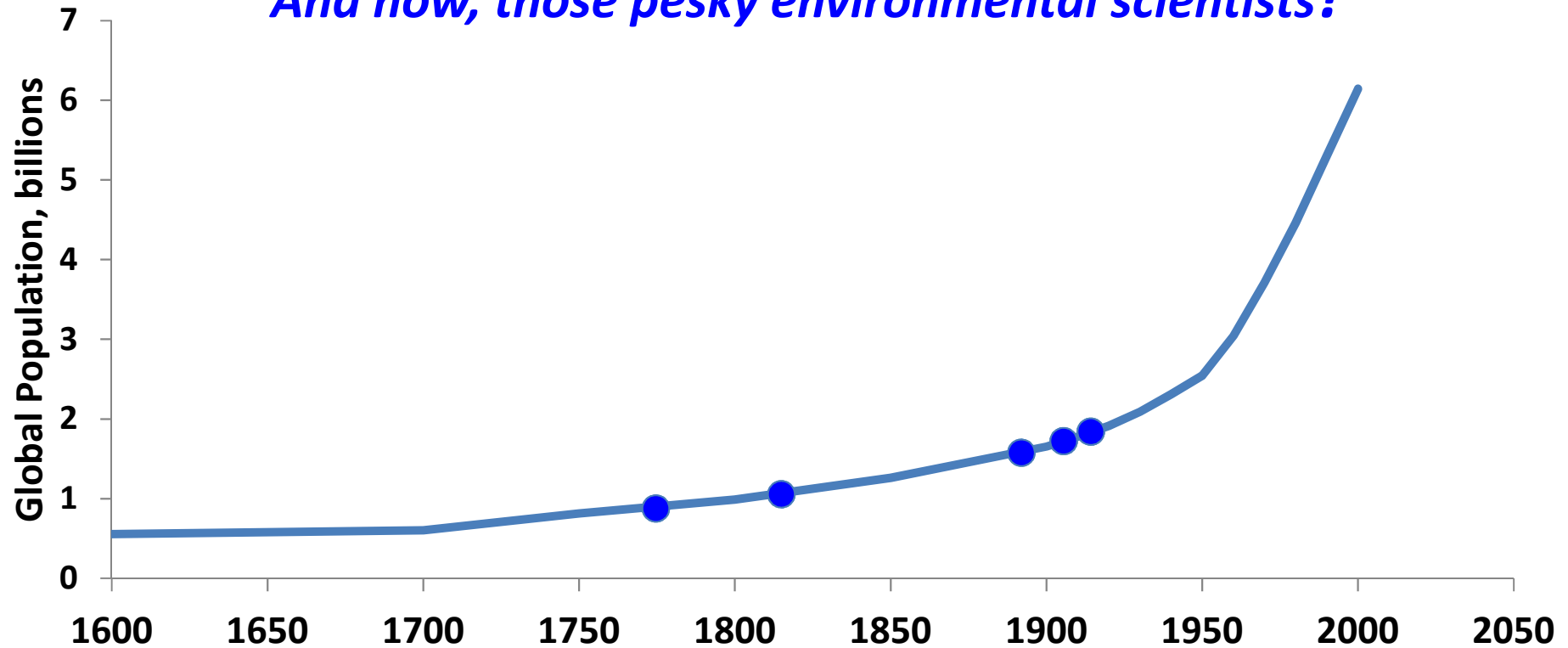


**Food**  
*on purpose*

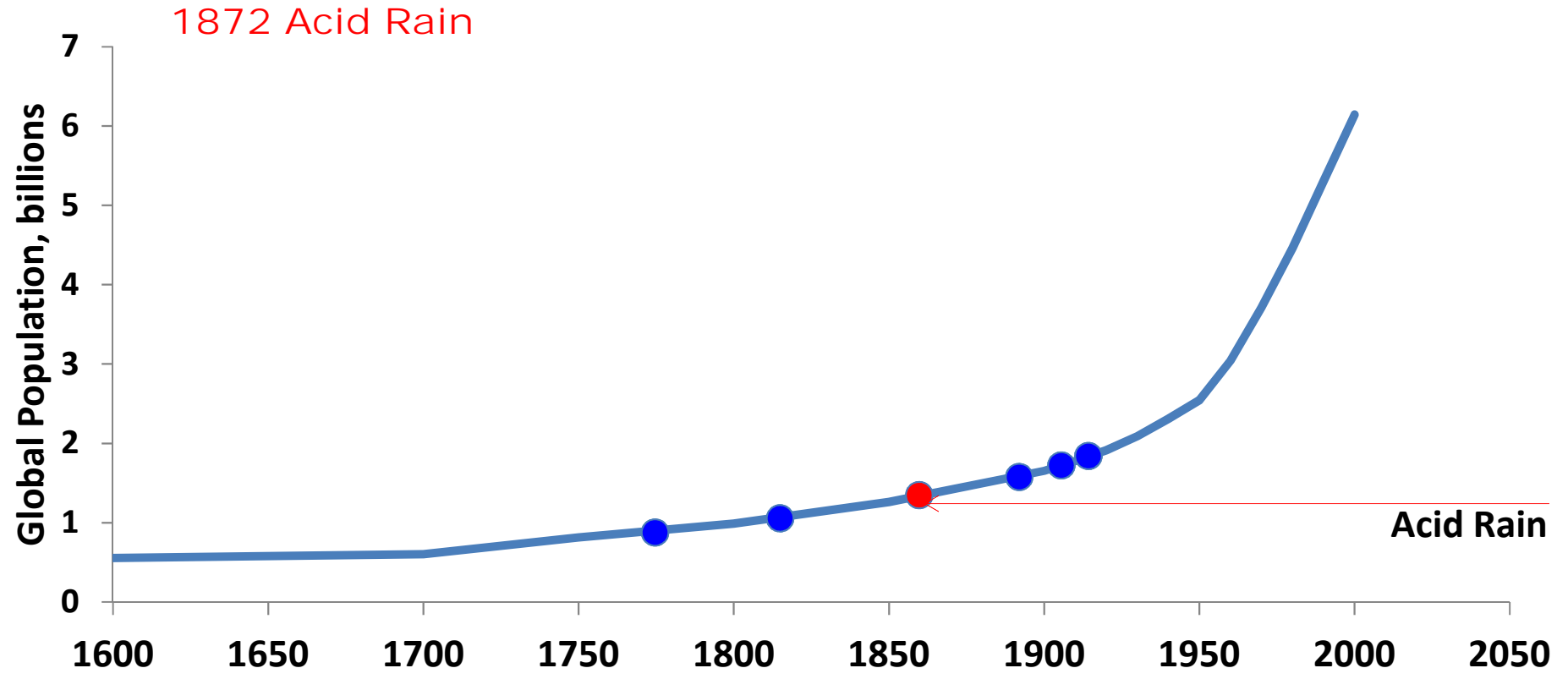


# The Growth of Nitrogen Knowledge

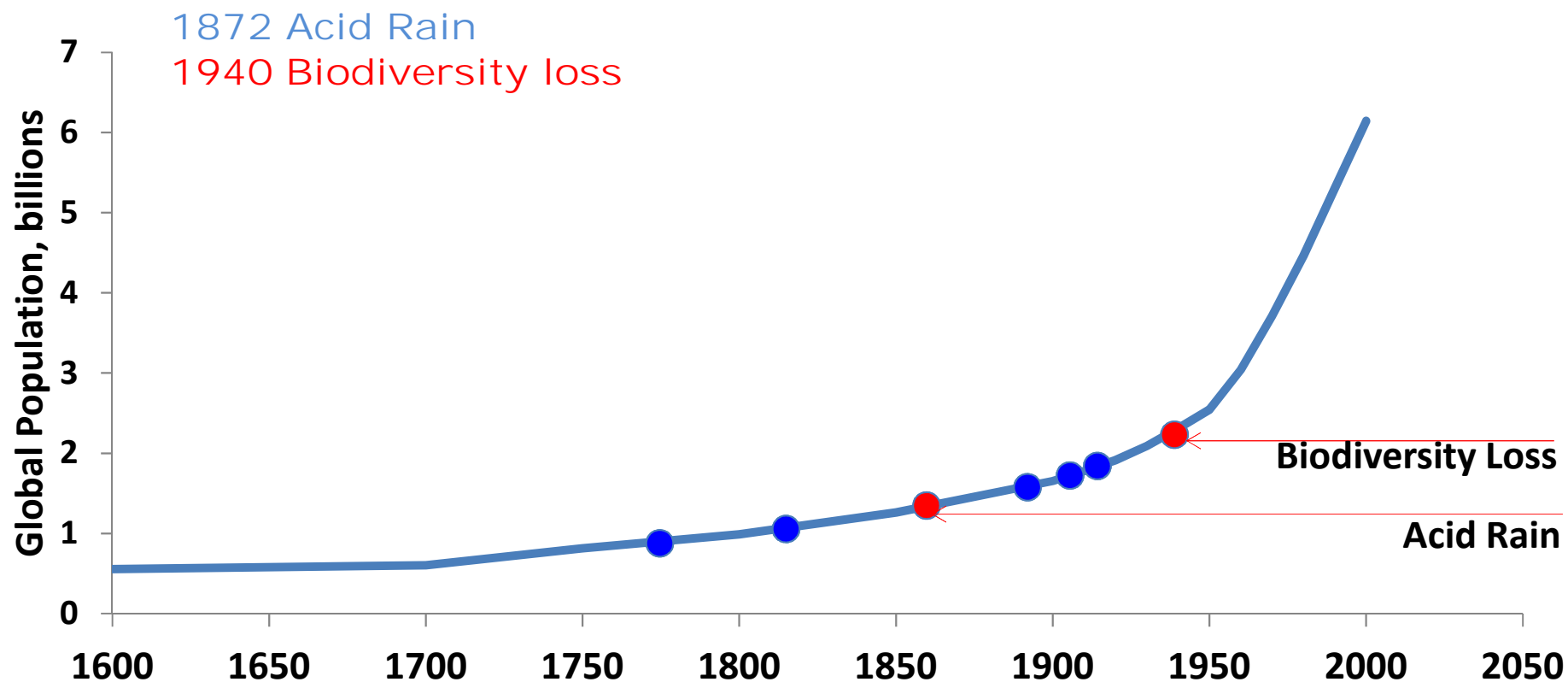
*And now, those pesky environmental scientists!*



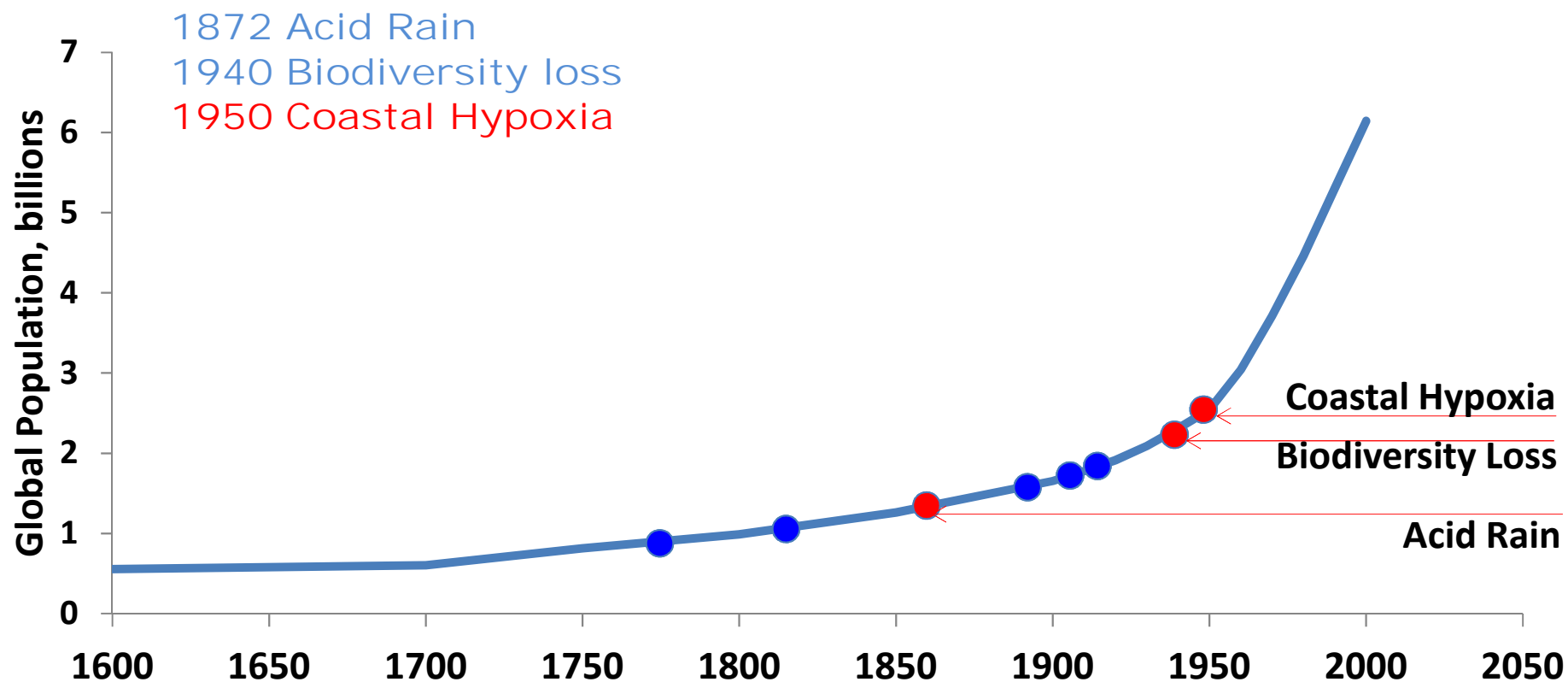
# The Growth of Nitrogen Knowledge



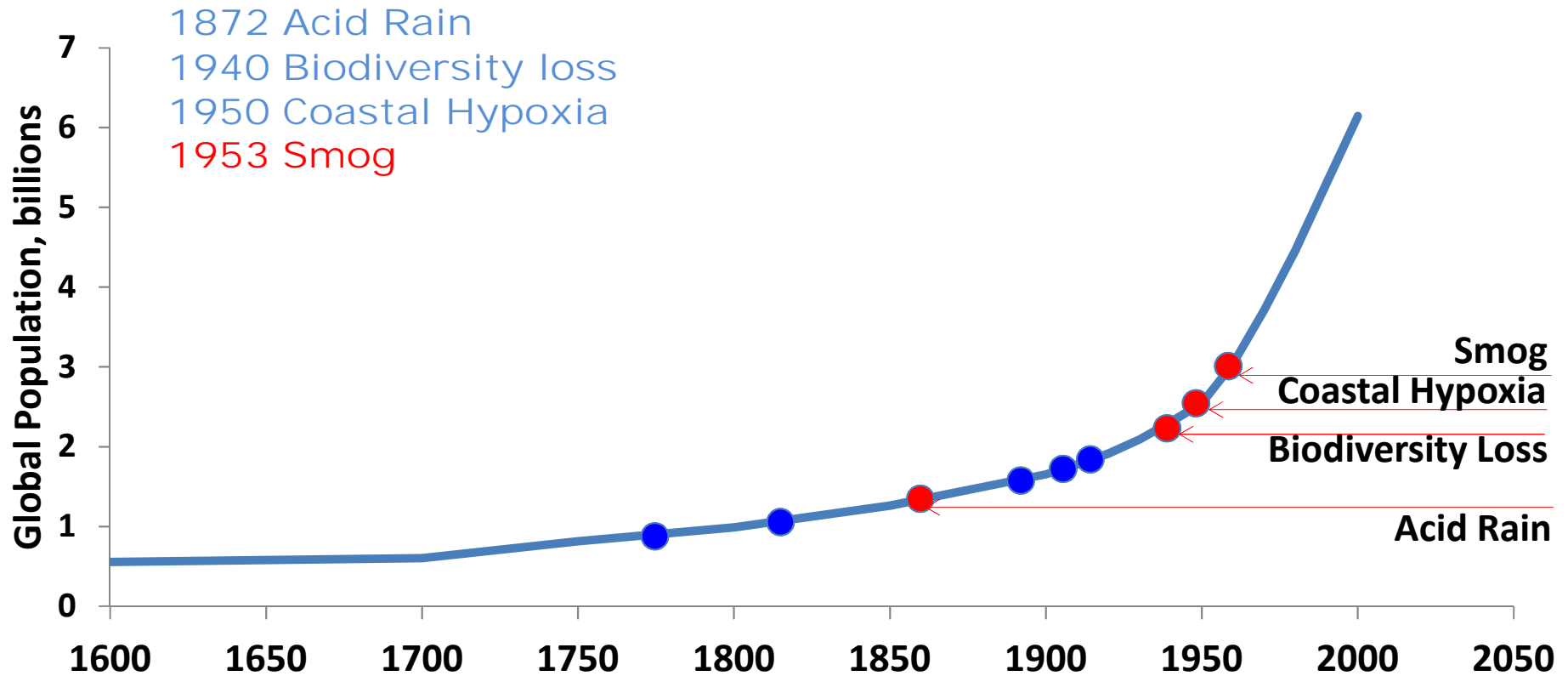
# The Growth of Nitrogen Knowledge



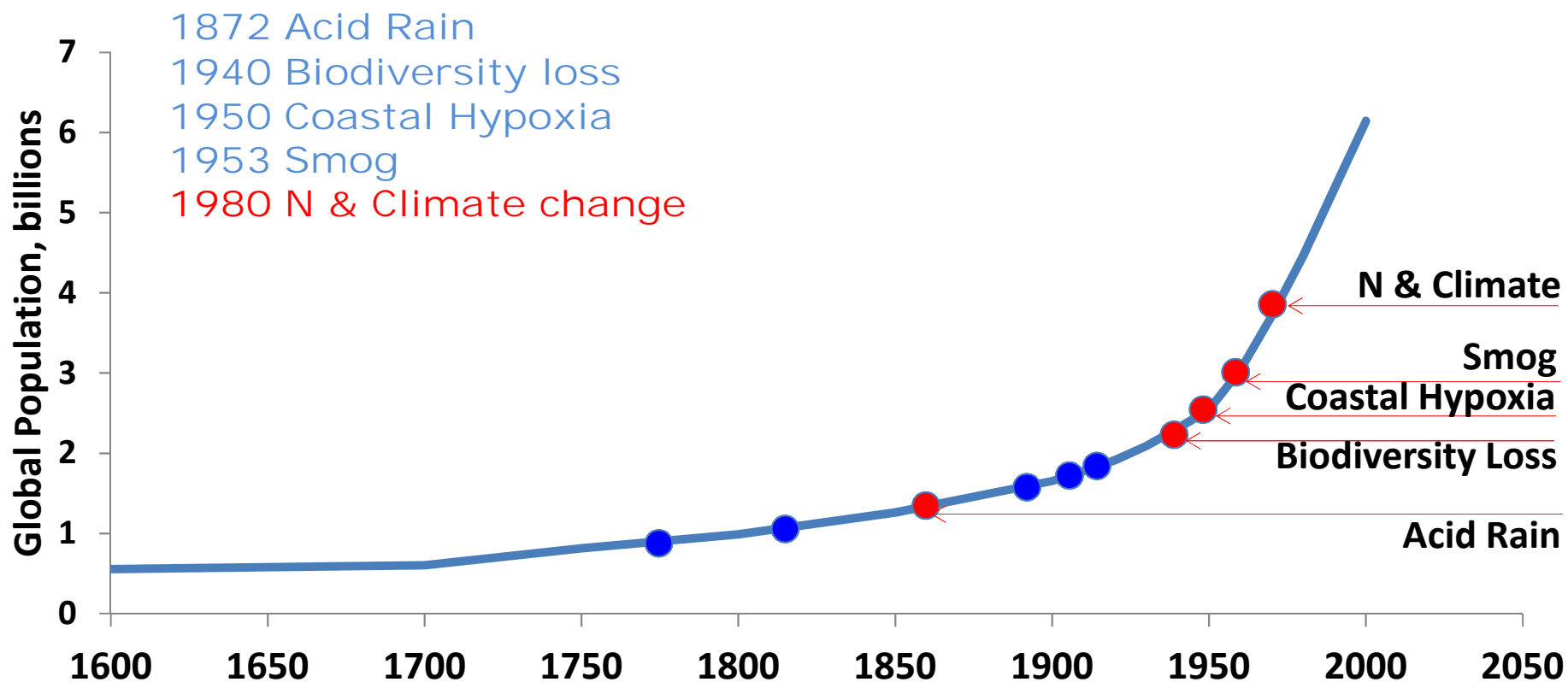
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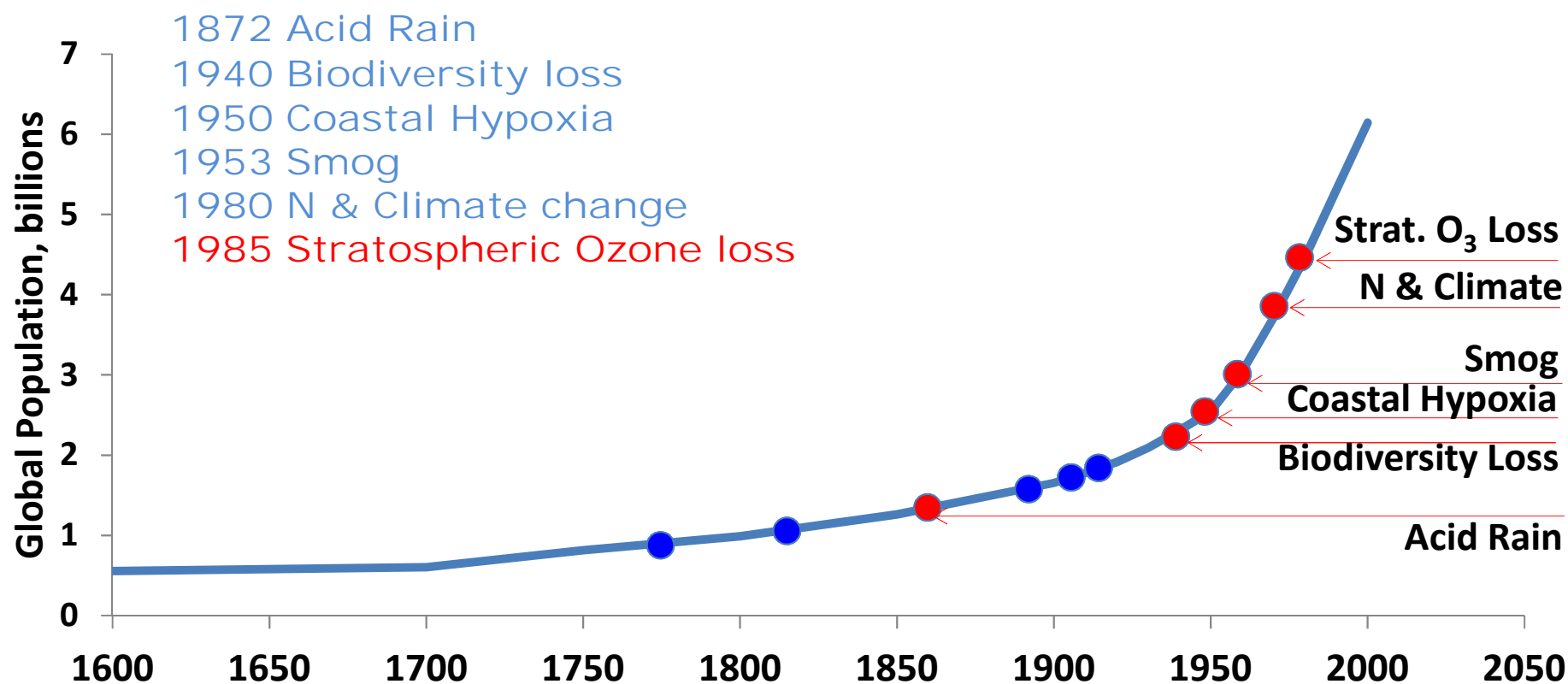
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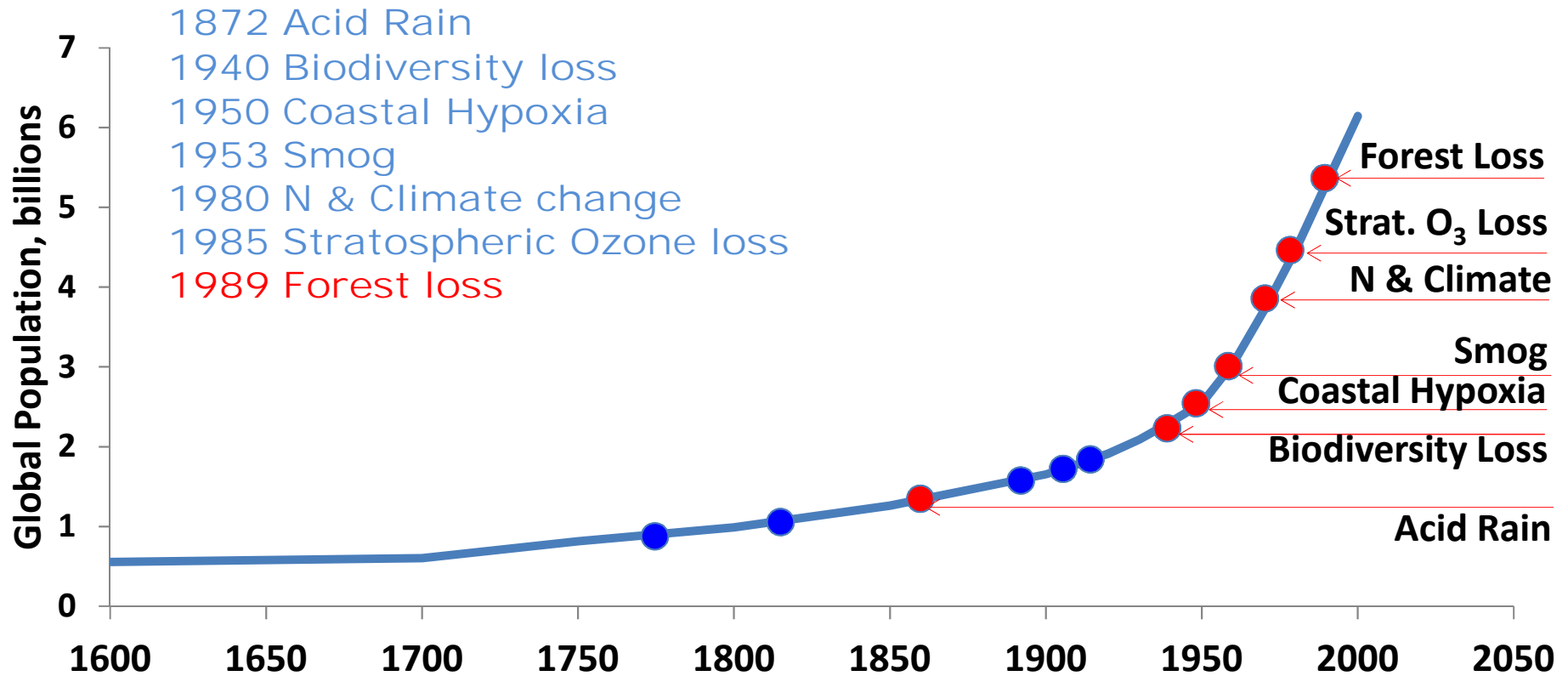
# The Growth of Nitrogen Knowledge



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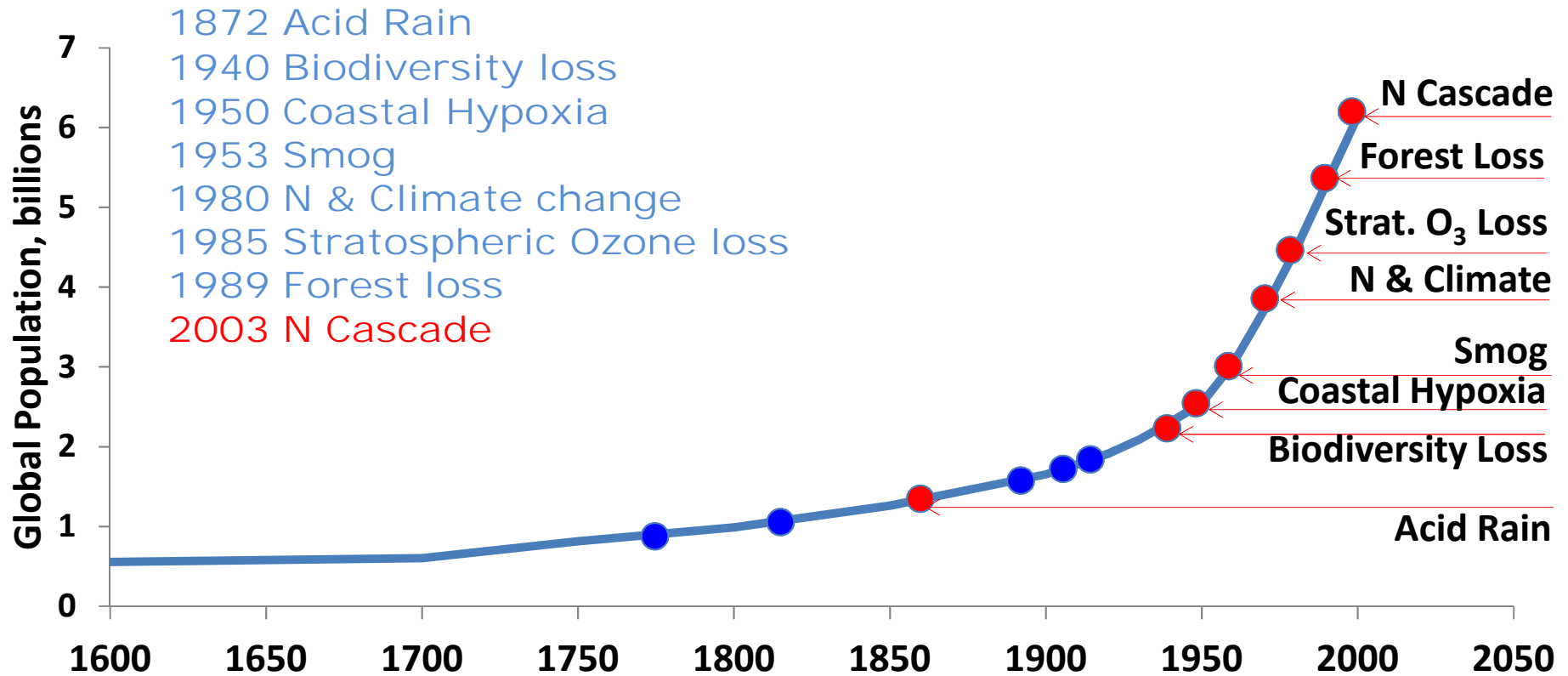


# The Growth of Nitrogen Knowledge





# The Growth of Nitrogen Knowledge

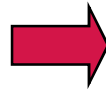


# Too Much Nitrogen: In a Cascade

E  
N  
V  
I  
R  
O  
N  
M  
E  
N  
T



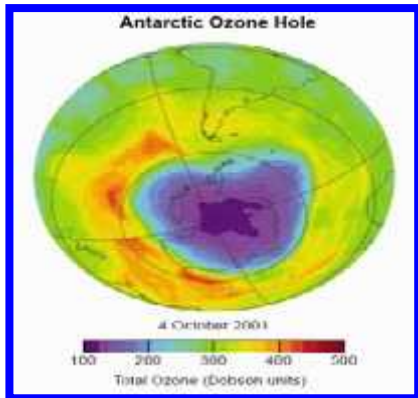
Smog, Haze



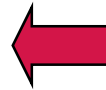
Forest Impacts



Acidification



Ozone Hole



Global Warming



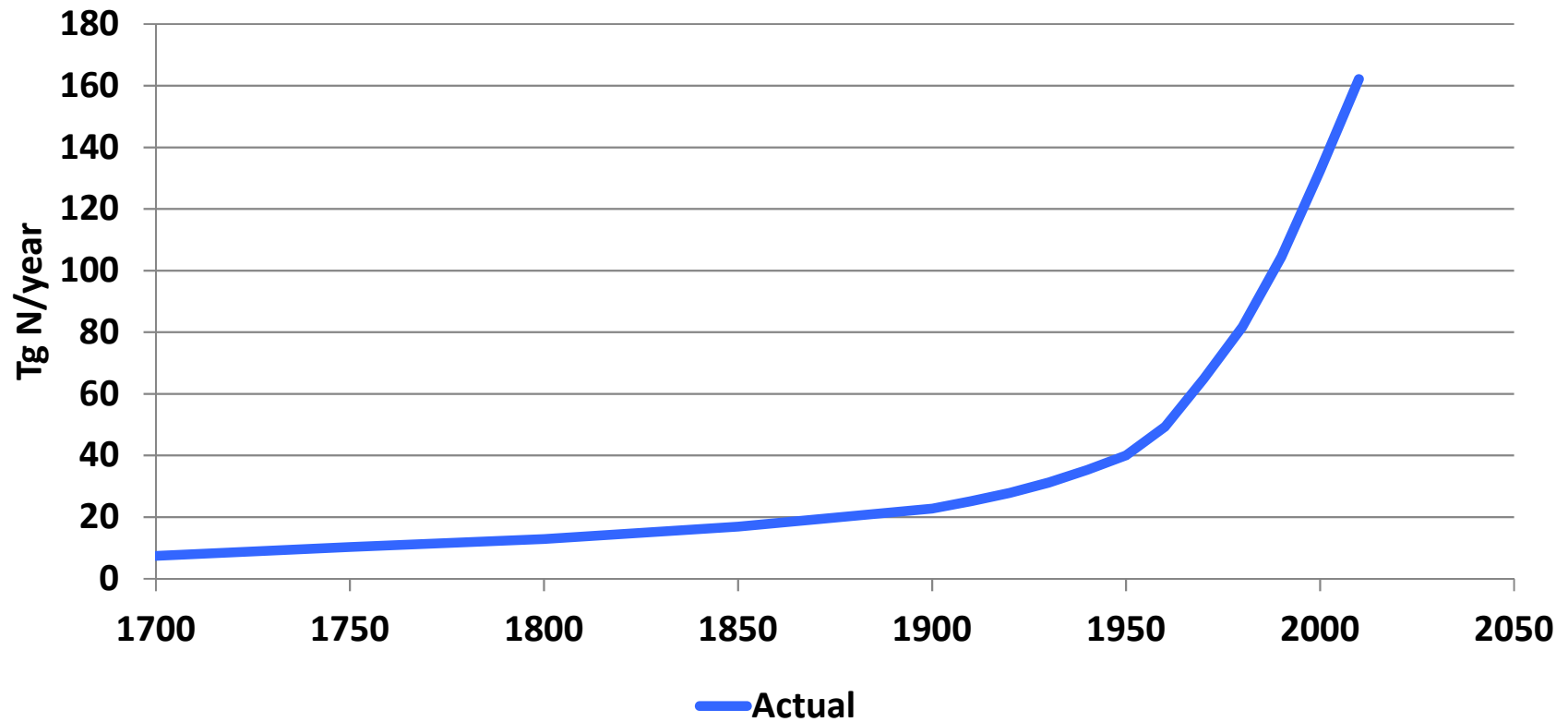
Eutrophication

# The Main Topics

- The Era of Ignorance
  - Food without N knowledge
- Knowledge about N: Part I
  - Microbes and agriculture
  - All good news!
- Knowledge about N: Part II
  - Environmental push back
  - Local on to global
- Perspective on the past
  - What if?
  - Lessons for the future.
- Scenarios for the future
  - We have opportunity for influence!
  - Let's start here!

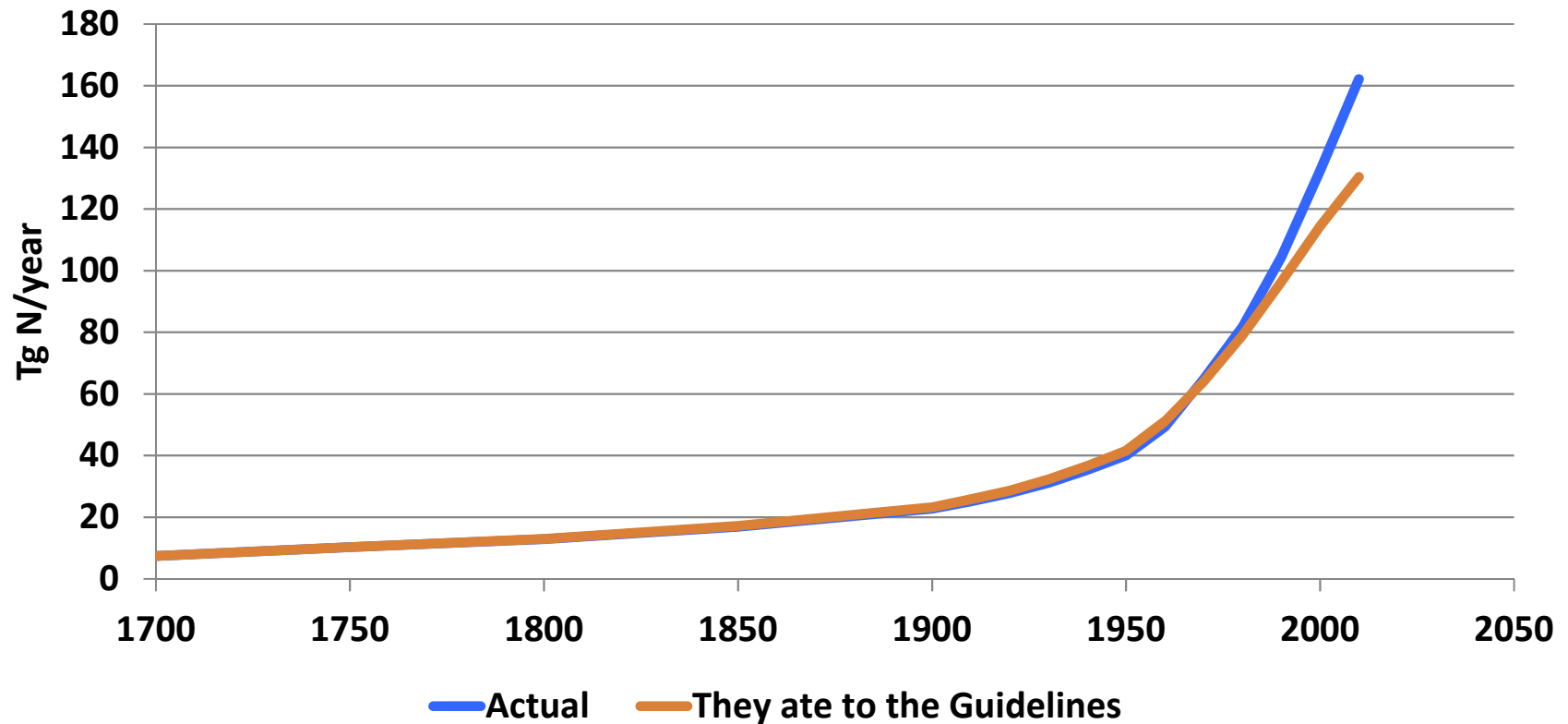
# N used in Food Production

## *Actual, 1700 - 2010*



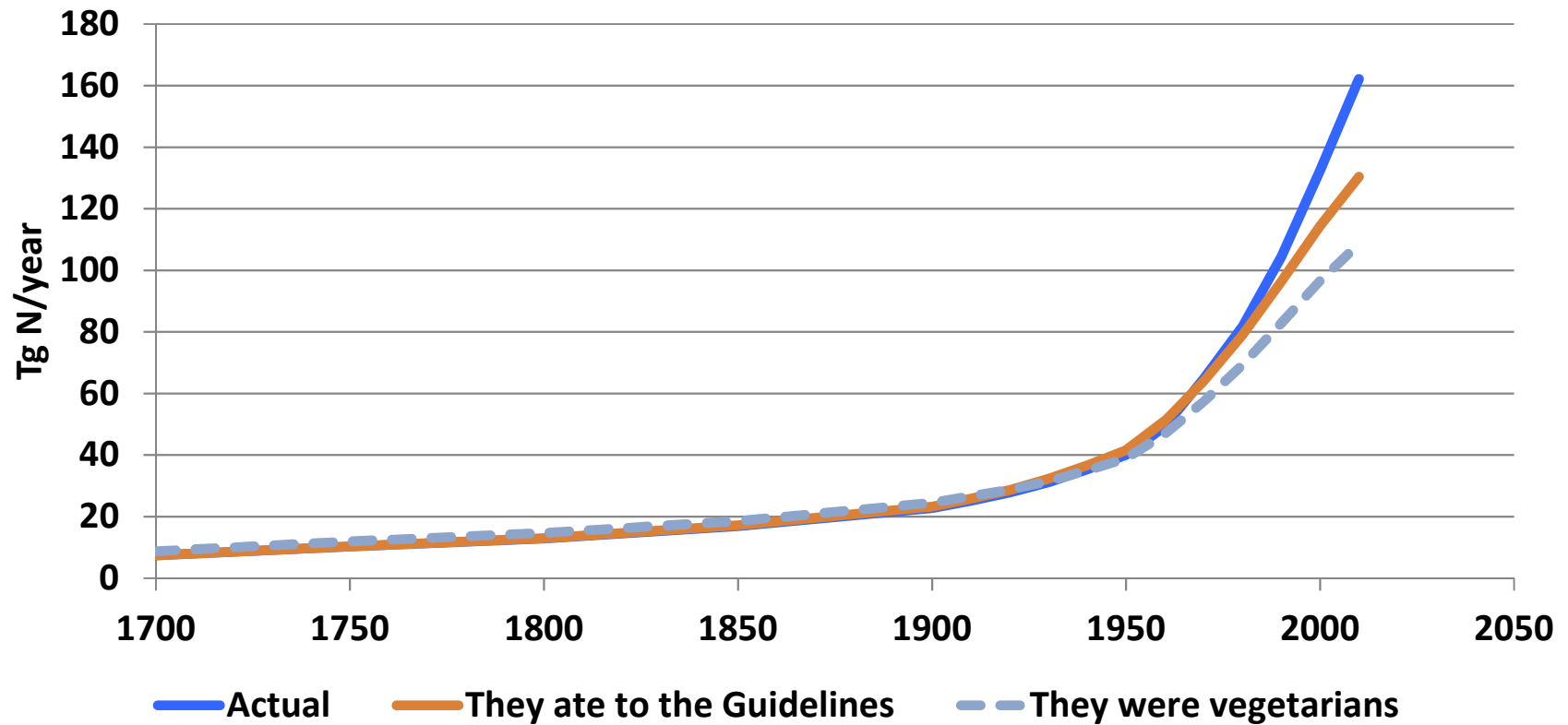
# N used in Food Production

*If they had eaten to nutritional guidelines*



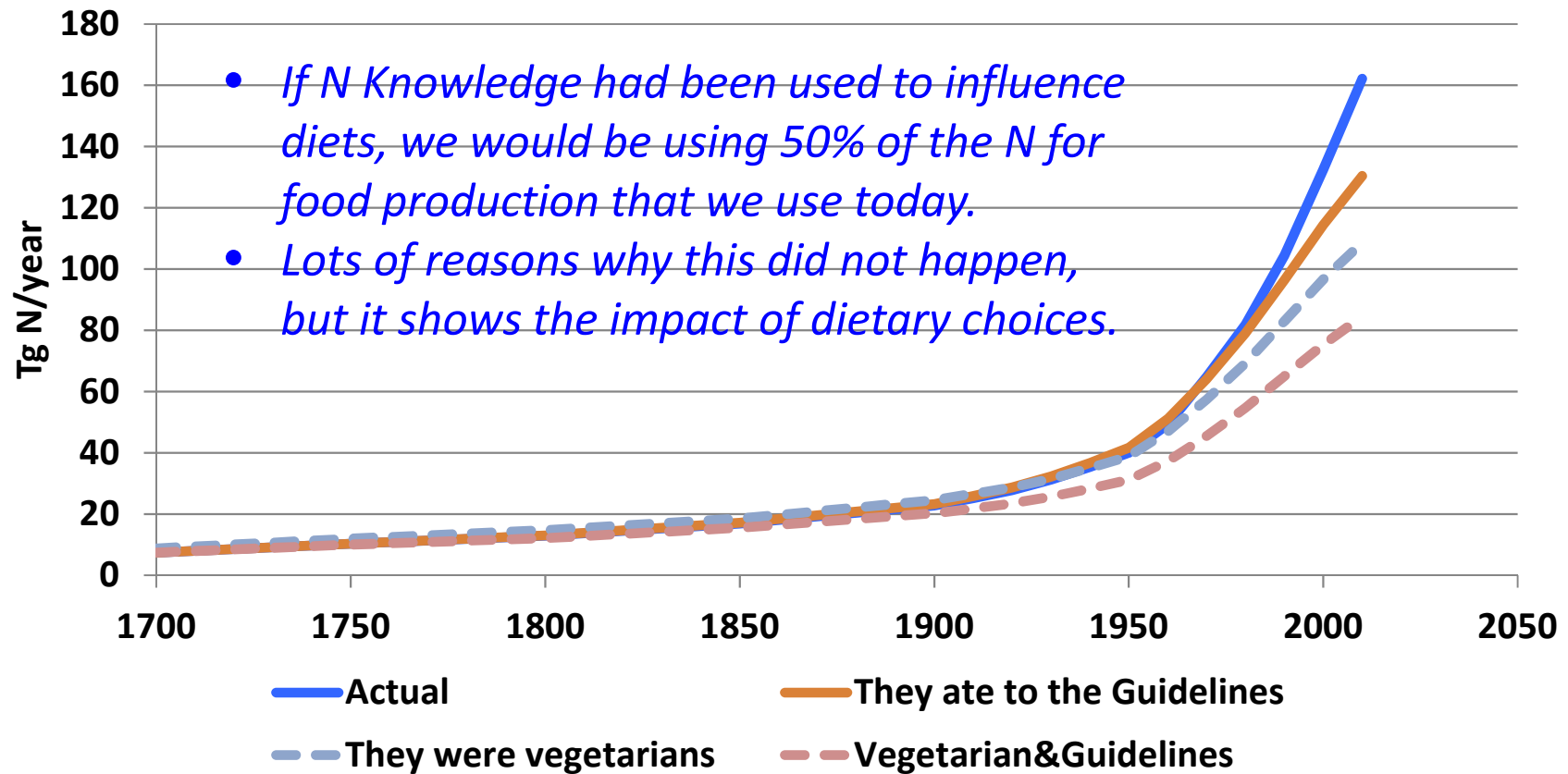
# N used in Food Production

## *If they had become vegetarians*

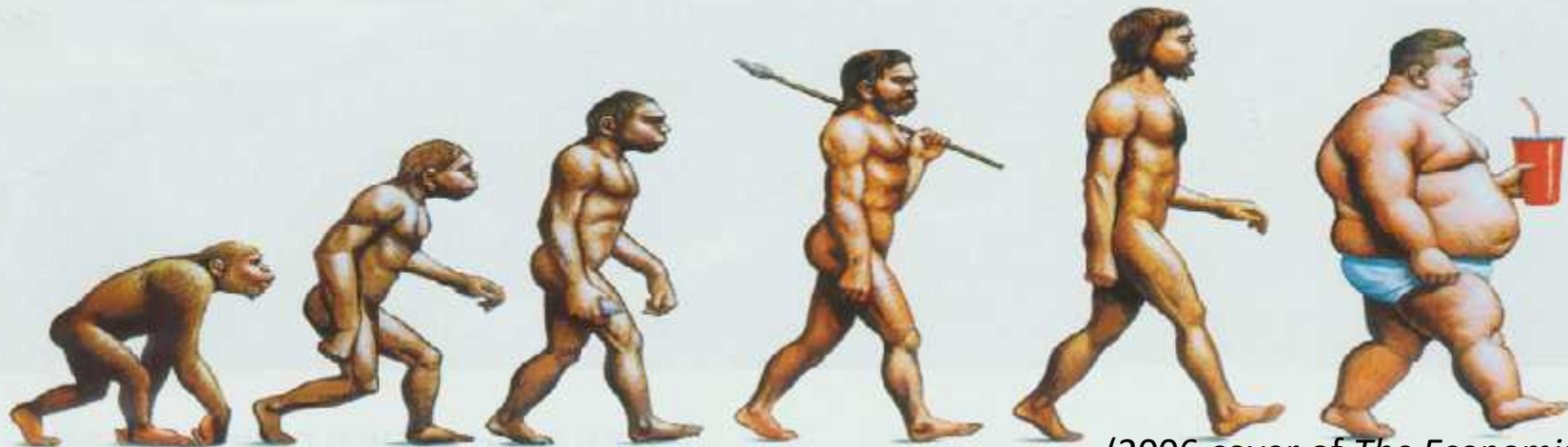


# N used in Food Production

## *If they had done both!*



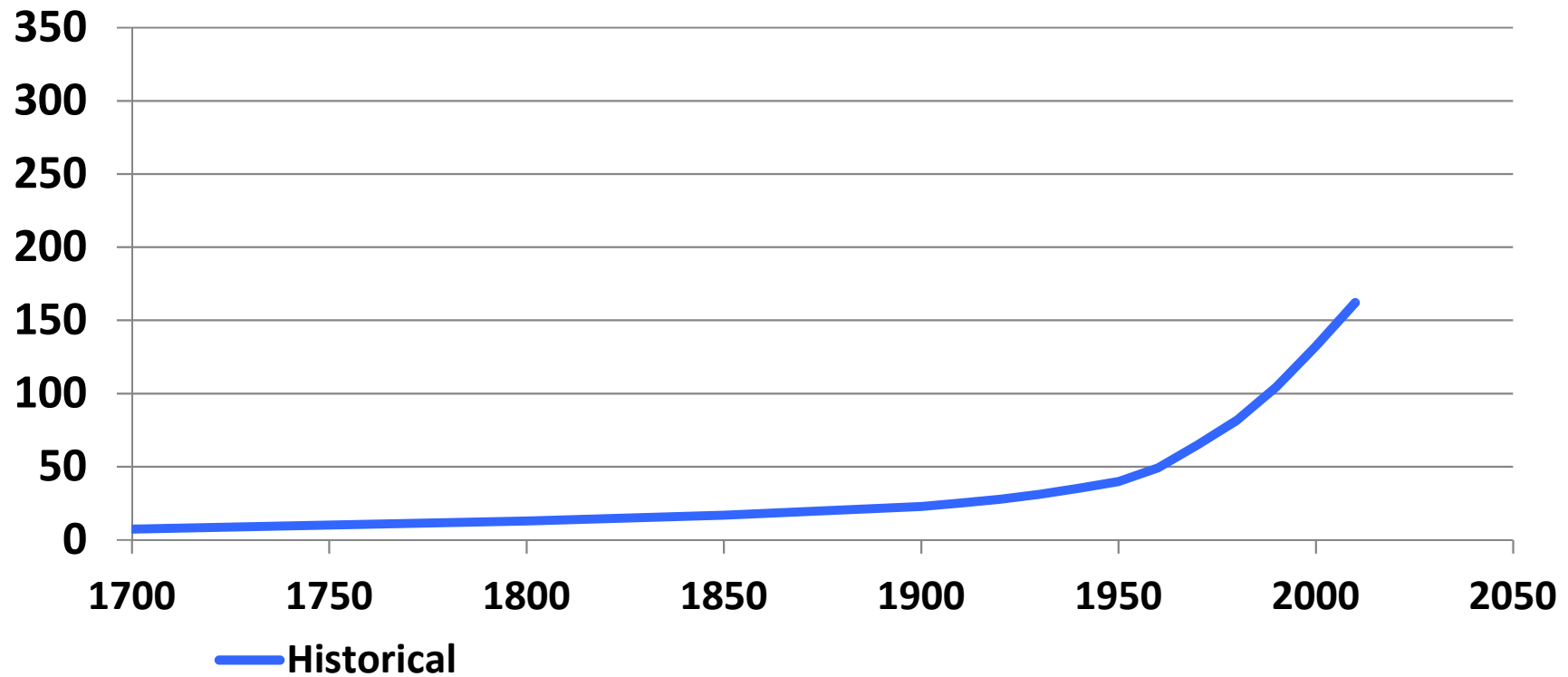
# The shape of things to come



(2006 cover of *The Economist*)

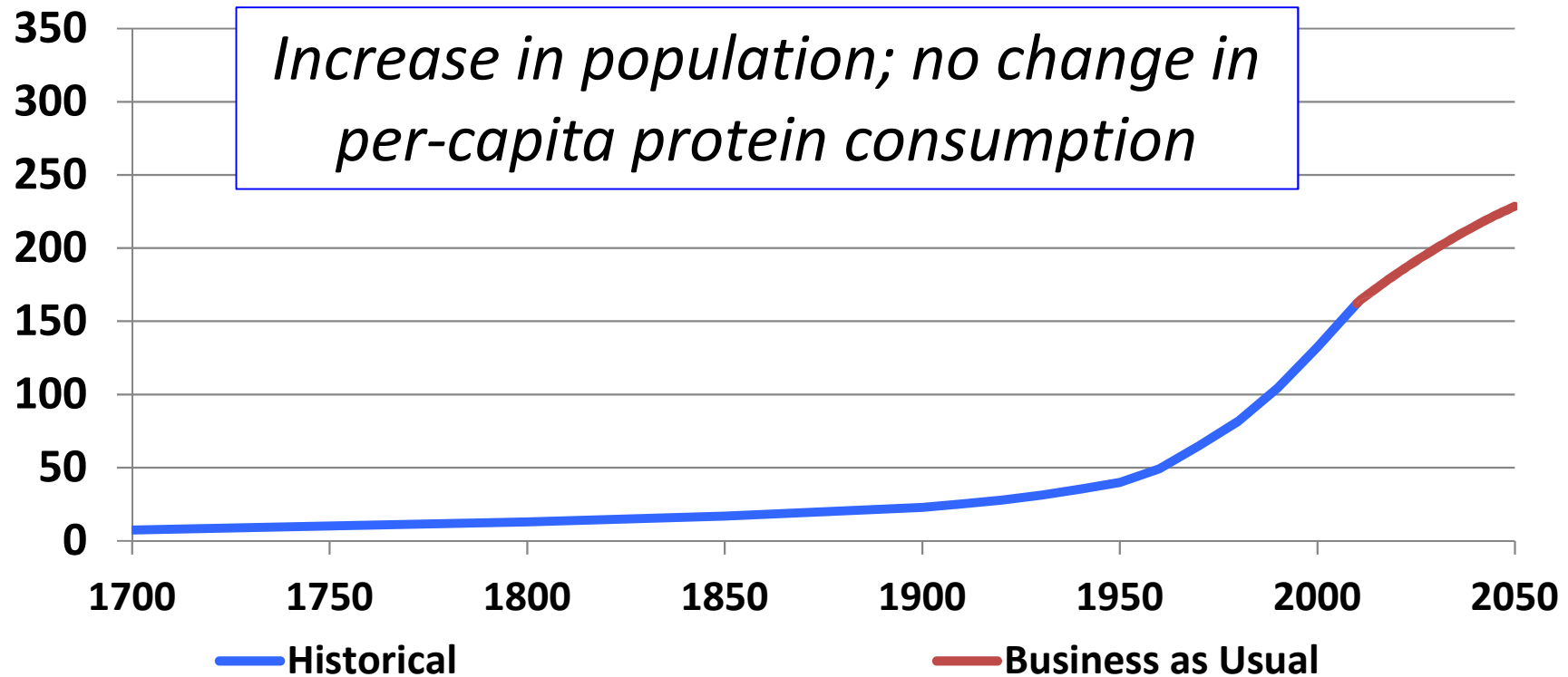


## Human Creation of Reactive Nitrogen for Food Production, Tg N/yr



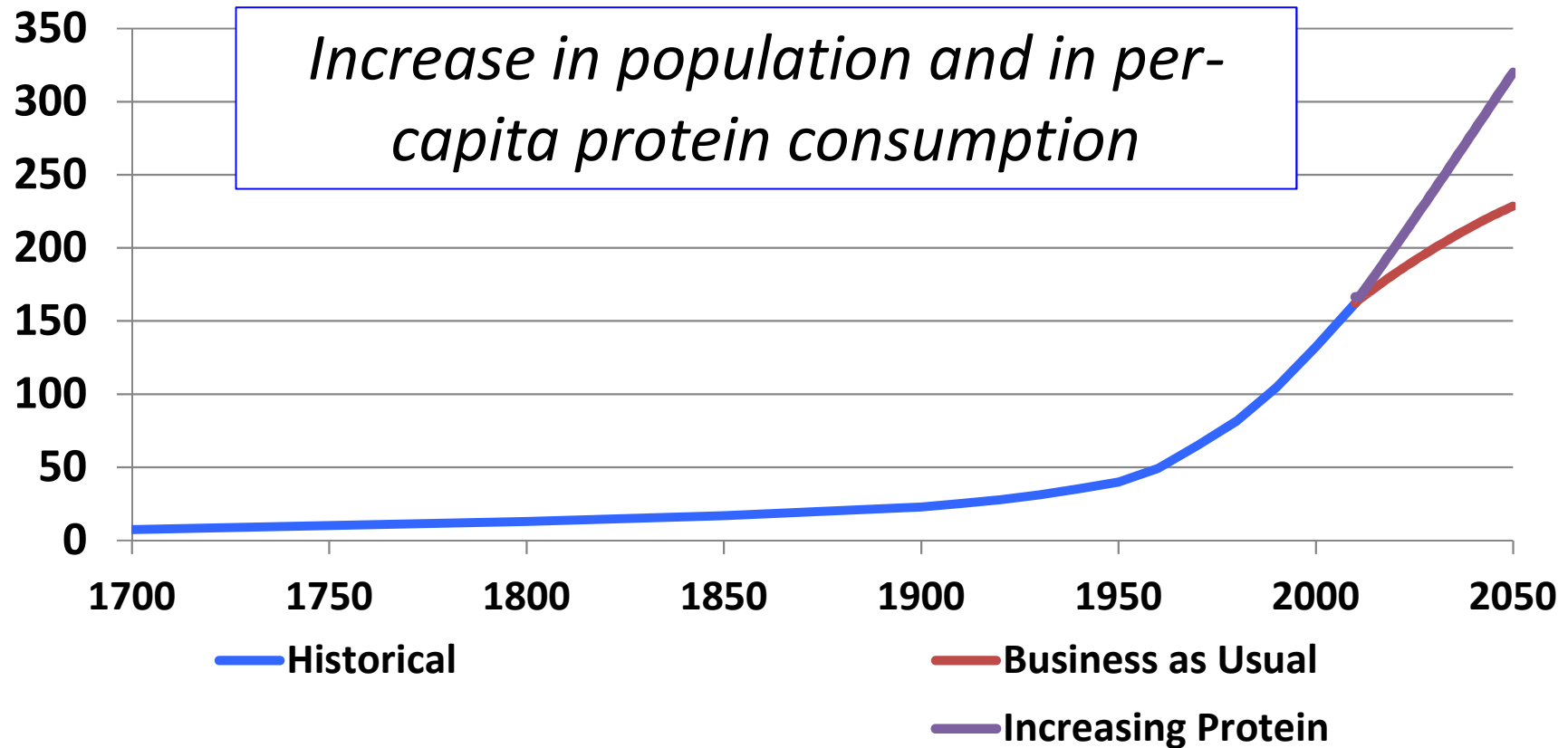
Galloway et al., 2016

## Human Creation of Reactive Nitrogen for Food Production, Tg N/yr

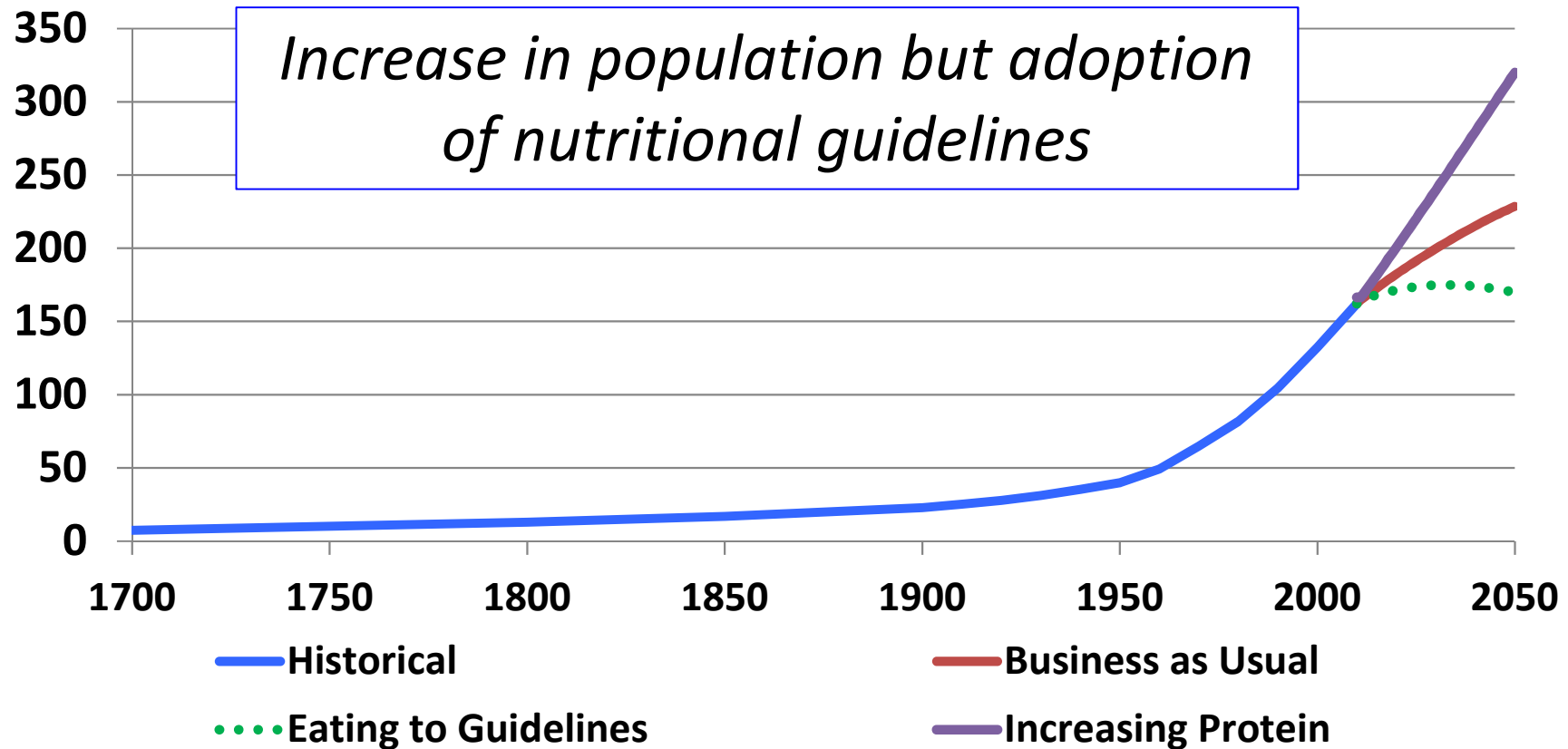


Galloway et al., 2016

# Human Creation of Reactive Nitrogen for Food Production, Tg N/yr



# Human Creation of Reactive Nitrogen for Food Production, Tg N/yr



# Solving the Problem



***A Shared Responsibility***

# It's a Shared Responsibility to solve the N Dilemma

## 1. Policy



## 2. Technology



## 3. Individual/Institutional Action



# **The 6<sup>th</sup> N Footprint Workshop**

## **Dec 2, University of Melbourne**



# **The 6<sup>th</sup> N Footprint Workshop**

## **Dec 2, University of Melbourne**

**Group 1: Improving and streamlining the methodology**  
**Group 2: Improving communication and outreach to consumers**  
**Group 3: Linking with environmental impacts, cost, and policy**  
**Group 4: Developing N-Neutrality metrics for N2016**





## 6<sup>th</sup> N Footprint Workshop: Findings

- **Different approaches and audiences:** There are a number of approaches to determining N Footprints. N-Print will continue to develop these approaches to optimize them for different audiences (e.g., for countries, consumers, producers, policy makers).
- **Communication:** A key focus is to develop audience-specific communication strategies.
- **Damage costs:** Part of the expansion is to produce an initial estimate of the damage costs associated with nitrogen footprints of at least 4 countries, based on existing N-print data and cost estimates from existing EU and US studies.
- **N-Neutrality:** The concept of N-Neutrality, developed for INI-2013, has grown in usefulness and complexity. The next step is to engage a broader community in its use.
- **N-Print** will work together with INI and INMS to develop these next steps.

# The Nitrogen Dilemma

## Benefits:

- Necessary for life
- Synthetic nitrogen fertilizer provides unlimited food supply



## Drawbacks:

- NO<sub>x</sub> emissions: N<sub>r</sub> losses
- Excess reactive nitrogen negatively affects environmental and human health



## Challenge:

Optimizing the use of nitrogen,  
while minimizing the negative impacts

# How Big are our Feet?

## N Footprints at INI-2016

- At INI-2016 we can determine three aspects of our N footprints.
- The first two are conference-related, the third one is on an average annual basis.
- Conference Related
  - You can calculate your daily meal N footprint at the conference.
  - You can find out your N footprint associated with your travel to and from the conference.
- Your personal overall N footprint
  - you can calculate your annual average personal N footprint.



## Another Aspect of N-Related Problems in the Environment

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United States: The Revis family of North Carolina; Food expenditure for one week \$341.98 (Menzel and D'Aluisio, 2007)

## Another Aspect of N-Related Problems in the Environment

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United States: The Revis family of North Carolina; Food expenditure for one week \$341.98 (Menzel and D'Aluisio, 2007)



Chad: The Aboubakar family of Breidjing Camp; Food expenditure for one week: \$1.23 (Menzel and D'Aluisio, 2007)



# Conference footprint activities for INI-2016

## #3. Personal N Footprint using Australian version of N footprint calculator (Liang et al., 2016).

- Calculate your footprint at:
  - [au.calc.nprint.org](http://au.calc.nprint.org)
- Report your results at:
  - [https://goo.gl/forms/8kwi0ovrcKAjw1wZ2\\_](https://goo.gl/forms/8kwi0ovrcKAjw1wZ2_)

We will all pretend we are Australians for this exercise. There will be prizes!

If you have any questions, please contact us at [info@n-print.org](mailto:info@n-print.org) or visit [n-print.org](http://n-print.org) for more information.

