

THINKING AND ACTING
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SCIENTIST

TEACHER'S GUIDE

Human Impact on Earth

How has human population and use of natural
resources impacted Earth's systems?

GRADES 6–8

Earth & Space





Human Impact on Earth

Grade Level/ Content	6–8/Earth and Space Science
Lesson Summary	In this lesson, students analyze data sets to construct an argument to show how human activity and per-capita consumption have impacted Earth’s systems.
Estimated Time	1, 45-minute class period
Materials (per team)	Data Set , Internet access, presentation software, Investigation Plan , Assessment , journal
Secondary Resources	World of 7 Billion Our World in Data Population, Consumption, and the Futures
NGSS Connection	MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.
Learning Objectives	<ul style="list-style-type: none">• Students will identify and evaluate evidence to support a claim about how natural resource consumption changes Earth’s system.• Students will make a connection between human population growth and natural resource consumption.• Students will develop a slideshow to explain the causal role that changes in human population have had in changing Earth’s systems.

How has human population and use of natural resources impacted Earth’s systems?

Over 7.4 billion people live on Earth, and the number is rising. Each human has an impact on Earth through the use of its natural resources. Examples of natural resources are fresh water, land, metals, and fossil fuels. Natural resources also include living things, such as forests which provide lumber for construction, as well as sources of food, such as wheat, rice, corn, and fish. Many of the natural resources found on Earth are available in a limited supply. As Earth’s population increases, more of those resources are used.

In addition to using more of Earth’s resources, an increase in population can affect the quality of those resources as well. Industrialization, for example, increases the risk of pollution to the atmosphere and water supplies. Since Earth’s systems interact, a negative impact on one resource can harm other systems as well.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science.
In all investigations:



Students don’t know the “answer” they are supposed to get.



Students play a driving role in determining the process for learning.



Teachers and students construct meaning together by journaling.



Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

Each group will need:

- [Data Set](#)
- Internet access
- [Investigation Plan](#)
- Presentation software
- [Assessment](#)
- Journal

Part 2

INVESTIGATION FACILITATION



Question

Introduce the investigation question.

How has human population and use of natural resources impacted Earth's systems?

CRITICAL THINKING

Ask students to think about how much plastic they use on a daily basis. What effect does the plastic that they use have on Earth's ecosystems? How many ideas can they come up with? Encourage students to think beyond the idea of plastic just sitting in landfills. For example, how could burning plastic affect the atmosphere? How could plastic litter affect fish or animal populations? Then, introduce the investigation question.

HABITS OF MIND

Ask students which of these habits of mind they think will help them most with the investigation:

- Curiosity
- Openness to new ideas
- Creative thinking
- Critical thinking
- Perseverance
- Adaptability
- Self-direction
- Integrity

They should review their choices when the investigation is over and determine if these were the habits of mind that helped them the most or if there were others. Then, introduce the investigation question.



Personal Knowledge

Students capture what they already know about the impact of human population and per-capita consumption on Earth's systems.

- Have students share what they already know about how their personal activities impact Earth's systems.
- Ask students to share what problems they know Earth's systems are currently facing. For example, students may share about climate change or deforestation.
- As a class, try to come up with a list of 5-10 problems caused by humans that are currently impacting Earth's systems.



Secondary Knowledge

Students learn the four Earth systems and define “per-capita consumption” to prepare for the investigation.

- Make sure students understand Earth’s systems:
 - geosphere (solid and molten rock, soil, and sediments)
 - hydrosphere (water and ice)
 - atmosphere (air)
 - biosphere (living things, including humans)
- Also make sure students understand the concept of per-capita consumption. *Per capita*, literally means “per head.” Per-capita consumption is used to refer to how much each person uses. So the per-capita consumption of natural resources refers to the amount of natural resources used by each person on Earth.



Investigation Plan

Students investigate to determine how human population and per-capita consumption have impacted Earth’s systems.

- Distribute the [Investigation Plan](#) for this investigation. Review the information students need to complete this assignment.
- Divide students into four groups, and provide each group with a [Data Set](#).
- Have students review their assigned data and discuss its meaning with their groups. Instruct groups to develop an argument to explain how human population and per-capita consumption have impacted Earth’s systems.
- Groups should use the information they obtain from the data sets as well as additional information they obtain from the Internet (or other sources) to generate evidence that supports their claim.

INVESTIGATION PLAN
HUMAN IMPACT ON EARTH

1. Look at the data set provided to your group. Think about what the data suggests about the impact of human population and per-capita consumption on Earth’s systems.
2. Record information in the data set that you find interesting in your journal.
3. Discuss your observations about the data set with others in your group. Develop an argument about the impact of human population and per-capita consumption on Earth’s system.
4. Record your argument (or claim) in your journal.
5. Discuss the information from your data with others in your group. Think about other types of data you might use to support your argument.
6. Research online to obtain more data to support your argument. Record the information in your journal.

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Investigation Plan

DATA SET 1
HUMAN IMPACT ON EARTH

California Population Growth 1900-2017

Source: 1900-2010 U.S. Census; 1910-2017 population data from the U.S. Census Bureau

California Water Use by Category

Source: <http://www.sacramento.gov/department/water/irrigation>

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Data Set

CRITICAL THINKING

Use the [Fair Test](#) checklist to help students think critically about the investigation plan. Help them understand that a good investigation involves significant research and credible sources. The more critically students think about their investigation plan, the more confident they can be in their results.



Observation

Students document information from the data sets and other resources to generate evidence that supports their claim.

- As students review their data, have them record information in their journal they think is interesting and/or relevant to their argument.
- Remind students to use credible sources on the Internet.

ADAPTABILITY

The process of gathering information to support a claim isn’t always straightforward. Students may develop one argument from the initial data set, yet when they search for supporting data, they may want to change their argument.



Data Analysis

Students make sense of their data by organizing it and representing it visually.

Have students analyze their data. They may wish to use the [Data Analysis](#) prompt as a guide.

- Have students **evaluate** their data for trustworthiness.
- Then, have them analyze their data to find patterns and trends. They may **organize** the data and/or **represent** it visually to construct meaning. For example, they may want to combine information from multiple graphs into their own graph; or, they may want to convert information from text to a graph or from one type of graph to another to better support their argument.
- Have students **interpret** what the identified patterns or trends mean.
- Ensure they have enough data that it can be used as evidence to support a claim.



Secondary Knowledge

Students use secondary sources to understand how human population and per-capita consumption impact Earth's systems.

- Use these resources to help clarify misconceptions or to give students a broader understanding of how per-capita consumption impacts Earth's systems.

[World of 7 Billion](#)

[Our World in Data](#)

[Population, Consumption, and the Futures](#)

- Allow students to look at how per-capita consumption of different natural resources has changed over time.
- Ask students to consider whether there are any areas that do not seem to have been as negatively affected by human population and/or per-capita consumption, and if so, why.



Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write an explanation that answers their investigation question. Students may wish to use the [Explanation](#) prompt as a guide. Have them write their explanation in their journal.
- Have students develop a **Claim** to answer the question: How has human population and per-capita consumption of natural resources impacted Earth's systems?
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Continued

Claim

As per-capita consumption of beef products has risen, animal populations in the rainforest have decreased.

Evidence

Currently, the biggest cause of deforestation in the Amazon rainforest is due to the creation of cattle ranches. Many of those cattle ranches are used for cattle that eventually are imported as beef to America. As the number of cattle ranches has increased, so has the rate of deforestation which is required to make room for the cattle ranches.

Deforestation has caused animals to lose their habitats. Hundreds of rainforest species disappear each year because of deforestation. For example, if 18,500 acres/year of Amazon rainforest continues to be destroyed, the number of bird species will drop significantly. In 2000, the number of bird species was around 1700, but it is projected to be 1350 by 2150. That means more than two bird species are disappearing each year and those disappearing species can have an impact on other animal types, particularly those that feed on the disappearing species.

Reasoning

Investigation: My investigation gave me the details about how human consumption of a specific natural resource has changed over time. Human consumption of beef has a direct correlation to the amount of deforestation in the rainforest, thereby causing animal populations to decrease and species to disappear entirely.

Science: The amount of the resource available and the amount of the resource being used annually as shown on graphs helped me make connections about the impact of human consumption. For example, I could see that as deforestation increased in the Amazon rainforest, the number of bird species decreased. Additionally, as the amount of per-capita beef consumption increased, so did the rate of deforestation and cattle ranches, which provide beef for consumption.

- Once the explanation is written, have students discuss their results using a [Present and Defend](#).

DISCOURSE

Have students conduct a [Present and Defend](#) to develop presentation skills as well as audience participation. Research teams present a summary of their investigation to the class. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Research teams defend their explanation with evidence and reasoning. If all students are doing the same investigation plan, have 1 or 2 groups share.



Evaluation

Students reflect on the investigation.

- Ask students to describe one thing that surprised them most about the analysis of the data.
- Ask students to explain how the evidence helps support their argument about human impact on Earth's systems.
- Ask students to list additional data they might want to find to strengthen their argument.

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

Students produce a slideshow that presents an argument about how human population and per-capita consumption have impacted Earth's systems, using evidence found while analyzing the data sets.



Application

- Have students construct a slideshow that explains how human population and per-capita consumption have impacted Earth's systems. Emphasize to students that they should provide explicit details about which of Earth's systems are impacted and how they are impacted.
- Students can review the presentations of the other groups in the class and make a list of the ways per-capita consumption and human population can impact Earth's systems.
- Students may also list how their daily activities can impact Earth's systems.
- Have students select a human activity and research its effects on Earth's systems.

CREATIVE THINKING

Students should determine the best way to display their information in the slideshow to present a convincing argument. Challenge them to be creative in their storytelling and design.

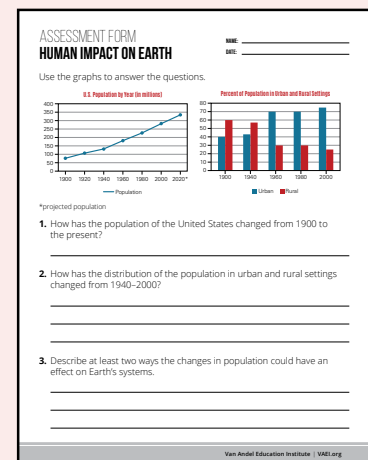
STUDENT CHOICE

As a group, students should determine what type of presentation software they want to use. Some examples include PowerPoint, animoto.com, and photopeach.com, but encourage them to find the presentation format that best meets their needs.

Assessment

Students assess their knowledge by analyzing evidence to explain how human population and per-capita consumption impact Earth's systems.

- Use the **Assessment** to evaluate student learning about how human population and per-capita consumption impact Earth's systems:
 1. How has the population of the United States changed from 1900 to the present? (*The population has steadily increased.*)
 2. How has the distribution of the population in urban and rural settings changed from 1940–2000? *Between 1940 and 1960, the urban population significantly increased and the rural population significantly decreased, but both have been relatively stable in recent years. Prior to 1960, the rural population exceeded the urban population. Since 1960, the urban population has exceeded the rural population.*
 3. Describe at least two ways the changes in population could have an effect on Earth's systems. *The shift to a greater urban population could mean an increase in energy use which could lead to increases in air and water pollution. Because cities tend to be heat islands, increased urbanization could lead to an increase in air temperatures.*



Assessment

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

INVESTIGATION PLAN

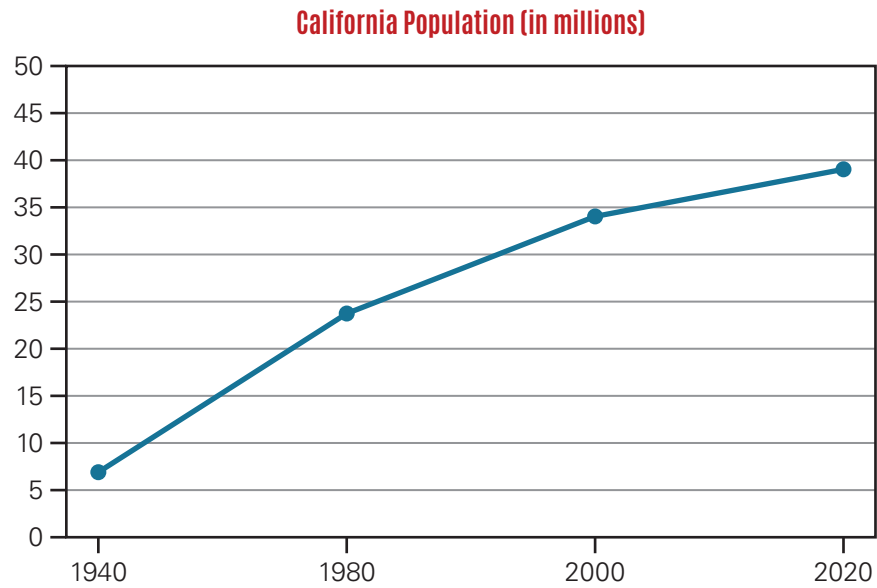
HUMAN IMPACT ON EARTH

- 1.** Look at the data set provided to your group. Think about what the data suggests about the impact of human population and per-capita consumption on Earth's systems.
- 2.** Record information in the data set that you find interesting in your journal.
- 3.** Discuss your observations about the data set with others in your group. Develop an argument about the impact of human population and per-capita consumption on Earth's system.
- 4.** Record your argument (or claim) in your journal.
- 5.** Discuss the information from your data with others in your group. Think about other types of data you might use to support your argument.
- 6.** Research online to obtain more data to support your argument. Record the information in your journal.

DATA SET 1

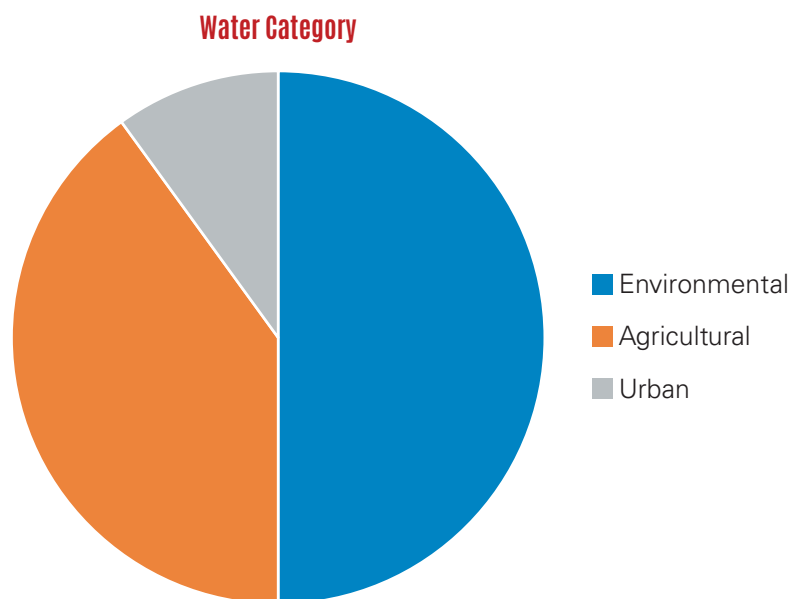
HUMAN IMPACT ON EARTH

California Population Growth 1900–2017



Sources: 1850–2010 U.S. Census, <http://www.ppic.org/publication/californias-population/>

California Water Use by Category

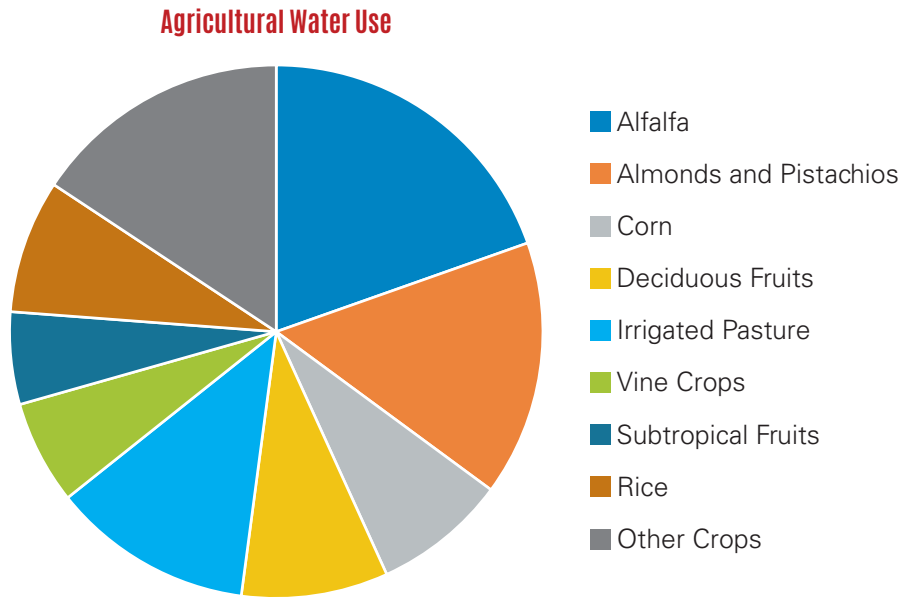


Source: <http://www.ppic.org/publication/water-use-in-california/>

DATA SET 1 CONTINUED

HUMAN IMPACT ON EARTH

California Agricultural Water Use by Category

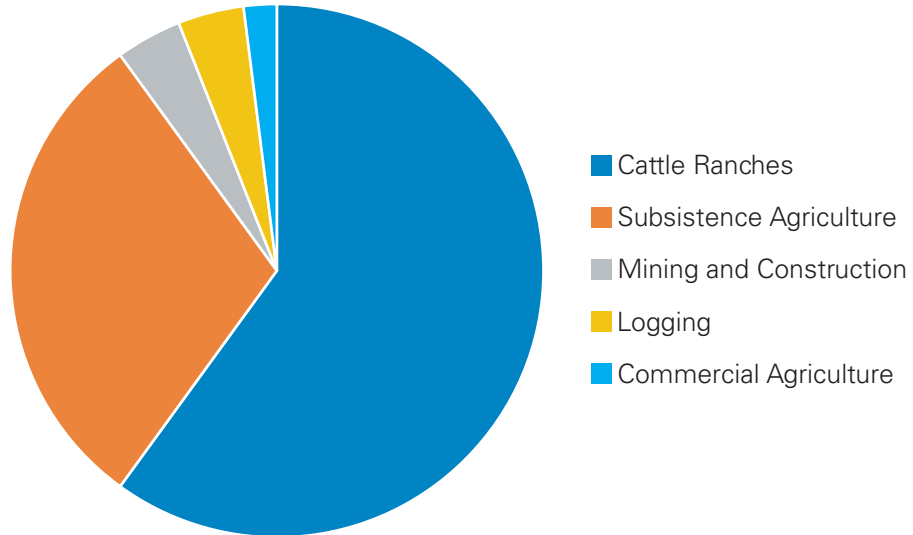


Source: <https://mavensnotebook.com/2015/04/15/california-water-law-symposium-the-advancements-and-challenges-of-agricultural-water-use-efficiency-since-2009/>

DATA SET 2

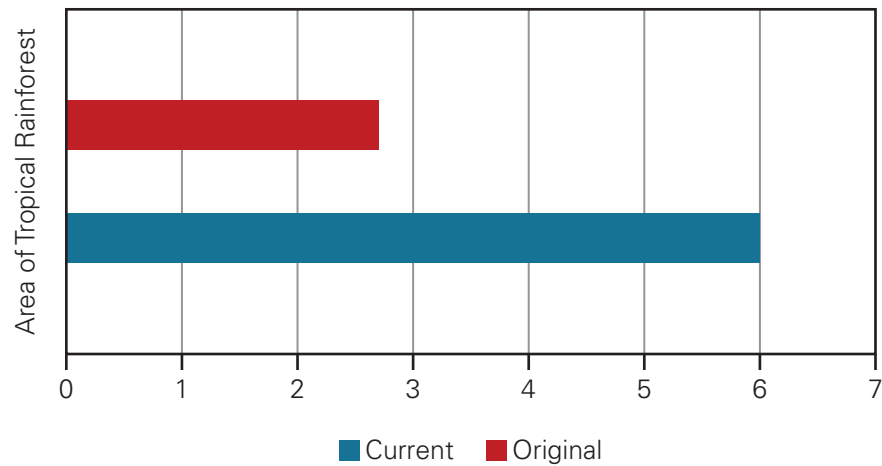
HUMAN IMPACT ON EARTH

Causes of Deforestation in Amazon Rainforest



Source: <http://rainforests.mongabay.com/amazon/charts.html>

Area Tropical Rainforests Worldwide (millions of acres)

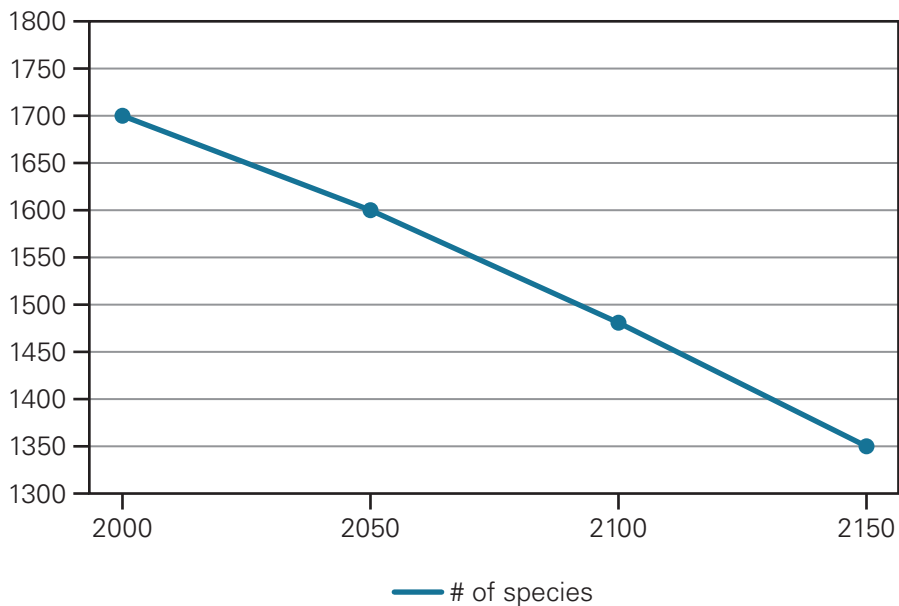


Sources: <https://mongabay-images.s3.amazonaws.com/14/01-world-rainforest-map-1500.jpg>

DATA SET 2 CONTINUED

HUMAN IMPACT ON EARTH

Projected Number of Bird Species in Brazil



*if 18,500 acres/year continues to be destroyed

Sources: http://sitemaker.umich.edu/section2group3/results_and_discussion

Rates of Deforestation in the Amazon Rainforest

Year	Rate (km ²)
2000	18,226
2003	25,396
2006	14,196
2009	7,008
2012	5,000
2015	7,989

DATA SET 3

HUMAN IMPACT ON EARTH

World Cities with the Most Air Pollution

City	Approximate Population Density (km ²)
Zabol, Iran	48
Gwalior, India	445
Allahabad, India	1,087
Riyadh, Saudi Arabia	3,600
Al Jubail, Saudi Arabia	12
Patna, India	16,925
Raipur, India	4,500
Bamenda, Cameroon	99.12
Xingtai, China	570

Source: <http://www.cbsnews.com/pictures/the-most-polluted-cities-in-the-world-ranked/>

World Cities with the Least Air Pollution

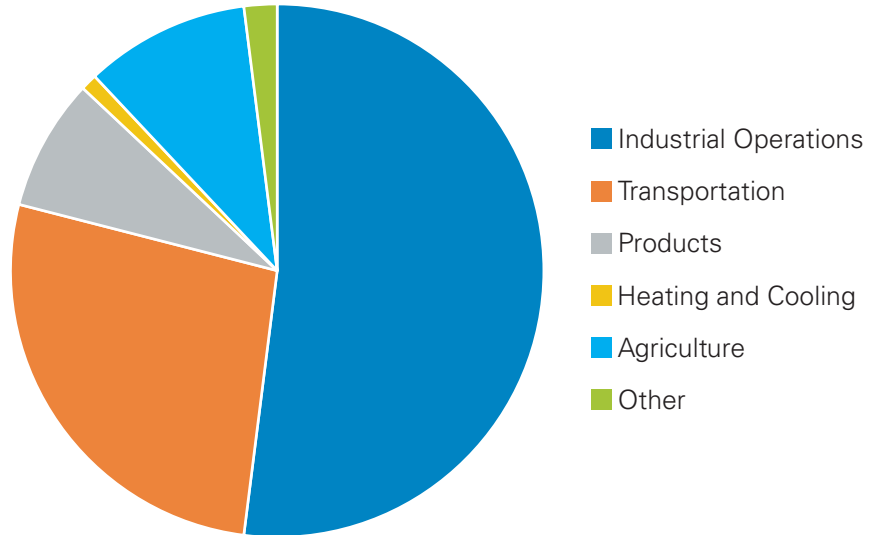
City	Approximate Population Density (km ²)
Whitehorse, Yukon, Canada	55.9
Santa Fe, New Mexico, USA	643
Honolulu, Hawaii, USA	2,236
Great Falls, Montana, USA	1,123
Calgary, Alberta, Canada	1,329
Ottawa, Ontario, Canada	316.6
Helsinki, Finland	3,050
Stockholm, Sweden	3,597
Zurich, Switzerland	1,075

Source: <http://www.care2.com/causes/10-cities-with-the-cleanest-air-in-the-world.html>

DATA SET 3 CONTINUED

HUMAN IMPACT ON EARTH

Sources of Air Pollution

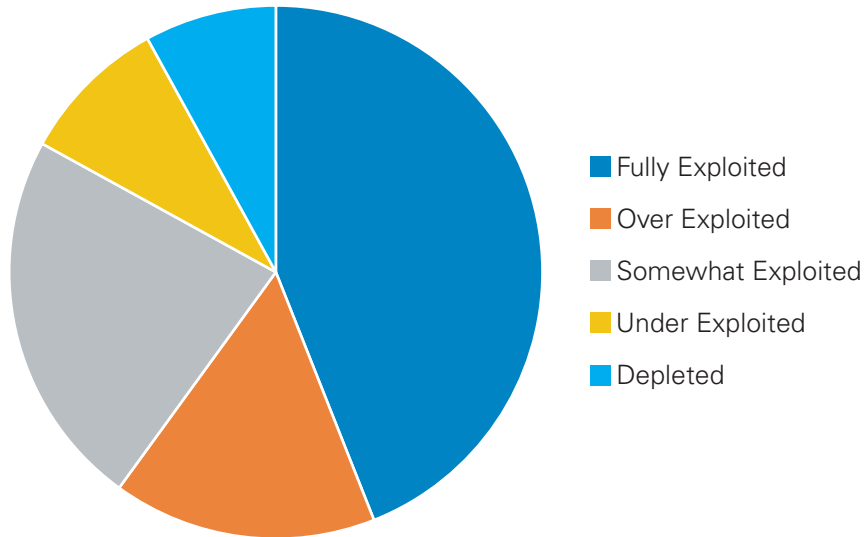


Source: http://samples.jbpub.com/9780763780449/80449_Ch02_021_rev2.pdf

DATA SET 4

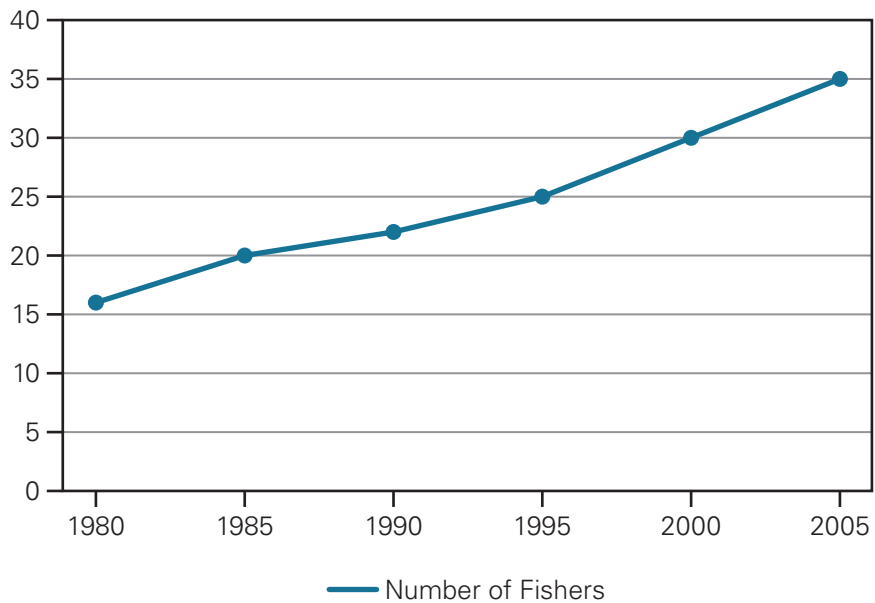
HUMAN IMPACT ON EARTH

World Fishery Exploitation



Source: wwf.panda.org/about_our_earth/blue_planet/problems/problems_fishing/

Number of Fishers (in millions)

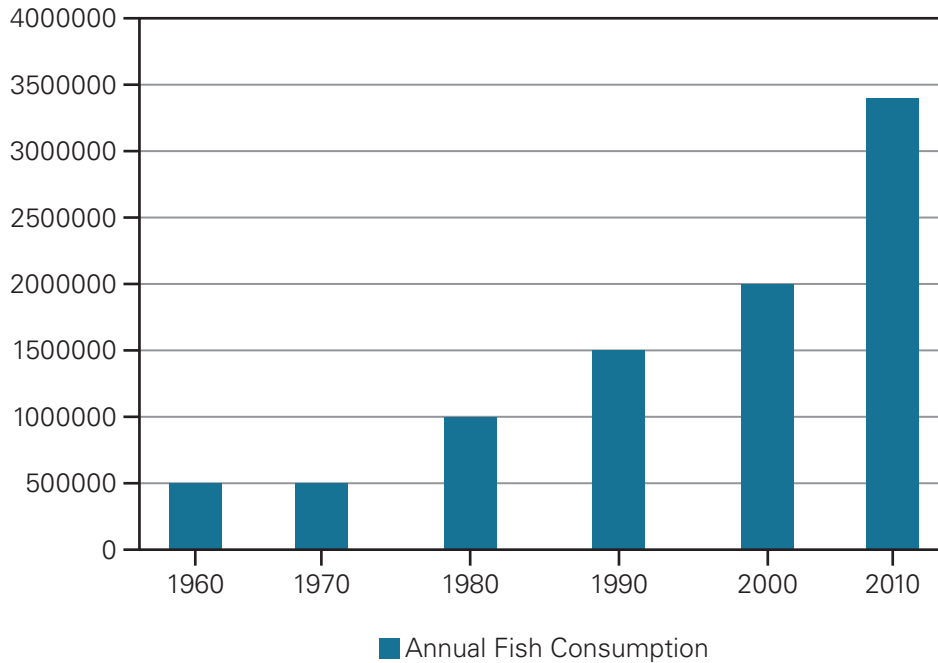


Sources: [ftp://ftp.fao.org/FI/DOCUMENT/c929_article/C929e_article.pdf](http://ftp.fao.org/FI/DOCUMENT/c929_article/C929e_article.pdf)

DATA SET 4 CONTINUED

HUMAN IMPACT ON EARTH

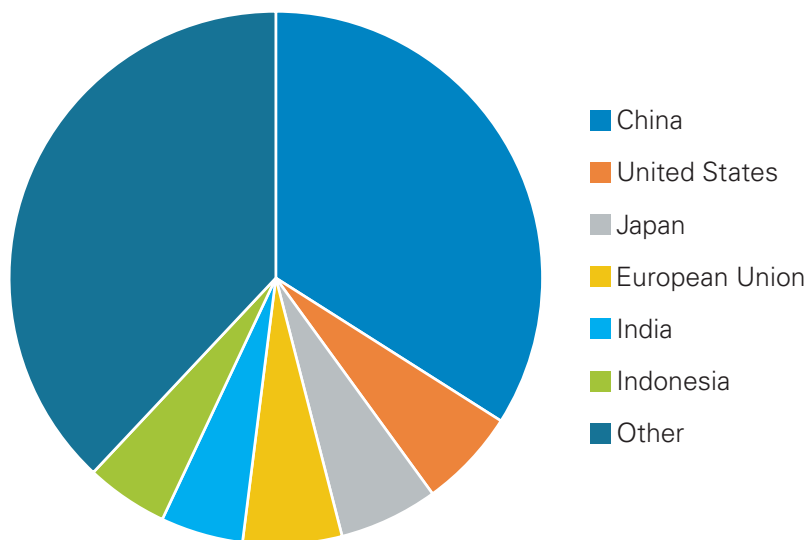
Annual Fish Consumption (in tons)



Sources: <http://puregrownaquaculture.com/about-us/history-of-aquaculture/>

Wild Caught Fish Consumption by Country

Consumption by Country



Source: <http://globalsherpa.org/whats-for-dinner/>, <http://www.fao.org/news/story/en/item/213522/icode/>, <http://entopro.com/journal/2015/10/2/aquaculture>