The Ecological Footprint and Biocapacity of California

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Foreword: What is at stake?

For most of the 20th century, resources were relatively cheap and easily available. As a result most economies, including California’s, became increasingly dependent on large amounts of natural resources—water, fossil fuels, and biological resources—and the services that they provide.

While resources are still relatively cheap, the increasing global demand is meeting a supply crunch. It now takes more effort to extract fossil fuels and, in some places, access fresh water, which has greater impact on biodiversity. Agricultural production is also becoming increasingly fuel intensive. As a consequence, basic commodities, such as food and fibers, are getting more expensive, ever more straining our economies.

Given its relatively high average per person income, California is still less affected by its resource constraints than are many other areas, even with the recent economic turmoil. But in regions that don’t have California’s economic advantage, such as Central America or the Mediterranean basin, resource deficits are already a massive economic burden, amplifying if not driving the turmoil. But even California is experiencing some of the crunch, particularly through energy costs and water shortages. Global climate change will only exacerbate these issues.

This stress is not a short-lived anomaly. The cumulative, persistent trend of resource demand meeting limited supply is turning those resource dynamics into an ever more significant driver of economic performance. The decision-makers who ignore these trends risk social and economic decline.

In order to shift these trends, and adjust to new realities, decision-makers need to recognize the speed and scale of the challenge, and the time-lags involved. For instance, adapting infrastructure to a resource-constrained world requires foresight, time, and solid implementation and monitoring programs.

Understanding speed and scale requires robust information. This is the purpose of this report: To detail California’s ecological assets and resource demand with the Ecological Footprint and its supply-side complement, biocapacity.

One significant result of this assessment surprised us: the realization of how little per capita biocapacity—that is, nature’s ability to sustainably provide ecological resources and services—California has available compared to its own consumption. California contains just about one-sixth of the ecological resources it demands, even though its per capita Ecological Footprint is somewhat lower than the U.S. average.
In a world of growing ecological overshoot, access to sufficient natural capital is key to success. It is in the overwhelming self-interest of any country, state, city and investor to address resource constraints pro-actively. California is no exception.

California’s Assembly Bill 32: Global Warming Solutions Act may in fact be one of the most significant competitiveness drivers for California – even though it only addresses one interwoven portion of the Footprint: carbon emissions.

Footprint and biocapacity accounts help provide an overview, show what factors drive what kinds of resource demands, and where resource deficits occur. This analysis is just a first summary, more detail could be added, such as to evaluate changes over time.

But the initial point is straightforward: If indeed biocapacity is becoming more critical to economic success in the 21st century, and the state is running a significant resource deficit, California cannot ignore its growing risk exposure. As a global center of innovation, California has the ability to address this challenge. If not California, who can?

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Executive summary

The Ecological Footprint for California, forming part of the California Sustainability Indicators project undertaken by the U.S. Environmental Protection Agency Region 9, represents a significant development in the use of the Ecological Footprint: this is the first Ecological Footprint study of the state of California.

The Ecological Footprint is an accounting tool that measures the amount of biologically productive land and sea area required to produce what a population (or an activity) consumes and to absorb its waste, using prevailing technology and management practice. The Ecological Footprint is compared to available biocapacity, the planet's or a region’s biological capacity to provide the products and services people demand.

This is a baseline study undertaken with the purpose of identifying the drivers and California’s Ecological Footprint and biocapacity. Data were only available for one year (2008), so time trends cannot be made under the current analysis. Details about the source data and methodology used to determine these results are presented in a separate report¹.

Key findings

• Although California’s per capita Ecological Footprint is less than the United States’, California is still running a significant ecological deficit, with its population using more than five times the biological capacity (or biocapacity) than is available within the state. This means that the state of California consumes renewable biological materials at a rate that is faster than they can be regenerated, and is emitting carbon dioxide into the atmosphere at a rate that is faster than carbon dioxide can be sequestered within California.

• Most of the difference between the national per capita Footprint and California's is due to lower per capita carbon dioxide emissions in California. Some of this difference can be explained by mild weather that reduces energy demand for heating and cooling, implementation of energy efficiency measures, and by the use of hydropower in California. In addition, California uses natural gas in some places where other states might use coal.

• California's per capita biocapacity is much less than that of the United States'. This is mostly due to California's relatively high population density but also to the aridity of much of California.

Even though the agricultural sector of California’s economy is robust, California’s cropland biocapacity is relatively small. California’s cropland biocapacity comprises only 3 percent of the total cropland biocapacity in the United States, although agricultural production in California was 17 percent of the total agriculture economic output of the United States, measured in monetary value. While the dollar value of crops produced in California is typically high, biocapacity is based on the physical weight of crops harvested and the area used to grow crops. In other words, biocapacity reflects biological productivity, not revenue.

- Even though California has a lot of biocapacity in fishing grounds and forest land, Californians export a lot of what is produced with this biocapacity. Although there is a lot of biocapacity within the state, California imports most of the products from fishing grounds and forest land that are consumed by the population.

- Carbon emissions account for 73 percent of California’s Ecological Footprint. This is driven by transportation and electricity generation.
## Table of Contents

Forward .................................................................................................................................................... 3  
Executive summary .................................................................................................................................... 5  
  Key findings........................................................................................................................................... 5  
List of figures............................................................................................................................................. 8  
California Sustainability Indicators................................................................................................................ 9  
What is the Ecological Footprint?.................................................................................................................. 9  
  Footprint of consumption, production, and trade ...................................................................................... 10  
  Biocapacity.......................................................................................................................................... 10  
  Summary of land types ......................................................................................................................... 11  
  Ecological deficit................................................................................................................................... 13  
    The United States has run an ecological deficit since at least 1961 .......................................................... 14  
California’s Ecological Footprint.................................................................................................................. 17  
  California’s per capita Ecological Footprint is smaller than the United States ................................................ 18  
    California is running an ecological deficit overall ................................................................................... 19  
  Cropland ............................................................................................................................................. 21  
  Grazing land ........................................................................................................................................ 24  
  Fishing grounds.................................................................................................................................... 26  
  Forest land .......................................................................................................................................... 28  
  Carbon............................................................................................................................................. 29  
California’s biocapacity.............................................................................................................................. 34  
APPENDIX A: FAQ .................................................................................................................................... 37  
APPENDIX B: Glossary .............................................................................................................................. 41  
APPENDIX C: Data tables .......................................................................................................................... 45
List of figures

Figure 1 The Ecological Footprint measures the human demand for energy, infrastructure, food, fiber, timber, paper and seafood. It is compared to biocapacity of five distinct land types: built-up land, grazing land, cropland, fishing grounds and forests (which serve two distinct functions: carbon sequestration and generation of forest products).  

Figure 2 Five factors drive the ecological deficit.  

Figure 3 Ecological creditors (green) and debtors (red) in 2008.  

Figure 4 The total Ecological Footprint and biocapacity of the United States, 1961 - 2008.  

Figure 5 The Ecological Footprint of the United States per land type, 1961 - 2008.  

Figure 6 The Ecological Footprints and biocapacity of the United States compared to California, 2008.  

Figure 7 California’s Ecological Footprint by household consumption activity, 2008.  

Figure 8 California’s cropland biocapacity by crop type. The percentages are based on total global hectares.  

Figure 9 The kinds of consumption that drive California’s forest product Footprint, 2008.  

Figure 10 Consumption activities that drive the carbon component of California’s Ecological Footprint, 2008. This summary reflects the demand for goods and consumer activities that drive carbon emissions; this summary does not reflect the source of emissions.  

Figure 11 California’s biocapacity by land type, 2008.
California Sustainability Indicators

Growing human population, ever-increasing energy and material use, and waste generation characterize our current economic and social systems. However, ecosystem services that provide materials and absorb waste are limited. Time trends show a widening gap between increasing human demand for these ecosystem services and decreasing ability of nature to support this demand. The U.S. Environmental Protection Agency, Region 9 has developed a suite of substantive and informative indicators of our economy’s effects on the ecosystems that support the economy to facilitate decision-making for the long-term benefit of California.

In addition to the Ecological Footprint, this suite of indicators includes: the Water Footprint, provided by the University of California-Davis; Groundwater Estimates from the Gravity Recovery and Climate Experiment (GRACE), provided by Jet Propulsion Laboratory and California Institute of Technology; Satellite Indicators of Vegetation Condition, Crop Canopy Development, and Agricultural Water Use in California provided by NASA Ames and California State University-Monterey Bay.

This report presents the results of the baseline Ecological Footprint of California using data from the year 2008 (the most recent year complete data sets were available).

What is the Ecological Footprint?

The Ecological Footprint is an accounting tool that measures the amount of biologically productive land and sea area required to produce what a population (or an activity) consumes and to absorb its waste, using prevailing technology and management practice. The Ecological Footprint is compared to available biocapacity, the planet's or a region’s biological capacity to provide the products and services people demand.

Biologically productive land and sea includes area that 1) supports human demand for food, fiber, timber and space for infrastructure and 2) absorbs the emitted waste. Current national accounts, as well as this one for California, only include the carbon dioxide emissions from fossil fuel burning from the waste side. With better, and internationally comparable data sets, other waste streams could be included as well. Biologically productive areas include cropland, grazing land, forest and fishing grounds, and do not include deserts, glaciers and the open ocean.

The Ecological Footprint tracks demand for products that come from five distinct area types: cropland, grazing land, fishing grounds, built-up land and forests. Forests provide two typically mutually exclusive services: they generate forest products such as timber and fire wood, and they provide CO₂ sequestration for the carbon Footprint. These services are typically two distinct, mutually exclusive demands on forests since harvested forest products release the captured CO₂ again, while forests for
sequestration need to remain unharvested. Average bioproductivity differs between various area types, as well as between countries for any given area type. For comparability across area types and countries, Ecological Footprint and biocapacity are expressed in units of world-average bioproductive area, referred to as global hectares (gha).

**Footprint of consumption, production, and trade**

The most commonly reported type of Ecological Footprint measures the biocapacity used to support a defined population’s consumption. Unless otherwise specified, when you see Ecological Footprint values, they represent the Footprint of consumption.

\[
EF_{\text{Consumption}} = EF_{\text{Production}} + EF_{\text{Imports}} - EF_{\text{Exports}}
\]

The Footprint of consumption (\(EF_C\)) is calculated from production and trade flows; it is the Ecological Footprint of all domestic economic production (\(EF_P\) - calculated as the Footprint from local biocapacity and of all local carbon dioxide emissions), plus the Footprint embodied in imports (\(EF_I\)), less the Footprint embodied in exports (\(EF_E\)).

**Biocapacity**

Biocapacity is a measure of the amount of biologically productive land and sea area available to provide the ecosystem services that humanity consumes – our ecological budget or nature’s regenerative capacity\(^2\). California’s biocapacity was determined using land cover data as well as data on the average productivity of different land types. The amount of biocapacity can change over time due to increases or decreases in the amount and productivity of the living things in a particular area. All else equal, if resources are degraded, biocapacity will decline, in some cases to the point that no biologically useful material remains for human consumption or to meet the needs of wild species.

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Summary of area types

Cropland
Cropland is the most bioproductive of all the land-use types and consists of areas used to produce food and fiber for human consumption, feed for livestock, oil crops, and rubber. Current cropland Footprint calculations do not take into account the extent to which farming techniques or unsustainable agricultural practices cause long-term degradation of soil.

Grazing land
Grazing land is used to raise livestock for meat, dairy, hide and wool products. The grazing land Footprint is calculated by comparing the amount of feed crops that are fed to livestock with the total amount required to support livestock, with the difference assumed to come from grazing land.

Fishing grounds
The fishing grounds Footprint is calculated using estimates of the maximum sustainable catch for a variety of fish species. These sustainable catch estimates are converted into an equivalent mass of primary production based on the various species’ trophic levels. This estimate of maximum harvestable primary production is then divided amongst the continental shelf areas of the world.

Fishing grounds Footprint and biocapacity includes the ocean, inland waterways, and aquaculture.

Forest
Forest biocapacity provides for two mutually exclusive demands:

The forest product Footprint
The forest product Footprint is calculated based on the amount of lumber, pulp, timber products and fuelwood consumed by a population.

Carbon Footprint
Carbon dioxide emissions from burning fossil fuels are the only waste product included in the current national Ecological Footprint methodology. On the demand side, the carbon component of the Ecological Footprint, the carbon Footprint, is calculated as the amount of forest land required to sequester (through photosynthesis) carbon emissions release by humans and not sequestered by oceans. It is the largest portion of humanity’s current Footprint, but quite small in some lower-income countries.

We use carbon Footprint, the carbon component of the Ecological Footprint, with a more specific meaning than it typically carries in the general literature and the climate debate. In much of the climate debate, carbon footprint merely refers to the number of tonnes of carbon dioxide, tonnes of
CO₂-equivalent, or tonnes of carbon per unit of currency or for an activity. In our case, we translate these tonnes into the corresponding bioproductive area needed for sequestering this amount of CO₂. When used in Ecological Footprint studies, the phrase “Carbon Footprint” refers to the pressure placed on biocapacity to sequester (through photosynthesis) the carbon dioxide emissions from fossil fuel combustion³. (Its unit of measure is global hectares rather than amounts of CO₂ emissions.)

Because very little forest area is legally dedicated to long-term CO₂ sequestration, we do not distinguish forest for forest products from forest for sequestration. We only report forest area as a whole.

Figure 1 The Ecological Footprint measures the human demand for energy, infrastructure, food, fiber, timber, paper and seafood. It is compared to biocapacity of five distinct area types: built-up land, grazing land, cropland, fishing grounds, and forests. The latter serve two distinct functions: carbon sequestration and generation of forest products.

³ More precisely, the amount of CO₂ sequestered by oceans and removed by (non-land-based) human intervention is subtracted from the fossil fuel generated CO₂ emission. Additional details on the difference between the Carbon Footprint and the carbon component of the Ecological Footprint can be found in: Galli, A.; Wiedmann, T.; Ercin, E.A.; Knoblauch, D.; Ewing, B.; Giljum, S. 2012. Integrating ecological, carbon, and water footprint into a “footprint family” of indicators: Definition and role in tracking human pressure on the planet. Ecological Indicators, 16, 100–112.
**Built-up land**

The built-up land Footprint is calculated based on the area of land covered by human infrastructure — transportation, housing, industrial structures, and reservoirs for hydropower. Built-up land typically occupies what would otherwise be cropland. In our current calculations, to simplify, the built-up land Footprint is always equal to the built-up land biocapacity.

**Ecological deficit**

Ecological Footprint and biocapacity calculations capture the rate at which renewable biological materials are being produced and used and the rate at which carbon dioxide emissions are being generated. Data used in the calculations reflect data for five significant drivers of supply and demand: land area, biological productivity, population, consumption, and technology.

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**Figure 2** *Five factors determine the ecological reserve (or deficit), the difference between biocapacity and the Ecological Footprint.*

An ecological deficit occurs when the Footprint of a population exceeds the biocapacity of the geographic area available to that population. When a region or country is in ecological deficit, it meets demand by either importing embedded biocapacity through trade, liquidating its own ecological assets,
and/or using the global commons such as fishing in international waters or polluting CO₂ into the global atmosphere.

In contrast, when there is enough biocapacity to support the population’s Ecological Footprint in net terms, there is an **ecological reserve**.

![Ecological creditors (green) and debtors (red) in 2008.](image)

**Figure 3** Ecological creditors (green) and debtors (red) in 2008.

**The United States has run an ecological deficit since at least 1961**

The earliest year for which complete national-level data are available is 1961. As a country, the United States has consistently had one of the largest Ecological Footprints in the world – in terms of both its total and its average (per capita) Ecological Footprint for this entire time series.

Even though the per capita Footprint has not increased as significantly or quickly as many other countries, the Ecological Footprint of the United States continues to increase. While individual consumption in the United States continues to rise, population growth is an even more significant driver of the country’s total Ecological Footprint, accounting for 86 percent of the increase between 1961 and 2008.
In other countries, population has an even larger effect on the total Ecological Footprint. In 2008, the most current year data are available, the total Footprint of the United States (2.2 billion gha) was second in size only to that of China (2.9 billion gha). But comparing the per capita Ecological Footprints in 2008, China’s (2.1 gha per capita) is much smaller than that of the United States (7.2 gha per capita).

In 2008, the United States had the world's fifth largest per capita Ecological Footprint among countries with more than one million inhabitants, after Qatar (11.7 gha per person), Kuwait (9.7 gha per person), the United Arab Emirates (8.4 gha per person), and Denmark (8.3 gha per person).

Carbon remains the largest component of the United States’ Ecological Footprint, accounting for 68 percent of in the Ecological Footprint 2008. The activities of consumers in the United States that contribute most to the carbon component of its Ecological Footprint are housing and transportation. Housing includes electricity, gas and other fuels, water supply and maintenance and repairs, and accounts for 32 percent of the United States’ carbon Footprint; transportation includes purchase and operation of personal vehicles and public transportation services, accounting for another 24 percent of the United States’ carbon Footprint.

**Figure 4** The total Ecological Footprint and biocapacity of the United States, 1961 - 2008.
Figure 5 The Ecological Footprint of the United States per land type, 1961 - 2008.
California’s Ecological Footprint
The following results present the first year for which the Ecological Footprint and biocapacity for the state of California are calculated. This section starts with a brief overview and then provides detail for each of the land types.

**California’s per capita Ecological Footprint is smaller than the United States**

In 2008, California's per capita Ecological Footprint of 5.9 gha was smaller than the United States (7.2 gha per person). If California were a country, it would have the world's 15th largest per capita Ecological Footprint, between Ireland (6.2 gha) and Sweden (5.7 gha).

Most of the difference between the national Footprint average and California's is due to lower per capita carbon dioxide emissions in California (the carbon component of California’s Ecological Footprint is 4.3 gha per capita, which is 0.6 gha less than the United States' 4.9 gha average). Part of this difference is due to the mild climate in California that does not require as much heating and cooling, implementation of energy efficiency measures, and some of this difference can be explained by the use of hydropower in California. In addition, California does not use coal like other parts of the United States.

**Table 1** The per capita Ecological Footprints and biocapacity of California, the United States, and the World in gha per capita, 2008.

<table>
<thead>
<tr>
<th>Land Type</th>
<th>California</th>
<th>United States</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ecological Footprint</td>
<td>Biocapacity</td>
<td>Ecological Footprint</td>
</tr>
<tr>
<td>Cropland</td>
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<td>0.34</td>
<td>1.09</td>
</tr>
<tr>
<td>Grazing Land</td>
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<td>0.08</td>
<td>0.19</td>
</tr>
<tr>
<td>Fishing Grounds</td>
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<td>0.22</td>
<td>0.09</td>
</tr>
<tr>
<td>Forest Product</td>
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<td>0.27</td>
<td>0.86</td>
</tr>
<tr>
<td>Carbon Footprint</td>
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<td>4.87</td>
<td></td>
</tr>
<tr>
<td>Built-up Land</td>
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<td>0.12</td>
<td>0.07</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5.92</td>
<td>1.02</td>
<td>7.19</td>
</tr>
</tbody>
</table>

http://www.eia.gov/state/state-energy-profiles.cfm?sid=ca
California is running an ecological deficit overall

Although California’s Ecological Footprint is less than the United States’, California is still running an ecological deficit: In 2008, California’s per capita biocapacity was 1.02 global hectares. This means that biocapacity in California could support only 17 percent of the population’s Ecological Footprint. The remaining 83 percent was made up through importing biocapacity from elsewhere and releasing carbon dioxide emissions into the global atmosphere.

Figure 6 The Ecological Footprints and biocapacity of the United States and California, per capita, 2008.
The largest shares of California's cropland, grazing land, and fishing grounds Footprint components are in the food that Californians eat. While smaller percentages of these components are included in housing, transportation, goods, and services, these latter consumption categories account for the majority of the forest product and carbon components of California’s Ecological Footprint.

The differences between what Californian’s consume and the amount of biocapacity available within the state varies between the different land types. Next we examine California’s Ecological Footprint and biocapacity by each land type.
**Cropland**

California’s cropland supports a significant portion of the population’s diet and the state’s economy. The cropland products that Californian’s consume in their diet accounts for 9 percent of the state's overall Ecological Footprint.

**California’s cropland biocapacity is surprisingly small**

On the supply side, cropland biocapacity in California is significant because California generated $27.3 billion worth of agricultural output in 2008. This was 17 percent of the total agricultural economic output of the United States.

There are 173 million hectares of cropland in the United States, and California has just 3 million (or 2 percent of the total cropland in the country). As a proportion of California’s bioproductive land area, cropland only comprises 7 percent of California, while cropland is 12 percent of the total bioproductive land in the United States. However, crops grown in California have higher than world average and national yields, so proportionally less land is needed for crop production in California than
in the United States to produce the same amount of crops. Although the market value of crops produced in California is relatively high, biocapacity reflects biological productivity, not revenue.

In per capita terms, the cropland biocapacity for the United States was 1.5 global hectares, and in California it was 0.3 global hectares. This large difference is driven by a higher population density in California (0.9 people per hectare) compared to the United States (0.3 people per hectare), however future research should focus on the other inputs and drivers of biocapacity as well (e.g. land area, agricultural water use, fossil fuel-based inputs, productivity, etc.).

![Figure 8](image)

**Figure 8** California’s cropland biocapacity by crop type. The percentages are based on total global hectares, 2008.

Agriculture in California is also different from the rest of the country in another way. Although proportionally less land in California is used to grow crops, there is a larger variety of crop products grown. In 2008, three crop products contributed 39 percent of California’s cropland biocapacity: grapes, wheat, and rice paddy. Compared to the United States, where the three largest crop products are corn, soybeans, and wheat and make up 73 percent of the total biocapacity; 38 percent of the country’s cropland biocapacity is corn alone.
In 2008, cropland biocapacity in California was 12.4 million gha, and 5.5 million global hectares of this biocapacity was embodied in exports (this equals 44 percent of the California’s cropland biocapacity that was embodied in exports).

To make up for low biocapacity, California relies on imports of crop products

In 2008, California’s cropland Footprint of consumption (what the population consumes) was 157 million global hectares, which was much larger than cropland biocapacity that year (28.7 million gha). This gap between biocapacity and the Ecological Footprint was made up with imports, meaning Californians depended on cropland biocapacity from outside the state to support most of their food and fiber consumption.
Grazing land comprised only 1 percent of California's Ecological Footprint in 2008, compared to 3 percent nationally.

**California's grazing land biocapacity is large enough to support its Footprint**

The grazing land Footprint represents the amount of grassland that is required to support animals that are consumed by humans. In California, there is enough grazing land biocapacity to support the grass portion of livestock feed mixes for animals that produce the meat and dairy products that Californians consume. In 2008, California's grazing land biocapacity was 2.8 million global hectares, which is greater than Californians' grazing land Footprint (2.6 million global hectares). The difference between grazing land biocapacity and Ecological Footprint indicates that California has an *ecological reserve* of grazing land.

**California is a net exporter of products derived from livestock**

The Footprint of production is the area necessary for supporting the actual harvest of primary products, reflecting the activities of the livestock and dairy sectors of California's economy, i.e. the Footprint of production does not reflect the products consumed by Californians, just the animals that are raised on the grazing land within the state. In California, 98 percent of grazing land used to support livestock production was for cattle and products derived from cattle; sheep and goats made up the remaining 2 percent. And although California imports some meat and dairy products, it exports
more than it imports; net exports (imports – exports) were 250,000 global hectares in 2008 (equivalent to 9 percent of production).

However, not all livestock feed on grazing land. California livestock are fed a significant quantity of imported crop feed, and California is home to many intensive feed-lot operations that rely on cropland rather than grazing land. Data limitations make it difficult to assess exactly how cropland, either from California or beyond, is consumed by feed-lot operations, but this would be a useful avenue for future research.
**Fishing grounds**

The fishing grounds component of California's Ecological Footprint is another component of the Ecological Footprint. Our calculations indicate that there may be an *ecological reserve* in this category, meaning that there may be more biocapacity available to match the average Ecological Footprint of products from the ocean or inland waterways.

Whether this is the case cannot be determined with current data since the data informing the biocapacity analysis, and the complexity of trophic levels and collection of accurate production data, make the comparison of supply and demand in the fisheries component unreliable.

According to our calculations, the total fishing grounds biocapacity in 2008 was 8.2 million global hectares; while the fishing grounds Footprint was 3.0 million global hectares. This does not necessarily mean that each individual marine species has a healthy population. Some species may be severely overfished and are suffering from declining stocks, while others have a population that is large enough for sustaining human demand.

**California exports most of what is caught**

However, looking at how this local biocapacity is used, we can evaluate the Footprint of production again, which for fishing grounds represents the area needed to grow all of the fish that are caught off the coast of California and in California’s inland water ways. Fishing for squid (opalescent inshore squid or *Loligo opalescens*) made up half of California's fishing grounds Footprint of Production in 2008. North Pacific hake (*Merluccius productus*) contributed another 18 percent to the fishing Footprint of Production. These were also California's largest fish exports, comprising 57 percent of the fishing grounds Footprint of exports from just these two species of fish. Most of the fish caught in the state of California and off the coast were exported out of the state.
Californians import most of the fish products that are consumed

Net imports accounted for 75 percent of the fishing grounds Footprint of consumption. The embodied Footprint of fish products that California imports is much larger than the Footprint of Production — imports were more than 4 times larger than production. California imported most of these products from countries in the Asian-Pacific region, namely Thailand, China, Indonesia, Viet Nam and the Philippines; fish products from these countries made up 75 percent of the fishing grounds Footprint embodied in imports. Another 11 percent came from Latin American countries including Ecuador, Chile and Mexico.

Tuna products totaled half of the embodied Footprint of imports. The largest imports of tuna into California are from Thailand, but Ecuador, Fiji and the Philippines are also large suppliers.
In 2008, California's forest product Footprint makes up 10 percent of the state's Ecological Footprint. In that year, California's forest product Footprint (21.8 million global hectares) exceeded its biocapacity (9.9 million global hectares), meaning the state was running an ecological deficit in forest land, just with the forest product demand alone. The second demand on forest biocapacity, i.e., carbon Footprint, is discussed in the Carbon Footprint section below.

**Harvest of timber products in California is lower than forest biocapacity, but California still consumes more than is available**

With 9.9 million global hectares of forest biocapacity in California, only 2.2 million global hectares were actually harvested in 2008. Most of the forest products that California consumed were imported into the state; net imports accounted for 90 percent of the forest product Footprint. Even if California used all of the 9.9 million global hectares of forest biocapacity available within the state, half of the lumber, pulp and timber products Californians consumed would still have to be imported.
Figure 9 The kinds of consumption that drive California’s forest product Footprint, 2008.

Unlike cropland, grazing land, and fishing grounds Footprints that are driven primarily by the food that Californian’s eat, the forest product Footprint is driven by other kinds of consumption. California’s forest product Footprint is primarily embodied in goods like recreational equipment, tools and equipment for house maintenance and gardening, furniture, and paper.

Carbon Footprint

Carbon is the largest component of California’s Ecological Footprint, accounting for 73 percent of the total. More than half of this component is from carbon dioxide emissions generated within the state of California; in 2008 emissions from activities in California equaled 90 million global hectares, which is 57 percent of the state’s total carbon Footprint (157 million global hectares). The rest of the carbon Footprint is embodied in goods that are imported into the state — meaning that emissions were generated elsewhere to manufacture goods that are consumed in the state of California.
The largest driver of the carbon component of California’s Footprint is transportation

Transportation for people can be separated into two categories: personal transportation and public transportation. *Personal transportation* includes operation of personal transport equipment, such as cars, trucks and motorcycles. A separate category called transport services includes *public transportation* of passengers by railway, road, air and water.

The Footprint from transportation includes not only indirect emissions from burning gas, but it includes embodied carbon or the carbon dioxide emissions generated by the manufacture of spare parts and accessories, fuels and lubricants – all of the goods and services for maintenance and repair (original manufacture of cars is included in the separate category for "Purchase of vehicles"). Together, direct emissions and embodied emissions in personal and public transportation made up 24 percent of California’s total Ecological Footprint in 2008 – including all land types. This is a larger portion than in the United States, where transportation (direct and embodied emissions, public and private vehicles) accounts for 17 percent.

*Electricity* was the second largest driver of the carbon component, accounting for 8 percent of California’s carbon Footprint in 2008. Almost half of this electricity (49 percent) is imported from outside of the state. Compared to the United States, electricity is 22 percent of the carbon component of its Ecological Footprint.
As described above, there is no specific forest biocapacity associated with the carbon component of the Ecological Footprint – the forest biocapacity is shared with the forest product Footprint. Currently, carbon dioxide emissions are accumulating in the atmosphere at a rate that is faster than they can be sequestered by the planet’s biocapacity; carbon dioxide emissions from fossil fuel burning are overloading global carbon sinks.

Globally, the carbon component of the world’s Ecological Footprint has been the fastest growing component since 1961 (the earliest year for which data are available). In 2008 the carbon component of the world’s Ecological Footprint (all countries combined) was 9.9 billion global hectares. To this, California contributed 0.16 billion global hectares, or 2 percent of the global total, while the population of California made up 0.6 percent of the global population.

Figure 10: Consumption activities that drive the carbon component of California’s Ecological Footprint, 2008. This summary reflects the demand for goods and consumer activities that drive carbon emissions; this summary does not reflect the source of emissions.
How the carbon component of the Ecological Footprint relates to forest biocapacity

All components of the Ecological Footprint represent demands on ecosystem services that compete for space. In the case of potatoes and carrots, it is the crop area needed to produce them (plus area for other agricultural inputs and the harvest, processing and distribution). In the case of using fossil fuel, there are a number of ecological services that are required—from mining to use. The largest among all those demand is the need for waste sinks for the carbon emissions when burning the fuel. This demand on ecosystems can be quite distant in space and time from the site of emission. But it is real demand nevertheless. Without that service, an ecological debt builds up: it manifests as a higher carbon concentration in the atmosphere. Current national Footprint calculations (and the one presented here for California) are limited to the carbon emission of fossil fuel burning, since it is the most dominant demand on nature when using fossil fuel. More complete data sets would allow us to include a larger array of demands on nature imposed by the use of fossil fuels.

As described earlier, the carbon component of the Ecological Footprint is calculated as the amount of forest area required to sequester carbon dioxide emissions from fossil fuel burning, after subtracting out what is absorbed by the oceans. The underlying assumption here is that all released carbon dioxide emissions that are not absorbed by the oceans add to the carbon debt in the atmosphere. To neutralize this debt, the extra carbon needs to be sequestered by vegetation. We assume that this vegetation would be forests.

Applying this assumption globally, in 2008 there were 5.1 billion global hectares of forest biocapacity available. Of this, 1.8 billion global hectares were used to support the global forest product Footprint, leaving 3.3 billion global hectares potentially available to sequester carbon. However, the carbon component of the global Ecological Footprint totaled 10 billion global hectares, meaning that there was only enough growth in forest land worldwide to sequester 33 percent of global carbon dioxide emissions.
As discussed above in the forest section, California had approximately 7.7 million global hectares of domestic forest biocapacity in 2008, though its total forest product Footprint far exceeded available biocapacity due to imports. The two demands on forests combined, forest products and carbon Footprint, far exceed California’s forest biocapacity. It is tempting to assume that any reserve of forest biocapacity directly mitigates some of the carbon Footprint. However, without a firm legal commitment to keeping this portion of the forest dedicated to carbon sequestration, it cannot be considered as a lasting carbon sink.

The Ecological Footprint methodology assumes that biocapacity provides a number of services: the provision of renewable resources, provision of space for infrastructure, and the sequestration of emitted waste such as carbon dioxide from fossil fuel burning. While forests provide both resource provision services (lumber, fiber, fuel, etc.) and waste absorption (forests are the dominant land type for carbon sequestration), there is no clear data on how much of countries’ forests is committed to long-term carbon sequestration. Without globally consistent data coverage, by country, of the amounts of forest land set aside for carbon sequestration and the amounts of forest land from which wood products are harvested, Ecological Footprint and biocapacity values of both forest products and carbon emissions have to be compared against forest biocapacity as a whole.

The usefulness of considering carbon dioxide as a component of the Ecological Footprint is to place carbon dioxide emissions within the context of ecosystem services: Carbon dioxide emissions place pressure on ecosystems globally. Not sequestering all the emitted CO₂ in a given year means leaving a carbon debt for the future in the form of higher carbon concentration in the atmosphere. Such overuse due to carbon emissions is similar to leaving a forest debt when harvesting more timber from a forest than is being renewed.
California’s biocapacity

Biocapacity is the capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and technologies; it is a measure of how quickly renewable biological resources can be regenerated from the area of land that is available. It is like the interest rate on a bank account: The principle amount in the account generates additional money every year, and expenditures (Ecological Footprint) that exceed the interest rate (biocapacity) deplete the principle.

If California were a country, it would have the world's 138th largest per capita biocapacity and the 55th largest total biocapacity out of 150 countries. In 2008, the largest portion of California’s biocapacity was in cropland, followed by forest land and fishing grounds.

There are a number of inputs that influence the productivity of land areas, and thus biocapacity, including: water, land area, sun, soil and fossil fuels, and in California, one of the main limiting factors is water. Although the Ecological Footprint and biocapacity calculations do not directly include water use or water availability, water resources are intrinsic to biocapacity. Lack of water or polluted water has a direct impact on the availability and yields of productive areas; without enough water, California will have less biocapacity.

Energy is used not only to harvest, process, and distribute California’s biocapacity, but also to transport California’s water resources. Reliance on fossil fuels is another important limiting factor that, like water, is not directly included in biocapacity calculations. However, the risks associated with use of fossil fuel are similar to the risks associated with water: as the supply is depleted and/or as the price of oil increases, access to biocapacity will be limited.
California is already running an ecological deficit. As the competition for global resources increases, obtaining the primary inputs to California's biocapacity (e.g. water, oil, etc.), as well as the products that Californians demand will become more difficult. Because water is a critical production factor for biocapacity (and also an input to production of other items that come from cropland, grazing land, forest land and fishing grounds), managing water resources is of central concern for any policy in the state, whether social, economic, or environmental. With continuous monitoring of California’s Ecological Footprint and biocapacity, including the water resources that underpin biocapacity, critical relationships between resource availability and economic success in California can be identified. Such monitoring can help identify how far and how fast we need to go to avoid depleting our ecological assets—not just to avoid loss of biodiversity, but to feed the economy.

**Future Developments**

Several additional research avenues could strengthen the already detailed data provided by this analysis of Ecological Footprint and biocapacity for California.

One large area of research might be to examine the policy options available to address the largest components of California's Ecological Footprint, particularly carbon, taking into account the detailed breakdown of highest-carbon consumption activities in Figure 10, and the context of existing greenhouse gas reduction efforts such as AB 32.

Similarly, it may be useful to investigate strategies to increase California's available biocapacity, especially on a per capita basis and given expected increases in population.

Higher resolution data are needed to assess in more detail the components of livestock operations and grazing land Footprint. Although cattle are the largest consumers of grazing land by far, a full chart of grazing land consumption by animal is not possible given current data, nor can comparisons be made between, for example, the relative Footprint efficiency of grazing land consumption across different livestock species. As discussed above, research into the domestic and imported cropland consumption by large feed-lot operations could also be valuable.

A complementary analysis that isolates water availability and consumption to, particularly, changes in cropland Footprint and biocapacity, would help to link the impact of another valuable resource to those covered in this report.

Lastly, further research is also needed into the health of individual marine species with respect to their share of the fishing grounds biocapacity and Footprint. While methodologically challenging, it would be useful to understand what fraction of the fishing grounds Footprint and biocapacity stable or growing populations occupy, in what fraction of current consumption and availability is from species that are at
the greatest risk of collapse. It would be further useful to understand these issues in the context of fish imports and exports – how does the long-term viability of fish and other marine populations differ between what Californians produce and what they consume?
APPENDIX A: FAQ

How is the Ecological Footprint calculated?

The Ecological Footprint measures the amount of biologically productive land and water area required to produce the resources an individual, population or activity consumes and to their emitted waste, given prevailing technology and resource management. On the waste side, current National Footprint Accounts only include carbon dioxide from fossil fuel burning. The Footprint and the biocapacity areas are expressed in global hectares (biologically active hectares with world average biological productivity). To express results in global hectares, Footprint calculations use yield factors to normalize countries’ biological productivity to world averages (e.g., comparing tonnes of wheat per UK hectare versus the corresponding world average) and equivalence factors to take into account differences in world average productivity among area types (e.g., world average forest versus world average cropland).

Footprint and biocapacity results for countries are calculated annually by Global Footprint Network, based on UN statistics. Collaborations with national governments are invited, and serve to improve the data and methodology used for the National Footprint Accounts. To date, Switzerland has completed a review, and Belgium, Ecuador, Finland, Germany, Ireland, Japan and the UAE have partially reviewed or are reviewing their accounts. See examples at www.footprintnetwork.org/reviews. The continuing methodological development of the National Footprint Accounts is overseen by a formal review committee. A detailed methods paper and copies of sample calculation sheets can be obtained from www.footprintnetwork.org.

Footprint analyses can be conducted at any scale. There is growing recognition of the need to standardize sub-national Footprint applications in order to increase comparability across studies and longitudinally. Methods and approaches for calculating the Footprint of municipalities, organizations and products are currently being aligned through a global Ecological Footprint standards initiative. Two editions of standards have already been issued, the initial in 2006, and the second edition in 2009. For more information on Ecological Footprint standards see www.footprintstandards.org.

What is included in the Ecological Footprint?

What is excluded?

To avoid exaggerating human demand on nature, the Ecological Footprint includes only those aspects of resource consumption and waste production for which the Earth has regenerative capacity, and where data exists that allow this demand to be expressed in terms of productive area. For example, toxic releases are not accounted for in Ecological Footprint accounts. Nor are freshwater withdrawals, although carbon dioxide emissions associated with the energy used to pump or treat water are included.
Also, demands on biocapacity are only included in so far as they exclude each other. In other words, demands that can be accommodated by the same surface area are only counted as one demand in order not to double count the same surface.

Ecological Footprint accounts provide snapshots of past resource demand and availability. They do not predict the future. Thus, while the Footprint does not estimate future losses caused by current degradation of ecosystems, if this degradation persists, it may be reflected in future accounts as a reduction in biocapacity.

Footprint accounts also do not indicate the intensity with which a biologically productive area is being used. Being a biophysical measure, it also does not evaluate other essential social and economic dimensions of sustainability.

**How is international trade taken into account?**

The National Footprint Accounts calculate the Ecological Footprint associated with each country’s total consumption by summing the Footprint of its imports and its production, and subtracting the Footprint of its exports. This means that the resource use and emissions associated with producing a car that is manufactured in Japan, but sold and used in India, will contribute to India’s rather than Japan’s consumption Footprint.

National consumption Footprints can be distorted when the resources used and waste generated in making products for export are not fully documented for every country. Inaccuracies in reported trade can significantly affect the Footprint estimates for countries where trade flows are large relative to total consumption. However, this does not affect the total global Footprint.

**How does the Ecological Footprint account for the use of fossil fuels?**

Fossil fuels such as coal, oil and natural gas are extracted from the Earth’s crust and are not renewable in ecological time spans. When these fuels burn, carbon dioxide (CO₂) is emitted into the atmosphere. There are two ways in which this CO₂ can be stored: human technological sequestration of these emissions, such as deep-well injection, or natural sequestration. Natural sequestration occurs when ecosystems absorb CO₂ and store it either in standing biomass, such as trees, or in soil.

Caron sequestration land is calculated by estimating how much natural sequestration would be necessary to maintain a constant concentration of CO₂ in the atmosphere. After subtracting the amount of CO₂ absorbed by the oceans, Ecological Footprint accounts calculate the area required to absorb and retain the remaining carbon based on the average sequestration rate of the world’s forests. CO₂ sequestered by artificial means would also be subtracted from the Ecological Footprint total, but at present this quantity is negligible. In 2008, 1 global hectare could absorb the CO₂ released by burning approximately 1,450 liters of gasoline.
Expressing CO\textsubscript{2} emissions in terms of an equivalent bioproductive area does not imply that carbon sequestration in biomass is the key to resolving global climate change. On the contrary, it shows that the biosphere has insufficient capacity to offset current rates of anthropogenic CO\textsubscript{2} emissions. The contribution of CO\textsubscript{2} emissions to the total Ecological Footprint is based on an estimate of world average forest yields. This sequestration capacity may change over time. As forests mature, their CO\textsubscript{2} sequestration rates tend to decline. If these forests are degraded or cleared, they may become net emitters of CO\textsubscript{2}.

Carbon emissions from some sources other than fossil fuel combustion are incorporated in the National Footprint Accounts at the global level. These include fugitive emissions from the flaring of gas in oil and natural gas extraction, carbon released by chemical reactions in cement production and emissions from tropical forest clearing.

**How does the Ecological Footprint account for carbon emissions absorbed by the oceans versus uptake by forests?**

The National Footprint Accounts calculate the carbon Footprint by considering sequestration by the world’s oceans and forests. Annual ocean uptake values are taken from Khatiwala \textit{et al.}, 2009\textsuperscript{5} and used with the anthropogenic carbon emissions taken from CDIAC (CDIAC, 2011). There is a relatively constant percentage uptake for oceans, varying between 28 per cent and 35 per cent over the period 1961-2008. The remaining CO\textsubscript{2} requires land based sequestration. Due to the limited availability of large-scale datasets, the calculation currently assumes the world average sequestration rate for uptake of carbon dioxide into forests. Therefore, the carbon Footprint is a measure of the area of world average forest land that is necessary to sequester the carbon dioxide emissions that are not absorbed into the world’s oceans.

**Does the Ecological Footprint take into account wild species?**

The Ecological Footprint compares human demand on biocapacity with the natural world’s capacity to meet this demand. It thus serves as an indicator of human pressure on local and global ecosystems. In 2008, humanity’s demand exceeded the biosphere’s regeneration rate by more than 50 per cent. This overshoot may result in depletion of ecosystems and fill-up of waste sinks, resulting in ecosystem stresses that may negatively impact biodiversity. However, the Footprint does not measure the latter impact directly, nor does it specify how much overshoot must be reduced if negative impacts on biodiversity are to be avoided.

\textsuperscript{5} Khatiwala, S. \textit{et al.}, 2009. Reconstruction of the history of anthropogenic CO\textsubscript{2} concentrations in the ocean. \textit{Nature} 462, 346-350
Does the Ecological Footprint say what is a “fair” or “equitable” use of resources?

The Footprint documents what has happened in the past. It can quantitatively describe the ecological resources used by an individual or a population, but it does not prescribe what they should be using. Resource allocation is a policy issue, based on societal beliefs about what is or is not equitable. While Footprint accounting can determine the average biocapacity that is available per person, it does not stipulate how this biocapacity should be allocated among individuals or countries. However, it does provide a context for such discussions.

How relevant is the Ecological Footprint if the supply of renewable resources can be increased and advances in technology can slow the depletion of non-renewable resources?

The Ecological Footprint measures the current state of resource use and carbon dioxide waste generation. It asks: In a given year, did human demands on ecosystems exceed the ability of ecosystems to meet these demands? Footprint analysis reflects both increases in the productivity of renewable resources and technological innovation (for example, if the paper industry doubles the overall efficiency of paper production, the Footprint per tonne of paper will halve). Ecological Footprint Accounts capture these changes once they occur and can determine the extent to which these innovations have succeeded in bringing human demand within the capacity of the planet’s ecosystems. If there is a sufficient increase in ecological supply and a reduction in human demand due to technological advances or other factors, Footprint Accounts will show this as the elimination of global overshoot.

For additional information about current Ecological Footprint methodology, data sources, assumptions and results, please visit: www.footprintnetwork.org/atlas. For further information on the methodology used to calculate the Ecological Footprint, please see (Borucke et al., 2013)\(^6\).

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APPENDIX B: Glossary

**Biological capacity (or biocapacity):** The capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and technologies. “Useful biological materials” are defined as those used by the human economy. Hence what is considered “useful” can change from year to year (e.g. use of corn/maize stover for cellulosic ethanol production would result in corn stover becoming a useful material, increasing the total yields and thus the biocapacity of maize cropland). The biocapacity of an area is calculated by multiplying the actual physical area by the yield factor and the appropriate equivalence factor. Biocapacity is usually expressed in global hectares.

**Biologically productive land and water:** The land and water (both marine and inland waters) area that supports significant photosynthetic activity and the accumulation of biomass used by humans. Non-productive areas as well as marginal areas with patchy vegetation are not included. Biomass that is not of use to humans is also not included. The total biologically productive area on land and water in 2008 was approximately 12 billion global hectares.

**Carbon Footprint:** When used in Ecological Footprint studies, this term is synonymous with demand on CO₂ area. The phrase “Carbon Footprint” has been picked up in the climate change debate. Several web-calculators use the phrase “Carbon Footprint”. Many just calculate tonnes of carbon, or tonnes of carbon per unit of currency, rather than the demand on bioproductive area. The Ecological Footprint encompasses the carbon Footprint, and also captures the extent to which measures for reducing the carbon Footprint lead to changes in other Footprint components.

**Consumption:** The term consumption has different meanings, depending on the context. As commonly used in regard to the Footprint, it refers to the use of goods or services. A consumed good or service embodies all the resources, including energy, necessary to provide it to the consumer. In full life-cycle accounting, everything used along the production chain is taken into account, including any losses along the way. For example, consumed food includes not only the plant or animal matter people eat or waste in the household, but also that lost during processing or harvest, as well as all the energy used to grow, harvest, process and transport the food.

As used in Input-Output analysis (a methodology often used in Footprint studies), consumption has a strict technical meaning. Two types of consumption are distinguished: intermediate and final. According to the (economic) System of National Accounts terminology, intermediate consumption refers to the use of goods and services by a business in providing goods and services to other businesses. Final consumption refers to non-productive use of goods and services by households, the government, the capital sector, and foreign entities.
**Derived product:** The product resulting from the processing of a primary product. For example wood pulp, a secondary product, is a derived product of roundwood. Similarly, paper is a derived product of wood pulp.

**Ecological deficit/reserve (or biocapacity deficit/reserve):** The difference between the biocapacity and Ecological Footprint of a region or country. An ecological deficit occurs when the Footprint of a population exceeds the biocapacity of the area available to that population. Conversely, an ecological reserve exists when the biocapacity of a region or country exceeds the Footprint of its population. If there is a regional or national ecological deficit, it means that the region or country is either importing embedded biocapacity through trade, liquidating its own ecological assets, or emitting carbon dioxide waste into a global commons such as the atmosphere. In contrast to the national scale, the global ecological deficit cannot be compensated for through trade, and is therefore overshoot by definition.

**Ecological Footprint:** A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices. The Ecological Footprint is usually measured in global hectares. Because trade is global, an individual or country's Footprint can include land or sea from all over in the world. Ecological Footprint is often referred to in short form as Footprint. "Ecological Footprint" and "Footprint." Because they are proper nouns they are capitalized (as opposed to a foot's footprint, as in a human footprint in the sand).

**Ecological Footprint Standards:** Specified criteria governing methods, procedures, data sources and reporting to be used in Footprint studies. Standards are established by the Global Footprint Network Standards Committees, composed of scientists and Footprint practitioners from around the world. Standards serve to produce transparent, reliable and mutually comparable results in studies done throughout the Footprint community. Where Standards are not appropriate, Footprint Guidelines should be consulted. For more information, consult [www.footprintstandards.org](http://www.footprintstandards.org).

**Embodied energy:** Embodied energy is the energy used during a product's entire life cycle in order to manufacture, transport, use, and dispose of the product. Footprint studies often use embodied energy when tracking the trade of goods.

**Footprint of consumption:** The most commonly reported type of Ecological Footprint; it is defined as the area used to support a defined population's consumption. The Footprint of consumption (in gha) includes the area needed to produce the materials consumed and the area needed to absorb the carbon dioxide waste associated with that consumption. The Footprint of consumption of a nation is calculated in the National Footprint Accounts as a nation's Footprint of production plus the Footprint of imports minus the Footprint of exports, and is thus, strictly speaking, a Footprint of apparent
consumption. The national average or per capita Footprint of consumption is equal to a country's Footprint of consumption divided by its population.

**Footprint of production:** In contrast to the Footprint of consumption, the Footprint of production is the sum of the Footprints for all of the resources harvested and all of the carbon dioxide waste generated within the defined geographical region. This includes all the area within a country (cropland, pasture land, forestland and fishing grounds) necessary for supporting the actual harvest of primary products, food, fiber and timber, the country's built-up area (roads, factories, cities), and the area needed to absorb all fossil fuel carbon emissions generated within the defined geographical region. In other words, the forest Footprint represents the area necessary to regenerate all the timber harvested (hence, depending on harvest rates, this area can be bigger or smaller than the forest area that exists within the country). Or, for example, if cotton is grown for export, the productive area required is not included in that population's Footprint of consumption; rather, it is included in the Footprint of consumption of the population that imports the t-shirts. However, this productive area is included in the exporting country's Footprint of production.

**Global hectare (gha):** A productivity-weighted area used to report both the biocapacity of the earth, and the demand on biocapacity (the Ecological Footprint). The global hectare is normalized to the area-weighted average productivity of biologically productive land and water in a given year. Because different land types have different productivity, a global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world bioproductivity varies slightly from year to year, the value of a global hectare may change slightly from year to year.

**National Footprint Accounts:** The central data set of the Footprints and biocapacities of the world and roughly 220 nations from 1961 to the present (generally with a three-year lag due to data availability). The ongoing development, maintenance and upgrades of the National Footprint Accounts are coordinated by Global Footprint Network and its 80+ partners.

**Primary product:** In Footprint studies, a primary product is the least-processed form of a biological material that humans harvest for use. There is a difference between the raw product, which is all the biomass produced in a given area, and the primary product, which is the biological material humans will harvest and use. For example, a fallen tree is a raw product that, when stripped of its leaves and bark, results in the primary product of roundwood. Primary products are then processed to produce secondary products like wood pulp and paper. Other examples of primary products are potatoes,
cereals, cotton, and types of forage. Examples of secondary products are kWh of electricity, bread, clothes, beef, and appliances.\textsuperscript{7}

**Productivity:** The amount of biological material useful to humans that is generated in a given area. In agriculture, productivity is called yield.

**Yield:** The amount of primary product, usually reported in tonnes per year, that humans extract per area unit of biologically productive land or water.

\textsuperscript{7} Note: Primary product is a Footprint-specific term. It is not related to, and should not be confused with, the ecological concepts of primary production, gross primary productivity (GPP) and net primary productivity (NPP).
APPENDIX C: Data tables

The Ecological Footprint and biocapacity analysis for the state of California is described in technical detail in a separate report titled: Methodology for calculating the Ecological Footprint of California\(^8\). The purpose of this report is to present the results of this analysis.

The first two tables show the results of the Ecological Footprint and biocapacity analysis as totals (Table 2) and in per capita terms (Table 3). Table 4 shows the portion of the Ecological Footprint that can be accounted for by household consumption (e.g. not including consumption paid for by government or investments in Gross Fixed Capital which is not immediately consumed); these data are summarized by consumption category based on the Classification of Individual Consumption According to Purpose\(^9\) used by the United Nations Statistic Division.

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### Table 2. California’s total Ecological Footprint and biocapacity (total gha) 2008.

<table>
<thead>
<tr>
<th></th>
<th>Cropland</th>
<th>Grazing land</th>
<th>Fishing grounds</th>
<th>Forest products</th>
<th>Carbon Footprint</th>
<th>Built-up land</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td>Footprint of production</td>
<td>12,361,631</td>
<td>2,836,741</td>
<td>744,853</td>
<td>2,242,887</td>
<td>89,549,955</td>
<td>4,259,005</td>
<td>111,995,071</td>
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<td>Footprint of imports</td>
<td>21,794,378</td>
<td>565,941</td>
<td>3,040,178</td>
<td>20,268,991</td>
<td>103,474,631</td>
<td>-</td>
<td>149,144,119</td>
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<td>Footprint of exports</td>
<td>5,484,998</td>
<td>815,902</td>
<td>794,485</td>
<td>695,295</td>
<td>35,765,348</td>
<td>-</td>
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<td>Footprint of consumption</td>
<td>28,671,012</td>
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<td>2,990,545</td>
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<td>2,836,741</td>
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<td>9,933,040</td>
<td>-</td>
<td>4,259,005</td>
<td>37,636,630</td>
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### Table 3. California’s per capita Ecological Footprint and biocapacity (gha per capita), 2008.

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<tr>
<th></th>
<th>Cropland</th>
<th>Grazing land</th>
<th>Fishing grounds</th>
<th>Forest products</th>
<th>Carbon Footprint</th>
<th>Built-up land</th>
<th>TOTAL</th>
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<td>0.55</td>
<td>2.82</td>
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<td>4.06</td>
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<tr>
<td>Footprint of exports</td>
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<td>0.02</td>
<td>0.97</td>
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<td>Footprint of consumption</td>
<td>0.78</td>
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<tr>
<td>Biocapacity</td>
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<td>0.22</td>
<td>0.27</td>
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<td>0.12</td>
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Table 4. California's per capita household Ecological Footprint by consumption category (excluding Gross Fixed Capital expenditures, and consumption paid for by government), 2008.

<table>
<thead>
<tr>
<th>Consumption category</th>
<th>Crop land</th>
<th>Grazing land</th>
<th>Forest products</th>
<th>Fishing grounds</th>
<th>Built-up land</th>
<th>Carbon Footprint</th>
<th>TOTAL</th>
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