

Measuring Marin County's Ecological Footprint

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Advancing the Science of Sustainability

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MEASURING MARIN'S ECOLOGICAL IMPACT

Marin County is known for its distinctive natural setting and community support for environmental causes.

From the early efforts of the Marin Open Space District to the county's current membership in the Cities for Climate Protection Campaign, Marin's long history of conservation and environmentally-aware planning and development has

served as a model for cities and counties throughout the Bay Area and the nation.

Continuing in this tradition, the current update to Marin's Countywide Plan adopts sustainability as a guiding principle, and offers programs and targets that provide a solid foundation for continuing the transition towards sustainable development in Marin County.

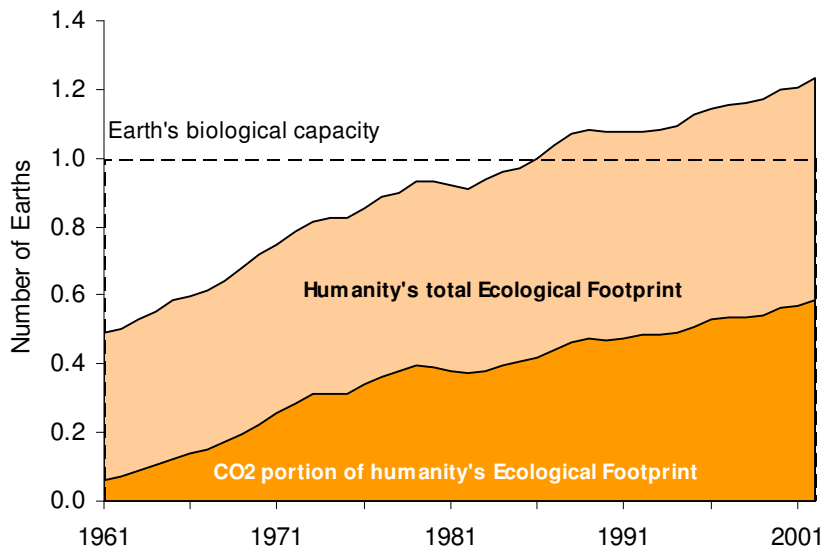
To what extent will successful implementation of these programs and targets actually reduce Marin's demand on ecosystems? One way to answer this question is to evaluate how consumption of ecological resources and services will change, using a measure known as the Ecological Footprint.



WHAT IS THE ECOLOGICAL FOOTPRINT?

There are many ways to measure our impact on nature. One of the most widely used metrics is the *Ecological Footprint*, an accounting tool first developed in the early 1990s. A Footprint measures ecological demand associated with human activities in terms of the area of biologically productive land and sea required to provide the resources being used and to absorb the wastes generated, given current technology. This area is reported in “global acres,” acres adjusted to reflect world-average biological productivity.

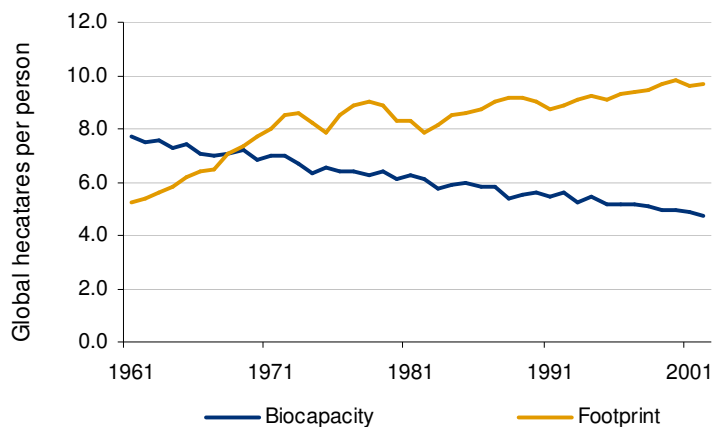
Footprint (demand) can be compared to *biocapacity* (supply), a measure of the total biologically productive area available. Globally, the average person’s Footprint is 5.4 global acres, while only 4.4 global acres are available per person. Even less would be available if some of this area was left for the use of wild species.



Global “overshoot” - humanity’s Footprint exceeding world biocapacity - began in the mid-1980s and has been growing steadily since. Now at 23%, overshoot is possible in the short-term by harvesting more resources than nature can replace each year or by allowing wastes, such as carbon dioxide (CO₂), to accumulate in the biosphere. If overshoot continues, ecosystems become depleted and are at risk of collapse.

In the United States today, the average Footprint per person is more than twice the domestic biocapacity available per person. The Footprint has increased steadily over the past 40 years, largely due to increased use of energy and associated emissions of carbon dioxide (the energy Footprint is discussed in more detail on page 4). At the same time the biocapacity available per person in the U.S. has decreased, primarily because of population growth.

Footprint and Biocapacity in the United States



Today, over 24 global acres are needed to support the consumption of the average U.S. resident; if everyone on the globe were to consume at this level, we would need more than five planets.

MARIN COUNTY'S ECOLOGICAL FOOTPRINT

Marin's Ecological Footprint was recently measured at 27 global acres per person, slightly higher than that of the average American and more than double that of many industrialized European countries. How do countries like France, Germany and Italy achieve their high standards of living with significantly lower demands on ecosystems?

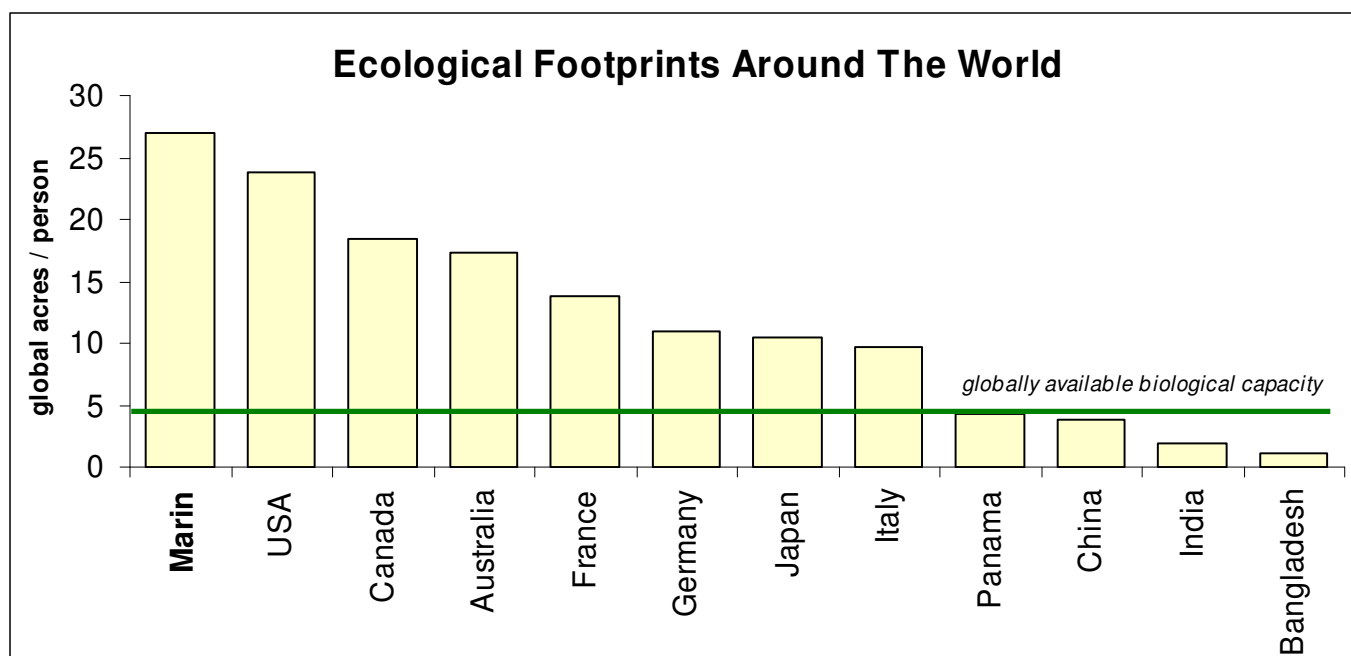
To some extent, people in these countries simply consume less than U.S. residents. The average resident of France, for example, uses 1.3 global acres of timber land each year for everything from telephone poles to wood furniture to the

daily newspaper. The average resident of the United States uses 3.2 global acres of timber land to provide these same types of products.

While much of a person's Footprint is determined by individual decisions and activities, a significant portion also depends on the consumption patterns of the country they live in. County, state, and federal government activities - providing education, health and military services, for example - require the use of resources, and these are reflected in the Ecological Footprint of every Marin resident. Individual decisions,

such as how fuel efficient a car to buy, influence the size of one's Footprint, as do collective decisions, such as whether transportation funds are used to build highways or bike lanes.

By calling for county-wide programs that will encourage both individual and collective Footprint savings, Marin's Countywide Plan exemplifies the type of actions that will be necessary if we are to reduce global overshoot and achieve a prosperous and ecologically sustainable future.



GREENHOUSE GAS

Human activities powered by fossil fuels such as coal, oil, and natural gas cause the waste product carbon dioxide (CO₂) to be released into the air. By far, the largest contributors to these emissions both worldwide and in Marin County are vehicle traffic and energy use in buildings.

Some of these emissions are absorbed by the oceans. The energy Footprint is the area of forest land required to absorb the remaining CO₂ emissions if they are not to accumulate in the atmosphere. Energy land is the single largest component of the Ecological Footprint in most industrialized countries, including the United States.

Marin has already taken steps towards decreasing its energy Footprint, including joining the

Cities for Climate Protection Campaign (CCP), and completing a comprehensive study on local sources of carbon dioxide emissions and the potentials for reduction. The Countywide Plan sets a target of reducing carbon dioxide emissions by 15-20% by the year 2015.

One ton of carbon dioxide has a Footprint of 0.67 global acres, the amount of land area required to sequester one ton of this greenhouse gas each year. Marin County's energy land Footprint, for the energy used in transportation and buildings, is 1.6 million global acres. A 20% reduction in this total Footprint would produce a savings of 320,000 global acres.

Climate and Carbon

- Humanity's single largest demand on ecosystems comes from emissions of carbon dioxide.
- Globally, humanity's energy Footprint grew 700% in the past 40 years.
- The area required to sequester Marin residents' CO₂ emissions makes up 62% of the county's total Footprint.
- Energy use in buildings is responsible for 44% of Marin's greenhouse gas emissions. 53% comes from transportation.
- In the year 2000, Marin County emitted over 2.6 million tons of carbon dioxide.
- Marin County has a total energy Footprint of 1.6 million global acres.

PROGRAMS to reduce CARBON DIOXIDE Footprint

Many different types of activities and programs can reduce Marin's carbon dioxide emissions. The most important ways to reduce emissions are through (1) changes in transportation patterns and (2) energy efficiency and conservation in buildings, both commercial and residential. Actions focused specifically on carbon dioxide and other greenhouse gas emissions can be found in programs in the Atmosphere and Climate section of the Countywide Plan.

Programs and policies that call for more specific activities that can have an impact on carbon dioxide emissions are described in the TRANSPORTATION and ELECTRICITY pages in this report. Important transportation-related policies include TR-1 through TR-4. Significant energy reductions can be realized through policies EN-1 through EN-3 in the Energy and Green Buildings sections.

GETTING AROUND MARIN COUNTY

Fossil fuel-burning vehicles contribute significantly to Marin's Ecological Footprint. In the United States, transportation accounts for approximately one third of the total energy Footprint.

The modes of transportation with the highest Footprints are air and car travel, which emit the most carbon dioxide per passenger mile. Carpooling with another person halves the Footprint of driving per person, while commuting by bus has only one-fourth the Footprint of driving alone. Walking or biking have almost zero Footprint—in addition to the health benefits!

Changing the relative use of different modes of

transportation, such as driving alone, carpooling or public transit, can contribute significantly to reducing the overall Footprint of Marin. The County has set targets for decreases in the percentage of single drivers, and for doubling, by the year 2015, the number of residents who walk and bike to work. This latter change alone would save 9,000 global acres of Footprint each year.

The list below includes some of the many programs contained in the Countywide Plan that can help reduce the transportation component of Marin's Ecological Footprint.

From Here to There

- Marin residents drive over 2 billion miles each year.
- Transportation is responsible for more than half of Marin's greenhouse gas emissions.
- The average gasoline car in Marin gets 22 miles to the gallon. Increasing this by 10 mpg would save 200,000 global acres of Footprint each year.
- Nearly half of Marin residents work outside the county.
- Two thirds of Marin commuters drive to work alone, 11% carpool, and 10% take public transit.
- Driving an average car 12,000 miles a year produces an energy Footprint of over three global acres.

PROGRAMS to reduce TRANSPORTATION Footprint

- 1) Promoting *Satellite Work Centers* can reduce the total travel necessary for a worker (CD-3.b).
- 2) An effort to *Allow Mixed Use In Commercial Districts* moves residents closer to their places of business, reducing commute distance and Footprint (DES-2.c).
- 3) Programs to *Encourage Bicycling*, *Support Bike Stations* and *Consider Attended Parking* can substitute a zero Footprint mode of commuting for a fossil fuel-intensive one (TR-2.a; TR-2.c).
- 4) *Increasing Bus Service* and *Providing Reduced-Cost Transit Passes* can help to shift transport patterns away from private cars and towards buses. A trip driven in a car has more than four times the Footprint of the same trip in a bus (TR-3.a; TR-3.c).
- 5) When driving is a necessity, the County can *Support Green Fuels* and *Encourage Zero, Partial Emission, and Low-Emission Vehicle Use* to reduce the driving Footprint (TR-4.c; TR-4.d).

POWERING MARIN

Energy use within buildings is responsible for nearly one quarter of Marin County's total Footprint. Much of this comes from the use of electricity.

Marin has set a target of reducing total electricity consumption 20% by 2015. Part of this reduction can be accomplished by traditional conservation measures, such as turning down the thermostat during the winter.

Increasing efficiency can also reduce energy consumption dramatically, often without decreasing comfort or quality of life. Compact fluorescent light bulbs (CFLs), for

example, provide the same amount of light as incandescent bulbs with only one quarter the electricity consumption.

In addition to the quantity of electricity used, the way electricity is generated can dramatically change the total Footprint of electricity consumption. Coal plants produce electricity with the highest Footprint, followed by natural gas. Renewable sources of electricity such as wind, small-scale hydroelectric, or geothermal have nearly zero energy Footprint.

The Countywide Plan has targets that aim to increase the percentage of Marin's electricity generated by renewable sources to 25% by the year 2010, and to 40% by 2015.

Electricity Use

- Marin can decrease its energy Footprint through conservation and efficiency as well as by using renewable sources of electricity.
- Reducing total energy consumption 20% by 2015 would save 77,000 global acres in that year alone.
- 15% of Marin County's electricity comes from renewable sources - the rest is generated by fossil fuel and nuclear plants.
- Electricity from coal plants has a Footprint of 0.7 global acres per megawatt hour.
- Natural gas electricity has a Footprint 60% of that from coal.
- Meeting just Marin's targets for renewable energy in 2015 would save 114,000 global acres of Footprint.

PROGRAMS to reduce ELECTRICITY Footprint

- 1) Programs to *Adopt Energy Efficiency Standards for New and Remodeled Buildings* and *Require Green Building Practices* will decrease electricity use in buildings (EN-1.b; EN-3.a; EN-3.b).
- 2) Because pumping and treating water for Marin County is very energy intensive, programs that *Support and Integrate Water Conservation Efforts* and *Minimize the Demand for Water in New Development* can also result in large savings in electricity (PFS-2.a; PFS-2.b).
- 3) The growth of renewable energy resources will be promoted by Marin's programs to *Provide Incentives for Alternative Energy Production* and *Use Renewable Energy in County Facilities* (EN-2.e; EN-2.f).
- 4) The Countywide Plan requires Marin County to *Establish a Permanent Sustainable Energy Planning Process*, a commitment that will help to ensure that energy savings from other programs are realized and carried forward into the future (EN-1.a).

DEALING WITH WASTE

Marin County's waste places that still require ecological demands on ecosystems in many resources to produce. Reducing different ways. Most visibly, consumption by eliminating disposing of solid waste has a unnecessary packaging, buying Footprint associated with the durable products, reusing them physical area occupied by where possible, and recycling landfills. This area could them at the end of their useful otherwise be available for life will generate Footprint grazing, farming, or other forms savings all along the production of ecological productivity. chain, in addition to reducing the

The trucks and roads needed to transport solid waste, along with the material and energy resources required to process the waste stream, have a total Footprint many times larger than the Footprint area occupied by the landfills. Decreasing the amount of waste created by individuals and businesses in Marin can reduce the magnitude of all these Footprint components.

Beyond the resources required to dispose of physical waste, waste itself represents products that are not serving human needs, but

Footprint of waste processing and disposal.

Recycling in particular has an important role to play in reducing Footprint. Recycled products such as paper and cans can have a dramatically lower Footprint than these same products made from virgin materials. With one of the highest diversion rates in California, Marin has already recognized the importance of recycling, and the County has developed programs and set targets to further extend this success.

Trash and Recycling

- In 2002, Marin County generated 410,000 tons of waste.
- Marin County has one of the highest rates of waste diversion in all of California (71%).
- One ton of virgin paper has a Footprint as high as 4.4 global acres.
- A ton of recycled paper can have a Footprint as low as 0.9 global acres.
- Mining aluminum requires a particularly large amount of energy. Recycling one ton of aluminum can save 9.1 global acres of Footprint.
- A very conservative estimate suggests that the 57,000 tons of food thrown away in Marin each year has a Footprint of 68,000 global acres.

PROGRAMS to reduce WASTE Footprint

- 1) The program to *Divert Construction Waste* will require building projects to recycle or reuse a minimum of 50% of leftover or unused materials (EN-3.c).
- 2) An effort to *Reduce Wood Waste and Encourage Reuse of Urban Lumber* will specifically target the forest Footprint of Marin's buildings (DES-1.d).
- 3) With a program to *Promote Alternative Materials and Conservation*, Marin will specifically reduce the demand for mineral resources by working to optimize recycling of construction and demolition waste (MIN-1.l).
- 4) Marin will approach recycling most broadly through an overall commitment to *Reduce Waste at Landfill* by recycling, resource recovery, and composting (PFS-4.c).

PROTECTING THE LAND

Sustainability isn't only about reducing consumption and the demand it places on ecological resources; it is also about the balance between demand and supply. Managing the supply of ecological resources, through preservation and restoration, is an important part of balancing our ecological budget.

While the Ecological Footprint reflects demand on nature's resources, biocapacity is a measure of supply, nature's ability to regenerate these resources. Open space and ecosystems such as cropland, pasture, forest and fisheries differ in their ability to produce useful resources; this is taken into account in measuring their biocapacity.

An acre of cropland, for example, has a biocapacity more than twice that of the average biologically productive acre worldwide. An

acre of pasture, by comparison, has a biocapacity one half that of the world average acre.

Marin's biocapacity resides in its open space preserves and in its extensive agricultural lands. By the year 2015, Marin County hopes to preserve an additional 24,000 acres of land as open space, and place an additional 33,000 acres of agricultural land in easements. Biocapacity can also be found in smaller spaces, such as the urban gardens or parks noted in the Countywide Plan.

In addition to protecting land in through easements, open space, and zoning, Marin can also preserve its biocapacity by slowing activities that negatively impact ecosystem productivity. This might include measures to mitigate mining impacts and ensure adequate buffer areas.

Biocapacity

- Only about 22% of Earth's total surface area is highly productive. The rest is mostly low-productivity ocean, ice caps, and deserts.
- There are 4.5 global acres of biocapacity available per person on Earth. The average per person Footprint is 5.4 global acres.
- 48% of the land area of Marin County is already in open space preserves.
- One acre of cropland, the most productive type of land, has a biocapacity of 2.2 global acres (acres with world average productivity).
- Land degradation can decrease its future biocapacity. Sustainable farming practices help ensure that cropland biocapacity does not decline over time.

PROGRAMS to PROTECT BIOCAPACITY

- 1) As one of the most visible parts of Marin's ecological capacity, the commitment to *Acquire and Protect Lands Pursuant to the Open Space District's Mission Statement* will continue to ensure that Marin's land conservation strategy remains an example to other counties in the Bay Area (OS-2.c).
- 2) Protecting agricultural areas through programs to *Preserve Agricultural Lands and Uses* and *Maintain Agriculture in the Inland Rural Corridor* will help maintain Marin's agricultural biocapacity in the future (AG-1.i; CD-1.d).
- 3) Biocapacity isn't only found in large tracts of farm land and open spaces. Marin can also *Encourage Community Gardens* and *Encourage Small-Scale Green Spaces* to increase local biocapacity (AG-3.a; DES-3.c).
- 4) Programs to *Preclude Mining at Ring Mountain* and *Mitigate Impacts* associated with mining operations can help preserve the integrity of biological capacity in mining areas (MIN-1.b; MIN-1.g).

HOW MUCH CAN WE SAVE?

Marin's Countywide Plan includes many different types of programs and targets. Not all of them can be evaluated in terms of potential Footprint savings, either because they address issues, such as human health, which are not within the research domain addressed by the Footprint, or because the data required for an accurate Footprint analysis is not yet available.

For many of the programs and targets, however, Ecological Footprint analysis clearly reveals the potential power of collective and individual choice to reduce pressure on

ecosystems. Meeting just the three specified targets below would reduce Marin County's Footprint by nearly half a million global acres each year from 2015 forward.

How does this compare with the total Footprint of Marin County residents? At 27 global acres per person, the total Footprint of Marin residents is 6.7 million global acres. The potential savings approach 8% of this total Footprint.

While this reduction will not shrink the average Marin Footprint to that of Italy, it will bring it close to that of the

average resident of the United States. This is no small feat, considering the relatively high quality of life enjoyed by Marin County residents.

A wider perspective can help reveal the full significance of an 8% Footprint savings. If everyone in the United States reduced their Footprint by 8%, we could save an area of 550 million global acres, an area one quarter the physical size of the entire United States.

1) Conserving Energy

Marin has set a non-binding target of decreasing total electricity consumption within the county by 20% by 2015. Achieving this target would save Marin County 77,000 global acres of Footprint each year. This is an area of Footprint equivalent to nearly one quarter of the physical size of the county of Marin.

2) Shifting to Renewables

Even if electricity use begins to decline, switching from fossil fuel to renewably generated sources of electricity would result in additional Footprint savings. Marin hopes to increase its share of renewably generated electricity to 40% by the year 2015. This shift to renewables would save an additional 91,000 global acres each year from the year 2015 onward.

3) Decreasing Transportation Impacts

Transportation, the other major contributor to the energy Footprint, is also targeted by the Countywide Plan. Programs in the plan will increase the number of bicycle lanes and promote clustered development, both of which can allow an individual to walk or bike to work with nearly zero Footprint. Marin's target of doubling the number of commuters who walk or bike to work would save 9,000 global acres of Footprint each year.

4) Reducing CO₂ Emissions

Reducing CO₂ emissions within the borders of Marin County can result in very large Footprint savings. Meeting a 20% emissions reduction target would save an additional 310,000 global acres beyond all the savings described above.