

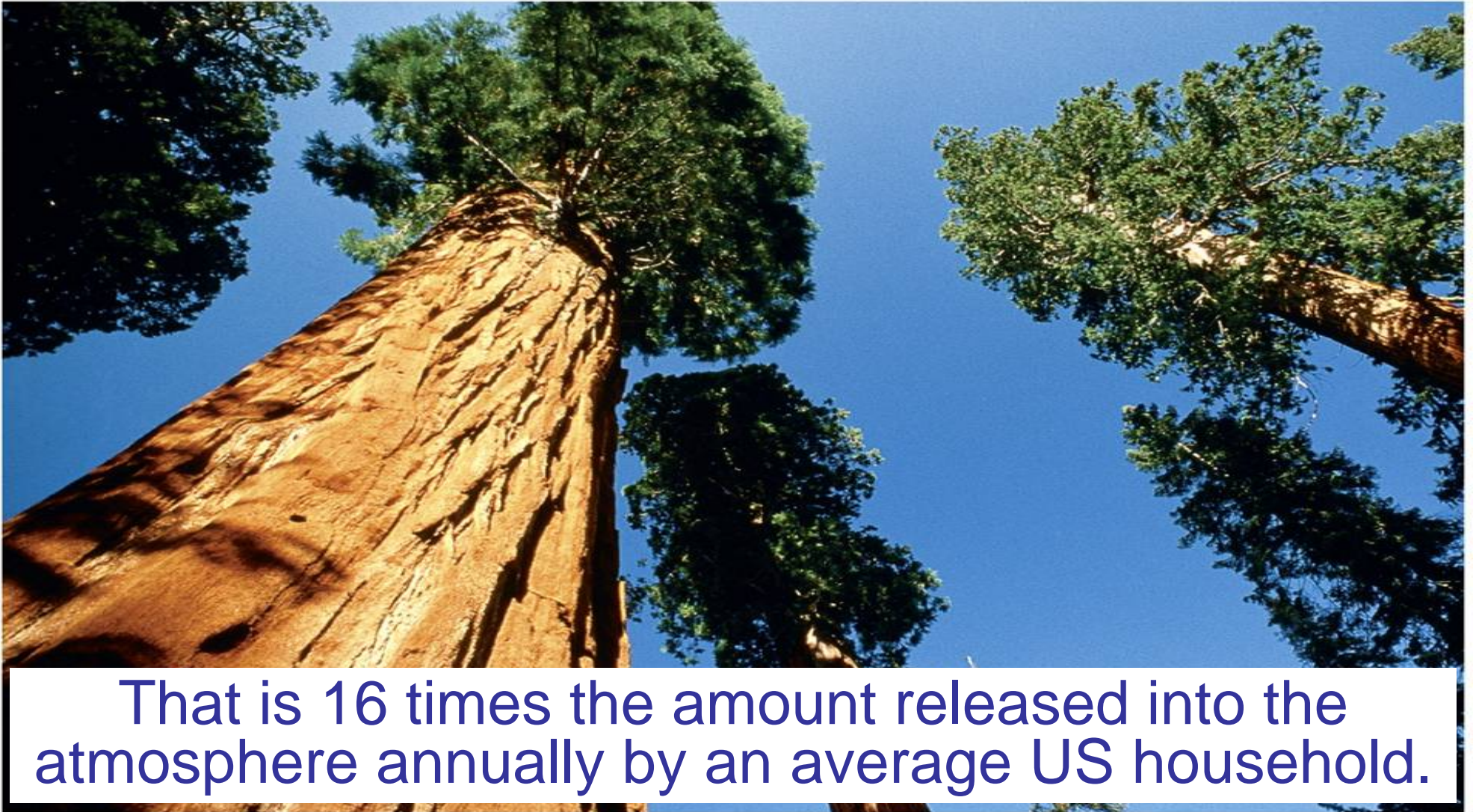


Plants as solutions to global warming?

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A mature redwood tree can contain
the equivalent of 800 tons of CO₂



That is 16 times the amount released into the
atmosphere annually by an average US household.

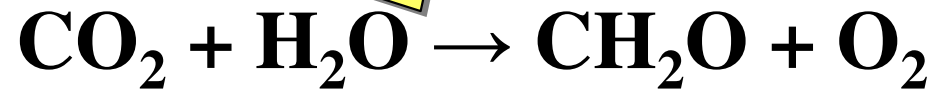


Plants take up CO₂ (and produce it, too...)



Photosynthesis:

 *solar energy*



- Some of the energy fixed by plants is used to maintain and repair plant tissues and their functions. That energy is used through respiration: $\text{CH}_2\text{O} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{energy}$



Photosynthesis takes place in chloroplasts, mostly in leaves

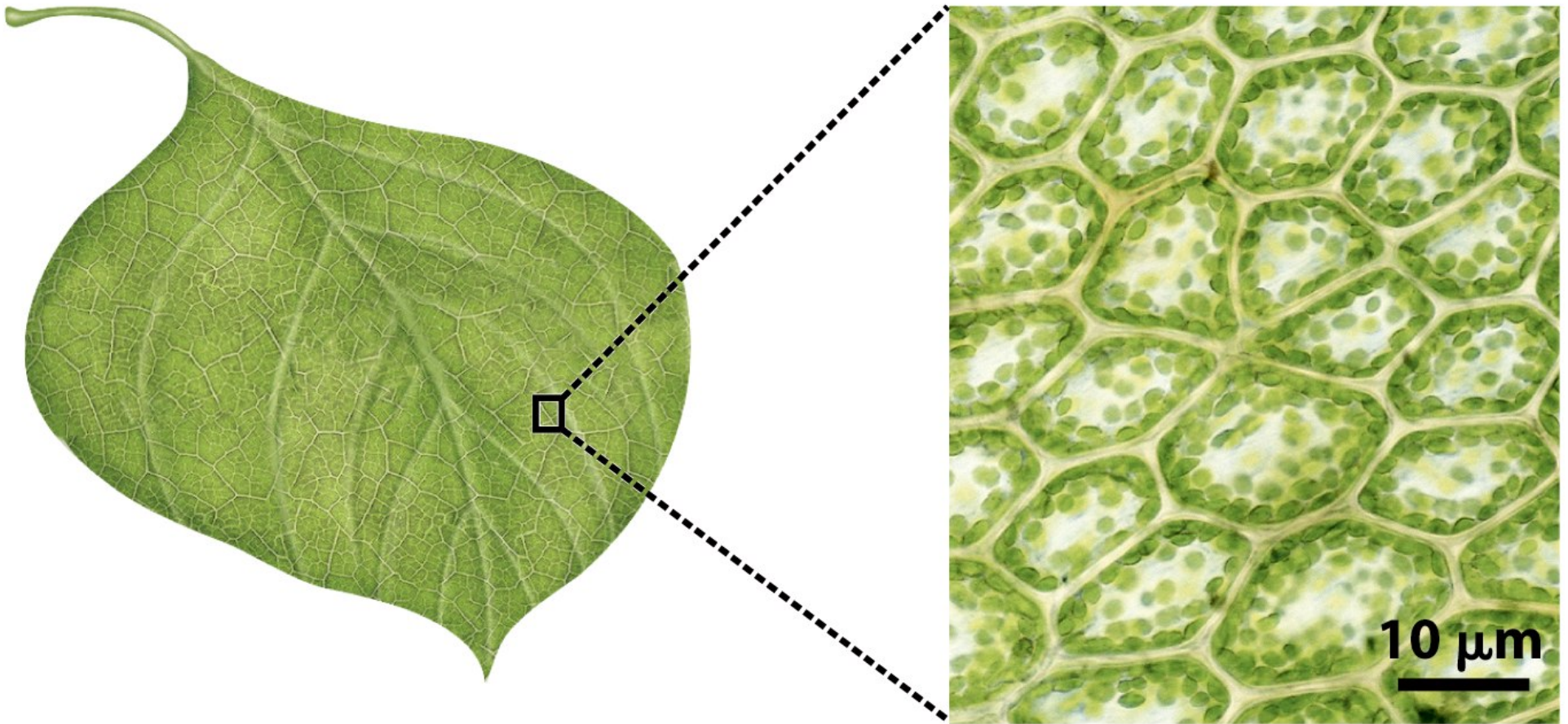
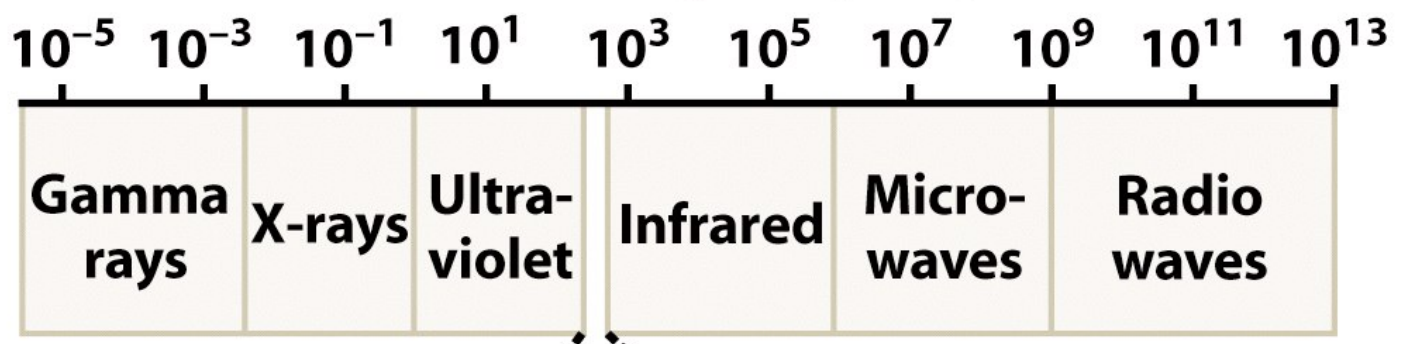


Figure 10-2a part 1 Biological Science, 2/e



Wavelengths (nm)



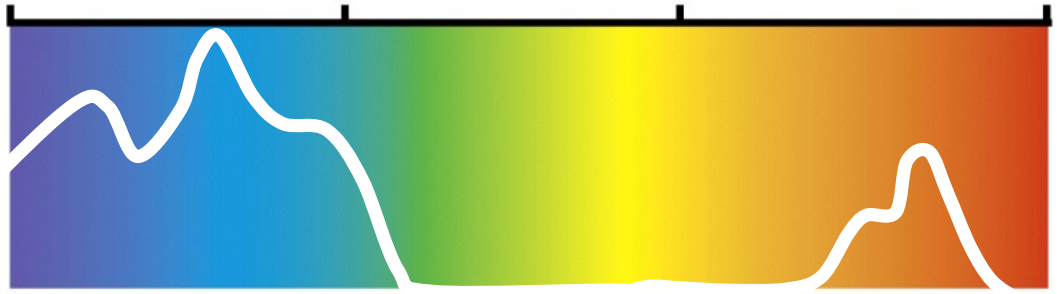
Shorter wavelength

Longer wavelength

Visible light

400 500 600 710 nm

Absorption spectrum of photosynthetic pigments

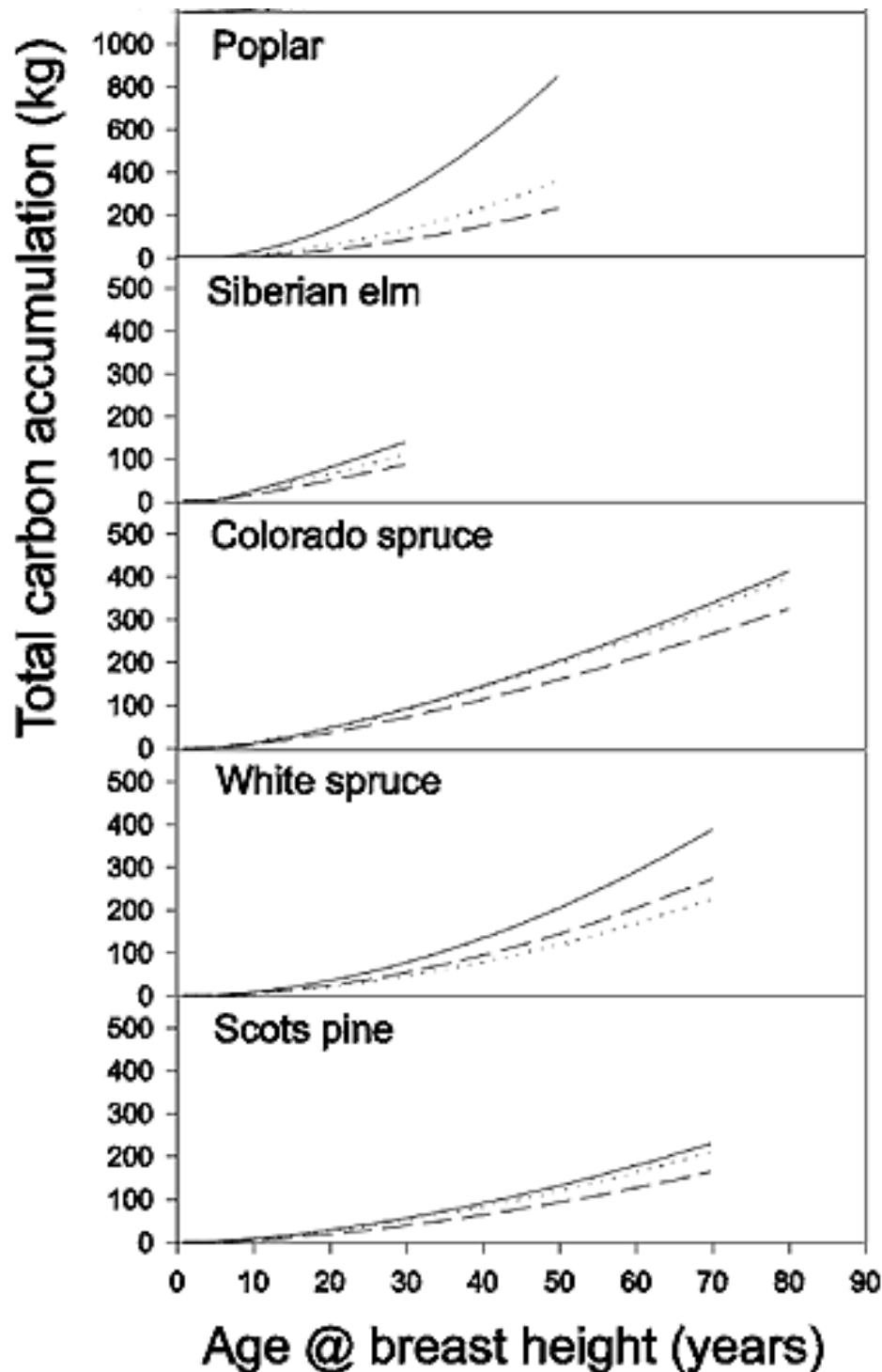


Higher energy

Lower energy



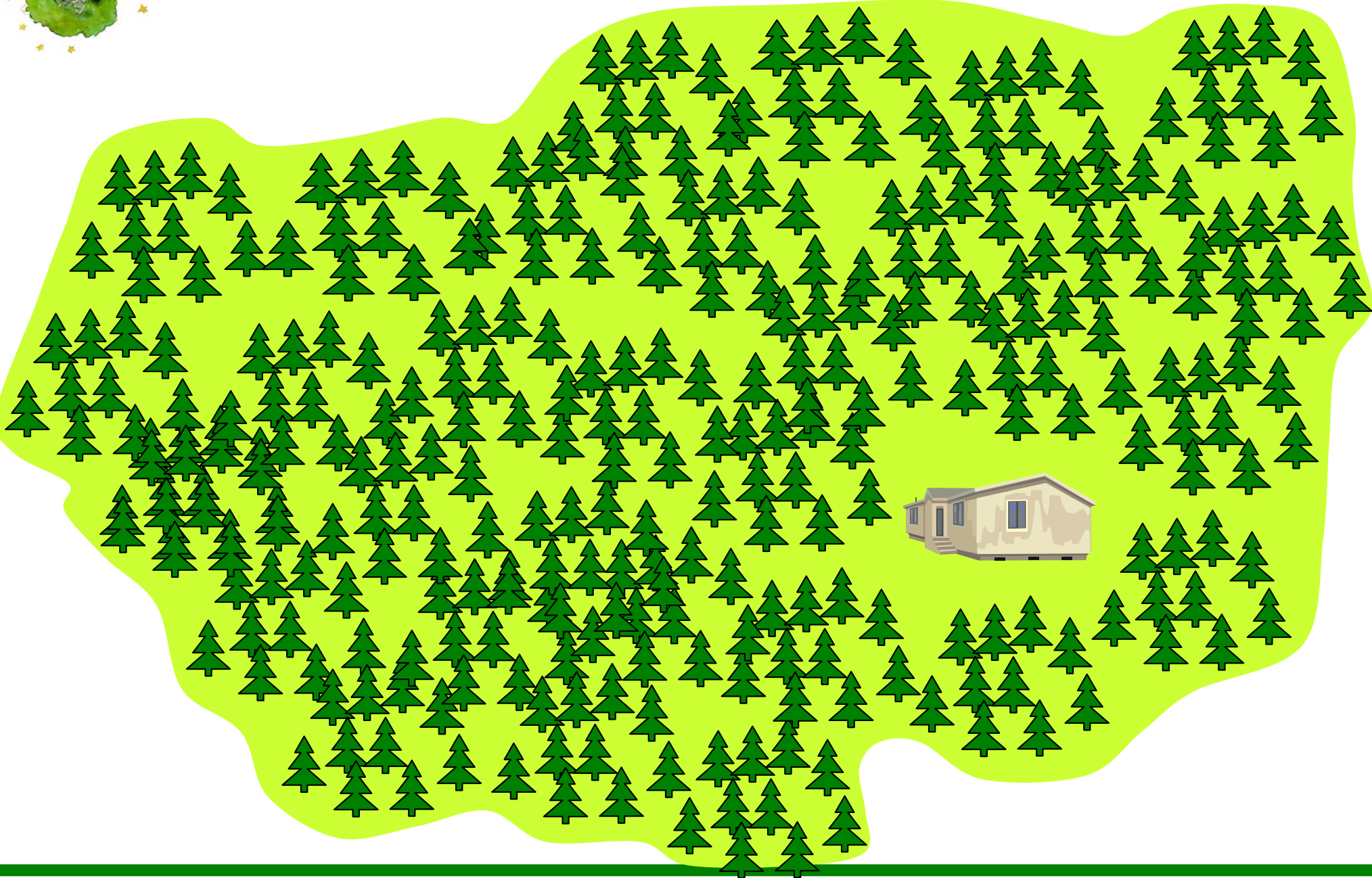
Figure 10-4 Biological Science, 2/e



Carbon accumulation takes time and trees

- It would take **300** 25-year-old pine trees to offset a typical US household's 50 t CO₂ carbon footprint.

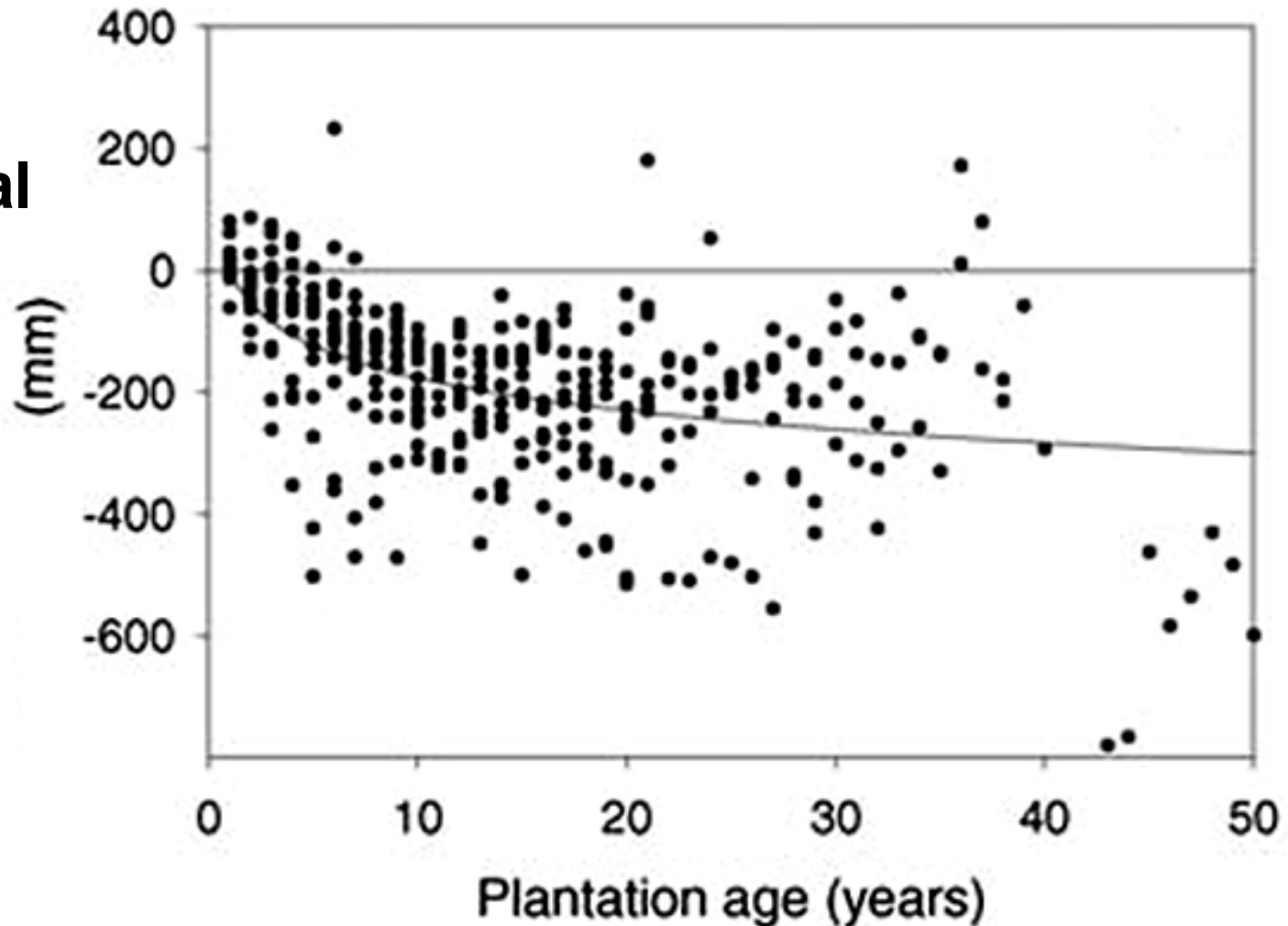
1 house, 300 pine trees





... and trees use water ...

**Change
in annual
runoff**

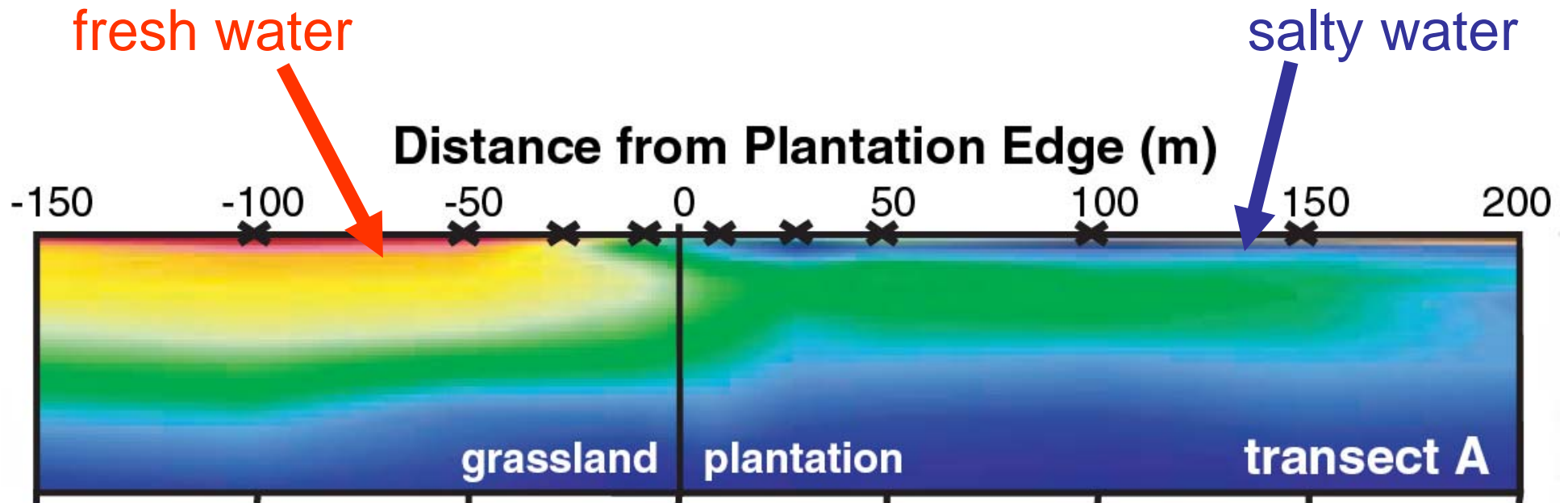


- **Jackson et al. 2005.** Trading water for carbon with biological carbon sequestration. *Science* **310**: 1944-1947.



... and can have other effects on the environment, ...

- ...such as soil salinization by redistribution of saline groundwater to the surface soil. This was observed under *Eucalyptus* plantations in Argentina.



Jackson et al. 2005. Science 310: 1944-1947.



Carbon sequestration vs. plants as bioenergy

- Using trees for carbon sequestration (= carbon offsets)
 - requires a lot of trees,
 - requires water,
 - takes a long time,
 - may have adverse environmental impacts,
 - and requires certainty that carbon stays in the trees and their ecosystems for a long time (e.g., no fires!).
- Using plants as bioenergy to replace fossil fuels has a much more immediate impact on carbon emissions.



Bioenergy crops

Platforms	Feedstock	NEB ^b GJ/ha/yr	NER ^b	CO ₂ balance
Ethanol from starch or sucrose	Maize	10–80	1.5–3.0	Positive
	Sugarcane	55–80	3.0–4.0	Positive
	Sugar beet	40–100	2.5–3.5	Positive
	Sweet sorghum	85–300	5–10	Positive
Ethanol from lignocellulosic feedstocks	Miscanthus	250–550	15–70	Possibly negative
	Switchgrass	150–500	10–50	Possibly negative
	Poplar	150–250	10–20	Possibly negative
Biodiesel	Soybean	–20–10	0.2–0.6	Positive
	Canola	–5–2	0.7–1.0	Positive
	Sunflower	–10–0	0.3–0.9	Positive

Possibly also sequester carbon

NEB = net energy balance, NER = ratio of energy output to energy input
 Source: Yuan *et al.* 2008. Trends in Plant Science 13:421-429.



Miscanthus

Source: University of Arkansas: <http://dailyheadlines.uark.edu/>



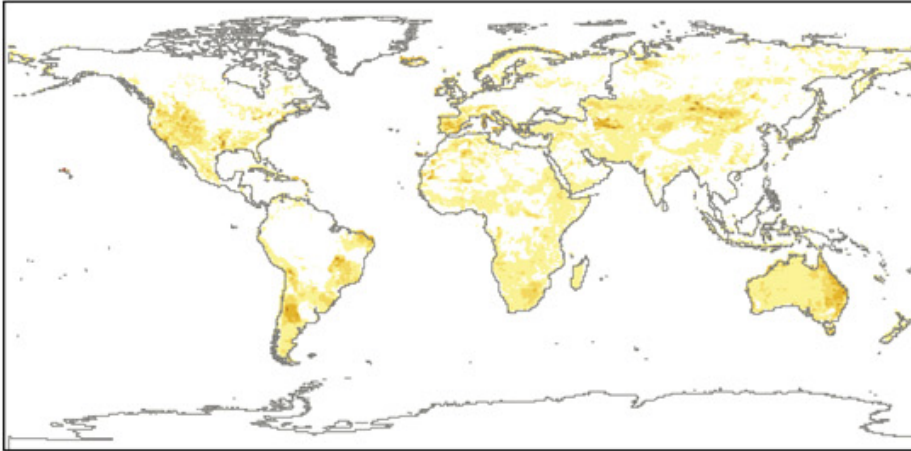
Where to plant bioenergy crops?

- ~~Lands now occupied by natural vegetation.~~
 - ~~This would result in a net CO₂ release.~~
- ~~Agricultural lands now used for food production:~~
 - ~~A terrible idea that has already caused food shortages and resulted in rising food prices globally (Gallagher Review 2008, UK Renewable Fuels Agency).~~
- Abandoned agricultural lands.
 - The area of such lands worldwide is limited.

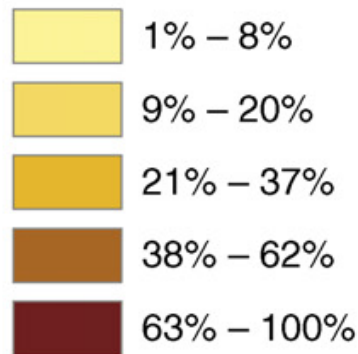


Abandoned agricultural lands

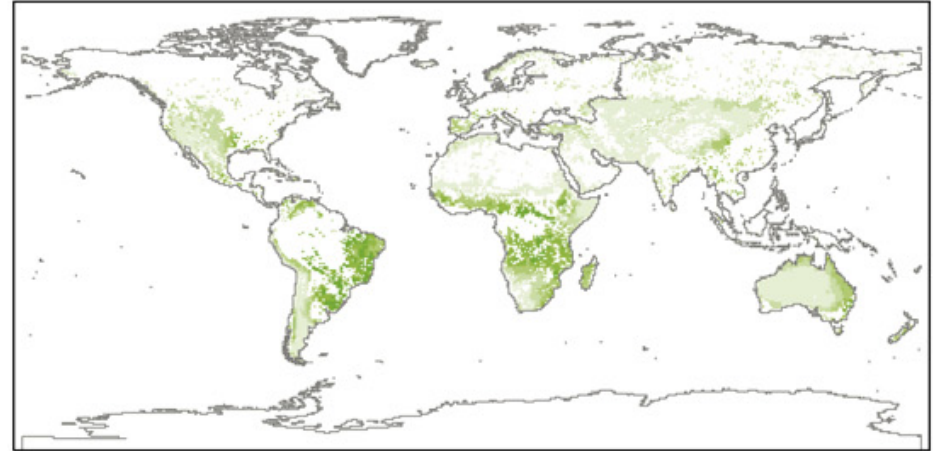
(a) Abandoned area



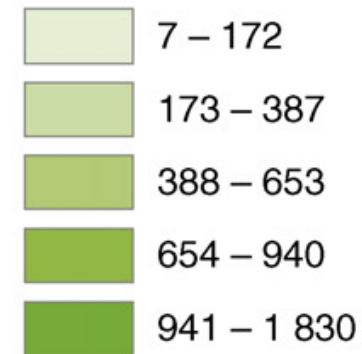
Area (%)



(b) Abandoned NPP



NPP (gC/m²/yr)



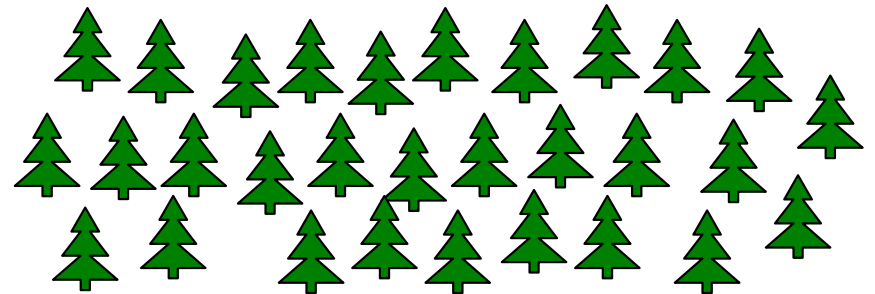
TRENDS in Ecology & Evolution

- Plant growth on these areas could offset ~5% of global energy consumption (Field *et al.* 2008. *TREE* 23:65-72).



So how can plants help us?

- Carbon sequestration in trees and bioenergy cannot be the only solutions to global warming,
- ... but they can be solutions if we reduce our carbon footprints!
- Remember the 300 pine trees needed to offset a current US household's annual carbon footprint?
- How about reducing our households' carbon footprints to 5 t CO₂ and using 30 pine trees to offset that whole footprint?



Calculate your carbon footprint



A screenshot of the CoolCalifornia.org Carbon Calculator website. The browser address bar shows the URL: http://www.coolcalifornia.org/calculator.html. The website header includes the logo 'COOLCALIFORNIA.ORG' and a 'Font Size' selector. A navigation menu on the left lists: HOME, ABOUT US, BUSINESS, CARBON CALCULATOR (with sub-links for Calculator FAQ and Calculator Documentation), TAKE ACTION, CLIMATE CHAMPIONS, RESOURCES, and FEEDBACK. Below the menu is a 'Join our mailing list' section with an email input field and a 'Submit' button. The main content area is titled 'CARBON CALCULATOR' and includes a welcome message, instructions, and a progress bar with six steps: 1 Intro, 2 Transport, 3 Housing, 4 Food, 5 Goods/Services, and 6 Summary. The first step is active. A 'Your Footprint: 38 tons CO2/yr' display is visible at the bottom right of the calculator interface.

- One of the best carbon footprint calculators is at:
<http://www.coolcalifornia.org/calculator.html>



What can you do?

- Help to **plant trees** now so that they can become part of a future solution as they grow.
 - Support the UNEP “Billion Tree Campaign”
- **Urban trees** sequester carbon and can reduce air-conditioning bills by shading buildings.
 - Calculate your carbon savings with the CUFR Tree Carbon Calculator at:
<http://www.fs.fed.us/ccrc/topics/urban-forests/>
- **Biodiesel** is no global solution, but using biodiesel from used vegetable oil can be a solution for individuals like you.



The solution to global warming

Drawing: Antoine de Saint-Exupéry's
"The little prince".