

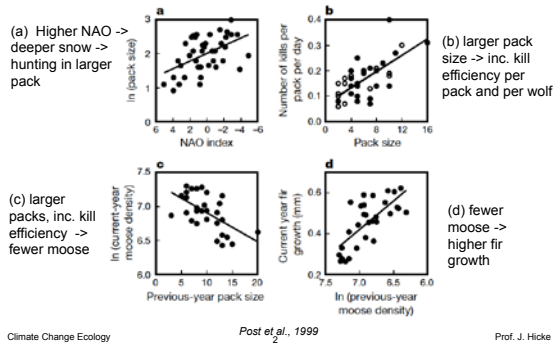
Section 5: Habitats, Communities, Ecosystems

Reading: Ch 3 (coral bleaching, ocean acidification, polar bear habitat); Ch 5

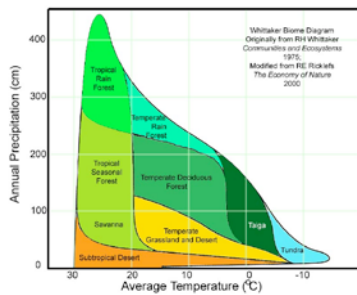
Learning outcomes

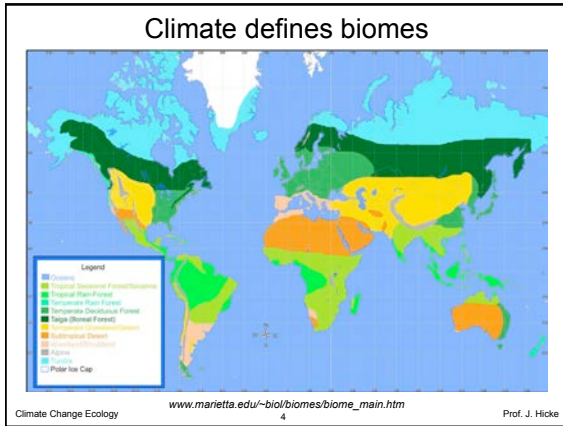
- understand definitions related to ecosystems
- explain how climate change affects biomes, and what the impacts are to ecosystem processes
- discuss examples of how climate change affects tropical, temperate, polar, freshwater, and marine ecosystems, and what the consequences of these changes are

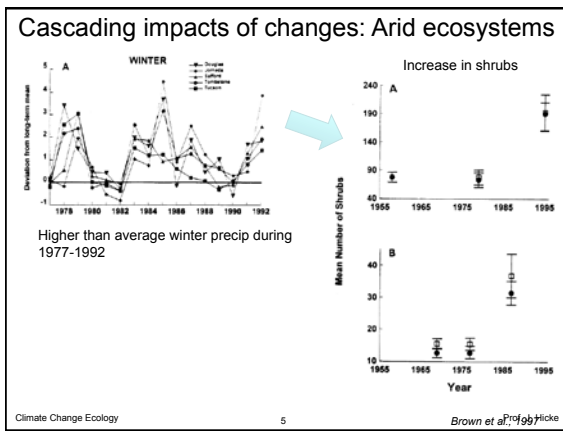
“Ecosystem consequences of wolf behavioural response to climate”

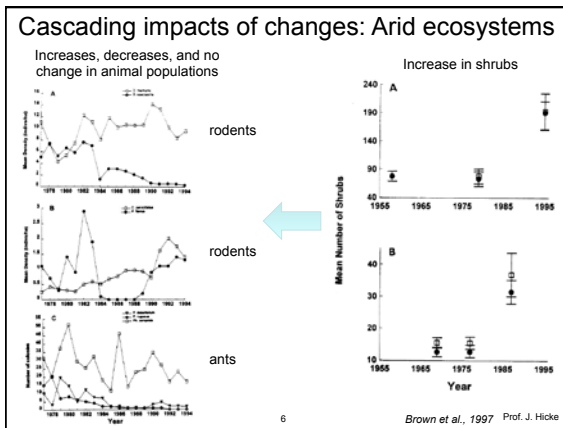


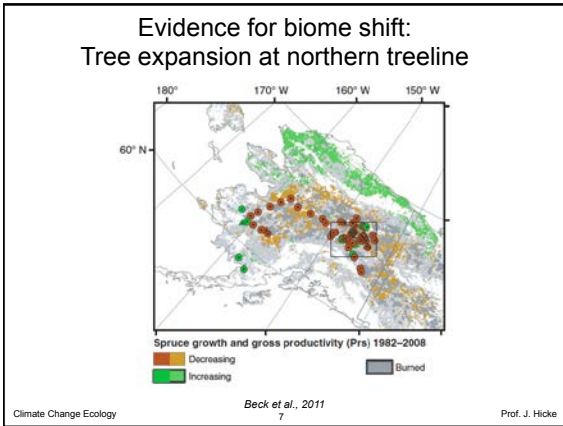
Climate defines biomes

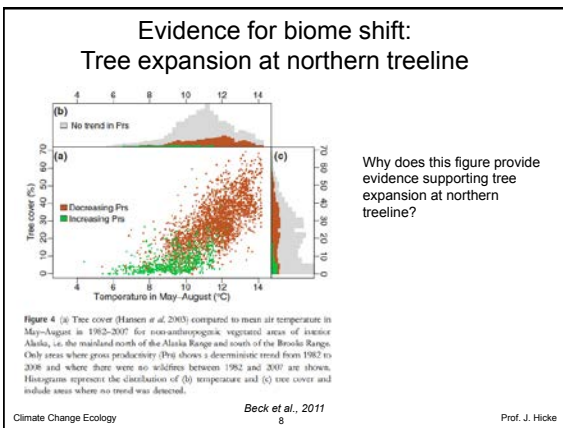






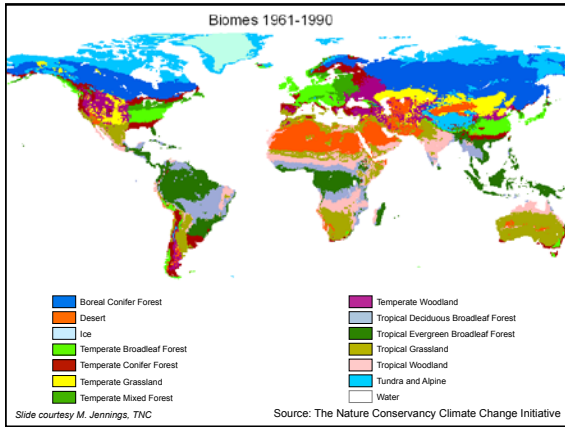


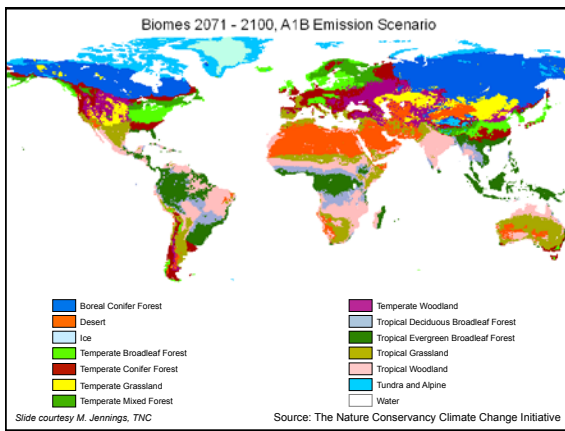


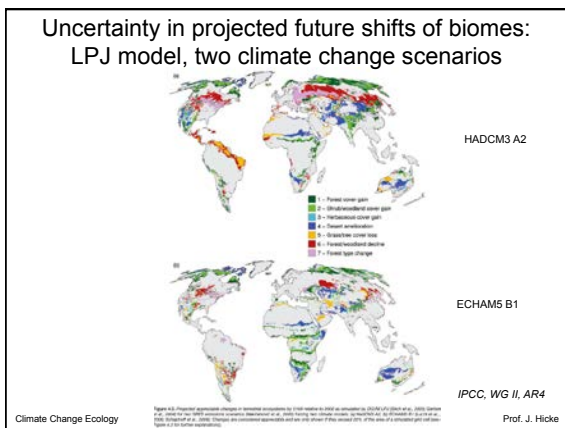


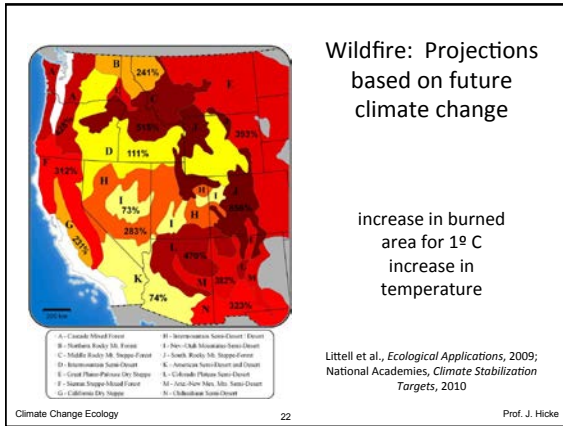
Why does this figure provide evidence supporting tree expansion at northern treeline?

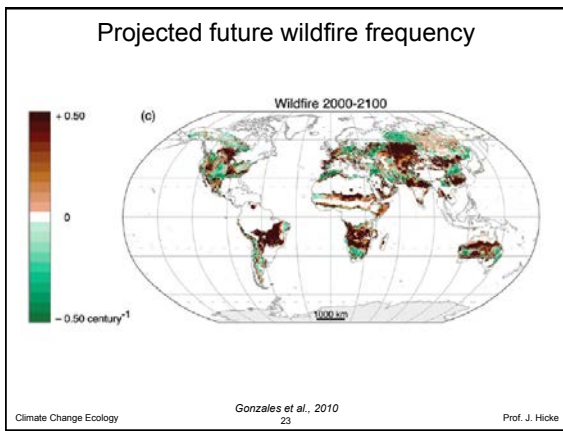


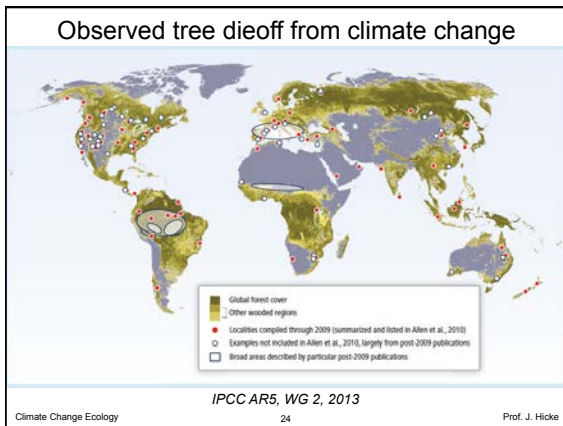












Drought: Texas drought in 2011



Dr. Ron Billings, Texas Forest Service

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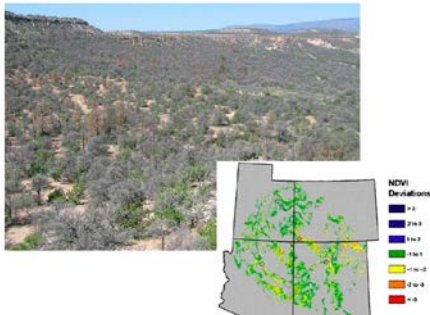
Drought: Pinyon pine dieoff in Southwest in 2000s



Jemez Mts. near Los Alamos, October 2002

Photo: Craig D. Allen, USGS

Drought: Pinyon pine dieoff in Southwest in 2000s



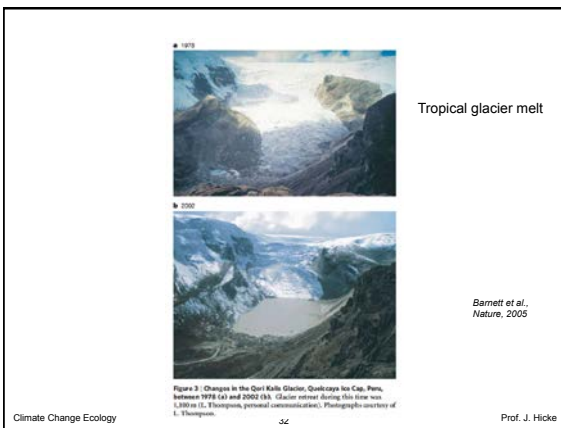
Breshears et al., 2011

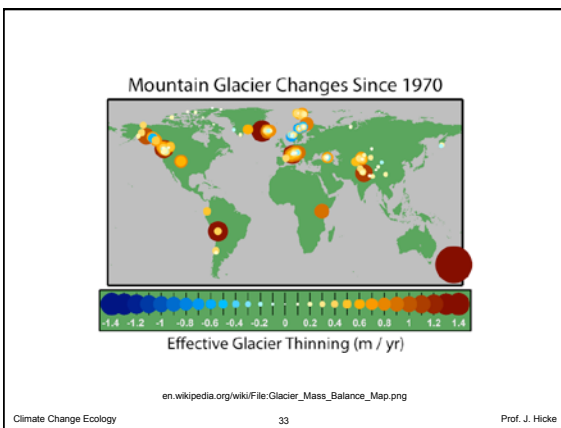
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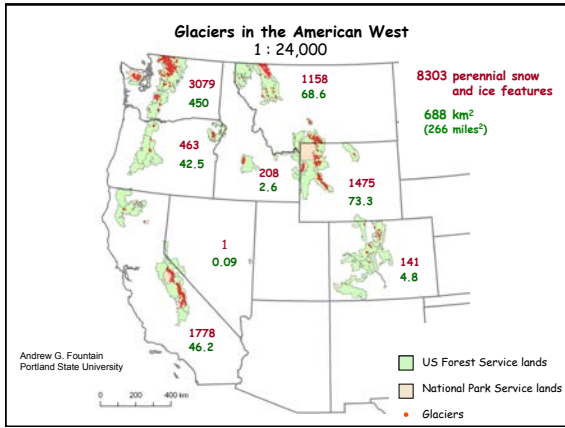
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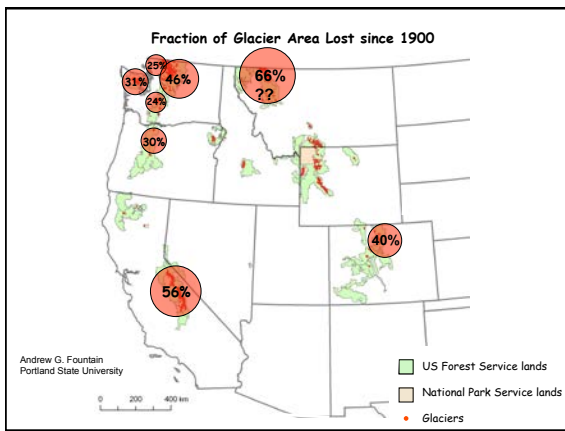
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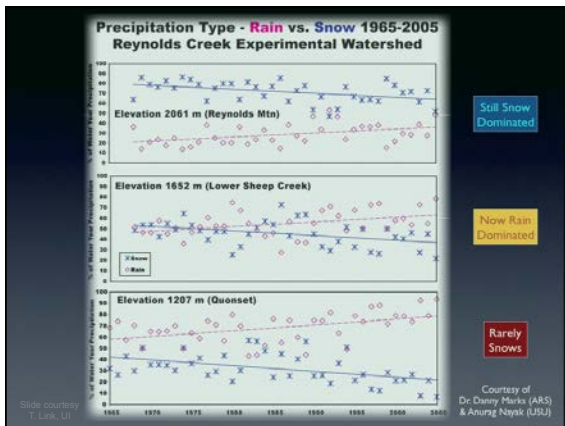


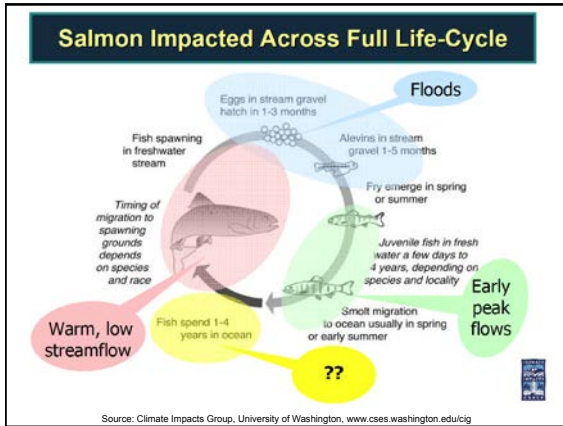


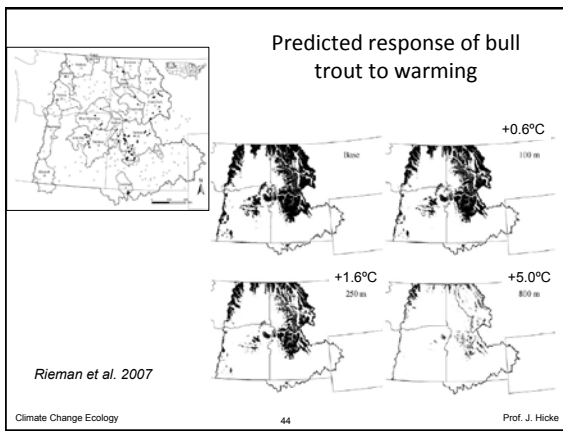


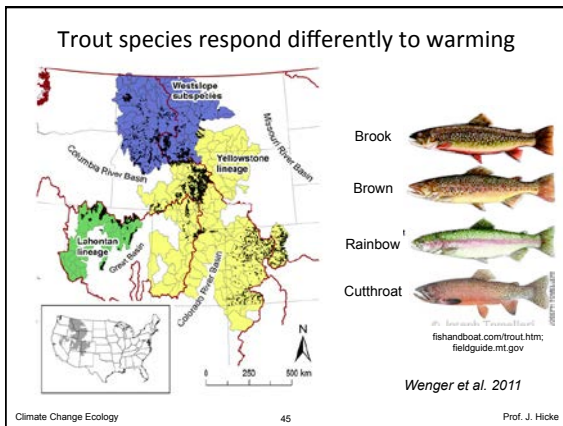


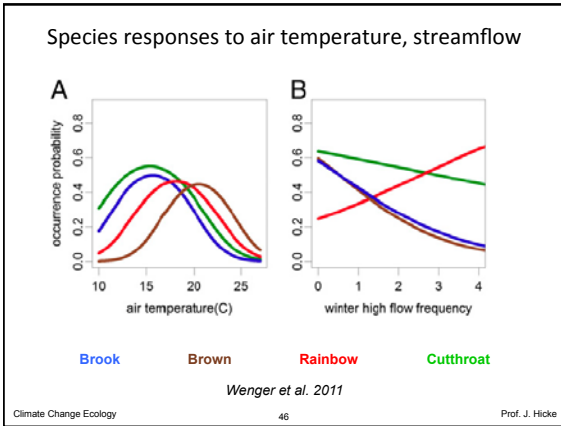


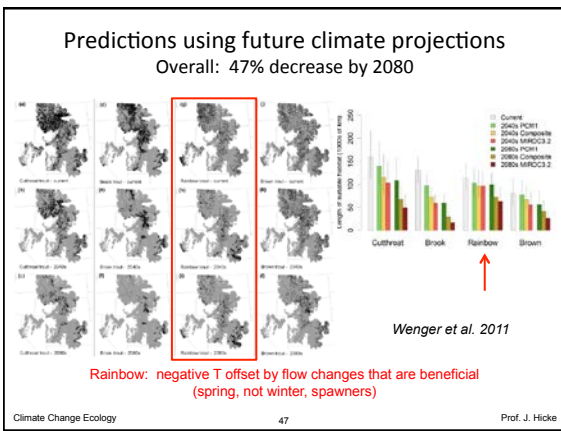


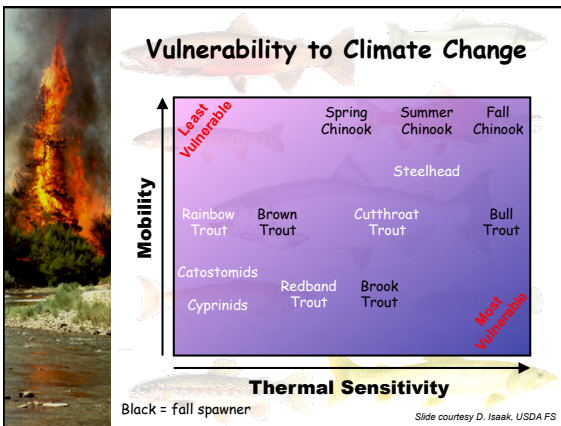


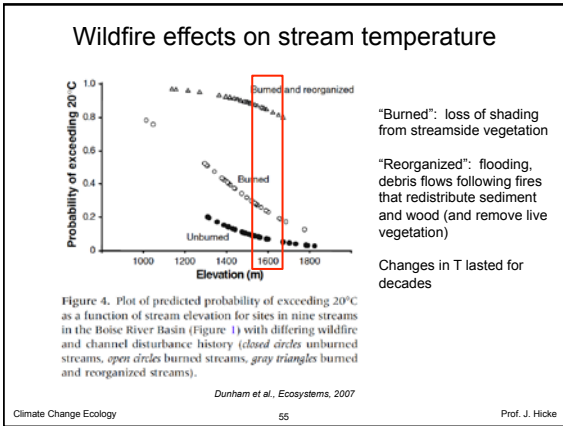


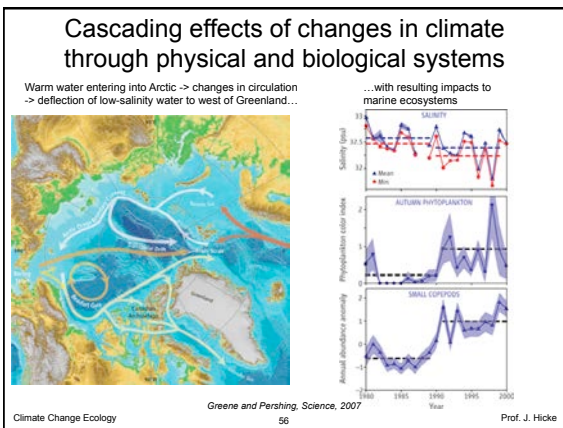














Coral bleaching

FIGURE 3.2 1997 – 1998: A Deadly Year for Corals. The right panel shows corals bleached in the El Niño event of 1997 – 1998. The left panels show a single coral head pre- and postbleaching: (a) prebleaching, (b) bleached coral head, (c) partially recovered coral head, and (d) fully recovered postbleaching. *Left Source: Manzello et al., 2007; Right Source: Courtesy U.S. National Oceanic and Atmospheric Administration.*

Hannah, 2011

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Coral bleaching

Marshall, Schuttenberg, 2006

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Ocean acidification

The pH scale
 $pH = -\log_{10} [H^+]$
 $[H^+] = 0.001 \text{ mol/L}$ pH = 3
 $[H^+] = 0.000001 \text{ mol/L}$ pH = 6
 $[H^+] = 0.00000001 \text{ mol/L}$ pH = 9

*Average global surface ocean pH

Figure 11 • Diagram of the pH scale, labeled with the average pH values for some common solutions, including seawater. pH is defined as the negative log of the hydrogen ion concentration in a solution. Neutral pH is 7.0; solutions that have pH values < 7.0 are acidic, and those that have pH values > 7.0 are basic. The term 'ocean acidification' refers to the direction of change toward more acidic conditions with increasing atmospheric CO₂ concentrations. Like the Richter scale, the pH scale is logarithmic. This means that a pH of 7 is 10 times more acidic than a pH of 8.

NOAA. State of Washington Report on Ocean Acidification, 2012

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Ocean acidification

$$\text{CO}_2 + \text{H}_2\text{O} + \text{CO}_3^{2-} \rightarrow 2 \text{HCO}_3^-$$

carbon dioxide

water

carbonate ion

2 bicarbonate ions

consumption of carbonate ions impedes calcification

http://pmei.noaa.gov/co2/files/oareaction.jpg

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Ocean acidification

Recent changes in atmospheric CO₂, CO₂ in seawater, and pH

Figure 1.3 - Time series of atmospheric CO₂ at Mauna Loa (in ppm; mole fraction in dry air) and surface-ocean pH and pCO₂ (µatm) at Ocean Station Aloha in the subtropical North Pacific Ocean. Note that the increase in oceanic CO₂ over the last 19 years is consistent with the atmospheric increase within the statistical limits of the measurements. Mauna Loa data: Dr. Pieter Tans, NOAA/ESRL (<http://www.esrl.noaa.gov/gmd/ccgg/trends/>); HOTS/ALOHA data: Dr. John Dere, University of Hawaii (<http://hahana.soest.hawaii.edu>).

NOAA, State of Washington Report on Ocean Acidification, 2012

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Ocean acidification

History and future of OA at the ocean surface

Figure 1.4 - Schematic diagram of the changes in pH, CO₃²⁻, and CO₃²⁻ of the surface oceans under a high CO₂ emission scenario out to 2100 (after Wolf-Gladrow et al., 1999). The pH has declined by about 0.1 (equivalent to a hydrogen ion concentration increase of about 30%) since the beginning of the industrial era.

NOAA, State of Washington Report on Ocean Acidification, 2012

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