Horizon scanning: identifying future threats to ecosystems
Why horizon scanning? Don’t we have enough to worry about?
Have an idea for a sustainability project on campus?

APPLY FOR FUNDING THROUGH THE SUSTAINABILITY INNOVATION AND ENGAGEMENT FUND (SIEF)

APPLICATION DEADLINE: FEBRUARY 16TH 2018

APPLY ONLINE:
TINYURL.COM/SUSTAINABILITYFUND
Aims of Horizon Scanning

• It is NOT about:
  – predicting the future

• It IS about:
  – exploring possibilities for the future to ensure that your strategies are robust
  – Looking beyond usual time scales
  – Looking beyond usual sources
  – Considering a range of future scenarios

H.J. Woodroof, 2008
Example that could have been avoided: Corn-based biofuels
Example that could have been avoided: Corn-based biofuels
## Corn biofuels and land use change

<table>
<thead>
<tr>
<th>Source of fuel</th>
<th>Making feedstock</th>
<th>Refining fuel</th>
<th>Vehicle operation (burning fuel)</th>
<th>Net land-use effects</th>
<th>% Change in net GHGs versus gasoline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>+4</td>
<td>+15</td>
<td>+72</td>
<td>0</td>
<td>+92</td>
</tr>
<tr>
<td>Corn ethanol (GREET)</td>
<td>+24</td>
<td>+40</td>
<td>+71</td>
<td>–62</td>
<td>+135 without feedstock credit</td>
</tr>
<tr>
<td>Corn ethanol plus land use change</td>
<td>+24</td>
<td>+40</td>
<td>+71</td>
<td>–62</td>
<td>+104</td>
</tr>
<tr>
<td>Biomass ethanol (GREET)</td>
<td>+10</td>
<td>+9</td>
<td>+71</td>
<td>–62</td>
<td>+27</td>
</tr>
<tr>
<td>Biomass ethanol plus land use change</td>
<td>+10</td>
<td>+9</td>
<td>+71</td>
<td>–62</td>
<td>+111</td>
</tr>
</tbody>
</table>

Searchinger et al., 2008
Jump in Amazonian deforestation following biofuels legislation

2007: Big jump in Amazon fires
Fires in the July-Sept period from 2003-2007 according to the AQUA satellite

- MATO GROSSO
- PARÁ
- TOCANTINS
- RONDÔNIA
- MARANHÃO
- AMAZONAS
- ACRE

mongabay.com
Horizon scanning: New forms of pollution
Horizon scanning: New forms of pollution

Ingredients:
Water, Glycerin, Sodium Laureth Sulfate, Polyethylene, Lauryl Glycoside, Acrylates/C10-30 Alkyl Acrylate Crosspolymer ...
**Studies identifying microplastic pollution**

Table 1  Size categories (millimeters) and marine habitats considered in pollution studies referring to virgin plastic pellets, small plastic fragments, and microplastics

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Habitat</th>
<th>Nomenclature</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 6</td>
<td>Beaches in New Zealand</td>
<td>Pellets only</td>
<td>Gregory 1977</td>
</tr>
<tr>
<td>1 to 5</td>
<td>Beaches in Canada and Bermuda</td>
<td>Pellets only</td>
<td>Gregory 1983</td>
</tr>
<tr>
<td>2 to 5</td>
<td>Western North Atlantic Ocean</td>
<td>Pellets only</td>
<td>Wilber 1987</td>
</tr>
<tr>
<td>0.1 to 0.2</td>
<td>Laboratory</td>
<td>Spherules only</td>
<td>Zitko and Hanlon 1991</td>
</tr>
<tr>
<td>&lt;0.5</td>
<td>Laboratory</td>
<td>Micro</td>
<td>Gregory 1996</td>
</tr>
<tr>
<td>2 to 5</td>
<td>Faeces of fur seals in Macquarie Island</td>
<td>Small</td>
<td>Erikson and Burton 2003</td>
</tr>
<tr>
<td>1 to 15</td>
<td>Beaches in Hawaii</td>
<td>Small</td>
<td>McDermid and McMullen 2004</td>
</tr>
<tr>
<td>~2</td>
<td>Beaches, coastal sediments, and invertebrates in UK</td>
<td>Micro</td>
<td>Thompson et al. 2004</td>
</tr>
<tr>
<td>&gt;0.16</td>
<td>Beaches and coastal waters in Singapore</td>
<td>Micro</td>
<td>Ng and Obbard 2006</td>
</tr>
<tr>
<td>2 to 20</td>
<td>Beaches, Fernando de Noronha</td>
<td>Small</td>
<td>Ivar do Sul et al. 2009</td>
</tr>
<tr>
<td>20 to 100</td>
<td>Archipelago, Equatorial Atlantic</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>2 to 5</td>
<td>Plastic pellets</td>
<td>Micro</td>
<td>Fendall and Sewell 2009</td>
</tr>
<tr>
<td>0.01 to 0.5</td>
<td>Laboratory</td>
<td>Small</td>
<td>Present work</td>
</tr>
<tr>
<td>1 to 20</td>
<td>Boa Viagem beach in Brazil</td>
<td>Micro</td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Costa et al., 2010
Microplastics can help transport other chemicals and pollutants
Microplastics found in seal scat on Macquarie Island

Figure 3. The frequency distribution of particle shapes (length/width).

<table>
<thead>
<tr>
<th>Polymer type</th>
<th>Numbers of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flotsam</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>76</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>28</td>
</tr>
<tr>
<td>Polyethylene/Polypropylene</td>
<td>1</td>
</tr>
<tr>
<td>Polymid resin or nylon-like</td>
<td>1</td>
</tr>
<tr>
<td>Poly(1,4-butadiene) polychloroprene</td>
<td>3</td>
</tr>
<tr>
<td>Melamine-urea (phenol)(formaldehyde) resin</td>
<td>1</td>
</tr>
<tr>
<td>Cellulose</td>
<td>1</td>
</tr>
<tr>
<td>Polyethylene terephthalate (PET)</td>
<td>18</td>
</tr>
<tr>
<td>Polystyrene (unexpanded)</td>
<td>26</td>
</tr>
<tr>
<td>Casein-based glue</td>
<td>2</td>
</tr>
<tr>
<td>Polystyrene co-acrylonitrile co-urethane</td>
<td>1</td>
</tr>
<tr>
<td>Polyester resin</td>
<td>4</td>
</tr>
<tr>
<td>Ester resin phenol modified alkyd</td>
<td>1</td>
</tr>
<tr>
<td>Polyester urethane</td>
<td>1</td>
</tr>
<tr>
<td>Polyester resin + glass fibers</td>
<td>2</td>
</tr>
<tr>
<td>PVC and polyethylene co-vinyl acetate</td>
<td>1</td>
</tr>
<tr>
<td>Seawater</td>
<td>161</td>
</tr>
</tbody>
</table>

Seal food
Plastics at sea

Yamashita & Tanimura, 2007
Macroplastic ingestion is also a problem

Fig. 2. Laysan albatross chick, Kure Atoll, 2002, photo: Cynthia Vanderlip, AMRF.

Moore, 2008
Horizon scanning: Geoengineering

Solar Radiation Management
- Sulfate injections into the stratosphere
- Mirrors in space
- Cloud seeding over the ocean
- Increasing land albedo

Carbon Dioxide Removal
- Biochar
- Ocean fertilization
- Synthetic trees
Geoengineering: Increased Stratospheric Aerosols
Geoengineering: Increased Stratospheric Aerosols

**Stratosphere**: Increasing temperature with altitude (*due to increasing absorbed UV radiation*)

**Troposphere**: Decreasing temperature with altitude (*due to emissions from earth*)
Geoengineering field tests are happening now

Scientists think of geoengineering as an option of last resort, but the actual engineering tests are moving forward.
Geoengineering: Increased Stratospheric Aerosols

c) 3x Katmai SAT Anomaly (°C) JJA 1912

Oman et al., 2004
Geoengineering: Increased Stratospheric Aerosols

3x Katmai Cloud Cover Anomaly (%) JJA 1913

Oman et al., 2004
Geoengineering: Biochar
Biochar from agricultural waste
Biochar – another scaling problem

Addressing a climate problem at the expense of ecosystems
Geoengineering Ideas

Source: “Geoengineering the climate. Science, governance and uncertainty” (Royal Society, 2009)
Horizon scanning: Policy changes

Reducing emissions from deforestation and forest degradation (REDD+)

... policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.

— UNFCCC Decision 2/CP.13–11

• Payments for maintaining forest
• Dependent on a market for carbon
• Reduces habitat loss in forests and reduces CO₂ emissions
REDD+ and Afforestation
REDD+ and Reforestation
Plantation forests aren’t great for biodiversity

Fitzherbert et al., 2008
Solutions: Valuing carbon and biodiversity

Rands et al., 2010
REDD+ & Future trends in conservation?

Fig. 1. Community tree nursery in Harapan Forest, lowland Sumatra, Indonesia, where an innovative 2007 law enabled management of logging concessions for ecosystem restoration rather than timber extraction. Harapan’s is the first such license, and the concession now covers nearly 100,000 ha of biodiversity-rich habitat (inset) with restoration being carried out under a joint project of Burung Indonesia, the Royal Society for the Protection of Birds (UK), and BirdLife International. The Indonesian government is committed to expanding the area licensed for forest restoration to 2 million ha by 2020. [Photo: Harapan Rainforest Initiative/M. Lamberti]

Rands et al., 2010
Future trends in conservation?

Fig. 2. A flower collector in Flower Valley, South Africa, harvesting pincushions (Leucospermum spp.) as part of a sustainable use initiative. Sales of sustainably harvested wild fynbos flower bouquets help to subsidize the conservation costs of the site. [Photo: Juan Pablo Moreiras/Fauna & Flora International]

Rands et al., 2010
Horizon Scanning: Mobile Technologies

Invasive Species Mapping Made Easy!

EDDMapS, started in 2005 with Southeastern U.S. focus, is now providing a picture of the distribution of invasive species across the U.S.

- Fast and easy to use - no knowledge of GIS required
- Web-based mapping of invasive species distribution to help fill gaps and identify "leading edge" ranges
- Facilitates Early Detection and Rapid Response implementation with online data entry forms, e-mail alerts and network of expert verifiers
- One Database for both local and national data
- Data can be searched, queried and downloaded in a variety of formats
- Cooperates with and aggregates data from other invasive species mapping projects
- Custom/hosted applications can be quickly and inexpensively developed
Horizon Scanning: Mobile Technologies

Mobile Gulf Observatory
A free iPhone app to help save the Gulf’s wildlife

With the largest oil spill in U.S. history looming in the Gulf of Mexico, the wildlife and coastal habitats of the Gulf are under siege. As oil hits the coasts, thousands of birds, dolphins and sea turtles will be stranded along coastal shorelines. Although wildlife rescue networks are in place and have started rescue efforts, the task is enormous and trained staff too few. But you can help save wildlife by installing the free MoGO app on your iPhone™.

What is MoGO?
MoGO is a free iPhone™ app that turns you and your iPhone™ into a ‘citizen scientist’ helping wildlife experts find and rescue oiled birds, sea turtles, and dolphins. The MoGO app allows you to take and submit photos of oiled, injured, and dead marine and coastal wildlife; tar balls on beaches; oil slicks on water; and oiled coastal habitats.

Guide Rescue Efforts & Save Wildlife
Once you upload your photo, the locations of oiled and injured wildlife are pin-pointed with a GPS code generated by your iPhone™. You are then immediately connected to the Wildlife Hotline to report your observations so trained responders can be deployed to rescue oiled and

Creating Citizen Scientists
MoGO offers a method by which citizens can participate in rescue and recovery efforts of wildlife and restoration of the Gulf’s habitats. Download MoGO today and start submitting data. Soon, citizen scientists will also be able to view submissions from MoGO users through this website and the Louisiana Bucket Brigade mapping website. Each photo uploaded will be reviewed by a team of experts, and your geo-tagged MoGO photos will be placed in a comprehensive, public database to help guide restoration of coastal and marine habitats of the Gulf.

News from the Gulf
The numbers...
Date provided by USFWS, NOAA, and other response and rehabilitation centers in the GulfIs publicly available through the Consolidated Fish and Wildlife Collection Reports.

Which birds are most at risk in the Gulf?
Click on the image to the left for a map of Globally Important Bird Areas from American Bird Conservatory.

How much oil has leaked to date?
Watch the live stream and track gallons leaked.
Horizon Scanning: Mobile Technologies
Horizon Scanning: Citizen Science

Reporting your observations is easy to do! Simply mark the dates of the phenophases of trees, shrubs, or flowers in your community. See the Steps to Getting Started for complete information including a reporting form to help you note the phenological changes as they occur throughout the year.

- Report Your Observations Now!
- Login or Join! to become a Member

We have member registration! By registering with us, you can save your observation site(s) and plant(s) that you are monitoring throughout the year and for coming years. This also allows you to report the phenological changes as they occur each month!

Project BudBurst has targeted 97 native trees, shrubs, wildflowers, and grasses for you to monitor throughout the year! With your help, we will be compiling valuable environmental information that can be compared to historical records. By recording the timing of the leafing and flowering of native species each year, scientists can learn about the prevailing climatic characteristics in a region over time.