Activities
The overall goal of the Sustain 2 project is to develop and test integrated assessment methods by focusing on the combined effects of climate and petroleum development on the sustainability of Arctic communities.

There are six major activities:

1. **Develop first stage-integrated assessment modeling tools** using the marine relationships as a test bed.
2. **Extrapolating caribou modeling** to multiple herds in North America
3. **Incorporating marine relationships** focusing on bowhead and beluga availability to communities
4. **Developing monitoring-management feedback-policy components** for bowhead and caribou
5. **Extrapolating from a single community model to a regional model highlighting differences among communities** in the range of the Porcupine Caribou Herd
6. **Broadening the scope of caribou relationships** beyond the calving season to include non-summer forage dynamics.

See Project Plan in web library ([www.taiga.net/sustain](http://www.taiga.net/sustain))

**Develop first stage integrated assessment modeling tools (Craig Nicolson)**

- **Approach**: Computer simulation models are a useful tool for synthesizing knowledge from different disciplines into a coherent and unified framework. Our integrated assessment efforts in this project are therefore built around modeling. A common approach to IA is to bring all the necessary experts together in a large workshop, and to have a team of modelers produce a working model by the end of the workshop. This approach is expensive and does not guarantee that the workshop participants will ‘buy into’ and trust the model.

We have chosen to take a different approach. Instead of a single large workshop, our lead synthesis modeler (Nicolson) works with individual investigators (or with small groups of people from within a single discipline) and represents the key components of their knowledge in a prototype system idea map. This ‘box and arrow’ idea map is a visual representation of the key relationships in the system and serves as a first step in synthesizing the knowledge of different investigators.

An overall system idea map includes information on dozens of relevant relationships. It is therefore complex to look at and understand. We therefore break the system idea map into several different component idea maps. With recent advances in hypertext technology, it is possible to link more detailed descriptions of the variables and components to the idea maps so that people can explore the integrated view of the system according to their interests and can
see the data underlying the various relationships and variables and the current status of the modeling.

- **Major Activities**
  - Identified key relationships for subsistence whaling. (Nicolson, Braund, Kruse, George, Suydam, O’Hara)
  - Spring bowhead hunting in Barrow
  - Fall bowhead hunting in Barrow and Kaktovik
  - Developed a set of marine system idea maps to represent relationships between (Nicolson, Braund, Kruse, George, Suydam, O’Hara):
    - climate change
    - offshore oil development
    - regulatory policies
    - subsistence hunting of bowhead and beluga whales
      - Developed hypertext component idea maps for the following relationships (Nicolson, Braund):
        - Climate $\rightarrow$ Environmental conditions $\rightarrow$ Whale harvesting
        - Climate $\rightarrow$ Shelf-basin conditions $\rightarrow$ Whale migration $\rightarrow$ Availability to hunters
        - Off-shore oil $\rightarrow$ Whale migration $\rightarrow$ Availability to hunters
        - Whale population dynamics $\rightarrow$ Regulatory policy $\rightarrow$ Hunting quotas
      - Developed idea maps for caribou to represent relationships between (Nicolson, Russell, Griffith, Gunn, Kruse, Kofinas):
        - Climate $\rightarrow$ Forage $\rightarrow$ Body condition $\rightarrow$ Herd population
        - Climate & Industrial activity & Human disturbance $\rightarrow$ Caribou migration
        - Climate & Socio-cultural factors $\rightarrow$ Hunting effort $\rightarrow$ Harvest success
        - Co-management $\rightarrow$ Industrial activity
        - Co-management $\rightarrow$ Regulatory policy $\rightarrow$ Policy Hunting effort
  - Integrated our research with research underway by Amanda Lynch (Kruse). We are developing locally defined variables relating climate to community sustainability. Lynch’s project seeks to use locally defined variables to identify climate model proxy variables to be used in simulations. The two projects thus complement each other.

**Extrapolating caribou modeling (Don Russell)**

- **Approach**: We are working toward a North American caribou simulation capability. We started with the existing Porcupine Caribou Simulation Model. This model identifies what we hypothesize to be key variables in simulating climate and development-related changes to caribou energetics and population. We review this variable set with biologists working with other herds to determine if there are additional relevant variables. Based on this analysis, we are developing an integrated, relational database. This database will contain comparable data for these key variables and will incorporate a capability to estimate values for missing data. We will then build a multi-herd simulation modeling capability based on the relational database.
Major Activities

- Developed a Three-Year Task Plan for the caribou component - see project web site. (Russell, Griffith, Kruse, Kofinas, Nicolson, Eamer, Gunn)
- Reviewed key variables and relationships for the Bathurst, Western Arctic and George River herds with herd biologists (Russell, Griffith, Gunn, Kofinas)
- Incorporating marine relationships (Steve Braund)
  - Approach: We are working towards an integrated assessment of the combined effects of climate change and petroleum development on both marine and terrestrial subsistence resources. We need to consider all relevant relationships but need to identify those likely to account for variations in sustainability of Arctic communities. On the basis of this exercise we can identify critical data needs, and relationships that need to be incorporated in synthesis modeling.
  - Major Activities
    - Initiated marine hypothesis development to understand potential climate change relationships on marine ecosystems. Held work session with Jackie Grebmeier to integrate project with ARCSS Shelf-Basins Interaction initiative. (Kruse)
    - Initiated hypothesis development linking marine ecosystem changes and marine mammal energetics, population movements, and population dynamics. Worked with Sue Moore (NMFS) (Nicolson)
    - Developed idea maps for marine relationships in work session with North Slope Borough biologists (George, Suydam, O'Hara, Braund, Kruse, Kofinas)
Developing monitoring-management feedback-policy components (Gary Kofinas)

- **Approach**: We have identified two major policy arenas: International Whaling Commission (IWC) bowhead harvest quotas and US-Canada offshore and onshore petroleum development policies. IWC quotas are affected by the estimated rate of increase of the bowhead population. The measured rate of increase is potentially affected by the same environmental variables (including climate change and petroleum development) that affect the success of the subsistence bowhead hunt. If we are to understand the cumulative effects of climate change and petroleum development on the availability of bowhead to Arctic communities, we must take into account both direct relationships to subsistence hunting and relationships to the IWC bowhead quota. These relationships include a monitoring and feedback component to the IWC.

Petroleum development effects are likely to be cumulative and confounded with climate-related changes. We are building on a community-based monitoring system in the range of the Porcupine Caribou Herd to develop a monitoring-feedback-management response simulation capability. Of particular importance is the distribution of benefits and risks to different communities in the region and the interaction between climate changes and petroleum development effects.

- **Major Activities**
  - Developed an idea map incorporating bowhead monitoring (census)-management feedback (IWC)-policy (quota) relationships. (Kruse, George, Suydam, O’Hara, Braund, Kofinas)
  - Developed an approach to caribou cumulative impact assessment for the Bathurst Herd (Russell, Griffith, Kofinas)
  - Developed an approach to caribou cumulative impact assessment for the Porcupine Herd and reviewed this approach with the Porcupine Caribou Management Board (Russell, Kofinas, Nicolson)
  - Contacted local organizations to propose formation of a regional working group of community representatives and agency personnel that will make use of the project’s assessment tools to discuss their policy applications at the regional level.
  - Reviewed the project goals at a public meeting and one-on-one work sessions in Kaktovik Alaska. As a part of that meeting we presented the preliminary findings of our Nuiqsut - Alpine Field petroleum development study (Haley), and discussed logistical details regarding of community’s participation in the project (Kofinas).

Extrapolating from a single community model to a model highlighting differences among communities (Matt Berman)

- **Approach**: We are working toward a North American simulation capability, focusing in this project on development of a regional view that reflects differences in effects among communities. Our hypothesis is that we can take advantage of
the diversity of communities in the study region to better understand how communities in other regions – and hence how these regions as a whole – are affected by climate change and development.

- **Major Activities:**
- Identified the types of development patterns, climate effects, other environmental changes, and regional or national policies --forces for change -- that might lead to differing outcomes for partner communities, and which of these might be useful to consider modeling. (Berman, Nicolson)

**Broadening the scope of caribou relationships (Brad Griffith)**

- **Approach:** We focused in Sustain 1 on what we thought was most important to explaining variations in caribou population dynamics due to climate change: the quality of forage during the calving season. Comparisons of our simulations with monitoring data suggest that there are important variations in forage availability at other times of the year.

- **Major Activities:**
- We acquired NDVI data from early July through fall senescence, 1985-2000. It is now being registered/calibrated for analysis. We are continuing to collect parturition and calf survival data for the PCH. We recalibrated all NDVI data with the latest calibration coefficients from the literature, created new datasets, and tested correlations between parturition related events and NDVI up through 21 June in the previous year.
- With David Douglas, we worked with Robert Stone of NOAA on the relationship between large scale Arctic weather patterns (cyclonic activity associated with the Aleutian Low) snowfall, and snowmelt.