Arctic LTER Project

The Arctic LTER Project: Mid-term Site Review 18-19 June 2013

Welcome everyone

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- Tuesday 18 June
  - Morning: Overview, science presentations
  - Afternoon: Field trips
  - Evening: Posters
- Wednesday 19 June
  - Morning I: Management, Information, Education, Training, Outreach
  - Morning II: Feedback, discussion with Review Team
  - Afternoon I: Review team executive session, writing
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What is the Arctic LTER?

"LTER" STANDS FOR LONG TERM ECOLOGICAL RESEARCH

Ecological research at the Arctic LTER site began in 1975 with NSF funding, with acceptance into the LTER Network in 1987. ***The overall aim has always been: to develop a predictive understanding of the arctic landscape near Toolik Lake including tundra, streams, lakes, and their interactions.*** The specific focus evolves continuously and changes with each renewal cycle, as understanding grows and as new opportunities are recognized.

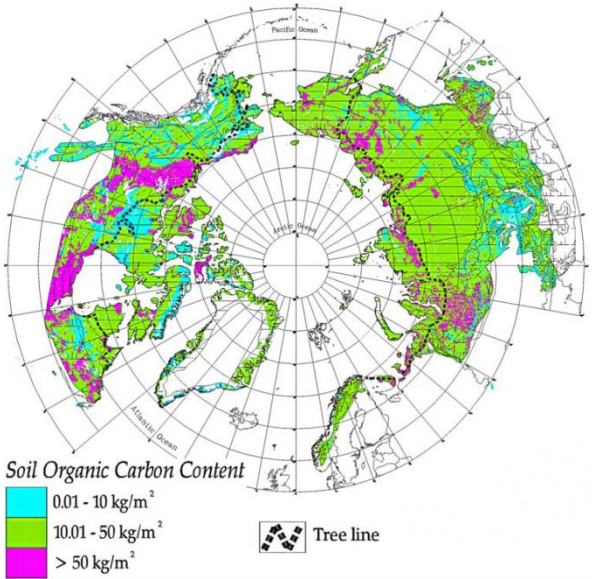
THE ARCTIC LTER SITE IS PART OF THE US LTER NETWORK

LTER Network Goals:

- **Understanding**: To understand a diverse array of ecosystems at multiple spatial and temporal scales.
- **Synthesis**: To create general knowledge through long-term, interdisciplinary research, synthesis of information, and development of theory.
- **Information**: To inform the LTER and broader scientific community by creating well designed and well documented databases.
- **Legacies**: To create a legacy of well-designed and documented long-term observations, experiments, and archives of samples and specimens for future generations.
- **Education**: To promote training, teaching, and learning about long-term ecological research and the Earth's ecosystems, and to educate a new generation of scientists.
- **Outreach**: To reach out to the broader scientific community, natural resource managers, policymakers, and the general public by providing decision support, information, recommendations and the knowledge and capability to address complex environmental challenges.

Why an Arctic LTER?

- The Arctic is a unique and valuable region in itself
- The Arctic region plays a unique and important role in the global environmental system
- Arctic ecosystems are model systems for fundamental understanding



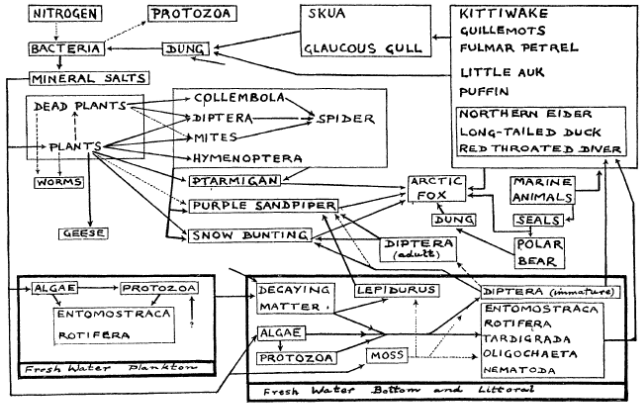


FIG. 2. Diagram of "Nitrogen Cycle" on Bear Island.
..... Probable, but no evidence from here.
----- Transformation.

Summerhayes, V.S. and C.S. Elton. 1923
J. Ecology 11: 214-286

Evolving goals of the Arctic LTER

- **LTER I (1987-1992):** Descriptions of tundra, stream, and lake ecosystems; Long-term change versus short-term controls on ecosystem components
- **LTER II (1992-1998):** Ecological variability and long-term change; top-down versus bottom-up controls on tundra, streams, and lakes
- **LTER III (1998-2004):** Prediction of the future characteristics of arctic ecosystems and landscapes; controls on ecosystems by physical, climatic, and biotic factors
- **LTER IV (2004-2010)**: Understanding changes in the Arctic system at catchment and landscape scales through knowledge of linkages and interactions among ecosystems.
- **LTER V (2010-2016):** Understanding changes in the arctic system at catchment and landscape scales as the product of: (i) Direct effects of climate change on terrestrial and aquatic ecosystems, and (ii) Indirect effects of climate change on ecosystems through a changing disturbance regime..

Fig 2-4. Disturbances create patches of dramatically different biogeochemistry and environmental conditions that can dominate the C or energy balance and community dynamics of much larger areas. LEFT: 1000 km^2 Anaktuvuk River Burn (arrow) adjacent to the 9200 km^2 Kuparuk River watershed. CENTER: <1 ha thermokarst (arrow) on the shore of 25 ha Lake NE-14. RIGHT: Extreme low water in the Kuparuk River caused by occasional drought blocks fish migration to headwater lakes 10 km away.

LTER V: Goals for 2010-2016

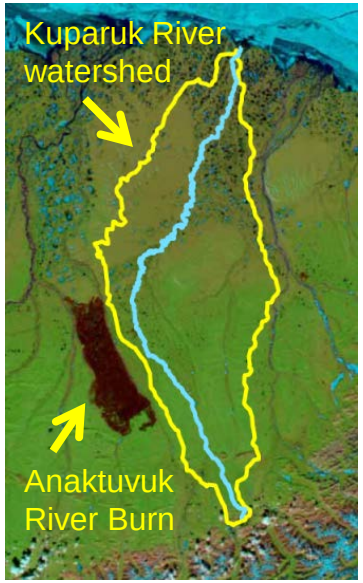
Increasingly….it is apparent that climatic warming in the Arctic is accompanied by dramatic changes in disturbance regime, including disturbances related to thawing of permafrost, a surprising increase in wildfire, and changes in the seasonality and synchrony of ecosystem processes.

….The result is much more dramatic and rapid change in communities and element cycles than is predicted in response to warming alone. In the long term, warming-related changes in disturbance regime may be more important than the direct effects of warming on arctic tundra and freshwater ecosystems, and on the entire Arctic……

Our long-term goal, to develop a predictive understanding of the landscape of Northern Alaska including tundra, streams, lakes, and their interactions, remains the same but we will refocus our efforts for the next six years to include a new emphasis on changing disturbance regimes and their interactions with climate change.

Barrow
Wainwright
Prudhoe Bay
Kaktovik
Atqasuk
Nuiqsut
Pt Lay
Pt Hope
Anaktuvuk Pass
Toolik Lake

The ARC LTER site is the North Slope of Alaska, with research based at Toolik Field Station, near Toolik Lake. This area of ~200,000 km^2 includes three major physiographic provinces (mountains, foothills, coastal plain), an array of local landscapes differing by >4 My in time since deglaciation, eight Native villages with subsistence-based economies, and a major oilfield. The resident human population is <10,000 and there is only one road.



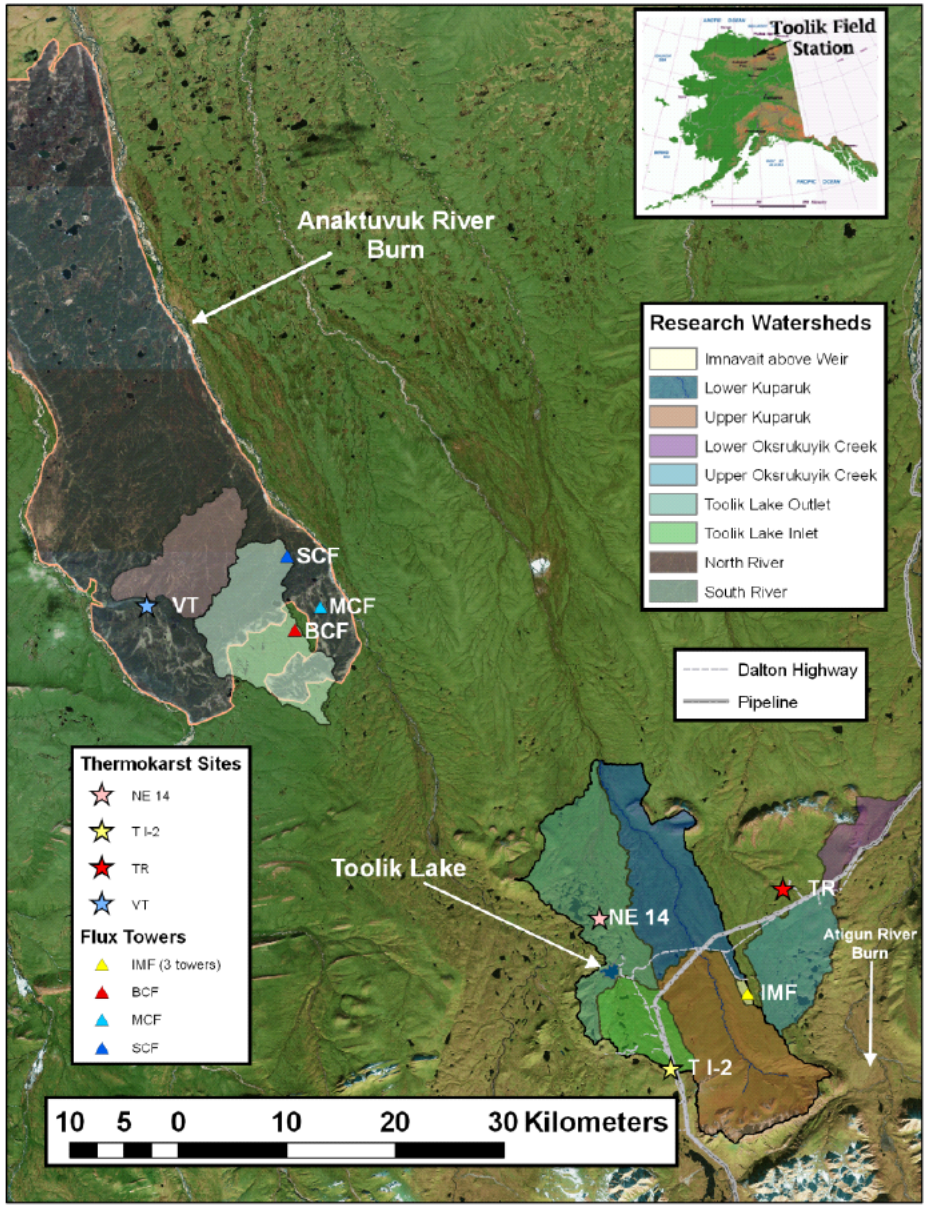


Fig 2-2. Major research sites and place names. The main Arctic LTER research site includes the drainage basin enclosing the two branches of the headwaters of the Kuparuk River (including Toolik Lake and its drainage basin, the upper Kuparuk River, and Imnavait Creek). The ARC LTER research also includes sections of Oksrukuyik Creek, lakes and springs in the mountains and foothills near Toolik Lake (not on this map), the 2004 Atigun River Burn (not shown) and the 2007 Anaktuvuk River Burn 40 km to the northwest.

Key to thermokarst and flux sites:

NE-14 = glacial thermokarst on lake shore; TI-2 = Toolik Inlet thermokarst; TR = Toolik River thermokarst; VT = Valley of Thermokarsts; IMF = Imnavait Creek flux towers (3); BCF=unburned control flux tower; MCF=Moderate burn flux tower; SCF=severe burn flux tower.

Project organization

Research of the Arctic LTER includes three major components:

1. **Long-term monitoring and surveys** of natural variation and change of terrestrial and aquatic ecosystems in space and time
2. **Long-term experimental manipulations** of terrestrial and aquatic ecosystems
3. **Synthesis of results and predictive modeling** at ecosystem and watershed scales.

Most of the research of the Arctic LTER is accomplished via collaborations with a wide range of individually-funded projects

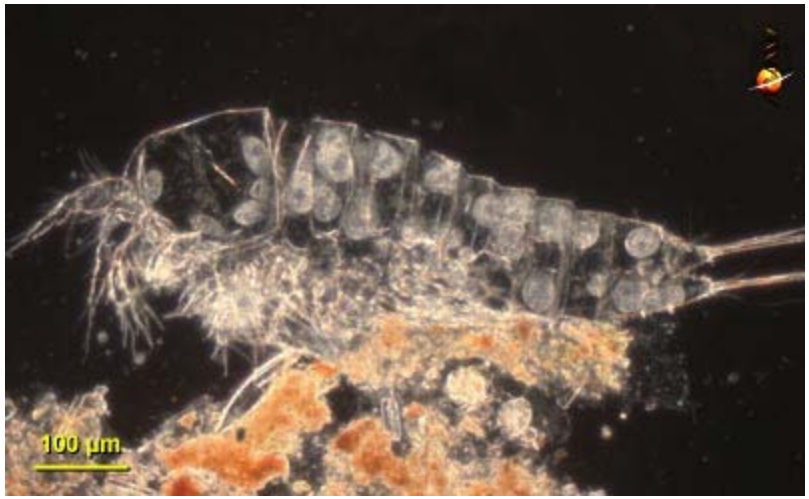
How does it work?

Four research groups, proposed adding a fifth

- Terrestrial
- Land-Water Interactions
- Streams
- Lakes
- (Social Science)

Each group participates in all three components of ARC LTER research (monitoring, manipulations, synthesis)

	Surface Area (ha)	Max Depth (m)	Sampling Frequency (per summer)
Toolik	149	25	10
E1	2.6	11	1
Fog 2	5.9	20.3	2
Fog 4	1.9	4.4	2
NE9b	.4	6	1
NE12	8.2	17.1	1
N1	4.3	14.2	1
S6	1.1	5.2	1
S7	.8	2.9	1
S11	.3	9.5	1
l Series	2.1-17	3.1-15	3
E5	11.3	12.7	5
E6	1.9	3.2	5
N2	1.6	9.7	2
Dimple	10.6	9.0	3
Horn	35.8	5.0	3
Luna	4.75	2.5	3
Perched	15.1	12.0	3
North	32.9	2.0	3



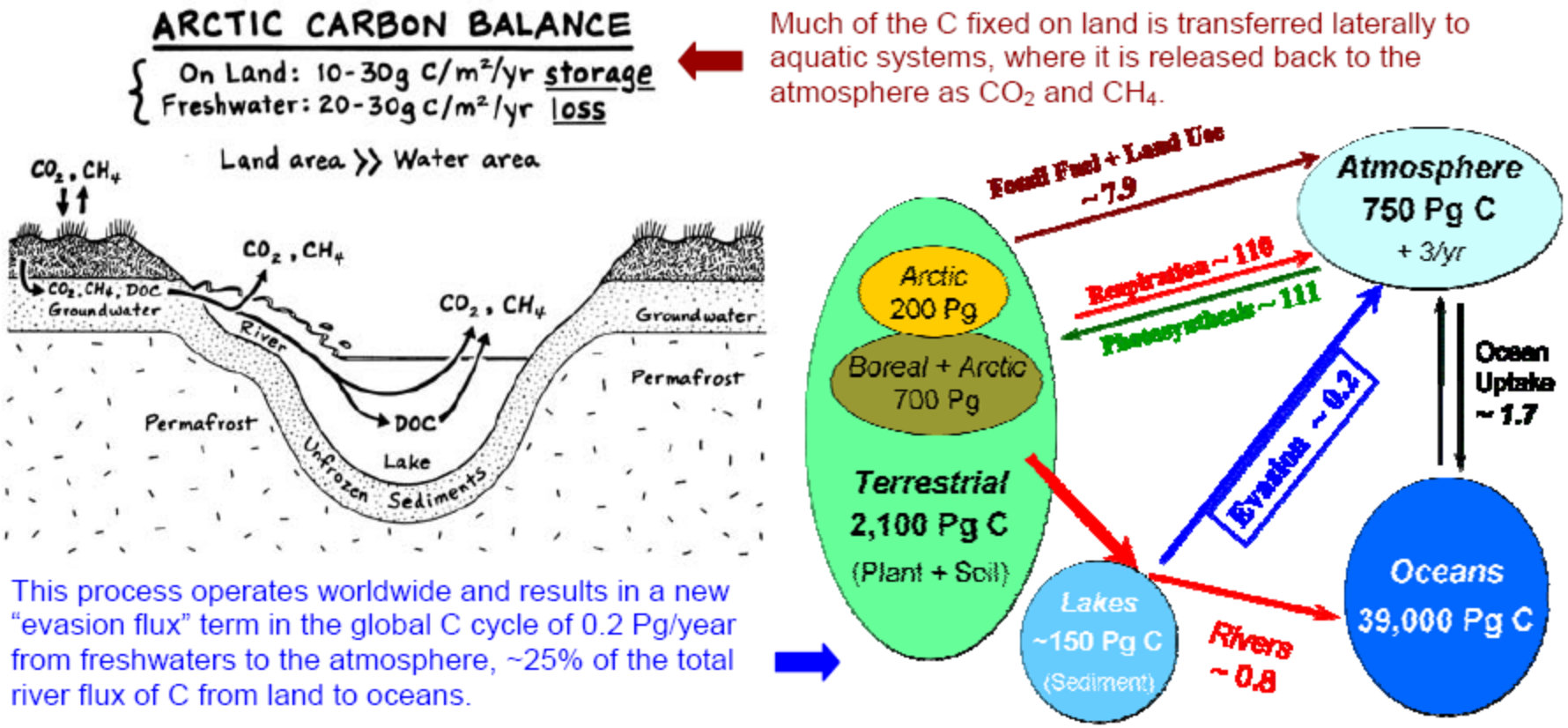


Figure LW-2. Schematic showing land-water transfer paths of C gases, and importance in the global C cycle (from (Kling et al. 1991, 1992; Kling 1995; Reeburgh et al. 1998).

ARC V organizing questions

1. How does climate control ecosystem states, processes, and linkages?
2. How do disturbances change ecosystem states, processes, and linkages?
3. How do climate and disturbance interact to control biogeochemical cycles and biodiversity at catchment and landscape scales?

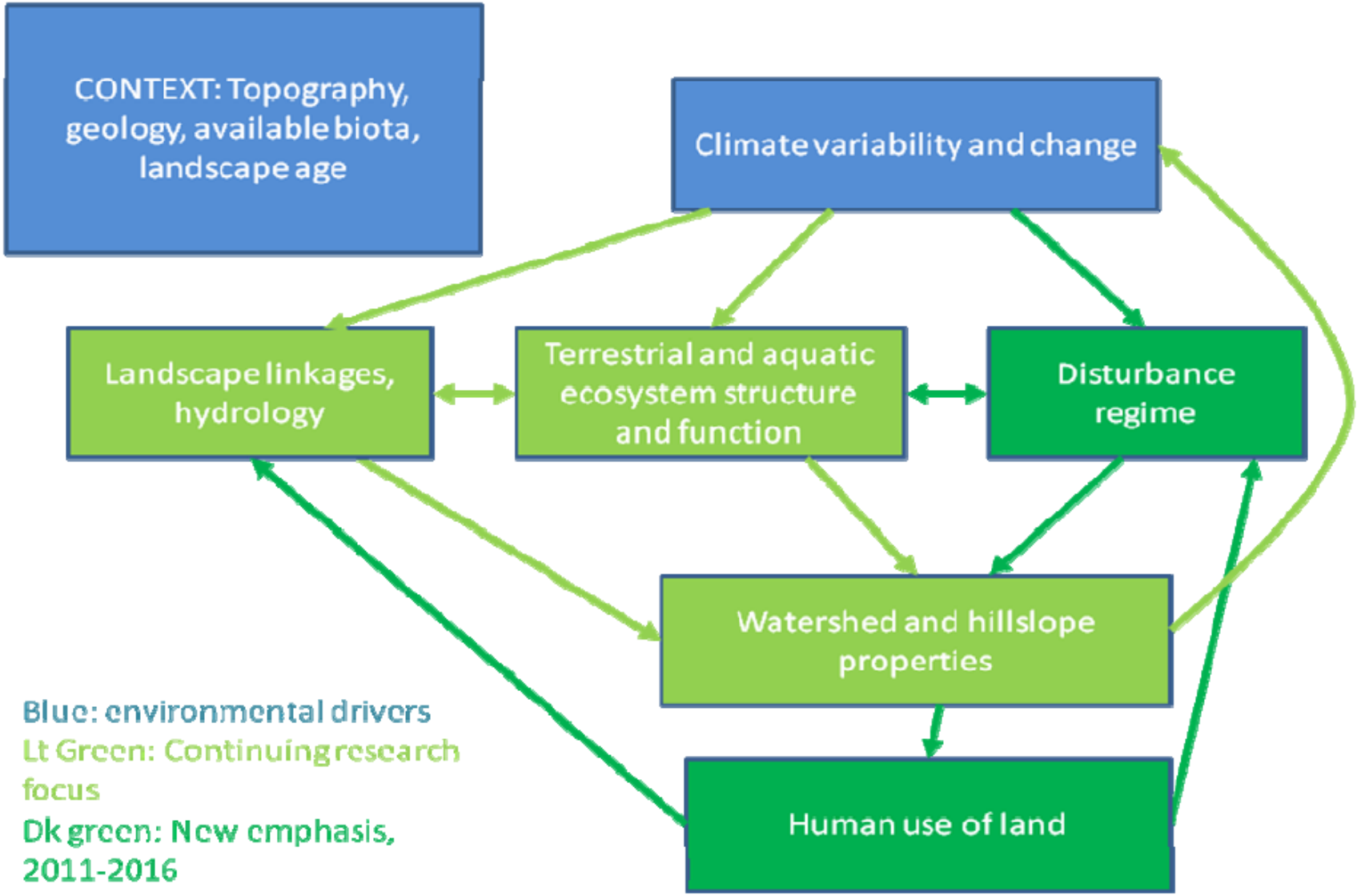
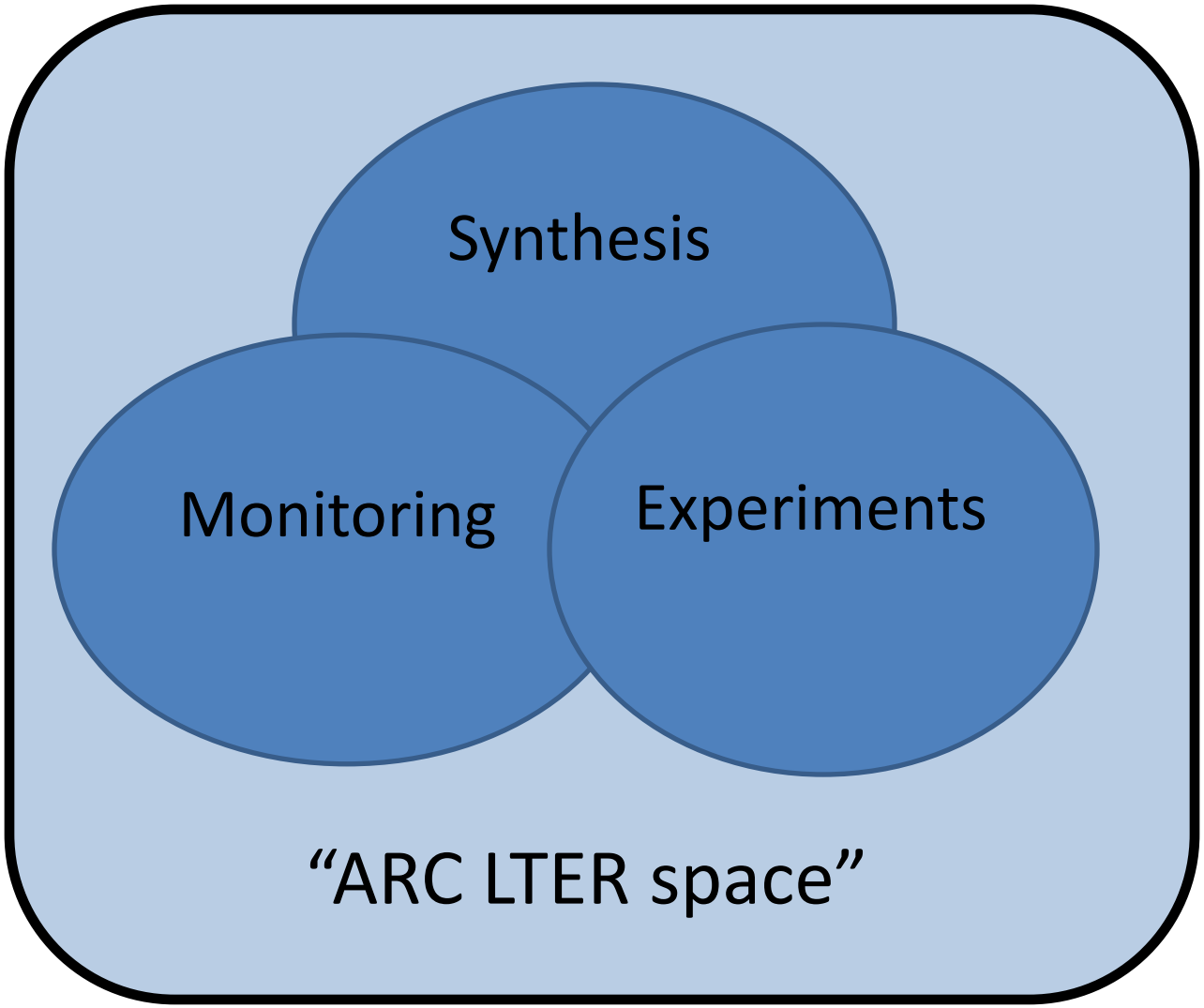


Fig 2-3. Conceptual Framework for 2011-2016. (see text for explanation).

How does it work?



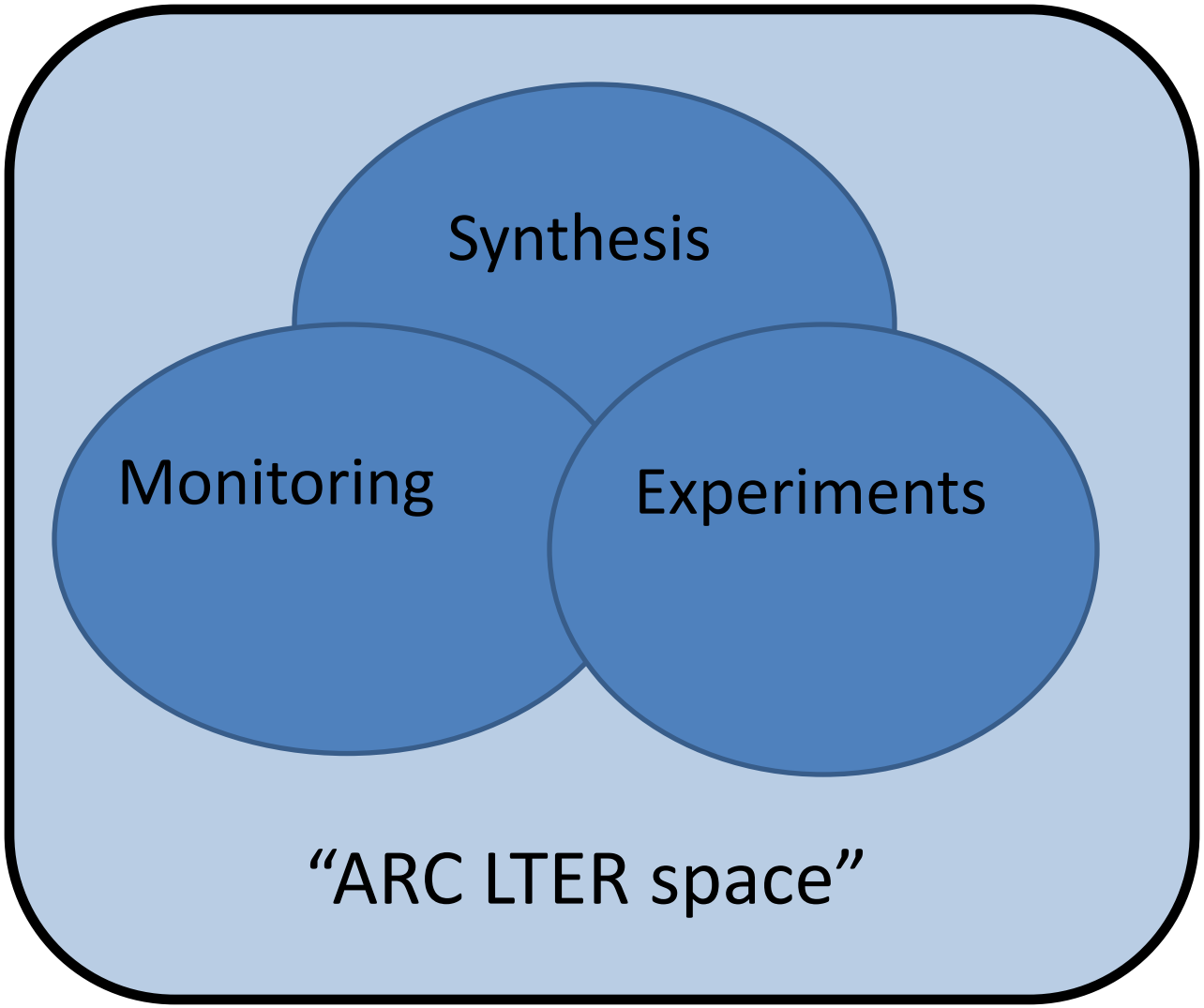
Importance of collaborations

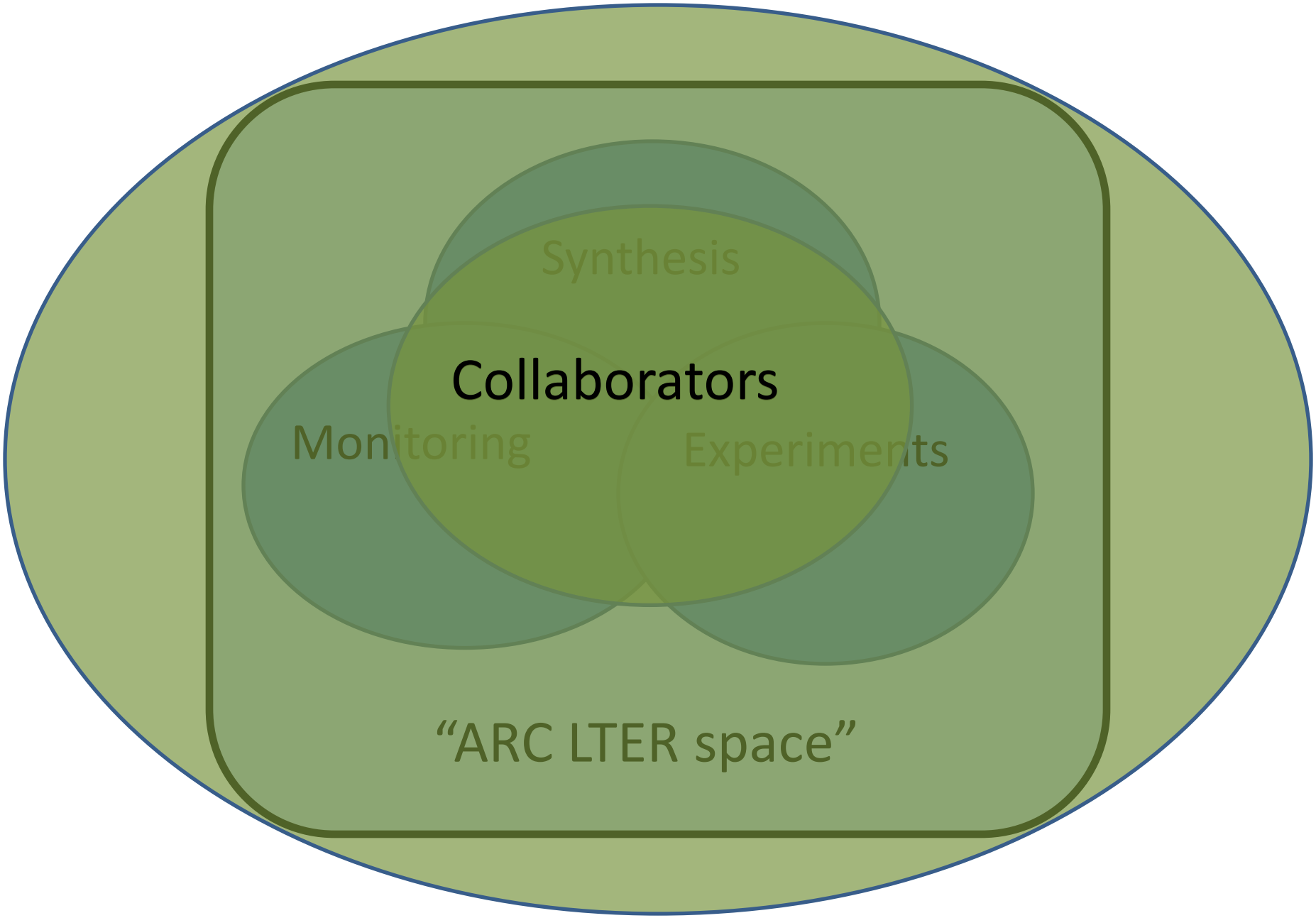
- Historic---close links to multiinvestigator Lakes, Landscapes projects
- Changes during LTER IV---large collab projects ended, growth of multiple small projects
- Current---trying to adjust; lay out new way of operating
- Benefits to all
- Importance of synthesis including collaborations

Importance of collaborations

- 35 collaborating projects in 2010 (start of current project)
- Annual budgets of collaborating projects collectively total $4-8M, for science “leverage” of 4-8 fold
- Virtually all of our “ARC LTER” publications acknowledge both LTER and other funding sources (especially NSF-OPP)
- Many of our collaborators are former students, postdocs
- Recruitment of new collaborators is a high priority
- Collaboration is currently the most important management challenge of ARC LTER

How does it work?




Synthesis
Collaborators
Monitoring
Experiments
“ARC LTER space”

How are we doing?

Back to the 6 core LTER network goals:

(1) Understanding: A long history of high-impact publications, continuing during ARC V

(2) Synthesis: Site synthesis volume *in press*; consistent productivity of within-site, cross-site/PanArctic, and Network syntheses

(3) Information: Well-documented data sets available and used, including many data sets credited to collaborating projects

(4) Legacies: Multiple long-term whole-ecosystem experiments and monitoring observations

(5) Education (and training/capacity development):

i. K-12 and Teacher involvement
ii. Undergraduate, graduate, postdoctoral, and New Investigator mentoring
iii. Science journalism program

(6) Outreach: National and international service on panels, advisory boards, editorial boards. New book on natural history of northern Alaska

Publications and Products

SUMMARY	Since Dec 2010	Since 1975
Total Journal Articles	**75**	**522**
Number of Unique Journals	*45*	*129*
Contributing Authors	*357*	*1012*
Total Books	**3**	**7**
Total Book chapters	**7**	**88**
Total Student works	**18**	**104**
Ph.D Theses	*5*	*32*
Masters Theses	*5*	*65*
Senior Research projects	*8*	*13*
Number of universities/colleges	*8*	*32*

Tomorrow morning:

Project management & logistics
Information Management
Education
Broader Impacts

Next: Research of the Arctic LTER

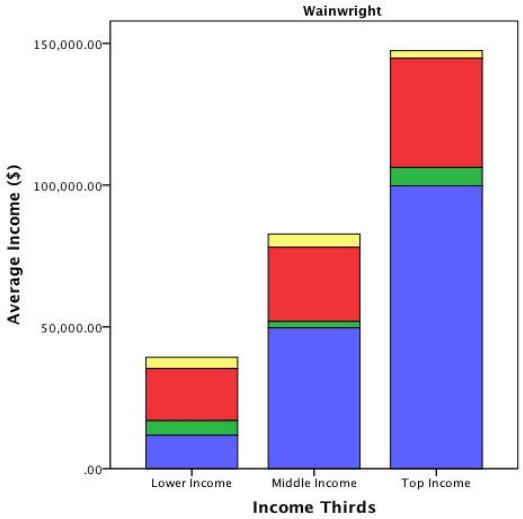
- Terrestrial ----Laura
- Land-Water---George
- Streams---Breck
- Lakes---Phaedra/Anne
- Synthesis---Gus

- In most of examples to follow most of the work and expense actually provided by collaborators but the work could not have been done without essential contributions from LTER---data, experiments, seed money, user days

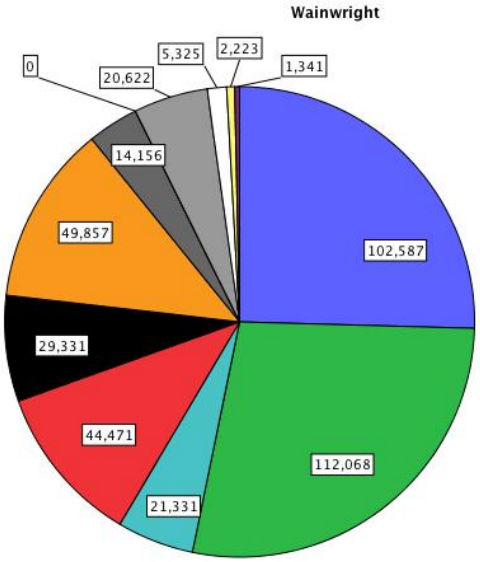
Social-Ecological Studies related to ARC LTER

- Mixed subsistence-cash economies
- Adaptation and adaptive Capacity

Mixed Subsistence-Cash Economies are important features of the Arctic's Social-Ecological Systems in Alaska

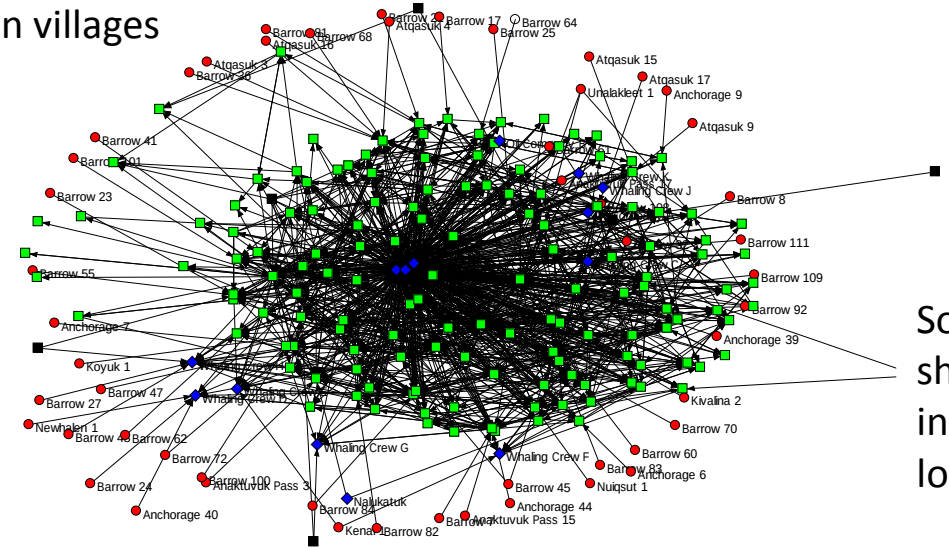


There is a diversity of HH cash inputs in villages



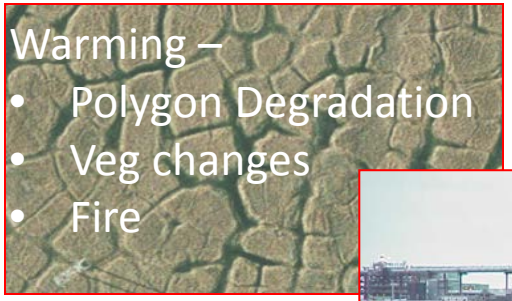
¾ of all inflows to HHs are from social relations (sharing, cooperative hunting); only ¼ from own harvesting

Sharing Project: Kofinas, BurnSilver, Magdanz



Social networks of sharing are extensive, including local and non-local HHs

How resilient are villages to changes in land cover, land use, and economies?



Changes in Ecosystem Services
(Infrastructure; Harvested resources; Access to hunting grounds)

Assessing Adaptive Capacity
Human capital; Technology; social organization; Institutional

Possible Village-level Transformations
Ecological Transformations: Δ in key species and mode of subsistence harvesting
Economic Transformations: Mixed to cash only based economy
Ethnic Transformation: Indigenous to a community of mixed ethnicity
Cultural Transformation: loss of indigenous spoken language
Settlement Transformation: Permanent -> to holiday settlements or unviable settlement

Method
- Participatory mapping
- Agent-based modeling
- Structured Decision making

ACE /EPSCoR
(Alaska Adapting to Changing Environments)

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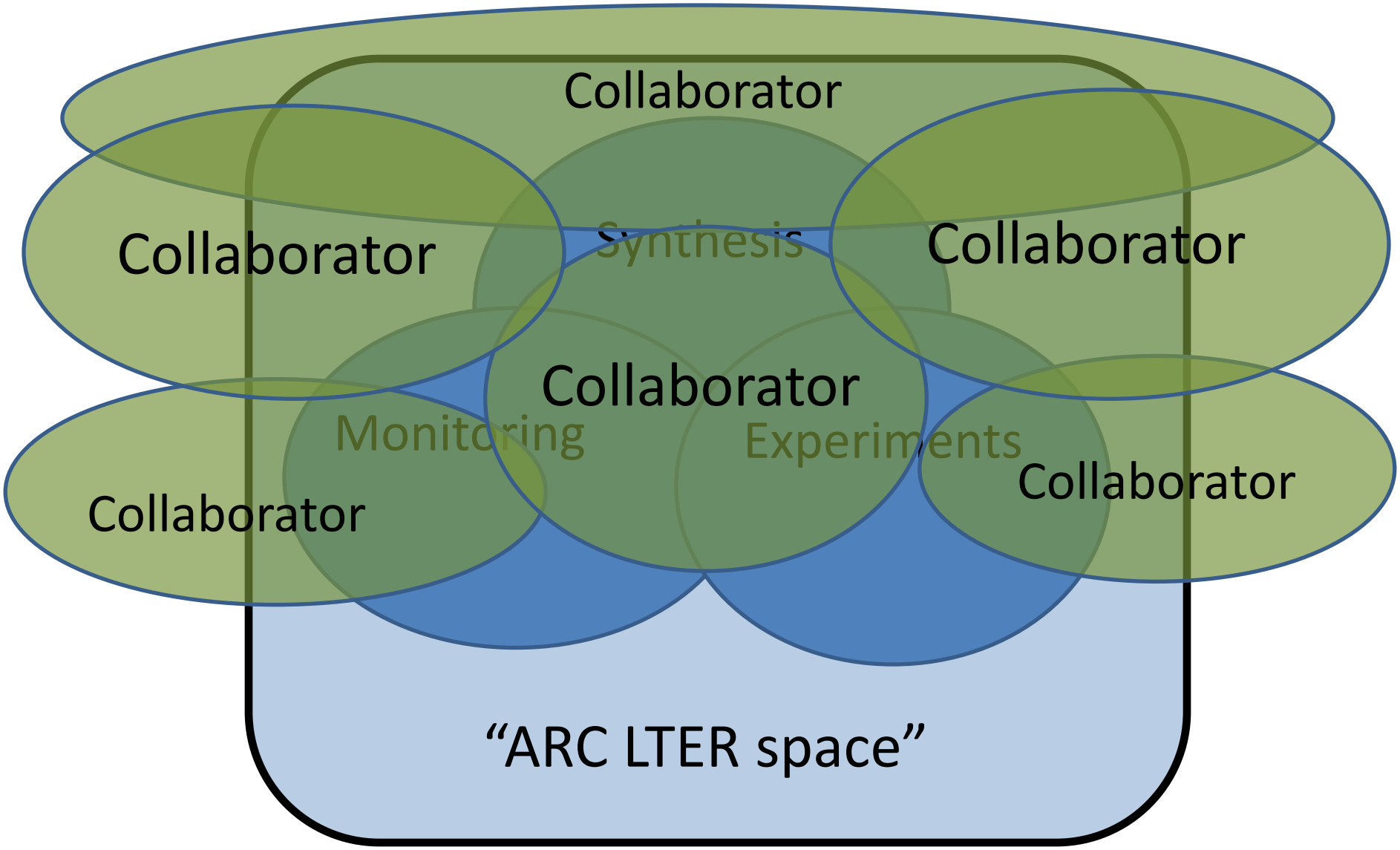
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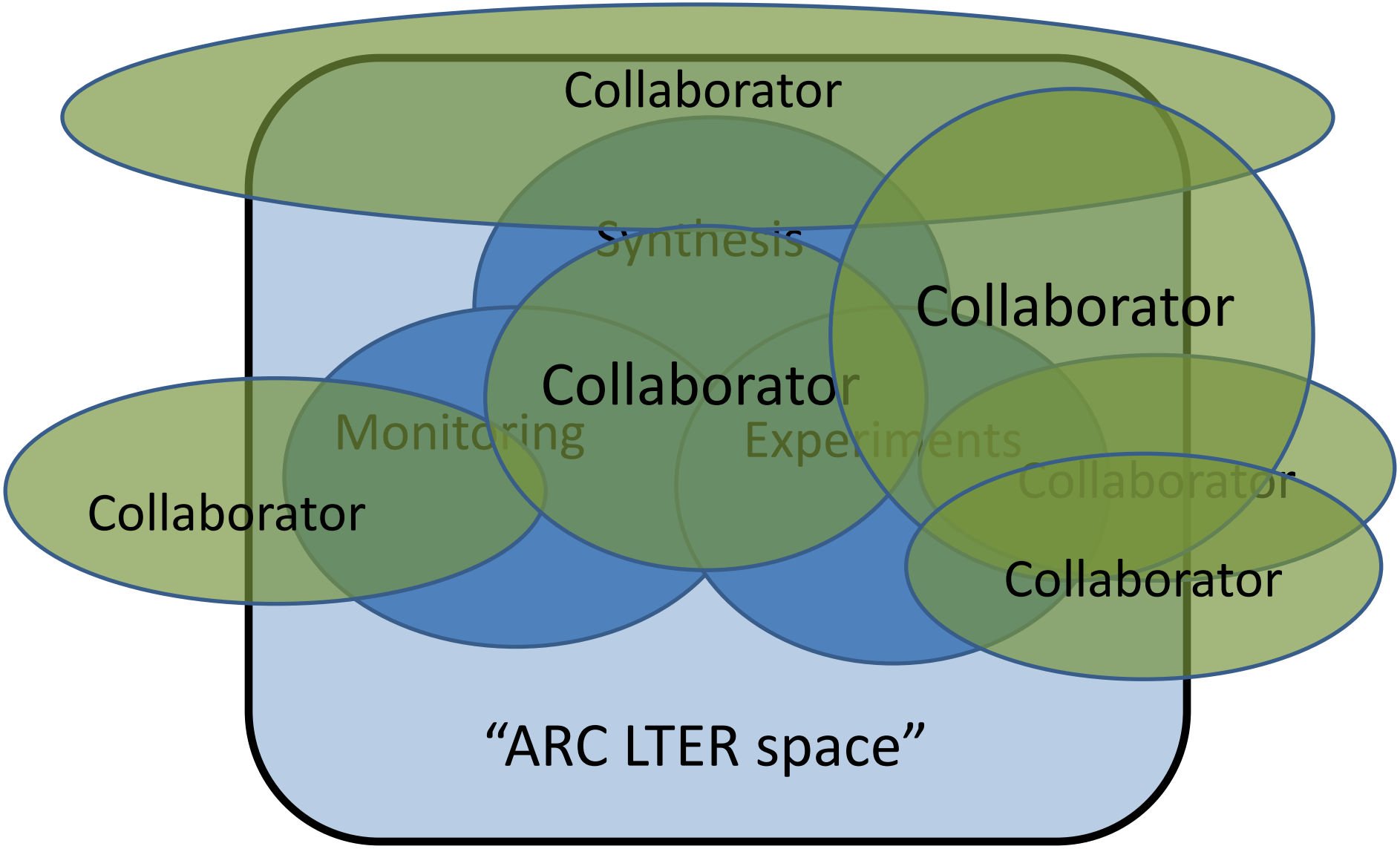
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How does it work?

Fig 2-1. Research of the ARC LTER involves multiple landscape components and processes. For management purposes the research is divided into terrestrial, lake, stream, and landscape interactions components. Here, this structure is shown against a background of the foothills and mountains at Toolik Lake (modified from U.S. Postal Stamp Series Nature of America # 5); examples of research by each component are in the boxes. In 2010-2016 we will add a fifth component, focused on subsistence land use and impacts of climate change and on Native communities.