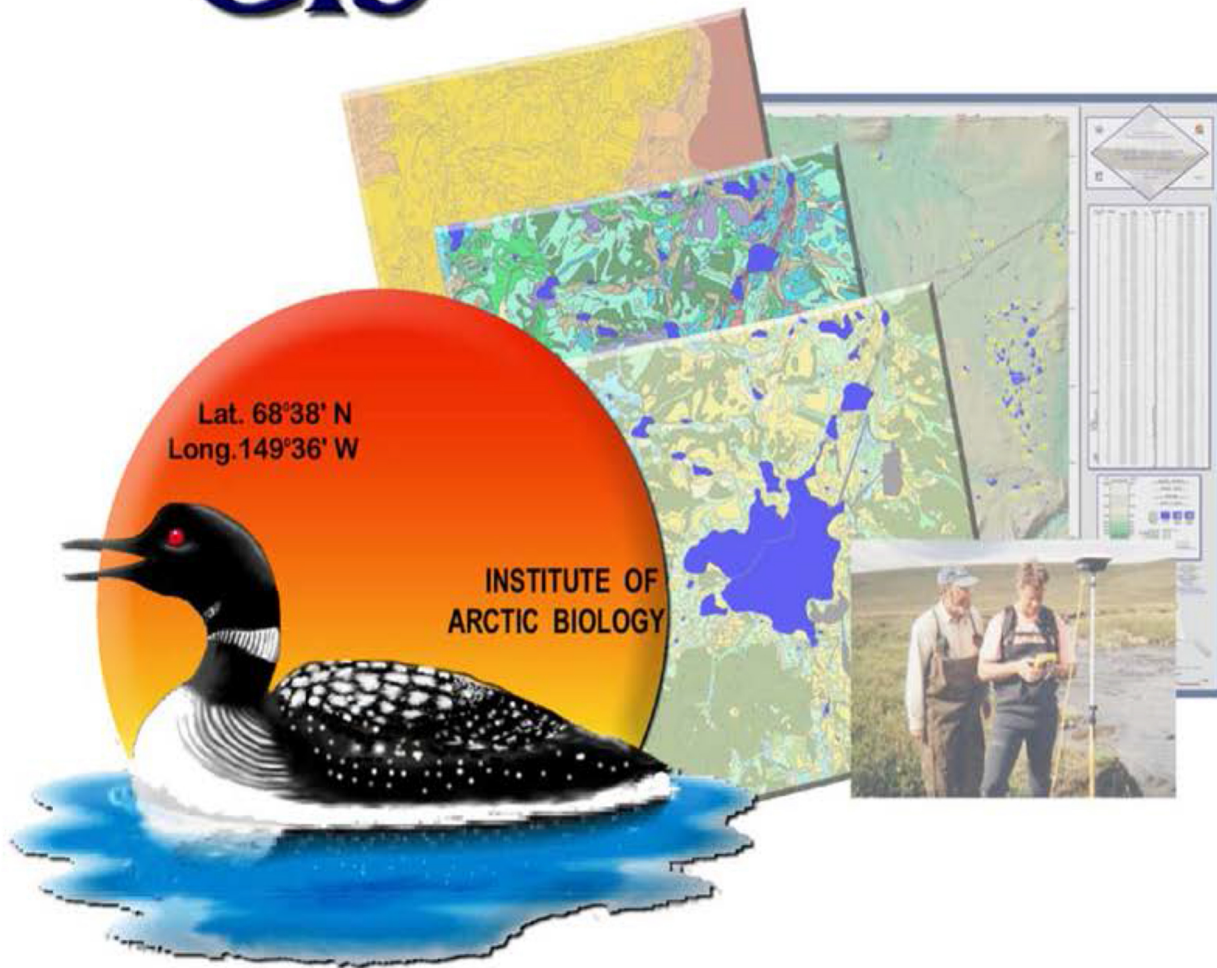# Toolik Field Station
GIS

Lat. 68°38' N
Long.149°36' W

INSTITUTE OF
ARCTIC BIOLOGY

Annual Report
2014

Jason Stuckey, GIS & Remote Sensing Manager
Institute of Arctic Biology
University of Alaska Fairbanks

EXECUTIVE SUMMARY

GIS Services 2013-2014

This past year, Toolik Field Station continued to provide its standard suite of GIS services which included: assisting researchers with site-selection requests, recording the location of new sampling sites, collecting survey-grade data, producing customized maps, and providing comprehensive project support and analysis. This past year, Toolik GIS fulfilled over 250 requests from researchers from thirty-three institutions. As in previous years, three staff members were onsite at the field station during peak periods of June and July, and two staff members were on hand the remaining time. With three GIS staff members onsite during peak periods, Toolik GIS was able to provide immediate turnaround for all time sensitive requests such as field maps, site coordinates, field GPS support, and GPS training. This year Toolik GIS provided field GPS support for 11 projects, and site selection assistance for an additional 11 research groups. Toolik GIS also completed 32 requests for spatial analyses. Highlights from this year include the processing and analyses of 8 years of Toolik River Thermokarst survey data, as well as the delineation and derivation of landscape characteristics for 7 research watersheds for Dr. Breck Bowden. For a second year, Toolik GIS assisted the BLM archaeologist with his aerial archaeological survey of the Toolik Research Natural Area in an effort to further refine high and low probability areas of cultural artifacts in support of the NSF-BLM MOU currently in development. The Toolik GIS website was updated with new maps, data, aerial photographs, and a beta online mapping service.

GIS Services 2014-2015

Toolik GIS will continue to provide on-site GIS and remote sensing services to support Toolik research and TFS administration and management. Direct support of individual projects includes field GPS data collection and analyses, data development and distribution, statistical summary, and production of figures for use in presentations and publications. Indirect support includes the upgrade and maintenance of GPS and GIS equipment and base stations, and the continued acquisition and integration of framework data into the GIS database. In order to remain up to date on the most current GIS and GPS software, techniques and equipment, Toolik GIS staff will attend the Alaska Mapping and Surveying Conference in March 2015. Toolik GIS will continue to reprocess historic aerial imagery to align correctly with the newly acquired 2013 aerial dataset. Toolik GIS will continue with our summer staffing level of 3 people, adjusting our work and overtime hours in response to user demand. Toolik GIS will maintain 2 staff members during the winter season to handle data maintenance, perform advanced GIS and remote sensing analyses, and produce custom maps for an ever increasing number of requests from scientists, state and federal land managers, and Toolik Management.

TOOLIK FIELD STATION GIS & REMOTE SENSING

SUMMARY

Toolik GIS continued to provide an array of services for Toolik research, administration and management. Direct support followed the model of previous years, and included a variety of requests, analyses, data development and distribution, statistical summary, and production of graphs, tables, maps, and figures for use in presentations, reports, and publications.

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DIRECT SUPPORT

Examples of direct support include one or more of the following major categories: 1) data development, 2) spatial analysis, 3) logistical support, 4) statistical summary and 5) production of maps/graphs/tables/figures for presentations/reports/publications. The following examples from this past year illustrate some typical examples.

Data Development and Spatial Analysis

For the last 8 years, Toolik GIS has annually surveyed the Toolik River Thermokarst by request of Dr. Breck Bowden in order to monitor the changes in and around the thermokarst. This spring Toolik GIS completed the processing and analyses of the entire 8 year dataset. Maps and graphs were created to illustrate the morphological change over time of the thermokarst feature (Figure 6.3.1). These products and results will form the basis of an AGU presentation this winter in addition to a possible publication. Toolik GIS staff will be listed as authors for both the AGU presentation and manuscript.

Landscape Characteristics

In support of a manuscript that Dr. Breck Bowden is working on, Toolik GIS performed a series of spatial analyses to delineate research watersheds and calculated metrics for a variety of landscape characteristics. Dr. Bowden requested this information to support his changing seasonality research on the biogeochemical dynamics in arctic streams. Products included a publication map (Figure 6.3.2) and a spreadsheet detailing landscape characteristics metrics.
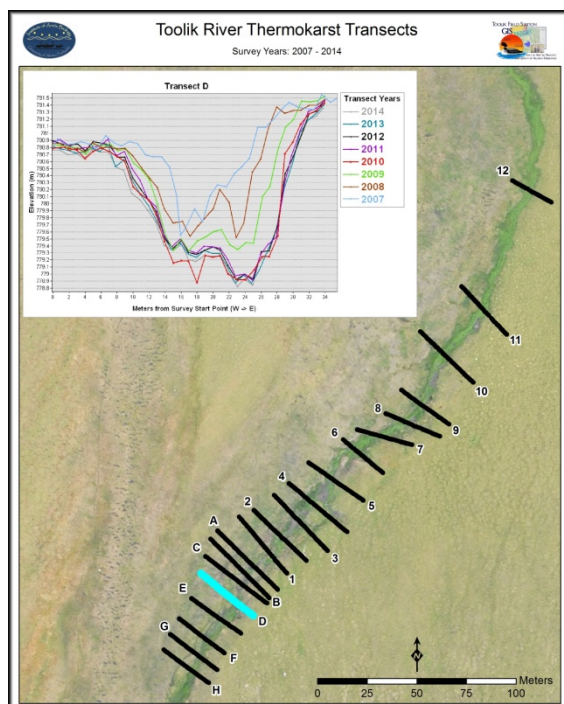

Figure 6.3.1: The blue transect corresponds to the inset graph which shows the morphological change over time of that transect.
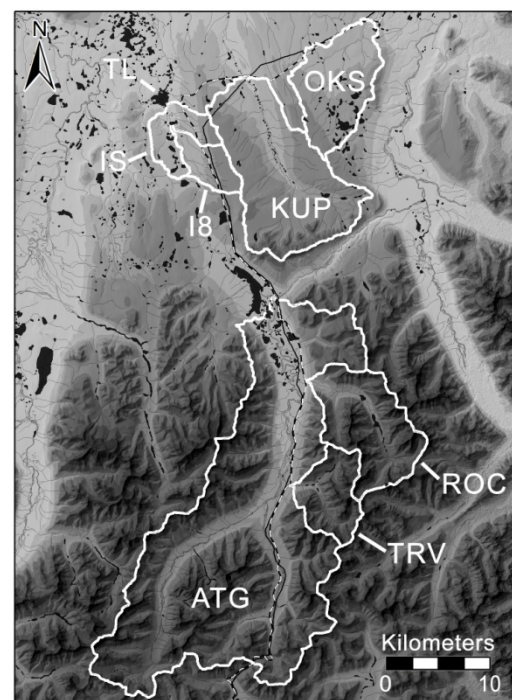

Figure 6.3.2: Publication map created for Dr. Breck Bowden showing the boundaries of the research watersheds delineated by Toolik GIS.

Summer Field Support

This year Toolik GIS provided field support for 11 different projects. One example of a project Toolik GIS supported was Dr. Beth Neilson's Hillslope Hydrology project. Toolik GIS collected ground control data at one of their research sites at Imnavait Creek at the beginning and end of the summer field season. Toolik GIS provided training and equipment to support Dr. Neilson's hydrology research on remote sections of the Kuparuk River. On two occasions one of our staff members accompanied Dr. Neilson's research team to help and oversee spatial data collection at these remote sites. In addition, bathymetric data was collected at 5 research pools at Imnavait Creek. Toolik GIS processed all of the spatial data from these three research areas, and delivered this data to Dr. Neilson by the end of the field season.

Site Selection Requests

During the spring and early summer of 2014, Toolik GIS provided site selection assistance to the following 11 research groups: Sue Natali, Julie Jastrow, Neon, Inc., Daniel Obrist, Kelsey Kremers, Ned Fetcher, Charlie Flowers, Carly Phillips, Josh Schimel, Ashley Asmus, and Case Preger. Over the last few years, an increasing portion of our time has been spent assisting new projects with identifying research locations.

Administration & Management

BLM Archaeological Aerial Survey

In support of the NSF-BLM MOU currently in development, Toolik GIS accompanied BLM archaeologist Bill Hedman on his aerial archaeological survey of the Toolik Research Natural Area, June 11-12. Toolik GIS recorded the GPS location of all the aerial photographs that Mr. Hedman took and georeferenced each photograph in our GIS software. Mr. Hedman will use these photographs along with other GIS data layers to begin identifying those areas within the Toolik RNA that have a high probability of containing archaeological artifacts. This work will be used to complete the first draft of the MOU.

Upgrades to Common Use Boardwalk

Toolik GIS has continued to collaborate and work with CPS staff to identify and prioritize common use boardwalk in need of replacement or repair. To date, all of the common use boardwalk south of camp is now in good condition. This is the result of four years of effort by GIS and CPS staff. Plans for next year will focus on repairing common use boardwalks at Imnavait Creek.

Boardwalk Permitting

Over the past year, Toolik GIS has worked with CPS staff and scientists to identify the ownership of existing boardwalks. Once ownership was determined, our staff, along with input from the science community, helped CPS determine which sections should be transferred to their

BLM permit for common use boardwalk. In support of this effort, Toolik GIS has created five maps identifying boardwalk ownership and associated lengths.

Maps in Support of Toolik Management

Over the past year, Toolik GIS created the following maps in support of Toolik Management:

- **Toolik Research Natural Area Expansion Map:** Toolik GIS, in consultation with the Toolik Management Team and the research community, created a map showing the proposed expansion of the Toolik Research Natural Area (Figure 6.3.3). This map was submitted to the BLM during the public comment period as part of BLM's Central Yukon Resource Management Plan now under development.

- **Dalton Highway Oil Spill Map:** In response to researchers' concern about the location of an oil truck spill on the Dalton Highway north of the field station, Toolik GIS created a map which was distributed to the research community showing the location of the spill (Figure 6.3.4).

- **Preliminary Siting of USDA Trailers:** In preparation for the delivery of the two USDA trailers donated to the field station, Toolik GIS assisted Toolik Management with the preliminary siting and location of the trailers.

- **BLM Lease Map:** Toolik GIS created a series of maps in support of Toolik Management efforts to expand the BLM lease area for the field station.
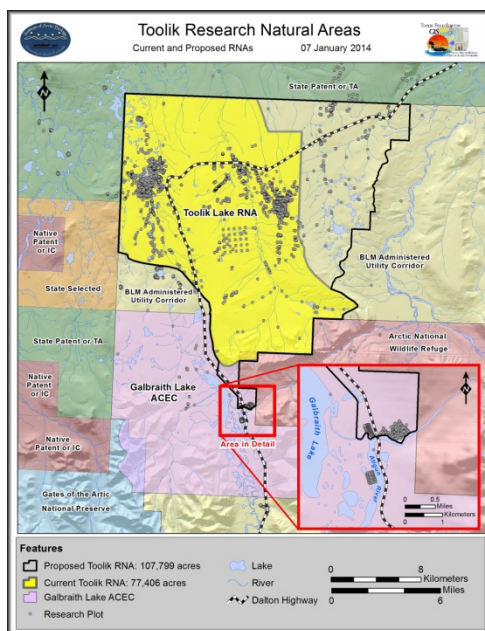

Figure 6.3.3: Map showing the proposed expansion to the Toolik Natural Research Area.
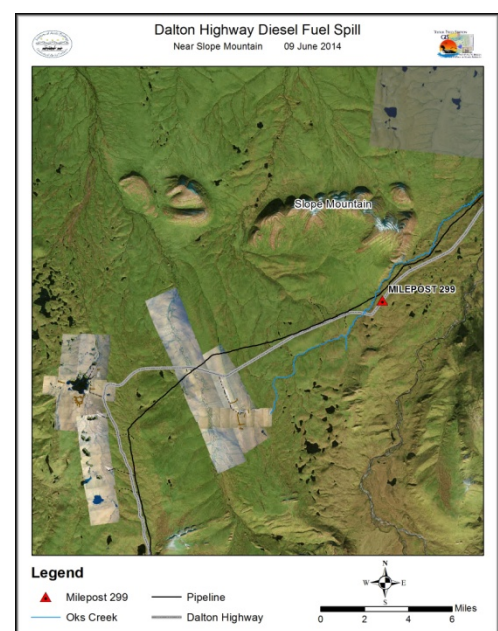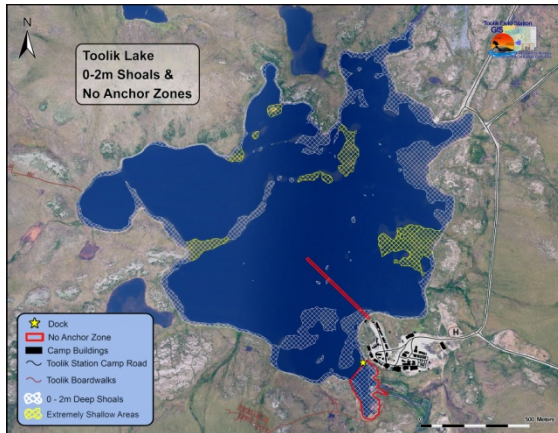

Figure 6.3.4: Map showing the location of the oil spill along the Dalton Highway.

- **Shoals and No Anchor Zones for Toolik Lake:** In order to inform Toolik boat users and to promote safety, Toolik GIS created a map identifying no anchor zones and shallow areas in the lake to avoid (Figure 6.3.5).

Figure 6.3.5: Map showing the no anchor zones and shallow areas hazardous to boats.

INDIRECT SUPPORT

In order to remain responsive to Toolik-user requests, Toolik GIS must pay substantial attention to the continued acquisition, ingest and maintenance of primary framework data, and to the update and expansion of critical infrastructure - primarily equipment. Below are some examples of Toolik GIS activities/involvement that do not address any one project in particular, but instead maintain the program's ability to remain current, responsive, well-informed, and efficient.

Updated Toolik GIS Website

Over the past year, the following updates have been made to the Toolik GIS website:

- A Bathymetric Catalog containing 48 new bathymetric maps and hypsographic curves has been added.
- Various resolution DEMs, and high resolution orthophotos from 2013 are now available.
- A new online mapping service is available via the homepage, which replaces the outdated and no longer supported Toolik Map Engine.

Equipment Upgrades

This year Toolik GIS added two new handheld GPS units to our fleet of units available to scientists for check-out.

High-Resolution Digital Elevation Models

High-resolution digital elevation models (DEMs) have been in high demand since 2007. It is only now that Toolik GIS has been able to acquire and make these products available to the research community. Through a Memorandum of Understanding (MOU) with Dr. Lee Vierling, Toolik GIS was able to obtain a high-resolution elevation dataset covering the research area south of the field station in return for the extensive field support Toolik GIS conducted for their project. From this dataset Toolik GIS can create a variety of different products for researchers such as DEMs, hillshades, and contours. In addition to the Vierling dataset, Toolik GIS was able to generate additional high-resolution DEMs from the 2013 aerial photo dataset collected by Dr. Jessie Cherry the previous year. These datasets are being made available to researchers upon request.

CONFERENCES & TRAININGS

2014 Alaska Mapping and Surveying Conference

During the spring of 2014, Toolik GIS staff attended the 2014 Alaska Mapping and Surveying Conference. While at the conference, Toolik GIS staff expanded their knowledge of new geodetic models by better understanding their spatial accuracy limitations, and how that applies to GIS work at the field station. A 1-day GIS Programming class was attended where Toolik GIS staff learned how to use ESRI's ArcPython to automate repetitive tasks in order to improve efficiencies.

PROGRAM PLAN 2014-2015

Training and Conferences

Remaining up to date with the most current software, techniques and equipment is important for the GIS program in order to offer the best available services to the Toolik research community. To accomplish this, Toolik GIS staff will attend the 2015 Alaska Mapping & Surveying Conference. At this conference, GIS professionals will meet and discuss the latest developments and practices related to GIS mapping and GPS surveying. In addition, Toolik GIS staff will take advantage of the various technical training courses this conference offers.

Reprocess Historic Aerial Imagery

Our historic aerial imagery has a significant offset from the 2013 aerial imagery due to limitations in the processing software used at that time. Toolik GIS will continue to reprocess the historic imagery to improve alignment and minimize offsets.

LONG-TERM PROGRAM PLAN

The long-term program plan for the Toolik GIS Department is as follows:

- **Upgrade Survey GPS Equipment:** Researchers regularly ask Toolik GIS to collect spatial data of the highest possible accuracy. Our current survey GPS equipment, on loan to us from UNAVCO, is over 10 years old. This equipment cannot take advantage of new GPS satellites which are regularly put into orbit and made available to the newest GPS units. Therefore, it will be essential to upgrade our survey GPS equipment in the near future to take advantage of new satellites and advancements in GPS technology that would allow us to collect spatial data with greater accuracy. Next year Toolik GIS will contact UNAVCO to begin discussions on a plan to replace our current outdated equipment with more modern equipment.

- **Online Web Mapping Services:** The GIS industry, with existing technologies, can now deliver real-time data to people in the field utilizing extended wireless networks, and GIS servers. With the addition of new GIS server technology, combined with the planned Toolik Mesh-Net wireless system, Toolik researchers could access real-time maps and GIS data in the field using their own smart device (iPhone, iPad, etc.). This would enable researchers to reference valuable spatially explicit scientific datasets (e.g. glacial geology, vegetation, geomorphology, etc.) relative to their current location in the field. Toolik GIS will continue to monitor developments in this field, and present this information to Toolik researchers to show how the application of this technology could benefit their research.

- **Unmanned Aerial Systems (UAS):** Toolik GIS will stay abreast of developments in the field of unmanned aerial systems and their associated FAA regulations. This growing field will open up endless opportunities for high-resolution, near real-time data collection with the capability for frequent repeat observations, all at a cost substantially lower than currently available systems. This technology would enable us to provide researchers the high-resolution, high-frequency data (e.g. aerial imagery, NDVI, snow cover, elevation models, etc.) that researchers have been wanting for years.

LIST OF PRIMARY SERVICES

Year Round Services

Map reproduction and distribution
Custom cartography/figures
- Hardcopy maps
- PowerPoint figures
- Publication figures

Data and metadata distribution
Custom data development
Simple metrics
- Coordinate locations
- Estimates of area, distance
- Landscape characteristics
- Presence/absence/number of specific features

Custom analyses
- Site selection
- Landscape characteristics
- Synthesis of field data with spatial data
- Modeling
- Data manipulation

Project Level Support
- Scoping
- Proposal help
- Analysis & data development
- Written & Verbal presentation

Field Season Services (additional to Year Round Services)

GPS equipment available to Toolik users
- Post-processed (code and carrier phase; to sub-meter precision)
- RTK (real-time kinematic) processed (to sub-meter in real-time)

GPS technical training (informal)
GPS field work/consultation
- Mission planning
- Data collection
- Post-processing
- Data manipulation
- Data distribution and archiving

Assistance for site location and landscape/permit management
Assistance for field planning and last-minute adjustment
Spatial data support for aircraft-based work (helicopter and small fixed-wing)

PEOPLE & INSTITUTIONS SERVED

PI/Administrator/Group	Affiliation	Daily Request (<5 days)	Larger Request (>5 days)
Abbot, Ben	UAF	X	
ACUASI	UAF	X	X
Asmus, Ashley*	Univ. of Texas at Arlington	X	
Barnes, Brian*	UAF	X	
Boelman, Natalie*	Columbia University	Y	
Bowden, Breck*	Univ. of Vermont	Y	Y
Bret-Harte, Donie*	UAF	Y	
Budy, Phaedra*	MBL	Y	
Cory, Rose	Univ. of Michigan	X	
Neely, Annelisa	CPS	Y	
Dalton, Jenny	Univ. of Chicago	Y	
Deegan, Linda*	MBL	X	
Dimova, Natasha	Univ. of Alabama	X	
Dorrepaal, Ellen*	Umeå University, Sweden, Abisko	Y	
Environmental Data Center*	TFS	Y	
Euskirchen, Eugenie	AUF	Y	
Fetcher, Ned*	Wilkes University	Y	
Flower, Charlie	Univ. of Illinois at Chicago	Y	
Giblin, Anne*	MBL	Y	
Godsey, Sarah*	Idaho State University	Y	
Greaves, Heather	Univ. of Idaho	Y	
Harms, Tamara*	UAF	Y	
Hedman, Bill	BLM	Y	
Jastrow, Julie	Argonne National Laboratory	Y	

* indicates a group (PI s, research assistants, students, post-docs, staff)
X indicates single request
Y indicates multiple requests

PI/Administrator/Group	Affiliation	Daily Request (<5 days)	Larger Request (>5 days)
Kane, Doug*	UAF	X	
Kling, George*	Univ. of Michigan	Y	
Koltz, Amanda	Duke University	X	
LaBelle, Jim	Dartmouth	X	
Laundre, Jim	MBL	Y	
Longo, Will	Brown University	Y	
MacIntyre, Sally	USCB	Y	
Natalie, Sue	MBL	Y	
Neilson, Beth*	Utah State University	Y	Y
Oberbauer, Steve*	FIU	Y	
Obrist, Daniel	Desert Research Institute	Y	
Paytan, Adina*	UC Santa Cruz	Y	
Phillips, Carly	Univ. of Georgia	Y	
Ray, Peter	UAF	X	
Rocha, Adrian*	Univ. of Notre Dame	Y	
Rowe, Rebecca*	Univ. of New Hampshire	Y	
Schaefer, Kevin	UCB	X	
Schimel, Josh	USCB	X	
Shaver, Gus*	MBL	Y	
Springer, Yuri	NEON, Inc.	Y	
Timm, Jeb	TFS	Y	
Toolik Management	TFS	Y	
Tweedie, Craig*	UTEP	Y	
Vierling, Lee*	Univ. of Idaho	Y	
Walker, Skip*	UAF	Y	
Wallenstein, Matt*	Colorado State Univ.	Y	
Weintraub, Mike	Univ. of Toledo	X	
Welker, Jeff	UAA	X	

* indicates a group (PI s, research assistants, students, post-docs, staff)
X indicates single request
Y indicates multiple requests

	Science Support Requests		Management Support Requests		Data Development		Computer /Network Support
	Daily	Larger	Daily	Larger	Framework	Project Specific	
Field Season	50%	<25%	5%	0%	10%	<5%	<5%
Rest of Year	40%	<5%	10%	10%	20%	15%	<5%

Request Category	# Requests Filled
GPS Training	21
GPS Use	59
GPS Survey Data Collection and Analysis	28
Site Map w/ Coordinates	24
Consultation/Site Selection/ Permit Assistance	46
Stock Maps	9
Custom Maps/Posters	34
GIS/RS Analysis	32
Total	**253**