Field material list for SCALER experiment (one biome, one year) (alphabetical)

1 L volumetric cylinders
100% Formalin (1L)
12 mL pre-evacuated Exetainers (30x; if gas extraction in the field)
12 v battery
125 mL sample bottles (acid-washed Nalgene: 110)
140 mL Piston Syringes (3x, if gas extration inthe field)
250 µm sieve (2x)
250 mL sample bottles (FBOM: 60, potentially reusable depending on processing time)
250 mL sampling bottles (optional, 30x per release)
30 mL sample bottles (acid-washed Nalgene: minimum 250)
4 L marked bucket
40 mL glass scint vial (10 per plateau) OR vacutainers/exetainers (88 per site)
4ft ½ in rebar (18x for DO and Light probes; 24 for patch exclosures; ~100 for all fences)
50 mL Conical Centrifuge Tube (40x, if gas extraction in the field)
500 mL Nalgene bottles (50x, resuse possible depending on sample processing)
60 mL Nalgene bottle (Stoich: 120; waterchem: 60; 30 acid-washed Nalgene per pulse: ~18 pulses = 540)
60 mL Nalgene bottles (for voucher specimen)
60 mL Piston Syringe (3x, if gas extration in the field)
7 L marked bucket
Aerators/bubblers
Ammonium stock solution for chamber uptake (3 mL per 10 L to increase to a minimum of 25 ug/L NH4-N but generally 3x background concentration)
Aquarium net
Auto-level (24x) & Tripod OR clöinometer OR cell phone app
Backpack electroshocker
Battery
Black window screen large enough to cover a chamber (5x)
Bucket to collect and mix substrates
Buckets to keep macro-consumers
Bull’s eye level
Chamber tools and spare parts (Allen wrenches, screw drivers, duct tape, assortment of screws etc., supplied with chamber)
Compass
Conductance meter or Bromide meter
Conductivity meter, ion-specific probe, or fluorometer
Cooler with ice
Core sampler: bottomless 5 Gallon Bucket with 4mL poly plastic skirt
Dip nets
Electrical boxes for chambers (7x, one as reserve/backup)
Exclosure wood frame: wood pieces (W×H×L 0.5×0.5×19 in.): 24x 20.5” pieces and 96x 19” pieces
Fabric chamber covers (7x, one as reserve/backup)
Fencing (3ft high, 200ft long for patch exclosures, 4 ft high, 300 ft long for fences, depending on stream width)
Filter apparatus (GFF, Zefon type filters)

Filters (GFF from Zefon)
Flow meter (optional)
Forceps
Funnel
GPS
Graduated cylinder
Gravelometer OR Ruler
Injection solutions for plateaus and/or pulses (i.e., appropriate amounts of NH_4Cl and conservative tracer – Cl or Br)
Label paper
Loeb sampler with brush
Mallet or sledgehammer
Measuring boards for macro-consumers
Mesh lining for strawberry baskets (if deemed necessary)
Meter stick
Meter tape OR Range finder
Metering pump and tubing
Minnow traps and bait
Multiparameter sonde (use YSI ProODO for temperature)
Multiple airtight solution bags fitted with tubing and stopcock ranging in volume from 10 to 80 L
Neoprene template (4.9 cm^2 area) and toothbrush for chla sampling
Notebook
Odyssey irradiance meters (minimum 12x; more depending on overlap of deployment)
Open-topped bucket/garbage can/carboy/release container for mixing/pouring release solutions
Pencil
Recirculating chambers (7x, one as reserve/backup)
Salt or dye solution (can be mixed quantitatively in field with stream water)
Sample syringe(s)
Seine
SF_6 gas
Shovels
Small plastic ruler
Small PVC cylinder (4.9 cm^2 area) and a thin, stainless steel, non-slotted spatula (chla soft substrates)
Spherical densiometer
Squirt bottle
Stainless steel brushes
Staple gun and staples
Stopwatch
Strawberry baskets (W ×L×H 10×10×6 cm): 80 per experimental site for patches, 32 for reaches (total 336) in 2013; 50 in 2014
Syringe Luer Lock
Test tube racks for organizing vacutainers/exetainers (2x, if using vacutainers)
Thermometer
Turkey baster
Two-Way Luer-Lock Stop Cocks (3x, if gas extraction in the field)
Vacutainer needle holders (4x, if gas pulse method)
Waders
Whirlpacks (CBOM: 60; Inverts: 96; chla (if whole-rock: 96; Stoichiometry: 48)
White tray

Wire clippers/cutters or heavy duty scissors
YSI ProODO meters with extended battery compartment (minimum 12x; more depending on overlap of deployment)
Zip ties (the more the better J, 100s)

Table detailing corrections used for chlorophyll a values based on Parker et al. 2016.

Biome	Instrument Used	Solvent	Volume of Sample (mL)	Acid Concentration (mol HCl L-1)	Volume of Acid (mL)	Post-Acidification Sample Acid Conc. (mol HCl L-1)	Post-Acidification Read Time	Correction Equation
AND	Spectrophotometer	95% Ethanol	3				n/a	$Chla\ (mg\ m^{-2}) = 0.008 + (Chla_{90s} * 1.260)$
ARC	Spectrophotometer	95% Ethanol	3	0.10	0.03	0.001	90 s	$Chla\ (mg\ m^{-2}) = 0.139 + (Chla_{90s} * 4.926)$
AUS	Spectrophotometer	90% Acetone	3				n/a	n/a
CPC	Spectrophotometer	95% Ethanol	3	0.10	0.10	0.003	90 s	Chla (mg m-2) = 0.008 +(Chla90s * 1.260)
CWT	Spectrophotometer	95% Ethanol	3	0.10	0.10	0.003	90 s	Chla (mg m-2) = 0.008 +(Chla90s * 1.260)
KNZ	Fluorometer	95% Ethanol	3	0.10	0.10	0.003	n/a	Chla (mg m-2) = 0.008 +(Chla90s * 1.260)
LUQ	Spectrophotometer	95% Ethanol	3	0.10	0.03	0.001	90 s	Chla (mg m-2) = 0.139 +(Chla90s * 4.926)

SCALER Project **December 2013**
2014 Consumer Field Planning

This document will be a working document to discuss the consumer experimental design for the 2014 field season. We were tasked by Walter to consider the following three questions:

- **What is each biome planning on doing?**
- **Why are you doing it?**
- **Where do opportunities exist for comparison amongst biomes?**

NOVEMBER MEETING NOTES

KNZ:

- Continue with SCALER methods for Kings Creek at least – patch and control and treatment reach – They already have two years
- May alter a little based on observations
- Increase electricity to streams
- Also use extra invert measurements to get production from inverts
- Could do a cross site comparison with increased patches if other sites wanted to

LUQ:

- Focus on heterogeneity in river networks – natural gradient in consumer community
- Get better measurements of community throughout drainage network – specifically shrimp and fish
- Use patches and sites with strong consumer gradients to test responses along natural gradient to find threshold where shrimp matter for metabolism
- This may depend on basal resources in patches and may not be able to see effect within reach
- So will do patch enclosures along natural gradient, but no reach enclosures.
- Could do a spatial extrapolation of consumer effect within stream network based on observed community shifts along drainage network
- Bill – more synoptic sampling – i.e., increase number of intensive sites OR redo patch-scale manipulation along natural gradient – Don't have enough resources to do both…
- Natural gradient would take advantage of water fall break and effect on consumer.
- Patches (at least with electric exclosure) show some obvious changes in benthic OM; but we don't know if it changes with metabolism.
- Patches upstream of waterfall would control for underlying geology/geomorphology.
- Lauren – Should have time to do both as long as reach-scale enclosures are eliminated…

CWT:

- Focus on enclosures rather than exclusion.
- Focus on two points in river network – small streams salamanders; large streams fish (Sculpins)
- Consumer titration – add gradient of consumer density to "reptariums" (large patch enclosures used previously for salamanders)
- Temporal sampling of chambers for basal resources, macroinverts, metabolism, nutrient uptake
- This allows us to test consumer-metabolism relationships over seasons and across time.
- We would take a time point of consumers to correspond with SCALER reach measurements.
- Mechanistically tie basal resources to trophic levels to metabolism
- Spatial extrapolation to small streams in the region and potential model simulations about how consumer extirpation / basal resources change might affect small stream ecosystems across larger scale
- Will also measure OM transport dynamics, so could scale this too - i.e, how much to headwater streams contribute to downstream OM transport under different scenarios.
- Maybe do representative replicates in all drainage networks in C Creek watershed.

- Could add in whole reach metabolism (two DO stations) when you sample patches.
- Mesh size to keep salamanders out allows "normal" macro invert communities; alters flow and CPOM inflow. We'll stock the enclosures with CPOM and measure FPOM. We could also put drift net upstream to measure what we're "not getting" in terms of CPOM.
- Use shading over patches to get light relationships for each chamber. Also manipulate temp with this method. KF: I have no recollection of this, or what it means… probably was an extra idea provided by Ford or Amy

CPC:

- Also talked about consumer enclosure density manipulations
- Use Sculpin to do this
- Have temporal variability in distribution of fishes – so want to define spatial variability at different times of year – one site over time and multiple sites over space (?)
- Will also have baskets (like North Carolina)
- Could have similar treatments for Sculpins for Alaska vs NC for a direct comparison; Kansas wants in on the enclosure action
- Below beaver dams are where the most Sculpin are – sub-reach and within network differences in density – hot spots and moments
- Synoptic sampling could also include a natural Sculpin – Grayling gradient (since not constrained by stream size by whole reach exclosures)

ARC:

- Better understand distribution of benthic inverts and fish within the stream network – stream network heterogeneous in geomorphology (lakes) and fish distributions.
- Synoptic sampling for communities, densities, biomass.
- Intensive sites – try to get a handle on secondary production; P:B ratio; basal resources; also focus on population estimates for fish because they are so patchy in their distributions (i.e., based on pool – riffle dynamics)
- Throughout watershed – measure present/absence of fish (are they really absent where we've never seen them?)
- No more reach exclosures – don't work here.
- Physical alteration of patches is a big deal for these streams; so, would also like to drop patch work here.
- Previous work has really focused on biological/physical effects of grayling…. What we don't have is a good understanding of where/when graylings are there.
- Previous work depleted grayling in some reaches and added up to 10X in other reaches in enriched and unenriched streams. No effects on Chl A or any other benthic macroinverts. Then looked at YOY in pools in nutrient enriched vs unenriched up to 40X ambient - saw no differences in Chl A… some effects on inverts and population dynamics (i.e., density dependent affect).
- Also very low fish production relative to benthic macro invert production, so we probably don't expect fish to be huge contribution.

Year 2 Data Collected Across Biomes

- Aeration at 6 intensive synoptics + 3 2013 experimental sites (now über synoptics)
- Nutrient uptake/TASCC at 6 intensive synoptics + 3 2013 experimental sites
- Whole-stream metabolism at 6 intensive synoptics (1 station?) + 3 2013 experimental sites (2 station). Preferably the aeration experiments are conducted while the ODO sondes are logging.
- 30-day strawberry basket incubations for chl a, FBOM, inverts, chambers at 6 intensive synoptics + 3 2013 experimental sites (? – maybe at least at 2013 experimental sites, then do this at as many sites as you can?)
- Reach-scale FBOM (sample 10 transects using corer) + chlorophyll a (sample 10 transects using appropriate chl. method based on rock size) at 6 intensive synoptics and 3 2013 experimental sites
- Water chemistry sampling + stream discharge measurements (preferably over 1-2 days)

YEAR 2 (2014) CONSUMER PLAN

KONZA

Our consumer plan will focus on 3 experimental approaches.

1. **Reach Scale Manipulation and Scaling-**
   We will continue with the 2013 reach and patch scale exclusion protocol in lower Kings Creek. This will be the third consecutive time that this protocol will be used in this reach and we believe that densities are high enough to detect an effect. We will include a control, patch, and treatment reach, with some differences in protocol and timing as previous years. Based on data from previous studies, and visual observations from previous years, we are proposing to shorten the experimental duration of the consumer exclusion to between 2-4 weeks. Previous studies on Konza suggest that consumer effects are most likely to occur with in this period (citation). We will place extra baskets (n=40) within the control reach 30 days prior to final measurements (d=0). These will be used to directly compare and model scaling within the control reach, and will be comparable to methods used at our other experimental sites. We will also set up fencing above and below the control reach at this time. Two weeks (approximately) prior to the final measurement date (d=14), we will set up the patch and consumer exclsusion reaches. Therefore, measurements from patch exclusions, and contol and treatment reaches will be taken at the same time as patch mesurements within the control reach (d=30).
2. **Patch Scale Consumer Stocking-**
   Fish-Downstream of the lower Kings Creek experimental site, we are proposing to conduct two patch scale fish and crayfish stocking experiments. Fish will be stocked in cages with a wood frame (x x) covered with 1/8 `` wire mesh (same size as reach and patch exclusion fencing). A total of 15 cages will be used with 3 treatments: control (no fish), 10 g/m2, and 20 g/m2 (n=5 per treatment). Both Central Stonerollers and Southern Redbelly Dace, the 2 dominat herbivores in this reach, will be included in each cage. Cages will be installed a few days before the beginning

of the SCALER experiment to allow for equilibration with the stream. Stocking will occur 2 weeks prior to final measuements (d=14) and will coincide with reach and patch exclusion experiments. Each cage will be filled with substrate representative of the stream, as well as 5 baskets. The same structural and functional measurements in the patch exclusion will be collected from baskets in the stocked cages (d=30).

Crayfish- This experiment will also occur downstream of the lower Kings Creek experimental reach. Crayfish will be stocked in plastic tubs used in previous crayfish stocking experiments on Konza. Each tub (x x) has mesh covered openings in the upstream and downstream ends to allow movement of flow. Lids for the tubs were cut out to allow light penetration to substrates, but covered with mesh to prevent tampering from racoons. A total of 10 tubs will be used with 2 treaments: control (no crayfish) and ambient crayfish densities (n=5 per treatment). Tubs will be installed a few days before the beginning of the SCALER experiment to allow for equilibration with the stream. Stocking will occur one week prior to final measurments (d=21, this time period is based off of previously collected data). Each tub will be filled with substrate representative of the stream, as well as 5 baskets. The same structural and functional measurements in the patch exclusion and fish stocking experiments will be collected from baskets in the stocked tubs (d=30).

3. **Patch Scale Consumer Exclusions-**
   In accordance with discussion at the Konza workshop in November, we will install 8 patch-scale exclusions within each reach at the two other experimental sites. This will be the primary consumer manipulation that can compared across the 5 different SCALER biomes. Upstream of each patch, we will place extra baskets in order to determine any potential cage effects and will be used for scaling related questions if an identifiable cage effect exists. Patches will be installed at the beginning of the SCALER experiment (d=0), with final measurements (same as 2013) approximately 30 days following.

LUQUILLO

2014 Experimental Approach

Due to permitting constraints, the 2014 field season will be shortened and will be focused on characterizing basal resources and rates of metabolism/nutrient uptake throughout the Rio Mameyes watershed. No consumer manipulations will be conducted in 2014. In March 2014 we aim to accomplish the following:

- Reaeration measurements at (6) intensive synoptics and (3) 2013 experimentals
- 30-day basket incubations at intensive synoptics and 2013 experimentals. Baskets measured for AFDM, chl. a, inverts, chamber metabolism & nutrient uptake
- Whole-stream nutrient uptake experiments at intensive synoptics and 2013 experimentals
- Whole-stream metabolism at intensive synoptics and 2013 experimentals (using Odyssey light loggers and ProODOs)
- Sample water chemistry and measure discharge at all synoptics and 2013 experimentals

Proposed Consumer Plan

SCALER Project **December 2013**
2014 Consumer Field Planning

We will investigate the role of consumers on ecosystem processes at Luquillo in January – February 2015.

In 2013, we experienced the following troubles with the reach-scale exclusions:

-Reach-scale exclusion fences were compromised during high flow events, when high CPOM export and high water lead the fences to overtop and diverted the water around the exclusion fence.

-Exclusion effectiveness. We are not confident that shrimp followed the assumptions of depletion sampling, specifically that the probability of capture remains constant across subsequent passes. We almost always detected fewer individual shrimp when using depletion sampling, but hypothesize that this is because of shrimp behavior of hiding in rock crevices after the first pass.

-Identifying mechanisms driven by specific consumer groups. In 2013 we attempted to exclude all large-bodied consumers, including fish, filter-feeding shrimp, shrimp grazers, and omnivorous shrimp. Doing so did not allow us to test the strength of the trophic cascade that likely exists in these tropical headwater streams, involving fish (mountain mullet and big mouth sleeper), (*Atya spp.*, *Xiphocaris spp.*, and *Macrobrachium spp.*), and benthic resources (benthic organic matter and benthic primary producers).

Luquillo will thus not perform the reach-scale consumer exclusions in winter 2015.

In 2013, we found no significant differences in benthic resource standing stocks between control/treatment reaches across the three experimental sites. We also found no significant differences in chlorophyll a or benthic organic matter standing stocks between open/closed patch treatments following the 30-day exclusions at our medium (E2) and large (E3) experimental sites. We did find, however, that the chlorophyll a standing stock was significantly lower in the open side of the patch compared to the side of the patch that was closed to consumers at our small experimental site (E1). A similar treatment effect was not detected for benthic organic matter at this site, however.

These results from 2013 were counterintuitive to our hypothesis that shrimp significantly alter benthic resource standing stocks at the patch and reach scales. This hypothesis was predicated on past work from the Luquillo LTER that reported shrimp alter the benthic sediment, algal biovolume, and fine benthic organic matter at the patch scale (Pringle et al. 1993; Pringle and Blake 1994), and leaf-litter decomposition and carbon/nitrogen release at the reach scale (Crowl et al. 2001). We hypothesize that the lack of treatment effect in our 2013 SCALER experiment was due to the natural densities of shrimp in the Bisley (SCALER) streams compared to the streams used in previous LTER studies, where higher densities of shrimp are found, suggesting a threshold shrimp density at which shrimp can alter the standing stock of food web resources and ecosystem process rates.

In 2015, we propose to focus on shrimp effects on benthic resource standing stocks and ecosystem process rates across a natural gradient in shrimp density. We aim to determine this density threshold by conducting patch-scale experiments at 3 LTER stream sites that span a natural gradient in shrimp density: the Rio Icacos (very few shrimp), the Rio Bisley (few to moderate shrimp densities), and the Rio Prieta (high shrimp densities). We will incubate baskets at the reach-scale (approximate n = 15) for 30 days at each stream site, after which the baskets will be analyzed for chlorophyll a, benthic organic matter, invertebrate taxa and biomass, and metabolism/nutrient uptake by chamber experiments. In addition, we will deploy 8 patch exclosures (sensu SCALER 2013) at each of these three study sites to experimentally test for consumer effects on benthic resource standing stocks and ecosystem process rates. We will use the results from the patch exclosure baskets to scale to our reach-level estimates of benthic food web resources and rates of metabolism and nutrient retention.

References

Crowl, T.A., W.H. McDowell, A.P. Covich, and S.L. Johnson. 2001. Freshwater shrimp effects on detrital processing and nutrients in a tropical headwater stream. Ecology 82: 775 – 783.

Pringle, C.M., G.A. Blake, A.P. Covich, K.M. Buzby, and A. Finley. 1993. Effects of omnivorous shrimp in a montane tropical stream: sediment removal, disturbance of sessile invertebrates and enhancement of understory algal biomass. Oecologia 93(1): 1 – 11.

Pringle, C.M., and G.A. Blake. 1994. Quantitative effects of Atyid shrimp (Decapoda: Atyidae) on the depositional environment in a tropical stream: use of electricity for experimental exclusion. Canadian Journal of Fisheries and Aquatic Sciences 51(6): 1443 – 1450.

COWEETA

Overview & Justification:

Based on the Spring 2013 exclusions, we realize the importance of overcoming the following obstacles:

- Effective ongoing exclusion of consumers. Reach-scale exclusion fences were continually challenged by high water and fast flows. As a result, fences were routinely overtopped and/or banks were undercut, allowing for potential passage of consumers into the treatment reach. We know that consumers were either reentering reaches, or not effectively removed initially, as a single pass of electroshocking was conducted every 10 days at each exclusion reach, and substantial biomass was removed each time. In addition, the SCALER removal method using electroshocking was not able to effectively remove salamander larvae. Combined with cold temperatures driving salamander larvae into inaccessible subsurface areas, we are not confident in the effectiveness of whole-reach exclusions.
- Pinpointing mechanisms driven by specific consumers. By attempting to exclude all large-bodied consumers, we were unable to pinpoint specific mechanisms through which different consumer species affected measured processes and pools. Since it is unlikely, barring catastrophic stream changes, that all large-bodied consumers will be lost from a stream, we feed it is important to pinpoint the role of dominant consumers, rather than the full community.

The Coweeta group proposes altering the consumer component of SCALER to focus on an *enclosure* of key consumers rather than an *exclosure* of all large-bodied consumers. This would provide the following benefits over the exclosure design attempted in spring 2013:

- **Decouple scaling experiment from consumer experiment.** The quality of data for whole-stream measures of metabolism and ammonium uptake was limited in part by short reach lengths and travel times. By using smaller consumer enclosures, rather than whole-reach exclosures and paired control reaches, we can increase the reach length used for whole-stream measurements.

- **Focus efforts at each stream size on consumers that are likely to have the biggest effects.** This will occur by using the enclosures to examine the effects of the dominant consumer in the reach, based on biomass collected during electroshocking efforts in 2013.

- **Examine potential specific mechanisms through which consumers affect ecosystem rates.** With whole-reach exclosures, we are unable to pinpoint mechanisms driving consumer effects on whole-stream metabolism and ammonium uptake. By enclosing a known biomass

- **Understand how biomass of consumers alters consumer effects.** With a known biomass of consumers in each enclosure, we can assess ecosystem rates in terms of biomass-per-unit-area. Such rates can then be forward or back projected, to predict the effects of consumer loss as well as the historical role of consumers, given that current studies are looking at altered baselines of consumer biomass.

Detailed Consumer Plan:

In Coweeta streams, consumers are not evenly distributed throughout the drainage, with headwater sites dominated by larval salamanders (plus crayfish), while lower elevation, higher discharge sites are dominated by a few species of fishes. Despite differences in identity, most Coweeta consumers are insectivorous. Thus, in addition to examining whether consumers affect ecosystem respiration and ammonium uptake, we are interested in whether consumer identify affects its role in the stream.

Focal question:

How does a dominant consumer (by biomass) affect ecosystem process rates?

- Are the effects of dominant consumers the same across a stream network, when the dominant consumer varies based on location in the stream network?
- Are contemporary densities of dominant consumers sufficient to detect consumer effects on ecosystem processes?
- How would altered density of a dominant consumer (increase or decrease due to climate change, for example) affect ecosystem rates?

General Hypotheses:

- H_0: Dominant consumers do not affect ecosystem process rates.
- H_A: Dominant consumers affect ecosystem process rates.
    - H_1: Different species of consumers will exert the same type of effect on ecosystem processes.
    - H_2: Sculpin will exert greater effects on NEP, via consumption of grazing invertebrates, while salamanders will exert greater effects on NH_4 uptake, via consumption of shredding invertebrates.

The enclosure approach will utilize a "consumer titration", in that enclosure treatments will vary in their biomass per area of consumers, ranging from no consumers to X times ambient densities. Along this consumer biomass gradient, initial basal resource pool size will be standardized across treatments. This will allow us to assess how changes in consumer density affect carbon transport. To account for potential enclosure-driven alterations in hydrology, "ambient" baskets will be installed in the stream near the enclosures, and run for the same response metrics.

Since salamanders are the dominant consumer in headwater streams, enclosures at our smallest experimental site (i.e., Lick Branch) will examine how larval blackbelly (*Desmognathus quadramaculatus*) and Blue Ridge two-lined (*Eurycea wildeae*) salamanders affect stream processes. Based on Keitzer and Goforth (2013), it is important to include both salamander species because while *D. quadramaculaus* dominates the biomass of larval salamanders in the stream, abundance of *E. wilderae* can be comparable, and the two species feed on different invertebrate pools (larger-bodied and smaller-bodied, respectively). Thus, salamander "titrations" will vary both species in the same way along the consumer biomass gradient (i.e., if *D.q.* biomass is doubled, *E.w.* biomass will be doubled as well).

Only the highest discharge streams in Coweeta have fish (i.e., Coweeta Creek, Lower and Middle Ball Creek, Shope Fork, Cunningham Creek), and in these sites, mottled sculpin (*Cottus bairdii*) comprise a considerable amount of the biomass. As benthic-dwelling fish, we expect that mottled sculpin exert greater influence on ecosystem rates than pelagic fish (i.e., brook trout, longnose dace).

The target timing for enclosures is up to 60 days of consumer enclosure. Enclosures will be installed ~14 days prior to adding consumers, to allow for enclosures to more closely approximate ambient conditions. Timing of enclosure will vary by consumer type, with sculpin enclosures being in place during the late spring (~mid April - mid June), and salamander enclosures being deployed in early fall (~ early September – early November).

Measurement Metrics:
Ecosystem Rates (quantified via sets of 3 substrate-filled baskets)
- Chamber metabolism (ER and NEP)
- Ammonium uptake

Carbon Pool Sizes (quantified from baskets run in chambers)
- CBOM (biomass)
- FBOM (biomass)*
- Algal biofilm (biomass and chl-a)
- Benthic invertebrates (biomass and community structure)

* FBOM export from enclosures will also be assessed via capture ports on downstream side

Endpoints:
Measurements of NEP and NH_4 uptake that correspond to a gradient of consumer biomass density. This will allow us to predict if there are biomass thresholds to detect consumer effects, as well as model how stream process rates may change if consumer biomass density increases or decreases in the future.

Links to Other SCALER Sites:
- CPC (Christina) plans to do a sculpin enclosure experiment as well. Kait and Christina will collaborate on the design of these enclosures (i.e., relative densities of consumers, duration of deployment, metrics measured) with the goal of performing a comparison of ecosystem level effects between slimy sculpin (CPC) and mottled sculpin (CWT).
- Since KNZ will continue to utilize open/closed patches for measurement of NEP and NH_4 uptake, ecosystem rate measurements from CWT and KNZ "open" patches can be compared, along with the biomass and identity of consumers present.

CARIBOU POKER CREEK

2013 Overview & justification of changes in 2014
Based on the Spring 2013 exclusions, we realize the importance of overcoming the following obstacles:
- Reach scale exclusion were not effective due to increased stream flow during storms. It was also logistically impossible to keep fences cleaned at experimental sites, which crated altered hydrologic conditions and contributed to fence collapse.
- Only one site had fish both at the beginning and end of the experiment. This is largely due to natural gradients in fish density, but may also have been a result of fences blocking upstream migration of fishes.
- We did observe a patch scale increase in primary production with fish presence in riffle habitats, but we cannot express this as a per unit biomass effect because we do not have fish biomass measurements within patches.
- It would be valuable to know how fish density and biomass varies across the network, and this information could be coupled with per unit biomass effects of fish on metabolism and nutrient uptake to estimate effects of fish across the network.

SCALER Project **December 2013**
2014 Consumer Field Planning

The CPCRW group proposes to

- **Decouple scaling experiment from consumer experiment.** Scaling of ecosystem processes from habitat patch to reach will still be a focus at all experimental sites in 2014. However, fish manipulation will only occur at the habitat patch scale and will only be conducted in the largest discharge site.

- **Focus efforts at each stream size on consumers that are likely to have the biggest effects.** This will occur by using the enclosures to examine the effects of the dominant consumer in the reach, based on density estimates during trapping and electroshocking efforts in 2013. At CPCRW, sculpin were the dominant consumer in terms of density, and are the only species likely to have a direct effect on habitat patch processes.

- **Understand how biomass of consumers alters consumer effects.** With a known biomass of consumers in each enclosure, we can assess ecosystem rates in terms of biomass-per-unit-area. We will compare effects of low vs. high sculpin densities on metabolism and nutrient uptake.

- **Characterize fish distribution, relative density and biomass across the network.**

Detailed Consumer Plan:

Sculpin Experiment

Consumer densities vary within a site potentially due to barriers of movement, food availability and habitat preference. Among sites there exists a natural density gradient with higher densities occurring in down network sites and fewer fish occurring in up-network sites. To evaluate the influence of consumer density on ecosystem function we will manipulate fish densities and measure response of ecosystem metabolism and nutrient uptake at the habitat patch scale.

Sculpin enclosure experiments will be conducted in the Caribou Creek and/or Poker Creek mainstem. We will have three treatments replicated 6(?) times each. Treatments will consist of controls (no sculpin), ambient density (1 sculpin/m^2), and high density, (3 sculpin/m^2). Densities are based on 2013 sampling within the Caribou Creek mainstem.

Enclosures will cover a 1m^2 benthic area and will be built of a wooden frame enclosed in 6mm hardware cloth on all 4 sides and bottom. Baskets of benthic cobble, gravel and sand will be placed inside the enclosure and surrounded by additional benthic sediments. Enclosures will be left to naturally colonize with invertebrates and organic matter for a ~14-day period before fish are added. Fish will be held in enclosures for ~30 days.

We will characterize sculpin habitat preference within reaches by sampling with minnow traps at 6 sites within the network. 20 to 30 unbaited traps will be installed within each 100m reach for a 24 hour period.

Measurement Metrics**:**
Ecosystem Rates (quantified via sets of 3 substrate-filled baskets)

- Chamber metabolism (ER and NEP)
- Ammonium uptake
- Phosphorus uptake

Carbon Pool Sizes (quantified from baskets run in chambers)

- CBOM (biomass)
- FBOM (biomass)
- Algal biofilm (biomass and chl-a)
- Benthic invertebrates (biomass and community structure)

Network Fish Sampling

In streams that experience seasonal freeze thaw cycles, fish migrate downstream to escape freezing in the winter and upstream to forage or escape predation in the summer. If habitat and food requirements are met at downstream sites, fish may not continue migrating upstream. Alternatively, barriers or bifurcations may reduce movement into smaller streams. Thus, there exists a natural gradient in fish densities from highest at downstream sites and lowest at upstream sites. In CPCRW, the relative density of fishes throughout the network is unknown and the timing of highest density is unknown.

To compliment our enclosure study to examine effects of fish density on primary production and respiration, we also propose to sample fish throughout the Caribou-Poker Creek stream network to estimate relative density of fishes. This sampling will involve single pass electrofishing in ~100 m reaches at experimental and intensive synoptic sites Sampling will be conducted a few times over the course of the summer to ensure that we characterize fish distribution patterns at peak densities. Captured fish will be measured for length and a subset of fish will be measured and weighed to establish length-weight regressions.

TOOLIK

Overview and Justification:

Previous food web manipulation studies carried out on the North Slope of Alaska have indicated that top-down and bottom-up