VT Watershed Grant FY11 – Final Summary Report

Project Name: Thermal monitoring, habitat evaluation, and identification of management strategies for Lewis Creek watershed fish

Project Sponsor: Lewis Creek Association, 442 Lewis Creek Road, Charlotte, VT 05445

Project Location:

Lewis Creek watershed, Addison & Chittenden County towns of Ferrisburgh, Monkton, Bristol, Starksboro, Hinesburg, and Charlotte.

Project Description:

Lewis Creek Association (LCA), with help from South Mountain Research & Consulting (SMRC) and cooperating partners including Vermont Fish & Wildlife (VFW), US Fish & Wildlife (USFW) and VTDEC, has collected baseline data on thermal trends in the Lewis Creek watershed. Interpretive maps were created to evaluate temperature data alongside existing geomorphic, habitat, macroinvertebrate, hydrologic and water quality data to identify constraints to passage, spawning and rearing of various fish species on the main stem and major tributaries of Lewis Creek. The maps and temperature monitoring data have provided the basis for web site content which will be suitable for outreach to town officials and citizens residing in the watershed. LCA has shared the data with state and federal agency partners to inform discussions of management strategies for restoration and conservation of fish habitats in the Lewis Creek.

Work Plan Accomplishments:

a. Acquire temperature monitoring equipment and deploy:

LCA purchased five HOBO™ Water Temp Pro v2 data loggers, HOBOware Pro software, and a waterproof shuttle with couplers. These five HOBOs were deployed at stations in the Lewis Creek watershed from June to October 2011 (see Attachment 1). Each data logger was protected within a 12-inch long section of 1.5-inch diameter iron pipe (see Photo 1). At each station, the pipe containing the data logger was secured with zip-ties to either a piece of rebar driven into the stream bed or a submerged tree root. LCA's data loggers complemented an existing network of four loggers installed by Vermont Fish & Wildlife / USFW and one logger installed by the VT Department of Environmental Conservation (see Figure 1; Table 1).

b. Process temperature data.

LCA data loggers were retrieved in October and data were downloaded to spreadsheets for processing. Temperature logging data were also obtained from VFW and VTDEC for five additional stations in the Summer of 2011, and for a total of six stations from the Summer of 2010 (see Table 2). Statistics were compiled and data were graphed for the summer months of each year, 2010 and 2011. Results were summarized in a technical memo (Attachment 2) and shared with these cooperating agencies.

c. Conduct manual temperature surveys.

Manual temperature surveys were conducted using thermometers for two purposes. Manual measurements were made at the LCA monitoring stations on select dates as a quality assurance check on the operation of the HOBO data loggers. Manual measurements were also made by LCA volunteers at various locations along the main stem on one date, 24 September 2011. This exercise was a way to engage citizens in the temperature monitoring study and was a pilot test of a crowd-sourcing application developed by Kevin Behm at Addison County Regional Planning Commission (ACRPC), in which volunteers could transmit their data via text, email, Tweet, or phone to a central repository (see

Attachment 3). With this system now established, LCA can utilize crowd-sourcing to monitor temperatures during future summer months.

d. Prepare interpretive maps.
With assistance from ACRPC and SMRC, three interpretive maps of the Lewis Creek watershed were prepared for this project. The Aquatic Natural Communities Map includes and associated report.
See Attachment 4.
MAPS:
Physical Features
Aquatic Natural Communities
Natural Resources with Conserved Land

These maps display the license plate logo of the Vermont Watershed Grant Program.

Interpretive maps leveraged existing geomorphic assessment, habitat assessment, biological assessment and bridge & culvert assessment data developed by partners or from previously funding from the VT Water Quality Division (ANR Clean & Clear grants), Lake Champlain Basin Program, FEMA Project Impact and Pre-disaster Mitigation programs and Lewis Creek Association.

e. Share data with agency cooperators.
Three Steering Committee meetings were held on 4 August 2011, 29 November 2011, and 21 February 2012 with primary cooperators on this project: Brian Chipman (VFW), Nick Staats (USFW/ VFW), and Jim Kellogg (VTDEC). Also in attendance were Marty Illick (Executive Director of LCA), Kristen Underwood (SMRC), and Misha Bailey (LCA intern/ meeting facilitator).

An additional meeting was held on 18 January 2012 with VTDEC Water Quality Division staff including: Rich Langdon, Steve Fiske, and Jim Kellogg. Marty Illick, Kristen Underwood and Kevin Behm were in attendance. The purpose of this meeting was to share temperature monitoring data, review draft interpretive maps and receive feedback on management strategies for fish and aquatic natural communities. Several subsequent meeting occurred with ACRPC, SMRC and LCA to finalize the maps.

f. Develop website content.
Interpretive maps developed for this project were uploaded to the LCA website (http://lewiscreek.org/) where they are available for viewing as a "pdf" document (Adobe Acrobat®). Narrative text was developed based on these maps and relying on the technical memo of temperature monitoring data (Attachment 2). The web site narrative acknowledges the financial support of the Vermont Watershed Grant program, and the license plate logo appears on each interpretive map.

g. Grant summary report & identification of management strategies.
This grant summary report summarizes the tasks accomplished.
Management strategies recognize that Lewis Creek has 6 of 7 fish, and 9 of 10 macroinvertebrate aquatic natural stream community types found in Vermont, and that town plan and landowner management goals and strategies should recognize this watershed's unusual biological diversity. Management strategies also note that, according to VT State fish and macroinvertebrate data, Lewis Creek aquatic natural communities for fish and macroinvertebrates are in very good to excellent biological condition except for the section from Prison Hollow down to Pond Brook where data indicate slightly degraded biological conditions.

Four notable watershed wide recommendations are:

-- A. Protect forested areas in headwaters and in "the flats". LC now has ~65% forest cover over all, but some riparian lands are not forested.
-- B. Restore natural cover connectivity for the length of the creek using Best Management Practices for agriculture, forestry, development and roads. Buffer plans should be informed by geomorphic assessments and have 100ft min on main stem and 50ft min on smaller tribs.
–C. Restore or maintain full aquatic organism passage and geomorphic compatibility conditions for all Bridge/Culvert and stream intersections considering Aquatic Natural Community indicator species needs.
–D. Be prepared to retrofit or replace as needed for AOP/GC when willing town, state or landowner culverts are up for replacement or where there are scheduled Right of Way upgrades.

Benefits to the Watershed:
The 2011 and 2010 temperature monitoring data have provided valuable base line information on Summer-season thermal regimes in the Lewis Creek watershed. The project has documented temporal and spatial trends in stream temperature in the Lewis Creek watershed along reaches impaired (303d list) and in need of further study (Part C list) due to impacts to aquatic life support and contact recreation uses from bank instability, erosion and loss of riparian buffers. The interpretive maps help to visualize the longitudinal connectivity of conditions favorable to fish and have informed management strategies to restore and enhance optimal natural habitats for specific fish species known to be present in Lewis Creek. Future temperature monitoring in the watershed will focus on Pond Brook tributary contributions, bracketing this confluence to better define the influence of this tributary on thermal regimes in the Lewis Creek main stem (separate study funded in 2012-2013). LCA plans to act on recommendations from its cooperators in the study to further characterize the headwaters of the Lewis Creek in Starksboro and Hinesburg. Funding will be sought to conduct further study along the upper main stem, High Knob tributary and Hollow Brook tributary, including biomonitoring, water chemistry monitoring, temperature monitoring and culvert / bridge evaluation for Aquatic Organism Passage (AOP).

Results of this current study and interaction with cooperating agencies has informed restoration and conservation projects currently being implemented or developed in the watershed including AOP planning for VT Route 116 culverts in Starksboro and Hinesburg (transportation grants in Addison County and Chittenden County); and riparian protection and conservation easements (VT Land Trust, VT River Conservancy, Wetlands Reserve Program) along geomorphic reaches M03 (Ayer below Greenbush Rd); M12 (Baldwin Farm below Baldwin Rd), M15 (Spencer/Kielman/Lorance/Mainer below Tyler Bridge Rd), and T3.01 (Russell Farm on the lower Pond Brook).

Benefits to the Community:
Interpretive maps and associated narrative developed as part of this study are available on the LCA web site (http://lewiscreek.org/). LCA plans to share these resources in ongoing outreach to boards in the six watershed towns so that information about aquatic natural communities can be incorporated in town plans.

In keeping with the new management recommendations, LCA has been facilitating conservation easement projects in the riparian corridor including the development of two new public fishing access points in the lower and middle watershed areas, as well riparian zone easements to protection of riparian forests, wetlands and fluvial erosion belt width areas (seven landowners).

Figures: see below
1. Location of temperature monitoring stations in the Lewis Creek watershed

Tables: see below
1. Temperature logging stations in the Lewis Creek watershed, 2011
2. Temperature logging stations in the Lewis Creek watershed, 2010

Project Budget: see below

Personnel	$1769.45
SMRC service	$4318.43
ACRPC service	$500.00
Equipment	$1173.12
LCA indirect	$239.00
Total expenses	$8000.00

Photographs: See below

Attachments: See below
1. Deployment of HOBO temperature loggers in the Lewis Creek watershed, 2011.
2. Technical memorandum summarizing temperature monitoring results, 2011 and 2010.
3. Instructions for volunteer temperature monitoring and crowd-sourcing.

Project Maps: http://www.lewiscreek.org/participation
Physical Features
Aquatic Natural Communities
Natural Resources with Conserved Land

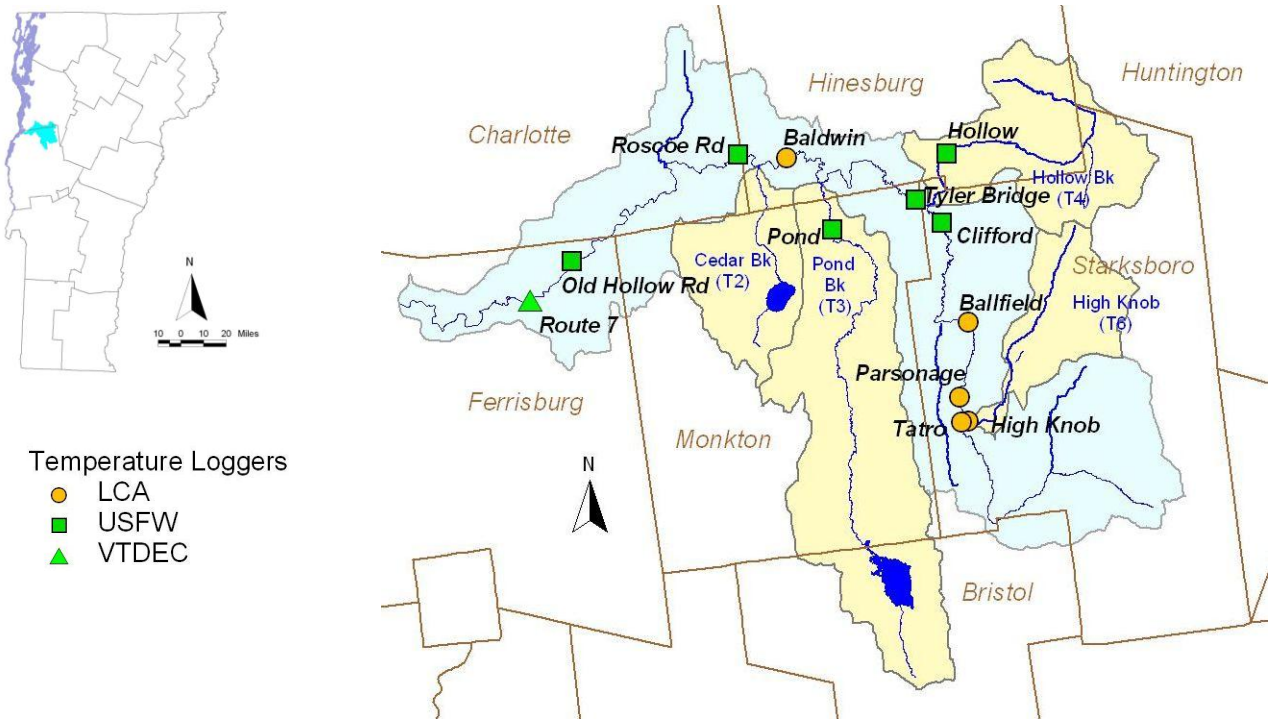


Figure 1. Location of temperature monitoring stations in the Lewis Creek watershed.

Table 1. Temperature logging stations in the Lewis Creek watershed, 2011

Org	Location	Description	Geomorphic Reach	Town	Lat	Lon	Deploy Date	Retrieval Date	Logging Interval (Hr:Min)	Notes
LCA	Tatro	200 ft downstream of Tatro Road bridge	M21A	Starksboro	44.21603	-73.06341	06/10/11	10/12/11	0:30	
LCA	HighKnob	350 ft upstream of confluence with Lewis Creek	T6.01	Starksboro	44.21637	-73.06069	06/10/11	10/12/11	0:30	
LCA	Parsonage	300 ft upstream of Parsonage Road bridge	M20A	Starksboro	44.22278	-73.06408	06/06/11	10/12/11	0:30	
LCA	BallField	Cota Ballfields, 100 ft upstream of parking lot river access	M19A	Starksboro	44.24356	-73.06098	06/06/11	10/12/11	0:30	
VFW	Hollow	Rt 116 bridge over the Hollow Brook	T4.01B	Hinesburg	44.29003	-73.07014	05/23/11	12/01/11	1:00	likely logger exposure above water as channel dried up
VFW	Tyler Bridge	Tyler Bridge Road bridge over Lewis Creek	M15B	Monkton	44.27729	-73.08131	05/23/11	12/01/11	1:00	
LCA	Baldwin	100 ft upstream of Baldwin Road bridge	M12B	Hinesburg	44.28853	-73.13093	06/10/11	09/23/11	0:30	logger housing partially above water upon retrieval; suspect readings during other low-flow times of Summer
VFW	Roscoe Rd	Roscoe Road (Upper Covered Bridge) over Lewis Creek	M10F	Charlotte	44.28887	-73.15037	05/23/11	12/01/11	1:00	
VFW	Old Hollow Rd	Old Hollow Rd near bedrock falls at North Ferrisburgh village, Lewis Creek	M07	Ferrisburgh			05/23/11	12/01/11	1:00	
VTDEC	Route 7	Upstream of Rt 7 bridge near USGS gaging station	M05	Ferrisburgh	44.24893	-73.22834	05/12/11	11/16/11	1:00	

Table 2. Temperature logging stations in the Lewis Creek watershed, 2010

Org	Location	Description	Geomorphic Reach	Town	Lat	Lon	Deploy Date	Retrieval Date	Logging Interval (Hr:Min)	Notes
VFW	Hollow	Rt 116 bridge over the Hollow Brook	T4.01B	Hinesburg	44.29003	-73.07014	05/07/10	10/14/10	1:00	likely logger exposure above water as channel dried up
VFW	Tyler Bridge	Tyler Bridge Road bridge over Lewis Creek	M15B	Monkton	44.27729	-73.08131	05/07/10	10/14/10	1:00	
VFW	Pond	Silver Street bridge over Pond Brook	T3.01C	Monkton	44.26846	-73.11337	05/25/10	10/14/10	1:00	
VFW	Roscoe Rd	Roscoe Road (Upper Covered Bridge) over Lewis Creek	M10F	Charlotte	44.28887	-73.15037	05/07/10	10/14/10	1:00	
VFW	Old Hollow Rd	Old Hollow Rd near bedrock falls at North Ferrisburgh village, Lewis Creek	M07	Ferrisburgh			05/07/10	10/14/10	1:00	
VTDEC	Route 7	Upstream of Rt 7 bridge near USGS gaging station	M05	Ferrisburgh	44.24893	-73.22834	05/04/10	11/15/10	0:15	

Photographs

Photo 1. Temperature monitoring equipment

Photo 2. Volunteer temperature monitoring, M. Illick on Lewis Creek upstream of Scott Pond Dam.

Project Budget

Expense Item	Grant Expense	Local Match	Other non-local Match	Total Cost
Administrative Overhead	$ 239.00 (LCA)	$	$	$239.00
Direct Labor	$ 1769.45 (LCA)	$ 1420.50 (LCA) $ 900.00 (intern, volunteers)		$4089.95
Purchased Materials and Services	$ 947.50 (Equip) $ 225.62 (Equip) $ 500.00 (ACRPC) $4162.88 (SMRC)	$ 675.00 (SMRC)	$ 2,550.00 (USFW, VFW,ANR) $ 525.00 (ACRPC)	$9586
Other Costs (Mileage)	$ 155.55 (SMRC)		$	$155.55
TOTALS	$ 8000.00	$ 2995.50	$ 3075	$14,070.50

("Local," "Other non-local" and "grant request" columns should add up to "total cost" figures.)

Grant Request: $ 8,000 Total Cost of Project: $ 14070.50

VFW, USFW, VTDEC, ACRPC, LCA volunteer hours resulted in a match contribution of $6060.50 (43%)

Attachments:

Attachment 1.

Deployment of HOBO temperature loggers in the Lewis Creek watershed, 2011

Attachment 2.

Technical memorandum summarizing temperature monitoring results, 2011 and 2011

Attachment 3.

Instructions for volunteer temperature monitoring and crowd-sourcing

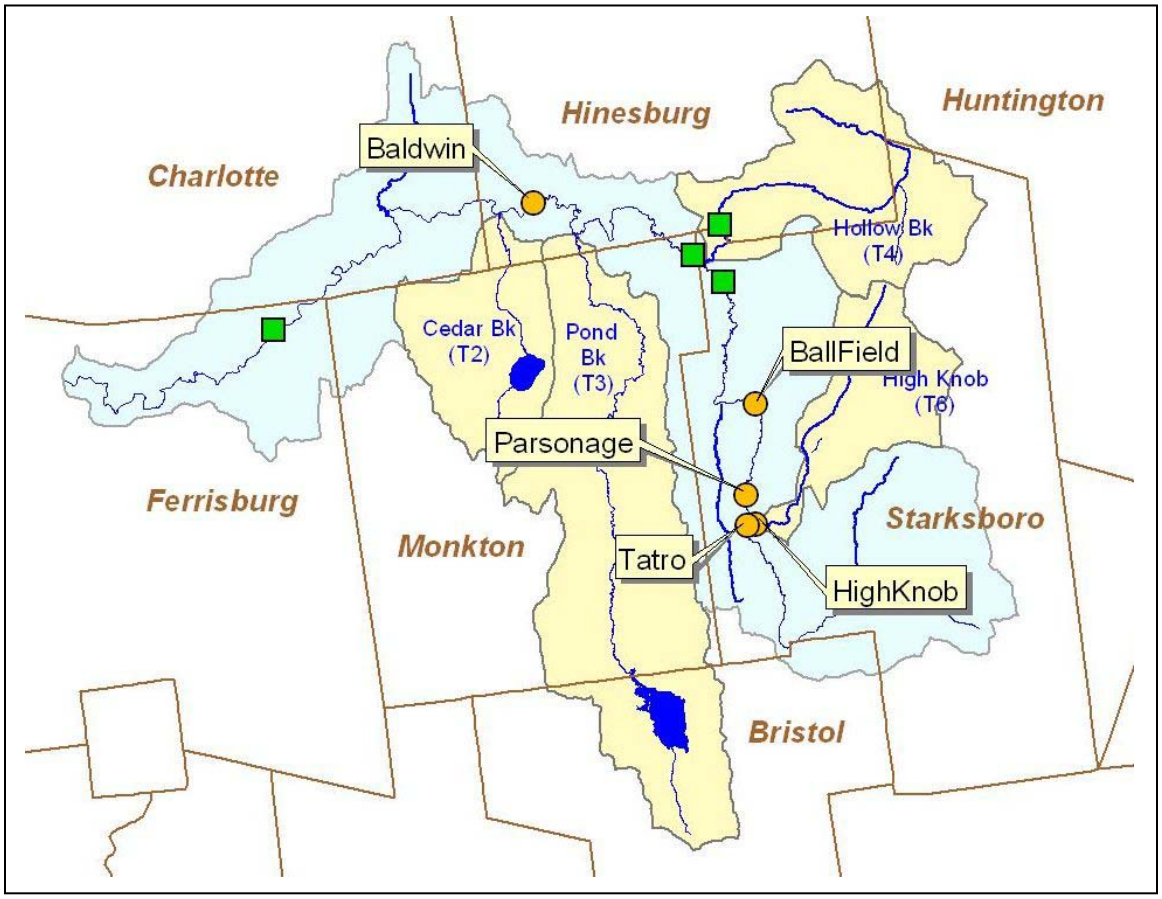
Attachment 4.

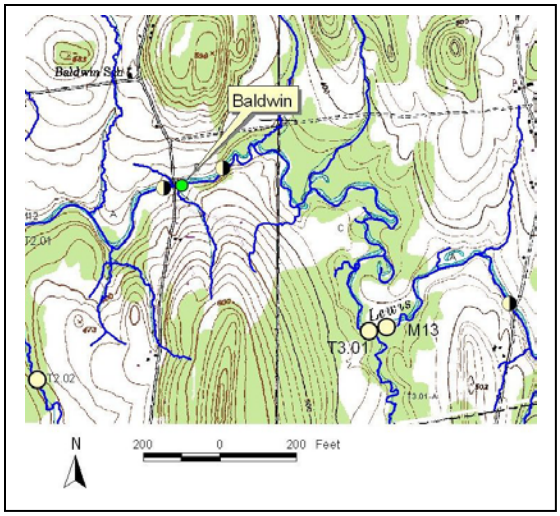
Overview of Aquatic Natural Communities in Lewis Creek, Fiske and Langdon 2012

2011 Temperature Logging
Lewis Creek watershed

Logger Model: HOBO U22 Water Temp Pro v2

Serial #	Description	Location	Lat	Lon	Date Deployed	Time Deployed	Logging Interval
99034 60	Tatro	Approx 200 ft downstream of Tatro Road bridge; right bank; secured to tree root, covered by cobbles	44.21602903	-73.06340550	6/10/11	15:15	0:30
99034 59	HighKnob	Approx 350 ft upstream of confluence with Lewis Creek; left bank; secured to tree root, covered by cobbles	44.21636523	-73.06069077	6/10/11	14:50	0:30
99034 58	Parsonage	Approx 300 ft upstream of Parsonage Road bridge; left bank; lee of large boulder, secured to rebar, covered by cobbles	44.22278199	-73.06407915	6/6/11	15:35	0:30
99034 56	BallField	Approx 100 ft upstream of parking lot river access; right bank; across from left-bank pink survey tape; secured to rebar, covered by cobbles.	44.24355788	-73.06098112	6/6/11	16:00	0:30
99034 53	Baldwin	Approx 100 ft upstream of Baldwin Road bridge; left bank; upstream end of sand bar; secured to rebar.	44.28852570	-73.13093129	6/10/11	16:15	0:30




Baldwin
Lewis
M13
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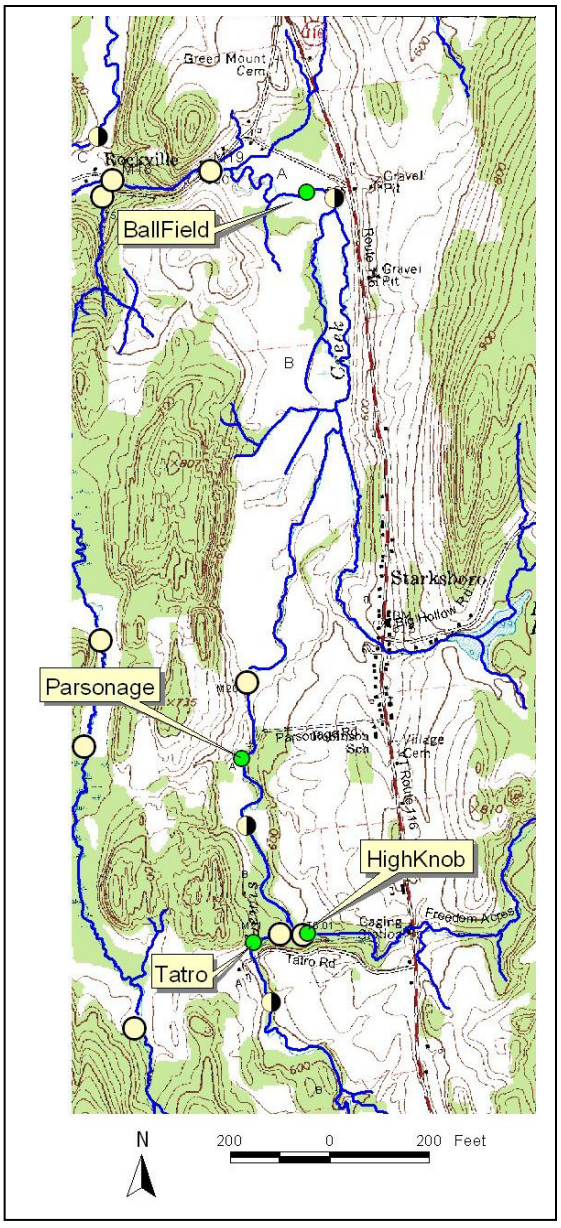
Green Mount Cem
Rockville
BallField
Gravel Pit
Gravel Pit
Route
Creek
Starkshoro
Parsonage
Parsonage Rd
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Village Cem
Route 16
HighKnob
Caging
Freedom A Cres
Tatro
Tatro Rd
N
200
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200 Feet

Tatro

High Knob

View upstream; logger is approx 350 ft upstream from confluence with Lewis Creek

Pink flagging tape in Y of small yellow birch approx 10 feet to south of logger; logger on LB directly across from twin boulders.

Parsonage

Park at pull off on west side of Parsonage Road bridge. Follow path along east edge of hay field, west side river, south from the bridge. Look for pink flagging tape along tree/shrub buffer approx 300 ft upstream of the bridge. Enter buffer and follow path to river's edge. Look for flagging tape above boulder. Logger is secured to rebar in lee of this boulder, covered by cobbles.

BallField

Park at Ball Fields near gazebo. Walk to river access at south end of parking lot. Walk upstream approx 100 feet. Look for pink flagging tape secured to a shrub on **left** bank. Logger is directly across the channel from the flagging tape, secured to rebar in the shade of tree roots, covered by cobbles.

View upstream from logger site.

Baldwin

Park at pull off on south east side of Baldwin bridge. Walk down the rock-lined ditch channel east of the parking area to its confluence with the Lewis Creek. Turn upstream and walk to the vegetated sand bar along the left bank of the river channel. Logger is secured to a piece of rebar driven into the channel at the upstream end of this sand bar.

TECHNICAL MEMORANDUM

Date: 14 March 2012

From: Kristen Underwood, South Mountain Research & Consulting

To: Marty Illick, Lewis Creek Association
Brian Chipman, VT Fish & Wildlife
Nick Staats, US Fish & Wildlife
Jim Kellogg, VTDEC Water Quality Division

Re: Temperature Monitoring in the Lewis Creek, 2010, 2011

Relying in part on data sets from cooperating agencies, temperature data from the Lewis Creek watershed were compiled for nine stations monitored in the summer of 2011 and six stations monitored in the summer of 2010. Monitoring locations for each year are detailed in Tables 1 and 2 (attached). The locations of monitoring stations are also depicted in Figure 1 – a map of the watershed divided into three topographic zones: the Upper, Middle, and Lower Watershed. Along the profile of the main stem these zones are separated at prominent bedrock falls. The Upper Watershed is located mostly within the Northern Green Mountain physiographic province, and is composed of the higher-elevation headwaters draining to the States Prison Hollow Road gorge, including the High Knob and Hogback tributaries. The upper reaches of Hollow Brook tributary above a short bedrock falls along Hinesburg Hollow Road are also grouped with the Upper Watershed. The Middle and Lower Watersheds are located within the Champlain Valley physiographic province. Generally, the Middle Watershed is composed of all those lands draining to the main stem between the States Prison Hollow Road gorge and the North Ferrisburgh falls from river mile 23 to river mile 6. This area includes the subwatersheds of Pond Brook tributary and Cedar Brook tributary. The Lower Watershed consists of all those lands draining to the main stem below North Ferrisburgh falls, or the lower 6 miles of the river.

In 2010, temperature data were available for the period from June 1 through September 30 (122 days). In 2011, data were recorded for the period June 11 through October 11 (123 days). Data have been analyzed and presented in Appendix 1, containing Slides 1 through 7. Baldwin station data for 2011 were not included since this temperature logger was exposed above or near the water surface for much of the monitoring period.

Slides 1 & 2

Slides 1 and 2 depict 2011 and 2010 data, respectively. Daily mean temperatures at each monitoring station are plotted versus time, along with daily mean flow recorded for the monitoring period at the USGS Gage #04282780 located just upstream from the Route 7 bridge crossing. The mean daily air temperature (Burlington airport) was also plotted for reference. Generally, monitoring occurred during low-flow to base-flow conditions – one exception being the storm flow that resulted from Tropical Storm Irene in late August / early September 2011. The peak flow (provisional) recorded at the USGS gaging station during this event was 2,480 cfs at 9 AM on 8/29/11 (daily mean flow of 1,660 cfs). According to Olson (2002), this peak flow equates to a 2-year to 5-year storm magnitude in the Lewis Creek watershed.

As a general point of reference, the 70°F line has been emphasized in each graph. Since a variety of fish and other aquatic species exist in the Lewis Creek, it would be impractical to plot temperatures that represent tolerance limits for specific species. A general threshold of 70°F has been chosen since temperatures in excess of this value are not well tolerated by cold-water fish species including brook trout. The Lewis Creek is regulated as a cold-water fishery (Vermont Water Quality Standards, 2008), although the watershed includes includes a range of cold water, mixed water and warm water fish community types.

Along the Lewis Creek main stem, a general warming trend is evident with distance downstream. Lower Watershed stations – Route 7 and Old Hollow – were consistently warmer than Upper Watershed stations – Tatro, Parsonage, and Ballfield – and appeared to track closely with the mean daily air temperature. Water temperatures at downstream stations frequently exceeded 70°F, especially during the months of July and August. In 2010, water temperatures in the Pond Brook tributary were very similar to temperatures recorded at Roscoe Rd, Old Hollow and Route 7. Pond Brook tributary has an apparent warming effect on main stem temperatures, based on comparison of the records for Tyler Bridge (which is upstream of the Pond Brook confluence) and Roscoe Rd (located downstream of the confluence). Pond Brook represents 32% of the total upstream drainage area at its point of confluence with the Lewis Creek main stem just west of the Silver Street crossing. Approximately 82% of the 14-mile Pond Brook channel has an open canopy. This tributary receives outflow from Bristol Pond which is approximately 200 acres in area and generally between two and five feet deep (Lakes & Ponds Section depth chart).

Particularly low water temperatures were recorded in the Hollow Brook tributary at the Tyler Bridge Rd bridge crossing. No malfunction of this logger was reported by VFW. It appears that temperatures at this location are influenced by groundwater, particularly during base-flow conditions. Occasional spikes in daily mean temperature at this station were coincident with storm flows as indicated by the daily mean flow hydrograph on Slides 1 and 2 – demonstrating the contributions of event-based, warmer surface waters from the upstream drainage area in Hollow Brook.

Slides 3 & 4

In Slides 3 and 4, the 2011 and 2010 data have been summarized in Box & Whisker plots to emphasize the mean and range of mean daily water temperatures recorded at each main-stem station for the respective monitoring periods. A legend for these graphs is presented on Slide 4. Monitoring stations are organized along the x-axis in order from upstream (right) to downstream (left). Breaks between the Upper, Middle and Lower Watersheds have been identified.

Generally, the median of the mean daily water temperature increases with distance downstream (as does the range). A similar trend is apparent for the 2010 monitoring season, although data were no available that year for the Upper Watershed stations. Mean daily water temperatures were slightly higher in 2010 than 2011 at the four main stem stations that were measured in both years (Tyler Bridge, Roscoe, Old Hollow, and Route 7).

Slides 5 & 6

July 22 was the day of warmest water temperatures in 2011; July 8 was the warmest day in 2010. Slides 5 and 6 depict the profile of the maximum daily temperature recorded at each station for the warmest day of each year, respectively. The x-axis reflects the distance to each temperature logging station upstream from Lake Champlain. A warming trend with distance downstream is indicated by each graph. Maximum recorded temperatures were above 70°F, including stations in the Upper Watershed (Ballfield, Parsonage, Tatro and High Knob). One exception was the Hollow Brook station which recorded a maximum temperature of 56°F on 8 July 2010 and 57°F on 22 July 2011.

Slide 7

This graph presents a temperature exceedance profile for the Lewis Creek watershed in the summer months of 2010 (yellow squares) and 2011 (white squares). For each station, the plotted value represents the percentage of hours during each summer monitoring period that water temperatures exceeded 70°F. These percentages have been plotted versus upstream distance of each station. Temperatures at the Upper Watershed stations (Ballfield, Parsonage, Tatro, and High Knob) rarely exceeded this threshold; whereas temperatures in the Lower Watershed stations exceeded 70°F for nearly half of the Summer season. Pond Brook had temperature trends similar to the Lower Watershed stations. Temperatures at the Tyler Bridge station on the Lewis Creek exceeded 70°F for 11.5% and 14% of the summer in 2011 and 2010, respectively. Cooler waters contributed by the Hollow Brook tributary just upstream of this station appear to be moderating main-stem temperatures and at times offering refuge for cold-water species during the summer months.

The percent of forest cover in the total upstream watershed draining to each temperature monitoring station has also been plotted on Slide 7 (green triangles). It is interesting to note that a decrease in forest cover correlates with the warming trend in water temperatures with distance downstream.

Table 1. Temperature monitoring stations in the Lewis Creek watershed, 2011

Org	Location	Description	Geomorphic Reach	Town	Lat	Lon	Deploy Date	Retrieval Date	Logging Interval (Hr:Min)	Notes
LCA	Tatro	200 ft downstream of Tatro Road bridge	M21A	Starksboro	44.21603	-73.06341	06/10/11	10/12/11	0:30	
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VFW	Hollow	Rt 116 bridge over the Hollow Brook	T4.01B	Hinesburg	44.29003	-73.07014	05/23/11	12/01/11	1:00	likely logger exposure above water as channel dried up
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VFW	Old Hollow Rd	Old Hollow Rd near bedrock falls at North Ferrisburgh village, Lewis Creek	M07	Ferrisburgh			05/23/11	12/01/11	1:00	
VTDEC	Route 7	Upstream of Rt 7 bridge near USGS gaging station	M05	Ferrisburgh	44.24893	-73.22834	05/12/11	11/16/11	1:00	

Table 2. Temperature monitoring stations in the Lewis Creek watershed, 2010

Org	Location	Description	Geomorphic Reach	Town	Lat	Lon	Deploy Date	Retrieval Date	Logging Interval (Hr:Min)	Notes
VFW	Hollow	Rt 116 bridge over the Hollow Brook	T4.01B	Hinesburg	44.29003	-73.07014	05/07/10	10/14/10	1:00	likely logger exposure above water as channel dried up
VFW	Tyler Bridge	Tyler Bridge Road bridge over Lewis Creek	M15B	Monkton	44.27729	-73.08131	05/07/10	10/14/10	1:00	
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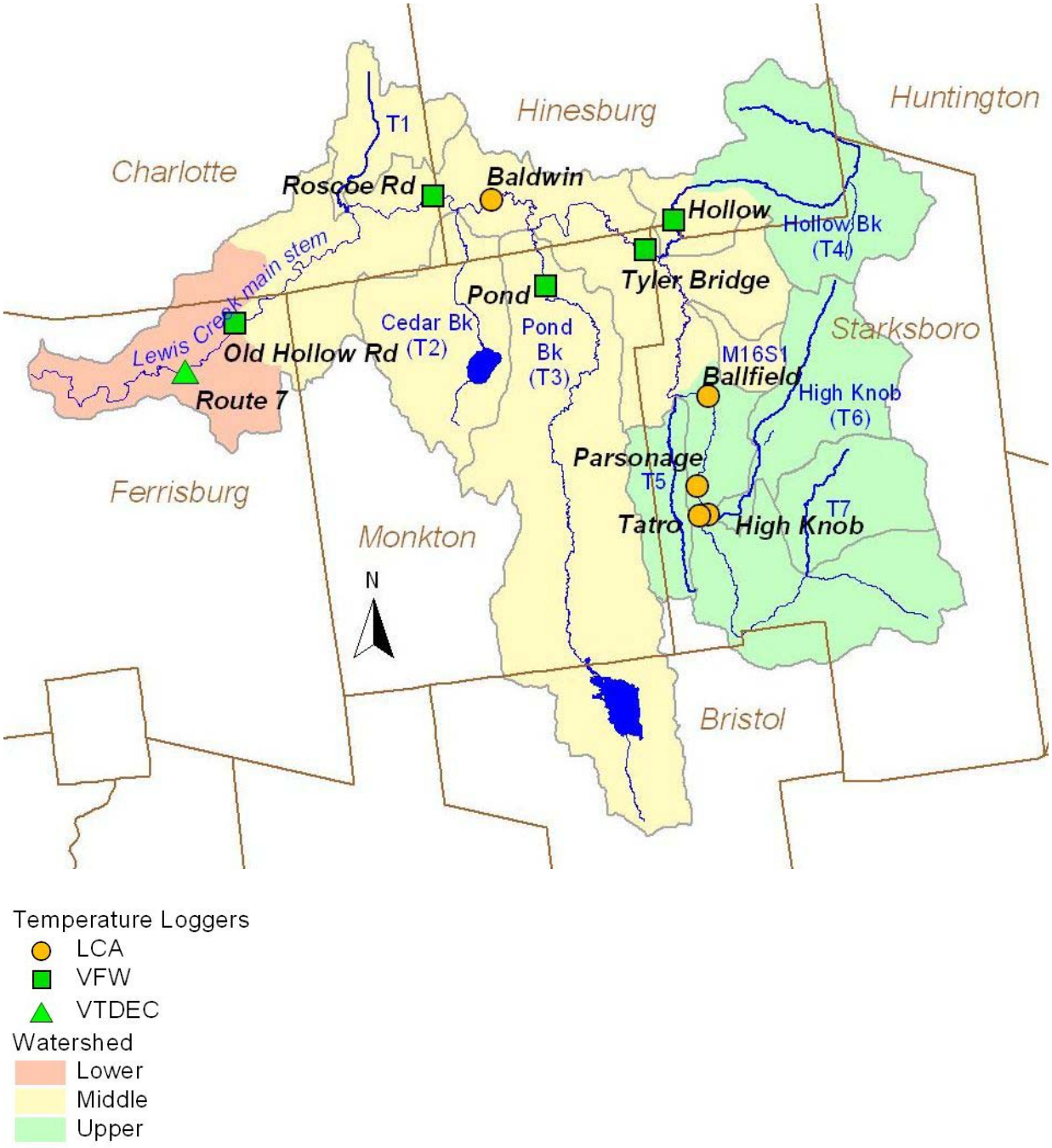
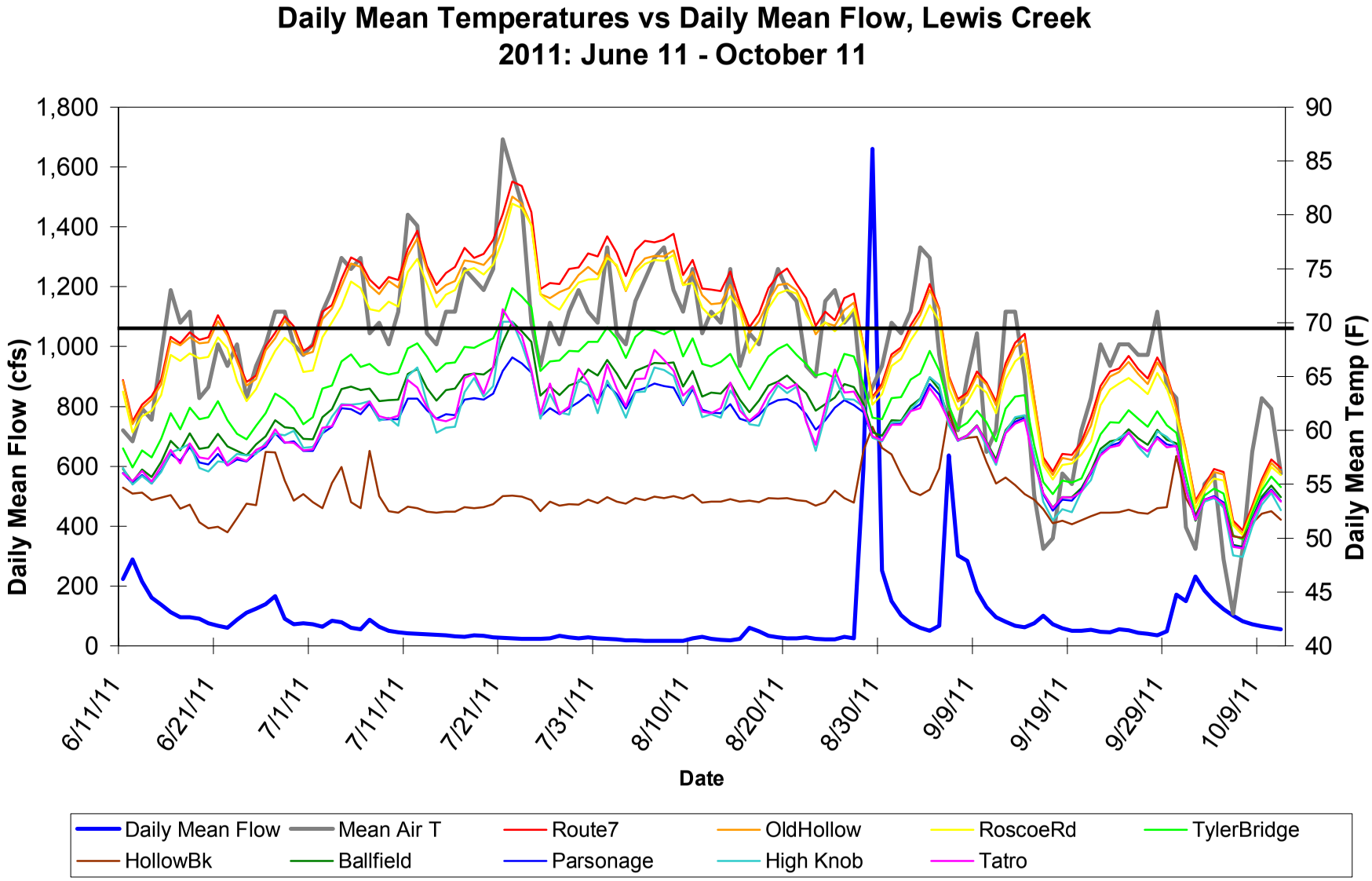


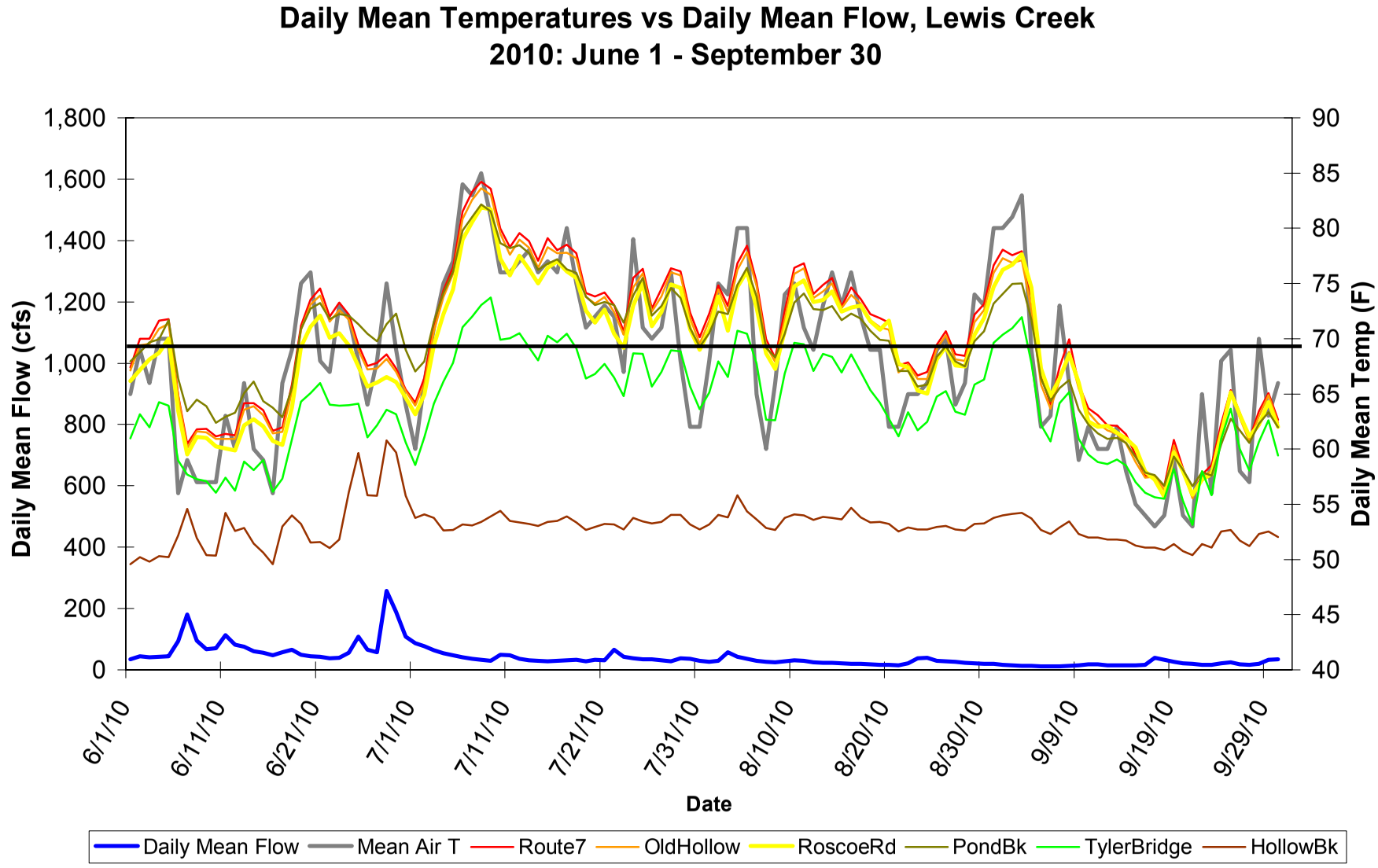
Figure 1. Location of temperature monitoring stations in the Lewis Creek watershed, 2010 and 2011.

Appendix 1

Slides 1 - 7

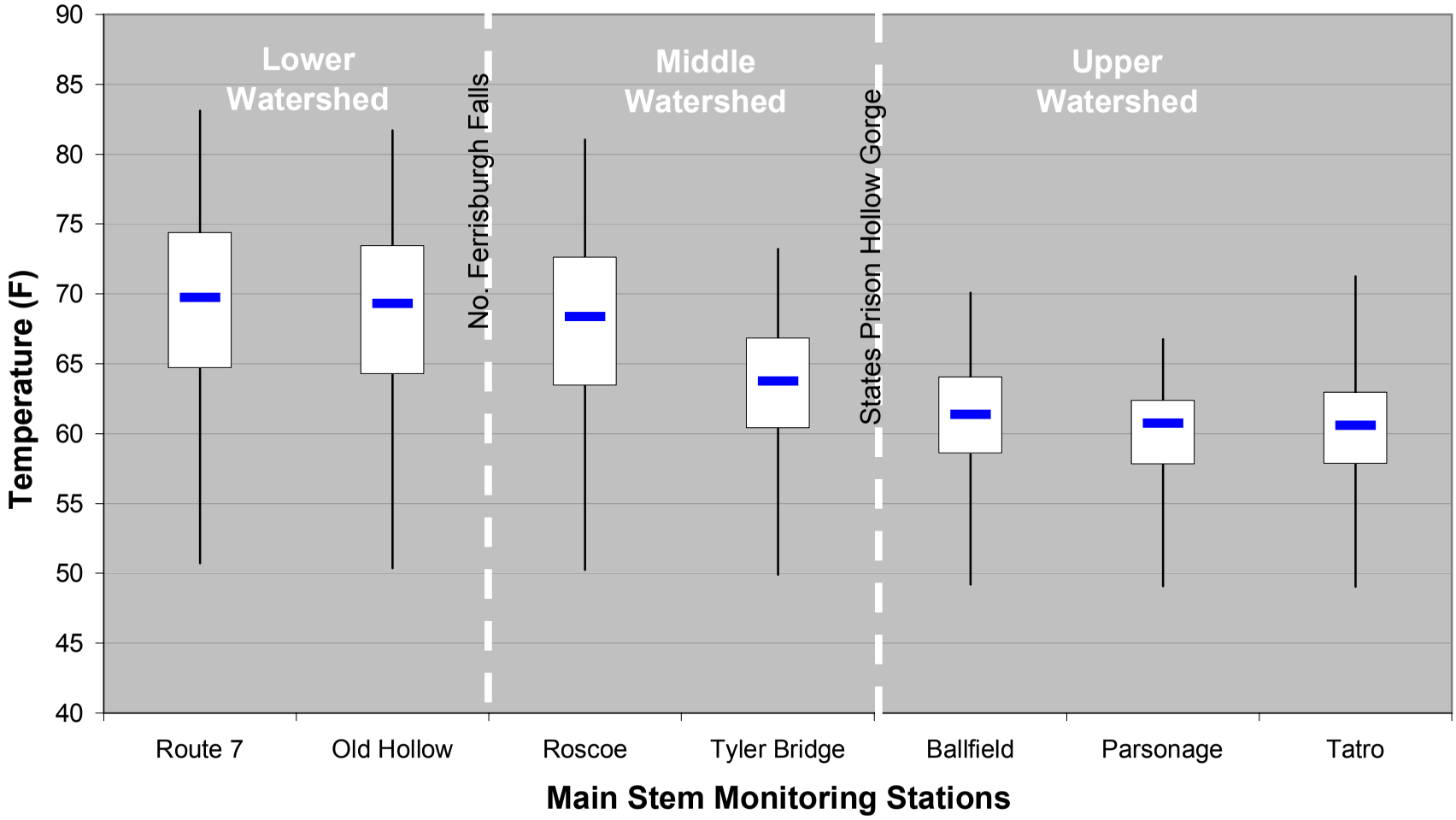

Daily Mean Temperatures vs Daily Mean Flow, Lewis Creek
2011: June 11 - October 11
Daily Mean Flow (cfs)
Daily Mean Temp (F)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
90
85
80
75
70
65
60
55
50
45
40
6/11/11
6/21/11
7/1/11
7/11/11
7/21/11
7/31/11
8/10/11
8/20/11
8/30/11
9/9/11
9/19/11
9/29/11
10/9/11
Date
Daily Mean Flow
Mean Air T
Route7
OldHollow
RoscoeRd
TylerBridge
HollowBk
Ballfield
Parsonage
High Knob
Tatro

Slide 1


Daily Mean Temperatures vs Daily Mean Flow, Lewis Creek
2010: June 1 - September 30
Daily Mean Flow (cfs)
Daily Mean Temp (F)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
90
85
80
75
70
65
60
55
50
45
40
6/1/10
6/11/10
6/21/10
7/1/10
7/11/10
7/21/10
7/31/10
8/10/10
8/20/10
8/30/10
9/9/10
9/19/10
9/29/10
Date
Daily Mean Flow
Mean Air T
Route7
OldHollow
RoscoeRd
PondBk
TylerBridge
HollowBk

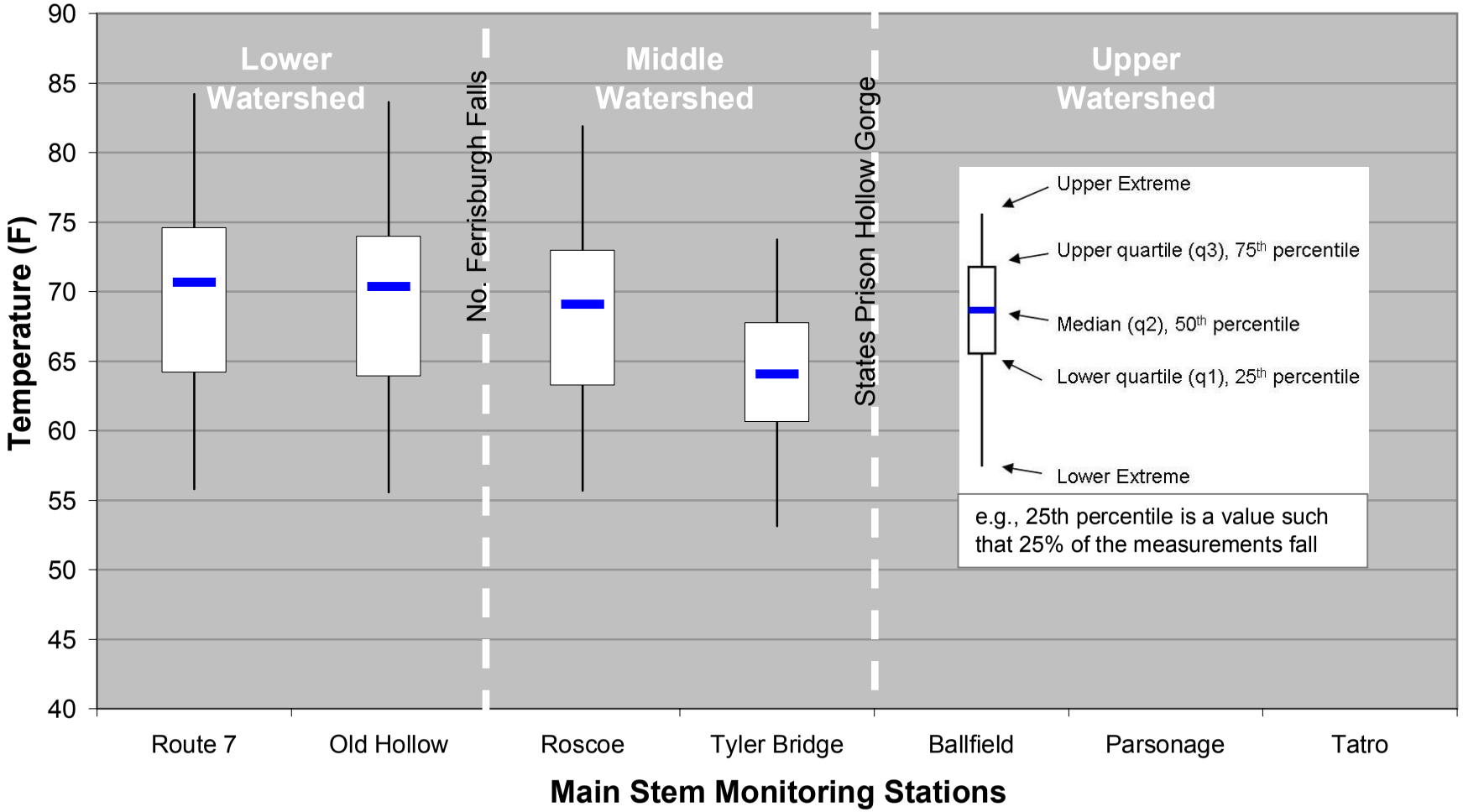
Slide 2

Mean Daily Water Temperature, Lewis Creek
2011: June 11 - October 11



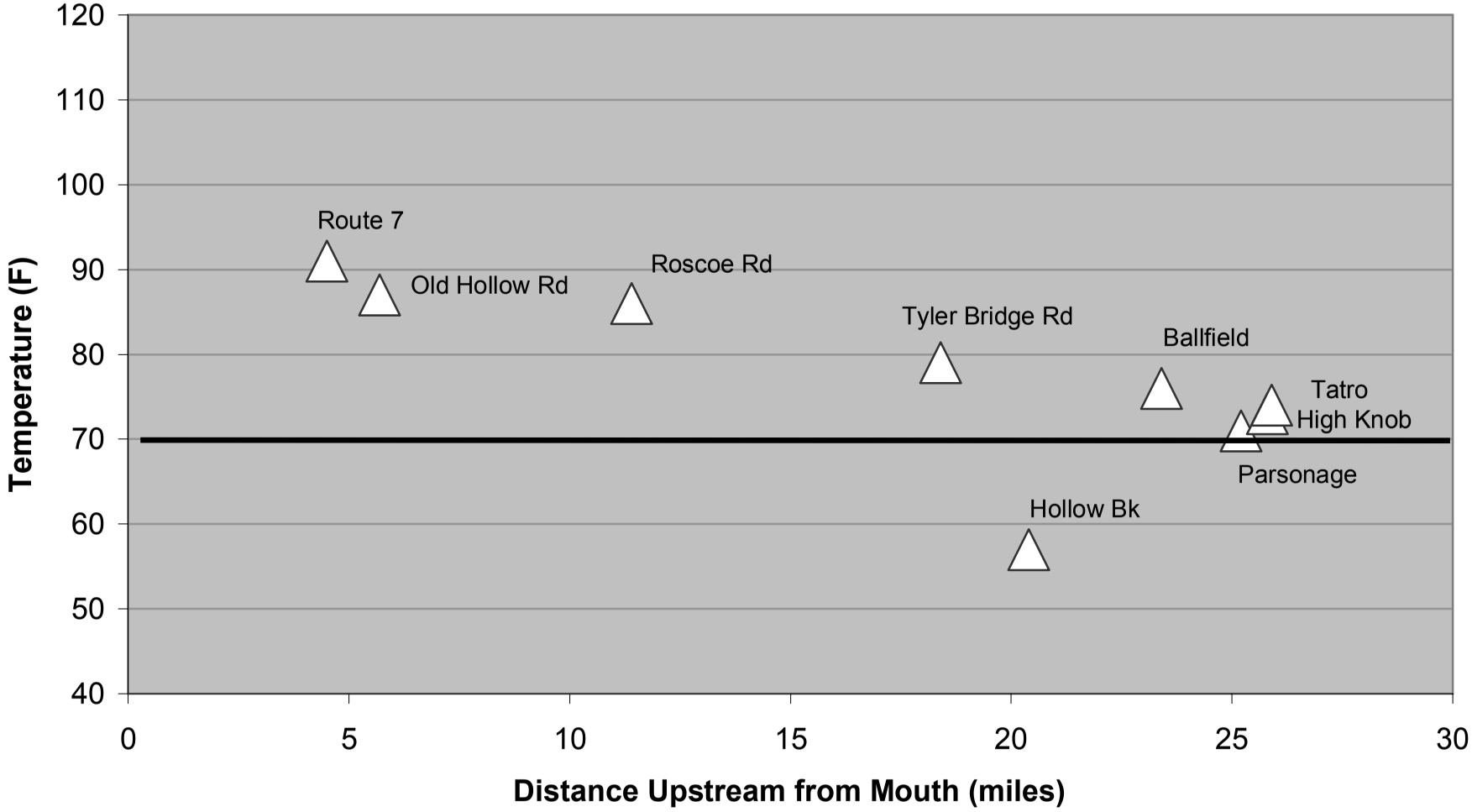
Slide 3

Mean Daily Water Temperature, Lewis Creek
2010: June 1 - September 30

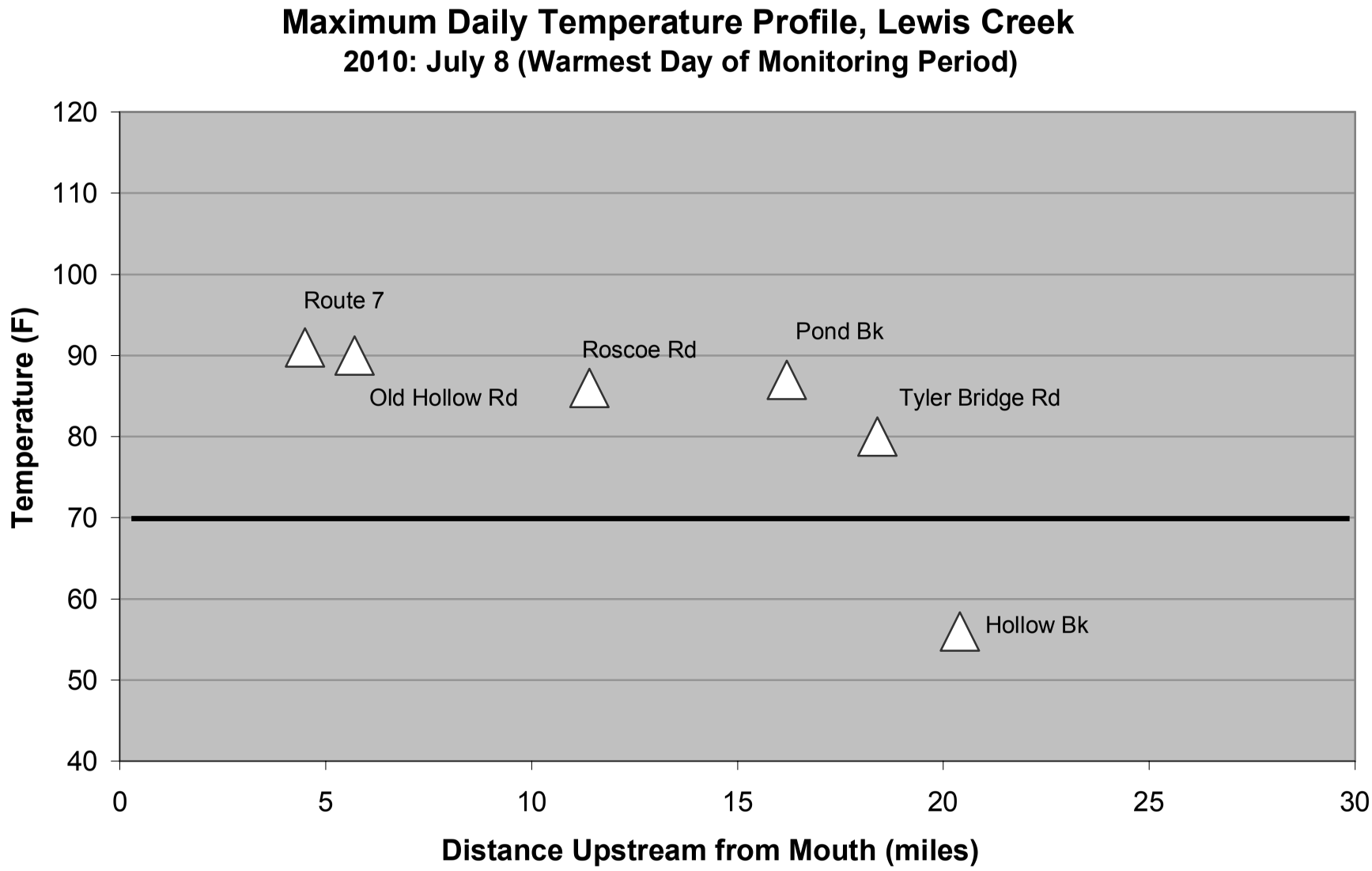


Slide 4

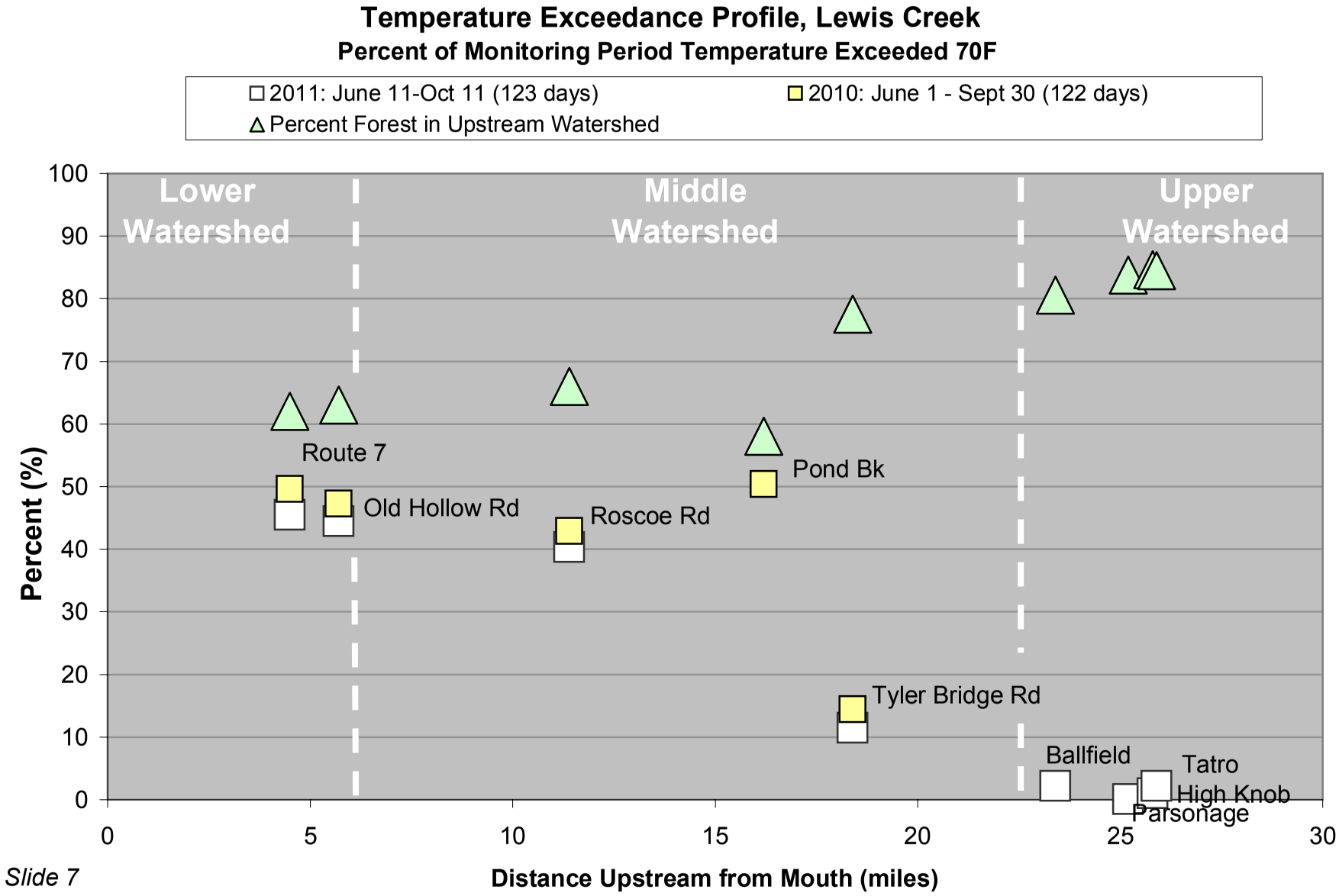
Maximum Daily Temperature Profile, Lewis Creek
2011: July 22 (Warmest Day of Monitoring Period)



Slide 5


Maximum Daily Temperature Profile, Lewis Creek
2010: July 8 (Warmest Day of Monitoring Period)
Temperature (F)
120
110
100
90
80
70
60
50
40
0
5
10
15
20
25
30
Distance Upstream from Mouth (miles)
Route 7
Old Hollow Rd
Roscoe Rd
Pond Bk
Tyler Bridge Rd
Hollow Bk

Slide 6


Temperature Exceedance Profile, Lewis Creek
Percent of Monitoring Period Temperature Exceeded 70F
2011: June 11-Oct 11 (123 days)
2010: June 1 - Sept 30 (122 days)
Percent Forest in Upstream Watershed
Lower Watershed
Middle Watershed
Upper Watershed
Route 7
Old Hollow Rd
Roscoe Rd
Pond Bk
Tyler Bridge Rd
Ballfield
Tatro
High Knob
Parsonage
Percent (%)
Distance Upstream from Mouth (miles)
0
10
20
30
40
50
60
70
80
90
100
0
5
10
15
20
25
30

Slide 7

LEWIS CREEK ASSOCIATION

Instructions for Monitoring Temperature
Lewis Creek Watershed

Methods:

Air Temperature: Proceed to the edge of the channel at your stream site, preferably to a location shaded from direct sunlight. Read the temperature on the thermometer. Ideally, collect this reading before you measure the water temperature, because the thermometer has had time to adjust to the surrounding air on your walk to the stream, and is not in the process of re-adjusting to air temperature, having recently been immersed in the cooler water of the stream.

Water Temperature: If possible, find a location along the channel relatively shaded from direct sunlight. Wade into the channel and find a deeper spot along the cross section of the river, where there is a noticeable current of stream flow. Try to avoid the shallow backwater areas along the edge of the stream. Fully submerge the thermometer in the deepest part of the channel. Hold it there for at least a minute. Then remove it from the current and read the temperature.

Record:

Site Location
Date
Time
Air Temperature
Water Temperature

Temperatures can be recorded in either Fahrenheit or Celsius; please be sure to record an °F or °C next to the temperature reading, accordingly. LCA has provided Celsius thermometers to some volunteers.

Report:

We have several ways to send in your monitoring results to Lewis Creek Association. With help from Kevin Behm at Addison County Regional Planning, we are using a technology called *crowd-sourcing*, where citizens can report valuable information to a centralized web site. Kevin has developed a crowd-sourcing web site for our use to receive and compile temperature measurements from the Lewis Creek. We will place a link to this web site on the Lewis Creek Association website, www.lewiscreek.org

However, you do not have to log on to this website to report your data. There are a few convenient ways to send your data in from the field. Once you have recorded temperature data at your site(s), you can choose from the following methods to send that information in to our temperature monitoring website.

1. Text the data in by sending your information to this phone number: **802-234-1527**
2. Send the data in an email to lewiscreekvt@gmail.com
3. Tweet the data by sending a message with the hashtag/s **#LewisCreekVT**

If you prefer, you may access the crowd-sourcing website and file a formal report of the data, following instructions on the web page. You can also later access the webpage to see all of the temperature data that has been sent in by volunteers.

Lewis Creek Association

Temperature Monitoring Record

Site Name	Location	Date	Time	Air Temperature	Water Temperature	Notes

Overview of Aquatic Natural Communities Occurrences in the Lewis Creek Watershed

Prepared by: Steve Fiske, Rich Langdon, VT Department of Environmental Conservation, February 14, 2012
Prepared for: Lewis Creek Association

The following overview is intended to give narrative to the Aquatic Natural Community Planning Map assembled by the Lewis Creek Watershed Association. This overview presents a narrative for the macroinvertebrate and fish assemblage **types** that are likely to be present within the mapped Aquatic Natural Community reaches. The associations are based on monitoring data collected by the VTDEC within the Lewis Creek watershed; and the report Classification of the Aquatic Communities of Vermont 1998 (CACV 1998) and updates.

Aquatic Natural Community Assemblage Types

Lewis Creek, despite its moderate watershed size (about 217 km2) compared to the other major rivers (700-2500 km2) entering Lake Champlain, has representative stream reaches from 6 of 7 fish, and 9 of 10 macroinvertebrate aquatic natural stream community **types** found in Vermont. By comparison the watershed is relatively low in both number of lakes and the natural lake community types represented (one of four types found in Vermont).

Lewis Creek Aquatic Natural Community Types:

The high diversity in stream natural community assemblage types present within the Lewis Creek watershed is due to:

1- The watershed landscape and geologic features span the range from those found in the steep, high elevation western Green Mountains to the gentle slopes and low elevations of the broad Champlain Valley floor. The most important of these physical and chemical attributes and the resulting aquatic community environments are elevation, canopy cover (influence stream temperature, primary food sources and biogeography), drainage area size (stream size and permanence, hydrology, primary food sources), gradient (substrate composition, and water velocity), and soil and bedrock geology (pH, alkalinity, calcium) and

2- The influence of biogeography. Champlain Valley waters support native fish and mussel species from *two* glacial refugia. Unlike the remainder of Vermont waters which were populated only by eastern species, the mid- and lower elevation waters in the Champlain drainage contain both eastern and western species resulting in streams that support greater numbers of species than streams of similar size streams elsewhere in Vermont.

Nine natural stream macroinvertebrate **types** and six fish assemblage **types** are found within the Lewis Creek watershed and are presented in Table 1. This table presents the macroinvertebrate and fish community assemblage **types** that likely occur within the broader mapped seven *Aquatic Natural Community stream reaches* presented on the Lewis Creek Aquatic Natural Communities Map.

It should be noted that the lower reach of Lewis Creek does not support the full array of species associated with Vermont's *Large Warm Water Low-Moderate Gradient* community type that is typified by the lower reaches of larger tributaries to Lake Champlain. Lewis Creek drains a much smaller watershed thereby provides less habitat volume (shallower and less diverse) than rivers such as the Winooski River and Otter Creek.

Table 1.

Aquatic Natural Communities found in Lewis Creek Watershed and depicted on the LCA Aquatic Natural Community Map- (last column); and the Bug (macroinvertebrate), and Fish assemblage types likely found within these aquatic natural communities.

Location in Watershed	**Bug (B) and Fish (F) Assemblage Types**	**Indicator Species** ***Macroinvertebrate/Bug*** **Fish**	**MAP Aquatic Natural Community Descriptions**
Upper Headwaters east of Rte 116, and Prindle (Pease) Brook in M10	B2,F1,F2,F3	*Rithrogenia, Ceratopsyche sparna, ventura, Dolophilodes, Simulium tubersome grp, Oulimnius latisculus, Peltoperla ,Malerekus, Polypedilum aviceps,* Brook Trout, Blacknose Dace, Slimy Sculpin	Small Cold Water High Gradient
Upper-Mid Hollow Brook adjacent to Hinesburg Hollow Road, Small N/S trib entering at Prison Hollow Road	B5, B6,F4	*Hydatophylax sp Polycentropus sp, Litobrancha sp, Cordulegaster sp,Hyallela sp Dubiraphia sp, Polypedilum scalaenum, Leptophlebidae, Pisisdium spp* *Odonata - Aeshnidae, Calopterygidae, Coenargionidae, Gomphidae.* Blacknose Dace, Brook Trout, Common Shiner	Small - Moderate Mixed Water Low Gradient
Mid Below Rt 116 to Pond Brook confluence	B3,F3,F5	*Chloroperlidae1-4; Dolophilodes1-5; Hexatoma1-3; Rhychophila1Lepidostoma; Apatania; Ceratopsyche slossonae; Promoresia tardella; Optioservous sp; Eukiefferella brehmi; Tvetenia bavarica; Microtendipes; Epeorus; Capniidae; Leuctridae; Agnetina; Isogenoides* Bluntnose Minnow, Creek Chub, Brook Trout, Blacknose Dace	Moderate Mixed Water/Cool High Gradient
Mid Short reaches immediately below Outlets of Monkton Pond & Bristol Pond	B9,F4,F5	*Simulidae, Hydropsyche, Chematopsyche, Ceratopsyche. Tanytarsini* Blacknose Dace, Common Shiner, Brook Trout	Lake Marsh Outlet Streams
Mid-Lower Small streams directly entering Lewis Creek from Pond Brook outlet stream to Lake Champlain	B6,B7,F5	*Apsectrotnypus sp, Hyallela sp, Pisidium sp Dubiraphia sp, Polypedilum scalaenum, Leptophlebidae, Odonata - Aeshnidae, Calopterygidae, Coenargionidae, Gomphidae. Hydatophylax sp* Creek Chub, Blacknose Dace, Bluntnose Minnow	Small-Moderate Warm Water Low Gradient
Mid-Lower Below Pond Brook to Rte. 7/Greenbush	B4,F5	*Promeresia elegans; Neoperla; Chimara ; Stenelmis ; Isonychia; Polypedilum convictum; Dubiraphia; Promoresia elegans* Bluntnose Minnow, Creek Chub	Large Warm Water Moderate Gradient
Lower Below Fall line, Rte. 7/ Greenbush to Lake Champlain	B8,F6,	*Potamilus alatus, Lampsilis ovata, Leptodea fragilus, Pyganodon grandis, Hexagenia limbata, Sphaerium spp; Pisidium henslowanum; Dubiraphia, Phylocentropus, Gammarus sp Polypedilum halterale, Spheromias & Culicoides* Redhorse, Lamprey, Pumpkinseed, Bluntnose Minnow	Large Warm Water Low-Moderate Gradient

Lewis Creek Macroinvertebrate Assemblage Categories and Types

High and *Moderate* Gradient Categories - Coarse substrates of gravel-cobble-boulder

Type MA2: *Small Headwater Canopied Mountain Streams*, *low-moderate alkalinity and pH*
These are small full canopied heterotrophic headwater streams found all over Vermont that are not critically acidic. Taxa from the leaf shredder functional group are well represented. They are more common at elevations over 1000 feet, but can be found at lower elevations if the gradient right.

Indicator Taxa*:* *Rithrogenia sp1,2,3; Symphitopsyche sparna 1-4; Simulium tubersom 1-4; Antocha 1; Glossosoma 1-2*
Preferential taxa: *Peltoperla; Chloroperlidae; Malirekus; Capniidae; Olimnius; Optioservus; Ectopria; Cricotopus; Agnetina; Ephemerella; Serratella; Polipedilum aviceps; Hexatoma*

Type MA3: *Moderate Sized Open Canopied Mountain Streams,* *moderate alkalinity and pH.*
These are streams that are open to direct sunlight overhead often having on the average about 45% canopy cover. The pH is often over 7.0, and the alkalinity never limiting. Species that are functionally classified as algae shredders or scrapers are usually well represented taking advantage of the autotrophic stream productivity.

Indicator Taxa: *Chloroperlidae1-4; Dolophilodes1-5; Hexatoma1-3; Rhychophila1-3*; *Olimnius1*
Preferential taxa: *Brachycentrus sp; Lepidostoma; Apatania; Symphitopsyche slossonae; Polycentropus; Promoresia tardella; Optioservous sp; Eukiefferella brehmi; Tvetenia bavarica; Parachaetocladius; Micropsectra; Microtendipes; Polypedilum aviceps*; *Epeorus; Rhithrogena; Gomphidae; Capniidae; Peltoperla; Leuctridae; Agnetina; Isogenoides.*

Type MA4: *Large Streams (small rivers)*, open canopy and warmer summer temperatures
A moderate to high alkalinity and pH.
These are large streams and as a result the canopy cover is often less then 35%. They are usually high in pH and alkalinity. In Vermont they are generally found in the lower valleys of the major watersheds.

Indicator Taxa*:* *Promeresia elegans1-3 ; Neoperla 1-3; Chimara 1-6; Stenelmis 1-5;*
Preferential Taxa: *Isonychia4-5; Polypedilum convictum 1-2; Dubiraphia 1; Promoresia elegans 1-3*

Low Gradient Categories - Clay-silt-sand dominated substrates

Type MA5: *Small Headwater Marsh Streams*
These streams are generally found in Green Mts at elevations over 500 ft. They tend to have more sand then silt and clay, and are often associated with springs, and therefore are cold. Wetland vegetation along the riparian zone is dense offering a complete canopy of the stream. The riparian zone vegetation is often alder, willow, red dogwood or cedar.
Indicator Taxa: Pisidium sp, Polycentropus sp, Litobrancha sp, Cordulegaster sp.

Type MA6: *Medium Sized Midreach Meandering Streams of Moderate to High Elevation*
These streams are located in the broader valleys of Vermont with low slopes of large drainage areas. They often are associated with a large well developed floodplain/marsh. The riparian vegetation again is often dominated by alders, willows, and poplars.
Indicator Taxa: Dubiraphia sp, Polypedilum scalaenum, Leptophlebidae, Pisisdium spp
Odonata - Aeshnidae, Calopterygidae, Coenargionidae, Gomphidae. Hydatophylax sp

Type MA7: *Small Streams in Lake Champlain Valley*, many enter directly into the lake.
These streams originate in the Champlain Valley and are always high in pH and alkalinity most do not contain large mussels. They are generally alder/willow lined and often have Beaver dams.
Indicator Taxa: Tipula sp, Atherix sp, Simulium grpA, Apsectrotnypus sp, Hyallela sp, Pisidium sp, Rheocricotopus sp, Stenonema sp

Type MA8: *Moderate to Larger Rivers Immediate to Lake Champlain*
These streams are all located below the glacial lake Afall line@ located at about 250 foot elevation. The communities contain additional species of bivalves and gastropods that are only found in Vermont below this Afall line@ feature. The rivers are often dominated by sand gravel in midstream with silt/clay banks.
Indicator Taxa: Potamilus alatus, Lampsilis ovata, Leptodea fragilus, Pyganodon grandis, Hexagenia limbata, Sphaerium spp; Pisidium henslowanum; Dubiraphia, Phylocentropus, Gammarus sp Polypedilum halterale, Spheromias & Culicoides

Special Stream Habitats

Type MA9: ***Lake/Marsh Outlet Streams***. Ashort stream reach immediately below the outlet of a lake or large wetland. These communities are dominated by filter collector species. They are often warm in the summer and carry a seston and high dissolved organic matter load from the upstream lake/wetland. They are often dominated by Blackflies in the spring/summer and caddisflies in the summer/fall. **Indicator Taxa*:*** Simulidae, Hydropsyche, Chematopsyche, Symphytopsyche. Tanytarsini,

Lewis Creek Fish Assemblage Categories and Types

Assemblage 1*: *Brook Trout

This assemblage type is comprised of only brook trout. This species is most often the only species to be present in uppermost headwater areas of coldwater streams. This category can be found nearly anywhere in the state where waters are cool enough. The brook trout assemblage does not occur in the lower elevations of the Champlain Valley where warm water assemblages dominate.

Assemblage 2: Brook Trout-Slimy Sculpin

This cold water assemblage is found in nearly identical habitats as assemblage 1 but situated slightly farther downstream. Brook trout are joined in this assemblage type by slimy sculpin and blacknose dace. The slimy sculpin is also a cold, headwater species not found in the lower elevation warmer streams of the Champlain Valley. The blacknose dace is a hearty, widespread minnow found in a range of stream conditions from near pristine to degraded.

Assemblage 3: Brook Trout - Blacknose Dace

This cool mixed water group is characterized by those species from assemblages 1 and 2 plus additional species. Some of the species are also found in warm water assemblages. In addition to those of the first two categories, prominent species of this group are longnose dace, creek chub, longnose and white sucker. Also common are the exotic rainbow and brown trout. Sites from this group have slightly larger drainage areas and are present at most elevations above the Champlain Valley floor.

Assemblage 4: Common Shiner– Brook Trout

This is a transition cold-warm water community. More warmwater species enter into this assemblage type which is dominated by black and longnose dace, white sucker and creek chub. Common shiners first appear in this assemblage. Tolerant forms from the genus *Pimephales* (fathead and bluntnose minnow) become more common in this group. Locations supporting this assemblage type are low to mid elevation, with intermediately-sized drainage areas.

Assemblage 5: Bluntnose Minnow-Creek Chub

This assemblage is essentially a warm water community type, dominated by bluntnose minnow, creek chub, blacknose dace, tessellated darter and white sucker. The three principle coldwater stenotherms are essentially absent. Most of these sites will be located in the lower elevation Champlain valley in the proximity of Lake Champlain. A majority of these sites are intermediate to large size.

Assemblage 6: Pumpkinseed- Bluntnose Minnow

This group can be described as a warm water collection of species in moderate to large tributaries of Lake Champlain. These sites are located at or near lake level and include the lower Poultney River, Otter and Lewis Creek, and the Winooski, Lamoille and Mississquoi Rivers. Assemblages of these areas are the most diverse in Vermont owing in part to their close connection to Lake Champlain which supports about 80 of the 91 fish species that occur in Vermont.

Table 2 -
Lewis Creek Fish Assemblage Categories and Types

General temperature categories are indicated for each fish assemblage type. Each assemblage type includes a list of species present in order of frequency encountered at sites in the category.
Bolded species include native and exotic species documented in Lewis Creek. Exotic species are marked with double asterisks. Fish Community Type 6 is below the "Fall Line".

COLD WATER		**TRANSITION/MIXED**		**WARM WATER**	
Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
BROOK TROUT	**BROOK TROUT SLIMY SCULPIN**	**BROOK TROUT BLACKNOSE DACE**	**COMMON SHINER BROOK TROUT**	**BLUNTNOSE MINNOW CREEK CHUB**	**PUMPKINSEED BLUNTNOSE MINNOW**
Brook Trout	**Blacknose Dace** **Slimy Sculpin** **Brook Trout**	**Blacknose Dace** **Slimy Sculpin** **Brook Trout** Longnose Dace ****Brown Trout** **Creek Chub** Longnose Sucker **White Sucker** ****Rainbow Trout** Fathead Minnow **Common Shiner** Redbelly Dace Lake Chub Tessellated Darter Bluntnose Minnow **Brown Bullhead**	**Blacknose Dace** **Longnose Dace** **White Sucker** **Slimy Sculpin** **Common Shiner** **Creek Chub** Fallfish **Brook Trout** ****Brown Trout** **Longnose Sucker** ****Rainbow Trout** Burbot **Bluntnose Minnow** Fathead Minnow Rock bass Cutlips Minnow Finescale Dace Fantail Darter Smallmouth Bass **Golden Shiner** Mimic Shiner Chain Pickerel *Pearl dace *Brassy Minnow	**Creek Chub** **Blacknose Dace** **Bluntnose Minnow** **White Sucker** **Common Shiner** **Tessellated Darter** **Log Perch** **Longnose Dace** Banded Killifish Rock Bass **Redbelly Dace** Cutlips Minnow Brown Bullhead Pumpkinseed Smallmouth Bass Spotfin Shiner **Rosyface Shiner** Yellow Perch Golden Shiner Brook Stickleback Mottled Sculpin Brook Trout Finescale Dace Fantail Darter Mimic Shiner Chain Pickerel **Fathead Minnow** ****Brown Trout** * Troutperch **Sea Lamprey**	**Pumpkinseed** **Bluntnose Minnow** **Yellow Perch** **Silvery Minnow** **White Sucker** **Creek Chub** **Tesselated Darter** **Golden Shiner** **Mimic Shiner** **Log Perch** **Fallfish** **Spotfin Shiner** **Rosyface Shiner** Blackchin Shiner **Blacknose Dace** Bluegill Bridle Shiner **Brown Bullhead** **Emerald Shiner** **Rock Bass** **Sea Lamprey** Cutlips Minnow **Smallmouth Bass** **Longnose Dace** **Fathead Minnow** **Chain Pickerel** **Common Shiner** *E. Sand Darter *Channel Darter ***Redhorse sp**. *Blacknose Shiner *Longnose Gar ***Northern Pike** *Walleye ***White Perch** ***American Eel**

Rare and Endangered species of Lewis Creek

Table 3 below lists the rare and Vermont listed (threatened and endangered) species found within the Lewis Creek watershed. Lewis Creek currently supports populations of six listed animal species, four endangered mussels and two threatened mussels. Five of these are found in the lower reaches of Lewis Creek within the natural community macroinvertebrate type B8. The sixth *Margaritifera margaritifera* Eastern Pearlshell found within mid-reaches of Lewis Creek as part of macroinvertebrate natural community type B3.

Several additional mussel species, the common mudpuppy, and two fish species are considered rare to uncommon in Vermont by the VTFW Natural Heritage Program and receive an S2 or S3 ranking. All of these species are found in habitats that are found in the main branch from Scott Pond to the Lake. Six aquatic plant species are also ranked as S1, S2, or S3 – very rare, rare, or uncommon by VTFW Natural Heritage program. All these plants are found in one or both of Cedar or Winona Lakes.

Table 3.
Vermont listed Endangered, Threatened, and Rare S1, S2 ranked aquatic species within stream reaches or lakes of the Lewis Creek watershed. These species are associated with certain macroinvertebrate assemblage types described in Table 1.

Animal	Scientific Name	Status	MA/B ANC Type	General Location
Pocketbook	*Lampsilis ovata*	E	B8	Below Rt 7 to Lake
Fluted Shell	*Lasmigona costata*	E	B8	Below Scott Pd to Lake
Pink heelsplitter	*Potamilus alatus*	E	B8	Below Rt 7 to Lake
Fragile papershell	*Leptodea fragilis*	E	B8	Near mouth
Giant Floater	*Pyganodon grandis*	T	B8	Near mouth
Eastern Pearlshell	*Margaritifera margaritifera*	T	B3	Mid main stem
Creek Heelsplitter	*Lasmigona compressa*	S2	B6,B8	Ab Scott Pd, Pond Brk
Triangle Floater	*Alasmidonta undulata*	S3	B3, B8	Mid Main stem and Below Rt 7 to Lake
Common mudpuppy	*Necturus maculosus*	S2		Lower Lewis Creek
E.Silvery Minnow	*Hybognathus regius*	S2		Below Ferrisburg falls
Rosyface shiner	*Notropus rubellus*	S2S3		Scott Pd-Lake
Plant				
Straight-leaf pondweed	*Potamogeton strictifolius*	S2		Cedar Lake, Winona Lake
Nuttall waterweed	*Elodea nuttali*	S2		Cedar Lake
Common water-nymph	*Najas guadalupensis*	S1		Winona Lake
Arrowleaf	*Peltandra virginica*	S1		Winona Lake
Humped bladderwort	*Utricularia gibba*	S3		Winona Lake
Hidden-fruited bladderwort	*Utricularia geminiscapa*	S3		Cedar Lake, Winona Lake