

Supplemental Material

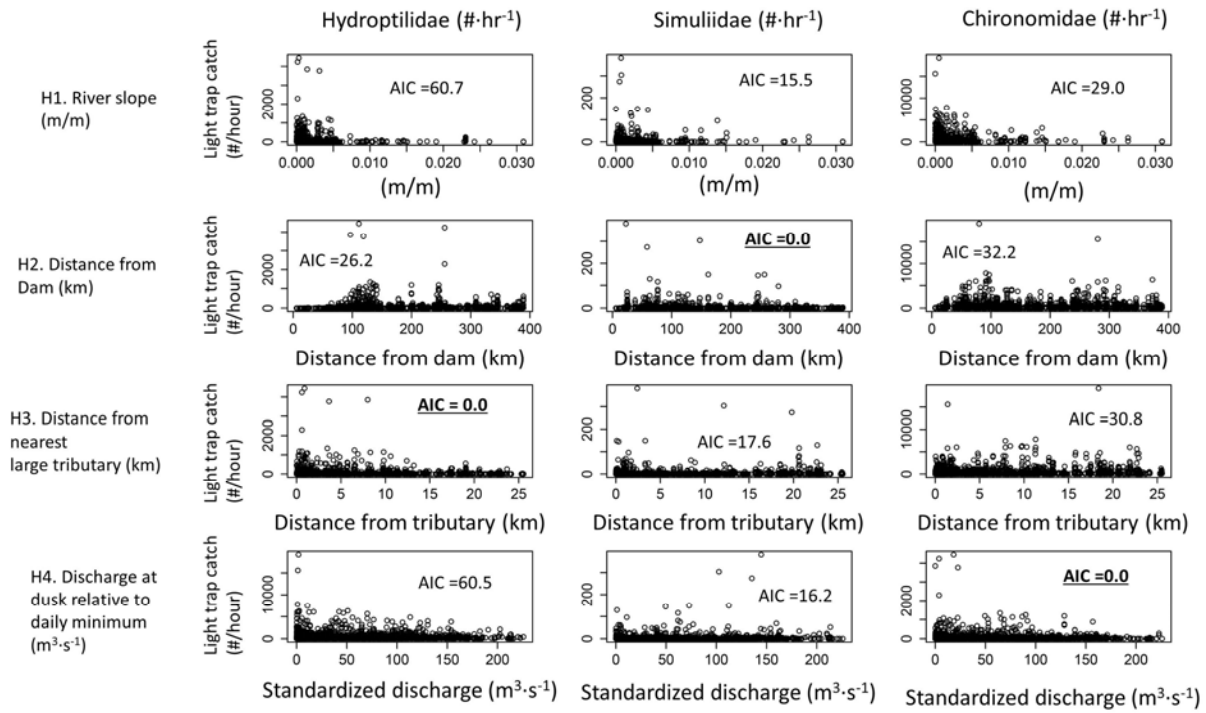


Figure S1. Twelve-panel figure showing relationship between abundance of three aquatic insect taxa in Grand Canyon and 4 hypothesized controls. Δ BIC for each model is shown, with the best performing model for each taxa underlined and **BOLD**.

Table S1. Δ BIC table comparing multivariate models for the three dominant insect taxa collected in Grand Canyon light trap samples. The best performing model for each taxa is underlined and **BOLD**.

Model	Micro-caddisflies	Blackflies	Midges
Base model (temporal and spatial random effects)	63.9	11.9	27.4
River slope	71.7	15.5	29.0
Distance from dam	37.3	<u>0.0</u>	32.2
Distance from tributaries	11.1	17.6	30.8
Hydropeaking waves	71.6	16.2	<u>0.0</u>
River slope, distance from dam	45.1	3.2	33.8
River slope, distance from tribs	18.1	21.5	32.4
River slope, hydropeaking waves	79.4	19.3	0.6
Distance from dam, distance from tribs	<u>0.0</u>	7.3	36.4
Distance from dam, hydropeaking waves	44.3	4.4	1.6
Distance from tribs, hydropeaking waves	17.9	22.0	4.0
River slope, distance from dam, distance from tribs	7.4	10.7	39.3
River slope, distance from dam, hydropeaking	52.1	7.3	2.1
River slope, distance from tribs, hydropeaking	24.7	25.5	5.1
Distance from dam, distance from tribs, hydropeaking	6.1	12.0	6.7
River slope, distance from dam, distance from tribs, hydropeaking	13.3	15.0	7.5

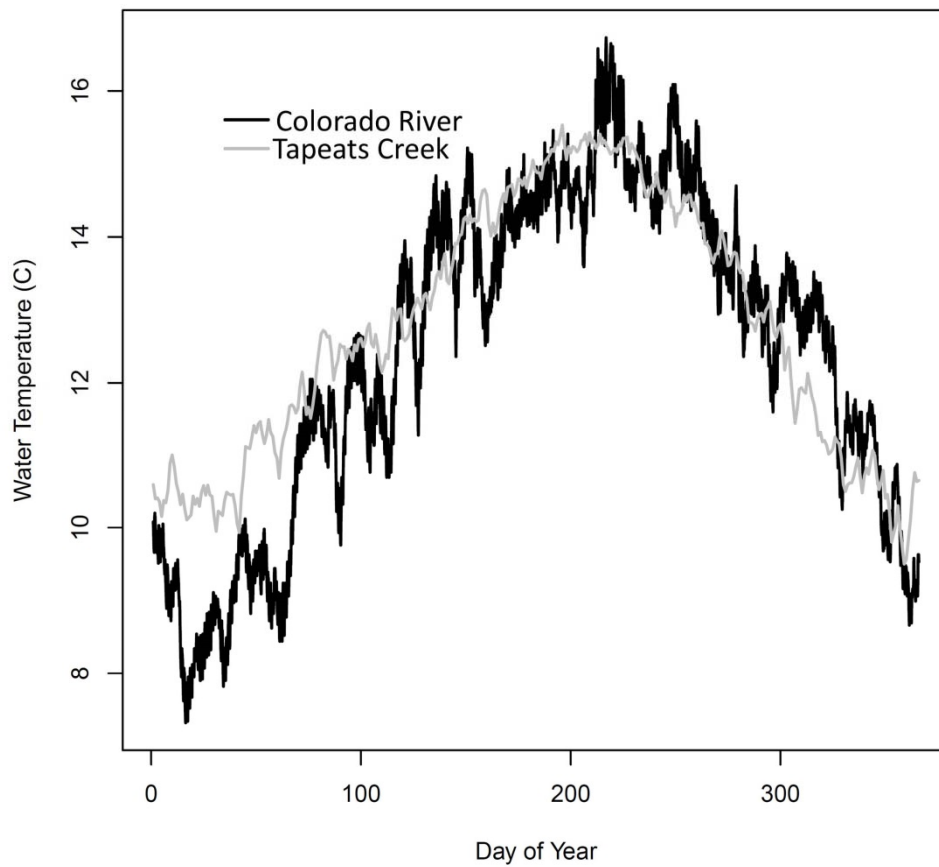


Figure S2. Tapeats Creek and the mainstem Colorado River have similar water temperatures, yet the 11 EPT taxa that are present in Tapeats Creek have not colonized the mainstem river. Mainstem Colorado River data are from the temperature gage at river mile 127 (~229 kilometers from the dam). Tapeats Creek is 240 kilometers from the dam. Data are available at http://www.gcmrc.gov/discharge_qw_sediment/stations/GCDAMP

Table S2. Summary table of dams, rivers, hydropeaking index, and invertebrate data included in figure 6b.

Letter in figure 6	Dam	River	State	Hydropeaking index	Mean EPT %	n	Years	Data source
A	Hoover	Colorado	NV/AZ	0.56	0.06	46	2015	USGS GCMRC
B	Glen Canyon	Colorado	AZ	0.17	0.00	634	2006-2009	USGS GCMRC
C	Flaming Gorge	Green	UT	0.13	7.56	327	1985-2013	USU Bug Lab, Nelson
D	Deer Creek	Lower Provo	UT	0.10	28.65	3	1999-00	USGS BioData
E	Starvation	Strawberry	UT	0.07	39.75	3	2001-02, 2007	USU BugLab, Nelson, Carlisle
F	Pine Flat	Kings	CA	0.05	57.33	6	2006-07, 1996-97,	Kings River Cons. Dist., CADFG
G	Echo	Weber	UT	0.05	56.32	9	2002-05, 2007	USU BugLab
H	Wanship	Weber	UT	0.03	31.20	7	1994-2006, 2008-12	USU BugLab
I	Causey	Ogden	UT	0.03	33.97	4	1996-98	USU Bug Lab
J	Owyhee	Owyhee	OR	0.03	49.24	30	2001-02, 2005	USU Bug Lab, Perkins
K	Libby	Kootenai	MT	0.03	35.45	3	2005, 1996-98,	EcoAnalysts
L	Crystal	Gunnison	CO	0.02	38.30	12	2001, 2003-04, 2007, 2011	USGS BioData, USU Bug Lab
M	Navajo	San Juan	NM	0.02	28.67	67	1994-96, 2005-07, 2009-10	DuBey, McKinstry, USU Bug Lab, EcoAnalysts
N	Fontenelle	Green	WY	0.01	50.96	86	1995-2013	USU Bug Lab, Nelson, Carlisle
O	Tongue	Tongue	MT	0.01	71.29	3	2004, 2011	USGS BioData, USU BugLab
P	Holter	Missouri	MT	0.01	40.29	17	1995-2011	PPL Montana

Table S3. Δ BIC table comparing various models for the regional insect diversity data. The best performing model is underlined and **BOLD**. Univariate hydropeaking model comparisons are for different curve types for the hydropeaking index variable (linear, exponential, or logistic), indicating that the logistic function produced the best performing model. Variables other than the hydropeaking index, when included in models either in isolation or in combination, actually decreased model quality based on increases in BIC (Bayesian information criterion). Only linear models were compared for those other variables, because univariate models (not shown) for those variables indicated that the linear model performed better than exponential or logistic functions in those cases.

Model	Δ BIC	Model weight
Hydropeaking (Linear)	0.8	0.2906
Hydropeaking (Exponential)	14.8	0.0003
Hydropeaking (Logistic)	<u>0.0</u>	0.4335
Dam Height	4.2	0.0536
Channel width	15.9	0.0002
Hydropeaking + Dam height	1.6	0.1997
Hydropeaking + Channel width	6.8	0.0144
Hydropeaking + Dam height + Channel width	8.1	0.0074

Table S4. Key to genera pictured in figure 7.

Order of appearance	Fontenelle	Flaming Gorge	Glen Canyon	Phylum	Class	Order	Family	Genus	Photo source	Photographer copyright	Website
1		X		Arthropoda	Insecta	Ephemeroptera	Baetidae	Acentrella	USGS Fort Collins Sci. Center	USGS Fort Collins Sci. Center.	https://www.fort.usgs.gov/
2	X	X		Arthropoda	Insecta	Ephemeroptera	Baetidae	Baetis	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
3	X	X		Arthropoda	Insecta	Ephemeroptera	Baetidae	Callibaetis	CA Aq. Bioassessment Lab	CA Aq. Bioassessment Lab, 2015	http://www.dfg.ca.gov/abl/
4	X			Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Attenella	CalPhotos	Shelley Pneh, 2015	http://www.calphotos.berkeley.edu/
5	X	X		Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Ephemerella	USGS Fort Collins Sci. Center	USGS Fort Collins Sci. Center.	https://www.fort.usgs.gov/
6	X			Arthropoda	Insecta	Ephemeroptera	Ephemeridae	Ephemerella	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
7	X	X		Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Ephemerella	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
8	X	X		Arthropoda	Insecta	Ephemeroptera	Leptohyphidae	Tricorythodes	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
9	X			Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	Choroterpes	USGS Fort Collins Sci. Center	USGS Fort Collins Sci. Center.	https://www.fort.usgs.gov/
10		X		Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	Leptophlebia	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
11		X		Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	Paraleptophlebia	CalPhotos	Shelley Pneh, 2015	http://www.calphotos.berkeley.edu/
12		X		Arthropoda	Insecta	Trichoptera	Brachycentridae	Brachycentrus	Discoverlife.org	Donald S. Chandler, 2007	http://www.discoverlife.org/
13		X		Arthropoda	Insecta	Trichoptera	Brachycentridae	Micrasema	USGS Fort Collins Sci. Center	USGS Fort Collins Sci. Center.	https://www.fort.usgs.gov/
14	X			Arthropoda	Insecta	Trichoptera	Glossosomatidae	Culoptila	Inaturalist.org	Bob Henricks, 2010	http://www.inaturalist.org/
15	X			Arthropoda	Insecta	Trichoptera	Helicopsychidae	Helicopsycha	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
16	X			Arthropoda	Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
17	X	X		Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsycha	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
18	X	X		Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsycha	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
19	X	X		Arthropoda	Insecta	Trichoptera	Hydropsychidae	Leucotrichia	CalPhotos	Shelley Pneh, 2015	http://www.calphotos.berkeley.edu/
20	X	X		Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostoma	USGS Fort Collins Sci. Center	USGS Fort Collins Sci. Center.	https://www.fort.usgs.gov/
21	X			Arthropoda	Insecta	Trichoptera	Lentoceridae	Ceraeola	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
22	X	X		Arthropoda	Insecta	Trichoptera	Leptoceridae	Oecetis	Discoverlife.org	Donald S. Chandler, 2008	http://www.discoverlife.org/
23		X		Arthropoda	Insecta	Trichoptera	Limnephilidae	Psychodolynha	CalPhotos	Shelley Pneh, 2015	http://www.calphotos.berkeley.edu/
24		X		Arthropoda	Insecta	Trichoptera	Rhyacophilidae	Rhyacophila	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
25	X			Arthropoda	Insecta	Plecoptera	Chloroperlidae	Sweltsa	Discoverlife.org	Donald S. Chandler, 2008	http://www.discoverlife.org/
26	X	X		Arthropoda	Insecta	Plecoptera	Perlidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
27	X	X		Arthropoda	Insecta	Plecoptera	Perlidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
28		X		Arthropoda	Insecta	Plecoptera	Taeniopterygidae		USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
29	X			Arthropoda	Insecta	Lepidoptera	Pyrilidae		USGS Fort Collins Sci. Center	USGS Fort Collins Sci. Center.	https://www.fort.usgs.gov/
30	X	X		Arthropoda	Insecta	Odonata	Coenagrionidae		USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
31	X			Arthropoda	Insecta	Odonata	Gomphidae	Ophiogomphus	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
32	X	X		Arthropoda	Insecta	Hemiptera	Corixidae	Hesperocorixa	Discoverlife.org	Malcolm Storev, 2011-2015	http://www.discoverlife.org/
33	X			Arthropoda	Insecta	Hemiptera	Corixidae	Sigara	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
34	X			Arthropoda	Insecta	Hemiptera	Corixidae	Trichocorixa	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
35		X		Arthropoda	Insecta	Hemiptera	Notonectidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
36		X		Arthropoda	Insecta	Coleoptera	Dryopidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
37	X			Arthropoda	Insecta	Coleoptera	Dytiscidae	Agabus	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
38	X			Arthropoda	Insecta	Coleoptera	Dytiscidae	Stictotarsus	CA Aq. Bioassessment Lab	CA Aq. Bioassessment Lab, 2015	http://www.dfg.ca.gov/abl/
39	X	X		Arthropoda	Insecta	Coleoptera	Elmidae	Optioservus	USGS Fort Collins Sci. Center	USGS Fort Collins Sci. Center.	https://www.fort.usgs.gov/
40	X			Arthropoda	Insecta	Coleoptera	Hydraenidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
41	X			Arthropoda	Insecta	Coleoptera	Hydraenidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
42		X		Arthropoda	Insecta	Diptera	Athericidae	Atherix	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
43	X	X		Arthropoda	Insecta	Diptera	Ceratopogonidae		USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
44	X	X	X	Arthropoda	Insecta	Diptera	Chironomidae		USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
45		X		Arthropoda	Insecta	Diptera	Dolichopodidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
46		X		Arthropoda	Insecta	Diptera	Empididae	Chelifera	U Iowa State Hygenic Lab	U Iowa State Hygenic Lab, 2016	http://www.shl.uiowa.edu/
47	X	X		Arthropoda	Insecta	Diptera	Empididae	Hemerodromia	USGS Fort Collins Sci. Center	USGS Fort Collins Sci. Center.	https://www.fort.usgs.gov/
48		X		Arthropoda	Insecta	Diptera	Ephydriidae		USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
49	X			Arthropoda	Insecta	Diptera	Muscidae		USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
50	X			Arthropoda	Insecta	Diptera	Psychodidae	Limnophora	USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
51	X	X	X	Arthropoda	Insecta	Diptera	Simuliidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
52		X		Arthropoda	Insecta	Diptera	Stratiomyidae	Caloparyphus	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
53	X	X		Arthropoda	Insecta	Diptera	Tipulidae	Tipula	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
54	X	X	X	Arthropoda	Malacostraca	Amphipoda	Gammaridae	Gammarus	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
55	X	X		Arthropoda	Malacostraca	Amphipoda	Hyalellidae	Hyalella	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
56	X			Mollusca	Bivalvia	Veneroida	Pisidiidae	Pisidium	Discoverlife.org	Malcolm Storev, 2011-2015	http://www.discoverlife.org/
57	X		X	Mollusca	Bivalvia	Veneroida	Sphaeriidae		Discoverlife.org	Malcolm Storev, 2011-2015	http://www.discoverlife.org/
58	X	X		Mollusca	Gastropoda	Basommatophora	Lymnaeidae	Lymnaea	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
59	X			Mollusca	Gastropoda	Basommatophora	Lymnaeidae	Stagnicola	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
60	X	X	X	Mollusca	Gastropoda	Basommatophora	Physidae	Physa	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
61	X	X		Mollusca	Gastropoda	Basommatophora	Planorbidae	Gyraulus	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
62	X			Mollusca	Gastropoda	Neotaenioiostoma	Hydrobiidae	Fluminicola	Smithsonian Nat. Mus. of Nat.	Robert Hersher, 1999	http://collections.nmnh.si.edu/
63	X	X	X	Mollusca	Gastropoda	Neotaenioiostoma	Hydrobiidae	Potamopyrgus	USFWS Pacific Region	Dan Gustafson, 2012	https://www.flickr.com/photos/usfwsnspacific/
64	X			Annelida	Citellata	Arhynchobdellida	Erbobdellidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
65		X		Annelida	Citellata	Arhynchobdellida	Erbobdellidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
66	X	X		Annelida	Citellata	Arhynchobdellida	Erbobdellidae		Discoverlife.org	Malcolm Storev, 2011-2015	http://www.discoverlife.org/
67	X	X	X	Annelida	Citellata	Arhynchobdellida	Erbobdellidae		Discoverlife.org	Malcolm Storev, 2011-2015	http://www.discoverlife.org/
68	X			Annelida	Citellata	Arhynchobdellida	Erbobdellidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
69	X			Annelida	Citellata	Arhynchobdellida	Erbobdellidae		USU/BLM BugLab	USU/BLM BugLab, 2016	http://www.usu.edu/buglab/
70	X	X	X	Arthropoda	Arachnida	Trombidiformes	Glossiphoniidae	Glossiphonia	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
71	X	X	X	Nemata				Helobdella	VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
72	X	X	X	Platyhelminthes	Turbellaria				VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/
73	X			Porifera	Demospongiae	Haplosclerida	Spongiellidae		VCSU Waterbug Key	VCSU Waterbug Key, 2016	http://www.waterbugkey.vcsu.edu/