

American Eel Sampling in Lake Champlain 2016 Progress Report

Prepared By
Nicholas Staats, Fishery Biologist
USFWS, Lake Champlain Fish and Wildlife Conservation Office
Essex Junction, Vermont
Nicholas_Staats@fws.gov



Introduction

American eel *Anguilla rostrata* support important commercial fisheries where populations remain at harvestable levels. However, downward trends in harvest data have raised concern for the population of eel in the United States and Canada. Organizations such as the Great Lakes Fishery Commission and the Atlantic States Marine Fisheries Commission have identified the eel as a high research priority and/or have prepared management plans for the species. In Vermont, the American eel is listed as a medium priority species in the state's wildlife action plan with monitoring populations and maintaining an eel database ranking as high priorities (Vermont Fish & Wildlife Department 2015)

The Richelieu River connects northern Lake Champlain to the St. Lawrence River and supported a commercial eel fishery until it was closed in 1998 because harvest dramatically declined. Poor eel passage associated with the rebuilding of two dams on the river has been partly to blame for the decline (Verdon et al. 2003). Dams at Saint-Ours, Québec and Chambly, Québec were refurbished in the mid-1960s and evidence on eel recruitment to Lake Champlain was observed in eel surveys in 1979 and 1985. Mark-recapture studies conducted in three Lake Champlain bays, Paradise Bay, Keelers Bay and Converse Bay, indicated a decline in population size (Labar and Facey 1983, Labar 1987) and an increase in average size of eel caught, reflecting an aging population that has not been sufficiently supplemented by recruits. Total catch in Paradise Bay declined from 85 eels captured in 1979 to 50 in 1985. Keeler Bay eel catch dropped from 146 eels captured to 81 eels; and Converse Bay catch dropped from 138 to 78 eels.

In 1997 an eel ladder was constructed at the dam in Chambly and in 2001 a fish ladder and an eel ladder were built at St Ours. To further enhance eel recruitment, Faune Québec, a commercial fishermen union and Hydro- Québec, initiated a ten-year eel stocking program in 2005. From 2005 to 2008 an average of about 692 thousand elvers (50-65 millimeters in length) were transferred annually from the Atlantic Coast (Nova Scotia, Canada) to the Richelieu River (Table 1), where they were scatter stocked during the daytime in the first 15 km of the river, between Saint-Paul-de-l'Île-aux-Noix and the Canada-US border. All the eels were marked with oxytetracycline which leaves a permanent mark on calcified structures (i.e., otoliths). Marks can be observed under a microscope using a fluorescent light source.

In order to monitor the success of these stocking efforts and new passage facilities, Québec asked the U.S. Fish and Wildlife Service (Service) for assistance by repeating the Lake Champlain surveys. The Service conducted eel surveys in 2007, 2010, 2012 and 2014. This report presents the findings of the 2016 sampling efforts.

Study Area

Lake Champlain (1,140 km²) borders New York and Vermont and extends into Québec (Figure 1). Five stations were included in the 2016 eel sampling efforts – the three stations sampled in 1979 and 1985 plus two additional stations (Figure 1).

In the main lake, Crane Point, Converse Bay and Grand Isle were sampled. In the Inland Sea (or what is described as the Northeast Arm of the lake), Keeler and Paradise Bays were sampled

which are situated on the eastern side of South Hero, Vermont. All the stations varied in substrate from mud with vegetation to bare rock.

Methods

Electrofishing was conducted by boat with a pulsed direct current of ~6-9 amps. Sampling was conducted after dark when eels were presumed to be most active. Sampling transects were electronically recorded using a global positioning system unit and followed the shoreline generally staying in less than 2 meters depth. An effort of one hour was selected as the sampling time which covered approximately 2 kilometers of shoreline. Collected eels were anesthetized, measured, weighed and checked for presence of a passive integrated transponder tag (PIT). Eels were tagged with PIT tags during the 2014 sampling efforts.

Results/Discussion

Eel sampling occurred from August 2 to August 10, 2016 (Figures 2 - 5). Numbers of eels collected at each location were similar or greater relative to sampling in 2014 (Table 2). The greatest increase in numbers of eels encountered was in Paradise Bay where only two eels were collected in 2012, 17 in 2014, and 31 eels were collected in 2016. Converse Bay would have had greater numbers of eels collected but we had an inexperienced netter helping in 2016.

Eels collected ranged in size from 336 millimeters (mm) to 742 mm. Mean length was 543 mm (SD = 84, n=158) and mean weight was 329 grams (SD = 176) (Table 3). Except for 2007, the average size of eel collected has increased each year and 2016 was no different. Mean total length of eels collected in 2016 were significantly larger than collected in 2014 (508 mm, SD=81, n=82) (two sample t-test, p=.002, Figure 6). Much larger eels were collected by Facey and Labar (1981) in 1979. They found lengths ranged from 430-900 mm with a mean of 670 mm (SD=91) (Figure 7). Smaller eels (< 300 mm) were not collected in 2016 as they were in the 2010 or 2012 sampling years. Figure 7 compares length frequencies for all sampling years.

In 2015, 2,247 eels migrating upstream were counted at the eel ladder in Chambly on the Richelieu River (Guillemette et al. 2015). Mean length of eels sampled was 330.7 mm (SD=70.1, n=1,488). This is similar to average lengths in 2014 and 2013 and larger than in some previous years (Table 4).

It would appear that numbers of eels in the main lake portion of Lake Champlain has increased. In previous years, movement of eel into the Northeast Arm (Keeler and Paradise Bay) had been less successful but numbers are increasing too. The Northeast Arm is somewhat isolated from the main lake by highway and old railroad causeways. Access into the Northeast Arm is limited to small openings in these causeways that allow boat traffic to pass. It would be expected that movement into this portion of the lake would be less rapid than the main lake.

Although the number of eels collected at each sampling location increased in 2016 (or at least are similar to previous years as in the case of Converse Bay), to suggest that recruitment to Lake Champlain is good is not necessarily the case. The shift in size structure towards larger eels and fewer smaller eels observed during sampling indicates fewer eels entering the lake from the

Richelieu River. Numbers of eels migrating past the dam at Chambly has been quite variable since 2003. The 2015 total of 2,247 eels passing the dam is the highest since 2010 but it is unsure if these numbers are enough to sustain a population of eel in the lake. The proportion of these eels marked as stocked eels is estimated to be 38.9% in 2009, 33.4% in 2011 and 59.6% in 2013 (Verreault et al. 2014). Given these percentages, Verreault estimates the number of eels resulting from natural recruitment at the dam to be 378 eels in 2009, 710 in 2011 and 547 in 2013, which he considers being poor natural recruitment and far from what seems necessary to rebuild the eel stock in Lake Champlain.

Prepared By: Nicholas Staats – Fishery Biologist
U.S. Fish and Wildlife Service

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References

- Facey, D. E., and G. W. Labar. 1981. Biology of American eels in Lake Champlain, Vermont. *Transactions of the American Fisheries Society* 110:396-402.
- Guillemette, S., A. Guindon et D. Desrochers. 2015. Suivi des passes migratoires à anguille à la centrale de Beauharnois et au barrage de Chambly – 2015. MILIEU Inc., pour l'unité Environnement, Gestion des actifs et conformité réglementaire, Hydro-Québec Production. 71 p.
- Labar, G. W. 1987. Changes in population structure of American eels, *Anguilla rostrata*, in Lake Champlain, Vermont, U.S.A., after initiation of a commercial fishery. Presented at the 1987 meeting of the European Inland Fisheries Advisory Council Working Party on Eel, Bristol, England, 12-16 April, 1987.
- Labar, G. W., and D. E. Facey. 1983. Local movements and inshore population sizes of American eels in Lake Champlain, Vermont. *Transactions of the American Fisheries Society* 112:114-116.
- Verdon, R., D. Desrochers, and P. Dumont. 2003. Recruitment of American eels in the Richelieu River and Lake Champlain: Provision of upstream passage as a regional-scale solution to a large-scale problem. *American Fisheries Society Symposium* 33: 125-138.
- Vermont Wildlife Action Plan Team. 2015. Vermont Wildlife Action Plan 2015. Vermont Fish and Wildlife Department. Montpelier, VT. 1177 p.
- Verreault, G., R. Tardif et M. Tremblay. 2014. Structure en âge des anguilles d'Amérique (*Anguilla rostrata*) en montaison aux passes migratoires de Beauharnois et de Chambly en 2009, 2011 et 2013. Ministère des Forêts, de la Faune et des Parcs Direction régionale de la faune du Bas-Saint-Laurent. 25 p.

Table 1. Summary of American eel stocking in the upper Richelieu River.

Year	Number of glass eels
2005	600,000
2006	1,000,000
2007	425,500
2008	746,000
Total	2,771,500

Table 2. Comparison of American eel sampling efforts in Lake Champlain. It should be noted that many eels were missed during the 2016 Converse Bay sampling due to an inexperienced netter.

Year	Number of eels collected				
	Keeler Bay	Paradise Bay	Crane Point	Converse Bay	Grand Isle
2007	0	0	na	0	1
2010	1	1	na	25	14
2012	1	2	na	57	21
2014	12	17	na	54	Not sampled
2016	18	31	41	58	10

Table 3. Summary of mean length (mm) and weight (g) of American eel sampled in Lake Champlain.

Year	Mean	SD	Min	Max	Number
Length					
2007	665	---			1
2010	458	83	282	672	41
2012	430	87	232	638	92
2014	508	81	320	760	82
2016	543	85	336	742	158
Weight					
2007	930	---			1
2010	208	131	20	640	41
2012	164	108	20	560	92
2014	297	167	40	1040	82
2016	329	176	60	980	158

Table 4. Summary of the total number and mean lengths (mm) of American eels migrating upstream through the fishway at the Chambly dam, 2007-2015. See appendix 1 for complete summary.

Year	2015	2014	2013	2012	2011	2010	2009	2008	2007
Number	2247	1264	1353	663	1066	6476	619	3333	1340
Length	331 n=1488	340 n=540	340 n=354	312 n=177	274 n=98	290 n=1070	318 n=154	295 n=1019	327 n=332

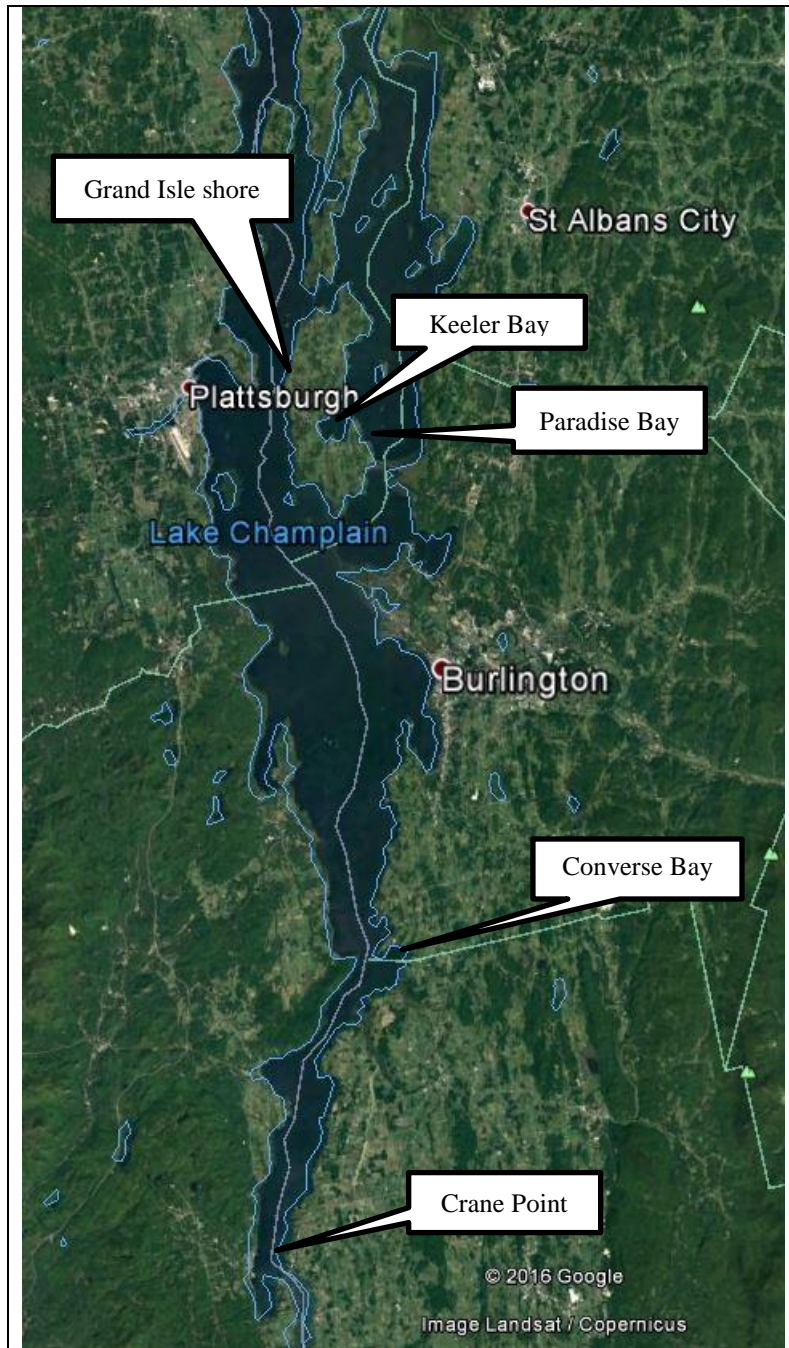


Figure 1. Map of Lake Champlain showing sampling areas.

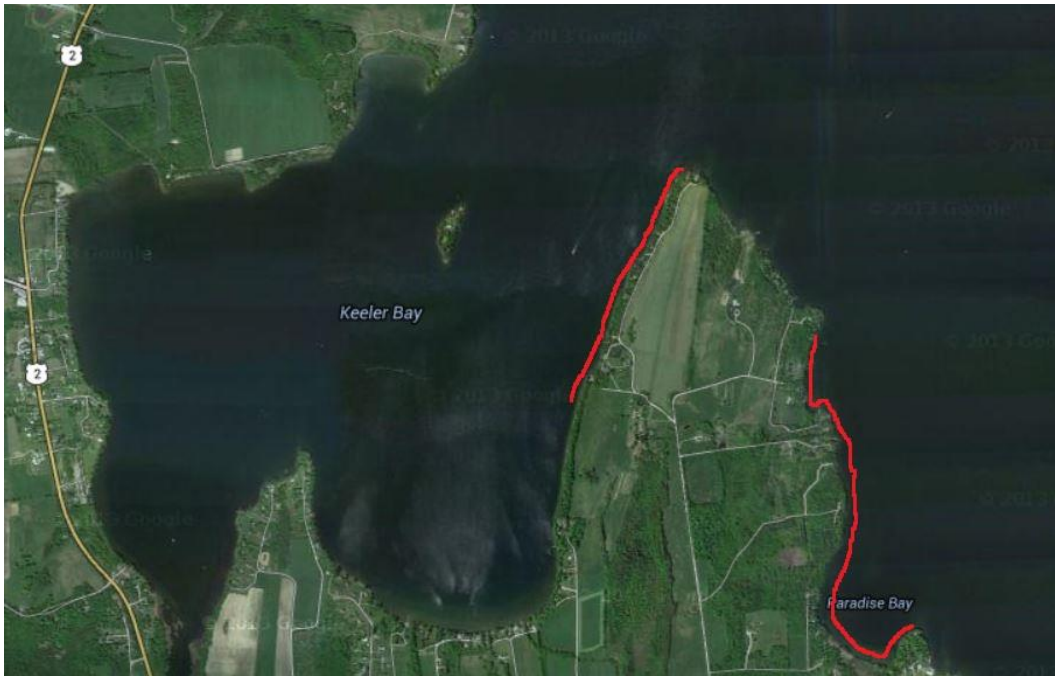


Figure 2. Map of Keeler and Paradise Bay 2016 electrofishing transects.

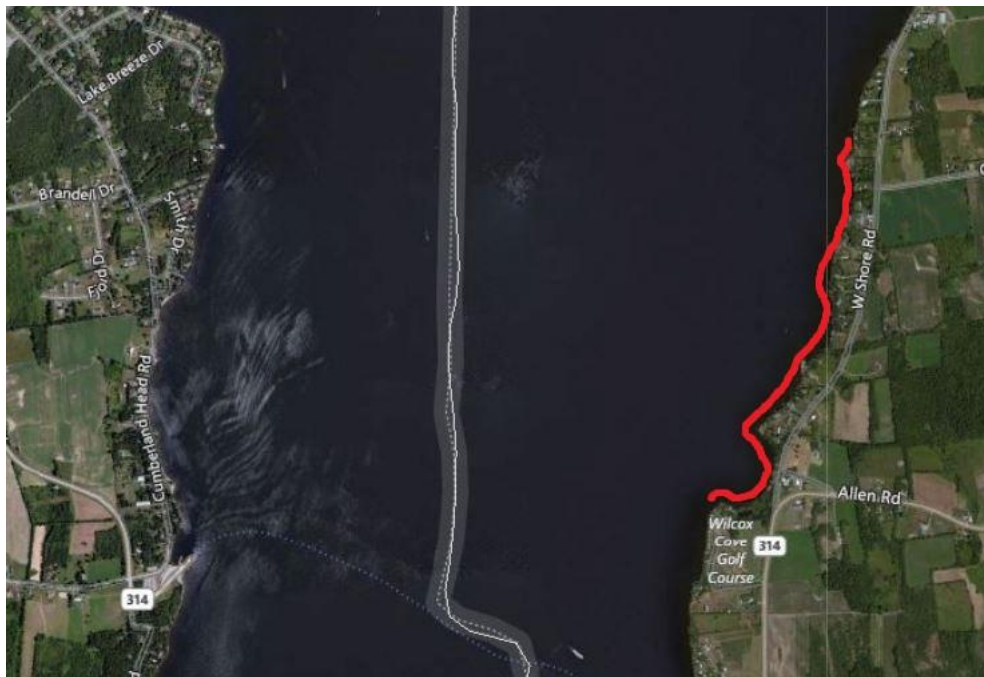


Figure 3. Map of Grand Isle 2016 electrofishing transect.



Figure 4. Map of Converse Bay 2016 electrofishing transect.



Figure 5. Map of Crane Point 2016 electrofishing transect.

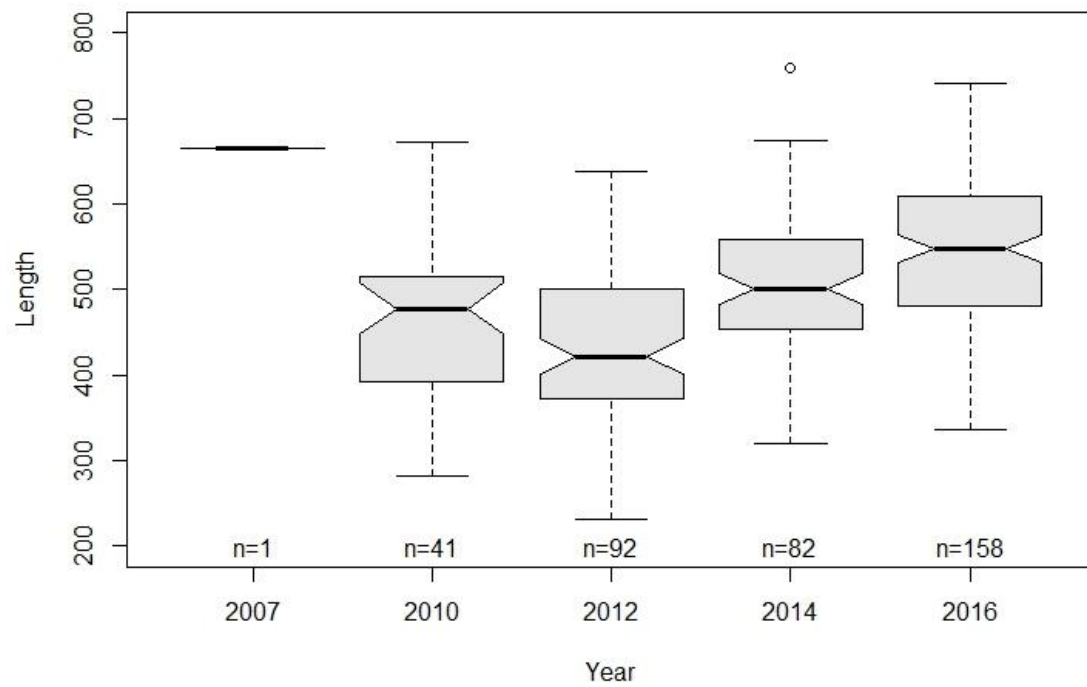


Figure 6. Box plots of length of American eels collected in Lake Champlain.

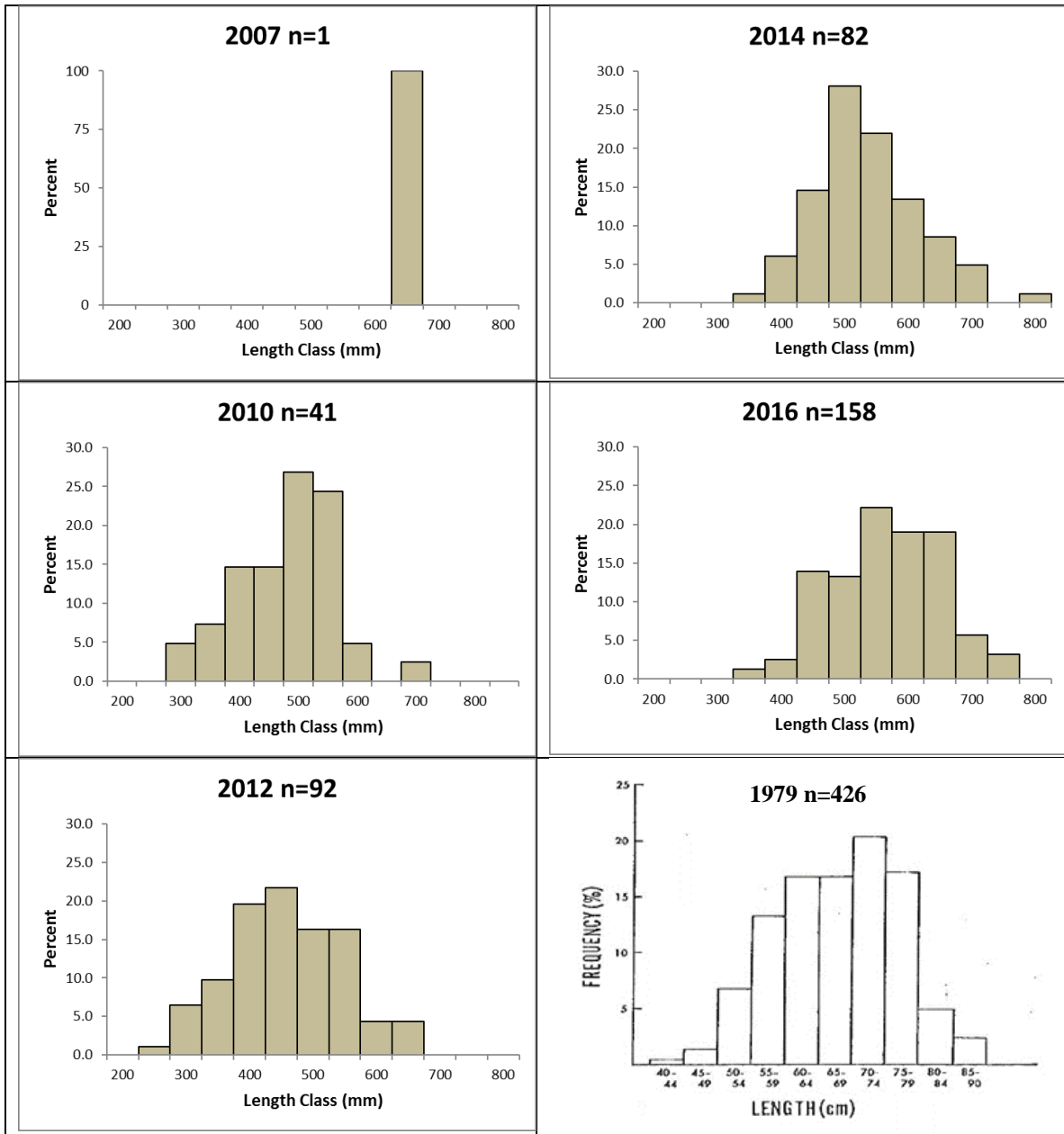


Figure 7. Comparison of length frequency (percent composition) distributions of American eel sampled in Lake Champlain including eel sampled in 1979 (n = 426), from Facey and Labar 1981.

Appendix 1

Summary of monthly counts of American eels at the Chambly dam fishway, 1998-2015. From Guillemette, S. et al. 2015.

Year	June	July	August	September	October	Total
1998	5257	2012	2126	455	25	9875
1999	721	1440	848	676	-	3685
2000	-	169	61	9	-	239
2001	-	124	156	77	-	357
2002	-	-	170	67	3	240
2003	320	1638	1378		-	3336
2004	0	574	126	27	0	727
2005	123	1986	61	7	0	2177
2006	8	377	42	7	0	434
2007	32	839	403	66	0	1340
2008	262	2949	100	22	0	3333
2009	24	103	483	9	0	619
2010	369	4653	485	969	0	6476
2011	0	762	269	35	0	1066
2012	60	210	319	74	0	663
2013	27	1190	93	43	0	1353
2014	39	340	700	156	29	1264
2015	279	798	648	517	5	2247
Percent of total	12.4	35.5	28.8	23.0	0.2	100.0
Number of Days	29	31	31	29	13	133
Average/day	9.6	25.7	20.9	17.8	0.4	16.9

Summary of mean, minimum and maximum lengths (mm) of American eels measured at the Chambly dam fishway, 1997-1998 and 2005-2015. From Guillemette, S. et al. 2015.

Year	Mean	SD	Min	Max	Number
1997	379.7	73.4	192	689	7608
1998	386.3	79.3	196	741	6737
2005	324.8	73.4	190	596	480
2006	383.3	93.4	211	625	262
2007	327.4	69.6	186	563	332
2008	294.8	63.8	196	686	1019
2009	317.8	86.9	192	730	154
2010	290.5	48.7	202	629	1070
2011	273.5	61.0	202	511	98
2012	312.2	87.6	181	638	177
2013	340.1	99.7	196	739	354
2014	340.0	89.4	190	744	540
2015	330.7	70.1	183	782	1488