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SUMMARY REPORT

STATUS OF WHITE STURGEON IN THE LOWER FRASER RIVER

REPORT ON THE FINDINGS OF THE LOWER FRASER RIVER WHITE STURGEON MONITORING AND ASSESSMENT PROGRAM 2014

BY

TROY C. NELSON[1]
DAVID ROBICHAUD[2]
TONY MOCHIZUKI[2]
JIM RISSLING[2]
KARL K. ENGLISH[2]
WILLIAM J. GAZEY[3]

FRASER RIVER STURGEON CONSERVATION SOCIETY

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[1] TCNelson Consulting, Sheldon, Queensland 4157 Australia (*troyaustralia@bigpond.com*)
[2] LGL Limited environmental research associates, 9768 Second Street, Sidney, BC V8L 3Y8
[3] W. J. Gazey Research, 1214 Camas Court, Victoria, BC V8X 4R1

TABLE OF CONTENTS

Page

LIST OF TABLES 3
LIST OF FIGURES 3
LIST OF APPENDICES 4
SUMMARY 5
ACKNOWLEDGMENTS 7
REFERENCES 9

TABLES
FIGURES
APPENICES

LIST OF TABLES

Table 1. Sampling zones used for population estimation of White Sturgeon, 2013-2014.

Table 2. Sampling regions used for population estimates of White Sturgeon, 2013-2014.

Table 3. Parameter estimates for linear and non-linear sturgeon growth models, 2008-2009.

Table 4. Population estimates for White Sturgeon in the lower Fraser River, by sampling region, 2014.

Table 5. Summary of mean annual population estimates, proportional (percent) changes in estimates between years, and 95% confidence limits for annual estimates (numeric and percent of respective mean estimates) of White Sturgeon in the lower Fraser River, 2001-2014.

Table 6. Population estimates for White Sturgeon in the lower Fraser River, by 20-cm (FL) size group, 2014.

LIST OF FIGURES

Figure 1. Illustration of the general study area and the location of the four main sampling regions (A, B, C, and D) used for data summaries presented in this report.

Figure 2. Mean population estimates of White Sturgeon in the lower Fraser River, by sampling region, 2014.

Figure 3. Mean population estimates of White Sturgeon in the lower Fraser River, by 20-cm (FL) size group, 2014.

Figure 4. Comparison of mean annual population estimates of lower Fraser River White Sturgeon, 2001-2014.

Figure 5. Comparison of mean population estimates of White Sturgeon in the lower Fraser River, by 20-cm (FL) size group, for assessment years 2004 through 2014.

Figure 6. Estimated numbers of juvenile, sub-mature, and mature adult White Sturgeon in the lower Fraser River, 2004-2014.

Figure 7. Illustration of the changes in the annual proportions of sturgeon less than 100 cm FL from all measured samples captured by angling, 2000-2014.

Figure 8. Illustration of the changes in the annual proportions of sturgeon less than 100 cm FL from all measured samples captured in the Albion Test Fishery, 2000-2014.

Figure 9. Comparison of the number of White Sturgeon (all sizes) captured in the Albion Test Fishery, 2000-2014.

Figure 10. Comparison of the number of White Sturgeon (all sizes) captured in the Albion Test Fishery, by month, 2000-2014.

Figure 11. Number of sturgeon examined for the presence of a PIT tag, by month, 2000-2014.

Figure 12. Monthly variability in estimated mark rates for White Sturgeon, 2000-2014.

Figure 13. Number of tags applied and reported number of tags recaptured, and the annual mark rate, by assessment year, 2000-2014.

Figure 14. Number of tags applied and reported number of tags recaptured, and the annual mark rate, by assessment year, in the Harrison River, 2000-2014

Figure 15. Comparison of average annual growth increments of White Sturgeon (cm), by 20-cm (FL) size group, 2001-2014.

Figure 16. Comparison of average annual growth increments of White Sturgeon (cm), by 20-cm (FL) size group, in the lower Fraser River during three time periods: 2000-04 (averaged), 2005-09 (averaged), and 2010-14 (averaged).

LIST OF APPENDICES

Appendix A. Sturgeon biosampling, tagging, and recapture data entry form.

Appendix B. Lower Fraser River sturgeon sampling, tagging, and recapture summary, by month and year, 1999-2014.

Appendix C. Numbers of sturgeon examined for marks, and numbers of recaptures, by month and sampling zone, 2013-2014.

Appendix D. Number of sturgeon recaptured and examined for a mark, by sampling zone of release and recapture, 2013-2014.

Appendix E. Proportion (corrected) of sturgeon recaptured, by sampling zone of release, 2013-2014.

Appendix F. Numbers of marked sturgeon released each month from January 2013 to December 2014, by sampling zone.

SUMMARY

The Fraser River Sturgeon Conservation Society (FRSCS), a not-for-profit charitable organization founded in 1997, has a mandate to conserve and restore Fraser River White Sturgeon, raise public awareness of Fraser River White Sturgeon and their ecosystem, and produce reliable information regarding the status Fraser River White Sturgeon and their habitat. This summary report provides population status assessments (as of January 2014) derived from the FRSCS' Lower Fraser River White Sturgeon Monitoring and Assessment Program. For detailed information regarding program background, methodologies, and population modeling, please refer to Nelson et al. (2008, 2013; the former available on the FRSCS web site: www.fraserstrgeon.com).

Since April 2000, this program has relied on the volunteer contributions of angling guides, recreational, commercial, and Aboriginal fishermen, test fishery and enforcement personnel, and various fishery monitors. Volunteers from each of these sectors were trained to sample and tag White Sturgeon, and record and transfer data (Appendix A). By December 2014, volunteers had conducted 123,245 sturgeon sampling events, tagged and released 61,009 sturgeon, and documented 56,333 recapture events of tags applied by FRSCS volunteers (Appendix B).

A Bayesian mark-recapture model has been used since 2000 to provide reliable estimates of the abundance of White Sturgeon in the lower Fraser River study area, by size/age group and location (Tables 1 and 2, Figure 1). The model includes information of tag distribution, seasonal mixing, and growth (Table 3), and estimates of mortality, emigration, and observer error. Population estimates generated from the model were bounded by sturgeon samples 40-279 cm fork length (FL), a rolling data window of 24 months, and four spatial sampling regions (see Figure 1). The model requires that any unique mark (PIT tag) had to be encountered at least twice in a 24-month window to be deemed a recapture. Valid recaptures were thus defined as either of the following occurring within the defined 24-month sampling period: 1) an initial tag application/release and a subsequent recapture of that tag, or; 2) two (or more) separate recapture events for the same tag. Appendix C presents the numbers of sturgeon examined for marks and the number of recaptures, by month and sampling zone, for the 2013-14 data window. Appendix D and E present the numbers of sturgeon recaptured and examined for a mark, and the corrected proportions of sturgeon recaptured, by sampling zone of release, for 2013-14, respectively. Appendix F presents the final numbers of marked sturgeon released by month from 2013-14, by sampling zone.

Annual population estimates generated for this series of reports (2000-2014) represent the standing population of White Sturgeon within the lower Fraser River study area at a point in time that is essentially the mid-point of the respective 24-month data windows. The 2014 population estimates presented in this summary report were generated from a 24-month data window that ran from January 2013 to December 2014; thus, the 2014 population estimates represent the standing population in January 2014. For consistency and for direct comparison of population estimates between years, annual population estimates generated for this series of reports have been based only on samples collected from the core study area (Table 1, Figure 1).

As of January 2014, the mean abundance estimate for White Sturgeon from 40-279 cm FL in the lower Fraser River was 49,130 (95% CLs +/- 4.6% of the estimate; Table 4). The average abundance of White Sturgeon within the study area in 2014 downstream of the Mission Bridge (Sampling Regions A and B) was 23,048 (46.9% of the total population estimate; Table 4, Figure 2). The average abundance of White Sturgeon within the study area in 2014 upstream of the Mission Bridge (to Lady Franklin Rock near Yale; Sampling Regions C and D) was 26,082 (53.1% of the total population estimate; Table 4, Figure 2). The total 2014 population estimate represents 5.4% decrease from the 2013 estimate, and a 15.4% decrease from the peak abundance estimated in 2003 (Table 5, Figure 4).

The total population estimate of White Sturgeon in the lower Fraser River is presented by 20-cm (FL) size group in Table 6 and Figure 3. In 2014 there was a continued decline in the number of juvenile sturgeon less than 100 cm FL, most notably for fish in the 80-99 cm FL size group (Figures 5 and 6).. The mean estimate of juvenile sturgeon in the smallest size group (40-59 cm FL) increased from the respective 2013 estimate; however, this increase was not significant (Figure 5). The estimated number of sub-mature sturgeon (100-159 cm FL) decreased slightly from the 2013 estimate, while the estimated number of mature sturgeon (160+ cm FL) increased over the 2013 estimate (Figure 6).

Comparisons of the proportions of juvenile sturgeon captured by angling only and by the Albion Test Fishery (an independent program that utilizes drift gill net gear) also suggest that the abundance of juvenile White Sturgeon less than 100 cm FL has been decreasing since 2003. In 2000, over half of the angled samples (53.2%) were less than 100 cm FL, whereas in 2014 this proportion dropped to 26.7% (Figure 7). Comparatively, samples from the Albion Test Fishery in 2000 were composed of 64.7% juvenile sturgeon less than 100 cm FL; this proportion has dropped to 16.5% in 2014 (Figure 8). Small juvenile sturgeon (less than 60 cm) are not likely sampled by angling gear as effectively as larger fish (i.e., they are not well-represented in the angled sample). Either these smaller fish are not as susceptible to angling (i.e., hook size or bait preference), or they are simply in low abundance within the population, or both; population estimates provide no information on the mechanism. Regardless of the reason, the low numbers of small juvenile sturgeon observed in the samples means that our ability to detect change in the population of sturgeon from the smallest size groups is much less than sturgeon from the larger size groups.

The abundances presented in this report are estimates of the number of sturgeon in the 40-279 cm FL size range that resided within the study area over during the 24-month data window. Although our study annually samples and applies tags to several sturgeon smaller than 40 cm and larger than 279 cm FL, the numbers of recaptured tags within those size ranges (within the 24-month assessment period) is typically too low for those samples to be included in our population analyses. In addition, some of the 40-279 cm lower Fraser River origin White Sturgeon may be located in marine and freshwater areas outside our core study area during the assessment period; thus, our estimates do not represent the entire population of lower Fraser River White Sturgeon. Other methods, such as Stock Reduction Analysis (Whitlock and McAllister 2012) and multi-year mark-recapture models, have been used to estimate both the trends and annual abundance for the entire population of lower Fraser White Sturgeon. These methods and associated assumptions have been the focus of on-going assessments under a separate project funded by the Habitat Conservation Trust Foundation (English and Bychkov 2013; Gazey and English 2014).

Freshwater areas accessible to lower Fraser River White Sturgeon that are outside the sampling areas used in the population assessments include: the entire North Arm and adjacent Middle Arm south of Lulu Island; the Pitt River (upstream of the Highway 7 bridge) and Pitt Lake; and Harrison Lake. All marine waters westward of the entrances of the Fraser River at Garry Point and Canoe Pass (Figure 1) are outside the sampling areas used in the population assessments. White Sturgeon have been observed and captured in the bays and mouths of rivers in northern Puget Sound, with additional sightings and captures in the southern Strait of Georgia and inlets/estuaries on southern and western Vancouver Island. Acoustic telemetry data have shown that a portion of lower Fraser River White Sturgeon may migrate to outer estuarine or marine areas beyond the shoreline front of the Fraser River, particularly during summer months (unpublished data, Lower Fraser River White Sturgeon Telemetry Program 2008-2012, LGL Limited.). Water and sturgeon fin ray/tissue samples from Puget Sound, the lower Fraser River, and major tributaries to the Fraser River are being collected for microchemistry and genetic analyses that could help determine the origin of individual fish, and thus further our understanding of the life history of White Sturgeon present in Puget Sound and other marine waters adjacent to the Fraser River.

Recaptures of tagged sturgeon during this study have confirmed that movements and migrations occur throughout the entire lower Fraser River study area. Many of the sturgeon tagged during this program have been recaptured and sampled multiple times by program volunteers. Approximately 50.1% (28,204 individual fish) of all sturgeon tagged through December 2014 have been sampled multiple times since the beginning of the study (for example, 3,506 individual sturgeon have been sampled five times, and 29 sturgeon have been sampled 15 times); one individual sturgeon has been sampled 22 times since 2000. Documented capture rates are produced from data submitted by FRSCS volunteers and do not reflect actual levels of capture from all sources (non-retention recreational fishery, commercial net fisheries, First Nations fisheries, illegal fisheries). Multiple capture/sampling events of individual tagged sturgeon (by FRSCS volunteers) sturgeon can occur on an annual basis, with some fish sampled up to six times in a single year. Since the commencement of the program in 1999, angling has accounted for 90.5% of all sturgeon samples, followed by samples from the Albion Test Fishery (4.2%) and First Nations net fisheries (4.0%). Comparisons of the total annual catch of White Sturgeon by the Albion Test Fishery from 2000-20014 are presented in Figure 9 (total annual catch) and Figure 10 (annual catch by month). The data used for Figures 9 and 10 are from Fisheries and Oceans Canada and are for assessment sets only.

An illustration of the distribution of the annual numbers of sturgeon examined by month from 2000-2014 is presented in Figure 11. In 2014, sturgeon samples were collected in the same relative pattern as in previous years, with an initial spike in April and a second spike from September-November. An illustration of the variability in estimated mark rates, by month, from 2000-2014, is presented in Figure 12. Figure 13 presents an illustration of the number of PIT tags applied and recaptured, and the respective annual mark rates, by assessment year. In 2014, FRSCS volunteers applied 2,596 PIT tags and recaptured 5,972 tagged sturgeon (Appendix B). The mark rate for the entire study area in 2014 varied from a low of 51.0% in February to a high of 71.8% in August; the overall mark rate for 2014 was 65.7% (Appendix B, Figure 13). Mark rates for sub-locations within the study area will vary from the respective overall mark rate; for example, the mark rate for sturgeon sampled from the Harrison River in 2014 was 87.8% (Figure 14).

A comparison of average annual growth rates, determined from measurements obtained from individual tagged sturgeon that were subsequently recaptured and re-measured, suggests that annual growth rates for most size groups of White Sturgeon were greater before 2005 (Figure 15). In 2014, the average annual growth rate for all size groups (4.37 cm/year) was very close to the respective growth rate in 2013 (4.29 cm/yr; Figure 15). The average annual growth rate for sturgeon 60-180 cm FL from 2010-2014 (4.66 cm/year) was 14.9% lower than the respective average growth rate from 2000-2004 (5.48 cm/year; Figure 16).

ACKNOWLEDGEMENTS

The novel and reliable information that has been produced by this program is a direct result of the energy, commitment, and dedication of program volunteers and sponsors. The level of in-kind contributions to the program from program volunteers, however measured (in hours, equipment, dollars, or numbers of individuals), is second-to-none for recent BC-based fisheries research programs. Program volunteers are the true stewards of the resource that is Fraser River White Sturgeon. The level of program involvement by volunteers and the significant support and interest shown by both program sponsors and the public at large is a testimony to the broad community commitment toward stock recovery of lower Fraser River White Sturgeon.

Much of the success of this program has been the result of strong leadership and scientific oversight provided by the FRSCS, a not-for-profit, registered society with a volunteer-based board of directors. The FRSCS has organized a science and technical committee, composed mostly of fishery science professionals, that provides key input regarding program design and direction and conducts critical reviews of program results. Individuals from the FRSCS Science and Technical Committee also serve on the Lower and Middle Fraser River White Sturgeon Technical Working Group and the National Recovery Team for White Sturgeon in Canada.

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TABLES

Table 1. Sampling zones used for population estimation of White Sturgeon, 2013-2014.

Zone	River Km	From	To
S*	0-25	Georgia Strait	Eastern Annacis Island
3, 5**	26-56.5 & P0-P4	Eastern Annacis Island	Albion Ferry Crossing
6, 7***	56.5-78	Albion Ferry Crossing	Mission Bridge
8	79-93	Mission Bridge	Mouth of Sumas River
10	H0-H21	Confluence Fraser River	Outlet of Harrison Lake
12	94-122	Mouth of Sumas River	Agassiz Bridge
13	123-158	Agassiz Bridge	Hwy 1 Bridge (Hope)
14	159-187	Hwy 1 Bridge (Hope)	Lady Franklin Rock (Yale)

* Zone S is the Main (South) Arm including Canoe Pass; from Figure 2 this is zone 2S and zone 2C
** Zone 5 includes the lower 4 kms of the Pitt River, from the Fraser mainstem to the Hwy 7 Bridge (rkm P0-P4)
*** Zone 7 is the lower 2 kms of the Stave River, downstream of the dam (rkm ST0-ST2)

Table 2. Sampling regions used for population estimates of White Sturgeon, 2013-2014.

Region	Zones	Description
A	S	Georgia Strait to Eastern Annacis Island (South Arm of Fraser)
B	3, 5, 6, 7	E. Annacis Is. to Mission Bridge; lower 4 km of Pitt River (below Hyw 7 bridge); lower Stave River (below dam)
C	8, 10, 12, 13	Mission Bridge to Hope including the Harrison River
D	14	Hwy 1 Bridge (Hope) to Lady Franklin Rock (Yale)

Table 3. Parameter estimates for linear and non-linear sturgeon growth models from 2008-2009.

Parameter	Estimate	Std Error	R^2
Linear			
Daily Increment	8.212E-03	4.100E-04	0.158
Non-Linear von-Bertalanffy			
L_∞	532.6	15.8	
g	2.076E-05	1.003E-06	

Table 4 Population estimates for White Sturgeon in the lower Fraser River, by sampling region, 2014.

Sampling Region		Zone			95% HPD[2]		
From	To	Codes[1]	Mean	Mode	Low	High	Std. Dev
A Georgia Strait	East Annacis Is.	S	6,652	6,410	4,994	8,467	898
B East Annacis Is.	Mission Bridge	3, 5, 6, 7	16,396	16,350	15,200	17,625	615
C Mission Bridge	Hwy 1 Bridge (Hope)	8, 10, 12, 13	23,736	23,720	22,950	24,530	400
D Hwy 1 Bridge (Hope)	Yale	14	2,346	2,334	2,138	2,562	108
		Total	49,130		46,847	51,413	1,165

[1] See Table 1

[2] HPD - Highest Probability Density. See Nelson et al. 2004 for explanation of this statistic.

Table 5. Summary of mean annual population estimates, proportional (percent) changes in estimates between years, and 95% confidence limits for annual estimates (numeric and percent of respective mean estimates) of White Sturgeon in the lower Fraser River, 2001-2014.

Population Assessment Year:	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Mean (Annual) Population Estimate:	48,136	48,362	58,090	56,268	49,955	46,957	46,108	45,896	43,628	45,399	44,713	49,127	51,956	49,130
% Change from Previous (Annual) Estimate:	-	0.5%	20.1%	-3.1%	-11.2%	-6.0%	-1.8%	-0.5%	-4.9%	4.1%	-1.5%	9.9%	5.8%	-5.4%
95% Confidence Bounds (+/-):	3,359	3,058	4,600	3,453	2,304	2,238	2,136	2,349	2,514	3,048	2,079	2,402	2,449	2,283
95% Confidence Bounds as % of Estimate:	7.0%	6.3%	7.9%	6.1%	4.6%	4.8%	4.6%	4.6%	5.8%	6.7%	4.6%	4.9%	4.7%	4.6%

Table 6. Population estimates for White Sturgeon in the lower Fraser River, by 20-cm (FL) size group, 2014. Scaled MLE values are calculated from the MLE of each size bin scaled to the mean total estimate (see Table 4). An illustration of these estimates and their associated HPD values is presented in Figure 5.

Size	Scaled		HPD[2] (percent)		
Class (cm)	MLE[1]	Percent	Low	High	CV[3] (%)
40-59	3,509	7.1	2202.1	6123.0	26.7
60-79	3,004	6.1	2679.6	3389.6	6.0
80-99	5,817	11.8	5450.8	6229.5	3.4
100-119	8,283	16.9	7767.4	8848.4	3.3
120-139	7,835	15.9	7295.6	8440.7	3.7
140-159	6,386	13.0	5951.2	6870.8	3.7
160-179	5,010	10.2	4575.9	5511.5	4.7
180-199	3,609	7.3	3197.2	4104.1	6.3
200-219	2,711	5.5	2258.2	3314.0	9.7
220-239	1,843	3.8	1361.6	2621.2	16.8
240-259	995	2.0	574.9	2009.7	33.6
260-279	127	0.3	58.4	430.6	59.2
Total	49,130	100.0			2.7

[1] MLE - Maximum Likelihood Estimate

[2] HPD - Highest Probability Density

[3] CV - Coefficient of Variation

FIGURES

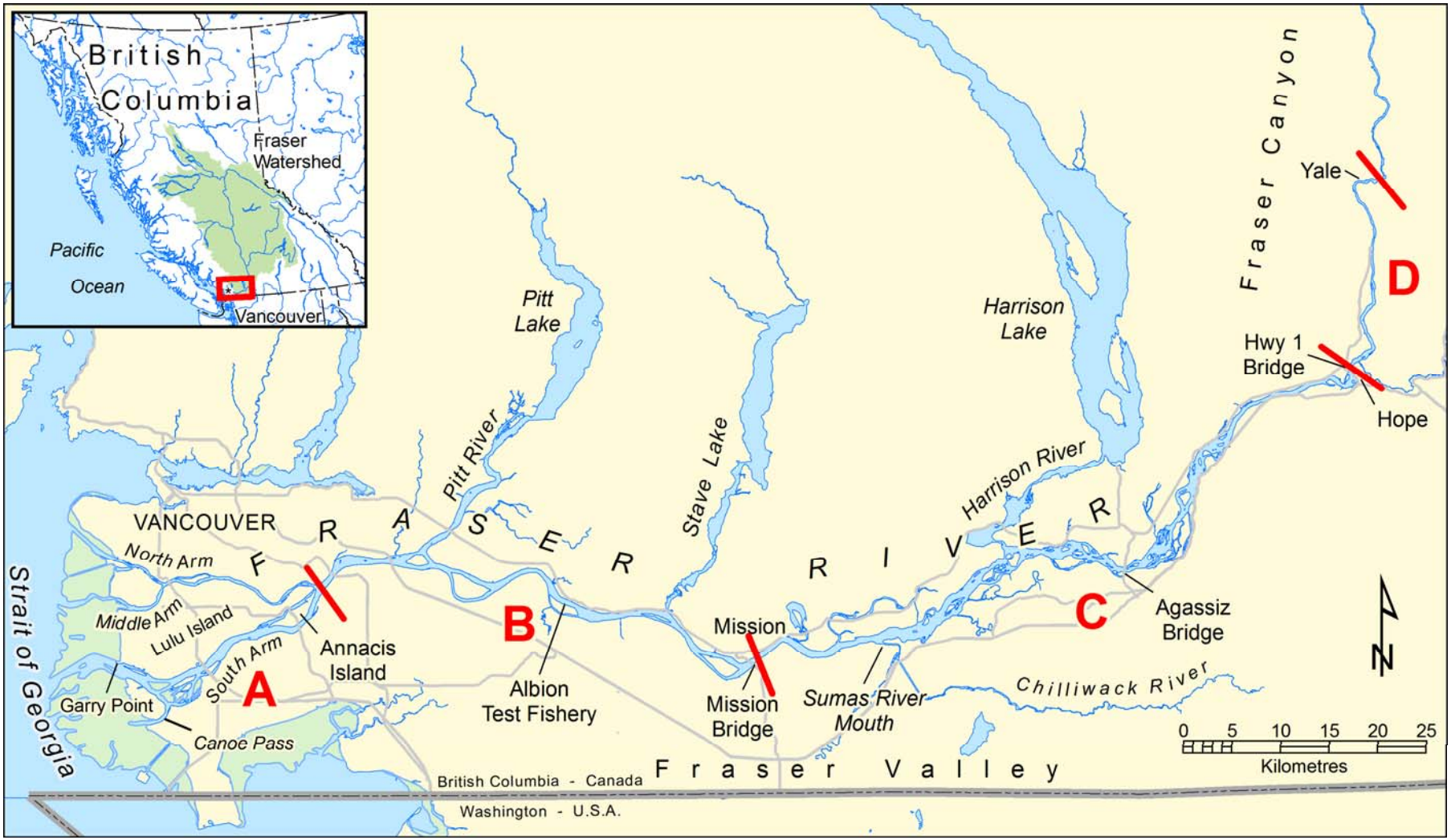


Figure 1. Illustration of the general study area and the location of the four main sampling regions (A, B, C, and D) used for data summaries presented in this report. Each sampling region is made up of individual sampling zones used in the analytical model to stratify tag release and recapture data; see Table 1 for a description of sampling zone locations. See Table 2 for a description of the boundaries for each sampling region.

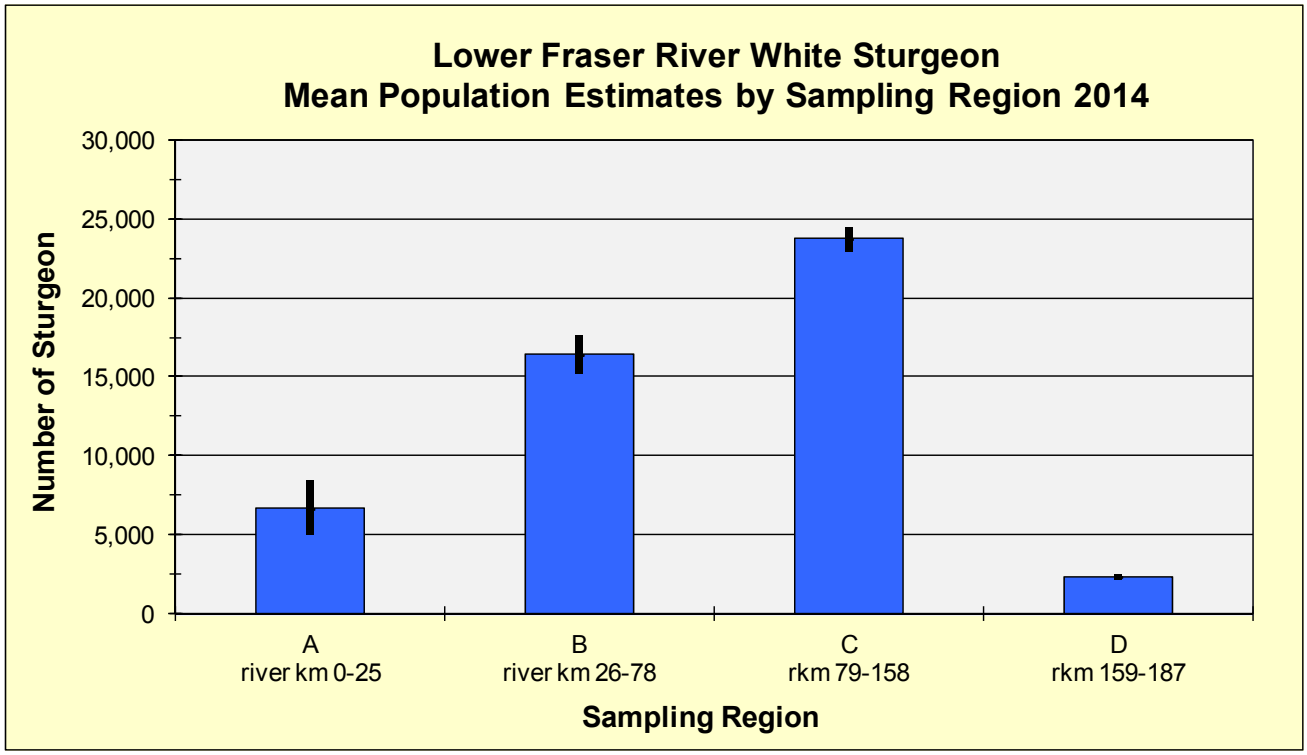


Figure 2. Mean population estimates of White Sturgeon in the lower Fraser River, by sampling region, 2014 (see Table 4). Ranges show the 95% Highest Probability Density. Sturgeon movement and migration within the study area will result in a proportional redistribution of these mean population estimates, by season. The average abundance of White Sturgeon within the study area in 2014 downstream of the Mission Bridge (Sampling Regions A and B) was 23,048 (46.9% of the total population estimate). The average abundance of White Sturgeon within the study area in 2014 upstream of the Mission Bridge (to Lady Franklin Rock near Yale; Sampling Regions C and D) was 26,082 (53.1% of the total population estimate).

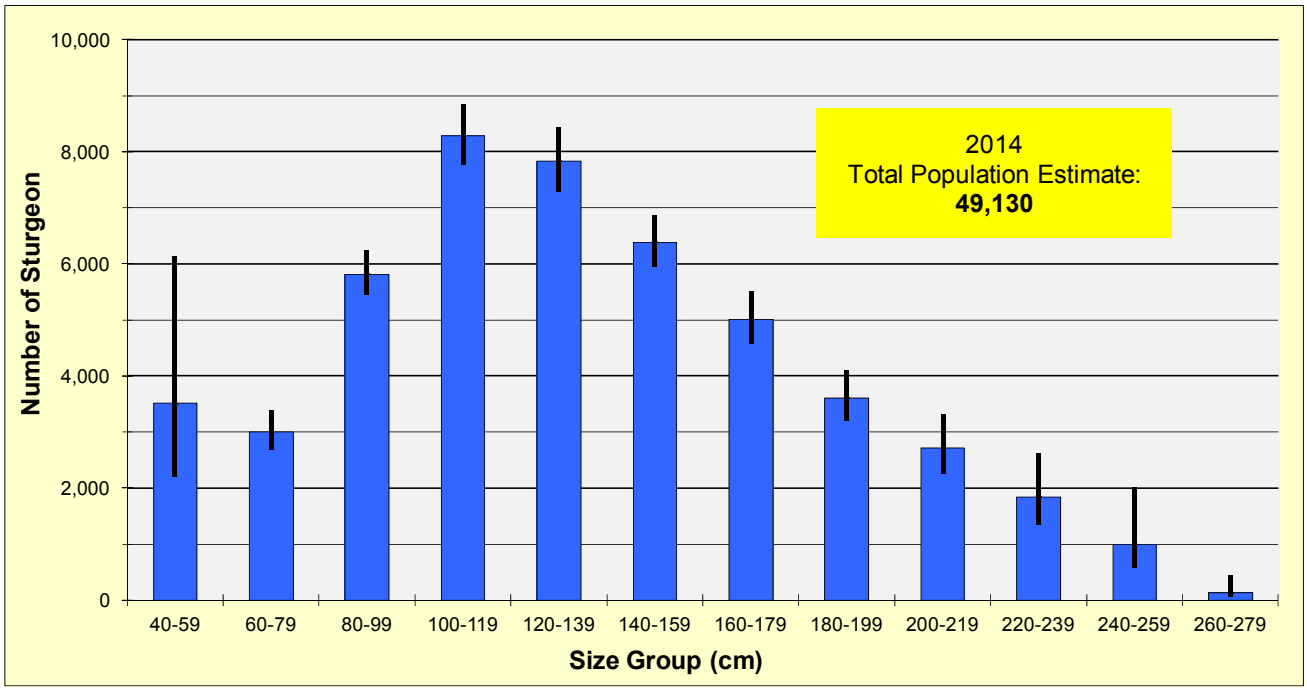
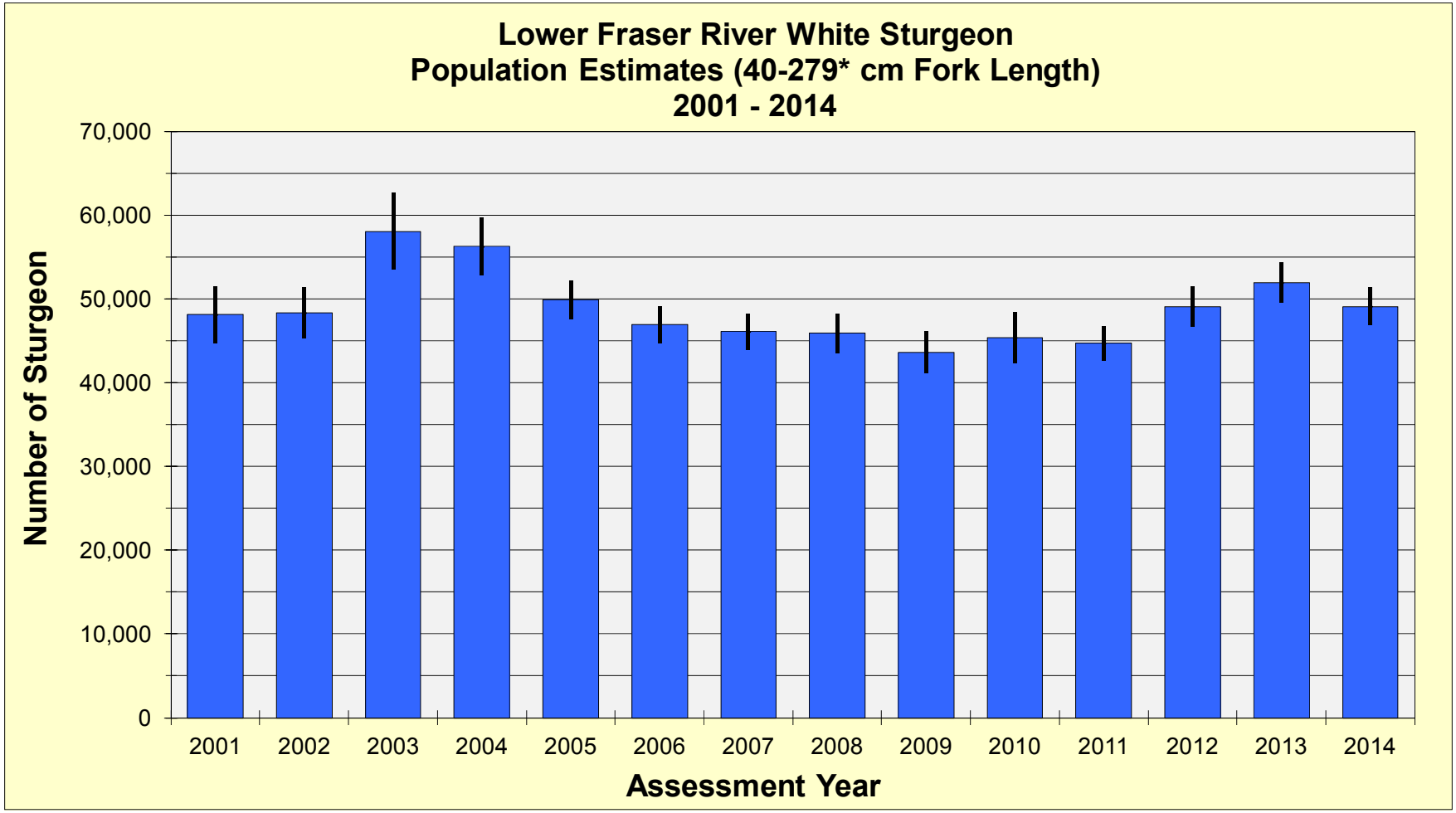


Figure 3. Mean population estimates of White Sturgeon in the lower Fraser River, by 20-cm (FL) size group, 2014. Ranges show the 95% Highest Probability Density. All sampling regions are combined for this analysis.



* The 2001-2004 estimates do not include fish over 239 cm FL

Figure 4. Comparison of mean annual population estimates of lower Fraser River White Sturgeon, 2001-2014. Confidence ranges show the 95% Highest Probability Density. All sampling regions are combined for this analysis.

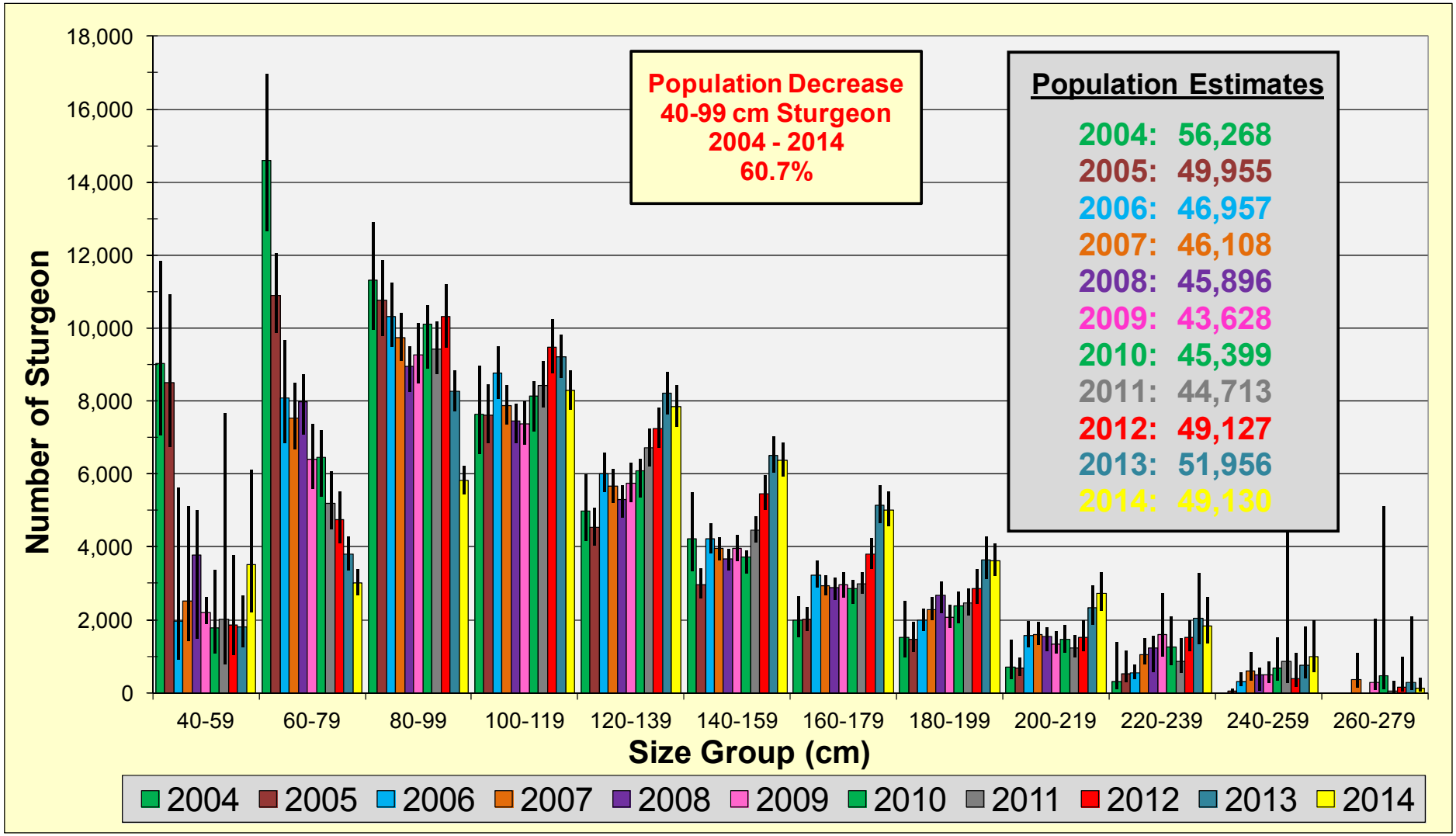


Figure 5. Comparison of mean population estimates of White Sturgeon in the lower Fraser River, by 20-cm (FL) size group, for assessment years 2004 through 2014. Confidence ranges show the 95% Highest Probability Density. The population of juvenile sturgeon (40-99 cm FL) in the lower Fraser River decreased 60.7% between 2004 and 2014. Between 2013 and 2014 there was a significant decrease in the number of juvenile sturgeon in the 80-99 cm FL size group.

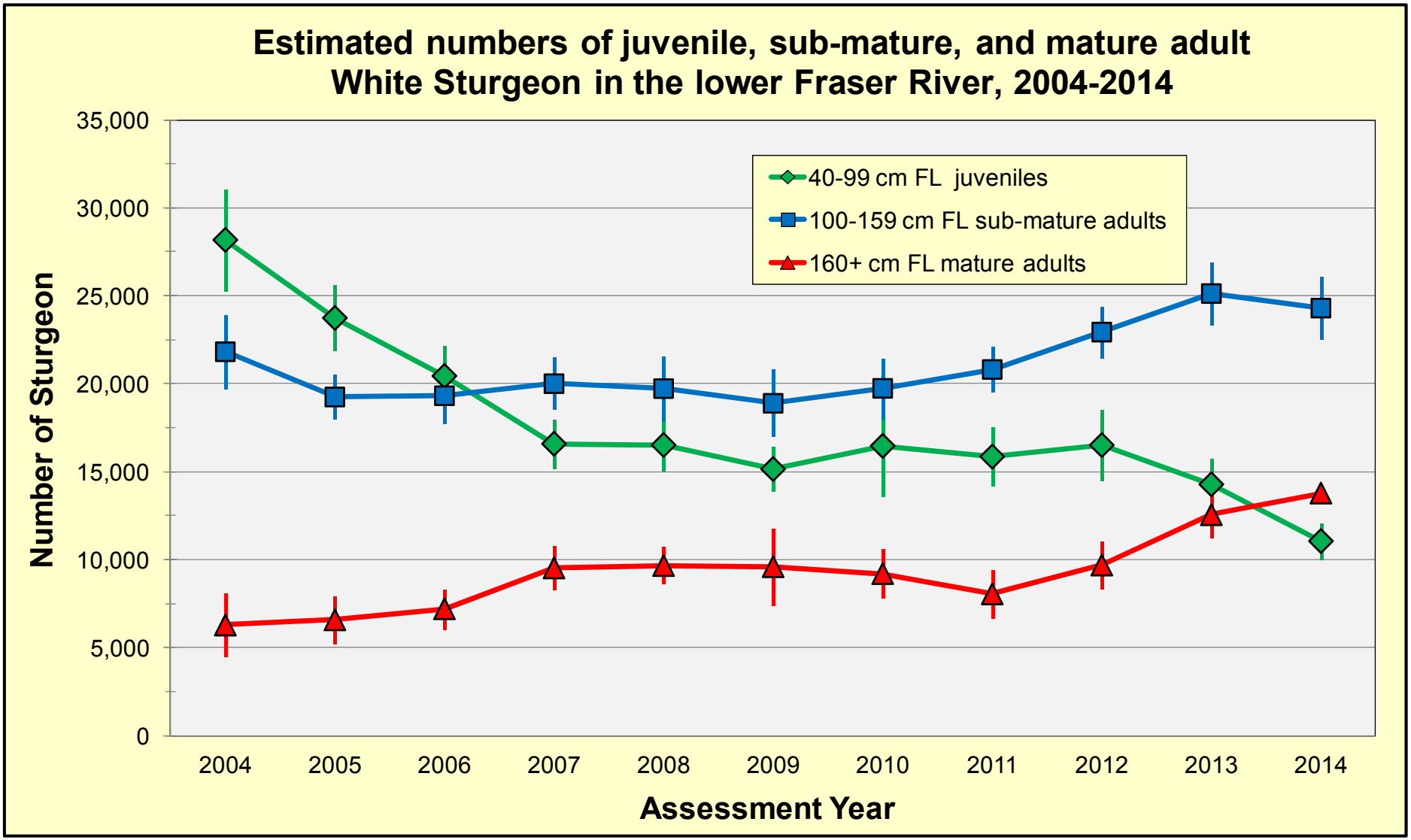


Figure 6. Estimated numbers of juvenile sturgeon (40-99 cm FL), sub-mature sturgeon (100-159 cm FL), and mature adult sturgeon (>160 cm FL) in the lower Fraser River, 2004-2014. Pooling of data for three size groups, as opposed to 20-cm size groups (presented in Table 5 and Figure 5), provided a sufficient number of recaptures to use a spatially stratified approach that addresses observed differences in the mark rates and size of sturgeon caught in the four sampling regions. The vertical bars indicate the 95% CLs for each estimate. In 2014 there was a continued decline in the number of juvenile sturgeon (most notably for fish from 80-99 cm FL) and an increase in the number of mature sturgeon over 160 cm FL (see Figure 5).

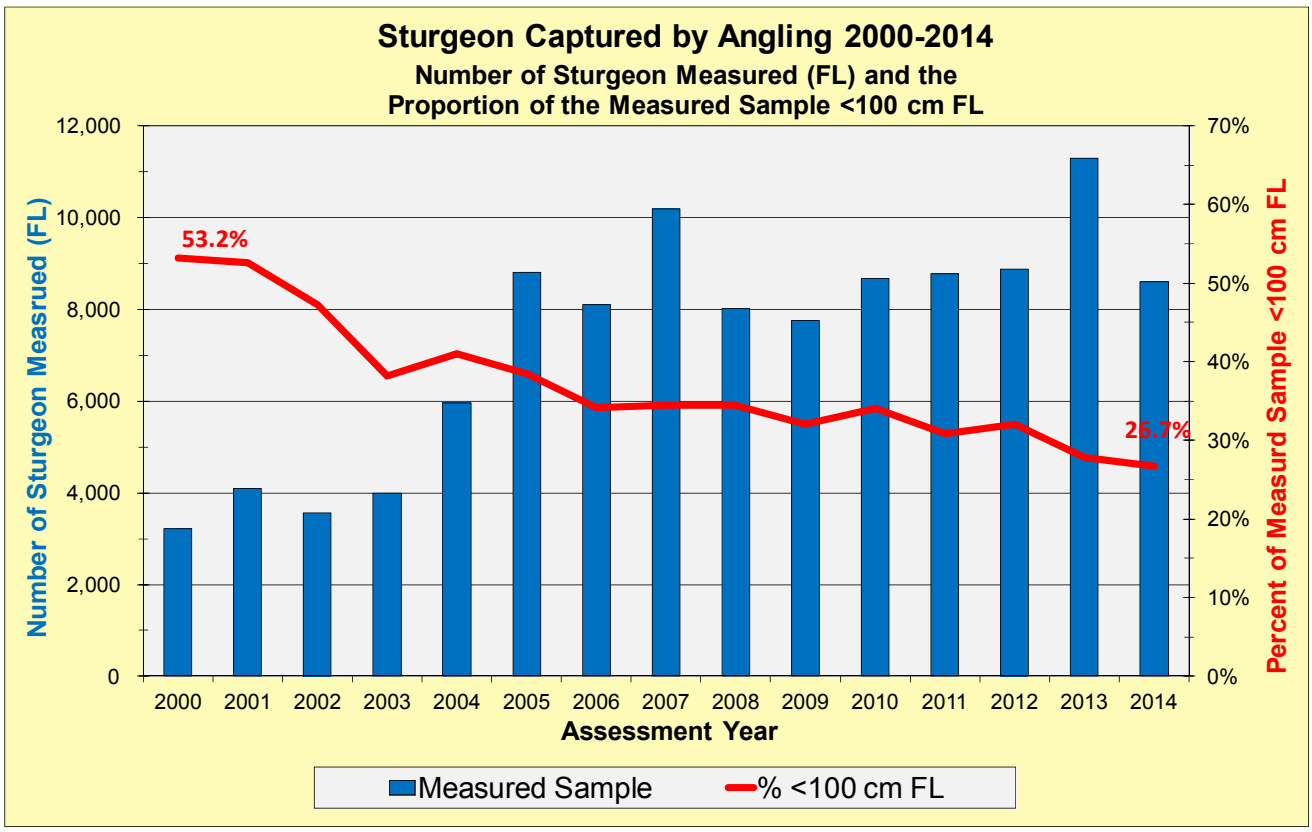


Figure 7. Illustration of the changes in the annual proportions of sturgeon less than 100 cm FL from all measured samples captured by angling, 2000-2014.

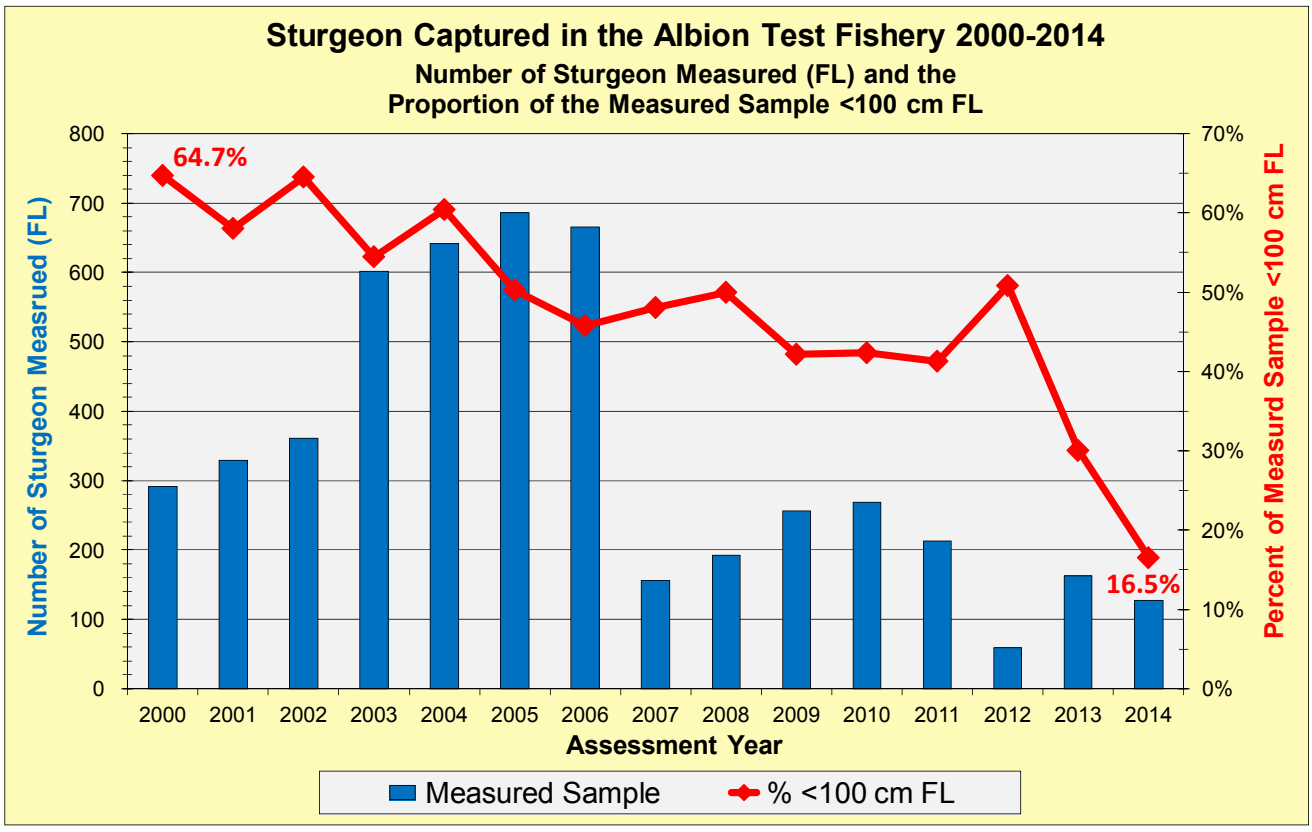


Figure 8. Illustration of the changes in the annual proportions of sturgeon less than 100 cm FL from all measured samples captured in the Albion Test Fishery, 2000-2014.

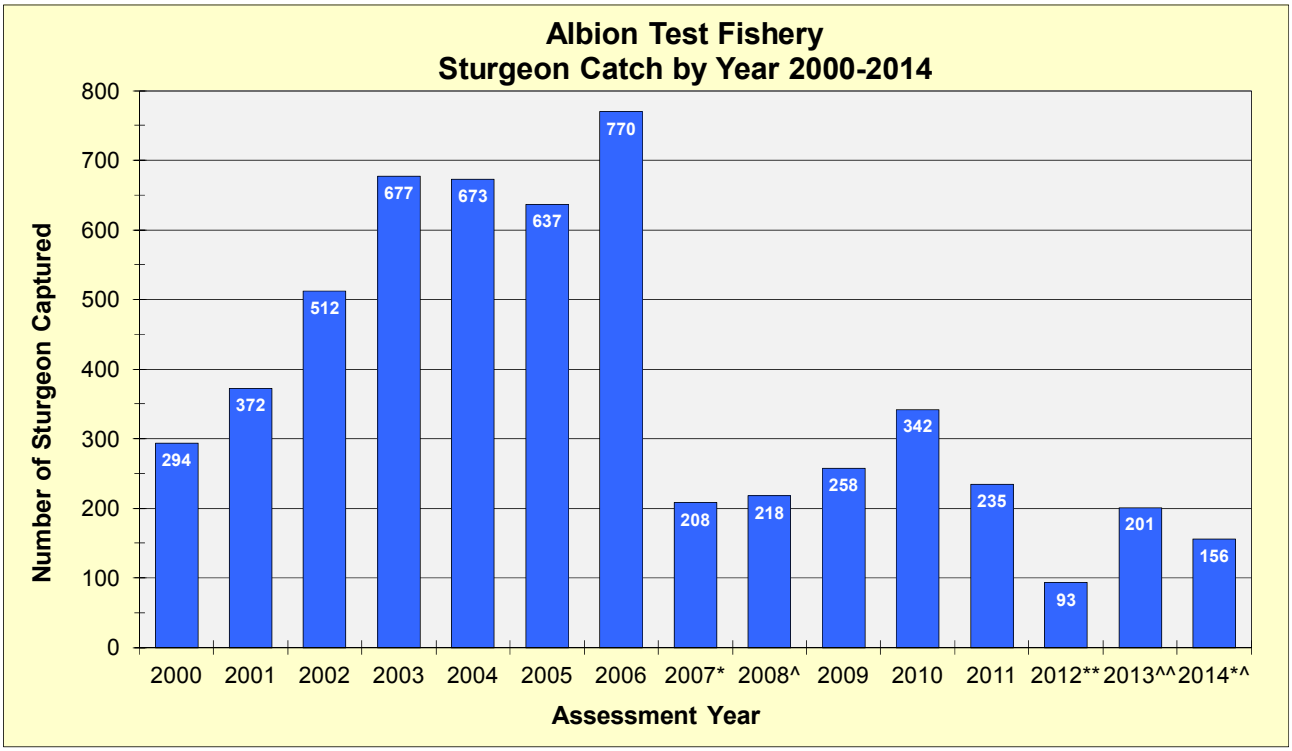


Figure 9. Comparison of the number of White Sturgeon (all sizes) captured in the Albion Test Fishery, 2000-2014. Data (from Fisheries and Oceans Canada) are the total number of sturgeon sampled by the Albion Test Fishery during assessment net sets.

Notes:
* In 2007 the test fishery operated from 18 June through 30 November (applies to Figures 9 and 10)
^ In 2008 the test fishery operated from 5 May through 30 November (applies to Figures 9 and 10)
** In 2012 the test fishery operated from 25 April through 30 November (applies to Figures 9 and 10)
^^ In 2013 the test fishery operated from 21 April and on alternate days from 10-23 November
*^ In 2014 the test fishery operated from 22 April and on alternate days from 10-23 November

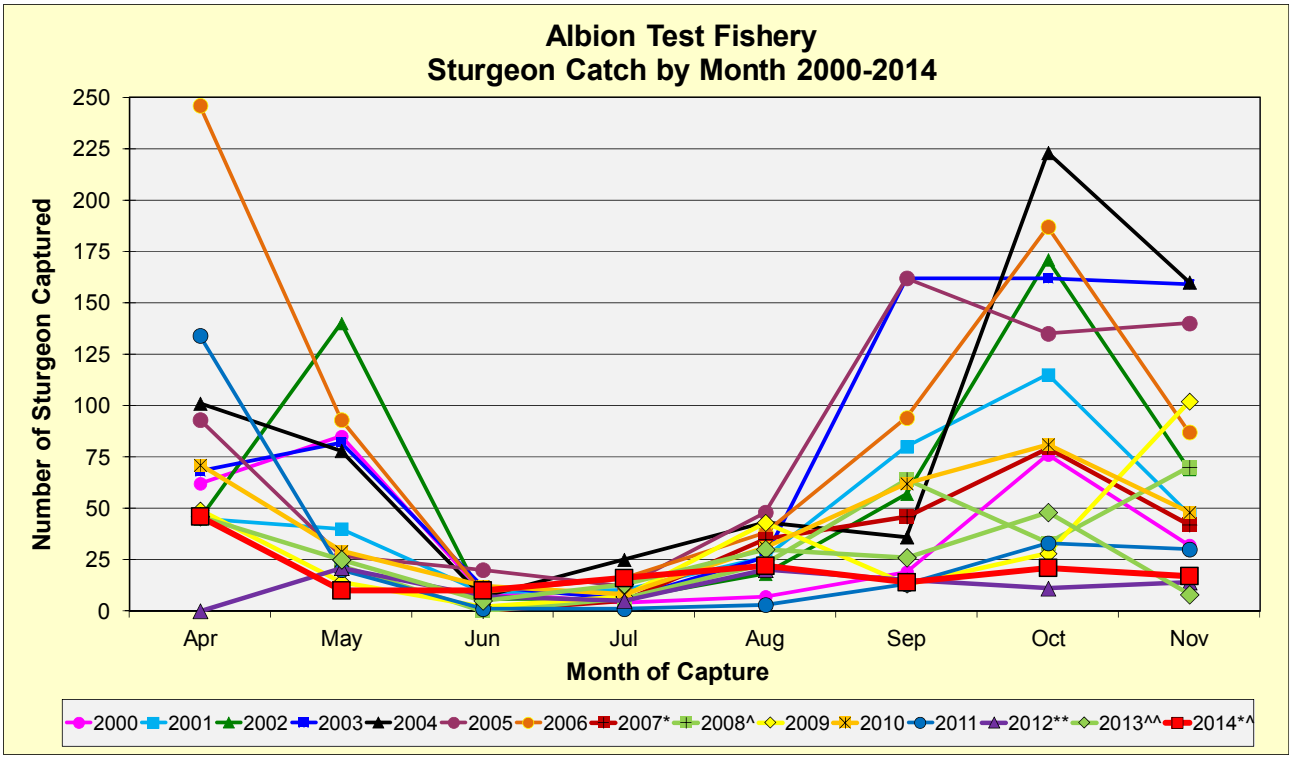


Figure 10. Comparison of the number of White Sturgeon (all sizes) captured in the Albion Test Fishery, by month, 2000-2014. See the footnote in Figure 9 for additional information.

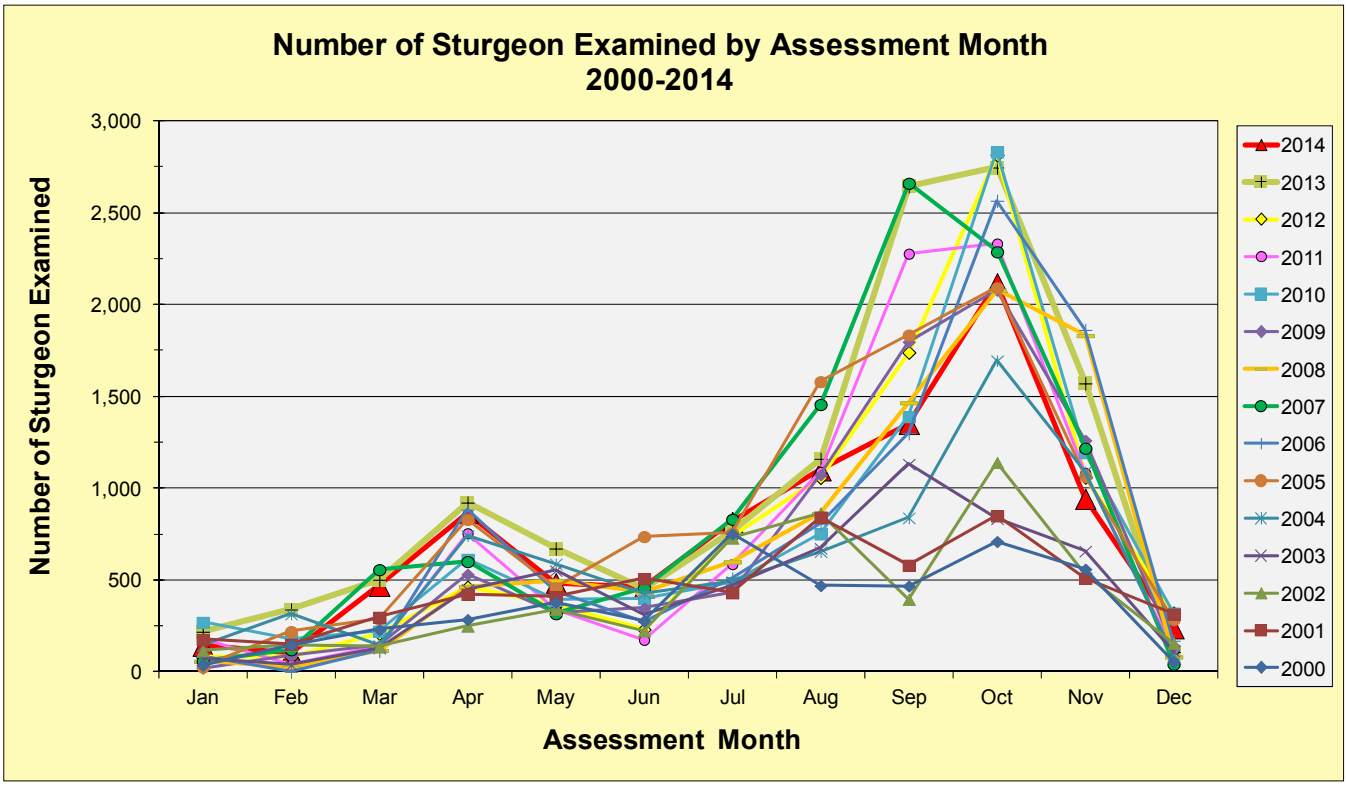


Figure 11. Number of sturgeon examined for the presence of a PIT tag, by month, 2000-2014.

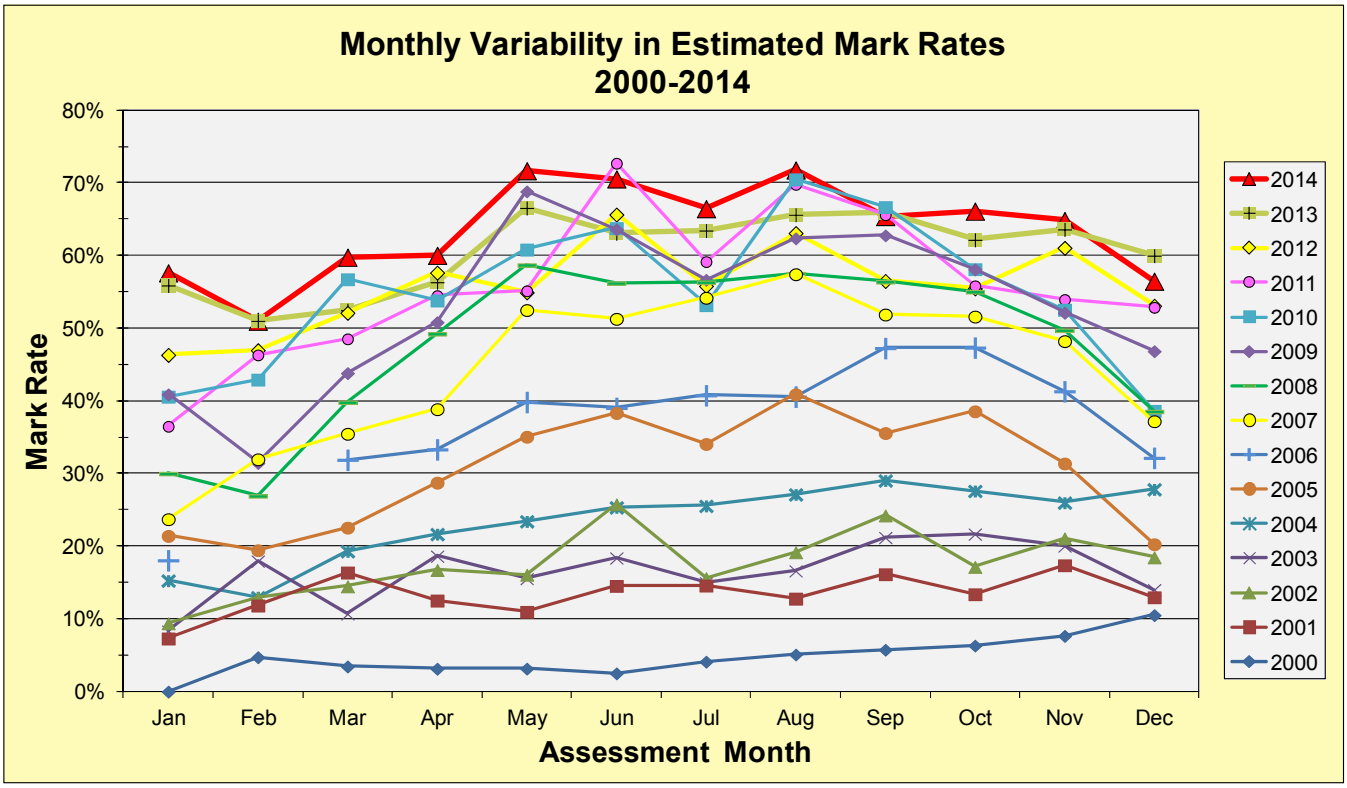


Figure 12. Monthly variability in estimated mark rates for White Sturgeon, 2000-2014.

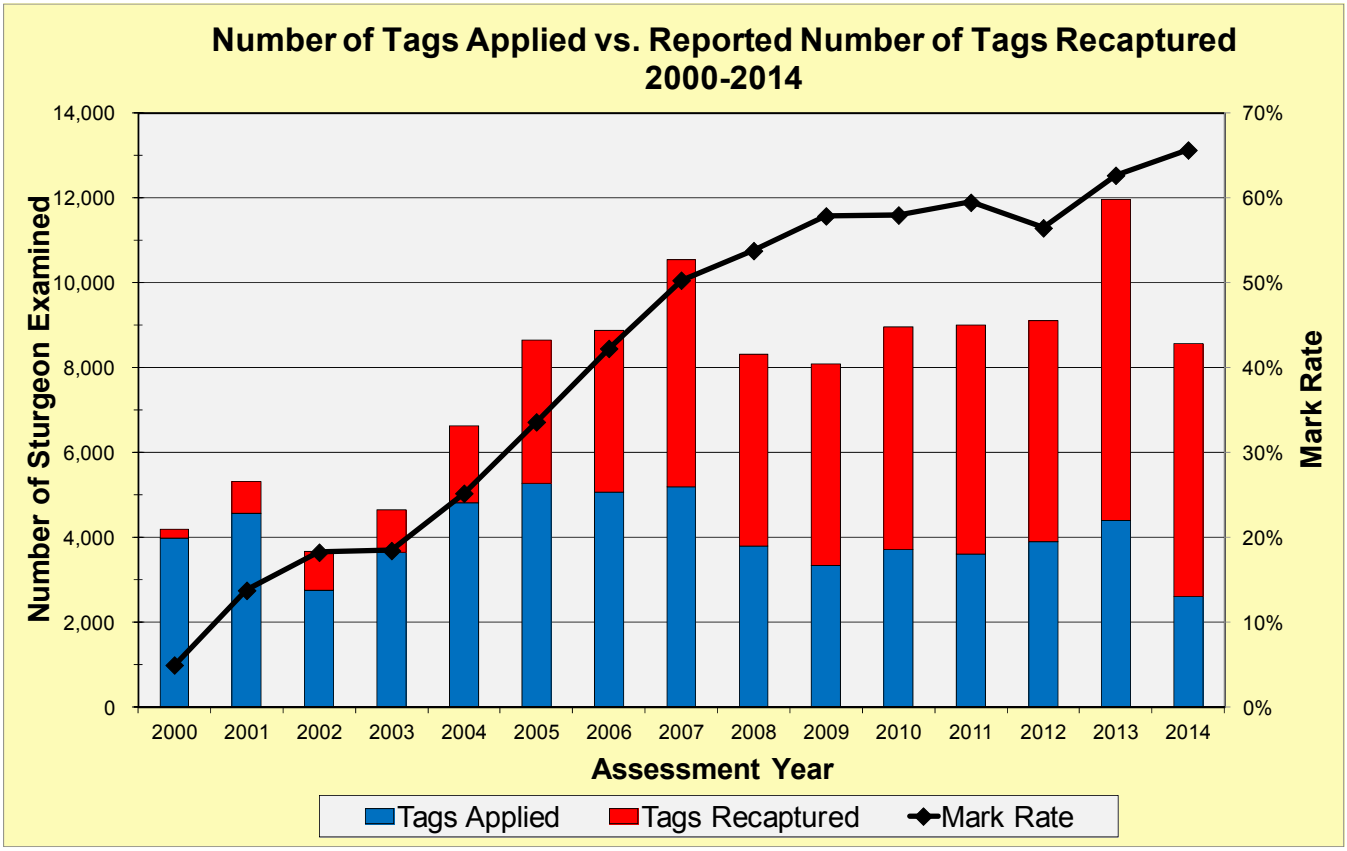


Figure 13. Number of tags applied and reported number of tags recaptured, and the annual mark rate, by assessment year, 2000-2014.

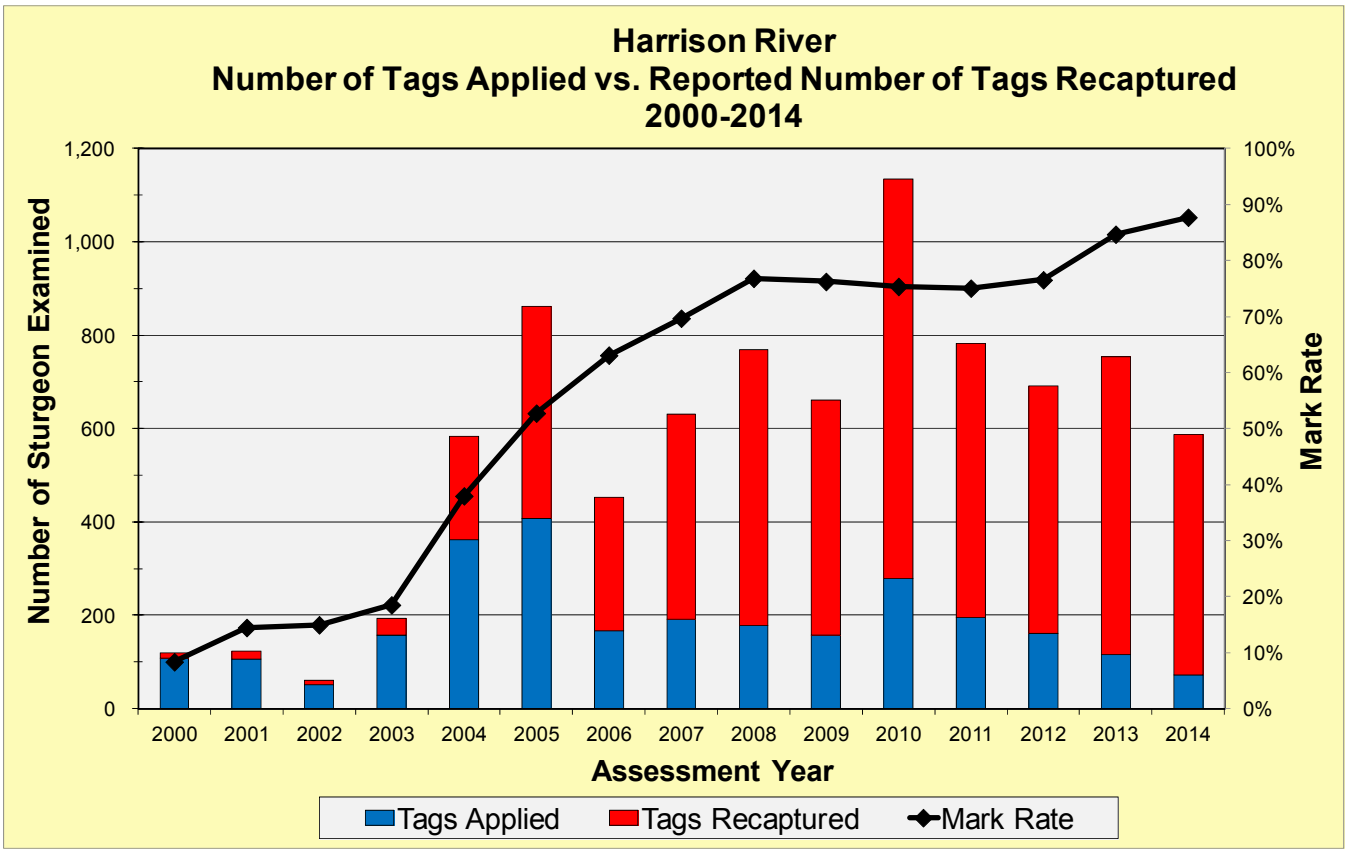


Figure 14. Number of tags applied and reported number of tags recaptured, and the annual mark rate, by assessment year, in the Harrison River, 2000-2014.

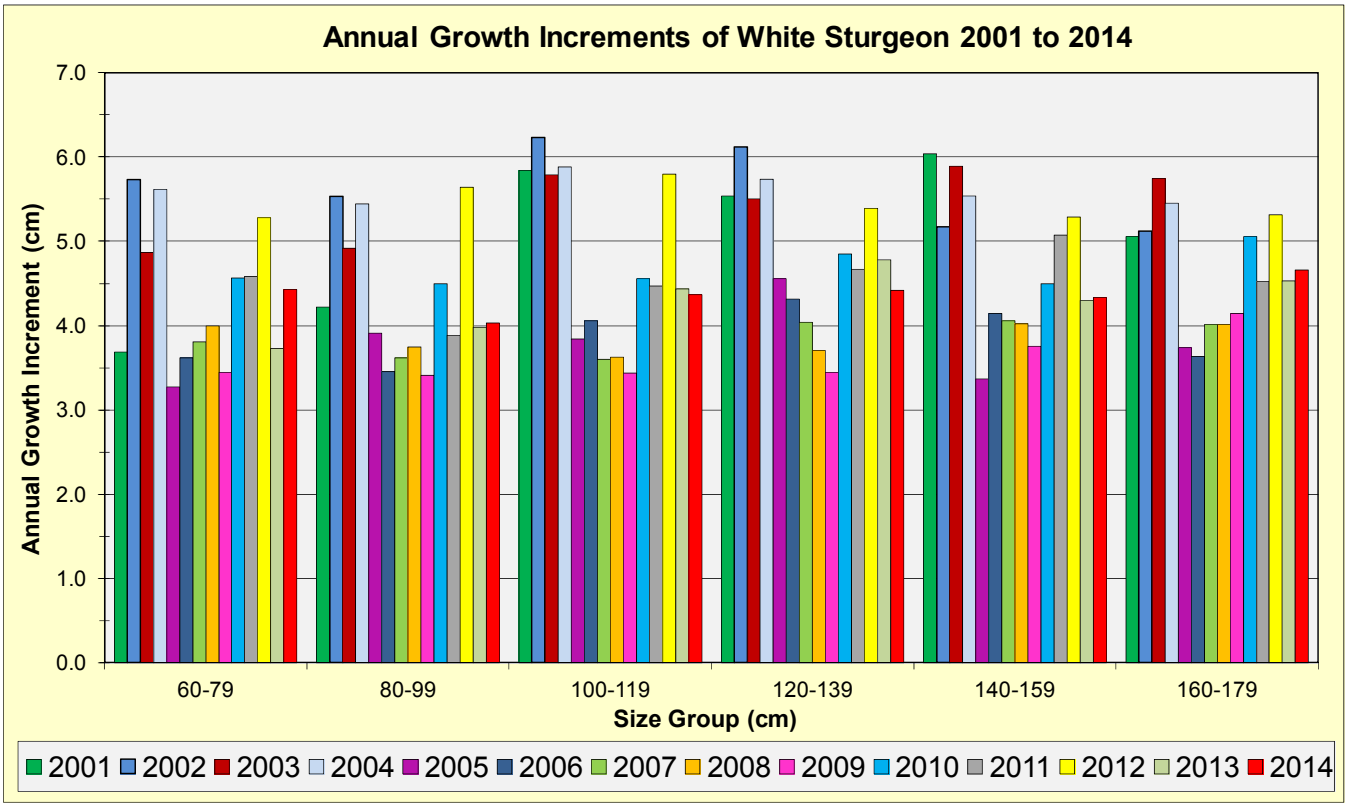


Figure 15. Comparison of average annual growth increments (cm) of White Sturgeon, by 20-cm (FL) size group, 2001-2014. Annual growth was determined from measurements obtained from individual, tagged sturgeon that were subsequently recaptured.

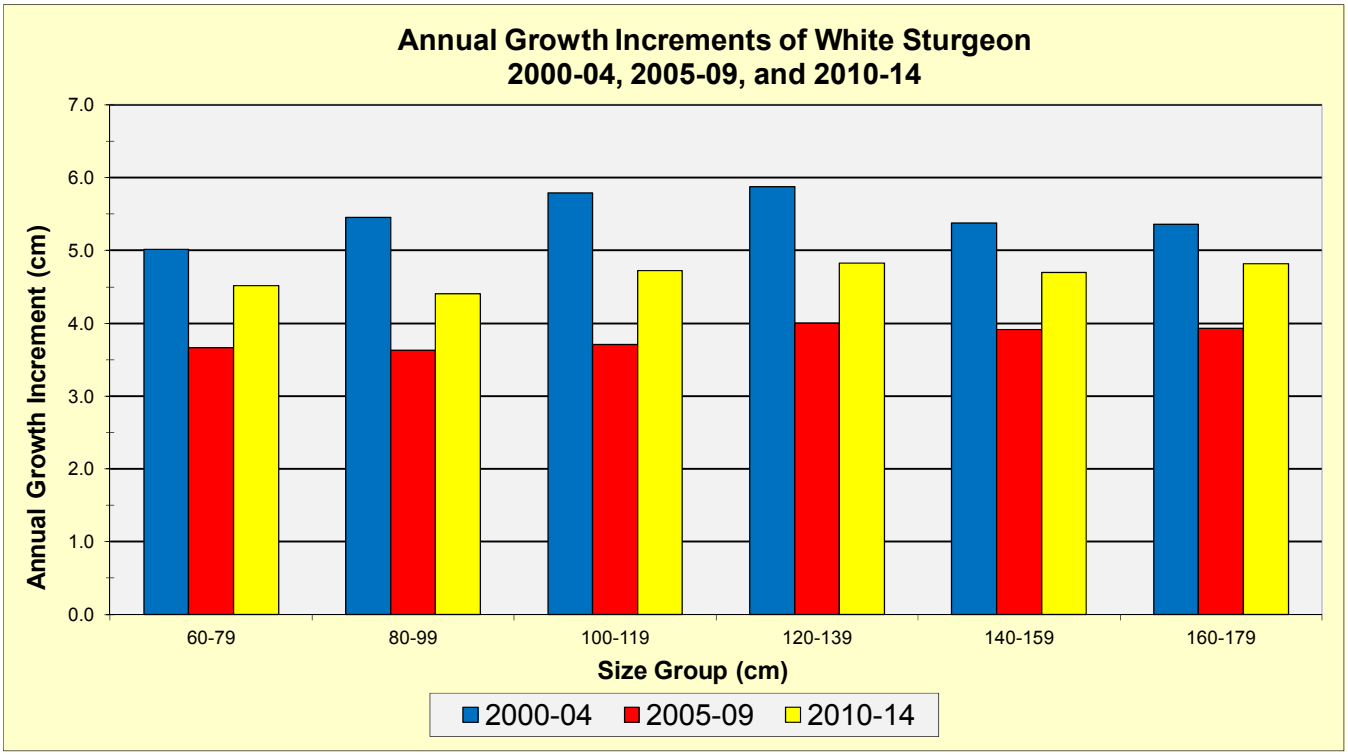


Figure 16. Comparison of average annual growth increments of White Sturgeon (cm), by 20-cm (FL) size group, in the lower Fraser River during three time periods: 2000-04 (averaged), 2005-09 (averaged), and 2010-14 (averaged). Growth rates for all size groups of White Sturgeon declined in 2005 and have remained at levels well below those observed prior to 2005 (see Figure 15). From 2010-2014, growth rates increased from 2005-09 levels for all size groups, but were still below pre-2005 rates.

APPENDIX A

Sturgeon biosampling, tagging, and recapture data entry form

FRASER RIVER STUGEON CONSERVATION SOCIETY FAX to Jim Rissling: 604-792-2630 (phone: 604-792-4368)

WHITE STURGEON BIOSAMPLING, TAGGING, AND MARK- RECAPTURE RECORDS Page: _____ of _____

Name/Phone Number of Person that Recorded Data: _____

Phone No: _____

Date (dd/mmm/yy _____ Sampling Area: _____ Weather: _____ No. Passengers: _____

Vessel Information: Vessel Name _____ Launch Location _____ Launch Time: _____ Return Time: _____

Angling/Sampling Effort	Start Time	End Time	Total Minutes	Start Time	End Time	Total Minutes	Start Time	End Time	Total Minutes	Grand Total (Minutes)
Rod/Gear 1 (Name) _____										
Rod/Gear 2 (Name) _____										
Rod/Gear 3 (Name) _____										
Rod/Gear 4 (Name) _____										

COMPLETE FOR ALL STURGEON CAPTURED						TAGS APPLIED	RECAPTURES	tn2OTHER	
Fish No.	**River Km (Captured)**	**Was the Sturgeon Scanned? (Yes/No)**	**Fork Length (cm)**	**Girth (cm)**	**Deformity / Wound Code[1]**	**Verified (Scanned at release) Tag Number**	**Tag Number**	**Condition code for sturgeon at release[2]**	**Comments**

Comments:

[1]Deformity/wound/scar codes: DEF = physical deformity; BLED = bleeding; BITE = seal bite; CUT = slice or tear; NET = net scar; OTHER = other (note in comments)

[2]Condition codes: 1 = vigorous, no bleeding; 2 = vigorous, bleeding; 3 = lethargic, no bleeding; 4 = lethargic, bleeding; 5 = dead

APPENDIX B

Lower Fraser River sturgeon sampling, tagging, and recapture summary, by month and year, 1999-2014

Appendix B. Lower Fraser River sturgeon sampling, tagging, and recapture summary, by month and year, 1999-2014.

Month	No. Scanned (All)	No. Released With Tag (Head)	No. Scanned, Not Tagged, Not Recaptured	No. Recaptured (Head Tag)	Mark Rate (%)	Year	No. Scanned (All)	No. Released With Tag (Head)	No. Scanned, Not Tagged, Not Recaptured	No. Recaptured (Head Tag)	Mark Rate (%)
Oct-99	96	89	7	0	0.0%						
Nov-99	206	182	24	0	0.0%						
Dec-99	157	143	14	0	0.0%	**1999**	459	414	45	0	**0.0%**
Jan-00	38	37	1	0	0.0%						
Feb-00	148	135	6	7	4.7%						
Mar-00	232	191	33	8	3.4%						
Apr-00	286	265	12	9	3.1%						
May-00	380	351	17	12	3.2%						
Jun-00	279	257	15	7	2.5%						
Jul-00	753	695	27	31	4.1%						
Aug-00	471	424	23	24	5.1%						
Sep-00	469	437	5	27	5.8%						
Oct-00	711	629	37	45	6.3%						
Nov-00	561	506	12	43	7.7%						
Dec-00	57	45	6	6	10.5%	**2000**	4385	3972	194	219	**5.0%**
Jan-01	178	165	0	13	7.3%						
Feb-01	152	134	0	18	11.8%						
Mar-01	299	250	0	49	16.4%						
Apr-01	423	340	30	53	12.5%						
May-01	410	360	5	45	11.0%						
Jun-01	509	427	8	74	14.5%						
Jul-01	432	355	14	63	14.6%						
Aug-01	844	717	19	108	12.8%						
Sep-01	582	484	4	94	16.2%						
Oct-01	851	711	26	114	13.4%						
Nov-01	512	417	6	89	17.4%						
Dec-01	316	197	78	41	13.0%	**2001**	5508	4557	190	761	**13.8%**
Jan-02	117	60	46	11	9.4%						
Feb-02	147	45	83	19	12.9%						
Mar-02	138	65	53	20	14.5%						
Apr-02	251	107	102	42	16.7%						
May-02	342	173	114	55	16.1%						
Jun-02	225	131	36	58	25.8%						
Jul-02	730	529	87	114	15.6%						
Aug-02	866	622	78	166	19.2%						
Sep-02	396	149	151	96	24.2%						
Oct-02	1142	582	364	196	17.2%						
Nov-02	531	187	232	112	21.1%						
Dec-02	157	97	31	29	18.5%	**2002**	5042	2747	1377	918	**18.2%**
Jan-03	72	55	11	6	8.3%						
Feb-03	39	20	12	7	17.9%						
Mar-03	131	89	28	14	10.7%						
Apr-03	451	290	77	84	18.6%						
May-03	553	383	84	86	15.6%						
Jun-03	310	180	73	57	18.4%						
Jul-03	474	311	92	71	15.0%						
Aug-03	674	473	89	112	16.6%						
Sep-03	1132	758	134	240	21.2%						
Oct-03	835	585	69	181	21.7%						
Nov-03	659	395	132	132	20.0%						
Dec-03	114	97	1	16	14.0%	**2003**	5444	3636	802	1006	**18.5%**
Jan-04	144	122	0	22	15.3%						
Feb-04	316	271	4	41	13.0%						
Mar-04	145	114	3	28	19.3%						
Apr-04	743	575	7	161	21.7%						
May-04	589	446	5	138	23.4%						
Jun-04	430	313	8	109	25.3%						
Jul-04	493	362	5	126	25.6%						
Aug-04	656	434	44	178	27.1%						
Sep-04	840	582	14	244	29.0%						
Oct-04	1695	916	311	468	27.6%						
Nov-04	1092	603	205	284	26.0%						
Dec-04	97	64	6	27	27.8%	**2004**	7240	4802	612	1826	**25.2%**

continued

Appendix B. Lower Fraser River sturgeon sampling, tagging, and recapture summary, by month and year, 1999-2014.

Month	No. Scanned (All)	No. Released With Tag (Head)	No. Scanned, Not Tagged, Not Recaptured	No. Recaptured (Head Tag)	Mark Rate (%)	Year	No. Scanned (All)	No. Released With Tag (Head)	No. Scanned, Not Tagged, Not Recaptured	No. Recaptured (Head Tag)	Mark Rate (%)
Jan-05	28	22	0	6	21.4%						
Feb-05	221	178	0	43	19.5%						
Mar-05	288	222	1	65	22.6%						
Apr-05	831	572	20	239	28.8%						
May-05	459	279	19	161	35.1%						
Jun-05	738	438	17	283	38.3%						
Jul-05	757	479	20	258	34.1%						
Aug-05	1581	786	148	647	40.9%						
Sep-05	1835	767	415	653	35.6%						
Oct-05	2092	965	320	807	38.6%						
Nov-05	1067	420	312	335	31.4%						
Dec-05	286	136	92	58	20.3%	**2005**	10183	5264	1364	3555	**34.9%**
Jan-06	83	68	0	15	18.1%						
Feb-06	2	2	0	0	0.0%						
Mar-06	116	76	3	37	31.9%						
Apr-06	885	582	8	295	33.3%						
May-06	439	254	10	175	39.9%						
Jun-06	274	161	6	107	39.1%						
Jul-06	510	289	13	208	40.8%						
Aug-06	808	450	30	328	40.6%						
Sep-06	1301	676	10	615	47.3%						
Oct-06	2566	1337	14	1215	47.3%						
Nov-06	1863	1054	38	770	41.3%						
Dec-06	171	116	0	55	32.2%	**2006**	9018	5065	132	3820	**42.4%**
Jan-07	59	45	0	14	23.7%						
Feb-07	122	83	0	39	32.0%						
Mar-07	558	359	1	198	35.5%						
Apr-07	602	363	5	234	38.9%						
May-07	318	148	3	167	52.5%						
Jun-07	460	222	2	236	51.3%						
Jul-07	832	378	3	451	54.2%						
Aug-07	1457	614	6	837	57.4%						
Sep-07	2661	1244	36	1381	51.9%						
Oct-07	2288	1091	16	1181	51.6%						
Nov-07	1219	614	17	588	48.2%						
Dec-07	43	27	0	16	37.2%	**2007**	10619	5188	89	5342	**50.3%**
Jan-08	60	42	0	18	30.0%						
Feb-08	26	18	1	7	26.9%						
Mar-08	118	66	5	47	39.8%						
Apr-08	465	231	5	229	49.2%						
May-08	499	200	6	293	58.7%						
Jun-08	434	185	5	244	56.2%						
Jul-08	600	253	0	338	56.3%						
Aug-08	864	353	14	497	57.5%						
Sep-08	1466	618	21	827	56.4%						
Oct-08	2079	922	0	1144	55.0%						
Nov-08	1832	906	15	911	49.7%						
Dec-08	83	51	0	32	38.6%	**2008**	8526	3845	72	4587	**53.8%**
Jan-09	22	13	0	9	40.9%						
Feb-09	89	61	0	28	31.5%						
Mar-09	146	82	0	64	43.8%						
Apr-09	533	254	8	271	50.8%						
May-09	321	100	0	221	68.8%						
Jun-09	349	124	3	222	63.6%						
Jul-09	434	183	5	246	56.7%						
Aug-09	1074	389	15	670	62.4%						
Sep-09	1798	654	15	1129	62.8%						
Oct-09	2079	847	24	1208	58.1%						
Nov-09	1262	588	16	658	52.1%						
Dec-09	143	61	15	67	46.9%	**2009**	8250	3356	101	4793	**58.1%**

continued

Appendix B. Lower Fraser River sturgeon sampling, tagging, and recapture summary, by month and year, 1999-2014.

Month	No. Scanned (All)	No. Released With Tag (Head)	No. Scanned, Not Tagged, Not Recaptured	No. Recaptured (Head Tag)	Mark Rate (%)	Year	No. Scanned (All)	No. Released With Tag (Head)	No. Scanned, Not Tagged, Not Recaptured	No. Recaptured (Head Tag)	Mark Rate (%)
Jan-10	271	161	0	110	40.6%						
Feb-10	178	102	0	76	42.7%						
Mar-10	223	92	4	127	57.0%						
Apr-10	614	277	6	331	53.9%						
May-10	393	146	2	245	62.3%						
Jun-10	402	140	4	258	64.2%						
Jul-10	488	225	4	259	53.1%						
Aug-10	753	219	6	528	70.1%						
Sep-10	1391	448	16	927	66.6%						
Oct-10	2832	1156	26	1650	58.3%						
Nov-10	1195	556	11	628	52.6%						
Dec-10	321	194	3	124	38.6%	**2010**	9061	3716	82	5263	**58.1%**
Jan-11	178	113	0	65	36.5%						
Feb-11	41	22	0	19	46.3%						
Mar-11	138	71	0	67	48.6%						
Apr-11	756	336	8	412	54.5%						
May-11	339	148	4	187	55.2%						
Jun-11	176	48	0	128	72.7%						
Jul-11	588	236	4	348	59.2%						
Aug-11	1090	325	4	761	69.8%						
Sep-11	2279	771	12	1496	65.6%						
Oct-11	2333	995	35	1303	55.9%						
Nov-11	1084	475	23	586	54.1%						
Dec-11	121	55	2	64	52.9%	**2011**	9123	3595	92	5436	**59.6%**
Jan-12	82	44	0	38	46.3%						
Feb-12	83	44	0	39	47.0%						
Mar-12	211	101	0	110	52.1%						
Apr-12	463	192	4	267	57.7%						
May-12	364	163	1	200	54.9%						
Jun-12	233	79	1	153	65.7%						
Jul-12	738	322	4	412	55.8%						
Aug-12	1058	378	12	668	63.1%						
Sep-12	1741	744	13	984	56.5%						
Oct-12	2816	1225	28	1563	55.5%						
Nov-12	1061	404	9	648	61.1%						
Dec-12	322	149	2	171	53.1%	**2012**	9172	3845	74	5253	**57.3%**
Jan-13	220	97	0	123	55.9%						
Feb-13	341	166	0	175	51.3%						
Mar-13	503	238	1	264	52.5%						
Apr-13	923	388	15	520	56.3%						
May-13	673	221	4	448	66.6%						
Jun-13	455	164	4	287	63.1%						
Jul-13	766	279	2	485	63.3%						
Aug-13	1163	382	16	765	65.8%						
Sep-13	2643	870	30	1743	65.9%						
Oct-13	2734	1002	28	1704	62.3%						
Nov-13	1533	537	14	982	64.1%						
Dec-13	110	44	0	66	60.0%	**2013**	12064	4388	114	7562	**62.7%**
Jan-14	144	60	1	83	57.6%						
Feb-14	102	50	0	52	51.0%						
Mar-14	470	188	1	281	59.8%						
Apr-14	866	339	7	520	60.0%						
May-14	484	133	4	347	71.7%						
Jun-14	462	129	7	326	70.6%						
Jul-14	817	260	14	543	66.5%						
Aug-14	1099	192	118	789	71.8%						
Sep-14	1352	310	158	884	65.4%						
Oct-14	2117	581	136	1400	66.1%						
Nov-14	944	276	56	612	64.8%						
Dec-14	239	78	26	135	56.5%	**2014**	9096	2596	528	5972	**65.7%**
				Totals All Years		**1999-2014**	**123,245**	**61,009**	**5,880**	**56,333**	**45.7%**

* Lower Fraser River samples only for sturgeon captured downstream of rkm 188 (Yale).

APPENDICES C, D, E, and F

Appendix C. Numbers of sturgeon examined for marks, and numbers of recaptures, by month and sampling zone, 2013-2014.

Appendix D. Number of sturgeon recaptured and examined for a mark, by sampling zone of release and recapture, 2013-2014.

Appendix E. Proportion (corrected) of sturgeon recaptured, by sampling zone of release, 2013-2014.

Appendix F. Numbers of marked sturgeon releases available for recapture by sampling zone and month, 2013-2014.

Apendix C. Numbers of sturgeon examined for marks (Catch), and number of recaptures (Rec)[1], by month and sampling zone, 2013-14.

	Zone S		Zone 3, 5		Zone 6, 7		Zone 8		Zone 10		Zone 12		Zone 13		Zone 14		Total	
Month	Catch	Rec	Catch	Rec	Catch	Rec	Catch	Rec	Catch	Rec	Catch	Rec	Catch	Rec	Catch	Rec	Catch	Rec
Jan-2013	36	0	44	0	46	0	7	0	20	0	8	0	0	0	0	0	161	0
Feb-2013	4	0	97	0	106	0	21	0	1	0	12	0	0	0	0	0	241	0
Mar-2013	0	0	244	11	148	5	54	1	0	0	10	0	0	0	2	0	458	17
Apr-2013	3	0	308	16	232	6	249	8	12	1	71	1	12	0	9	0	896	32
May-2013	20	1	91	5	144	6	207	8	5	0	84	3	57	0	32	1	640	24
Jun-2013	15	2	35	4	107	5	87	15	2	0	114	7	43	3	38	4	441	40
Jul-2013	95	5	55	2	40	4	155	20	2	0	241	28	37	1	93	6	718	66
Aug-2013	63	4	134	8	107	5	174	27	85	10	219	27	87	5	203	22	1,072	108
Sep-2013	126	6	88	3	203	9	773	77	102	6	883	153	174	29	172	33	2,521	316
Oct-2013	19	2	230	22	499	40	1,049	122	235	41	494	87	57	7	31	2	2,614	323
Nov-2013	11	4	158	18	202	16	641	87	256	62	172	37	41	8	4	0	1,485	232
Dec-2013	0	0	70	15	15	3	7	2	7	3	1	0	0	0	0	0	100	23
Jan-2014	0	0	36	8	21	1	19	4	5	1	18	1	26	4	0	0	125	19
Feb-2014	0	0	1	0	67	8	0	0	5	2	0	0	8	1	0	0	81	11
Mar-2014	0	0	2	1	126	27	254	54	12	3	40	7	11	5	0	0	445	97
Apr-2014	2	0	107	12	210	34	351	79	22	9	114	27	27	7	2	2	835	170
May-2014	0	0	22	7	78	18	72	14	5	1	215	62	56	13	12	1	460	116
Jun-2014	21	4	6	2	26	6	42	15	0	0	205	67	78	19	59	14	437	127
Jul-2014	68	16	31	4	38	11	91	34	0	0	240	86	114	43	169	57	751	251
Aug-2014	29	6	54	12	36	3	176	63	90	42	262	96	186	58	220	89	1,053	369
Sep-2014	44	1	96	14	113	28	333	66	119	51	307	116	155	59	128	60	1,295	395
Oct-2014	5	0	102	20	585	116	588	140	226	70	279	110	171	68	49	23	2,005	547
Nov-2014	0	0	67	4	245	53	294	74	99	38	128	46	51	19	0	0	884	234
Dec-2014	0	0	8	0	46	10	0	0	18	9	0	0	0	0	0	0	72	19
Totals	561	51	2,086	188	3,440	414	5,644	910	1,328	349	4,117	961	1,391	349	1,223	314	19,790	3,536

[1] Recaptures listed in this table are recaptured marks that were sampled or applied during the sampling period of Jan 2013-Dec 2014.

Appendix D. Number of sturgeon recaptured and examined for a mark, by sampling zone of release and recapture, 2013-2014.

Release Zone	Recapture Zone								
	Zone S	Zone 3, 5	Zone 6, 7	Zone 8	Zone 10	Zone 12	Zone 13	Zone 14	Total
Zone S	18	6	9	12	0	1	2	1	49
Zone 3-5	16	128	53	58	8	21	4	0	288
Zone 6, 7	5	22	218	112	11	46	2	2	418
Zone 8	7	18	89	538	25	165	19	10	871
Zone 10	0	0	9	7	187	93	7	0	303
Zone 12	3	11	29	159	111	587	82	9	991
Zone 13	2	2	4	9	6	39	209	27	298
Zone 14	0	1	3	15	1	9	24	265	318
Number Recaptured	561	2086	3440	5644	1328	4117	1391	1223	19790
Number Examined	51	188	414	910	349	961	349	314	3536

Appendix E. Proportion (corrected) of sturgeon recaptured, by sampling zone of release, 2013-2014 (recapture corrected for sampling intensity; see equation 3).

Release Zone	Recapture Zone								
	Zone S	Zone 3, 5	Zone 6, 7	Zone 8	Zone 10	Zone 12	Zone 13	Zone 14	Total
Zone S	0.760	0.068	0.062	0.050	0.000	0.006	0.034	0.019	1.000
Zone 3-5	0.220	0.474	0.119	0.079	0.046	0.039	0.022	0.000	1.000
Zone 6,7	0.071	0.084	0.506	0.158	0.066	0.089	0.011	0.013	1.000
Zone 8	0.056	0.039	0.116	0.427	0.084	0.180	0.061	0.037	1.000
Zone 10	0.000	0.000	0.015	0.007	0.817	0.131	0.029	0.000	1.000
Zone 12	0.016	0.016	0.025	0.083	0.246	0.420	0.174	0.022	1.000
Zone 13	0.018	0.005	0.006	0.008	0.023	0.049	0.776	0.114	1.000
Zone 14	0.000	0.002	0.004	0.011	0.003	0.009	0.072	0.900	1.000

Appendix F. Number of marked sturgeon released each month from January 2013 to December 2014, by sampling sampling zone. This summary includes releases of fish that were previously tagged (i.e., recaptures) and marked fish removed (i.e., recapture not returned) from the population (see equation 4).

Month	Zone S	Zone 3, 5	Zone 6, 7	Zone 8	Zone 10	Zone 12	Zone 13	Zone 14	Total
Jan-2013	41	28	32	16	24	13	5	2	161
Feb-2013	33	56	68	35	17	22	7	2	241
Mar-2013	64	124	105	64	27	35	12	6	439
Apr-2013	95	166	177	166	75	105	45	23	851
May-2013	56	63	106	122	55	89	76	45	612
Jun-2013	30	29	67	59	43	71	59	42	400
Jul-2013	93	43	52	91	71	122	84	94	651
Aug-2013	90	81	94	111	136	136	125	184	957
Sep-2013	175	103	213	401	336	471	302	186	2,186
Oct-2013	149	179	374	516	373	407	181	80	2,260
Nov-2013	81	106	181	289	255	202	93	33	1,241
Dec-2013	13	27	13	9	7	5	2	0	77
Jan-2014	9	16	16	13	11	14	22	4	105
Feb-2014	5	5	30	10	7	6	6	2	70
Mar-2014	19	17	74	104	39	60	24	10	348
Apr-2014	52	72	132	158	71	107	52	16	660
May-2014	14	17	43	49	51	83	65	21	343
Jun-2014	20	8	19	28	39	68	75	52	309
Jul-2014	54	24	30	48	47	82	95	115	495
Aug-2014	33	26	32	59	84	94	124	121	572
Sep-2014	68	50	74	137	114	132	115	56	746
Oct-2014	76	87	274	259	226	205	143	56	1,325
Nov-2014	38	51	113	127	100	97	56	15	596
Dec-2014	3	4	17	5	10	4	1	0	44
Totals	1,311	1,380	2,338	2,876	2,219	2,631	1,769	1,165	15,689