

Population Monitoring Work Group Meeting

March 23, 2017

Meeting Materials:

Meeting Agenda

Meeting Minutes

Main Channel Fisheries Monitoring - 2015 Report: Metrics for Adaptive Management of Habitat Restoration Sites for the RGSM [not included]

Statement of Work: RGSM Population Monitoring [not included]

Reclamation RGSM Population Monitoring Contract Update

Projected Spawning Dates for RGSM - 2017

1993-2016 Raw Mean and EX

Beach Seine Graphs

Fish Population Monitoring Workshop Planning Agenda

March 23, 2017, 2:00 pm

Location:

DBS&A
6020 Academy
NE, Suite 100,
Albuquerque

Meeting called by: R. Billings

Facilitator: B. Salvas

Invitees: Rick Billings (ABCWUA), Thomas Archdeacon (FWS), Dave Campbell (FWS), Jason Davis (FWS), Thomas Sinclair (FWS), Grace Haggerty (ISC), Rich Valdez (SWCA/ISC), Juddson Sechrist (USBR), Jennifer Bacchus (USBR), Eric Gonzales (USBR), Ann DeMint (USBR), Michael Porter (USACE), Susan Bittick (USACE), David Gensler (MRGCD), Anne Marken (MRGCD); Matthew Wunder (NMDGF); Debbie Lee (WEST), Mike Marcus (APA), Beth Salvas (DBS&A)

Agenda Topic	Presenter	Time allotted
October 2016 monitoring data report	Billings	10
USBR 2 year contract with ASIR	Bacchus	10
DBMS status as of March 31st	Salvas	10
Summary of 2016 monitoring meetings	Salvas	10
Continue Task 2 - Evaluate recommendations and changes to sampling design for information	Billings	20
Break		10
Preparation for April retreat	Billings	40
Set up next meeting - date/time/place	Salvas	5
Review of action items	Salvas	5

Fish Population Monitoring Workgroup Meeting

Thursday, March 23, 2017 from 2:00 pm to 4:15 pm

Location:

DBS&A
Albuquerque
Office

**Meeting
called by:** R. Billings

Facilitator: B. Salvas

Invitees: Rick Billings (ABCWUA), Thomas Archdeacon (FWS), Dave Campbell (FWS), Jason Davis (FWS), Thomas Sinclair (FWS), Grace Haggerty (ISC), Rich Valdez (SWCA/ISC), Jennifer Bacchus (USBR), Eric Gonzales (USBR), Brian Hobbs (USBR), Ann DeMint (USBR), Michael Porter (USACE), Susan Bittick (USACE), David Gensler (MRGCD), Anne Marken (MRGCD), Matthew Wunder (NMDGF), Debbie Lee (WEST), Mike Marcus (APA), Beth Salvas (DBS&A), Kenny Calhoun (DBS&A)

Attendees: Rick Billings (ABCWUA), Mo Hobbs (ABCWUA), Thomas Archdeacon (FWS), Jason Davis (FWS), Grace Haggerty (ISC), Rich Valdez (SWCA/ISC), Eric Gonzales (USBR), Brian Hobbs (USBR), Susan Bittick (USACE), Michael Porter (USACE), Justin Reale (USACE), Mike Marcus (APA), Matthew Wunder (NMDGF), Debbie Lee (WEST), Beth Salvas (DBS&A), for DBMS discussion only-Kenny Calhoun (DBS&A)

Agenda Topic and Related Action Items

Thursday, March 23, 2017

1. Mike Marcus requested several members of the workgroup volunteer to prepare 1 to 2 scopes of work (SOW) about 1 page in length for future projects to be submitted to the Science Workgroup prior to their next meeting ~ April 10, 2017. Potential SOW would move forward for review and funding to Coordination Committee (CC) and then Executive Committee (EC).
2. Beth Salvas and Kenny Calhoun (DBS&A) provided an update on the database management system (DBMS) status. The Collaborative Program database management system has been funded by USACE for the past 7 years or so, but license will expire on March 31, 2017, and a contract is not in place to continue funding DBMS. The DBMS will be unplugged at close of business Friday March 31st at which time the calendar, data, maps, and associated documents will no longer be accessible from the internet. DBMS hardware is at or near end of life and in need of upgrading, software query interface could be improved also. USACE will have funding sometime later in spring but the future of the DBMS is yet to be determined.

Several meeting attendees use the DBMS and would like to keep it accessible. Kenny estimates \$1,200 to \$1,500 per month is needed to keep DBMS online in the short term until a more long term solution is determined. Also to keep costs down, Kenny recommended any data updates be provided in the approved data submission templates available on the website:

<http://mrgescp.dbstephens.com/DataSubmissionTemplates.aspx>

Rick Billings will check whether ABCWUA may be able to fund the DBMS for a few months in the near term.

3. Beth Salvas provided a summary of 2016 fish population monitoring workgroup meetings and important events:

- **February 18, 2016** - Reviewed all comments to the January 27, 2016 draft *Summary of Findings by the External Expert Panelists: Rio Grande Silvery Minnow Population Monitoring Workshop*. Afterwards comments were compiled.
- **May 3, 2016** - Discussed approval of *Task 1 for Review of the Collaborative Program Fish Monitoring Program for the Rio Grande Silvery Minnow, A Proposal for a CPUE, Metrics and Methodologies Workshop* document. The group reached consensus that the next step was to begin Task 2 from the EC proposal. Each workgroup member was asked to look at the report recommendations and develop draft tasks and work efforts prior to the next meeting.

Wayne Hubert gave a May 19th presentation before EC on the summary of findings from the Workshop and document was finalized and available on website and emailed to workgroup.

- **July 12, 2016** - Discussed recommendations from the final *Summary of Findings by the External Expert Panelists: Rio Grande Silvery Minnow Population Monitoring Workshop* report with workgroup responses received prior to the meeting. The workgroup then ranked the recommendations regarding existing monitoring data (pre-2017):
 - Ranking of 3 = can be easily be completed by group or consultant with existing data
 - Ranking of 2 = not easily completed or limited by existing data, but possible
 - Ranking of 1 = extremely limited with existing data
 - Ranking of 0 = not possible with existing data

Based on consensus of the workgroup the following rankings were given to the expert peer review recommendations:

- Ranking = 3 for recommendations: 1a, 1b, 2, 3 (included in 1a), 4, 6c, 10a, 10b, 11a, 11b, and 12

- Ranking = 2 for recommendations: 5a, 5b, 6a, 6b, 14, 15/16, 17, and 18
 - Ranking = 1 for recommendations: 7a, 7b, 9, 19, 20/21, 22, and 24
 - Ranking = 0 for recommendations: 8, 13, and 23
- **August 23 2016** - Meeting for stakeholders only regarding USBR SOW for 2 year monitoring contract.
 - **December 5, 2016** - The U.S. Fish and Wildlife Service completed and released a new biological opinion (BO) providing Endangered Species Act coverage for water-related activities in the Upper and Middle Rio Grande.
4. The workgroup discussed the top ranked expert peer review recommendations from the July 2016 meeting:
- **1a** - Separate data and compute separate CPUE indices for the catch and effort data from the small-mesh and fine-mesh seines into two data sets
 - **1b** - Separate data and compute separate CPUE indices for individual age classes captured in each gear type
 - **2** - Compute length-at-age data and frequency histograms for cohorts
 - **3** - Include only larval fish in computing CPUE indices for catch from the fine-mesh seine
 - **4** - Omit dry sample sites as zero CPUE values from CPUE computations for RGSM
 - **6c** - Compute mean site-specific CPUE from individual seine hauls
 - **10a** - Use October data from 1993 to 2014 data in the mixture model to assess the relationship of hydrological covariates and estimates of the mean annual CPUE for RGSM
 - **10b** - Use the individual seine-haul approach data from October for 2006 to 2016 in the mixture model to assess the relationship of hydrological covariates and estimates of the mean annual CPUE for RGSM
 - **11a** - Fully define that the assumptions of the mixture models
 - **11b** - Document and interpret the influence wherever results of CPUE analyses potential violate the 11a assumptions
 - **12** - Increase the number of sampling sites (20-50 per reach) to improve accuracy of RGSM CPUE estimates and to allow reach-specific computations of CPUE estimates

USBR stated that ASIR had incorporated some of the above expert peer review recommendations (possibly recommendations 1a, 1b, 3, 4, and 10a) with 2016 data only, and have gone back previous years for recommendation 4.

Rich Valdez suggested refine or revise the CPUE for at least 5 years. Mike Marcus suggested using a range of wet and drought years. Michael Porter will review the

2016 report and identify which recommendations applied to 2016 should be used to go analyze previous years data. Rick Billings, Mike Marcus, and Michael Porter will meet in the next week to brainstorm ideas and then develop a SOW.

5. Rick Billings provided review of draft 2016 annual monitoring report, a good and dense report beneficial to adaptive management but also hard to read, need a better way to get the information to the decision makers and management. Mike Marcus suggested an executive summary prepared by participants and stakeholders would be useful, and had comments to draft to make it clearer. Rich Valdez noted the annual report driving the BO, has recommendations to improve the report if USBR interested, and suggested improved writing would make report easier to read.
6. Eric Gonzales provided update on pending monitoring contract and went over the handout prepared by Jennifer Bacchus responding to specific questions given to USBR prior to the meeting. The new monitoring contract is pending and in final review process. Monitoring should start in April. The new contract incorporates the following new items, recommendations from the science panel using feedback from this working group, while maintaining the integrity of the protocol for the long-term dataset:
 - Making February and December sampling an optional task line item
 - Increasing the number of sites to 30 sites for April and October sampling, to evaluate the effect on monitoring data from added sites (Option Year could increase to 60 sites in those two months, optional task depending on outcome of sampling 30 sites)
 - Detections of RGSM by mesh size, and specific to mesohabitat type, calculating CPUE by total catch rates, by age class (larval/YOY/non-YOY), and by mesh size
 - The use of replacement sites if any of the 20 standard sites are dry at the time of sampling
 - Reporting density estimates both including/excluding dry sites, and with/out replacement sites
 - Monthly sampling now at 7 months (March/April through October), plus continuing intensive in November
 - Reporting includes a table of assumptions that apply to the analyses, risk that assumption could be violated, steps taken to minimize that likelihood, and explaining potential impact
 - Additional sampling per seine haul as an optional task
 - Workshop as an optional task if needed

Grace Haggerty stated ISC would like to have a say in the additional monitoring site locations. Brian Hobbs noted that all options from the SOW were bid on in the selected proposal, but until the contract is awarded USBR could not provide the proposal details, answer specific questions of the workgroup, or coordinate with ISC on the additional site locations.

USBR provided a data table with the requested E(x) and mean values for Figure 7 in the 2016 report. The draft 2016 report has undergone the review period for comment and suggestions on reporting format and presentation. The next contract has reporting requirements that were the outcome of feedback and comment from this workgroup. Any additional reporting preferences for presentation of the data can be considered if no added cost.

7. Rich Valdez provided a discussion on recent analysis to better understand the variables leading to spawning by the Rio Grande silvery minnow in the Middle Rio Grande. Figures A and B were provided to illustrate the possible relationships between estimated spawning dates and river temperature and flow.

Figure A - Estimated Spawning Dates for RGSM and Temperature Degree Days in 2016, preliminary interpretations:

- In 2016, persistent daily spawning began 4/13/2016 at 771 TDDs and after a flow increase of 163 cfs/day
- A sharp increase in spawning was seen 5/8/2016 at 1,060 TDDs and a flow increase of 120 cfs/day
- The peak of spawning occurred 5/16/2016 at 1,263 TDDs and a flow increase of 160 cfs/day
- If river temperature and flow are driving variables for spawning dates of silvery minnow, it appears that the fish need about 771 to 1,060 TDDs and a daily flow change of about 120 to 160 cfs

Figure B - Flow and Projected Temperature Degree Days (2016 vs 2017), preliminary interpretations:

- TDDs for 2017 are following a similar pattern as for 2016, but are warmer on a daily basis by 13 to 36%; this is likely to advance initiation of spawning by a few days—unless the snow-melt runoff cools the river before sufficient TDDs are reached
- The early flow increase starting 3/11/2017 is not expected to cue significant spawning because TDDs are only ~500 (spawning occurred at 771 to 1,060 TDDs in 2016)
- Fish should be ready to spawn (i.e., mature ovaries) about 4/10/2017 to 5/1/2017 based on projected TDDs, but surge will probably be cued by daily flow change
- The 2016 information gives us some insight into possible spawning dates of silvery minnow for 2017; however, flow and possibly river temperature are different than 2016
- We cannot at this time reliably predict spawning dates for the silvery minnow, but should be able to reach reasonable projections with additional information from observed spawning in future years and from post-hoc analyses of data from past years

Why does the timing of spawning matter? Two main reasons:

- Being able to predict the start of spawning could allow water management to correspond river flow with spawning and maximize spawning success, survival of larvae, and recruitment
- Timing of the spawn establishes the annual survival curve for age-0 fish and fish density (CPUE) during population monitoring

Figures C and D were provided to illustrate the difference in CPUE as the year progresses and the fish experience natural mortality.

Figure C - Survival of Age-0 RGSM—2004, 2007, 2016:

- This figure shows the mean monthly CPUE and a negative exponential function fit to the data of each year such that the exponent e^{-Zt} represents the slope on a monthly time step; monthly survival is computed as $\text{Exp}(-Zt)$, where t = time in months.
- Mortality rates (i.e., slopes of the curves) are quite different for the 3 years—2004, 2007, and 2016.
- A point on a given curve is a prediction of the CPUE for age-0 fish at that time; e.g., July, August, September, or October.
- In years like 2007 and 2016, where CPUE was moderate, the difference for samples 1 month apart is nearly 3 fish/100 m². That could make a difference in the “October” CPUE.
- In a year like 2004, when CPUE is low, the difference is not as great (< 1 fish/100 m²) for samples taken 1 month apart.

Figure D - Survival of Age-0 RGSM—2005:

- This figure is provided to illustrate how big the difference in CPUE can be when the year-class is strong and fish density is high.
- The difference if samples were taken November 1 as opposed to October 1 is a CPUE of more than 9 fish/100 m² lower.

8. Michael Porter provided analysis of USACE 2013-2015 Albuquerque reach catch data for all fish (>16,000 total), and for the red shiner, flathead chub, and silvery minnow (898 total) individually. Paired histograms show the size distributions from the beach seine and bag seine. Overall the catchability results were:

- All fish: 60% beach seine and 40% bag seine
- Red shiner: 70% beach seine and 30% bag seine
- Flathead chub: 60% beach seine and 40% bag seine
- Silvery minnow: 40% beach seine and 60% bag seine

Another graph calculated the relative catchability of the beach seine as a percent of the total catch for each size class by analyzing the silvery minnows separately by standard length, showing that silvery minnows smaller than 22 mm were predominately caught by beach seine, while silvery minnows larger than 22 mm were predominately caught by bag seine. The results support the CPUE panel recommendation to use the monitoring program to assess age 0 trends. A technical report will be prepared after completion of more analysis.

9. Planning for April retreat was briefly discussed. The focus will be on program funding and not technical. WEST is planning and facilitating the event. Debbie Lee said 2 possibly 3 people will attend for each signatory.

Next Meeting

- Late May or early June after April sampling results are available, TBD

Action Items

- **All** - Provide 1 page scope of work project ideas to the Science group prior to April 10, 2017 Science Workgroup meeting (suggestion).
 - Mike Marcus, Rick Billings, and Michael Porter and will meet to discuss and prepare a SOW regarding analysis of the applicable top ranked expert peer review recommendations with existing data.
 - Rich Valdez and Michael Porter will prepare a SOW regarding temperature degrees days and potential relationship to peak of spawning and timing of October sampling.
 - **Rick Billings** - Determine if ABCWUA would be able to fund DBMS for a few months to prevent it from going offline COB Friday March 31, 2017.
 - **USBR** - Provide to ISC (Grace Haggerty) requested information regarding the selected 2 year monitoring plan proposal after the contract is awarded.
 - **Beth Salvias** - Send out meeting notes and conduct a doodle poll for next meeting date during late May or early June.
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Reclamation RGSM Population Monitoring Contract Update

March 2017

- **Update on the monitoring contract status?**
 - Last fall 2016, the population monitoring working group met and discussed priorities for the science panel recommendations.
 - Reclamation incorporated that information into the Statement of Work (SOW) where that represented consensus feedback related to recommendations from the science panel.
 - Reclamation pushed that opportunity for input to the latest possible date while keeping the acquisition process moving.
 - A new contract was required by February 2017; however, the February and December sampling were made an optional line item, per recommendations from this group. Sampling now needs to start in April.
 - The contract award is pending; it is undergoing the final steps in the review process and is being expedited as much as possible.

- **How any of the options were working out if those have been tried yet? How are the modifications to the sampling protocol, as recommended by the Pop Mon Workgroup, being implemented for 2017 (e.g., expanded number of sites, alternate sites for dry sites, etc.)?**
 - The new aspects added to the SOW can be implemented once the contract is in place. That will start this year (FY17) – target date is now April.
 - The new contract incorporates the following new items, recommendations from the science panel using feedback from this working group, while maintaining the integrity of the protocol for the long-term dataset. These are the new or modified items that came out of this group’s discussions last fall, and the final updated SOW that was shared with the group last fall, as a refresher:
 - i. Making February and December sampling an optional task line item
 - ii. Increasing the number of sites to 30 sites for April and October sampling, to evaluate the effect on monitoring data from added sites (Option Year could increase to 60 sites in those two months, optional task depending on outcome of sampling 30 sites)
 - iii. Detections of RGSM by mesh size, and specific to mesohabitat type, calculating CPUE by total catch rates, by age class (larval/YOY/non-YOY), and by mesh size.
 - iv. The use of replacement sites if any of the 20 standard sites are dry at the time of sampling.
 - v. Reporting density estimates both including/excluding dry sites, and with/out replacement sites.
 - vi. Monthly sampling now at 7 months (March/April through October), plus continuing intensive in November.
 - vii. Reporting includes a table of assumptions that apply to the analyses, risk that assumption could be violated, steps taken to minimize that likelihood, and explaining potential impact.
 - viii. Additional sampling per seine haul as an optional task

ix. Workshop as an optional task if needed

- **In future Pop Mon Final Reports, it would be helpful to:**

- (a) include a table of computed mixture model estimates ($E(x)$) for each year to support Figure 7 of the Final Report.**

- See handout, Reclamation requested $E(x)$ and mean values for Figure 7, which is in the 2016 report (produced under prior contract that is ending).
 - Once a new contract is in place, as long as there is not an added cost we can request this type of table/data be included in the report.

- (b) identify the samples in Appendix D that were used to compute the October CPUE shown in Figure 7; would help to see a separate table of the samples, dates, number of fish caught, effort, and computed CPUE for each sample.**

- Appendix D provides information on all monthly, site-specific RGSM detections, including monitoring (sampling) results for RGSM, dates, number caught (and broken down by age), and effort (in terms of area sampled) are given in Appendix D. A CPUE calculation can be conducted by using the # of RGSM and the area sampled.
 - The mixture model methodology for $E(x)$ density estimates is provided in the Methods section of the report.
 - Page 5 of the draft 2016 annual report states “*Analyses were conducted on the full dataset and on a portion of the dataset that excluded all dry sampling sites.*” Here the contractor refers to a portion of the dataset (Appendix D data) in order to analyze the inclusion and exclusion of dry sites – see Figures 7 and 12 in the draft 2016 report. Was this the focus of this question?
 - The draft 2016 report has undergone the review period for comment and suggestions on reporting format and presentation. The next contract has reporting requirements that were the outcome of feedback and comment from this group on the SOW. Any additional reporting preferences for presentation of the data can be considered if no added cost; otherwise, the next contract can consider incorporating those during SOW review if there is consensus they should be requirements.

Projected Spawning Dates for Rio Grande Silvery Minnow—2017
Richard A. Valdez, Ph.D.
March 21, 2017 (revised from March 19, 2017)

Spawning Dates

This is my attempt to try and better understand the variables that lead to spawning by the Rio Grande silvery minnow in the Middle Rio Grande.

Below are two figures that illustrate possible relationships between estimated spawning dates and river temperature and flow. The following explains each of these figures:

Figure A: Estimated Spawning Dates for RGSM and Temperature Degree Days in 2016.

Explanation of Variables:

- This figure illustrates the estimated spawning dates in 2016 as the narrow gray vertical bars of a histogram (each bar is the number of fish that spawned on a given day).
- Estimated hatching dates were computed from lengths of captured larvae using a temperature-dependent growth model for 20°C from Platania and Dudley (2003), and advanced by 2 days to derive spawning dates.
- Flow was derived from mean daily discharge for the Rio Grande at Alameda Bridge, USGS gage #08329918 (blue line).
- Temperature degree-days (TDDs) were computed as cumulative mean daily temperature starting January 1 for data from the Rio Grande at Alameda Bridge, #08329918 (orange line).
- The number of eggs captured on a given data during the 2016 egg survey (Dudley et al. 2016) are represented as small black circles (sum of all eggs for all sites from Belen to San Marcial).

Preliminary Interpretations:

- In 2016, persistent daily spawning began 4/13/2016 at 771 TDDs and after a flow increase of 163 cfs/day (indicated by first vertical red line).
- A sharp increase in spawning was seen 5/8/2016 at 1,060 TDDs and a flow increase of 120 cfs/day (indicated by second vertical red line).
- The peak of spawning occurred 5/16/2016 at 1,263 TDDs and a flow increase of 160 cfs/day.
- If river temperature and flow are driving variables for spawning dates of silvery minnow, it appears that the fish need about 771-1,060 TDDs and a daily flow change of about 120-160 cfs.
- Note that the egg survey data reflected the concentration of spawning, but did not reflect the magnitude or the start or end dates for spawning.

Figure B: Flow and Projected Temperature Degree Days (2016 vs 2017).

Explanation of Variables:

- This figure illustrates a preliminary spawning dates for 2017, based on projected TDDs (dotted orange line); the green line is TDDs for 2016.
- Flow was derived from mean daily discharge for the Rio Grande at Alameda Bridge, USGS gage #08329918; the blue line that ends 3/19/2017 is for 2017 to date, and the gray line if for 2016.

Preliminary Interpretations:

- TDDs for 2017 are following a similar pattern as for 2016, but are warmer on a daily basis by 13-36%; this is likely to advance initiation of spawning by a few days—unless the snow-melt runoff cools the river before sufficient TDDs are reached.
- The early flow increase starting 3/11/2017 is not expected to cue significant spawning because TDDs are only ~500 (spawning occurred at 771-1060 TDDs in 2016).
- Fish should be ready to spawn (i.e., mature ovaries) about 4/10/2017 to 5/1/2017 based on projected TDDs, but surge will probably be cued by daily flow change.
- The 2016 information gives us some insight into possible spawning dates of silvery minnow for 2017; however, flow and possibly river temperature are different than 2016.
- We cannot at this time reliably predict spawning dates for the silvery minnow, but should be able to reach reasonable projections with additional information from observed spawning in future years and from post-hoc analyses of data from past years.

Survival Curves

The above discusses spawning dates for RGSM. Why does the timing of spawning matter? Two main reasons:

1. Being able to predict the start of spawning could allow water management to correspond river flow with spawning and maximize spawning success, survival of larvae, and recruitment; and
2. Timing of the spawn establishes the annual survival curve for age-0 fish and fish density (CPUE) during population monitoring (see Figures C and D).

Below are Figures C and D that illustrate the difference in CPUE as the year progresses and the fish experience natural mortality. The slope of the lines in these figures represent mortality and any point on the line is the estimated CPUE for that point in time.

Figure C: Survival of Age-0 RGSM--2004, 2007, 2016

- This figure shows the mean monthly CPUE (taken from the monthly ASIR Reports and represented as dots color coded by year) and a negative exponential function fit to the

data of each year such that the exponent e^{-Zt} represents the slope on a monthly time step; monthly survival is computed as $\text{Exp}(-Zt)$, where t = time in months.

- It is clear to see that the mortality rates (i.e., slopes of the curves) are quite different for the 3 years—2004, 2007, and 2016.
- A point on a given curve is a prediction of the CPUE for age-0 fish at that time; e.g., July, August, September, or October.
- The two vertical lines in this figure represent October 1 and November 1 of each year, and the table at the upper right corner of the figure shows the differences in CPUE for each year if samples were taken 1 month apart; i.e., October 1 vs November 1.
- In years like 2007 and 2016, where CPUE was moderate, the difference for samples 1 month apart is nearly 3 fish/100 m². That could make a difference in the “October” CPUE.
- In a year like 2004, when CPUE is low, the difference is not as great (< 1 fish/100 m²) for samples taken 1 month apart.

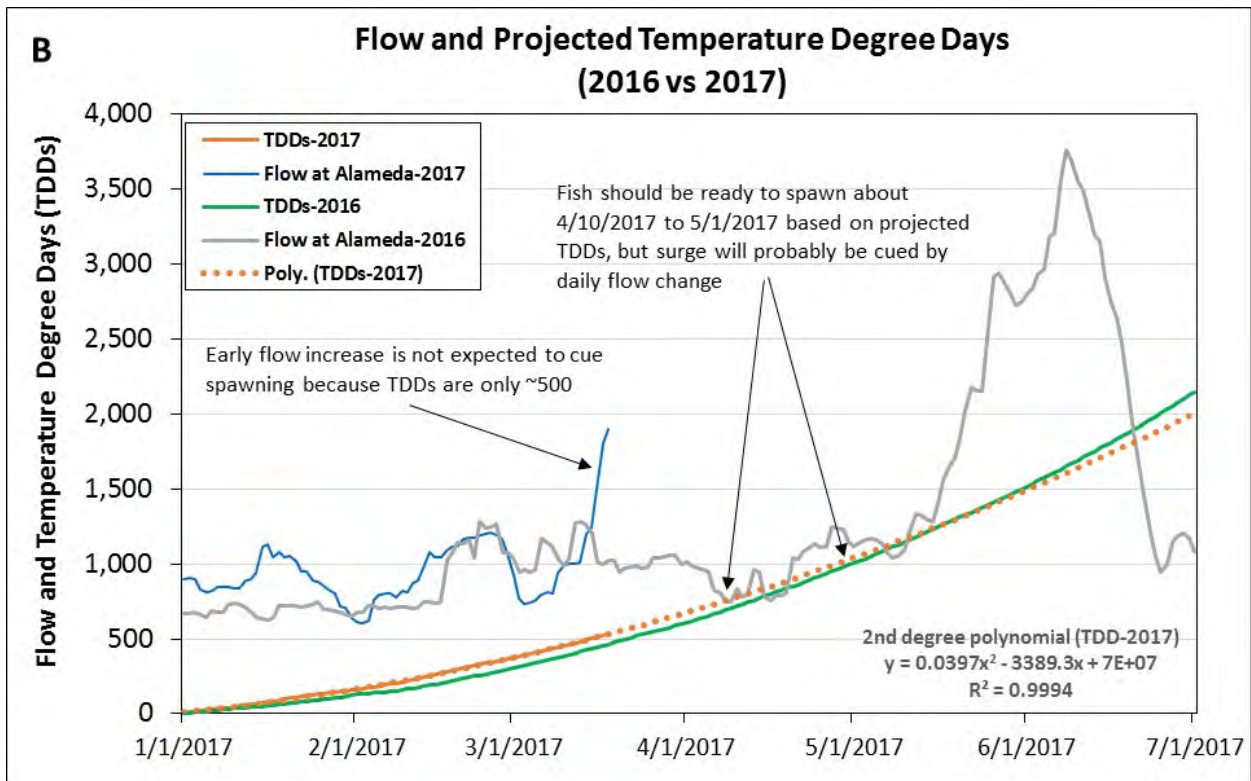
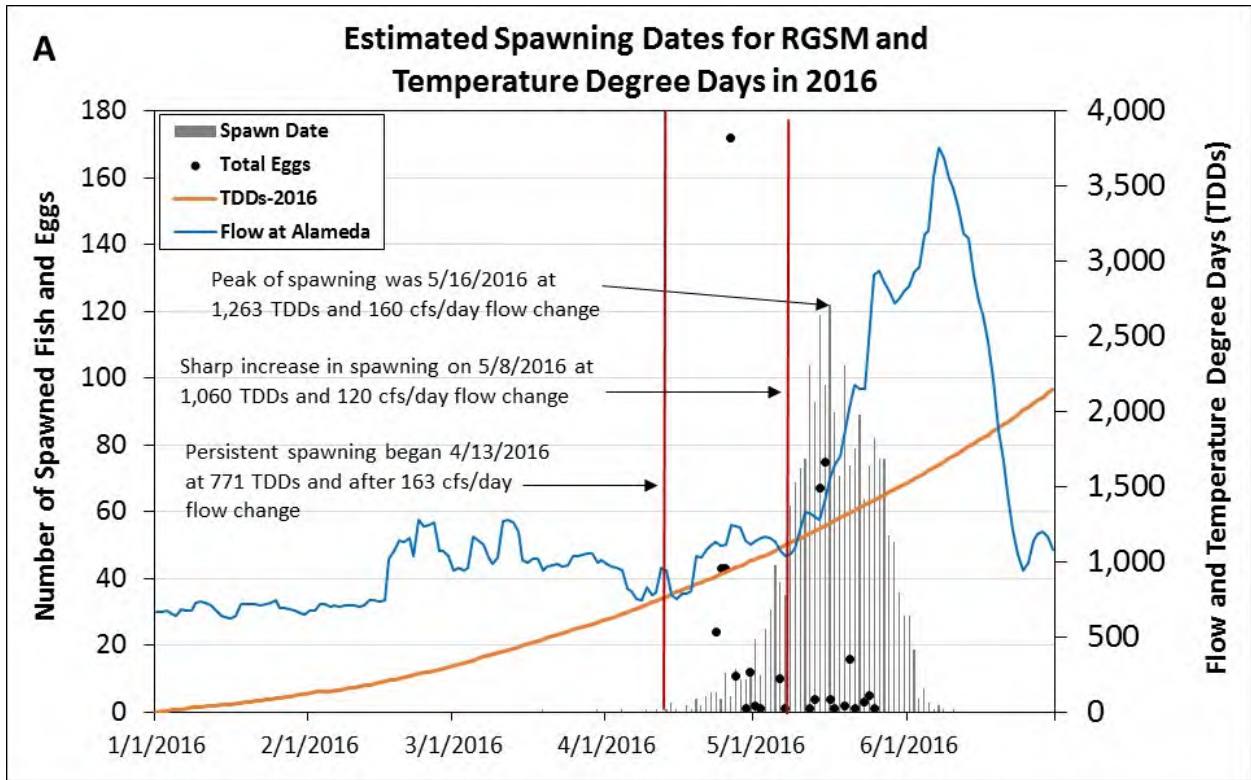
Figure D: Survival of Age-0 RGSM—2005

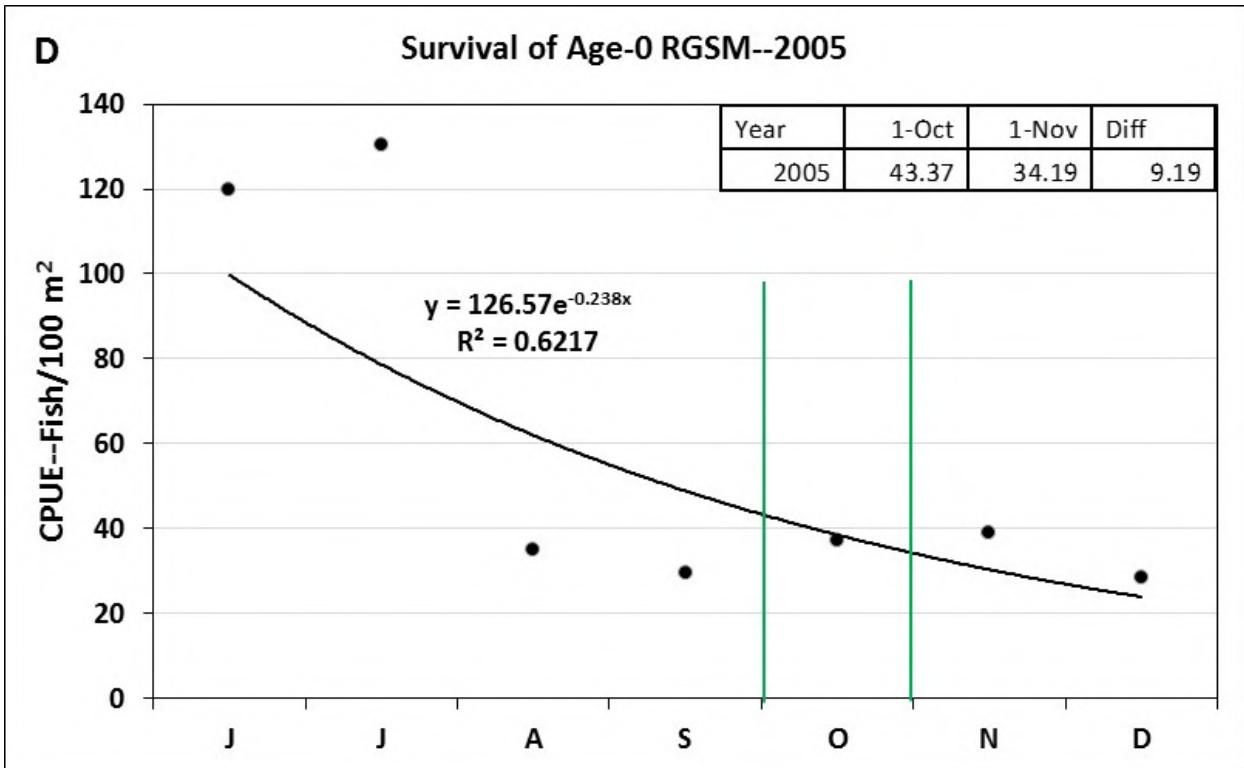
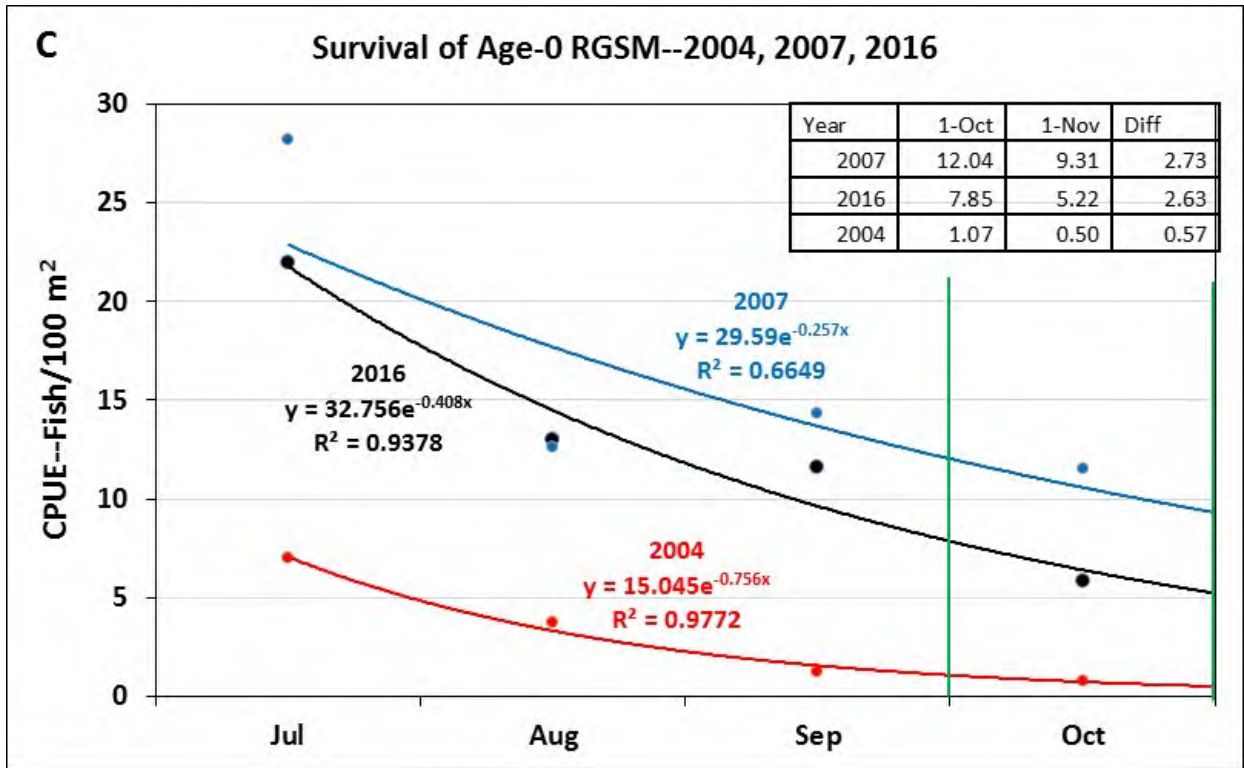
- This figure is provided to illustrate how big the difference in CPUE can be when the year-class is strong and fish density is high.
- The difference if samples were taken November 1 as opposed to October 1 is a CPUE of more than 9 fish/100 m² lower.

Literature Cited

Dudley, R.K., S.P. Platania, and G.C. White. 2016. Rio Grande silvery minnow reproductive monitoring during 2016 in the Rio Grande and selected irrigation canals. American Southwest Ichthyological Researchers, L.L.C., Albuquerque, New Mexico.

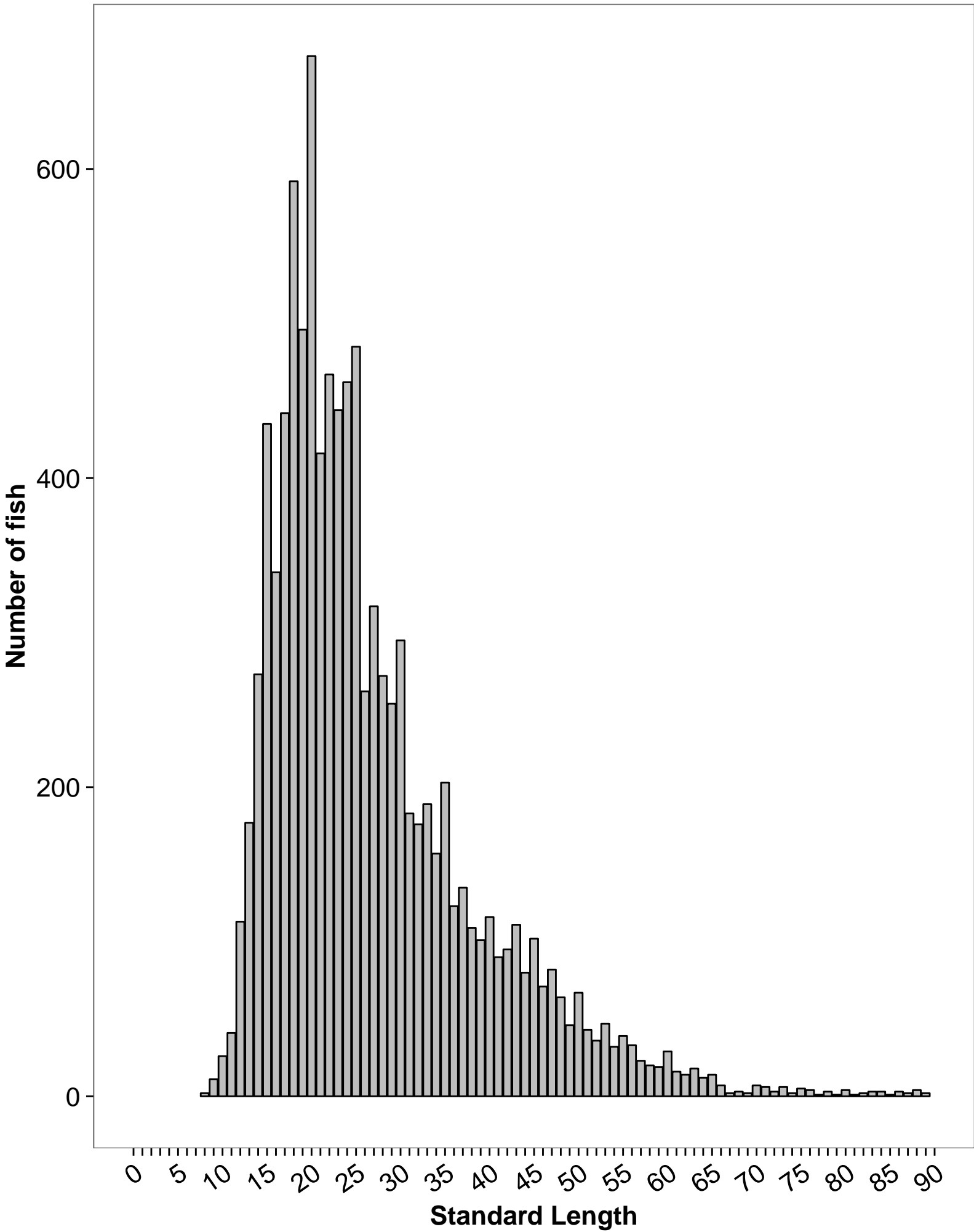
Platania, S.P., and R.K. Dudley. 2003. Summary of the biology of Rio Grande silvery minnow, an endangered species in the Middle Rio Grande. American Southwest Ichthyological Researchers, L.L.C., Albuquerque, New Mexico.



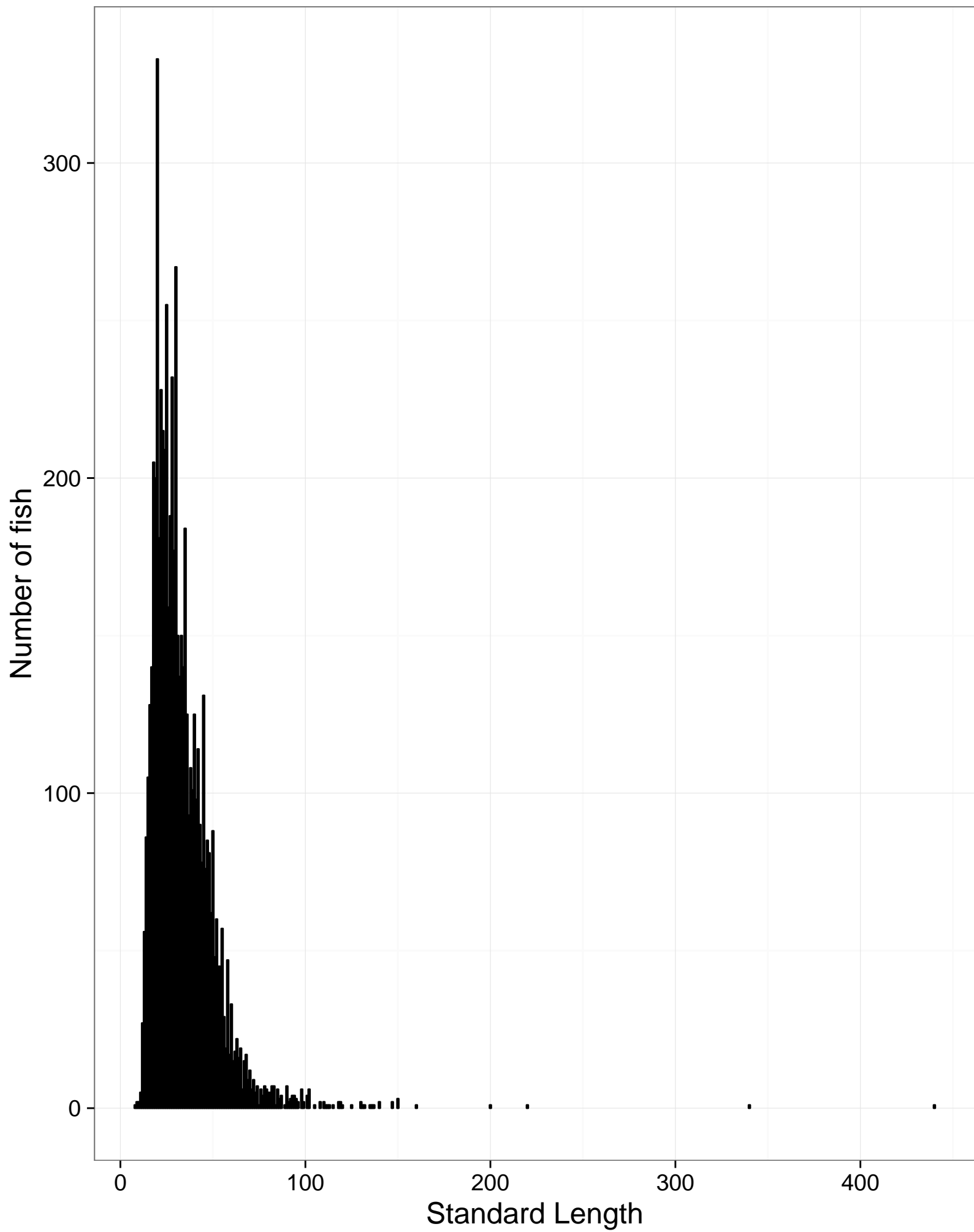


Obs	Year	Raw_Mean	EX	LCI_EX	UCI_EX
1	1993	11.7744	14.7985	5.1992	42.121
2	1994	12.5634	18.1625	3.7343	88.338
3	1995	26.7892	36.0332	7.8493	165.416
4	1996	1.3991	1.5074	0.5414	4.197
5	1997	13.6439	15.485	6.7539	35.503
6	1999	6.2894	6.7623	2.4228	18.874
7	2000	0.429	0.4322	0.184	1.015
8	2001	0.8552	0.9243	0.4564	1.872
9	2002	0.0796	0.0763	0.0272	0.215
10	2003	0.0142	0.0262	0.0017	0.402
11	2004	0.858	0.8918	0.32	2.485
12	2005	37.3406	44.8387	18.3453	109.592
13	2006	0.9207	0.9588	0.565	1.627
14	2007	10.6493	13.0536	4.5877	37.142
15	2008	8.3302	10.5454	5.1901	21.426
16	2009	15.0137	14.1789	8.3666	24.029
17	2010	1.2089	1.2057	0.5966	2.436
18	2011	1.1494	1.2698	0.3871	4.166
19	2012	0	0		
20	2013	0.0297	0.0297	0.0104	0.084
21	2014	0	0		
22	2015	0.1564	0.1573	0.0834	0.297
23	2016	5.4037	7.2021	2.6041	19.919

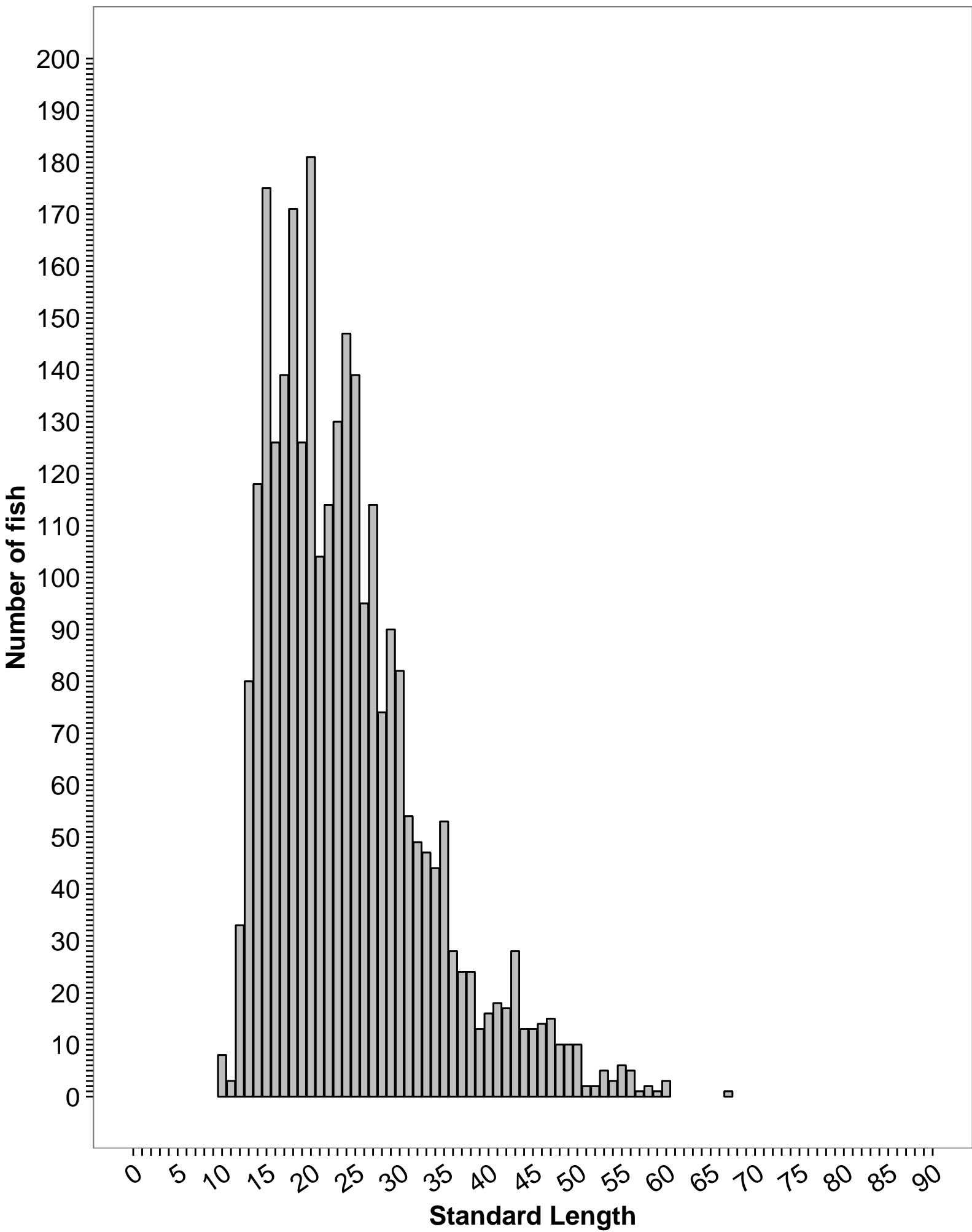
Beach Seine – All fish



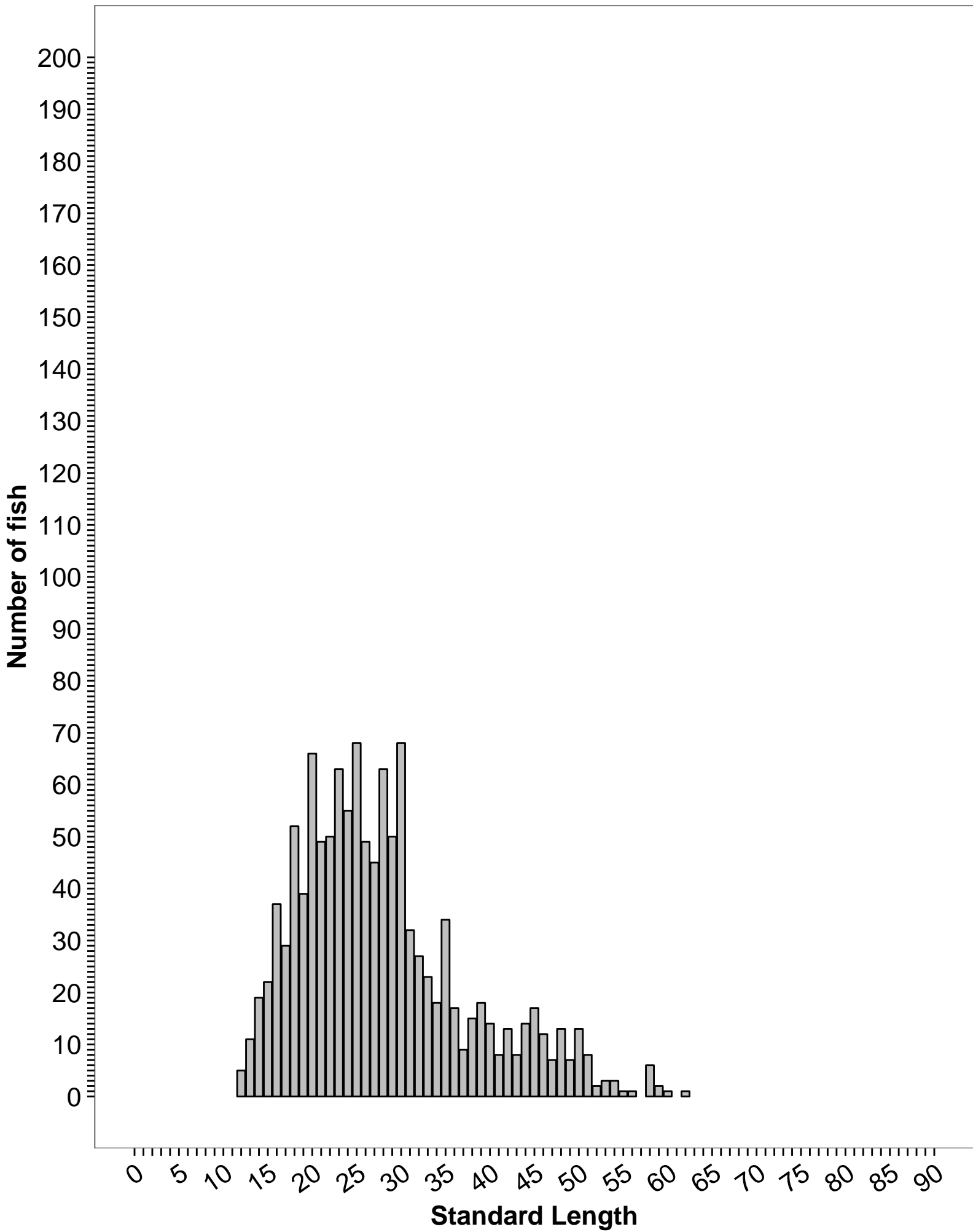
Bag Seine – All fish



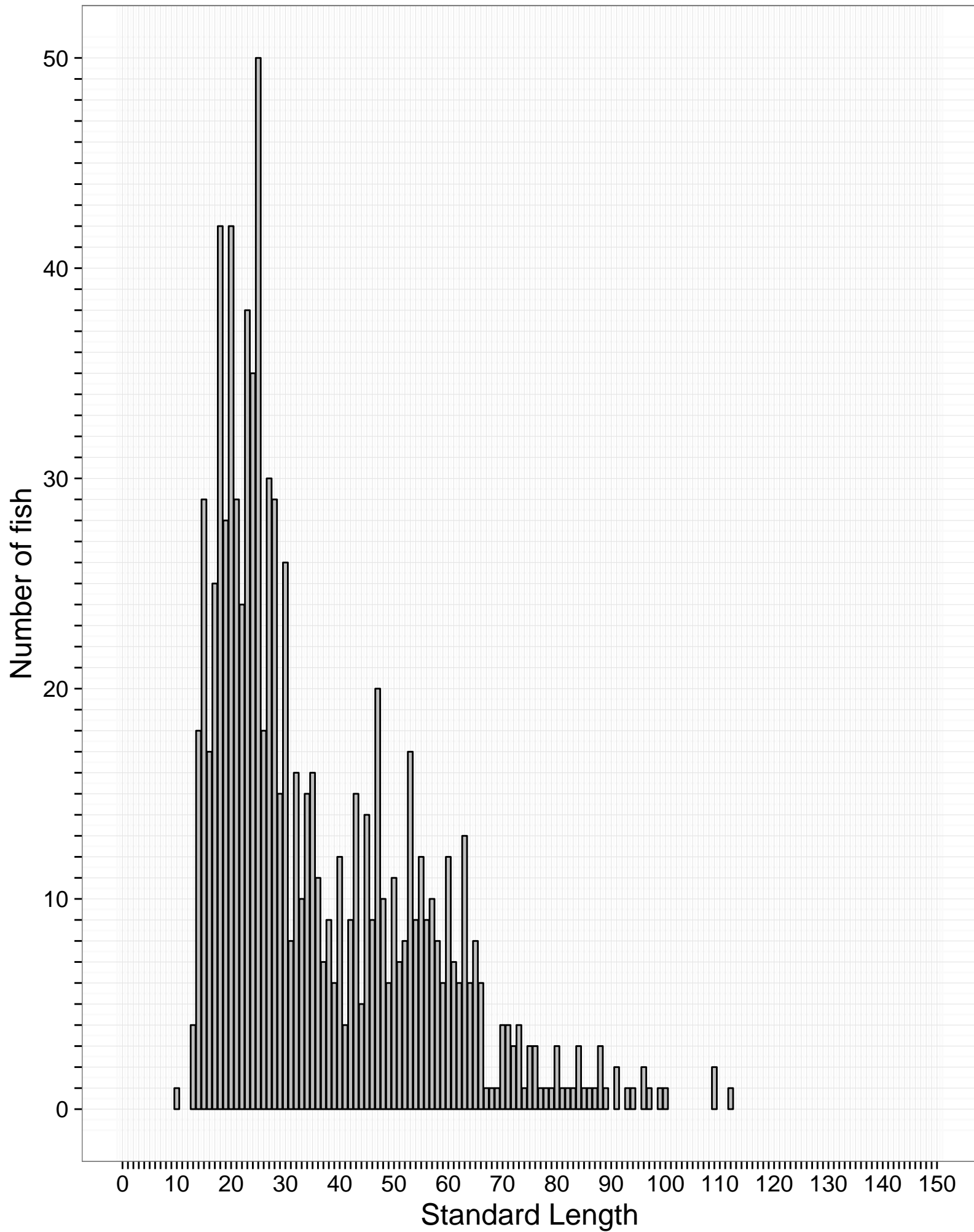
Beach Seine – Red Shiner



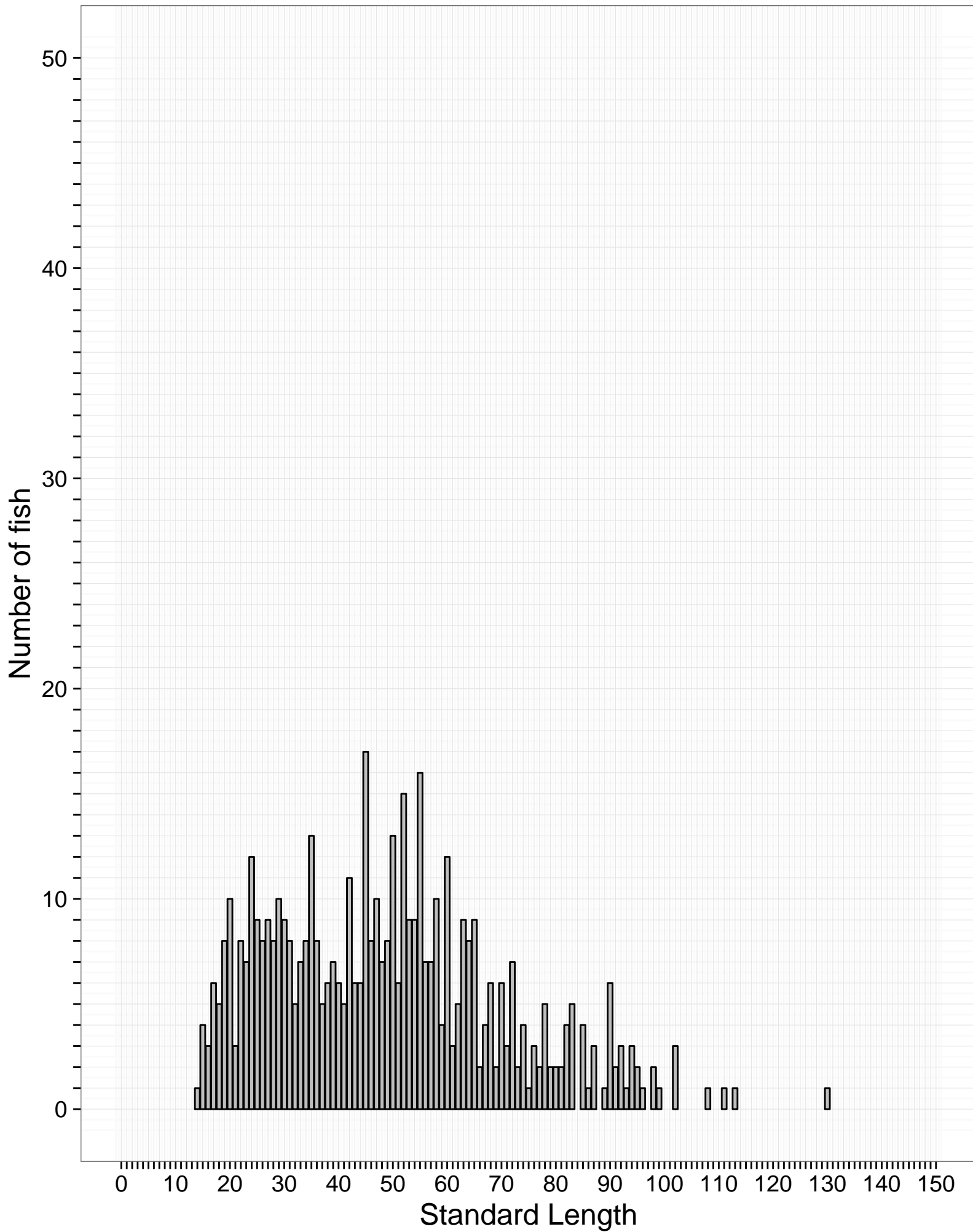
Bag Seine – Red Shiner



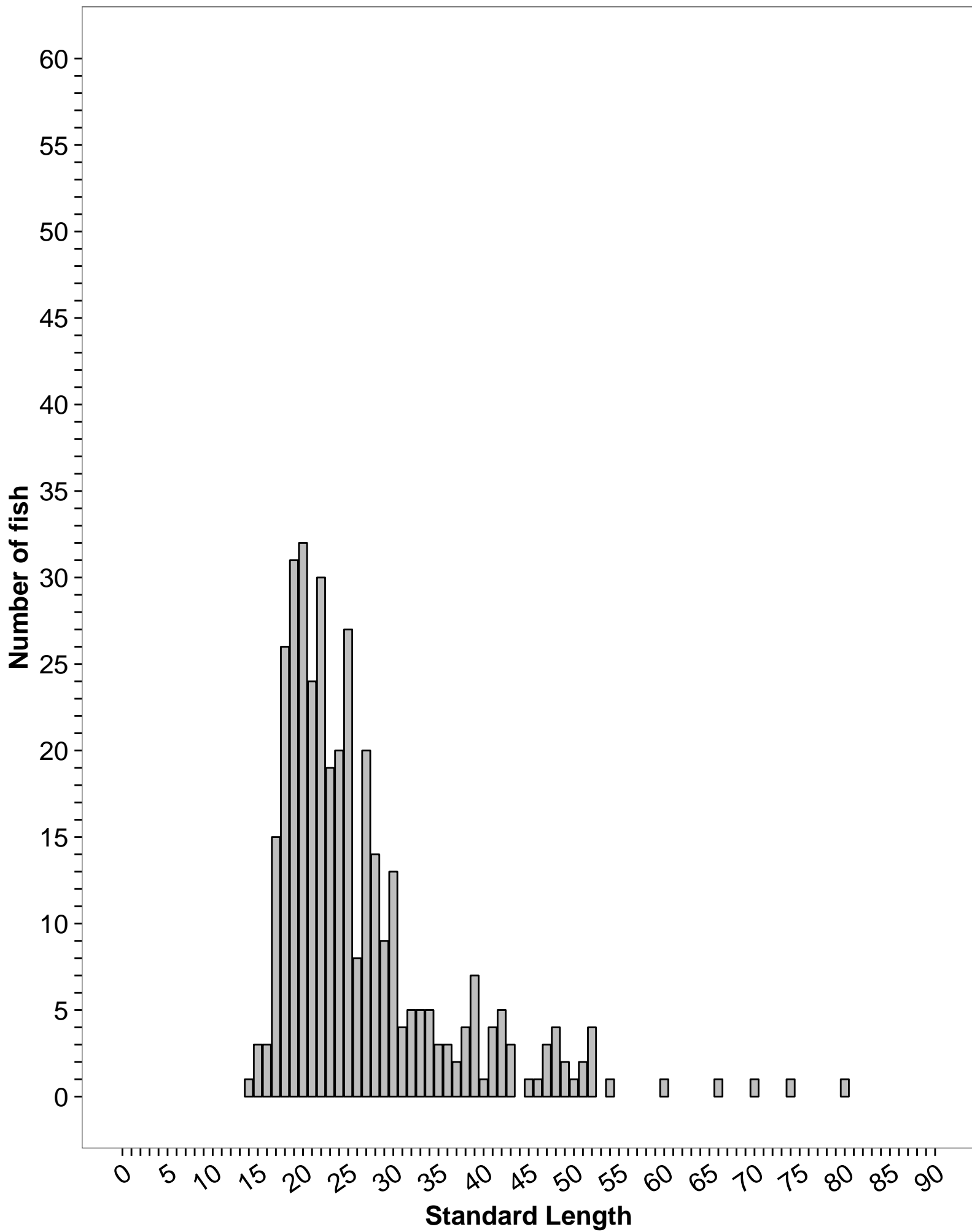
Beach Seine – Flathead chub



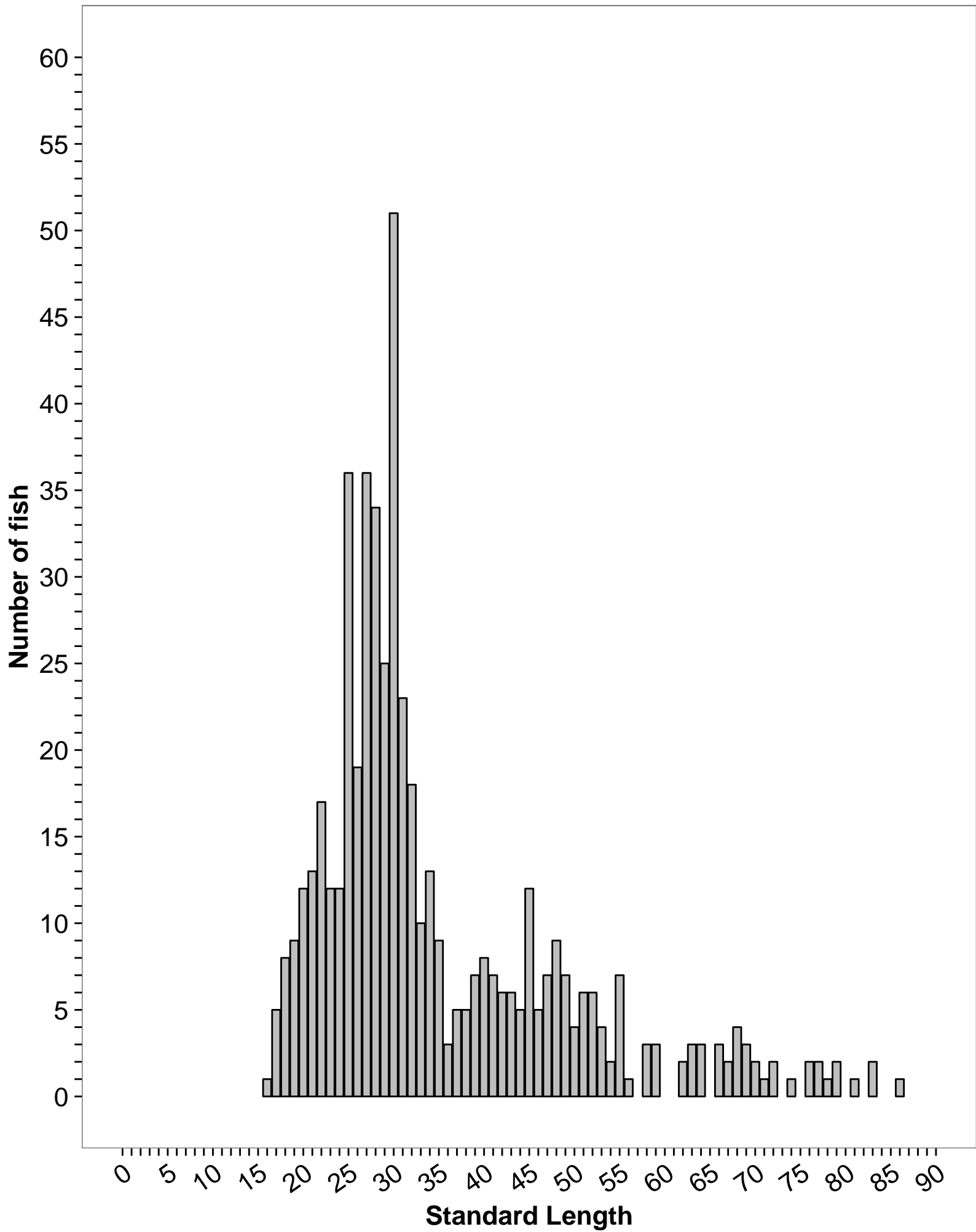
Bag Seine – Flathead chub



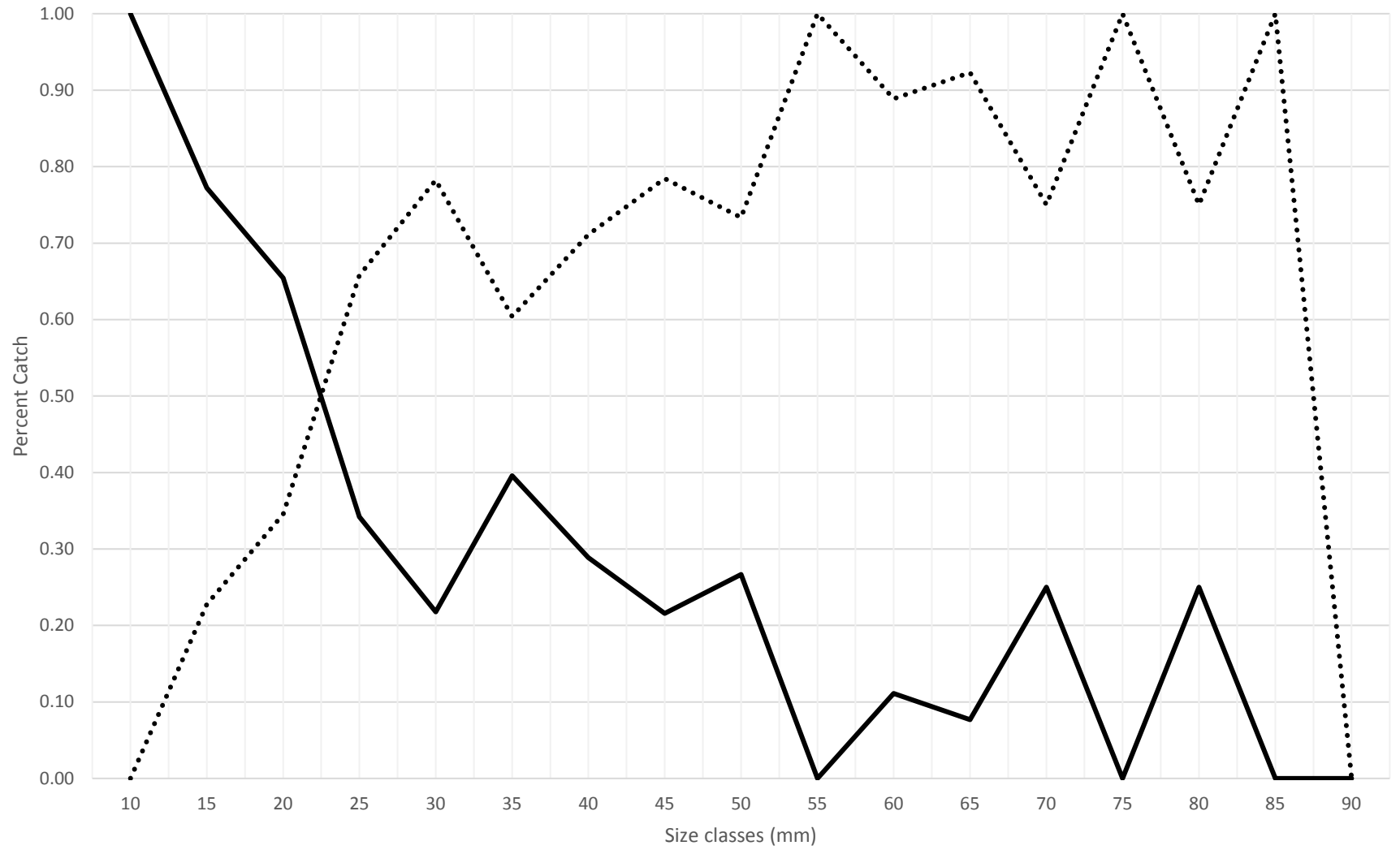
Beach Seine – Silvery Minnow



Bag Seine– Silvery Minnow



RGSM catchability



— % catchability - beach

..... % catchability - bag