MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
Instream Flows TWC Meeting

January 24, 2017

Final KMK 2-16-17

ATTENDEES:

Bill Argentieri (SCE&G)
Ray Ammarell (SCE&G)
Caleb Gaston (SCANA)
Brandon Stutts (SCANA)
Tom McCoy (USFWS)
Melanie Olds (USFWS)
Dick Christie (SCDNR)
Bill Marshall (SCDNR)
Ron Ahle (SCDNR)
Alex Pellett (SCDNR)
Gerrit Jobsis (American Rivers)
Bill Stangler (Congaree Riverkeeper)
Henry Mealing (Kleinschmidt)
Brandon Kulik (Kleinschmidt) via conf. call
Bret Hoffman (Kleinschmidt)
Jason Moak (Kleinschmidt)
Jordan Johnson (Kleinschmidt)
Kelly Kirven (Kleinschmidt)

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Henry opened the meeting with introductions and distributed a memo entitled "Parr IFIM Study – Habitat Duration Analysis and Misc. Action Items" dated January 23, 2017. This memo was an update of the "Habitat Duration" memo distributed in December 2016. Henry then began a PowerPoint presentation, which is attached to the end of these notes along with the January 23rd memo. The goals of the meeting included selecting values for minimum flows, selecting seasonal date ranges for low, mid, and high minimum flows, discussing potential observation dates and discussing methods and transects for observation. Regarding the timing for the observation flows, Henry suggested that there will likely be three separate outings to view the flows; one in early spring, one in May, and one in August. Henry then reviewed the action items from the previous meeting. The corrected WUA tables from the IFIM report are included in Attachment A of the memo, the new figures and tables of WUA by target species and life-stage are in Attachment B of the memo, and the Habitat Duration Analysis is in Attachment C of the memo. The WUA data weighted by mesohabitat is presented in the body of the memo.

Henry then turned the presentation over to Bret, who discussed the Habitat Duration Analysis. He explained that seasonal hydrologic availability was compared to WUA and to the seasonal minimum flow ranges that were proposed at the previous TWC meeting (held on September 27, 2016). Bret explained that there was an inflection point in the prorated data around 3,900 cfs, which resulted in overestimation of inflows below this point and underestimation of inflows above it. Because of this, he used non-prorated data to complete the habitat duration analysis. Also, in order to tailor the effort during this analysis, he focused on select months, species/life stages and study sites that were noted as having the greatest interest or importance. Bret said the exceedance

percentages, which are in Table 2 of the memo, display how often the low, transitional, and high flows are exceeded. For example, a flow of 1,800 cfs in June is available 74 percent of the time and not available 26 percent of the time. Henry added that this Project is not a storage reservoir, so outflows are totally dependent on inflow. SCE&G is not able to hold back excess water in the spring for release in the summer. Ray said that since SCE&G will try to avoid dropping gates as part of a parallel effort to dampen downstream flow fluctuations, this will drive water through the powerhouse more consistently.

Gerrit began discussing a potential Low Inflow Protocol (LIP). He said that, for example, if Flow A is the minimum flow and inflow decreases to a certain point, then Flow B will become the minimum flow. If inflow decreases to within 200 cfs of the minimum flow, then the minimum flow can be reduced and act as a buffer. Gerrit asked how SCE&G currently operates when they are at inflow now. Ray said when they are at inflow, they release inflow minus evaporation. He said he finds that losses are greater in the system as a whole than what is calculated for inflow, so they can still operate Fairfield, just a little less each day. Monticello Reservoir starts dropping each day during a drought or period of low flows, so the maximum amount you can release is constantly decreasing. He said in extreme periods of low flows, which may have more impact on Parr Hydro in the future due to the two new nuclear units at V.C. Summer, Fairfield operations are limited. When a storm comes and flows increase, SCE&G attempts to make up losses in the reservoir that occurred over the low flow period until Monticello is restored to full pool. The group agreed that this recovery mechanism for Monticello Reservoir should be incorporated into the LIP.

Henry said that he wants to ensure SCE&G has some flexibility in their operations so that they can meet their minimum flows and consistently stay within compliance. He also noted that a change in philosophy on how the Project is run, including removing downstream pulses and no longer operating with a daily average minimum flow, will affect the new minimum flows in a positive way.

The group refocused on the presentation and Jordan began explaining the representative reach analysis and methods for weighting WUA. He explained that this analysis focuses on Reach 2 of the IFIM study because this reach is hydraulically linked unlike Reach 1, which is split into east and west channels by Hampton Island and because Reach 2 includes critical study sites that were identified by the TWC. He then explained that the total linear feet for each mesohabitat type within Reach 2 was measured using ArcGIS. Study sites 6, 7, and 8 were assessed separately from Bookman Island because they contained different types of habitat and were modeled using different methods. The two areas were weighted based on their individual linear lengths and then the weighted values were summed to provide WUA for the entire Reach 2. Graphs were reviewed that compare WUA availability by species for low flows, high flows and transitional flows.

One conclusion from the analysis that Henry noted is that a low flow of 700 cfs provides 79-120 percent of the suitability of a flow of 1,200 cfs. Ron noted that the 700 cfs flow only reach 120 percent suitability when small mouth bass fry are included. He said that the fry stage lasts for a very short period of time and shouldn't be taken into account for low flows.

The stakeholders held a breakout session to review and discuss the data presented in the memo.

After lunch, the group reconvened. Gerrit acted as the spokesperson for the stakeholder group and explained what they had discussed and the recommendation they were proposing. He said that there

were two important things they looked at regarding their flow recommendations. First, they identified certain species that were most affected by flows. Second, they identified Study Site 3 as being important since whatever flows are released in that area, a portion will be diverted to the west channel. They also identified Bookman Shoals and Haltiwanger Island as important areas. Gerrit said they also looked at the exceedance flows and took into account how often certain flows would be available in the river. They identified a flow duration exceedance (not a WUA score) of 75-80 percent as acceptable.

Gerrit said the minimum flows that the stakeholders are recommending are as follows:

- Low Flows – June 1-November 30 – base flow of 1,200 cfs – drivers are adult smallmouth bass habitat, Study Site 3 (West Channel)

- Transitional Flows – January, May, December – base flow of 2,250 cfs – drivers are adult smallmouth bass habitat, robust redhorse spawning (deep fast guild), Study Site 3

- High Flows – February, March, April – base flow of 3,000 cfs – drivers are robust redhorse spawning, American shad spawning, Study Site 3

Gerrit added that they also discussed having a step down mechanism built into the LIP. They identified 200 cfs as a reasonable buffer flow. For example, during the minimum flow period when inflow reaches 1,400 cfs, the minimum flow released from the Project will drop from 1,200 cfs to 1,000 cfs. Then, when inflow drops below 1,000 cfs, outflow will equal inflow. The same consideration will apply to transitional and high flows. When inflow is 3,200 cfs, the minimum flow will drop to 2,800 cfs (for high flow periods) and when inflow is 2,450 cfs, the minimum flow will drop to 2,050 cfs (for transitional flow periods). Stakeholders also agree to include a recovery period to allow Monticello Reservoir to recover to full pool after periods of low flows.

Ray said that these proposed minimum flows are higher than what the stakeholders proposed at the previous meeting. He said that including June in the low flow period and removing it from the transitional period seems reasonable. He said that a base flow of 1,200 cfs will be difficult to accomplish in August. SCE&G already struggles to meet the current minimum flow in August, which is a daily average of 800 cfs. Ron asked what years of data were included in the monthly exceedance percentages shown in Table 2 of the memo. Henry said that those numbers were developed using 35 years of data. Ron said that if the exceedance percentages were calculated using only the last 10 years or so, they may drop down. Kleinschmidt will redo the table using only data from the last 15 years, to possibly give a clearer image of recent flows.

Ray said that the suggested low flows are concerning and will be difficult to comply with since the Project doesn't have a storage reservoir. Ray asked if the stakeholders are okay with subtracting evaporation from inflow. Gerrit said yes. Ray said that an instantaneous minimum flow of 1,200 cfs versus a daily average of 800 cfs will be difficult and inflow may be what's passed very often, since summer flows are often below 1,200 cfs. Bill A. asked if they are open to having these numbers be daily averages. Gerrit said no, these numbers are instantaneous minimums.

Bill A. asked how long flows should be low before they step down to a lower minimum flow per the LIP. Gerrit said one 15 minute reading shouldn't cause an issue, but when the whole river drops down to a new level, then the LIP should be initiated.

Bill S. said that they had to consider moving flows to the west channel and how this would affect the east channel in Study Site 3. Caleb asked how much flow do stakeholders envision being diverted to the west channel. Bill S. said around 200 cfs. Henry said he was surprised by the proposed minimum flows and he thought they would move closer to the 20/30/40 % numbers identified in the state recommendations for minimum flows.

Ron said they didn't separate spawning and adult habitats for robust redhorse. Henry asked if the deep/fast guild was a driver in the proposed flows. Gerrit said that adults were a driver and they are in the deep/fast guild. He said that American shad and robust redhorse were drivers during high flows and the west channel was a driver for all flows. Henry reminded the group that the robust redhorse spawn in shallow fast habitats. After the meeting KA reviewed the record and robust redhorse juvenile and fry stages were originally placed in the deep slow guild based on studies on the Pee Dee River, which had been omitted in previous meetings. The deep fast habitat is likely linked only with adult habitat and not linked to spawning and recruitment.

Gerrit said he doesn't envision many long periods where only the minimum flow is passed. He thinks the outcome will be better if SCE&G doesn't focus on what the minimum flow is as much as they focus on better flow management. He said he doesn't want to close the book on coming up with something creative that addresses American Rivers' interest, which is having flows mimic natural river flows.

Henry asked if all transects and all species were considered. Ron said that with all of the transects put together, they will get 66 percent of the smallmouth bass habitat at 1,200 cfs. By ensuring water is there for smallmouth bass, they won't be taking anything away from other species. The stakeholders agree that smallmouth bass is an especially important species for recreation.

Henry noted that the higher the minimum flows, the more chances SCE&G could have deviations because the Project will be in the "or inflow" mode of operation. Henry said SCE&G has agreed to do several operational changes during the new license including diverting water to the west channel, stop or minimize downstream fluctuation flows, and implement new minimum flows. Henry asked if the stakeholders would consider allowing for a minimum flow adaptive management plan to test the new minimum flows over several years and see how easy or difficult it is to comply with the other operational changes being proposed. They can show progress each year on how they are meeting this goal and even submit reports to FERC. Gerrit said this is a reasonable request and might be possible.

Melanie asked if a gliding minimum flow could be set up, using a percentage of inflow from the previous day minus evaporation. The group agrees this is a good idea and Henry said we will explore this idea further. Henry said that something similar to this was agreed to at an Entergy Project on the Ouachita River and one of the Coosa Developments in Alabama. They use percentages of inflow to adjust outflows on a frequent basis.

Bill A. noted that based on this new set of flows proposed by the stakeholders, observation flow dates would not be scheduled at this time since the stakeholder flows had increased from their previous proposal.

Following this discussion, the meeting adjourned. Action items from the meeting are listed below.

ACTION ITEMS:

- Kleinschmidt will put together meeting notes and distribute to the group.
- Kleinschmidt will recalculate the exceedance percentages on Table 2 of the memo, using only data from the last 15 years.
- SCE&G will discuss the new proposed minimum flows with management and they will work with Kleinschmidt to come up with other possible options.
- Kleinschmidt and SCE&G will review the TWC recommendation and perform additional hydrologic and biological analysis for minimum flows more in line with the proposal from the last meeting.

Parr IFIM – Additional Analyses
01-24-2017

Parr Hydro Project

FERC No. 1894

Kleinschmidt

Meeting Goals

- Select values for minimum flows
- Select seasonal date ranges for low, mid, high minimum flows
- Discuss potential observation dates
- Discuss methods/transects for observation

Action Items from Last Meeting

- Correct WUA tables presented in IFIM report
  - Attachment A
- Create figures and tables of WUA by target species/life-stage
  - Attachment B
- Habitat Duration Analysis
  - Attachment C
- Representative Reach Analysis
  - Weighting of WUA data by mesohabitat

Habitat Duration Analysis

- Compare seasonal hydrologic availability vs. WUA
  - Also compare availability with proposed seasonal minimum flow ranges from IFIM TWC meeting (9/27).

- Facilitate selection of minimum flow values based on hydrologic availability and habitat benefits in the affected reach downstream of Parr Shoals Dam.

Methods

- Polynomial equations created from WUA curves for each species/life stage, and guild, at select study sites
- Monthly inflow datasets were used to determine flow exceedance percentages
- WUA curves for relevant species/life & guilds were plotted as a function of exceedance
- Also plotted previously discussed seasonal min flow values

Inflow Data Selection

- Non-prorated and prorated daily inflow datasets considered
  - Prorated dataset identical to the Parr HEC ResSim model
  - Non-prorated data based on sum of three upstream USGS gages
    - Broad River near Carlisle, Tyger River near Delta, and Enoree River at Whitmire
- Non-prorated data selected for habitat-duration analysis
  - Prorated flows have a statistical bias above and below 3,900 cfs
  - Low flows are overestimated, little or no additional runoff
  - Hydrologic availability for low flows best represented by non-prorated

Habitat Duration Curves

- Curves were generated for March, May, and August at Study Sites 6, 7, 8, and 10 (Bookman Island)
  - Represent high, transitional, and low flow seasons
- Species/Life Stages – presented in months when applicable
  - Smallmouth Bass – spawning, adult, juvenile and fry
  - Redbreast sunfish – spawning and adult
  - American shad – spawning
  - Shallow – fast guild
  - Deep – fast guild
  - Deep – slow guild
- Months
  - March – high flow
  - May – transitional flow
  - August – low flow

	Feb 15 – May 15 (Spring Spawning Flow)	May 16 – Jun 30, Dec 1 – Feb 14 (Transitional Flow)	Jul 1 – Nov 30 (Summer/Fall Low Flow)
Proposed Flow A	2,500	1,800	1,200
Proposed Flow B	2,000	1,300	700

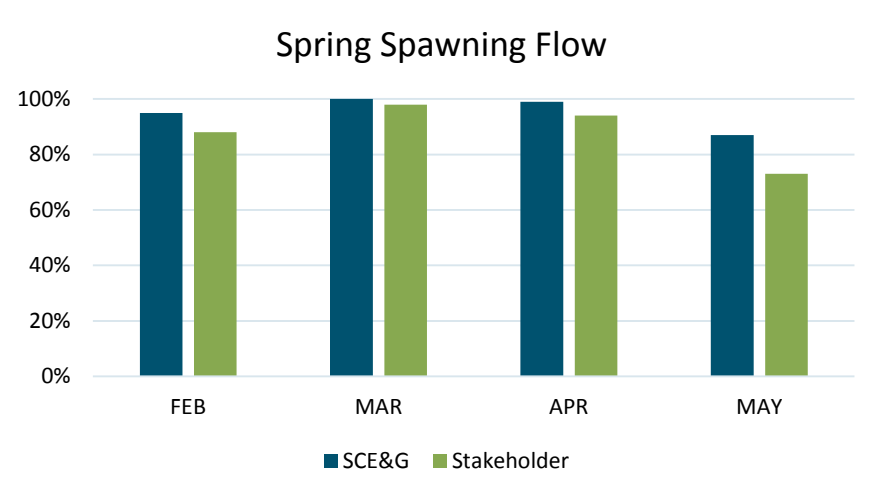
Results

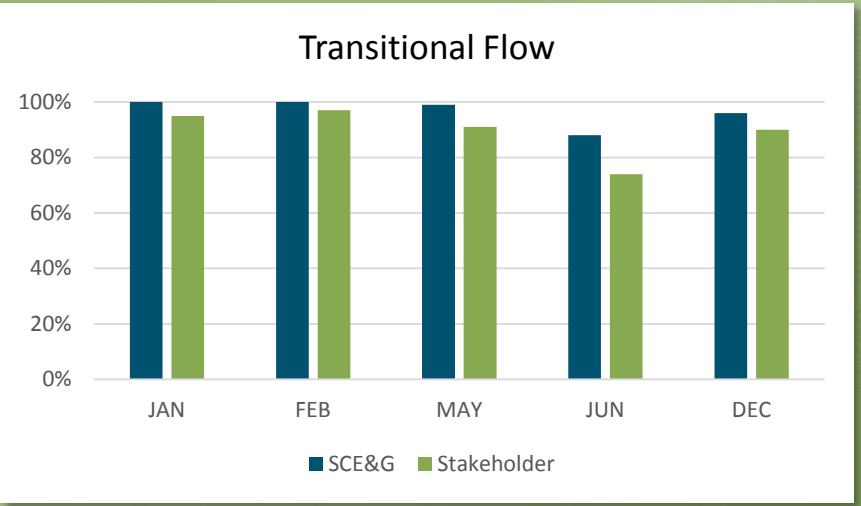
- Provided in Attachment C

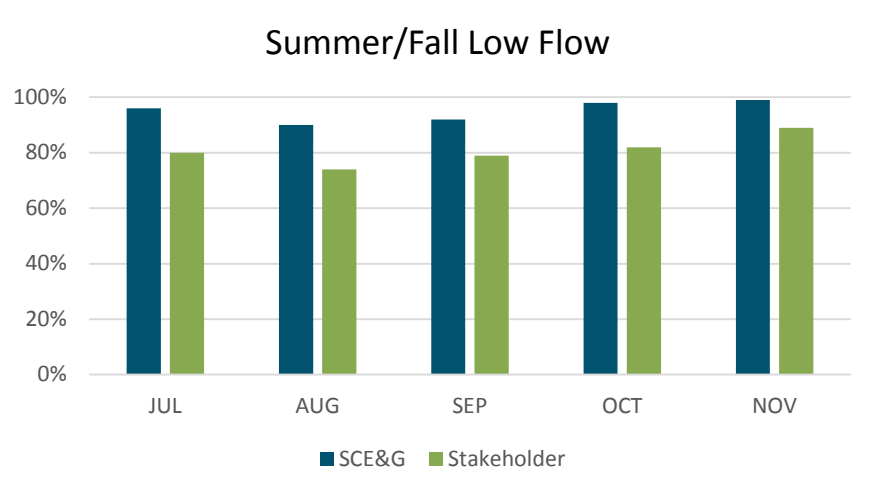
Monthly Exceedance Percentages for Proposed Min Q Values

Min Q	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2,000	--	95%	100%	99%	87%	--	--	--	--	--	--	--
2,500	--	88%	98%	94%	73%	--	--	--	--	--	--	--
1,300	100%	100%	--	--	99%	88%	--	--	--	--	--	96%
1,800	95%	97%	--	--	91%	74%	--	--	--	--	--	90%
700	--	--	--	--	--	--	96%	90%	92%	98%	99%	--
1,200	--	--	--	--	--	--	80%	74%	79%	82%	89%	--

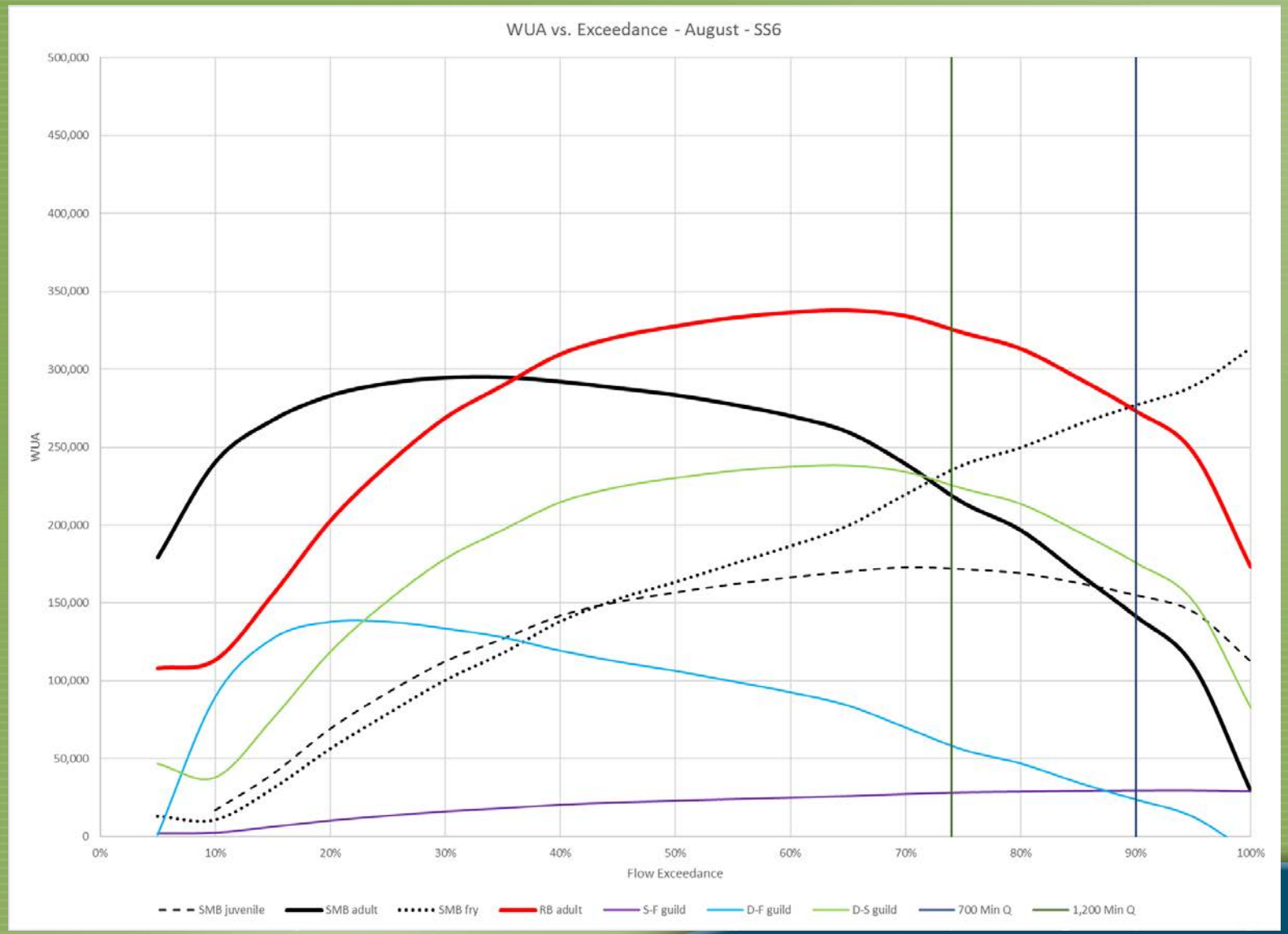
Results (cont…)





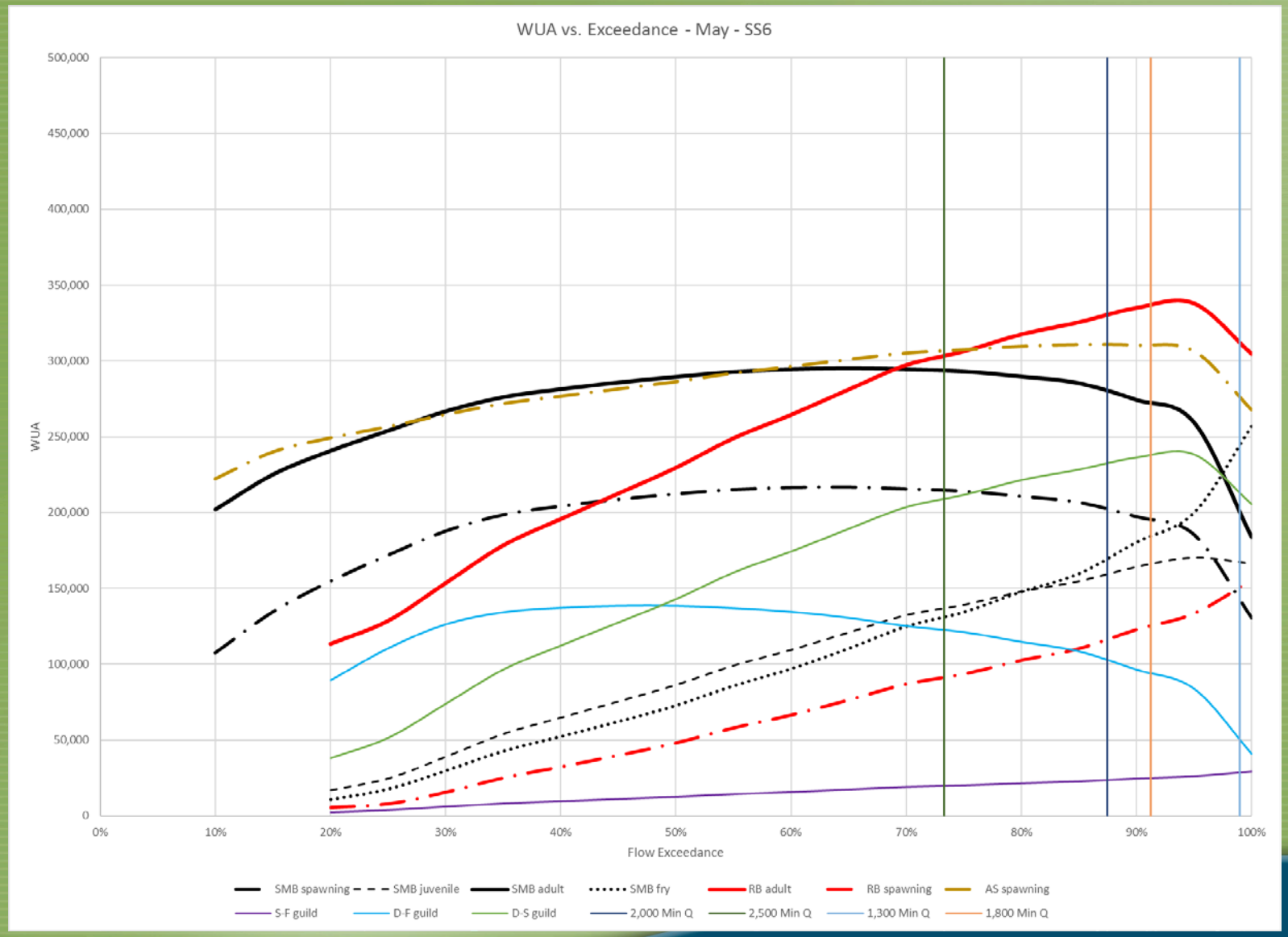


Habitat Duration Examples



- Higher proposed flow has more WUA for most species / life stages
- Lower proposed flow has more WUA for SMB fry

Habitat Duration Examples

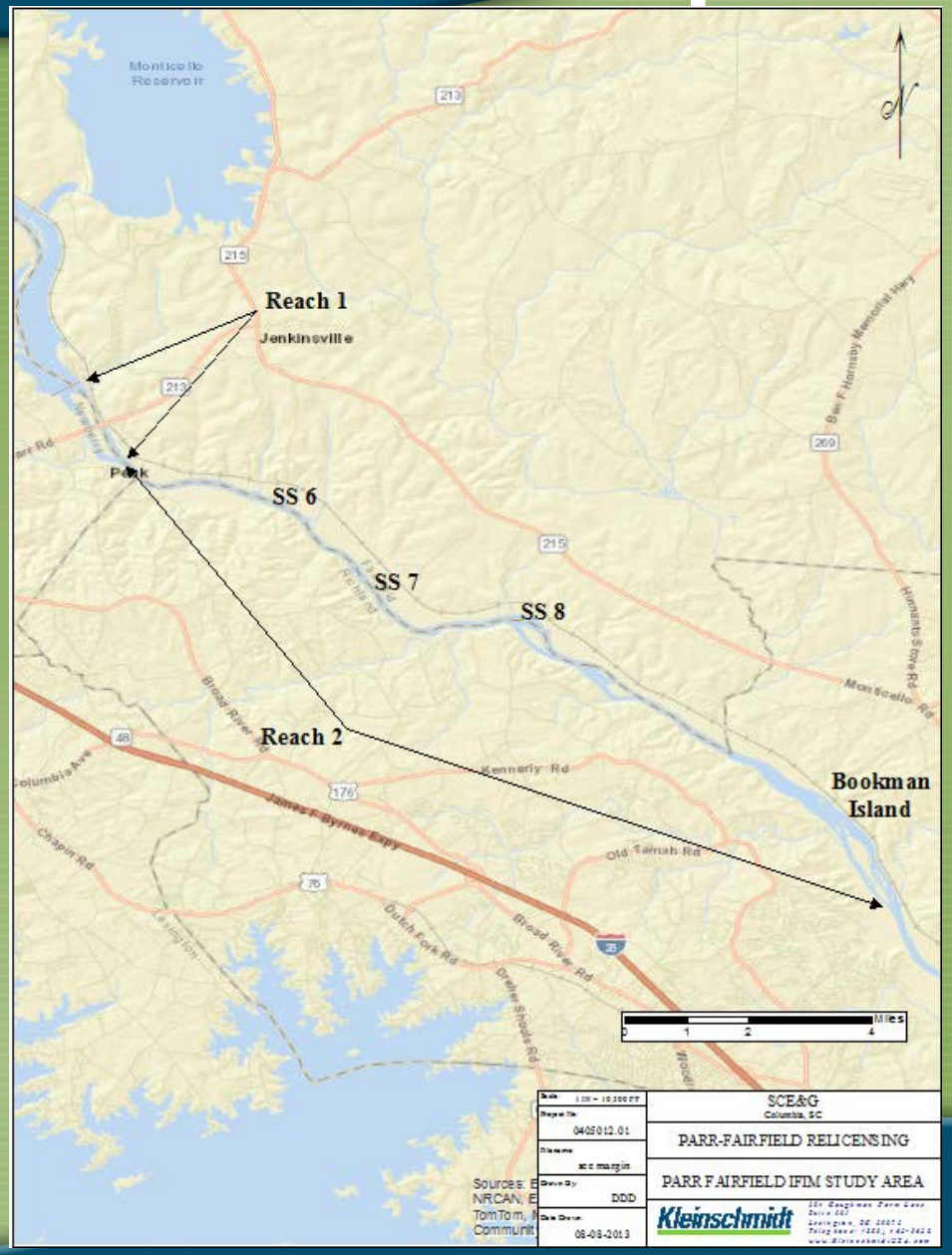


- Higher spring spawning flow has less WUA for most species / life stages
- Higher spring spawning flow has slight benefit for SMB Adult & spawning, deep fast guild

Representative Reach Analysis

- Reach 2 study sites were analyzed
  - Linked hydraulically, from downstream of Hampton Island to Columbia Dam
  - Critical study sites identified by the TWC
- WUA data from each study site was weighted by the linear feet of stream of the applicable mesohabitat
  - Raw unweighted PHABSIM modeling output is in standard WUA/1,000 linear feet of stream
  - Earlier Mesohabitat mapping quantifies relative lengths for each mesohabitat class

Reach Map


Monticello Reservoir
Reach 1
Jenkinsville
Parr
SS 6
SS 7
SS 8
Reach 2
Bookman Island
Broad River Rd
Dutch Fork Rd
Old Tamah Rd
Kennerly Rd
Chapin Rd
Columbia Ave
James F Byrnes Expy
Miles
SCE&G
Columbia, SC
PARR-FAIRFIELD RELICENSING
PARR FAIRFIELD IFIM STUDY AREA
Kleinschmidt
08-08-2013

Methods

- 1. Measure total linear feet for each mesohabitat type within Reach 2 using ArcGIS.
  - Study Sites 6, 7, and 8 were assessed separately from Bookman Island due to differing types of habitat and modeling methods.
- 3. Total length of each mesohabitat summed for Reach 2 (16,272 ft)
  - from beginning of Reach 2 (USGS Gage at Alston) to beginning of Bookman Island complex
- 4. Total length of the modeled area for Bookman Island was measured (13,200 ft)
  - Encompassed all mesohabitat types

Study Site Mesohabitat Types

STUDY SITE	TRANSECT ID	MESOHABITAT
6	6.2	Glide
	6.1	Riffle
7	7.2	Glide
	7.1	Riffle
8	8.2	Riffle
	8.1	Riffle

Mesohabitat Percentages Based on Stream Length

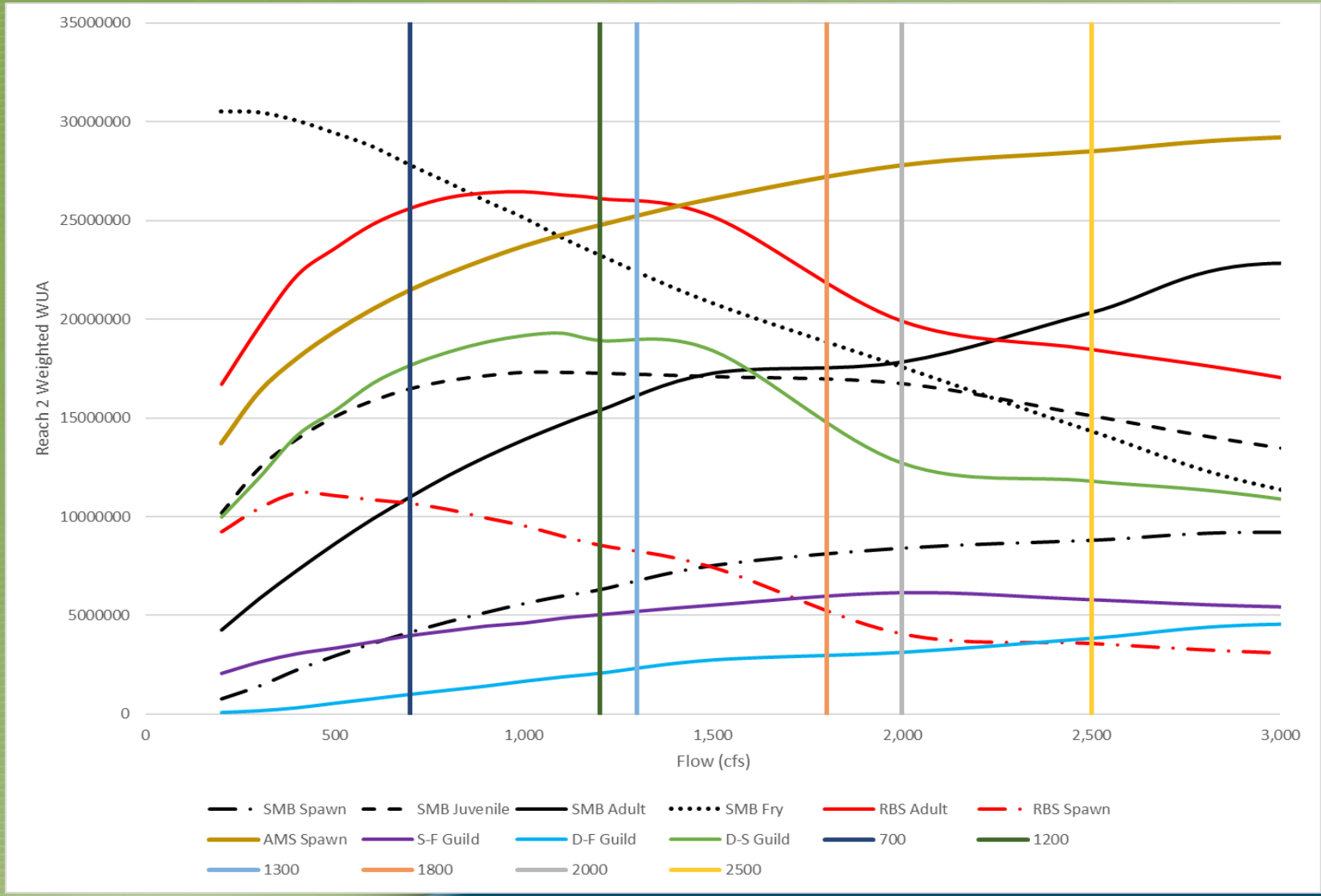
Mesohabitat Weighting		
MESHOHABITAT	SS 6-7-8	Bookman
Glide	5.9%	1.1%
Riffle	14.3%	1.7%
Pool	40.2%	17.0%
Shoal	9.1%	48.4%
Run	30.4%	31.8%
Total	100.0%	100.0%

Methods (cont…)

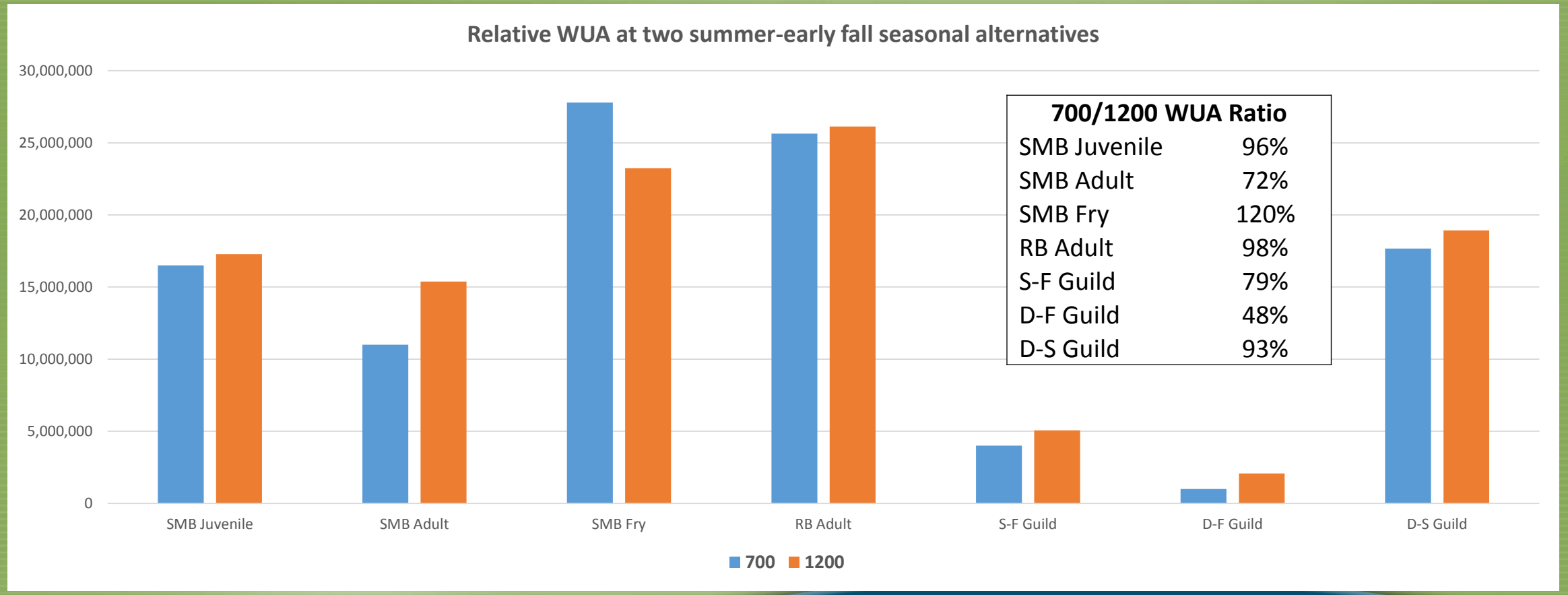
- 4. Reach-level study site weighting
  - –WUA results for Study sites 6-8 were summed and weighted by 16.27.
  - –WUA results Bookman Island were weighted by 13.20.
  - –Weighted values for Study sites 6-8 and Bookman were then summed providing WUA for entire Reach 2

Results

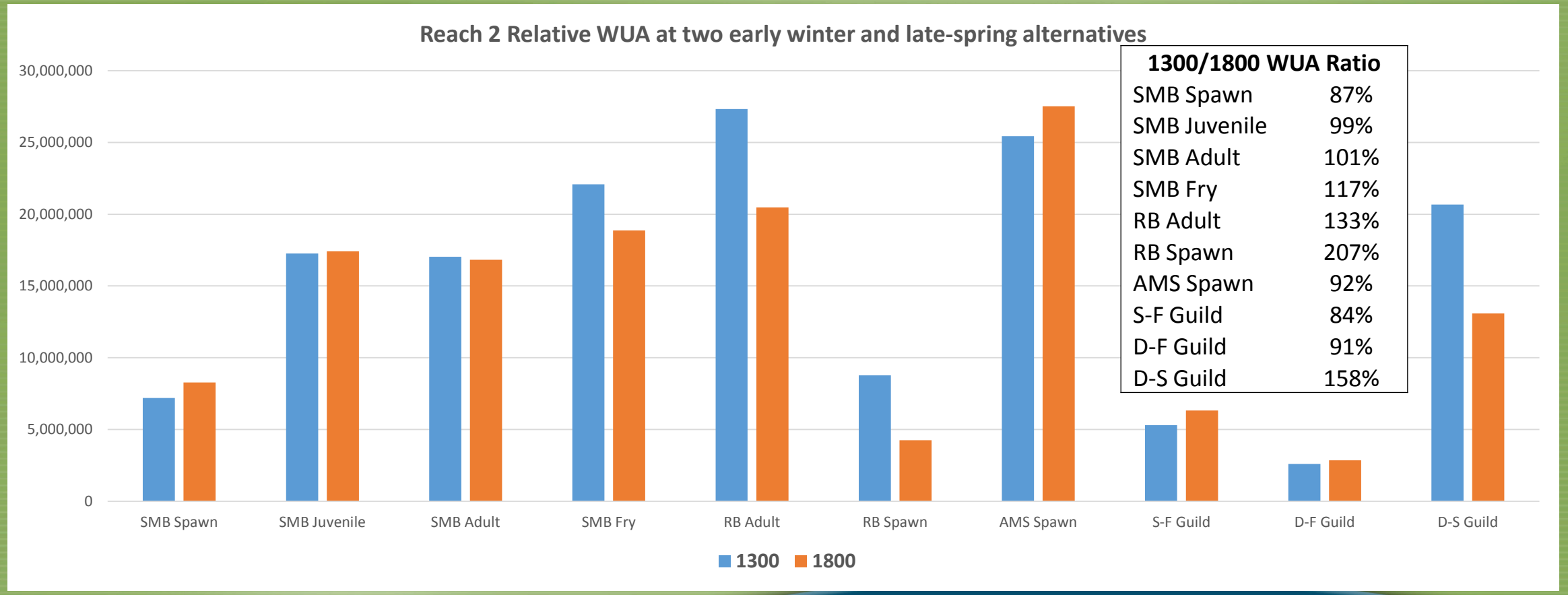
Total Weighted Reach 2 WUA up to 3,000 cfs



Comparison of Low Min Q WUA

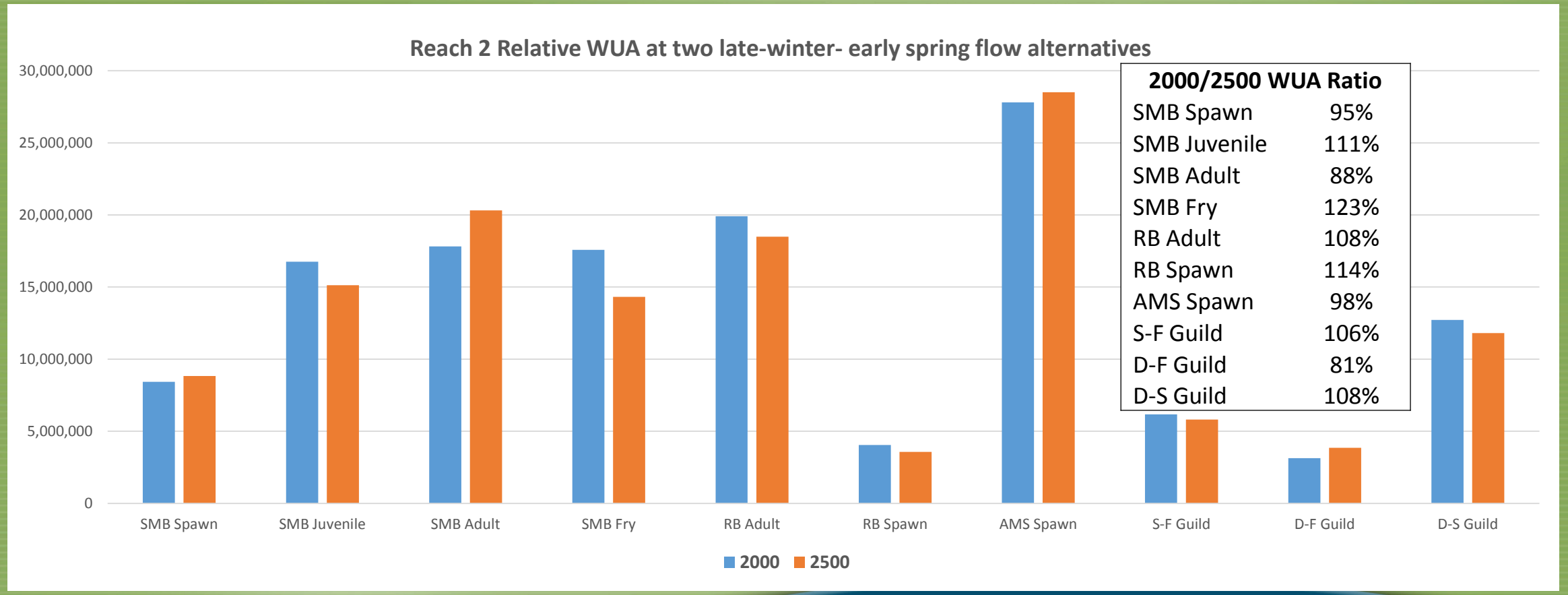


Comparison of Transition Q WUA



1300/1800 WUA Ratio	
SMB Spawn	87%
SMB Juvenile	99%
SMB Adult	101%
SMB Fry	117%
RB Adult	133%
RB Spawn	207%
AMS Spawn	92%
S-F Guild	84%
D-F Guild	91%
D-S Guild	158%

Comparison of High Min Q WUA



2000/2500 WUA Ratio	
SMB Spawn	95%
SMB Juvenile	111%
SMB Adult	88%
SMB Fry	123%
RB Adult	108%
RB Spawn	114%
AMS Spawn	98%
S-F Guild	106%
D-F Guild	81%
D-S Guild	108%

Flows/Time Frames from 9/27 Meeting

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
90% Exceedance	2,435	2,571	3,365	2,978	2,036	1,368	1,045	771	865	1,083	1,235	1,979
50% Exceedance	5,000		6,000	5,000	3,750	3,000	2,500	2,250	2,160	2,300	3,000	4,400
		D/F	AMS	AMS	AMS juv (shallow, fast)							
				RRH	RRH							
				SMB (spawn)	SMB (spawn fry)	SMB (juv/fry)						
					RBS (spawning)	RBS (spawn/fry)	RBS (fry/juv)					
				Striped Bass	Striped Bass							
	2/15				5/15 or 31		6/30					11/30
FLOW	Medium		High Flow Stakeholder -2,500 SCEG-2,000		Medium Flow Stakeholder -1,800 SCEG-1,300				Low Flow Stakeholder-1,200 SCEG-700			

Conclusions

- **Low flow**:
  - 700 cfs provides 79-120% of the suitability of 1200 cfs*
- **Mid flow**:
  - 1,300 cfs provides 84-207% of the suitability of 1,800 cfs*
- **High flow**:
  - 2,000 cfs provides 88-123% of the suitability of 2,500 cfs*

- *There is relatively low net habitat suitability for Deep-Fast guild at any flow

Next Steps

- Select values for minimum flows
- Select seasonal date ranges for low, mid, high minimum flows
- Discuss potential observation dates
- Discuss methods/transects for observation
- Low Inflow Protocol

MEMORANDUM

TO: Parr Hydro Relicensing – Instream Flow TWC

FROM: Brandon Kulik, Jordan Johnson, Bret Hoffman, and Henry Mealing

DATE: January 23, 2017

RE: Parr IFIM Study – Habitat Duration Analysis and Misc. Action Items

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During the Instream Flow TWC meeting held on September 27, 2016, stakeholders identified several action items that were necessary to wrap up the study and to facilitate development of a well-informed minimum flow recommendation.

WEIGHTED USABLE AREA TABLE UPDATES

Several errors were identified in the IFIM Report tables noting percent of maximum Weighted Usable Area (WUA), which were presented for each study site. These tables have been corrected, are included in Attachment A of this memorandum, and will be included in the Final IFIM Report.

During the meeting, stakeholders discussed the representative reach vs. critical reach approach to analyzing multiple study sites, and also requested that the WUA results be summarized on a target species/life-stage basis. We prepared both tabular and graphical visualization for this request for key transects identified during the meeting: SS3, SS5, SS6, SS7, SS8, and SS10. These tables and graphs are included as Attachment B of this memorandum.

HABITAT – DURATION ANALYSIS

TWC members also requested that a habitat duration analysis be completed to evaluate the seasonal availability of water for fulfilling the range of seasonal flows that were developed during the September 27th meeting. The habitat duration analysis has been completed and is presented below. This memorandum and the Attachments will be incorporated into the Final Parr IFIM Report.

Kleinschmidt developed a series of curves to facilitate evaluating Broad River flows and their effect on WUA in the reach below the Parr Shoals dam. Flow was characterized from the perspective of hydrologic availability, which allows comparison of the frequency with which WUA can be met for each selected species and life-stage of interest, as well as guilds. The purpose of this effort was to facilitate selection of minimum flow values based on hydrologic availability and habitat benefits at select locations in the affected river reach.

Methods

Tabular values relating WUA to flow at select study sites were used to develop polynomial equations. Monthly inflow data were used to determine exceedance percentages. The flow for given exceedance values was then plotted using the polynomial equations, which provided habitat-duration curves.

Inflow Data Selection

Non-prorated and prorated mean daily inflow datasets were both considered for evaluating the hydrologic availability for minimum flow selection. The prorated mean daily data were identical to the dataset created in support of the Parr HEC ResSim model, while the non-prorated dataset was based only on the sum of the same three gages[1], for an identical period of record (1981 – 2015).

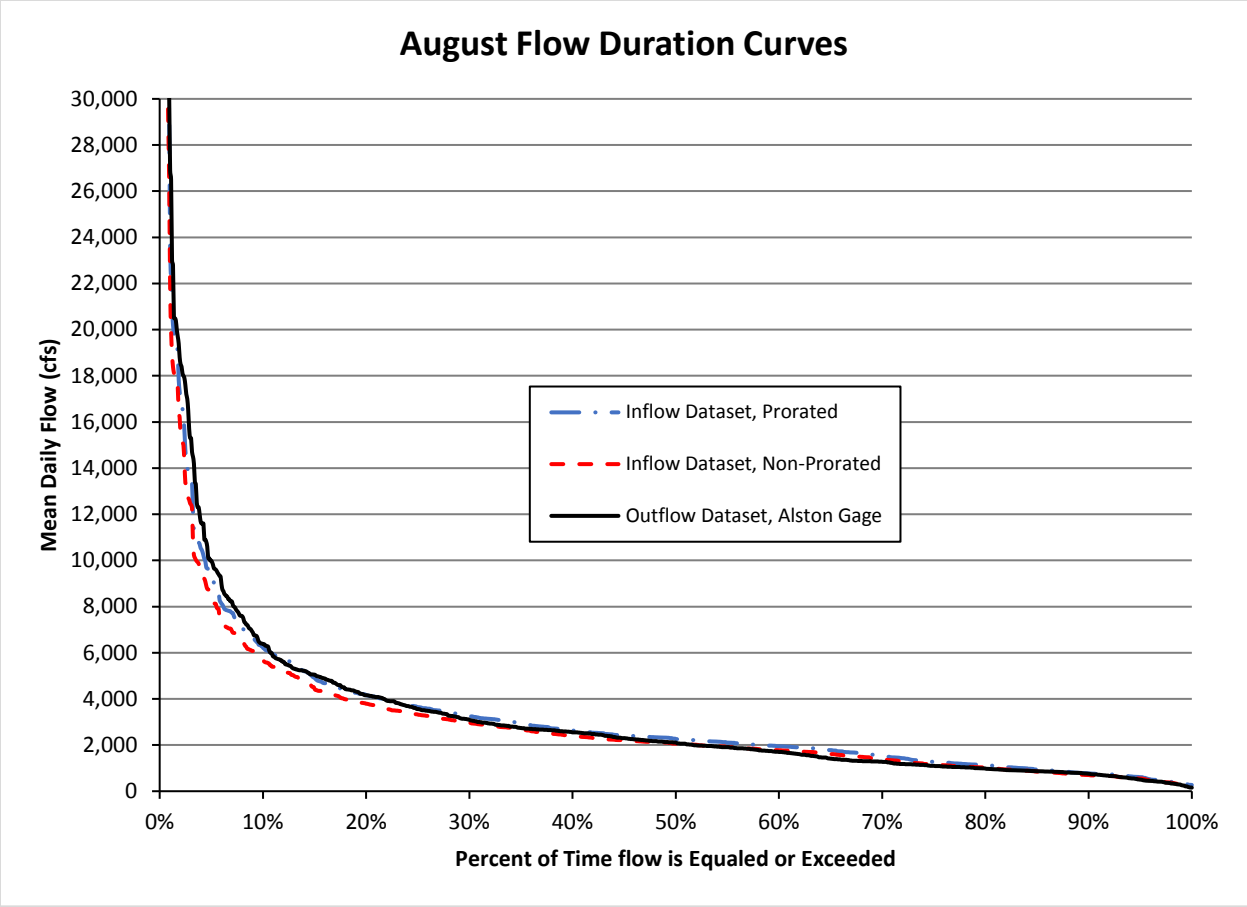


FIGURE 1 COMPARISON OF FLOW DURATION CURVES

As outlined in the May 2014 Inflow Dataset Development report, the prorated inflows have a statistical bias above and below 3,900 cfs. Prorated flow above this value are underestimated, while flows below this value are overestimated; this is evident in the comparison of the flow duration curves (Figure 1). Part of the reason for this is that during lower inflow months, precipitation runoff in the ungauged contributing drainage area is more sporadic. With the exception of these infrequent local precipitation events, baseline inflows are more accurately represented by the non-prorated gaged inflows. Local precipitation events simply result in temporarily underestimated inflows. As the Project does not store excess water from high flow events, downstream flows are temporarily increased, until the Project storage is reestablished and normal daily operation resumes.

[1] USGS 02156500, Broad River near Carlisle, SC; USGS 02160105, Tyger River near Delta, SC; and USGS 02160700, Enoree River at Whitmire, SC

If compliance is met using the downstream Alston gage, selecting a minimum flow requirement based upon prorated data would result in a requirement to release more than the actual inflow. As the Project is not a storage facility, this is not possible. Therefore, the minimum flow should be evaluated using the non-prorate sum of the three upstream gages, as opposed to prorated values. Habitat-duration for all flows is more accurately represented by prorated data, but during low flow periods it is more accurately represented by non-prorated data. Because the purpose of this analysis is to evaluate the hydrologic availability to meet minimum flows (which are all below the inflection point of 3,900 cfs), non-prorated flows were used to develop the habitat-duration curves.

Habitat-Duration Curves

Due to the extensive effort associated with developing and analysis for each target species/life-stages and guild at each study site, habitat-duration graphs were only created for key months and study sites of interest. The species/life-stages and guilds represented on each graph were:

- Smallmouth bass – spawning, adult, juvenile and fry;
- Redbreast sunfish – spawning and adult;
- American shad – spawning;
- Shallow – fast guild;
- Deep – fast guild; and
- Deep – slow guild.

The months of March, May and August were selected to represent the high flow, transitional flow (high to low), and low flow months, respectively. Study Sites 6, 7, 8 and 10 were evaluated. These are understood to be locations of best overall habitat in the reach, and therefore would be key locations for selecting a minimum flow. Two sets of seasonally varying minimum flow targets were proposed at the last TWC meeting, with the date ranges and values as follows:

TABLE 1 SEASONAL VALUES FOR TWO PROPOSED MINIMUM FLOW ALTERNATIVES

	Feb 15 – May 15 (Spring Spawning Flow)	May 16 – Jun 30, Dec 1 – Feb 14 (Transitional Flow)	Jul 1 – Nov 30 (Summer/Fall Low Flow)
Proposed Flow A	2,500	1,800	1,200
Proposed Flow B	2,000	1,300	700

RESULTS AND DISCUSSION

Habitat duration curves for each target species/life-stage and guild at each of the key study sites (i.e., Study Sites 6, 7, 8 and 10) are presented in **Attachment C**. Note that the y-axis (WUA) were all set at 500,000 for uniform comparison between sites and months. Due to the large magnitude of WUA provided for American shad during March and May at study sites 8 and 10 tends to compress other species and life-stage curves, and are thus excluded. Graphs including a y-axis illustrating American shad spawning data are provided at the end as a second set of attachments.

For some months at some study sites, the higher of the two proposed minimum flow value result in decreased WUA for some or all of the species and life-stages (e.g., Study Site 6 during August). Other graphs indicate an overall benefit more from the higher proposed minimum flow value (e.g., Study Site 6 during May spring spawning flow). For most of the study sites and months plotted, the slope of the habitat curves between the proposed minimum flow values is not very steep, and the overall change in WUA for each species, life-stage and guild does not greatly increase or decrease. During some months, higher flows may benefit a given species and life-stage at one location, but have the opposite effect at another (e.g., redbreast sunfish adults in August at Study Sites 6 and 7).

The available habitat for the proposed spring spawning flow values during March are very close, as are the flow exceedance percentages. While these vertical lines are very close, note that March is the highest flow month, and the minimum flows during that time of the year are proposed to start in mid-February and extend through mid-May. As indicated on the May graphs, the differential between the two vertical lines representing the proposed upper minimum flow values widens to 14 percent, with the higher flow unavailable 27 percent of the time. This effect is similar in February, albeit less significant, where the 2,500 cfs and 2,000 cfs flow exceedances differ by six percent.

The proposed transitional flow values are met over 90 percent of the time in May. However, the reduction in hydrologic availability by the end of June reduces the higher proposed transitional flow to just 73 percent. The proposed summer low flows have significant gaps in August, with one available over 90 percent of the time, and the other less than 75 percent.

TABLE 2 MONTHLY EXCEEDANCE PERCENTAGES FOR PROPOSED MIN Q VALUES

Min Q	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2,000	--	95%	100%	99%	87%	--	--	--	--	--	--	--
2,500	--	88%	98%	94%	73%	--	--	--	--	--	--	--
1,300	100%	100%	--	--	99%	88%	--	--	--	--	--	96%
1,800	95%	97%	--	--	91%	74%	--	--	--	--	--	90%
700	--	--	--	--	--	--	96%	90%	92%	98%	99%	--
1,200	--	--	--	--	--	--	80%	74%	79%	82%	89%	--

STUDY SITE WEIGHTING OF WUA

In addition to the Habitat Duration analysis, we performed a "Representative Reach" analysis, by weighting the WUA data from each study site by the relative amount (linear feet) of each applicable mesohabitat type. PHABSIM modeling results originally presented were in the standard WUA/1000 linear ft of stream; the mesohabitat mapping analysis quantified the total stream lengths for each of the mesohabitat classes within each of the study reaches. The mapping data allows scaling of the study reaches according to relative amounts of each habitat type. For this analysis, we only analyzed Reach 2 study sites because the study sites are all linked hydrologically; Reach 2 included the largest amount of river; and Reach 2 contained the critical study areas/transects identified by the TWC at the last meeting.

Mesohabitat Calculation

We reviewed the mesohabitat data for each study site to identify the mesohabitats represented by the WUA results for each study site (Table 1). We then used ArcGIS to analyze the original mesohabitat mapping data to measure the total stream lengths for each mesohabitat type identified within Reach 2 (Table 2). Study sites 6, 7, and 8 were assessed separately from the Bookman Island complex due to the different type of habitat (main channel vs braided transect) and modeling. Stream lengths represented by sites 6 through 8 were measured for each mesohabitat identified from the beginning of Reach 2 to the beginning of the Bookman Island complex and summed to calculate a total length of riffle and glide habitat, which totaled 16,272 ft. The Bookman Island area encompassed all habitats for the entire stream length of 13,200 ft.

TABLE 1 STUDY SITE MESOHABITAT TYPES

STUDY SITE	TRANSECT ID	MESOHABITAT
6	6.2	Glide
	6.1	Riffle
7	7.2	Glide
	7.1	Riffle
8	8.2	Riffle
	8.1	Riffle

TABLE 2 MESOHABITAT PERCENTAGES BASED ON STREAM LENGTH

MESOHABITAT PERCENTAGES		
TYPE	**SS 6, 7, 8**	**BOOKMAN**
Glide	5.9%	1.1%
Riffle	14.3%	1.7%
Pool	40.2%	17.0%
Shoal	9.1%	48.4%
Run	30.4%	31.8%
TOTAL	**100.0%**	**100.0%**

Reach Weighting

The WUA results were then scaled (weighted) using the stream lengths identified from the mesohabitat analysis. WUA results for each species/guild for study sites 6, 7, and 8 were summed and multiplied by 16.27. WUA results for each species/guild for Bookman Island were multiplied by 13.20. The weighted WUA values for study sites 6-8 and Bookman Island were then summed to represent WUA for the entire Reach 2.

The results of this analysis are illustrated in Figures 1 and 2. Figure 1 displays Reach 2 total WUA curves by species up to 8,000 cfs. Figure 2 illustrates the same results up to 3,000 cfs to provide more detail in the area that the TWC has been considering for a minimum flow recommendation.

This analysis is helpful in looking at a combination of WUA by Species with a weighting factor to account for the amount of habitat covered in Reach 2. Tables of data used to develop the Figures are available for TWC review if requested.

NEXT STEPS

After the TWC has reviewed this information, we plan to schedule a meeting to review the data and answer any questions. Our hope is that we can select a series of minimum flows and time frames that can be put into the Settlement Agreement for the Parr Relicense Final Application.

FIGURE 1 TOTAL WEIGHTED REACH 2 WUA UP TO 8,000 CFS

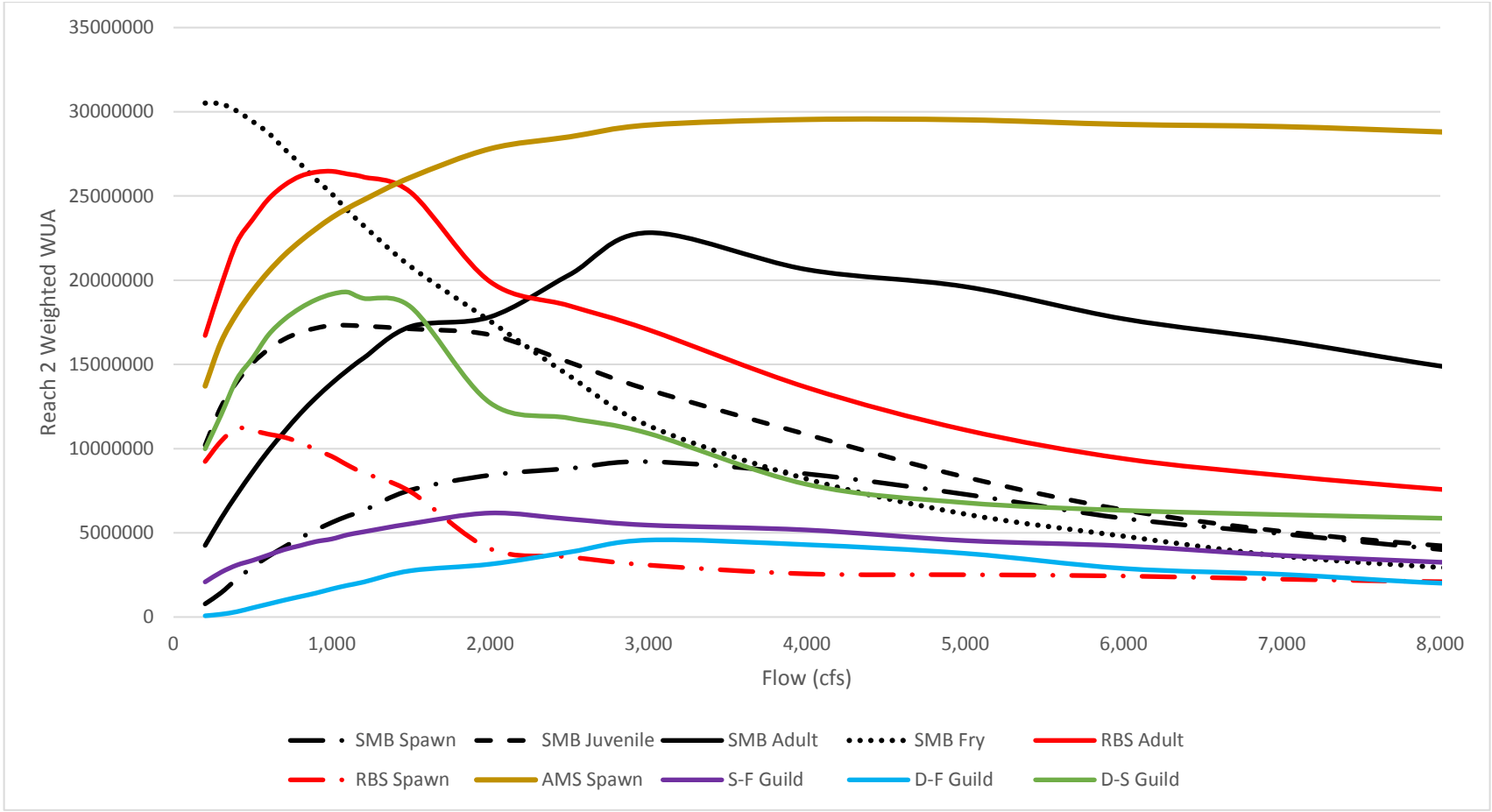
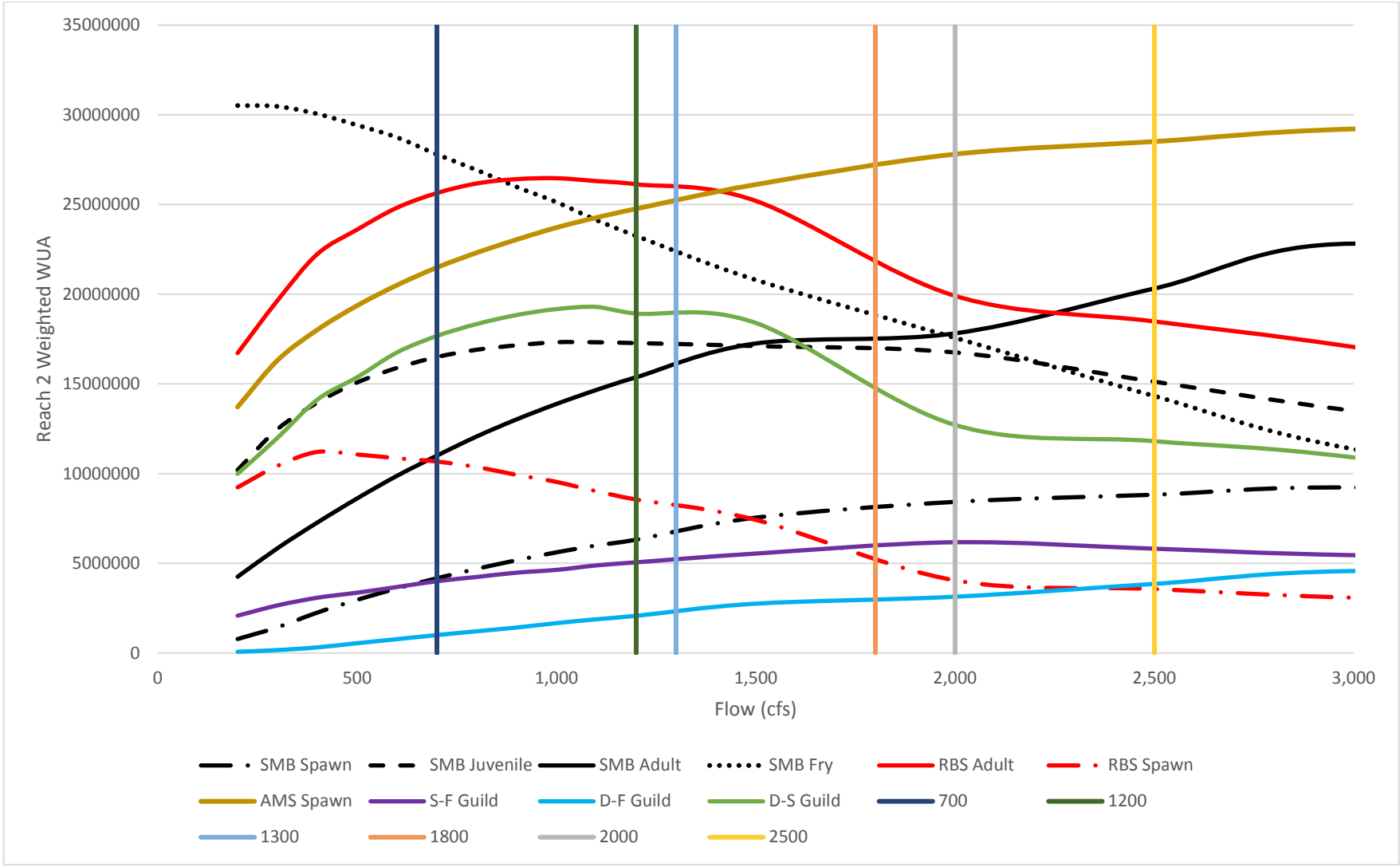


FIGURE 2 TOTAL WEIGHTED REACH 2 WUA UP TO 3,000 CFS



ATTACHMENT A

STUDY SITE 3 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	22,010	10%	35,895	48%	3,245	3%	246,534	100%	44,190	43%	56,194	88%	120,632	41%	20,227	100%	66,201	64%	0	0%	6,155	17%
300	39,568	17%	53,023	71%	8,842	7%	247,519	100%	63,111	62%	64,009	100%	153,920	52%	14,301	71%	83,824	82%	0	0%	11,464	31%
350	49,956	22%	59,398	79%	12,657	10%	243,919	99%	70,590	69%	61,535	96%	167,976	57%	9,857	49%	91,012	89%	0	0%	14,970	41%
400	60,444	27%	63,598	85%	17,079	13%	241,241	97%	75,583	74%	54,781	86%	180,321	61%	15,779	78%	97,020	94%	0	0%	18,557	51%
500	84,153	37%	69,445	93%	27,450	22%	235,249	95%	84,730	83%	52,279	82%	202,960	69%	7,678	38%	102,671	100%	18	0%	26,424	72%
600	108,176	48%	71,675	96%	38,563	30%	220,223	89%	90,492	89%	52,231	82%	218,096	74%	7,989	39%	102,207	100%	1,084	0%	28,182	77%
750	144,211	63%	75,020	100%	55,233	43%	197,685	80%	99,135	97%	52,159	81%	240,800	82%	8,456	42%	101,510	99%	2,683	1%	30,820	84%
900	169,961	75%	74,625	99%	70,526	55%	177,690	72%	100,972	99%	49,417	77%	254,511	86%	6,481	32%	95,779	93%	9,107	4%	32,714	89%
1,000	187,128	82%	74,361	99%	80,722	63%	164,360	66%	102,196	100%	47,588	74%	263,652	90%	5,165	26%	91,959	90%	13,389	5%	33,976	93%
1,100	198,374	87%	72,351	96%	89,180	70%	153,828	62%	100,034	98%	46,805	73%	269,389	91%	5,037	25%	87,850	86%	21,793	9%	35,273	96%
1,200	209,621	92%	70,340	94%	97,638	77%	143,295	58%	97,872	96%	46,021	72%	275,126	93%	4,908	24%	83,741	82%	30,196	12%	36,570	100%
1,300	215,631	95%	67,729	90%	103,323	81%	135,051	55%	94,529	92%	44,706	70%	278,857	95%	4,721	23%	80,277	78%	41,700	17%	36,553	100%
1,400	221,641	97%	65,117	87%	109,007	85%	126,806	51%	91,187	89%	43,392	68%	282,587	96%	4,534	22%	76,813	75%	53,205	22%	36,537	100%
1,500	227,651	100%	62,505	83%	114,691	90%	118,562	48%	87,845	86%	42,077	66%	286,317	97%	4,346	21%	73,349	71%	64,709	26%	36,520	100%
1,600	226,903	100%	59,717	80%	116,507	91%	111,868	45%	84,541	83%	43,188	67%	287,860	98%	3,909	19%	70,025	68%	77,711	32%	34,663	95%
2,000	223,911	98%	48,562	65%	123,771	97%	85,089	34%	71,328	70%	47,632	74%	294,034	100%	2,162	11%	56,730	55%	129,719	53%	27,237	74%
2,250	218,971	96%	43,563	58%	127,623	100%	72,426	29%	67,802	66%	45,587	71%	294,550	100%	2,559	13%	49,660	48%	166,430	68%	23,277	64%
2,400	211,716	93%	40,901	55%	126,207	99%	66,497	27%	65,714	64%	44,409	69%	293,666	100%	2,384	12%	46,342	45%	179,569	73%	21,766	60%
2,600	206,879	91%	39,126	52%	125,263	98%	62,544	25%	64,322	63%	43,624	68%	293,076	99%	2,268	11%	44,130	43%	188,329	77%	20,759	57%
3,000	182,696	80%	30,254	40%	120,543	94%	42,781	17%	57,363	56%	39,697	62%	290,129	98%	1,686	8%	33,070	32%	232,128	95%	15,725	43%
3,500	157,697	69%	23,741	32%	111,904	88%	32,844	13%	52,545	51%	37,521	59%	284,590	97%	1,563	8%	26,136	25%	238,302	97%	14,404	39%
4,000	132,698	58%	17,228	23%	103,264	81%	22,907	9%	47,726	47%	35,346	55%	279,051	95%	1,440	7%	19,202	19%	244,475	100%	13,084	36%
4,500	114,045	50%	13,765	18%	93,499	73%	18,286	7%	45,068	44%	32,764	51%	272,609	93%	1,462	7%	14,954	15%	220,313	90%	11,167	31%
5,000	95,391	42%	10,302	14%	83,733	66%	13,665	6%	42,410	41%	30,183	47%	266,167	90%	1,483	7%	10,706	10%	196,150	80%	9,249	25%
6,000	73,583	32%	7,408	10%	66,396	52%	9,506	4%	40,400	40%	25,129	39%	250,501	85%	1,184	6%	5,364	5%	128,195	52%	6,275	17%
7,000	53,598	24%	6,030	8%	48,860	38%	7,856	3%	38,010	37%	20,758	32%	238,542	81%	721	4%	2,515	2%	69,829	29%	5,693	16%
100%	227,651		75,020		127,623		247,519		102,196		64,009		294,550		20,227		102,671		244,475		36,570	
75%	170,738		56,265		95,717		185,639		76,647		48,007		220,913		15,171		77,004		183,356		27,428	

STUDY SITE 5 HABITAT SUITABILITY

Discharge	SMB spawn		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	28,083	54%	53,848	100%	56,543	63%	86,800	100%	136,977	100%	52,055	100%	68,051	85%	7,018	100%	6,342	96%	7,119	16%	136,092	100%
300	34,276	66%	49,561	92%	64,142	72%	67,987	78%	132,491	97%	40,997	79%	71,047	89%	6,160	88%	6,572	100%	17,363	40%	131,583	97%
400	36,049	69%	38,556	72%	66,756	75%	45,721	53%	133,190	97%	39,197	75%	69,047	87%	6,514	93%	5,081	77%	29,183	67%	129,485	95%
500	38,478	74%	39,271	73%	68,494	77%	42,613	49%	124,819	91%	36,520	70%	72,001	90%	6,032	86%	6,393	97%	32,730	75%	116,099	85%
600	43,284	83%	36,677	68%	76,693	86%	37,280	43%	127,556	93%	32,985	63%	75,054	94%	4,695	67%	5,556	85%	37,055	85%	119,861	88%
750	50,493	97%	32,787	61%	88,993	99%	29,282	34%	131,661	96%	27,682	53%	79,632	100%	2,689	38%	4,302	65%	43,541	100%	125,505	92%
900	51,580	99%	28,062	52%	89,268	100%	21,450	25%	121,716	89%	24,781	48%	78,559	99%	2,743	39%	3,989	61%	42,314	97%	112,328	83%
1,000	52,305	100%	24,913	46%	89,452	100%	16,229	19%	115,085	84%	22,847	44%	77,843	98%	2,779	40%	3,780	58%	41,495	95%	103,544	76%
1,150	50,107	96%	23,438	44%	89,140	100%	13,336	15%	106,593	78%	21,608	42%	76,174	96%	2,590	37%	3,268	50%	36,121	83%	95,210	70%
1,350	47,177	90%	21,472	40%	88,725	99%	9,478	11%	95,271	70%	19,956	38%	73,949	93%	2,338	33%	2,586	39%	28,956	67%	84,098	62%
1,500	44,979	86%	19,998	37%	88,413	99%	6,584	8%	86,780	63%	18,717	36%	72,279	91%	2,149	31%	2,075	32%	23,583	54%	75,763	56%
1,650	41,695	80%	18,779	35%	86,552	97%	6,532	8%	81,081	59%	19,116	37%	73,316	92%	2,150	31%	2,219	34%	24,783	57%	68,674	50%
1,850	37,318	71%	17,155	32%	84,070	94%	6,462	7%	73,483	54%	19,647	38%	74,697	94%	2,152	31%	2,411	37%	26,384	61%	59,221	44%
2,000	34,035	65%	15,936	30%	82,209	92%	6,410	7%	67,785	49%	20,045	39%	75,734	95%	2,153	31%	2,555	39%	27,585	63%	52,131	38%
2,500	17,113	33%	14,441	27%	80,148	90%	3,840	4%	54,643	40%	11,662	22%	61,197	77%	4,216	60%	91	1%	1,333	3%	52,594	39%
3,000	10,080	19%	12,385	23%	74,277	83%	3,483	4%	47,300	35%	14,517	28%	57,062	72%	4,976	71%	0	0%	0	0%	50,984	37%
3,500	6,759	13%	10,156	19%	68,334	76%	3,235	4%	42,455	31%	14,154	27%	53,573	67%	4,421	63%	0	0%	0	0%	50,415	37%
4,000	4,938	9%	8,315	15%	62,530	70%	3,046	4%	39,279	29%	13,929	27%	51,134	64%	3,144	45%	0	0%	0	0%	49,753	37%
4,900	2,439	5%	5,211	10%	56,984	64%	2,667	3%	35,760	26%	14,309	27%	47,393	60%	2,098	30%	0	0%	0	0%	50,663	37%
5,000	3,049	6%	5,526	10%	53,526	60%	2,802	3%	35,985	26%	14,020	27%	48,334	61%	1,890	27%	0	0%	0	0%	48,825	36%
6,000	2,213	4%	4,004	7%	42,668	48%	2,604	3%	34,497	25%	14,561	28%	47,419	60%	2,263	32%	0	0%	0	0%	50,155	37%
7,500	1,615	3%	2,883	5%	34,807	39%	2,755	3%	33,855	25%	15,873	30%	47,275	59%	2,690	38%	0	0%	0	0%	50,047	37%
100%	52,305		53,848		89,452		86,800		136,977		52,055		79,632		7,018		6,572		43,541		136,092	
75%	39,229		40,386		67,089		65,100		102,733		39,041		59,724		5,264		4,929		32,656		102,069	

STUDY SITE 6 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	26,585	12%	84,857	49%	24,118	8%	285,437	89%	114,115	34%	113,475	62%	131,577	43%	119,617	100%	27,340	86%	0	0%	49,474	19%
300	42,637	20%	110,798	65%	45,260	15%	306,222	96%	160,968	47%	133,234	73%	165,137	53%	106,635	89%	30,427	96%	0	0%	79,497	30%
400	61,906	28%	137,727	80%	76,247	26%	319,394	100%	230,410	68%	181,637	100%	198,199	64%	77,266	65%	26,471	84%	2,864	2%	136,779	52%
500	72,730	33%	146,876	86%	89,526	31%	305,488	96%	236,882	70%	169,259	93%	213,162	69%	57,169	48%	31,181	99%	5,417	3%	128,920	49%
600	85,471	39%	156,886	91%	112,313	38%	294,903	92%	265,947	78%	167,381	92%	230,434	74%	44,331	37%	31,617	100%	10,954	7%	152,720	58%
700	98,310	45%	163,508	95%	135,068	46%	281,734	88%	290,581	85%	179,292	99%	244,294	79%	37,514	31%	31,491	100%	16,941	10%	176,107	67%
800	111,494	51%	168,086	98%	157,142	54%	270,554	85%	310,409	91%	178,462	98%	255,182	82%	28,297	24%	30,600	97%	23,183	14%	197,806	75%
900	123,595	57%	170,807	100%	176,480	60%	261,320	82%	323,790	95%	169,242	93%	263,953	85%	22,044	18%	29,573	94%	30,634	19%	209,830	79%
1,000	134,345	62%	171,663	100%	194,370	66%	252,831	79%	332,639	98%	162,699	90%	271,192	88%	16,105	13%	28,176	89%	39,037	24%	226,852	86%
1,100	143,613	66%	171,112	100%	210,820	72%	244,155	76%	337,882	99%	155,421	86%	276,775	89%	13,912	12%	26,919	85%	47,747	29%	244,469	92%
1,200	151,615	70%	168,556	98%	225,268	77%	235,503	74%	340,255	100%	146,664	81%	281,595	91%	13,618	11%	25,488	81%	54,830	34%	253,984	96%
1,300	164,134	76%	173,091	101%	231,444	79%	226,229	71%	331,496	97%	145,608	80%	294,630	95%	11,944	10%	27,702	88%	65,221	40%	231,018	87%
1,500	195,308	90%	171,373	100%	268,572	92%	205,111	64%	337,243	99%	125,677	69%	301,792	97%	8,596	7%	24,979	79%	86,147	53%	264,661	100%
2,000	202,531	93%	150,005	87%	268,770	92%	157,825	49%	258,831	76%	84,461	47%	309,582	100%	4,538	4%	27,685	88%	101,722	62%	158,617	60%
2,200	209,216	96%	151,132	88%	287,947	98%	152,866	48%	321,302	94%	105,948	58%	310,388	100%	3,818	3%	21,888	69%	112,206	69%	224,504	85%
2,400	213,372	98%	141,837	83%	292,280	100%	137,972	43%	309,712	91%	96,009	53%	308,210	100%	3,099	3%	20,368	64%	119,576	73%	214,391	81%
3,000	217,358	100%	97,067	57%	293,225	100%	87,967	28%	232,410	68%	48,187	27%	296,949	96%	942	1%	14,045	44%	163,477	100%	145,056	55%
4,000	200,810	92%	54,266	32%	275,050	94%	49,201	15%	182,416	54%	32,379	18%	280,009	90%	204	0%	8,629	27%	146,235	89%	99,247	37%
4,900	175,703	81%	34,291	20%	266,943	91%	22,600	7%	165,653	49%	20,187	11%	251,537	81%	0	0%	3,575	11%	90,326	55%	84,097	32%
5,000	174,226	80%	33,445	19%	255,326	87%	26,829	8%	147,997	43%	21,491	12%	262,462	85%	0	0%	4,891	15%	109,750	67%	71,327	27%
6,000	146,633	67%	25,185	15%	232,790	79%	14,774	5%	122,888	36%	14,915	8%	244,481	79%	0	0%	2,732	9%	72,430	44%	43,378	16%
7,000	121,113	56%	20,946	12%	212,332	72%	8,898	3%	103,098	30%	10,256	6%	227,281	73%	0	0%	1,687	5%	40,786	25%	32,282	12%
8,000	96,921	45%	18,087	11%	192,959	66%	6,637	2%	85,223	25%	7,271	4%	211,218	68%	0	0%	1,055	3%	18,319	11%	29,607	11%
9,000	74,082	34%	15,851	9%	174,016	59%	5,770	2%	68,824	20%	5,035	3%	197,430	64%	0	0%	836	3%	7,838	5%	26,329	10%
10,000	55,106	25%	14,153	8%	157,095	54%	5,083	2%	55,986	16%	3,257	2%	186,297	60%	0	0%	883	3%	3,321	2%	20,375	8%
15,000	20,244	9%	7,050	4%	100,384	34%	2,152	1%	22,933	7%	1,460	1%	158,756	51%	0	0%	863	3%	7,059	4%	7,834	3%
100%	217,358		171,663		293,225		319,394		340,255		181,637		309,582		119,617		31,617		163,477		264,661	
75%	163,019		128,747		219,919		239,546		255,191		136,228		232,186		89,713		23,713		130,782		198,495	

STUDY SITE 7 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	4,778	7%	185,059	57%	106,819	41%	341,484	100%	261,525	79%	79,634	98%	190,039	51%	122,349	100%	28,370	18%	2,170	5%	190,546	74%
300	12,942	18%	227,495	70%	131,731	50%	337,537	99%	290,739	87%	81,168	100%	217,716	58%	79,969	65%	41,312	27%	4,747	11%	208,321	81%
400	22,121	31%	257,381	80%	154,708	59%	331,938	97%	310,815	93%	75,471	93%	238,470	64%	64,989	53%	54,353	35%	7,648	18%	222,996	86%
500	34,302	49%	284,854	88%	181,096	69%	340,459	100%	329,123	99%	79,053	97%	257,465	69%	31,947	26%	54,073	35%	15,931	38%	247,404	96%
600	41,500	59%	301,292	93%	195,795	75%	333,109	98%	332,707	100%	75,154	93%	270,953	73%	18,056	15%	65,422	42%	20,536	49%	258,756	100%
700	47,678	68%	312,857	97%	206,639	79%	319,872	94%	330,990	99%	69,883	86%	283,123	76%	13,759	11%	76,079	49%	24,832	60%	251,728	97%
800	51,975	74%	319,568	99%	216,098	83%	306,876	90%	323,038	97%	59,448	73%	293,809	79%	10,047	8%	86,486	56%	27,215	65%	240,446	93%
900	55,638	79%	322,798	100%	225,065	86%	293,088	86%	309,500	93%	48,517	60%	303,336	81%	8,054	7%	96,392	62%	29,135	70%	236,609	91%
1,000	58,836	84%	321,939	100%	233,257	89%	275,941	81%	293,562	88%	39,499	49%	311,927	84%	7,023	6%	106,071	69%	31,049	75%	223,683	86%
1,100	61,701	88%	319,118	99%	240,484	92%	255,893	75%	277,494	83%	32,494	40%	319,565	86%	5,963	5%	115,004	75%	32,678	79%	202,451	78%
1,200	64,396	92%	314,315	97%	246,780	94%	234,437	69%	263,507	79%	28,756	35%	326,457	87%	5,119	4%	123,672	80%	33,791	81%	171,054	66%
1,300	67,643	96%	315,288	98%	254,726	97%	230,913	68%	263,636	79%	33,511	41%	332,994	89%	4,413	4%	126,117	82%	35,087	84%	179,006	69%
1,500	70,354	100%	296,828	92%	261,265	100%	183,945	54%	223,513	67%	22,186	27%	341,146	91%	3,001	2%	143,933	93%	35,123	84%	109,837	42%
2,000	68,846	98%	246,315	76%	261,421	100%	132,089	39%	155,888	47%	19,335	24%	351,931	94%	1,539	1%	154,310	100%	36,462	88%	72,651	28%
2,200	69,055	98%	226,429	70%	272,572	104%	116,519	34%	144,594	43%	15,107	19%	356,989	96%	1,262	1%	143,123	93%	39,370	95%	68,212	26%
2,400	66,324	94%	204,106	63%	270,189	103%	97,214	28%	122,944	37%	13,673	17%	358,686	96%	985	1%	140,114	91%	39,393	95%	49,752	19%
3,000	56,303	80%	153,774	48%	259,133	99%	73,814	22%	102,887	31%	20,563	25%	365,229	98%	154	0%	106,998	69%	41,599	100%	54,884	21%
5,000	19,731	28%	79,456	25%	185,911	71%	28,076	8%	69,454	21%	19,786	24%	373,297	100%	0	0%	35,689	23%	30,924	74%	31,185	12%
6,000	11,261	16%	65,346	20%	157,747	60%	21,965	6%	62,599	19%	18,668	23%	373,525	100%	0	0%	21,625	14%	23,526	57%	31,344	12%
7,000	7,733	11%	54,310	17%	116,788	45%	17,849	5%	56,946	17%	18,123	22%	373,111	100%	0	0%	13,469	9%	13,985	34%	31,344	12%
8,000	6,028	9%	46,404	14%	92,940	36%	14,344	4%	54,355	16%	16,964	21%	371,234	99%	0	0%	9,784	6%	9,834	24%	27,074	10%
9,000	4,534	6%	40,600	13%	81,702	31%	11,438	3%	53,145	16%	15,861	20%	368,321	99%	0	0%	7,763	5%	9,207	22%	21,086	8%
10,000	3,312	5%	36,778	11%	70,898	27%	9,418	3%	51,921	16%	14,828	18%	364,584	98%	0	0%	6,388	4%	9,782	24%	20,862	8%
100%	70,354		322,798		261,421		341,484		332,707		81,168		373,525		122,349		154,310		41,599		258,756	
75%	52,765		242,098		196,066		256,113		249,530		60,876		280,144		91,762		115,733		31,199		194,067	

STUDY SITE 8 HABITAT SUITABILITY

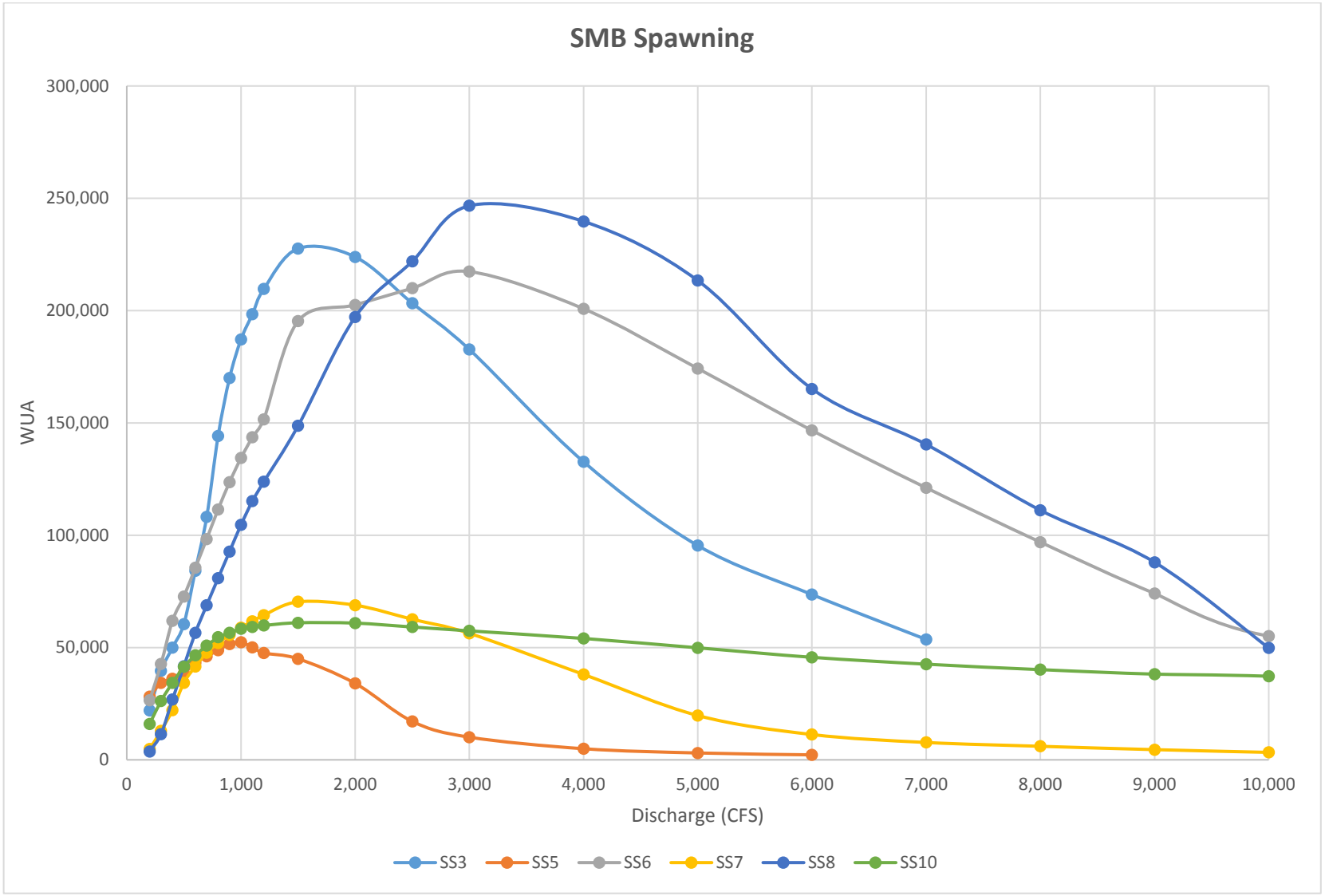
Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	3,720	2%	195,659	45%	46,839	10%	721,773	98%	356,086	57%	270,665	82%	314,815	40%	414,242	100%	24,760	11%	166	0%	149,560	35%
300	11,454	5%	245,974	57%	75,439	17%	733,279	100%	429,842	69%	324,069	98%	380,288	48%	379,840	92%	32,086	15%	840	1%	192,595	45%
400	26,831	11%	266,697	62%	91,273	20%	727,425	99%	482,042	77%	329,175	99%	407,905	52%	220,601	53%	41,293	19%	1,875	2%	232,315	54%
500	41,634	17%	290,381	67%	115,972	26%	718,183	98%	528,262	84%	331,371	100%	437,285	55%	175,901	42%	48,963	23%	3,065	3%	275,507	65%
600	56,489	23%	308,680	71%	141,045	31%	713,354	97%	561,905	90%	324,021	98%	461,329	58%	147,922	36%	55,300	25%	4,562	5%	314,469	74%
700	68,856	28%	323,788	75%	162,671	36%	702,619	96%	584,088	93%	307,575	93%	481,975	61%	123,687	30%	64,177	30%	5,953	7%	345,334	81%
800	80,862	33%	335,029	77%	184,653	41%	688,045	94%	601,579	96%	299,726	90%	499,479	63%	107,299	26%	70,081	32%	7,639	8%	367,988	86%
900	92,719	38%	343,683	79%	203,627	45%	667,906	91%	615,229	98%	293,642	89%	515,893	65%	95,238	23%	77,859	36%	9,176	10%	384,954	90%
1,000	104,570	42%	350,523	81%	221,233	49%	650,628	89%	622,795	99%	283,118	85%	530,301	67%	84,249	20%	83,585	39%	11,013	12%	398,347	93%
1,100	115,183	47%	357,569	83%	234,509	52%	636,083	87%	626,048	100%	266,684	80%	543,988	69%	74,911	18%	90,937	42%	12,743	14%	408,175	96%
1,200	123,807	50%	362,965	84%	248,852	55%	623,217	85%	627,310	100%	251,980	76%	555,727	70%	67,242	16%	96,478	44%	14,539	16%	407,006	95%
1,300	135,931	55%	381,990	88%	254,726	56%	617,335	84%	610,259	97%	229,004	69%	575,565	73%	62,106	15%	103,656	48%	14,509	16%	388,249	91%
1,500	148,669	60%	370,903	86%	284,722	63%	584,023	80%	615,528	98%	212,865	64%	585,840	74%	51,834	13%	113,087	52%	19,458	22%	426,396	100%
1,750	172,905	70%	401,724	93%	288,049	63%	553,105	75%	530,790	85%	134,574	41%	618,084	78%	26,971	7%	130,762	60%	20,089	22%	323,960	76%
2,000	197,141	80%	432,546	100%	291,377	64%	522,187	71%	446,052	71%	56,283	17%	650,328	82%	2,109	1%	148,437	68%	20,719	23%	221,524	52%
2,200	206,603	84%	418,891	97%	272,572	60%	476,477	65%	477,693	76%	88,042	27%	667,309	84%	1,747	0%	150,509	69%	28,621	32%	256,493	60%
2,400	217,057	88%	418,704	97%	270,189	59%	445,859	61%	441,153	70%	65,300	20%	680,423	86%	1,386	0%	159,173	73%	31,796	35%	219,901	52%
2,500	221,910	90%	420,686	97%	361,574	80%	437,908	60%	408,119	65%	50,305	15%	682,629	86%	1,205	0%	163,054	75%	31,787	35%	183,913	43%
3,000	246,679	100%	408,827	95%	431,772	95%	353,629	48%	370,186	59%	44,326	13%	714,931	90%	301	0%	177,672	82%	42,856	48%	146,301	34%
3,500	243,189	99%	380,938	88%	443,135	97%	298,212	41%	308,111	49%	41,869	13%	728,038	92%	371	0%	193,536	89%	49,060	55%	85,503	20%
4,000	239,700	97%	353,049	82%	454,498	100%	242,795	33%	246,036	39%	39,412	12%	741,146	94%	441	0%	209,400	96%	55,265	61%	24,704	6%
4,500	226,543	92%	314,586	73%	449,830	99%	210,318	29%	203,154	32%	48,211	15%	747,432	94%	354	0%	212,696	98%	64,126	71%	12,632	3%
5,000	213,386	87%	276,123	64%	445,163	98%	177,842	24%	160,272	26%	57,011	17%	753,718	95%	267	0%	215,992	100%	72,986	81%	561	0%
6,000	165,147	67%	195,876	45%	380,246	84%	130,922	18%	101,113	16%	65,215	20%	758,374	96%	105	0%	217,047	100%	67,462	75%	0	0%
7,180	140,433	57%	146,134	34%	366,469	81%	80,343	11%	83,555	13%	64,896	20%	773,326	98%	0	0%	194,347	90%	89,994	100%	0	0%
8,180	111,113	45%	114,875	27%	320,858	71%	53,984	7%	70,642	11%	63,805	19%	777,900	98%	0	0%	176,258	81%	86,345	96%	0	0%
9,170	87,961	36%	93,164	22%	281,520	62%	34,044	5%	63,590	10%	63,553	19%	781,042	99%	0	0%	153,515	71%	81,857	91%	0	0%
10,840	49,805	20%	60,943	14%	233,230	51%	14,076	2%	60,365	10%	63,484	19%	791,919	100%	0	0%	68,001	31%	73,303	81%	0	0%
100%	246,679		432,546		454,498		733,279		627,310		331,371		791,919		414,242		217,047		89,994		426,396	
75%	185,009		324,409		340,873		549,960		470,482		248,528		593,939		310,681		162,785		67,496		319,797	

STUDY SITE 10 HABITAT SUITABILITY

Discharge	SMB spawning		SMB juvenile		SMB adult		SMB fry		RB adult		RB spawning		AS spawning		S-S guild		S-F guild		D-F guild		D-S guild	
200	15,928	26%	199,145	73%	102,985	20%	649,442	100%	364,539	78%	128,007	100%	254,591	49%	161,819	100%	58,679	64%	2,612	6%	276,504	68%
300	26,186	43%	225,022	83%	131,339	25%	611,007	94%	401,820	86%	126,720	99%	295,234	56%	134,449	83%	73,244	80%	5,633	13%	316,376	78%
400	34,282	56%	241,384	89%	153,838	30%	577,108	89%	423,349	91%	126,515	99%	323,861	62%	112,886	70%	82,985	91%	8,648	21%	340,069	83%
500	41,427	68%	252,537	93%	176,506	34%	547,736	84%	439,415	94%	123,901	97%	348,047	66%	99,508	61%	89,424	98%	11,441	27%	361,310	89%
600	46,541	76%	258,908	95%	194,749	38%	523,940	81%	450,035	97%	124,147	97%	366,965	70%	90,537	56%	91,205	100%	14,193	34%	374,690	92%
700	50,821	83%	263,908	97%	211,866	41%	498,166	77%	456,214	98%	122,416	96%	383,823	73%	82,987	51%	91,627	100%	17,128	41%	385,859	95%
800	54,551	89%	266,671	98%	226,999	44%	479,577	74%	460,611	99%	122,401	96%	398,192	76%	76,764	47%	90,558	99%	20,359	48%	395,625	97%
900	56,569	93%	267,506	98%	240,853	47%	461,675	71%	462,315	99%	122,196	95%	410,855	78%	73,243	45%	88,219	96%	22,786	54%	402,553	99%
1,000	58,310	96%	272,046	100%	252,029	49%	450,274	69%	465,506	100%	124,383	97%	424,207	81%	72,492	45%	82,685	90%	26,305	63%	406,112	100%
1,100	59,200	97%	267,211	98%	265,624	52%	427,936	66%	462,794	99%	122,957	96%	433,210	83%	69,395	43%	83,046	91%	27,813	66%	407,510	100%
1,200	59,811	98%	266,324	98%	275,994	54%	413,859	64%	462,037	99%	121,360	95%	441,486	84%	64,222	40%	80,362	88%	29,999	71%	407,904	100%
1,300	58,061	95%	267,766	98%	300,794	58%	408,723	63%	456,080	98%	118,241	92%	443,746	85%	61,746	38%	76,294	83%	31,908	76%	400,966	98%
1,500	61,016	100%	261,923	96%	303,244	59%	376,252	58%	459,447	99%	117,753	92%	463,727	88%	56,794	35%	72,480	79%	35,081	84%	406,762	100%
1,750	60,939	100%	254,760	94%	320,287	62%	353,185	54%	453,329	97%	113,632	89%	476,669	91%	52,762	33%	66,538	73%	38,541	92%	405,882	100%
2,000	60,862	100%	247,598	91%	337,330	65%	330,119	51%	447,210	96%	109,511	86%	489,611	93%	48,730	30%	60,597	66%	42,000	100%	405,001	99%
2,200	64,817	106%	247,375	91%	383,636	74%	308,161	47%	455,121	98%	106,837	83%	504,908	96%	46,407	29%	64,333	70%	40,202	96%	418,976	103%
2,400	64,922	106%	239,629	88%	394,890	77%	292,325	45%	451,911	97%	104,092	81%	512,815	98%	44,084	27%	61,298	67%	40,607	97%	419,468	103%
2,500	59,135	97%	228,452	84%	426,528	83%	298,556	46%	434,926	93%	101,818	80%	502,668	96%	42,923	27%	52,835	58%	41,335	98%	402,054	99%
3,000	57,409	94%	209,306	77%	515,726	100%	266,992	41%	422,641	91%	94,124	74%	515,726	98%	37,115	23%	45,073	49%	40,670	97%	399,108	98%
3,500	55,722	91%	192,263	71%	452,623	88%	246,280	38%	410,404	88%	87,456	68%	520,046	99%	34,156	21%	40,010	44%	36,471	87%	395,051	97%
4,000	54,035	89%	175,220	64%	389,520	76%	225,568	35%	398,166	86%	80,787	63%	524,367	100%	31,196	19%	34,947	38%	32,272	77%	390,995	96%
4,500	51,951	85%	162,609	60%	391,503	76%	211,806	33%	387,110	83%	74,935	59%	524,136	100%	28,958	18%	31,245	34%	27,596	66%	389,029	95%
5,000	49,866	82%	149,997	55%	393,487	76%	198,045	30%	376,055	81%	69,083	54%	523,905	100%	26,720	17%	27,544	30%	22,921	55%	387,064	95%
6,000	45,643	75%	129,004	47%	391,164	76%	176,282	27%	359,215	77%	62,778	49%	519,506	99%	22,182	14%	22,432	24%	16,984	40%	387,711	95%
7,000	42,583	70%	112,357	41%	387,016	75%	157,062	24%	336,321	72%	55,331	43%	512,876	98%	20,562	13%	18,775	20%	13,608	32%	382,017	94%
8,000	40,152	66%	99,624	37%	381,099	74%	142,052	22%	315,493	68%	50,430	39%	505,625	96%	18,433	11%	16,008	17%	11,391	27%	374,653	92%
9,000	38,147	63%	89,761	33%	372,981	72%	130,865	20%	296,073	64%	45,753	36%	498,147	95%	15,818	10%	14,138	15%	10,965	26%	367,839	90%
10,000	37,224	61%	82,577	30%	364,316	71%	119,961	18%	276,451	59%	43,285	34%	490,768	94%	16,374	10%	12,723	14%	11,698	28%	365,756	90%
15,000	28,938	47%	58,283	21%	326,924	63%	87,254	13%	205,152	44%	35,439	28%	460,335	88%	9,615	6%	6,631	7%	16,741	40%	300,232	74%
20,000	26,610	44%	43,863	16%	286,761	56%	67,153	10%	152,602	33%	27,737	22%	438,390	84%	7,585	5%	5,804	6%	19,210	46%	242,391	59%
100%	61,016	100%	272,046	100%	515,726	100%	649,442	100%	465,506	100%	128,007	100%	524,367	100%	161,819	100%	91,627	100%	42,000	100%	407,904	100%
75%	45,762		204,035		386,795		487,082		349,129		96,006		393,275		121,364		68,720		31,500		305,928	

ATTACHMENT B

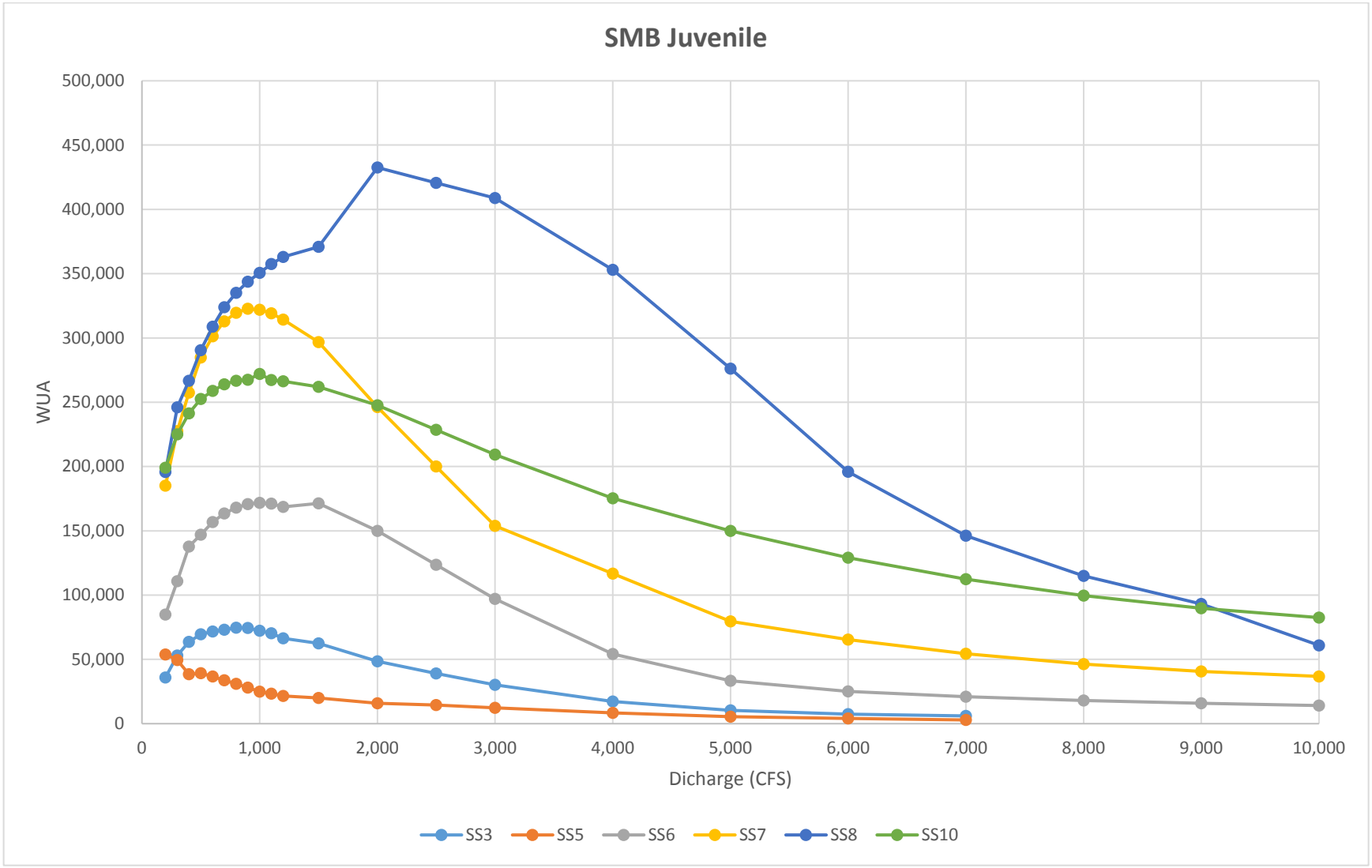
SMB SPAWNING



SMB SPAWNING

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	22,010	10%	28,083	54%	26,585	12%	4,778	7%	3,720	2%	15,928	26%
300	39,568	17%	34,276	66%	42,637	20%	12,942	18%	11,454	5%	26,186	43%
400	49,956	22%	36,049	69%	61,906	28%	22,121	31%	26,831	11%	34,282	56%
500	60,444	27%	38,478	74%	72,730	33%	34,302	49%	41,634	17%	41,427	68%
600	84,153	37%	43,284	83%	85,471	39%	41,500	59%	56,489	23%	46,541	76%
700	108,176	48%	46049.39	88%	98,310	45%	47,678	68%	68,856	28%	50,821	83%
800	144,211	63%	48814.84	93%	111,494	51%	51,975	74%	80,862	33%	54,551	89%
900	169,961	75%	51,580	99%	123,595	57%	55,638	79%	92,719	38%	56,569	93%
1,000	187,128	82%	52,305	100%	134,345	62%	58,836	84%	104,570	42%	58,310	96%
1,100	198,374	87%	50,107	96%	143,613	66%	61,701	88%	115,183	47%	59,200	97%
1,200	209,621	92%	47,543	91%	151,615	70%	64,396	92%	123,807	50%	59,811	98%
1,500	227,651	100%	44,979	86%	195,308	90%	70,354	100%	148,669	60%	61,016	100%
2,000	223,911	98%	34,035	65%	202,531	93%	68,846	98%	197,141	80%	60,862	100%
2,500	203,304	89%	17,113	33%	209,945	97%	62,575	89%	221,910	90%	59,135	97%
3,000	182,696	80%	10,080	19%	217,358	100%	56,303	80%	246,679	100%	57,409	94%
4,000	132,698	58%	4,938	9%	200,810	92%	38,017	54%	239,700	97%	54,035	89%
5,000	95,391	42%	3,049	6%	174,226	80%	19,731	28%	213,386	87%	49,866	82%
6,000	73,583	32%	2,213	4%	146,633	67%	11,261	16%	165,147	67%	45,643	75%
7,000	53,598	24%			121,113	56%	7,733	11%	140,433	57%	42,583	70%
8,000					96,921	45%	6,028	9%	111,113	45%	40,152	66%
9,000					74,082	34%	4,534	6%	87,961	36%	38,147	63%
10,000					55,106	25%	3,312	5%	49,805	20%	37,224	61%
15,000					20,244						28,938	47%
20,000											26,610	44%
100%	227,651		52,305		217,358		70,354		246,679		61,016	
75%	170738.4		39228.86		163018.7325		52765.31		185009.3		45762	

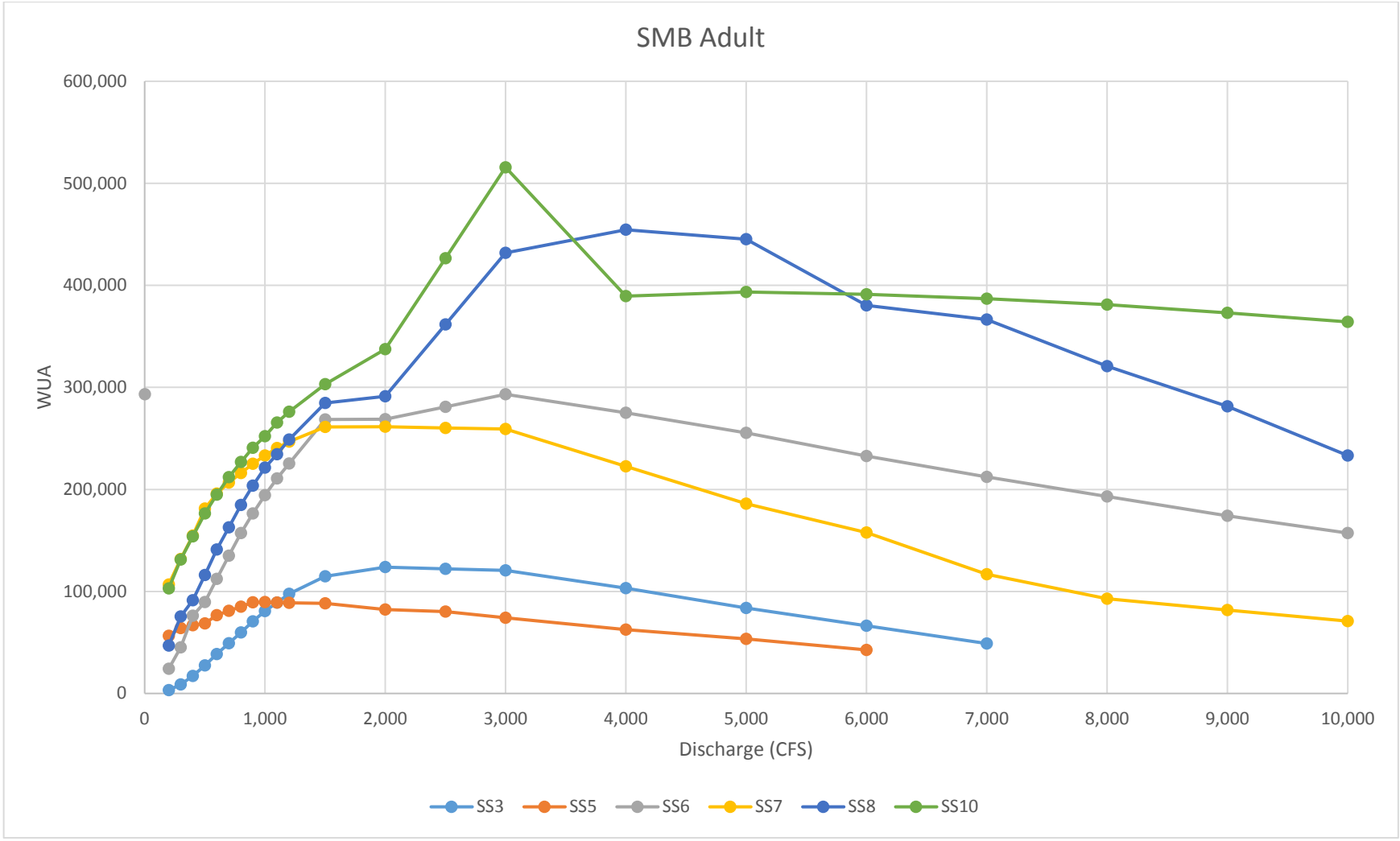
SMB JUVENILE



SMB JUVENILE

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	35,895	48%	53,848	100%	84,857	49%	185,059	57%	195,659	45%	199,145	73%
300	53,023	71%	49,561	92%	110,798	65%	227,495	70%	245,974	57%	225,022	83%
400	63,598	85%	38,556	72%	137,727	80%	257,381	80%	266,697	62%	241,384	89%
500	69,445	93%	39,271	73%	146,876	86%	284,854	88%	290,381	67%	252,537	93%
600	71,675	96%	36,677	68%	156,886	91%	301,292	93%	308,680	71%	258,908	95%
700	73,150	98%	33805.51	63%	163,508	95%	312,857	97%	323,788	75%	263,908	97%
800	74,625	100%	30933.85	57%	168,086	98%	319,568	99%	335,029	77%	266,671	98%
900	74,361	100%	28,062	52%	170,807	100%	322,798	100%	343,683	79%	267,506	98%
1,000	72,351	97%	24,913	46%	171,663	100%	321,939	100%	350,523	81%	272,046	100%
1,100	70,340	94%	23,274	43%	171,112	100%	319,118	99%	357,569	83%	267,211	98%
1,200	66,423	89%	21,636	40%	168,556	98%	314,315	97%	362,965	84%	266,324	98%
1,500	62,505	84%	19,998	37%	171,373	100%	296,828	92%	370,903	86%	261,923	96%
2,000	48,562	65%	15,936	30%	150,005	87%	246,315	76%	432,546	100%	247,598	91%
2,500	39,126	52%	14,441	27%	123,536	72%	200,045	62%	420,686	97%	228,452	84%
3,000	30,254	41%	12,385	23%	97,067	57%	153,774	48%	408,827	95%	209,306	77%
4,000	17,228	23%	8,315	15%	54,266	32%	116,615	36%	353,049	82%	175,220	64%
5,000	10,302	14%	5,526	10%	33,445	19%	79,456	25%	276,123	64%	149,997	55%
6,000	7,408	10%	4,004	7%	25,185	15%	65,346	20%	195,876	45%	129,004	47%
7,000	6,030	8%	2,883	5%	20,946	12%	54,310	17%	146,134	34%	112,357	41%
8,000					18,087	11%	46,404	14%	114,875	27%	99,624	37%
9,000					15,851	9%	40,600	13%	93,164	22%	89,761	33%
10,000					14,153	8%	36,778	11%	60,943	14%	82,577	30%
15,000					7,050	4%					58,283	21%
20,000											43,863	16%
100%	74,625		53,848		171,663		322,798		432,546		272,046	
75%	55968.55		40386.16		128747.2		242098.3		324409.5		204034.5	

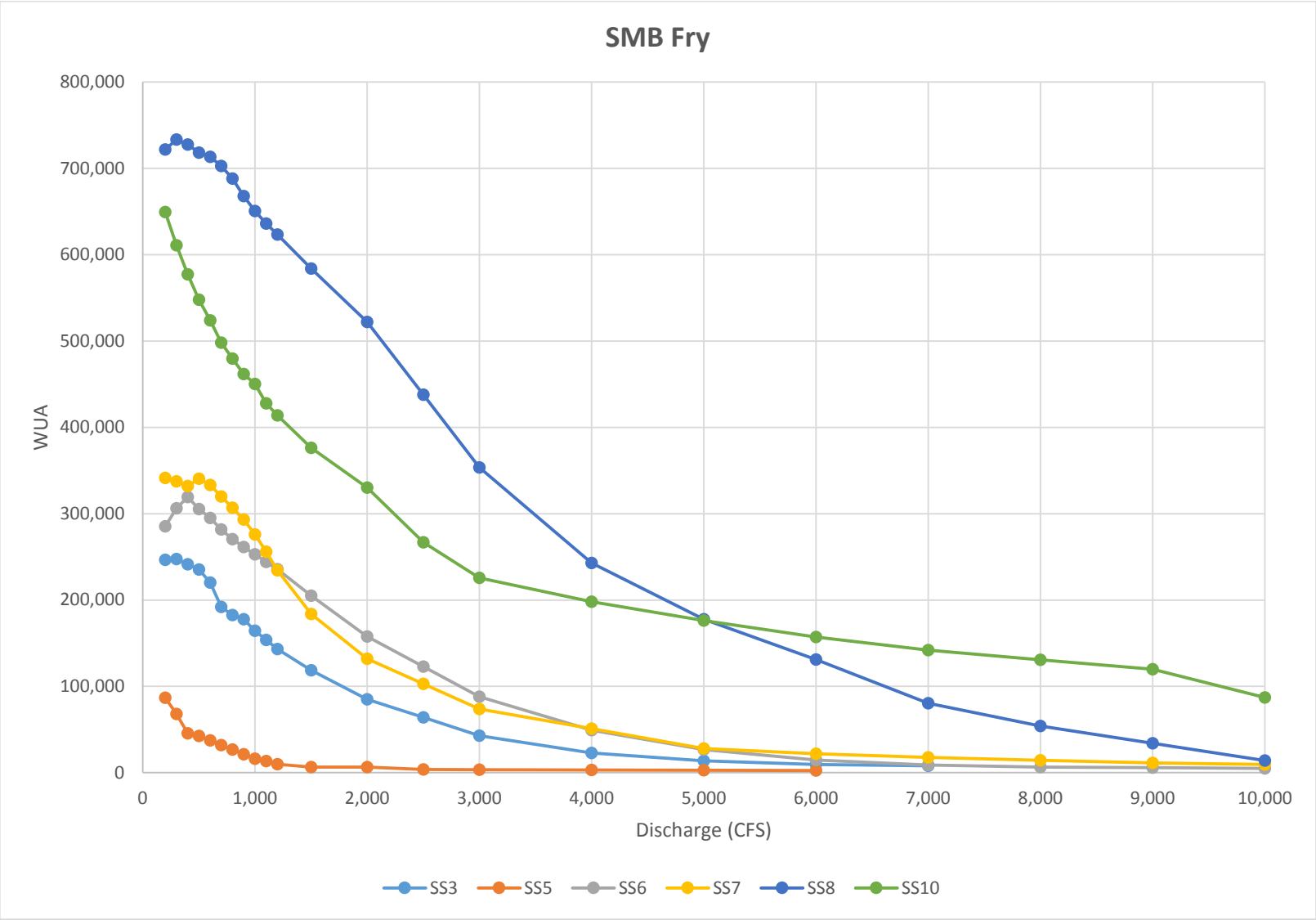
SMB ADULT


SMB Adult
600,000
500,000
400,000
300,000
200,000
100,000
0
WUA
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Discharge (CFS)
SS3
SS5
SS6
SS7
SS8
SS10

SMB ADULT

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	3,245	3%	56,543	63%	24,118	8%	106,819	41%	46,839	10%	102,985	20%
300	8,842	7%	64,142	72%	45,260	15%	131,731	50%	75,439	17%	131,339	25%
400	17,079	14%	66,756	75%	76,247	26%	154,708	59%	91,273	20%	153,838	30%
500	27,450	22%	68,494	77%	89,526	31%	181,096	69%	115,972	26%	176,506	34%
600	38,563	31%	76,693	86%	112,313	38%	195,795	75%	141,045	31%	194,749	38%
700	49,217	40%	80885.05	90%	135,068	46%	206,639	79%	162,671	36%	211,866	41%
800	59,872	48%	85076.74	95%	157,142	54%	216,098	83%	184,653	41%	226,999	44%
900	70,526	57%	89,268	100%	176,480	60%	225,065	86%	203,627	45%	240,853	47%
1,000	80,722	65%	89,452	100%	194,370	66%	233,257	89%	221,233	49%	252,029	49%
1,100	89,180	72%	89,140	100%	210,820	72%	240,484	92%	234,509	52%	265,624	52%
1,200	97,638	79%	88,777	99%	225,268	77%	246,780	94%	248,852	55%	275,994	54%
1,500	114,691	93%	88,413	99%	268,572	92%	261,265	100%	284,722	63%	303,244	59%
2,000	123,771	100%	82,209	92%	268,770	92%	261,421	100%	291,377	64%	337,330	65%
2,500	122,157	99%	80,148	90%	280,997	96%	260,277	100%	361,574	80%	426,528	83%
3,000	120,543	97%	74,277	83%	293,225	100%	259,133	99%	431,772	95%	515,726	100%
4,000	103,264	83%	62,530	70%	275,050	94%	222,522	85%	454,498	100%	389,520	76%
5,000	83,733	68%	53,526	60%	255,326	87%	185,911	71%	445,163	98%	393,487	76%
6,000	66,396	54%	42,668	48%	232,790	79%	157,747	60%	380,246	84%	391,164	76%
7,000	48,860	39%			212,332	72%	116,788	45%	366,469	81%	387,016	75%
8,000					192,959	66%	92,940	36%	320,858	71%	381,099	74%
9,000					174,016	59%	81,702	31%	281,520	62%	372,981	72%
10,000					157,095	54%	70,898	27%	233,230	51%	364,316	71%
15,000					100,384	34%					326,924	63%
20,000											286,761	56%
100%	123,771		89,452		293,225		261,421		454,498		515,726	
75%	92828.35		67089.14		219918.7		196065.7		340873.3		386794.5	

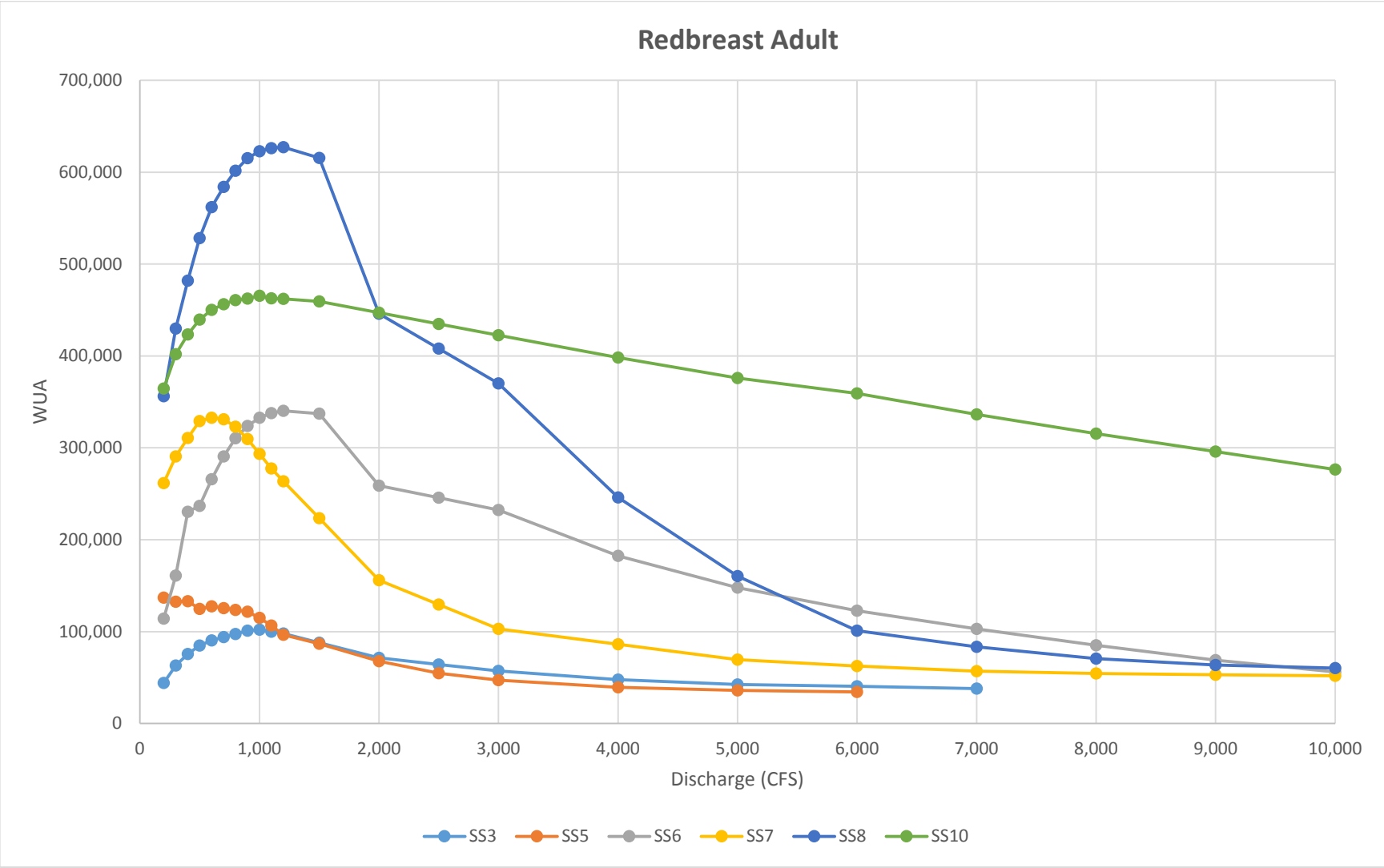
SMB FRY


SMB Fry
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
WUA
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Discharge (CFS)
SS3
SS5
SS6
SS7
SS8
SS10

SMB FRY

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	246,534	100%	86,800	100%	285,437	89%	341,484	100%	721,773	98%	649,442	100%
300	247,519	100%	67,987	78%	306,222	96%	337,537	99%	733,279	100%	611,007	94%
400	241,241	97%	45,721	53%	319,394	100%	331,938	97%	727,425	99%	577,108	89%
500	235,249	95%	42,613	49%	305,488	96%	340,459	100%	718,183	98%	547,736	84%
600	220,223	89%	37,280	43%	294,903	92%	333,109	98%	713,354	97%	523,940	81%
700	191,868	78%	32003.66	37%	281,734	88%	319,872	94%	702,619	96%	498,166	77%
800	182,699	74%	26745.6	31%	270,554	85%	306,876	90%	688,045	94%	479,577	74%
900	177,690	72%	21,450	25%	261,320	82%	293,088	86%	667,906	91%	461,675	71%
1,000	164,360	66%	16,229	19%	252,831	79%	275,941	81%	650,628	89%	450,274	69%
1,100	153,828	62%	13,336	15%	244,155	76%	255,893	75%	636,083	87%	427,936	66%
1,200	143,295	58%	9,960	11%	235,503	74%	234,437	69%	623,217	85%	413,859	64%
1,500	118,562	48%	6,584	8%	205,111	64%	183,945	54%	584,023	80%	376,252	58%
2,000	85,089	34%	6,410	7%	157,825	49%	132,089	39%	522,187	71%	330,119	51%
2,500	63,935	26%	3,840	4%	122,896	38%	102,951	30%	437,908	60%	266,992	41%
3,000	42,781	17%	3,483	4%	87,967	28%	73,814	22%	353,629	48%	225,568	35%
4,000	22,907	9%	3,046	4%	49,201	15%	50,945	15%	242,795	33%	198,045	30%
5,000	13,665	6%	2,802	3%	26,829	8%	28,076	8%	177,842	24%	176,282	27%
6,000	9,506	4%	2,604	3%	14,774	5%	21,965	6%	130,922	18%	157,062	24%
7,000	7,856	3%			8,898	3%	17,849	5%	80,343	11%	142,052	22%
8,000					6,637	2%	14,344	4%	53,984	7%	130,865	20%
9,000					5,770	2%	11,438	3%	34,044	5%	119,961	18%
10,000					5,083	2%	9,418	3%	14,076	2%	87,254	13%
15,000					2,152	1%					67,153	10%
20,000												
100%	247,519		86,800		319,394		341,484		733,279		649,442	
75%	185639.3		65099.9		239545.7		256113.2		549959.5		487081.5	

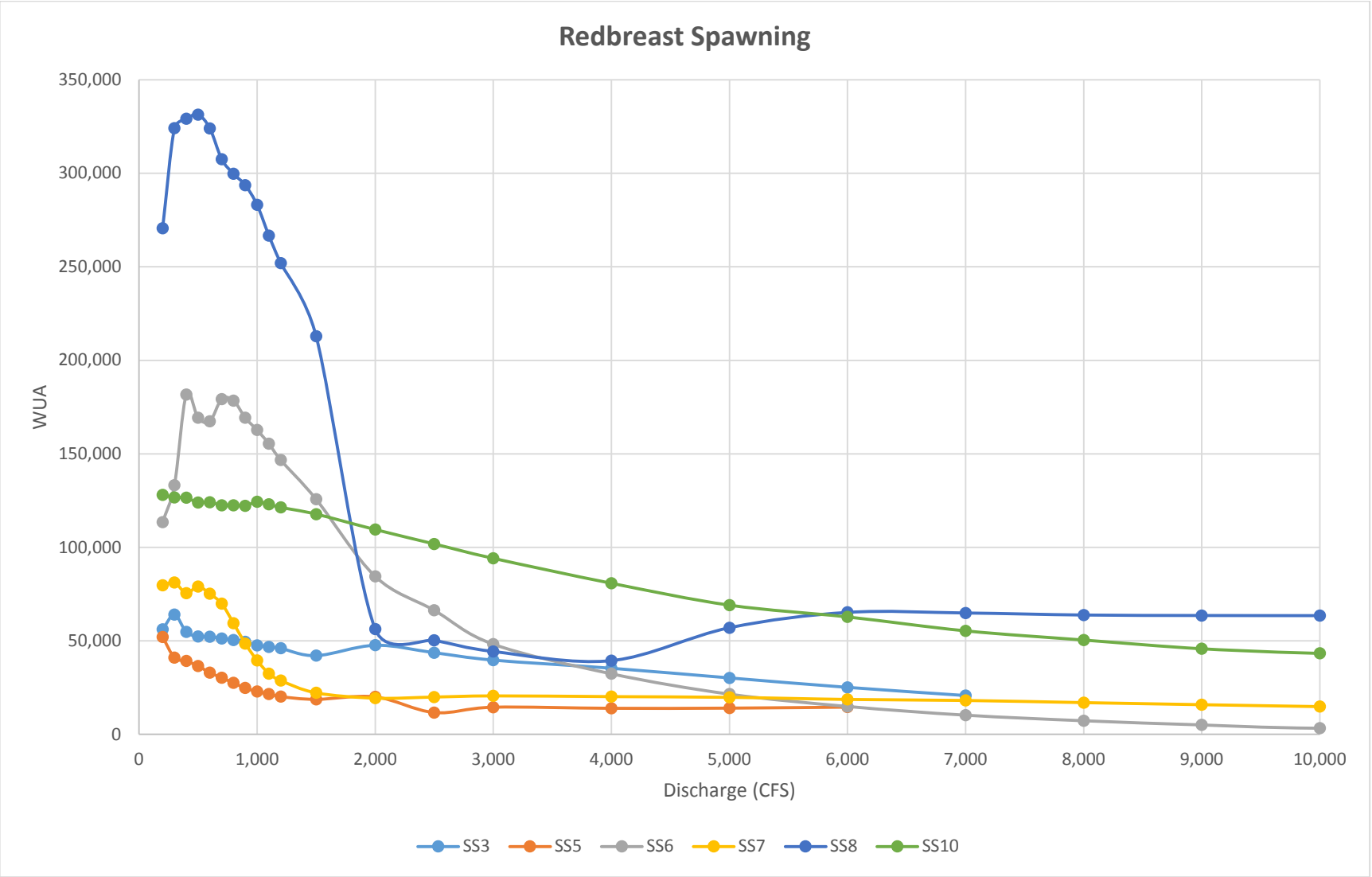
REDBREAST ADULT



REDBREAST ADULT

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	44,190	43%	136,977	100%	114,115	34%	261,525	79%	356,086	57%	364,539	78%
300	63,111	62%	132,491	97%	160,968	47%	290,739	87%	429,842	69%	401,820	86%
400	75,583	74%	133,190	97%	230,410	68%	310,815	93%	482,042	77%	423,349	91%
500	84,730	83%	124,819	91%	236,882	70%	329,123	99%	528,262	84%	439,415	94%
600	90,492	89%	127,556	93%	265,947	78%	332,707	100%	561,905	90%	450,035	97%
700	93,985	92%	125609.3	92%	290,581	85%	330,990	99%	584,088	93%	456,214	98%
800	97,478	95%	123662.4	90%	310,409	91%	323,038	97%	601,579	96%	460,611	99%
900	100,972	99%	121,716	89%	323,790	95%	309,500	93%	615,229	98%	462,315	99%
1,000	102,196	100%	115,085	84%	332,639	98%	293,562	88%	622,795	99%	465,506	100%
1,100	100,034	98%	106,593	78%	337,882	99%	277,494	83%	626,048	100%	462,794	99%
1,200	97,872	96%	96,687	71%	340,255	100%	263,507	79%	627,310	100%	462,037	99%
1,500	87,845	86%	86,780	63%	337,243	99%	223,513	67%	615,528	98%	459,447	99%
2,000	71,328	70%	67,785	49%	258,831	76%	155,888	47%	446,052	71%	447,210	96%
2,500	64,345	63%	54,643	40%	245,621	72%	129,387	39%	408,119	65%	434,926	93%
3,000	57,363	56%	47,300	35%	232,410	68%	102,887	31%	370,186	59%	422,641	91%
4,000	47,726	47%	39,279	29%	182,416	54%	86,170	26%	246,036	39%	398,166	86%
5,000	42,410	41%	35,985	26%	147,997	43%	69,454	21%	160,272	26%	376,055	81%
6,000	40,400	40%	34,497	25%	122,888	36%	62,599	19%	101,113	16%	359,215	77%
7,000	38,010	37%			103,098	30%	56,946	17%	83,555	13%	336,321	72%
8,000					85,223	25%	54,355	16%	70,642	11%	315,493	68%
9,000					68,824	20%	53,145	16%	63,590	10%	296,073	64%
10,000					55,986	16%	51,921	16%	60,365	10%	276,451	59%
15,000					22,933	7%					205,152	
20,000											152,602	
100%	102,196		136,977		340,255		332,707		627,310		465,506	
75%	76647.24		102732.7		255191.4		249530.3		470482.2		349129.4	

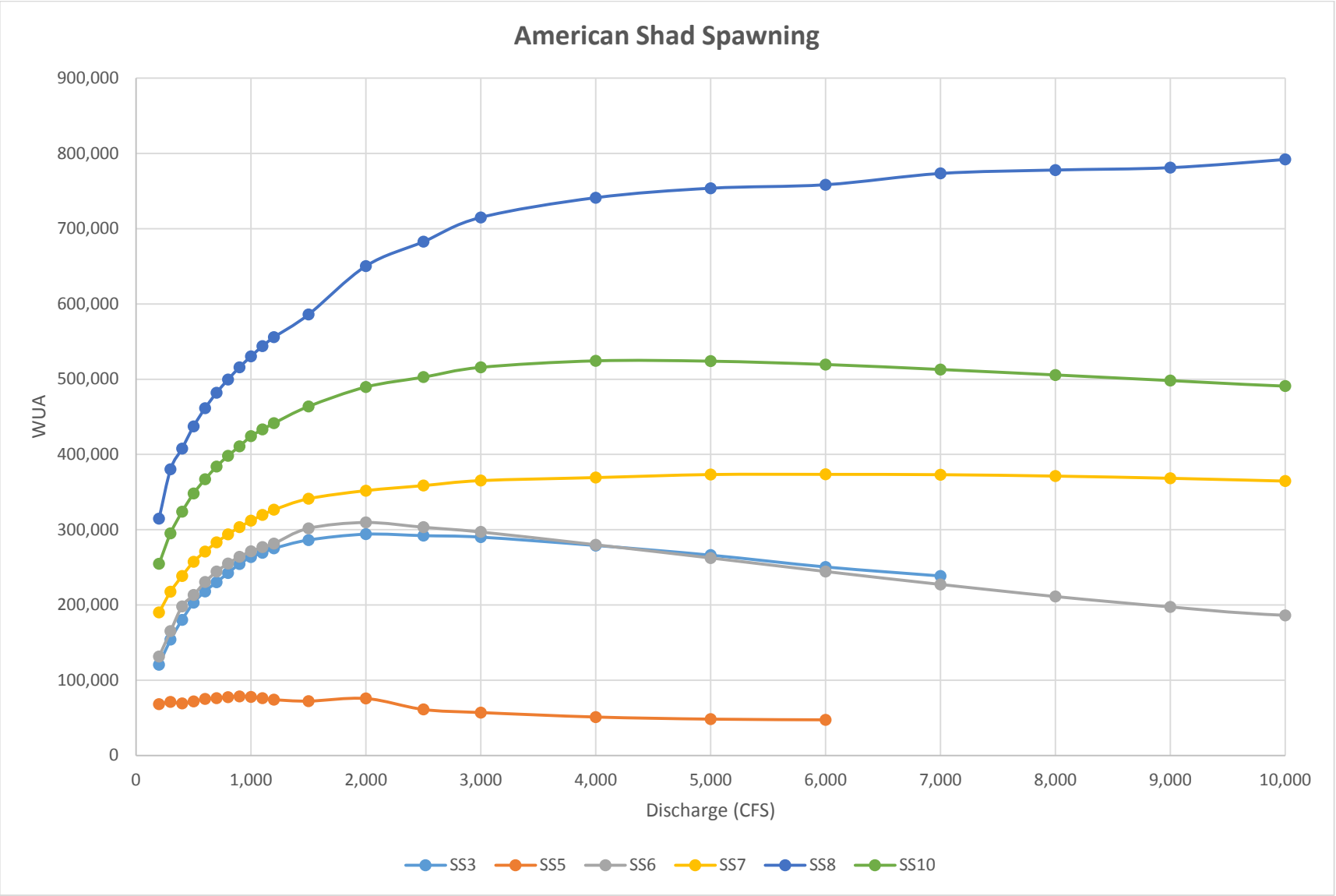
REDBREAST SPAWNING



REDBREAST SPAWNING

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	56,194	88%	52,055	100%	113,475	62%	79,634	98%	270,665	82%	128,007	100%
300	64,009	100%	40,997	79%	133,234	73%	81,168	100%	324,069	98%	126,720	99%
400	54,781	86%	39,197	75%	181,637	100%	75,471	93%	329,175	99%	126,515	99%
500	52,279	82%	36,520	70%	169,259	93%	79,053	97%	331,371	100%	123,901	97%
600	52,231	82%	32,985	63%	167,381	92%	75,154	93%	324,021	98%	124,147	97%
700	51,293	80%	30250.5	58%	179,292	99%	69,883	86%	307,575	93%	122,416	96%
800	50,355	79%	27515.96	53%	178,462	98%	59,448	73%	299,726	90%	122,401	96%
900	49,417	77%	24,781	48%	169,242	93%	48,517	60%	293,642	89%	122,196	95%
1,000	47,588	74%	22,847	44%	162,699	90%	39,499	49%	283,118	85%	124,383	97%
1,100	46,805	73%	21,608	42%	155,421	86%	32,494	40%	266,684	80%	122,957	96%
1,200	46,021	72%	20,163	39%	146,664	81%	28,756	35%	251,980	76%	121,360	95%
1,500	42,077	66%	18,717	36%	125,677	69%	22,186	27%	212,865	64%	117,753	92%
2,000	47,632	74%	20,045	39%	84,461	47%	19,335	24%	56,283	17%	109,511	86%
2,500	43,664	68%	11,662	22%	66,324	37%	19,949	25%	50,305	15%	101,818	80%
3,000	39,697	62%	14,517	28%	48,187	27%	20,563	25%	44,326	13%	94,124	74%
4,000	35,346	55%	13,929	27%	32,379	18%	20,174	25%	39,412	12%	80,787	63%
5,000	30,183	47%	14,020	27%	21,491	12%	19,786	24%	57,011	17%	69,083	54%
6,000	25,129	39%	14,561	28%	14,915	8%	18,668	23%	65,215	20%	62,778	49%
7,000	20,758	32%			10,256	6%	18,123	22%	64,896	20%	55,331	43%
8,000					7,271	4%	16,964	21%	63,805	19%	50,430	39%
9,000					5,035	3%	15,861	20%	63,553	19%	45,753	36%
10,000					3,257	2%	14,828	18%	63,484	19%	43,285	34%
15,000					1,460	1%					35,439	28%
20,000											27,737	22%
100%	64,009		52,055		181,637		81,168		331,371		128,007	
75%	48006.62		39041.08		136227.5		60875.67		248528.3		96005.55	

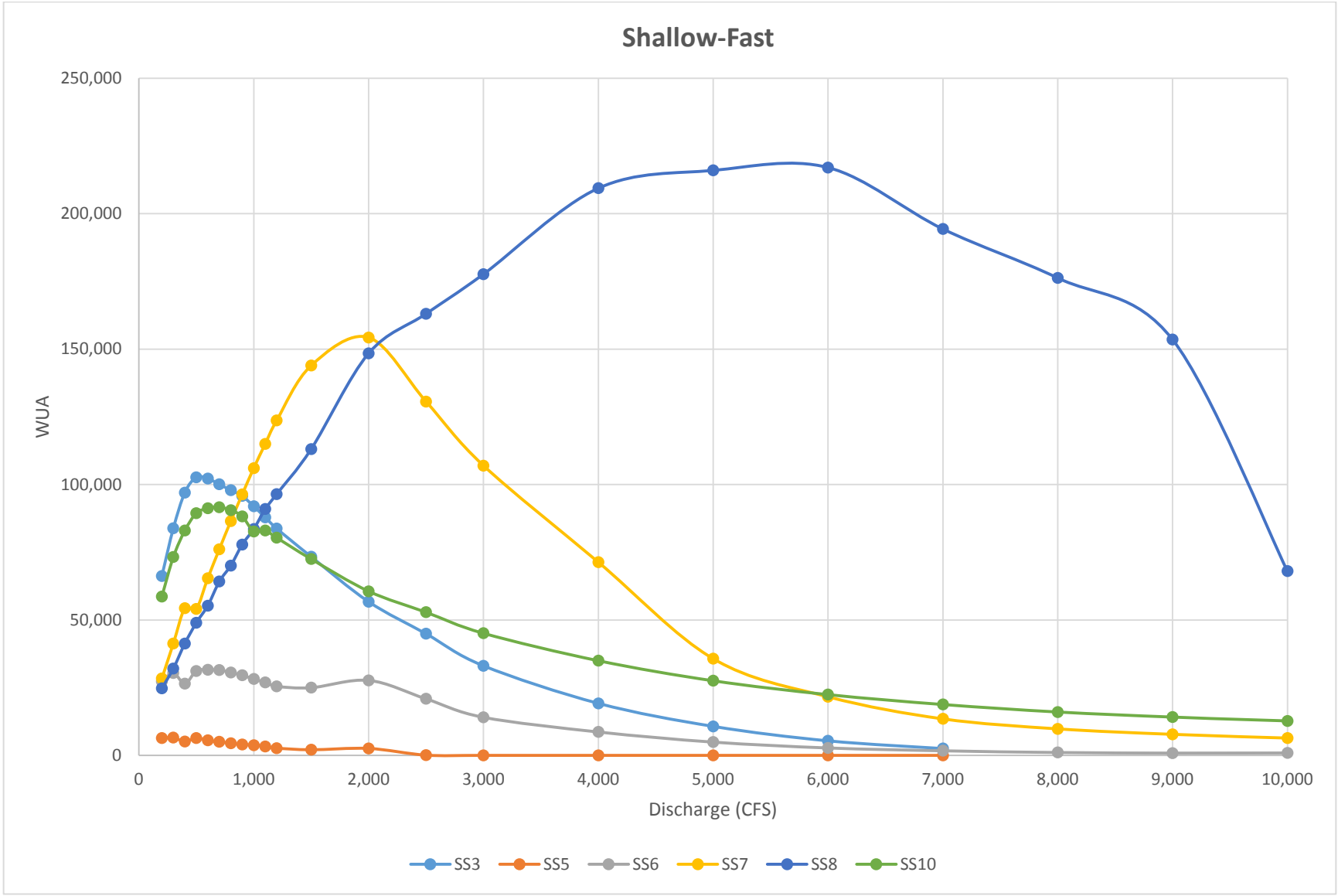
AMERICAN SHAD SPAWNING



AMERICAN SHAD SPAWNING

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	120,632	41%	68,051	87%	131,577	43%	190,039	51%	314,815	40%	254,591	49%
300	153,920	52%	71,047	90%	165,137	53%	217,716	58%	380,288	48%	295,234	56%
400	180,321	61%	69,047	88%	198,199	64%	238,470	64%	407,905	52%	323,861	62%
500	202,960	69%	72,001	92%	213,162	69%	257,465	69%	437,285	55%	348,047	66%
600	218,096	74%	75,054	96%	230,434	74%	270,953	73%	461,329	58%	366,965	70%
700	230,234	78%	76222.19	97%	244,294	79%	283,123	76%	481,975	61%	383,823	73%
800	242,373	82%	77390.59	99%	255,182	82%	293,809	79%	499,479	63%	398,192	76%
900	254,511	87%	78,559	100%	263,953	85%	303,336	81%	515,893	65%	410,855	78%
1,000	263,652	90%	77,843	99%	271,192	88%	311,927	84%	530,301	67%	424,207	81%
1,100	269,389	92%	76,174	97%	276,775	89%	319,565	86%	543,988	69%	433,210	83%
1,200	275,126	94%	74,227	94%	281,595	91%	326,457	87%	555,727	70%	441,486	84%
1,500	286,317	97%	72,279	92%	301,792	97%	341,146	91%	585,840	74%	463,727	88%
2,000	294,034	100%	75,734	96%	309,582	100%	351,931	94%	650,328	82%	489,611	93%
2,500	292,081	99%	61,197	78%	303,265	98%	358,580	96%	682,629	86%	502,668	96%
3,000	290,129	99%	57,062	73%	296,949	96%	365,229	98%	714,931	90%	515,726	98%
4,000	279,051	95%	51,134	65%	280,009	90%	369,263	99%	741,146	94%	524,367	100%
5,000	266,167	91%	48,334	62%	262,462	85%	373,297	100%	753,718	95%	523,905	100%
6,000	250,501	85%	47,419	60%	244,481	79%	373,525	100%	758,374	96%	519,506	99%
7,000	238,542	81%			227,281	73%	373,111	100%	773,326	98%	512,876	98%
8,000					211,218	68%	371,234	99%	777,900	98%	505,625	96%
9,000					197,430	64%	368,321	99%	781,042	99%	498,147	95%
10,000					186,297	60%	364,584	98%	791,919	100%	490,768	94%
15,000					158,756						460,335	88%
20,000											438,390	84%
100%	294,034		78,559		309,582		373,525		791,919		524,367	
75%	220525.2		58919.24		232186.2		280143.6		593939		393275	

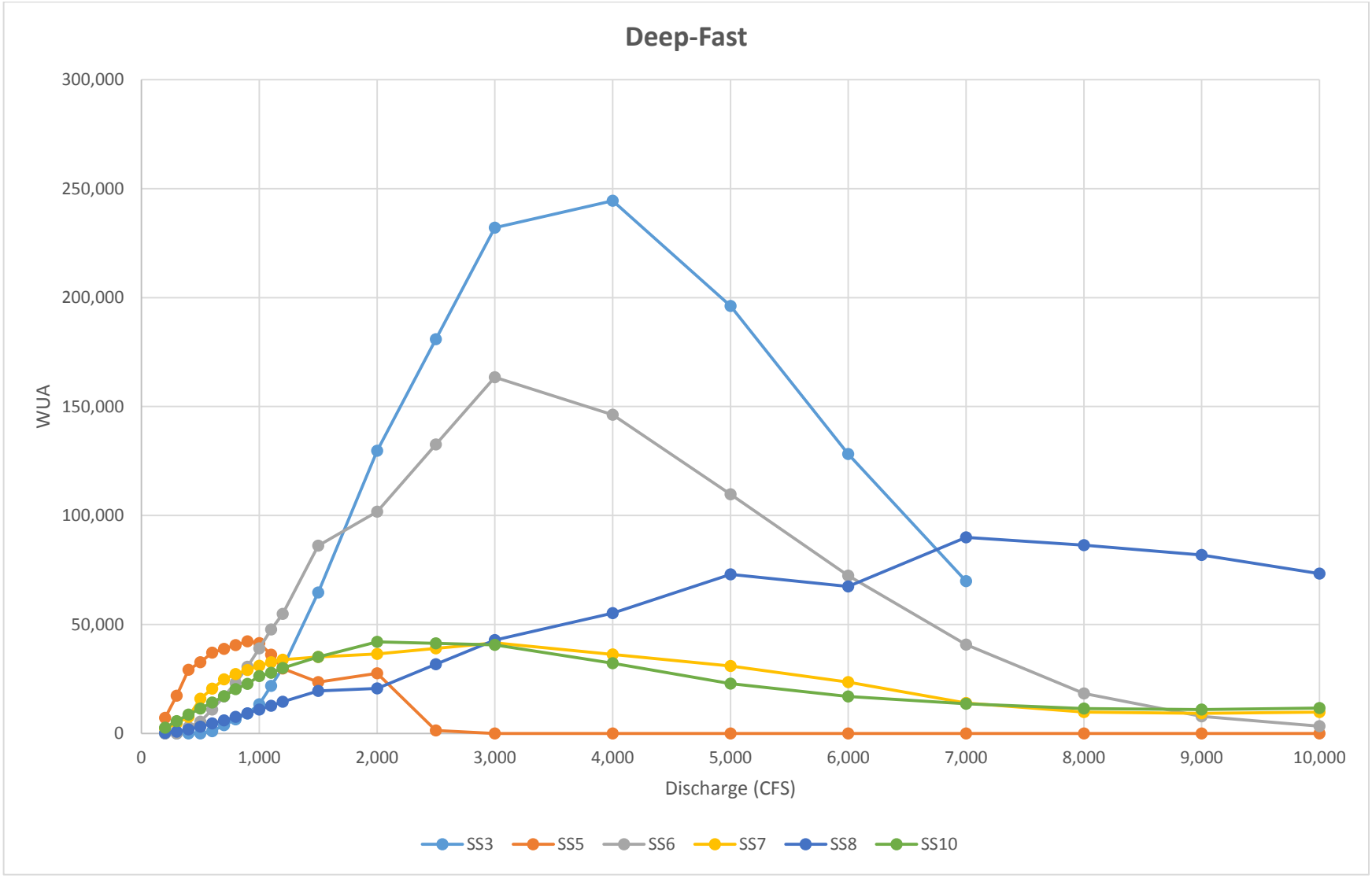
SHALLOW FAST GUILD



SHALLOW FAST GUILD

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	66,201	64%	6,342	96%	27,340	86%	28,370	18%	24,760	11%	58,679	64%
300	83,824	82%	6,572	100%	30,427	96%	41,312	27%	32,086	15%	73,244	80%
400	97,020	94%	5,081	77%	26,471	84%	54,353	35%	41,293	19%	82,985	91%
500	102,671	100%	6,393	97%	31,181	99%	54,073	35%	48,963	23%	89,424	98%
600	102,207	100%	5,556	85%	31,617	100%	65,422	42%	55,300	25%	91,205	100%
700	100,064	97%	5033.878	77%	31,491	100%	76,079	49%	64,177	30%	91,627	100%
800	97,922	95%	4511.272	69%	30,600	97%	86,486	56%	70,081	32%	90,558	99%
900	95,779	93%	3,989	61%	29,573	94%	96,392	62%	77,859	36%	88,219	96%
1,000	91,959	90%	3,780	58%	28,176	89%	106,071	69%	83,585	39%	82,685	90%
1,100	87,850	86%	3,268	50%	26,919	85%	115,004	75%	90,937	42%	83,046	91%
1,200	83,741	82%	2,671	41%	25,488	81%	123,672	80%	96,478	44%	80,362	88%
1,500	73,349	71%	2,075	32%	24,979	79%	143,933	93%	113,087	52%	72,480	79%
2,000	56,730	55%	2,555	39%	27,685	88%	154,310	100%	148,437	68%	60,597	66%
2,500	44,900	44%	91	1%	20,865	66%	130,654	85%	163,054	75%	52,835	58%
3,000	33,070	32%	0	0%	14,045	44%	106,998	69%	177,672	82%	45,073	49%
4,000	19,202	19%	0	0%	8,629	27%	71,344	46%	209,400	96%	34,947	38%
5,000	10,706	10%	0	0%	4,891	15%	35,689	23%	215,992	100%	27,544	30%
6,000	5,364	5%	0	0%	2,732	9%	21,625	14%	217,047	100%	22,432	24%
7,000	2,515	2%	0	0%	1,687	5%	13,469	9%	194,347	90%	18,775	20%
8,000					1,055	3%	9,784	6%	176,258	81%	16,008	17%
9,000					836	3%	7,763	5%	153,515	71%	14,138	15%
10,000					883	3%	6,388	4%	68,001	31%	12,723	14%
15,000					863	3%					6,631	7%
20,000											5,804	6%
100%	102,671		6,572		31,617		154,310		217,047		91,627	
75%	77003.61		4929.285		23712.99		115732.8		162785.3		68720.25	

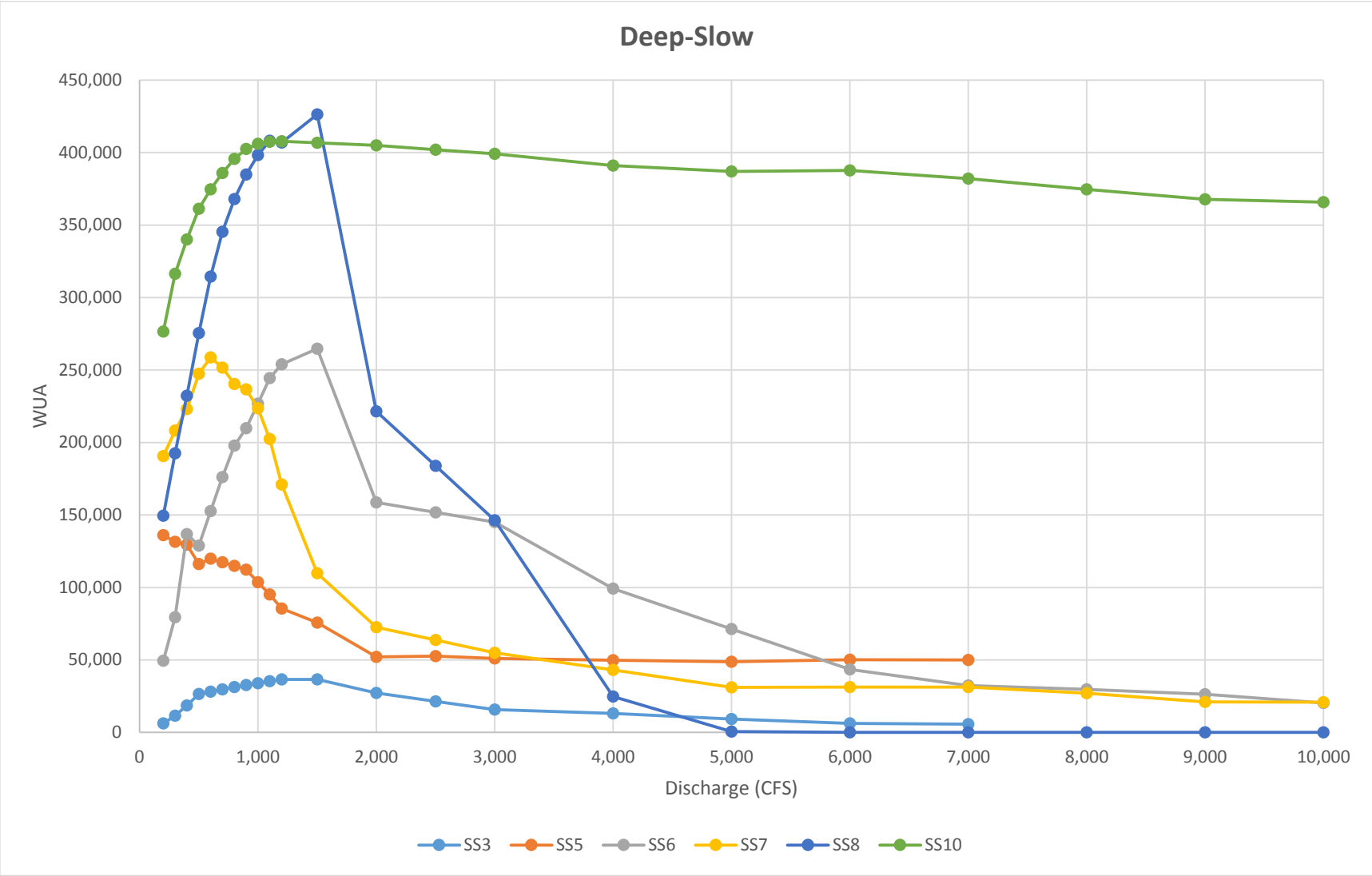
DEEP-FAST GUILD



DEEP-FAST GUILD

Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	0	0%	7,119	17%	0	0%	2,170	5%	166	0%	2,612	6%
300	0	0%	17,363	41%	0	0%	4,747	11%	840	1%	5,633	13%
400	0	0%	29,183	69%	2,864	2%	7,648	18%	1,875	2%	8,648	21%
500	18	0%	32,730	77%	5,417	3%	15,931	38%	3,065	3%	11,441	27%
600	1,084	0%	37,055	88%	10,954	7%	20,536	49%	4,562	5%	14,193	34%
700	3,758	2%	38807.74	92%	16,941	10%	24,832	60%	5,953	7%	17,128	41%
800	6,432	3%	40560.68	96%	23,183	14%	27,215	65%	7,639	8%	20,359	48%
900	9,107	4%	42,314	100%	30,634	19%	29,135	70%	9,176	10%	22,786	54%
1,000	13,389	5%	41,495	98%	39,037	24%	31,049	75%	11,013	12%	26,305	63%
1,100	21,793	9%	36,121	85%	47,747	29%	32,678	79%	12,743	14%	27,813	66%
1,200	30,196	12%	29,852	71%	54,830	34%	33,791	81%	14,539	16%	29,999	71%
1,500	64,709	26%	23,583	56%	86,147	53%	35,123	84%	19,458	22%	35,081	84%
2,000	129,719	53%	27,585	65%	101,722	62%	36,462	88%	20,719	23%	42,000	100%
2,500	180,923	74%	1,333	3%	132,600	81%	39,030	94%	31,787	35%	41,335	98%
3,000	232,128	95%	0	0%	163,477	100%	41,599	100%	42,856	48%	40,670	97%
4,000	244,475	100%	0	0%	146,235	89%	36,262	87%	55,265	61%	32,272	77%
5,000	196,150	80%	0	0%	109,750	67%	30,924	74%	72,986	81%	22,921	55%
6,000	128,195	52%	0	0%	72,430	44%	23,526	57%	67,462	75%	16,984	40%
7,000	69,829	29%	0	0%	40,786	25%	13,985	34%	89,994	100%	13,608	32%
8,000			0	0%	18,319	11%	9,834	24%	86,345	96%	11,391	27%
9,000			0	0%	7,838	5%	9,207	22%	81,857	91%	10,965	26%
10,000			0	0%	3,321	2%	9,782	24%	73,303	81%	11,698	28%
15,000			0	0%	7,059	4%					16,741	40%
20,000											19,210	46%
100%	244,475		42,314		163,477		41,599		89,994		42,000	
75%	183356.5		31735.22		122607.9		31198.96		67495.68		31500	

DEEP-SLOW

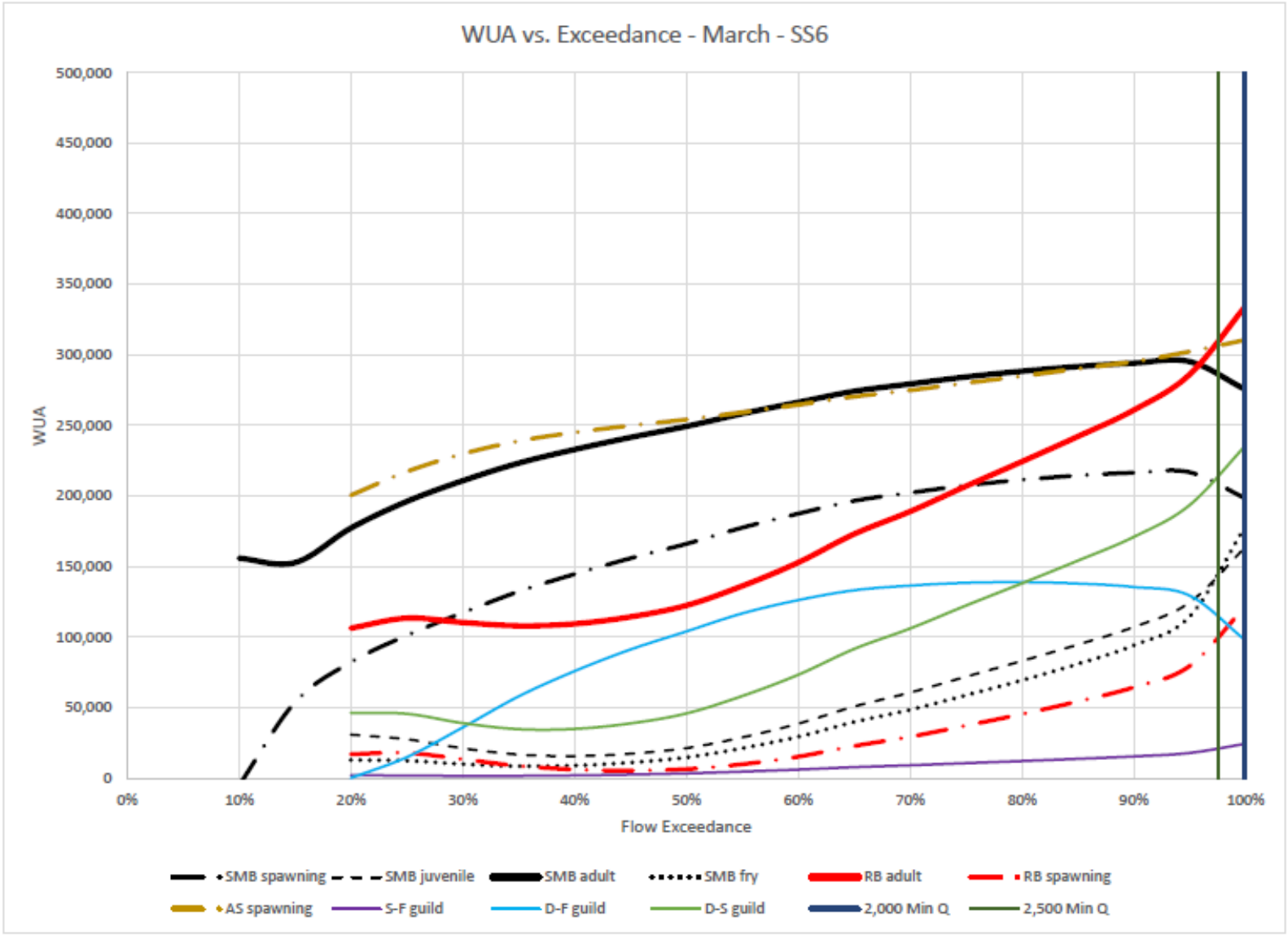

Deep-Slow
WUA
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Discharge (CFS)
SS3
SS5
SS6
SS7
SS8
SS10

DEEP-SLOW

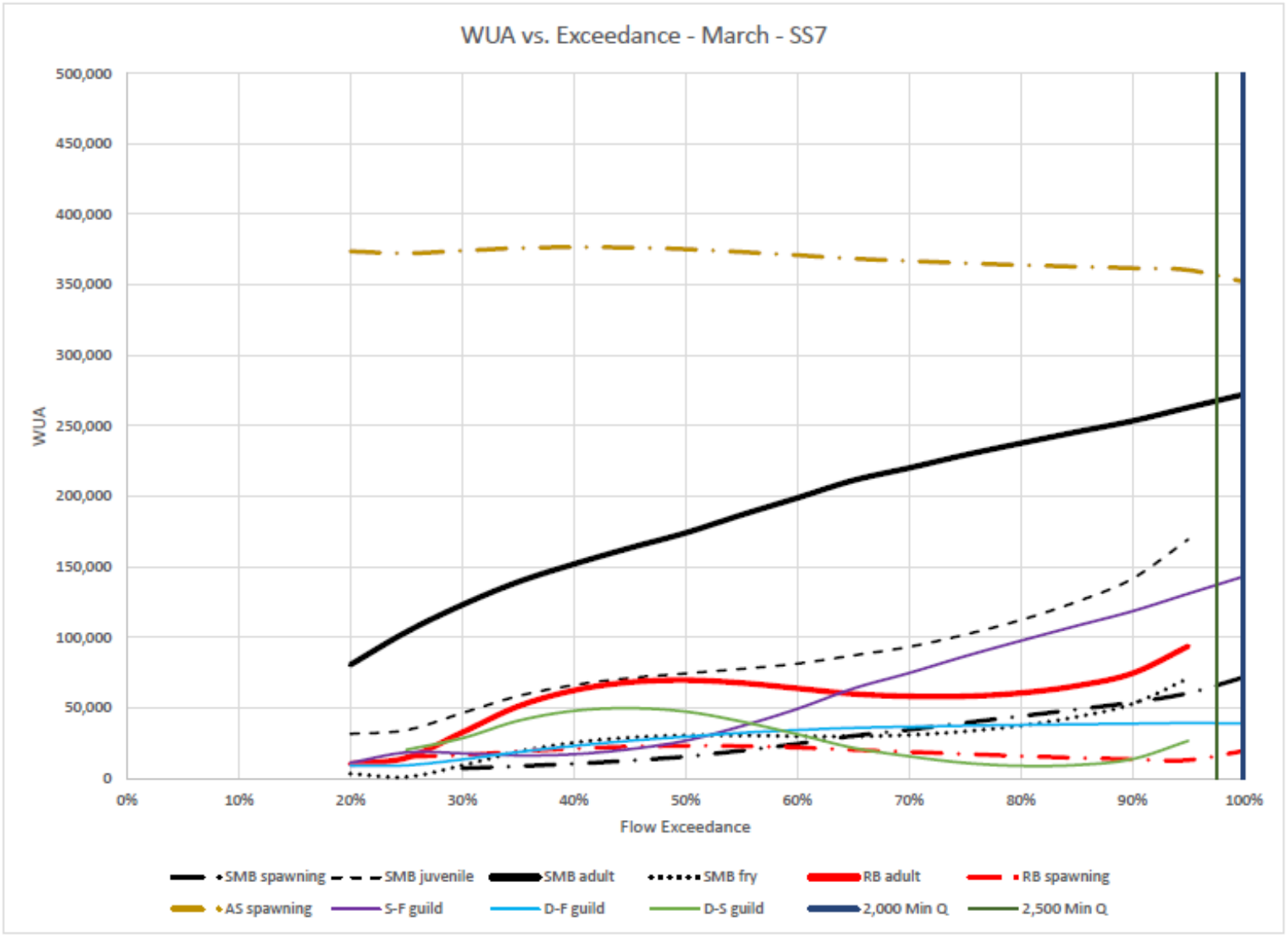
Discharge	SS3		SS5		SS6		SS7		SS8		SS10	
200	6,155	17%	136,092	100%	49,474	19%	190,546	74%	149,560	35%	276,504	68%
300	11,464	31%	131,583	97%	79,497	30%	208,321	81%	192,595	45%	316,376	78%
400	18,557	51%	129,485	95%	136,779	52%	222,996	86%	232,315	54%	340,069	83%
500	26,424	72%	116,099	85%	128,920	49%	247,404	96%	275,507	65%	361,310	89%
600	28,182	77%	119,861	88%	152,720	58%	258,756	100%	314,469	74%	374,690	92%
700	29,693	81%	117350.4	86%	176,107	67%	251,728	97%	345,334	81%	385,859	95%
800	31,203	85%	114839.3	84%	197,806	75%	240,446	93%	367,988	86%	395,625	97%
900	32,714	89%	112,328	83%	209,830	79%	236,609	91%	384,954	90%	402,553	99%
1,000	33,976	93%	103,544	76%	226,852	86%	223,683	86%	398,347	93%	406,112	100%
1,100	35,273	96%	95,210	70%	244,469	92%	202,451	78%	408,175	96%	407,510	100%
1,200	36,570	100%	85,487	63%	253,984	96%	171,054	66%	407,006	95%	407,904	100%
1,500	36,520	100%	75,763	56%	264,661	100%	109,837	42%	426,396	100%	406,762	100%
2,000	27,237	74%	52,131	38%	158,617	60%	72,651	28%	221,524	52%	405,001	99%
2,500	21,481	59%	52,594	39%	151,836	57%	63,768	25%	183,913	43%	402,054	99%
3,000	15,725	43%	50,984	37%	145,056	55%	54,884	21%	146,301	34%	399,108	98%
4,000	13,084	36%	49,753	37%	99,247	37%	43,034	17%	24,704	6%	390,995	96%
5,000	9,249	25%	48,825	36%	71,327	27%	31,185	12%	561	0%	387,064	95%
6,000	6,275	17%	50,155	37%	43,378	16%	31,344	12%	0	0%	387,711	95%
7,000	5,693	16%	50,047	37%	32,282	12%	31,344	12%	0	0%	382,017	94%
8,000					29,607	11%	27,074	10%	0	0%	374,653	92%
9,000					26,329	10%	21,086	8%	0	0%	367,839	90%
10,000					20,375	8%	20,862	8%	0	0%	365,756	90%
15,000					7,834	3%					300,232	74%
20,000											242,391	59%
100%	36,570		136,092		264,661		258,756		426,396		407,904	
75%	27427.61		102069.2		198495.4		194066.8		319797.2		305927.7	

ATTACHMENT C

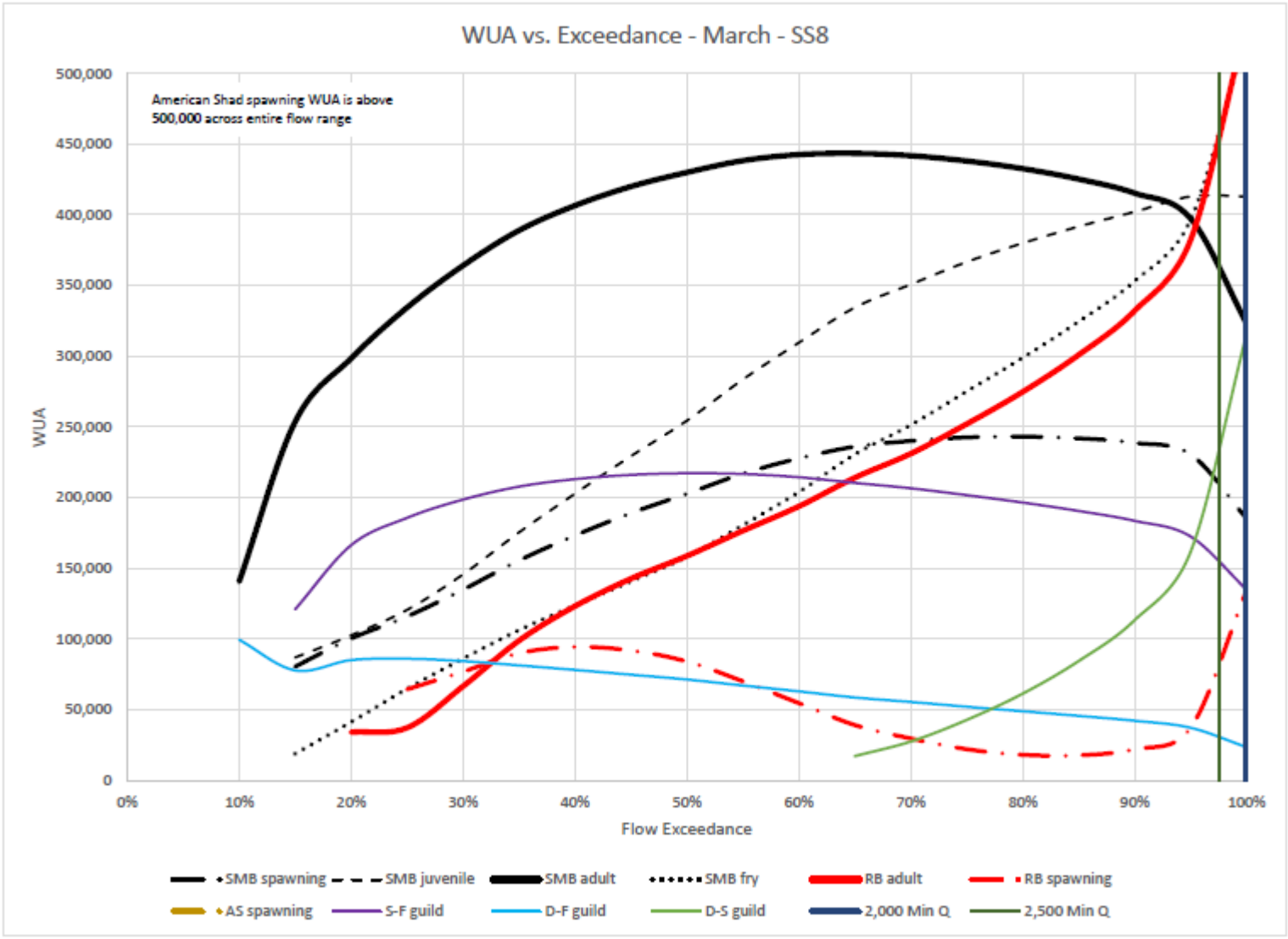
WUA vs. Exceedance – March – SS6



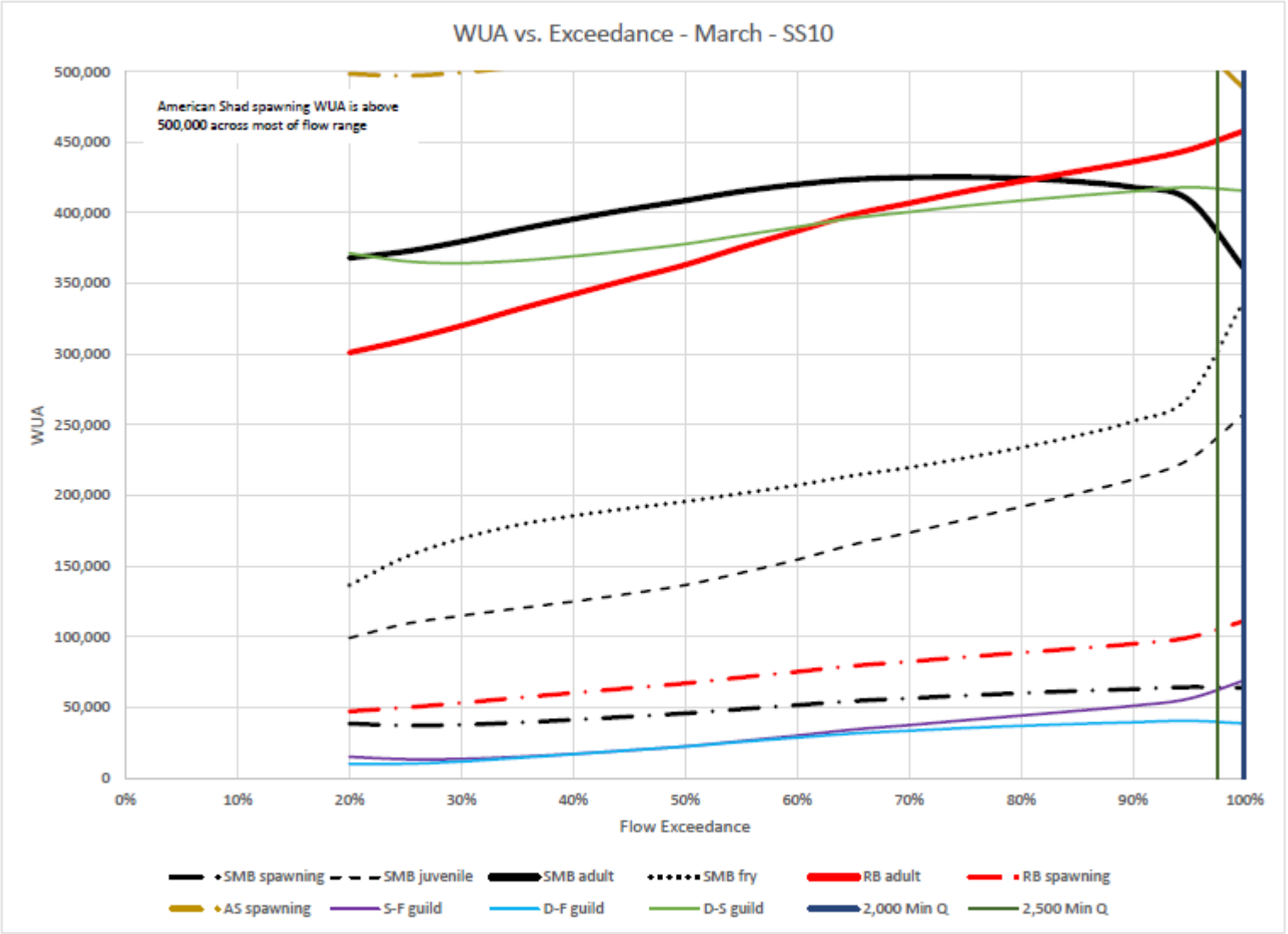
WUA vs. Exceedance – March – SS7



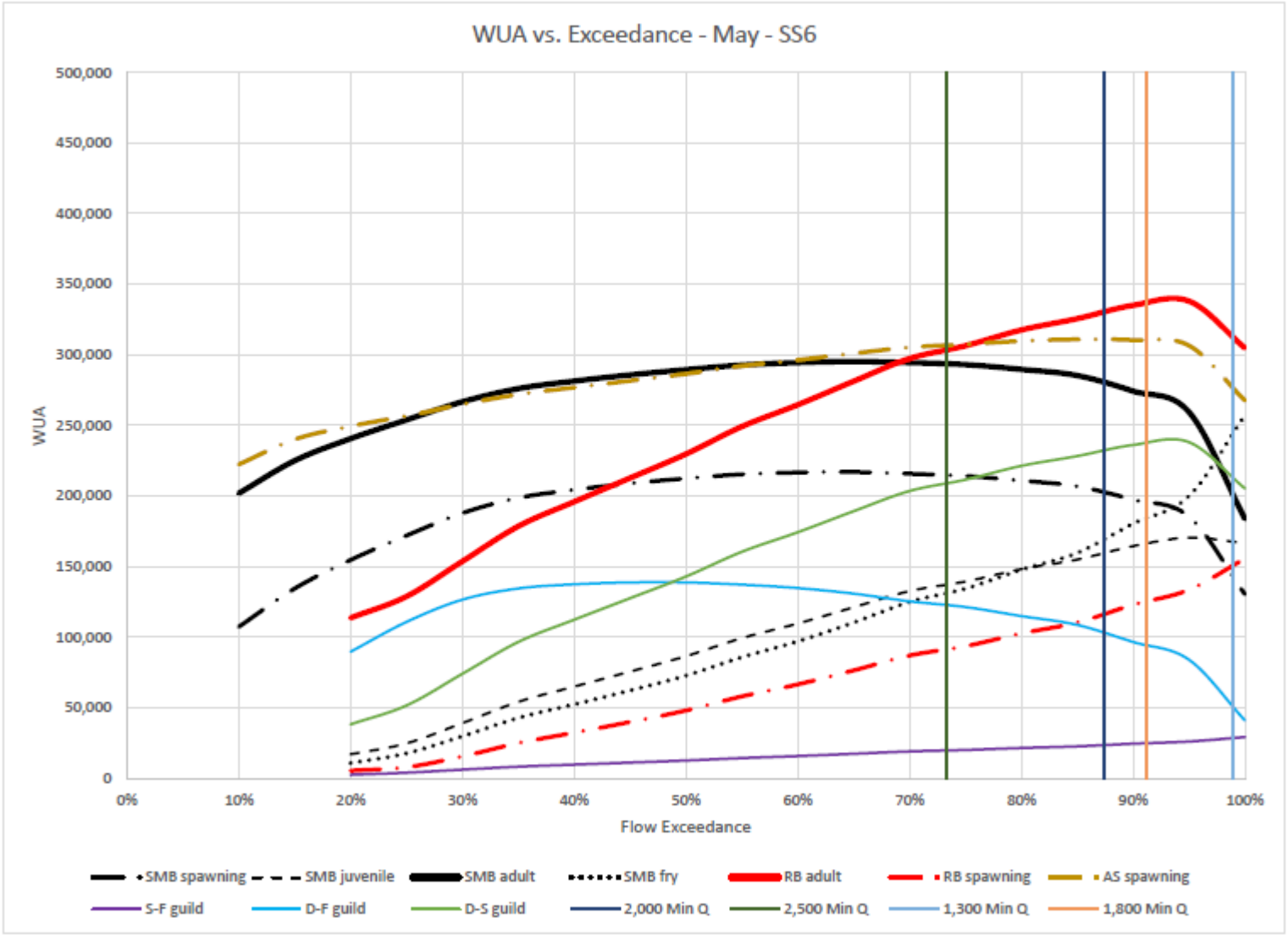
WUA vs. Exceedance – March – SS8



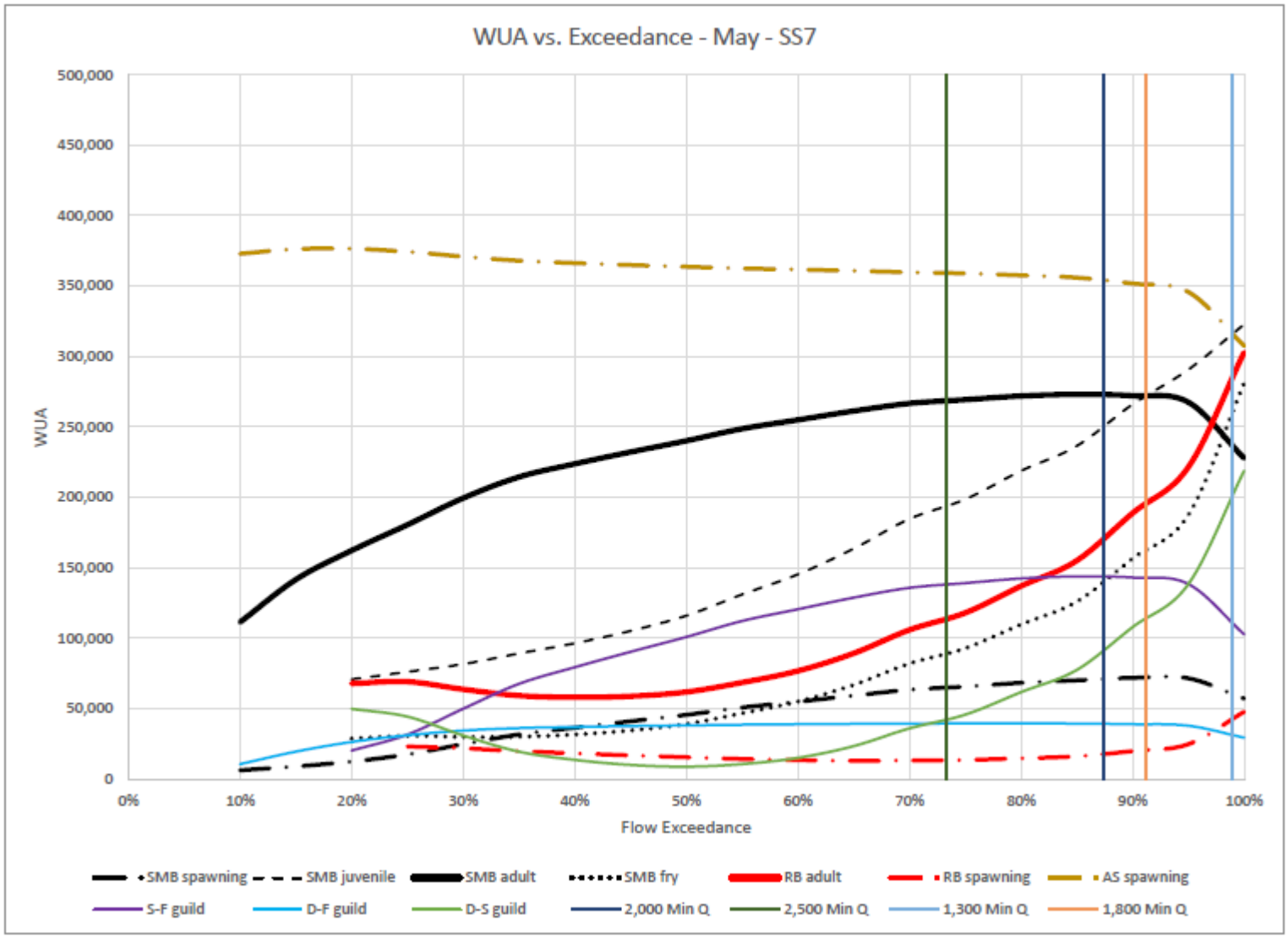
WUA vs. Exceedance – March – SS10



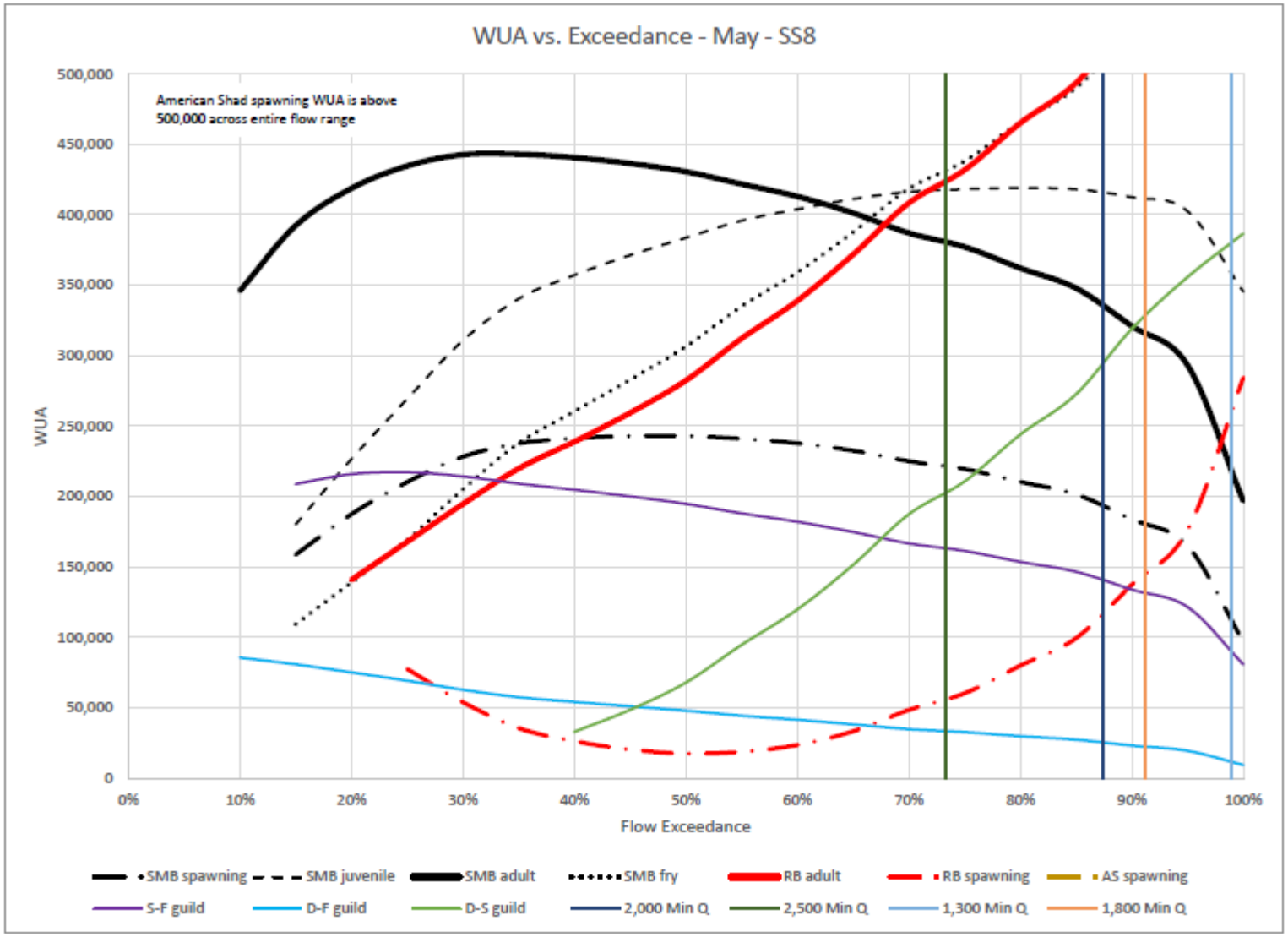
WUA vs. Exceedance – May – SS6



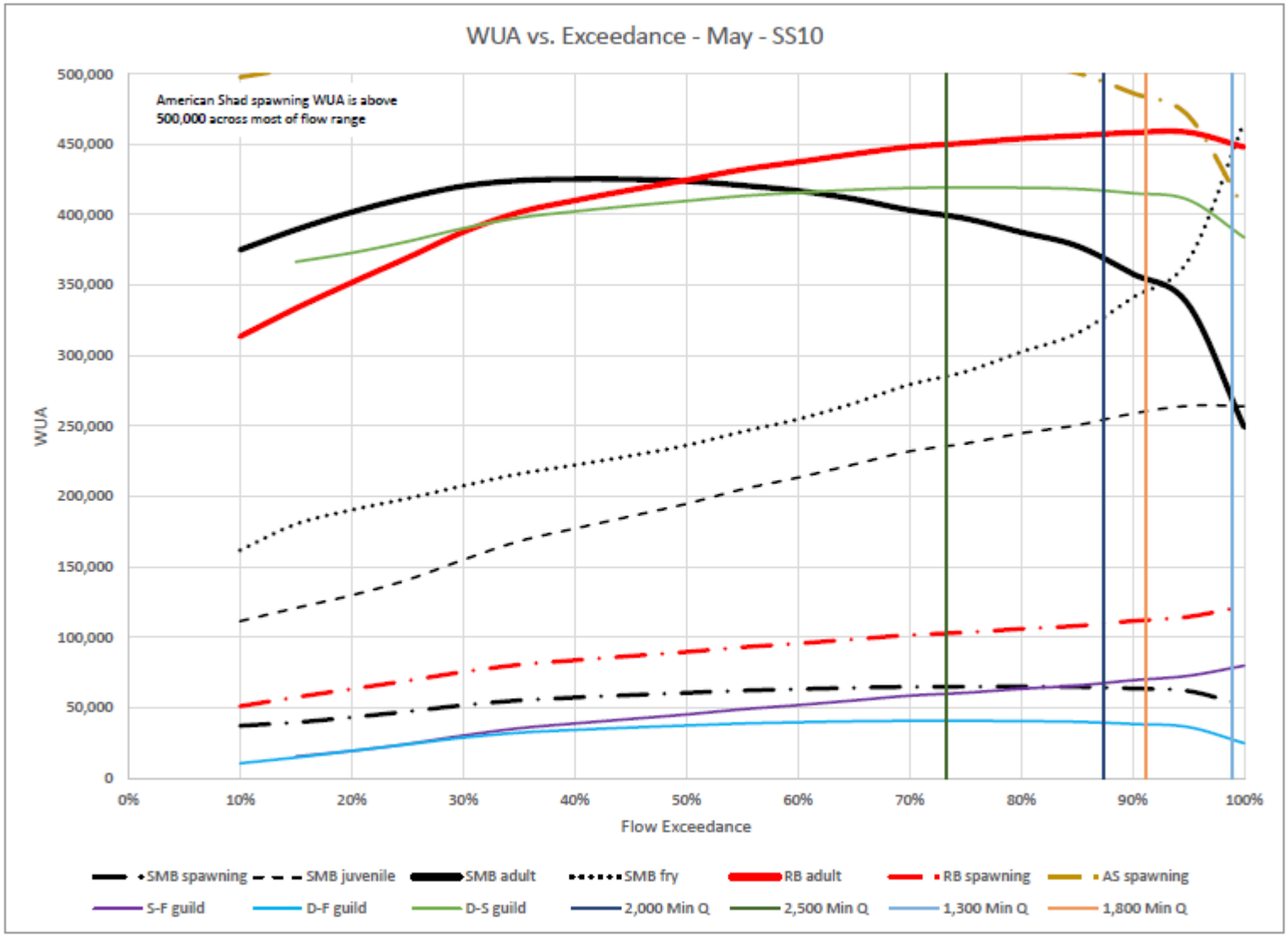
WUA vs. Exceedance – May – SS7



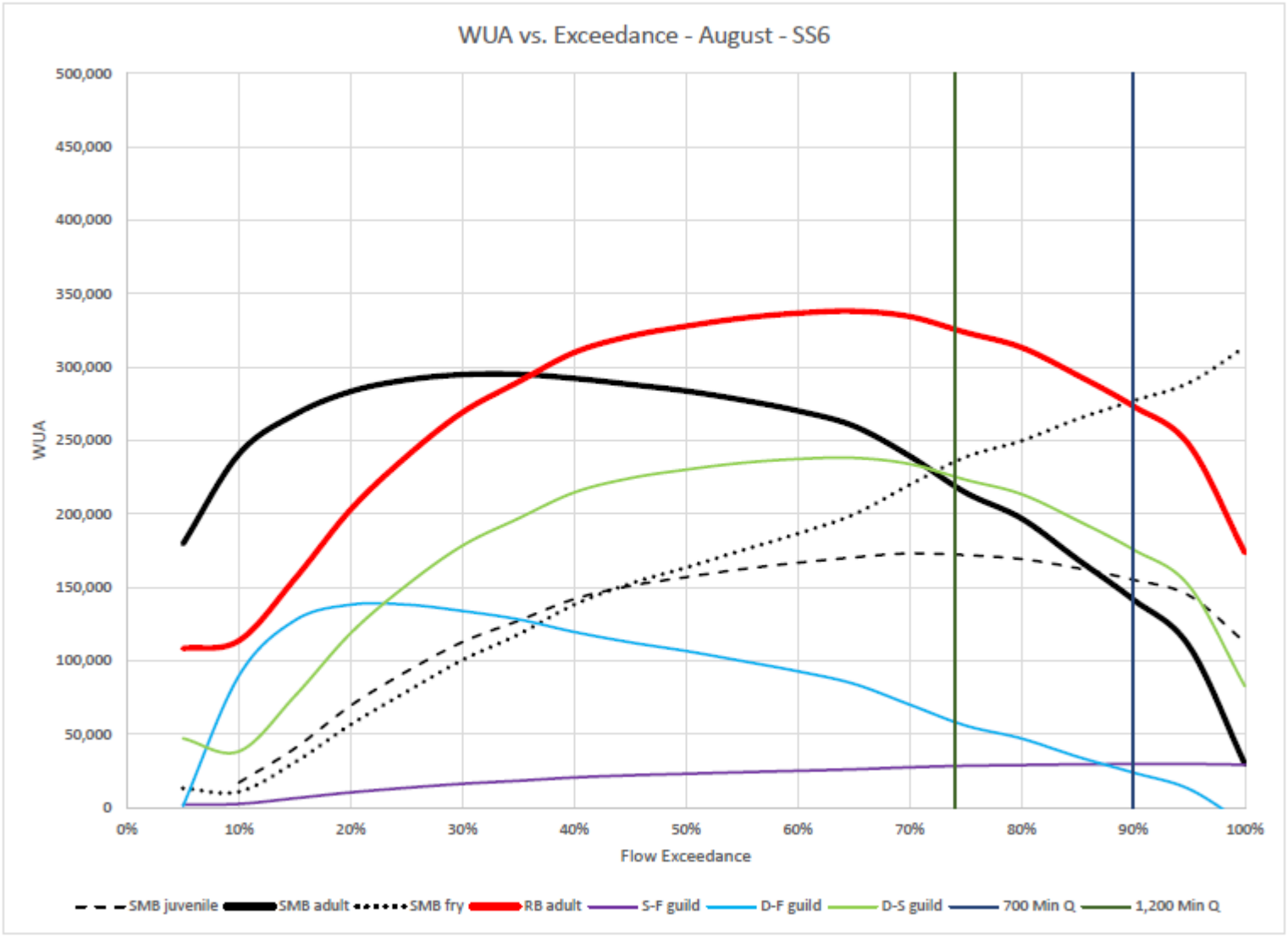
WUA vs. Exceedance – May – SS8



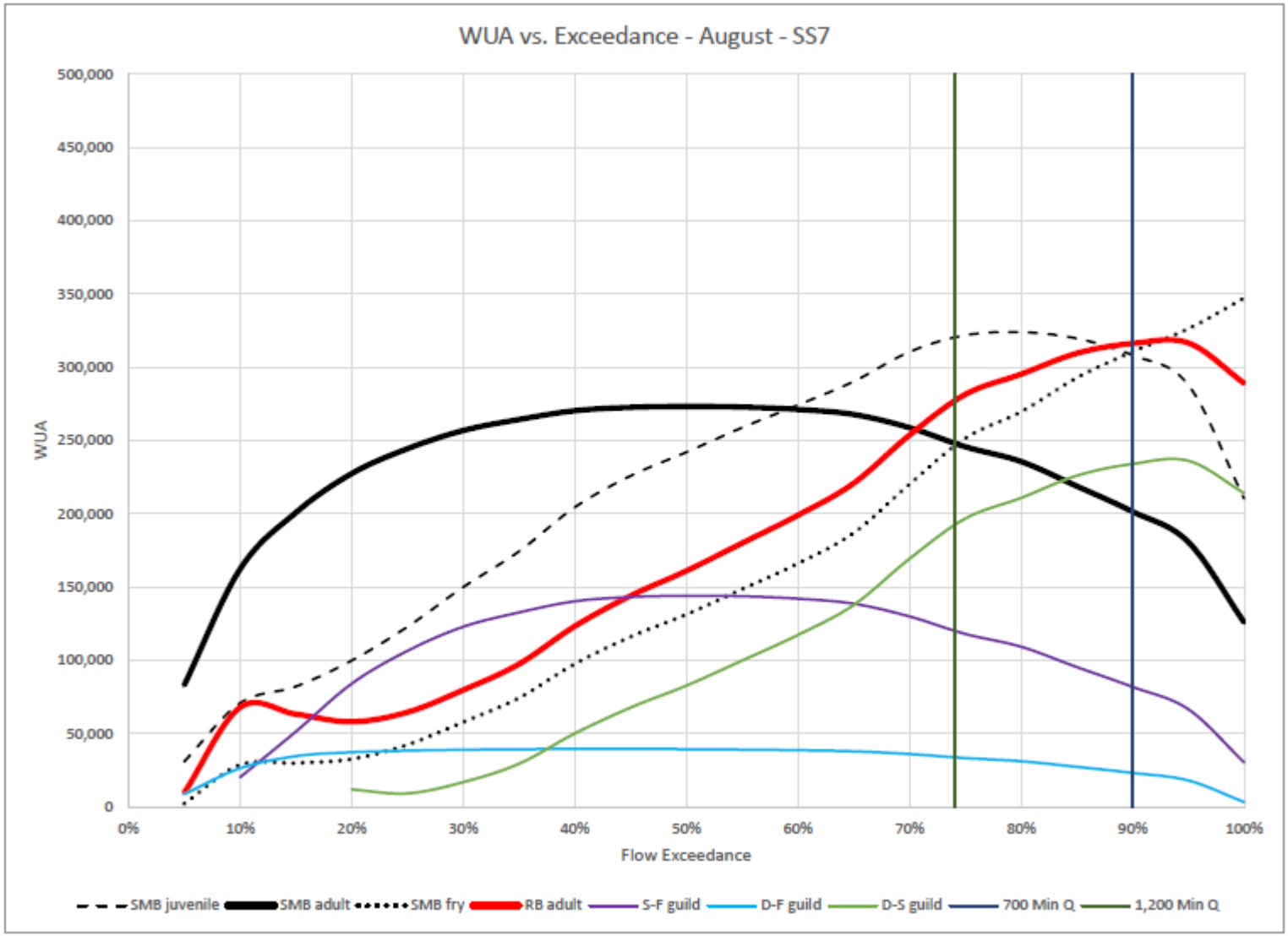
WUA vs. Exceedance – May – SS10



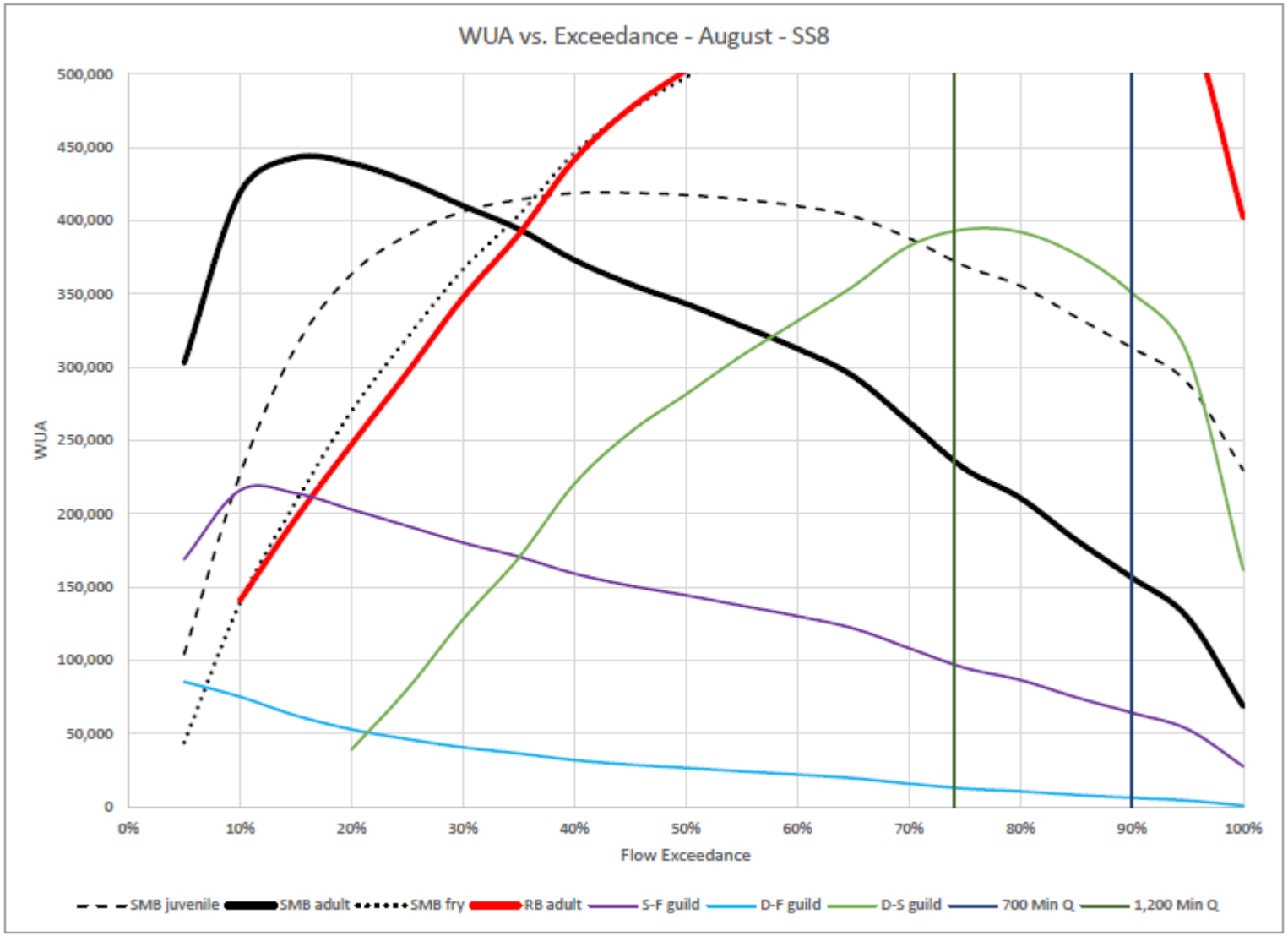
WUA vs. Exceedance – August – SS6



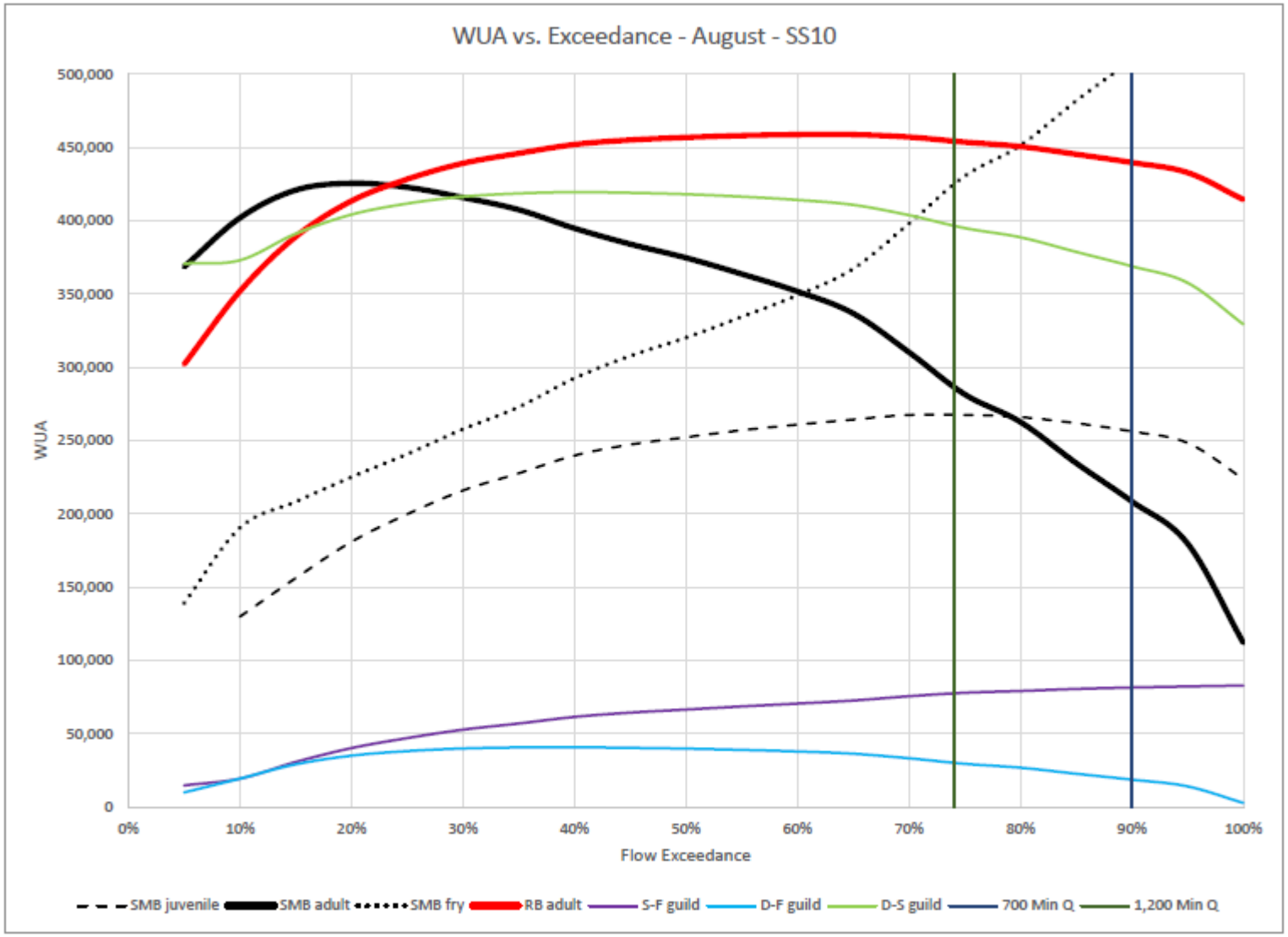
WUA vs. Exceedance – August – SS7



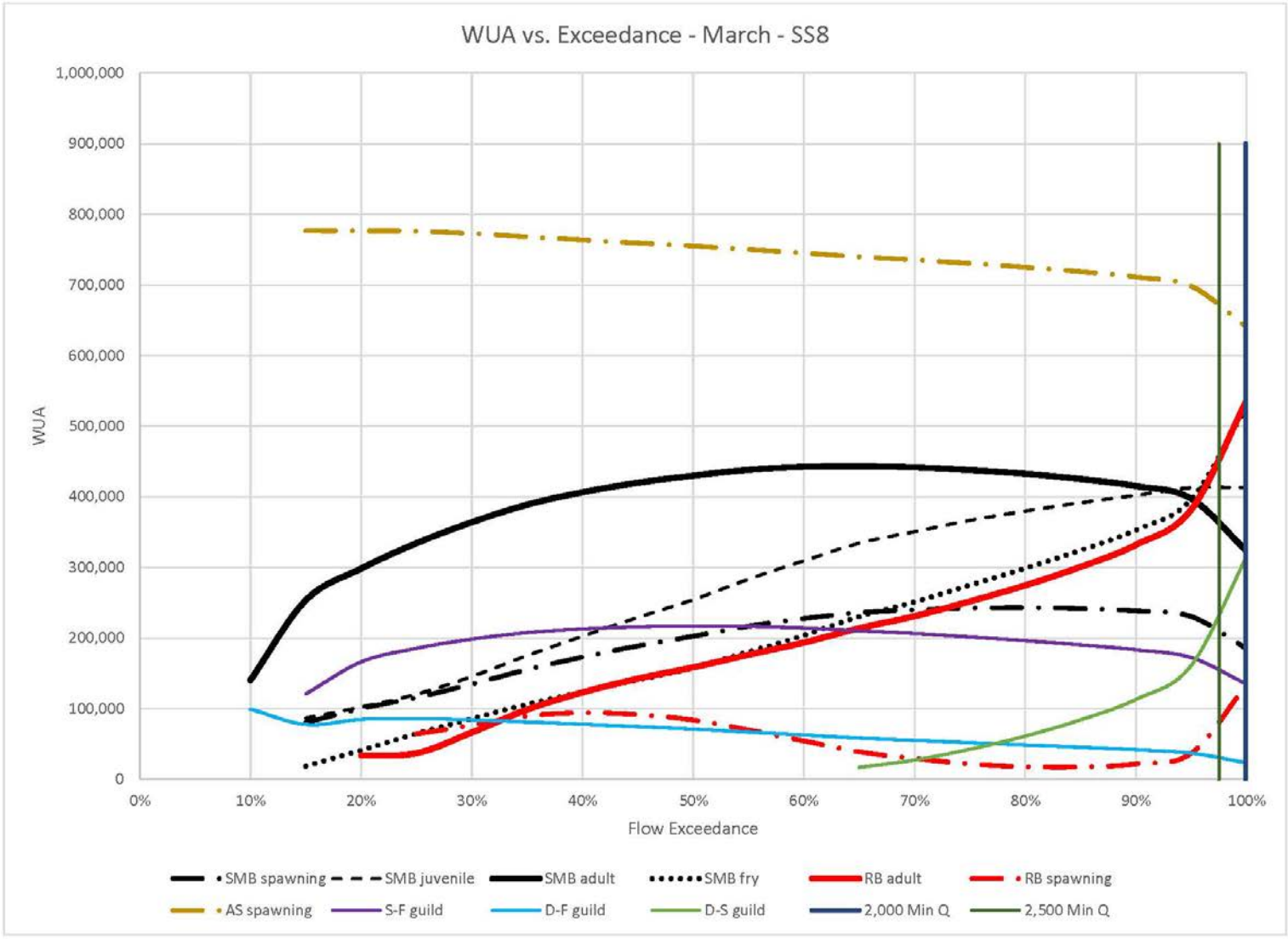
WUA vs. Exceedance – August – SS8



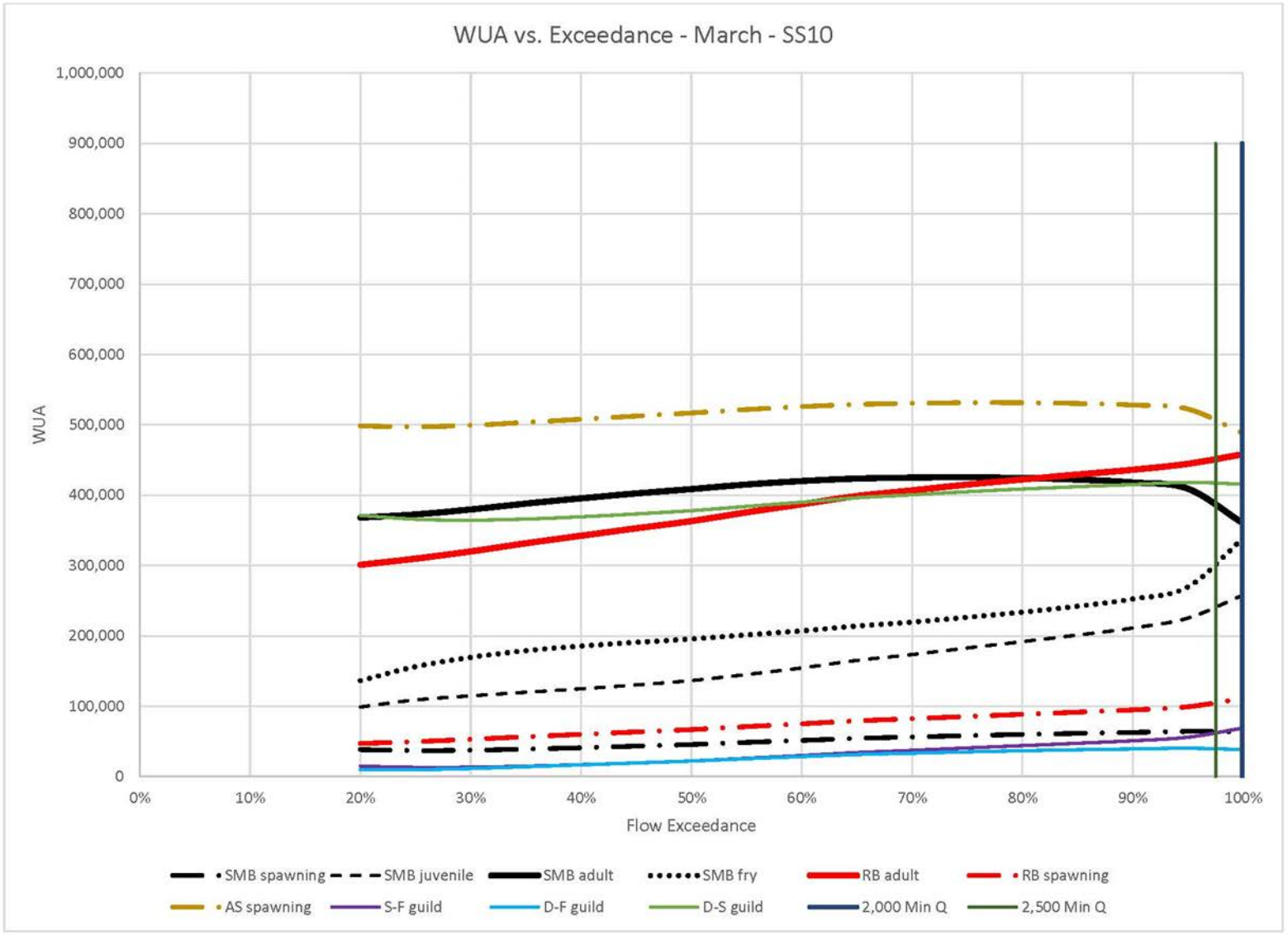
WUA vs. Exceedance – August – SS10



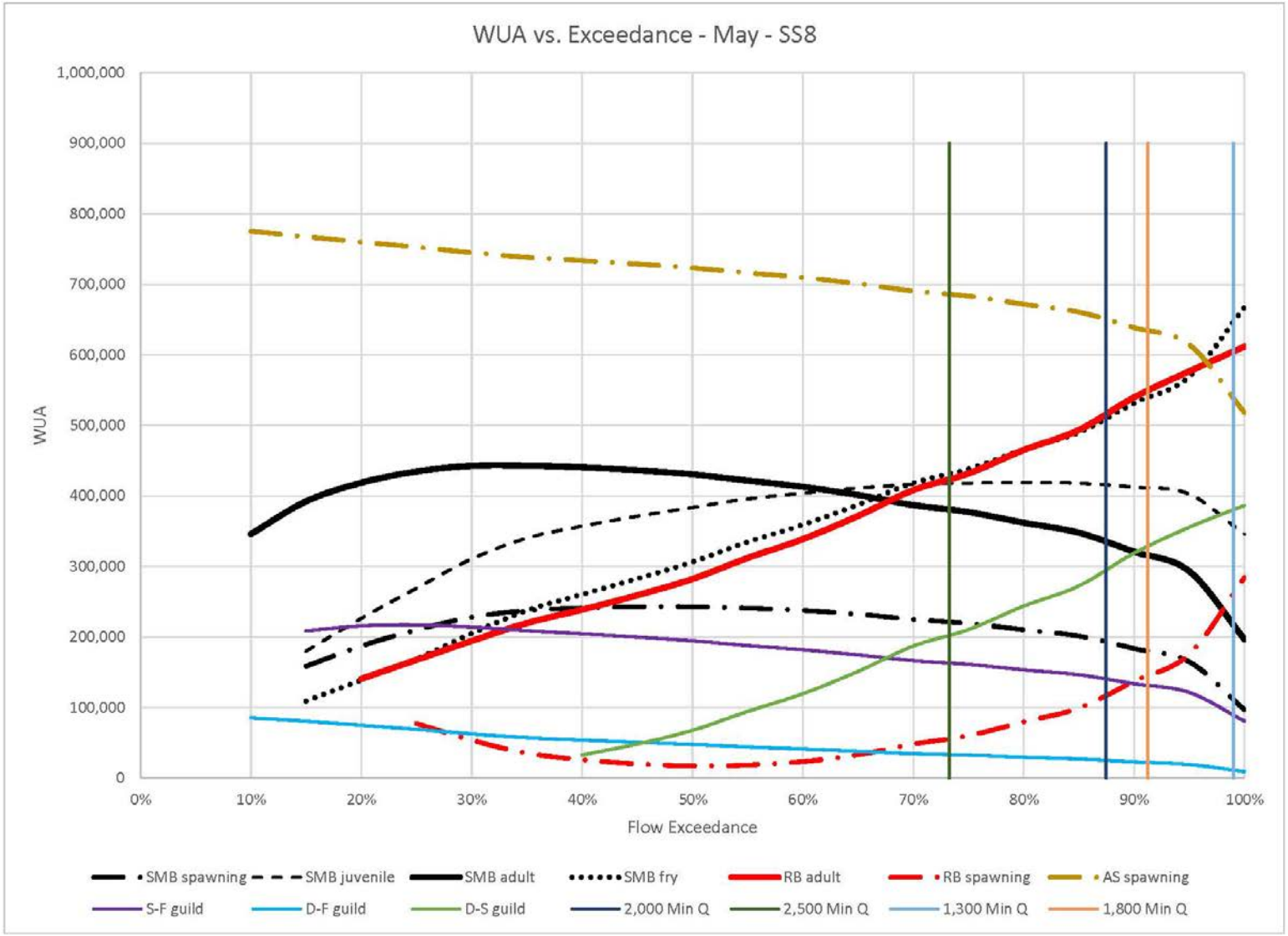
WUA vs Exceedance – March – SS8



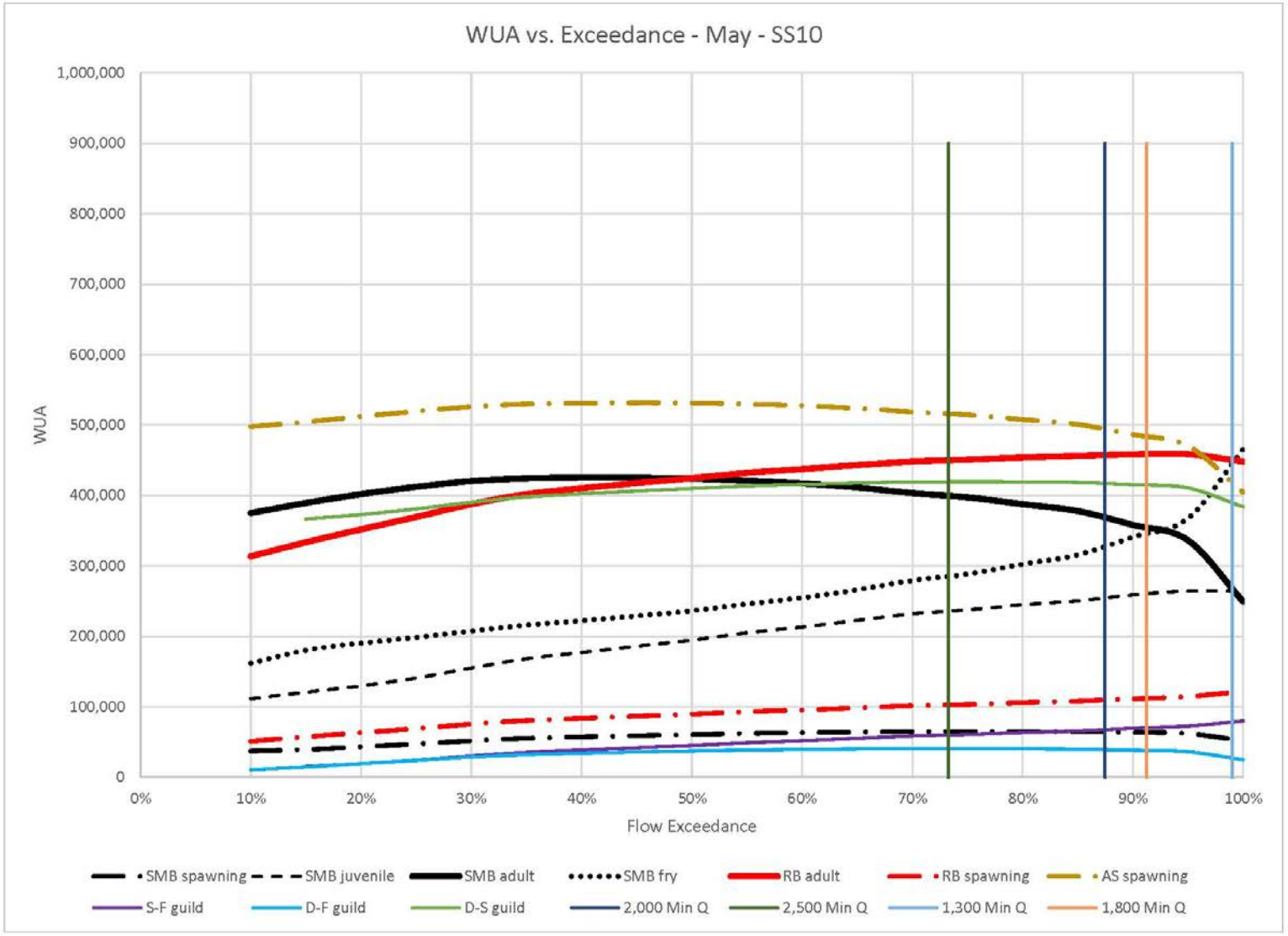
WUA vs. Exceedance – March – SS10



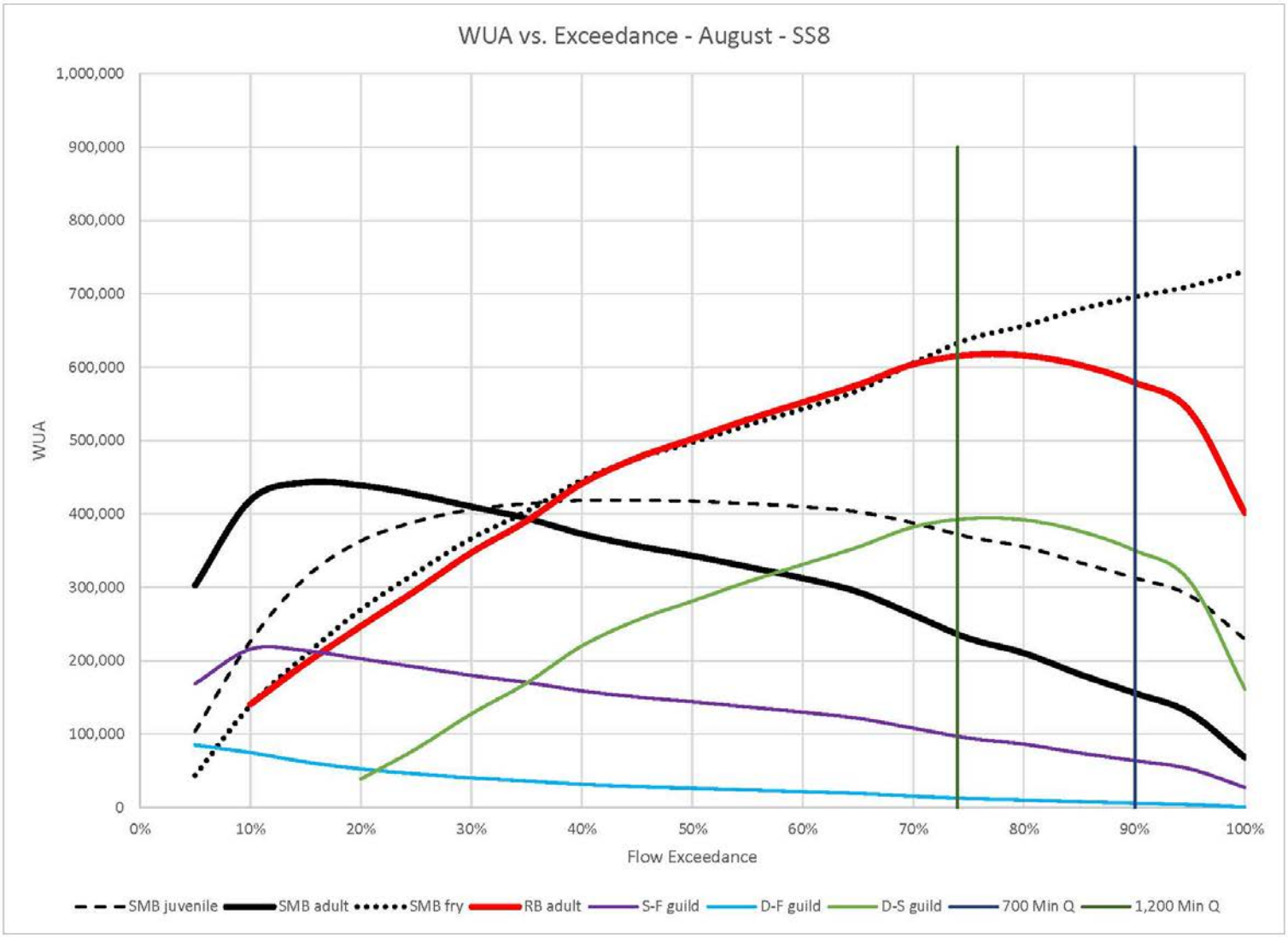
WUA VS. EXCEEDANCE – MAY SS8



WUA vs. Exceedance – May SS10



WUA vs. Exceedance – August – SS8



WUA VS. EXCEEDANCE – AUGUST – SS10