CESAM-PD-EI 6 April 2007

MEMORANDUM FOR RECORD

SUBJECT: Implementation of Biological Opinion for Jim Woodruff Dam Interim Operations Plan – Semi-Annual Meeting with U.S. Fish and Wildlife Service

1. The U.S. Fish and Wildlife Service (USFWS) issued a Biological Opinion (BO) on 5 September 2006 regarding the Interim Operations Plan for Jim Woodruff Dam relating to releases to the Apalachicola River in support of endangered and threatened species and critical habitat for such species. Representatives of the US Army Corps of Engineers, Mobile District (CESAM) met with representatives of the USFWS at the Panama City Field Office on 01 March 2007, to discuss the updated status of operations under the IOP and measures taken and planned to assure compliance with the terms and conditions for the reasonable and prudent measures (RPMs) specified in the BO. A copy of the agenda for the meeting is attached. The following representatives participated in the meeting discussions.

Jerry Ziewitz, USFWS	850-769-0552, Ext. 223
Joanne Brandt, CESAM-PD-EI	251-690-3260
Brian Zettle, CESAM-PD-EI	251-690-2115
Memphis Vaughan, CESAM-EN-HW	251-690-2730
Cheryl Hrabovsky, CESAM-EN-HW**	251-694-4018
James Hathorn, CESAM-EN-H	251-690-2735
Bill Stubblefield, CESAM-EN-HH	251-690-3116

[***participated by teleconference*]

2. Following is a summary of the status of implementing each of the five RPMs in the BO, as discussed during the meeting. An excerpted portion of the BO detailing the RPMs is attached for easy reference.

a. RPM1 - Adaptive Management.

(1) Semi-Annual Meetings. This meeting represents the second semi-annual meeting. During the first semi-annual meeting on 26 October 2006 it was suggested that the semi-annual meetings be held in the early spring (prior to initiation of fish spawn operations on the Apalachicola-Chattahoochee-Flint basin projects, and in the early fall of each year, with August and February suggested as the appropriate meeting dates. If possible, the February meeting would be held in conjunction with the annual fish management/Morone meetings, either immediately prior to or following those annual meetings. This spring's meeting could not be held in conjunction with the annual fish management meeting (held on 7 February), but was scheduled concurrent with the initiation of fish spawn management at Jim Woodruff on 1 March, and following completion of coordination of a proposed modification to the IOP to implement the provisions of RPM3, as described below.

(2) Volumetric balancing of releases to match basin inflows. Cheryl described the methodology used to account for volumetric balancing. Jerry was most concerned that the balancing of releases be limited to those over-releases specifically due to the gradual down ramping rates specified in the IOP that may be more gradual than the natural fall in river stages. The balancing of flows by volume becomes more critical when flows are below 10,000 cfs. Cheryl indicated that all inflows and releases, and ramping volumes are accounted for in a spreadsheet maintained on a daily basis, as well as flood control operations, head limits, hydropower generation and other operations that are not included in the balancing volumes. She agreed to provide Jerry a copy of the spreadsheet for his review and so he can understand the computation process used in our daily management decisions. Jerry will also share the spreadsheet he developed to evaluate the modeling data during preparation of the BO. We will continue to discuss as appropriate.

(3) Possible additional modifications of the IOP to minimize harm (consideration of other elements of stakeholder alternative concepts for a drought provision operation or alternative IOP operations?). Several additional concepts for an IOP at Jim Woodruff Dam were presented by stakeholders during consideration of a drought provision operation pursuant to RPM3 (see below discussion). Although alternative proposals for an IOP operation were presented by both the Atlanta Regional Commission and the State of Florida, both plans represented changes to the underlying water control plan for the Apalachicola, Chattahoochee, Flint (ACF) basin, which was not under consideration at this time. However, both proposals also contained an element comprised of using forecasting to assist in determining minimum flows and basic operations under the IOP. Florida used the Jan-Mar flows as a predictor for the remainder of the year; and the ARC proposal used a long-term forecast with a running daily to weekly revised forecast method. USFWS had requested that Mobile District consider the feasibility of identifying a forecasting tool that could be used to determine when a drought provision would be exercised. James presented the results of a review of historic climatic and hydrological data to determine if there were sufficient relationships between conditions early in the year that could forecast or predict anticipated flow conditions later in the year. He had also discussed predictive tools being used by the State of Georgia with the State climatologist office staff. A copy of his presentation is attached. Also attached is a summary of a possible forecast tool looking at the relationship between lower basin inflows (cumulative Walter F. George inflow). Although there may be some merit in pursuing a short-term predictive relationship between pool levels or inflows in the lower basin, further investigation will be required. Also, it would be risky to commit to longer term operations beyond a limited forecast period. There may also be merit in using short-term (week to week) forecasts in our daily or weekly operation decisions. Short-term forecasting is used to some degree in our current operations.

(3) Possible flow/velocity studies below Jim Woodruff Dam. At the first semi-annual meeting in October 2006 USFWS had expressed the desire to collect flow/velocity

information in the rock ledge spawning habitat areas below Jim Woodruff Dam. At that time we noted the possibility of completing flow rating studies with the U.S. Geological Survey (USGS) below Jim Woodruff Dam this spring, during which velocity readings could also be collected to establish flow/velocity relationship. This effort has been delayed due to funding constraints. However, Memphis indicated we would still attempt to collect this data periodically throughout the year, probably beginning after conclusion of fish spawn operations at the end of May.

(4) Other information requirements. The USFWS had requested consideration of additional salinity studies in Apalachicola Bay and the estuarine areas, to determine potential impact to young sturgeon staging and/or feeding in these areas. It is still planned to collect this information during studies by NOAA using the Apalachicola Bay 3-dimensional hydrological model in association with the Lake Lanier Interim Storage Contracts Environmental Impact Statement. Jerry also noted that very few Gulf sturgeon have been observed moving into the river during the month of March over the past couple of years when intensive monitoring was conducted. This could potentially indicate that March may be too early for the implementation of sturgeon spawning operations. However, we may want to monitor in the future for better sturgeon migration data before proposing any changes in operation dates.

(5) Improved tools. James indicated that the Hydrological Engineering Center (HEC) is still testing the new HEC-ResSim model. The model currently reflects the original IOP operation, and will need to be updated to reflect the final BO operations and the recently approved RPM3 modifications. It is still planned to use the updated ResSim model to assist in evaluations associated with the Lake Lanier Interim Storage Contracts and other future consultations.

b. RPM2 – Adjust the June through February threshold in the IOP to 10,000 cfs. This modification was implemented immediately upon issuance of the BO on 5 September 2006, and a revised IOP table was provided to USFWS on 7 September 2006 and posted on the Mobile District web site. No further adjustments to the June through February operations thresholds were proposed as part of the modified RPM3 operations (see below).

c. RPM3 – Drought Provision. RPM3 required the implementation of a drought provision by 30 January 2007, which would identify those hydrological and climatic conditions under which the minimum flow of 5,000 cfs would be released in accordance with the current water control provisions; and those conditions when a higher minimum flow could be provided in support of mussel species on the Apalachicola River. Mobile District began discussions on elements of a drought provision with USFWS at the 26 October 2006 semi-annual meeting, and presented a conceptual plan to USFWS on 6 December 2006, which both agencies agreed held some merit. A workshop was held on 13 December in Columbus, GA, with representatives of the States of Alabama, Florida and Georgia and other interested stakeholders during which the proposed conceptual drought provision concept (Concept 3) was presented. The drought provision concept was based on composite storage within the ACF federal reservoirs, and included an adjustment to the flow thresholds for the March-May Gulf sturgeon operations (upper threshold of 25,000 cfs and lower threshold of 16,000 cfs); with a higher desired minimum flow of 6,500 cfs when the composite storage is at or above zone 3, and reversion to the required minimum flow of 5,000 cfs when composite storage falls below the top of zone 3 and until the composite storage recovers to above the top of zone 2. Mobile District completed evaluation of the initial Concept 3 drought provision on 26 January 2007, using the same evaluation procedures included in the BO. At that time it was determined that while the desired benefits of higher flows for mussels would be provided, there was a potential for impact to host fish for mussels due to reduced frequency and duration of inundation of floodplain habitat for certain flow conditions. Therefore, Mobile District requested, and USFWS agreed to an extension of the due date for implementation of the RPM3 operation until 28 February 2007, in order to allow completion of the evaluation of a further adjustment of the RPM3 operation, which was limited to an adjustment of the lower flow threshold to 18,000 cfs. Mobile District and USFWS reviewed comments received as a result of the workshop and determined that certain elements in the comments were already captured in the conceptual plan; other elements would involve changes to the water control plan and could not be implemented at this time; and other elements might merit additional consideration but cannot be implemented prior to initiation of fish spawn operations in the Spring of 2007. A copy of the Biological Assessment was submitted to USFWS on 16 February, additional information addressing the stakeholder comments was provided on 23 February, and USFW issued approval of the RPM3 operation on 28 February 2007. As agreed, the RPM3 operation was to be implemented during the 2007 sturgeon spawning period in March 2007. A copy of the updated RPM3 IOP operation is attached.

d. RPM4 – Sedimentation/River Morphology Panel. Initiation of the sedimentation/morphology panel has been delayed due to lack of funding (the Corps has been operating under Continuing Resolution Act (CRA) funding constraints, limiting ability to award contracts or task orders). As noted in the Annual Report filed 31 January 2007, additional funding was anticipated this spring, and the Mobile District has accordingly requested the current due date be extended from 30 March 2007 to 30 August 2007. Jerry indicated that the request for an extension was consistent with the BO that recognized possible funding constraints, provided the exercises its best effort to obtain the funding. Preliminary discussions had continued to plan for the panel, however, and identified three possible panel representatives: David Biedenharn, former sediment/hydraulics specialist from ERDC; Michael Harvey, renowned river morphologist from Musseter Engineering firm; and Kirk Vincent, research river geomorphologist from USGS. Jerry agreed to confirm whether the USFWS would fund the USGS participation on the panel; and the Mobile District would fund the other two panelists. It was tentatively agreed that a 3-day meeting of the panel would serve as a “kickoff” meeting of the panel, with Day 1 to brief the panelists on the problems and issues; Day 2 to visit the river and identified vulnerable areas for mussels; and Day 3 to discuss the next steps. A follow-on meeting would also be scheduled to present the report/view/recommendations of the panelists. Mobile District will prepare a draft Scope of Work (SOW) and coordinate the SOW with the USFWS before awarding task orders. USFWS SOW with USGS would be similar to the Mobile District SOW. It was agreed to schedule a teleconference(s) to further discuss once funding was procured.

e. RPM5 - Mussel Monitoring Plan. Development of the mussel monitoring plan had also been delayed by CRA funding constraints. It was agreed that the mussel monitoring plan would be developed in conjunction with the sedimentation/morphology panel recommendations, and the mussel specialists would attend the panel meetings and river site inspections. This will allow transfer of information regarding mussel habitat requirements to the panelists; and information on anticipated trends that could affect mussel habitat or vulnerable areas to the mussel specialists. Jerry stressed that mussel mortality observed in 2006 was observed at abnormal deposition areas (probably due to sedimentation during Hurricane Dennis floods). The mussel monitoring data should identify the relative abundance in both stable and unstable areas; and utilize data from the sedimentation/morphology panel to identify where these areas would likely occur. Mobile District indicated that discussions had been initiated with Drew Miller, formerly of ERDC and Barry Payne currently at ERDC regarding the proposed monitoring efforts. A draft SOW would be coordinated with USFWS and initiated once funding is obtained, which is anticipated later this spring.

3. USFWS and the Mobile District will continue to evaluate comments received on the IOP operations and new information as it is developed to identify potential modification that would further reduce harm to the listed species or critical habitat for the species; and that could improve our ability to address potential impacts to the species in future consultations. Opportunities will also continue to be investigated to implement the recommended conservation measures. The next semi-annual meeting will be scheduled for fall of 2007.

JOANNE BRANDT
Senior Environmental Specialist
Inland Environment Team

Enclosures
Agenda
Except from BO, RPMs and Terms and Conditions
Summary of Hathorn Presentation
Hathorn Powerpoint Presentation
RPM3 IOP table

Jim Woodruff Dam Interim Operations Plan
Implementation of Terms and Conditions of Biological Opinion
Semi-Annual Meeting
1 March 2007

Reasonable and Prudent Measure (RPM) #1: Adaptive Management

- Volumetric balancing of releases to match basin inflows

- Possible additional modifications of the IOP to minimize harm (consideration of other elements of stakeholder alternative concepts for a drought provision operation or alternative IOP operations?)

- Possible flow/velocity studies below Jim Woodruff Dam

- Other information Requirements?

RPM #2: Monitoring for possible take

- Status at end of calendar year 2006

RPM #3: Drought Provision

- Implementation of the RPM #3 Drought Provision (Concept 5)

- Possible additional information to be considered or other elements to be considered in conjunction with RPM#1 Adaptive Management for future modifications to the IOP

RPM #4: Sedimentation/River Morphology Panel

- Status of Funding for FY07

- Composition of the panel

- Goals for the panel evaluation

- Elements of SOW for panelists

- Revised Schedule for implementation

RPM #5: Mussel Monitoring Plan

- Status of Funding for FY07

- Elements of a monitoring plan

- Integration with river morphology panel?

7.3 REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take of fat threeridge and purple bankclimber on the Apalachicola River.

RPM1. Adaptive management. Identify ways to minimize harm as new information is collected.

Rationale. Additional information will be collected about the listed species and their habitats in the action area, water use upstream, and climatic conditions. This information needs to be evaluated to determine if actions to avoid and minimize take associated with the Corps' water management operations are effective or could be improved.

RPM2. Adjust June to February Lower Threshold to 10,000 cfs. Replace the proposed 8,000 cfs threshold in the IOP with a threshold of 10,000 cfs.

Rationale. Mussels may be in vulnerable areas where take may occur when flows are less than 10,000 cfs. Not increasing reservoir storage when basin inflow is 10,000 cfs or less from June to February will avoid and minimize the potential for take in the zone of 8,000 to 10,000 cfs.

RPM3. Drought provisions. Develop modifications to the IOP that provide a higher minimum flow to the Apalachicola River when reservoir storage and hydrologic conditions permit.

Rationale. Take of listed species due to the IOP may occur when the Corps is using a portion of basin inflow to increase ACF reservoir storage. The Corps can minimize mussel mortality due to low-flow conditions by supporting a higher minimum flow when total reservoir storage and/or hydrologic conditions permit. As proposed, the IOP uses reservoir storage to support a 5,000 cfs minimum flow. The available data indicates that higher minimum flows are supportable during normal and wet hydrologic periods, and during dry periods when the reservoirs are relatively full. Conversely, during extended drier than normal conditions, it may be prudent to store more water than allowed under the IOP during certain times of the year to insure minimum water availability later. Possible components and triggers of the drought plan could be, but are not limited to: Corps reservoir action zones, cumulative reservoir storage remaining, total basin inflows, indictors of fish spawn, climatic condition indices, and flow levels at gages downstream of the Chattahoochee gage, such as the gage at Wewahitchka.

RPM4. Sediment dynamics and channel morphology evaluation. Improve our understanding of the channel morphology and the dynamic nature of the Apalachicola River.

Rationale. The dynamic conditions of the Apalachicola need to be evaluated to monitor the zone at which take may occur and to identify alternatives to minimize effects to listed mussels in vulnerable locations. Both sediment transport and channel morphology need to be considered to provide a basis for predicting changes in morphology that may affect the relative vulnerability of mussels to take due to the IOP. The amount of mussel habitat and thus IOP-related take depends on channel morphology. This evaluation will inform alternatives that may be considered under RPM1 and RPM3.

RPM5. Monitoring. Monitor the level of take associated with the IOP and evaluate ways to minimize take by studying the distribution and abundance of the listed mussels in the action area.

Rationale. Take needs to be monitored monthly to insure that the level of take identified in the biological opinion is not exceeded. As natural conditions change, the populations of the species need to be assessed and the amount of take evaluated relative to any new information. Since this is an interim plan and there will be additional consultations on the overall operations of the ACF project for flood control, water supply contracts, hydropower, and navigation, the monitoring information is needed to prepare the biological assessments for these future consultations.

7.4 TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are mandatory. Studies and other outreach programs in the RPMs and conservation measures are subject to the availability of funds by Congress. The Corps will exercise its best efforts to secure funding for those activities. In the event the necessary funding is not obtained to accomplish the RPM activities by the dates established, the Corps will reinitate consultation with USFWS.

7.4.1 Adaptive management (RPM1)

a. The Corps shall organize semi-annual meetings with the Service to review implementation of the IOP and new data, identify information needs, scope methods to address those needs, including, but not limited to, evaluations and monitoring specified in this Incidental Take Statement, review results, formulate actions that minimize take of listed species, and monitor the effectiveness of those actions.

b. The Corps shall assume responsibility for the studies and actions that both agencies agree are reasonable and necessary to minimize take resulting from the Corps' water management actions.

c. The Corps shall evaluate refinements to predictive tools.

d. The Corps shall provide an annual report to the Service on or before January 31 each year documenting compliance with the terms and conditions of this Incidental Take Statement during the previous federal fiscal year, any conservation measures implemented for listed species in the action area; and recommendations for actions in the coming year to minimize take of listed species.

7.4.2 Adjust June to February Lower Threshold to 10,000 cfs. (RPM2)

a. The Corps shall immediately release the 7-day moving average basin inflow, but not less than 5,000 cfs, when the 7-day moving average basin inflow is less than 10,000 cfs for the months of June to February, and shall incorporate this revision into the IOP table of minimum discharges.

7.4.3 Drought provisions (RPM3).

a. The Corps, with Service concurrence, shall initiate by January 30, 2007, IOP drought provisions that identify the reservoir, climatic, hydrologic, and/or listed species conditions that would allow supporting a higher minimum flow in the Apalachicola River, and that identify recommended water management measures to be implemented when conditions reach the identified drought trigger point(s).

b. If modifications to the IOP parameters for the months of March through May are adopted as part of the drought provisions, the Corps shall assess potential affects to Gulf sturgeon spawning and floodplain inundation. The Corps shall provide the models and a biological assessment of the effects of the drought provisions on listed species at least 135 days in advance of implementing the drought provisions in order to reinitiate this consultation relative to any proposed changes in the IOP.

7.4.4 Sediment dynamics and channel morphology evaluation (RPM4).

a. In coordination with the Service, and other experts jointly identified, the Corps shall evaluate before March 30, 2007, the current status of sediment transport and channel stability in the Apalachicola River as it relates to the distribution of listed mussels and their vulnerability to low-flow conditions. The goals of the evaluation are to identify: 1) feasible water and/or habitat management actions that would minimize listed mussel mortality; 2) current patterns and trends in morphological changes; and 3) additional information needed, if any, to predict morphological changes that may affect the listed mussels. This evaluation shall be based on available information and tools and best professional judgement.

7.4.5 Monitoring (RPM5).

a. The Corps shall monitor the number of days that releases from Woodruff Dam (daily average discharge at the Chattahoochee gage) are less than the daily basin inflow when daily basin inflow is less than 10,000 cfs but greater or equal to 8,000 cfs. If the total number of days of releases in this range in a calendar year is projected to exceed the total number of days of daily basin inflow in this range by more than 39, the Corps shall reinitiate consultation immediately.

b. In coordination with the Service, the Corps shall develop on or before March 30, 2007, a feasible plan to monitor listed mussels in the action area. The goals are to:
1) periodically estimate total abundance of listed mussels in the action area; and
2) determine the fraction of the population that is located in habitats that are vulnerable to low-flow impacts.

c. The Corps shall implement the studies outlined above as soon as is practicable.

d. The Corps shall include monitoring results in the annual report provided to the Service under Condition 1.c.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that the action will result in no more than 39 days per year when project operations reduce basin inflow when it is in the range of 8,000-10,000 cfs. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring the reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking, and review with the Service the need for possible modification of the reasonable and prudent measures.

8 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by conducting conservation programs for the benefit of endangered and threatened species. Towards this end, conservation recommendations are discretionary activities that an action agency may undertake to minimize or avoid the adverse effects of a proposed action, help implement recovery plans, or develop information useful for the conservation of listed species.

The Service recommends that the Mobile District of the U.S. Army Corps of Engineers:

1. Identify watershed-planning opportunities that would assist in identifying alternatives to reduce overall depletions in the ACF basin, particularly the Flint River, thereby increasing baseline flow to the Apalachicola River.

2. Improve the public understanding of water management of the ACF system, the related conservation needs of listed species, and the management of the multiple purposes of the federal reservoirs.

3. Consider alternatives that would increase flexibility in the management of reservoir storage including the feasibility of flood control alternatives (e.g. moving structures from the floodplain, land acquisition) and providing for recreational access at a variety of pool elevations.

4. Provide additional data and hydrodynamic models that would assist in determining areas of bed stability that should be surveyed for listed mussels.

5. Implement freshwater mussel recovery actions including developing habitat suitability indices, conducting a population assessment of the listed mussels of the Apalachicola River, restoring reaches to provide stable habitat, and validating aging techniques for these species.

6. Use the models developed for the Tri-State Comprehensive Study to determine if changes in flow compared to pre-Lanier flows are significant relative to Gulf sturgeon juvenile growth and if changes in the operation of the reservoirs will benefit Gulf sturgeon recovery.

7. Implement Gulf sturgeon recovery actions such as studies of Gulf sturgeon ecology in Apalachicola Bay and possible effects of reduced basin inflow on the ability of the bay to support sturgeon and providing for fish passage at Jim Woodruff Dam.

8. Establish a clearinghouse for biological and water resource information about the ACF system and make such information readily available in several key locations in the basin.

9. Participate in stakeholder discussions to develop a long-term biological monitoring program for the ACF system and support, as feasible, implementation of a long-term program.

10. Update, as soon as practicable, tools for assessing the effects of ongoing and future system operations, including estimates of basin inflow and consumptive demands. The tools should assist in identifying flows that provide sufficient magnitude, duration, frequency, and rate of change to support the survival and recovery of the listed species in the ACF.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

Summary of James Hathorn Presentation to U.S. Fish and Wildlife Service
Evaluation of FDEP Drought Provision Proposal for
Forecasting Hydrological/Climatic Conditions and
Possible Alternative Forecasting Measures
1 March 2007

I have attached the powerpoint used during the subject meeting. I made a few minor revisions for clarification.

Florida DEP described a concept to use 1st quarter (Jan-Mar) flow as a flow predictor in a letter dated Jan 16, 2007 to USFWS. COE has investigated a variation of the concept to determine the validity of using the 1st quarter flow as the dry year predictor. The methodology is briefly described below.

1. Annual basin inflow computed from 1939 to 2001 daily basin inflow.
2. 20th percentile value computed and used to classify a calendar year as dry. All years with an annual flow less the than the 20th percentile (15,141 cfs) classified as dry. The following years are dry: 1941, 1950,1951, 1954, 1955, 1956, 1968, 1981, 1985, 1986, 1988, 1999 and 2000.
3. 1st quarter flow computed for basin inflow local flow at Buford, West Point, WF George, Jim Woodruff, and cumulative basin inflow at WF George and Jim Woodruff.
4. Compute 20th percentile value for each 1st quarter flow category listed in step 3.
5. Identify the years the 1st quarter flow is less than the 20th percentile.
6. Count the number of occurrences that the years from step 2 and 5 are the same. The results are listed below.

	BUF LOC	WP LOC	WFG LOC	JW LOC	BI	WFG LOC CUM
Count	9	10	10	9	9	11
Percent	69%	77%	77%	69%	69%	85%

7. From the results above the WF George cumulative basin inflow identifies 11 of the 13 dry years. Using this information there is an 85% chance that a dry year will occur if the 1st quarter WF George cumulative basin inflow is dry. This statement is based on using the 20 percentile flow as the indicator of a dry year.

The analysis indicates some predictability of using the 1st quarter flow as a dry year indicator. COE will continue to investigate this tool. COE initiated preliminary discusses with the University of Georgia, Department of Biological and Agricultural Engineering and the Georgia State Climatologist to investigate this approach and others.

James Hathorn
US Army Corps of Engineers, Mobile District

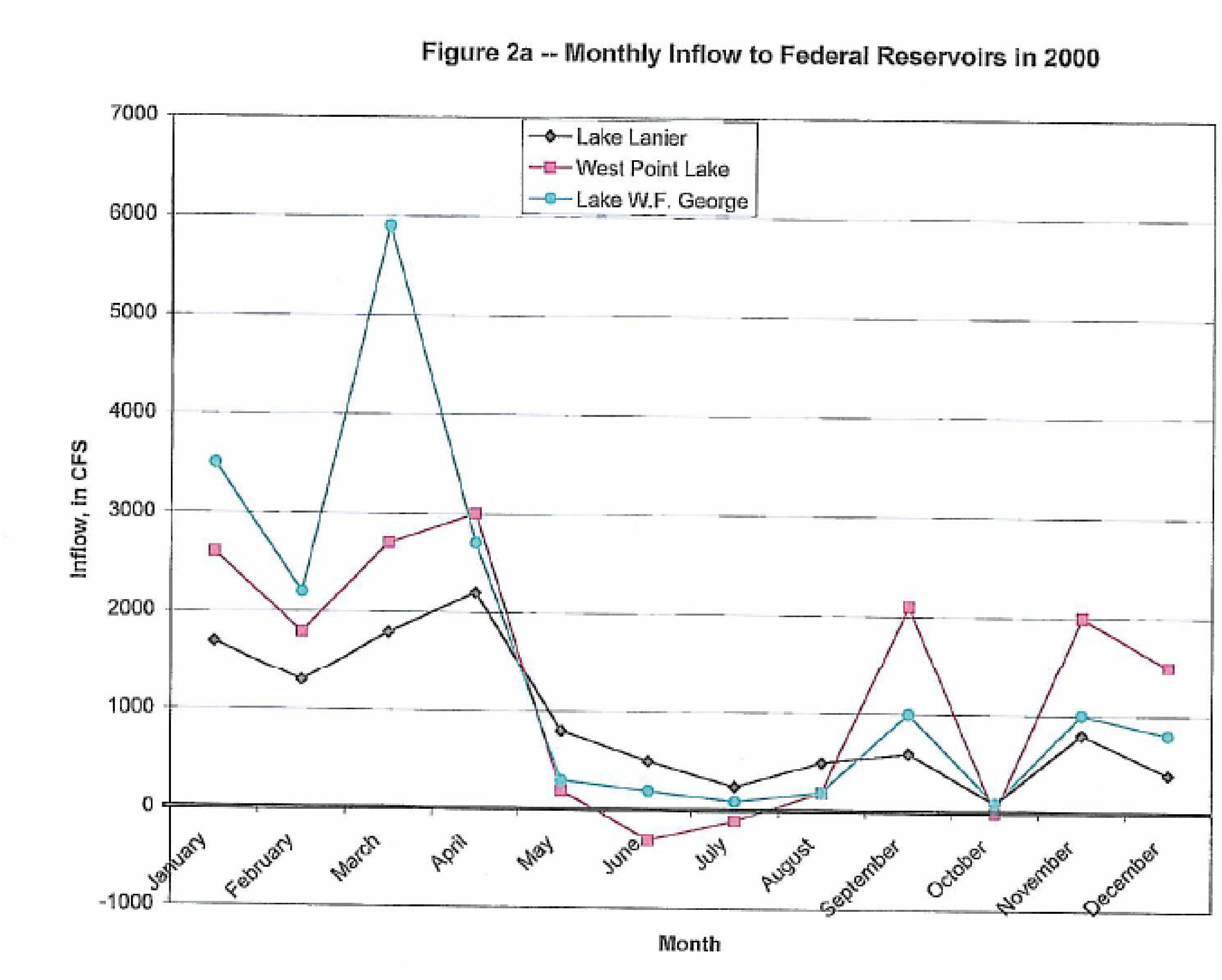
Florida Suggested Predicitive Tool

A. Early Year Basin Inflow Can Be a Key Predictive Tool

It is critical to anticipate accurately whether dry conditions will persist throughout a given year when rainfall or Basin Inflow is below normal in the January - March period. We examined the reliability of using flows in January - March as a predictor for the remainder of the year.[12]

The monthly distribution of inflow in the Chattahoochee Basin and at Seminole is very homogeneous. On average over the entire basin and at each of the reservoirs, approximately 50% of the total Basin Inflow is received from January through April. At Lanier, West Point, Walter F. George and Seminole, the local inflows during January to April are 48%, 52%, 59% and 50% of the total yearly inflow, respectively.. Roughly 36% to 46% of the total is received in January to March. **Figure 1** illustrates the cumulative monthly inflow at each of the four federal reservoirs. These distributions are very similar, indicating that average inflows at one location correlate very well with inflows at other locations. Inflows are also spatially similar under low flow conditions.

Figure 2 Monthly Inflow to Reservoirs



Jan to Mar Reliable Predictor

- Analyzed variation in Jan to Mar Flow
- Used to predict remainder of year
- Expressed as ratio to quarterly average flow
- Values <1 below long term average
- Values >1 greater than long term average

Florida also analyzed the temporal variation in flow to determine if conditions early in the year (January to March) were a reliable predictor of conditions for the remainder of the year. **Figure 3** illustrates the quarterly observed flows at the Chattahoochee gage for the period 1939 to 2005 expressed as the ratio to the quarterly average flow. For example, if the observed value is identical to the average, the ratio will be exactly 1 (i.e., the observed flow is 100% of the average). Values less than 1 are instances in which below average flow was observed. Values greater than 1 are instances in which the observed flow is greater than the long-term average.

Figure 3 Quarterly Flow at Chattahoochee

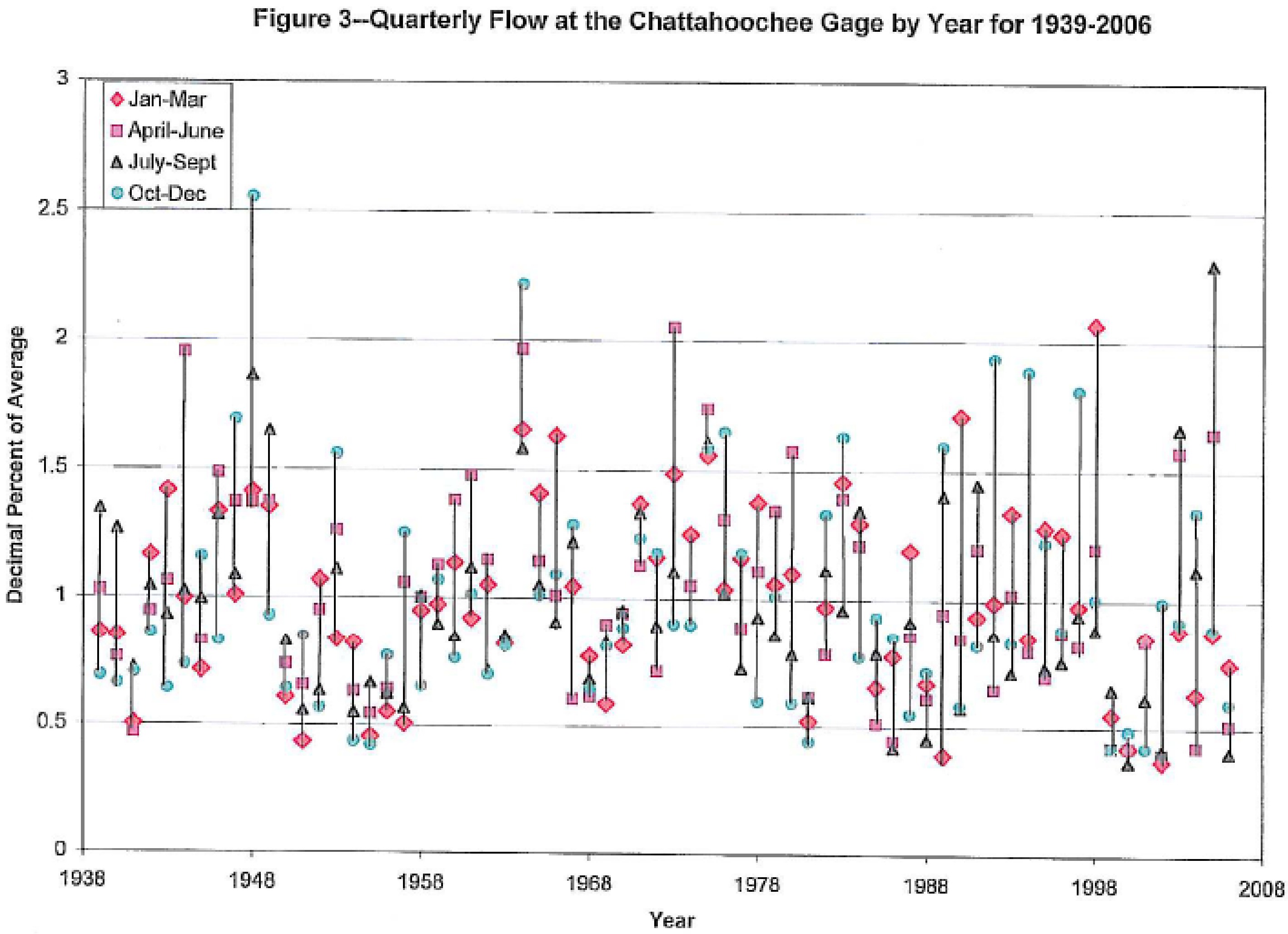
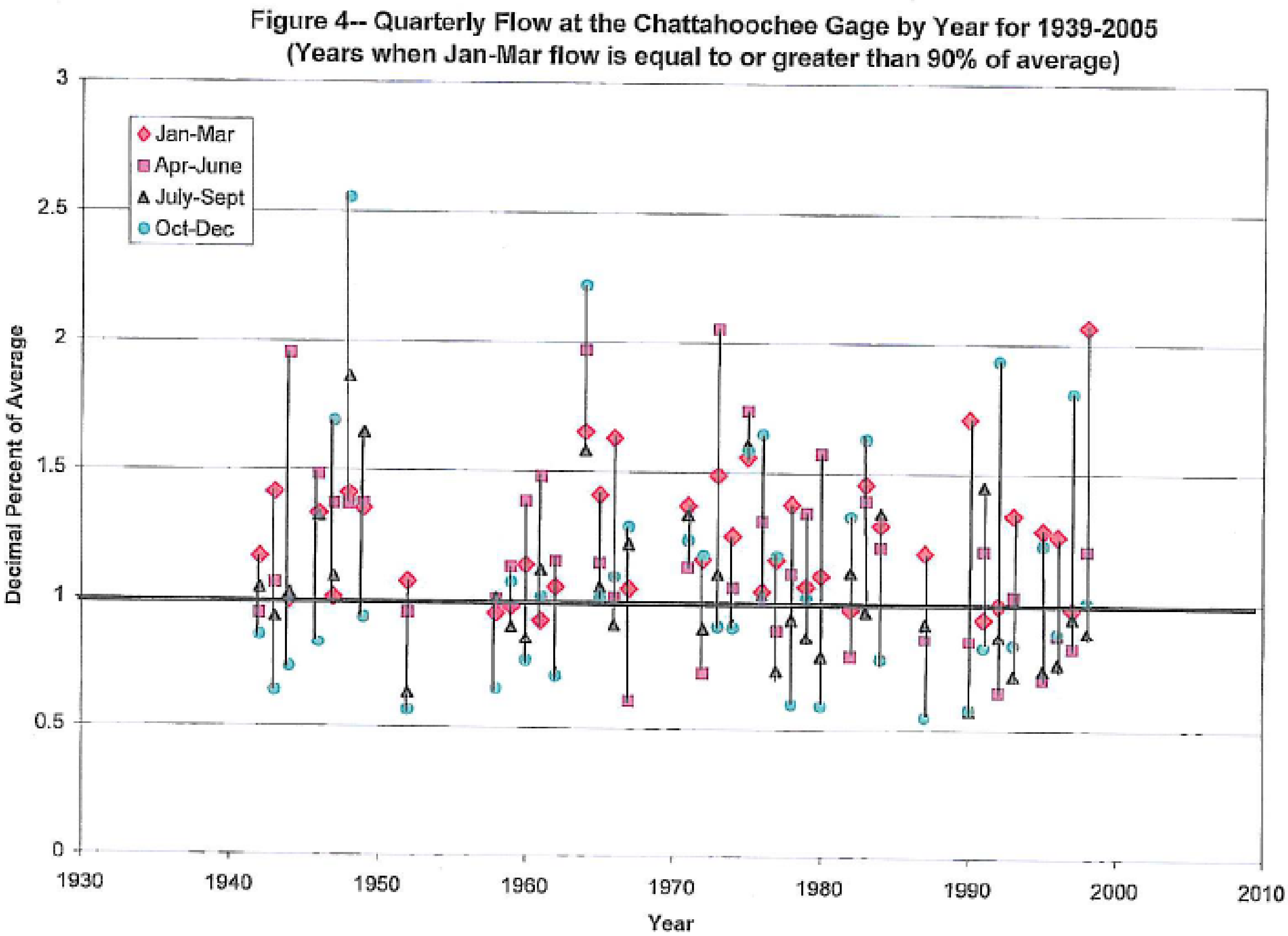


Figure 4 Quarterly Flow at Chattahoochee

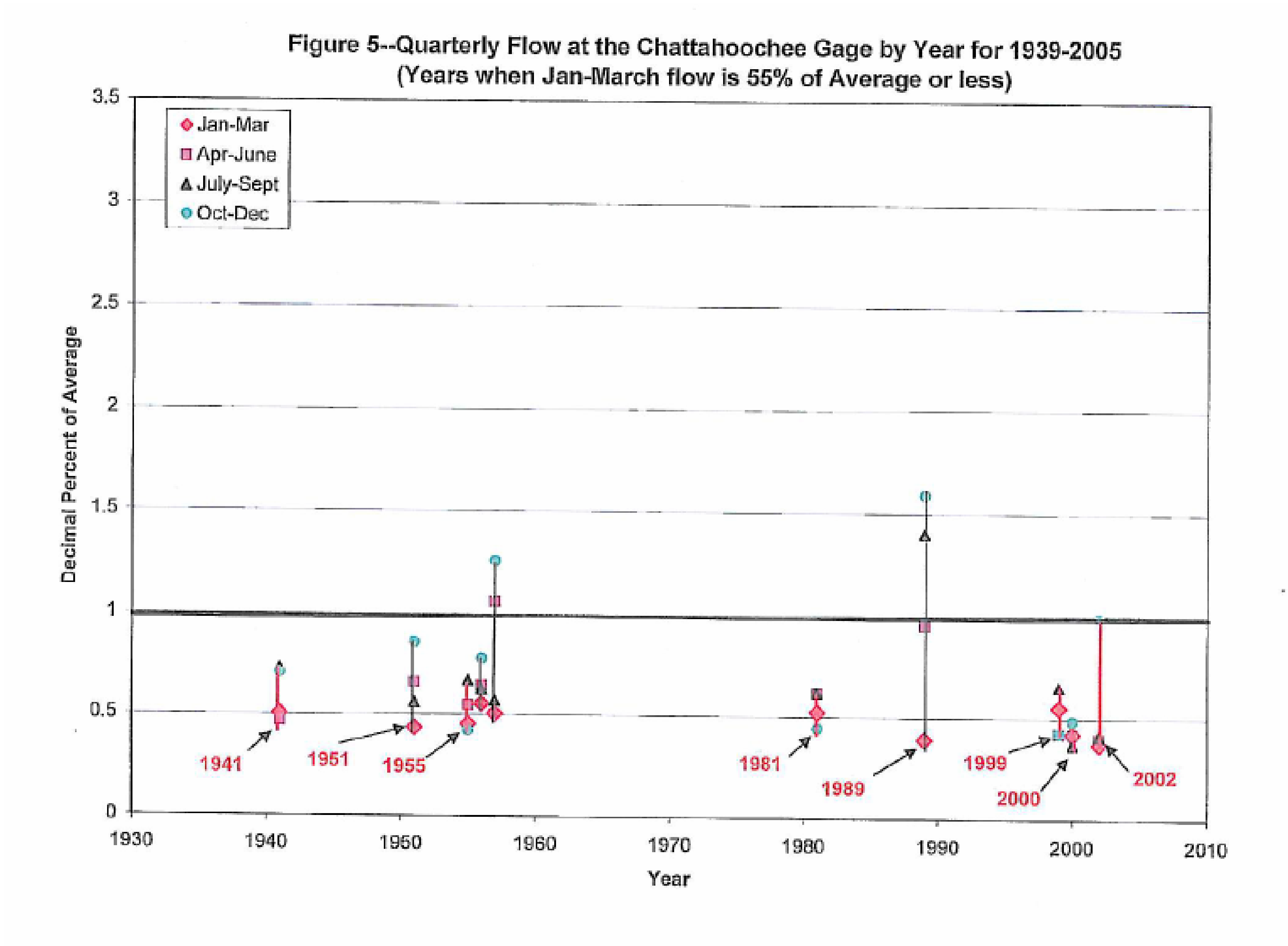


Probability of Severe Drought

- If Jan-Mar flow < 55% normal then there is a very high probability that sever drought and low flow conditions will occur during the dry season.

In contrast, if the January – March flow is only 55% of normal or less, then there is a very high probability that severe drought and low flow conditions will occur during the dry season. This condition occurred in 10 of the 67 years (**Figure 5**). All the most severe droughts of record occurred in years in which the January - March flows were 37% to 55% of normal (Figure 4). This condition occurred in 1981, 1999, 2000 and 2002 without exception. Earlier in the record, this condition also occurred in 1941, 1951, 1955 and 1956. Similarly, these were all drought years.[13]

Jan-Mar Flow < 55% of Average



Florida's Conclusion

From the above it is evident that flow in the January - March period can be used with reasonable accuracy to anticipate conditions for the remainder of the year. In sum:

- If flow at the Chattahoochee gage from January - March is 90% of average or greater, there is essentially a zero probability that the year will be a drought year.

- If flow at the Chattahoochee gage from January - March is 56% to 89% of the average, there is a 33% chance that persistently dry conditions (i.e., less than 90% of average at Chattahoochee) will continue for the remainder of the year.

- If flow at the Chattahoochee gage from January - March is 55% of average or less, there is a high probability that drought conditions have already started and will continue for the remainder of the year. There is also a high probability that conditions will be severe and that flows and reservoir levels will be impacted.

Florida's Recommendation

1. In January and February, preferentially store water in Lake Lanier. Allocate Basin Inflow above Buford between storage and minimum required releases (+/- 850 cfs). Refill to the top of the conservation pool (1,071). Retain the release schedule from the IOP for Basin Inflow below Buford.

2. In March, draft storage as necessary to support a flow floor of 6,300 cfs at Chattahoochee (which never has occurred in the entire period of record). At higher Basin Inflow operate as provided in the IOP.

3. On April 1, 2006, check aggregate January – March Chattahoochee flow and set the mussel-related flow floor for the year as noted in Table A below. At higher Basin Inflow operate as provided in the IOP.

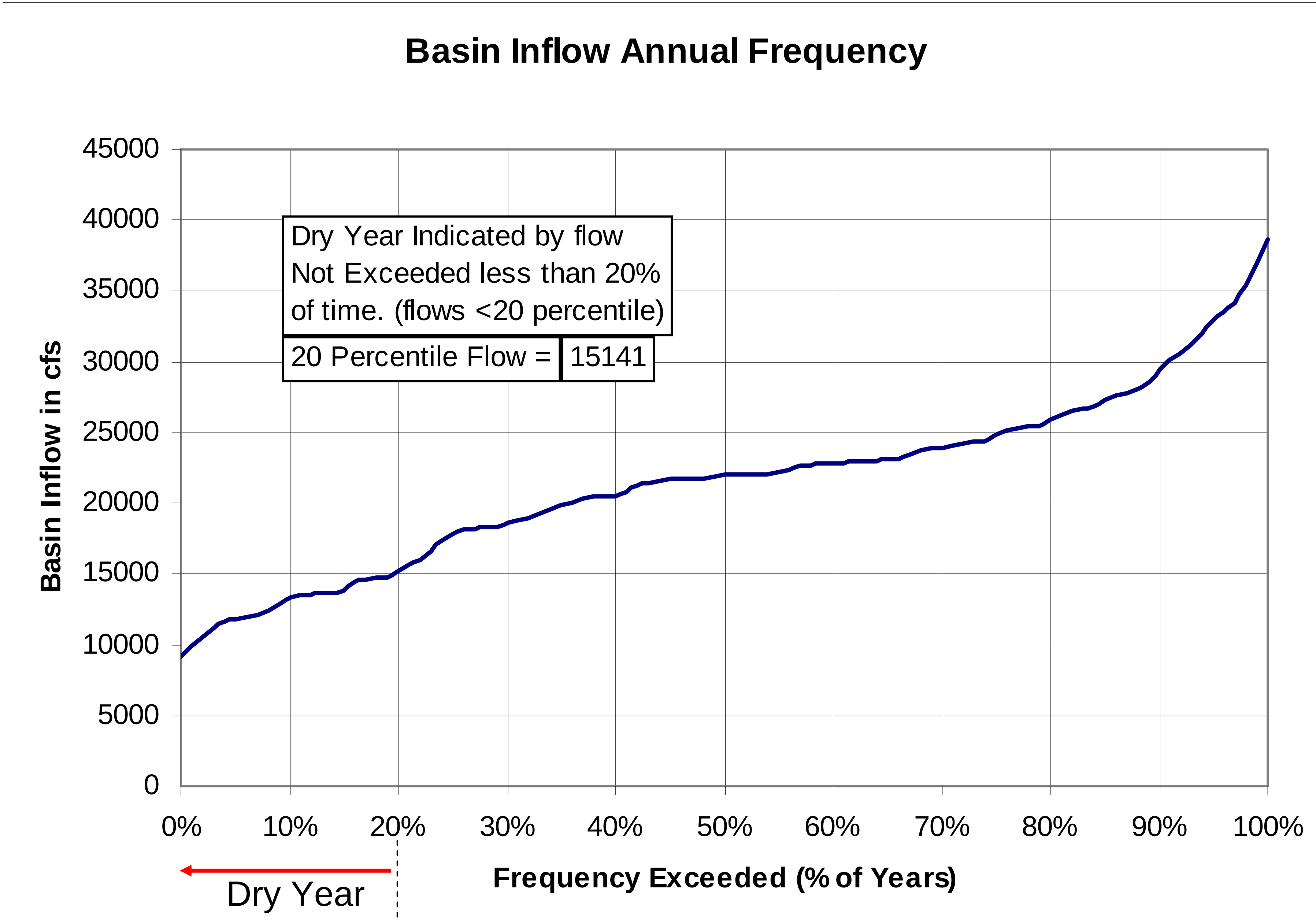
Table A: Possible Alternative Flow Floors

January – March Flows as a percentage of long-term avg.	**Applicable flow floor at the Chattahoochee Gage**
90% or greater	6,300 cfs
56% - 89%	6,000 cfs
55% or less	5,700 cfs

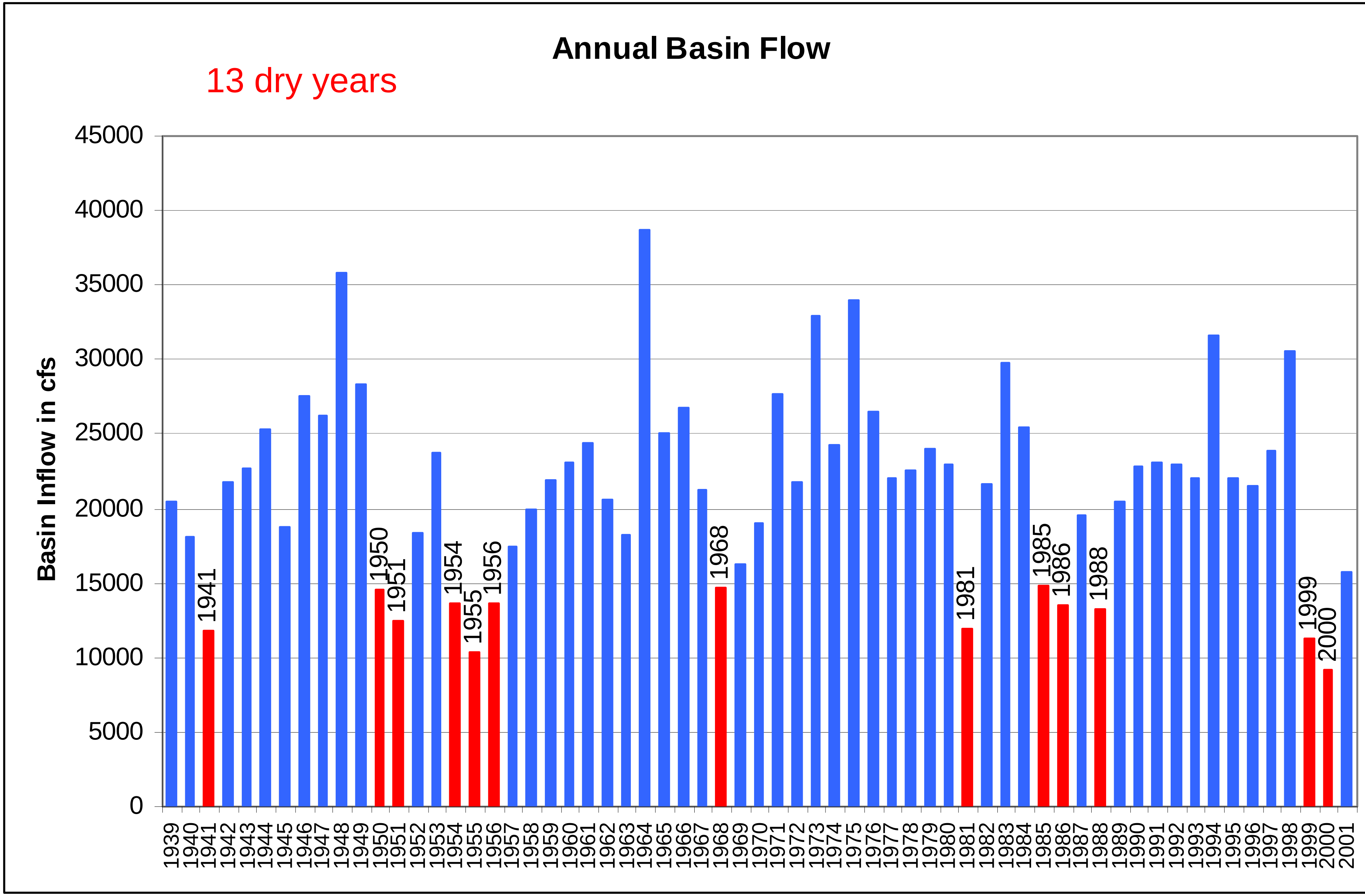
Methodologies

- Florida compared the Chattahoochee quarterly flow to the long term average quarterly flow
  - Dry year, unknown
- COE investigate the uncontrolled basin inflow quarterly flow to long term average annual flow
  - Dry year, annual flow < 20 percentile

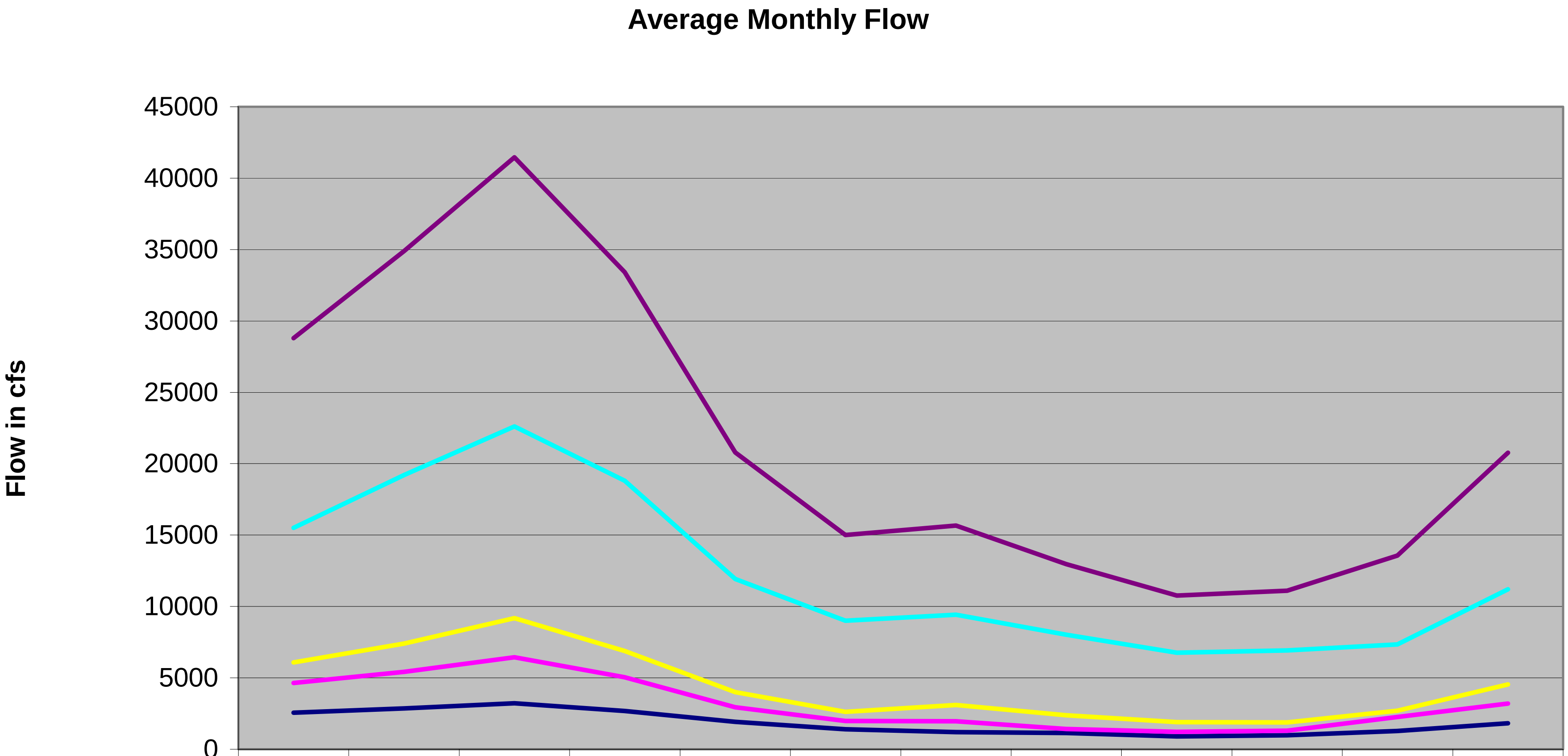
Dry Year Indicator



Dry Years Using 20 Percentile Indicator

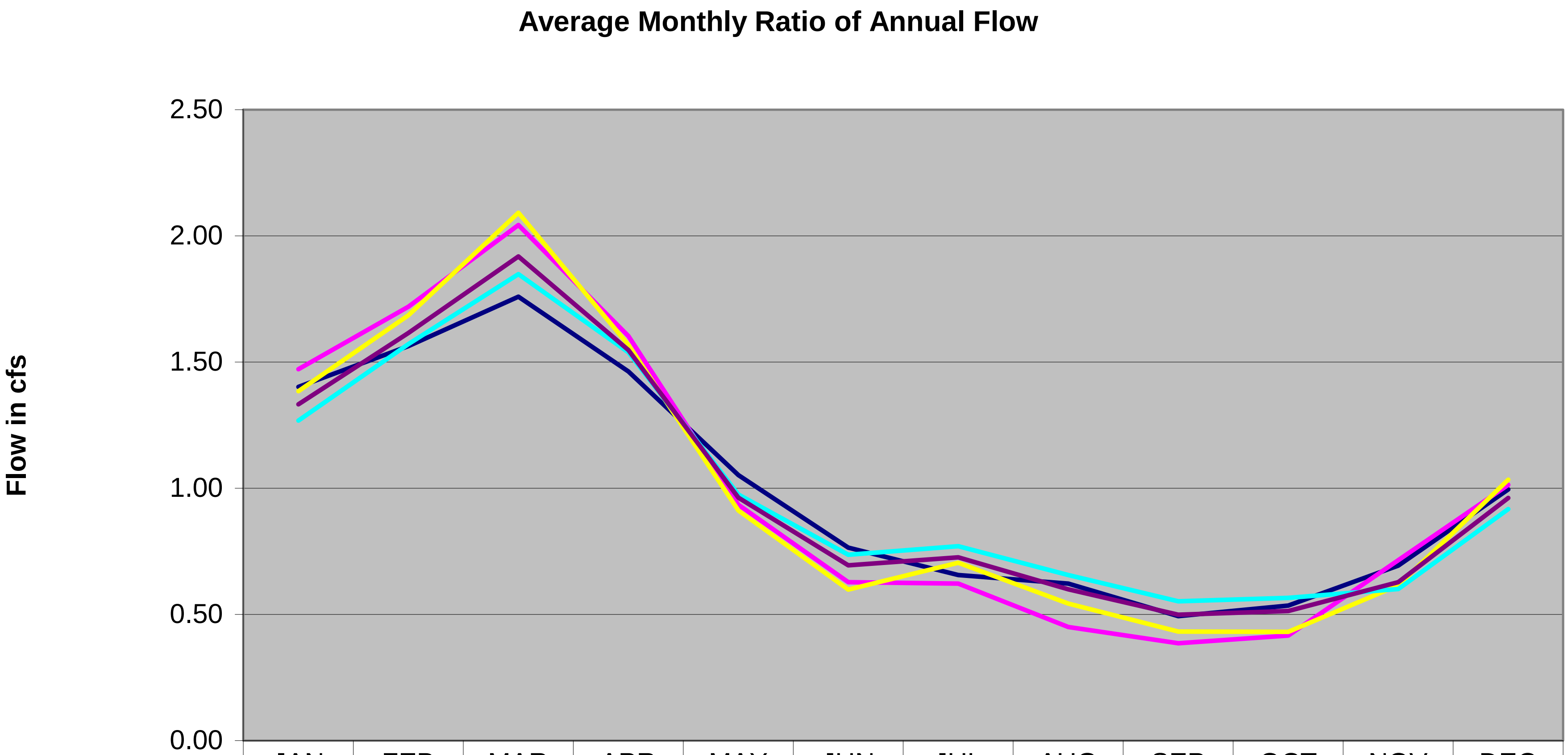


Average Monthly Basin Inflow



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BUF LOC	2568	2865	3223	2680	1928	1402	1201	1139	904	980	1271	1825
WP LOC	4636	5417	6436	5050	2943	1977	1959	1418	1215	1310	2251	3192
WFG LOC	6081	7402	9188	6884	4007	2627	3096	2387	1896	1891	2702	4542
JW LOC	15501	19204	22603	18806	11915	9002	9417	8016	6754	6918	7344	11213
BI	28786	34888	41451	33420	20793	15008	15674	12960	10770	11098	13570	20773

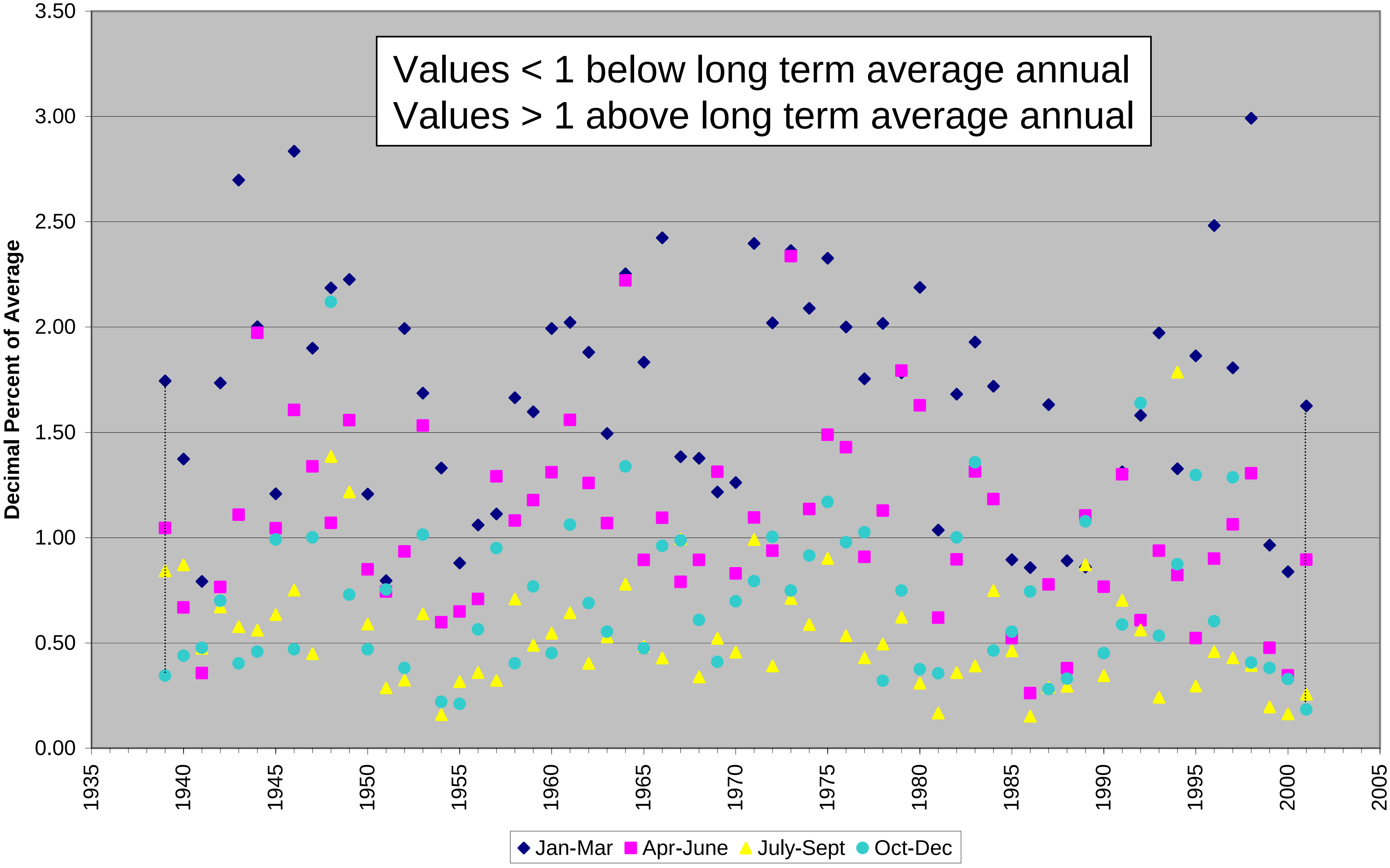
Average Monthly Ratio of Annual Flow

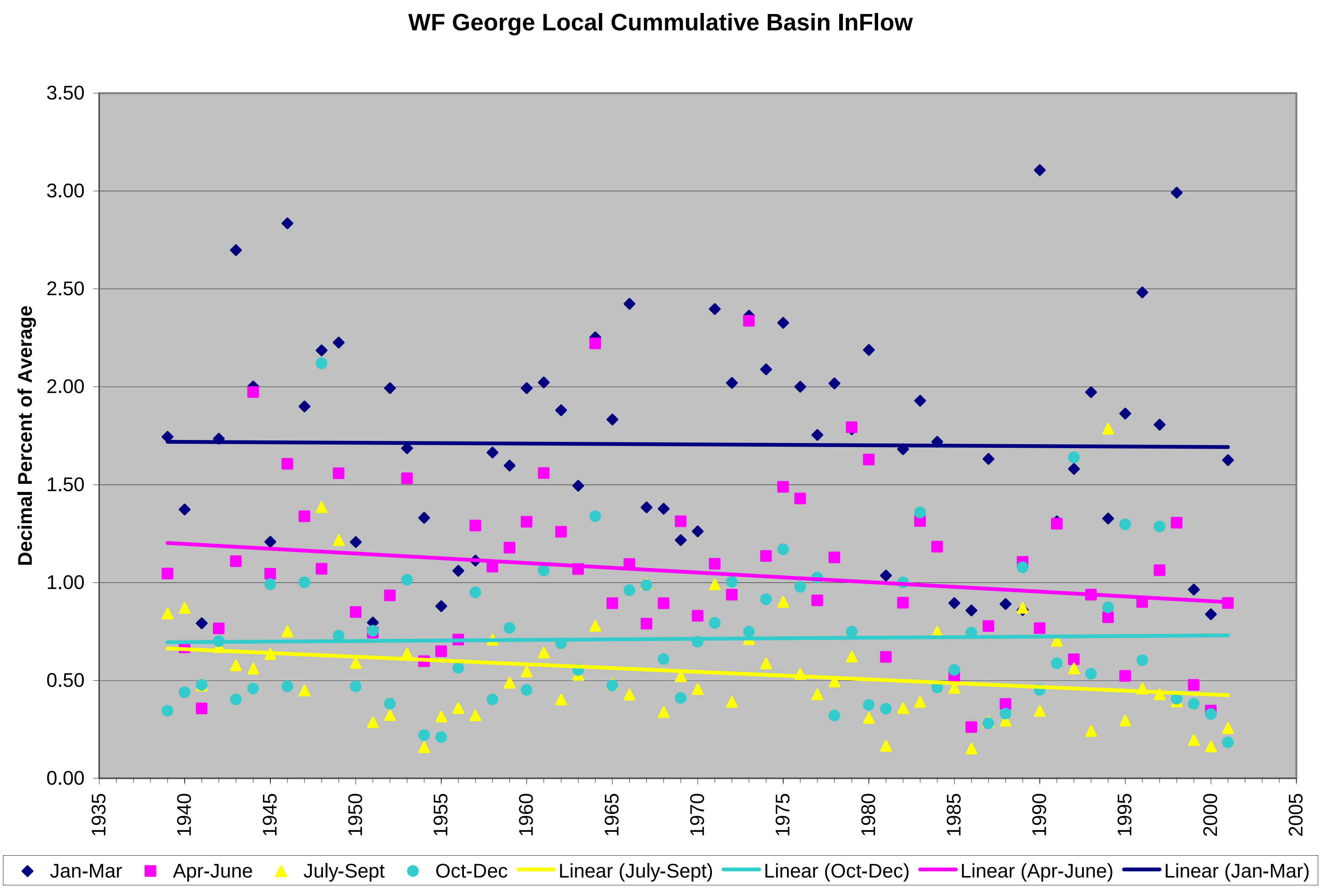


	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BUF LOC	1.40	1.56	1.76	1.46	1.05	0.77	0.66	0.62	0.49	0.53	0.69	1.00
WP LOC	1.47	1.72	2.04	1.60	0.93	0.63	0.62	0.45	0.39	0.42	0.71	1.01
WFG LOC	1.38	1.69	2.09	1.57	0.91	0.60	0.71	0.54	0.43	0.43	0.62	1.03
JW LOC	1.27	1.57	1.85	1.54	0.97	0.74	0.77	0.66	0.55	0.57	0.60	0.92
BI	1.33	1.62	1.92	1.55	0.96	0.69	0.73	0.60	0.50	0.51	0.63	0.96

BUF LOC WP LOC WFG LOC JW LOC BI

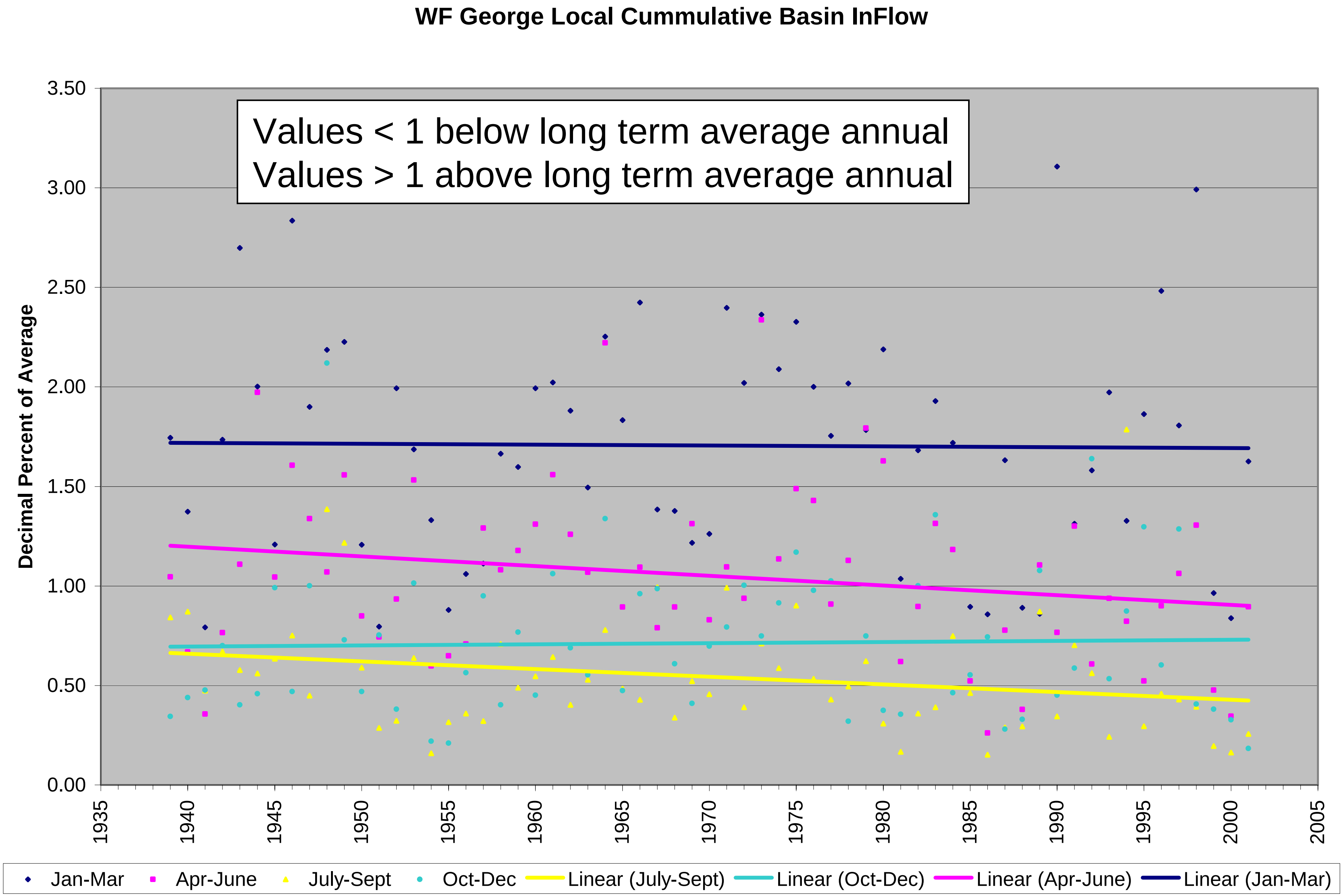
WF George Local Cumulative Basin Inflow Quarterly Flow ratio to Long Term Average Annual





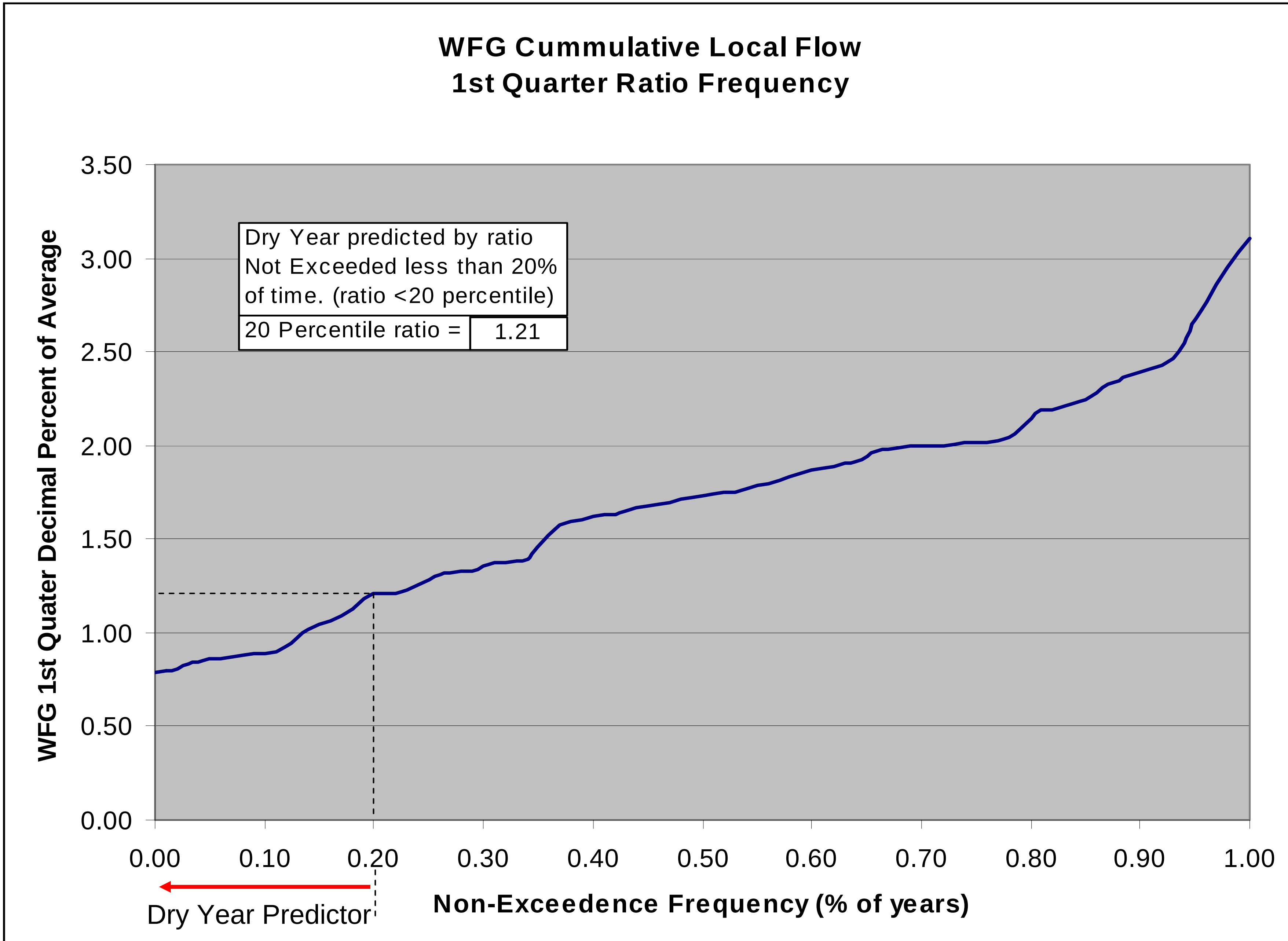
WF George Local Cummulative Basin InFlow
Decimal Percent of Average
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Jan-Mar
Apr-June
July-Sept
Oct-Dec
Linear (July-Sept)
Linear (Oct-Dec)
Linear (Apr-June)
Linear (Jan-Mar)

Trend of Quarterly Basin Inflow



Demonstrate Flow distribution through the year

Dry Year Predictor



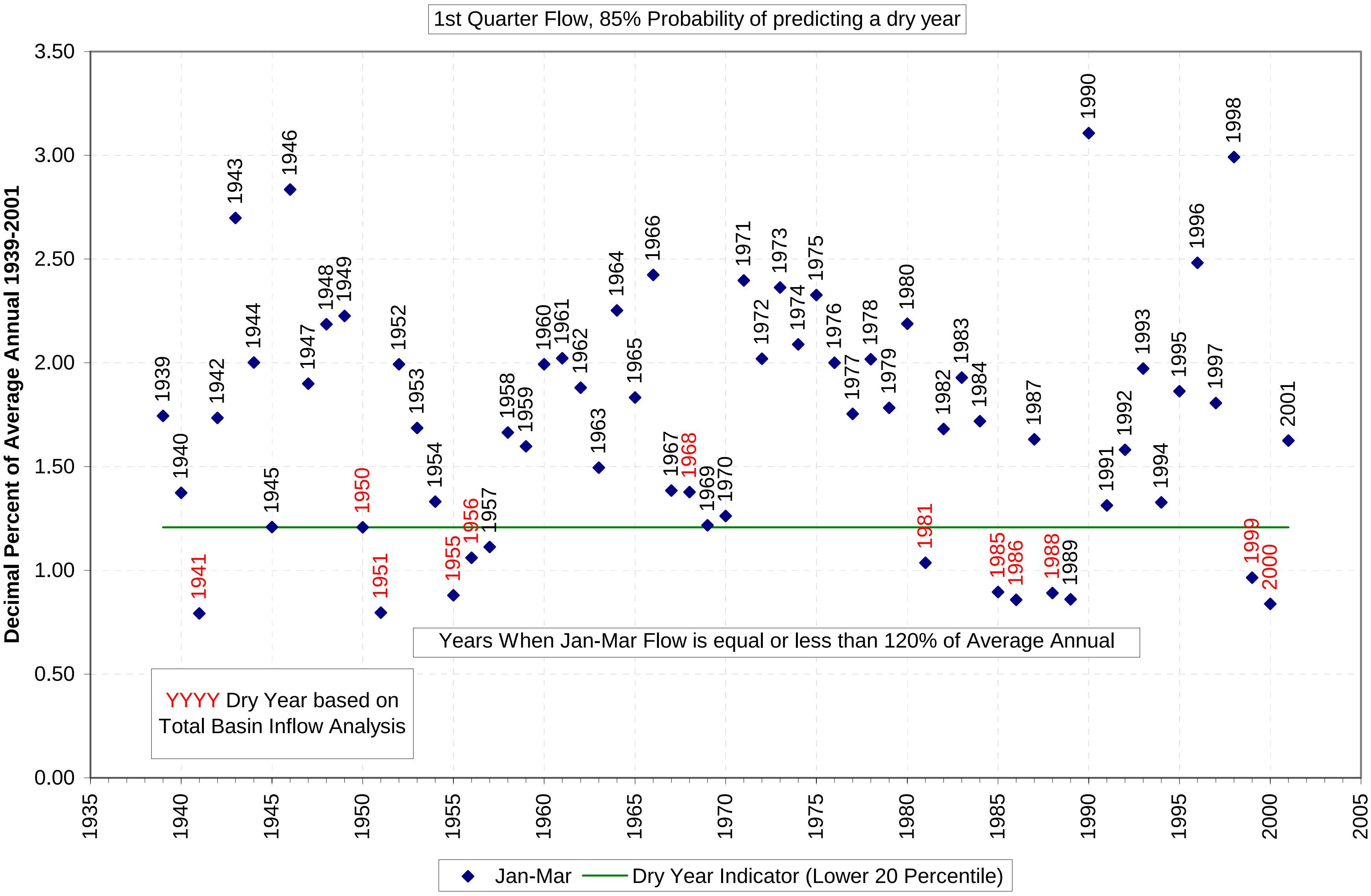
Results of 1st Quarter Predictor

		QUARTER	BUF LOC	WP LOC	WFG LOC	JW LOC	BI	WFG LOC CUM
Indicate Dry Year	Count	1	9	10	10	9	9	11
	Percent	1	69%	77%	77%	69%	69%	85%
Indicate Trigger	Count	1	7	7	6	5	6	7
	Percent	1	70%	70%	60%	50%	60%	70%

Using the Walter F George 1st quarter flow, 11 of the 13 actual dry years were predicted as dry. An 85% prediction rate

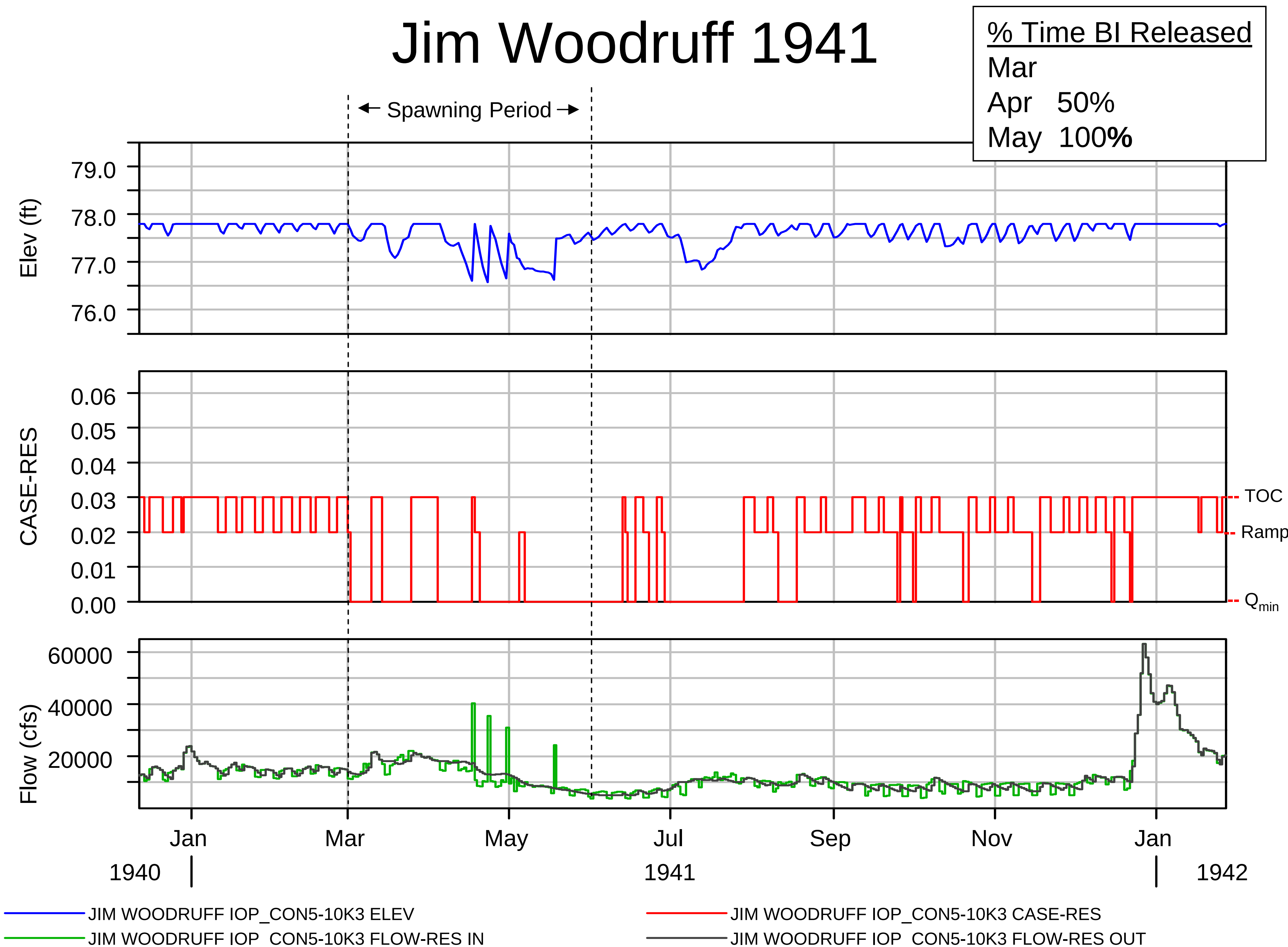
Basin Inflow Predictive Tool

WF George Local Cummulative Basin InFlow



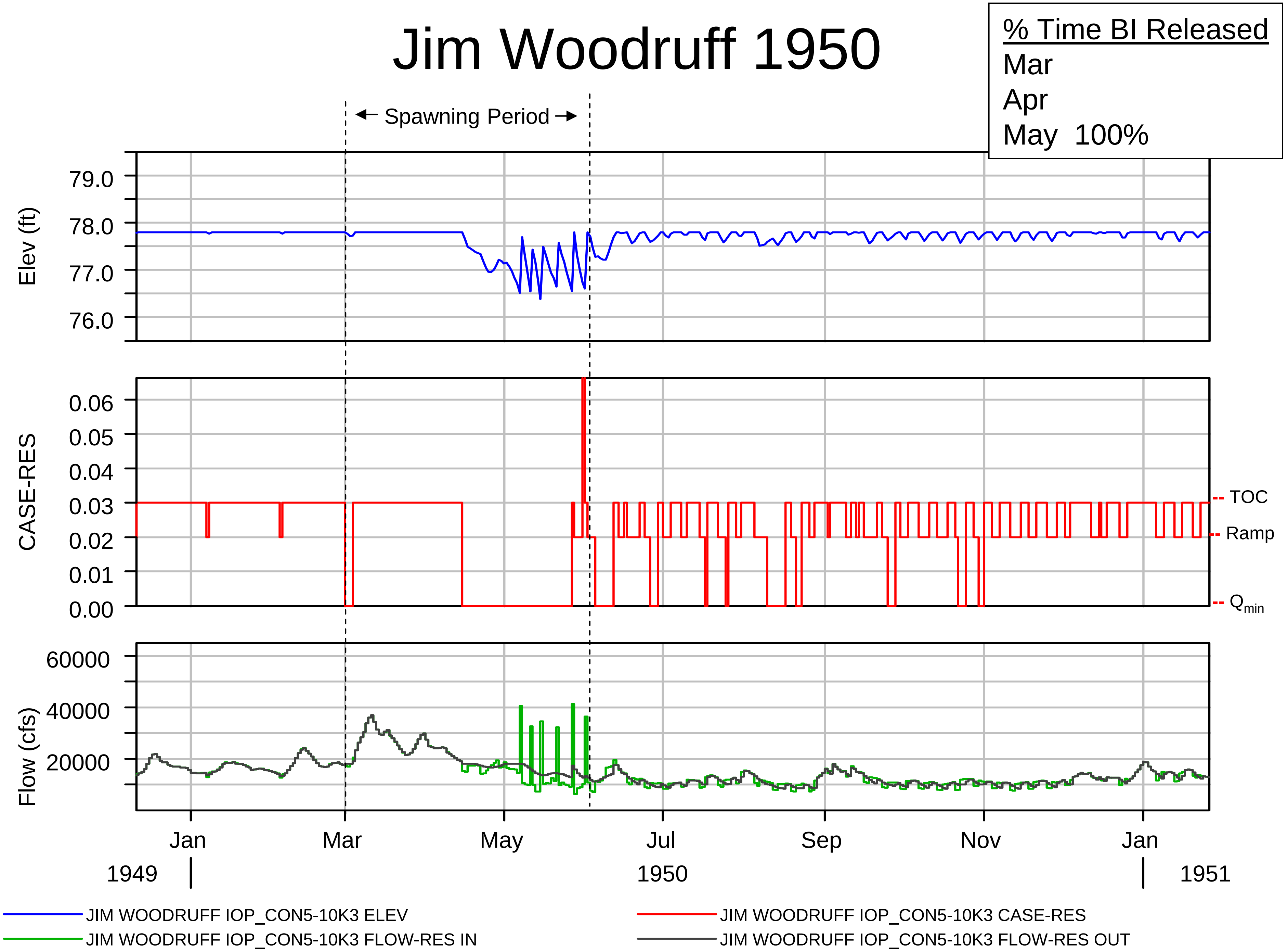
Reservoir Release During Spawning Period

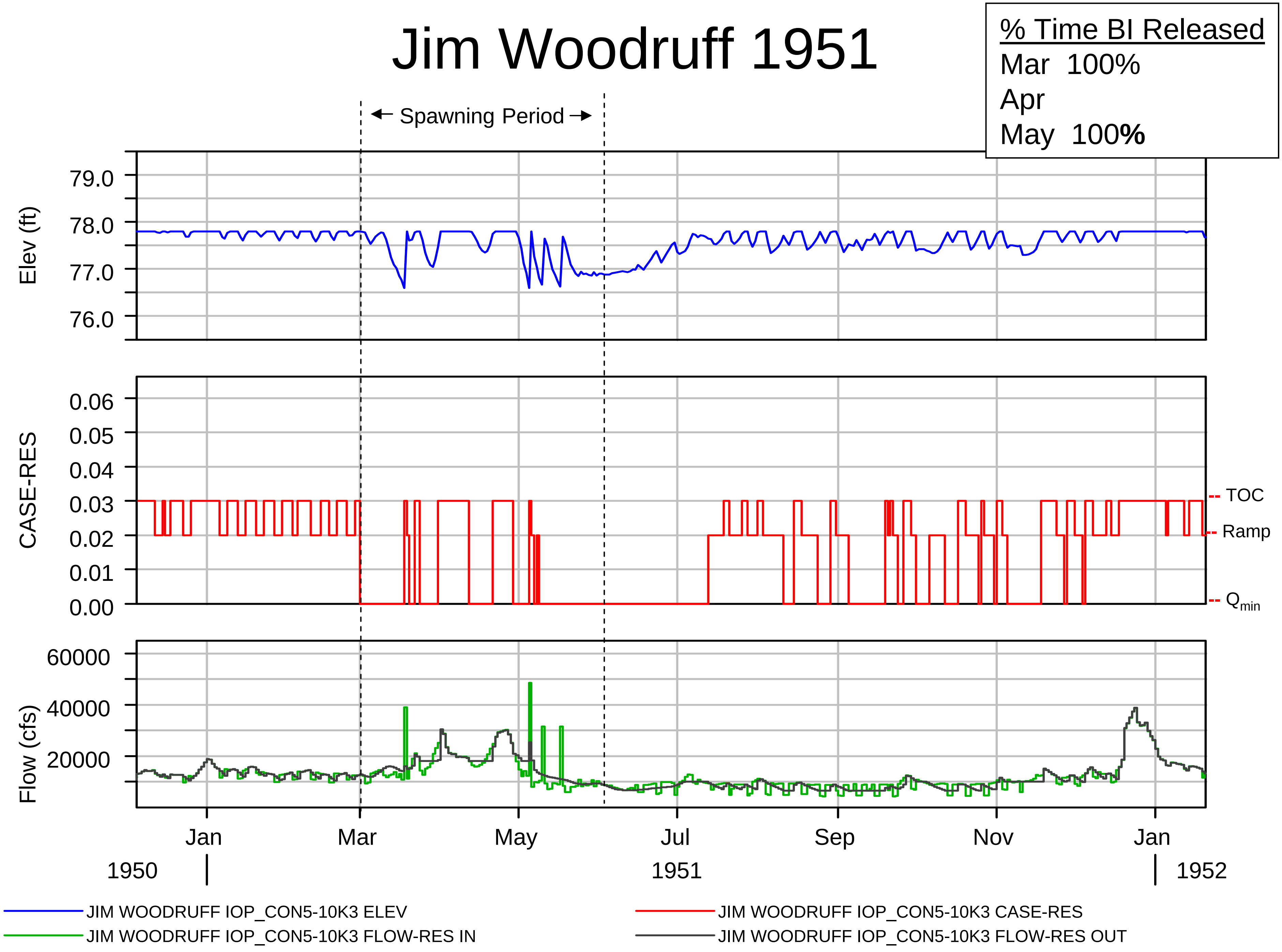
- The next series of slides examine the reservoir releases during the March – April spawning period for the 13 dry years
  - Visually determine percent of time basin inflow released
- Graphics
  - Pool elevation
  - Release decision
  - Reservoir inflow and outflow



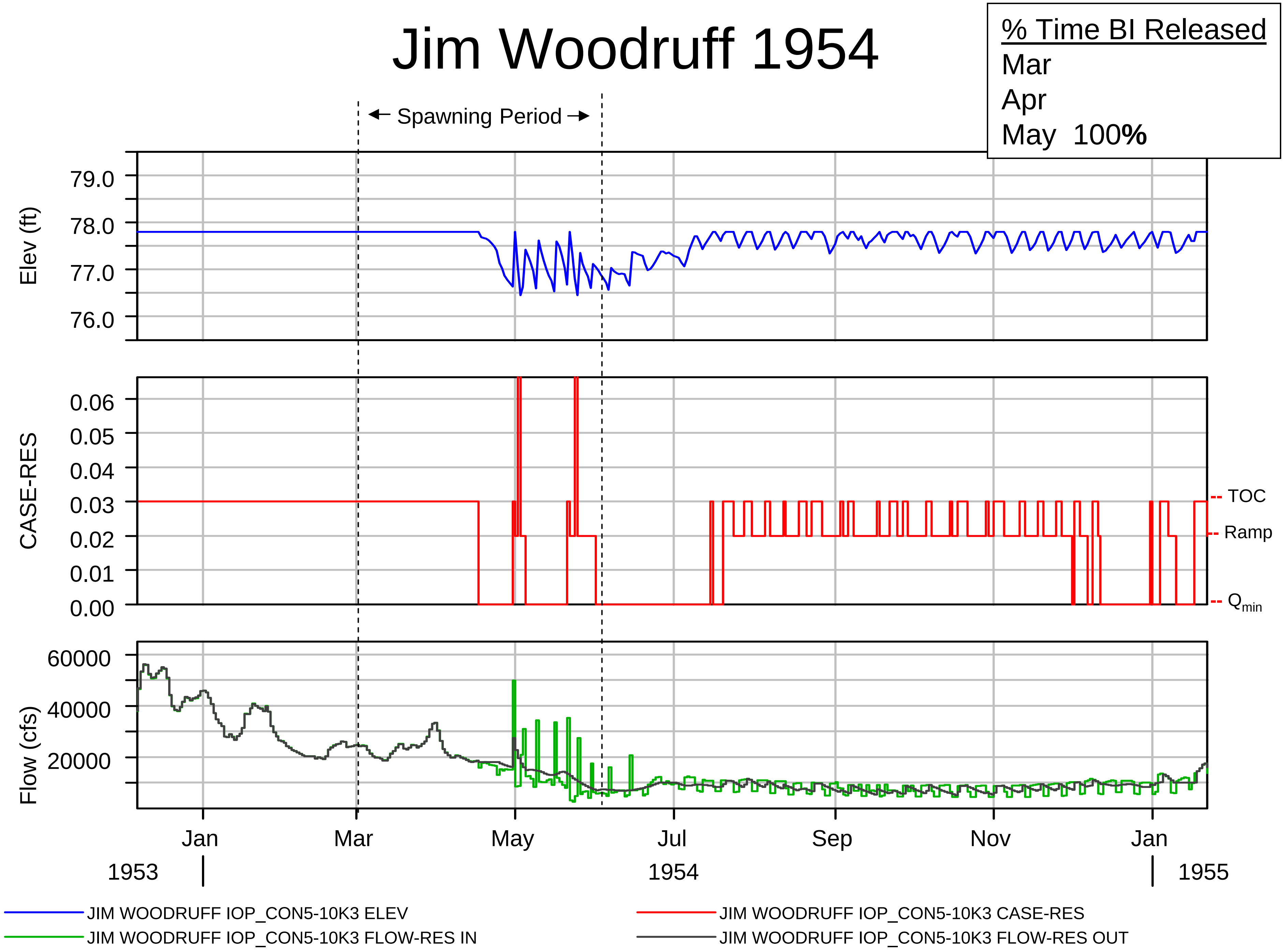
Jim Woodruff 1941
% Time BI Released
Mar
Apr 50%
May 100%
Spawning Period
Elev (ft)
79.0
78.0
77.0
76.0
CASE-RES
0.06
0.05
0.04
0.03
0.02
0.01
0.00
TOC
Ramp
Q min
Flow (cfs)
60000
40000
20000
Jan
Mar
May
Jul
Sep
Nov
Jan
1940
1941
1942
JIM WOODRUFF IOP_CON5-10K3 ELEV
JIM WOODRUFF IOP_CON5-10K3 CASE-RES
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES IN
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES OUT

Jim Woodruff 1950





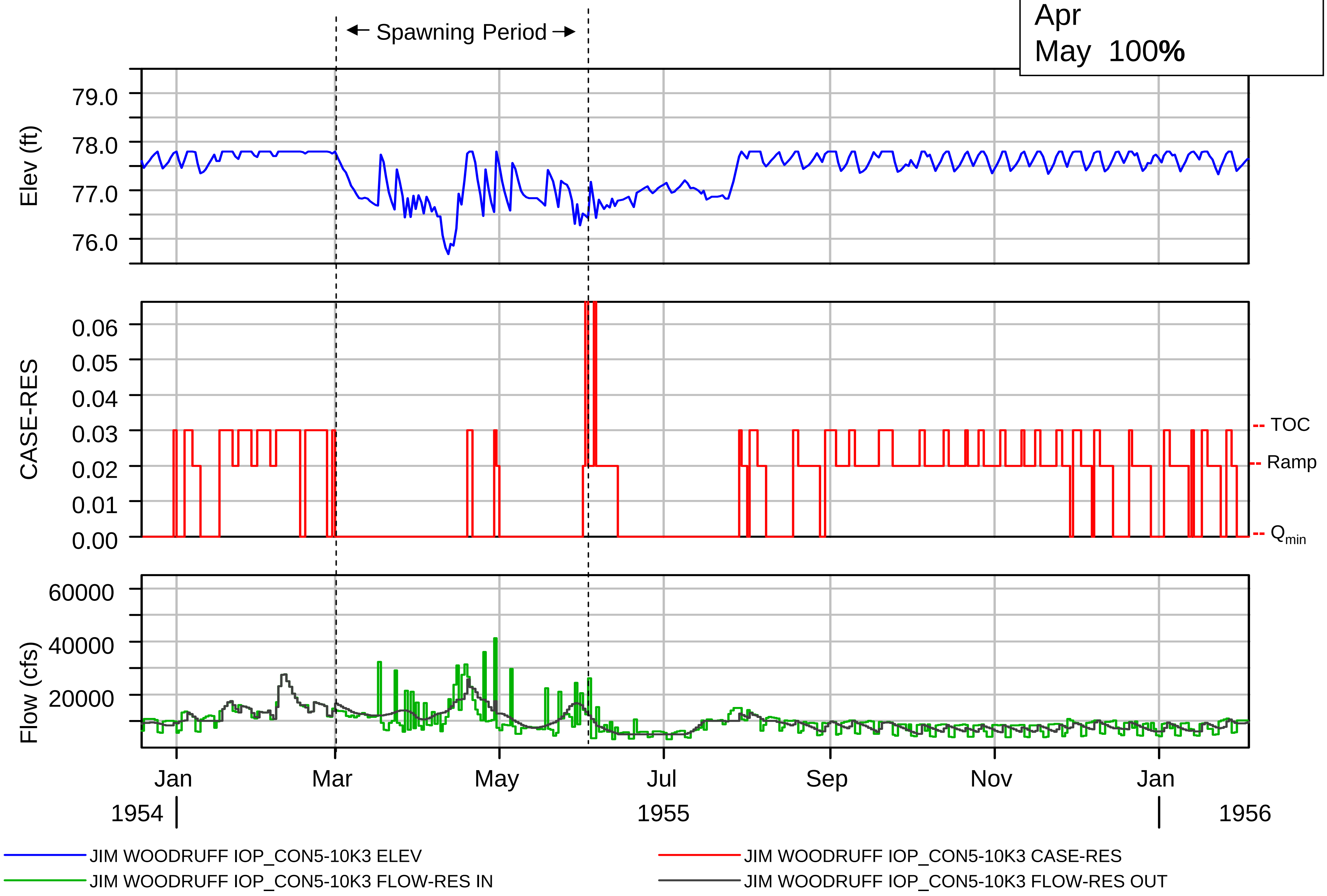
Jim Woodruff 1951
% Time BI Released
Mar 100%
Apr
May 100%
Spawning Period
Elev (ft)
79.0
78.0
77.0
76.0
CASE-RES
0.06
0.05
0.04
0.03
0.02
0.01
0.00
TOC
Ramp
Qmin
Flow (cfs)
60000
40000
20000
Jan
Mar
May
Jul
Sep
Nov
Jan
1950
1951
1952
JIM WOODRUFF IOP_CON5-10K3 ELEV
JIM WOODRUFF IOP_CON5-10K3 CASE-RES
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES IN
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES OUT



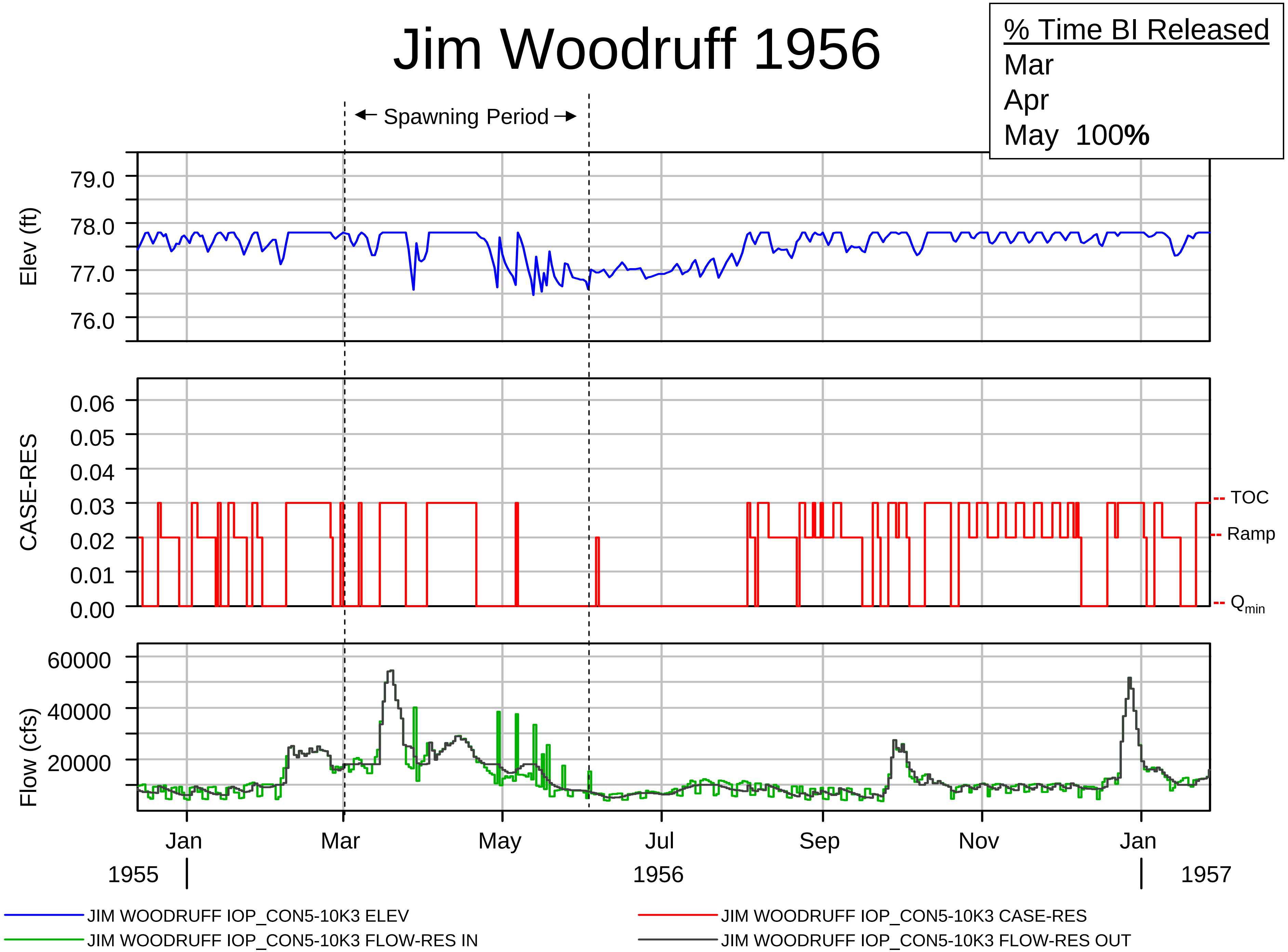
Jim Woodruff 1954
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
79.0
78.0
77.0
76.0
CASE-RES
0.06
0.05
0.04
0.03
0.02
0.01
0.00
TOC
Ramp
Qmin
Flow (cfs)
60000
40000
20000
Jan
Mar
May
Jul
Sep
Nov
Jan
1953
1954
1955
JIM WOODRUFF IOP_CON5-10K3 ELEV
JIM WOODRUFF IOP_CON5-10K3 CASE-RES
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES IN
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES OUT

Jim Woodruff 1955

% Time BI Released	
Mar	100%
Apr	
May	100%

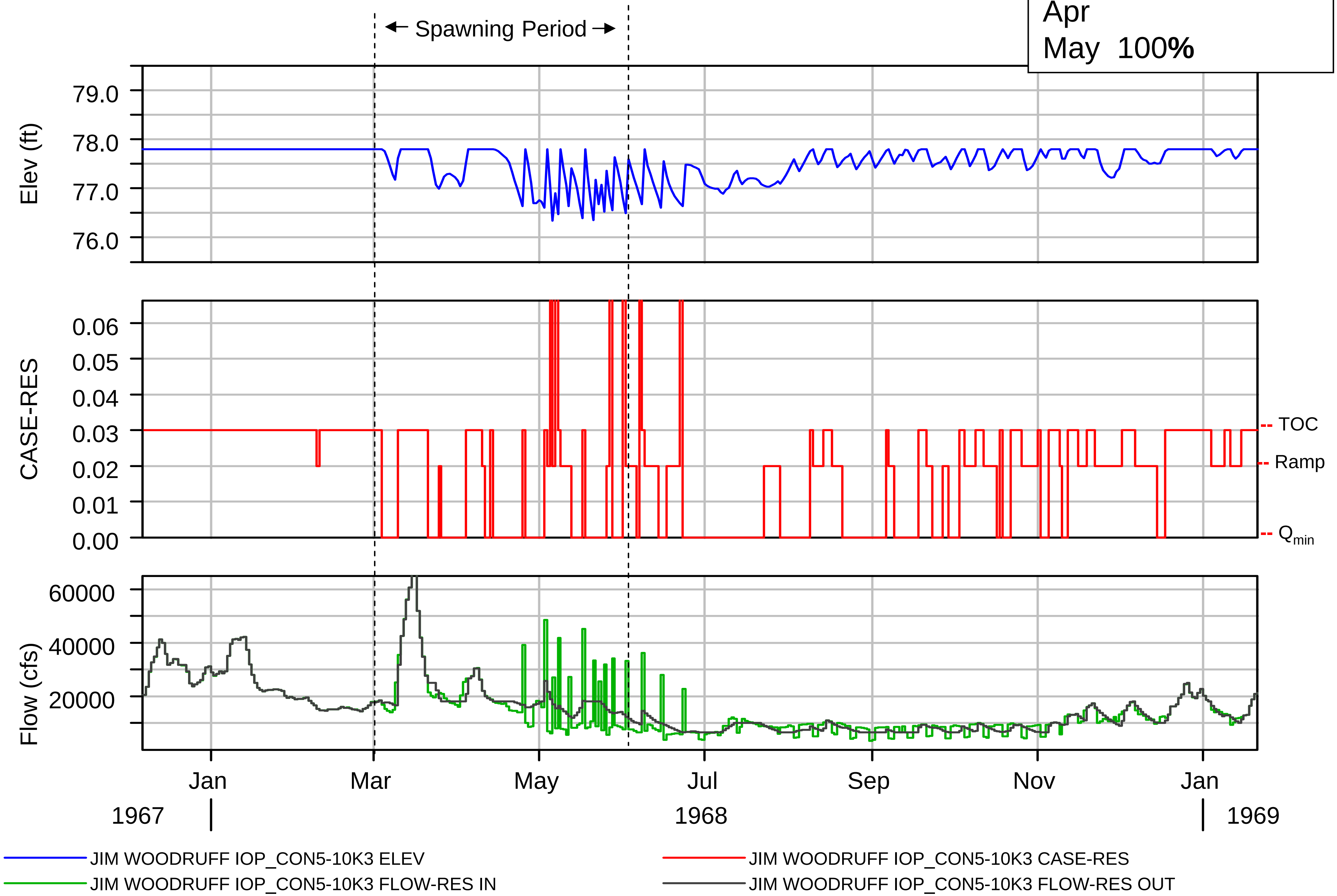


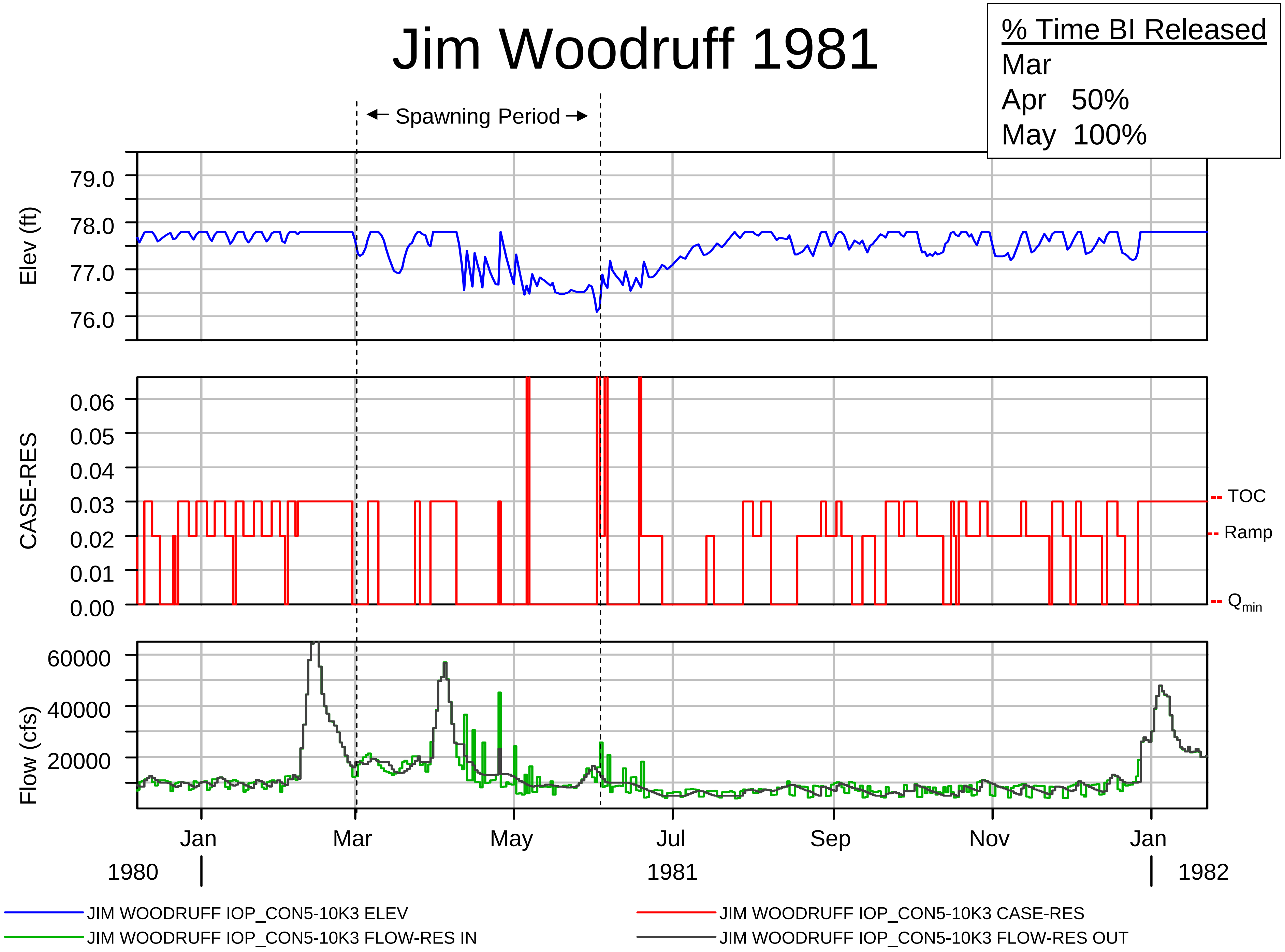
Jim Woodruff 1956



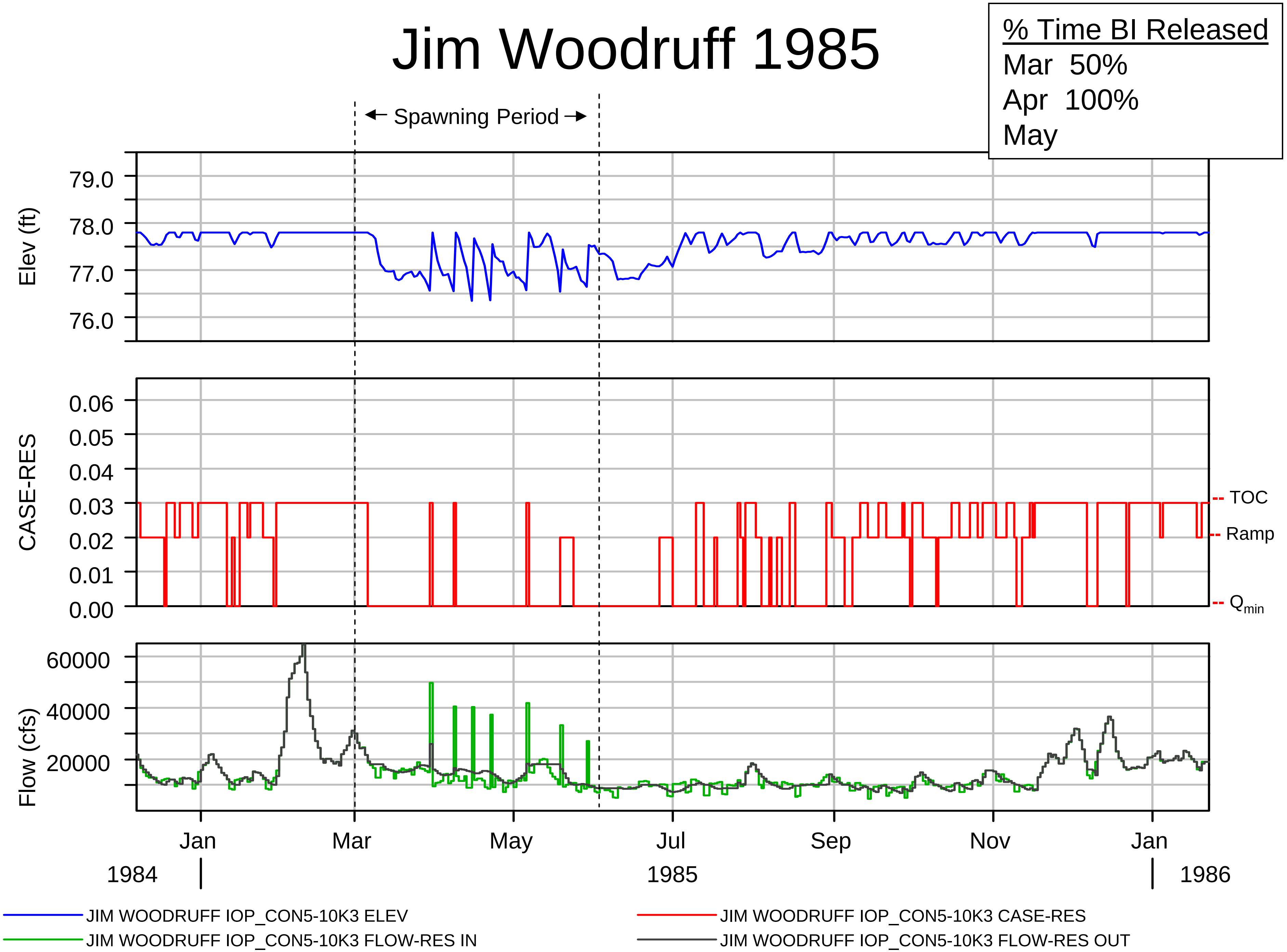
Jim Woodruff 1968

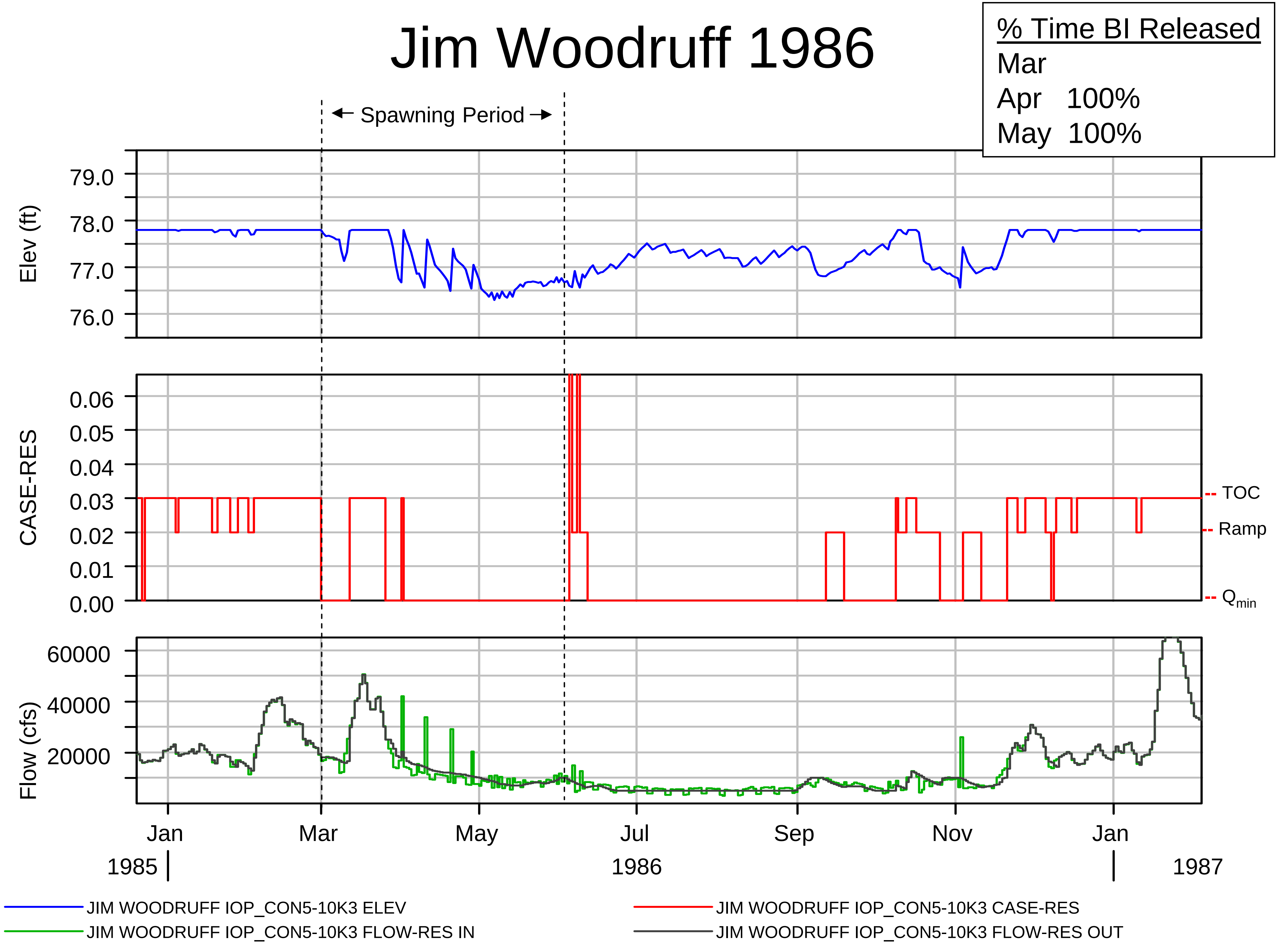
% Time BI Released
Mar
Apr
May 100%




Jim Woodruff 1981
% Time BI Released
Mar
Apr 50%
May 100%
Spawning Period
Elev (ft)
79.0
78.0
77.0
76.0
CASE-RES
0.06
0.05
0.04
0.03
0.02
0.01
0.00
TOC
Ramp
Qmin
Flow (cfs)
60000
40000
20000
Jan
Mar
May
Jul
Sep
Nov
Jan
1980
1981
1982
JIM WOODRUFF IOP_CON5-10K3 ELEV
JIM WOODRUFF IOP_CON5-10K3 CASE-RES
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES IN
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES OUT

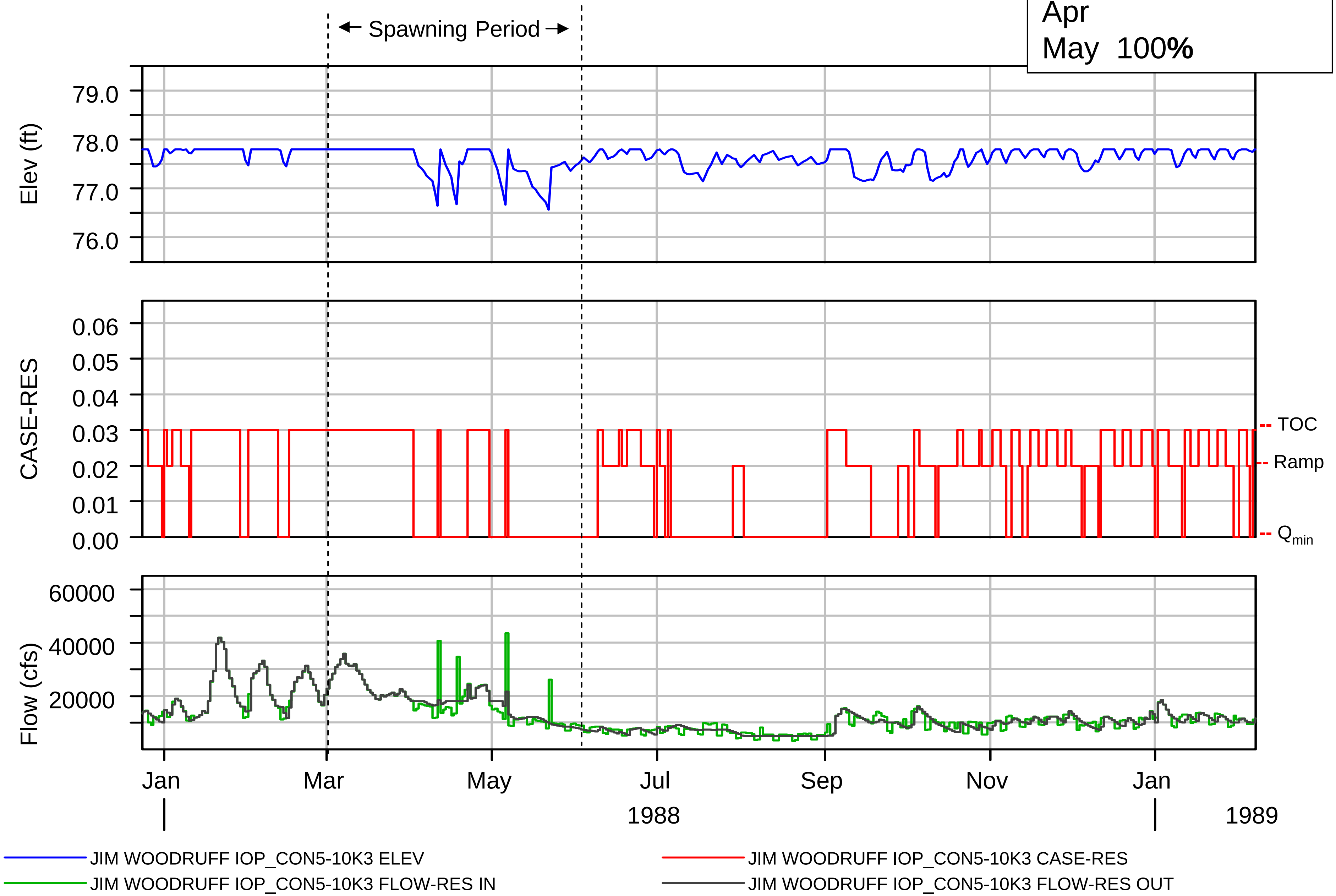
Jim Woodruff 1985

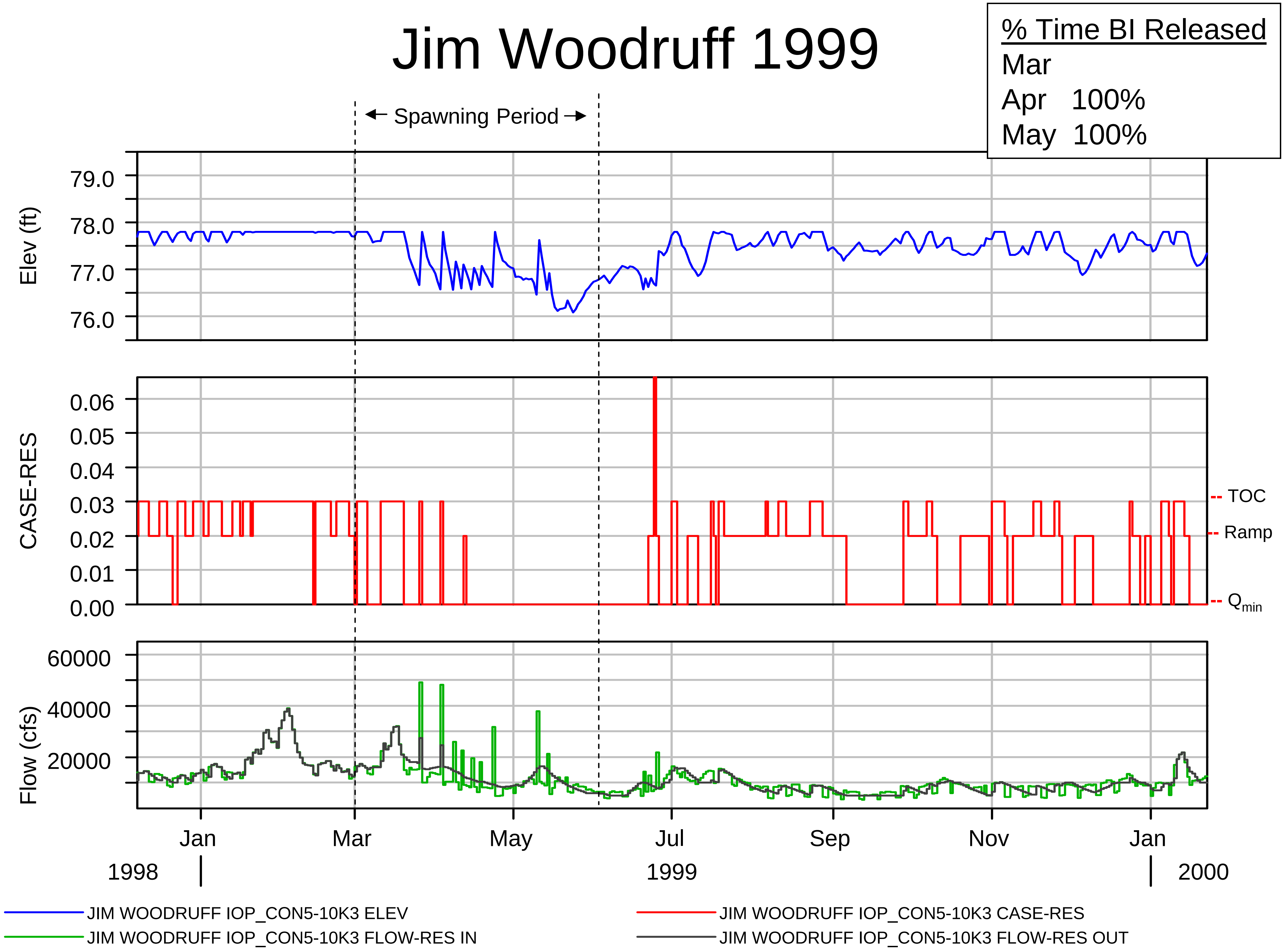



Jim Woodruff 1986
% Time BI Released
Mar
Apr 100%
May 100%
Spawning Period
Elev (ft)
79.0
78.0
77.0
76.0
CASE-RES
0.06
0.05
0.04
0.03
0.02
0.01
0.00
TOC
Ramp
Q_{min}
Flow (cfs)
60000
40000
20000
Jan
Mar
May
Jul
Sep
Nov
Jan
1985
1986
1987
JIM WOODRUFF IOP_CON5-10K3 ELEV
JIM WOODRUFF IOP_CON5-10K3 CASE-RES
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES IN
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES OUT

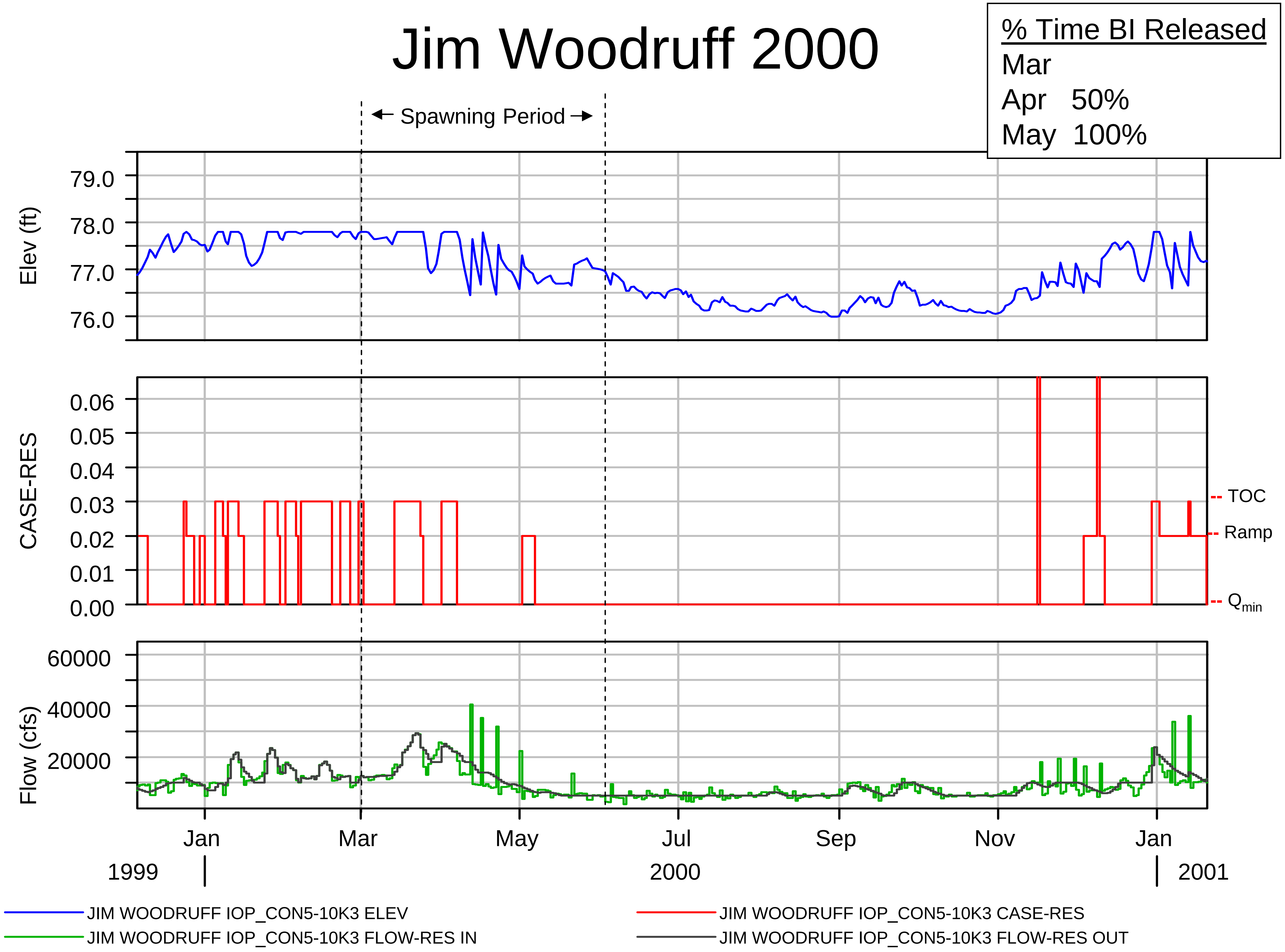
Jim Woodruff 1988

% Time BI Released	
Mar	
Apr	
May	**100%**

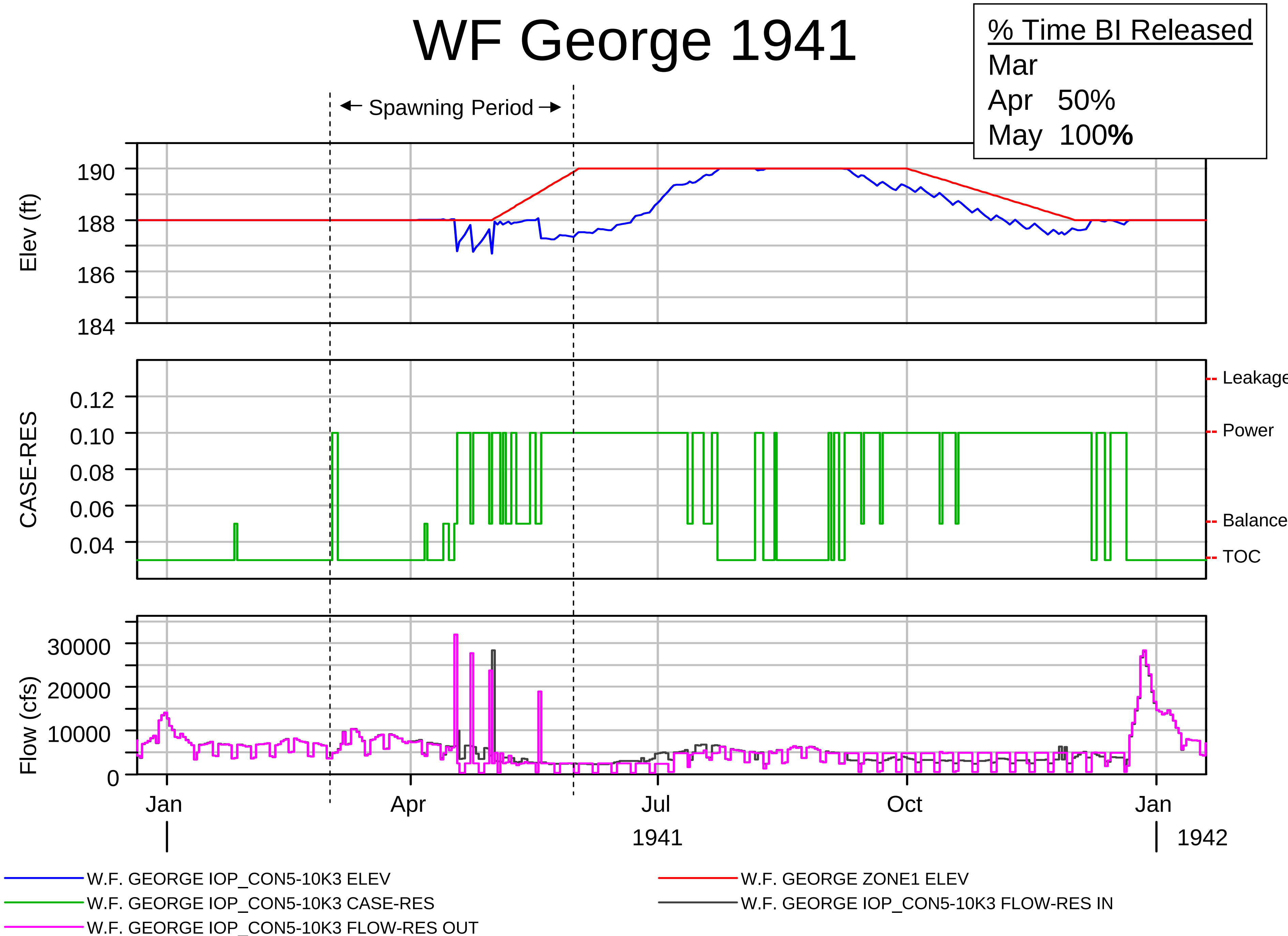


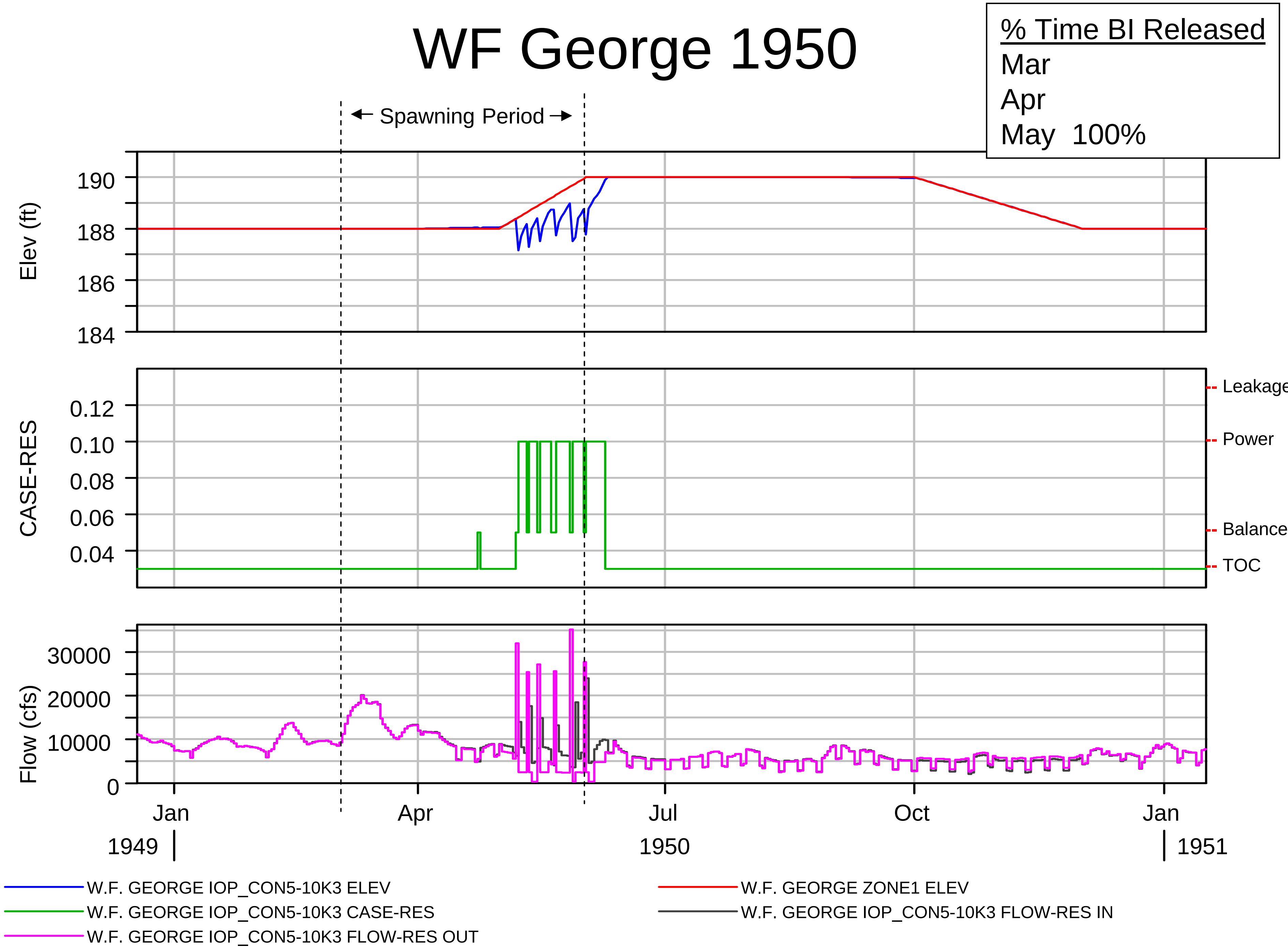


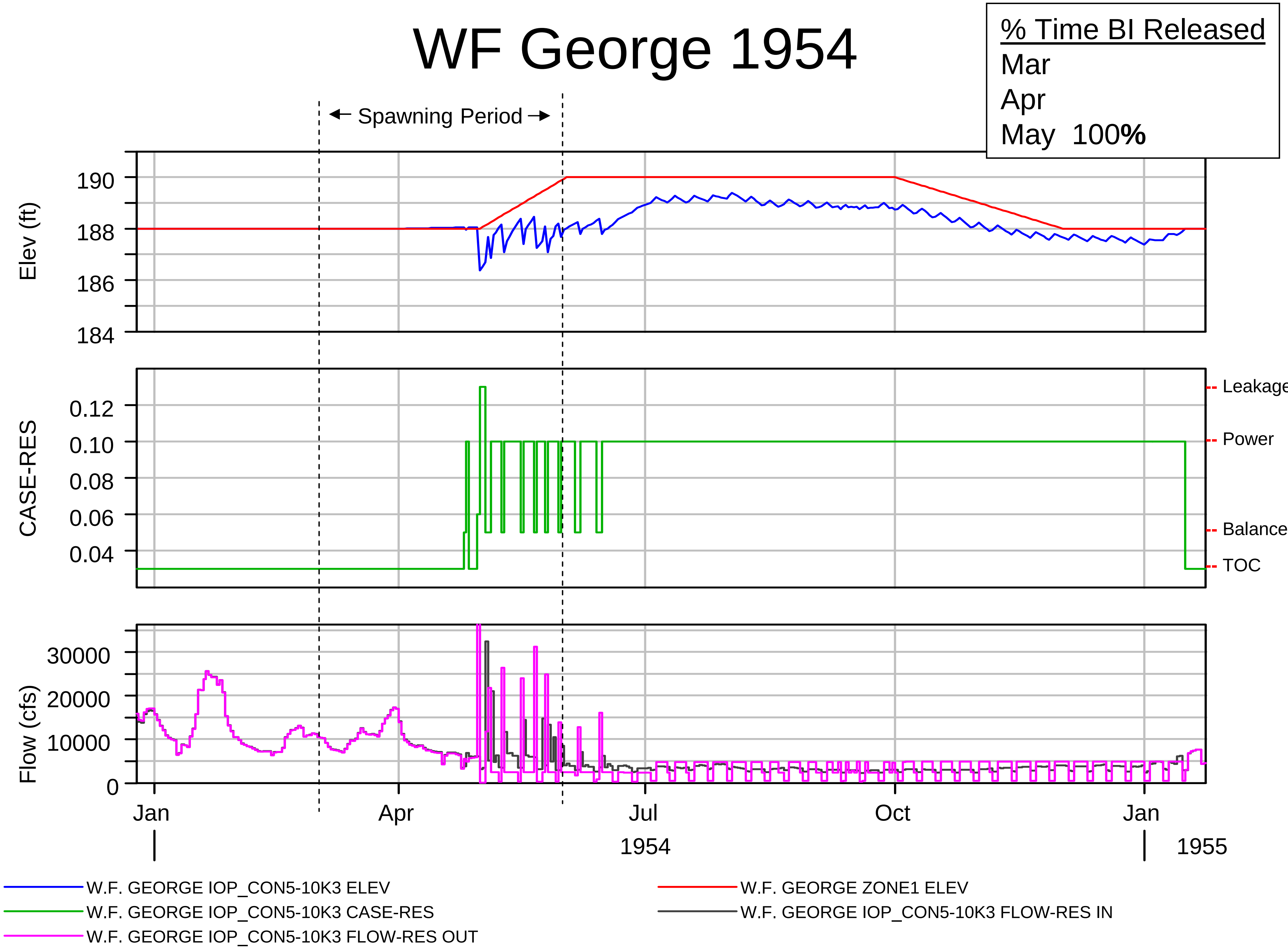
Jim Woodruff 1999
% Time BI Released
Mar
Apr 100%
May 100%
Spawning Period
Elev (ft)
79.0
78.0
77.0
76.0
CASE-RES
0.06
0.05
0.04
0.03
0.02
0.01
0.00
TOC
Ramp
Q_{min}
Flow (cfs)
60000
40000
20000
Jan
Mar
May
Jul
Sep
Nov
Jan
1998
1999
2000
JIM WOODRUFF IOP_CON5-10K3 ELEV
JIM WOODRUFF IOP_CON5-10K3 CASE-RES
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES IN
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES OUT


Jim Woodruff 2000
% Time BI Released
Mar
Apr 50%
May 100%
Spawning Period
Elev (ft)
79.0
78.0
77.0
76.0
CASE-RES
0.06
0.05
0.04
0.03
0.02
0.01
0.00
TOC
Ramp
Q_{min}
Flow (cfs)
60000
40000
20000
Jan
Mar
May
Jul
Sep
Nov
Jan
1999
2000
2001
JIM WOODRUFF IOP_CON5-10K3 ELEV
JIM WOODRUFF IOP_CON5-10K3 CASE-RES
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES IN
JIM WOODRUFF IOP_CON5-10K3 FLOW-RES OUT

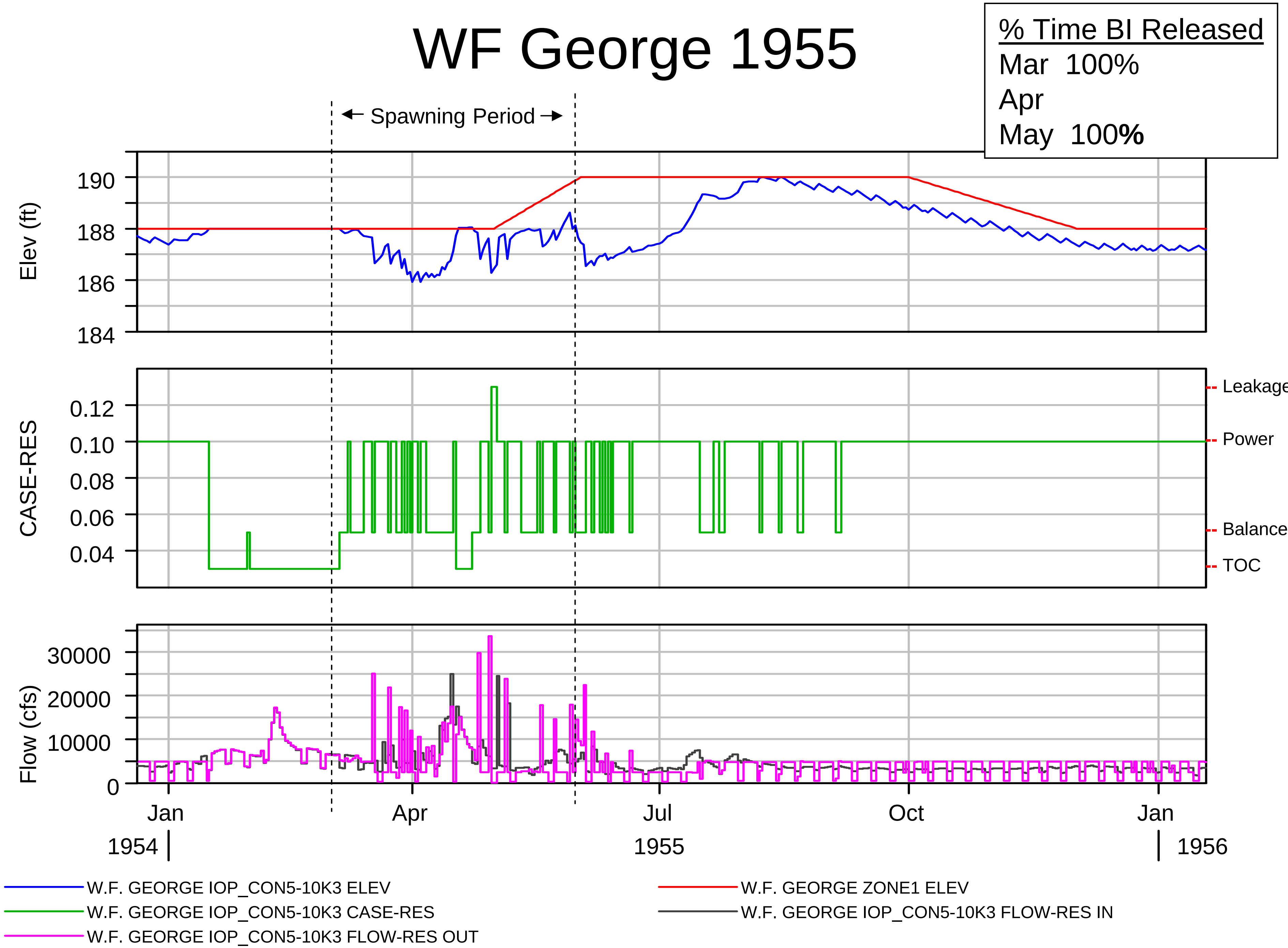
WF George 1941




WF George 1950
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
190
188
186
184
CASE-RES
0.12
0.10
0.08
0.06
0.04
Leakage
Power
Balance
TOC
Flow (cfs)
30000
20000
10000
0
Jan
Apr
Jul
Oct
Jan
1949
1950
1951
W.F. GEORGE IOP_CON5-10K3 ELEV
W.F. GEORGE ZONE1 ELEV
W.F. GEORGE IOP_CON5-10K3 CASE-RES
W.F. GEORGE IOP_CON5-10K3 FLOW-RES IN
W.F. GEORGE IOP_CON5-10K3 FLOW-RES OUT



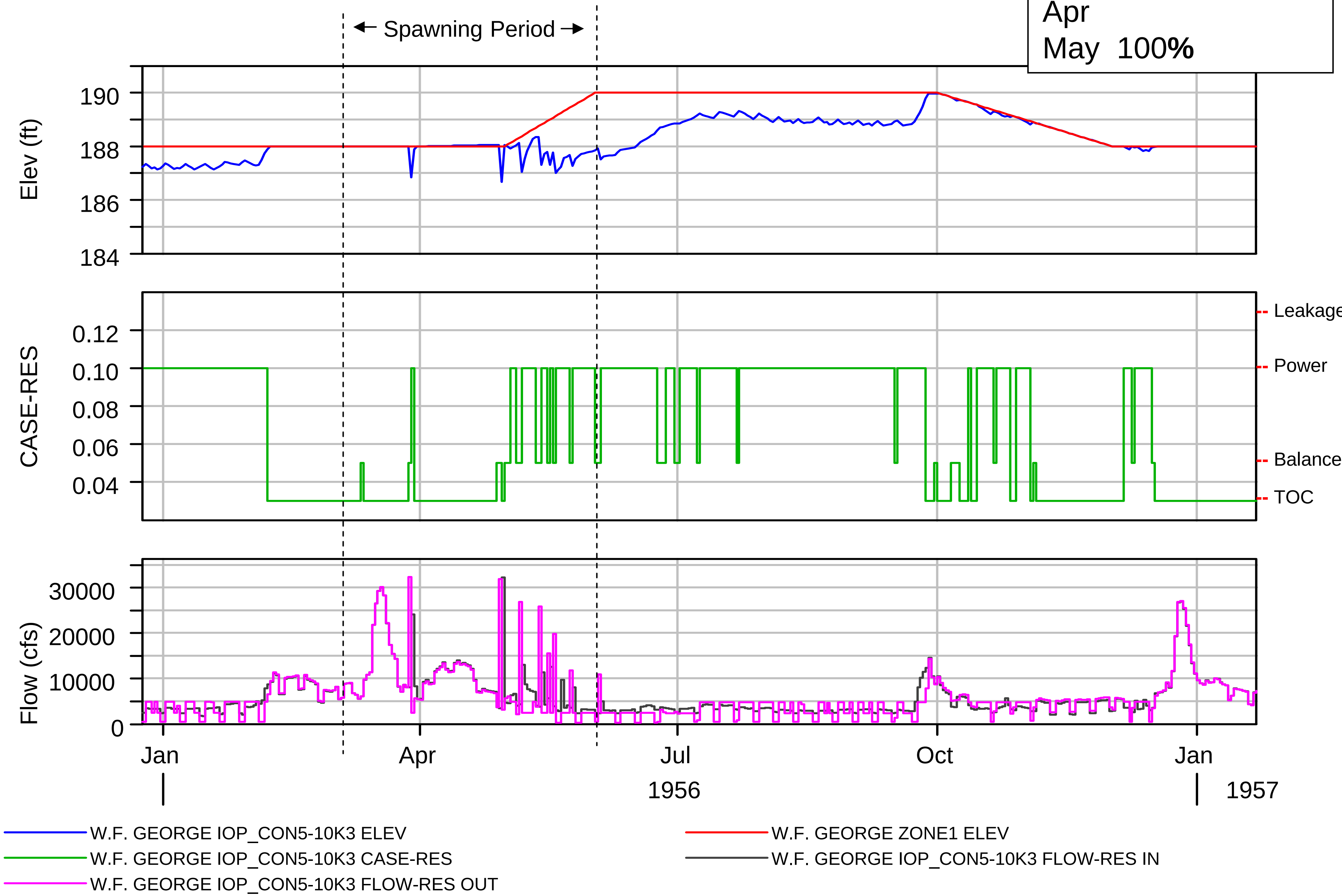
WF George 1954
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
190
188
186
184
CASE-RES
0.12
0.10
0.08
0.06
0.04
Leakage
Power
Balance
TOC
Flow (cfs)
30000
20000
10000
0
Jan
Apr
Jul
Oct
Jan
1954
1955
W.F. GEORGE IOP_CON5-10K3 ELEV
W.F. GEORGE IOP_CON5-10K3 CASE-RES
W.F. GEORGE IOP_CON5-10K3 FLOW-RES OUT
W.F. GEORGE ZONE1 ELEV
W.F. GEORGE IOP_CON5-10K3 FLOW-RES IN



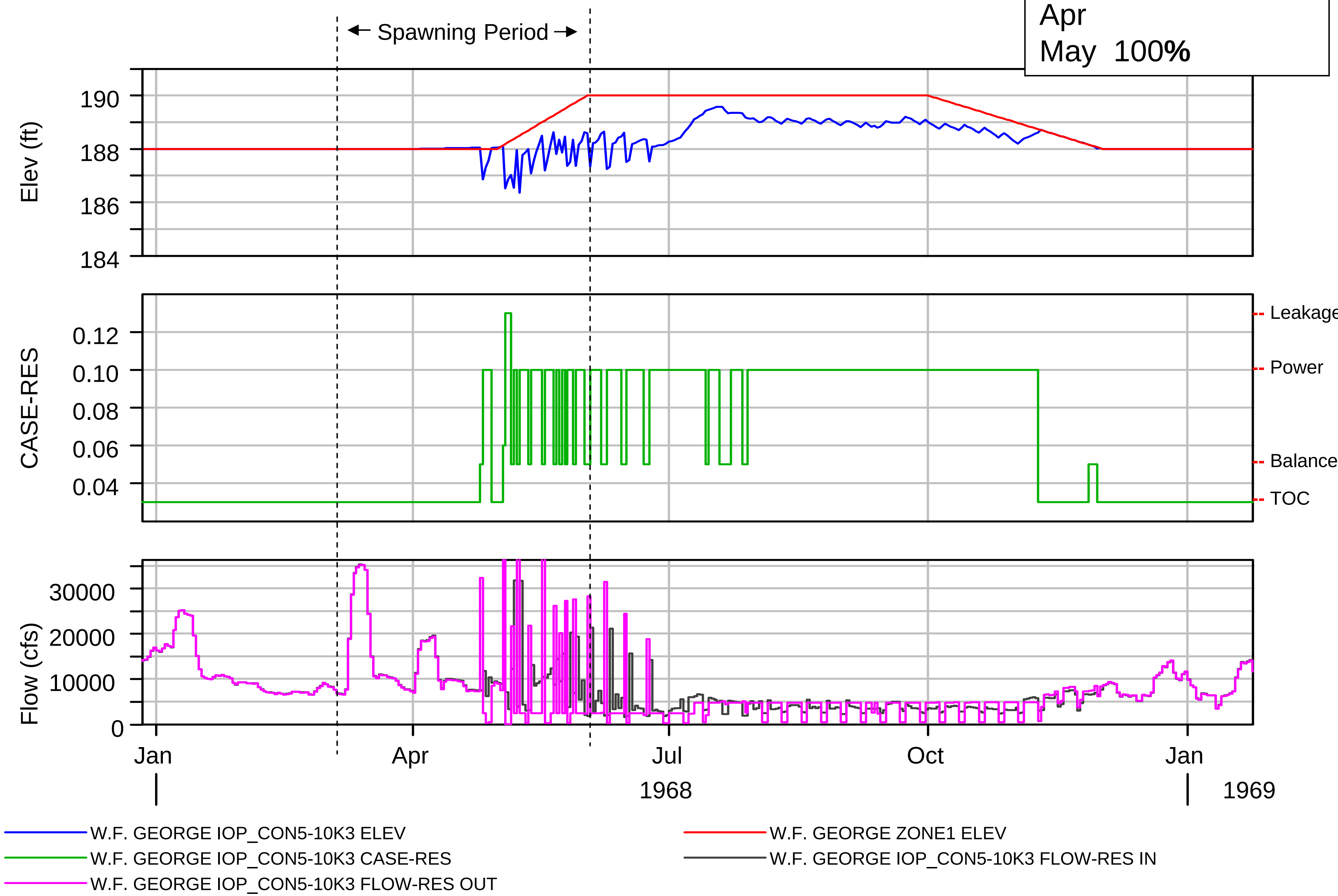
WF George 1955
% Time BI Released
Mar 100%
Apr
May 100%
Spawning Period
Elev (ft)
190
188
186
184
CASE-RES
0.12
0.10
0.08
0.06
0.04
Leakage
Power
Balance
TOC
Flow (cfs)
30000
20000
10000
0
Jan
Apr
Jul
Oct
Jan
1954
1955
1956
W.F. GEORGE IOP_CON5-10K3 ELEV
W.F. GEORGE ZONE1 ELEV
W.F. GEORGE IOP_CON5-10K3 CASE-RES
W.F. GEORGE IOP_CON5-10K3 FLOW-RES IN
W.F. GEORGE IOP_CON5-10K3 FLOW-RES OUT

WF George 1956

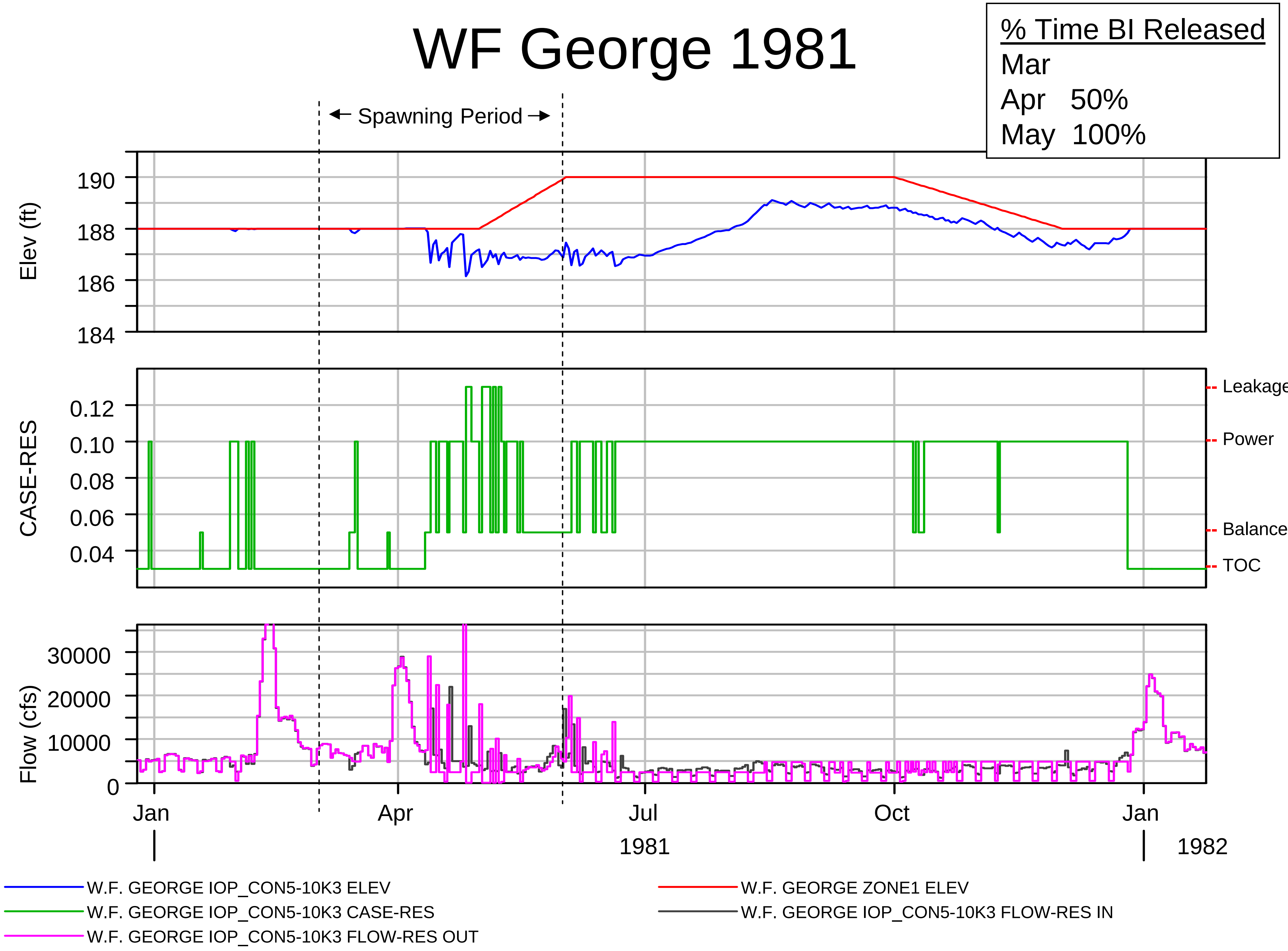
% Time BI Released	
Mar	
Apr	
May	100%

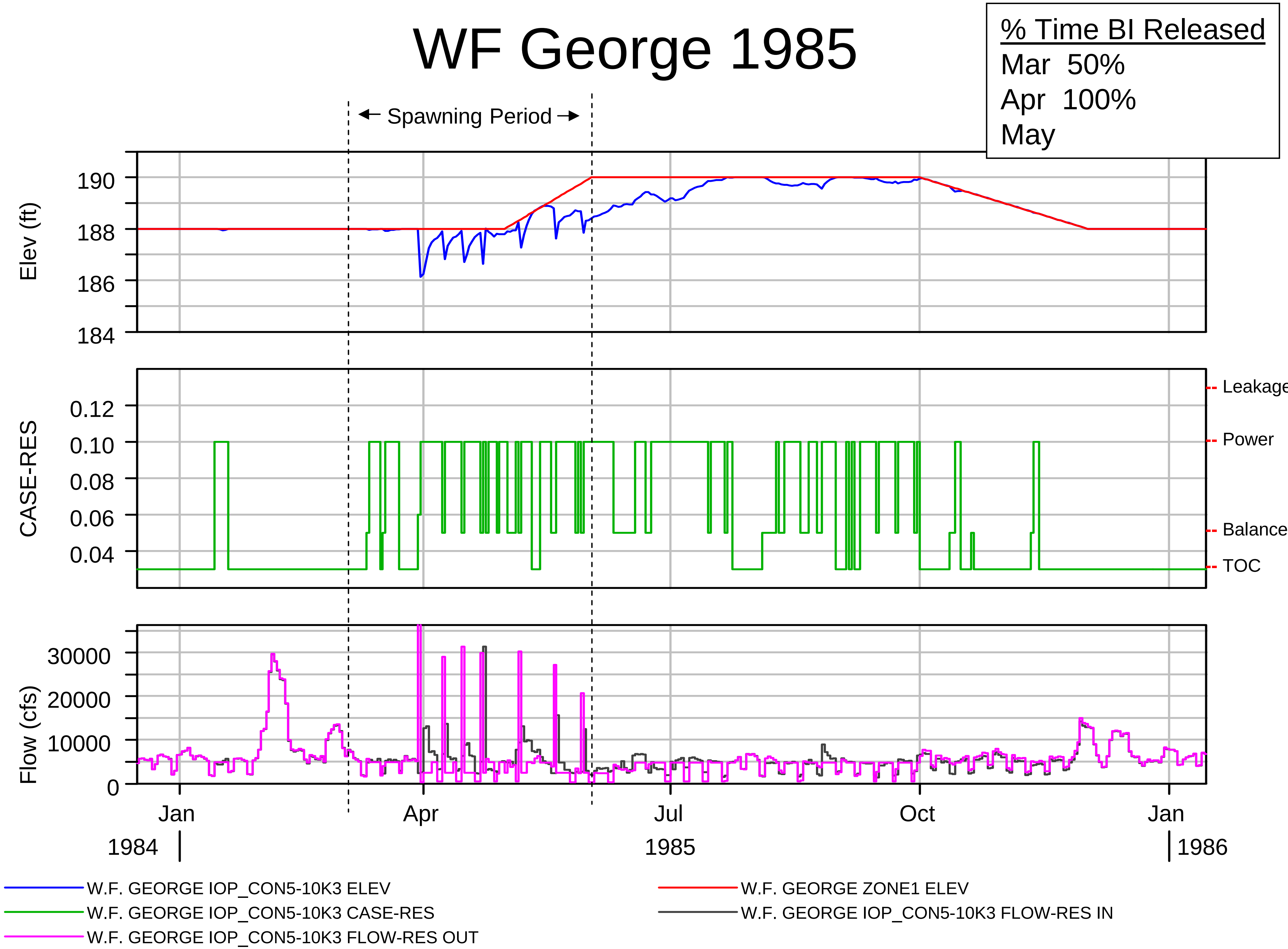


WF George 1968



WF George 1981

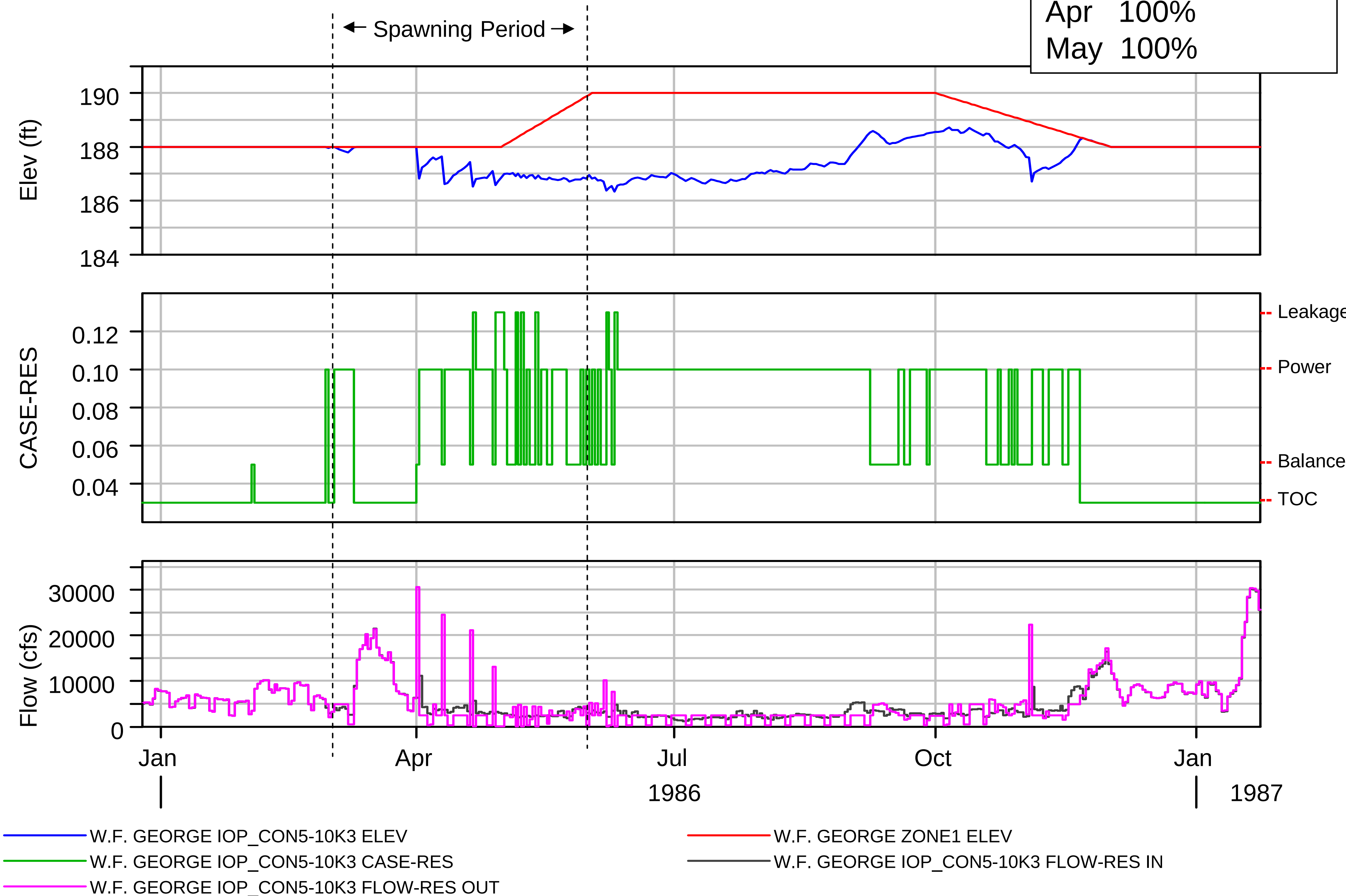


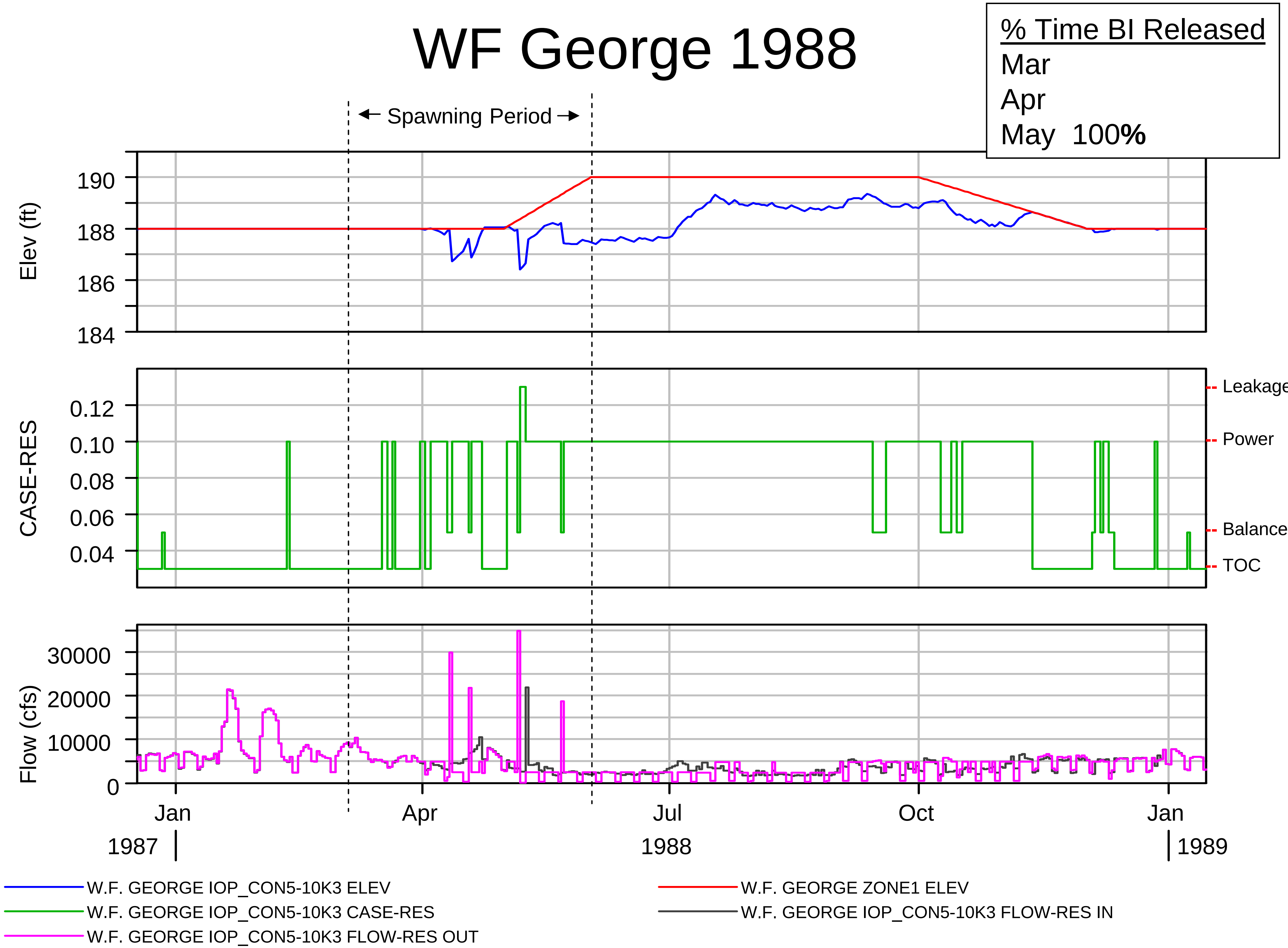


WF George 1985
% Time BI Released
Mar 50%
Apr 100%
May
Spawning Period
Elev (ft)
190
188
186
184
CASE-RES
0.12
0.10
0.08
0.06
0.04
Leakage
Power
Balance
TOC
Flow (cfs)
30000
20000
10000
0
Jan
Apr
Jul
Oct
Jan
1984
1985
1986
W.F. GEORGE IOP_CON5-10K3 ELEV
W.F. GEORGE ZONE1 ELEV
W.F. GEORGE IOP_CON5-10K3 CASE-RES
W.F. GEORGE IOP_CON5-10K3 FLOW-RES IN
W.F. GEORGE IOP_CON5-10K3 FLOW-RES OUT

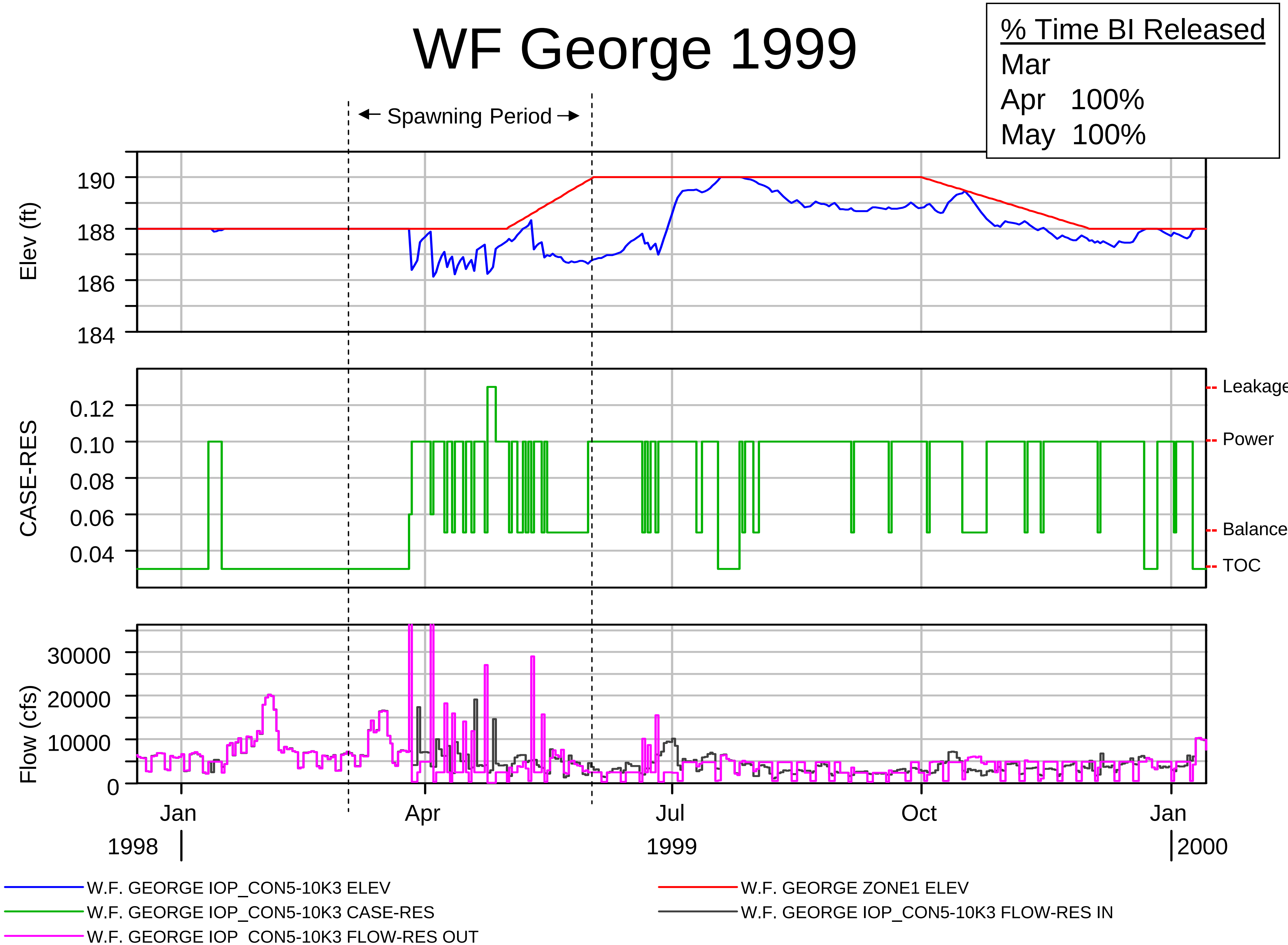
WF George 1986

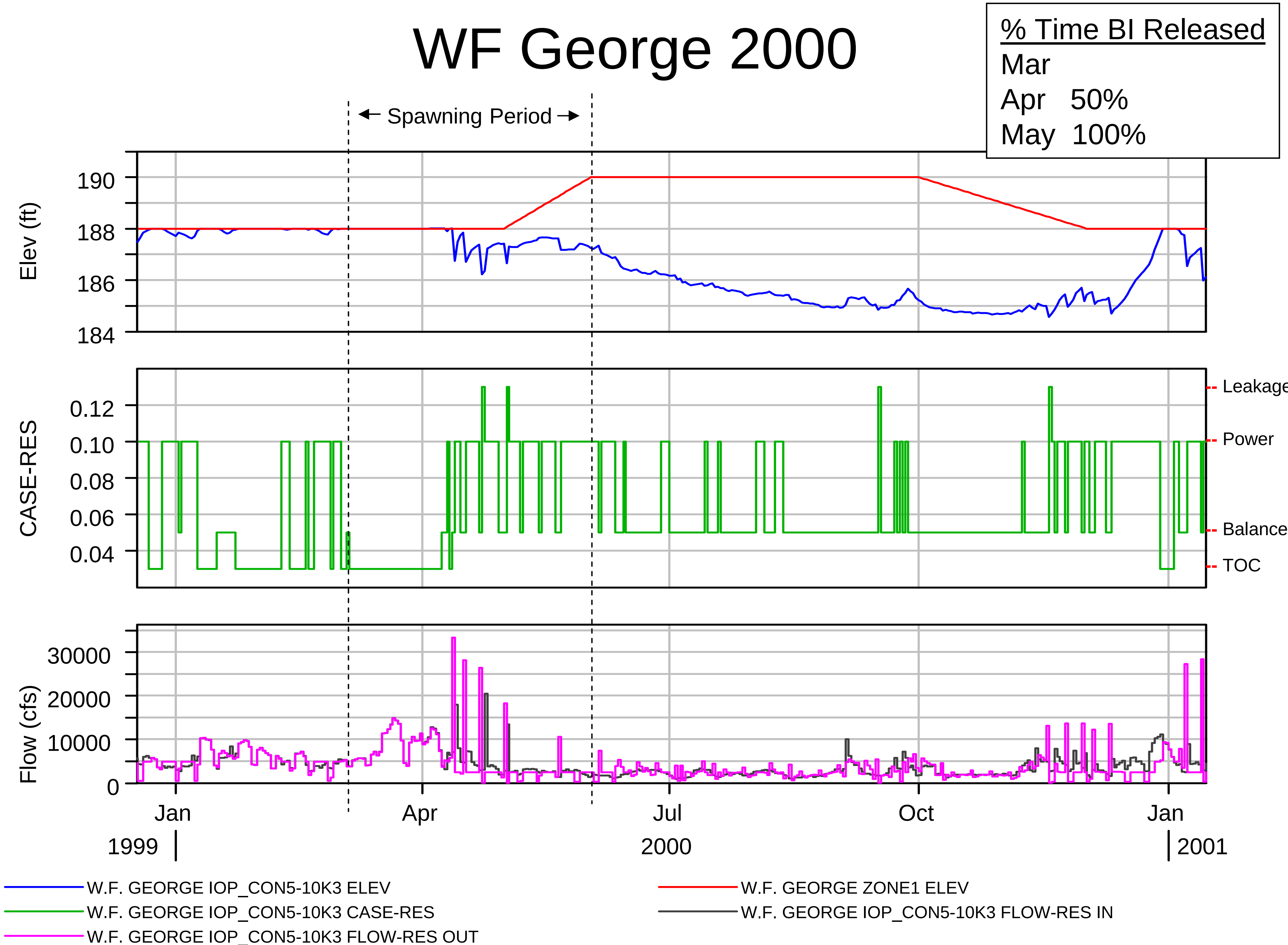
% Time BI Released	
Mar	
Apr	100%
May	100%





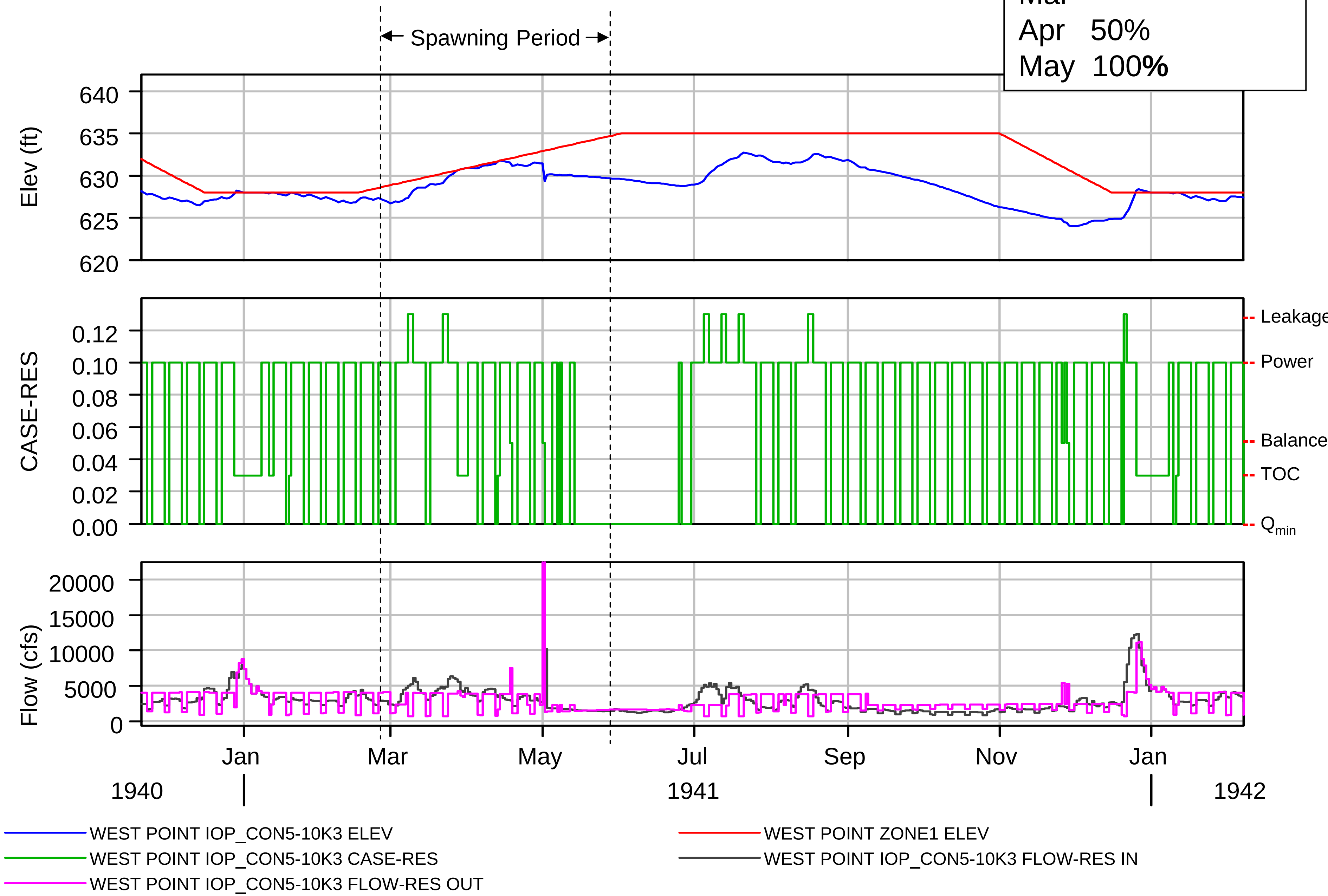
WF George 1988
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
190
188
186
184
CASE-RES
0.12
0.10
0.08
0.06
0.04
Leakage
Power
Balance
TOC
Flow (cfs)
30000
20000
10000
0
Jan
Apr
Jul
Oct
Jan
1987
1988
1989
W.F. GEORGE IOP_CON5-10K3 ELEV
W.F. GEORGE ZONE1 ELEV
W.F. GEORGE IOP_CON5-10K3 CASE-RES
W.F. GEORGE IOP_CON5-10K3 FLOW-RES IN
W.F. GEORGE IOP_CON5-10K3 FLOW-RES OUT

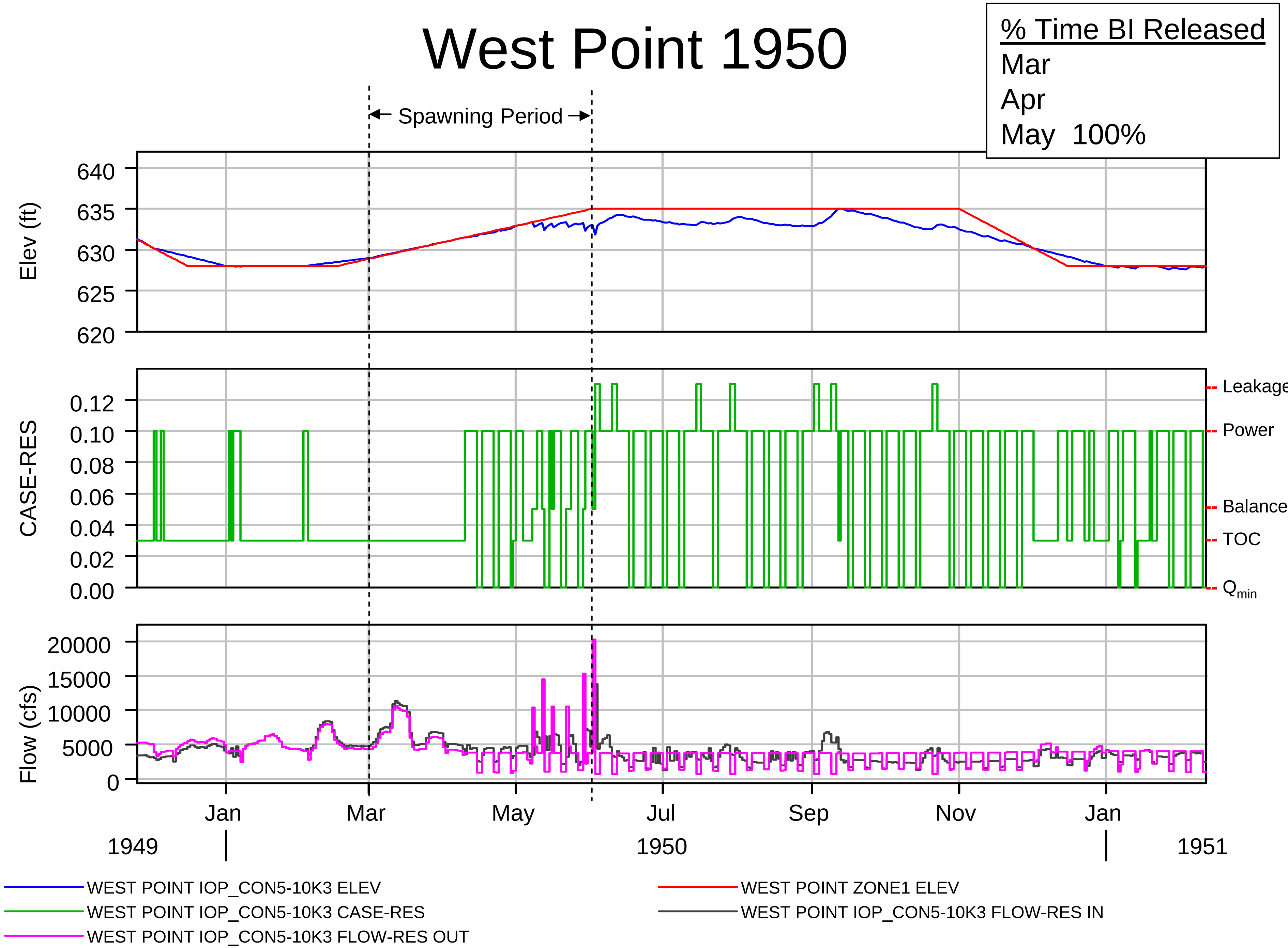

WF George 1999
% Time BI Released
Mar
Apr 100%
May 100%
Spawning Period
Elev (ft)
190
188
186
184
CASE-RES
0.12
0.10
0.08
0.06
0.04
Leakage
Power
Balance
TOC
Flow (cfs)
30000
20000
10000
0
Jan
Apr
Jul
Oct
Jan
1998
1999
2000
W.F. GEORGE IOP_CON5-10K3 ELEV
W.F. GEORGE ZONE1 ELEV
W.F. GEORGE IOP_CON5-10K3 CASE-RES
W.F. GEORGE IOP_CON5-10K3 FLOW-RES IN
W.F. GEORGE IOP_CON5-10K3 FLOW-RES OUT



WF George 2000
% Time BI Released
Mar
Apr 50%
May 100%
Spawning Period
Elev (ft)
190
188
186
184
CASE-RES
0.12
0.10
0.08
0.06
0.04
Leakage
Power
Balance
TOC
Flow (cfs)
30000
20000
10000
0
Jan
Apr
Jul
Oct
Jan
1999
2000
2001
W.F. GEORGE IOP_CON5-10K3 ELEV
W.F. GEORGE ZONE1 ELEV
W.F. GEORGE IOP_CON5-10K3 CASE-RES
W.F. GEORGE IOP_CON5-10K3 FLOW-RES IN
W.F. GEORGE IOP_CON5-10K3 FLOW-RES OUT

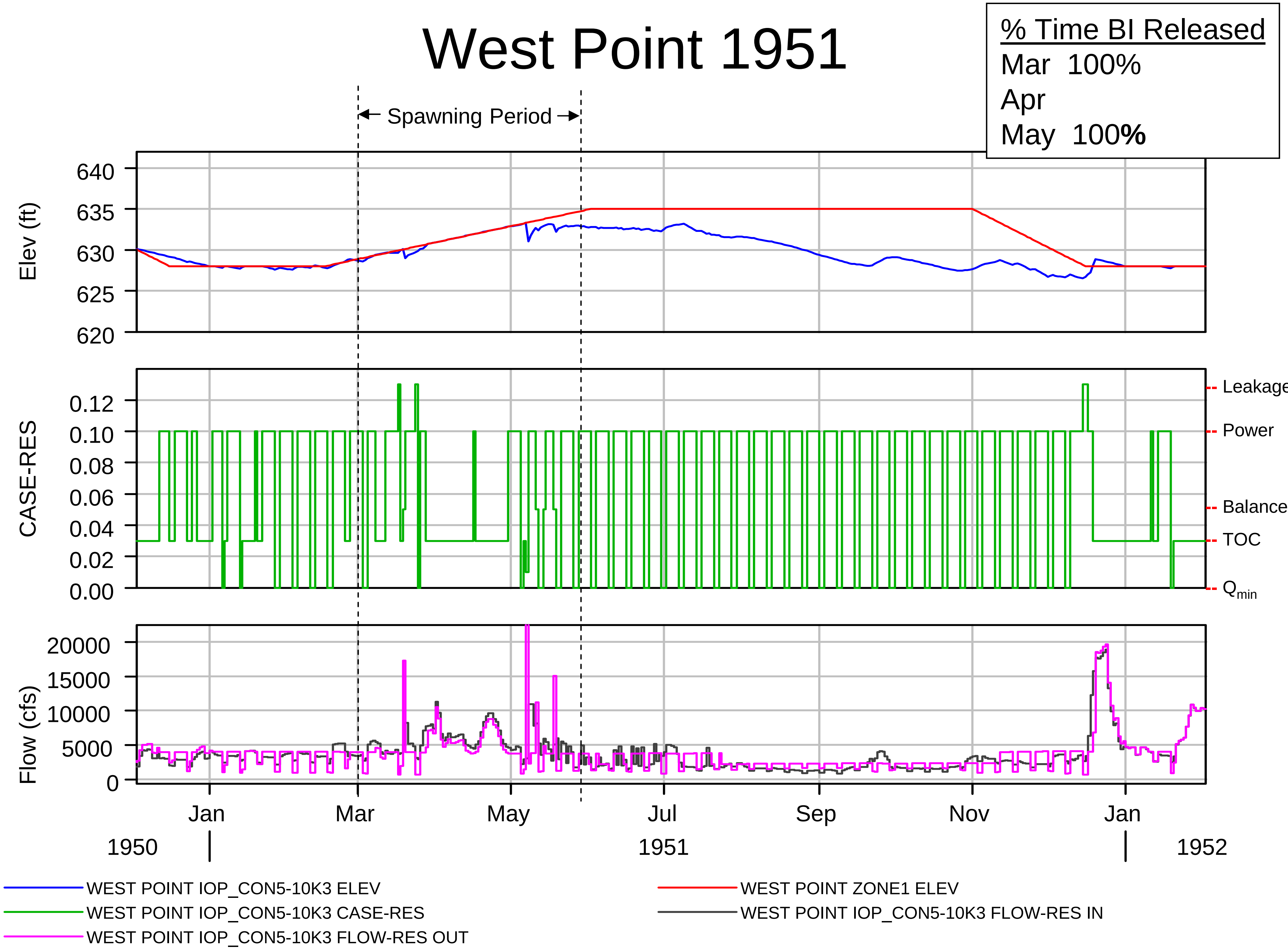
West Point 1941



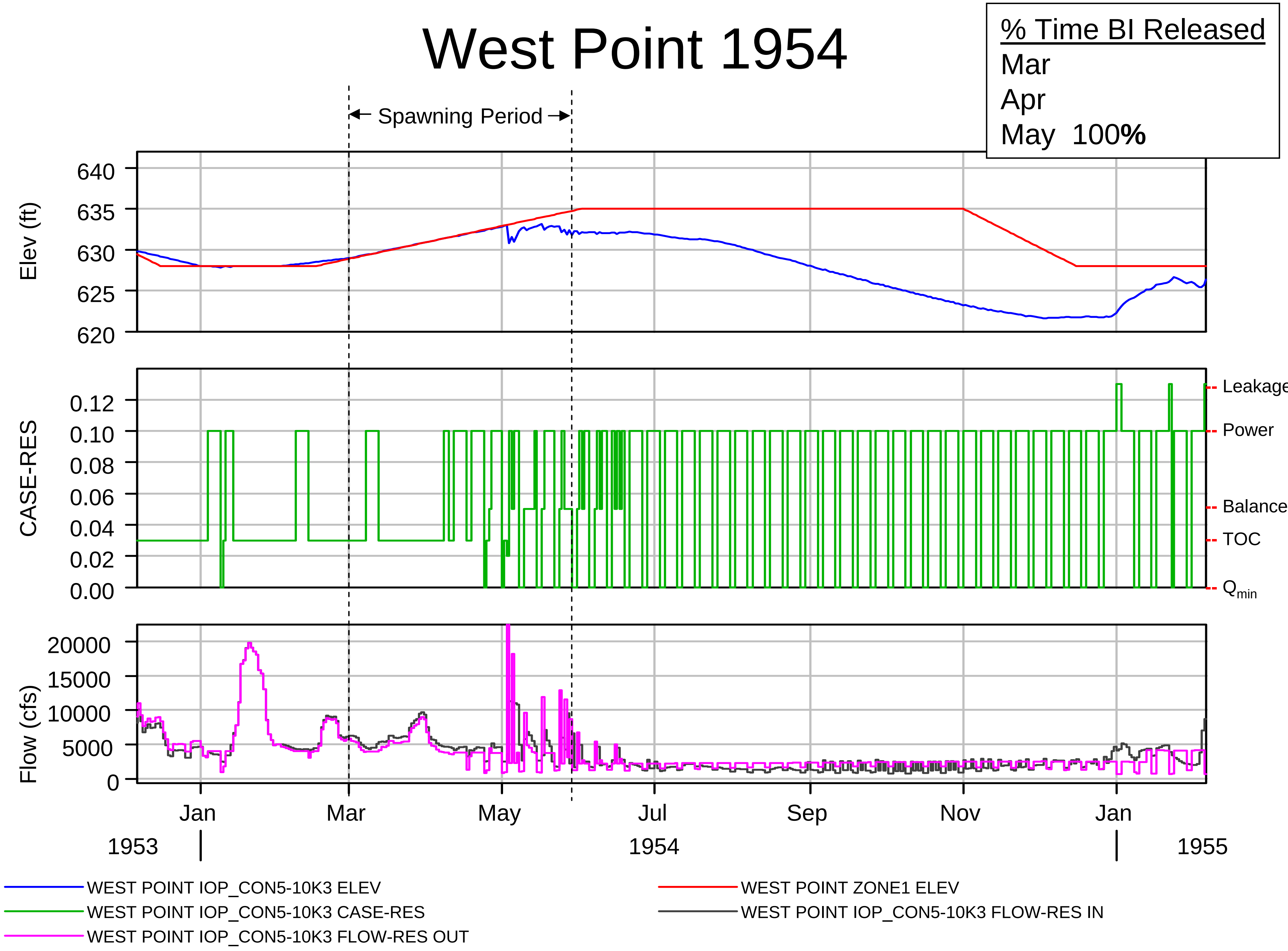


West Point 1950
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
640
635
630
625
620
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Leakage
Power
Balance
TOC
Q min
Flow (cfs)
20000
15000
10000
5000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1949
1950
1951
WEST POINT IOP_CON5-10K3 ELEV
WEST POINT ZONE1 ELEV
WEST POINT IOP_CON5-10K3 CASE-RES
WEST POINT IOP_CON5-10K3 FLOW-RES IN
WEST POINT IOP_CON5-10K3 FLOW-RES OUT

West Point 1951

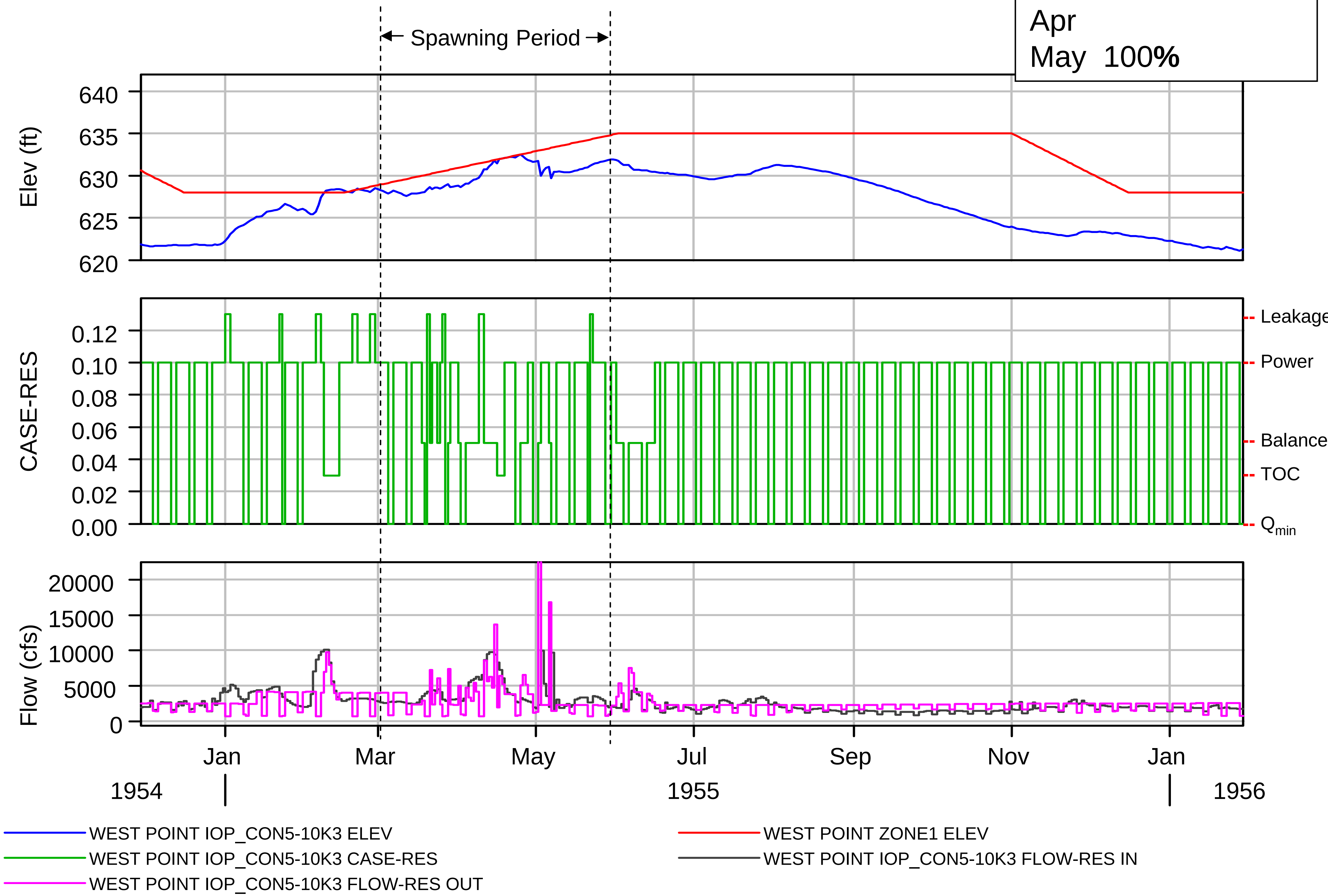


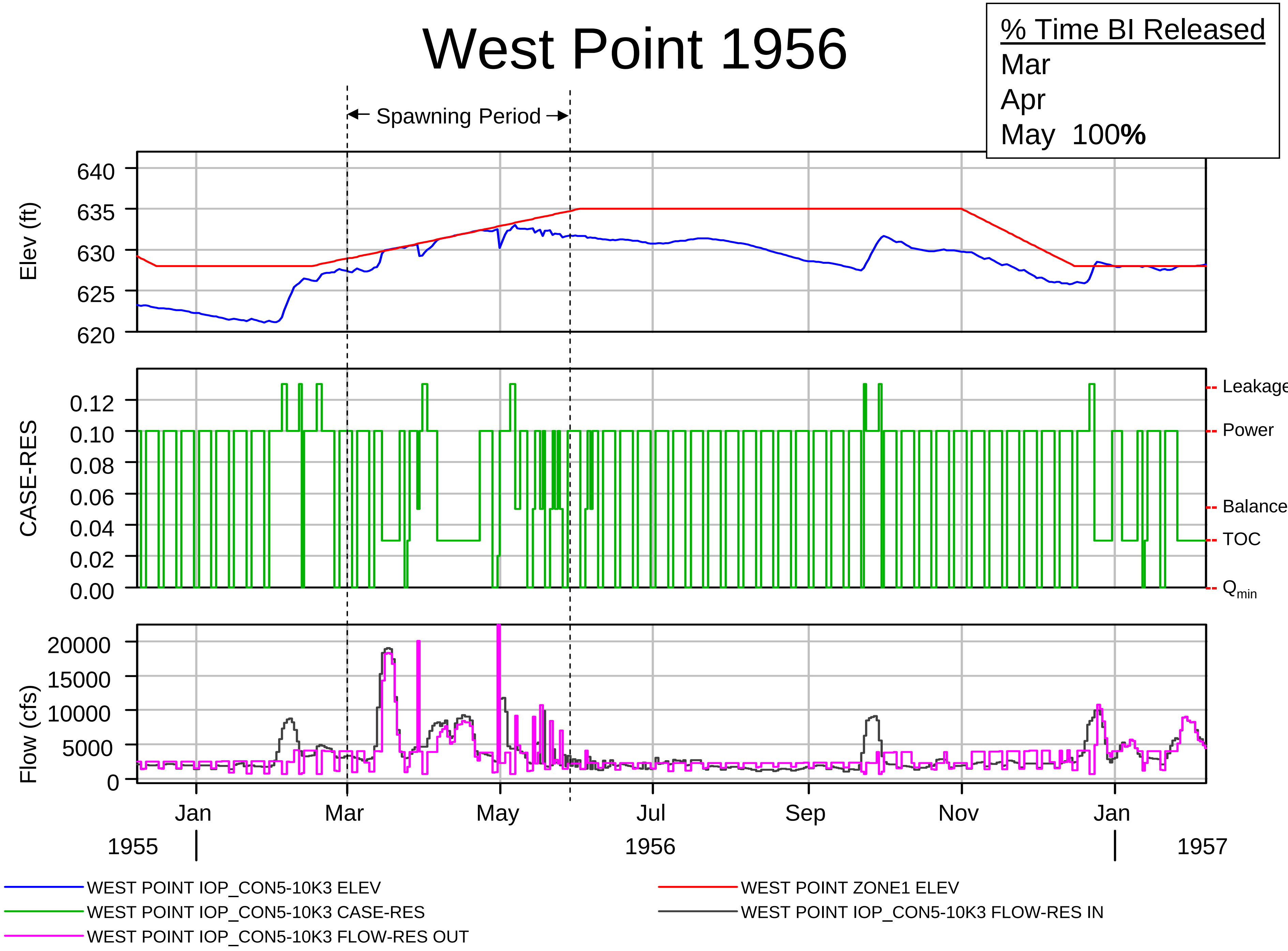
West Point 1954



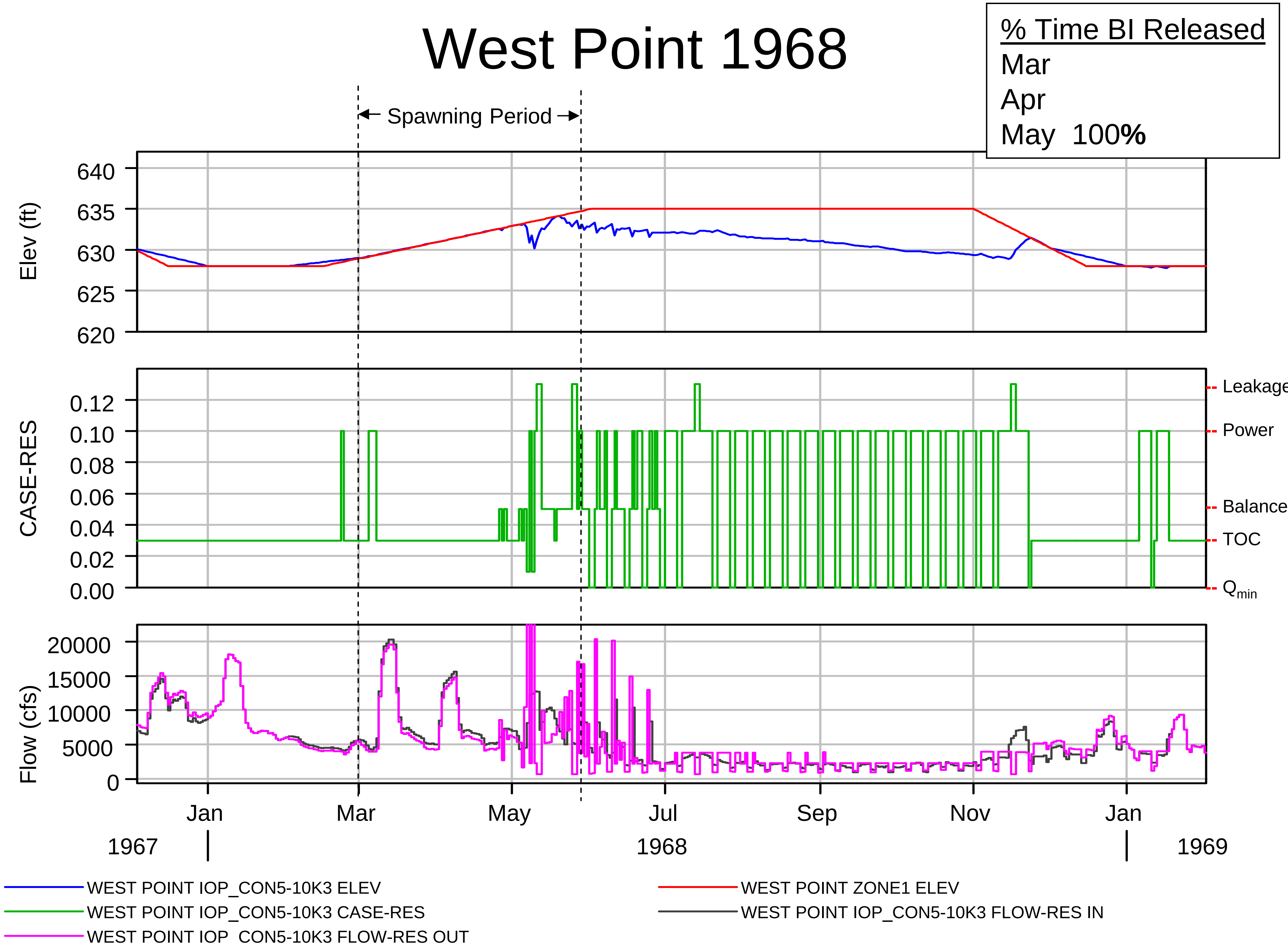
West Point 1955

% Time BI Released	
Mar	100%
Apr	
May	100%

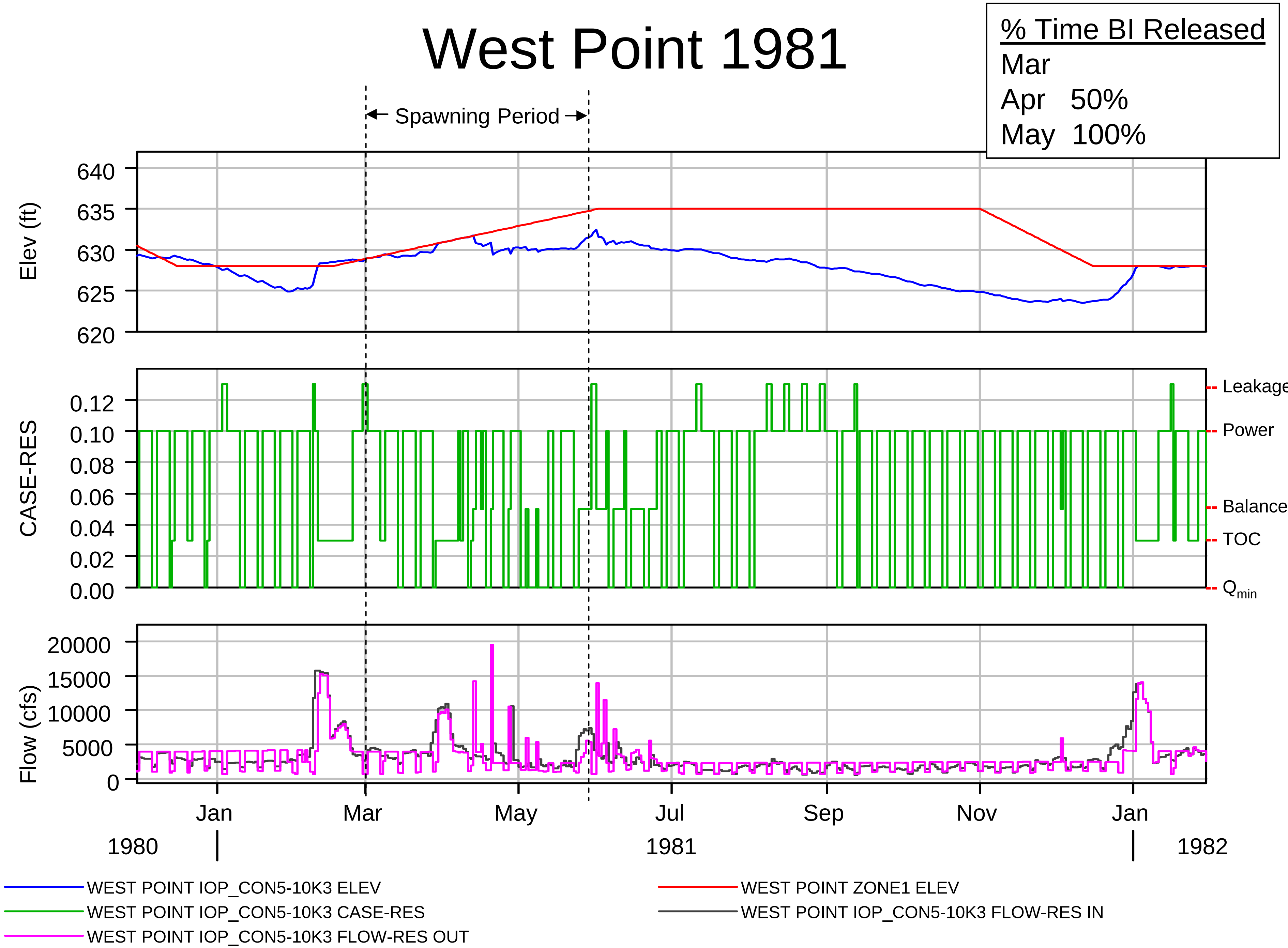




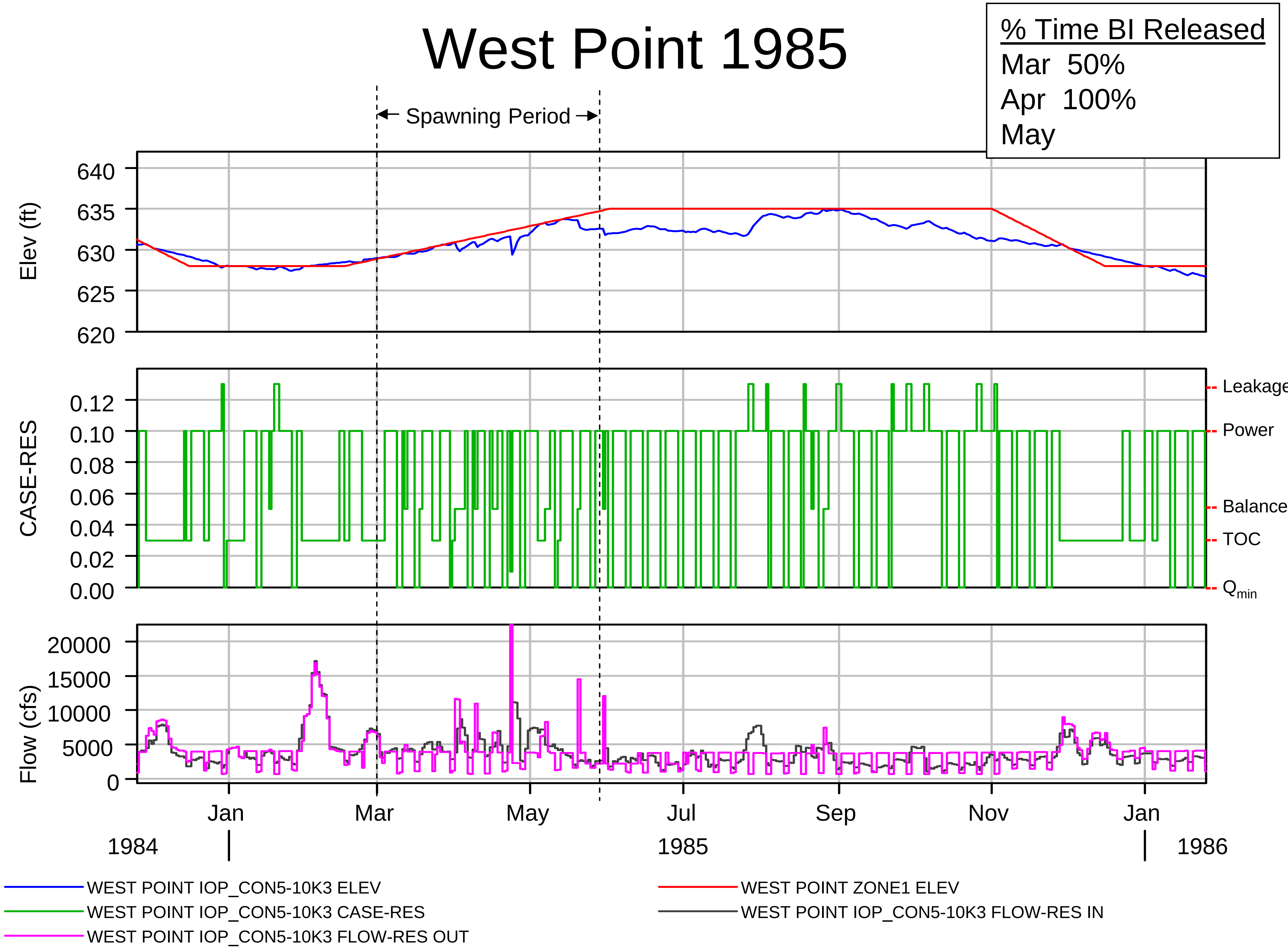
West Point 1956
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
640
635
630
625
620
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Leakage
Power
Balance
TOC
Q min
Flow (cfs)
20000
15000
10000
5000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1955
1956
1957
WEST POINT IOP_CON5-10K3 ELEV
WEST POINT ZONE1 ELEV
WEST POINT IOP_CON5-10K3 CASE-RES
WEST POINT IOP_CON5-10K3 FLOW-RES IN
WEST POINT IOP_CON5-10K3 FLOW-RES OUT

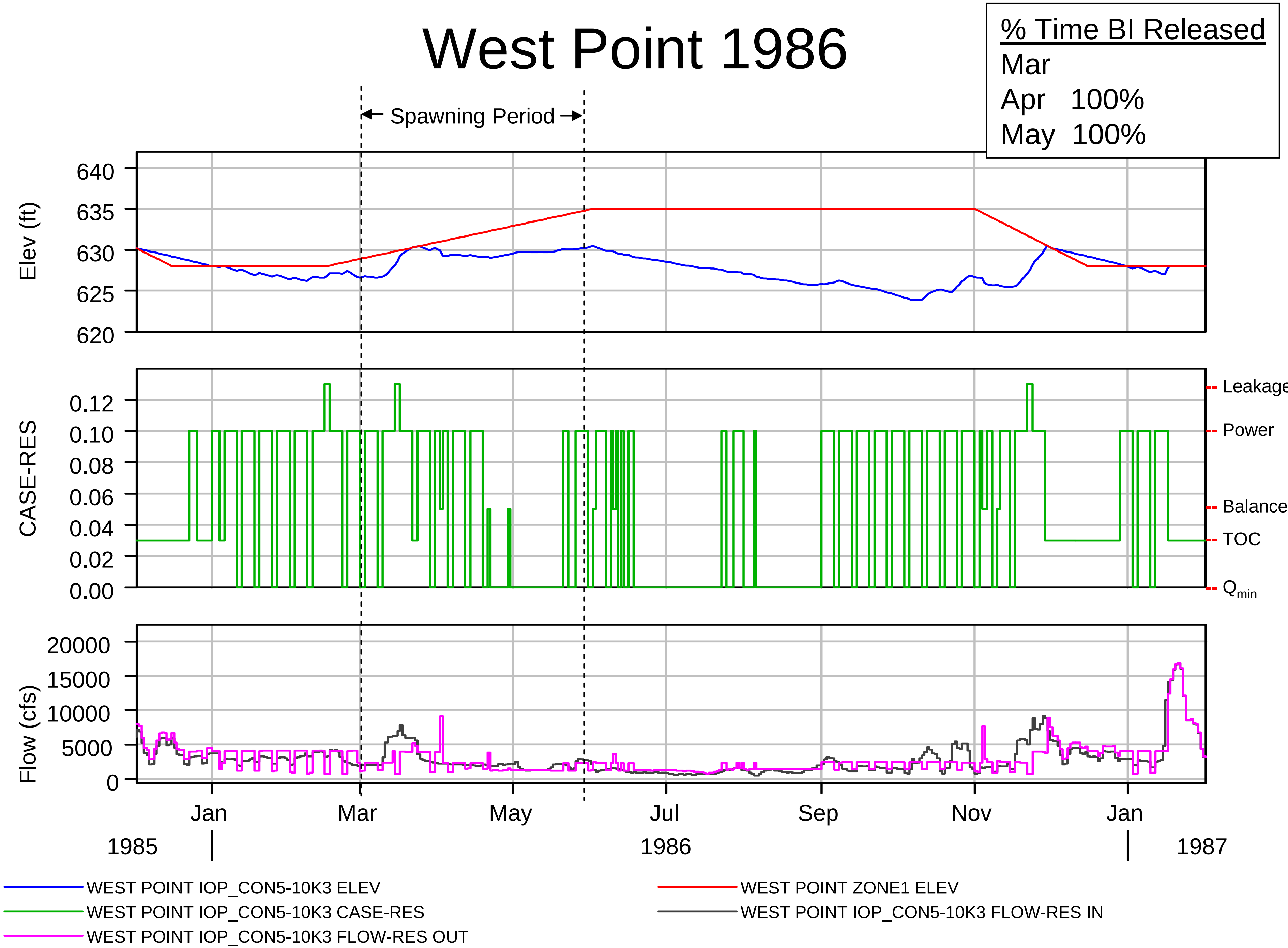


West Point 1968
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
640
635
630
625
620
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Leakage
Power
Balance
TOC
Q min
Flow (cfs)
20000
15000
10000
5000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1967
1968
1969
WEST POINT IOP_CON5-10K3 ELEV
WEST POINT ZONE1 ELEV
WEST POINT IOP_CON5-10K3 CASE-RES
WEST POINT IOP_CON5-10K3 FLOW-RES IN
WEST POINT IOP_CON5-10K3 FLOW-RES OUT



West Point 1981
% Time BI Released
Mar
Apr 50%
May 100%
Spawning Period
Elev (ft)
640
635
630
625
620
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Leakage
Power
Balance
TOC
Qmin
Flow (cfs)
20000
15000
10000
5000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1980
1981
1982
WEST POINT IOP_CON5-10K3 ELEV
WEST POINT ZONE1 ELEV
WEST POINT IOP_CON5-10K3 CASE-RES
WEST POINT IOP_CON5-10K3 FLOW-RES IN
WEST POINT IOP_CON5-10K3 FLOW-RES OUT

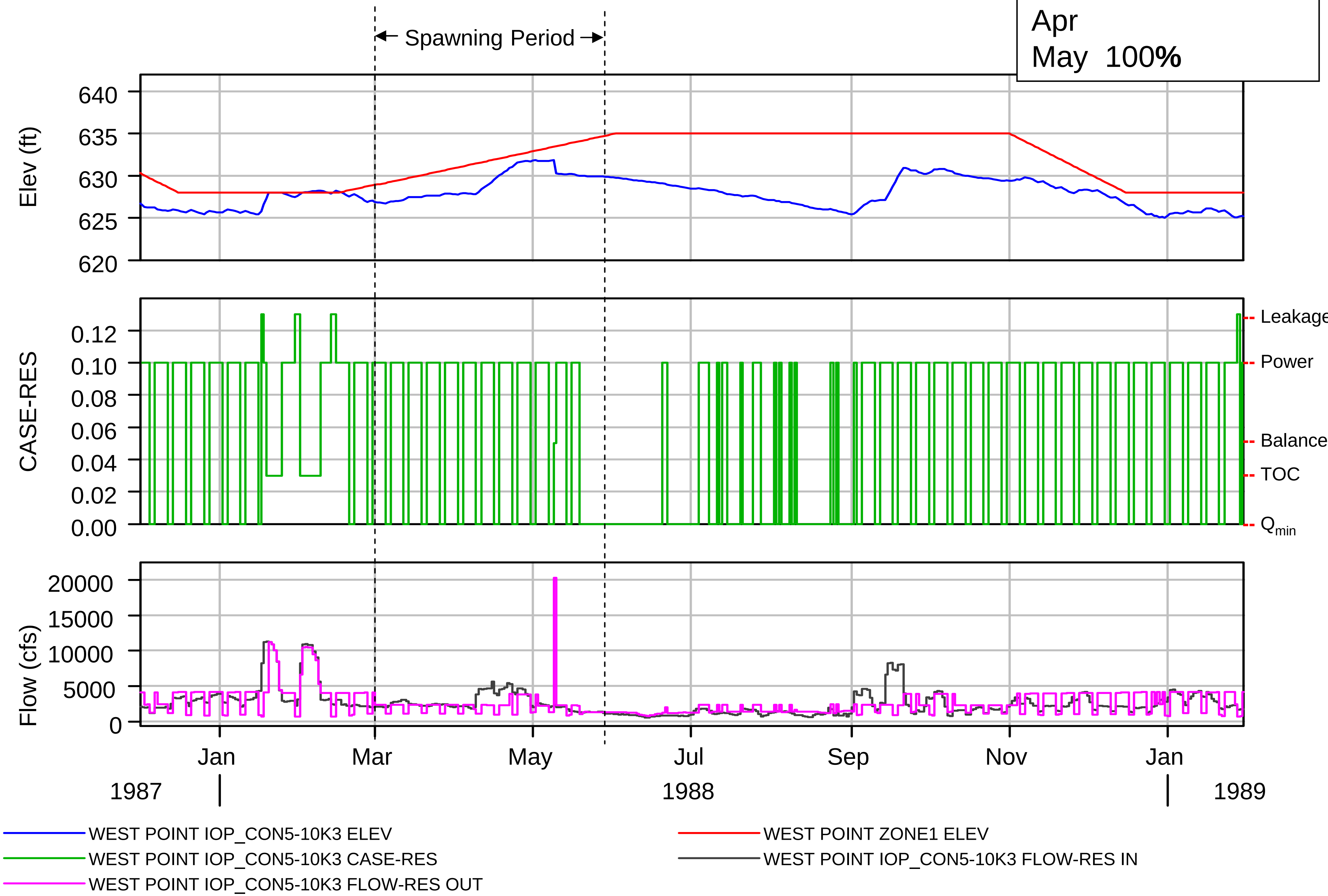

West Point 1985
% Time BI Released
Mar 50%
Apr 100%
May
Spawning Period
Elev (ft)
640
635
630
625
620
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Leakage
Power
Balance
TOC
Qmin
Flow (cfs)
20000
15000
10000
5000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1984
1985
1986
WEST POINT IOP_CON5-10K3 ELEV
WEST POINT ZONE1 ELEV
WEST POINT IOP_CON5-10K3 CASE-RES
WEST POINT IOP_CON5-10K3 FLOW-RES IN
WEST POINT IOP_CON5-10K3 FLOW-RES OUT



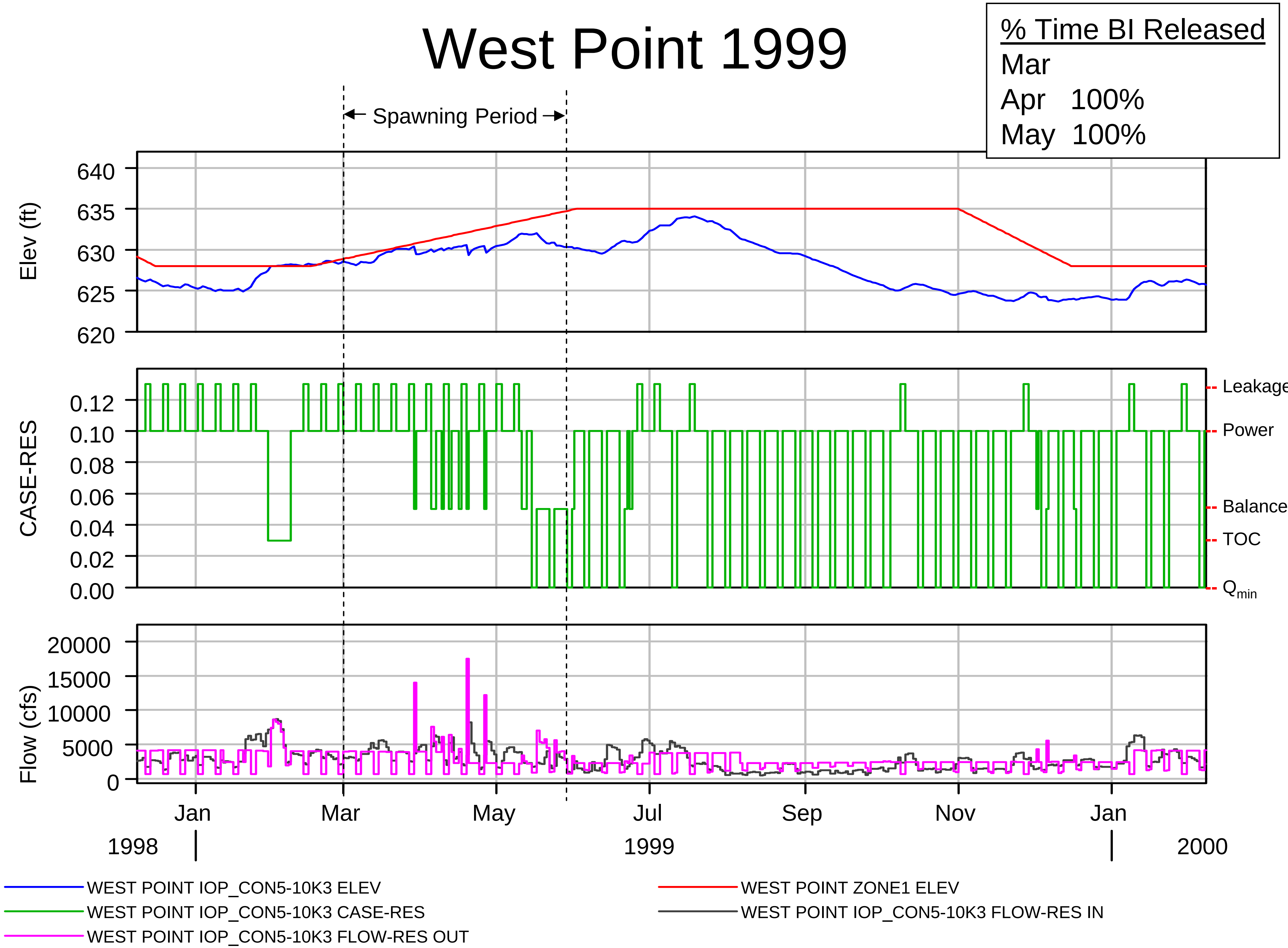
West Point 1986
% Time BI Released
Mar
Apr 100%
May 100%
Spawning Period
Elev (ft)
640
635
630
625
620
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Leakage
Power
Balance
TOC
Q_{min}
Flow (cfs)
20000
15000
10000
5000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1985
1986
1987
WEST POINT IOP_CON5-10K3 ELEV
WEST POINT ZONE1 ELEV
WEST POINT IOP_CON5-10K3 CASE-RES
WEST POINT IOP_CON5-10K3 FLOW-RES IN
WEST POINT IOP_CON5-10K3 FLOW-RES OUT

West Point 1988

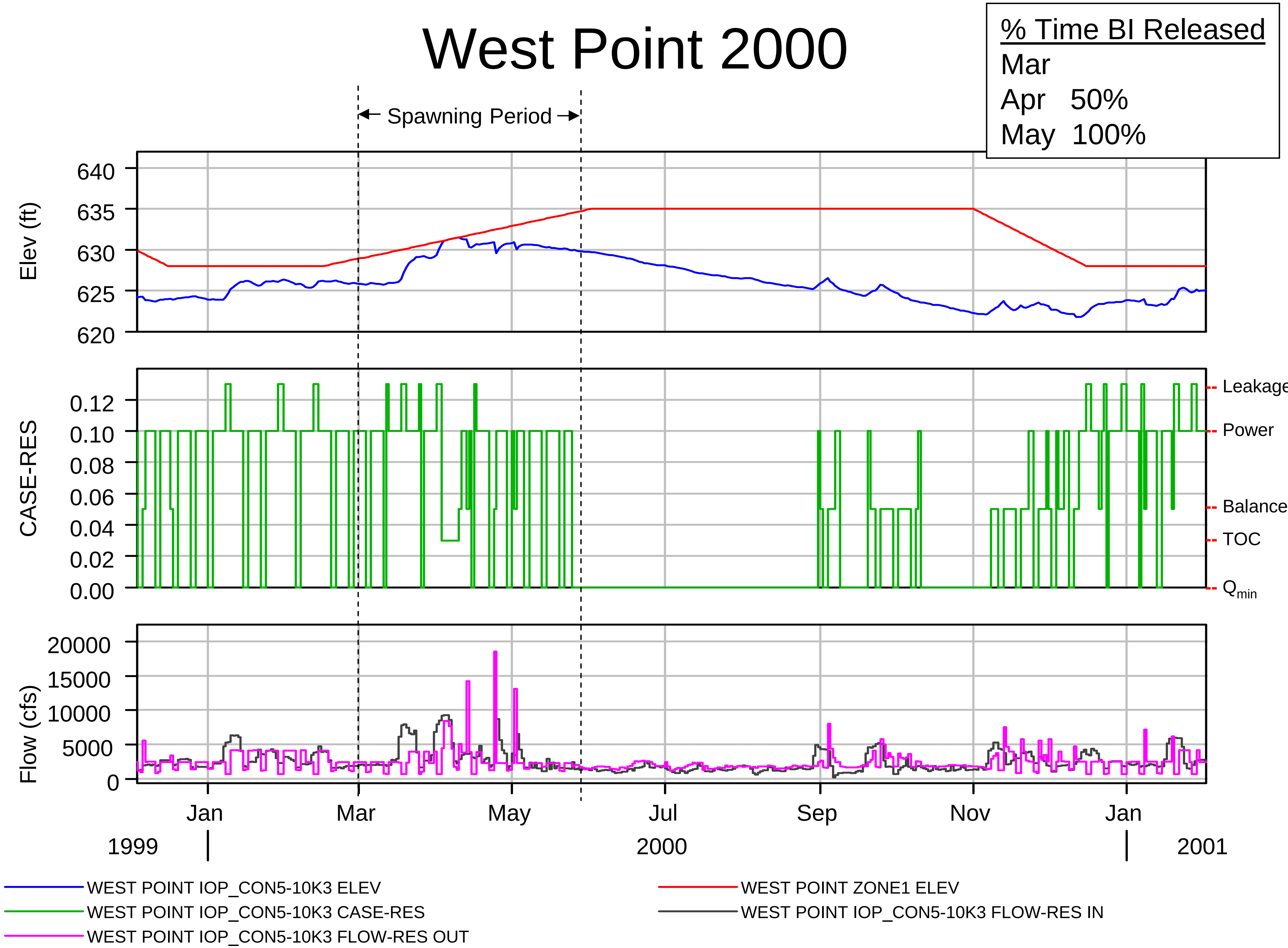
% Time BI Released
Mar
Apr
May **100%**



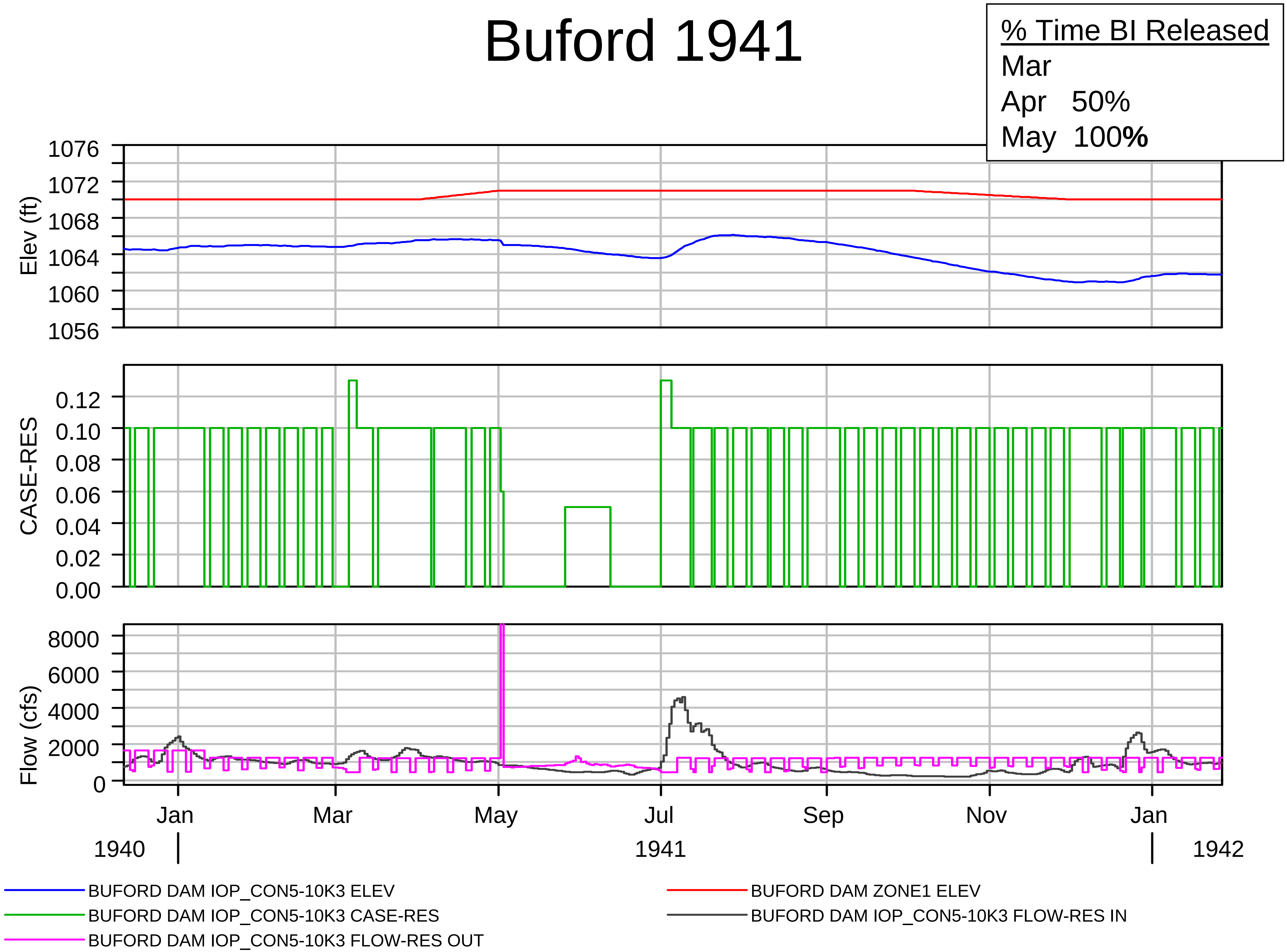
West Point 1999



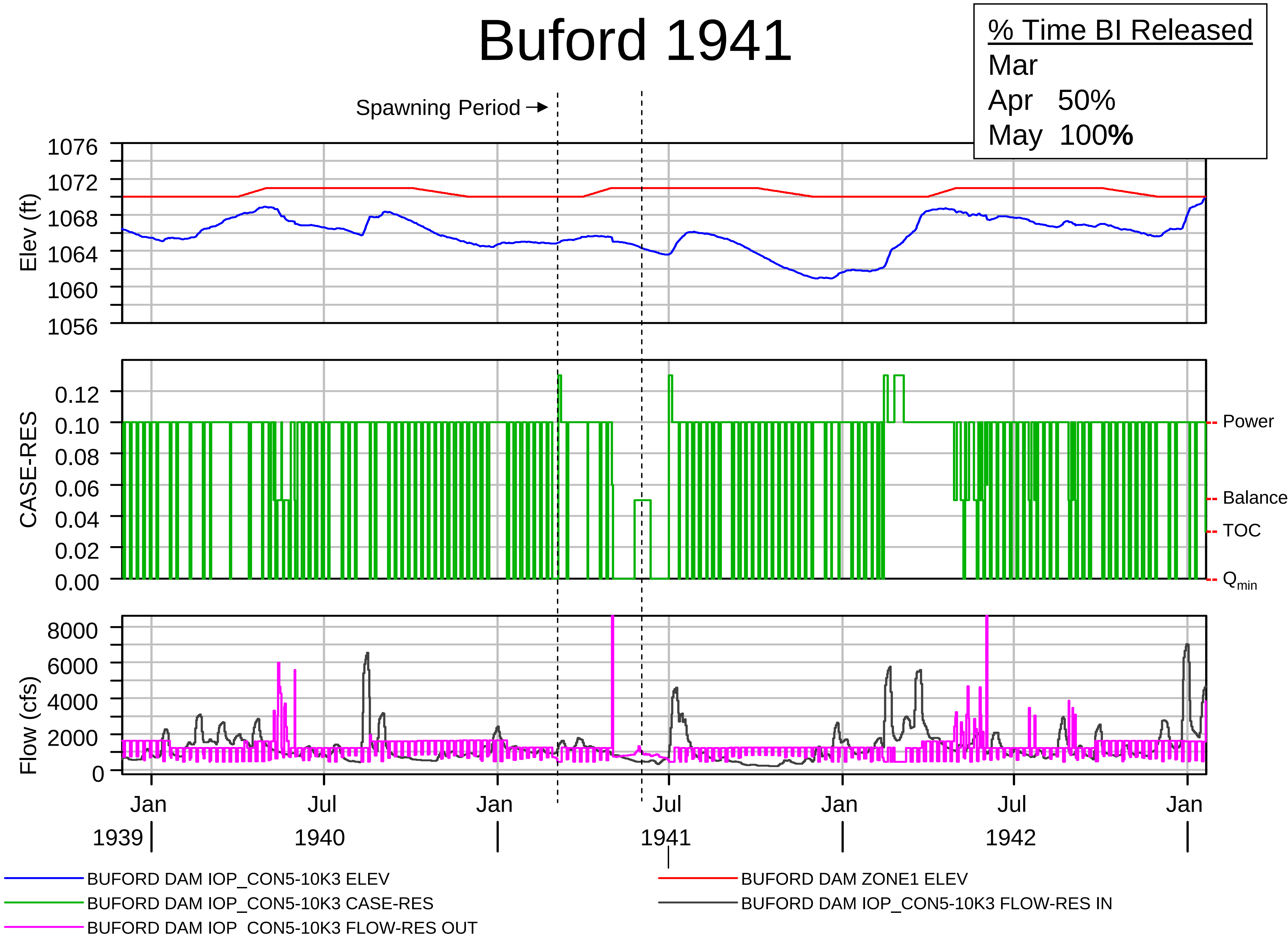
West Point 2000



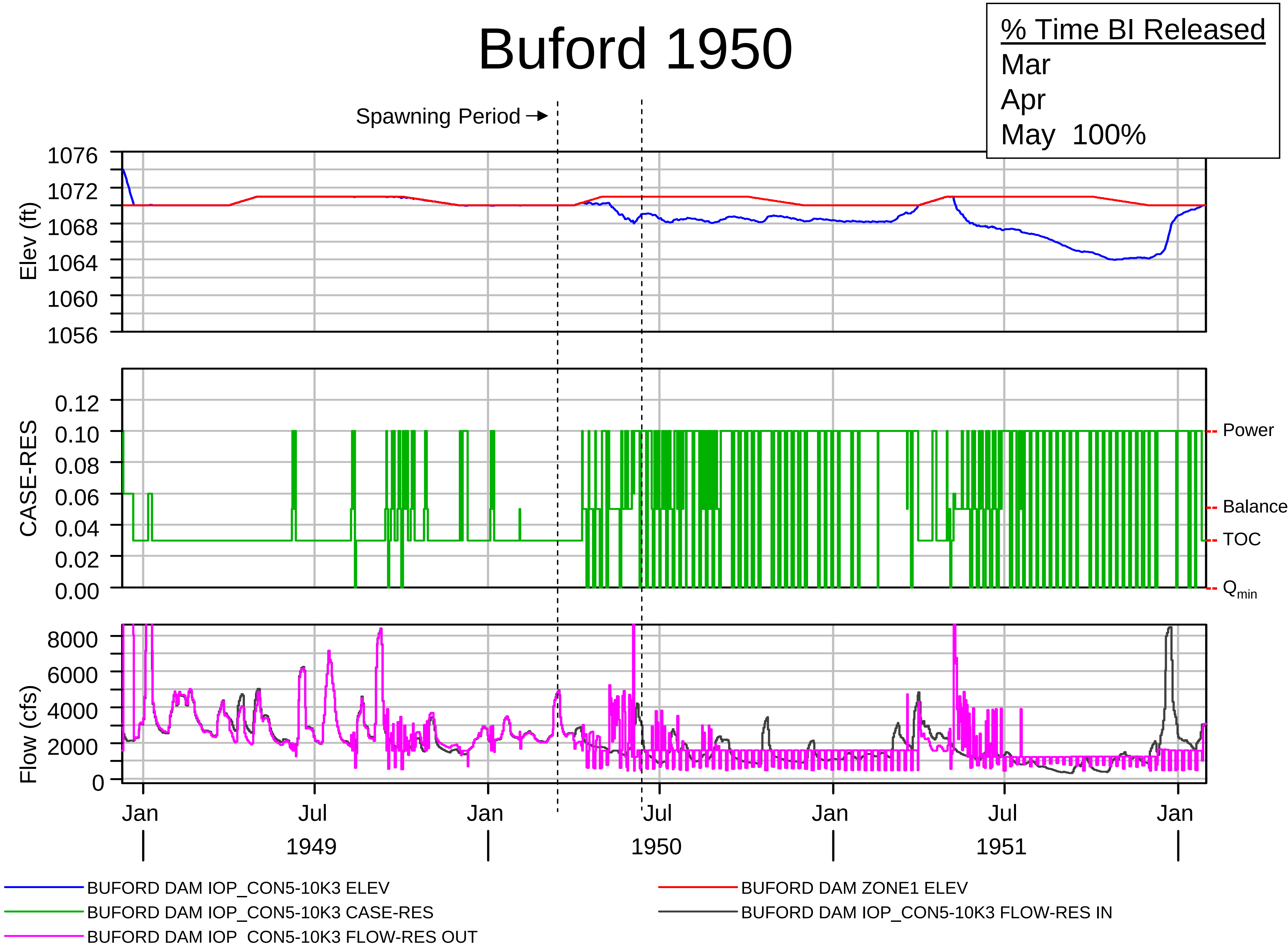
Buford 1941



% Time BI Released
Mar
Apr 50%
May 100%
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Flow (cfs)
8000
6000
4000
2000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1940
1941
1942
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

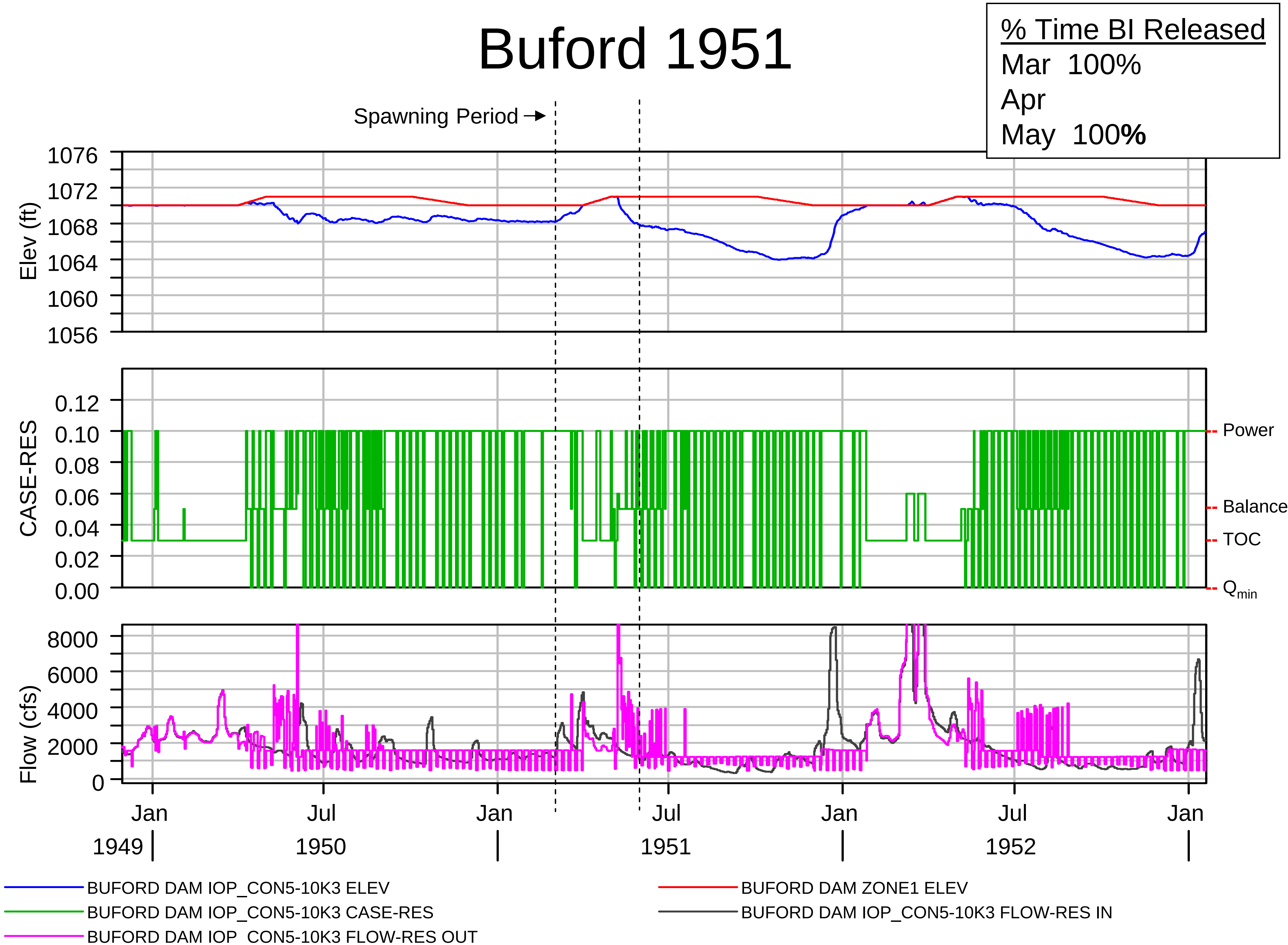


Buford 1941
% Time BI Released
Mar
Apr 50%
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1939
1940
1941
1942
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

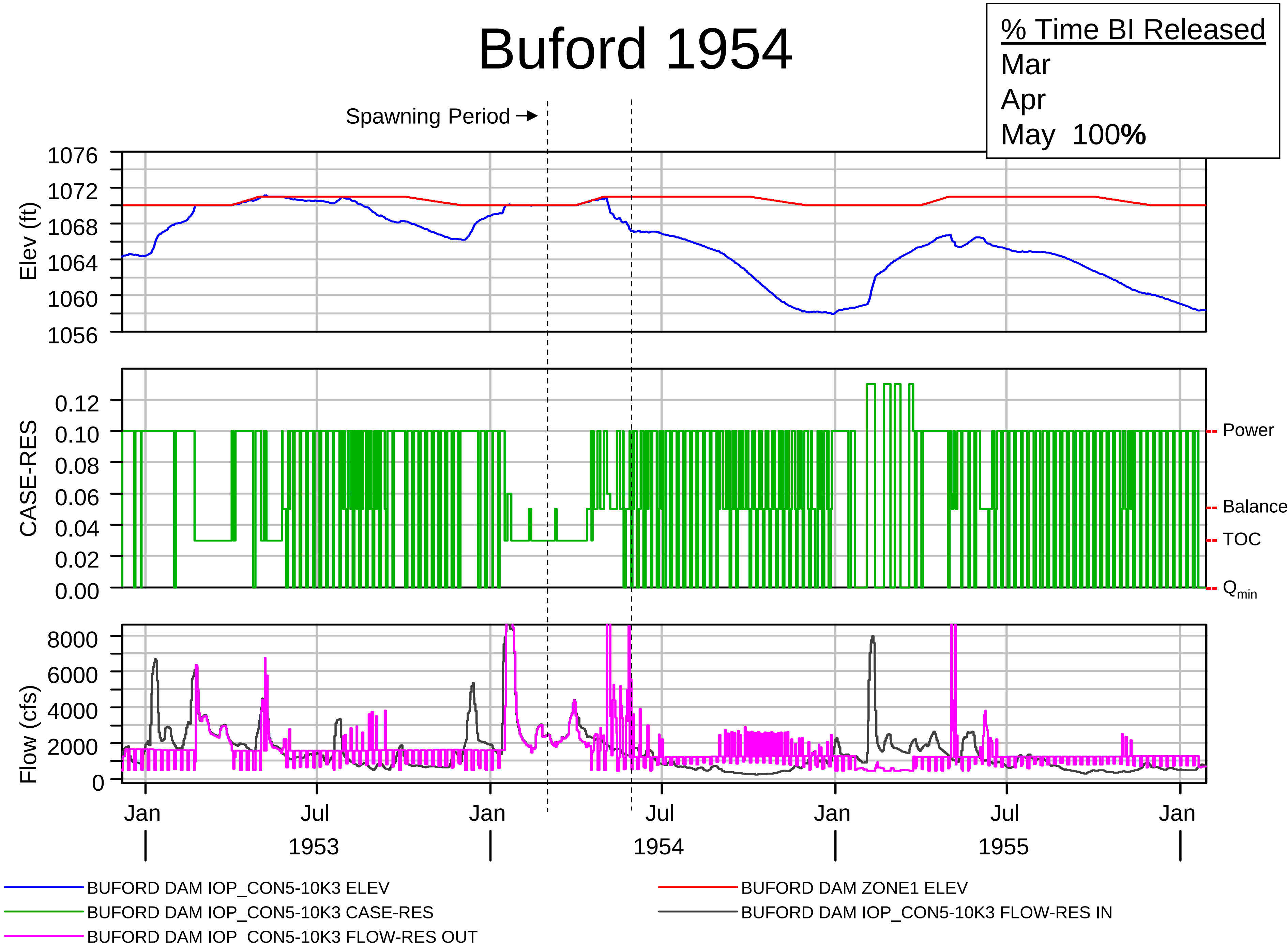


Buford 1950
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Q_{min}
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1949
1950
1951
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

Buford 1951

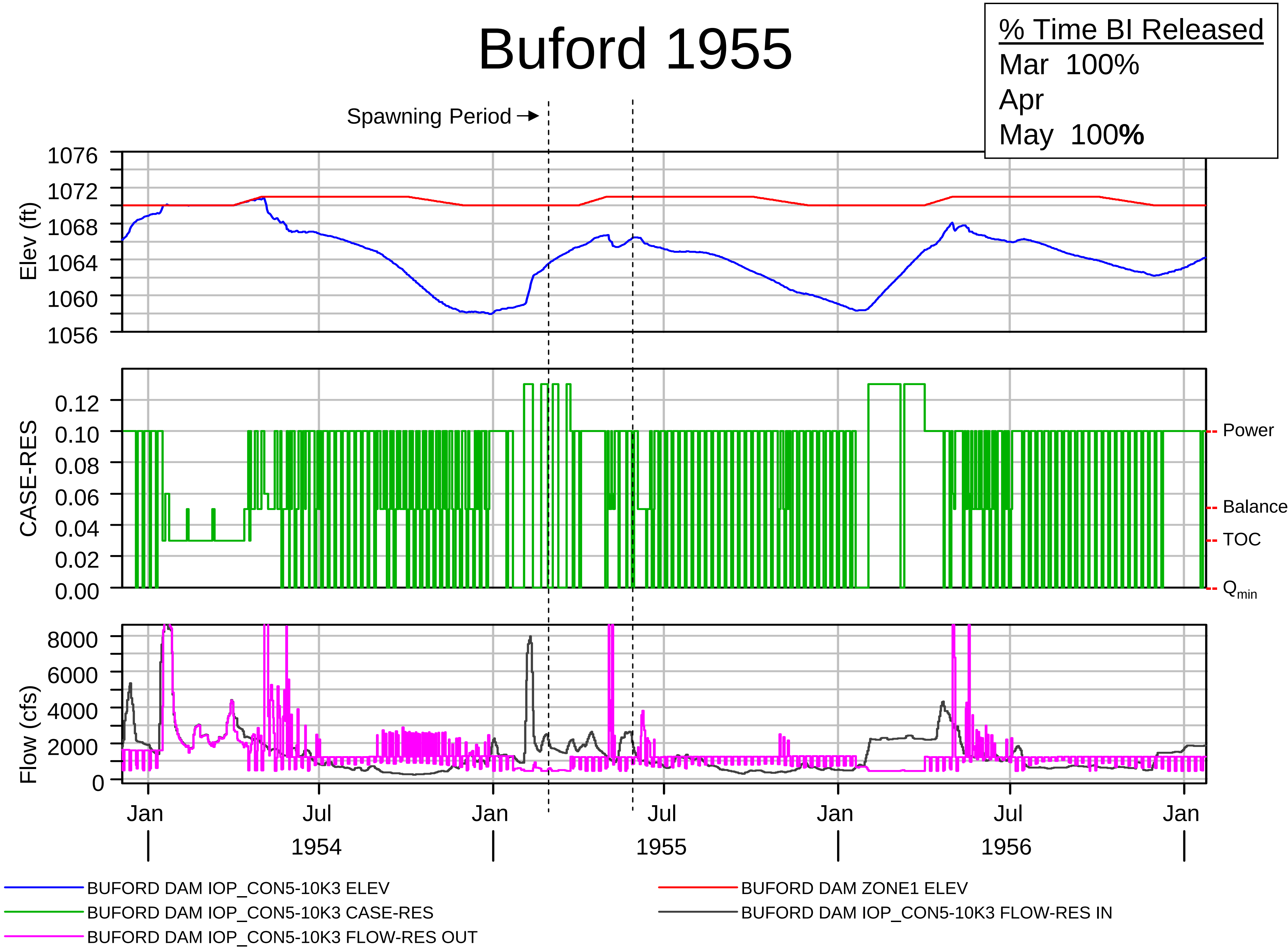


% Time BI Released
Mar 100%
Apr
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1949
1950
1951
1952
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

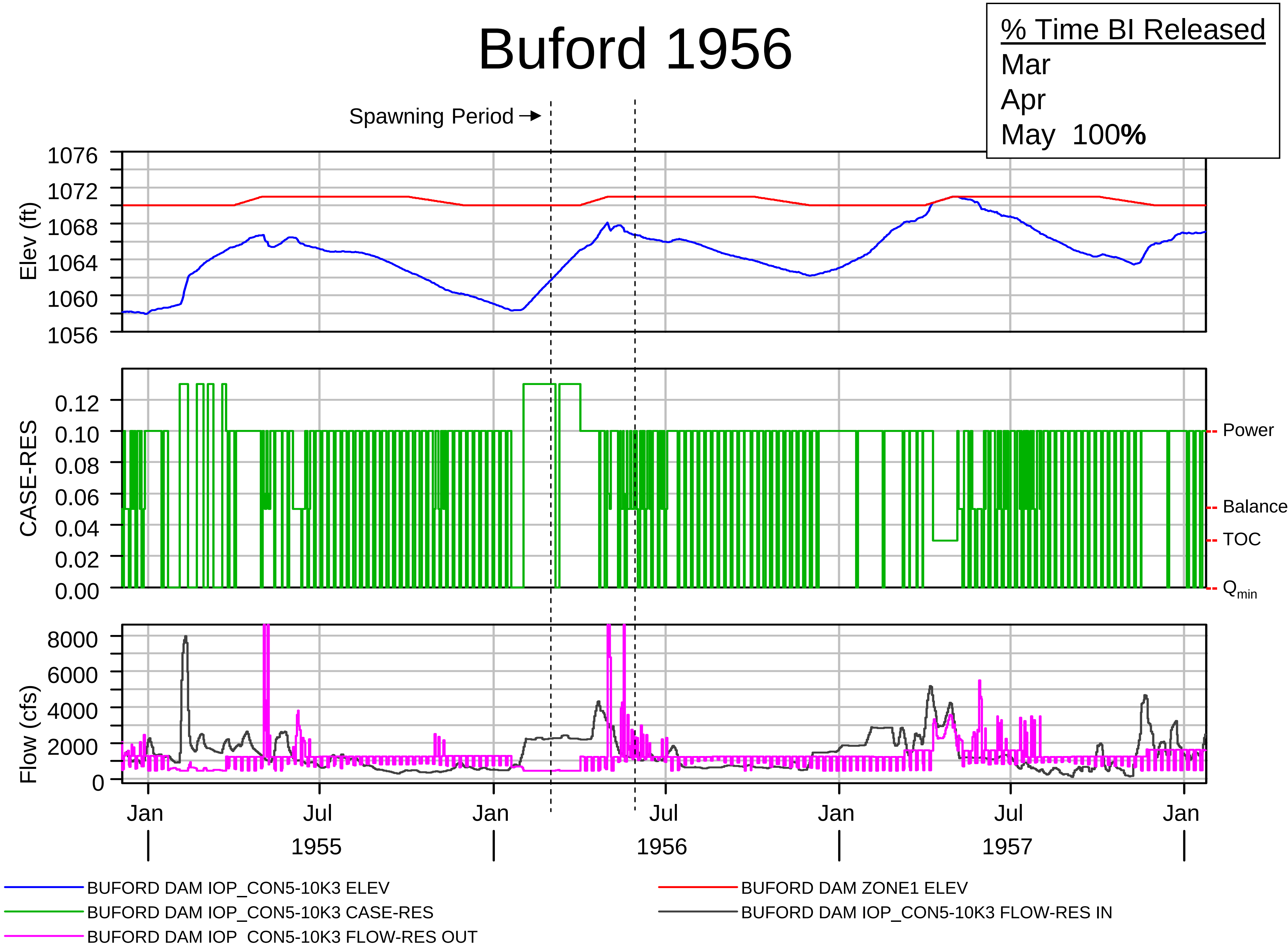


Buford 1954
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1953
1954
1955
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

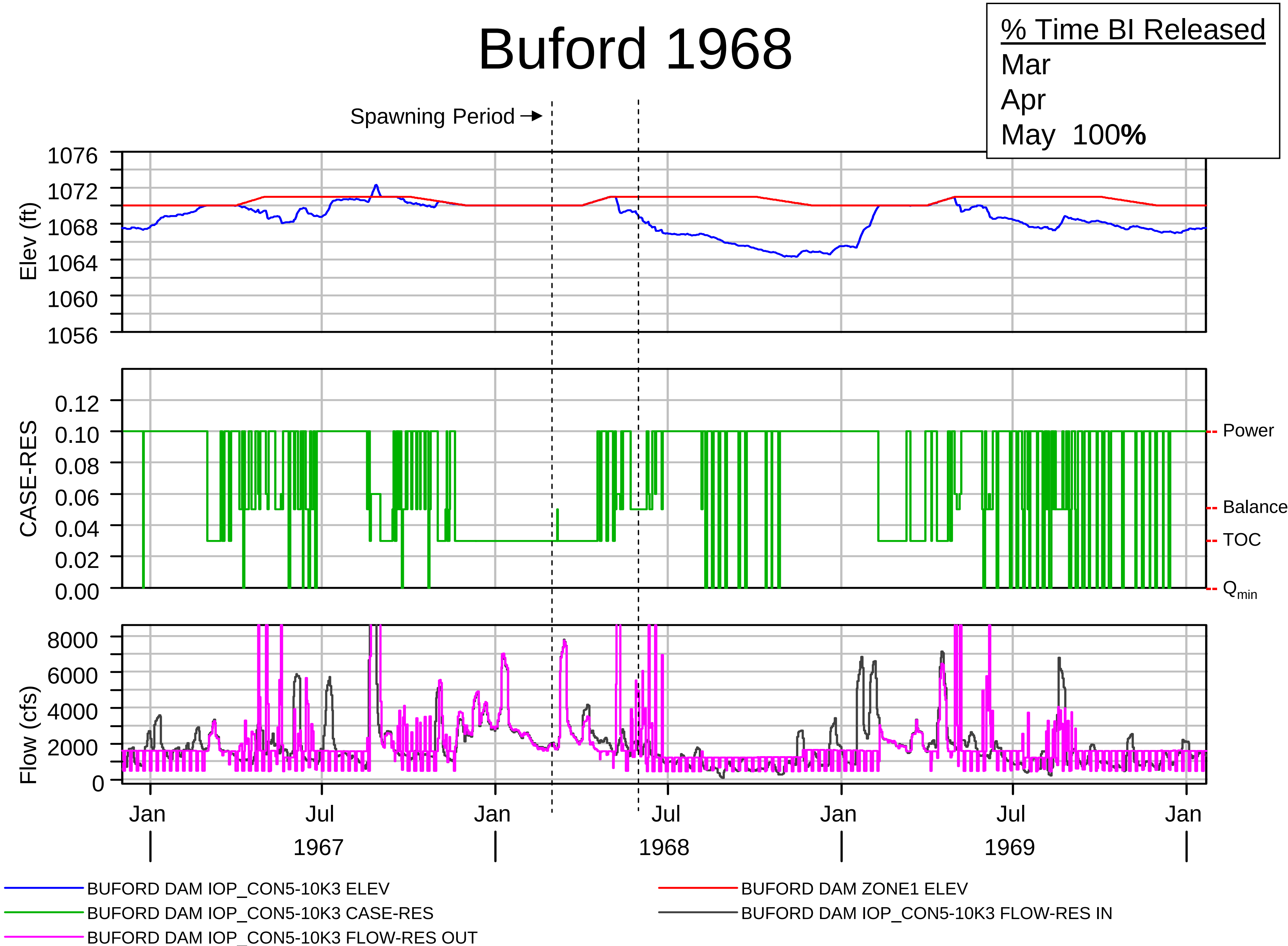
Buford 1955

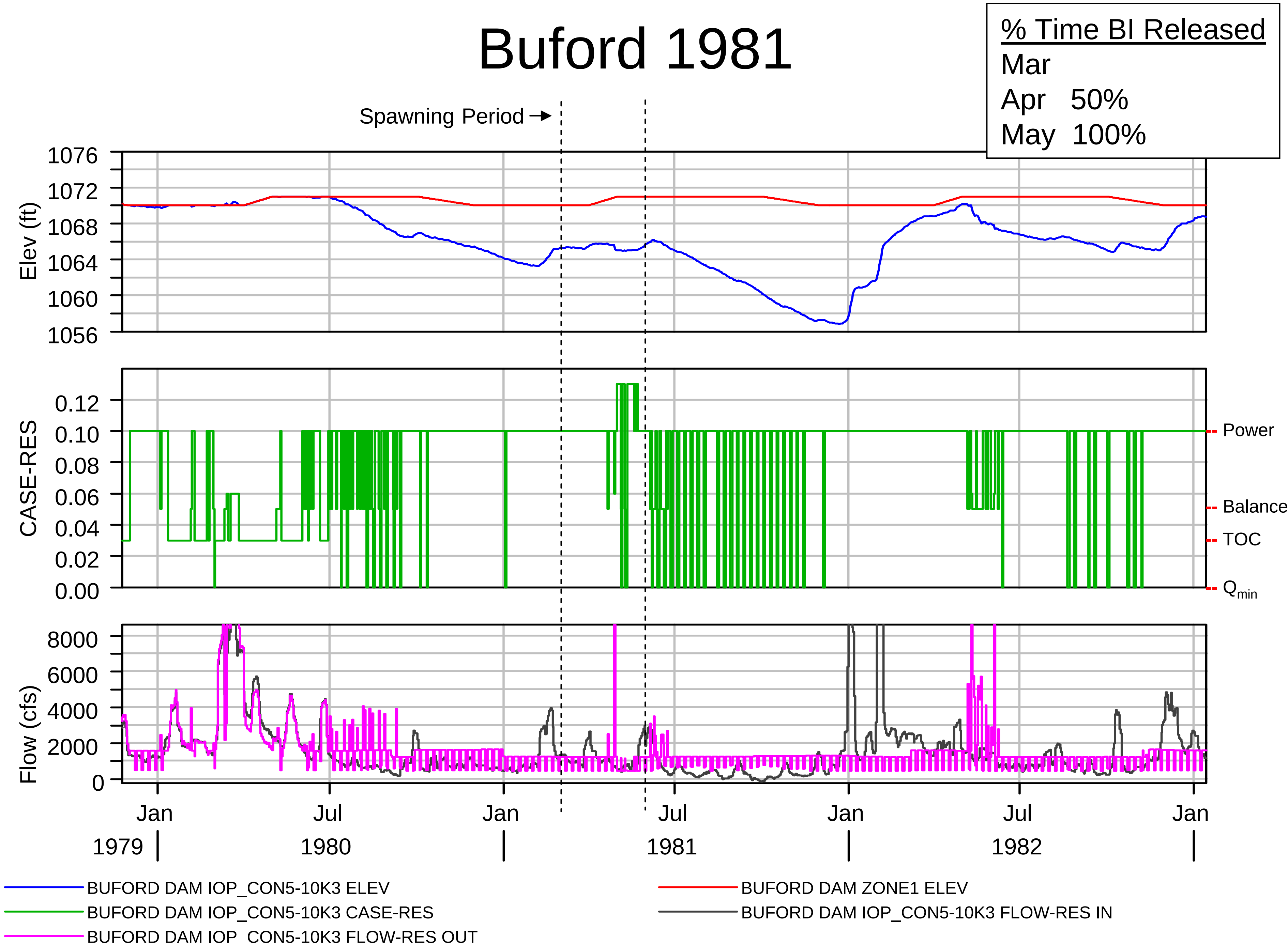


% Time BI Released
Mar 100%
Apr
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1954
1955
1956
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT



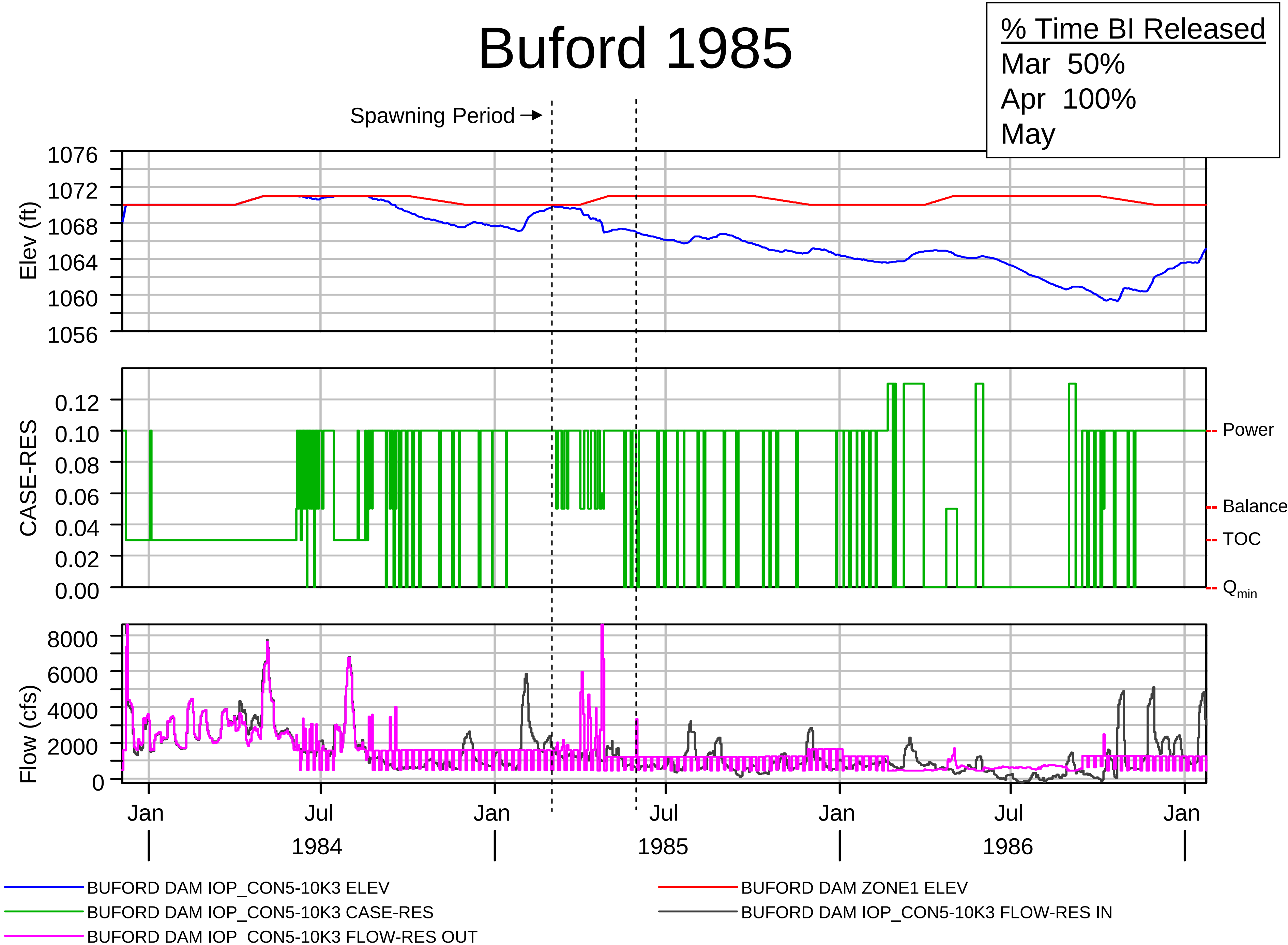
Buford 1956
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1955
1956
1957
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

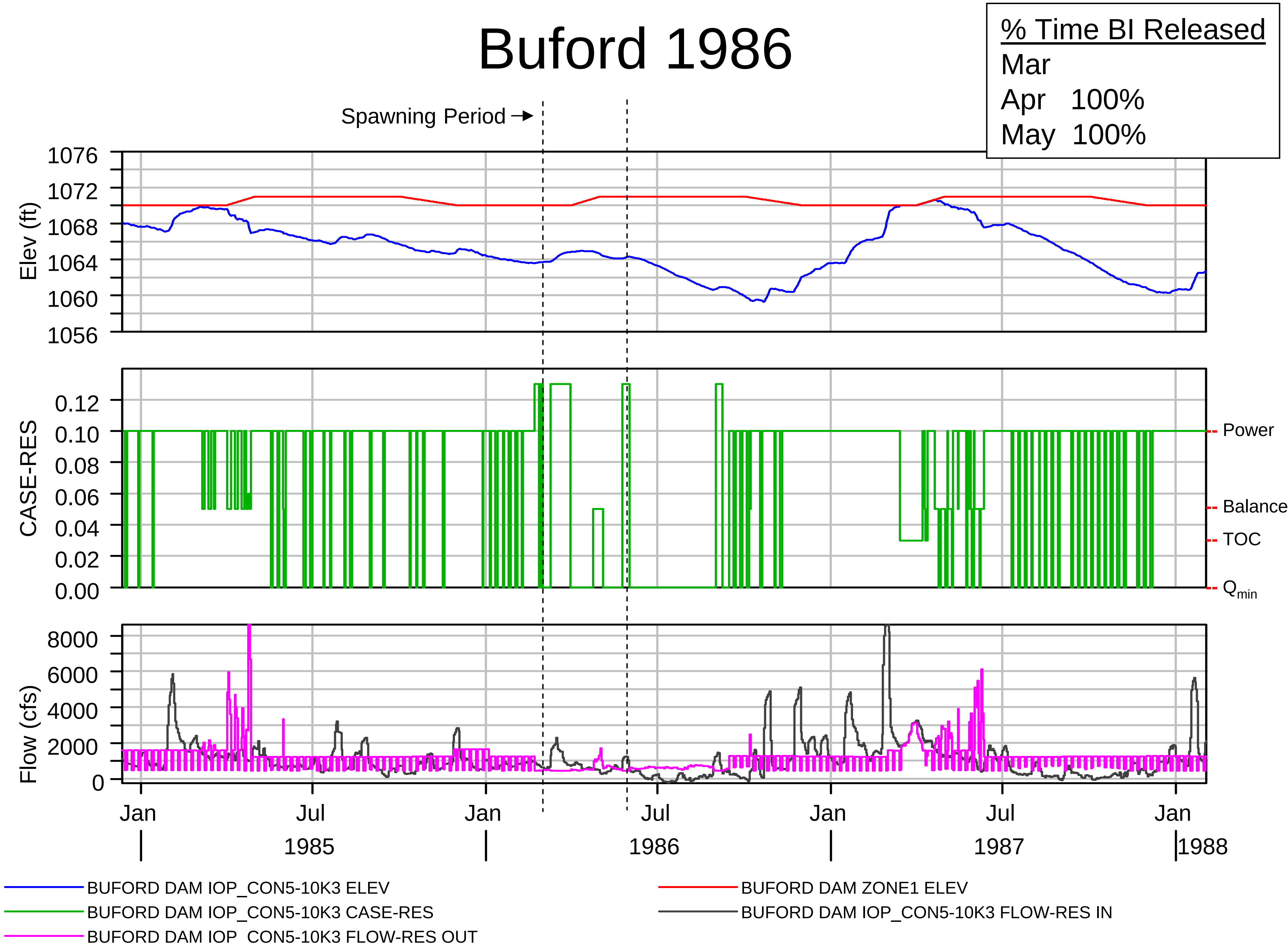

Buford 1968
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Q min
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1967
1968
1969
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

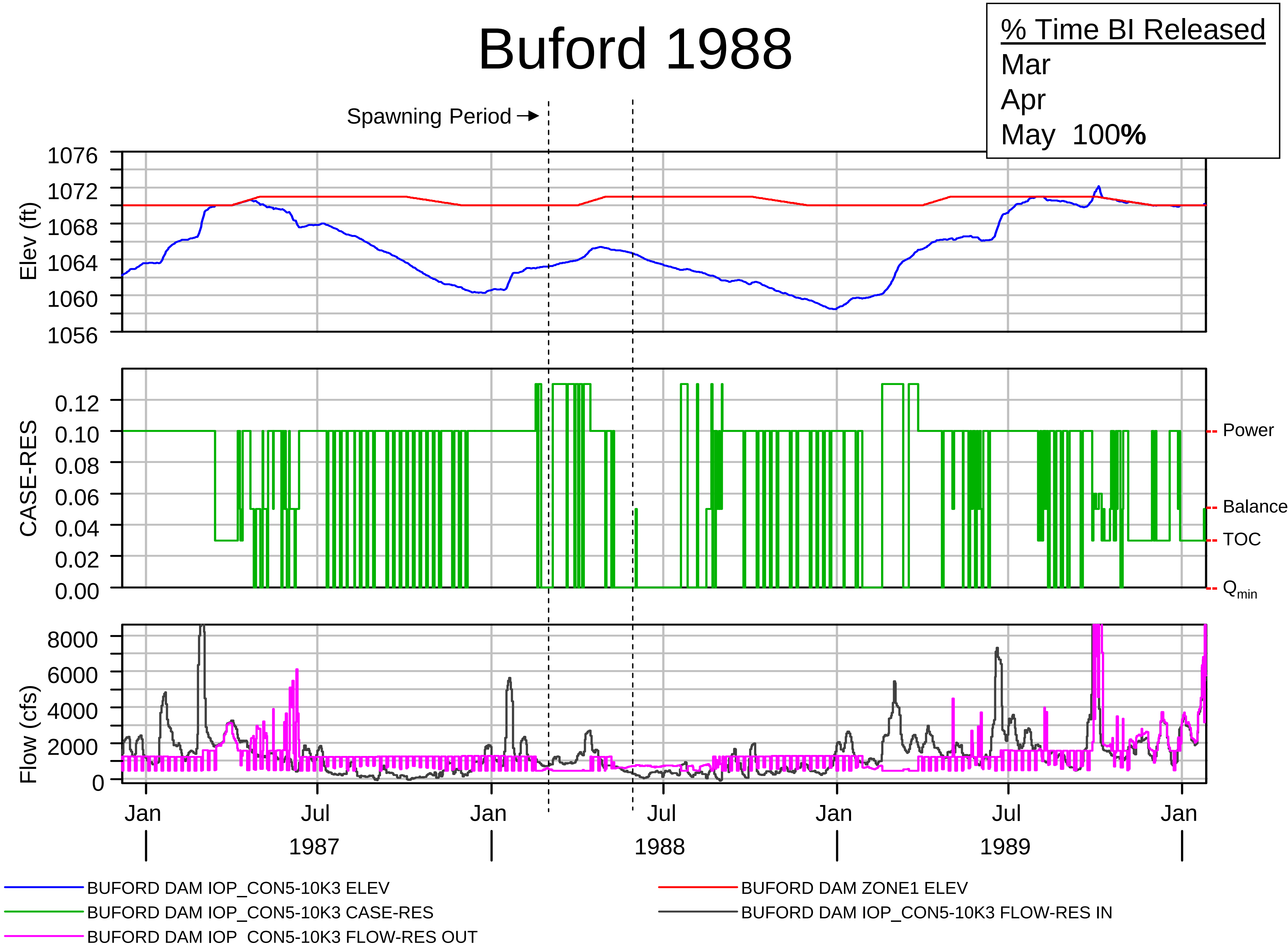


Buford 1981
% Time BI Released
Mar
Apr 50%
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1979
1980
1981
1982
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

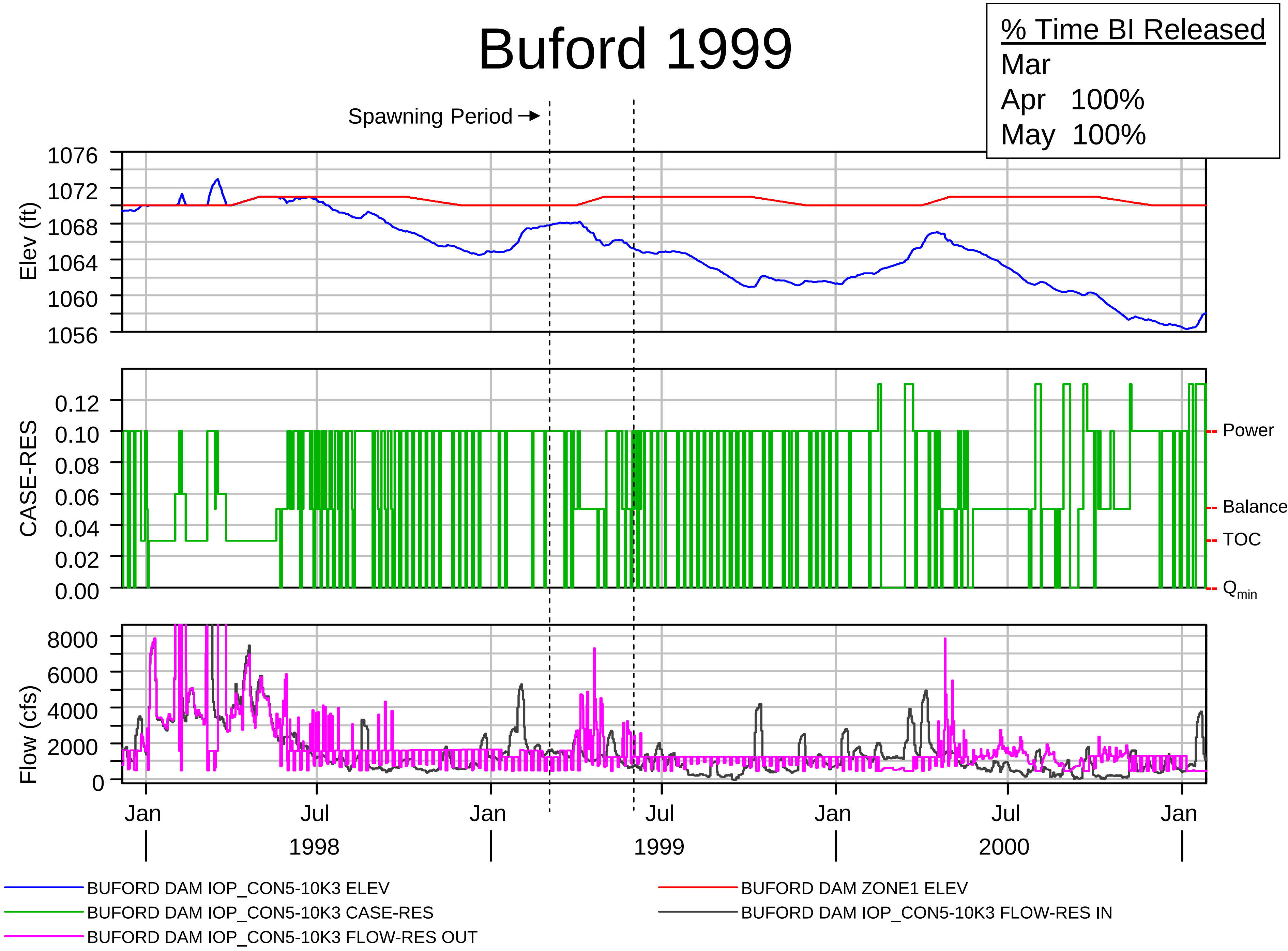
Buford 1985


% Time BI Released
Mar 50%
Apr 100%
May
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1984
1985
1986
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

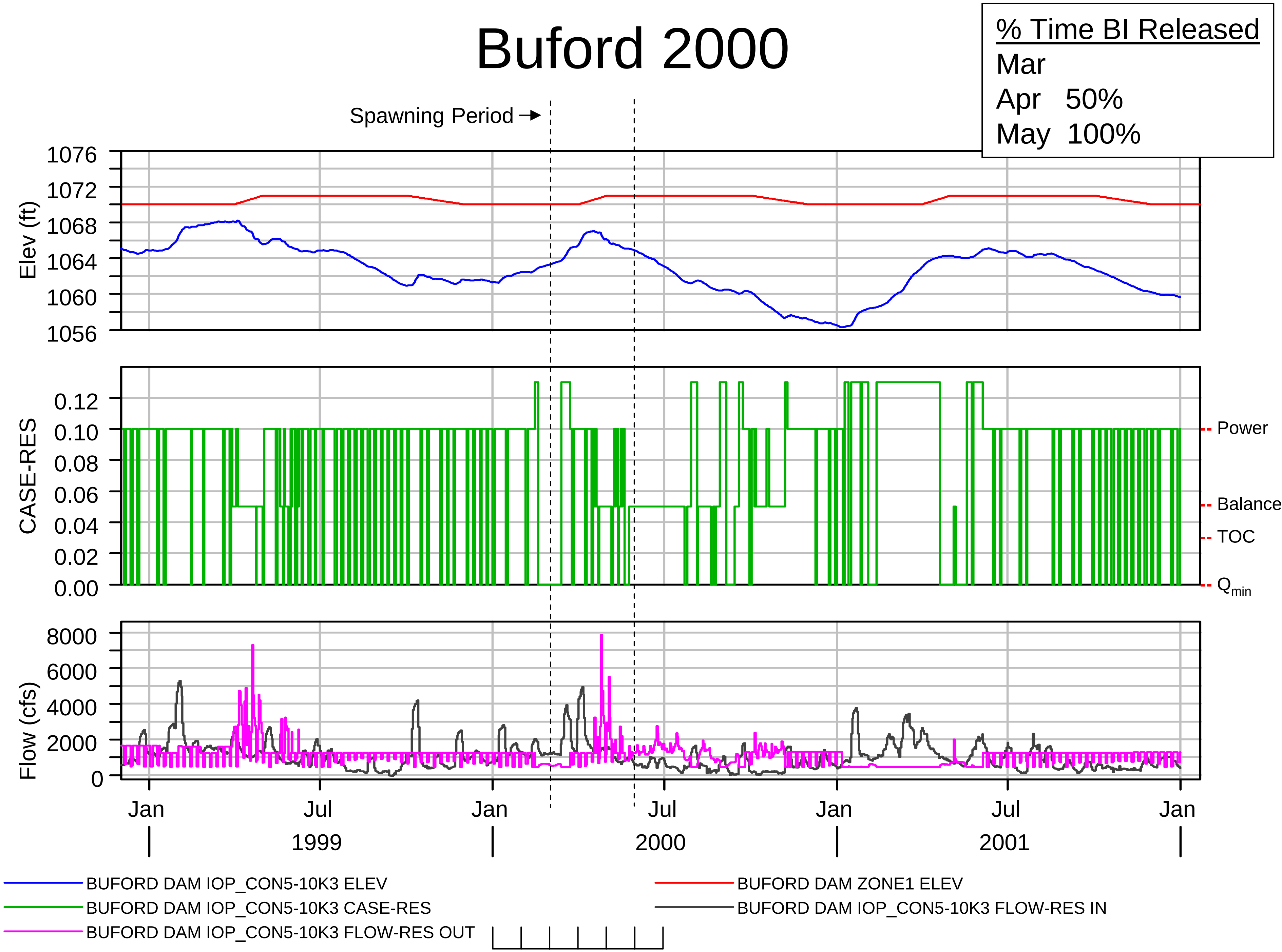

Buford 1986
% Time BI Released
Mar
Apr 100%
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1985
1986
1987
1988
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

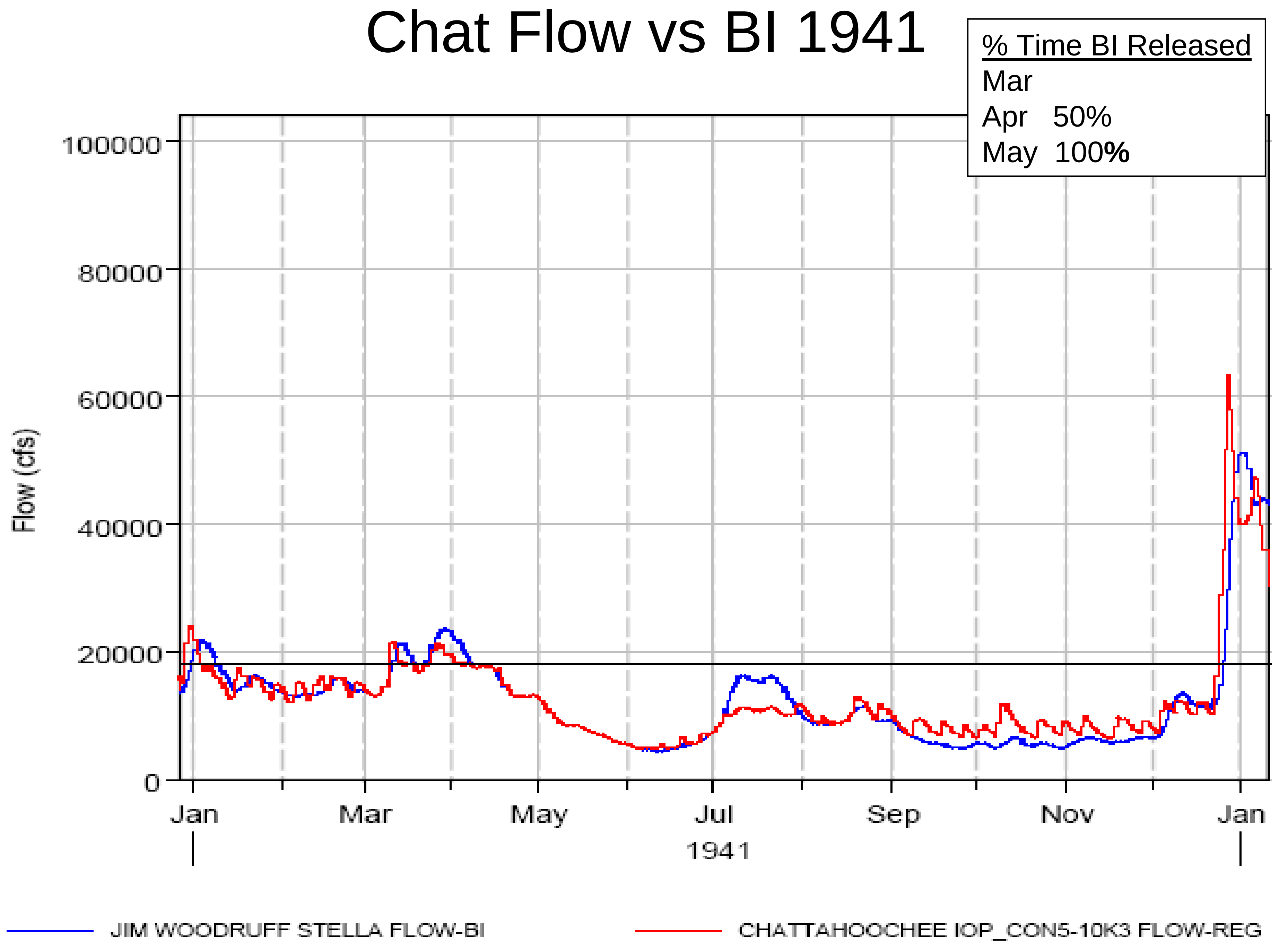


Buford 1988
% Time BI Released
Mar
Apr
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1987
1988
1989
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT


Buford 1999
% Time BI Released
Mar
Apr 100%
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1998
1999
2000
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

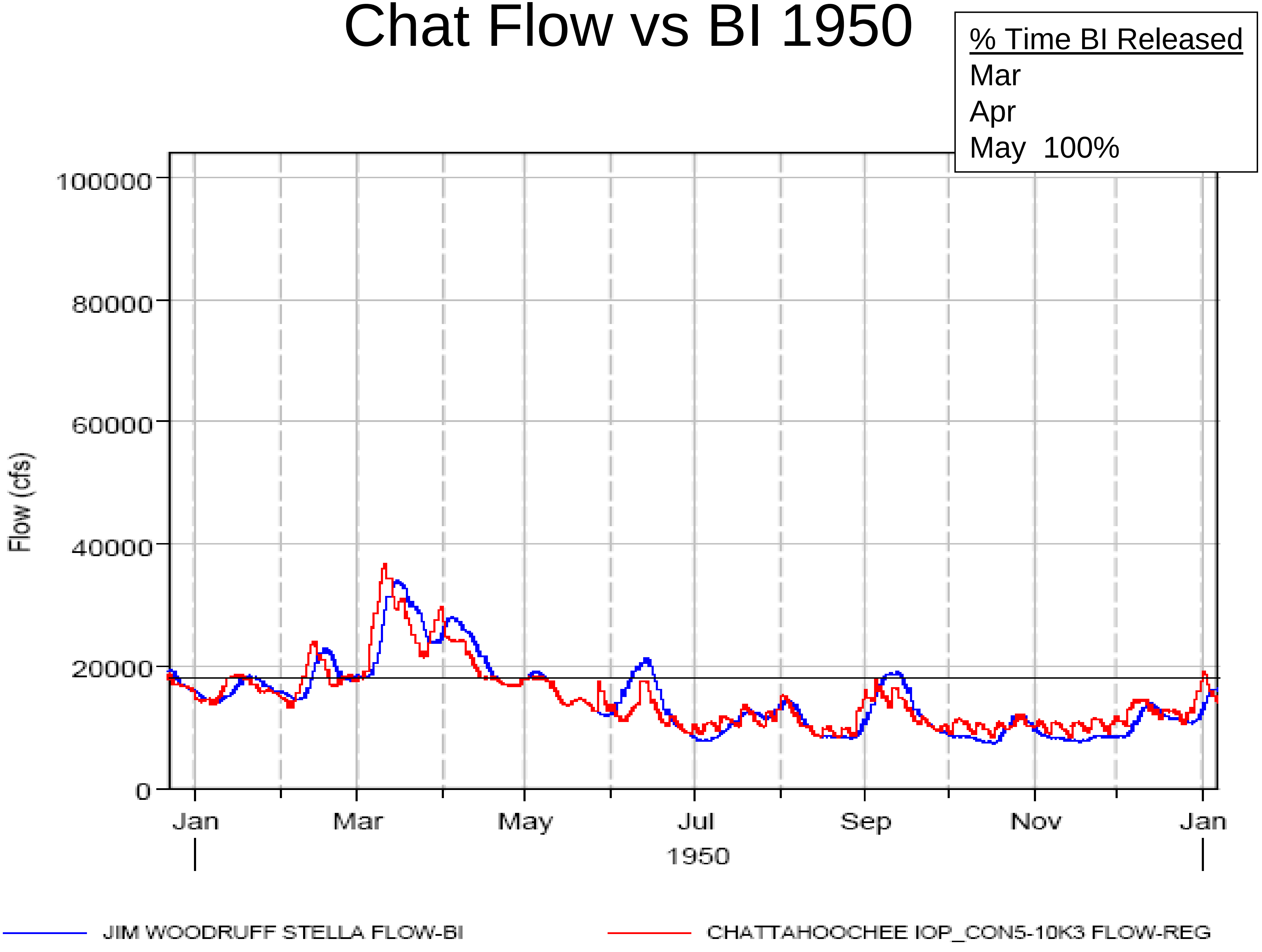
Buford 2000


% Time BI Released
Mar
Apr 50%
May 100%
Spawning Period
Elev (ft)
1076
1072
1068
1064
1060
1056
CASE-RES
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Power
Balance
TOC
Qmin
Flow (cfs)
8000
6000
4000
2000
0
Jan
Jul
Jan
Jul
Jan
Jul
Jan
1999
2000
2001
BUFORD DAM IOP_CON5-10K3 ELEV
BUFORD DAM ZONE1 ELEV
BUFORD DAM IOP_CON5-10K3 CASE-RES
BUFORD DAM IOP_CON5-10K3 FLOW-RES IN
BUFORD DAM IOP_CON5-10K3 FLOW-RES OUT

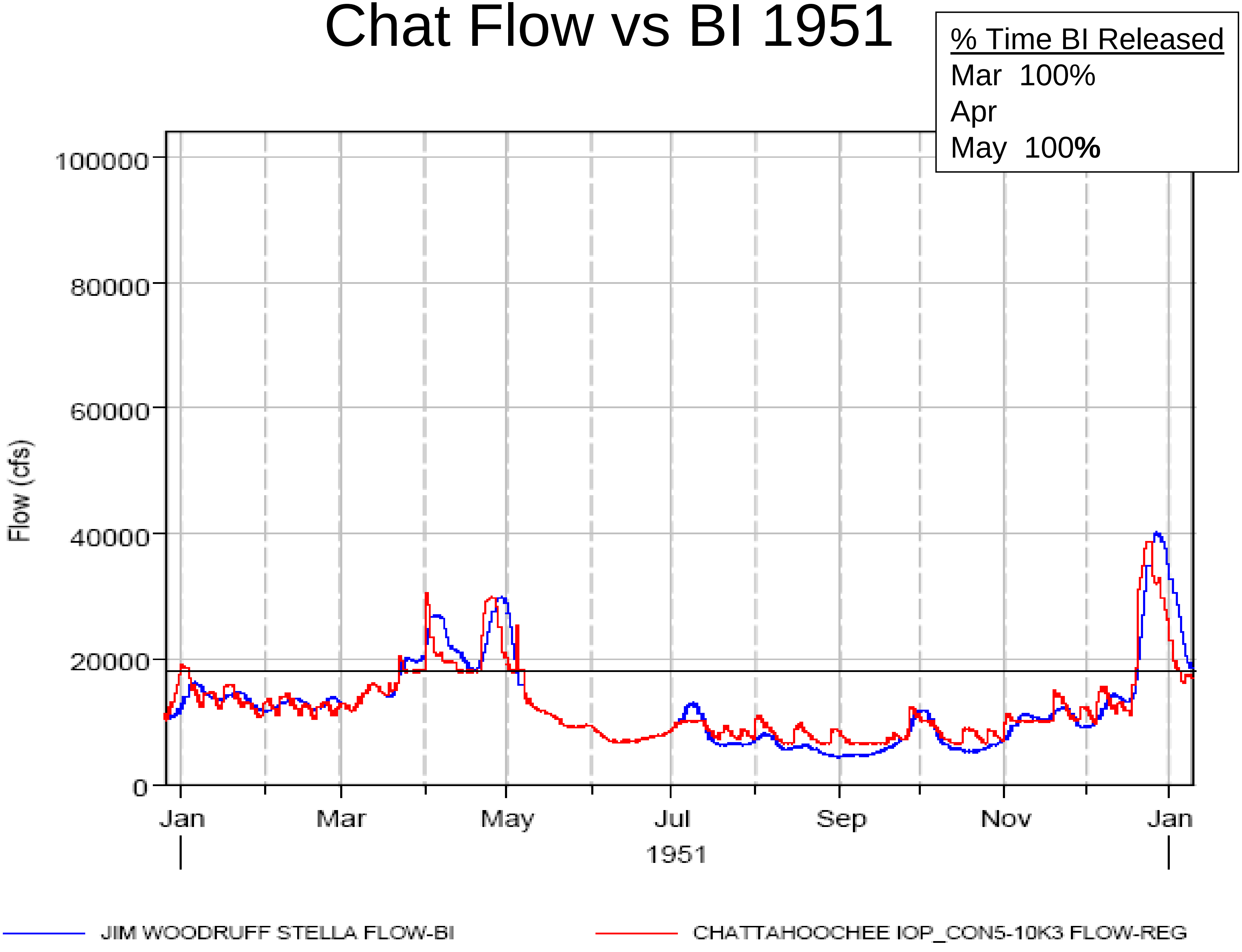


Chat Flow vs BI 1941
% Time BI Released
Mar
Apr 50%
May 100%
Flow (cfs)
100000
80000
60000
40000
20000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1941
JIM WOODRUFF STELLA FLOW-BI
CHATTAHOOCHEE IOP_CON5-10K3 FLOW-REG

Chat Flow vs BI 1950

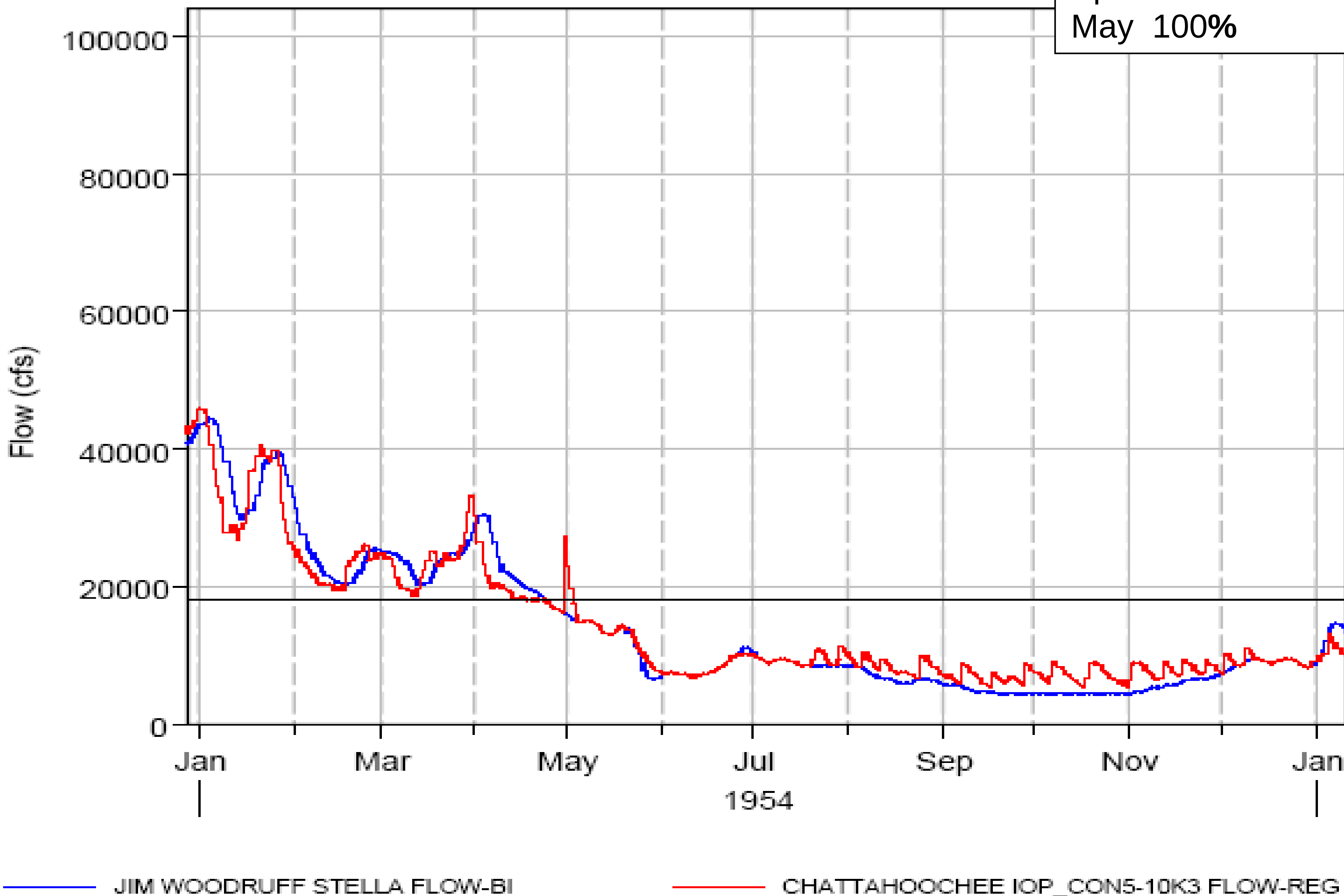


Chat Flow vs BI 1951



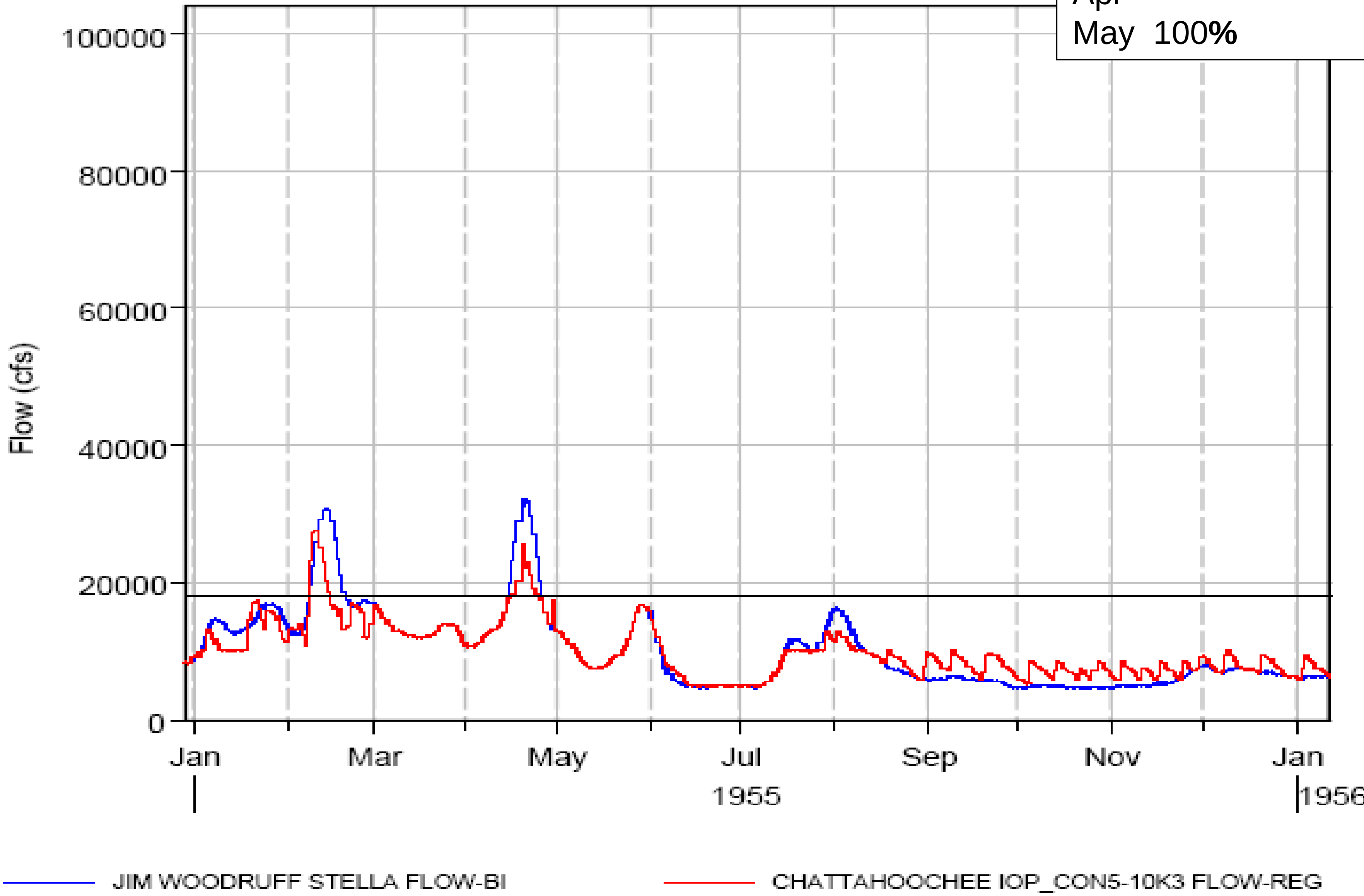
Chat Flow vs BI 1954

% Time BI Released	
Mar	
Apr	
May	100**%**

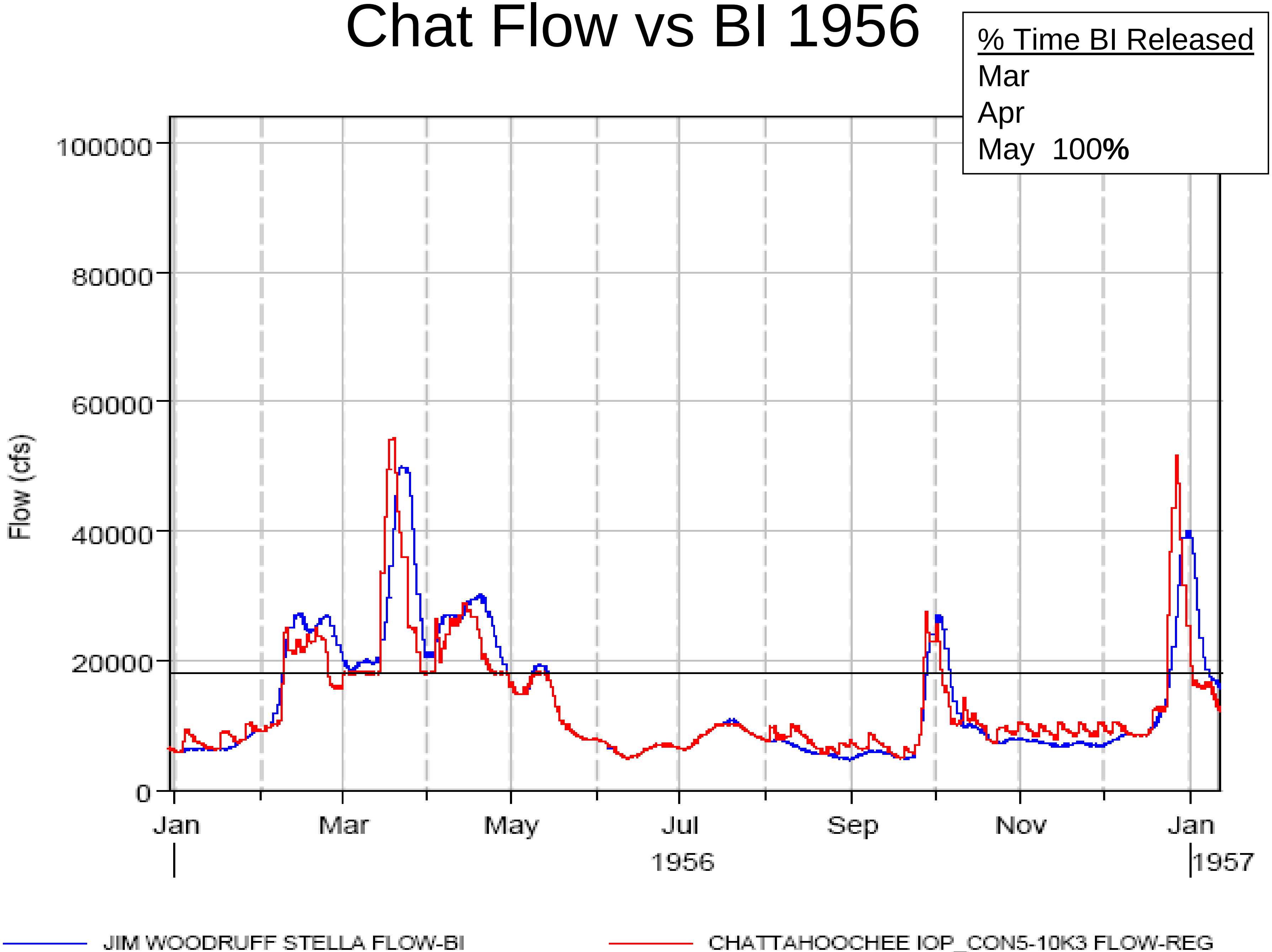


Chat Flow vs BI 1955

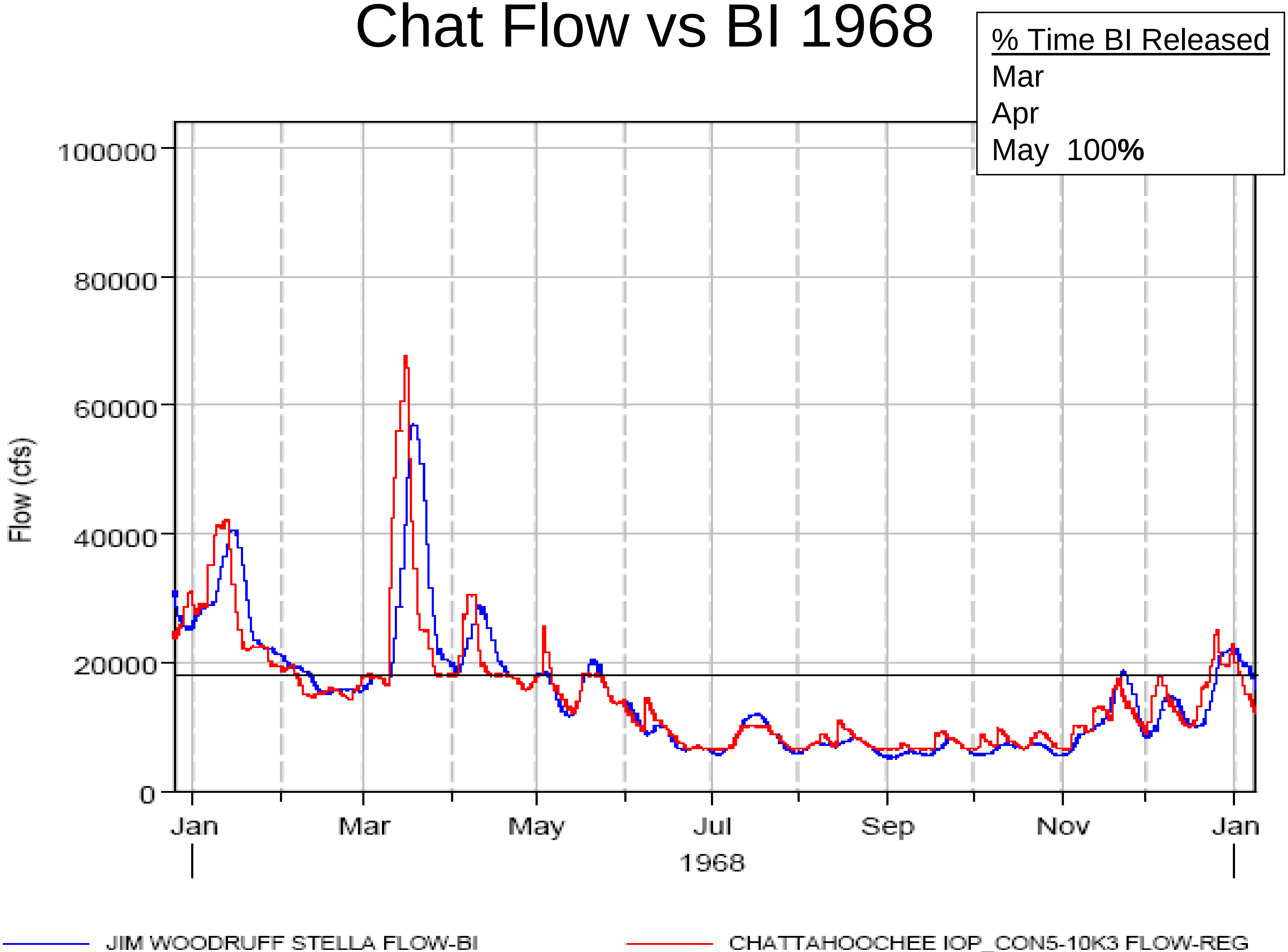
% Time BI Released	
Mar	100%
Apr	
May	100%



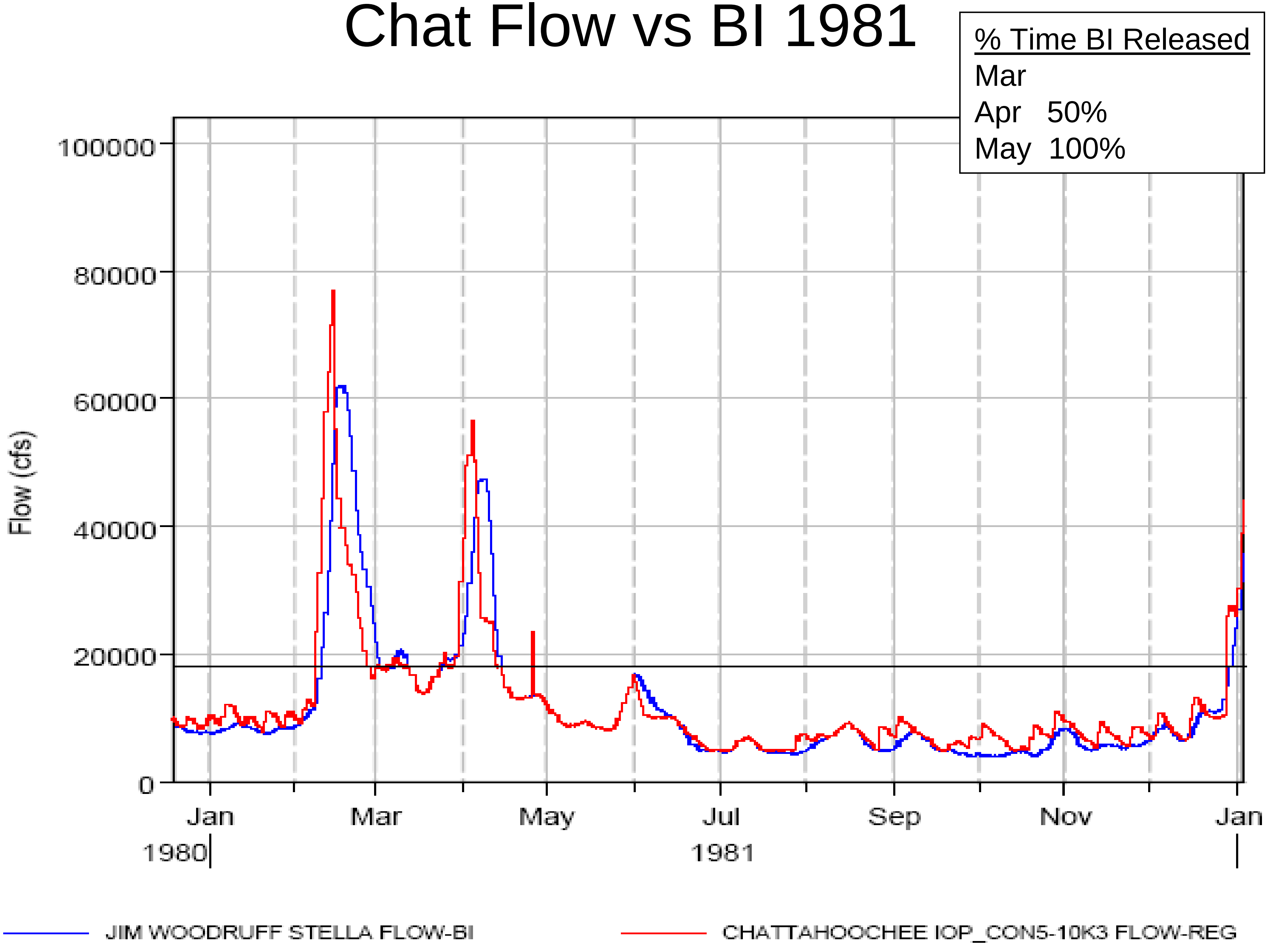
Chat Flow vs BI 1956

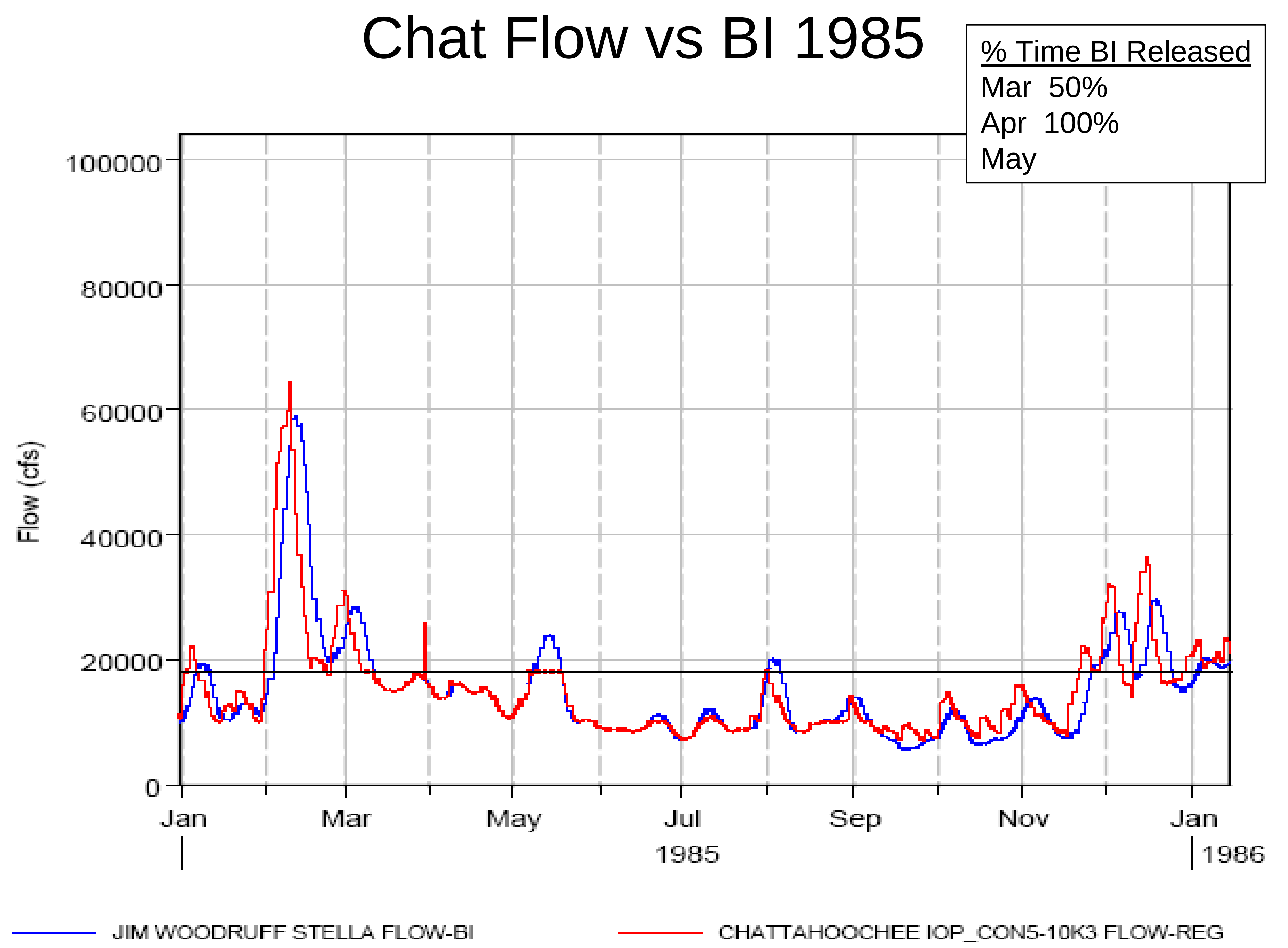


Chat Flow vs BI 1968



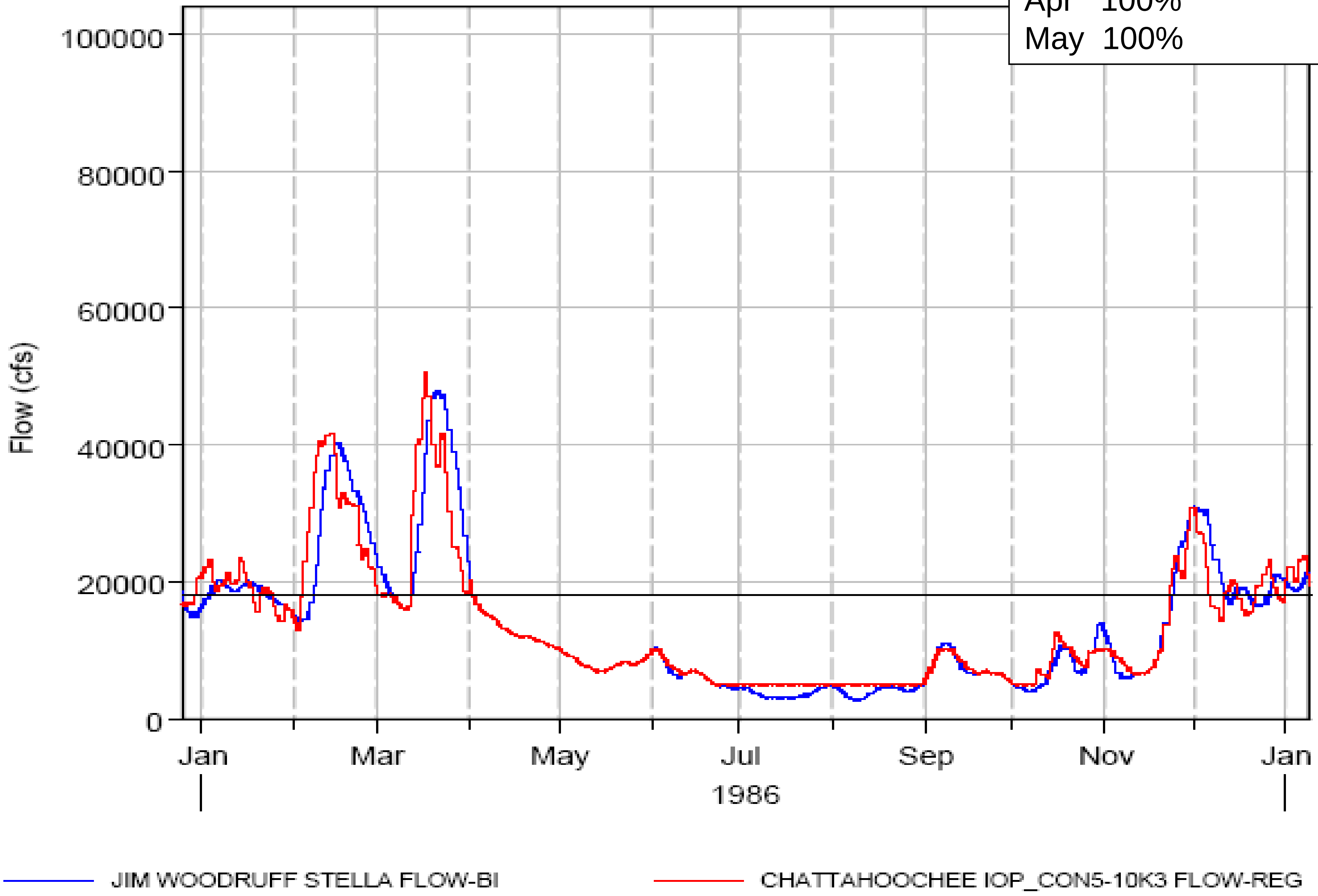
Chat Flow vs BI 1981




Chat Flow vs BI 1985
% Time BI Released
Mar 50%
Apr 100%
May
Flow (cfs)
100000
80000
60000
40000
20000
0
Jan
Mar
May
Jul
Sep
Nov
Jan
1985
1986
JIM WOODRUFF STELLA FLOW-BI
CHATTAHOOCHEE IOP_CON5-10K3 FLOW-REG

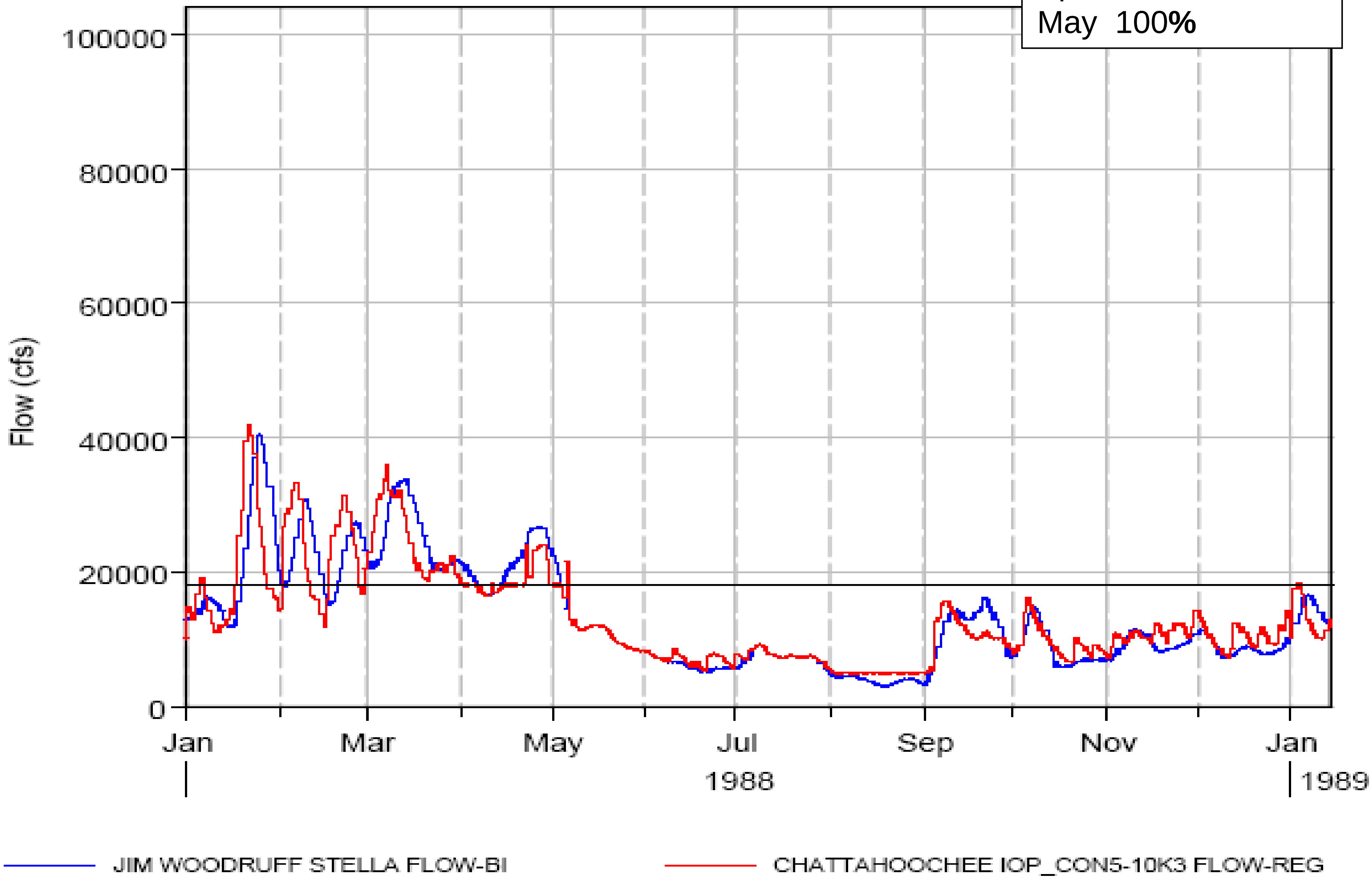
Chat Flow vs BI 1986

% Time BI Released	
Mar	
Apr	100%
May	100%

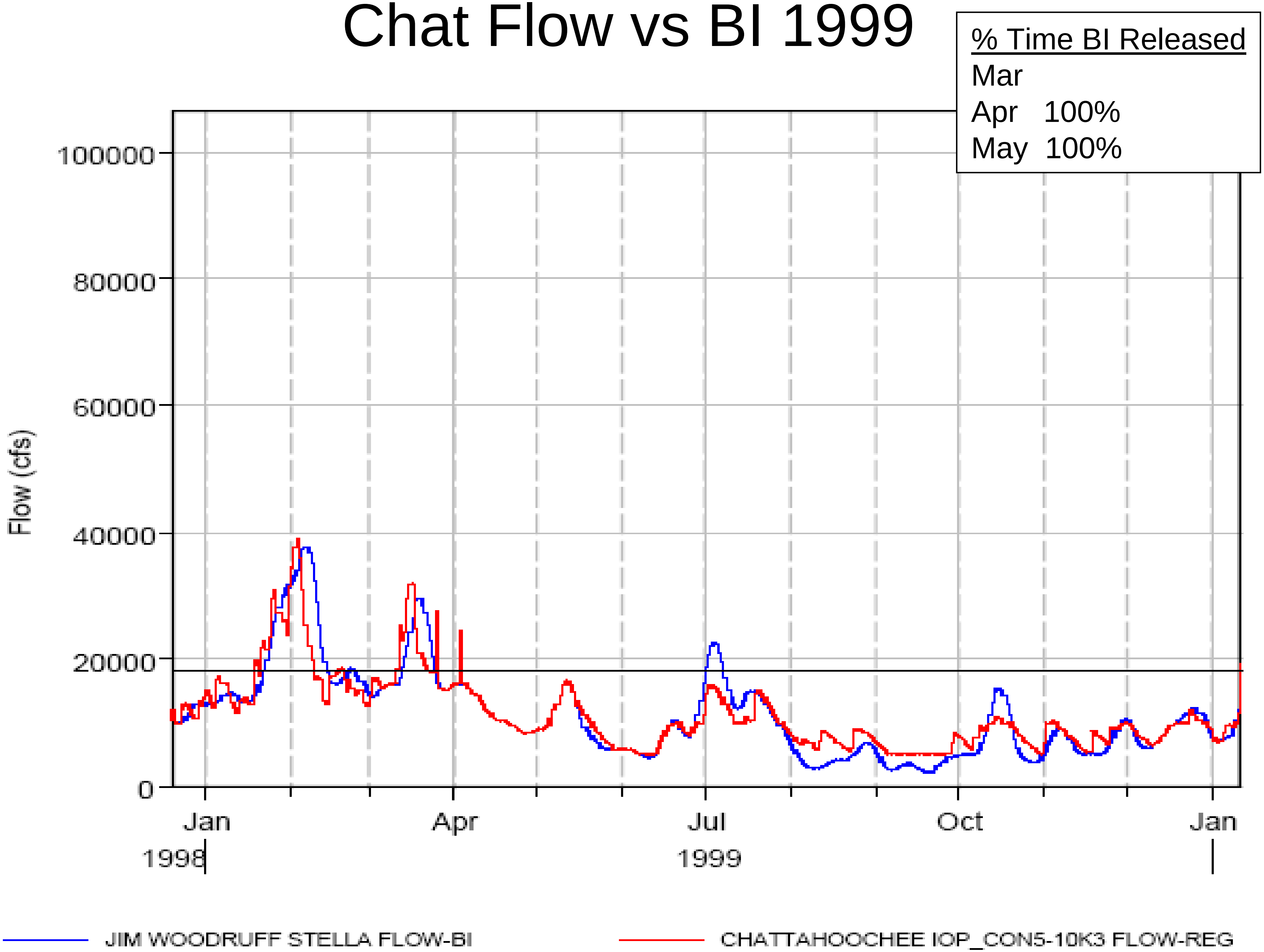


Chat Flow vs BI 1988

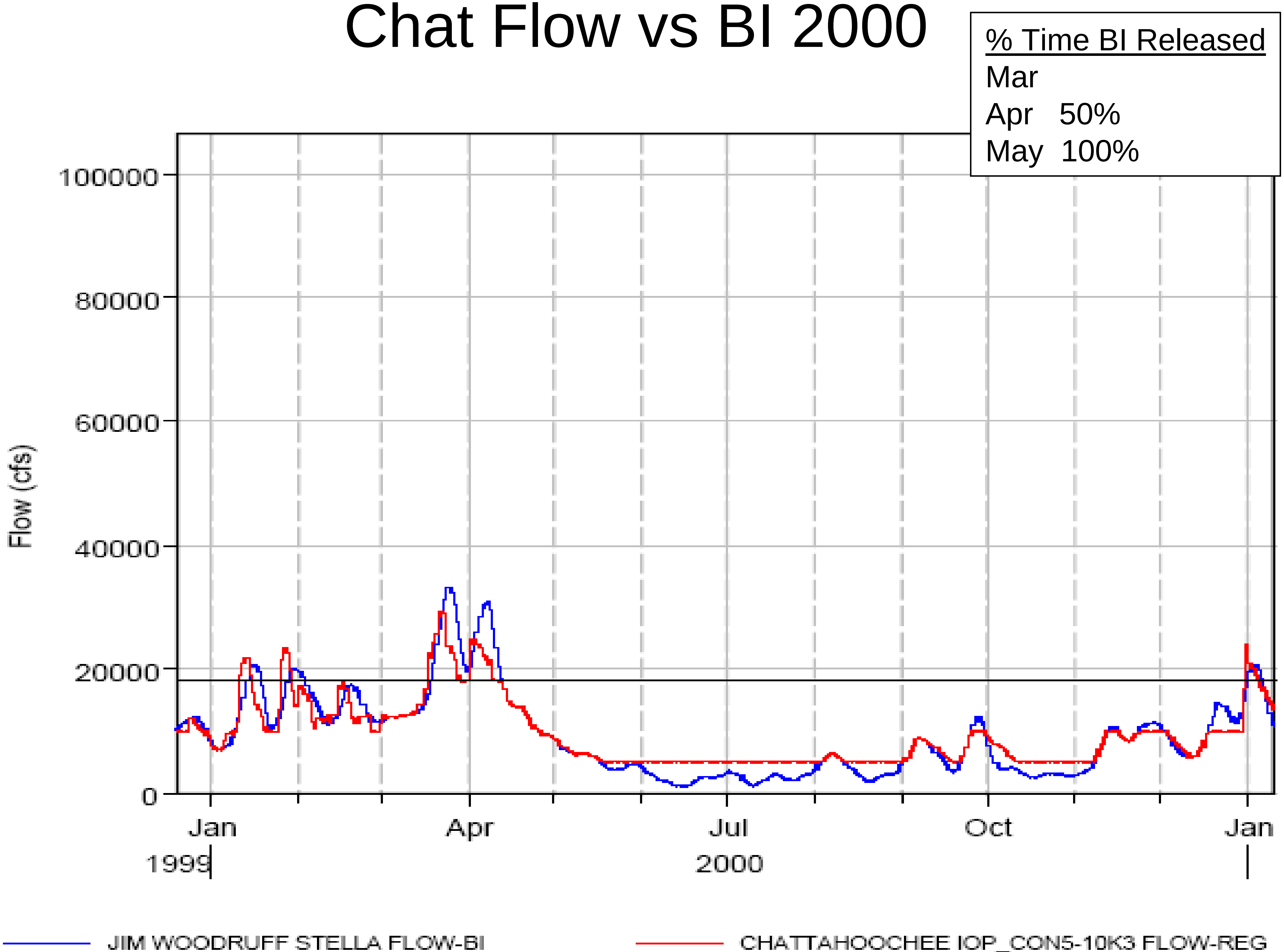
% Time BI Released	
Mar	
Apr	
May	**100%**



Chat Flow vs BI 1999



Chat Flow vs BI 2000



- Results
  - For 12 of 13 years 100% basin inflow released during the month of May
  - For 6 of 13 years 50-100% of basin inflow released during the month of April
  - For 3 of 13 years 50-100% of basin inflow released during the month of March
  - West Point and WF George below TOC for all 13 years by May 31st.

RPM3 Interim Operations Plan (approved 28 February 2007)

Minimum Releases

Months	Basin Inflow (BI) (cfs)	Releases from JWLD (cfs)
March - May	>= 35,800	not less than 25,000
	>= 18,000 and < 35,800	>= 70% BI; not less than 18,000
	< 18,000	>= BI; not less than 6,500 (Desired Flow)*
		>= BI; not less than 5,000 (Required Flow)
June - February	>= 23,000	not less than 16,000
	>=10,000 and < 23,000	>= 70% BI; not less than 10,000
	< 10,000	>= BI; not less than 6,500 (Desired Flow)*
		>= BI; not less than 5,000 (Required Flow)

*Drought Provision: When Composite Storage is within Zones 1 and 2, then the higher minimum Release of 6,500 cfs would be maintained. When Composite Storage falls below the top of Zone 3, then Release will be reduced to the 5,000 cfs minimum; when Composite Storage is restored to above the top of Zone 2 (i.e., within Zone 1), then the higher minimum Release of at least 6,500 cfs would again be maintained. Composite Storage is the combined storage of Lake Sidney Lanier, West Point Lake, and Walter F. George.

Down Ramping Rates

Release Range	Maximum Fall Rate (ft/day), measured at Chattahoochee gage
Flows greater than 30,000 cfs*	No ramping restriction**
Flows greater than 20,000 cfs but <= 30,000*	1.0 to 2.0 ft/day
Exceeds Powerhouse Capacity (~16,000 cfs) but <= 20,000 cfs*	0.5 to 1.0 ft/day
Within Powerhouse Capacity and > 8,000 cfs*	0.25 to 0.5 ft/day
Within Powerhouse Capacity and <=8,000 cfs*	0.25 ft/day or less

*Consistent with safety requirements, flood control purposes, equipment cababilities.
**For flows greater than 30,000 cfs, it is not reasonable or prudent to attempt to control down ramping rate, and no ramping rate is required.