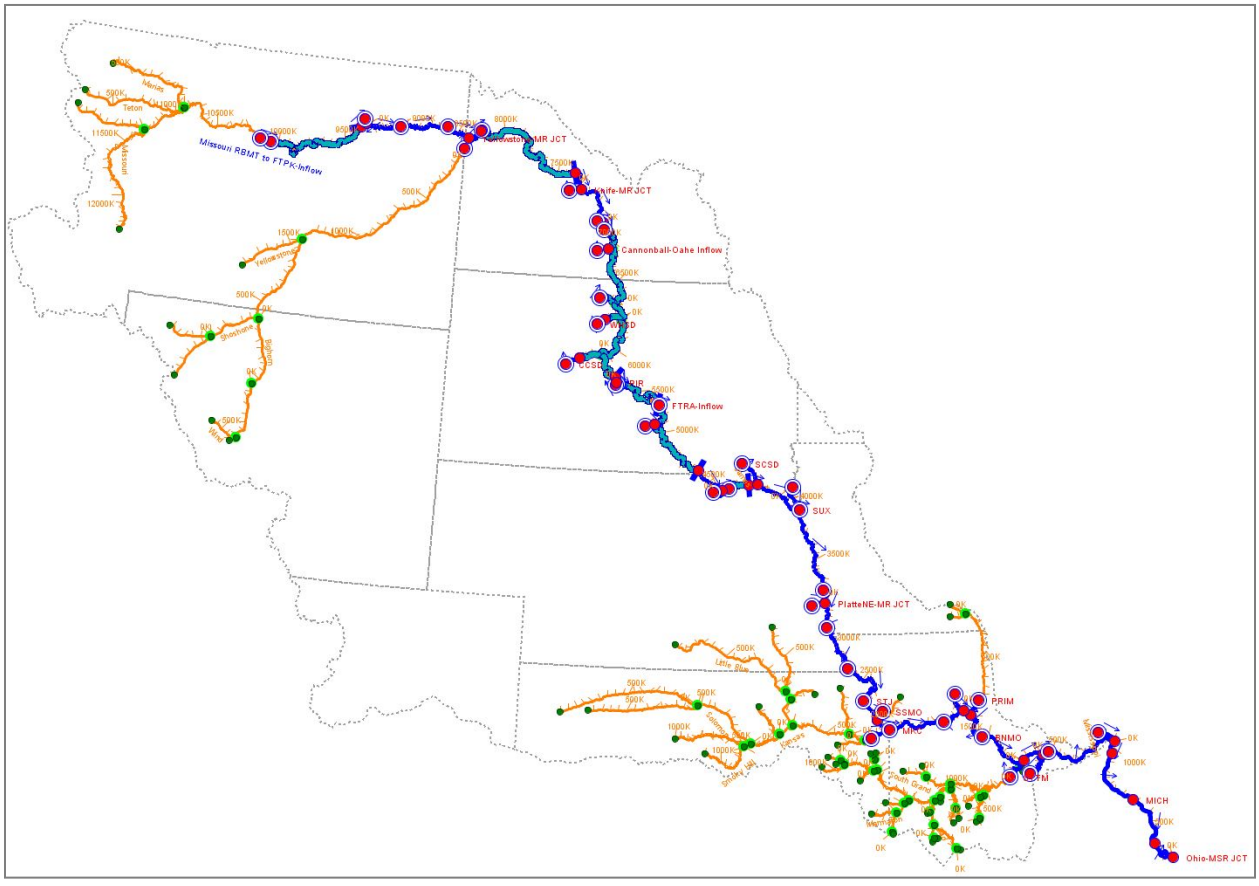
US Army Corps of Engineers ®

Missouri River Mainstem HEC-ResSim Modeling DRAFT

Mainstem Missouri River Reservoir Simulation Alternatives Technical Report



HYDROLOGIC ENGINEERING BRANCH

ENGINEERING DIVISION

December 2016

USACE – Northwestern Division
Omaha and Kansas City Districts
DRAFT

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1 INTRODUCTION

The Missouri River Mainstem ResSim model was developed for the Missouri River Recovery Program (MRRP) to assist in the assessment of various operational changes to the mainstem reservoir system (System), shown in Figure 1-1, that could potentially benefit three endangered species on the Missouri River: piping plovers, least terns, and pallid sturgeons. The operational changes were simulated for an eighty two year period-of-record (1931-2012) and compared to a No Action simulation to estimate the changes that would occur to the System if an alternative were implemented. ResSim results were used as input into other models, which provided information other than pool elevations and releases, and used directly to quantify impacts on a variety of interests within the Missouri River Basin. The results of those assessments are detailed in the Environmental Impact Statement (EIS) (U.S. Army Corps of Engineers, 2016). In this document, System operations for each alternative assessed for the Recovery Program are described for four seasons: spring (March – April), summer (May – August), fall (September – November), and winter (December – February). Operational criteria are further described based on operational decisions for the System downstream of Gavins Point and operational decisions for the System upstream of Gavins Point. Plots of release and pool elevation changes relative to Alternative 1 are included to show how the System is impacted by each alternative. Refer to *Mainstem Missouri River Reservoir Simulation Report* (U.S. Army Corps of Engineers, 2015) for detailed documentation of the Missouri River ResSim model.

Figure 1-1: Missouri River Mainstem System.

1.1 ALTERNATIVE DESCRIPTIONS

1.1.1 Alternative 1 – No Action

Under Alternative 1 (Alt 1), the Missouri River Mainstem Projects would continue operate as they are currently. Operations within the ResSim model were set up to closely follow the Master Manual (U.S. Army Corps of Engineers, 2006) that is used during real-time operations of the System; however, the model does have limitations and cannot capture all real-time decisions that occur. For a more complete description of Alt 1 that describes other changes to the Missouri River Basin besides reservoir operations, refer to Chapter 2 of the EIS (U.S. Army Corps of Engineers, 2016).

1.1.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

Alternative 2 (Alt 2) represents the U.S. Fish and Wildlife Service (USFWS) interpretation of the management actions that would be implemented as part of the 2003 Amended BiOp RPA (U.S. Fish and Wildlife Service, 2003). Operational criteria include different early and late spring spawning cues, low summer flows, and a maximum winter release limit. For a more complete

description of Alt 2 that describes other changes to the Missouri River Basin besides reservoir operations, refer to Chapter 2 of the EIS (U.S. Army Corps of Engineers, 2016).

1.1.3 Alternative 3 – Mechanical Construction Only

Alternative 3 (Alt 3) consists of mechanical construction of emergent sandbar habitat (ESH). Operational criteria consist of removing the early and late spring spawning cues in Alt 1. For a more complete description of Alt 3 that describes other changes to the Missouri River Basin besides reservoir operations, refer to Chapter 2 of the EIS (U.S. Army Corps of Engineers, 2016).

1.1.4 Alternative 4 – Spring Habitat-Forming Flow Release

Under Alternative 4 (Alt 4), the early and late spring spawning cues in Alt 1 are removed from the operational criteria and a spring ESH-creating reservoir release from Gavins Point and Garrison is added. While the ESH-creation release is occurring from Gavins Point, flood targets are increased to allow the ESH-creation release the opportunity to run. For a more complete description of Alt 4 that describes other changes to the Missouri River Basin besides reservoir operations, refer to Chapter 2 of the EIS (U.S. Army Corps of Engineers, 2016).

1.1.5 Alternative 5 – Fall Habitat-Forming Flow Release

Alternative 5 (Alt 5) removes the early and late spring spawning cues in Alt 1 and adds a fall ESH-creating reservoir release from Gavins Point and Garrison to the operational criteria. While the ESH-creation release is occurring from Gavins Point, flood targets are increased to allow the ESH-creation release the opportunity to run. For a more complete description of Alt 5 that describes other changes to the Missouri River Basin besides reservoir operations, refer to Chapter 2 of the EIS (U.S. Army Corps of Engineers, 2016).

1.1.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Alternative 6 (Alt 6) replaces the early and late spring spawning cues with different spawning cues. The early spring spawning cue in Alt 6 occurs at the same time as the early spring spawning cue in Alt 1 but with a higher peak release. The late spring spawning cue in Alt 6 occurs later in May than the late spring spawning cue in Alt 1 and has a larger peak release. For a more complete description of Alt 6 that describes other changes to the Missouri River Basin besides reservoir operations, refer to Chapter 2 of the EIS (U.S. Army Corps of Engineers, 2016).

2 SPRING: MARCH – APRIL

2.1 DOWNSTREAM OF GAVINS POINT

2.1.1 Alternative 1 – No Action

March 1 begins the operational year for the System within the ResSim model. Any excess flood storage from the previous year has been evacuated and the System is assessed for the upcoming year's runoff. On March 1, a System storage assessment determines if the early spring spawning cue for the pallid sturgeon will occur. If System storage is greater than 40.0 million acre-feet (MAF) on March 1, the early spring spawning cue will occur at the end of March or early April, coinciding with the rise in releases for support of navigation.

Between March 1 and the start of the navigation season, a minimum release of 9.0 kcfs (1,000 cubic feet per second) is specified to support water supply downstream of Gavins Point. In addition to the minimum release requirements, the ResSim model treats the minimum release from Gavins Point as a minimum flow requirement at three locations downstream of Gavins Point: Sioux City, Omaha, and Kansas City. If the flow at one of those three locations is forecasted to drop below 9.0 kcfs while Gavins Point is releasing 9.0 kcfs for water supply, Gavins Point releases will be increased until the forecasted flow at all three locations exceeds 9.0 kcfs. This can occur if there are depletions that remove water from the river causing flows to be less than what is released from Gavins Point. Figure 2-1 shows the minimum release for water supply during the spring, which is highlighted by the dashed red box.

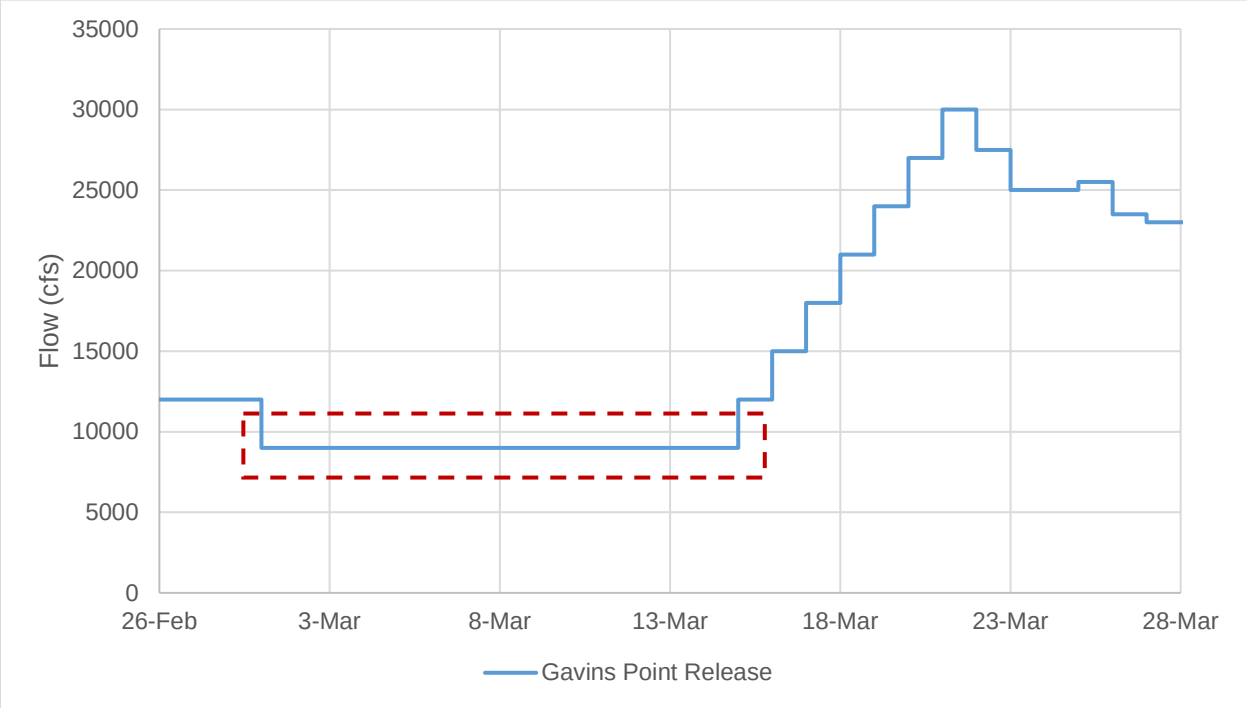

Figure 2-1: Spring water supply release from Gavins Point.

System storage is assessed again on March 15 to determine if operations will begin supporting navigation. A minimum of 31.0 MAF of System storage is required for a navigation season. If System storage is greater than 31.0 MAF on March 15, a service level is computed, which represents the level of navigation support. Table 2-1 summarizes the System storage and service level relationship. Minimum service is specified if System storage is between 31.0 MAF and 49.0 MAF. An intermediate service level is specified if System storage is between 49.0 MAF and 54.5 MAF by linear interpolation. Full service is specified if the System storage is at least 54.5 MAF. Figure 2-2 shows an example of the System storage check and resulting service level. In this example, System storage was 53.4 MAF on March 15, which was between the full-service and minimum-service thresholds. The service level was linearly interpolated resulting in a service level of 33.8 kcfs for the first half of the navigation season.

Table 2-1: Service level requirements. Summarized from Table VII-2 in the Master Manual (U.S. Army Corps of Engineers, 2006).

Date	Service Level (kcfs)	Water in System Storage (MAF)
March 15	35.0 (full-service)	54.5 or more
March 15	29.0 (minimum-service)	31.0 – 49.0
March 15	No service	31.0 or less
July 1	35.0 (full-service)	57.0 or more
July 1	29.0 (minimum-service)	50.5 or less

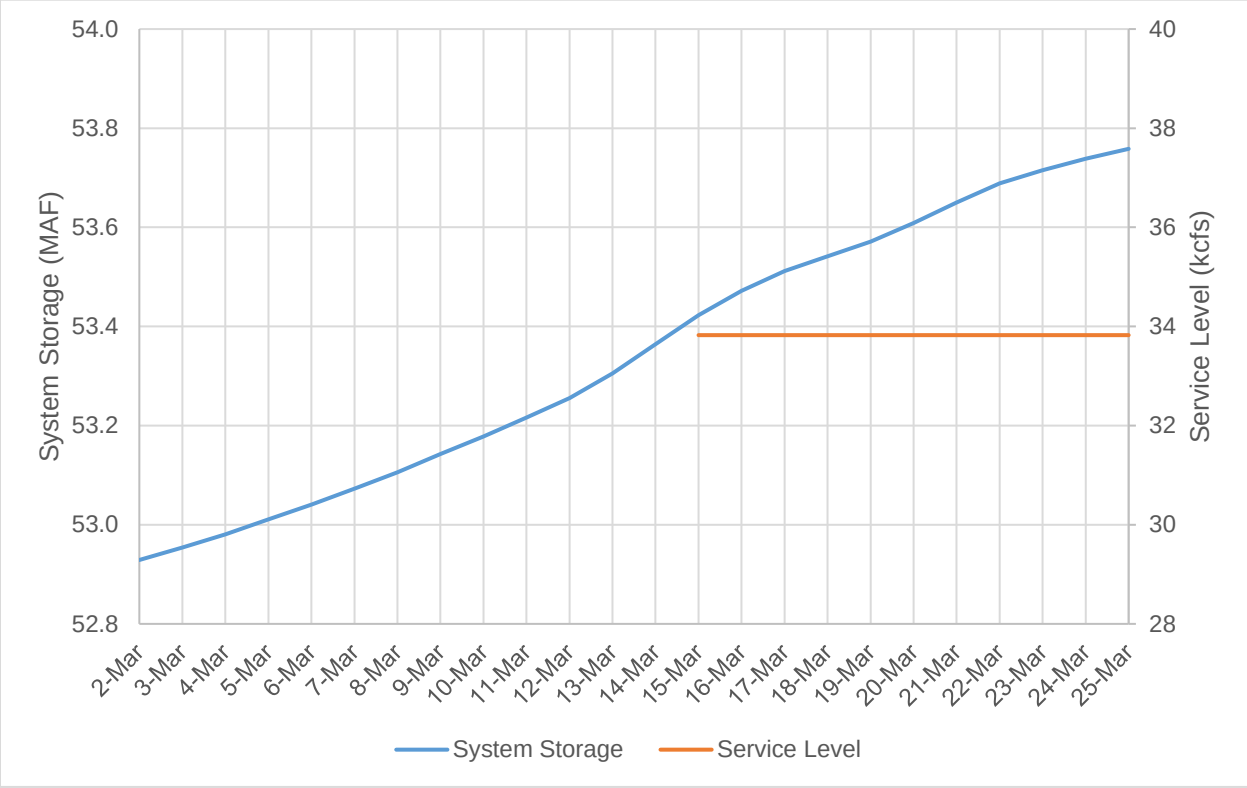

Figure 2-2: March 15 System storage assessment and resulting service level.

Based on the service level, navigation target flows are calculated for four locations: Sioux City, Omaha, Nebraska City, and Kansas City using the criteria summarized in Table 2-2. These navigation target flows represent minimum flow that will be provided to support navigation between Sioux City and Kansas City. ResSim forecasts flows at the four target locations and adjusts Gavins Point releases to ensure that each location's target flow is met throughout the navigation season, which varies by location. Table 2-3 summarizes the navigation start and end dates for an 8-month navigation season; the calculated navigation end date is for the mouth of the river and all other location-specific end dates are based on travel time from the mouth. Figure 2-3 shows the four target locations with their respective navigation targets and flows during a navigation season.

Table 2-2: Navigation target flows related to service level. Summarized from Table VII-1 in the Master Manual (U.S. Army Corps of Engineers, 2006).

Target Location	Target Flow Deviation from Service Level
Sioux City	- 4.0 kcfs
Omaha	- 4.0 kcfs
Nebraska City	+ 2.0kcfs
Kansas City	+ 6.0 kcfs

Table 2-3: Navigation season at each target location. Summarized from Section 7-03.4.1 in the Master Manual (U.S. Army Corps of Engineers, 2006).

Target Location	Opening Date	Closing Date
Sioux City	March 23	November 22** (Nav End Date – 9 days)
Omaha	March 25	November 24** (Nav End Date – 7 days)
Nebraska City*	March 26	November 25** (Nav End Date – 6 days)
Kansas City	March 28	November 27** (Nav End Date – 4 days)
Mouth	April 1	December 1** (Nav End Date)

*There is no navigation start or end dates specified in the Master Manual for Nebraska City. For modeling purposes, they were assumed to be 1 day after Omaha's start and end dates.

**Example dates listed are for a normal 8-month navigation season.

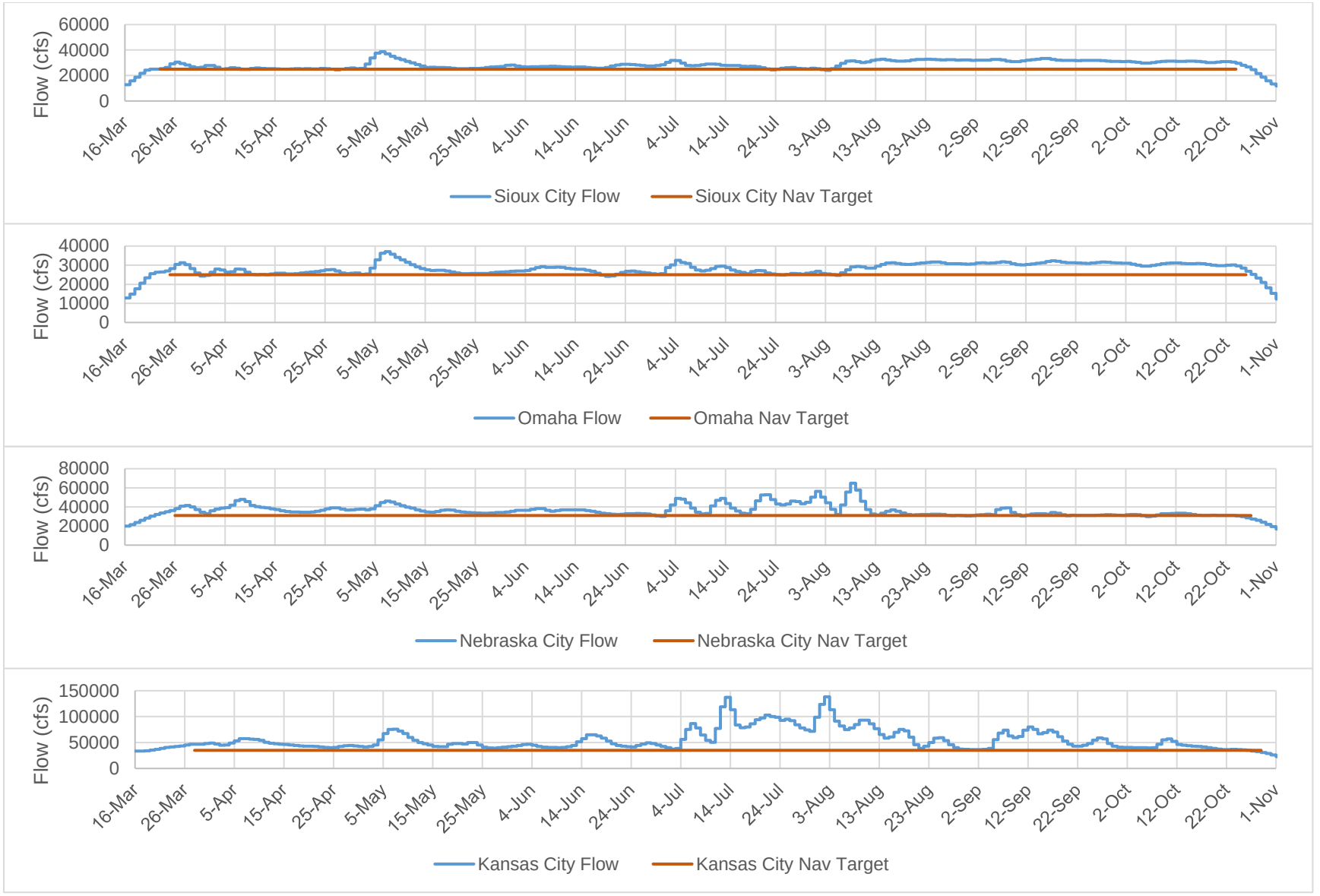

Figure 2-3: Navigation target locations with target and simulated flows.

Once the target flows are initially reached at the four target locations and Gavins Point releases are no longer increasing, the early spring spawning cue occurs if the System storage requirement was met on March 1. The pulse is 5.0 kcfs less the contribution from the James River. The term "pulse" refers to the magnitude of flow that is added to normal releases to produce the spawning cue. During Alt 1's early spawning cue, the total release from Gavins Point cannot exceed 35.0 kcfs. Releases are increased to the peak release in one day and maintained for two days before being reduced over the next five days, back to flow-to-target (FTT) navigation releases based on the current service level. Flow-to-target navigation operations refers to releases from Gavins Point that can be adjusted daily to ensure navigation target flows are met. Specialized downstream flood target flows at Omaha, Nebraska City, and Kansas City, which are summarized in Table 2-4, are monitored during the spawning cue. If any of the flood target flows are forecasted to be exceeded, the spawning cue is reduced by 0.5 kcfs until the flood targets are no longer forecasted to be exceeded or the peak pulse is 0.0 kcfs. Upon completion or elimination of the spawning cue, FTT navigation operations resume. Figure 2-4 shows an example of the early spring spawning cue in Alt 1, which is highlighted by the dashed red box.

Table 2-4: Downstream flood targets during early the spring spawning cue.

	Flood Target Flow (kcfs)
Omaha	41.0
Nebraska City	47.0
Kansas City	71.0

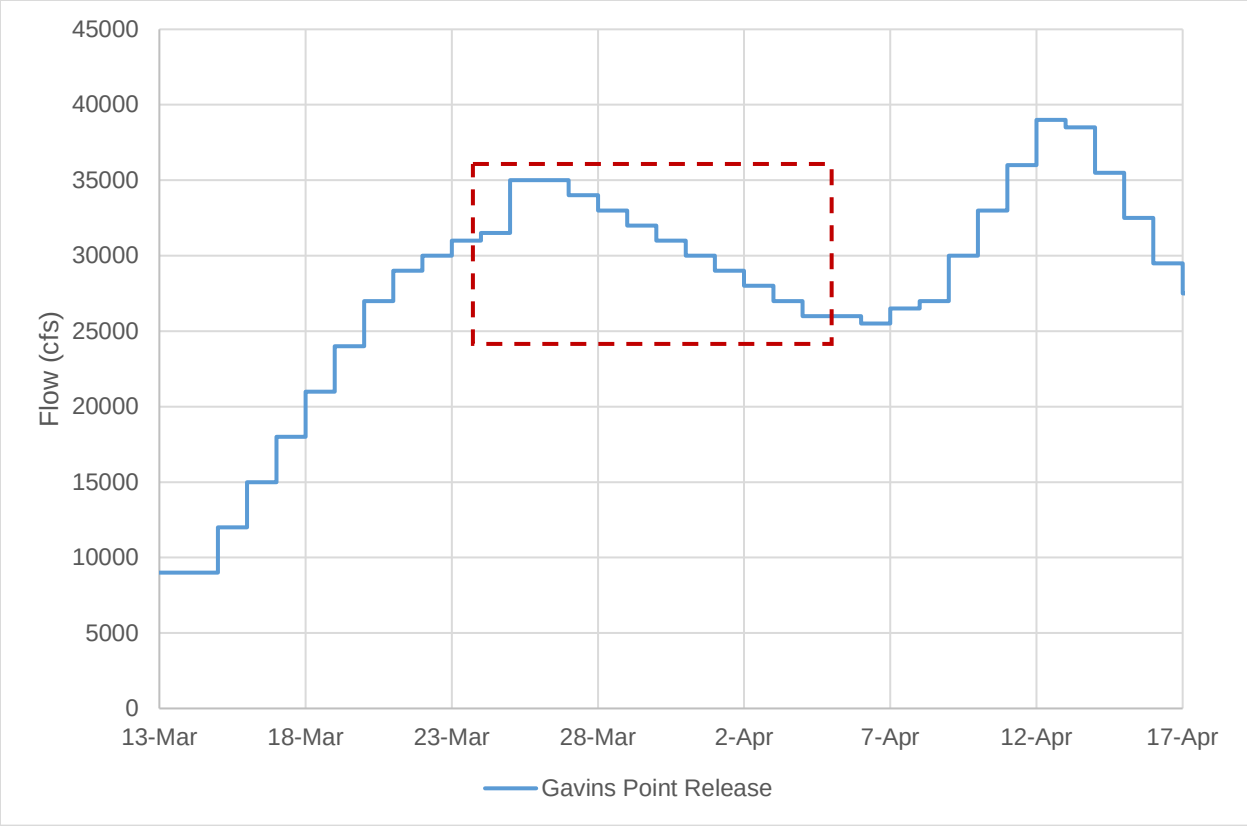

Figure 2-4: Early spring spawning cue for Alt 1.

While the System is supporting downstream navigation and not conducting a spawning cue, Gavins Point releases can be reduced if flows at Omaha, Nebraska City, and Kansas City are forecasted to exceed different flood target flows, which are summarized in Table 2-5. There are two tiers of flood targets that vary with the service level. The first tier is triggered when flow at Omaha or Nebraska City is forecasted to exceed their respective navigation target flow plus 10.0 kcfs or when flow at Kansas City is forecasted to exceed its navigation target flow plus 30.0 kcfs. When this occurs, Gavins Point releases are reduced to a level that minimizes downstream flooding and still supports full-service navigation flows at Sioux City, Omaha, Nebraska City, and Kansas City. If the full-service flood target is forecasted to be exceeded during an intermediate service level (i.e. 29.1 – 34.9 kcfs), Gavins Point releases are reduced to a level that minimizes downstream flooding and still supports minimum-service navigation flows at each of the four target locations. The second tier is triggered when flow at Omaha is forecasted to exceed its navigation target flow plus 15.0 kcfs, when flow at Nebraska City is forecasted to exceed its navigation target flow plus 20.0 kcfs, or when flow at Kansas City is forecasted to exceed it navigation target flow plus 60.0 kcfs. When this occurs, Gavins Point releases are reduced to a level that minimizes downstream flooding and still supports minimum-service at Sioux City, Omaha, Nebraska City, and Kansas City.

Table 2-5: Downstream flood targets. Summarized from Tables VII-7 and VII-8 in the Master Manual (U.S. Army Corps of Engineers, 2006).

	Flood Targets	
	Full-Service (1st Level)	Minimum-Service (2nd Level)
Omaha	Target Flow + 10.0 kcfs	Target Flow + 15.0 kcfs
Nebraska City	Target Flow + 10.0 kcfs	Target Flow + 20.0 kcfs
Kansas City	Target Flow + 30.0 kcfs	Target Flow + 60.0 kcfs

Figure 2-5 shows an example of how ResSim reduces Gavins Point releases when flows at a target location were forecasted to exceed its flood targets. Sioux City and Nebraska City are shown in this example, but all four navigation target locations and all three flood target locations are considered. The service level is 30.1 kcfs for the first half of the navigation season, which sets Sioux City's and Nebraska City's target flows to 26.1 and 32.1 kcfs, respectively. Nebraska City's full-service and minimum-service flood target flows are 42.1 and 52.1 kcfs, respectively. Nebraska City's flow is forecasted to exceed its full-service flood target on April 1. Since the service level was set at an intermediate service level, Gavins Point releases are reduced while still supporting minimum-service navigation flows, which are 25.0 kcfs and 31.0 kcfs at Sioux City and Nebraska City, respectively. The reduction of Gavins Point releases is highlighted by the dashed red box in the top plot of Figure 2-5. By April 5, flows at Sioux City and Nebraska City are forecasted to fall below their navigation target flows, so Gavins Point releases are increased through April 9, which is highlighted by the dashed green box in the top plot of Figure 2-5. On April 9, Nebraska City's flows are forecasted to exceed its full-service flood target so Gavins Point release are again reduced until Sioux City's flows are forecasted to fall below its navigation target. The second reduction in Gavins Point releases is highlighted by the dashed orange box in the top plot of Figure 2-5. Once this occurs, releases can no longer be reduced for downstream flooding and operate to meet minimum-service requirements at Sioux City.

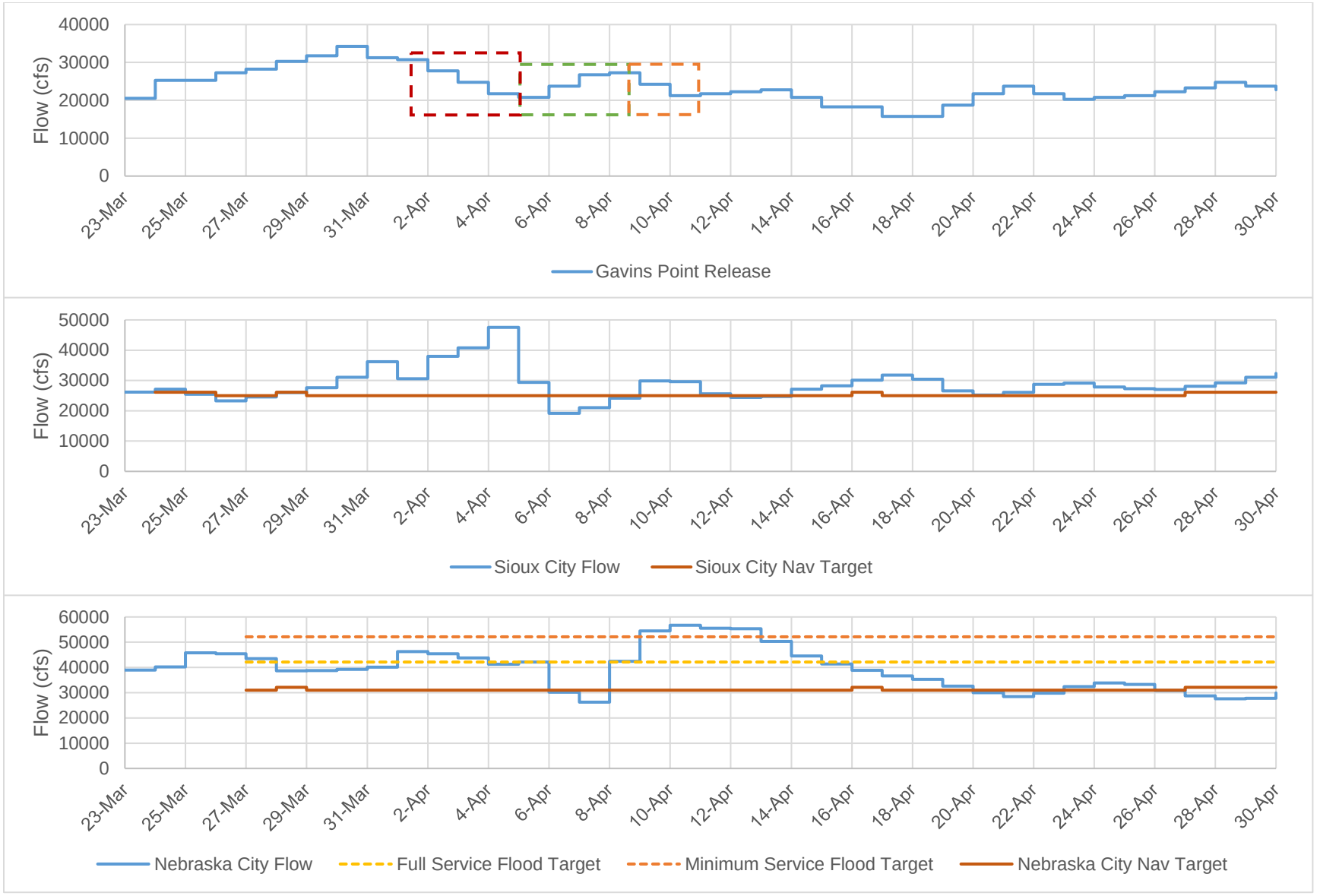

Figure 2-5: Example of reducing Gavins Point due to exceeding flood targets at Nebraska City.

If System storage was less than 31.0 MAF on March 15 and the navigation season is cancelled, System operations continue to support water supply by releasing a spring time minimum of 9.0 kcfs from Gavins Point and ensuring that a minimum flow of 9.0 kcfs is observed at the three target locations.

2.1.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

Similar to Alt 1, System storage is assessed on March 1 to determine if Alt 2's early spring spawning cue for the pallid sturgeon will occur. If System storage is greater than 40.0 MAF on March 1, the early spring spawning cue will occur at the end of March or early April, coinciding with the rise in releases for support of navigation.

Water supply and navigation requirements remain unchanged from Alt 1 operations during March and April: a minimum release of 9.0 kcfs from Gavins Point and ensuring a minimum of 9.0 kcfs is observed at the three target locations.

Alt 2's early spring spawning cue has the same timing as the early spring spawning cue in Alt 1, occurring in late March or early April once Gavins Point releases are no longer increasing in support of navigation, but the shape is different. Releases from Gavins Point are increased to 31.0 kcfs over seven days and maintained for an additional seven days before being reduced back to FTT navigation releases over seven days. If flows are forecasted to exceed flood downstream flood targets, the peak release is reduced by 0.5 kcfs until forecasted flows no longer exceed flood targets or the peak release is less than the navigation release. If the service level is higher than 35.0 kcfs, signifying that flood evacuation operations are in effect, the early spring spawning cue is disregarded. Figure 2-6 shows a comparison between Gavins Point releases for Alt 1's early spring spawning cue, highlighted by the dashed red box, and Alt 2's early spring spawning cue, highlighted by the dashed green box.

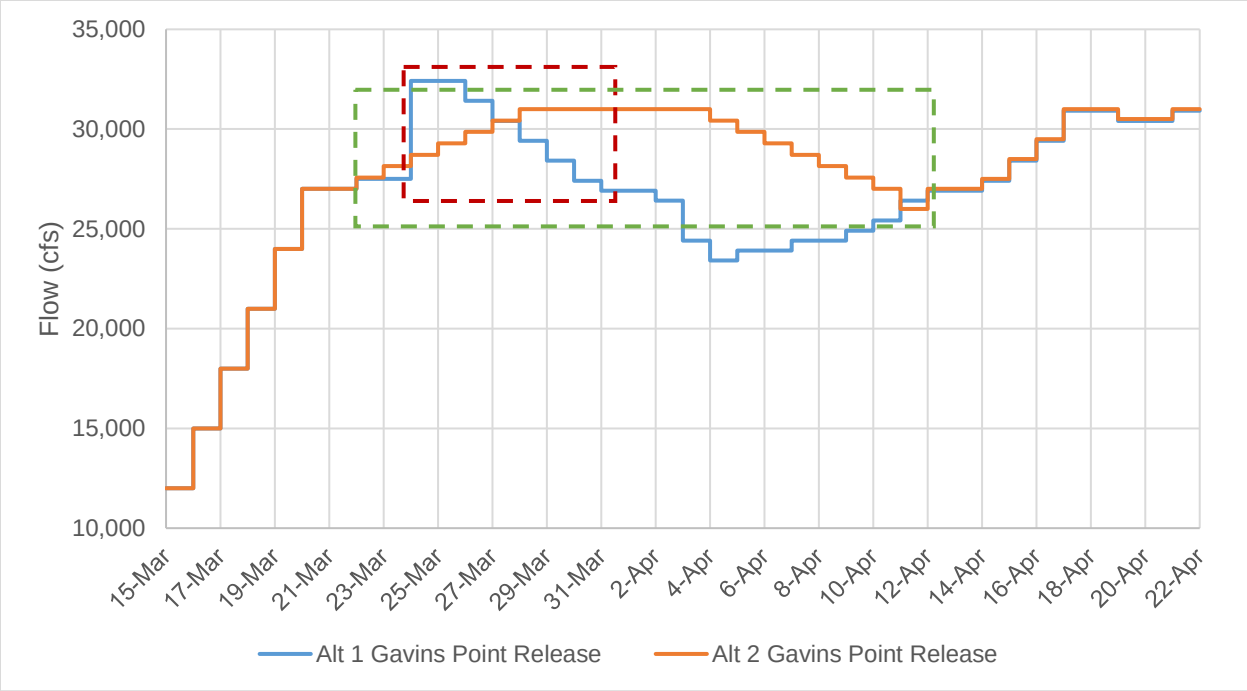

Figure 2-6: Alt 1 vs Alt 2 early spring spawning cue.

Flood targets for the early spring spawning cue in Alt 1 are increased by the pulse. For example, in Figure 2-6, Gavins Point is releasing 27.0 kcfs to support navigation prior to initiation of Alt 2's early spring spawning cue and the peak release for the spawning cue is 31.0 kcfs. The pulse is 4.0 kcfs (31.0 – 27.0), so 4.0 kcfs is added to the flood target flows utilized during Alt 1's early spring spawning cue. During Alt 2's early spring spawning cue shown in Figure 2-6, the flood target flows at Omaha, Nebraska City, and Kansas City become 45.0 kcfs, 51.0 kcfs, and 75.0 kcfs, respectively.

Table 2-6: Downstream flood targets during Alt 2's early spring spawning cue.

	Flood Target Flow (kcfs)
Omaha	41.0 + Pulse
Nebraska City	47.0 + Pulse
Kansas City	71.0 + Pulse

The operational changes in Alt 2 discussed throughout this document cause changes in Gavins Point's spring releases when compared to releases in Alt 1, shown in Figure 2-12. Some of the release changes occur as a direct result of Alt 2's early spring spawning cue, which runs to completion eighteen times and partially runs twenty four times between 1931 and 2012 causing an increase in spring releases when compared to releases in Alt 1.

The minor changes in spring pool elevation as compared to Alt 1, shown in Figure 2-11, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to

keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 2. Guide curve elevations are seasonally varying target elevations for a reservoir.

2.1.3 Alternative 3 – Mechanical Construction Only

Alt 3 does not change water supply, navigation, and flood target operations compared to Alt 1 during March and April. However, the early spring spawning cue that occurs in Alt 1 does not occur in Alt 3. Once navigation target flows are reached at each of the four target locations, FTT navigation operations continue through April. Figure 2-7 shows a comparison between Gavins Point releases during Alt 1 and Alt 3. Alt 1's early spring spawning cue is highlighted by the dashed red box.

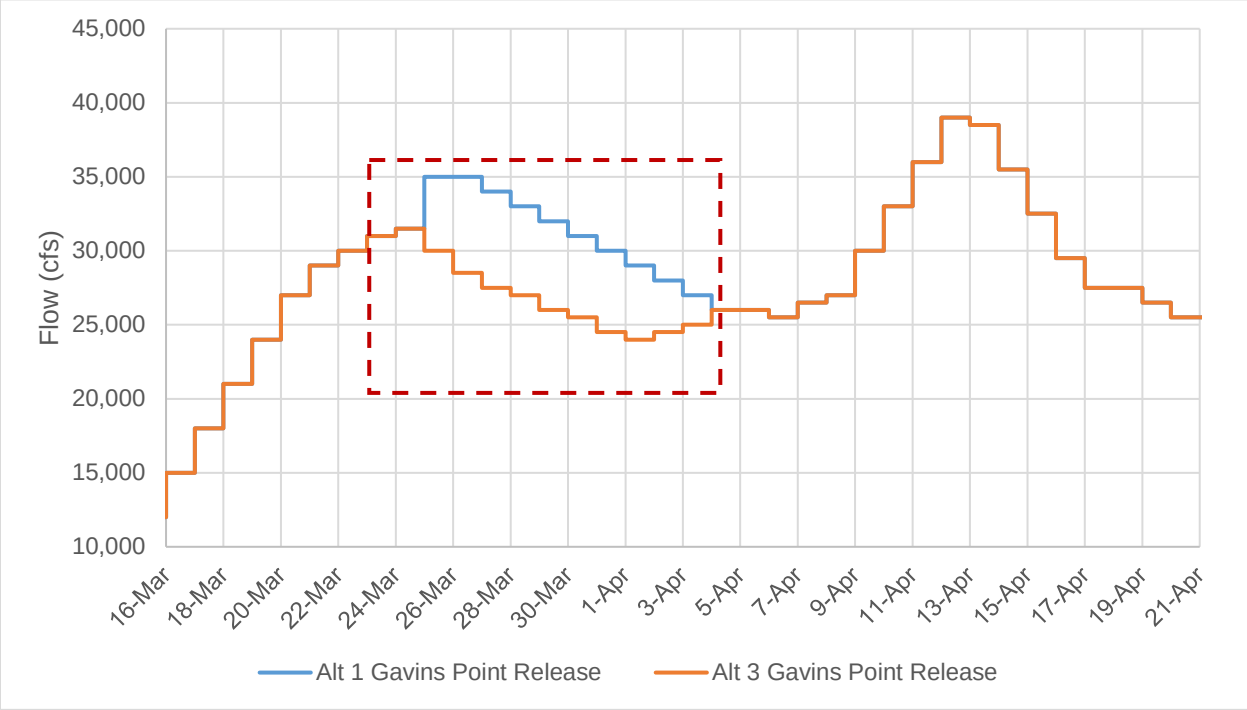

Figure 2-7: Alt 1 early spring spawning cue vs Alt 3 FTT navigation releases.

The operational changes in Alt 3 discussed throughout this document cause changes in Gavins Point's spring releases when compared to releases in Alt 1, shown in Figure 2-12. Removing Alt 1's early spring spawning, which runs to completion thirty times and partially runs four times between 1931 and 2012, does not significantly change Gavins Point's releases due to the small volume and relatively low peak release of the early spring spawning cue.

The minor changes in spring pool elevation as compared to Alt 1, shown in Figure 2-11, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 3.

2.1.4 Alternative 4 – Spring Habitat-Forming Flow Release

Alt 4 does not change water supply, navigation, or flood target operations compared to Alt 1 during March and April. However, the early spring spawning cue that occurs in Alt 1 is replaced with an

ESH-creating release. On April 1, System storage is assessed. If System storage is greater than 42.0 MAF, an ESH-creating release with a peak release of 60.0 kcfs is initiated. Gavins Point releases are increased by 7.0 kcfs per day until 60.0 kcfs is reached or a flood target at Omaha, Nebraska City, or Kansas City is forecasted to be exceeded. Specialized downstream flood target flows are used while the System is operating for the ESH-creating release, increasing the flood target flows from Alt 1 so the ESH-creating release has the opportunity to run more frequently. Table 2-7 lists the flood target locations and their associated target flows. If a flood target flow is forecasted to be exceeded at any of the three locations, the ESH-creating release peak release is reduced by 5.0 kcfs until the flood targets are no longer forecasted to be exceeded or the peak ESH-creating release is less than 45.0 kcfs.

Table 2-7: Flood targets during an ESH-creating release.

	Flood Target Flow (kcfs)
Omaha	71.0
Nebraska City	82.0
Kansas City	126.0

Minimum durations for each magnitude of ESH-creating release are specified based on a relationship between existing ESH, magnitude of release, and a target amount of new ESH created. For example, in order to create five hundred acres of new ESH below Gavins Point when there is a maximum of two hundred fifty acres of existing habitat, Gavins Point needs to release 60.0 kcfs for five weeks. Two hundred fifty acres was chosen as the assumed maximum because an ESH-creating release is more efficient at creating new habitat when existing habitat is relatively low. When existing habitat is greater than two hundred fifty acres, releases erode some of the existing habitat requiring a longer duration release to create the same amount of habitat. Table 2-8 summarizes the required durations for various releases to create five hundred acres of new habitat for the Gavins Point to Sioux City reach. Since the ResSim model does not calculate the amount of habitat and running an ESH-creating release is more efficient when the existing habitat is low, an ESH release would only be attempted if releases from Gavins Point did not meet any of the requirements listed in Table 2-8 during the previous three years. Utilizing this frequency helps to ensure a lower amount of existing habitat when an ESH-creating release occurs as the existing habitat would have eroded during the previous three years.

Table 2-8: Required release durations for the Gavins Point to Sioux City reach assuming a maximum of 250 acres of existing sandbar habitat.

	Duration (weeks)			
Reach / Release	45.0 kcfs	50.0 kcfs	55.0 kcfs	60.0 kcfs
Gavins Point to Sioux City	25	11	7	5

Figure 2-8 shows a five year period of Alt 1 and Alt 4 Gavins Point releases. High releases from Gavins Point occur in the first year due to normal flood evacuation releases, which meet the requirements summarized in Table 2-8; therefore, an ESH release is not attempted for the next

three years. In year five, an ESH-creating release occurs and is able to complete a full-duration 60.0 kcfs release from Gavins Point, which is highlighted by the dashed red box. Figure 2-9 shows the ESH-creating releases from Gavins Point occurring in year five of Figure 2-8. The dashed red box highlights Alt 1's early spring spawning cue, and the dashed green box highlights Alt 1's late spring spawning cue.

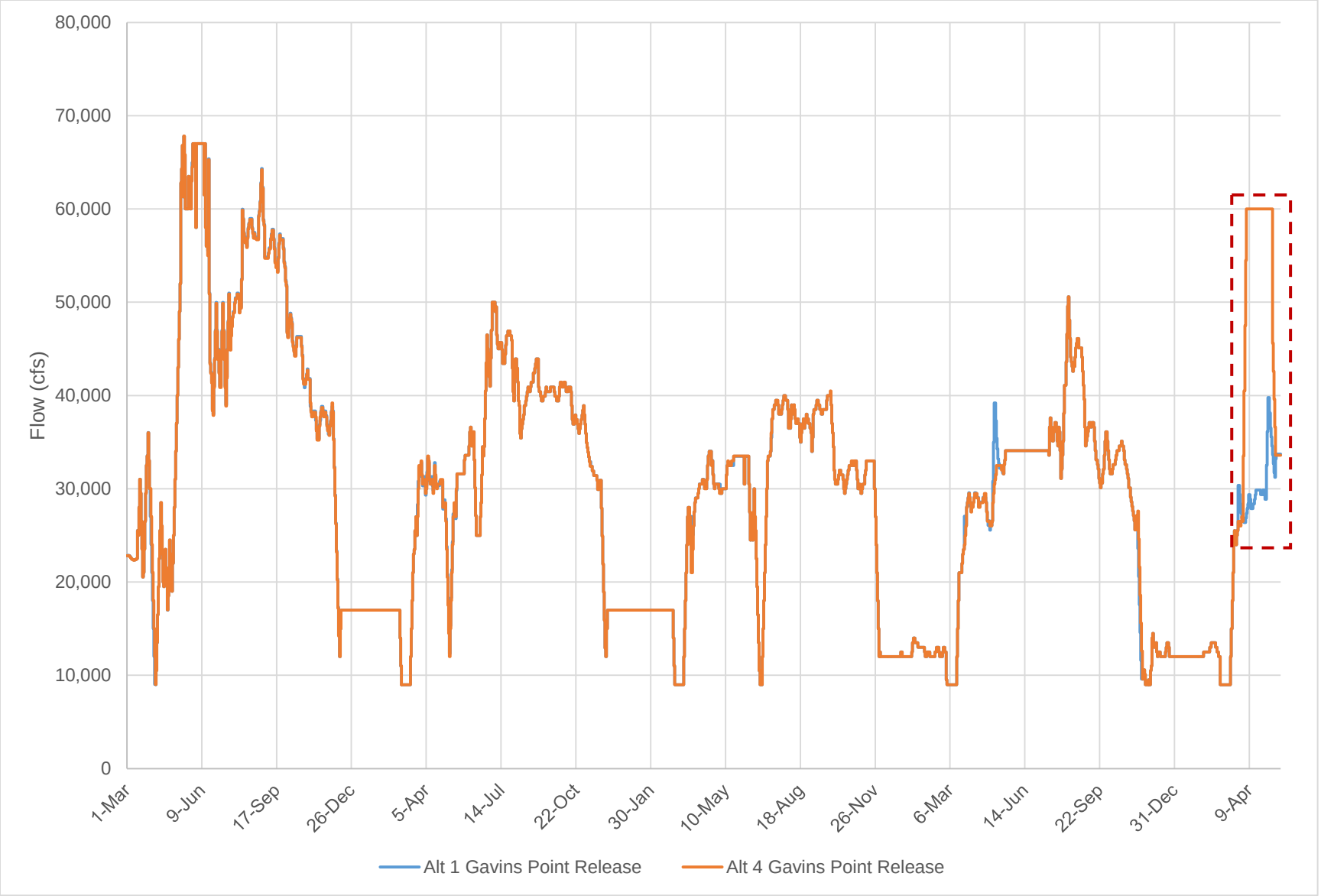

Figure 2-8: Comparison of Alt 1 vs Alt 4 Gavins Point releases during a five year period with ESH-creating release operations.

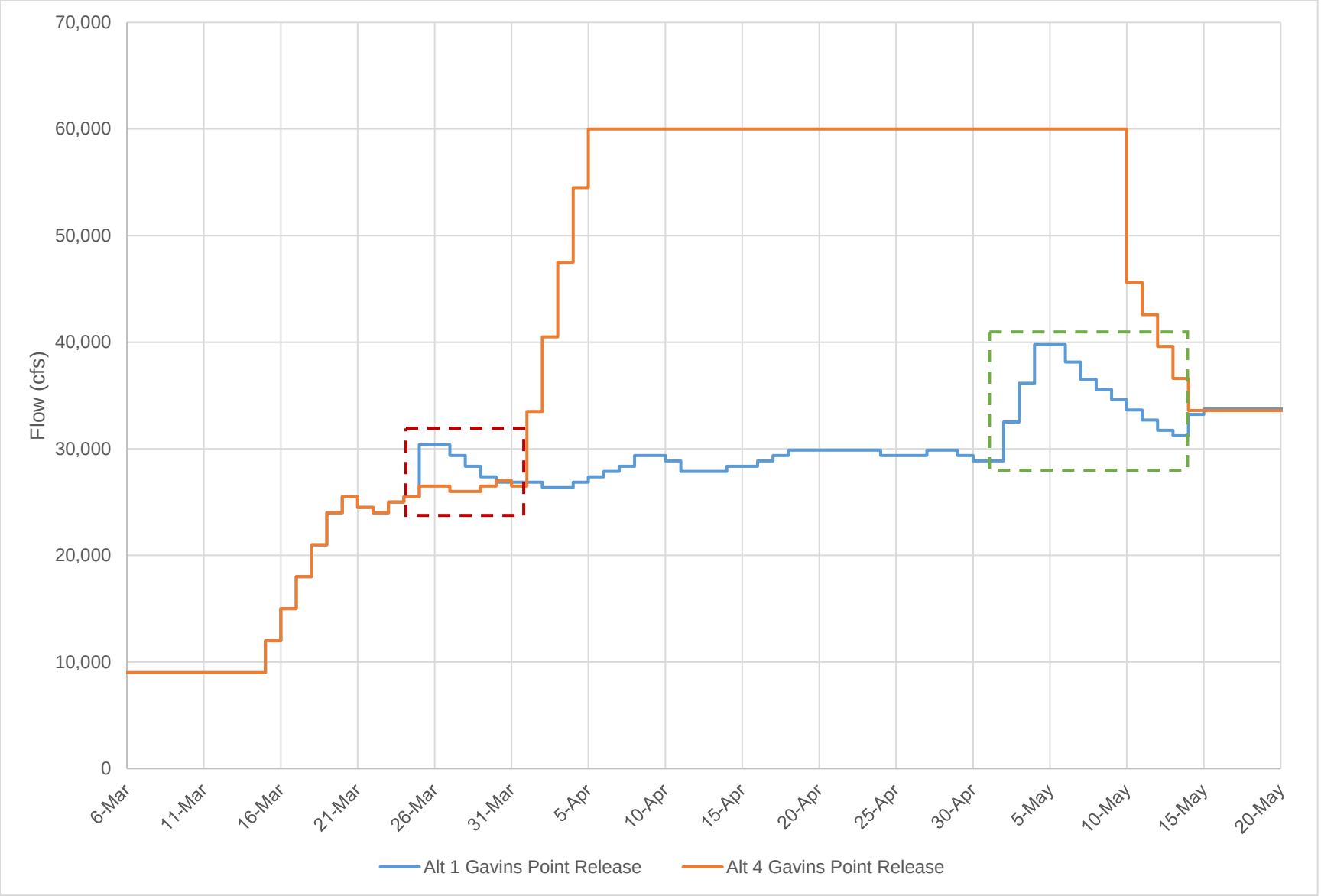

Figure 2-9: Comparison of Alt 1 vs Alt 4 Gavins Point releases during the ESH-creating release shown in Figure 2-8.

The operational changes in Alt 4 discussed throughout this document cause changes in Gavins Point's spring releases when compared to releases in Alt 1, shown in Figure 2-12. Some of the release changes, especially the > 10.0 kcfs release changes, occur as a direct result of replacing Alt 1's early spring spawning cue with an ESH-creating release, which runs to completion ten times and partially runs seven times between 1931 and 2012. The ESH-creating release also contributes to lower spring releases in Alt 4 compared to Alt 1 because of the lagged effect of lower System storage caused by using extra water for the ESH-creating release. Lower System storage results in reduced service levels in years following an ESH-creating release. If the service level has been reduced, Gavins Point releases will also be reduced because a lower release is required for a lower level of navigation support.

The minor changes in spring pool elevation as compared to Alt 1, shown in Figure 2-11, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 4.

2.1.5 Alternative 5 – Fall Habitat-Forming Flow Release

Alt 5 does not change water supply, navigation, or flood target operations compared to Alt 1 during March and April. However, the early spring spawning cue that occurs in Alt 1 does not occur in Alt 5. Once navigation target flows are reached at each of the four target locations, FTT navigation operations continue through April. Flood targets, which are summarized in Table 2-5, are checked daily. During water supply operations, Gavins Point releases a minimum of 9.0 kcfs and ensures a minimum of 9.0 kcfs at Sioux City, Omaha, and Kansas City.

The operational changes in Alt 5 discussed throughout this document cause changes in Gavins Point's spring releases when compared to releases in Alt 1, shown in Figure 2-12. Removing Alt 1's early spring spawning cue does not significantly change Gavins Point's releases due to the small volume and relatively low peak release of the early spring spawning cue.

The minor changes in spring pool elevation as compared to Alt 1, shown in Figure 2-11, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 5.

2.1.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Alt 6 does not change water supply, navigation, or flood target operations compared to Alt 1 during March and April. However, the early spring spawning cue that occurs in Alt 1 is replaced with a different early spring spawning cue. A minimum of 40.0 MAF in System storage is required on March 15 for the early spring spawning cue to occur. If System storage is at least 40.0 MAF on March 15, the early spring spawning cue will begin once navigation target flows are reached at each of the four target locations. Releases are increased by 2.2 kcfs per day until the peak release is reached. The pulse is equal to the release on the day the spawning cue was initiated, which results in a peak Gavins Point release equal to double the release occurring on the day the spawning cue is initiated. The peak release is maintained for two days and then releases are reduced by 1.7 kcfs per day until FTT releases are reached. Flood targets are increased during the spawning cue to allow it to run more frequently. The flood targets summarized in Table 2-4 are increased by the pulse. For example, if Gavins Point's release is 25.0 kcfs when Alt 6's early spring spawning cue is initiated, the pulse is 25.0 kcfs. The flood targets during the early spring

spawning cue become 66.0 kcfs, 72.0 kcfs, and 96.0 kcfs at Omaha, Nebraska City, and Kansas City, respectively. Under Alt 6, the early spring spawning cue is cancelled if flows at any of the three target locations are forecasted to exceed their respective flood target flows. Table 2-9 summarizes the flood target flows at each of the 3 locations during Alt 6's early spring spawning cue and Figure 2-10 compares the early spring spawning cue in Alt 1 and Alt 6. Alt 1's early spring spawning cue is highlighted by the dashed red box and Alt 6's early spring spawning cue is highlighted by the dashed green box.

Table 2-9: Downstream flood targets during Alt 6 early spring spawning cue.

	Flood Target Flow (kcfs)
Omaha	41.0 + Pulse
Nebraska City	47.0 + Pulse
Kansas City	71.0 + Pulse

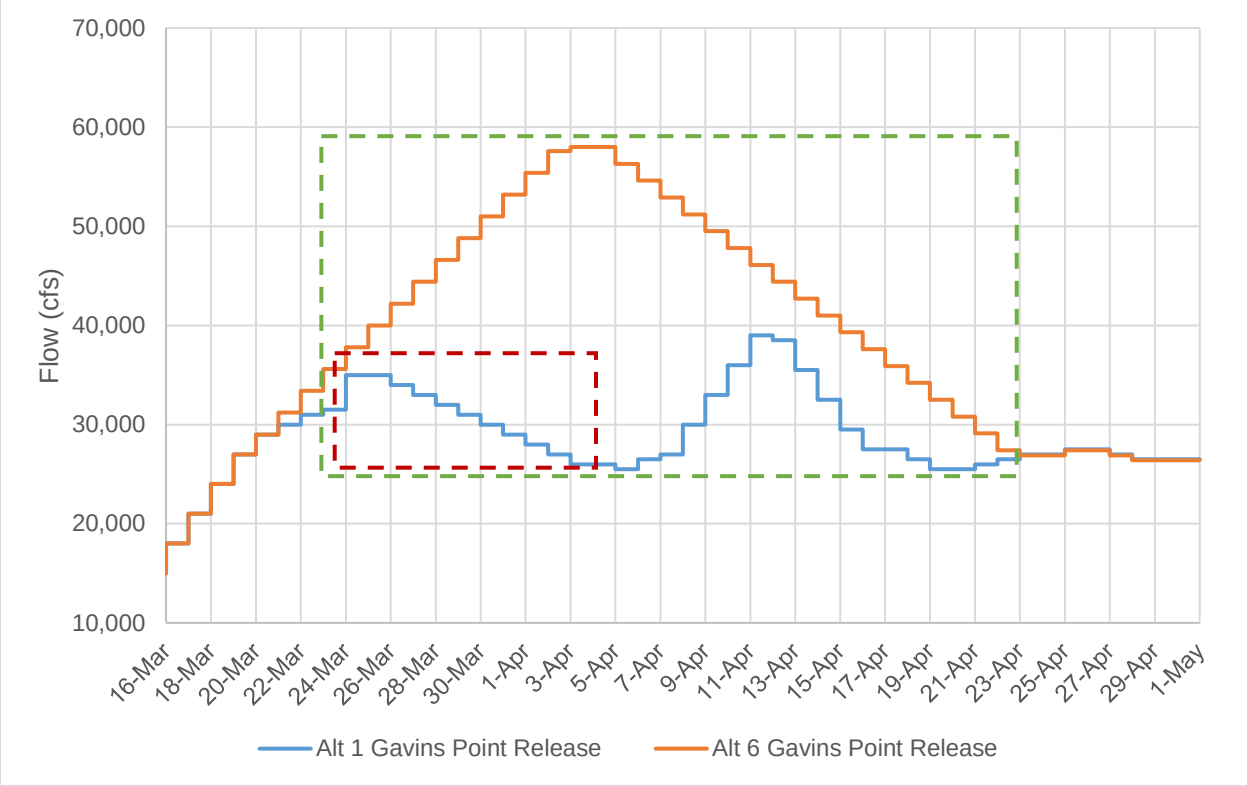

Figure 2-10: Alt 1 vs Alt 6 early spring spawning cue.

The operational changes in Alt 6 discussed throughout this document cause changes in Gavins Point's spring releases when compared to releases in Alt 1, shown in Figure 2-12. Some of the release changes, especially the > 10.0 kcfs release changes, occur as a direct result of replacing Alt 1's early spring spawning cue with a larger early spring spawning cue, which runs to completion seventeen times and partially runs 26 times between 1931 and 2012. Alt 6's early spring spawning cue also contributes to lower spring releases in Alt 6 compared to Alt 1 because

of the lagged effect of lower System storage caused by using extra water. Lower System storage results in reduced service levels in years following an early spring spawning cue. If the service level has been reduced, Gavins Point releases will also be reduced because a lower release is required for a lower level of navigation support.

The minor changes in spring pool elevation as compared to Alt 1, shown in Figure 2-11, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 6.

2.1.7 Elevation and Release Changes at Gavins Point during Spring Months for Alternative 1 – 6

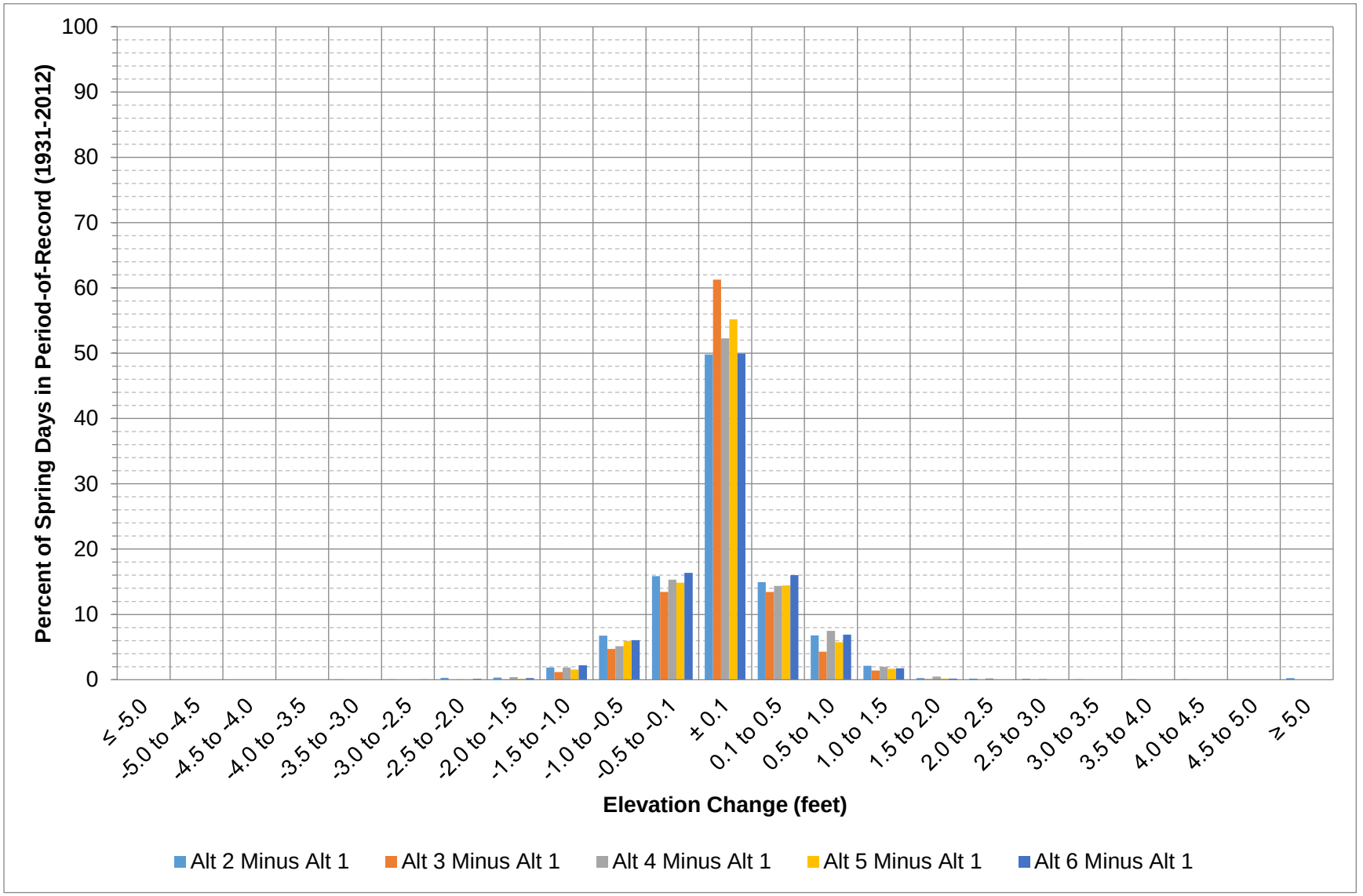

Figure 2-11: Gavins Point elevation change between each alternative and Alt 1 during March – April.

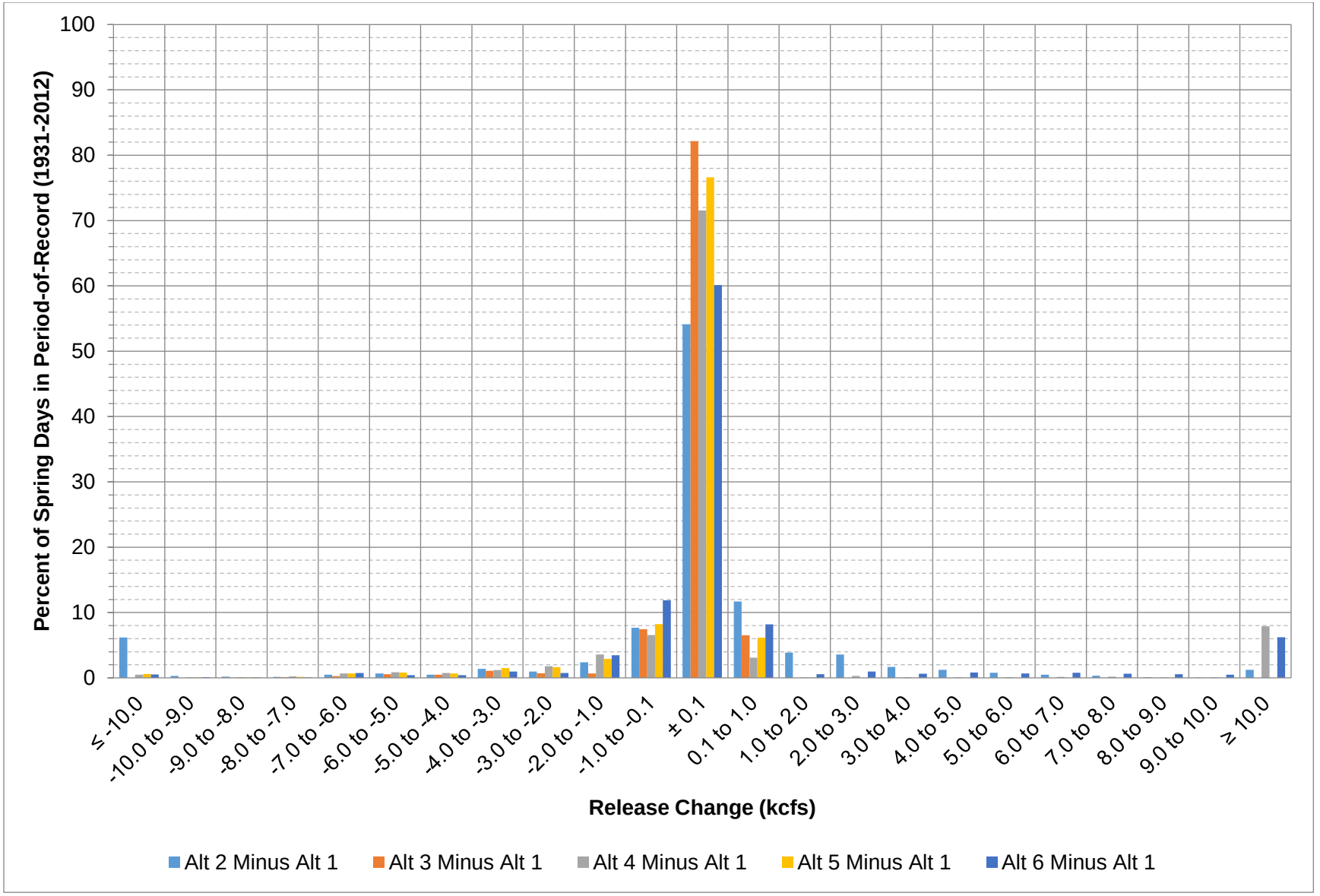

Figure 2-12: Gavins Point release change between each alternative and Alt 1 during March – April.

2.2 UPSTREAM OF GAVINS POINT

2.2.1 Alternative 1 – No Action

After setting the System or Gavins Point releases, the model focuses on setting releases for storage balancing at Fort Peck, Garrison, and Oahe, water supply flows at Wolf Point, Culbertson, and Bismarck, and guide curve operations at Big Bend, Fort Randall, and Gavins Point.

Storage balancing focuses on balancing the amount of occupied Carryover Multiple Use Zones in Fort Peck, Garrison, and Oahe where over ninety percent of the total System storage resides. During an ideal runoff year, Fort Peck, Garrison, and Oahe would begin the year at the bottom of their respective Annual Flood Control & Multiple Use Zone (top of the Carryover Multiple Use Zone). Annual runoff would be captured and released to meet the eight authorized purposes such that Fort Peck, Garrison, and Oahe all reach the bottom of their respective Annual Flood Control & Multiple Use Zone prior to the start of next year's runoff season. In this case, System storage is balanced as Fort Peck, Garrison, and Oahe all have zero percent of their respective Annual Flood Control & Multiple Use Zone or one hundred percent of their Carryover Multiple Use Zone occupied. During an extended drought, System operations cause Fort Peck, Garrison, and Oahe to draft into their Carryover Multiple Use Zone, which was designed to provide water for the System to operate for all eight authorized purposes during extended droughts. In this case, storage balancing operations use monthly runoff and release forecasts to set releases at Fort Peck and Garrison so Fort Peck, Garrison, and Oahe all have an equal percentage of occupied Carryover Multiple Use Zones by the start of next year's runoff season. Figure 2-13 shows an example of how Fort Peck, Garrison, and Oahe are balanced throughout the runoff year. The percentage of occupied carryover storage in each reservoir fluctuates throughout the runoff year but as the year progresses towards the next runoff season, the percentages of occupied carryover storage begin to converge resulting in balanced storage.

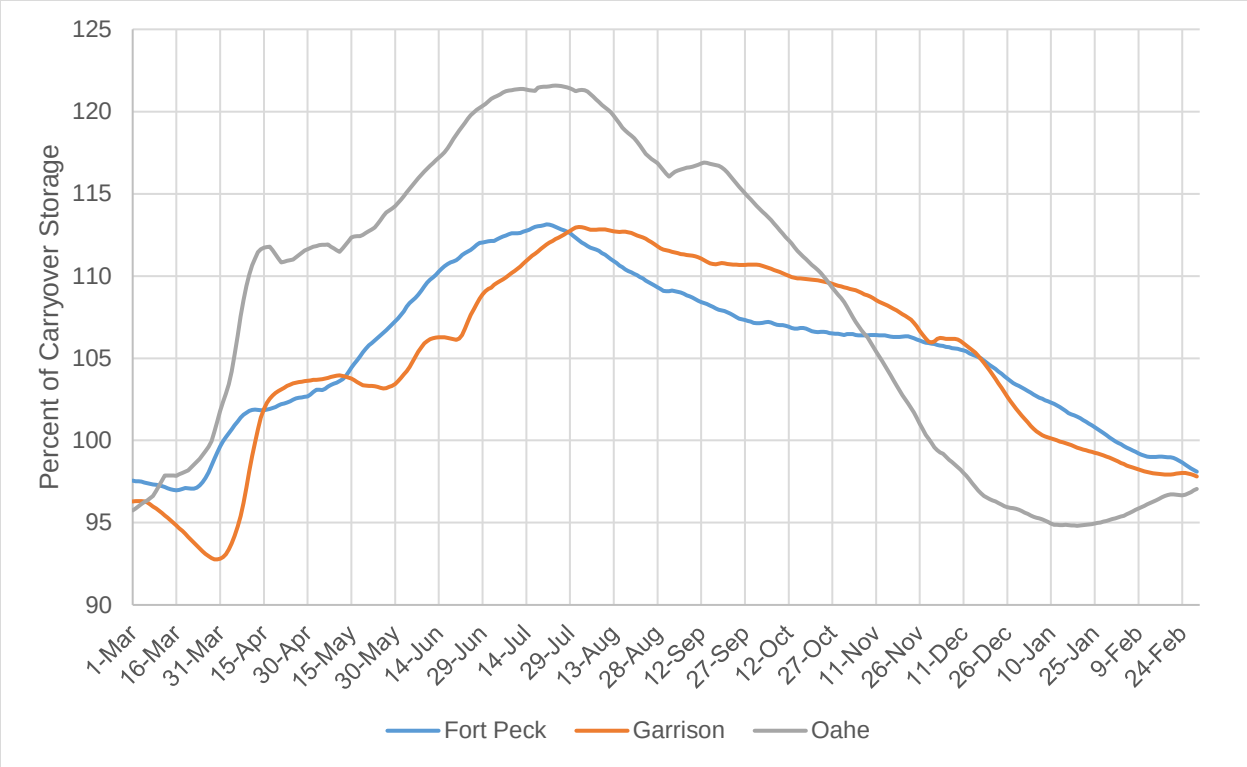

Figure 2-13: Storage balancing at Fort Peck, Garrison, and Oahe.

After setting releases at Fort Peck and Garrison, minimum flows at Wolf Point, Culbertson, and Bismarck are checked. Releases from Fort Peck are increased to ensure a minimum flow of 3.0 kcfs is forecasted at Wolf Point and Culbertson during March and April. Releases from Garrison are increased to ensure a minimum flow of 10.0 kcfs is forecasted at Bismarck during March and April.

While storage balancing and water supply operations are responsible for setting releases from Fort Peck and Garrison, guide curve operations govern releases from Oahe, Big Bend, and Fort Randall. Big Bend is a run-of-river project mainly operated for hydropower, which keeps the normal operating pool between 1420.0 feet (NGVD 29) and 1421.0 feet (NGVD 29) throughout the year. Fort Randall's pool elevation begins March near 1350.0 feet (NGVD 29) and rises to 1355.0 feet (NGVD 29) by April 1. Once Fort Randall's pool elevation reaches 1355.0, it is held constant for the remainder of April. This is accomplished by adjusting releases from Oahe and Big Bend together. Gavins Point's pool elevation is kept within a narrow operational range near 1206.0 feet (NGVD 29) during March and April by adjusting releases from Fort Randall.

2.2.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

Upstream operations in Alt 2 do not change compared to Alt 1 March – April. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to their reservoirs at their

respective guide curve elevations. The observed changes that are shown in Figure 2-16 through Figure 2-25 are attributed to changes described in Sections 2.1.2, 3.1.2, 4.1.2, and 5.1.2.

Figure 2-16, Figure 2-18, and Figure 2-20 show a higher percentage of the spring months with lower elevations compared to Alt 1 at Fort Peck, Garrison, and Oahe, respectively. This is due to larger spawning cues than in Alt 1. Alt 2's spawning cues (Sections 2.1.2 and 3.1.2) lower System storage and since over ninety percent of System storage resides in those three reservoirs, they display the effect of lower System storage. Even though the spawning cues lower System storage, Alt 2's low summer flow operations and lower max winter release (Section 5.1.2) also conserve water, which is stored in Fort Peck, Garrison, and Oahe. This is why some of the spring months show higher elevations compared to Alt 1. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 2-22 and Figure 2-24 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Figure 2-17 and Figure 2-19 show slightly lower spring releases at Fort Peck and Garrison, respectively. Since Fort Peck and Garrison operate to balance System storage, their releases only need to slightly change over the course of a year to release large volumes of water needed to balance System storage between Fort Peck, Garrison, and Oahe. Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 2-21; Figure 2-23; Figure 2-25, respectively, have evenly distributed changes. Some of the > 10.0 kcfs changes observed at all three locations are attributed to the spawning cue from Gavins Point as water is released from Oahe to keep Gavins Point at its guide curve. However, Oahe's releases are highly variable regardless of spawning cues at Gavins Point as water is released to keep Big Bend, Fort Randall, and Gavins Point at their respective guide curves.

2.2.3 Alternative 3 – Mechanical Construction Only

Upstream operations in Alt 3 do not change compared to Alt 1 March – April. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep their reservoirs at their respective guide curve elevations. The observed changes that are shown in Figure 2-16 through Figure 2-25 are attributed to changes described in Sections 2.1.3 and 3.1.3.

Fort Peck's, Garrison's, Oahe's, Big Bend's, and Fort Randall's elevation and releases changes compared to Alt 1 all have minimal changes as shown in Figure 2-16 through Figure 2-25. Removing the early and late spring spawning cues from Alt 1 results in higher System storage. However, the increase in System storage does not significantly affect reservoir elevations or releases.

2.2.4 Alternative 4 – Spring Habitat-Forming Flow Release

Upstream operations for Alt 4 do not change compared to Alt 1 except during an ESH-creating release from Gavins Point. Since Gavins Point is operated within a small range of pool elevations, Fort Randall's releases typically mirror Gavins Point's releases. Therefore, any year that has an ESH-creating release from Gavins Point, similar releases will be made from Fort Randall. Although Garrison is not directly tied to Gavins Point operations as Fort Randall is, Garrison also

conducts an ESH-creating release in years when Gavins Point conducts an ESH-creating release; this assumes that existing habitat is low in the Garrison to Oahe reach during the same years that it is low in the Gavins Point to Sioux City reach. Table 2-10 summarizes the required durations for various releases to create five hundred acres of new habitat for the Garrison to Oahe and Fort Randall to Gavins Point reaches. Even though Garrison's required durations to create five hundred acres of habitat are longer than Gavins Point's durations, Garrison's ESH-creating release follows Gavins Point's durations. This was done to prevent unbalancing System storage by storing extra water in Oahe, which can be detrimental to flood control operations as Oahe is the most downstream reservoir in the System that has substantial flood storage. Figure 2-14 compares a five year period of Alt 1 and Alt 4 releases from Gavins Point, Fort Randall and Garrison. In year five, an ESH-creating release occurs and is able to complete a full-duration 60.0 kcfs release from Gavins Point, which is highlighted by a dashed red box. Fort Randall's releases are increased during the ESH-creating release to keep Gavins Point near its guide curve and Garrison's releases are increased per Alt 4 operational requirements. Figure 2-15 shows the ESH-creating releases from Gavins Point, Fort Randall, and Garrison occurring in year five of Figure 2-14.

Table 2-10: Required release durations for the Fort Randall to Gavins Point and Garrison to Oahe reaches assuming a maximum of 250 acres of existing sandbar habitat.

	Duration (weeks)			
Reach / Release	45.0 kcfs	50.0 kcfs	55.0 kcfs	60.0 kcfs
Fort Randall to Gavins Point	34	24	19	16
Reach / Release	27.5 kcfs	32.5 kcfs	37.5 kcfs	42.5 kcfs
Garrison to Oahe	70	16	9	6

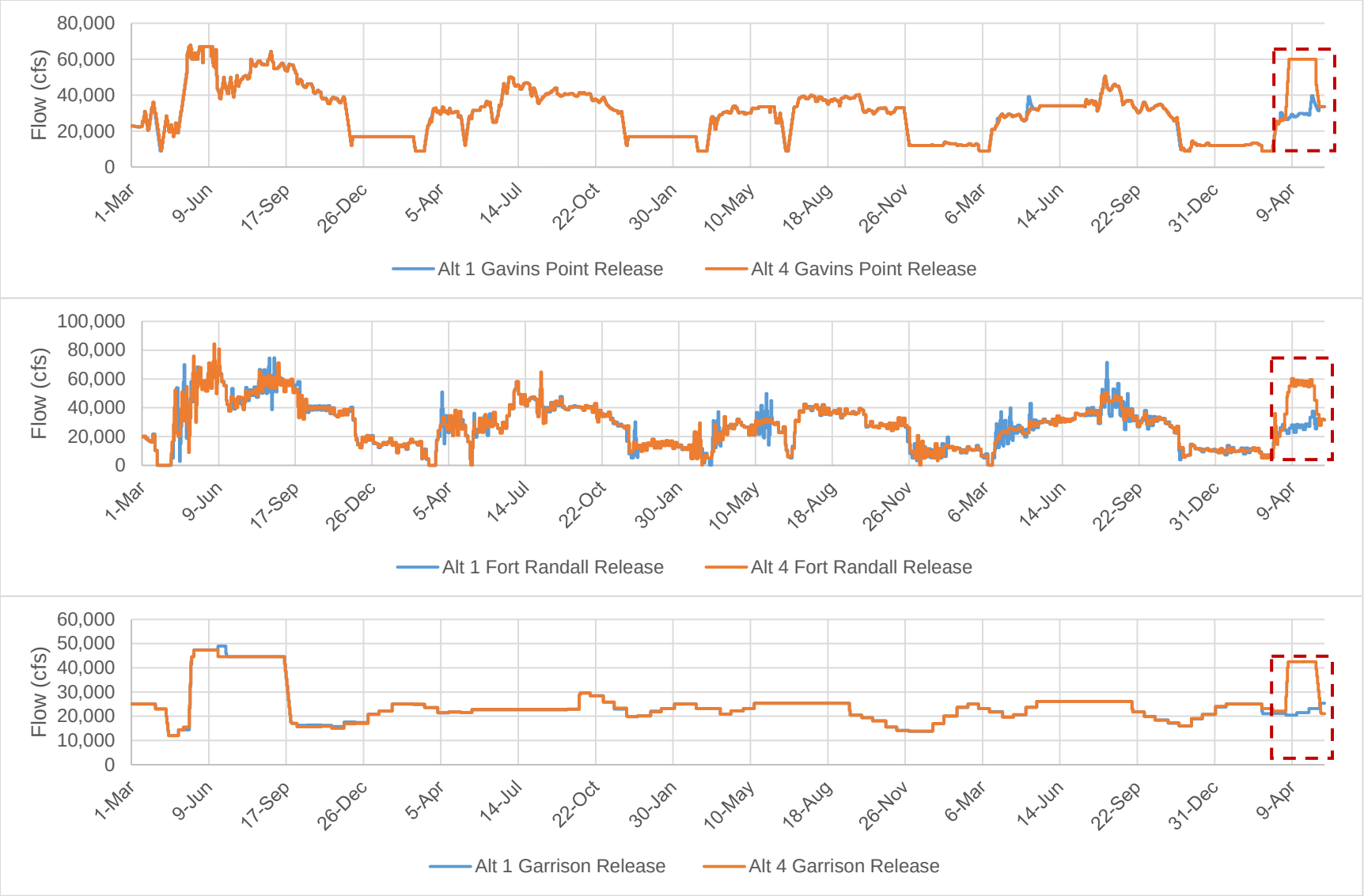

Figure 2-14: Comparison of Alt 1 vs Alt 4 Gavins Point, Fort Randall, and Garrison releases during same five year period with ESH-creating release operations as shown in Figure 2-8.

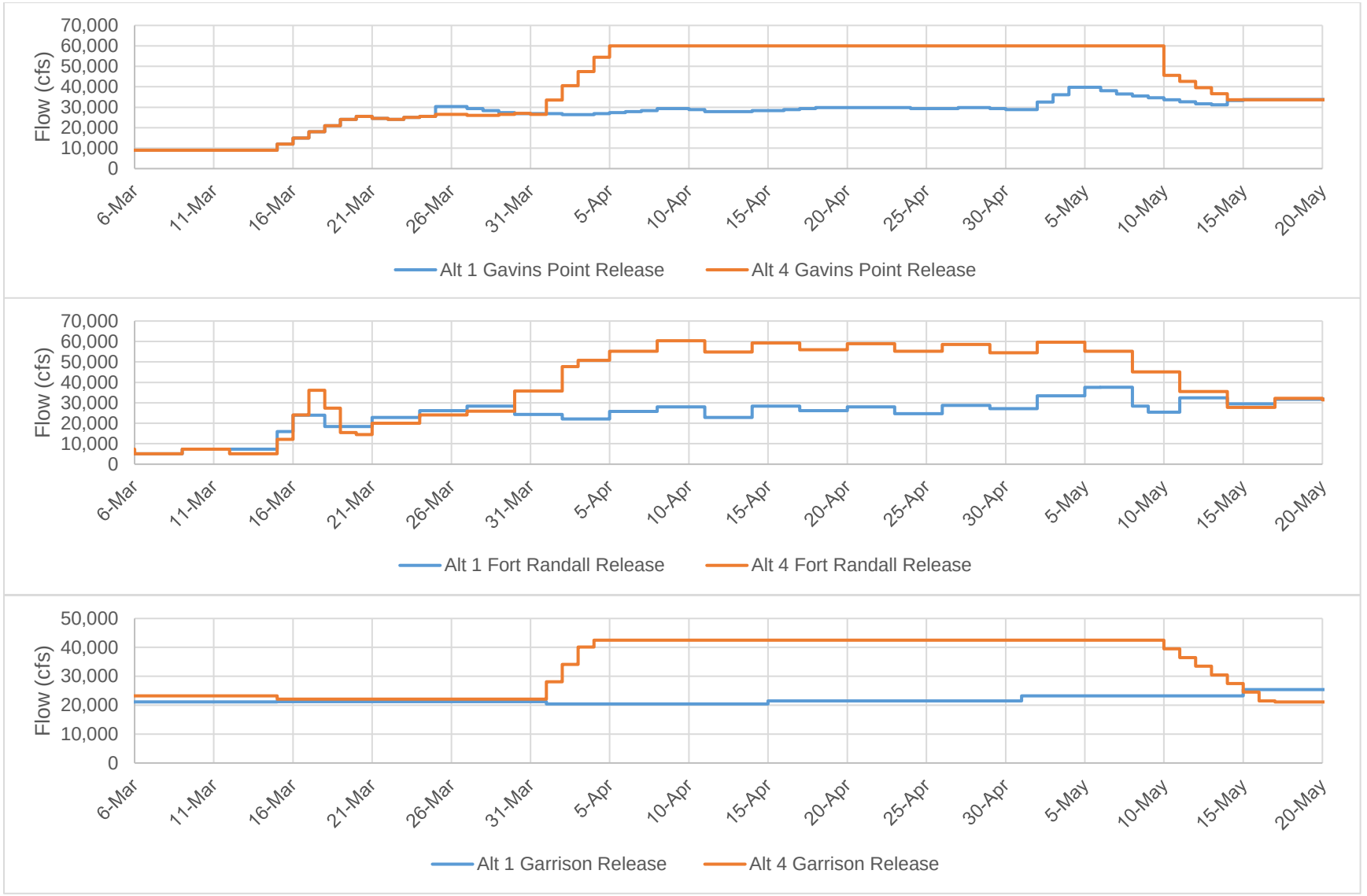

Figure 2-15: Comparison of Alt 1 vs Alt 4 Gavins Point, Fort Randall, and Garrison's releases during the ESH-creating release shown in Figure 2-14.

Fort Peck's, Garrison's, and Oahe's elevation changes show lower spring elevations compared to Alt 1 as shown in Figure 2-16, Figure 2-18, and Figure 2-20. This is caused by the ESH-creating release discussed in Section 2.1.4 and 2.2.4. Gavins Point's ESH-creating release directly reduces System storage as water leaves the reservoir system. Oahe's elevation is lowered the most during the spring because Oahe supplies the water for Gavins Point's ESH-creating release. Garrison also shows lower spring pool elevations as an ESH-creating release occurs at Garrison any time an ESH-creating release occurs at Gavins Point. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 2-22 and Figure 2-24 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

As the ESH-creating release is conducted at Gavins Point, Oahe's releases increase to supply water to Big Bend, Fort Randall, and Gavins Point, which causes a higher releases from Oahe, especially the > 10.0 kcfs release change. Oahe's release changes propagate downstream through Big Bend and Fort Randall as they operate for their respective guide curves. Figure 2-21, Figure 2-23, and Figure 2-25 show the full range of Oahe's, Big Bend's, and Fort Randall's release changes during the spring months, respectively. Although System storage is lower in the years following the release, Fort Peck's and Garrison's releases are not significantly affected by the lower System storage as they only need to slightly adjust their releases to account for the System storage change while balancing System storage. Garrison does show a higher percentage of the spring months with > 10.0 kcfs release change, which is attributed to the ESH-creating release at Garrison. Figure 2-17 and Figure 2-19 show Fort Peck's and Garrison's full range of release changes during the spring months, respectively.

2.2.5 Alternative 5 – Fall Habitat-Forming Flow Release

Upstream operations in Alt 5 do not change compared to Alt 1 March – April. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep the lower three reservoirs (Big Bend, Fort Randall, and Gavins Point) at their respective guide curve elevations. Any observed changes in pool elevations or releases shown in Figure 2-16 through Figure 2-25 are attributed to changes described in Sections 2.1.5, 3.1.5, and 4.1.5.

Figure 2-16, Figure 2-18, and Figure 2-20 show slightly lower pool elevations compared to Alt 1 at Fort Peck, Garrison, and Oahe, respectively. Although the pool elevations are slightly lower, most of the change falls between ±1.0 feet. Since the Alt 5's ESH-creating release occurs in the fall, spring pool elevations are not affected to the degree they are in Alt 4. The elevation effects are attributed to lower System storage in years following the fall ESH-creating release. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 2-22 and Figure 2-24 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

As with the elevation change, releases from Fort Peck and Garrison are not significantly affected since the ESH-creating release occurs in the fall. Most of the release changes fall between ±1.0 kcfs at both reservoirs. Oahe's releases are highly variable as it releases water to keep Big Bend,

Fort Randall, and Gavins Point at their respective guide curve elevations. Oahe's percentage of the spring months that have > 10.0 kcfs change is lower than in Alt 4 because there are not high releases occurring in the spring as a result of Alt 4's ESH-creating release. Big Bend's and Fort Randall's release change percentages mirror Oahe's release change as Big Bend and Fort Randall operate for their respective guide curves. Figure 2-21, Figure 2-23, and Figure 2-25 show the full range of release changes for Oahe, Big Bend, and Fort Randall, respectively.

2.2.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Upstream operations in Alt 6 do not change compared to Alt 1 March – April. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep the lower three reservoirs at their respective guide curve elevations. Any observed changes in pool elevations or releases shown in Figure 2-16 through Figure 2-25 are attributed to changes described in Sections 2.1.6 and 3.1.6.

Figure 2-16, Figure 2-18, and Figure 2-20 show lower pool elevations compared to Alt 1 at Fort Peck, Garrison, and Oahe, respectively. Alt 6's early spring spawning cue lowers the pool elevations during the spring at those three projects as it utilizes extra System storage compared to Alt 1. Alt 6's early spring spawning cue completely runs seventeen times and partially runs 26 times during the period-of-record. The late spring spawning cue, discussed in Section 3.1.6, also contributes to lowering reservoir elevations during the spring, but the effects are lagged and observed in the years following a spawning cue since the late spring spawning cue occurs in the summer. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 2-22 and Figure 2-24 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Releases from Fort Peck and Garrison are not significantly affected since both resevoirs are attempting to balance System storage and can slightly adjust their releases in order to move the necessary volume throughout the year. Most of the release changes fall between ±1.0 kcfs at both reservoirs. Oahe's releases are highly variable as it releases water to keep Big Bend, Fort Randall, and Gavins Point at their respective guide curve elevations. Oahe's percentage of the spring months that have > 10.0 kcfs change increases in Alt 6 because of the early spring spawning cue from Gavins Point. Big Bend's and Fort Randall's release change percentages mirror Oahe's release change as Big Bend and Fort Randall operate for their respective guide curves. Figure 2-21, Figure 2-23, and Figure 2-25 show the full range of release changes for Oahe, Big Bend, and Fort Randall, respectively.

2.2.7 Elevation and Release Changes Upstream of Gavins Point during Spring Months for Alternative 1 – 6

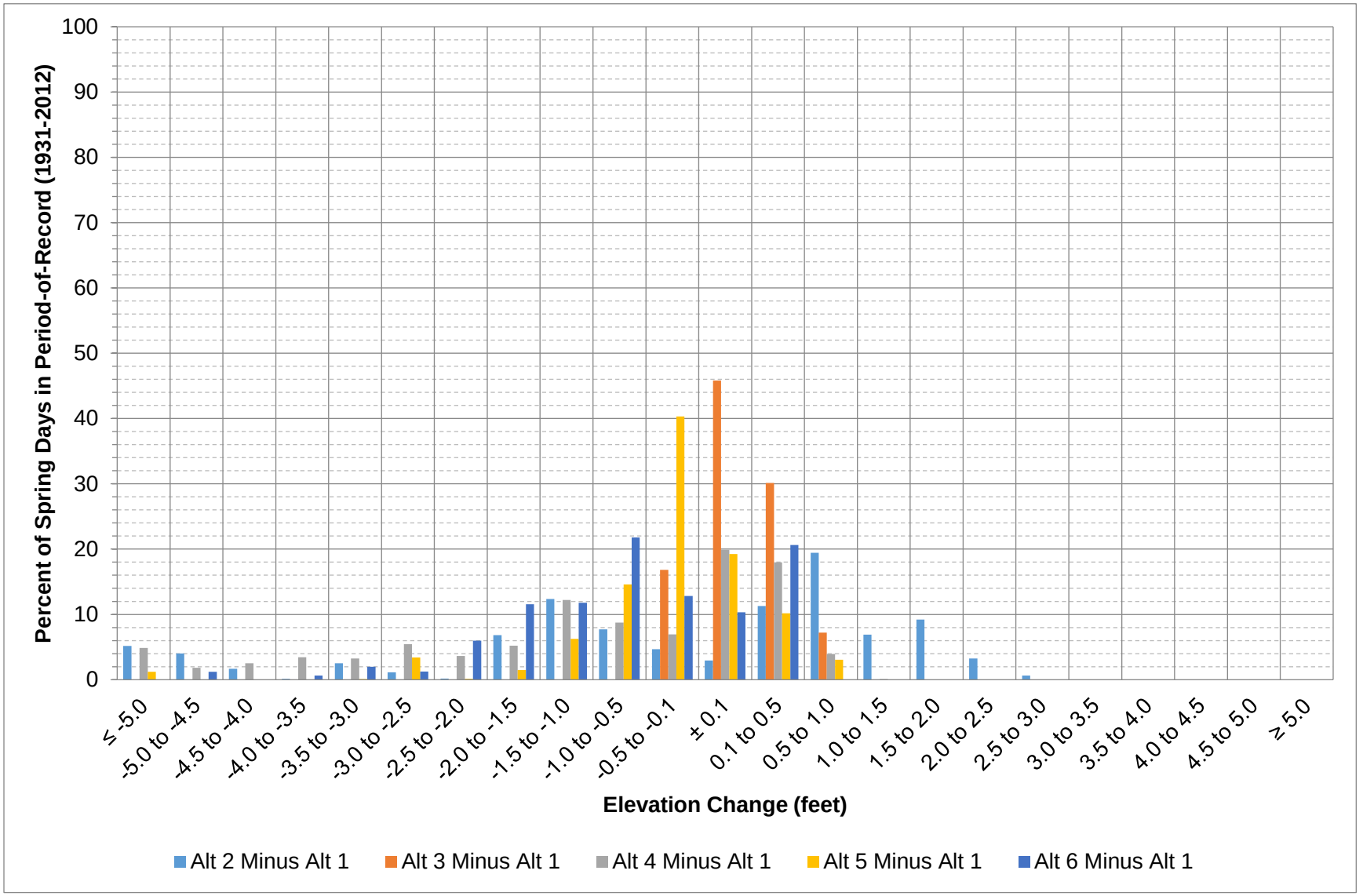

Figure 2-16: Fort Peck elevation change between each alternative and Alt 1 during March – April.

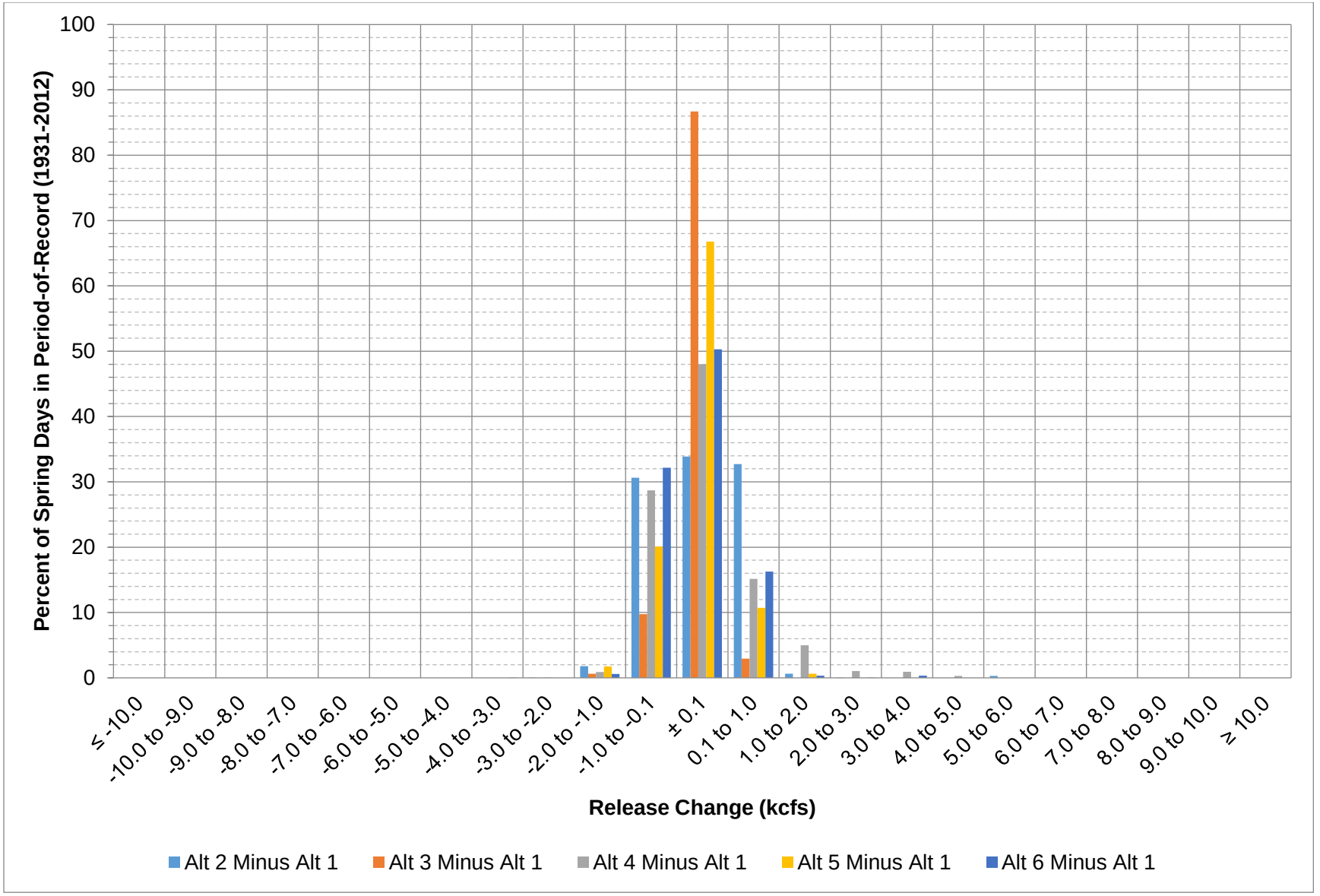

Figure 2-17: Fort Peck release change between each alternative and Alt 1 during March – April.

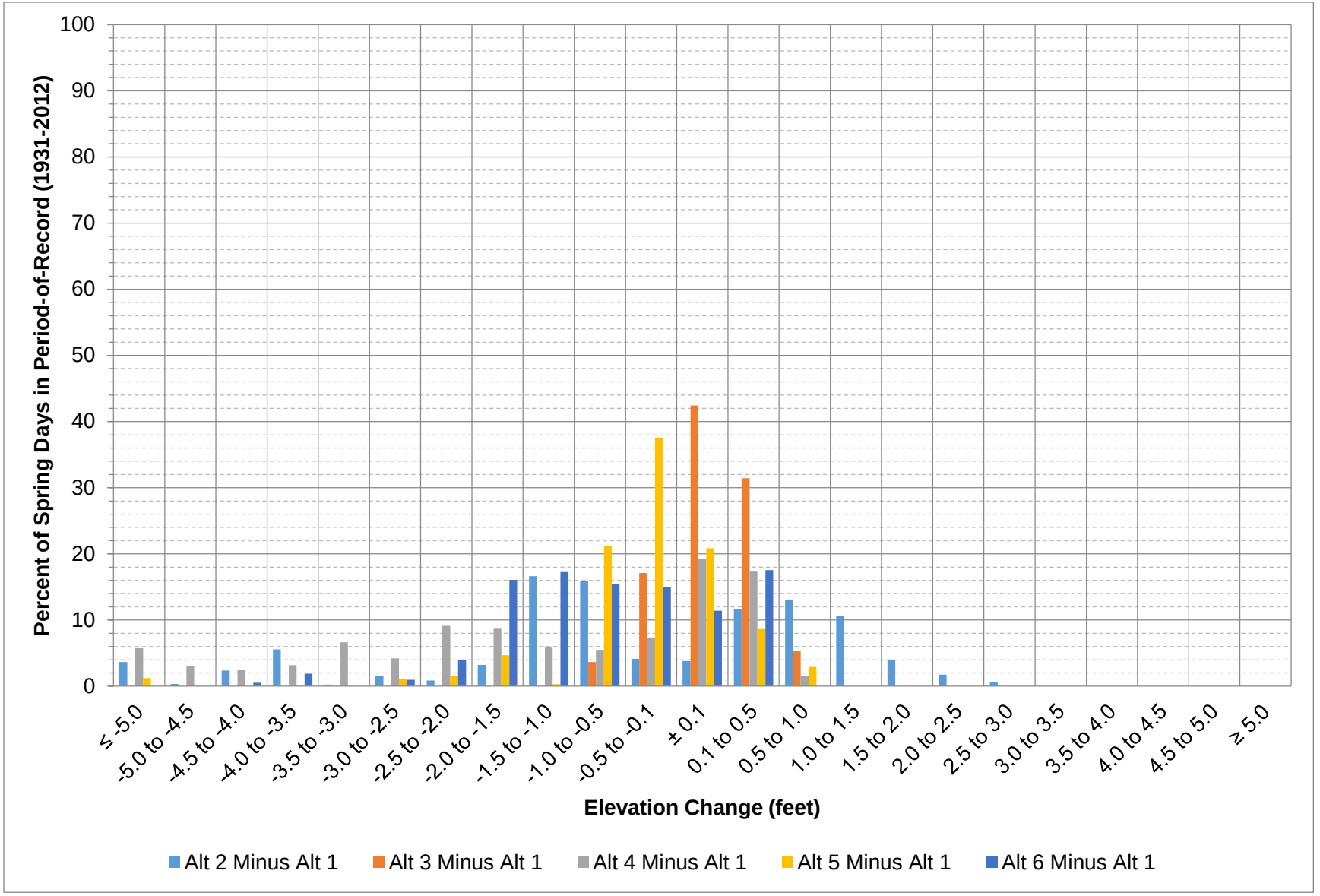

Figure 2-18: Garrison elevation change between each alternative and Alt 1 during March – April.

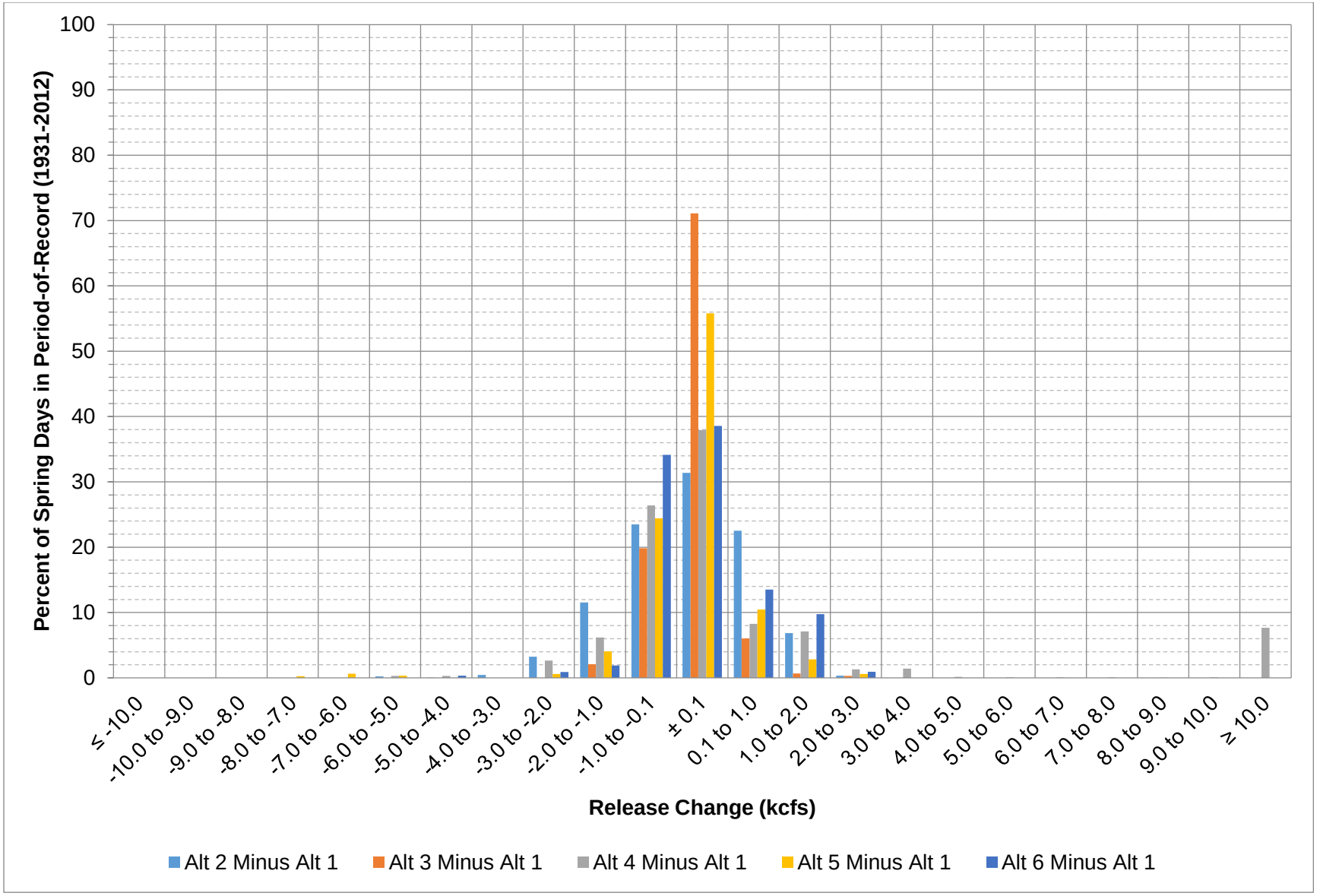

Figure 2-19: Garrison release change between each alternative and Alt 1 during March – April.

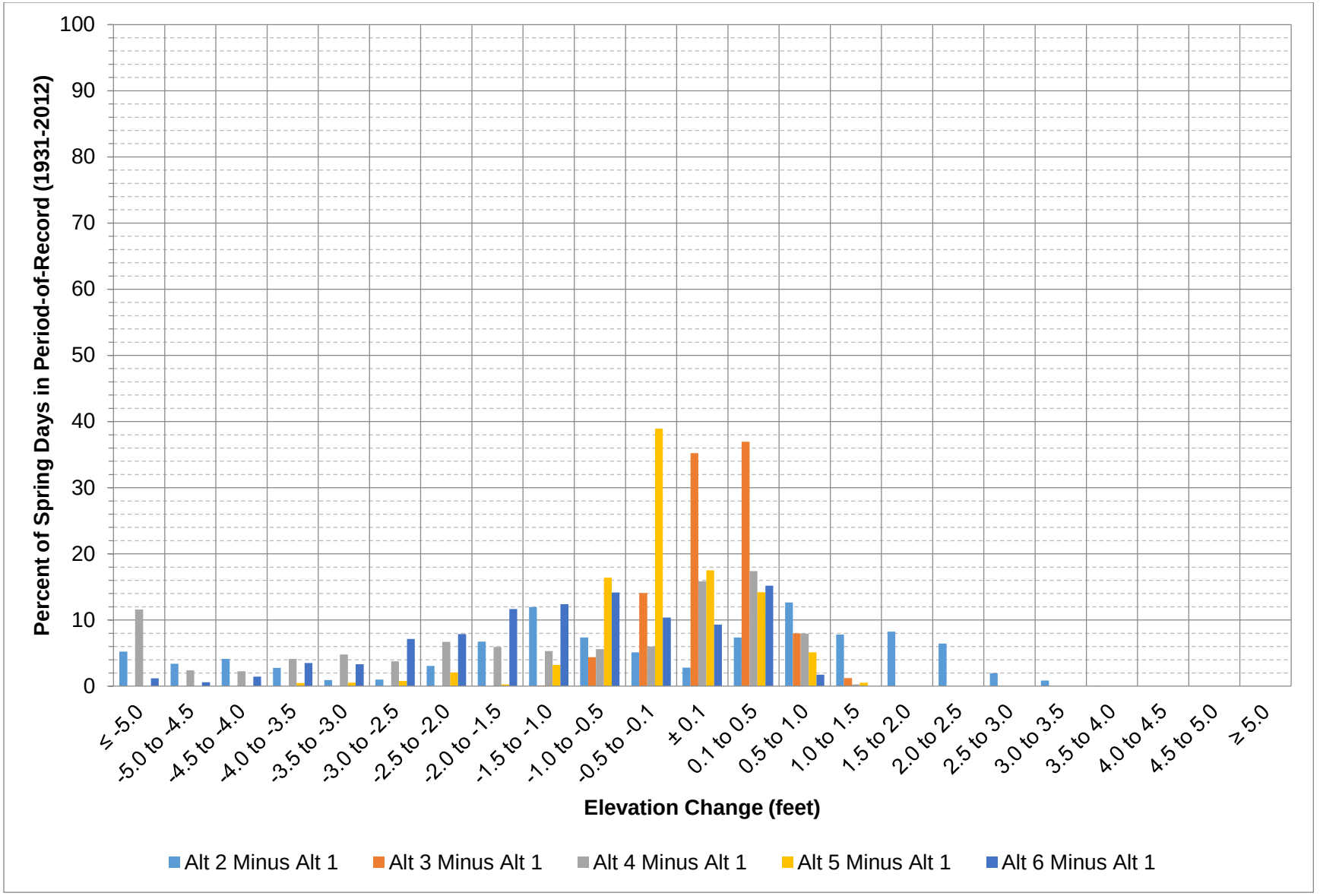

Figure 2-20: Oahe elevation change between each alternative and Alt 1 during March – April.

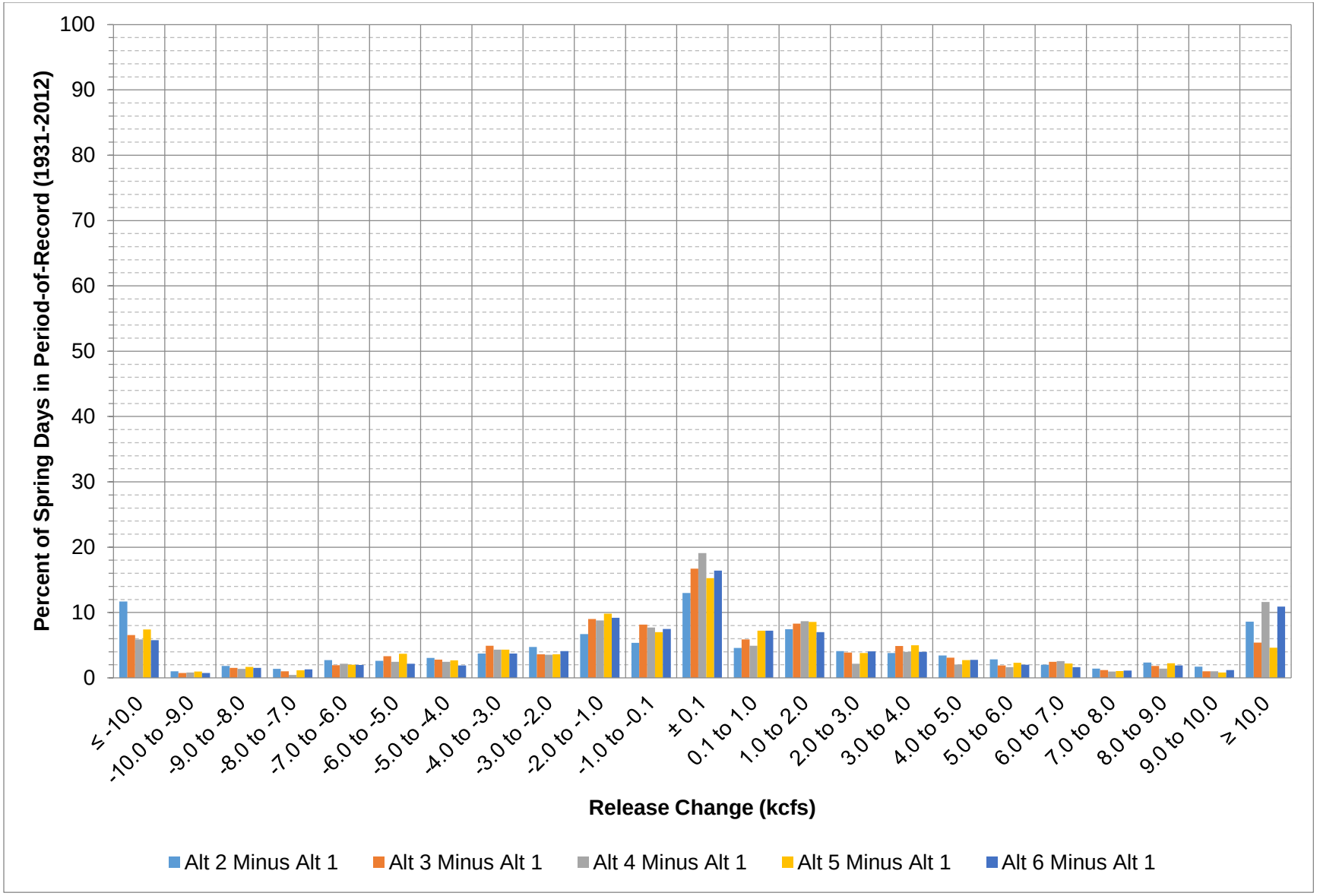

Figure 2-21: Oahe release change between each alternative and Alt 1 during March – April.

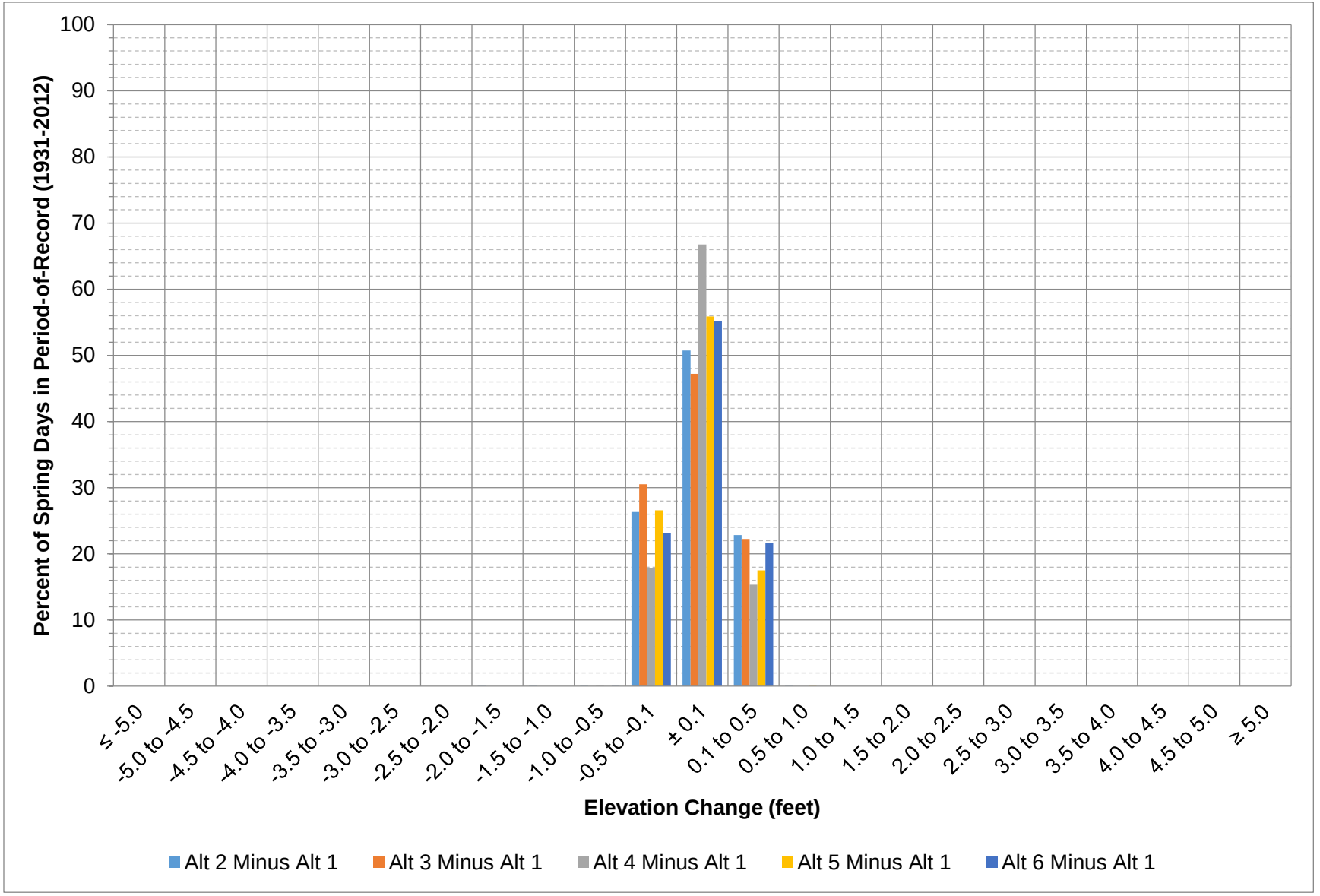

Figure 2-22: Big Bend elevation change between each alternative and Alt 1 during March – April.

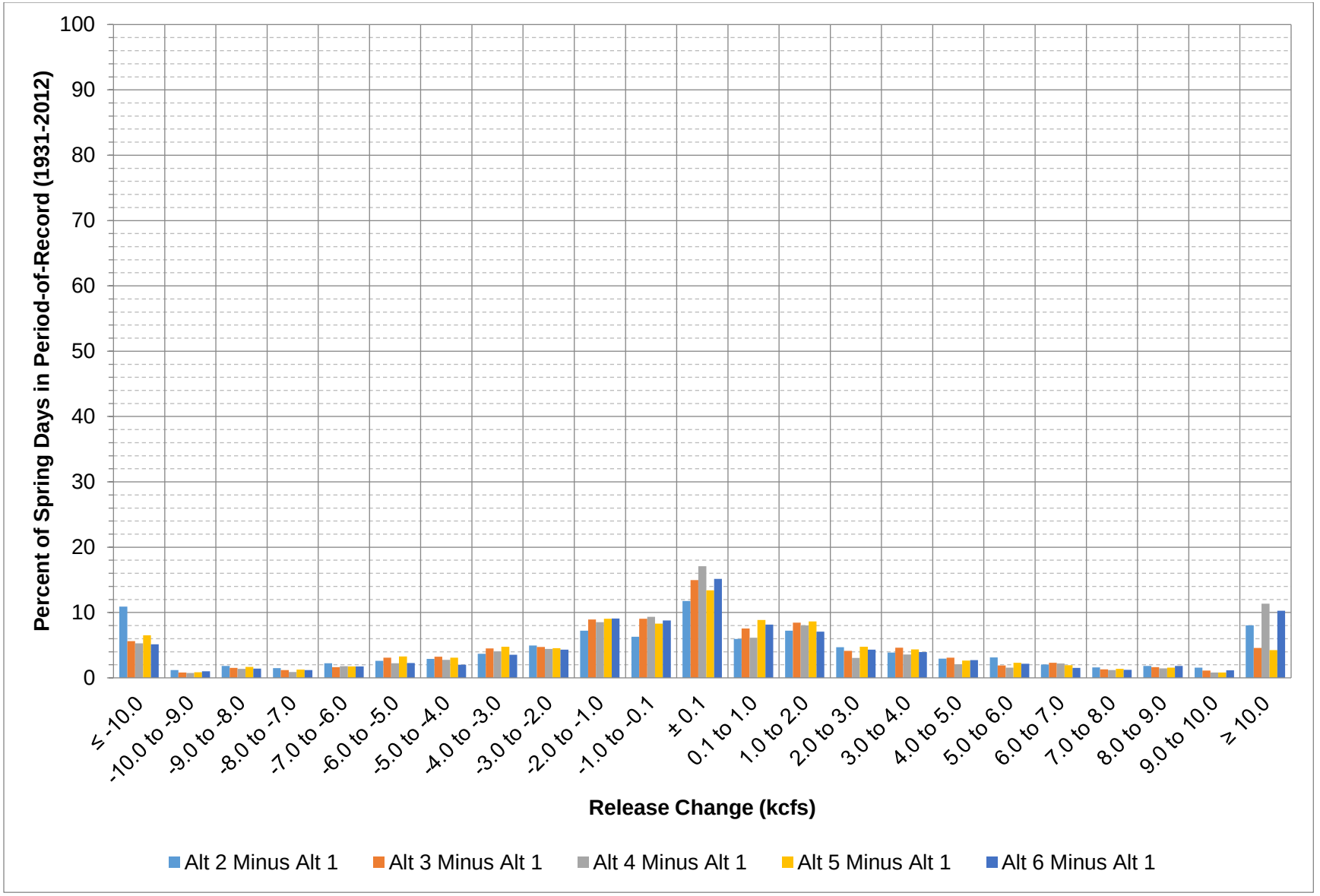

Figure 2-23: Big Bend release change between each alternative and Alt 1 during March – April.

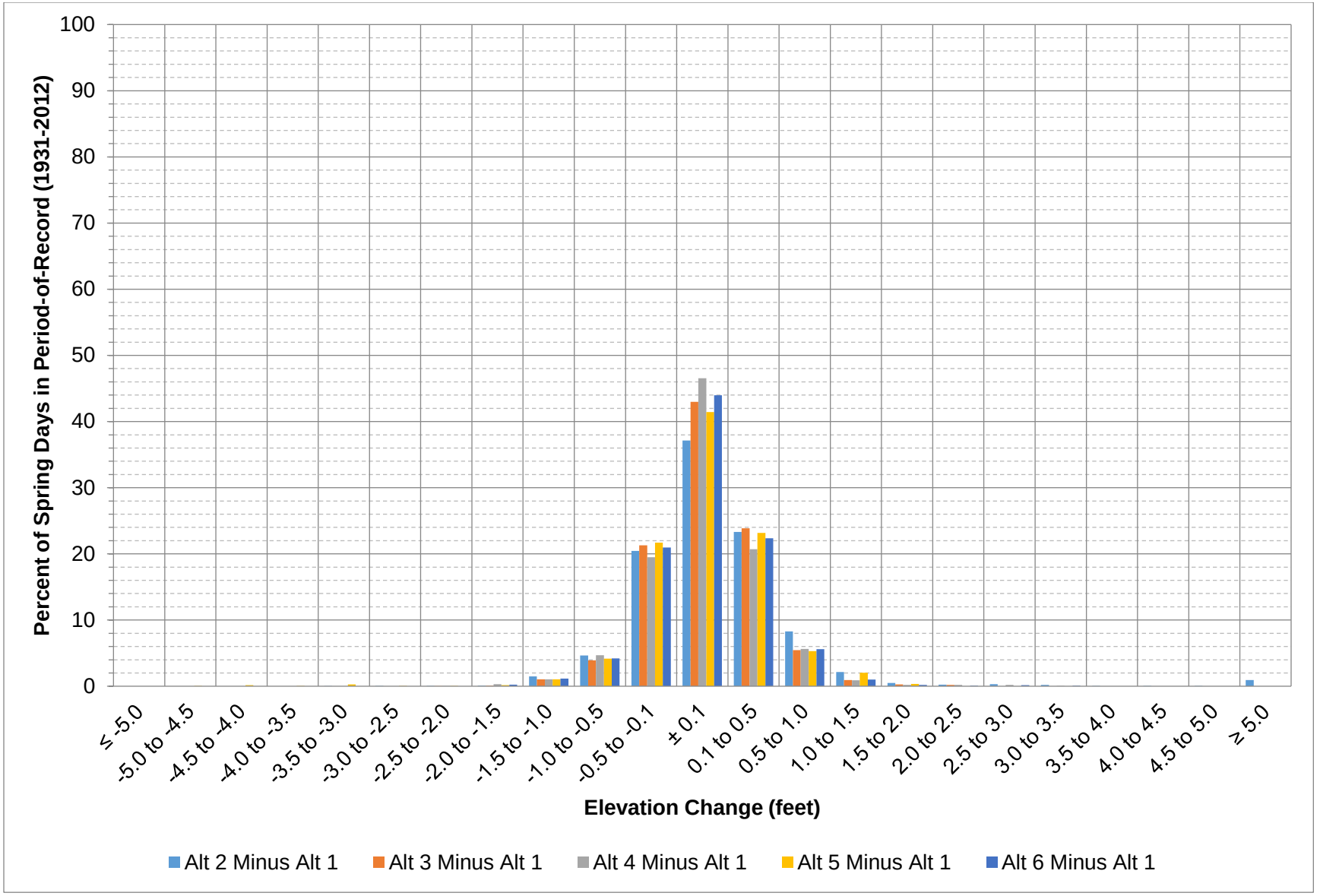

Figure 2-24: Fort Randall elevation change between each alternative and Alt 1 during March – April.

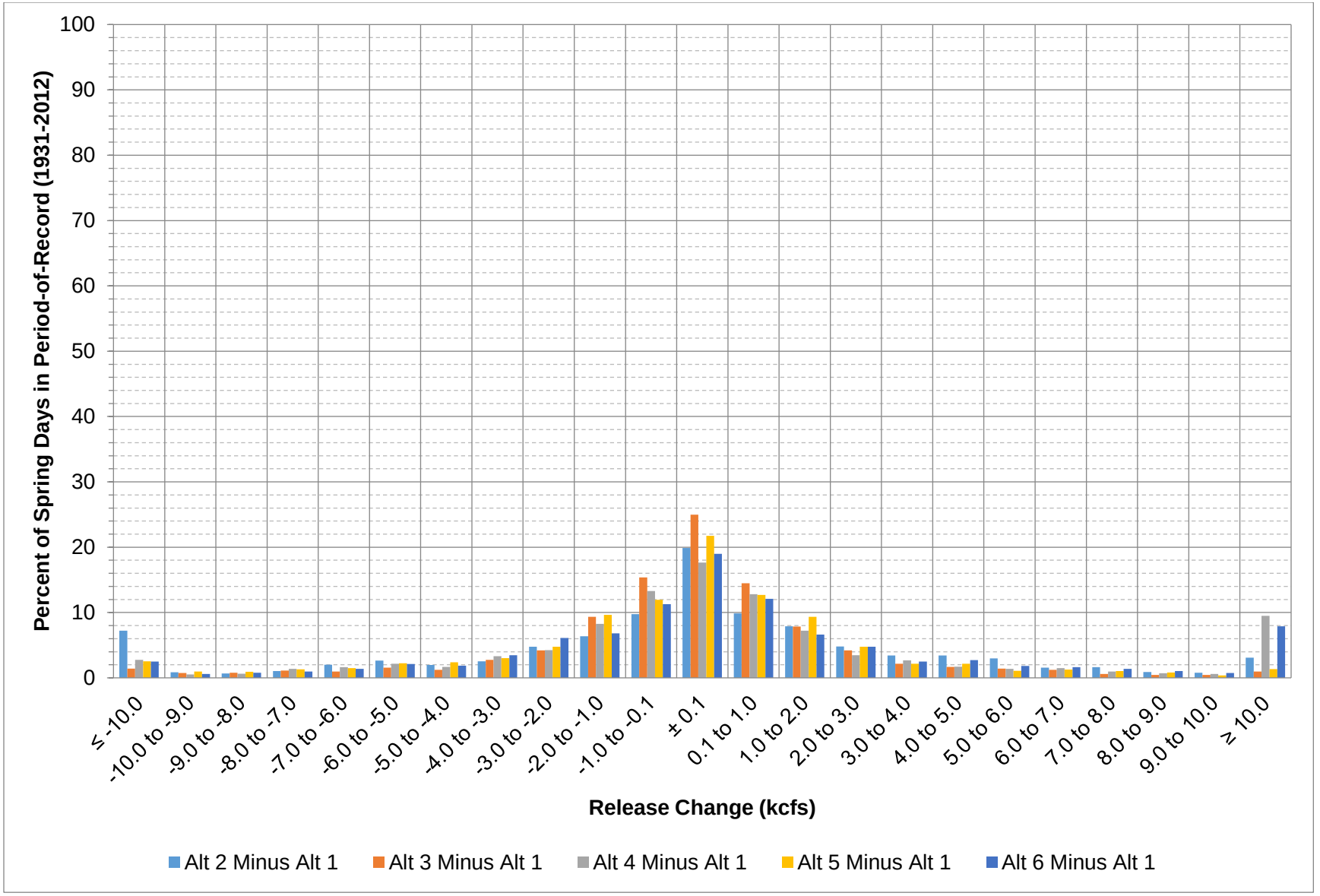

Figure 2-25: Fort Randall release change between each alternative and Alt 1 during March – April.

3 SUMMER: MAY – AUGUST

3.1 DOWNSTREAM OF GAVINS POINT

3.1.1 Alternative 1 – No Action

On May 1, System storage is assessed and if there is at least 40.0 MAF, the late spring spawning cue begins. Gavins Point's release on May 1 is increased to the peak spawning cue release over three days from the FTT navigation release. The pulse is first prorated based on System storage. If System storage is greater than or equal to 54.5 MAF on May 1, it is set to 16.0 kcfs. If System storage is 40.0 MAF, the pulse is set to 12.0 kcfs; the pulse is linearly interpolated if System storage is between 40.0 MAF and 54.5 MAF. The pulse is then prorated based on May 1 forecasted runoff. If the forecast is a median year, the pulse does not change from the first pulse proration. If the forecast is greater than or equal to an upper quartile runoff, the initial pulse is increased by 4.0 kcfs. If the forecast is less than or equal to a lower quartile runoff, the initial pulse is decreased by 3.0 kcfs. The pulse is linearly interpolated if the forecasted runoff is between any of the three points described. Gavins Point's peak release is held for two days and then drops by thirty percent over the next two days, followed by a proportional reduction in releases back to FTT or Steady Release Flow-to-Target (SRFTT) over the next eight days. Figure 3-1 shows an example of the late spring spawning cue, highlighted by a dashed red box, where System storage was 67.7 MAF on May 1, which set the initial pulse and peak Gavins Point release to 16.0 kcfs and 42.1 kcfs, respectively. After the May 1 runoff forecast was assessed, the pulse and peak Gavins Point release were lowered to 13.0 kcfs and 39.1 kcfs, respectively, because the runoff forecast was less than a lower quartile runoff. Peak releases are held for two days and then releases are reduced by 3.9 kcfs (thirty percent of the pulse) over the first two days of release reductions. Releases are then reduced by the remainder of pulse, 9.1 kcfs (13.0 kcfs – 3.9 kcfs), spread evenly over the next eight days. Since the reduced release of the spawning cue falls below the FTT or SRFTT navigation releases after six days of reduction, the spawning cue is terminated early.

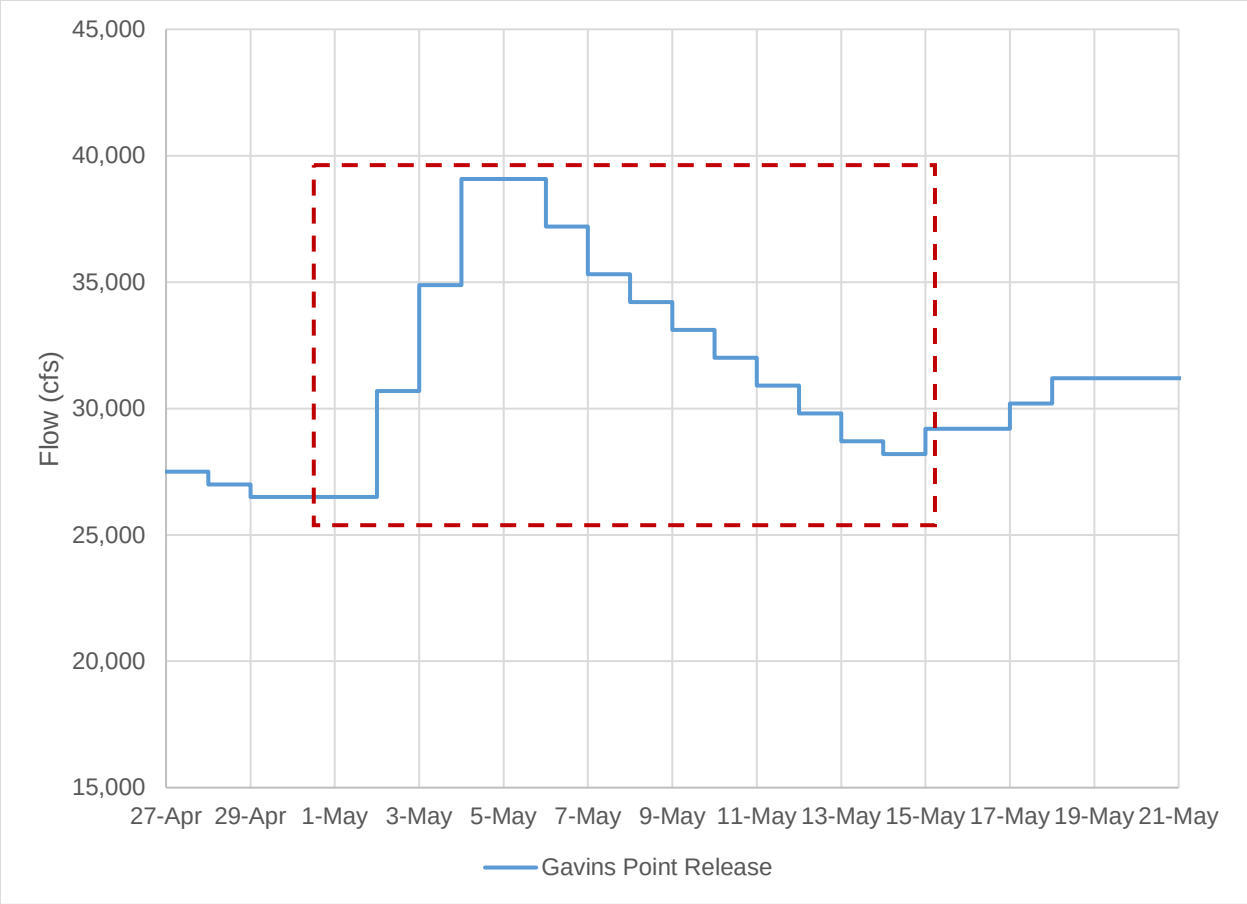

Figure 3-1: Late spring spawning cue for Alt 1.

FTT navigation operations are still in effect between May 1 and May 15. Operations shift to a SRFTT criteria during the endangered bird species nesting period, which begins on May 15. A steady release is selected based on the forecasted runoff and current service level with the assumption that a higher release will be needed later in the summer to meet navigation targets when downstream tributary flows tend to recede. By selecting a higher release in May, birds are forced to nest higher and ideally, releases will not need to be increased until after the modeled nesting season ends on July 15. For example, if a median runoff was forecasted on May 1 and the System was supporting full-service navigation, a steady release of 31.6 kcfs would be initiated on May 15. Table 3-1 summarizes the steady release criteria. Gavins Point release can be increased if navigation targets will not be met while releasing the steady release. In this case, Gavins Point releases are increased until all navigation targets are met and then releases are held constant at the new steady release. However, if a release higher than Kansas City's navigation target is required to meet all navigation targets, the new steady release is set to Kansas City's navigation target and FTT operations take precedent while higher releases are needed to meet downstream navigation targets. Flood targets are assessed during the steady release and if any of the three targets are forecasted to be exceeded, Gavins Point releases are reduced. Once the flood targets are no longer forecasted to be exceeded, the steady release resumes. Figure 3-2 shows an example of the steady release operations where the System is supporting

minimum-service navigation and the forecasted runoff is greater than or equal to median runoff, so the initial steady release is set to 25.6 kcfs on May 15. However, a release of 26.0 kcfs is required to meet Nebraska City's navigation target so releases are immediately increased and the new steady release is set to 26.0 kcfs. The May 19 downstream forecast indicates that a release greater than 26.0 kcfs is required to meet Kansas City's navigation target, so Gavins Point release is increased to 30.5 kcfs. Gavins Point release is again increased on May 25 to 31.5 kcfs in order to meet Kansas City's navigation target and the new steady release is held constant through July 6. On July 7, downstream forecasting indicates a Gavins Point release in excess of 35.0 kcfs is required to meet navigation targets at all four target locations. Since Kansas City's navigation target flow is 35.0 kcfs, FTT operations begin and continue through the remainder of the steady release period.

Table 3-1: Steady release criteria. Typical Gavins Point releases needed to meet navigation target flows in July based on 1950 to 1996 data.

	Median, Upper Quartile, Upper Decile Runoff Forecast
Full-service	31.6 kcfs
Minimum-service	25.6 kcfs
	Lower Quartile, Lower Decile Runoff Forecast
Full-service	34.3 kcfs
Minimum-service	28.3 kcfs

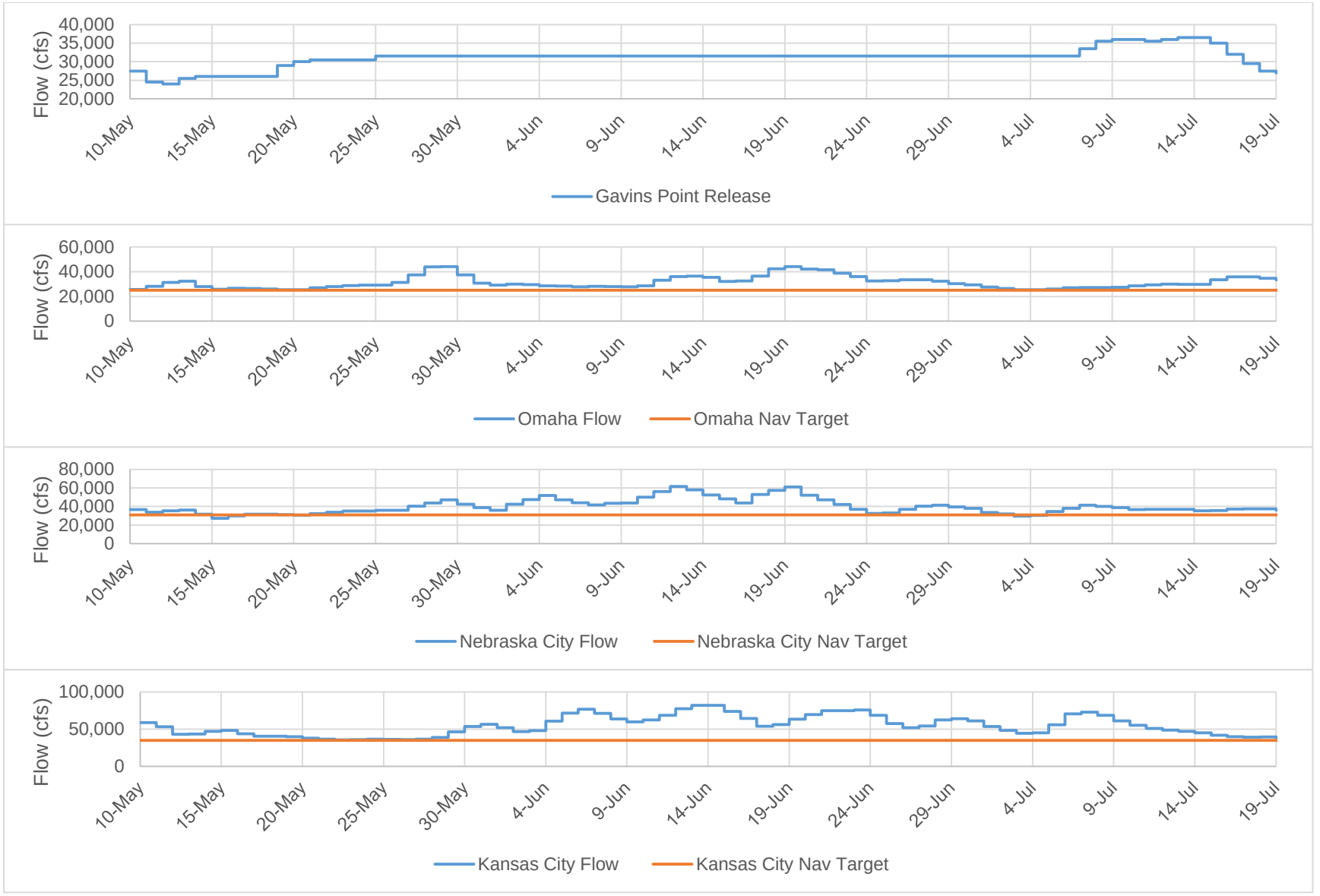

Figure 3-2: Steady release operations.

System storage is assessed on July 1 and the service level is set for the remainder of the navigation season. Table 2-1 summarizes the System storage and service level relationship. Minimum service is specified if System storage is less than 50.5 MAF. An intermediate service level is specified if System storage is between 50.5 MAF and 57.0 MAF by linear interpolation. Full service is specified if the System storage is at least 57.0 MAF. Figure 3-3 shows an example of the July 1 System storage check. In this example, System storage is greater than 57.0 MAF on July 1, so the service level is set to 35.0 kcfs or full service for the 2nd half of the navigation season.

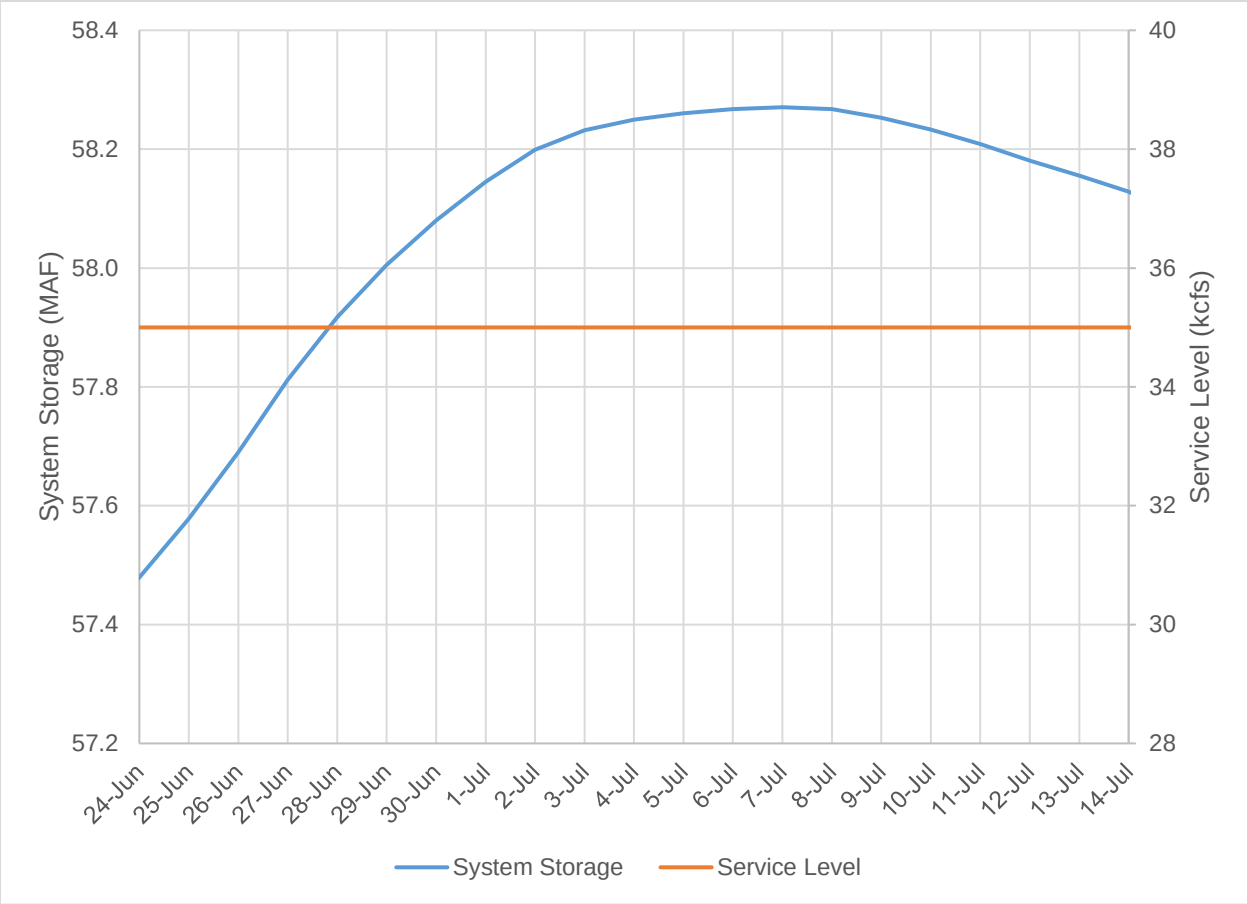

Figure 3-3: July 1 System storage assessment and resulting service level.

The navigation season length is also set based on the July 1 storage assessment. The closure date at the mouth of the Missouri River is December 1 if System storage is 51.5 MAF or greater. The closure date is November 1 if System storage is between 41.0 MAF and 46.8 MAF; the closure date is October 1 if System storage is 36.5 MAF or less. If System storage is between the specified storage criteria, the closure date is linearly interpolated. Table 3-2 summarizes the season length or closure dates for the navigation season on the Missouri River.

Table 3-2: Navigation season length requirements. Summarized from Table VII-2 in the Master Manual (U.S. Army Corps of Engineers, 2006).

Date	System Storage (MAF)	Season Closure Date at Mouth of the Missouri River
July 1	36.5 or less	October 1 (6-month season)
July 1	41.0 – 46.8	November 1 (7-month season)
July 1	51.5 or more	December 1 (8-month season)

The steady release is terminated after July 15 and FTT operations resume allowing Gavins Point releases to be adjusted daily to meet downstream navigation requirements.

If the navigation season was cancelled, System operations continue to support water supply but the minimum water supply requirement is increased. Gavins Point releases enough water to ensure that a minimum flow of 18.0 kcfs is observed at the three target locations. During summer water supply operations, Gavins Point releases can be reduced to 9.0 kcfs if there is sufficient tributary flow downstream to support a minimum flow of 18.0 kcfs at the three target locations. Figure 3-4 shows an example of summer water supply operations where Omaha was the critical location.

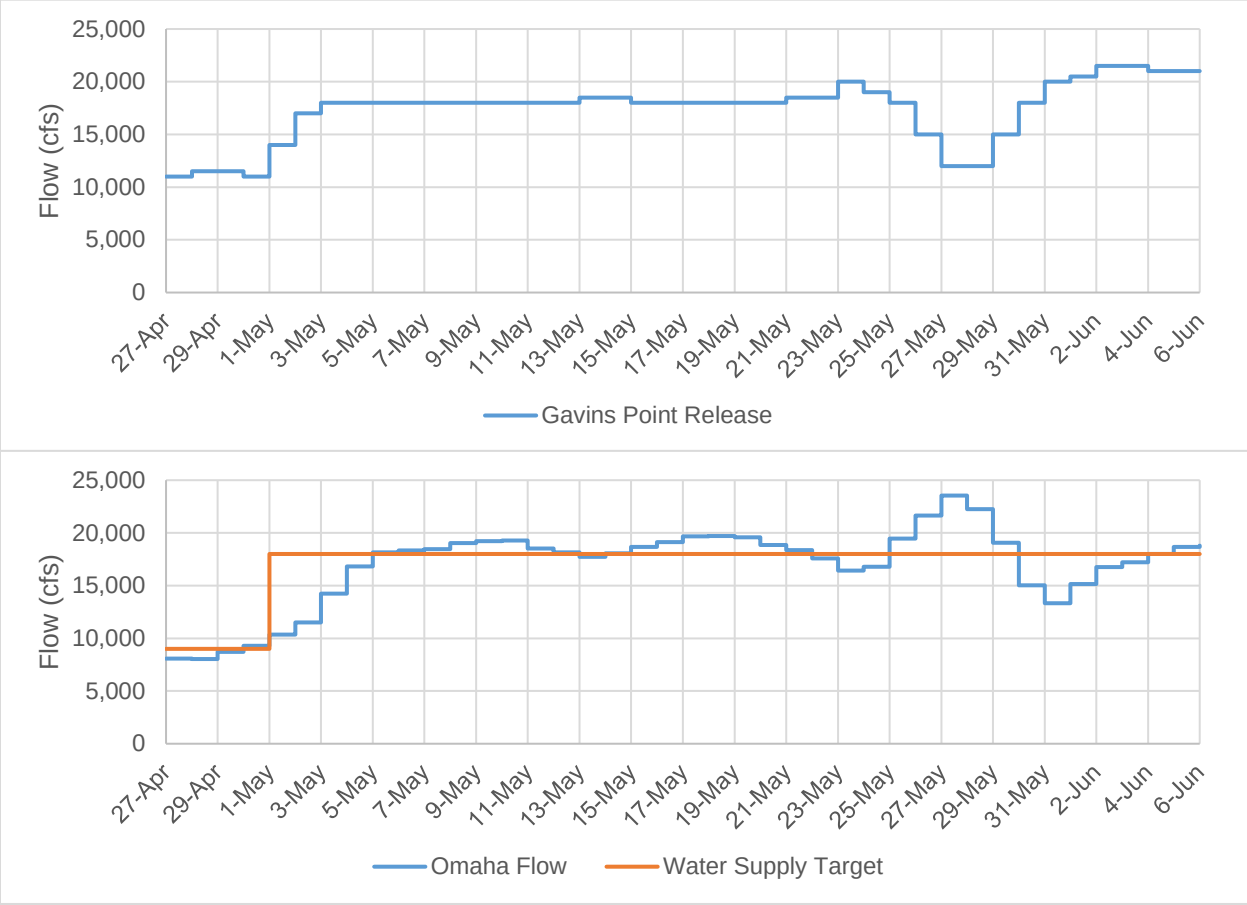

Figure 3-4: Summer water supply operations.

3.1.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

Water supply and navigation requirements remain unchanged from Alt 1 operations during May – August. Gavins Point releases enough water to ensure that a minimum flow of 18.0 kcfs is observed at the three target locations. During summer water supply operations, Gavins Point releases can be reduced to 9.0 kcfs if there is sufficient tributary flow downstream to support a minimum flow of 18.0 kcfs at the three target locations.

The late spring spawning cue is different than Alt 1's late spring spawning cue. As with Alt 1's late spring spawning cue, Alt 2's late spring spawning cue begins on May 1 if System storage is greater than 40.0 MAF on May 1, but the peak and shape are different than Alt 1's late spring spawning cue. Releases increase from FTT navigation releases over seven days until the peak spawning cue release is reached. The pulse is prorated based on the May runoff year forecast. If the forecast is a median year, the pulse is set to 16.0 kcfs and held at the peak for twenty five days. The pulse is set to 20.0 kcfs and held at the peak for thirty five days if the forecast is greater than or equal to an upper quartile runoff. If the forecast is less than or equal to a lower quartile runoff, the pulse is set to 12.0 kcfs and held at the peak for fourteen days. Both duration and pulse are linearly interpolated if the forecasted runoff is between any of the three points described. Gavins Point releases are also limited to a maximum release of 60.0 kcfs during the late spring spawning cue. Releases are then decreased over a minimum of seven days to the steady release. While the spawning cue is occurring, the flood targets are increased by the pulse to allow for the spawning cue to occur more frequently. If flow at one of the flood target locations is forecasted to exceed its respective flood target flow, the pulse is reduced by 0.5 kcfs until either the flood targets are no longer forecasted to be exceeded or the pulse is 0.0 kcfs. Releases return to FTT navigation releases if the spawning cue is eliminated before May 15 and return to SRFTT navigation releases if the spawning cue is eliminated after May 15. Figure 3-5 shows a comparison of Alt 1's late spring spawning cue, highlighted by the dashed red box, and Alt 2's late spring spawning cues, highlighted by the dashed green box.

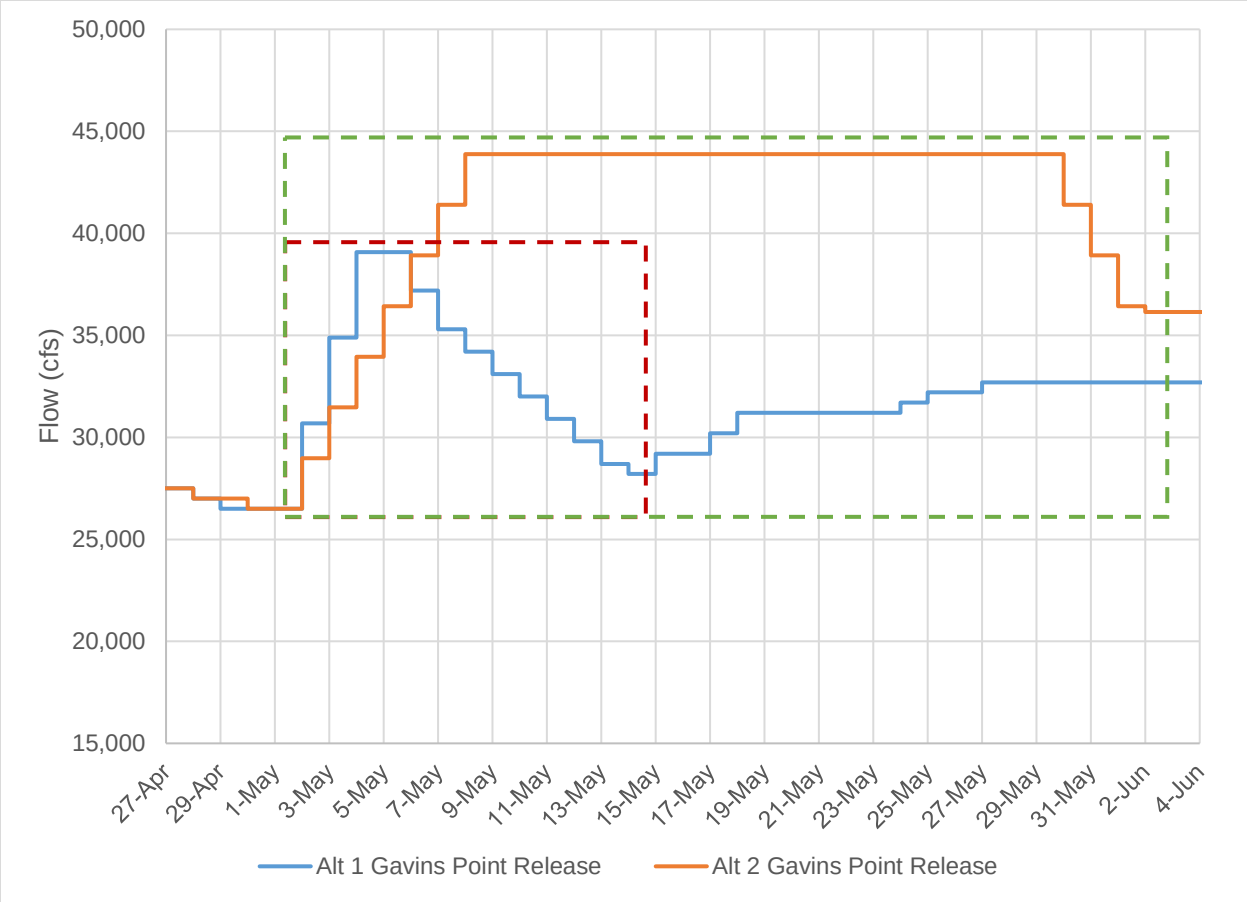

Figure 3-5: Alt 1 vs Alt 2 early spring spawning cue.

Low summer flows occur between June 23 and September 1 during the two years following completed March and May pulses. Gavins Point releases are lowered to 25.0 kcfs on June 23. Releases are again lowered if the navigation season is shortened based on the July 1 System storage check. Gavins Point releases are reduced and support water supply for the duration that the navigation season was shortened less the eight days that have already occurred between June 23 and July 1. For example, Figure 3-6 compares Gavins Point releases for Alt 1 and Alt 2 during the summer of a year with a shortened navigation season. The System storage on July 1 resulted in a navigation season that would have been shortened twenty three days, with a closure date of November 8 at the mouth. However, the low summer flow criteria shifts those twenty three days from the end of the navigation season to July; Gavins Point releases from July 1 to July 16 only support water supply and releases from November 8 – November 22 (the approximate date when releases decrease for the end of an 8-month navigation season) provide navigation support. Low summer flow criteria does not consider the volume difference caused by different water supply releases in the summer and the fall, 18.0 kcfs vs 9.0 kcfs, respectively. If the navigation season was not shortened based on the July 1 System storage check, Gavins Point releases remain at 25.0 kcfs until July 15, then drop to 21.0 kcfs until August 15. Between August 15 and September 1, Gavins Point releases are set at 25.0 kcfs.

Figure 3-6: Alt 1 Gavins Point releases vs Alt 2's Gavins Point releases for low summer flow operations.

The operational changes in Alt 2 discussed throughout this document cause changes in Gavins Point's summer releases when compared to releases in Alt 1, shown in Figure 3-11. Some of the release changes occur as a direct result of Alt 2's late spring spawning cue, which runs to completion fifteen times and partially runs twenty five times between 1931 and 2012 causing an increase in summer releases when compared to releases in Alt 1. The low summer flows contribute to the lower summer releases during portions of the summer months.

The minor changes in summer pool elevation as compared to Alt 1, shown in Figure 3-10, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 2.

3.1.3 Alternative 3 – Mechanical Construction Only

Alt 3 does not change water supply, navigation, and flood target operations compared to Alt 1 during May – August. However, the late spring spawning cue that occurs in Alt 1 does not occur in Alt 3. FTT navigation operations continue until May 15 and then steady release operations begin. On July 15, steady release operations transition back to FTT navigation operations through the end of August. Figure 3-7 shows a comparisons between Gavins Point releases during Alt 1 and Alt 3. Alt 1's late spring spawning cue is highlighted by a dashed red box

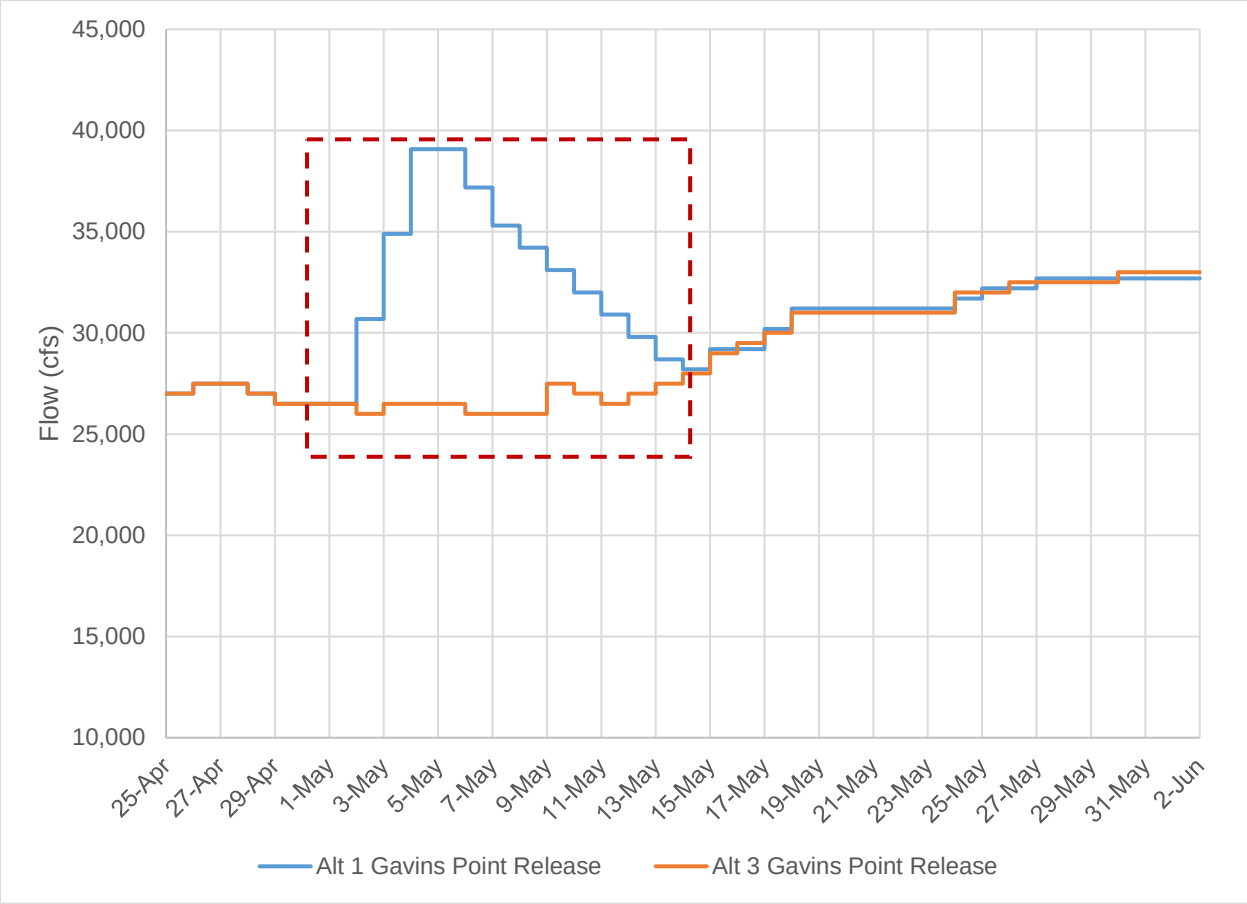

Figure 3-7: Alt 1 late spring spawning cue vs Alt 3 FTT navigation releases.

The operational changes in Alt 3 discussed throughout this document cause changes in Gavins Point's summer releases when compared to releases in Alt 1, shown in Figure 3-11. Removing Alt 1's late spring spawning cue, which runs to completion twenty one times and partially runs eight times between 1931 and 2012, does not significantly change Gavins Point's releases due to the small volume and relatively low peak release of the early spring spawning cue.

The minor changes in spring pool elevation as compared to Alt 1, shown in Figure 3-10, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 3.

3.1.4 Alternative 4 – Spring Habitat-Forming Flow Release

Alt 4 does not change water supply or navigation compared to Alt 1 during May – August. However, the ESH-creating release that was initiated on April 1 can continue through the summer depending on the peak release. If the System is still operating for an ESH-creating release, the flood targets listed in Table 2-7 are used until the ESH-creating release has completed, at which time, the flood targets listed in Table 2-5 resume. Figure 3-8 compares Gavins Point releases for Alt 1 and Alt 4 during an ESH-creating release that extends into June. After the completion of the ESH-creating release, the steady release resumes until July 15.

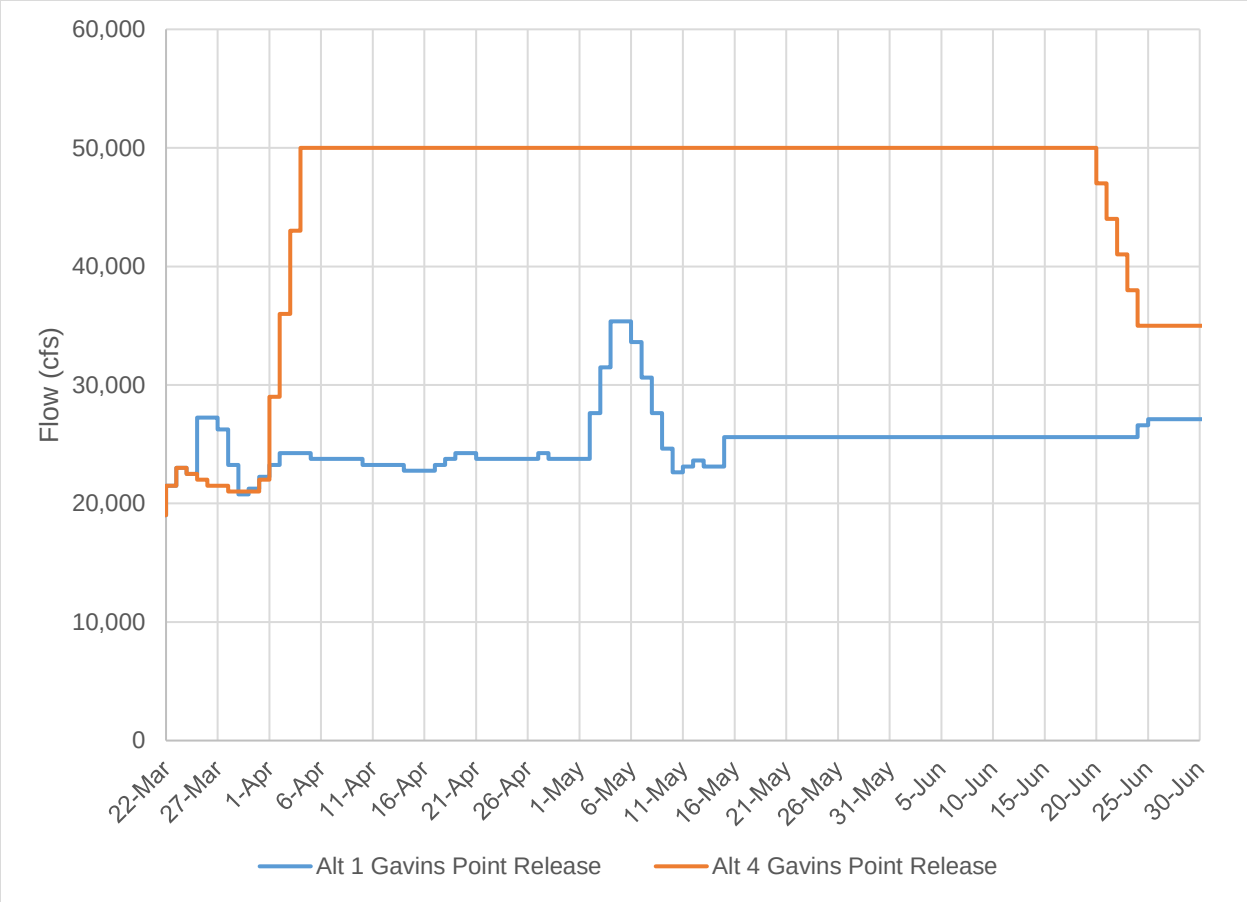

Figure 3-8: Comparison of Gavins Point releases in Alt 1 and Alt 4 during an extended ESH-creating release.

The operational changes in Alt 4 discussed throughout this document cause changes in Gavins Point's summer releases when compared to releases in Alt 1, shown in Figure 3-11. Some of the release changes occur as a direct result of an extended ESH-creating release, which is evident by the percentage of > 10.0 kcfs changes during the summer months. The lower summer releases compared to Alt 1 is caused by the lower navigation support in years following an ESH-creating release.

The minor changes in summer pool elevation as compared to Alt 1, shown in Figure 3-10, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 4.

3.1.5 Alternative 5 – Fall Habitat-Forming Flow Release

Alt 5 does not change water supply, navigation, or flood target operations compared to Alt 1 during May – August. However, the late spring spawning cue that occurs in Alt 1 does not occur in Alt 3. FTT navigation operations continue until May 15 and then SRFTT operations begin. On July 15, SRFTT operations transition back to FTT navigation operations through the end of August. If the navigation season was cancelled, System operations continue to support water supply but the minimum release is increased. Gavins Point releases enough water to ensure that a minimum

flow of 18.0 kcfs is observed at the three target locations. During summer water supply operations, Gavins Point releases can be reduced to 9.0 kcfs if there is sufficient tributary flow downstream to support a minimum flow of 18.0 kcfs at Sioux City, Omaha, and Kansas City.

The operational changes in Alt 5 discussed throughout this document cause changes in Gavins Point's summer releases when compared to releases in Alt 1, shown in Figure 3-11. Summer releases are slightly lower during the summer due to the fall ESH-creating release, which uses extra water and lowers navigation support during the years following the release. Alt 1's late spring spawning cue does not run during the summer in Alt 5, but the small volume and relatively low peak release during the late spring spawning cue does not significantly change releases during the summer as most of the observed releases changes fall between ±1.0 kcfs.

The minor changes in summer pool elevation as compared to Alt 1, shown in Figure 3-10, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 5.

3.1.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Alt 6 does not change water supply, navigation, or flood target operations compared to Alt 1 during May – August. However, the late spring spawning cue that occurs in Alt 1 is replaced with a different late spring spawning cue, which runs to completion eleven times and partially runs six times between 1931 and 2012. Like the early spring spawning cue in Alt 6, the late spring spawning cue requires a minimum of 40.0 MAF in System storage on March 15. If System storage is at least 40.0 MAF on March 15, the late spring spawning cue will begin on May 18. Releases are increased by 2.2 kcfs per day until the peak release is reached. The pulse is equal to the steady release, which results in a peak Gavins Point release equal to double the steady release. The peak release is maintained for two days and then releases are reduced by 1.9 kcfs per day until SRFTT releases are reached. Flood targets are increased using the same requirements as the early spring spawning cue to allow it to run more frequently and are summarized in Table 2-9. As with the early spring spawning cue in Alt 6, the late spring spawning cue is eliminated if forecasted flows at any of the flood target locations exceeds their respective flood target flows. Figure 3-9 compares the late spring spawning cue in Alt 1, highlighted by the dashed red box and Alt 6, highlighted by the dashed green box.

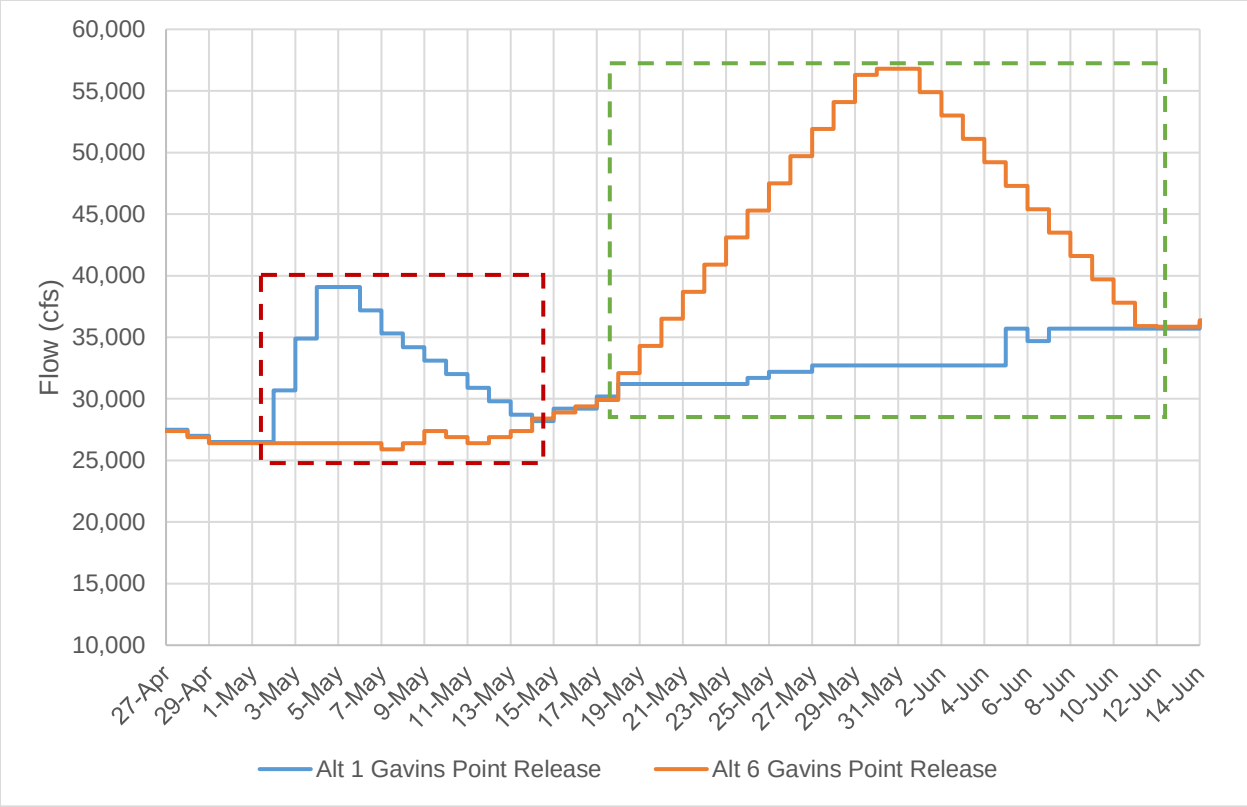

Figure 3-9: Alt 1 vs Alt 6 late spring spawning cue.

The operational changes in Alt 6 discussed throughout this document cause changes in Gavins Point's summer releases when compared to releases in Alt 1, shown in Figure 3-11. . Alt 6's late spring spawning cue increases releases above what is observed in Alt 1, especially the > 10.0 kcfs change. As both the late and early spring spawning cues utilize additional water, System storage is reduced in years following the spawning cues. Lower System storage results in lower Gavins Point releases as navigation support is lowered. Figure 3-11 shows this effect as negative release changes are increased.

The minor changes in summer pool elevation as compared to Alt 1, shown in Figure 3-10, are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 6.

3.1.7 Elevation and Release Changes at Gavins Point during Summer Months for Alternative 1 – 6

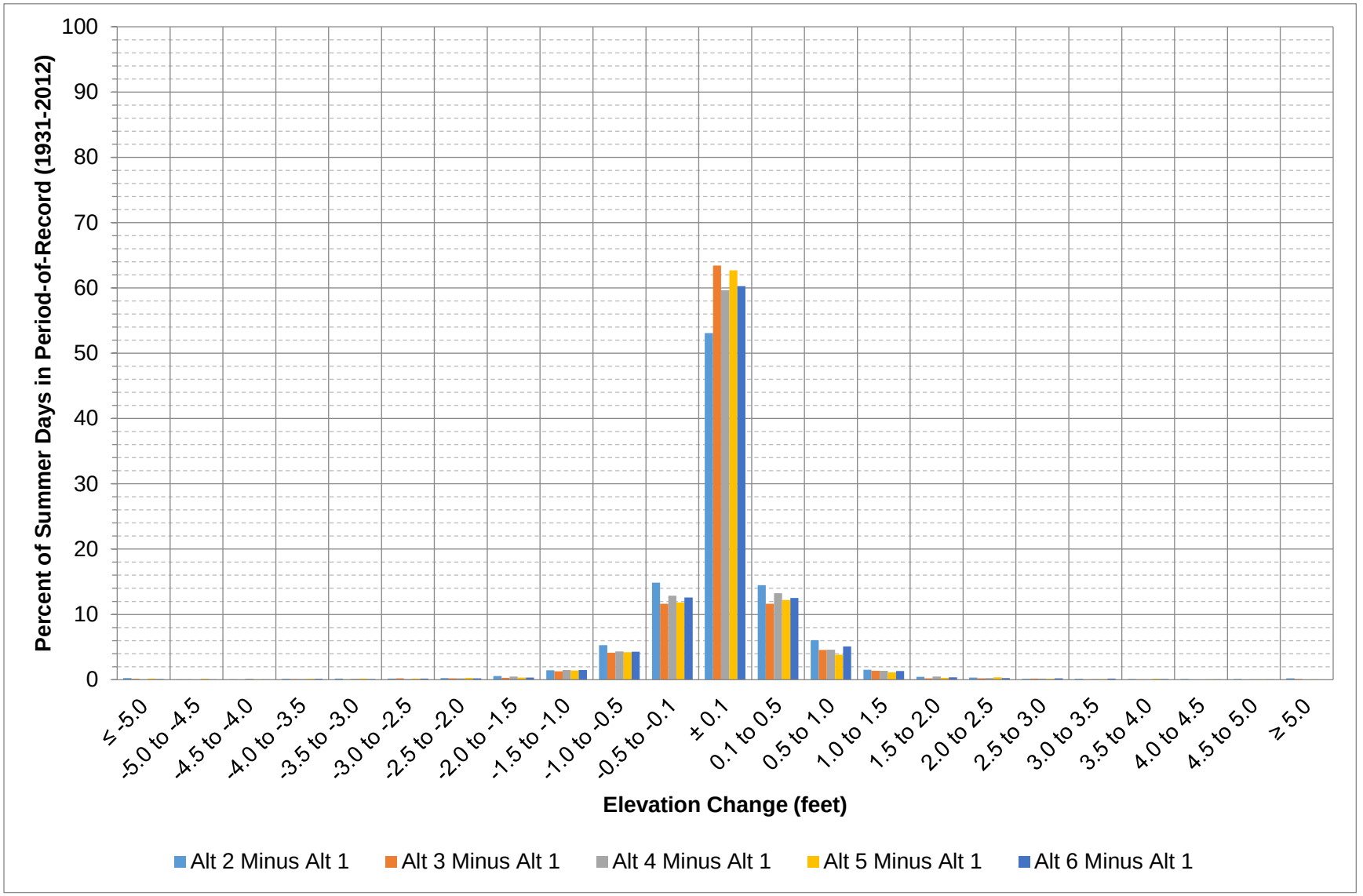

Figure 3-10: Gavins Point elevation change between each alternative and Alt 1 during May – August.

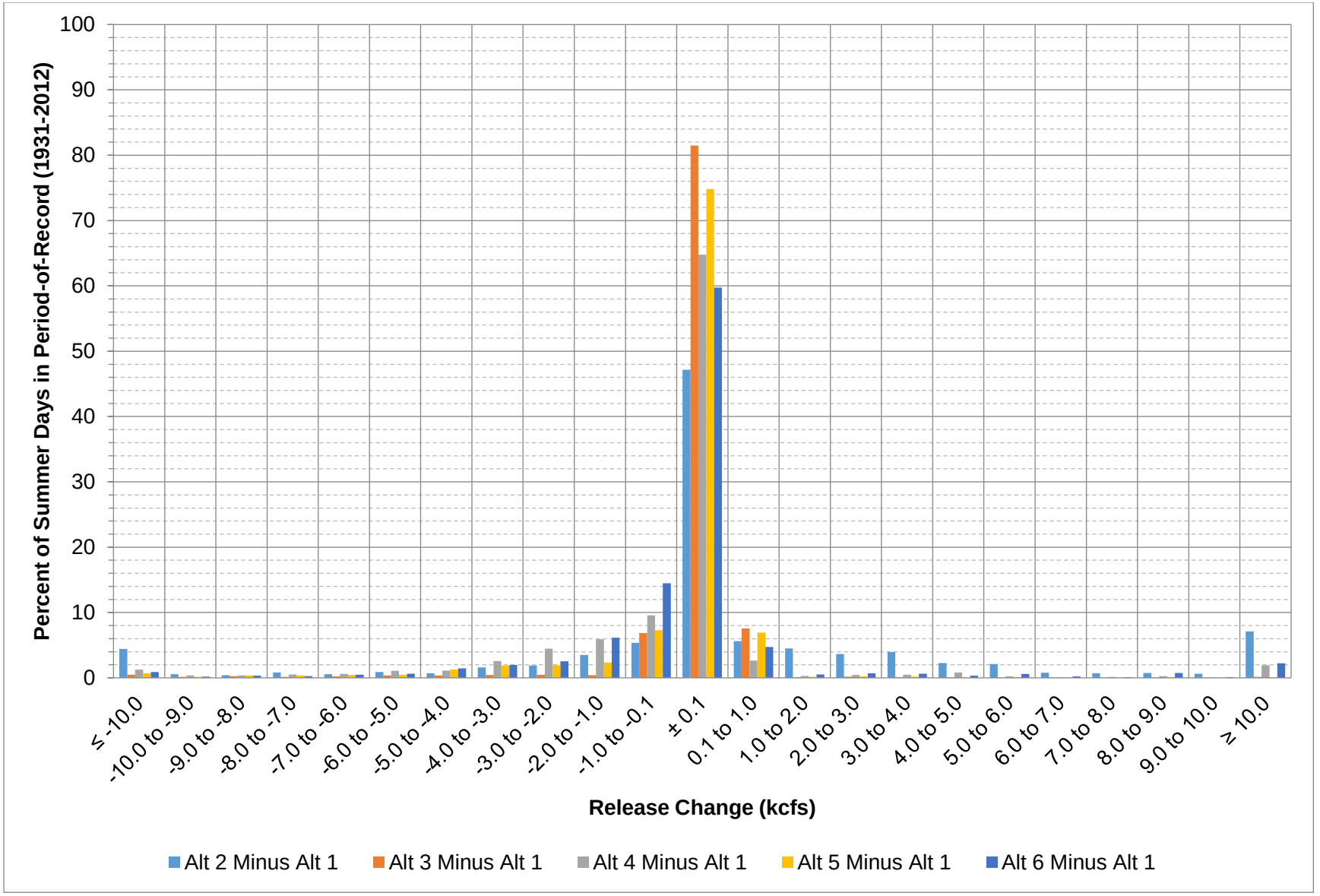

Figure 3-11: Gavins Point release change between each alternative and Alt 1 during May – August.

3.2 UPSTREAM OF GAVINS POINT

3.2.1 Alternative 1 – No Action

After setting the System or Gavins Point releases, the model focuses on setting releases for storage balancing at Fort Peck, Garrison, and Oahe, water supply flows at Wolf Point, Culbertson, and Bismarck, and guide curve operations at Big Bend, Fort Randall, and Gavins Point.

Fort Peck and Garrison still release water based on the forecasted System storage as the model attempts to balance Fort Peck's, Garrison's, and Oahe's amount of occupied Carryover Multiple Use Zones. The balancing release specified at Fort Peck and Garrison on May 15 is attempted to remain steady through August 31 to help the endangered bird species during their nesting season. Pool elevation boundaries were established for both Fort Peck and Garrison during the steady release period that allow the releases to come off a steady release during drought and extreme flood periods. Drought conservation elevations were established for Fort Peck, Garrison, and Oahe that allow fluctuations in summer releases if either the releasing reservoir's or the downstream reservoir's pool elevation falls below their respective drought conservation elevation. Each reservoir's drought conservation elevation was calculated by adding twenty five percent of the total height of their respective Carryover and Multiple Use Zone to the elevation of their respective permanent pool elevation. For example, Fort Peck's drought conservation elevation was 2160.0 + (2234.0 – 2160.0) * 0.25, which equaled 2178.5 feet (NGVD 29). Garrison's drought conservation elevation was 1790.6 feet (NGVD 29) and Oahe's was 1556.9 feet (NGVD 29). The upper steady release operational boundary for each reservoir was the top of their Annual Flood Control & Multiple Use Zones, which are 2246.0 feet (NGVD 29) at Fort Peck, 1850.0 feet (NGVD 29) at Garrison, and 1620.0 feet (NGVD 29) at Oahe. Using Fort Peck as an example, Fort Peck would have a steady release during the summer if its pool elevation was between 2178.5 feet (NGVD 29) and 2246.0 feet (NGVD 29) and Garrison's pool elevation was greater than 1790.6 feet (NGVD 29). Table 3-3 lists the pool elevation requirements for Fort Peck's and Garrison's steady release.

Table 3-3: Pool requirements for Fort Peck's and Garrison's steady release.

	Fort Peck Steady Release Criteria	Garrison Steady Release Criteria
Fort Peck Pool Elevation (feet) (NGVD 29)	2178.5 – 2250.0	N/A
Garrison Pool Elevation (feet) (NGVD 29)	greater than 1790.6	1790.6 – 1850.0
Oahe Pool Elevation (feet) (NGVD 29)	N/A	greater than 1556.9

Fort Peck's steady release occurs if its pool elevation is greater than 2178.5 feet (NGVD 29), which is 18.5 feet higher than the top of Fort Peck's permanent pool, and less than 2246.0 feet (NGVD 29), which is the top of its Annual Flood Control & Multiple Use Zone. Garrison's steady release occurs if its pool elevation is greater than 1790.6 feet (NGVD 29), which is 15.6 feet higher than the top of its permanent pool, and less than 1850.0 feet (NGVD 29), which is the top of its

Annual Flood Control & Multiple Use Zone. Fort Peck's and Garrison's releases are allowed to come off of their respective steady releases during droughts or extreme flooding to either conserve water or evacuate flood storage.

After setting releases at Fort Peck and Garrison, minimum flows at Wolf Point, Culbertson, and Bismarck are checked. Releases from Fort Peck are increased to ensure a minimum flow of 3.0 kcfs is forecasted at Wolf Point and Culbertson between May 1 and May 14. The minimum flow requirement at Wolf Point and Culbertson increases to 5.0 kcfs between May 15 and August 31. Releases from Garrison are increased to ensure a minimum flow of 10.0 kcfs is forecasted at Bismarck between May 1 and August 31.

Guide curve operations still govern releases from Oahe, Big Bend, and Fort Randall. Big Bend keeps its pool between 1420.0 feet (NGVD 29) and 1421.0 feet (NGVD 29). Fort Randall's pool elevation remains near 1355.0 feet (NGVD 29) through August 31. Gavins Point's pool elevation is kept near 1206.0 feet (NGVD 29) through August 1, but begins to slowly rise to 1207.0 feet (NGVD 29) by September 1. Figure 3-12 shows Gavins Point rising during August.

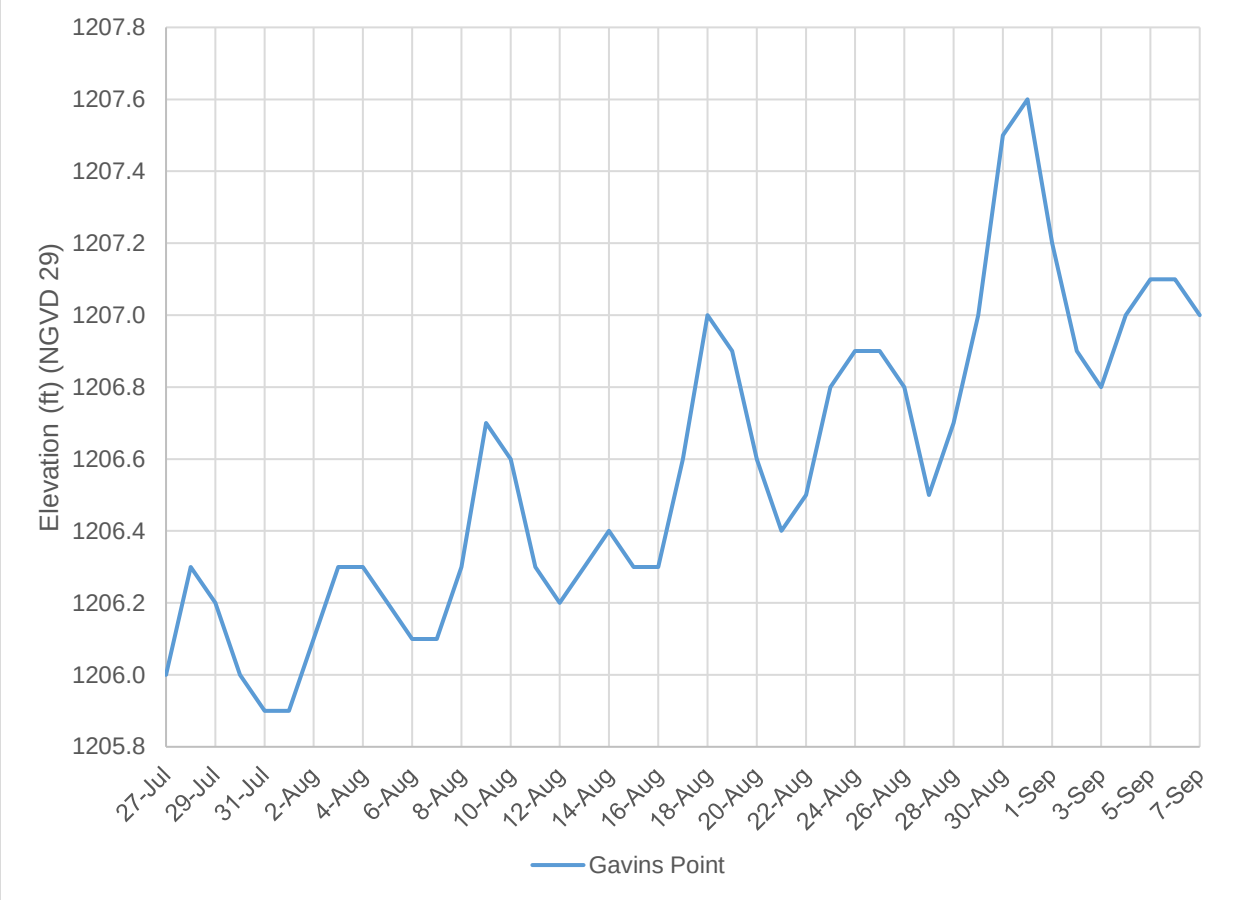

Figure 3-12: Gavins Point summer pool elevation rise.

3.2.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

Upstream operations in Alt 2 do not change compared to Alt 1 May – August. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep their reservoirs at their respective guide curve elevations. The observed changes that are shown in Figure 3-14 through Figure 3-23 are attributed to changes described in Sections 2.1.2, 3.1.2, 4.1.2, and 5.1.2.

Figure 3-14, Figure 3-16, and Figure 3-18 show a higher percentage of the summer months with lower elevations compared to Alt 1 at Fort Peck, Garrison, and Oahe, respectively. This is due to larger spawning cues than in Alt 1. Alt 2's spawning cues (Sections 2.1.2 and 3.1.2) lower System storage. Even though the spawning cues lower System storage, Alt 2's low summer flow operations and lower max winter release (Section 5.1.2) also conserve water, which is stored in Fort Peck, Garrison, and Oahe. This is why some of the summer months show a higher elevations compared to Alt 1. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 3-20 and Figure 3-22 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Figure 3-15 and Figure 3-17 show a slightly higher percentage of the summer months with higher releases for Fort Peck and Garrison, respectively. Since Fort Peck and Garrison operate to balance System storage, their releases only need to slightly change over the course of a year to release large volumes of water needed to balance System storage between Fort Peck, Garrison, and Oahe. Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 3-19, Figure 3-21, and Figure 3-23, respectively, have evenly distributed changes. Some of the > 10.0 kcfs changes observed at all three locations are attributed to the spawning cue from Gavins Point as water is released from Oahe to keep Gavins Point at its guide curve. Conversely, Alt 2's low summer flows contribute to some of the < -10.0 kcfs change as navigation support is ignored during a portion of the summer. Since Oahe's releases are highly variable regardless of those operations as water is released to keep Big Bend, Fort Randall, and Gavins Point at their respective guide curves, comparing Alt 2's changes to Alt 3's changes gives an estimate of how much of the changes are a direct result of the spawning cues and low summer flows in Alt 2.

3.2.3 Alternative 3 – Mechanical Construction Only

Upstream operations in Alt 3 do not change compared to Alt 1 May – August. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep the lower three reservoirs at their respective guide curve elevations. The observed changes that are shown in Figure 3-14 through Figure 3-23 are attributed to changes described in Sections 2.1.3 and 3.1.3.

Fort Peck's, Garrison's, Oahe's, Big Bend's, and Fort Randall's elevation and releases changes compared to Alt 1 all have minimal changes as shown in Figure 3-14 through Figure 3-23. Removing the early and late spring spawning cues from Alt 1 results in higher System storage.

However, the increase in System storage does not significantly affect reservoir elevations or releases.

3.2.4 Alternative 4 – Spring Habitat-Forming Flow Release

Upstream operations for Alt 4 do not change compared to Alt 1 except when an ESH-creating release from Gavins Point continues into the summer. When this occurs, Garrison, Oahe, Big Bend, and Fort Randall continue to operate for an ESH-creating release as described in Section 2.1.4. Garrison operates for an ESH release; Oahe and Big Bend releases increase as Fort Randall's releases increase to keep Lewis and Clark at its operating elevation. Figure 3-13 shows a comparison of Garrison's, Fort Randall's, and Gavins Point's releases during the ESH-creating release shown in Figure 2-8.

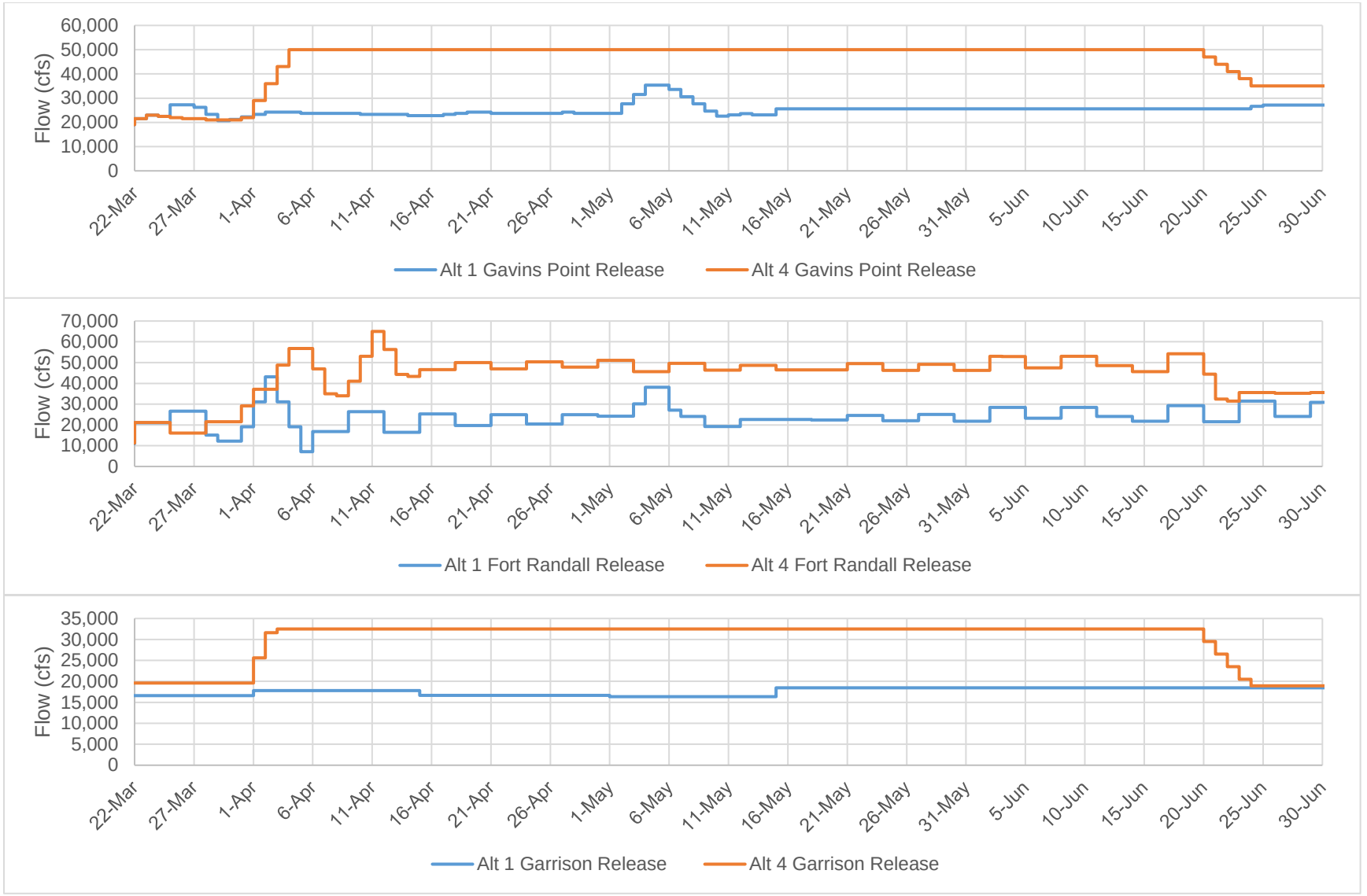

Figure 3-13: Comparison of Alt 1 vs Alt 4 Gavins Point, Fort Randall, and Garrison's releases during the ESH-creating release that extends into June.

Fort Peck, Garrison, and Oahe display a trend of lower reservoir elevations compared to Alt 1. Figure 3-14, Figure 3-16, and Figure 3-18 show lower pool elevations compared to Alt 1 similar to the pool elevations during the spring months discussed in Section 2.1.4, which is attributed to the ESH-creating release lowering System storage. Oahe's elevation is lowered the most of the upper three reservoirs because Oahe supplies the water for Gavins Point's ESH-creating release. Garrison also lower pool elevations during summer months as an ESH-creating release occurs at Garrison any time an ESH-creating release occurs at Gavins Point. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 3-20 and Figure 3-22 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Fort Peck displays slightly higher releases during the summer months compared to Alt 1. Because Garrison's pool elevation is lowered more than Fort Peck, Fort Peck tends to release more water in order to balance System storage, which is why Figure 3-15 shows a higher percentage of summer months with higher releases. Figure 3-17 shows that Garrison's > 10.0 kcfs release change is slightly higher as releases remain higher when the ESH-creating release continues into the summer months. In the years following an ESH-creating release, Garrison's releases tend to be lower in Alt 4 compared to Alt 1, which is shown in Figure 3-17 that shows higher percentages of -6.0 kcfs to -1.0 kcfs release changes.

Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 3-19, Figure 3-21, and Figure 3-23, respectively, have evenly distributed changes. Some of the > 10.0 kcfs changes observed at all three locations are attributed to the ESH-creating release from Gavins Point as water is released from Oahe to keep Big Bend, Fort Randall, and Gavins Point at their guide curves. Since Oahe's releases are highly variable regardless of those operations, comparing Alt 4's changes to Alt 3's changes gives an estimate of how much of the changes are a direct result of the ESH-creating release in Alt 4.

3.2.5 Alternative 5 – Fall Habitat-Forming Flow Release

Upstream operations in Alt 5 do not change compared to Alt 1 May – August. Fort Peck and Garrison still operate to balance storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep the lower three reservoirs at their respective guide curve elevations. Any observed changes in pool elevations or releases shown in Figure 3-14 through Figure 3-23 are attributed to changes described in Sections 2.1.5, 3.1.5, and 4.1.5.

Figure 3-14, Figure 3-16, Figure 3-18 show a slightly higher percentage of the summer months with lower pool elevations compared to Alt 1 at Fort Peck, Garrison, and Oahe, respectively. Although there are lower pool elevations, most of the change falls between ±1.0 feet. Since the Alt 5's ESH-creating release occurs in the fall, summer pool elevations are not affected to the degree they are in Alt 4. The elevation effects are attributed to lower System storage in years following the fall ESH-creating release. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their

guide curve operations. Figure 3-20 and Figure 3-22 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

As with the elevation change, releases from Fort Peck and Garrison are not significantly affected since the ESH-creating release occurs in the fall. Most of the release changes fall between ±1.0 kcfs at both reservoirs. Oahe's releases are highly variable as it releases water to keep Big Bend, Fort Randall, and Gavins Point at their respective guide curve elevations, so there is not a discernable trend in Oahe's releases under Alt 5 compared to Alt 1. Big Bend's and Fort Randall's release change percentages mirror Oahe's release change as Big Bend and Fort Randall operate for their respective guide curves. Figure 3-19, Figure 3-21, and Figure 3-23 show the full range of release changes for Oahe, Big Bend, and Fort Randall, respectively.

3.2.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Upstream operations in Alt 6 do not change compared to Alt 1 May – August. Fort Peck and Garrison still operate to balance storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep their reservoirs at their respective guide curve elevations. Any observed changes in pool elevations or releases shown in Figure 3-14 through Figure 3-23 are attributed to changes described in Sections 2.1.6 and 3.1.6.

Figure 3-14, Figure 3-16, Figure 3-18 show a trend of lower elevations at Fort Peck, Garrison, and Oahe when compared to Alt 1 during the summer months. Both of Alt 6's spawning cues lower System storage, which in turn, lowers Fort Peck's, Garrison's, and Oahe's pool elevations. A portion of the lower pool elevations during the summer is attributed to a lagged effect of lower System storage in the years following the spawning cues. In these years, releases from Fort Peck and Garrison tend to be slightly lower compared to Alt 1. The remaining portion of lower pool elevations during the summer is attributed to a direct effect as the late spring spawning cue occurs during May and June. The higher releases that occur during this spawning cue, directly lower reservoir elevations during the summer and also increase releases slightly as the System attempts to balance System storage among Fort Peck, Garrison, and Oahe. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 3-20 and Figure 3-22 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

3.2.7 Elevation and Release Changes Upstream of Gavins Point during Summer Months for Alternative 1 – 6

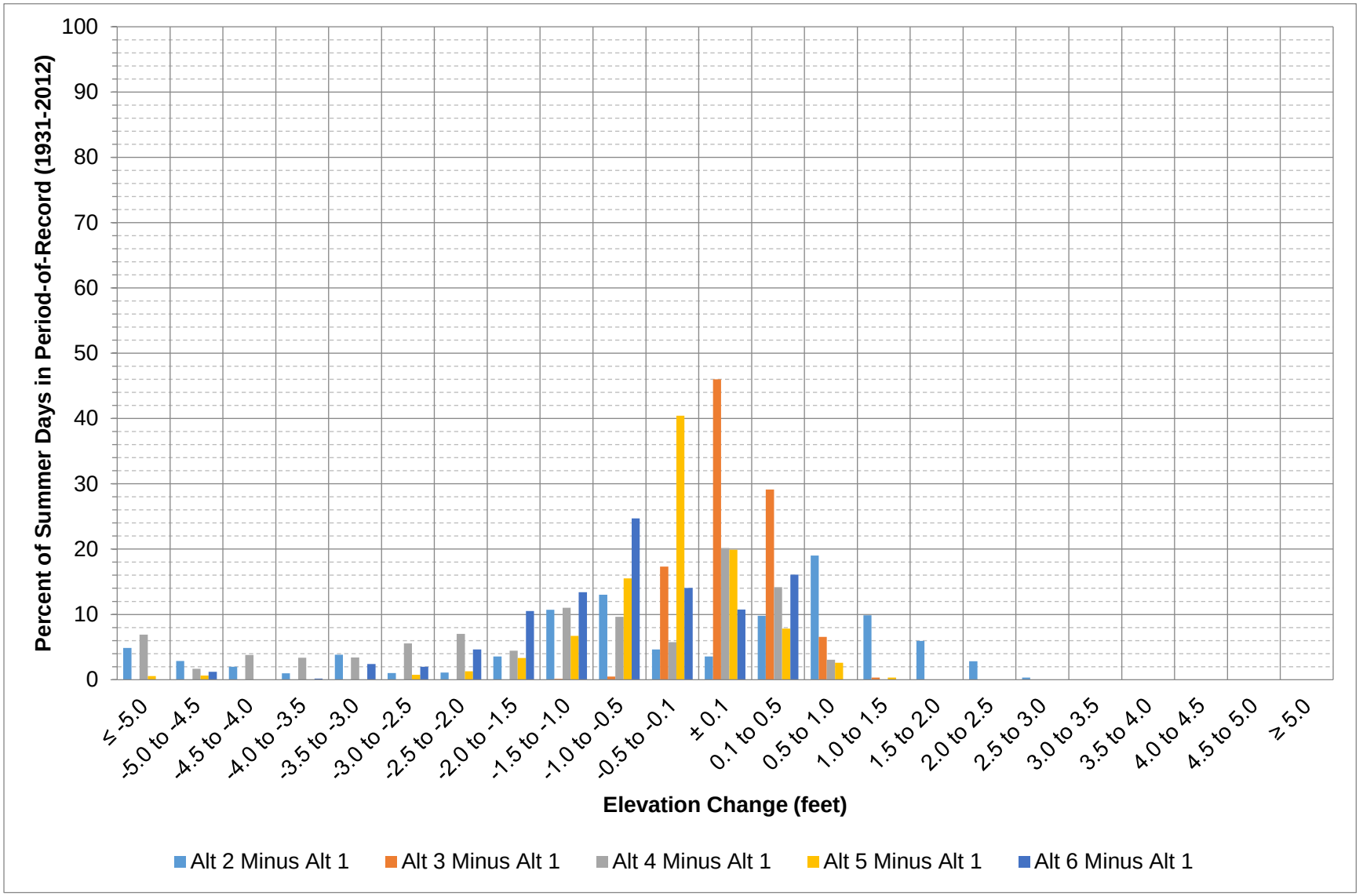

Figure 3-14: Fort Peck elevation change between each alternative and Alt 1 during May – August.

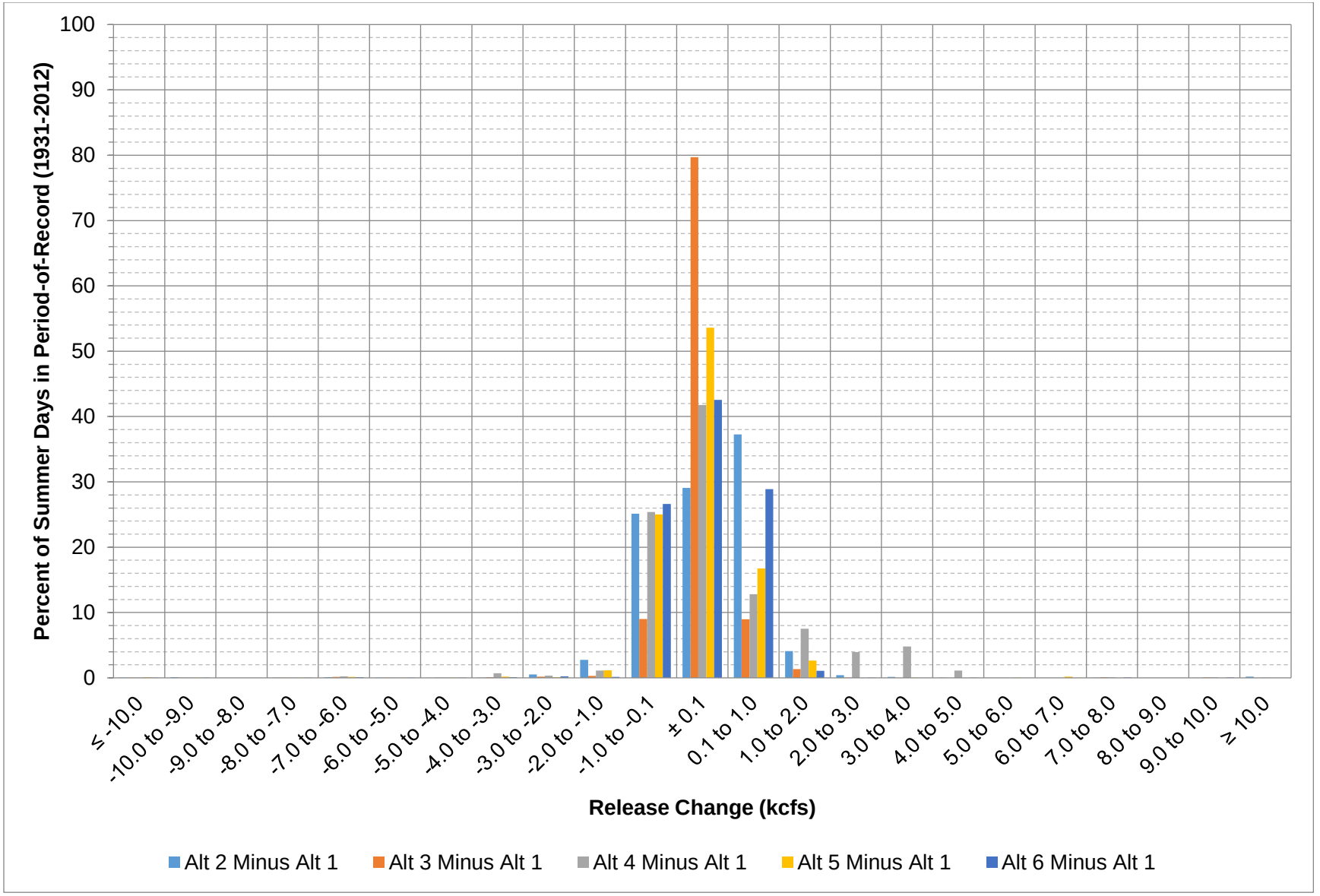

Figure 3-15: Fort Peck release change between each alternative and Alt 1 during May – August.

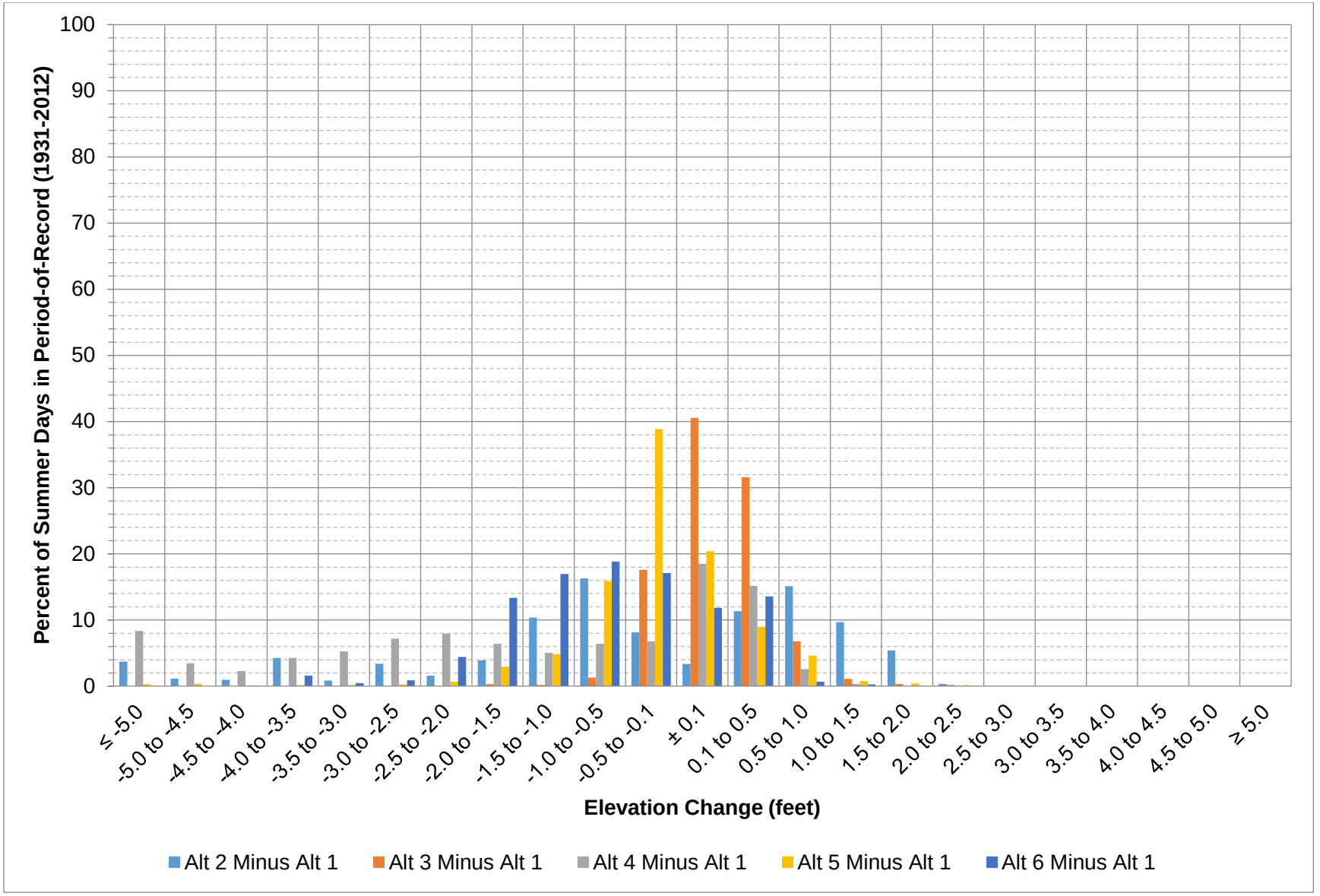

Figure 3-16: Garrison elevation change between each alternative and Alt 1 during May – August.

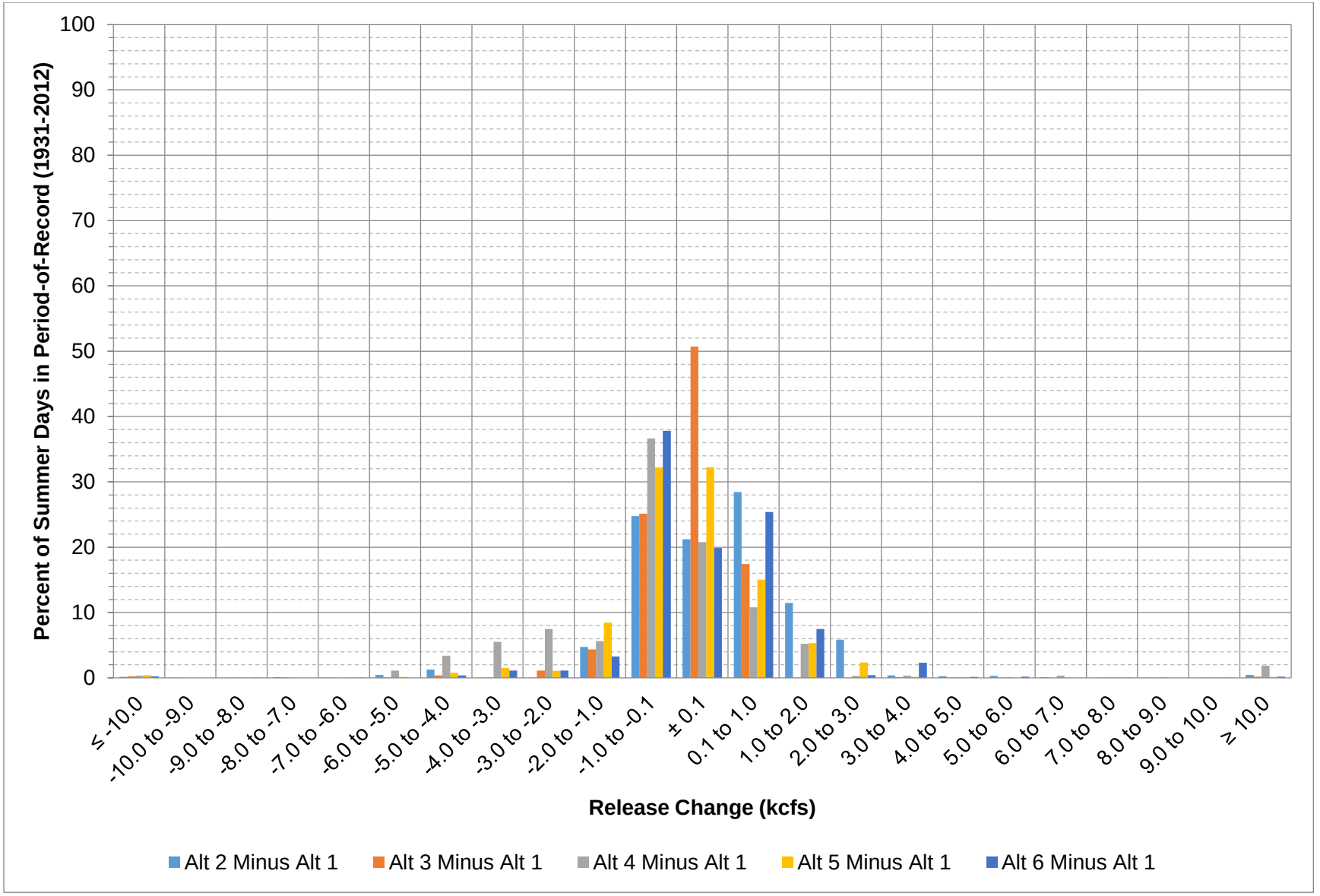

Figure 3-17: Garrison release change between each alternative and Alt 1 during May – August.

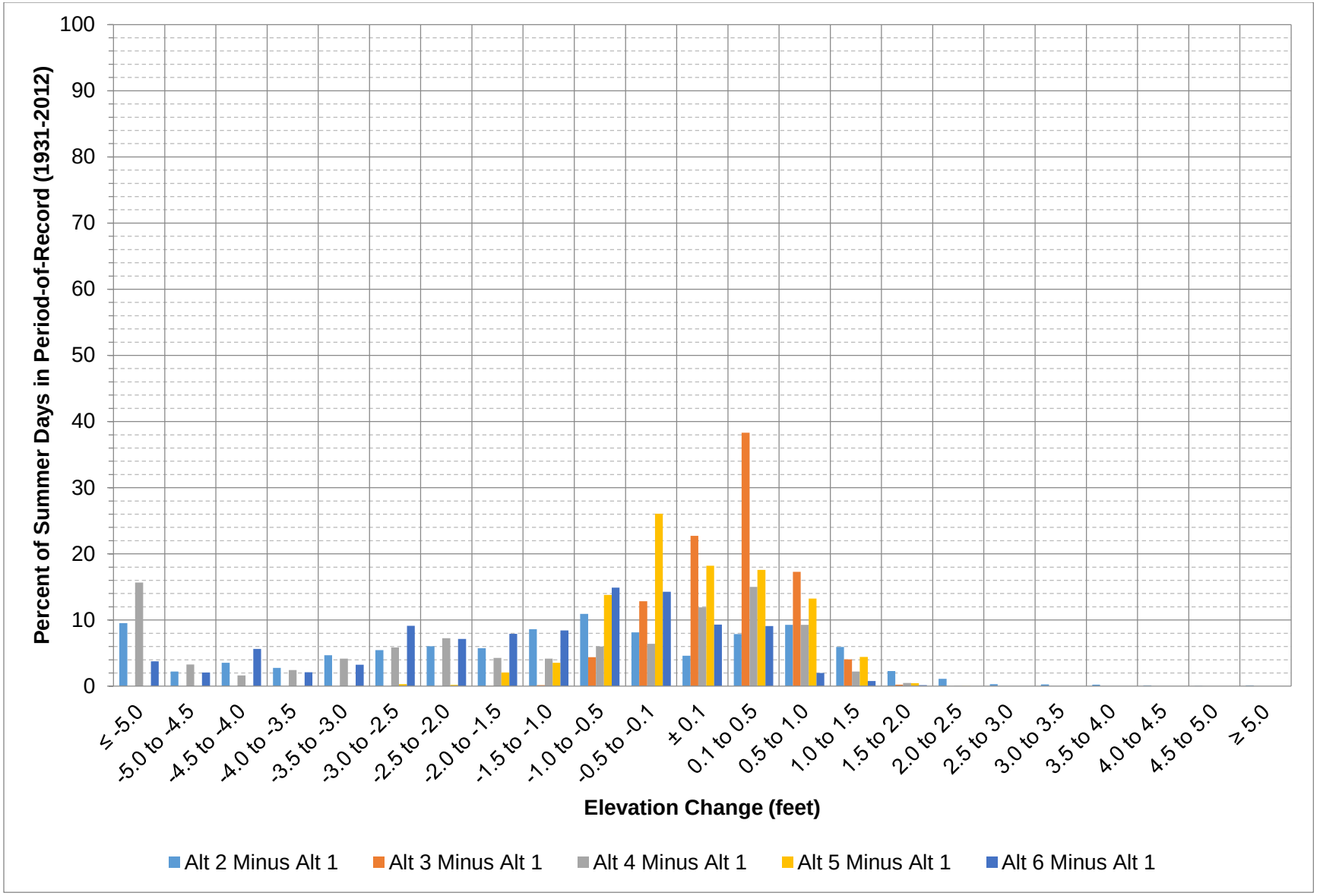

Figure 3-18: Oahe elevation change between each alternative and Alt 1 during May – August.

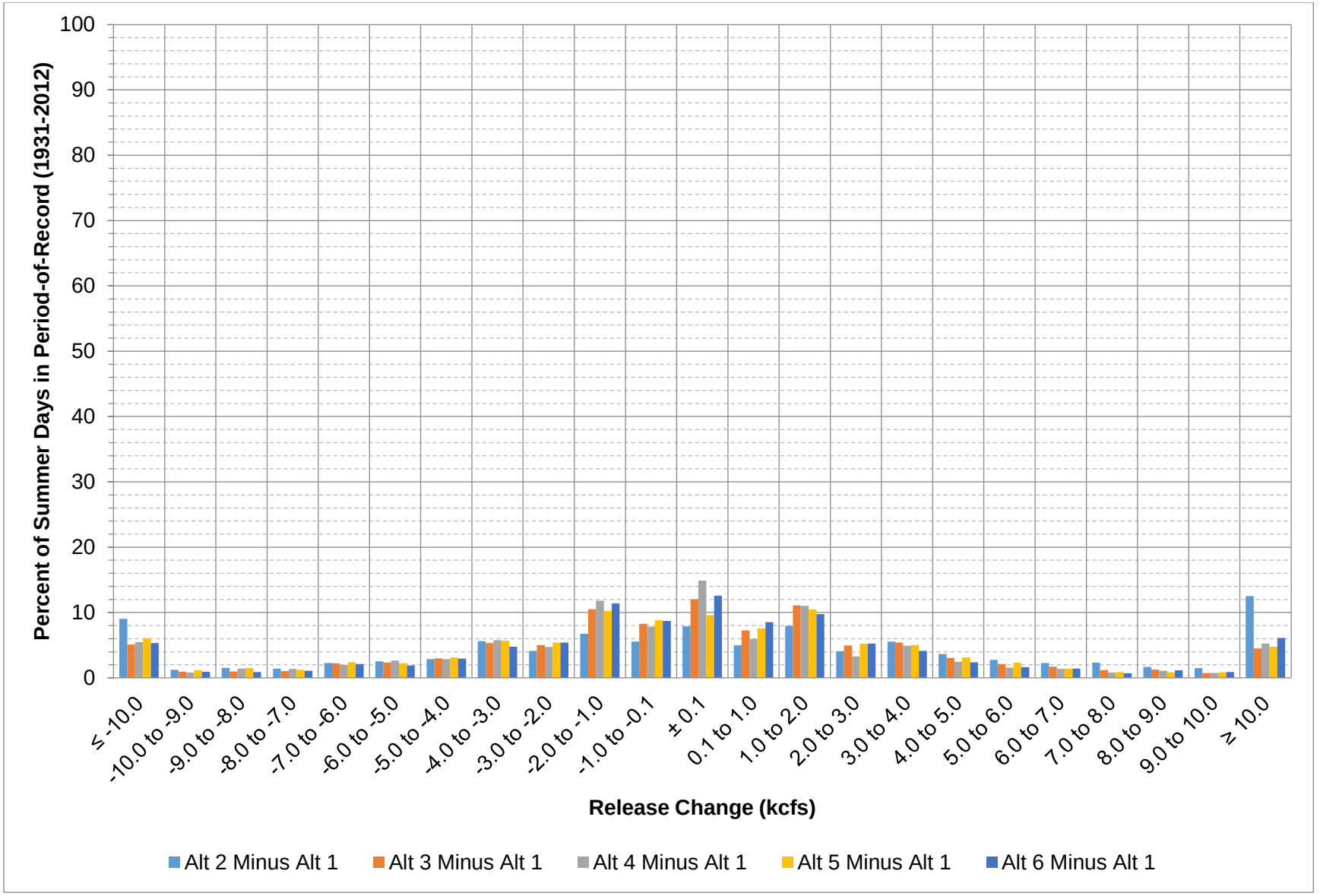

Figure 3-19: Oahe release change between each alternative and Alt 1 during May – August.

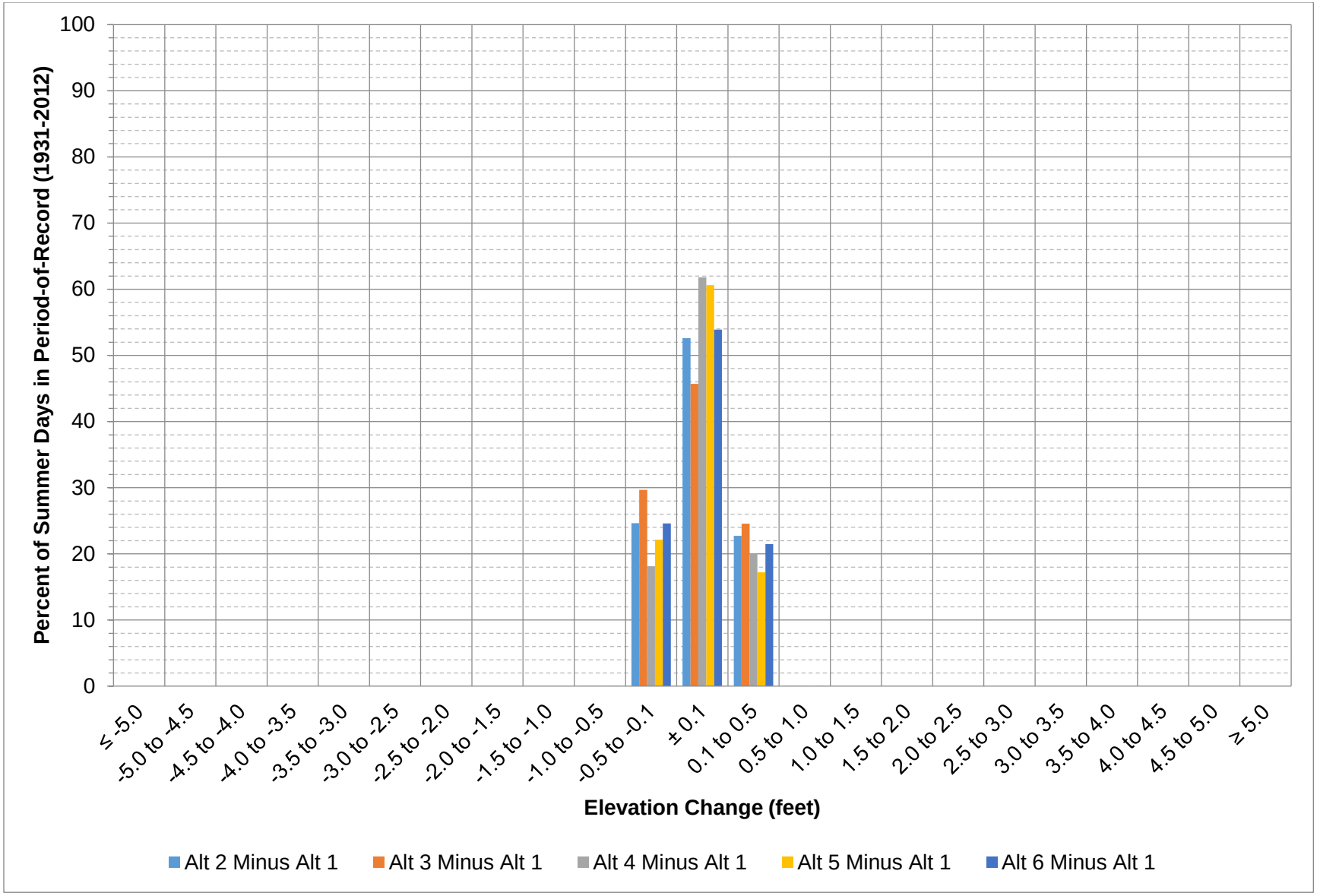

Figure 3-20: Big Bend elevation change between each alternative and Alt 1 during May – August.

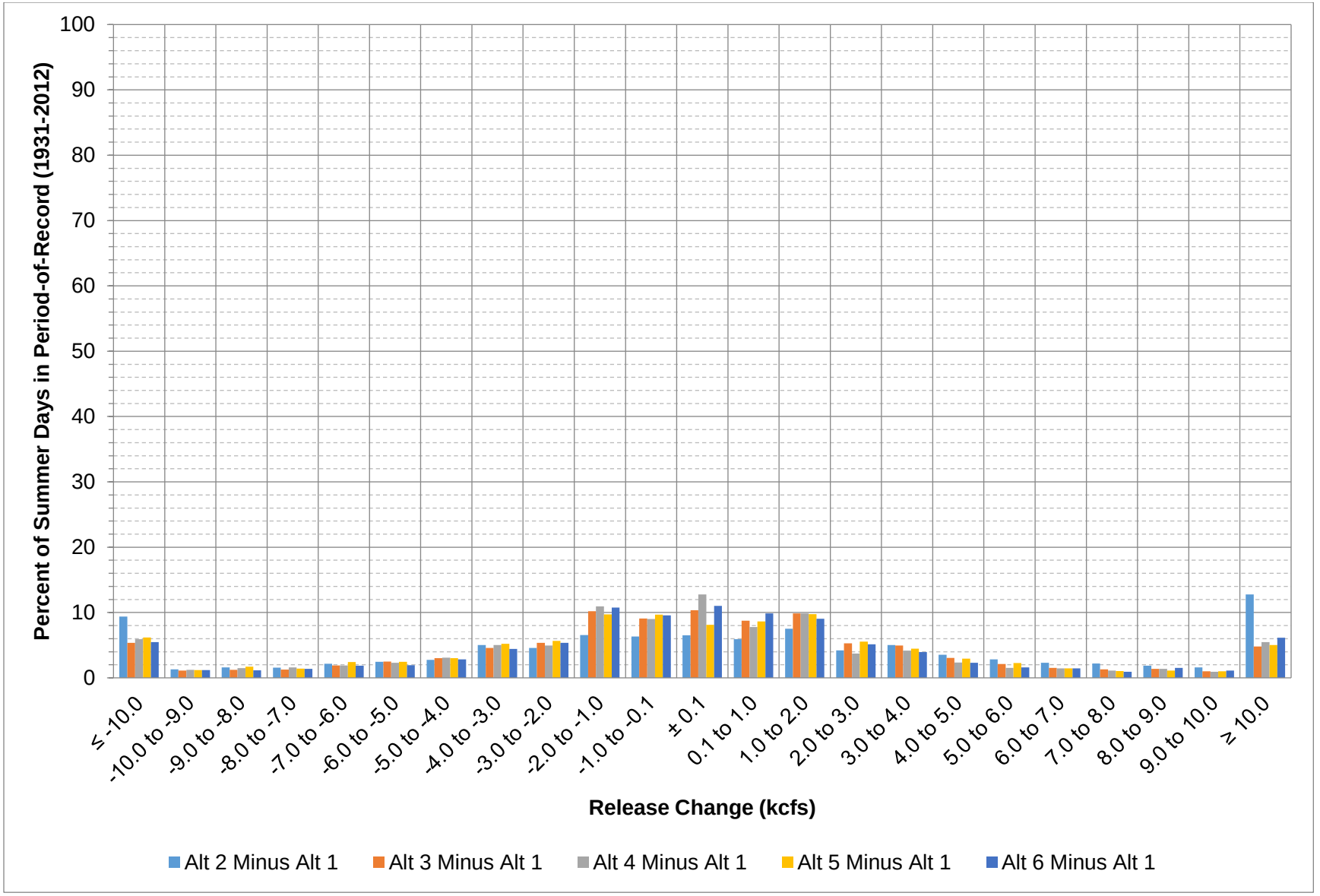

Figure 3-21: Big Bend release change between each alternative and Alt 1 during May – August.

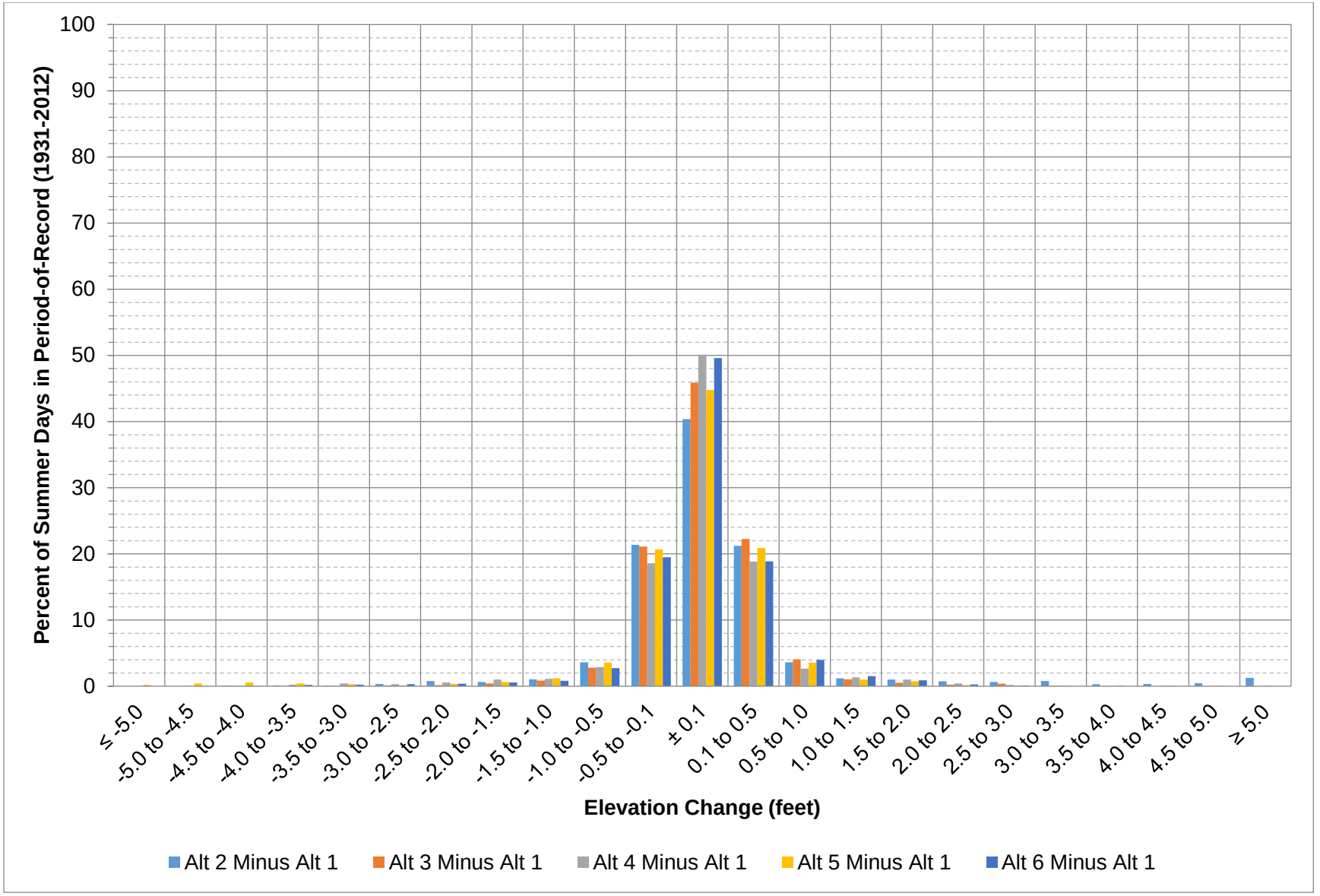

Figure 3-22: Fort Randall elevation change between each alternative and Alt 1 during May – August.

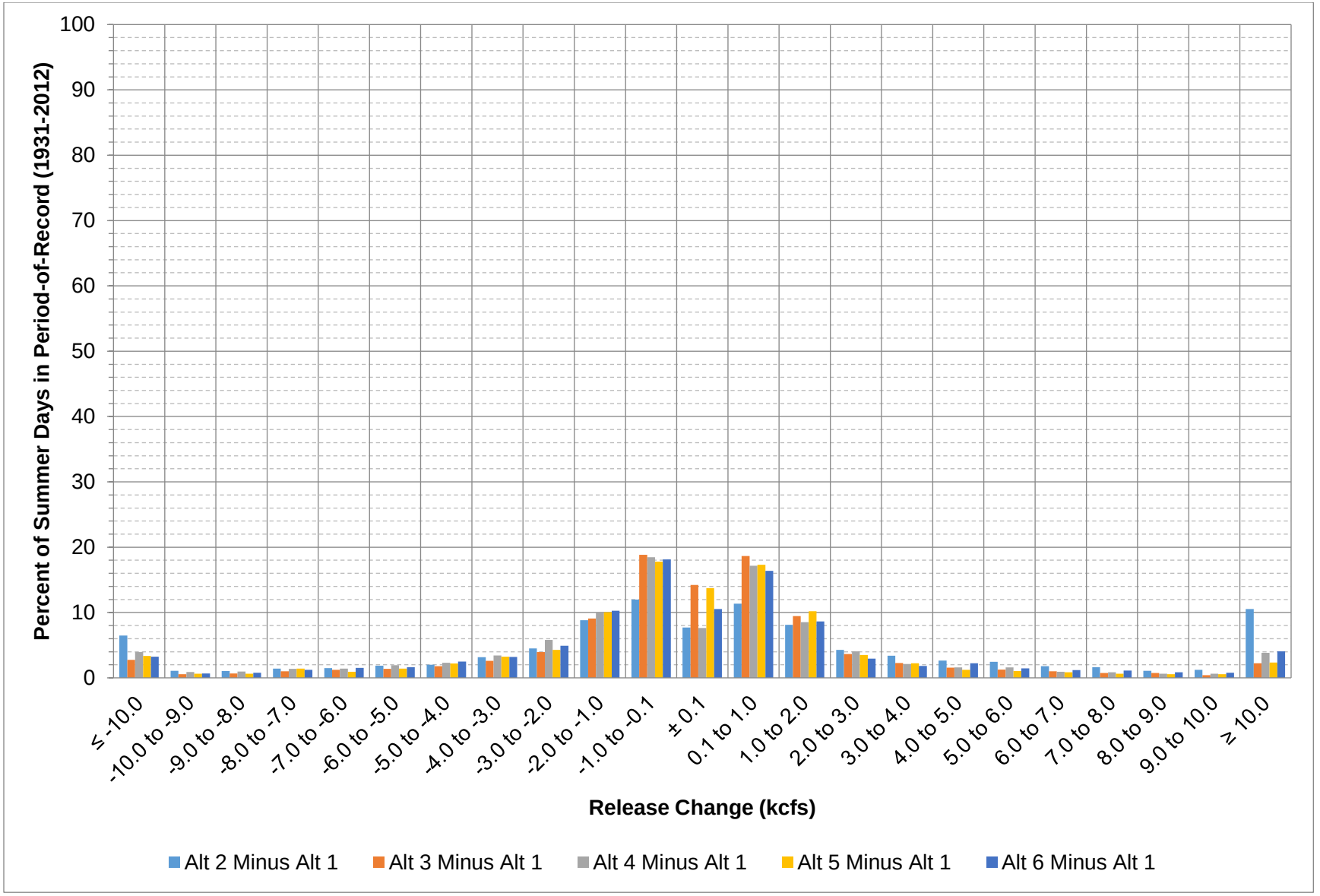

Figure 3-23: Fort Randall release change between each alternative and Alt 1 during May – August.

4 FALL: SEPTEMBER – NOVEMBER

4.1 DOWNSTREAM OF GAVINS POINT

4.1.1 Alternative 1 – No Action

On September 1, System storage is assessed and the winter release is set based on the criteria summarized in Table 4-1. If System storage is 58.0 MAF or more on September 1, Gavins Point's winter release is set to 17.0 kcfs. If the System storage is 55.0 MAF or less on September 1, Gavins' Point winter release is set to 12.0 kcfs. The winter release is linearly interpolated between 12.0 and 17.0 kcfs if the System storage is between 58.0 and 55.0 MAF.

For modeling purposes, the September 1 System storage check also determines if there will be an extension to the navigation season. If System storage is greater than or equal to 60.0 MAF, ten days are added to the navigation season to evacuate flood storage.

Table 4-1: Winter release criteria. Summarized from Tables VII-4 in the Master Manual (U.S. Army Corps of Engineers, 2006).

September 1 System Storage (MAF)	Average Winter Release from Gavins Point (kcfs)
58.0 or more	17.0
55.0 of less	12.0

Flow-to-Target navigation releases, based on the service level established on July 1, and flood targets based on the criteria described in Section 2.1.1 continue through the remainder of the navigation season.

System operations support water supply when not operating for navigation. Gavins Point releases a minimum of 9.0 kcfs and ensures that a minimum flow of 9.0 kcfs is observed at Sioux City, Omaha, and Kansas City. Figure 4-1 shows an example of fall water supply operations after a shortened navigation season where Gavins Point releases are reduced to 9.0 kcfs by October 1 and remain near 9.0 kcfs until the winter releases operations take effect. At the end of October, Gavins Point releases are increased to ensure a minimum of 9.0 kcfs at Omaha, which was the only target location in this example that required more water to reach 9.0 kcfs.

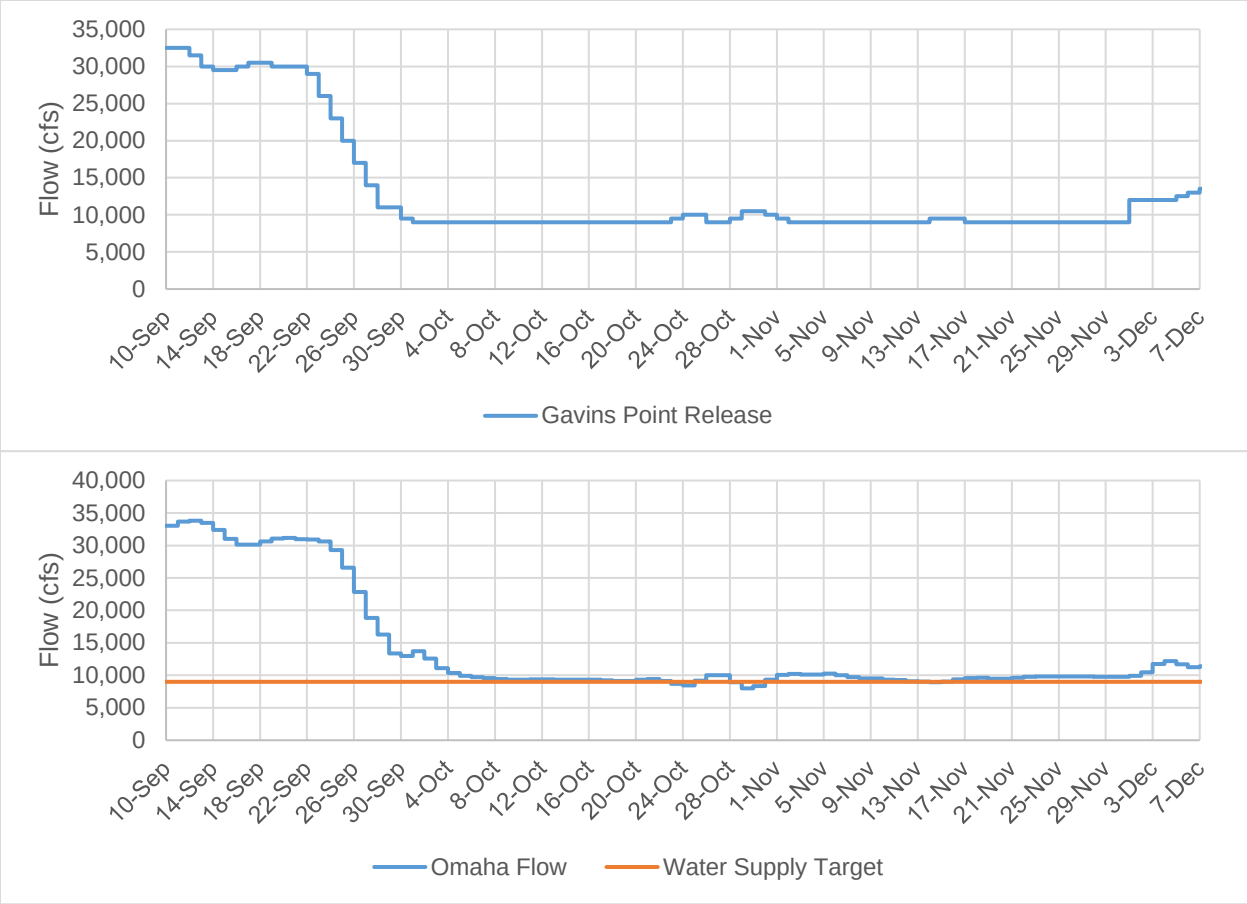

Figure 4-1: Fall water supply operations.

4.1.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

Water supply requirements remain unchanged from Alt 1 operations during September - November. Gavins Point releases a minimum of 9.0 kcfs and ensures that a minimum flow of 9.0 kcfs is observed at the three target locations. Navigation requirements remain unchanged except during years when low summer flows occur and there is a shortened navigation season. As described in Section 3.1.2, when a shortened navigation season would normally occur, the water supply operation days between the end of the computed navigation season and the end of a full 8-month navigation season, December 1, are moved to the summer. During Alt 2, navigation operations continue through December 1. Figure 4-2 compares Gavins Point releases during the end of a shortened navigation in Alt 1 and Alt 2.

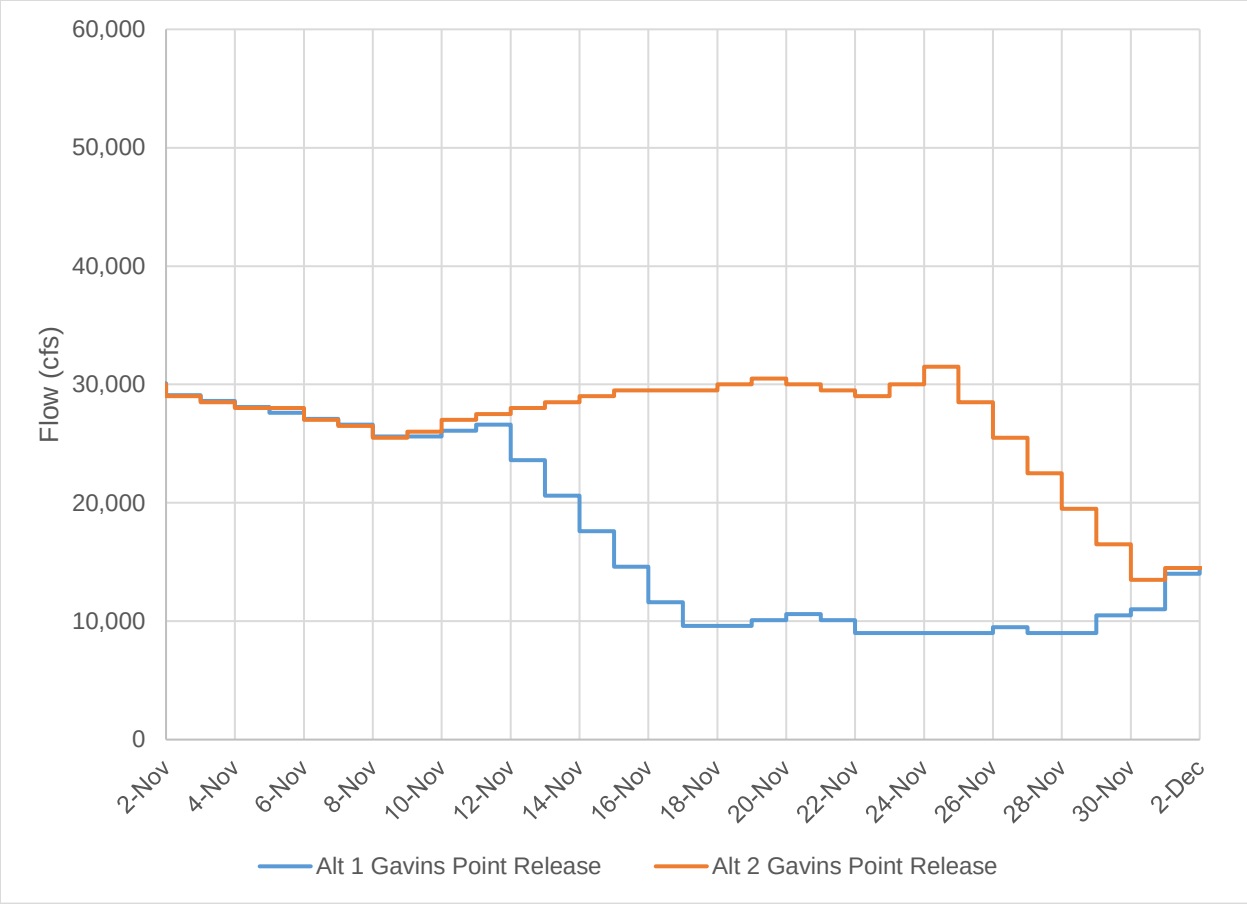

Figure 4-2: Alt 1 Gavins Point releases vs Alt 2's Gavins Point releases for end-of-the-season navigation operations.

As with Alt 1, Gavins Point's winter release is determined with a System storage check on September 1 using the criteria in Table 4-1; however, in Alt 2, if the computed winter release is greater than 16.0 kcfs, the winter release is overwritten to 16.0 kcfs. Alt 2's winter release is discussed in more detail in Section 5.1.2.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 2. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 4-5 shows the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of fall days (September – November) during the period-of-record.

Alt 2 changes in releases shown in Figure 4-6 are a result of the split navigation season and other operational changes described in Sections 2.1.2, 3.1.2, and 5.1.2. Since the number of days the navigation season was shortened is shifted to the summer months and releases are supporting navigation downstream of Gavins Point, Gavins Point releases show an increase in releases relative to Alt 1 during the fall months for a portion of the period-of-record.

4.1.3 Alternative 3 – Mechanical Construction Only

Water supply and navigation requirements remain unchanged from Alt 1 operations during September - November. Gavins Point releases a minimum of 9.0 kcfs and ensures that a minimum flow of 9.0 kcfs is observed at the three target locations for water supply and FTT navigation operations occur during the navigation season. Any release changes that are observed are due to the changes in operations described in Sections 2.1.3 and 3.1.3.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 3. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 4-5 shows the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of fall days (September – November) during the period-of-record.

As a result of the removing Alt 1's early and late spring spawning cue, Gavins Point's releases are changed throughout the period-of-record, showing a slight trend of higher fall releases under Alt 3 compared to Alt 1. System storage is slightly increased when the spawning cues are removed from the operations so navigation seasons during dry years are not shortened as much compared to Alt 1. Longer navigation seasons result in higher fall releases for longer periods as the System supports downstream navigation. Figure 4-6 shows the changes in Gavins Point's releases for each alternative compared to Alt 1 as a percentage of fall days (September – November) during the period-of-record.

4.1.4 Alternative 4 – Spring Habitat-Forming Flow Release

Water supply and navigation requirements remain unchanged from Alt 1 operations during September – November. Gavins Point releases a minimum of 9.0 kcfs and ensures that a minimum flow of 9.0 kcfs is observed at the three target locations for water supply and FTT navigation operations occur during the navigation season. Any release changes that are observed are due to the changes in operations described in Sections 2.1.4, 3.1.4, and 3.2.4.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 4. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 4-5 show the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of summer days (September – November) during the period-of-record.

As a result of Alt 4's ESH-creating release, Gavins Point's releases are changed throughout the period-of-record. Fall releases show a trend of lower releases in Alt 4 than in Alt 1. This is attributed to lower System storage and shorter navigation seasons as a result of Alt 4's spring ESH-creating release; with shorter navigation seasons, fall releases support water supply for longer periods compared to Alt 1. Figure 4-6 shows the changes in Gavins Point's releases for each alternative compared to Alt 1 as a percentage of fall days (September – November) during the period-of-record.

4.1.5 Alternative 5 – Fall Habitat-Forming Flow Release

Alt 5 does not change water supply or navigation operations compared to Alt 1 during September – November. On October 10, service level is assessed and if the service level is at least 35.0 kcfs or full-service, an ESH-creating release with a magnitude of 60.0 kcfs is initiated. Gavins Point releases are increased by 7.0 kcfs per day until 60.0 kcfs is reached or a flood target at Omaha, Nebraska City, or Kansas City is forecasted to be exceeded. Specialized downstream flood target flows are used while the System is operating for the ESH-creating release, increasing the flood target flows from Alt 1 so the ESH-creating release will run more frequently. Table 2-7 lists the flood target locations and their associated target flows, which are the same as the flood targets in Alt 4 when the ESH-creating release is occurring. If a flood target flow is forecasted to be exceeded at any of the three locations, the ESH-creating release peak magnitude is reduced by 5.0 kcfs until the flood targets are no longer forecasted to be exceeded or the ESH-creating release peak magnitude is less than 45.0 kcfs.

Minimum durations for each magnitude of ESH-creating release are specified based on a relationship between existing ESH, magnitude of release, and a target amount of new ESH created. For example, in order to create five hundred acres of new ESH below Gavins Point Dam when there is a maximum of two hundred fifty acres of existing habitat, Gavins Point needs to release 60.0 kcfs for five weeks. Two hundred fifty acres was chosen as the assumed maximum because an ESH-creating release is more efficient at creating new habitat when existing habitat is relatively low. When existing habitat is greater than two hundred fifty acres, releases erode some of the existing habitat requiring a longer duration release to create the same amount of habitat. Table 2-8 summarizes the required durations for various releases to create five hundred acres of new habitat for the Gavins Point to Sioux City reach. Since a fall ESH-creating release begins in October, an ESH release with a magnitude less than 60.0 kcfs will not be able to meet the duration requirements in Table 2-8 prior to the end of the navigation season when releases are reduced for the winter period. As with the ESH-creating release in Alt 4, the fall ESH-creating release is only attempted if releases from Gavins Point did not meet any of the requirements listed in Table 2-8 during the previous three years. Utilizing this frequency helps to ensure a lower amount of existing habitat when an ESH-creating release occurs since the existing habitat would have eroded during the previous three years.

Figure 4-3 shows a five year period of Alt 1 and Alt 5 Gavins Point releases. High releases from Gavins Point occur in the first year due an ESH-creating release meeting the requirements summarized in Table 2-8; therefore, an ESH release is not attempted for the next three years. In year five, an ESH-creating release occurs and is able to complete a full-duration 60.0 kcfs release from Gavins Point, which is highlighted by a dashed red box. Figure 4-4 shows the ESH-creating releases from Gavins Point occurring in year five of Figure 4-3.

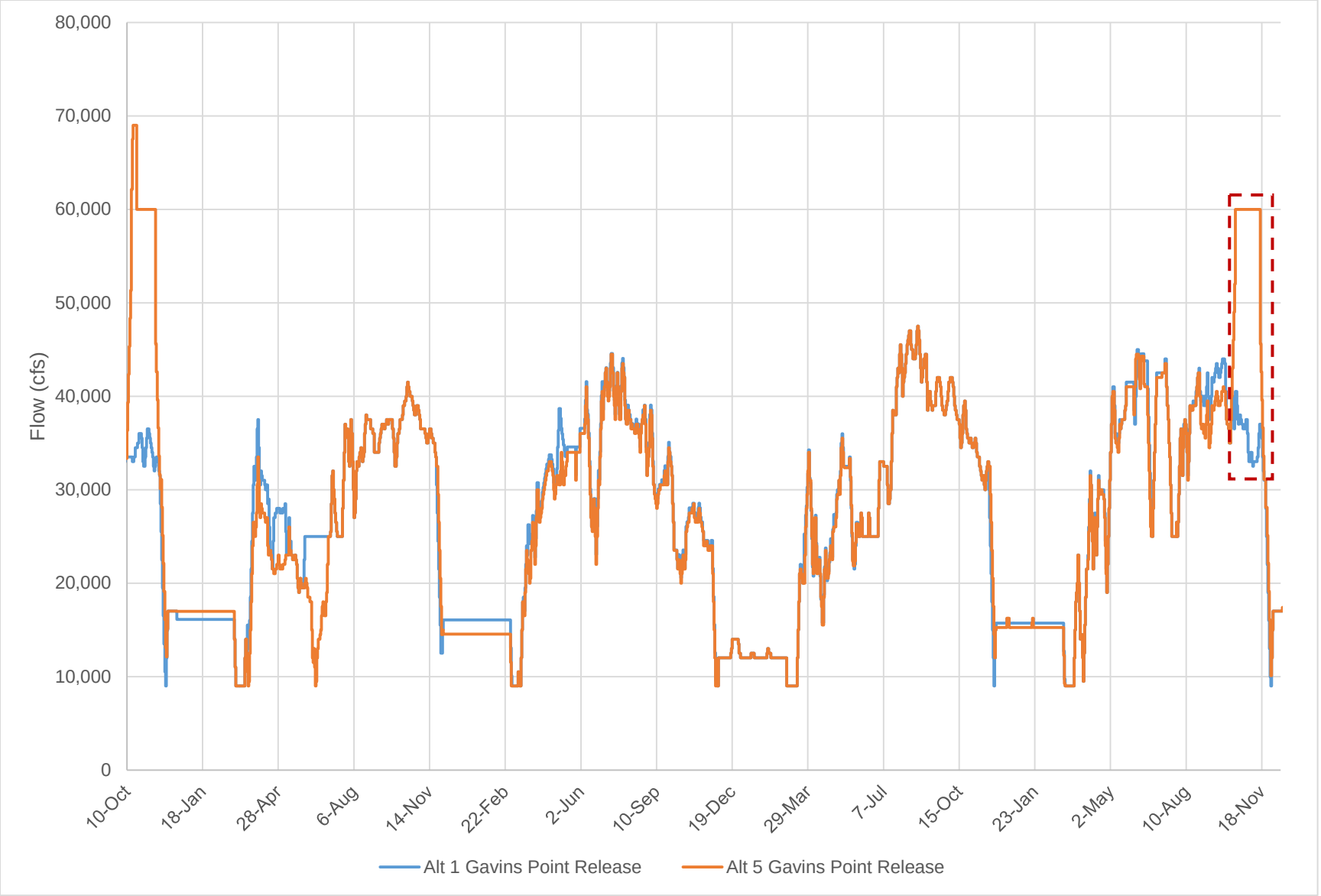

Figure 4-3: Comparison of Alt 1 vs Alt 5 Gavins Point releases during a five year period with ESH-creating release operations.

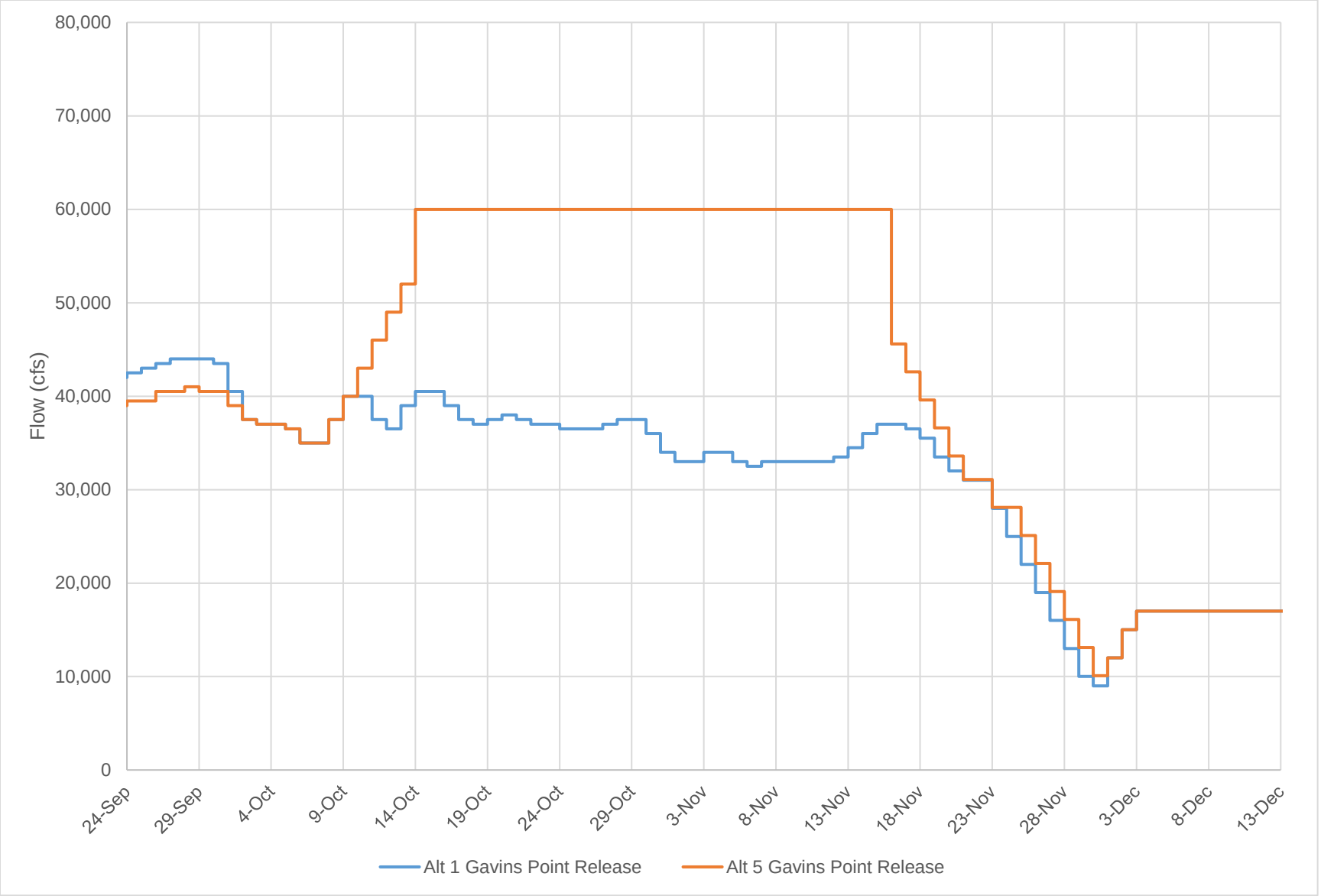

Figure 4-4: Comparison of Alt 1 vs Alt 5 Gavins Point releases during the ESH-creating release shown in Figure 4-3.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 5. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 4-5 show the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of summer days (September – November) during the period-of-record.

Gavins Point's releases are changed each year an ESH-creating release occurs and also throughout the period-of-record as System storage is lowered due to the ESH-creating release. Fall releases show a trend of higher releases in Alt 5 than in Alt 1 caused by the occurrence of the ESH-creating release, which runs to completion seven times and partially runs two times during the period-of-record. The trend of higher releases is especially apparent in the percentage of > 10.0 kcfs release change in Figure 4-6, which shows the changes in Gavins Point's releases for each alternative compared to Alt 1 as a percentage of fall days (September – November) during the period-of-record. In years following an ESH-creating release, releases tend to be lower under Alt 5 compared to Alt 1. The lower releases are attributed to the lower System storage, which affects the level and length of navigation support.

4.1.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Water supply and navigation requirements remain unchanged from Alt 1 operations during September – November. Gavins Point releases a minimum of 9.0 kcfs and ensures that a minimum flow of 9.0 kcfs is observed at the three target locations for water supply and FTT navigation operations occur during the navigation season. Any release changes that are observed are due to the changes in operations described in Sections 2.1.6 and 3.1.6.

The change in releases shown in Figure 4-6 are a result of the operational changes that occur during the spring and summer. Replacing Alt 1's early and late spring spawning cues with larger spawning cues lowers System storage. This causes a trend of lower fall releases in Alt 6 compared to Alt 1 as the level and length of navigation support is decreased. Figure 4-6 shows the changes in Gavins Point's releases for each alternative compared to Alt 1 as a percentage of fall days (September – November) during the period-of-record.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 6. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 4-5 show the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of summer days (September – November) during the period-of-record.

4.1.7 Elevation and Release Changes at Gavins Point during Fall Months for Alternative 1 – 6

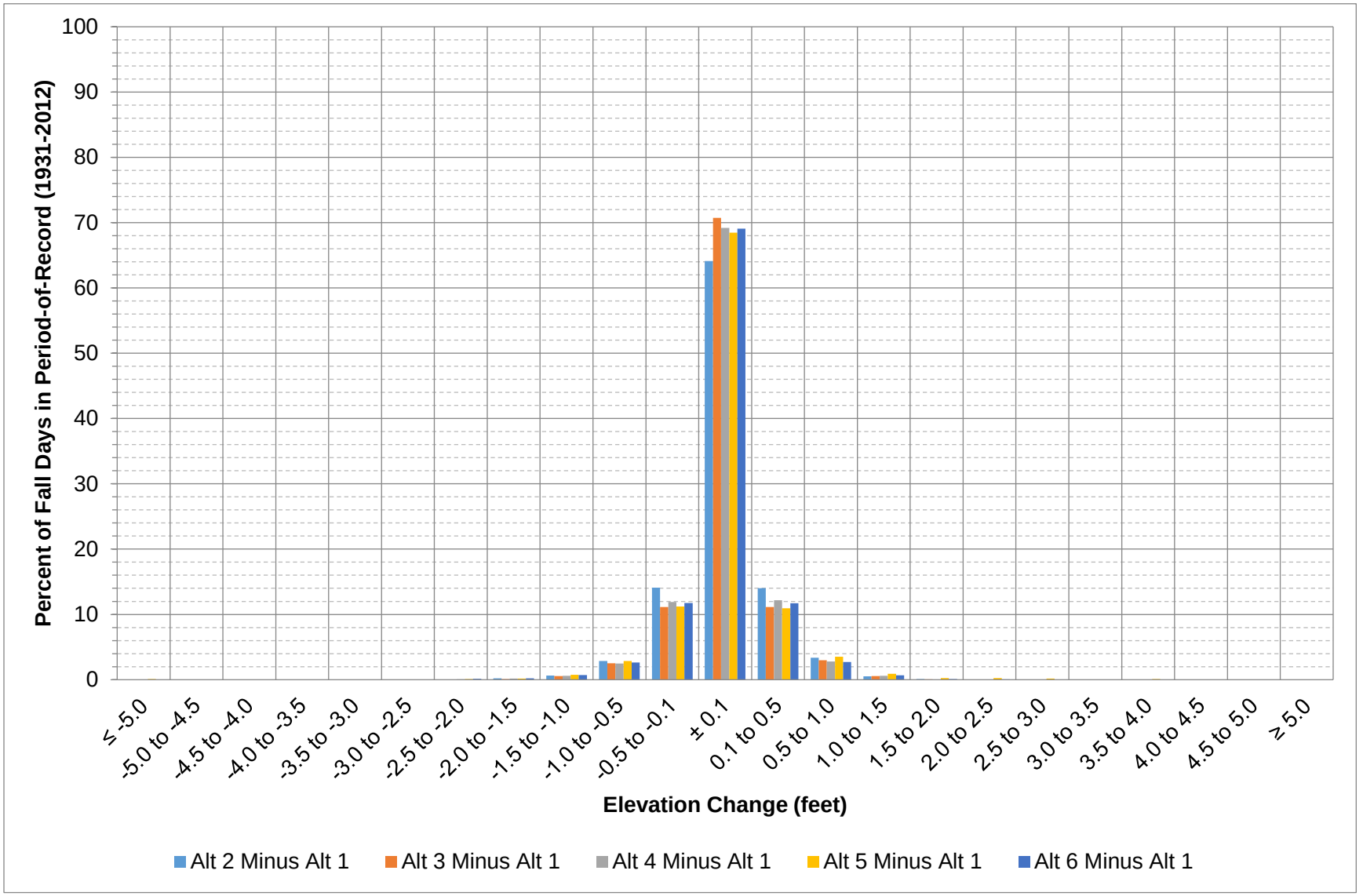

Figure 4-5: Gavins Point elevation change between each alternative and Alt 1 during September – November.

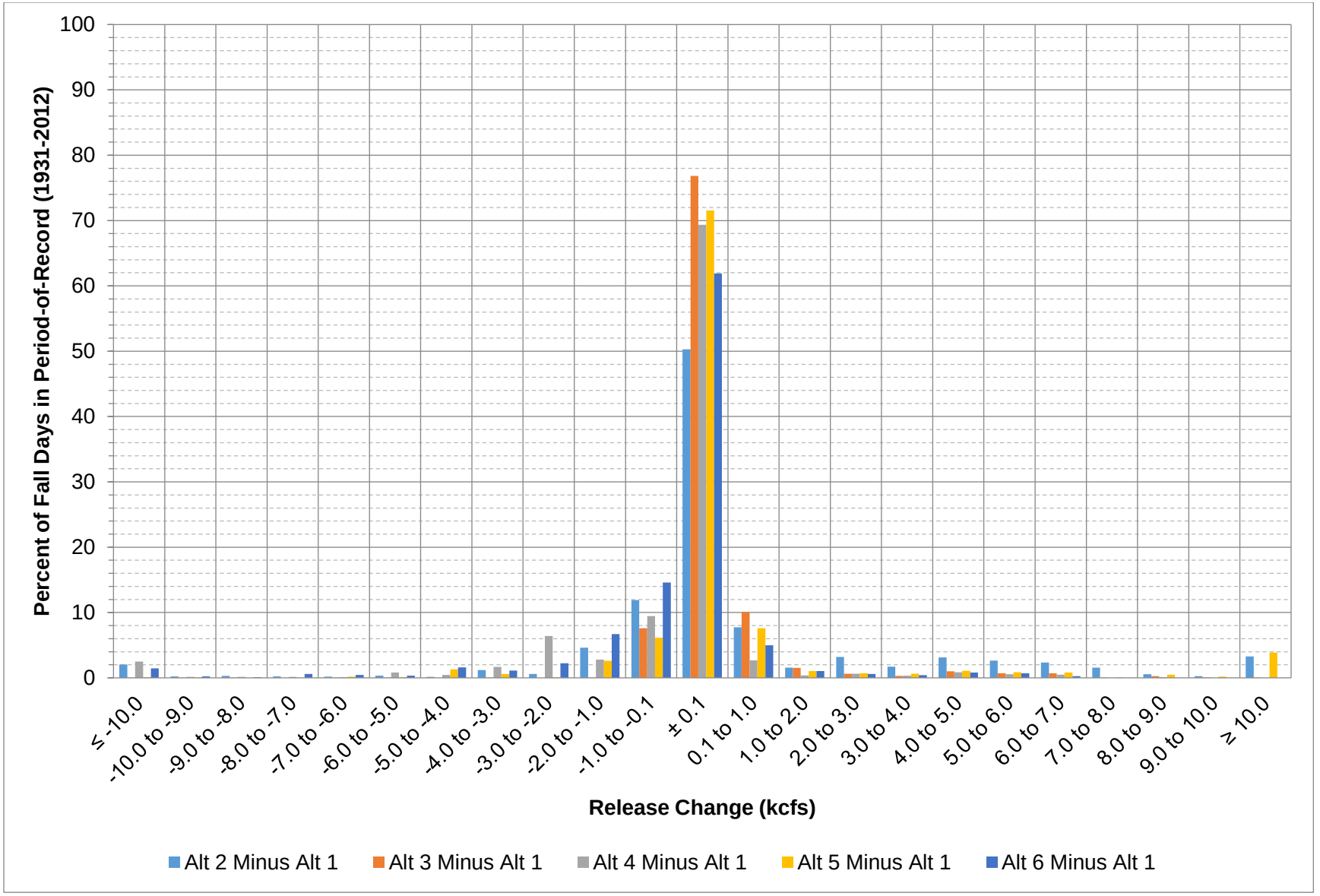

Figure 4-6: Gavins Point release change between each alternative and Alt 1 during September – November.

4.2 UPSTREAM OF GAVINS POINT

4.2.1 Alternative 1 – No Action

Fort Peck and Garrison still release water based on the forecasted System storage as the model attempts to balance Fort Peck's, Garrison's, and Oahe's amount of occupied Carryover Multiple Use Zones prior to the start of next year's runoff. The balancing release specified at Fort Peck and Garrison on May 15 attempts to remain steady through September 15 to help the endangered bird species during their nesting season. Releases can change if the pool elevation requirements listed in Table 3-3 are exceeded.

After setting releases at Fort Peck and Garrison, minimum flows at Wolf Point, Culbertson, and Bismarck are checked. Releases from Fort Peck are increased to ensure a minimum flow of 3.0 kcfs is forecasted at Wolf Point and Culbertson between September 1 and November 30. Releases from Garrison are increased to ensure a minimum flow of 9.0 kcfs is forecasted at Bismarck between September 1 and November 30.

Guide curve operations continue at Big Bend, Fort Randall, and Gavins Point, but Fort Randall begins its fall drawdown on September 1. Fort Randall's pool elevation remains near 1355.0 feet (NGVD 29) during the summer but is drawn down to 1337.5 feet (NGVD 29) by the end of the navigation season for hydropower benefits. The rate of drawdown and refill depends on the navigation end date. Figure 4-7 shows two examples of Fort Randall's drawdown: a drawdown occurring during a full navigation season and a drawdown occurring during a shortened navigation season. Fort Randall begins refilling after the end of the navigation season, so its refilling rate is slower during years with a shortened navigation season as it reaches elevation 1350.0 feet (NGVD 29) on March 1.

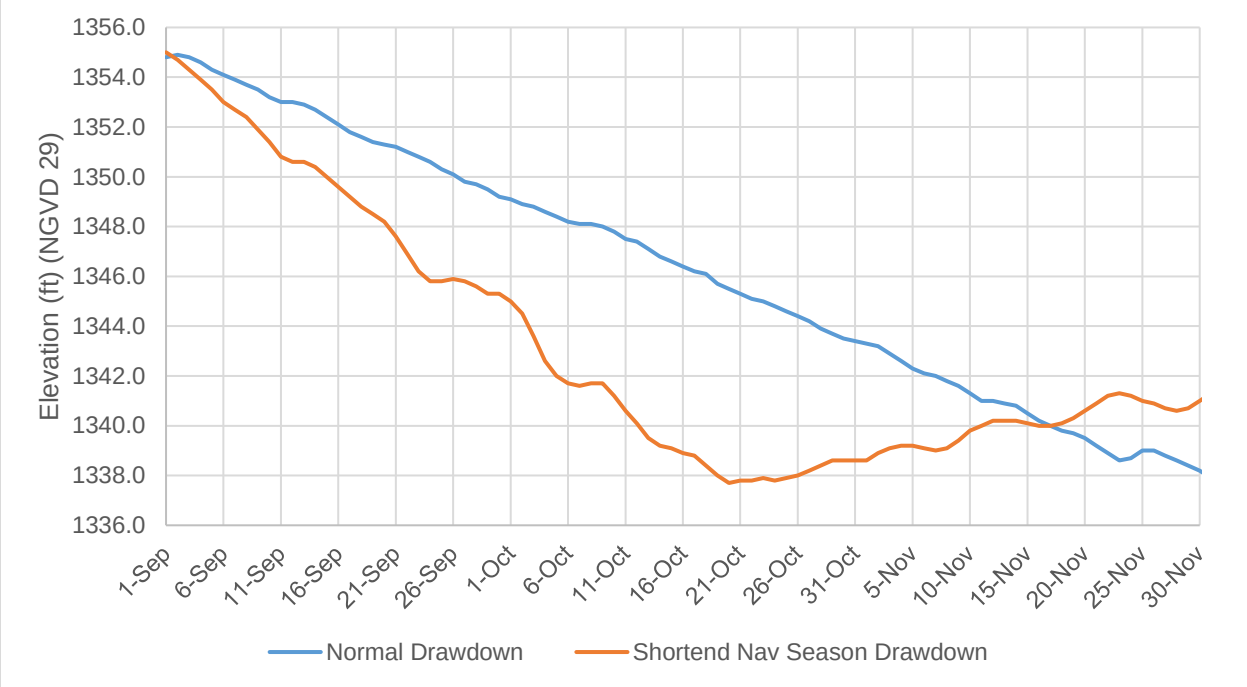

Figure 4-7: Fort Randall fall drawdown.

4.2.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

Upstream operations in Alt 2 do not change compared to Alt 1 September – November. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep their reservoirs at their respective guide curve elevations. The observed changes that are shown in Figure 4-10 through Figure 4-19 are attributed to changes described in Sections 2.1.2, 3.1.2, 4.1.2, and 5.1.2.

Figure 4-10, Figure 4-12, and Figure 4-14 show a mixture of higher and lower elevations at Fort Peck, Garrison, and Oahe, respectively, under Alt 2 compared to Alt 1, although the lower extremes are more prevalent than the higher extremes. As water is conserved due to the low summer flow operations, pool elevations at Fort Peck, Garrison, and Oahe increase causing a portion of the period-of-record to show higher elevations during the fall. However, the spawning cue operations lower reservoir elevations and utilize more water than the low summer flow operations conserves. This results in more of the fall months in the period-of-record having lower pool elevations at those three reservoirs when compared to Alt 1. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 4-16 and Figure 4-18 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Figure 4-11 and Figure 4-13 show relatively no change in Fort Peck's and Garrison's releases as most of the period-of-record falls between ±1.0 kcfs. Since Fort Peck and Garrison operate to balance System storage, their releases only need to slightly change over the course of a year to release large volumes of water needed to balance System storage between Fort Peck, Garrison, and Oahe. Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 4-15, Figure 4-17, and Figure 4-19, respectively, have evenly distributed changes. Some of the > 10.0 kcfs changes observed at all three locations are attributed to the longer navigation seasons during dry years in Alt 2. Since Oahe's releases are highly variable regardless of those operations as water is released to keep Big Bend, Fort Randall, and Gavins Point at their respective guide curves, comparing Alt 2's changes to Alt 3's changes gives an estimate of how much of the changes are a direct result of the lengthened navigation seasons in Alt 2.

4.2.3 Alternative 3 – Mechanical Construction Only

Upstream operations in Alt 3 do not change compared to Alt 1 September – November. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep the lower three reservoirs at their respective guide curve elevations. The observed changes that are shown in Figure 4-10 through Figure 4-19 are attributed to changes described in Sections 2.1.3 and 3.1.3.

Fort Peck's, Garrison's, Oahe's, Big Bend's, and Fort Randall's elevation and releases changes compared to Alt 1 all have minimal changes as shown in Figure 4-10 through Figure 4-19. Removing the early and late spring spawning cues from Alt 1 results in higher System storage. However, the increase in System storage does not significantly affect reservoir elevations or releases.

4.2.4 Alternative 4 – Spring Habitat-Forming Flow Release

Upstream operations in Alt 4 do not change compared to Alt 1 September – November. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep the lower three reservoirs at their respective guide curve elevations. Any observed changes in releases are attributed to changes described in Sections 2.1.4, 3.1.4, and 3.2.4.

Figure 4-10, Figure 4-12, and Figure 4-14 show a trend of lower elevations at Fort Peck, Garrison, and Oahe when Alt 4 is compared to Alt 1 with Oahe having the most extreme elevation change. Alt 4's ESH-creating release lowers Fort Peck's, Garrison's and Oahe's pool elevations as it lowers System storage in the years following the release. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 4-16 and Figure 4-18 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Figure 4-11 and Figure 4-13 show a slight reduction in Fort Peck's and Garrison's releases as lower System storage equates to lower releases as the reservoirs balance System storage throughout a year. Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 4-15, Figure 4-17, and Figure 4-19, respectively, have evenly distributed changes.

4.2.5 Alternative 5 – Fall Habitat-Forming Flow Release

Upstream operations for Alt 5 do not change compared to Alt 1 except during an ESH-creating release from Gavins Point. Since Gavins Point is operated within a small range of pool elevations, Fort Randall's releases typically mirror Gavins Point's releases. Therefore, any year that has an ESH-creating release from Gavins Point, similar releases will be made from Fort Randall. Although Garrison is not directly tied to Gavins Point operations as Fort Randall is, Garrison also conducts an ESH-creating release in years when Gavins Point conducts an ESH-creating release; this assumes that existing habitat is low in the Garrison to Oahe reach during the same years that it is low in the Gavins Point to Sioux City reach. Table 2-10 summarizes the required durations for various releases to create five hundred acres of new habitat for the Garrison to Oahe and Fort Randall to Gavins Point reaches. Even though Garrison's required durations to create five hundred acres of habitat are longer than Gavins Point's durations, Garrison's ESH-creating release follows Gavins Point's durations. This was done to prevent unbalancing System storage by storing extra water in Oahe, which can be detrimental to flood control operations. Releases from Oahe are increased as Gavins Point's releases are increased to keep Big Bend and Fort Randall at their respective guide curve elevations. The net change in storage at Oahe during an ESH-creating release is minor while both Garrison and Gavins Point are running an ESH-creating release. However, if Gavins Point's ESH-creating release completes its required duration, but

Garrison's ESH-creating release still needs to run for additional weeks to create five hundred acres, the additional water is stored in Oahe. This minimizes the System's flood control capability because Oahe is the most downstream reservoir with significant flood control storage and a portion of its flood control storage is now occupied by the water released from Garrison's ESH-creating release. Figure 4-8 compares the same five year period of Alt 1 and Alt 5 releases from Gavins Point as in Figure 4-3 to releases from Fort Randall and Garrison. In year five, an ESH-creating release occurs and is able to complete a full-duration 60.0 kcfs release from Gavins Point. Fort Randall's releases are increased during the ESH-creating release to keep Gavins Point near its operational elevation and Garrison's releases are increased per Alt 5 operational requirements. All ESH releases are highlighted by a dashed red box. Figure 4-9 shows the ESH-creating releases from Gavins Point, Fort Randall, and Garrison occurring in year five of Figure 4-3.

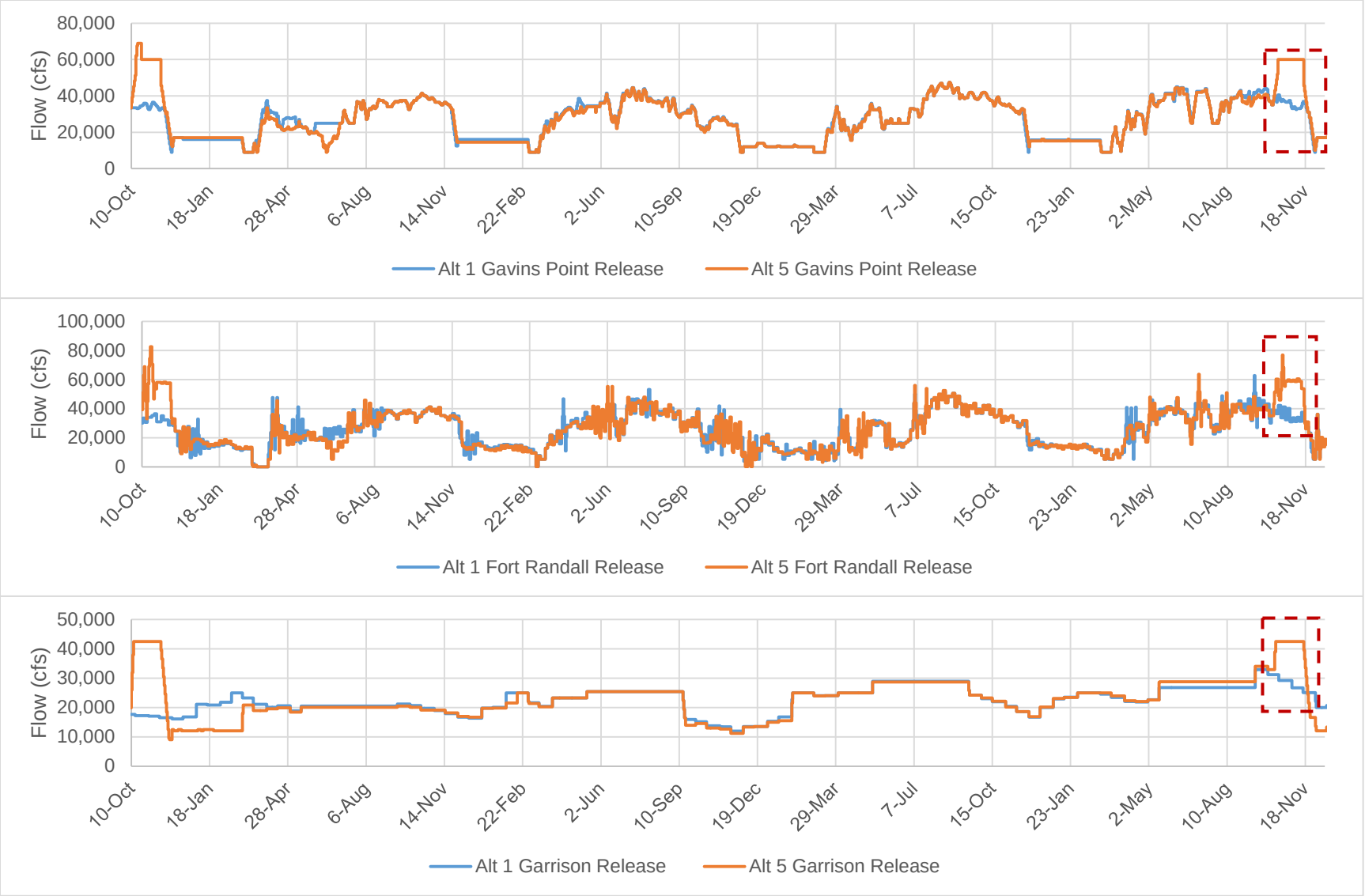

Figure 4-8: Comparison of Alt 1 vs Alt 5 Gavins Point, Fort Randall, and Garrison releases during the same five year period with ESH-creating release operations as shown in Figure 4-3.

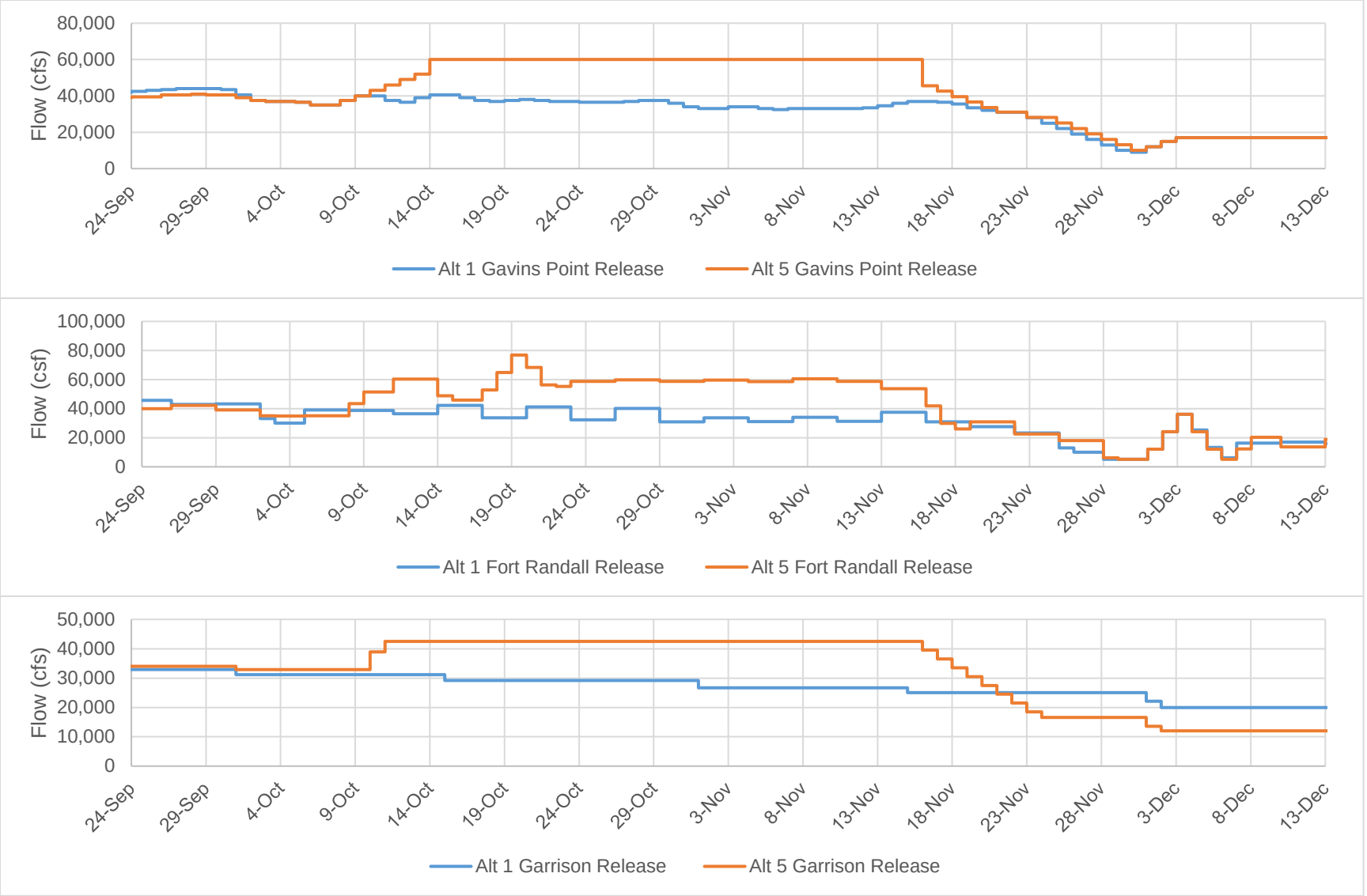

Figure 4-9: Comparison of Alt 1 vs Alt 5 Gavins Point, Fort Randall, and Garrison's releases during the ESH-creating release shown in Figure 4-8.

Fort Peck's and Garrison's elevation changes show a slight trend of lower pool elevations compared to Alt 1 as shown in Figure 4-10 and Figure 4-12. This is caused by the fall ESH-creating release. Gavins Point's ESH-creating release directly reduces System storage as water leaves the reservoir system, which then reduces Fort Peck's and Garrison's pool elevations. The lower pool is not as extreme as in Alt 4 because Alt 5's ESH-creating release only runs to completion seven times and partially runs two times compared to Alt 4's ESH-creating release running to completion ten times and partially running seven times. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 4-16 and Figure 4-18 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

The most notable release changes occur at Garrison, Oahe, Big Bend, and Fort Randall as each reservoir shows a percentage of > 10.0 kcfs release change, which is attributed to the ESH-creating release occurring at both Gavins Point and Garrison. Oahe's, Big Bend's, and Fort Randall's releases all increase during Gavins Point's ESH-creating release to keep the lower three reservoirs at their guide curve elevations. Figure 4-13, Figure 4-15, Figure 4-17, and Figure 4-19 show Garrison's, Oahe's, Big Bend's, and Fort Randall's full range of release changes during the fall months, respectively. Fort Peck's release remain relatively unchanged, shown in Figure 4-11, since Fort Peck's releases only need to slightly change over the course of a year to release large volumes of water needed to balance System storage.

4.2.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Upstream operations in Alt 6 do not change compared to Alt 1 September – November. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep the lower three reservoirs at their respective guide curve elevations. Any observed changes in pool elevations or releases shown in Figure 4-10 through Figure 4-19 are attributed to changes described in Sections 2.1.6 and 3.1.6.

Figure 4-10, Figure 4-12, and Figure 4-14 show a trend of lower elevations at Fort Peck, Garrison, and Oahe when compared to Alt 1 during the fall months. Both of Alt 6's spawning cues lower System storage, which in turn, lowers Fort Peck's, Garrison's, and Oahe's pool elevations. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 4-16 and Figure 4-18 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Figure 4-11 and Figure 4-13 show relatively minor release changes for Fort Peck and Garrison, respectively. Since Fort Peck and Garrison operate to balance System storage, their releases only need to slightly change over the course of a year to release large volumes of water needed to balance System storage between Fort Peck, Garrison, and Oahe. Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 4-15, Figure 4-17, and Figure 4-19, respectively, have evenly distributed changes.

4.2.7 Elevation and Release Changes Upstream of Gavins Point during Fall Months for Alternative 1 – 6

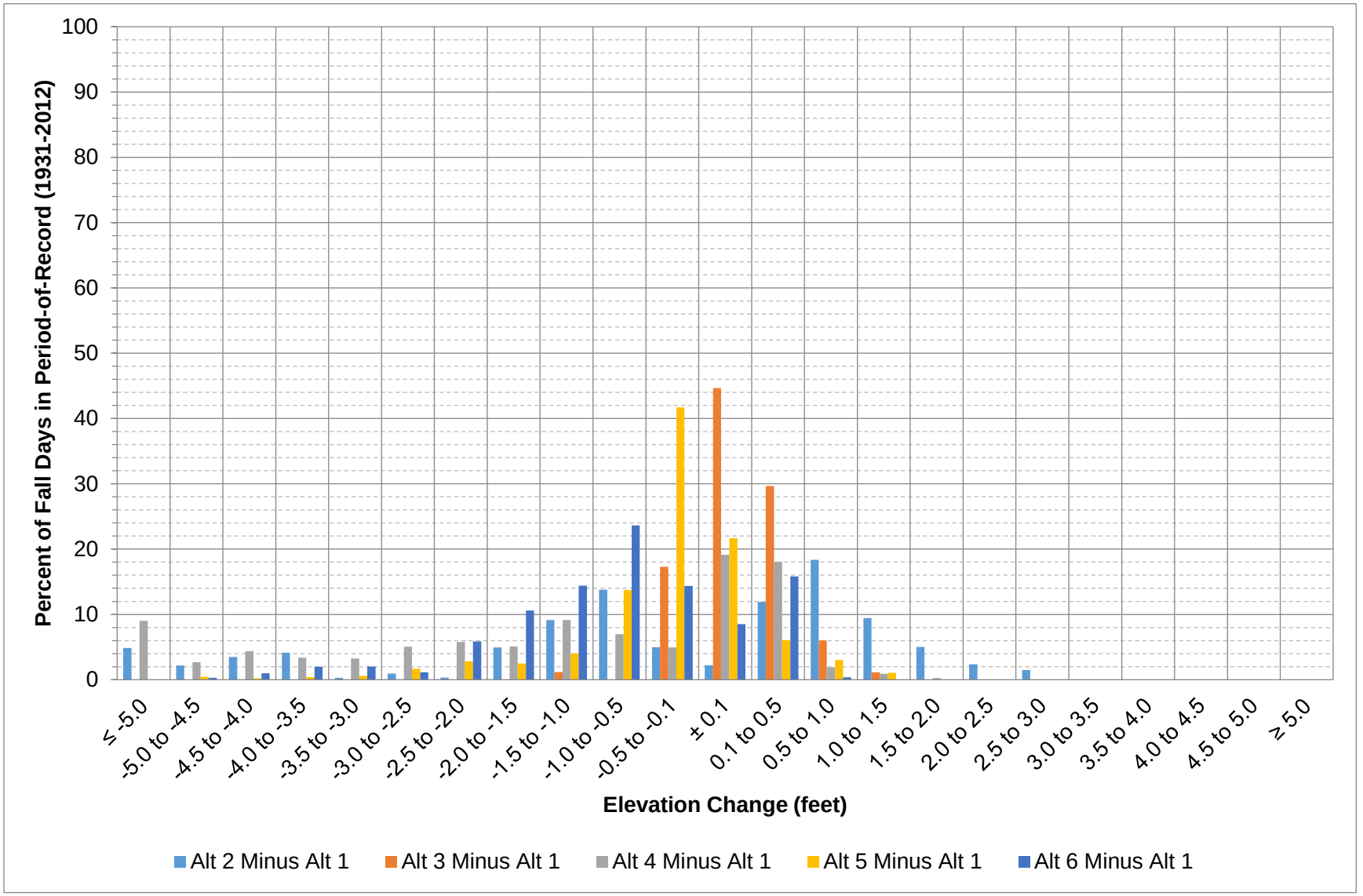

Figure 4-10: Fort Peck elevation change between each alternative and Alt 1 during September – November.

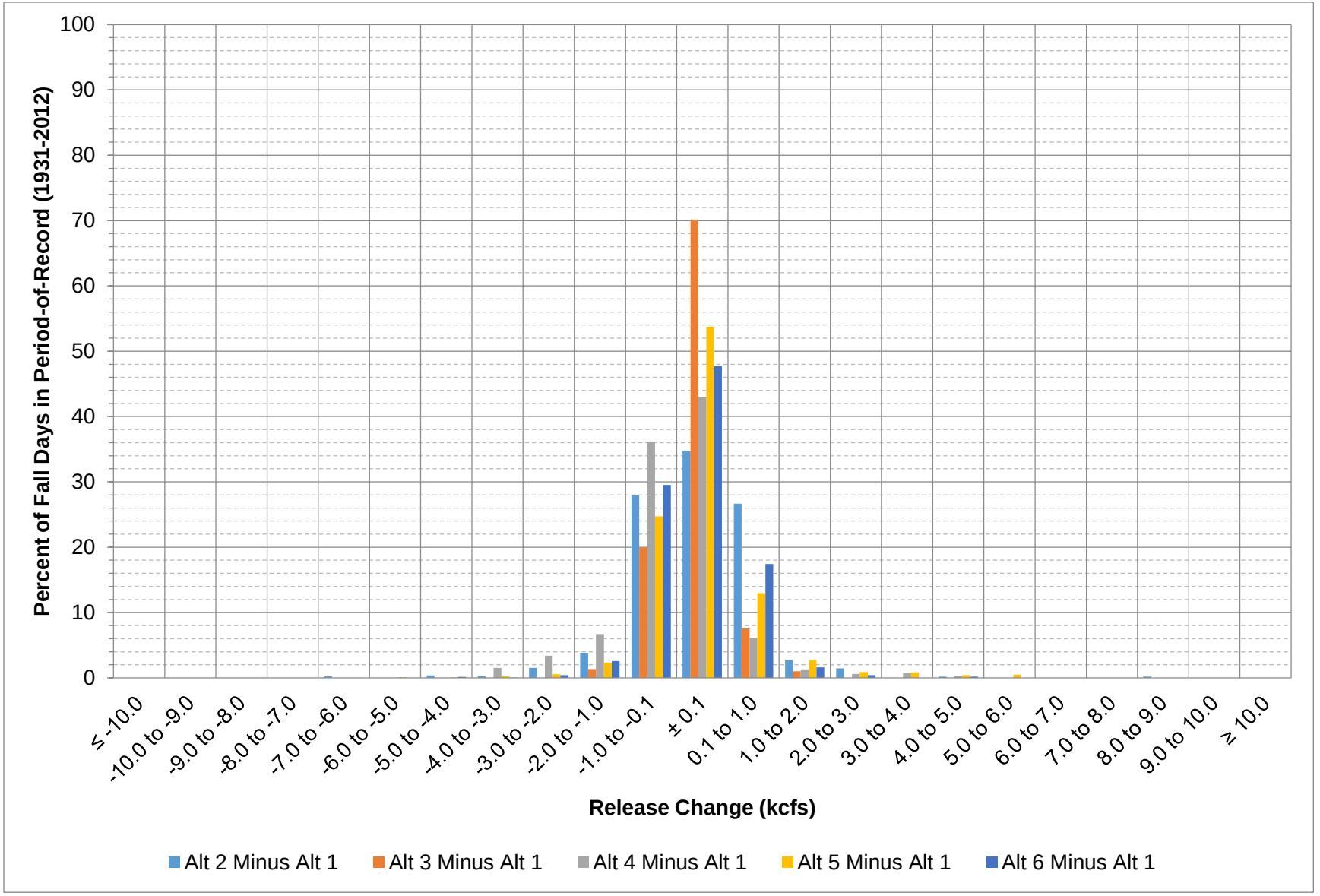

Figure 4-11: Fort Peck release change between each alternative and Alt 1 during September – November.

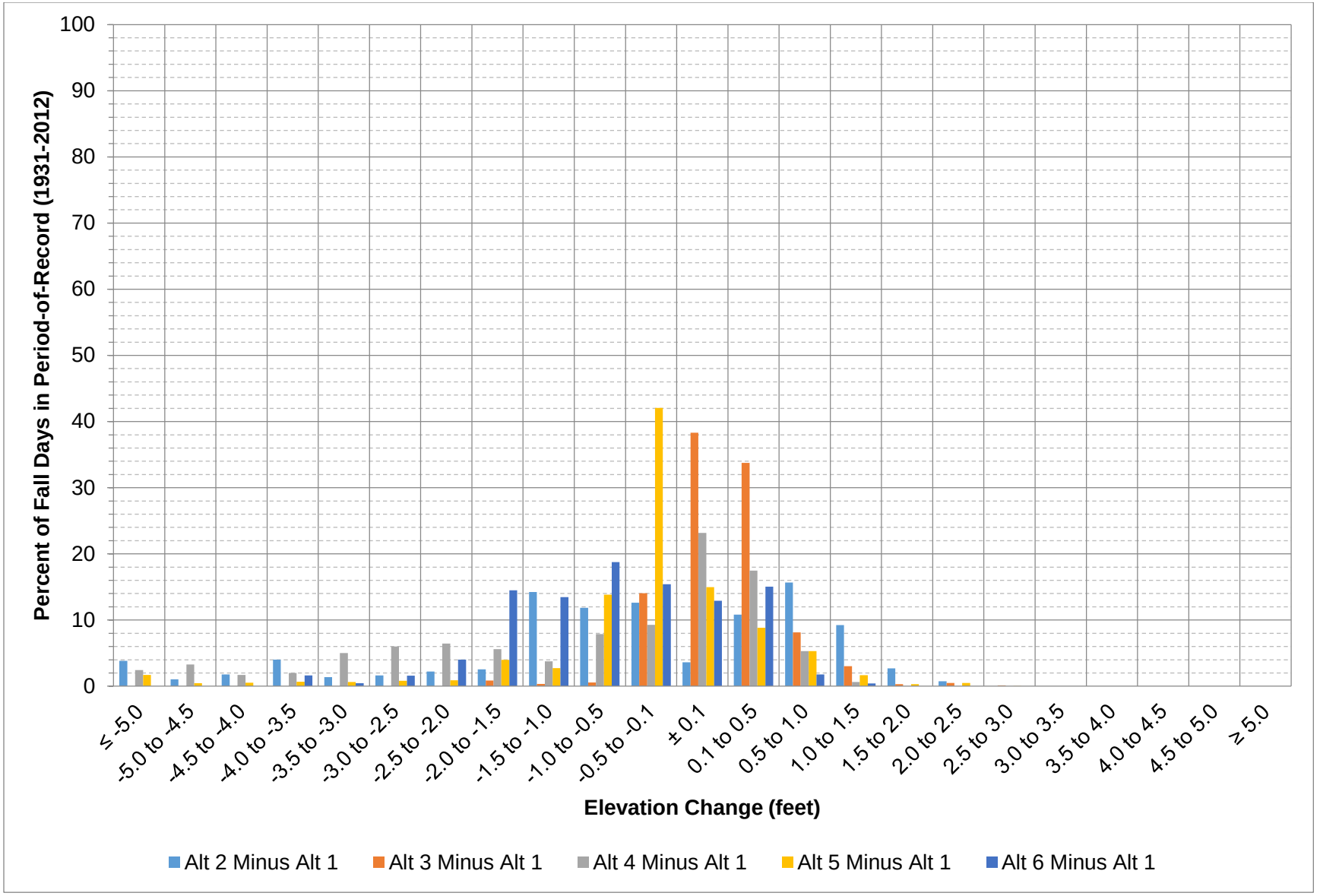

Figure 4-12: Garrison elevation change between each alternative and Alt 1 during September – November.

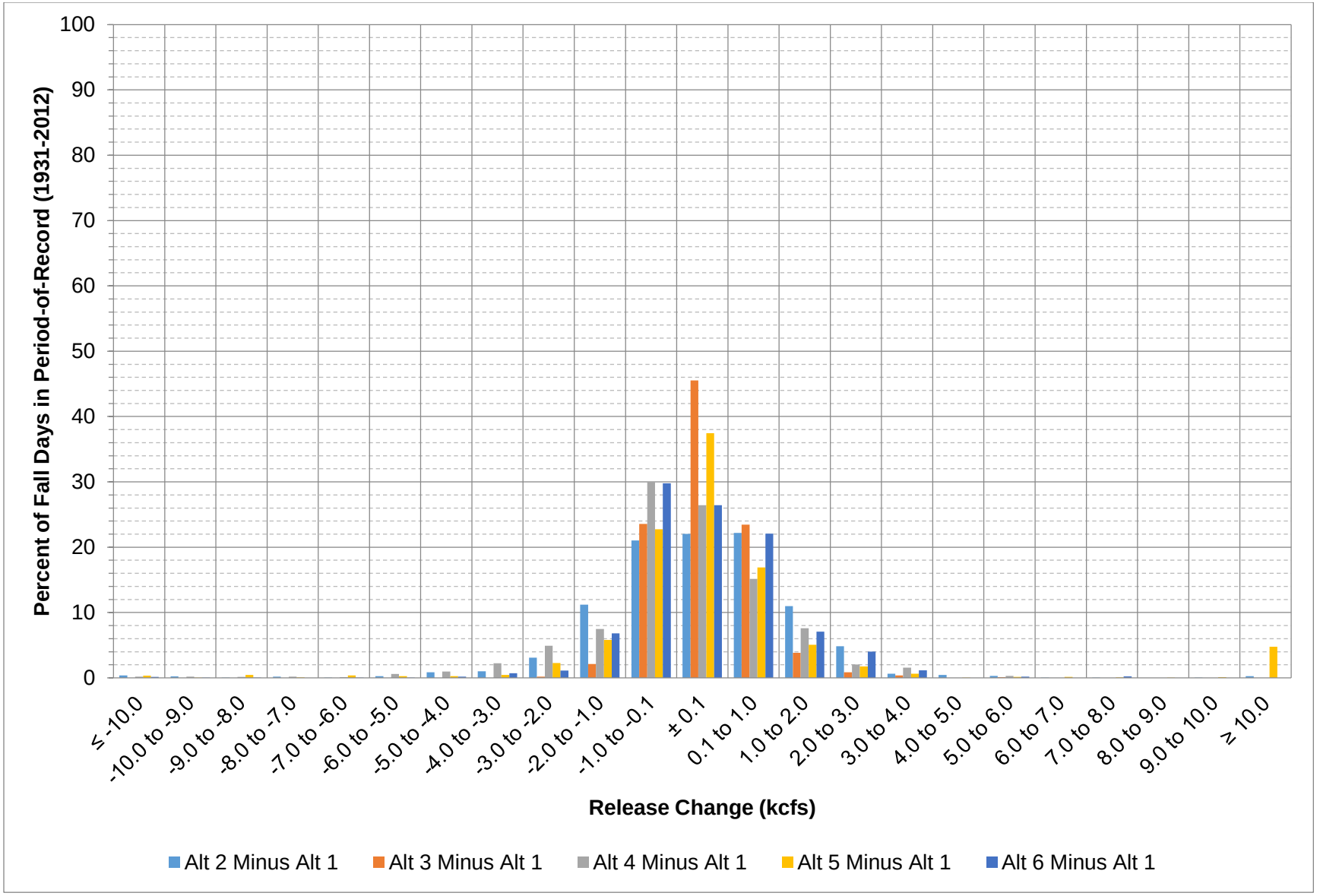

Figure 4-13: Garrison release change between each alternative and Alt 1 during September – November.

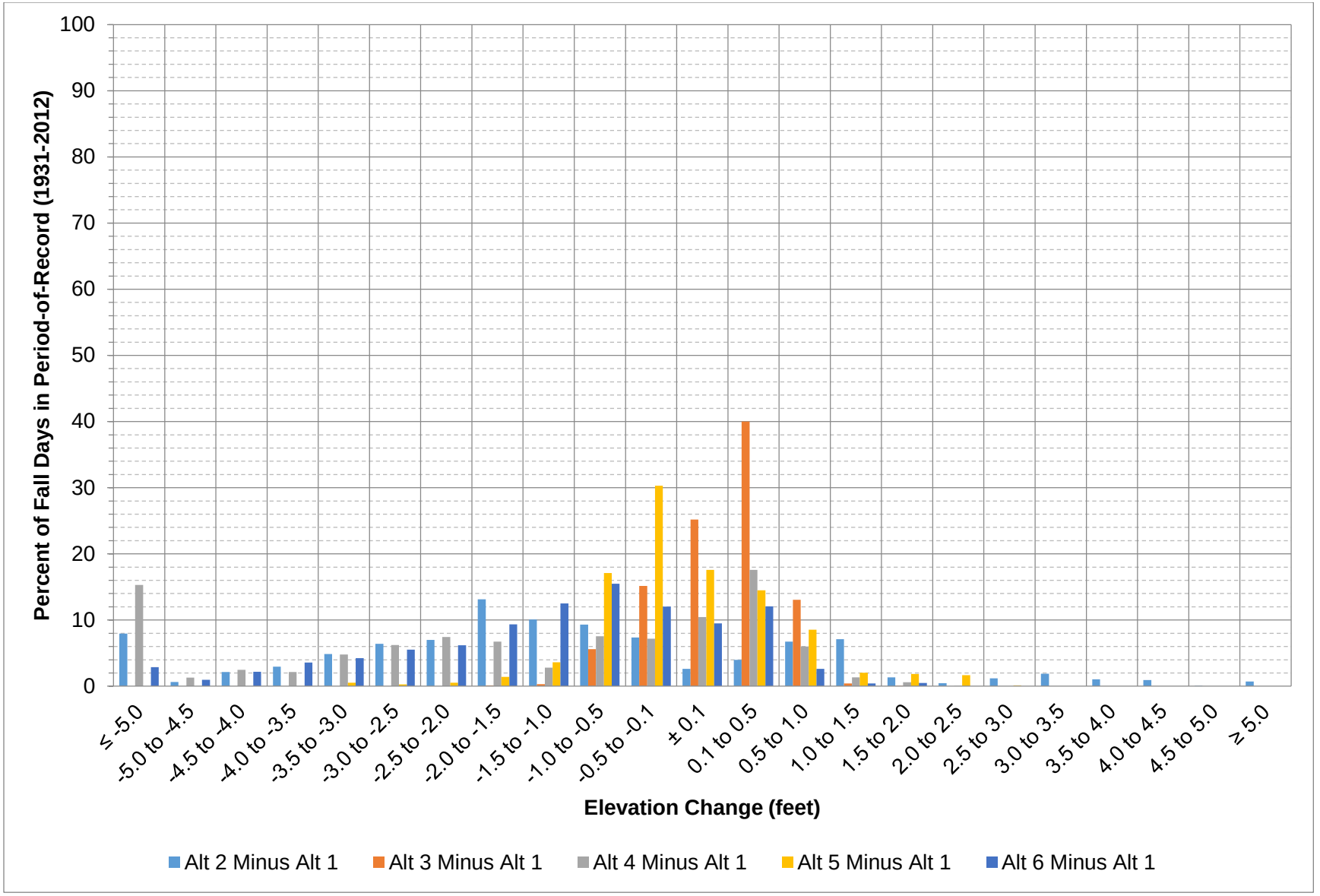

Figure 4-14: Oahe elevation change between each alternative and Alt 1 during September – November.

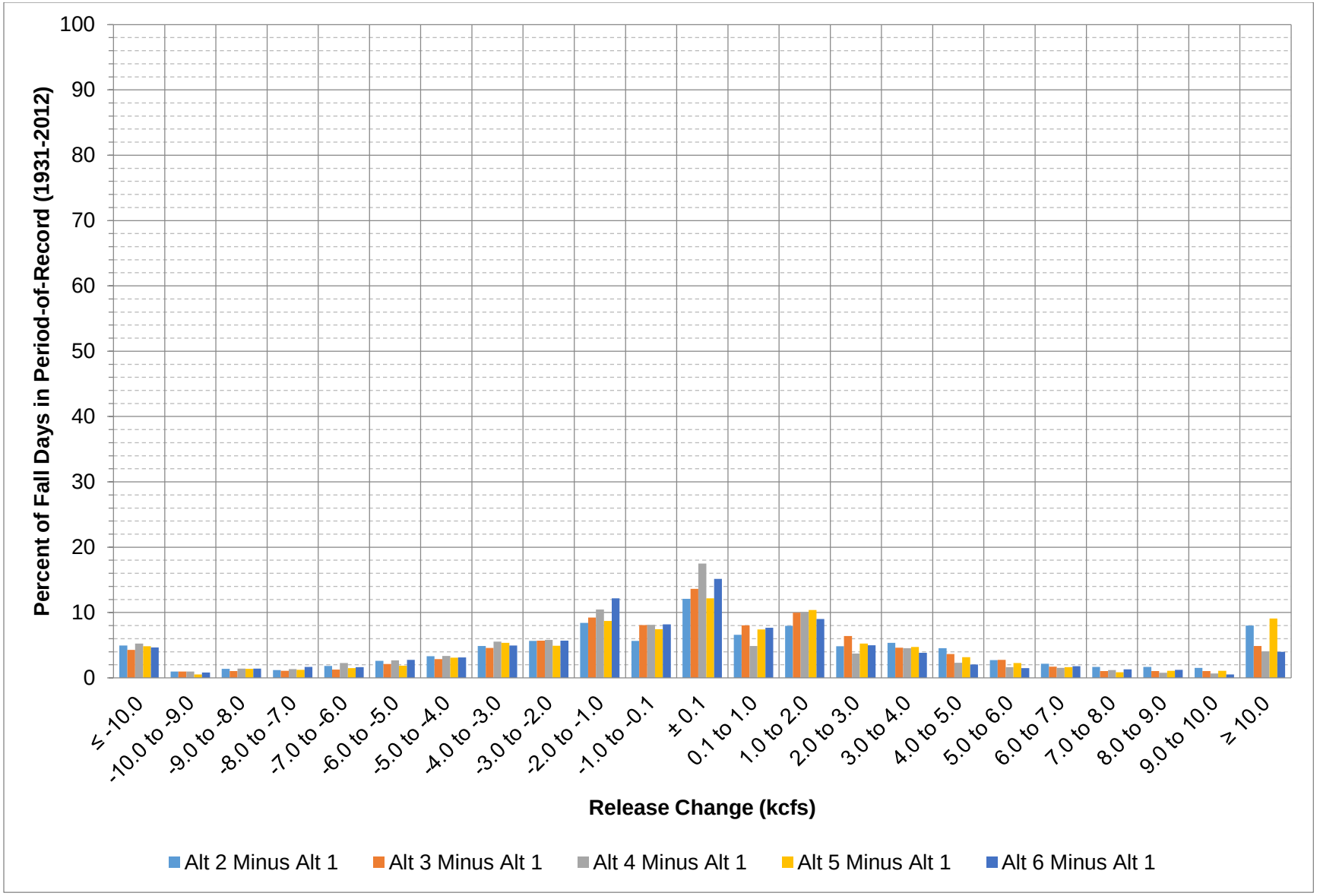

Figure 4-15: Oahe release change between each alternative and Alt 1 during September – November.

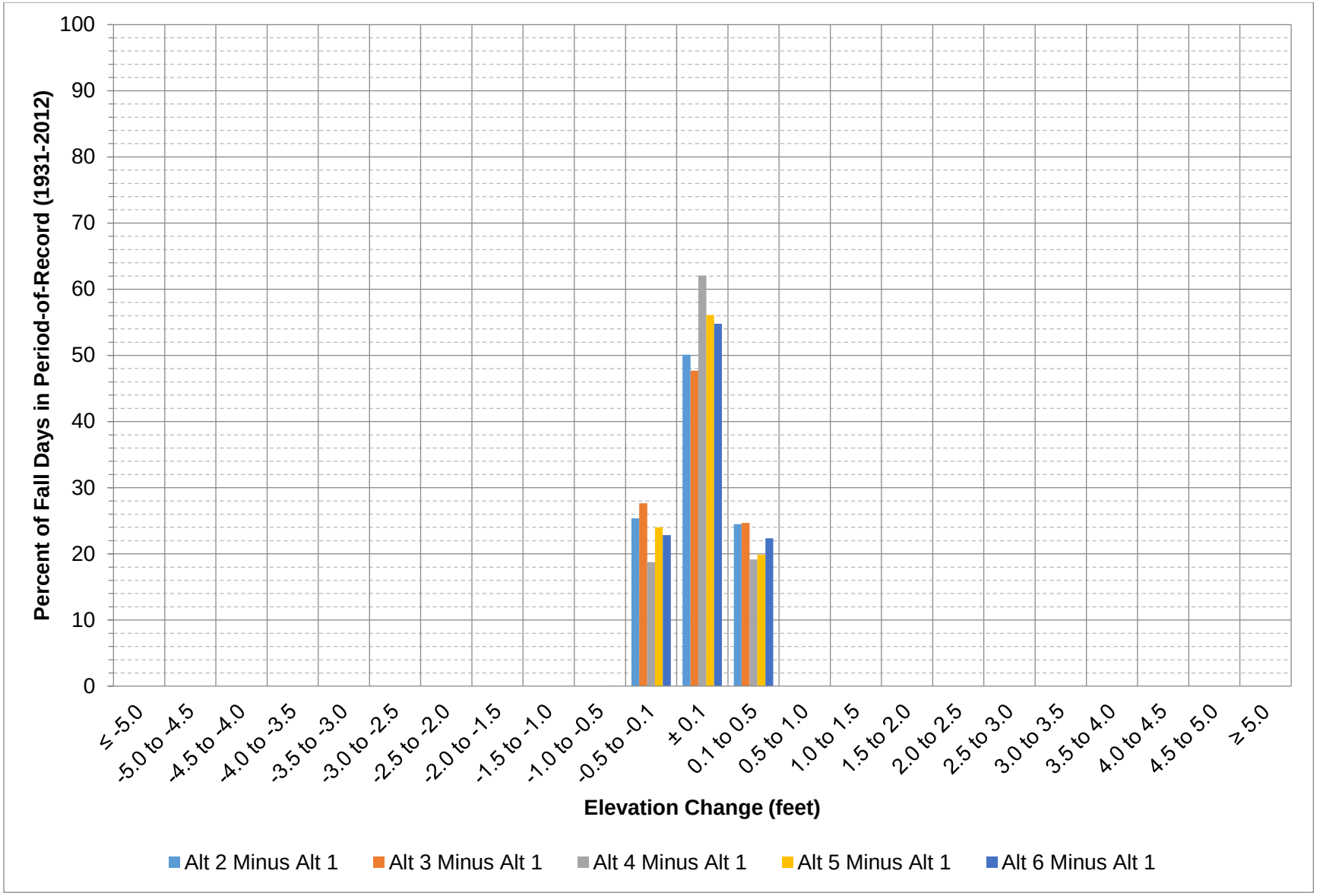

Figure 4-16: Big Bend elevation change between each alternative and Alt 1 during September – November.

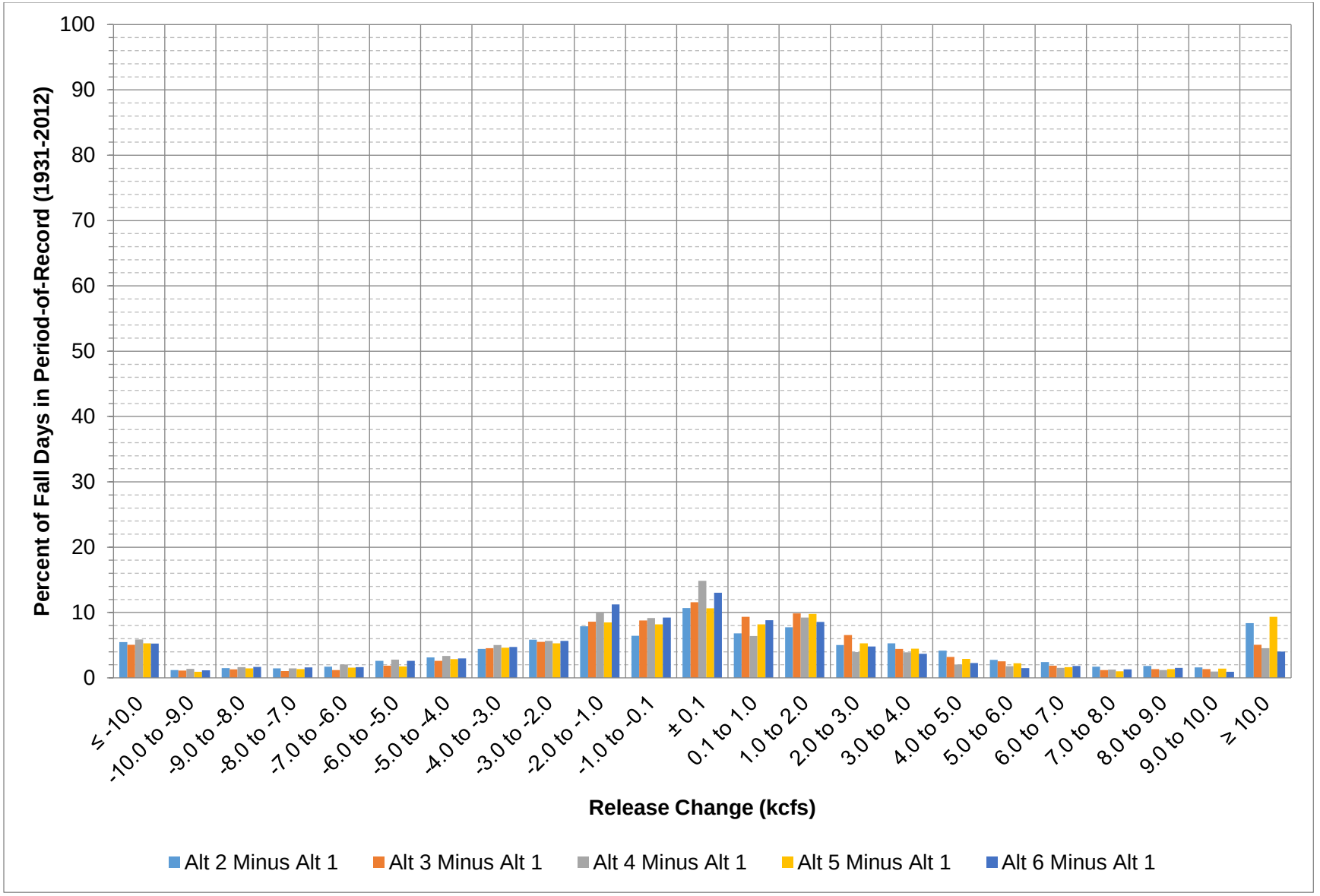

Figure 4-17: Big Bend release change between each alternative and Alt 1 during September – November.

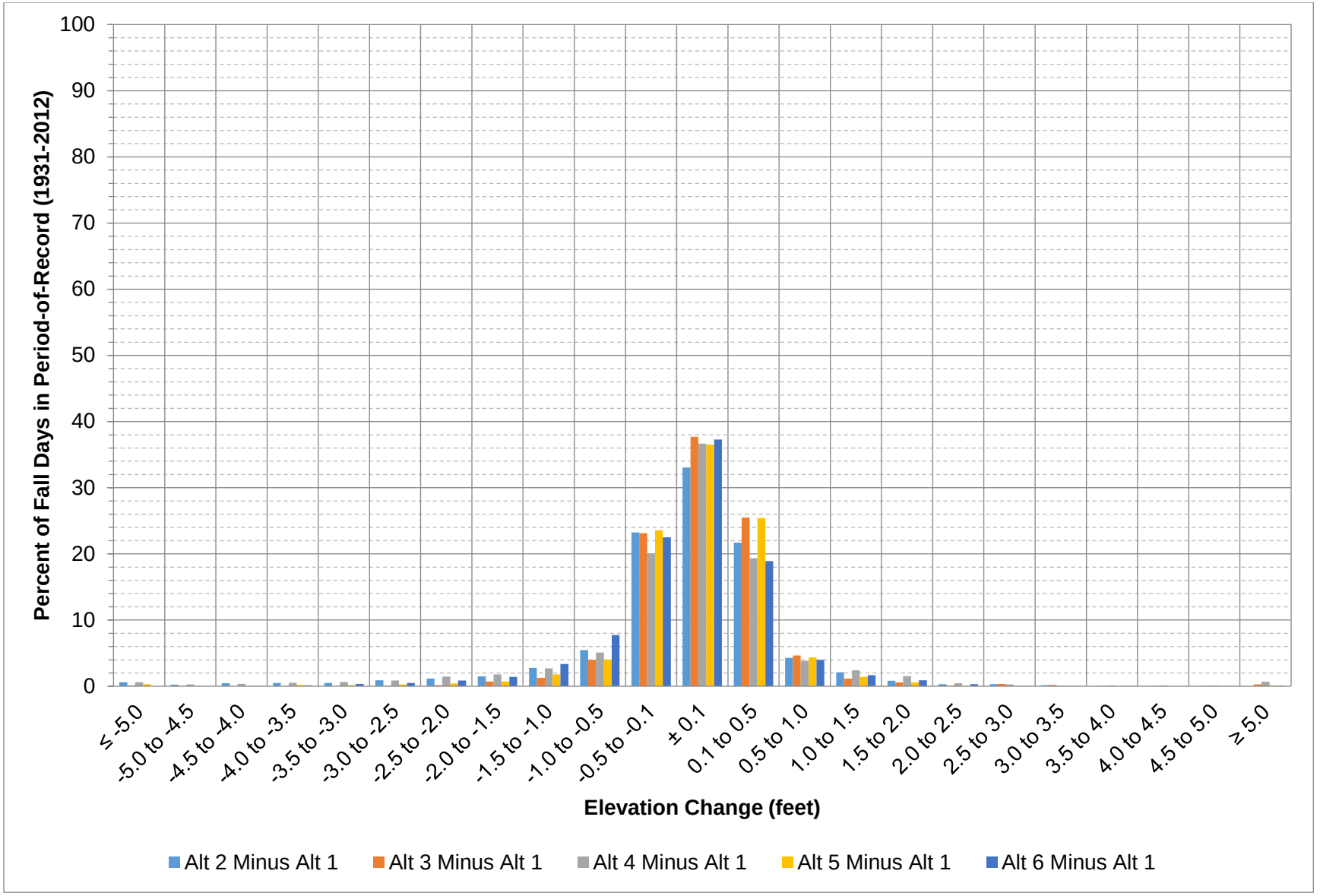

Figure 4-18: Fort Randall elevation change between each alternative and Alt 1 during September – November.

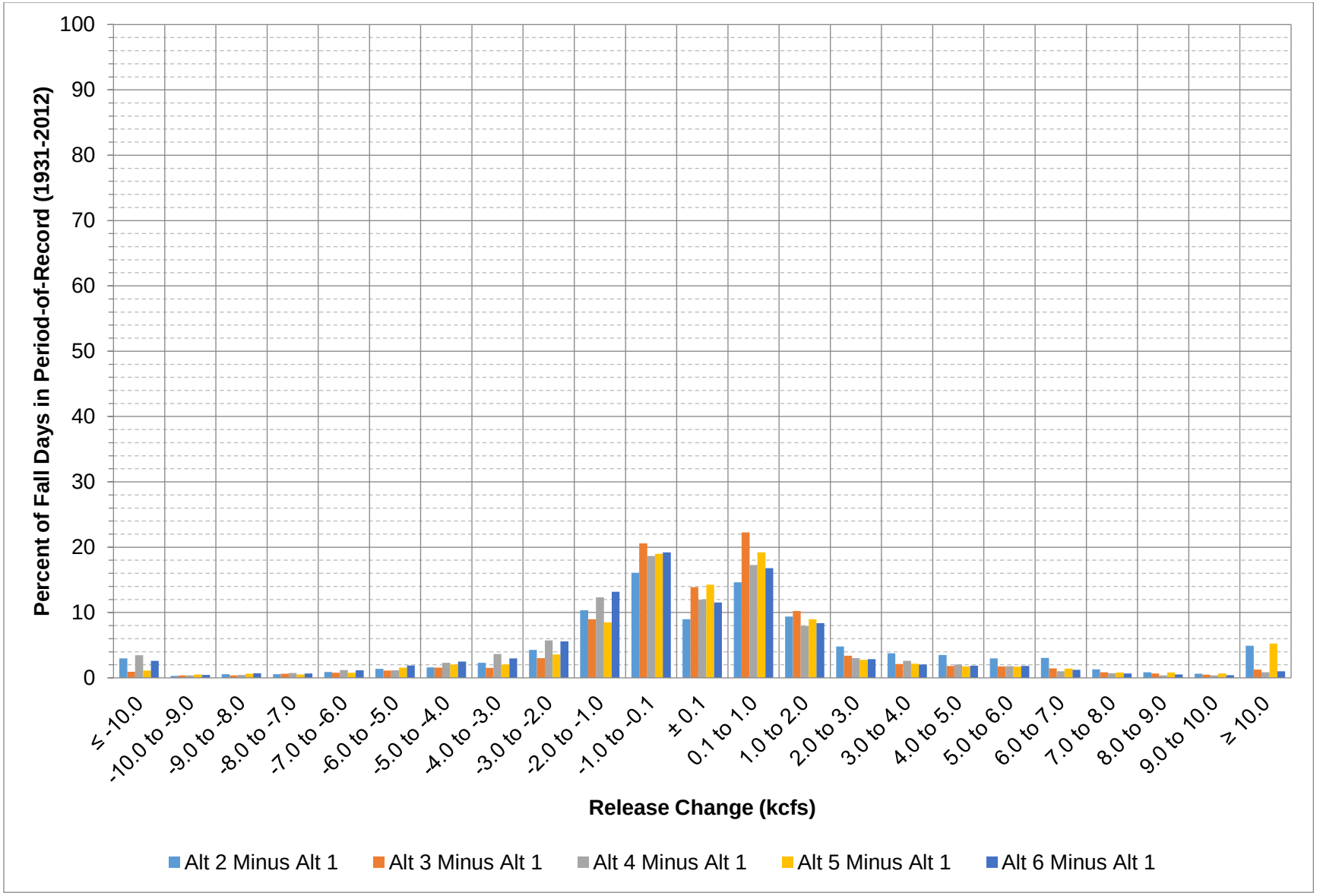

Figure 4-19: Fort Randall release change between each alternative and Alt 1 during September – November.

5 WINTER: DECEMBER – FEBRUARY

5.1 DOWNSTREAM OF GAVINS POINT

5.1.1 Alternative 1 – No Action

Operations shift to winter releases beginning on December 1 or December 10 if there is a ten day extension to the navigation season. Gavins Point releases a minimum equal to the winter release computed on September 1 using System storage. If there is flood storage that still needs to be evacuated, a higher winter release can occur. Table 5-1 shows the high winter release criteria used in ResSim. Between December 1 and March 21, if System storage is greater than or equal to 62.0 MAF, Gavins Point winter release is increased to 27.0 kcfs to evacuate the remainder of the flood storage prior to the beginning of the next runoff season. Gavins Point winter release is linearly interpolated between 25.0 and 27.0 kcfs if System storage is between 56.5 and 62.0 MAF. Gavins Point winter release is linearly interpolated between 20.0 and 25.0 kcfs if System storage is between 56.1 and 56.5 MAF. The high winter release is allowed to continue through the spring water supply operations if needed. If the System storage falls below 56.1 MAF while operating for a high winter release, Gavins Point's release is reduced to 17.0 kcfs, which is the normal winter release. Figure 5-1 shows an example of high winter releases from Gavins Point Dam which occur after a ten day extension. System operations also support water supply during winter months. The ResSim model ensures that a minimum flow of 12.0 kcfs is observed at Sioux City, Omaha, and Kansas City by increasing Gavins Point releases as needed. Figure 5-2 shows an example of ResSim increasing releases on December 13 when Omaha's flow is forecasted to fall below 12.0 kcfs.

Table 5-1: High winter release criteria.

Date	System Storage (MAF)	Gavins Point Release (kcfs)
01Dec – 21Mar	56.1	20.0
	56.5	25.0
	62.0	27.0

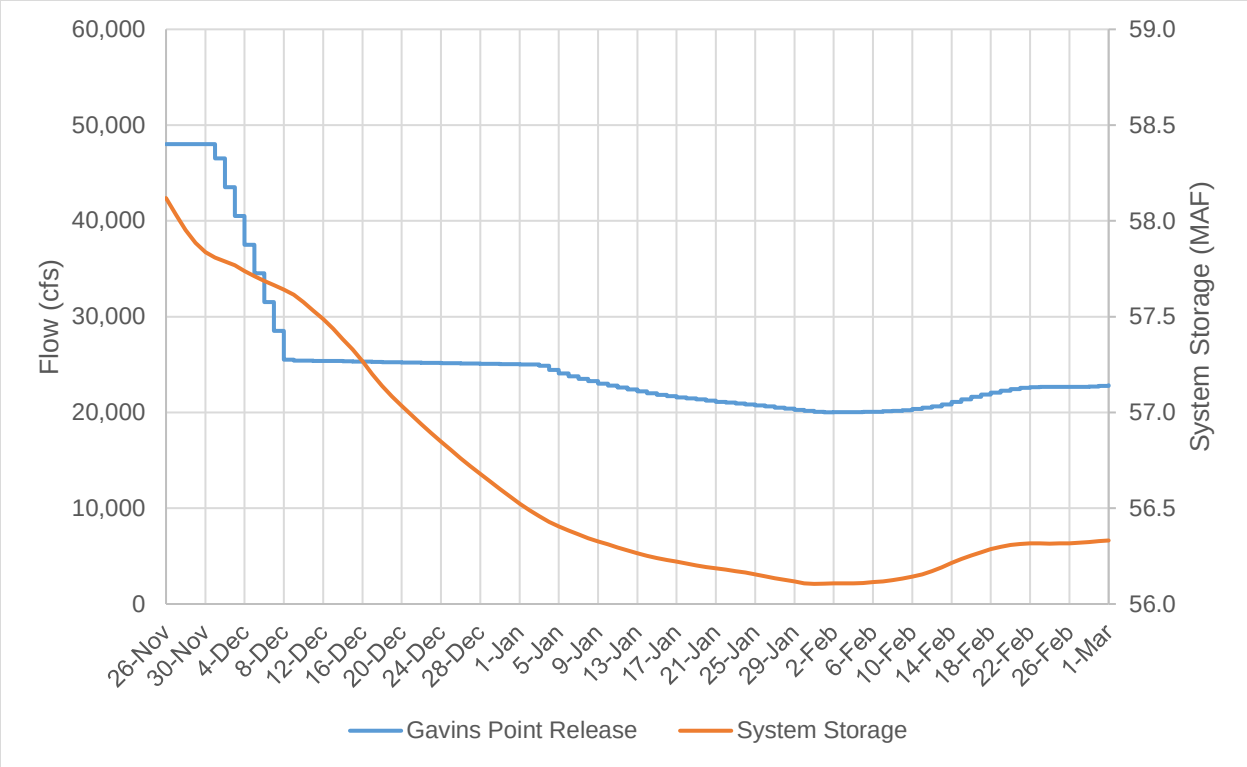

Figure 5-1: High winter releases from Gavins Point Dam.

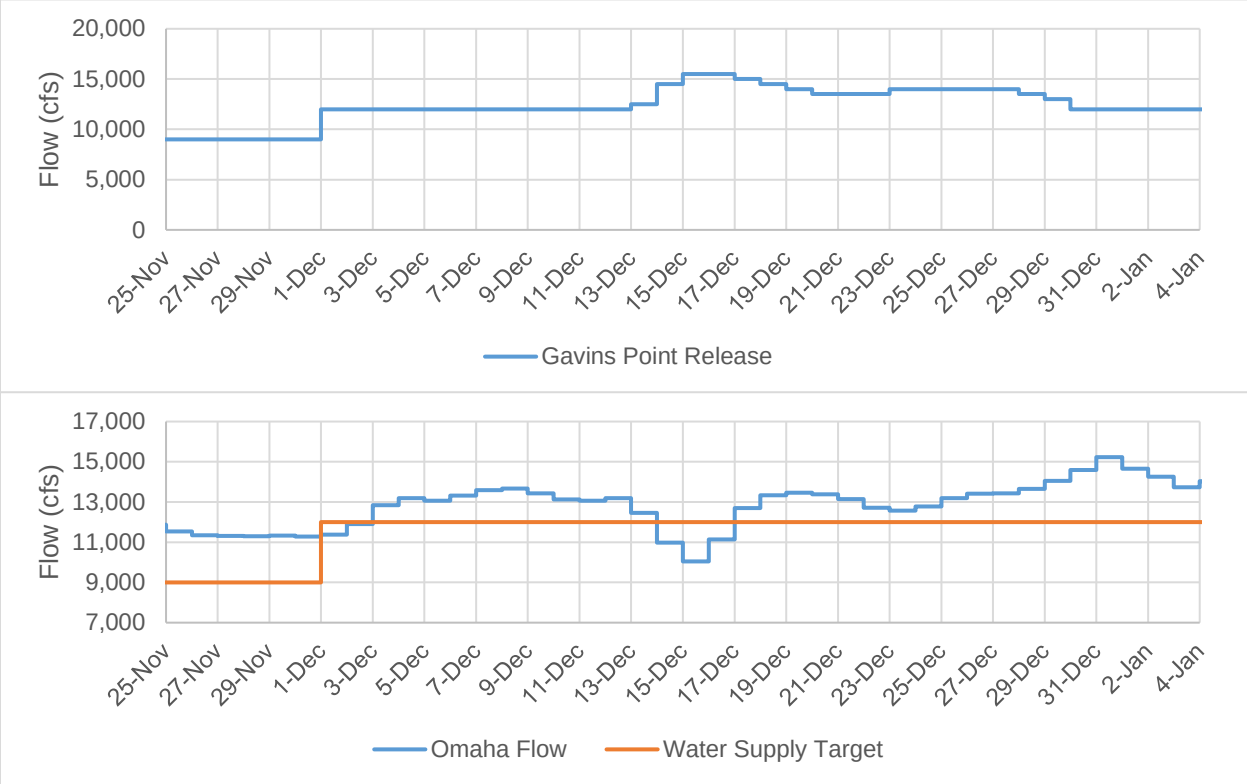

Figure 5-2: Low winter releases from Gavins Point Dam.

5.1.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

As stated in Section 4.1.2, Gavins Point's winter release is altered from the winter release in Alt 1. Gavins Point's winter release is 17.0 kcfs when System storage is 58.0 MAF or more on September 1 with the flexibility to be increased to 25.0 kcfs if there is still flood control storage that needs to be evacuated by the start of next year's runoff season. Gavins Point's winter release does not have that flexibility in Alt 2; Alt 1's criteria for setting the winter release is still used, but if the computed winter release is greater than 16.0 kcfs, the computed winter release is superseded and set to 16.0 kcfs. Figure 5-3 compares the winter releases for Alt 1 and Alt 2 during a flood evacuation winter period and Figure 5-4 compares the winter releases for Alt 1 and Alt 2 during a normal winter period.

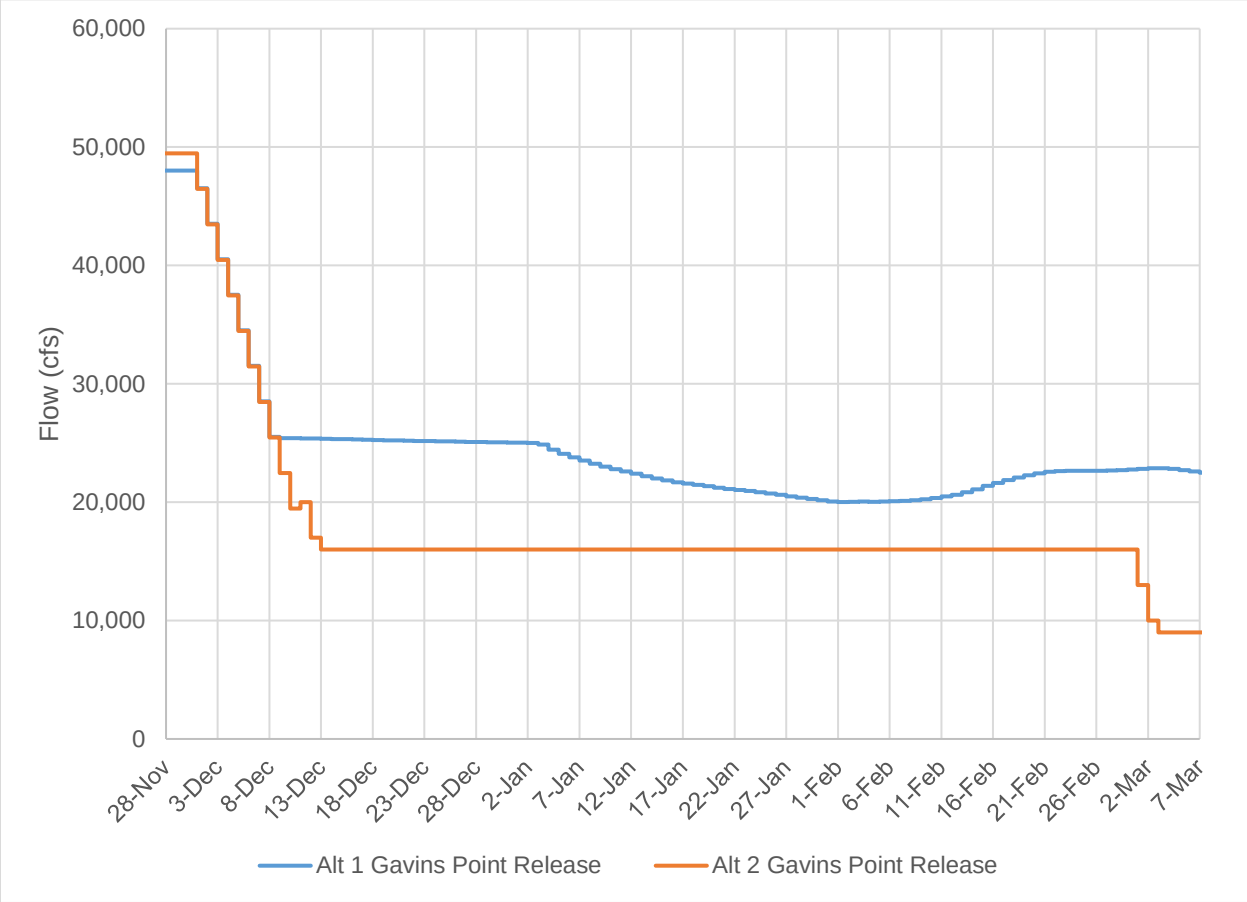

Figure 5-3: Alt 2's vs Alt 1's winter release during a flood evacuation winter.

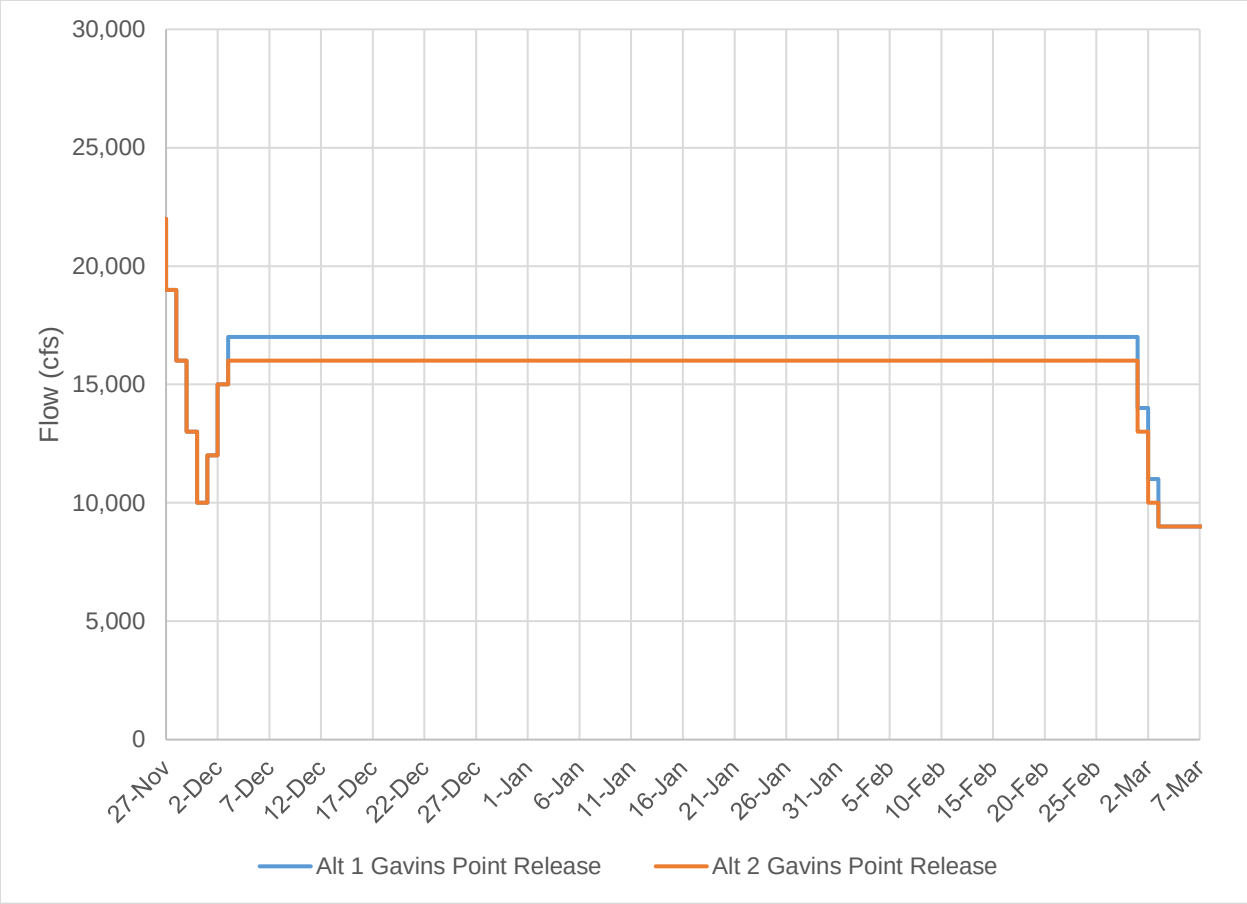

Figure 5-4: Alt 2's vs Alt 1's winter release during a normal winter.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 2. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 5-5 shows the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of winter days (December – February) during the period-of-record.

As a result of the operational changes, Gavins Point's releases are changed throughout the period-of-record. Alt 2 changes in releases shown in Figure 5-6 show a trend of lower winter releases under Alt 2 than Alt 1 as a result a lower maximum winter release. The percentage of winter months falling within the -10.0 kcfs to -9.0 kcfs range are of particular importance because those releases occur during years when winter releases would normally have been used to evacuate the remaining flood storage, but are maximized at 16.0 kcfs per Alt 2 specifications.

5.1.3 Alternative 3 – Mechanical Construction Only

Water supply and navigation requirements remain unchanged from Alt 1 operations during December – February. Gavins Point releases a minimum of 12.0 kcfs and ensures that a minimum flow of 12.0 kcfs is observed at the three target locations for water supply. Any release

changes that are observed are due to the changes in operations described in Sections 2.1.3 and 3.1.3.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 3. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 5-5 shows the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of winter days (December – February) during the period-of-record.

As a result of the removing Alt 1's early and late spring spawning cue, Gavins Point's winter releases are relatively unchanged throughout the period-of-record. Even though System storage is slightly increased when the spawning cues are removed from the operations winter releases are not significantly affected by the storage increase. Figure 5-6 shows the changes in Gavins Point's releases for each alternative compared to Alt 1 as a percentage of winter days (December – February) during the period-of-record.

5.1.4 Alternative 4 – Spring Habitat-Forming Flow Release

Water supply and navigation requirements remain unchanged from Alt 1 operations during December – February. Gavins Point releases a minimum of 12.0 kcfs and ensures that a minimum flow of 12.0 kcfs is observed at the three target locations for water supply. Any release changes that are observed are due to the changes in operations described in Sections 2.1.4, 3.1.4, and 3.2.4.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 4. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 5-5 show the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of winter days (December – February) during the period-of-record.

As a result of Alt 4's ESH-creating release, Gavins Point's releases are changed throughout the period-of-record. Winter releases show a slight trend of lower releases in Alt 4 than in Alt 1. This is attributed to Alt 4's ESH-creating release lower System storage, which is used to set the winter release each year. Figure 4-6 shows the changes in Gavins Point's releases for each alternative compared to Alt 1 as a percentage of winter days (December – February) during the period-of-record.

5.1.5 Alternative 5 – Fall Habitat-Forming Flow Release

Water supply and navigation requirements remain unchanged from Alt 1 operations during December – February. Gavins Point releases a minimum of 12.0 kcfs and ensures that a minimum flow of 12.0 kcfs is observed at the three target locations for water supply. Any changes that are observed are due to the changes in operations described in Sections 2.1.5, 3.1.5, and 4.1.5.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 5. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 5-5 shows the changes in Gavins Point's pool elevation compared to Alt 1 as a percentage of winter days (December – February) during the period-of-record.

The change in releases shown in Figure 5-6 can be a direct and a lagged effect of the fall ESH-creating release. Since the fall ESH-creating release occurs after the winter release has been set, the winter release in the current year is not affected by the reduction in System storage. However, the following year's winter release could be affected as next year's runoff season begins with a lower System storage. The ESH-creating release could cause a direct effect on winter releases during years when flood storage is still being evacuated. When this occurs, running the ESH-creating release reduces the level of winter releases needed to evacuate all of the flood storage prior to the start of the next runoff season.

5.1.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Water supply and navigation requirements remain unchanged from Alt 1 operations during December – February. Gavins Point releases a minimum of 12.0 kcfs and ensures that a minimum flow of 12.0 kcfs is observed at the three target locations for water supply. Any changes that are observed are due to the changes in operations described in Sections 2.1.6 and 3.1.6.

Figure 5-6 shows little change between releases in Alt 6 compared to Alt 1. During low System storage years when the winter release is set to 12.0 kcfs, which comprises forty six of the eighty two year period-of-record, releases cannot be affected by a reduction in System storage since 12.0 kcfs is the minimum release during the winter. Any reduction in System storage prior to September 1 when the winter release is set, will still result in a winter release of 12.0 kcfs. The lower releases shown in Figure 5-6 represent the few years with a winter release greater than 12.0 kcfs coinciding with early and late spring spawning cues that utilize enough storage to affect the winter release.

Changes in pool elevation are a result of the ResSim model's inability to perfectly calculate the correct Fort Randall release to keep Gavins Point at its guide curve elevation and are not due to operational changes in Alt 6. Typically Gavins Point's elevation will not significantly vary between alternatives. Figure 5-5 show the changes in Gavins Point's pool elevation for each alternative compared to Alt 1 as a percentage of winter days (December – February) during the period-of-record.

5.1.7 Elevation and Release Changes at Gavins Point during Winter Months for Alternative 1 – 6

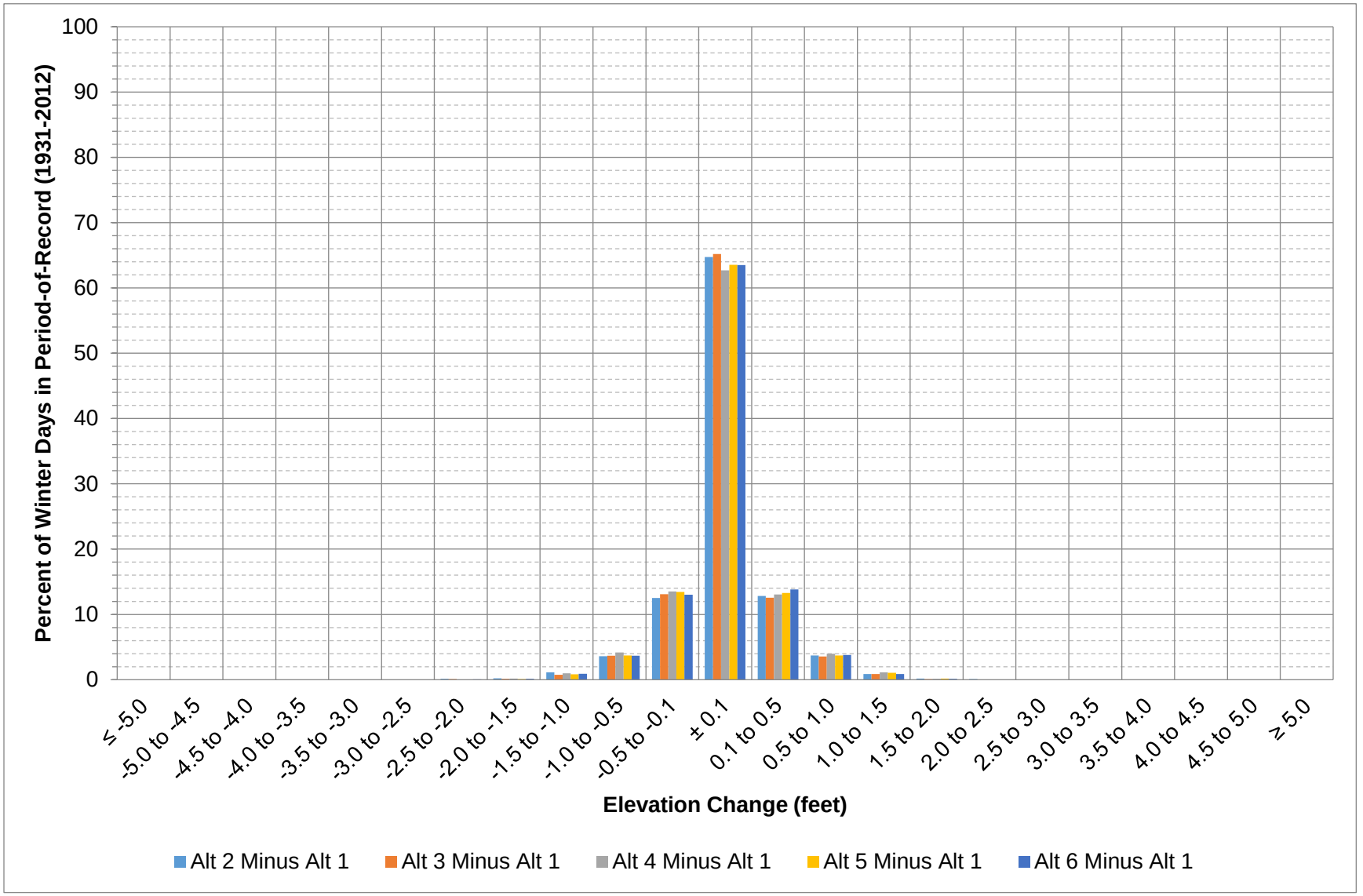

Figure 5-5: Gavins Point elevation change between each alternative and Alt 1 during December – February.

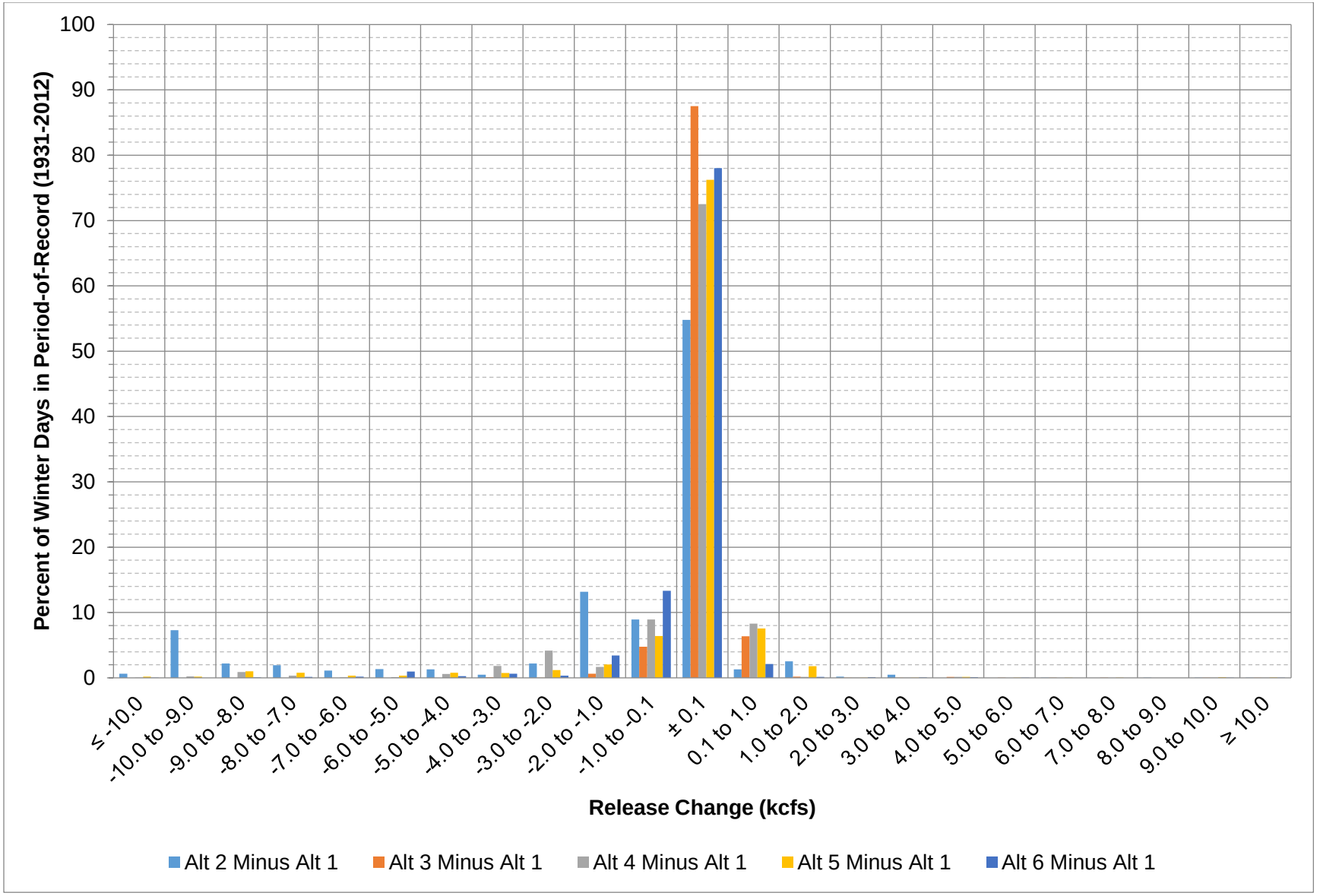

Figure 5-6: Gavins Point release change between each alternative and Alt 1 during December – February.

5.2 UPSTREAM OF GAVINS POINT

5.2.1 Alternative 1 – No Action

Fort Peck and Garrison still release water based on the forecasted System storage as the model attempts to balance Fort Peck's, Garrison's, and Oahe's amount of occupied Carryover Multiple Use Zones prior to the start of next year's runoff.

After setting releases at Fort Peck and Garrison, minimum flows at Wolf Point, Culbertson, and Bismarck are checked. Releases from Fort Peck are increased to ensure a minimum flow of 5.0 kcfs is forecasted at Wolf Point and Culbertson between December 1 and February 28. Releases from Garrison are increased to ensure a minimum flow of 12.0 kcfs is forecasted at Bismarck between December 1 and February 28.

Guide curve operations continue at Big Bend, Fort Randall, and Gavins Point. Fort Randall continues to refill to elevation 1350.0 feet (NGVD 29) by March 1. Gavins Point is lowered from 1207.0 feet (NGVD 29) starting on January 1 to 1206.0 feet (NGVD 29) by February 1.

5.2.2 Alternative 2 – U.S. Fish and Wildlife Service 2003 Biological Opinion Projected Actions

Upstream operations in Alt 2 do not change compared to Alt 1 December – February. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to their reservoirs at their respective guide curve elevations. The observed changes that are shown in Figure 5-7 through Figure 5-16 are attributed to changes described in Sections 2.1.2, 3.1.2, 4.1.2, and 5.1.2.

Figure 5-7, Figure 5-9, and Figure 5-11 show a mixture of higher and lower elevations at Fort Peck, Garrison, and Oahe, respectively, under Alt 2 as compared to Alt 1, although the lower extremes are more prevalent than the higher extremes. As water is conserved due to the low summer flow operations and lower winter releases, pool elevations at Fort Peck, Garrison, and Oahe increase causing a portion of the period-of-record to show higher elevations during the winter. However, the spawning cue operations lower reservoir elevations and utilizes more water than the low summer flow and winter release operations conserves. This results in more of the winter months in the period-of-record having lower pool elevations at those three reservoirs when compared to Alt 1. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 5-13 and Figure 5-15 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Figure 5-8 and Figure 5-10 show moderate changes to Fort Peck's and Garrison's releases as the reservoirs attempt to balance System storage with a lower than normal winter release. These changes can be lower or higher than Alt 1 depending on the year and the levels of Fort Peck, Garrison, and Oahe. Although there are moderate release changes, most of the winter releases still fall between ±1.0 kcfs. Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 5-12, Figure 5-14, and Figure 5-16, respectively, have evenly distributed changes. Some of the < -10.0 kcfs changes observed at all three locations are attributed to lower winter releases

in Alt 2. Since Oahe's releases are highly variable regardless of those operations as water is released to keep Big Bend, Fort Randall, and Gavins Point at their respective guide curves, comparing Alt 2's changes to Alt 3's changes gives an estimate of how much of the changes are a direct result of lower winter releases in Alt 2.

5.2.3 Alternative 3 – Mechanical Construction Only

Upstream operations in Alt 3 do not change compared to Alt 1 during December – February. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep the lower three reservoirs at their respective guide curve elevations. The observed changes that are shown in Figure 5-7 through Figure 5-16 are attributed to changes described in Sections 2.1.3 and 3.1.3.

Fort Peck's, Garrison's, Oahe's, Big Bend's, and Fort Randall's elevation and release changes compared to Alt 1 are minimal as shown in Figure 5-7 through Figure 5-16. Removing the early and late spring spawning cues from Alt 1 results in higher System storage. However, the increase in System storage does not significantly affect reservoir elevations or releases.

5.2.4 Alternative 4 – Spring Habitat-Forming Flow Release

Upstream operations in Alt 4 do not change compared to Alt 1 during December – February. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep their reservoirs at their respective guide curve elevations. Any observed changes in releases are attributed to changes described in Sections 2.1.4, 3.1.4, and 3.2.4.

Figure 5-7, Figure 5-9, and Figure 5-11 show a trend of lower elevations at Fort Peck, Garrison, and Oahe when Alt 4 is compared to Alt 1 with Oahe having the most extreme elevation change. Alt 4's ESH-creating release lowers Fort Peck's, Garrison's and Oahe's pool elevations as it lowers System storage in the years following the release. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 5-13 and Figure 5-15 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Figure 5-8 shows a slight reduction in Fort Peck's releases and Figure 5-10 shows evenly distributed change in releases at Garrison. When water is used for the ESH-creating release, Fort Peck and Garrison adjust their releases throughout the remainder of the runoff year to balance System storage, but most of the release adjustments occur during the summer and fall months. This is why the winter months do not show significant change in releases. Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 5-12, Figure 5-14, and Figure 5-16, respectively, have evenly distributed changes.

5.2.5 Alternative 5 – Fall Habitat-Forming Flow Release

Upstream operations in Alt 5 do not change compared to Alt 1 December – February. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the

start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep their reservoirs at their respective guide curve elevations. Any observed changes in releases are attributed to changes described in Sections 2.1.5, 3.1.5, and 4.1.5.

Figure 5-7, Figure 5-9, and Figure 5-11 show Fort Peck's, Garrison', and Oahe's elevation changes during the winter months (December – February) over the period-of-record. All three reservoirs show a trend of lower pool elevations when compared to Alt 1. This is caused by the ESH-creating release as it lowers System storage during the fall. Garrison has the most significant reduction in pool elevations as the ESH-creating release directly lowers its reservoir and reduces the impact Gavins Point's ESH-creating release has on Oahe. This is different than in Alt 4, where Oahe had the most significant reduction in pool elevations; in Alt 5, the water from Garrison's ESH-release can be stored in Oahe since Oahe's release during the winter are much lower than during the navigation season. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 5-13 and Figure 5-15 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Fort Peck's winter releases do not show a definitive trend (shown in Figure 5-8), but Garrison's winter releases show a decrease in winter releases when compared to Alt 1 (shown in Figure 5-10). As the fall ESH-creating release lowers Garrison's reservoir, winter releases are reduced to help balance System storage between Fort Peck, Garrison, and Oahe. Oahe's, Big Bend's, and Fort Randall's release changes, shown in Figure 5-12, Figure 5-14, and Figure 5-16, respectively, have evenly distributed changes.

5.2.6 Alternative 6 – Pallid Sturgeon Spawning Cue

Upstream operations in Alt 6 do not change compared to Alt 1 December – February. Fort Peck and Garrison still operate to balance the storage among Fort Peck, Garrison, and Oahe by the start of next year's runoff season while also ensuring water supply requirements are met at Wolf Point, Culbertson, and Bismarck. Oahe, Big Bend, and Fort Randall operate to keep their reservoirs at their respective guide curve elevations. Any observed changes in pool elevations or releases shown in Figure 5-7 through Figure 5-16 are attributed to changes described in Sections 2.1.6 and 3.1.6.

Figure 5-7, Figure 5-9, and Figure 5-11 show a trend of lower elevations at Fort Peck, Garrison, and Oahe when compared to Alt 1 during the winter months. Both of Alt 6's spawning cues lower System storage, which in turn, lowers Fort Peck's, Garrison's, and Oahe's pool elevations. Big Bend and Fort Randall show little elevation change relative to Alt 1, with most of the changes falling between ±0.5 feet, which is attributed to their guide curve operations. Figure 5-13 and Figure 5-15 show Big Bend's and Fort Randall's full range of elevation changes, respectively.

Figure 5-8 and Figure 5-10 show relatively minor release changes for Fort Peck and Garrison, respectively. Since Fort Peck and Garrison operate to balance System storage, their releases only need to slightly change over the course of a year to release large volumes of water needed to balance System storage between Fort Peck, Garrison, and Oahe. Oahe's, Big Bend's, and

Fort Randall's release changes, shown in Figure 5-12, Figure 5-14, and Figure 5-16, respectively, have evenly distributed changes and do not display a trend.

5.2.7 Elevation and Release Changes Upstream of Gavins Point during Winter Months for Alternative 1 – 6

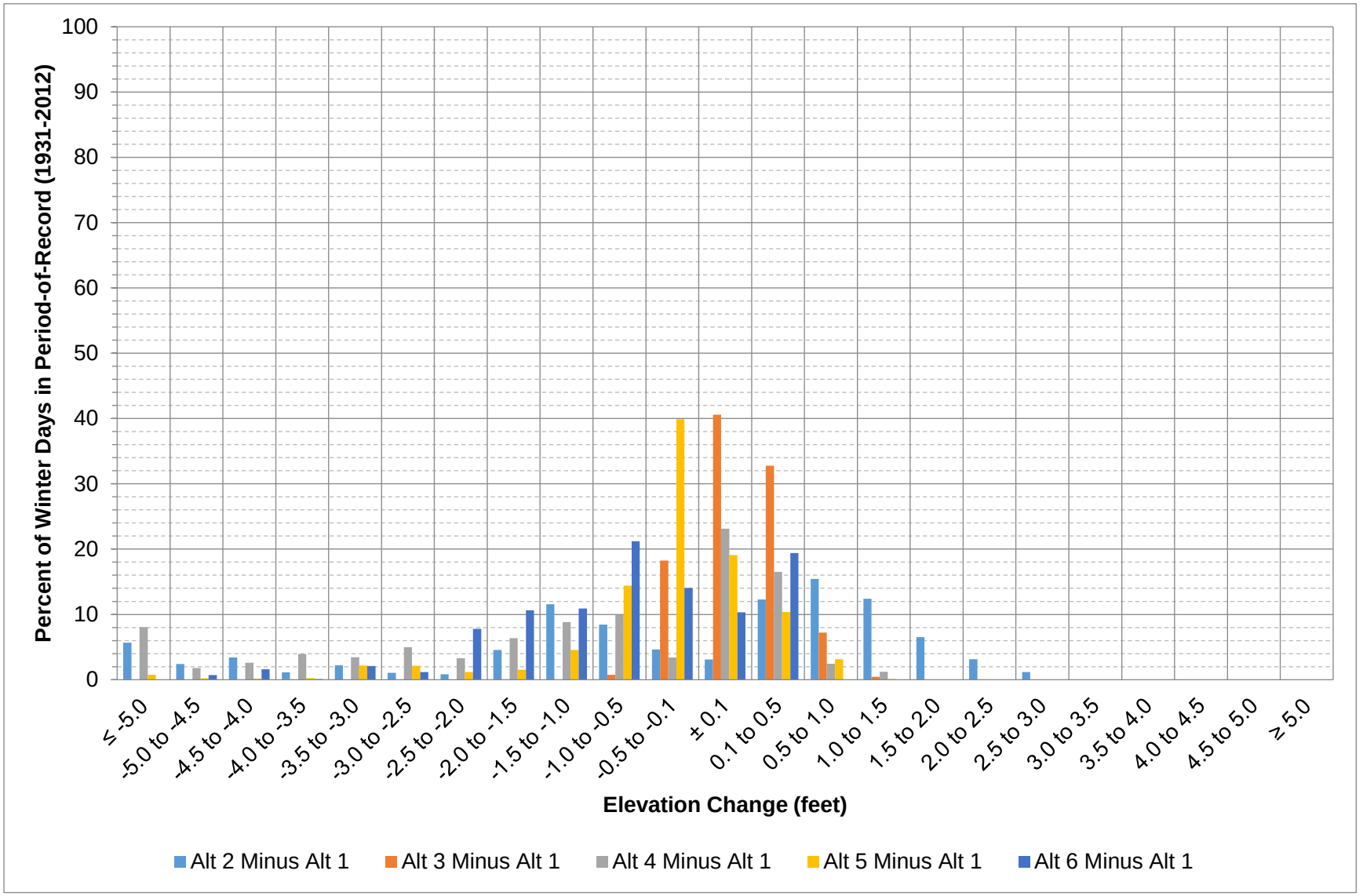

Figure 5-7: Fort Peck elevation change between each alternative and Alt 1 during December – February.

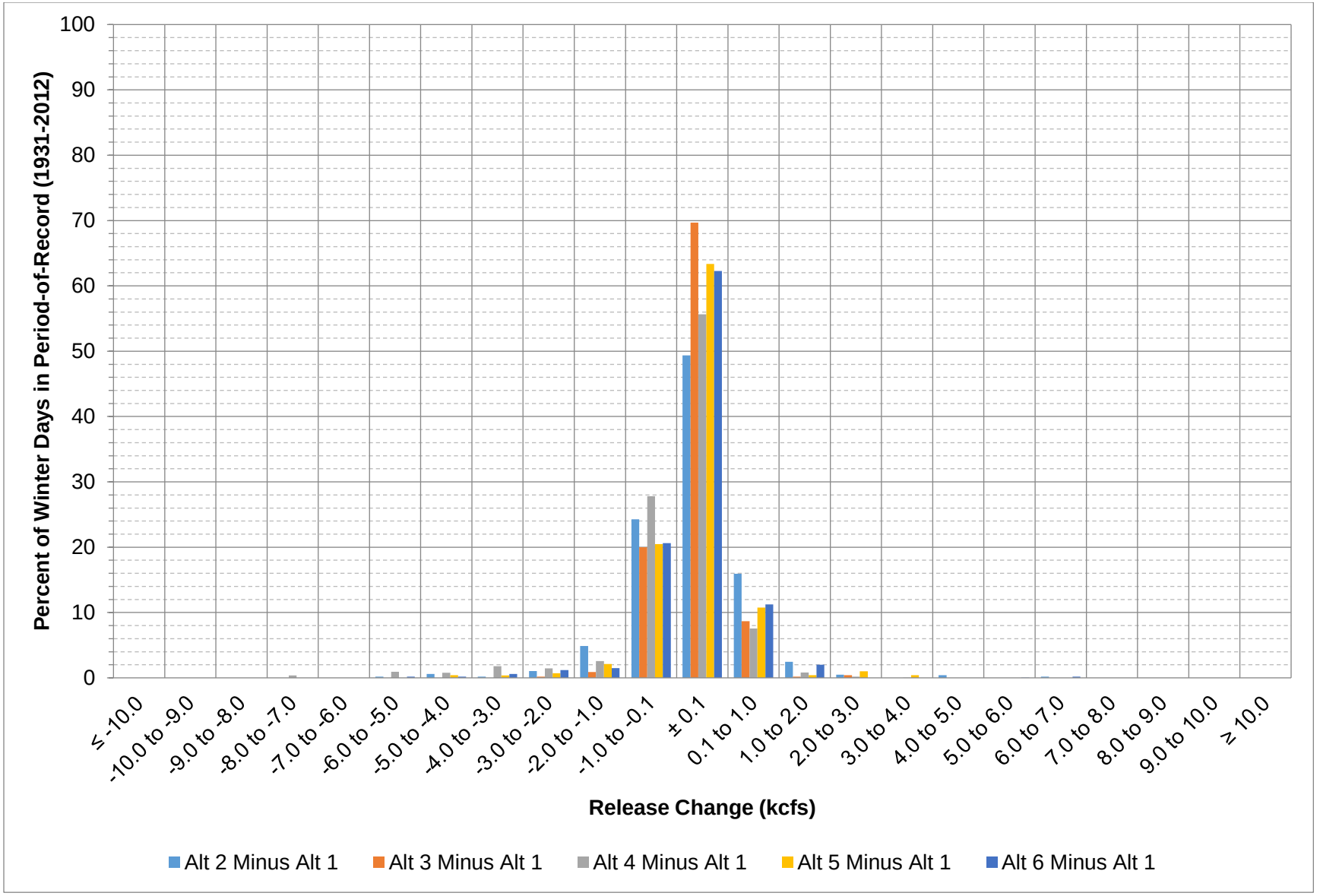

Figure 5-8: Fort Peck release change between each alternative and Alt 1 during December – February.

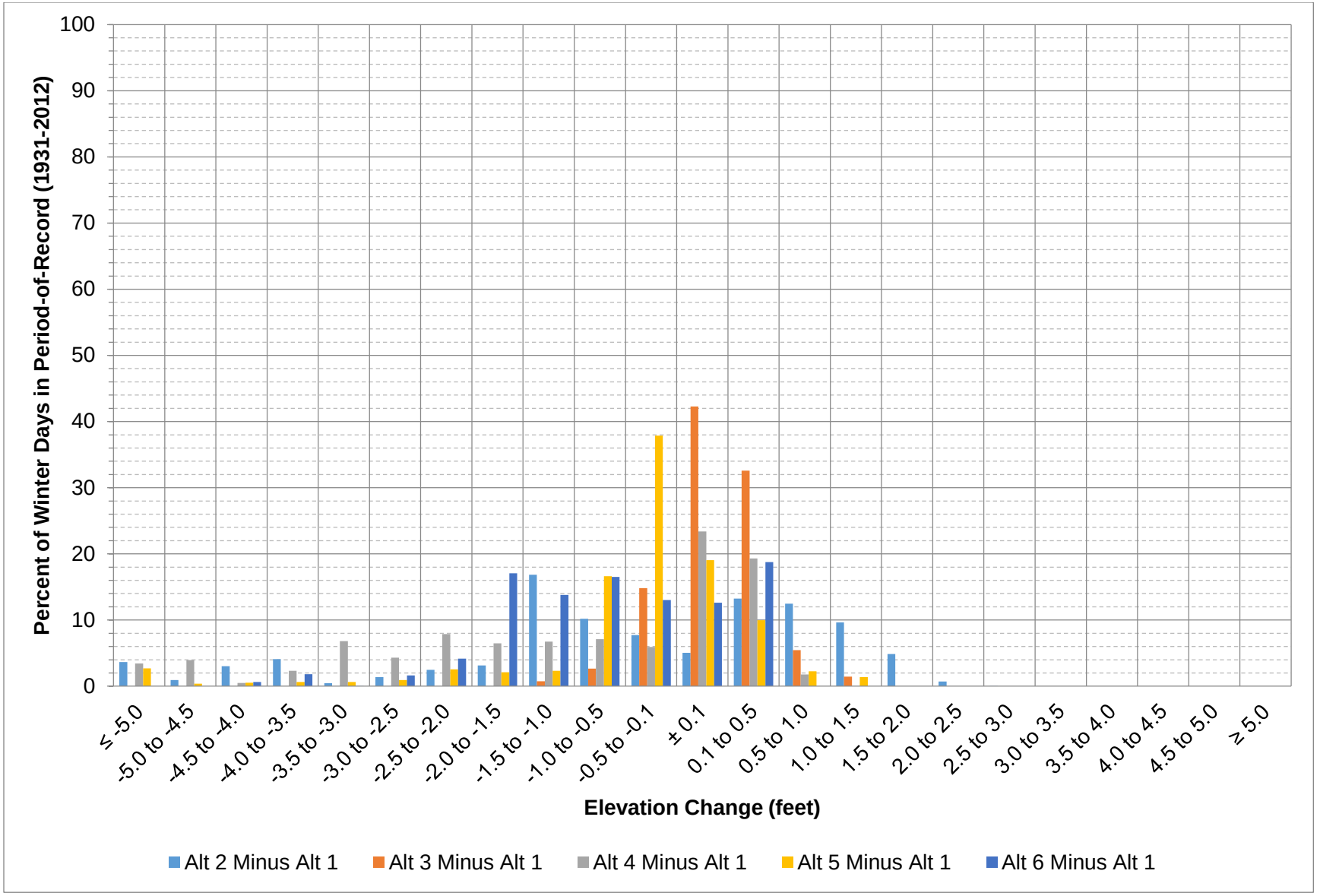

Figure 5-9: Garrison elevation change between each alternative and Alt 1 during December – February.

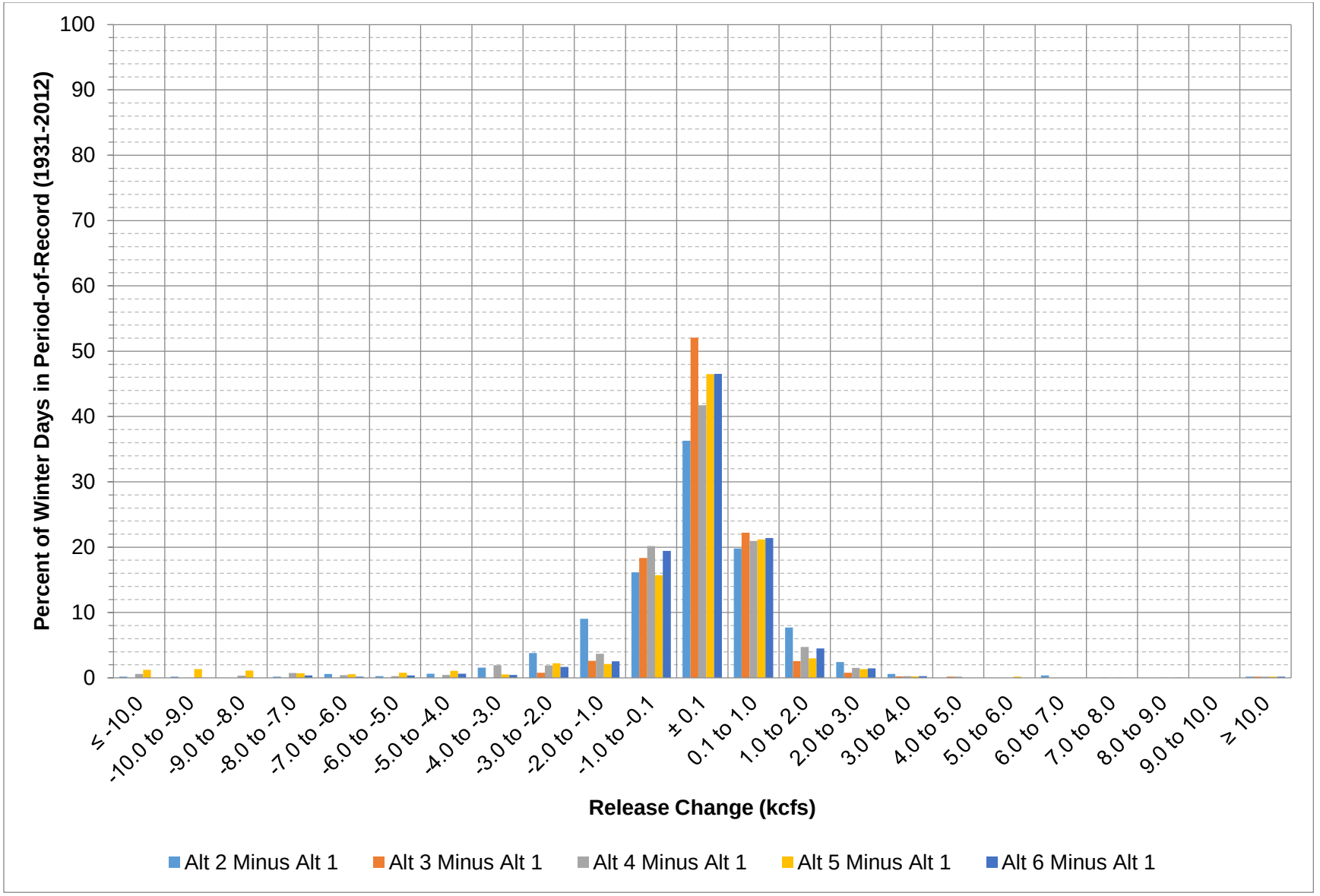

Figure 5-10: Garrison release change between each alternative and Alt 1 during December – February.

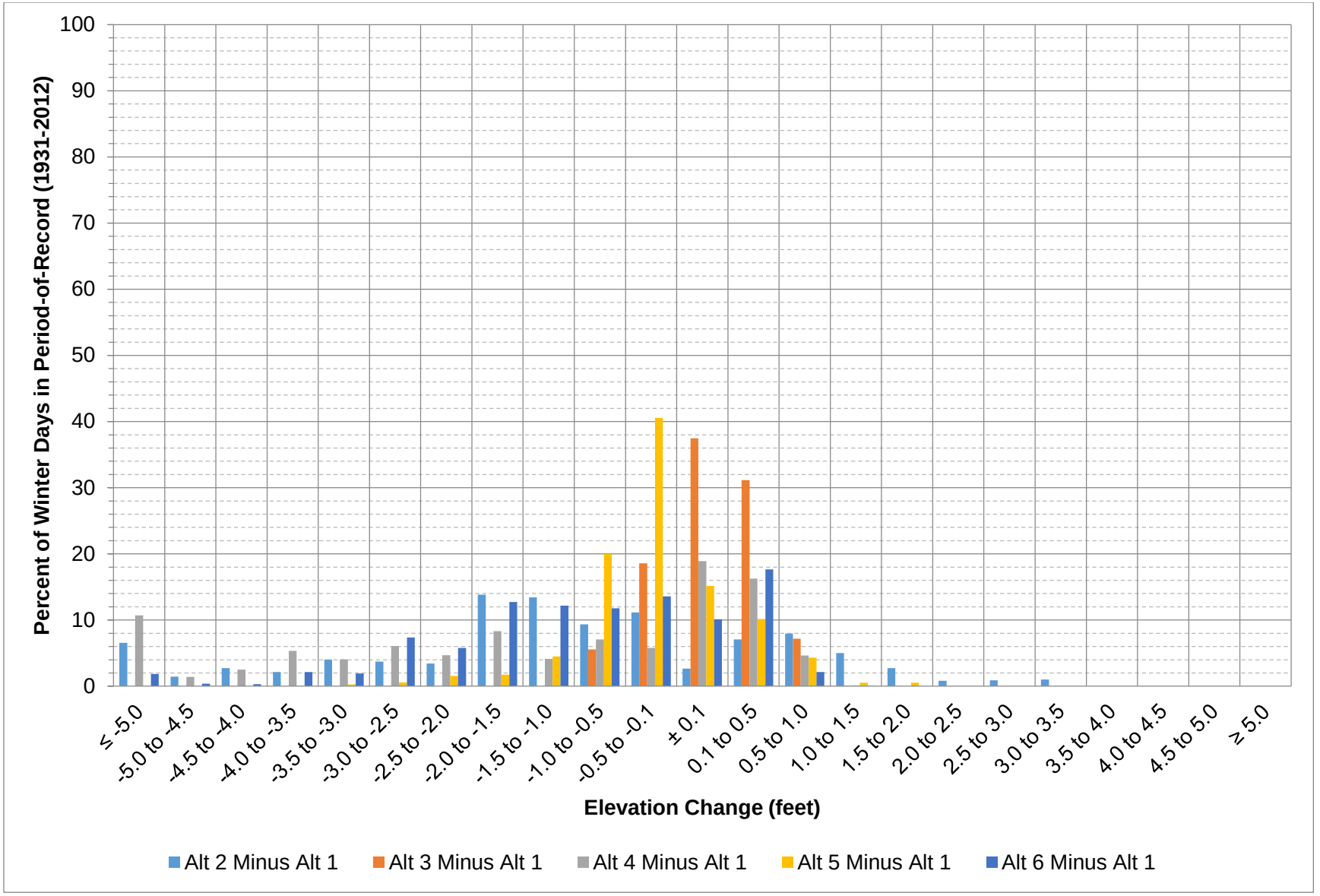

Figure 5-11: Oahe elevation change between each alternative and Alt 1 during December – February.

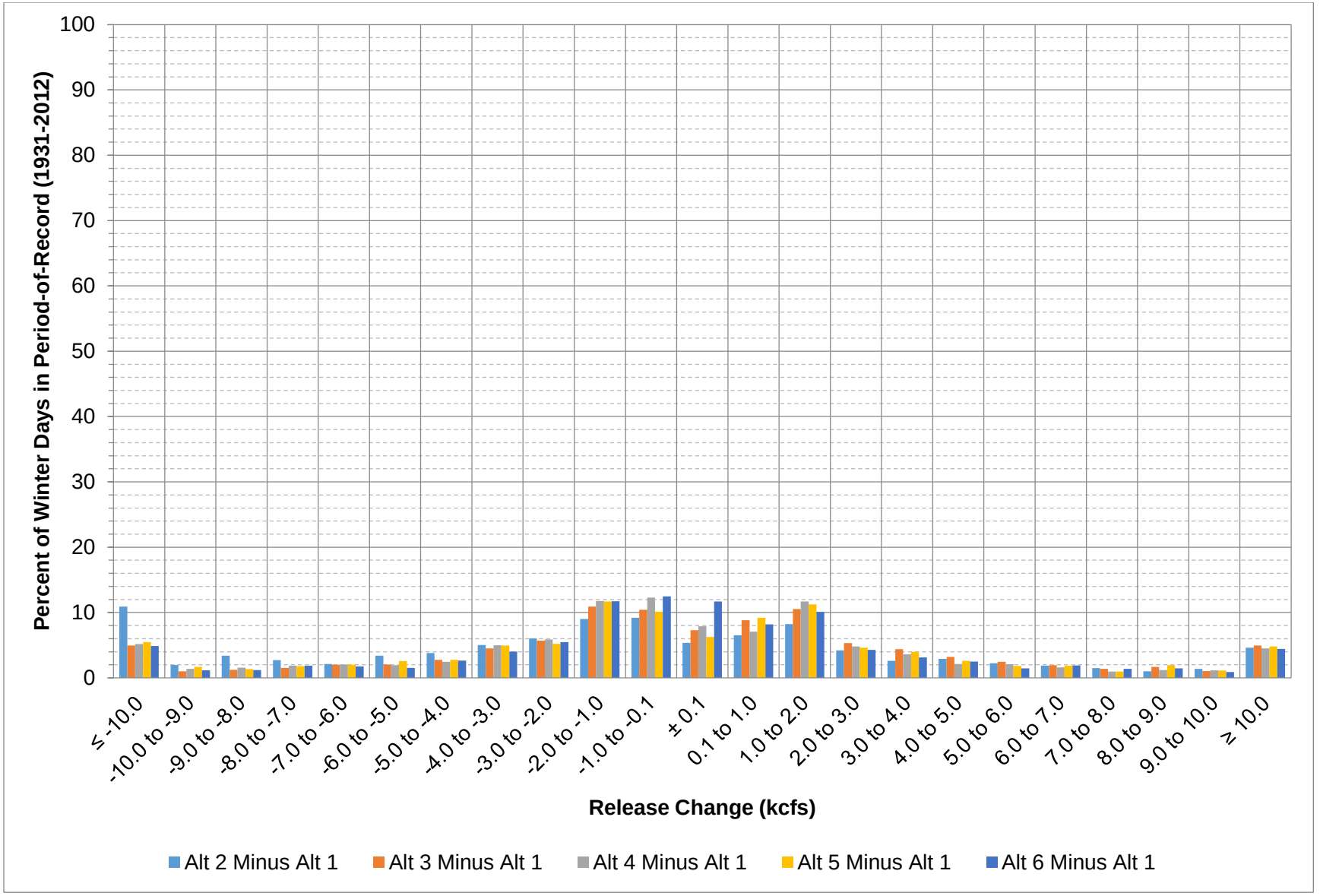

Figure 5-12: Oahe release change between each alternative and Alt 1 during December – February.

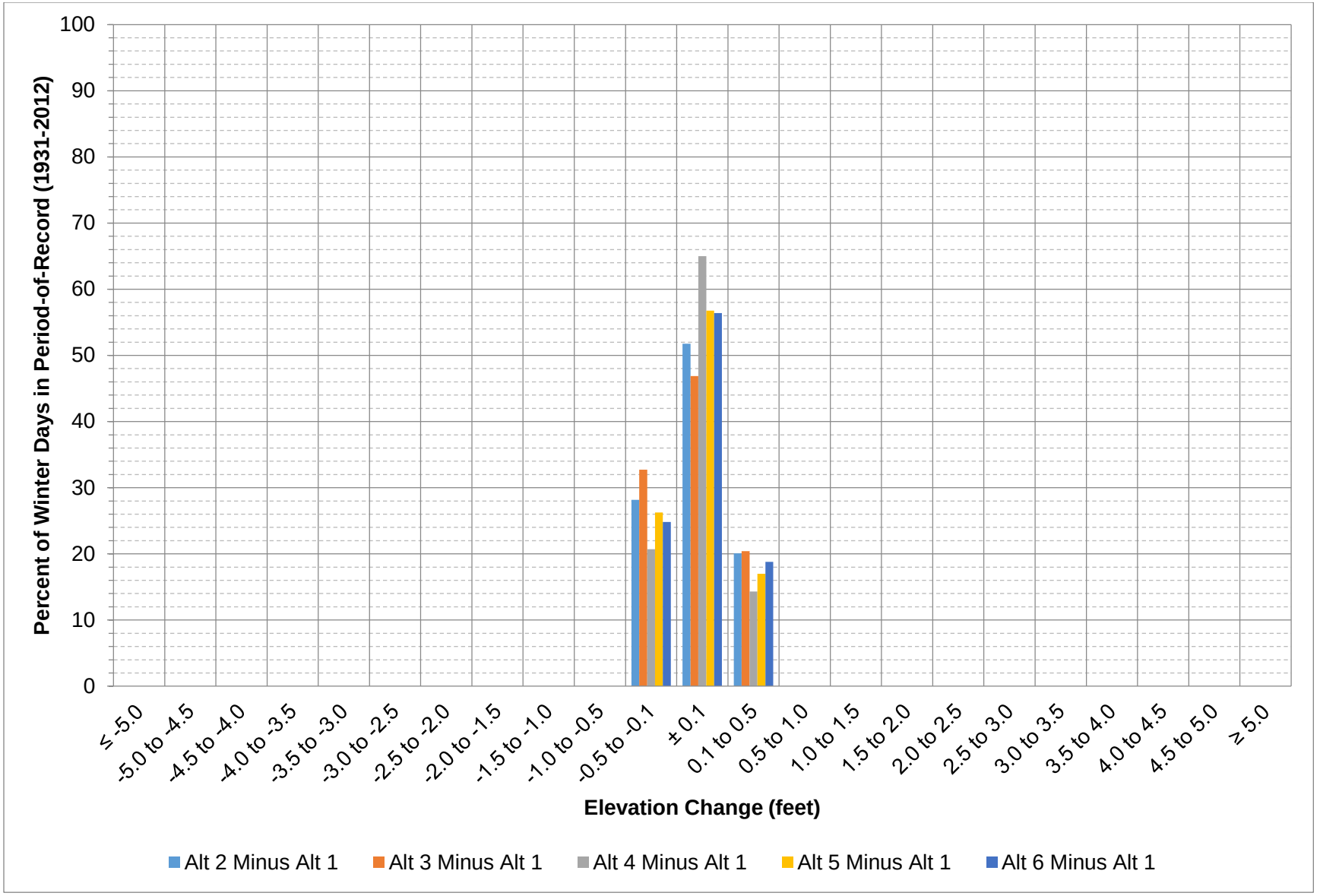

Figure 5-13: Big Bend elevation change between each alternative and Alt 1 during December – February.

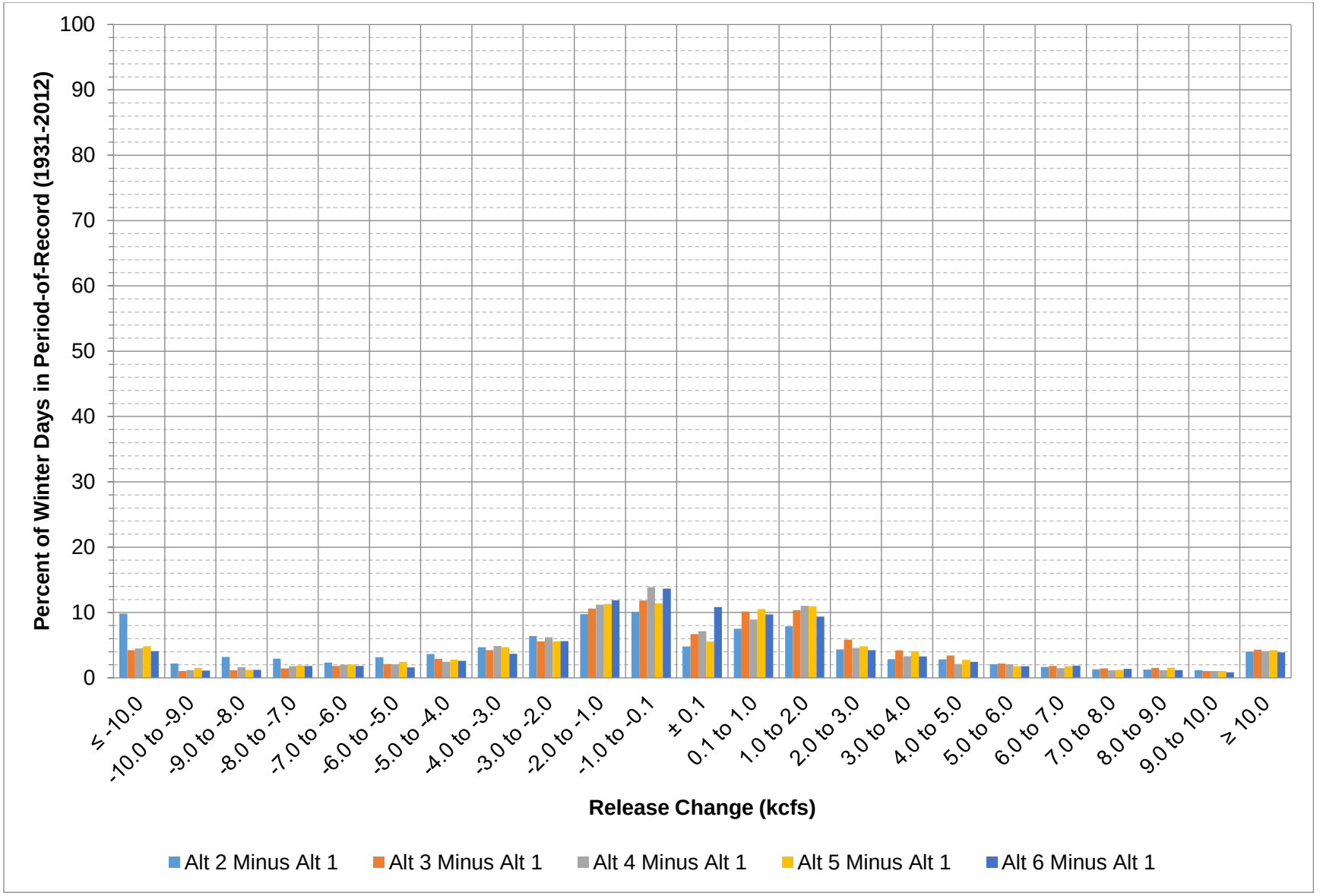

Figure 5-14: Big Bend release change between each alternative and Alt 1 during December – February.

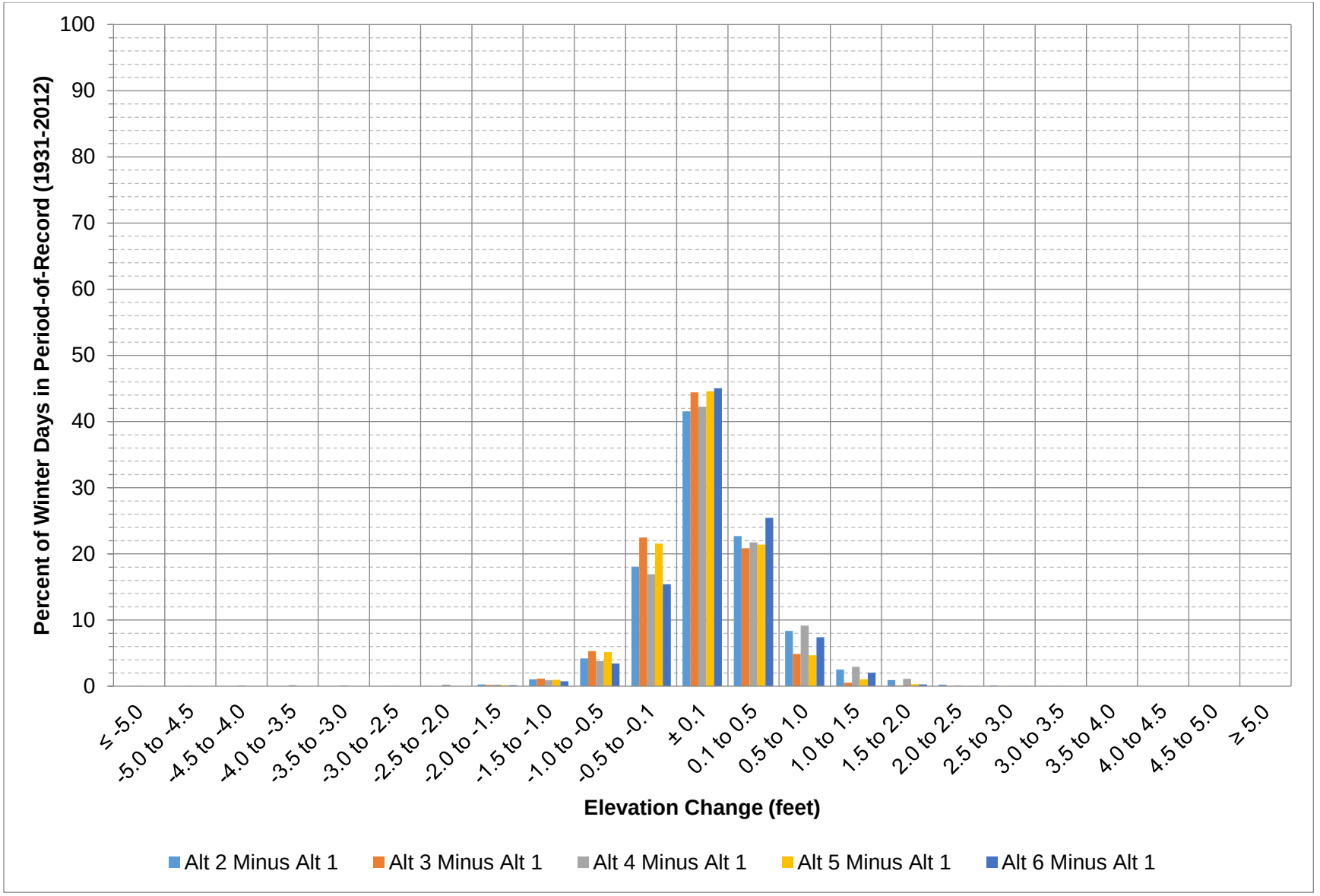

Figure 5-15: Fort Randall elevation change between each alternative and Alt 1 during December – February.

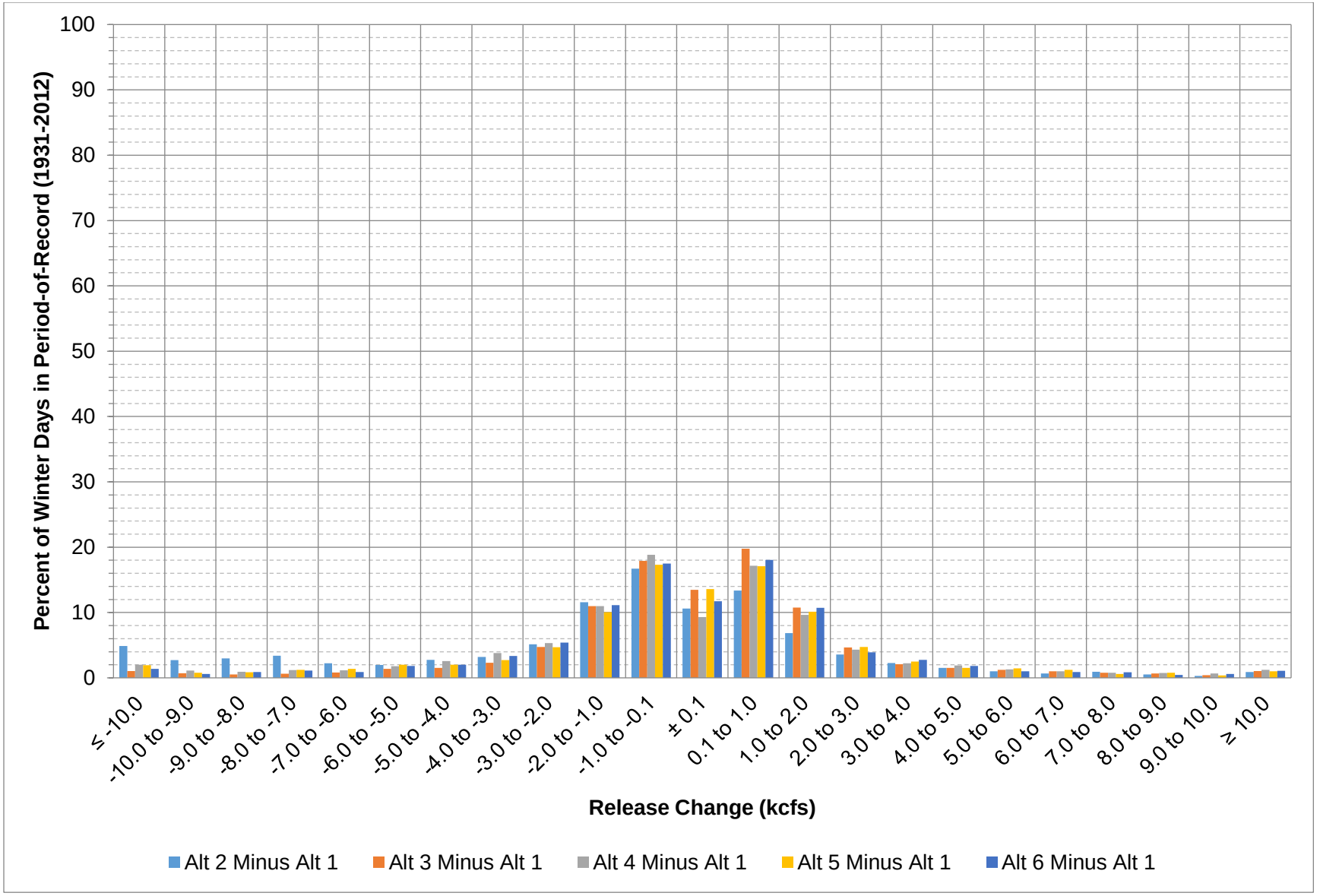

Figure 5-16: Fort Randall release change between each alternative and Alt 1 during December – February.

6 SUMMARY OF PERIOD-OF-RECORD DIFFERENCES

The operational changes described in the previous sections and summarized in Table 6-1 alter pool elevations and releases of the six mainstem reservoirs causing differences in System storage. Many of the seasonal trends that were mentioned are also apparent when the entire period-of-record is assessed as shown in Figure 6-1 through Figure 6-12. Alt 2, Alt 4, Alt 5, and Alt 6 show a trend of lower pool elevations at Fort Peck, Garrison, and Oahe when compared to Alt 1 over the period-of-record due to the ESH-creating or spawning cues in each alternative. Table 6-2 summarizes the frequency of each alternative's ESH-creating release or spawning cue throughout the period-of-record. Alt 2 does increase pool elevations at those three reservoirs during portions of the period-of-record as the low summer flows and winter releases conserve water. Pool elevations at Big Bend, Fort Randall, and Gavins Point remain mostly unchanged as they operate for their respective guide curves. Changes in Fort Peck's, Garrison's, and Oahe's pool elevations closely follows changes in System storage as shown in Figure 6-13. Alt 2, Alt 4, Alt 5, and Alt 6 show a trend of lower System storage on March 1; however Alt 2's low summer flow and winter release operations conserve water during some years resulting in higher System storage on March 1. Alt 3's operations have a minimal effect on System storage as all of the changes are within ±0.5 MAF.

Minor release changes occur at Fort Peck and Garrison under all alternatives as those reservoirs can make minor release adjustments and still balance System storage. The most significant changes are attributed to the spawning cue or ESH-creating releases. Releases at Oahe are highly variable regardless of operations so it is difficult to determine a trend to the changes except for the extreme changes that occur when there is a spawning cue or ESH-creating release from Gavins Point. Big Bend's and Fort Randall's releases mirror Oahe's releases as they operate for their respective guide curves. Gavins Point's releases under Alt 2 show trends of lower releases caused by low summer flow operations, lower winter releases, and lower System storage in years following the spawning cues. Gavins Point's releases also show trends of higher releases caused by the spawning cues. Alt 4, Alt 5, and Alt 6 releases from Gavins Point show trends of lower releases than in Alt 1 with the exception of > 10.0 kcfs change, which is attributed to times when the ESH-creating release or spawning cues occur.

Table 6-1: Summary of operational changes for each alternative compared to Alt 1.

Alternative	March - April	May - August	September - November	December - February
Alt 2	Alt 1 early spring spawning cue replaced by Alt 2 early spring spawning cue	Alt 1 late spring spawning cue replaced by Alt 2 late spring spawning cue Low summer flow occur between June 25 and September 1	Navigation season always ends on December 1	Maximum winter release is 16 kcfs
Alt 3	Alt 1 early spring spawning cue removed	Alt 1 late spring spawning cue removed	No operational changes	No operational changes
Alt 4	Alt 1 early spring spawning cue removed Alt 4 ESH-creating release from Gavins Point and Garrison	Alt 1 late spring spawning cue removed Alt 4 ESH-creating release from Gavins Point and Garrison may continue into summer months	No operational changes	No operational changes
Alt 5	Alt 1 early spring spawning cue removed	Alt 1 late spring spawning cue removed	Alt 5 ESH-creating release from Gavins Point and Garrison	No operational changes
Alt 6	Alt 1 early spring spawning cue replaced by Alt 6 early spring spawning cue	Alt 1 late spring spawning cue replaced by Alt 6 late spring spawning cue	No operational changes	No operational changes

Table 6-2: Summary of ESH-creating and spawning cue releases for each alternative.

Alternative	Month	Frequency during 82-year Period of Record (1931-2012)			
		Eliminated[1]	Partial Completion[2]	Full Completion/Duration[3]	
		No. of Years	No. of Years	No. of Years	Percent
Alt 1	March	48	4	30	37
	May	53	8	21	26
	Both months			**16**	**20**
Alt 2	March	40	24	18	22
	May	42	25	15	18
	Both months			**10**	**12**
Alt 3		not applicable, no flow management action included			
Alt 4		65	7	**10**[4]	**12**
Alt 5		73	2	**7**[4]	**8**
Alt 6	March	39	26	17	21
	May	65	6	11	13
	Both months			**11**	**13**

[1] Eliminated: Hydrological conditions in these years would not have been appropriate for any release.
[2] Partial Completion: Releases would have occurred but not at the full planned volume or duration.
[3] Full Completion/Duration: Releases would have occurred for the full planned volume and duration.
[4] Shown values for spring (Alternative 4) and fall (Alternative 5) are deliberate releases. These values do not include eight events for each alternative when targeted flow release levels would have been achieved "naturally" during normal operations.

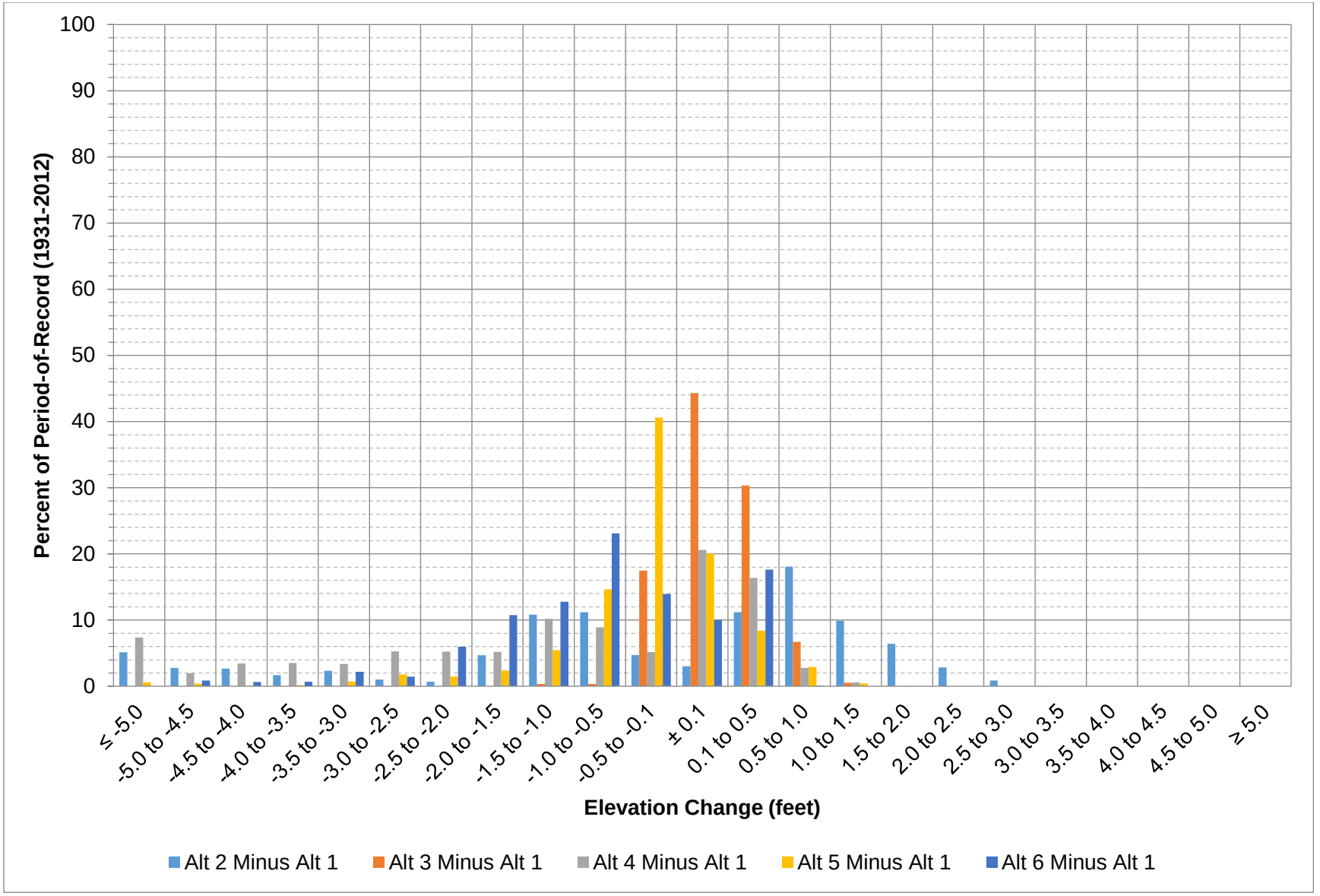

Figure 6-1: Fort Peck elevation change between each alternative and Alt 1 for all days in the period-of-record.

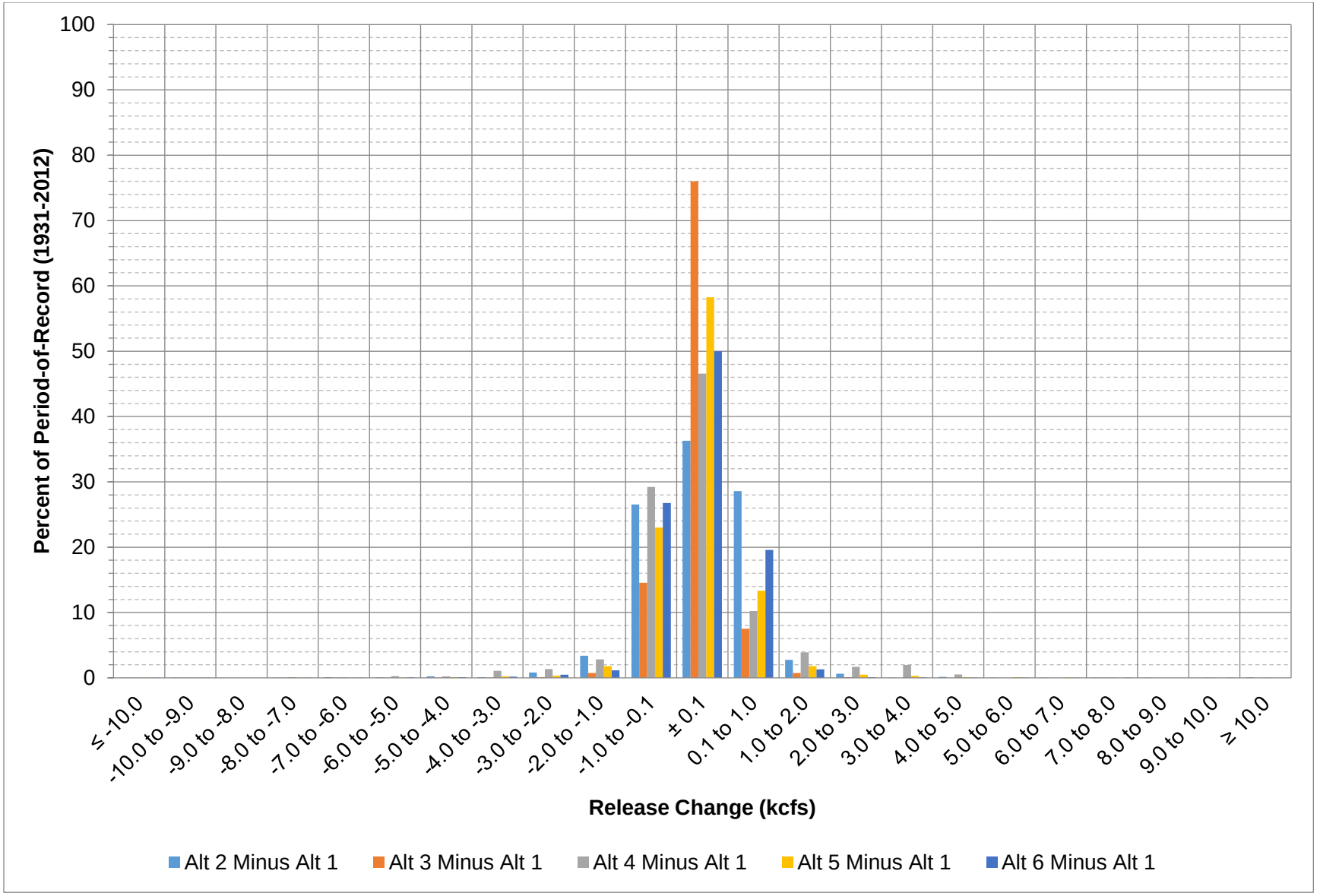

Figure 6-2: Fort Peck release change between each alternative and Alt 1 for all days in the period-of-record.

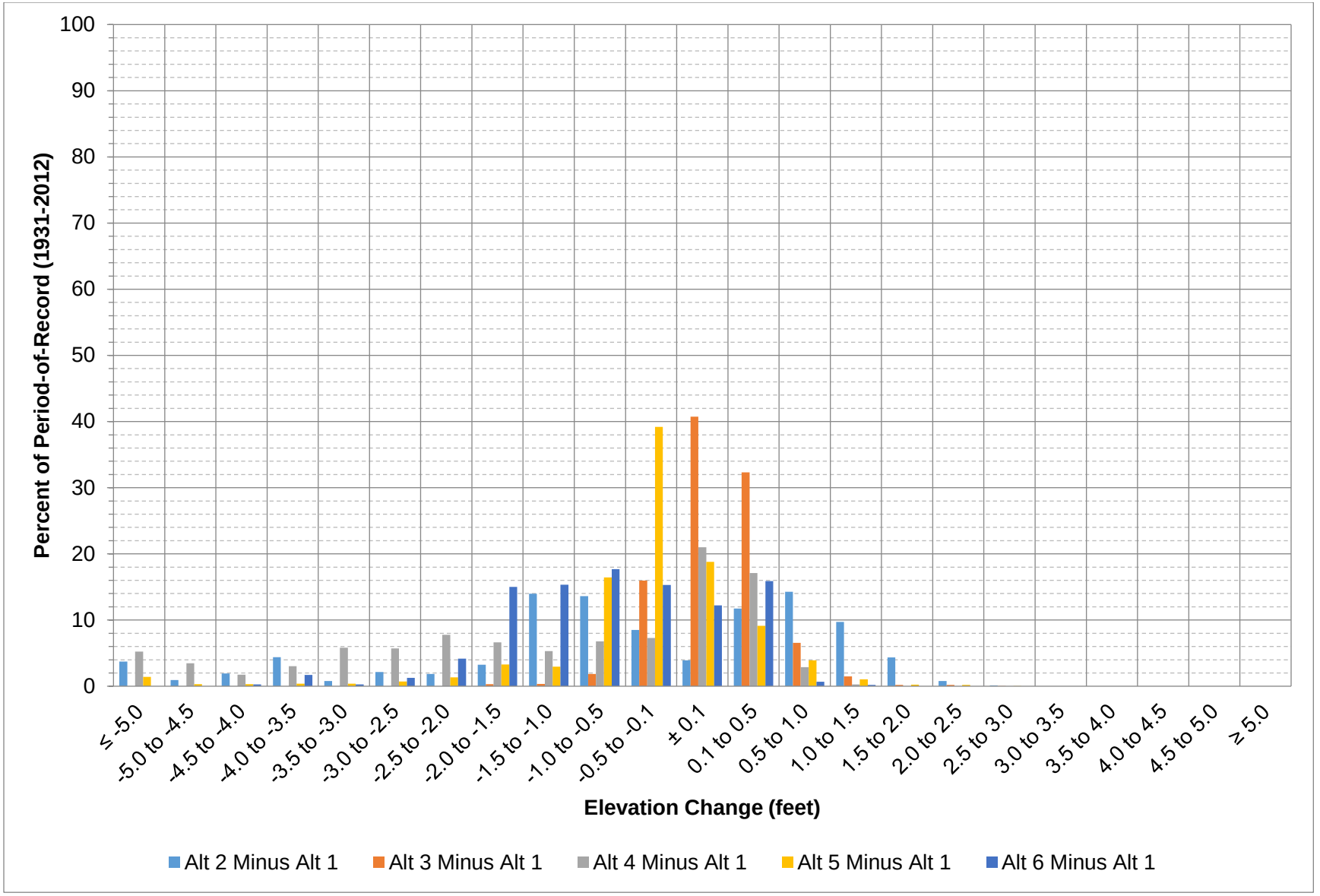

Figure 6-3: Garrison elevation change between each alternative and Alt 1 for all days in the period-of-record.

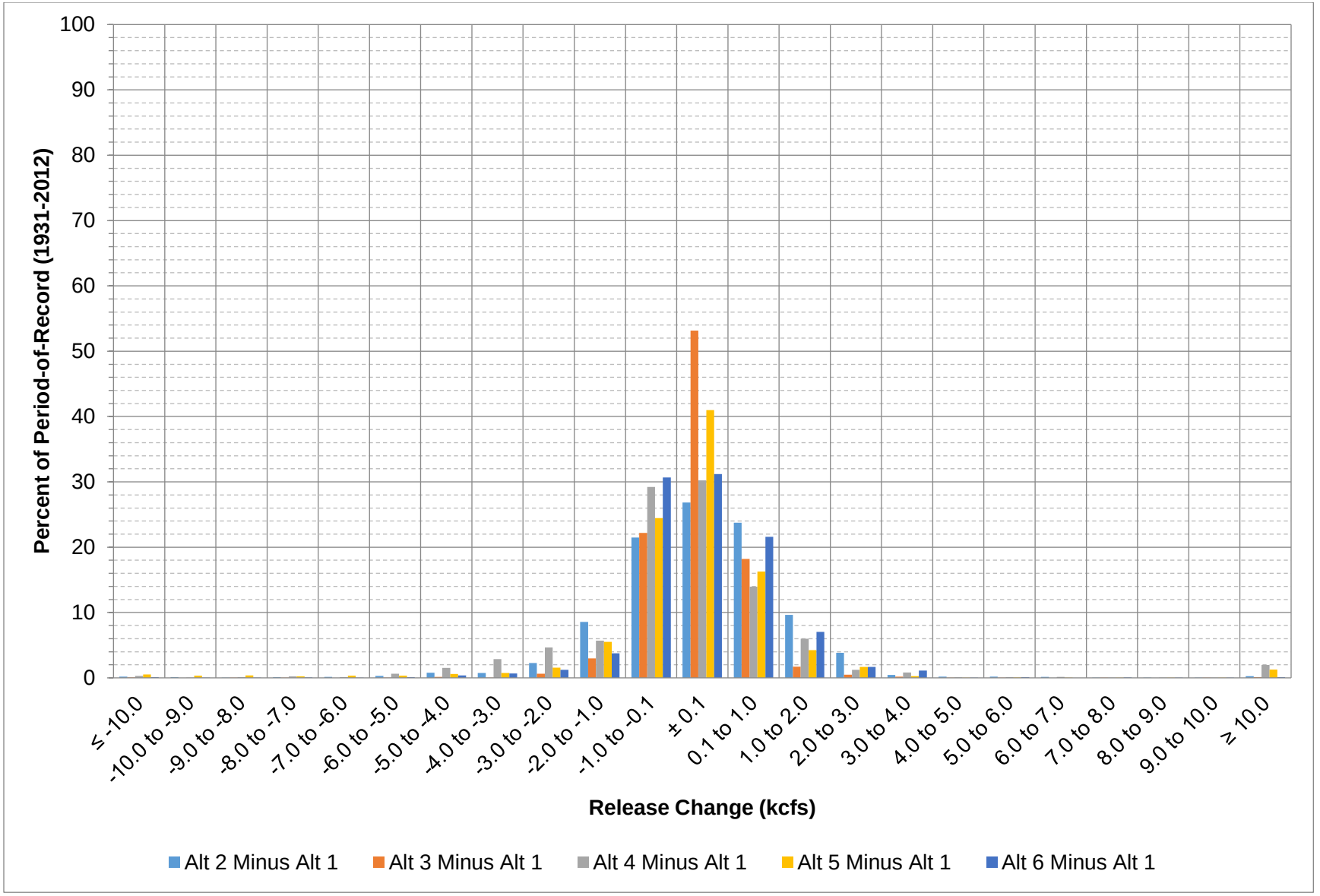

Figure 6-4: Garrison release change between each alternative and Alt 1 for all days in the period-of-record.

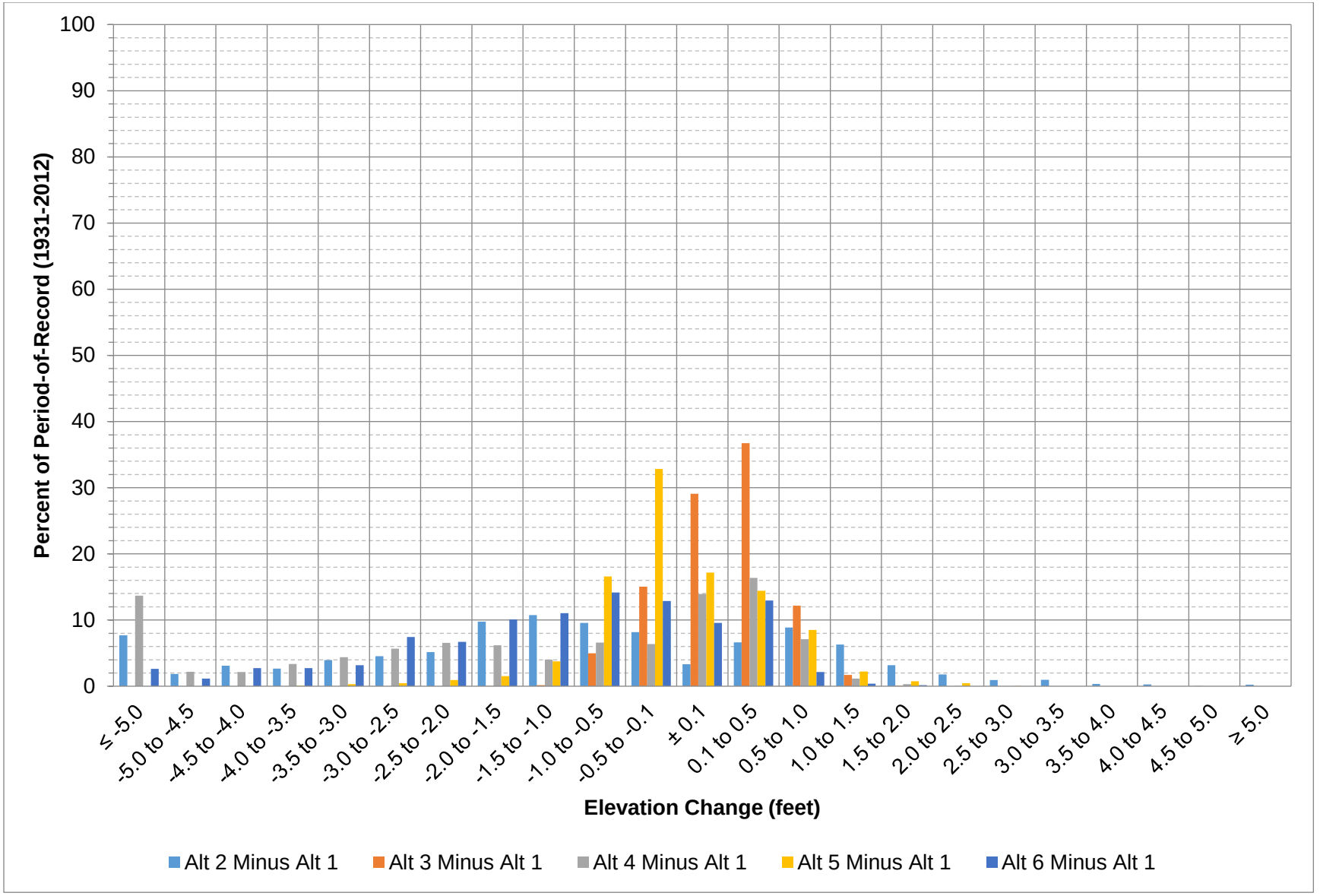

Figure 6-5: Oahe elevation change between each alternative and Alt 1 for all days in the period-of-record.

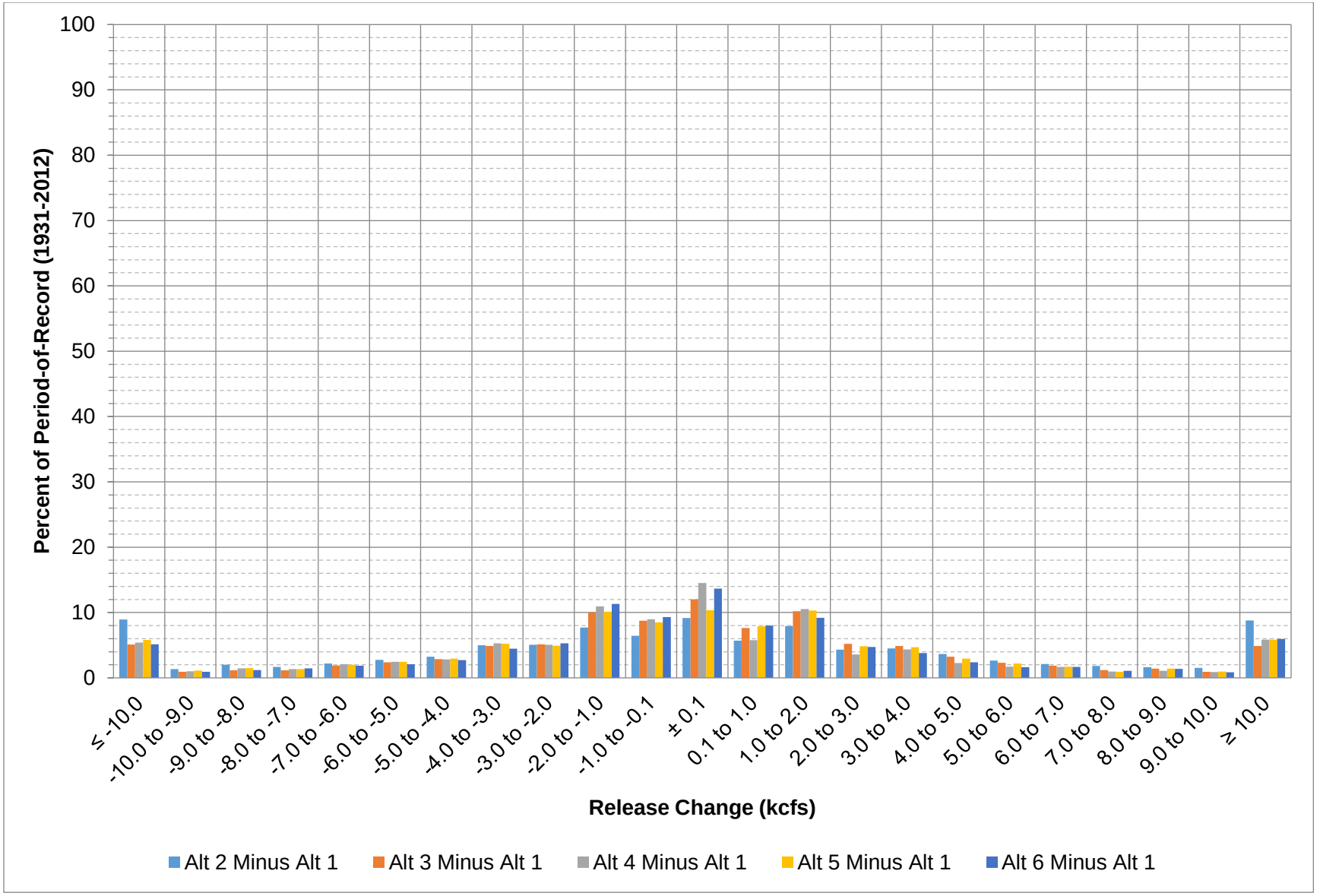

Figure 6-6: Oahe release change between each alternative and Alt 1 for all days in the period-of-record.

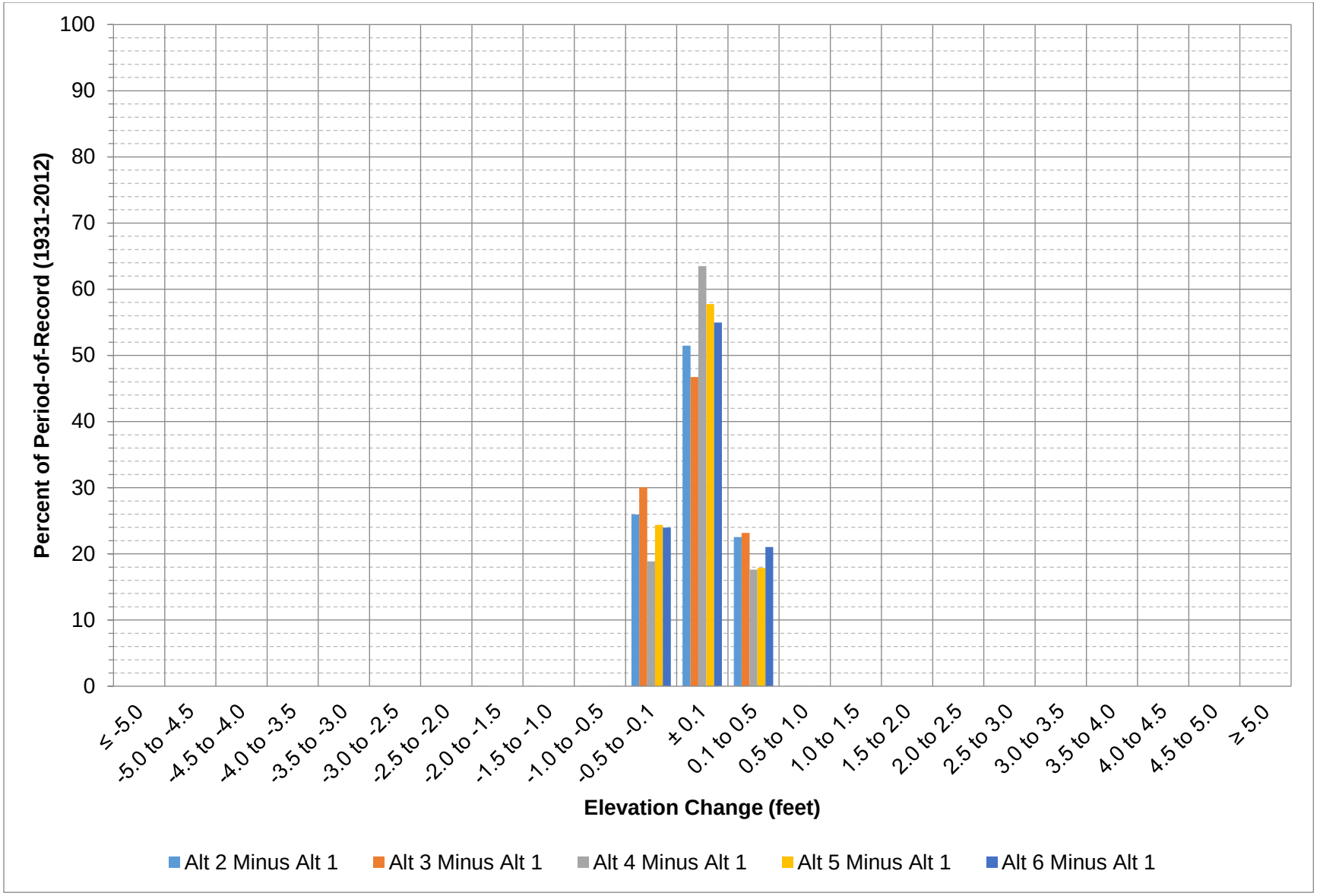

Figure 6-7: Big Bend elevation change between each alternative and Alt 1 for all days in the period-of-record.

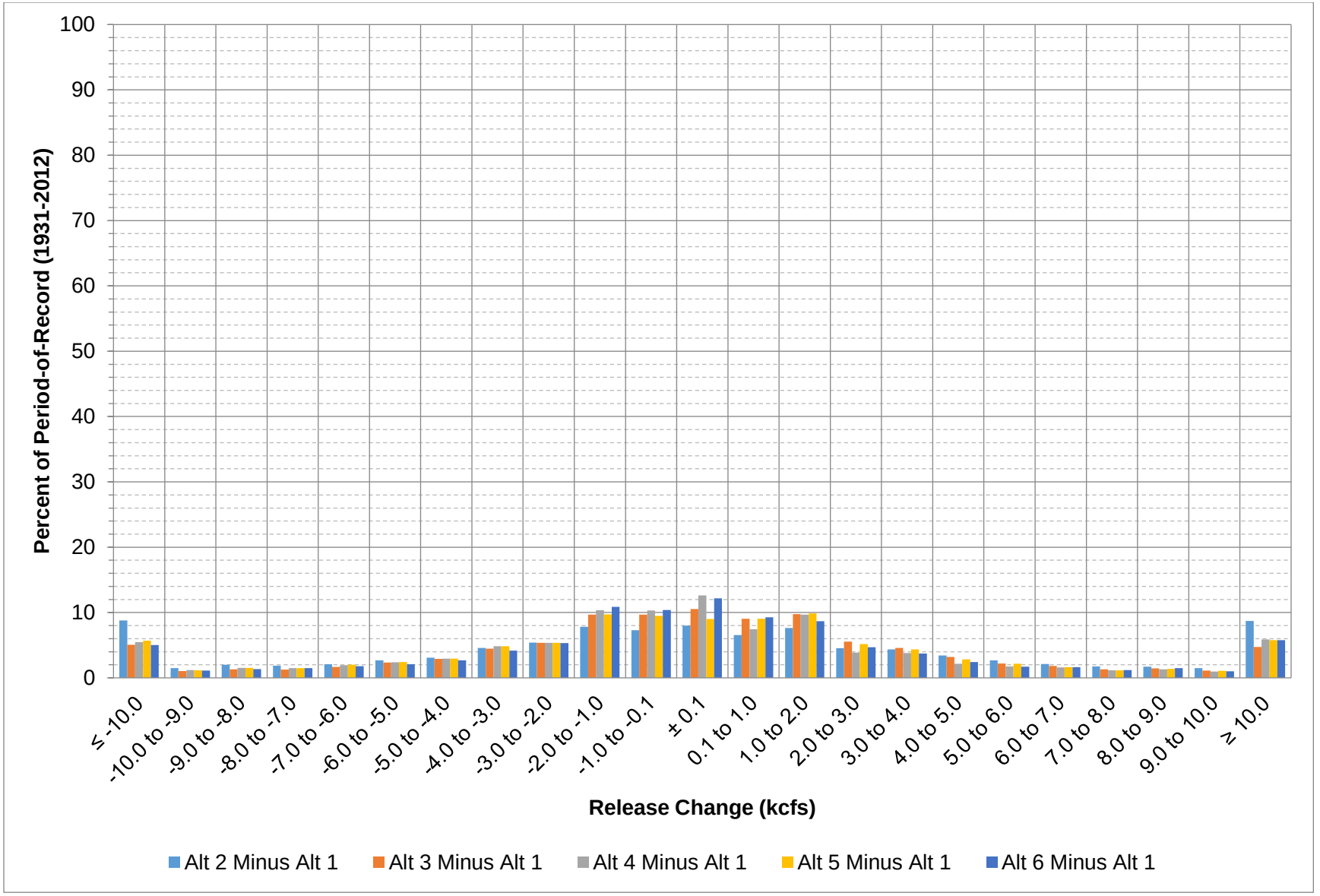

Figure 6-8: Big Bend release change between each alternative and Alt 1 for all days in the period-of-record.

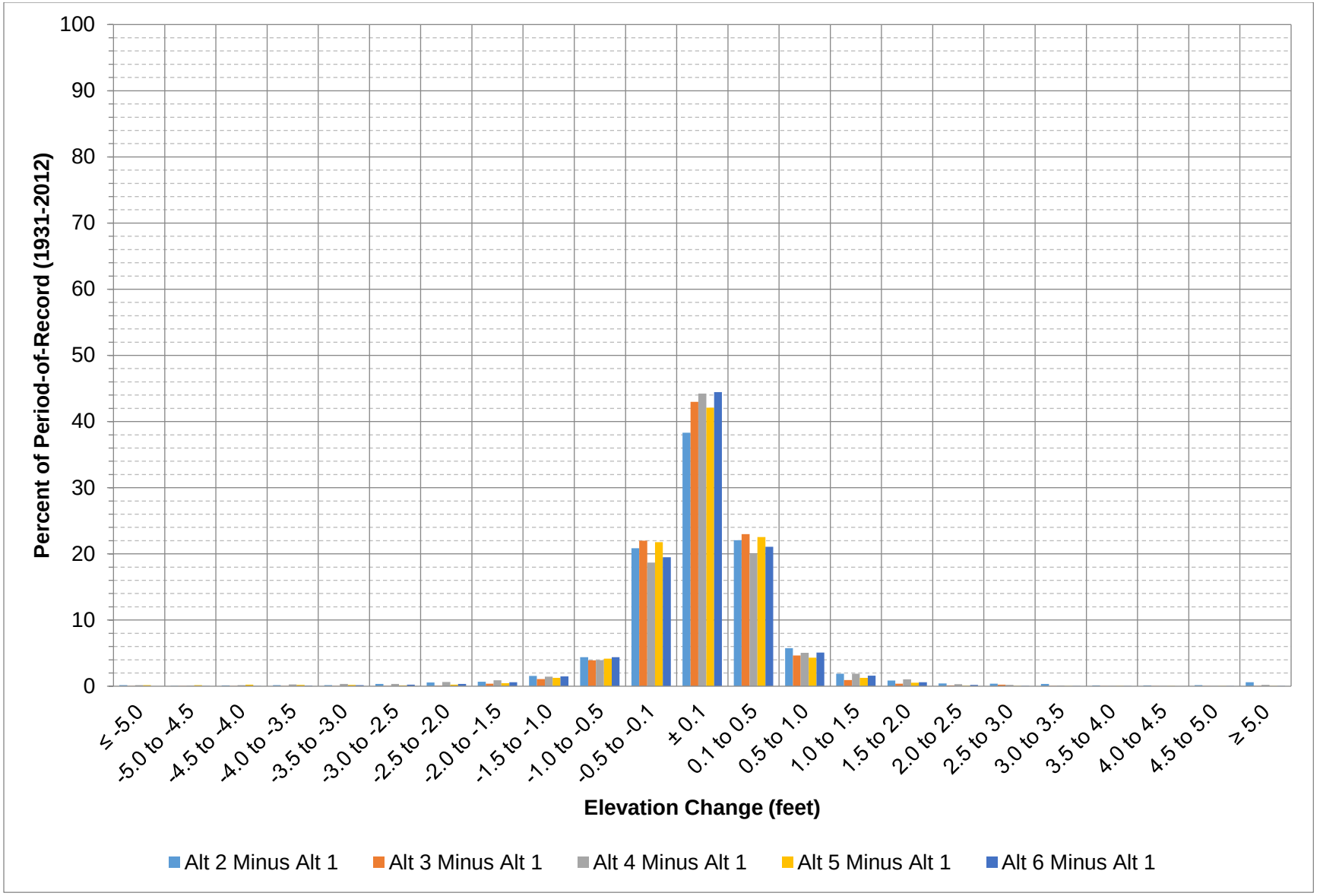

Figure 6-9: Fort Randall elevation change between each alternative and Alt 1 for all days in the period-of-record.

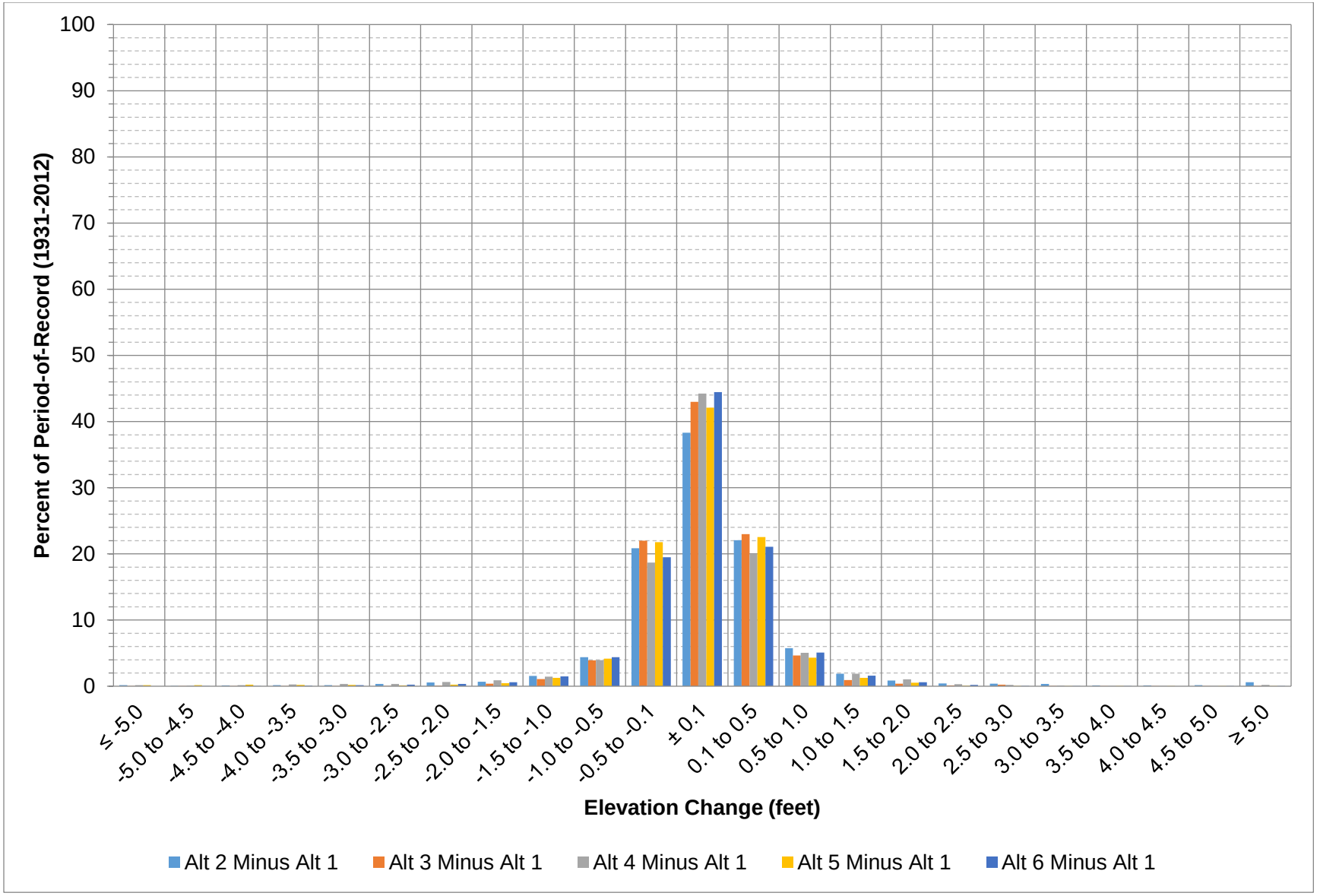

Figure 6-10: Fort Randall release change between each alternative and Alt 1 for all days in the period-of-record.

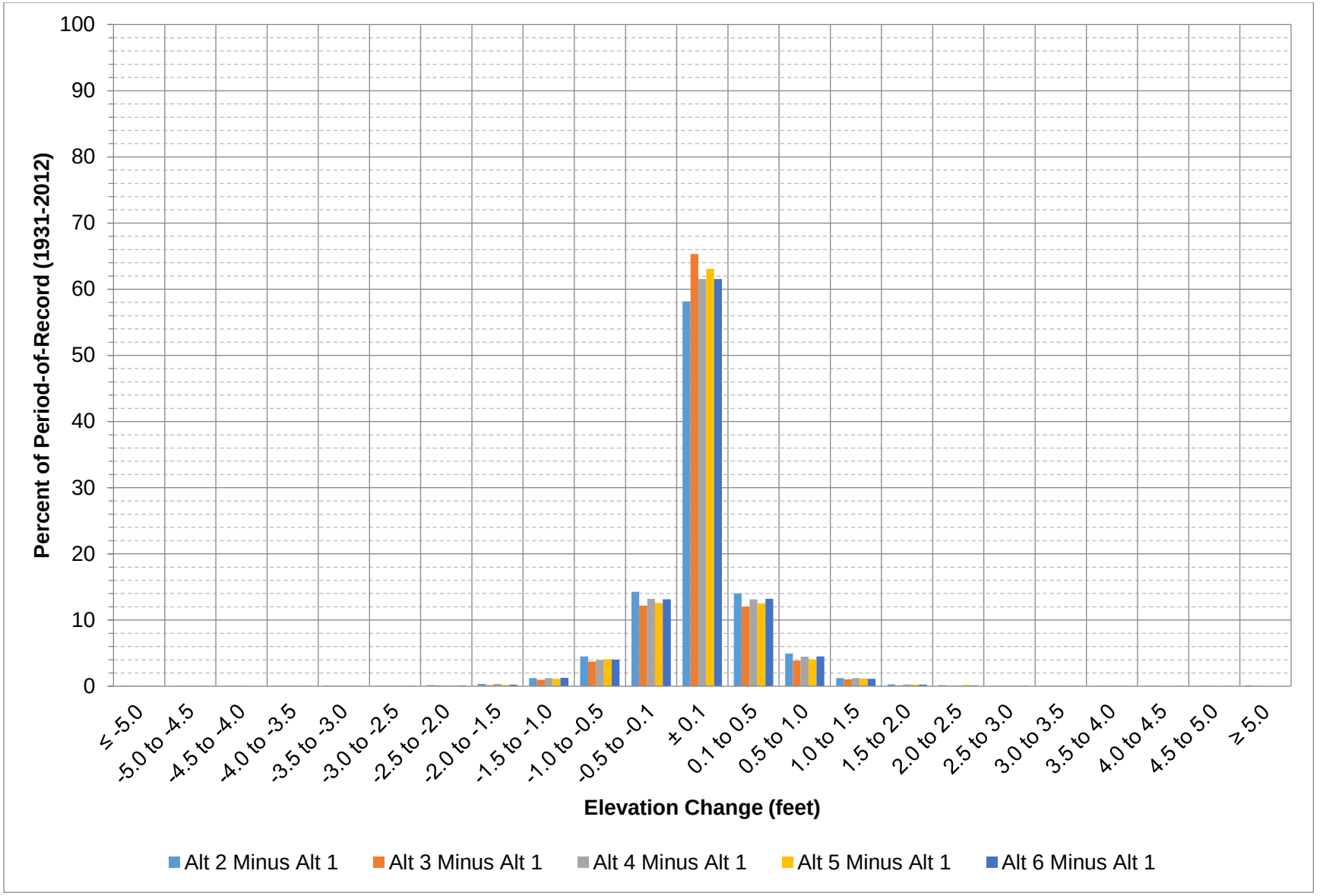

Figure 6-11: Gavins Point elevation change between each alternative and Alt 1 for all days in the period-of-record.

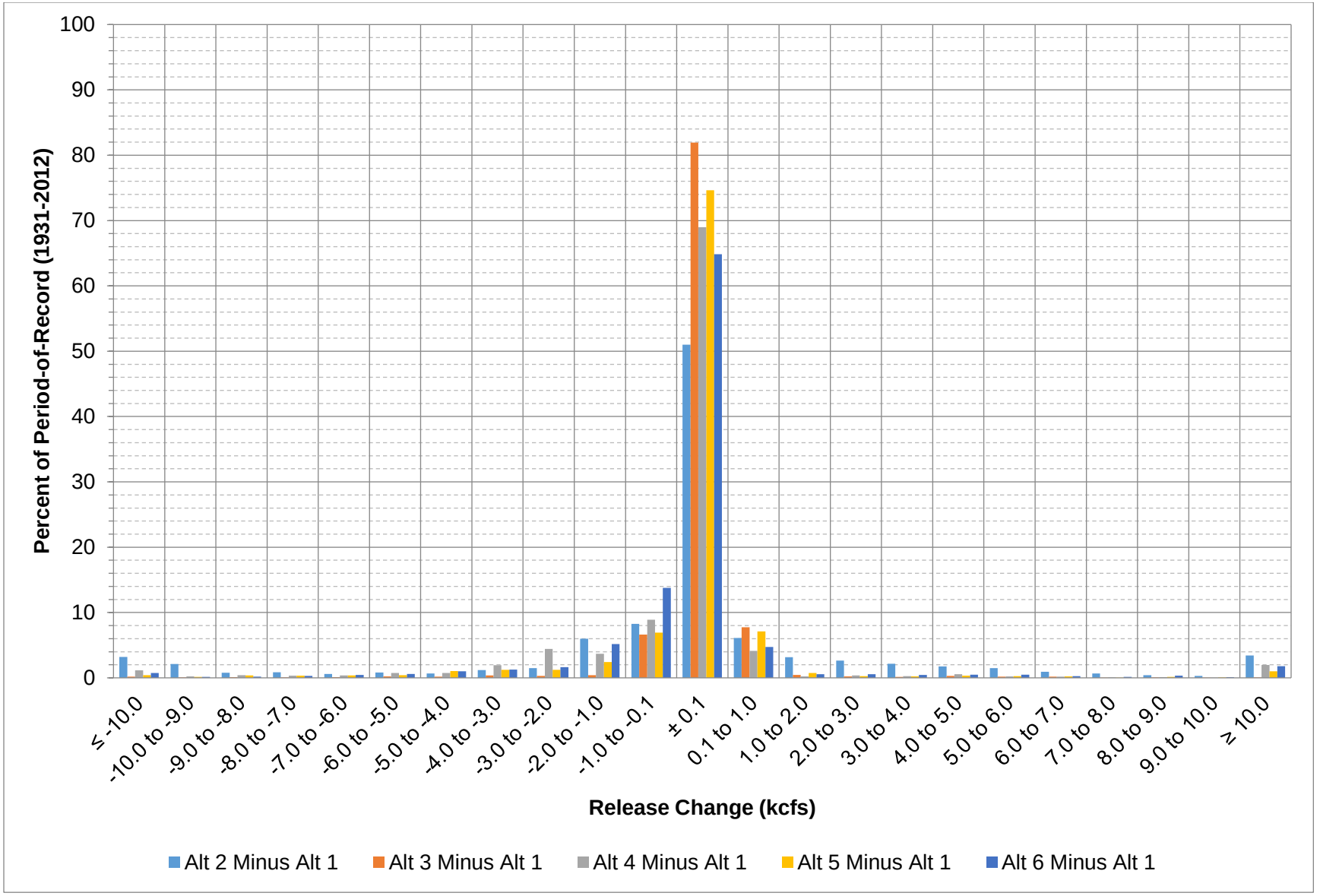

Figure 6-12: Gavins Point release change between each alternative and Alt 1 for all days in the period-of-record.

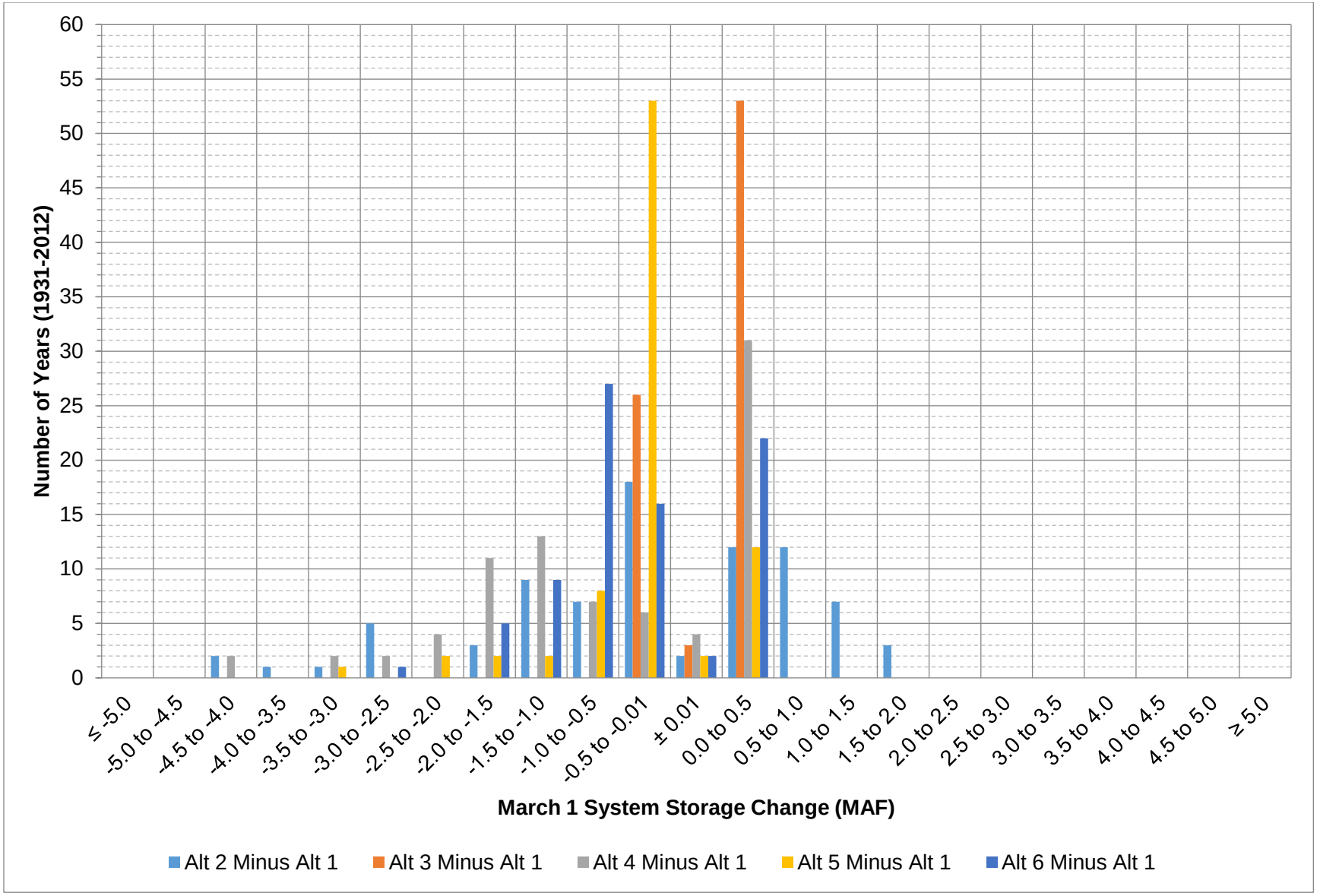

Figure 6-13: March 1 System storage change between each alternative and Alt 1 for all years in the period-of-record.

7 REFERENCES

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8 APPENDIX A – STATISTICS OF ELEVATION AND RELEASE DIFFERENCES

Table 8-1: Summary statistics of elevation change between each alternative and Alt 1 for all days in the period-of-record grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	-0.6	2.1	-1.260	-4.2	-1.3	0.1	0.8	1.5
	Garrison	-0.6	1.8	-1.166	-3.7	-1.3	-0.4	0.6	1.2
	Oahe	-1.2	2.3	-0.655	-4.4	-2.4	-1.0	0.4	1.3
	Big Bend	0.0	0.1	-0.115	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.1	0.9	1.331	-0.4	-0.1	0.0	0.2	0.5
	Gavins Point	0.0	0.5	0.493	-0.3	-0.1	0.0	0.1	0.3
Alt 3 Minus Alt 1	Fort Peck	0.1	0.2	0.539	-0.1	-0.1	0.1	0.2	0.4
	Garrison	0.1	0.3	0.604	-0.3	-0.1	0.1	0.2	0.5
	Oahe	0.1	0.4	0.144	-0.3	-0.1	0.1	0.3	0.6
	Big Bend	0.0	0.1	-0.269	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.5	1.305	-0.3	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-1.376	-0.2	-0.1	0.0	0.1	0.2
Alt 4 Minus Alt 1	Fort Peck	-1.5	2.0	-1.330	-4.4	-2.5	-0.8	0.1	0.3
	Garrison	-1.4	2.0	-1.487	-4.1	-2.5	-0.6	0.1	0.3
	Oahe	-1.8	2.6	-1.423	-5.7	-3.1	-0.9	0.1	0.4
	Big Bend	0.0	0.1	0.023	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.8	-0.165	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-0.231	-0.3	-0.1	0.0	0.1	0.3
Alt 5 Minus Alt 1	Fort Peck	-0.4	0.8	-2.837	-1.2	-0.6	-0.2	-0.1	0.2
	Garrison	-0.5	1.1	-4.346	-1.1	-0.6	-0.2	-0.1	0.3
	Oahe	-0.2	0.7	-0.483	-0.8	-0.5	-0.2	0.1	0.6
	Big Bend	0.0	0.1	-0.433	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.6	-3.758	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.5	-1.015	-0.3	-0.1	0.0	0.1	0.2
Alt 6 Minus Alt 1	Fort Peck	-0.9	1.0	-1.249	-2.1	-1.4	-0.7	0.0	0.2
	Garrison	-0.8	0.9	-0.899	-1.9	-1.4	-0.7	0.0	0.2
	Oahe	-1.3	1.5	-1.161	-3.3	-2.1	-0.9	-0.1	0.2
	Big Bend	0.0	0.1	-0.061	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.5	-0.608	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-0.960	-0.3	-0.1	0.0	0.1	0.3

Table 8-2: Summary statistics of release change between each alternative and Alt 1 for all days in the period-of-record grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	1	816	1.521	-500	-153	0	200	500
	Garrison	3	1,768	-0.703	-1,286	-400	0	420	1,200
	Oahe	18	8,257	0.389	-9,156	-3,336	0	3,327	9,189
	Big Bend	17	8,099	0.376	-9,149	-3,334	0	3,288	9,117
	Fort Randall	16	6,329	0.263	-6,667	-1,696	0	1,669	6,172
	Gavins Point	16	4,728	0.373	-3,000	-114	0	14	3,500
Alt 3 Minus Alt 1	Fort Peck	-2	375	-1.362	-100	-7	0	8	100
	Garrison	-6	1,141	-7.382	-273	-100	0	84	292
	Oahe	-9	6,231	-0.184	-6,113	-2,087	0	2,155	6,181
	Big Bend	-10	6,067	-0.165	-6,232	-2,058	0	2,142	6,254
	Fort Randall	-11	3,734	-0.043	-2,960	-854	0	863	2,953
	Gavins Point	-11	1,059	-1.576	-59	0	0	0	90
Alt 4 Minus Alt 1	Fort Peck	5	1,067	0.146	-573	-169	0	21	546
	Garrison	11	3,225	3.767	-2,029	-492	-16	100	1,015
	Oahe	26	7,420	0.987	-6,666	-2,239	-3	1,668	6,292
	Big Bend	25	7,319	1.033	-6,781	-2,266	-4	1,668	6,621
	Fort Randall	25	5,882	1.783	-4,453	-1,438	-30	927	3,889
	Gavins Point	25	4,385	4.489	-2,000	-34	0	0	92
Alt 5 Minus Alt 1	Fort Peck	5	695	-8.424	-200	-100	0	23	242
	Garrison	12	2,982	4.790	-1,050	-200	0	100	596
	Oahe	15	7,185	0.747	-6,862	-2,419	-1	2,079	6,571
	Big Bend	15	6,978	0.795	-6,939	-2,418	0	2,078	6,608
	Fort Randall	14	4,960	1.500	-3,904	-1,110	0	928	3,332
	Gavins Point	14	3,005	5.626	-466	0	0	0	115
Alt 6 Minus Alt 1	Fort Peck	8	576	-0.129	-284	-100	0	100	409
	Garrison	20	1,446	-4.082	-679	-255	0	248	1,050
	Oahe	41	6,721	0.378	-6,229	-2,044	-1	1,677	6,515
	Big Bend	41	6,572	0.415	-6,359	-2,019	0	1,691	6,658
	Fort Randall	41	5,082	0.967	-4,078	-1,298	0	952	4,149
	Gavins Point	41	3,233	3.954	-1,080	-100	0	0	100

Table 8-3: Summary statistics of elevation change between each alternative and Alt 1 for spring months grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	-0.5	2.1	-1.322	-4.2	-1.3	0.2	0.8	1.6
	Garrison	-0.6	1.8	-1.060	-3.8	-1.3	-0.5	0.7	1.3
	Oahe	-0.6	2.3	-0.800	-4.4	-1.6	-0.2	1.0	2.0
	Big Bend	0.0	0.1	-0.681	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.1	0.9	6.705	-0.4	-0.1	0.0	0.2	0.6
	Gavins Point	0.0	0.6	2.958	-0.5	-0.1	0.0	0.1	0.5
Alt 3 Minus Alt 1	Fort Peck	0.1	0.2	0.874	-0.1	-0.1	0.1	0.2	0.4
	Garrison	0.0	0.3	-0.213	-0.3	-0.1	0.0	0.2	0.3
	Oahe	0.1	0.3	0.131	-0.3	-0.1	0.1	0.3	0.5
	Big Bend	0.0	0.1	-0.202	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.4	0.450	-0.3	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.3	-0.430	-0.3	-0.1	0.0	0.1	0.3
Alt 4 Minus Alt 1	Fort Peck	-1.2	1.8	-1.437	-3.9	-2.0	-0.6	0.1	0.3
	Garrison	-1.5	1.8	-1.024	-4.1	-2.5	-0.9	0.1	0.2
	Oahe	-1.7	2.5	-1.610	-5.5	-3.0	-0.8	0.1	0.4
	Big Bend	0.0	0.1	-0.116	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.4	1.208	-0.3	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.5	0.398	-0.4	-0.1	0.0	0.1	0.5
Alt 5 Minus Alt 1	Fort Peck	-0.4	0.8	-3.159	-1.2	-0.7	-0.2	-0.1	0.2
	Garrison	-0.5	1.0	-5.133	-0.9	-0.6	-0.2	-0.1	0.1
	Oahe	-0.3	0.6	-2.083	-0.7	-0.5	-0.2	0.0	0.4
	Big Bend	0.0	0.1	-0.341	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.5	-2.778	-0.3	-0.1	0.0	0.2	0.4
	Gavins Point	0.0	0.4	-0.022	-0.4	-0.1	0.0	0.1	0.4
Alt 6 Minus Alt 1	Fort Peck	-0.8	1.0	-1.244	-2.1	-1.4	-0.6	0.0	0.2
	Garrison	-0.8	0.9	-0.952	-1.9	-1.5	-0.7	0.0	0.2
	Oahe	-1.2	1.3	-0.929	-3.0	-2.0	-1.0	-0.1	0.2
	Big Bend	0.0	0.1	-0.160	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.4	1.218	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-0.219	-0.4	-0.1	0.0	0.1	0.5

Table 8-4: Summary statistics of release change between each alternative and Alt 1 for spring months grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	37	466	3.915	-200	-136	0	200	400
	Garrison	-167	870	-0.998	-1,134	-546	0	200	657
	Oahe	-421	8,629	0.564	-10,975	-3,797	0	3,332	9,282
	Big Bend	-427	8,289	0.425	-10,368	-3,357	0	3,004	8,762
	Fort Randall	-462	6,146	-0.150	-6,737	-1,835	0	1,667	5,370
	Gavins Point	-527	4,648	-0.376	-2,553	0	0	102	2,000
Alt 3 Minus Alt 1	Fort Peck	-5	105	-7.655	-100	0	0	11	87
	Garrison	-28	254	0.601	-169	-53	0	0	100
	Oahe	-168	6,300	-0.191	-6,964	-2,523	0	2,086	6,668
	Big Bend	-166	5,882	-0.165	-6,559	-2,281	0	1,924	6,447
	Fort Randall	-170	3,373	-0.587	-3,147	-926	0	741	2,814
	Gavins Point	-151	787	-5.889	-190	0	0	0	58
Alt 4 Minus Alt 1	Fort Peck	110	652	2.826	-327	-100	0	100	593
	Garrison	1,516	5,563	3.142	-900	-232	0	142	2,900
	Oahe	2,004	10,454	1.869	-6,664	-1,710	0	3,120	12,021
	Big Bend	1,993	10,240	1.944	-6,230	-1,710	0	2,741	11,757
	Fort Randall	1,973	9,148	2.252	-4,418	-1,112	0	1,481	9,078
	Gavins Point	1,890	8,017	3.147	-942	0	0	0	246
Alt 5 Minus Alt 1	Fort Peck	-6	275	-0.088	-200	-65	0	0	176
	Garrison	-133	826	-5.151	-450	-100	0	0	163
	Oahe	-439	6,408	-0.254	-8,092	-2,663	0	1,950	6,591
	Big Bend	-428	6,029	-0.325	-7,213	-2,556	0	1,855	5,963
	Fort Randall	-381	4,005	-0.767	-4,709	-1,310	0	911	3,149
	Gavins Point	-361	1,420	-5.866	-722	0	0	0	31
Alt 6 Minus Alt 1	Fort Peck	22	360	4.232	-206	-100	0	33	400
	Garrison	61	710	-0.410	-445	-200	0	100	1,114
	Oahe	1,122	8,407	1.014	-6,668	-1,670	0	3,329	10,754
	Big Bend	1,119	8,093	1.108	-6,185	-1,668	0	2,948	10,030
	Fort Randall	1,178	6,638	1.932	-4,075	-1,111	0	1,882	7,688
	Gavins Point	1,194	5,177	3.329	-500	0	0	0	4,114

Table 8-5: Summary statistics of elevation change between each alternative and Alt 1 for summer months grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	-0.6	2.1	-1.278	-4.1	-1.3	0.1	0.8	1.5
	Garrison	-0.6	1.8	-1.131	-3.7	-1.3	-0.4	0.7	1.3
	Oahe	-1.2	2.3	-0.858	-4.5	-2.3	-0.8	0.4	1.3
	Big Bend	0.0	0.1	-0.171	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.1	0.9	4.489	-0.3	-0.1	0.0	0.2	0.5
	Gavins Point	0.0	0.6	0.517	-0.4	-0.1	0.0	0.1	0.4
Alt 3 Minus Alt 1	Fort Peck	0.1	0.2	0.806	-0.1	-0.1	0.1	0.2	0.4
	Garrison	0.1	0.3	0.505	-0.3	-0.1	0.1	0.2	0.4
	Oahe	0.1	0.4	0.340	-0.3	0.0	0.1	0.3	0.6
	Big Bend	0.0	0.1	-0.202	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.4	0.430	-0.3	-0.1	0.0	0.1	0.3
	Gavins Point	0.0	0.4	-1.255	-0.2	-0.1	0.0	0.1	0.2
Alt 4 Minus Alt 1	Fort Peck	-1.4	1.9	-1.312	-4.3	-2.4	-0.8	0.1	0.3
	Garrison	-1.5	2.0	-1.359	-4.5	-2.7	-0.9	0.1	0.2
	Oahe	-1.8	2.6	-1.366	-5.7	-3.1	-0.8	0.1	0.5
	Big Bend	0.0	0.1	0.009	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.5	-0.998	-0.3	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.5	-0.225	-0.3	-0.1	0.0	0.1	0.3
Alt 5 Minus Alt 1	Fort Peck	-0.4	0.8	-3.105	-1.2	-0.6	-0.2	-0.1	0.2
	Garrison	-0.4	1.0	-4.783	-1.0	-0.6	-0.2	-0.1	0.2
	Oahe	-0.2	0.6	-0.922	-0.8	-0.5	-0.2	0.1	0.5
	Big Bend	0.0	0.1	-0.377	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.6	-3.219	-0.3	-0.1	0.0	0.1	0.3
	Gavins Point	0.0	0.5	-1.045	-0.3	-0.1	0.0	0.1	0.3
Alt 6 Minus Alt 1	Fort Peck	-0.8	1.0	-1.269	-2.1	-1.4	-0.6	0.0	0.2
	Garrison	-0.8	0.9	-0.939	-1.9	-1.4	-0.7	0.0	0.2
	Oahe	-1.3	1.5	-1.165	-3.4	-2.2	-0.9	-0.1	0.2
	Big Bend	0.0	0.1	-0.046	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.4	-1.325	-0.3	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.5	-0.816	-0.3	-0.1	0.0	0.1	0.3

Table 8-6: Summary statistics of release change between each alternative and Alt 1 for summer months grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	18	831	2.006	-400	-142	0	200	500
	Garrison	23	1,820	-0.884	-1,100	-377	0	400	1,100
	Oahe	-57	8,520	0.239	-10,000	-3,467	0	3,335	9,785
	Big Bend	-60	8,309	0.213	-9,822	-3,384	0	3,332	9,594
	Fort Randall	-44	6,736	0.351	-7,223	-1,884	0	1,665	6,663
	Gavins Point	-52	4,951	0.461	-4,000	-180	0	0	3,500
Alt 3 Minus Alt 1	Fort Peck	5	426	-1.294	-100	-1	0	9	100
	Garrison	-41	1,353	-6.638	-275	-100	0	57	230
	Oahe	-109	6,159	-0.208	-6,349	-2,123	0	2,036	6,017
	Big Bend	-108	5,934	-0.170	-6,307	-2,100	0	2,008	5,955
	Fort Randall	-109	3,935	-0.065	-3,215	-925	0	774	2,780
	Gavins Point	-110	1,055	-4.553	-79	0	0	0	55
Alt 4 Minus Alt 1	Fort Peck	115	1,168	0.029	-370	-100	0	100	1,239
	Garrison	112	3,824	3.388	-2,200	-571	-58	45	1,015
	Oahe	283	7,808	1.382	-6,666	-2,191	-1	1,670	6,673
	Big Bend	282	7,674	1.434	-6,672	-2,189	-1	1,669	6,956
	Fort Randall	299	6,599	1.973	-4,712	-1,468	-1	1,026	4,523
	Gavins Point	299	5,058	4.526	-1,942	-25	0	0	98
Alt 5 Minus Alt 1	Fort Peck	-20	688	-14.547	-200	-98	0	20	208
	Garrison	-241	1,724	-5.109	-1,050	-200	0	76	400
	Oahe	-377	6,487	-0.172	-7,087	-2,604	-2	1,889	5,639
	Big Bend	-374	6,227	-0.185	-7,001	-2,544	-2	1,861	5,661
	Fort Randall	-351	4,427	-0.560	-4,258	-1,132	0	814	2,814
	Gavins Point	-352	1,651	-5.426	-559	0	0	0	60
Alt 6 Minus Alt 1	Fort Peck	20	616	-0.159	-200	-100	0	100	464
	Garrison	5	1,587	-4.199	-578	-266	0	226	942
	Oahe	228	7,036	0.606	-6,234	-1,903	0	1,858	7,062
	Big Bend	231	6,839	0.673	-6,261	-1,886	0	1,869	7,157
	Fort Randall	257	5,601	1.151	-4,146	-1,258	0	1,106	4,806
	Gavins Point	260	3,698	4.132	-1,000	-77	0	0	160

Table 8-7: Summary statistics of elevation change between each alternative and Alt 1 for fall months grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	-0.6	2.1	-1.260	-4.2	-1.3	0.1	0.8	1.5
	Garrison	-0.6	1.8	-1.163	-3.7	-1.3	-0.4	0.6	1.2
	Oahe	-1.2	2.3	-0.673	-4.4	-2.4	-0.9	0.4	1.3
	Big Bend	0.0	0.1	-0.129	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.9	1.329	-0.4	-0.1	0.0	0.2	0.5
	Gavins Point	0.0	0.5	0.526	-0.3	-0.1	0.0	0.1	0.3
Alt 3 Minus Alt 1	Fort Peck	0.1	0.2	0.544	-0.1	-0.1	0.1	0.2	0.4
	Garrison	0.1	0.3	0.647	-0.3	-0.1	0.1	0.2	0.5
	Oahe	0.1	0.4	0.140	-0.3	0.0	0.1	0.3	0.6
	Big Bend	0.0	0.1	-0.249	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.5	1.358	-0.3	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-1.412	-0.2	-0.1	0.0	0.1	0.2
Alt 4 Minus Alt 1	Fort Peck	-1.5	2.0	-1.321	-4.4	-2.5	-0.8	0.1	0.3
	Garrison	-1.4	2.0	-1.473	-4.2	-2.5	-0.6	0.1	0.3
	Oahe	-1.8	2.6	-1.408	-5.8	-3.1	-0.9	0.1	0.5
	Big Bend	0.0	0.1	0.016	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.8	-0.027	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-0.219	-0.3	-0.1	0.0	0.1	0.3
Alt 5 Minus Alt 1	Fort Peck	-0.4	0.8	-2.898	-1.2	-0.6	-0.2	-0.1	0.2
	Garrison	-0.4	1.0	-4.345	-1.1	-0.6	-0.2	-0.1	0.3
	Oahe	-0.2	0.7	-0.497	-0.8	-0.5	-0.2	0.1	0.6
	Big Bend	0.0	0.1	-0.407	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.6	-3.821	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.5	-1.121	-0.2	-0.1	0.0	0.1	0.2
Alt 6 Minus Alt 1	Fort Peck	-0.9	1.0	-1.251	-2.1	-1.4	-0.7	0.0	0.2
	Garrison	-0.8	0.9	-0.897	-1.9	-1.4	-0.7	0.0	0.2
	Oahe	-1.3	1.5	-1.152	-3.4	-2.1	-0.9	-0.1	0.2
	Big Bend	0.0	0.1	-0.061	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.5	-0.654	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-0.961	-0.3	-0.1	0.0	0.1	0.3

Table 8-8: Summary statistics of release change between each alternative and Alt 1 for fall months grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	9	836	1.551	-500	-152	0	200	500
	Garrison	7	1,823	-0.682	-1,300	-400	0	433	1,214
	Oahe	177	8,324	0.412	-8,929	-3,278	0	3,338	9,409
	Big Bend	173	8,177	0.394	-8,961	-3,170	0	3,336	9,369
	Fort Randall	179	6,405	0.297	-6,295	-1,553	0	1,822	6,403
	Gavins Point	172	4,795	0.419	-2,466	-78	0	85	4,000
Alt 3 Minus Alt 1	Fort Peck	0	387	-1.329	-100	-6	0	8	100
	Garrison	-8	1,189	-7.114	-275	-100	0	77	292
	Oahe	-25	6,253	-0.205	-6,036	-2,042	0	2,104	5,960
	Big Bend	-30	6,104	-0.186	-6,232	-2,038	0	2,100	6,143
	Fort Randall	-13	3,749	-0.038	-2,921	-809	0	813	2,850
	Gavins Point	-17	1,087	-1.837	-59	0	0	0	90
Alt 4 Minus Alt 1	Fort Peck	16	1,104	0.120	-573	-160	0	26	575
	Garrison	5	3,364	3.631	-2,200	-550	-63	83	1,015
	Oahe	53	7,568	1.009	-6,664	-2,240	-2	1,668	6,313
	Big Bend	48	7,478	1.051	-6,817	-2,269	-2	1,668	6,663
	Fort Randall	57	6,037	1.801	-4,468	-1,413	-31	924	3,912
	Gavins Point	53	4,568	4.326	-2,000	-40	0	0	92
Alt 5 Minus Alt 1	Fort Peck	4	714	-8.589	-200	-100	0	22	242
	Garrison	67	3,038	5.038	-1,050	-200	0	100	600
	Oahe	41	7,247	0.773	-6,742	-2,357	0	2,095	6,488
	Big Bend	37	7,054	0.812	-6,878	-2,367	0	2,088	6,587
	Fort Randall	41	5,017	1.578	-3,849	-1,105	0	921	3,332
	Gavins Point	38	3,088	5.672	-479	0	0	0	115
Alt 6 Minus Alt 1	Fort Peck	9	590	-0.114	-282	-100	0	100	409
	Garrison	15	1,500	-3.987	-681	-277	0	264	1,092
	Oahe	52	6,809	0.390	-6,228	-2,010	-1	1,677	6,515
	Big Bend	49	6,675	0.428	-6,383	-2,001	0	1,706	6,667
	Fort Randall	62	5,198	0.989	-4,093	-1,300	0	936	4,259
	Gavins Point	59	3,367	3.811	-1,316	-106	0	0	115

Table 8-9: Summary statistics of elevation change between each alternative and Alt 1 for winter months grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	-0.6	2.1	-1.260	-4.2	-1.3	0.1	0.8	1.5
	Garrison	-0.6	1.8	-1.166	-3.7	-1.3	-0.4	0.6	1.2
	Oahe	0.1	0.9	1.331	-0.4	-0.1	0.0	0.2	0.5
	Big Bend	0.0	0.1	-0.115	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.1	0.9	1.331	-0.4	-0.1	0.0	0.2	0.5
	Gavins Point	0.0	0.5	0.493	-0.3	-0.1	0.0	0.1	0.3
Alt 3 Minus Alt 1	Fort Peck	0.1	0.2	0.539	-0.1	-0.1	0.1	0.2	0.4
	Garrison	0.1	0.3	0.604	-0.3	-0.1	0.1	0.2	0.5
	Oahe	0.0	0.5	1.305	-0.3	-0.1	0.0	0.1	0.4
	Big Bend	0.0	0.1	-0.269	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.5	1.305	-0.3	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-1.376	-0.2	-0.1	0.0	0.1	0.2
Alt 4 Minus Alt 1	Fort Peck	-1.5	2.0	-1.330	-4.4	-2.5	-0.8	0.1	0.3
	Garrison	-1.4	2.0	-1.487	-4.1	-2.5	-0.6	0.1	0.3
	Oahe	0.0	0.8	-0.165	-0.4	-0.1	0.0	0.1	0.4
	Big Bend	0.0	0.1	0.023	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.8	-0.165	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-0.231	-0.3	-0.1	0.0	0.1	0.3
Alt 5 Minus Alt 1	Fort Peck	-0.4	0.8	-2.837	-1.2	-0.6	-0.2	-0.1	0.2
	Garrison	-0.5	1.1	-4.346	-1.1	-0.6	-0.2	-0.1	0.3
	Oahe	0.0	0.6	-3.758	-0.4	-0.1	0.0	0.1	0.4
	Big Bend	0.0	0.1	-0.433	-0.2	-0.1	0.0	0.1	0.1
	Fort Randall	0.0	0.6	-3.758	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.5	-1.015	-0.3	-0.1	0.0	0.1	0.2
Alt 6 Minus Alt 1	Fort Peck	-0.9	1.0	-1.249	-2.1	-1.4	-0.7	0.0	0.2
	Garrison	-0.8	0.9	-0.899	-1.9	-1.4	-0.7	0.0	0.2
	Oahe	0.0	0.5	-0.608	-0.4	-0.1	0.0	0.1	0.4
	Big Bend	0.0	0.1	-0.061	-0.2	-0.1	0.0	0.1	0.2
	Fort Randall	0.0	0.5	-0.608	-0.4	-0.1	0.0	0.1	0.4
	Gavins Point	0.0	0.4	-0.960	-0.3	-0.1	0.0	0.1	0.3

Table 8-10: Summary statistics of release change between each alternative and Alt 1 for winter months grouped by alternative. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Alt 2 Minus Alt 1	Fort Peck	1	816	1.521	-500	-153	0	200	500
	Garrison	3	1,768	-0.703	-1,286	-400	0	420	1,200
	Oahe	16	6,329	0.263	-6,667	-1,696	0	1,669	6,172
	Big Bend	17	8,099	0.376	-9,149	-3,334	0	3,288	9,117
	Fort Randall	16	6,329	0.263	-6,667	-1,696	0	1,669	6,172
	Gavins Point	16	4,728	0.373	-3,000	-114	0	14	3,500
Alt 3 Minus Alt 1	Fort Peck	-2	375	-1.362	-100	-7	0	8	100
	Garrison	-6	1,141	-7.382	-273	-100	0	84	292
	Oahe	-11	3,734	-0.043	-2,960	-854	0	863	2,953
	Big Bend	-10	6,067	-0.165	-6,232	-2,058	0	2,142	6,254
	Fort Randall	-11	3,734	-0.043	-2,960	-854	0	863	2,953
	Gavins Point	-11	1,059	-1.576	-59	0	0	0	90
Alt 4 Minus Alt 1	Fort Peck	5	1,067	0.146	-573	-169	0	21	546
	Garrison	11	3,225	3.767	-2,029	-492	-16	100	1,015
	Oahe	25	5,882	1.783	-4,453	-1,438	-30	927	3,889
	Big Bend	25	7,319	1.033	-6,781	-2,266	-4	1,668	6,621
	Fort Randall	25	5,882	1.783	-4,453	-1,438	-30	927	3,889
	Gavins Point	25	4,385	4.489	-2,000	-34	0	0	92
Alt 5 Minus Alt 1	Fort Peck	5	695	-8.424	-200	-100	0	23	242
	Garrison	12	2,982	4.790	-1,050	-200	0	100	596
	Oahe	14	4,960	1.500	-3,904	-1,110	0	928	3,332
	Big Bend	15	6,978	0.795	-6,939	-2,418	0	2,078	6,608
	Fort Randall	14	4,960	1.500	-3,904	-1,110	0	928	3,332
	Gavins Point	14	3,005	5.626	-466	0	0	0	115
Alt 6 Minus Alt 1	Fort Peck	8	576	-0.129	-284	-100	0	100	409
	Garrison	20	1,446	-4.082	-679	-255	0	248	1,050
	Oahe	41	5,082	0.967	-4,078	-1,298	0	952	4,149
	Big Bend	41	6,572	0.415	-6,359	-2,019	0	1,691	6,658
	Fort Randall	41	5,082	0.967	-4,078	-1,298	0	952	4,149
	Gavins Point	41	3,233	3.954	-1,080	-100	0	0	100

Table 8-11: Summary statistics of elevation change between each alternative and Alt 1 for all days in the period-of-record grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	-0.6	2.1	-1.260	-4.2	-1.3	0.1	0.8	1.5
	Alt 3 Minus Alt 1	0.1	0.2	0.539	-0.1	-0.1	0.1	0.2	0.4
	Alt 4 Minus Alt 1	-1.5	2.0	-1.330	-4.4	-2.5	-0.8	0.1	0.3
	Alt 5 Minus Alt 1	-0.4	0.8	-2.837	-1.2	-0.6	-0.2	-0.1	0.2
	Alt 6 Minus Alt 1	-0.9	1.0	-1.249	-2.1	-1.4	-0.7	0.0	0.2
Garrison	Alt 2 Minus Alt 1	-0.6	1.8	-1.166	-3.7	-1.3	-0.4	0.6	1.2
	Alt 3 Minus Alt 1	0.1	0.3	0.604	-0.3	-0.1	0.1	0.2	0.5
	Alt 4 Minus Alt 1	-1.4	2.0	-1.487	-4.1	-2.5	-0.6	0.1	0.3
	Alt 5 Minus Alt 1	-0.5	1.1	-4.346	-1.1	-0.6	-0.2	-0.1	0.3
	Alt 6 Minus Alt 1	-0.8	0.9	-0.899	-1.9	-1.4	-0.7	0.0	0.2
Oahe	Alt 2 Minus Alt 1	-1.2	2.3	-0.655	-4.4	-2.4	-1.0	0.4	1.3
	Alt 3 Minus Alt 1	0.1	0.4	0.144	-0.3	-0.1	0.1	0.3	0.6
	Alt 4 Minus Alt 1	-1.8	2.6	-1.423	-5.7	-3.1	-0.9	0.1	0.4
	Alt 5 Minus Alt 1	-0.2	0.7	-0.483	-0.8	-0.5	-0.2	0.1	0.6
	Alt 6 Minus Alt 1	-1.3	1.5	-1.161	-3.3	-2.1	-0.9	-0.1	0.2
Big Bend	Alt 2 Minus Alt 1	0.0	0.1	-0.115	-0.2	-0.1	0.0	0.1	0.2
	Alt 3 Minus Alt 1	0.0	0.1	-0.269	-0.2	-0.1	0.0	0.1	0.2
	Alt 4 Minus Alt 1	0.0	0.1	0.023	-0.2	-0.1	0.0	0.1	0.2
	Alt 5 Minus Alt 1	0.0	0.1	-0.433	-0.2	-0.1	0.0	0.1	0.1
	Alt 6 Minus Alt 1	0.0	0.1	-0.061	-0.2	-0.1	0.0	0.1	0.2
Fort Randall	Alt 2 Minus Alt 1	0.1	0.9	1.331	-0.4	-0.1	0.0	0.2	0.5
	Alt 3 Minus Alt 1	0.0	0.5	1.305	-0.3	-0.1	0.0	0.1	0.4
	Alt 4 Minus Alt 1	0.0	0.8	-0.165	-0.4	-0.1	0.0	0.1	0.4
	Alt 5 Minus Alt 1	0.0	0.6	-3.758	-0.4	-0.1	0.0	0.1	0.4
	Alt 6 Minus Alt 1	0.0	0.5	-0.608	-0.4	-0.1	0.0	0.1	0.4
Gavins Point	Alt 2 Minus Alt 1	0.0	0.5	0.493	-0.3	-0.1	0.0	0.1	0.3
	Alt 3 Minus Alt 1	0.0	0.4	-1.376	-0.2	-0.1	0.0	0.1	0.2
	Alt 4 Minus Alt 1	0.0	0.4	-0.231	-0.3	-0.1	0.0	0.1	0.3
	Alt 5 Minus Alt 1	0.0	0.5	-1.015	-0.3	-0.1	0.0	0.1	0.2
	Alt 6 Minus Alt 1	0.0	0.4	-0.960	-0.3	-0.1	0.0	0.1	0.3

Table 8-12: Summary statistics of release change between each alternative and Alt 1 for all days in the period-of-record grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	1	816	1.521	-500	-153	0	200	500
	Alt 3 Minus Alt 1	-2	375	-1.362	-100	-7	0	8	100
	Alt 4 Minus Alt 1	5	1,067	0.146	-573	-169	0	21	546
	Alt 5 Minus Alt 1	5	695	-8.424	-200	-100	0	23	242
	Alt 6 Minus Alt 1	8	576	-0.129	-284	-100	0	100	409
Garrison	Alt 2 Minus Alt 1	3	1,768	-0.703	-1,286	-400	0	420	1,200
	Alt 3 Minus Alt 1	-6	1,141	-7.382	-273	-100	0	84	292
	Alt 4 Minus Alt 1	11	3,225	3.767	-2,029	-492	-16	100	1,015
	Alt 5 Minus Alt 1	12	2,982	4.790	-1,050	-200	0	100	596
	Alt 6 Minus Alt 1	20	1,446	-4.082	-679	-255	0	248	1,050
Oahe	Alt 2 Minus Alt 1	18	8,257	0.389	-9,156	-3,336	0	3,327	9,189
	Alt 3 Minus Alt 1	-9	6,231	-0.184	-6,113	-2,087	0	2,155	6,181
	Alt 4 Minus Alt 1	26	7,420	0.987	-6,666	-2,239	-3	1,668	6,292
	Alt 5 Minus Alt 1	15	7,185	0.747	-6,862	-2,419	-1	2,079	6,571
	Alt 6 Minus Alt 1	41	6,721	0.378	-6,229	-2,044	-1	1,677	6,515
Big Bend	Alt 2 Minus Alt 1	17	8,099	0.376	-9,149	-3,334	0	3,288	9,117
	Alt 3 Minus Alt 1	-10	6,067	-0.165	-6,232	-2,058	0	2,142	6,254
	Alt 4 Minus Alt 1	25	7,319	1.033	-6,781	-2,266	-4	1,668	6,621
	Alt 5 Minus Alt 1	15	6,978	0.795	-6,939	-2,418	0	2,078	6,608
	Alt 6 Minus Alt 1	41	6,572	0.415	-6,359	-2,019	0	1,691	6,658
Fort Randall	Alt 2 Minus Alt 1	16	6,329	0.263	-6,667	-1,696	0	1,669	6,172
	Alt 3 Minus Alt 1	-11	3,734	-0.043	-2,960	-854	0	863	2,953
	Alt 4 Minus Alt 1	25	5,882	1.783	-4,453	-1,438	-30	927	3,889
	Alt 5 Minus Alt 1	14	4,960	1.500	-3,904	-1,110	0	928	3,332
	Alt 6 Minus Alt 1	41	5,082	0.967	-4,078	-1,298	0	952	4,149
Gavins Point	Alt 2 Minus Alt 1	16	4,728	0.373	-3,000	-114	0	14	3,500
	Alt 3 Minus Alt 1	-11	1,059	-1.576	-59	0	0	0	90
	Alt 4 Minus Alt 1	25	4,385	4.489	-2,000	-34	0	0	92
	Alt 5 Minus Alt 1	14	3,005	5.626	-466	0	0	0	115
	Alt 6 Minus Alt 1	41	3,233	3.954	-1,080	-100	0	0	100

Table 8-13: Summary statistics of elevation change between each alternative and Alt 1 for spring months grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	-0.5	2.1	-1.322	-4.2	-1.3	0.2	0.8	1.6
	Alt 3 Minus Alt 1	0.1	0.2	0.874	-0.1	-0.1	0.1	0.2	0.4
	Alt 4 Minus Alt 1	-1.2	1.8	-1.437	-3.9	-2.0	-0.6	0.1	0.3
	Alt 5 Minus Alt 1	-0.4	0.8	-3.159	-1.2	-0.7	-0.2	-0.1	0.2
	Alt 6 Minus Alt 1	-0.8	1.0	-1.244	-2.1	-1.4	-0.6	0.0	0.2
Garrison	Alt 2 Minus Alt 1	-0.6	1.8	-1.060	-3.8	-1.3	-0.5	0.7	1.3
	Alt 3 Minus Alt 1	0.0	0.3	-0.213	-0.3	-0.1	0.0	0.2	0.3
	Alt 4 Minus Alt 1	-1.5	1.8	-1.024	-4.1	-2.5	-0.9	0.1	0.2
	Alt 5 Minus Alt 1	-0.5	1.0	-5.133	-0.9	-0.6	-0.2	-0.1	0.1
	Alt 6 Minus Alt 1	-0.8	0.9	-0.952	-1.9	-1.5	-0.7	0.0	0.2
Oahe	Alt 2 Minus Alt 1	-0.6	2.3	-0.800	-4.4	-1.6	-0.2	1.0	2.0
	Alt 3 Minus Alt 1	0.1	0.3	0.131	-0.3	-0.1	0.1	0.3	0.5
	Alt 4 Minus Alt 1	-1.7	2.5	-1.610	-5.5	-3.0	-0.8	0.1	0.4
	Alt 5 Minus Alt 1	-0.3	0.6	-2.083	-0.7	-0.5	-0.2	0.0	0.4
	Alt 6 Minus Alt 1	-1.2	1.3	-0.929	-3.0	-2.0	-1.0	-0.1	0.2
Big Bend	Alt 2 Minus Alt 1	0.0	0.1	-0.681	-0.2	-0.1	0.0	0.1	0.2
	Alt 3 Minus Alt 1	0.0	0.1	-0.202	-0.2	-0.1	0.0	0.1	0.2
	Alt 4 Minus Alt 1	0.0	0.1	-0.116	-0.2	-0.1	0.0	0.1	0.1
	Alt 5 Minus Alt 1	0.0	0.1	-0.341	-0.2	-0.1	0.0	0.1	0.1
	Alt 6 Minus Alt 1	0.0	0.1	-0.160	-0.2	-0.1	0.0	0.1	0.2
Fort Randall	Alt 2 Minus Alt 1	0.1	0.9	6.705	-0.4	-0.1	0.0	0.2	0.6
	Alt 3 Minus Alt 1	0.0	0.4	0.450	-0.3	-0.1	0.0	0.1	0.4
	Alt 4 Minus Alt 1	0.0	0.4	1.208	-0.3	-0.1	0.0	0.1	0.4
	Alt 5 Minus Alt 1	0.0	0.5	-2.778	-0.3	-0.1	0.0	0.2	0.4
	Alt 6 Minus Alt 1	0.0	0.4	1.218	-0.4	-0.1	0.0	0.1	0.4
Gavins Point	Alt 2 Minus Alt 1	0.0	0.6	2.958	-0.5	-0.1	0.0	0.1	0.5
	Alt 3 Minus Alt 1	0.0	0.3	-0.430	-0.3	-0.1	0.0	0.1	0.3
	Alt 4 Minus Alt 1	0.0	0.5	0.398	-0.4	-0.1	0.0	0.1	0.5
	Alt 5 Minus Alt 1	0.0	0.4	-0.022	-0.4	-0.1	0.0	0.1	0.4
	Alt 6 Minus Alt 1	0.0	0.4	-0.219	-0.4	-0.1	0.0	0.1	0.5

Table 8-14: Summary statistics of release change between each alternative and Alt 1 for spring months grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	37	466	3.915	-200	-136	0	200	400
	Alt 3 Minus Alt 1	-5	105	-7.655	-100	0	0	11	87
	Alt 4 Minus Alt 1	110	652	2.826	-327	-100	0	100	593
	Alt 5 Minus Alt 1	-6	275	-0.088	-200	-65	0	0	176
	Alt 6 Minus Alt 1	22	360	4.232	-206	-100	0	33	400
Garrison	Alt 2 Minus Alt 1	-167	870	-0.998	-1,134	-546	0	200	657
	Alt 3 Minus Alt 1	-28	254	0.601	-169	-53	0	0	100
	Alt 4 Minus Alt 1	1,516	5,563	3.142	-900	-232	0	142	2,900
	Alt 5 Minus Alt 1	-133	826	-5.151	-450	-100	0	0	163
	Alt 6 Minus Alt 1	61	710	-0.410	-445	-200	0	100	1,114
Oahe	Alt 2 Minus Alt 1	-421	8,629	0.564	-10,975	-3,797	0	3,332	9,282
	Alt 3 Minus Alt 1	-168	6,300	-0.191	-6,964	-2,523	0	2,086	6,668
	Alt 4 Minus Alt 1	2,004	10,454	1.869	-6,664	-1,710	0	3,120	12,021
	Alt 5 Minus Alt 1	-439	6,408	-0.254	-8,092	-2,663	0	1,950	6,591
	Alt 6 Minus Alt 1	1,122	8,407	1.014	-6,668	-1,670	0	3,329	10,754
Big Bend	Alt 2 Minus Alt 1	-427	8,289	0.425	-10,368	-3,357	0	3,004	8,762
	Alt 3 Minus Alt 1	-166	5,882	-0.165	-6,559	-2,281	0	1,924	6,447
	Alt 4 Minus Alt 1	1,993	10,240	1.944	-6,230	-1,710	0	2,741	11,757
	Alt 5 Minus Alt 1	-428	6,029	-0.325	-7,213	-2,556	0	1,855	5,963
	Alt 6 Minus Alt 1	1,119	8,093	1.108	-6,185	-1,668	0	2,948	10,030
Fort Randall	Alt 2 Minus Alt 1	-462	6,146	-0.150	-6,737	-1,835	0	1,667	5,370
	Alt 3 Minus Alt 1	-170	3,373	-0.587	-3,147	-926	0	741	2,814
	Alt 4 Minus Alt 1	1,973	9,148	2.252	-4,418	-1,112	0	1,481	9,078
	Alt 5 Minus Alt 1	-381	4,005	-0.767	-4,709	-1,310	0	911	3,149
	Alt 6 Minus Alt 1	1,178	6,638	1.932	-4,075	-1,111	0	1,882	7,688
Gavins Point	Alt 2 Minus Alt 1	-527	4,648	-0.376	-2,553	0	0	102	2,000
	Alt 3 Minus Alt 1	-151	787	-5.889	-190	0	0	0	58
	Alt 4 Minus Alt 1	1,890	8,017	3.147	-942	0	0	0	246
	Alt 5 Minus Alt 1	-361	1,420	-5.866	-722	0	0	0	31
	Alt 6 Minus Alt 1	1,194	5,177	3.329	-500	0	0	0	4,114

Table 8-15: Summary statistics of elevation change between each alternative and Alt 1 for summer months grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	-0.6	2.1	-1.278	-4.1	-1.3	0.1	0.8	1.5
	Alt 3 Minus Alt 1	0.1	0.2	0.806	-0.1	-0.1	0.1	0.2	0.4
	Alt 4 Minus Alt 1	-1.4	1.9	-1.312	-4.3	-2.4	-0.8	0.1	0.3
	Alt 5 Minus Alt 1	-0.4	0.8	-3.105	-1.2	-0.6	-0.2	-0.1	0.2
	Alt 6 Minus Alt 1	-0.8	1.0	-1.269	-2.1	-1.4	-0.6	0.0	0.2
Garrison	Alt 2 Minus Alt 1	-0.6	1.8	-1.131	-3.7	-1.3	-0.4	0.7	1.3
	Alt 3 Minus Alt 1	0.1	0.3	0.505	-0.3	-0.1	0.1	0.2	0.4
	Alt 4 Minus Alt 1	-1.5	2.0	-1.359	-4.5	-2.7	-0.9	0.1	0.2
	Alt 5 Minus Alt 1	-0.4	1.0	-4.783	-1.0	-0.6	-0.2	-0.1	0.2
	Alt 6 Minus Alt 1	-0.8	0.9	-0.939	-1.9	-1.4	-0.7	0.0	0.2
Oahe	Alt 2 Minus Alt 1	-1.2	2.3	-0.858	-4.5	-2.3	-0.8	0.4	1.3
	Alt 3 Minus Alt 1	0.1	0.4	0.340	-0.3	0.0	0.1	0.3	0.6
	Alt 4 Minus Alt 1	-1.8	2.6	-1.366	-5.7	-3.1	-0.8	0.1	0.5
	Alt 5 Minus Alt 1	-0.2	0.6	-0.922	-0.8	-0.5	-0.2	0.1	0.5
	Alt 6 Minus Alt 1	-1.3	1.5	-1.165	-3.4	-2.2	-0.9	-0.1	0.2
Big Bend	Alt 2 Minus Alt 1	0.0	0.1	-0.171	-0.2	-0.1	0.0	0.1	0.2
	Alt 3 Minus Alt 1	0.0	0.1	-0.202	-0.2	-0.1	0.0	0.1	0.1
	Alt 4 Minus Alt 1	0.0	0.1	0.009	-0.2	-0.1	0.0	0.1	0.1
	Alt 5 Minus Alt 1	0.0	0.1	-0.377	-0.2	-0.1	0.0	0.1	0.1
	Alt 6 Minus Alt 1	0.0	0.1	-0.046	-0.2	-0.1	0.0	0.1	0.2
Fort Randall	Alt 2 Minus Alt 1	0.1	0.9	4.489	-0.3	-0.1	0.0	0.2	0.5
	Alt 3 Minus Alt 1	0.0	0.4	0.430	-0.3	-0.1	0.0	0.1	0.3
	Alt 4 Minus Alt 1	0.0	0.5	-0.998	-0.3	-0.1	0.0	0.1	0.4
	Alt 5 Minus Alt 1	0.0	0.6	-3.219	-0.3	-0.1	0.0	0.1	0.3
	Alt 6 Minus Alt 1	0.0	0.4	-1.325	-0.3	-0.1	0.0	0.1	0.4
Gavins Point	Alt 2 Minus Alt 1	0.0	0.6	0.517	-0.4	-0.1	0.0	0.1	0.4
	Alt 3 Minus Alt 1	0.0	0.4	-1.255	-0.2	-0.1	0.0	0.1	0.2
	Alt 4 Minus Alt 1	0.0	0.5	-0.225	-0.3	-0.1	0.0	0.1	0.3
	Alt 5 Minus Alt 1	0.0	0.5	-1.045	-0.3	-0.1	0.0	0.1	0.3
	Alt 6 Minus Alt 1	0.0	0.5	-0.816	-0.3	-0.1	0.0	0.1	0.3

Table 8-16: Summary statistics of release change between each alternative and Alt 1 for summer months grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	18	831	2.006	-400	-142	0	200	500
	Alt 3 Minus Alt 1	5	426	-1.294	-100	-1	0	9	100
	Alt 4 Minus Alt 1	115	1,168	0.029	-370	-100	0	100	1,239
	Alt 5 Minus Alt 1	-20	688	-14.547	-200	-98	0	20	208
	Alt 6 Minus Alt 1	20	616	-0.159	-200	-100	0	100	464
Garrison	Alt 2 Minus Alt 1	23	1,820	-0.884	-1,100	-377	0	400	1,100
	Alt 3 Minus Alt 1	-41	1,353	-6.638	-275	-100	0	57	230
	Alt 4 Minus Alt 1	112	3,824	3.388	-2,200	-571	-58	45	1,015
	Alt 5 Minus Alt 1	-241	1,724	-5.109	-1,050	-200	0	76	400
	Alt 6 Minus Alt 1	5	1,587	-4.199	-578	-266	0	226	942
Oahe	Alt 2 Minus Alt 1	-57	8,520	0.239	-10,000	-3,467	0	3,335	9,785
	Alt 3 Minus Alt 1	-109	6,159	-0.208	-6,349	-2,123	0	2,036	6,017
	Alt 4 Minus Alt 1	283	7,808	1.382	-6,666	-2,191	-1	1,670	6,673
	Alt 5 Minus Alt 1	-377	6,487	-0.172	-7,087	-2,604	-2	1,889	5,639
	Alt 6 Minus Alt 1	228	7,036	0.606	-6,234	-1,903	0	1,858	7,062
Big Bend	Alt 2 Minus Alt 1	-60	8,309	0.213	-9,822	-3,384	0	3,332	9,594
	Alt 3 Minus Alt 1	-108	5,934	-0.170	-6,307	-2,100	0	2,008	5,955
	Alt 4 Minus Alt 1	282	7,674	1.434	-6,672	-2,189	-1	1,669	6,956
	Alt 5 Minus Alt 1	-374	6,227	-0.185	-7,001	-2,544	-2	1,861	5,661
	Alt 6 Minus Alt 1	231	6,839	0.673	-6,261	-1,886	0	1,869	7,157
Fort Randall	Alt 2 Minus Alt 1	-44	6,736	0.351	-7,223	-1,884	0	1,665	6,663
	Alt 3 Minus Alt 1	-109	3,935	-0.065	-3,215	-925	0	774	2,780
	Alt 4 Minus Alt 1	299	6,599	1.973	-4,712	-1,468	-1	1,026	4,523
	Alt 5 Minus Alt 1	-351	4,427	-0.560	-4,258	-1,132	0	814	2,814
	Alt 6 Minus Alt 1	257	5,601	1.151	-4,146	-1,258	0	1,106	4,806
Gavins Point	Alt 2 Minus Alt 1	-52	4,951	0.461	-4,000	-180	0	0	3,500
	Alt 3 Minus Alt 1	-110	1,055	-4.553	-79	0	0	0	55
	Alt 4 Minus Alt 1	299	5,058	4.526	-1,942	-25	0	0	98
	Alt 5 Minus Alt 1	-352	1,651	-5.426	-559	0	0	0	60
	Alt 6 Minus Alt 1	260	3,698	4.132	-1,000	-77	0	0	160

Table 8-17: Summary statistics of elevation change between each alternative and Alt 1 for fall months grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	-0.6	2.1	-1.260	-4.2	-1.3	0.1	0.8	1.5
	Alt 3 Minus Alt 1	0.1	0.2	0.544	-0.1	-0.1	0.1	0.2	0.4
	Alt 4 Minus Alt 1	-1.5	2.0	-1.321	-4.4	-2.5	-0.8	0.1	0.3
	Alt 5 Minus Alt 1	-0.4	0.8	-2.898	-1.2	-0.6	-0.2	-0.1	0.2
	Alt 6 Minus Alt 1	-0.9	1.0	-1.251	-2.1	-1.4	-0.7	0.0	0.2
Garrison	Alt 2 Minus Alt 1	-0.6	1.8	-1.163	-3.7	-1.3	-0.4	0.6	1.2
	Alt 3 Minus Alt 1	0.1	0.3	0.647	-0.3	-0.1	0.1	0.2	0.5
	Alt 4 Minus Alt 1	-1.4	2.0	-1.473	-4.2	-2.5	-0.6	0.1	0.3
	Alt 5 Minus Alt 1	-0.4	1.0	-4.345	-1.1	-0.6	-0.2	-0.1	0.3
	Alt 6 Minus Alt 1	-0.8	0.9	-0.897	-1.9	-1.4	-0.7	0.0	0.2
Oahe	Alt 2 Minus Alt 1	-1.2	2.3	-0.673	-4.4	-2.4	-0.9	0.4	1.3
	Alt 3 Minus Alt 1	0.1	0.4	0.140	-0.3	0.0	0.1	0.3	0.6
	Alt 4 Minus Alt 1	-1.8	2.6	-1.408	-5.8	-3.1	-0.9	0.1	0.5
	Alt 5 Minus Alt 1	-0.2	0.7	-0.497	-0.8	-0.5	-0.2	0.1	0.6
	Alt 6 Minus Alt 1	-1.3	1.5	-1.152	-3.4	-2.1	-0.9	-0.1	0.2
Big Bend	Alt 2 Minus Alt 1	0.0	0.1	-0.129	-0.2	-0.1	0.0	0.1	0.2
	Alt 3 Minus Alt 1	0.0	0.1	-0.249	-0.2	-0.1	0.0	0.1	0.1
	Alt 4 Minus Alt 1	0.0	0.1	0.016	-0.2	-0.1	0.0	0.1	0.1
	Alt 5 Minus Alt 1	0.0	0.1	-0.407	-0.2	-0.1	0.0	0.1	0.1
	Alt 6 Minus Alt 1	0.0	0.1	-0.061	-0.2	-0.1	0.0	0.1	0.2
Fort Randall	Alt 2 Minus Alt 1	0.0	0.9	1.329	-0.4	-0.1	0.0	0.2	0.5
	Alt 3 Minus Alt 1	0.0	0.5	1.358	-0.3	-0.1	0.0	0.1	0.4
	Alt 4 Minus Alt 1	0.0	0.8	-0.027	-0.4	-0.1	0.0	0.1	0.4
	Alt 5 Minus Alt 1	0.0	0.6	-3.821	-0.4	-0.1	0.0	0.1	0.4
	Alt 6 Minus Alt 1	0.0	0.5	-0.654	-0.4	-0.1	0.0	0.1	0.4
Gavins Point	Alt 2 Minus Alt 1	0.0	0.5	0.526	-0.3	-0.1	0.0	0.1	0.3
	Alt 3 Minus Alt 1	0.0	0.4	-1.412	-0.2	-0.1	0.0	0.1	0.2
	Alt 4 Minus Alt 1	0.0	0.4	-0.219	-0.3	-0.1	0.0	0.1	0.3
	Alt 5 Minus Alt 1	0.0	0.5	-1.121	-0.2	-0.1	0.0	0.1	0.2
	Alt 6 Minus Alt 1	0.0	0.4	-0.961	-0.3	-0.1	0.0	0.1	0.3

Table 8-18: Summary statistics of release change between each alternative and Alt 1 for fall months grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	9	836	1.551	-500	-152	0	200	500
	Alt 3 Minus Alt 1	0	387	-1.329	-100	-6	0	8	100
	Alt 4 Minus Alt 1	16	1,104	0.120	-573	-160	0	26	575
	Alt 5 Minus Alt 1	4	714	-8.589	-200	-100	0	22	242
	Alt 6 Minus Alt 1	9	590	-0.114	-282	-100	0	100	409
Garrison	Alt 2 Minus Alt 1	7	1,823	-0.682	-1,300	-400	0	433	1,214
	Alt 3 Minus Alt 1	-8	1,189	-7.114	-275	-100	0	77	292
	Alt 4 Minus Alt 1	5	3,364	3.631	-2,200	-550	-63	83	1,015
	Alt 5 Minus Alt 1	67	3,038	5.038	-1,050	-200	0	100	600
	Alt 6 Minus Alt 1	15	1,500	-3.987	-681	-277	0	264	1,092
Oahe	Alt 2 Minus Alt 1	177	8,324	0.412	-8,929	-3,278	0	3,338	9,409
	Alt 3 Minus Alt 1	-25	6,253	-0.205	-6,036	-2,042	0	2,104	5,960
	Alt 4 Minus Alt 1	53	7,568	1.009	-6,664	-2,240	-2	1,668	6,313
	Alt 5 Minus Alt 1	41	7,247	0.773	-6,742	-2,357	0	2,095	6,488
	Alt 6 Minus Alt 1	52	6,809	0.390	-6,228	-2,010	-1	1,677	6,515
Big Bend	Alt 2 Minus Alt 1	173	8,177	0.394	-8,961	-3,170	0	3,336	9,369
	Alt 3 Minus Alt 1	-30	6,104	-0.186	-6,232	-2,038	0	2,100	6,143
	Alt 4 Minus Alt 1	48	7,478	1.051	-6,817	-2,269	-2	1,668	6,663
	Alt 5 Minus Alt 1	37	7,054	0.812	-6,878	-2,367	0	2,088	6,587
	Alt 6 Minus Alt 1	49	6,675	0.428	-6,383	-2,001	0	1,706	6,667
Fort Randall	Alt 2 Minus Alt 1	179	6,405	0.297	-6,295	-1,553	0	1,822	6,403
	Alt 3 Minus Alt 1	-13	3,749	-0.038	-2,921	-809	0	813	2,850
	Alt 4 Minus Alt 1	57	6,037	1.801	-4,468	-1,413	-31	924	3,912
	Alt 5 Minus Alt 1	41	5,017	1.578	-3,849	-1,105	0	921	3,332
	Alt 6 Minus Alt 1	62	5,198	0.989	-4,093	-1,300	0	936	4,259
Gavins Point	Alt 2 Minus Alt 1	172	4,795	0.419	-2,466	-78	0	85	4,000
	Alt 3 Minus Alt 1	-17	1,087	-1.837	-59	0	0	0	90
	Alt 4 Minus Alt 1	53	4,568	4.326	-2,000	-40	0	0	92
	Alt 5 Minus Alt 1	38	3,088	5.672	-479	0	0	0	115
	Alt 6 Minus Alt 1	59	3,367	3.811	-1,316	-106	0	0	115

Table 8-19: Summary statistics of elevation change between each alternative and Alt 1 for winter months grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	-0.6	2.1	-1.260	-4.2	-1.3	0.1	0.8	1.5
	Alt 3 Minus Alt 1	0.1	0.2	0.539	-0.1	-0.1	0.1	0.2	0.4
	Alt 4 Minus Alt 1	-1.5	2.0	-1.330	-4.4	-2.5	-0.8	0.1	0.3
	Alt 5 Minus Alt 1	-0.4	0.8	-2.837	-1.2	-0.6	-0.2	-0.1	0.2
	Alt 6 Minus Alt 1	-0.9	1.0	-1.249	-2.1	-1.4	-0.7	0.0	0.2
Garrison	Alt 2 Minus Alt 1	-0.6	1.8	-1.166	-3.7	-1.3	-0.4	0.6	1.2
	Alt 3 Minus Alt 1	0.1	0.3	0.604	-0.3	-0.1	0.1	0.2	0.5
	Alt 4 Minus Alt 1	-1.4	2.0	-1.487	-4.1	-2.5	-0.6	0.1	0.3
	Alt 5 Minus Alt 1	-0.5	1.1	-4.346	-1.1	-0.6	-0.2	-0.1	0.3
	Alt 6 Minus Alt 1	-0.8	0.9	-0.899	-1.9	-1.4	-0.7	0.0	0.2
Oahe	Alt 2 Minus Alt 1	-1.2	2.3	-0.655	-4.4	-2.4	-1.0	0.4	1.3
	Alt 3 Minus Alt 1	0.1	0.4	0.144	-0.3	-0.1	0.1	0.3	0.6
	Alt 4 Minus Alt 1	-1.8	2.6	-1.423	-5.7	-3.1	-0.9	0.1	0.4
	Alt 5 Minus Alt 1	-0.2	0.7	-0.483	-0.8	-0.5	-0.2	0.1	0.6
	Alt 6 Minus Alt 1	-1.3	1.5	-1.161	-3.3	-2.1	-0.9	-0.1	0.2
Big Bend	Alt 2 Minus Alt 1	0.0	0.1	-0.115	-0.2	-0.1	0.0	0.1	0.2
	Alt 3 Minus Alt 1	0.0	0.1	-0.269	-0.2	-0.1	0.0	0.1	0.2
	Alt 4 Minus Alt 1	0.0	0.1	0.023	-0.2	-0.1	0.0	0.1	0.2
	Alt 5 Minus Alt 1	0.0	0.1	-0.433	-0.2	-0.1	0.0	0.1	0.1
	Alt 6 Minus Alt 1	0.0	0.1	-0.061	-0.2	-0.1	0.0	0.1	0.2
Fort Randall	Alt 2 Minus Alt 1	0.1	0.9	1.331	-0.4	-0.1	0.0	0.2	0.5
	Alt 3 Minus Alt 1	0.0	0.5	1.305	-0.3	-0.1	0.0	0.1	0.4
	Alt 4 Minus Alt 1	0.0	0.8	-0.165	-0.4	-0.1	0.0	0.1	0.4
	Alt 5 Minus Alt 1	0.0	0.6	-3.758	-0.4	-0.1	0.0	0.1	0.4
	Alt 6 Minus Alt 1	0.0	0.5	-0.608	-0.4	-0.1	0.0	0.1	0.4
Gavins Point	Alt 2 Minus Alt 1	0.0	0.5	0.493	-0.3	-0.1	0.0	0.1	0.3
	Alt 3 Minus Alt 1	0.0	0.4	-1.376	-0.2	-0.1	0.0	0.1	0.2
	Alt 4 Minus Alt 1	0.0	0.4	-0.231	-0.3	-0.1	0.0	0.1	0.3
	Alt 5 Minus Alt 1	0.0	0.5	-1.015	-0.3	-0.1	0.0	0.1	0.2
	Alt 6 Minus Alt 1	0.0	0.4	-0.960	-0.3	-0.1	0.0	0.1	0.3

Table 8-20: Summary statistics of release change between each alternative and Alt 1 for winter months grouped by mainstem project. The quantiles are listed as 10Q, 25Q, etc, which show non-exceedance values.

		Mean	St Dev	Skew	10Q	25Q	50Q	75Q	90Q
Fort Peck	Alt 2 Minus Alt 1	1	816	1.521	-500	-153	0	200	500
	Alt 3 Minus Alt 1	-2	375	-1.362	-100	-7	0	8	100
	Alt 4 Minus Alt 1	5	1,067	0.146	-573	-169	0	21	546
	Alt 5 Minus Alt 1	5	695	-8.424	-200	-100	0	23	242
	Alt 6 Minus Alt 1	8	576	-0.129	-284	-100	0	100	409
Garrison	Alt 2 Minus Alt 1	3	1,768	-0.703	-1,286	-400	0	420	1,200
	Alt 3 Minus Alt 1	-6	1,141	-7.382	-273	-100	0	84	292
	Alt 4 Minus Alt 1	11	3,225	3.767	-2,029	-492	-16	100	1,015
	Alt 5 Minus Alt 1	12	2,982	4.790	-1,050	-200	0	100	596
	Alt 6 Minus Alt 1	20	1,446	-4.082	-679	-255	0	248	1,050
Oahe	Alt 2 Minus Alt 1	18	8,257	0.389	-9,156	-3,336	0	3,327	9,189
	Alt 3 Minus Alt 1	-9	6,231	-0.184	-6,113	-2,087	0	2,155	6,181
	Alt 4 Minus Alt 1	26	7,420	0.987	-6,666	-2,239	-3	1,668	6,292
	Alt 5 Minus Alt 1	15	7,185	0.747	-6,862	-2,419	-1	2,079	6,571
	Alt 6 Minus Alt 1	41	6,721	0.378	-6,229	-2,044	-1	1,677	6,515
Big Bend	Alt 2 Minus Alt 1	17	8,099	0.376	-9,149	-3,334	0	3,288	9,117
	Alt 3 Minus Alt 1	-10	6,067	-0.165	-6,232	-2,058	0	2,142	6,254
	Alt 4 Minus Alt 1	25	7,319	1.033	-6,781	-2,266	-4	1,668	6,621
	Alt 5 Minus Alt 1	15	6,978	0.795	-6,939	-2,418	0	2,078	6,608
	Alt 6 Minus Alt 1	41	6,572	0.415	-6,359	-2,019	0	1,691	6,658
Fort Randall	Alt 2 Minus Alt 1	16	6,329	0.263	-6,667	-1,696	0	1,669	6,172
	Alt 3 Minus Alt 1	-11	3,734	-0.043	-2,960	-854	0	863	2,953
	Alt 4 Minus Alt 1	25	5,882	1.783	-4,453	-1,438	-30	927	3,889
	Alt 5 Minus Alt 1	14	4,960	1.500	-3,904	-1,110	0	928	3,332
	Alt 6 Minus Alt 1	41	5,082	0.967	-4,078	-1,298	0	952	4,149
Gavins Point	Alt 2 Minus Alt 1	16	4,728	0.373	-3,000	-114	0	14	3,500
	Alt 3 Minus Alt 1	-11	1,059	-1.576	-59	0	0	0	90
	Alt 4 Minus Alt 1	25	4,385	4.489	-2,000	-34	0	0	92
	Alt 5 Minus Alt 1	14	3,005	5.626	-466	0	0	0	115
	Alt 6 Minus Alt 1	41	3,233	3.954	-1,080	-100	0	0	100