

# Appendix C-2: Alternative 303

## Agricultural Flooding

### HEC-ResSim Alternative Assessment

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## 1. Alternative Description & Objective

The purpose of this alternative is to model the reduction in downstream agricultural damages through the implementation of maximum flow constraints enforced at Minot, ND. Flow constraints are implemented through restrictions on releases from Lake Darling Dam. Results derived to reflect the suggested alternative were compared to baseline model results. Baseline model results reflect present day operations (Annex A & Annex B). The baseline run uses the same simulation time window as the alternative (1930-2017).

### 1.1 Alternative Development

Alternative 303 builds off of work completed as part of Phase 2 Alternative 3, which implemented a downstream control rule at Lake Darling for Bantry, ND. Results from Phase 2 indicated Bantry was not a realistic location for the ResSim model to operate for. It drastically increased the run time of the model, and Lake Darling was not able to reliably control its releases to meet the downstream target. Therefore, in Alternative 303, the downstream maximum control rule was moved from Bantry, ND to Minot, ND, and a regression analysis was completed to determine what the maximum flow at Minot should be for a given target flow at Bantry.

#### 1.1.1 Regression Analysis

To move the downstream maximum rule from Bantry to Minot, a regression analysis was completed using observed data at the two locations. Linear regression statistics were computed for each month using the first day of the month as a representative flow value for the entire month. The regression coefficient and y-intercept values computed for the month of July, which had the highest  $R^2$  value of any month, were chosen to translate targets at Bantry to targets at Minot. The regression equation and translated Phase 2 values are shown in Table 1.

Table 1. Regression equation and corresponding flow targets at Minot, ND

Date	Phase 2 Bantry Target	Phase 3 Minot Target	
		Computed	Rounded
1-Jan	350	238.5	200
1-Feb	3,000	2,274.4	2,200
1-May	3,000	2,274.4	2,200
2-May	1,500	1,122.0	1,100
2-Jun	1,500	1,122.0	1,100
3-Jun	350	238.5	200
1-Oct	350	238.5	200
$y = 0.768245(\text{Bantry Target}) - 30.348$			

#### 1.1.2 ResSim Model

In the ResSim model, a maximum downstream control rule is used to limit releases as a function of date. The dates and corresponding maximum flows for the seven simulations run as part of this alternative are shown in Table 2. The restrictions on the releases from Lake Darling are intended to simulate how

downstream flow and agricultural damage would be reduced if Lake Darling Reservoir were operated to limit flow downstream. Each simulation has a different effective constraint from the Jun 3 to Feb 1 each year, ranging from 200 cfs to 1,500 cfs. These flow values were determined based on bankfull capacities downstream of Lake Darling as well as input from the Resource and Agency Advisory Group (RAAG) and Public Advisory Group (PAG).

*Table 2. Seasonal flow constraints at Minot, ND*

303_Bantry	01Feb	2,200
	02May	1,100
	03Jun	200
303_500	01Feb	5,000
	02May	5,000
	03Jun	500
303_700	01Feb	5,000
	02May	5,000
	03Jun	700
303_900	01Feb	5,000
	02May	5,000
	03Jun	900
303_1100	01Feb	5,000
	02Jun	5,000
	03Jun	1,100
303_1300	01Feb	5,000
	02May	5,000
	03Jun	1,300
303_1500	01Feb	5,000
	02May	5,000
	03Jun	1,500

## 1.2 HEC-ResSim Nomenclature

Within HEC-ResSim, a new network, alternative and simulation run was generated to reflect this proposed alternative. To generate the alternative network, a copy of the base network was made and modified to reflect the proposed alternative. A table indicating the nomenclature associated with the ResSim networks, alternatives and simulations used to model both baseline and alternative operations is shown in



Table 3.

Table 3. Model nomenclature

Scenario	Tim Window	ResSim Model Name	Network Name	Alternative Name	Simulation Name
Agricultural Damage Reduction	1930-2017	SourisRiverPoS	303_Ag_Bantry_XXXX XXXX = any given flow constraint (8 runs)	303_XXXX XXXX = any given flow constraint (7 runs)	303_Minot_Flow_Incremental_200_1500

## 2. Operational Rules

**Error! Reference source not found.** presents the operational rules that were included in the base HEC-ResSim model alternative to specifically reflect the changes required in support of the 3a\_Bty\_Ag alternative. No other modifications were made in the state variable or otherwise in the model.

Table 4. Rules specific to alternative

Name of Dam	Name of Rule, Outlet or IF Statement or State Variable Element	Rule Description
Rafferty Reservoir		
Boundary Reservoir		
Grant Devine Reservoir		
Lake Darling Reservoir	DS_Bntry_Cntrol_Mint	Seasonal downstream maximum constraint at Minot, ND

**Error! Reference source not found.** displays the operations rule tree for Lake Darling Reservoir with the new operating rule implemented, with red boxes indicating the new rule at Minot, ND. The seasonality of the rule can be seen both in the table and in the graphical display located to the right of the table.

This screenshot is taken from the simulation of the alternative exploring downstream constraint limited to 1,500 cfs at Minot during the winter months.

All other seasonal constraints are set at 5,000 cfs. This was a modeling technique used to force the model to revert to the previously defined DS\_Minot\_sv rule (seen in Figure 1) that is retained from the baseline BL\_Norm model. This allows the model to be consistently compared to baseline conditions.

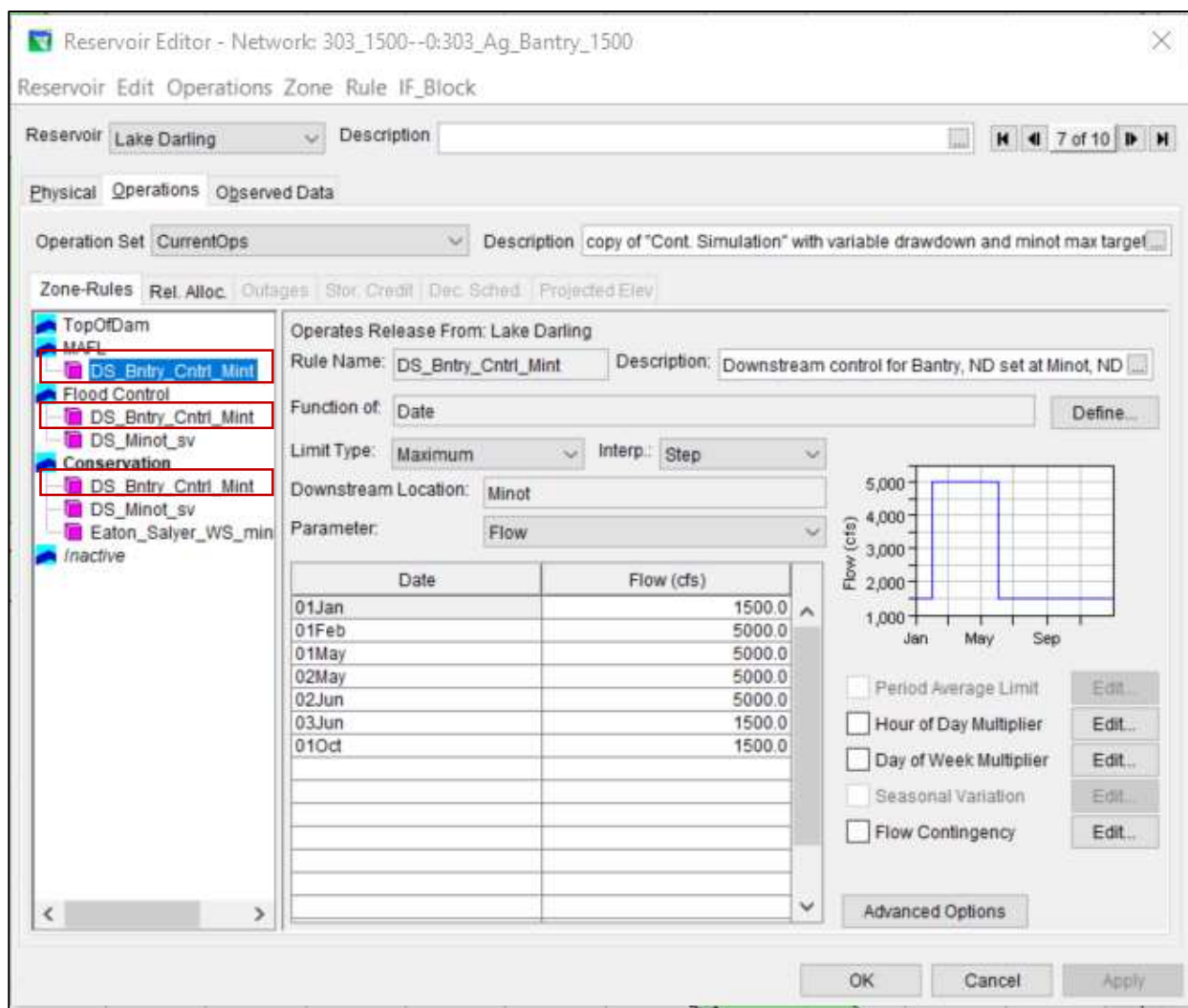


Figure 1: Rule tree with new downstream maximum constraint at Bantry

The rule was set up as a downstream constraint for Lake Darling Reservoir as a whole. It is a maximum release constraint and is a function of date, using step interpolation.

### 3. Alternative vs Baseline Condition Results

Plates 01-08 show hydrographs detailing the results of Alternative 303 relative to the baseline scenario at Rafferty, Boundary, Grant Devine, and Lake Darling reservoirs, as well as seven critical mainstem flow locations, for 1951, 1972, 1974, and 1975. These years were chosen, because they show a range of change from the baseline simulation and vary in magnitude.

Plate 09 displays performance indicator results for all study reaches over the entire simulation (1930-2017). More information regarding performance indicator (PI) results and PI development can be found in the Data Collection for the Analysis of Alternatives Report (DW4) and Appendix A-5.

Even though seven simulations were run in this alternative, only the 200 cfs (most restrictive) and 1500 cfs (least restrictive) simulation results are plotted. Results from these simulations show the range of possible flows and pool elevations in all model runs for Alternative 303.

#### 4. Summary of Results

Baseline conditions and alternative conditions are the same at and below Rafferty and Grant Devine Reservoirs. Since the only changes to this model from the baseline are at Lake Darling Reservoir, all effects are at or below Lake Darling.

As expected, this alternative does not show significant change from the baseline simulation during drought years, as natural flows are typically under the Minot target. During more normal years, such as 1951 and 1972, Lake Darling shows it has the capacity to limit its releases to the lowest simulated target (200 cfs) while generally keeping its pool below 1598 ft.

During flood years, such as 1974 and 1975, model results indicate Lake Darling could potentially limit flows at Minot to near 200 cfs if rainfall does not persist into the summer months. However, if the spring flood event is too large or occurs later in the spring, Lake Darling likely cannot severely restrict its releases beginning June 1 without its pool rising to Max Allowable Flood Level (MAFL). In both 1974 and 1975, Lake Darling quickly rises to MAFL by June 1, and restrictive releases keep its pool high throughout the summer.

At Bantry, flows are reduced to below bankfull capacity (300 cfs) by early June in 1972, showing that, in “normal” years without excessive local flow downstream of Lake Darling, restricting Lake Darling’s releases during the summer months can keep flows within bank at Bantry. However, there are some years in which, even though Lake Darling successfully hits its 200 cfs target at Minot, flooding occurs at Bantry due to uncontrolled local flow. An example of this is 1951, where significant local flow occurs between Minot and Verendrye in early June, causing flows to go out of bank at Bantry. During larger flood years, such as 1974 and 1975, there is typically too much uncontrolled local flow to keep Bantry within bank in June, but severely restricting Lake Darling’s releases does cause flood waters to recede faster than in the baseline simulation.

#### 4.1 Performance Indicators

##### 4.1.1 Reservoirs

As expected, there are no significant changes to the performance indicators (PIs) at Rafferty, Boundary, or Grant Devine reservoirs. At Lake Darling, restrictive releases lead to higher reservoir elevations during the summer months. This causes significantly more flooding at Mouse River Park, more flooding of archaeological sites and boating access points, and a loss of wildlife habitat within the refuge. Lake Darling’s pool also rises to MAFL in several years when releases are severely limited, which increases dam safety risk.

#### 4.1.2 Riverine Reaches

As expected, there are no significant changes to any PI above Lake Darling. Below Lake Darling, there are benefits to severely restricting flows from Lake Darling during the summer months. In general, flows are kept within bank more often, and there are fewer structural and agricultural damages. Archaeological sites are also flooded less often. Conversely, when there are not significant restrictions on Lake Darling's releases during the summer months, most benefits go away, and extended out-of-bank flows occur slightly more often in reaches downstream of Minot and upstream of Eaton Irrigation.

#### 5. Path Forward

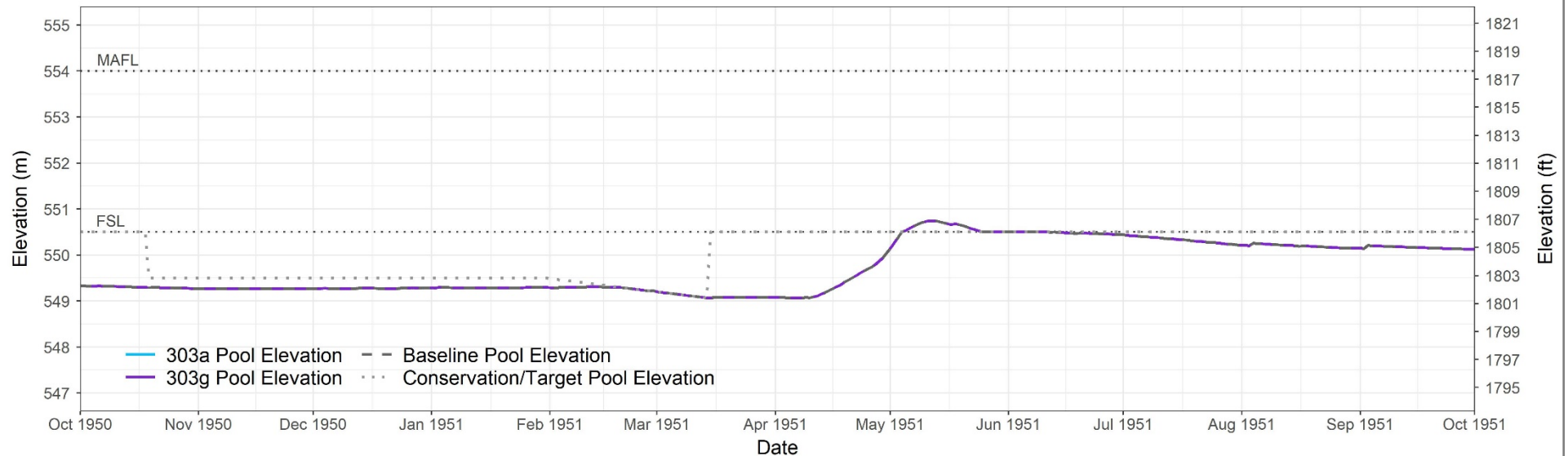
Alternative 303 shows there are benefits downstream of Lake Darling when a maximum flow of 200 cfs is targeted at Minot during the summer months, and this is possible during many non-flood years. However, this release restriction should be lifted when Lake Darling's pool exceeds a given threshold to limit flood impacts at the reservoir.

In Phase 3.5, Alternative 303 will be combined with Alternative 305 to develop a variable pool elevation-based summer operating plan that balances downstream interests with risks to the reservoir pool.

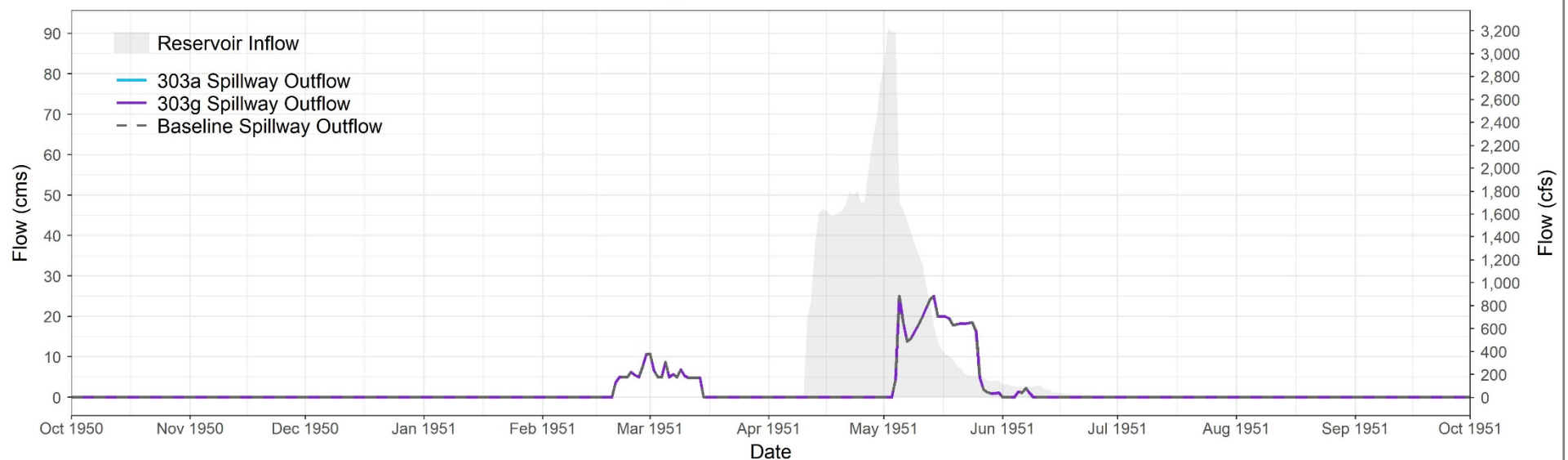
#### 6. References

1. "HEC-DSSVue," U.S Army Corps of Engineers, Hydraulic Engineering Center, February 2010.
2. "HEC-ResSim, Reservoir System Simulation, Version 3.3", U.S Army Corps of Engineers, Hydraulic Engineering Center, December 2018.
3. Canada and USA, 1989. Agreement between the Government of Canada and the United States for Water Supply and Flood Control in the Souris River Basin.
4. Canada and USA, 2000. Interim Measures As Modified For Apportionment of the Souris River.
5. There was email communication with the Frank Durbian (U.S.FWS), Elizabeth Nelsen (U.S. Army Corps of Engineers Hydrology and Water Management Section Chief), James Fay, Curtis Hallborg (WSA) during initial modeling stages for this alternative. Frank Durbian offered some insight on changing parts of the alternative and should be included in the fine tuning process as this alternative progresses.

Rafferty Reservoir - Elevation

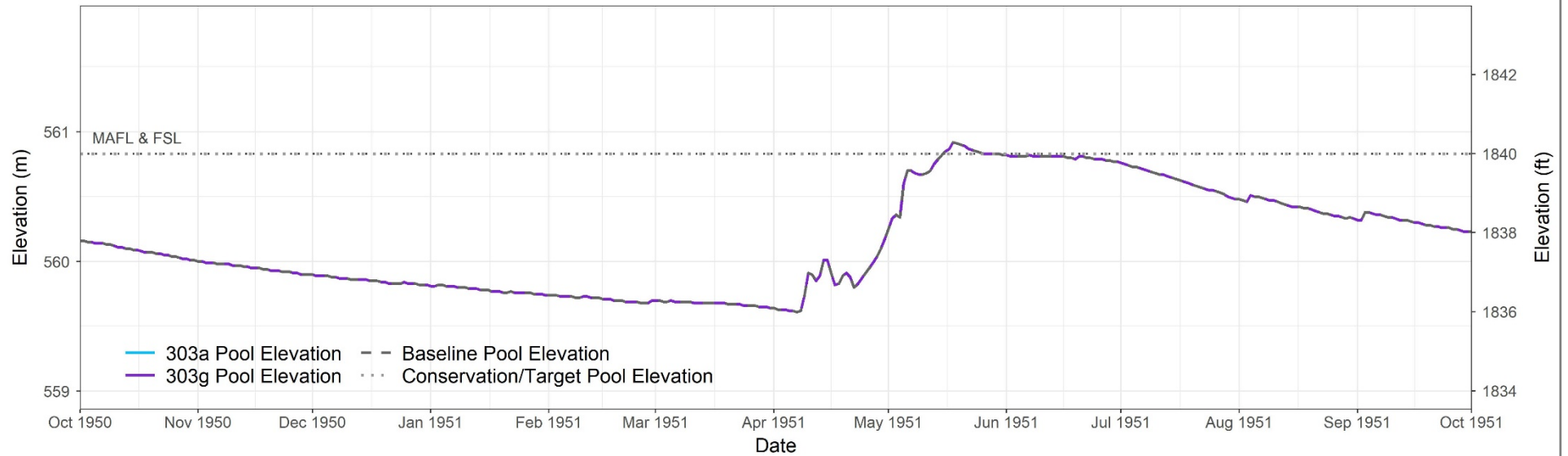


Rafferty Reservoir - Releases

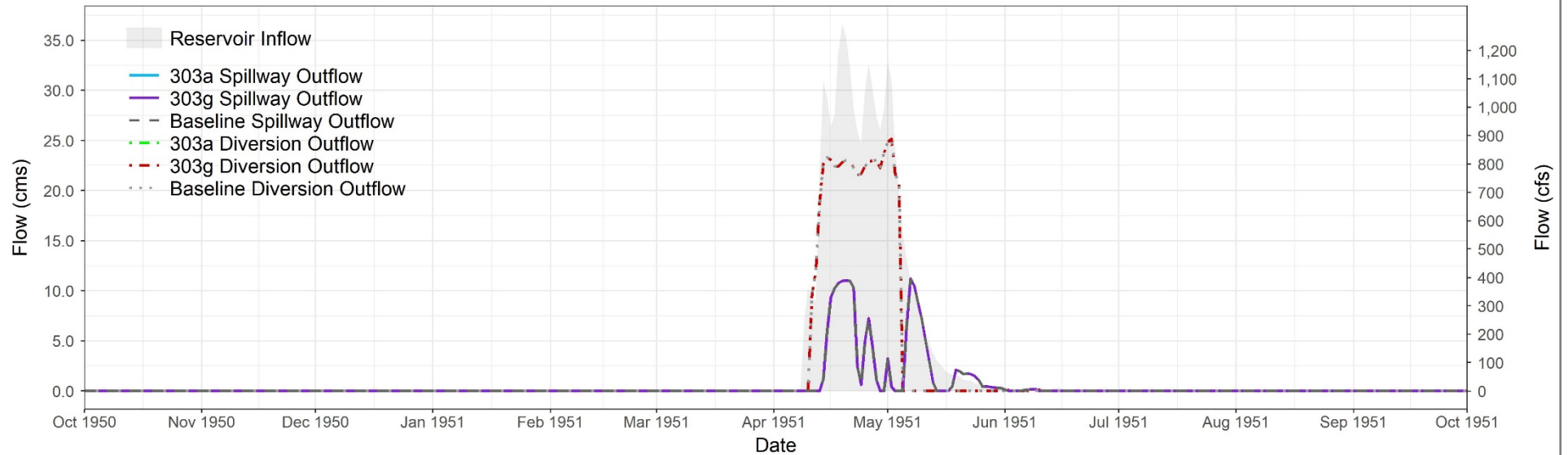


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Boundary Reservoir - Elevation

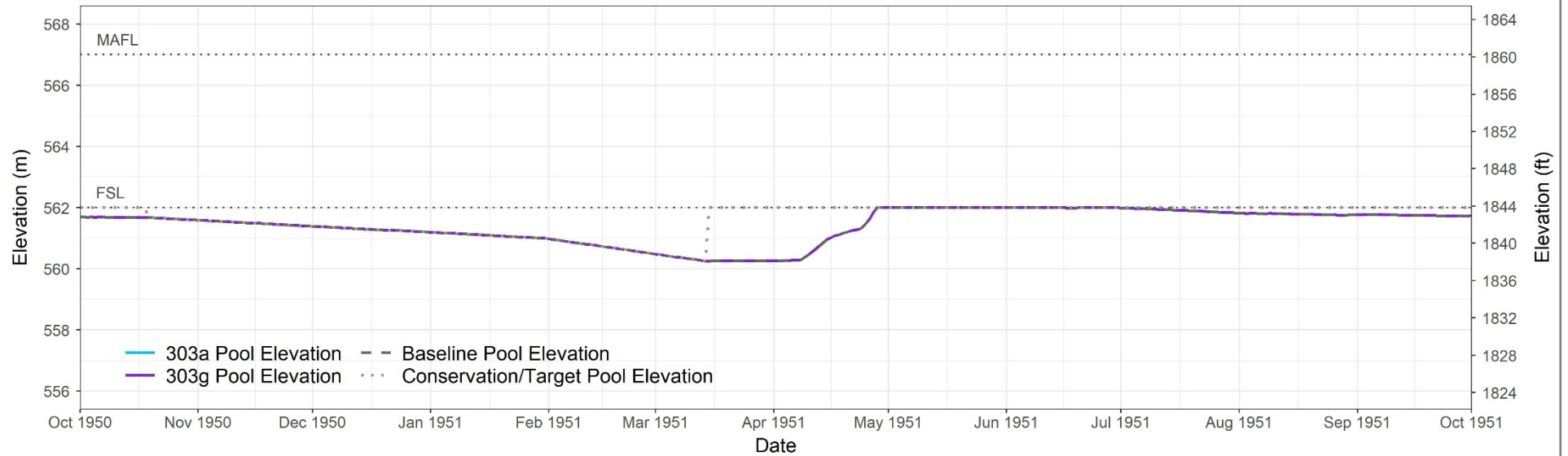


### Boundary Reservoir - Releases

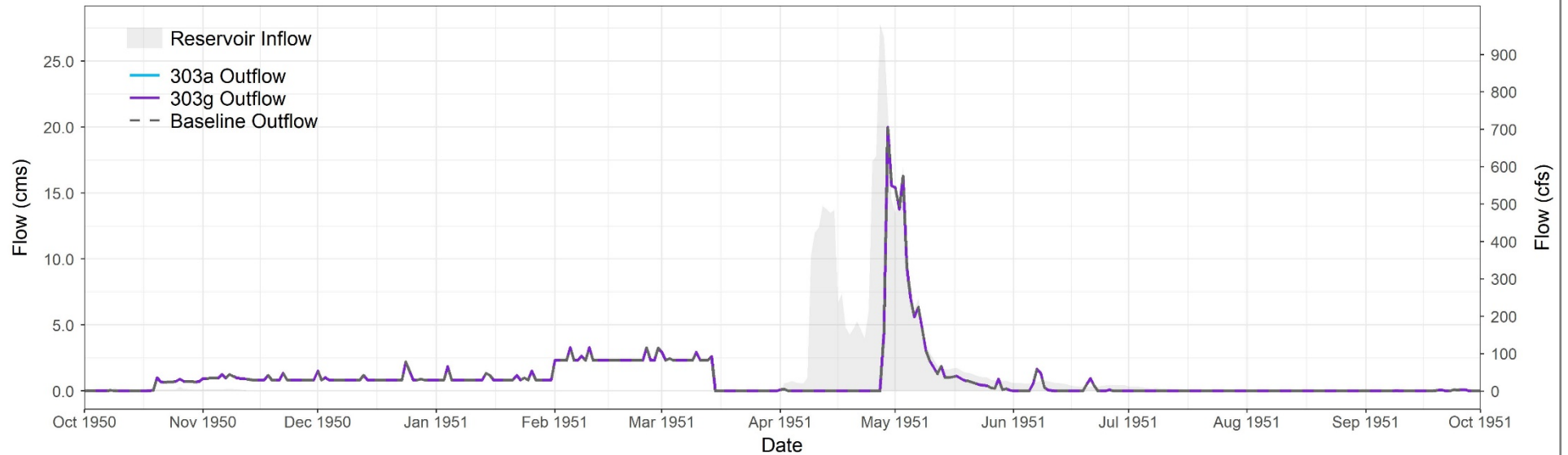


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Grant Devine Reservoir - Elevation



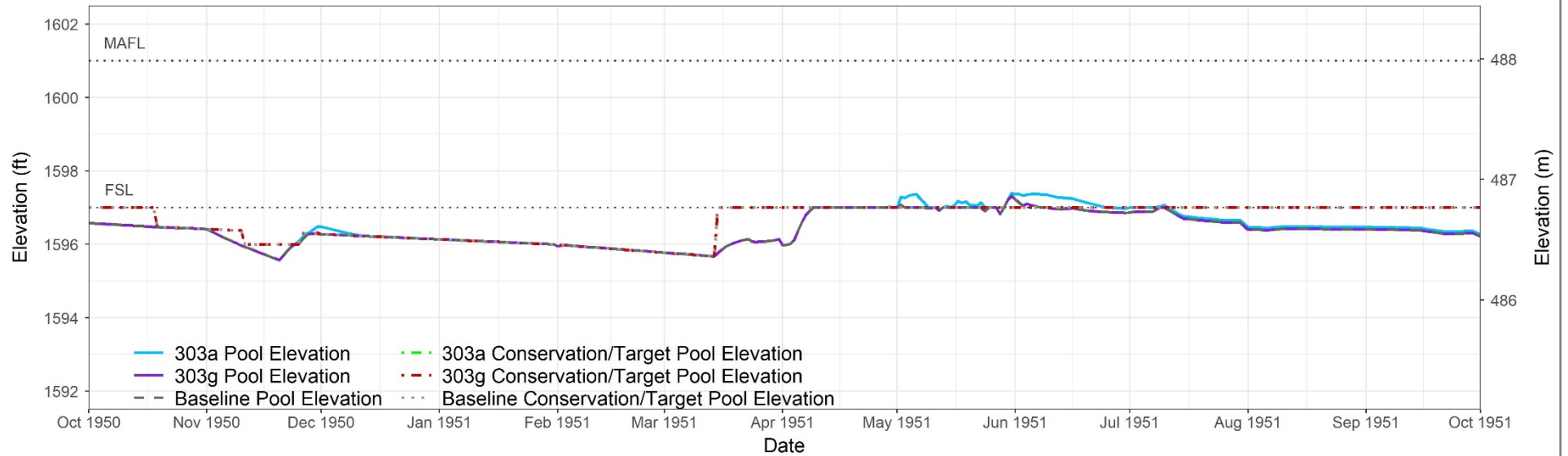
### Grant Devine Reservoir - Releases



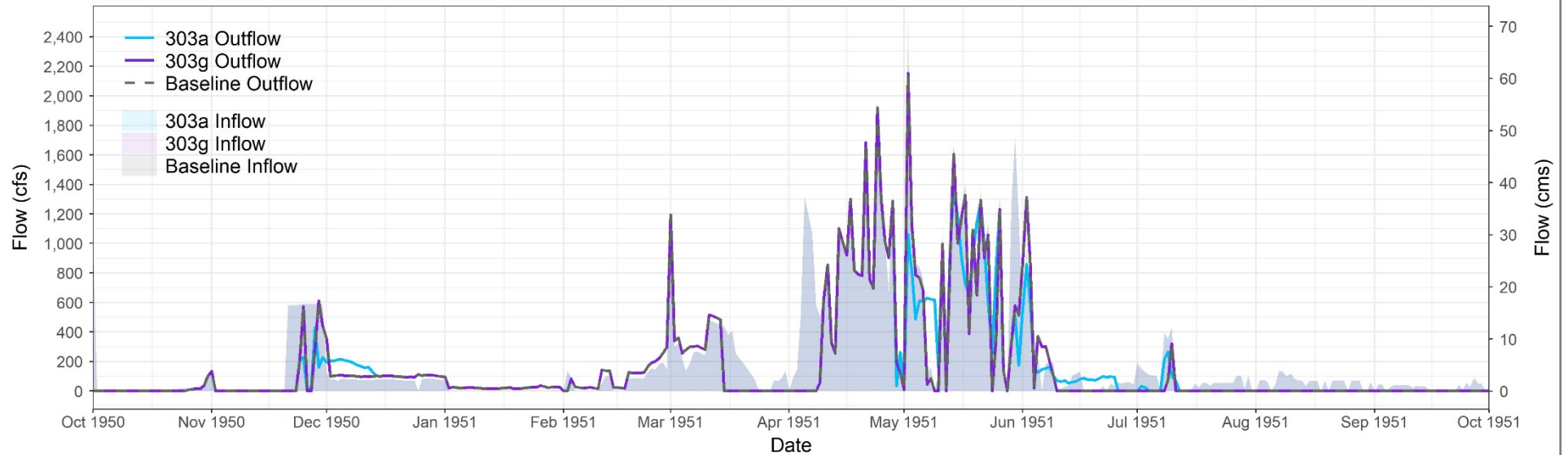
**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND



### Lake Darling - Elevation



### Lake Darling - Releases



**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

# Plate 02

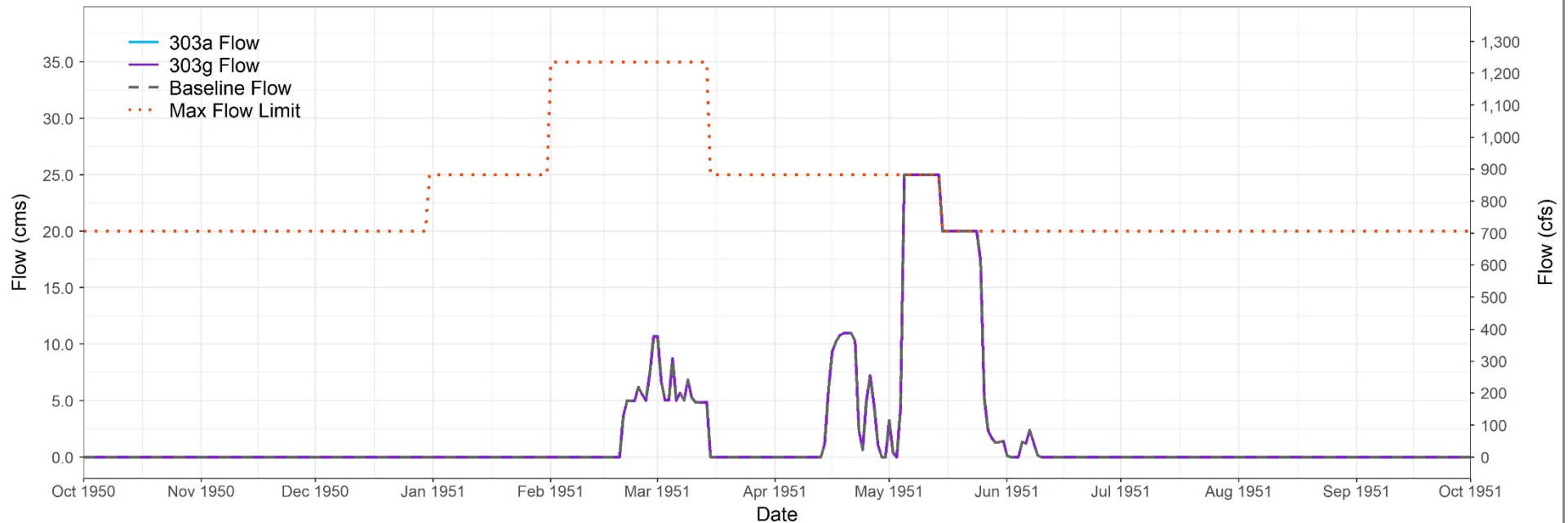
## Critical Flow Locations – 1951

### Alternative 303 (Phase 3)

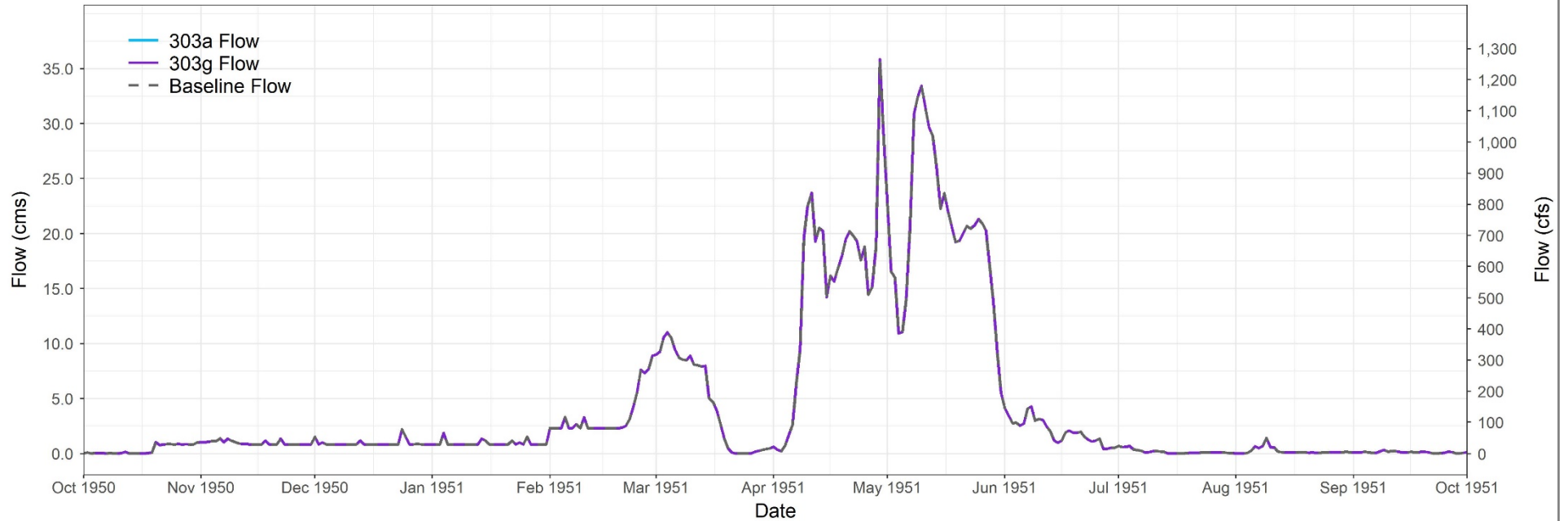
#### Souris River Plan of Study

**303a** = 200 cfs maximum at Minot, ND  
**303g** = 1,500 cfs maximum at Minot, ND

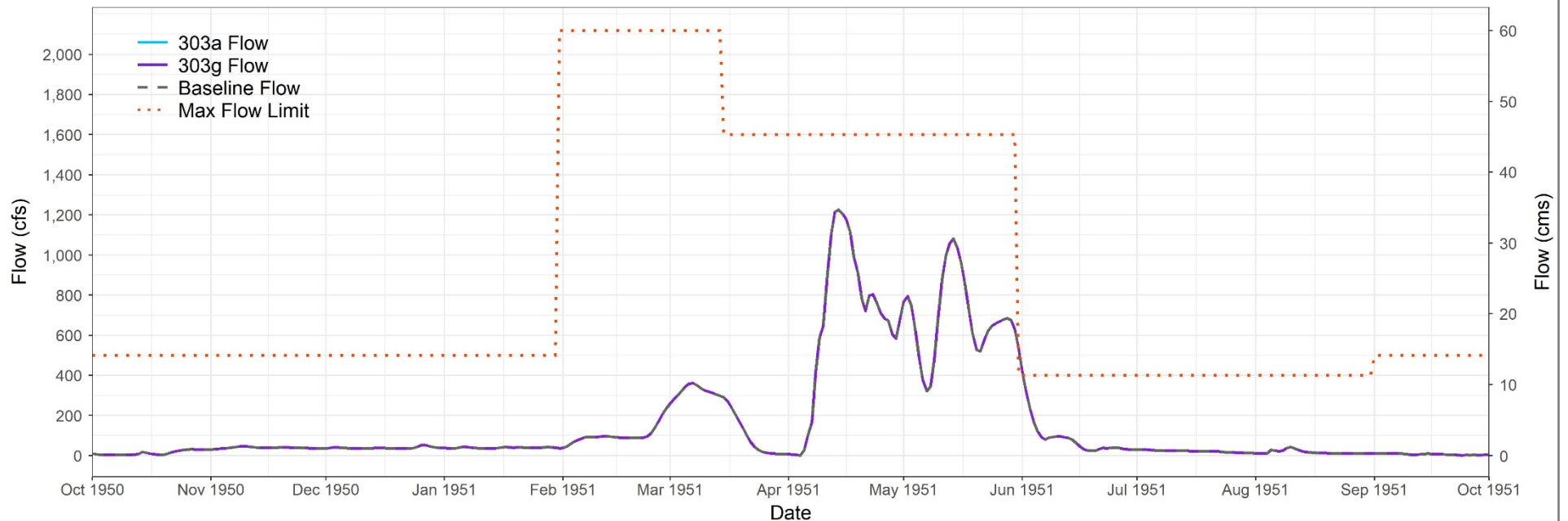
Souris River at Estevan, SK



### Souris River at Oxbow, SK

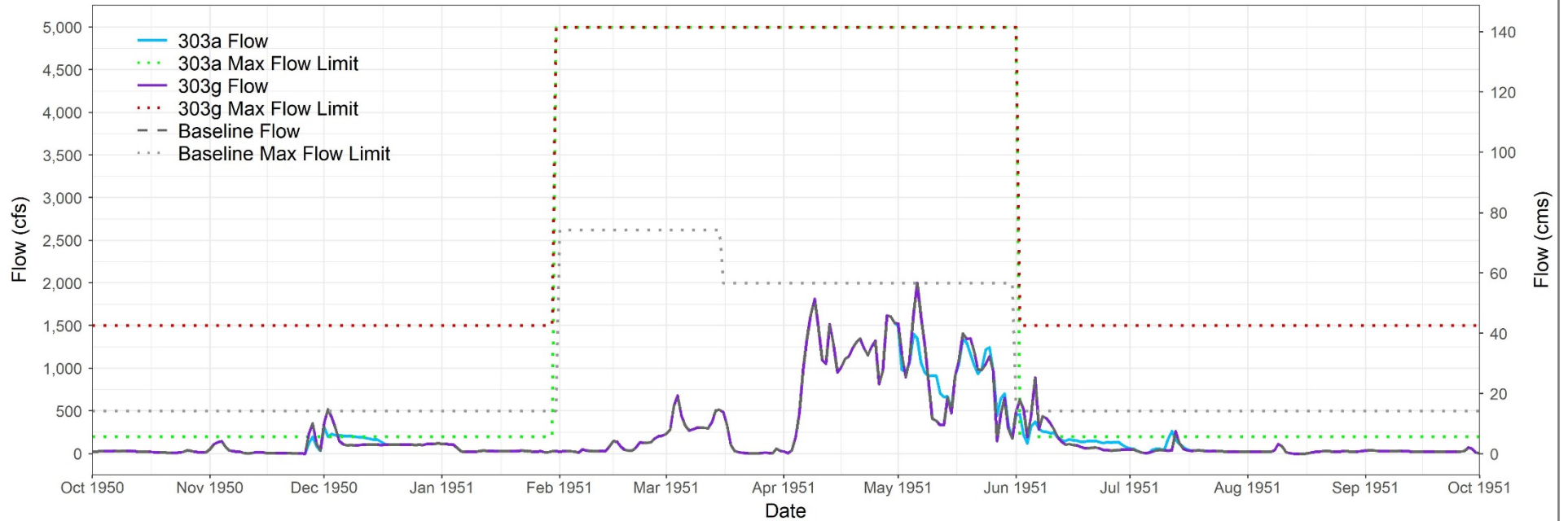


### Souris River at Sherwood, ND

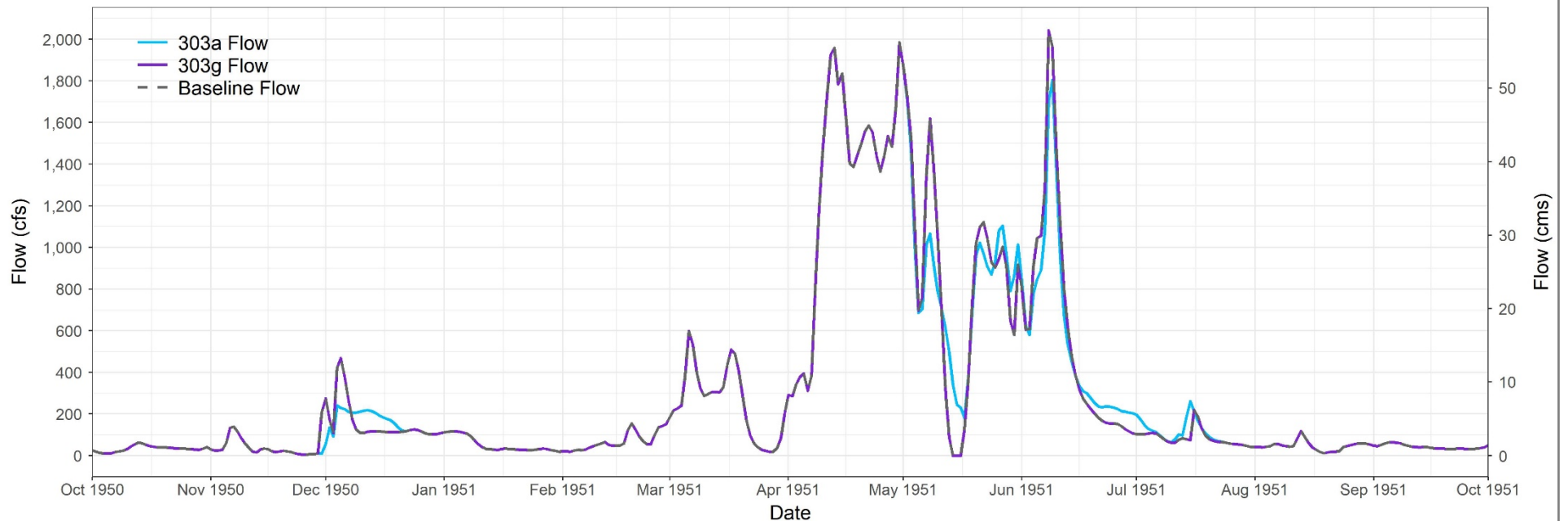


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

Souris River at Minot, ND - Flow

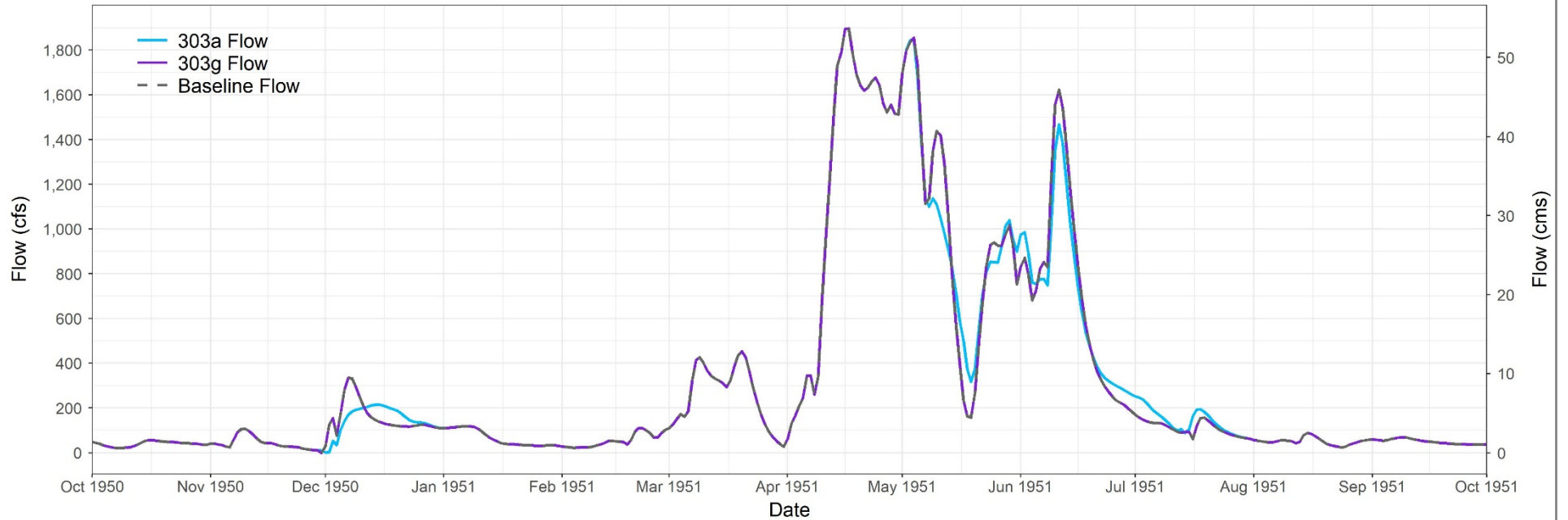


Souris River at Verendrye, ND

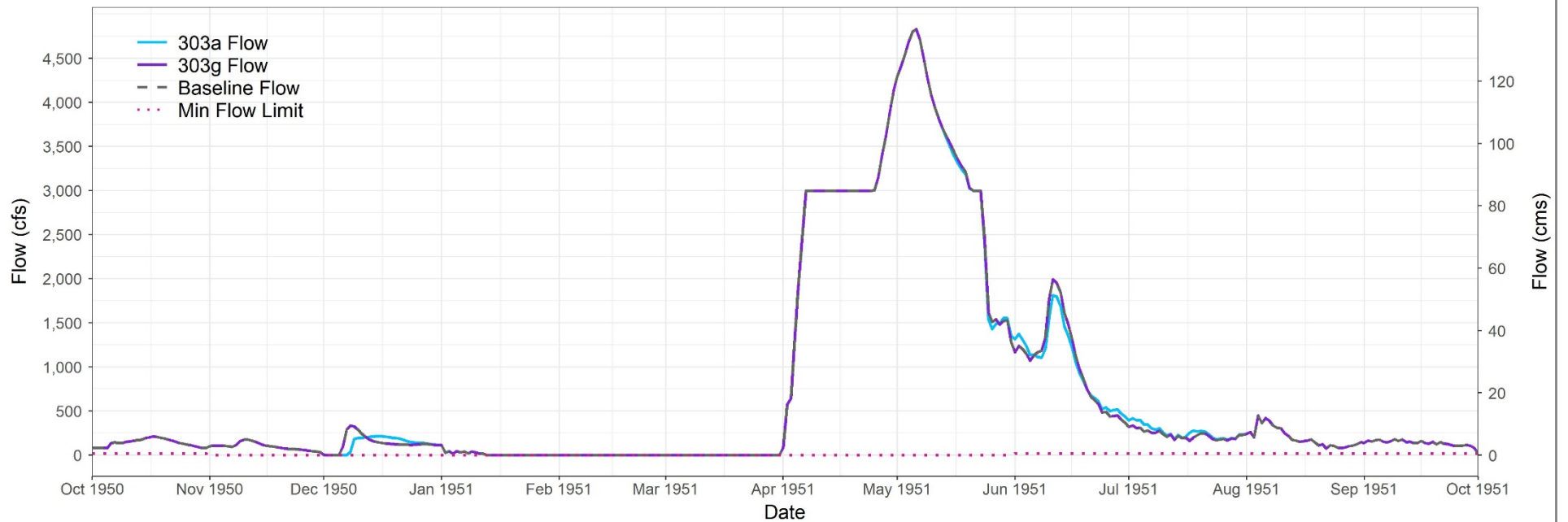


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Souris River at Bantry, ND



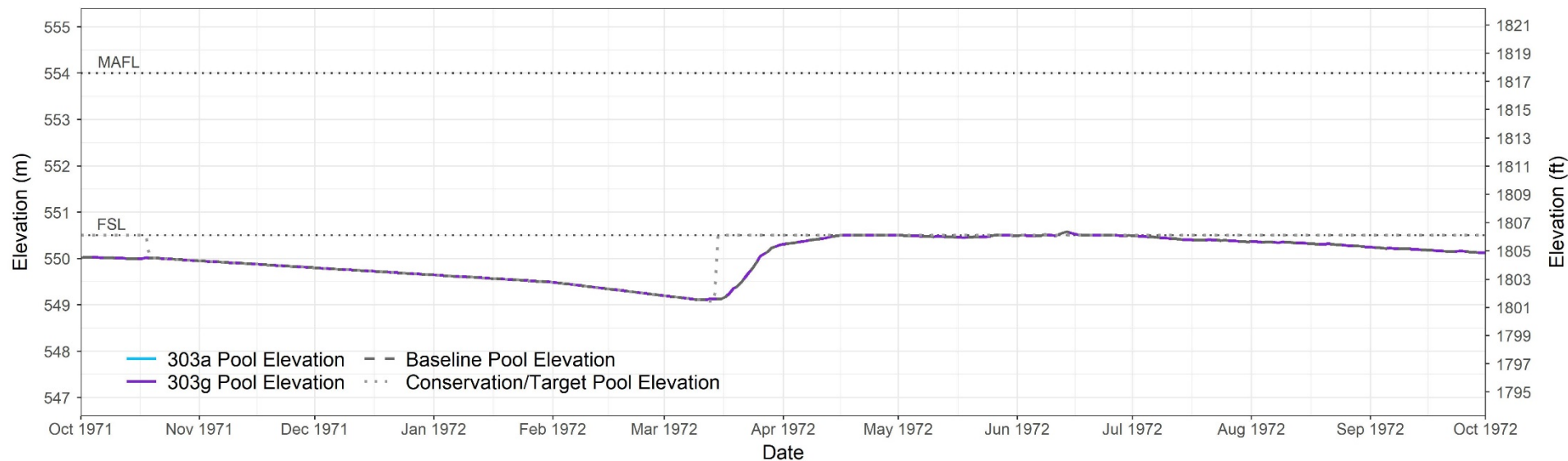
### Souris River at Westhope, ND



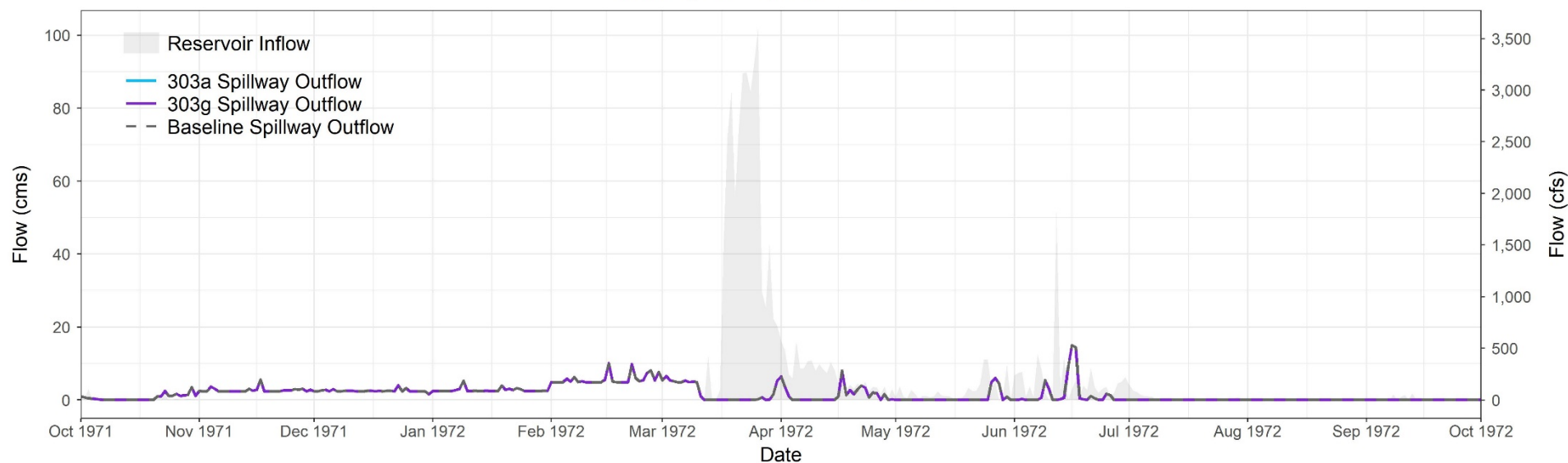
**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND



Rafferty Reservoir - Elevation

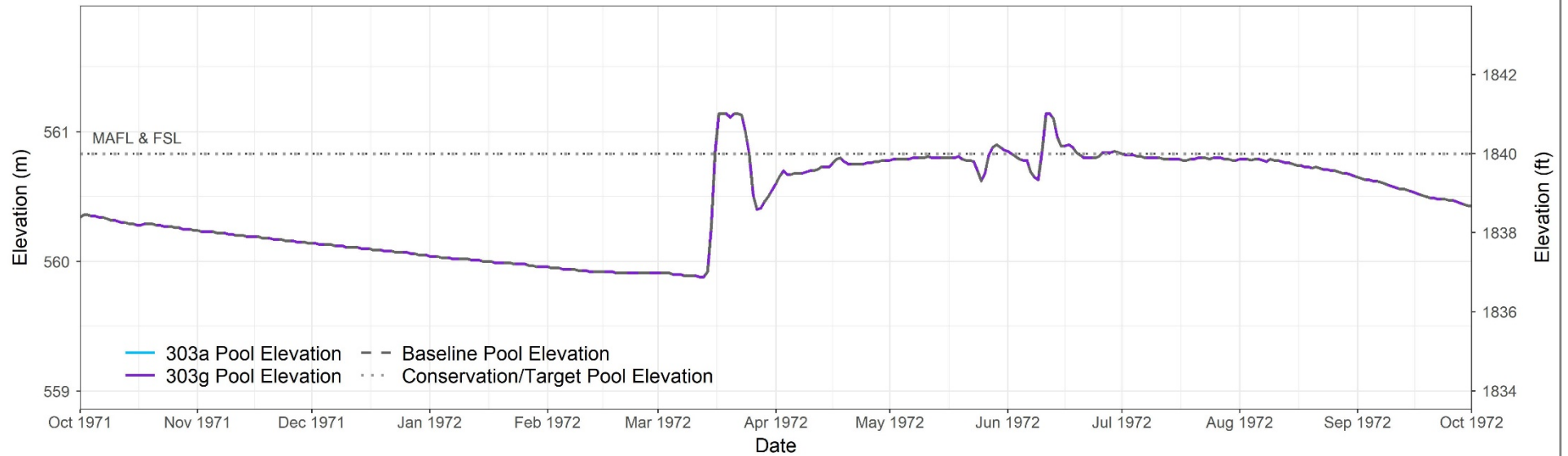


Rafferty Reservoir - Releases

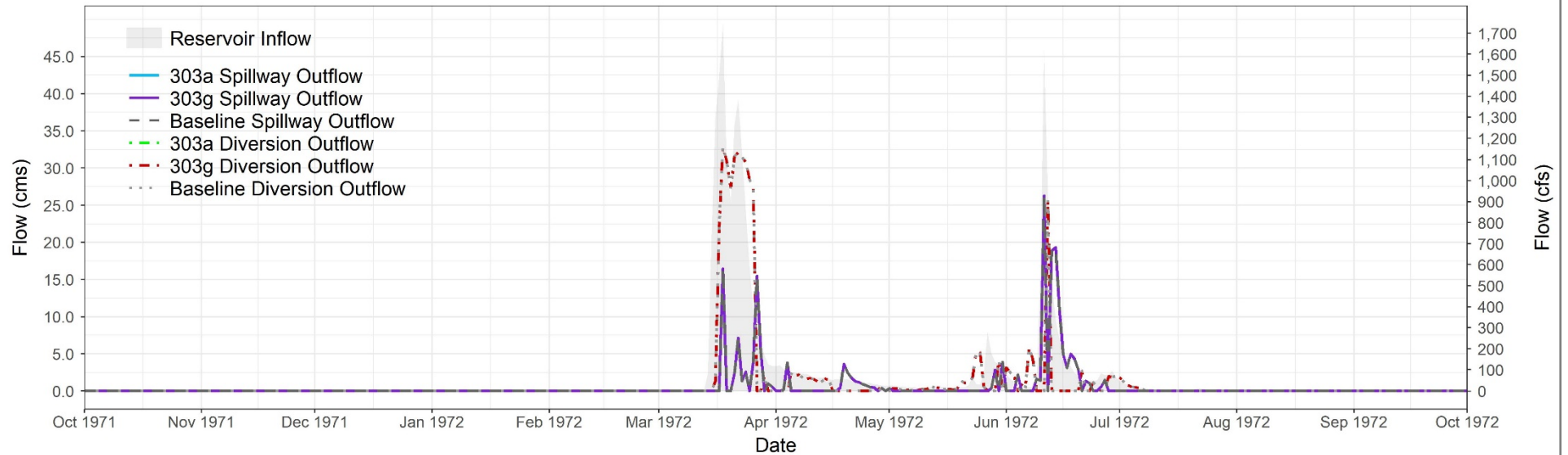


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Boundary Reservoir - Elevation

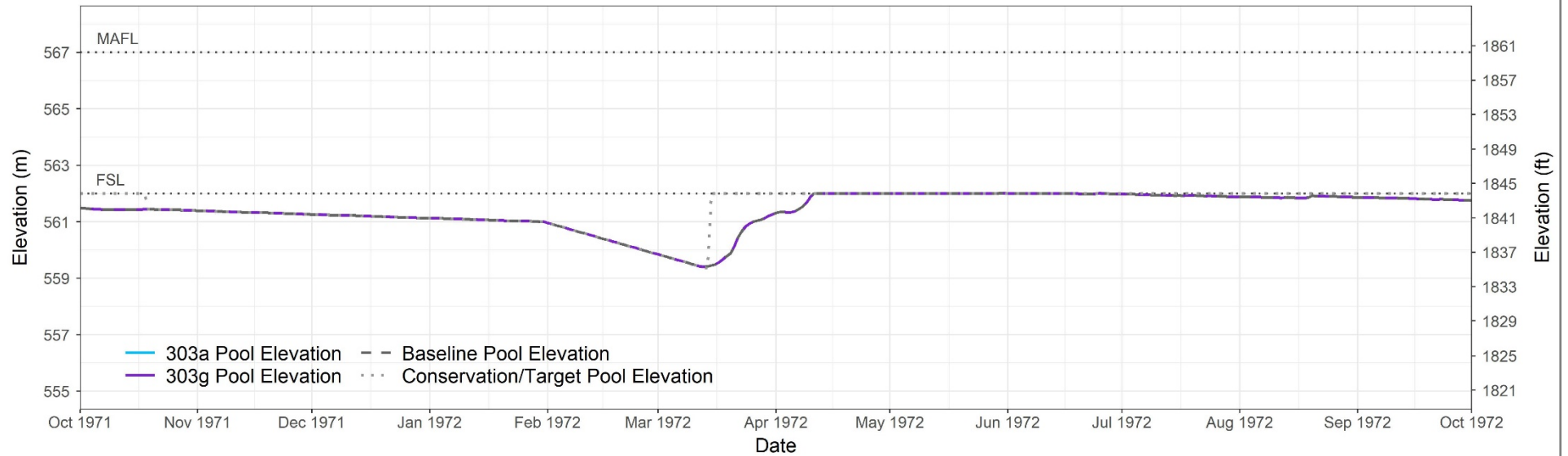


### Boundary Reservoir - Releases

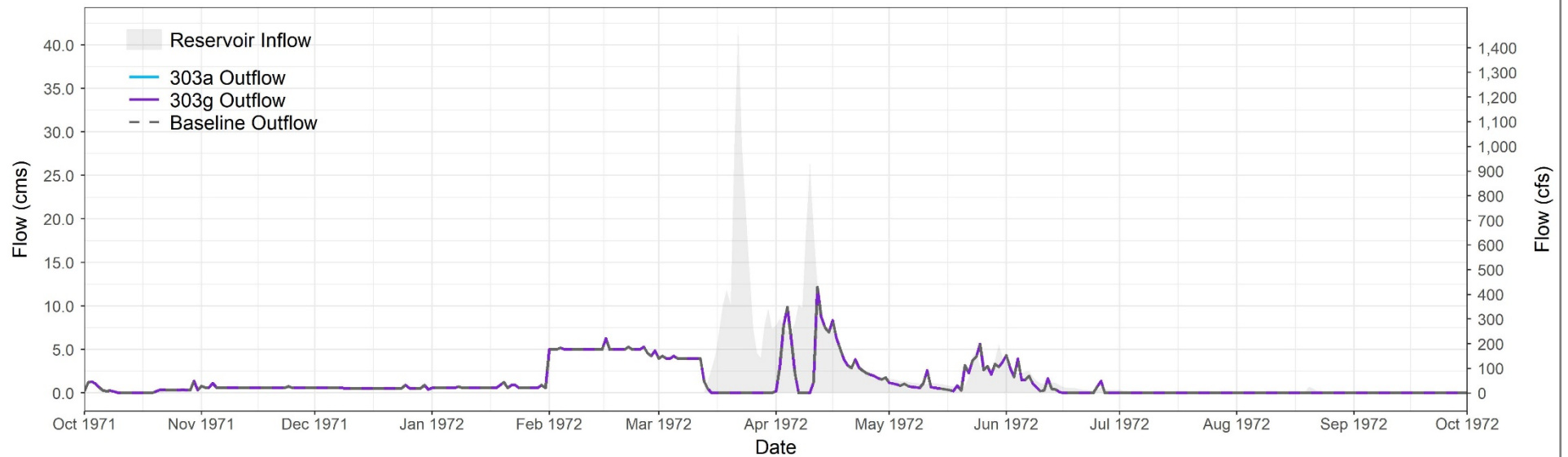


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Grant Devine Reservoir - Elevation



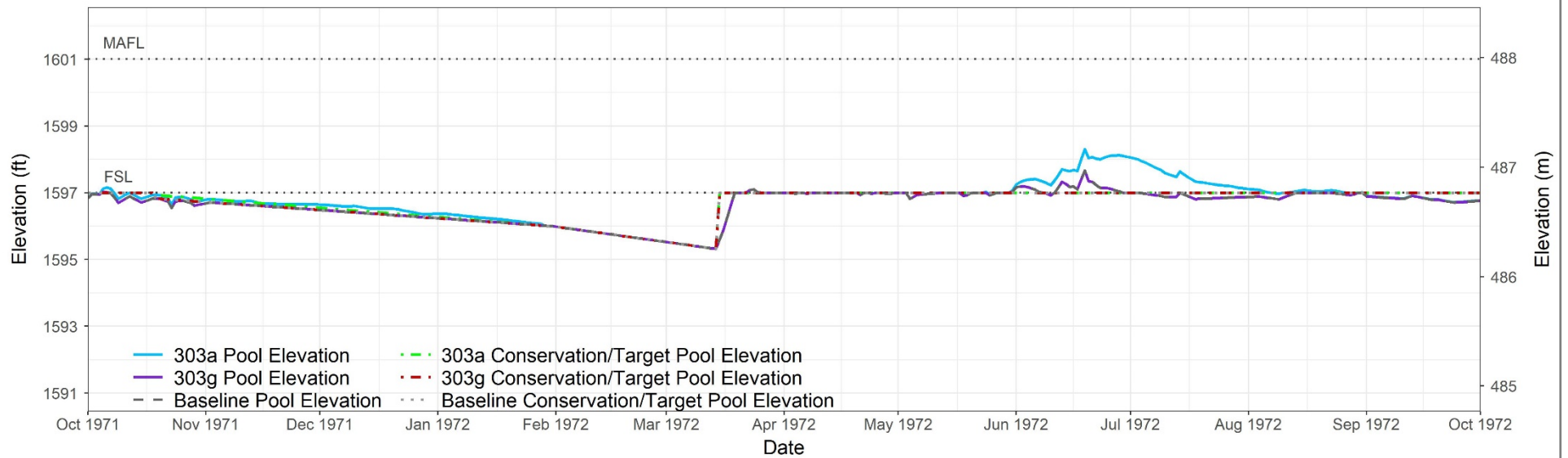
### Grant Devine Reservoir - Releases



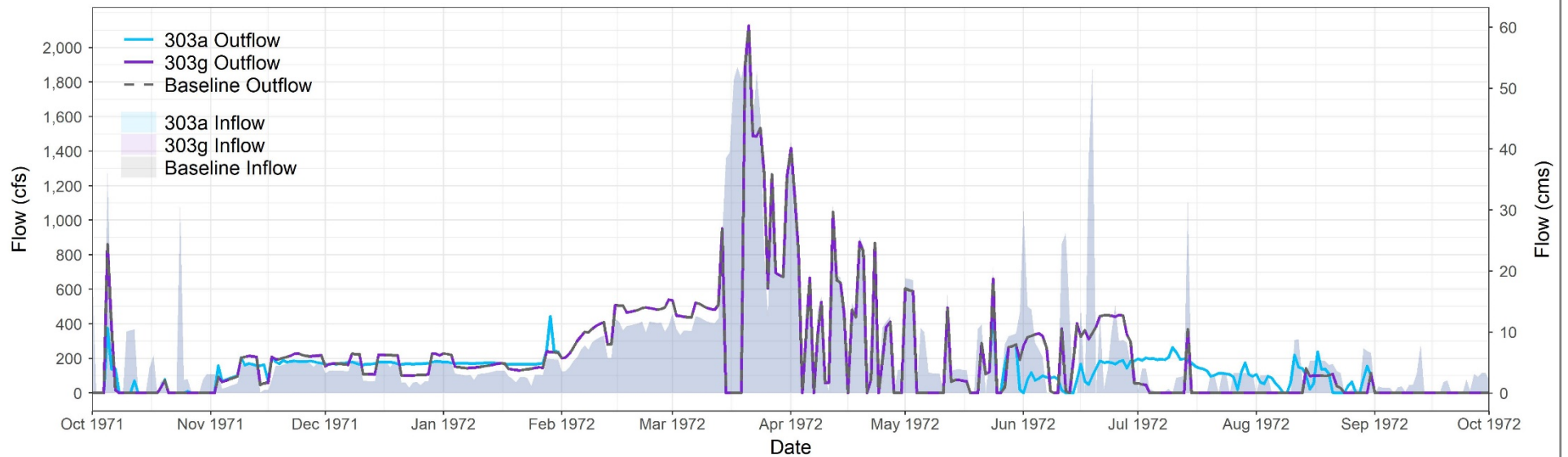
**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND



### Lake Darling - Elevation



### Lake Darling - Releases



**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

# Plate 04

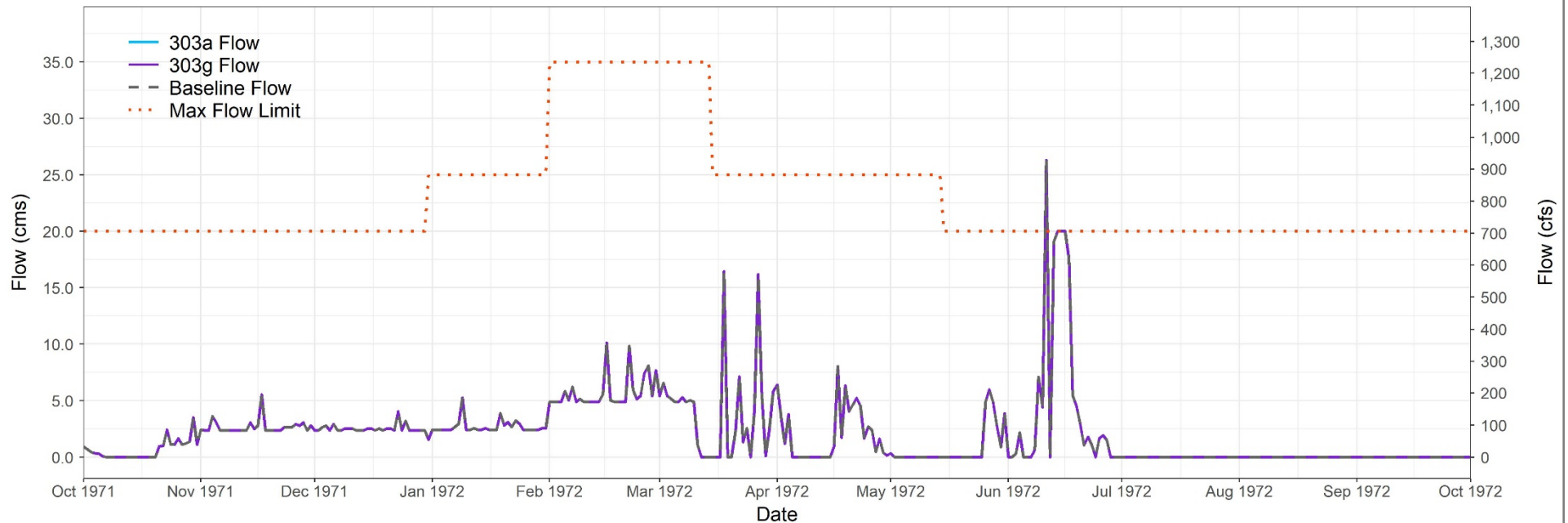
## Critical Flow Locations – 1972

### Alternative 303 (Phase 3)

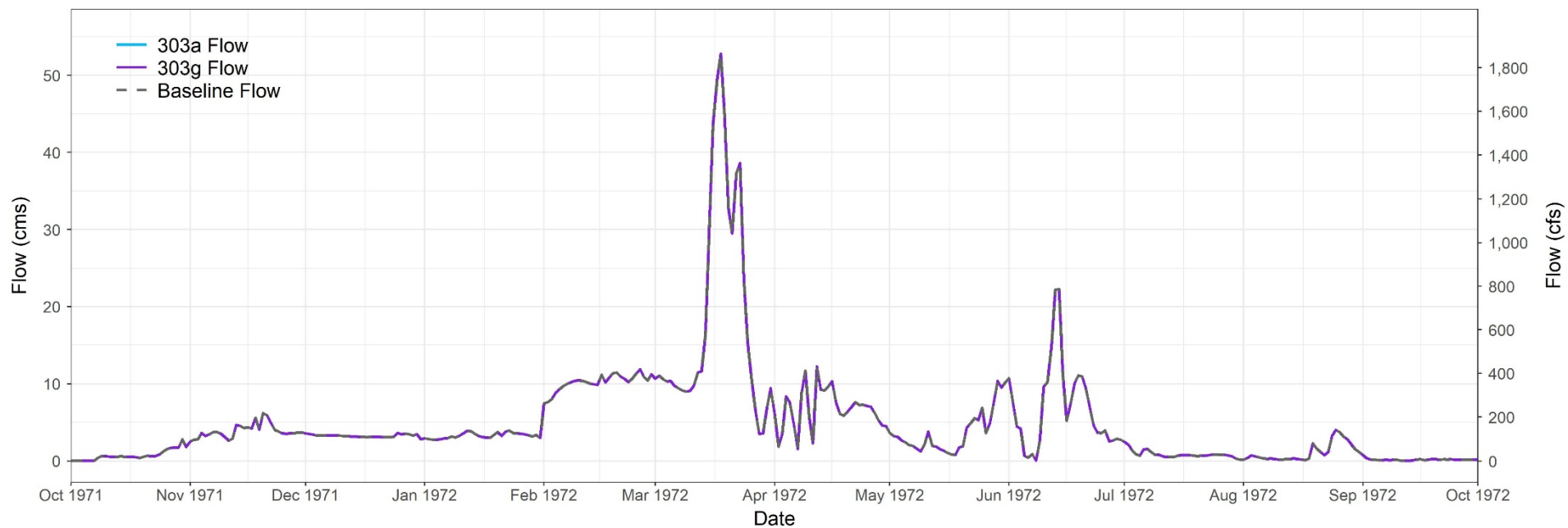
#### Souris River Plan of Study

**303a** = 200 cfs maximum at Minot, ND  
**303g** = 1,500 cfs maximum at Minot, ND

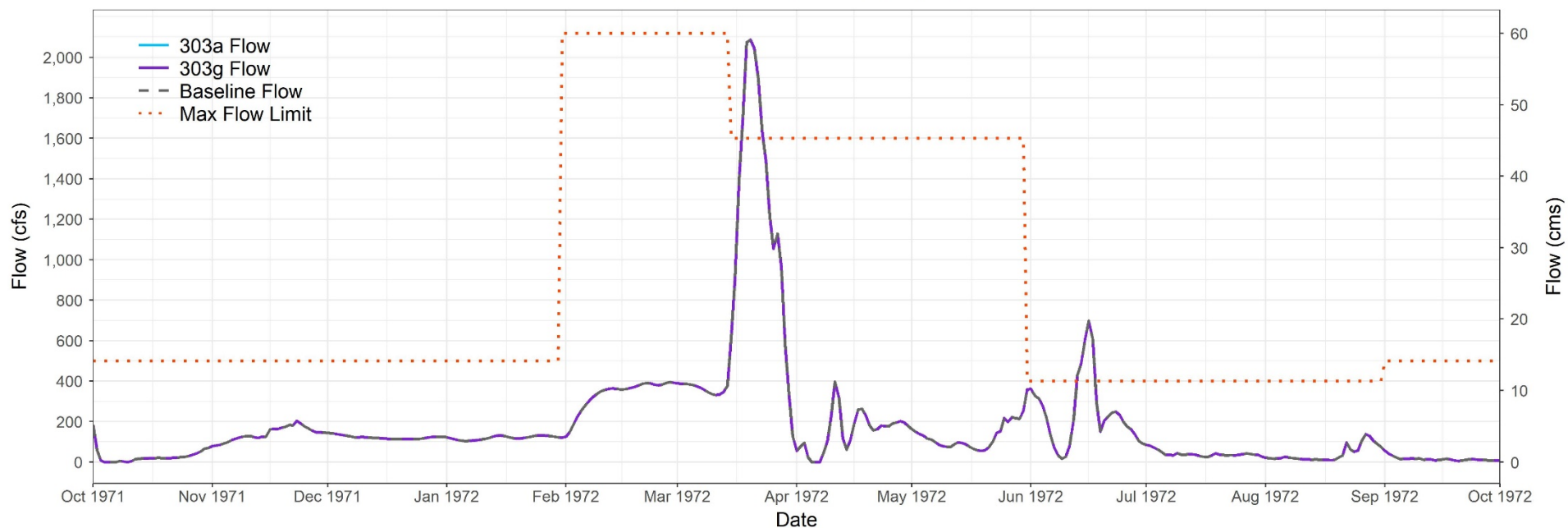
Souris River at Estevan, SK



### Souris River at Oxbow, SK

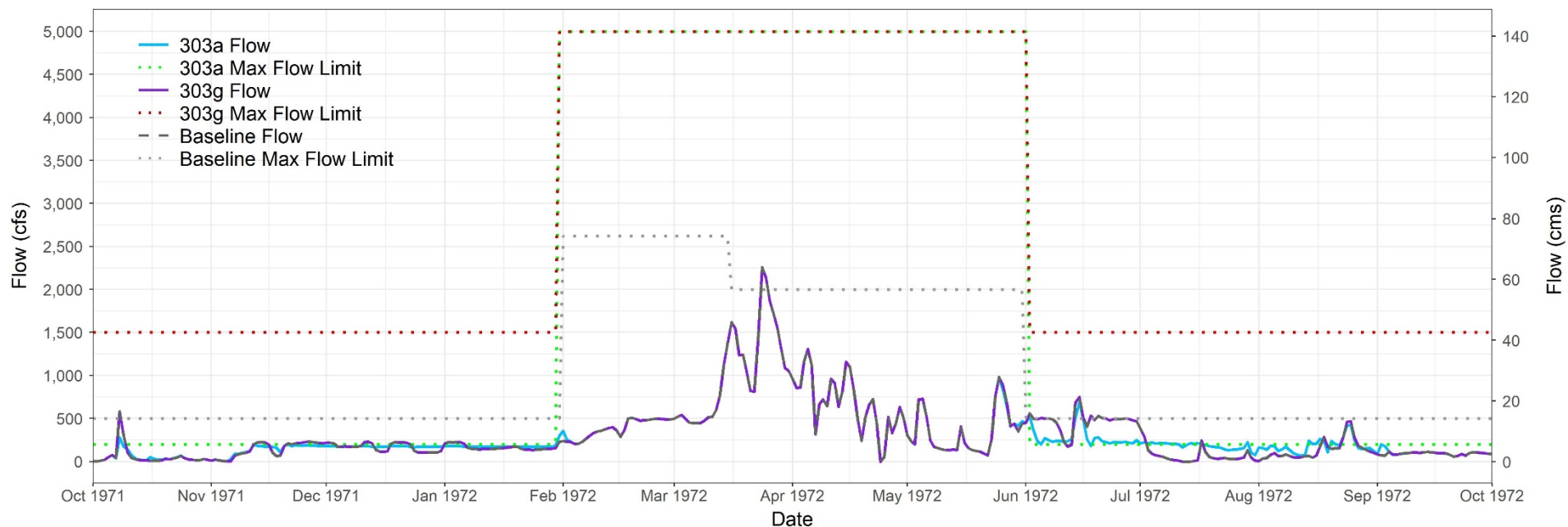


### Souris River at Sherwood, ND

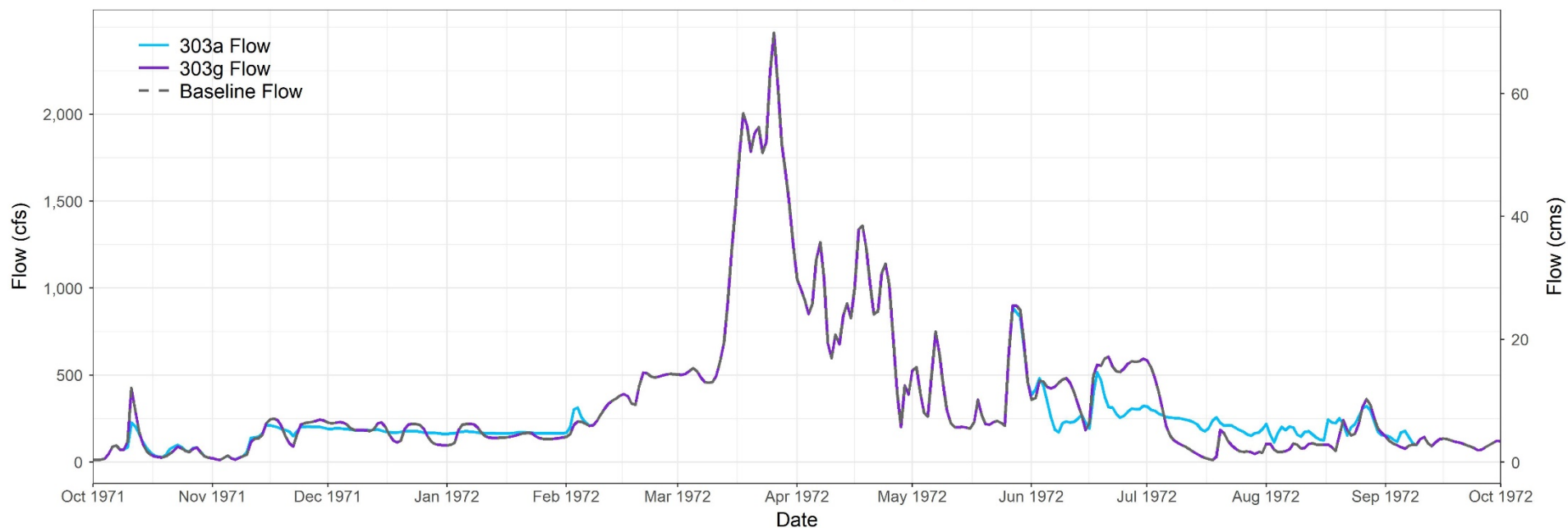


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

Souris River at Minot, ND - Flow

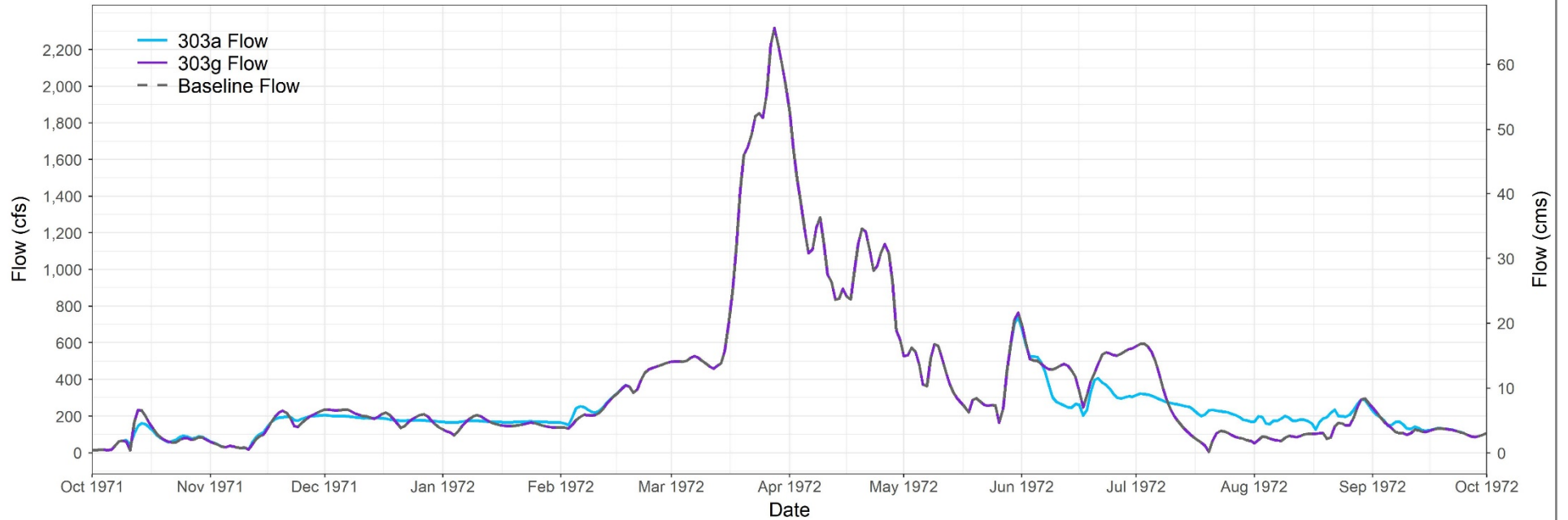


Souris River at Verendrye, ND

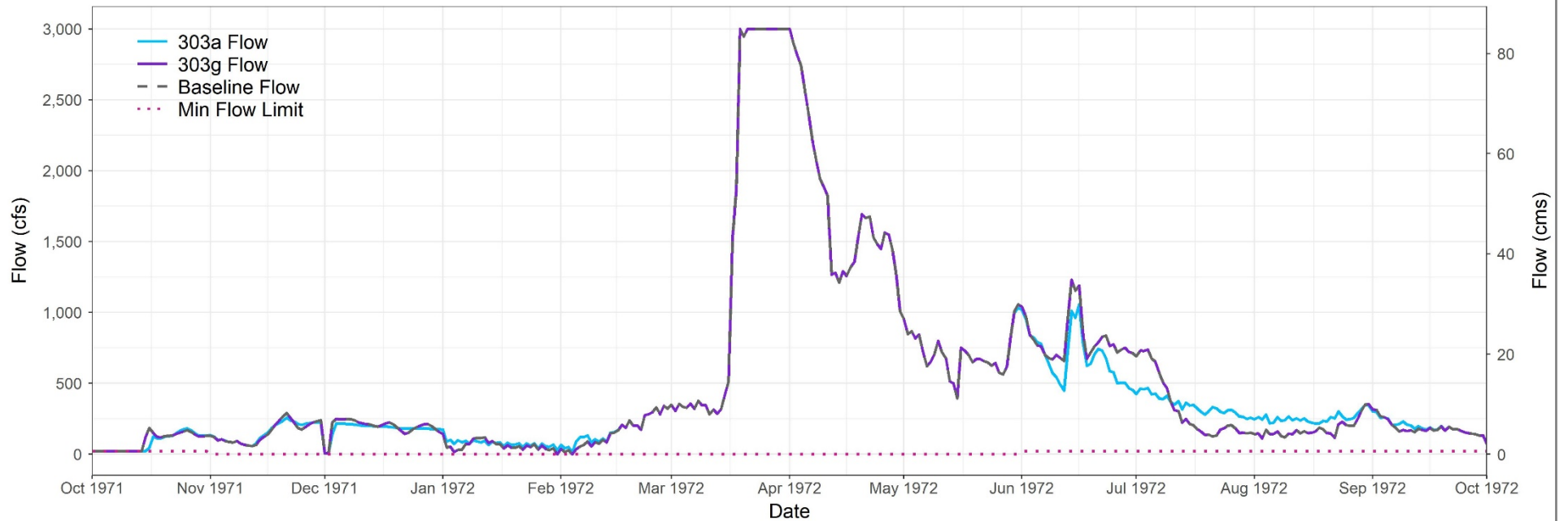


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

Souris River at Bantry, ND



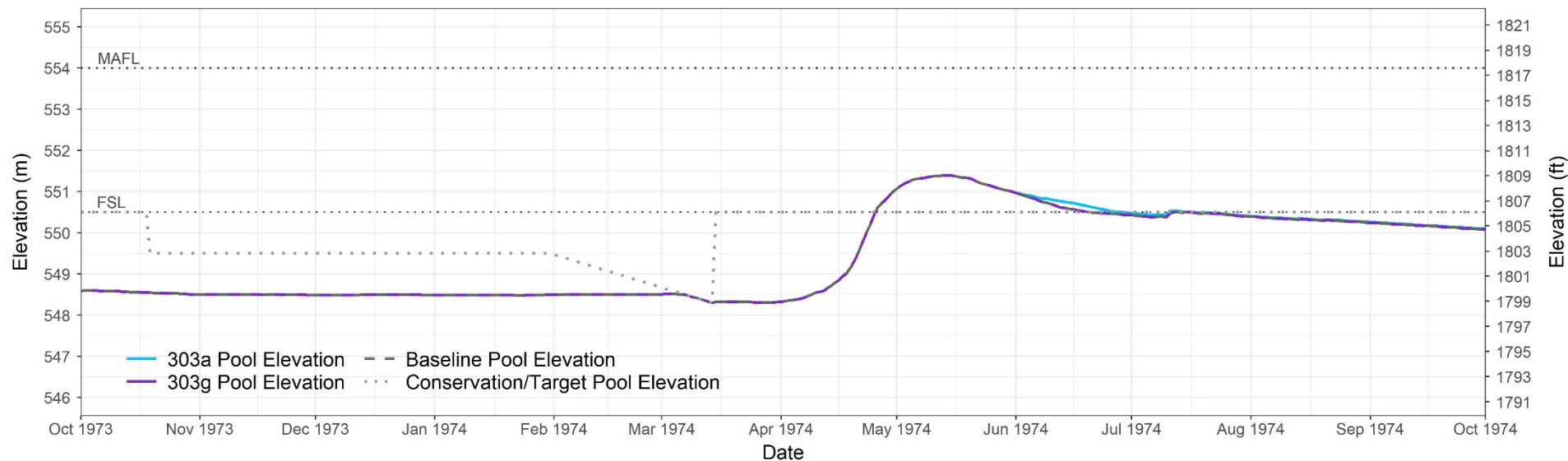
Souris River at Westhope, ND



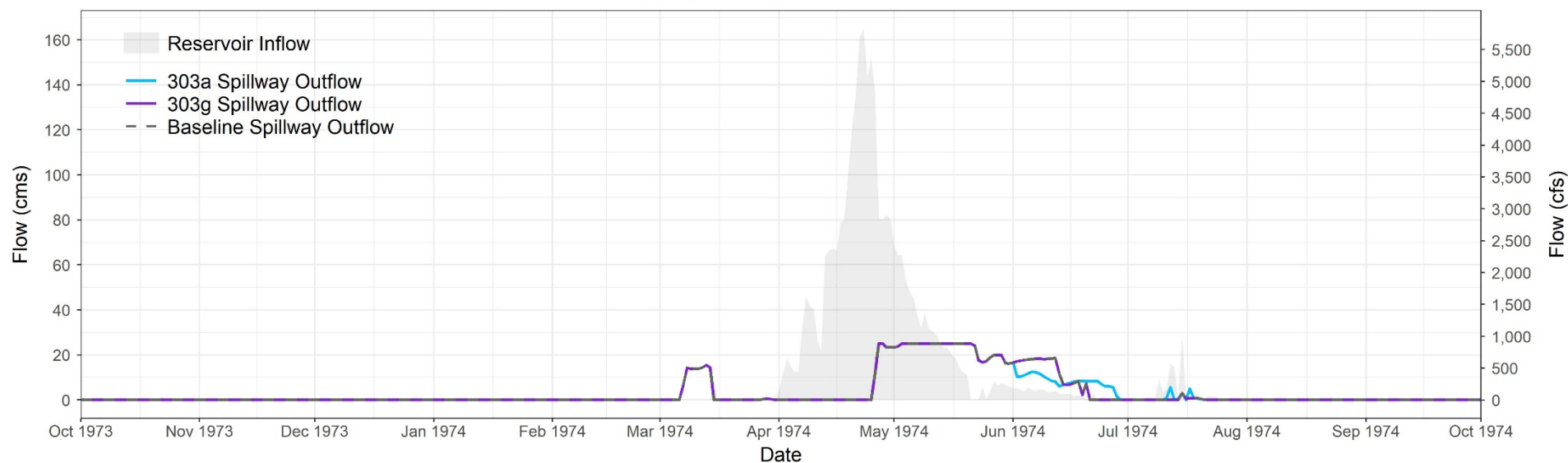
**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND



Rafferty Reservoir - Elevation

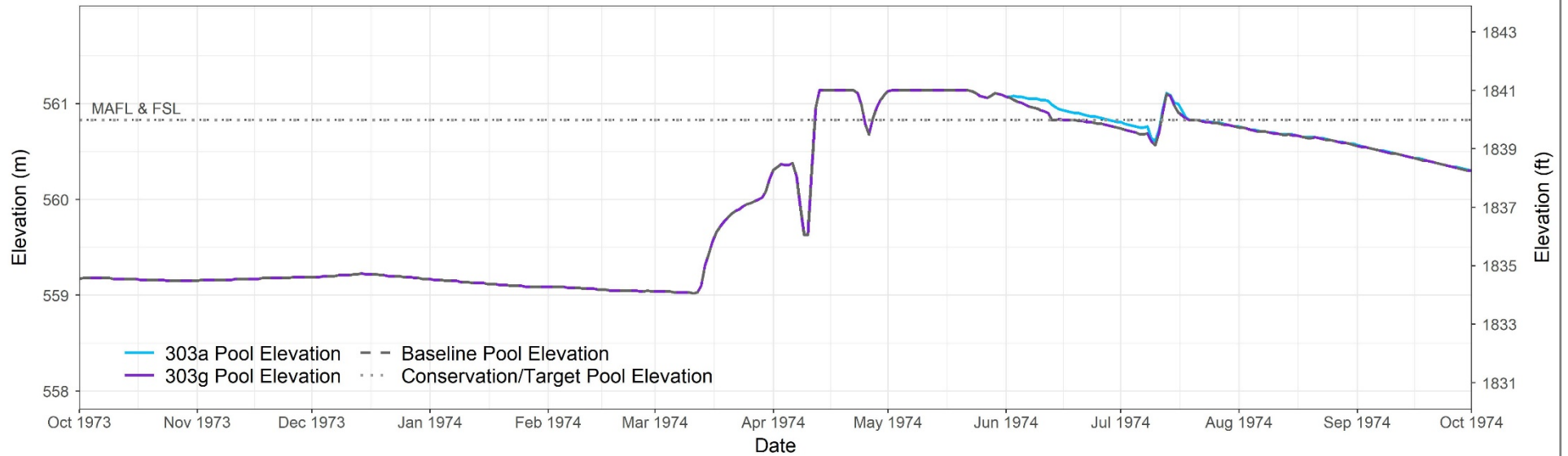


Rafferty Reservoir - Releases

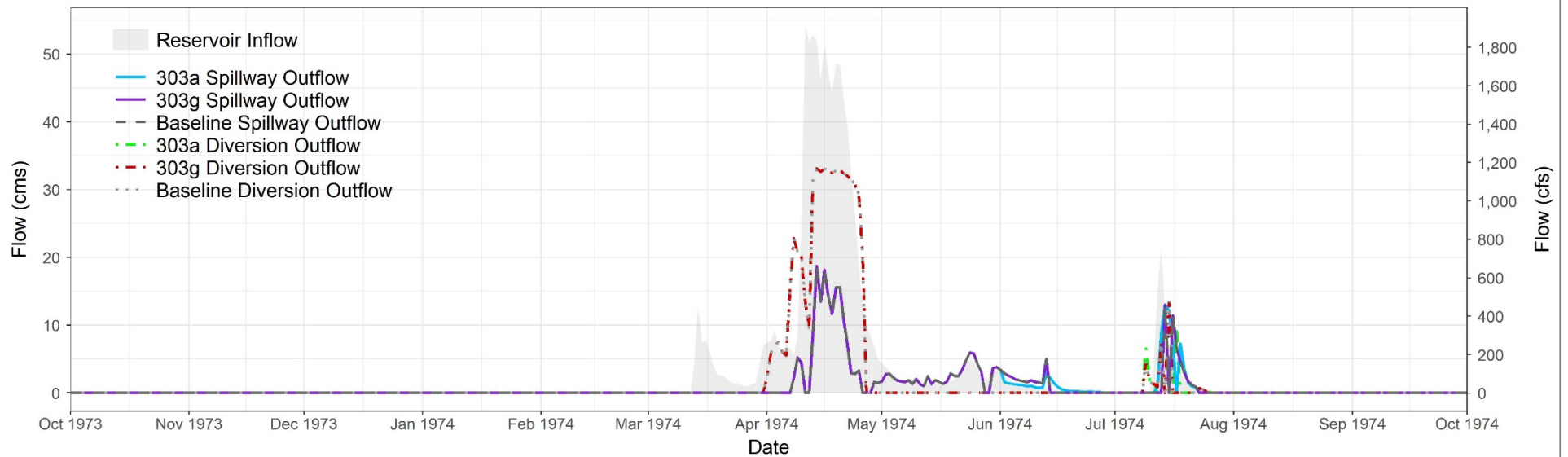


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Boundary Reservoir - Elevation

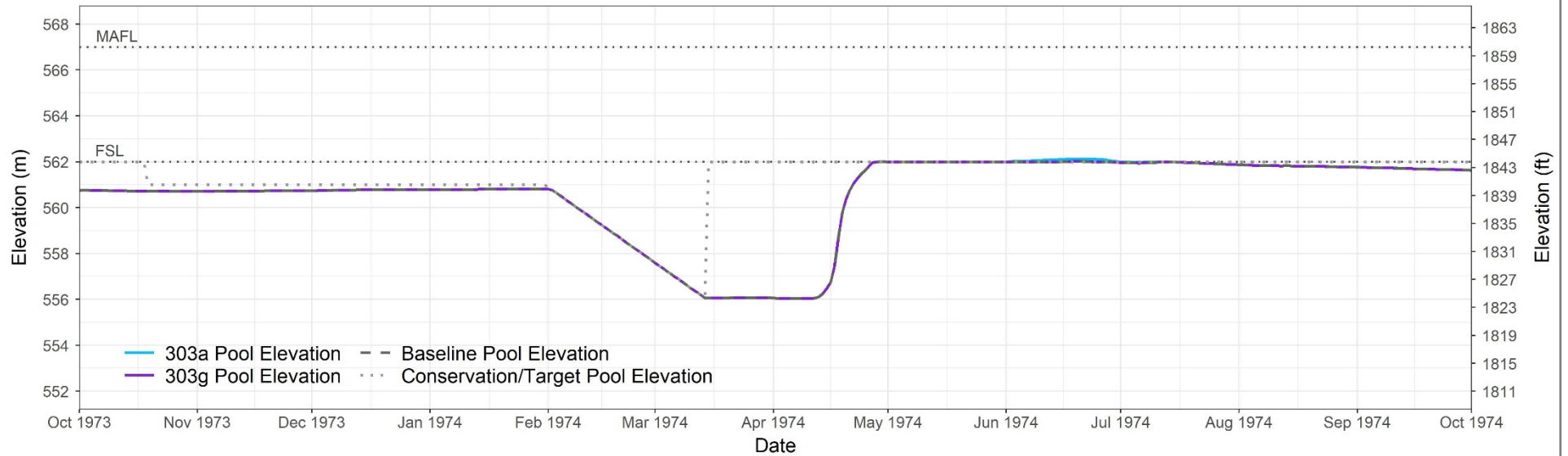


### Boundary Reservoir - Releases

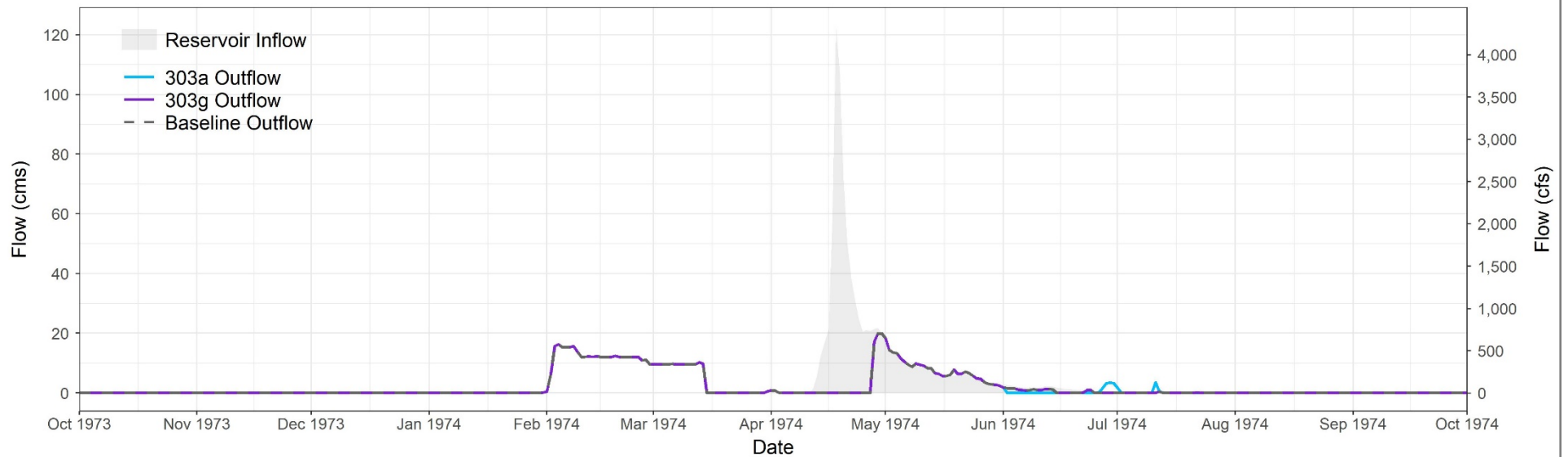


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Grant Devine Reservoir - Elevation



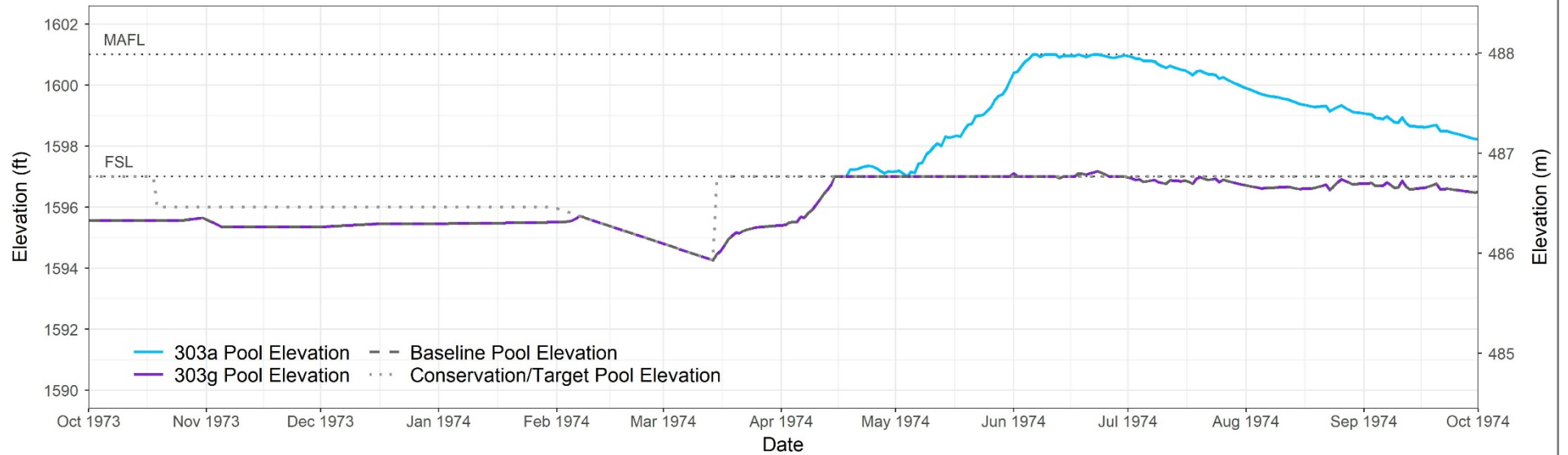
### Grant Devine Reservoir - Releases



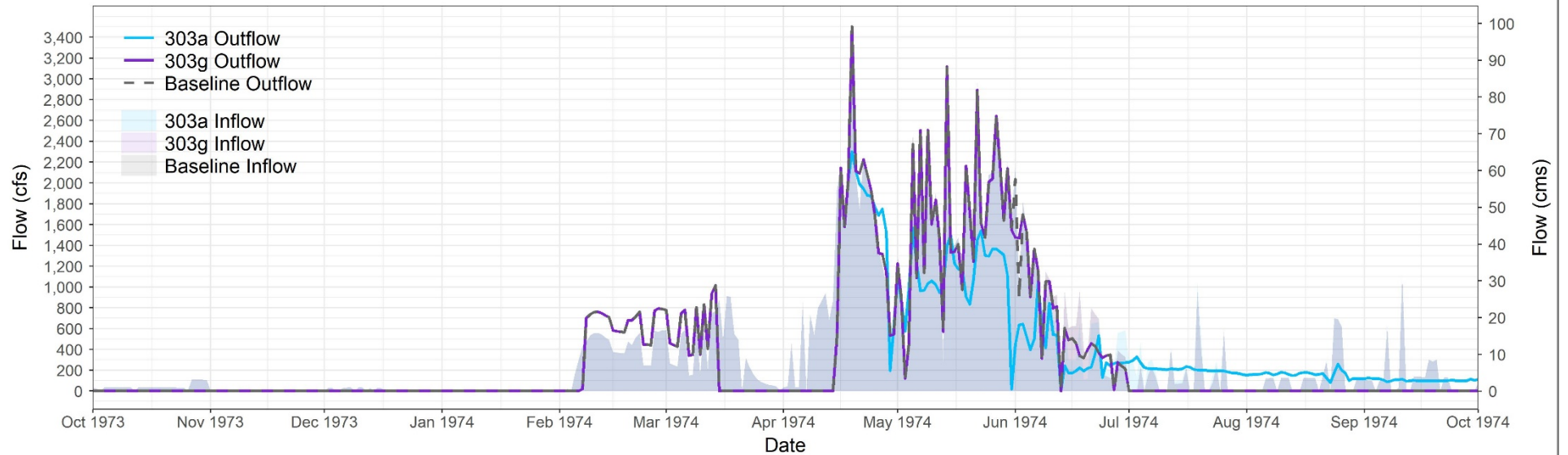
**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND



### Lake Darling - Elevation



### Lake Darling - Releases



**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

# Plate 06

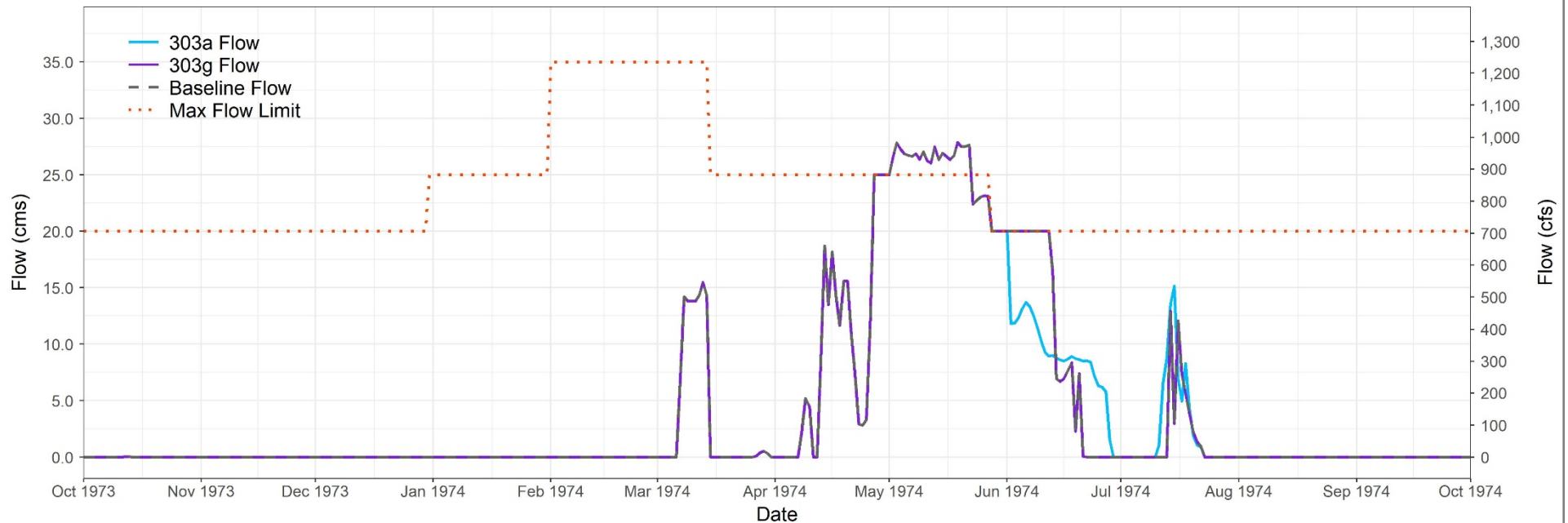
## Critical Flow Locations – 1974

### Alternative 303 (Phase 3)

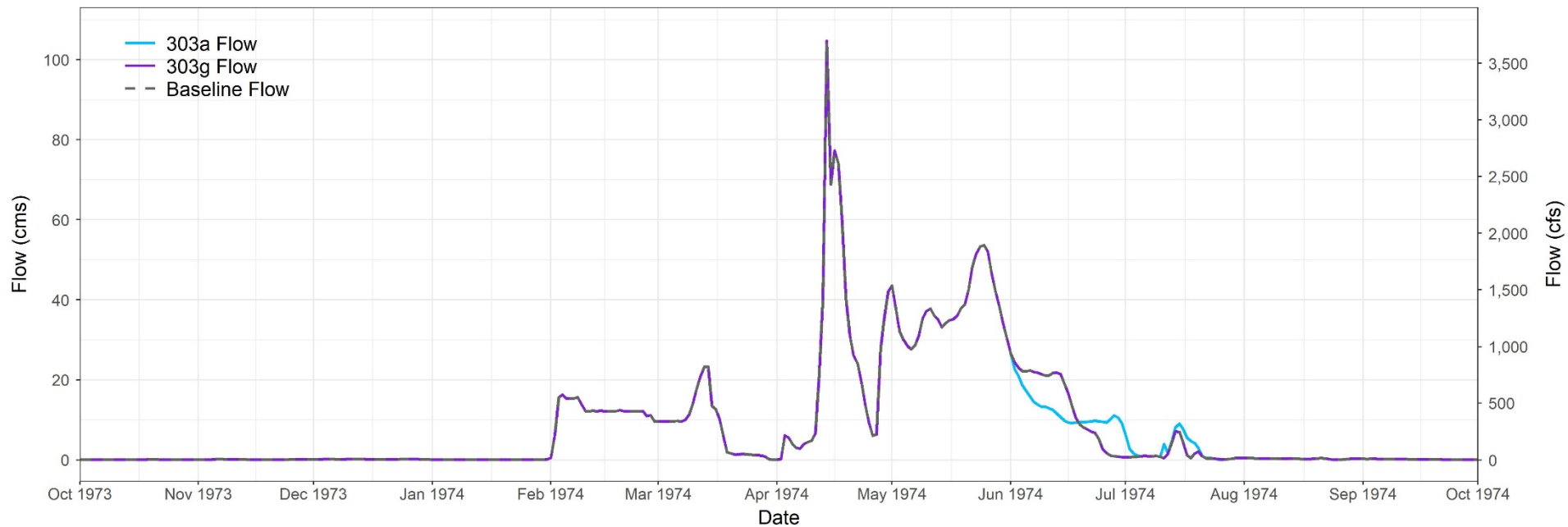
#### Souris River Plan of Study

**303a** = 200 cfs maximum at Minot, ND  
**303g** = 1,500 cfs maximum at Minot, ND

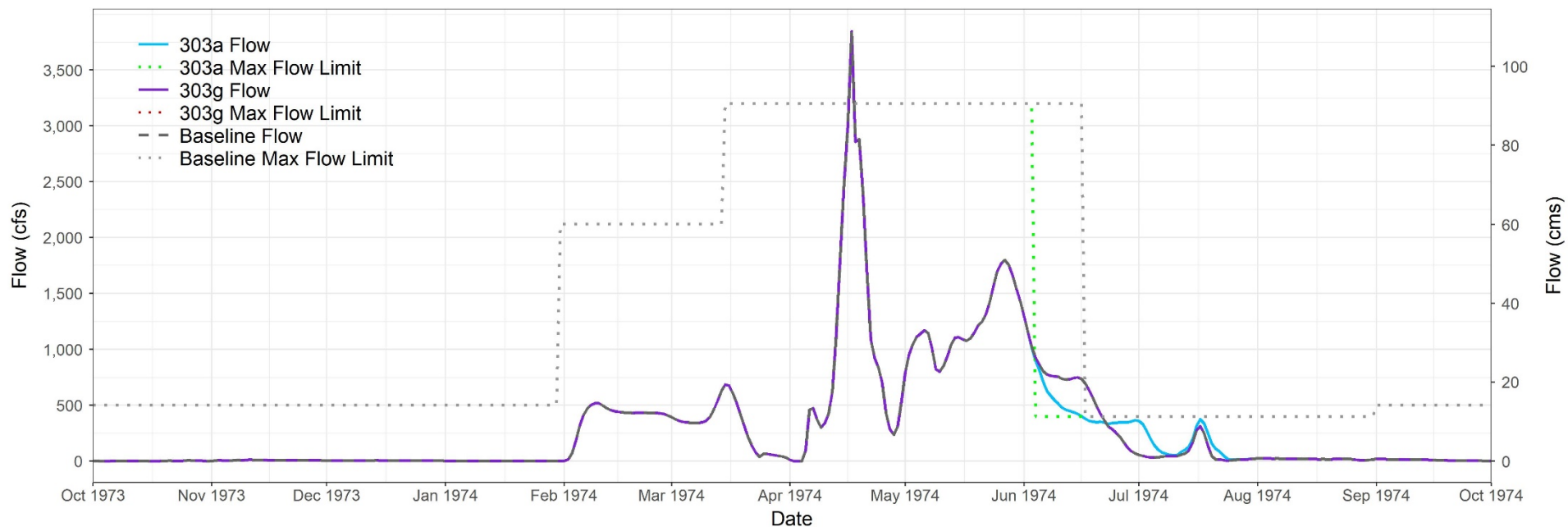
Souris River at Estevan, SK



### Souris River at Oxbow, SK

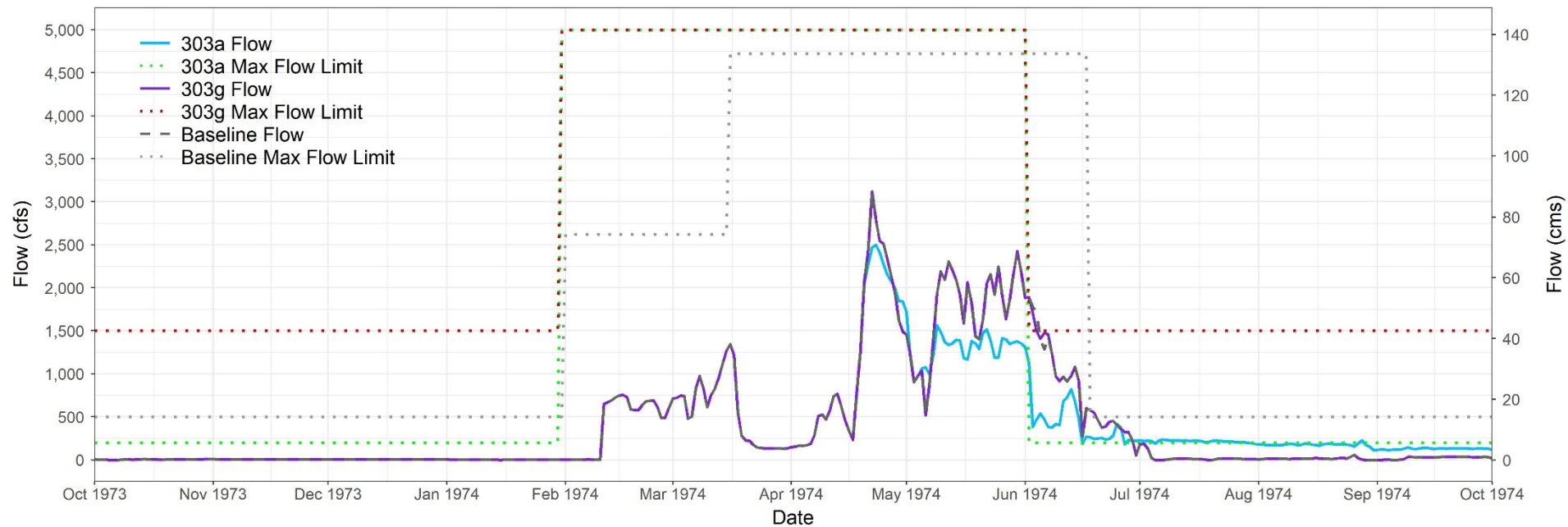


### Souris River at Sherwood, ND

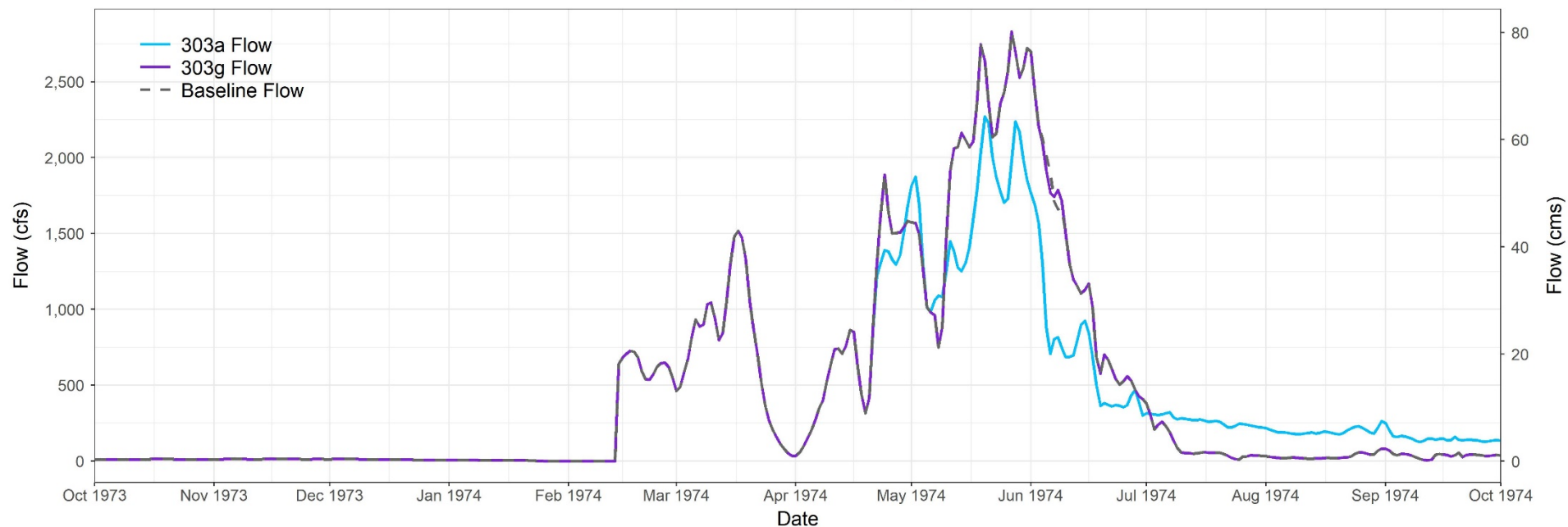


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

Souris River at Minot, ND - Flow

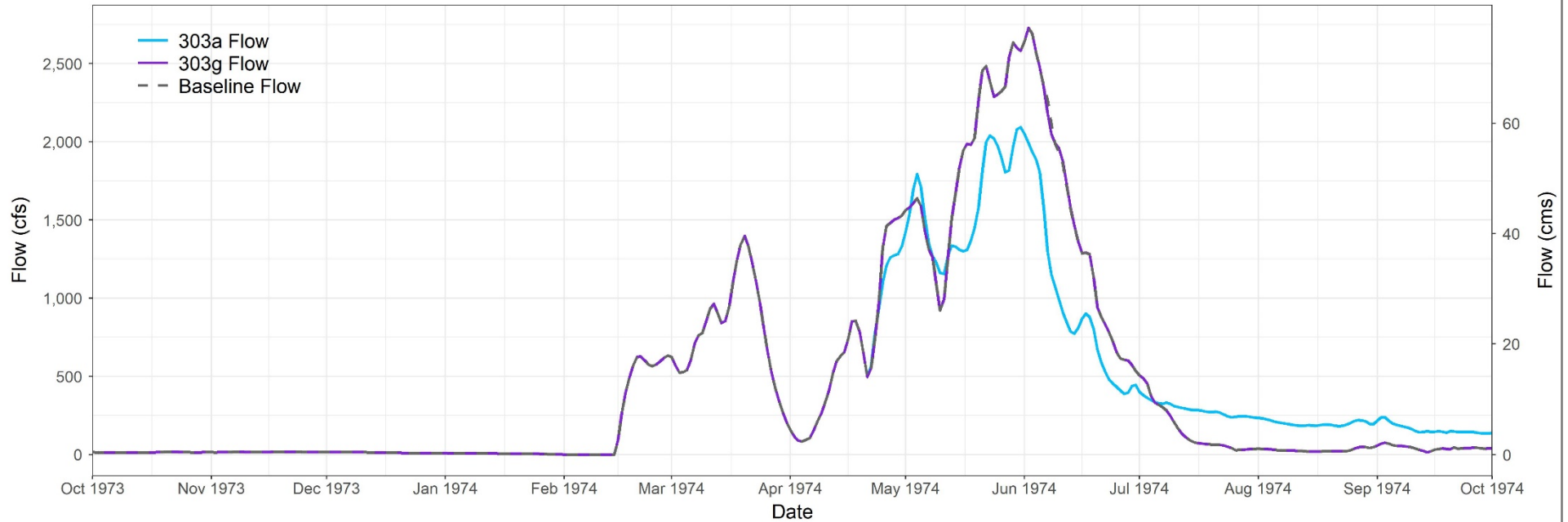


Souris River at Verendrye, ND

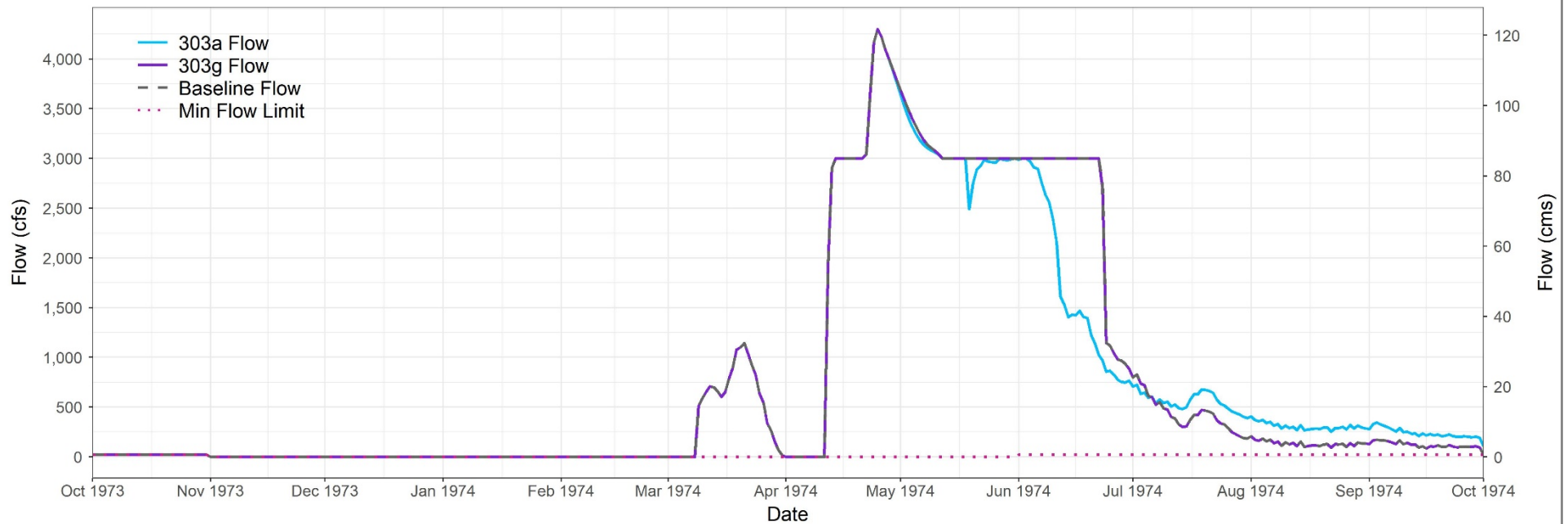


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

Souris River at Bantry, ND



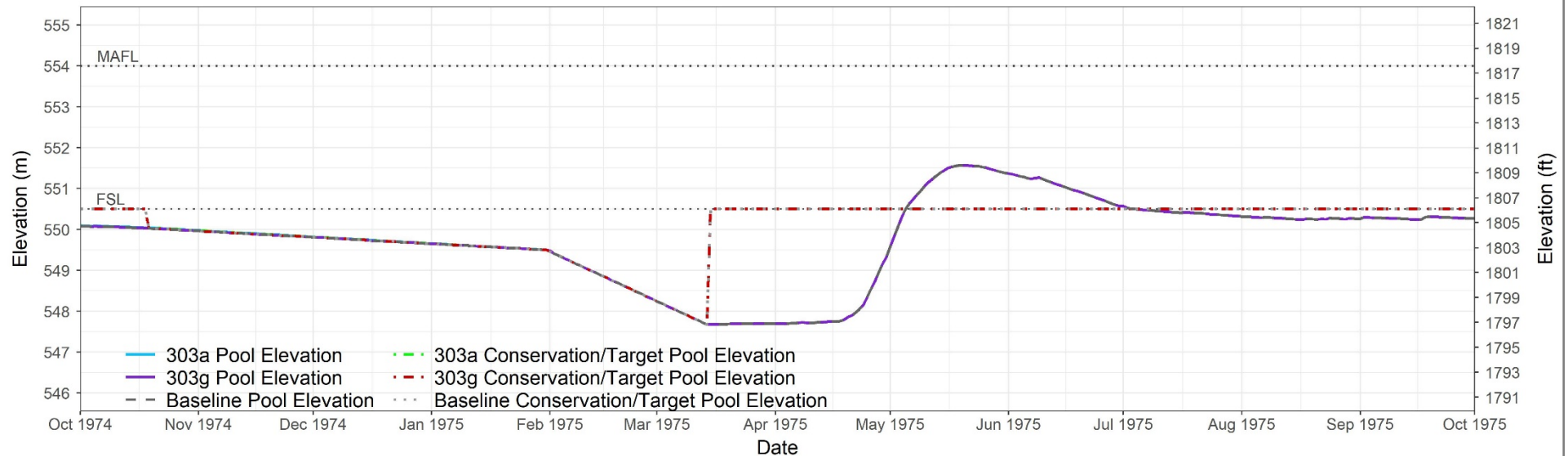
Souris River at Westhope, ND



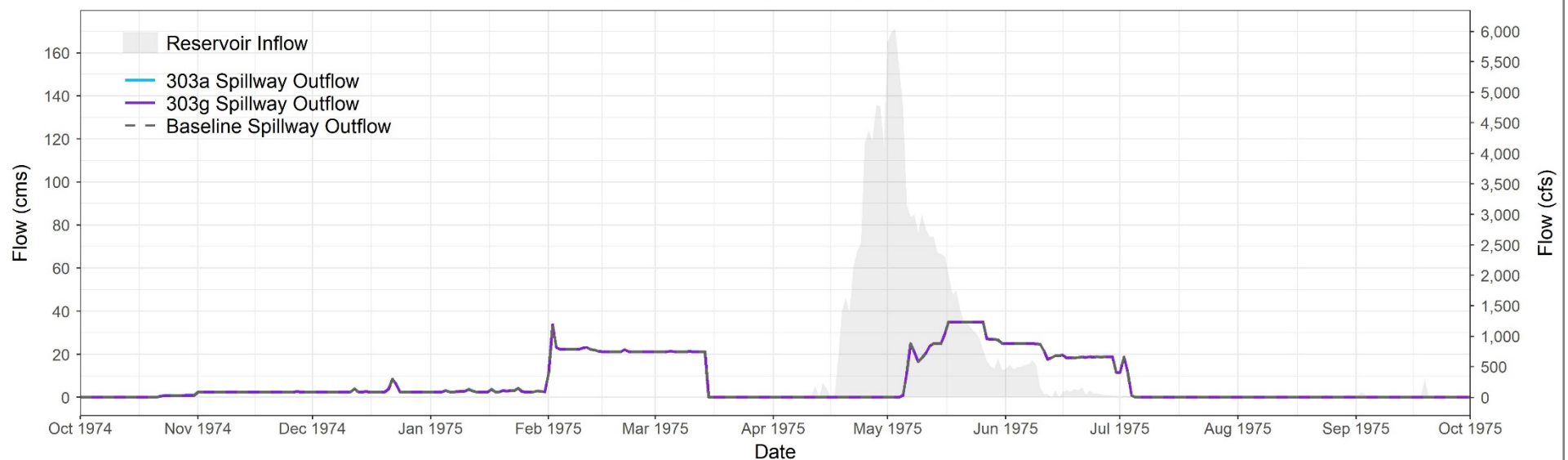
**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND



Rafferty Reservoir - Elevation

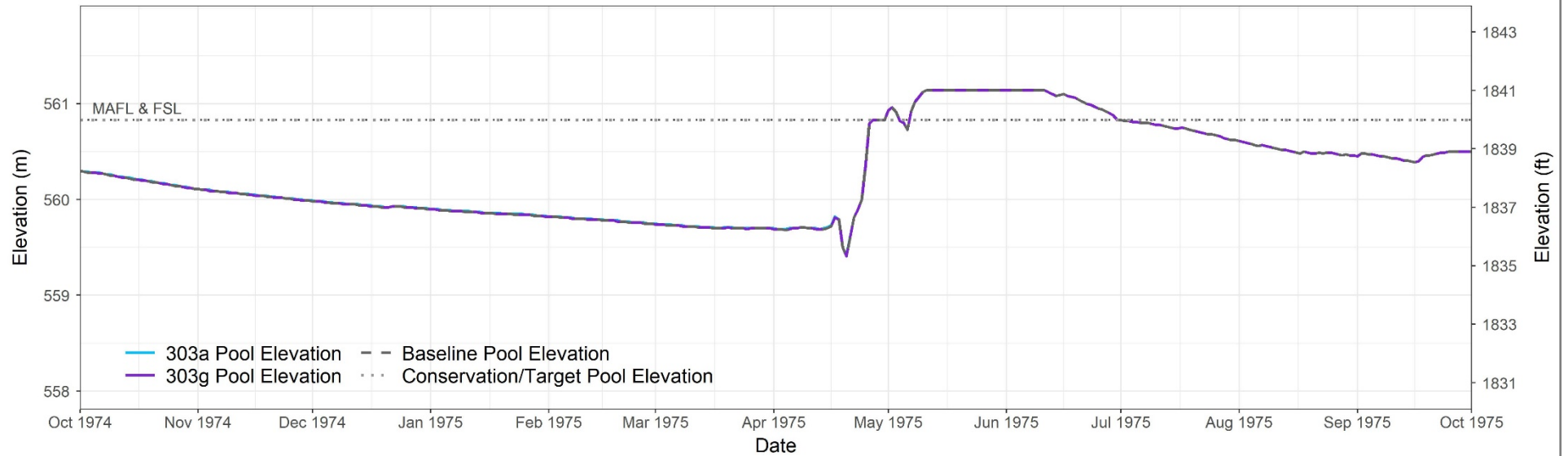


Rafferty Reservoir - Releases

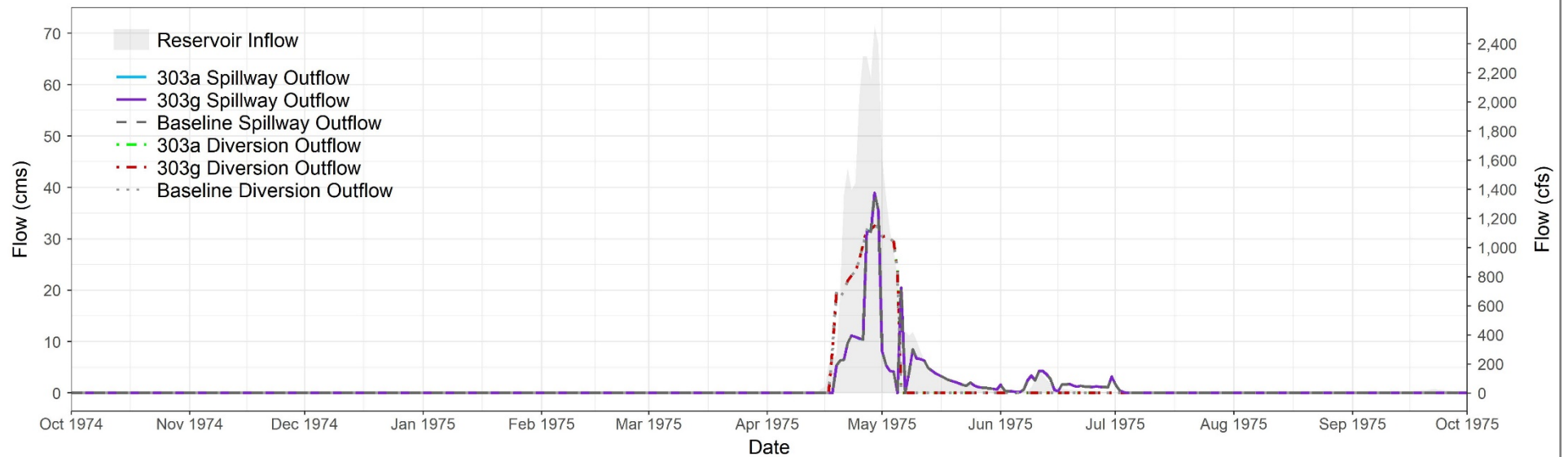


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Boundary Reservoir - Elevation

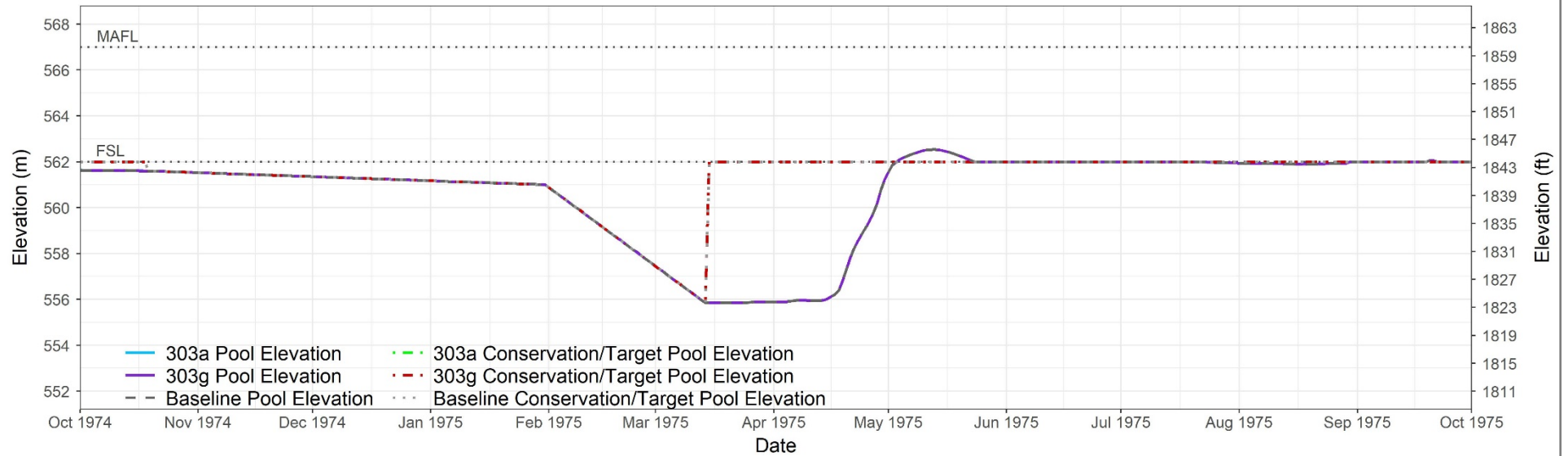


### Boundary Reservoir - Releases

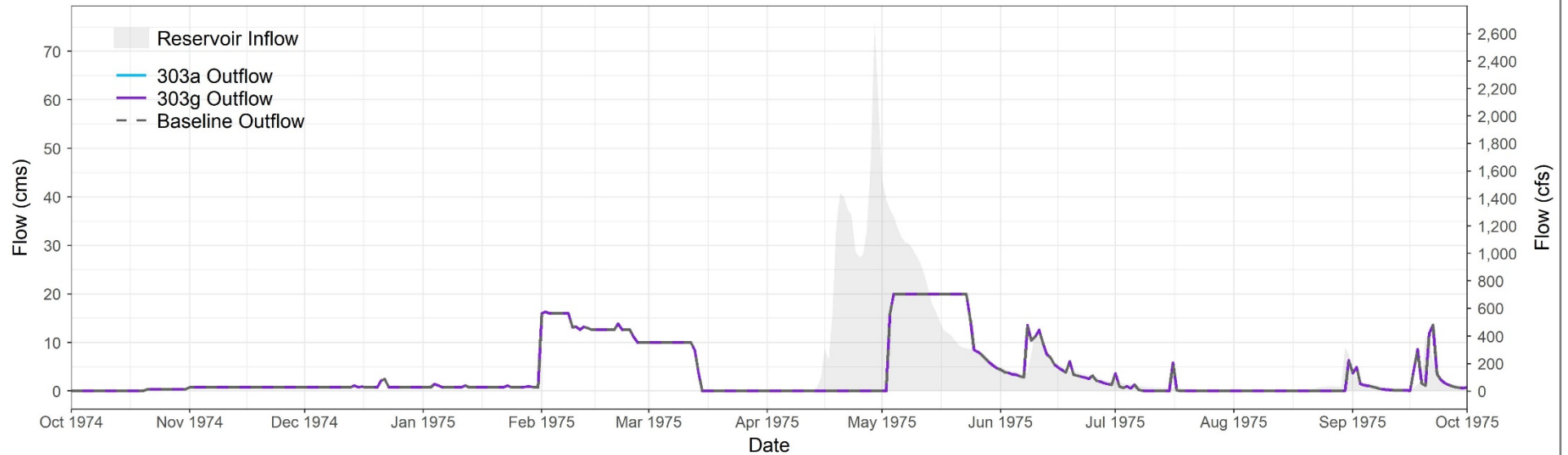


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

### Grant Devine Reservoir - Elevation



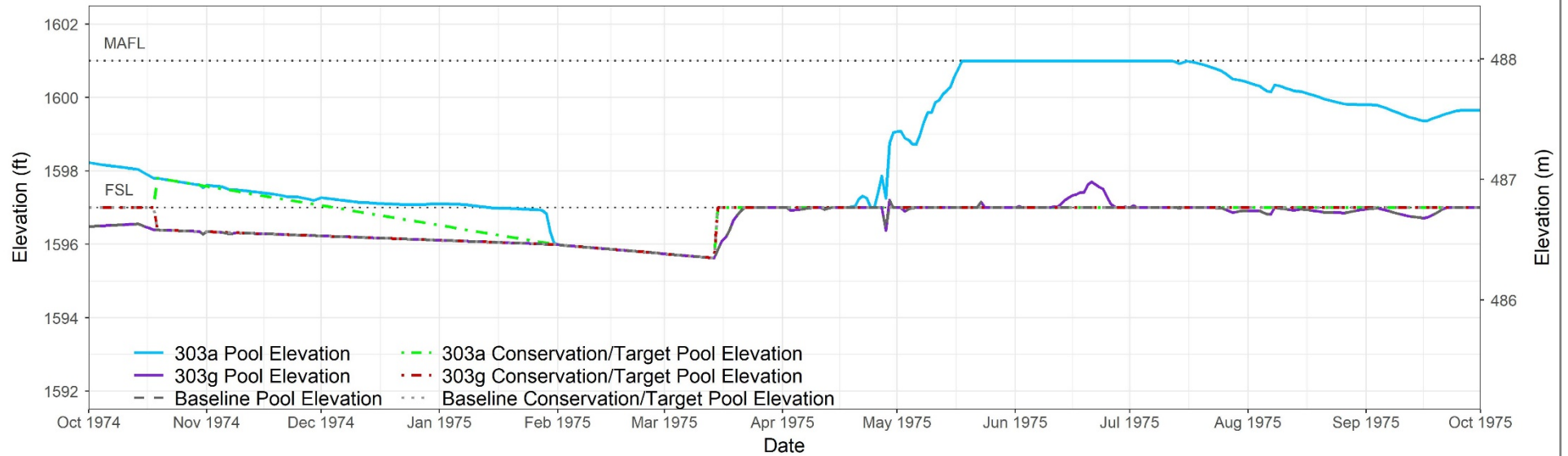
### Grant Devine Reservoir - Releases



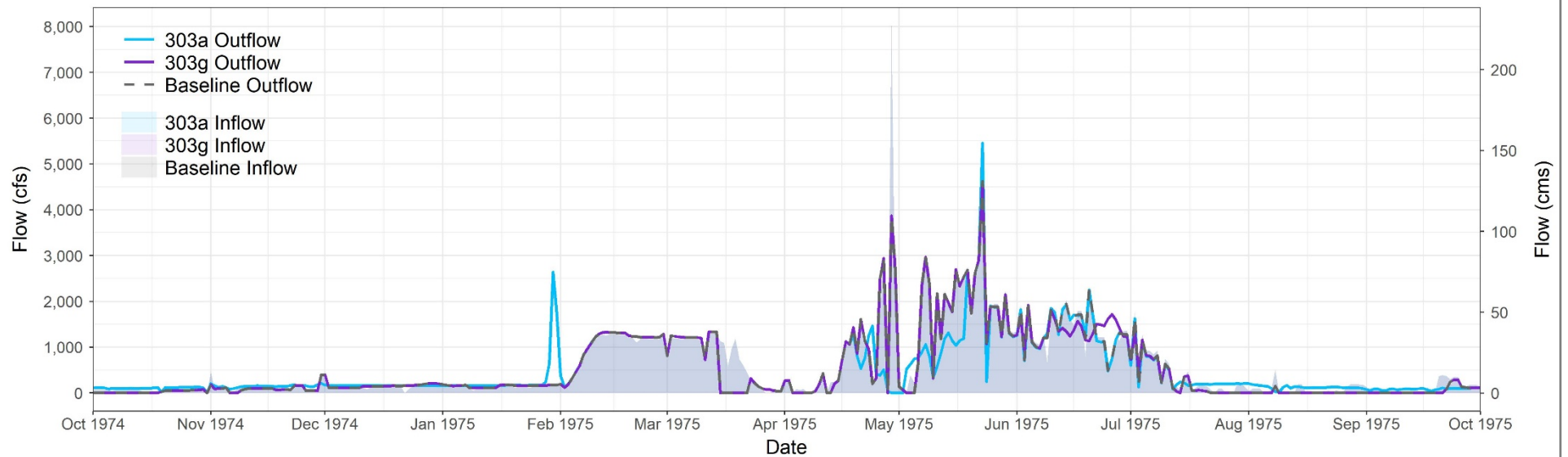
**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND



### Lake Darling - Elevation



### Lake Darling - Releases



**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

# Plate 08

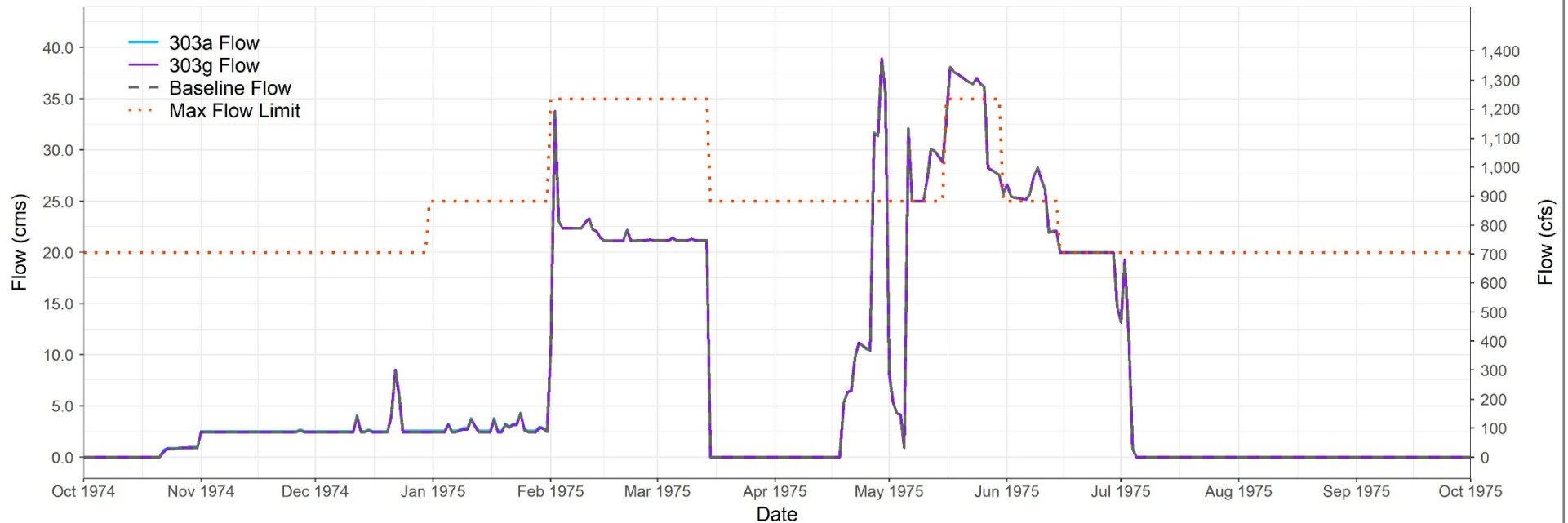
## Critical Flow Locations – 1975

### Alternative 303 (Phase 3)

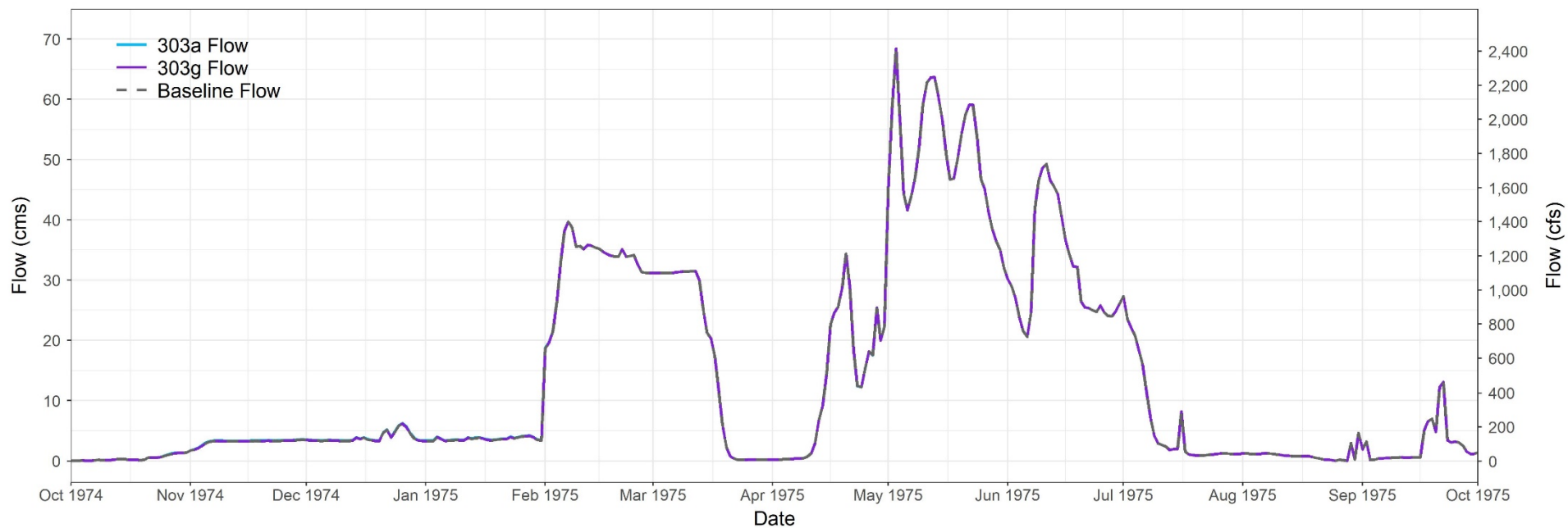
#### Souris River Plan of Study

**303a** = 200 cfs maximum at Minot, ND  
**303g** = 1,500 cfs maximum at Minot, ND

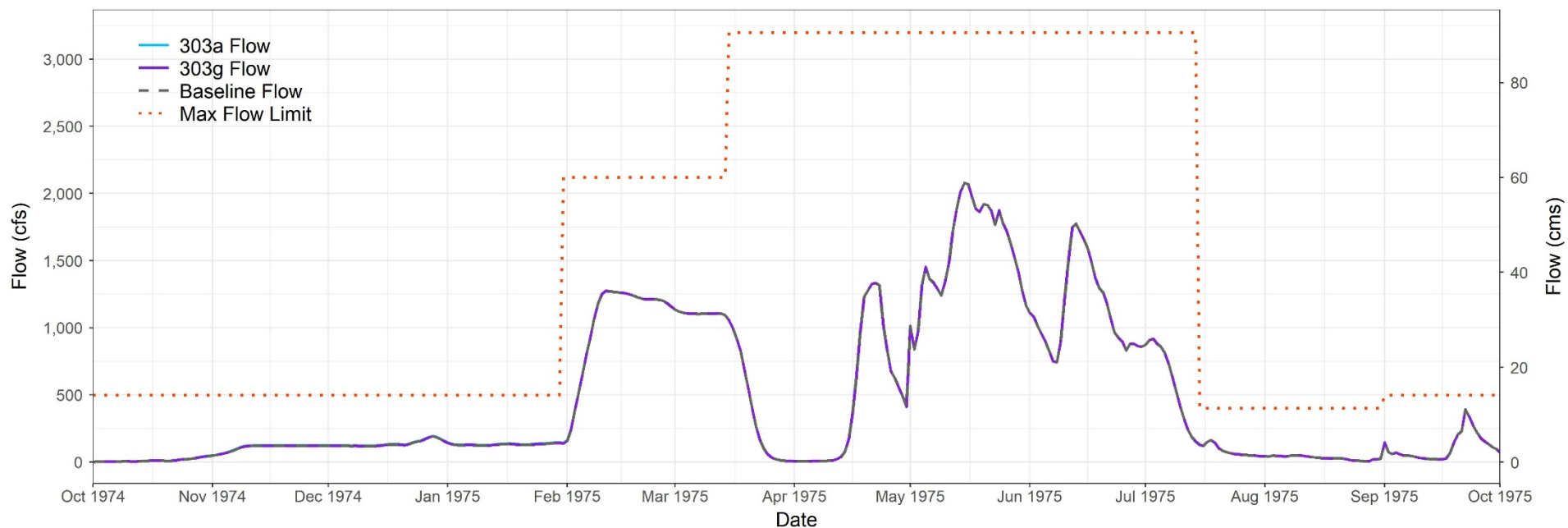
Souris River at Estevan, SK



### Souris River at Oxbow, SK

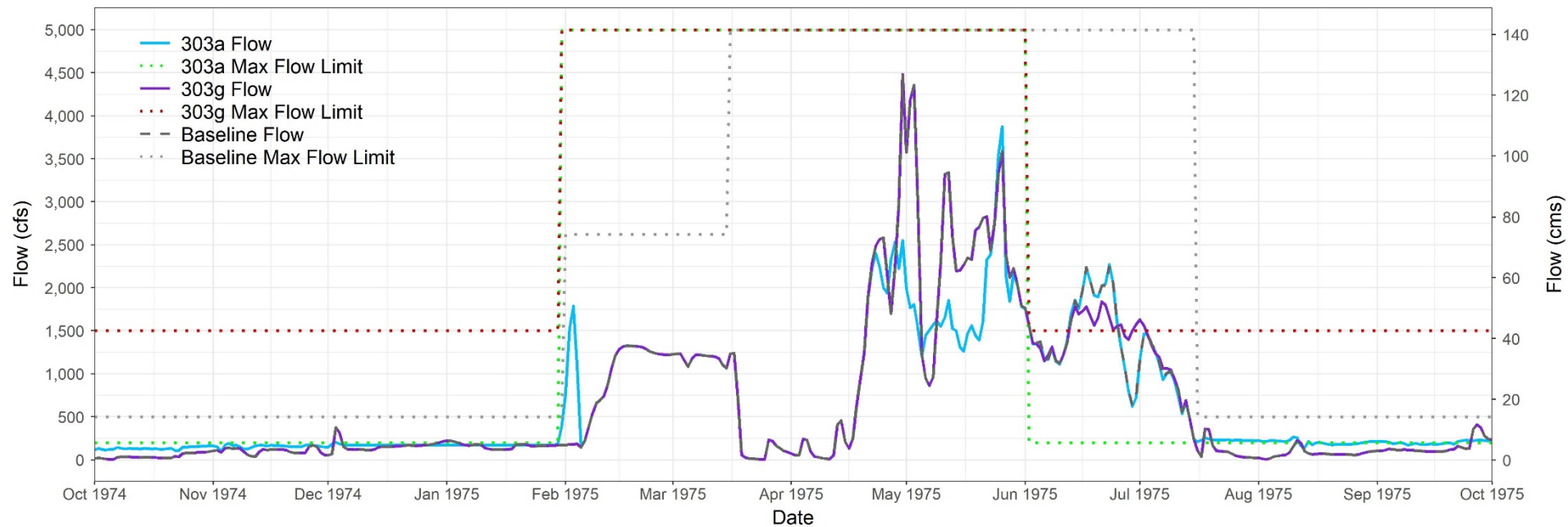


### Souris River at Sherwood, ND

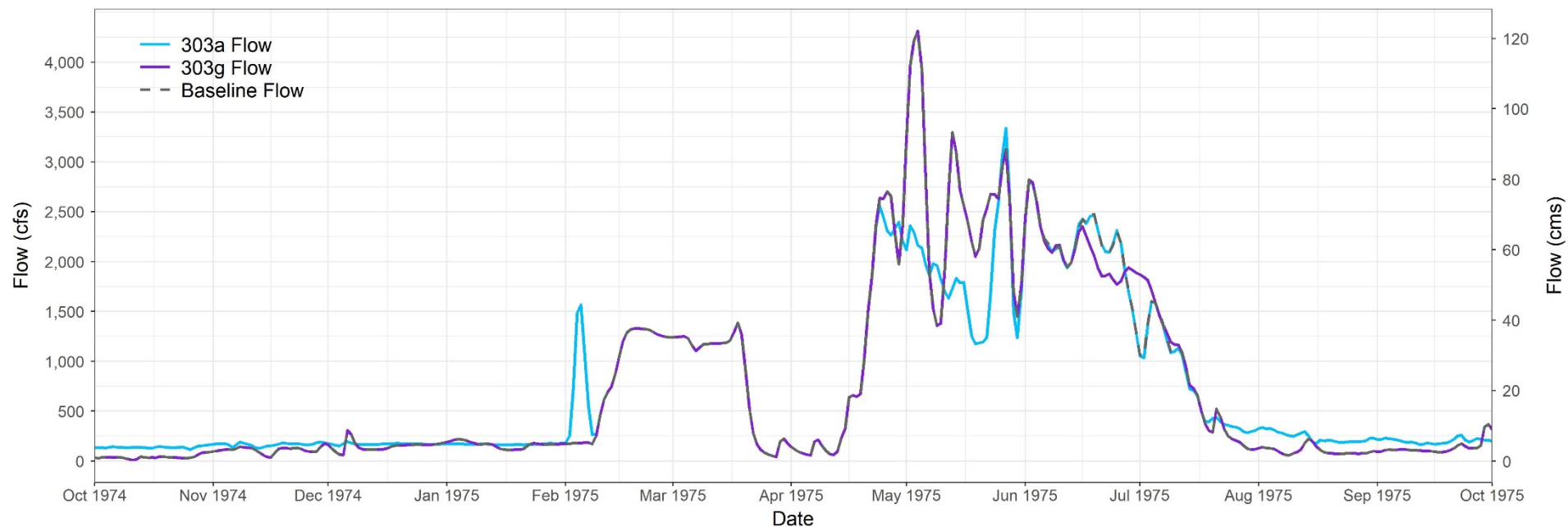


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

Souris River at Minot, ND - Flow

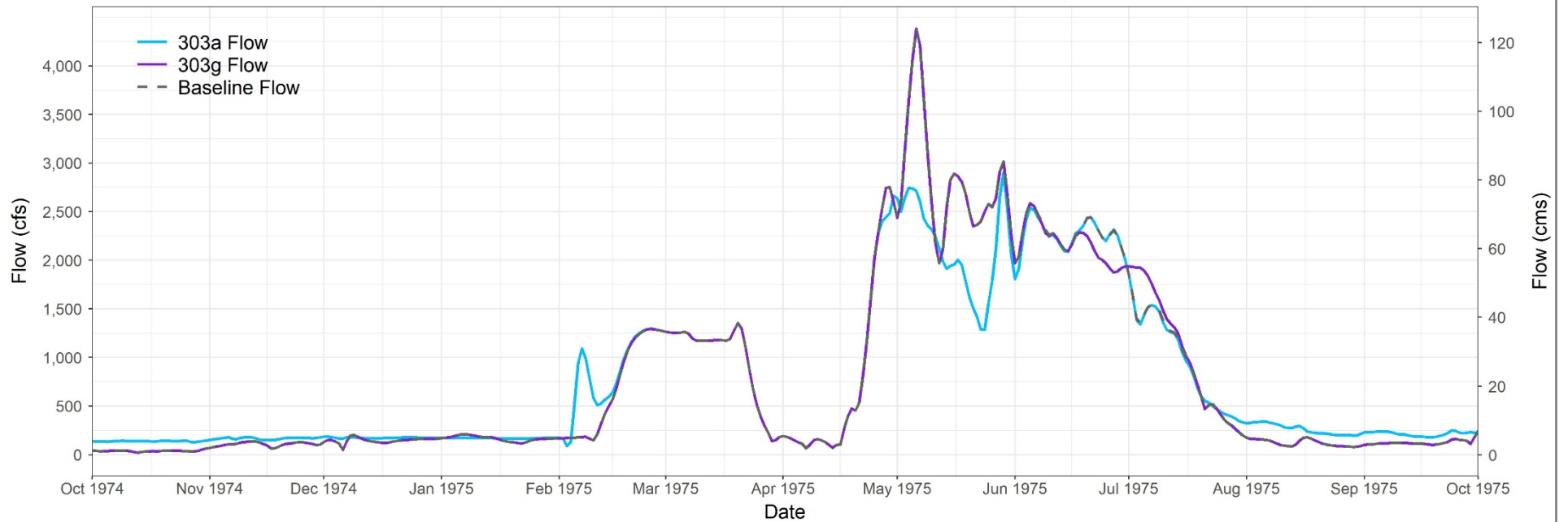


Souris River at Verendrye, ND

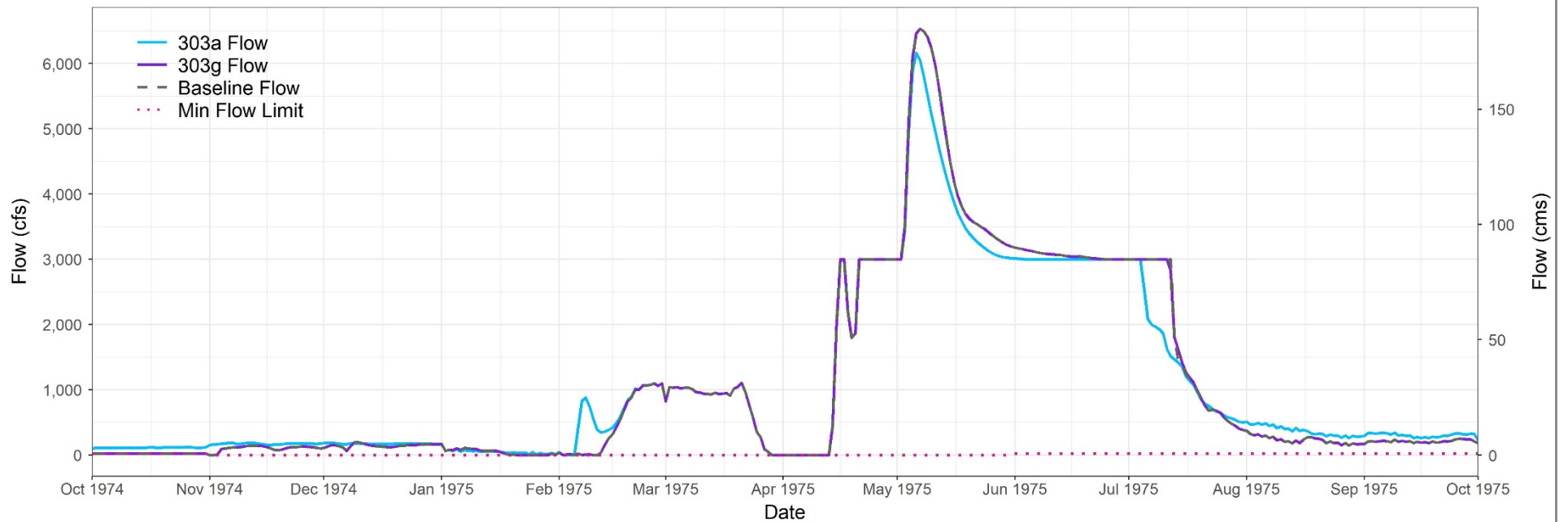


**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND

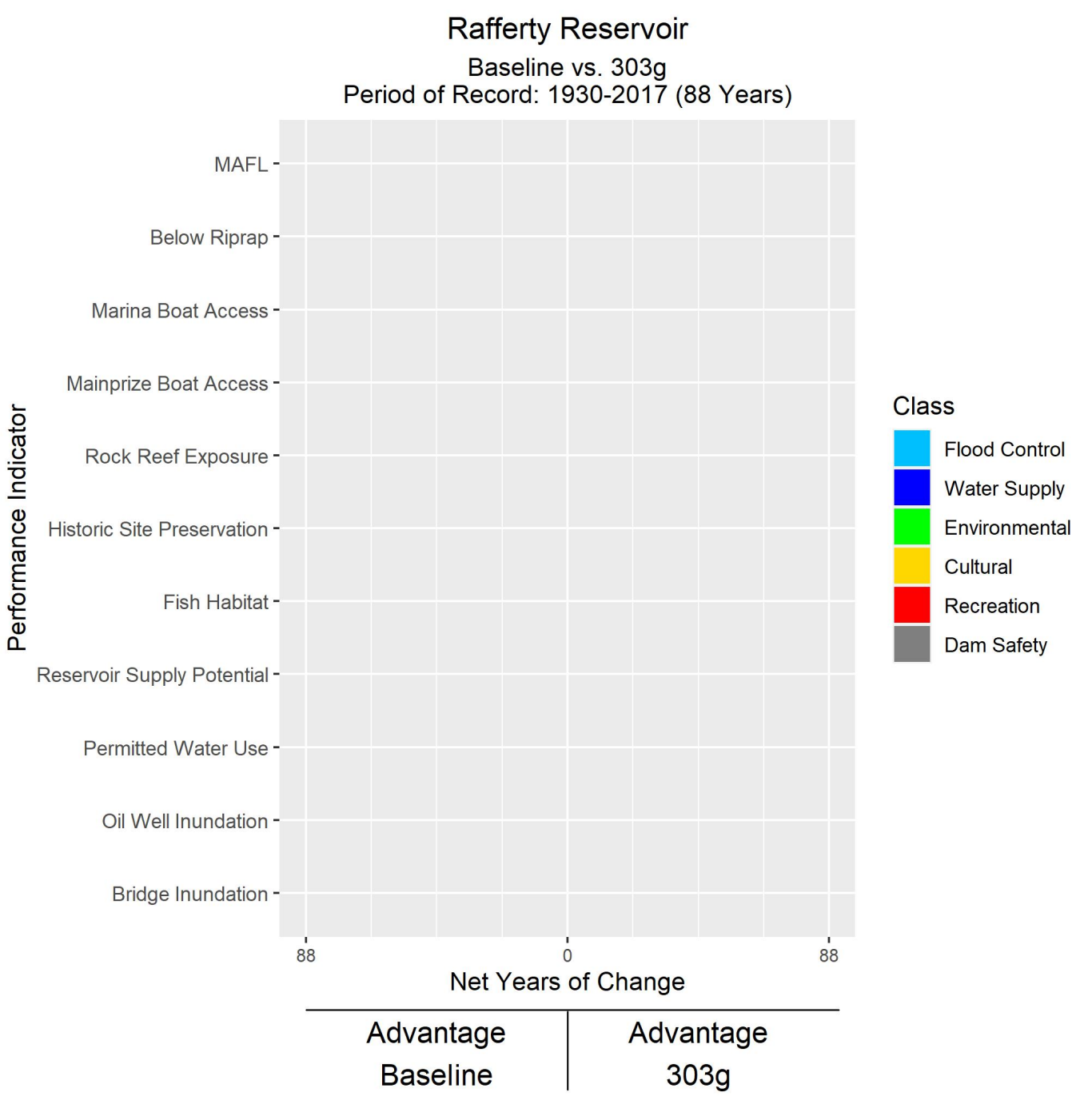
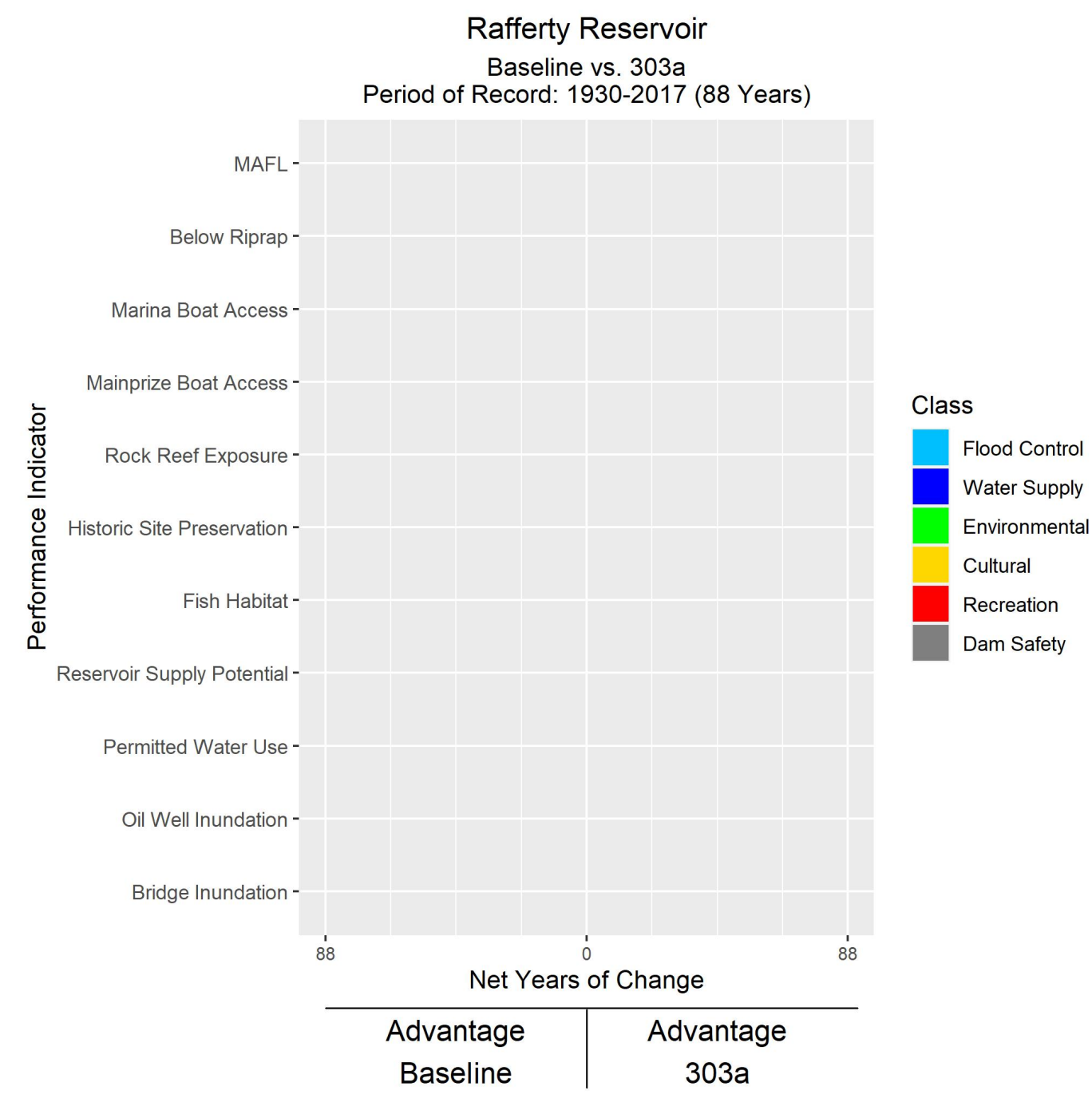
Souris River at Bantry, ND



Souris River at Westhope, ND



**303a** = 200 cfs maximum at Minot, ND, **303g** = 1,500 cfs maximum at Minot, ND



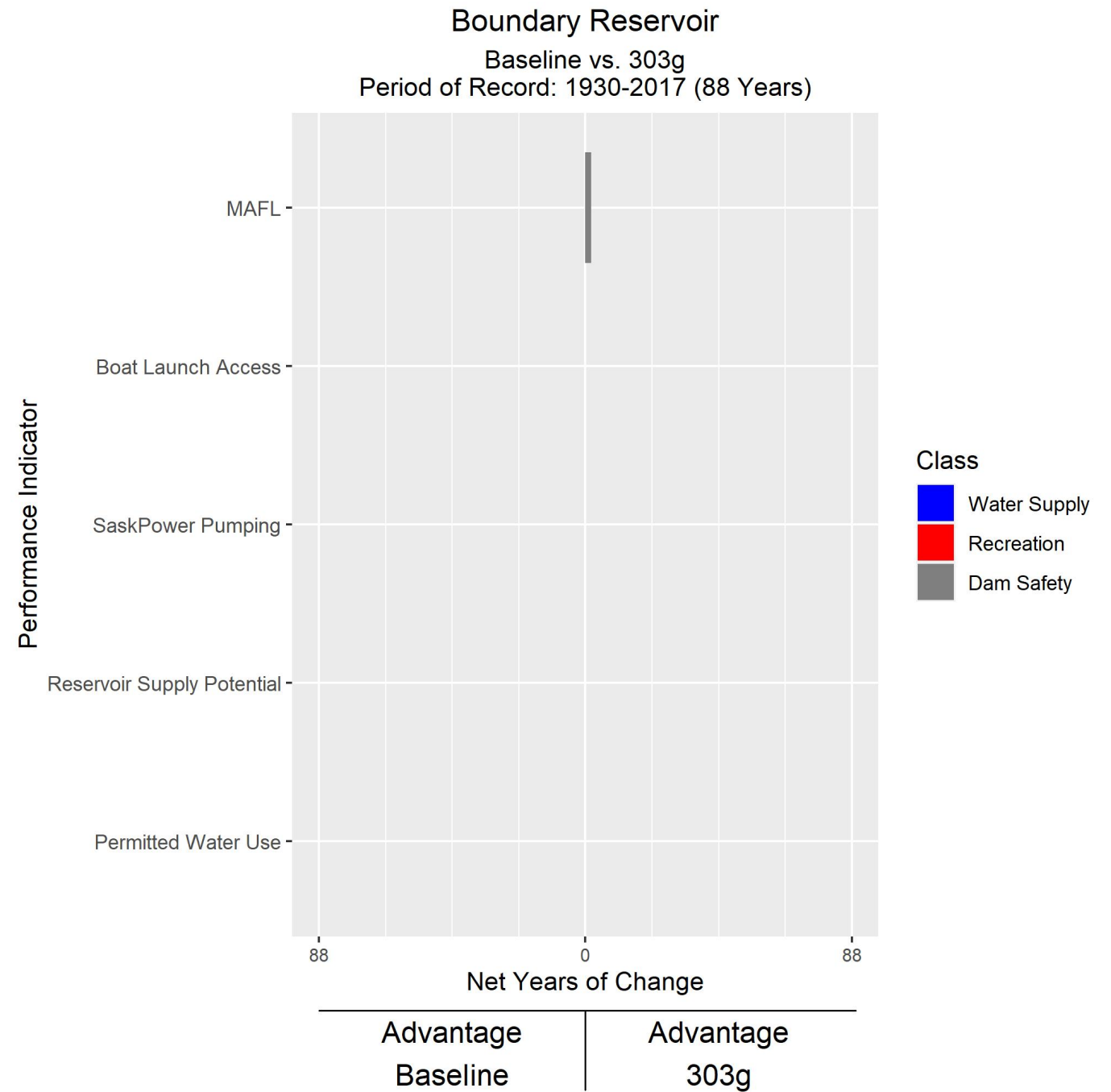
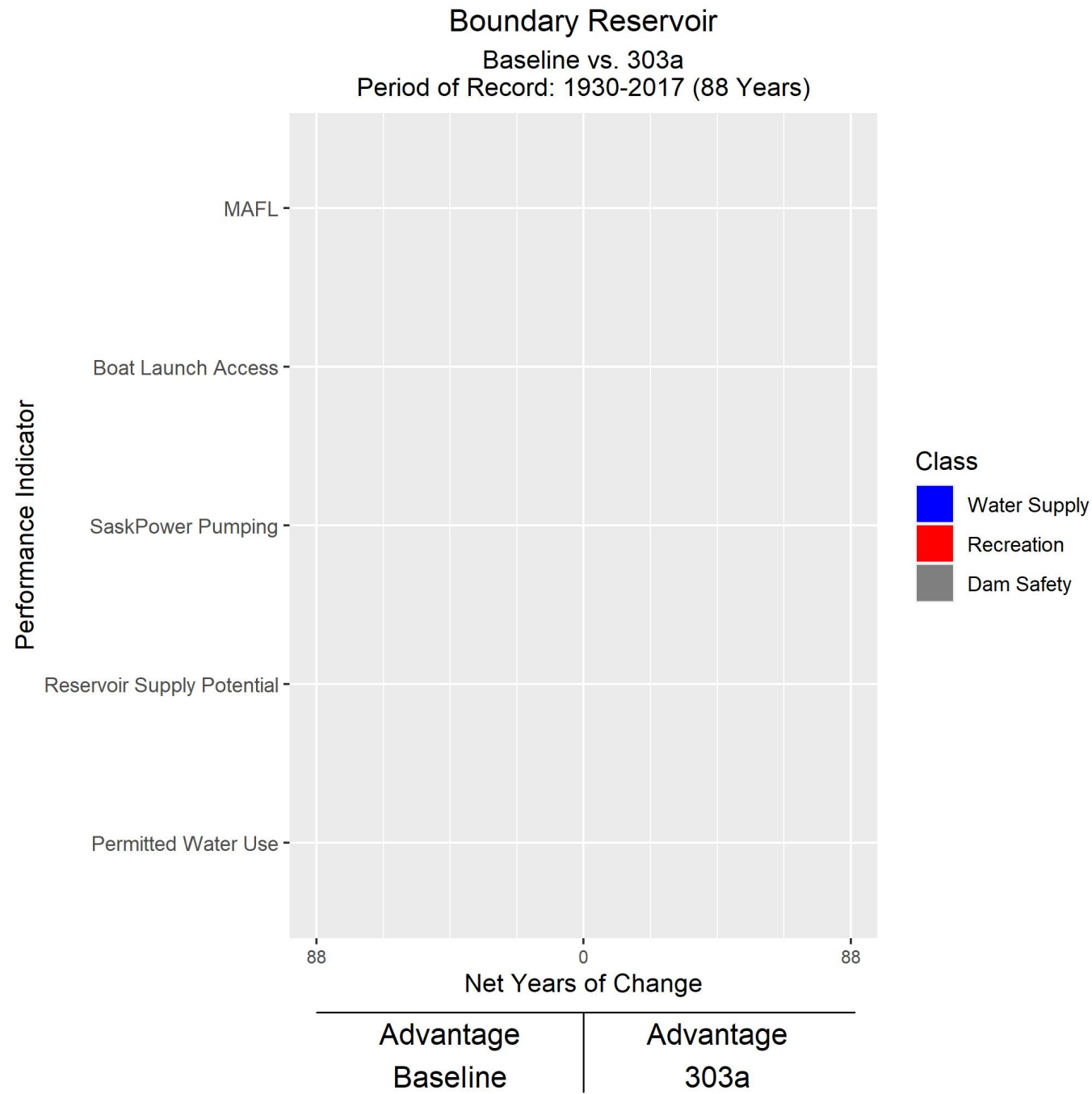
Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303





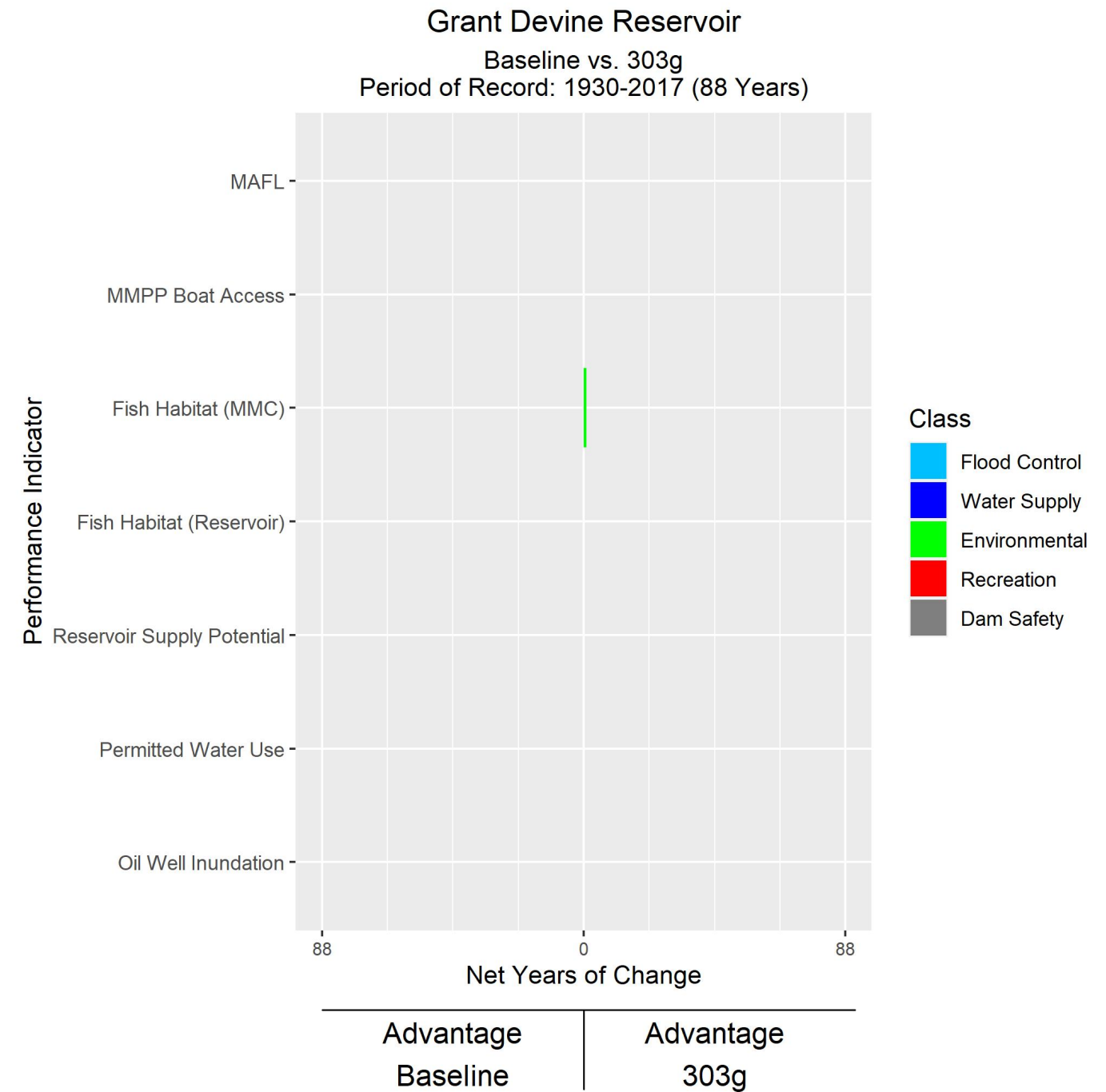
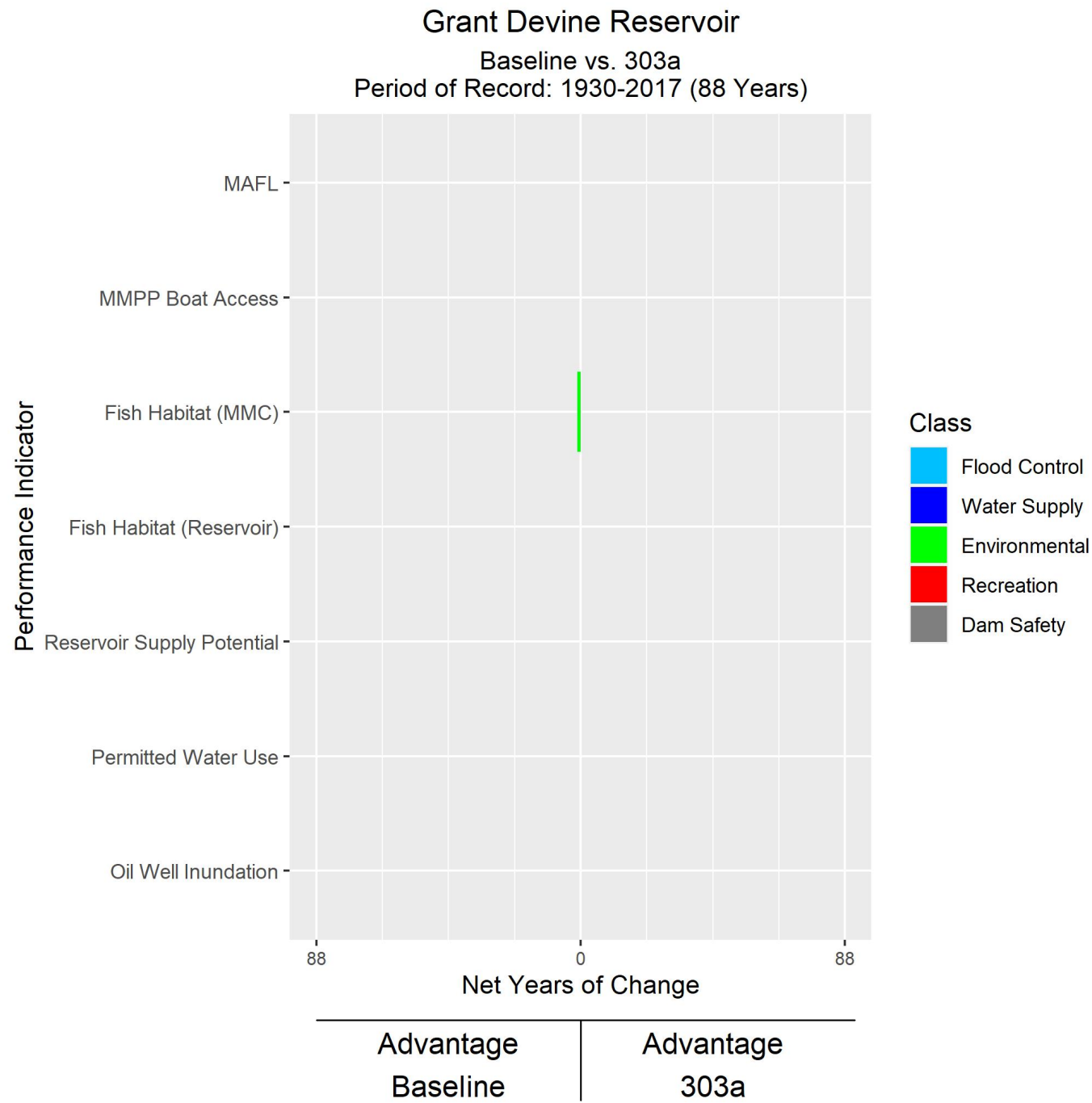
**Alternative 303a**

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

**Alternative 303g**

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303



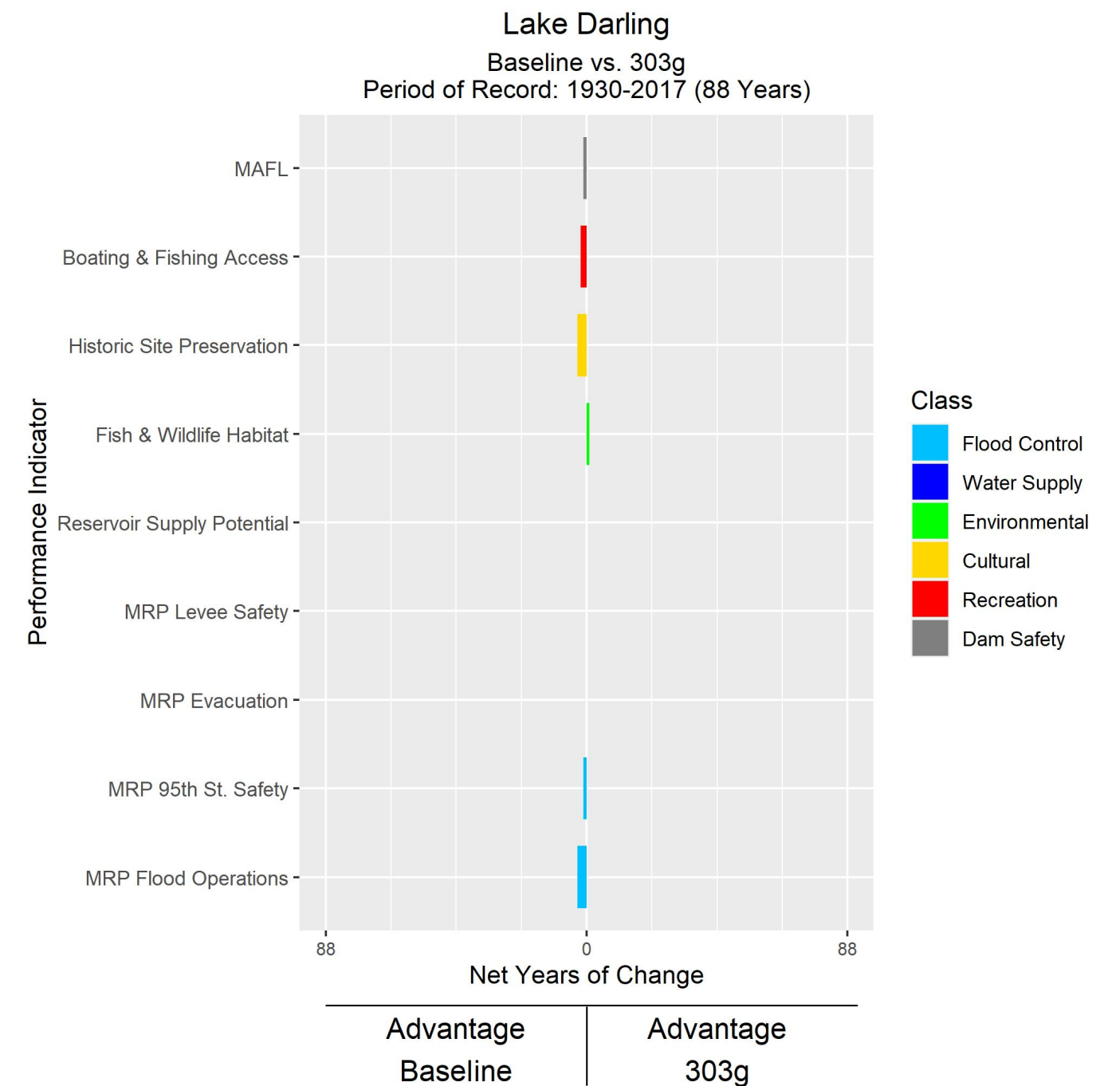
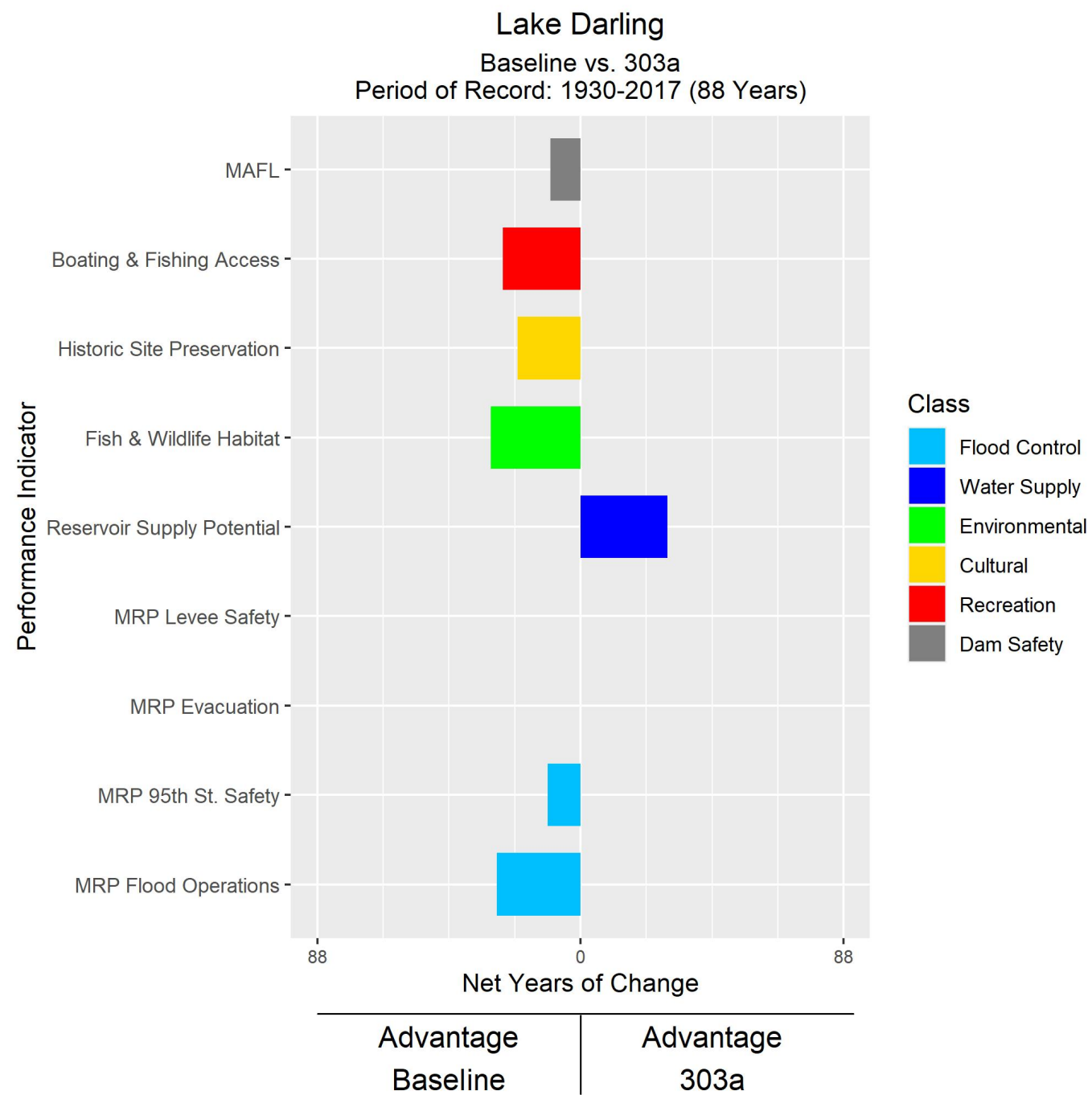


**Alternative 303a**

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

**Alternative 303g**

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303



#### Alternative 303a

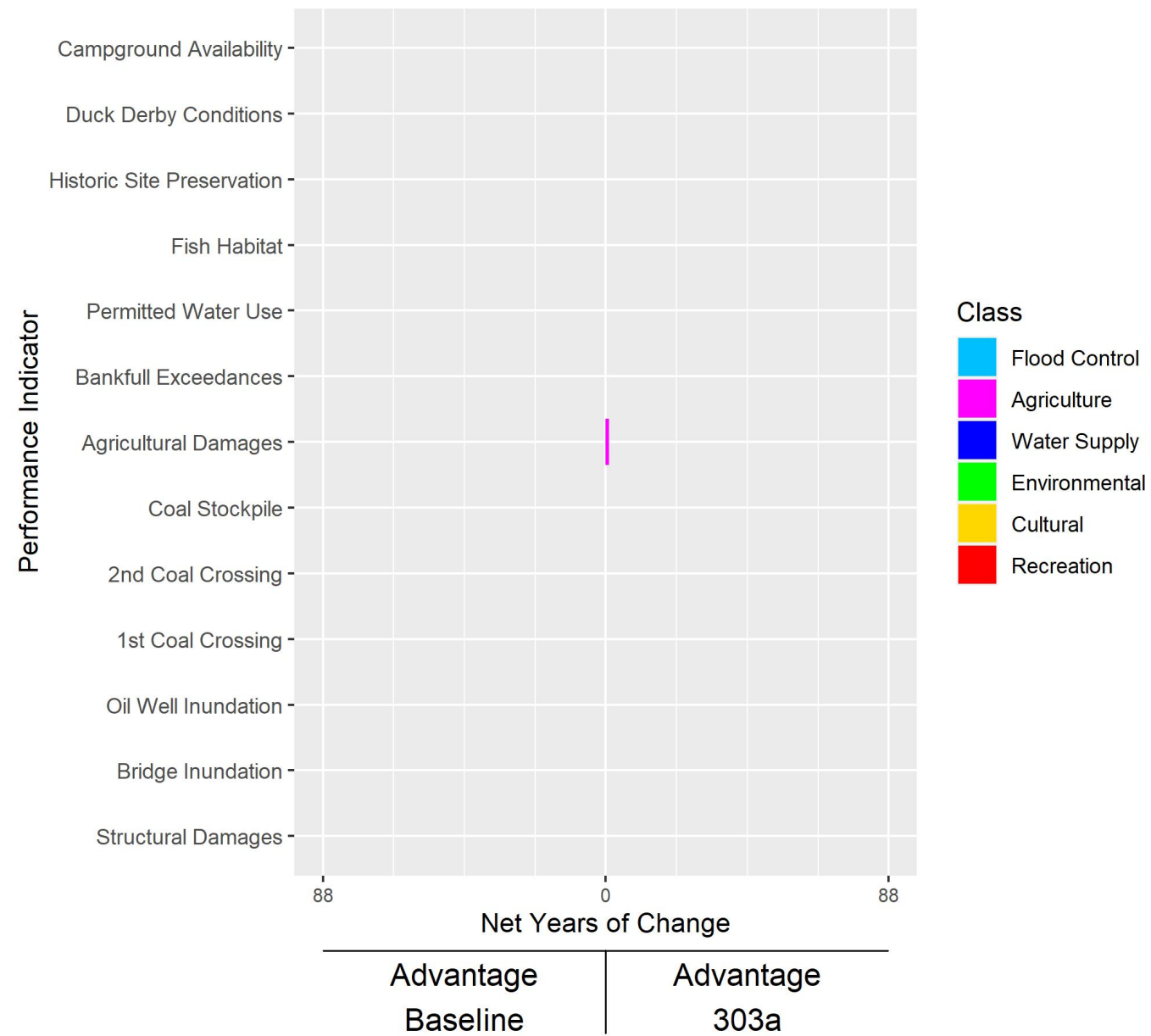
- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

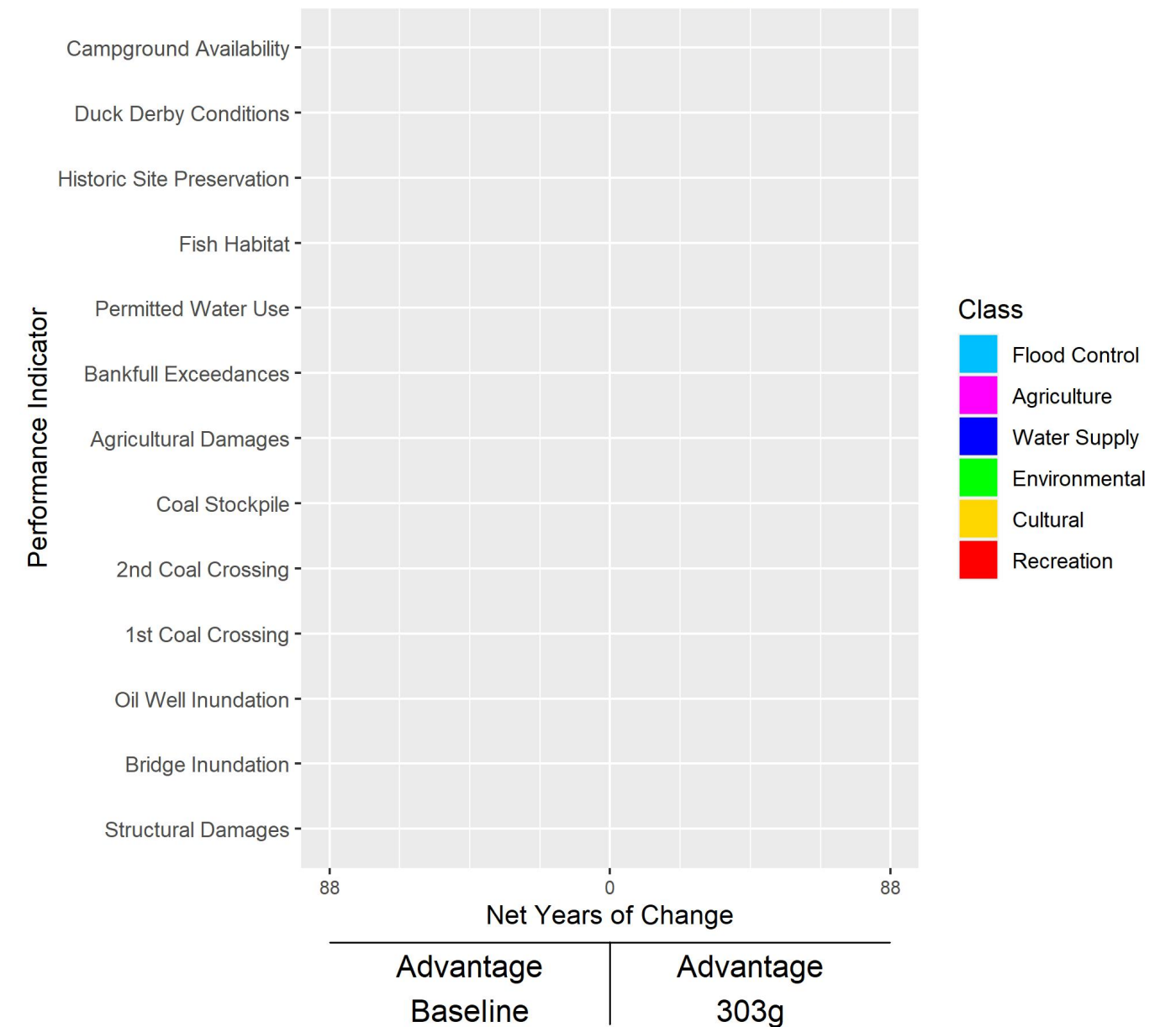
### Saskatchewan - All Riverine Reaches

Baseline vs. 303a  
Period of Record: 1930-2017 (88 Years)



### Saskatchewan - All Riverine Reaches

Baseline vs. 303g  
Period of Record: 1930-2017 (88 Years)



#### Alternative 303a

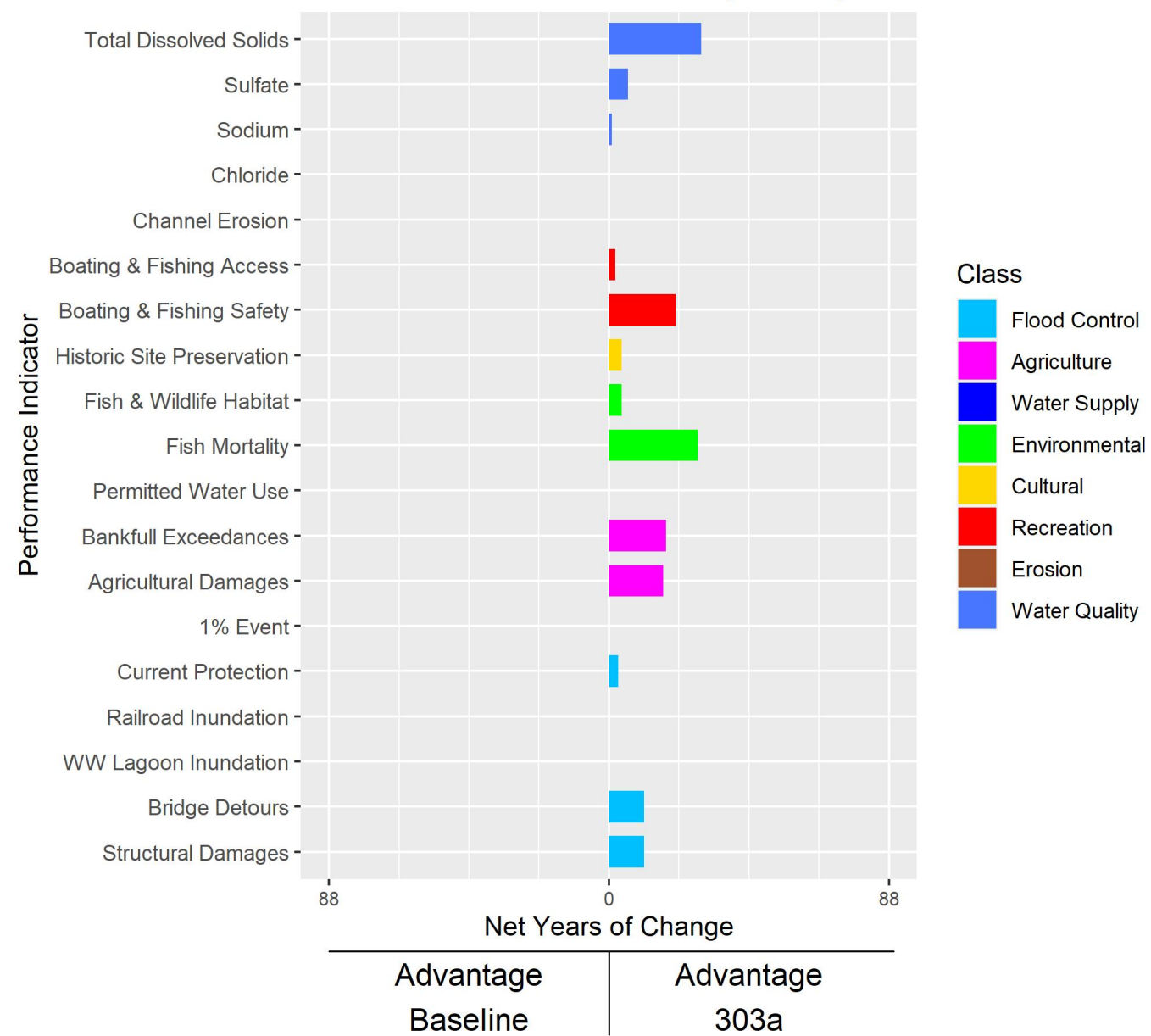
- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

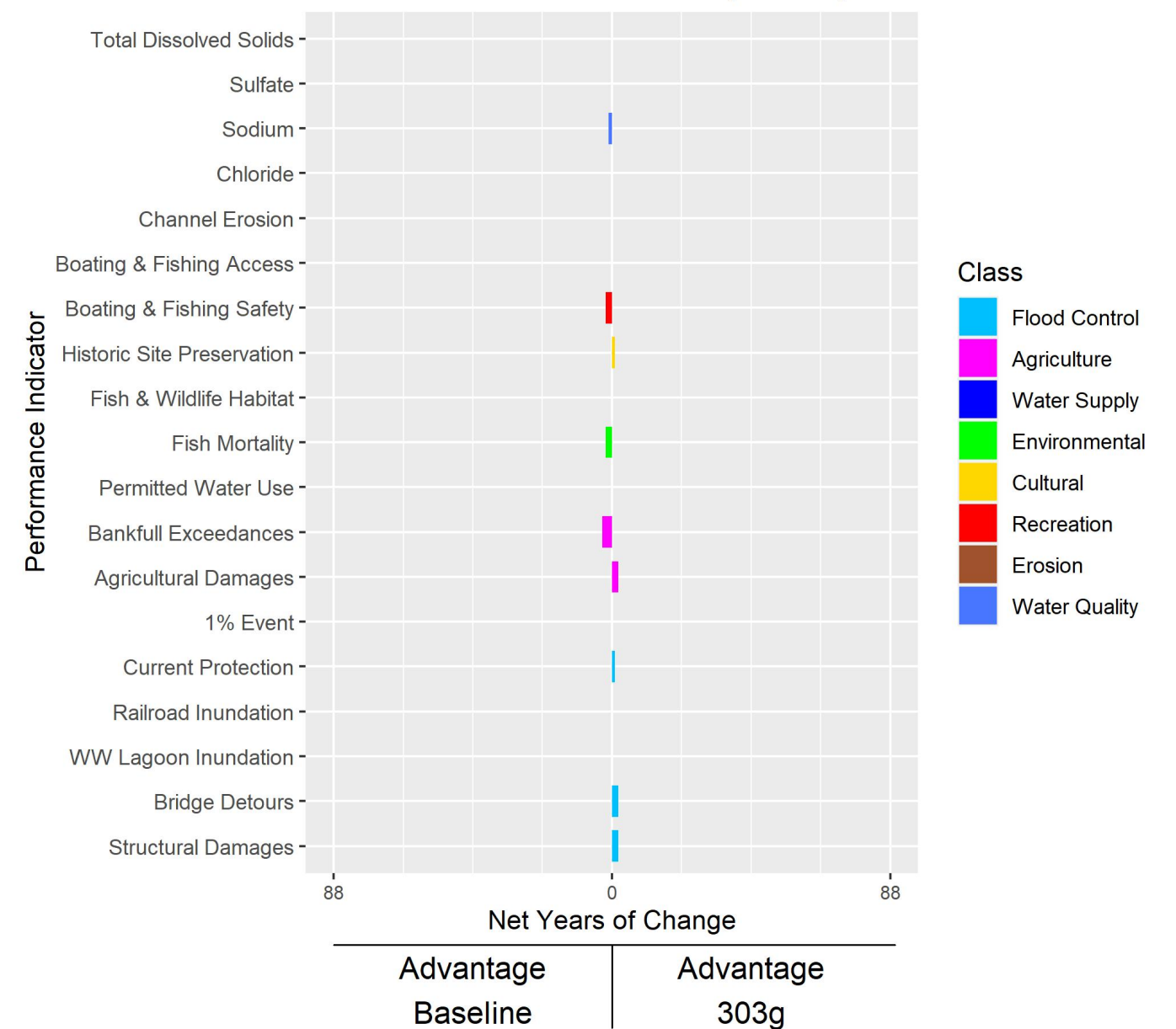
### North Dakota - All Riverine Reaches

Baseline vs. 303a  
Period of Record: 1930-2017 (88 Years)



### North Dakota - All Riverine Reaches

Baseline vs. 303g  
Period of Record: 1930-2017 (88 Years)

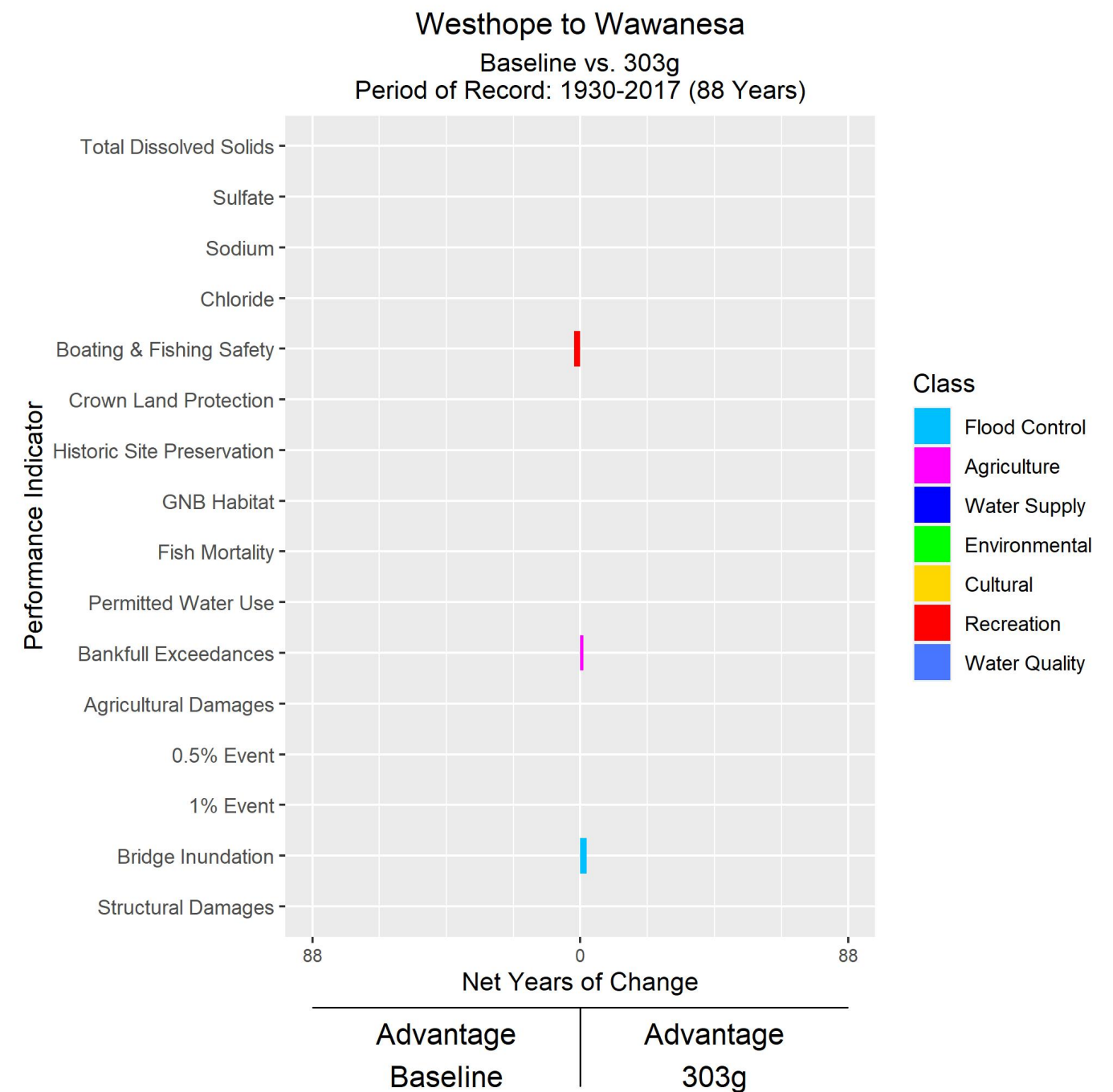
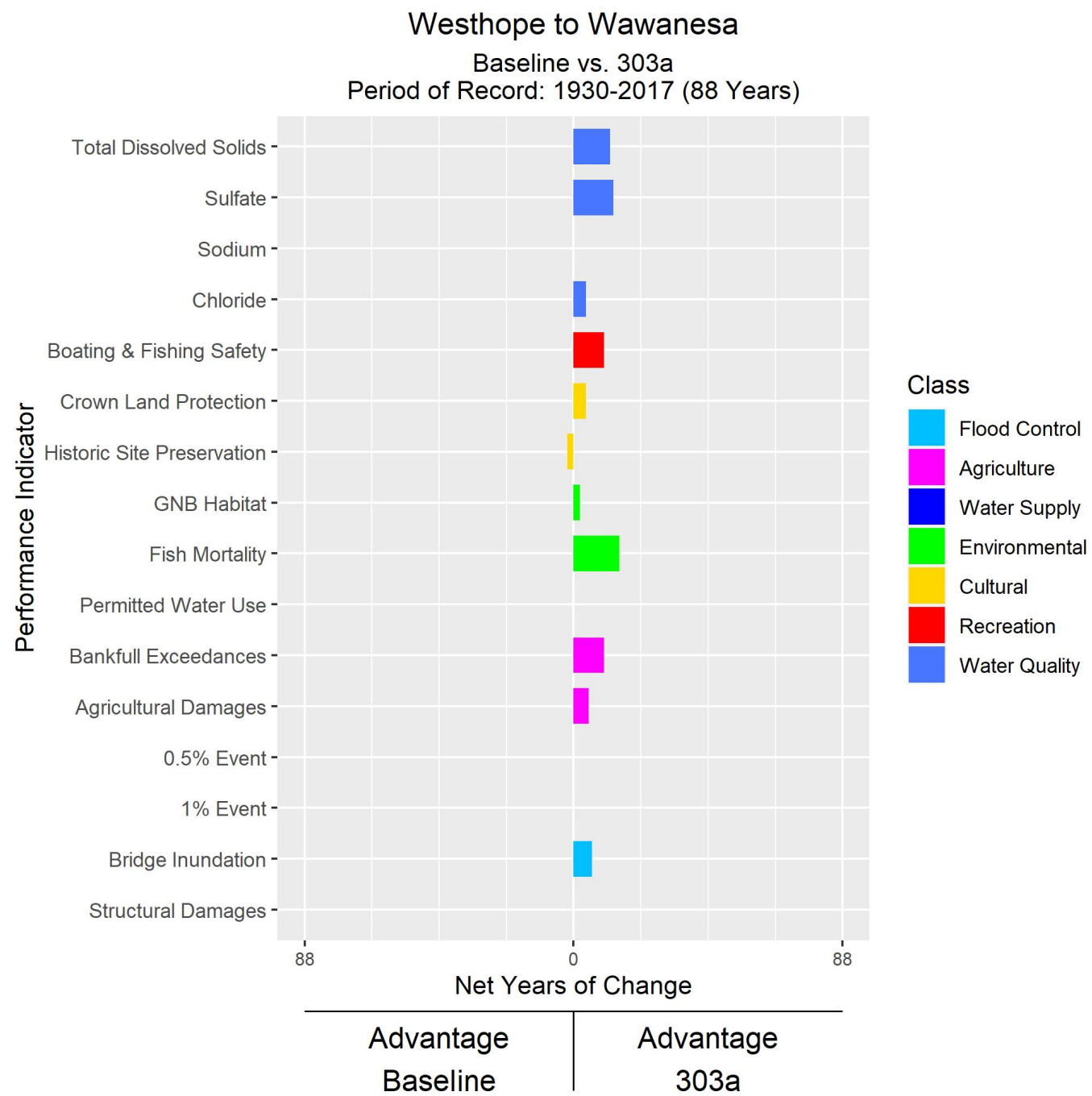


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

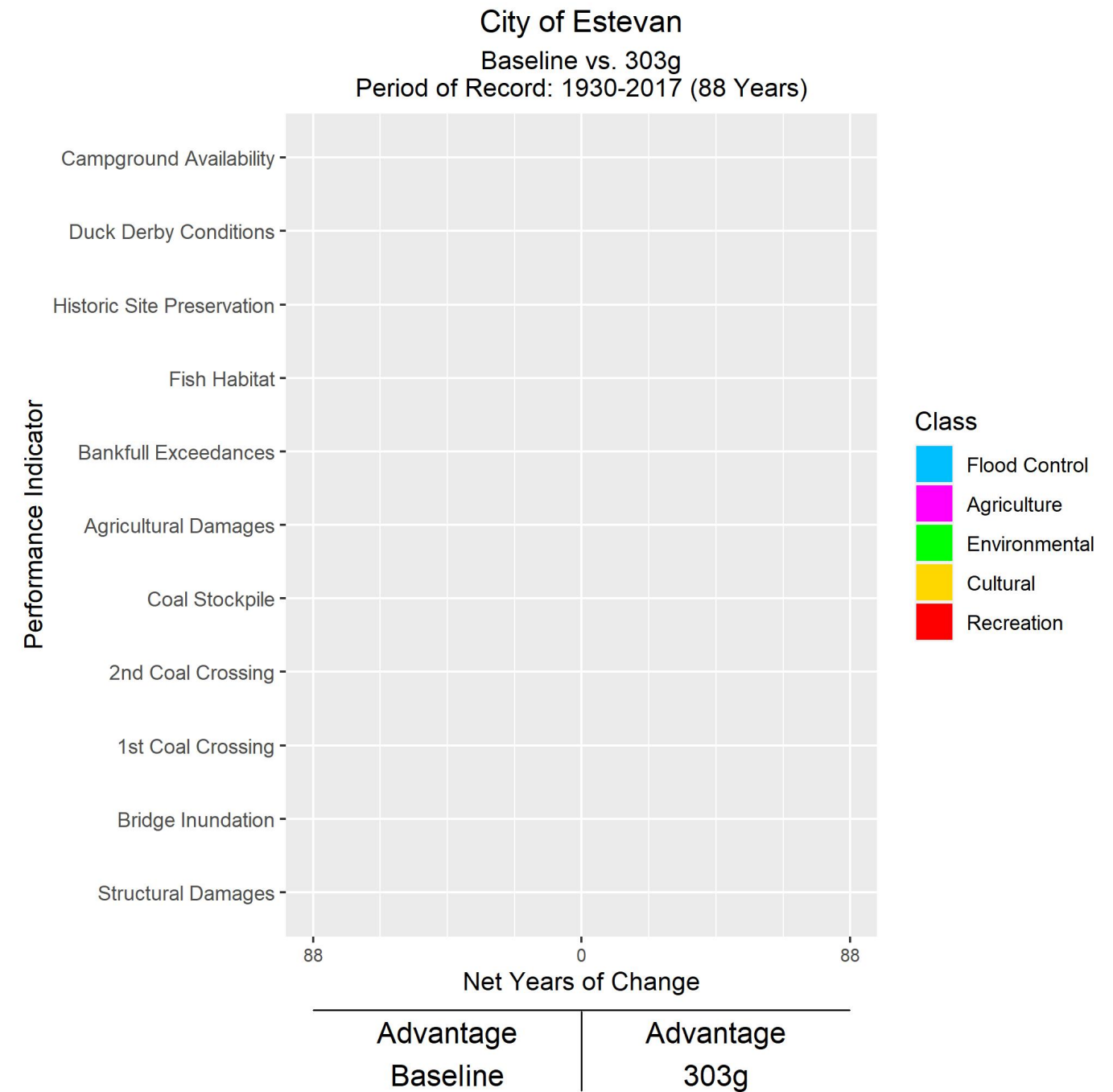
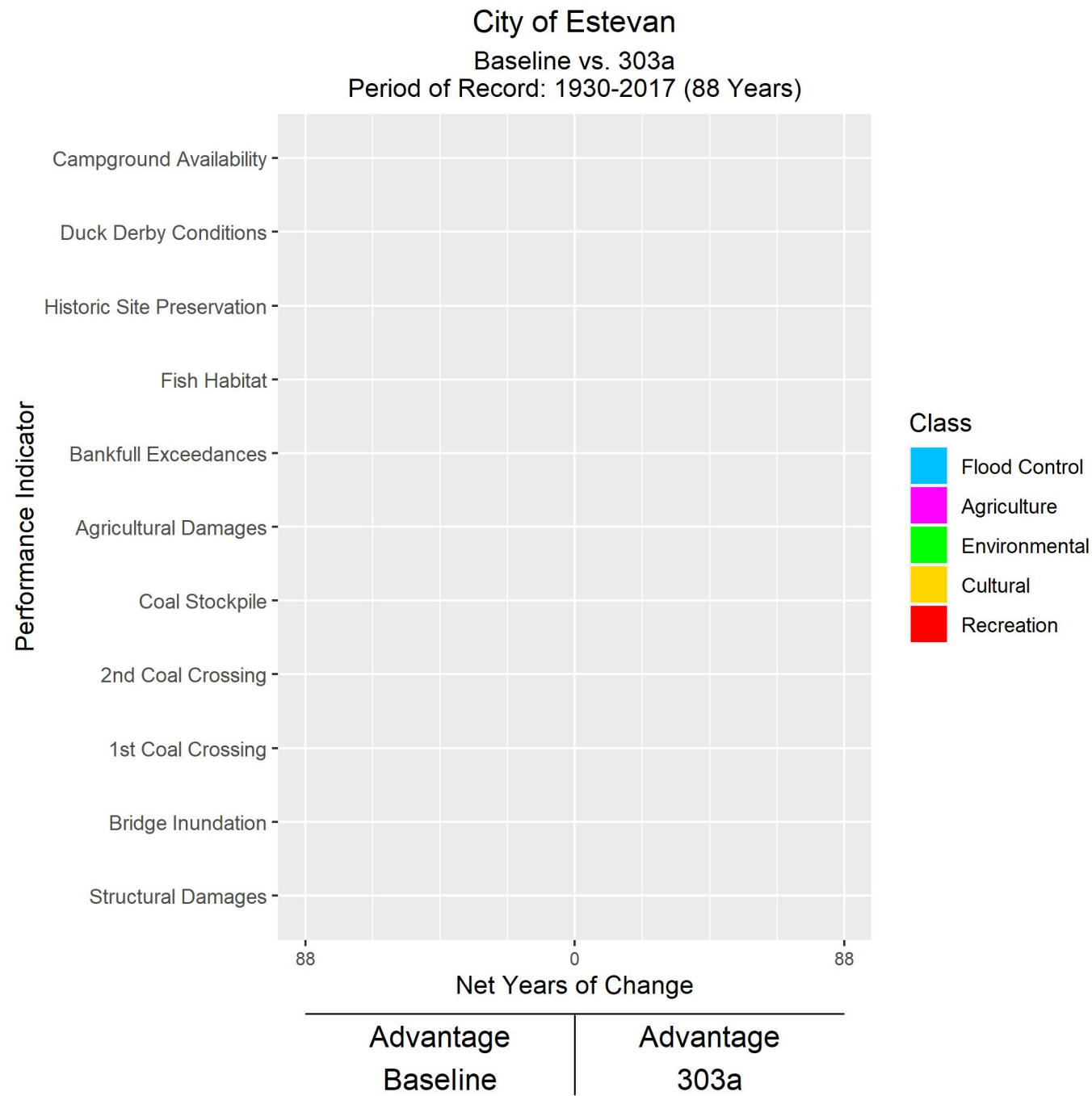


**Alternative 303a**

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

**Alternative 303g**

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

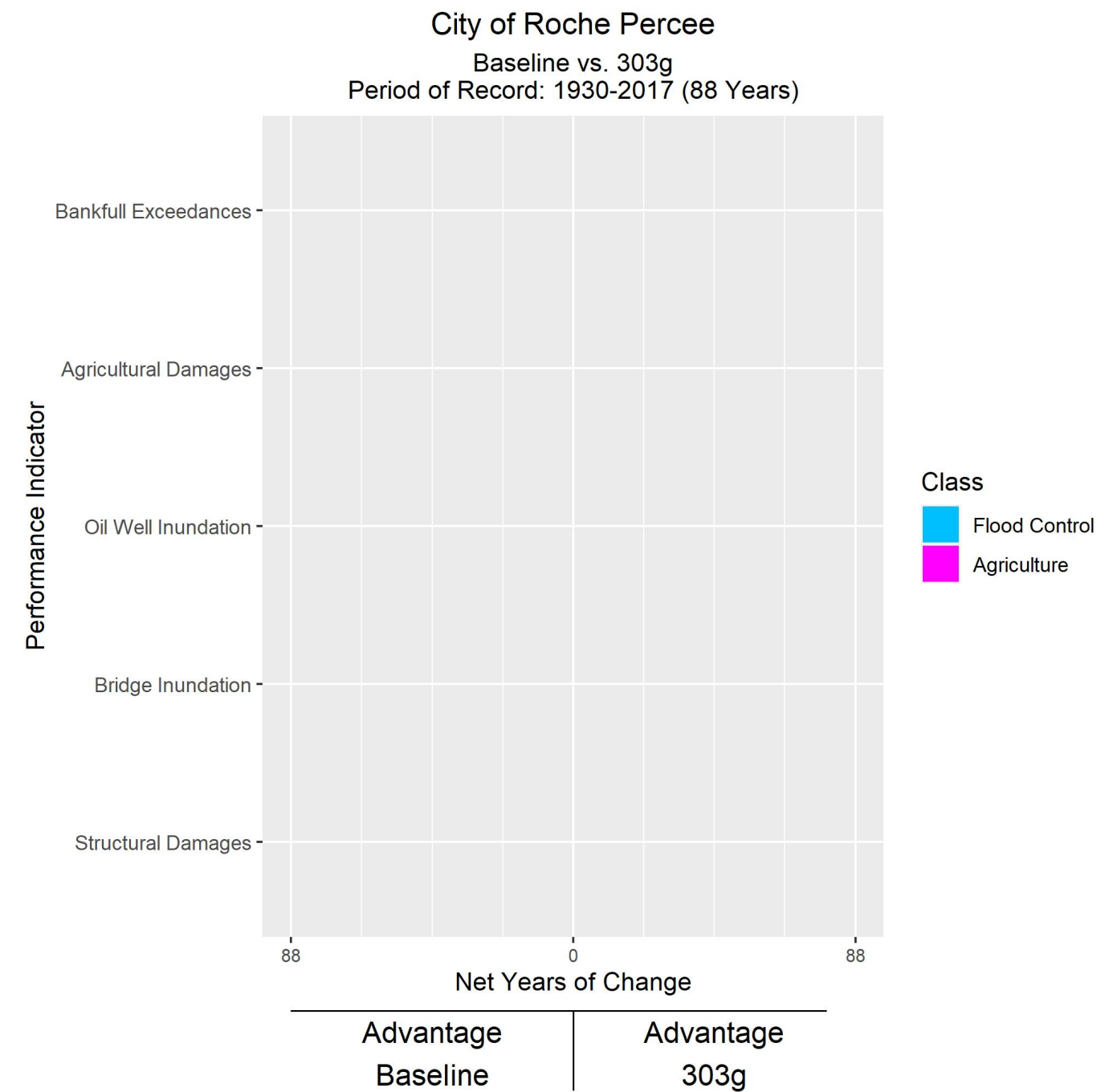
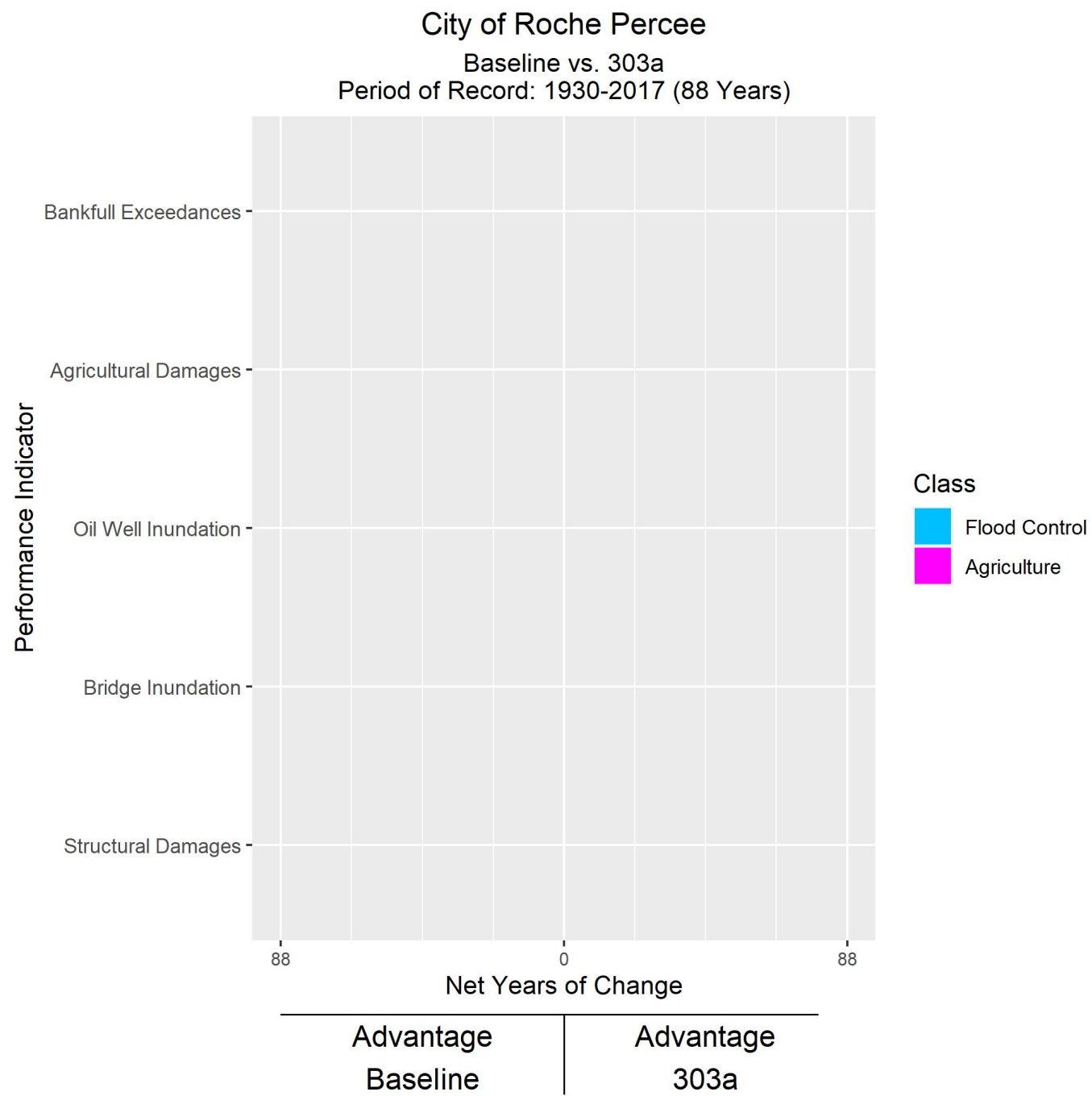


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303



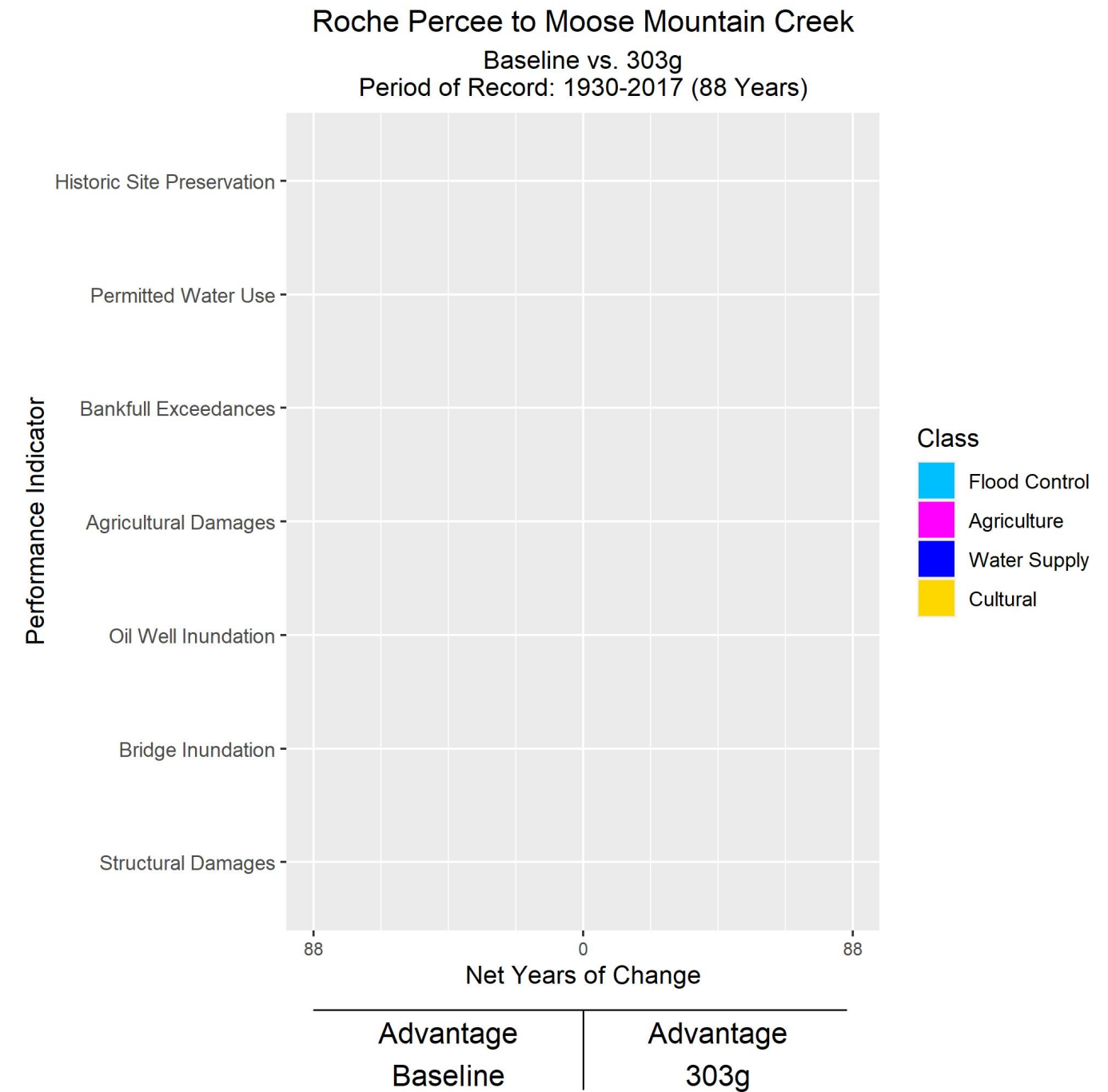
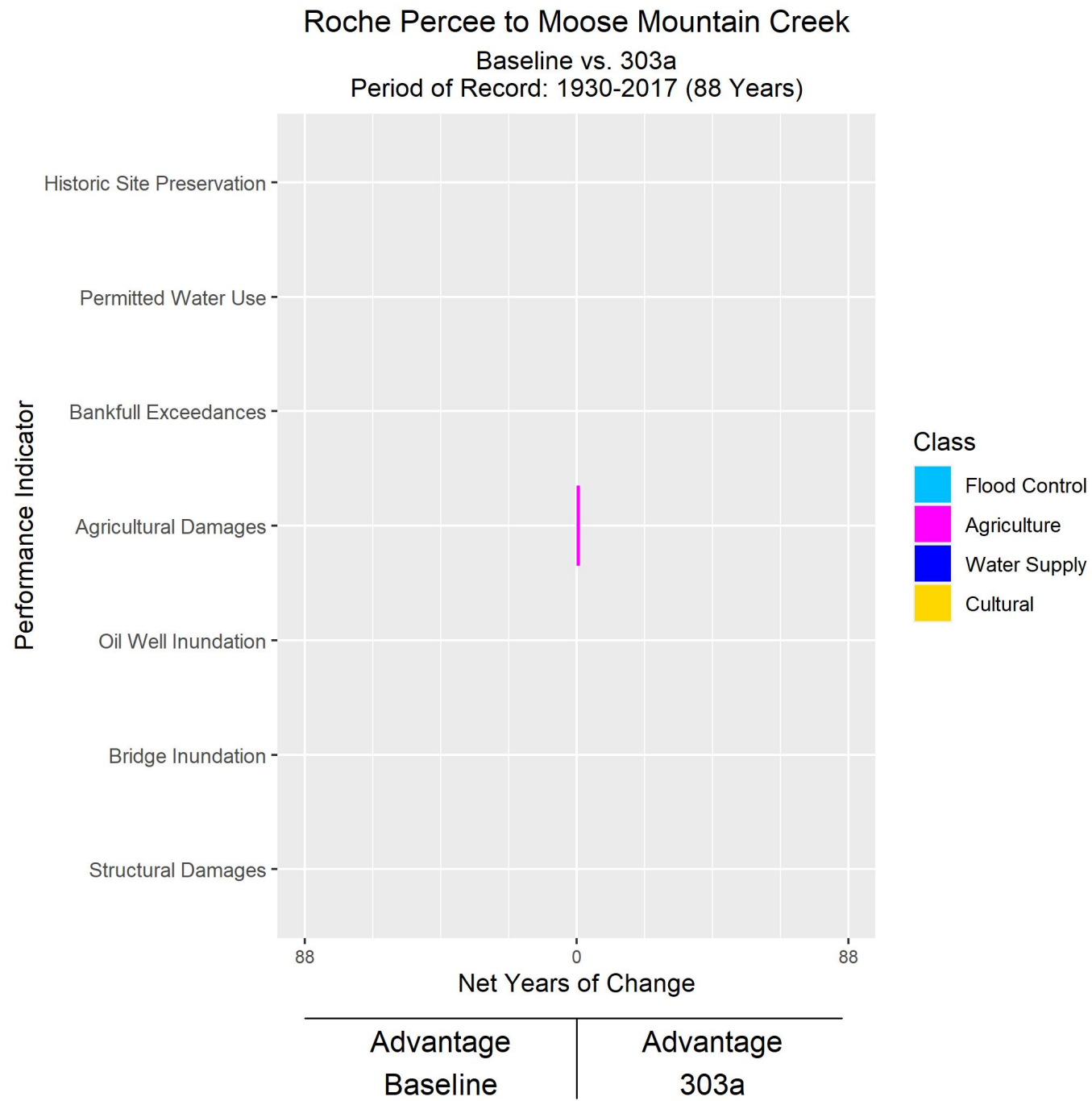
**Alternative 303a**

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

**Alternative 303g**

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303



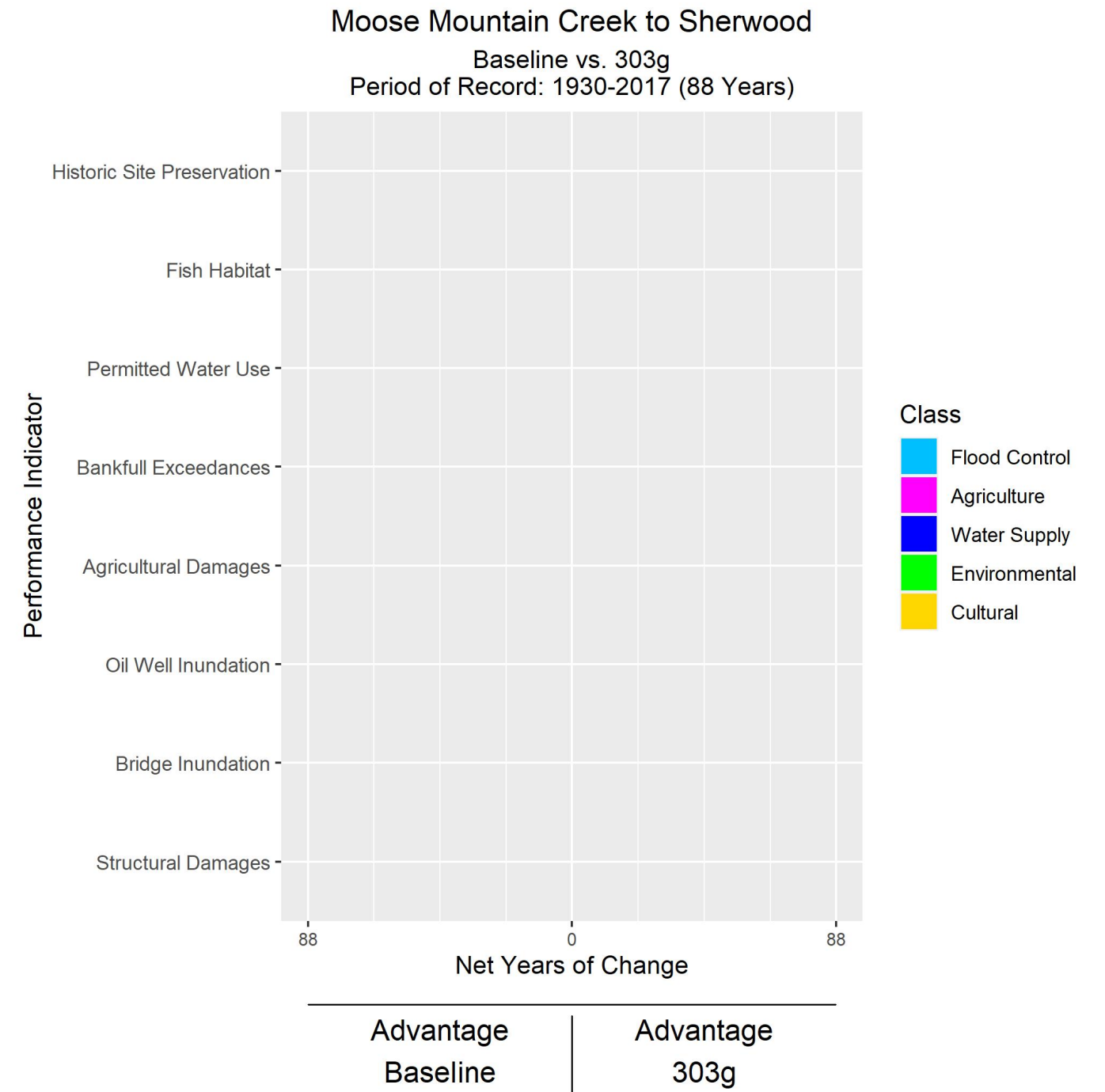
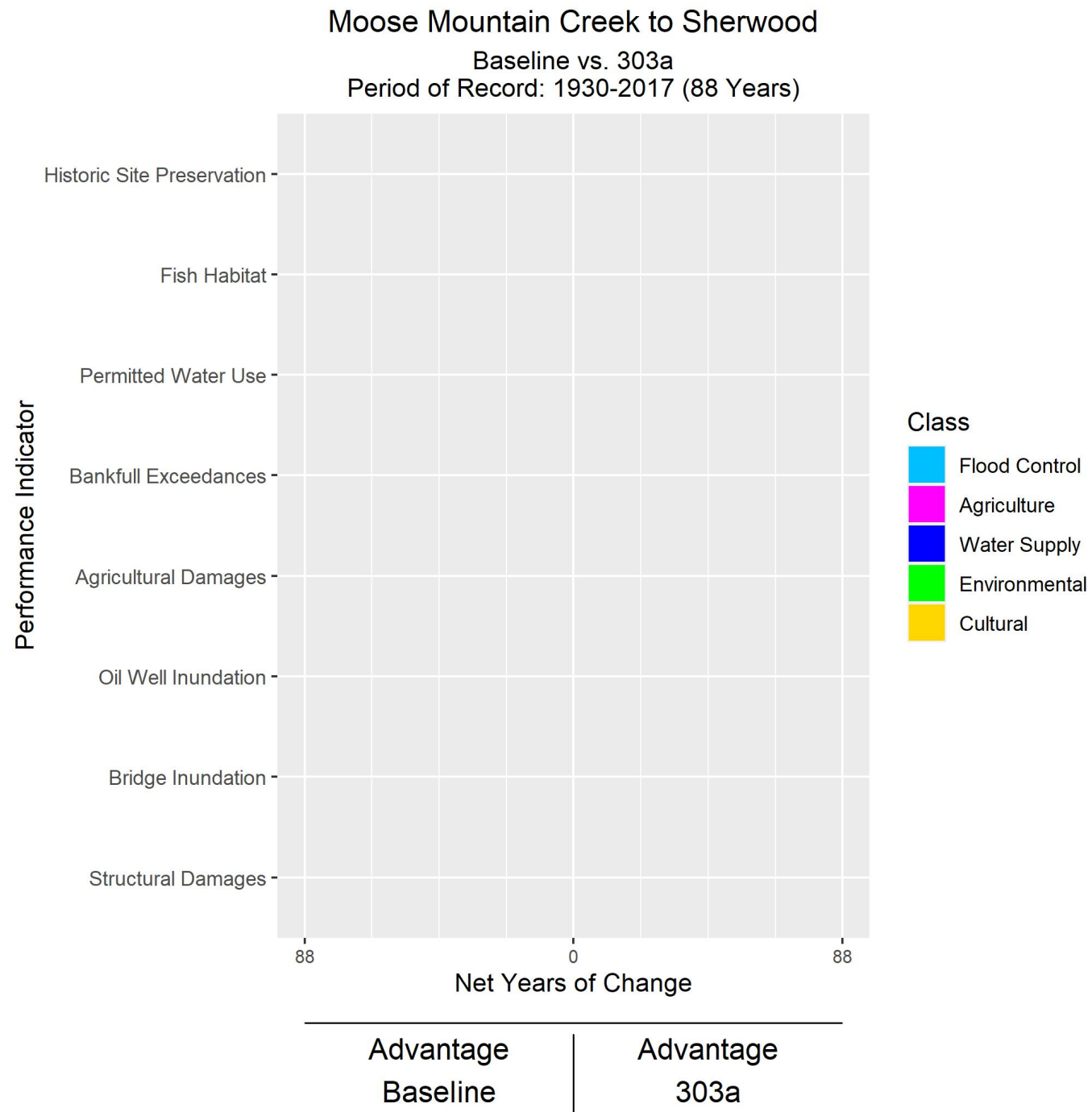


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

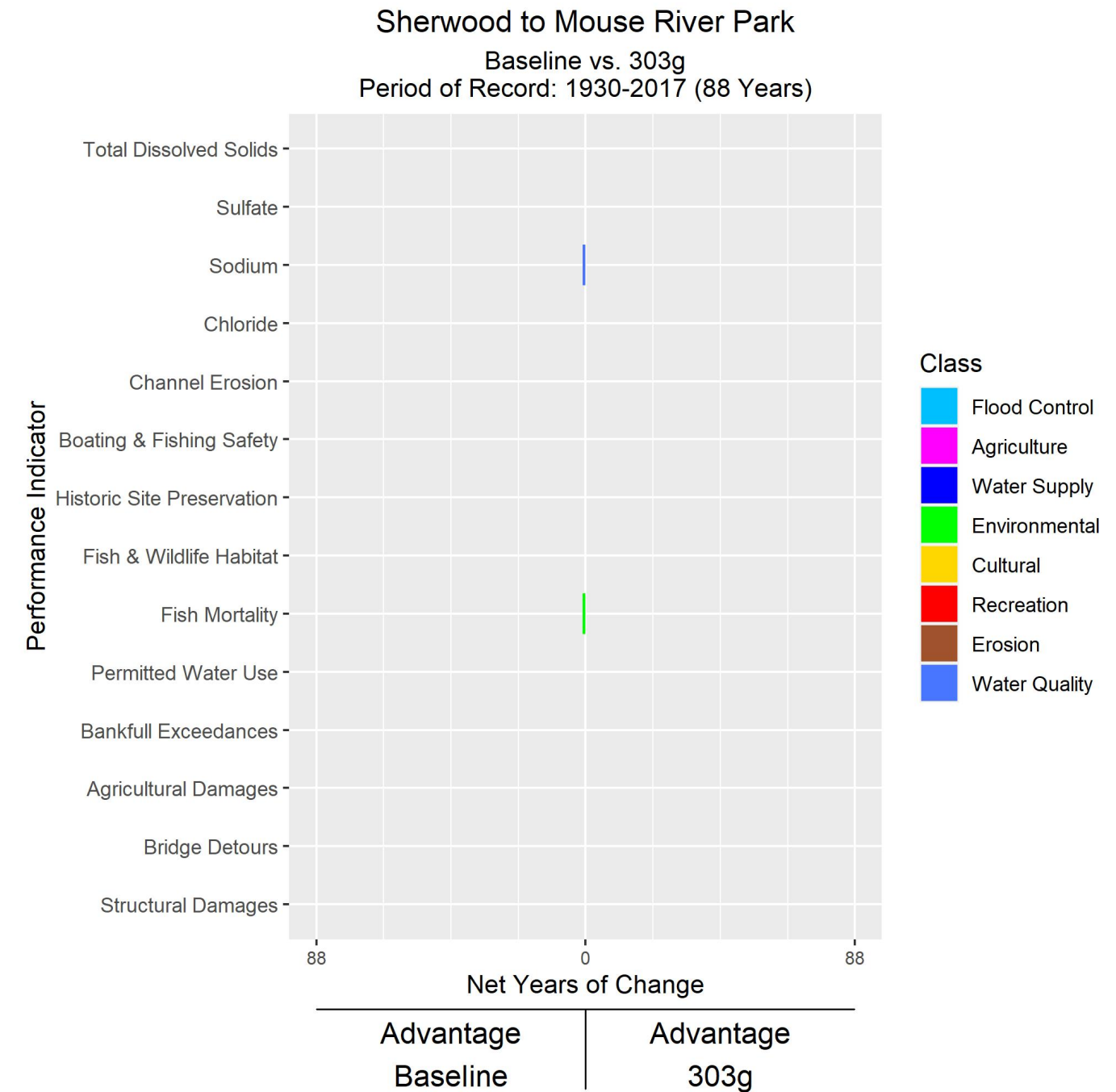
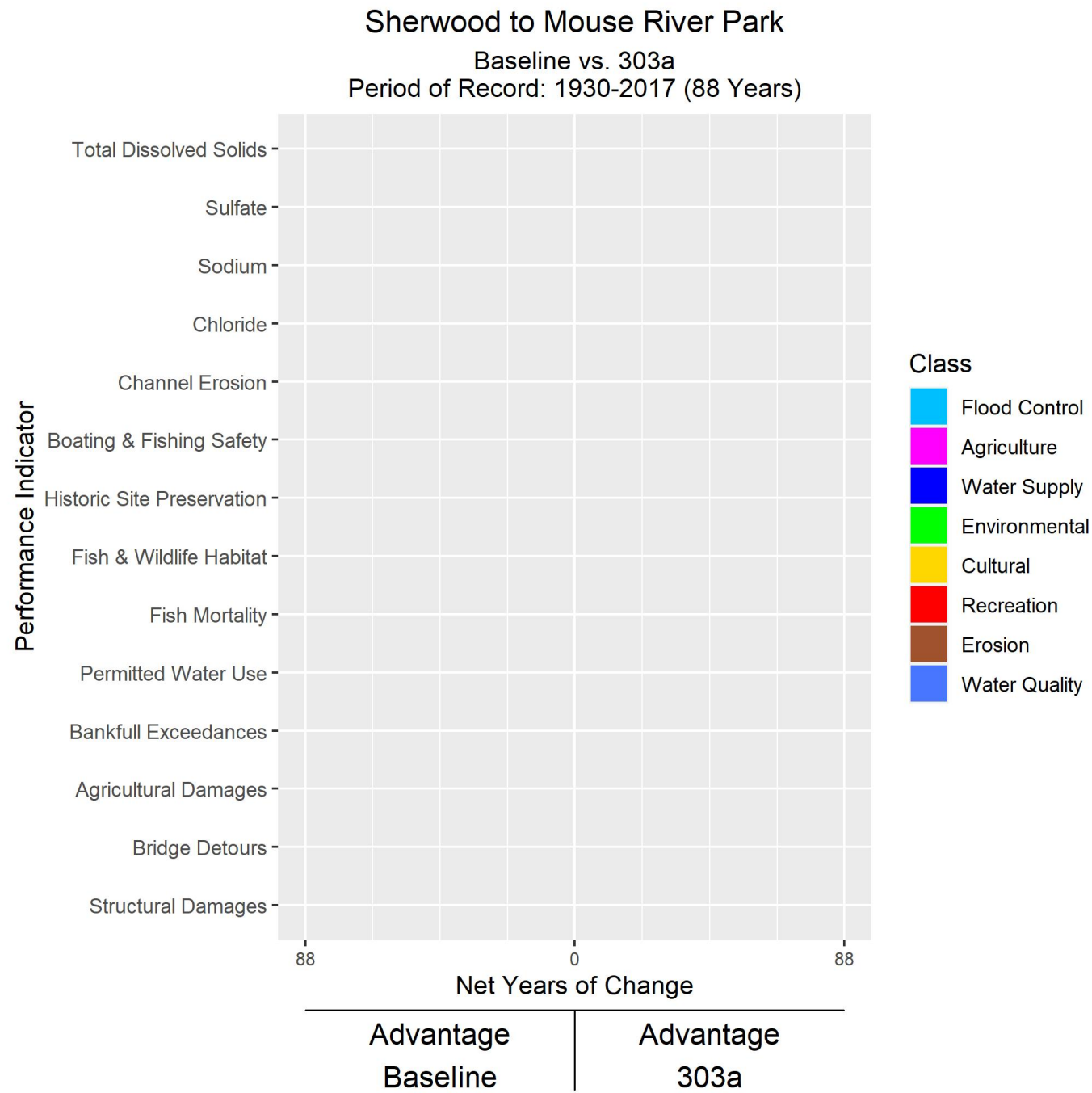


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

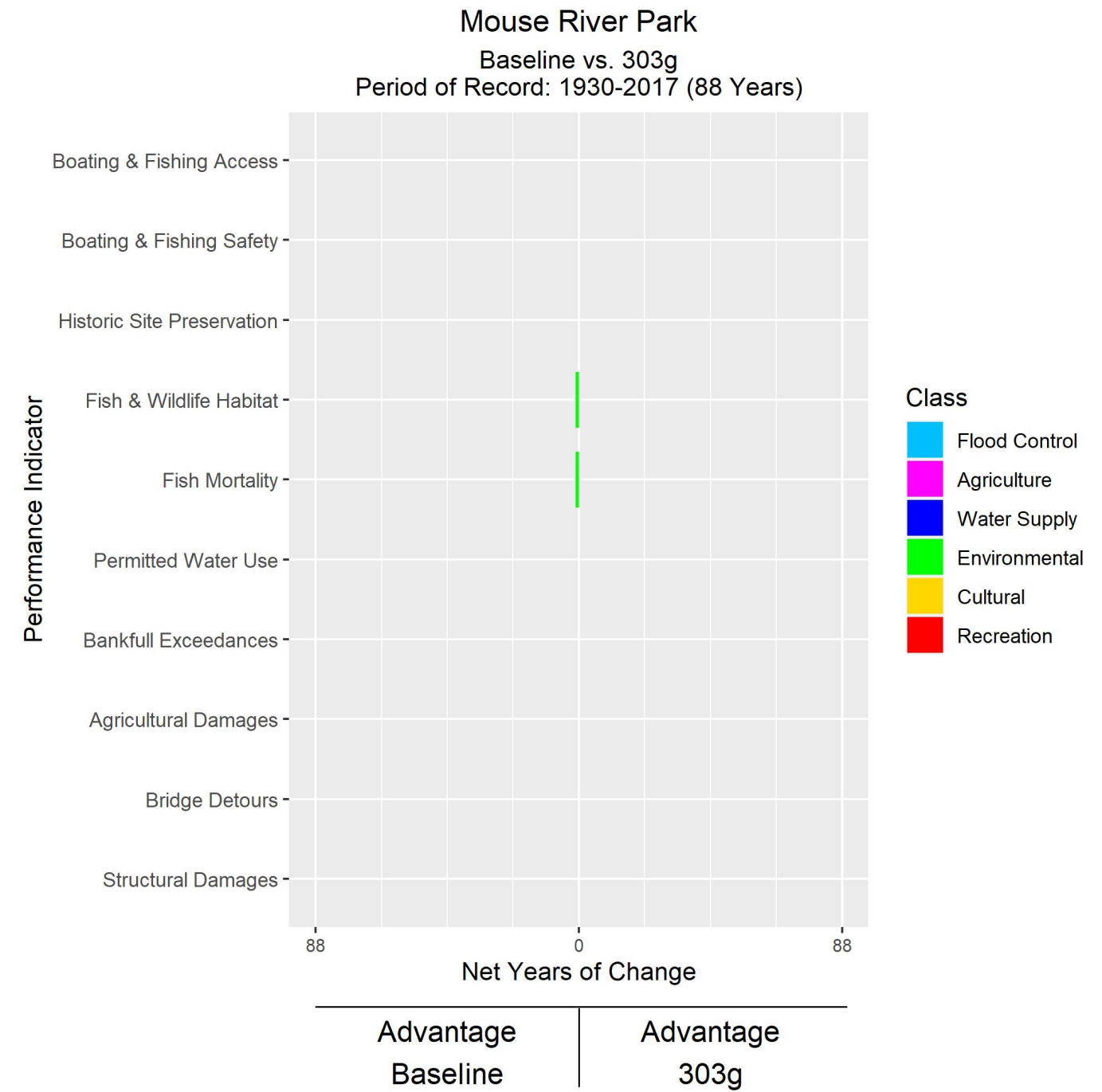
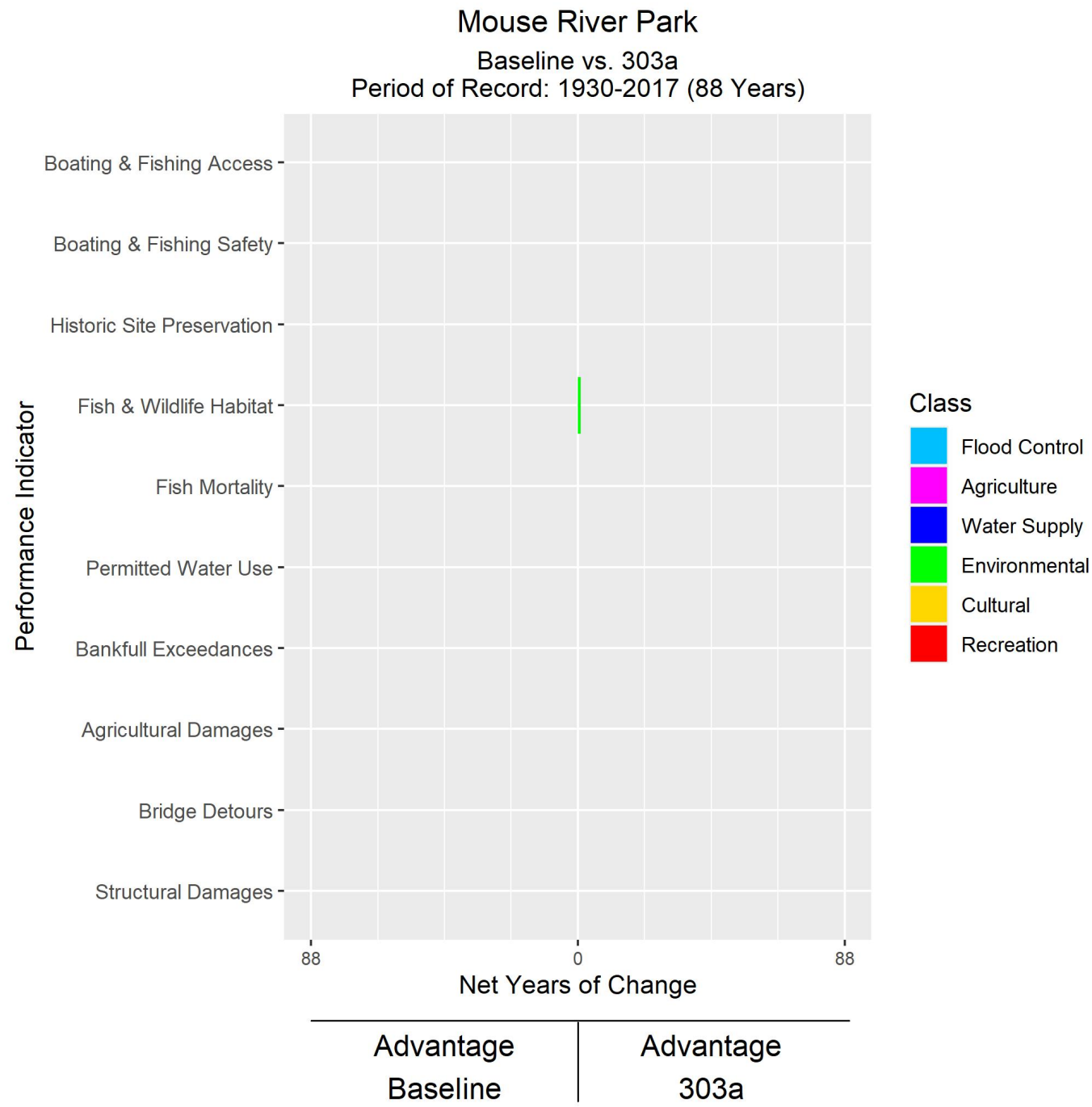
#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303



- Alternative 303a**
- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
  - Most restrictive simulation in Alternative 303

- Alternative 303g**
- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
  - Least restrictive simulation in Alternative 303

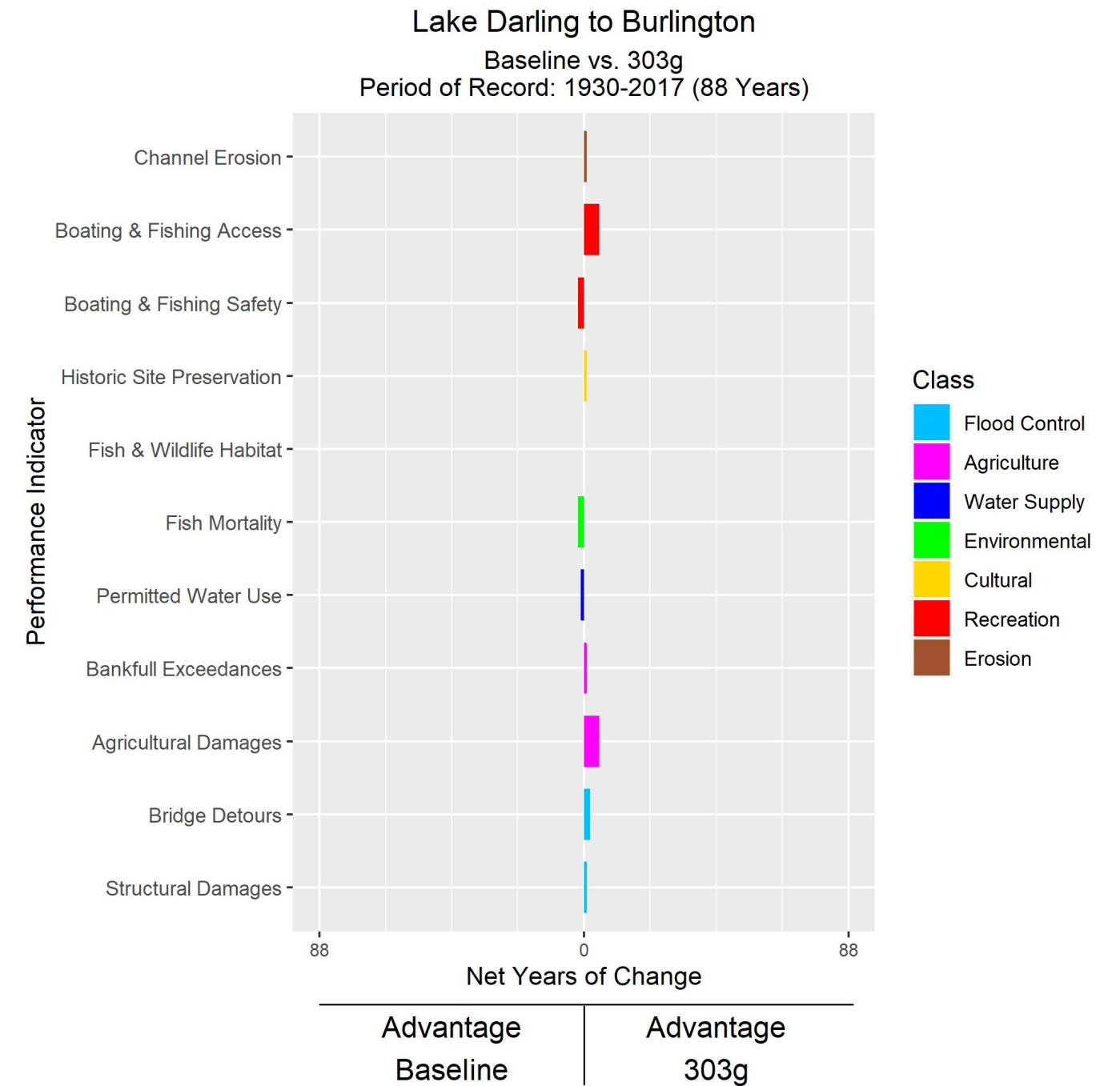
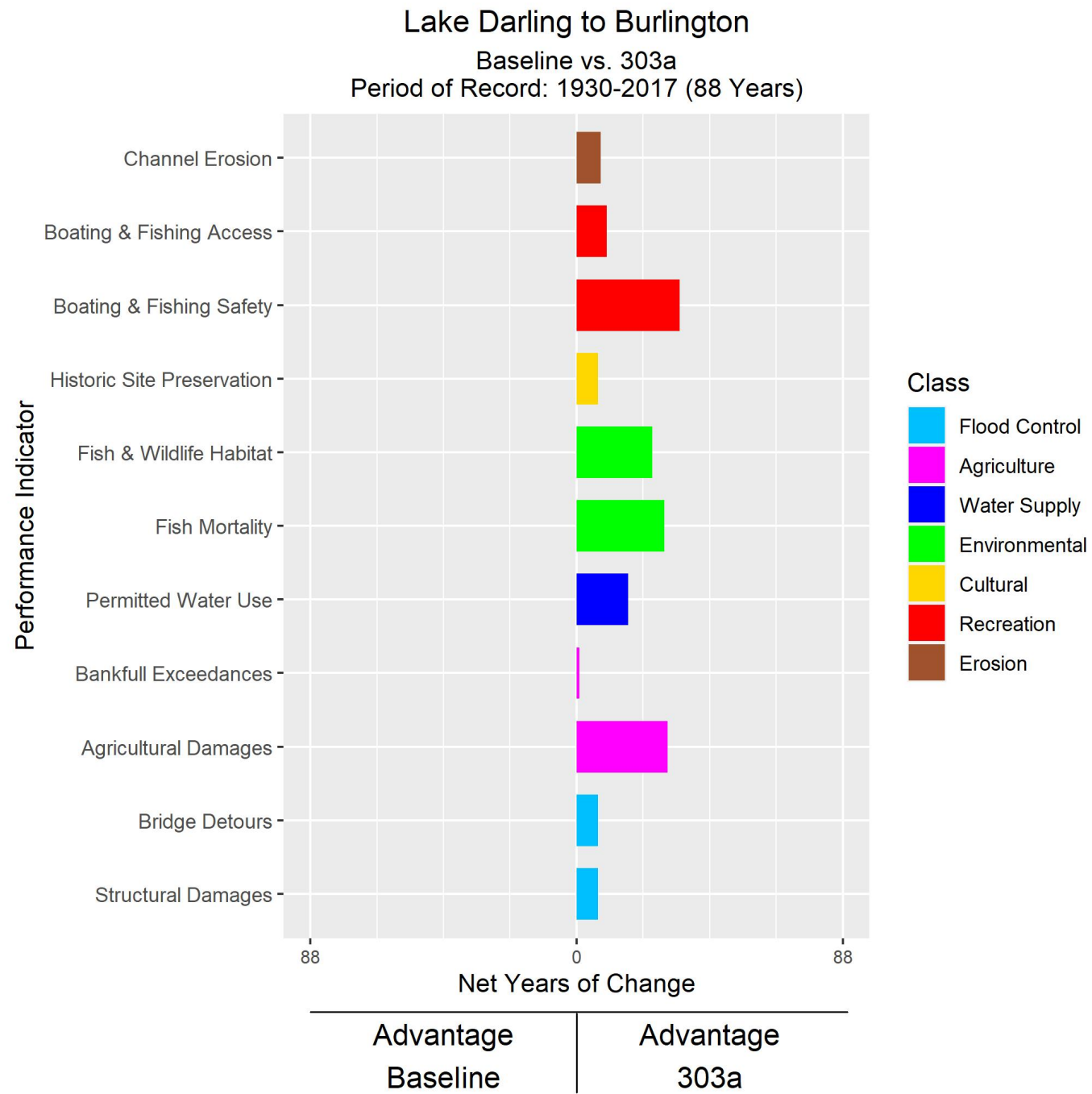


**Alternative 303a**

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

**Alternative 303g**

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

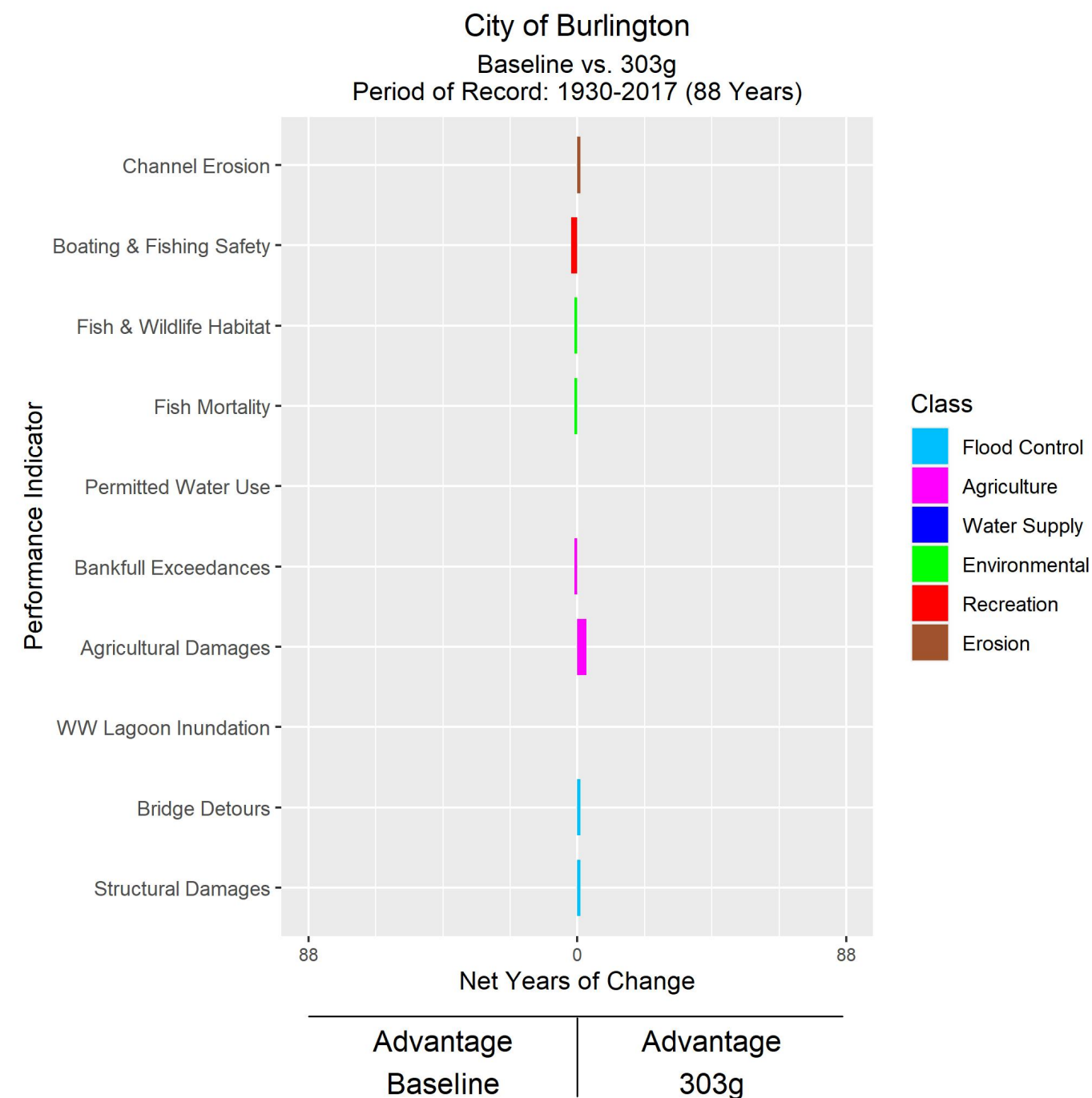
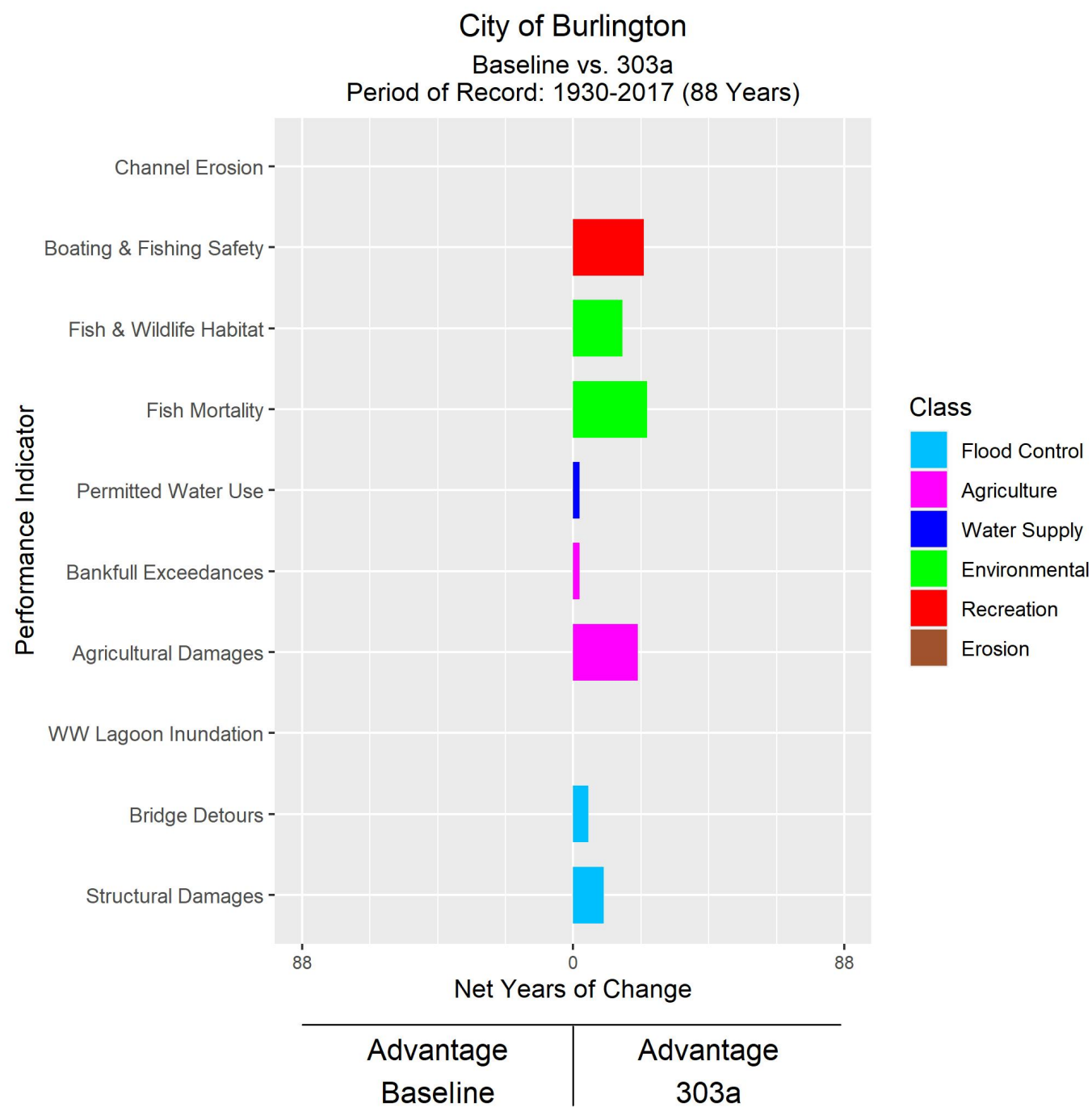


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

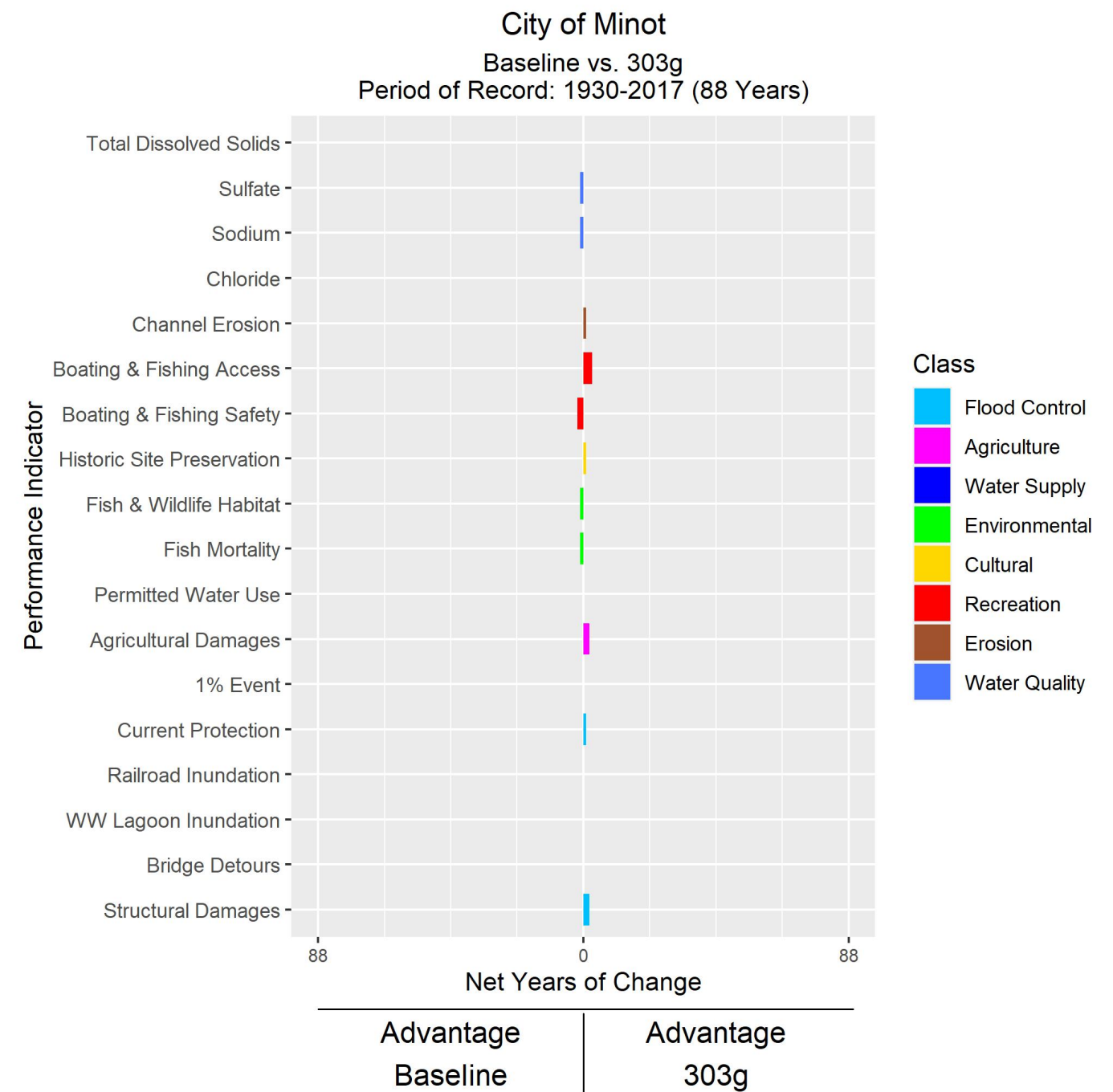


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303



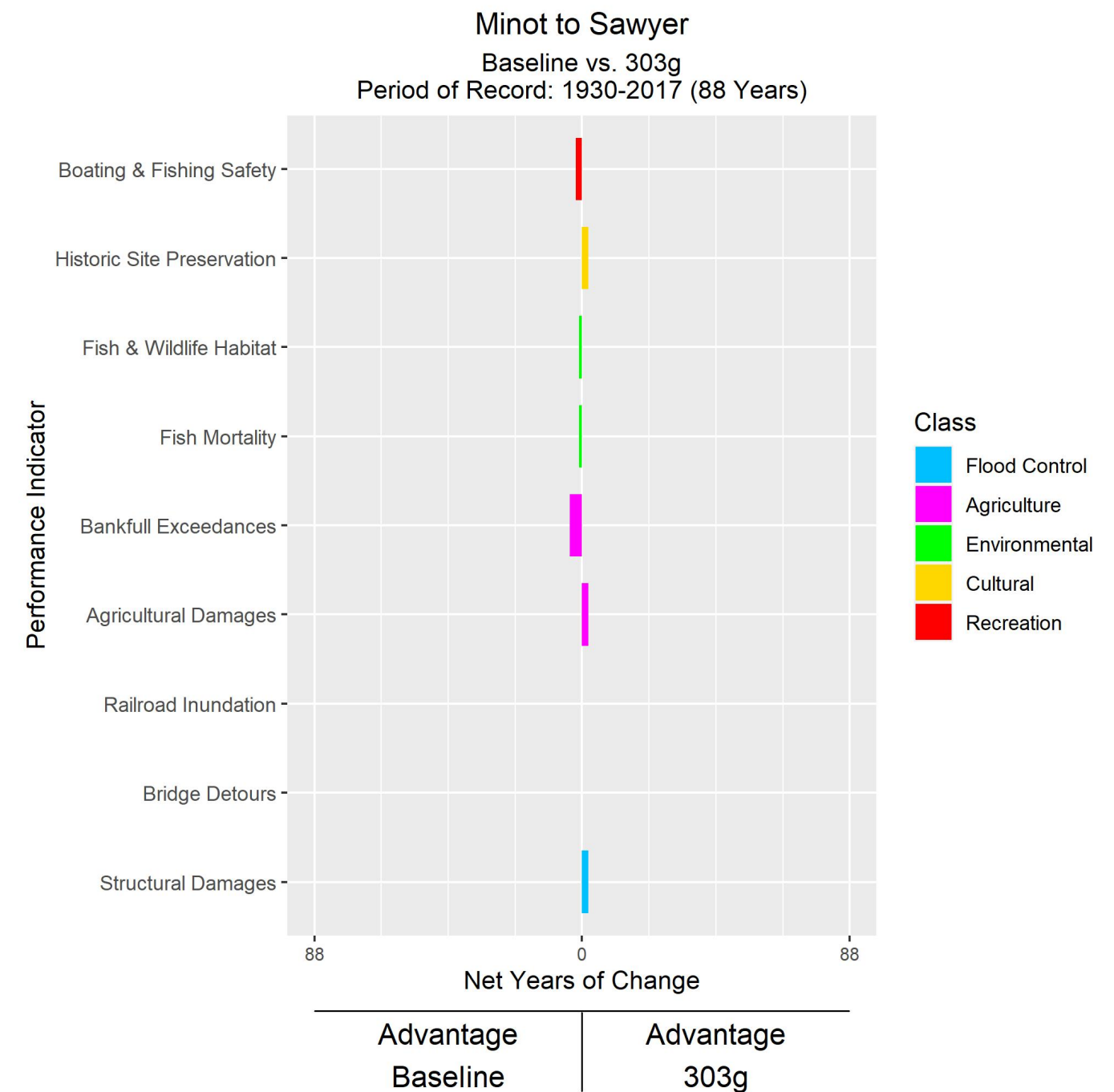
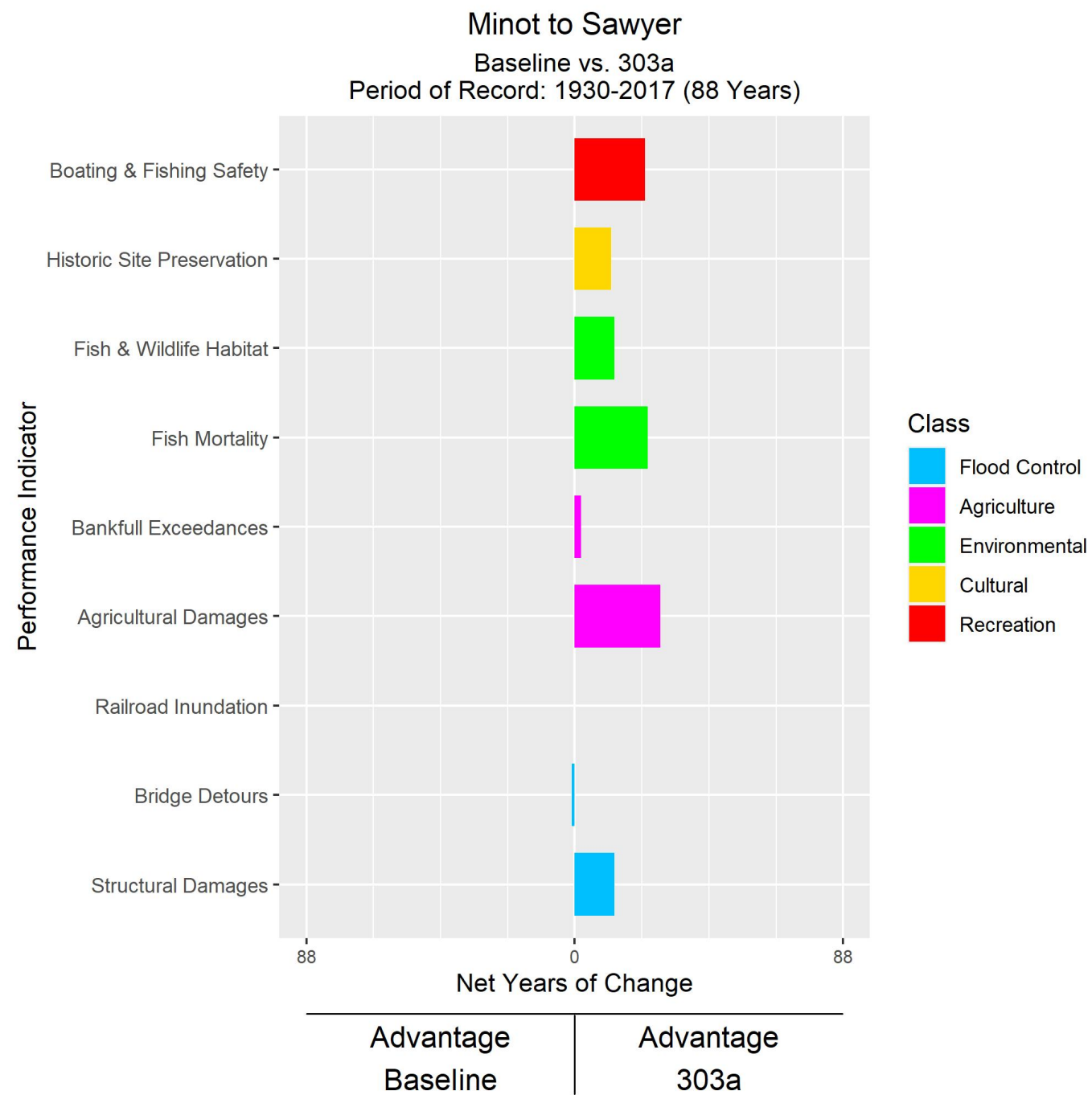
#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303



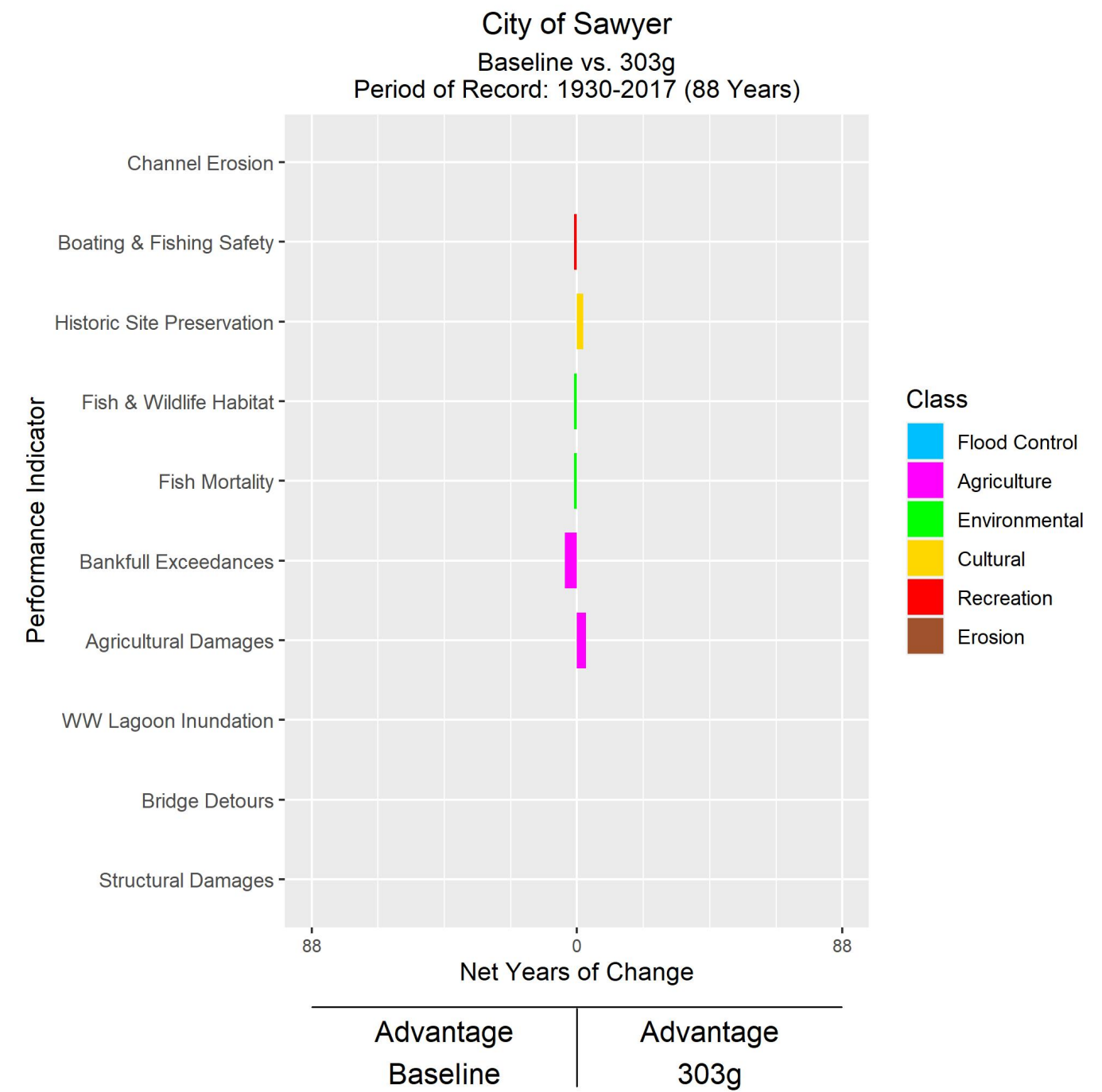
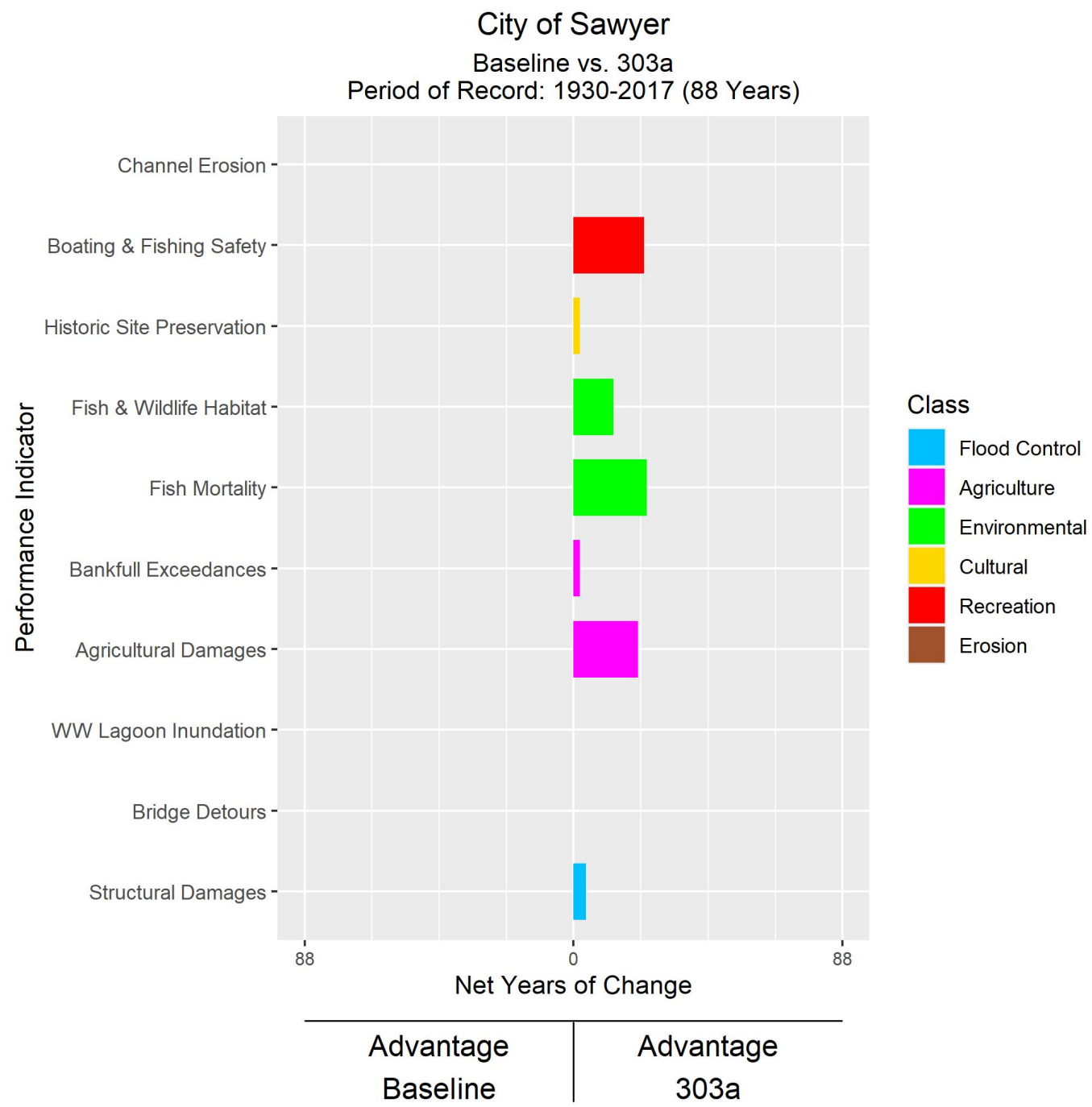


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

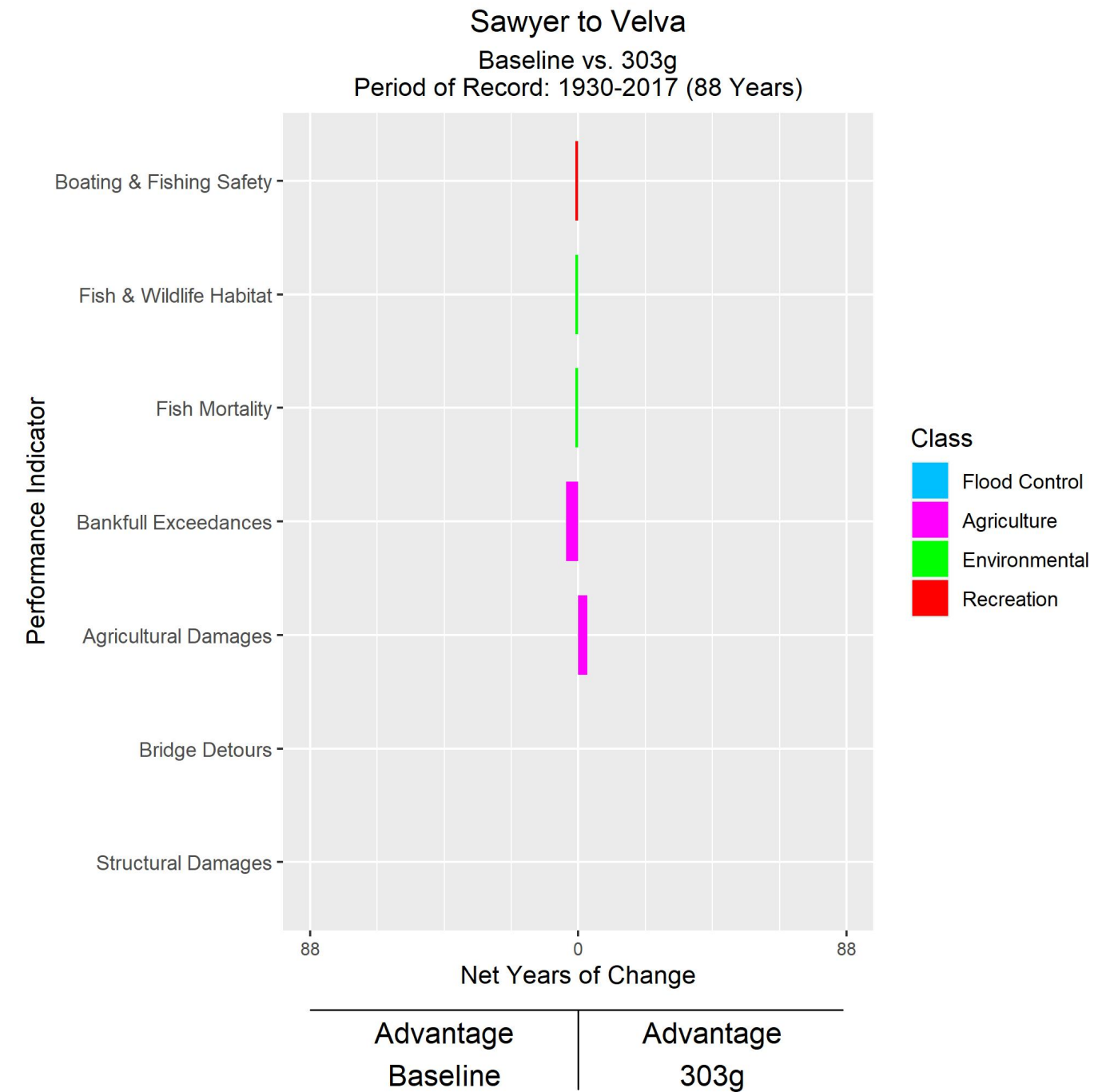
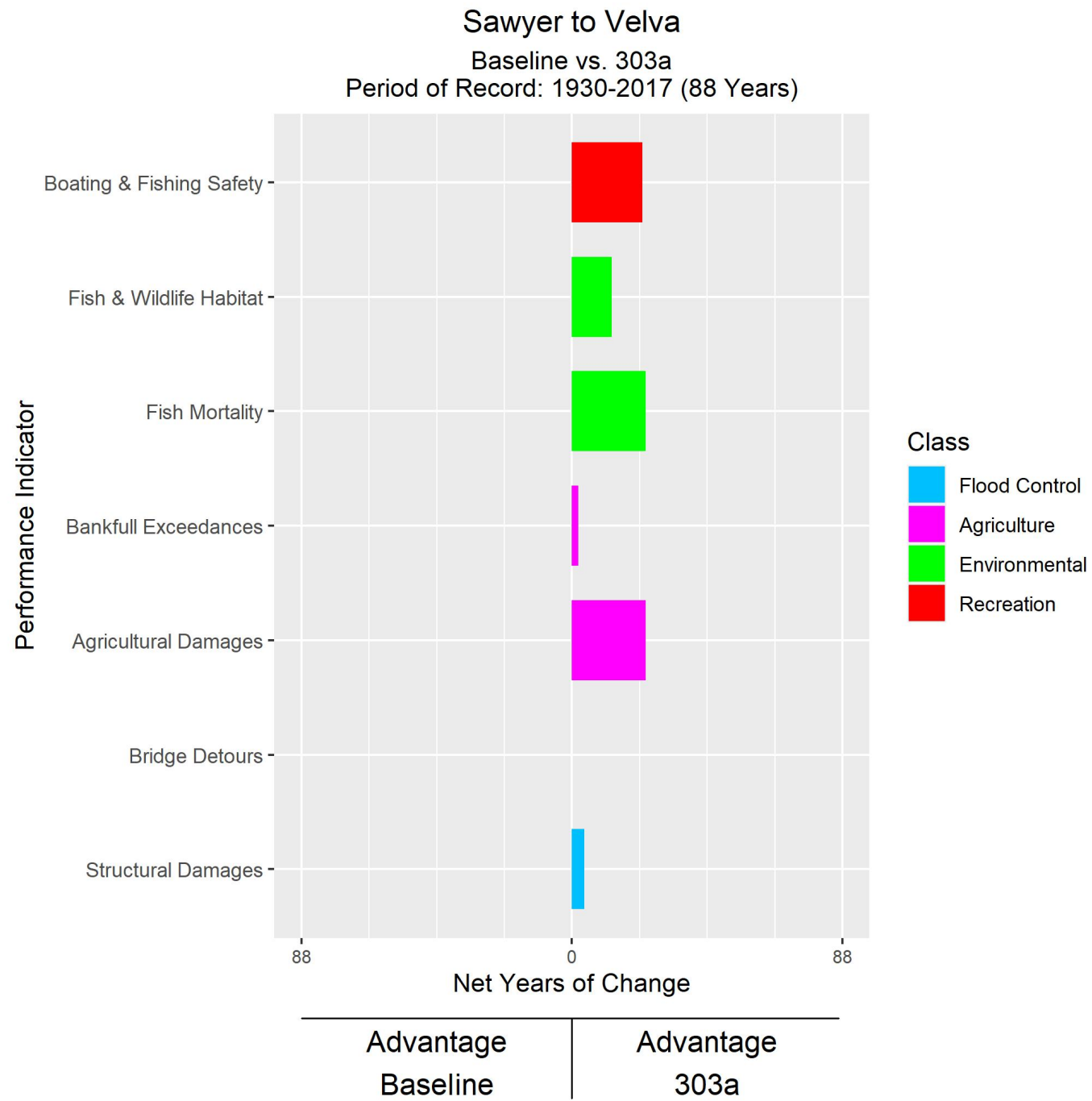


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

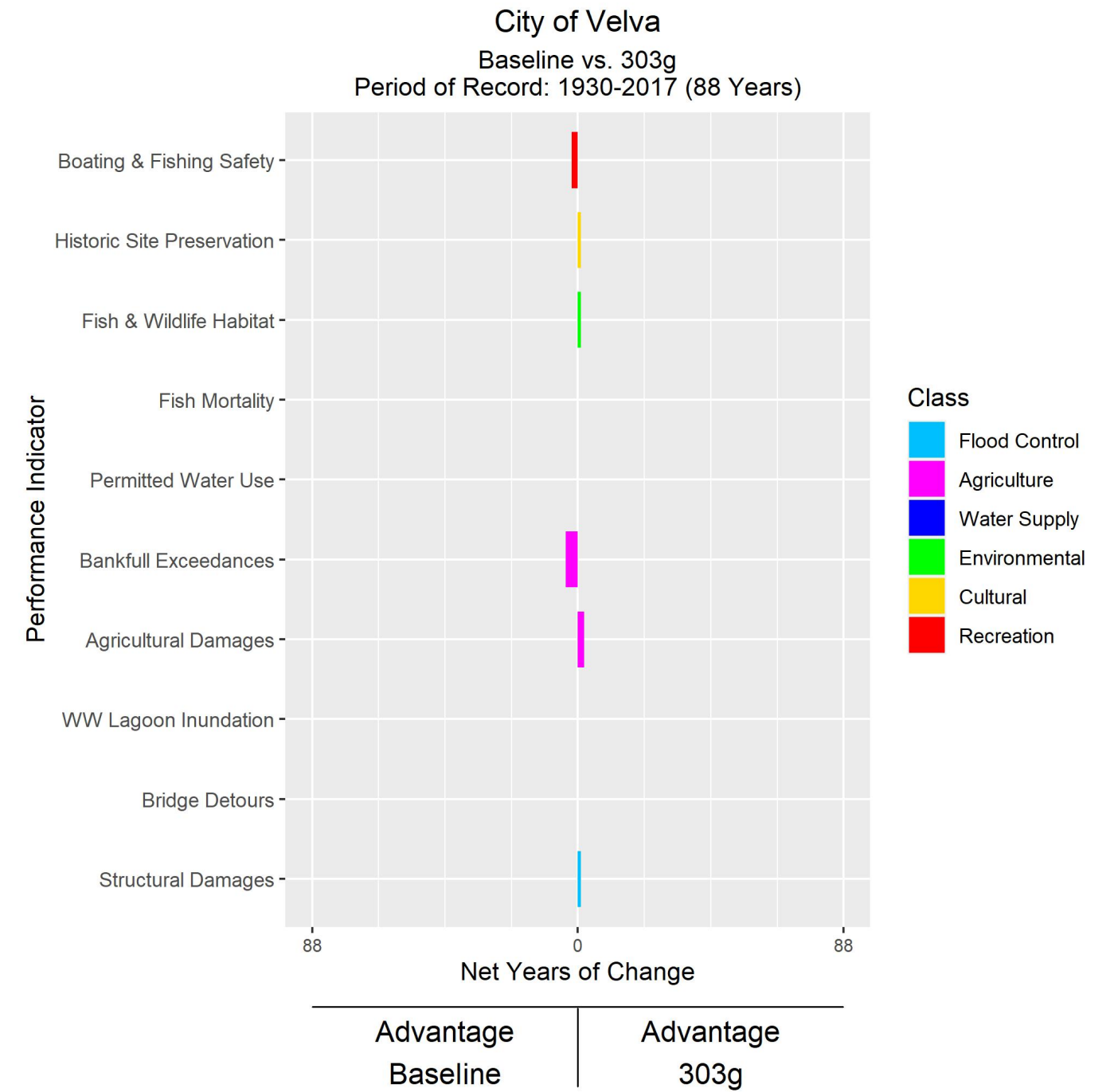
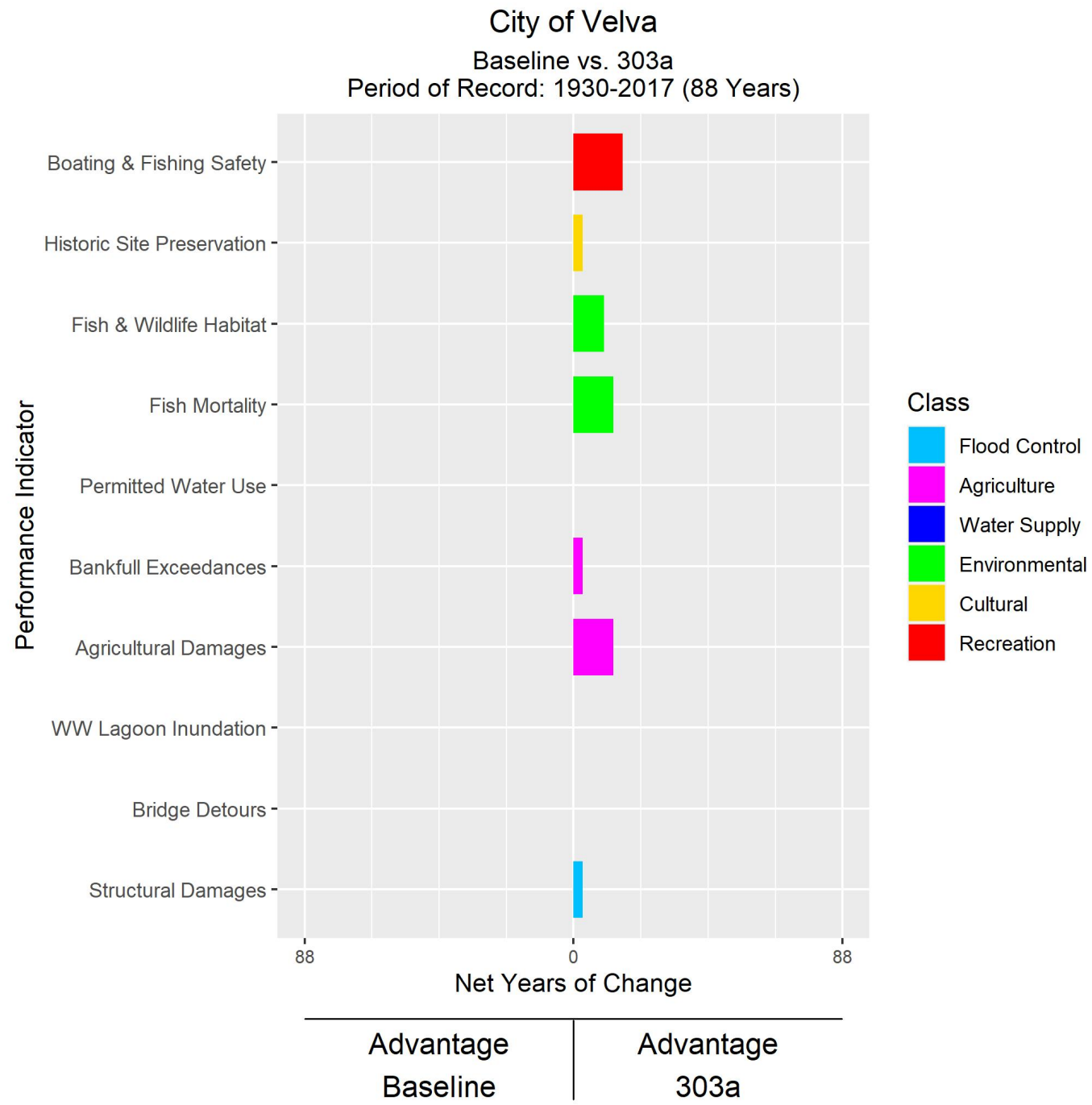


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

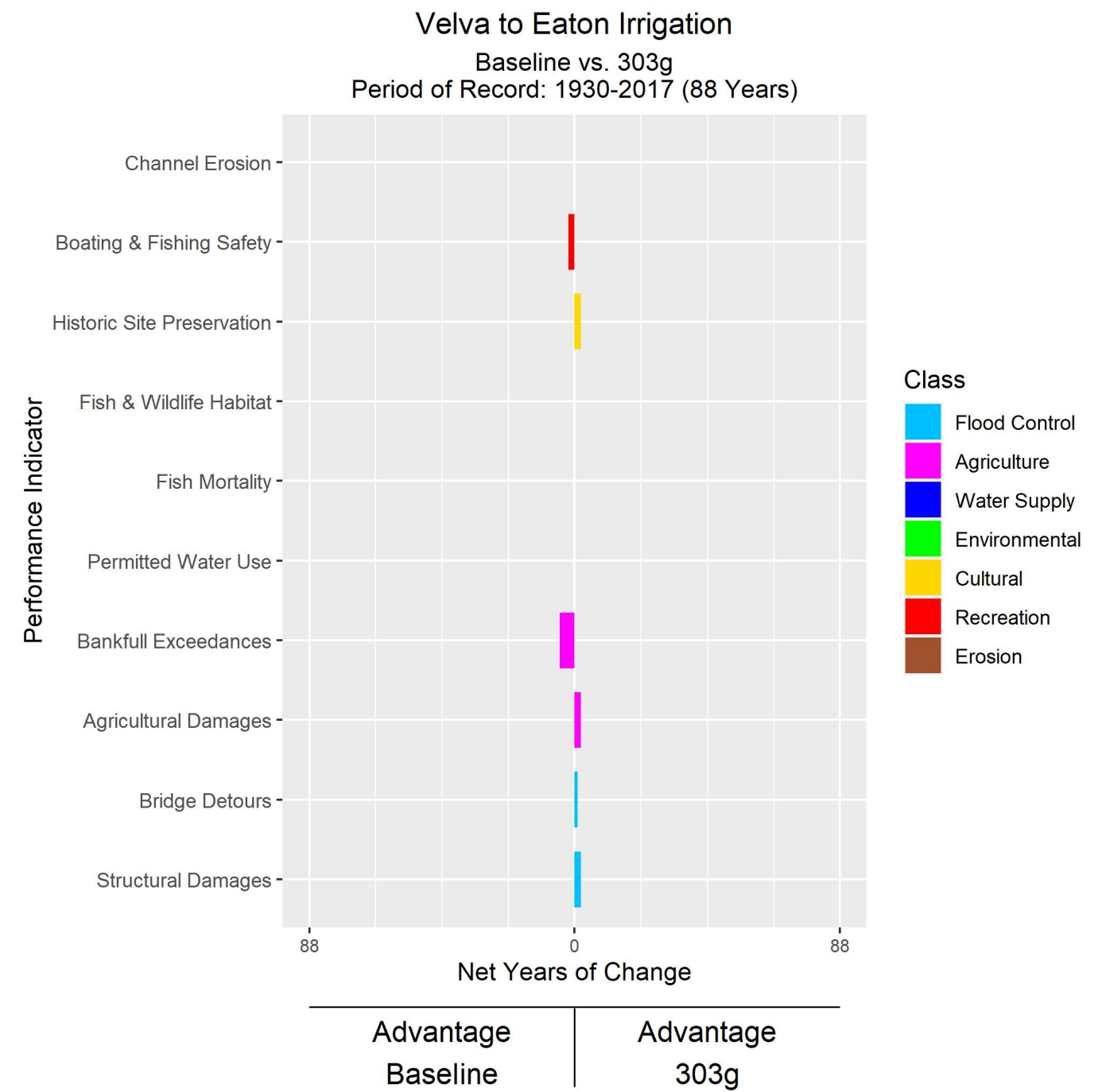
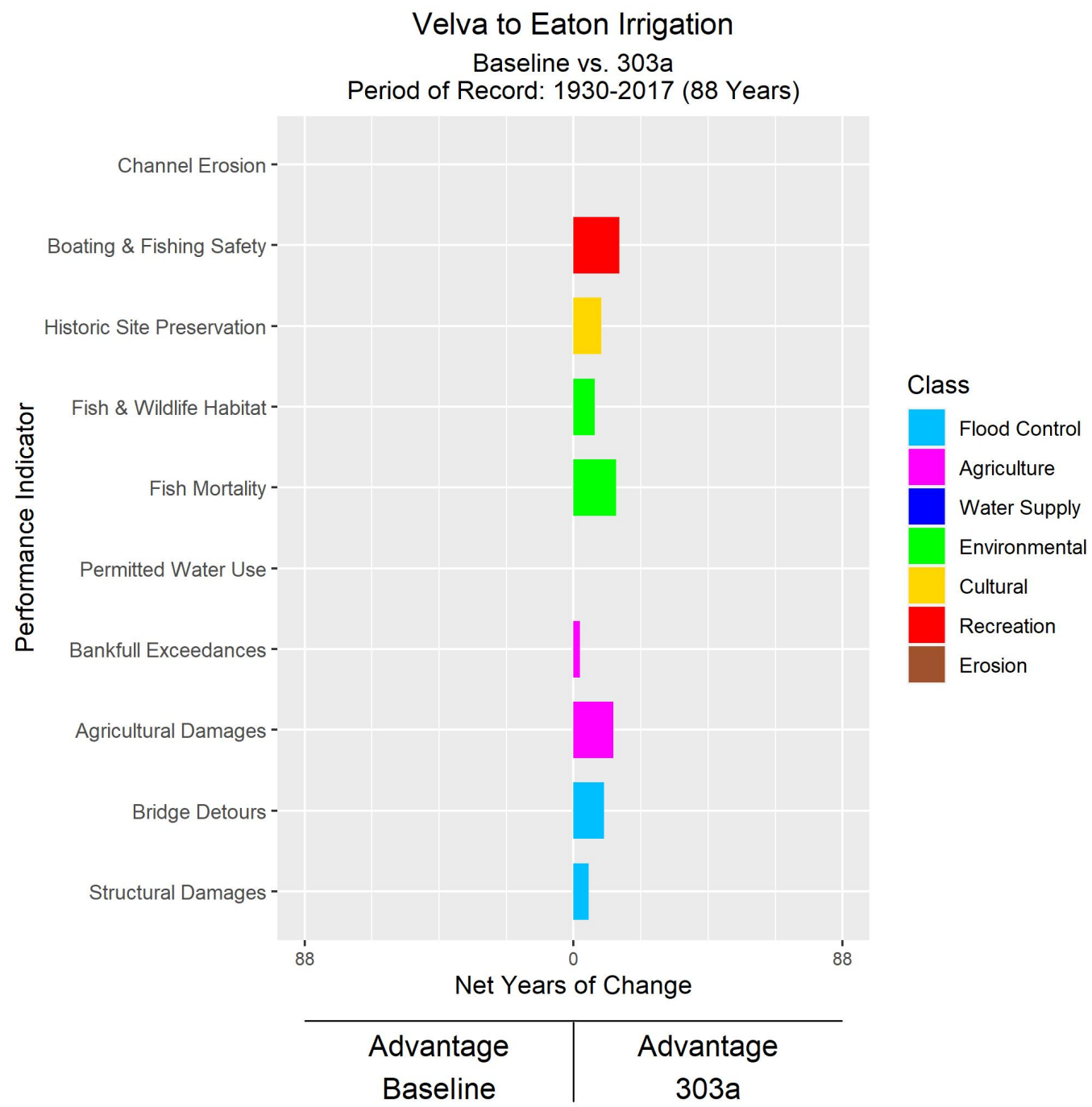


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
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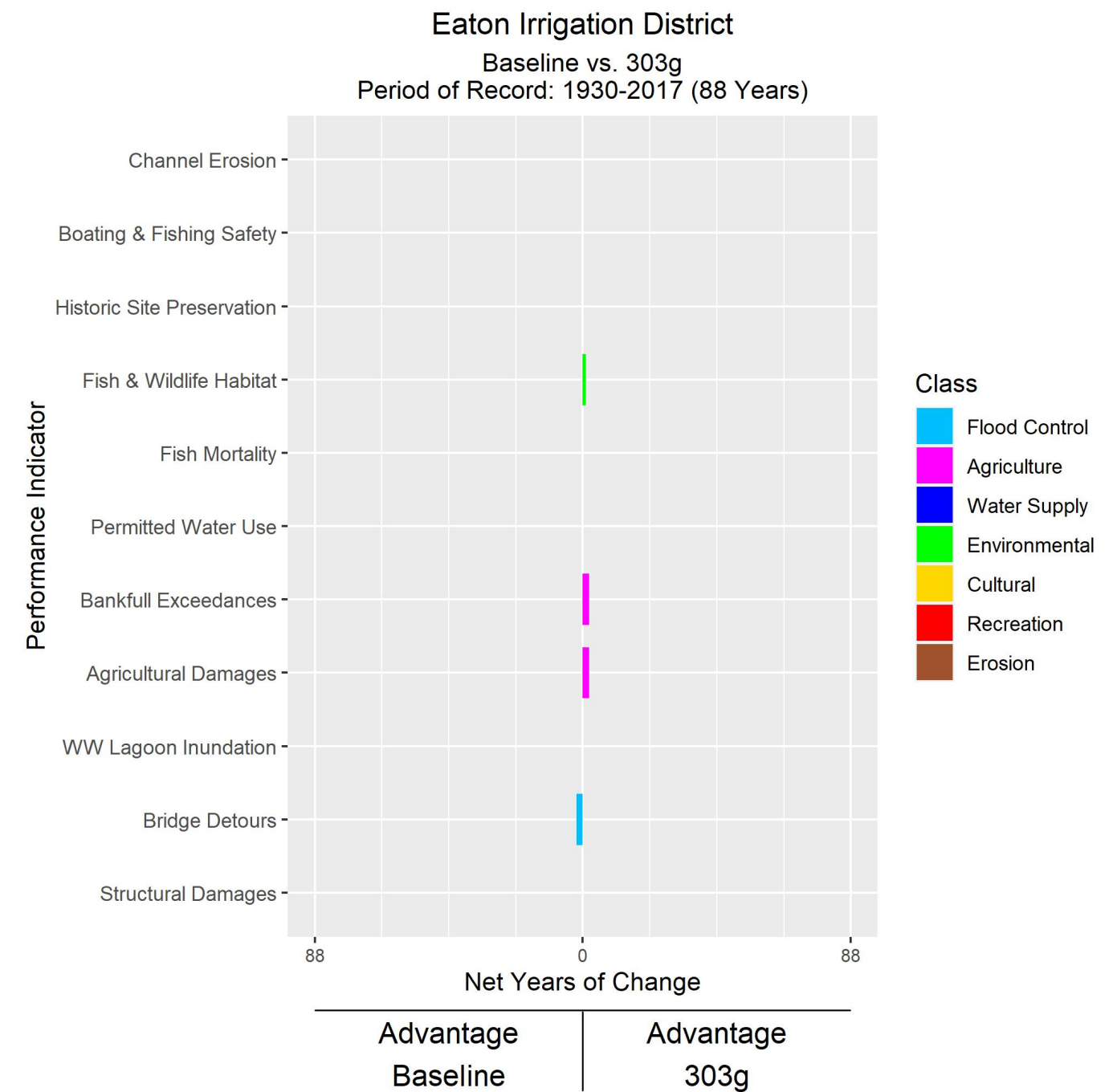
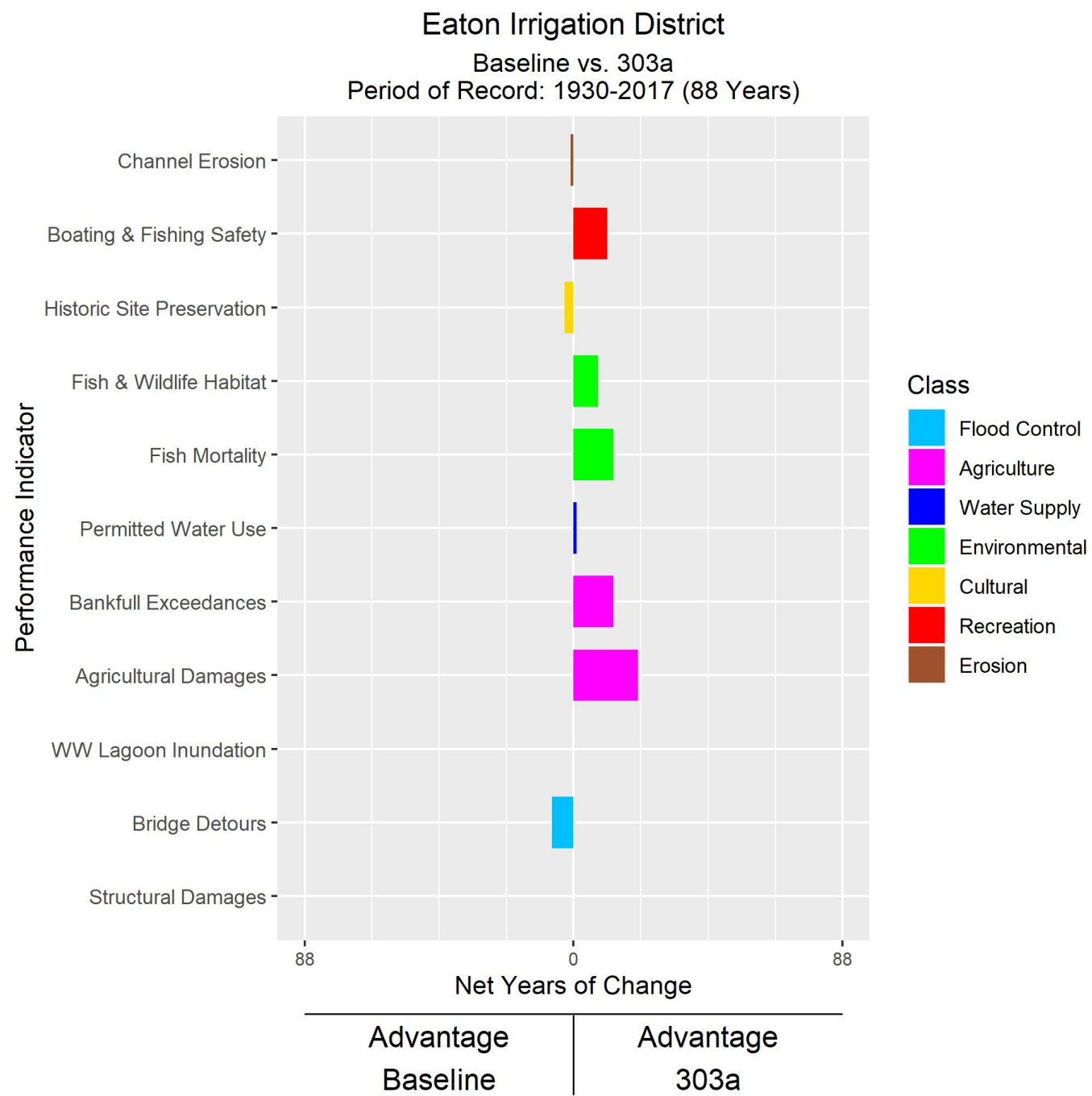


#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
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- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
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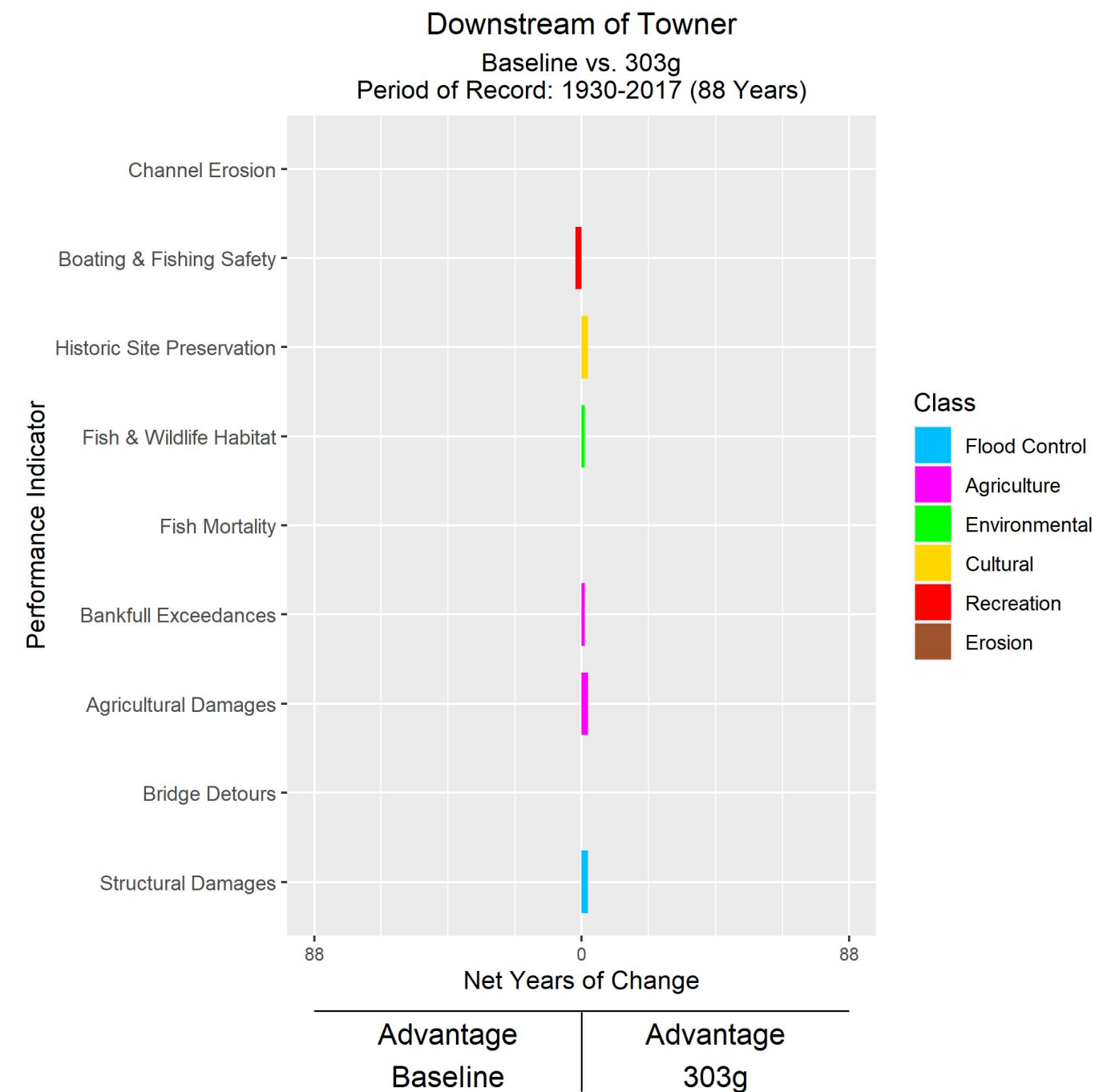
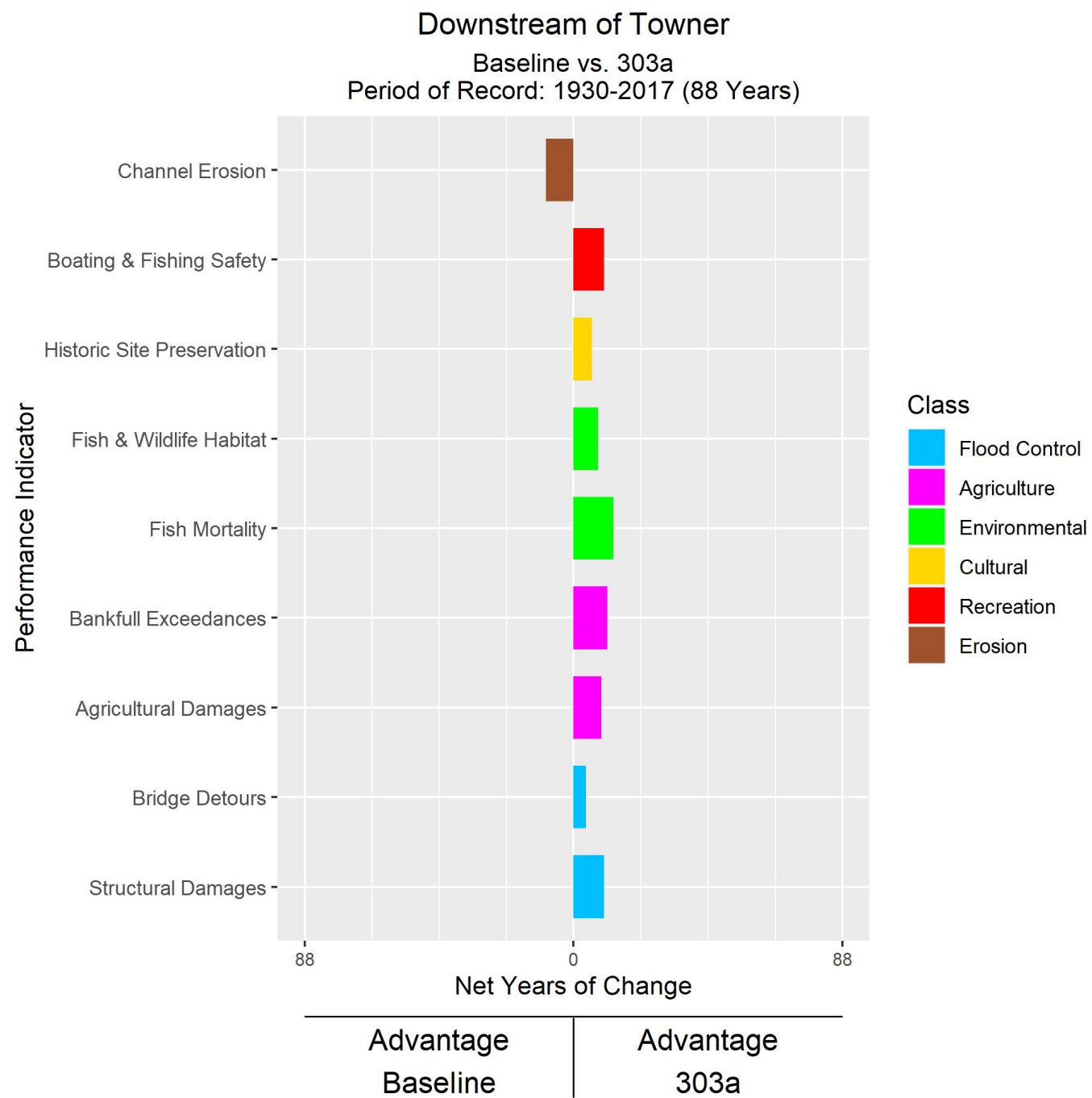
#### Alternative 303a

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- Most restrictive simulation in Alternative 303

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- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
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#### Alternative 303a

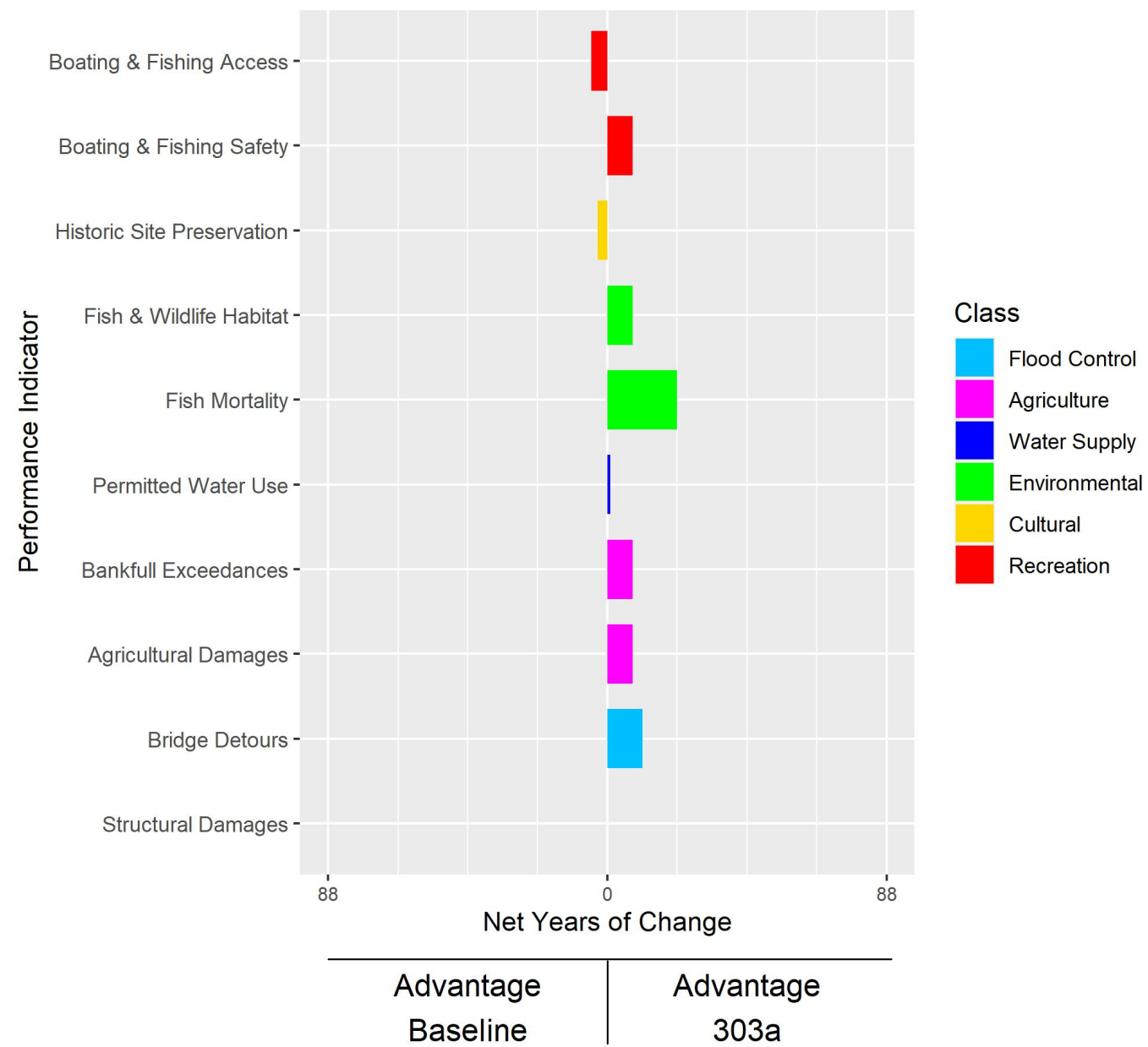
- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303

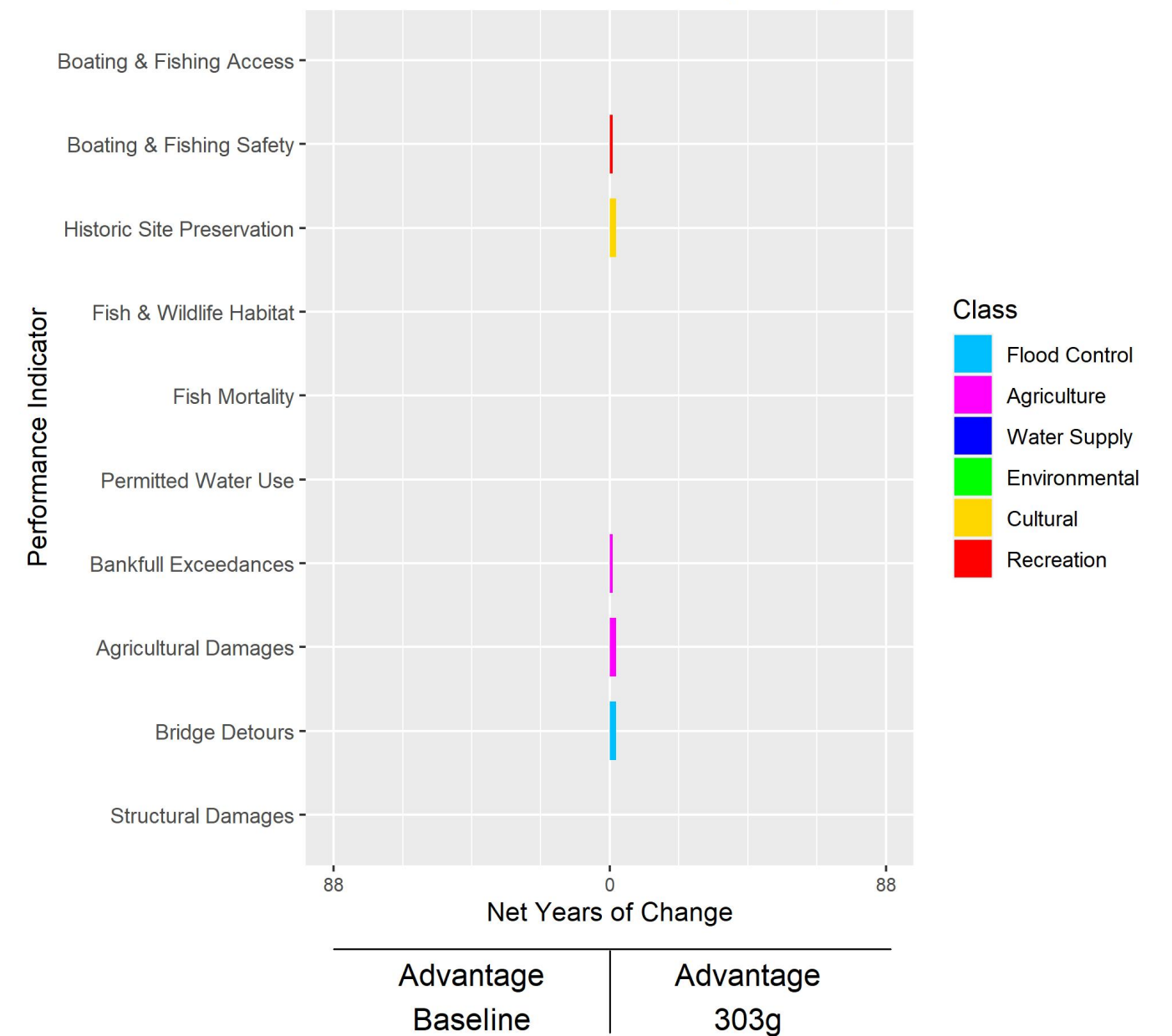
### J. Clark Salyer National Wildlife Refuge

Baseline vs. 303a  
Period of Record: 1930-2017 (88 Years)



### J. Clark Salyer National Wildlife Refuge

Baseline vs. 303g  
Period of Record: 1930-2017 (88 Years)



#### Alternative 303a

- Maximum flow restriction of 200 cfs at Lake Darling Jun 3 to Feb 1
- Most restrictive simulation in Alternative 303

#### Alternative 303g

- Maximum flow restriction of 1500 cfs at Lake Darling Jun 3 to Feb 1
- Least restrictive simulation in Alternative 303