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# SECTION 3.0 EVALUATE CONSUMPTIVE AND ENVIRONMENTAL AND RECREATIONAL CONSIDERATIONS

This section provides an overview of considerations that the BIP will use to assess the water needs, shortages and potential future supplies of the YWG Basin. The majority of information presented in this chapter was developed through a series of SWSI and Basin-wide studies. This includes the 2014 P&M Study, which is the most recently completed study conducted by the YWG BRT. This section includes an overview of considerations, a summary of water management and administration, a discussion of the recently completed hydrologic modeling in the P&M Study, and a description of water shortages specific to the M&I, SSI, agricultural, environmental, and recreational sectors.

It is important to note that the M&I, SSI, agricultural, environmental, and recreational results presented in this section are based on the P&M Study and additional modeling completed since submission of the first draft BIP in July 2014. This second "final" draft includes the demand updates noted in Section 2, additional IPPs recommended for modeling by the BIP Committee, and more reliable indicators of shortages. As the BIP process moves forward, refinements to the model will continue and discussions will ensue on how best to meet the shortages throughout YWG Basin.

## 3.1 OVERVIEW OF CONSIDERATIONS

The YWG BRT recognizes that almost any water supply, whether it is categorized as an IPP or not, will involve complex and nuanced tradeoffs. Each project will present its own specific set of opportunities and constraints; and what is a constraint for one project might be an opportunity for another. Consequently, at this time, the YWG BRT believes it is not possible to develop a comprehensive list of opportunities and constraints. Instead, the BIP sets out planning "considerations" to guide the future development and evaluation of water supply and resource projects. An overview of the current considerations are summarized in Table 3-1 and discussed below.

**Table 3-1 Considerations for Water Supply Planning in the YWG Basin**

| Summary of Considerations for the YWG Basin |
|---|
| Less developed relative to other basins in the State |
| Relatively junior water rights relative to other basins in the State |
| Limited storage |
| Less developed diversion infrastructure |
| No history of mainstem administration |
| Numerous large conditional water rights |
| Flow requirements for endangered species protection<br>▪ Yampa PBO<br>  ○ Increase in irrigated lands<br>  ○ Increase in agricultural consumptive use<br>▪ Green River Record of Decision (ROD)<br>▪ Prospective White River PBO |

Balancing the uses and needs for water in the YWG Basin first requires coordination within YWG Basin and amongst its stakeholders to ensure the long-term viability of its current water supplies and some future development of its native water supplies. Other parties within the State have expressed interest in diversions from the Yampa, and downstream States have delivery needs that are partially met from the Yampa and White Rivers. This BIP serves as a

forum to address the need to protect existing uses, to enable future growth, and to retain the recreational and environmental values important to the YWG Basin and to the State. These are the core outcomes that the YWG Basin is seeking. Through this BIP, the YWG BRT strives to balance the current and future needs of the YWG Basin while integrating these important considerations into the statewide planning process.

***Development.*** The YWG Basin drainages are relatively less developed compared to other basins in the State. Economic and population growth came later to the YWG Basin, with the result that the YWG Basin has lower levels of water use relative to average annual flows compared to more developed basins in the State. This is an opportunity for further in-basin development and for preservation of environmental and recreational values, but it also makes the YWG Basin an attractive target of proposals for new TDMs, which could impose significant constraints on opportunities for IPPs and on our ability to meet the goals of the YWG Basin.

***Junior water rights***. Another consideration for the YWG Basin is that, due to the later development and growth in the YWG Basin, particularly for M&I uses, appropriation dates for water rights in the YWG Basin are more junior relative to other Colorado River tributaries. This causes concern because Colorado River Compact administration could lead to a more severe curtailment of existing uses in the YWG Basin than in basins with a more senior water rights portfolio.

***Limited storage.*** The YWG Basin drainages have less storage relative to average flow than do other basins. Although there is some existing storage for agricultural supplies, particularly in the upper Yampa Basin, most of the storage is reserved for dry-year supplies for M&I uses. The small amount of storage coupled with relatively junior water rights in the YWG Basin presents a concern about reduced physical and legal reliability of its water resources, particularly during drought periods. Flows on the mainstem and on tributary streams without storage are often inadequate in the late season. On the other hand, riverine systems in the YWG Basin are unique because they are some of the few in the State that exhibit a more natural hydrograph due to the lack of large on-channel storage capacity. This BIP recognizes that the more natural hydrograph provides valuable benefits to endangered species, riparian habitat, and recreationists.

***Diversion infrastructure***. Diversion structures are not well developed. Irrigators often construct gravel pushup dams to divert water, but these dams cannot sweep the river. Numerous diversions do not have measuring devices.

***Administration.*** Administration has only occurred on the mainstem Yampa and White Rivers in special circumstances, such as protecting reservoir releases in dry conditions. This historical lack of administration is not solely due to the relatively lesser development on these basins (water shortages are common during dry seasons); it is also due to a neighborly culture of a willingness to share shortages voluntarily and the presence of undeveloped diversion infrastructure. The Division engineer will not allow calls to be placed at diversions that do not have measuring devices or that cannot sweep the river.

***Conditional water rights.*** As shown in Table 3-2 there are a number of conditional storage water rights, particularly in the lower White Basin (District 43) and lower Yampa Basin (District 44). This presents both an opportunity and a constraint for the long-term water resource development of these sub-basins. For example, conditional senior water rights held by energy companies in the White Basin can discourage the development of new projects relying on junior water rights. The yield of these junior water supply projects could be reduced to infeasible levels if senior conditional water rights are developed and made absolute at a later date. Conversely, these senior conditional water rights provide the potential for development of relatively firm IPPs with senior priority. This situation illustrates the need for careful collaboration and cooperation in order to reach the best outcome for the YWG Basin.

**Table 3-2 Volume of Conditional Storage Rights by Priority in the YWG Basin***

| Water District | Stream Name | 1900-1920 (AF) | 1920-1940 (AF) | 1940-1960 (AF) | 1960-1980 (AF) | 1980-2002 (AF) | Total (AF) |
|---|---|---|---|---|---|---|---|
| 43 | White River | 204 | 0 | 12,548 | 1,018,918 | 266,128 | 1,297,798 |
| 44 | Williams Fork/Yampa River | 0 | 0 | 844,294 | 638,662 | 1,179,449 | 2,662,405 |
| 54 | Slater Creek/Little Snake River | 0 | 0 | 0 | 323,580 | 166,898 | 490,478 |
| 55 | Little Snake River | 0 | 0 | 0 | 0 | 46,426 | 46,426 |
| 56 | Green River | 0 | 0 | 0 | 1,200 | 500 | 1,700 |
| 57 | Yampa River | 0 | 0 | 0 | 111,010 | 52,616 | 163,626 |
| 58 | Elk/Yampa River | 0 | 0 | 34 | 201,579 | 97,449 | 299,062 |
| **Total** | | **204** | **0** | **856,876** | **2,294,949** | **1,809,466** | **4,961,495** |

Source: Water Supply and Needs Report for the YWG Basin, (CDNR 2006)
* Note that this table is current as of 2006; additional water rights have likely been filed and abandoned since that time, e.g., the abandonment of the Juniper-Cross water right in Water District 44 exceeded 1 MAF.

***Endangered species.*** Constraints on water development and water management to protect habitat for endangered species are in place in the Green and Yampa Basins, and similar constraints are being contemplated for the White Basin. Accordingly, the BIP addresses how the YWG Basin's water needs must be developed in ways that provide collaborative solutions to water supply challenges while maintaining a balanced and diverse economic base long into the future. Existing flow protections for endangered species must be also considered in this process.

In particular, the Yampa PBO is based on existing storage and a current depletion of 125,271 AF above the Little Snake River with a projected increase in depletion of 30,104 acre feet by 2045[1]. The estimates of current and future depletions above the Little Snake River in the P&M Study are significantly higher than this. One of the major reasons is that the StateCU and StateMod models were refined to include the Denver Water High Altitude crop coefficients for pasture grass/hay fields above 6,500 feet. In order to be consistent with CRWAS and common State Engineer Office practices, an elevation adjustment of 10% per 1,000 meters above sea level was made for all crops. When compared to previous SWSI IWR estimates, the IWR requirement increased by 54 percent basin-wide when the high–altitude coefficient for the grass/hay was included and by 65% when the elevation adjustment and high altitude crops were incorporated[2]. The Yampa PBO was based on un-adjusted consumptive use, which leads to an "apples-to-oranges" comparison. Additional modeling efforts and coordination will be necessary to incorporate updated depletions and determine the amount of flow that could be sustainably maintained in the Yampa River for protection of endangered species.

## 3.2 WATER MANAGEMENT AND WATER ADMINISTRATION

The YWG Basin is one of the few areas in Colorado where a large part of the YWG Basin is not over appropriated and regularly under administration. Nonetheless, certain tributaries are frequently administered at certain times of the year (e.g., the Elk River and the Yampa River mainstem upstream of the Town of Yampa). Still, significant portions of the YWG Basin have not experienced a call due in part to water users within the YWG Basin coordinating diversions and avoiding a formal call.

[1] The cooperative agreement implementing the management plan for the PBO also provides: "When the first increment of depletions in Colorado [of 30,104 acre feet] approaches full development, the impacts of developing a second increment [of 20,000 AF] and the status of the endangered fish species at that time will be re-evaluated pursuant to the PBO for this Agreement to implement the Management Plan.".
[2] Agricultural Water Needs Assessment Report, 2011

The majority of historical calls in the YWG Basin, other than in the Elk River, are attributed to irrigation uses. Occasional calls have been made by CWCB to maintain instream flows in the Elk River. In addition to calls, certain stream reaches have been administered to ensure that reservoir releases are conveyed to the designated downstream use. Streams that are commonly administered include:

- Green River Basin - Talamantes Creek, Vermillion Creek, Beaver Creek and Pot Creek
- Yampa River Basin – Bear Creek, Phillips Creek, Hunt Creek tributaries, Fish Creek,[3] Soda Creek, Elk River, Trout Creek, Elkhead Creek, Fortification Creek, Deer Creek and Morapos Creek
- White River Basin – Piceance Creek.

Pot Creek, a tributary to the Green River that flows between Colorado and Utah, is administered based on the Pot Creek Memorandum of Understanding (MOU). This MOU includes a schedule of priorities for use in both states and defines a period before which direct flow diversion cannot be exercised.

## 3.3 HYDROLOGIC MODELING

The 2014 P&M Study was the primary study used to inform the BIP regarding future water supplies, demands, and shortages including projections of demands and alternative hydrologic conditions.[4] The P&M Study used the StateMod modeling platform which is Colorado's water allocation model maintained by CDSS. StateMod is the water allocation model in CDSS that is used for the primary purpose of modeling water rights and allocating water to those rights. StateMod uses strict prior appropriations (i.e., first in time, first in right) to model diversions. The model was initially developed in 1994 and has been continually updated as new studies and data becomes available. The 2009 release for both the Yampa and White Basins was used for this study. The model uses a monthly time-step. A variety of previous studies discussed in Appendix A were used to inform the modeling effort. The P&M study was conducted by the YWG BRT to:

- Develop a common understanding of consumptive, recreational, and environmental water needs in the YWG Basin.
- Analyze Yampa River and White River operations, including alternative model scenarios.
- Evaluate water right priorities of SWSI Alternatives relative to those of the YWG Basin.

The P&M Study evaluated Baseline Conditions and six modeling scenarios. As shown in Figure 3-1 these scenarios consist of a combination of demands, hydrology and supply projects (IPPs). The demand inputs include the current and future year (2050) water needs for the M&I, energy, agriculture, environment and recreation sectors at specific modeling nodes in the StateMod model. Information on how the demands were developed for each of these sectors is provided in Chapter 2. The P&M Study results present the percentage of average annual water shortages at each of the respective StateMod nodes and for each of the sectors both in tables and spatial figures.

[3] Administration of this reach is becoming less frequent. CWCB has historically placed an instream flow right call on Fish Creek, however, the Mt. Werner Water District is leaving more flows in the Creek which lessens the need for an instream flow call.
[4] The YWG BIP Committee decided on March 5th, 2014 that the P&M Study would serve as the major study informing the BIP.

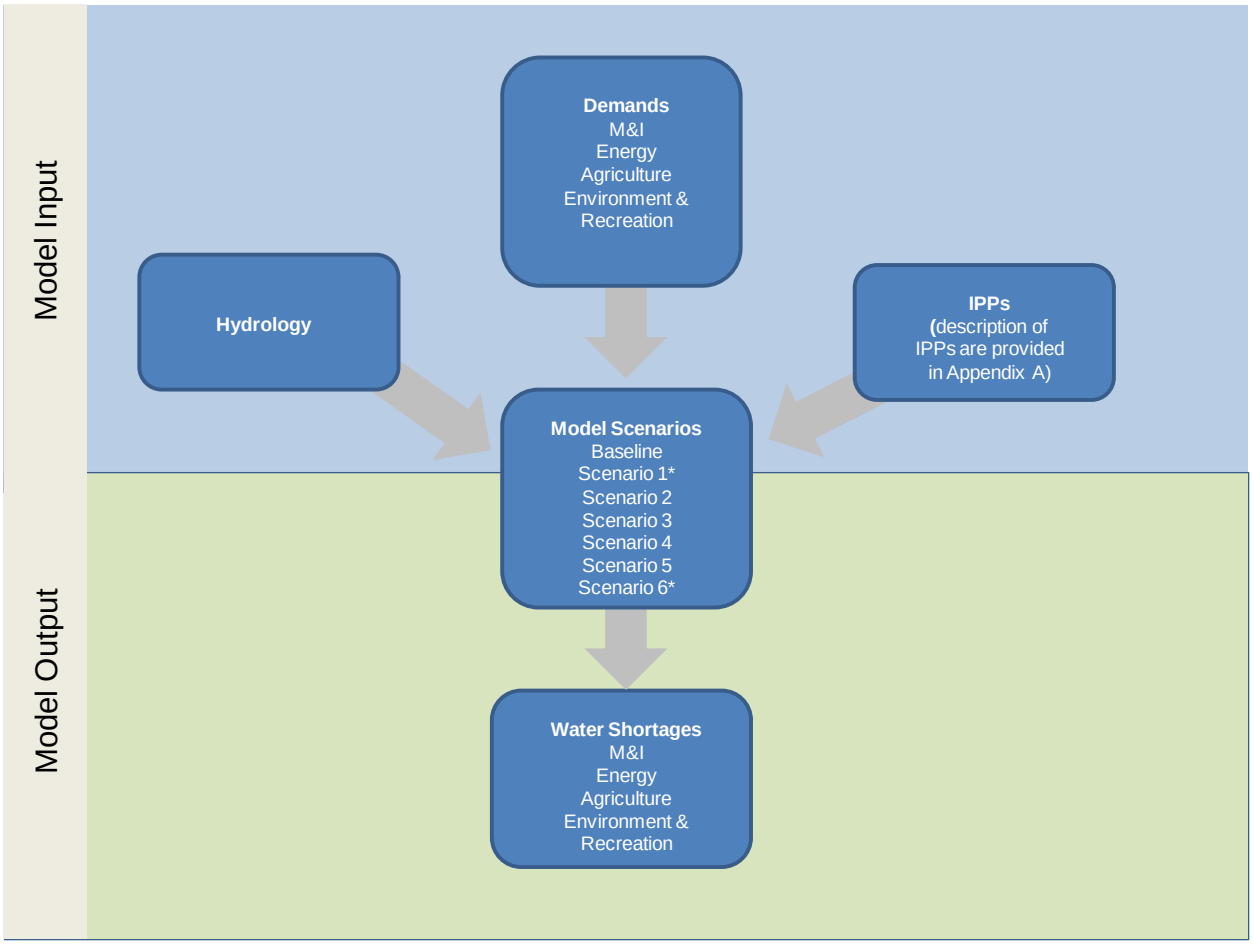


**Figure 3-1 Elements of the Model Scenarios**

Table 3-3 shows the elements for each of the respective scenarios incorporated into the BIP. The modeled baseline represents current conditions and operations. This includes all existing reservoirs, water rights, imports, diversions, and return flows while incorporating the historical hydrology and climate over the period 1950 through 2005. It provides a means to compare the other scenarios (e.g., supply projects, climate change, new demands, etc.). The Dry Future IPP Scenario and Dry Future Scenario entail high demands and dry hydrology which provides a conservative planning framework to best guarantee that the YWG Basin's future water needs can be met. These scenarios are referred to as Scenario 1 and Scenario 6, respectively, in the 2014 P&M Study.

**Table 3-3 Model Scenarios**

| BIP Scenario | Nomenclature in the P&M Study | Hydrology | Demands | IPPs |
|---|---|---|---|---|
| Baseline | Baseline | Historical | Existing demands | No IPPs Selected |
| Dry Future IPP Scenario | Scenario 1 | Dry | High | All IPPs Selected |
| Dry Future Scenario | Scenario 6 | Dry | High | No IPPs Selected |

## 3.4 CHANGES TO THE YWG BASIN STATEMOD MODEL

During the second phase of the BIP development, the P&M Study StateMod model for the YWG Basin was modified to refine some of the model nodes' demands and refine operations and model assumptions under the Baseline Scenario and future scenarios (Dry Future IPP Scenario and Dry Future Scenario). These updates were requested by stakeholders in the YWG Basin. Updating the modeling is still in progress and its completion will be an important next step. The prelimary results described in this section are based on the updated modeling that has been done so far, unless indicated otherwise. Several examples of shortages to consumptive and non-consumptive needs are also presented for the 2000-2005 period using the updated modeling, but no new assessments of flow alteration risks to fisheries, cottonwoods, or recreationaal boating have been updated to reflect the updated modeling. As stated above, all of the modeling remains preliminary and a work in progress. Updates to the YWG Basin StateMod model will continue in the future after the State Water Plan has been finalized.

The primary changes made to the YWB Basin StateMod model during the development of the BIP are summarized below.

- The total demand for the three units of Craig Station was increased under the baseline scenario from approximately 12,000 AFY to 14,000 AFY.
- An operating rule was added to the model to simulate a release from Stagecoach Reservoir to meet a minimum of 20 cfs flow in the Yampa River downstream of Stagecoach Reservoir from August to November to reflect Federal Energy Regulatory Commission (FERC) environmental requirements.
- A release from Stagecoach Reservoir was modeled under the Dry Future IPP Scenario to meet remaining shortages at the Upper Yampa ISF. This release is not modeled under the Baseline and Dry Future Scenarios.
- The unlimited filling of reservoirs was turned off for all of the modeling scenarios. A start date for administering annual fill was implemented for all the reservoirs based upon the intended use (i.e.: irrigation, municipal, industrial, etc.) for the reservoirs and any requirements enforced by the Division Engineer.
- All reservoirs were modeled to start empty.
- An augmentation plan was modeled for Stagecoach Reservoir under the Dry Future IPP Scenario. Under this augmentation plan, 2,000 AF of fully consumptive water would leave Stagecoach Reservoir each year.
- The modeled releases from Steamboat Lake to Willow Creek ISF and Elk River ISF were deactivated for all three modeling scnearios.
- The modeled water rights for Stagecoach Reservoir were modified to conform to a StateMod model that was previously developed by the Upper Yampa Water Conservancy District.
- The modeled M&I demands for Routt County were adjusted for all three modeling scenarios. The changes to the M&I demands were based on feedback from Mt. Werner Water and Sanitation District and the City of Steamboat Springs. The M&I demands for the following model nodes were adjusted: 57_AMY001, 58_AMY001, Fish Creek Municipal Intake, Steamboat Well A, Mt Werner Well H and Mt Werner Well G.

## 3.5 CURRENT AND FUTURE SHORTAGES ANALYSIS

The updated P&M Study Statemod model was used to analyze shortages in the YWG Basin. As discussed in Section 3.3, this BIP focuses on the modeled Baseline Conditions and future scenario assuming high demands and dry hydrology. Both the Dry Future IPP Scenario and the Dry Future Scenario are based on dry hydrology. The Dry Future IPP Scenario includes a series of supply and storage IPPs while the Dry Future Scenario does not include these IPPs. The specific IPPs included in the Dry Future IPP Scenario are discussed in Chapter 4. Appendix A provides further information on the scenarios and IPPs.

### *M&I Shortages*

As discussed in Chapter 2, M&I demands are small compared to agricultural demands in the YWG Basin. Under the Baseline Scenario, no shortages exist to M&I demand nodes due to generally adequate water supply and augmentation

from reservoirs. M&I shortages exist under the high-demand, low-water supply scenarios of the Dry Future IPP Scenario and the Dry Future Scenario but remain insignificant. As an example, under both the Dry Future IPP Scenario and the Dry Future scenarios, District 43 Existing M&I in Rio Blanco County (Rangely Water, Meeker Demand) begin to exhibit shortages, whereas Moffat County municipal nodes do not show M&I shortages under either scenario. If IPPs are developed that include M&I use, shortages would likely decrease in locations with supply augmentation.

### *SSI Shortages*

Under the Baseline Scenario, no shortages exist for SSI which is primarily related to thermoelectric power generation. Slight shortages exist for the Hayden Station and Craig Station under the Dry Future IPP Scenario and the Dry Future Scenario. These scenarios meet thermoelectric demands with redundant water supplies from Steamboat Lake for Hayden Station and Elkhead and Stagecoach Reservoirs for Craig Station. Using historical data, hypothetical shortages would have occurred for the Hayden Station in the dry months of August 1961 March 1962, September 1977, and September 2002) and for the Craig Station in the dry months of November 1963, September 1977, December 2002, and a few months in 1949.

However, SSI water users consider their water supply short at any time when they must rely upon redundant water supplies. For example, the years 2002, 2003, 2012, and 2013 were considered water supply short or borderline short by some SSI water users due to reliance on redundant supplies.

### *Agricultural Shortages*

The P&M Study and Agricultural Water Needs Study highlight the following areas of shortage under modeled Baseline Conditions:

- The Piceance Creek watershed has the highest agricultural shortages in the White Basin. This watershed is important for future energy development.
- Fortification and Morapos Creeks have some of the highest agricultural shortages in the Yampa Basin.
- Many of the diversions in the upper tributaries have low irrigation efficiencies and small drainage areas which result in unreliable irrigation supplies.

The percentages of agricultural shortages significantly increase in the eastern and southern portions of theYWG Basin under the simulated high-demand, dry-hydrology conditions for the Dry Future IPP and Dry Future scenarios. Agricultural shortages significantly increase for the Dry Future IPP Scenario and the Dry Future Scenario in Districts 43, 44, 54, 57 and 58; minimal changes are observed in Water Districts 55 and 56 in the northwest portion of theYWG Basin.

The simulated increase in shortages for the Dry Future IPP and Dry Future scenarios are largely attributed to the drier hydrology and a shift to earlier season runoff as a result of warmer temperatures with climate change. The simulated late season shortages tend to increase unless there is storage available. Modeled shortages are common in the upper tributaries without existing storage or an IPP.

Comparison of the Dry Future IPP Scenario and the Dry Future Scenario for the 1950-2005 period indicate that the development of IPPs would significantly reduce agricultural shortages in District 44: shortages totaling approximately 56,000 AF would be reduced to approximately 22,000 AF with the development of the modeled IPP reservoirs in the headwaters of this District. Additional information on these IPPs is provided in Chapter 4. Shortages are also reduced in Water Districts 54 and 57 as a result of the IPPs.

Figures 3-2 through Figure 3-5, which are based on the updating modeling, show examples of monthly shortages in selected irrigation ditches for the period 2000-2005.

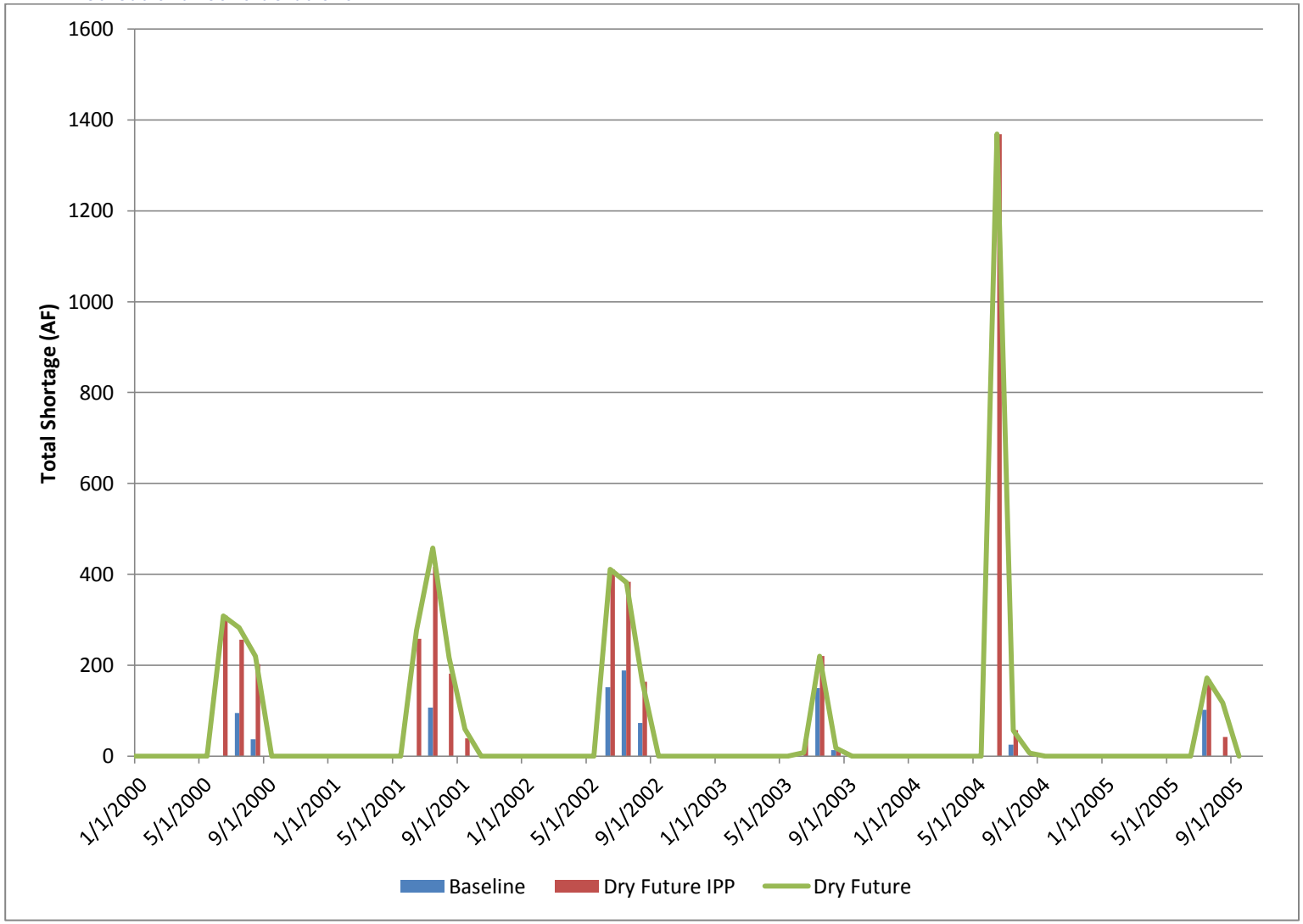


Figure 3-2 DD&E Ditch

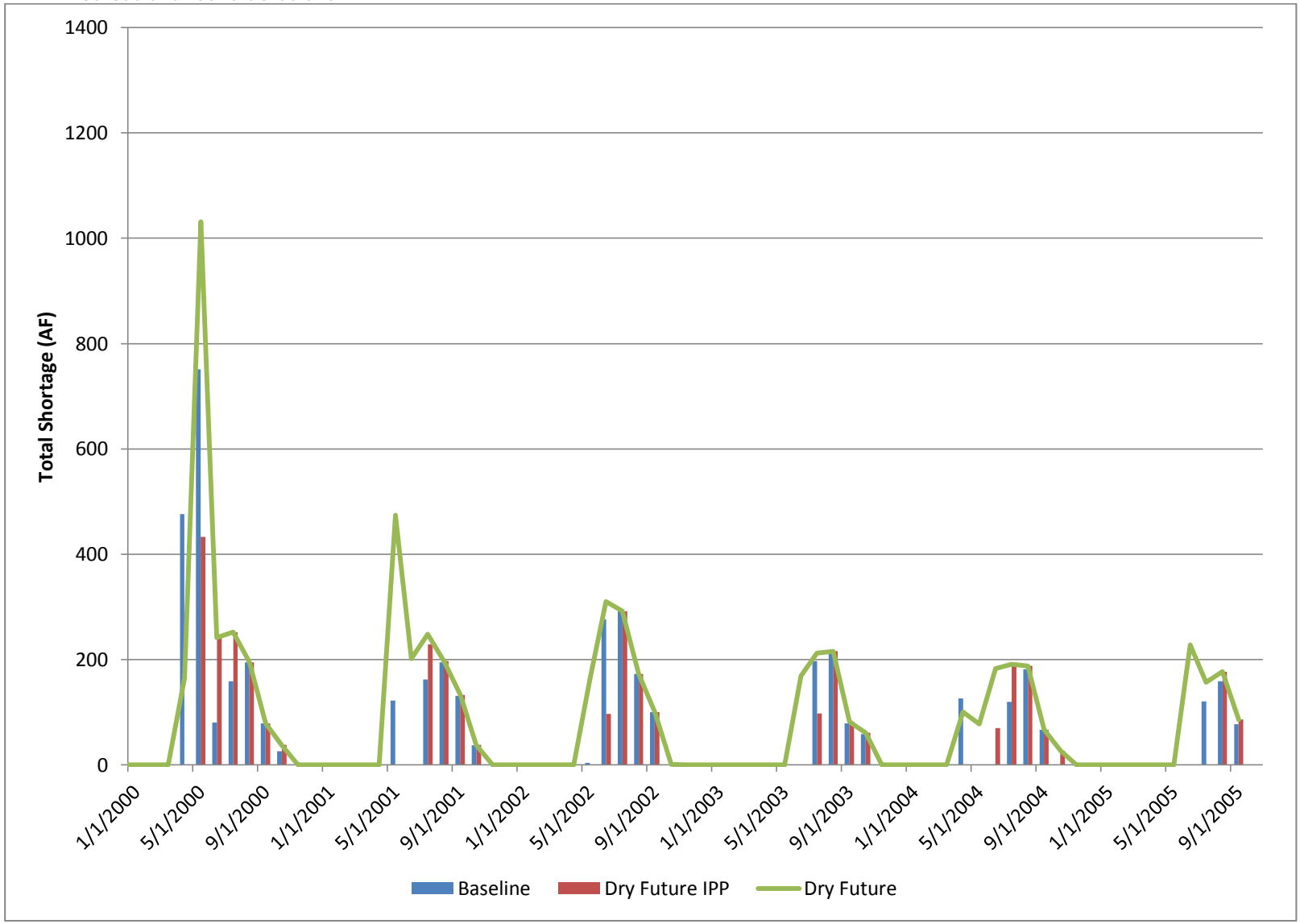


Figure 3-3 Deer Creek and Morapos Ditch

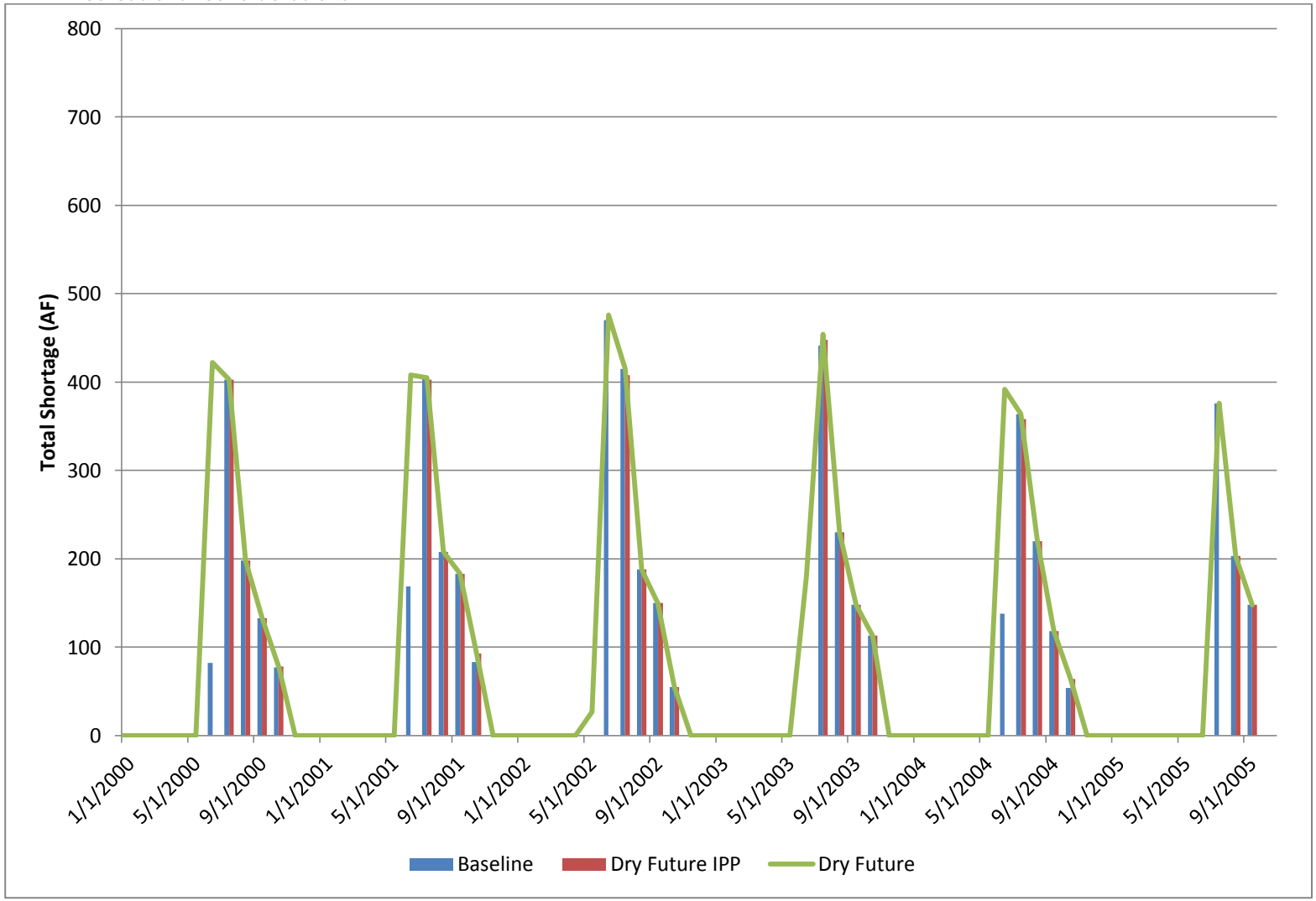


Figure 3-4 Haughey Irrigation Ditch

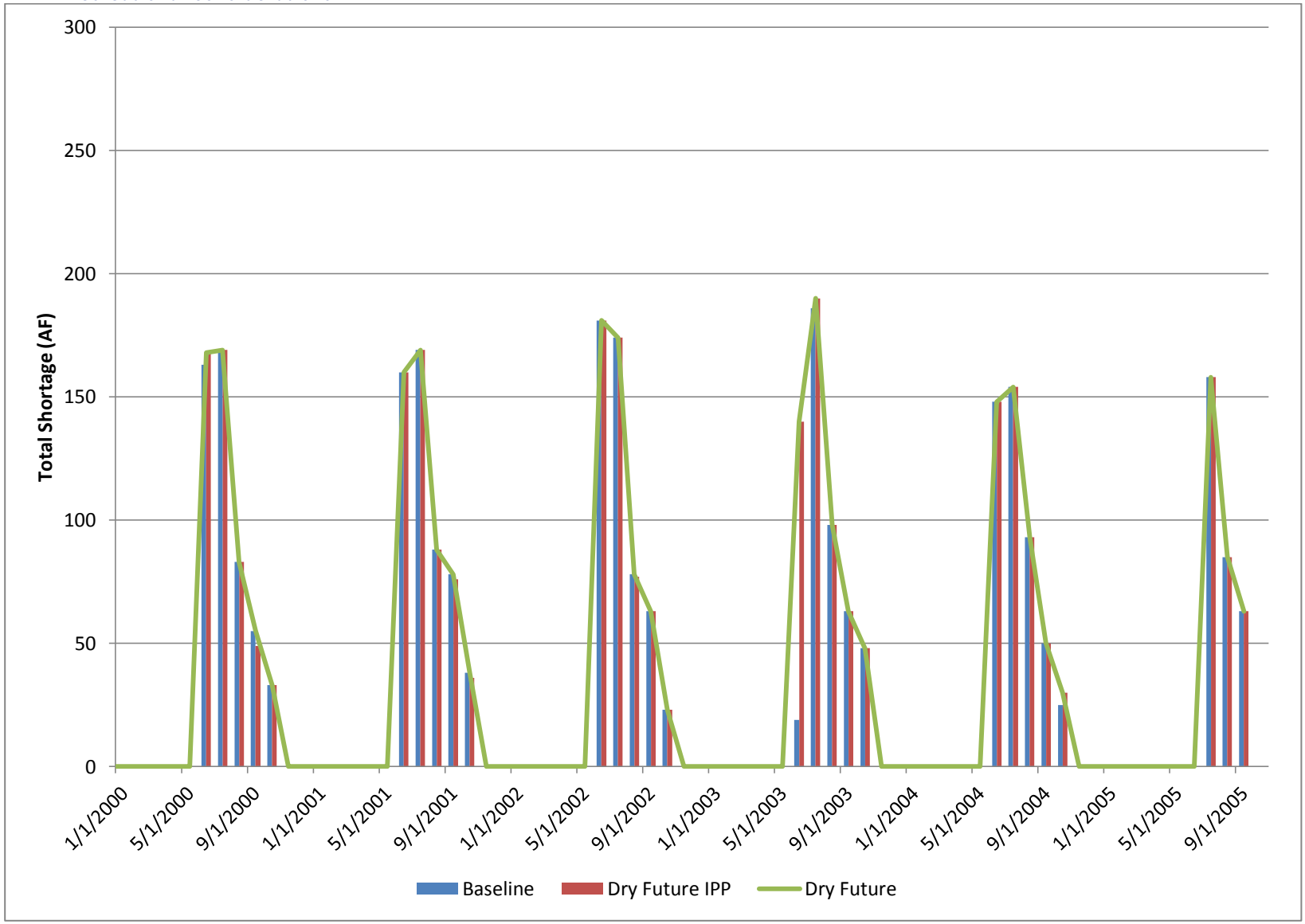


Figure 3-5 McDonald Ditch

### 3.5.1 Environmental and Recreational Shortages

***Instream Flows***

In the P&M Study, thirty-five (35) ISFs were modeled for the YWG Basin. In the headwaters of the Yampa River, several of the modeled streams demonstrated significant shortages under the Baseline Scenario. The Elk River (node 581355), Green Creek (node 582245), Hunt Creek (582519), and Bear River-Lower (node 582202) show some of the greatest shortages. This suggests that these streams are not meeting the minimum flows needed to sustain ecological health. In many upper Yampa tributaries protected by ISFs are often not met even during runoff or in low-water conditions during the late summer and winter.[5]

In the White River, model runs indicate that instream flow shortages will increase on the majority of the modeled streams under the Dry Future Scenario . Some of stream reaches most impacted include the East Fork of the Williams Fork River (node 441452), Marvine Creek (node 432334), North Fork of the White River (node 432339), South Fork of the White River (node 432344), and the mainstem of the White River (node 431845).

The comparison of the Dry Future IPP Scenario and the Dry Future Scenario for the 2000-2005 period suggests that the implementation of the modeled IPPs under high demand/dry conditions will have little impact on improving flows for the majority of the modeled ISF reaches. In some cases, the implementation of IPPs would increase instream flow shortages significantly (eg. Trout Creek).

The 2000-2005 monthly shortages for a few example ISFs are provided in Figures 3-6 through 3-8. These figures, which are based on the updated modeling, show the extent to which modeled stream flows do not meet the decreed instream flows on a monthly basis from 2000-2005

[5] P&M Study, 2014

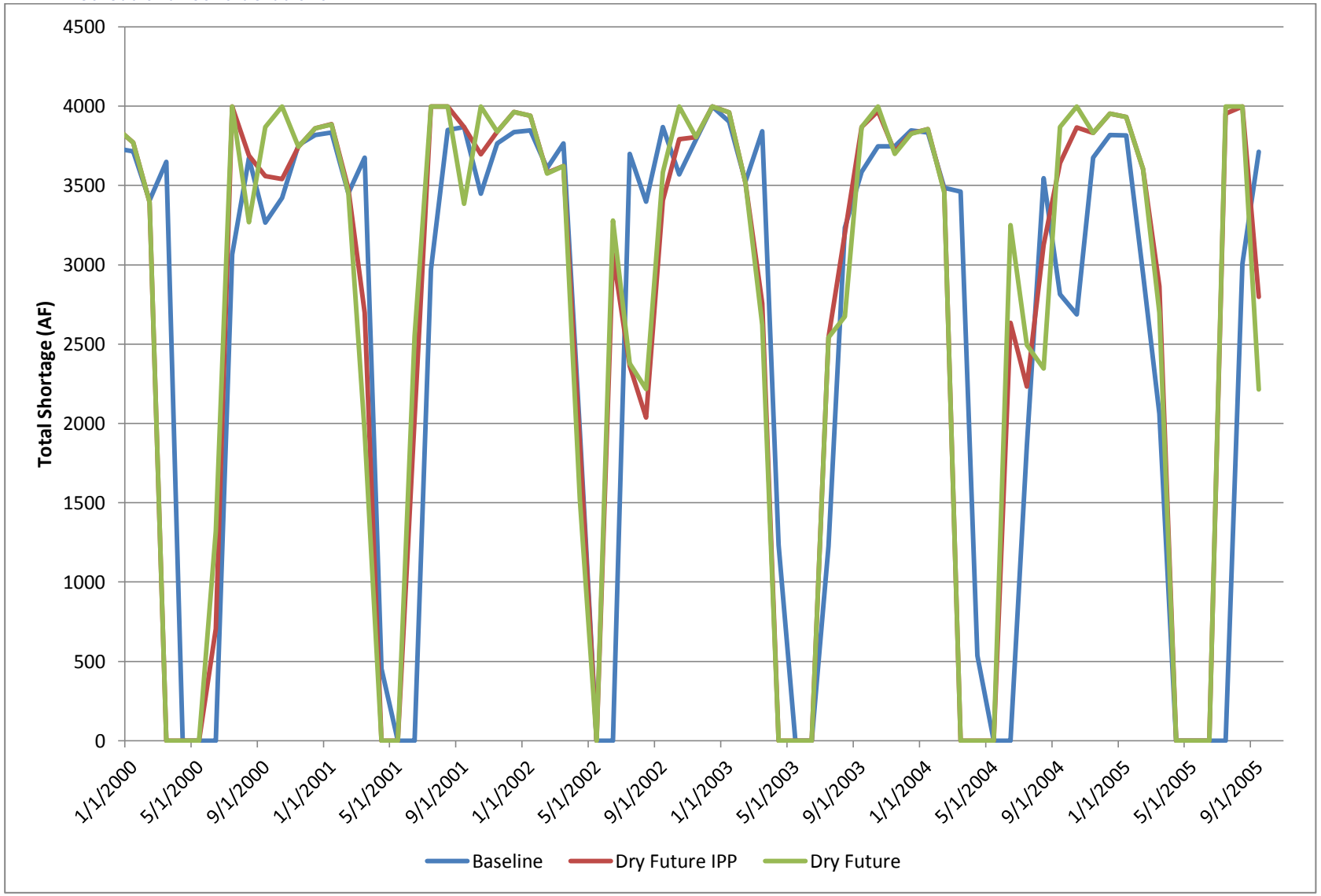


Figure 3-6 Elk River Lower MSF

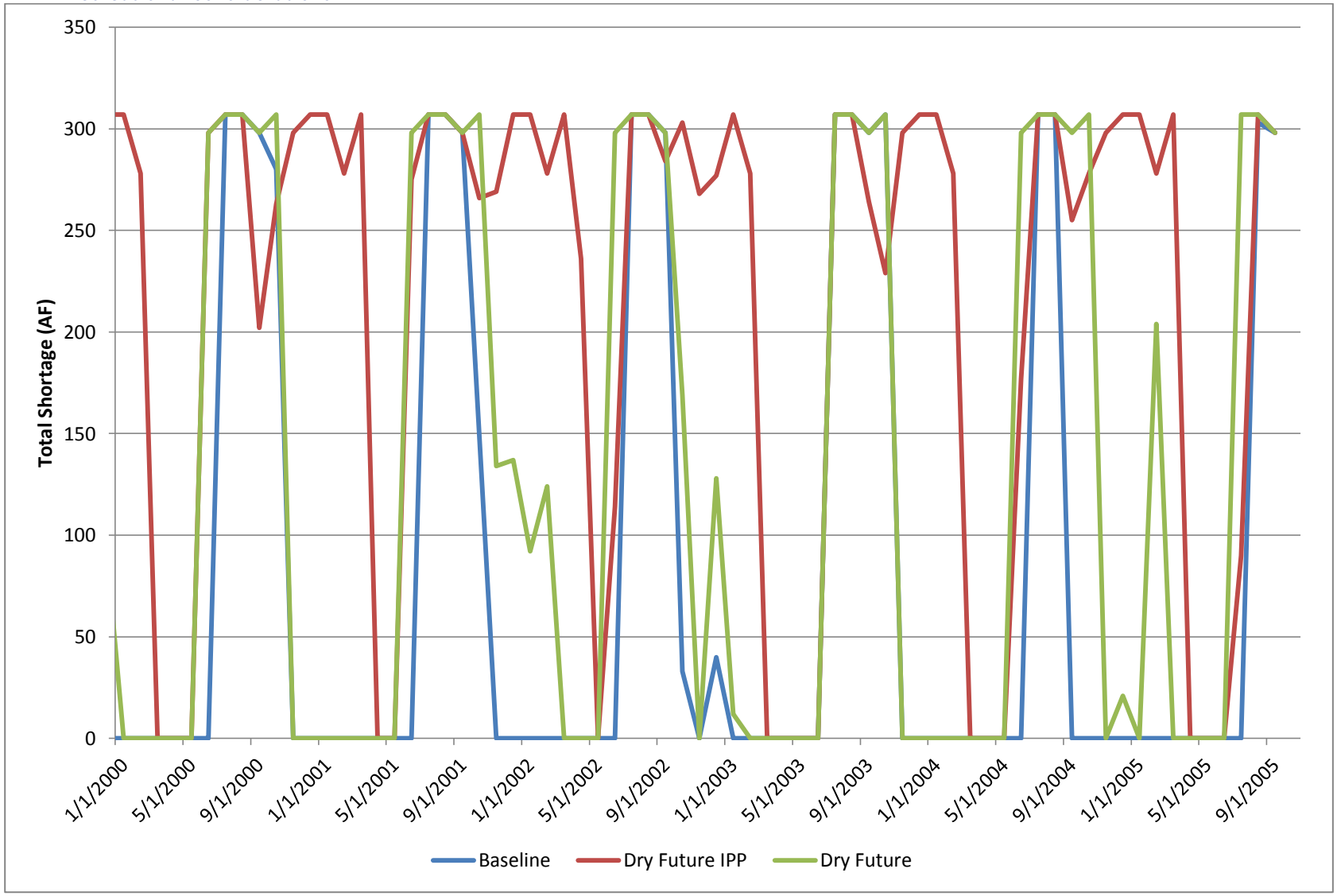


Figure 3-7 Trout Creek Lower MSF

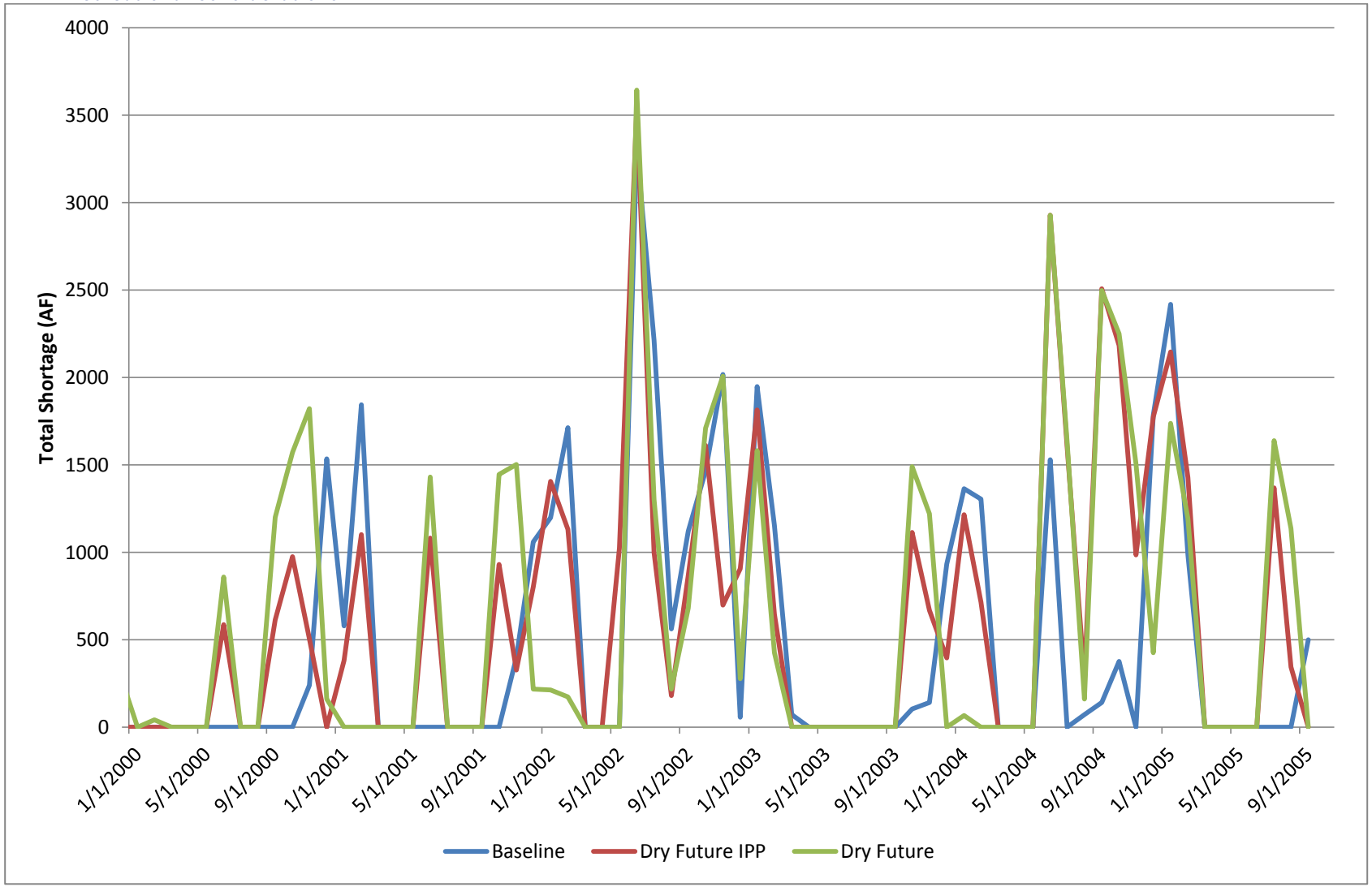


Figure 3-8 Upper Yampa ISF

### *Yampa PBO – Endangered Species Fish Flow Target*

Figure 3-9 shows the monthly shortages at the Yampa PBO stream reach for the endangered fish recovery[6] under Baseline Scenario and under the Dry Future scenarios. The location and extents of this stream reach is shown in Figure 2-10. The 2000-2005 monthly shortages in Figure 3-9, that are based on the updated modeling described in Section 3.4, indicate that the modeled instream flows do not meet the instream flow targets under baseline conditions or the dry future scenarios.

The ability to meet the Yampa PBO base flow augmentation targets significantly decreases when both Future Dry scenarios are compared to Baseline Scenario. Based upon the updated modeling for the 1950-2005 period, during fall and winter months shortages occurred 20%, 52%, and 67% under the Baseline Scenario, Dry Future Scenario, and Dry Future IPP Scenario, respectively. Based upon the updated modeling for the 1950-2005 period, during the summer months shortages occurred 11%, 48%, and 49% under the Baseline Scenario, Dry Future Scenario, and Dry Future IPP Scenario, respectively.

[6] The P&M Study did not address the rest of the flow regime that may be necessary for endangered fish recovery on this reach of the Yampa River, on the lower Little Snake River, on the Yampa River in Dinosaur National Monument, and on the Green River. These flow needs were addressed for the WFET report by replicating the full flow assessment of the existing and future depletions covered by the Yampa PBO.

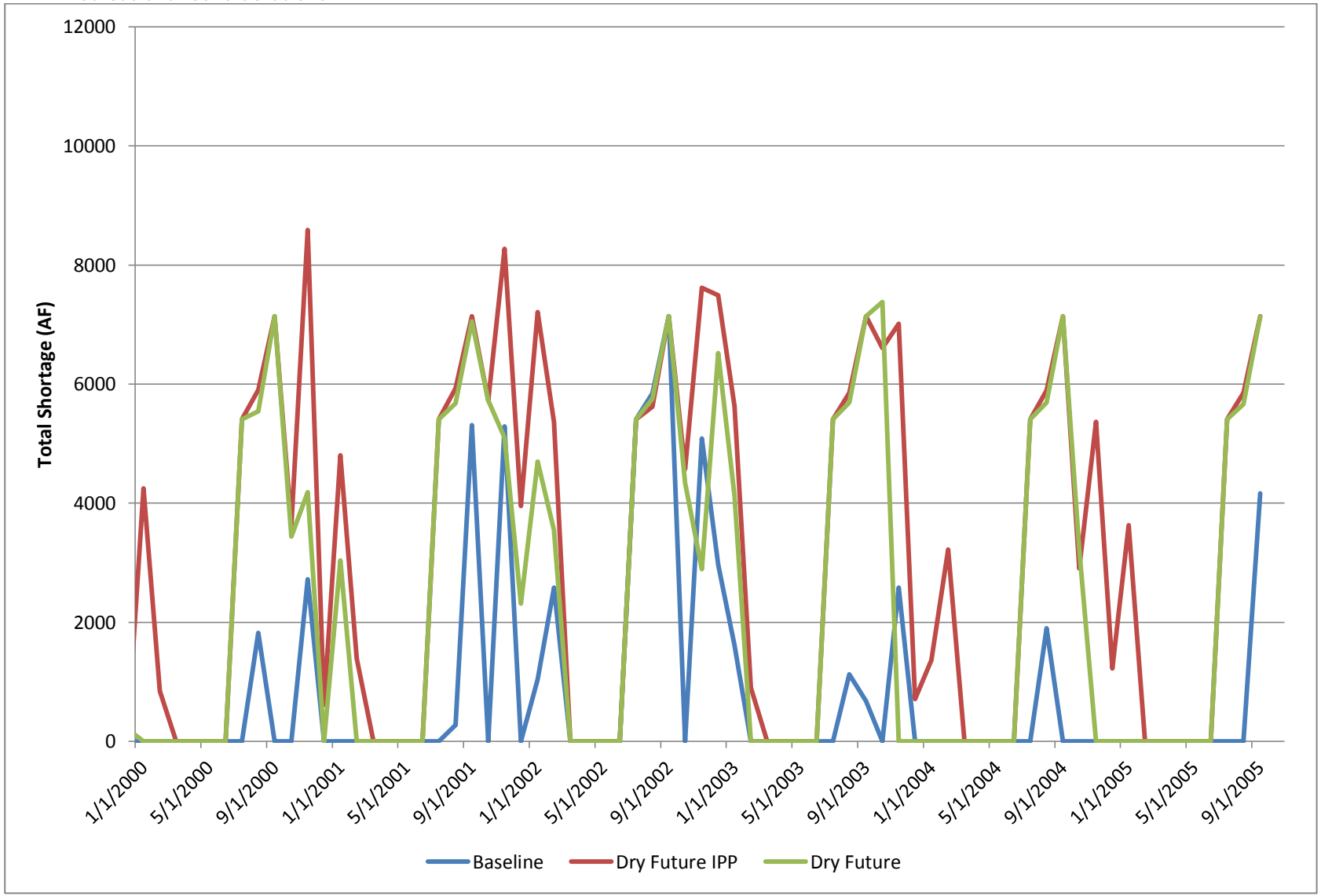


Figure 3-9 Yampa PBO Fish Reach

### *Steamboat RICD*

Figure 3-10 shows the monthly shortages for the Steamboat RICD under the Baseline Scenario and the Dry Future IPP and Dry Future Scenarios for the 2000-2005 period with the updated modeling. The RICD has flow targets in the following months: April, May, June, July, and August. Over the entire modeling period from 1950-2005 and on average during these months, the flow target for the RICD was not met for 9% of the time, 37% of the time, and 33% of the time, under the Baseline Scenario, DryFuture Scenario, and DryFutureIPP Scenario, respectively.

Table 3-7 shows the Steamboat RICD flow targets and the modeled percentage of years from 1950-2005 there is a shortage under the Baseline Scenario, Dry Future Scenario, and Dry Future IPP Scenario. The most significant impacts occur in June and July followed by August. Comparison of the Baseline Scenario against the Dry Future Scenario and Dry Future IPP Scenario over the the 1950-2005 period indicates that flows within the RICD reach decrease significantly under the Dry Future scenarios during the period of April to August. Comparison of the Dry Future IPP Scenario and Dry Future Scenario over the 1950-2005 period indicates that the IPPs increase the flows slightly within the RICD reach in June and July and more significantly in August.

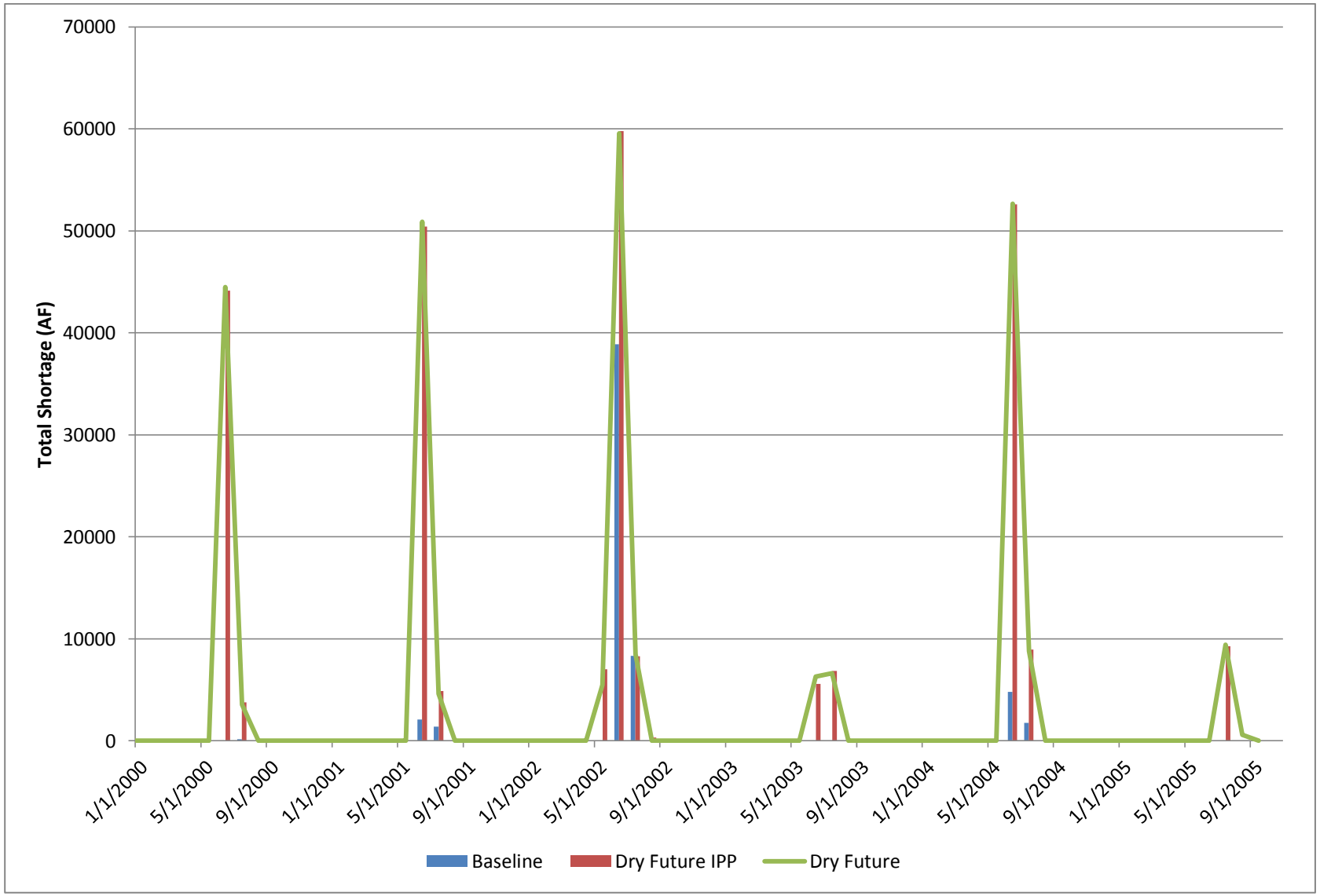


Figure 3-10 Steamboat RICD

**Table 3-4 Steamboat RICD and Modeled Percentage of Years from 1950-2005 There is a Shortage**

| Model Scenario | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow Target (cfs) | n/a | n/a | n/a | n/a | n/a | n/a | 200 | 825 | 1025 | 175 | 47.5 | 0 |
| Baseline | n/a | n/a | n/a | n/a | n/a | n/a | 0% | 2% | 20% | 21% | 0% | 0% |
| Dry Future IPP Scenario | n/a | n/a | n/a | n/a | n/a | n/a | 0% | 9% | 48% | 95% | 11% | 0% |
| Dry Future Scenario | n/a | n/a | n/a | n/a | n/a | n/a | 0% | 7% | 50% | 98% | 29% | 0% |

### *Fisheries and Cottonwood Flow-Ecology Relationship Risks*

No new assessements of flow alteration risks to fisheries or cottonwoods have been generated using the updated model. The assessment and results described under this section of the report are based upon the P&M Study (i.e. these results do not reflect the changes to the model described in Section 3.4). Questions about the modeling and other details of the prior flow assessmsents will be addressed in the modeling still to be completed.

The results for the P&M Study model Baseline Scenario, the Dry Future IPP Scenario and the Dry Future Scenario are presented in Table 3-5 through Table 3-7. Figures 3-11 through Figure 3-13 show the flow-ecology relationships for the trout, warm water fish and cottonwood. Chapter 2 and Appendix A provide detailed information on the development of these flow-ecology relationships.

Generally the most vulnerable reaches for trout are streams with low flows in the upper tributaries. Some of the upper tributaries in the YWG Basin have low or zero flow in late summer/early fall, which can make these tributaries "high risk" even when there is no significant development. Table 3-5 indicates that an increase in demands and dry conditions for the Dry Future IPP Scenario and Dry Future Scenario do not increase the level of risk observed for trout under Baseline Conditions for the following reaches: Slater Creek (node 540570), Willow Creek below Steamboat Lake (node 583787), and the Yampa River from Stagecoach Reservoir to the northern boundary of Sarvis Creek State Wildlife area (node 9237500). The remaining reaches reflect an increased magnitude of risk under both the Dry Future IPP Scenario and the Dry Future Scenario conditions. Comparison of the Dry Future IPP Scenario with the Dry Future Scenario indicate that the development of IPPs do not significantly affect the level of ecological risk to trout within the modeled reaches

**Table 3-5 Modeled Results of the Flow-Ecology Relationship Risks for Trout**

| | Reach Name | Model Node | Trout Flow Risk (Aug and Sept) | | |
|---|---|---|---|---|---|
| | | | Baseline | Dry Future IPP Scenario | Dry Future Scenario |
| | | | Existing Demand Historical | High Demand Dry (with IPPs) | High Demand Dry (no IPPs) |
| 2 | Yampa River from Pump Station to confluence of Elkhead Creek | 9244410 | Moderate Risk | Very High Risk | Very High Risk |
| 4 | Elk River from headwaters to the County Road 129 bridge at Clark; including the North, Middle and South Fork as well as the mainstem of the Elk | 9241000 | Minimal Risk | Moderate Risk | Moderate Risk |
| 5 | White River from headwaters to Meeker; including the North and South Fork and mainstem of the White | 9304500 | Minimal Risk | Very High Risk | Very High Risk |
| 8 | Slater Creek from headwaters to the Beaver Creek confluence | 540570 | Moderate Risk | Moderate Risk | Moderate Risk |
| 10 | South Fork of the Little Snake from headwaters to confluence of Johnson Creek | 9253000 | High Risk | Very High Risk | Very High Risk |
| 11a | East Fork of the Williams Fork from headwaters to the confluence of the Forks | 9249000 | Minimal Risk | High Risk | Moderate Risk |
| 11b | South Fork of the Williams Fork from headwaters to the confluence of the Forks | 9249200 | High Risk | Very High Risk | Very High Risk |
| 11c | Williams Fork - from South Fork to confluence of the Yampa River | 9249750 | Moderate Risk | High Risk | High Risk |
| 14 | Yampa River from Stagecoach Reservoir "Tailwaters" to northern boundary of Sarvis Creek State Wildlife area | 9237500 | Minimal Risk | Minimal Risk | Minimal Risk |
| 16 | Yampa River from Chuck Lewis Wildlife Area to Pump Station | 9239500 | Moderate Risk | High Risk | High Risk |
| 18 | Willow Creek below Steamboat Lake to confluence with the Elk | 583787 | Low Risk | Low Risk | Low Risk |
| 19 | Bear River from headwaters to USFS boundary | 9236000 | Low Risk | Minimal Risk | Minimal Risk |

Table 3-6 shows that the overall level of ecological risk for warm water fish is less than for trout. Areas of high risk are generally associated with water development. The majority of warm water fish reaches show an increase in risk under both the Dry Future IPP Scenario and Dry Future Scenario (high demand dry hydrology) with the exception to the Little Snake River extending from Moffat County Road 10 to the confluence with the Yampa River (node 9260000) which is consistently at high risk.

Comparison of the Dry Future IPP and Dry Future Scenarios indicates that the development of IPPs do not significantly affect the level of ecological risk for warm water fish within the modeled reaches with an exception for the South Fork of the Little Snake from its headwaters to its confluence with Johnson Creek (node 9253000) and for the Yampa River from Craig (Hwy 394 Bridge) to the mouth of Cross Mountain Canyon (node 9251000).

**Table 3-6 Modeled Results of the Flow-Ecology Relationship Risks for Warm Water Fish**

| | Reach Name | Model Node | Warm Water Flow Risk (July - Nov) | | |
|---|---|---|---|---|---|
| | | | Baseline | Dry Future IPP Scenario | Dry Future Scenario |
| | | | Existing Demand Historical | High Demand Dry (with IPPs) | High Demand Dry (no IPPs) |
| 1 | Yampa River from entrance of Cross Mountain Canyon (East Cross Mountain) to confluence with Green River | 9260050 | Moderate Risk | High Risk | High Risk |
| 2 | Yampa River from Pump Station to confluence of Elkhead Creek | 9244410 | Low Risk | Moderate Risk | Moderate Risk |
| 5 | White River from headwaters to Meeker; including the North and South Fork and mainstem of the White | 9304500 | Low Risk | High Risk | High Risk |
| 6 | White River below Kenney Reservoir dam to Utah State line | 434433 | Low Risk | High Risk | High Risk |
| 7 | White River from Rio Blanco dam to Kenney Reservoir | 9306290 | Low Risk | High Risk | High Risk |
| 10 | South Fork of the Little Snake from headwaters to confluence of Johnson Creek | 9253000 | Low Risk | Moderate Risk | High Risk |
| 12 | Little Snake River from Moffat County Road 10 to confluence of the Yampa River | 9260000 | High Risk | High Risk | High Risk |
| 13 | Yampa River from Craig (Hwy 394 Bridge) to mouth of Cross Mountain Canyon | 9251000 | Moderate Risk | Moderate Risk | Very High Risk |
| 14 | Yampa River from Stagecoach Reservoir "Tailwaters" to northern boundary of Sarvis Creek State Wildlife area | 9237500 | Low Risk | Moderate Risk | Moderate Risk |
| 16 | Yampa River from Chuck Lewis Wildlife Area to Pump Station | 9239500 | Low Risk | Moderate Risk | Moderate Risk |

Table 3-7 shows that the overall level of ecological risk for cottonwood is relatively low for the majority of modeled scenarios with the following exceptions: the White River from its headwaters to Meeker (node 9304500), the White River below Kenney Reservoir (node 434433), and the Yampa River from Stagecoach Reservoir to the northern boundary of the Sarvis Creek State Wildlife Area (node 9237500). The reach of the Yampa River below Stagecoach Reservoir is at high risk under Baseline Conditions and would currently benefit the most from an IPP that increases high flows from April to June.

Comparison of the Dry Future IPP Scenario and the Dry Future Scenario indicates that the development of the modeled IPPs would not significantly impact the high-flow conditions occurring in April to June. As shown in Table 3-7 7, the cottonwood abundance metric is generally low risk regardless of the presence of IPPs with exception to the White River below Kenney Reservoir (node 43433). IPPs could significantly reduce the risk to cottonwood within this reach.

## Table 3-7 Modeled Results of the Flow-Ecology Relationship Risks for Cottonwood

| | Reach Name | Model Node | Cottonwood Abundance Risk (April - June) | | |
|---|---|---|---|---|---|
| | | | Baseline | Dry Future IPP Scenario | Dry Future Scenario |
| | | | Existing Demand Historical | High Demand Dry (with IPPs) | High Demand Dry (no IPPs) |
| 1 | Yampa River from entrance of Cross Mountain Canyon (East Cross Mountain) to confluence with Green River | 9260050 | Low Risk | Low Risk | Low Risk |
| 2 | Yampa River from Pump Station to confluence of Elkhead Creek | 9244410 | Low Risk | Low Risk | Low Risk |
| 4 | Elk River from headwaters to the County Road 129 bridge at Clark; including the North, Middle and South Fork as well as the mainstem of the Elk | 9241000 | Low Risk | Low Risk | Low Risk |
| 5 | White River from headwaters to Meeker; including the North and South Fork and mainstem of the White | 9304500 | Low Risk | Moderate Risk | Moderate Risk |
| 6 | White River below Kenney Reservoir dam to Utah State line | 434433 | Moderate Risk | Very High Risk | Low Risk |
| 8 | Slater Creek from headwaters to the Beaver Creek confluence | 540570 | Low Risk | Low Risk | Low Risk |
| 9 | Elkhead Creek from headwaters to confluence of North Fork of Elkhead Creek | 9245000 | Low Risk | Low Risk | Low Risk |
| 10 | South Fork of the Little Snake from headwaters to confluence of Johnson Creek | 9253000 | Low Risk | Low Risk | Low Risk |
| 11c | Williams Fork - from South Fork to confluence of the Yampa River | 9249750 | Low Risk | Low Risk | Low Risk |
| 12 | Little Snake River from Moffat County Road 10 to confluence of the Yampa River | 9260000 | Low Risk | Low Risk | Low Risk |
| 13 | Yampa River from Craig (Hwy 394 Bridge) to mouth of Cross Mountain Canyon | 9251000 | Low Risk | Low Risk | Low Risk |
| 14 | Yampa River from Stagecoach Reservoir "Tailwaters" to northern boundary of Sarvis Creek State Wildlife Area | 9237500 | High Risk | High Risk | High Risk |
| 15 | Fish Creek from Fish Creek Falls to confluence of the Yampa River | 9238900 | Low Risk | Low Risk | Low Risk |
| 16 | Yampa River from Chuck Lewis Wildlife Area to Pump Station | 9239500 | Low Risk | Low Risk | Low Risk |
| 18 | Willow Creek below Steamboat Lake to confluence with the Elk | 583787 | Low Risk | Low Risk | Low Risk |

### *Recreational Whitewater Boating Flow Risk Metric*

No new assessements of flow alteration risks to recreational boating have been generated using the updated model. The assessment and results described under this section of the report are based upon the P&M Study (i.e. these results do not reflect the changes to the model described in Section 3.4). Questions about the modeling and other details of the prior assessmsents of the the flow alteration risks to recreataionl boating will be addressed in the modeling still to be completed.

Table 3-8 presents the percentage of the boating season with usable flows at designed modeled nodes for the modeled Baseline Scenario, Dry Future IPP Scenario, and Dry Future Scenario.[7] These results indicate that there is a significant variability in usable days throughout the YWG Basin. Slater Creek (node 540570) and Willow Creek (node 583787) have very few usable days for all three modeled scenarios, whereas the percentage of usable days on the Yampa River from Cross Mountain Canyon to the Green River (node 9260050) is 87% under Baseline Conditions and 70% for the Dry Future IPP and Dry Future Scenarios. The number of usable days increases slightly for the following nodes from Baseline Conditions to the Dry Future Scenario: Fish Creek (node 9238900), Yampa River from Chuck Lewis Wildlife Area to Pump Station (node 9239500) and Willow Creek (node 583787). This is due to the timing and duration of the flows resulting in a slightly larger percent of usable days, but not necessarily higher flows.

[7] The timing and duration of the whitewater boating season is customized to each individual model node. Additional information on the boating seasons may be found in the WFET.

**Table 3-8 Modeled Results for the Recreational Whitewater Boating Flow Risk Metric**

| | Reach Name | Model Node | Percentage of Boating Season with Usable Flows (Seasons of Use Varies by Node) | | |
|---|---|---|---|---|---|
| | | | Baseline | Dry Future IPP Scenario | Dry Future Scenario |
| | | | Existing Demand Historical | High Demand Dry (with IPPs) | High Demand Dry (no IPPs) |
| 1 | Yampa River from entrance of Cross Mountain Canyon (East Cross Mountain) to confluence with Green River | 9260050 | 87% | 69% | 70% |
| 2 | Yampa River from Pump Station to confluence of Elkhead Creek | 9244410 | 20% | 7% | 7% |
| 4 | Elk River from headwaters to the County Road 129 bridge at Clark; including the North, Middle and South Fork as well as the mainstem of the Elk | 9241000 | 48% | 48% | 48% |
| 6 | White River below Kenney Reservoir dam to Utah State Line | 434433 | 33% | 25% | 26% |
| 7 | White River from Rio Blanco Lake dam to Kenney Reservoir | 9306290 | 58% | 25% | 47% |
| 8 | Slater Creek from headwaters to the Beaver Creek confluence | 540570 | 1% | 1% | 1% |
| 13 | Yampa River from Craig (Hwy 394 Bridge to mouth of Cross Mountain Canyon, including Little Juniper Canyon | 9251000 | 43% | 29% | 28% |
| 15 | Fish Creek from Fish Creek Falls to confluence with Yampa River | 9238900 | 12% | 18% | 18% |
| 16 | Yampa River from Chuck Lewis Wildlife Area to Pump Station | 9239500 | 55% | 57% | 57% |
| 18 | Willow Creek below Steamboat Lake to confluence with the Elk | 583787 | 0% | 3% | 3% |

Figures 3-11 through 3-13 show the flow alteration risks to fisheries, cottonwoods, and recreational boating under the Baseline, Dry Future IPP, and Dry FutureScenarios.

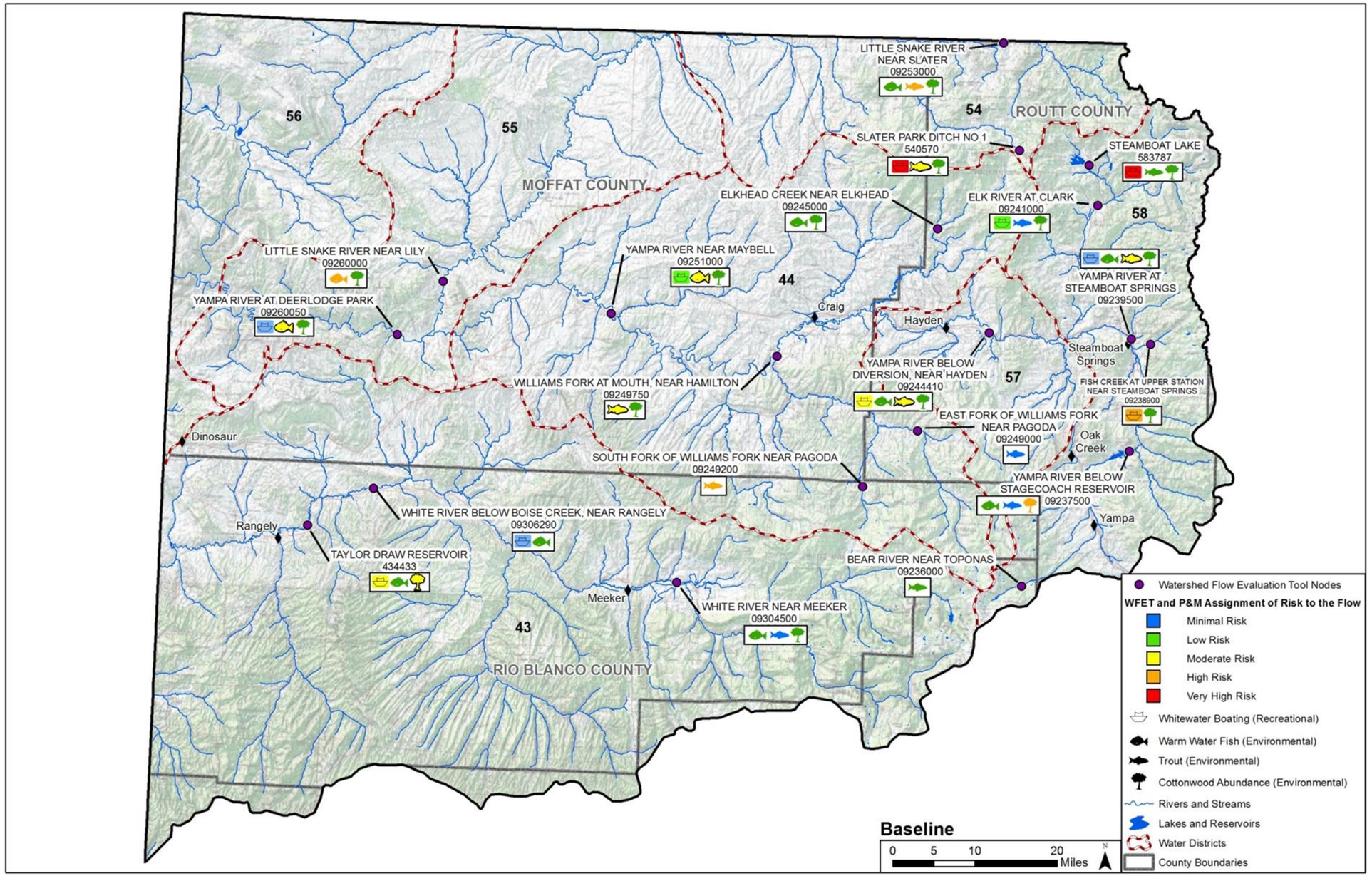


Figure 3-11 Flow Ecology Relationship Risks for Modeled Baseline Conditions

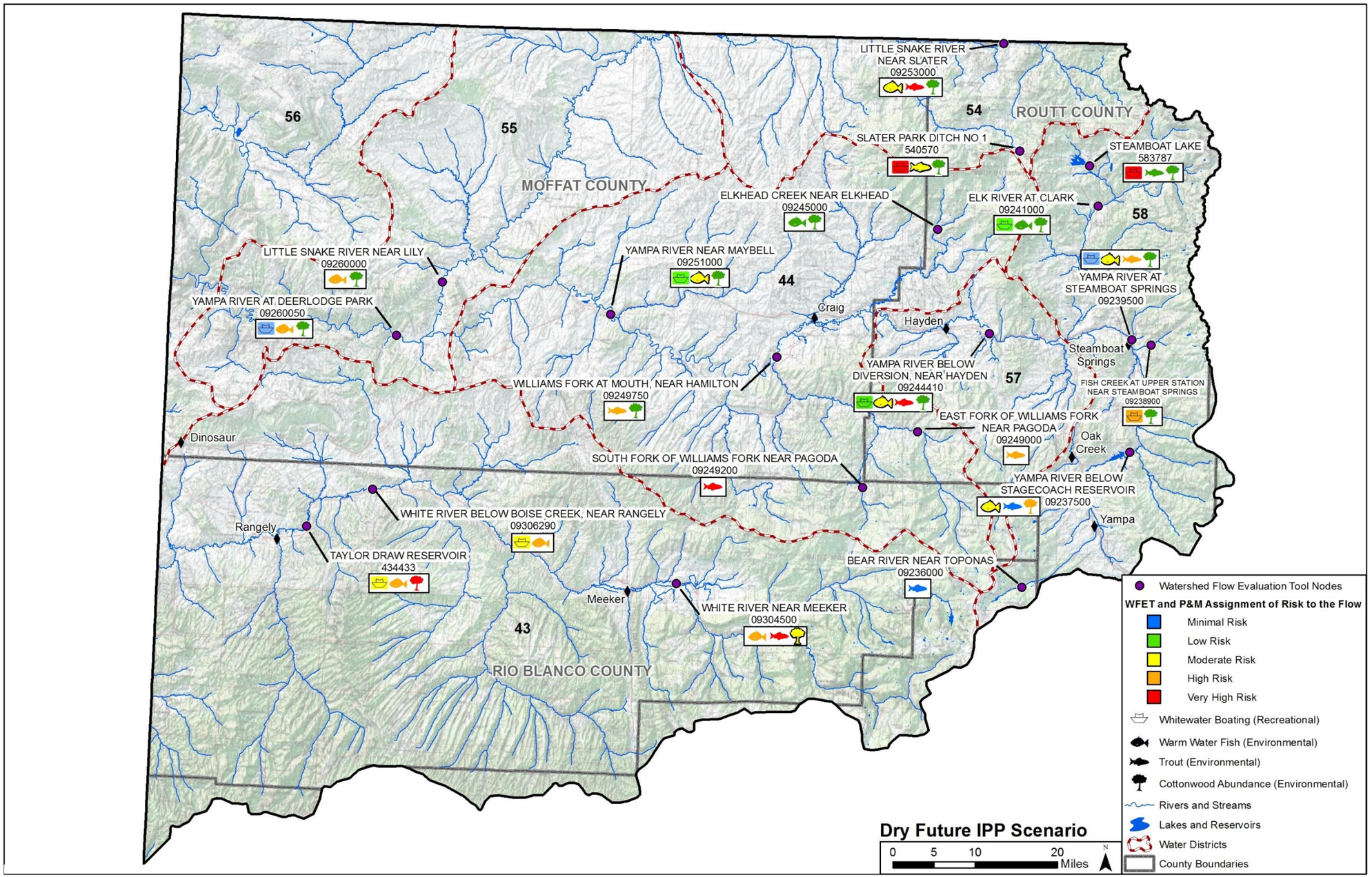


Figure 3-12 Flow Ecology Relationship Risks for Modeled Dry Future IPP Scenario

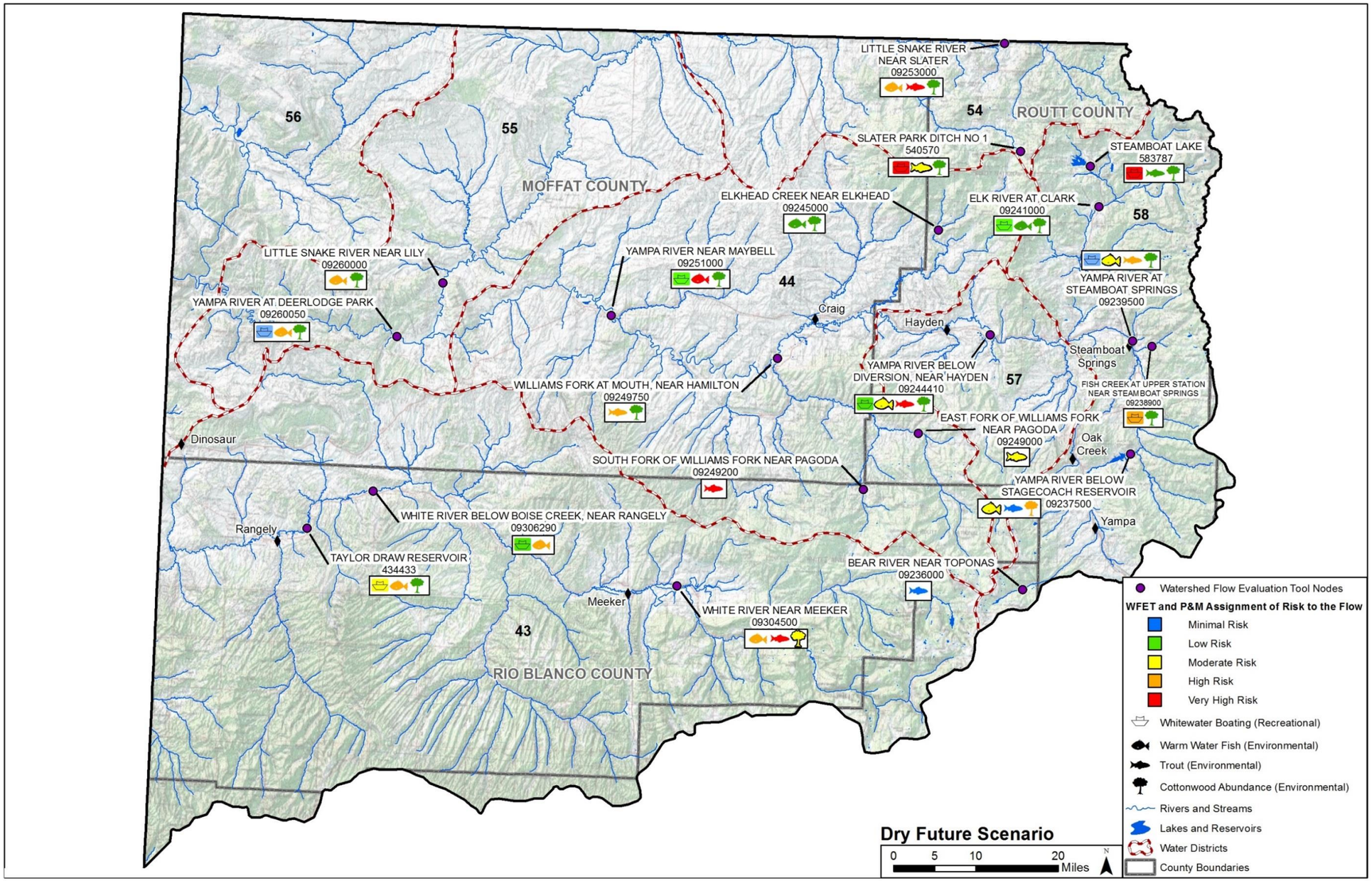


Figure 3-13 Flow Ecology Relationship Risks for Modeled Dry Future Scenario