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Department of Water Resources
Eastern Region

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BEFORE THE DEPARTMENT OF WATER RESOURCES
OF THE STATE OF IDAHO

IN THE MATTER OF APPLICATION FOR)
PERMIT NO. 01-10626 IN THE NAME OF)
SNAKE RIVER VALLEY IRRIGATION)
DISTRICT)

and)

IN THE MATTER OF APPLICATION FOR)
PERMIT NO. 01-10625 IN THE NAME OF)
PEOPLES CANAL & IRRIGATION)
COMPANY)

**IDFG'S NOTICE OF SERVICE OF
EXPERT REPORT**

Pursuant to the Scheduling Order, Idaho Department of Fish and Game by and through its attorneys of record hereby serves the *Rationale for Protest of Permit Applications 01-10625 and 01-10626, Idaho Department of Fish and Game And Dr. Robert Van Kirk, Senior Scientist, Henry's Fork Foundation.*

DATED this 9th day of May 2014.

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL



W. DALLAS BURKHALTER
Deputy Attorney General

CERTIFICATE OF SERVICE

I hereby certify that on this 9th day of May 2014 a true and correct copy of the foregoing
ANSWER was faxed or mailed postage prepaid to:

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W. Dallas Burkhalter
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MAY 14 2014

Department of Water Resources
Eastern Region**Rationale for Protest of Permit Applications 01-10625 and 01-10626**

**Idaho Department of Fish and Game
And
Dr. Robert Van Kirk
Senior Scientist, Henry's Fork Foundation**

Expert Report

Peoples Canal and Irrigation Company filed Application For Permit (01-10625) for groundwater recharge in the amount of 350 cubic feet per second (cfs) of Snake River water from 1/1 to 12/31 each year. Snake River Valley Irrigation District filed Application For Permit (01-10626) for groundwater recharge in the amount of 585 cfs of Snake River water from 1/1 to 12/31 each year. The Idaho Department of Fish and Game (IDFG) is seeking to fulfill its mission of protecting, preserving, perpetuating and managing fish and wildlife resources by providing technical information to decision makers regarding fish, wildlife and affiliated resources such as riparian and riverine habitat (fish and wildlife resources), identifying the potential effects of the proposed water rights on the fish and wildlife, and assessing how any adverse effects can be avoided, minimized or mitigated. The importance of considering and protecting the public interest is emphasized in the State Water Plan (see esp. 2B, 2C, 2E, 3G, and 6B), ESPA CAMP, Swan Falls Reaffirmation Agreement, and 1999 Water Resources Report (see esp. Appendix A and B). IDFG neither supports nor opposes these managed aquifer recharge proposals. IDFG is providing this information and any recommendations to maintain the public interest benefits mandated in the above documents to protect the public trust values associated with Idaho's fish and wildlife resources.

In addition to other Snake River water rights which may be in priority at various times, there are requirements for 3,900 cfs from April 1 to October 31 and 5,600 cfs from November 1 to March 31 at the Murphy Gauging Station (Swan Falls Reaffirmation Agreement), and 2,700 cfs at Minidoka Dam (Bureau of Reclamation unsubordinated hydropower right).

The applications do not specify the actual dates of proposed diversion or specific project design or locations for groundwater recharge. The applications state that the water "... will be diverted in priority primarily prior to delivery of water for irrigation purposes. If still in priority after irrigation begins, provided there is available capacity in the canal, water can be delivered to developed off canal sites where it will be measured and monitored 24/7." Because IDFG is endeavoring to provide technical information, the lack of specific information about the proposed diversions impedes IDFG's ability to provide specific technical information or recommendations. Given the general nature of the requested water rights, IDFG made several assumptions (see pages 14 – 17) in order to analyze the potential effects of the proposed diversions. Based on the assumptions, scientific literature and professional judgment, IDFG identified greatest effect, least effect, and IDFG recommended case scenarios for the timing of diversions and the effects on fish and wildlife resources.

Introduction

The science and management of altered flow regimes is informed by a substantial body of literature (Poff and Zimmerman 2010). In the upper Snake River basin of Idaho, irrigation and water development projects began in the 1860s, and over the last 140+ years have resulted in dozens of water storage reservoirs and numerous river diversions throughout the basin. The Snake River is now the most heavily dammed river in the western U.S. (Collier et al. 1996). Most of the surface water in the basin has been appropriated for irrigation and other uses, and in recent decades, groundwater pumping has also significantly increased. The increase in groundwater use, coupled with improved irrigation efficiency has resulted in declining levels of the Eastern Snake Plain Aquifer (ESPA). One area where this decline is readily observed is the reduced measured discharge in recent decades from springs in the Thousand Springs area. This connection between ground water and surface water is acknowledged in Idaho's conjunctive management rules

The increased demand for water in the upper Snake River basin and the evident impact on the ESPA has resulted in various public and private entities filing water rights applications for the purpose of aquifer recharge. Idaho law and policy supports the beneficial use of water that has historically spilled past Milner Dam to be appropriated for aquifer recharge (in priority and when available). On average, about 1.8 million acre-feet of water annually spills past Milner Dam, although the distribution of spill across water years is highly variable. In some water years, essentially no water spills past Milner Dam, while in others, the spill has exceeded 4 million acre-feet. The diversion of surface water through a variety of managed recharge methods and the application of this water to recharge sites overlaying the ESPA is part of the ESPA Comprehensive Aquifer Management Plan (CAMP) to stop the decline of the aquifer.

IDFG is aware of recharge applications including points of diversion on the South Fork and the Henrys Fork (and tributaries) of the Snake River, and the Snake River between the confluence of the Henrys Fork and South Fork and Blackfoot, Idaho. Surface water diversion from any or all of these reaches, in any combination, affects stream flow in the Snake River between the South Fork-Henrys Fork confluence and American Falls Reservoir (hereafter referred as the Snake River). This report demonstrates the potential negative effect such diversions could have on fish and wildlife resources in the Snake River if water recharge plans are authorized and implemented without managing the timing and quantities of water diverted for recharge as it relates to Snake River hydrologic functions important to fish and wildlife resources. The ideas and principals in this discussion have broad application for negative effects to riverine systems from incremental flow reductions. This document covers only the potential recharge diversion impacts to the Snake River above American Falls Reservoir.

Area of Fish and Wildlife Resource Concern

Fisheries

From a fisheries perspective, the Snake River from the backwaters of American Falls Reservoir upstream to the confluence of the South Fork and Henrys Fork can be divided into four sections: (1) from American Falls Reservoir upstream to Tilden Bridge (35 km), (2) from Tilden Bridge upstream to the Gem State Power Project Dam (FERC # P-2952) (67 km), (3) from the Gem State Power Project Dam upstream to the Idaho Falls Hydroelectric Project Upper Plant Dam (FERC # P-2842) (17 km), and (4) from the Upper Plant Dam upstream to the confluence of the Henrys Fork and South Fork (48 km).

The Snake River from the backwaters of American Falls Reservoir upstream to Tilden Bridge (section 1) flows through mixed cottonwood riparian forest and agricultural land. The fishery produces large native Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri*, stocked and naturally reproducing Rainbow Trout *O. mykiss*, naturally reproducing Brown Trout *Salmo trutta*, and native Mountain Whitefish *Prosopium williamsoni*. This river section currently provides year around suitable conditions for trout survival, including overwinter, spawning and rearing and it also serves as a migration corridor for trout and other native fish, particularly as American Falls Reservoir is drawn down. The river in this area has very limited walk-in public access because of private land and the Fort Hall Indian Reservation, and is mostly accessible by boats.

From Tilden Bridge upstream to the Gem State Power Dam (section 2), the river runs through mixed cottonwood riparian forest or agricultural lands. This section of the Snake River supports a coldwater fishery that includes trophy-sized Brown Trout, Rainbow Trout, Yellowstone Cutthroat Trout, and Mountain Whitefish. The Brown Trout, Yellowstone Cutthroat Trout, and Mountain Whitefish fisheries are all supported entirely by naturally reproducing wild fish. The Rainbow Trout fishery is supported by both wild and hatchery-stocked fish. During the irrigation season and early fall, river flows vary depending on a combination of precipitation, amounts released from storage, and on the amount diverted at each point of diversion. In spite of these alterations, in most years, this section of river continues to provide year around suitable conditions for trout survival, including overwinter, spawning and rearing and it also serves as a migration corridor for trout and other native fish. White Sturgeon *Acipenser transmontanus* have been stocked in this stretch of river during the last decade to provide a recreational catch-and-release fishery.

From the Gem State Power Project dam upstream to the Upper Power Plant Dam (section 3), the Snake River is characterized by a series of dams and pools and flows through agricultural and residential/industrial landscapes. Access for bank anglers and boaters is very good in this section. The IDFG and the City of Idaho Falls stock this section with catchable Rainbow Trout but native Yellowstone Cutthroat Trout, naturally reproducing Rainbow Trout and Brown Trout are also important components of the fishery. Since 2007, White Sturgeon have been stocked in the power plant pools to provide a recreational catch-and-release fishery. The hydropower impoundments in this section have reduced available spawning habitat, blocked upstream

migration of spawning trout, and provide less productive trout habitat than run-of-the-river reaches that are characterized by intact floodplains and riparian cottonwood forests.

The remainder of the upper Snake River from the Idaho Falls Upper Power Plant upstream to the confluence of the Henrys Fork and South Fork (section 4) flows mainly through agricultural land but has extensive mixed cottonwood riparian forests in the upper reaches of the river. This river section supports a trophy fishery for Rainbow Trout, Brown Trout, and Yellowstone Cutthroat Trout. Brown trout are known to exceed 30 inches in this reach. Rainbow Trout are stocked in the uppermost power plant pool in this reach of river that extends from the Upper Power Plant to the Idaho Irrigation Districts diversion dam. No hatchery trout stocking occurs in the river upstream of Idaho Irrigation Districts diversion dam. The fishery in this area declined following the 1976 Teton Dam failure due to silt deposition and a resulting loss of spawning habitat. Similar to Section 2, water is diverted from the river at numerous points. During the irrigation season and early fall, river flows vary due to the same influences as section (1) above. Despite the loss of habitat resulting from sediment deposition and altered flows, natural reproduction does occur for the trout species listed above in quantities sufficient to maintain fishable populations with good angler catch rates.

Another important sport fish (Smallmouth Bass *Micropterus salmoides*) is resident in this section of the Snake River as well as numerous native non-game fish species. While salmonids are the keystone fish species for the Snake River, providing adequate year-round streamflow for salmonids will also likely satisfy basic ecological needs for other sympatric native and recreationally-important fish species.

Riparian Habitat, Wildlife, and Plants

Riparian habitats, including wetlands, are plant communities adjacent to and affected by surface or ground water of perennial or ephemeral water bodies such as rivers, lakes, playas, or drainage-ways. They have different vegetative species than adjacent areas, or may have similar species that exhibit more robust growth. Riparian habitats along the Snake River in the Area of Resource Concern ("ARC") are identified as a high conservation priority by several studies. Based on wetland conservation strategies for southeastern Idaho (Jankovsky-Jones 1997) and the upper Snake River (Jankovsky-Jones 2001), the ARC is bounded by portions of two significant riparian wetland sites of high conservation value. The upper boundary, the South Fork Snake River near Heise downstream to the Henrys Fork and South Fork confluence, is recognized for its extensive Narrowleaf Cottonwood *Populus angustifolia* forest (an ecosystem in decline range-wide) which supports a broad array of rare plant and animal species (Jankovsky-Jones 1997). The lower boundary includes the Fort Hall Bottoms portion of the American Falls Reservoir wetland conservation site (Jankovsky-Jones 2001). This area also supports an array of rare plants and animals, as well as floodplain dependent Black Cottonwood *P. trichocarpa* riparian forests, willow-dominated scrub-shrub wetlands, and spring-fed plant communities in good to excellent ecological condition. This area was identified as the fifth highest conservation priority for Idaho's wetlands in a 2005 statewide ranking based on wetland diversity, habitat function, recreation value, and landscape condition (Hahn et al. 2005).

The floodplain geomorphology (wide, unconfined valleys) and hydrologic processes creating these biologically important cottonwood riparian forests also extend from the Henrys Fork confluence down the Snake River to Roberts, and from Firth downstream to the Fort Hall Bottoms. The Snake River from Roberts extending upstream to Palisades Dam was identified as the highest conservation priority (Hahn et al., 2005). This ranking resulted because the area supports the most extensive, intact Narrowleaf Cottonwood gallery forest in the Intermountain West and is one of the most unique and biologically diverse ecosystems in Idaho. A more recent wetland prioritization identified two additional conservation priorities within the ARC (Murphy et al. 2012). The Snake River from Roberts downstream to the Jefferson-Bonneville County line includes floodplain oxbows and marshy wetlands in meander scars and sloughs supporting a high concentration of bird species, including wintering Trumpeter Swans *Cygnus buccinator* and globally rare snail species. The Snake River from Firth to Blackfoot has a broad, active floodplain occupied by an extensive cottonwood gallery forest. Riparian shrubs fill gaps, creating a dense and productive habitat for common and rare bird species, such as Yellow-billed Cuckoo *Coccyzus americanus* (Murphy et al. 2012).

The riparian habitat found along the ARC is classified as Columbia Basin or Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland depending on the vegetation map used (Murphy et al. 2012). Both of these ecological systems are rare, and very reduced in extent due to human impacts, sensitive to disturbance, difficult to restore, and/or declining.

Bald Eagles *Haliaeetus leucocephalus*, common along the Snake River, were delisted from Endangered Species Act (ESA) in 2007 but are currently protected by the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and are designated as a Species of Greatest Conservation Need in Idaho. Early January aerial surveys of the Snake River, conducted as part of the annual nationwide Midwinter Bald Eagle survey, have found an average of 69 wintering Bald Eagles from American Falls Reservoir Dam to Blackfoot (1990-2005); and average of 7 wintering Bald Eagles from Blackfoot to Idaho Falls (1990-2005); an average of 11 Bald Eagles from Idaho Falls to the confluence of the Henrys Fork and South Fork Snake River (intermittently from 1986-2005). While Bald Eagles nest in three primary areas in Idaho, with the largest nesting population located in eastern Idaho along the lower Henrys Fork and South Fork of the Snake River (IDFG 2009), the Snake River also provides important nesting habitat for Bald Eagles. Large mature cottonwoods are used as nest trees in the river corridor from the confluence of the Henrys Fork and the South Fork downstream to American Falls Reservoir. A Bald Eagle nest survey conducted in 2008 found 11 active Bald Eagle nests from American Falls Reservoir to Shelley and 4 nests between Idaho Falls and the Henrys Fork-South Fork confluence, representing approximately 8% of the total occupied nest territories in the state (IDFG 2009). An additional four active Bald Eagle nests were documented in the confluence area of the South Fork and Henrys Fork of the Snake River. A study of Bald Eagle ecology in the Greater Yellowstone Ecosystem (Swenson et al. 1986) found 45% of nests were in cottonwoods for the study area that included the Snake River and its major tributaries from above Jackson Lake downstream to the confluence of the Henrys Fork and the South Fork.

Trumpeter Swans in Idaho are part of the Rocky Mountain Population (RMP) that numbers approximately 6,425 individuals (United States Fish and Wildlife Service (“USFWS”) 2013). Trumpeter Swans are an Idaho Species of Greatest Conservation Need (IDFG 2005) and

the state participates in efforts to conserve and expand their winter and summer range in the Snake River corridor. The Trumpeter Swan is also listed as a focal species by the Intermountain West Joint Venture due to its importance as an indicator of protected marsh habitat and its ability to initiate wetland conservation partnerships. In the 2014 mid-winter Trumpeter Swan aerial survey 1,319 swans were counted using the river and associated fields from the upper part of American Falls Reservoir to Tilden Bridge; 180 swans were counted from Tilden Bridge to Idaho Falls; and 1,355 swans were counted upstream of Idaho Falls in the Roberts and Deer Parks area. All together 44% of the entire RMP of Trumpeter Swans wintered in the Snake River ARC in 2014.

Desert (Utah) Valvata *Valvata utahensis* is a small freshwater gastropod (snail) found primarily in the main stem of the Snake River and the lower reaches of the Henrys Fork and South Fork. The Desert Valvata was listed as Endangered under the US Endangered Species Act on December 14, 1992 due to significant constriction of its historic range, ongoing threats from proposed hydroelectric development, operation of existing hydroelectric dams, degraded water quality, diversion of water for irrigation and aquaculture, lack of regulatory protections for spring habitats, and invasion of the introduced New Zealand mudsnail (USFWS 1992). Desert Valvata was delisted in 2010, due in part to additional colonies found in the Snake River near the towns of Firth, Shelley, Payne, and Roberts, and in the Henrys Fork approximately 15 km upstream from its confluence with the Snake River (USFWS 2010). Desert Valvata is designated as a Species of Greatest Conservation Need in Idaho (IDFG 2005).

The Snake River from the confluence of the Henrys Fork and South Fork to American Falls Reservoir provides important winter and migratory habitat for thousands of waterfowl. In fact, the North American Waterfowl Management Plan designates this area as one of 43 Areas of Greatest Continental Significance to North American ducks, geese and swans. In an aerial survey conducted during the winter of 2008, approximately 9,000 ducks and 8,000 geese were counted in an area including American Falls Reservoir, Fort Hall Bottoms, and the Snake River from American Falls Reservoir to Idaho Falls. Ducks and geese also use the river corridor and associated riparian and wetland habitats for nesting. Wood Ducks *Aix sponsa* are cavity nesters and utilize cavities generally found in relatively large mature trees, such as cottonwoods, for nesting.

Ute Ladies' Tresses *Spiranthes diluvialis* is an orchid listed as Threatened under the U. S. Endangered Species Act that occurs at two sites within or adjacent to the Snake River Area of Resource Concern. A large population (Annis Island) occurs approximately 2 km east of the confluence of the Henrys Fork and the South Fork of the Snake River. Another population lies within the Fort Hall Bottoms upstream from American Falls Reservoir. Approximately 57% of all known Ute Ladies' Tresses populations range-wide occur on alluvial banks, point bars, floodplains, channels, or oxbows associated with streams and rivers (Fertig et al. 2005). Most of these occurrences are in wide, unconfined valleys where stream flow rates slow to allow sediment deposition. In these unconfined or minimally confined (e.g., by levees or bedrock) valleys such as the upper Snake River, flood events and channel meandering shift alluvial bars and terraces to create early successional conditions conducive to the establishment or persistence of Ute Ladies' Tresses (Moseley 2000). Suitable habitat occurs throughout the ARC. The species

can be difficult to detect due to annual variation in flowering individuals and its occurrence in dense riparian or meadow vegetation.

On October 3, 2013, the USFWS published a proposal to list the Yellow-billed Cuckoo, Western Distinct Population Segment (DPS), as threatened under the Endangered Species Act. Currently known occupied breeding habitat in Idaho occurs along: (1) the South Fork Snake River between Palisades Dam and the confluence with the Henrys Fork; (2) the lower Henrys Fork from St. Anthony to Warm Slough; (3) Deer Parks Wildlife Management Unit (“WMU”) along the Snake River between Menan and Roberts; and (4) the Snake River between Blackfoot and American Falls Reservoir (IDFG, unpublished data). Approximately 50% of the known occupied habitat for Yellow-billed Cuckoo in Idaho occurs on the Snake River between American Falls Reservoir and the confluence of the Henrys Fork and South Fork.

Hunting and Fishing

The Snake River from the confluence of the South Fork and Henrys Fork downstream to American Falls Reservoir provides significant recreational fishing opportunity and economic benefit to the citizens of Idaho despite the regulated nature of the hydrograph. The IDFG estimated angler use and associated fishing-related spending in this reach as part of statewide angler economic surveys conducted in 2003 (Grunder et al. 2008) and 2011 (IDFG, unpublished data). In 2003, anglers took an estimated 75,000 trips and spent nearly \$9.3 million to participate in this fishery (Table 1). In 2011, anglers took fewer trips (59,000) but spent a similar total amount (\$9.9 million). Much of this direct spending occurs in eastern Idaho communities near the river and generates additional economic activity (economic multiplier) well beyond the figures for direct spending. This information, for fishing activity alone, shows that the Snake River under current water management practices represents an important public trust resource that has tangible value to Idaho citizens, visitors, and communities.

The cottonwood riparian forest along this section of the Snake River provides excellent habitat for populations of White-tailed Deer *Odocoileus virginianus* and Moose *Alces alces*, and supports small herds of Elk *Cervus canadensis*. Excellent big game opportunities are found on BLM islands and for hunters able to gain permission from private landowners. This river stretch is included in game management units (“GMU”) 68A and 63A, which provide a variety of hunting opportunity to Idaho hunters. In 2012, for GMU 68A, 377 hunters, representing over 3,000 hunter days, hunted for deer and 77 hunters, representing approximately 600 hunter days, hunted for elk. In 2012, for Unit 63A, 1,089 hunters, representing over 10,000 hunter days, hunted for deer; 123 hunters, totaling 850 hunter days, hunted for elk; and 25 hunters hunted for moose. Moose hunting in these units are highly regulated through controlled hunt permits and are intended to provide an exceptional hunting experience. The loss or degradation of riparian habitat along the Snake River may result in reduced big game populations and thus a reduction in the public’s wildlife-related recreation opportunities.

Migratory waterfowl populations on the Snake River provide significant public wildlife recreation benefits through hunting and wildlife viewing opportunities. A 2009 hunter survey found 2,700 hunters, representing 22,000 hunter days, participated in waterfowl hunting in the Department’s Southeast Region. The same survey found 3,000 hunters, representing 27,000

hunter days, participating in waterfowl hunting in IDFG's Upper Snake Region. Many of these hunters are using waterfowl habitats associated with the Snake River Corridor and adjacent wetlands. Wintering waterfowl populations take advantage of the open water habitats of the Snake River for roosting and security areas and use adjacent agricultural fields for feeding.

General Riverine Ecological Concepts

Hauer et al. (2004) highlight five primary time intervals during the water year, with each interval having specific and mostly different ecological constraints. Interval 1 is the winter period, which generally extends from early November to late February or early March. In the Snake River, the primary winter ecological constraint is for adequate fish habitat in the form of sufficient stream flows, especially for Yellowstone Cutthroat Trout, Rainbow Trout, Brown Trout, and Mountain Whitefish. The Snake River and its associated riparian areas also provide important winter habitat for other species such as the Bald Eagle and thousands of wintering waterfowl. Interval 2 is the initiation of spring snowmelt, usually in March or April. Hauer et al. (2004) note that in high volume water years, discharge may be unnaturally increased in the South Fork Snake River during this interval to create storage space in Palisades Reservoir to reduce the risk of spring flooding. This may force fish to respond physiologically to increased discharge during a time interval that is not natural, the effect that such releases from Palisades Dam has on streamflow in the Snake River is moderated by streamflow in the Henrys Fork and by diversions and loss to groundwater between Heise and Blackfoot. Interval 3 is the spring high flow period, when under natural conditions snowmelt (which usually occurs from April through June) generates the flows necessary to accomplish channel maintenance work in the river channel and maintain a functioning river-floodplain interface. The high flow period is essential for maintaining riparian habitats and for those wildlife species that are dependent on healthy riparian habitat, some of which are listed under the ESA. Interval 4 is the period after high flow, usually in late June and July, and is important because the rate of the decline in the falling limb of the hydrograph can affect the regeneration and sustainability of the riparian cottonwood forest. Interval 5 focuses on the summer and fall hydrograph recession period (generally from July through October), up to the onset of winter.

Within the proposed aquifer recharge time period, all intervals would potentially experience altered flow. In the rare instances when the proposed aquifer recharge might occur during Interval 5, impacts from flow alterations under the current proposal would likely be minimal in most years. Interval 1 (winter flow) will be considered as a separate time period for addressing biological concerns relative to recharge events. Intervals 2-4 will be considered collectively as the period of spring-summer high flows that includes the ascending, peak, and descending limbs of the hydrograph.

Effects of winter stream flow reductions on fish (Interval 1)

In northern latitude rivers, winter can be a very stressful period for stream-dwelling fish. In fact, overwinter survival may be the most prominent limiting factor for stream-dwelling salmonids (Cunjak 1996) when they face a variety of stressful conditions. First and foremost, water temperatures can be extremely cold. Because salmonids are poikilotherms that do not hibernate, cold water temperatures limit their swimming and acceleration abilities, which makes

them more susceptible to displacement and predation (Huusko et al. 2007). Moreover, metabolic processes are slowed at such temperatures, and stream-dwelling trout often suffer a metabolic deficit during acclimation to rapidly declining water temperatures at the onset of winter (Cunjak and Power 1987; Cunjak et al. 1987). Consequently, energy reserves may not be sufficient to survive the winter, and any added stress, such as flow reductions, may exacerbate their metabolic deficit.

A second difficulty for salmonids in winter is that stream flow is usually reduced to the lowest levels of the year. The availability of suitable physical habitat is already considered the primary factor regulating stream trout populations in winter (Chapman 1966), and additional stream flow reductions, which might occur during aquifer recharge diversions, may magnify this shortfall, further limiting habitat availability and reducing food supplies for stream-dwelling fish.

A third winter stressor on stream-dwelling salmonids in northern latitudes is ice formation. Three types of ice – frazil ice, anchor ice, and surface ice (such as ice shelves) – are common in streams, and all can be harmful to salmonids. Shelf ice can collapse, crushing fish underneath (Needham and Jones 1959), trapping fish in concealment habitat, or preventing them from accessing concealment habitat. In some situations, anchor ice may fill pools where trout would normally aggregate during winter (Brown and Mackay 1995; Jakober et al. 1998), the result being increasing stream velocities in whatever habitat remains. The shallower the river is, the more detrimental ice will likely be to stream-dwelling fish.

Numerous studies have noted the common winter behavior exhibited by salmonids of daytime concealment in rocky substrate, woody debris, and other complex habitat structure (e.g., Schrader and Griswold 1992; Griffith and Smith 1993; and Meyer and Gregory 2000). In larger rivers, salmonids conceal almost exclusively along shore (Schrader and Griswold 1992; Griffith and Smith 1993). Salmonids concealment during the day is likely a behavior adopted to provide protection from many of the above-mentioned stressors. Concealment may provide protection from physical damage due to ice formation (Brown et al. 2011). Daytime concealment also reduces a fish's exposure to endothermic predators such as birds and mammals (Valdimarsson and Metcalfe 1998). Concealment in cobble/boulder substrate may also provide a thermal benefit (Smith and Griffith 1994).

Whether Mountain Whitefish conceal during winter is not known. Davies and Thompson (1976) reported that Mountain Whitefish overwintered in shallow backwater habitat, which could be dewatered by recharge withdrawals, potentially impacting overwinter survival of whitefish. Other large-bodied, adult fish in the Snake River probably overwinter in deep pools where depth provides adequate cover, since suitably sized concealment spaces are usually limited for most adult-sized fish. The accumulation of frazil ice may compromise the utility of pools, and in such cases, side-channel and backwater habitat may at times provide the only available habitat for large-bodied fish during winter (Cunjak 1996).

Because of the above-mentioned conditions during Interval 1, salmonids have a reduced ability to respond to changes in their environment. Unfortunately, water temperatures, discharge, and ice conditions are rarely constant during winter (Brown et al. 2011), so fish are already required to rapidly adapt to changing conditions during a stressful period of the year. Because

juvenile salmonids conceal almost exclusively along shore, fluctuations in discharge, especially during the day, can result in fish stranding, and may lead directly to fish mortality (Bradford et al. 1995; Bradford 1997). The availability of backwater habitat in rivers may decrease the numbers of fish that are caught in the current and forced to move downstream, such as during ice break-up events, and if these habitats are unavailable, mortality rates for salmonids may increase.

Two of the salmonids managed for in the Snake River (Mountain Whitefish and Brown Trout) are fall spawners, and eggs of these species incubate through the winter before alevins emerge in the spring (Scott and Crossman 1973; Northcote and Ennis 1994; Elliott and Hurley 1998). Egg deposition can occur in extremely shallow water for both Mountain Whitefish (Brown 1952) and Brown Trout (Shirvell and Dungey 1983), and any dewatering or freezing of these spawning areas before or soon after emergence may decrease the survival rate of emerging juvenile fish (Elliott 1985).

Potential adverse effects of winter stream flow reductions on wildlife (Interval 1)

The North American Waterfowl Management Plan designates the area between the Henrys Fork and South Fork confluence to the upper portions of American Falls Reservoir as one of 43 Areas of Greatest Continental Significance to North American ducks, geese, and swans. The IDFG and USFWS mid-winter aerial surveys have regularly documented thousands of ducks, geese, and swans in this section of the Snake River. Waterfowl hunting is very popular along this reach of the Snake River. Reductions of river flow caused by aquifer recharge proposals during winter months could reduce the amount of open water habitat and displace waterfowl out of this reach of river, which could impact local hunter participation and cause economic loss to local communities. Water withdrawals during short periods of time could be exacerbated by cold temperatures which may lead to excessive ice-formation and loss of open water habitat. In winter, Trumpeter Swans, ducks and geese feed and roost in the Snake River, which provides crucial ice-free habitat. Therefore, maintaining adequate winter river flows to ensure ample open water habitat is an important consideration for waterfowl hunting, conservation, and management.

The Snake River provides vital winter foraging habitat, and the riparian cottonwoods provide important winter perch and roost habitat for Bald Eagles. Steenhof et al. (1980) found that Bald Eagles preferred tree perches compared to cliffs, ice, logs, or the ground, and preferred stout, horizontal branches. In this study, nearly all perches were within 30 m of the river and 58% of the perches were within 5 m of the river bank, and eagles preferred mature cottonwood trees. During winter Bald Eagles forage on fish and waterfowl that are accessible and/or abundant in open water habitat. Bald Eagle foraging could be affected by loss of open water habitats due to winter aquifer recharge efforts.

Effects of reduced spring peak flows on fish and wildlife (Intervals 2 – 4)

It has long been recognized that high stream flows are a necessary component of the annual hydrograph (Leopold et al. 1964). In the seminal paper by Poff et al. (1997), naturally-occurring high flow events are crucial to the long-term health of river and floodplain ecosystems because they put in motion a number of important stream ecosystem processes. Bankfull

streamflow initiates bedload transport and scouring of vegetation, which helps maintain channel morphology. High flows inundate the floodplain, which sustains and regenerates important streambank and floodplain vegetation such as cottonwoods and willows. High flows also recruit new woody material to the channel and rearrange existing woody debris, creating a mosaic of complex habitat that is important for fish, invertebrates, and other animals. Finally, high flows help flush spawning habitat for salmonids, cleaning fine sediment from the gravel beds where salmonids build redds to incubate their eggs.

Fundamentally, the shape and function of the river channel, and therefore the habitat for fish and other aquatic organisms, is determined by the physical processes of moving water and sediment in the channel and between the channel and the floodplain (Poff et al. 1997). Rivers migrate across their floodplain by eroding material from the outside bank of meander bends and depositing material on the inside of meander bends, and this occurs primarily at or above bankfull discharge (Leopold et al. 1964). Along the upper Snake River, this “shifting habitat mosaic” and associated functions (e.g., hyporheic exchange, baseflow support, thermoregulation, etc.) and outcomes (e.g., cottonwood forest) are present, but negatively influenced by decades of flow alterations (Hauer and Loring 2004). Sections of the Snake River below the confluences of the Henrys Fork and South Fork (e.g., downstream of Firth) are nearly as meandering as upstream reaches of both tributaries, and are replete with islands, alluvial point bars, side-channels, meanders, and backwater and oxbow habitat. Thus channel maintenance flows in this river reach are paramount to maintaining fish habitat, riparian vegetation, and a functioning floodplain.

Schmidt and Potyondy (2004) describe and highlight the following ecological benefits of channel maintenance flows:

- Conveyance of water and erosion products from tributary areas through the stream system without aggradation or degradation;
- Maintenance of the relationship between the channel and floodplain by temporarily storing flood flows on the floodplain;
- Maintenance of pools, riffles, meanders, and other physical habitats necessary to sustain aquatic ecosystems;
- Providing navigation conduits on larger streams and rivers for recreational floating and power boating;
- Stabilization of streambanks by riparian vegetation and rootwads which protects banks from erosion and collapse;
- A vegetation filter that removes and stabilizes sediments and nutrients moving toward the stream from adjacent slopes;
- Surface roughness on the floodplain favorable for recharging groundwater systems;
- Effective floodplain soil conditions to detain flood water for later release to sustain low flows;
- Moist corridors that act as natural fuel-breaks, fire line anchor points, and safety zones;
- Large woody debris which helps create structural features that form pools and bars;
- Shade to the stream that maintains cooler water temperatures necessary to sustain cold-water aquatic life.

Bankfull discharge can be determined empirically by measuring the discharge at which flooding begins to flow out of the stream channel and across the floodplain. However, because this data is often not available, it is more commonly determined based on the knowledge that, in most gravel-bed river drainages, bankfull discharge occurs at roughly a 1.5 year recurrence interval (Leopold et al. 1964; Schmidt and Potyondy 2004). This translates to roughly the 33rd percentile of the annual maximum daily flow over the period of record.

Precise estimation of bankfull discharge in the Snake River under unregulated conditions (i.e., in the absence of upstream storage and diversion) would require mathematical modeling of the entire surface water and ground water system. However, a reasonable approximation of unregulated bankfull discharge can be made by assuming that the unregulated flow in the Snake River at Blackfoot would equal the unregulated flow in the Henrys Fork plus the unregulated flow in the South Fork, minus any loss to groundwater. The U.S. Bureau of Reclamation (USBR) maintains a record of daily unregulated discharge in the South Fork at Heise. This record was modified slightly by applying a 7-day moving average to the daily data to smooth errors in reservoir stage measurement due to wind and ice. Van Kirk (2012) estimated unregulated flow in the Henrys Fork, which he defined as the sum of unregulated flow from the upper Henrys Fork, Fall River, and the Teton River. Both estimates account for upstream reservoir storage and evaporation. The Henrys Fork estimate accounts for upstream irrigation diversion and return flow. Downstream inflow from small tributaries account for only a few percent of the overall water budgets in the entire system and can therefore be ignored. Reach gain calculations and modeling suggest that, under unregulated conditions, loss to groundwater upstream of the Snake River at Blackfoot would total about 2,500 cfs in the entire system (R. Van Kirk, Henrys Fork Foundation, unpublished data).

Unregulated discharge estimates for the Snake River at Blackfoot were made for water years 1979-2008 (Van Kirk, unpublished data), and unregulated bankfull discharge was determined as above (i.e., the annual high flow with a 1.5-year recurrence interval). Based on these analyses and assumptions, the unregulated bankfull discharge for the Snake River at Blackfoot was estimated to be 31,341 cfs, and we therefore rounded the unregulated bankfull discharge to 31,300 cfs. It is this level of discharge that is needed for channel maintenance and floodplain maintenance in the Snake River at Blackfoot. However, spring high flows in the Snake River are already profoundly altered by upstream storage and diversions for irrigation. For the Snake River at Blackfoot in water years 1979-2013, the 33rd percentile of the maximum daily discharge was only 11,344 cfs. The Snake River channel morphology was originally formed by unregulated stream flows, thus the current condition of the channel and its associated floodplain already reflect the consequences of decades of diminished flow.

The ability of a river to scour its channels and maintain functioning floodplains is dependent not only on regularly reaching and exceeding bankfull flows, but also dependent on the duration that bankfull flows occur. While it is true that bankfull flows are not needed every year, and naturally do not occur every year, it is also true that reaching bankfull discharge for only a few days each year may not be adequate for maintaining channel capacity and floodplain function (Schmidt and Potyondy 2004). Since water year 1979, streamflow in the Snake River at Blackfoot has exceeded the unregulated bankfull discharge of 31,300 cfs only two times, once in 1997 for 13 days and once in 2011 for one day.

Maintenance of healthy riparian and aquatic habitat are essential for existing salmonid populations as well as migratory and breeding waterfowl, Yellow-billed Cuckoo, Desert Valvata, Bald Eagles, Ute Ladies' Tresses, and big game species that use the Snake River corridor from the Henrys Fork and South Fork confluence to American Falls Reservoir.

The USFWS determined that the Yellow-billed Cuckoo Western DPS is threatened due to the destruction, modification, and degradation of its riparian breeding habitat (USFWS 2013). A principle cause of these impacts is "alteration of hydrology due to dams, water diversions, management of riverflow that differs from natural hydrological patterns, channelization, and levees and other forms of bank stabilization that encroach into the floodplain" (USFWS 2013). Furthermore, USFWS (2013) states that "the hydrologic regime (stream flow pattern) and supply of (and interaction between) surface and subsurface water is a driving factor in the long-term maintenance, growth, recycling, and regeneration of western Yellow-billed Cuckoo habitat". The cottonwood stands that currently provide potentially suitable habitat for Yellow-billed Cuckoo will become altered through natural succession, flood plain dynamics, and human disturbance. Therefore, long-range planning should allow for recruitment of new nesting stands. Maintaining Yellow-billed Cuckoo habitat along the upper Snake River requires flow management that considers the ecology of cottonwood riparian forests including maintenance and recruitment (USFWS 2013).

The Desert Valvata primarily occurs in well-oxygenated pools adjacent to rapids or in perennial flowing reaches of the Snake River (IDFG 2005). Dams and diversions that alter the temperature and flow characteristics of the river are a principal threat to the persistence of the Desert Valvata. Other threats include habitat loss, eutrophication from agricultural effluent, freshwater aquaculture inputs, residential and industrial developments, and introductions of exotic mollusks (IDFG 2005).

Because of the reliance of Bald Eagles on mature cottonwoods for nesting and winter roosting and perching along the upper Snake River, the loss or degradation of riparian vegetation, particularly reduced recruitment and survival of cottonwoods, will likely result in a reduction of the number Bald Eagles able to utilize this habitat.

Most bank, floodplain, and oxbow Ute Ladies' Tresses sites, including those on the South Fork, have moist sandy soil with a high water table (usually 45 to 60 cm from the surface during summer), typically with seasonal flooding, and occur on terraces about 0.4 to 1.2 m above summer baseflows (Moseley 2000). A drop in the local water table can occur if flows of adjacent rivers are reduced due to diversion (Rood et al. 1995; Hauer and Lorang 2004). Alternatively, diversion-reduced spring runoff river flows may be inadequate to maintain meandering and sediment transport in the system, resulting in channel aggradation and reduced local water table (Rood et al. 2003), an outcome observed on the upper Snake River (Hauer and Lorang 2004). Both scenarios can result in habitat too dry to support Ute Ladies' Tresses. Ute Ladies' Tresses grow in sunny, herbaceous habitats on the margins of Narrowleaf Cottonwood, willow, or other shrub assemblages, where associated vegetation is kept short by flooding or other disturbances. In the absence of flood disturbance or as sites become drier due to flow diversion, streamside meadow habitats can become invaded by riparian shrubs or trees, resulting in diminished or

extirpated Ute Ladies' Tresses populations. Habitat monitoring of populations on the upper Snake has shown that woody cover has notably increased at numerous occurrences and, in the absence of large disturbance-inducing flood events due to diverted flows, may lead to loss of orchid habitat by succession (Miller 2010).

In Idaho, based on historic photos, reconstructed floodplain succession, and lead isotope dating (Merigliano 1996), it is believed that most Ute Ladies' Tresses populations occur on alluvial surfaces formed before Palisades Dam was completed in 1956 (Moseley 2000; Murphy 2001). Populations may occur within the modern spring flood zone (usually 20,000 cfs) or on higher terraces that are only rarely flooded in extreme high water events (such as the summer 1997 flood with 43,000 cfs) (Moseley 2000). One population at Black Canyon occurs on a sand and cobble bar formed after Palisades Dam was completed. This site is frequently flooded but stable enough to have sandy soil (Murphy 2000, 2001). It is evidence that Ute Ladies' Tresses is adapted to a dynamic floodplain and colonizes new fluvial surfaces. These younger fluvial surfaces are required for long-term persistence of the species because older sites will be lost to succession (Hauer et al. 2004). However, on the upper Snake River, the creation of younger fluvial surfaces require flood events greater than about 26,000 cfs, a flow sufficient for shifting sediment in the system (Merigliano 1996) and similar to our estimated unregulated bankfull discharge of 31,300 cfs. Under current flow management, Ute Ladies' Tresses will probably continue to be adversely affected by diminished floods and reduced deposition and erosion processes on the South Fork (Hauer and Lorang 2004; Hauer et al. 2004; U. S. Bureau of Reclamation 2004). With additional flow diversions for aquifer recharge, these sediment moving flows will be even rarer and Ute Ladies' Tresses populations and habitat throughout the area of concern is likely to decline in quantity and quality.

Potential adverse effects of reduced spring peak flows on cottonwood forests (Intervals 2 - 4)

The South Fork Snake River supports the most extensive cottonwood gallery forest remaining in Idaho and probably the largest such ecosystem in the Intermountain West (Palmer 1991). This ecosystem extends upstream in the Henrys Fork as well as downstream in the main stem Snake River, especially below Firth, and is comprised of both Black Cottonwood and Narrowleaf Cottonwood. The health of riparian cottonwood forest ecosystems has been declining across western North America, including along the Snake River, due to long-term impacts from damming, water diversions, and the clearing of floodplain habitats for agricultural use and livestock grazing (Braatne et al. 1996; Rood et al. 2003; Hauer and Lorang 2004).

Seed germination and seedling survival of cottonwoods is dependent on the combination of flood events, which provides necessary moisture at the right time, and the shifting habitat mosaic produced by flood scouring and deposition, which provides the ideal barren soil seed bed (Rood et al. 1995; Braatne et al. 1996; Mahoney and Rood 1998; Rood et al. 2003). Critical to cottonwood seedling success is the timing and rate of decline of the falling limb of the hydrograph (Mahoney and Rood 1998). In a typical year of a natural system, cottonwoods release their short-lived seeds after the peak flood flow has dramatically declined. Seeds land on barren sand and cobble bars left after the flood. They rapidly germinate but rely on a slow decline of water levels to maintain soil moisture needed for seedlings to survive the summer drought. Numerous studies from across the West (including the South Fork Snake River) have

shown that when this process is disrupted by flow alteration and/or diversion during or after spring flood flows, cottonwood recruitment declines (Rood et al. 1995; Braatne et al. 1996; Merigliano 1996; Rood et al. 2003; Braatne et al. 2007).

Flow diversions (for irrigation or other purposes) which reduce base flows have also been shown to negatively impact cottonwoods. Persistence of cottonwoods is dependent on instream flows which maintain the local alluvial groundwater table during drought periods (Braatne et al. 1996; Mahoney and Rood 1998; Rood et al. 2003). For example, cottonwoods along sections of the Big Lost River completely died in 5 years when channels were dewatered for irrigation (Rood et al. 2003). When river channels are drawn down due to irrigation diversion, seedlings may opportunistically find suitable sites below the baseflow level to grow, but they are typically scoured out the next spring during even small floods (Braatne et al. 2007).

Studies conducted in the 1990's concluded that the health of the riparian cottonwood ecosystem along the Snake River floodplain was being impacted because of a lack of seedling recruitment (Merigliano 1996). Since cottonwoods are a relatively short-lived tree (100-200 years), a decline in seedling recruitment over the past 50 years has led to an age structure of the cottonwood community that is dominated by older individuals. Since the construction of Palisades Dam in 1956, annual peak flows rarely exceed 26,000 cfs at the Heise gauge, the flow necessary to mobilize channel sediments and create barren alluvial bars necessary for cottonwood seed germination (Merigliano 1996; Hauer and Lorang 2004). It is likely that these disruptions would impact cottonwoods downstream to American Falls Reservoir. Without recruitment of new seedlings, the riparian cottonwood ecosystem along the floodplain of the Snake River is in jeopardy. Additional diversions will further truncate flood flows necessary for creating sand and cobble bars for cottonwood seeds and further alter the rate of decline of the falling limb of the hydrograph—both causing worse conditions for cottonwood persistence.

Analyses of likely stream flows and potential effects on fish and wildlife for flow scenarios based upon current recharge proposals

The water-rights applications referenced at the top of this document (01-10625 and 01-10626) request combined diversion of up to 935 cfs for aquifer recharge. These applications each carry priority dates of 6/19/2013. The Idaho Water Resource Board (IWRB) has also filed applications to divert water for aquifer recharge. Applications 01-10612, 01-10613, 21-7577, 21-7578, 21-7580, and 21-13160, in combination, request diversion of up to 7,503 cfs from the Henrys Fork, Snake River upstream of the Henrys Fork confluence ("South Fork"), and Snake River upstream of Blackfoot. Diversion at any or all of these points reduces streamflow in the reach under consideration in this document. These IWRB applications each carry a priority date of 3/20/1998 and are thus senior to applications 01-10625 and 01-10626. It is reasonable to assume that under most circumstances, diversion would not occur under applications 01-10625 and 01-10626 until and unless the IWRB rights were already being exercised. Therefore, the most appropriate analysis of the effects of diversion under applications 01-10625 and 01-10626 assumes that these diversions will occur in addition to that allowed under the IWRB applications.

The most appropriate gage for the analyses within the area of concern is the U.S. Geological Survey (USGS) gage for the Snake River at Blackfoot (USGS gage number

13062500), since this is the most upstream gage station that is downstream of the points of diversion listed in applications 01-10625 and 01-10626. This gage depicts the cumulative effects of upstream water storage and diversion in the reach of concern, without being affected by inflow from the Blackfoot River. These applications do not include any points of diversion on the Snake River from USGS Station 13062500 downstream to American Falls Reservoir. The period of record for stream flow at this gage includes water years 1979 to present.

The following information was provided by the Idaho Department of Water Resources (IDWR) based on IDFG's request for details regarding (1) recharge capacity at different diversion locations along the Snake River system, and (2) the volume of water available for recharge in recent years at the Blackfoot gage and relevant upstream gages (namely, Heise and St. Anthony). To determine recharge capacity, IDWR looked at historical recharge and spoke to canal managers to determine how much each site could divert for recharge, and estimated the infiltration rate based on previous recharge, site testing, canal manager information, or ESPAM2.1 calibrated canal leakage.

The following bullets highlight important caveats and assumptions regarding recharge availability and potential alterations to stream flow that were provided by IDWR:

- The amount of water available for recharge was calculated by IDWR using the period of record for water years 2000-2012.
- The recharge water right was considered to be in priority at the point of diversion.
- It was assumed that the U.S. Bureau of Reclamation hydropower water rights at Minidoka Dam are satisfied.
- The volume of water available for recharge was limited to water at the recharge point of diversion minus an assumed amount of flow to be left in the stream channel, whichever was smaller. The IDWR assumed that low flows would be – Blackfoot, 200 cfs; South Fork, 900 cfs; and Henrys Fork, 200 cfs.
- It was assumed that the infrastructure necessary to divert and recharge all of the available water exists.
- Gains to the river due to recharge were ignored, since gains will be temporally and spatially dislocated from the recharge event.
- The availability of water, both physically and in right, was calculated independently for each of the three relevant river reaches (Henrys Fork, South Fork, and Snake River from Menan to Blackfoot).
- The State of Idaho has adopted a goal of 250,000 acre-feet of recharge per year. However, diversion for recharge under a combination of IWRB and private rights could exceed this amount. Regardless, 250,000 acre-feet per year is the target identified in the ESPA CAMP and provides a meaningful reference point for the analysis.
- Water availability was reported as the total monthly volume available for recharge during each month from November 1999 through October 2012 and the number of days during each month when the IWRB recharge rights would be in priority. These data were

reported for the Henrys Fork, South Fork, and Snake River at Blackfoot. No information was reported at the daily time scale.

Based on this and other information, we made the following assumptions in our calculations of the potential effects of recharge under the IWRB 1998 applications.

- We assumed that when water was available for recharge upstream of Blackfoot, as specified by IDWR's analysis, this water would be diverted under some combination of the IWRB 1998 applications, the applications in question in this document, and other private applications, according to priority. As noted above, priority indicates that rights 01-10625 and 01-10626 would be exercised only after the IWRB rights are filled. The analysis of physical hydrology is independent of the exact combination of rights under which the diversion would occur.
- We assumed that diversion for recharge under these and any other new rights would occur over and above all diversions that actually occurred for any purpose during water years 2000-2012. Thus, we used the actual flow at the Blackfoot gage over the period of analysis as the baseline from which new diversions would be subtracted.
- We acknowledged that water availability is not independent across these three reaches. Thus we limited the total amount that could be diverted for recharge to either the sum of available water in the Henrys Fork and South Fork or the total amount available for recharge upstream of Blackfoot, whichever was smaller.
- We restricted maximum recharge amounts for any given month to 250,000 acre-feet, but the entire water year may depict scenarios that exceed 250,000 acre-feet in order to display the entire range of flow effects that could conceivably occur. However, we make note (in the text and figure captions) wherever the annual total exceeds 250,000 acre-feet.
- Because we were provided only monthly totals and number of days per month when recharge was possible, we did not know the particular dates on which water would be available for recharge and how much water would be available on each of these days. Thus, we assumed that the maximum amount available for recharge on a daily basis during any given month was the monthly total volume divided by the number of days of availability. For example, 116,364 acre-feet was available for recharge upstream of Blackfoot in March 2012, and the water was available for 9 days. We therefore assumed a diversion rate of 12,929 acre-feet (6,530 cfs) per day for 9 days during that month.
- Because we did not know the actual dates on which water was available for recharge, we analyzed two scenarios. For "greatest effect" scenarios, we assumed that daily diversion for recharge would occur at the most inopportune times of any given month that recharge was possible, e.g., when high flows that approached bankfull conditions would be reduced, or when flows could be reduced as low as possible, which according to IDWR is roughly 200 cfs.
- For "least effect" scenarios, we assumed that daily diversion for recharge would occur at the best possible times in any given month, such as at a time when the lowest flows would not be exacerbated, or when very high spring discharges would still be allowed to occur.

- A final scenario is recommended to best sustain important fish and wildlife resource values. The “IDFG recommended” scenario, was equivalent to the “least effect” scenario except that no recharge flows were allowed to decrease discharge below 2,070 cfs. This minimum flow was derived from the 1999 recommendation that IDFG made for a recharge proposal made at that time (see IDWR 1999). This minimum flow corresponds closely to the recommendations of Tennant (1976), which is to maintain at least 30% of the unregulated average annual flow to maintain good quality aquatic habitat. For this stretch of river, unregulated average annual flow from 1979-2008 was estimated to be 7,914 cfs (R. Van Kirk, unpublished data), and thus 2,070 cfs corresponds to 26% of the average unregulated flow. At 30% of the unregulated average annual flow, Tennant (1976) argues that a number of important characteristics of the river will be functioning adequately, including: (1) good survival will be achieved for most aquatic species; (2) most side channels will carry water; (3) most islands should function as habitat refuges for wildlife; (4) many runs and pools will be deep enough to hold fish; and (5) wetted width should extend to the normal streambank, so bank vegetation can provide hiding cover for aquatic species. Although regulated flows in this section of the river already decline below 2,070 cfs in most years, the “IDFG recommended” scenario would preclude recharge diversions from causing flows to decline below 2,070 cfs.
- Although return flow to the stream from recharge was not considered in estimating availability of water for recharge, we included return flows in all of the final hydrographs except the actual hydrograph. Although recharge upstream of Blackfoot could conceivably occur at numerous different locations, we assumed that all recharge upstream of Blackfoot is most likely to occur on Egin Bench or somewhere else in the lower Henrys Fork area. Thus, we used ESPAM2.1 to calculate reach gains in the Ashton-to-Rexburg, Heise-to-Shelley and Shelley-to-Blackfoot reaches from a unit recharge event on Egin Bench. The gains in these three reaches were summed to obtain the total gain to the river upstream of Blackfoot. Figure 2 shows the return-flow hydrograph from a single recharge event on Egin Bench and the cumulative hydrographs for water years 2000-2012.

Based on these assumptions and caveats, and the analyses provided by IDWR, within the 13 water years from 2000 to 2012, there was available water that could have been used for recharge in seven years. In 2000 (a dry water year that followed a wet year), according to IDWR, recharge diversions would have been possible in February, March, April, and May, for a total of 44 days, during which time 357,597 acre-feet of water could have been diverted. Depending on when recharge was implemented, winter flows in February or March could have been drastically reduced for many days, to as low as 201 cfs (Figures 2 and 3). Under the “recommended” recharge scenario, an estimated 21,891 acre-feet of water would have been prevented from being diverted by not allowing recharge to reduced flows below 2,030 cfs.

In 2006 (an average water year), according to IDWR, recharge diversions would have been possible in April, May, and June, for a total of 50 days, during which time 522,961 acre-feet of water could have been diverted. Depending on when recharge was implemented, spring stream flows in April and May could have been reduced to as low as about 250 cfs for several days even under the “least effect” scenario (if maintaining maximum flows in the spring was considered more important than extreme low flows) (Figures 4 and 5). Under the

“recommended” recharge scenario, an estimated 17,419 acre-feet of water would have been prevented from being diverted by not allowing recharge to reduce flows below 2,070 cfs.

In 2007 (a dry water year), according to IDWR, recharge diversions would have been possible only in the month of April and for only 4 days, during which time 13,321 acre-feet of water could have been diverted. Under the “greatest effect” scenario, discharge in April could have been reduced to as little as 200 cfs for four days, but under the “least effect” scenario, little impact would have materialized due the recharge diversions in 2007 (Figures 6 and 7). Under the “recommended” recharge scenario, an estimated 3,895 acre-feet of water would have been prevented from being diverted by not allowing recharge to reduce flows below 2,070 cfs.

In 2009 (an average water year), according to IDWR, recharge diversions would have been possible in April, May, June, and July, for a total of 60 days, during which time 665,398 acre-feet of water could have been diverted. Depending on when recharge was implemented, spring stream flows in April could have been reduced to as low as 200 cfs for several days, and even under the “least effect” scenario, high spring flows in June could have been reduced by several thousand cfs (Figures 8 and 9). Under the “recommended” recharge scenario, an estimated 1,652 acre-feet of water would have been prevented from being diverted by not allowing recharge to reduce flows below 2,070 cfs.

In 2010 (a dry water year), according to IDWR, recharge diversions would have been possible only in the month of June for 16 days, during which time 15,019 acre-feet of water could have been diverted. Even the “greatest effect” scenario would have resulted in immeasurable impact on the hydrograph in water year 2010 (Figures 10 and 11). For water year 2010, the only difference between hydrographs for the “least effect”, “greatest effect”, and “recommended” scenarios was the result of legacy effects of different estimated return flows in previous water years.

In 2011 (a wet water year that followed a dry year), according to IDWR, recharge diversions would have been possible in May, June, July, and August, for a total of 82 days, during which time 791,725 acre-feet of water could have been diverted. Under the “greatest effect” scenario, spring high flows in May, which reached an unregulated bankfull discharge of 31,400 cfs that year, could have been reduced to 23,973 cfs, and/or flows in August could have been reduced to as low as 200 cfs for several days (Figures 12 and 13). For water year 2011, the “recommended” recharge scenario would not have altered the diversion amount because stream flow under the “least effect” scenario were not reduced below 2,070 cfs.

In 2012 (an average water year that followed a wet year), according to IDWR, recharge diversions would have been possible in March, April, May, and June, for a total of 56 days, during which time 454,053 acre-feet of water could have been diverted. Depending on when recharge was implemented, stream flows in late winter (March) or in May could have been reduced to as low as 200 cfs for many days, even under the “least effect” scenario (Figures 14 and 15). Under the “recommended” recharge scenario, only an estimated 26,050 acre-feet of water would have been prevented from being diverted by not allowing recharge to reduce flows below 2,070 cfs.

Based on these scenarios, it is apparent that stream flow in the Snake River at Blackfoot frequently could have been reduced to about 200 cfs by recharge diversions. For water years 1979-2013, actual discharge was as low as 200 cfs for only 13 days, but implementation of water recharge scenarios could have created another 58 days where discharge was reduced to about 200 cfs, across six of the seven years that recharge capacity was available. Reducing stream flows to only 200 cfs in the Snake River would have a devastating impact on juvenile, sub-adult, and adult fish at any time during the water year, but especially during the winter when (as mentioned above) conditions are most severe for stream-dwelling salmonids and when Brown Trout and Mountain Whitefish eggs are incubating. Following the “recommended” scenario of not allowing any recharge event to diminish flows below 2,070 cfs would have resulted in the loss of an estimated 70,907 acre-feet of recharge potential across all years combined.

For the 35 water years from 1979-2013, unregulated bankfull discharge in the Snake River at Blackfoot was attained only twice, but in the 13 water years (2000-2012) for which IDWR estimated the volume of water available for recharge, it occurred only once (in water year 2011). Based on estimates from IDWR, implementation of recharge scenarios in water year 2011 could have precluded stream flows from reaching this unregulated bankfull discharge. Considering that unregulated bankfull discharge is so rarely achieved under current water management, further diversions of bank full discharge flows could substantially further reduce the river’s ability to scour channels, maintain adequate fish habitat, and sustain a functioning floodplain. Indeed, rivers such as the Snake River, which are below upstream impoundments, tend to have a decreased channel capacity over time, due to bedload aggradation and vegetative encroachment (Andrews 1986; Brandt 2000; Schmidt and Potyondy 2004). At the same time, floodplain vegetation, especially cottonwoods, tend to suffer from lack of recruitment of new seedlings (Merigliano 1996). In the Snake River, this would likely jeopardize the health of the cottonwood forest, diminish important fish habitat characteristics for salmonids (such as side channels, woody debris, and pool habitat), and reduce the quality of riparian habitat for such species as the Bald Eagle the Yellow-billed Cuckoo, and Ute Ladies’ Tresses.

Conclusion

The Snake River from American Falls Reservoir upstream to the confluences of the Henrys Fork and South Fork currently experiences stream flows that are drastically altered from unregulated conditions. Winter stream flows are already frequently reduced to less than 1,000 cfs and periodically are less than 500 cfs, but implementation of the current recharge proposal could markedly increase the number of days where stream flows are extremely low (i.e., around 200 cfs). Moreover, the bankfull discharge for the Snake River (31,300 cfs), which for adequate maintenance of channel function and riparian connectivity should be realized on 1.5 year recurrence, has been achieved only twice in the last 35 water years; under the current recharge proposal, it likely would not have been achieved even in those two years.

IDFG is extremely concerned that implementation of the current recharge proposals (within the assumptions defined due to lack of important details in the proposals) will further alter and minimize natural river flows, exacerbating the existing effects that the regulated hydrograph is having on fish, wildlife, and plants in and along the Snake River further impeding productivity of these resources. Consequently, the current diverse array of fishing and hunting

opportunities would likely be further diminished by implementation of the current recharge proposal. The Snake River under current water management paradigms represents many aspects of an important public trust resource that has tangible value to Idaho citizens, visitors, and communities. Maintaining adequate winter and spring flow regimes in the framework of consideration for current recharge applications is strongly recommended by IDFG and the department is committed to providing technical assistance in developing stream flow options that support its mission while maximizing recharge management within that context.

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Table 1. Estimated angler trips and associated spending for The Snake River above American Falls Reservoir in Bonneville and Bingham counties, 2003 and 2011.

Year	Estimated Angler Trips	Estimated Total Spending
2003		
Bonneville County	45,300	\$6,650,000
Bingham County	30,400	\$2,630,000
Total	75,700	\$9,280,000
2011		
Bonneville County	39,500	\$8,330,000
Bingham County	19,900	\$1,540,000
Total	59,400	\$9,870,000

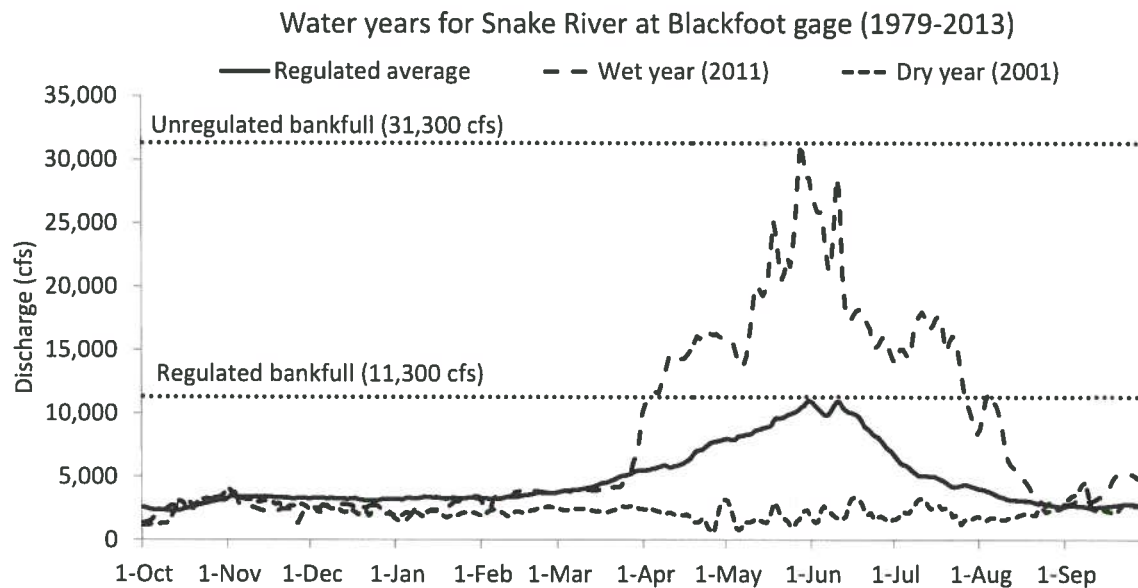


Figure 1. Waters years for the Snake River at Blackfoot gage for a typical wet year, typical dry year, and for the average over all available years of data.

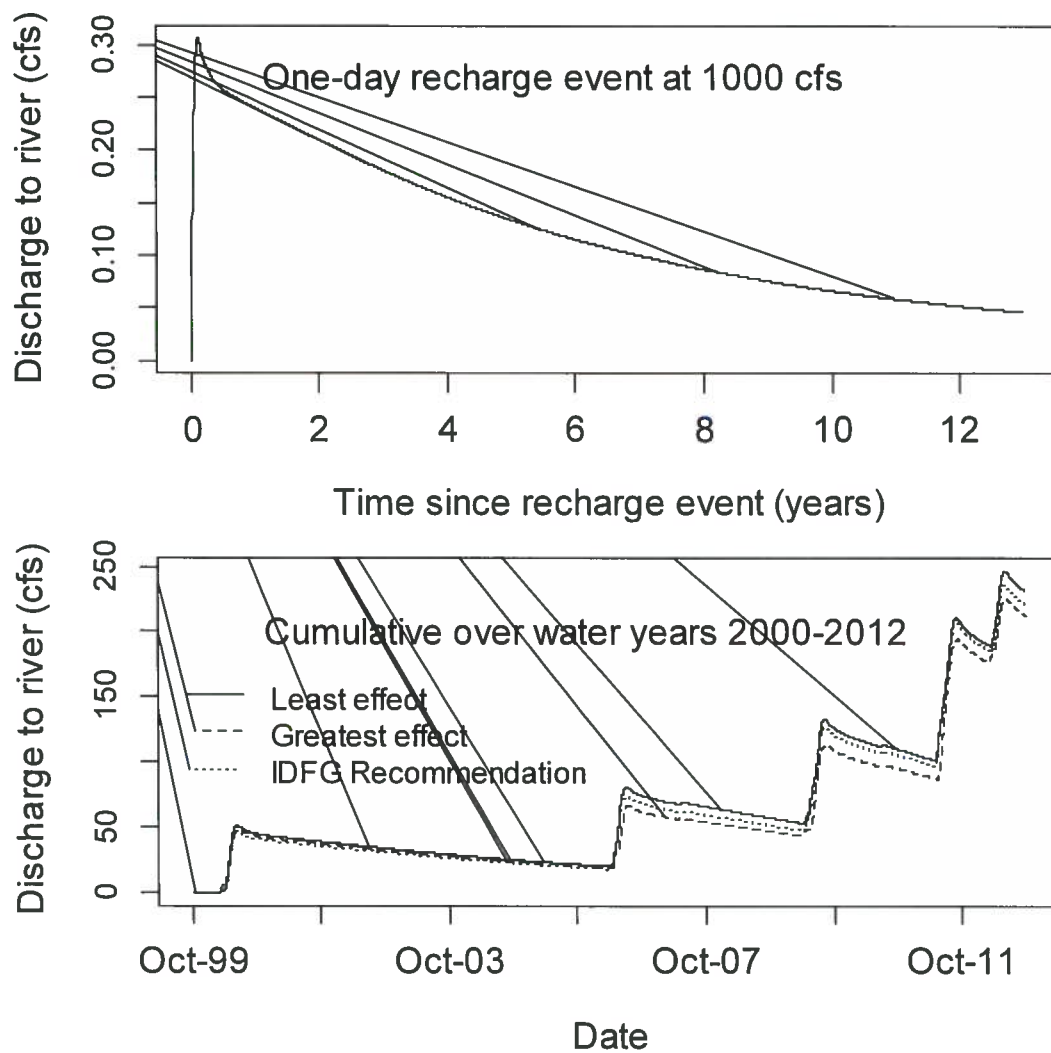


Figure 2. Return flow to the Snake River upstream of Blackfoot resulting from recharge at Egin Lakes, as calculated by ESPAM2.1. Top panel shows return flow for a single-day recharge event at a diversion rate of 1,000 cfs. Bottom panel shows cumulative return flow for recharge over water years 2000-2012, as calculated from the above methodology.

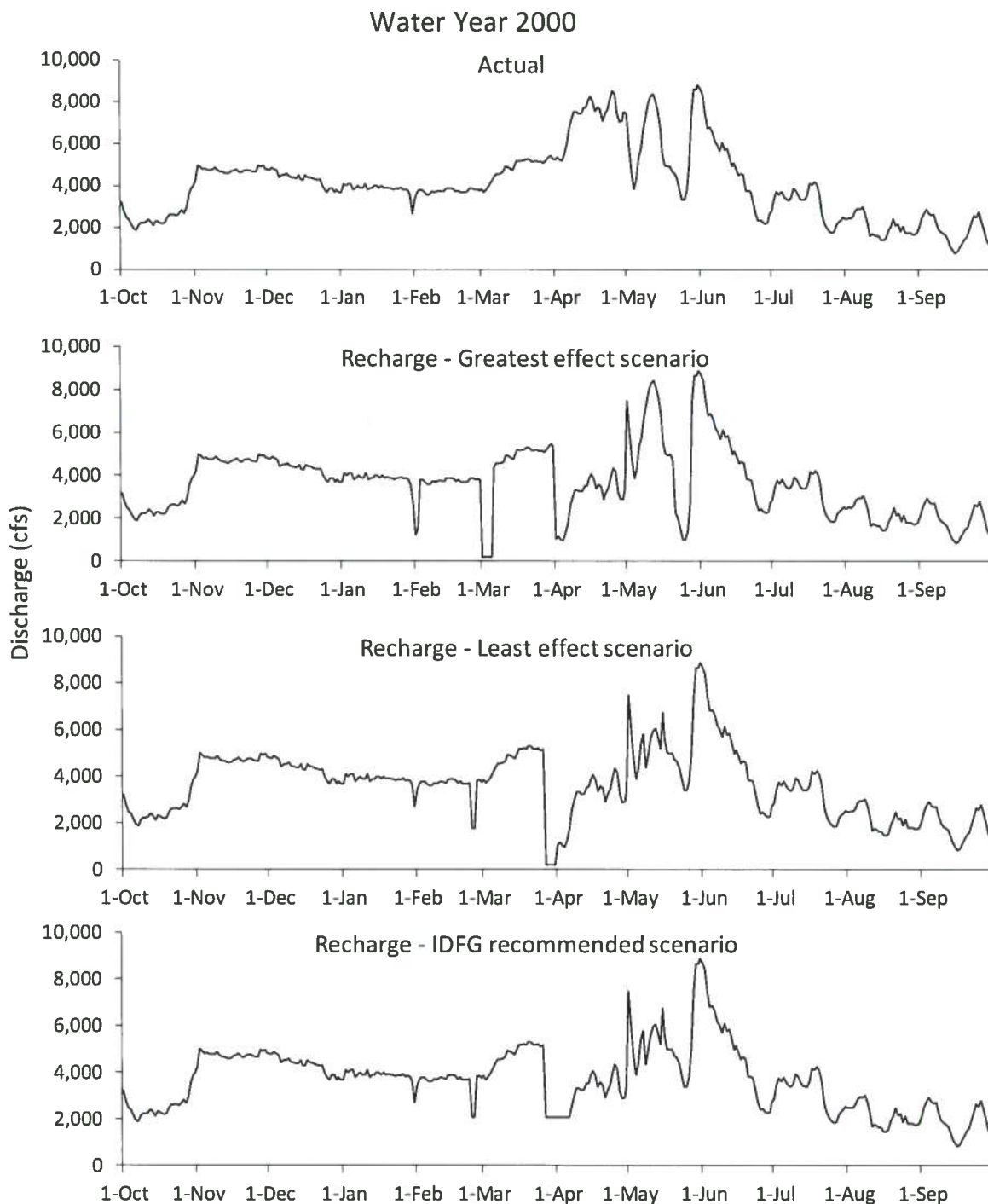


Figure 3. Actual hydrograph for water year 2000, greatest effect and least effect recharge scenarios, and a recommended recharge scenario (if recharge is implemented) that reduces impacts to fish and wildlife. All simulated hydrographs except “actual” reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

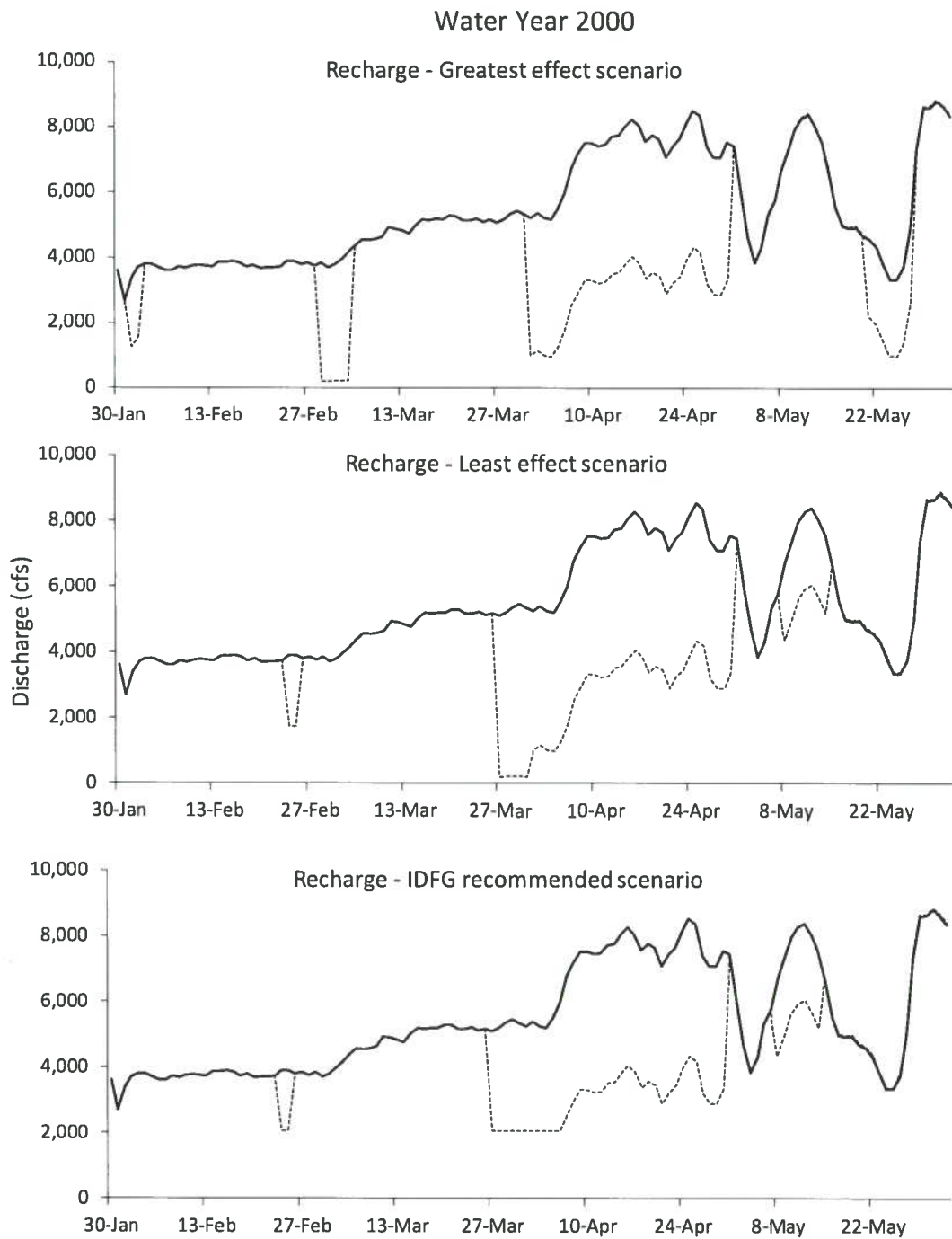


Figure 4. Hydrograph in year 2000 during months with altered flow if the proposed water recharge diversions had been implemented. Solid lines are the actual hydrograph whereas dashed lines are the altered scenarios if recharge had occurred. All scenarios except the actual hydrograph reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

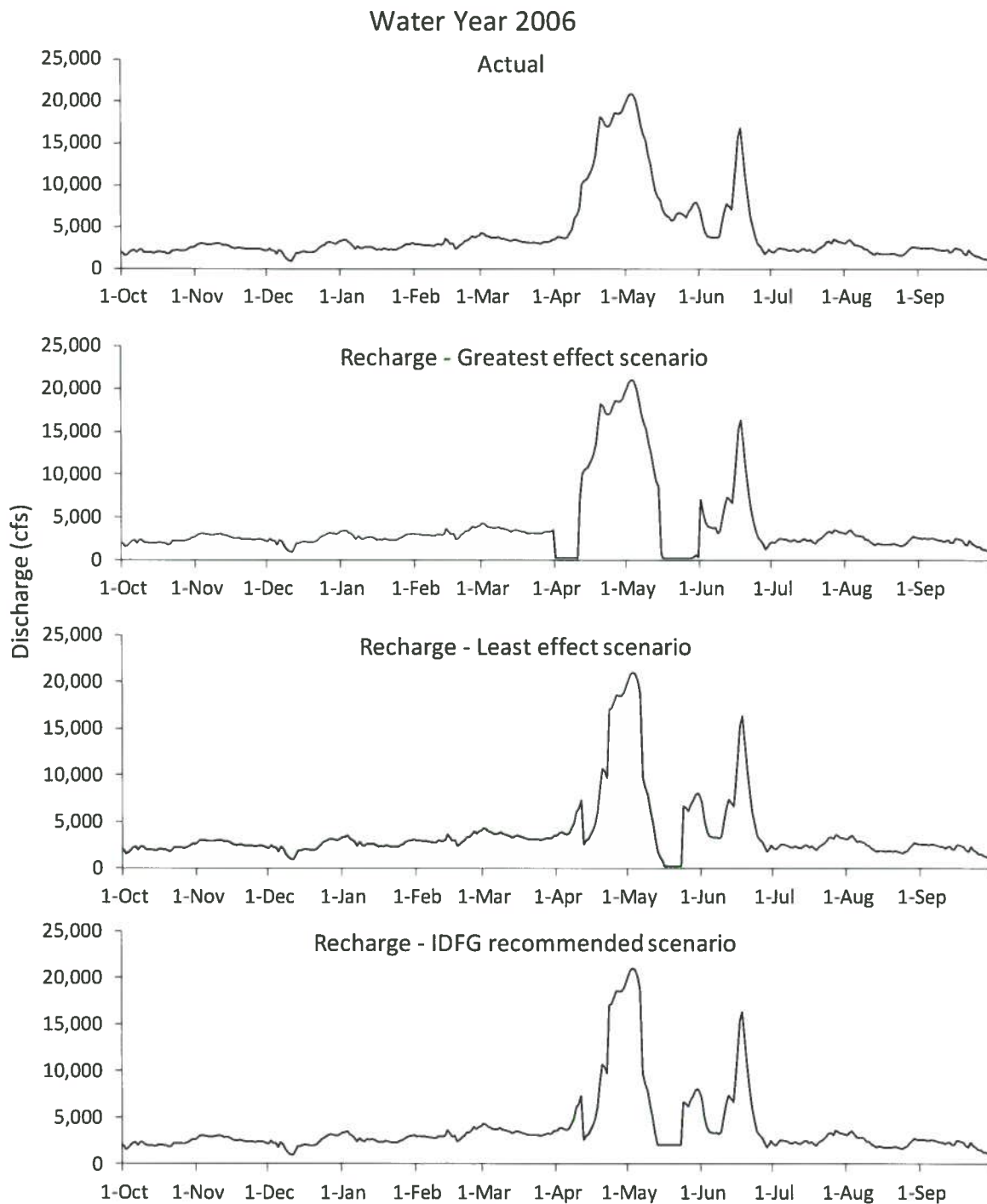


Figure 5. Actual hydrograph for water year 2006, greatest effect and least effect recharge scenarios, and a recommended recharge scenario (if recharge is implemented) that reduces impacts to fish and wildlife. All simulated hydrographs except “actual” reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

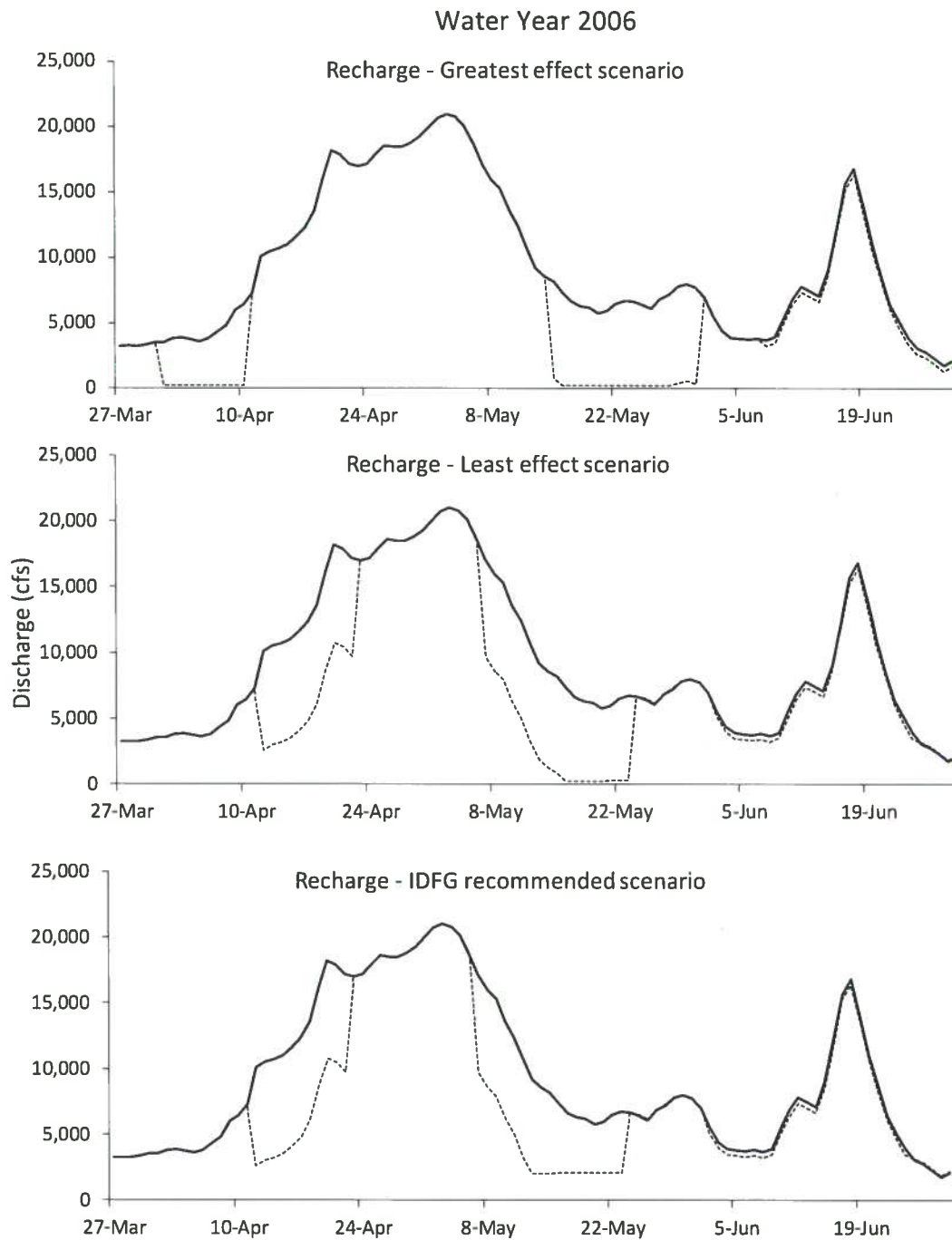


Figure 6. Hydrograph in year 2006 during months with altered flow if the proposed water recharge diversions had been implemented. Solid lines are the actual hydrograph whereas dashed lines are the altered scenarios if recharge had occurred. All scenarios except the actual hydrograph reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

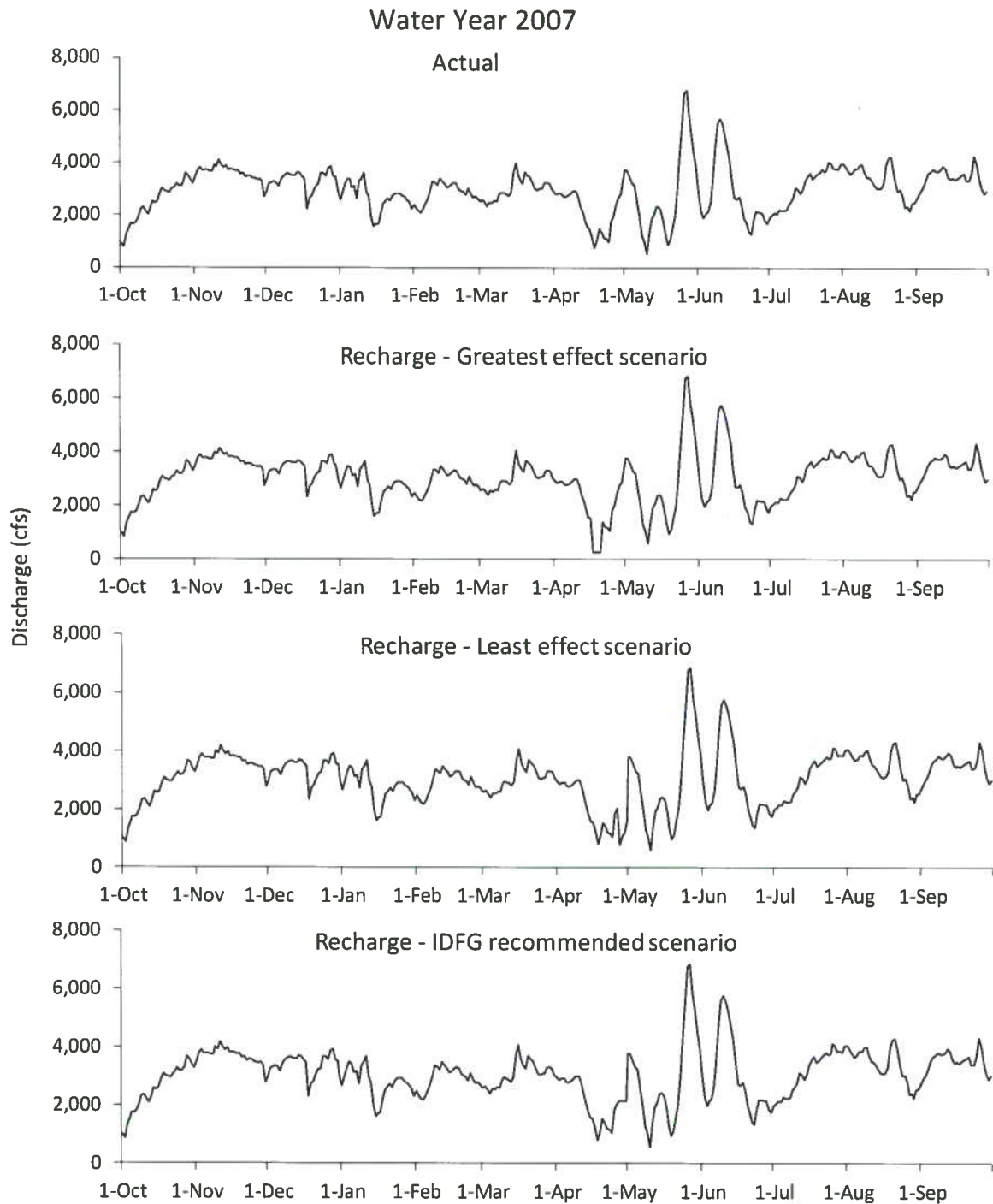


Figure 7. Actual hydrograph for water year 2007, greatest effect and least effect recharge scenarios, and a recommended recharge scenario (if recharge is implemented) that reduces impacts to fish and wildlife. See page 16 for explanations of recharge scenarios.

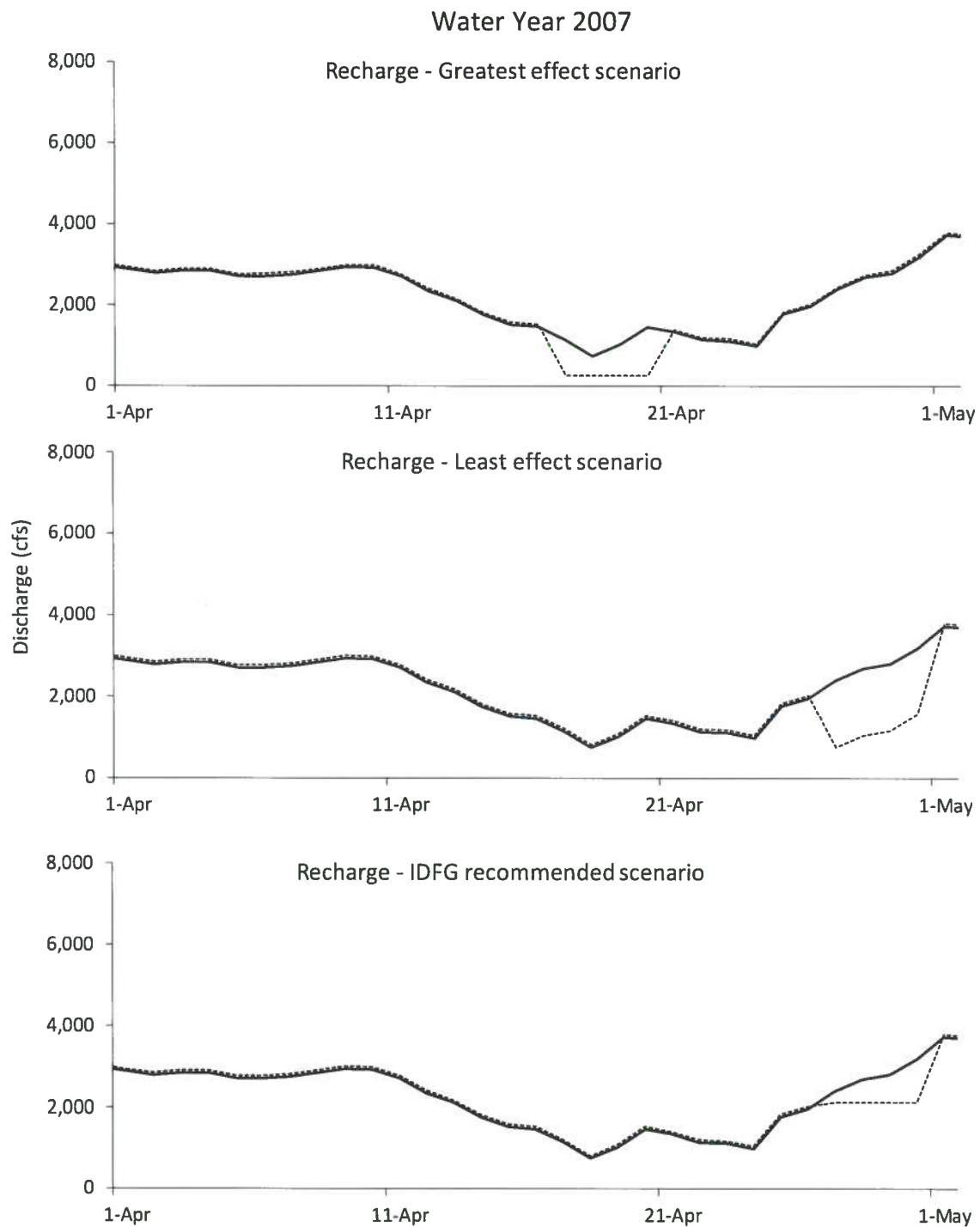


Figure 8. Hydrograph in year 2007 during months with altered flow if the proposed water recharge diversions had been implemented. Solid lines are the actual hydrograph whereas dashed lines are the altered scenarios if recharge had occurred. See page 16 for explanations of recharge scenarios..

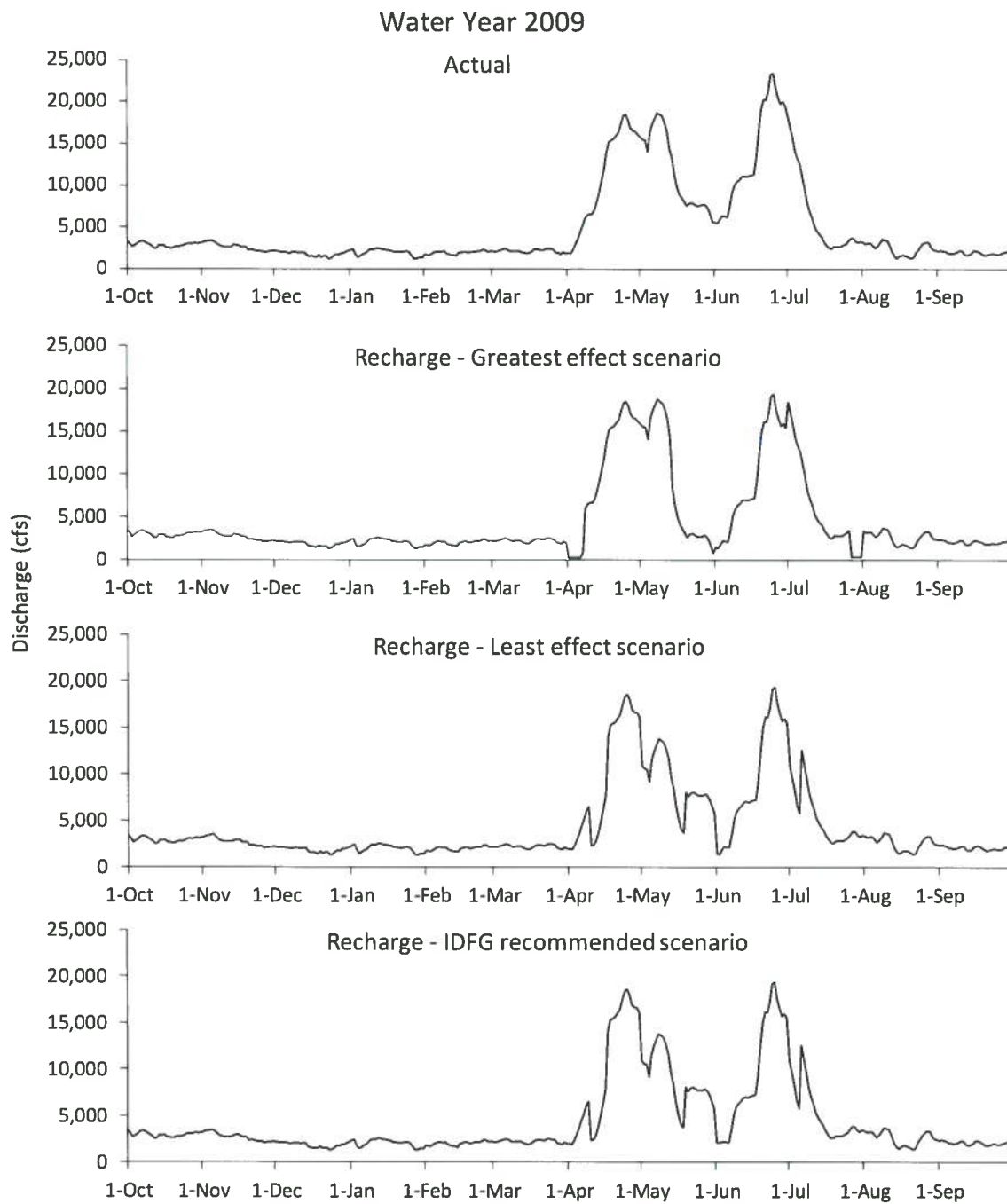


Figure 9. Actual hydrograph for water year 2009, greatest effect and least effect recharge scenarios, and a recommended recharge scenario (if recharge is implemented) that reduces impacts to fish and wildlife. All simulated hydrographs except “actual” reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

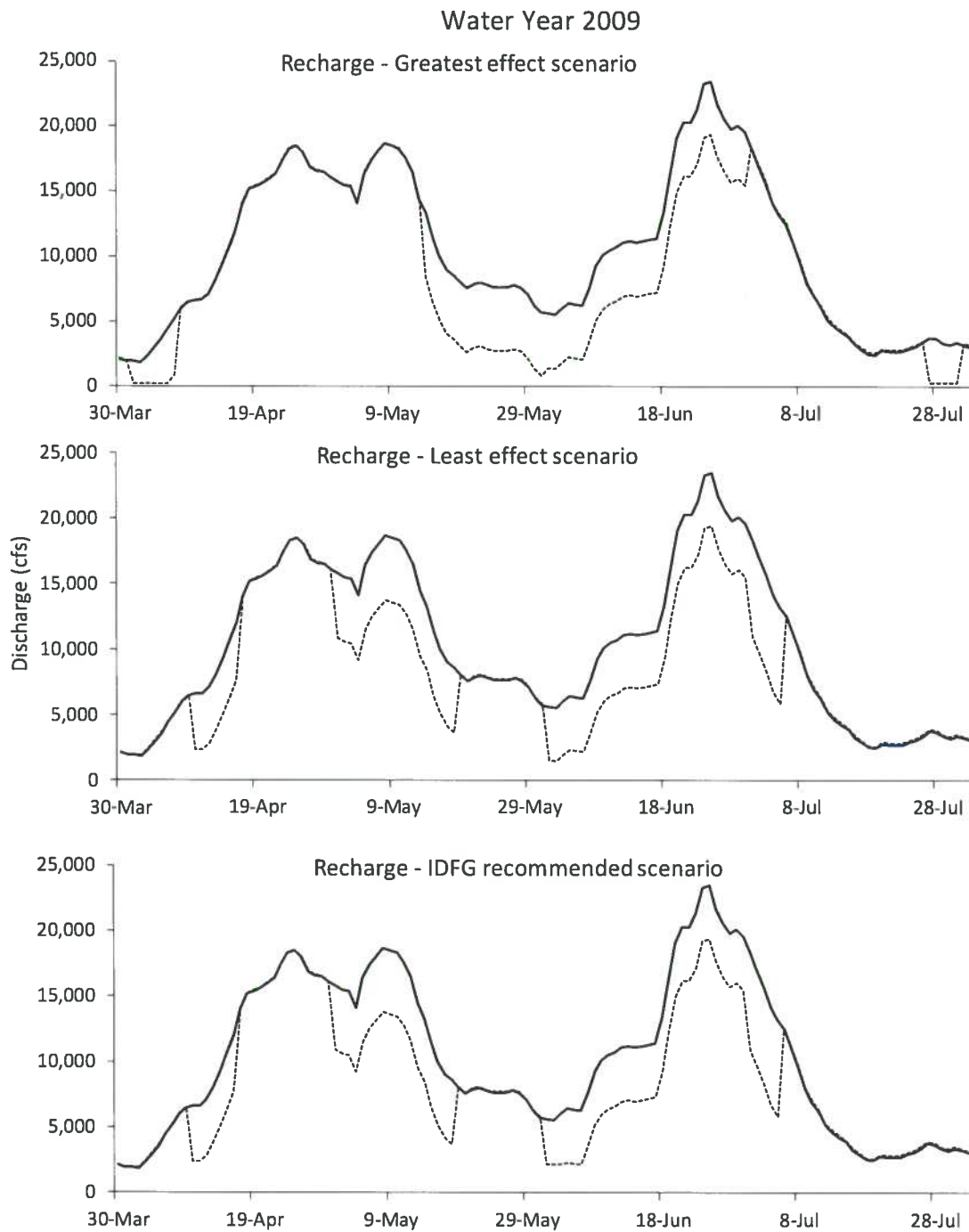


Figure 10. Hydrograph in year 2009 during months with altered flow if the proposed water recharge diversions had been implemented. Solid lines are the actual hydrograph whereas dashed lines are the altered scenarios if recharge had occurred. All scenarios except the actual hydrograph reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

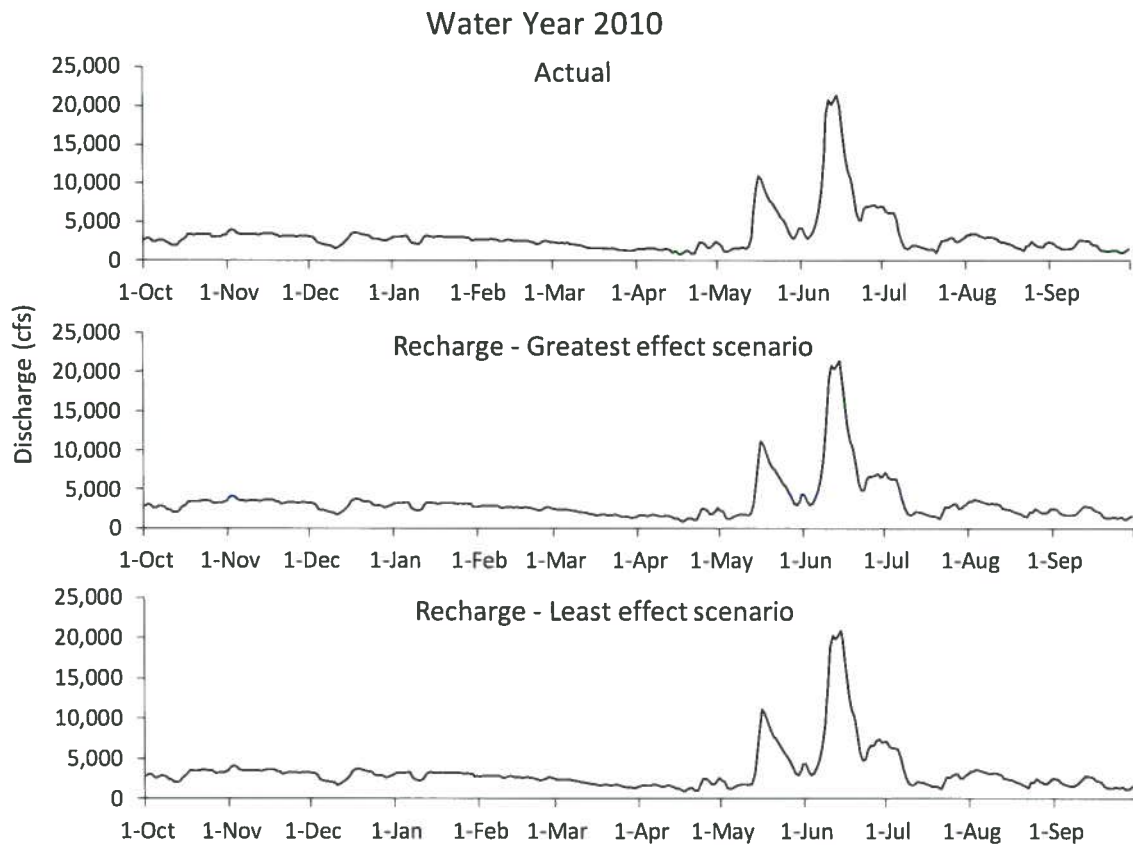


Figure 11. Actual hydrograph for water year 2010, and greatest effect and least effect recharge scenarios if recharge is implemented. Recommended recharge scenario is not depicted because for water year 2010 it would have been identical to the least effect scenario. All simulated hydrographs except “actual” reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

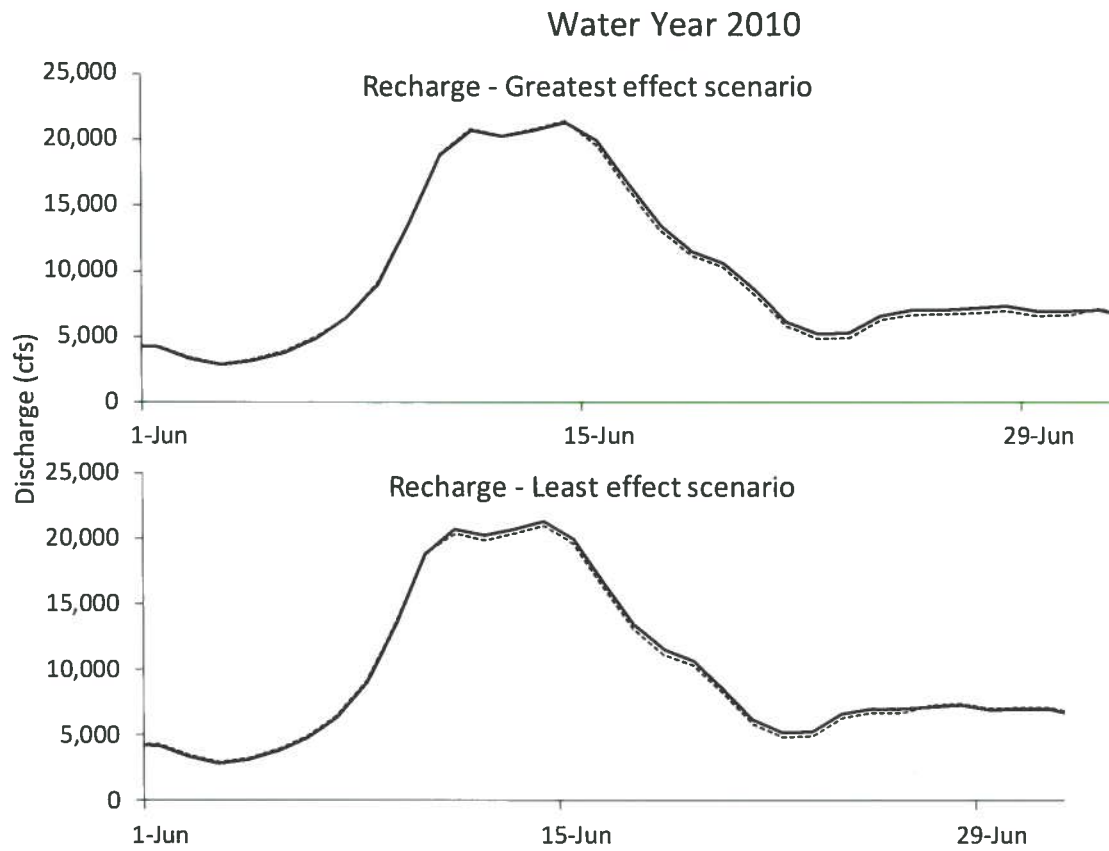


Figure 12. Hydrograph in year 2010 during months with altered flow if the proposed water recharge diversions had been implemented. Solid lines are the actual hydrograph whereas dashed lines are the altered scenarios if recharge had occurred. Recommended recharge scenario is not depicted because for water year 2010 it would have been identical to the least effect scenario. All scenarios except the actual hydrograph reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

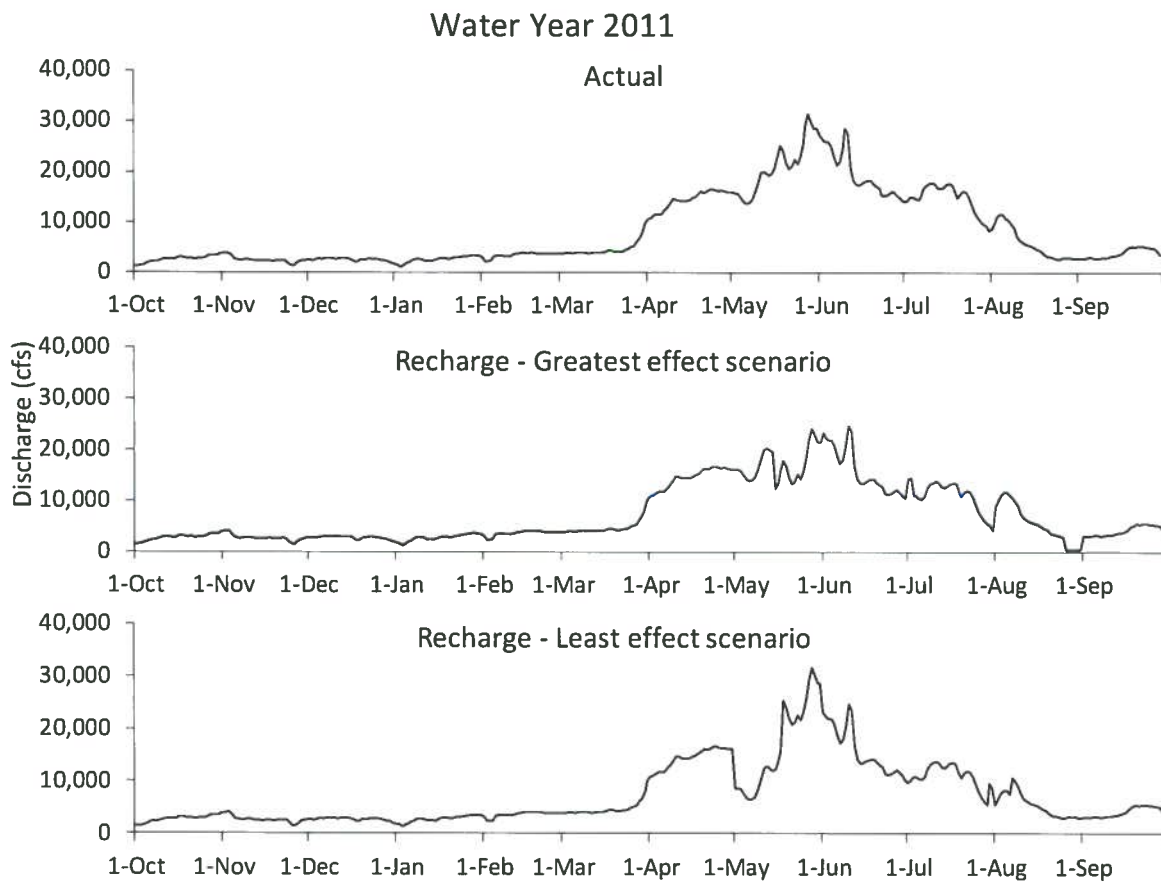


Figure 13. Actual hydrograph for water year 2011, and greatest effect and least effect recharge scenarios if recharge is implemented. Recommended recharge scenario is not depicted because for water year 2011 it would have been identical to the least effect scenario. All simulated hydrographs except “actual” reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

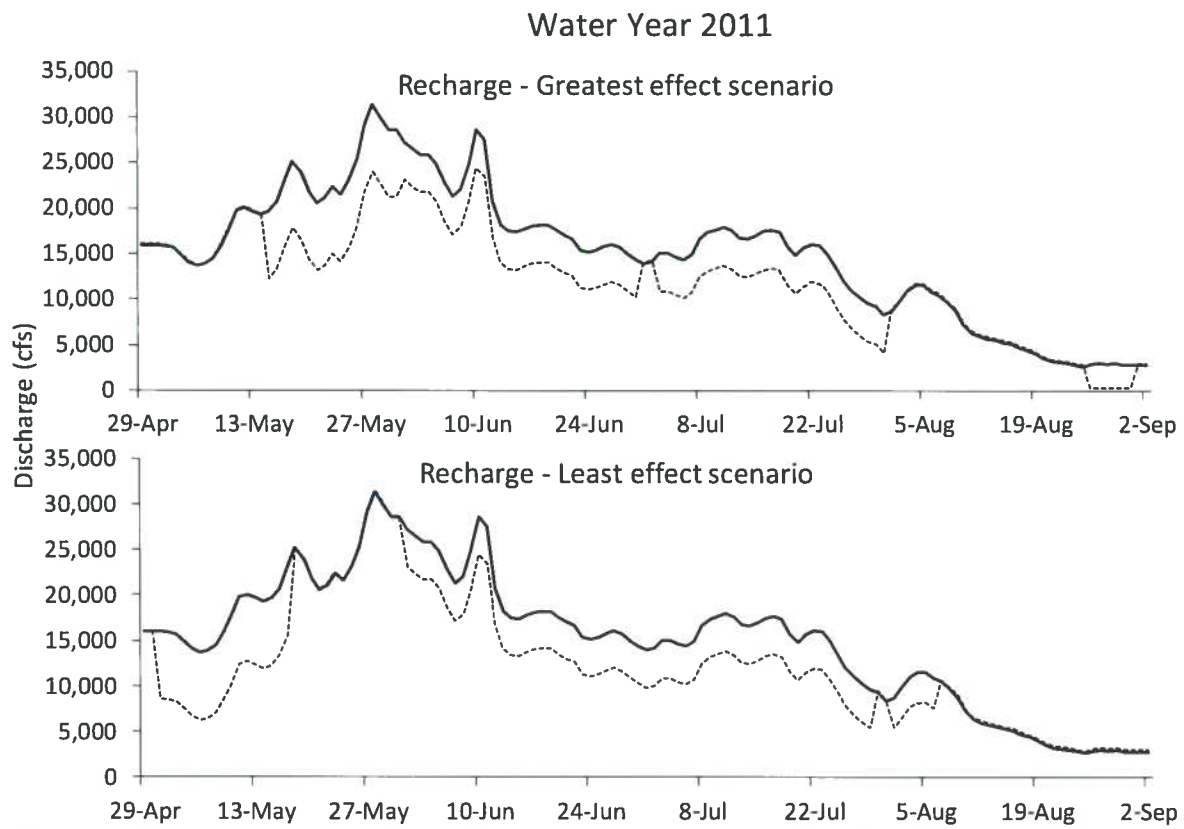


Figure 14. Hydrograph in year 2011 during months with altered flow if the proposed water recharge diversions had been implemented. Solid lines are the actual hydrograph whereas dashed lines are the altered scenarios if recharge had occurred. Recommended recharge scenario is not depicted because for water year 2011 it would have been identical to the least effect scenario. All scenarios except the actual hydrograph reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

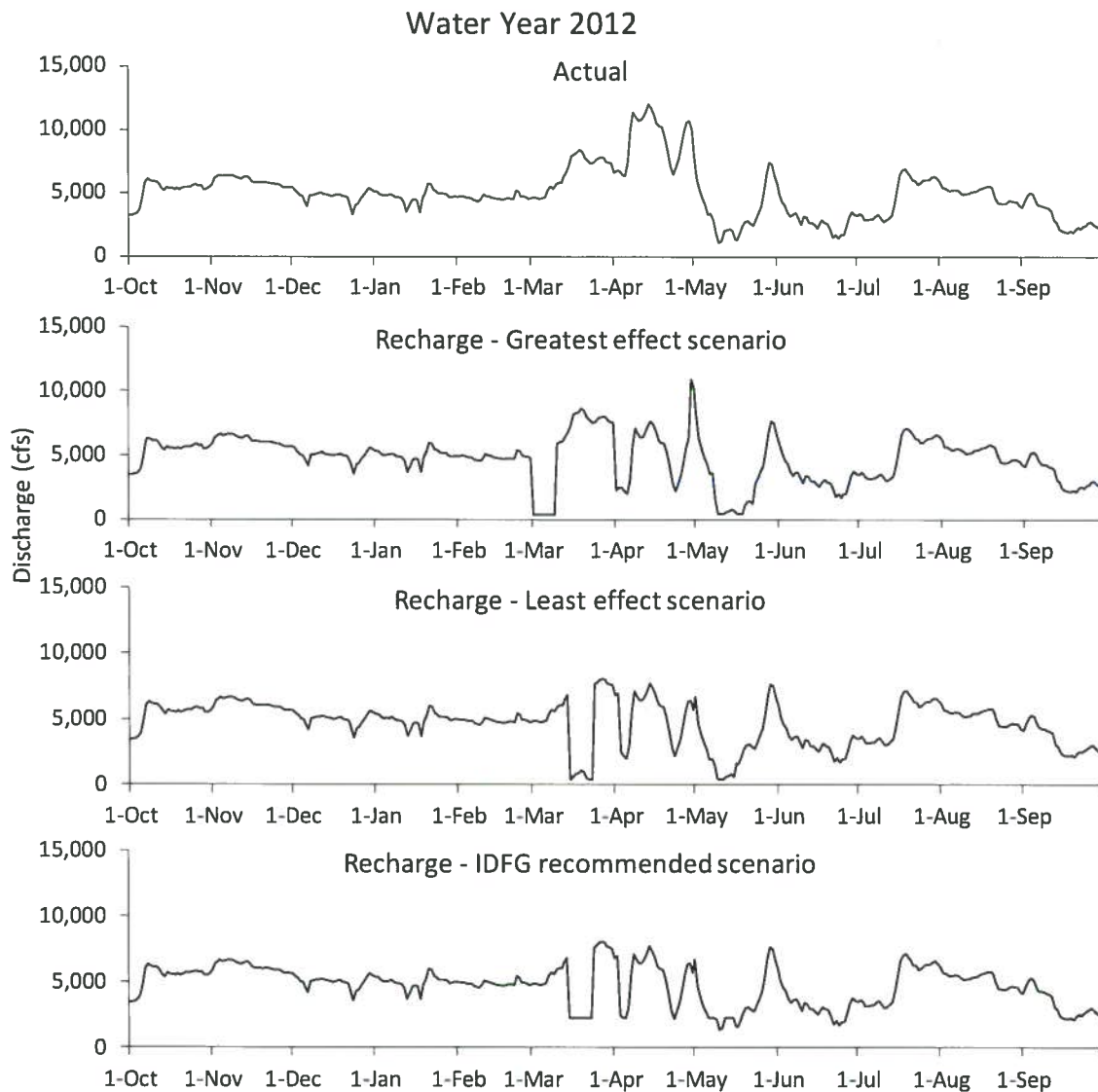


Figure 15. Actual hydrograph for water year 2012, greatest effect and least effect recharge scenarios, and a recommended recharge scenario (if recharge is implemented) that reduces impacts to fish and wildlife. All simulated hydrographs except “actual” reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.

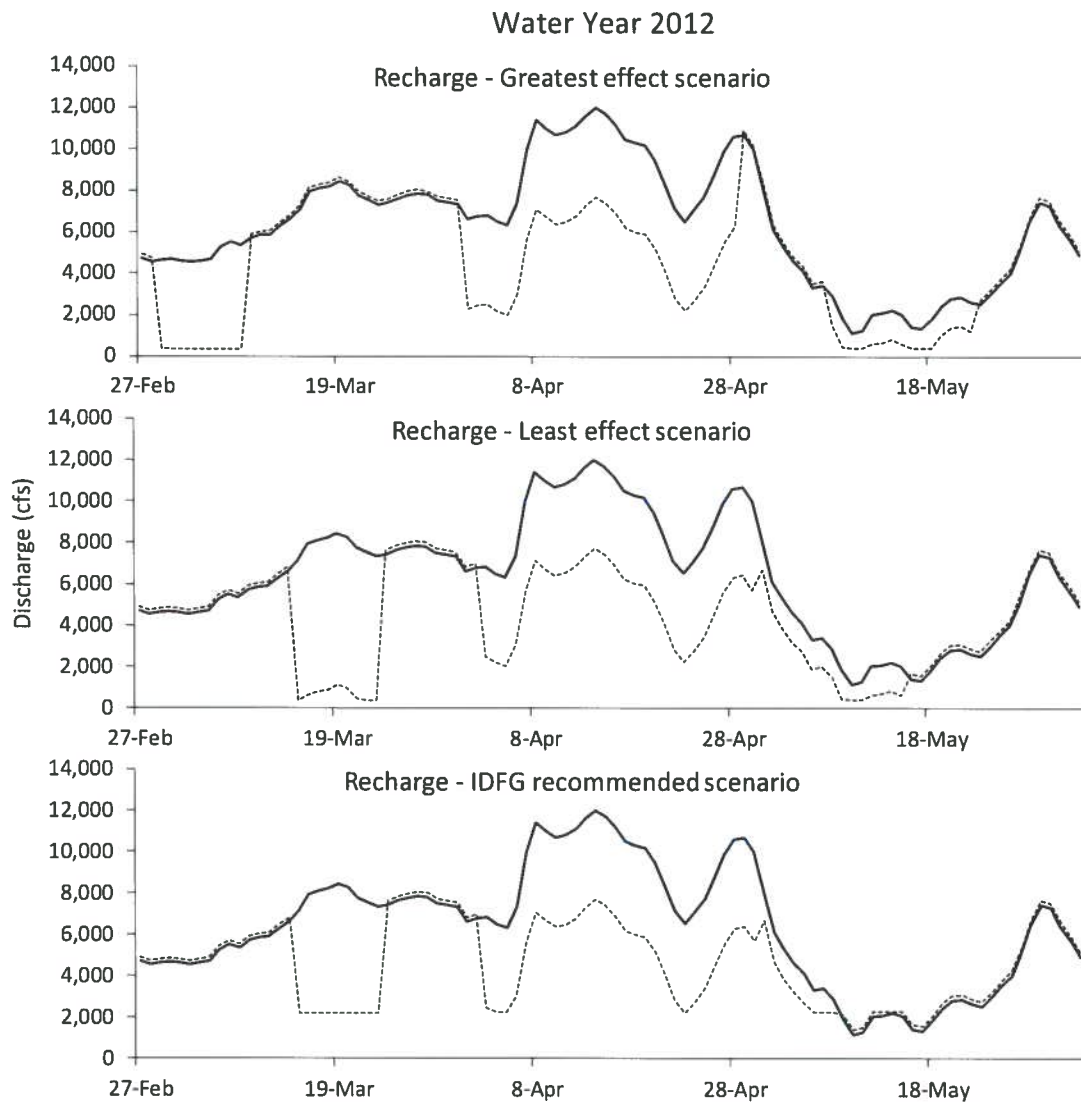


Figure 16. Hydrograph in year 2012 during months with altered flow if the proposed water recharge diversions had been implemented. Solid lines are the actual hydrograph whereas dashed lines are the altered scenarios if recharge had occurred. All scenarios except the actual hydrograph reflect recharge in excess of 250,000 acre-feet annually. See page 16 for explanations of recharge scenarios.