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14. ABSTRACT
This report details modeling to: 1) codify flow-ecology relationships for riparian species of the Bill Williams River as operational guidance for water managers, 2) test the guidance under different climate scenarios, and 3) revise the operational guidance as needed to address the effects of climate change. Model applications detailed herein include the River Analysis System (HEC-RAS) and the Ecosystem Functions Model (HEC-EFM), which was used to generate more than three million estimates of local seedling recruitment areas. Areas were aggregated and compared to determine which scenarios generated the most seedling area per unit volume of water. Scenarios that maximized seedling area were grouped into a family of curves that serve as guidance for water managers. This work has direct connections to water management decision-making and builds upon and adds to the rich history of science-based management for the Bill Williams River, Arizona, USA.

15. SUBJECT TERMS
Bill Williams River, Climate Change, Modeling, Ecosystem Functions Model (HEC-EFM), River Analysis System (HEC-RAS), Reservoir Operations, Riparian Seedling Recruitment, Flow-Ecology, LIDAR, *Populus fremontii*, *Salix gooddingii*, non-native *Tamarix* spp., Recession Tables, Southwestern U.S. Rivers

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Abbreviations

ArcGIS	ArcGIS is a registered trademark of ERSI, Inc.
BCSD	Bias-Corrected and Spatially Downscaled
BWRCSC	Bill Williams River Corridor Steering Committee
cfs	cubic feet per second
cm	centimeter
CMIP	Coupled Model Intercomparison Project
cms	cubic meters per second (also m^3/s)
GCM	Global Circulation Model
GIS	Geographic Information System
ha	hectare
ha-m	hectare - meter
HEC	Hydrologic Engineering Center
HEC-EFM	Hydrologic Engineering Center's Ecosystem Functions Model (software)
HEC-RAS	Hydrologic Engineering Center's River Analysis System (software)
IWR	Institute for Water Resources
km	kilometer
LCC	Landscape Conservation Cooperative
LIDAR	Light Detection and Ranging
m	meter
mi	mile
NCDC	National Climatic Data Center
RCP	Representative Concentration Pathway
s	second
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Executive Summary

John T. Hickey[1], Andrew Hautzinger[2], Steven E. Sesnie[2], Patrick B. Shafroth[3], Dick Gilbert[4], and Woodrow L. Fields[1]

Evolution of policies that guide operation of individual reservoir systems begins with a relative flurry of activity associated with the building of dams. Over perhaps a ten year period, operations are proposed in anticipation of construction, implemented when the dam is complete, and then modified as the effects, capabilities, and limitations of the project become better understood. After these initial adjustments, the policy process slows to a simmer. Operational changes are then driven by short-term influences that are largely episodic (e.g., droughts and floods) and long-term influences (e.g., social and economic factors) that affect operations more gradually.

Science is a long-term and waxing influence. As scientific understanding advances, it simultaneously grows as a resource for managers and as a line of reasoning that compels its consideration. In hydrologic and ecological sciences, recent decades have seen a growing focus on refinement of relationships that link hydrodynamics with ecosystem responses. Advocates for the ecosystem services that reservoirs provide or could provide uphold this knowledge as a foundation for improving environmental operating strategies at existing reservoirs. To water managers, this is both an opportunity and a challenge.

Water managers have a keen understanding of water and the services provided by manipulating its flow. Ideas about strategies with potential to yield different benefits interest water managers at a very fundamental level. Their challenge is to understand how changing operations to realize this potential might affect the gamut of other purposes for which the reservoir is operated. Traditionally, the types of tools used by water managers to analyze these tradeoffs have been more proficient at assessing services such as hydropower generation and flood reduction than management of natural resources. This remains true today, though the gap has narrowed.

Since the early 1990's, the Bill Williams River Corridor Steering Committee (BWRCSC) has served as a group of stakeholders interested in the management of the Bill Williams, a remote river in a largely undeveloped watershed that hosts both a U.S. Army Corps of Engineers (USACE) reservoir with a high degree of control on river flows and a riparian corridor of regional ecological significance (www.billwilliamsriver.org). Through communications and coordination, the Steering Committee provides the USACE input regarding reservoir operations, while encouraging sound and consistent approaches to natural resource management with an emphasis on science-based decision-making informed via field experiments, study, and documentation. The Committee, in cooperation with scientists, engineers, and other professionals from a variety of organizations, has nurtured both the investigation of ecological dynamics and the application of engineering models related to flow management for the Bill Williams River.

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This Desert Landscape Conservation Cooperative (Desert LCC) project applies this rich scientific understanding and technological capability to: 1) codify flow-ecology relationships for riparian species of the Bill Williams River as operational guidance for water managers, 2) test the guidance under different climate scenarios, and 3) revise guidance as needed to address the effects of climate change such that rules allow responsible and adaptive management of water to maintain or enhance riparian habitats.

Thousands of model runs by the Ecosystem Functions Model (HEC-EFM) generated more than three million estimates of local riparian seedling potential recruitment areas. These areas were then aggregated and compared to determine which runs generated the most potential seedling area per unit volume of water. Runs that maximized potential seedling area were grouped into a family of curves that serve as guidance for water managers. Specifically, water managers with a particular volume of water to commit to generation of riparian seedlings can use the guidance to determine how high seedling recruitment flows should go, how the flows should recede, and how much seedling area is anticipated.

This guidance was applied in hindsight to a 2006 experimental release that was timed and shaped to recruit Fremont Cottonwood (*Populus fremontii*) and Goodding's Willow (*Salix gooddingii*) while minimizing initiation of non-native Salt Cedar (*Tamarix spp.)*. It was found that potential seedling recruitment area would have increased 76 percent by reshaping the recession volume of the historical experimental release per the guidance; if the whole event were reshaped, recruitment area would have increased by 145 percent.

Consideration of climate change was made possible by the online archives of climate and hydrologic projections hosted by the Bureau of Reclamation, Climate Analytics Group, Climate Central, Lawrence Livermore National Laboratory, Santa Clara University, Scripps Institution of Oceanography, USACE, U.S. Geological Survey, and National Center for Atmospheric Research (http://gdo-dcp.ucllnl.org/downscaled_cmip_projections). Historical and projected air temperatures, precipitation, and river flows were compared. Air temperatures were projected to increase with the mean annual average temperature increasing from 16.6 to 19.0 degrees Celsius. Annual precipitation rates were projected to decrease slightly, approximately negative one percent. Projected river flows were markedly different in character than the historical, which limited comparisons.

The slight change in projected precipitation suggests that climate change may prove more influential ecologically than hydrologically for this watershed. Germination periods are likely to occur earlier. If vegetative stresses are proportional to air temperatures, tolerable recession rates and summer survival of riparian vegetation are likely to decrease. These possible responses are important to the efficacy of this work, though it should be noted that the guidance defined herein is based on the interaction of landform and river flows. As new field data are collected that indicate changing ecological needs, water managers will simply need to consider the new conditions when deciding whether or how to use the family of curves. The guidance and information provided will not change directly with climate though periodic updating will be required to maintain an acceptable representation of land and channel forms.

This report has two chapters and two appendices. The first chapter covers development of the operational guidance for water managers, including model development, verification, application, and interpretation of results. The second details the climate change analysis and discusses how a changing climate affects the operational guidance. Appendix A revisits the scope and anticipated budgets of the project, while Appendix B contains the hydrograph recession data for the project.

Chapter 1

Modeling Flow-Ecology Relationships to Inform Reservoir Operations for Riparian Seedling Recruitment

Woodrow L. Fields, John T. Hickey, and Patrick B. Shafroth

Recognition of the importance of riparian ecosystems has sparked interest in understanding processes that drive the distribution and abundance of dominant riparian plants. Changes in streamflow patterns downstream of dams have profoundly affected riparian vegetation composition and structure. For example, in the southwestern United States, flow regulation has contributed to the replacement of many riparian forests historically dominated by the native *Populus fremontii* (Fremont Cottonwood) and *Salix gooddingii* (Goodding's Willow) by exotic *Tamarix* spp. (Salt Cedar). In this chapter, we describe a generic modeling framework to provide guidance to water managers for implementing environmental flows. Modeling involves the U.S. Army Corps of Engineer (USACE) Hydrologic Engineering Center's (HEC) Ecosystem Functions Model (HEC-EFM) and River Analysis System (HEC-RAS), ESRI's ArcMap, and Applied Imagery's Quick Terrain Modeler. As an example, we apply this framework to define operational guidance to maximize downstream recruitment of native *Populus* and *Salix* species below Alamo Dam on the Bill Williams River, Arizona, U.S.A. Interpretation of modeling results on the Bill Williams River culminates in guidance that managers of Alamo Dam can readily apply during operations and incorporate into policy.

1.1 Introduction

Dams have altered river systems globally, causing alterations to river-dependent ecosystems (Poff et al. 1997, Postel and Richter 2003) and consequent interest in restoration (Bernhardt et al. 2005, Hirji and Davis 2009, Petts 2009, Richter and Thomas 2007, Poff et al. 2010). Managing reservoirs to achieve ecological purposes is one example of implementing “environmental” flows, a globally expanding field in both water management and environmental restoration (Hughes et al. 2005, Arthington et al. 2006, Konrad et al. 2011, Zhang et al. 2011). Various approaches have been developed to define flow needs for ecosystem components (King et al. 2003, Richter et al. 2006, Chan et al. 2012, Zhang et al. 2012). However, there are relatively few tools to assist reservoir and dam operators with quantifying potential benefits of these endeavors.

Growing appreciation of the importance of riparian ecosystems for fish and wildlife habitat, water quality, and other ecosystem functions has raised interest in obtaining an improved understanding of the processes that drive riparian vegetation dynamics (Busch and Smith 1995, Scott et al. 1996, Naiman et al. 2005, Marks et al. 2014). Factors that exert the greatest influence on riparian vegetation are directly or indirectly related to streamflow (Stromberg et al. 2007a). For example, large floods and associated disturbance influence the establishment, mortality, and distribution of riparian vegetation. Stresses from low streamflow or deep water tables influence plant survival, growth, and species composition (Stromberg et al. 1996, Shafroth et al. 2002).

In the Southwestern United States, many riparian forests historically dominated by the native *Populus fremontii* (Fremont Cottonwood) and *Salix gooddingii* (Goodding's Willow) have been replaced by non-native species in the genus *Tamarix* (Salt Cedar; Pataki et al. 2005, Nagler et al. 2011), at least in part due to flow regulation (Stromberg et al. 2007b, Merritt and Poff 2010). Changes to key flow components for seedling establishment such as the timing of peak flows relative to seed dispersal timing and recession rates can favor *Tamarix* (Shafroth et al. 1998). *Tamarix* can form dense monocultures and influence vegetation structure, animal species diversity, soil salinity, and hydraulic characteristics of sites where it becomes dominant (Shafroth et al. 2005, Nagler et. al. 2008). Where seedlings of multiple species co-occur, the native *Populus* and *Salix* are capable of outcompeting *Tamarix* given availability of sufficient soil moisture (Sher et al. 2000, Bhattacharjee et al. 2008).

Land and water managers have long sought to reduce the abundance of *Tamarix* and increase the abundance of *Populus* and *Salix* along rivers in the western U.S. Given the connections between flow regime and establishment of these riparian seedlings, one means to both control *Tamarix* and expand *Populus* and *Salix* is to manage streamflow downstream of dams to favor the native taxa (Stromberg 2001, Rood et al. 2005, Shafroth et al. 2008). Key streamflow components have been linked to requirements for seedling establishment in models, most notably the "recruitment box" (Mahoney and Rood 1998) and applied to environmental flow prescriptions that seek to promote native riparian tree establishment (Rood et al. 2003; Shafroth et al. 2010; Morrison and Stone 2015).

This chapter describes a framework that uses generic software and methods to provide clear guidance to water managers on how to implement environmental flows. The framework is applied to codify operational guidance for Alamo Dam and Lake, a multi-purpose reservoir on the Bill Williams, and relies heavily on the assemblage of flow-biota research and field science focused on riparian vegetation dynamics of the Bill Williams River (e.g., Shafroth et al. 1998, Shafroth et al. 2010, Stromberg et. al. 2012, Wilcox and Shafroth 2013). Ecological and river hydraulic models were developed and calibrated using hydrologic data and field observations from an experimental flow release in 2006. Models were then applied to arrays of hydrographs to identify those most conducive to seedling recruitment. Different hydrographs were evaluated based on their magnitude, shape, water volume required, and area of potential seedling recruitment stimulated to inform reservoir operations. Investigations focused on recession-limb operations of flood hydrographs such that results of this work guide reservoir managers in the shaping and release of stored waters to best support establishment of desired riparian seedlings.

1.2 Study Area

The Bill Williams River is approximately 58 kilometers long and flows from Alamo Reservoir through the Buckskin Mountains in west central Arizona to the Colorado River at Lake Havasu, just above Parker Dam. It is the largest tributary of the Colorado River between the Virgin and Gila Rivers. The Bill Williams River drops from an elevation of approximately 338 meters to an elevation of 137 meters, with an average gradient of 0.003 degrees (slope ranges between 0.001-0.009) and passes through canyons interspersed with alluvial basins (Figure 1). The most notable alluvial basin is the roughly 12 km long Planet Valley, located 14-26 km upstream of the confluence with Lake Havasu on the Colorado River. Channel bed and floodplain sediments are dominated by coarse particles, primarily sand, and are generally low in electrical conductivity (Shafroth et al. 1998). Flood flows of 35.1 m^3/s and larger readily transport the poorly consolidated sand (Hautzinger et al. 2006). Average annual precipitation in the watershed ranges from 23 cm near Alamo Dam (NCDC station 020100 Alamo Dam) to 12.2 cm near the Colorado River (NCDC station 026250 Parker 6 NE). Historically, the Bill Williams River is prone to large flood events: the estimated pre-dam 10 year flood magnitude is approximately 1,811 m^3/s.

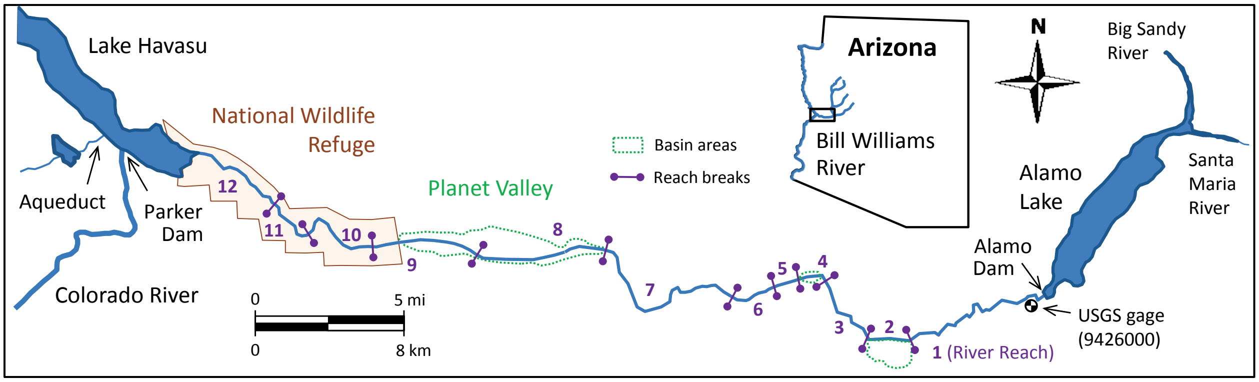


Figure 1. Map of the Bill Williams River study area, Arizona, USA.

Riparian zones along the Bill Williams River are comprised of a combination of ranch lands, riparian land, and crop fields. Vegetation in the riparian corridor is relatively diverse (Stromberg et al. 2012) and is dominated by woody species including *Populus fremontii, Salix gooddingii, Baccharis salcifolia* (mulefat), *Tamarix* spp. (*T. chinensis, T. ramosissima*, and/or hybrids), *Pluchea sericea* (arrowweed), *Hymenoclea monogyra* (burrobrush), and *Prosopis* spp. (*P. velutina* and *P. glandulosa*; mesquite).

Alamo Dam was constructed between 1963 and 1968 by USACE as a multipurpose project under authorization of the Flood Control Act of 1937. Congress authorized the dam with specific storage allocations for flood control, water conservation, and recreation. Hydropower was authorized, but not developed. Fish and wildlife was added as a purpose after construction (USACE 1992, USACE 2003). The outlet works include three large slide gates, which allow a maximum gated release of 198 m^3/s (7,000 cfs). Completion of Alamo Dam in 1968 drastically altered the system's flow regime, particularly by reducing the magnitude of peak flows and increasing base flows in recent decades (House et al. 2006, Shafroth et al. 2010). Riparian vegetation along the river corridor expanded greatly after dam completion, particularly *Tamarix* (Shafroth et al. 2002).

A new approach to managing Alamo Dam that optimized natural resource and recreation benefits while meeting reservoir operation requirements was endorsed in 1994 (BWRCTC 1994) and later incorporated into the water control manual by the USACE Los Angeles District (USACE 2003). Since that manual update, several experimental releases from Alamo have been implemented to clarify flow-ecology relationships, including small floods and recessions to recruit riparian vegetation, particularly native *Populus fremontii* and *Salix gooddingii* (Shafroth et al. 2010). The modeling described herein follows and builds on that history of experimentation and associated field science. Guidance resulting from model outputs is envisioned for inclusion in a future manual update for use within the context of all operational purposes. The Bill Williams River and Alamo Dam are part of the Sustainable Rivers Project whose goal is to define and implement environmental flows through adaptive reservoir management (Warner et. al. 2014).

1.3 Model Development

Land surface, vegetation, and flow-ecology information were used to develop models that were then applied to define operational guidance for reservoir managers at Alamo Dam and Lake. While data are primarily specific to the Bill Williams River, the process described herein is generic and facilitated through the use of two software packages developed by the Hydrologic Engineering Center (HEC) of the USACE, both of which are free and publicly available (http://www.hec.usace.army.mil/). Models were developed, calibrated, validated, and applied for the entire length of the Bill Williams River, from Alamo Dam to its confluence with the Colorado.

To analyze relationships between ecosystem dynamics and hydrology, version 2.0 of the Ecosystem Functions Model (HEC-EFM; USACE 2013; Hickey et al. 2015) was used. Central to HEC-EFM is the concept of functional relationships which link characteristics of hydrologic and hydraulic time series (flow and stage) to elements of the ecosystem through a combination of four basic criteria: season, duration, rate of change, and frequency. For hydraulic analysis of the Bill Williams River, the river analysis system HEC-RAS version 4.0.1 Beta (USACE 2008) and its companion HEC-GeoRAS Version 4.2.93 were applied. HEC-RAS performs one-dimensional steady (individual flow rates, as in this application) and one- and two-dimensional unsteady (time series of flow rates) hydraulic calculations for networks of natural and constructed channels.

1.3.1 Ecological Model

The general ecological relationship addressed was seedling recruitment for three riparian tree species that commonly occur along the Bill Williams and other western North American rivers: native *Populus fremontii* and *Salix gooddingii*, and non-native *Tamarix* spp. Recruitment of new cohorts is dependent on high flows that occur and recede during seed dispersal and germination periods and stage recession rates that can be tolerated by young seedlings. For analysis with EFM, three distinct eco-hydrological relationships were developed for each of the three species: timing of seed dispersal, tolerable rate of stage recession, and tolerable duration of inundation following germination and early establishment.

Each of the three riparian tree species has a unique period of seed dispersal and tolerable rate of stage recession, though they may overlap (Table 1a). *Salix gooddingii* disperses seeds later than the *Populus fremontii* on the Bill Williams River and thus tends to germinate either in response to later floods or to a later period of the flood recession limb. Seed dispersal of the non-native *Tamarix* species begins later than that of *Populus fremontii* on the Bill Williams (Shafroth et al. 1998), though not all rivers in Western North America follow this trend (Cooper et al. 1999), and continues throughout the growing season and into fall months. Thus, *Tamarix* is not nearly as dependent as *Populus* or *Salix* on precisely timed floods for establishment. After germination, seedling survival is a function of the rate of stage recession (Mahoney and Rood 1991, Horton and Clark 2001, Stella et al. 2010). As surface waters recedes, seedling root growth must keep pace with the declining shallow groundwater table, which is closely connected to surface waters because the substrate of the Bill Williams River is mainly sand and very well-drained. Seed dispersal periods and rates of stage recession considered for the three species (Table 1a) were defined based on observational data from the Bill Williams River (Shafroth et al. 1998) and experimental studies (Mahoney and Rood 1991, Horton and Clark 2001, Stella et al. 2010). Multiple recession rates were used to better represent the range of viable recession rates documented in the literature and allowed for a more detailed comparison of simulated and observed seedling recruitment. In HEC-EFM, each combination of season and recession rate was modeled as a separate relationship.

Following germination and early growth, survival can be affected by subsequent inundation. Eight and 10-week-old *Tamarix* species have been reported to be completely killed if inundated for 4 weeks (Horton et al. 1960). Five to seven-week-old *Tamarix* were reported to have greater than 99% mortality when submerged during fall for 25 days (Gladwin and Roelle 1998). *Salix gooddingii* has been found the most tolerant to inundation of the three species in this study (Vandersande et al. 2001). Cottonwoods are least tolerant to inundation of the three species. Eastern Cottonwood, *Populus deltoides*, seedlings die following 16-32 days of complete submergence (Hosner 1958). Gladwin and Roelle (1998) reported a 21% survival of 9- to 10-week-old plains cottonwoods (*P. deltoides* ssp. *monilifera*) partially inundated for 25 days. Using inundation to control growth may be undesirable since submergence of desirable species may also occur (Sprenger et al. 2001, Tallent-Halsell and Walker 2002). HEC-EFM relationships for inundation mortality following the 2006 flood event are provided in Table 1b.

Table 1. Bill Williams River flow-ecology relationships developed for use in HEC-EFM.

a. EFM recruitment relationships			
Species	**Season start**	**Season end**	**Stage recession rates (cm/day)**
Populus fremontii	February 19th	April 13th	6.0, 4.0
Salix gooddingii	March 22nd	June 20th	6.0, 4.0
Tamarix spp.	March 29th	October 9th	6.0, 2.3
b. EFM inundation mortality relationships			
Species	**Season start**	**Season end**	**Sustained inundation**
Populus fremontii	March 30th	December 31st	20 days
Salix gooddingii	March 30th	December 31st	32 days
Tamarix spp.	March 30th	December 31st	25 days

1.3.2 Hydraulic Model

LIDAR-based elevation data and ortho-rectified imagery collected in March 2005 and September 2005, respectively, assisted in creating the hydraulic input data. A total of 341 cross sections were placed along a 61 km river centerline with land surface elevations along the cross sections obtained from the LIDAR data. Cross section locations were chosen to best represent channel geometry. With no perennial tributaries, the Bill Williams River was modeled as a single river reach. Roughness is an important parameter in hydraulic models and is well-described in engineering literature. It is a representation of resistance to flow and varies with the size, density, and orientation of objects and channel forms that affect the downstream passage of water. For the Bill Williams below Alamo Dam, a largely undeveloped and sand bed river, roughness of riverine and floodplain areas are primarily related to vegetation. The spatial distribution of vegetation was provided by an unpublished vegetation map produced from imagery taken in September 2005. The map had 16 cover types. Scientists and engineers familiar with the Bill Williams River and its vegetation ordered the cover types from most open ("bare sand bar") to most dense ("dense floodplain – *Tamarix*"). Corresponding roughness values for the 16 cover types were then estimated with guidance from the literature such that roughness increased with cover type order (Fasken 1963, Barnes 1967, Arcement and Schneider 1984, Hicks and Mason 1991, Phillips and Ingersoll 1998). Roughness values were applied along the length of the cross sections, varying per cover type in the vegetation map.

During calibration of the HEC-RAS model, the spatially distributed roughness values were adjusted such that simulated and observed water surface elevations of a 2005 high flow event (approximately 185 m^3/s; 6,600 cfs) at twenty river locations were matched as closely as possible by minimizing the sum of the squared differences between simulated and observed water surfaces. The mean, maximum, and minimum differences between simulated and observed water surface elevations were 0.10, 0.46, and -0.34 m, respectively. Roughness values were adjusted by the same multiplier for all cover types, which facilitated calibration and maintained the relative roughness order of the different cover types. Additional details about calibration are included in an unpublished document that is typically distributed with the HEC-RAS model application and is available upon request. Water surface elevations were generated with HEC-RAS Version 4.0.1 Beta and HEC-RAS Version 5.0 (the most recent version available online), compared, and found to have only slight differences (results identical at nineteen of the twenty calibration locations, and a +0.1 meters at one location).

After calibration, the river hydraulics model was used in two ways: 1) flow values ranging from 0.03 m^3/s to 227 m^3/s were simulated to produce flow-stage rating curves at each cross section for input to the HEC-EFM modeling component of the riparian seedling response analysis and 2) HEC-EFM results, in terms of flows that met the ecological criteria in Table 1, were simulated to generate maps of areas associated with seedling recruitment and inundation.

1.4 Model Verification

Riparian seedling responses to stage recession were assessed for the 2006 experimental event. Daily mean flows were obtained from the U.S. Geological Survey gage station (USGS; 09426000) located immediately below Alamo Dam. Corresponding stages were acquired using the flow-stage rating curves at each cross section from the HEC-RAS model. Each cross section has a unique rating curve, and therefore a unique stage hydrograph, based on its channel shape. Flow regimes comprised of the USGS flow time series and the local rating curve were added to HEC-EFM for each of the 341 hydraulics model cross sections.

HEC-EFM calculated ecological responses for seedling recruitment at each cross section. Specifically, HEC-EFM translated the flow hydrograph (Figure 2a) to local stage hydrographs using flow-stage rating curves produced by HEC-RAS for each cross section (Figure 2b) and then queried those stage series per the criteria in Table 1a to compute the local stages (Figure 2c) and corresponding flows (Figure 2d) at which the local hydrograph recession became suitable for seedling recruitment. This set of spatial HEC-EFM flow results (a flow at each cross section; Figures 2d and 3a) were simulated in HEC-RAS to generate maps (depth grids with a 3 m cell size) of areas associated with seedling recruitment such that each unique flow result had an associated depth grid for the whole river (Figure 3b). Depth grids were then spliced (in ArcGIS) at the mid-point between cross sections with differing flow results to create a single layer (Figure 3c). This process was done for each of the HEC-EFM functional relationships shown in Table 1a. The models were also used to investigate the sustained inundation that preempted recruitment or drowned seedlings per the criteria in Table 1b with HEC-EFM computing the limiting flow for each species and HEC-RAS generating the corresponding depth grids. Once splicing was complete, areas of inundation were removed (Figure 3d) leaving only viable areas of recruitment.

The resulting layer was a single mosaic of seedling recruitment areas that reflected both the hydrograph timing and shape and the corresponding local seedling responses (both recruitment and inundation) at each cross section. Mosaics were done for each combination of species and threshold recession rate (6; 3 species, each with 2 rates) for the 2006 experimental release.

1.4.1 Results for 2006 Flow Event

Local stage recessions were assessed by HEC-EFM at all cross section locations in the HEC-RAS model. Stage results, or the stage at which the local recession became suitable for recruitment, were translated to flow results via local rating curves and are presented in Figure 3 for *Populus fremontii*. In comparison with the other species, *Populus* had higher flow results at a greater number of cross sections (Table 2; HEC-EFM results displayed in Figure 3 are summarized in Table 2), which means that more of the recession was suitable for *Populus* recruitment than for the other

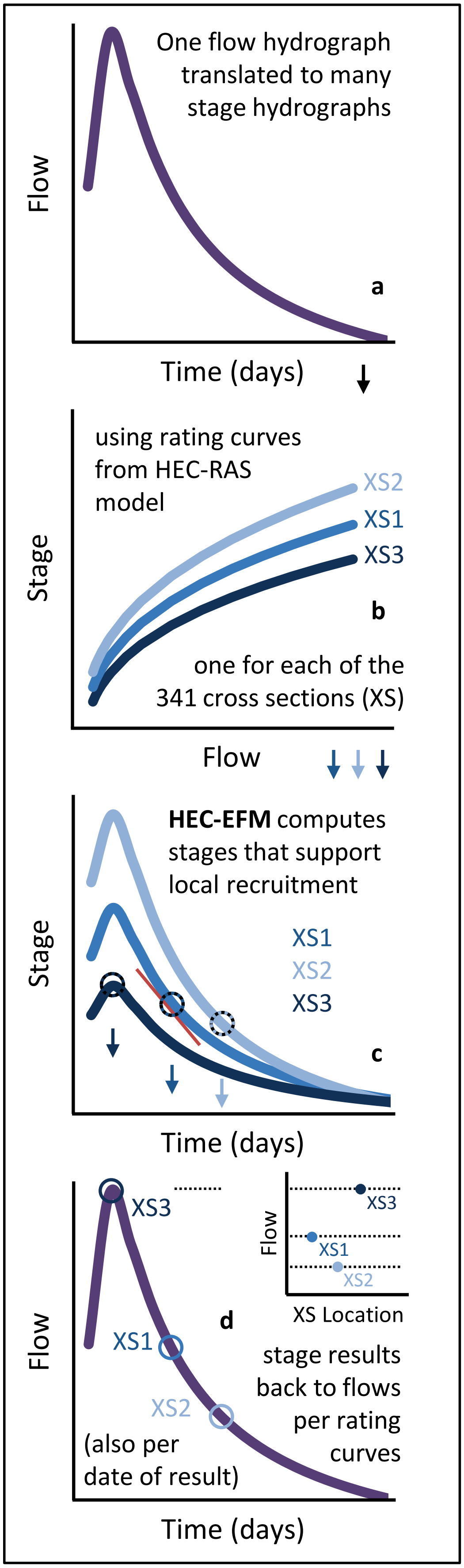
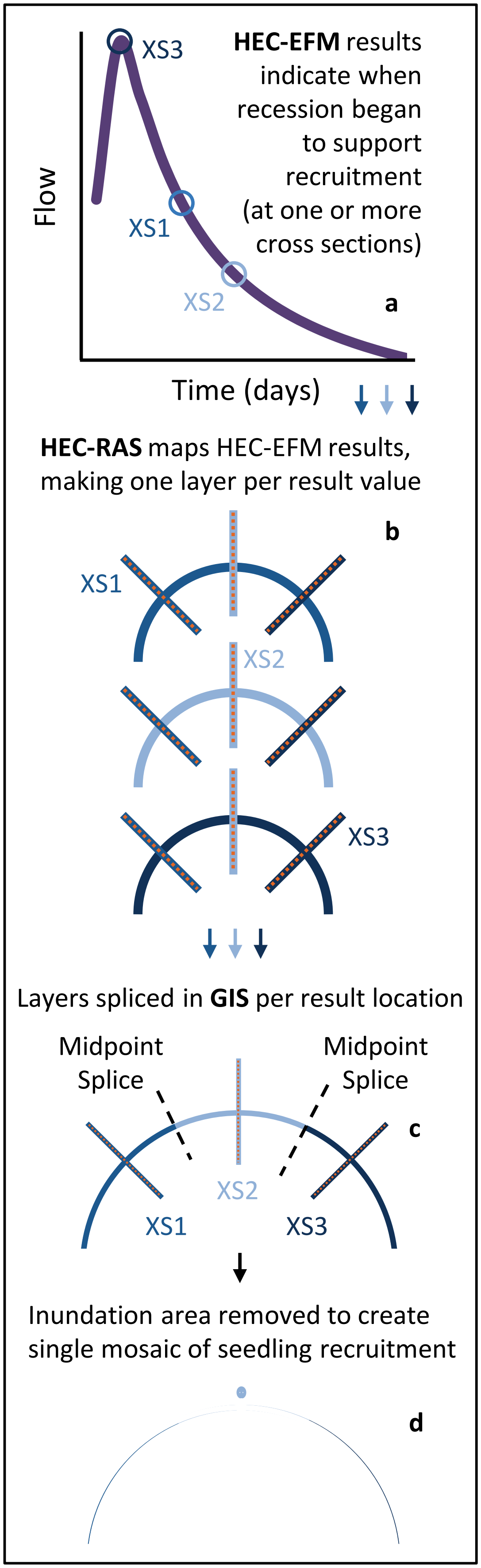


Figure 2. Hydrologic and ecological aspects of process to map potential seedling recruitment areas, which involved translating a single flow hydrograph (a) to local stage hydrographs using rating curves (b) produced by HEC-RAS (one for each of the 341 cross sections in the model). Stage hydrographs were then analyzed by HEC-EFM to determine the stage and corresponding flow at which the recession became suitable for recruitment (c). Local stage results were translated back to flows per the rating curves (d) and can be viewed longitudinally along river (d; Figure 4).



species. This is due to the timing of the 2006 experimental flood release, which was purposely timed to encourage *Populus* recruitment and discourage *Tamarix*.

Seasons for *Salix* and *Tamarix* begin March 22 and 29, respectively. Therefore any portion of the recession occurring before then, even if suitable per the recession rate, is irrelevant for those species. Conversely, if the experimental release had occurred one month later, *Populus* recruitment would have been significantly limited because most of the event would occur after its end of season.

With the latest start of season, *Tamarix* results show the lowest range of suitable recession flows, 1.10 m^3/s to 3.17 m^3/s (Table 2). Also, since the *Salix* recruitment season begins between the other two species seasons, the simulated ecosystem responses were in between the other two species on the hydrograph. Higher HEC-EFM flow results for recruitment tended to occur at cross sections in basin areas with broad floodplains (Figure 1), where wide and flat cross sections led to gradual stage recessions. The most common flow recession result for *Populus* was 12.46 m^3/s (Table 2), which occurred primarily in the canyon areas (Figure 1, non-basin areas) that typify most of the river below Alamo Dam. Per the process detailed in Figures 2 and 3, HEC-RAS was used to generate depth layers for each unique flow result point on the hydrograph recession with layers then spliced between cross sections in accordance with the differing recruitment flow results.

Figure 3. Hydraulic and spatial aspects of process to map potential seedling recruitment areas, which involved simulating HEC-EFM flow results (a) with HEC-RAS to generate a depth layer for each unique HEC-EFM result (b). Layers were then spliced according to the cross section locations of the HEC-EFM results (c). Areas of inundation that preempted germination or drowned seedlings were removed from the spliced layer to create a single mosaic of recruitment areas (d).

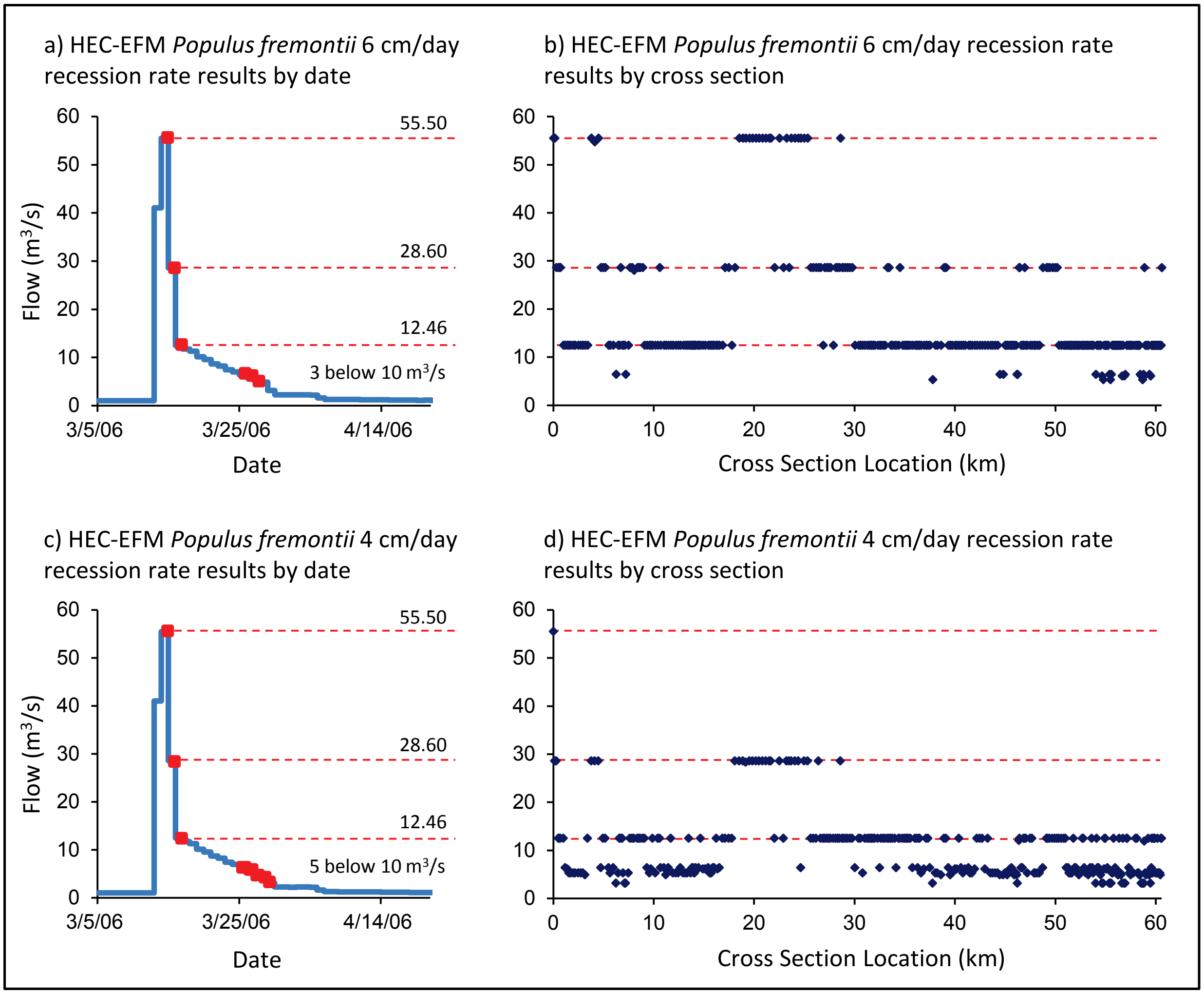


Figure 4. HEC-EFM results for *Populus fremontii* at all cross sections of the Bill Williams River for 6.0 cm/day (a-b) and 4.0 cm/day (c-d) stage recession rate thresholds from mouth of river (0 km) to Alamo Dam (61 km). Horizontal dashed lines show that many cross sections share the same result, that is, recessions at those locations became suitable on the same date. Lines omitted for results less than 10 m^3/s to improve clarity (see Table 2 for summary of results).

Inundation relationship results for the three species occurred later in the water year, between June 27 and July 4. Ecologically, these results are the flows that either preempted germination due to open water during the recruitment season or drowned seedlings after germination. The HEC-EFM inundation flow results were 1.44 m^3/s for *Populus*, 1.36 m^3/s for *Salix*, and 1.42 m^3/s for *Tamarix* (Table 2). These results were slightly higher than the 1.27 m^3/s flow held steady in April after the experimental release. This difference between post-event and subsequent inundation flows represents the flow range corresponding to stages where seedling drowning would be predicted. Due to the small difference, area of drowning was not investigated or computed for 2006, but this consideration is potentially significant in situations where recruitment events are followed by higher flows.

Table 2. HEC-EFM results for seedling recruitment and inundation, 2006 experimental flow, Bill Williams River. For recruitment, HEC-EFM determined the stages (Figure 2c) and corresponding flows (Figure 2d) at which local recessions became suitable for recruitment. Conditions at many cross sections became suitable on the same date (or at the same flow rate), as reported below and illustrated in Figure 4.

Recruitment	**Species:**	***Populus fremontii***		***Salix gooddingii***		***Tamarix* spp.**	
Recession	Date	Flow (m^3/s)	# Cross Sections	Flow (m^3/s)	# Cross Sections	Flow (m^3/s)	# Cross Sections
6.0 cm/day	14-Mar	55.50	25	--[1]	--[1]	--[1]	--[1]
	15-Mar	28.60	57	--[1]	--[1]	--[1]	--[1]
	16-Mar	12.46	236	--[1]	--[1]	--[1]	--[1]
	22-Mar	--[2]	--[2]	8.24	318	--[1]	--[1]
	25-Mar	6.40	13	6.40	13	--[1]	--[1]
	26-Mar	6.12	6	6.12	6	--[1]	--[1]
	27-Mar	5.30	4	5.30	4	--[1]	--[1]
	29-Mar	--[2]	--[2]	--[2]	--[2]	3.17	341
4.0 cm/day	14-Mar	55.50	1	--[1]	--[1]	--[3]	--[3]
	15-Mar	28.60	27	--[1]	--[1]	--[3]	--[3]
	16-Mar	12.46	130	--[1]	--[1]	--[3]	--[3]
	22-Mar	--[2]	--[2]	8.24	158	--[3]	--[3]
	25-Mar	6.40	44	6.40	44	--[3]	--[3]
	26-Mar	6.12	22	6.12	22	--[3]	--[3]
	27-Mar	5.30	77	5.30	77	--[3]	--[3]
	28-Mar	4.90	21	4.90	21	--[3]	--[3]
	29-Mar	3.17	19	3.17	19	--[3]	--[3]
2.3 cm/day[4]	29-Mar	--[3]	--[3]	--[3]	--[3]	3.17	320
	3-Apr	--[3]	--[3]	--[3]	--[3]	2.27	1
	4-Apr	--[3]	--[3]	--[3]	--[3]	2.18	15
	5-Apr	--[3]	--[3]	--[3]	--[3]	1.61	2
	19-Apr	--[3]	--[3]	--[3]	--[3]	1.10	1
Inundation	27Jun-4Jul	1.44	--[5]	1.36	--[5]	1.42	--[5]

[1] Date occurred before the start of recruitment season.
[2] No HEC-EFM results occurred; marks start of season for a species.
[3] Combination of species and recession that was not investigated.
[4] Two of the 341 cross sections (0.6%) had a HEC-EFM result of "off-rating", which is most typically returned when the software encounters a flow value outside the range of the flow-stage rating curve. Upon review, this was not the case here and the oddity was not investigated further.
[5] Inundation reflects a flow that was sustained long enough to preempt germination or drown seedlings. As a flow, it was modeled as characteristic of the whole reach (all 341 cross sections) below Alamo Dam.

Inundation results were simulated with HEC-RAS. Inundation areas were removed from the spliced recruitment layers (Figure 5). The remaining areas represent the total potential recruitment area for each species and threshold recession rate (Table 3).

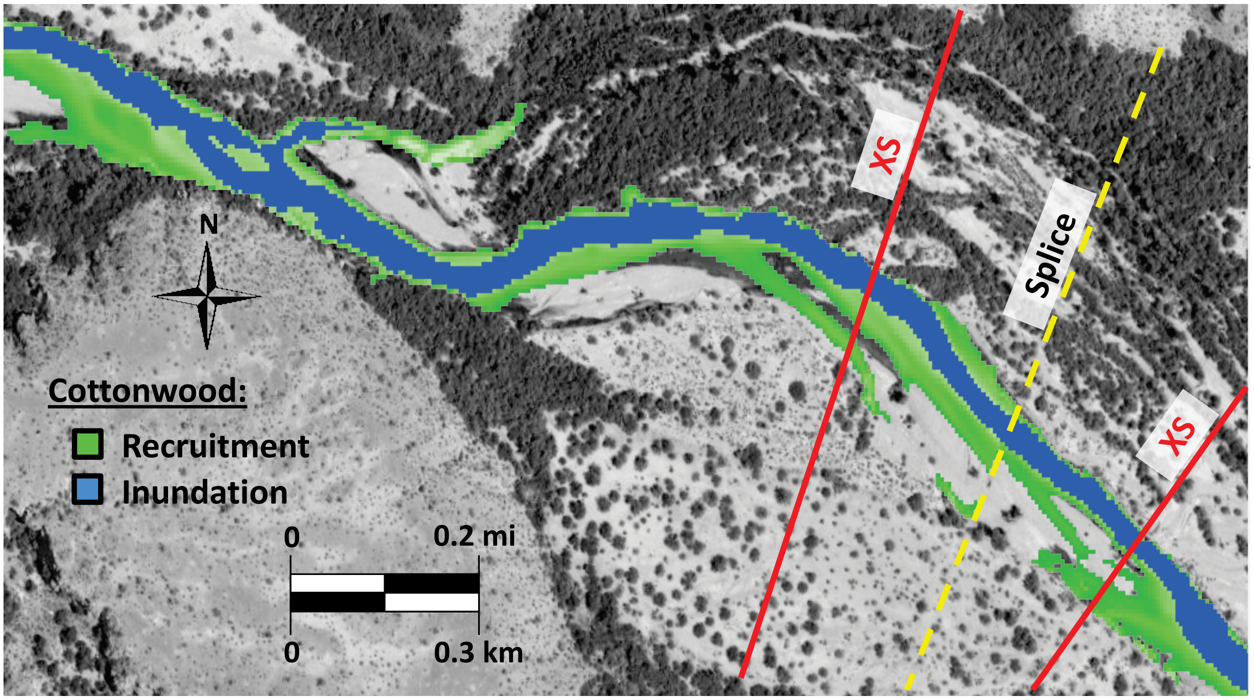


Figure 5. Portion of the 2006 seedling recruitment mosaic for *Populus fremontii*, 6.0 cm/day recession. Cross section downstream of splice (to left) has the higher local HEC-EFM recession result as shown by its larger recruitment area extent. Figure 4b shows this transition as a change in flow (upstream cross section is at river km 37.8). Figure adapted from Hickey et al. 2015.

Table 3. Potential recruitment area for species and recession rate.

Species	Recession	Potential Recruitment Area (Hectares)
Populus fremontii	6.0 cm/day	480.97
	4.0 cm/day	279.62
Salix gooddingii	6.0 cm/day	188.30
	4.0 cm/day	173.97
Tamarix spp.	6.0 cm/day	59.62
	2.3 cm/day	58.89

Populus fremontii had the highest potential recruitment area for the 2006 experimental flood release with a range of 279.62 to 480.97 hectares. *Salix gooddingii* had a range of 173.97 to 188.30 hectares. *Tamarix* had the lowest potential recruitment area with a range of 58.89 to 59.62 hectares. These results highlight the importance of life history information, especially the differences in start of recruitment seasons in this case, for determining the timing of environmental flows.

1.4.2 Correlation of Simulated and Observed Recruitment for the 2006 Flow Event

In October 2006, a survey was conducted by boat and foot along the entire main river channel of the Bill Williams River. The number of seedling patches of *Populus fremontii*, *Salix gooddingii*, and *Tamarix* spp. visible from the main channel were noted. A patch was defined as an area covering at least 10 m^2 and containing at least 5 individuals of a species. Patches containing multiple species were tallied for each species.

Simulated patches were obtained using the mosaics of potential recruitment area for *Populus*, *Salix*, and *Tamarix*. Recruitment areas with connected grid cell edges were grouped in patches (i.e., cells connected to each other with shared edges were considered part of the same patch). To address line of sight issues (seedling areas beyond viewable range of the scientists), simulated patch grids were clipped to a "line of sight" buffer from the river stream centerline. Due to uncertainty with line of sight, buffers of 20, 30, and 40 m were used. Simulated patches less than or equal to 9 m^2 (i.e., single isolated cells) were considered scattered individuals and were not included in patch counts. For simulated patches larger than 100 m^2, corresponding patch counts were equal to the total area divided by 100 m^2 with the remainder equaling an additional patch (e.g., a patch of 232 m^2 would yield a patch count of 3). A software tool called HEC-GeoEFM, a spatial accessory for HEC-EFM, was used to create and count patches (USACE 2011).

Simple correlations between numbers of field-surveyed and simulated patches were performed on a reach-scale. This statistic is a measure of association between two variables and is also known as Pearson correlation coefficient. A result of 1 would indicate that the two variables are perfectly associated, that is, both fluctuate (increase or decrease) in the same direction and by the same proportion relative to the mean of each set of variable values. A result of 0 would indicate that the two variables are uncorrelated. A result of -1 would indicate that the two variables are perfectly inverted, as one increases the other decreases, proportionally. The entire river below Alamo Dam was divided into 12 contiguous reaches (Figure 1) with observed and simulated patches tallied separately per reach and then correlated. Correlations were computed for each species, threshold recession rate, and buffer with and without Reach 8 (Table 4). Reach 8 is the widest valley area along the river and has significant interaction between surface and ground waters, a dynamic pertinent to recruitment that was not simulated as part of this modeling effort.

All correlations were positive and highest for *Salix* and *Tamarix*, which is likely related to the lower range of HEC-EFM flow results associated with their later starts of recruitment season. Removing reach 8 improved correlations, most so for *Populus*. Several factors likely contribute to this. The flatter topography in reach 8 leads to dissimilar line of sight conditions and channel braiding, which raised questions about potential differences between stream centerline used for buffering and sampling path traveled by field surveyors. The majority of cross sections that supported recruitment for the entire experimental flow event (roughly 20 of the 25) were located in reach 8. High suitable flows equate to larger areas of recruitment, which is relevant to the braiding and centerline versus sampling path concern because larger areas are more likely to be distributed amongst multiple braids and therefore more prone to line-of-sight challenges and any centerline-sampling path discrepancies. High suitable flows also occur early in the experimental event when the difference between hydrologic condition before and during the experimental flow was most pronounced and likely most affected by unmodeled surface-ground water interactions.

Table 4. Correlation of modeled and observed seedlings patch counts (a) and not including reach 8 (b) for line-of-sight buffers of 20 m, 30 m, and 40 m.

a. Seedling patch count correlations

		"Line of Sight" Buffer		
Species	**Recession**	**20 m**	**30 m**	**40 m**
Populus fremontii	6.0 cm/day	0.71	0.70	0.66
	4.0 cm/day	0.78	0.76	0.72
Salix gooddingii	6.0 cm/day	0.88	0.91	0.89
	4.0 cm/day	0.89	0.91	0.88
Tamarix spp.	6.0 cm/day	0.91	0.95	0.94
	2.3 cm/day	0.93	0.95	0.94

b. Seedling patch count correlations without reach 8

		"Line of Sight" Buffer		
Species	**Recession**	**20 m**	**30 m**	**40 m**
Populus fremontii	6.0 cm/day	0.78	0.81	0.80
	4.0 cm/day	0.86	0.87	0.85
Salix gooddingii	6.0 cm/day	0.91	0.96	0.96
	4.0 cm/day	0.93	0.96	0.96
Tamarix spp.	6.0 cm/day	0.91	0.95	0.96
	2.3 cm/day	0.93	0.95	0.95

Albeit these and other potential sources of error, it is important to acknowledge that even the lowest correlation, 0.66 for *Populus* with a 6.0 cm/day recession rate and a 40 m buffer, is an encouraging result for comparisons between modeled and observed ecosystem responses. Results for the other species were better yet, at least 0.88 for *Salix* and 0.91 for *Tamarix*.

1.5 Model Application

For riparian areas on the Bill Williams River, a reservoir operator seeking to encourage seedling recruitment downstream should plan and implement releases that meet the seasonality and stage recession criteria required by the species of interest. To recruit seedlings contiguously for an entire downstream reach, operators would have to cater to the most demanding topography – in this case, the cross section with the steepest stage-flow relationship – a strategy that would produce a small amount of seedling area per volume of water released. The verified models were applied to determine the magnitude and shape of reservoir outflows that would maximize potential recruitment area per volume of water released.

The modeling approach compared multiple hydrographs to determine which were most efficient in terms of recruitment area per volume of water (Figure 6). Hydrographs were prepared for combinations of peak flow, recession rate, and cross section location. Nine peak flows were used, increasing incrementally from 10 m^3/s to 200 m^3/s, which is approximately the maximum release that can be discharged through the outlet gates of Alamo Dam. Three recession rates were used, 2.0, 4.0, and 6.0 cm/day, with 2.0 cm/day being gradual enough for all modeled species to survive with low mortality and 6.0 cm/day being near the maximum tolerable recession rate for seedlings of these species (Shafroth et al. 1998; Mahoney and Rood 1991; Horton and Clark 2001; Stella et al. 2010). For each of the 341 cross sections, hydrographs began at the peak flow and then receded according to the exact local tolerable drop in stage. For example, using the flow-stage rating curve for an individual cross section, the peak flow was translated to a stage (day 1), that stage was reduced by the recession rate to determine stage on day 2, which was then reduced by the rate to compute day 3 stage, and so forth. Each daily stage was translated to a daily flow via the same rating curve. This process continued until flow equaled 0.283 m^3/s, the minimum flow required below Alamo Dam. The resulting hydrograph is perfectly efficient at recruiting seedlings for that cross section location and recession – any less water would lead to a recession too high for seedling survival.

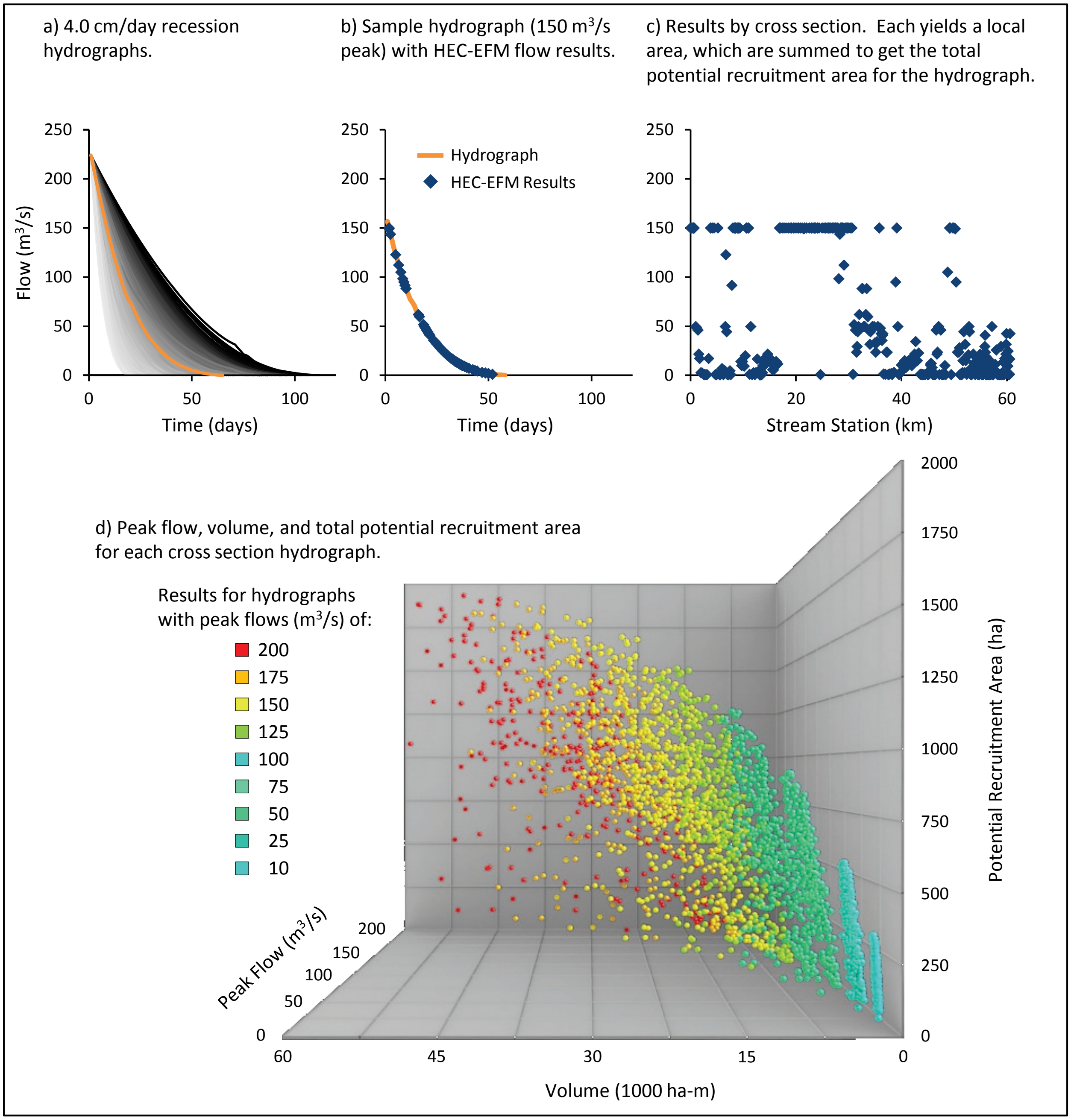


Figure 6. Results of the 4.0 cm/day recession hydrograph analysis. Image illustrates processing of one of the 341 recession hydrographs (a) as it is analyzed independently (b) using HEC-EFM to determine the local recruitment flow for each cross section (c). Local results were summed in terms of recruitment area and displayed for the entire river for each 4.0 cm/day recession hydrograph (d).

This suite of hydrographs, 9,207 in all (9 peak flows, 3 recessions, and 341 cross sections), was analyzed with HEC-EFM to determine the portion of recession suitable for recruitment at each cross section. This is shown in Figure 6 with one of the 341 4.0 cm/day recession hydrographs (6a) being analyzed independently (Figure 6b) for a peak flow of 150 m^3/s to determine recruitment flow results for each cross section (Figure 6c).

As it was infeasible to generate and splice the depth grids corresponding to the more than 3 million local HEC-EFM results (9,207 hydrographs assessed at 341 locations), a simplified spatial process was used to compute the total recruitment area (Figure 7). Local flow results from HEC-EFM were converted to local stages via the rating curve at each cross section location. Local stage results were converted to wetted perimeter based on cross section shape. Any portion of the wetted perimeter that would have been inundated by the minimum flow (0.283 m^3/s) was removed from the total. This wetted perimeter of recruitment was then multiplied by the representative length of the cross section (from midpoint to midpoint between cross sections) to compute the local potential recruitment area.

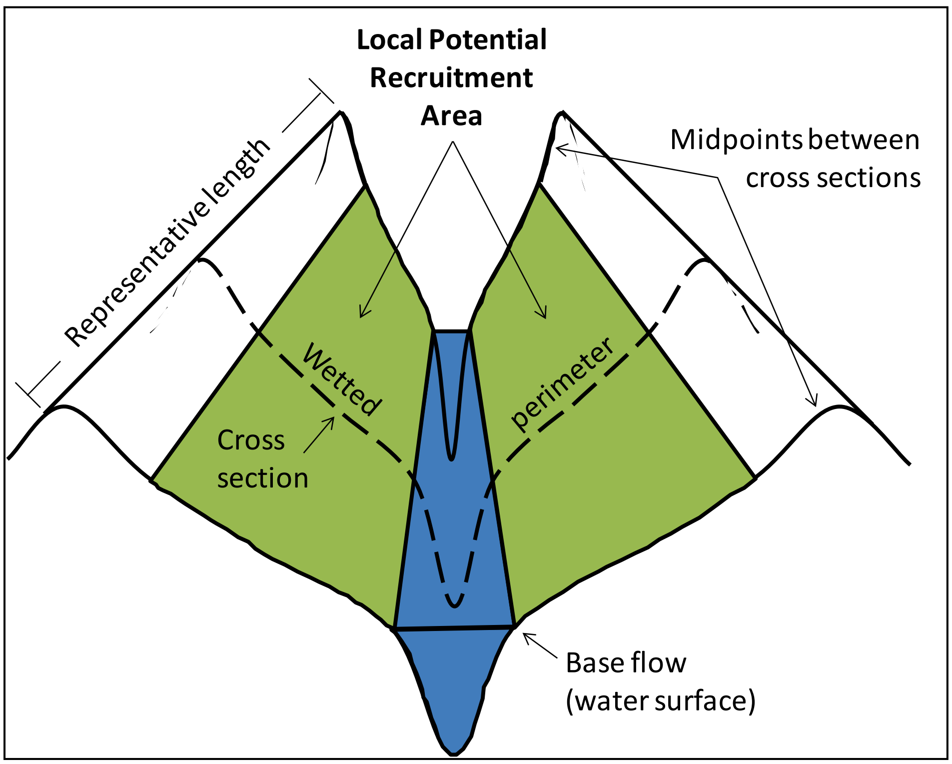


Figure 7. Local potential recruitment area concept for a single cross section.

Local potential recruitment areas were summed for each hydrograph to obtain a total potential recruitment area. This process, though not as explicit as the splicing and clipping GIS work done for the 2006 event, was a necessary simplification accomplished via spreadsheets instead of raster grids. Volumes for each hydrograph were also computed in spreadsheets.

At this point, each hydrograph was characterized by three variables: peak flow, volume, and potential recruitment area. These values were compared visually (Figure 6d) and numerically for each recession rate to determine the maximized surface of recruitment area per volume of water.

1.5.1 Guidance for Reservoir Operators

Hydrographs that generated less potential recruitment area than others with the same volume or less were discarded. Hydrographs that generated the greatest potential recruitment area per volume of water were retained to help define operational guidance for reservoirs. Collectively, these maximizing hydrographs form a family of curves (Figure 8) that allow water managers with a volume of water available for riparian seedling recruitment to obtain an area of potential recruitment and the release hydrograph (peak, shape, and volume) required to generate it.

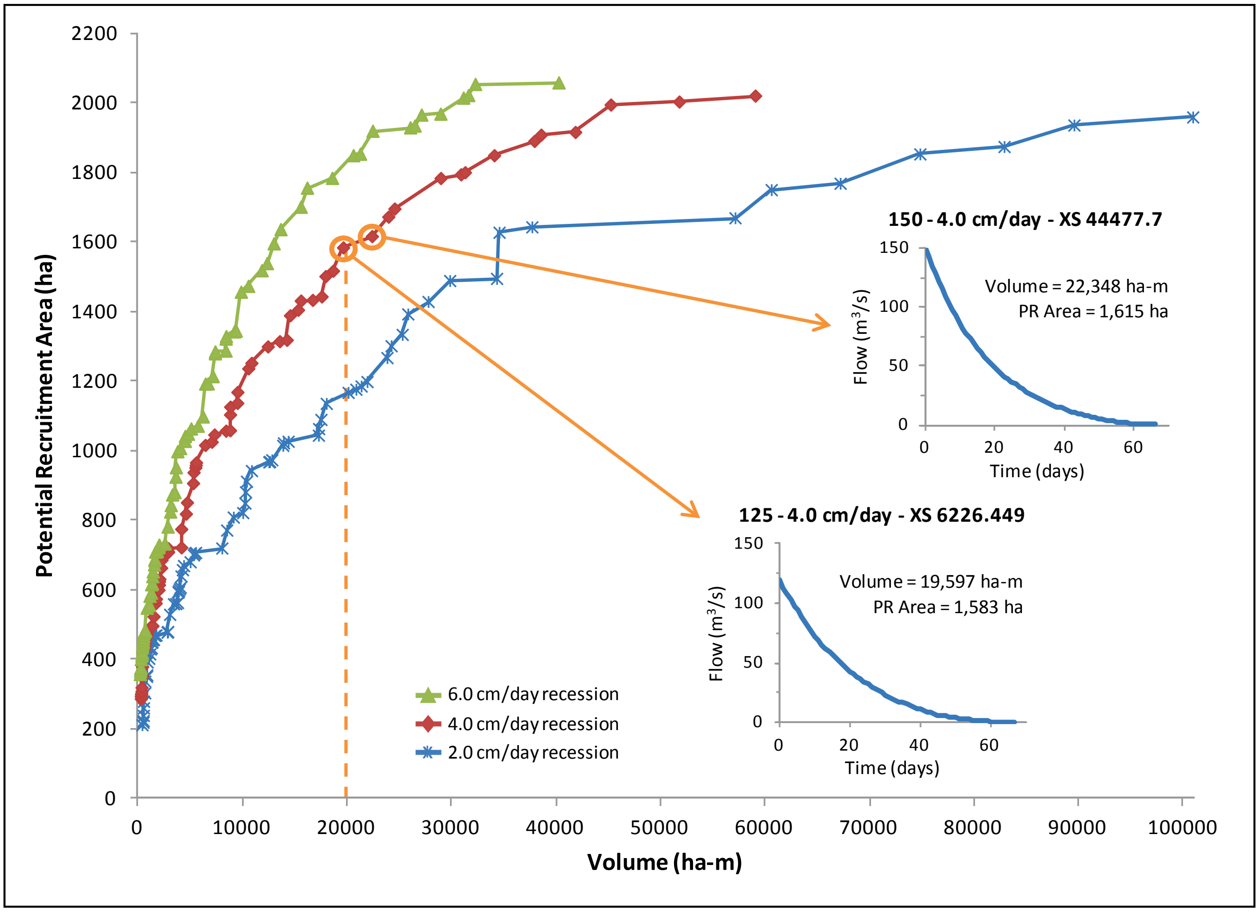


Figure 8. Reservoir operations guidance plot for the 2.0, 4.0, and 6.0 cm/day recession rates on the Bill Williams River, AZ. Each point represents a recession limb hydrograph that maximizes potential recruitment for a particular recession rate.

To illustrate how this information can be used, consider a hypothetical inflow event that leaves Alamo reservoir with 20,000 hectare-meters of water above its target pool and available for seedling recruitment, a volume that would fill roughly 20% of the operational flood storage space at Alamo. The reservoir manager would first consider seasonality. If the timing of water availability is coincident or could be aligned with the recruitment season of desired riparian species, then the operator would refer to the family of curves (Figure 8). The curves show that the volume, used efficiently, could stimulate between 1,100 and 1,800 hectares of potential seedling area, depending on recession rate. Choice of recession rate is left to the reservoir operator. A conservative approach that would stimulate germination and carefully support seedling survival with a gradual recession (2.0 cm/day) would yield less recruitment area than a more aggressive approach (6.0 cm/day) that generates more area with higher rates of seedling mortality (i.e., a larger fraction of seedlings in those areas die). Using the 4.0 cm/day curve, the moderate approach and recession rate that correlated best for *Populus*, the volume intersects with the curve between two design hydrographs. The first has a peak flow of 125 m^3/s, a volume of 19,597 hectare-meters, and is estimated to generate 1,583 hectares of potential recruitment area. The second has a peak flow of 150 m^3/s, a volume of 22,348 hectare-meters, and is estimated to generate 1,615 hectares of potential recruitment area. Again, choice is left to the operator. Required volumes and potential recruitment areas help inform that decision and peak flows and recessions guide its implementation. Appendix B tabulates the recessions.

1.5.2 2006 Revisited

The 2006 experimental release involved a flood pulse that peaked on March 14 and a recession limb that began March 16 and ended April 6 (Figure 9). The peak was intended to physically prepare recruitment areas by clearing and wetting substrates. The recession was shaped to promote seedling recruitment by providing recession rates of approximately 2.5 cm/day based on single cross-section hydraulics models performed at 8 cross-sections (Shafroth et al. 1998). Volumes of recession and whole event were approximately 1,100 and 2,200 hectare-meters, respectively. The event was timed to occur wholly in the *Populus fremontii* recruitment season. Seasons for *Salix* and *Tamarix* recruitment started towards the end of the recession.

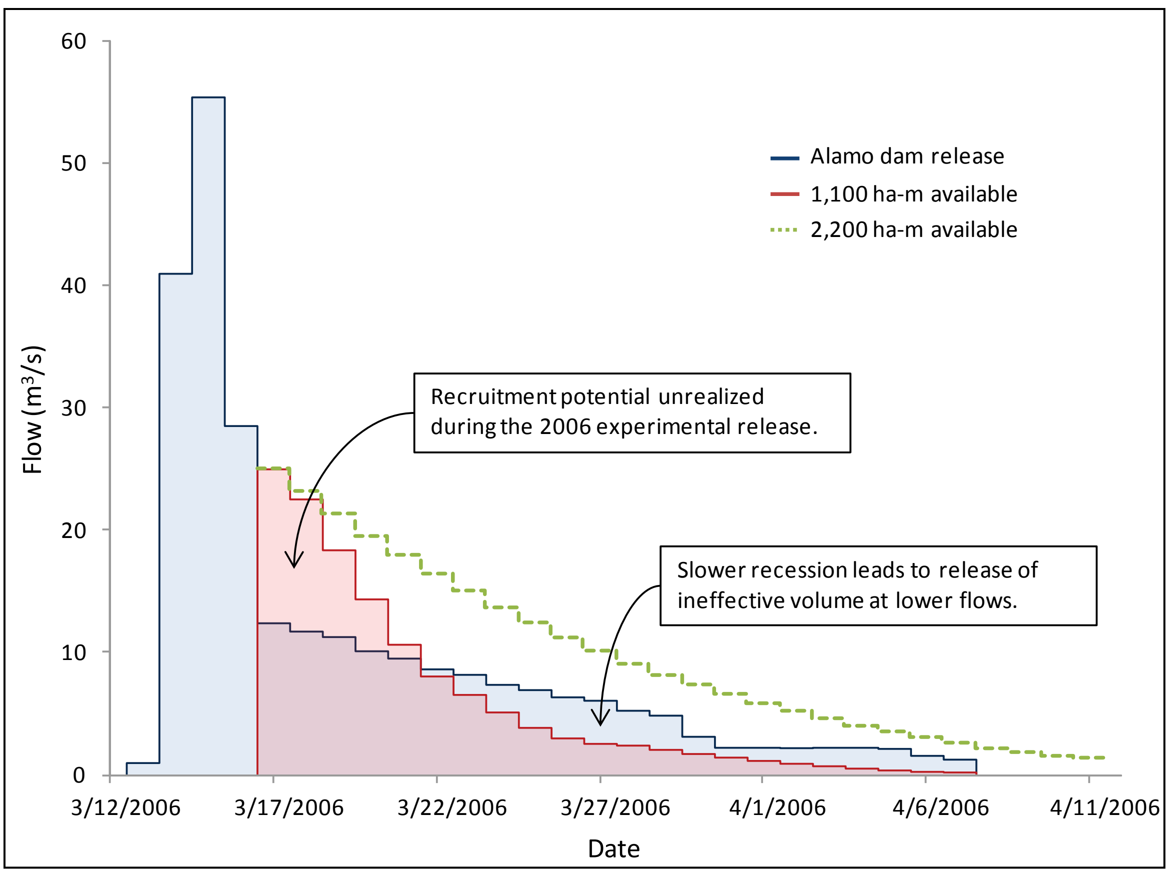


Figure 9. Historic (blue) and revisited outflows from Alamo Dam for the 2006 experimental release. Revisited outflows convey the volume of the historical recession (red; 16Mar to 6Apr) and the whole historical event (green; 13Mar to 6Apr) while following recessions determined to maximize potential recruitment of riparian seedlings.

Based on the moderate 4.0 cm/day curve (Figure 8), the 1,100 hectare-meters volume had potential to create 492.46 hectares of potential recruitment area (Appendix B, hydrograph volume of 1,144.76 hectare-meters). Analysis of the 2006 event during model development via the HEC-EFM to HEC-RAS to GIS splicing method resulted in a simulated recruitment area of 279.62 hectares for the same 4.0 cm/day recession rate (Table 3). Therefore, if the curves had been incorporated into the operating policies of the reservoir and used to guide shaping of the experimental release, 76% more potential recruitment area could have been generated with the same volume of water (Figure 7). And if the entire 2,200 hectare-meters could have been used in the recession, as might be the case when an earlier hydrologic event had already prepared substrates, the total area of potential recruitment would increase to 685.01 hectares, or 145% more than simulated (Appendix B, hydrograph volume of 2,219.76 hectare-meters).

1.6 Discussion

The goal of this chapter is to describe and detail application of a modeling framework to quantify potential seedling recruitment associated with managed flows below dams such that results could be used to verify the models and verified models could be used to define guidance for future management decisions. Previous efforts have been made to spatially estimate potential seedling recruitment by coupling hydraulic modeling with seedling recruitment requirements (Dixon and Turner 2006, Morrison and Stone 2014, Benjankar et al 2014). The approach in this chapter differs by evaluating ecosystem responses statistically and spatially, with flow-ecology relationships considered per hydrograph and per cross section - rendered based on land surface representations for the entire management area, and by using results to construct guidance. Quantifying the relationship between potential seedling recruitment area and available reservoir water volume informs the decision process regarding release of waters for seedling recruitment below Alamo Dam, thereby connecting science with operations.

The approach used in this chapter has limitations that are specific to the Bill Williams River example and that are generally associated with modeling, including:

- *Data are imperfect and necessary*. Much time was spent processing LIDAR data to remove data points that had returned from vegetation instead of the desired bare-earth land surface, a common challenge that persists even with increased densification of points (Sithole and Vosselman 2004, James et al. 2007). Comparisons between LIDAR and manually surveyed cross sections showed inaccuracies that varied latitudinally (within individual cross sections) and longitudinally (from cross section to cross section). Data from the USGS gage below Alamo Dam (09426000) were questionable at high flows which was a concern for calibration of the hydraulics model. All of these data imperfections were addressed such that the best available information was used responsibly in modeling. Importantly, these efforts will need to be repeated as new data sets become available and operational policies are periodically updated. This is foundational to consideration of flow-ecology relationships and should simply be integrated with the standard practice of reservoir management, especially in water-scarce systems such as the Bill Williams River.

- *Models could be better*. Even given the strong correlations and ambitious modeling done to assess the design hydrographs, future modeling on the Bill Williams River would be advanced via use of an unsteady hydraulics model that includes surface-groundwater interactions as is now possible through a coupling of HEC-RAS and MODFLOW, a USGS groundwater model. This would account for lag and attenuation between cross sections and simulate the surface-groundwater dynamics that are especially pronounced in the valley areas (House et al. 1999). Also, there are now versions of the river hydraulics and ecosystem functions models applied herein that simulate in multiple dimensions. HEC-RAS has capabilities that spread water dynamically through areas of 2 dimensional cells and HEC-EFM has a related program called HEC-EFMSim that simulates ecological communities temporally and spatially (in 2 dimensions). Combining the capabilities of both allows simulation of seedling recruitment within a contiguous mesh of elements covering the riparian area, as well as seedling mortality, growth, advancement to adulthood, provision of forage and habitat to other species, succession, and others with the potential to enable automated informational loops between the tools during a simulation (denser and bigger vegetation increases hydraulic roughness, which alters hydrodynamics, which stimulates different ecosystem responses and so forth).

- *Spatial considerations could be more thorough.* In the model application portion of this section, a representative cross section length was used to compute potential recruitment area. This was a necessary simplification to accommodate the number of hydrographs being assessed, but is less explicit than the splicing method used in model development. Even splicing, inherently related to cross section number and location, is a simplification of true recruitment, which would occur seamlessly as channel forms change with river station. Also, there are other spatial considerations that were not taken into account. Herbivory, existing vegetation, proximity to beaver, seed sources, and sediment scour and deposition are among the many spatial factors that could be overlaid to reduce simulated potential recruitment areas to a more comprehensive depiction of recruitment.

The synthesis of the modeling effort, with its thousands of hydrographs and millions of local potential recruitment areas, is presented simply and offered as guidance for management of stored waters that become available episodically (Figure 8). Simple information, clearly conveyed and implementable, is important in operations where decisions need to be measured and made and then attention paid elsewhere. In ecological management, as is well appreciated by reservoir managers, the standing resource and the benefits it has and will provide are shaped by a long sequence of decisions. Considering seedling recruitment from a longer management perspective changes the question from “what should be done with this water?” to “what riparian condition is desired?” and begs questions about goals and sequences of events and contingencies.

Maintaining a healthy riparian corridor that provides habitat and environmental benefits is an articulated goal of resource management for the Bill Williams River. A healthy riparian corridor generally contains diverse species and age structure (Nilsson and Svedmark 2002). Mixed-age riparian areas require multiple flow events whose sequence and frequency, allow for survival of existing stands, recruitment of new, and renewal of old. In this sense, disturbance, vegetation, and channel and other fluvial landforms are interconnected and co-evolve as part of an integrated system that is dynamic in time and space (Resh et al. 1988, Gregory et al. 1991, Ward et al. 2002, and Benda et al. 2004).

Though not in the simple synthesis, the modeling work described herein offers information that could help manage riparian areas in accordance with this perspective of a dynamic system. For example, given identical volumes in adjacent water years, Figure 8 applied blindly would recommend the same releases twice, largely replacing one cohort with the next. Modeling results, however, are more instructive and rich than this. For example, following a curve for a lesser recession rate in the subsequent year would support higher survival rates over less area, thereby encouraging a mixture of age and condition. Sub-maxima results may be useful too. Review of the hydrographs that maximized recruitment showed recruitment areas distributed across both canyon and valley landscapes. Consideration of sub-maxima results may identify hydrographs that specialize in either valleys or canyons, which might allow for recruitment to be stimulated for different spatial areas of the riparian zone with some degree of independence.

Interestingly, this potential for spatial considerations is also suggested via inspection of results from the hydrograph analysis (Figure 10). Hydrographs that maximized recruitment were overlaid on aerial photography and categorized as either "valley" or "canyon" based on a visual review of location and landform. Viewing the sequence of max recruitment cross sections from lowest to highest volume reveals patterns regarding cross section type. Valley cross sections tend to be first to maximize recruitment. With increasing volume, location generally transitions to canyon cross sections at the same peak flow, before returning to valleys at the next higher peak flow and so on. While the maximized results in Figure 10 are the same as shown in Figure 8 (e.g., in both figures, see distinct separation between 37,000 and 57,000 ha-m results for 2.0 cm/day recession), cross section type and peak flow have promise as additional information that managers could consider during decision making. Continuing with the "identical volumes in adjacent water years" example, hydrograph selection in the second year may well still be for a lesser recession, but also for a lower peak flow and for the alternate cross section type (i.e., valley instead of canyon or vice versa). Refining these considerations for inclusion in operational guidance would require a more detailed spatial understanding of the recruitment areas supported by different hydrographs.

All modeling described in this chapter was related to one ecosystem dynamic, three species, and directly relevant for a small fraction of the year. As such, this is only a piece of a larger vision for implementation of environmental flows. In 2005, environmental flow needs were defined for the Bill Williams River (Shafroth and Beauchamp 2006, Shafroth et al. 2010, Warner et al. 2014). Riparian recruitment was one of seven components that collectively span the water year. It is an intriguing idea that models, parameterized and verified with field data, could be used to quantify ecosystem responses for all of the components such that, given available volume at any time of year, reservoir managers could readily identify which ecosystem aspects are in season, how they should be catered to, and what responses are anticipated. Armed with such information, water managers would be empowered to better operate for ecological purposes within the operational flexibilities of reservoirs to a much greater degree than simply adhering to the minimum or nonexistent flow requirements that currently comprise environmental strategies for most reservoirs.

One advantage of the models used herein is that HEC-RAS and HEC-EFM are generic, applicable to a wide range of rivers and ecosystems. In this sense, the framework illustrated for riparian seedlings on the Bill Williams River is applicable for other rivers in the southwestern US, for fishes of the Columbia, birds of the Missouri, and any other setting where ecosystem responses are influenced by patterns of flow and water-land interactions.

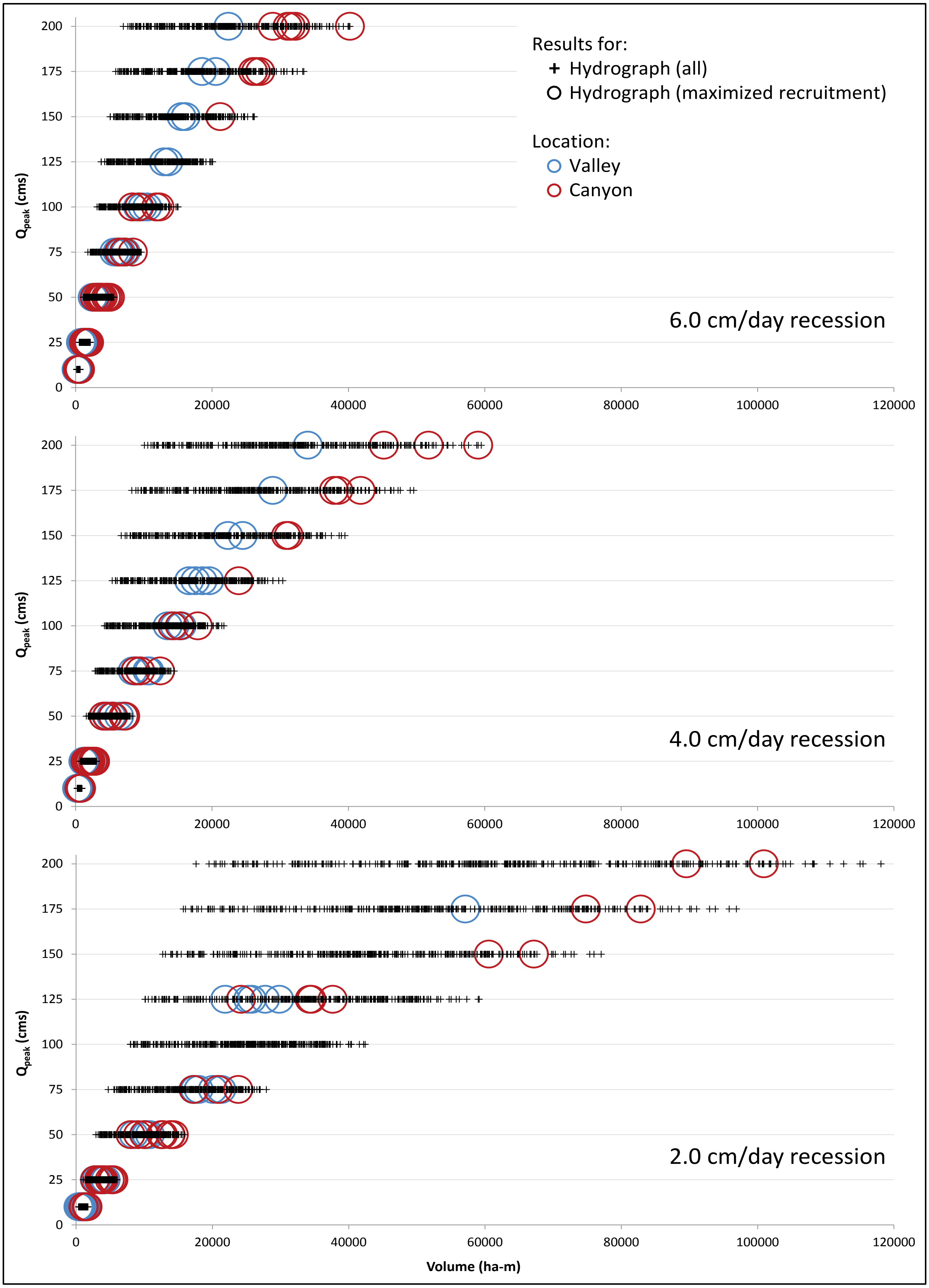


Figure 10. Hydrograph volumes and peak flows. Hydrographs that maximized recruitment are shown also with circles, blue for cross sections located in valley areas and red for canyon areas.

1.7 Conclusions

Balancing multiple water demands with limited water availability is an increasing challenge. Having ecological guidance in place promotes continuity in benefits for all operating purposes and acknowledges the inherent place of environment in water resource decision-making. This chapter describes and applies a modeling framework to define how available waters could be managed to produce an environmental benefit, in this case, renewal of the locally and regionally important riparian forests of the Bill Williams River through seedling recruitment. Cultivating this ability to be opportunistic is an advance at reservoirs where the status quo for ecological management strategies is minimalistic and protective. It has promise to add variability to environmental releases and to encourage resource managers to better communicate connections between water and ecosystem management.

Model development and verification described in this section was underpinned by the long history of science-based stewardship for the Bill Williams River. Key information available *a priori* included flow-ecology relationships used in ecological modeling with HEC-EFM, and vegetation maps and surface topography generated from LIDAR data used in hydraulic modeling with HEC-RAS. These data sets were critical for the development of operational guidance related to seedling recruitment. The burden of compiling, maintaining, and applying such data should be incorporated into the standard operating practices of reservoir operations.

The methods and software used in this section are generic, applicable to other rivers and natural resources. Per the scope of this project, modeling was done to codify guidance for reservoir operations regarding seedling recruitment, which was one of seven environmental flow components defined for the Bill Williams River. Others are also being studied, including a "riparian rework" flow aimed to change the distribution of woody vegetation through high flows that scour off-channel habitats. Together, these components provide current, science-based recommendations for how the Bill Williams River should be managed from an ecological and ecosystem services perspective. Modeling that quantifies ecosystem responses to flows can be used to define guidance for operators. This encourages management decisions that are opportunistic, water-efficient, and maximize ecological benefits.

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Chapter 2

Climate Change Implications for Use of Flow-Ecology Relationships to Inform Reservoir Operations

John T. Hickey

The previous section describes work partnered by USACE, U.S. Fish and Wildlife Service (USFWS), and USGS in a modeling project supported by the Desert LCC to translate flow-ecology relationships for riparian plants to operating guidance for water managers at Alamo Dam, a reservoir on the Bill Williams River managed by the Los Angeles District of the USACE. This section considers the effects of a changing climate on the efficacy of that guidance. Two particular points are considered: how might the amount and how might the timing of waters available for riparian management change under different climate scenarios.

2.1 Data Analyses

Projections of average air temperature and precipitation were extracted from the 1/8 degree Bias-Corrected and Spatially Downscaled (BCSD) Coupled Model Intercomparison Project Version 5 (CMIP5) Global Circulation Models (GCM) projections (BCSD5; Maurer et al. 2007). Historical average air temperatures and precipitation were extracted from the 1/8 degree observed (Maurer 2002) data. All of these monthly data were obtained through an online archive made available by U.S. Bureau of Reclamation, Climate Analytics Group, Climate Central, Lawrence Livermore National Laboratory, Santa Clara University, Scripps Institution of Oceanography, USACE, USGS, and National Center for Atmospheric Research (http://gdo-dcp.ucllnl.org/downscaled_cmip_projections).

Data were extracted for a latitude-longitude box located in the Bill Williams River watershed at and above Alamo Dam (34.1875 to 34.8125 and -113.5625 to -112.8125) in Arizona (Figure 11). Each of the 1/8 degree coordinate pairs above is the midpoint of the spatial area it represents. For example, data reported at the most southwesterly latitude-longitude point (34.1875, -113.5625) represent an area that begins 1/16 of a degree to the south and to the west of that point (34.125, -113.625) and ends 1/16 of a degree to its north and to its east (34.25, -113.5). The latitude-longitude box used for the Bill Williams was comprised of six increments of latitude and seven of longitude or 42 spatial tiles, each roughly 12 km by 12 km. This region encompassed approximately 6,687 km^2 (2,582 mi^2) or 54 percent of the total area that drains to Alamo Dam. Air temperatures were monthly mean values in degrees Celsius at the surface. Precipitation values were monthly mean daily rates in mm/day. Extractions are accompanied by a file named "MetaData.txt" that helps clarify spatial extents of the data. More information about the data is available at http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/#About.

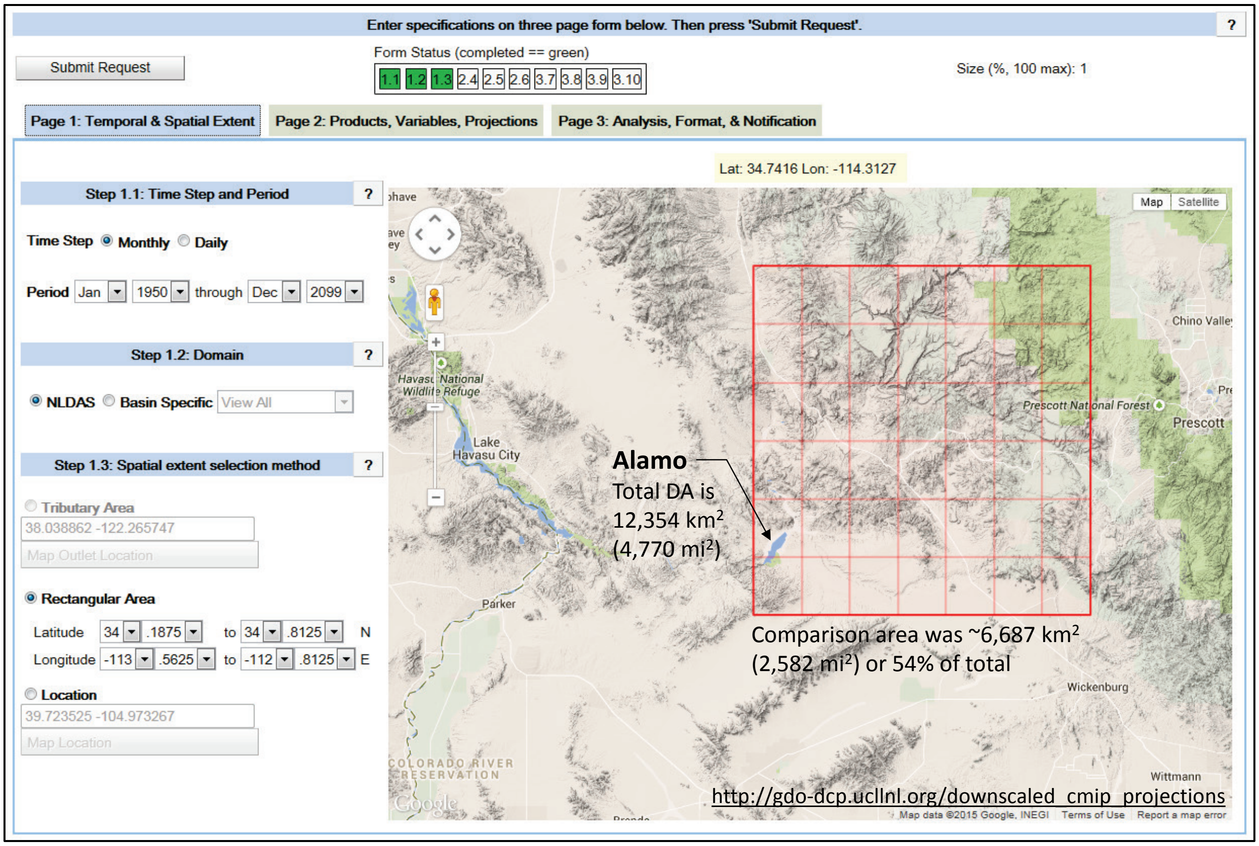

Figure 11. Spatial extent of comparisons between projected and historical air temperatures and precipitation. Comparisons of river flows performed for the Bill Williams River below Alamo USGS gage site (9426000), which is located just below the Alamo dam.

The Bill Williams River below Alamo Dam was also one of 418 locations in the continental US where climate data had been down-scaled and translated to daily time series of river flow via the variable infiltration capacity (VIC) model (Liang et al. 1994) in 2014. Down-scaled daily flows were obtained from the National Center for Atmospheric Research portion of the flow archive (ftp://gdo-dcp.ucllnl.org/pub/dcp/archive/cmip5/hydro/routed_streamflow/cmip5_ncar_day/). Historical flows were obtained from the Reservoir Regulation Section of the Los Angeles District of USACE (Peacock, personal communication). Construction of Alamo Dam was completed in 1968. Pre-dam historical data are comprised of mean daily gaged flows from the Bill Williams below Alamo gage (USGS 9426000; Figure 1). Post-dam historical data were computed by adding the daily change in pool storage (expressed as a flow rate per day) to daily mean gaged outflows and the daily estimated evaporation from the pool (also as a flow rate per day). This process produced a time series of flows at the below Alamo gage location reflecting unimpaired conditions or the flow of the river as though Alamo Dam was not there.

Historical and projected average air temperatures, precipitation, and river flows were compared. Historical temperatures and precipitation had a period of record from 1/1950 to 12/1999. Historical flows were available from 10/2/1928 to 9/29/2005.

The online archive of temperature and precipitation projections is comprised of output from models developed by climate centers from around the world (e.g., model labels beginning with BCC and CSIRO are, respectively, products of the Beijing Climate Center of China and the

Commonwealth Scientific and Industrial Research Organization of Australia). The archive offers model projections for four Representative Concentration Pathways (RCP), each of which is a unique social, political, and economic scenario that involves emission, concentration, land-use, fuel use, and carbon capture technology trajectories (van Vuuren 2011). Models have different numbers of projections within and across RCPs (e.g., BCC-CSM1.1(m) has one model run available for RCP 4.5 and RCP 8.5 and CSIRO-MK3-6-0 has 10 runs available for each of the four RCPs). All told and per the count of the author, there are 37 models listed in the archive with a total of 231 runs (53 runs for RCP 2.6, 71 for 4.5, 37 for 6.0, and 70 for 8.5). From these 231 archived projections, 105 were extracted for comparison of temperature and precipitation (22 runs for RCP 2.6, 33 for 4.5, 18 for 6.0, and 32 for 8.5). These 105 are simply output from each model whose first run was available through the archive (Figure 12). This was done in order to ensure that each model would be represented no more than once in the comparisons for a single RCP. It is unknown to the author whether any systematic bias may have been introduced by picking only from the first runs as opposed to the lattermost runs, but it is reassuring that many models only had the first run available (15 of the 22 runs for RCP 2.6 were from models that had only the first run available). The period of record for 102 of the projections was 1/1950 to 12/2099. The other three ended 11/2099.

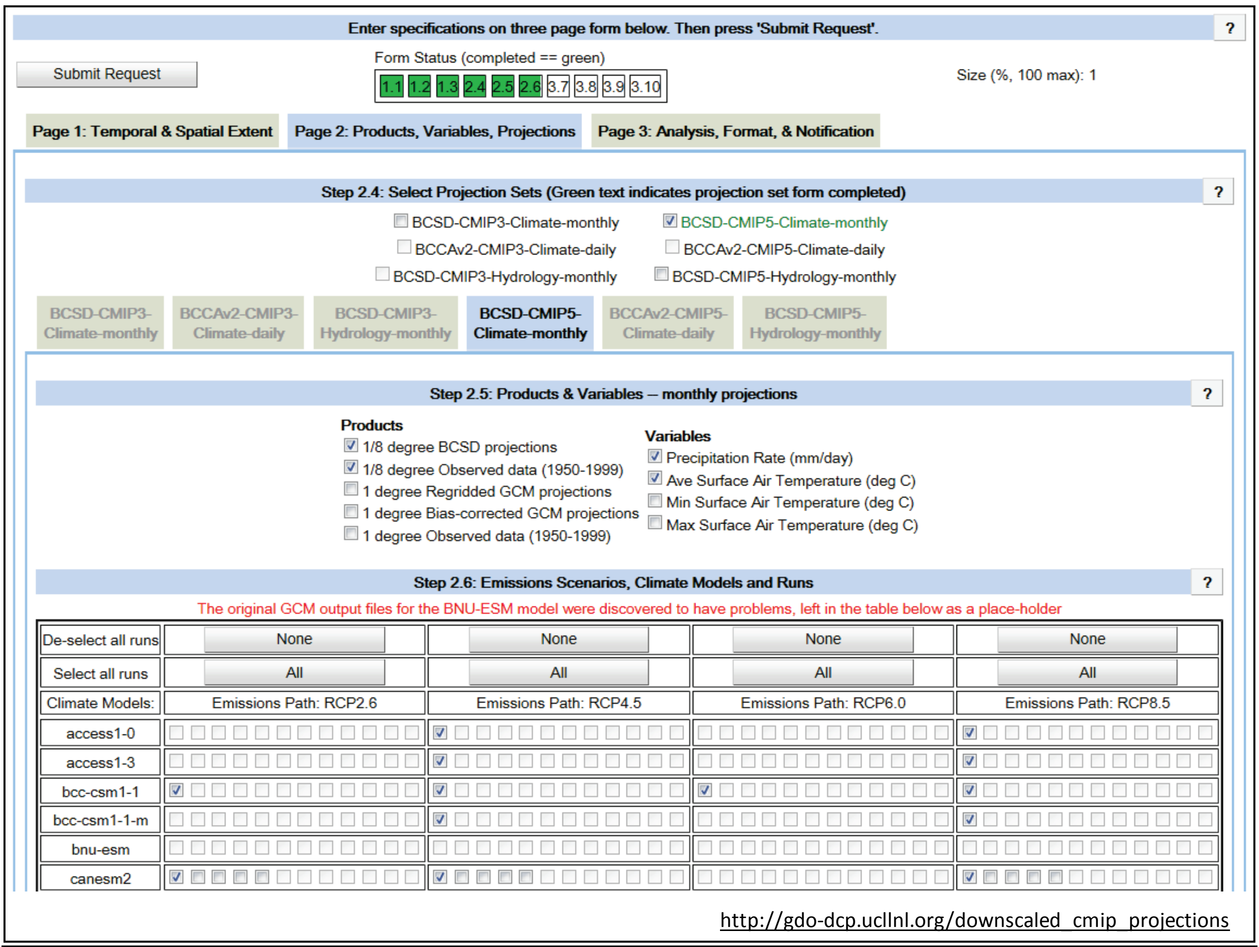

Figure 12. Selection of the first run model results from online archives of projected and observed air temperatures and precipitation.

2.2 Results

Statistical comparisons of average air temperatures and precipitation were performed using the entire period of record for historical data (1950 to 1999) and 2006 to 2099 for projections. Until 2006, projections by a single model, at least as reviewed for BCC and CSIRO models, were identical regardless of RCP. Statistical results were compared for individual RCPs and for the collective of all extracted runs spanning climate center, model, and RCP.

Air temperatures were projected to increase with the mean annual average temperature (for the collective) increasing from 16.6 to 19.0 degrees C, or a 14% increase (Figure 13). Within the target season of the recession rule, mean air temperatures (for the collective) were projected to increase by approximately 21%. Temperature predictions were very consistent between models, with annual mean temperatures for the central 50% of models grouping within 1.1 degrees C of each other (+11 to +17% change from historical), and between RCPs, with mean monthly temperatures increasing proportionally with RCP.

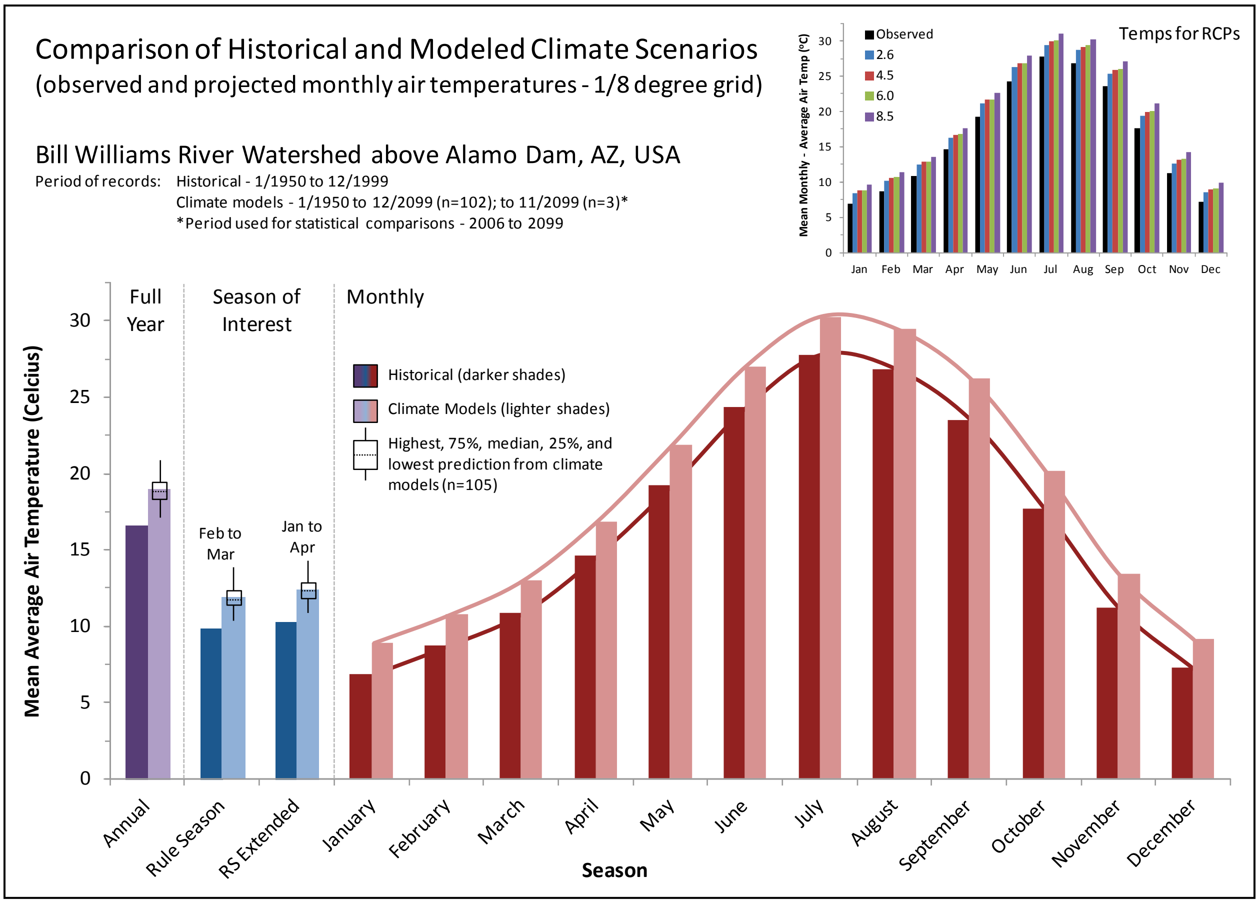

Figure 13. Comparison of historical and projected monthly air temperatures. Results show a consistent increase in projected mean monthly air temperatures for the Bill Williams River, AZ.

Changes in precipitation were more complicated. Annual precipitation rates (for the collective) were projected to decrease slightly, approximately -1% (Figure 14). Precipitation rates during the rule season (for the collective) were projected to fall by about -5% with this decrease being somewhat offset by higher rates in July through September. Projections of precipitation were

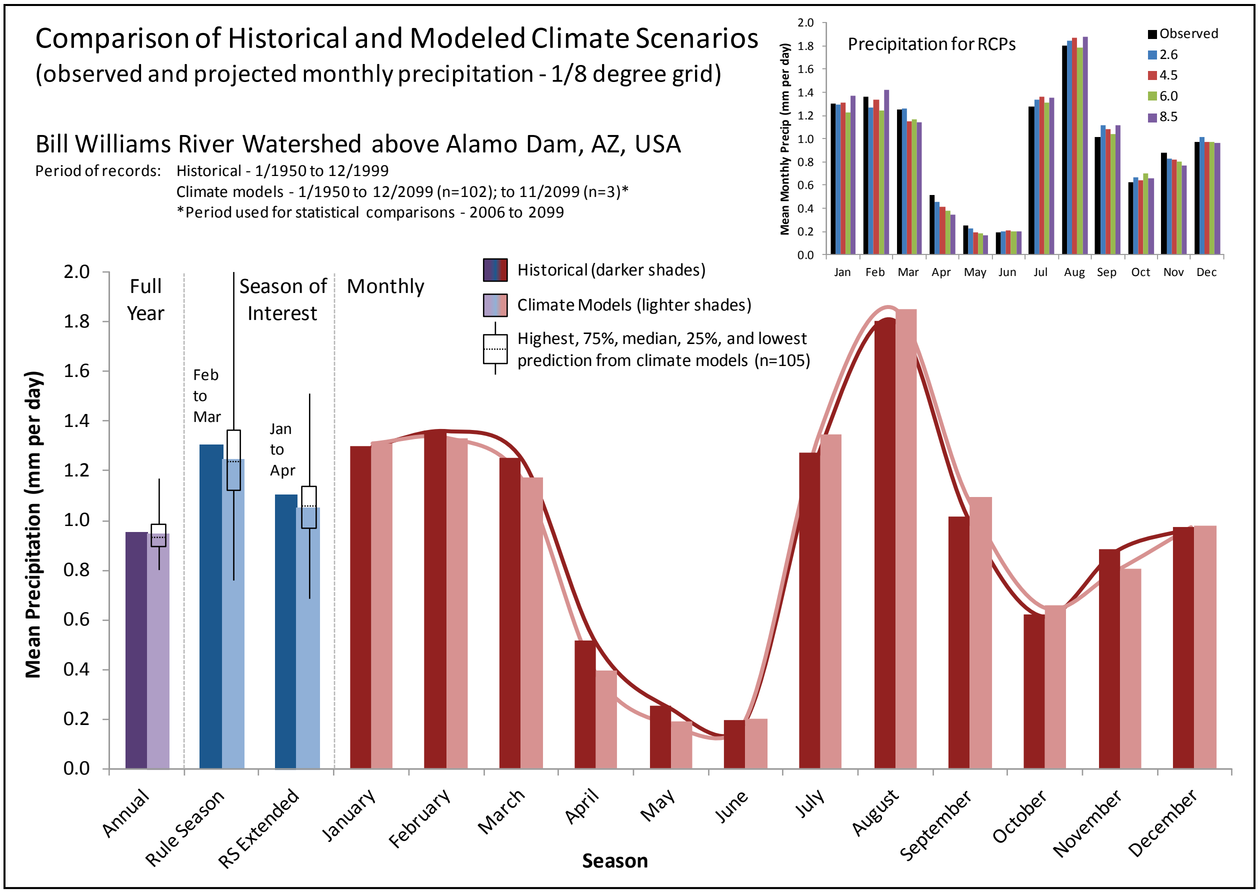

Figure 14. Comparison of historical and projected precipitation rates. Results show slight decreases in annual precipitation rates (-1%) and during the recruitment season (-4%) for the Bill Williams River, AZ.

more variable than those of average air temperature. For example, whereas temperature projections for the rule season ranged from +6 to +41% of historical amongst model runs, precipitation ranged from -41% to +54%. It was also interesting to note that mean monthly precipitation rates did not change consistently across the RCPs.

Statistical comparisons of river flows were performed using the entire period of record for both historical flows (10/2/1928 to 9/29/2005) and projections (1/1/1950 to 12/31/2099 or to 11/30/2099 for three of the models). Unlike temperature and precipitation, flow projections diverged per model and per RCP at the beginning of the record - this seemed odd and its cause is unknown and worth future investigation. A Pettitt test was run to test for nonstationarity conditions in the historical record (Pettitt 1979). The Pettitt test returns the timing and statistical significance of any change-point in a time series. For the historical record, a single break was recognized in 1941. Statistical significance was low (0.5), which indicates that the break was not especially distinct. The number of flow projections considered (93) was less than that for the temperature and precipitation (105). Specifically, 14 runs from 4 models (ACCESS1-3, IPSL-CM5A, MIROC-ESM-CHEM, and NORESM1-ME) were not available or were omitted. Also, one run (CNRM-CM5_RCP45) was included in flow comparisons and not for temperature or precipitation. This run may have been overlooked when extracting projections from the archive because it does appear to be available for temperature and precipitation. These inconsistencies were not corrected or fully investigated because they primarily affected comparisons of flow and, even with a lesser number of runs and concerns about homogeneity of the historical record, those comparisons were already clearly showing significant and non-intuitive differences between historical and projected series (Figure 15).

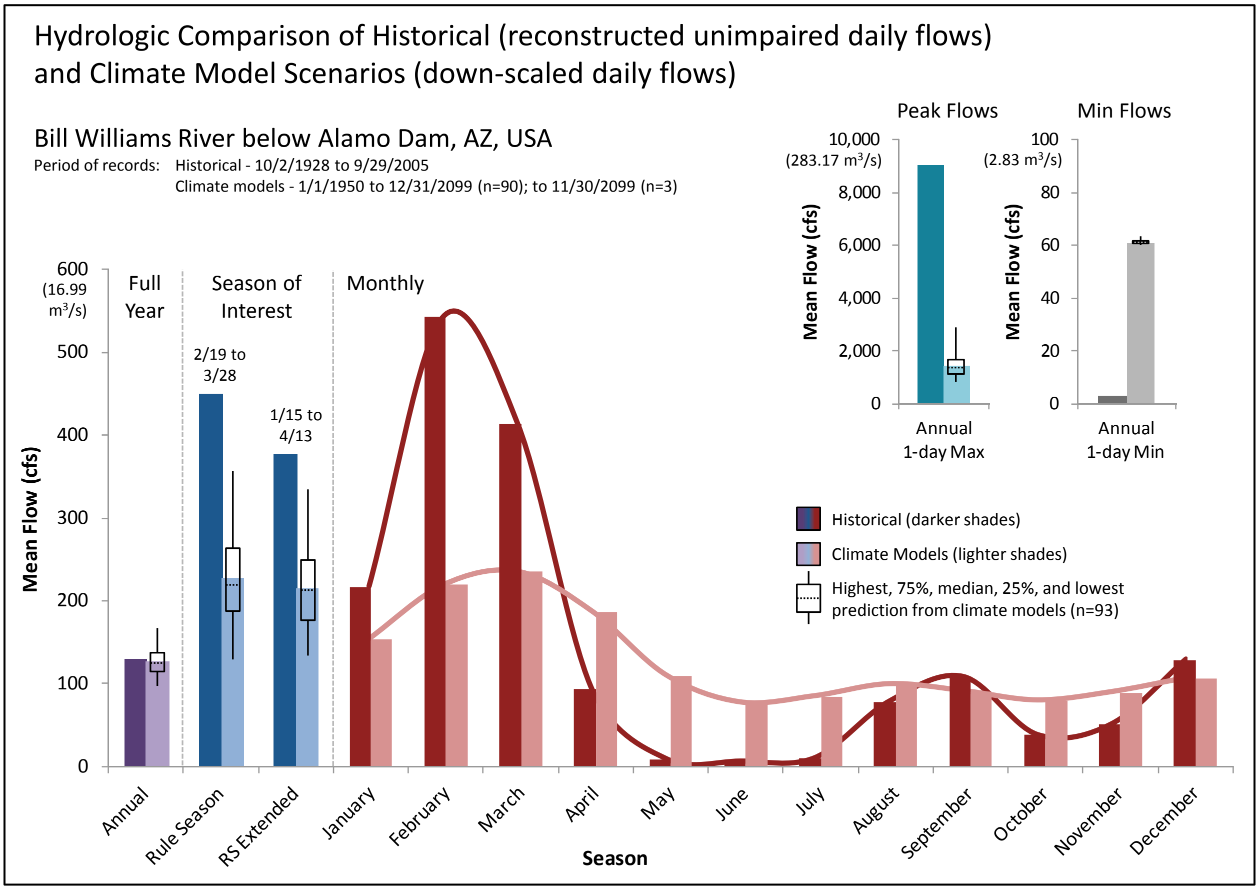

Figure 15. Comparison of historical and projected stream flows. Results show a marked difference between historical and projected flows for the Bill Williams River, AZ, which limited any statistical comparisons. Statistical results computed with HEC-EFM.

When considered in terms of annual volumes, historical and projected flows are quite comparable with the mean of all projected annual flows being slightly less (-2%) than historical. The character of the hydrograph, however, is markedly different. Projected flows are much more evenly distributed throughout the year than historical. The mean annual maximum flow fell from 256.07 to 41.51 m^3/s (9,043 to 1,466 cfs; -84%). The mean annual minimum flow increased from 0.08 to 1.73 m^3/s (3 to 61 cfs; +1,934%). Much of the volume that historically flowed in the wet season was projected to flow in the dry season. For example, flows in the rule season (2/19 to 3/28, which is a wet time of the year) fell by around half (-49%) and flows in the dry season (May to July) increased by an order of magnitude (0.23 to 2.55 m^3/s; 8 to 90 cfs; or +982%) when comparing mean average flow values. Models were consistent in this prediction. In fact, all models predicted less flow in the rule season (even the most water-rich projection was 21% less than historical; 10.08 versus 12.71 m^3/s; 356 versus 449 cfs) and more flow in the dry season (even the most water-poor projection had a +852% shift from historical; 2.27 versus 0.23 m^3/s; 80 versus 8 cfs). These shifts are fundamentally out of tune with the nature of the Bill Williams River, regardless of climate. Notably, they are also out of tune with the precipitation analysis, which raises questions about processes used to down-scale climate projections to daily river flows.

2.3 Summary

All runs projected higher average air temperatures. Effects on precipitation were less conclusive with 57 of 105 runs projecting less precipitation during the critical rule season. Mean precipitation rates for the collective of runs were slightly less than historical (-1% for the whole year, -4% for the rule season, and -5% for the extended rule season). These trends both suggest reduced river flows, with less precipitation leading to less runoff and higher temperatures leading to more evaporation and transpiration, assuming higher temperatures do not increase vegetation mortality. Down-scaled flows were suspect though it should be acknowledged that a flashy arid-lands river in the Sonoran Desert is perhaps the most challenging proving grounds for any climate-to-hydrology transform applied generally for many climactic regions (e.g., humid cool Northeastern and arid hot Southwestern U.S.) and hydrologic conditions (e.g., dry and wet seasons).

Given the slight changes in precipitation, climate change may prove more influential ecologically than hydrologically for this watershed (Perry et al. 2012). Germination periods are likely to occur earlier. If vegetative stresses are proportional to air temperatures, tolerable recession rates and summer survival of riparian vegetation are likely to decrease. These possible responses are important to the efficacy of this work, though it should be noted that the rule defined herein is based on landform and a range of recession rates. It is not bound to any particular season or rate. As new field data is collected that points to changing ecological needs such as earlier germination seasons, reservoir managers will simply need to consider the new conditions when deciding whether or how to use the guidance. The guidance itself, including the information and direction it provides, will not change.

2.4 Acknowledgements

The detailed comparisons of historical and projected conditions would not have been possible without the online archive made available by Bureau of Reclamation, Climate Analytics Group, Climate Central, Lawrence Livermore National Laboratory, Santa Clara University, Scripps Institution of Oceanography, U.S. Army Corps of Engineers, U.S. Geological Survey, and National Center for Atmospheric Research. The website was excellent for obtaining data and providing information about the data (http://gdo-dcp.ucllnl.org/downscaled_cmip_projections). The assistance of Bryan Baker, USACE Cold Regions Laboratory, in guiding the use of the archives and understanding the data was much appreciated. Bryan also performed the Pettitt test to check for non-stationarities in the historical record.

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Appendix A

Scope and Budget Revisited for this Desert LCC Project (R13PG80649)

John T. Hickey

After a project is completed, often lost are details about how it came to pass and the tangential advances it helped create. This section is not intended as an exhaustive history of the project. Instead it seeks to detail a few noteworthy moments and actions that might otherwise not be recognized.

The proposal for this project was submitted in June 2013. Notice of award was received in August 2013 with funding becoming available in December 2013. The overall timeline for the project was estimated at 13 months from availability of funds, or January 2015.

Scoped work fell generally into two categories: modeling and climate change considerations (as detailed in the previous two sections) and collection and processing of LIDAR data. Estimated costs were roughly the same for these parts, with modeling and climate and LIDAR acquisition and process scoped at $50k and $45k, respectively (Figure 16).

				Hours (Fall 2013 to Summer 2014)				Costs (Fall 2013 to Summer 2014)				
Task	**Category**	**Staff Level**	**Hourly Rate**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Task Totals**
Preparation of hydrologic scenarios	Labor	Sr. Engineer	$ 115.00	12				$ 1,380	$ -	$ -	$ -	$ 5,000
	Labor	Engineer	$ 90.00	22				$ 1,980	$ -	$ -	$ -	
	Labor	Eng. Intern	$ 40.00	41				$ 1,640	$ -	$ -	$ -	
Acquisition of LiDAR data	Labor	Sr. Engineer	$ 115.00	12	8			$ 1,380	$ 920	$ -	$ -	$ 45,000
	Labor	Engineer	$ 90.00	22	8			$ 1,980	$ 720	$ -	$ -	
	Labor	Eng. Intern	$ 40.00	0	0			$ -	$ -	$ -	$ -	
	Contracting	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	$ -	$40,000	$ -	$ -	
Model simulations for existing conditions	Labor	Sr. Engineer	$ 115.00		1	1		$ -	$ 115	$ 115	$ -	$ 2,000
	Labor	Engineer	$ 90.00		4	5		$ -	$ 360	$ 450	$ -	
	Labor	Eng. Intern	$ 40.00		12	12		$ -	$ 480	$ 480	$ -	
Post-processing results to formulate operational rule	Labor	Sr. Engineer	$ 115.00		4	16		$ -	$ 460	$ 1,840	$ -	$ 15,000
	Labor	Engineer	$ 90.00		20	70		$ -	$ 1,800	$ 6,300	$ -	
	Labor	Eng. Intern	$ 40.00		20	95		$ -	$ 800	$ 3,800	$ -	
Simulations for all hydro scenarios	Labor	Sr. Engineer	$ 115.00			4	2	$ -	$ -	$ 460	$ 230	$ 3,000
	Labor	Engineer	$ 90.00			15	4	$ -	$ -	$ 1,350	$ 360	
	Labor	Eng. Intern	$ 40.00			11	4	$ -	$ -	$ 440	$ 160	
Finalization of rule and coordination with operators	Labor	Sr. Engineer	$ 115.00				30	$ -	$ -	$ -	$ 3,450	$ 10,000
	Labor	Engineer	$ 90.00				51	$ -	$ -	$ -	$ 4,590	
	Labor	Eng. Intern	$ 40.00				49	$ -	$ -	$ -	$ 1,960	
Documentation of methods and results	Labor	Sr. Engineer	$ 115.00				60	$ -	$ -	$ -	$ 6,900	$ 15,000
	Labor	Engineer	$ 90.00				90	$ -	$ -	$ -	$ 8,100	
	Labor	Eng. Intern	$ 40.00				0	$ -	$ -	$ -	$ -	
			Totals:	109	77	229	290	$ 8,360	$45,655	$15,235	$25,750	**$ 95,000**

Figure 16. Estimated costs for Desert LCC supported aspects of this project.

In kind work was estimated at $128k (Figure 17). The two most substantial in kind tasks were 1) management and processing of the LIDAR data set; and, 2) software development of a splicing feature to automate the creation of habitat mosaics (as described in the model development section earlier in this report).

				Hours (Fall 2013 to Summer 2014)				Costs (Fall 2013 to Summer 2014)				
Task	**Category**	**Staff Level**	**Hourly Rate**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Task Totals**
Coding and testing of	Labor	Sr. Engineer	$ 115.00	80				$ 9,200	$ -	$ -	$ -	$ 40,344
habitat mosaic feature	Labor	Eng. Intern	$ 40.00	120				$ 4,800	$ -	$ -	$ -	
in EFM (USACE)	Contracting	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	$26,344	$ -	$ -	$ -	
Project administration	Labor	Refuge Manager	$ 76.00	40	40	20	20	$ 3,040	$ 3,040	$ 1,520	$ 1,520	$ 25,680
and coordination	Labor	Supv. Hydrologist	$ 72.00	60	40	20	40	$ 4,320	$ 2,880	$ 1,440	$ 2,880	
(USFWS)	Labor	Ecologist	$ 42.00	20	20	40	40	$ 840	$ 840	$ 1,680	$ 1,680	
LiDAR data processing	Labor	Spatial Ecologist	$ 57.00		320			$ -	$18,240	$ -	$ -	$ 41,740
(USFWS)	Equipment	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	$ -	$23,500	$ -	$ -	
Info transfer and	Labor (USACE)	Sr. Engineer	$ 115.00			24	24	$ -	$ -	$ 2,760	$ 2,760	$ 20,160
meeting participation	Labor (USACE)	Engineer	$ 90.00			24	24	$ -	$ -	$ 2,160	$ 2,160	
(USGS, USFWS, and	Labor (USGS)	Research Ecologist	$ 100.00			30	30			$ 3,000	$ 3,000	
USACE)	Labor (USFWS)	Supv. Hydrologist	$ 72.00			30	30	$ -	$ -	$ 2,160	$ 2,160	
			Totals:	320	420	188	208	$48,544	$48,500	$14,720	$16,160	**$ 127,924**

Figure 17. Estimates costs for In Kind supported aspects of this project.

Actual and estimated spending differed significantly for the LIDAR data collection effort. Contracting costs totaled to $61.5k, well above the $40k scoped. This overage was initially covered with funds from the modeling portion of the LCC funded tasks and eventually absorbed elsewhere, which added at least $20k to the in kind total. The LIDAR collection effort was leveraged with funds from the Los Angeles District to also allow collection of aerial photography. Jon Sweeten, with the USACE Reservoir Regulation Section in Los Angeles, was instrumental in procuring the additional funds ($68k) required. Ted Stanton, Chief of the Geodesy and Photogrammetry Section with USACE in St. Louis, handled contracting for both efforts. Steve Sesnie, with USFWS in Albuquerque, led the LIDAR efforts for the LCC team and was very helpful, knowledgeable, and involved throughout. Ted and Steve managed and led quality assurance and control efforts, a process that entailed at least three iterations of review with the contractors. The paired LIDAR and aerial photography data will be a valuable resource for continued study and stewardship of the Bill Williams River for years to come.

Consideration of climate change was a small, but interesting part of this work. In terms of tasks, climate analyses were scoped as part of the "Preparation of hydrologic scenarios" and "Simulation for all hydro scenarios" model-related tasks, which totaled to only $8k. This work was hugely advanced by the online archives of climate projections and fortuitous in that the Bill Williams River was one of 418 locations in the continental United States with down-scaled projects of daily mean river flows, a standard input for the HEC-EFM software used to compare historical and projected conditions. Mr. Bryan Baker, with the USACE Cold Regions Laboratory in Hanover, was very helpful in demonstrating use of the archives and explaining the fundamentals of model projections. All told, the climate dataset analyzed in this project contained roughly 5.1 million data points, which made for one of the most data-intensive applications of HEC-EFM to date. During processing, it was determined that while HEC-EFM was capable of computing and reporting results of the analyses, the software was incapable of outputting detailed results for the entire analysis (output of detailed results is an user option in HEC-EFM and was a sizeable request in this case – an estimated 3.4 GB of storage on disk was needed). Through the dialogue with Bryan, who was intrigued by the potential of Bill Williams River analyses to serve as a template for similar climate comparisons at other river-reservoir systems across the United States, the output deficiency in HEC-EFM was diagnosed, solutions scoped, and ultimately funded through a climate change effort Mr. Bryan Baker works with. Software improvements are currently being implemented.

The HEC-EFM suite was also advanced through development of software features that allow automation of the GIS splicing needed to create habitat mosaics. This feature is applicable to the Bill Williams River modeling where local cross section-based results were spliced and, more generally, to any application where hydrologic or ecological conditions change within an area of interest. River systems with multiple tributaries are a useful example. In situations where one species is utilizing different connected streams, habitat maps of those reaches can be spliced to create a single habitat mosaic.

With these software developments and the LIDAR/photography efforts, the total of in kind costs increased to over $250k. And while this report comes several months after the scoped conclusion of the Desert LCC project, it is gratifying to recognize that this work accomplished its goal of codifying climate-tested science-based guidance for water managers while also advancing the body of scientific knowledge that enabled it (adding LIDAR and aerial photography to the data resources of the Bill Williams River) and making stronger for all future applications the modeling framework (automation of splicing and output enhancements) used to connect river science and reservoir operations.

The investigators, authors, and collaborators for this project thank the Desert LCC and U.S. Bureau of Reclamation for supporting this work.

Appendix B - Recession Tables

This appendix contains the hydrograph recessions that maximized growth area potential (GAP) for riparian seedlings. Three tables, one for each recession rate, are provided. To use, compute the volume of water available for release, go to the desired recession rate table, find the columns with volumes that bracket the available volume. Pick which hydrograph to use and, per the modeling, follow the sequence of receding flows to generate the associated seedling GAP (Figure B-1).

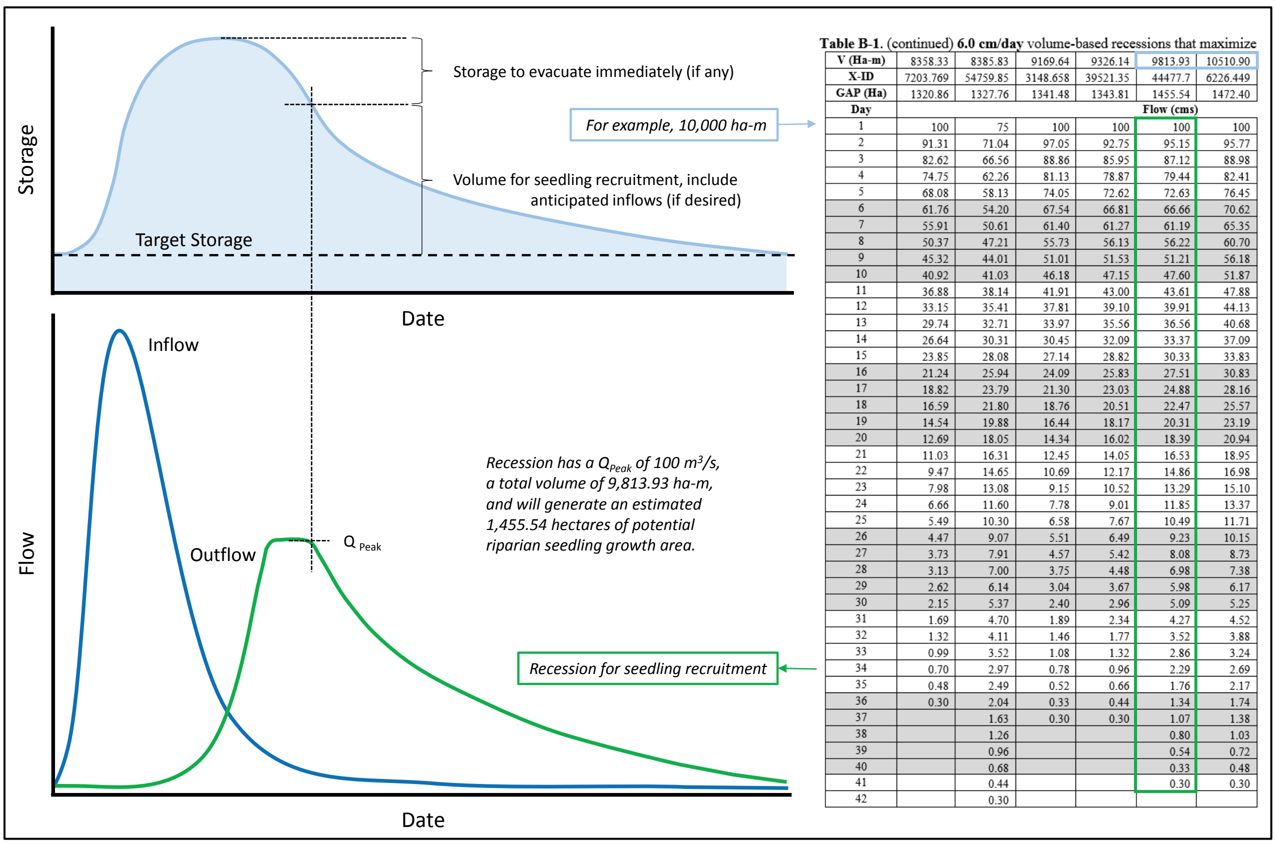

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize

V (Ha-m)	8358.33	8385.83	9169.64	9326.14	9813.93	10510.90
X-ID	7203.769	54759.85	3148.658	39521.35	44477.7	6226.449
GAP (Ha)	1320.86	1327.76	1341.48	1343.81	1455.54	1472.40
Day					Flow (cms)	
1	100	75	100	100	100	100
2	91.31	71.04	97.05	92.75	95.15	95.77
3	82.62	66.56	88.86	85.95	87.12	88.98
4	74.75	62.26	81.13	78.87	79.44	82.41
5	68.08	58.13	74.05	72.62	72.63	76.45
6	61.76	54.20	67.54	66.81	66.66	70.62
7	55.91	50.61	61.40	61.27	61.19	65.35
8	50.37	47.21	55.73	56.13	56.22	60.70
9	45.32	44.01	51.01	51.53	51.21	56.18
10	40.92	41.03	46.18	47.15	47.60	51.87
11	36.88	38.14	41.91	43.00	43.61	47.88
12	33.15	35.41	37.81	39.10	39.91	44.13
13	29.74	32.71	33.97	35.56	36.56	40.68
14	26.64	30.31	30.45	32.09	33.37	37.09
15	23.85	28.08	27.14	28.82	30.33	33.83
16	21.24	25.94	24.09	25.83	27.51	30.83
17	18.82	23.79	21.30	23.03	24.88	28.16
18	16.59	21.80	18.76	20.51	22.47	25.57
19	14.54	19.88	16.44	18.17	20.31	23.19
20	12.69	18.05	14.34	16.02	18.39	20.94
21	11.03	16.31	12.45	14.05	16.53	18.95
22	9.47	14.65	10.69	12.17	14.86	16.98
23	7.98	13.08	9.15	10.52	13.29	15.10
24	6.66	11.60	7.78	9.01	11.85	13.37
25	5.49	10.30	6.58	7.67	10.49	11.71
26	4.47	9.07	5.51	6.49	9.23	10.15
27	3.73	7.91	4.57	5.42	8.08	8.73
28	3.13	7.00	3.75	4.48	6.98	7.38
29	2.62	6.14	3.04	3.67	5.98	6.17
30	2.15	5.37	2.40	2.96	5.09	5.25
31	1.69	4.70	1.89	2.34	4.27	4.52
32	1.32	4.11	1.46	1.77	3.52	3.88
33	0.99	3.52	1.08	1.32	2.86	3.24
34	0.70	2.97	0.78	0.96	2.29	2.69
35	0.48	2.49	0.52	0.66	1.76	2.17
36	0.30	2.04	0.33	0.44	1.34	1.74
37		1.63	0.30	0.30	1.07	1.38
38		1.26			0.80	1.03
39		0.96			0.54	0.72
40		0.68			0.33	0.48
41		0.44			0.30	0.30
42		0.30				

Figure B-1. Example use of information in Appendix B to guide reservoir operations.

The three tables are available in the following sections.

B.1 6.0 cm/day recessions

Table B-1. **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	148.04	176.93	184.62	198.62	218.83	237.92	300.59	327.65	338.85
X-ID	16.61351	19825.81	132.3145	4104.055	19165.92	4469.405	27603.03	11699.79	47053.28
GAP (Ha)	356.64	364.71	370.95	374.09	375.40	399.51	409.52	414.24	419.01
Day	Flow (cms)								
1	10	10	10	10	10	10	10	10	10
2	4.55	6.40	6.31	6.07	6.72	6.19	7.47	8.21	8.06
3	1.79	3.10	3.12	3.38	4.14	3.81	5.56	6.08	6.09
4	0.50	0.92	1.29	1.83	2.37	2.72	4.05	4.39	4.38
5	0.30	0.30	0.34	0.99	1.33	1.96	2.89	3.10	3.57
6			0.30	0.51	0.59	1.30	1.97	2.09	2.64
7				0.30	0.30	0.82	1.33	1.44	1.84
8						0.47	0.84	1.01	1.16
9						0.30	0.47	0.66	0.75
10							0.30	0.45	0.45
11								0.31	0.30
12								0.30	

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	352.87	371.92	385.08	422.46	433.72	435.98	451.26	462.26	482.09
X-ID	37499.16	24648.68	51275.36	51365.41	51483.17	36636.9	2493.211	44248.39	56226.04
GAP (Ha)	433.60	439.43	443.61	449.14	449.67	450.35	458.28	466.59	466.74
Day	Flow (cms)								
1	10	10	10	10	10	10	10	10	10
2	8.10	9.43	8.66	8.78	8.46	8.71	8.67	8.63	8.74
3	6.19	6.59	6.63	7.01	7.03	7.17	7.27	7.19	7.47
4	4.56	4.57	5.09	5.54	5.71	5.86	6.01	5.96	6.27
5	3.42	3.04	3.71	4.41	4.62	4.75	4.93	4.94	5.18
6	2.68	2.55	2.90	3.46	3.74	3.79	4.00	4.08	4.28
7	2.15	2.09	2.22	2.72	3.02	2.92	3.19	3.29	3.49
8	1.51	1.61	1.87	2.17	2.41	2.27	2.51	2.61	2.82
9	1.00	1.19	1.55	1.68	1.88	1.76	1.92	2.01	2.27
10	0.64	0.84	1.17	1.21	1.42	1.32	1.43	1.45	1.75
11	0.39	0.56	0.60	0.84	1.00	0.90	1.02	1.09	1.31
12	0.30	0.36	0.30	0.56	0.69	0.56	0.68	0.91	0.94
13		0.30		0.34	0.30	0.32	0.41	0.63	0.63
14				0.30		0.30	0.30	0.44	0.40
15								0.30	0.30

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	509.36	528.60	606.88	609.12	652.29	803.39	1047.80	1074.41	1214.03
X-ID	7091.917	7203.769	54648.7	54759.85	55468.13	24648.68	17462.45	4739.83	39336.49
GAP (Ha)	475.11	477.64	480.43	481.10	481.88	547.20	554.50	581.36	590.53
Day	**Flow (cms)**								
1	10	10	10	10	10	25	25	25	25
2	9.16	9.47	9.75	9.07	9.94	20.56	20.76	21.31	21.41
3	7.71	7.98	8.48	7.91	8.71	14.38	16.89	17.71	18.28
4	6.47	6.66	7.31	7.00	7.62	9.43	13.71	14.12	15.69
5	5.39	5.49	6.26	6.14	6.60	6.59	11.11	11.10	13.09
6	4.30	4.47	5.38	5.37	5.74	4.57	8.83	8.66	10.77
7	3.62	3.73	4.58	4.70	4.96	3.04	7.02	6.75	8.73
8	3.01	3.13	3.91	4.11	4.33	2.55	5.54	5.16	7.24
9	2.52	2.62	3.27	3.52	3.75	2.09	4.24	4.02	5.69
10	2.01	2.15	2.70	2.97	3.16	1.61	3.10	3.10	4.30
11	1.57	1.69	2.24	2.49	2.62	1.19	2.16	2.35	3.34
12	1.19	1.32	1.82	2.04	2.14	0.84	1.46	1.78	2.50
13	0.86	0.99	1.45	1.63	1.71	0.56	0.87	1.29	1.73
14	0.60	0.70	1.10	1.26	1.34	0.36	0.43	0.90	1.20
15	0.37	0.48	0.82	0.96	1.02	0.30	0.30	0.58	0.80
16	0.30	0.30	0.58	0.68	0.77			0.34	0.49
17			0.38	0.44	0.54			0.30	0.30
18			0.30	0.30	0.35				
19					0.30				

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	1230.18	1307.04	1340.84	1384.81	1505.96	1542.04	1551.05	1552.27	1613.74
X-ID	37776.21	38050.96	48393.66	11213.08	2715.69	48001.65	2938.422	44248.39	7091.917
GAP (Ha)	614.56	617.15	637.72	651.51	671.63	683.56	685.68	687.07	708.44
Day	**Flow (cms)**								
1	25	25	25	25	25	25	25	25	25
2	23.40	22.80	22.32	21.79	23.07	22.83	23.11	22.53	22.62
3	19.14	19.66	18.94	18.98	20.20	20.18	20.32	20.00	20.12
4	15.45	16.61	15.92	16.32	17.59	17.72	17.79	17.64	17.83
5	12.43	13.93	13.70	13.96	15.22	15.44	15.51	15.51	15.72
6	9.48	11.45	11.57	11.89	13.11	13.42	13.45	13.56	13.80
7	6.84	9.33	9.81	10.08	11.18	11.62	11.56	11.78	12.13
8	5.29	7.36	8.17	8.49	9.48	9.95	9.86	10.14	10.60
9	4.63	5.84	6.79	7.02	7.99	8.43	8.37	8.63	9.16
10	4.33	4.65	5.62	5.86	6.70	7.08	7.07	7.19	7.71
11	3.67	3.86	4.51	4.88	5.56	5.88	5.92	5.96	6.47
12	3.03	2.87	3.52	4.05	4.58	4.81	4.91	4.94	5.39
13	2.65	2.30	2.71	3.32	3.72	3.89	4.03	4.08	4.30
14	2.26	1.77	2.03	2.60	2.98	3.13	3.26	3.29	3.62
15	1.74	1.55	1.53	2.02	2.34	2.48	2.59	2.61	3.01
16	1.30	1.12	1.13	1.54	1.81	1.93	2.04	2.01	2.52
17	0.92	0.69	0.82	1.09	1.37	1.50	1.57	1.45	2.01
18	0.56	0.35	0.55	0.73	0.99	1.14	1.18	1.09	1.57
19	0.30	0.30	0.36	0.44	0.69	0.84	0.84	0.91	1.19
20			0.30	0.30	0.45	0.59	0.57	0.63	0.86
21					0.30	0.39	0.36	0.44	0.60
22						0.30	0.30	0.30	0.37
23									0.30

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	1757.44	1771.60	1927.89	1930.05	1970.79	2518.62	2805.34	3044.19	3106.86
X-ID	46146.75	6226.449	59488.79	54648.7	55468.13	4739.83	35781.2	16348.4	48393.66
GAP (Ha)	709.45	711.13	720.90	724.58	728.36	732.03	780.50	823.74	842.17
Day	**Flow (cms)**								
1	25	25	25	25	25	50	50	50	50
2	22.77	23.19	23.43	24.22	23.99	46.81	43.91	43.96	46.46
3	20.75	20.94	21.41	22.00	21.87	38.12	37.69	38.49	40.57
4	18.66	18.95	19.47	19.90	19.77	31.45	32.07	33.47	35.46
5	16.70	16.98	17.62	17.91	17.80	25.78	27.90	28.95	30.83
6	14.86	15.10	15.86	16.04	15.96	21.31	24.17	24.96	26.08
7	13.13	13.37	14.19	14.29	14.25	17.71	20.66	21.42	22.32
8	11.54	11.71	12.62	12.65	12.71	14.12	17.58	18.36	18.94
9	10.13	10.15	11.14	11.13	11.26	11.10	14.74	15.89	15.92
10	8.82	8.73	9.72	9.75	9.94	8.66	12.40	13.89	13.70
11	7.63	7.38	8.51	8.48	8.71	6.75	10.41	12.22	11.57
12	6.56	6.17	7.39	7.31	7.62	5.16	8.51	10.51	9.81
13	5.54	5.25	6.56	6.26	6.60	4.02	6.84	8.80	8.17
14	4.72	4.52	5.71	5.38	5.74	3.10	5.34	7.51	6.79
15	3.91	3.88	4.87	4.58	4.96	2.35	4.09	6.09	5.62
16	3.21	3.24	4.08	3.91	4.33	1.78	3.06	4.94	4.51
17	2.60	2.69	3.46	3.27	3.75	1.29	2.19	3.99	3.52
18	2.03	2.17	2.94	2.70	3.16	0.90	1.47	3.10	2.71
19	1.57	1.74	2.43	2.24	2.62	0.58	0.93	2.21	2.03
20	1.19	1.38	1.97	1.82	2.14	0.34	0.52	1.61	1.53
21	0.87	1.03	1.55	1.45	1.71	0.30	0.30	1.05	1.13
22	0.60	0.72	1.18	1.10	1.34			0.62	0.82
23	0.40	0.48	0.84	0.82	1.02			0.30	0.55
24	0.30	0.30	0.59	0.58	0.77				0.36
25			0.38	0.38	0.54				0.30
26			0.30	0.30	0.35				
27					0.30				

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	3239.79	3464.04	3566.58	3599.27	3737.53	3998.86	4449.08	4460.52	4752.51
X-ID	58939.63	11213.08	2715.69	2938.422	7203.769	7091.917	46146.75	44477.7	55384.28
GAP (Ha)	872.73	879.37	923.88	950.89	996.95	1006.10	1026.72	1040.81	1047.27
Day	Flow (cms)								
1	50	50	50	50	50	50	50	50	50
2	45.91	48.18	46.00	45.52	45.32	48.31	48.49	47.60	47.56
3	40.62	42.65	41.43	41.07	40.92	43.34	44.23	43.61	44.30
4	35.54	37.63	37.12	36.87	36.88	39.13	40.16	39.91	41.30
5	29.81	33.01	33.17	33.01	33.15	35.17	36.63	36.56	38.25
6	25.25	28.88	29.59	29.46	29.74	31.54	33.55	33.37	35.32
7	22.58	25.30	26.18	26.14	26.64	28.24	30.62	30.33	32.51
8	19.82	21.79	23.07	23.11	23.85	25.33	27.73	27.51	29.81
9	17.44	18.98	20.20	20.32	21.24	22.62	25.13	24.88	27.24
10	15.31	16.32	17.59	17.79	18.82	20.12	22.77	22.47	24.78
11	13.31	13.96	15.22	15.51	16.59	17.83	20.75	20.31	22.62
12	11.22	11.89	13.11	13.45	14.54	15.72	18.66	18.39	20.49
13	9.63	10.08	11.18	11.56	12.69	13.80	16.70	16.53	18.38
14	8.17	8.49	9.48	9.86	11.03	12.13	14.86	14.86	16.44
15	6.85	7.02	7.99	8.37	9.47	10.60	13.13	13.29	14.60
16	5.59	5.86	6.70	7.07	7.98	9.16	11.54	11.85	12.95
17	4.57	4.88	5.56	5.92	6.66	7.71	10.13	10.49	11.40
18	3.67	4.05	4.58	4.91	5.49	6.47	8.82	9.23	9.99
19	2.89	3.32	3.72	4.03	4.47	5.39	7.63	8.08	8.69
20	2.16	2.60	2.98	3.26	3.73	4.30	6.56	6.98	7.57
21	1.66	2.02	2.34	2.59	3.13	3.62	5.54	5.98	6.51
22	1.17	1.54	1.81	2.04	2.62	3.01	4.72	5.09	5.58
23	0.81	1.09	1.37	1.57	2.15	2.52	3.91	4.27	4.79
24	0.50	0.73	0.99	1.18	1.69	2.01	3.21	3.52	4.11
25	0.32	0.44	0.69	0.84	1.32	1.57	2.60	2.86	3.46
26	0.30	0.30	0.45	0.57	0.99	1.19	2.03	2.29	2.85
27			0.30	0.36	0.70	0.86	1.57	1.76	2.31
28				0.30	0.48	0.60	1.19	1.34	1.84
29					0.30	0.37	0.87	1.07	1.43
30						0.30	0.60	0.80	1.07
31							0.40	0.54	0.79
32							0.30	0.33	0.55
33								0.30	0.35
34									0.30

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	5035.18	5687.85	6167.57	6399.26	6646.41	7116.71	7326.11	7336.78	8349.17
X-ID	54759.85	13143.03	38223.18	7091.917	3148.658	46233.33	6226.449	44477.7	6954.144
GAP (Ha)	1062.39	1070.24	1097.01	1191.46	1191.97	1212.83	1278.45	1283.80	1286.52
Day	**Flow (cms)**								
1	50	75	75	75	75	75	75	75	100
2	47.21	70.16	70.98	73.04	74.05	72.92	70.62	72.63	90.44
3	44.01	62.92	64.37	66.12	67.54	67.37	65.35	66.66	81.56
4	41.03	55.85	58.17	59.84	61.40	62.11	60.70	61.19	73.47
5	38.14	49.87	52.55	53.82	55.73	57.14	56.18	56.22	66.70
6	35.41	44.90	47.39	48.31	51.01	52.34	51.87	51.21	60.92
7	32.71	40.16	42.65	43.34	46.18	47.74	47.88	47.60	55.47
8	30.31	35.82	38.30	39.13	41.91	43.37	44.13	43.61	50.14
9	28.08	31.66	34.30	35.17	37.81	39.25	40.68	39.91	45.05
10	25.94	27.98	30.90	31.54	33.97	35.48	37.09	36.56	41.12
11	23.79	24.68	27.72	28.24	30.45	32.32	33.83	33.37	37.26
12	21.80	21.73	24.82	25.33	27.14	29.03	30.83	30.33	33.51
13	19.88	18.95	22.13	22.62	24.09	26.17	28.16	27.51	30.19
14	18.05	16.42	19.65	20.12	21.30	23.45	25.57	24.88	27.14
15	16.31	14.13	17.33	17.83	18.76	21.00	23.19	22.47	24.44
16	14.65	12.14	15.16	15.72	16.44	18.80	20.94	20.31	21.79
17	13.08	10.37	13.16	13.80	14.34	16.73	18.95	18.39	19.30
18	11.60	8.83	11.34	12.13	12.45	14.85	16.98	16.53	17.01
19	10.30	7.45	9.69	10.60	10.69	13.10	15.10	14.86	15.00
20	9.07	6.30	8.08	9.16	9.15	11.54	13.37	13.29	13.12
21	7.91	5.23	6.77	7.71	7.78	10.17	11.71	11.85	11.36
22	7.00	4.24	5.49	6.47	6.58	9.00	10.15	10.49	9.83
23	6.14	3.42	4.31	5.39	5.51	7.86	8.73	9.23	8.38
24	5.37	2.66	3.37	4.30	4.57	6.81	7.38	8.08	7.07
25	4.70	2.09	2.63	3.62	3.75	5.87	6.17	6.98	5.84
26	4.11	1.58	2.10	3.01	3.04	5.04	5.25	5.98	4.88
27	3.52	1.16	1.70	2.52	2.40	4.30	4.52	5.09	3.99
28	2.97	0.81	1.28	2.01	1.89	3.63	3.88	4.27	3.20
29	2.49	0.52	1.00	1.57	1.46	3.02	3.24	3.52	2.51
30	2.04	0.34	0.72	1.19	1.08	2.47	2.69	2.86	1.93
31	1.63	0.33	0.49	0.86	0.78	1.94	2.17	2.29	1.41
32	1.26	0.32	0.30	0.60	0.52	1.52	1.74	1.76	1.01
33	0.96	0.30		0.37	0.33	1.08	1.38	1.34	0.68
34	0.68			0.30	0.30	0.75	1.03	1.07	0.42
35	0.44					0.48	0.72	0.80	0.30
36	0.30					0.30	0.48	0.54	
37							0.30	0.33	
38								0.30	

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	8358.33	8385.83	9169.64	9326.14	9813.93	10510.90	11801.29	12301.53	12953.80
X-ID	7203.769	54759.85	3148.658	39521.35	44477.7	6226.449	54648.7	54759.85	44477.7
GAP (Ha)	1320.86	1327.76	1341.48	1343.81	1455.54	1472.40	1517.35	1537.80	1594.60
Day	**Flow (cms)**								
1	100	75	100	100	100	100	100	100	125
2	91.31	71.04	97.05	92.75	95.15	95.77	94.64	95.95	122.17
3	82.62	66.56	88.86	85.95	87.12	88.98	89.34	90.59	112.55
4	74.75	62.26	81.13	78.87	79.44	82.41	84.22	85.43	103.68
5	68.08	58.13	74.05	72.62	72.63	76.45	79.30	80.52	95.15
6	61.76	54.20	67.54	66.81	66.66	70.62	74.54	75.71	87.12
7	55.91	50.61	61.40	61.27	61.19	65.35	69.92	71.04	79.44
8	50.37	47.21	55.73	56.13	56.22	60.70	65.53	66.56	72.63
9	45.32	44.01	51.01	51.53	51.21	56.18	61.33	62.26	66.66
10	40.92	41.03	46.18	47.15	47.60	51.87	57.31	58.13	61.19
11	36.88	38.14	41.91	43.00	43.61	47.88	53.51	54.20	56.22
12	33.15	35.41	37.81	39.10	39.91	44.13	49.91	50.61	51.21
13	29.74	32.71	33.97	35.56	36.56	40.68	46.46	47.21	47.60
14	26.64	30.31	30.45	32.09	33.37	37.09	43.18	44.01	43.61
15	23.85	28.08	27.14	28.82	30.33	33.83	40.04	41.03	39.91
16	21.24	25.94	24.09	25.83	27.51	30.83	37.06	38.14	36.56
17	18.82	23.79	21.30	23.03	24.88	28.16	34.22	35.41	33.37
18	16.59	21.80	18.76	20.51	22.47	25.57	31.52	32.71	30.33
19	14.54	19.88	16.44	18.17	20.31	23.19	28.94	30.31	27.51
20	12.69	18.05	14.34	16.02	18.39	20.94	26.55	28.08	24.88
21	11.03	16.31	12.45	14.05	16.53	18.95	24.22	25.94	22.47
22	9.47	14.65	10.69	12.17	14.86	16.98	22.00	23.79	20.31
23	7.98	13.08	9.15	10.52	13.29	15.10	19.90	21.80	18.39
24	6.66	11.60	7.78	9.01	11.85	13.37	17.91	19.88	16.53
25	5.49	10.30	6.58	7.67	10.49	11.71	16.04	18.05	14.86
26	4.47	9.07	5.51	6.49	9.23	10.15	14.29	16.31	13.29
27	3.73	7.91	4.57	5.42	8.08	8.73	12.65	14.65	11.85
28	3.13	7.00	3.75	4.48	6.98	7.38	11.13	13.08	10.49
29	2.62	6.14	3.04	3.67	5.98	6.17	9.75	11.60	9.23
30	2.15	5.37	2.40	2.96	5.09	5.25	8.48	10.30	8.08
31	1.69	4.70	1.89	2.34	4.27	4.52	7.31	9.07	6.98
32	1.32	4.11	1.46	1.77	3.52	3.88	6.26	7.91	5.98
33	0.99	3.52	1.08	1.32	2.86	3.24	5.38	7.00	5.09
34	0.70	2.97	0.78	0.96	2.29	2.69	4.58	6.14	4.27
35	0.48	2.49	0.52	0.66	1.76	2.17	3.91	5.37	3.52
36	0.30	2.04	0.33	0.44	1.34	1.74	3.27	4.70	2.86
37		1.63	0.30	0.30	1.07	1.38	2.70	4.11	2.29
38		1.26			0.80	1.03	2.24	3.52	1.76
39		0.96			0.54	0.72	1.82	2.97	1.34
40		0.68			0.33	0.48	1.45	2.49	1.07
41		0.44			0.30	0.30	1.10	2.04	0.80
42		0.30					0.82	1.63	0.54
43							0.58	1.26	0.33
44							0.38	0.96	0.30
45							0.30	0.68	
Cont. On								Pg. B-10	

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	13607.35	15535.56	16143.86	18538.53	20560.18	21219.64	22412.98	26014.31	26444.27
X-ID	6226.449	44477.7	6226.449	44477.7	6226.449	54759.85	6226.449	54005.46	54648.7
GAP (Ha)	1635.41	1699.87	1754.57	1782.84	1848.09	1852.33	1918.33	1928.02	1933.22
Day	**Flow (cms)**								
1	125	150	150	175	175	150	200	175	175
2	119.67	142.64	139.30	167.83	173.08	145.35	189.44	170.46	173.41
3	110.90	131.18	129.28	154.74	162.19	138.53	173.08	162.25	165.87
4	102.82	122.17	119.67	142.64	150.87	131.92	162.19	154.39	158.34
5	95.77	112.55	110.90	131.18	139.30	125.44	150.87	146.97	151.05
6	88.98	103.68	102.82	122.17	129.28	119.14	139.30	139.34	143.97
7	82.41	95.15	95.77	112.55	119.67	113.10	129.28	132.00	137.18
8	76.45	87.12	88.98	103.68	110.90	107.19	119.67	124.98	130.53
9	70.62	79.44	82.41	95.15	102.82	101.52	110.90	119.03	124.05
10	65.35	72.63	76.45	87.12	95.77	95.95	102.82	112.99	117.85
11	60.70	66.66	70.62	79.44	88.98	90.59	95.77	107.11	111.61
12	56.18	61.19	65.35	72.63	82.41	85.43	88.98	101.60	105.75
13	51.87	56.22	60.70	66.66	76.45	80.52	82.41	96.15	100.17
14	47.88	51.21	56.18	61.19	70.62	75.71	76.45	90.89	94.64
15	44.13	47.60	51.87	56.22	65.35	71.04	70.62	86.26	89.34
16	40.68	43.61	47.88	51.21	60.70	66.56	65.35	81.68	84.22
17	37.09	39.91	44.13	47.60	56.18	62.26	60.70	77.11	79.30
18	33.83	36.56	40.68	43.61	51.87	58.13	56.18	72.71	74.54
19	30.83	33.37	37.09	39.91	47.88	54.20	51.87	68.48	69.92
20	28.16	30.33	33.83	36.56	44.13	50.61	47.88	64.44	65.53
21	25.57	27.51	30.83	33.37	40.68	47.21	44.13	60.54	61.33
22	23.19	24.88	28.16	30.33	37.09	44.01	40.68	56.82	57.31
23	20.94	22.47	25.57	27.51	33.83	41.03	37.09	53.23	53.51
24	18.95	20.31	23.19	24.88	30.83	38.14	33.83	49.80	49.91
25	16.98	18.39	20.94	22.47	28.16	35.41	30.83	46.52	46.46
26	15.10	16.53	18.95	20.31	25.57	32.71	28.16	43.41	43.18
27	13.37	14.86	16.98	18.39	23.19	30.31	25.57	40.41	40.04
28	11.71	13.29	15.10	16.53	20.94	28.08	23.19	37.52	37.06
29	10.15	11.85	13.37	14.86	18.95	25.94	20.94	34.74	34.22
30	8.73	10.49	11.71	13.29	16.98	23.79	18.95	32.10	31.52
31	7.38	9.23	10.15	11.85	15.10	21.80	16.98	29.58	28.94
32	6.17	8.08	8.73	10.49	13.37	19.88	15.10	27.19	26.55
33	5.25	6.98	7.38	9.23	11.71	18.05	13.37	24.92	24.22
34	4.52	5.98	6.17	8.08	10.15	16.31	11.71	22.76	22.00
35	3.88	5.09	5.25	6.98	8.73	14.65	10.15	20.82	19.90
36	3.24	4.27	4.52	5.98	7.38	13.08	8.73	18.77	17.91
37	2.69	3.52	3.88	5.09	6.17	11.60	7.38	16.91	16.04
38	2.17	2.86	3.24	4.27	5.25	10.30	6.17	15.31	14.29
39	1.74	2.29	2.69	3.52	4.52	9.07	5.25	13.73	12.65
40	1.38	1.76	2.17	2.86	3.88	7.91	4.52	12.25	11.13
41	1.03	1.34	1.74	2.29	3.24	7.00	3.88	10.87	9.75
42	0.72	1.07	1.38	1.76	2.69	6.14	3.24	9.57	8.48
43	0.48	0.80	1.03	1.34	2.17	5.37	2.69	8.32	7.31
44	0.30	0.54	0.72	1.07	1.74	4.70	2.17	7.23	6.26
45		0.33	0.48	0.80	1.38	4.11	1.74	6.27	5.38
Cont. On		Pg. B-10	Pg. B-10	Pg. B-10	Pg. B-10	Pg. B-10	Pg. B-10	Pg. B-10	Pg. B-10

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	27082.31	28910.25	31095.77	31574.09	32231.51	40217.64
X-ID	54759.85	45191.66	54005.46	54648.7	54759.85	58676.5
GAP (Ha)	1964.75	1967.40	2013.50	2020.92	2052.85	2057.29
Day	**Flow (cms)**					
1	175	200	200	200	200	200
2	174.54	193.23	196.56	197.93	198.49	198.54
3	167.02	183.03	187.65	189.53	190.27	192.36
4	159.61	173.16	178.92	181.27	182.21	186.28
5	152.38	163.84	170.46	173.41	174.54	180.31
6	145.35	154.99	162.25	165.87	167.02	174.44
7	138.53	146.68	154.39	158.34	159.61	168.66
8	131.92	138.57	146.97	151.05	152.38	163.06
9	125.44	131.62	139.34	143.97	145.35	157.52
10	119.14	124.66	132.00	137.18	138.53	152.08
11	113.10	117.85	124.98	130.53	131.92	146.74
12	107.19	111.51	119.03	124.05	125.44	141.62
13	101.52	105.36	112.99	117.85	119.14	136.50
14	95.95	99.69	107.11	111.61	113.10	131.48
15	90.59	94.02	101.60	105.75	107.19	126.57
16	85.43	88.60	96.15	100.17	101.52	121.75
17	80.52	83.32	90.89	94.64	95.95	117.02
18	75.71	78.47	86.26	89.34	90.59	112.39
19	71.04	73.75	81.68	84.22	85.43	107.85
20	66.56	69.22	77.11	79.30	80.52	103.42
21	62.26	64.91	72.71	74.54	75.71	99.09
22	58.13	60.77	68.48	69.92	71.04	94.87
23	54.20	56.76	64.44	65.53	66.56	90.74
24	50.61	52.98	60.54	61.33	62.26	86.77
25	47.21	49.32	56.82	57.31	58.13	82.92
26	44.01	46.10	53.23	53.51	54.20	79.08
27	41.03	42.85	49.80	49.91	50.61	75.35
28	38.14	39.80	46.52	46.46	47.21	71.73
29	35.41	37.08	43.41	43.18	44.01	68.21
30	32.71	35.13	40.41	40.04	41.03	64.78
31	30.31	32.93	37.52	37.06	38.14	61.44
32	28.08	30.63	34.74	34.22	35.41	58.25
33	25.94	28.45	32.10	31.52	32.71	55.07
34	23.79	26.38	29.58	28.94	30.31	51.99
35	21.80	24.31	27.19	26.55	28.08	49.02
36	19.88	22.34	24.92	24.22	25.94	46.13
37	18.05	20.45	22.76	22.00	23.79	43.33
38	16.31	18.65	20.82	19.90	21.80	40.69
39	14.65	16.93	18.77	17.91	19.88	38.15
40	13.08	15.32	16.91	16.04	18.05	35.65
41	11.60	13.77	15.31	14.29	16.31	33.22
42	10.30	12.30	13.73	12.65	14.65	30.90
43	9.07	10.91	12.25	11.13	13.08	28.68
44	7.91	9.57	10.87	9.75	11.60	26.54
45	7.00	8.34	9.57	8.48	10.30	24.49
Cont. On	Pg. B-11	Pg. B-11	Pg. B-11	Pg. B-11	Pg. B-11	Pg. B-11

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	8358.33	8385.83	9169.64	9326.14	9813.93	10510.90	11801.29	12301.53	12953.80
X-ID	7203.769	54759.85	3148.658	39521.35	44477.7	6226.449	54648.7	54759.85	44477.7
GAP (Ha)	1320.86	1327.76	1341.48	1343.81	1455.54	1472.40	1517.35	1537.80	1594.60
Day	**Flow (cms)**								
Cont. From								Pg. B-7	
46								0.44	
47								0.30	

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	13607.35	15535.56	16143.86	18538.53	20560.18	21219.64	22412.98	26014.31	26444.27
X-ID	6226.449	44477.7	6226.449	44477.7	6226.449	54759.85	6226.449	54005.46	54648.7
GAP (Ha)	1635.41	1699.87	1754.57	1782.84	1848.09	1852.33	1918.33	1928.02	1933.22
Day	**Flow (cms)**								
Cont. From		Pg. B-8	Pg. B-8	Pg. B-8	Pg. B-8	Pg. B-8	Pg. B-8	Pg. B-8	Pg. B-8
46		0.30	0.30	0.54	1.03	3.52	1.38	5.41	4.58
47				0.33	0.72	2.97	1.03	4.62	3.91
48				0.30	0.48	2.49	0.72	3.91	3.27
49					0.30	2.04	0.48	3.25	2.70
50						1.63	0.30	2.67	2.24
51						1.26		2.11	1.82
52						0.96		1.67	1.45
53						0.68		1.27	1.10
54						0.44		0.94	0.82
55						0.30		0.67	0.58
56								0.48	0.38
57								0.31	0.30
58								0.30	

Table B-1. (continued) **6.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	27082.31	28910.25	31095.77	31574.09	32231.51	40217.64
X-ID	54759.85	45191.66	54005.46	54648.7	54759.85	58676.5
GAP (Ha)	1964.75	1967.40	2013.50	2020.92	2052.85	2057.29
Day	**Flow (cms)**					
Cont. From	Pg. B-9	Pg. B-9	Pg. B-9	Pg. B-9	Pg. B-9	Pg. B-9
46	6.14	7.22	8.32	7.31	9.07	22.54
47	5.37	6.17	7.23	6.26	7.91	20.66
48	4.70	5.25	6.27	5.38	7.00	18.87
49	4.11	4.36	5.41	4.58	6.14	17.16
50	3.52	3.60	4.62	3.91	5.37	15.56
51	2.97	2.92	3.91	3.27	4.70	14.02
52	2.49	2.31	3.25	2.70	4.11	12.57
53	2.04	1.80	2.67	2.24	3.52	11.21
54	1.63	1.40	2.11	1.82	2.97	9.93
55	1.26	1.06	1.67	1.45	2.49	8.74
56	0.96	0.76	1.27	1.10	2.04	7.64
57	0.68	0.48	0.94	0.82	1.63	6.63
58	0.44	0.30	0.67	0.58	1.26	5.71
59	0.30		0.48	0.38	0.96	4.92
60			0.31	0.30	0.68	4.31
61			0.30		0.44	3.84
62					0.30	3.32
63						2.77
64						2.30
65						1.87
66						1.48
67						1.13
68						0.82
69						0.56
70						0.35
71						0.30

B.2 4.0 cm/day recessions

Table B-2. **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	241.61	245.41	252.73	260.72	278.72	306.89	312.54	329.93	372.51
X-ID	16.61351	132.3145	24395.19	21484.44	23218.05	38916.2	4104.055	3420.058	23481.94
GAP (Ha)	285.78	292.02	294.65	299.68	301.17	307.24	318.17	348.56	352.33
Day	Flow (cms)								
1	10	10	10	10	10	10	10	10	10
2	9.06	7.41	7.41	7.52	7.76	7.98	8.67	6.94	8.25
3	4.55	4.86	5.01	4.88	5.49	6.05	6.07	5.18	6.59
4	2.52	3.12	3.31	3.37	3.82	4.35	4.11	4.56	5.10
5	1.24	1.69	1.89	2.19	2.46	2.82	2.73	3.42	3.88
6	0.50	0.88	0.96	1.30	1.48	1.87	1.83	2.69	2.87
7	0.30	0.34	0.45	0.66	0.77	1.32	1.18	1.98	2.15
8		0.30	0.30	0.30	0.33	0.61	0.78	1.45	1.50
9					0.30	0.33	0.51	0.99	1.02
10						0.30	0.30	0.56	0.72
11								0.30	0.50
12								0.30	0.34
13									0.30

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	373.57	444.99	521.31	565.44	593.28	641.59	656.24	676.38	699.01
X-ID	4469.405	24648.68	4739.83	38050.96	47871.32	38223.18	2715.69	5661.45	3148.658
GAP (Ha)	378.08	422.49	424.82	434.53	441.45	447.71	458.69	461.08	464.60
Day	Flow (cms)								
1	10	10	10	10	10	10	10	10	10
2	8.95	8.09	8.66	8.64	8.88	9.17	8.96	9.04	9.15
3	6.19	6.59	7.36	7.36	7.80	8.08	7.99	8.11	8.22
4	4.34	5.15	6.26	6.30	6.81	7.22	7.11	7.26	7.37
5	3.23	3.89	5.16	5.38	5.92	6.33	6.30	6.47	6.58
6	2.72	3.04	4.39	4.65	5.07	5.49	5.56	5.72	5.85
7	2.14	2.58	3.67	4.19	4.33	4.67	4.89	5.03	5.18
8	1.72	2.44	3.10	3.51	3.67	3.98	4.27	4.40	4.57
9	1.30	2.09	2.57	2.87	3.10	3.37	3.72	3.87	4.01
10	0.97	1.75	2.15	2.43	2.59	2.84	3.21	3.34	3.49
11	0.68	1.47	1.78	2.21	2.15	2.40	2.75	2.83	3.04
12	0.47	1.19	1.45	1.77	1.78	2.10	2.34	2.45	2.60
13	0.32	0.96	1.14	1.69	1.53	1.75	1.98	2.03	2.22
14	0.30	0.76	0.90	1.41	1.28	1.56	1.66	1.68	1.89
15		0.56	0.69	1.12	1.06	1.28	1.37	1.42	1.59
16		0.42	0.50	0.82	0.85	1.11	1.11	1.17	1.33
17		0.30	0.34	0.56	0.66	0.89	0.88	0.96	1.08
18		0.30	0.30	0.35	0.52	0.72	0.69	0.77	0.87
19				0.30	0.38	0.56	0.52	0.61	0.68
20					0.30	0.43	0.37	0.48	0.52
21						0.30	0.30	0.36	0.38
22								0.30	0.30

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	727.27	792.80	800.98	1144.76	1353.13	1458.93	1663.10	1687.00	1739.86
X-ID	7203.769	6226.449	54648.7	24648.68	8643.983	46442.96	4739.83	37776.21	51365.41
GAP (Ha)	466.96	472.09	477.83	492.46	495.44	522.30	560.61	572.60	595.40
Day	**Flow (cms)**								
1	10	10	10	25	25	25	25	25	25
2	9.47	9.65	9.34	22.55	21.88	22.92	24.21	23.40	23.12
3	8.45	8.73	8.48	18.39	18.79	19.88	21.31	20.55	20.56
4	7.53	7.84	7.65	14.38	16.01	17.03	18.62	17.91	18.17
5	6.66	6.93	6.94	10.68	13.60	14.68	16.57	15.45	16.15
6	5.85	6.17	6.26	8.09	11.43	12.67	14.12	13.45	14.31
7	5.13	5.51	5.67	6.59	9.57	11.07	12.06	11.39	12.46
8	4.47	5.00	5.08	5.15	8.01	9.13	10.25	9.48	10.81
9	3.93	4.52	4.58	3.89	6.76	7.64	8.66	7.70	9.41
10	3.52	4.07	4.12	3.04	5.63	6.26	7.36	6.20	8.21
11	3.13	3.66	3.70	2.58	4.70	5.01	6.26	5.29	7.01
12	2.77	3.24	3.27	2.44	3.88	4.00	5.16	4.67	5.99
13	2.47	2.86	2.89	2.09	3.12	3.11	4.39	4.59	5.10
14	2.15	2.51	2.57	1.75	2.47	2.51	3.67	4.33	4.41
15	1.84	2.17	2.24	1.47	1.88	1.99	3.10	3.97	3.74
16	1.55	1.88	1.96	1.19	1.41	1.59	2.57	3.48	3.20
17	1.32	1.63	1.69	0.96	1.01	1.29	2.15	3.03	2.72
18	1.10	1.38	1.45	0.76	0.71	1.03	1.78	2.72	2.34
19	0.89	1.14	1.20	0.56	0.47	0.79	1.45	2.61	1.99
20	0.70	0.92	1.00	0.42	0.30	0.60	1.14	2.26	1.68
21	0.55	0.72	0.82	0.30		0.40	0.90	1.93	1.38
22	0.41	0.55	0.65	0.30		0.30	0.69	1.58	1.11
23	0.30	0.40	0.51				0.50	1.30	0.84
24		0.30	0.38				0.34	1.04	0.64
25			0.30				0.30	0.80	0.47
26								0.56	0.34
27								0.37	0.30
28								0.30	

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	1848.55	1931.25	1974.52	1977.66	2018.72	2181.21	2219.76	2534.16	2580.59
X-ID	51076.81	58214.65	36636.9	47216.96	11213.08	56855.64	3148.658	56955.73	46146.75
GAP (Ha)	597.58	598.84	613.28	622.90	629.92	662.06	685.01	698.63	701.11
Day	**Flow (cms)**								
1	25	25	25	25	25	25	25	25	25
2	23.38	23.81	23.49	22.91	22.88	23.58	23.14	23.66	23.53
3	21.13	21.70	21.39	20.89	20.76	21.57	21.30	22.06	22.18
4	18.95	19.69	19.38	19.00	18.98	19.59	19.57	20.54	20.75
5	17.01	17.68	17.52	17.25	17.16	17.71	17.96	19.06	19.26
6	15.16	15.68	15.73	15.57	15.51	15.97	16.44	17.63	17.99
7	13.59	13.82	14.14	14.02	13.96	14.43	15.02	16.29	16.70
8	12.00	12.16	12.64	12.56	12.55	12.77	13.70	14.99	15.46
9	10.42	10.77	11.21	11.21	11.26	11.46	12.45	13.77	14.27
10	9.09	9.40	9.86	9.98	10.08	10.23	11.27	12.62	13.13
11	7.91	8.23	8.71	8.81	8.99	9.21	10.17	11.55	12.04
12	6.83	7.19	7.65	7.85	7.90	8.33	9.15	10.54	11.05
13	5.85	6.24	6.71	6.87	7.02	7.52	8.22	9.61	10.13
14	4.93	5.33	5.86	5.94	6.22	6.78	7.37	8.77	9.25
15	4.22	4.82	5.09	5.14	5.51	6.20	6.58	7.98	8.41
16	3.46	4.13	4.35	4.41	4.88	5.62	5.85	7.26	7.63
17	2.93	3.53	3.79	3.87	4.31	5.08	5.18	6.59	6.90
18	2.43	2.96	3.20	3.35	3.80	4.55	4.57	5.99	6.21
19	2.04	2.47	2.66	2.83	3.32	4.11	4.01	5.41	5.54
20	1.81	2.05	2.27	2.34	2.82	3.67	3.49	4.88	5.00
21	1.54	1.73	1.93	1.89	2.40	3.22	3.04	4.38	4.43
22	1.24	1.41	1.60	1.50	2.02	2.86	2.60	3.94	3.91
23	1.00	1.14	1.32	1.20	1.68	2.49	2.22	3.49	3.42
24	0.77	0.89	1.05	1.01	1.37	2.18	1.89	3.08	3.02
25	0.57	0.68	0.79	0.87	1.09	1.83	1.59	2.69	2.60
26	0.41	0.49	0.56	0.82	0.83	1.55	1.33	2.34	2.23
27	0.30	0.32	0.39	0.67	0.63	1.30	1.08	1.99	1.90
28		0.30	0.30	0.50	0.44	1.05	0.87	1.68	1.57
29				0.36	0.30	0.84	0.68	1.39	1.32
30				0.30		0.66	0.52	1.15	1.07
31						0.50	0.38	0.94	0.87
32						0.36	0.30	0.75	0.69
33						0.30		0.58	0.53
34								0.45	0.40
35								0.30	0.30

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	2692.16	2835.79	2840.07	2841.68	4106.07	4106.47	4553.09	4654.98	5239.98
X-ID	55384.28	59488.79	54005.46	54648.7	37776.21	51365.41	48393.66	11213.08	2715.69
GAP (Ha)	706.75	707.32	708.93	718.48	720.66	773.61	817.49	850.05	905.42
Day	**Flow (cms)**								
1	25	25	25	25	50	50	50	50	50
2	24.04	24.11	24.19	24.99	47.06	46.46	48.54	46.28	47.60
3	22.62	22.74	22.76	23.47	43.31	42.36	44.44	42.65	44.45
4	21.25	21.41	21.53	22.00	39.70	38.34	40.57	39.26	41.43
5	19.74	20.11	20.13	20.59	36.20	35.18	37.11	36.03	38.52
6	18.38	18.85	18.77	19.22	32.80	31.93	33.92	33.01	35.76
7	17.07	17.62	17.48	17.91	29.52	28.79	30.83	30.19	33.17
8	15.81	16.44	16.43	16.65	26.41	25.87	27.43	27.39	30.76
9	14.60	15.30	15.31	15.45	23.40	23.12	24.78	25.30	28.42
10	13.49	14.19	14.25	14.29	20.55	20.56	22.32	22.88	26.18
11	12.42	13.13	13.23	13.18	17.91	18.17	20.01	20.76	24.07
12	11.40	12.12	12.25	12.12	15.45	16.15	17.92	18.98	22.08
13	10.44	11.14	11.32	11.13	13.45	14.31	15.92	17.16	20.20
14	9.53	10.19	10.43	10.20	11.39	12.46	14.28	15.51	18.44
15	8.69	9.27	9.57	9.34	9.48	10.81	12.95	13.96	16.78
16	7.95	8.51	8.70	8.48	7.70	9.41	11.57	12.55	15.22
17	7.20	7.71	7.95	7.65	6.20	8.21	10.37	11.26	13.78
18	6.51	7.09	7.23	6.94	5.29	7.01	9.29	10.08	12.44
19	5.86	6.56	6.58	6.26	4.67	5.99	8.17	8.99	11.18
20	5.31	5.93	5.97	5.67	4.59	5.10	7.24	7.90	10.03
21	4.79	5.42	5.41	5.08	4.33	4.41	6.41	7.02	8.96
22	4.31	4.87	4.87	4.58	3.97	3.74	5.62	6.22	7.99
23	3.90	4.33	4.37	4.12	3.48	3.20	4.86	5.51	7.11
24	3.46	3.87	3.91	3.70	3.03	2.72	4.17	4.88	6.30
25	3.05	3.46	3.46	3.27	2.72	2.34	3.52	4.31	5.56
26	2.67	3.12	3.06	2.89	2.61	1.99	2.98	3.80	4.89
27	2.31	2.76	2.67	2.57	2.26	1.68	2.46	3.32	4.27
28	1.99	2.43	2.33	2.24	1.93	1.38	2.03	2.82	3.72
29	1.69	2.11	1.98	1.96	1.58	1.11	1.67	2.40	3.21
30	1.43	1.82	1.67	1.69	1.30	0.84	1.38	2.02	2.75
31	1.19	1.55	1.39	1.45	1.04	0.64	1.13	1.68	2.34
32	0.98	1.29	1.16	1.20	0.80	0.47	0.90	1.37	1.98
33	0.79	1.06	0.94	1.00	0.56	0.34	0.72	1.09	1.66
34	0.62	0.84	0.74	0.82	0.37	0.30	0.55	0.83	1.37
35	0.49	0.68	0.60	0.65	0.30		0.43	0.63	1.11
36	0.35	0.52	0.48	0.51			0.31	0.44	0.88
37	0.30	0.38	0.36	0.38			0.30	0.30	0.69
38		0.30	0.30	0.30					0.52
39									0.37
40									0.30

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	5287.71	5460.18	5494.26	5522.65	6392.34	7019.70	7271.40	8368.92	8770.06
X-ID	2938.422	7091.917	7203.769	3148.658	6226.449	55384.28	54648.7	13143.03	38223.18
GAP (Ha)	936.46	950.39	957.16	964.81	1015.05	1024.23	1044.96	1056.12	1057.32
Day	**Flow (cms)**								
1	50	50	50	50	50	50	50	75	75
2	47.04	46.56	46.94	47.74	47.88	48.66	49.91	72.95	70.98
3	44.04	43.34	43.77	44.89	45.35	46.45	47.60	67.62	66.52
4	41.07	40.53	40.92	41.91	42.92	44.30	45.34	62.92	62.25
5	38.23	37.81	38.18	39.15	40.68	42.34	43.18	58.02	58.17
6	35.54	35.17	35.58	36.49	38.17	40.27	41.09	53.80	54.37
7	33.01	32.71	33.15	33.97	35.98	38.25	39.02	49.87	50.79
8	30.65	30.40	30.83	31.60	33.83	36.27	37.06	46.34	47.39
9	28.32	28.24	28.67	29.31	31.83	34.37	35.16	43.19	44.19
10	26.14	26.22	26.64	27.14	29.88	32.51	33.30	40.16	41.15
11	24.09	24.40	24.76	25.07	28.16	30.70	31.52	37.32	38.30
12	22.15	22.62	22.95	23.14	26.43	28.94	29.78	34.13	35.62
13	20.32	20.92	21.24	21.30	24.76	27.24	28.18	31.66	33.20
14	18.61	19.32	19.60	19.57	23.19	25.58	26.55	29.15	30.90
15	17.00	17.83	18.06	17.96	21.67	24.04	24.99	26.85	28.76
16	15.51	16.42	16.59	16.44	20.27	22.62	23.47	24.68	26.73
17	14.10	15.08	15.21	15.02	18.95	21.25	22.00	22.66	24.82
18	12.80	13.80	13.88	13.70	17.62	19.74	20.59	20.84	23.00
19	11.56	12.67	12.69	12.45	16.35	18.38	19.22	18.95	21.28
20	10.40	11.61	11.57	11.27	15.10	17.07	17.91	17.24	19.65
21	9.35	10.60	10.50	10.17	13.90	15.81	16.65	15.63	18.08
22	8.37	9.62	9.47	9.15	12.81	14.60	15.45	14.13	16.59
23	7.49	8.66	8.45	8.22	11.71	13.49	14.29	12.75	15.16
24	6.68	7.71	7.53	7.37	10.65	12.42	13.18	11.52	13.81
25	5.92	6.87	6.66	6.58	9.65	11.40	12.12	10.37	12.53
26	5.23	6.07	5.85	5.85	8.73	10.44	11.13	9.33	11.34
27	4.60	5.39	5.13	5.18	7.84	9.53	10.20	8.36	10.23
28	4.03	4.61	4.47	4.57	6.93	8.69	9.34	7.45	9.17
29	3.50	4.00	3.93	4.01	6.17	7.95	8.48	6.65	8.08
30	3.04	3.62	3.52	3.49	5.51	7.20	7.65	5.93	7.22
31	2.59	3.19	3.13	3.04	5.00	6.51	6.94	5.23	6.33
32	2.21	2.82	2.77	2.60	4.52	5.86	6.26	4.57	5.49
33	1.88	2.52	2.47	2.22	4.07	5.31	5.67	3.97	4.67
34	1.57	2.18	2.15	1.89	3.66	4.79	5.08	3.42	3.98
35	1.30	1.86	1.84	1.59	3.24	4.31	4.58	2.91	3.37
36	1.06	1.57	1.55	1.33	2.86	3.90	4.12	2.47	2.84
37	0.84	1.31	1.32	1.08	2.51	3.46	3.70	2.09	2.40
38	0.66	1.07	1.10	0.87	2.17	3.05	3.27	1.75	2.10
39	0.50	0.86	0.89	0.68	1.88	2.67	2.89	1.44	1.75
40	0.36	0.67	0.70	0.52	1.63	2.31	2.57	1.16	1.56
41	0.30	0.51	0.55	0.38	1.38	1.99	2.24	0.95	1.28
42		0.37	0.41	0.30	1.14	1.69	1.96	0.71	1.11
43		0.30	0.30		0.92	1.43	1.69	0.52	0.89
44					0.72	1.19	1.45	0.38	0.72
45					0.55	0.98	1.20	0.34	0.56
Cont. On					Pg. B-21	Pg. B-21	Pg. B-21	Pg. B-21	Pg. B-21

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	8779.73	8790.50	9467.99	9481.46	10523.15	10823.19	12385.73	13514.33	14202.63
X-ID	43987.58	7091.917	7203.769	3148.658	44477.7	6226.449	54648.7	5661.45	39521.35
GAP (Ha)	1102.60	1125.01	1135.91	1167.34	1235.19	1251.03	1298.21	1313.29	1317.25
Day	Flow (cms)								
1	75	75	75	75	75	75	75	100	100
2	71.51	70.68	74.75	74.05	72.63	72.49	74.54	96.12	98.08
3	66.74	66.12	70.32	69.73	68.58	68.72	71.43	90.84	92.75
4	62.13	61.86	65.90	65.45	65.34	65.35	68.43	85.68	88.09
5	57.95	57.86	61.76	61.40	61.19	62.21	65.53	80.81	83.77
6	54.28	53.82	57.85	57.55	57.54	59.16	62.70	76.27	78.87
7	49.98	50.12	53.97	54.00	54.72	56.18	59.97	72.46	74.71
8	46.13	46.56	50.37	51.01	51.21	53.20	57.31	68.23	70.60
9	43.15	43.34	46.94	47.74	48.79	50.52	54.75	64.28	66.81
10	40.18	40.53	43.77	44.89	46.22	47.88	52.28	60.58	63.06
11	37.66	37.81	40.92	41.91	43.61	45.35	49.91	57.02	59.52
12	35.31	35.17	38.18	39.15	41.12	42.92	47.60	53.63	56.13
13	33.22	32.71	35.58	36.49	38.74	40.68	45.34	50.42	53.08
14	31.06	30.40	33.15	33.97	36.56	38.17	43.18	47.39	50.06
15	28.89	28.24	30.83	31.60	34.47	35.98	41.09	44.47	47.15
16	26.83	26.22	28.67	29.31	32.32	33.83	39.02	41.70	44.36
17	24.88	24.40	26.64	27.14	30.33	31.83	37.06	39.04	41.67
18	23.02	22.62	24.76	25.07	28.43	29.88	35.16	36.55	39.10
19	21.26	20.92	22.95	23.14	26.60	28.16	33.30	34.21	36.81
20	19.62	19.32	21.24	21.30	24.88	26.43	31.52	31.98	34.38
21	18.06	17.83	19.60	19.57	23.25	24.76	29.78	29.84	32.09
22	16.56	16.42	18.06	17.96	21.72	23.19	28.18	27.83	29.88
23	15.12	15.08	16.59	16.44	20.31	21.67	26.55	25.89	27.79
24	13.76	13.80	15.21	15.02	19.05	20.27	24.99	24.04	25.83
25	12.50	12.67	13.88	13.70	17.74	18.95	23.47	22.28	23.97
26	11.29	11.61	12.69	12.45	16.53	17.62	22.00	20.58	22.18
27	10.23	10.60	11.57	11.27	15.41	16.35	20.59	18.97	20.51
28	9.23	9.62	10.50	10.17	14.32	15.10	19.22	17.43	18.90
29	8.27	8.66	9.47	9.15	13.29	13.90	17.91	16.00	17.43
30	7.50	7.71	8.45	8.22	12.32	12.81	16.65	14.65	16.02
31	6.68	6.87	7.53	7.37	11.38	11.71	15.45	13.39	14.69
32	5.84	6.07	6.66	6.58	10.49	10.65	14.29	12.18	13.43
33	5.17	5.39	5.85	5.85	9.64	9.65	13.18	11.08	12.17
34	4.56	4.61	5.13	5.18	8.82	8.73	12.12	10.03	11.05
35	3.97	4.00	4.47	4.57	8.08	7.84	11.13	9.04	9.99
36	3.44	3.62	3.93	4.01	7.34	6.93	10.20	8.11	9.01
37	2.98	3.19	3.52	3.49	6.65	6.17	9.34	7.26	8.10
38	2.56	2.82	3.13	3.04	5.98	5.51	8.48	6.47	7.27
39	2.17	2.52	2.77	2.60	5.38	5.00	7.65	5.72	6.49
40	1.81	2.18	2.47	2.22	4.82	4.52	6.94	5.03	5.76
41	1.51	1.86	2.15	1.89	4.27	4.07	6.26	4.40	5.09
42	1.22	1.57	1.84	1.59	3.78	3.66	5.67	3.87	4.48
43	0.97	1.31	1.55	1.33	3.33	3.24	5.08	3.34	3.93
44	0.75	1.07	1.32	1.08	2.86	2.86	4.58	2.83	3.42
45	0.56	0.86	1.10	0.87	2.50	2.51	4.12	2.45	2.96
Cont. On	Pg. B-21	Pg. B-21	Pg. B-21	Pg. B-21	Pg. B-21	Pg. B-21	Pg. B-21	Pg. B-21	Pg. B-21

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	14515.49	15281.05	15546.51	16666.59	17538.42	17910.72	18628.61	19596.90	22347.95
X-ID	44477.7	46146.75	6226.449	3148.658	5661.45	54648.7	44477.7	6226.449	44477.7
GAP (Ha)	1387.73	1403.66	1430.07	1432.03	1441.93	1500.43	1516.06	1582.96	1615.33
Day	Flow (cms)								
1	100	100	100	125	125	100	125	125	150
2	97.91	96.87	97.61	118.37	118.93	98.30	122.17	119.67	142.64
3	92.47	92.76	93.70	111.97	113.43	94.64	115.82	113.16	134.94
4	87.12	88.67	88.98	105.84	107.10	91.08	109.38	108.15	127.90
5	81.86	84.49	84.46	99.93	101.29	87.61	103.68	102.82	122.17
6	77.72	80.56	80.49	94.28	96.12	84.22	97.91	97.61	115.82
7	72.63	76.68	76.45	88.86	90.84	80.92	92.47	93.70	109.38
8	68.58	72.93	72.49	83.59	85.68	77.69	87.12	88.98	103.68
9	65.34	69.24	68.72	78.78	80.81	74.54	81.86	84.46	97.91
10	61.19	65.70	65.35	74.05	76.27	71.43	77.72	80.49	92.47
11	57.54	62.31	62.21	69.73	72.46	68.43	72.63	76.45	87.12
12	54.72	59.04	59.16	65.45	68.23	65.53	68.58	72.49	81.86
13	51.21	56.00	56.18	61.40	64.28	62.70	65.34	68.72	77.72
14	48.79	52.94	53.20	57.55	60.58	59.97	61.19	65.35	72.63
15	46.22	49.94	50.52	54.00	57.02	57.31	57.54	62.21	68.58
16	43.61	47.04	47.88	51.01	53.63	54.75	54.72	59.16	65.34
17	41.12	44.23	45.35	47.74	50.42	52.28	51.21	56.18	61.19
18	38.74	41.52	42.92	44.89	47.39	49.91	48.79	53.20	57.54
19	36.56	39.01	40.68	41.91	44.47	47.60	46.22	50.52	54.72
20	34.47	36.63	38.17	39.15	41.70	45.34	43.61	47.88	51.21
21	32.32	34.55	35.98	36.49	39.04	43.18	41.12	45.35	48.79
22	30.33	32.60	33.83	33.97	36.55	41.09	38.74	42.92	46.22
23	28.43	30.62	31.83	31.60	34.21	39.02	36.56	40.68	43.61
24	26.60	28.66	29.88	29.31	31.98	37.06	34.47	38.17	41.12
25	24.88	26.84	28.16	27.14	29.84	35.16	32.32	35.98	38.74
26	23.25	25.13	26.43	25.07	27.83	33.30	30.33	33.83	36.56
27	21.72	23.53	24.76	23.14	25.89	31.52	28.43	31.83	34.47
28	20.31	22.18	23.19	21.30	24.04	29.78	26.60	29.88	32.32
29	19.05	20.75	21.67	19.57	22.28	28.18	24.88	28.16	30.33
30	17.74	19.26	20.27	17.96	20.58	26.55	23.25	26.43	28.43
31	16.53	17.99	18.95	16.44	18.97	24.99	21.72	24.76	26.60
32	15.41	16.70	17.62	15.02	17.43	23.47	20.31	23.19	24.88
33	14.32	15.46	16.35	13.70	16.00	22.00	19.05	21.67	23.25
34	13.29	14.27	15.10	12.45	14.65	20.59	17.74	20.27	21.72
35	12.32	13.13	13.90	11.27	13.39	19.22	16.53	18.95	20.31
36	11.38	12.04	12.81	10.17	12.18	17.91	15.41	17.62	19.05
37	10.49	11.05	11.71	9.15	11.08	16.65	14.32	16.35	17.74
38	9.64	10.13	10.65	8.22	10.03	15.45	13.29	15.10	16.53
39	8.82	9.25	9.65	7.37	9.04	14.29	12.32	13.90	15.41
40	8.08	8.41	8.73	6.58	8.11	13.18	11.38	12.81	14.32
41	7.34	7.63	7.84	5.85	7.26	12.12	10.49	11.71	13.29
42	6.65	6.90	6.93	5.18	6.47	11.13	9.64	10.65	12.32
43	5.98	6.21	6.17	4.57	5.72	10.20	8.82	9.65	11.38
44	5.38	5.54	5.51	4.01	5.03	9.34	8.08	8.73	10.49
45	4.82	5.00	5.00	3.49	4.40	8.48	7.34	7.84	9.64
Cont. On	Pg. B-22	Pg. B-22	Pg. B-22	Pg. B-22	Pg. B-22	Pg. B-22	Pg. B-22	Pg. B-22	Pg. B-22

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	23922.84	24511.03	28927.47	30863.33	31256.04	34048.06	37893.02	38530.55	41804.99
X-ID	54648.7	6226.449	6226.449	54759.85	54648.7	6226.449	54005.46	54648.7	55468.13
GAP (Ha)	1671.32	1694.52	1782.36	1792.97	1799.02	1847.84	1889.03	1906.93	1914.70
Day	**Flow (cms)**								
1	125	150	175	150	150	200	175	175	175
2	121.94	146.82	169.56	145.35	148.68	199.88	170.46	173.41	171.55
3	117.85	139.30	162.19	140.77	143.97	189.44	164.96	168.39	167.10
4	113.61	132.43	154.40	136.30	139.43	178.34	159.68	163.36	162.70
5	109.64	125.22	146.82	131.92	134.96	169.56	154.39	158.34	158.37
6	105.75	119.67	139.30	127.58	130.53	162.19	149.20	153.45	154.09
7	102.06	113.16	132.43	123.32	126.19	154.40	144.41	148.68	149.88
8	98.30	108.15	125.22	119.14	121.94	146.82	139.34	143.97	145.75
9	94.64	102.82	119.67	115.23	117.85	139.30	134.42	139.43	141.68
10	91.08	97.61	113.16	111.11	113.61	132.43	129.62	134.96	137.67
11	87.61	93.70	108.15	107.19	109.64	125.22	124.98	130.53	133.74
12	84.22	88.98	102.82	103.41	105.75	119.67	121.08	126.19	129.88
13	80.92	84.46	97.61	99.63	102.06	113.16	117.00	121.94	126.06
14	77.69	80.49	93.70	95.95	98.30	108.15	112.99	117.85	122.30
15	74.54	76.45	88.98	92.36	94.64	102.82	109.05	113.61	118.61
16	71.43	72.49	84.46	88.86	91.08	97.61	105.36	109.64	114.97
17	68.43	68.72	80.49	85.43	87.61	93.70	101.60	105.75	111.40
18	65.53	65.35	76.45	82.13	84.22	88.98	97.98	102.06	107.90
19	62.70	62.21	72.49	78.91	80.92	84.46	94.33	98.30	104.34
20	59.97	59.16	68.72	75.71	77.69	80.49	90.89	94.64	100.92
21	57.31	56.18	65.35	72.59	74.54	76.45	87.87	91.08	97.56
22	54.75	53.20	62.21	69.53	71.43	72.49	84.68	87.61	94.25
23	52.28	50.52	59.16	66.56	68.43	68.72	81.68	84.22	91.01
24	49.91	47.88	56.18	63.68	65.53	65.35	78.64	80.92	88.04
25	47.60	45.35	53.20	60.87	62.70	62.21	75.62	77.69	85.07
26	45.34	42.92	50.52	58.13	59.97	59.16	72.71	74.54	82.13
27	43.18	40.68	47.88	55.49	57.31	56.18	69.86	71.43	79.20
28	41.09	38.17	45.35	52.98	54.75	53.20	67.11	68.43	76.31
29	39.02	35.98	42.92	50.61	52.28	50.52	64.44	65.53	73.48
30	37.06	33.83	40.68	48.34	49.91	47.88	61.82	62.70	70.71
31	35.16	31.83	38.17	46.10	47.60	45.35	59.28	59.97	68.11
32	33.30	29.88	35.98	44.01	45.34	42.92	56.82	57.31	65.48
33	31.52	28.16	33.83	42.01	43.18	40.68	54.41	54.75	62.90
34	29.78	26.43	31.83	40.04	41.09	38.17	52.08	52.28	60.39
35	28.18	24.76	29.88	38.14	39.02	35.98	49.80	49.91	57.93
36	26.55	23.19	28.16	36.30	37.06	33.83	47.60	47.60	55.55
37	24.99	21.67	26.43	34.52	35.16	31.83	45.47	45.34	53.27
38	23.47	20.27	24.76	32.71	33.30	29.88	43.41	43.18	51.03
39	22.00	18.95	23.19	31.09	31.52	28.16	41.40	41.09	48.82
40	20.59	17.62	21.67	29.54	29.78	26.43	39.45	39.02	46.66
41	19.22	16.35	20.27	28.08	28.18	24.76	37.52	37.06	44.55
42	17.91	15.10	18.95	26.67	26.55	23.19	35.65	35.16	42.58
43	16.65	13.90	17.62	25.17	24.99	21.67	33.85	33.30	40.56
44	15.45	12.81	16.35	23.79	23.47	20.27	32.10	31.52	38.58
45	14.29	11.71	15.10	22.45	22.00	18.95	30.41	29.78	36.67
Cont. On	Pg. B-23	Pg. B-23	Pg. B-23	Pg. B-23	Pg. B-23	Pg. B-23	Pg. B-23	Pg. B-23	Pg. B-23

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	45202.72	51752.01	59029.40
X-ID	54648.7	55468.13	58676.5
GAP (Ha)	1993.53	2002.18	2019.27
Day	**Flow (cms)**		
1	200	200	200
2	195.11	199.55	198.54
3	189.53	194.74	194.40
4	184.01	190.01	190.32
5	178.59	185.27	186.28
6	173.41	180.64	182.30
7	168.39	176.07	178.34
8	163.36	171.55	174.44
9	158.34	167.10	170.57
10	153.45	162.70	166.80
11	148.68	158.37	163.06
12	143.97	154.09	159.35
13	139.43	149.88	155.70
14	134.96	145.75	152.08
15	130.53	141.68	148.51
16	126.19	137.67	144.99
17	121.94	133.74	141.62
18	117.85	129.88	138.20
19	113.61	126.06	134.82
20	109.64	122.30	131.48
21	105.75	118.61	128.19
22	102.06	114.97	124.95
23	98.30	111.40	121.75
24	94.64	107.90	118.59
25	91.08	104.34	115.46
26	87.61	100.92	112.39
27	84.22	97.56	109.36
28	80.92	94.25	106.36
29	77.69	91.01	103.42
30	74.54	88.04	100.52
31	71.43	85.07	97.67
32	68.43	82.13	94.87
33	65.53	79.20	92.11
34	62.70	76.31	89.40
35	59.97	73.48	86.77
36	57.31	70.71	84.21
37	54.75	68.11	81.63
38	52.28	65.48	79.08
39	49.91	62.90	76.59
40	47.60	60.39	74.14
41	45.34	57.93	71.73
42	43.18	55.55	69.38
43	41.09	53.27	67.06
44	39.02	51.03	64.78
45	37.06	48.82	62.55
Cont. On	Pg. B-24	Pg. B-24	Pg. B-24

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	5287.71	5460.18	5494.26	5522.65	6392.34	7019.70	7271.40	8368.92	8770.06
X-ID	2938.422	7091.917	7203.769	3148.658	6226.449	55384.28	54648.7	13143.03	38223.18
GAP (Ha)	936.46	950.39	957.16	964.81	1015.05	1024.23	1044.96	1056.12	1057.32
Day	**Flow (cms)**								
Cont. From					Pg. B-16	Pg. B-16	Pg. B-16	Pg. B-16	Pg. B-16
46					0.40	0.79	1.00	0.33	0.43
47					0.30	0.62	0.82	0.32	0.30
48						0.49	0.65	0.31	
49						0.35	0.51	0.30	
50						0.30	0.38		
51							0.30		

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	8779.73	8790.50	9467.99	9481.46	10523.15	10823.19	12385.73	13514.33	14202.63
X-ID	43987.58	7091.917	7203.769	3148.658	44477.7	6226.449	54648.7	5661.45	39521.35
GAP (Ha)	1102.60	1125.01	1135.91	1167.34	1235.19	1251.03	1298.21	1313.29	1317.25
Day	**Flow (cms)**								
Cont. From	Pg. B-17	Pg. B-17	Pg. B-17	Pg. B-17	Pg. B-17	Pg. B-17	Pg. B-17	Pg. B-17	Pg. B-17
46	0.39	0.67	0.89	0.68	2.10	2.17	3.70	2.03	2.54
47	0.30	0.51	0.70	0.52	1.76	1.88	3.27	1.68	2.12
48		0.37	0.55	0.38	1.47	1.63	2.89	1.42	1.77
49		0.30	0.41	0.30	1.20	1.38	2.57	1.17	1.47
50			0.30		1.07	1.14	2.24	0.96	1.19
51					0.89	0.92	1.96	0.77	0.96
52					0.71	0.72	1.69	0.61	0.75
53					0.54	0.55	1.45	0.48	0.57
54					0.39	0.40	1.20	0.36	0.44
55					0.30	0.30	1.00	0.30	0.32
56							0.82		0.30
57							0.65		
58							0.51		
59							0.38		
60							0.30		

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	14515.49	15281.05	15546.51	16666.59	17538.42	17910.72	18628.61	19596.90	22347.95
X-ID	44477.7	46146.75	6226.449	3148.658	5661.45	54648.7	44477.7	6226.449	44477.7
GAP (Ha)	1387.73	1403.66	1430.07	1432.03	1441.93	1500.43	1516.06	1582.96	1615.33
Day	**Flow (cms)**								
Cont. From	Pg. B-18	Pg. B-18	Pg. B-18	Pg. B-18	Pg. B-18	Pg. B-18	Pg. B-18	Pg. B-18	Pg. B-18
46	4.27	4.43	4.52	3.04	3.87	7.65	6.65	6.93	8.82
47	3.78	3.91	4.07	2.60	3.34	6.94	5.98	6.17	8.08
48	3.33	3.42	3.66	2.22	2.83	6.26	5.38	5.51	7.34
49	2.86	3.02	3.24	1.89	2.45	5.67	4.82	5.00	6.65
50	2.50	2.60	2.86	1.59	2.03	5.08	4.27	4.52	5.98
51	2.10	2.23	2.51	1.33	1.68	4.58	3.78	4.07	5.38
52	1.76	1.90	2.17	1.08	1.42	4.12	3.33	3.66	4.82
53	1.47	1.57	1.88	0.87	1.17	3.70	2.86	3.24	4.27
54	1.20	1.32	1.63	0.68	0.96	3.27	2.50	2.86	3.78
55	1.07	1.07	1.38	0.52	0.77	2.89	2.10	2.51	3.33
56	0.89	0.87	1.14	0.38	0.61	2.57	1.76	2.17	2.86
57	0.71	0.69	0.92	0.30	0.48	2.24	1.47	1.88	2.50
58	0.54	0.53	0.72		0.36	1.96	1.20	1.63	2.10
59	0.39	0.40	0.55		0.30	1.69	1.07	1.38	1.76
60	0.30	0.30	0.40			1.45	0.89	1.14	1.47
61			0.30			1.20	0.71	0.92	1.20
62						1.00	0.54	0.72	1.07
63						0.82	0.39	0.55	0.89
64						0.65	0.30	0.40	0.71
65						0.51		0.30	0.54
66						0.38			0.39
67						0.30			0.30

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	23922.84	24511.03	28927.47	30863.33	31256.04	34048.06	37893.02	38530.55	41804.99
X-ID	54648.7	6226.449	6226.449	54759.85	54648.7	6226.449	54005.46	54648.7	55468.13
GAP (Ha)	1671.32	1694.52	1782.36	1792.97	1799.02	1847.84	1889.03	1906.93	1914.70
Day	**Flow (cms)**								
Cont. From	Pg. B-19	Pg. B-19	Pg. B-19	Pg. B-19	Pg. B-19	Pg. B-19	Pg. B-19	Pg. B-19	Pg. B-19
46	13.18	10.65	13.90	21.15	20.59	17.62	28.77	28.18	34.80
47	12.12	9.65	12.81	19.88	19.22	16.35	27.19	26.55	32.98
48	11.13	8.73	11.71	18.65	17.91	15.10	25.66	24.99	31.22
49	10.20	7.84	10.65	17.46	16.65	13.90	24.19	23.47	29.55
50	9.34	6.93	9.65	16.31	15.45	12.81	22.76	22.00	27.90
51	8.48	6.17	8.73	15.19	14.29	11.71	21.53	20.59	26.29
52	7.65	5.51	7.84	14.11	13.18	10.65	20.13	19.22	24.72
53	6.94	5.00	6.93	13.08	12.12	9.65	18.77	17.91	23.27
54	6.26	4.52	6.17	12.08	11.13	8.73	17.48	16.65	21.87
55	5.67	4.07	5.51	11.14	10.20	7.84	16.43	15.45	20.47
56	5.08	3.66	5.00	10.30	9.34	6.93	15.31	14.29	19.10
57	4.58	3.24	4.52	9.48	8.48	6.17	14.25	13.18	17.80
58	4.12	2.86	4.07	8.67	7.65	5.51	13.23	12.12	16.56
59	3.70	2.51	3.66	7.91	6.94	5.00	12.25	11.13	15.37
60	3.27	2.17	3.24	7.30	6.26	4.52	11.32	10.20	14.25
61	2.89	1.88	2.86	6.72	5.67	4.07	10.43	9.34	13.21
62	2.57	1.63	2.51	6.14	5.08	3.66	9.57	8.48	12.20
63	2.24	1.38	2.17	5.62	4.58	3.24	8.70	7.65	11.26
64	1.96	1.14	1.88	5.12	4.12	2.86	7.95	6.94	10.36
65	1.69	0.92	1.63	4.70	3.70	2.51	7.23	6.26	9.52
66	1.45	0.72	1.38	4.32	3.27	2.17	6.58	5.67	8.71
67	1.20	0.55	1.14	3.92	2.89	1.88	5.97	5.08	7.98
68	1.00	0.40	0.92	3.52	2.57	1.63	5.41	4.58	7.27
69	0.82	0.30	0.72	3.15	2.24	1.38	4.87	4.12	6.60
70	0.65		0.55	2.80	1.96	1.14	4.37	3.70	6.01
71	0.51		0.40	2.49	1.69	0.92	3.91	3.27	5.47
72	0.38		0.30	2.18	1.45	0.72	3.46	2.89	4.96
73	0.30			1.89	1.20	0.55	3.06	2.57	4.55
74				1.63	1.00	0.40	2.67	2.24	4.13
75				1.38	0.82	0.30	2.33	1.96	3.75
76				1.15	0.65		1.98	1.69	3.35
77				0.96	0.51		1.67	1.45	2.98
78				0.77	0.38		1.39	1.20	2.62
79				0.60	0.30		1.16	1.00	2.29
80				0.44			0.94	0.82	1.99
81				0.30			0.74	0.65	1.71
82							0.60	0.51	1.45
83							0.48	0.38	1.22
84							0.36	0.30	1.02
85							0.30		0.84
86									0.68
87									0.54
88									0.41
89									0.30
90									0.30

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	45202.72	51752.01	59029.40
X-ID	54648.7	55468.13	58676.5
GAP (Ha)	1993.53	2002.18	2019.27
Day	**Flow (cms)**		
Cont. From	Pg. B-20	Pg. B-20	Pg. B-20
46	35.16	46.66	60.35
47	33.30	44.55	58.25
48	31.52	42.58	56.11
49	29.78	40.56	54.03
50	28.18	38.58	51.99
51	26.55	36.67	49.99
52	24.99	34.80	48.04
53	23.47	32.98	46.13
54	22.00	31.22	44.26
55	20.59	29.55	42.48
56	19.22	27.90	40.69
57	17.91	26.29	39.00
58	16.65	24.72	37.30
59	15.45	23.27	35.65
60	14.29	21.87	34.02
61	13.18	20.47	32.44
62	12.12	19.10	30.90
63	11.13	17.80	29.41
64	10.20	16.56	27.96
65	9.34	15.37	26.54
66	8.48	14.25	25.17
67	7.65	13.21	23.83
68	6.94	12.20	22.54
69	6.26	11.26	21.27
70	5.67	10.36	20.05
71	5.08	9.52	18.87
72	4.58	8.71	17.72
73	4.12	7.98	16.61
74	3.70	7.27	15.56
75	3.27	6.60	14.53
76	2.89	6.01	13.53
77	2.57	5.47	12.57
78	2.24	4.96	11.65
79	1.96	4.55	10.78
80	1.69	4.13	9.93
81	1.45	3.75	9.13
82	1.20	3.35	8.37
83	1.00	2.98	7.64
84	0.82	2.62	6.95
85	0.65	2.29	6.31
86	0.51	1.99	5.71
87	0.38	1.71	5.17
88	0.30	1.45	4.70
89		1.22	4.31
90		1.02	4.01
Cont. On		Pg. B-25	Pg. B-25

Table B-2. (continued) **4.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	45202.72	51752.01	59029.40						
X-ID	54648.7	55468.13	58676.5						
GAP (Ha)	1993.53	2002.18	2019.27						
Day	**Flow (cms)**								
Cont. From		Pg. B-24	Pg. B-24						
46		0.84	3.66						
47		0.68	3.32						
48		0.54	2.96						
49		0.41	2.61						
50		0.30	2.30						
51		0.30	2.01						
52			1.73						
53			1.48						
54			1.24						
55			1.02						
56			0.82						
57			0.65						
58			0.48						
59			0.35						
60			0.30						

B.3 2.0 cm/day recessions

Table B-3. **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	350.11	446.96	458.18	476.57	489.77	496.59	609.35	618.68	787.77
X-ID	16.61351	132.3145	24395.19	21484.44	18877.1	4104.055	3420.058	4469.405	13490.56
GAP (Ha)	210.86	218.00	222.67	237.70	259.19	278.30	302.54	336.09	349.96
Day	Flow (cms)								
1	10	10	10	10	10	10	10	10	10
2	9.06	8.90	8.69	8.98	8.92	8.67	8.00	8.95	9.04
3	6.55	7.41	7.41	7.52	7.39	7.16	6.94	7.51	8.28
4	4.55	6.31	6.11	6.08	6.14	6.07	6.41	6.19	7.64
5	3.24	4.86	5.01	4.88	5.01	4.97	5.18	5.19	6.92
6	2.52	3.75	4.10	4.05	4.07	4.11	4.74	4.34	6.26
7	1.79	3.12	3.31	3.37	3.32	3.38	4.56	3.81	5.58
8	1.24	2.38	2.51	2.75	2.73	2.73	3.87	3.23	4.98
9	0.83	1.69	1.89	2.19	2.17	2.24	3.42	3.07	4.22
10	0.50	1.29	1.36	1.72	1.79	1.83	3.01	2.72	3.79
11	0.30	0.88	0.96	1.30	1.43	1.50	2.69	2.38	3.24
12		0.60	0.68	0.96	1.15	1.18	2.28	2.14	2.80
13		0.34	0.45	0.66	0.89	0.99	1.98	1.96	2.48
14		0.30	0.32	0.44	0.66	0.78	1.66	1.72	2.19
15			0.30	0.30	0.48	0.67	1.45	1.50	1.94
16					0.34	0.51	1.11	1.30	1.71
17					0.30	0.39	0.99	1.13	1.50
18						0.30	0.72	0.97	1.32
19							0.56	0.82	1.16
20							0.42	0.68	1.01
21							0.30	0.56	0.86
22							0.30	0.47	0.77
23								0.38	0.65
24								0.32	0.55
25								0.30	0.47
26									0.39
27									0.34
28									0.33
29									0.32
30									0.31
31									0.30

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	805.38	844.62	995.55	1091.47	1141.59	1239.23	1267.36	1307.21	1353.28
X-ID	27603.03	24648.68	4739.83	51365.41	47871.32	38223.18	2715.69	5661.45	3148.658
GAP (Ha)	354.27	391.39	401.83	414.31	428.44	431.86	447.60	448.84	454.99
Day	**Flow (cms)**								
1	10	10	10	10	10	10	10	10	10
2	9.03	9.43	9.36	9.41	9.48	9.69	9.48	9.53	9.64
3	8.22	8.09	8.66	8.78	8.88	9.17	8.96	9.04	9.15
4	7.47	7.08	8.03	8.21	8.31	8.56	8.46	8.56	8.67
5	6.78	6.59	7.36	7.56	7.80	8.08	7.99	8.11	8.22
6	6.15	5.90	6.75	7.01	7.30	7.71	7.55	7.68	7.78
7	5.56	5.15	6.26	6.48	6.81	7.22	7.11	7.26	7.37
8	5.01	4.57	5.69	5.99	6.36	6.77	6.70	6.84	6.96
9	4.52	3.89	5.16	5.54	5.92	6.33	6.30	6.47	6.58
10	4.05	3.42	4.76	5.10	5.47	5.90	5.92	6.09	6.21
11	3.63	3.04	4.39	4.71	5.07	5.49	5.56	5.72	5.85
12	3.23	2.69	4.02	4.41	4.69	5.08	5.22	5.37	5.51
13	2.89	2.58	3.67	4.03	4.33	4.67	4.89	5.03	5.18
14	2.53	2.55	3.34	3.74	3.99	4.31	4.58	4.72	4.87
15	2.22	2.44	3.10	3.46	3.67	3.98	4.27	4.40	4.57
16	1.97	2.30	2.85	3.20	3.37	3.66	3.99	4.11	4.28
17	1.70	2.09	2.57	2.96	3.10	3.37	3.72	3.87	4.01
18	1.51	1.92	2.35	2.72	2.84	3.09	3.46	3.61	3.75
19	1.33	1.75	2.15	2.52	2.59	2.84	3.21	3.34	3.49
20	1.14	1.61	1.97	2.34	2.37	2.63	2.98	3.11	3.25
21	0.99	1.47	1.78	2.17	2.15	2.40	2.75	2.83	3.04
22	0.84	1.34	1.60	1.99	1.97	2.26	2.54	2.63	2.82
23	0.71	1.19	1.45	1.84	1.78	2.10	2.34	2.45	2.60
24	0.60	1.08	1.29	1.68	1.65	1.92	2.15	2.22	2.40
25	0.47	0.96	1.14	1.53	1.53	1.75	1.98	2.03	2.22
26	0.36	0.84	1.02	1.38	1.38	1.70	1.81	1.85	2.05
27	0.30	0.76	0.90	1.21	1.28	1.56	1.66	1.68	1.89
28		0.64	0.78	1.11	1.17	1.41	1.51	1.55	1.74
29		0.56	0.69	0.97	1.06	1.28	1.37	1.42	1.59
30		0.49	0.58	0.84	0.97	1.18	1.23	1.30	1.46
31		0.42	0.50	0.73	0.85	1.11	1.11	1.17	1.33
32		0.36	0.41	0.64	0.75	1.00	0.99	1.06	1.20
33		0.30	0.34	0.56	0.66	0.89	0.88	0.96	1.08
34		0.30	0.30	0.47	0.60	0.80	0.79	0.86	0.97
35				0.41	0.52	0.72	0.69	0.77	0.87
36				0.34	0.46	0.65	0.60	0.68	0.78
37				0.30	0.38	0.56	0.52	0.61	0.68
38					0.33	0.49	0.45	0.54	0.60
39					0.30	0.43	0.37	0.48	0.52
40						0.36	0.31	0.41	0.45
41						0.30	0.30	0.36	0.38
42								0.31	0.33
43								0.30	0.30

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	1455.60	1557.43	1693.24	2763.50	2809.71	3001.02	3367.22	3588.21	3751.81
X-ID	6226.449	54648.7	55468.13	49711.45	46442.96	4739.83	51365.41	51076.81	58214.65
GAP (Ha)	456.08	467.45	468.79	476.93	478.80	528.15	558.33	559.09	562.24
Day	**Flow (cms)**								
1	10	10	10	25	25	25	25	25	25
2	9.65	9.75	9.94	24.60	24.50	24.21	24.47	24.53	24.90
3	9.18	9.34	9.52	22.89	22.92	22.64	23.12	23.38	23.81
4	8.73	8.90	9.11	21.39	21.43	21.31	21.82	22.24	22.74
5	8.28	8.48	8.71	19.88	19.88	19.97	20.56	21.13	21.70
6	7.84	8.07	8.36	18.57	18.47	18.62	19.35	20.05	20.68
7	7.38	7.65	7.98	17.19	17.03	17.71	18.17	18.95	19.69
8	6.93	7.31	7.62	15.86	15.88	16.57	16.85	18.01	18.68
9	6.52	6.94	7.27	14.64	14.68	15.48	16.15	17.01	17.68
10	6.17	6.60	6.91	13.48	13.76	14.12	15.23	16.06	16.70
11	5.82	6.26	6.60	12.36	12.67	13.06	14.31	15.16	15.68
12	5.51	5.93	6.31	11.36	11.78	12.06	13.38	14.29	14.72
13	5.25	5.67	6.01	10.37	11.07	11.10	12.46	13.59	13.82
14	5.00	5.38	5.74	9.50	9.90	10.25	11.54	12.68	12.93
15	4.76	5.08	5.47	8.70	9.13	9.36	10.81	12.00	12.16
16	4.52	4.83	5.21	7.91	8.35	8.66	10.20	11.19	11.49
17	4.29	4.58	4.96	7.28	7.64	8.03	9.41	10.42	10.77
18	4.07	4.35	4.75	6.61	6.84	7.36	8.78	9.82	10.06
19	3.88	4.12	4.55	5.91	6.26	6.75	8.21	9.09	9.40
20	3.66	3.91	4.33	5.43	5.62	6.26	7.56	8.48	8.78
21	3.46	3.70	4.13	4.93	5.01	5.69	7.01	7.91	8.23
22	3.24	3.48	3.96	4.45	4.47	5.16	6.48	7.36	7.69
23	3.06	3.27	3.75	3.94	4.00	4.76	5.99	6.83	7.19
24	2.86	3.08	3.55	3.57	3.53	4.39	5.54	6.33	6.61
25	2.69	2.89	3.35	3.22	3.11	4.02	5.10	5.85	6.24
26	2.51	2.70	3.16	2.87	2.80	3.67	4.71	5.38	5.73
27	2.34	2.57	2.98	2.56	2.51	3.34	4.41	4.93	5.33
28	2.17	2.40	2.79	2.29	2.22	3.10	4.03	4.59	4.98
29	2.02	2.24	2.62	2.04	1.99	2.85	3.74	4.22	4.82
30	1.88	2.09	2.45	1.82	1.78	2.57	3.46	3.77	4.46
31	1.74	1.96	2.29	1.59	1.59	2.35	3.20	3.46	4.13
32	1.63	1.82	2.14	1.38	1.44	2.15	2.96	3.23	3.83
33	1.50	1.69	1.99	1.20	1.29	1.97	2.72	2.93	3.53
34	1.38	1.56	1.85	1.05	1.15	1.78	2.52	2.67	3.24
35	1.25	1.45	1.71	0.90	1.03	1.60	2.34	2.43	2.96
36	1.14	1.31	1.57	0.78	0.89	1.45	2.17	2.23	2.69
37	1.03	1.20	1.45	0.66	0.79	1.29	1.99	2.04	2.47
38	0.92	1.10	1.34	0.55	0.68	1.14	1.84	1.90	2.24
39	0.82	1.00	1.22	0.47	0.60	1.02	1.68	1.81	2.05
40	0.72	0.90	1.12	0.37	0.51	0.90	1.53	1.68	1.88
41	0.64	0.82	1.02	0.30	0.40	0.78	1.38	1.54	1.73
42	0.55	0.73	0.93		0.34	0.69	1.21	1.38	1.58
43	0.48	0.65	0.84		0.30	0.58	1.11	1.24	1.41
44	0.40	0.58	0.77			0.50	0.97	1.11	1.28
45	0.34	0.51	0.68			0.41	0.84	1.00	1.14
Cont. On	Pg. B-35	Pg. B-35	Pg. B-35			Pg. B-35	Pg. B-35	Pg. B-35	Pg. B-35

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	3805.16	3845.62	3926.37	4011.29	4086.23	4220.83	4328.44	4958.75	5276.17
X-ID	48393.66	47216.96	11213.08	47871.32	2715.69	2938.422	3148.658	56955.73	55384.28
GAP (Ha)	592.08	596.16	601.32	606.06	638.36	656.57	668.43	679.11	699.12
Day	**Flow (cms)**								
1	25	25	25	25	25	25	25	25	25
2	24.78	23.94	24.00	24.58	24.07	24.09	24.09	24.47	24.78
3	23.54	22.91	22.88	23.57	23.07	23.11	23.14	23.66	24.04
4	22.32	21.92	21.79	22.59	22.08	22.15	22.21	22.86	23.32
5	21.14	20.89	20.76	21.63	21.12	21.21	21.30	22.06	22.62
6	20.01	19.93	19.72	20.69	20.20	20.32	20.43	21.28	21.93
7	18.94	19.00	18.98	19.77	19.30	19.45	19.57	20.54	21.25
8	17.92	18.11	18.06	18.86	18.44	18.61	18.76	19.79	20.49
9	16.92	17.25	17.16	17.96	17.59	17.79	17.96	19.06	19.74
10	15.92	16.42	16.32	17.17	16.78	17.00	17.18	18.34	19.06
11	15.04	15.57	15.51	16.31	15.99	16.24	16.44	17.63	18.38
12	14.28	14.80	14.72	15.50	15.22	15.51	15.72	16.95	17.72
13	13.70	14.02	13.96	14.71	14.48	14.79	15.02	16.29	17.07
14	12.95	13.28	13.24	13.94	13.78	14.10	14.34	15.60	16.44
15	12.24	12.56	12.55	13.24	13.11	13.45	13.70	14.99	15.81
16	11.57	11.88	11.89	12.59	12.44	12.80	13.06	14.42	15.20
17	10.96	11.21	11.26	11.97	11.80	12.17	12.45	13.77	14.60
18	10.37	10.60	10.65	11.30	11.18	11.56	11.85	13.19	14.02
19	9.81	9.98	10.08	10.67	10.59	10.98	11.27	12.62	13.49
20	9.29	9.39	9.52	10.06	10.03	10.40	10.69	12.08	12.95
21	8.77	8.81	8.99	9.48	9.48	9.86	10.17	11.55	12.42
22	8.17	8.38	8.49	8.88	8.96	9.35	9.64	11.04	11.90
23	7.69	7.85	7.90	8.31	8.46	8.84	9.15	10.54	11.40
24	7.24	7.37	7.45	7.80	7.99	8.37	8.67	10.07	10.92
25	6.79	6.87	7.02	7.30	7.55	7.92	8.22	9.61	10.44
26	6.41	6.40	6.62	6.81	7.11	7.49	7.78	9.18	9.99
27	6.01	5.94	6.22	6.36	6.70	7.07	7.37	8.77	9.53
28	5.62	5.53	5.86	5.92	6.30	6.68	6.96	8.38	9.10
29	5.23	5.14	5.51	5.47	5.92	6.29	6.58	7.98	8.69
30	4.86	4.77	5.18	5.07	5.56	5.92	6.21	7.61	8.35
31	4.51	4.41	4.88	4.69	5.22	5.57	5.85	7.26	7.95
32	4.17	4.11	4.59	4.33	4.89	5.23	5.51	6.90	7.57
33	3.85	3.87	4.31	3.99	4.58	4.91	5.18	6.59	7.20
34	3.52	3.61	4.05	3.67	4.27	4.60	4.87	6.28	6.83
35	3.23	3.35	3.80	3.37	3.99	4.31	4.57	5.99	6.51
36	2.98	3.10	3.55	3.10	3.72	4.03	4.28	5.69	6.20
37	2.71	2.83	3.32	2.84	3.46	3.76	4.01	5.41	5.86
38	2.46	2.58	3.09	2.59	3.21	3.50	3.75	5.14	5.58
39	2.22	2.34	2.82	2.37	2.98	3.26	3.49	4.88	5.31
40	2.03	2.11	2.60	2.15	2.75	3.04	3.25	4.63	5.04
41	1.84	1.89	2.40	1.97	2.54	2.81	3.04	4.38	4.79
42	1.67	1.69	2.20	1.78	2.34	2.59	2.82	4.16	4.55
43	1.53	1.50	2.02	1.65	2.15	2.39	2.60	3.94	4.31
44	1.38	1.31	1.84	1.53	1.98	2.21	2.40	3.71	4.11
45	1.25	1.20	1.68	1.38	1.81	2.04	2.22	3.49	3.90
Cont. On	Pg. B-35	Pg. B-35	Pg. B-35	Pg. B-35	Pg. B-35	Pg. B-35	Pg. B-35	Pg. B-35	Pg. B-35

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	5356.61	5480.26	7990.94	8458.57	9089.46	9992.98	10203.21	10263.09	10355.89
X-ID	54648.7	55468.13	51365.41	48393.66	11213.08	47216.96	13143.03	2715.69	2938.422
GAP (Ha)	703.45	705.99	718.73	770.36	807.65	820.48	848.05	880.08	910.70
Day	**Flow (cms)**								
1	25	25	50	50	50	50	50	50	50
2	24.99	24.72	48.61	48.54	48.18	48.57	49.87	49.25	48.67
3	24.22	23.99	46.46	46.46	46.28	47.03	48.01	47.60	47.04
4	23.47	23.27	44.33	44.44	44.39	45.53	46.34	46.00	45.52
5	22.73	22.57	42.36	42.47	42.65	44.06	44.90	44.45	44.04
6	22.00	21.87	40.32	40.57	40.97	42.59	43.19	42.89	42.50
7	21.29	21.19	38.34	38.80	39.26	41.17	41.57	41.43	41.07
8	20.59	20.47	36.81	37.11	37.63	39.77	40.16	39.96	39.64
9	19.90	19.77	35.18	35.46	36.03	38.40	38.72	38.52	38.23
10	19.22	19.10	33.54	33.92	34.48	37.05	37.32	37.12	36.87
11	18.56	18.44	31.93	32.36	33.01	35.72	35.82	35.76	35.54
12	17.91	17.80	30.35	30.83	31.58	34.43	34.13	34.46	34.27
13	17.28	17.18	28.79	29.13	30.19	33.21	33.05	33.17	33.01
14	16.65	16.56	27.28	27.43	28.88	31.97	31.66	31.95	31.81
15	16.04	15.96	25.87	26.08	27.39	30.74	30.38	30.76	30.65
16	15.45	15.37	24.47	24.78	26.34	29.54	29.15	29.59	29.46
17	14.86	14.81	23.12	23.54	25.30	28.36	27.98	28.42	28.32
18	14.29	14.25	21.82	22.32	24.00	27.23	26.85	27.29	27.22
19	13.72	13.72	20.56	21.14	22.88	26.10	25.74	26.18	26.14
20	13.18	13.21	19.35	20.01	21.79	25.01	24.68	25.11	25.09
21	12.65	12.71	18.17	18.94	20.76	23.94	23.65	24.07	24.09
22	12.12	12.20	16.85	17.92	19.72	22.91	22.66	23.07	23.11
23	11.62	11.73	16.15	16.92	18.98	21.92	21.73	22.08	22.15
24	11.13	11.26	15.23	15.92	18.06	20.89	20.84	21.12	21.21
25	10.66	10.81	14.31	15.04	17.16	19.93	19.76	20.20	20.32
26	10.20	10.36	13.38	14.28	16.32	19.00	18.95	19.30	19.45
27	9.75	9.94	12.46	13.70	15.51	18.11	18.08	18.44	18.61
28	9.34	9.52	11.54	12.95	14.72	17.25	17.24	17.59	17.79
29	8.90	9.11	10.81	12.24	13.96	16.42	16.42	16.78	17.00
30	8.48	8.71	10.20	11.57	13.24	15.57	15.63	15.99	16.24
31	8.07	8.36	9.41	10.96	12.55	14.80	14.86	15.22	15.51
32	7.65	7.98	8.78	10.37	11.89	14.02	14.13	14.48	14.79
33	7.31	7.62	8.21	9.81	11.26	13.28	13.42	13.78	14.10
34	6.94	7.27	7.56	9.29	10.65	12.56	12.75	13.11	13.45
35	6.60	6.91	7.01	8.77	10.08	11.88	12.14	12.44	12.80
36	6.26	6.60	6.48	8.17	9.52	11.21	11.52	11.80	12.17
37	5.93	6.31	5.99	7.69	8.99	10.60	10.93	11.18	11.56
38	5.67	6.01	5.54	7.24	8.49	9.98	10.37	10.59	10.98
39	5.38	5.74	5.10	6.79	7.90	9.39	9.84	10.03	10.40
40	5.08	5.47	4.71	6.41	7.45	8.81	9.33	9.48	9.86
41	4.83	5.21	4.41	6.01	7.02	8.38	8.83	8.96	9.35
42	4.58	4.96	4.03	5.62	6.62	7.85	8.36	8.46	8.84
43	4.35	4.75	3.74	5.23	6.22	7.37	7.89	7.99	8.37
44	4.12	4.55	3.46	4.86	5.86	6.87	7.45	7.55	7.92
45	3.91	4.33	3.20	4.51	5.51	6.40	7.03	7.11	7.49
Cont. On	Pg. B-36	Pg. B-36	Pg. B-36	Pg. B-36	Pg. B-36	Pg. B-36	Pg. B-36	Pg. B-36	Pg. B-36

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	10827.90	12487.47	12566.16	12772.96	13824.20	13891.14	14336.97	17235.89	17253.96
X-ID	3148.658	46146.75	6226.449	56955.73	55384.28	54648.7	55468.13	43987.58	7091.917
GAP (Ha)	941.50	966.48	967.50	972.45	1013.91	1021.08	1025.75	1043.08	1061.98
Day	**Flow (cms)**								
1	50	50	50	50	50	50	50	75	75
2	49.36	49.94	49.18	49.10	49.78	49.91	49.92	73.97	73.04
3	47.74	48.49	47.88	47.91	48.66	48.76	48.82	71.51	70.68
4	46.18	47.04	46.60	46.70	47.56	47.60	47.74	69.10	68.39
5	44.89	45.62	45.35	45.54	46.45	46.46	46.66	66.74	66.12
6	43.39	44.23	44.13	44.41	45.37	45.34	45.60	64.21	63.94
7	41.91	42.85	42.92	43.28	44.30	44.26	44.55	62.13	61.86
8	40.53	41.52	41.72	42.16	43.32	43.18	43.53	60.07	59.84
9	39.15	40.16	40.68	41.07	42.34	42.11	42.58	57.95	57.86
10	37.81	39.01	39.33	39.99	41.30	41.09	41.57	55.87	55.86
11	36.49	37.79	38.17	38.92	40.27	40.04	40.56	54.28	53.82
12	35.21	36.63	37.09	37.87	39.25	39.02	39.57	52.15	52.01
13	33.97	35.55	35.98	36.83	38.25	38.04	38.58	49.98	50.12
14	32.75	34.55	34.90	35.80	37.25	37.06	37.62	48.54	48.31
15	31.60	33.55	33.83	34.80	36.27	36.10	36.67	46.13	46.56
16	30.45	32.60	32.79	33.81	35.32	35.16	35.73	44.79	44.90
17	29.31	31.67	31.83	32.83	34.37	34.22	34.80	43.15	43.34
18	28.21	30.62	30.83	31.88	33.44	33.30	33.89	41.60	41.86
19	27.14	29.62	29.88	30.93	32.51	32.40	32.98	40.18	40.53
20	26.09	28.66	29.05	29.86	31.60	31.52	32.10	38.89	39.13
21	25.07	27.73	28.16	28.99	30.70	30.64	31.22	37.66	37.81
22	24.09	26.84	27.28	28.06	29.81	29.78	30.35	36.50	36.46
23	23.14	25.95	26.43	27.13	28.94	28.94	29.55	35.31	35.17
24	22.21	25.13	25.57	26.23	28.08	28.18	28.73	33.94	33.92
25	21.30	24.32	24.76	25.33	27.24	27.36	27.90	33.22	32.71
26	20.43	23.53	23.96	24.47	26.41	26.55	27.09	32.12	31.54
27	19.57	22.77	23.19	23.66	25.58	25.76	26.29	31.06	30.40
28	18.76	22.18	22.43	22.86	24.78	24.99	25.49	29.94	29.31
29	17.96	21.50	21.67	22.06	24.04	24.22	24.72	28.89	28.24
30	17.18	20.75	20.94	21.28	23.32	23.47	23.99	27.84	27.24
31	16.44	20.01	20.27	20.54	22.62	22.73	23.27	26.83	26.22
32	15.72	19.26	19.62	19.79	21.93	22.00	22.57	25.85	25.33
33	15.02	18.66	18.95	19.06	21.25	21.29	21.87	24.88	24.40
34	14.34	17.99	18.28	18.34	20.49	20.59	21.19	23.94	23.50
35	13.70	17.34	17.62	17.63	19.74	19.90	20.47	23.02	22.62
36	13.06	16.70	16.98	16.95	19.06	19.22	19.77	22.12	21.76
37	12.45	16.07	16.35	16.29	18.38	18.56	19.10	21.26	20.92
38	11.85	15.46	15.72	15.60	17.72	17.91	18.44	20.43	20.12
39	11.27	14.86	15.10	14.99	17.07	17.28	17.80	19.62	19.32
40	10.69	14.27	14.49	14.42	16.44	16.65	17.18	18.83	18.56
41	10.17	13.70	13.90	13.77	15.81	16.04	16.56	18.06	17.83
42	9.64	13.13	13.37	13.19	15.20	15.45	15.96	17.31	17.11
43	9.15	12.58	12.81	12.62	14.60	14.86	15.37	16.56	16.42
44	8.67	12.04	12.25	12.08	14.02	14.29	14.81	15.81	15.72
45	8.22	11.54	11.71	11.55	13.49	13.72	14.25	15.12	15.08
Cont. On	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	17475.42	17988.58	20075.47	20821.05	21322.94	21886.56	23796.61	24192.20	25253.98
X-ID	2938.422	3148.658	44477.7	46146.75	6226.449	13143.03	54648.7	7203.769	2938.422
GAP (Ha)	1088.30	1134.60	1166.13	1175.14	1184.44	1197.20	1266.10	1300.24	1332.79
Day	**Flow (cms)**								
1	75	75	75	75	75	175	75	125	125
2	73.75	74.05	72.63	74.78	74.39	173.75	74.54	121.16	121.68
3	71.62	71.93	70.59	72.93	72.49	167.82	72.99	117.97	118.32
4	69.41	69.73	68.58	71.07	70.62	162.31	71.43	114.43	115.13
5	67.21	67.54	66.66	69.24	68.72	156.63	69.92	110.82	111.89
6	65.12	65.45	65.34	67.44	67.10	152.42	68.43	107.24	108.79
7	63.10	63.43	63.46	65.70	65.35	148.06	66.97	103.81	105.74
8	61.05	61.40	61.19	64.00	63.68	143.33	65.53	100.31	102.73
9	59.14	59.46	59.33	62.31	62.21	138.39	64.11	96.94	99.78
10	57.21	57.55	57.54	60.66	60.70	133.67	62.70	94.44	96.88
11	55.37	55.73	56.22	59.04	59.16	128.56	61.33	91.31	94.08
12	53.64	54.00	54.72	57.55	57.66	123.79	59.97	88.33	91.30
13	52.07	52.50	52.81	56.00	56.18	119.15	58.63	85.47	88.63
14	50.33	51.01	51.21	54.46	54.68	114.62	57.31	82.62	85.91
15	48.67	49.36	49.65	52.94	53.20	110.23	56.02	79.92	83.33
16	47.04	47.74	48.79	51.43	51.87	105.95	54.75	77.28	80.85
17	45.52	46.18	47.60	49.94	50.52	101.81	53.51	74.75	78.49
18	44.04	44.89	46.22	48.49	49.18	96.92	52.28	72.55	76.06
19	42.50	43.39	44.89	47.04	47.88	92.91	51.07	70.32	73.75
20	41.07	41.91	43.61	45.62	46.60	90.35	49.91	68.08	71.62
21	39.64	40.53	42.35	44.23	45.35	87.33	48.76	65.90	69.41
22	38.23	39.15	41.12	42.85	44.13	83.08	47.60	63.79	67.21
23	36.87	37.81	39.91	41.52	42.92	79.92	46.46	61.76	65.12
24	35.54	36.49	38.74	40.16	41.72	76.93	45.34	59.79	63.10
25	34.27	35.21	37.65	39.01	40.68	75.80	44.26	57.85	61.05
26	33.01	33.97	36.56	37.79	39.33	72.95	43.18	55.91	59.14
27	31.81	32.75	35.51	36.63	38.17	70.16	42.11	53.97	57.21
28	30.65	31.60	34.47	35.55	37.09	67.62	41.09	52.19	55.37
29	29.46	30.45	33.37	34.55	35.98	65.39	40.04	50.37	53.64
30	28.32	29.31	32.32	33.55	34.90	62.92	39.02	48.63	52.07
31	27.22	28.21	31.31	32.60	33.83	60.46	38.04	46.94	50.33
32	26.14	27.14	30.33	31.67	32.79	58.02	37.06	45.32	48.67
33	25.09	26.09	29.37	30.62	31.83	55.85	36.10	43.77	47.04
34	24.09	25.07	28.43	29.62	30.83	53.80	35.16	42.29	45.52
35	23.11	24.09	27.51	28.66	29.88	51.83	34.22	40.92	44.04
36	22.15	23.14	26.60	27.73	29.05	49.87	33.30	39.54	42.50
37	21.21	22.21	25.74	26.84	28.16	48.01	32.40	38.18	41.07
38	20.32	21.30	24.88	25.95	27.28	46.34	31.52	36.88	39.64
39	19.45	20.43	24.05	25.13	26.43	44.90	30.64	35.58	38.23
40	18.61	19.57	23.25	24.32	25.57	43.19	29.78	34.35	36.87
41	17.79	18.76	22.47	23.53	24.76	41.57	28.94	33.15	35.54
42	17.00	17.96	21.72	22.77	23.96	40.16	28.18	31.98	34.27
43	16.24	17.18	21.00	22.18	23.19	38.72	27.36	30.83	33.01
44	15.51	16.44	20.31	21.50	22.43	37.32	26.55	29.74	31.81
45	14.79	15.72	19.66	20.75	21.67	35.82	25.76	28.67	30.65
Cont. On	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	25787.72	27732.10	29798.57	34287.65	34527.45	37662.18	57104.13	60568.60	67165.01
X-ID	3148.658	44477.7	6226.449	45046.39	54648.7	55468.13	6226.449	54648.7	55468.13
GAP (Ha)	1391.76	1427.39	1487.67	1493.80	1626.47	1641.98	1668.14	1748.98	1767.30
Day	**Flow (cms)**								
1	125	125	125	125	125	125	175	150	150
2	121.72	124.98	122.62	123.80	124.05	124.17	173.08	148.68	149.88
3	118.37	122.17	119.67	121.34	121.94	122.30	169.56	146.31	147.81
4	115.19	119.13	116.06	118.89	119.84	120.45	166.84	143.97	145.75
5	111.97	115.82	113.16	116.47	117.85	118.61	162.19	141.66	143.70
6	108.88	112.55	110.90	114.13	115.88	116.78	157.85	139.43	141.68
7	105.84	109.38	108.15	111.95	113.61	114.97	154.40	137.18	139.66
8	102.85	106.30	105.42	109.79	111.61	113.18	150.87	134.96	137.67
9	99.93	103.68	102.82	107.61	109.64	111.40	146.82	132.73	135.70
10	97.05	100.73	100.17	105.42	107.67	109.65	143.12	130.53	133.74
11	94.28	97.91	97.61	103.36	105.75	107.90	139.30	128.34	131.80
12	91.52	95.15	95.77	101.24	103.96	106.08	135.44	126.19	129.88
13	88.86	92.47	93.70	99.10	102.06	104.34	132.43	124.05	127.96
14	86.18	89.84	91.13	97.09	100.17	102.62	129.28	121.94	126.06
15	83.59	87.12	88.98	95.06	98.30	100.92	125.22	119.84	124.17
16	81.13	84.47	86.62	93.01	96.46	99.23	122.62	117.85	122.30
17	78.78	81.86	84.46	91.05	94.64	97.56	119.67	115.88	120.45
18	76.36	79.44	82.41	89.13	92.86	95.90	116.06	113.61	118.61
19	74.05	77.72	80.49	87.32	91.08	94.25	113.16	111.61	116.78
20	71.93	75.21	78.36	85.33	89.34	92.63	110.90	109.64	114.97
21	69.73	72.63	76.45	83.48	87.61	91.01	108.15	107.67	113.18
22	67.54	70.59	74.39	81.64	85.90	89.46	105.42	105.75	111.40
23	65.45	68.58	72.49	79.82	84.22	88.04	102.82	103.96	109.65
24	63.43	66.66	70.62	78.19	82.56	86.57	100.17	102.06	107.90
25	61.40	65.34	68.72	76.43	80.92	85.07	97.61	100.17	106.08
26	59.46	63.46	67.10	74.69	79.30	83.59	95.77	98.30	104.34
27	57.55	61.19	65.35	72.97	77.69	82.13	93.70	96.46	102.62
28	55.73	59.33	63.68	71.28	76.10	80.66	91.13	94.64	100.92
29	54.00	57.54	62.21	69.76	74.54	79.20	88.98	92.86	99.23
30	52.50	56.22	60.70	68.12	72.99	77.75	86.62	91.08	97.56
31	51.01	54.72	59.16	66.58	71.43	76.31	84.46	89.34	95.90
32	49.36	52.81	57.66	65.07	69.92	74.89	82.41	87.61	94.25
33	47.74	51.21	56.18	63.59	68.43	73.48	80.49	85.90	92.63
34	46.18	49.65	54.68	62.11	66.97	72.08	78.36	84.22	91.01
35	44.89	48.79	53.20	60.63	65.53	70.71	76.45	82.56	89.46
36	43.39	47.60	51.87	59.18	64.11	69.46	74.39	80.92	88.04
37	41.91	46.22	50.52	57.76	62.70	68.11	72.49	79.30	86.57
38	40.53	44.89	49.18	56.41	61.33	66.78	70.62	77.69	85.07
39	39.15	43.61	47.88	55.12	59.97	65.48	68.72	76.10	83.59
40	37.81	42.35	46.60	53.79	58.63	64.18	67.10	74.54	82.13
41	36.49	41.12	45.35	52.48	57.31	62.90	65.35	72.99	80.66
42	35.21	39.91	44.13	51.19	56.02	61.63	63.68	71.43	79.20
43	33.97	38.74	42.92	49.93	54.75	60.39	62.21	69.92	77.75
44	32.75	37.65	41.72	48.94	53.51	59.15	60.70	68.43	76.31
45	31.60	36.56	40.68	47.92	52.28	57.93	59.16	66.97	74.89
Cont. On	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	74794.80	82851.15	89539.27	100905.97
X-ID	54648.7	55468.13	54648.7	55468.13
GAP (Ha)	1851.66	1872.93	1934.76	1957.95
Day	**Flow (cms)**			
1	175	175	200	200
2	173.41	173.80	197.93	199.55
3	170.91	171.55	195.11	197.14
4	168.39	169.32	192.30	194.74
5	165.87	167.10	189.53	192.37
6	163.36	164.89	186.77	190.01
7	160.88	162.70	184.01	187.61
8	158.34	160.52	181.27	185.27
9	155.89	158.37	178.59	182.95
10	153.45	156.22	176.02	180.64
11	151.05	154.09	173.41	178.34
12	148.68	151.97	170.91	176.07
13	146.31	149.88	168.39	173.80
14	143.97	147.81	165.87	171.55
15	141.66	145.75	163.36	169.32
16	139.43	143.70	160.88	167.10
17	137.18	141.68	158.34	164.89
18	134.96	139.66	155.89	162.70
19	132.73	137.67	153.45	160.52
20	130.53	135.70	151.05	158.37
21	128.34	133.74	148.68	156.22
22	126.19	131.80	146.31	154.09
23	124.05	129.88	143.97	151.97
24	121.94	127.96	141.66	149.88
25	119.84	126.06	139.43	147.81
26	117.85	124.17	137.18	145.75
27	115.88	122.30	134.96	143.70
28	113.61	120.45	132.73	141.68
29	111.61	118.61	130.53	139.66
30	109.64	116.78	128.34	137.67
31	107.67	114.97	126.19	135.70
32	105.75	113.18	124.05	133.74
33	103.96	111.40	121.94	131.80
34	102.06	109.65	119.84	129.88
35	100.17	107.90	117.85	127.96
36	98.30	106.08	115.88	126.06
37	96.46	104.34	113.61	124.17
38	94.64	102.62	111.61	122.30
39	92.86	100.92	109.64	120.45
40	91.08	99.23	107.67	118.61
41	89.34	97.56	105.75	116.78
42	87.61	95.90	103.96	114.97
43	85.90	94.25	102.06	113.18
44	84.22	92.63	100.17	111.40
45	82.56	91.01	98.30	109.65
Cont. On	Pg. B-40	Pg. B-40	Pg. B-40	Pg. B-40

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	1455.60	1557.43	1693.24	2763.50	2809.71	3001.02	3367.22	3588.21	3751.81
X-ID	6226.449	54648.7	55468.13	49711.45	46442.96	4739.83	51365.41	51076.81	58214.65
GAP (Ha)	456.08	467.45	468.79	476.93	478.80	528.15	558.33	559.09	562.24
Day	**Flow (cms)**								
Cont. From	Pg. B-28	Pg. B-28	Pg. B-28			Pg. B-28	Pg. B-28	Pg. B-28	Pg. B-28
46	0.30	0.45	0.61			0.34	0.73	0.88	1.01
47		0.38	0.54			0.30	0.64	0.77	0.89
48		0.33	0.47				0.56	0.66	0.79
49		0.30	0.41				0.47	0.57	0.68
50			0.35				0.41	0.49	0.58
51			0.30				0.34	0.41	0.49
52			0.30				0.30	0.34	0.39
53								0.30	0.32
54									0.30

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	3805.16	3845.62	3926.37	4011.29	4086.23	4220.83	4328.44	4958.75	5276.17
X-ID	48393.66	47216.96	11213.08	47871.32	2715.69	2938.422	3148.658	56955.73	55384.28
GAP (Ha)	592.08	596.16	601.32	606.06	638.36	656.57	668.43	679.11	699.12
Day	**Flow (cms)**								
Cont. From	Pg. B-29	Pg. B-29	Pg. B-29	Pg. B-29	Pg. B-29	Pg. B-29	Pg. B-29	Pg. B-29	Pg. B-29
46	1.13	1.11	1.54	1.28	1.66	1.88	2.05	3.28	3.68
47	1.02	1.01	1.37	1.17	1.51	1.72	1.89	3.08	3.46
48	0.90	0.93	1.21	1.06	1.37	1.57	1.74	2.89	3.24
49	0.82	0.87	1.09	0.97	1.23	1.43	1.59	2.69	3.05
50	0.72	0.84	0.97	0.85	1.11	1.30	1.46	2.51	2.85
51	0.64	0.82	0.83	0.75	0.99	1.18	1.33	2.34	2.67
52	0.55	0.76	0.73	0.66	0.88	1.06	1.20	2.17	2.48
53	0.48	0.67	0.63	0.60	0.79	0.95	1.08	1.99	2.31
54	0.43	0.57	0.53	0.52	0.69	0.84	0.97	1.83	2.14
55	0.36	0.50	0.44	0.46	0.60	0.75	0.87	1.68	1.99
56	0.31	0.44	0.35	0.38	0.52	0.66	0.78	1.53	1.84
57	0.30	0.36	0.30	0.33	0.45	0.57	0.68	1.39	1.69
58		0.31		0.30	0.37	0.50	0.60	1.26	1.55
59		0.30			0.31	0.43	0.52	1.15	1.43
60					0.30	0.36	0.45	1.04	1.31
61						0.31	0.38	0.94	1.19
62						0.30	0.33	0.85	1.07
63							0.30	0.75	0.98
64								0.66	0.88
65								0.58	0.79
66								0.51	0.70
67								0.45	0.62
68								0.35	0.55
69								0.30	0.49
70									0.43
71									0.35
72									0.31
73									0.30

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	5356.61	5480.26	7990.94	8458.57	9089.46	9992.98	10203.21	10263.09	10355.89
X-ID	54648.7	55468.13	51365.41	48393.66	11213.08	47216.96	13143.03	2715.69	2938.422
GAP (Ha)	703.45	705.99	718.73	770.36	807.65	820.48	848.05	880.08	910.70
Day	**Flow (cms)**								
Cont. From	Pg. B-30	Pg. B-30	Pg. B-30	Pg. B-30	Pg. B-30	Pg. B-30	Pg. B-30	Pg. B-30	Pg. B-30
46	3.70	4.13	2.96	4.17	5.18	5.94	6.65	6.70	7.07
47	3.48	3.96	2.72	3.85	4.88	5.53	6.30	6.30	6.68
48	3.27	3.75	2.52	3.52	4.59	5.14	5.93	5.92	6.29
49	3.08	3.55	2.34	3.23	4.31	4.77	5.58	5.56	5.92
50	2.89	3.35	2.17	2.98	4.05	4.41	5.23	5.22	5.57
51	2.70	3.16	1.99	2.71	3.80	4.11	4.90	4.89	5.23
52	2.57	2.98	1.84	2.46	3.55	3.87	4.57	4.58	4.91
53	2.40	2.79	1.68	2.22	3.32	3.61	4.24	4.27	4.60
54	2.24	2.62	1.53	2.03	3.09	3.35	3.97	3.99	4.31
55	2.09	2.45	1.38	1.84	2.82	3.10	3.70	3.72	4.03
56	1.96	2.29	1.21	1.67	2.60	2.83	3.42	3.46	3.76
57	1.82	2.14	1.11	1.53	2.40	2.58	3.16	3.21	3.50
58	1.69	1.99	0.97	1.38	2.20	2.34	2.91	2.98	3.26
59	1.56	1.85	0.84	1.25	2.02	2.11	2.66	2.75	3.04
60	1.45	1.71	0.73	1.13	1.84	1.89	2.47	2.54	2.81
61	1.31	1.57	0.64	1.02	1.68	1.69	2.27	2.34	2.59
62	1.20	1.45	0.56	0.90	1.54	1.50	2.09	2.15	2.39
63	1.10	1.34	0.47	0.82	1.37	1.31	1.92	1.98	2.21
64	1.00	1.22	0.41	0.72	1.21	1.20	1.75	1.81	2.04
65	0.90	1.12	0.34	0.64	1.09	1.11	1.58	1.66	1.88
66	0.82	1.02	0.30	0.55	0.97	1.01	1.44	1.51	1.72
67	0.73	0.93		0.48	0.83	0.93	1.31	1.37	1.57
68	0.65	0.84		0.43	0.73	0.87	1.16	1.23	1.43
69	0.58	0.77		0.36	0.63	0.84	1.04	1.11	1.30
70	0.51	0.68		0.31	0.53	0.82	0.95	0.99	1.18
71	0.45	0.61		0.30	0.44	0.76	0.81	0.88	1.06
72	0.38	0.54			0.35	0.67	0.71	0.79	0.95
73	0.33	0.47			0.30	0.57	0.61	0.69	0.84
74	0.30	0.41				0.50	0.52	0.60	0.75
75		0.35				0.44	0.46	0.52	0.66
76		0.30				0.36	0.38	0.45	0.57
77		0.30				0.31	0.34	0.37	0.50
78						0.30	0.34	0.31	0.43
79							0.33	0.30	0.36
80							0.33		0.31
81							0.32		0.30
82							0.32		
83							0.32		
84							0.31		
85							0.30		

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	10827.90	12487.47	12566.16	12772.96	13824.20	13891.14	14336.97	17235.89	17253.96
X-ID	3148.658	46146.75	6226.449	56955.73	55384.28	54648.7	55468.13	43987.58	7091.917
GAP (Ha)	941.50	966.48	967.50	972.45	1013.91	1021.08	1025.75	1043.08	1061.98
Day	Flow (cms)								
Cont. From	Pg. B-31	Pg. B-31	Pg. B-31	Pg. B-31	Pg. B-31	Pg. B-31	Pg. B-31	Pg. B-31	Pg. B-31
46	7.78	11.05	11.18	11.04	12.95	13.18	13.72	14.43	14.44
47	7.37	10.58	10.65	10.54	12.42	12.65	13.21	13.76	13.80
48	6.96	10.13	10.15	10.07	11.90	12.12	12.71	13.11	13.21
49	6.58	9.68	9.65	9.61	11.40	11.62	12.20	12.50	12.67
50	6.21	9.25	9.18	9.18	10.92	11.13	11.73	11.90	12.13
51	5.85	8.82	8.73	8.77	10.44	10.66	11.26	11.29	11.61
52	5.51	8.41	8.28	8.38	9.99	10.20	10.81	10.74	11.10
53	5.18	8.02	7.84	7.98	9.53	9.75	10.36	10.23	10.60
54	4.87	7.63	7.38	7.61	9.10	9.34	9.94	9.70	10.12
55	4.57	7.27	6.93	7.26	8.69	8.90	9.52	9.23	9.62
56	4.28	6.90	6.52	6.90	8.35	8.48	9.11	8.74	9.16
57	4.01	6.56	6.17	6.59	7.95	8.07	8.71	8.27	8.66
58	3.75	6.21	5.82	6.28	7.57	7.65	8.36	7.81	8.15
59	3.49	5.89	5.51	5.99	7.20	7.31	7.98	7.50	7.71
60	3.25	5.54	5.25	5.69	6.83	6.94	7.62	7.08	7.29
61	3.04	5.26	5.00	5.41	6.51	6.60	7.27	6.68	6.87
62	2.82	5.00	4.76	5.14	6.20	6.26	6.91	6.29	6.47
63	2.60	4.72	4.52	4.88	5.86	5.93	6.60	5.84	6.07
64	2.40	4.43	4.29	4.63	5.58	5.67	6.31	5.55	5.70
65	2.22	4.16	4.07	4.38	5.31	5.38	6.01	5.17	5.39
66	2.05	3.91	3.88	4.16	5.04	5.08	5.74	4.86	4.99
67	1.89	3.66	3.66	3.94	4.79	4.83	5.47	4.56	4.61
68	1.74	3.42	3.46	3.71	4.55	4.58	5.21	4.26	4.30
69	1.59	3.21	3.24	3.49	4.31	4.35	4.96	3.97	4.00
70	1.46	3.02	3.06	3.28	4.11	4.12	4.75	3.70	3.80
71	1.33	2.81	2.86	3.08	3.90	3.91	4.55	3.44	3.62
72	1.20	2.60	2.69	2.89	3.68	3.70	4.33	3.21	3.38
73	1.08	2.41	2.51	2.69	3.46	3.48	4.13	2.98	3.19
74	0.97	2.23	2.34	2.51	3.24	3.27	3.96	2.76	3.01
75	0.87	2.03	2.17	2.34	3.05	3.08	3.75	2.56	2.82
76	0.78	1.90	2.02	2.17	2.85	2.89	3.55	2.36	2.67
77	0.68	1.72	1.88	1.99	2.67	2.70	3.35	2.17	2.52
78	0.60	1.57	1.74	1.83	2.48	2.57	3.16	1.98	2.36
79	0.52	1.41	1.63	1.68	2.31	2.40	2.98	1.81	2.18
80	0.45	1.32	1.50	1.53	2.14	2.24	2.79	1.66	2.01
81	0.38	1.19	1.38	1.39	1.99	2.09	2.62	1.51	1.86
82	0.33	1.07	1.25	1.26	1.84	1.96	2.45	1.37	1.71
83	0.30	0.97	1.14	1.15	1.69	1.82	2.29	1.22	1.57
84		0.87	1.03	1.04	1.55	1.69	2.14	1.09	1.43
85		0.78	0.92	0.94	1.43	1.56	1.99	0.97	1.31
86		0.69	0.82	0.85	1.31	1.45	1.85	0.85	1.19
87		0.60	0.72	0.75	1.19	1.31	1.71	0.75	1.07
88		0.53	0.64	0.66	1.07	1.20	1.57	0.66	0.97
89		0.46	0.55	0.58	0.98	1.10	1.45	0.56	0.86
90		0.40	0.48	0.51	0.88	1.00	1.34	0.48	0.77
Cont. On		Pg. B-41	Pg. B-41	Pg. B-41	Pg. B-41	Pg. B-41	Pg. B-41	Pg. B-41	Pg. B-41

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	17475.42	17988.58	20075.47	20821.05	21322.94	21886.56	23796.61	24192.20	25253.98
X-ID	2938.422	3148.658	44477.7	46146.75	6226.449	13143.03	54648.7	7203.769	2938.422
GAP (Ha)	1088.30	1134.60	1166.13	1175.14	1184.44	1197.20	1266.10	1300.24	1332.79
Day	**Flow (cms)**								
Cont. From	Pg. B-32	Pg. B-32	Pg. B-32	Pg. B-32	Pg. B-32	Pg. B-32	Pg. B-32	Pg. B-32	Pg. B-32
46	14.10	15.02	19.05	20.01	20.94	34.13	24.99	27.64	29.46
47	13.45	14.34	18.39	19.26	20.27	33.05	24.22	26.64	28.32
48	12.80	13.70	17.74	18.66	19.62	31.66	23.47	25.70	27.22
49	12.17	13.06	17.13	17.99	18.95	30.38	22.73	24.76	26.14
50	11.56	12.45	16.53	17.34	18.28	29.15	22.00	23.85	25.09
51	10.98	11.85	15.96	16.70	17.62	27.98	21.29	22.95	24.09
52	10.40	11.27	15.41	16.07	16.98	26.85	20.59	22.08	23.11
53	9.86	10.69	14.86	15.46	16.35	25.74	19.90	21.24	22.15
54	9.35	10.17	14.32	14.86	15.72	24.68	19.22	20.40	21.21
55	8.84	9.64	13.80	14.27	15.10	23.65	18.56	19.60	20.32
56	8.37	9.15	13.29	13.70	14.49	22.66	17.91	18.82	19.45
57	7.92	8.67	12.80	13.13	13.90	21.73	17.28	18.06	18.61
58	7.49	8.22	12.32	12.58	13.37	20.84	16.65	17.32	17.79
59	7.07	7.78	11.85	12.04	12.81	19.76	16.04	16.59	17.00
60	6.68	7.37	11.38	11.54	12.25	18.95	15.45	15.88	16.24
61	6.29	6.96	10.93	11.05	11.71	18.08	14.86	15.21	15.51
62	5.92	6.58	10.49	10.58	11.18	17.24	14.29	14.54	14.79
63	5.57	6.21	10.06	10.13	10.65	16.42	13.72	13.88	14.10
64	5.23	5.85	9.64	9.68	10.15	15.63	13.18	13.26	13.45
65	4.91	5.51	9.23	9.25	9.65	14.86	12.65	12.69	12.80
66	4.60	5.18	8.82	8.82	9.18	14.13	12.12	12.12	12.17
67	4.31	4.87	8.43	8.41	8.73	13.42	11.62	11.57	11.56
68	4.03	4.57	8.08	8.02	8.28	12.75	11.13	11.03	10.98
69	3.76	4.28	7.68	7.63	7.84	12.14	10.66	10.50	10.40
70	3.50	4.01	7.34	7.27	7.38	11.52	10.20	9.99	9.86
71	3.26	3.75	6.98	6.90	6.93	10.93	9.75	9.47	9.35
72	3.04	3.49	6.65	6.56	6.52	10.37	9.34	8.98	8.84
73	2.81	3.25	6.31	6.21	6.17	9.84	8.90	8.45	8.37
74	2.59	3.04	5.98	5.89	5.82	9.33	8.48	7.98	7.92
75	2.39	2.82	5.67	5.54	5.51	8.83	8.07	7.53	7.49
76	2.21	2.60	5.38	5.26	5.25	8.36	7.65	7.08	7.07
77	2.04	2.40	5.09	5.00	5.00	7.89	7.31	6.66	6.68
78	1.88	2.22	4.82	4.72	4.76	7.45	6.94	6.24	6.29
79	1.72	2.05	4.55	4.43	4.52	7.03	6.60	5.85	5.92
80	1.57	1.89	4.27	4.16	4.29	6.65	6.26	5.49	5.57
81	1.43	1.74	4.02	3.91	4.07	6.30	5.93	5.13	5.23
82	1.30	1.59	3.78	3.66	3.88	5.93	5.67	4.79	4.91
83	1.18	1.46	3.52	3.42	3.66	5.58	5.38	4.47	4.60
84	1.06	1.33	3.33	3.21	3.46	5.23	5.08	4.18	4.31
85	0.95	1.20	3.06	3.02	3.24	4.90	4.83	3.93	4.03
86	0.84	1.08	2.86	2.81	3.06	4.57	4.58	3.73	3.76
87	0.75	0.97	2.68	2.60	2.86	4.24	4.35	3.52	3.50
88	0.66	0.87	2.50	2.41	2.69	3.97	4.12	3.31	3.26
89	0.57	0.78	2.29	2.23	2.51	3.70	3.91	3.13	3.04
90	0.50	0.68	2.10	2.03	2.34	3.42	3.70	2.95	2.81
Cont. On	Pg. B-42	Pg. B-42	Pg. B-42	Pg. B-42	Pg. B-42	Pg. B-42	Pg. B-42	Pg. B-42	Pg. B-42

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	25787.72	27732.10	29798.57	34287.65	34527.45	37662.18	57104.13	60568.60	67165.01
X-ID	3148.658	44477.7	6226.449	45046.39	54648.7	55468.13	6226.449	54648.7	55468.13
GAP (Ha)	1391.76	1427.39	1487.67	1493.80	1626.47	1641.98	1668.14	1748.98	1767.30
Day	**Flow (cms)**								
Cont. From	Pg. B-33	Pg. B-33	Pg. B-33	Pg. B-33	Pg. B-33	Pg. B-33	Pg. B-33	Pg. B-33	Pg. B-33
46	30.45	35.51	39.33	46.82	51.07	56.73	57.66	65.53	73.48
47	29.31	34.47	38.17	45.71	49.91	55.55	56.18	64.11	72.08
48	28.21	33.37	37.09	44.63	48.76	54.40	54.68	62.70	70.71
49	27.14	32.32	35.98	43.57	47.60	53.27	53.20	61.33	69.46
50	26.09	31.31	34.90	42.52	46.46	52.16	51.87	59.97	68.11
51	25.07	30.33	33.83	41.51	45.34	51.03	50.52	58.63	66.78
52	24.09	29.37	32.79	40.50	44.26	49.92	49.18	57.31	65.48
53	23.14	28.43	31.83	39.52	43.18	48.82	47.88	56.02	64.18
54	22.21	27.51	30.83	38.57	42.11	47.74	46.60	54.75	62.90
55	21.30	26.60	29.88	37.64	41.09	46.66	45.35	53.51	61.63
56	20.43	25.74	29.05	36.73	40.04	45.60	44.13	52.28	60.39
57	19.57	24.88	28.16	35.85	39.02	44.55	42.92	51.07	59.15
58	18.76	24.05	27.28	34.99	38.04	43.53	41.72	49.91	57.93
59	17.96	23.25	26.43	34.16	37.06	42.58	40.68	48.76	56.73
60	17.18	22.47	25.57	33.35	36.10	41.57	39.33	47.60	55.55
61	16.44	21.72	24.76	32.55	35.16	40.56	38.17	46.46	54.40
62	15.72	21.00	23.96	31.76	34.22	39.57	37.09	45.34	53.27
63	15.02	20.31	23.19	30.98	33.30	38.58	35.98	44.26	52.16
64	14.34	19.66	22.43	30.22	32.40	37.62	34.90	43.18	51.03
65	13.70	19.05	21.67	29.47	31.52	36.67	33.83	42.11	49.92
66	13.06	18.39	20.94	28.73	30.64	35.73	32.79	41.09	48.82
67	12.45	17.74	20.27	28.00	29.78	34.80	31.83	40.04	47.74
68	11.85	17.13	19.62	27.27	28.94	33.89	30.83	39.02	46.66
69	11.27	16.53	18.95	26.56	28.18	32.98	29.88	38.04	45.60
70	10.69	15.96	18.28	25.86	27.36	32.10	29.05	37.06	44.55
71	10.17	15.41	17.62	25.17	26.55	31.22	28.16	36.10	43.53
72	9.64	14.86	16.98	24.49	25.76	30.35	27.28	35.16	42.58
73	9.15	14.32	16.35	23.81	24.99	29.55	26.43	34.22	41.57
74	8.67	13.80	15.72	23.16	24.22	28.73	25.57	33.30	40.56
75	8.22	13.29	15.10	22.51	23.47	27.90	24.76	32.40	39.57
76	7.78	12.80	14.49	21.87	22.73	27.09	23.96	31.52	38.58
77	7.37	12.32	13.90	21.24	22.00	26.29	23.19	30.64	37.62
78	6.96	11.85	13.37	20.63	21.29	25.49	22.43	29.78	36.67
79	6.58	11.38	12.81	20.03	20.59	24.72	21.67	28.94	35.73
80	6.21	10.93	12.25	19.44	19.90	23.99	20.94	28.18	34.80
81	5.85	10.49	11.71	18.87	19.22	23.27	20.27	27.36	33.89
82	5.51	10.06	11.18	18.29	18.56	22.57	19.62	26.55	32.98
83	5.18	9.64	10.65	17.72	17.91	21.87	18.95	25.76	32.10
84	4.87	9.23	10.15	17.16	17.28	21.19	18.28	24.99	31.22
85	4.57	8.82	9.65	16.60	16.65	20.47	17.62	24.22	30.35
86	4.28	8.43	9.18	16.06	16.04	19.77	16.98	23.47	29.55
87	4.01	8.08	8.73	15.59	15.45	19.10	16.35	22.73	28.73
88	3.75	7.68	8.28	15.06	14.86	18.44	15.72	22.00	27.90
89	3.49	7.34	7.84	14.55	14.29	17.80	15.10	21.29	27.09
90	3.25	6.98	7.38	14.03	13.72	17.18	14.49	20.59	26.29
Cont. On	Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	74794.80	82851.15	89539.27	100905.97
X-ID	54648.7	55468.13	54648.7	55468.13
GAP (Ha)	1851.66	1872.93	1934.76	1957.95
Day	**Flow (cms)**			
Cont. From	Pg. B-34	Pg. B-34	Pg. B-34	Pg. B-34
46	80.92	89.46	96.46	107.90
47	79.30	88.04	94.64	106.08
48	77.69	86.57	92.86	104.34
49	76.10	85.07	91.08	102.62
50	74.54	83.59	89.34	100.92
51	72.99	82.13	87.61	99.23
52	71.43	80.66	85.90	97.56
53	69.92	79.20	84.22	95.90
54	68.43	77.75	82.56	94.25
55	66.97	76.31	80.92	92.63
56	65.53	74.89	79.30	91.01
57	64.11	73.48	77.69	89.46
58	62.70	72.08	76.10	88.04
59	61.33	70.71	74.54	86.57
60	59.97	69.46	72.99	85.07
61	58.63	68.11	71.43	83.59
62	57.31	66.78	69.92	82.13
63	56.02	65.48	68.43	80.66
64	54.75	64.18	66.97	79.20
65	53.51	62.90	65.53	77.75
66	52.28	61.63	64.11	76.31
67	51.07	60.39	62.70	74.89
68	49.91	59.15	61.33	73.48
69	48.76	57.93	59.97	72.08
70	47.60	56.73	58.63	70.71
71	46.46	55.55	57.31	69.46
72	45.34	54.40	56.02	68.11
73	44.26	53.27	54.75	66.78
74	43.18	52.16	53.51	65.48
75	42.11	51.03	52.28	64.18
76	41.09	49.92	51.07	62.90
77	40.04	48.82	49.91	61.63
78	39.02	47.74	48.76	60.39
79	38.04	46.66	47.60	59.15
80	37.06	45.60	46.46	57.93
81	36.10	44.55	45.34	56.73
82	35.16	43.53	44.26	55.55
83	34.22	42.58	43.18	54.40
84	33.30	41.57	42.11	53.27
85	32.40	40.56	41.09	52.16
86	31.52	39.57	40.04	51.03
87	30.64	38.58	39.02	49.92
88	29.78	37.62	38.04	48.82
89	28.94	36.67	37.06	47.74
90	28.18	35.73	36.10	46.66
Cont. On	Pg. B-44	Pg. B-44	Pg. B-44	Pg. B-44

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	10827.90	12487.47	12566.16	12772.96	13824.20	13891.14	14336.97	17235.89	17253.96
X-ID	3148.658	46146.75	6226.449	56955.73	55384.28	54648.7	55468.13	43987.58	7091.917
GAP (Ha)	941.50	966.48	967.50	972.45	1013.91	1021.08	1025.75	1043.08	1061.98
Day	**Flow (cms)**								
Cont. From	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37	Pg. B-37
91		0.35	0.40	0.45	0.79	0.90	1.22	0.39	0.67
92		0.30	0.34	0.35	0.70	0.82	1.12	0.32	0.60
93			0.30	0.30	0.62	0.73	1.02	0.30	0.51
94					0.55	0.65	0.93		0.44
95					0.49	0.58	0.84		0.37
96					0.43	0.51	0.77		0.30
97					0.35	0.45	0.68		0.30
98					0.31	0.38	0.61		
99					0.30	0.33	0.54		
100						0.30	0.47		
101							0.41		
102							0.35		
103							0.30		
104							0.30		

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	17475.42	17988.58	20075.47	20821.05	21322.94	21886.56	23796.61	24192.20	25253.98
X-ID	2938.422	3148.658	44477.7	46146.75	6226.449	13143.03	54648.7	7203.769	2938.422
GAP (Ha)	1088.30	1134.60	1166.13	1175.14	1184.44	1197.20	1266.10	1300.24	1332.79
Day	Flow (cms)								
Cont. From	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38	Pg. B-38
91	0.43	0.60	1.92	1.90	2.17	3.16	3.48	2.77	2.59
92	0.36	0.52	1.76	1.72	2.02	2.91	3.27	2.62	2.39
93	0.31	0.45	1.61	1.57	1.88	2.66	3.08	2.47	2.21
94	0.30	0.38	1.47	1.41	1.74	2.47	2.89	2.32	2.04
95		0.33	1.34	1.32	1.63	2.27	2.70	2.15	1.88
96		0.30	1.20	1.19	1.50	2.09	2.57	1.99	1.72
97			1.11	1.07	1.38	1.92	2.40	1.84	1.57
98			1.07	0.97	1.25	1.75	2.24	1.69	1.43
99			0.99	0.87	1.14	1.58	2.09	1.55	1.30
100			0.89	0.78	1.03	1.44	1.96	1.44	1.18
101			0.80	0.69	0.92	1.31	1.82	1.32	1.06
102			0.71	0.60	0.82	1.16	1.69	1.20	0.95
103			0.63	0.53	0.72	1.04	1.56	1.10	0.84
104			0.54	0.46	0.64	0.95	1.45	0.99	0.75
105			0.47	0.40	0.55	0.81	1.31	0.89	0.66
106			0.39	0.35	0.48	0.71	1.20	0.80	0.57
107			0.33	0.30	0.40	0.61	1.10	0.70	0.50
108			0.30		0.34	0.52	1.00	0.63	0.43
109					0.30	0.46	0.90	0.55	0.36
110						0.38	0.82	0.48	0.31
111						0.34	0.73	0.41	0.30
112						0.34	0.65	0.34	
113						0.33	0.58	0.30	
114						0.33	0.51		
115						0.32	0.45		
116						0.32	0.38		
117						0.32	0.33		
118						0.31	0.30		
119						0.30			

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	25787.72	27732.10	29798.57	34287.65	34527.45	37662.18	57104.13	60568.60	67165.01
X-ID	3148.658	44477.7	6226.449	45046.39	54648.7	55468.13	6226.449	54648.7	55468.13
GAP (Ha)	1391.76	1427.39	1487.67	1493.80	1626.47	1641.98	1668.14	1748.98	1767.30
Day	**Flow (cms)**								
Cont. From	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39	Pg. B-39
91	3.04	6.65	6.93	13.53	13.18	16.56	13.90	19.90	25.49
92	2.82	6.31	6.52	13.03	12.65	15.96	13.37	19.22	24.72
93	2.60	5.98	6.17	12.55	12.12	15.37	12.81	18.56	23.99
94	2.40	5.67	5.82	12.07	11.62	14.81	12.25	17.91	23.27
95	2.22	5.38	5.51	11.60	11.13	14.25	11.71	17.28	22.57
96	2.05	5.09	5.25	11.14	10.66	13.72	11.18	16.65	21.87
97	1.89	4.82	5.00	10.68	10.20	13.21	10.65	16.04	21.19
98	1.74	4.55	4.76	10.23	9.75	12.71	10.15	15.45	20.47
99	1.59	4.27	4.52	9.79	9.34	12.20	9.65	14.86	19.77
100	1.46	4.02	4.29	9.36	8.90	11.73	9.18	14.29	19.10
101	1.33	3.78	4.07	8.92	8.48	11.26	8.73	13.72	18.44
102	1.20	3.52	3.88	8.54	8.07	10.81	8.28	13.18	17.80
103	1.08	3.33	3.66	8.15	7.65	10.36	7.84	12.65	17.18
104	0.97	3.06	3.46	7.76	7.31	9.94	7.38	12.12	16.56
105	0.87	2.86	3.24	7.38	6.94	9.52	6.93	11.62	15.96
106	0.78	2.68	3.06	7.00	6.60	9.11	6.52	11.13	15.37
107	0.68	2.50	2.86	6.65	6.26	8.71	6.17	10.66	14.81
108	0.60	2.29	2.69	6.29	5.93	8.36	5.82	10.20	14.25
109	0.52	2.10	2.51	5.94	5.67	7.98	5.51	9.75	13.72
110	0.45	1.92	2.34	5.60	5.38	7.62	5.25	9.34	13.21
111	0.38	1.76	2.17	5.26	5.08	7.27	5.00	8.90	12.71
112	0.33	1.61	2.02	4.97	4.83	6.91	4.76	8.48	12.20
113	0.30	1.47	1.88	4.66	4.58	6.60	4.52	8.07	11.73
114		1.34	1.74	4.36	4.35	6.31	4.29	7.65	11.26
115		1.20	1.63	4.09	4.12	6.01	4.07	7.31	10.81
116		1.11	1.50	3.83	3.91	5.74	3.88	6.94	10.36
117		1.07	1.38	3.58	3.70	5.47	3.66	6.60	9.94
118		0.99	1.25	3.33	3.48	5.21	3.46	6.26	9.52
119		0.89	1.14	3.10	3.27	4.96	3.24	5.93	9.11
120		0.80	1.03	2.87	3.08	4.75	3.06	5.67	8.71
121		0.71	0.92	2.65	2.89	4.55	2.86	5.38	8.36
122		0.63	0.82	2.43	2.70	4.33	2.69	5.08	7.98
123		0.54	0.72	2.23	2.57	4.13	2.51	4.83	7.62
124		0.47	0.64	2.04	2.40	3.96	2.34	4.58	7.27
125		0.39	0.55	1.87	2.24	3.75	2.17	4.35	6.91
126		0.33	0.48	1.72	2.09	3.55	2.02	4.12	6.60
127		0.30	0.40	1.57	1.96	3.35	1.88	3.91	6.31
128			0.34	1.42	1.82	3.16	1.74	3.70	6.01
129			0.30	1.29	1.69	2.98	1.63	3.48	5.74
130				1.15	1.56	2.79	1.50	3.27	5.47
131				1.02	1.45	2.62	1.38	3.08	5.21
132				0.90	1.31	2.45	1.25	2.89	4.96
133				0.80	1.20	2.29	1.14	2.70	4.75
134				0.69	1.10	2.14	1.03	2.57	4.55
135				0.61	1.00	1.99	0.92	2.40	4.33
Cont. On				Pg. B-45	Pg. B-45	Pg. B-45	Pg. B-45	Pg. B-45	Pg. B-45

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	74794.80	82851.15	89539.27	100905.97
X-ID	54648.7	55468.13	54648.7	55468.13
GAP (Ha)	1851.66	1872.93	1934.76	1957.95
Day	**Flow (cms)**			
Cont. From	Pg. B-40	Pg. B-40	Pg. B-40	Pg. B-40
91	27.36	34.80	35.16	45.60
92	26.55	33.89	34.22	44.55
93	25.76	32.98	33.30	43.53
94	24.99	32.10	32.40	42.58
95	24.22	31.22	31.52	41.57
96	23.47	30.35	30.64	40.56
97	22.73	29.55	29.78	39.57
98	22.00	28.73	28.94	38.58
99	21.29	27.90	28.18	37.62
100	20.59	27.09	27.36	36.67
101	19.90	26.29	26.55	35.73
102	19.22	25.49	25.76	34.80
103	18.56	24.72	24.99	33.89
104	17.91	23.99	24.22	32.98
105	17.28	23.27	23.47	32.10
106	16.65	22.57	22.73	31.22
107	16.04	21.87	22.00	30.35
108	15.45	21.19	21.29	29.55
109	14.86	20.47	20.59	28.73
110	14.29	19.77	19.90	27.90
111	13.72	19.10	19.22	27.09
112	13.18	18.44	18.56	26.29
113	12.65	17.80	17.91	25.49
114	12.12	17.18	17.28	24.72
115	11.62	16.56	16.65	23.99
116	11.13	15.96	16.04	23.27
117	10.66	15.37	15.45	22.57
118	10.20	14.81	14.86	21.87
119	9.75	14.25	14.29	21.19
120	9.34	13.72	13.72	20.47
121	8.90	13.21	13.18	19.77
122	8.48	12.71	12.65	19.10
123	8.07	12.20	12.12	18.44
124	7.65	11.73	11.62	17.80
125	7.31	11.26	11.13	17.18
126	6.94	10.81	10.66	16.56
127	6.60	10.36	10.20	15.96
128	6.26	9.94	9.75	15.37
129	5.93	9.52	9.34	14.81
130	5.67	9.11	8.90	14.25
131	5.38	8.71	8.48	13.72
132	5.08	8.36	8.07	13.21
133	4.83	7.98	7.65	12.71
134	4.58	7.62	7.31	12.20
135	4.35	7.27	6.94	11.73
Cont. On	Pg. B-46	Pg. B-46	Pg. B-46	Pg. B-46

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	25787.72	27732.10	29798.57	34287.65	34527.45	37662.18	57104.13	60568.60	67165.01
X-ID	3148.658	44477.7	6226.449	45046.39	54648.7	55468.13	6226.449	54648.7	55468.13
GAP (Ha)	1391.76	1427.39	1487.67	1493.80	1626.47	1641.98	1668.14	1748.98	1767.30
Day	**Flow (cms)**								
Cont. From				Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43	Pg. B-43
136				0.51	0.90	1.85	0.82	2.24	4.13
137				0.44	0.82	1.71	0.72	2.09	3.96
138				0.37	0.73	1.57	0.64	1.96	3.75
139				0.32	0.65	1.45	0.55	1.82	3.55
140				0.30	0.58	1.34	0.48	1.69	3.35
141					0.51	1.22	0.40	1.56	3.16
142					0.45	1.12	0.34	1.45	2.98
143					0.38	1.02	0.30	1.31	2.79
144					0.33	0.93		1.20	2.62
145					0.30	0.84		1.10	2.45
146						0.77		1.00	2.29
147						0.68		0.90	2.14
148						0.61		0.82	1.99
149						0.54		0.73	1.85
150						0.47		0.65	1.71
151						0.41		0.58	1.57
152						0.35		0.51	1.45
153						0.30		0.45	1.34
154						0.30		0.38	1.22
155								0.33	1.12
156								0.30	1.02
157									0.93
158									0.84
159									0.77
160									0.68
161									0.61
162									0.54
163									0.47
164									0.41
165									0.35
166									0.30
167									0.30

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	74794.80	82851.15	89539.27	100905.97
X-ID	54648.7	55468.13	54648.7	55468.13
GAP (Ha)	1851.66	1872.93	1934.76	1957.95
Day	**Flow (cms)**			
Cont. From	Pg. B-44	Pg. B-44	Pg. B-44	Pg. B-44
136	4.12	6.91	6.60	11.26
137	3.91	6.60	6.26	10.81
138	3.70	6.31	5.93	10.36
139	3.48	6.01	5.67	9.94
140	3.27	5.74	5.38	9.52
141	3.08	5.47	5.08	9.11
142	2.89	5.21	4.83	8.71
143	2.70	4.96	4.58	8.36
144	2.57	4.75	4.35	7.98
145	2.40	4.55	4.12	7.62
146	2.24	4.33	3.91	7.27
147	2.09	4.13	3.70	6.91
148	1.96	3.96	3.48	6.60
149	1.82	3.75	3.27	6.31
150	1.69	3.55	3.08	6.01
151	1.56	3.35	2.89	5.74
152	1.45	3.16	2.70	5.47
153	1.31	2.98	2.57	5.21
154	1.20	2.79	2.40	4.96
155	1.10	2.62	2.24	4.75
156	1.00	2.45	2.09	4.55
157	0.90	2.29	1.96	4.33
158	0.82	2.14	1.82	4.13
159	0.73	1.99	1.69	3.96
160	0.65	1.85	1.56	3.75
161	0.58	1.71	1.45	3.55
162	0.51	1.57	1.31	3.35
163	0.45	1.45	1.20	3.16
164	0.38	1.34	1.10	2.98
165	0.33	1.22	1.00	2.79
166	0.30	1.12	0.90	2.62
167		1.02	0.82	2.45
168		0.93	0.73	2.29
169		0.84	0.65	2.14
170		0.77	0.58	1.99
171		0.68	0.51	1.85
172		0.61	0.45	1.71
173		0.54	0.38	1.57
174		0.47	0.33	1.45
175		0.41	0.30	1.34
176		0.35		1.22
177		0.30		1.12
178		0.30		1.02
179				0.93
180				0.84
Cont. On	Pg. B-47	Pg. B-47	Pg. B-47	Pg. B-47

Table B-3. (continued) **2.0 cm/day** volume-based recessions that maximize seedling recruitment.

V (Ha-m)	74794.80	82851.15	89539.27	100905.97
X-ID	54648.7	55468.13	54648.7	55468.13
GAP (Ha)	1851.66	1872.93	1934.76	1957.95
Day	**Flow (cms)**			
Cont. From	Pg. B-46	Pg. B-46	Pg. B-46	Pg. B-46
181				0.77
182				0.68
183				0.61
184				0.54
185				0.47
186				0.41
187				0.35
188				0.30
189				0.30