Alternatives Analysis for San Juan Creek and Western San Mateo Creek Watersheds, Orange County, California: Potential Impacts to Waters of the United States and Riparian Ecosystems

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November 2005

This report should be cited as:

Smith, R. D. 2005. Alternatives Analysis for San Juan and Western San Mateo Creek Watersheds, Orange County, California: Potential Impacts to Waters of the United States and Riparian Ecosystems. U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS.

Executive Summary

The Los Angeles District Corps of Engineers, Regulatory Branch is preparing an Environmental Impact Statement (EIS) for the Special Area Management Plan (SAMP) for the San Juan Creek and western San Mateo Creek watersheds in southern Orange County, California. The proposed action being evaluated in the EIS includes eight alternative development scenarios in San Juan Creek and western San Mateo Creek watersheds with the potential to impact Waters of the United States (WoUS) regulated under Section 404 of the Clean Water Act (CWA).

As part of the SAMP effort, the objective of this project was to assess direct and indirect impacts of each alternative on Waters of the United States (WoUS) and associated riparian ecosystems. Several specific tasks were required to meet these objectives. The first task was to conduct a planning level delineation of WoUS and associated riparian ecosystems to identify their location. The second task was to identify and assess “riparian reaches” using a suite of indicators of riparian ecosystem integrity. The third task was to determine potential direct and indirect impacts of alternative on WoUS and riparian ecosystems.

Waters of the United States and associated riparian ecosystems were identified using a planning-level delineation approach that adapts the methods outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and 33 CFR 328 to a watershed scale. The approach provides a map of jurisdictional wetlands and WoUS at a level of resolution that is suitable for use in project planning, but the map does not serve as a substitute for the on-site jurisdictional delineation that is normally conducted as part of Section 404 permit review process.

Following the planning level delineation, riparian ecosystems in the watershed were divided into “riparian reach” assessment units defined as a segment of the main stem, bankfull stream channel and the adjacent riparian ecosystem exhibiting relatively homogenous characteristics with respect to geology, geomorphology, channel morphology, substrate type, vegetation communities, and cultural alteration. To document baseline conditions, each riparian reach was assessed using a suite of indicators related to the physical, chemical and biological condition of riparian ecosystems at three spatial scales: the riparian reach proper, uplands adjacent to the riparian reach, and the drainage basin of the riparian reach. Sixteen indicators related to land use

/ land cover, vegetation communities, hydrology, sediment, and disturbance factors were used. Indicator metrics were measured in the field using ground data collection methods supplemented with aerial photography. Indicator metrics were scaled to a culturally unaltered "reference condition," and selected indicators were integrated into hydrology, water quality, and habitat integrity indices for each riparian reach.

To assess the potential direct and indirect impacts of each alternative on WoUS and riparian ecosystems, the changes that could be expected to occur in each riparian reach as a result of each alternative were simulated and indicators metrics were assessed under the simulated conditions.

Twenty-three criteria were used to assess the potential impact of alternatives on WoUS, riparian ecosystems, and threatened, endangered, and sensitive species. They included:

Criterion 1: Non-wetland waters and main stem stream channels directly impacted

Criterion 2: Main stem stream channels indirectly impacted

Criterion 3. Aquatic resources directly impacted

Criterion 4: Main stem riparian ecosystems directly impacted

Criterion 5: Main stem riparian ecosystems indirectly impacted

Criteria 6a-i: Major or important population areas of threatened, endangered, and sensitive species directly impacted

Criteria 7a-c: Quantity of hydrologic, water quality, and habitat integrity units in riparian reaches with direct impacts

Criteria 8a-c: Change/Loss in hydrologic, water quality, and habitat integrity units in riparian reaches with direct impacts

Criteria 9a-c: Change/Loss in hydrologic, water quality, and habitat integrity units riparian reaches with indirect impacts

Results of the criteria analysis were displayed in tabular and graphical formats to summarize the information and facilitate the comparison of potential direct and indirect impacts of each alternative.

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1.0 Introduction

The Los Angeles District Corps of Engineers, Regulatory Branch is developing a Special Area Management Plan (SAMP) for the San Juan Creek and Western San Mateo Creek watersheds in southern Orange County, California (Figure 1). The SAMP is being conducted in coordination with the proposed Southern Subregion Natural Communities Conservation Plan/ Master Streambed Alteration Agreement/Habitat Conservation Plan (NCCP/MSAA/HCP). The Southern Subregion NCCP/MSAA/HCP is being developed by the California Department of Fish and Game (DFG) and the U.S. Fish and Wildlife Service (FWS). The goal of the SAMP is

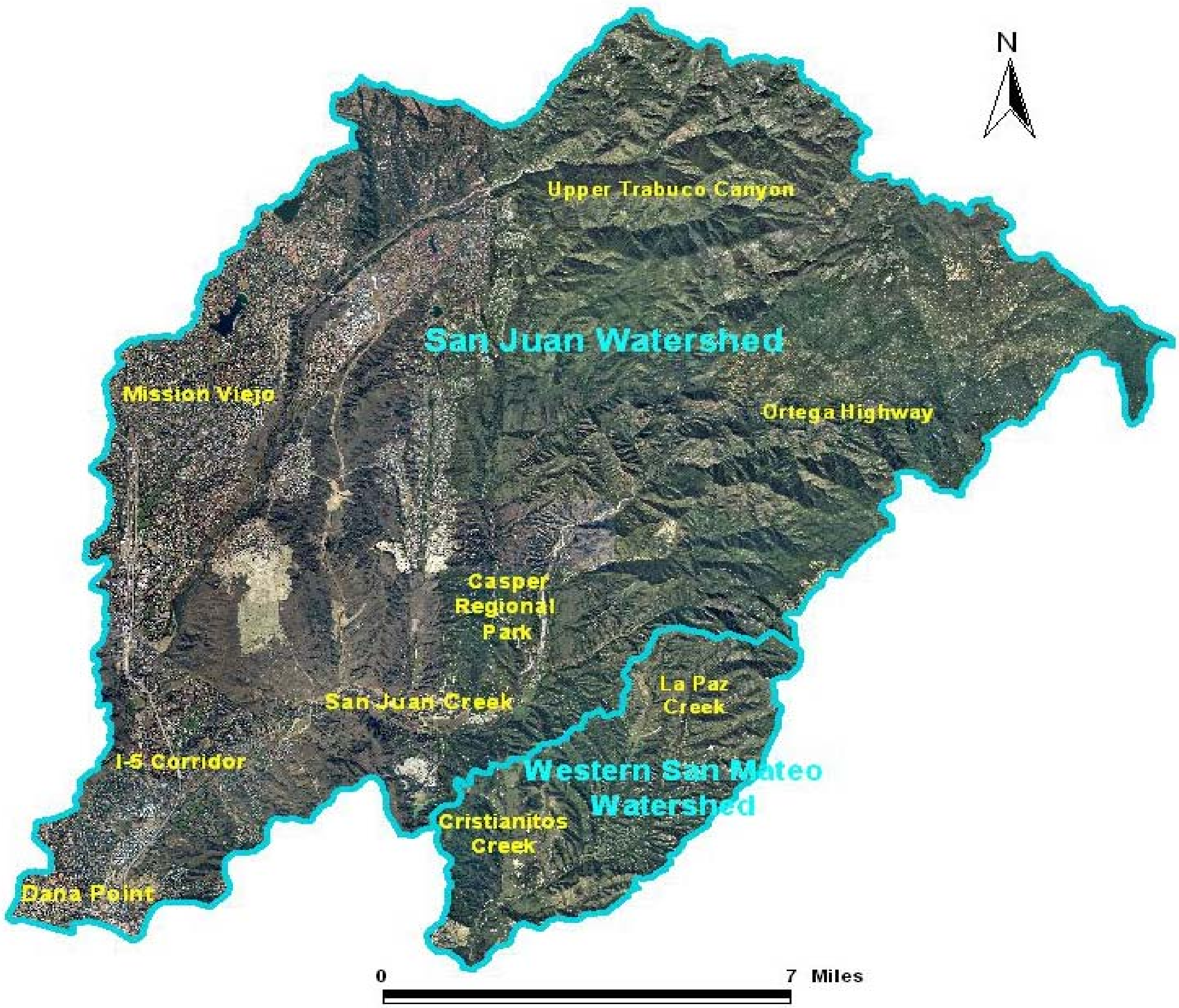


Figure 1. San Juan Creek and Western San Mateo Creek watershed study area

to…"develop and implement a watershed-wide aquatic resource management plan and implementation program, which will include preservation, enhancement, and restoration of aquatic resources, while allowing reasonable and responsible economic development and activities within the watershed-wide study area" (Los Angeles District Corps of Engineers 1999).

In support of the SAMP several studies have been conducted. These include a watershed wide delineation of aquatic resources using a unique planning level delineation procedure (Lichvar 2002), and a baseline assessment of riparian ecosystem integrity (Smith 2002). Waters of the United States and associated riparian ecosystems were identified using a planning-level delineation approach that represents and adaptation of the methods outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and 33 CFR 328 to a watershed scale. The approach provides a high quality map of jurisdictional wetlands and WoUS, suitable for use in project planning. However, it does not serve as a substitute for the on-site jurisdictional delineation that is normally conducted as part of Section 404 permit review process.

Following the planning level delineation, riparian ecosystems in the watershed were divided into "riparian reach" assessment units defined as a segment of the main stem, bankfull stream channel and the adjacent riparian ecosystem exhibiting relatively homogenous characteristics with respect to geology, geomorphology, channel morphology, substrate type, vegetation communities, and cultural alteration. To document baseline conditions, each riparian reach was assessed using a suite of indicators related to the physical, chemical and biological condition of riparian ecosystems at three spatial scales: the riparian reach proper, uplands adjacent to the riparian reach, and the drainage basin of the riparian reach. Sixteen indicators related to land use / land cover, vegetation communities, hydrology, sediment, and disturbance factors were used. Indicator metrics were measured in the field using ground data collection methods supplemented with aerial photography. Indicator metrics were scaled to a culturally unaltered "reference condition," and selected indicators were integrated into hydrology, water quality, and habitat integrity indices for each riparian reach.

2.0 Objectives

The objective of this study was to analyze the potential direct and indirect impacts of alterative development scenarios on Waters of the United States (WoUS) and associated riparian ecosystem in the San Juan Creek and western San Mateo Creek watersheds. The eight alternatives are shown in Table 1. "The No Action Alternative assumes all permits will be decided case by case. Alternative B4, the original Rancho Mission Viejo Ranch plan, was originally filed in 2001 as an application for a General Plan Amendment and Zone Change. Alternative B5 completely avoided development in the San Mateo Creek watershed, concentrating development within the San Juan Creek watershed. Alternative B6 avoided development within the Chiquita sub-basin and parts of the San Mateo Creek Watershed. Alternative B8 avoids both the Chiquita sub-basin and San Mateo Creek watershed. Alternative B9 addressed the draft Southern Watershed Planning Principles (SWPP) and the draft Southern Planning Guidelines (SPG) while providing for additional avoidance in the San Mateo Creek Watershed. Alternative B10 addressed the Draft SWPP and the Draft SPG. Alternative B10m was approved as part of the General Plan Amendment (GPA) and Zone Change (ZC) for the study area. Alternative B11 addressed maximum compliance with the Orange County Projection 2000 growth estimates while considering the Draft SWPP and Draft SPG."

Table 1. Matrix of alternatives

Alternatives	Development Acres
No SAMP – Case by case permitting	Not Applicable
B4 – Original Rancho Mission Viejo Ranch Plan	7,694
B5 – Avoid San Mateo Creek Watershed	7,170
B6 – Avoid Chiquita Sub-Basin and parts of San Mateo Creek Watershed	6.740
B8 – Avoid Chiquita Sub-Basin and San Mateo Creek Watersheds	3,680
B9 – Compliance with Draft Southern Watershed Planning Principles and Draft Southern Planning Guidelines	6,582
B10 – Incorporation of Draft SWPP and Draft SPG	7,683
B10m – Approved GPA/ZC	7,683
B11 – OCP 2000 Alternative	8,621

Table 2 identifies the various types of impacts that occurred. Not all types of impacts occurred under each alternative. Columns 1 and 2 of Table 2 identifies the labels assigned to each impact type in the original ArcView files and pdf maps supplied by Rancho Mission Viejo. Column 3 identifies the impact category each type of impact was assigned for the analysis.

Table 2. Types of impacts

RMV Original ArcView Attribute Table Labels	PDF Map Labels	Impact Category*
100yrflood	100-year floodplain	No Change
Casitas	The Casitas (Small homes) are located near the golf course in Gabino (PA-9)	Partial Loss
DEV	Developed Land; outside RMV boundary, inside study area	Total Loss
Estate	Low density, typically lots of 1-5 ac.	Alt 4: Total Loss Alt 10: Partial Loss
Estate PA 9	Low density, typically lots of 1-5 ac.	Total Loss
FTSPDL	Foothill Trabuco Specific Plan Developable Land	Total Loss
FTSPWC	Foothill Trabuco Specific Plan Wildlife Corridors	No Change
Golf OS	Existing/ Approved Golf Course	Partial Loss/No Change
Golf_planned	Proposed Golf Course Footprint	Total Loss
Golf_planned Grading	Proposed Golf Course Footprint	Total Loss
Golf-Resid	Proposed Residential adjacent to golf course	Partial Loss
Golf-Resort	Proposed Resort Hotel with golf course	Total Loss
LP_LAKE_DAM	New dam	Total Loss
LP_LAKE_H20	New lake	Total Loss
LP_W_PARK	Wilderness park	No Change
NAP		No Change
NROS	Non Reserve Open Space	No Change
NRFL	Non-reserve Federal Land	No Change
Out	Not Part of Plan e.g., Chiquita Water Treatment Plant	N/A or No Change
P_Dev	Potential Future Development	Total Loss
RA	Restoration Areas	No Change
Res/ OS	Reserve/ Open Space	No Change
Unresolved	Unresolved	Total Loss
Phase 2 OS	Reserve/ Open Space	No Change
WQB OS	Reserve/ Open Space	No Change
WQB-DEV		Total Loss
1310 Setback P_Dev	Potential Future Development	Total Loss
1310 Setback WQB-DEV		Total Loss
* Impact Category Descriptions		
No Change: No change in indicator metrics.		
Total Loss: Assume complete loss of riparian ecosystem within boundaries of impact. Indicator metrics for the reach were modified to reflect this complete loss.		

Partial Loss: Assumed no loss of riparian ecosystem, but due to impacts outside the riparian ecosystem, some indicators (i.e., land use, buffers, perennnialization) were changed to reflect the impacts.

3.0 Background, Definitions, and Assumptions

3.1 Riparian Ecosystems

Riparian ecosystems are linear corridors of variable width that occur along perennial, intermittent, and ephemeral streams (Williams 1978). Perennial streams are defined as streams in which base flow is maintained year round by groundwater. Intermittent streams are defined as streams in which groundwater-maintained base flow occurs intermittently at different times of the year. Ephemeral streams are defined as streams in which flow is attributable only to surface water runoff in response to precipitation. Two features that distinguish riparian ecosystems are the hydrologic interaction that occurs between the stream channel and adjacent areas through the periodic exchange of surface and ground water, and the distinctive geomorphic features and vegetation communities that develop in response to this hydrologic interaction (Richards 1982; Harris 1987; Kovalchik and Chitwood 1990; Gregory et al. 1991; Malanson 1993; and Goodwin et al. 1997).

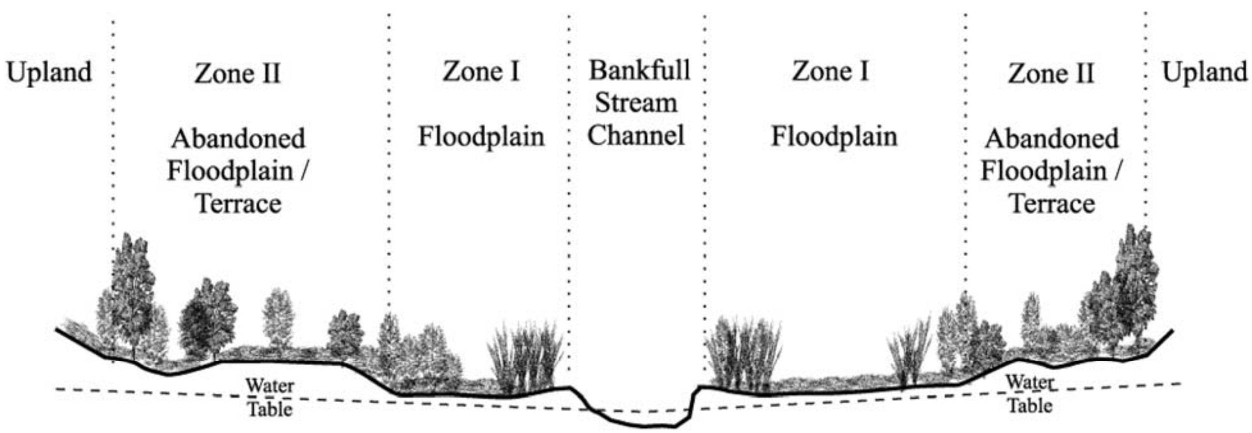
The hydrologic interaction between streams and adjacent riparian areas typically results in two distinct zones, although either zone may be narrow and seemingly absent under certain geologic or geomorphic conditions. The first zone, the active floodplain, includes the areas that are inundated by overbank flooding at least once every five years. This zone exhibits the fluvial features associated with recurring flooding such as point bars, areas of scour, sediment accumulation, natural levees, debris wrack, and vegetation communities that are either short lived or able to survive the effects of frequent flooding (Figure 2).

Figure 2. Generalized cross section of a riparian ecosystem

The second zone consists of abandoned floodplains and historical terraces formed by fluvial processes that took place under a historical, and often different, climatic condition or hydrologic regime (Knox et al. 1975; Graf et al. 1991; Rumsby and Macklin 1994). Under current climatic conditions and hydrologic regimes these areas are infrequently flooded during large magnitude events (Dunn and Leopold 1978). Vegetation communities in this zone are generally composed of woody perennials that require the higher water table present in the riparian zone, and are capable of surviving, or reestablishing, after floods. For the purposes of this project, riparian ecosystems were defined from a functional perspective as the areas along perennial, intermittent, and ephemeral streams where the interaction with surface and groundwater results in distinctive geomorphic features and vegetation communities. Under natural circumstances, the riparian ecosystem includes the bank full stream channel, active floodplain, and less frequently flooded, historical floodplains/terraces.

3.2 Waters of the United States Versus Functional Riparian Ecosystems

Waters of the United States (WoUS) are the areas subject to regulation under Section 404 of the Clean Water Act (33 CFR Part 328.3). Wetlands are a subset of WoUS, and throughout this discussion, the term WoUS should be interpreted as including wetlands. Two categories of WoUS occur in association with southern California riparian ecosystems. The first category, non-wetland waters, are the areas along perennial, intermittent, and ephemeral stream channels that exhibit a distinct bed and bank, but fail to meet one or more of the hydrologic, hydrophytic



vegetation, and hydric soils criteria outlined in the Corps of Engineers Wetlands Delineation

Manual (Environmental Laboratory 1987). The second category is wetlands that are the areas meeting all of the hydrologic, hydrophytic vegetation, and hydric soils criteria.

It is important to note the "functional" riparian ecosystem, as defined for this project, has no special recognition, meaning, or status in the context of the 404 Program. While functional riparian ecosystems normally include all WoUS regulated under the 404 Program and California Department of Fish and Game (CDFG) 1600 Program, the riparian ecosystem at times includes areas that fall outside the jurisdiction of one or both of these programs. Consequently, a one-to-one spatial correspondence between riparian ecosystems and WoUS in the watershed may be absent. This lack of spatial correspondence is common in the arid southwestern United States, where the active floodplain or historical terrace portion of the riparian ecosystem often meets one or two of the delineation criteria, but fails to meet all three delineation criteria necessary to qualify as a regulated wetland.

The spatial inconsistency between WoUS and riparian ecosystems is a result of the relatively generic hydrologic, hydrophytic vegetation, and hydric soil delineation criteria developed under the 404 Program for use in the wide variety of wetland types that occur in the United States. These generic delineation criteria necessarily ignore the unique way in which specific characteristics and processes contribute to the creation and maintenance of riparian as well as other functional wetland ecosystems. The intra- and inter-regional insensitivity of the generic delineation criteria is widely recognized, and while the need for a regionalization of delineation criteria has been identified (Committee on Characterization of Wetlands 1995), no solution to this formidable task has been developed, much less implemented.

The spatial inconsistency is problematic in the context of the mandate to assess functions of WoUS as part of the 404 permit review process. Clearly, an assessment cannot be accomplished by considering only the characteristics and processes of WoUS proper. This is because the functions of WoUS are influenced by characteristics and processes taking place in the riparian ecosystem, the upland areas adjacent to the riparian ecosystem, and the drainage basin of the riparian ecosystem (Kratz et al. 1991; Hornbeck and Swank 1992; Bedford 1996).

A solution for meeting this challenge was outlined as part of the Hydrogeomorphic (HGM) Approach (Smith et al. 1995). In the HGM Approach, characteristics and processes occurring in the functional ecosystem, as well as the adjacent upland areas and the drainage basin are considered during the assessment process. However, when applying the results of the assessment in the context of the 404 permit review process, the results are applied only to WoUS. This project used a similar approach in that the influence of the riparian ecosystem, adjacent uplands, and drainage basin were considered in assessing riparian ecosystem integrity. Consequently, when applying the results of the assessment, consistency with policies and assumptions of the SAMP, the 404 permit review process, Section 7 consultation, or the California Department of Fish and Game 1600 Program must be taken into account.

3.3 Riparian Ecosystem Integrity and Assessment Endpoints

Much has been written about the concepts of ecological or ecosystem health and integrity (Rapport 1989; Costanza, Norton and Haskell 1991; Suter 1993; Scrimgeour and Wicklum 1996; Karr 1999). The two terms are often used interchangeably; however, the distinction made by Karr (1996) is instructive, and important in interpreting and applying the mandate of the Clean Water Act. Health refers to a flourishing condition, well-being, or vitality (Guralnik and Friend 1968). Integrity, on the other hand, refers to the quality, or state of being complete, and implies correspondence with a natural or original condition. Based on these distinctions, a cornfield, pine plantation, commercial nursery, and other culturally altered ecosystems qualify as healthy, but do not qualify as ecosystems with high integrity. For this project, riparian ecosystems with high integrity were defined as riparian ecosystems that support a balanced, diverse, and adaptive biological community resulting from natural evolutionary and biogeographic processes, and exhibit the full range of physical, chemical, and biological attributes and processes that characterized riparian ecosystems in the region, over short and long term cycles, prior to cultural alteration.

The concept of ecosystem integrity is difficult to define because of its abstract nature. However, it is even more difficult to assess because of the wide variety of characteristics and processes that influence riparian ecosystem across multiple spatial scales (i.e., riparian reach, local drainage, and drainage basin). Consequently no single, direct measure of ecosystem integrity exists. This project focused on three quantities of interest, or assessment “endpoints,” to represent riparian ecosystem integrity (Liebowitz and Hyman 1999). These included hydrologic, water quality, and habitat integrity. The selection of these endpoints followed directly from the mandate in Section 101(a) of the Clean Water Act to "…restore and maintain the chemical, physical, and biological integrity of the Nation's waters".

3.4 Use of Indicators to Assess Hydrologic, Water Quality, and Habitat Integrity

Once assessment endpoints have been selected, metrics must be selected to assess the endpoints. There are two categories of metrics. "Direct metrics" are a quantitative direct measure of an endpoint. For example, cubic feet per second, is a direct metric that measures the stream discharge endpoint. Direct metrics can be identified when the assessment endpoint (i.e., attribute or process) is a narrowly defined and directly measurable. Direct metrics cannot be identified for broadly defined, abstract concepts like ecosystem integrity.

The second category of metric is the "indirect metric" or "indicator". Indicators are qualitative or quantitative measures that are in some way related to an assessment endpoint. Indicators are used to assess complex, or abstract, endpoints for which no direct metric exists. However, indicators are also frequently used when direct measures are too difficult or costly. For example, tree basal area is a metric used to indicate the endpoint of tree biomass. Many existing biological/ecological assessment methods use indicators for these reasons. For example, the Habitat Evaluation Procedure (HEP) (USFWS 1980) has used habitat characteristics as indicators for more than 25 years to assess a "habitat suitability" endpoint in lieu of the more difficult and time consuming task of sampling animal populations directly (USFWS 1980). Indicators are used in a similar fashion in the Index of Biological Integrity (IBI) and related methods (Karr and Chu 1997), the Instream Flow Incremental Methodology (IFIM) (Bovee 1986), the Synoptic Approach (Leibowitz et al. 1992; Abbruzzese and Leibowitz 1997), and the Hydrogeomorphic (HGM) Approach (Smith et al. 1995).

Liebowitz and Hyman (1999) make an important distinction between "confirmed" and "judgment" indicators. Confirmed indicators are those in which the relationship between the indicator and endpoint can be described in a precise manner (i.e., mathematical) with a known level of statistical confidence. Judgment indicators, on the other hand, are those in which the relationship between the indicator and endpoint is less precisely defined. The relationship is typically based on trends or patterns from the literature, field observations, or professional judgment. Given adequate research, the assumed relationship between a judgment indicator and an endpoint can be confirmed. For example, it is possible to define a relatively precise mathematical relationship between land use and water quality in a watershed using numerical modeling methods (Hamlett et al. 1992). The use of confirmed versus judgment indicators represents a tradeoff in terms of the degree of certainty of the relationship between the indicator and endpoint, and the ability to obtain the information necessary to assess selected endpoints. Some authors have questioned the use of judgment indicators (Conroy and Noon 1996, Schumaker 1996). However, in real world situations the use of judgment indicators is often unavoidable given time and resource constraints, the lack of existing confirmed indictors, or the unavailability of quantitative data necessary to develop a confirmed indicator (Abbruzzese and Leibowitz 1997). Each of the indicators selected to assess hydrologic, water quality, and habitat integrity are discussed in greater detail in the Assessment Indicators Section below.

3.5 Reference Condition

In order to assess the integrity of a riparian reach, a standard of comparison or "reference condition" must be defined. The reference condition serves two purposes. First, it provides a concrete or virtual representation of the conditions, across multiple spatial scales, under which riparian ecosystems achieve and sustain a high level of integrity. Second, the reference condition provides a starting point from which to define and scale the relationship between the indicators and assessment endpoints.

Several different reference condition scenarios were suggested and considered for this project. Two of these were the "culturally unaltered" and "least culturally altered" reference condition. In southern California riparian ecosystems, the culturally unaltered reference condition implies conditions that existed prior to grazing, agriculture, fire suppression, water resource management, transportation corridors, urbanization, and other cultural alterations that can be identified. It is synonymous with what McCann (1999) referred to as pre-Columbian, meaning the conditions that existed prior to the influence of European explorers and subsequent immigrants. The least culturally altered reference condition refers to those conditions that currently exist in a watershed or region and most closely reflect culturally unaltered conditions.

Culturally unaltered was selected as reference condition for this project for several reasons. First, it represents the physical, chemical, and biological conditions under which riparian ecosystems have evolved naturally, and therefore, presumably represents the physical, chemical, and biological conditions that the Clean Water Act mandates should be maintained. While it can be argued that the culturally unaltered reference condition does not exist in southern California due to widespread existence of grazing, fire suppression, urban development, non-point air pollution, the disruption of historical metapopulation dynamics (Hastings and Harrison 1994), and a host of other factors, it is possible to make reasonable speculations as to what culturally unaltered conditions were like (Sedell and Luchessa 1981; Schubauer-Berigan 2000). It can also be argued while it is impossible to restore culturally unaltered conditions, it may be feasible to restore some of the larger, isolated and remote areas to a condition that functionally approximates the culturally unaltered condition given adequate time and resources, and appropriate management.

In the restoration context, a reference condition based on the culturally unaltered scenario provides an appropriate target for restoring ecosystem integrity and function. On the other hand, a restoration target based on the least culturally altered reference condition provides an entirely arbitrary, and often inappropriate target with the potential to “successfully” restore riparian ecosystems with low ecosystem integrity and function, and no natural corollary.

The second reason for selecting culturally unaltered as the reference condition is the generally unappreciated advantage, both in terms of interpretation and comparability of results, of using the “absolute” standard of comparison culturally unaltered represents versus the “relative” standard of comparison least culturally altered represents. To illustrate this advantage, consider the following scenario. Assessments of ecosystem integrity are done on riparian ecosystems in two watersheds, one heavily urbanized and the other occupying a wilderness area without roads. Two assessments are done in each watershed. The first assessment uses culturally unaltered conditions as the reference condition, and second uses least culturally altered conditions as the reference condition. Indices of ecosystem integrity are generated for both assessments ranging from 1 to 10 with an index of 1 indicating low integrity. In the first assessment, using culturally unaltered conditions as the reference condition, the indices for the urban watershed are likely to be at the lower end of the index range, while the indices for the wilderness watershed are likely to be in the higher end of the index range. These results are intuitively reasonable, and in reality correct, because heavily urbanized watersheds have significantly less ecosystem integrity than wilderness area watersheds due to changes in land use, stream channelization, loss of habitat, and other factors.

Now consider the results for the second assessment using least culturally altered conditions as the reference condition. Indices for the urban watershed will be at the high end of the index range, because least culturally altered conditions, specific to the urban watershed, were used to scale indicators of ecosystem integrity. Indices for the wilderness watershed will also be at the high end of the index range for the same reason. However, these results are not intuitive because, using the foregoing definition of ecosystem integrity, the urban watershed in reality has a lower level of ecosystem integrity than the wilderness area, despite the fact that the indices of ecosystem integrity indicate there is little difference between the two. The non-intuitive nature of these results, and the inability to compare areas makes the use of the relative, least culturally altered reference condition, problematic at best.

The third reason for selecting culturally unaltered as the reference condition was the ability to define a culturally unaltered condition for the indicators of riparian ecosystem integrity without extensive reconnaissance in the watershed prior to conducting the assessment. For example, in the case of the indicators related to land use, it was reasonable to assume that under the culturally unaltered condition no grazing, agriculture, transportation, or urban development land uses existed. Similarly, in the case of the altered hydrologic conveyance indicator, it was reasonable to assume that under culturally unaltered conditions, stream channels were not straightened, lined, impounded, or underground. The same could not be said for defining the least culturally altered condition. In order to define least culturally altered condition for assessment indicators it would be necessary to conduct reconnaissance in the watershed, prior to conducting the assessment, to determine the range of cultural alteration that existed and what represented least culturally altered condition.

4.0 Methods

Some of the data and methods used during this study were developed during previous studies in the San Juan Creek and western San Mateo Creek watersheds (Lichvar 2002 and Smith 2002). These two reports are available from the US Army Corps of Engineers, Los Angeles District - Regulatory Branch (Points of Contact: Mr. Jae Chung). The data and methods from the previous studies are not repeated here. Rather, reference is made to these two studies throughout this report where appropriate. Methods unique to this analysis are described below.

4.1 Preparation of Geographical Information System Themes

In order to analyze the direct and indirect impacts of alternatives several themes were developed using the ArcView geographical information system (GIS). Each of these themes is described in the following sections. ArcView shape files for each of the themes can be found on the CD accompanying this report. The contents of the CD are described in Appendix 1.

4.1.1 Baseline Themes

Several themes used during the analysis were produced during the baseline delineation and assessment (Lichvar 2002 and Smith 2002). These included: local drainages, main stem stream channels, and non-wetland waters illustrated in Figure 3, and aquatic resources illustrated in Figure 4. The shape file for these themes is contained in the "Baseline" folder on the CD accompanying this report.

4.1.2 Direct Impacts

Direct impact footprints for each alternative show the location and type of impact associated with each alternative (Figures 5-12). Directly impacted local drainages are those in which the impact footprint covers any portion of the local drainage. The direct impact footprint does not have to impact the riparian ecosystem to have a direct impact. The different types of impacts in these figures are summarized in Table 2. The ArcView shape files of impacts were provided by the Rancho Mission Viejo (Point of Contact: Ms. Laura Eisenburg). The shape files are contained in the "Direct Impact Footprints" folder on the CD accompanying this report.

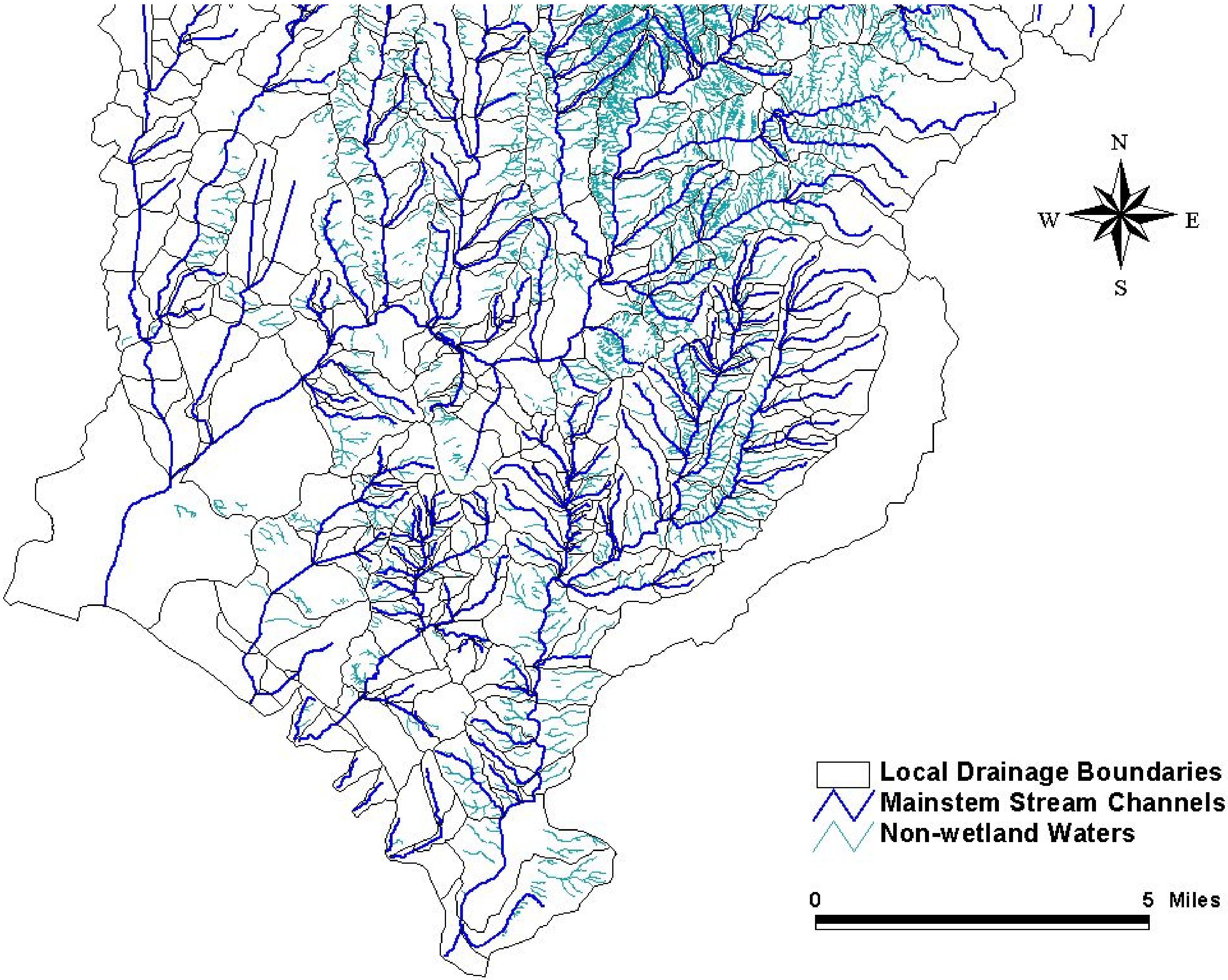


Figure 3. Local drainages, main stem stream channels, and non-wetland waters

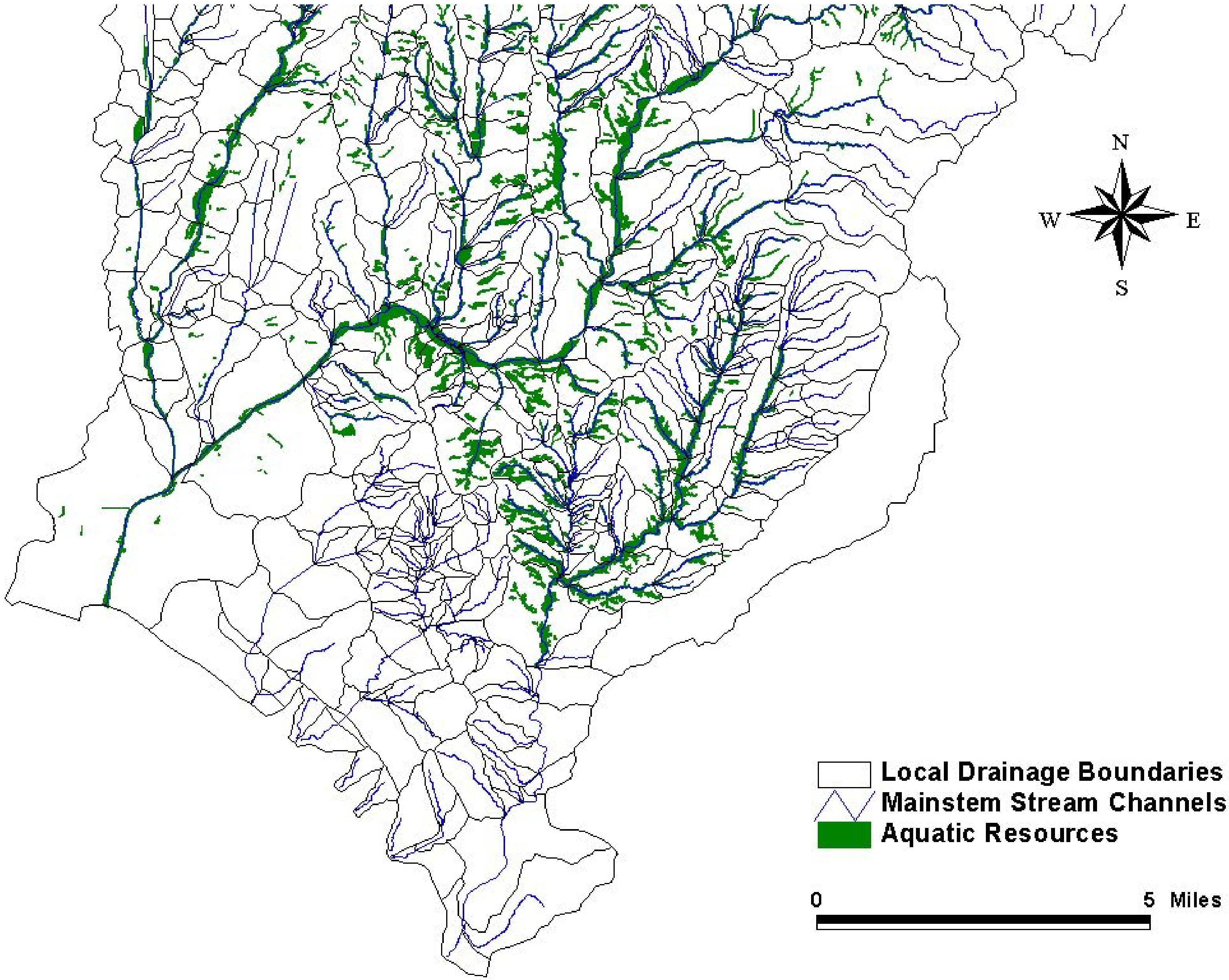


Figure 4. Aquatic resources

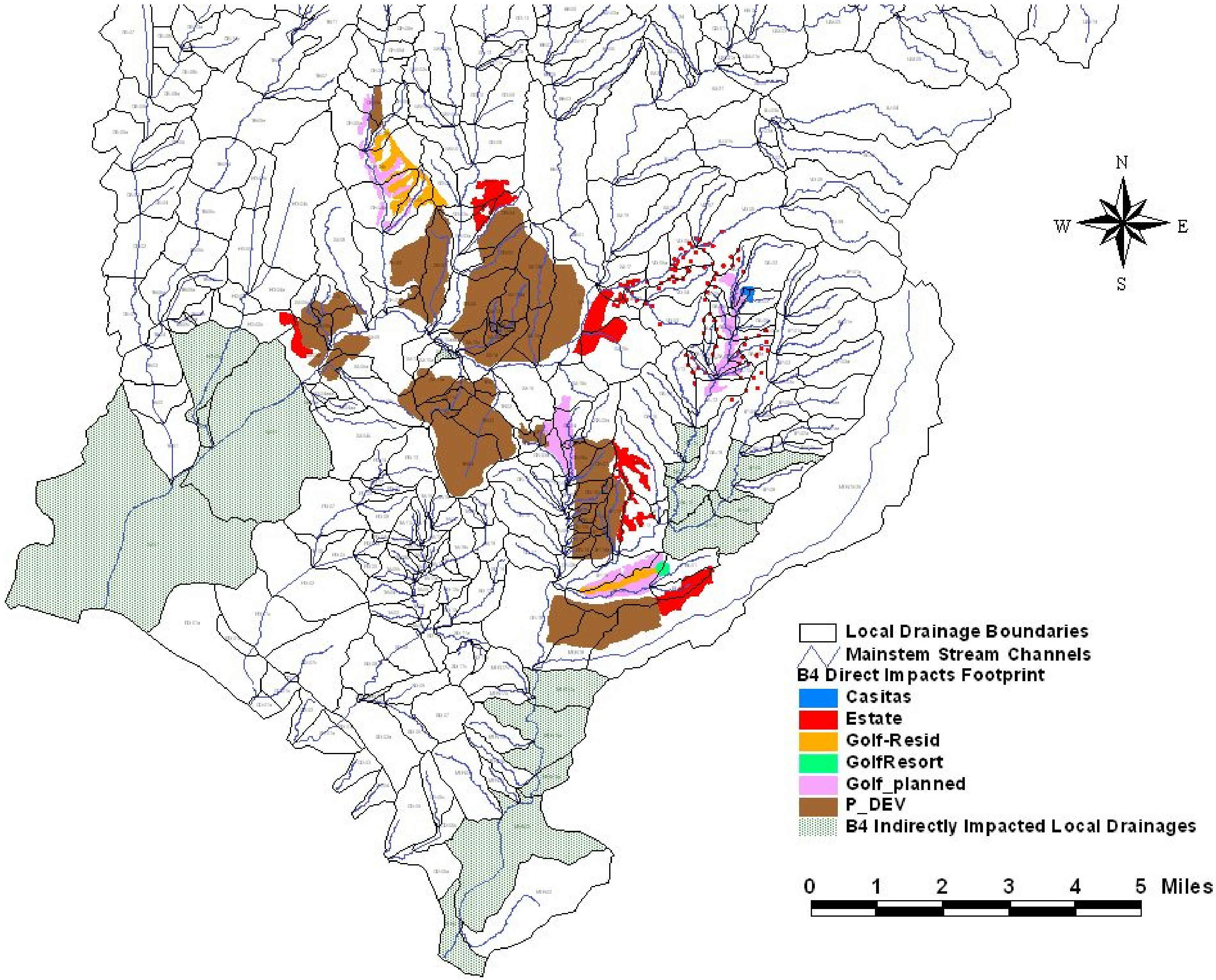


Figure 5. Alternative B4 direct impacts footprint and indirectly impacted local drainages

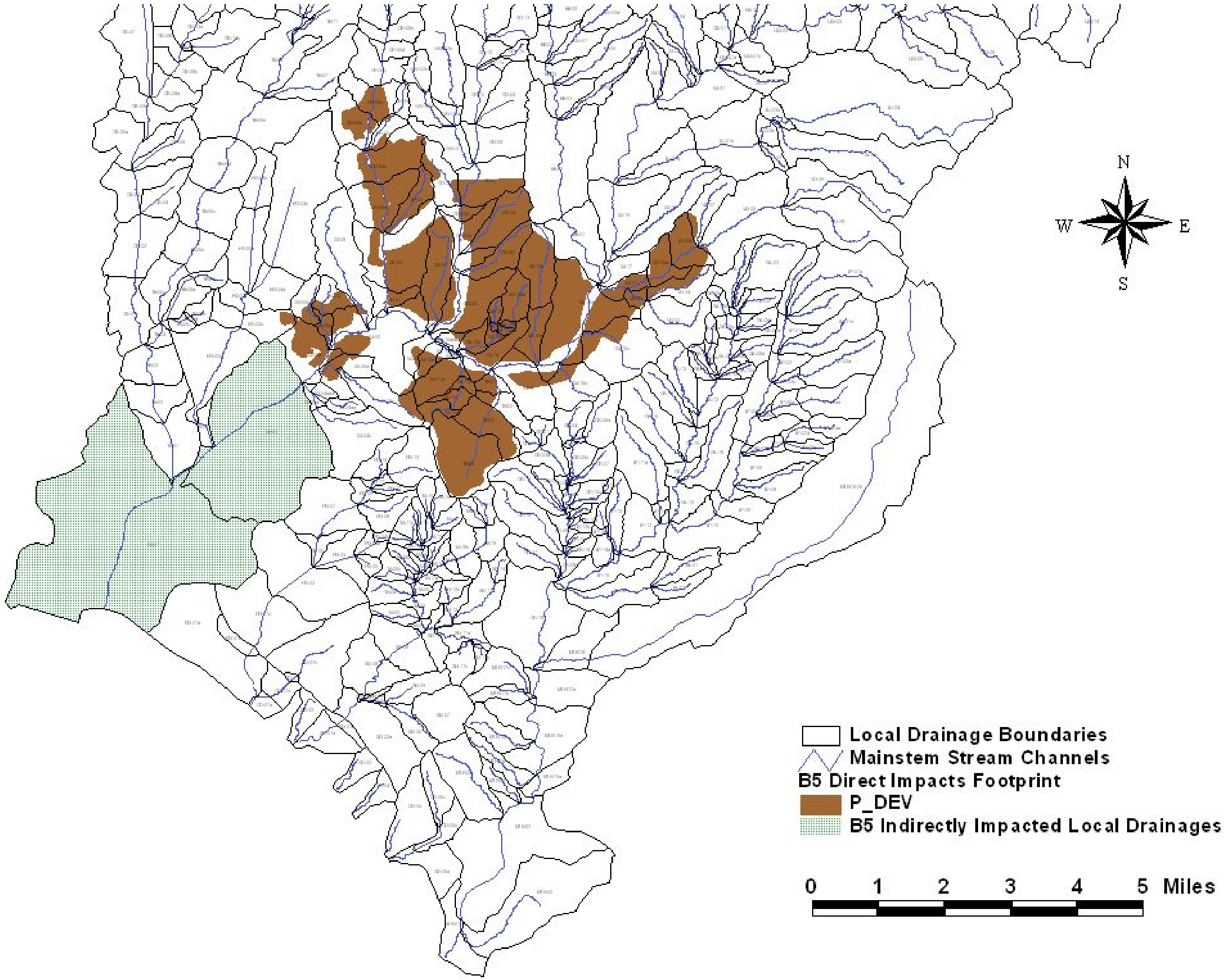


Figure 6. Alternative B5 direct impacts footprint and indirectly impacted local drainages

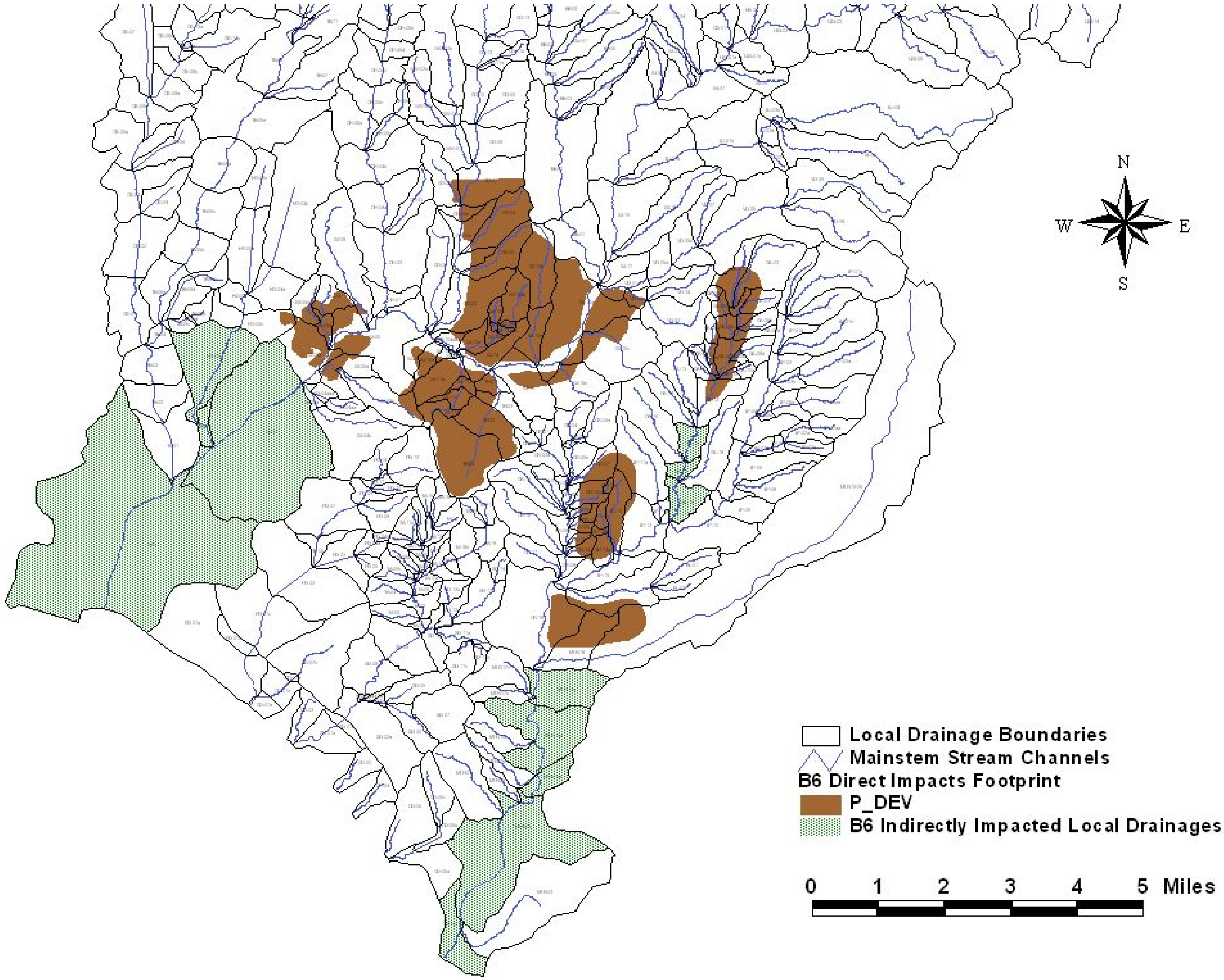


Figure 7. Alternative B6 direct impacts footprint and indirectly impacted local drainages

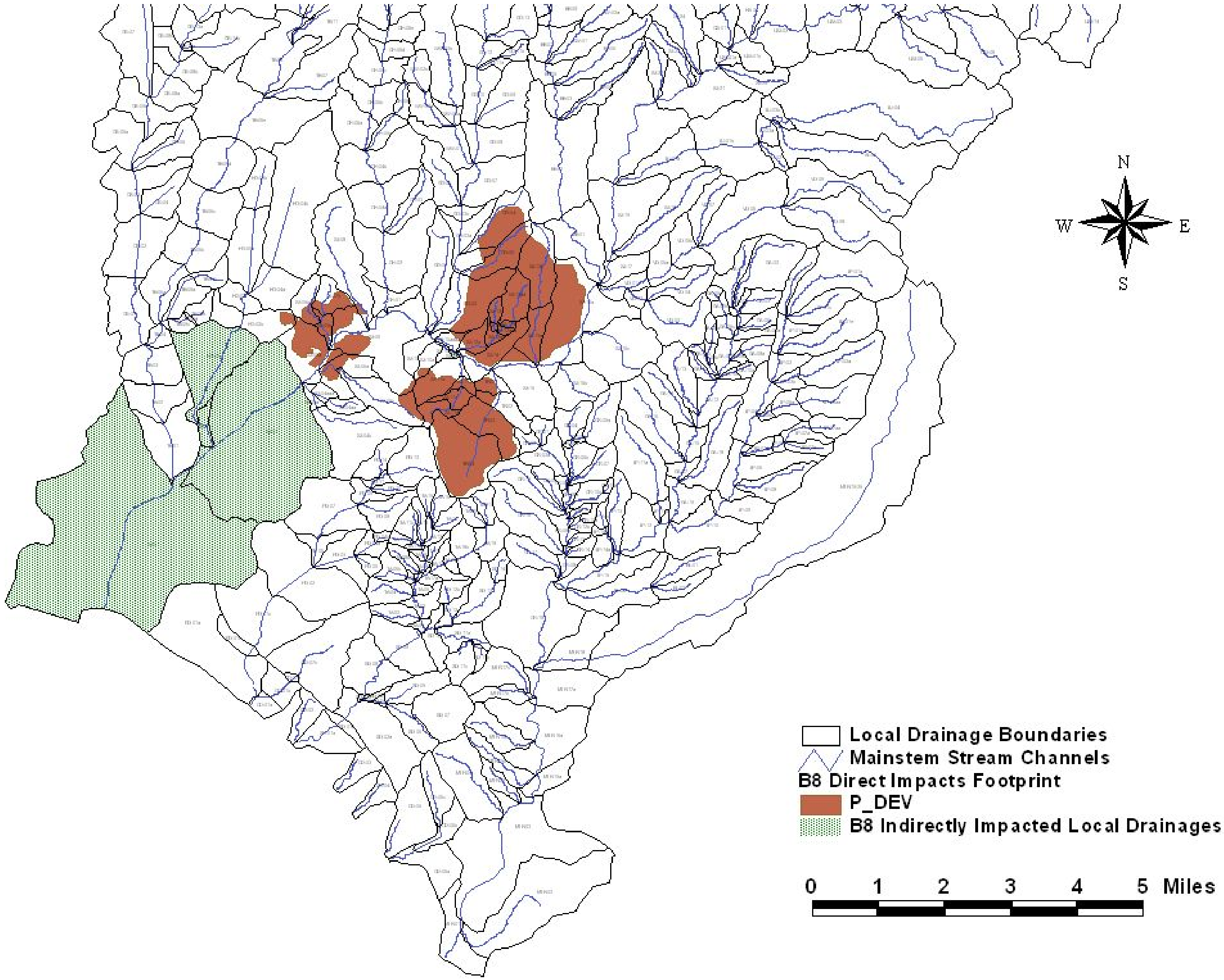


Figure 8. Alternative B8 direct impacts footprint and indirectly impacted local drainages

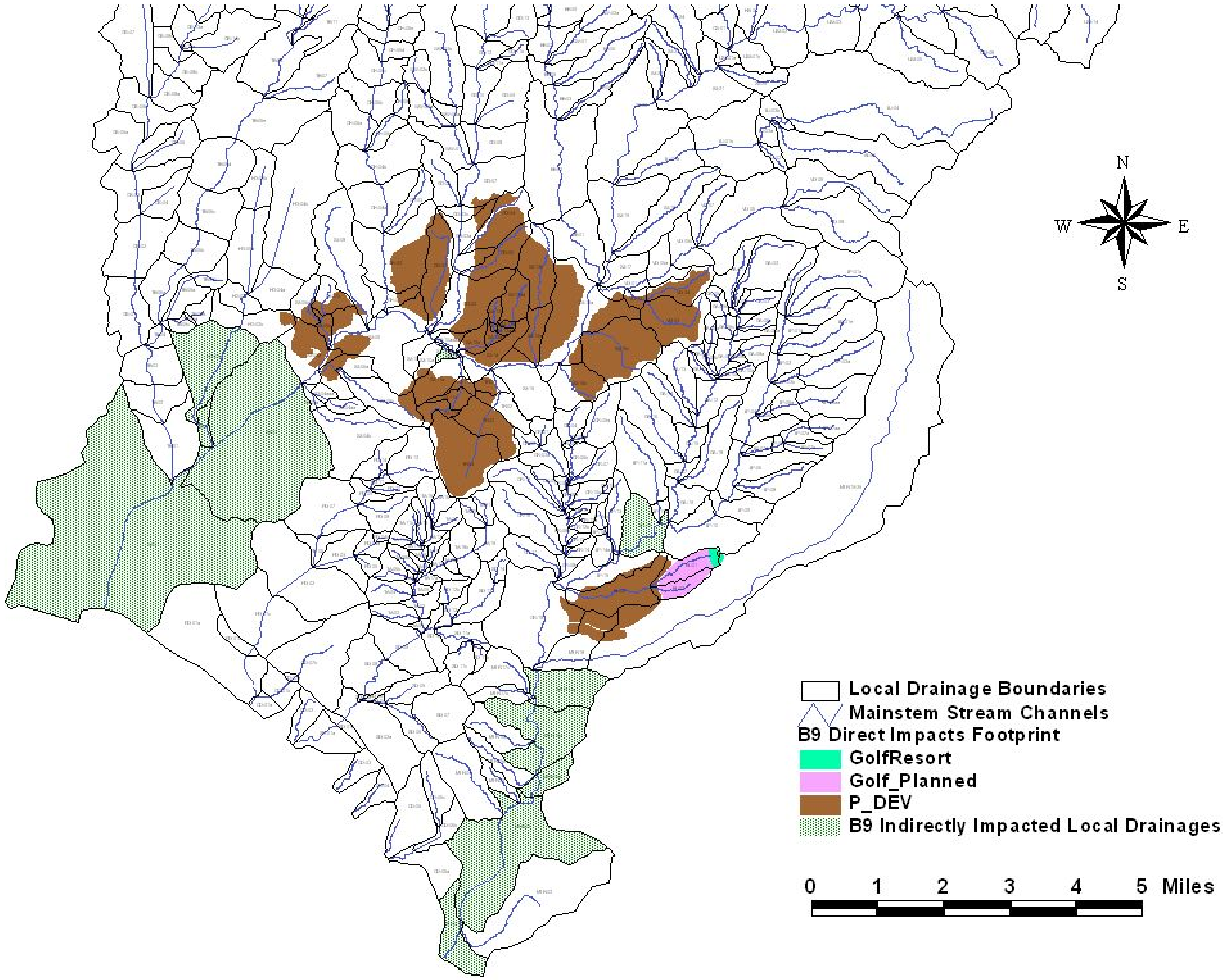


Figure 9. Alternative B9 direct impacts footprint and indirectly impacted local drainages

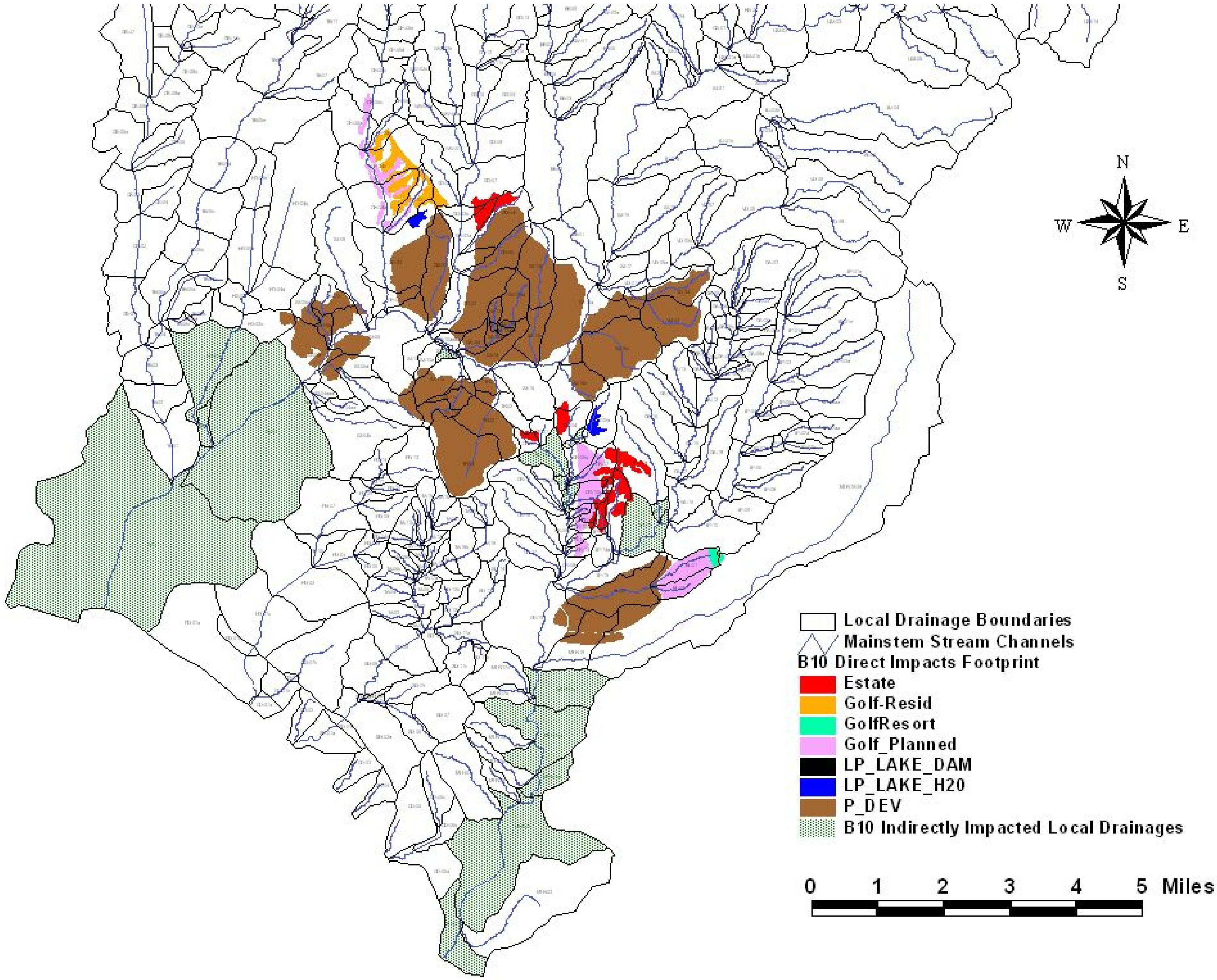


Figure 10. Alternative B10 direct impacts footprint and indirectly impacted local drainages

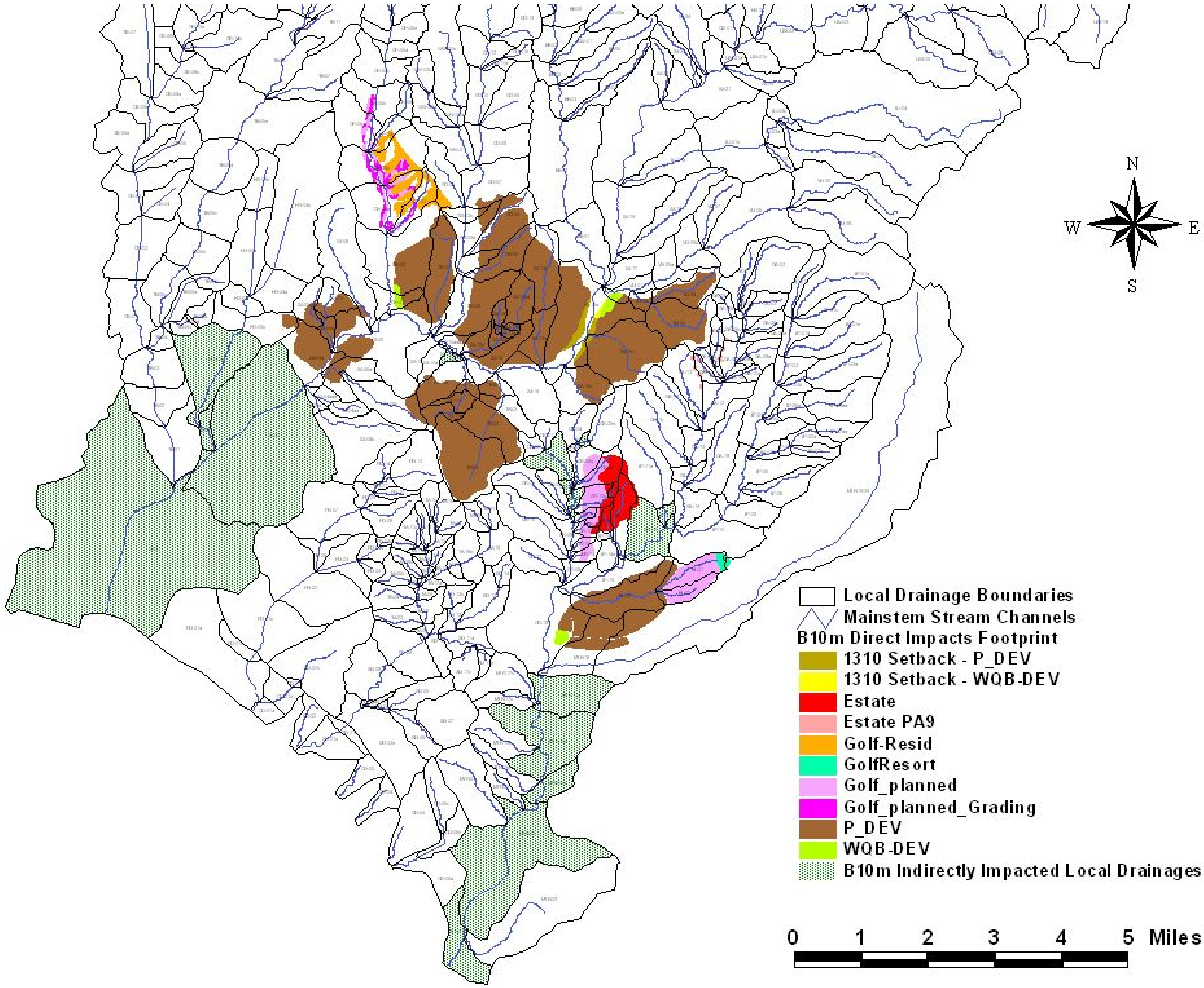


Figure 11. Alternative B10m direct impacts footprint and indirectly impacted local drainages

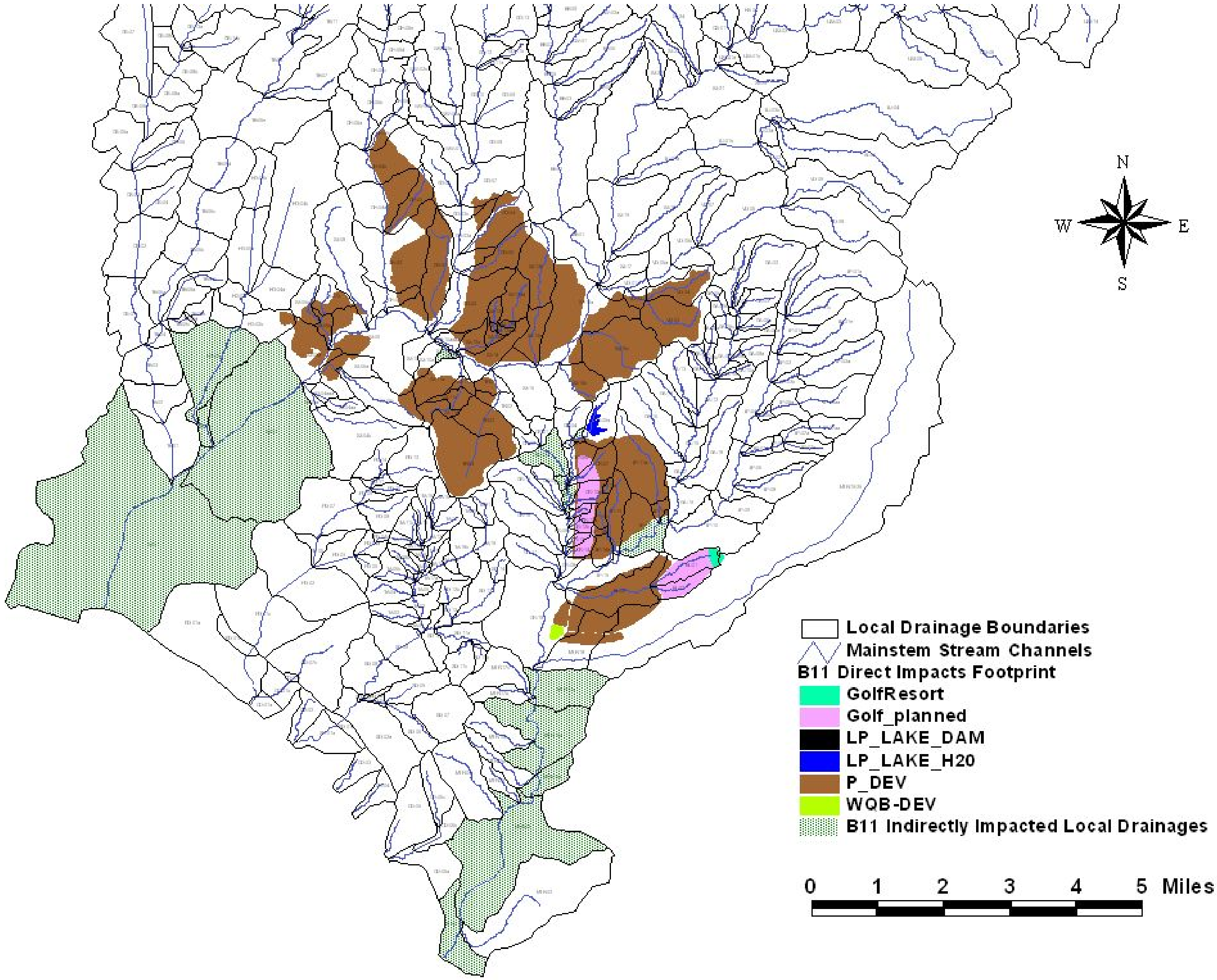


Figure 12. Alternative B11 direct impacts footprint and indirectly impacted local drainages

4.1.3 Indirect Impacts

Indirectly impacted local drainages are local drainages that do not have direct impacts in the local drainage, but because of the occurrence of direct impacts in upstream local drainages have the potential of being indirectly impacted. The local drainages with the potential for indirect impacts are also shown in Figures 5-12. Indirectly impacted local drainage themes were created by identifying the local drainages downstream of directly impacted local drainages. Once identified these local drainage polygons were copied to a new ArcView theme. Shape files for main stems in the indirectly impacted local drainages were created in a similar manner. These shape files are contained in the "Indirect Impacts" folder, on the CD accompanying this report.

4.1.4 Riparian Ecosystems

Another theme developed for each of the alternatives was riparian ecosystems. This theme was created by removing all non-riparian ecosystem polygons from the aquatic resources theme. Figure 13 illustrates this theme against the background of the local drainage boundaries. The shape file and metadata for this theme are contained in the "Riparian" folder, on the CD.

4.1.5 Major or Important Population Areas

Another set of themes developed for use during the analysis identified the location of major or important population areas for specific threatened, endangered, and sensitive species (NCCP/SAMP Working Group 2003). Figure 14 provides and example of these themes for the Intermediate Mariposa Lily. Shape files for these themes are contained in the "Major or Important Population Areas" folder, on the CD.

4.2 Criteria for Evaluating the Impact of Alternatives

Twenty three criteria were used to assess the potential impact of alternatives on WoUS, riparian ecosystems, and threatened, endangered, and sensitive species. They are listed below and described in the following sections.

Criterion 1: Non-wetland waters and main stem stream channels directly impacted
Criterion 2: Main stem stream channels indirectly impacted
Criterion 3. Aquatic resources directly impacted
Criterion 4: Main stem riparian ecosystems directly impacted
Criterion 5: Main stem riparian ecosystems indirectly impacted

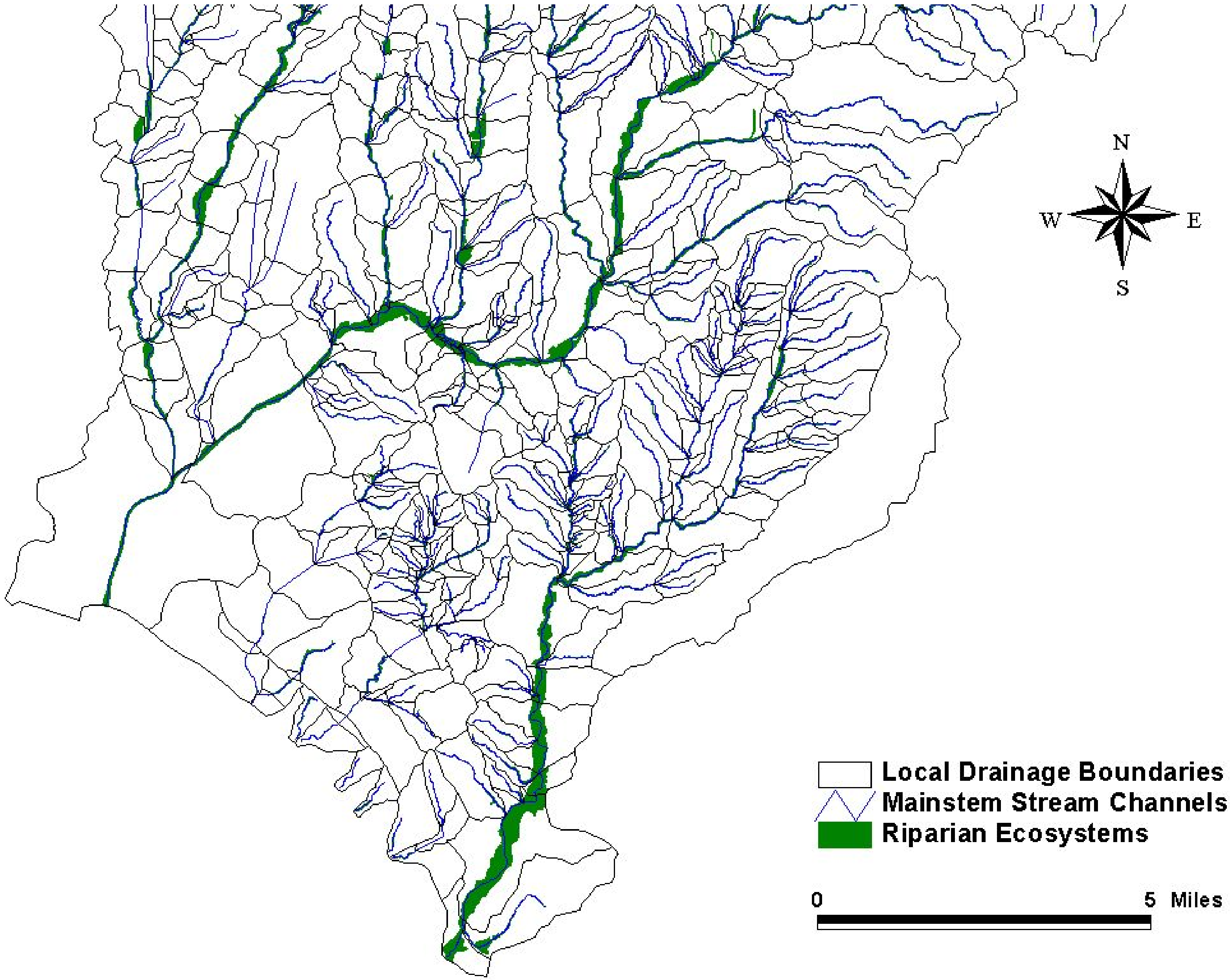


Figure 13. Riparian ecosystems

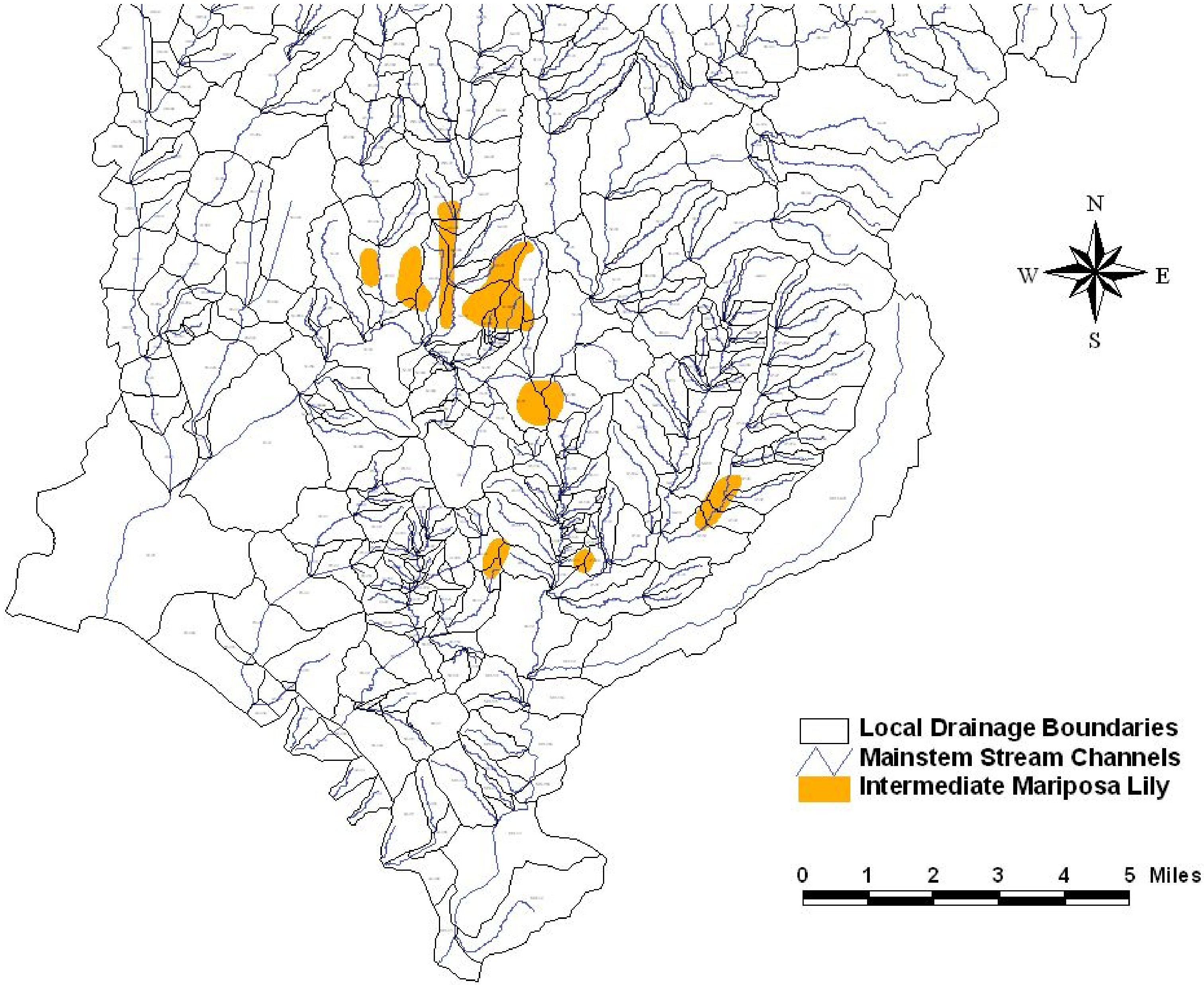


Figure 14. Intermediate Mariposa Lily major or important population areas

Criteria 6a-i: Major or important population areas of threatened, endangered, and sensitive species directly impacted

Criteria 7a-c: Quantity of hydrologic, water quality, and habitat integrity units in riparian reaches with direct impacts

Criteria 8a-c: Change/Loss in hydrologic, water quality, and habitat integrity units in riparian reaches with direct impacts

Criteria 9a-c: Change/Loss in hydrologic, water quality, and habitat integrity units in riparian reaches with indirect impacts

One way to compare the impacts of different alternatives is to determine the quantity of the impact. Criteria 1-6 compare the impacts of different alternatives in terms of the quantity of non-wetland water and main stem stream channels, aquatic resources, riparian ecosystems, and major or important population areas of threatened, endangered, or sensitive species impacted. Although useful, quantitative comparisons are relatively simplistic, or incomplete, in that they ignore potential "qualitative" differences that exist between whatever is being measured (i.e., non-wetland waters, main stems, wetland resources, riparian ecosystems, major or important population areas, and potentially important habitat for threatened, endangered or sensitive species). For example, when comparing the impacts of different alternatives on non-wetland waters (Criterion 1) no distinction is made to account for differences related to the degree of disturbance/alteration or integrity. In other words, a highly altered, 200 foot segment of non-wetland waters and a undisturbed, 200 foot segment of non-wetland waters, are weighted equally. Similarly, wetland resources and riparian ecosystems of the same areal extent, regardless of their degree of disturbance/alteration or integrity, are weighted equally.

Criteria 7-9 however, provide both a quantitative and qualitative measure of how different alternatives impact riparian ecosystem integrity. The integrity index of a riparian reach indices represent the quality of riparian ecosystem in the reach, while the areal extent of riparian ecosystem in a riparian reach represents the quantity of riparian ecosystem in a reach. Integrity units, which are calculated by multiplying the integrity index of a riparian reach by the area of riparian ecosystem within the riparian reach provides a measure of impact that integrates both quantity and quality.

4.2.1 Criterion 1: Non-wetland Waters and Main Stem Stream Channels Directly Impacted

Criterion 1 compares the direct impact of each alternative on non-wetland water and main stream channels. The metric used to quantify this criterion was miles of stream channel directly impacted by the impact footprint of an alternative. This analysis was done in ArcView by clipping the non-wetland waters theme with the footprint of each alternative, and then calculating the length of stream channels by Strahler stream order (Strahler 1957) or main stem channel.

Strahler stream order refers to a stream numbering system in which the smallest, terminal stream segments receive a designation of first order or “1” (Figure 15). A stream segment downstream from the confluence of two first order stream segments receives a designation of second order or “2”. A stream segment downstream from the confluence of two second order stream segments receives a designation of third order or “3," and so on. In all cases, stream order increases only when two stream segments of equal order come together.

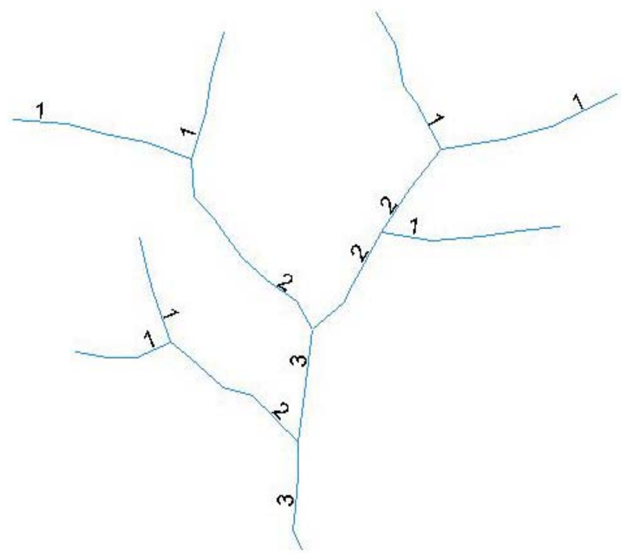


Figure 15. Example of Strahler stream orders

4.2.2 Criterion 2: Main Stem Stream Channels Indirectly Impacted

Criterion 2 compares the indirect impact of each alternative on main stem stream channels downstream from the point of impact. The metric used to quantify this criterion was the miles of main stem stream channel downstream from the impact footprint of each alternative. This analysis was done in ArcView by intersecting the indirect local drainage theme for each alternative with the main stem theme and then summing the length of resulting main stem stream channels.

4.2.3 Criterion 3: Aquatic Resources Directly Impacted

Criterion 3 compares the direct impact of each alternative on the aquatic resources as mapped by Lichvar (2000). The metric used to quantify this criterion was the number of acres of aquatic resources directly impacted by the footprint of each alternative. This analysis was done in ArcView by clipping the aquatic resources theme with the footprint of each alternative, and then calculating the area of aquatic resources affected.

4.2.4 Criterion 4: Main Stem Channel Riparian Ecosystems Directly Impacted

Criterion 4 compares the direct impact of each alternative on riparian ecosystems along main stem channels. This differs from Criterion 3 in that it excludes aquatic resources not associated with main stem stream channels. The metric used to quantify this criterion was the number of acres of riparian ecosystem directly impacted by the footprint of each alternative. This analysis was done in ArcView by clipping the riparian ecosystem theme with the project footprint of each alternative, and then calculating the area of riparian ecosystems affected.

4.2.5 Criterion 5: Main Stem Channel Riparian Ecosystems Indirectly Impacted

Criterion 5 compares the indirect impact of each alternative on riparian ecosystems along main stem channels downstream from the impact footprint of each alternative. This differs from Criterion 4 that compares main stem channel riparian ecosystems directly impacted by the impact footprint of each alternative. The metric used to quantify Criterion 5 was the number of acres of riparian ecosystem along main stem channels downstream from the direct footprint of each alternative. This analysis was done in ArcView by intersecting the riparian ecosystem theme with the indirect local drainage theme, and then summing area of the resulting riparian ecosystems.

4.2.6 Criteria 6a-6i: Major or Important Population Areas Directly Impacted

Criteria 6a-i compares the potential for different alternatives to directly impact major or important population areas of threatened, endangered, or sensitive species. Poplulation areas for seven species were analyzed including: Arroyo Toad (*Bufo californicus*) (Criterion 6a), California Gnatcatcher (*Polioptila californica californica*) (Criterion 6b), Coulter's Saltbush (*Atriplex coulteri*) (Criterion 6c), Least Bell's Vireo (*Vireo bellii pusillus*) (Criterion 6d), Many-Stemmed Dudleya (*Dudleya multicaulis*) (Criterion 6e), Intermediate Mariposa Lilly

(*Calochortus weedii* var. *intermedius*) (Criterion 6f), Southern Tar Plant (*Hemizonia parryi* var. *australis*) (Criterion 6g), Thread-Leaved Brodiaea (*Brodiaea filifolia*) (Criterion 6h), and Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (Criterion 6i). The metric used to quantify this criterion was the acres of major or important population areas directly impacted by the footprint of an alternative. This was determined in ArcView by clipping the appropriate sensitive species habitat theme with the impact footprint of each alternative, and then calculating the area of major or important populations directly impacted."

4.2.7 Criteria 7a-c: Quantity of Hydrologic, Water Quality, and Habitat Integrity Units in Riparian Reaches

The hydrology, water quality, and habitat integrity indices and integrity units for all riparian reaches were calculated using the methods described in Smith (2002). To briefly summarize those methods, hydrologic, water quality, and habitat integrity indices are the integration of multiple indicator metrics that represent a variety of ecological characteristics and processes that influence riparian ecosystem integrity at three spatial scales (i.e., the riparian reach, local drainage, and drainage basin). Integrity units are calculated by multiplying the hydrology, water quality, and habitat integrity indices of each riparian reach by the area of riparian ecosystem within each riparian reach.

Criteria 7a-c represents the baseline (i.e., preproject) condition of riparian ecosystem integrity in riparian reaches. The baseline measure is useful for comparing the quantity and quality of riparian ecosystems in different riparian reaches, but does not indicate the actual impact of a proposed alternative on riparian ecosystem integrity, other than the potential extent of the impact (i.e., how many integrity units are there in a riparian reach that could potentially be lost). However, by comparing the baseline integrity units to the integrity units resulting from a simulation of a proposed alternative, the change in integrity units provides an explicit measure of how an alternative directly or indirectly riparian ecosystem integrity. These are the changes measured by Criterion 8a-c and 9a-c respectively.

4.2.8 Criteria 8a-c: Change in Hydrologic, Water Quality, and Habitat Integrity Units in Riparian Reaches with Direct Impacts

Criteria 8a-c measure the change in hydrologic, water quality, and habitat integrity units in directly impacted riparian reaches by comparing the number of baseline integrity units of a riparian reach to the number of simulated integrity units of a riparian reach. Change in the value of indicator metrics resulting from potential direct impacts of an alternative was simulated by overlaying the impact footprint of each alternative over baseline conditions maps and aerials in ArcView and determining whether, as a result of impacts associated with an alternative, a metric value would change. For example, if the impact footprint of an alternative directly impacted a portion of a WoUS or riparian ecosystems the metric value of several indicators including Altered Hydraulic Conveyance, Floodplain Interaction, Area of Native Riparian Vegetation, and Riparian Corridor Connectivity could be expected to change. Similarly, if the impact fooprint of an alternative directly impacted uplands in the local drainage or drainage basin of a riparian reach, several indicators including Land Use / Land Cover at Riparian Ecosystem Boundary, and Land Use / Land Cover in Upland Buffer could be expected to change. Based on these changes to indicator metric values "simulated" integrity indices and integrity units were recalculated for directly impacted riparian reaches. The change in hydrologic, water quality, and habitat integrity units between baseline and simulated conditions was determined for each alternative by subtracting the baseline integrity units from the simulated integrity units for directly impacted riparian reaches.

4.2.9 Criteria 9a-c: Change in Hydrologic, Water Quality, and Habitat Integrity Units in Riparian Reaches with Indirect Impacts

Criteria 9a-c measure the change in hydrologic, water quality, and habitat integrity units in indirectly impacted riparian reaches by comparing the number of baseline integrity units of a riparian reach to the number of simulated integrity units of a riparian reach. Change in the value of indicator metrics resulting from potential indirect impacts of an alternative was simulated by overlaying the impact footprint of each alternative over baseline conditions maps and aerials in ArcView and determining whether, as a result of impacts associated with an alternative, a metric value would change. For example, if the impact footprint of an alternative directly impacted uplands in the drainage basin of a riparian reach that would constitute an indirect impact to downstream riparian reaches and several indicator metrics including Land Use / Land Cover at Riparian Ecosystem Boundary, Land Use / Land Cover in Upland Buffer, Land Use / Land Cover Contributing to Nutrients, Pesticides, Hydrocarbons, and Sediment, as well as Altered Hydraulic Conveyance and Riparian Corridor Connectivity at the drainage basin scale. Based on these changes to indicator metric values "simulated" integrity indices and integrity units were recalculated for indirectly impacted riparian reaches. The change in hydrologic, water quality, and habitat integrity units between baseline and simulated conditions was determined for each alternative by subtracting the baseline integrity units from the simulated integrity units for indirectly impacted riparian reaches.

4.3 Archiving of Information

All of the information collected during the assessment of riparian reaches and analysis of alternatives were archived in Excel spreadsheets and ArcView themes (Appendix 1).

5.0 Results and Discussion

5.1 Criteria for Assessing Potential Impacts

The results of analyzing the criteria used to assess the potential direct and indirect impact of the each alternative on WoUS, riparian ecosystems, and threatened, endangered and sensitive species are summarized in Tables 3-25 and Figures 16-38.

Table 3 and Figure 16 show miles of WoUS stream channels directly impacted by each alternative by Strahler stream order or mainstem channel categories. Column 8 shows the normalized rank score. To determine the normalized rank score, the level of impact (i.e, number of miles, acres of riparian ecosystem, or number of integrity units) of each alternative was divided by the level of impact of the alternative with the greatest level of impact. For example, in Table 3 the total miles for each alternative was divided by 67.7 miles (Alternative B10). Normalized rank scores for all criteria and criteria subsets are summarized in Section 5.2.

Table 3. Criterion 1: Non-wetland waters and main stem channels directly impacted

Alternative	Length of Stream in Miles By Strahler Order / Mainstem						Normalized Rank Score
	1st Order	2nd Order	3rd Order	4th Order	Mainstem	Total	
B4	24.9	6.9	0.9	0.1	21.8	54.6	0.72
B5	26.8	11.1	1.8	0.2	17.1	57.1	0.75
B6	23.9	6.3	0.8	0.0	20.1	51.0	0.67
B8	11.3	4.3	0.5	0.0	8.2	24.3	0.32
B9	31.3	10.3	2.2	0.0	16.9	60.7	0.80
B10	34.6	10.8	2.6	0.0	20.2	68.1	0.90
B10m	34.8	10.7	2.3	0.0	19.9	67.7	0.89
B11	37.9	11.5	2.4	0.0	24.1	75.9	1.00

Table 4 and Figure 17 show miles of downstream main stem channel indirectly impacted.

Table 4. Criterion 2: Downstream main stem channels indirectly impacted

Alternative	Length in Miles	Normalized Rank Score
B4	67.9	1.00
B5	27.0	0.40
B6	41.6	0.61
B8	19.4	0.29
B9	36.5	0.54
B10	49.7	0.73
B10m	56.6	0.83
B11	44.3	0.65

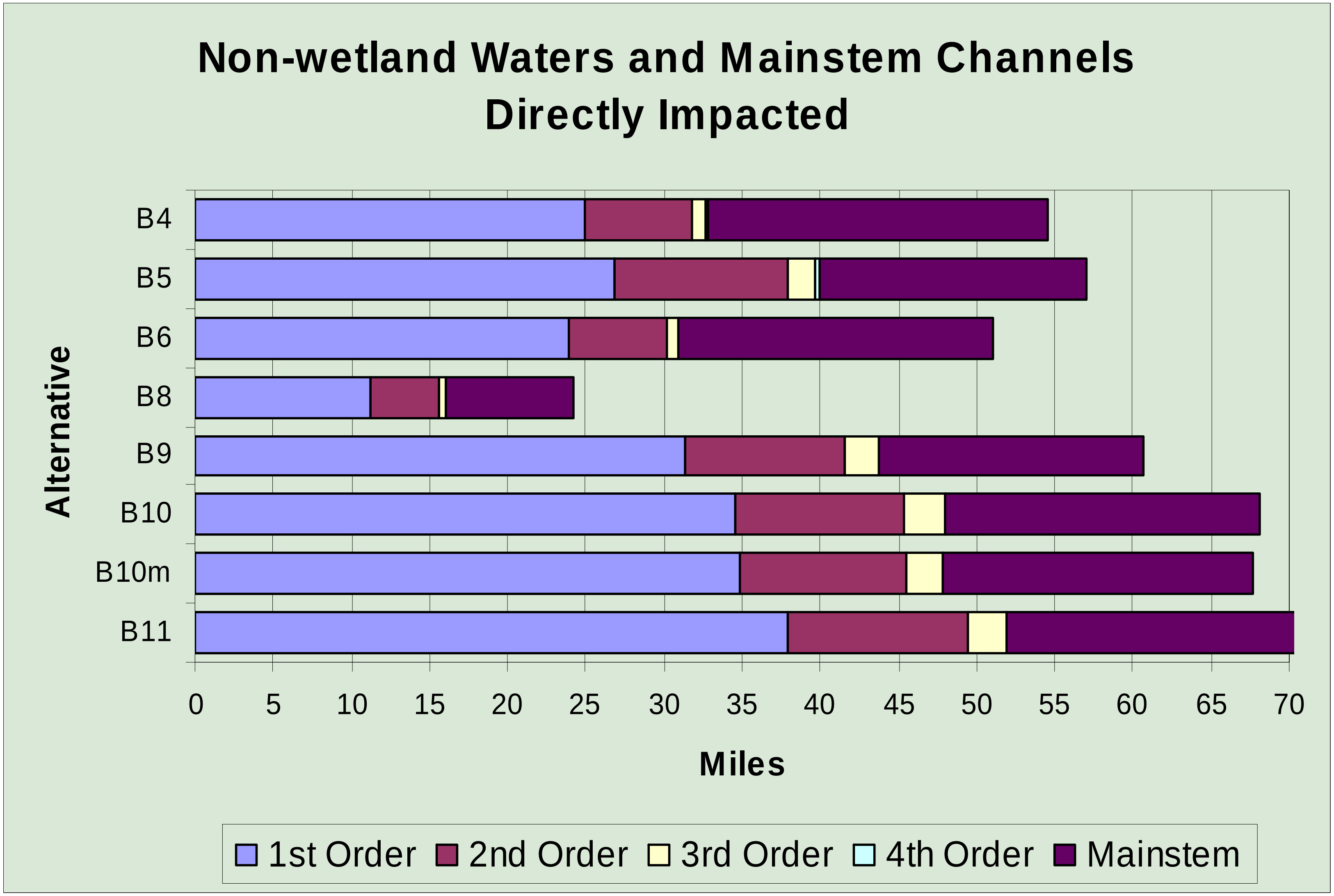


Figure 16. Criteria 1: Non-wetland waters and main stem channels directly impacted

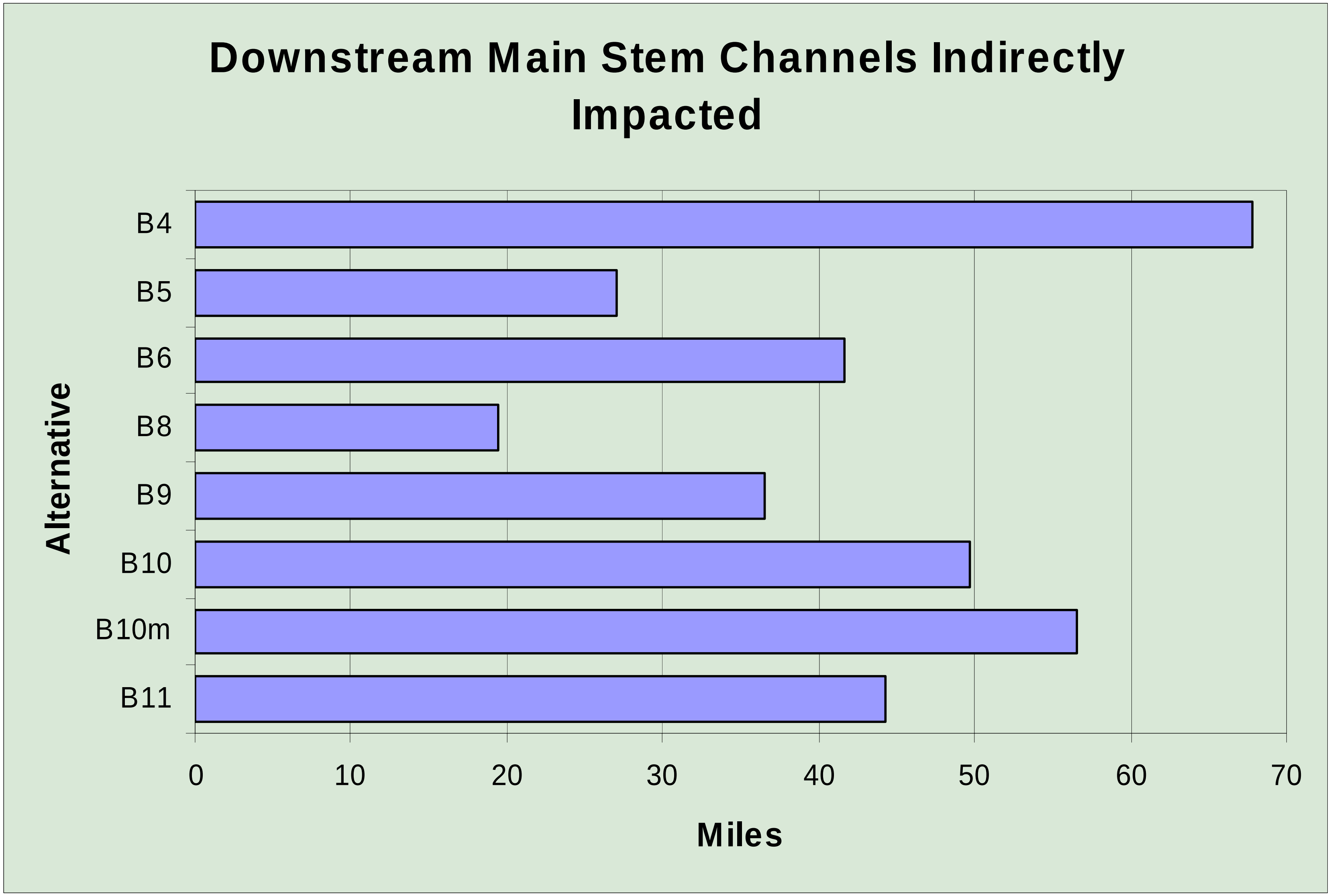


Figure 17. Criteria 2: Downstream main stem channels indirectly impacted

Table 5 and Figure 18 show acres of aquatic resource directly impacted by each alternative.

Table 5. Criterion 3: Aquatic resources directly impacted

Alternative	Acres of Aquatic Resources Directly Impacted	Normalized Rank Score
B4	406.7	0.78
B5	503.9	0.97
B6	487.1	0.94
B8	233.3	0.45
B9	456.9	0.88
B10	485.1	0.93
B10m	469.0	0.90
B11	520.9	1.00

Tables 6 and 7 and Figures 19 and 20 show acres of riparian ecosystem impacted directly and indirectly by each alternative.

Table 6. Criterion 4: Main stem riparian ecosystem directly impacted

Alternative	Acres of Riparian Ecosystem Directly Impacted	Normalized Rank Score
B4	67.7	1.00
B5	67.8	1.00
B6	58.2	0.86
B8	26.2	0.39
B9	42.3	0.62
B10	49.0	0.72
B10m	48.3	0.71
B11	53.7	0.79

Table 7. Criterion 5: Main stem riparian ecosystem indirectly impacted

Alternative	Acres of Riparian Ecosystem Indirectly Impacted	Normalized Rank Score
B4	1679.6	1.00
B5	804.0	0.48
B6	1467.3	0.87
B8	667.3	0.40
B9	1449.3	0.86
B10	1559.6	0.93
B10m	1573.6	0.94
B11	1530.0	0.91

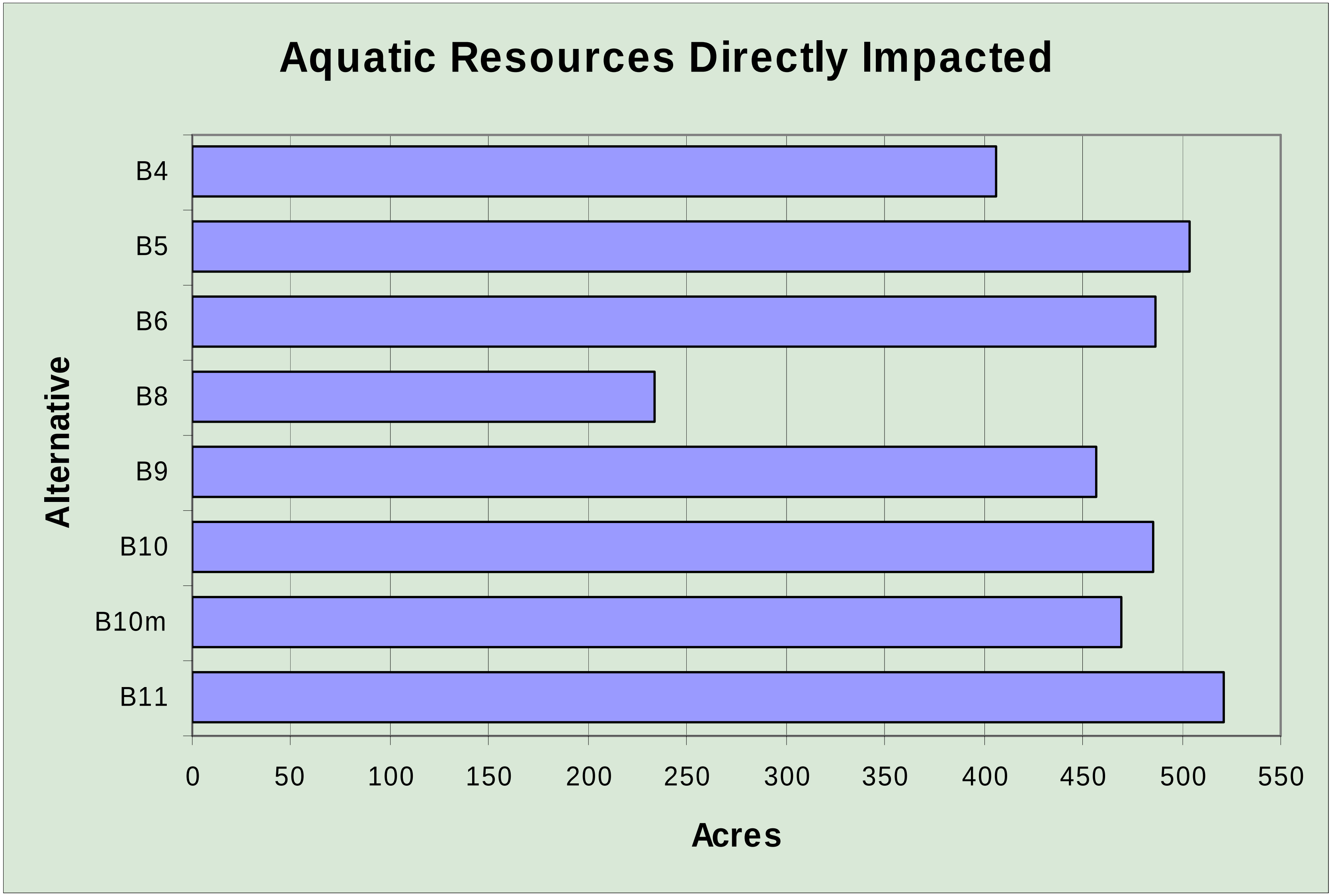


Figure 18. Criteria 3: Aquatic resources directly impacted

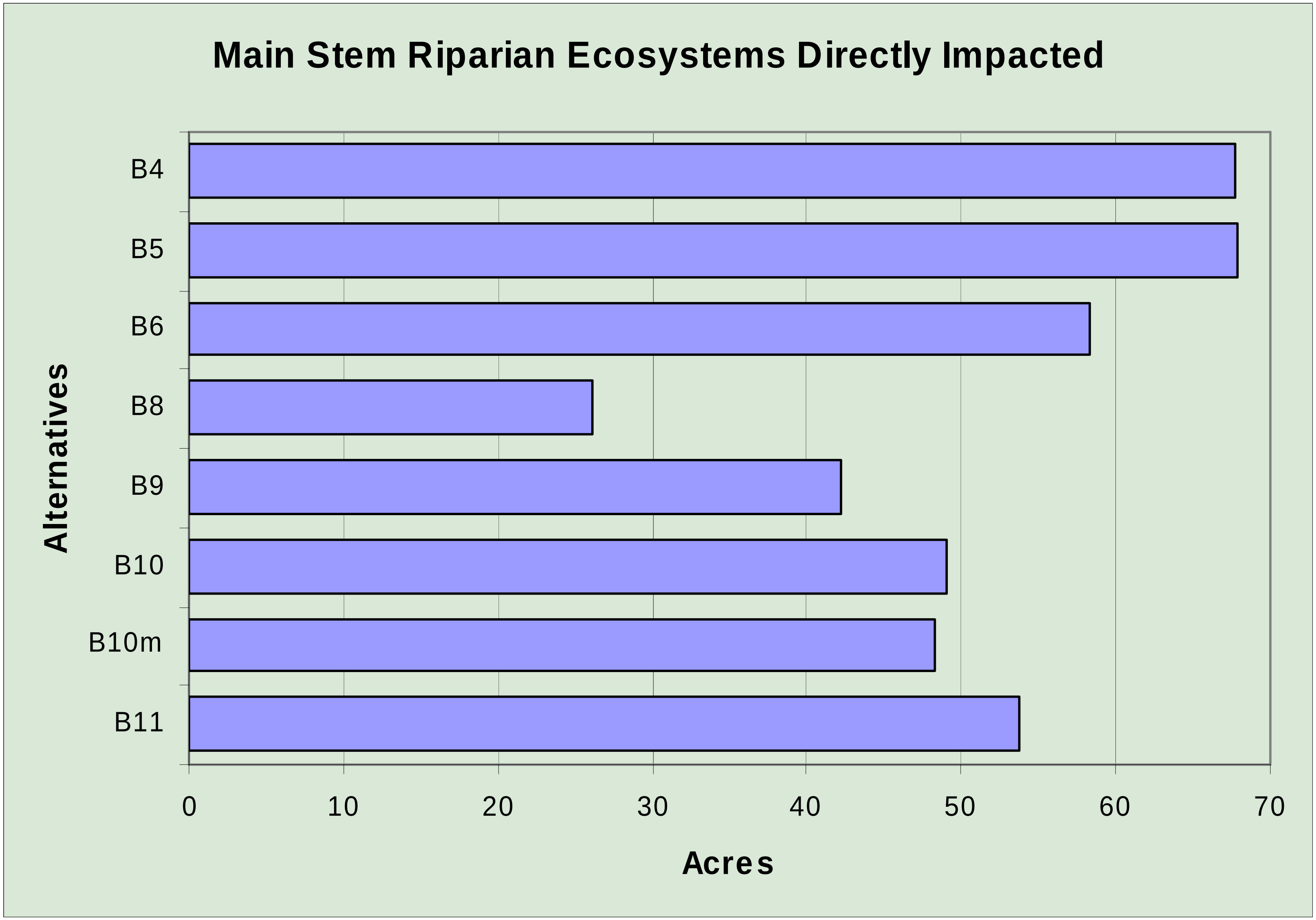


Figure 19. Criteria 4: Main stem riparian ecosystem directly impacted

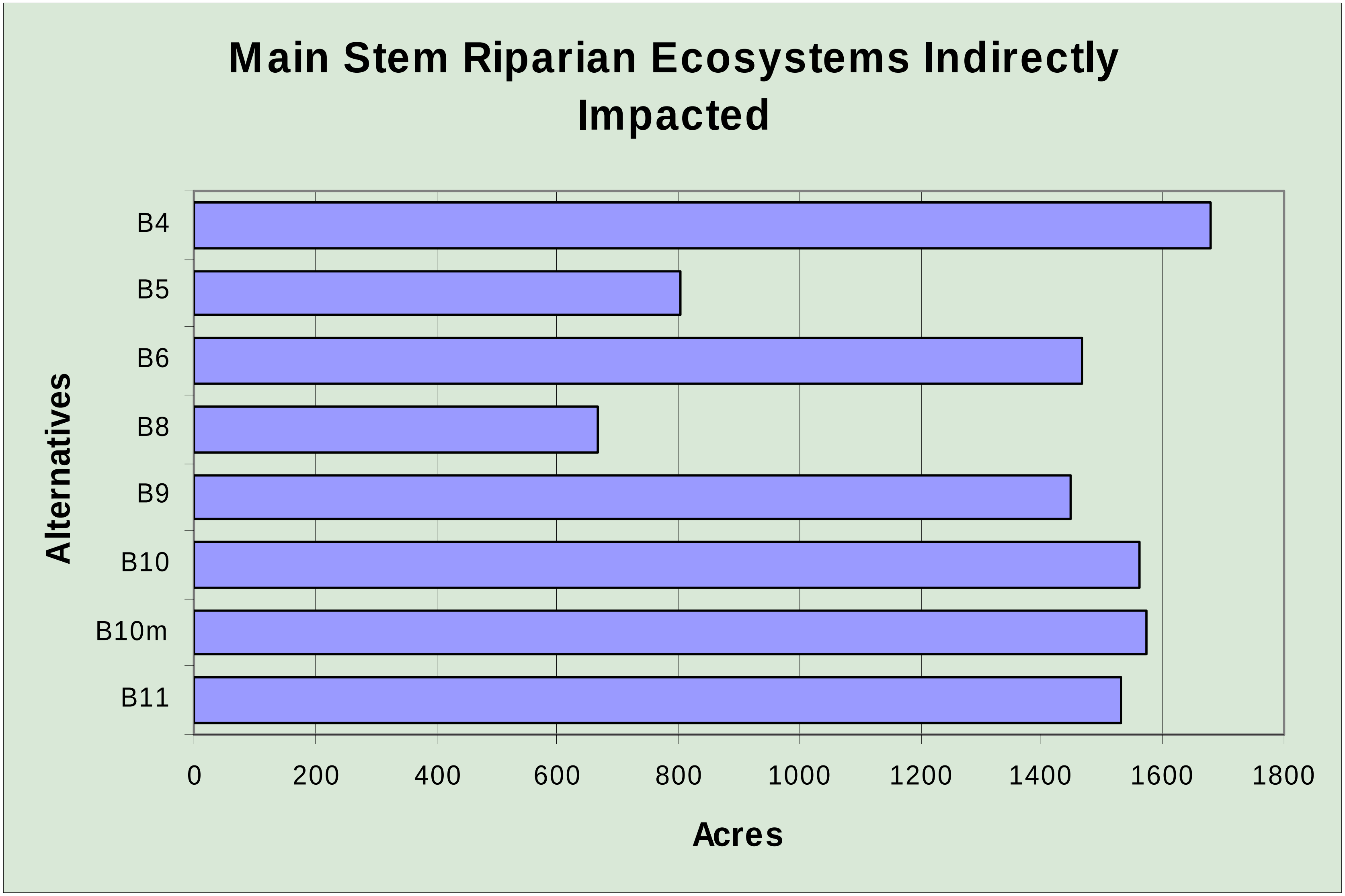


Figure 20. Criteria 5: Main stem riparian ecosystem indirectly impacted

Table 8 and Figure 21 show acres of Arroyo Toad directly impacted.

Table 8. Criterion 6a: Direct impacts to Arroyo Toad

Alternative	Acres of Arroyo Toad Directly Impacted	Normalized Rank Score
B4	149.0	0.94
B5	157.3	0.99
B6	159.2	1.00
B8	115.2	0.72
B9	116.0	0.73
B10	136.5	0.86
B10m	137.7	0.86
B11	150.6	0.95

Table 9 and Figure 22 show acres of California Gnatcatcher directly impacted.

Table 9. Criterion 6b: Direct impacts to California Gnatcatcher

Alternative	Acres of California Gnatcatcher Directly Impacted	Normalized Rank Score
B4	1241.3	0.66
B5	1874.2	1.00
B6	143.1	0.08
B8	96.9	0.05
B9	710.8	0.38
B10	1099.6	0.59
B10m	1120.2	0.60
B11	1232.2	0.66

Table 10 and Figure 23 show acres of Coulter's Saltbush directly impacted.

Table 10. Criterion 6c: Direct impacts to Coulter's Saltbush

Alternative	Acres of Coulter's Saltbush Directly Impacted	Normalized Rank Score
B4	277.8	0.57
B5	487.2	1.00
B6	51.0	0.10
B8	0.0	0.00
B9	11.3	0.02
B10	149.3	0.31
B10m	173.9	0.36
B11	178.9	0.37

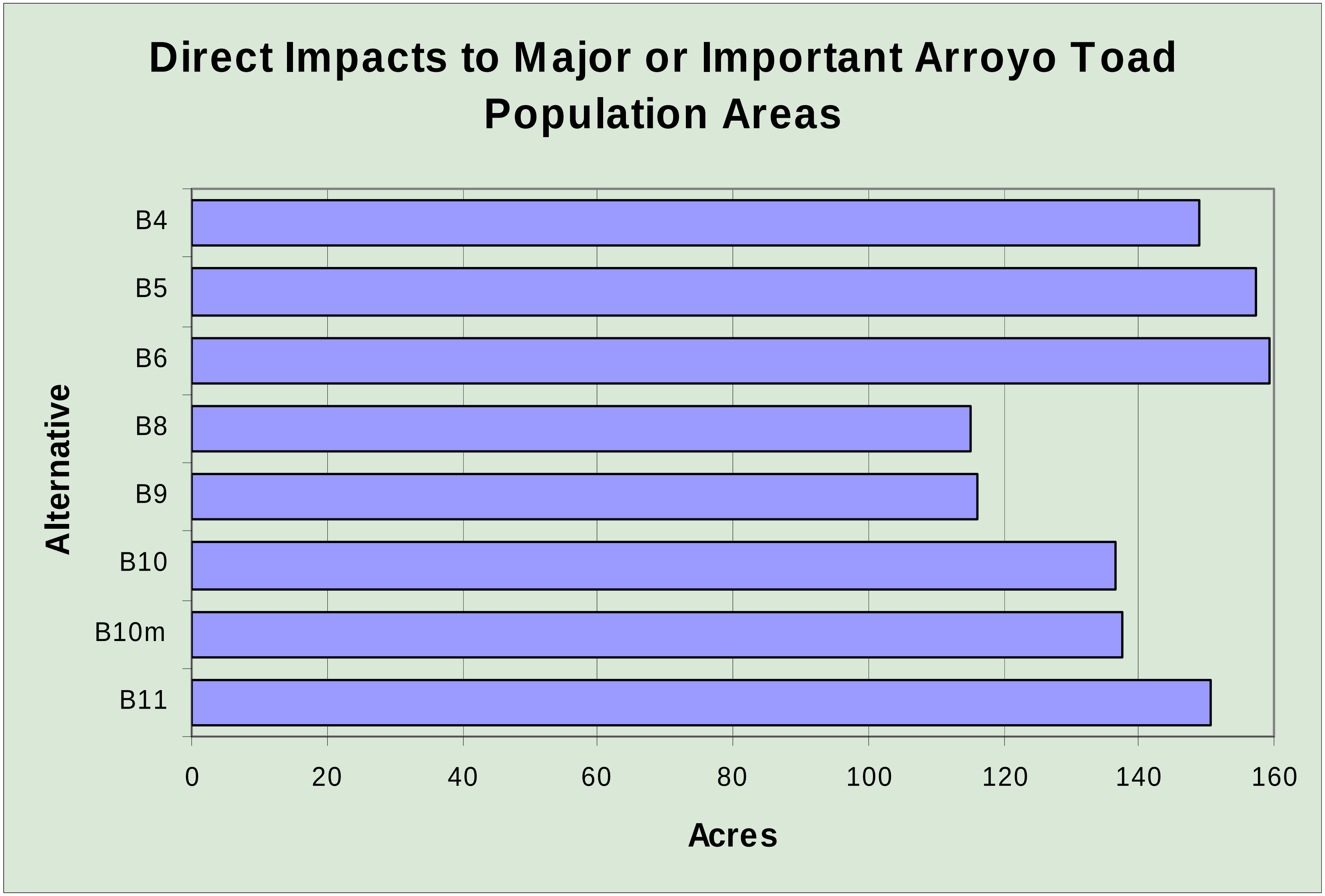


Figure 21. Criterion 6a: Direct impacts to Arroyo Toad

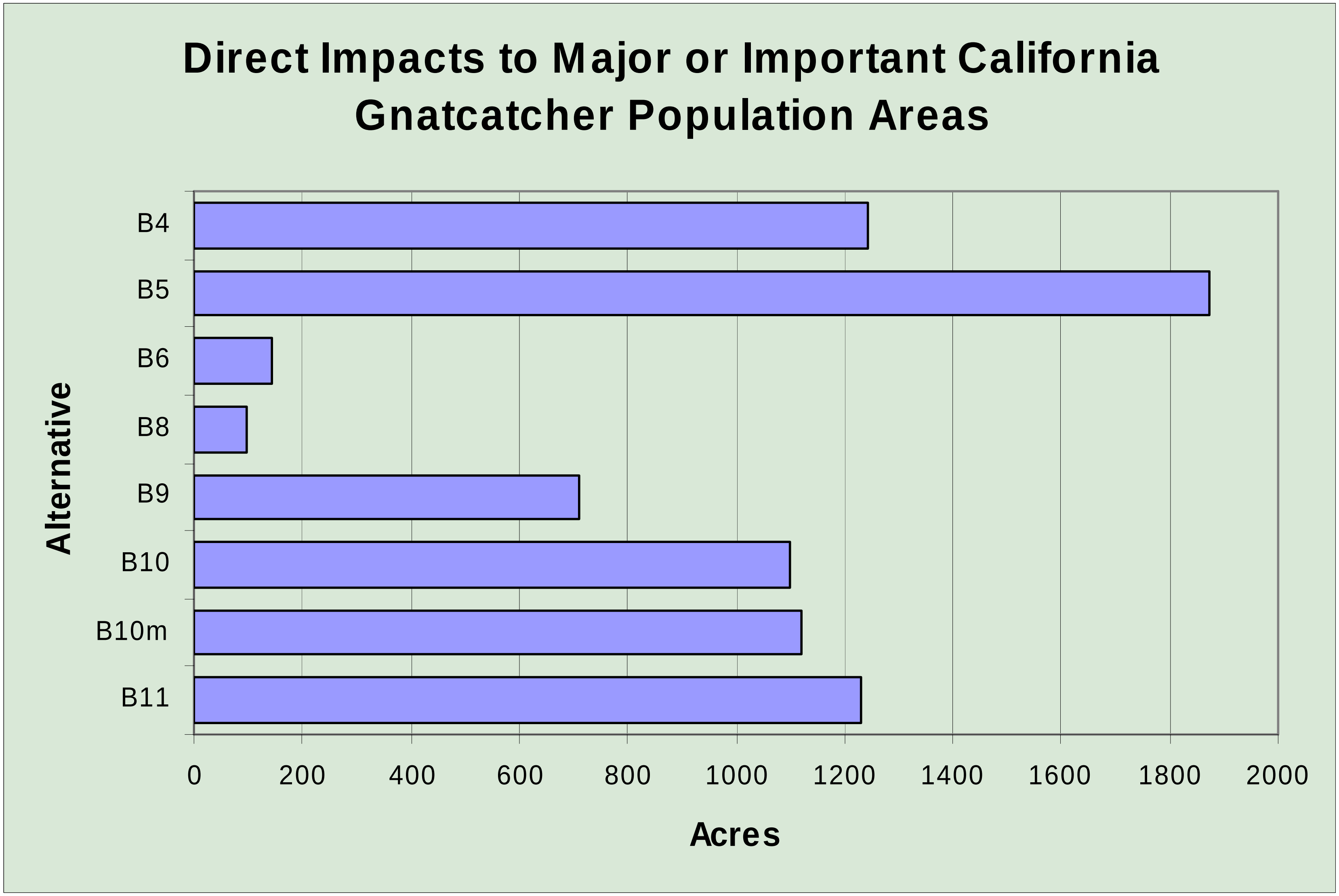


Figure 22. Criterion 6b: Direct impacts to California Gnatcatcher

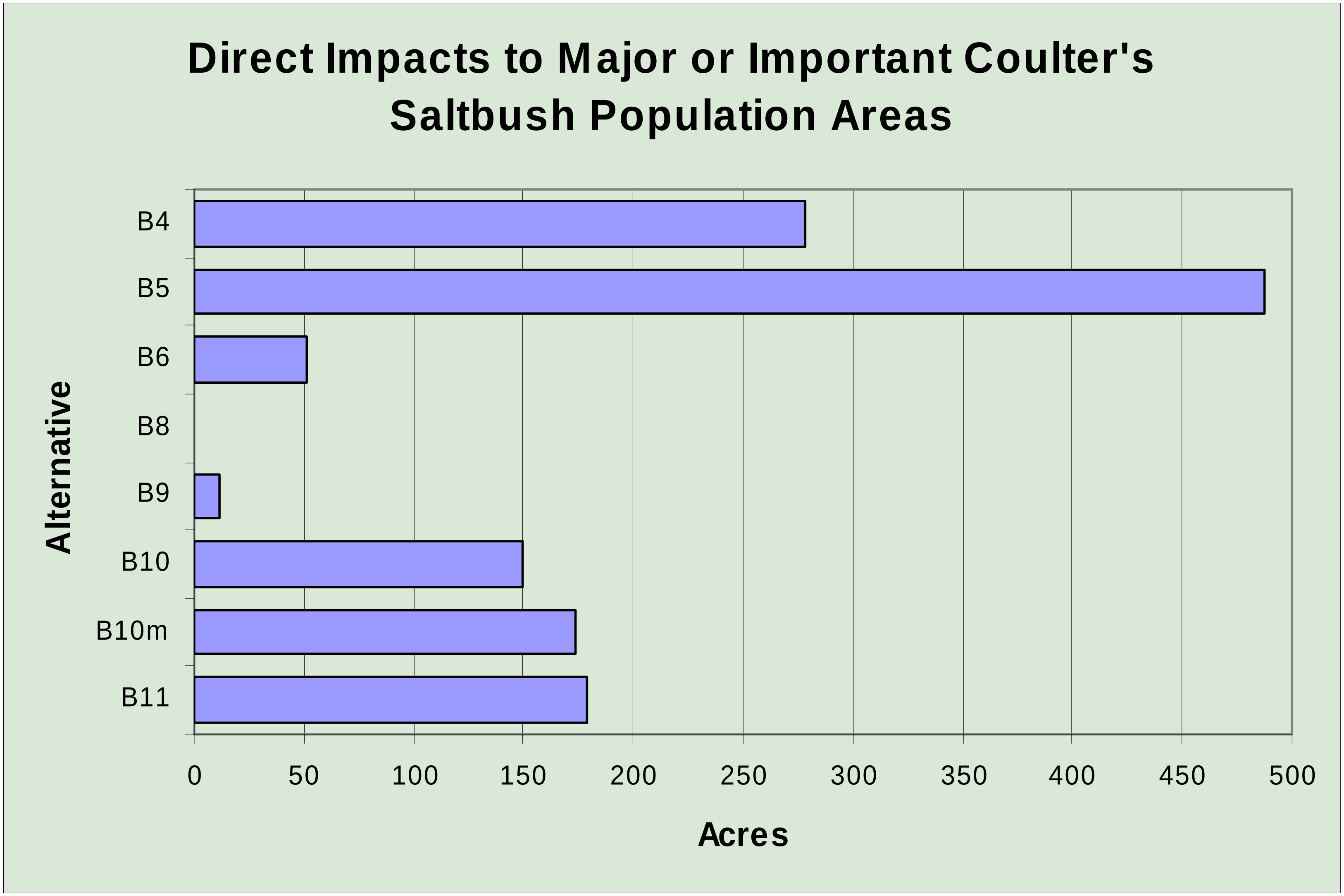


Figure 23. Criterion 6c: Direct impacts to Coulter's Saltbush

Table 11 and Figure 24 show the acres of direct impacts to Least Bell's Vireo.

Table 11. Criterion 6d: Direct impacts to Least Bell's Vireo

Alternatives	Acres of Least Bell's Vireo Directly Impacted	Normalized Rank Score
B4	88.8	0.56
B5	158.1	1.00
B6	112.0	0.71
B8	87.7	0.55
B9	93.9	0.59
B10	93.9	0.59
B10m	93.9	0.59
B11	93.9	0.59

Table 12 and Figure 25 show direct impacts to Many-Stemmed Dudleya.

Table 12. Criterion 6e: Direct impacts to Many-Stemmed Dudleya

Alternatives	Acres of Many-Stemmed Dudleya Directly Impacted	Normalized Rank Score
B4	2044.5	1.00
B5	1337.0	0.65
B6	1396.1	0.68
B8	622.4	0.30
B9	1211.6	0.59
B10	1599.8	0.78
B10m	1613.7	0.79
B11	1800.4	0.88

Table 13 and Figure 26 show acres of direct impacts to Intermediate Mariposa Lily

Table 13. Criterion 6f: Direct impacts to Intermediate Mariposa Lily

Alternatives	Acres of Intermediate Mariposa Lily Directly Impacted	Normalized Rank Score
B4	805.0	0.81
B5	990.9	1.00
B6	691.1	0.70
B8	528.3	0.53
B9	767.8	0.77
B10	779.8	0.79
B10m	779.7	0.79
B11	813.2	0.82

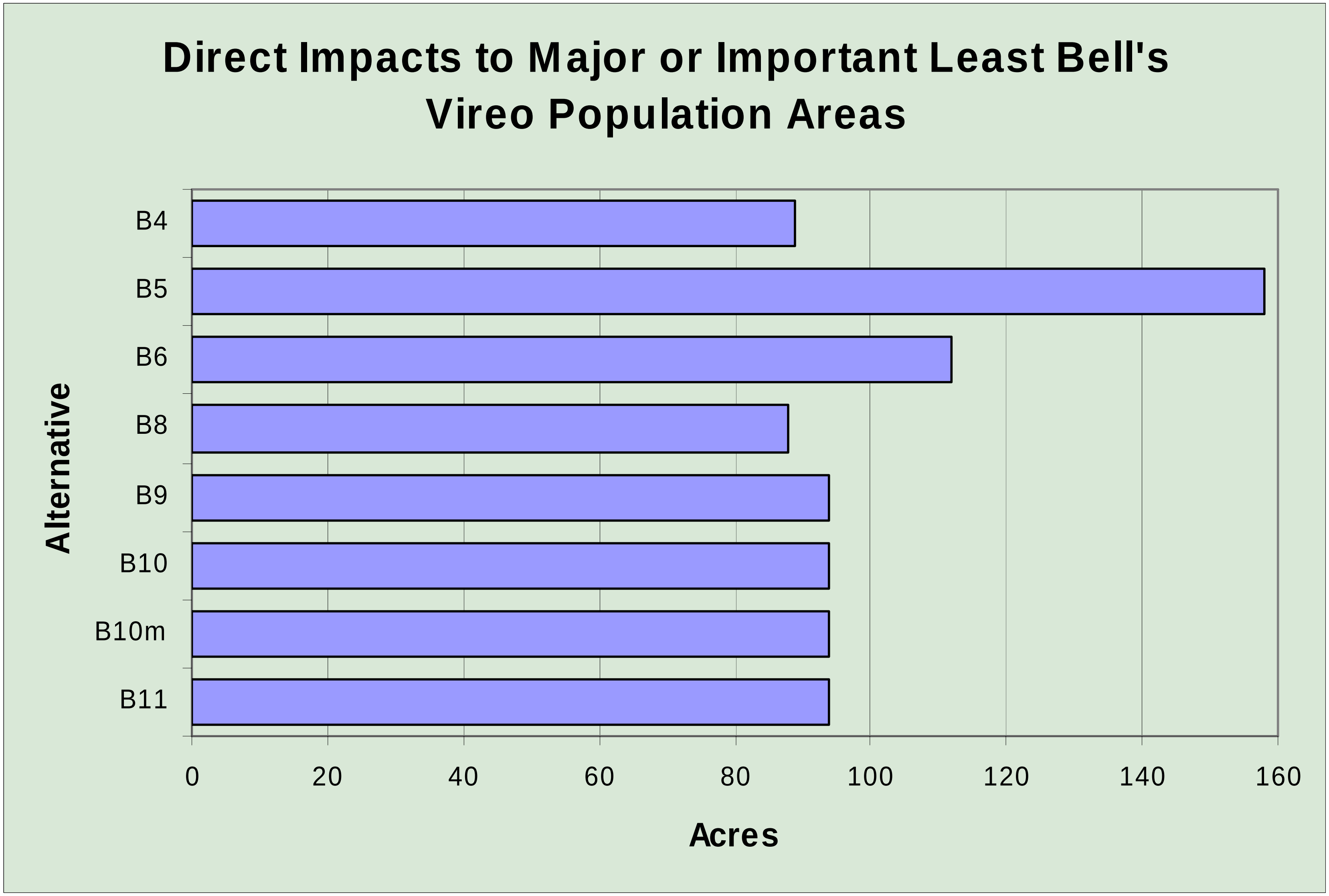


Figure 24. Criterion 6d: Direct impacts to Least Bell's Vireo

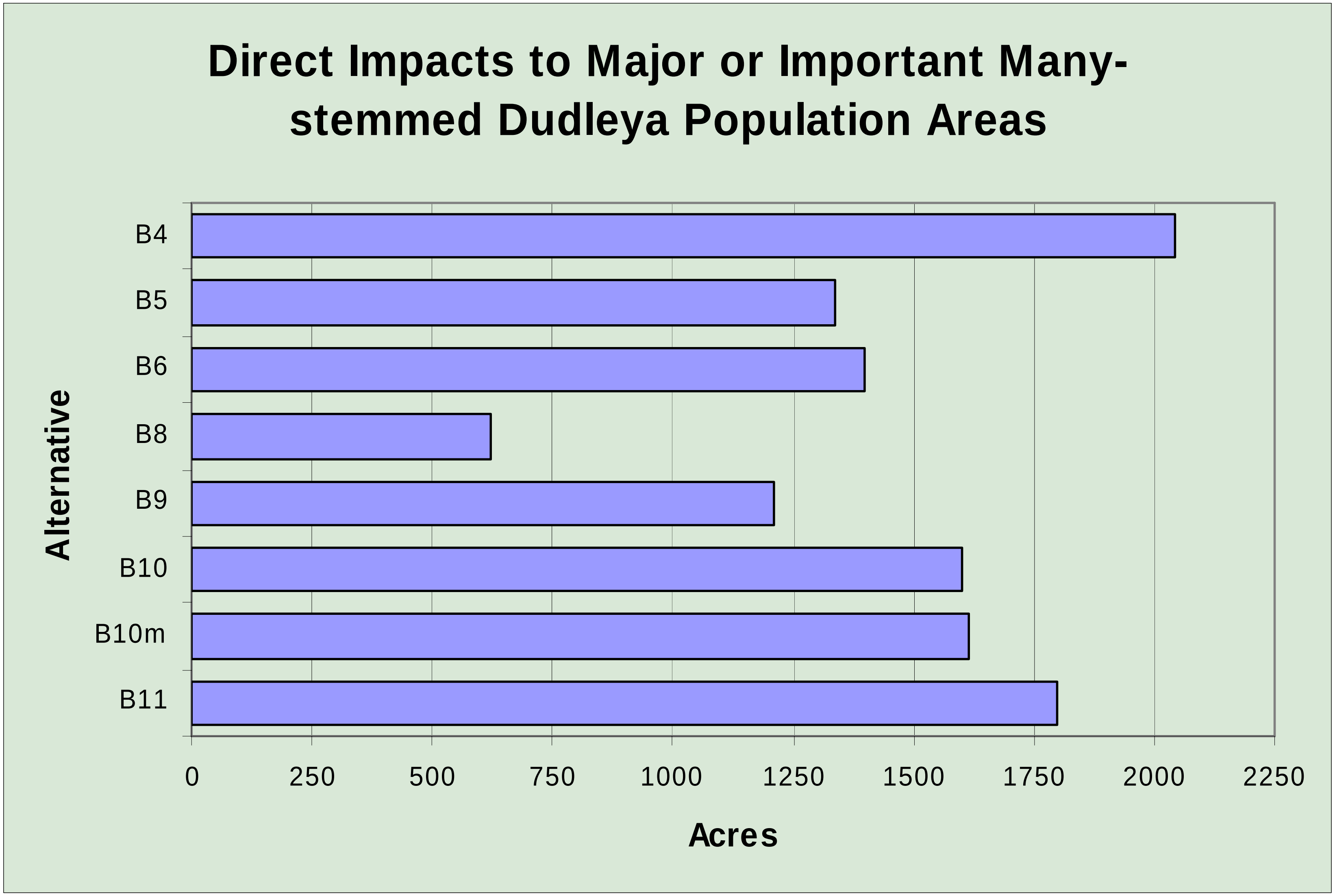


Figure 25. Criterion 6e: Direct impacts to Many-Stemmed Dudleya

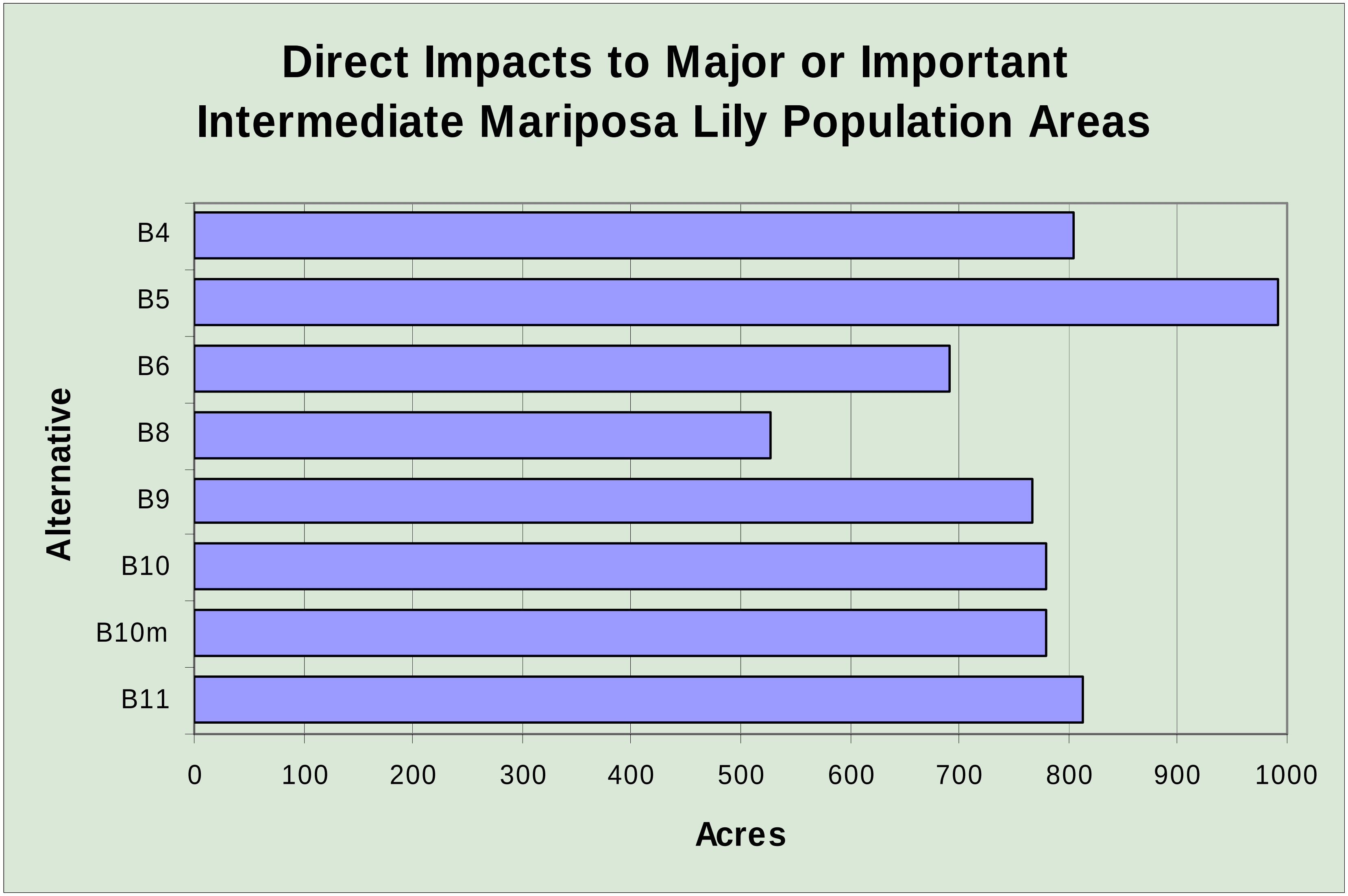


Figure 26. Criterion 6f: Direct impacts to Intermediate Mariposa Lily

Table 14 and Figure 27 show acres of direct impacts to Southern Tar Plant.

Table 14. Criterion 6g: Direct impacts to Southern Tar Plant

Alternatives	Acres of Southern Tar Plant Directly Impacted	Normalized Rank Score
B4	183.6	0.36
B5	508.4	1.00
B6	12.5	0.02
B8	0.0	0.00
B9	13.2	0.03
B10	128.0	0.25
B10m	151.0	0.30
B11	137.7	0.27

Table 15 and Figure 28 show acres of direct impacts to Thread-leaved Brodiaea

Table 15. Criterion 6h: Direct impacts to Thread-leaved

Alternatives	Acres of Thread-leaved Directly Impacted	Normalized Rank Score
B4	559.0	1.00
B5	195.1	0.35
B6	131.8	0.24
B8	0.0	0.00
B9	241.1	0.43
B10	408.9	0.73
B10m	409.4	0.73
B11	463.8	0.83

Table 16 and Figure 29 show acres of direct impacts to Southwestern Willow Flycatcher.

Table 16. Criterion 6i: Direct impacts to Southwestern Willow Flycatcher

Alternatives	Acres of Southwestern Willow Flycatcher Directly Impacted	Normalized Rank Score
B4	46.9	0.70
B5	67.2	1.00
B6	61.7	0.92
B8	46.9	0.70
B9	49.5	0.74
B10	49.5	0.74
B10m	49.5	0.74
B11	49.5	0.74

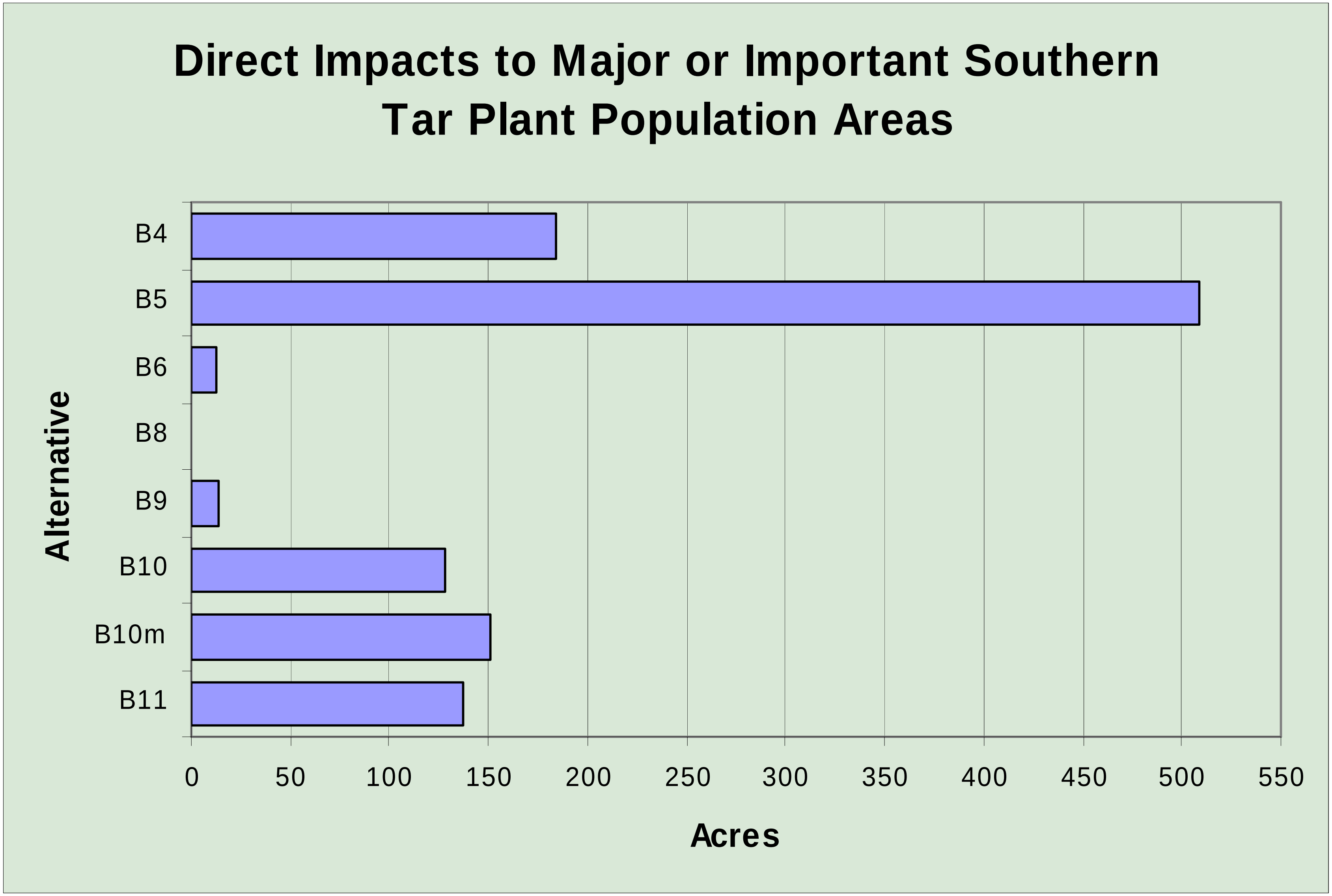


Figure 27. Criterion 6g: Direct impacts to Southern Tar Plant

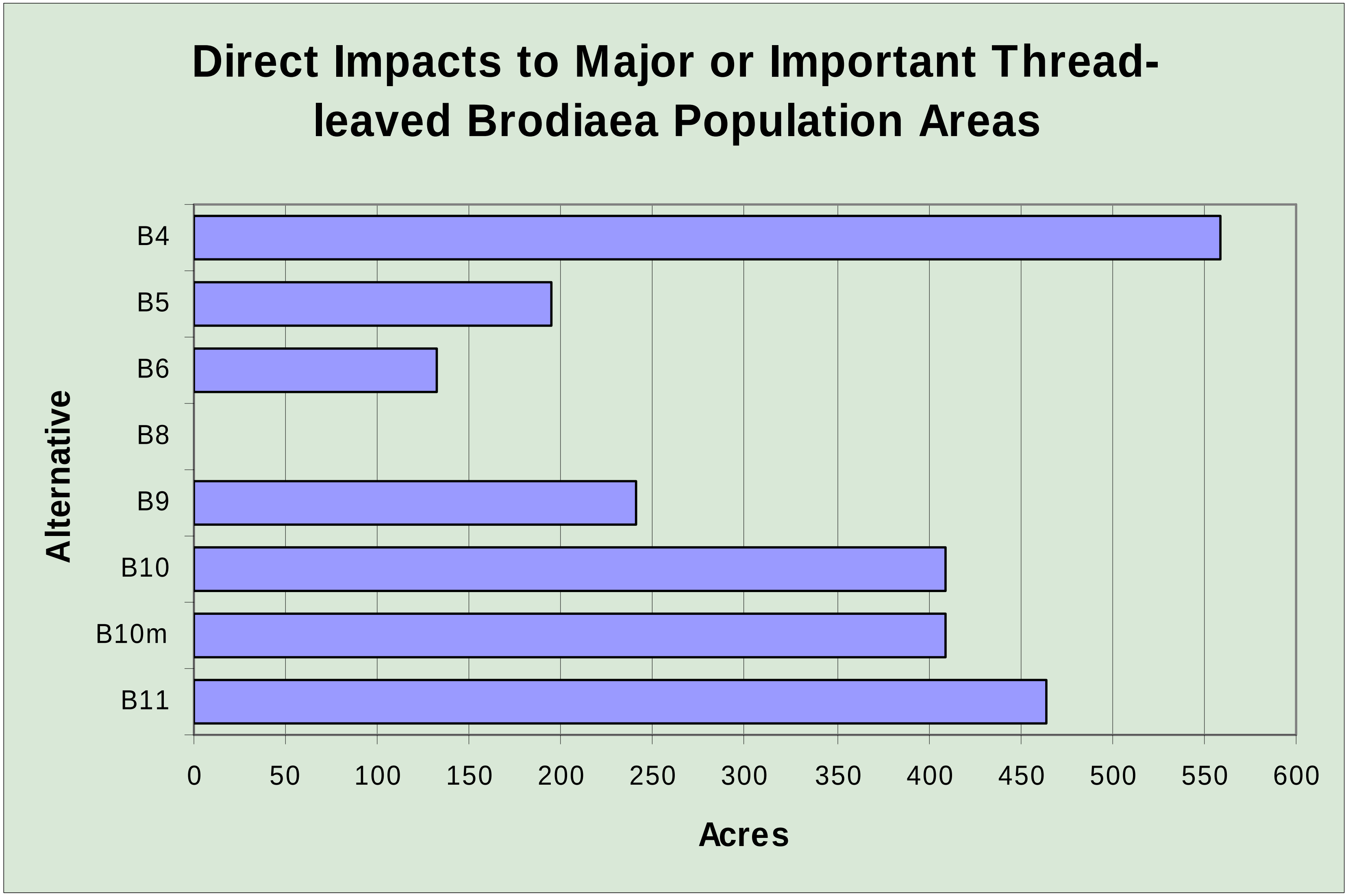


Figure 28. Criterion 6h: Direct impacts to Thread-leaved Brodiaea

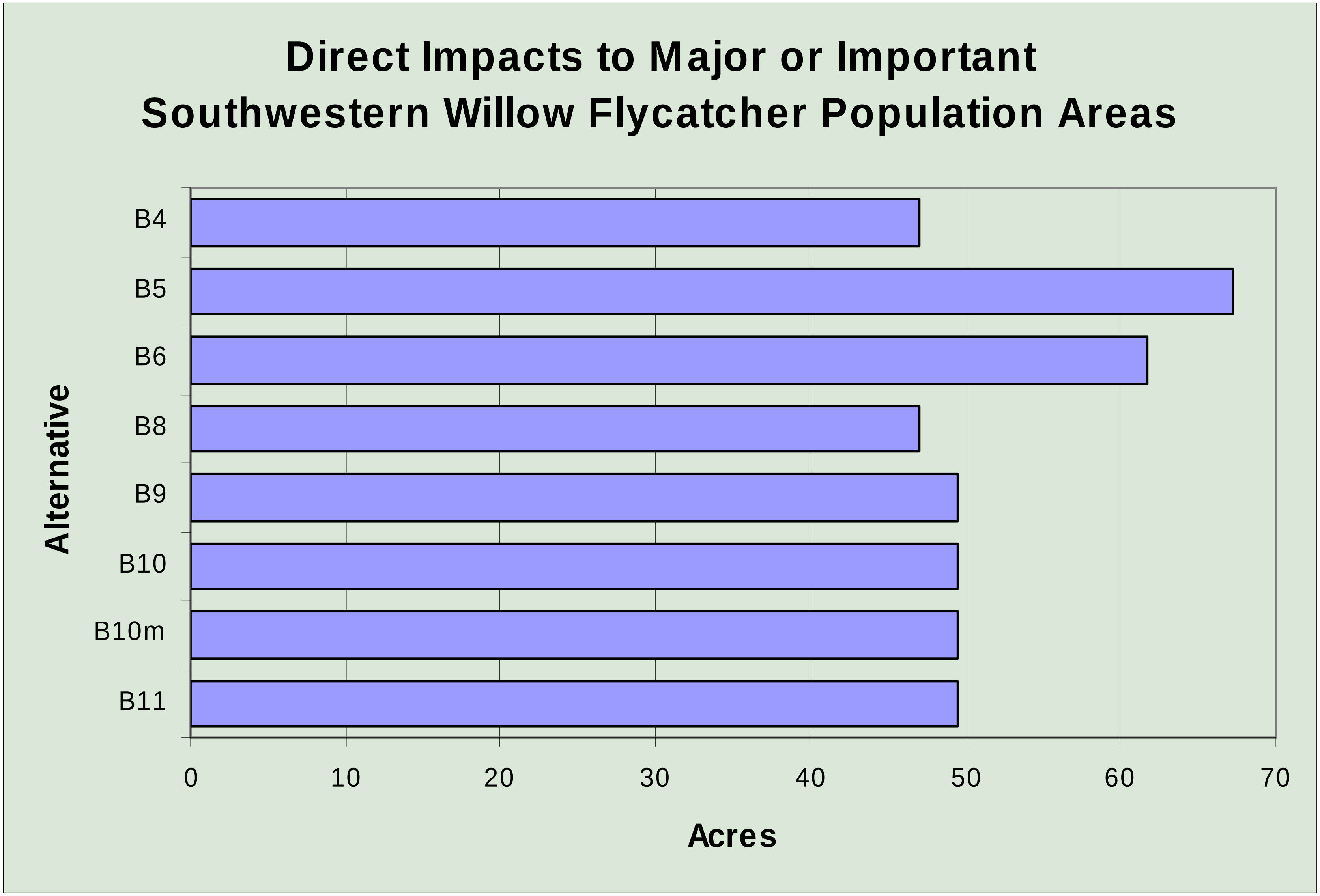


Figure 29. Criterion 6i: Direct impacts to Southwestern Willow Flycatcher

Table 17 and Figure 30 show the quantity of hydrologic integrity units in riparian reaches. Quantities are grouped into high, medium, and low integrity index ranges where the high range includes normalized integrity indices ≥0.7, the moderate range includes normalized integrity indices <0.7 and ≥0.4, and the low range includes normalized integrity indices <0.4.

Table 17. Criterion 7a: Quantity of hydrologic integrity units in riparian reaches

Alternatives	Quantity of Hydrology Integrity Units in Riparian Reaches				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total	
B4	60.6	2.4	0.0	63.1	0.93
B5	61.9	5.8	0.0	67.7	1.00
B6	51.5	5.8	0.0	57.3	0.85
B8	23.7	2.4	0.0	26.1	0.39
B9	39.7	2.4	0.0	42.2	0.62
B10	45.5	2.9	0.0	48.4	0.71
B10m	42.7	2.4	0.0	45.1	0.67
B11	48.0	2.4	0.0	50.4	0.75

Table 18 and Figure 31 show the quantity of water quality integrity units in riparian reaches.

Table 18. Criterion 7ba: Quantity of water quality integrity units in riparian reaches

Alternatives	Quantity of Water Quality Integrity Units in Riparian Reaches				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total	
B4	43.1	7.0	0.3	50.3	0.89
B5	50.1	6.4	0.3	56.7	1.00
B6	36.9	9.1	0.3	46.3	0.82
B8	18.2	2.7	0.3	21.1	0.37
B9	31.9	2.7	0.3	34.8	0.61
B10	36.2	3.4	0.3	39.8	0.70
B10m	34.1	3.0	0.3	37.3	0.66
B11	37.3	4.1	0.3	41.7	0.74

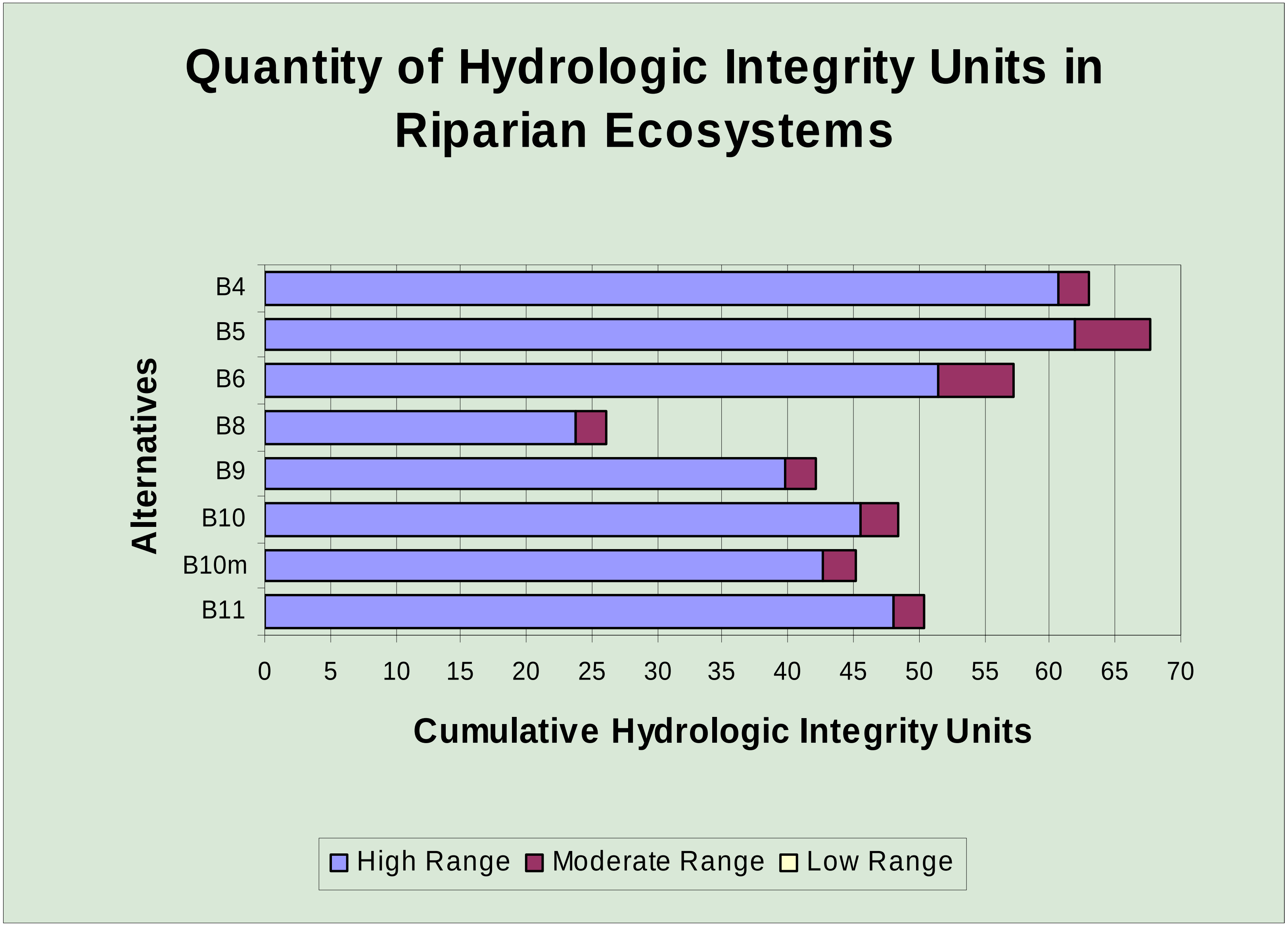


Figure 30. Criterion 7a: Hydrologic integrity units in riparian reaches

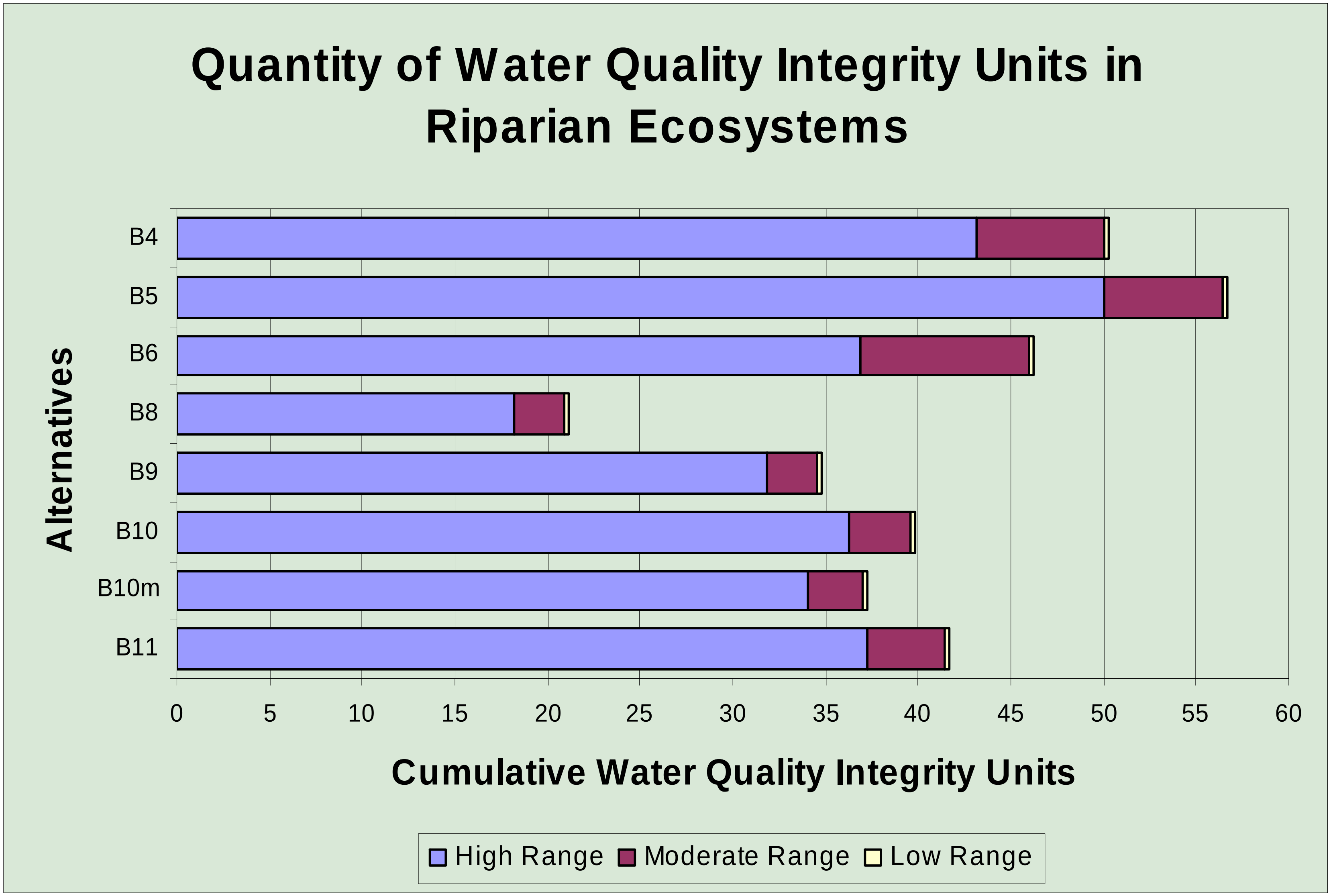


Figure 31. Criterion 7b: Water quality integrity units in riparian reaches

Table 19 and Figure 32 show quantity of habitat integrity units in riparian reaches.

Table 19. Criterion 7c: Quantity of habitat integrity units in riparian reaches

Alternatives	Quantity of Habitat Integrity Units in Riparian Reaches				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total	
B4	33.4	9.5	3.4	46.3	0.82
B5	47.5	6.6	2.1	56.2	1.00
B6	28.5	8.7	3.4	40.6	0.72
B8	14.0	2.0	2.1	18.1	0.32
B9	28.2	2.0	2.1	32.2	0.57
B10	30.7	3.3	2.4	36.4	0.65
B10m	27.5	3.9	2.1	33.6	0.60
B11	31.6	3.6	2.6	37.8	0.67

Table 20 and Figure 33 show the change/loss in the quantity of hydrologic integrity units in riparian reaches and local drainages directly impacted. In Table 19, Columns 2, 3, and 4 show the change in the quantity of hydrologic integrity units in the high, medium, and low integrity index ranges for each alternative that results from subtracting the number of hydrologic integrity units in each alternative prior to the simulation of direct or indirect impacts from the number of hydrologic integrity units in each alternative after the simulation of direct or indirect impacts. Column 5 shows the total loss of integrity units. In this table, and subsequent tables, it should be noted that positive numbers indicate the number of integrity units lost, and negative numbers indicate the number of hydrologic integrity units gained.

Table 20. Criterion 8a: Change in the quantity of hydrologic integrity units in riparian reaches and local drainages directly impacted

Alternatives	Change In The Quantity Of Hydrologic Integrity Units In Riparian Reaches And Local Drainages Directly Impacted				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total Loss	
B4	300.0	-86.0	-24.0	190.0	0.62
B5	648.8	-360.0	-6.7	282.1	0.92
B6	645.5	-334.6	-8.6	302.3	0.99
B8	436.7	-257.4	-1.8	177.5	0.58
B9	571.2	-324.8	-2.3	244.1	0.80
B10	256.0	-86.5	-3.3	166.2	0.54
B10m	637.9	-362.2	-2.7	273.0	0.89
B11	701.3	-392.0	-2.6	306.8	1.00

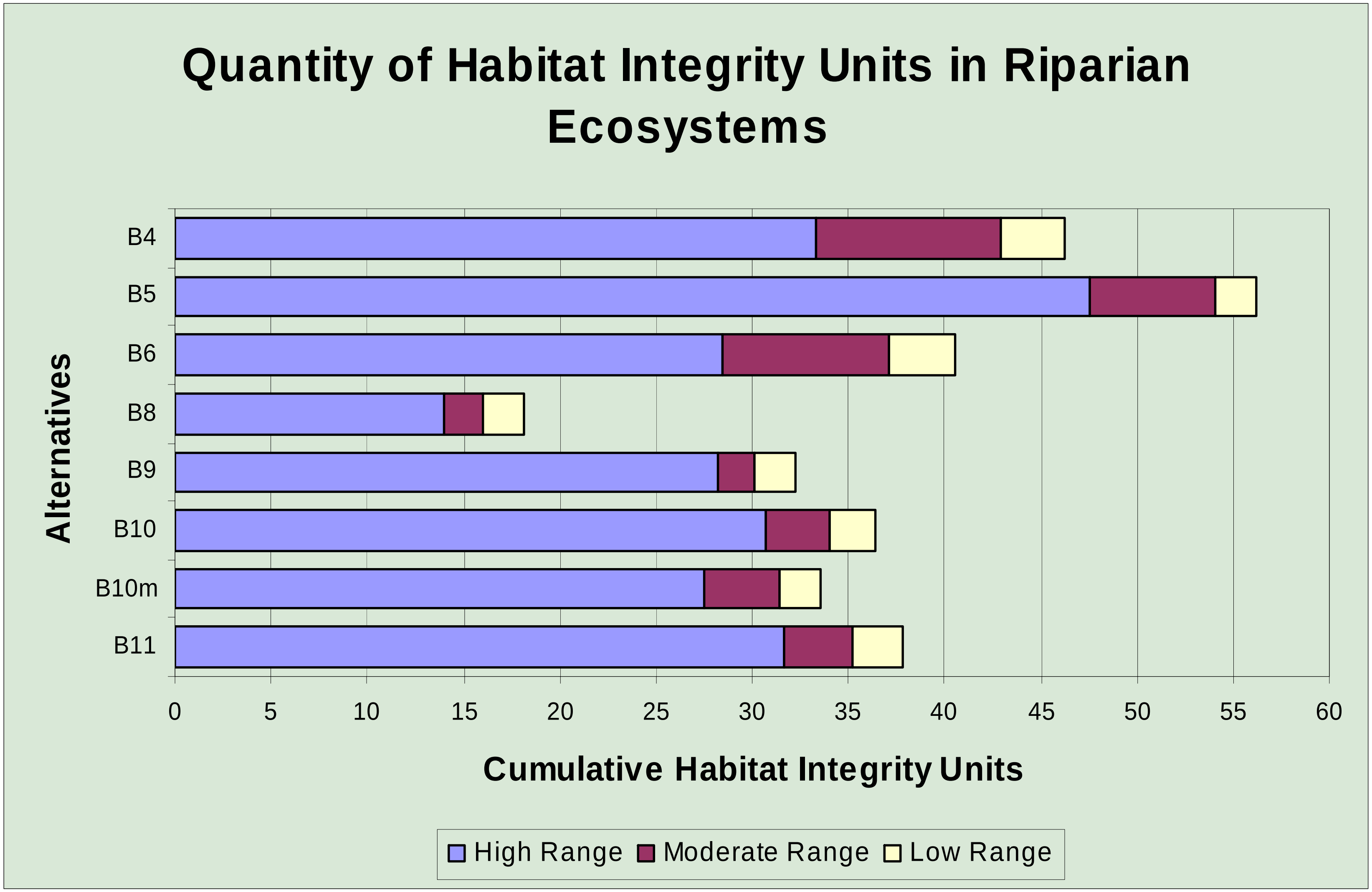


Figure 32. Criterion 7c: Habitat integrity units in riparian reaches

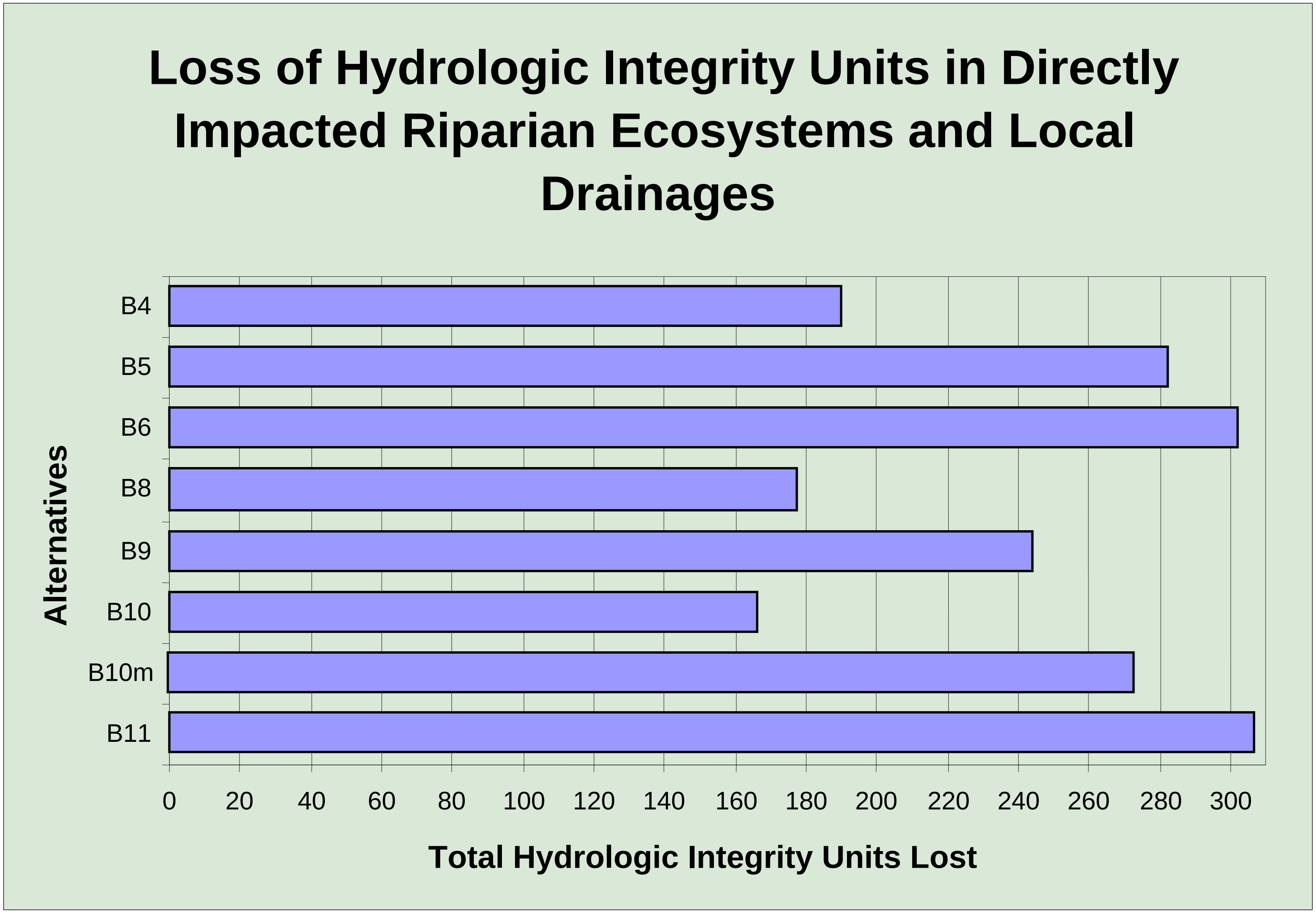


Figure 33. Criterion 8a: Loss of hydrologic integrity units in riparian reaches and local drainages directly impacted

It may seem unusual to gain (i.e., negative number) integrity units after a direct impact. However, this occurs when the integrity index of a reach shifts from one range to another under simulation of direct impacts. For example, if the integrity index of a reach is 0.8 prior to simulation and 0.6 after the simulation, the number of integrity units in the high range decreases, but the number of integrity units in the medium range increases. In all cases, the total number of integrity units in a reach decreases, or remains the same, as a result of direct impacts.

Tables 21 and 22, and Figures 34 and 35 shows the change/loss in the quantity of water quality and habitat integrity units respectively in riparian reaches and local drainages directly impacted.

Table 21. Criterion 8b: Change in the quantity of water quality integrity units in riparian reaches and local drainages directly impacted

Alternatives	Change In The Quantity Of Water quality Integrity Units In Riparian Reaches And Local Drainages Directly Impacted				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total Loss	
B4	382.2	-239.8	-13.7	128.7	0.57
B5	417.7	-216.6	-4.6	196.5	0.86
B6	415.1	-206.0	-6.8	202.4	0.89
B8	306.6	-190.9	0.0	115.7	0.51
B9	337.2	-170.4	-0.5	166.3	0.73
B10	398.7	-245.7	-4.1	148.9	0.65
B10m	417.8	-196.7	-12.4	208.7	0.92
B11	468.0	-228.6	-12.1	227.3	1.00

Table 22. Criterion 8c: Change in the quantity of habitat integrity units in riparian reaches and local drainages directly impacted

Alternatives	Change In The Quantity Of Habitat Integrity Units In Riparian Reaches And Local Drainages Directly Impacted				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total Loss	
B4	477.8	-304.7	-7.0	166.0	1.00
B5	341.0	-183.4	-5.9	151.6	0.91
B6	497.6	-339.7	-2.1	155.8	0.94
B8	164.8	-105.2	-2.1	57.6	0.35
B9	316.6	-198.1	-2.8	115.7	0.70
B10	211.2	-117.9	-2.7	90.6	0.55
B10m	366.3	-227.6	-4.1	134.5	0.81
B11	419.5	-252.0	-2.5	165.0	0.99

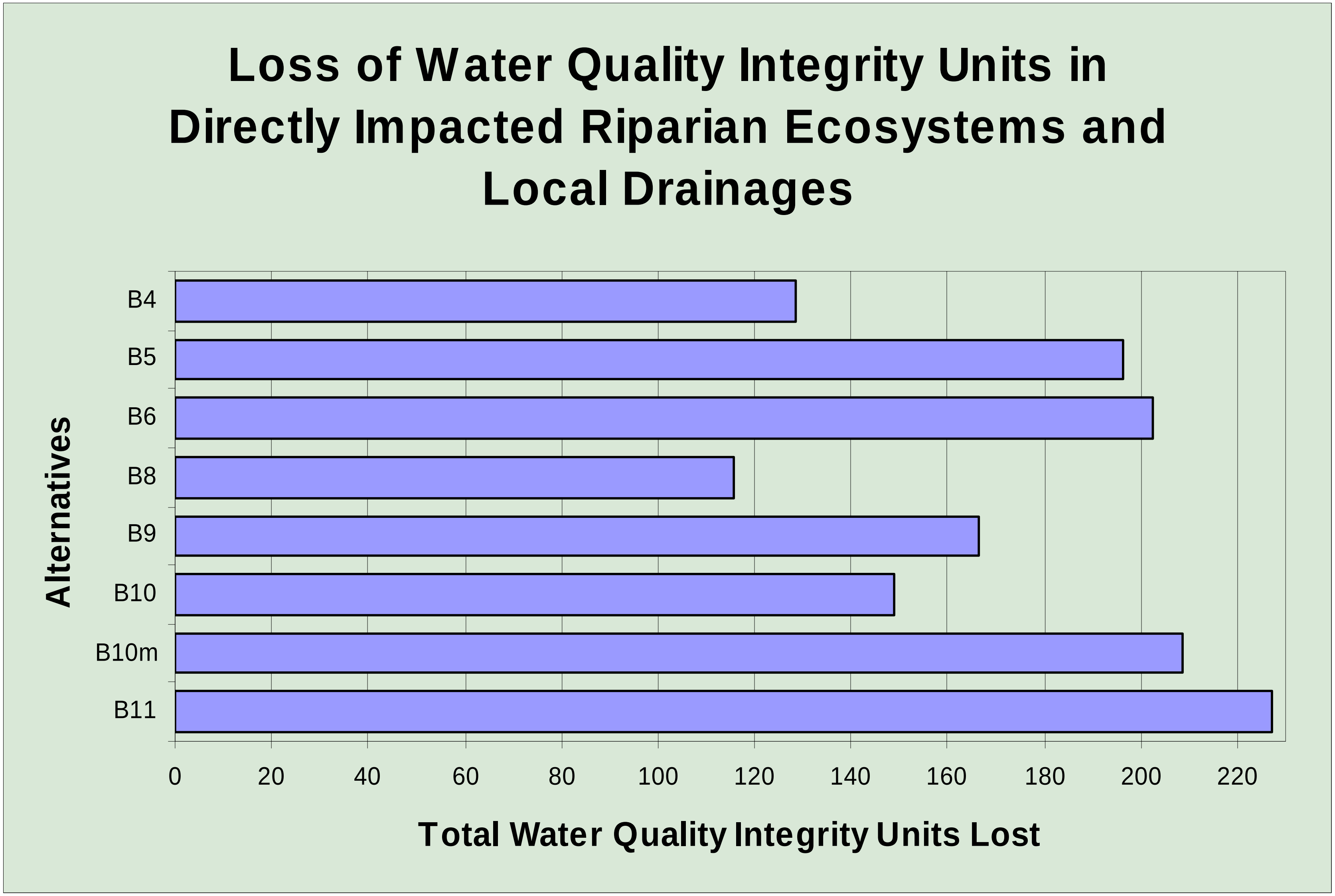


Figure 34. Criterion 8b: Loss of water quality integrity units in riparian reaches and local drainages directly impacted

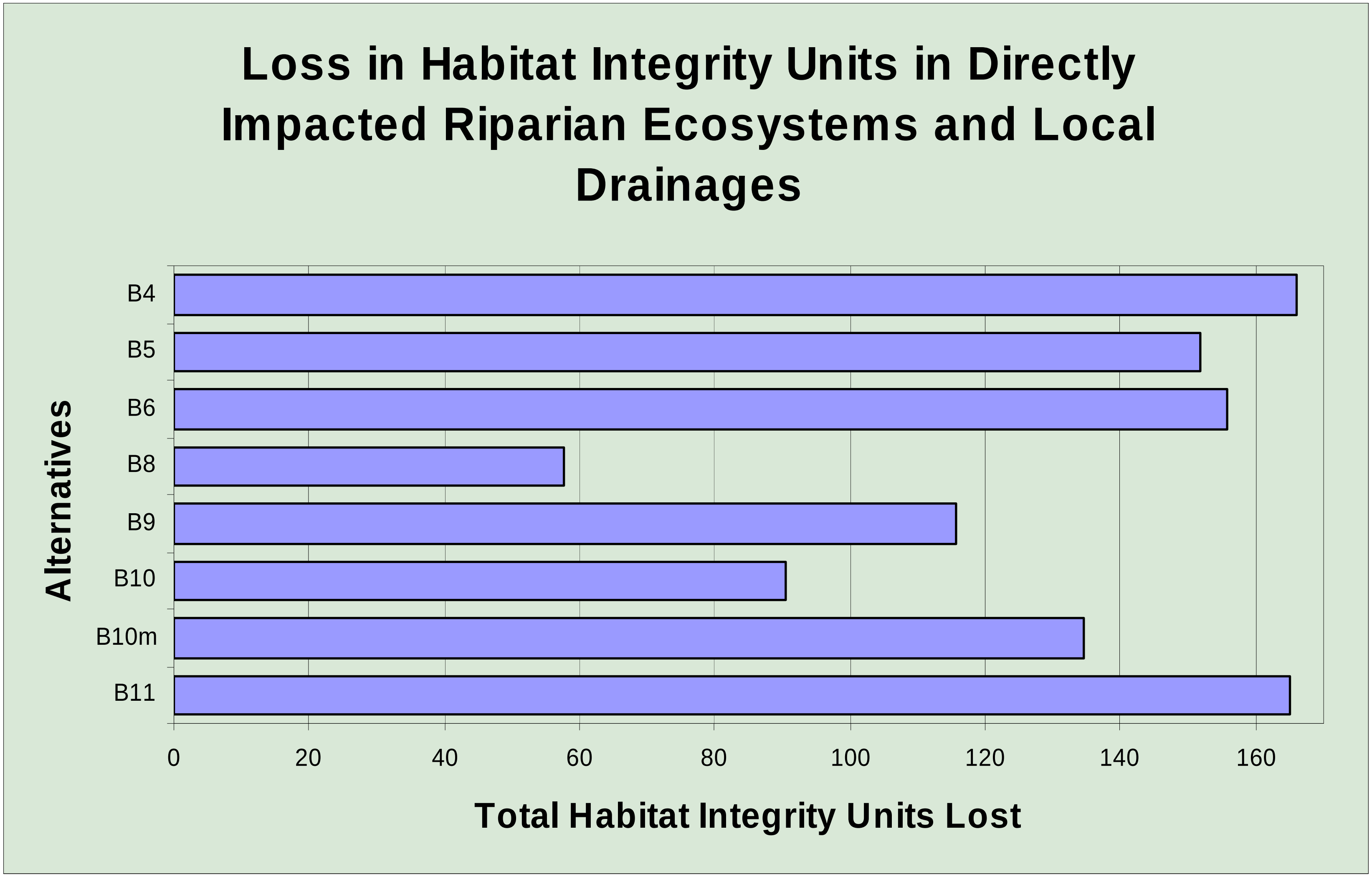


Figure 35. Criterion 8c: Loss of habitat integrity units in riparian reaches and local drainages directly impacted

Table 23 and Figure 36 show the change/loss in the quantity of hydrologic integrity units in riparian reaches and local drainages indirectly impacted.

Table 23. Criterion 9a: Change in the quantity of hydrologic integrity units in riparian reaches and local drainages indirectly impacted

Alternatives	Change/Loss In The Quantity Of Hydrologic Integrity Units In Riparian Reaches And Local Drainages Indirectly Impacted				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total Loss	
B4	278.3	-86.3	-16.6	175.4	0.64
B5	551.6	-304.0	-15.0	232.6	0.85
B6	618.4	-344.9	-10.3	263.2	0.96
B8	423.2	-262.7	-2.4	158.0	0.58
B9	552.8	-330.0	-4.5	218.3	0.80
B10	220.7	-87.3	-5.3	128.1	0.47
B10m	615.2	-365.9	-5.0	244.3	0.89
B11	669.2	-390.3	-5.2	273.6	1.00

Table 24 and Figure 37 show the change/loss in the quantity of water quality integrity units in riparian reaches and local drainages indirectly impacted.

Table 24. Criterion 9b: Change in the quantity of water quality integrity units in riparian reaches and local drainages indirectly impacted

Alternatives	Change/Loss In The Quantity Of Water quality Integrity Units In Riparian Reaches And Local Drainages Indirectly Impacted				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total Loss	
B4	365.4	-241.8	-8.9	114.8	0.58
B5	382.9	-218.6	-11.9	152.5	0.77
B6	391.9	-215.1	-7.9	168.9	0.86
B8	291.5	-193.2	-0.5	97.8	0.50
B9	317.3	-172.6	-2.2	142.5	0.72
B10	380.0	-253.7	-8.9	117.4	0.59
B10m	399.8	-202.3	-14.5	183.0	0.93
B11	442.0	-230.4	-14.2	197.4	1.00

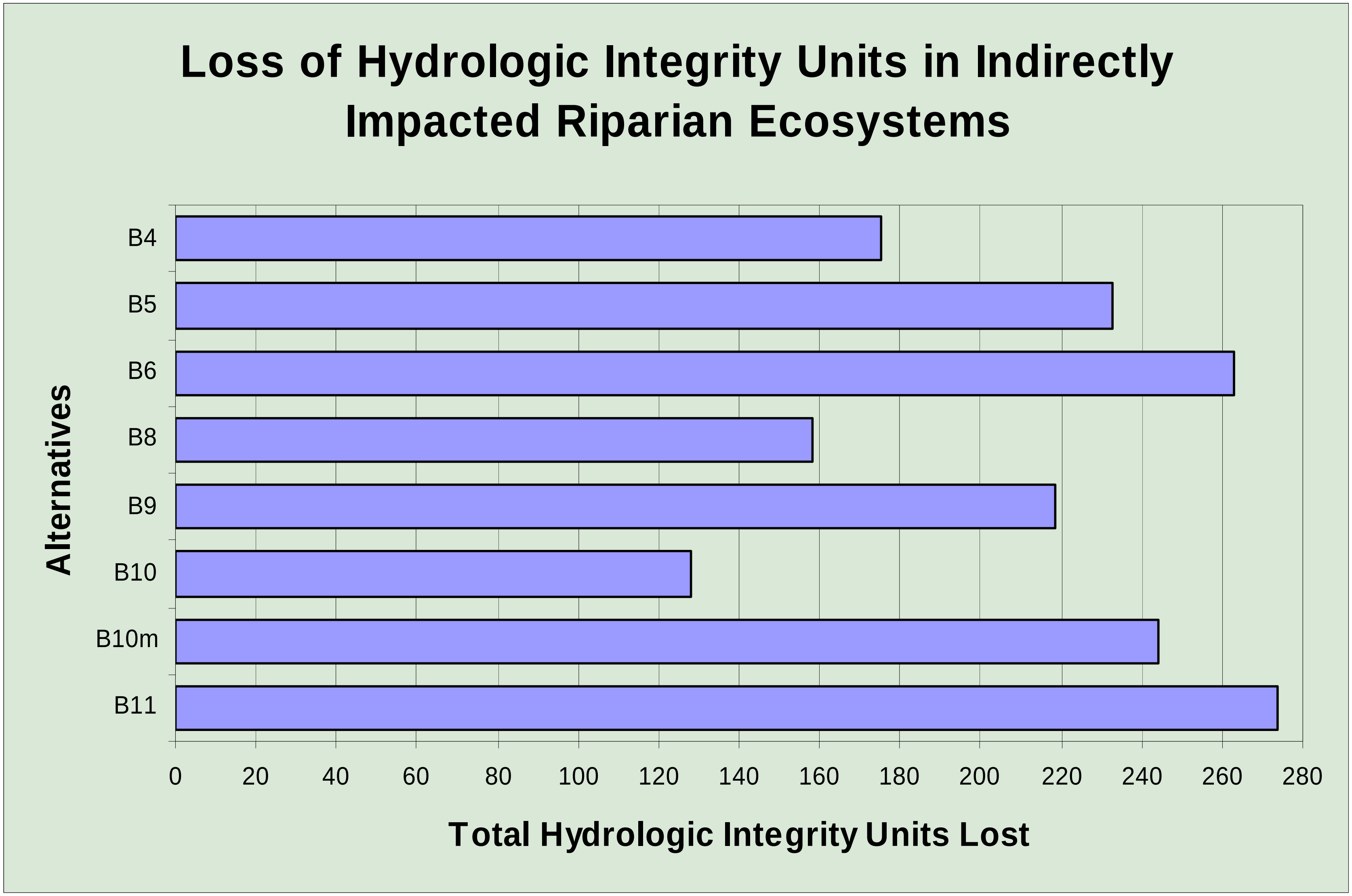


Figure 36. Criterion 9a: Loss of hydrologic integrity units in riparian reaches and local drainages directly impacted

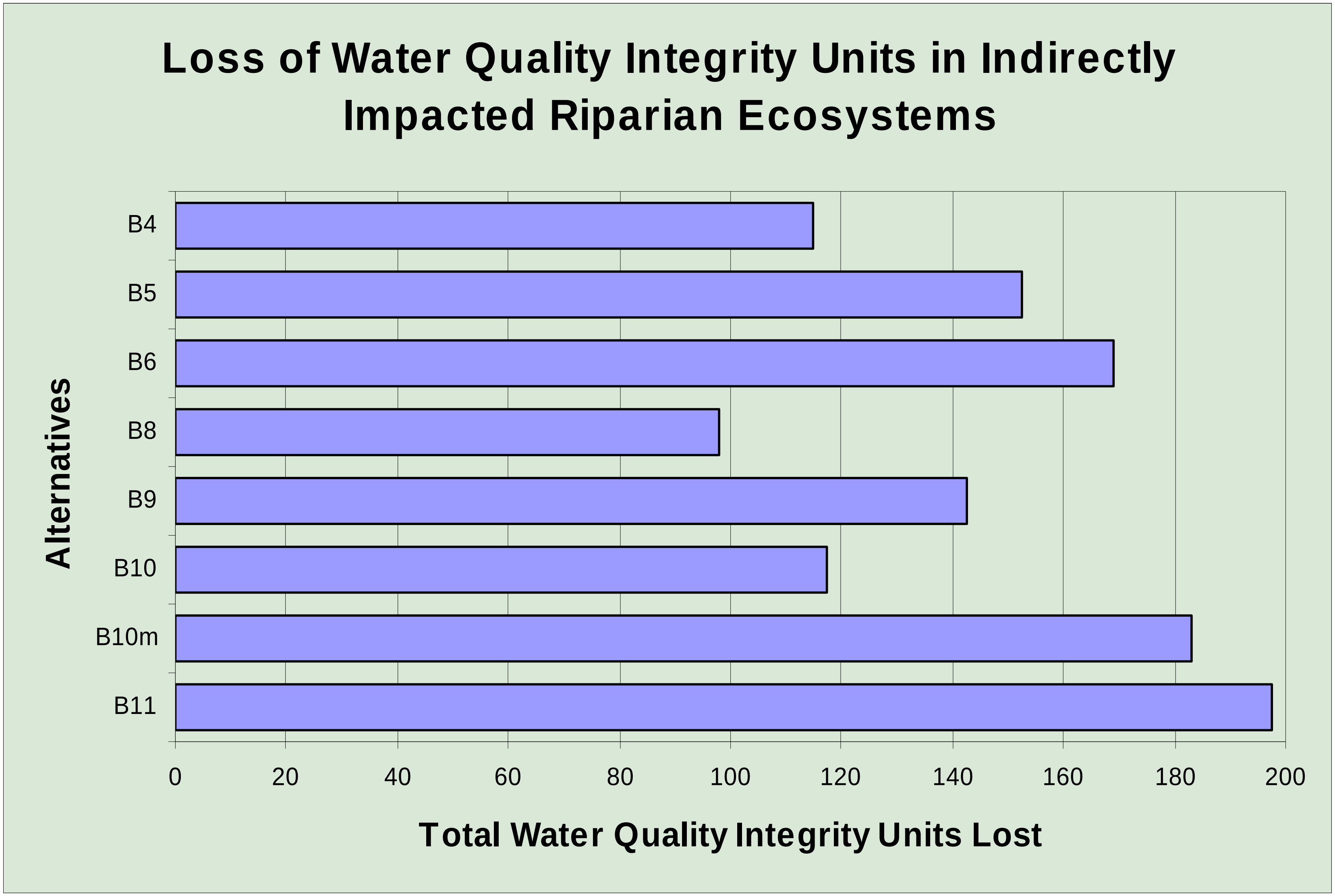


Figure 37. Criterion 9b: Loss of water quality integrity units in riparian reaches and local drainages directly impacted

Table 25 and Figure 38 show the change/loss in the quantity of water quality integrity units in riparian reaches and local drainages indirectly impacted.

Table 25. Criterion 9c: Change in the quantity of habitat integrity units in riparian reaches and local drainages indirectly impacted

Alternatives	Change/Loss In The Quantity Of Habitat Integrity Units In Riparian Reaches And Local Drainages Indirectly Impacted				Normalized Rank Score
	High Range	Moderate Range	Low Range	Total Loss	
B4	469.2	-311.4	-7.0	150.8	1.00
B5	309.7	-188.9	-13.3	107.5	0.71
B6	484.7	-352.6	-4.7	127.4	0.84
B8	154.3	-111.0	-1.0	42.4	0.28
B9	303.3	-204.2	-4.2	95.0	0.63
B10	191.3	-122.2	-7.5	61.7	0.41
B10m	350.6	-233.7	-6.7	110.2	0.73
B11	401.4	-257.7	-6.0	137.8	0.91

5.2 Summary of Normalized Rank Scores

The following tables and figures summarize the large amount of information generated during this analysis. The values in these tables were calculated as follows. For all the criteria analyzed above, each alternative was assigned a normalized rank score to allow comparison with other alternatives. To determine normalized rank score, the level of impact (i.e, number of miles, acres of riparian ecosystem, or integrity units.) of each alternative was divided by the level of impact of the alternative with the greatest number of miles, acres, or integrity units impacted for that criterion. For example, in Table 25, Alternative B4 received a normalized rank score of 1.00 because it had the greatest loss of habitat integrity units of all the alternatives. All other alternatives received a normalized rank score of <1.00 because they had a total loss of habitat integrity units less than Alternative B4 (i.e., total loss of specific alternative divided by total loss of Alternative B4).

Table 26 and Figure 39 show the normalized rank scores for all 24 criteria evaluated. The last column in these tables shows the sum of the normalized rank scores. This value gives a general indication of the overall impact of a particular alternative based on all criteria. Other tables were constructed using the normalized rank scores to display information pertaining to specific criteria subsets. Table 27 and Figure 40 show the results for alternatives based on criteria related to direct impacts to WoUS and riparian ecosystems (i.e., Criteria 1, 3, and 4),

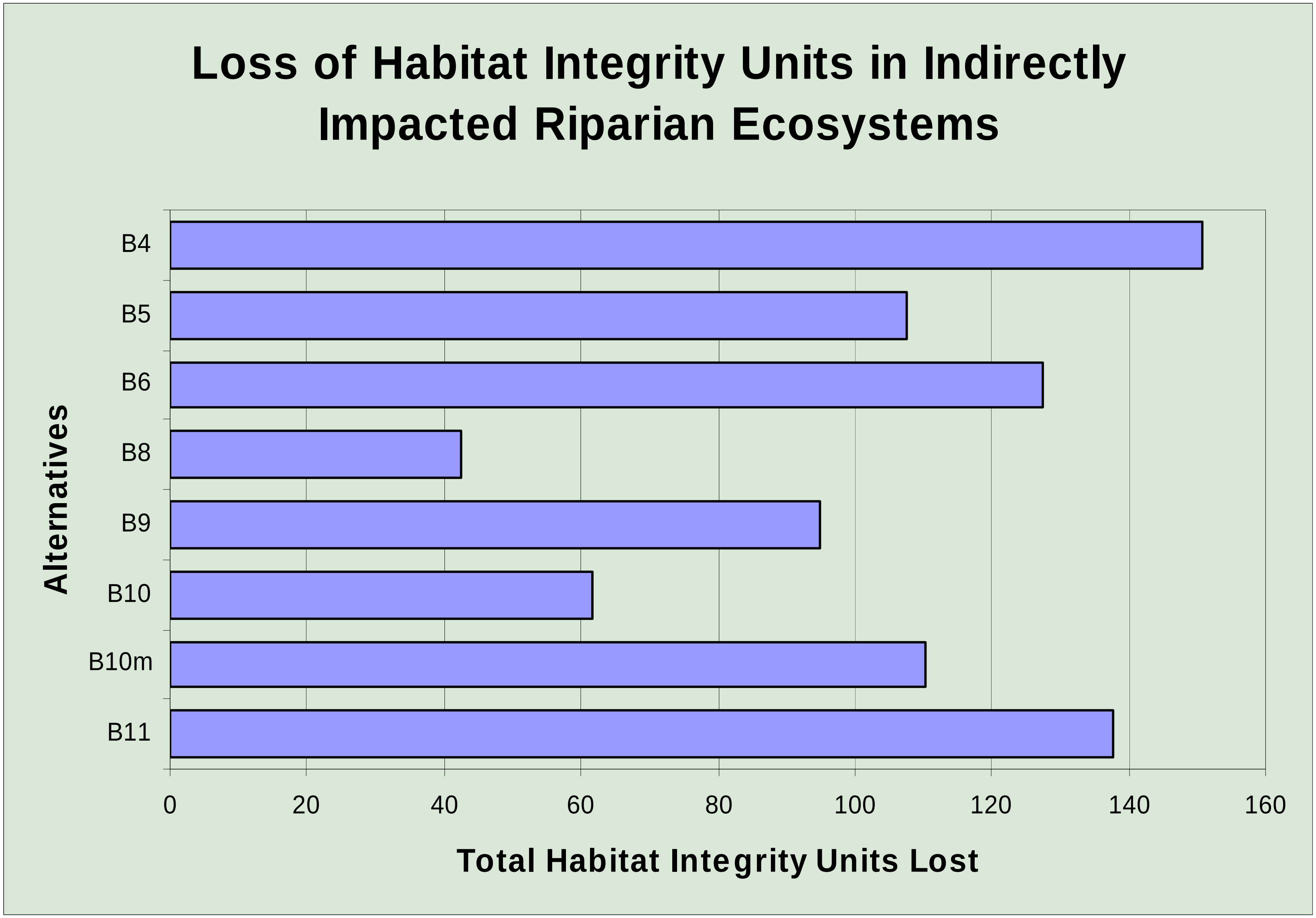


Figure 38. Criterion 9c: Loss of habitat integrity units in riparian reaches and local drainages directly impacted

Table 26. Normalized rank scores for alternatives based on all criteria

Alternative	Criteria																							Sum of Normalized Rank Scores
	1	2	3	4	5	6a	6b	6c	6d	6e	6f	6g	6h	6i	7a	7b	7c	8a	8b	8c	9a	9b	9c	
B4	0.72	1.00	0.78	1.00	1.00	0.94	0.66	0.57	0.56	1.00	0.81	0.36	1.00	0.70	0.93	0.89	0.82	0.62	0.57	1.00	0.64	0.58	1.00	18.15
B5	0.75	0.40	0.97	1.00	0.48	0.99	1.00	1.00	1.00	0.65	1.00	1.00	0.35	1.00	1.00	1.00	1.00	0.92	0.86	0.91	0.85	0.77	0.71	19.62
B6	0.67	0.61	0.94	0.86	0.87	1.00	0.08	0.10	0.71	0.68	0.70	0.02	0.24	0.92	0.85	0.82	0.72	0.99	0.89	0.94	0.96	0.86	0.84	16.26
B8	0.32	0.29	0.45	0.39	0.40	0.72	0.05	0.00	0.55	0.30	0.53	0.00	0.00	0.70	0.39	0.37	0.32	0.58	0.51	0.35	0.58	0.50	0.28	8.57
B9	0.80	0.54	0.88	0.62	0.86	0.73	0.38	0.02	0.59	0.59	0.77	0.03	0.43	0.74	0.62	0.61	0.57	0.80	0.73	0.70	0.80	0.72	0.63	14.17
B10	0.90	0.73	0.93	0.72	0.93	0.86	0.59	0.31	0.59	0.78	0.79	0.25	0.73	0.74	0.71	0.70	0.65	0.54	0.65	0.55	0.47	0.59	0.41	15.12
B10m	0.89	0.83	0.90	0.71	0.94	0.86	0.60	0.36	0.59	0.79	0.79	0.30	0.73	0.74	0.67	0.66	0.60	0.89	0.92	0.81	0.89	0.93	0.73	17.12
B11	1.00	0.65	1.00	0.79	0.91	0.95	0.66	0.37	0.59	0.88	0.82	0.27	0.83	0.74	0.75	0.74	0.67	1.00	1.00	0.99	1.00	1.00	0.91	18.52

Table 27. Normalized rank scores for criteria directly impacting WoUS and riparian ecosystems

Alternative	Criteria			Sum of Normalized Rank Scores
	Criterion 1	Criterion 3	Criterion 4	
B4	0.72	0.78	1.00	2.50
B5	0.75	0.97	1.00	2.72
B6	0.67	0.94	0.86	2.47
B8	0.32	0.45	0.39	1.15
B9	0.80	0.88	0.62	2.30
B10	0.90	0.93	0.72	2.55
B10m	0.89	0.90	0.71	2.50
B11	1.00	1.00	0.79	2.79

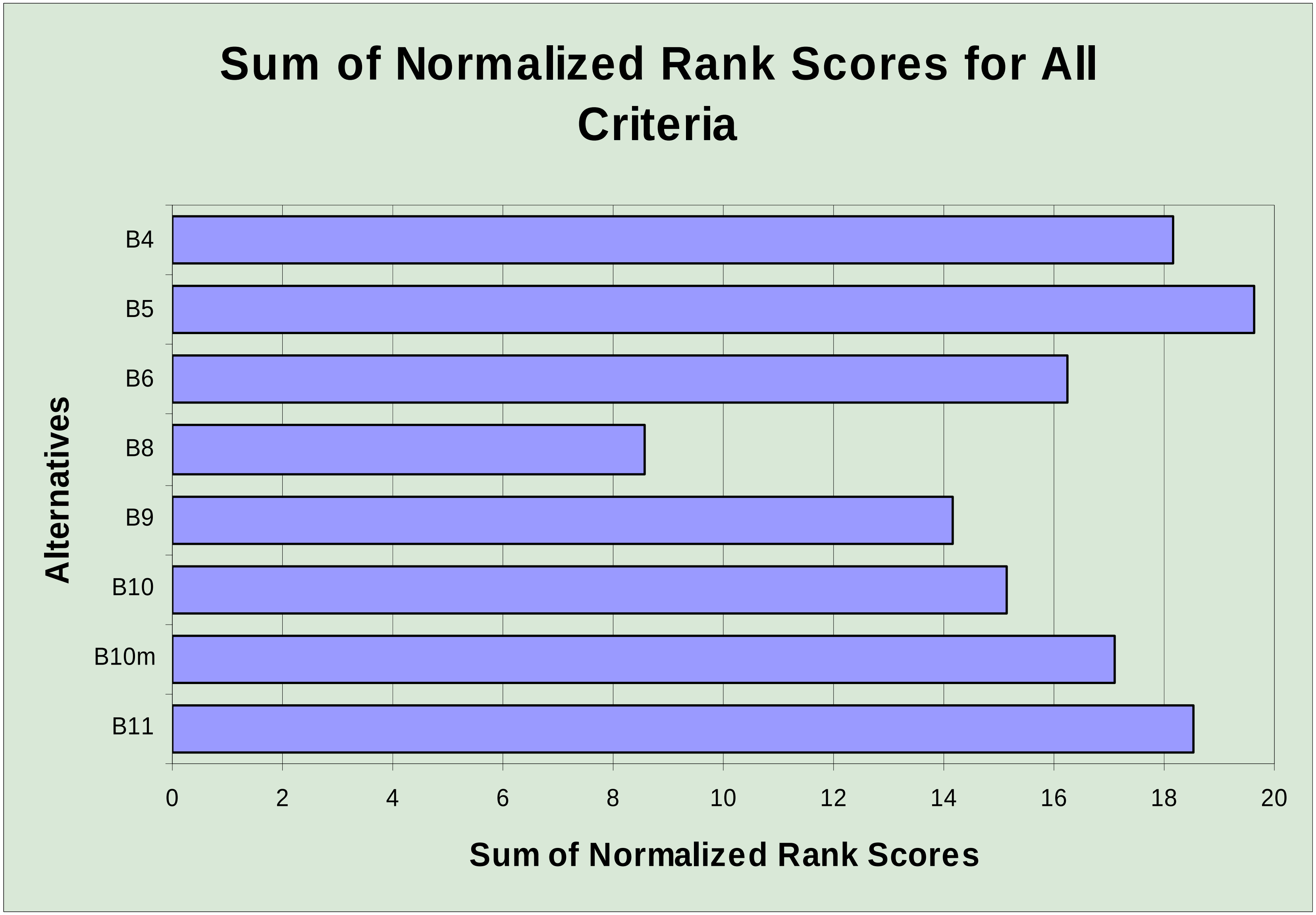


Figure 39. Sum of normalized rank scores for all criteria

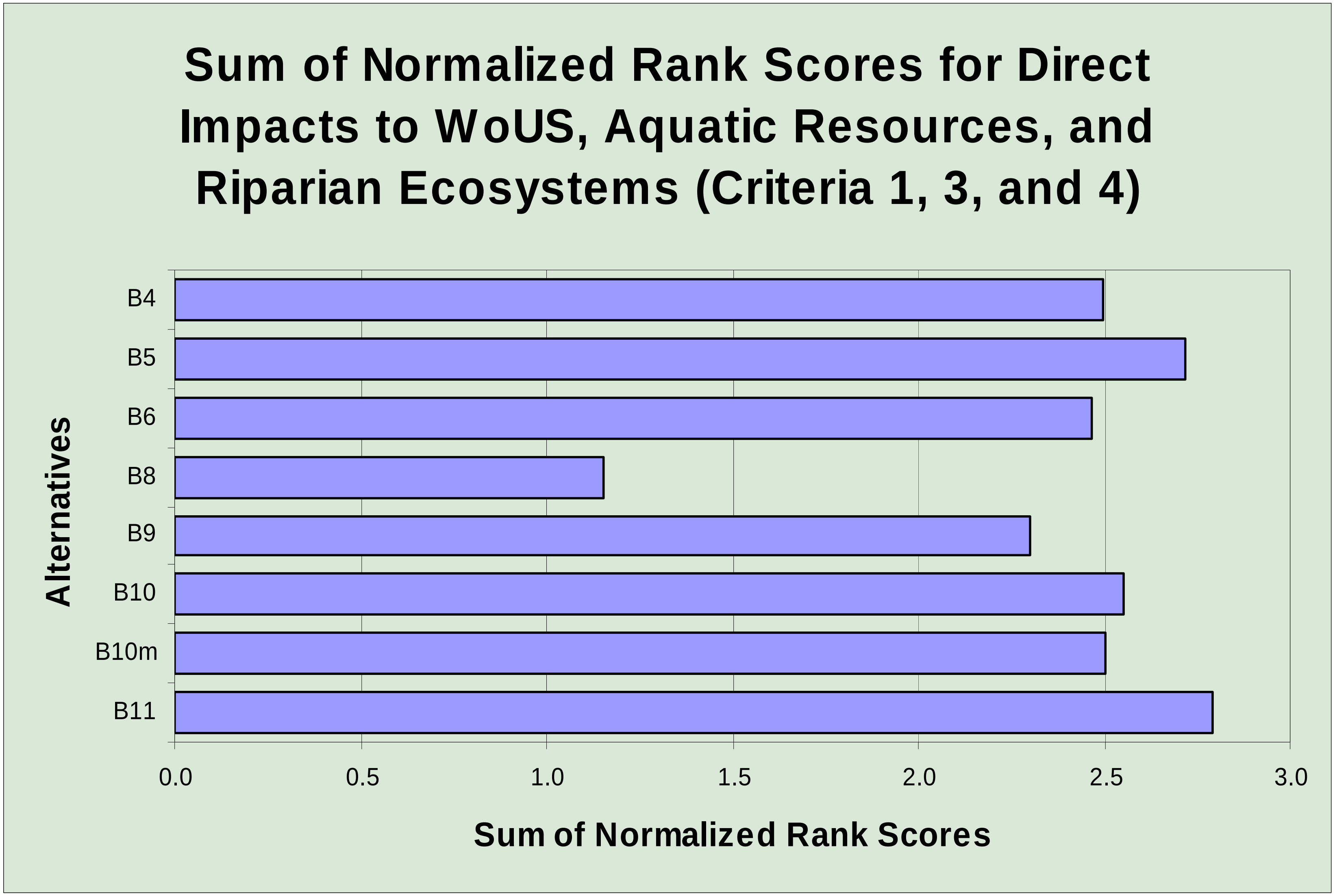


Figure 40. Sum of normalized rank scores for criteria directly impacting WoUS and riparian ecosystems

Table 28 and Figure 41 show the results for alternatives based on criteria related to indirect impacts to WoUS and riparian ecosystems (i.e., Criteria 2 and 5). Table 29 and Figure 42 show the results for alternatives based on criteria related to threatened or endangered species habitat (i.e., Criteria 6a –6i).

Table 28. Normalized rank scores for criteria indirectly impacting WoUS and riparian ecosystems

Alternative	Criteria		Sum of Normalized Rank Scores
	Criterion 2	Criterion 5	
B4	1.00	1.00	2.00
B5	0.40	0.48	0.88
B6	0.61	0.87	1.49
B8	0.29	0.40	0.68
B9	0.54	0.86	1.40
B10	0.73	0.93	1.66
B10m	0.83	0.94	1.77
B11	0.65	0.91	1.56

Table 29. Normalized rank scores for criteria impacting threatened or endangered species habitat

Alternative	Criteria									Sum of Normalized Rank Scores
	6a	6b	6c	6d	6e	6f	6g	6h	6i	
B4	0.94	0.66	0.57	0.56	1.00	0.81	0.36	1.00	0.70	6.60
B5	0.99	1.00	1.00	1.00	0.65	1.00	1.00	0.35	1.00	7.99
B6	1.00	0.08	0.10	0.71	0.68	0.70	0.02	0.24	0.92	4.45
B8	0.72	0.05	0.00	0.55	0.30	0.53	0.00	0.00	0.70	2.87
B9	0.73	0.38	0.02	0.59	0.59	0.77	0.03	0.43	0.74	4.29
B10	0.86	0.59	0.31	0.59	0.78	0.79	0.25	0.73	0.74	5.63
B10m	0.86	0.60	0.36	0.59	0.79	0.79	0.30	0.73	0.74	5.76
B11	0.95	0.66	0.37	0.59	0.88	0.82	0.27	0.83	0.74	6.10

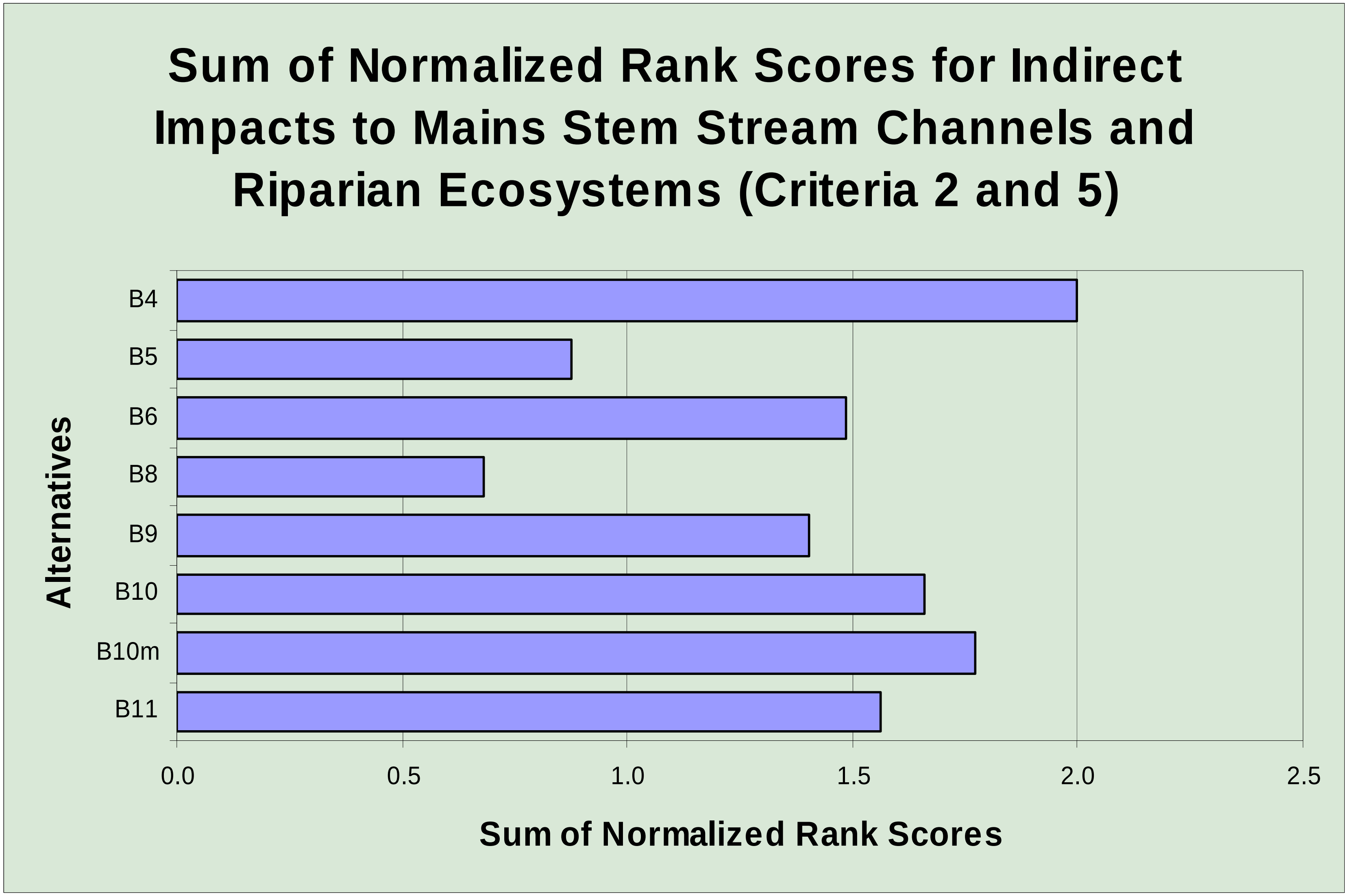


Figure 41. Sum of normalized rank scores for criteria indirectly impacting WoUS and riparian ecosystems

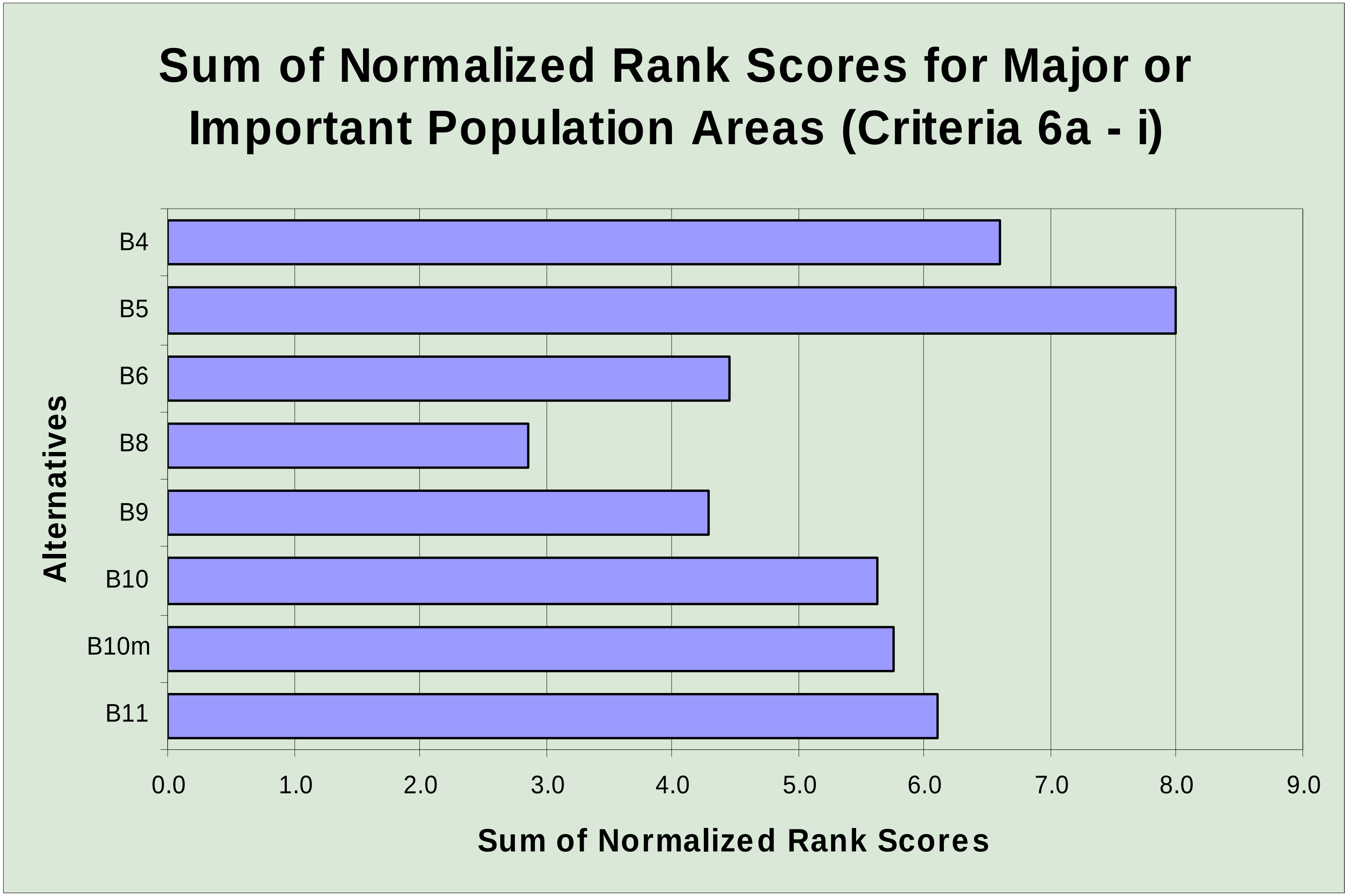


Figure 42. Sum of normalized rank scores for criteria impacting threatened or endangered species habitat

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* used as reference only, not cited in text

Appendix 1: Arcview Data, Report, and Supporting Spreadsheets

ArcView themes and images, this report and supporting spreadsheets developed for this project are contained in folders on the attached CD. These folders and the shape files are described below. All shape files are in UTM NAD83, Zone 11, with meters as the map unit. The "xxx" designates the various ArcView extensions attached to shape files created for each theme (i.e., dbf, shp, shx).

Baseline

This folder contains themes developed during the baseline delineation and assessment.

local drainages.xxx
main stems.xxx
nonwetland waters.xxx
aquatic resources.xxx

Direct Impacts

The shape files of the direct impact footprints for each of the alternatives are contained in the "Direct Impacts" folder. The original shape files from EDAW (point of contact: Laura Eisenburg) are contained in the "Originals" subfolder. These original files were manipulated as follows to create the shape files contained in the "Manipulated" subfolder. First, the shape files were reprojected to UTM, NAD83, Zone 11, and clipped to the Rancho Mission Viejo property boundary. Second, the original land use categories (labeled: "resconcept" in the attribute table) were reclassified into one of three categories: total loss, partial loss, or no change (labeled: "reclassified impact" in the attribute table). Third, the reclassified no change polygons were removed from the themes leaving total loss and partial loss polygons. The "land use reclassification table" in the "Manipulated Shape Files" subfolder shows how original land use categories were reclassified.

Originals	Manipulated
B4xxx.xxx	B4_direct.xxx
B5xxx.xxx	B5_direct.xxx
B6xxx.xxx	B6_direct.xxx
B8xxx.xxx	B8_direct.xxx
B9xxx.xxx	B9_direct.xxx
B10xxx.xxx	B10_direct.xxx
B10mxxx.xxx	B10mxxx.xxx
B11xxx.xxx	B11xxx.xxx

Indirect Impacts

The shape files for indirectly impacted local drainages are contained in the "Indirect Impacts" folder.

B4 indirect ld.xxx
B5 indirect ld.xxx
B6 indirect ld.xxx
B8 indirect ld.xxx
B9 indirect ld.xxx
B10 indirect ld.xxx
B10mxxx.xxx

Riparian Ecosystems

The shape file for the riparian ecosystems along main stem channels is contained in the "Riparian" folder.

riparian.xxx

Major or Important Population Areas

Shape files for Arroyo Toad (arto), California Gnatcatcher (cagn), Coulter's Saltbush (cosb), Least Bell's Vireo (lbv), Many-Stemmed Dudleya (msd), Intermediate Mariposa Lily (mpl), Southern Tar Plant (stp), Thread-Leaved Brodiaea (tlb), and Southwestern Willow Flycatcher (wfc) major or important population areas are contained in the "Major Population Areas" folder. Original shape files of major or important population areas are contained in the "Originals" subfolder. Shape files of major or important population areas clipped using the direct impact footprint of each alternative are contained in the "Alternative Clips" subfolder. The shapefiles in this folder are named using the parenthetical acronyms above. For example, California Gnatcatcher files are named "cagn.xxx." Shape files in this folder include:

Originals	Alternative Clips
arroyotoad.xxx	artoxxx..xxx
coulter'ssaltbush.xxx	cagn.xxx
gnatcatcher.xxx	cosb.xxx
leastbell'svireo.xxx	lbv.xxx
manystemmeddudleya.xxx	mpl.xxx
intmariposalily.xxx	msd.xxx
outherntarplant.xxx	stp.xxx
tlbrodiaea.xxx	tlb.xxx
swwillowflycatcher.xxx	wfc.xxx

Images

Two folders contain aerial and digital raster graphic images ("tif") of the project area The aerial images are from US Air Photo, and were taken in February of 2002. The digital raster graphics image is from Sure Maps Raster. The names of files in this folder are:

images aerial folder
images drg folder

Spreadsheets

This folder contains two spreadsheets. The first contains indicator metrics, scores, and integrity indices for baseline assessment and alternative simulations. The second contains summary data, tables and graphics resulting from the analysis of all criteria. Files in this folder are named:

sjsm baseline and simulations.xls
sjsm criteria.xls

Report

This folder contains two documents. The first is the final report in Microsoft Word format. The second is the final report in Adobe Acrobat format. The files in this folder are named:

sjsm report.doc sjsm report. pdf