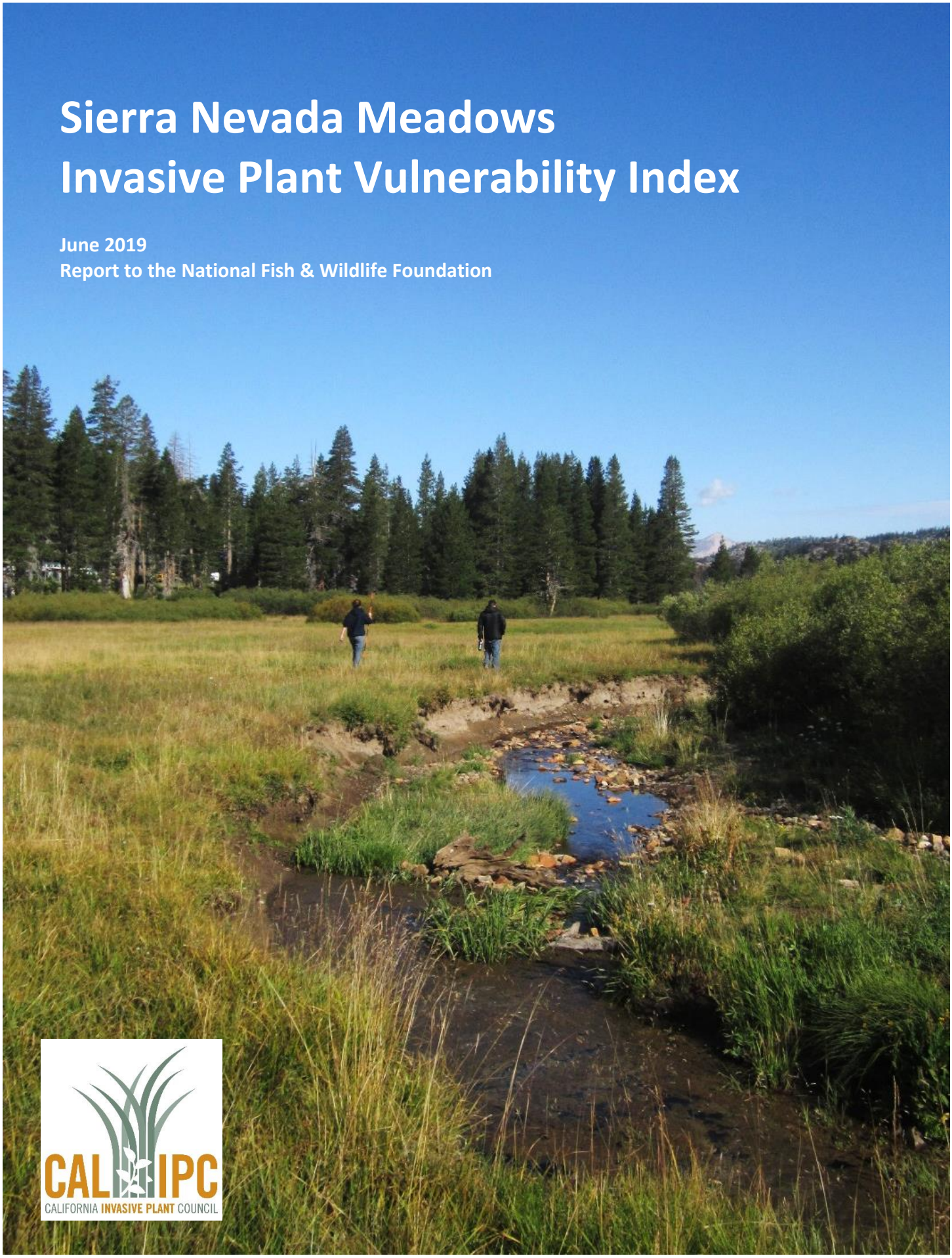
Sierra Nevada Meadows Invasive Plant Vulnerability Index

June 2019
Report to the National Fish & Wildlife Foundation



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Acknowledgments

Many individuals contributed to this project and we greatly appreciate their partnership.

Giselle Block of the US Fish & Wildlife Service (USFWS) shared the Invasive Plant Inventory and Early Detection Tool (IPIEDT) with us and helped determine the best way to use it for our purposes.

Shana Gross of the US Forest Service's Lake Tahoe Basin Management Unit provided significant input into recasting the IPIEDT criteria to relate specifically to Sierra meadows.

Toni Lyn Morelli, Research Ecologist, US Dept. of Interior Northeast Climate Science Center, and Sean Maher, Asst. Professor at Missouri State University, shared insights and data from their research on meadow connectivity and climate refugia in the Sierra.

The following individuals provided expert knowledge regarding specific Sierra meadows:

- Matt Brown, Botanist, Eldorado National Forest
- Joanna Clines, Botanist, Sierra National Forest
- Athena Demetry, Restoration Ecologist, Sequoia-Kings Canyon National Park
- Garrett Dickman, Botanist, Yosemite National Park
- Erik Frenzel, Ecologist, Sequoia-Kings Canyon National Park
- Mike Friend, Botanist, Plumas National Forest
- Jennie Haas, Botanist, Stanislaus National Forest
- Ed King, Deputy Agricultural Commissioner, Placer County Dept. of Agriculture
- LeeAnne Mila, Deputy Agricultural Commissioner, El Dorado & Alpine County Depts. of Agriculture
- Kendra Sikes, Vegetation Ecologist, California Native Plant Society
- Joel Trumbo, Sr. Environmental Scientist, California Dept. of Fish & Game

We hope this collaborative effort leads toward enhanced stewardship of Sierra meadows.

Overview

Sierra Nevada meadows provide important wildlife habitat and hydrologic function and invasive plants can degrade these values. The ability of land managers to effectively address the impacts of invasive plants with their limited capacity depends in large part on prioritization—determining which weed species in which locations should be targeted to have the greatest conservation benefit. This project aims to support Sierra Nevada land managers in determining which meadows to focus their weed management activities on.

Cal-IPC used a "vulnerability index" (VI) approach to prioritize the need for invasive plant management among a set of sites. We previously used this approach with tidal marshes around San Francisco Bay, scoring marshes based on their conservation value, current condition, ease of management, etc. That VI scoring provided a substantive ranking for investment of management dollars aimed at achieving the greatest conservation benefit at the Bay-wide landscape scale.

But while there were approximately forty tidal marsh sites in the San Francisco Bay effort, there are thousands of meadow sites in the Sierra Nevada. (The GIS dataset on the UC Davis Sierra Nevada Meadows Data Clearinghouse includes 18,780 as of the time of this report.) The assessment process for the tidal marshes involved substantial discussion about each site and clearly this level of site-by-site detail is not feasible for Sierra meadows given their quantity. This project was designed as a pilot to see whether there is a process that could include enough detail to be useful while remaining streamlined enough to be practical for evaluating thousands of sites.

To design a pilot project our approach was to: (1) design a meadow VI scoring system; (2) randomly select a sample set of 100 meadows across the region; (3) score those meadows using a combination of GIS analysis and collecting expert knowledge via interviews; (4) translate and share the results with land managers in the region and solicit their feedback on its usefulness; and (5) determine if there is a streamlined methodology for scaling this approach up to score VI for thousands of meadows.

VI Scoring System

As we had done previously for the San Francisco Bay VI scoring effort, we modified an existing scoring system developed by the US Fish & Wildlife Service, the Invasive Plant Inventory and Early Detection Prioritization Tool (IPIEDT). IPIEDT was developed to help national refuge managers prioritize which areas to survey for invasive plants, and which plants to survey for. We used only the section designed to set priorities among a set of areas since we have other tools (like Cal-IPC's Inventory and regional prioritizations) to prioritize invasive plant species.

The criteria in the IPIEDT system are generic, so we tailored them to be more specific to Sierra meadows (calling out historic grazing disturbance, for instance). This was especially important for defining the various ranking levels for each criterion so that we could be reasonably confident that different respondents would answer consistently. Appendix A lists the criteria and the definitions for each ranking.

We also reduced the number of criteria (from 11 to 8) and combined the criteria in a slightly different way than what was already programmed into IPIEDT. This made sense in that our goal with the ranking –

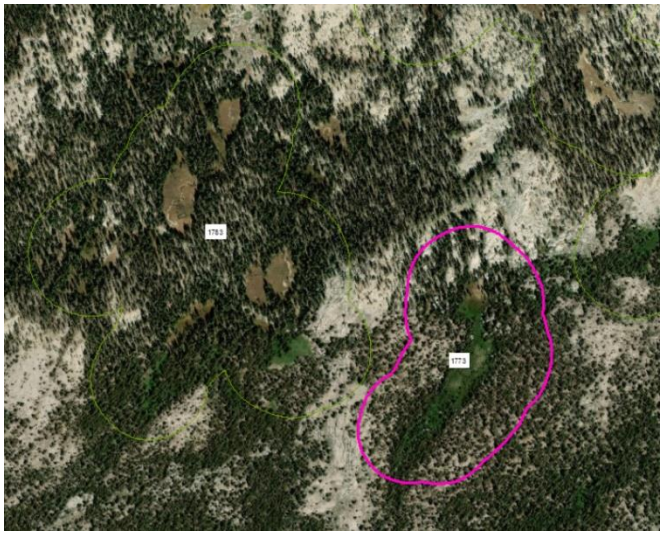
identifying sites for control – was slightly different than the original goal of the tool – identifying sites for survey. The criteria are listed below. The score for each criterion rolls up to the score of that section, and then the scores for the three sections are combined to produce the final VI score. The scoring followed the logic that high meadow value, high risk for invasion, and low current level of invasion all contribute toward a high VI score.

1. ***Value of the meadow***
   - 1.1. Ecological integrity (hydrology, compaction, vegetation)
   - 1.2. Conservation importance to federal- or state-listed species *
   - 1.3. Conservation importance to other resources (connectivity, climate refugia) *
2. ***Risk for invasion***
   - 2.1. Innate resistance to plant invasion
   - 2.2. Risk via transportation (roads) *
   - 2.3. Risk via disturbance (planned restoration)
3. ***Current level of invasion***
   - 3.1. Current infestation level
   - 3.2. Number of weed species present *

For those criteria derived primarily from GIS analysis (marked above with an *), a detailed description of the scoring methodology is included in Appendix B. Since the goal of this project is to develop a method that can be streamlined for thousands of sites, GIS analysis is a preferred approach over more time-intensive expert interviews.

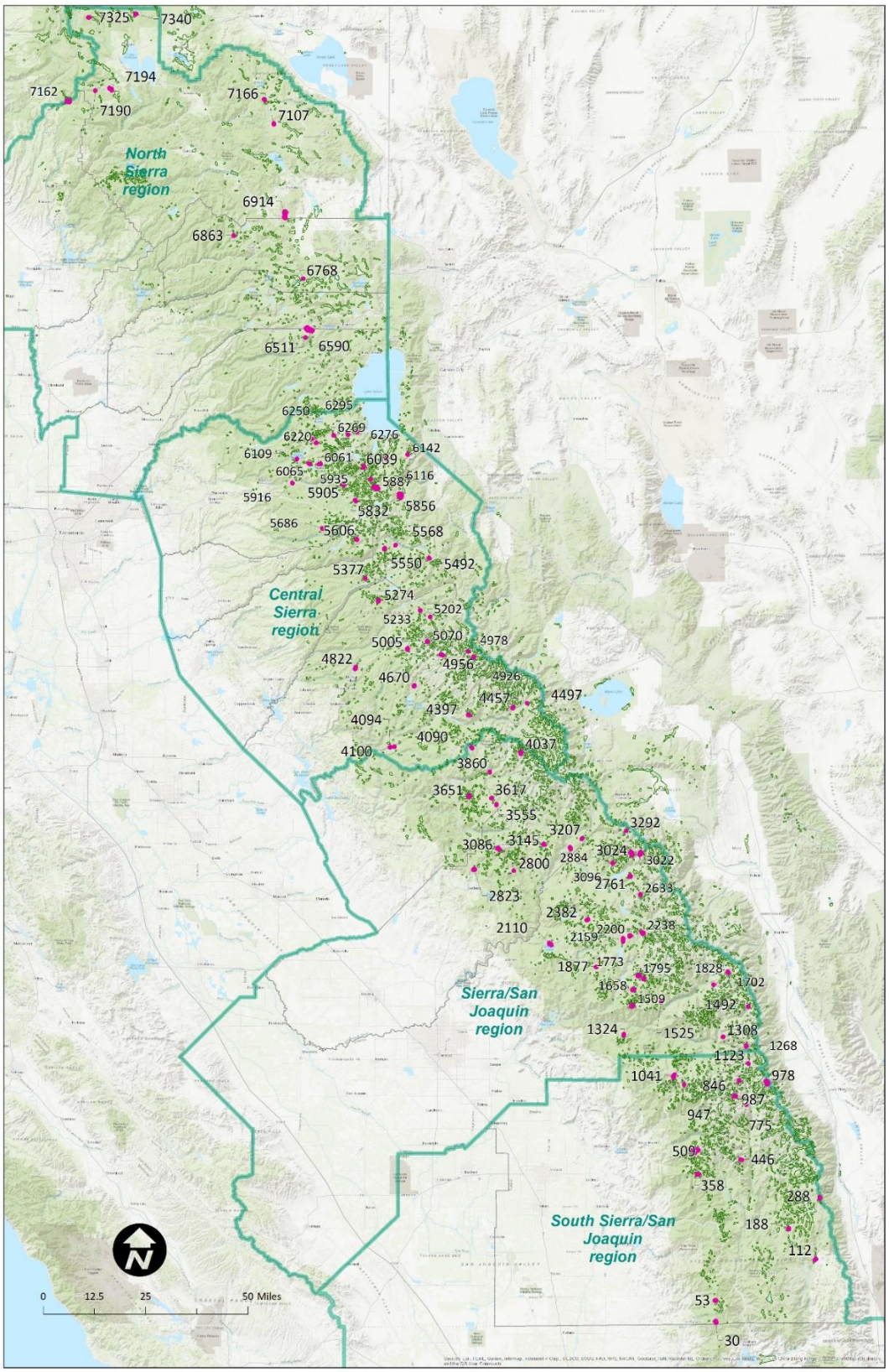
Sample Set of Meadows

The meadows dataset that we used for this study was generated by researcher Toni Morelli, who started from Version 1 of the UC Davis Meadows shapefile (17,039 meadows) and combined meadow polygons that were within 150 meters of each other to arrive at 5,894 "meadow complexes" that she used to consider connectivity of complexes for future suitable habitat as the climate shifts. (For ease, we refer to these meadow complexes simply as meadows in this report.) The figure below shows an example of how the buffered meadows join into complexes.



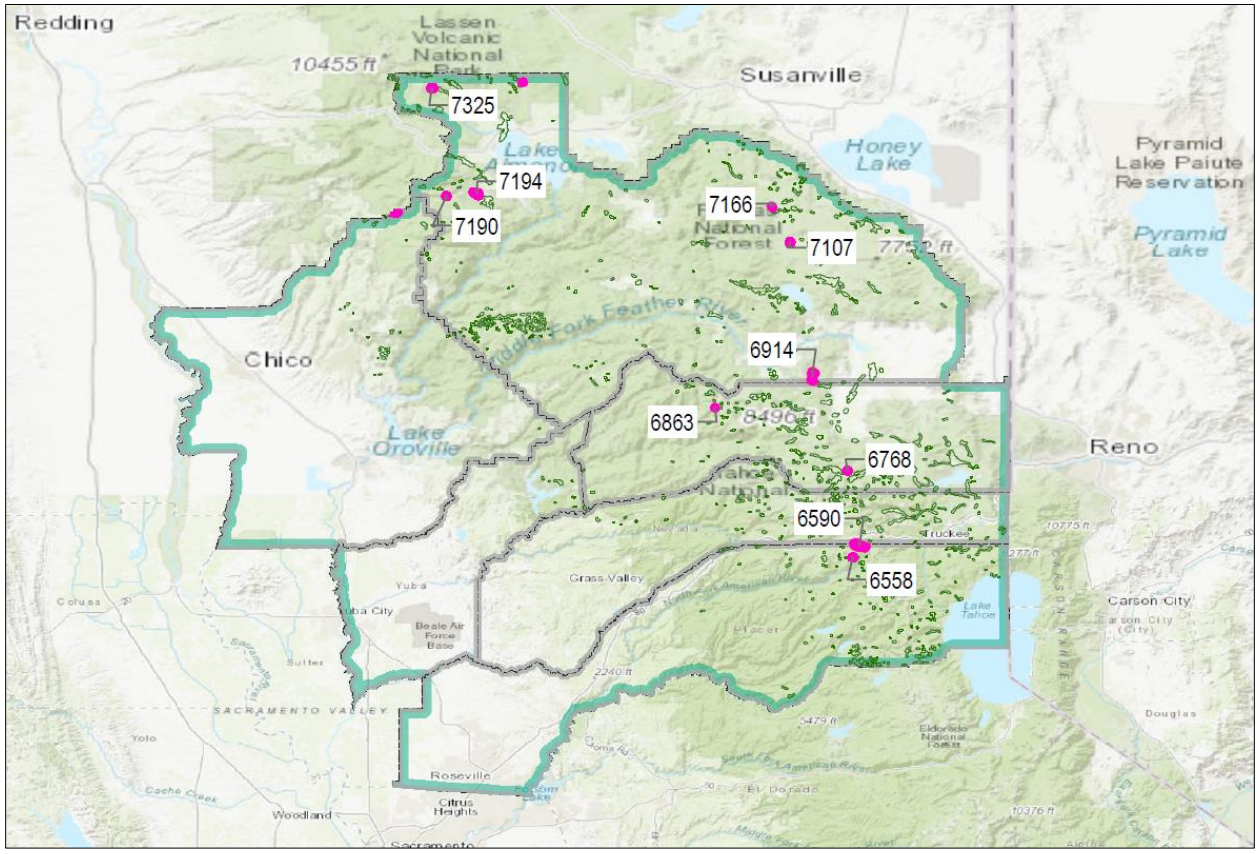
Meadow complexes. The meadow outlined in pink shows a single meadow with the 150m buffer. This is one of the 100 meadows randomly selected for our project. The meadow complex outlined in green at left has combined multiple meadow polygons that, when buffered out by 150 meters, intersect with each other.

We used a random selection methodology to choose 100 meadows from within a 15-county area encompassed by four Cal-IPC planning regions. (This excluded ~1,000 meadows in Shasta, Lassen, Modoc, Tehama, Inyo and Mono counties and in the state of



Selected meadows. We randomly selected a set of 100 meadows from the region covered by four Cal-IPC planning regions indicated. Selected meadows are shown in pink and labeled with an ID number. Other meadows from the dataset from are shown in green. See Appendix D for high-resolution PDF.

Nevada.) We tested these meadows to verify that they were a representative sample by looking at the distribution of our random sample in comparison to the data therein. The distribution of elevation, geographic location and ownership compared relatively well between the random sample and the dataset. The map shows the selected meadows across the Sierra Nevada ecoregion.



Northern Sierra. This map shows a close-up view of the northern region of the Sierra Nevada as an example of the detail of the many meadows in the meadows layer (shown in green) and the small portion represented by our random sample (in pink).

Scoring Meadows

As stated, we used two complementary approaches to scoring each criterion—GIS analysis and collection of expert knowledge via interviews. Interviews were better at identifying site-specific information for the scoring, while GIS analysis has the potential to automate scoring for many sites. Our task was to explore the balance between quality and quantity for information on meadows. (In our process, we allowed experts to change scores generated by GIS if they felt that the scores were inaccurate. We estimate that this happened on 20-30% of the values.) The table below summarizes the criteria and how they were scored. Default values were used when there was not information about a given criterion.

Criteria	Scoring	GIS analysis	Expert knowledge
1.1 Ecological Integrity	10 / 7 / 3/ 1 Default: 3 10 pts for high integrity		Evaluate hydrologic condition, fragmentation
1.2 Importance to Listed Species	10 / 5 / 0 Default: 5 10 pts for high importance	Yes, using CNDDB occurrences and critical habitat boundaries	
1.3 Importance for Other Factors	10 / 5 / 0 Default: 5 10 pts for high importance	Yes, using ACE, connectivity values, and climate refugia calcs	
2.1 Innate Resistance to Invasion	1 / 5 / 10 Default: 5 10 pts for low resistance		Rank based on grazing history and other factors.
2.2 Risk via Transportation	1 / 5 / 10 Default: 1 10 pts for high risk		Rank intensity, duration, frequency of human traffic.
2.3 Risk from Disturbance	1 / 5 / 10 Default: 1 10 pts for high risk		Rank human-caused disturbance in last 10 years/next 2 years.
Terrestrial Pathways*	0 / 3 / 7 / 10 10 pts for high risk	Yes, ESRI roads layer and Morelli table	
Aquatic Pathways*	0 / 3 / 7 / 10 10 pts for high risk	Yes, ESRI waterways layer and Morelli table	
3.1 Infestation Level	10 / 7 / 3 / 1 Default: 3 10 pts for no weeds		Estimate the % net infested.
3.2 Number of Weed Species	10 / 7 / 3 / 1 Default: 3 10 pts for no weeds	Yes, match to CalWeedMapper quads	
Level of Information*	10 / 7 / 3 / 1 10 pts for no info in last 10 yrs		Based on knowledge of age of existing data.

Criteria from IPIEDT. Each criterion has discrete scoring levels, as described in Appendix A. Scoring for each criterion is structured so that a high score contributes toward high vulnerability. Only the criteria numbered here were used in our VI calculation. Additional IPIEDT criteria for which data was collected but that were not used in our VI calculation are marked with an asterisk (*). The two pathways criteria may prove useful in the future since they are derived from GIS. The “Level of Information” criterion was used separately from the VI as an indicator of confidence in the assessment and need for further survey.

Most meadows do not have extensive documentation of their condition, so interview-based data collection with experts was necessary. This method of data collection requires local experts to get comfortable making best guess estimates. We estimate that it took approximately 20 minutes to score a single meadow once a person became familiar with the process. However, it took extensive time arranging for a meeting with these busy experts to conduct the scoring. This will be discussed more in the final section on how to move forward.

For the initial GIS scoring, we used the meadows dataset to compare overlap and proximity with other factors that were already spatially documented in GIS. This allowed us to answer some of the criteria in the IPIEDT. These criteria, and the specific scoring methodology for each, are described below.

***Criterion 1.2* – Conservation importance to federal- or state-listed species**

For the "listed species" sub-score we compared meadow locations with the California Natural Diversity Database (CNDDB). A given meadow site was scored based on whether it overlaps with habitat for one or more listed species. When there was no overlap of either, the value was set to "unknown" rather than "no habitat value" since the data in CNDDB is not considered comprehensive.

***Criterion 1.3* – Conservation importance to other resources**

The "other valued resources" sub-score was classified by scoring and combining three factors: the Areas of Conservation Emphasis (ACE version II) score from the Cal. Dept. of Fish & Wildlife along with a habitat connectivity score and a climate refugia score from data used in Maher *et al.* (2017). The ACE score was calculated as the average of all ACE values within the meadow complex (ACE's biological richness layer is constructed from native species richness, rarity, endemism, and sensitive habitats compiled into statewide layer at 2.5 square mile hexagon grid). The connectivity score for each meadow was taken directly from scores generated by Maher *et al.* (2017). The refugia score for each meadow was derived by assessing how many of the following conditions were met based on data for each meadow from Maher *et al.* (2017):

- annual climate water deficit stable within 10% of historic conditions;
- annual mean temperature within 1 degree C of historic value;
- annual precipitation within 10% of historic value;
- minimum temperature of coldest month within 1 degree C of historic value;
- maximum temperature of hottest month within 1 degree C of historic value;
- coldest quarter mean temperature within 1 degree C of historic value.

***Criterion 3.2* – Number of weed species present**

We estimated the approximate number of invasive plant species present in each meadow by using the number of species listed in CalWeedMapper (https://calweedmapper.cal-ipc.org/) for the 7.5-minute quad where the meadow is located. This was done by spatially joining the center-point of the meadow polygon to the count of invasive species in that quad.

The remaining criteria were scored using expert knowledge via interviews. The details on each criterion are found in Appendix A.

In addition to the criteria that we used for our VI scoring, we also scored three additional criteria from the original IPIEDT schema. These criteria were used to complement the VI scoring (see Appendix B for details). Because the first two can be scored using GIS they may be useful to include if this effort moves forward with assessing thousands of meadows. The three criteria are described below.

Invasion risk from terrestrial pathways

For terrestrial pathways we focused on distribution and density of roads in proximity to each meadow. We used two sources: the ESRI roads dataset, and the "distance to roads" field in the dataset from Morelli et al. (2016). Because trails are not included in these GIS layers, they were not included in the GIS analysis. However, when experts reviewed the GIS-generated scoring, they could adjust the scoring based on their personal knowledge or what was depicted on the 7.5-minute USGS quadrangle, including presence of trails.

Invasive risk from aquatic pathways

For aquatic pathways we focused on distribution and density of waterways. In parallel with the above methodology for terrestrial pathways, we used GIS to compare to the ESRI waterways dataset and folded that into the "distance to rivers/streams" field from Maher *et al.* (2016). This analysis included all features in the datasets for any size waterway. And again, when experts reviewed the GIS-generated scoring, they could adjust the scoring based on their personal knowledge or the water features depicted on the 7.5-minute USGS quadrangle, and whether they thought those features could serve as a transport vector.

Level of information

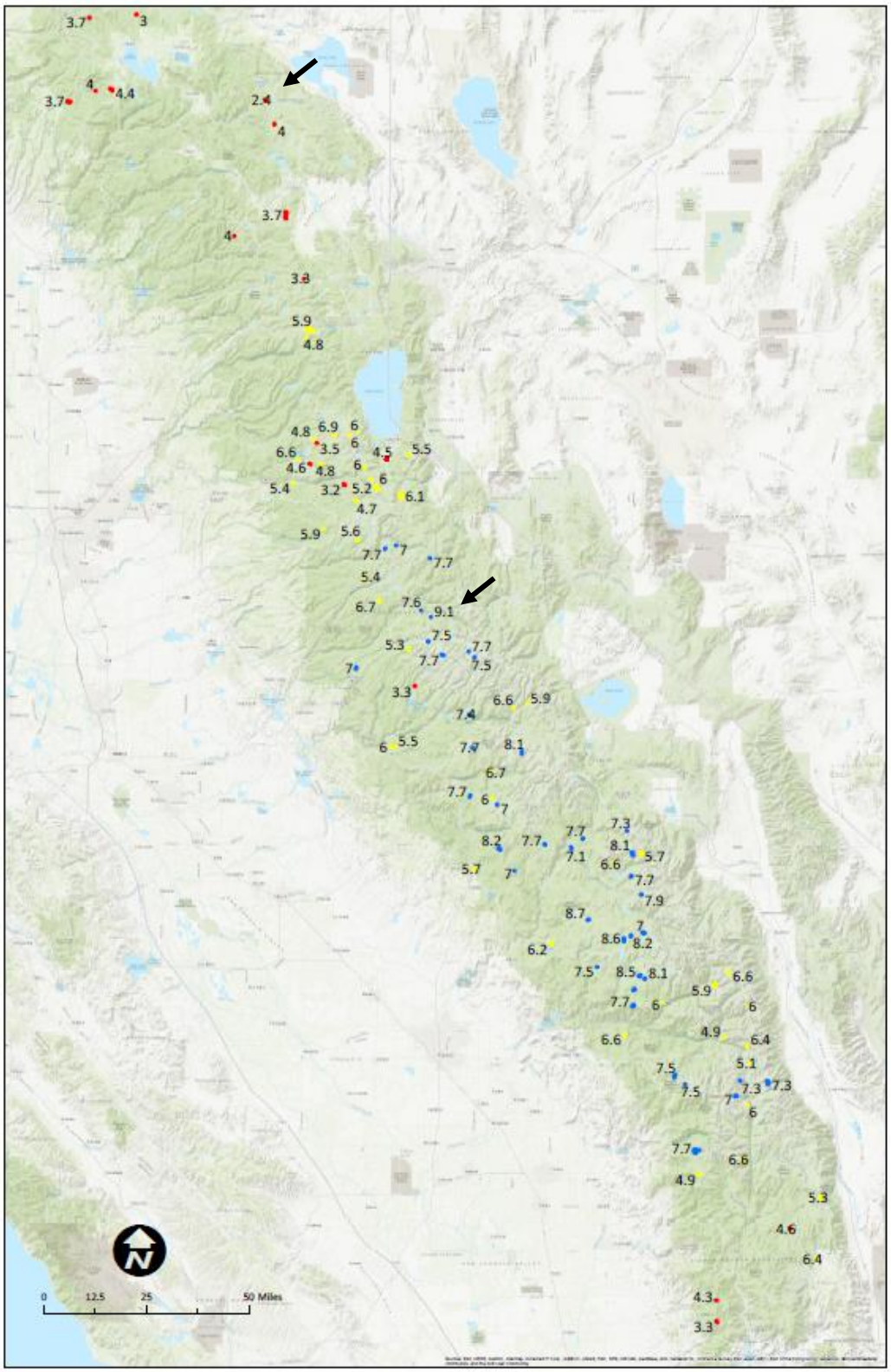
This criterion gauges the level of relatively current (within the last ten years) information on the distribution of invasive plants in the meadow. Because the IPIEDT was originally designed to prioritize areas to survey for weeds, this was a key factor in the assessment, but since we are using the system to assess which areas are most vulnerable to weed spread it is not relevant. We do use it as additional information for land managers.

Vulnerability Index Results

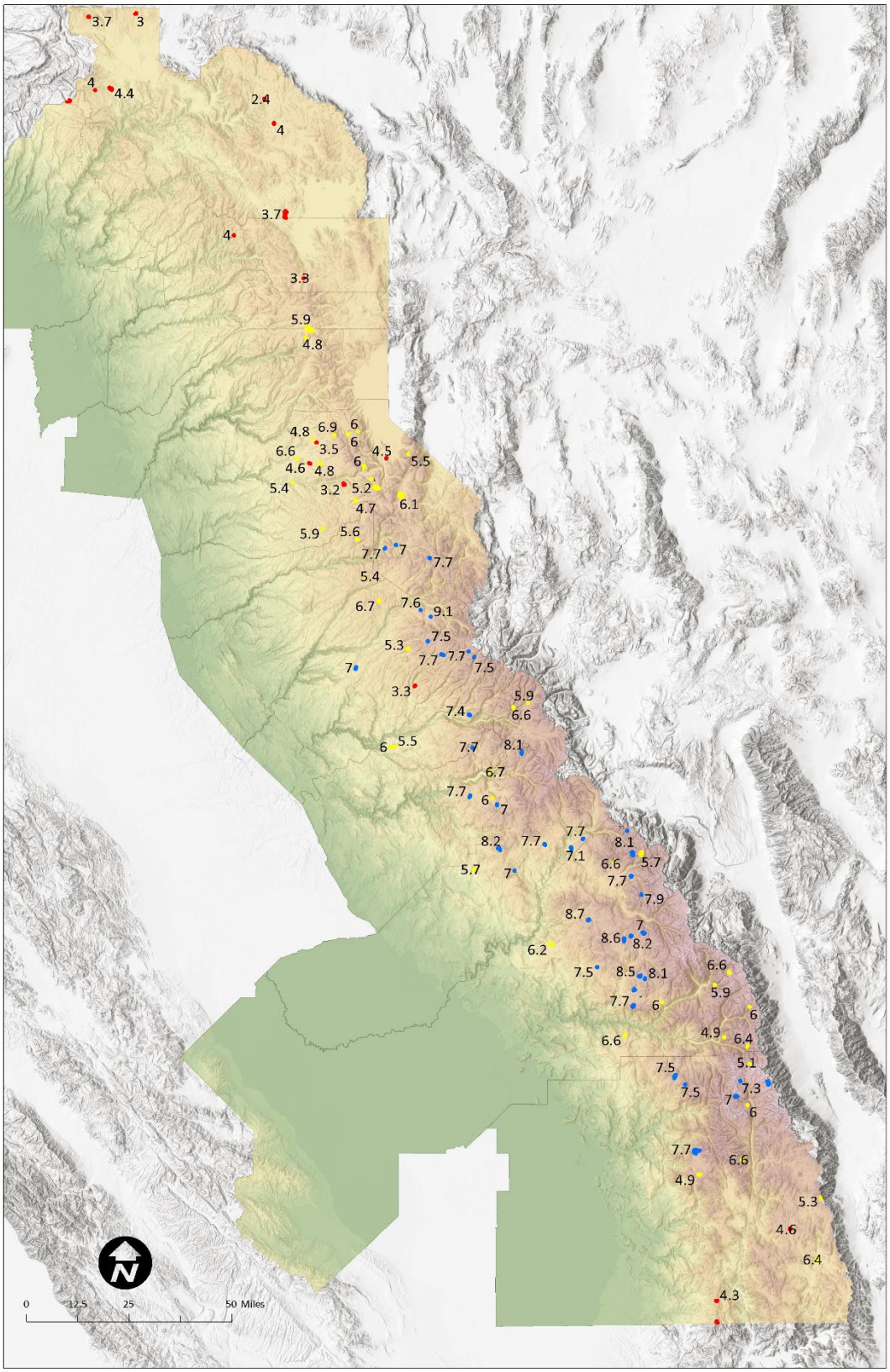
For calculating each of the three section scores we averaged the scores of the section's constituent criteria. (Note that scoring for each criterion is structured so that a high score contributes toward high vulnerability.) These three section scores were then totaled using a weighting of 40% for value of the meadow value, 30% for risk of invasion and 30% for current level of invasion. This total VI score ranged from 2.4 to 9.1, with higher score indicating higher vulnerability and 10 being the maximum possible. (Scores for all meadows can be found in Appendix C, with scoring methodology described in Appendix B.) Meadow scores are shown on the map below and in Appendix D (which has a high-resolution PDF which can be zoomed in on for close-up detail).

To get a sense for the range, it is instructive to look at the top-ranked meadow (most vulnerable) and the lowest-ranked meadow (least vulnerable). The top-ranked meadow (ID#5202) is a 3-acre site at 7,900-feet elevation in the Stanislaus National Forest in Tuolumne County. It scored very high on meadow value (with high ecological integrity and importance to listed species and other conservation factors), high for risk (low resistance, high levels of transportation risk and disturbance risk), and low current weediness (in terms of numbers of weed species present and amount present).

At the other end of the spectrum, the bottom-ranked meadow (ID#7166) is a 26-acre site at 5,640-foot elevation on the Plumas National Forest in Sierra County. It scores as low value, low risk of invasion, and it is already highly weedy.

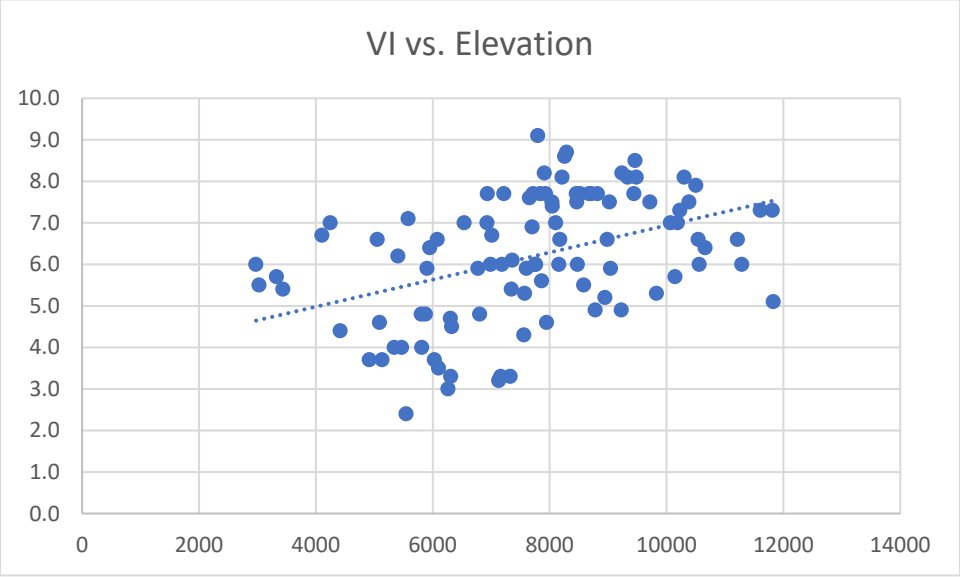


Vulnerability Index (VI) scores. Meadows color-coded by score, with the top scores colored blue, the lowest scores in red, and the moderate scores in yellow. The highest-scoring meadow and the lowest are indicated with arrows. High score indicates high vulnerability to invasive plant damage and thus a priority for management. See Appendix E for high-resolution PDF.



Vulnerability Index (VI) scores with elevational shading. Meadows color-coded by score as in preceding figure, with background shading showing elevation. There is a correlation between higher elevation and higher VI score. See Appendix E for high-resolution PDF.

Several patterns are evident from the map. No meadows north of Calaveras County were in the top third of scores, while meadows in Calaveras County and south are mostly in the top third. This may reflect a higher level of historic disturbance in the northern region. Elevation also plays a role. The scatterplot below shows a correlation between higher elevation and higher VI. Finally, more remote meadows score higher on the VI. As described in the following section, we scored accessibility of each meadow. Those meadow which were least accessible (scored as a "C") averaged a VI of 6.6 while meadows scoring a "B" averaged a VI of 5.9 and meadows scoring a "C" averaged a VI of 5.7.



Additional Scoring

In discussing the results with Sierra meadow land managers, however, we realized that a top goal was to determine which meadows were most important to target with limited invasive plant management resources. While the VI has the advantage of combining many factors into one simple score, land management decisions may require weighing individual factors against each other. Not all land managers will weigh factors in the same way. Some factors—like current weediness—may encourage management in some situations and discourage it in others. Thus, we saw value in separating out the following five parameters of interest, some of them constituent pieces of the VI and others ancillary information useful for setting management priorities. We separated out each meadow's:

1. value and risk of invasion
2. current weediness
3. size
4. accessibility
5. level of information

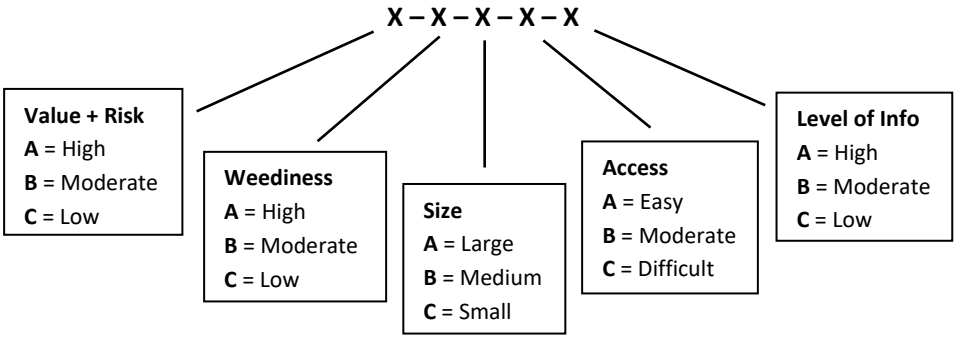
For the first factor we simply used the first two of the three sections of VI criteria. The third section of the VI criteria was used for the following factor, the current weediness of the meadow. The weediness factor was pulled out of the overall ranking because a meadow being weedy already can be used in several different ways, while the meadow value and invasion risk are consistent and straightforward to interpret. While the original VI gives high points for meadows that are not yet very infested, the condition of being weedy is also an indication that there is work to be done.

The size of the meadow (and its elevation) were generated by the GIS. (Because meadows were buffered and joined into meadow complexes when closer than 150m, the values are not accurate but do provide an indication of relative scale.)

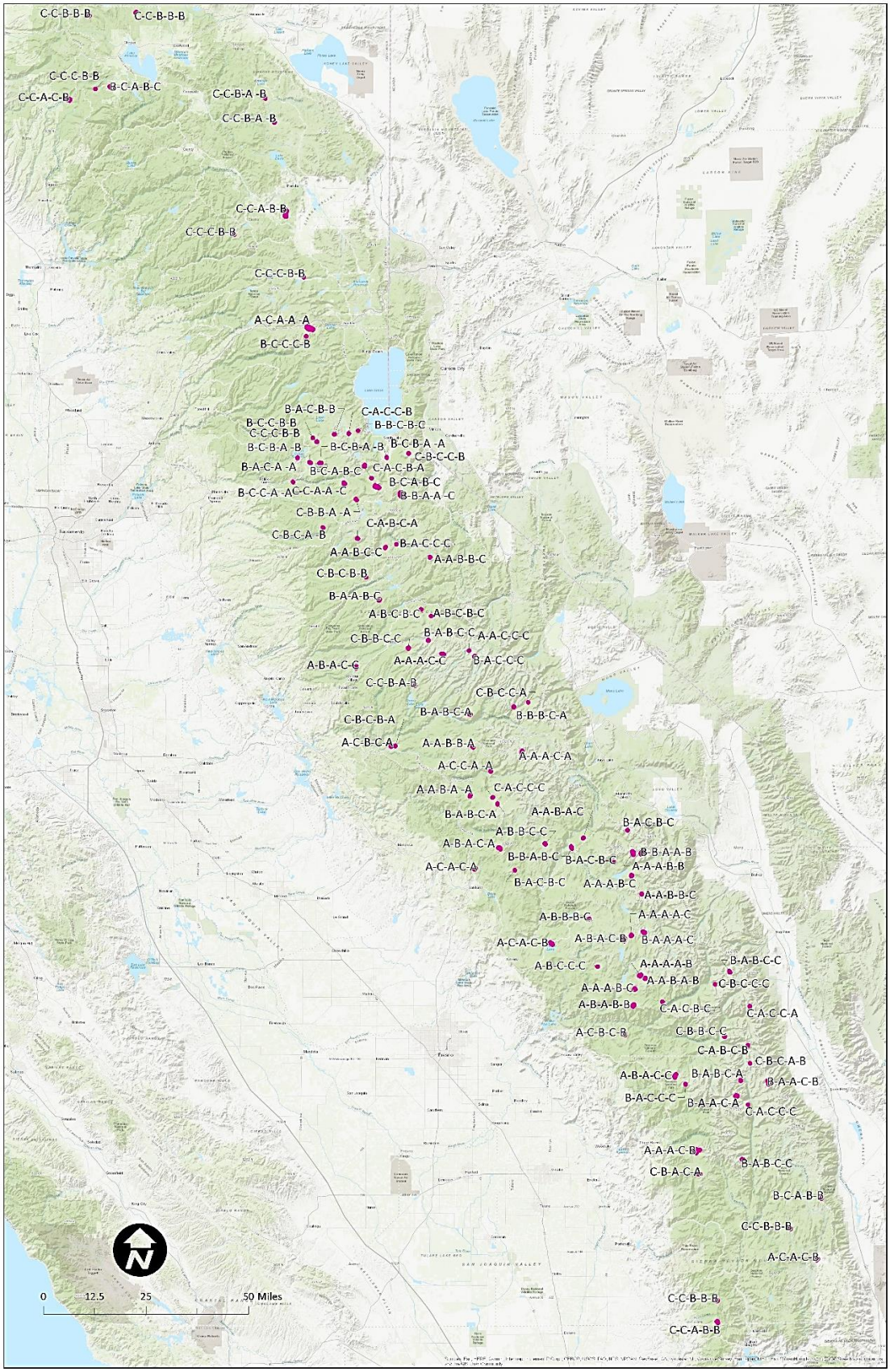
The relative accessibility of a meadow was a factor we had queried land managers about early on, assuming it would be useful information to have. Accessibility informs how feasible weed management is and helps land managers estimate costs.

For the relative level of information on hand about a given meadow, we used the IPIEDT criterion that asks about the currency of invasive plant data for the meadow, how comprehensive it is and how well-documented it is. (This is an IPIEDT criterion that we did not use in our VI calculation. Its inclusion in IPIEDT reflects the tool's original purpose—to help USFWS land managers prioritize areas for survey to collect information on invasive plants.) This factor provides a confidence check and helps assess the relative importance of future site visits to collect additional information before formalizing an assessment of the meadow.

Each of these five factors received a letter score. An overall score of A-A-A-A-A would indicate that the meadow is: high value, at high risk of being invaded, already weed-infested, relatively large, relatively accessible, and relatively well-known in terms of current information (Appendix B describes our scoring methodology). The following maps show the letter score for each of the 100 meadows. The scoring matrix below serves as a key for interpretation.



Interpreting 5-letter scores. These five letters score five factors relevant to a land manager's determination of priority for management. The diagram indicates how each score is interpreted. Scores of "A" are assumed to indicate a high priority for management, though the second factor, "weediness," can also be interpreted in the opposite direction (which the VI does), indicating that the meadow is a higher priority when it is still fairly weed-free. Likewise, while scoring for the third factor, "size," is oriented toward the importance of larger meadows, a large size may also indicate the need for a higher investment.



Five-letter scores. This map shows the scores of the selected meadows (in pink) in the project area. See Appendix F for high-resolution PDF.

Conclusion:

The assessments produced by this pilot project for 100 Sierra meadows were judged to be meaningful by land managers, which is a success. The VI and five-letter score provided useful distinctions between sites. However, the process of collecting information to assess meadows was not efficient enough to make scoring all 6,000 meadow complexes in the region feasible.

Though personal knowledge can be extremely useful, the availability of the handful of experts is low. Personal knowledge is typically limited to a small portion of the many meadows in a jurisdiction. It may be most efficient to have experts review GIS-generated results and add their information. Regardless, securing some dedicated time from the small number of experts in the region is important. There may be additional experts that we have not yet tapped from local chapters of the California Native Plant Society.

Two options for streamlining our approach are: reducing the number of criteria and using GIS analysis whenever possible rather than expert knowledge. Fortunately, this is now more possible with the recent publication of the GIS-based Sierra Meadow Prioritization Tool that has scored 24 conservation targets for all Sierra meadows. These targets include similar factors to our analysis—carbon storage, hydrologic importance, wildlife habitat—so the aggregate score should serve well as a surrogate for the first section of our assessment, on meadow conservation value.

For the second section of our assessment, on risk of invasion, we chose three criteria that required expert knowledge: resistance to invasion, transport risk and disturbance risk. These seemed most meaningful, but they are not easily assessed using GIS. However, we did leave out two criteria that can be generated by GIS: terrestrial pathways of introduction (for instance, proximity of roads) and aquatic pathways of introduction (proximity to watercourses). It seems reasonable to use just these two criteria to generate a score for risk of invasion, and then use expert knowledge to adjust if needed.

For the third and last section, we are able to generate from GIS the number of invasive plant species found in the USGS quad (about 6 by 8 miles) in which the meadow is located. This is quite coarse and may be better related to the second section on risk of invasion. It does not directly address how invaded the meadow itself is. Expert knowledge did a relatively good job of this for the meadows that were known—many were not. So it may be that this factor should not be part of the assessment. Indeed, for our five-letter scoring we separated the "weediness" out from the "value + risk".

To move forward with a large set of meadows, then, we propose the following. The value score of each meadow is set using the cumulative score from the Sierra Meadow Prioritization Tool. The invasion risk score is set based on a GIS analysis of (1) road proximity, (2) watercourse proximity, and (3) number of invasive plant species known from the USGS quad. The value score and the risk score are combined to produce the Vulnerability Index score. From there, land managers can contribute whatever information they have on current levels of weediness and access feasibility.

Another way to streamline the approach is to make simple assumptions up front that reduce the number of meadows to be assessed. For instance, it's well documented that there are fewer weeds at higher elevations (D'Antonio et al. 2004, Underwood et al. 2004, Klinger et al. 2006, Dickman 2014). Yosemite National Park staff said that they have no big weed concerns over 10,000-feet elevation and that they see a significant drop-off above the 7,000-foot level where mixed-conifer forest shifts to red fir

and ponderosa pine habitat (Garrett Dickman, pers. comm.). So, adopting a specific elevation band could be an appropriate way to reduce the number of meadows being assessed. For instance, limiting evaluation to meadows below the 7,000-foot elevation point could eliminate as many as 60% of the meadows. Likewise, if funding is only available to work on certain lands – say a single National Forest – that will further select for a smaller set of meadows.

Of course, this is counter to the general trend showing VI increasing with elevation. Once again, this points out the difference in how a land manager may interpret the factor of current weediness. While the VI interprets low current weediness as contributing to a higher vulnerability and thus a higher management priority, managers like Dickman in Yosemite may take the opposite approach—if the current weediness is low, leave the meadow alone (and Yosemite has thought about planning and prioritization more than most; see for instance Dickman 2014). Thus, the parsed five-letter scores are useful in allowing land managers to interpret weediness in the way that makes the most sense to their situation.

Another factor that may be useful to include in the future is exposure to horses and pack animals uses for recreation, since animal dung is an effective vector for nonnative plants if requirements for weed-free forage (including before a trip into the backcountry) are not in place or are not followed. Integrating this factor into the assessment of risk would be facilitated if land management entities such as national forests have databases for such use that can be joined to the meadows database.

The VI score serves as an important baseline for prioritizing meadows for invasive plant management. Between a VI analysis and actual project implementation lies additional information collection through meadow site visits to inventory the weed species present, gauge the potential impacts, determine appropriate control approaches and goals, and evaluate the feasibility and cost of implementation.

Meadows should be surveyed consistently, using a standard methodology in the same way American Rivers has developed a meadow scorecard for hydrologic condition. We anticipate working on this with partners in the region as a next step. On-the-ground field surveys remain the gold standard, but as aerial imagery increases in resolution it may become possible to pick out some invasive plant species. The US Forest Service currently conduct aerial surveys over the Sierra each year to document forest health – there may be an opportunity to dovetail with that effort.

Though there are funding sources available for projects to protect upper watersheds, including Sierra meadows (from, for instance, the Sierra Nevada Conservancy and the California Wildlife Conservation Board) only a portion of the funds are dedicated to planning, and those funds are targeted toward preparatory steps like CEQA compliance. Projects to control invasive plants at multiple sites do not fit into this funding structure well, and prioritization and inventory to determine the most important sites to target is even farther back in the project planning pipeline. However, it is essential that funds be dedicated to this essential planning if priority weeds in priority meadows are to be addressed. Such work is critical for protecting valuable Sierra meadows in a warming future.

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Appendix A: IPIEDT Criteria

Below are the definitions of each criterion and its scoring from the USFWS Invasive Plant Inventory and Early Detection Tool (IPIEDT). Some of the scoring is the original scoring from USFWS. For other criteria Cal-IPC modified the definitions and scoring as noted. The bulleted considerations are what we developed to guide expert contributors in thinking about the criterion specifically for Sierra meadows.

Criteria 1.1 Ecological Integrity. The structure, composition, and functions of ecological communities within the bounds of natural or historic disturbance regimes, with a focus on hydrology.

Scored by experts based on their knowledge. They were asked to consider:

- To what degree hydrologic processes are intact. What are sediment dynamics like? Is the ground compacted?
- How fragmented the meadow is (for example, by conifer encroachment, roads, etc.)
- The presence of key indicator species of native plants and animals.

USFWS definition	Score
Very good ecological integrity: The landscape contains natural habitats that are essentially unfragmented (reflective of intact ecological—such as hydrologic—processes) and with little to no human-induced threats (e.g. contaminants); vegetation structure and composition, soils, and hydrology are within natural ranges of variation; key native plant and animal indicators are present.	10
Good ecological integrity: Largely natural habitats with minimal fragmentation and few human induced threats; vegetation structure and composition, soils, and hydrology are within natural ranges of variation; many key plant and animal indicators are present.	7
Fair ecological integrity: Moderately fragmented natural habitat with several human-induced threats; biotic and abiotic factors are outside their natural range of variation; a moderate number of human induced threats are present; many of the key plant and animal indicators are absent. Management is needed to maintain or restore major ecological attributes.	3
Poor ecological integrity: Little natural habitat and very fragmented; biotic and abiotic factors are severely altered well beyond their natural range of variation; a relatively high number of human induced threats are present; most (if not all) key plant and animal indicators are absent. There may be little long-term conservation value without intense management and restoration, and such restoration may be difficult or uncertain.	1
Default/Unknown	3

Criteria 1.2 Importance to Federal- or State-listed Species. The relative importance of the area to federal- or state-listed endangered or threatened species as it relates to the presence or proximity of a species or its habitat.

Calculated using GIS and multiple date sources: CNDDB (California Natural Diversity Database which includes Fed and state endangered/threatened species and CNPS Rare Plant Inventory species) and CDFW Critical Habitat. Adjusted by expert knowledge.

Cal-IPC definition *(GIS criteria described in italics)*	Score
High importance: The area contains listed species habitat OR one or more listed species have been documented in the area in the last 10 years. *(If CNDDB hits is >0 OR if count of critical habitat hits is >0.)*	10
Moderate importance: The area may or may not contain listed species habitat or be adjacent to areas that support listed species, and no listed species have been documented in the area in the last 10 years. *(If there are no CNDDB or critical habitat hits.)*	5
Default/Unknown	5

Criteria 1.3 Importance to Other Resources. The relative importance of the area to other natural resources of priority conservation concern

Calculated via GIS from CDFW's ACE (Areas of Conservation Emphasis), Toni Lyn Morelli Connectivity score, and a Refugia Score calculated from climatic data in a table provided by Morelli. Factor were scored to produce an even spread, then summed and put into an ordinal scale to meet the classifications below. Adjusted by expert knowledge.

USFWS definition	Score
High importance: The area currently supports natural resources of priority conservation concern.	10
Moderate: The area does not support priority resources of conservation concern but is immediately adjacent to areas that do.	5
Low: The area does not support priority resources of conservation concern and is not adjacent to areas that do support priority resources of conservation concern.	0
Default/Unknown	5

Criteria 2.1 Innate Resistance to Invasion. The innate capacity of an ecosystem to resist establishment and spread of invasive plant species.

Scored by experts based on their knowledge. They were asked to consider:

- Grazing and grazing history
- Percent bare ground
- Adjacent sources of propagule pressure

USFWS definition	Score

Low resistance: At least two of the following criteria are true: site has a high level of grazing/grazing history; site has >50% bare ground; and/or there are significant adjacent sources of weed propagules.	10
Moderate resistance: Only one of the above criteria is true.	5
High resistance: None of the above criteria is true.	1
Default/Unknown	5

Criteria 2.2 Transportation Vectors. The presence, frequency, and duration of human-mediated transport vectors in the area compared to the project scope. This includes vehicles, boats, hikers, equipment, etc.

Scored by experts based on their knowledge. They were asked to consider:

- Human visitation, hunting, hiking, biking, boating
- Frequency - high visitation volume increases rank
- Construction equipment

USFWS definition	Score
High coverage or density: Human-mediated vectors operate in the area AND frequency and duration of vector events is high relative to the other areas in the project scope.	10
Medium relative to other areas within the project scope.	5
Low relative to other areas within the project scope.	1
Default/Unknown	5

Criteria 2.3 Anthropogenic Disturbance. The intensity, duration, and frequency of human-caused disturbance events. Includes restoration/enhancement activities, regular maintenance activities, resource extraction, and toxic spills.

Scored by experts based on their knowledge. They were asked to consider discrete recent events where the landscape has been altered in the last ten years (or is planned to be altered in the next 2 years) such as meadow restoration, revegetation, invasive plant treatment, and current grazing.

USFWS definition	USFWS
The area has experienced high levels of anthropogenic disturbance (e.g., high intensity, duration, or frequency) relative to other areas within the project scope in the last 10 years.	10
Medium levels of anthropogenic disturbance.	5
Low levels of anthropogenic disturbance.	1
Default/Unknown	1

Criteria 3.1 Infestation Level. The status of invasive plant infestations in the area based upon area-specific knowledge or past inventory data.

Scored by experts based on their knowledge.

USFWS definition	USFWS
Trace (<1%) of the area is infested by one or more invasive plant species.	10
1-5% of the area is infested by one or more invasive plant species.	7
6-25% of area is infested by one or more invasive plant species.	3
>25% of area is infested by one or more invasive plant species.	1
Default/Unknown	3

Criteria 3.2 Number of Invasive Species. The approximate number of invasive plant species infesting the area based upon area-specific knowledge or past inventory data.

Calculated via GIS using the number of Cal-IPC Inventory species mapped in CalWeedMapper within the quad that contains the meadow. Adjusted by expert knowledge.

Cal-IPC definition	Score
0-5 Cal-IPC species.	10
6-11 Cal-IPC species.	7
12-22 Cal-IPC species.	3
23+ Cal-IPC species.	1
Default/Unknown	3

Three additional IPIEDT criteria were given values but were not used in our VI analysis. They do have other utility though. The Terrestrial Pathways criterion is used to determine accessibility for those meadows that do not have an accessibility score from the local expert. And the Level of Information criterion is used in our five-factor scoring.

Terrestrial Pathways. The distribution and density of terrestrial pathways such as roads.

Calculated using GIS and based on intersection of meadows with roads from the ESRI roads dataset and assessment by Morelli et al. (2016) on distance to road for each meadow. Adjusted by expert knowledge.

USFWS definition *(Cal-IPC GIS criteria described)*	Score
Terrestrial pathway spatial coverage and/or density is high relative to other areas within the project scope. *(Meadow intersects directly a road on ESRI roads layer)*	10
Medium relative to other areas within the project scope. *(<5km from a road per Morelli 2016)*	7

Low relative to other areas within the project scope. *(5-15km from a road per Morelli 2016)*	3
None. *(>15km from a road per Morelli 2016)*	0

Aquatic Pathways. The distribution and density of aquatic pathways such as rivers.

Calculated via GIS using ESRI waterways dataset and assessment by Morelli et al. (2016) on distance to rivers/streams for each meadow. Adjusted by expert knowledge.

USFWS definition *(Cal-IPC GIS criteria described)*	Score
Aquatic pathway spatial coverage and/or density is high relative to other areas within the project scope. *(Meadow intersects directly a road on ESRI stream layer)*	10
Medium relative to other areas within the project scope. *(<1km from a river per Morelli 2016)*	7
Low relative to other areas within the project scope. *(1-2.5km from a river per Morelli 2016)*	3
None. *(>15km from a river per Morelli 2016)*	0

Level of Information. The status of invasive plant inventories or monitoring in the area.

Scored by experts based on knowledge of existing invasive plant data from the meadow.

USFWS definition *(Cal-IPC GIS criteria described)*	Score
Data on distribution and abundance of priority invasive plants has not been collected in the area in the last 10 years.	10
Data has been collected in the last 10 years but is not comprehensive or well documented.	7
Data has been collected in the last 10 years and is comprehensive and well documented.	3
Data has been collected in the last 5 years and is comprehensive and well documented.	1

Appendix B - Scoring Methodology

The scoring methodology for the Vulnerability Index was simple. The scoring for each criterion is on a scale of 0 to 10. The scores for the questions in each section were averaged as follows. For each criterion, higher points were given for conditions that indicate higher vulnerability as noted in italics.

Score for Section 1 - Value of the meadow equals the average of the scores for:

1.1. Ecological integrity *(high points for high integrity)*
1.2. Conservation importance to federal- or state-listed species *(high points for high importance)*
1.3. Conservation importance to other resources *(high points for high importance)*

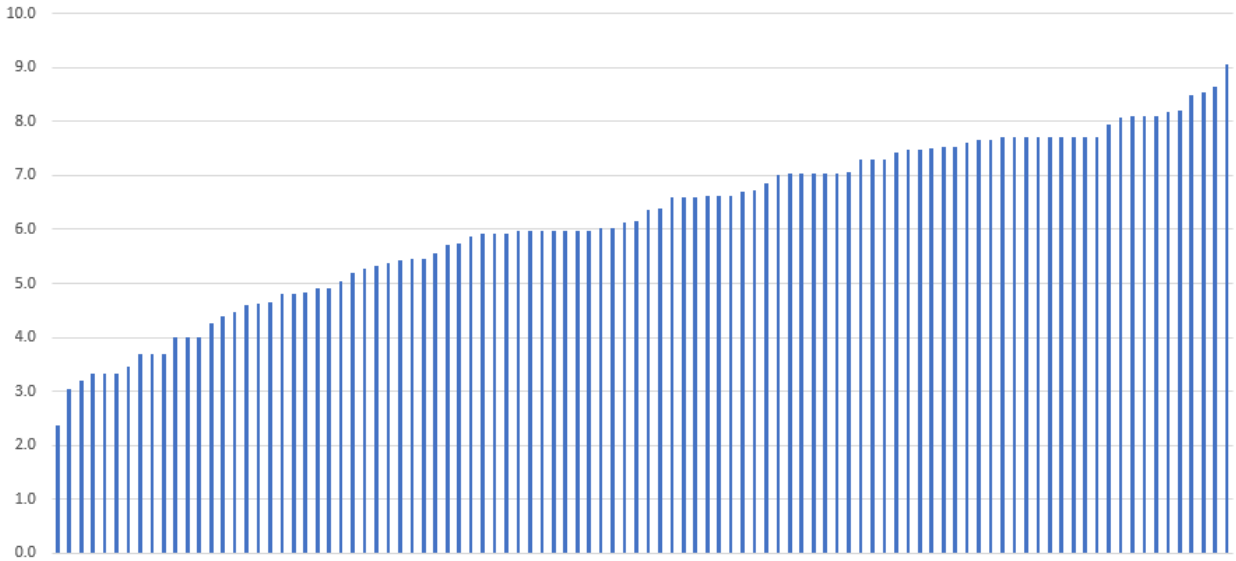
Score for Section 2 – Risk for invasion equals the average of the scores for:

2.1. Innate resistance to plant invasion *(high points for low resistance)*
2.2. Risk via transportation *(high points for high risk)*
2.3. Risk via disturbance *(high points for high risk)*

Score for Section 3 – Current level of invasion equals the average of the scores for:

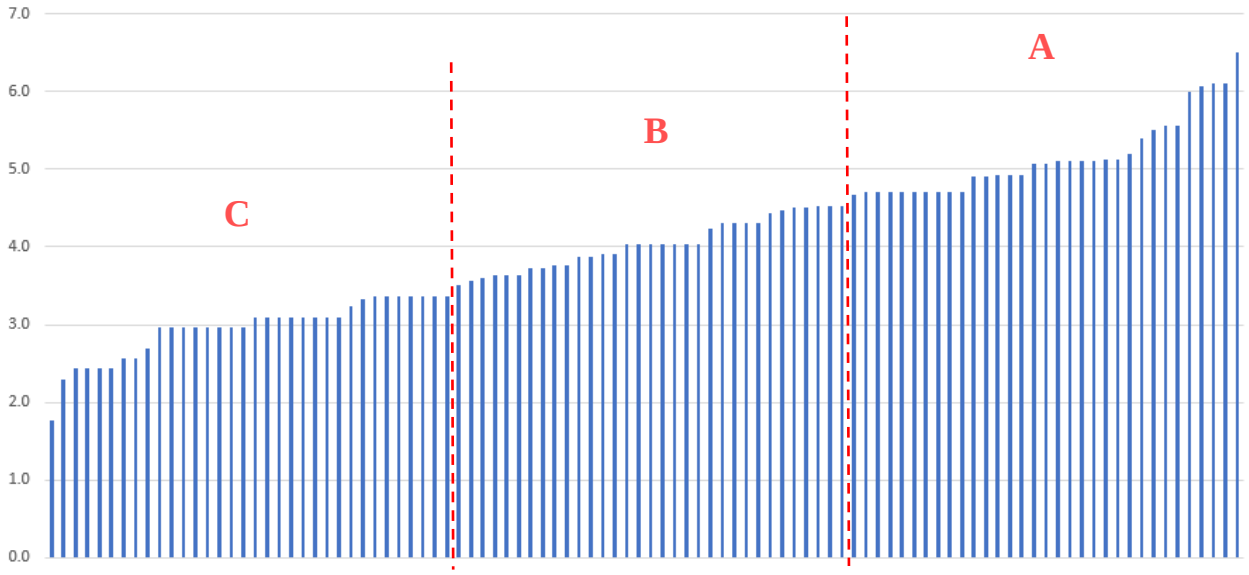
3.1. Current infestation level *(high points for low level)*
3.2. Number of weed species present *(high points for low number)*

These three section scores were then weighted and summed. The Section 1 score was multiplied by 40%, the Section 2 and Section 3 scores each by 30%. The maximum total score possible is 10. The resulting scores ranged from 2.4 to 9.1 with higher score indicating higher vulnerability. Scores for all meadows can be found in Appendix C. The range of scores is shown below.

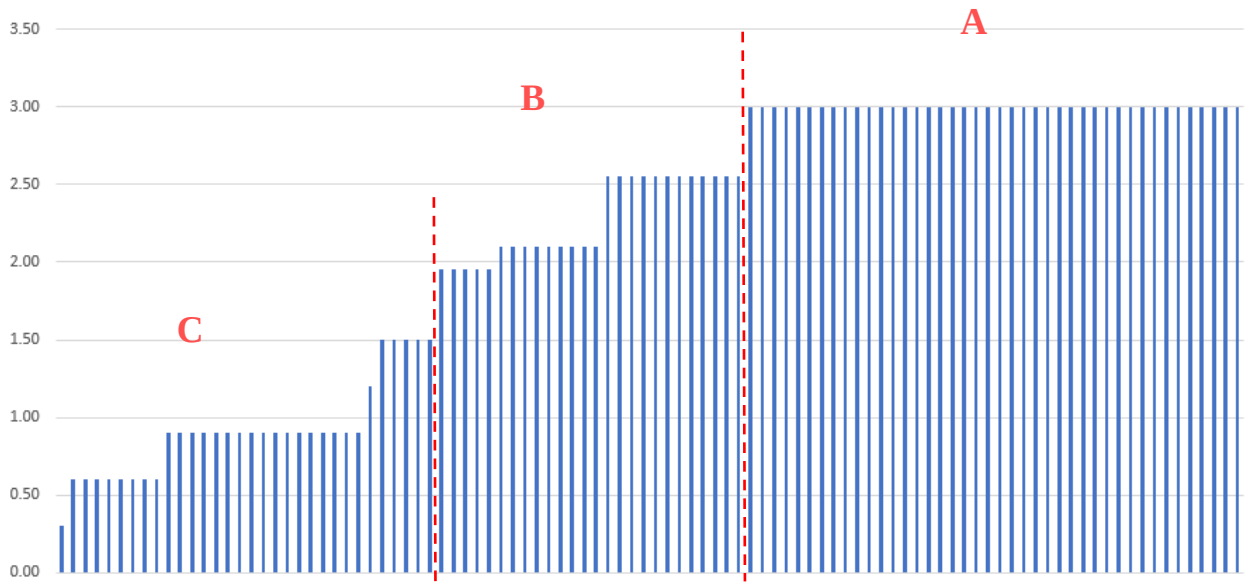


For scoring the five separated factors we used the following procedures.

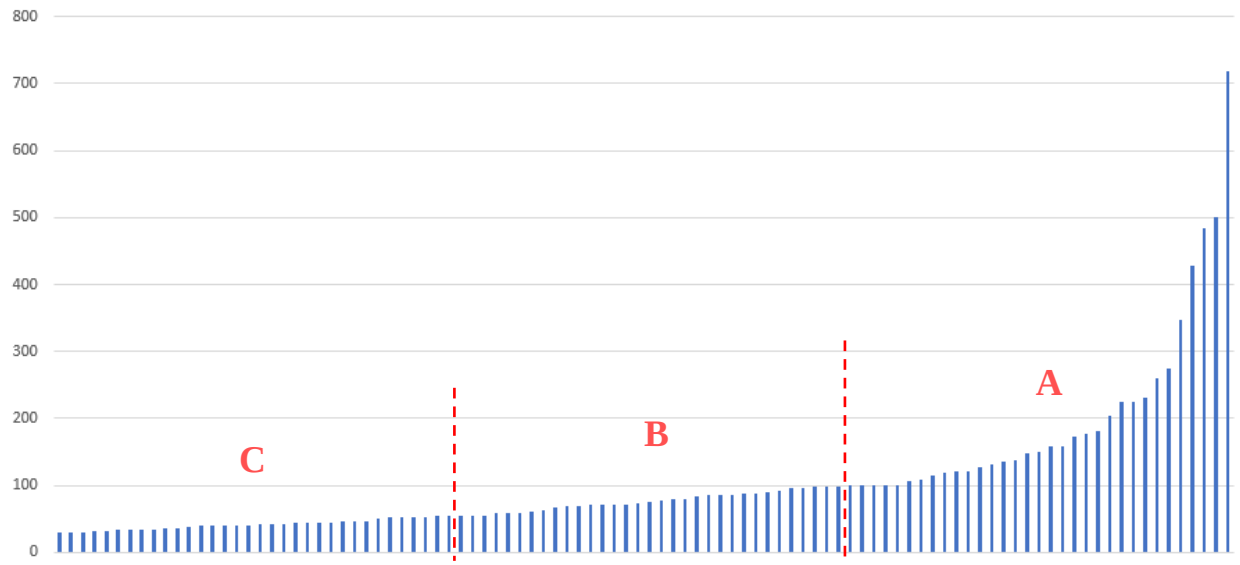
Value and risk: We summed the existing weighted section scores for Section 1 and Section 2 as described above and again divided into three groups, with 33 As, 33 Bs, and 34 Cs as shown below.



Weediness: We used the Section 3 score and divided into three groups, with 42 As, 26 Bs, and 32 Cs as shown below.



Size: We used the size in acres as generated by GIS. These sizes are not accurate since individual meadow sites were buffered by 150m and then joined with any neighboring meadows they intersected to form meadow complexes, but they do provide an indication of relative scale. Size ranged from 29 acres to 719 acres. (Making the simplifying assumption of circular polygons and subtracting the area of the buffer, this indicates an approximate meadow size ranging from 1 to 500 acres.) Meadows were then divided into three groups, with 33 As, 33 Bs, and 34 Cs.



Accessibility: We used the information provided by land managers, who ranked accessibility as low, medium or high. We gave meadows ranked "high" an A, "medium" a B, and "low" a C. We only received answers for 58 out of 100 meadows. For the others, we used Terrestrial Pathways criterion as a surrogate for access since the criterion is based on a GIS assessment of proximity to roads. When Terrestrial Pathways is "none" we scored the meadow as a "C" for access. When Terrestrial Pathways was "low" or "moderate" we scored the meadow as a "B" for access. And when Terrestrial Pathways was "high" we scored the meadow as an "A" for access. This resulted in 22 As, 36 Bs and 42 Cs.

Level of Information: We used the IPIEDT question that scored the level of current documentation of weed distribution at the site. If the answer to the IPIEDT question indicated that there is thorough documentation from the last 10 years, this was scored as an "A." If there is some information from the last 10 year, it gets a "B" and if there's no information, it gets a "C."

Appendix C - Scoring Tables

The table below shows the scoring for 100 meadows included in this pilot project, sorted by ascending Vulnerability Index (VI).

ID No.	County	Elev. Range	Acres	1.1	1.2	1.3	S1 Score	2.1	2.2	2.3	S2 Score	3.1	3.2	S3 score	VI	Value + Risk	Weed-iness	Size	Access	Info
7166	Plumas	3,001 to 7,000	86	3	5	0	1.07	5	1	1	0.70	3	1	0.60	2.4	C	C	B	A	B
7340	Plumas	3,001 to 7,000	79	3	5	5	1.73	5	1	1	0.70	3	1	0.60	3.0	C	C	B	B	B
5905	El Dorado	7,001 to 11,000	120	7	5	0	1.60	5	1	1	0.70	3	3	0.90	3.2	C	C	A	A	C
30	Tulare	7,001 to 11,000	131	3	5	5	1.73	5	1	1	0.70	3	3	0.90	3.3	C	C	A	B	B
4670	Tuolumne	3,001 to 7,000	71	3	5	5	1.73	5	1	1	0.70	3	3	0.90	3.3	C	C	B	A	B
6768	Plumas	7,001 to 11,000	34	3	5	5	1.73	5	1	1	0.70	3	3	0.90	3.3	C	C	C	B	B
6220	El Dorado	3,001 to 7,000	53	7	5	5	2.27	1	1	1	0.30	3	3	0.90	3.5	C	C	C	B	B
6914	Plumas	3,001 to 7,000	428	3	5	10	2.40	5	1	1	0.70	3	1	0.60	3.7	C	C	A	B	B
7162	Butte	3,001 to 7,000	225	3	10	5	2.40	5	1	1	0.70	3	1	0.60	3.7	C	C	A	C	B
7325	Plumas	3,001 to 7,000	90	3	10	5	2.40	5	1	1	0.70	3	1	0.60	3.7	C	C	B	B	B
6863	Plumas	3,001 to 7,000	54	3	10	5	2.40	5	1	1	0.70	3	3	0.90	4.0	C	C	C	B	B
7107	Plumas	3,001 to 7,000	72	3	10	5	2.40	5	1	1	0.70	3	3	0.90	4.0	C	C	B	A	B
7190	Plumas	3,001 to 7,000	40	3	10	5	2.40	5	1	1	0.70	3	3	0.90	4.0	C	C	C	B	B
53	Tulare	7,001 to 11,000	97	10	5	5	2.67	5	1	1	0.70	3	3	0.90	4.3	C	C	B	B	B
7194	Plumas	3,001 to 7,000	225	3	10	5	2.40	5	5	1	1.10	3	3	0.90	4.4	B	C	A	B	C
6116	El Dorado	3,001 to 7,000	55	3	5	0	1.07	5	10	10	2.50	3	3	0.90	4.5	B	C	B	A	A
188	Tulare	7,001 to 11,000	87	3	10	5	2.40	5	1	1	0.70	3	7	1.50	4.6	C	C	B	B	B
6065	El Dorado	3,001 to 7,000	86	3	5	5	1.73	5	5	10	2.00	3	3	0.90	4.6	B	C	B	A	B
5832	El Dorado	3,001 to 7,000	84	7	5	0	1.60	1	5	5	1.10	10	3	1.95	4.7	C	B	B	A	A
6061	El Dorado	3,001 to 7,000	98	3	10	5	2.40	5	5	5	1.50	3	3	0.90	4.8	B	C	B	A	B
6250	El Dorado	3,001 to 7,000	36	3	10	5	2.40	5	5	5	1.50	3	3	0.90	4.8	B	C	C	B	B
6511	Placer	3,001 to 7,000	40	3	5	5	1.73	5	10	10	2.50	1	3	0.60	4.8	B	C	C	C	B
1308	Fresno	7,001 to 11,000	55	10	10	0	2.67	1	1	1	0.30	10	3	1.95	4.9	C	B	B	C	C
358	Tulare	7,001 to 11,000	106	10	5	5	2.67	1	1	1	0.30	10	3	1.95	4.9	C	B	A	C	A
1123	Tulare	over 11,000	42	3	10	5	2.40	5	1	1	0.70	3	10	1.95	5.1	C	B	C	A	B
5887	El Dorado	7,001 to 11,000	347	7	10	10	3.60	5	1	1	0.70	3	3	0.90	5.2	B	C	A	B	C
288	Tulare	7,001 to 11,000	101	3	10	10	3.07	5	1	1	0.70	3	7	1.50	5.3	B	C	A	B	B
5005	Tuolumne	7,001 to 11,000	96	3	5	5	1.73	5	5	5	1.50	7	7	2.10	5.3	C	B	B	C	C
5916	El Dorado	3,001 to 7,000	42	1	10	0	1.47	10	10	10	3.00	3	3	0.90	5.4	B	C	C	A	A
5377	Calaveras	7,001 to 11,000	40	3	5	5	1.73	10	1	5	1.60	7	7	2.10	5.4	C	B	C	B	B
6142	El Dorado	7,001 to 11,000	47	7	5	5	2.27	5	5	1	1.10	7	7	2.10	5.5	C	B	C	C	B
4100	Tuolumne	3,001 to 7,000	45	7	5	5	2.27	5	5	1	1.10	7	7	2.10	5.5	C	B	C	B	A
5606	Amador	7,001 to 11,000	72	3	5	0	1.07	5	5	5	1.50	10	10	3.00	5.6	C	A	B	C	A
3022	Fresno	7,001 to 11,000	230	3	10	10	3.07	5	1	1	0.70	3	10	1.95	5.7	B	B	A	A	B
2823	Madera	3,001 to 7,000	136	1	5	10	2.13	10	10	10	3.00	3	1	0.60	5.7	A	C	A	C	A
6590	Placer	3,001 to 7,000	719	3	10	10	3.07	5	10	10	2.50	1	1	0.30	5.9	A	C	A	A	A
5686	El Dorado	3,001 to 7,000	42	7	10	0	2.27	1	5	5	1.10	10	7	2.55	5.9	C	B	C	A	B
1702	Fresno	7,001 to 11,000	30	10	10	0	2.67	5	1	1	0.70	7	10	2.55	5.9	C	B	C	C	C
4497	Tuolumne	7,001 to 11,000	31	10	5	5	2.67	1	5	1	0.70	7	10	2.55	5.9	C	B	C	C	A
775	Tulare	7,001 to 11,000	32	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	C	C
1525	Fresno	7,001 to 11,000	33	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	B	C
3617	Mariposa	7,001 to 11,000	45	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	C	C
6295	El Dorado	7,001 to 11,000	29	7	5	5	2.27	10	5	1	1.60	7	7	2.10	6.0	B	B	C	B	C
6276	El Dorado	7,001 to 11,000	47	7	10	0	2.27	1	5	1	0.70	10	10	3.00	6.0	C	A	C	C	B
1492	Fresno	over 11,000	45	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	C	A
5935	El Dorado	7,001 to 11,000	47	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	B	A
4094	Tuolumne	3,001 to 7,000	62	1	10	5	2.13	10	10	10	3.00	3	3	0.90	6.0	A	C	B	C	A
6039	El Dorado	7,001 to 11,000	109	10	5	10	3.33	10	1	1	1.20	7	3	1.50	6.0	B	C	A	B	C
5856	Alpine	7,001 to 11,000	483	7	5	10	2.93	5	5	1	1.10	7	7	2.10	6.1	B	B	A	A	C
2110	Fresno	3,001 to 7,000	172	3	10	10	3.07	5	10	1	1.60	3	7	1.50	6.2	A	C	A	C	B
1268	Fresno	7,001 to 11,000	76	10	5	5	2.67	1	5	1	0.70	10	10	3.00	6.4	C	A	B	C	B
112	Tulare	3,001 to 7,000	101	3	10	5	2.40	10	10	5	2.50	3	7	1.50	6.4	A	C	A	C	B
4457	Tuolumne	7,001 to 11,000	72	10	5	10	3.33	5	1	1	0.70	7	10	2.55	6.6	B	B	B	C	A
6109	El Dorado	3,001 to 7,000	51	7	5	0	1.60	5	5	10	2.00	10	10	3.00	6.6	B	A	C	A	A
1324	Fresno	3,001 to 7,000	78	3	5	10	2.40	10	10	10	3.00	7	1	1.20	6.6	A	C	B	C	B
446	Tulare	7,001 to 11,000	80	10	10	5	3.33	1	1	1	0.30	10	10	3.00	6.6	B	A	B	C	C
1828	Fresno	7,001 to 11,000	86	10	10	5	3.33	1	1	1	0.30	10	10	3.00	6.6	B	A	B	C	C
2884	Fresno	7,001 to 11,000	52	7	10	5	2.93	5	1	1	0.70	10	10	3.00	6.6	B	A	C	B	C
3860	Mariposa	3,001 to 7,000	54	7	10	10	3.60	10	10	5	2.50	3	1	0.60	6.7	A	C	C	A	A
5274	Tuolumne	7,001 to 11,000	100	1	5	10	2.13	5	1	10	1.60	10	10	3.00	6.7	B	A	A	B	C
6269	El Dorado	7,001 to 11,000	53	10	5	5	2.67	10	1	1	1.20	10	10	3.00	6.9	B	A	C	B	B
4822	Tuolumne	3,001 to 7,000	115	3	10	5	2.40	10	10	5	2.50	7	7	2.10	7.0	A	B	A	C	C

ID No.	County	Elev. Range	Acres	1.1	1.2	1.3	S1 Score	2.1	2.2	2.3	S2 Score	3.1	3.2	S3 score	VI	Value + Risk	Weed-iness	Size	Access	Info
5568	Alpine	7,001 to 11,000	41	7	10	5	2.93	5	5	1	1.10	10	10	3.00	7.0	B	A	C	C	C
2238	Fresno	7,001 to 11,000	147	10	10	5	3.33	5	1	1	0.70	10	10	3.00	7.0	B	A	A	A	C
2800	Madera	7,001 to 11,000	35	10	5	10	3.33	5	1	1	0.70	10	10	3.00	7.0	B	A	C	B	C
846	Tulare	7,001 to 11,000	158	10	10	5	3.33	1	5	1	0.70	10	10	3.00	7.0	B	A	A	C	A
3555	Mariposa	7,001 to 11,000	59	10	10	5	3.33	1	5	1	0.70	10	10	3.00	7.0	B	A	B	C	A
3096	Madera	3,001 to 7,000	127	3	5	10	2.40	10	10	1	2.10	7	10	2.55	7.1	B	B	A	B	C
3292	Fresno	7,001 to 11,000	34	10	10	10	4.00	1	1	1	0.30	10	10	3.00	7.3	B	A	C	B	C
978	Tulare	over 11,000	275	10	10	10	4.00	1	1	1	0.30	10	10	3.00	7.3	B	A	A	C	B
987	Tulare	over 11,000	59	10	10	10	4.00	1	1	1	0.30	10	10	3.00	7.3	B	A	B	C	A
4397	Tuolumne	7,001 to 11,000	98	10	10	5	3.33	5	5	1	1.10	10	10	3.00	7.4	B	A	B	C	A
1041	Tulare	7,001 to 11,000	182	10	5	10	3.33	10	5	1	1.60	10	7	2.55	7.5	A	B	A	C	C
1877	Fresno	7,001 to 11,000	40	7	10	5	2.93	10	5	5	2.00	7	10	2.55	7.5	A	B	C	C	C
5070	Tuolumne	7,001 to 11,000	73	3	10	5	2.40	10	1	10	2.10	10	10	3.00	7.5	B	A	B	C	C
947	Tulare	7,001 to 11,000	44	10	10	5	3.33	10	1	1	1.20	10	10	3.00	7.5	B	A	C	C	C
4926	Tuolumne	7,001 to 11,000	52	10	5	10	3.33	10	1	1	1.20	10	10	3.00	7.5	B	A	C	C	C
5233	Tuolumne	7,001 to 11,000	38	3	10	10	3.07	5	10	5	2.00	7	10	2.55	7.6	A	B	C	B	C
1509	Fresno	7,001 to 11,000	203	7	10	10	3.60	5	5	5	1.50	7	10	2.55	7.7	A	B	A	B	B
3145	Madera	7,001 to 11,000	87	3	10	10	3.07	10	10	5	2.50	7	7	2.10	7.7	A	B	B	C	C
2761	Fresno	7,001 to 11,000	100	10	10	10	4.00	5	1	1	0.70	10	10	3.00	7.7	A	A	A	B	C
3207	Madera	7,001 to 11,000	60	10	10	10	4.00	5	1	1	0.70	10	10	3.00	7.7	A	A	B	A	C
4956	Tuolumne	7,001 to 11,000	121	10	10	10	4.00	1	5	1	0.70	10	10	3.00	7.7	A	A	A	C	C
4978	Tuolumne	7,001 to 11,000	29	10	10	10	4.00	1	1	5	0.70	10	10	3.00	7.7	A	A	C	C	C
5492	Alpine	7,001 to 11,000	59	10	10	10	4.00	5	1	1	0.70	10	10	3.00	7.7	A	A	B	B	C
5550	Alpine	7,001 to 11,000	67	10	10	10	4.00	5	1	1	0.70	10	10	3.00	7.7	A	A	B	C	C
509	Tulare	7,001 to 11,000	501	10	10	10	4.00	1	5	1	0.70	10	10	3.00	7.7	A	A	A	C	B
3651	Mariposa	7,001 to 11,000	99	10	10	10	4.00	1	5	1	0.70	10	10	3.00	7.7	A	A	B	A	A
4090	Mariposa	7,001 to 11,000	69	10	10	10	4.00	1	1	5	0.70	10	10	3.00	7.7	A	A	B	B	A
2633	Fresno	7,001 to 11,000	55	10	10	5	3.33	10	5	1	1.60	10	10	3.00	7.9	A	A	B	B	C
3024	Fresno	7,001 to 11,000	259	3	10	10	3.07	10	5	5	2.00	10	10	3.00	8.1	A	A	A	B	B
1658	Fresno	7,001 to 11,000	119	7	10	10	3.60	5	5	5	1.50	10	10	3.00	8.1	A	A	A	B	C
1773	Fresno	7,001 to 11,000	69	10	10	10	4.00	5	1	5	1.10	10	10	3.00	8.1	A	A	B	A	B
4037	Mariposa	7,001 to 11,000	138	10	10	10	4.00	5	5	1	1.10	10	10	3.00	8.1	A	A	A	C	A
3086	Madera	7,001 to 11,000	177	3	10	10	3.07	10	10	10	3.00	7	7	2.10	8.2	A	B	A	C	A
2200	Fresno	7,001 to 11,000	101	7	10	10	3.60	10	5	1	1.60	10	10	3.00	8.2	A	A	A	A	C
1795	Fresno	7,001 to 11,000	151	10	10	10	4.00	5	5	5	1.50	10	10	3.00	8.5	A	A	A	A	B
2159	Fresno	7,001 to 11,000	158	10	10	10	4.00	5	10	5	2.00	7	10	2.55	8.6	A	B	A	C	B
2382	Fresno	7,001 to 11,000	92	10	10	10	4.00	10	10	1	2.10	7	10	2.55	8.7	A	B	B	B	C
5202	Tuolumne	7,001 to 11,000	34	10	10	10	4.00	10	10	5	2.50	7	10	2.55	9.1	A	B	C	B	C

The table below shows scoring for all meadows sorted by ID number.

ID No.	County	Elevation Range	Acres	1.1	1.2	1.3	Sec. 1 Score	2.1	2.2	2.3	Sec. 2 Score	3.1	3.2	Sec. 3 score	VI	Value + Risk	Weed iness	Size	Access	Info
30	Tulare	7,001 to 11,000 ft	131	3	5	5	1.73	5	1	1	0.70	3	3	0.90	3.3	C	C	A	B	B
53	Tulare	7,001 to 11,000 ft	97	10	5	5	2.67	5	1	1	0.70	3	3	0.90	4.3	C	C	B	B	B
112	Tulare	3,001 to 7,000 ft	101	3	10	5	2.40	10	10	5	2.50	3	7	1.50	6.4	A	C	A	C	B
188	Tulare	7,001 to 11,000 ft	87	3	10	5	2.40	5	1	1	0.70	3	7	1.50	4.6	C	C	B	B	B
288	Tulare	7,001 to 11,000 ft	101	3	10	10	3.07	5	1	1	0.70	3	7	1.50	5.3	B	C	A	B	B
358	Tulare	7,001 to 11,000 ft	106	10	5	5	2.67	1	1	1	0.30	10	3	1.95	4.9	C	B	A	C	A
446	Tulare	7,001 to 11,000 ft	80	10	10	5	3.33	1	1	1	0.30	10	10	3.00	6.6	B	A	B	C	C
509	Tulare	7,001 to 11,000 ft	501	10	10	10	4.00	1	5	1	0.70	10	10	3.00	7.7	A	A	A	C	B
775	Tulare	7,001 to 11,000 ft	32	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	C	C
846	Tulare	7,001 to 11,000 ft	158	10	10	5	3.33	1	5	1	0.70	10	10	3.00	7.0	B	A	A	C	A
947	Tulare	7,001 to 11,000 ft	44	10	10	5	3.33	10	1	1	1.20	10	10	3.00	7.5	B	A	C	C	C
978	Tulare	11,001 ft and Above	275	10	10	10	4.00	1	1	1	0.30	10	10	3.00	7.3	B	A	A	C	B
987	Tulare	11,001 ft and Above	59	10	10	10	4.00	1	1	1	0.30	10	10	3.00	7.3	B	A	B	C	A
1041	Tulare	7,001 to 11,000 ft	182	10	5	10	3.33	10	5	1	1.60	10	7	2.55	7.5	A	B	A	C	C
1123	Tulare	11,001 ft and Above	42	3	10	5	2.40	5	1	1	0.70	3	10	1.95	5.1	C	B	C	A	B
1268	Fresno	7,001 to 11,000 ft	76	10	5	5	2.67	1	5	1	0.70	10	10	3.00	6.4	C	A	B	C	B
1308	Fresno	7,001 to 11,000 ft	55	10	10	0	2.67	1	1	1	0.30	10	3	1.95	4.9	C	B	B	C	C
1324	Fresno	3,001 to 7,000 ft	78	3	5	10	2.40	10	10	10	3.00	7	1	1.20	6.6	A	C	B	C	B
1492	Fresno	11,001 ft and Above	45	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	C	A
1509	Fresno	7,001 to 11,000 ft	203	7	10	10	3.60	5	5	5	1.50	7	10	2.55	7.7	A	B	A	B	B
1525	Fresno	7,001 to 11,000 ft	33	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	B	C
1658	Fresno	7,001 to 11,000 ft	119	7	10	10	3.60	5	5	5	1.50	10	10	3.00	8.1	A	A	A	B	C
1702	Fresno	7,001 to 11,000 ft	30	10	10	0	2.67	5	1	1	0.70	7	10	2.55	5.9	C	B	C	C	C
1773	Fresno	7,001 to 11,000 ft	69	10	10	10	4.00	5	1	5	1.10	10	10	3.00	8.1	A	A	B	A	B
1795	Fresno	7,001 to 11,000 ft	151	10	10	10	4.00	5	5	5	1.50	10	10	3.00	8.5	A	A	A	A	B
1828	Fresno	7,001 to 11,000 ft	86	10	10	5	3.33	1	1	1	0.30	10	10	3.00	6.6	B	A	B	C	C
1877	Fresno	7,001 to 11,000 ft	40	7	10	5	2.93	10	5	5	2.00	7	10	2.55	7.5	A	B	C	C	C
2110	Fresno	3,001 to 7,000 ft	172	3	10	10	3.07	5	10	1	1.60	3	7	1.50	6.2	A	C	A	C	B
2159	Fresno	7,001 to 11,000 ft	158	10	10	10	4.00	5	10	5	2.00	7	10	2.55	8.6	A	B	A	C	B
2200	Fresno	7,001 to 11,000 ft	101	7	10	10	3.60	10	5	1	1.60	10	10	3.00	8.2	A	A	A	A	C
2238	Fresno	7,001 to 11,000 ft	147	10	10	5	3.33	5	1	1	0.70	10	10	3.00	7.0	B	A	A	A	C
2382	Fresno	7,001 to 11,000 ft	92	10	10	10	4.00	10	10	1	2.10	7	10	2.55	8.7	A	B	B	B	C
2633	Fresno	7,001 to 11,000 ft	55	10	10	5	3.33	10	5	1	1.60	10	10	3.00	7.9	A	A	B	B	C
2761	Fresno	7,001 to 11,000 ft	100	10	10	10	4.00	5	1	1	0.70	10	10	3.00	7.7	A	A	A	B	C
2800	Madera	7,001 to 11,000 ft	35	10	5	10	3.33	5	1	1	0.70	10	10	3.00	7.0	B	A	C	B	C
2823	Madera	3,001 to 7,000 ft	136	1	5	10	2.13	10	10	10	3.00	3	1	0.60	5.7	A	C	A	C	A
2884	Fresno	7,001 to 11,000 ft	52	7	10	5	2.93	5	1	1	0.70	10	10	3.00	6.6	B	A	C	B	C
3022	Fresno	7,001 to 11,000 ft	230	3	10	10	3.07	5	1	1	0.70	3	10	1.95	5.7	B	B	A	A	B
3024	Fresno	7,001 to 11,000 ft	259	3	10	10	3.07	10	5	5	2.00	10	10	3.00	8.1	A	A	A	B	B
3086	Madera	7,001 to 11,000 ft	177	3	10	10	3.07	10	10	10	3.00	7	7	2.10	8.2	A	B	A	C	A
3096	Madera	3,001 to 7,000 ft	127	3	5	10	2.40	10	10	1	2.10	7	10	2.55	7.1	B	B	A	B	C
3145	Madera	7,001 to 11,000 ft	87	3	10	10	3.07	10	10	5	2.50	7	7	2.10	7.7	A	B	B	C	C
3207	Madera	7,001 to 11,000 ft	60	10	10	10	4.00	5	1	1	0.70	10	10	3.00	7.7	A	A	B	A	C
3292	Fresno	7,001 to 11,000 ft	34	10	10	10	4.00	1	1	1	0.30	10	10	3.00	7.3	B	A	C	B	C
3555	Mariposa	7,001 to 11,000 ft	59	10	10	5	3.33	1	5	1	0.70	10	10	3.00	7.0	B	A	B	C	A
3617	Mariposa	7,001 to 11,000 ft	45	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	C	C
3651	Mariposa	7,001 to 11,000 ft	99	10	10	10	4.00	1	5	1	0.70	10	10	3.00	7.7	A	A	B	A	A
3860	Mariposa	3,001 to 7,000 ft	54	7	10	10	3.60	10	10	5	2.50	3	1	0.60	6.7	A	C	C	A	A
4037	Mariposa	7,001 to 11,000 ft	138	10	10	10	4.00	5	5	1	1.10	10	10	3.00	8.1	A	A	A	C	A
4090	Mariposa	7,001 to 11,000 ft	69	10	10	10	4.00	1	1	5	0.70	10	10	3.00	7.7	A	A	B	B	A
4094	Tuolumne	3,001 to 7,000 ft	62	1	10	5	2.13	10	10	10	3.00	3	3	0.90	6.0	A	C	B	C	A
4100	Tuolumne	3,001 to 7,000 ft	45	7	5	5	2.27	5	5	1	1.10	7	7	2.10	5.5	C	B	C	B	A
4397	Tuolumne	7,001 to 11,000 ft	98	10	10	5	3.33	5	5	1	1.10	10	10	3.00	7.4	B	A	B	C	A
4457	Tuolumne	7,001 to 11,000 ft	72	10	5	10	3.33	5	1	1	0.70	7	10	2.55	6.6	B	B	B	C	A
4497	Tuolumne	7,001 to 11,000 ft	31	10	5	5	2.67	1	5	1	0.70	7	10	2.55	5.9	C	B	C	C	A
4670	Tuolumne	3,001 to 7,000 ft	71	3	5	5	1.73	5	1	1	0.70	3	3	0.90	3.3	C	C	B	A	B
4822	Tuolumne	3,001 to 7,000 ft	115	3	10	5	2.40	10	10	5	2.50	7	7	2.10	7.0	A	B	A	C	C
4926	Tuolumne	7,001 to 11,000 ft	52	10	5	10	3.33	10	1	1	1.20	10	10	3.00	7.5	B	A	C	C	C
4956	Tuolumne	7,001 to 11,000 ft	121	10	10	10	4.00	1	5	1	0.70	10	10	3.00	7.7	A	A	A	C	C
4978	Tuolumne	7,001 to 11,000 ft	29	10	10	10	4.00	1	1	5	0.70	10	10	3.00	7.7	A	A	C	C	C
5005	Tuolumne	7,001 to 11,000 ft	96	3	5	5	1.73	5	5	5	1.50	7	7	2.10	5.3	C	B	B	C	C
5070	Tuolumne	7,001 to 11,000 ft	73	3	10	5	2.40	10	1	10	2.10	10	10	3.00	7.5	B	A	B	C	C
5202	Tuolumne	7,001 to 11,000 ft	34	10	10	10	4.00	10	10	5	2.50	7	10	2.55	9.1	A	B	C	B	C
5233	Tuolumne	7,001 to 11,000 ft	38	3	10	10	3.07	5	10	5	2.00	7	10	2.55	7.6	A	B	C	B	C
5274	Tuolumne	7,001 to 11,000 ft	100	1	5	10	2.13	5	1	10	1.60	10	10	3.00	6.7	B	A	A	B	C

5377	Calaveras	7,001 to 11,000 ft	40	3	5	5	1.73	10	1	5	1.60	7	7	2.10	5.4	C	B	C	B	B
5492	Alpine	7,001 to 11,000 ft	59	10	10	10	4.00	5	1	1	0.70	10	10	3.00	7.7	A	A	B	B	C
5550	Alpine	7,001 to 11,000 ft	67	10	10	10	4.00	5	1	1	0.70	10	10	3.00	7.7	A	A	B	C	C
5568	Alpine	7,001 to 11,000 ft	41	7	10	5	2.93	5	5	1	1.10	10	10	3.00	7.0	B	A	C	C	C
5606	Amador	7,001 to 11,000 ft	72	3	5	0	1.07	5	5	5	1.50	10	10	3.00	5.6	C	A	B	C	A
5686	El Dorado	3,001 to 7,000 ft	42	7	10	0	2.27	1	5	5	1.10	10	7	2.55	5.9	C	B	C	A	B
5832	El Dorado	3,001 to 7,000 ft	84	7	5	0	1.60	1	5	5	1.10	10	3	1.95	4.7	C	B	B	A	A
5856	Alpine	7,001 to 11,000 ft	483	7	5	10	2.93	5	5	1	1.10	7	7	2.10	6.1	B	B	A	A	C
5887	El Dorado	7,001 to 11,000 ft	347	7	10	10	3.60	5	1	1	0.70	3	3	0.90	5.2	B	C	A	B	C
5905	El Dorado	7,001 to 11,000 ft	120	7	5	0	1.60	5	1	1	0.70	3	3	0.90	3.2	C	C	A	A	C
5916	El Dorado	3,001 to 7,000 ft	42	1	10	0	1.47	10	10	10	3.00	3	3	0.90	5.4	B	C	C	A	A
5935	El Dorado	7,001 to 11,000 ft	47	10	5	5	2.67	1	1	1	0.30	10	10	3.00	6.0	C	A	C	B	A
6039	El Dorado	7,001 to 11,000 ft	109	10	5	10	3.33	10	1	1	1.20	7	3	1.50	6.0	B	C	A	B	C
6061	El Dorado	3,001 to 7,000 ft	98	3	10	5	2.40	5	5	5	1.50	3	3	0.90	4.8	B	C	B	A	B
6065	El Dorado	3,001 to 7,000 ft	86	3	5	5	1.73	5	5	10	2.00	3	3	0.90	4.6	B	C	B	A	B
6109	El Dorado	3,001 to 7,000 ft	51	7	5	0	1.60	5	5	10	2.00	10	10	3.00	6.6	B	A	C	A	A
6116	El Dorado	3,001 to 7,000 ft	55	3	5	0	1.07	5	10	10	2.50	3	3	0.90	4.5	B	C	B	A	A
6142	El Dorado	7,001 to 11,000 ft	47	7	5	5	2.27	5	5	1	1.10	7	7	2.10	5.5	C	B	C	C	B
6220	El Dorado	3,001 to 7,000 ft	53	7	5	5	2.27	1	1	1	0.30	3	3	0.90	3.5	C	C	C	B	B
6250	El Dorado	3,001 to 7,000 ft	36	3	10	5	2.40	5	5	5	1.50	3	3	0.90	4.8	B	C	C	B	B
6269	El Dorado	7,001 to 11,000 ft	53	10	5	5	2.67	10	1	1	1.20	10	10	3.00	6.9	B	A	C	B	B
6276	El Dorado	7,001 to 11,000 ft	47	7	10	0	2.27	1	5	1	0.70	10	10	3.00	6.0	C	A	C	C	B
6295	El Dorado	7,001 to 11,000 ft	29	7	5	5	2.27	10	5	1	1.60	7	7	2.10	6.0	B	B	C	B	C
6511	Placer	3,001 to 7,000 ft	40	3	5	5	1.73	5	10	10	2.50	1	3	0.60	4.8	B	C	C	C	B
6590	Placer	3,001 to 7,000 ft	719	3	10	10	3.07	5	10	10	2.50	1	1	0.30	5.9	A	C	A	A	A
6768	Plumas	7,001 to 11,000 ft	34	3	5	5	1.73	5	1	1	0.70	3	3	0.90	3.3	C	C	C	B	B
6863	Plumas	3,001 to 7,000 ft	54	3	10	5	2.40	5	1	1	0.70	3	3	0.90	4.0	C	C	C	B	B
6914	Plumas	3,001 to 7,000 ft	428	3	5	10	2.40	5	1	1	0.70	3	1	0.60	3.7	C	C	A	B	B
7107	Plumas	3,001 to 7,000 ft	72	3	10	5	2.40	5	1	1	0.70	3	3	0.90	4.0	C	C	B	A	B
7162	Butte	3,001 to 7,000 ft	225	3	10	5	2.40	5	1	1	0.70	3	1	0.60	3.7	C	C	A	C	B
7166	Plumas	3,001 to 7,000 ft	86	3	5	0	1.07	5	1	1	0.70	3	1	0.60	2.4	C	C	B	A	B
7190	Plumas	3,001 to 7,000 ft	40	3	10	5	2.40	5	1	1	0.70	3	3	0.90	4.0	C	C	C	B	B
7194	Plumas	3,001 to 7,000 ft	225	3	10	5	2.40	5	5	1	1.10	3	3	0.90	4.4	B	C	A	B	C
7325	Plumas	3,001 to 7,000 ft	90	3	10	5	2.40	5	1	1	0.70	3	1	0.60	3.7	C	C	B	B	B
7340	Plumas	3,001 to 7,000 ft	79	3	5	5	1.73	5	1	1	0.70	3	1	0.60	3.0	C	C	B	B	B

Appendix D – High-Resolution Map of Meadows with ID Codes

Appendix E – High-Resolution Map of Meadows with VI Scores

Appendix F – High-Resolution Map of Meadows with 5-Letter Scores