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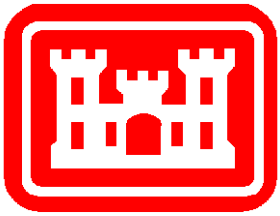
NON-NATIVE INVASIVE SPECIES MANAGEMENT GUIDANCE



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FACILITIES ENGINEERING
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NON-NATIVE INVASIVE SPECIES MANAGEMENT GUIDANCE

1. Purpose

a. This Public Works Technical Bulletin (PWTB) provides guidance to address problems encountered in combating infestations of invasive plant species at the installation level. It also provides guidance to help installations comply with various federal laws and military instructions, as outlined in Section 3 below.

b. The guidance in this PWTB summarizes the best professional information from numerous agencies and activities where policies and programs exist for the purpose of managing the spread of invasive species. This guidance does not contain specific recommendations for general use of pesticides to perform or assist in this management, but rather focuses on techniques and technology for minimizing or preventing the introduction and establishment of invasive species.

c. All PWTBs are available electronically at the Whole Building Design Guide webpage:
http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability

a. This PWTB applies to all U.S. Army facilities engineering activities. It is designed for use by all natural resource

managers, pest control operators, land managers, and private agencies.

3. References

a. Army Regulation (AR) 200-1, “Environmental Protection and Enhancement,” paragraph 4-3d, 13 December 2007.

b. Department of Defense Instruction (DoDI) 4715.03, “Natural Resources Conservation Program,” 18 March 2011. http://www.dtic.mil/whs/directives/corres/pdf/471503p.pdf

c. Executive Order (EO) 13112, “Invasive Species,” 3 Feb 1999. http://www.gpo.gov/fdsys/pkg/FR-1999-02-08/pdf/99-3184.pdf.

d. Department of Defense Instruction (DODI) 4150.7. “DoD Pest Management Program.” 29 May 2008. http://www.dtic.mil/whs/directives/corres/pdf/415007p.pdf

e. Technical Manual (TM) 5-629, “Weed Control and Plant Growth Regulation.” Washington, DC: Department of the Army, 24 May 1989. http://armypubs.army.mil/eng/DR_pubs/dr_a/pdf/tm5_629.pdf

4. Discussion

a. Concern about management costs and potential detriments to mission capabilities due to invasive species on Army installations has resulted in the need to develop policy and procedures that effectively identify and manage such issues in the installation setting.

b. AR 200-1 sets forth policy, procedures, and responsibilities for the conservation, management, and restoration of land and natural resources consistent with the military mission and in consonance with national policies. In fulfilling their conservation responsibilities, paragraph 4-3d(10) Noxious weeds and invasive species management, tasks the Director of Public Works to “Prepare and implement an invasive species management component (ISMC) of the INRMP consistent with specific Federal or State initiatives,” and references EO 13112 (ref. 3.c, above) as the basis for the requirement. Paragraph 4-3d (10) (c) broadly requires that the Director “Conduct mission activities in a manner that precludes the introduction or spread of invasive species,” and further requires that all actions be consonant with the requirements of DODI 4150.7 (ref. 3d, above) and TM 5-629 (ref. 3e, above). TM 5-629 also outlines most

aspects of a continuing program to address known weed populations and locations.

c. Management of invasive species generally consists of three stages: (1) preventing the introduction of propagules of the species (including seeds, spores, roots, and other viable stages of the life cycle); (2) identifying initial introduction and applying control measures to prevent widespread establishment; and (3) implementing a long-term control plan if there is a successful invasion. The guidance in this PWTB is mostly directed at the first stage—that is, preventing initial introduction.

d. Appendix A summarizes recommendations for Army installations that are considering ways to minimize or prevent introduction of invasive species, either within the installation or on adjacent Army Compatible Use Buffer (ACUB) lands.

e. Appendix B reproduces a US Forest Service report about portable vehicle washing equipment testing to give managers information about this option for controlling invasive species.

f. Appendix C reproduces a PLANTS database tutorial to assist managers in learning the use of standardized, normally four-letter, identifiers for weeds.

g. Appendix D reproduces guidance for managing invasive species through use of a Weed Management Area and also provides a Site Assessment Worksheet with instructions.

h. Appendix E reproduces guidance on invasive species from the DoD-sponsored publication “Conserving Biodiversity on Military Lands,” available on the DoD’s biodiversity website.

i. Appendix F reproduces a report on the development of a Range Rider Program, which creates an organization for joint weed management by a group of landowners or other stakeholders with similar concerns. This appendix includes an example of a factsheet used in the program.

j. Appendix G lists references used in this PWTB, along with a list of resources featuring guidance prepared by private groups and various government agencies for invasive species management within the United States or elsewhere.

k. Appendix H lists acronyms and abbreviations used in this PWTB.

5. Points of Contact

a. Headquarters, US Army Corps of Engineers (HQUSACE) is the proponent for this document. The point of contact (POC) at HQUSACE is Mr. Malcolm E. McLeod, CEMP-CEP, 202-761-5696, or e-mail: Malcolm.E.Mcleod@usace.army.mil.

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Appendix A:

DEVELOPING AND IMPLEMENTING AN INVASIVE SPECIES MANAGEMENT PLAN

This bulletin addresses concerns related to managing installation resources in response to Presidential Executive Order (EO) 13112. In effect since 1999, the EO's requirements have been variously interpreted by different U.S. government agencies. These various interpretations likely reflect the widely varied pressures and perceptions most relevant to each agency.

The Army further identifies, in AR 200-1, par **4–3.***d.*(10), some specific responsibilities for the Department of Public Works (DPW) function. These responsibilities also are based on the requirements of EO 13112 and DODI 4150.7, as noted in parentheses following the lettered statements below.

"**4–3.***d.*(10) *Noxious weeds and invasive species management.* The Director of Public Works is the proponent for noxious weeds and invasive species management.

(a) Prepare and implement an invasive species management component (ISMC) of the INRMP consistent with specific Federal or State initiatives. (LD: EO 13112).

(b) Where applicable, synchronize invasive species management practices with objectives of the installation ITAM program.

(c) Conduct mission activities in a manner that precludes the introduction or spread of invasive species. (LD: EO 13112).

(d) Do not use invasive species in installation landscaping or land rehabilitation and management projects. (LD: EO 13112).

(e) Use the most effective and environmentally sound approach for controlling invasive species, to include the use (or reduction in use) of pesticides. (PD: DODI 4150.7).

(f) Assure that installation INRMP and pest management plan are in concert regarding noxious weeds management. (PD: DODI 4150.7)."

Further, in the AR 200-1 Glossary, Section II, the term "invasive species" is defined as:

"An alien species whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Alien species means with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem."

Developing a Management Plan

As outlined previously in the front matter of this PWTB, there are three stages of response when there is a perceived risk of invasion by a non-native species. Largely, these stages apply to all such species, whether plant or animal and whether terrestrial or aquatic. While EO 13112 includes all species, the focus of most Army-relevant effort has been on terrestrial plant species.

- Stage 1: preventing introduction of propagules of the species (including seeds, spores, roots, and other viable stages of the life cycle).

- Stage 2: identifying an initial introduction and applying control measures to prevent species' widespread establishment.

- Stage 3: implementing a long-term control plan following a successful invasion of such species.

Stage 1: Prevention

Unless there is a confirmed problem, land managers may perceive the effort required for prevention as more time-consuming than appears to be justified. The logic apparently often applied by land mangers is: "If we don't have a current problem with that species, then we cannot justify spending time and money to avoid invasion." Of course, this logic is a large hurdle to overcome. Additionally, Army programs themselves often do not focus on prevention and instead focus only on remediation.

The following principles are adapted for Army land management purposes from the California Bureau of Land Management document, "Weed Prevention and Management Guidelines for Public Lands." These principles emphasize the importance of prevention in an invasives management program.

Certainly the best way to control weeds is to prevent them from taking root or becoming established in the first place. Some of the guidelines for preventing weeds from entering public lands are listed below, arranged by the most common vectors of invasion.

Dispersal via Seed

- Use quality seed. Commercially purchased seed contaminated with noxious weed seeds can be prevented by requiring that the seed label comply with the state inspection code. In addition, it should be required that the label show the seed is free of noxious weeds. Never buy uncleaned field-run seed, even though it might be cheaper; an exception could be buying or collecting native seed from uninfested areas, including your own land, for augmenting native plantings. This could be the ideal—using local genetics could guarantee that no noxious weeds will be present, unless of course, they are already present.

- Question seeding. Why are you reseeding? Is the erosion potential so bad that seeding is required? Why won't the natives come back? Perhaps seeding should only be done in regraded areas or restoration areas where excessive erosion will occur if seeding is not done.

- Monitor contractor performance and specifications. Many weed infestations have occurred through poor contractor performance, failure to provide adequate specifications of seed quality, or failure to specify that seed must be free of noxious weeds. Be sure that the seed bags are inspected before the seed is applied in the field. Are you getting what you ordered? Include wording in the contract which requires the contractor to deliver the seed, mulch, fertilizer, etc., under your inspection. Be sure to check the amount applied per acre verses what the contract calls for.

Dispersal via Feed

- Control feeding. Livestock are a major source of unwanted plant species from their droppings or from their supplemental feed. One of the best ways to prevent introductions of weed pests onto public land is to prohibit supplemental feeding while livestock are grazing on public land. If this is not possible, then supplemental feeding should be in one place only so that if weeds show up, they are at least confined to one area and eradication will be easier.

- Control manure. Noxious weeds can also be introduced in livestock dung. The animals may have been grazing in environments hundreds of miles away before being loaded for

shipment. This mode of infestation may be minimized by requiring that livestock be kept in a fenced holding field for at least 48 hours before they are released into the open range. Local stock shouldn't need confinement holding, but stock from unknown origins should always be required to be placed in holding pens.

- Control bedding. Control of weeds from bedding in trailers and hay fed to horses is a more difficult problem. One suggestion is to require that horsemen purchase their hay and straw locally from a supplier known to offer only noxious weed-free products. Easier, but perhaps less effective, would be to require only that the hay and straw be free from locally important weeds. Another suggestion, if there are no local suppliers of weed-free hay, is to suggest, or even require, the use of only pelletized feed. The processing involved to make this feed destroys most of the viable weed seeds present.

Dispersal via Mulches

Mulching bare areas, restored sites, new construction sites, etc., is a necessary management practice. Unfortunately, mulching may be an important route for unwanted seeds because mulch materials often contain weed seeds.

- Create specifications. Both small and large construction projects should include mulching and seeding that include verification that the materials are free of invasive, and particularly, noxious weeds. Poor specifications and/or poor contractor performance can allow noxious weeds to be brought in through contaminated mulch. Have the contracting officer include good specifications and require that the contract monitor inspect all materials before they are applied.

- Use local material. One way to prevent weed invasion in mulch for DPW-managed projects is to hire a contractor to cut and bale grass growing locally. This material should be known to be weed-free. An added benefit should be if any of the local seeds in the grass germinate, they would be native or at least local. Another way is to chip brush either in-house or by contract from local and native plants growing on the installation. The same benefits would be derived as from local hay baling. Never allow contractors for the local utility companies to deliver free chippings

to your site. They are almost guaranteed to bring in unwanted trees, shrubs, and weeds.

- Monitor and inspect sites. Always monitor sites where seed, feed, hay, straw, or mulch has been applied. If weeds do appear, eradicate them before they can seed. If this was a big contracted project, both the environmental document and the contract specifications should require the contractor to maintain the site weed free for a specified time. Inspect the contract and make the contractor do his job.

Dispersal via Gravel and Fill

Surprisingly large quantities of road rock and gravel are required to maintain the network of unpaved roads in the training area. The hundreds (or thousands) of tons of material or thousands of yards of fill material that may be required for major construction projects can often be an unexpected source of invasive species. One solution is to design contracts that call for providing an on-site place from which fill may be taken. While finding a suitable place from which it may be excavated is a problem, excavation may end up being a lesser issue than bringing in numerous truckloads of offsite material. These outside loads may include not only seeds, but also roots and stems which spread vegetatively. Where possible, inspect gravel pits and fill sources to identify weed-free sources. At a minimum, regularly inspect that the rock and soil do not contain unwanted plant parts.

Dispersal via Animals

If the installation has grazing activities, especially on tracts that have both weed-infested and relatively weed-free areas at moderate or high ecological risk, then preventing movement of animals from infested to uninfested areas should be curtailed after the season of weed seed production. Wildlife, especially larger grazing and browsing species, must also move seeds regularly, but installation managers usually have little control of the movement of such species. In order to prevent excessive soil disturbance at salt licks, salt should be kept in containers and moved periodically. Require that the leasing District revise contracts to require weed prevention and management. Note that dispersal via supplemental animal feed was examined earlier, and these precautions relate to the grazing animals themselves.

Dispersal via People

Humans can track weeds from infested areas to non-infested areas without knowing it. Troops on foot probably spread more invasive plants than anyone realizes. Boots, clothing, many types of equipment, and even weapons may all carry seeds from one training area to another. Further, the seeds may stay viable for weeks or months while being carried unknowingly, so the origin may not only have been miles from the place where deposited, it may also have been weeks distant in time as well. This combination makes it very difficult to control this route of spread. As a part of the installation's weed management plan, those training areas known to have infestation by invasives should be mapped, and units using those areas requested to conduct cleaning activities before they leave that area and return to barracks.

Dispersal via Vehicles

Army vehicles are known to carry heavy loads of soil and seeds. Clearly, transport of these loads from one training area to another is a huge potential source of unwanted weed infestation. The standard Army wash rack or tank bath is somewhat effective as a way to remove soil and associated embedded seeds. However, for greatest effectiveness, vehicle cleaning should take place before leaving the area where the soil and seed were picked up. The typical placement of washing facilities is in garrison and close to the motor pool areas, which means that under usual conditions, these seeds may be spread widely before vehicle cleaning occurs.

Appendix B contains a technical report by the US Forest Service (USFS) reporting the results of a DoD-sponsored study on the efficacy of field-portable vehicle cleaning systems. In applying these systems, the USFS generally locates them at the entry points of active fire-fighting zones, and all vehicles entering and leaving are washed. For this study, five generally similar systems currently used for this type of application were tested. Results showed that the best cleaning system removed 88% of the soil, but the average removal rate was only about 74%. All systems tested also had the capability to filter and retain the sludges and seeds cleaned off the vehicles. This capability is important to prevent seeds from being dispersed at the cleaning sites themselves.

In the military installation context, the potential application for portable wash systems would be to wash vehicles while still

in the training area. Thus, soil and associated weed seeds would be left where they were already found. One of the conclusions of the report, however, is that the operating cost of many systems (all were leased from private businesses and operated by the contracted personnel) may not be economically justified. Figure A-1 is an example of one of the relocatable washing systems. All five were based on a system developed by the USFS and were similar in most respects.

Figure A-1. A relocatable vehicle washing system.

Ideally, movement should be restricted for non-tactical or civilian-pattern uncleaned equipment or machinery going from a noxious weed-contaminated area to an uncontaminated area. A possible way to effect some reduction in this is to require that all contractor machinery be cleaned before entering the installation. In many jurisdictions, it is already required that forest harvest equipment be cleaned before being moved from one property to another. This precaution should include equipment or machinery used for or by construction, recreation, agriculture, forestry, fire prevention, oil and gas exploration and production, utility companies, mining, and tourism. All off-road equipment should be cleaned of all mud, dirt, and plant parts before moving into relatively weed-free areas. In the absence of dedicated cleaning facilities, self-service car washes suffice to greatly reduce the soil and weed seed load. The equipment may either be driven through by itself, or it may be cleaned while still on a trailer or flatbed hauler. Don’t forget that the

empty trailer or hauler must also be cleaned before the equipment is reloaded. Ideally, this requirement should be stated in the contract, lease, or permit so it is known before entry to the installation is scheduled. One state-operated training area in Idaho has required this for many years, and washing facilities are located immediately outside the only entrance to the training area.

Contracting and Management Reminders Related to Invasive Species Management

The list below provides reminders of many management and contracting actions which will assist in reducing the initial entry of invasive species. While implementing these provisions may result in some added cost initially, it must be realized that operating a long-term invasive control program may add significant costs for decades. The expense related to prevention, however, may end up saving costs in the long run.

- Require incoming vehicles and equipment to be power washed before entry to the installation.
  - Identify local facilities where cleaning may be performed.
  - Include in all contracts expected use of heavy equipment (make a standard clause to be used when relevant).
    - Excavation
    - Utility trenching
    - Forest management (inform Corps District Real Estate of the requirement)
    - Road construction and repair
  - Provide inspector to examine equipment.
  - Include off-road recreational vehicle usage.
    - POVs entering base after off-road usage elsewhere (visibly muddy)
      - Have entry gate officers send them to be cleaned.
      - Warn OHV users to clean vehicles before return to base.
    - Make vehicle cleaning a part of hunting permits.
    - Consider providing cleaning equipment for personal use at entry points.

    - Make cleaning a requirement for visiting (and returning) units under the Range Regulations and Reserve training plans.
        - Require inspection of vehicles and equipment before entry to base.
        - Assign an inspector to examine equipment.
- Control movement of rock, gravel and fill.
    - In contracts, identify sources of all bulk materials to be placed on base.
    - Inform District Military Program POCs of need for this requirement.
        - At a minimum, identify on-post sources where possible.
            - Inspect sources to identify possible invasive species growing there.
    - Provide inspector to examine fill materials before placement.
        - Get authority from District to prevent placement of infested material OR to require treatment after placement.
    - Monitor sites following placement to watch for unwanted weeds.
- Control placement of mulch and other erosion control materials
    - In contracts, identify sources of all mulch and organic materials to be placed on base.
    - Prepare standard specifications for these materials as they relate to all types of projects.
    - Require mulch materials to be certified weed-free.
    - Inform District Military Program POCs of need for this requirement
        - At a minimum, identify on-post sources where possible.
    - Monitor sites following placement to watch for unwanted weeds.

Dispersal via Disturbance

On a military installation, especially an active training facility, minimizing invasive species by minimizing disturbance is a real challenge. It is obvious that weeds regularly start growth on bare soil areas. Training activities sometimes seem to be designed to create as much bare soil as possible. Surface disturbances which need to be minimized as much as possible include not only field training activity, but also construction, reconstruction, maintenance, and even fire suppression activities. Especially in areas known to be prone to infestation when disturbed, land managers should require revegetation of native species immediately after the disturbance has occurred. The ITAM program or other locally empowered activities should be regularly following up on which areas need repair. Land users need to be required to follow through to successful vegetative recovery.

Dispersal via Outleasing

Include weed prevention and treatment in all outleasing plans, oil and gas activity plans, and sand and gravel extraction plans. For mineral activity, retain bonds for weed control until the site is returned to desired vegetative conditions. Ensure that weed prevention is built into timber management project designs. Recreation activity permits should include weed prevention guidelines and/or information on weed species present. Include weed-risk considerations in environmental analyses for habitat improvement projects. All land use permits should include an assessment for weed control. Include weed prevention stipulations in all right-of-way authorizations.

Stage 2: Controlling Spread

When invasive species have already been found on the installation, three management activities should be implemented:

1. Determine with as much accuracy as possible just where each invasive species on the installation is now located and how extensive the population is.

2. Develop processes to identify which persons or units have used those locations recently or propose to use them in the near future.

3. Prepare an action plan which will provide for the vehicles and equipment exiting those sites to be cleaned before they can

spread soil and seeds to areas currently not infested with the invasive species.

Following is a sample mapping of a weed occurrence. It is based on a slide presentation by Andrea Williams, "Mapping and Gathering Data, Field Techniques for Recording and Reporting Invasive Plants" given in 2011 to the Bay Area Early Detection Network (BAEDN) and California Invasive Plant Council (Cal-IPC) Field Techniques workshop.[1]

If it is determined that a weed map is a necessary prelude to an organized management plan, the following questions will need to be answered:

- What are the objectives of the project? For example:
  - What information is essential and what is optional?
  - How will the data be used?
  - What is already known or obtainable from other sources?

If you can answer these questions, and still wish to proceed, the following three steps should be completed:

Step 1: Reconnaissance

Perform reconnaissance to create an initial rough survey of weed occurrence. This survey should be based on all potential information sources, which will likely reinforce each other. At this stage, however, do not rely on a single source, even if it appears to have all the needed data. Assemble your initial survey team from a combination of natural resources, ITAM, forestry, training directorate, and other persons who regularly work in various parts of the installation. Organizing the team by training area or forest parcel is logical if either designation is used locally. Personnel may be tasked to do this survey as a separate activity or just asked for inputs after their normal field assignments. Each of these groups should, of course, be "trained" or at least alerted to which weed species are of particular interest; they should then be provided with photographs of those weeds.

Often, examining aerial photos will show zones of the invasive species. Drawings made on paper maps and later transferred to

[1] http://calweedmappinghandbook.org/book/export/html/83; presentation itself is available from CAL-IPC on CD.

digital format can help make the process more interactive and faster. Use whatever standard installation land use names and areas are in effect at the location. Do not create new names and titles solely for the weed areas.

Examples of what should be recorded: Ideally, include species, general location, approximate size of infestation and/or abundance, and rate of spread (if the history is known). At a minimum, installation overprint maps showing the road network and training area boundaries should be used. Global positioning system (GPS) records are probably not necessary at this stage, but if GPS units (or smartphones with similar capability) are on hand, they may be utilized. You can map all the problem weeds simultaneously or focus on only the high-priority ones, depending on management goals. Keep in mind, however, that you may not realize a particular species is a high priority until you see the initial results, and priorities might change in the future as well.

Step 2: Baseline Monitoring

Based on the principle that “you can’t manage something if you don’t know where it is,” you are now ready to start monitoring. Conflict with training activities is often a complicating factor to accomplishing monitoring. Access to impact areas, or at least the safety zones associated with them, may be important in order to understand what is taking place. Remember not to overlook any areas because of access difficulties.

By completing the first step (reconnaissance), you know something about the pattern of the infestation and spread. Making initial decisions on “occurrences” is done at this stage and will have an effect on the way you record monitoring data going forward. Large areas that are evenly infested can be shown as a single occurrence, to be described in a corresponding assessment for each step in time. Smaller populations can either be grouped as a single occurrence or each can be given individual status, depending on the level of detail of monitoring desired. An example occurrence could be expressed, “Area B-16 is heavily infested with toad flax which appears to be advancing into Areas B-18 and D-5 along the roads and trails.” A corresponding monitoring decision could be “Monitor the B-16 + B-18 + D-5 complex as a single region as described in the survey records, as well as monitoring the new infestations more intensively as separate Occurrences.”

Examples of what should be recorded: Region/Survey combinations should record region name and location, date, observer name, weed species, percentage cover, and other descriptors. Occurrence combinations should record weed species, exact location, date, observer, size of infestation, phenology, and other descriptors.

Step 3: Follow-up Monitoring

Timing affects monitoring of weed populations. Monitoring should be done at the time of year and with a frequency that allow for detection of change in the populations and the effects of any treatments. Usually, funding and personnel time are limiting factors, and monitoring is often done simultaneously with treatments to save on both factors. As with the initial reconnaissance, conflict with training activities may be a complicating factor to effective monitoring. However, do not overlook impact areas and safety fans because of access difficulties and record them as best you are able.

Examples of what should be recorded: Basically you will be repeating the observations made in your baseline survey, and it is helpful to review that data and even have it with you as you make the new observations, so that they compare well.

Summary of Steps

With limited budgets for weed management, it can seem hard to justify spending time and money on weed inventories or maps. It might appear that time and money be better spent toward actual weed management. An analogy might be made here that fighting a weed encroachment is very much like fighting a range fire. You need to know where it is centered, whether it is moving, and if so, in what direction and at what speed. Usually containment is the first step in fighting either problem. Like a wildfire, once the infestation has been contained, it can be further reduced by working from the outside in.

In addition to enabling weed managers to prioritize which part of an infestation to treat first, the use of invasive weed inventories can increase the efficiency of almost any method of weed management. As one example, natural resources managers might combine weed inventories with spot treatment of infestations that are found during the survey. Maps by themselves will not themselves kill weeds, but they are invaluable planning tools that help get the most from limited weed management dollars.

One example of a well-organized spot treatment effort is described in *Protection of Prioritized Rangelands from Weed Spread with Range Riders*.[2] The authors reported the use of ATV-mounted survey/spray teams to seek out new weed infestations across a 1.7 million acre range area in Montana. Figure A-2 is an example of the spray-equipped ATV. The crews used GPS to identify more than 1,000 small infestations, and then treated them on the spot. The scale of this effort, which required about two person-years in all, is comparable to (and may exceed) the areas involved in military installation application of this approach. The authors also noted that portable washing stations, similar to those described above and shown in Figure A-1, were used to clean the ATVs to prevent inadvertent transfer of seeds when they moved from one property to another.

Figure A-2. Range riders used ATVs outfitted with GPS units and spray equipment to inventory rangelands and eradicate new invasions. (Photo courtesy of Liberty County, Montana.)

Maps and inventory information are also critical to monitoring efforts. No matter what tool is used to manage weeds, monitoring should be done to evaluate the effectiveness of the efforts and to make sure the area has not been reinfested. Many weeds have seeds that remain viable for decades, far longer than can

[2] (reproduced later in this document as Appendix F)

realistically be tracked solely by memory. Many long-time personnel have good knowledge about where the major weed incursions are and the history of treatment practices, but when these individuals retire, change jobs, and are no longer available, their institutional knowledge will be lost unless it is recorded in a way that enables others to work from it. By putting this information on paper maps or in computer databases, weed management efforts can continue past the duration of any particular person's career.

One of the most important benefits of weed inventories lies in using them to generate awareness. One could say that "a map is worth a thousand reports." Whether the audience is DPW staff, Range Control, the ITAM staff, or even the Garrison Commander, being able to tie the problem back to their geographic area of interest will dramatically increase their receptiveness and interest.

Use a level of detail in mapping weeds appropriate to installation goals and weed distribution in the region. Don't reinvent the wheel. An important reminder is that when using a GPS unit, make sure it is set for the correct datum and projection. Most modern systems automatically set datum to World Geodetic System (WGS) 84 when Universal Transverse Mercator (UTM) coordinates are being used, but not all will do so. If you are using Lat-Long rather than UTM, mapping should be to North American Datum (NAD) 83. Remember to map also where weeds are *not* found. It is just as important to be able to state where you surveyed and did *not* find weeds as where you did. Record data promptly; the "forgetting curve" will be at work if there is a gap of even a few hours between mapping and recording the data. If you can store daily data in a portable storage system, it will help to alleviate this problem. The use of Geographic Information Systems (GIS) in creating these maps has not been emphasized here, but that technology, where available, can be extremely valuable. Applications using GIS may not only keep track of the latest locations of weeds, but may also help to predict where new infestations are most likely to occur. A paper in the journal Weed Science(Rew et al. 2005) examines the application of this technology to the weed mapping need.

Be cautious about creating local codes and abbreviations, since they are often hard to understand later, especially by persons who did not collect the data. The only codes recommended for use are those set out in the PLANTS database (NRCS 2013), where all of these weeds have been given a standard 4 (or 5) character identifier (based on the genus and species of the plant) to

simplify and standardize record keeping. It is likely that you are using these identifiers already, but if not, then refer to Appendix C, where the use of the identifiers is explained.

Programs need to prioritize which species are mapped and to what level of detail they are mapped. Here are some principles to help design the best strategy for your program. Simplistic mapping may be done using the grid on paper installation maps at the 1:25000 or 1:50000 scale. This will give points with a ± 50 m accuracy, which is probably adequate for initial surveys. Use of GPS will reduce errors to no more than 10 m, and probably less, which is totally reasonable for this purpose.

Remember why you are mapping. Infestations which are pioneers in an otherwise un-infested area are typically prioritized for aggressive eradication, such as by the Range Rider teams described above. A control project in heavily infested area may not make much progress initially, or ever, if reintroduction and regrowth is vigorous. Remember that you can map at different resolutions within a region for the same species as well as different species – one size need not fit all. In areas where weeds are very heavy, it is not necessary or feasible to do fine-grained, intensive mapping. Mapping these weeds at the entire training area or parcel level can provide most of the information that is necessary for prioritizing. Where the weeds are in small, localized populations, then more accurate locality information is needed for eradication efforts. Mapping weeds intensively and accurately at the edge of a containment zone is also critical to succeeding at stopping their spread. Populations that are smaller pioneers or outliers in an otherwise uninfested area deserve the most intensive mapping effort because these should be targeted for long-term eradication efforts.

Long-Term Control

This last step in the control process is by far the most discouraging for the majority of facilities. The reason for this is that any real progress is often hard to see; the weeds continue to grow in many areas, including those where control was attempted. Most aspects of a continuing program which addresses known weed populations and locations are outlined in TM 5-629, “Weed Control and Plant Growth Regulation.”[3] This TM, however, does not address invasives prevention or the management

[3] As referenced in front matter portion of this PWTB.

of invasive species. The recommendations for establishing and operating a long-term plan generally reflect the steps given earlier (i.e., first prevention, and then control and monitoring). The long-term control plan should recap the steps already presented above.

Establish a Prevention Program

This aspect of long-term control is simple conceptually but may be difficult to implement. To do the best possible job, review the procedures given above in Stage 1: Prevention. Seriously consider requesting implementation of a requirement for washing contractor's vehicles prior to their entering the installation. The contract function is likely to respond negatively, but the support of the DPW Chief and the Garrison Commander should be enlisted if at all possible. The potential for added cost to the resulting contracts needs to be weighed against the threat of continual reinvasion of species for which cost of control is already committed.

Examine the potential for using a portable washing system similar to that described in Stage 1: Prevention. A portable or fixed washing location situated so that vehicles may conveniently be cleaned prior to entering the installation is a superior long-term investment. Implementation of a range regulation requiring that entering vehicles operated by offsite units be cleaned before entering is also potentially valuable. As noted above, existing motor pool washing facilities (even the tank baths) usually clean vehicles only after they already have been driven long distances within the property. Such wash facilities may be effective in removing soil and seeds, but not in preventing invasion from outside.

Establish an Inventory and Monitoring Program

Detailed mapping using geographic information system (GIS) capabilities as described above may be appropriate for your facility. At a minimum, develop a reporting system for all land management personnel to report infestations of the invasive species of concern. This included adequate training so that the species may be identified with some reliability.

Consider joining a regional weed management program so that identification of new or serious infestations of target species may be performed outside the installation boundary. As with wildlife, these species do not recognize fence lines. The knowledge that the next-door property is having a problem may

provide notice that your program needs to be focused on a high-priority, possibly unsurveyed, portion of your lands.

Create a Long-Term Control Program

Provide adequate training for land management personnel who are identified as herbicide applicators. Training is available through Army programs, and some states provide training which is considered equivalent. Note that the basic training is only a prerequisite to more specialized certifications for different specific certifications in forestry, right-of-way, turf, and other areas. Contracted personnel should have appropriate licensing from the state, and this requirement should be a part of any scope of work (SOW) or performance work statement (PWS).

At this stage, all responsible personnel should be aware that the (annual) list of available herbicides compiled by Armed Forces Pest Management Board (AFPMB)[4] restricts which products may be procured at the installation level. Be aware, however, that some invasive species are showing resistance to the most popular chemical controls. Remain aware of this possibility, and do not simply plan all control actions as a repetition of the previous year or years. Regional weed management program leaders and local or regional US Department of Agriculture (USDA) offices are the best sources for up-to-date information as to which control chemicals have lost some or most of their control action. Develop a control program which rotates among different classes of herbicides to realize maximum effectiveness for the expenditures available.

[4] Link to current list available at http://www.afpmb.org/content/dod-standard-pesticides-and-pest-control-equipment.

APPENDIX B:

"COMPARISON OF VEHICLE WASHING SYSTEMS: PREPARED FOR US FOREST SERVICE"[5]

The US Forest Service Technical Report incorporated in this appendix resulted from a study sponsored by the DoD Strategic Research and Development (SERDP) program under the project designation RC-1545. Dr. Harold Balbach, the POC for this PWTB (contact info in Par 5.b) served as a cooperator in the SERDP project and technical monitor of the study performed by the USFS. He prepared the first draft of this report, and commented on the final version. In that sense, the USFS Technical Report serves also as the report for SERDP and the Army on the results of this interagency study.

[5] Reproduced from original, except blank pages deleted to save space (thus reproduced page numbers are no longer consecutive. Full publication details located in the "Reference and Resources" Appendix of this PWTB.

United States
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Forest Service

**Technology &
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5100 Fire Management

0851-1808—SDTDC
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Comparison of Vehicle Washing Systems: Prepared for U.S. Forest Service

Comparison of Vehicle Washing Systems: Prepared for U.S. Forest Service

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U.S. Department of Agriculture, Forest Service
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San Dimas, California

September 2008

Table of Contents

Acknowledgements:
The vehicle washing studies conducted at the California Department of Forestry Fire Training Academy (Cal Fire) facility at Ione, CA. SDTDC is appeciative of the Cal Fire facilities and equipment that were at our disposal for the duration of the study.

Note: The wash system contractors are listed alphabetically, which does not coincide with the Contractor numbers used in this report.

Acme Endeavors

All Clean Water Solutions

Breezeco

Little Red Hen LLC

S-K Environmental

ABSTRACT

Many land management activities on Federal, State, and private lands involve the movement of vehicles and equipment at off-road locations where seeds and spores can be picked up, transported, and transplanted great distances from their place of origin. When relocated to new areas invasive and nonnative species of plants and fungi can become established where the native ecosystem cannot coexist without being compromised. Some species of prolific plants can dominate new environments and upset the natural balance of plant life and wildlife to the extent that it will endanger other species and resources.

Plant seeds and fungal spores are often transported in the soil that is picked up by vehicles and equipment. Other times, seeds are picked up directly by undercarriage components that strike the host plant. Several contractors have developed systems for cleaning vehicles and equipment that could carry invasive or nonnative species propagules (seeds, for instance) into areas where they could disturb or destroy the native ecosystem. The intent is to reduce the amount of propagules that might be transported and thereby reduce the threat of infesting new areas.

The San Dimas Technology & Development Center (SDTDC) of the U. S. Department of Agriculture, Forest Service partnered with the U.S. Army Corps of Engineers, Engineer Research and Development Center (ERDC), Champaign, IL; Montana State University (MSU), Bozeman, MT; California Department of Forestry and Fire Protection (Cal Fire); and the El Dorado National Forest to evaluate a range of systems with respect to efficacy, economics, waste containment, waste disposal, and the viability of any propagules that were collected in the cleaning process. The effort was the result of a proposal by this team to the Department of Defense Strategic Environmental Research and Development Program (SERDP). SERDP funded the project in early 2007.

SDTDC took the lead role in developing the equipment, testing methods, and protocols used in this study, while MSU led the effort to evaluate the viability of propagules post-cleaning. ERDC had the primary oversight role and Cal Fire provided the location as well as some of the vehicles, machines, and logistical support to make this study possible. The El Dorado National Forest provided local support for the project. Many of the contractors made contributions and suggestions that were also valuable.

We assembled a core crew of seven workers to assist with system-efficacy testing while MSU sent two students to assist us in evaluating propagule viability and recycling-system performance. The testsite was located at the State of California Cal-Fire Training Academy in Ione, CA (figure 1). We tested equipment from five washing contractors over a 6-week period (June 18, 2007 to July 27, 2007).

Figure 1—Ione location photo.

TEST OBJECTIVES

The purpose of this evaluation is to provide contracting officers from various government agencies with guidance on the parameters for contract washing systems. Often we find that the actual decision about what type (if any) wash station to order is usually made by an incident response buying team member who may be simultaneously told to do contradictory things: including to get good equipment, get low-cost contracts, abide by all environmental regulations and best management practices, and get it done quickly. When the decisionmaking process is left entirely to the contracting officers, or party in charge, without providing any definition of what a washing system should include, the default guidance to the contracting officer becomes cost. They very likely will hire the lowest cost contractor who claims to have a system and has an Emergency Equipment Rental Agreement (EERA) on file with the government. For most types of equipment, when a contractor is listed with an EERA, the equipment has to meet certain requirements that are measurable or notable. In some cases they are required to give proof of compliance to the contracting agency. These systems are an exception because we do not have national standards for portable vehicle washing systems. As a result some contractors will propose that a pressure washer and a tarp is a functional system. Other contractors who may be more conscientious about the overall objectives, the environment, and the related regulations governing waste disposal, will have made a significant investment in their equipment, but it is impossible for them to compete with the low-budget contractors on a strict daily cost basis.

As we are still in the process of defining what characterizes a bona fide washing system we limited the range of systems tested to those we considered to have the potential to conform to the underlying needs. This resulted in selecting a range of units of varying cost and performance. For now, we have adopted the term "Type 1" to define systems that recover and recycle the majority of the washwater. Naturally, it is impossible to recover all of the water as long as the vehicles drive away wet. As this technology evolves we may set standards for several optional types of systems and assign type designations to them as well.

Our objectives for the Ione test were to evaluate reasonably priced Type 1 contract vehicle cleaning systems for the following:

- **Cleaning system efficacy** - The amount of debris removed from the vehicles and equipment over a certain time period, compared to the total amount of debris that could be removed from the vehicles.
- **Recycling system performance** - The ability of the contractor's recycling system to process a known amount of soil and seeds and extract all particles greater than 100 microns.
- **Waste containment** - The contract system's ability to contain the waste from the cleaning system.
- **Seed viability** - The amount of viable seeds remaining in the system waste compared to the known quantity of seeds that each system processed.

Note: The seed-viability testing was performed by a team from MSU, Bozeman, MT, headed by Dr. Lisa J. Rew; (Weed Ecology). Dr. Rew has written a phase 1 report on the results to date and other results are pending. To access this report; "Developing functional parameters for a science-based vehicle cleaning program to reduce transport of non-indigenous invasive plant species," visit Dr. Rew's Web site: http://landresources.montana.edu/rew/

Test Protocol

We developed a protocol for evaluating the various systems and we used the same procedures and equipment for each contractor. We tested the cleaning systems in the same location on a paved helipad.

We used three types of vehicles from the Forest Service fleet to perform the tests :

Vehicle Type 1. Wildland fire engines (three; only two were used for test cycles).

Figure 2—Wildland fire engines.

Vehicle Type 2. Light-duty trucks (two) and sport utility vehicle (one).

Figure 3—Light-duty trucks and sport utility vehicle.

Vehicle Type 3. Caterpillar D6 High-Track bulldozer (one).

Figure 4—Caterpillar D6.

Our weekly routine was to set up and test the contractor's equipment on Monday, ensuring that all components were functioning. We would run Type-1 vehicles on Tuesday; Type-2 vehicles on Wednesday; and soil-and-clean the Type-3 bulldozer on Thursday. We started the MSU seed-viability and recycling-system tests on Thursday afternoon and we let the contractor's recycling system settle overnight before collecting the captured waste. Fridays were for cleanup and travel home.

Test Location

The Cal-Fire Academy has more than 5,400 acres located in the Sierra Nevada foothills approximately 40 miles southeast of Sacramento, CA. The terrain is mostly gentle hills with some level open fields. We chose the paved helipad as a good solid footing where we could set up all of the contractor wash systems as well as our washing and inspection areas. Use of the helipad helps to minimize the introduction of soil to the wash systems from sources other than the vehicles we were using. Since we were going to be tilting vehicles, jacking up axles, and removing wheels we wanted a firm and fairly level work platform and the helipad satisfied that requirement.

Course and Soil Classification

We laid out the test course in a cleared, open, and level field with little or no surface vegetation. The soil in the test area is described in a survey by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) as "very deep, well-drained soils formed... from basic igneous and granite rocks." The clay content usually averages 6 to 12 percent. The NRCS classification report is included as appendix 2.

TEST CYCLES

The wheeled vehicles had somewhat different soiling-and-cleaning cycles than did the bulldozer, due to the operational and physical differences between the different types of machines. The entire soiling-and-cleaning process for each vehicle type is described in detail below.

Type 1 and 2 Wheeled Vehicle: Test Course

We would drive the wheeled vehicles through a fabricated mud bog and then 2.75 times around a figure-8 course before returning them to the washing area on the helipad (figure 5). We know that it is very hard to control multiple natural and human-induced variables simultaneously so we tried to keep some of the human inputs, such as driving speed and course tracking constant, but our results seem to suggest that we may have experienced some form of boundary creep with respect to speed and tracking. We cannot know for sure how much variance there was since we did not have active speed and position monitoring.

Mud Bog. The mud bog was created by plowing a shallow trench 12-foot (ft) wide and 50-ft long with a maximum depth of 1 ft. We placed a heavy-duty tarp in the trench, and filled it with loose, excavated soil. We then used a Cal Fire watertruck to saturate the soil in the trench. We would recondition the mud bog between test periods for each of the different vehicle types by adding soil and water until it was saturated.

Figure 8 Section. After passing through the mud bog we drove the vehicles around a figure-8 course that was approximately a football field long (300 ft) and 100 ft wide. We loosened the soil in the figure-8 area with a roadgrader scarifier after each series of 18 soil-and-wash cycles for the Type 1 and 2 vehicles. In the early morning prior to running a test series with Type-1 or Type-2 vehicles, we applied water from a water truck to the figure 8, and periodically as the course would become dry.

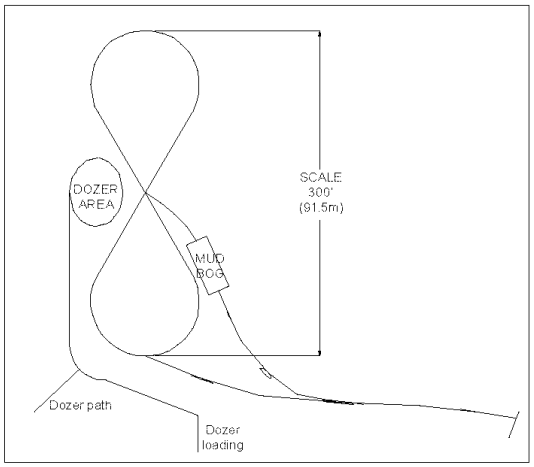


Figure 5—Figure 8 course drawing.

Type 1 and 2 Wheeled Vehicle: Wash Cycles

Each cycle of soiling and cleaning wheeled vehicles is outlined below:

Step 1. Drive through the mud bog at 10 to 15 miles per hour (mph)

Step 2. Enter the figure-8 course at the intersection and drive 2-3/4 laps around at 10 to 15 mph before exiting the course and returning to the washing area on the helipad. The first two steps typically took about 5 minutes including the drive to and from the wash area.

Contractor Wash. Drive onto the contractor's wash-containment pad and allow up to 5 minutes for cleaning. During this time the vehicle is moved at the direction of the contractor if they desire. Soil removed here is "credited" to the contactor.

NOTE: We noticed early in the testing that if you turned the front wheels lock-to-lock it would often expose a significant amount of debris that might have otherwise missed. Some of the contractors were aware of this and used the wheel-turning procedure to better access hidden debris.

Post Wash. Drive onto our washrack (Hydropad®) and rinse further, concentrating on hard-to-reach areas and places that are often missed. This step typically took another 5 minutes but there was no time limit. Soil removed here is counted as "missed" by the contractor wash.

Step 3. Return to the course and repeat.

We ran 18 cycles of each wheeled vehicle type through the course for each contractor and collected the soil and debris from both the contractor's wash containment and our second wash separately.

FINAL CLEANING

After the 18 daily soiling-and-cleaning cycles, we ran each vehicle once through a more meticulous, two-step cleaning and inspection process. All of the final cleaning phases were performed using fresh hydrant water and a pressure washer with a selection of spray nozzles. All material removed here was also considered "missed" by the contractor.

Figure 6—Cleaning ramp photo.

Inspection Ramp

We built a ramp upon which we could drive each side of the vehicle to get better access and view of the undercarriage. Raising each side of the vehicle separately allowed us to clean and inspect more meticulously without compromising safety.

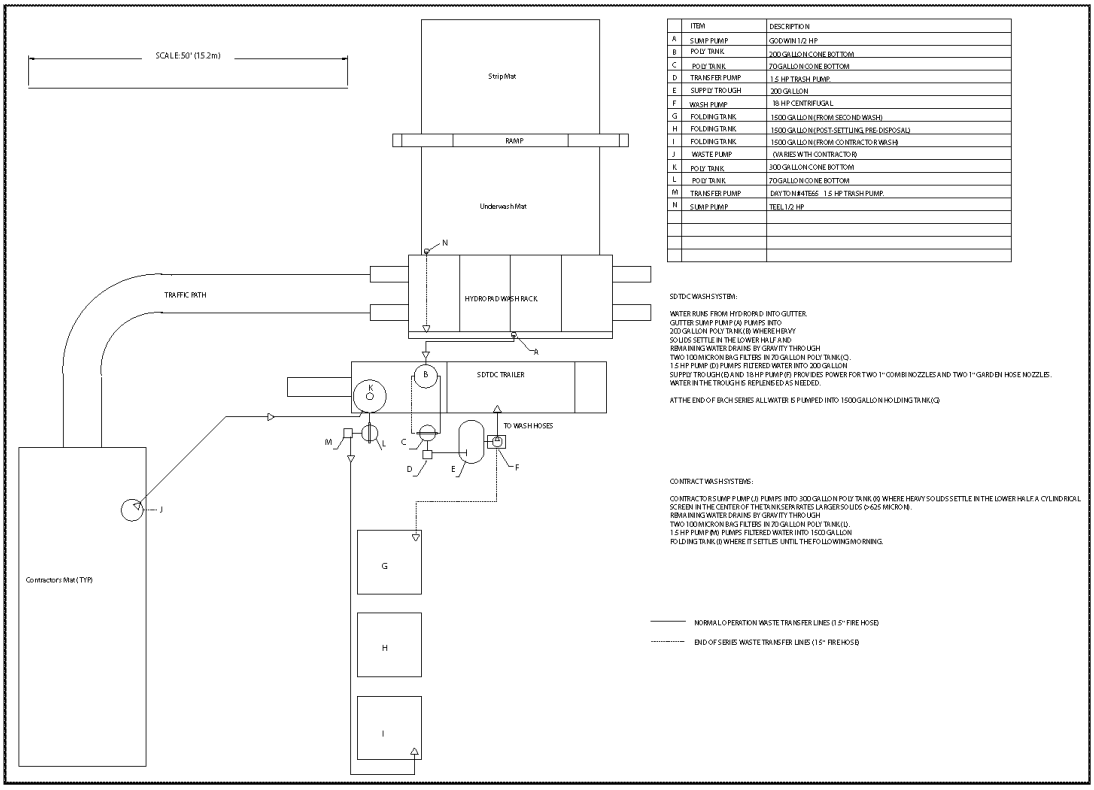
Figure 7—SUV engine on inspection ramp.

Teardown

After cleaning each side of the undercarriage we put the vehicles over an adjacent containment mat and removed the wheels to get better access where debris could still be found on spindles, brake calipers, brake drums, springs, and between dual wheels. During this phase, we raised the hood, removed battery covers, dropped the tailgate and lowered the spare tire, as applicable to the vehicle. All material removed here was considered "missed" by the contractor as well.

We collected debris from the final cleaning phases in dewatering bags and by pumping liquid waste through the same system we used for the more routine rinses that followed the contractor's wash cycle.

A diagram of our cleaning waste-recovery process is shown below (figure 8).



	ITEM	DESCRIPTION
A	SUMP PUMP	GODWIN 1/2 HP
B	POLY TANK	300 GALLON CONE BOTTOM
C	POLY TANK	20 GALLON CONE BOTTOM
D	TRANSFER PUMP	1.5 HP TRASH PUMP
E	SUPPLY TROUGH	200 GALLON
F	WASH PUMP	15 HP CENTRIFUGAL
G	FOLDING TANK	1500 GALLON (FROM SECOND WASH)
H	FOLDING TANK	1500 GALLON (POST-SETTLING, PRE-DISPOSAL)
I	FOLDING TANK	1500 GALLON (FROM CONTRACTOR WASH)
J	WASTE PUMP	(VARIES WITH CONTRACTOR)
K	POLY TANK	300 GALLON CONE BOTTOM
L	POLY TANK	20 GALLON CONE BOTTOM
M	TRANSFER PUMP	DAYTON MMT66 1.5 HP TRASH PUMP.
N	SUMP PUMP	TEEL 1/2 HP

Figure 8—Waste-recovery drawing.

Type-3 Vehicle (Bulldozer): Test Course. We used an area near the intersection of the figure-8 course for the bulldozer workout routine (figure 5). We sprayed the area with approximately 700 gal of water, 1 to 2 hours before starting. Our bulldozer "workout" regimen included plowing, back-dragging, ripping, pivoting, and moderate-speed traversing.

Type-3 Vehicle (Bulldozer): Wash Cycles. We granted the contactors discretion over how they wanted to wash the bulldozer; either loaded on the trailer or directly on their washing pad. We let them use any tools at their disposal and we would move the dozer back and forth at their request.

First wash (cleaning) cycle: We allowed each contractor 1 hour to remove as much soil as possible from the bulldozer, noting the number of people working and the amount of time spraying with the wands or nozzles they would normally use. During the first 1-hour wash we did not credit the contractor with any soil that was removed from the bulldozer but remained on the trailer.

We cleaned the contractors wash pad completely after the first attempt at cleaning the bulldozer and collected all of the debris.

Second wash (cleaning) cycle: After the first cycle our crew joined with the contractor's crew and we used all available tools including our pressure washers and 1-in combination nozzles to remove any remaining soil. We put the machine back on or over the contractor's containment pad for the second cleaning attempt. We moved the machine as necessary to access all areas of the machine including all parts of the blade, rippers, and tracks. There was no time limit on the second attempt and we continued washing and inspecting until we did not see any more debris. The second attempt typically took another hour with an additional two to four crewmembers as well as the contractor's crew.

Note: Even when the dozer appeared to be completely free of debris while wet, we would always find a little more once it dried, but a very small and insignificant amount as a percentage of the total. We never attempted to collect debris remaining after the second washing attempt since it seemed we would never get it totally cleaned even after three attempts and there was not enough time to wash and dry the machine three or more times. The residual debris was virtually invisible when the machine was wet and therefore we would no longer see it once the machine was wet again. We made the decision not to clean the machine more than twice per contractor as a matter of practicality and we will never know exactly how much debris was remaining on the machine beyond that, but we speculate it did not amount to enough that it would change the results by even one tenth of 1 percent. Still, we are aware that even a few grams of plant propagules could cause the start of an infestation.

Type-3 Vehicle (Bulldozer): Debris Collection (Contractor). We did not screen or prefilter any of the wastewater from the bulldozer washing cycles. Most of the debris was put directly into dewatering bags as it came off the machine or the contractor's cleaning pad. We pumped all of the wastewater into a dedicated 1,500-gal holding tank and let it settle overnight in the same manner as we did with the Type 1 and 2 vehicles. We then collected the residual sediment in the same manner as we had for the other vehicles by pumping the top water off and putting the sediment in dewatering bags.

Type-3 Vehicle (Bulldozer): Debris Collection (Investigator). We used the same method described above for collection of debris from the second cleaning cycle. We bagged and tagged all solids and pumped all liquid waste into a separate 1,500-gal holding tank to settle overnight. We used floating pool-cover pumps to draw the settled water off the top of the tanks and then collected the residual fines using wet vacuums and shovels.

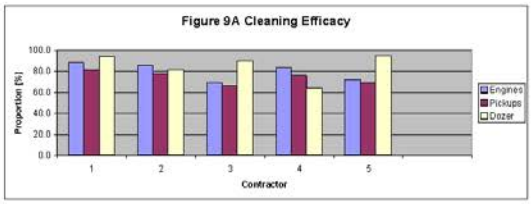
GENERAL REVIEW

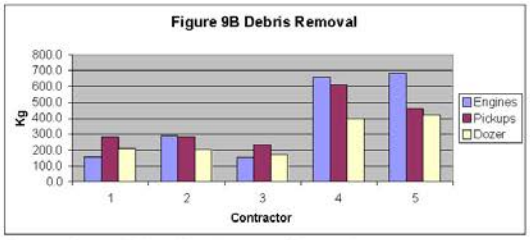
All five systems tested in Ione were fairly successful at removing the majority of debris from the vehicles and heavy equipment. However, even the most effective system could not remove more than about 88 percent of the debris from the wheeled vehicles and the average proportion of removal was around 77 percent. If we had allowed more time, the results would likely have been better but we decided to limit the vehicle washes to 5 minutes each to reflect fire-incident conditions. For the bulldozer we allowed a full hour for the contractors to clean it, and while some of them got better than 90 percent of the debris in that timeframe, we spent another hour cleaning it with five or more people and still did not get 100 percent of the remaining debris.

Cleaning Efficacy

Figures 9a and 9b show what each contractor removed from each vehicle type and what our crew removed afterward. You will note that as the test progressed the vehicles seemed to pick up more debris from the same course. We believe that the repeated tilling and driving over the course broke up some of the larger soil clumps to where they could more easily adhere to the vehicles. The more pulverized soil also created more of a

dust cloud and we had to increase the amount of water we were using for dust abatement as the test progressed. Therefore the later contractors, who may have recovered a lower percentage of debris from the vehicles, had a much larger amount of debris to remove, and in some cases almost five times as much.





Figures 9a and 9b—Contractor efficacy chart.

Water Usage

Although many of the contractors will provide all of the water for their washing system, there are cases where water is scarce, so we looked at the actual water use by each contractor on a per-wash basis. Some contractors have made the point that water recycling ends up being more costly than it's worth since it requires a lot of additional equipment and if the recycled water is still somewhat contaminated it can cause premature failure of pumps, valves, and nozzles. Even if water is in abundant supply it all has to be filtered to the point where it contains no invasive plant propagules before disposal. All wastewater must be contained and disposed of in accordance with the provisions of the Clean Water Act and any additional requirements of the water resource authority having jurisdiction for a given area.

We tested the contractors spray bars and wands individually prior to testing to see their performance. In some cases the systems did not deliver what was expected, so we made note of the actual output and proceeded to test. We had an observer timing the entire wash process, noting how long the spray bar(s) and wands were used. There were brief periods when a wand would not be spraying for a couple of seconds while the operator inspected an area, but generally the wands would spray whenever they were held and the underbody spray bar was off. We also estimated water usage by the level of recovered water in the portable holding tanks, but that does not take into account overspray, evaporation, and water that is carried off by the vehicles. Figure 10 lists water usage by contractor.

Note: Water use only represents the amount of water that was sprayed onto the vehicles. Since all of the systems tested have containment, recovery, and recycling systems, this does not equate to wastewater that would actually have to be disposed of in practice.

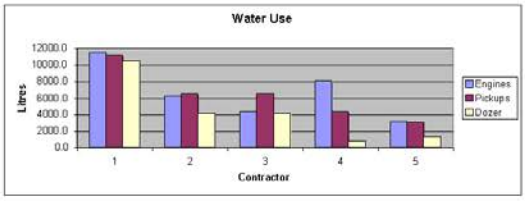


Figure 10—Water usage by contractor.

Wastewater

We collected water samples from the settling tanks after they had settled overnight. Our purpose was to estimate the solids still suspended in the wastewater when we disposed of it. The samples were analyzed for suspended solids and turbidity. Suspended solids ranged from 1,460 to 8,320 milligrams per liter. Any nonbuoyant suspended solids in the holding tank water were most likely below the 1-micron size since anything larger would have settled after 12 hours. Since we did not record the water use and wastewater amounts from the secondary and final cleaning phases, we did not add the suspended solids to the recovered waste amounts for determining efficacy.

Process Rate

We limited the contractors to 5 minutes per wash cycle for the wheeled vehicles and 1 hour for the bulldozer. Process rate is very important when you have many vehicles that all need cleaning at more or less the same time and if the wash cycle takes too long many drivers and operators often bypass the wash cycle because of a backlog of equipment waiting to be washed. Excessive delays cost in labor hours for the drivers, operators, and engine crews as well as fuel and morale.

The Forest Service has adopted a maximum average process time for wheeled vehicles in some regions. The interim standard for Region 1 (MT, ND, ID, WY, SD) requires that any wash system used on an EERA be capable of washing wheeled vehicles in no more than 5 minutes per vehicle on an average of 10 vehicles. We adopted the 5-minute limit for wheeled vehicles in our testing in Ione. Occasionally a contractor would run beyond the 5-minute mark, but we made note of that and stopped them as soon as possible afterward. We also note that the number of personnel employed in the washing varied from two to five, another variable that was not controlled here. Those who used a larger number of personnel appear to have taken less time per vehicle, which seems logical.

Figure 11 compares the five systems with regard to the average process rate per vehicle.

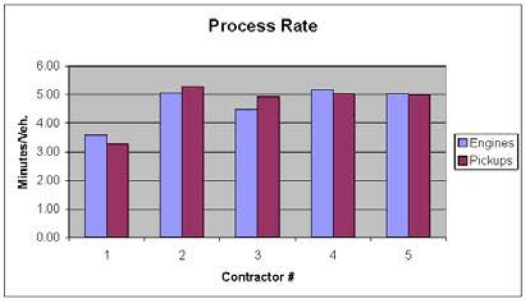


Figure 11—Process rate.

Cost

One of our primary objectives in this effort is to determine, as best possible, the value of various systems with regard for cost. What is the "best bang for the buck?"

The percentage of debris removed is presumably proportional to the percentage of invasive species propagules removed, so one would think that would be the key issue. But when the soil loads on the vehicles vary a great deal and the time limit to clean the vehicles remains constant, we cannot say that the removal percentage alone is a fair gauge of system efficacy or value. In the field, it is likely that some contractors would elect to clean a vehicle beyond our arbitrary 5-minute requirement. Since it can take as little as one propagule to start an infestation, you have to wonder what the value difference between 95-percent effective and 65-percent effective really is. Mathematically, of course, there's a simple answer but it does not address the real question. True, the additional remaining soil may well hold more seeds, so it may be a proportional issue, or it may not. Containment of the soil and debris removed is also important if the goal is to prevent spread of invasives, and not just to clean vehicles.

Beyond the value of efficacy between one system and another, we still need to determine the lower threshold where a system might be considered worthless. At this point we do not have a clear answer but other phases of this project are still in process and we may be able to get some answers upon their completion. Still, we will have to combine and prioritize the following factors to make a fair and objective value rating for any system:

- Cleaning efficacy.
- Containment ability.
- Waste treatment and disposal.
- Additional support required (water, power, etc).
- Deployment cost.
- Daily cost.
- Process rate.

Figure 12 gives a comparison of the five different systems in terms of total cost to run the test at Ione. Some contractors were stationed within a few hours of Ione while others had to travel for days to get there. Some carried all of their equipment in light-duty trucks while others needed heavier vehicles like a flatbed semitrailer, forklifts, or multiple-cargo trailers. We did not factor in the initial cost of bringing the contractor's equipment to Ione in cost figures 12 and 13, instead we used their daily rate for EERA rental divided by 5 days; one for set-up, 3 vehicle-washing days, 1 for cleanup and teardown.

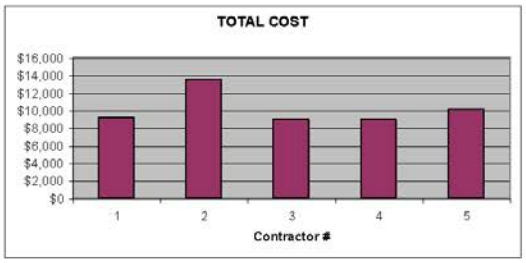


Figure 12—Total cost.

Figure 13 shows a cost comparison of the daily rates without any travel or lodging expenses. This is typically what the contractor would charge on an EERA.

Figure 13—Daily cost.

Figure 14 compares cost with regard for cleaning efficacy in terms of dollars spent per average percent removed from all three vehicle types.

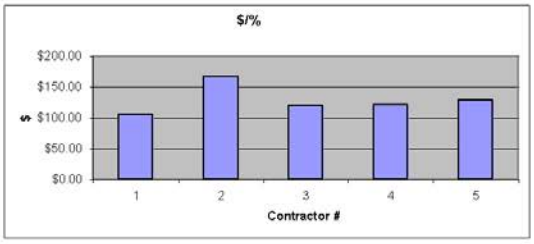


Figure 14—Cost versus percent removal.

OTHER ISSUES

We have heard comments from wash-service contractors, engine crews, equipment operators, government contracting officers, ecologists, and other concerned parties, regarding the cost, efficacy, cycle time, and overall practicality of washing vehicles and equipment for the purpose of mitigating the spread of invasive and nonindigenous plant species. A few of the points that have surfaced are mentioned below:

Contract Cost versus Equipment Provided

The Forest Service does not have any agency-wide guidelines that delineate just what the minimum equipment requirements are for a vehicle washing system and results from this study should help give some guidance for future contracts and EERAs. Naturally, the more elaborate a wash system is, the more it will cost to transport and operate, but we are still trying to define what we really need as a baseline for system performance and equipment criteria.

Given that there have not been any specific guidelines for the most part, entrepreneurs have developed washing systems based upon what they believe will do the best job of washing in a reasonably short time, while still safely containing all spoils and waste for proper disposal.

Traditionally, contractors who are listed in the EERA system, are dispatched on the basis of proximity to the need, with the closest being the first to get called in. Sometimes contractors are called in strictly on the basis of low bid. In either case we could be paying a lot for a system of unknown value and perhaps inferior performance. It is almost impossible for a contractor with a developed, completely self-contained system, and a well-trained experienced crew to compete with a minimally prepared contractor who has only a small financial investment and untrained labor.

Waste Disposal

All of the contractors we tested in Ione showed great concern for proper waste disposal practices. Waste from vehicle washing stations usually comes in two forms; liquid and solid, and there are different guidelines for the proper disposal of either. Often the waste is really neither truly liquid nor solid, but rather a sludge.

We understand that one of the common methods for sludge disposal involves settling at a wastewater treatment facility. The remaining sludge is pumped into tank trucks that spread it on farm fields that are to be planted in nonvegetable crops like hay. By U.S. Environmental Protection Agency regulation, farmers must plow the sludge into the soil to a minimum of 6 inches within 8 hours. Unless the waste has all been prefiltered to a small enough particle size that guarantees no plant propagules remain in it, there is a strong possibility that this disposal process could actually end up cultivating the very plants we were trying to eliminate. This is patently counter-productive.

Wastewater can contain hydrocarbons in toxic or dangerous quantities and in some cases unacceptable to the wastewater authority or treatment facility in a given location. The most commonly encountered hydrocarbons in vehicle washing are oils and grease. All five systems we tested have some removal mechanism for hydrocarbons but we did not test them for that feature. Contractor number 5 had his wastewater tested in 2004 after working at a fire incident and even though the system is designed to remove the hydrocarbons from the waste it still contained trace amounts. However, these levels were acceptable to the waste treatment or disposal facility the contractor used. We do not have any objective data on the typical hydrocarbon loading of wastewater from mobile-vehicle washing stations. As funding allows, we may gather some samples from a variety of mobile-washing facilities deployed under various circumstances such as fires, construction projects, and military operations for chemical analysis.

Solid waste from vehicle washing systems can contain invasive species propagules and the current most common practice for disposal is burial in a landfill. If you properly contain the waste in a fairly air-tight opaque bag or container the seeds should not germinate, and if they are buried deep enough that they will never see the light of day, you should not have to worry about starting an infestation.

Heavy Equipment Cleaning

Heavy earth-moving equipment can collect an enormous amount of debris in a very short time. These machines should be cleaned before they are loaded on their trailers to reduce the risk of spreading seeds along roadsides between deployment locations and fire camps. We may find that type 2 cleaning systems, which capture solid waste but do not recycle the water, are more appropriate for cleaning heavy equipment. During our tests in Ione we found that it seems more effective to remove most of the soil and debris from the bulldozer manually first, without using any water sprays, then follow up with washing. We noticed that the water spray would relocate a lot of the debris on the machine rather than remove it. The water also seemed to reduce the visual contrast between machine and mud so it was harder to see when the metal was clean. Contractors who dry cleaned the machine first removed a higher proportion of the debris. Again, our test conditions,

where most of the soil and debris on the dozer was dry material rather than muddy, may have affected this observation, and this might not be true in all cases.

RECOMMENDATIONS

We should, as agencies of the Federal Government:

1. Develop minimum equipment parameters and performance standards for washing systems which we contract.

2. Define washing systems by type with regard for water and waste containment, spray system, process rate, and cost range. We are still considering that there may be a cost advantage to systems that do not recycle the washwater but we do not yet have a definition of this type of system and we do not have any comparative data on the efficacy, productivity, and cost of these systems. We recommend formal comparative testing of the presumably less costly type 2 systems mentioned earlier.

3. Establish simple, easily followed test procedures to ensure that our minimum requirements are met by measurable, repeatable criteria.

4. Convert our contracting practices to a performance basis, where system efficacy, process rate, overall cost, and deployment time are all factored into the decision process. The resulting choice would represent the best value available.

5. Define specific acceptable guidelines for waste disposal that are universally acceptable. Some areas may allow variances but at least we would have a worst-case set of practices that contractors and contracting officers could revert to when there is no clear statute or rule governing disposal methods and practices. In any case, we should at least define a particle size that all wastewater and sludge will be filtered to before disposal.

SDTDC thanks Dr. Harold Balbach, U.S. Army Corps of Engineers, Engineer Research and Development Center and Ralph Taylor, Fire Program Leader (retired), San Dimas Technology and Development Center for their technical review of this publication.

SDTDC's national publications are available on the Internet at: http://www.fs.fed.us/eng/pubs/

Forest Service and U.S. Department of the Interior, Bureau of Land Management employees also can view videos, CDs, and SDTDC's individual project pages on their internal computer network at: http://fsweb.sdtdc.wo.fs.fed.us/

For additional information on vehicle washers, contact Joe Fleming at SDTDC. Phone: 909–599–1267 ext 263. E-mail: jfleming@fs.fed.us]

APPENDIX I
CONTRACTOR SYSTEM DESCRIPTIONS

NOTE: Since the technology is evolving, many details regarding system outputs, waste containment, and disposal practices have changed somewhat from what they were when tested in Ione, presumably for better or more economical practices and equipment. All values of water flow and pressure listed in appendixes 1 and 2 are in English units.

Contractor 1
Crew size: 4 constant, 1 intermittent
This washing system: Consists of a flexible containment mat with berms, a high-volume underbody spray-bar system, and two 1-inch combi nozzles.
The design output of this system is: Combi nozzles (2) 25 gallons per minute (gpm) at 75 pounds per square inch (psi)
Spray bar: 100 gpm at 75 psi
A self-priming trash pump (model, horsepower (hp), gpm, etc) moves wastewater and debris to the recycling system.
This system relies mostly on water volume to remove debris and the wastewater is pumped into several stages of settling and filtration before it is reused. An 80-micron shaker screen precedes three 25-gpm vortex separators before the water is returned to use or disposed of.
Solid waste containment: All solids placed in dewatering bags and in double plastic trash bags for landfill disposal.

Contractor 2
Crew size: 2 constant

Undercarriage wash system: Two remote controlled stationary undercarriage washers, each with four double-sets of free-rotating zero-degree nozzle washes (one entering, one leaving containment mat) at 18 gpm at 800 psi on a dual 6-inch elevated ramp system, over a 19- by 33-foot vinyl containment mat.

Hand detail wash system: Two manual dual-turbo nozzle detail spray wands, each operating at 9 gpm at 1,200 psi over a 19- by 33-foot vinyl containment mat.

High pressure system: Dual 9-gpm, 1,200 psi ceramic-plunger type pumps.

Fresh water supply: 3,000-gallon (gal) open, octagonal, external frame portable tank.

Waste and sediment containment system: Two sequential cone-bottom settling tanks, proprietary automated.

A 50-micron roll paper-filter system, 50-micron bag filter, and a final 100-micron discharge hose bag for filtered water discharge. A 1,000 gal "overflow" bladder tank is also available for very high traffic days (100+ vehicles) or as a backup containment system.

Water recycling system: 500-gal supply tank receives double-filtered water from sediment-removal system and gravity feeds high-pressure pumps.

Solid waste containment and disposal: All liquid waste material is filtered to solid waste, then placed in two independently sealed 4-mil black plastic trash bags, then sealed in a 40-pound poly "sandbag" marked for landfill disposal.

Liquid waste disposal: No liquid waste except triple-filtered (50 micron) silty water. Hydrocarbons are removed by bilge boom bags in all recycling and sediment tanks. Under normal operating conditions (50+ washes per day at 40 to 50 gal per wash), about 200 to 300 gal per day of silty filtered water is drained by hose onto dry (grassy) ground, and about 100 to 200 gal per day is lost to evaporation and carry off.

Contractor 3
Crew Size: 2 constant, 2 intermittent on dozer only
Stationary dual spray bars 20 gpm each at 2,000 psi
Dual manual detail spray wands (3 gpm each at 2,000 psi each)

Flexible mat containment (14- by 50-foot)

Water tanks: 340-gal supply tank; 340-gal settling tank; 80-gal effluent-accumulation tank; 135-gal sludge tank

Recycling system: Dual filtration, 200-micron and 20-micron bags, 1-1/4 inch specially engineered hydrocyclone, 340-gal settling tank, 20-gpm effluent-processing capacity.

Solids and wastewater disposal: Effluent effectively separates heavy solids into sludge cell and lighter particulate into settling cells, which can be periodically drained, flushed, and disposed of in approved monitored sites. Finest particulate and the majority of organic matter and seeds are captured in the filter bags, which are periodically removed and disposed of by burning or deep burial. Sludge can either be collected in landfill-only bags or collected by the greywater tender onsite for fires.

Contractor 4
Crew size: 2 constant, 1 intermittent.

Two movable spray bars with rotating and stationary nozzles.

Two manual detail spray wands, 6.3 gpm at 240 psi. (Note: Contractor has since changed to approximately 9.5 gpm at 230 psi.)

Water supply: Two 1,800-gal tanks; one with reclaimed filtered water and one tank with clean water.

Recycling system: Settling tanks, geotextile filter bags. (Note: Contractor has since changed to 100-micron nylon filter bags.)

Solids containment: Geotextile bags placed in heavy plastic bags for landfill disposal. (Note: Contractor has since changed to dewatering bags for solids containment.)

Waste water disposal: One baffled settling tank followed by filter bags. Skimmer pads are utilized in the settling tank to remove hydrocarbons. The water leaving the settling tank will be acceptable to most wastewater treatment facilities.

Contractor 5
Crew size: 2 constant, 1 intermittent
Elevated wash rack. Hydropad®
Manual pressure washers (2); 2 gpm @2,000 psi
Water supply:
Recycling system: Hydroclean® patented recycling system
Solid waste: Contained in heavy plastic bags, dewatering bags, with final deposition in a landfill.
Liquid waste: Disposal in municipal waste-treatment facility.

APPENDIX 2.
National Cooperative Soil Survey

LOCATION HONCUT CA

Established Series
Rev. RCH-GWH-RWK-MAV-ET
02/2003

HONCUT SERIES

The Honcut series consists of very deep, well drained soils that formed in moderately coarse textured alluvium from basic igneous and granitic rocks. Honcut soils are on floodplains and moderately sloping alluvial fans and have slopes of 0 to 9 percent. The mean annual precipitation is about 12 inches and the mean annual air temperature is about 62 degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, nonacid, thermic Typic Xerorthents

TYPICAL PEDON: Honcut loam - pasture. (Colors are for dry soil unless otherwise noted.)

A--0 to 13 inches; brown (7.5YR 5/2) loam, dark brown (7.5YR 4/2) moist; weak fine granular structure; hard, friable, slightly sticky and slightly plastic; many fine roots; many pores and insect burrows; low in organic matter; slightly acid (pH 6.5); gradual smooth boundary. (6 to 22 inches thick)

C--13 to 72 inches; brown (7.5YR 5/3) loam with few thin strata of fine sandy loam in lower part of the horizon, dark brown (7.5YR 4/3) moist; massive; hard, friable, slightly sticky and slightly plastic; roots and pores decreasing gradually with depth, a few roots penetrate deeper than six feet; neutral (pH 6.7).

TYPE LOCATION: Merced County, California; gravel pit on north side of Bear Creek, sec. 16, T.7S., R.15E.

RANGE IN CHARACTERISTICS: The mean annual soil temperature at a depth of 20 inches is 59 to 68 degrees F. and the soil temperature is not below 47 degrees F. for any significant period. The soil between depths of 8 to 24 inches is usually dry all of the time from late April until November and is usually moist in some or all parts all the rest of the year. The 10 to 40 inch control section averages sandy loam, coarse sandy loam, fine sandy loam, loam or gravelly equivalents of each. Rock fragments range from 0 to 25 percent. The control section has little or no stratification. Clay content usually averages 6 to 12 percent. Organic matter is less than 1 percent, decreases regularly with increasing depth and is below 0.2 percent at a depth of 60 inches. Some pedons have unrelated strata of sand, gravel or buried soils below depth of 40 inches. Reaction ranges from moderately acid to slightly alkaline. The profile is noneffervescent to depth of 40 inches or more.

The A horizon is 10YR 5/2, 5/4, 5/3, 5/6, 4/2, 4/3, 4/4; 7.5YR 5/2, 5/4, 5/6, 4/2, 4/4. Moist values are generally one unit less. This horizon is sandy loam, fine sandy loam, loam or gravelly equivalents of each.

The C horizon is 10YR 4/4, 4/6, 5/2, 5/3, 5/4, 4/3, 6/3, 6/4; 7.5YR 5/6, 6/4, 5/2, 5/4, 4/2, 4/4. Moist values are generally one unit less.

COMPETING SERIES: These are the Hanford, Pollasky (T), and Saugus series. Hanford soils have A horizons with a dry value of 6 or more. Saugus soils have a paralithic contact at depths more than 40 inches and are on irregular slopes of more than 9 percent.

GEOGRAPHIC SETTING: Honcut soils are on flood plains and alluvial fans at elevations less than 2,000 feet. Slopes are 0 to 9 percent. The soils formed in alluvium dominantly from basic rocks but are derived from acid igneous rocks in some places. The climate is dry subhumid mesothermal with hot dry summers and cool, moist winters. Mean annual precipitation is 9 to 25 inches. Mean annual temperature is 60 to 62 degrees F., average January temperature is about 45 degrees F., and average July temperature is about 80 degrees F. Frost-free period is about 200 to 280 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Burchell, Ryer, Yokohl and Wyman soils. All of these have argillic horizons. Also, Yokohl soils have a duripan at depths less than 40 inches.

DRAINAGE AND PERMEABILITY: Well drained; slow to medium runoff; moderately rapid permeability.

USE AND VEGETATION: Honcut soils are highly productive under irrigation. Crops are alfalfa, small grains, forage crops, apricots, peaches, grapes, prunes, apples, oranges, pears and berries. Some areas are dry farmed. Vegetation consists of open parklike areas of annual grasses, herbs and scattered oaks.

DISTRIBUTION AND EXTENT: They occur on the east side of the Central Valley and in the intermountain valleys of southern California. These soils are moderately extensive in MLRA-17.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Marysville Area, Sutter and Yuba Counties, California, 1909.

REMARKS: The activity class was added to the classification in February of 2003. Competing series were not checked at that time. - ET

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the zone from the surface to a depth of 13 inches (A)

National Cooperative Soil Survey
U.S.A.

APPENDIX C:

USDA PLANTS DATABASE TUTORIAL

The US Department of Agriculture has established a system which provides standard identifiers for all of the weed species likely to be encountered on an installation. In fact, virtually ALL native and introduced species are included. For understanding at all levels, it is highly recommended, as covered in Appendix A of this PWTB, that these standardized, normally four-letter, identifiers be used rather than local shorthand names for all record keeping related to weed management programs. The tutorial here provides simple instructions as to how to access the PLANTS database, and how to determine the recommended abbreviation to be used in record keeping.

The PLANTS Web Site:
Understanding Its Basic Functionality

<http:plants.usda.gov>

Table of Contents

NOTE: The PLANTS Web site is currently evolving and contains mostly updated pages, such as the Home Page, but also contains pages that are still in the older design. The older designed pages will be replaced as they are completed.

A. Searching for a Plant Name: This can be done through three primary avenues: 1) PLANTS Name Search, 2) State Search, and 3) Advanced Search. These are accessible from the PLANTS Home Page in the left navigation box at the top Search area.

1) PLANTS Name Search

The "PLANTS Name Search" is located on the PLANTS Home Page, at the top of the left hand navigation box. Note that you have to select the entity (Scientific Name, Common Name, or Symbol) for which you are searching from the "drop-down" box to inform the database about what you are inputting. This is a "String search," and will return anything that matches in the field (ex. inputting *Cryptantha* as a Scientific Name will bring back all of the species in the genus *Cryptantha*, plus the species *Phacelia cryptantha* and *Castilleja cryptantha*.

Once you have a returned list, you can search through the list for the name for which you are looking, then click on the "hot" scientific name to bring back that plant's Plant Profile.

Common Names

Currently in PLANTS, each plant species is designated by only 1 common name.

Search for	Returns
Western wheatgrass	Plant Profile for *Pascopyrum smithii*
Western wheat grass	No data found, because is isn't spelled the same as the name in the database; try

	searching on "western" or "wheat."
bluejoint	List of *Calamagrostis* species
wheatgrass	List of common names that contain "wheatgrass".

Scientific Names

Search for	Returns
Pascopyrum smithii	Plant Profile for *Pascopyrum smithii*
Pascoyprum	List of current names and synonyms that contain "*Pascopyrum*"
Elymus	List of current names and synonyms that contain "*Elymus*"
Elymus elymoides	List of current names and synonyms that contain "*Elymus elymoides*"
Elymum elymoides ssp. elymoides	Plant Profile for *Elymum elymoides* ssp. *elymoides*

Symbols

Each Latin binomial and trinomial is assigned a unique symbol. The symbol for a binomial consists of the first two letters of the genus, plus the first two letters of the specific epithet. For example the symbol for *Pascopyrum smithii* is PASM. Duplicates of 4 letter symbols are differentiated by adding a number as tie-breaking suffix. For example the symbol for *Elymus elymoides* is not ELEL but ELEL5. The symbol for a trinomial consists of the first two letters of the genus, plus the first two letters of the specific epithet, plus the first letter of the subspecific or varietal epithet. For example the symbol for *Elymus elymoides* ssp. *elymoides* is ELELE. Tie-breaking numbers are used here for differentiating duplicative letter combinations.

Search for	Returns
PASM	List of symbols including symbols of synonyms that contain PASM
ELEL	List of symbols including symbols of synonyms that contain ELEL
ELEL5	Plant Profile for *Elymus elymoides*

If you are unsure about the spelling of a scientific name or you desire a fast input for a return list, a symbol or the alpha portion of the symbol can be helpful.

Synonyms

A search for the Scientific Name, *Agropyron smithii,* which is a synonym of *Pascopyrum smithii,* returns the Plant Profile for *Pascopyrum smithii.*

2) State Search

Users can access the exact search by clicking State Search on the Home Page. You can search on Scientific Name, Common Name, Symbol, Family, and Genus. You can also filter this search by selecting one or more states/provinces, if desired. The output can also be sorted by Scientific Name, Common Name, or Symbol. The Scientific Name is default.

This is not a "string search." It searches for an exact match in the field that you select. If you search the Scientific Name for *Cryptantha*, the system will return the Plant Profile for the genus *Cryptantha*. If you search for the Genus *Elymus*, the system will return all of the names (including synonyms and their respective accepted names) containing the genus *Elymus*.

Common names

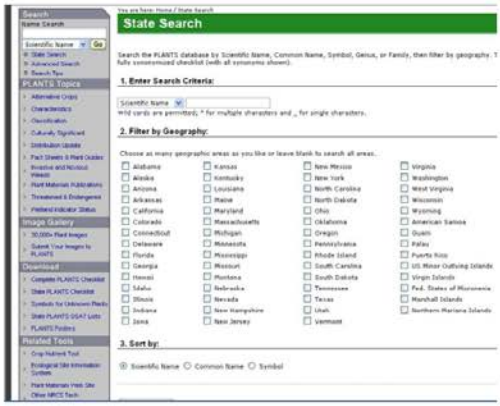
Search for	Returns
western wheatgrass	Plant Profile for *Pascopyrum smithii*
wheatgrass	List of species with common name wheatgrass.
*wheatgrass	List of species with multiple characters to the left of wheatgrass.
wheatgrass	List of species with multiple characters to the left and to the right of wheatgrass.

* The asterisk is a wild card that instructs PLANTS to include multiple characters.

Scientific name

A search for *Pascopyrum smithii* returns the Plant Profile for *Pascopyrum smithii.*

If you are working from a source which has a one or two letter misspelling, such as *Pascopyrun smithii*, when you enter it, PLANTS will return **No Data Found**. You might try <Pascopy*>, which will return a list of species which have multiple characters to the right of <Pascopy>, which includes *Pascopyrum smithii*. Also, you could search using the symbol.



Symbol

A search for PASM returns the Plant Profile for *Pascopyrum smithii*, since PASM is an exact match.

Within the State Search, if you use TRDA to search for *Tripsacum dactyloides*, it returns *Trichomanes davallioides*, since it is a direct match. You may want to use the PLANTS name search or search for TRDA*, and *Tripsacum dactyloides* will be included in the returned list.

State
Returns a list of all plants from genus downward that have been reported to occur in the selected state. These lists include synonyms. If you want a list without synonyms, please use the Advanced Search.

3) Advanced Search
Caution: The main thing to remember is that you have the option to either display output to the screen or click on the link to bring up the Advanced Search screen that downloads only and doesn't display the results to the screen. Browsers cannot currently handle the large and complex data sets that the Advanced Search is capable of generating. If you are doing anything except the simplest query, it is recommended that you click directly on the Search the PLANTS database and download the results without display link toward the top of the Advanced Query main page. The download portion of the Advanced Search is also available in the Download section of the left navigation bar.

Users can filter plant species by the boundaries of any attribute or any combination of attributes in the PLANTS database, and then download this information to in an ASCII delimited file.

Examples:

- Plant species that occur in Arizona and are Graminoids (Grasses).
- Plant species that occur in Wyoming, are shrubs, will grow with 14 inches or less precipitation, and with a soil pH of 7.5 or greater.
- Plants species that occur in Arizona and have Plant Guides.

There are two classes of attributes with which you can filter:

Part A: PLANTS Core Data
Basic attributes that are defined for all plant species in the PLANTS database.

Part B: Characteristics Data
Attributes that are defined for only 2500+ important conservation plant species. If you select plants by any of attributes in Part B, you will limit your plant selection to the 2500 conservation plants.

Examples: Select and download the Arizona noxious weed list.

Using Netscape	Using Explorer
Set attribute **State Noxious Status = Arizona**	Set attribute **State Noxious Status = Arizona**
Check **Display in Report**	Check **Display in Report**
Click **Display Report Now**	Click **Display Report Now**
Click **Download This Information** (at	Click **Download This Information** (at

bottom of web page) Click **File / Save As**	bottom of web page) **Right click / Save Target As…**

Excerpts from About the Advanced Search and Download on the PLANTS Web site-Advanced Search main page.

- You must display a field if you want to be able to sort on it.
- Requests for too much information will tax our server, be slow to appear, and may overwhelm your browser. In the latter event, try downloading the information without displaying it first. This option is available from the second link on the Advanced Search main page.
- You can select more than one value within a field by using the Control Key
- "Any" in the search means that any values will be reported in the results; it is equivalent to "all".

B. Plant Profile

General: The Plant Profile is the primary access point for information on a particular plant. There is a Plant Profile for every taxon in PLANTS. Some plants have more information than other, but all have a profile. All information for a taxon is available from that profile. When you click on most "hot" names produced in various lists within PLANTS, you will go directly to the Plant Profile for that taxon. Other products, such as Plant Guides will be accessible from that profile.

Example: Inputting the symbol ACHY for *Achnatherum hymenoides* (Indian ricegrass) or HYCA for *Hydrastis canadensis* (goldenseal) returns a list of plants with symbols containing the input characters. Click on the target name and bring up the Plant Profile. You can also just click on the Plant of the Week on the Home Page to view a Plant Profile.

The Plant Profile is designed to provide the user with access to information pertaining to that taxon.

Plant Profile: The topmost area (shown here) provides you with some basic attributes about the taxon, plus an image, if one is available on PLANTS.

Note that the attribute **Growth Habit** is hot and you can click this to bring up a window containing definitions.

To the right, under "More Information," you may find links to Plant Guides, Plant Characteristics, Fact Sheets, References, and other information that may be available.

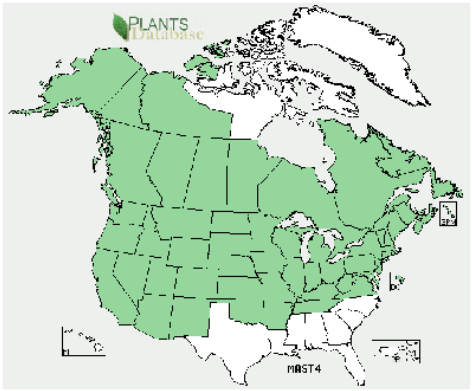
Note also that in the upper right corner of this area (just above the green Plant Profile bar), you have access to a **Printer-Friendly Version** of the Plant Profile.

Plant Synonyms and Plant Photographs (if pertinent to or available for the selected taxon): The second and/or third areas will contain additional Plant Images and Plant Synonyms will be displayed above the "Distribution by State" map.

At the top of the "Images" area, a link will also be provided to all images of that particular genus that are available in PLANTS. Several sizes of images may be available, from thumbnail, standard, and large to publication size. If available, these can be viewed by clicking on the photo for the next size. On the "large" image page, there will be a link at the bottom of the page if there is a publication-sized image available for download. Thousands of line drawings are also available.

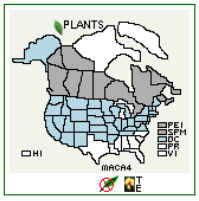
Plant Distribution: A map displays the state distribution (also territory and protectorate if available) as is currently known from specimens and the scientific literature.

If county level data are available, it is represented by the state abbreviations to the right of the map. You can click on the postal code or as you run your cursor over the map, your cursor will change to a hand for the states with underlying county data. For those states with "off-site" county data, this is noted under "Other Species Accounts and Images." For off-site data, a new browser window will be brought up with the distant site in it.



The map and its functionality have been updated to reflect North America with links to access maps illustrating nativity. You can click the "View Native Status" link below left of the distributional map to view a native status map on the Plant Profile. The PLANTS Floristic Area (PFA) will eventually range from Puerto Rico/Virgin Islands in the Caribbean through North America (north of Mexico) to the Northern Mariana Islands encompassing the protectorates and territories of the Pacific Basin.

Native Status: PLANTS native status has been completely reworked to better assist the field. Native in PLANTS previously meant that it was native to the somewhere in the U.S. or its Caribbean territories. Now nativity can apply to various jurisdictions, such as, the lower 48 states, Alaska, Hawaii, or Puerto Rico. The nativity maps use blue (native) and gray (introduced) colors. Please consult the "Native Status" link to the left of the primary image on the Plant Profile for further definitions.

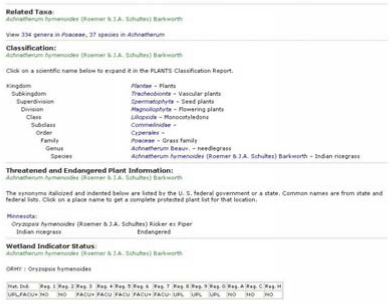


Related Taxa: Provides quick access to related taxa, either genera in the same family or species in the same genus.

Classification: Provides quick access to various levels of the taxon's classification tree. Click on any of the highlighted levels.

Noxious Weed Information (if pertinent): Indicates if the plant is considered noxious by Federal or state governments, plus provides access to further information on the entities noxious weed list.

Invasive Information (if pertinent): If the plant has been noted as having invasive qualities in certain situations or environments by the sources integrated into PLANTS, then it will be indicated here and the citations are made available for further information. Depending upon the use that is being made of the plant, invasiveness could be a positive or negative value.



Introduced Information (if pertinent): If the plant is introduced into the U.S. (including PR and VI), it will be noted by the presence of this area.

Wetlands Indicator Status (if pertinent): If the plant has been classified by the USFWS as having wetland indicator status, the regional and national indicator status is shown.

Other Species Accounts and Images (if available): Certain sites that contain plentiful, high quality information on the plant are integrated into the Plant Profile in this area.

Related Web Sites (if available): For selected species, additional links to off-site information are acquired and maintained in this area.

More Information: At the top right of the Plant Profile (to the right if the main image) are located links for several items that may be available for the plant that you have selected. Just click on these to bring them up in a separate browser window.

Characteristics
Database containing ca. 100 plant attributes for this species. This is the VegSpec plant characteristics data for this species. Over 2,500 species in PLANTS have these data.

Classification
Displays a hierarchical classification upward from the plant whose profile you are viewing.

Plant Fact Sheet and Plant Guides
This is a narrative about this plant, which includes a description of uses, management, establishment, cultivars, references, etc. The Plant Guide provides more information than the Fact Sheet. If available, both are accessible as Word (doc) or Adobe Acrobat (pdf) files.

Plant Source & References
This provides access to sources of taxonomic and distribution information/references that support the information on that species in PLANTS.

PM Publications
This provides access to Plant Materials Publications, if they are available through PLANTS for the target plant.

C. Plant Topics
Proceed back to the PLANTS Home Page and review the left hand navigation box entitled "Plant Topics" on the left of the screen.

1. Alternative Crops:
Access set of links to off-site information on alternative crops. You can select by broad crop types and filter by states where the information is available.

2. Characteristics:
List of the 2300+ conservation plant species for which the ca. 100 extended plant attributes are populated. From this list, you can click on the plant name to access its Plant Profile.

3. Classification:
Generate a hierarchical classification beginning at any taxonomic level and moving up or down through the hierarchy. For example, an entry of *Elymus elymoides* will display all the subspecies of *Elymus elymoides*. An entry of Elymus will display all the species within the genus *Elymus*.

4. Culturally Significant:
List of plant species that are culturally important to Native Americans. Access the Plant Profile by clicking on a name. Culturally significant information is contained in the Plant Guide of each species with a plant guide.

5. Distribution Update:
This module was partially funded by the Animal and Plant Health Inspection Service (APHIS). This permits PLANTS users to submit new State or County records for consideration and validation based upon specimens deposited in herbaria or citations from the scientific literature. This module also has a GIS function that allows the user to indicate the location of the occurrence.

It also allows for the submission of observations. Observations are more difficult to validate and are less likely than herbarium specimens or literature citations to be certified. This portion is targeted toward weeds new to the nation, a state, or county as a part of the Early Warning, Rapid Response initiative of the Federal Interagency Committee on the Management of Noxious and Exotic Weeds (FICMNEW).

In Step 1, there is a link at the bottom of the page that enables you to establish a new User ID and Password if you do not have one.

6. Fact Sheets & Plant Guides:

Access a complete list of the plants for which PLANTS currently exhibits a Plant Fact Sheet or Plant Guide. Click on the doc or pdf file.

7. Invasive & Noxious Weeds:

- Federal Noxious Weed list.
- State Noxious Weed lists.
- Search for plant species that are noted as having invasive qualities by selected sources.

8. Plant Materials Publications:
A search engine has been placed on indexed NRCS plant materials publications. Search by your keywords and other choices, review the documents, and then download the publications as pdf files. The NRCS Plant Materials discipline will continue to convert their publications and make them available through this venue.

9. Threatened & Endangered:
List of Federal and State T&E plant species by Family, Genus or State.

10. Wetland Indicator Status:
List of plant species and their USFWS wetland indicator status by Family, Genus or USFWS Region.

D. Image Gallery
This provides direct access to the PLANTS Image Gallery, where you are provided various query, viewing, and sorting options.

E. Download:
This area allows you access to download the following: 1) Complete PLANTS Checklist; 2) State PLANTS Checklist: 3) Advanced Search Download; 4) Symbols for Unknown Plants; 5) NRCS State GSAT Lists; 6) NRCS State Plants Lists; and 7) PLANTS Posters.

1. Complete PLANTS Checklist:
This is a very large ASCII file (about 7MB) that contains all accepted and synonym names.

2. State PLANTS Checklist:
This are provides access to state vascular plant checklists that are a subdivision of the national plant checklist. Just click on the state or territory in which you are interested.

3. Advanced Search Download:
This is the same capability as the Advanced Search in the "Search" area, but brings up the download portion of that search.

a. Downloading Data From PLANTS Into An Excel Spreadsheet: This is something that we are asked about quite a bit, particularly when folks are downloading data from the Advanced Search (located in the top of the left navigation box on the PLANTS Home Page). Note that at the top of the page, it states "**Search the PLANTS database and display the results**." Just below that heading you can click on "**Search the PLANTS database and download the results without display**."

First, let's address "**Search the PLANTS database and display the results**." After you make your selections and click the "Display Report Now" button, the data are displayed. If you read "About the download from this page," it will tell you how to download the data into a text file. Once you have saved a text file on your computer, then use the following instructions:

- Assume that the text file that was downloaded from the Advanced Search has the name 'ag234.txt'
- Open Microsoft Excel – click "File/Open"
- In the 'Open' dialogue box go to the directory where you saved the downloaded text file.
- At the bottom of the 'Open' dialogue box, select "Text Files" from the 'Files of type' menu.
- Open the file 'ag234.txt'
- In the Text Import Wizard, select "Delimited" – click "Next"
- Select "Comma" – click "Next"
- Select "General" – click "Finish"
- This file can be saved as a Microsoft Excel file. Click "File/save As", in the 'Save as type' menu, then select "Microsoft Office Excel Workbook"

A second method is as follows. If you open the Advanced Search and click on "**Search the PLANTS database and download the results without display**," it will permit you to download a comma delimited text file. After you make your selections, click on the "Download Report Now" button, the instructions are in the lines above the "PLANTS Download" box. You can also right click on the "PLANTS Download" link and then "Save Target As" (text file) in a particular directory on your computer for further use. This file can be imported into Microsoft Excel as described in the bulleted instructions.

4. Symbols for Unknown Plants:
The symbols for unknown plants represent generic categories such as 'deciduous tree' or 'herbaceous vine' that are useful in survey, monitoring, and inventory work when specific identification can not be made. These symbols and associated descriptive names are widely used by a number of federal agencies. The list contains only symbols and common names.

5. NRCS State GSAT Lists:
This area provides access to the State Grazing and Spatial Analysis Tool lists for loading into GSAT software. Not all state lists are available. For more information, please contact your state grazing lands specialist.

6. NRCS State Plants Lists:
NRCS personnel and cooperators can download an NRCS State Plants List which includes Symbol, Synonym Symbol, Scientific Name with Authors, preferred State Common Name, and Family. The data are downloaded as uncompressed ASCII text.

7. PLANTS Posters:
This provides a link to the NPDC Web site where you can download a PLANTS poster to place on your wall.

F. Related Tools
Proceed back to the PLANTS Home Page and view the "Related Tools" toward the bottom of the left navigation box. This provides access to other plant-related tools.

1. Crop Nutrient Tool:
The Crop Nutrient Tool provides estimates of nutrient removal by crops at various levels. The nutrient percentages utilized in this tool reflect national averages. These estimates are used to calculate nutrient balance sheets, which are employed in the design of animal waste management systems. The Crop Nutrient Tool automates and augments the information that is currently in Chapter 6 of the NRCS Agricultural Waste Management Field Handbook.

2. Ecological Site Information System (ESIS):
The Ecological Site Description is the official repository for all data associated with the development of forestland and rangeland ecological site descriptions by the Natural Resources Conservation Service. An ecological site description is presented in four major categories:

- **Site Characteristics** -Identifies the site and describes the physiographic, climate, soil, and water features associated with the site.
- **Plant Communities** - Describes the ecological dynamics and the common plant communities comprising the various vegetation states of the site.
- **Site Interpretations** - Interpretive information pertinent to the use and management of the site and its related resources.
- **Supporting Information** - Information useful in assessing the quality of the site description and its relationship to other ecological sites.

Example: Select a state and/or a MLRA. For example State = MT and MLRA = 58A. A MLRA is an homogenous eco-region.

An MLRA map is on the Internet from the NRCS National Soil Survey Center.
http://soils.usda.gov/soil_survey/geography/mlra/main.htm

The Ecological Site Description displays a site description under the following reports.

General	Physiographic Features
Climate Features	Water Features
Soil Features	Plant Communities
Site Interpretations	Supporting Information

The site ID is based on soil type. Map locations of site IDs are available from local NRCS field offices.

3. Plant Materials:
Provides access to the NRCS Plant Materials discipline Home Page information about using plants for conservation practices.

4. Other NRCS Tech Resources:
Provides a link to other NRCS Technical Resources

5. VegSpec:
Vegspec is a web-based decision support system that assists land managers in the planning and design of vegetative establishment practices. VegSpec utilizes soil, plant, and climate data to select plant species that are (1) site-specifically adapted, (2) suitable for the selected practice, and (3) appropriate for the purposes and objectives for which the planting is intended. The VegSpec application has the ability to determine site-specific adaptability of plant species. Please utilize "Introduction to VegSpec" in another document on the NPDC Web site under Publications.

An MLRA map is on the Internet from the NRCS National Soil Survey Center.
http://soils.usda.gov/soil_survey/geography/mlra/main.htm

G. Plant Links:
Access general plant-related links, such as State Floras, Fire Resistance, Native Plants and Gardening, Poisonous and Medicinal Plant Links, Landscaping, and Educational.

01 February 2008

APPENDIX D:

WEED MANAGEMENT AREAS

The material here was developed specifically for application to grazing lands in the Western states, but it is applicable to military installation activities. Management of invasive species, whether or not they meet the Noxious Weed definition, appears to require cooperation of adjacent landowners and managers (VanBebber 2003).

The remainder of this appendix is excerpted (with minor edits for consistency) from Chapter 11, “Weed Management Areas” of *Invasive Plant Management: CIPM (Center for Invasive Plant Management) Online Textbook,*[6] which is adapted from *BLM (Bureau of Land Management) Guidelines for Coordinated Management of Noxious Weeds.*[7]

Introduction

One of the most effective ways to manage weeds on a large portion of land is to form a Weed Management Area (WMA). WMAs are coalitions of neighboring landowners who pledge to pool their resources in the recognition that "weeds know no boundaries" and that "two (or five or ten...) heads are better than one." WMAs have been successful throughout the West in controlling or even eradicating weed infestations that cross boundary lines and/or require expensive or intensive treatment. WMAs are also great vehicles for involving the community in a project that requires diligence and cooperation. Press releases, flyers, banners, and fundraisers can all help to increase the WMA's profile and let the community know what is being done to halt the spread of invasive plants. The following information is adapted from the BLM’s Guidelines for Coordinated Management of Noxious Weeds.

Purpose of Weed Management Area

The purpose of creating a WMA is to facilitate cooperation among all land managers and owners to manage a common weed problem in a common area, and thereby prevent the reproduction and spread of weeds into and within the WMA. The formation of a WMA replaces jurisdictional boundaries that are barriers to weed

[6] http://www.weedcenter.org/textbook/11_WMAs.html#intro

[7] http://www.weedcenter.org/management/guidelines/tableofcontents.html

management programs in favor of natural or more logical boundaries that facilitate weed management and control. A WMA is an area in which one agency/landowner's weed control success will be largely determined by the cooperative efforts of other agencies or landowners in the area. WMAs have similar characteristics such as geography, weed problems, climate, common interest, or funding support. Boundaries may be a watershed or other geographic feature and eliminate jurisdictional barriers.

Advantages of Cooperating in a Weed Management Area

1. It encourages cooperators to plan through the problem to its successful resolution.

2. The plan results in the greatest good for the entire WMA in the long run. Planning establishes priorities.

3. Cooperators can locally prioritize and give emphasis to species that are a particular threat within individual WMAs.

4. The designation of a WMA by diverse individuals and agencies focuses attention and provides a united effort to state and federal legislators. It also communicates to the general public the seriousness of weeds by increasing their awareness of the weeds and the need to contain or prevent infestations.

5. A WMA pools talents and resources. For instance, WMAs enable one agency to contract with another for weed control.

6. Under the WMA plan, a landowner or land manager can address the problem of weeds spreading from neighboring land before the damage occurs.

7. A WMA provides a channel for communication within the WMA.

8. It reduces the risk of damage by control actions to water, crops, threatened & endangered (T&E) species, etc.

9. The formation of a WMA increases the effectiveness of weed management by basing control efforts on biological and geographical factors rather than legal divisions.

10. Designation of a WMA helps secure funding or identifies a method for funding.

11. The creation of different management zones within the WMA fits the most effective and environmentally sound weed management and control practices to each zone.

12. A well-written and implemented plan within the framework of a WMA addresses the following potential concerns:

- A private landowner or agency may relinquish some individual autonomy. Everyone gains efficiency and increases their ultimate success by participating in a WMA.

- Individual or agency priorities may differ from the WMA's priorities. Individual priorities are usually best served and success is greatest when managed within the context of the entire WMA's priorities.

- The weed prioritization and planning process created by a WMA ensures that one jurisdiction or agency cannot dominate.

- By involving representatives from all diverse interests within a WMA, residents of one jurisdiction—a county, for example,—better understand why their weed treatment crews spend time working in a different county or on other agency land.

How to Organize a Weed Management Area

Initiate Organization

1. Any agency, weed district, or individual may take the lead towards initiating a WMA.

2. Consult with weed management specialists for ideas.

3. Initiate a planning (or inter-agency) organizational meeting.

- Invite representatives from all management agencies within the perspective WMA.

- Invite principal landowners or representatives from key landowner groups (sports clubs, wildlife organizations, stockowners, conservation district, etc.).

- Keep the number of representatives from each agency or local interest to a minimum.

- To assure good attendance by the agencies and individuals involved, set the time and place of meeting to compensate for seasonal work schedules, community school events, and holidays.

4. Select a steering committee to initiate the next stages of organization.

Objectives of Initial Meeting

These objectives can also serve as part of the agenda for your organizational and public meetings.

1. Establish clearly-defined boundaries coordinated with other WMAs.

- Boundaries of a WMA may be created according to: watersheds, topography, weed species, land usage, and/or rights-of-way.

- Identify preliminary special management zones within the WMA such as aquatic areas, threatened and endangered species habitat or species of special concern, recreational/special use areas, transportation corridors — rights-of-way may need to be excluded from the WMA or treated as a separate WMA.

- Size of WMAs may be determined by land area or by the number of cooperators. Both should be workable for the organizers and cooperators.

    - o A larger land area may be identified when a few cooperators have large acreages.

    - o Smaller land areas may be identified as WMAs if there are many cooperators with smaller acreages.

2. Select a leader/chairperson, according to his/her abilities, interest, and qualifications, not on agency bias. Allow the chairperson access to office facilities and personnel to ensure completion of communications and reports.

3. Review funding and available resources.

- Discuss available funding and establish accounting guidelines.

- Determine manpower and time capabilities of individuals and agencies available within the WMA.

- Develop a plan to obtain additional funding if necessary.

4. Obtain appropriate state weed laws and agency weed regulations and policies.

5. Set date, time, and place for public meeting to allow input from all individuals within the WMA.

6. Set target dates for completion of different steps of the planning process.

Initial Assessment by WMA Steering Committee

1. At this stage, accurately evaluate the level of noxious weed awareness, the existence or status of noxious weed mapping and inventory, and prevention and control programs in the weed management area.

2. A second meeting of the steering committee may be required. This step in the process is critical to determine what is known and what information is missing.

3. Important reasons for the initial assessment at this stage include:

- This assessment helps predict the expected level of involvement of the residents, landowners, and other agency personnel in weed management planning and action process.

- The results of this assessment can determine initial weed management objectives. For instance, rather than treat weeds first, it may be most effective to establish awareness and prevention programs first.

- The assessment can provide answers to questions that may arise at the first public meeting. Your credibility and the potential value of an established WMA increase when you can correctly and concisely answer such questions as:

    - Why is weed management important?

    - How do weeds impact recreation, wildlife, fish, forestry, etc.?

    - Do we have a weed problem and what does it cost us?

- Can we keep weeds out or prevent their spreading in the WMA?
- What weed species predominate in the WMA?
- Where do weed infestations exist in the WMA?
- If there currently a weed control program established?
- Is there a weed prevention program in place?

Details of a Public Meeting

1. Use all forms of publicity to inform everyone who might be affected by or interested in the WMA.
2. Use a model for conducting a public meeting.
3. Ask the attendees to complete a WMA Questionnaire.
4. Review the designated area coordinated weed management concept with the participants.
5. Explain the planning process, mapping, WMA concept, and other information in the planning meeting.

- Be willing to modify initial objectives based on input from the public meeting.
- Because of various barriers, the proposed boundaries of the WMA may need to be changed.

6. Identify weed problems.

- Consider whether weed problems are a localized concern or a threat to the entire WMA.
- Accurately identify the weeds of concern.
- Provide a large scale map of WMA and use it to record infestations.

7. Clearly state that integrated weed management practices are required in the WMA.
8. Record all ideas for future consideration.

9. Make adjustments in the membership of the planning/working committee.

10. Obtain mailing addresses and mail results of WMA Questionnaire and Management Plan to attendees.

Writing a WMA Management Plan and Annual Operating Plan

The Management Plan (MP) is the guiding document for each Weed Management Area. It is developed after the steps outlined above are completed. The Annual Operating Plan (AOP) addresses how the MP is implemented on an annual basis. The planning/organization committee drafts the WMA MP after the public meeting. The draft is reviewed with all interested individuals before the MP is finalized. The MP must allow for changes or modifications as conditions change.

Management Plan

1. Define/describe the WMA.

- Provide name and legal description.
- Describe boundaries.
- Describe land use—forest, recreation, grazing, farming, mining, etc.
- Describe topography, major aquatic features, and other natural resources.
- Describe wildlife and flora.
- Describe endangered species and species of special concern.
- Identify urban areas.
- Identify archaeological and Native American cultural sites.

2. Define purpose of WMA Management Plan.

- Describe long-term goals, objectives, and methods for controlling noxious weeds in this WMA.
- Identify funding and resources for weed management.

- Establish cooperation with residents, landowners, agencies, towns, organizations, counties, and states to effectively implement programs of prevention and control within the WMA.

- Coordinate with other WMAs in the area.

3. Define WMA policy.

- Commitment to cooperation

- Commitment to the use of Integrated Weed Management (IWM) methods

- Establish adherence to management of noxious weed in accordance with area priorities as follows:

    - o Prevention of potential invaders

    - o Control of new and invading species new to a particular part of the WMA

    - o Containment and management efforts on established stands

- Commitment to comply with all policies for at least 5 years.

4. Define long-term WMA objectives. Objectives should address the needs of the individual WMA and may not need to include all aspects of noxious weed management listed here. Also, the need for and prioritization of the following objectives will vary between WMAs. It is important to consider each of these objectives, as success is greatest when an integrated plan is developed and implemented.

- Develop and maintain a survey and mapping system.

- Develop and maintain funding and administration.

- Develop awareness, education, and training programs.

- Develop prevention and early detection programs.

- Develop long-term management objectives for weeds of concern, according to area prioritization. (Refer to 3 above.)

- Develop and maintain monitoring and evaluation programs.
- Develop and maintain a reporting system.

5. Identify weeds of concern within the WMA.

- List weed species and acres infested.
- Describe methods of introduction.
- Describe most likely areas of future infestations.

6. Develop an IWM program for target weed species.

- Describe all appropriate control methods for each weed. Use the Site Assessment Worksheet (reproduced at end of this appendix) to determine the most effective IWM program.
- Determine who will make yearly control methods recommendations. Keep recommendations current.
- Describe safety precautions to be implemented.
- Include corrective measures to prevent recurrence of weed infestations.

7. Define cooperators’ roles and responsibilities.

- List agencies and jurisdictions involved.
- Identify signatures required.
- Define planning timetable.
- Define terms and time of termination if applicable.

8. Define collection and management of funds.

- Identify sources of funding.
- Establish a budget.
- Determine fund management responsibilities:
    - o Determine if the WMA needs its own account.
    - o Determine administrative costs.

Annual Operating Plan

The AOP addresses how the objectives of the over-all MP are implemented on an annual basis. Due to manpower, funding, or other limitations, it may not be possible for the AOP to address all the objectives of the MP in a given year. The MP must address long-term objectives and priorities. The AOP guides implementation of the MP in yearly increments. Budgets and circumstances may change from year to year and these changes are best addressed in making new AOPs, rather than rewriting the MP annually.

An AOP may be developed for different management zones within the WMA. These zone-specific plans should be utilized only if they enhance weed management and control. For instance, a specific AOP may be necessary to manage only roadside weed problems within the WMA.

1. Review the MP and long-term objectives.

2. Define roles and responsibilities.

- List agencies and jurisdictions involved.

- Obtain signatures required.

- Develop planning timetable.

- Define terms and time of termination, if applicable.

3. Define agreements and compliance.

- Voluntary agreements: compliance of all land managers within their agency guidelines.

- Written agreements in special management areas requiring intensive management may be needed.

- Written agreements with landowners for control of noxious weeds along roadways may be implemented.

- Procedure for non-compliance must be followed where applicable.

- Cooperative agreements: include state agencies, municipalities, federal agencies, railroads, power company, others. Should include listed noxious weed species.

- Revegetation standards and guidelines: written plan specifying methods for accomplishing revegetation, timing, methods.

- Cost-share programs: WMA steering committee should set standards for cost-share. Cost-share programs within the WMA may differ within special management areas.

4. Define annual funding and resource availability.

- Identify sources and amount of funding.

- Identify sources and amount of other resources:

    - o equipment availability
    - o staff availability
    - o cooperative mapping projects
    - o storage availability
    - o administration

5. Define specific actions to meet AOP objectives.

- Implement and maintain a mapping program:

    - o Define areas for survey and mapping.
    - o Determine who will be responsible.
    - o Determine manpower and funding required.

- Implement prevention and early detection programs:

    - o Define specific activities.
    - o Determine who will be responsible.
    - o Determine manpower and funding required.

- Implement awareness, education, and training programs:

    - o Define specific activities.
    - o Determine who will be responsible.

  - Determine manpower and funding required.

- Implement the IWM system for the weeds of concern.
  - Determine short-term IWM objectives and methods for each target weed.
  - Determine who will implement treatment program.
  - Determine manpower and funding required for control.

- Implement and maintain monitoring and evaluation for all targeted weeds and according to MP priorities and objectives.

- Develop and maintain a reporting system for all proposed actions according to MP priorities and objectives.

WMA Resources (from document but with updated links)

- Center for Invasive Plant Management CWMA Grants (See "Funding" under CWMA/CISMA Resources at http://www.weedcenter.org/cwma/index.html)

- Guidelines for Coordinated Management of Noxious Weeds: Development of Weed Management Areas. (Section IX at http://www.weedcenter.org/management/guidelines/tableofcontents.html). Developed in 1998 by the BLM, U.S. Forest Service, National Park Service, and state and county land managers. Includes sample contracts and agreements, and information about planning, weed awareness and education, mapping, monitoring, reporting procedures, and more.

- "Creating an Integrated Weed Management Plan—A Handbook for Owners and Managers of Lands with Natural Values." Volume IV in the Caring for the Land Series Publications from the Colorado Natural Areas Program of the Colorado State Parks. This volume includes the Weed Management Plan Outlines as Appendix 3. (http://www.parks.state.co.us/NaturalResources/CNAP/Publications/Pages/CNAP%20publications.aspx)

- Cooperative Weed Management Areas in the Northwest: Taking Stock and Moving Forward, provided an analysis of three CWMA locations throughout the Pacific Northwest (one on the OR, CA and NV border, one on the OR, ID, WA border and one covering three counties fully located within OR), and of the

Washington State Noxious Weed Control Board (BLM 2000).Listed in NAL catalog (AGRICOLA) and available by contacting AGRICOLA at http://agricola.nal.usda.gov/cgi-bin/Pwebrecon.cgi.

- California Department of Food and Agriculture, "Protecting California from Biological Pollution" http://www.cdfa.ca.gov/plant/reports/BioPollution08.pdf

- California Invasive Plant Council (Cal-IPC) "About Weed Management Areas." (http://www.cal-ipc.org/policy/state/wma.php)

- Idaho Dept. of Agriculture Cooperative Weed Management Areas, Idaho CWMA Cookbook: A Recipe for Success. 2003. http://www.agri.state.id.us/Categories/PlantsInsects/NoxiousWeeds/Documents/cwma/cookbook.pdf

NOTE: see following page for Site Assessment Worksheet.

WMA: Site Assessment Worksheet[8]

Appendix 10

Site Assessment Worksheet

I. Directions for filling out the Site Information Worksheet

WMA - Name given to this specific management area

Site description - Use the established method of description (range and township, longitude and latitude, references to symbols on a map, etc.)

Target weed - Use both the common and scientific names

Land use - General use of land included in treatment site (Range-land, non-crop, right-of-way, etc.)

Infested acres - Use the same reporting method for the entire program and record the method used.

1. Total acres inspected while surveying, regardless of the number of number of weeds found per acre, or
2. Total number of acres within the management area that contain at least one target weed, or
3. Total amount of land physically inhabited by target weeds

II. Options

A. Control Method - Indicate control method(s) (chemical, biological, physical, cultural) used for each option.

B. Control Agent.
   1. Herbicide - List the common or trade name.
   2. Biological - List the common or scientific name
   3. Physical/Mechanical - List equipment or manpower to be used.
   4. Cultural - List technique(s) used.

C. Rate per site
   1. Herbicide - List the amount of active ingredient(s) and total number of units in accordance with label directions.
   2. Biological - List the number of insects, pathogens, or head of livestock which will be released per site .
   3. Physical/Mechanical - List number of man-hours or equipment-hours per site or per acre.
   4. Cultural - List number of man-hours or equipment hours per site or acre.

D. Number of acres or releases - Estimated (or actual) number of infested acres treated at this site or number of biological releases to be made at this site.

E. Agent cost per unit - Estimated (or actual) cost of control agent per unit (gallon, pound, carton, etc.).

147 — Site Assessment Worksheet

[8] Reproduced from Appendix 10 of *Guidelines for Coordinated Management of Noxious Weeds: Development of Weed Management Areas*.

Appendix 10

F. Agent cost per site - Multiply the number of estimated releases or infested acres treated in this site by the cost per unit.
G. Method of distribution or application - Method in which the control agent will be dispersed or applied (if applicable).
   1. Herbicide - List type of application equipment to be used.
   2. Biological - List release method and/or methods for redistribution.
H. Labor required per site or unit - Number of hours of labor required per site or acre for distribution or application (do not include administration time).
I. Labor cost per release or unit - Cost of labor per hour (include only the direct cost of application or distribution, not administrative costs).
J. Total labor cost - Multiply the estimated number of releases or infested acres treated by the labor cost per release or acre.
K. Administrative cost per site - Total administrative costs of using this option.
L. Total cost per site - Add agent cost per site, labor cost per site, and administrative cost per site.
M. Effect on non-target species - Include if there is a potential adverse effect on non-target species with the use of this option.
N. Expected percent of control first, second, third, fifth, and tenth year - Use information from chemical companies, university studies, government studies, etc.

148 — Site Assessment Worksheet

WMA Site Assessment Worksheet

Weed Management Area (WMA) _____ Date _____

Completed by _____

Site # _____ Page # _____ of _____ Pages

Site Description					
Target Weed					
Land Use					
Infested Acres					
	Option #1	Option #2	Option #3	Option #4	Option #5
Control Method					
Control Agent					
Rate (Units/Acres or Site)					
# of Acres or Releases					
Agent Cost/Unit					
Agent Cost/Site					
Method of Distribution or Application					
Labor Required/Site-Acre					
Labor Cost/Release-Unit					
Total Labor Cost					
Administrative Cost/Site					
Total Treatment Cost					
Effect on Non-Target Species					
Exp % Control - 1st Year					
Exp % Control - 2nd Year					
Exp % Control - 5th Year					
Exp % Control - 10th Year					

149 — Site Assessment Worksheet

APPENDIX E:

INVASIVE SPECIES MANAGEMENT ON MILITARY LANDS

Reproduced from text of Chapter 7,[9]
"Invasive Species Management on Military Lands" by Troy Weldy
from *Conserving Biodiversity on Military Lands: A Guide for Natural Resources Managers*

NOTE: The Department of Defense funded the development of this publication in 2008. Several separate topics are addressed, including this review of the importance of managing non-native invasive species, as reproduced below (with edits or deletions as needed for updated links).

Non-native invasive species are a leading threat to our nation's rich biodiversity, as well as to national security, the economy, and human health. Since colonial periods, thousands of non-native species have been introduced to the United States, some by accident and others quite deliberately. Based on the U.S. Department of Agriculture (USDA) Plants Database, currently 13 percent (5,303 of 40,140) of the vascular plant species in the nation are not native to North America. These would include most of Americans' favorite foods and many ornamental plants. The majority of non-native plants and animals existing in the U.S. are not harmful, but some non-native species cause tremendous damage when released outside of their native habitats. As defined by Executive Order 13112, invasive species are those non-native species that "cause economic or environmental harm or harm to human health." The Congressional Office of Technology Assessment reported in 1993 that 15 percent of invasive plants and animals cause severe economic and environmental harm.

Invasive species occur throughout the lands and waters of the United States, and military lands are no exception. These invaders are a major and growing problem on military lands, impacting the ability to train the nation's armed forces, degrading ecosystem health of these public lands, endangering

[9] All chapters available at NatureServe website, www.dodbiodiversity.org

native biodiversity, and potentially causing harm to human health. The military faces some unique challenges in combating invasive species on their lands, challenges related to their primary goal of maintaining the quality of military lands for realistic training exercises, while also meeting their responsibility to safeguard the quality of natural resources and biodiversity on their lands.

Numerous military installations across the country have employed successful and innovative methods to control invasive species, examples of which will be referred to throughout this chapter and in the case studies. Given the vast amount of land that the military owns and manages in the United States, the military has a unique responsibility in managing invasive species and in helping to prevent new introductions. The Department of Defense (DoD), however, cannot stop the problem of invasive species on its own. Invasive species are a "beyond the fence line" issue that must be addressed comprehensively, by Congress and other state and federal public land management agencies, as well as by private entities and individuals. Given the far-reaching nature of this problem, DoD has formed many diverse partnerships in battling invasive species, some of which are highlighted below.1

Impacts on Military Operations

Invasive species affect the nation's military installations and operations worldwide. The National Wildlife Federation's recent report (Westbrook and Ramos 2005) on invasive species on military lands provides twelve cases outlining numerous threats and costs to military operations: from six-foot tall spiky yellow star-thistle shredding parachutes that average $4,000 apiece at Fort Hunter Liggett in California to *Phragmites* causing security concerns at Avon Park Air Force Range in Florida. Holloman AFB in New Mexico allocated over a half million dollars to remove invasive species from airstrips in order to protect the safety of Air Force pilots and prevent damage to aircraft worth tens of millions of dollars. And in Hawai‘i, dense non-native mangrove thickets can breach "line-of-sight" security for Marines assigned to protect base borders along the shoreline (Westbrook and Ramos 2005).

Ecological Impacts

Many reports have documented the ecological impacts of these non-native invaders, including citing invasive species as one of the greatest threats to biodiversity (e.g. Stein et al. 2000). Worldwide, an estimated 80 percent of endangered species could

suffer losses due to competition with or predation by invasive species (Pimentel et al. 2005). In addition to direct competitive impacts to native species, some of the worst invasive species are able to alter native habitats and ecosystems. Invasions by non-native species have been shown to modify ecosystem processes, like nutrient cycling, fire frequency, hydrologic cycles, sediment deposition, and erosion (Kelly 2007). On the Marine Corps Base Hawai‘i, nonnative mangrove stands take over native marsh habitats, converting critical habitat for endangered Hawaiian waterbirds into mangrove thickets that are inhospitable to both native species and to realistic military training exercises on base. On Avon Park Air Force Range in Florida, invasive wild hogs compete with the endangered Florida scrub jay for food and destroy nesting habitat for many other endangered species (Westbrook and Ramos 2005). Such feral hogs are a growing menace at several other military installations. When invasive species cause habitat destruction and harm rare native species, the result can lead to reductions in available training lands on installations.

Economic Impacts

Invasive species impact the United States economy in many ways, negatively affecting economic sectors such as western ranching, Great Lakes shipping, southern forest plantations, and Midwestern farming, just to name a few. Within the U.S., the estimated damage and management cost of invasive species is more than $138 billion annually, more than any other natural disaster (Pimentel et al. 2005). In addition to these costs, many economic losses from recreational and tourism revenues are difficult to calculate (Simberloff 2001); as a result, the $138 billion estimate may be low.

If monetary values could be assigned to the extinction of species, loss of biodiversity, and reduction of ecosystem services, costs from impacts of invasive species would drastically increase (Pimentel et al. 2005). For the military, the costs related to invasive species are significant and are increasing each year. To name one example, Camp Pendleton in southern California spent approximately $1.2 million over a five year period trying to control giant reed (*Arundo donax*) and tamarisk or salt cedar (*Tamarix ramossima*) (Westbrook and Ramos 2005). While it also can be expensive to prevent invasive species on military lands – for example through programs to wash tanks and other military vehicles before and after transport – prevention is a critical first-line defense against new invaders on military lands. Once established, managing invaders such as

the giant reed and tamarisk, mentioned above, can often be a multi-year and multi-million dollar effort.

Recreational Impacts

As many boaters and fishermen can attest, invasive species like water hyacinth (*Eichhornia crassipes*), hydrilla (*Hydrilla verticillata*), Eurasian milfoil (*Myriophyllum spicatum*), and water chestnut (*Trapa natans*) can reduce or prevent access to water bodies. In some cases, it is the recreational activities that have introduced or spread invasive species. So have people out for innocent walks; *Miconia calvescens*, a broad-leafed plant introduced as a handsome ornamental in Hawai‘i in the 1960s, produces tiny seeds that must be removed from shoe soles by vigorous brushing, lest they plant themselves elsewhere. It and other invasives can limit hiking options or reduce the outdoor experience. Conservative estimates of the economic costs from invasive species impacts on wildlife-related recreation in Nevada alone range from $6 million to $12 million annually (Elswerth et al. 2005).

Invasive Species Vector

Invasive species have arrived in the United States through a multitude of means, including introductions by early human settlers who seek reminders of their homelands, to importation of ornamental plants, to introductions by government agencies to combat some other problem (often an agricultural one), to an expanding global trade enterprise that inadvertently allows the rapid spread of species. Modern trade has greatly increased the spread of a number of species. Asian tiger mosquitoes hitchhike into new areas in rainwater pools in discarded tires and even aboard water-filled depressions on ship structures. This mosquito is associated with the transmission of many human diseases, including dengue virus, West Nile virus, and Japanese encephalitis (Global Invasive Species Database 2006).

Ship ballast, typically water pumped into a ship's tanks at one port and pumped out at another, is used to balance the weight and control the steerage of freight vessels and is a well-documented vector. The most noted species introduced by ballast is the zebra mussel. Zebra mussels (*Dreissena polymorpha*) are native to the Caspian Sea, but long ago began spreading throughout much of Europe. In 1988, they were detected in the Great Lakes where they had caused serious problems by out-competing native species for food and damaging harbors, boats, and power generation plants.

In some cases, the military itself unintentionally may have been responsible for the spread of invasive species. While it is difficult to pinpoint the precise time, location, and cause of introduction, there is speculation that the military introduced the brown tree snake to Guam, African iceplant to the San Francisco Bay area, black rats to the Midway Islands, and sakosia shrubs (*Timonius timon*) to Palau. The military has taken a leadership role to reduce future unintentional introductions. The Armed Forces Ballast Water Management Program, which requires DoD vessels to twice flush ballast water at least twelve nautical miles from shore, should be used as an example to commercial vessels. Transportation policy and procedures rules already require the washing of vehicles after field operations. The primary purpose is to extend the life of field equipment, but it also has a secondary purpose of reducing hitchhiking foreign pests from entering U.S. borders.

Federal Guidelines for Invasive Species

The United States has several legal guidelines that are intended to prevent and combat invasive species. Chief among them is the National Invasive Species Act of 1996. This act is a reauthorization and amendment to the 1990 Nonindigenous U.S. Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-646), which authorized the National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service to address aquatic invaders. Section 1103 of the 1996 act states that the "Secretary of Defense shall implement a ballast water management program for seagoing vessels of the Department of Defense and Coast Guard." The act also calls for the creation of state invasive species management plans, development of ballast water guidelines for commercial vessels, research studies, and demonstration projects. Advocates of the ballast program argue that the act needs reauthorization that includes the program's expansion to cover all commercial vessels similar to that of the armed services program. The Aquatic Nuisance Species Task Force is an intergovernmental group that helps to implement the act. There is also a hotline to report sightings of aquatic nuisance species (ANS) in the U.S. (telephone 877-STOP-ANS; http://cars.er.usgs.gov/Nonindigenous_Species/Stop_ANS/stop_ans.html).

Executive Order 13112, Invasive Species

Executive Order 13112, which was signed in 1999, created the National Invasive Species Council (NISC) that is composed of 13 federal departments and agencies, including the Department of

Defense. The council's principal objectives are to prevent the introduction of invasive species, monitor invasives' populations, promote restoration of native species, and promote public education on invasive species (http://www.invasivespeciesinfo.gov/laws/execorder.shtml). A five-year review of the NISC was recently completed (see http://www.invasivespeciesinfo.gov/docs/council/fiveyearreview.pdf). This document highlights the accomplishments to date and the NISC's future plans.

Armed Forces Pest Management Board

This board (http://www.AFPMB.org) provides numerous resources regarding invasive species and other pests impacting military lands and operations. The AFPMB has developed best management practices, standard pesticide use guidelines, resources for identifying invasive species, and links to research activities. The AFPMB publishes technical guidance for installation personnel who are responsible for pest management plans (see www.afpmb.org/sites/default/files/pubs/techguides/tg18.pdf - 2013-04-22).

The most cost-effective means to control invasive species is to prevent their initial arrival. The impacts of many of these species, however, are not understood until they are well established. For those species where environmental and economic impacts are known, measures need to be taken to reduce the risk of introduction, including surveys for these species at ports of entry and military bases where equipment and materials are imported or returned from foreign soils. Military vessels and equipment used in foreign lands and waters where potential invasive species are suspected should be thoroughly cleaned before leaving those foreign lands. If any invasive species are found at our first lines of defense (e.g., shipping ports), then immediate eradication should occur. As noted previously, preventing the discharge of foreign ballast water by military vessels in U.S. ports will reduce the introduction of invasive aquatic species.

On military lands where invasive species are already present, management activities should include restoration actions. The removal of invasive species without restoration can lead to the reestablishment of the same or new invasive species. Furthermore, on many installations, there is a chance that invasives species can reinvade from lands outside the installation boundaries. On Avon Park Air Force Range in Florida, the highly invasive and problematic climbing ferns and

tropical soda apple occur in public and private lands nearby. It is important for military natural resources managers at all installations to think beyond the fence line and cultivate public and private partnerships to keep invasive species under control.3

Early Detection/Rapid Response

The idea of early detection/rapid response is a two-part component: first, surveys to identify newly-established invasive species, and second, an effort to eradicate newly detected infestations. There are many cases where early detection has identified newly established pests, but managers have proven less adept at following up with eradication programs. Many scientists want to study the problem more, but agencies are bogged down in red tape that prevents immediate eradication. Given the potential environmental and economic impacts, a suggested strategy of "yank it now, ask questions later" may prove most cost effective. This is particularly important for species that are known to cause harm.

Mechanical Control

The use of mechanical control is often effective for dealing with small, newly established populations or as part of a large scale restoration program. Mechanical control may simply include hand pulling or the use of large equipment. No matter what control feature is employed, follow-up monitoring is necessary to ensure eradication.

Pesticides

Many modern pesticides have been vastly improved over earlier controls, such as DDT, with its notorious residual environmental impacts. Methodologies for applying pesticides have also improved. Cut-stump treatments (i.e., painting herbicides directly onto a cut surface), wet wicking (hand applying herbicides to individual target plants), and stem injections (the use of needles to inject herbicides directly into a target plant or impacted plant) allow applicators to directly apply chemicals to the target species with little or no non-target impacts. In extreme cases, broadcast spraying of herbicides may be viewed as the only option, in which case more care and review are needed. Drawbacks to chemical treatment include its cost and potential negative impact to the environment and to the applicators' health. Within the DoD, of course, a regularly updated list of materials which are approved for use on government property is available from the Armed Forces Pest

Management Board (AFPMB) at: http://afpmb.org/sites/default/files/pubs/standardlists/DOD_PESTICIDES_LIST.pdf.

Biological Controls

Biological controls are growing in use as non-chemical opponents of harmful invasive species and diseases. Biocontrols can be defined as the use of natural enemies, usually from a pest's native lands, to reduce the impact of problematic insects, diseases, and plants. There are many examples of successful use of biocontrols in the place of chemical poisons; a tiny parasitic wasp, part of a large group of parasitoids, controls many agricultural pests and diseases, for example. The Texas Agricultural Experiment Station has collaborated with the DoD to remove noxious weeds on military lands. The weeds include leafy spurge, field bindweed, spotted knapweed, Canada thistle, and St. John's wort; participating installations include Fort Carson, the Air Force Academy, Rocky Flats Environmental Technology Site, Buckley AFB, all in Colorado, and F.E. Warren AFB, Wyoming.

As with any effort to tinker with nature, biocontrol can have unintended, negative results. One danger is that the biological control agent – parasitoid, fungus, nematode, bacterium, competing organism, growth regulator – can gobble up or infect not only its intended target but also beneficial organisms. In the 1970s, for example, biologists released the Asian ladybug in an effort to control aphids that were attacking pecan trees in the southeastern U.S. These ladybugs were successful at eradicating these aphids, but they also had appetites for other insects. The result has been a biocontrol that eats so many aphids and other native ladybugs that many native ladybugs became threatened or extinct. Even New York's official state insect, the nine-spotted ladybug (*Coccinella novemnotata*), is now extinct from New York State as a result of competition with the Asian ladybug.

These and other examples should be viewed as cautionary tales. When biocontrols are thought to be the only solution, detailed research and extensive testing must be done. Researchers and land managers need to learn from the biocontrol failures. They need to ensure that biocontrols do not become the next wave of invasive species, potentially worse than the species they were meant to control. But if carefully evaluated before introduction, biological controls can be highly effective, as Jerry Johnson at Fairchild AFB, Washington, can attest (see case

study). Biocontrol agents are tightly controlled by the U.S. Department of Agriculture.

Partnerships

As a member of the National Invasive Species Council (http://www.invasivespecies.gov/), the Armed Forces Pest Management Board (http://www.afpmb.org/) works with multiple agencies to combat invasive species. Throughout the country, Cooperative Weed Management Areas (CWMAs) or similar partnerships are forming to address invasive species problems across multi-jurisdictions (see http://www.weedcenter.org/cwma/index.html). These partnerships may allow the DoD, along with other federal agencies, state agencies, NGOs, and local land managers, to share resources and experiences to better manage invasive species.

Conclusions

As with any land manager today, the military's first line of defense against invasive species must be prevention of new invasions and preventing expansion of existing invaders. The military already has many policies in place to aid in prevention, but consistent funding is needed in order for prevention programs to be successful. Since funding is often linked to an installation's Integrated Natural Resources Management Plan (INRMP), prevention of invasive species should always be considered in the INRMP, along with early detection, rapid response, and long-term management of invasives.

Perhaps the most important weapon in the fight against invasive species on any installation is outreach and partnerships. Installations such as Fort McCoy, Wisconsin, have enlisted the help of citizen volunteers in controlling numerous invasive plants, such as garlic mustard and leafy spurge. Staff at the Wisconsin fort have reached out to local stakeholders and developed partnerships to educate the community about the harmful impacts of invasive species on and off base. These partnerships have even aided Fort McCoy with bringing in funding for their efforts, through the National Fish and Wildlife Foundation's "Pulling Together Initiative" (see http://www.nfwf.org/Pages/pti/home.aspx) which provides grants for public and private partnerships to combat invasive species (Westbrook and Ramos 2005). The military can also form very beneficial partnerships with conservation organizations and invasive species researchers, to share resources, information, and best practices in the battle against invasives (see

https://www.denix.osd.mil). The military has teamed with nongovernmental organizations, such as The Nature Conservancy, to combat some of the nation's worst invaders, such as tamarisk or salt cedar.

Not only do installation natural resources managers need to look outside their borders to form partnerships, but they also should look to their own operational forces as partners in controlling invasive species. In some cases, management of invasive species can be aided by training activities, such as on the Marine Corps Base Hawai‘i, where Marines help clear out invasive pickleweed by running their amphibious assault vehicles over the invaded mudflats, helping to improve the habitat for native species such as the endangered Hawaiian stilt while simultaneously improving the training ranges for military maneuvers (Westbrook and Ramos 2005).

Managers of lands invaded by undesirable species also must consider native biodiversity and the entire ecosystem. When addressing the problem of invasive species in an INRMP, natural resources managers should always consider what they are managing for, not only what they are managing against. For example, in some cases, restoration efforts are necessary after invasive species have been removed from an area. Moreover, when managers think holistically, they are more likely to minimize any harmful environmental impacts of invasive species control efforts. Herbicides and biocontrols can be very useful management tools in some situations, but any potentially harmful side effects also must be examined, and the benefits weighed against the possible long-term costs. Partnering with other public and private land managers and with researchers in universities who have expertise in invasive species control can be critical for military natural resources managers seeking and testing the most cost effective and least environmentally harmful invasive species control methods.

Through sharing knowledge and expertise about invasive species prevention and management within the military, and among the military and various public and private partners, the battle against invasive species must continue in order to protect training lands from degradation and to safeguard the rich native biodiversity that occurs on military lands across the country.

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APPENDIX F:

RANGE RIDER PROJECT

"Protection of Prioritized Rangelands from Weed Spread with Range Riders"

Kim Goodwin and Shana Wood
Land Resources and Environmental Sciences Dept.,
Montana State University
Final Report for
Contribution Agreement #65-0325-05-0016
Submitted: 30 November 2006

NOTE: *This publication was prepared by Montana State University to record the experimental use of "range riders" mounted on all-terrain vehicles, as a means to attack widespread, but individually small, infestations of invasive weeds. The process appears to be adaptable to many aspects of military installation weed management programs. The setting, distances involved, level of effort, and many other characteristics appear to be analogous to Army installation concerns. It is reproduced in full, and readers are encouraged to self-identify those aspects of the procedures which may be adaptable to their situation and funding.*

Introduction

Weeds in rangeland may reduce forage yield and quality, increase the costs of cattle production and reduce producer profits, and impact wildlife habitat and native species biodiversity. Weed problems and associated impacts may be irreversible, and resources required to mitigate these problems are often cost-prohibitive. A majority of rangelands in Montana are weed-free, yet susceptible to invasion where prevention efforts remain an effective option. Weed prevention areas (WPAs) aim to meet this conservation need by working as local-level prevention systems to protect vulnerable rangelands from invasion and colonization. The purpose of seasonal weed scouts, or "range riders," is to reduce the likelihood of invasion and improve the detection, reporting, and eradication of new weeds in WPAs.

Goals and Objectives

The goal of this project is to provide prevention support to WPA ranchers and county weed districts using seasonal range riders.

Prevention support includes management actions implemented up to the point where eradication becomes infeasible. These actions include education, exclusion, detection, eradication, mapping, and ecosystem management. The objective of each range rider was to provide on-site ranch visits to at least 50% of the ranchers within participating WPAs during 2005 and 2006. The duties of the range riders during on-site ranch visits were to: (1) promote frequent and consistent communication between ranchers and county weed districts, (2) collect site-specific rancher knowledge on weed spread, (3) determine rancher needs to curb weed spread at the local-level, (4) increase rancher awareness and knowledge of early control through dissemination of prevention and early control literature, (5) promote project by posting WPA signs and informational boxes, (6) offer monitoring assistance to ranchers to map and eradicate new weeds and confirm weed-free areas using geographic positioning system (GPS) technology, (7) download data from rancher GPS units, and (8) offer personal GPS refresher training to ranchers.

Methods

WPA participation

Six pilot WPAs were chosen to participate in this program, based on the number of ranchers that would advocate the development of a native and invasive plant rangeland inventory program. The following WPAs were chosen to participate:

1. The Sweet Grass Hills WPA is about 345,000 acres in size, represented by 67 private and 3 public landowners, and located in northwestern Liberty County and northeastern Toole County;

2. The Hill County WPA is about 633,600 acres in size, represented by about 250 private and 3 public landowners, and located in northeastern Hill County;

3. The North and South Blaine County WPAs are collectively about 443,600 acres in size, represented by 68 private and 2 public landowners, and located in northwestern and south central Blaine County, respectively;

4. The Deep Creek WPA is about 172,000 acres in size, represented by 19 private and 5 public landowners, and located in southwestern Teton County; and

5. The Northside WPA is about 105,600 acres in size, represented by 1 public and 9 private landowners, and located in central Prairie County.

Ranching operations in the participating WPAs predominately consists of native rangeland cow-calf enterprises and dry land hay and small grain farming. The WPAs also include farms in fallow, some irrigated land and improved pasture, organic crops, and land held in the Conservation Reserve Program. Major weed threats among the WPAs include spotted knapweed and leafy spurge. Russian knapweed, diffuse knapweed, saltcedar, oxeye daisy, whitetop, and houndstongue also collectively threaten the WPAs. Weeds may be threatening invasion through different pathways that are specific to each WPA. For instance, the Deep Creek WPA may be subject to weed introductions from non-local recreationists. It is located at the Rocky Mountain Front, which has high recreation appeal (Figure F-1).

Figure F-1. The Deep Creek WPA is located at the Rocky Mountain Front and may be threatened by weed spread from recreational activity. (Photo courtesy of Teton County.)

Range Rider Procedures

Range riders contacted WPA ranchers by phone to discuss the program and schedule on-site ranch visits. They visited with the ranchers and collected rancher impressions of the project, in addition to noting rancher interest and motivation to maintain weed-free rangelands. The range riders also discussed prevention strategies and disseminated hunter brochures (attached). These brochures help regulate hunter activity for the purpose of minimizing weed invasion. The brochures also outline that WPA

restrictions are not arbitrary nuisances but necessary aspects of rangeland protection and wildlife habitat preservation. Range riders also disseminated fact sheets of priority weeds threatening the respective WPAs (see an example at end of this appendix). Six weed alert fact sheets of nine invasive weeds were available for distribution. These fact sheets include identification, biological information, habitat requirements, and early control techniques. The range riders also posted WPA signs at ranch entrances (Figure F-2) to educate visitors and reinforce rancher prevention commitments. They also installed WPA informational boxes (Figure F-3) at Montana Fish, Wildlife, and Parks Block Management Area entrances. These boxes contained WPA hunter brochures and NRCS – Zero Spread literature to educate hunters on weed spread.

Figure F-2. Range riders posted Weed Prevention Area signs to promote weed prevention. (Photo courtesy of Blaine County.)

Range riders arrived at ranches with a spray truck and an all terrain vehicle (ATV) outfitted with spray equipment and a GPS unit (Figure F-4). They inventoried ranches predominately by ATV. Range riders occasionally inventoried ranches on horseback and with landowner assistance. The transect width used by range riders to survey the WPAs varied with site characteristics.

Figure F-3. Range riders installed WPA information boxes at entrances of WPA ranches participating in the Block Management Area program. (Photo courtesy of Blaine County.)

Figure F-4. Range riders used ATVs outfitted with GPS units and spray equipment to inventory rangelands and eradicate new invasions. (Photo courtesy of Liberty County.)

GIS Map Production

Maps of the six WPAs were created in ArcGIS (ArcView) 9.1 and exported to Adobe PDF format. Shapefiles of weed point features were obtained from the WPA counties and overlaid on thematic layers obtained from the Montana Geographic Information Clearinghouse at the Montana Natural Resource Information System (NRIS). The NRIS thematic layers were used to provide spatial context to the weed points and included county boundary, townships, highways, streams, lakes, and towns. In addition, WPA counties provided shapefiles of WPA boundaries and areas that were surveyed by range riders and confirmed to be weed-free. Thus, the maps show where weeds are present as well as areas that were searched and no weeds were present.

Results and Discussion

Range Rider Deployment and Productivity

Four range riders were deployed during 2005 in the Sweet Grass Hills WPA, Hill County WPA, and the North and South Blaine County WPAs. Three range riders were deployed during 2006 in the same WPAs, with the North and South Blaine County WPAs sharing a range rider. Two additional range riders were deployed during 2006 in the Deep Creek WPA and Northside WPA, located in Teton and Prairie counties, respectively. The range riders collectively worked 3,660 hours during 2005 and 2006. Through their combined efforts, they visited 237 ranchers and surveyed 998,400 acres. On average, the range riders were able to survey about 200 acres per hour. This is a conservative calculation and accounts for planning and travel time to ranches. The range riders surveyed 60.3% (SE 7.26) of the total area of all WPAs combined. The range riders visited 66.5% (SE 11.4) of the WPA ranchers. These values were derived from results summarized in Table F-1.

Table F-1. Summary of acres surveyed and ranchers visited by range riders.

WPA County Location	WPA acres	WPA Acres Surveyed	WPA Ranchers	WPA Ranchers Visited	Acres Surveyed (%)	Ranchers Visited (%)	Year(s)
Liberty	345,600	299,000	67	60	87	90	2005/ 2006
Hill	633,600	230,400	250	142	36	57	2005/ 2006

WPA County Location	WPA acres	WPA Acres Surveyed	WPA Ranchers	WPA Ranchers Visited	Acres Surveyed (%)	Ranchers Visited (%)	Year(s)
Blaine	443,600	323,000	68	15	73	22	2005/ 2006
Teton	172,000	86,000	19	14	50	74	2006
Prairie	105,600	60,000	9	9	57	100	2006
TOTAL	1,700,400	998,400	413	237	60.3 (7.26) Mean (SE)	66.5 (11.4) Mean (SE)	

Range Rider Findings: Rancher Knowledge and Interests

The range riders collected site-specific rancher knowledge on weed spread and gathered rancher input and project impressions during on-site ranch visits. The ranchers clearly recognized roads and waterways were pathways that enhanced weed invasion into WPAs. These pathways were frequently disturbed, thus providing suitable habitat, and acted as corridors for dispersal. They acknowledged material brought into the WPAs, such as soil and gravel, forage and feed grains, railroad ties, building logs, and even corrugated tin panels may be contaminated and thus facilitate invasion. They believed visitors, such as hunters, anglers, and recreationists, may be transporting weeds on their boots, dogs, horses, boats, and equipment. Contaminated machinery, heavy equipment, and non-local vehicles and ATVs performing work in WPAs were also recognized as facilitating weed spread. They recognized seismograph and natural gas equipment frequently leave WPA roads and may be spreading weeds picked up from previous, non-local travel through infested sites. Ranchers also noted their own activity may be assisting invasion. Cattle shipments and livestock movement from “weedy” areas into weed-free rangeland were recognized as pathways where weed seeds may be transported in mud on the feet of livestock or through digestion. Ranchers also acknowledged wildlife may facilitate invasion. Transport by deer might explain the pattern of invasion on the Northside WPA map where leafy spurge is moving up the draws from the Yellowstone River. Blaine County ranchers noted leafy spurge and Russian knapweed plants were introduced

from contaminated crop seed or harvesting equipment. They noted they find houndstongue along cattle trails. And they found Dalmatian toadflax, whitetop, diffuse knapweed, and spotted knapweed most frequently along roadsides.

Exclusion and detection strategies identified by the ranchers included requesting weed-free material or closely monitoring sites for new weeds where at-risk material was used. Along with other strategies that included regulating hunter activity, ranchers requested a portable wash station to interrupt weed introductions from hunter vehicles. They note a portable wash station could also be used for educational purposes. The ranchers have elected to adopt travel restrictions consistent with USDI – Bureau of Land Management (BLM) policies so hunters will understand off-road restrictions are consistent throughout the WPAs. In this way, the landowners can assist each other so enforcement of violators can be done by neighbors. They also wanted to require strong prevention strategies be implemented by the oil and gas companies working in WPAs. To interrupt weed movement from cattle, ranchers elected to hold livestock in an easily accessible “sacrifice” pastures for five to seven days prior to release into weed-free rangeland. This pasture should then be monitored for new weeds each year. When sacrifice pastures are not available, the ranchers opted to feed weed-free hay to cattle prior to movement into the WPA. They are also designating “clean-out areas” to interrupt weed movement from shipping trailers.

Range Rider Findings: WPA Inventories

A total of 1,068 isolated weeds and small, eradicable patches were located within the 998,400 surveyed acres. Table F-2 provides a list and number of new weed locations detected. Maps of the WPA inventories are provided in Appendix A.[10] The presence of 1,068 weed features may imply these WPAs are not truly “weed-free.” However, after each weed point was amplified to the size of an acre, these 1,068 simulated acres are only 0.001% of the total 998,400 surveyed acres. For practical purposes, therefore, we maintain that these areas are fundamentally weed-free because the overall area invaded is so small. Most importantly, their quality ecological status will be improved as the invasions are eradicated, while it is still feasible to do so.

[10] NOTE: This use of Appendix A refers to original document and not to this PWTB.

Table F-2. Summary of new weed invasions detected by range riders.

WPA County Location	Spotted Knap-weed	Russian Knapweed	Diffuse Knapweed	Leafy Spurge	White Top	Hounds Tongue	Oxeye Daisy	Total
Liberty	10	0	14	0	0	0	0	24
Hill	116	12	0	3	0	0	0	131
Blaine	15	0	0	22	0	315	0	352
Teton	169	2	0	65	2	1	2	241
Prairie	0	0	0	320	0	0	0	320
TOTAL	310	14	14	410	2	316	2	1,068

County-Level Findings: Range Rider Project Improvements

County coordinators and Extension agents recognized project improvements were needed. These improvements included less “indirect” rancher contact through mailings and more direct, personal contact either in person or with phone calls. This improvement was noted as a result of low response rates from recent letters requesting rancher information. Project improvements also included the implementation of more meetings and GPS training opportunities for ranchers. More meetings would be beneficial to continue dialogue and gather rancher feedback in a group setting on what else we could be doing to help them. Additional meetings would also work to further document their ideas and exchange information. Many ranchers cannot afford the time to attend additional meetings. But even if a small group gathers, they may benefit and provide direct promotion by talking to their neighbors about the project. Additional GPS training workshops would encourage more use of GPS technology to map new weeds and improve rangeland operation management. A small percentage of WPA ranchers are using GPS, with the number slowly increasing each year, as they see how their neighbors are implementing it. This technology, however, is still novel for many ranchers and they prefer to rely on their range rider to help them. Range riders downloaded GPS data from seven rancher GPS units and provided on-site GPS refresher training to four ranchers during the project period. Ranchers acknowledge monitoring for new weeds is crucial, but they also recognized they are unable to adequately monitor for weeds by themselves. Ranchers are grateful for the monitoring and mapping assistance

provided by range riders. They have expressed to their county weed leaders they were very pleased their range rider was able to scout land they had intended to do, but could not find the time. The technical services provided to ranchers by range riders are working to build lasting relationships that aim to facilitate rancher adoption of prevention stewardship and long-term maintenance of healthy rangeland ecosystems.

Conclusion

Places still exist where prevention and local eradication remain viable options. Weed prevention areas (WPAs) work as coordinated, early intervention mechanisms that permit timely response to invasions in rangelands prioritized for prevention. We aim to improve rapid response performance in WPAs, improve rancher awareness, and facilitate rancher adoption of prevention stewardship with range riders. These technical service providers promote communication between the county- and local-level, increase rancher awareness of the importance of early control, collect rancher knowledge and identify local-level prevention needs, provide monitoring assistance to ranchers, generate native and invasive plant inventories, and assist ranchers with GPS technology.

Range riders were deployed in six WPAs during 2005 and 2006. They collectively worked 3,660 hours, provided on-site ranch visits to 66.5% (SE 11.4) of the 237 participating WPA ranchers, and surveyed 60.3% (SE 7.26) of the 1,700,000 WPA acres. A total of 1,068 isolated weeds and small, eradicable patches were located. The range riders collected site-specific rancher knowledge on weed spread and gathered rancher input and project impressions during on-site ranch visits. This information was recorded and will be shared with other ranchers during landowner meetings and disseminated in publications and presentations. This range rider project was most recently presented as a WPA component at the 2006 Western Society of Weed Science annual meeting (Goodwin and Sheley 2006). Project improvements include more direct contact with ranchers, additional landowner meetings, and more GPS training opportunities. This rancher-designed, on-the-ground program has been very well received by ranchers. They appreciate both the personal contact and technical services provided by range riders. Ranchers are pleased with this program and have indicated they want it to continue.

Fact Sheet Example

An example of factsheet used by the Range Rider program.

WATCH OUT *for* Yellow Starthistle

by Kim Goodwin, Montana State University
& Dave Burch, Montana Dept. of Agriculture

Invasive weeds are non-native plants that invade ecosystems and replace native plants. Noxious weeds are usually invasive and designated by State law as priority plants that require control by landowners. These weeds can reduce grazing land and impact wildlife habitat. Early detection and quick response is critical to slow spread and protect weed-free areas. The purpose of this bulletin is to provide early control methods for yellow starthistle (*Centaurea solstitialis*).

This plant is a new invader to Montana and requires immediate action. If starthistle is found, immediately contact your county weed coordinator before initiating control.

Yellow starthistle (Sunflower Family) is a winter annual with a deep taproot. It is native to the Mediterranean region and was introduced to North America in contaminated seed. Flowers are bright yellow and located singly at the ends of branches. Flowers have sharp, straw-colored spines, up to 2 inches long, surrounding the base and radiating in a star shape. Stems are rigid and appear winged due to extending leaf bases. The stems of yellow starthistle are covered with cottony hairs giving a whitish appearance. Mature plants are usually 2 to 3 feet tall.

Habitat and impacts

Yellow starthistle favors disturbed sites like roadsides, ditches, waste areas, and overgrazed rangeland. When site conditions are ideal, this plant can invade excellent condition rangelands. Starthistle requires at least 10 inches of annual precipitation that peaks in winter or spring. This plant will establish on deep, well-drained soils and shallow, rocky soils. Yellow starthistle does not tolerate shade. It requires light on the soil surface for rosette and taproot development.

This weed is a serious invader. It infests over 10 million acres in California and occupies large areas in Idaho, Oregon, and Washington. Starthistle appears to be moving north and eastward. Starthistle has been reported in 8 Montana counties since 1958. New invasions were detected early and immediately eradicated. Current trends indicate yellow starthistle will continue to invade Montana. To stop spread, it is important to anticipate invasion and detect new plants early as they invade.

Biology and spread

Yellow starthistle is a rapid colonizer. It germinates quickly under most conditions. Seeds germinate in the fall and overwinter as seedlings. Rosettes form during early spring and bolt during late spring. The plants flower and produce seeds in June through August, and then lose their leaves and dry in early fall. With fall rains, seeds begin germination and the cycle is repeated. Seedbank development and a long seed life make this plant extremely difficult to control. It is important to locate new invasions prior to reproduction and seedbank development.

Photo by B. Burch (TNC)

Yellow starthistle is adapted to open grasslands. It is expanding in rangelands by about 27,000 acres anually in the western United States.

Yellow starthistle reproduces by seed. A typical plant may produce about 120 seeds. Seed viability varies with depth of burial, but may last more than 10 years. Starthistle produces plumed and plumeless seeds. Plumed seeds are parachute-like and dispersed by wind. Plumeless seeds are retained in the seed head until it disintegrates in the fall or winter. Most plumeless seeds fall within a couple feet of the parent plant. Seeds are spread to new sites in mud on boots and impure materials like mulch, forage and feed grains, crop and grass seed, top soil, and gravel. Seeds can also be transported long distances by livestock shipments, vehicles and agriculture and construction equipment.

Early control methods

Yellow starthistle is a priority for immediate eradication. Contact you county weed coordinator before applying management. Herbicides are the recommended method and most effective when applied from the rosette to the early bud stage. Hand pulling can be effective and may augment herbicide treatments. Follow-up management ensures overlooked plants are removed to prevent reinvasion. Herbicide selection and timing should be advised by your county weed coordinator and application must follow label directions. Effective herbicide treatments on sites distant from surface or ground water follow. Include surfactants to improve herbicide performance.

- Clopyralid + 2,4-D (Curtail®) applied at a rate of 2 to 4 quarts/acre.
- Clopyralid + triclopyr (Redeem®) applied at a rate of 1 quart/acre.
- Dicamba (Banvel®) applied at a rate of 1 pint/acre plus 2,4-D at a rate of 2 pints/acre.
- Picloram (Tordon®) applied at a rate of 1 to 2 pints/acre plus 2,4-D at a rate of 1½ pints/acre.
- Aminopyralid (Milestone®) applied at a rate of 3 to 5 ounces/acre.

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Photo by C. Roche

Plumed (above) and plumeless (below) seeds of yellow starthistle allow for versatility of dispersal and greater access to a variety of habitats.

Prevent starthistle invasion by using weed-free mulch, forage and feed grains, crop and grass seed, top soil, and gravel. Monitor sites for new weeds where at-risk material was used. Encourage outdoor users to clean equipment, remain on trails, and report new invasions. Ensure roadsides are frequently monitored as roads influence quick and distant spread of new invaders.

If you find yellow starthistle, contact your county weed coordinator or Extension agent and the Montana Department of Agriculture at (406) 444-5400.

APPENDIX G:

REFERENCES AND RESOURCES

References Cited or Reproduced in this Document (as updated for this PWTB)

BLM (Bureau of Land Management) of California. 2008. *Weed Prevention and Management Guidelines for Public Lands.* Washington, DC: US Department of Interior. Available online at: http://www.blm.gov/ca/st/en/prog/weeds/weedprevent.html.

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Weldy, Troy. 2008. "Invasive Species Management on Military Lands," Chapter 7 from *Conserving Biodiversity on Military Lands: A Guide for Natural Resources Managers.* Arlington, VA: NatureServe (funding by Legacy Resource Management Program). All chapters available at www.dodbiodiversity.org.

"Weed Management Areas," Chapter 11 in *Invasive Plant Management: CIPM Online Textbook (*adapted from BLM Guidelines for Coordinated Mangement of Noxious Weeds). http://www.weedcenter.org.

Annotated Resources for Further Reading (as updated for this PWTB)

The following reports and publications contain recommendations relevant to many aspects of invasive species management.

- Clout, Mick N. and Peter A. Williams (eds.). 2009. *Invasive Species Management: A Handbook of Principles and Techniques*. New York: Oxford University Press.

This publication covers a wide range of species, including aquatic, marine, and terrestrial plants and animals. It is perhaps the best overall reference for initial examination of approaches for an invasive species problem.

- Miller, James H, Erwin B. Chambliss and Nancy J. Lowenstein. 2010. *A Field Guide for the Identification of Invasive Plants in Southern Forests*, General Technical Report SRS-119. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station.

While the term "Southern Forests" is used here, the value is far beyond that part of the United States, since many of the species in question are found throughout the eastern half of the country. It is illustrated in color to help with identifications and awareness training. This identification guide is a companion to the management guide below. It is available at http://www.srs.fs.fed.us/pubs/gtr/gtr_srs119.pdf.

- Miller, James H., Steven T. Manning and Stephen F. Enloe. 2010. *A Management Guide for Invasive Plants in Southern Forests*, General Technical Report SRS-131. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station.

This is an impressive, illustrated guide to development of invasive species management plans. It includes discussion of both mechanical and chemical control methods, and has species-specific guidance for 56 of the most common species considered invasive in the southeastern quarter of the United States. Many of these species are also found in other regions, however, so the application of these principles is much broader than the title suggests. The sections on equipment selection and safety

precautions are applicable in all regions. It is available at http://www.srs.fs.fed.us/pubs/gtr/gtr_srs131.pdf.

APPENDIX H:

ACRONYMS AND ABBREVIATIONS

Abbreviation	Spelled Out
ACUB	Army Compatible Use Buffer
AFPMB	Armed Forces Pest Management Board
ANS	Aquatic Nuisance Species
AOP	Annual Operating Plan
AR	Army Regulation
BLM	Bureau of Land Management
CCA	Candidate Conservation Agreement
CECW	Directorate of Civil Works, US Army Corps of Engineers
CEMP	Directorate of Military Programs, US Army Corps of Engineers
CERL	Construction Engineering Research Laboratory
CIPM	Center for Invasive Plant Management
CWMA	Cooperative Weed Management Area
DPW	Directorate of Public Works
DoD	Department of Defense
DODI	Department of Defense Instruction
EO	Executive Order
ERDC	Engineer Research and Development Center
GIS	geographic information system
GPS	global positioning system
HQUSACE	Headquarters, U.S. Army Corps of Engineers
INRMP	Installation Natural Resource Plan
ISMC	Invasive Species Management Component
IWM	Integrated Weed Management
NAD	North American Datum
NGO	non-governmental organization
NISC	National Invasive Species Council
NRIS	Natural Resource Information System
POC	point of contact
PWS	performance work statement
PWTB	Public Works Technical Bulletin
SERDP	Strategic Environmental Research and Development Program
SOW	statement of work
USACE	US Army Corps of Engineers
USDA	US Department of Agriculture
USFS	US Forest Service
UTM	Universal Transverse Mercator
WGS	World Geodetic System
WMA	Weed Management Area