Field Release of a Nonindigenous Leaf Beetle, *Diorhabda elongata* (Coleoptera: Chrysomelidae), for Biological Control of Deciduous Saltcedar, *Tamarix ?ramosissima* and *T. parviflora* (Tamaricaceae)

Environmental Assessment--Final Draft

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I. Description of the Proposed Action

The United States Department of Agriculture--Animal and Plant Health Inspection Service (APHIS) has received an application (Appendix 1) from the USDA--Agricultural Research Service (ARS) for a permit to release a nonindigenous leaf beetle, *Diorhabda elongata* Brulle (Coleoptera: Chrysomelidae). This insect defoliates deciduous saltcedar, *Tamarix ?ramosissima* Ledeb. and *T. parviflora* DC. (Tamaricaceae), introduced trees that grow in dense stands along waterways in 15 western States. The species identity of deciduous saltcedar in the desert Southwest is still a point of controversy among taxonomists. This environmental assessment (EA) follows the precedent of DeLoach (1994) in the use of the name *T. ?ramosissima*, although a question mark has been placed before the trivial name to indicate uncertainty. Throughout this document the term "saltcedar" refers to both *T. ?ramossisima* and *T. parviflora*.

The applicant proposes initially to transfer *D. elongata* from an insect quarantine facility into secure insect cages at a total of eight sites in four states, California, Nevada, Utah, and Wyoming (Appendix 2, map; Appendix 3, table). The cage sides will be constructed of plastic fabric (16 x 16 mesh). The bottoms will be nailed between 1"x 4" boards and buried in the ground (any equally secure method of sealing bottoms may be substituted). The corners will be guyed securely to stakes. A fence constructed of five-strand barbed wire attached to metal posts will surround each cage to prevent damage from livestock and large, native mammals.

Cage studies will be conducted during the first year to allow researchers to determine whether or not the beetle consumes saltcedar so rapidly that its spread might pose a risk to nesting habitat of an endangered species, the southwestern willow flycatcher (*Empidonax traillii extimus*). At certain sites in Arizona and Nevada the flycatcher nests in saltcedar where the weed has replaced native willow trees. All study sites are located at least 185 miles from the flycatcher's nesting areas. If the beetle is determined to be environmentally safe, cages will be removed during the second year to allow beetles to move from one part of the site to another. However, ARS and its cooperators will not distribute the beetle to other sites until ARS completes a separate consultation with the U. S. Fish & Wildlife Service. If the released beetles appear to be unsafe (i.e., if they consume saltcedar too rapidly), their spread will be slowed through applications of insecticides, herbicides, or mechanical controls.

The pending application was submitted in accordance with the Federal Plant Pest Act (7 USC 150aa *et seq.*). This EA was prepared in compliance with the National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*) as described in implementing regulations adopted by the Council on Environmental Quality (40 CFR 1500-1509), by USDA (7 CFR 1b), and by APHIS (7 CFR 372).

II. Purpose of and Need for the Proposed Action

Throughout this EA, most factual statements lacking explicit literature citations were drawn from DeLoach (1991, 1997). Statements drawn from primary sources are documented in standard format.

In 1960 the area covered by saltcedar was estimated to be 900,000 acres, and the projected estimate for 1970 was 1.3 million acres. These figures are only approximate and have been disputed. However, in 1998 the infested area probably approached, or even exceeded, a million acres. Along many water courses saltcedar now constitutes half or more of the total vegetation. Saltcedar is less desirable than native vegetation for the following reasons:

- *Low value for recreational land use.* Dense stands of saltcedar are inaccessible to campers, hikers, and picnickers. Projecting tree limbs create boating hazards.

- *High use of groundwater.* In studies reviewed by DeLoach, dense infestations of saltcedar extracted up to five feet of water annually. Most assemblages of native plants use much less, and water depletion greatly increases when saltcedar invades bare riverbanks.

- *Increased fire hazard.* Saltcedar, a decidous plant, deposits much combustible material on the ground each winter. Some infestations are swept by fires every few years, and bird nests and any animals that cannot escape are destroyed.

- *Low biodiversity.* Several studies indicate that rodent density, bird density, and bird species diversity are lower in riparian saltcedar infestations than in riparian communities of native plants (Anderson *et al.*, 1977; Anderson and Ohmart, 1982, 1985; Engel-Wilson and Ohmart, 1978). Saltcedar produces relatively little edible food for birds and mammals. It some places it has eliminated small streams and standing pools of water required by wildlife, including bighorn sheep. It increases salinity of upper soil layers, in some cases inhibiting germination of native plants. In some areas saltcedar stands are swept by fires every few years, and bird nests and any animals that cannot escape are destroyed.

- *Poor value as a forage plant for livestock.* Monotypic stands of saltcedar provide less nutritious forage than plants in natural communities.

- *Flooding of streams.* According to some authorities, saltcedar causes flooding either by blocking channels directly or by increasing the deposition of silt.

III. Alternatives to the Proposed Action

The "no-action" alternative to releasing *D. elongata* is to take no control actions, in which case the weed will continue to spread and reoccupy limited areas where is now under control. Other control measures are chemical control, mechanical control, burning, and controlled flooding.

IV. Environmental Impacts of the Proposed Action and Alternatives

A. No action.

If saltcedar is allowed to spread uncontrolled, it will displace more native plant communities and depress populations of native plants and animals, possibly including endangered species such as the peninsular bighorn sheep (*Ovis canadensis cremnobates*). Saltcedar will reoccupy some wildlife refuges such as Bosque del Apache in New Mexico. Dense stands of saltcedar along river banks in many western and southwestern states will continue to consume large volumes of water needed for irrigation and urban use.

B. Mechanical and chemical controls.

Mechanical controls include uprooting entire stands of plants with a bulldozer. This method is effective in the short term because uprooted trees do not resprout, but its high expense limits its use, and seeds arriving from upstream may quickly recolonize cleared areas. Of course, all native plants in a bulldozed area are destroyed. Another mechanical means of control is sawing which removes shoots one at a time. Chemical treatment of sawed stumps is necessary to prevent the stumps from resprouting. This combination of mechanical and chemical controls is effective in the short term but, like bulldozing, is expensive and often only temporary since seeds may soon reinvade cleared areas. Chemical controls alone (i.e., aerial spraying with herbicides) are generally low-cost but have the adverse effect of killing native plants. Applications of large quantities of herbicides to stream banks may kill aquatic organisms for many miles downstream. Chemicals tend to be ineffective because some saltcedar plants quickly resprout. Also, young saltcedar plants may quickly invade areas cleared of saltcedar by chemicals.

C. Burning and chemical controls.

Burning is inexpensive but of limited usefulness when used alone because burned trees quickly resprout from the crown. Sprouts may be killed with herbicides, but as in the case of mechanical control and control by a combination of mechanical and chemical means, seeds may soon reinvade cleared areas.

D. Flooding.

Managed flooding can effectively control saltcedar on a long-term basis, but the necessary prolonged submersion kills native plants that are needed to replace saltcedar infestations. Repeated flooding is necessary to kill saltcedar seedlings that are rapidly established from windblown seeds. In any case, conditions suitable for flooding exist only in relatively small areas such as highly managed wildlife refuges.

E. Biological control with *D. elongata*.

1. Impacts on the target weed.

Intended impacts. The intended environmental impacts of the proposed action are a reduction in density of saltcedar stands over large areas and the return of native plant and animal communities.

Actual impacts. The actual level of control cannot be predicted even approximately because it depends upon innumerable details in the biology of the control agents, the agents' interactions with the host plant, and the responses of the agents and host plant to climatic and edaphic factors. Given the historical success rate of biological control of weeds projects (*ca.* 30%), releases of biological agents may not produce significant control. However, it should be pointed out that chances of successful biological control increase with each additional species that is released, and saltcedar has many natural enemies in Asia that could be introduced into the United States. Because of the weed's great importance, 50% control would no doubt be considered a major success. Even higher levels of control are entirely possible but perhaps less likely given the enormous regenerative powers of the weed and the size and ecological diversity of the infested area (desert valleys to mountain slopes up to 3,000 feet in elevation in fifteen western states). If the level of control is significant, ornamental plantings of saltcedar might be damaged by releases of *D. elongata*, but saltcedar comprises only 0.24% of all shade trees in a large area of the desert Southwest.

D. elongata is adapted to arid and semi-arid regions that undergo wide temperature fluctuations. Hence, it may spread throughout a large area of the western United States wherever saltcedar infestations occur.

Rate of spread. Rate of spread cannot be predicted accurately, but other chrysomelid beetles such as *Aphthona* spp. (biological control agents for leafy spurge), *Galerucella* spp. (biological control agents for purple loosestrife), and *Ootheca bennigseni* (Hennessey, 1999) appear to spread relatively slowly at a maximum of several tens of meters per year.

2. Direct impacts on non-target plants.

The proposed introduction of a nonindigenous, plant-feeding insect into the United States raises the question of environmental safety because the agents might conceivably feed on nontarget plants. The U. S. Fish and Wildlife Service has issued a letter of concurrence (Appendix 4, concurrence; Appendix 5, amendment to concurrence); hence, no significant adverse impacts on threatened or endangered species are expected.

The following lines of evidence indicate that *D. elongata* are safe to release:

Field surveys. Surveys in China, Kazakhstan, and Turkmenistan revealed only saltcedar and a few other species of *Tamarix* as hosts for *D. elongata*.

Literature records. In the scientific literature *D. elongata* has been reported only from saltcedar and a few other species of *Tamarix*.

Plant geography. No members of the family Tamaricaceae are native to the United States. The absence of close relatives of the target species in the United States greatly reduces chances of attacks on nontarget species.

Seven species of *Tamarix* are used occasionally as ornamentals in the southeastern United States, six of which are naturalized (*T. gallica*, *T. ramosissima*, *T. canariensis*, *T. africana*, *T. tetragyna*, *T. parviflora*) (Crins, 1989). *T. mascatensis* is cultivated but not naturalized. It is unlikely that *D. elongata* would spread into the Southeast because the species has not been reported in similarly humid areas of Asia. In any case, undesirable stands of naturalized *Tamarix* would be more at risk than individual garden trees and *Tamarix* species have only minor value as ornamentals.

Laboratory tests. The selection of test plants is the first, and in some ways the most important, step in conducting laboratory tests of host specificity. Plants closely related to the target weed are tested most thoroughly because they are most likely to be attacked. Members of the same subgenus are the most closely related. Members of different subgenera within the same genus are more distantly related. Members of different genera within the same tribe are still more distantly related, and members of different tribes within the same family are even more distantly related. Plants in different families are very remotely related. Since saltcedar is not related at the family level to any native U.S. species, it was not possible to include such species in host specificity tests. However, several exotic species of *Tamarix* were tested.

In the first series of laboratory tests (Appendix 6) conducted in the United States and China, *D. elongata* larvae strongly preferred certain species of *Tamarix* over others. Larvae fed much less on *T. aphylla* (athel), an ornamental species in the southwestern United States, than on saltcedar. Both adults and larvae strongly preferred certain clones of *T. ramossissma* over others, a preference suggesting a high degree of host specificity (DeLoach, 1997). Feeding damage was noted on *Frankenia johnstonii*, an endangered species of Frankeniaceae in the order Violales, but fewer than 2% of tested larvae developed to the adult stage and the adults were deformed and unable to reproduce. *F. johnstonii* grows in different habitats than saltcedar. As indicated previously, the U. S. Fish and Wildlife Service issued a statement of concurrence.

In the first series of tests larvae of *D. elongata* did not feed upon 26 species of test plants representing 18 families in seven orders. Later, eight species of economic plants in the Asteraceae, Cucurbitaceae, Juglandaceae, Poaceae, Rosaceae, and Vitaceae were tested and also produced negative results.

3. Indirect impacts on wildlife.

In most projects, direct impacts on nontarget plants are the only environmental issue. In the case of saltcedar, however, indirect impacts on wildlife also are an issue because the weed grows large enough to provide habitat. The following discussion primarily concerns non-endangered species since, as already indicated, the U. S. Fish and Wildlife Service has issued a letter of concurrence and no significant adverse impacts on threatened and endangered species are expected.

Three factors must be considered in assessing indirect effects of saltcedar control on wildlife: (a) the level of control, (b) the habitat quality of saltcedar compared to that of native plants, and (c) the extent to which native plants will colonize areas that have been cleared of saltcedar.

a. Level of control. "Control" may mean either a reduction in density or a reduction in infested area. A 50% reduction in the area infested by saltcedar would equate to the clearing of about half a million acres. The level of control cannot be predicted, but assumptions make possible a risk analysis (see p. 8).

b. Habitat quality. Authorities agree that saltcedar generally provides poor habitat compared to native trees and shrubs. Many studies indicate that birds, large and small mammals, reptiles, and insects generally prefer cottonwood (*Populus fremontii*), willow (*Salix* spp.), honey mesquite (*Prosopis glandulosa*), and screwbean mesquite (*P. pubescens*) in pure or mixed stands. Schroeder (1993) found that bird densities in saltcedar along the Mojave River in California averaged only 42% of those in cottonwood/willow/mesquite and that species diversity in saltcedar was 86% of that in the native plant assemblage. Anderson *et al.* (1977) estimated that from December through February in the Lower Colorado River Valley birds were only 28% as dense in saltcedar as in honey mesquite. Figures for other vertebrates (including fish) and insects are generally similar, although a few exceptions have been noted. For example, along the Lower Colorado River Anderson and Ohmart (1977) found that most rodents were about as abundant in saltcedar as in native plants.

Great numbers of whitewing doves (*Zenaida asiatica*) utilize saltcedar as habitat in southern Arizona and the Lower Rio Grande Valley of Texas, but they nevertheless prefer native plants where those are available. In any case, the doves do not fully utilize the saltcedar habitat, and Brown (1989) estimates that their populations would decline only if the level of saltcedar control were to exceed 50%.

Control of saltcedar would result in a loss of pollen and nectar sources for honey bees only if the level of control exceeded 50% and if there were no replacement by native vegetation (Brown, 1989). Saltcedar ranked only seventh in importance to honey production and fourth for colony maintenance in Arizona.

c. Colonization by native plants of areas cleared of saltcedar. Areas cleared of saltcedar can be conveniently grouped in the following categories:

Category #1: Areas in which native shrubs and trees would not grow even before the invasion of saltcedar and which will still be unsuitable for these plants after saltcedar is controlled.

Clearance of saltcedar from category-1 areas can be considered as environmentally justifiable even though impacts on most wildlife would be negative. In this case biological control agents would simply be returning the land to its natural, relatively barren state.

Category #2: Areas in which soil and water conditions formerly supported growth of native shrubs and trees and which will be capable of supporting these plants again after saltcedar is removed.

Revegetation by native plants is expected to benefit wildlife dramatically since, as already indicated, native plants generally are far superior to saltcedar as wildlife habitat. However, the fate of wildlife in any given area will depend on whether or not revegetation actually proceeds. In some areas revegetation is certain to proceed because conditions favor natural revegetation. For example, in the Bosque del Apache Wildlife Refuge situated on the Rio Grande in New Mexico, cottonwood and willow are naturally replacing saltcedar that has been removed mechanically or through controlled flooding. There, animals (especially birds) are returning. In Topock Marsh, an area of 2,000 acres on the Lower Colorado River, conditions appear to suit natural recolonization by mesquite (USDI Bureau of Reclamation, 1995).

Areas unsuitable for natural revegetation may be revegetated artificially. In the Bosque del Apache Wildlife Refuge, wildlife populations and species diversity are increasing as artificial plantings of cottonwood and willow replace saltcedar. Several other agencies and organizations have conducted pilot projects in revegetation with varying results. All of these projects should be seen as mitigation measures for any negative impacts of saltcedar biological control. However, it is uncertain how much area will actually be revegetated artificially. The main limitation is expense: Artificial revegetation may cost as much as $2,260/acre (USDI Bureau of Reclamation, 1995), and the area to be planted is very large, many tens of thousands of acres at the least.

Anderson (1995) cautions that in many areas unless revegetation is done intensively (and therefore expensively), the resulting stands of native vegetation may be inferior to saltcedar for at least five years. On the other hand, weed-control over the vast area being contemplated (15 states) implies time-scales much longer than five years.

Category #3: Areas in which soil and water have become so saline (mostly because of the construction of dams) that native shrubs and trees will no longer grow.

In many areas of the desert Southwest, soils have become too saline and/or too dry to support the growth, or regrowth, of native shrubs and trees. Control of saltcedar in these areas will therefore have a negative impact on wildlife.

Dams are acknowledged as the major cause of salinification in the desert Southwest. Dams deprive streams, rivers, and lakes of the naturally fluctuating water levels needed to wash away accumulated salts. Hence, salinification is generally increasing. For example, in the Salt Creek area near Mecca, California, electrical conductivity (a measure of soil salinity) increased at an average rate of 0.6% annually from 1942 through 1992 (Anderson, 1995).

In principle, the amount of land suitable for native vegetation could be estimated by measuring (1) salinity of the surface soil, (2) salinity of the soil at a depth of about six feet, (3) the depth of the water table, (4) soil moisture content, and (5) soil type (clay, sandy loam, etc.). Of course, the more data that are available, the more reliable will be the assessment of suitability. Unfortunately, the entire scientific literature on this subject is based solely on samples that were analyzed for only three, two, or even one of the relevant parameters. Furthermore, data have been collected very unevenly over the broad geographic distribution of saltcedar. Most studies have centered on the desert Southwest where concern about soil salinity has been greatest, but even there sampling has been uneven. Conclusions about revegetation, therefore, are necessarily somewhat speculative.

The broadest studies were conducted by Anderson (1995) who worked in a total of nine areas of seven drainages located within an 850-mile-long area of southern California, Arizona, New Mexico, and Texas. Measurements were made of surface soil salinity, deep-soil salinity, and depth to the water table. Only 28% of 3,465 samples were suitable for cottonwood and willow, 46% for honey mesquite, 59% for screwbean mesquite, and 79% for saltcedar (these results take into account the limited geographic distributions of the two mesquite species). These percentage figures for sample numbers are not, of course, exactly equivalent to land areas, but the correlation probably is reasonably high, especially considering the large numbers of samples and the widely scattered locations. Anderson cautions that low soil moisture is common, and that 50-75% of the sites that were within the salt-tolerance limits of cottonwood and willow may have been too dry to support long-term survival of those species.

Anderson's dim view of prospects for revegetation is both brightened and complicated by an unusual facet of saltcedar biology: The weed itself salinifies the soil, and in some areas the salinification is reversible. Leaves accumulate salts while they are still attached to the tree, then drop to the ground freeing their salts into the soil. Where hydrologic conditions permit, rains and flooding may leach the salts away after saltcedar is removed and permit the return of native plants. However, in saltcedar-infested areas it is not always clear what proportion of the salinification is attributable to the weed versus other causes. Soils that are highly saline because of conditions other than the presence of saltcedar will remain so even after saltcedar is removed, and in such areas no native plants will be able to succeed the saltcedar.

The accumulated data on the subject of salinification and revegetation, although considerable, still do not support reasonably accurate predictions of the long-term impact of saltcedar control in large areas of the desert Southwest. However, it is possible to predict net impact given different assumptions about the values of important variables (a technique termed "sensitivity analysis"). The assumptions were (a) the level of control will be 20% or 50%, (b) the proportion of cleared land that will be revegetated with native plants is 20%, 50%, or 80%, and (b) native plants have 2 or 3 times the wildlife value of saltcedar (Appendix 7). Six combinations of assumptions resulted in a net gain for wildlife, four resulted in a net loss, and two resulted in no change. The greatest net gain was +70%, and the greatest net loss was -30%.

Although the sensitivity analysis assumed an unchanging area of infestation (estimated at roughly one million acres), the area is in fact increasing. Furthermore, some newly infested areas are ecologically precious, natural (i.e., hydrologically unaltered) stream beds in the California deserts. As saltcedar invades these stream beds, it replaces native plants and animals. If saltcedar is allowed to advance in California and other states, endangered species such as the desert pupfish (*Cyprinodon macularius*), the desert slender salamander (*Batrachoseps aridus*), the peninsular bighorn sheep, Preble's Meadow jumping mouse (*Zapus hudsonius preblei*), and the Yuma clapper rail (*Rallus longirostris yumanensis*) may be pushed further toward extinction. Other species such as the California black rail (*Laterallus jamaicensis coturniculus*) that are not yet endangered may become less common.

4. Mitigation of impacts on the southwestern willow flycatcher and possible impacts on other threatened and endangered species.

At the request of other agencies, ARS will adopt measures to mitigate risks that *D. elongata* might spread rapidly from its first release sites, invade nesting areas of the southwestern willow flycatcher, and kill saltcedar plants faster than native plants can regenerate. It should be emphasized that this chain of events is highly improbable. Chrysomelid beetles typically disperse at a rate of several tens of meters per year, far too slowly to rapidly invade flycatcher nesting areas 185 to 650 miles away. As the beetles reach new areas, they will almost certainly require at least several years to build their populations high enough to noticeably damage mature saltcedar plants. And even after damage becomes noticeable, it is expected that mature stands of saltcedar will be thinned only very slowly allowing native plants time to regenerate. Generally, plants compensate for insect damage, and the primary variable controlling the capacity to compensate is the availability of water. Biological agents are extremely unlikely to achieve rapid control of a weed such as saltcedar that becomes extremely large (i.e., several meters tall), develops a deep, extensive root system, and grows along water courses. Saltcedar seedlings with their undeveloped root systems may well sustain early, severe damage from *D. elongata*, but of course flycatchers do not nest in seedlings.

Caging the beetles during the first year is the first step of the mitigation plan. Monitoring release sites and, if necessary, manipulating them to slow the early spread of the beetle are the subsequent steps. Possible means of manipulation include treatment with herbicides or insecticides, cutting, bulldozing, and burning. The exact means used would depend on the size of the area occupied by the beetles, beetle population density, time of year, and type and density of wildlife. Given the extreme improbability of rapid biological control of mature saltcedar plants and the complex of factors that would determine the choice of mitigative control measures, it is not necessary or possible to develop a detailed control plan at the beginning of the project. If a release permit is issued, it will include monitoring and treatment plans as conditions but not specify details.

As already indicated, the U. S. Fish and Wildlife Service has issued a letter of concurrence and amendment; hence, no significant adverse impacts on threatened or endangered species are expected.

The outline of a complex monitoring plan has been developed to detect early signs of adverse environmental impacts (Appendix 8). Details of the plan are not necessary or possible at this early juncture, but given the requirements of FWS, the long history of financial support of this project, and intense interest by Federal and state agencies and special districts, there is every reason to believe that development of the plan will continue apace.

The biological characteristics of *D. elongata* preclude any adverse effects on human health. The beetles are not toxic, nor do they possess allergy-producing scales as some moths do. Furthermore, chrysomelid beetles are not known to create a nuisance by invading houses as do some lady beetles such as *Harmonia axiridis*.

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VI. List of Preparators, Consultants, and Reviewers

This environmental assessment was prepared by **Ronald Hennessey**, USDA--APHIS, Riverdale, MD. The document was reviewed by **Charles Bare; Charles Brown; Robert Flanders**, Ph.D.; **Kenneth Lakin**, Ph.D.; **Polly Lehtonen; Sivrimiah Shantharam**, Ph.D. (all at USDA--APHIS, Riverdale, MD); **Julio Medal**, Ph.D., University of Florida, Gainesville.

The following members of the technical advisory group (TAG) on biological control of weeds reviewed the initial release petition submitted by the applicant and recommended that APHIS issue a release permit: **Alfred F. Cofrancesco**, U. S. Army Corps of Engineers, Vicksburg, MS; **Jack R. Coulson**, USDA--ARS, Beltsville, MD; **James Kryson**, USDA--ARS, Beltsville, MD; **Dale Meyerdirk**, USDA--APHIS, Riverdale, MD; **Janine E. Powell**, USDA--Forest Service, Washington, DC; **James G. Saulmon**, U. S. Environmental Protection Agency, Washington, DC; **David Sisneros**, U. S. Bureau of Reclamation, Denver, CO; **Charles E. Turner** (deceased), USDA--ARS, Albany, CA; **B. D. Wright**, Oregon Department of Agriculture, Salem, OR.

VII. Appendices

Appendix 1: Application for a permit to release *Diorhabda elongata* in the United States.

Appendix 2: Proposed release sites for *Diorhabda elongata* (map).

Appendix 3: Proposed release sites for *Diorhabda elongata* (table).

Appendix 4: Letter of concurrence, U. S. Fish & Wildlife Service.

Appendix 5: Amendment to letter of concurrence, U. S. Fish & Wildlife Service.

Appendix 6: Plants used for host-range testing of *Diorhabda elongata* at Temple, Texas.

Appendix 7: Impacts of saltcedar control on wildlife value of riparian habitat.

Appendix 8: Monitoring plans.

Appendix 1: Application for a permit to release *Diorhabda elongata* in the United States.

FORM APPROVED
OMB NO. 0579-0054

CANT

ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE
BIOLOGICAL ASSESSMENT AND TAXONOMIC SUPPORT
RIVERDALE, MARYLAND 20737

APPLICATION AND PERMIT TO MOVE LIVE PLANT PESTS OR NOXIOUS WEEDS

TYPE OF PEST TO BE MOVED

☐ Pathogens [X] Arthropods ☐ Noxious Weeds

☐ Other (Specify): ____

his permit does not authorize the introduction, importation, interstate movement, r release into the environment of any genetically engineered organisms or roducts.

1. NAME, TITLE, AND ADDRESS (Include Zip Code)

Pat Fosse
USDI - Bureau of Land Management
35 East 500 North
Fillmore, Utah 84631

2. TELEPHONE NO. (   )

A. SCIENTIFIC NAMES OF PESTS TO BE MOVED	B. CLASSIFICATION (Orders, Families, Races, or Strains)	C. LIFE STAGES IF APPLICABLE	D. NO. OF SPECIMENS OR UNITS	E. SHIPPED FROM (Country or State)	F. ARE PESTS ESTABLISHED IN U.S.	G. MAJOR HOST(S) OF THE PEST
Diorhabda elongata (Brulle)	Coleoptera	Adults	3,000	Texas	No	Tamarix
	Chrysomelida	Eggs	3,000	Texas	No	Tamarix
		Larvae	2,000	Texas	No	Tamarix

. WHAT HOST MATERIAL OR SUBSTITUTES WILL ACCOMPANY WHICH PESTS (Indicate by line number)
Stems of Utah grown Tamarix plants (4, 5, 6)

. DESTINATION
Sevier River near Delta, Utah

9. PORT OF ARRIVAL

10. APPROXIMATE DATE OF ARRIVAL OR INTERSTATE MOVEMENT
June through August

11. NO. OF SHIPMENTS
Up to 10

12. SUPPLIER
USDA/ARS Temple, TX; Albany, CA; Pueblo, CO

13. METHOD OF SHIPMENT
☐ Air Mail [X] Air Freight [X] Baggage [X] Auto

14. INTENDED USE (Be specific, attach outline of intended research)
Biological control of Tamarix research.

15. METHODS TO BE USED TO PREVENT PLANT PEST ESCAPE
Sealed in plastic containers inside sealed cardboard box. Sealed in field cages.

16. METHOD OF FINAL DISPOSITION
Living material remaining aftertests to be separate and killed with ethyl acetate or steam autoclaved. Apply insecticide to soil and leaf litter at cage removal.

17. *Applicant must be a resident of the U.S.A. I/We agree to comply with the safeguards printed on the reverse of this form, and understand that a permit may be subject to other conditions specified in Sections B and C.*

SIGNATURE OF APPLICANT (Must be person named in item 1)
Pat Fosse

18. DATE
6/24/99

SECTION B - TO BE COMPLETED BY STATE OFFICIAL

19. RECOMMENDATION
☐ Concur (Approve) ☐ Comments (Disapprove)
☐ (Accept USDA Decision)

20. CONDITIONS RECOMMENDED

21. SIGNATURE AND TITLE

22. TITLE

23. STATE

24. DATE

SECTION C - TO BE COMPLETED BY FEDERAL OFFICIAL

PERMIT

25. PERMIT NO. 42277

(Permit not valid unless signed by an authorized official of the Animal and Plant Health Inspection Service)

Under authority of the Federal Plant Pest Act of May 23, 1957 or the Federal Noxious Weed Act of 1974, permission is hereby granted to the applicant named above to move the pests described, except as deleted, subject to the conditions stated on, or attached to this application. (See standard conditions on reverse side).

[1] For exotic plant pathogens, attach a completed PPQ form 526-1.

24. SIGNATURE OF PLANT PROTECTION AND QUARANTINE OFFICIAL

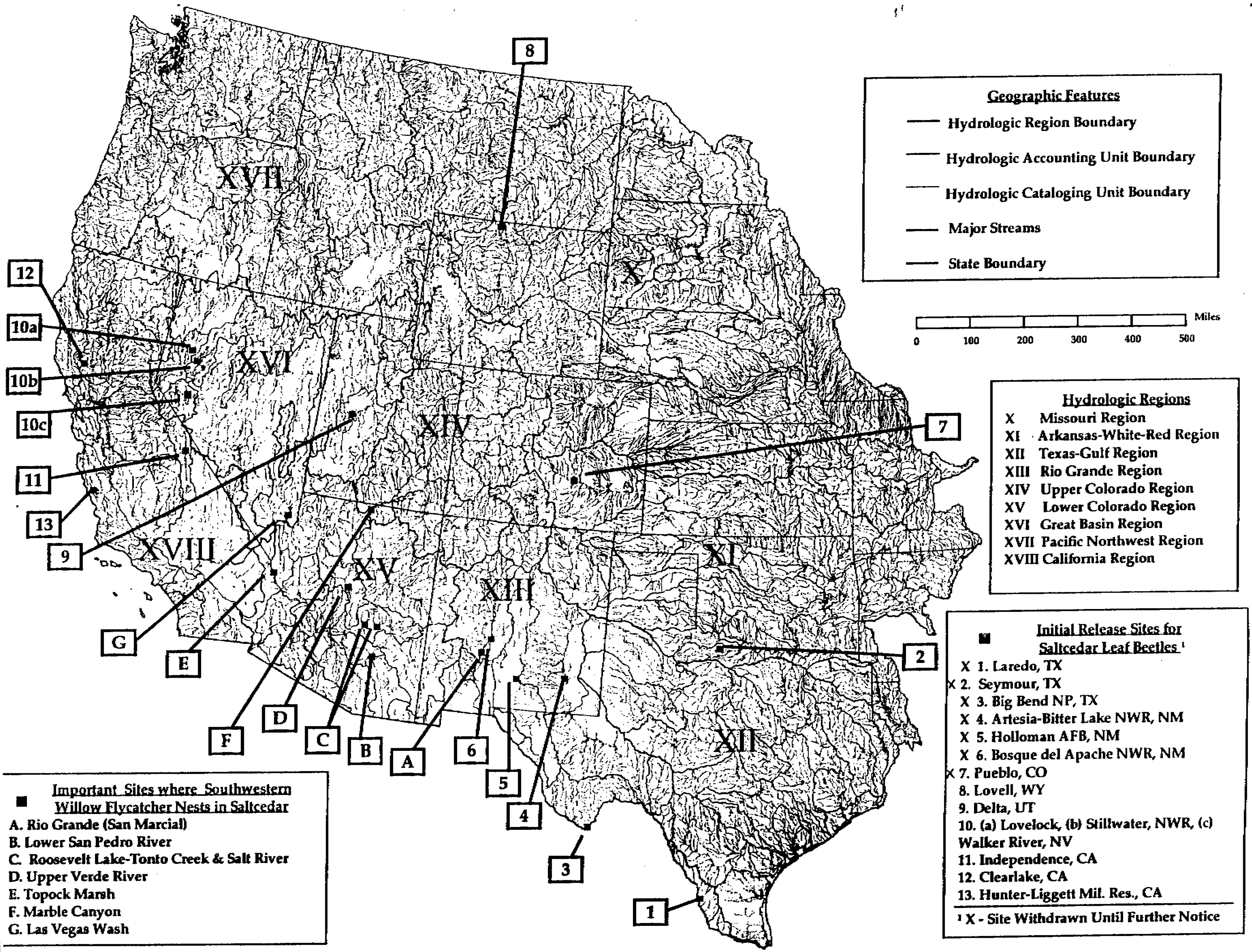
25. DATE

26. LABELS ISSUED

27. VALID UNTIL

28. PEST CATEGORY

Appendix 2. Proposed release sites for Diorhabda elongata (map).



Appendix 3: Proposed release sites for *Diorhabda elongata* (table).

Site No.	Location[2]	Land Owner[3]	USFWS Region	Miles to nearest SW willow flycatcher colony nesting in saltcedar	Monitoring Leads[3]
8	Lovell, WY (Big Horn River)	WY Game and Fish Dept.	6	650 mi to Grand Canyon	I-Kazmer (Univ. WY, Larimie, WY); P-Pomeroy (Bighorn Co. Weed & Pest Cont., Lovell, WY); W- (USGS-BRD?)
9	Delta, UT (Severe River)	USDI-BLM	6	210 mi to Grand Canyon	I- Abott (USDA-APHIS, Richfield, UT)), Gould (USDA-APHIS, Phoenix, AZ); P- Fosse (USDI-BLM, Filmore, UT); W- (USGS-BRD?)
10	Lovelock, NV; Stillwater National Wildlife Refuge; Walker River Paiute Indian Reservation	a) Private, b) USDI-FWS, c) Walker River Paiute Indian Reservation	1	a) 330 mi to Las Vegas Wash (LVW); b) 300 mi to LVW; c) 250 mi to LVW	I-Knight (NV Div. Agric., Reno, NV), Carruthers (USDA-ARS, Albany, CA); P-Young, Palmquist (USDA-ARS, Reno, NV); W- Longland ?
11	Independence, CA (Owens River)	Los Angeles Dept. Water and Power	1	185 mi to Las Vegas Wash	I-Carruthers (USDA-ARS, Albany, CA), Gould (USDA-APHIS, Phoenix, AZ); P-Cashore (Inyo. Co. Wat. Dept., Bishop, CA)
12	Clearlake, CA (Cache Creek)	USDI-BLM	1	450 mi to Las Vegas Wash	I-Carruthers (USDA-ARS, Albany, CA); P-Dudley (Univ. Cal. Berkeley)
13	Ft. Hunter-Liggett Military Reservation, CA (Nacimiento Creek)	USDOD-AR	1	330 mi to Las Vegas Wash	I-Carruthers (USDA-ARS, Albany, CA), P-Dudley (Univ. Cal. Berkeley)

As modified from: DeLoach, C. J. and Juli Gould. 1998. Biological Control of Exotic, Invading Saltcedars (*Tamarix* spp.) by the Introduction of *Tamarix*-specific Control Insects from Eurasia. USDA-ARS and -APHIS-PPQ; Temple, TX and Phoenix, AZ. Proposal to USFWS, 8/28/98.

X = site withdrawn until further notice

I = Insects; P = Plants, W = Wildlife; USDI-BLM, U.S. Dept. Interior, Bureau of Land Management; USDI-BR, U.S. Dept. Interior, Bureau of Reclamation; USDI-FWS, U.S. Dept. Interior, Fish and Wildlife Service; USDI-NPS, U.S. Dept. Interior, National Park Service; USDOD-AF, U.S. Dept. Defense, Air Force; USDOD-AR, U.S. Dept. Defense, Army, USDA-ARS, U.S. Dept. Agric., Agricu.tural Research Service, USDA-APHIS, U.S. Dept. Agric., Animal and Plant Health Inspection Service.

Appendix 4: Letter of concurrence, U. S. Fish & Wildlife Service.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington, D.C. 20240

In Reply Refer To:
FWS/TE

DEC 28 1998

Dr. Carl Bausch
Deputy Director
Environmental Analysis and Documentation
Policy and Program Development/APHIS
4700 River Road
Riverdale, Maryland 20737

Dear Dr. Bausch:

This responds to your request of December 9, 1998, for our review and concurrence with Dr. Jack Deloach's proposed experimental release of biological control agents on saltcedar of August 28, 1998. Saltcedar infestations have significantly diminished fish and wildlife habitat ecological value in the Western United States, particularly riparian ecosystems. The Fish and Wildlife Service is supportive of the utilization of appropriate techniques to deal with this non-native invasive species. Biological control is one technique that when developed and utilized with appropriate safeguards can and has in some instances provided a viable cost effective and efficient weed control.

We have reviewed your proposal to release 2 insects (leaf beetle (*Diorhabda elongata*) and mealybug (*Trabutina mannipara*)) on 13 sites in the Western United States to determine the effectiveness of these insects in controlling saltcedar and measure the response from native riparian vegetation after release from saltcedar encroachment. Your proposal contains a number of safeguards that will ensure adequate development of sufficient data to make a determination on the larger-scale (entire saltcedar range) in the future and minimize any potential impacts from this experimental release on the endangered southwestern willow flycatcher (*Empidonax trailii extimus*). Measures such as detailed monitoring of the impacts of the insects on saltcedar as well as on native vegetation, geographical isolation of release sites, and distance from any flycatchers occupying saltcedar stands (at least 200 miles) were incorporated into your proposal.

The Service has considered all of the available information regarding the host specificity of these two insects, the potential impacts to the flycatcher, and the monitoring protocols included in your proposal and concurs with your conclusion that this proposed experimental release will not adversely affect the southwestern willow flycatcher.

We appreciate your conscientious efforts to accommodate the Service's concerns and recommendations in the development of this proposal and we look forward to continue working with you in the development of the large-scale biological control program on saltcedar. The potential for the ultimate recovery of not only the flycatcher, but of our western riparian ecosystems will depend in grand part to our combined efforts to control saltcedar and provide for the reestablishment of native riparian species. If you have any questions please feel to contact the Division of Endangered Species (Attention: E. LaVerne Smith or Jim Kraus 703/358-2171).

Sincerely,

ASSISTANT DIRECTOR

Appendix 5: Amendment to letter of concurrence, U. S. Fish & Wildlife Service.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington, D.C. 20240

U.S. Department of the Interior 1849•1999

In Reply Refer To:
FWS/DTE

JUN - 3 1999

RECEIVED 6-24-99

Dr. Carl Bausch
Deputy Director
Environmental Analysis and Documentation
Policy and Program Development/APHIS
4700 River Road
Riverdale, Maryland 20737

Dear Dr. Bausch:

This is to amend our concurrence letter of December 28, 1998, with regard to Dr. Jack DeLoach's proposed experimental release of biological control agents on saltcedar. The December 1998 letter concurred with a "may affect, not likely to adversely affect" finding for the southwestern willow flycatcher *(Empidonax traillii extimus)*, listed as endangered under the Endangered Species Act of 1973, as amended. This amendment to the December 1998 letter is based on new information about the southwestern willow flycatcher and other species that was brought to this office's attention after the December concurrence had been completed. Since then, discussions have been held to review these issues within the Fish and Wildlife Service and between the Service and USDA staff. These discussions culminated in a meeting of APHIS, ARS, the Service and other parties involved in the study that was held on May 13, 1999. The Service appreciates the cooperation of all parties involved in addressing this new information.

Although the Service recognizes the need for control of saltcedar, the discussions regarding new information on the flycatcher focused on the recent discovery of flycatchers nesting in saltcedar near the Rio Grande in New Mexico, and the possible need for restoration following control of saltcedar in certain areas. Specific areas of concern are those where establishment of native riparian vegetation may be precluded as a result of land and water management that has lowered water tables, increased salinities, reduced winter/spring flooding and allowed livestock grazing. These are of particular concern in the southwestern U.S. With regard to flycatchers nesting in saltcedar, the Service is concerned that the nests of these severely endangered birds may be affected by saltcedar control via temperature increases and/or increased cowbird predation. Other concerns include host specificity of the control agents, control agents moving along riparian corridors faster than anticipated, release of control agents from cages prior to their planned release (Stage B), and lack of an adequate wildlife monitoring plan.

At the May 13 meeting, the Service was convinced by researchers that extensive host specificity testing has been undertaken by USDA, not only with regard to phylogenetic relatedness, but also on a wide range of native and agricultural plants with which the control agents might come in contact. In addition, the researchers made a convincing argument that distance and geographic barriers (large contiguous areas without saltcedar occurring) will be effective as a means of keeping the control agents from the sites on the Lower Colorado River in Arizona and the Rio Grande in New Mexico where flycatchers are nesting in saltcedar. Research on the control agents in their native habitats and in laboratories, in addition to monitoring of related insects used to control other invasive species, indicates that they should move on the order of tens of feet per year. Although we cannot be certain that this will be the case in every area for this species, the anticipated slow movement of the agents, coupled with their host specificity and the geographic barriers, will greatly limit the chance of their reaching the Arizona and New Mexico sites, which are located hundreds of miles from any release sites. However, to assure that there are not unanticipated consequences on the site in New Mexico where flycatchers are nesting in saltcedar, the researchers did agree that all sites on the Rio Grande (sites 1, 3, 4, 5, and 6, at Laredo, TX; Big Bend National Park, TX; Artesia-Bitter Lake National Wildlife Refuge, NM; Holloman Air Force Base, NM, and Bosque Del Apache NWR, NM respectively) would be removed from consideration in this consultation. For consideration of these and any additional sites, a separate consultation will need to be initiated.

The Service has now undertaken a thorough review of the proposed experimental release (Phase I - Stages A and B) of saltcedar biocontrol agents and agrees, given certain conditions, that this action is not likely to adversely affect the southwestern willow flycatcher or any other listed species. These conditions are as follows: 1) Sites 1, 3, 4, 5, and 6 (as specified above) will be dropped from the project; 2) control agents will not be released outside of the cages during Stage A in the case that numbers grow too large inside the cages as mentioned in the environmental assessment; 3) release of the control agents from cages at the release site (Stage B) will not be undertaken until vegetation and wildlife monitoring plans are completed; and 4) a new consultation will be initiated before Phase II, general release of the control agents, occurs.

We appreciate the patience of APHIS, ARS and other researchers on this project while we re-examined its effect on listed species. We also commend them on working to control this invasive species, which has significantly diminished the ecological value of fish and wildlife habitat in many areas of the western United States, particularly in riparian ecosystems.

If you have any questions, please feel free to contact me at 202/208-4646, or Rick Sayers, Division of Endangered Species, at 703/358-2106.

Sincerely,

GARY D. FRAZER

Assistant Director
Ecological Services

Appendix 6: Plants used for host-range testing of *Diorhabda elongata* at Temple, Texas.

Taxonomy[1]	Location Collected
A. Plants most closely related to *Tamarix*:	
ORDER VIOLALES	
Tamaricaceae from U.S.[2]	
Tamarix aphylla	AZ, Colorado River N of Yuma
Tamarix aphylla	S-TX, Uvalde
Tamarix canariensis	SE-TX, Texas City, Dollar Point
Tamarix canariensis	SW-LA, Cameron Parish
Tamarix canariensis	TX, Galveston
Tamarix gallica	S-TX, Boca Chica
Tamarix parviflora	Cent.-TX, Crawford
Tamarix ramosissima	AZ, Gila River nr. Liberty
Tamarix ramosissima	AZ, Colorado River N of Yuma
Tamarix ramosissima	CA, Bear Creek
Tamarix ramosissima	CA, San Luis Rey River at I-15
Tamarix ramosissima	KS, Cedar Bluff Reservoir
Tamarix ramosissima	NM, Pecos River nr. Artesia
Tamarix ramosissima	W-TX, Pecos River at I-10
Tamarix ramosissima	WY, Big Horn River
Tamaricaceae from China	
Tamarix austromongolica	CHINA, Inner Mongolia, Hohhot
Tamarix chinensis	CHINA, Cangzhou Prov.,
Tamarix ramosissima	CHINA, Xinjiang Prov., Turpan,
Myricaria soongorica	CHINA, Inner Mongolia, Ta Qing Mt.
Frankeniaceae	
Frankenia jamesii	W-TX, Hwy 180 nr. Salt Flat
Frankenia johnstonii	S-TX, nr. Zapata
B. Other families of Violales closely related to *Tamarix*:	
Flacourtiaceae	
Flacourtia indica (governor's plum)	FL, nursery (Old World tropical)
Xylosma flexuosa (brush-holly)	TX, Weslaco
Bixaceae	
Bixa orellana (annatto)	FL, nursery (tropical America)
Amoreuxia wrightii (yellowshow)	S-TX, nr. Roma
Cistaceae	
Lechea tenuifolia (pinweed)	TX, nr. Caldwell
Turneraceae	
Turnera diffusa (damiana)	S-TX, nr. Rio Grande City
Fouquieriaceae	
Fouquiera splendens (ocotillo)	S-CA, nr. Imperial
C. Other Violales and various groups more distantly related to *Tamarix*:	
Violaceae	
Viola missouriensis (violet)	Cent.-TX, Temple
Passifloraceae	
Passiflora incarnata (maypop)	Cent.-TX, Temple

[1] Taxonomy according to Cronquist (1981).

[2] Specimens collected at the sites where the U.S. *Tamarix* accessions were obtained were identified as above by Dr. Bernard Baum and Dr. William Crins.

Taxonomy	Location Collected
C. Other Violales and various groups more distantly related to *Tamarix* (cont.):	
Caricaceae	
Carica papaya (papaya)	TX, nursery
Curcurbitaceae	
Cucurbita pepo (squash)	seeds
Cucumis sativus (cucumber)	seeds
Begoniaceae	
Begonia rex (begonia)	nursery
Loasaceae	
Cevallia sinuata (stinging cevallia)	S-TX, nr. Rio Grande City
Mentzelia oligosperma (stick-leaf)	Cent.-TX, Temple
ORDER THEALES (=GUTIFFERALES and PARIETALES in part)	
Clusiaceae (=Guttiferae)	
Hypericum calycinum (rose-of-sharon)	nursery
Theaceae	
Camellia japonica (camellia)	TX, nursery
ORDER PRIMULALES	
Primulaceae	
Samolus ebracteatus	S-TX, nr. Rockport
ORDER PLUMBAGINALES (=PRIMULALES in past)	
Plumbaginaceae	
Limonium limbatum	W-TX, nr. Girvin
D. Habitat associates of *Tamarix* in the U.S.:	
ORDER FABALES	
Fabaceae	
Prosopis pubescens (screwbean mesquite)	TX
P. glandulosa var. glandulosa (honey mesquite)	Cent.-TX, Temple
P. velutina (velvet mesquite)	AZ
ORDER SALICALES	
Salicaceae	
Populus fremontii (cottonwood)	AZ, near Yuma
Salix nigra (willow)	AZ, near Yuma
ORDER ASTERALES	
Asteraceae	
Baccharis salicifolia (seepwillow)	S-TX, Nueces River
Tessaria sericea (arrowweed)	AZ, Colorado River nr. Yuma
E. Unrelated crop plants grown near proposed release areas:	
Triticum aestivum (wheat, Butte hard red spring)	CA, farm
Cucumis sativus (cucumber, Cool Breeze)	CA, farm
Lactuca sativa (lettuce, Romaine)	CA, farm
Helianthus annus (sunflower, Holiday)	CA, farm
Vitis vinifera (grape, Ruby Seedless)	CA, orchard
Juglans regia (walnut, Sinensis #5)	CA, orchard
Prunus cerasifera (plum, Myrobalan)	CA, orchard
Prunus dulcis (almond, Nonpariel)	CA, orchard

Appendix 7: Impacts of saltcedar control on wildlife value of riparian habitat.

Hypothetical net change in wildlife value of habitat as a function of three variables: level of saltcedar control, extent of revegetation, and relative habitat value[1] of the replacing vegetation.

Proportion of infested area cleared of saltcedar	Proportion of cleared area that is revegetated	Relative habitat value of replacement vegetation	Net change in value of wildlife habitat
.2	.2	2	- 12%
.2	.2	3	- 8%
.2	.5	2	0%
.2	.5	3	+ 10%
.2	.8	2	+ 12%
.2	.8	3	+ 28%
.5	.2	2	- 30%
.5	.2	3	- 20%
.5	.5	2	0%
.5	.5	3	+ 25%
.5	.8	2	+ 30%
.5	.8	3	+ 70%

[1]Value of saltcedar habitat = 1.

The table is based on the equation $\Delta w = 100\,((1-p_c + p_c p_r v) - 1)$

where:

Δw = % change in overall wildlife density compared to saltcedar
p_c = proportion of infested area cleared of saltcedar
p_r = proportion of cleared area that is revegetated
v = wildlife value of the replacement vegetation ($v_{saltcedar} = 1$)

The equation enables calculation of the net changes in the overall wildlife value of habitat in any area that initially is completely covered with saltcedar but later is at least partially cleared. The area might be, for example, a mile-long length of riverbank. The term p_c is the proportion of the total area that is cleared of saltcedar, and $1-p_c$ is, of course, the uncleared area. The term p_c is proportional to the absolute value of Δw but does not determine the sign. In other words, any degree of control may be either a benefit or a detriment to wildlife depending upon the values of p_r and v. If a large enough fraction of a cleared area is revegetated either naturally or artificially, and if the new vegetation is sufficiently superior to saltcedar in wildlife value, there will be a net benefit to wildlife even if a part of the cleared area remains barren. The table assumes two values of p_c, three values of p_r, and two values of v. Benefits to wildlife are greatest (+70%) when the level of control is relatively high (p_c = .5), a high proportion of the cleared area is revegetated (p_r = .8), and the new vegetation is greatly superior to saltcedar in wildlife value (v = 3). The adverse effects on wildlife (-30%) are greatest when the level of control is relatively high (p_c = .5), a low proportion of the cleared area is revegetated (p_r = .2), and the new vegetation is moderately superior to saltcedar in wildlife value (v = 2). Other values of v are intermediate between the extremes of -30% and +70%. Given the assumed values of p_r and v, six combinations of parameters produce a benefit to wildlife, four combinations produce an adverse effect, and two produce no effect on wildlife. The expected benefit (i.e., the sum of all values of v divided by the number of values) is relatively small at +8.8%.

As all models, the equation is only an approximation of the real world. The equation assumes an initial level of infestation (i.e., 100%) in a given area but does not take into account several important considerations:

--Increases in the total infested area and the ecological consequences. Actually, of course, the total infested area is increasing, and as noted in the text some of the newly infested areas are ecologically precious, pristine desert habitat.

--Increased availability of surface water. The equation assumes that all benefits (or detriments) to wildlife derive from the quantity and quality of the replacement vegetation. However, as indicated in the text, saltcedar control may make more surface water available to bighorn sheep and some other wildlife. Any replacement vegetation that diminishes surface water would actually be detrimental in this respect.

--Adverse effects of regular fires on wildlife populations. In some areas raging fires sweep saltcedar stands every few years destroying all wildlife that cannot escape.

Appendix 8: Monitoring plans (from DeLoach and Gould 1998, pp. 18-22).

1. *Research Phase.*

a. *Stage A: Release in Field Cages.*

During the first field season, while the control insects still are confined in field cages, monitoring will concentrate on the survival, reproduction and establishment of the control insects. Monitoring will be conducted at least weekly during the first generation after release (1 to 2 months depending on temperature at the site), at least monthly during the remainder of the first growing season, and weekly again during the following spring to record the date of emergence from overwintering quarters and of beginning feeding and reproduction. Factors to be monitored include the numbers of each life stage of the control insect present per sampling unit, amount and location of feeding on the plant, mating and oviposition, behavior of each stage, successful overwintering, number of generations, population increase, mortality factors, any disturbance to the cages, and weather conditions (temperature, rainfall, wetness of the soil or accumulation of water on the soil surface).

b. *Stage B: Field Release within the Circumscribed Sites.*

During this stage of the Research Phase, the released insects will be intensively monitored to determine their rate of increase and mortality factors (attack by native predators, parasitoids, or pathogens): amount and type of damage and rapidity of control of saltcedar: amount of feeding, reproduction on and damage (if any) to non-target plants: and rate of dispersion. The recovery of native vegetation and of wildlife after control will be monitored at the original sites for at least 5 years. Baseline aerial photography as developed by the ARS Remote Sensing Laboratory, Weslaco, TX will be obtained of each release site at least by the beginning of Stage B and repeated periodically as needed to document the progression of saltcedar control at each site.

A. *Goals of Monitoring.*

In order for the saltcedar biocontrol project to progress to areas outside the initial 13 Research Release Sites, we must demonstrate that insect population growth and dispersal occur relatively slowly, and that future releases will not likely adversely impact threatened or endangered species. We will do this by intensively monitoring insect population growth, dispersal, feeding and impact on saltcedar both inside cages (Stage 1) and outside cages (Stage 2).

Once the consortium concurs that the leaf beetle and the mealybug can be safely released outside the initial 13 sites, we will enter the Implementation Phase. Additional field insectaries may be established to provide insects for releasing at other sites, and it will probably be necessary to establish more "research" sites where intensive monitoring of insects, vegetation, and wildlife will occur. In addition, we will have taken baseline data on native vegetation and wildlife at the initial Research Release Sites and plan to follow changes in these parameters for approximately 10 years. Our hypothesis is that the insects will remove saltcedar from a site very slowly (over 5-10 years), allowing for gradual reestablishment of native plants and wildlife species. The goal of monitoring at the initial Research Sites and during the Implementation phase will be to test these hypotheses, as well as to use information about project success to guide future natural enemy releases.

The specific goals of the monitoring conducted during the different phases of the biocontrol project are as follows:

1. ***Research Phase - Stage 1 (in field cages):*** Determine if the biocontrol agents can survive and reproduce under local climatic conditions and the amount of feeding and damage the insects cause to saltcedar inside cages.

2. ***Research Phase - Stage 2 (after release from field cages):*** Determine the rate and method of insect dispersal, measure reproduction and population growth of insect populations, determine consumption of and damage to saltcedar, measure damage to non-target vegetation (if any), measure effect of saltcedar control on return of native vegetation, measure effect of saltcedar biocontrol on wildlife populations.

3. ***Implementation Phase 1 - Additional Research Sites and/or Field Insectaries outside boundaries of Research Release Sites:*** Intensive monitoring like that conducted during the Research Phase - Stage 2.

4. ***Implementation Phase 2 - Control Throughout Area:*** Monitor the establishment and population growth of insect populations and their impacts on saltcedar and native vegetation.

In addition to monitoring vegetation and wildlife at release sites, we will institute the same monitoring plan at nearby non-release (control) sites. Control locations will most desirably be on the same waterway or riparian area. Monitoring a control location will allow us to attribute changes in vegetation and wildlife use to the biocontrol program. As the biocontrol agents move into the control areas, we will have areas with extensive pre-"release" data and we can then monitor the changes that occur as the natural enemies begin to feed on saltcedar.

B. *Questions to be Addressed by Monitoring.*

1. *Insects.*

a. ***Reproduction and Population Growth:*** Can the released biocontrol agents survive and reproduce at the release site?

b. ***Feeding on Saltcedar: Do the released biocontrol agents feed on saltcedar?*** If they do, how much do they consume and how does their presence affect the vigor of the saltcedar?

c. ***Feeding on Native Vegetation: Do the released biocontrol agents feed on and significantly damage any native plants?***

d. ***Dispersal Capabilities:*** How far and how quickly do the biocontrol agents disperse after release? What is the mode of dispersal?

e. ***Mortality Factors:*** Is there any evidence of predation (ants, birds, lady beetles, etc.) parasitism, and disease affecting the released biocontrol organisms.

2. ***Saltcedar.***

a. ***Reproduction:*** Is the recruitment of saltcedar seedlings reduced after the biocontrol agents become established?

b. ***Change in Density over time:*** Does the canopy cover provided by saltcedar or the density (number of plants per unit area) of different size or age categories of plants decline after the establishment of the biocontrol agents?

3. ***Native Vegetation.***

a. ***Reproduction:*** Is the survival of existing plants and/or transplants or the recruitment of seedlings enhanced by the removal of saltcedar by the biocontrol agents?

b. ***Change in Density over time:*** Does canopy cover or density of different age classes of non-*Tamarix* plants increase after the establishment of the biocontrol agents?

4. ***Use of Habitat by Wildlife:*** Does the relative abundance of individual species and/or species diversity of reptiles and amphibians, fish, birds, and mammals increase after saltcedar is removed by biocontrol agents?

5. ***Soil Salinity:*** Does the soil salinity decline after saltcedar is removed by biocontrol agents?

6. ***Water Table Levels:*** Does the water table level rise after the removal of saltcedar by biocontrol agents.

The following table specifies which of the questions listed will be monitored during the research and implementation phases:

	Research Phase		Implementation Phase		
	Stage 1	Stage 2	Additional Insectaries/ Research Sites	Control Sites	Control Throughout Area
1a	X	X	X	X	X
1b	X	X	X	X	
1c		X	X	X	
1d		X	X	X	
1e		X	X	X	
2a		X	X	X	X
2b		X	X	X	X
3a		X	X	X	X
3b		X	X	X	X
4		X	X	X	
5		X	X	X	
6		X	X	X	

C. ***Development of a Monitoring Protocol.***

The specific monitoring protocol will be developed by a committee of scientific experts in the fields of entomology, botany, and wildlife studies (herpetology, ichthyology, mammology, ornithology). USDA-ARS and USDA-APHIS will take the lead on assembling the committee, planning meetings, and producing the manual. Committee members will be employed by several agencies including USDA-ARS, USDA-APHIS, USDI-FWS, USDI-USGS, state governments, and universities. The protocol will be written and approved by FWS prior to any open field releases (Research Phase - Stage 2). Information from the Research Releases (Stage 1) will give the entomologists valuable information on how to effectively sample the insect species, whose biology in the field is not well known.

Data on insects, vegetation (saltcedar and native plants), and wildlife will be collected along transects (the same transects for all organisms). Soil salinity and water table depth (if feasible) will be measured close to the release site. The distance between samples and the total number of samples along the transect will differ for the various organisms depending on their biology and distribution. Also, the frequency of sampling will vary among organisms. For instance, insects will be monitored intensively at first, with more intensive sampling for vegetation and changes in wildlife use coming later after the biocontrol agents have time to exert an effect.

D. *Implementation of Monitoring.*

At each local Research Release Site, local participants must sign an MOU agreeing to ensure that the monitoring plan will be followed. They must also agree to monitor a nearby non-release (control) site so that effects on vegetation and wildlife can be attributed to the biological control project. In cooperation with ARS and APHIS, technical personnel qualified to carry out the monitoring plan will be identified before releases are conducted. Insects will, in most cases, be monitored by ARS, APHIS, or university scientists. The USGS (Biological Resources Division) and FWS will be the lead agencies for monitoring plant and animal communities.

FINDING OF NO SIGNIFICANT IMPACT

The United States Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine has prepared an environmental assessment (EA) in response to an application for a permit to release *Diorhabda elongata* in the United States. This nonindigenous leaf beetle is potentially useful for the biological control of deciduous saltcedar, *Tamarix ?ramossissima* and *T. parviflora* (Tamaricaceae), an important weed of water courses and riparian habitats in 15 western states. Releases of *D. elongata* are expected to have no significant impact on environmental quality. This finding is based on the following considerations:

--evidence from all available sources (field surveys in China, the native land of *D. elongata*; host records in the scientific literature; records of the world distributions of the host plant and its relatives; laboratory tests of host specificity) indicated that *D. elongata* is specific to a few members of the family Tamaricaceae.

--The target weed, saltcedar, is unrelated at the family level to any plants native to the United States.

--No nontarget species of Tamaricaceae are commercially important.

--*D. elongata* has not been reported to cause adverse environmental effects in its native home, China.

--The U. S. Fish & Wildlife Service (FWS) has concurred with this finding of no significant impact, indicating that the *Diorhabda* beetle is not expected to cause adverse impacts to federally listed threatened and endangered species. (Mitigation measures requested by FWS are described in the EA, and the measures will be attached as conditions of the release permit.)

--Although the biological control of saltcedar might reduce wildife populations locally, it is expected that these losses will be offset either by increases in wildife populations after native plant communities are re-established or by the maintance of wildlife populations in pristine natural habitats that, in the absence of effective biological control, would be invaded by saltcedar.

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